ALIMENTARY AND MEDICINAL PLANTS IN FUNCTIONAL NUTRITION

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The book describes alimentary, spice and medicinal plants used in the production of functional nutrition products. The authors present characteristics of mononutrients, their influence on toxicity and their possible effects when used in food products. Written for a wide range of specialists, nutrition scientists, professors, graduate students and university students.
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Scientists state that most of the so-called civilization diseases – cardiovascular problems, diabetes, allergy, anemia, and metabolic dysfunctions – are alimentary dependent (related to nutrition) and can be controlled with the use of special food products that have specific physiological effects – antiseptic, antioxidant, controlling and renewing the body systems, immunomodulating, etc. According to the statistics of the European Union, a person consumes over 1 ton of food per year.

Food composition has a great influence on the human body. Depending on its quality and harmlessness food can be the source of both – health and disease, for, as we know, the consumed elements have effect on every cell and organ of the human body. During the last years, lots of people (especially from poor regions) constantly expose their health to risks caused by their habitat and malnutrition.

Fast scientific and technological development, pollution and urbanization during the last century have played their crucial part in man’s nutrition. The everyday diet of every person has become richer in gustatory senses but less balanced in its composition.

The life of a modern person is closely connected to the technical progress, the decrease of physical activity, and increase of stress. These factors lead to low power inputs and logically cause food consumption to decrease. At the same time the amount of necessary micronutrients (vitamins, minerals and biologically active elements) maintains the same level as before but can’t be provided by the consumed food. In this situation quantity and quality of food products, their nutrition facts play the most important part.

Many factors have negative impact on the nation’s health and most of them are connected with micronutrient deficit (i.e. lack of vitamins, microelements, polyunsaturated fatty acids) that causes dysfunction of antioxidant systems of the body, development of immune deficiency and as a result – a sharp decrease of body resistance to the unfriendly elements of the environment.

Most important nutrition dysfunctions:

− Vitamins deficit; especially of vitamin C (deficit noted among 80-90% of population), 40-80% of population suffers from vitamin $B_1$, $B_2$, $B_6$, and folic acid deficit, more than 40% have carotene deficit, etc. Vitamin deficit can mean a simultaneous lack of vitamins C, group B and carotene, which is called polyhypoavitaminosis. This negative factor is all-season and can be found among any social group in any region.

− Mineral deficit (calcium, ferrum)

− Microelements deficit (selenium, zinc, iodium, fluorine). Everyone one is familiar with the problem of iodium deficit that causes serious diseases (goiter, cretinoid idiocy, etc.).

− Dietary fiber deficit

− The necessity to produce dietary fiber and enriched food products is closely related to the increase of man’s consumption of refined food. The scietists
have calculated that the diet of a modern person contains only 15-20 grams of dietary fibers with the necessary daily norm being 40-70 grams.

Dietary fiber is a complex polysaccharide, consisting of cellulose, hemicellulose, pectin and lignin, and associated proteins, phenol compounds, etc. Its general feature is poor digestibility in the initial parts of the man’s digestive tract and destruction in the colon.

Lack of dietary fiber in the diet leads to a decrease on the resistance of human organism to the environmental stress. With the deterioration of environmental conditions on Earth, food is being contaminated with toxic substances, and their discharge from the human digestive tract to some extent depends on the amount of dietary fiber in the consumed food. However, the development of physical inactivity, in turn, leads to the deterioration of the motor activity of the human intestine.

Scientists have found a direct correlation between the lack of dietary fiber in human diet in developed countries and the active development of a number of certain diseases, such as:

− obesity, bowel disease, diabetes, atherosclerosis, coronary heart disease, etc. One way to combat these diseases is by consuming food rich with dietary fiber;
− excessive consumption of animal fats;
− deficit of polyunsaturated fatty acids;
− deficit of high-grade (animal) proteins.

The daily diet of a modern human should include about 80 grams of protein with a complete set of essential amino acids, 75 g. of fat, including unsaturated fatty acids, 300-320 g. of carbohydrates, 2.5 liters of water, 12 g. of sodium chloride, potassium, calcium, phosphorus, sulfur, and vitamins and minerals not exceeding a total of 0.5 grams.

Proteins are one of the main components of human food. In the stomach, proteins are broken down into amino acids, which are then absorbed by the blood and used by the body to build its own protein molecules. Plants, yeast and bacteria are able to synthesize all the amino acids needed to build protein molecules.

However, humans and some animals are able to synthesize only part of the 20 amino acids, whereas the rest is to be consumed with food. These amino acids are considered to be essential. Such acids include valine, histidine, isoleucine, lysine, methionine, cystine, leucine, phenylalanine, tyrosine, tryptophan, threonine. Although the human diet usually contains a high proportion of animal products, constant use of animal protein does not always have a positive effect on human health. With proteins the body receives a significant amount of saturated fatty acids, which may lead to metabolic disorders and, consequently, to obesity, various diseases of the cardiovascular, digestive and other systems.

Poor health may also be caused by both malnutrition and hypernutrition. Thus, the main disease of the civilized world is now considered to be obesity and serious illnesses such as diabetes that are provoked by obesity.
According to the modern conception of balanced diet it should provide a balance between the consumption and expenditure of human and supply the body with necessary organic and inorganic nutrients.

Taking into consideration the fact that the expenditure of energy by modern people has declined significantly due to objective reasons, man’s demand for energy derived from food has also decreased. That is today it is not possible to cover the existing deficit of certain nutrients from a normal diet, even when it is adequate. This fact became the main motivation for the creation and development of a new group of products, defined as healthy food or functional nutrition.

Today the main goal that would help improve the structure of the population’s nutrition is to increase the amount of consumer products with high nutritional and biological value, including products enriched with protein, vitamins and minerals.

A modern person has about 10^14 functioning cells that are constantly in need of essential nutrients that the body cannot synthesize itself.

The human body constantly contains more than 10 trillions of cells. Every 70 billion of cells die and the body requires additional expenditures of biologically active substances to substitute them.

Minimum life expectancy of some human cells is 1-2 days. Cells of the intestinal epithelium and an average of 2 billion of red blood cells die every day. At the same time all body cells experience an intensive update of elements and structures. All cells in the human body are functionally integrated in metabolic and regulatory processes. Their constant internal upgrade ensures the reliability of the organs and systems of our multicellular body.

Insufficient amount and the lack of some essential biologically active substances cause a dysfunction of biochemical reactions and functional processes. As a result, irreversible and reversible changes happen and lead to certain diseases and disorders.

Scientists note that a human diet should contain more than 600 different elements (nutrients) and should provide us not only with energy, major nutrients, macro- and micronutrients, but also with a number of non-food components.

Food is a source of proteins, carbohydrates, fats, vitamins, minerals, dietary fiber, etc. A special role in the body is played by essential nutrients. They include 10 essential amino acids, more than 15 vitamins and their precursors, and about 20 mineral elements.

A person becomes ill not only when their body lacks some essential nutrients, but also when consuming alien and toxic substances. Food products that contain harmful ingredients may cause significant risk to human health.

Well-balanced food products are the main source of defense reactions of the human body and its activity. One should bear in mind that unfriendly environment can contribute to a significant increase of consumption of essential amino acids, vitamins and minerals supposed to detoxify the body. This leads to an increase of their deficits and requires an addition of natural complexes of amino acids, vitamins and minerals to the diet. This fact is not always taken into account by the social and
health services.

It should be borne in mind that the current processes of food production and creation of long-term storage conditions have also led a reduction of the consumption of active ingredients consumed with food. Therefore, the most promising way to eliminate micronutrient deficiency is considered to be the artificial enrichment of food.

As part of the concept of optimal nutrition a new direction in science has been created - functional nutrition, which includes the development of theoretical foundations of food production, sale and consumption of functional foods. Functional foods sector is the most convenient and natural form of introduction and enrichment of the human body with micronutrients, including vitamins, minerals, microelements and other components.

Therefore, it is impossible to overcome the negative tendencies of health indicators by declaring the principles of healthy lifestyle and optimizing the nutritional status of the population only by means of propaganda, advertising and market development.

Modern food must not only meet the physiological needs of a man in nutrients, but also carry out preventive and curative functions.

The extensive international experience demonstrates that the most effective and affordable way to enhance public micronutrient availability on a national scale is further enrichment of food products of massive consumption to a level corresponding to the physiological needs of a human. In most countries of the world this purpose is reached by enriching flour, bread and pasta, soft drinks, milk and dairy products with vitamins, minerals and trace elements.

The idea of vitamins addition to food was first introduced in Russia in 1934. At the same time, the first pilot plant for production of vitamin C concentrate from spruce needles was opened – it was planned to add the concentrate to pastries and canned fruits. However, with the smell of pine needles did well with sweets, jams and other products. Later vitamin C for the confectionery industry was made of rose hips and black currant. In 1939 Professor of vitaminology Efremov persuaded the government to enrich flour. This idea was immediately taken over by the USA. During the Second World War, the U.S. Senate passed a law on mandatory vitaminization of bread with vitamins. Originally the plan was simply to restore the amount of vitamins in whole grains, replenishing the amount lost during purification. Later it was decided to enrich other products.

Today, all the developed countries are experiencing a boom in nutritional foods. The highest level of consumption of organic products is noted in Japan. Experts estimate the Japanese healthy food market in the $7 billion. A little less is the value of the US market - around $5 billion.

Someone may ask: why is necessary to vitaminize food, if you can buy vitamins at any store? The problem is that multivitamin therapy does not solve the problem of massive vitamin deficit. Not everyone can afford to buy expensive multivitamins, other people do not think about them, and some just do not have the patience to take multivitamin pills every day, year after year. The government can
provide almost the entire population with the missing micronutrients by enriching the most important and popular products - bread, milk, canned food, sweets, baby food, etc. Enrichment of food products with vitamins is important also due to the fact that with they can help lessen the vitamin deficit among those people are allergic to food colors and flavors. In addition, the vitamins from food products come into our bodies in the usual physiological way - with food and evenly. Person can’t have an overdose of vitamins that come with fortified foods - the safe doses of micronutrients are so large that even if you eat three or four portions of enriched food, nothing bad will happen.

The concept of state policy of healthy nutrition of the population of EU also defines the strategy for achieving the government’s priorities: building a legislative and judicial base, regulating prices, taxes and customs, scientific justification of new technologies for processing raw materials and food production, increased state control of healthy food production, including fortified products and proteins made from non-traditional sources, dietary supplements for pregnant women, nutrition for healthy and sick children, creation of professional and educational programs in healthy nutrition at different levels and for various audiences, constant monitoring of nutrition and public health, safety and quality of raw food materials and food products.

In recent years the attention to nutrition issues on the part of medical science and practice has increased greatly due to the understanding of the negative health effects that are connected with the violation of diets and nutritional status of the population on the one hand, and the success of a number of fundamental sciences (i.e. biochemistry, cell biology and threpsology), which help to identify the role of separate macro- and micronutrients and non-food bioactive nutritional components in the functioning of human organs and systems, and the lowering risk for the development of some alimentary-based diseases - on the other.

The people’s concept of food has also changed – the formula “Achieving good health via nutrition” has strengthened in the minds. Modern people understand that food is needed not only to provide them with nutrients and energy, but can have also direct effect on the body increasing resistance to adverse environmental factors, reducing the risk of cardiovascular, oncological and other diseases, eventually extending the active period of human life and the total duration of his life.

Therefore, a book containing information about the chemical contents, pharmaceutical effects of aromatic and medicinal fruits and plants and the rules of their storage would be very helpful to employees of food companies that produce food products using herbs and berries.
The medical purposes of using medicinal herbs are mainly aimed at preventing or treating various diseases: 1 out of 3 therapeutic drugs is produced from plants or with the addition of plant components. The results of an ethnobotanical research state that about 800 species of plants worldwide (300 [1, 2, 3, 4, 5] of which are being experimentally studied) can be used as antidiabetic agents. Medical drugs that are used in treatment of certain serious diseases are often produced from plant components. For example, drugs treating severe cardiovascular diseases by 77% consist of plant components, drugs that treat liver diseases and problems with the gastrointestinal tract - by 74%, medicine used for the treatment of the respiratory tract - 73%, etc. [6].

Infusions of sage and chamomile are widely used to prevent mouth and throat infections. In this regard it happens to be interesting to find out how justified is the use of infusions of herbs for treating inflammatory diseases. Belarusian scientists studied the influence of a number of herbal extracts on the pathogens.

The objects of study were aqueous extracts of dried herbs: basil, lemon balm, peppermint, chamomile, savory, sage, echinacea, lemongrass fruits and rose hips.

The objects of study were aqueous extracts of dried herbs: basil, lemon balm, peppermint, chamomile, savory, sage, echinacea, lemongrass fruits and rose hips.

Table 1
Impact of herb extracts on microorganisms

<table>
<thead>
<tr>
<th>Name of plant</th>
<th>Quantity of microorganisms, CFU/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>Control group</td>
<td>(4.0±0.3)×10⁸</td>
</tr>
<tr>
<td>Basil</td>
<td>(3.4±0.2)×10⁸</td>
</tr>
<tr>
<td>Lemongrass</td>
<td>(3.7±0.3)×10⁸</td>
</tr>
<tr>
<td>Lemon balm</td>
<td>(2.1±0.2)×10⁸</td>
</tr>
<tr>
<td>Peppermint</td>
<td>(3.0±0.2)×10⁸</td>
</tr>
<tr>
<td>Chamomile</td>
<td>(3.4±0.3)×10⁸</td>
</tr>
<tr>
<td>Savory</td>
<td>(1.0±0.1)×10⁸</td>
</tr>
<tr>
<td>Sage</td>
<td>(2.0±0.1)×10⁷</td>
</tr>
<tr>
<td>Rose hips</td>
<td>(3.5±0.2)×10⁸</td>
</tr>
<tr>
<td>Echinacea</td>
<td>(3.7±0.4)×10⁸</td>
</tr>
</tbody>
</table>

The results of microbiological studies (Table 1) suggest that the coccal and rod-shaped microfloras are sensitive to the studied extracts of plants. Coccal flora,
according to a decrease in the number of microorganisms in the experiments compared to the control of \((4 \cdot 10^8)\) to \((2 \times 10^7) \div (3.7 \times 10^7)\) CFU/cm\(^3\) is less sensitive to the extracts than the rod-shaped. There was a decrease in the amount of *Escherichia coli* bacteria with \(1.0 \times 10^9\) in the control to the \((5.0–8.5) \times 10^8\) CFU/cm\(^3\) in the experiment, and the *Salmonella typhimurium* bacteria - from \(7.0 \times 10^8\) in the control group to \((1.0–4.0) \times 10^8\) CFU/cm\(^3\) in the experiment.

Extracts of lemongrass, lemon balm, savory, sage and echinacea significantly inhibited the growth of the studied bacteria. The rose hips extract had almost no inhibitory effect on the tested microorganisms. The sage extract caused inhibition growth of the test organisms, which may be due to the presence of a wide range of biologically active substances in the extract.

However, the interest in plants is due not only to their therapeutic effect. There has recently been a great increase of interest in the use of aromatic and medicinal plants, fruits and berries in food production. Functional nutrition can play an important role in the process of achieving these goals.

Functional food products are those that are to be systematically consumed by all population groups, preserving and improving health and reducing the risk of the development of diet-related (nutritional) diseases due to the physiologically functional ingredients present in their composition [7, 8]. Functional food production technologies are based on modifications of traditional ingredients that provide an increase of the amount of mineral components in the food to a level correlating with the physiological needs or reduce the toxic effect of their components.

### Apricot (*Armeniaca vulgaris Lam.*)

**Botanical characteristics.** A small tree or shrub with grayish-brown cracked bark and egg-form acute serrulate leaves of the Rosaceae family (*Rosaceae*). Its height is around 3.8 m. The flowers are white or pink with many stamens and one pistil. The fruits are orange, aromatic succulent drupes with an oval-lanceolate seed separating from the flesh. The seeds are flat, light brown, sweet or bitter.

**Geographic range.** The wild form is found in the Far East and the Caucasus, Central Asia.

**Chemical composition.** The fruits contain a large amount of ascorbic acid, vitamin B, F, provitamin A, which makes the flesh of the fruit orange. In addition, the fruits contain iron, silver, carotene, sugar, inulin, a large amount of citric and tartaric acids (the amount of malic acid is minor) as well as flavonoids - quercetin, isoquercitrin, etc. The fruits contain tannin, starch and a considerable amount of mineral salts. The amount of sugar in dried apricots reaches 80-85%, so they have a great nutritional and medicinal value. The seeds contain vitamin B\(_15\), and up to 76% of fatty oil. The glycoside amygdalin gives the apricot seeds a bitter taste.

**Pharmacological properties.** Fruits are used to treat anemia, hypovitaminosis, avitaminosis, cardio-vascular diseases. The therapeutic value of apricot fruit is due to a high content of vitamins, carotene, lycopene, microelements and mineral
salts. Fresh apricots are widely used in diets. Dried apricots, apricot juice are effective for pregnant women and patients with cardiovascular diseases.

Application. Fruits can be eaten fresh; they are tasty, and characterized by high nutritive value and nice flavor. They can be also subjected to different treatments - dried, processed to juice, canned, used in making jams and compotes; 3/4 of a cup of apricot juice is enough to meet the daily needs of people in the ascorbic acid. Dried apricots are especially popular and are widely used in diets.

Apricots are used to prepare various alcoholic and soft drinks. Apricot wine is rather tasty, though sluggish and low flavored. There are spirits on the basis of apricots and brandy, or apricots, soaked in alcohol. Apricots positively influence the organoleptic ratings of beverages giving them a light aldehydless (almond) flavor. However, half-finished apricot seed should be prepared using fermentation [9].

Ordinary calamus, marsh calamus (Acorus calamus L.)

Botanical characteristics. A perennial herb of the Araceae family (Araceae), with a thick rhizome, up to 3 cm in diameter. The rhizome is creeping, branched, somewhat flattened, with numerous thin, threadlike roots. The rhizome is brown on the outside, covered with the remains of leaf sheaths, the inside is white with a pink tinge. The leaves are alternate, gathered at the ends of individual beams branching rhizomes, two-rowed, bright-green, narrowly linear, sword-shaped, up to 60-120 cm in length. The stem is erect, unbranched, green, grooved on one side, with a sharp edge on the opposite, flattened, and bearing a thick fleshy inflorescence - the spadix. The covering leaf, similar to the rest, being a continuation of the stem with the length of 50 cm. comes close to the inflorescence, directed obliquely upward. The stem and the covering leaf are about the same length as the leaves. The spadix is cylindrically conical, 4-12 cm long, completely seated with small, greenish, teli-anthus flowers. The perianth is simple, sixtional, with a slightly inward curved tip. The stamens are opposite to 6 petals (the perianth), the pistil with 3 cells, a nearly hexagonal ovary and sessile stigma. The fruit is oblong, somewhat dry, many-seeded red berry. The calamus usually blossoms from late May to June.

Geographic range. Sweet flag is found in temperate to subtemperate regions of Eurasia and the Americas can be occasionally found in the Caucasus and Central Asia. It grows on the banks of rivers, lakes, ponds and marshes, sometimes forming long thickets.

Chemical composition. Rhizomes contain essential oils (4.8%) that contain α-pinene (1%), camphene (7%), camphor (8.7%), borneol (3%), eugenol, methyleugenol, kalomol, asarone (60-
70%), caryophyllene, calamene (10%), sesquiterpene, neocarone, calamendiole, calarene, proazulene, turmeric, terpene, selinene, calacarene, acorne, acorenone B, isoacorone, neoacarone, bitter glycoside of acorine, calamine, tannins, ascorbic acid (150 mg) and microelements [10]. The roots and rhizomes of calamus contain a different amount of essential oils: the amount of oils in the roots is three times larger than in the rhizomes. The leaves contain tannin and essential oils.

Pharmacological properties. The water and spirit extract of the rhizomes stimulate appetite, increase the secretion of gastric juice and improve digestion, act as a sedative, analgesic, diuretic, expectorant and a carminative element. The infusion of calamus rhizomes containing volatile elements also has antiseptic effect. E-isomer of asarone has a cholesterol-lowering action, dilates blood vessels and relieves muscle spasms. The Z-isomer of asarone has a cleansing effect on insects. These compounds have a significant sedative, hypnotic and partly analgesic effect. The Z-isomer of asarone is a convulsive element, and the E-isomer - an anti-convulsant [11].

Due to the possible embryotoxic effect calamus-containing drugs are not to be taken during pregnancy.

Application. In medicine the drugs made of calamus rhizomes are used as aromatic bitterness to excite appetite and improve digestion, as well as a tonic inhibition of the central nervous system. The substances found in the rhizomes, especially the bitter glycoside of acorine, increase taste irritation, enhance reflex separation of bile and gastric juice. Sometimes calamus is used to treat kidney disorder. The dried rhizomes of calamus are used as a spice in pastry manufacture.

Calamus rhizomes and essential oils of calamus are used to prepare liquors, beer and vinegar. Calamus rhizomes are used to improve the taste of alcoholic drinks and balsams. The infusions are aromatic, yellowish and have bitter taste. The aroma of the essential oils improves after distillation. The content of Z-asarone in food should not exceed 1 mg / kg.
Common quince (Cydonia oblonga Mill.)

Botanical characteristics. A shrub or tree from the Rosaceae family (Rosaceae) 3 m high, often found in shrub form. Young shoots and leaves are tomentose-pubescent; the leaves are ovate or broad. The flowers are solitary, white or pink, like apple blossoms. The fruit is pear-shaped, yellow. Immature fruits are tomentose-pubescent with stony cells in the pulp. There are numerous varieties of quince. Quince trees are long-living – they live for about 50-70 years, but produce plenty of fruit for 30-50 years. During storage, the fruits become softer, the content of sugars and acids increases, and the astringent taste disappears.

Geographic range. Quince grows mainly in the Caucasus, the Caspian sector of the North of Iran and in Kopet Dagh (Turkmenistan), Afghanistan. It is cultivated in many countries with subtropical and temperate-warm climate. Plantations exist in the south of European Russia, Central Asia and the Caucasus.

Chemical composition. The fruits contain organic acids, tannins, pectin, fatty oil, amygdaline, emulsin, essential oils and carbohydrates, mostly fructose and less - glucose and sucrose. Quince contains provitamin A, vitamins B1, B12, B6, C, E, PP, macro- and micronutrients. It contains 10 times much potassium than it does sodium. Quince contains malic, citric, tartronic acids and pectin elements. Homonoterpene glycoside acid has also been noted [12].

Pharmacological properties. Mucus acts as an emollient for inflammation, the extract from the seeds is sometimes used as a remedy for coughs. In some Asian countries fruits and seeds are used as a coating, expectorant, and cardio-stimulating medicine.

Application. The fruits are used mainly in a cooked form (stewed fruit, juices, jams). Quince juice is made from ripe fruit because fresh fruits give little juice. To facilitate the processing scientists recommend using enzymes. The juice has a pleasant honey aroma and a tonic, antiseptic, styptic, astringent and diuretic effect. Quince juice is recommended to people suffering from anemia, cardiovascular diseases, respiratory diseases, problems with gastro-intestinal tract and asthma.

Quince juice is usually used in blends to improve the quality of fruit wines. With the use of water and alcohol infusions of quince produces special vodka and liqueurs [9].

Acacia, locust (Robinia pseudoacacia L.)

Botanical characteristics. A tree of the legume family (Fabaceae) with the height of 25 m. Young branches and twigs are green and smooth. The leaves are alternate, odd-pinnate, up to 35 cm in length; each leaf has 11-15 separate ovate leaflets, which bloom later than others. The upper surface of the leaves is green and smooth, the lower - the gray-green and velvety. It blossoms from May to June, white fragrant flowers, gathered in drooping brushes 10-25 cm in length. It is a good honey plant that requires a lot of light and tolerates drought and has many
winter-hardy forms. Its fruit is a flat dark-brown pod with 4-6 bean-shaped seeds that get ripe in June. It has spines on the shoots.

**Geographic range.** Acacia’s homeland is North America. It is greatly valued in the steppe afforestation as a fast-growing, drought-resistant and salt-resistant plant. Grows rapidly, prefers dry, sandy soil, and doesn’t like stagnant water.

**Chemical composition.** The flowers contain essential oils with heliotropin, methyl anthranilate, esters of salicylic acid and tannins. The leaves contain flavonoids and their glycosides (acacetin, acaciin, to a lesser extent robinin), the bark of the young shoots, and partly wood contain toxic robinin, tannins, fatty oils, phytosterol and stigmasterol.

![Chemical structure of robinin](image)

**Pharmacological properties.** In medicine flowers, leaves and the bark of young shoots are used. Acacia flowers are used to treat bladder, kidney and kidney stones diseases. In European medicine black locust is used as an expectorant and an aperient, traditional medicine it is used as an expectorant, antispasmodic, diuretic and a febrifuge. An alcohol extract of the leaves and young shoots, and a decoction of the bark are used during the exacerbation of gastritis and the peptic ulcer disease. The experiments on animals demonstrated that the plant has a diuretic, hypotensive and spasmolytic effect.

When using black locust one needs to know about the toxic ingredients contained in the bark, leaves and wood of the plans, especially the highly toxic albumin and ricin, and should strictly observe the dosage recommendations for the preparation of medicine. Gathering wood can lead to poisoning, which is accompanied by malaise, nausea, vomiting, headache or drowsiness.

**Application.** Fragrant oil from the flowers is used in the perfume industry. The flowers are non-toxic and are part of the ingredients used for the production of a low-proof semisweet liqueur. Along with the flowers of the black locust the flowers of the yellow wattle are also used in the production of beverages.
**Botanical characteristics.** Galangal is a plant of the ginger family (*Zingiberaceae*). It is large; its stems can reach 1.5 m in height. The shoots with leaves (10-40 pc.) are approximately half as high. The flowers are united into a short apical spike. The rhizome is long and branchy.

**Geographic range.** In the wild galangal can be found only on the Hainan Island in China, where it was cultivated long ago as an ornamental and medicinal plant.

**Chemical composition.** The rhizomes contain flavonoids (galangin, O-metilgalangin, quercetin, D-metilquercetin, kaempferol derivatives, kaempferide, isorhamnetin, rambocitrine, 7-hydroxy-3,5-dimetoxyflavon), sesquiterpene α-cadinene, cineole terpene alcohol, tannins and resins [13]. The essential oils contain cineole, eugenol, α-pinene, cadinene, methyl cinnamate. The rhizomes contain 0.6-1.0% of essential oil, which contains methyl cinnamate, eugenol and sesquiterpenes. In addition, the rhizomes also contain curcumin, dihydrocurcumin, hexahydrocurcumin, octahydrocurcumin, ketones - derivatives of 1,7-diphenylgeptanone and stigmasterol-O-β-D-glucopyranoside and campesterol- O-β-D-glucopyranoside. The plant also contains tannins and flavonoids. The hot taste of the roots is conditioned by the essential oils and resins.

**Pharmacological properties.** Galangal eases gas evolution, prevents the relapse in chronic diseases of internal organs, stimulates salivation, increases the functional activity of the stomach. It has antioxidant effect and inhibits the genotoxicity of certain chemicals, which seems promising for further investigation of the use of galangal as a prophylactic agent against cancer [14]. Gingerol and diarylheptanon extracted from the rhizomes of galangal are able to inhibit the biosynthesis of prostaglandins in the body [15].

**Application.** In oriental medicine the seeds of galangal are used against malaria, cholera, indigestion, heartburn, toothache. The rhizomes are used to cure chronic enteritis (inflammation of the small intestine) and indigestion, pain in the stomach. The rhizome is also used to treat exhaustion, lack of appetite, headaches, accompanied by syncope, hypochondria and seasickness.

The rhizome of galangal can also be used as aromatizers in alcoholic beverages [9] and as a spice in various sauces for meat and fish dishes.

The infusion has a reddish-brown color, hot peppery flavor and aroma, a ginger and cinnamon aroma.
Anise (Anisum vulgare Gaerth. / Pimpinella anisum L.)

**Botanical characteristics.** Anise is an annual plant of the Celery family (Apiaceae) with a thin spindle-shaped root. Its stem is straight, round, grooved, branched above, puberulent, with the height of 30-60 cm. The radical and lower stem leaves are macropodous, orbicular and kidney-shaped, integrate, incised, dentate or lobed; the medium leaves are long-petiolate, ternate, with wedged, often two-blade lateral segments and a three-blade finite segment. The upper leaves are situated in a narrow axil, are double-lobed with linearly stylus-like flowerets, the terminal leaves are three-lobed. The flowers are small, collected in umbels, reaching 2.5-6 cm in diameter, with 7-15 rays, the cup-teeth are slightly visible, the flower crown is pentapetalous and white with an inward curved tip, lowered from the outside, with the length of 1.5 mm. The flowers have 5 stamens and a pistil with a lower bilocular set and two columns. The fruits are ovate or slightly cordate diacheniums with the length of 3-4 mm, brownish-gray in color, aromatic, with a sweet-spicy flavor, do not usually break down into mericarps. The mericarps have 5 outstanding edges, 2 secretory canals on a flat side and numerous smaller canals on the convex side. The plant blossoms in June - July, and gives fruits in August.

**Geographic range.** Anise is considered to originate in Oceania and is cultivated in many countries of southern Europe, North Africa, Oceania and Mexico.

**Chemical composition.** The fruits contain essential oil (1.2-3.2%, sometimes up to 6%), which includes anethole (80-90%), methyl chavicol, anisic aldehyde, anisic ketone, and anisic acid, rutin [16]. The fruits contain macronutrients: potassium, calcium, magnesium, iron and trace elements: manganese, copper, zinc, concentrate copper and selenium.

**Pharmacological properties.** In medicine, fruit products and anise essential oil are used as an expectorant in bronchitis, bronchial asthma, as a stimulant of motor and secretory functions of the digestive system. It is also considered to be a slight disinfectant. Anise is considered to be an ancient estrogen and has been used to enhance lactation, stimulate of menstruation and ease birth [17].

**Application.** Medical products of anise are ammonia-anise drops and anise oil, anise fruits are used to make laxative and breast teas.

Anise seeds are used to flavor vodka and liqueurs, either alone or combined with other aromatic plants. The anise extract has a yellow-brown color and a characteristic sweet, slightly hot taste. During distillation the aromatic substances pass into the distillate with the first fractions. The distillate has various advantages over the infusion [9].


**Botanical characteristics.** Quite a tall tree which belongs to the Rutaceae family (Rutaceae) and has solid perennial leaves that are connected to its alate stem with the help of a wide intermediate coarticulation. Its white flowers sit on 6 tassels.
and consist of a 5-lobed envelope, with thick stamens and a single free or "upper" set (known as «fleurs d'orange»). The fruit is multilocular, multi-seeded, with thick and soft coat, the seeds are seated in pulp nests. Such type of fruit is called the Hesperidia.

Geographic range. Originally the plant comes from Southeast Asia, from where through Persia and India it came to the Middle East. Bitter orange was cultured under the name "bigarade" in the Mediterranean region (Sicily) and America (Jamaica, Puerto Rico, Brazil).

Chemical composition. The chemical composition of the essential oil obtained by pressing bitter orange isn’t different from the oils gained from sweet orange with the exception of the high-boiling part that gives the oil a bitter taste. Vacuum oil distillation gives 1.5-2% of terpenic-less oil containing decyl aldehyde (18-25%), linalool (14-41%) and linalyl acetate (40%). The unripe spherical rough (with a surface like sandpaper) orange fruits are up to 1 cm in diameter, dark gray in color and contain bitter glycosides: naringin, neohesperidin and hesperidin. They contain less than 1% of essential oils.

Application. Fresh (totally inedible) bitter orange fruits are used to prepare refreshing drinks, in small doses the fruits are sometimes used in the manufacture of marmalade.

For flavoring drinks specialists use the terpenic-less oil obtained by vacuum distillation - fractional distillation of the terpene part. During this process the water-insoluble portion of the oil (mostly hydrocarbons) is removed.

The dried peel of the fruit is used for infusions which are orange in color and have an orange flavor and a bitter taste. During distillation the pleasant fragrance is received with the first distillate fractions. Apart from the peel the unripe dried fruits (the so-called of orange walnuts, the size of a cherry, round, olive-yellow or greenish-black in color with a delicate aroma and a very bitter taste) are also used to produce fragrances and flavors. However, some beverage manufacturers prefer to create the flavor and taste of orange in their drinks using juniper flavored alcohol and an infusion of propolis or a mixture of mint and lemon oil [9].

Manchurian Aralia (Aralia mandshurica Rupr. Et Maxim. A. elata (Miq.) Seem.)

Botanical characteristics. A tree of the Aralia family (Araliaceae), reaching a height of 1.5-5 m, with large leaves growing on long stalks directly on top of the trunk (due to this fact the plant is sometimes called the palm of the Far East). The leaves have three blades and are united into 2-4 pairs each of which is made up of 5-9 ovate or oval smaller leaves. The plant has many spikes: big and thick on the trunk and small and sharp on the young shoots. The flowers are small, yellowish-white, gathered in inflorescences of several complex umbels in a form of a panicle with the length of 45 cm. The fruits are blackish blue seeds with five seats that ripen in September - October.
**Geographic range.** The plant grows on a height up to 700 m singly or in large groups on glades, forest edges, clearings in mixed and coniferous forests of the Far East (the Primorye, Sakhalin, the Kuril Islands), in northern China and the Korean peninsula. The plant can also be grown in gardens.

**Chemical composition.** The roots of the plant, especially their cortex, contain triterpene saponins (aralosides A, B, C), as well as alkaloid aralin, cardenolides, flavonoids, anthocyanins, starch, gum, resin, and tannins, essential oils, carbohydrates, mineral salts, Vitamins C, B₁, choline. The branches and leaves contain carbohydrates, essential oils, flavonoids, alkaloids, triterpenoids, organic acids and anthocyanins. The seeds contain unsaturated fatty acids (linoleic, octadecenic).

**Pharmacological properties.** Medicine prepared with the use of Manchurian aralia have an antitoxic, tonic, antibiotic, diuretic, hypotensive and sugar-reducing effect. The aqueous extract and infusion of the roots of Aralia have a stimulating effect on the central nervous system, stimulate the heart, reduce the duration of sleep caused by narcotic drugs, stimulate respiration, contribute to an increase of the vital capacity of lungs and muscle strength, have anti-stress effect. The positive effect of Aralia is connected with the activation of enzyme systems and amplification of energy supply of the body.

**Application.** The infusion of aralia roots is used to treat asthenic conditions, hypotension, depression, particularly caused by brain injuries with an asthenic syndrome, neurasthenic reactions in schizophrenia with an astheno-hypochondriacal syndrome, astenodepressive conditions, neurasthenia, impotence, amenorrhea, psychasthenia, metagrippal arachnoiditis with a severe asthenic syndrome, etc. The plant also helps cure mental and physical fatigue.

**Mountain arnica (Arnica montana L.)**

**Botanical characteristics.** Arnica is a perennial herb of the aster family (Asteraceae) with the height of 20-60 cm. Its rhizome is short and brown, penetrates into the soil to a depth of no more than 3 cm., the stem is upright, pubescent, with stem and rosette leaves. The stem leaves are opposite, oblong or lanceolate. The rosette leaves are oblong, ovate, integrate and thick. The stem and side shoots are crowned with orange and yellow baskets. The plant blossoms in June - July. The flowers have a pleasant smell.

**Geographic range.** Arnica is spread mainly in the alpine meadows of the Carpathians, in dry meadows of the Baltic region and in the Ukrainian Polesie. The plant depends greatly on the quality of the soil and air humidity, it requires a lot of light and prefers open spaces.

**Chemical composition.** The flowers contain the coloring agent arnicin (which ensures the biological effect of the plant), cynarin, organic acids (fumaric, malic, lactic), inulin, tannins, phytosterols, proteins, essential oils, etc.

**Pharmacological properties.** Arnica-containing medicine reduces the arterial pressure and enhances the separation of bile. They are used to cure cardiac-term
weakness and stenocardia, external and internal bleeding. On the outside (in form of lotions) the alcoholic extract of the herb used for treating bruises, abrasions, bruising small wounds, boils, trophic ulcers, burns and frostbite [18].

Traditional medicine recommends arnica to treat bronchitis, gout, influenza, convulsions, epilepsy, cerebral concussion, heart diseases and as a diuretic. The scientists note that the arnica-containing medicine when used in small doses have a tonic effect on the central nervous system, and in large doses reduce its tone and prevent the development of seizures, extend heart vessels and improve the nutrition of the heart muscle. Arnica is the source of triterpenes that inhibits the synthesis of melanin [19]. The alcohol industry produces a drink containing arnica.

Application. Arnica buds are used to make spirit extracts that have a pungent bitter taste and a delicate floral aroma similar to that of camomile. During distillation the pleasant flower aroma is extracted with the first distillate fractions. The distillate has an advantage over the infusion. It is included into the formula of a strong liquor "Shartrez" [30].

Aronia, black chokeberry (Aronia melanocarpa Elliot)

Botanical characteristics. Chokeberry is a deciduous shrub of the Rosaceae family (Rosaceae) with the height of 1.5-3 m. The young bush is compact and becomes sprawling with age. The leaves are simple, elliptic, glossy, leathery, dark green, in autumn - orange-red, similar to the form of cherry leaves. The flowers are white, small, gathered in an inflorescence with 10-20 pc. or more in each. The fruits of aronia are apple-like, round, black when ripe with a bluish wax bloom. The weight of a fruit is 1-1.5 g.

Geographic range. The homeland of chokeberry is Eastern North America. It grows in swamps and lowland forests, sometimes on better-drained soils and gravel sea coasts.

Chemical composition. Chokeberry fruits contain sugar, malic and other organic acids, pectin and tannin. They contain vitamins C, P, pro-vitamin A, riboflavin, folic, nicotinic acid, tocopherols, phylloquinone, pyridoxine, cyanine, thiamine, etc. In the fruit also contains amygdalin, coumarin, and other elements.

Pharmacological properties. Fresh, frozen, or dried fruit, juice or canned fruits are used for prophylactic and therapeutic purposes. Aronia is used to treat hypertension (for maintenance of normal permeability and elasticity of blood vessel walls), increased blood clotting, bleeding diathesis, Schönlein-Henoch disease, diabetes, kidney diseases, gastritis with low acidity, measles, typhus, scarlet fever, rheumatic disease, allergic conditions, hepatitis, poisoning, weeping eczema and other skin diseases. The plant lowers cholesterol in patients with atherosclerosis. The fruits and juice of aronia, well preserving vitamins, increase the body's defense system, stimulate appetite, increase the acidity and digestive power of gastric juice. The fresh fruits of chokeberry and its juice reduce blood pressure during hypertension. Medicine made with the use of chokeberry fruits is used for prevention and
treatment of hypovitaminosis and lack of vitamin P. It is not recommended to use chokeberry juice and fruits for treating gastric ulcer and duodenal ulcers, as well as hyperacid gastritis.

**Application.** Chokeberry fruits are used to make jam, jellies, marmalade, and juice. Aronia juice can be used for preparation of alcoholic beverages, aperitifs and balsams. The organoleptic properties of chokeberry products can be used as flavor additives in alcoholic and nonalcoholic beverages, in particular, syrups and soft balsams, pastry, ice cream, yogurt, chewing gum. The high dose of anthocyanins (5,0-9,0%) allows using the semi-products of aronia as a stable natural dye.

*Bergenia (Bergenia crassifolia (L.) Fritsch.)*

**Botanical characteristics.** Bergenia is a low perennial herb of the saxifrage family (*Saxifragaceae*) with the height of 15-35 cm (can rarely grow up to 50 cm). The plant has a long, branched, horizontal, creepy and fleshy rhizome, located at the surface of the soil. Its stem is thick, juicy and leafless. The leaves are hibernating, dark green, leathery, glossy, petiolar, gathered in a dense rosette of 3-8 pc. The leaf blade is broadly elliptical or nearly round, 30-35 cm long and 25-30 cm wide. In autumn the leaves become purple-red and spend the winter under the snow. The floral arrows are thick, naked, from 10 to 50 cm in height. The flowers are bluish-pink, collected in paniculate-corymbose inflorescences. The plant blossoms in May. The fruit is a capsule with lots of small, dark, smooth seeds (1.5-2.0 mm in diameter) that ripen in July - August.

**Geographic distribution.** The plant’s homeland is the Altai region, the Sayan Mountains, northern Mongolia, the alpine meadows and mountains of Central Asia. It can also be found on the banks of some Siberian rivers. The plant grows at an altitude of 400-2500 m in well-drained scree, in rock crevices and in the upper sub-alpine forest belt.

**Chemical composition.** The rhizomes of bergenia contain up to 27% of tannins, bergenin glycoside (4.5%), polyphenols, sugars (glucose and fructose) and dextrin. The leaves contain gallic acid, hydro-quinone (2-4%), carotene, volatile and ascorbic acid.

**Pharmacological properties.** Bergenia products have a local vasoconstrictor, astringent, styptic, anti-inflammatory and antimicrobial effect. The extract of bergenia has an anti-tumor and anticonvulsant effect, as well as the ability to reduce the sedative effects of barbiturates and alcohol.

**Application.** Bergenia rhizomes are used in dental practice and in the gastrointestinal disease treatment.

Bergenia leaves can serve as a source of valuable chemicals - hydroquinone, gallic acid, technical and pharmaceutical tannin.

Water soaked roots, containing starch, are used for food. The plant is used for making teas and cold drinks. The bergenia drinks strengthen the walls of blood
vessels, regulate blood pressure and increase heart rate. Its rhizomes are used for the production of balsams and infusions of therapeutic and preventive effect.

Ordinary star-anise, star-shaped anise (*Illicium verum* Hook. Fil.)

**Botanical characteristics.** Star-anise is an evergreen tropical tree of the Iliiciaceae family (*Iliciaceae*) with evergreen, leathery leaves. Its dried fruits are used as a spice. The trees begin to bear fruit only on the 5th year, but the fruits are harvested from 15/16-year-old trees. Some trees retain their ability to give fruit being up to 100 years old.

The flowers of star-anise are bright, pale yellow or light green. After blossoming the flowers form a fairly large star-like fruit "bag" with 6-8 angles (Fig. 1). As the fruit ripens its color changes to dark brown. Inside each bag there is a spicy brilliant seed (in a form of a shuttle) with a pleasant taste and a sweet-spicy flavor.

**Geographic range.** The plant’s homeland is South-East Asia. The thickets of anise form whole forests in southern China and Vietnam. It is also cultivated in the Philippines, Jamaica, Japan, India and other tropical countries. In Europe the plant became popular only in the 16th century.

**Chemical composition.** Anise contains up to 5-8% of aromatic essential oil the main components of which are anethole (80 to 90%) and safrole. In addition, the essential oil contains phellandrene, resins, tannin, sugar, etc.

**Pharmacological properties.** Anise has an antispasmodic effect and improves the functioning of the stomach. The hydroalcoholic extract of star anise has a strong antioxidant affect [20]. Some derivatives of safrole are considered to be carcinogenic [21, 22]. Due to the toxicity of safrole the EU has limited the daily dose of nutmeg consumption, whose nuclei contain significant amounts of safrole.

**Application.** Star-anise is more aromatic than anise itself. Its taste is spicy and sweet. The plant perfectly sweetens the taste of dough (especially in cookies), various fruit soups and puddings. It is used in the production of liquors, grog and compotes from plums, pears, apples and quince. Its essential oil and fruits are used in alcoholic beverages and food industry.
Common barberry (*Berberis vulgaris* L.)

*Botanical characteristics.* The plant is a shrub of the barberry family (*Berberidaceae*) with the height of 2.5 m and many branches. Young twigs are yellow and the old ones are gray. The wood is yellow. Its leaves are thin, elliptic or obovate, ciliated and serrate at the edges. The flowers are yellow and united into racemose inflorescences. The fruits are oblong or elliptic berries, bright red, very sour, with two seeds. The plant flowers in April – May and give fruit in September - October.

*Geographic range.* Barberry came to Europe from Africa through Spain. The eastern boundary of its European habitat is located in the Volga region. The natural habitat is difficult to establish, due to the fact that the fruit has been widely cultivated, but mostly it can be found in the steppe zones. It is quite common in the southern forest regions. It often grows on forest edges, meadows, on watersheds and on the slopes of ravines.

*Chemical composition.* All parts of barberry except for the ripe berries contain the berberine alkaloid. The roots of barberry also contain palmitin, columbamine, oxyacanthine, etc. [23]. The bark of the trunks, branches and leaves contain alkaloids (0,46-0,53%), tannic and resinous substances. The fruits contain auroxanthin, capsanthin, sugar (4.6% glucose and fructose), pectin, organic acids (6.62% of malic acid).

*Pharmacological properties.* Barberry has cholagogue, choleretic, anti-inflammatory, analgesic, sedative, spasmolytic and anti-cancer properties, it also slows down the activity of the heart, stimulates blood clotting and lowers blood pressure. The fruits are free of alkaloids and therefore safe are sometimes poorly tolerated if fresh. The leaves and bark of the roots contain alkaloids and therefore cannot be used without consulting a doctor. Overdose may cause loss of consciousness, vomiting, diarrhea, nose and kidney bleeding [24].

*Application.* The aqueous extract of berries is used to treat rheumatism (to soothe the pain) and malaria (as a diaphoretic). It is also an acidic drink substituting lemonade. The bark and fruits are used to treat diabetes. Barberry roots in the form of an infusion are used to normalize the low pH level. The bark of the branches and stems is used to treat flu and cough, can serve as an anti-inflammatory agent when dealing with eye diseases. The fruits are used in the food industry.

Bergamot (*Citrus bergamia* L.)

*Botanical characteristics.* Bergamot is a small evergreen fruit tree (with the height of 3-5 m), belonging to the Rutaceae family (*Rutaceae*). The branches have long, slender, sharp spines up to 10 cm long. The leaves are alternate, long (6,5-13,5 cm), 2.5-7.5 cm wide, petiolate, leathery, oblong-ovate or elliptical, acuminate, green and shiny on the upper side, light green on the other, slightly toothed and
wavy, with numerous translucent repositories of essential oil. The flowers are large, fragrant, solitary or gathered in axillary fascicles.

The fruits are medium in size, pear-shaped with a diameter of 4.5-6.0 cm. They are covered with thick (1 cm) ribbed skin. The skin is bright orange, easily separated from the pulp, with numerous repositories of essential oil. The pulp consists of 10-12 slices, is sour and slightly bitter. The seeds are flat, wedge-shaped, furrowed and light yellow in color. The plant blossoms in April - May, and the fruits ripen in November - January. Bergamot begins to bear fruit at the age of 7-8 years.

Geographic range. The plant is mainly cultivated and doesn’t live in the wild. Its homeland is South-East Asia. It is widely cultivated in countries of the Mediterranean region, on the humid subtropical Black Sea coast. Bergamot is grown in large quantities in the Italian province of Calabria.

Chemical composition. The fruits, flowers and leaves contain essential oils, including linalyl acetate, linalool, nerol, citral, limonene, pinene, bergapten, bergaptol. Bergapten contained in the fruits belongs to the furanocoumarins and is photodynamically active.

Pharmacological properties. Bergamot has analgesic, antihelmintic, antidepressant, antiseptic, anti spasmodic, carminative, diuretic, deodorant, healing and stimulating properties, helps increase lactation and stimulates digestion.

Application. Bergamot’s fruit-peel (so called “wild-orange rind”), unripe fruits ("wild-orange nuts"), and flowers are used in perfume and food industry. The skin of the pear-shaped golden-yellow fruits, the flowers, leaves and young shoots are used to produce bergamot oil (around 1.75%) which is then used in perfumes and confectionery industry.

On the basis of this oil in 1676 in the Italian city of Colon the first bergamot cologne was made. Bergamot oil has a pleasant fresh scent and is considered to be the best of all essential oils derived from citrus fruits. The fruits are used for the production of the famous "Earl Grey" tea.

Birch, white birch (Betula pendula Roth.)

Botanical characteristics. Birch is a fast-growing, deciduous, tall (30 m) tree of the birch family (Betulaceae) with smooth white bark. The most common species is the white birch and the drooping birch that live up to 100-150 years. The old branches have white bark, the young ones that droop at the ends – dark brown. The leaves are alternate, petiolate, triangle and rhomboidal, sharp-toothed at the edges. The leaves and young twigs are fragrant and covered with resinous glands. Pollen and pistillate flowers are united into catkins. The tree blossoms and gives buds in spring. During the flowering period long yellow catkins very similar to hazel catkins hang down from the branches. These are pollen inflorescences which are
united in brushes and consist of staminate flowers. The catkins produce a large amount of yellow powdery pollen that is carried away by the wind. Pistillate catkins are axillary, solitary, erect and much smaller than the pollen ones. They have greenish color and contain a lot of pistillate flowers with only one pistil. After blossoming these catkins grow and become small green cylinders. In late summer overgrown catkins turn brown and begin to crumble into small three-lobed scales and tiny webbed fruit. In the center of the fruit is an elongated seed, on the sides - two oval-shaped wings, representing the finest film. Fruits of birch can be distributed by wind over long distances.

Along with the warty birch the other type of this tree – the pubescent birch (Betula pubescens Ehrh.) is used for medical purposes. Unlike the downy birch its young shoots are nappy, and its leaf base is almost rounded (not tapered). The bark on its old trunks is smooth, with no cracks, and darkens only at the base of the trunk. The ends of its branches do not droop.

**Geographic range.** The birch is a widespread tree species that forms small-leaved forests across all climate zones, except for the tundra. The birch forests form in natural forests that are mainly coniferous. The birch often grows on poor but well-drained soils. It is light-requiring and can be easily replaced by a more long-living and large trees, and in many cases grows only in the lighter areas of the forests. The tree grows in an extensive area in the European part of Russia (from the tundra to the steppes), in Western Siberia, the Altai and Caucasus. It is also found throughout Europe except the Iberian Peninsula. White birch is the most numerous of the birch species. In mountain regions the tree rises to an altitude of 2100-2500 m.

**Chemical composition.** Birch bark contains a significant amount of betulin and its derivatives (10-14%), phytosterols and terpenes. The leaves contain saponins, glycosides spiracoside, hyperoside, tannins, essential oils (25% of betulol).

**Pharmacological properties.** Betulin and the cinnamic ester of betulinic acid have anti-inflammatory, hepato- and gastro- protective effects. Betulenol from the bark of the birch is used as a basis for hepatoprotective medication [25]. Today betulinic acid is being studied in the U.S. as a means for treatment and prevention of malignant melanoma, which causes death of 50% of diagnosed patients [26]. The experiments show that the galena elements produced from birch leaves have hepatoprotective, anti-inflammatory, antioxidant, anti-tumor and anti-cancer activity, and a diuretic and choleretic effect.

**Application.** Birch buds and leaves are used in the manufacture of balsams, and special vodkas.
**Hawthorn, Siberian hawthorn (Crataegus sanguinea Pall.)**

*Botanical characteristics.* Hawthorn is a small tree or a large shrub of the Rosaceae family (*Rosaceae*), it is 1-5 m tall with purplish-brown, shiny stems, lined with thick solid straight spines 2.5-4 cm long.

The leaves are 2-6 cm long, alternate, petiolate, egg-shaped or rhombic, pointed, with a wide wedged base, with three or seven blades. The blades are serrated and nappy on both sides. The stipules are crescent-shaped or heart-shaped. The flowers are small, white, with five petals in corymbose inflorescences 4-5 cm in diameter, with a faint specific aroma. There are 5 sepals that are oblong-triangular and become deflected after flowering. There are 20 stamens with purple anthers. The pistil consists of 3-5 carpels, fused with the concave receptacle. The fruits are 6-10 mm in diameter, spherical or ellipsoidal with a cup, the top seeds are compressed at the sides, pitted and keeled, the ones on the ventral side (2-5 seeds) are blood-red, sometimes brown, sweet-sour with a mealy pulp. The plant blossoms in May - June, fruits ripen in late August.

*Geographic range.* The plant grows in the Euro-Siberian area. In the wild it is presented in the eastern European and southern West Siberia. It has been cultivated in shelterbelts, roadside plantations, parks and squares far beyond the natural range. It naturally grows on the edges of forests and glades, rarely – in light shades in the river valleys, sometimes forms small thickets.

*Chemical composition.* The leaves of the plants contain crategolic, actanolic, chlorogenic, caffeic and ursolic acids, hyperoside, quercetin, vitexin rhamnoside and essential oil (up to 0.16%). Hawthorn is a source of vitamin P. The maximum amount of flavonoids that part of the P-vitamin complex is accumulated in the green leaves of the plant (4-5% in the blood-red plant), it remains in fallen leaves. Most of the flavonoids are in hyperin. The flowers of hawthorn contain flavonoids, tannins, essential oil, acetylcholine, choline, and trimethyltilamine, caffeic and chlorogenic acid, hyperoside, quercetin and macronutrients.

*Pharmacological properties.* Hawthorn is used to treat functional disorders of cardiac activity, hypertension disease, angina, atrial fibrillation, paroxysmal tachycardia, general atherosclerosis and climacteric neurosis. Medicine made with the use of fruits and flowers stimulate the heart muscle. They have hypotensive and sedative properties.

*Application.* The fruits contain a large amount of sugars, starch, organic acids, pectins, that give them a nice taste, especially after the frost. They are eaten fresh, dried, candied, are used for cooking stewed fruit, jelly, marmalade, caramel, toppings, etc. The ground fruit can be added to flour for making sweet dough.
**Cowberry, lingonberry (Vaccinium vitis-idaea L.)**

*Botanical characteristics.* Lingonberry is an evergreen shrub of the Ericaceae family (*Ericaceae*) with the height of 30 cm, with a long, thin, creeping rhizome. The stems are erect or ascending, branched and round. The leaves are alternate, elliptic and leathery.

*Geographic range.* The plants grow in all flatland regions of Europe, in the tundra and forest zones of Siberia, in the mountains behind the Caucasus. Lingonberry grows in the pine forests, coniferous forests in the light, in the plains and mountain tundra and bogs.

Another kind of this plant is low, up to 7 cm in height with a brush of 1-4 red flowers. It grows in the tundra region in peat hummocks and barren mountains.

*Chemical composition.* The leaves contain glycoside arbutin (9%), hydroquinone, ursolic, tartaric, gallic and quinic acids, tannins, hyperoside. The berries contain a large amount of sugars (10%), vitamin C, carotene and organic acids: citric, malic, oxalic, benzoic, acetic, glyoxylic, pyruvic and others. The seeds contain fatty oil (30%), linoleic and linolenic acids. Fresh crushed leaves emit volatile elements of phenolic nature.

*Pharmacological properties.* Lingonberry has diuretic, anti-inflammatory, sedative, antihelmintic and anti-septic properties.

*Application.* The plant’s leaves are used in teas for treating urinary stone disease, gout and cystitis, as a diuretic and disinfectant elements. The extract from the leaves is an even stronger diuretic.

The fresh, pickled or marinated plant is used for treating gastritis with low acidity. The berries are used to cure arthritis of exchange origin: rheumatoid and infectious. On the initial stages of the process such treatment is more effective. The berries can be eaten fresh: half a cup or a cup of berries a day. Fresh and dried berries are good antidiarrhoeal agents. Lingonberry tea or infusion is popularly used for treating the tophus, gout and arthritis.

The leaves of the plant are used in recipes of special vodkas and infusions. There are recipes for liqueurs with the berries of the plant. Berry juice by 30-40% reduces the time needed for alcoholic fermentation even with low concentrations of sugars [27]. The berries are used to produce jam, compote, jelly, juices, teas, candy, etc.

**Valerian (Valeriana officinalis L.)**

*Botanical characteristics.* Valerian is a perennial plant up to 1.5 m tall belonging to the valerian family (*Valerianaceae*). The leaves are opposite, glabrous or pubescent, pinnate-lobed, with 4 pairs of segments. The radical leaves have long, slightly fluted sprigs. The stem is straight, hollow, branched at the inflorescence, with imparipinnate leaves. Cauline leaves gradually become smaller to the top of the stem, the lower ones are stalked, the upper - sessile. The flowers are fragrant,
small, pale pink, telianthus, with the corolla funnel of 4-5 mm and lanceolate bracts. The inflorescence is large and corymbose. The fruit is an oblong-ovate flying achene with the length of 2.5-4.5 mm, width of 1-1.8 mm, with a crest of 10-12 arms. The rhizome is short, up to 1-1.5 cm, densely lined with brownish-yellow adventitious roots 10-30 cm long and 2-3 mm thick. Valerian blossoms in June - August, and gives fruit in July - September.

**Geographic range.** Valerian came from Europe, central and northern parts of Asia. On the territory of the CIS is found in the wild everywhere except for the far north and the desert regions of Central Asia. Valerian grows on mountain slopes, along rivers, on floodplains, swampy areas, forest edges. Often forms large thickets, which are used for harvesting the roots. The plant is cultivated in central and southern regions of the CIS.

**Chemical composition.** The rhizome and roots of plants contain up to 0.5-2% of essential oil, which is the main part of the isovalerate bornite (ether of isobutyric acid), iso-valeric acid, valtrate, valeranone and others. The roots and rhizomes of the plant also contain alkaloids: valerine, tannins, saponins, sugars and various organic acids: formic, acetic, malic, stearic, palmitic, and others; glycosides, as well as macronutrients: potassium, calcium, magnesium, iron and trace elements: manganese, copper, zinc, aluminum, barium, tungsten, selenium, nickel.

**Pharmacological properties.** Valerian has a multifaceted effect on the body: depresses the central nervous system, lowers its excitability, and reduces spasms of smooth muscle organs. The essential oil of valerian reduces seizures induced by the brucine alkaloid, which by the pharmacological properties is close to strychnine, reduces the stimulation caused by caffeine and prolongs the action of hypnotics, has an inhibiting effect on the oblongata and midbrain system, enhances functional mobility of the cortical processes.

Valerian regulates the activity of the heart, working through of the central nervous system and directly on the muscle and the conducting system of the heart, improves coronary circulation by direct action of borneol on to the vessels of the heart. In addition, the valerian enhances the secretion of the glandular apparatus of the gastro-intestinal tract, increases bile secretion. The extract of valerian reduces the convulsive effect of strychnine and removes hyperkinesis caused by cordiamin. Valerian is a tranquilizer.

**Application.** This plant is used in medicine since ancient times. Valerian as a sedative is used to treat chronic functional disorders of the central nervous system,
neurosis, hysteria, epilepsy, along with other medical interventions, acute excita-
tions on the basis of psychological trauma, insomnia, migraine, with nervousness,
and chronic heart violation of the coronary circulation, pain in the heart; the first
stage of hypertension as part of general neurosis, palpitations, arrhythmia, parox-
ysmal tachycardia associated with a neurotic condition, neuroses of the stomach,
accompanied by pain, spastic character, constipation and flatulence; violation of
the secretory function of the glandular apparatus of the gastrointestinal tract, esoph-
ageal spasms, especially cardiac spasms of a persistent nature, liver and biliary tract
diseases, Graves' disease with painful subjective symptoms (hot flashes, palpita-
tions, etc.); some forms of avitaminosis (as a sedative); menopausal disorders and
several other diseases accompanied by sleep disorders and increased irritability.
Valerian is more effective in systematic and long-term treatments due to the slow
development of the therapeutic effect.

The roots of valerian are components of fruit wines and balsams. Its infusion
is the color of tea. Valerian has a characteristic aroma and pungent taste. Organo-
leptic properties of the distillate are worse than those of the infusion. Permitted dose
in different sorts of mixtures is 1-2%. It is a smell preservative.

Vanilla (Vanilla planifolia Andr.)

Botanical characteristics. Vanilla is a perennial vine of the orchid family
(Orchidaceae). Vines climb up to the tree crowns, clinging with their aerial roots
to the trunks and branches of tall trees. The leaves are oval or lanceolate, fleshy,
dark green. The inflorescence is a brush consisting of pleasant-smelling flowers.
The flowers are large and light green. In culinary and medicine, the vanilla fruit is
used – a silicular boll with the length of 20-30 cm and width of up to 1 cm. Its seeds
are black and small.

Vanilla is propagated by cuttings that already begin to bear fruit at the age of
1-2 years. The liana grows very rapidly: up to 1 m per month. Flowers are pollinated
by insects. In areas where there are no necessary insects, vanilla is pollinated arti-
ficially. Vanilla’s ovary develops slowly – over 7-9 months after fertilization. The
plant gives fruit up to 20 - sometimes 50 years.

The fruits are harvested by hand at not having completed the stage of ma-
turity – when they are with-holding 80% of water and begin to turn yellow. Freshly
picked fruit does not have a smell. It appears after special treatment.

Geographic range. The homeland of vanilla is Mexico, Panama and the An-
tilles. The Aztecs used vanilla as a spice, years before the Spaniards conquered their
territory. Later, the Aztecs paid tribute to the Spaniards with vanilla. The Spaniards
brought vanilla to Europe.

Today vanilla is grown in Mexico in Florida, Brazil, Paraguay, on the islands
of Java, Reunion, Mauritius, Ceylon, Tahiti, and in West Africa.

Chemical composition. Vanilla seedpods are long-processed. They are gath-
ered immature - when they have no smell – and placed for 20 seconds into water at
a temperature of 80-85°C, then they are fermented slowly for a week in humid conditions at 60°C. As a result, the pods become brown in color and gain flavor. After 1-3 months the pods are dried in the shade in the open air until the surface of the pod is covered a white plaque, consisting of small needle-like crystals of vanillin. Fermentation and maturation make the hydrolytic enzymes break down the vanillin glycoside contained in the pods. In a similar way another glycoside (made from vanillin alcohol) is hydrolyzed. The released vanilinol is oxidized to vanillin.

Vanillin is not the only element that determines the aroma of the spice. In addition to vanillin (3%), dried fruits contain vanillin glycoside, an essential oil, which contains anisic alcohol, anisic aldehyde and anisic free acid. In addition to them natural vanilla contains piperonal, tannins, cinnamic ester, etc., more than 130 compounds in total.

Pharmacological properties. Vanilla has no value in pharmacology. It is used to flavor pills and syrups.

Application. Vanilla is used as a typical ether-oil plant. It is the most delicious spice that is used for flavoring expensive confectionery and other products.

The fruit of vanilla is added to alcoholic and soft drinks. Old (15-20 years old) Cognac are distinguished by the vanilla aroma that is provided by vanillin formed during the oxidation of coniferyl alcohol contained in the wood of the oak barrels.

The right mixture of ingredients and the optimum concentration of vanillin together with coumarin- and benzaldehyde-containing components, form the valuable drink flavor. When small amounts of coumarin are added to vanillin the vanilla smell in drinks lasts longer.

**Cornflower (Centaurea cyanus L.)**

Botanical characteristics. Cornflower is an annual herb of the Asteraceae family (Astracaceae) with a thin root. The stem is erect, ragged, branched, 30-60 cm tall. The leaves are linear-lanceolate; the lower ones are petioled. The flowers are united in anthodes at the ends of the branches, the ones on the edge are blue, the ones closer to the middle are purple. The plant flowers in June - July.

Geographic range. The plant is found in the Europa (except for the far north and extreme south), in the Caucasus, from time to time - in Siberia, Central Asia and the Far East. Sometimes can be found in fields, waste lands and gardens as a weed.

Chemical composition. The ray flower buds contain triterpenes, steroids, bitter glycoside tsentaurin, polysaccharides, traces of alkaloids, flavonoids (derivatives of apigenin, luteolin, quercetin, kaempferol and gispiduline; anthocyanins - cyanine, and pelargonidin), esculetin glycoside, chlorogenic, caffeic and protocatechuic acids, tannins, mucus and vitamin C.

Pharmacological properties. The flowers are used in medicine as a choleretic and a light diuretic antibacterial agent that treats edema caused by renal disorder and heart failure. At the same time the plant reduces blood pressure. The purified
complex of substances contained in extracts of cornflower has shown high anti-inflammatory, antimicrobial and diuretic activity in animal experiments.

(Application). In medicine the flowers are used as a diuretic to treat nephrolithiasis and as a cholagogue. In Mongolian traditional medicine cornflower is known as gastrointestinal drug.

The beverage industry uses cornflower flowers containing cyanine dye and bitter glycoside centaureine. The plant is included in to the recipes of sweet Italian vermouths in an amount from 12 to 135 g per 100 liters of infusion [28], and some domestic balsams.

Bean trefoil, bogbean (Menyanthes trifoliata L.)

Botanical characteristics. Trefoil is a perennial herb of the Menyanthaceae family (Menyanthaceae) with a long thick rhizome whose tip is slightly elevated and has a few (3-5) naked trifoliate, dark green leaves up to 17-30 cm long on long (20 cm) petioles. The leaves of the plant are alternate, with an amplexicaul axil. Supplementary roots grow from the bottom side of the rootstock. The floral stalk is leafless (arrow-like) with the length of 15-35 cm (with the brush). The flowers are pentameric, regular, pale pink or white, the inflorescence is a raceme. The calyx which remains with the fruits is 2-3 mm long, with 5 obtuse fused lobes. The corolla is 12-14 mm long, funnel-shaped, with a five-bladed limb. There flower has five stamens. The inflorescence is a dense apical brush, 3-7 cm long. The fruit is unilocular, almost round polyspermous capsule 7-8 mm long. The seeds are elliptical, smooth, yellowish or brownish, shining, 3 mm long. The plant blossoms in late May or early June.

Geographic range. The plant grows in central and northern belts of America, Europe and European Russia, Siberia and the Far East. It forms continuous thickets along the banks of marshy lakes, rivers and ponds, in the swamps and stagnant water.

Chemical composition. The leaves of the plant contain glycosides that provide the bitter taste: loganine, sverocide, foliamentin, amorphous glycoside menticaine, rutin, hyperoside. The leaves also contain up to 3% of tannins. The herb contains fatty oil, which consists of glycerides of palmitic and other fatty acids, choline, resin acids and other substances that contain a significant amount of iodine. The roots con-
tain glycoside meliatin, tannin, inulin, pectic elements and traces of alkaloids. The plant concentrates selenium that has strong influence on the immune system [29].

**Pharmacological properties.** Medicine containing trefoil has choleric, anti-inflammatory, antiseptic and mild laxative properties, enhances the secretion of the glands of the gastrointestinal tract.

**Application.** The plant is used to treat low-acid gastritis, hemorrhoidal bleeding, pulmonary tuberculosis, cough, anorexia caused by functional disorders, chronic constipation and can also serve as a cholagogue for liver and gallbladder diseases. Trefoil can also be used to cure catarrhal angina, parodontose, gingivitis, stomatitis and trophic ulcers.

The food industry uses the leaves in the brewing processes to give beer a pleasant velvety taste. The leaves are green; the taste is bitter and odorless. Distillation is not applicable.

Trefoil infusions are extremely bitter. At the same time, it has practically no influence the flavor of drinks. The plant is one of the components of a well-known and popular drink – Riga Black Balsam [30].

**Cherry, steppe cherry (Cerasus fruticosa Pall.)**

**Botanical characteristics.** Steppe cherry is a shrub of the Rosaceae family (*Rosaceae*), is 0.2-1 m tall, rarely grows up to 2 m. It has a dense crown. The branches are erect or drooping. The leaves are seated on short (10-15 mm long) petioles, are glabrous, dark or bright green, shiny, their bottom side is much lighter. The leaves are oblong-elliptic or lanceolate, the ones on short shoots are up to 3 cm long, on long shoots - 4-5 cm, their apex is acute or obtuse, the base is wedge-shaped with a serrated edge. The flowers are situated in sessile or short-stalked umbel-like (with 3-4 flowers) inflorescences at the ends of very short axillary shoots with a few small leaves at the base. The pedicels are 15-25 mm long, glabrous, reflexed, the petals are white, oblong, usually notched, 6 - 7 mm in length. The fruits are 8-10 mm long, ovate-oblung, nearly spherical-shaped or barrel-shaped, usually short-pointed at the top, the skin is red or dark red, the flesh is lightly colored with juice. The taste is sour-sweet, sometimes astringent. The seed is often ellipsoidal, pointed at both ends, rarely rounded, with smooth sides.

**Geographic range.** The plant grows in Central Europe, the Caucasus, Central Asia, Western Siberia.

**Chemical composition.** The cherry fruits contain sugar (12.7%), sucrose (0.5%), organic acids, mainly malic and lactic (up to 2.1%). It also contains a small amount of tanning and coloring materials. The seeds contain fatty oil (25-35%), amygdalin and essential oil. The bark contains tannin and coloring elements, glycoside fuskoprophlobaphene, rubrophlobaphene and citric acid, the leaves - lemon acid, tannin, quercetin, amygdalin, coumarin and camedine.
**Pharmacological properties.** The fruits have vessel-restorative, anti-sclerotic, diuretic, expectorant and anti-inflammatory effects. Cherry juice has a detrimental effect on the pathogens of dysentery and pyogenic infections - staphylococcus and streptococcus.

**Application.** The cherry berries are recommended for patients with respiratory tract catarrh, lung inflammation, gastritis, anemia, they improve appetite, digestion, quench thirst, relieve nausea and vomiting. Anti-diarrhea effect of the dried cherries is stronger than of the fresh fruits.

The aqueous extract of cherries is used as an antipyretic during colds, it also improves the appetite. The same infusion is recommended for removal of fermentation in the intestinal nickel and as a laxative. Leaves’ infusion mixed with milk helps treat jaundice. Tea made of roots is used has an anti-diarrhea effect. The fruit stems and berry decoction is used for treating rheumatism. Bulgarian herbalists use tea with cherry to cure mental illness and epilepsy.

Cherry fruits are eaten fresh, but they are mainly used for recycling. Cherry jam is one of the best. Cherry is used for preparing compotes, jelly, berry liqueurs. Cherry is assumed to be one of the best fruits (after grapes) suitable for producing wine. Cherry wine is thick, red, sometimes with a purple tint. The leaves and branches of the mountain cherry are used in recipes of bitter liqueurs and balsams. Cherry is used for the production of liqueurs, brandy and wine. Cherry wine is made from late berries via double distillation of fermented marc. It has a subtle taste and flavor, with hints of cherry and cherry seeds.

**Blueberry, swamp blueberry, bog whortleberry** (*Vaccinium uliginosum* L.)

**Botanical characteristics.** The plant is a long branched shrub of the heath family (*Ericaceae*) with the height up to 50-90 cm, with gray-brown or dark-gray bark. Its stem is erect and the young branches are green. The leaves are small, 0,7-3 cm long, 0,4-2,4 cm wide, short, sometimes on pubescent petioles, alternate, thick, obovate, integral, light green on the upper side and glaucous on the other. Blueberry flowers are small, soft, whitish, sometimes tinged with pink. They are smaller than a pea, with an almost spherical corolla, resembling in shape a wide pot. The flowers are arranged on the branches, so that the opening of the corolla looks downwards. The edge of the opening has 4-5 small serratures. The berries are oval, blue, with a bluish tinge. They look like bilberry (whortleberry), but they are larger. Their taste is sweet and sour, the pulp is greenish. The hallmark of this plant is a bluish tint of the leaves, which remind of the leaves of lingonberry in shape and size. However, unlike the lingonberry (cowberry) leaves, they are thin and tender, and fall off in autumn. The plant flowers in May - June, berries ripen in July - August.
**Geographic range.** The plant grows on moist coniferous forests and intermediate marshes, often in the tundra in the northern part of the Europe, Caucasus, Western and Eastern Siberia, the Far East. It can also be found in the tundra moss and sphagnum bogs.

**Chemical composition.** Blueberry contains proteins, carbohydrates, potassium, calcium, magnesium, phosphorus, iron, vitamin C, vitamin P and pectins. The leaves contain flavonoids and tannins.

**Pharmacological properties.** Blueberry has a chologagic, diuretic, anti-inflammatory effect, is used to treat atherosclerosis, scurvy and dysentery.

**Application.** The berries are used to make jam, compote, jelly, juices, teas, candy, etc.

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**Walnut (Juglans regia L.)**

**Botanical characteristics.** A walnut is a powerful spreading tree of the nut family (Juglandaceae). On older trunks the bark is light gray and has cracks, on the young ones the bark is smooth. The leaves are alternate, petiolate and pinnate. The leaflets are elliptic or oblong, dark green on the top and lighter at the bottom.

The leaves of the walnut are harvested in June, during flowering, when they haven’t reached the final stage of growth. They are quickly dried in the sun, making sure they do not turn black, otherwise they will lose their medicinal properties. The green pericarp is harvested in August.

**Geographic range.** In the wild the walnut is spread in the Caucasus, Transcaucasia and Central Asia. It grows along the gorges and river valleys singularly or in groups, rarely found in small forests. The plant has been cultivated since ancient times. It is grown in Central Asia, Caucasus, Crimea, Moldova, Ukraine and North Caucasus.

**Chemical composition.** Walnut leaves contain large amounts of biologically active substances - hydrojuglone that is easily oxidized to juglone, flavonoids (quercetin 3-arabinoside, kaempferol 3-arabinoside), aldehydes, essential oils, alkaloids, vitamins C, PP, carotene, phenol carbonic acids, tannins, coumarins, flavonoids, anthocyanins, quinones and highly aromatic hydrocarbons. The walnut’s pericarp contains organic acids, vitamin C, carotene, phenol carbonic acids, tannins, coumarins and quinones.

**Pharmacological properties.** Walnut-containing lotions, baths and body wraps are used as a means of preventing and treating acne. The pericarp and leaves
of the walnut have antibacterial, tonic, hemostatic, anti-inflammatory and wound healing effects, are good for resolving infiltrates.

*Application.* Decoction made of walnut leaves is used for bathing and washing while treating rheumatism, gout, rachitis, diathesis, rashes, acne, ulcers, eczema, and for rinsing to cure angina and gum disease.

The infusion of the leaves and pericarp is used as an external wound-healing agent in the form of lotions, internally as a fortifying agent. It can be used to treat inflammatory processes mouth and throat. Fresh leaves are crushed and applied to wounds and ulcers for quick healing.

Immature nuts are marinated in vinegar. The nuts (Fig. 2) are used in the beverage industry, for example, to make semisweet bitters, balsams and liqueurs [9].

**Elecampane, inula (Inula helenium L.)**

*Botanical characteristics.* Elecampane is a perennial herb of the aster family (*Asteraceae*). It has a thick, fleshy rhizome that is dark-brown on the outside and yellowish inside. It is often multi-headed and weighs up to 1.8 kg (0.6 kg in general), with one or more stems and a lot of large basal leaves. The stem is upright, furrowed, branched at the top, with the height 140-170 cm. The leaves are ovate and lanceolate, velvety-tomentose. The inflorescences are united in large singular anthodes at the ends of stems and branches. The flowers are goldish yellow. The fruit is an oblong, four-sided, brown achene with tussocks.

*Geographic range.* The plant grows in the Mediterranean region, Iran, Mongolia, the Caucasus, Central Asia; in Russia it is found in the steppe and forest-steppe zones of European region, Caucasus, Western Siberia. It grows on the banks of rivers and lakes, meadows, forest openings, in the mountains. It is cultivated in North America and some European countries.

*Chemical composition.* The rhizomes and roots contain essential oil (1-3%), consisting of a mixture of sesquiterpene lactones, derivatives of selinene, mostly alantolactone, isoalantolactone and dihydro alantolactone, easily soluble in organic solvents and poorly - in water. In addition, the roots contain inulin and its derivatives (up to 44%), organic acids (acetic, benzoic), saponins, and alkaloid elements.

*Pharmacological properties.* Elecampane has anti-inflammatory and expectorant effects. The essential oil also has antiseptic and antihelmintic properties. The sesquiterpene lactones of elecampane are included into antihepatotoxic medicine. The aqueous extract of the flowers when given to mice 30 minutes before intraperitoneal injections of ethanol increases the latency of alcohol anesthesia and shortens its duration. In experiments on rats, oral administration of aqueous extracts of flowers and leaves of *I. helenium* 30 min before and 2 hours after the ethanol injections reduces ethanol’s narcotic
effect and its concentration in the blood. A similar effect is provided by extracts of flowers of British inula (*I. britannica*) and willow-leaf inula (*I. salicina*). The extract of elecampane root has no effect on the severity of alcohol intoxication of the rats and leads to an increase of ethanol concentration in the blood of the animals. Having a "sobering" effect during acute ethanol administration the flower extract of the plant does not alter the delayed effects of severe alcohol intoxication and has no effect on the post-intoxication syndrome in rats after their forced five-day alcoholisation.

**Application.** The plant is used as an expectorant to treat chronic diseases of the respiratory tract: tracheitis, tuberculosis and bronchitis with a large release of mucus. It is also good for curing gastroenteritis and diarrhea of a non-infectious origin. Drugs containing elecampane are used to treat with asthma, whooping cough, the plant can be also used as an antihelmintic and styptic, it can be used externally for treating with eczema, scabies and other skin diseases. Alantolactone and its isomer isomalantolactone are part of the antiulcer drug called “Alanton”.

Elecampane rhizomes are used for flavoring and to improving the taste of balsams, fruit wines and liqueurs [9]. The infusions’ aroma is peculiar and very resistant. Its acceptable content in drinks is 1%.

**Melilot, sweet clover (Melilotus officinalis (L.) Pall.)**

**Botanical characteristics.** Melilot is a biennial herb of the legume family (*Fabaceae*), with the height of 1.5 m. Its leaves are green, rimmed, trifoliate. The flowers are yellow or white small flowers and gathered in a brush. The fruit is a double-seeded bean.

**Geographic range.** The plant grows on a very large territory of Europe, in West and East Siberia; in Kyrgyzstan, Kazakhstan, etc. It has other names: sweet clover, white-blossom sweet clover, etc. It grows in wastelands, on road slopes, in ravines and rare woods.

**Chemical composition.** The taste melilot is determined by the presence of coumarin, orto-coumaric and melilotic acids [31]. The plants flowers contain essential oils and, like many other herbs, resins and tannins. The aroma comes from the presence of melethyl acid and an oily substance called melilotol. The leaves and stems are rich in vitamins A, C and E. The content of coumarin is more than 1%.

**Pharmacological properties.** Coumarin reduces blood clotting. Due to this fact sweet clover has long been used for medicinal purposes. Melilot tea is used as an expectorant. It also has a calming effect and diuretic properties. It is used to treat headaches, angina and rheumatism. Folk medicine gives examples of the plant being used as treatment of joints’ pain, inflammation of the lacteal glands and boils. The plant should be used under medical supervision.

**Application.** The aromatic herb is often used in home cooking, as well as in the food industry. Most commonly the aerial part of the plant is used. Some countries of the Caucasus region use its roots as a spice. The plant gives a pleasant taste
and aroma to fish dishes. It is used in the production of canned fish. The leaves and flowers are used for flavoring soups, improving the flavor of salads, compotes and drinks. In the dairy industry the plant is used in the production of green cheese.

It is also widely used in the production of alcoholic beverages [32]. An alcoholic extract of dried flower tops and leaves has a golden-yellow color with a pleasant coumarin (fresh hay) flavor. Distillation is unnecessary.

Common oak, English oak (Quercus robur L. / Q. pedunculata Ehrh.)

Botanical characteristics. Oak is a large tree of the beech family (Fagaceae) up to 20-50 m tall, with a thick trunk (up to 1-1.5 m in diameter) with a dense crown and big root system. Young shoots are leafless, with an olive-brown bark, mature trees are dark gray, with deep cracks. The leaves are oblong, obovate, pinnately lobed, with 4-7 rounded lobes on each half of the leaf, with loops 7-15 cm long and 3-7 cm wide at the base. The leaves are shiny green on top, and mat, pale (slightly pubescent at first) on the bottom side. The petioles are short, 0.5-1 cm long. The stipules are deciduous. The flowers are unisexual. The staminate flowers are clustered in the rare, long slender pendulous catkins that are 2-4 cm long. The perianth is small, greenish-yellow, divided into six parts, with the same number of stamens. The pistillate flowers are reddish, on short pedicels.

The fruits – acorns – are 1.5-3.5 cm long, glabrous, reddish-brown with longitudinal stripes, on a stipe. The cupule is saucer-shaped, 0.5-1 cm long, and usually covers the acorn up to one third of its length. The tree blossoms at the same time when leaves appear – in April - May. The fruits ripen in September. Oak’s fruiting begins when the tree is 30-40 years in the wild and 50-60 years old - in plantations. There are two types of oaks - summer and winter oak. The first gives leave in April; and they fall in the winter, the second – gives leaves 2-3 weeks later (in May) and young specimens keep the leaves for the winter.

Geographic range. Widespread in Europe, Russia (in the central and southern regions), in the Crimea and the Caucasus, and parts of central Asia (Kazakhstan). The tree grows in the forest-steppe region, is found along rivers, gullies and ravines.

Chemical composition. Oak bark contains tannins of the pyro-gallic group (10-20%), gallic and ellagic acid, flavonoids quercetin and its glycoside quercitrine, a large amount of pentosans (up to 13-14%), pectins (up to 6%), in addition to this - sugar and fat. The acorns contain starch (40%), tannins (5-8%), sugar and fatty oil (5%). The leaves contain tannins, quercetin and quercitrine and pentosans.
Pharmacological properties. The bark of the oak contains tannins whose solutions are used to treat inflammatory processes in the mouth, nose and throat, ulcers and burns. The bark is used as a powerful astringent and tonic for blood vessels, as well as a sedative. It is used to treat burns, skin diseases, wounds and frostbite.

Application. The bark and fruits are used for medicinal purposes. Acorns and refuse wood are used for the production of drinks. Tannins in oak bark are used as an antidote for mushroom, lead and other heavy metals poisoning. The plant is used for mouth rinsing and applications. The infusion of oak bark is prescribed for treating inflammation of the gastrointestinal tract and dysentery. However, large quantities of the oak bark extract causes vomiting.

Particular attention is given to Quercus alba, which is used for the production of barrels for famous French brandy. The bark and oak wood are used for alcohol infusions and improve the taste of wine, liqueurs and balsams. Russian common species of oaks, according to the experts, are the best for making cognac containers [33].

Oregano, marjoram (Origanum vulgare L.)

Botanical characteristics. Oregano is a perennial herb of the Labiatae family with a branched creeping rhizome. The stems are reddish, 30-90 cm tall, erect, quadrangular, often branched at the base. The leaves are oblong, ovate, opposite, petiolate, 2-4 cm long, integral, dark green with translucent yellow dots - essential oil glands. The flowers are small, pale purple, seated in axils of bracts and forming a corymbose panicle on the top of the stem. The fruit consists of four nutlets 0.5 mm in length. The plant flowers in July - August. The flower tops are gathered in June - July.

Geographic range. Oregano is native to the Mediterranean, Europe (including the British Isles) and south and central Asia, and is cultivated elsewhere. It grows among shrubs in forests and steppe grasslands.

Chemical composition. Oregano contains essential oil (0.12-1.2%), which consists of phenols (44%) - thymol and carvacrol, bi- and tricyclic sesquiterpenes (12.5%), free alcohols (12.8 -15.4%) and geranyl acetate (2.63-5%). Oregano leaves contain tannins (20%), glycosides: 4'-O-β-D-glucopyranoside -3',4'-dihydro-oxy-benzyl-protocatechuic acid and 4'-O-β-D-glucopyranoside -3',4'-dihydro-oxy-benzyl-4-O-methyl-protocatechuic acid, ascorbic acid (more in the leaves than in flowers), the seeds contain fatty oil (28%).

Pharmacological properties. Medicine containing oregano has analgesic, sedative, expectorant, diuretic, diaphoretic, cholagogue action, increase the secretion of digestive and bronchial glands and intestinal peristalsis, and increase the intestines’ tone. Oregano has a serious antioxidant effect [34, 35]. The scientists note that this effect of aqueous extracts of marjoram is provided by protocatechuic acid glycosides [36].
Application. Is used for treating female weaknesses, has a styptic effect, increases lactation, relieves the menopause state and menstruation pain. It is used to treat insomnia, as a sedative for nervous disorders, with hypo-and anacidic gastritis, stomach and duodenal ulcers, flatulence, enterocolitis, intestines’ atony. Is used as an expectorant during bronchitis and bronchiectasis, and as a means of stimulating the appetite. It is used for treating hemorrhoids, migraines, asthma, pulmonary tuberculosis, jaundice, cholecystitis and biliary dyskinesia, as an antihelmintic. A strong oregano tea causes excessive sweating. Oregano is used for aromatic baths to relieve rheumatism, paralysis, epilepsy, allergies and rachitis, in the form of compresses it is used for the treatment of abrasions, suppuration, inflammation of the lymphnodes, some skin diseases.

The oregano infusion has brown color, a specific, light smell and a slightly bitter taste. During distillation oregano aroma is extracted with the first fractions. The tops of the flowering stems of oregano are used to flavor alcoholic beverages and improve the taste of balsams and tinctures. Oregano is used for the production of a bitter tincture "Yeger" [30].

Angelica officinalis, Angelica Diaghilev (Angelica archangelica L. // Archangelica officinalis Hoffm.)

Botanical characteristics. Angelica is a biennial herb of the celery family (Apiaceae), with the height of 1.5 to 2.5 m. Its stem is straight, thick, rounded and hollow, branched, furrowed, with a glaucous bloom, red at the bottom. The rhizome is short, thick, vertical, hollow, reddish-brown, containing white or yellowish milky juice. It has 1 or 2 thick uneven stalk roots or several supplementary roots. At a fresh fracture of a root dusky or whitish dots are visible. The weight of the root system is up to 200-300 g. The leaves are double- or triplelobed, up to 80 cm long, petiolate, with large swollen axil, with ovate leaflets. The stem leaves are short and small. The flowers are small, yellowish-green, in large umbels 8-15 cm in diameter with 20-40 rays. The plant flowers in June - August.

Geographic range. Angelica is found everywhere in to north and northeast Europe, Russia, Iceland, Greenland and the Himalayas. It is also widely cultivated and frequently naturalised in northern temperate regions, including the UK. It grows in wet places on banks of rivers and lakes, in ditches, swamp edges, water meadows, glades and edges of marshy forests, in osier-beds.

Chemical composition. The rhizomes and roots of plants contain organic acids (valeric, malic acid, angelic), wax, carotene, bitter elements and tannins, ethereal (1%) and fatty oil, starch, sugar, resins, volatile, phytosterol and coumarins.

The leaves and seeds of the plant contain fat and essential oil (the dose of essential oil retrieved from crushed roots is up to 25%), volatile. The leaves and flowers contain vitamin C and quercetin.

Pharmacological properties. Medicine containing angelica has a diuretic, anti-inflammatory, spasmolytic effect, improves the activity of the heart, inhibits
fermentation, improves bile secretion and relaxes the nervous system due to the presence of valeric acid.

Application. In traditional medicine the plant is used for treating stomach and bowel cramps as a means of stimulating the appetite, as well as for treating colds as a diaphoretic and expectorant - in case of bronchitis and laryngitis. The plant’s infusion removes mucus from the lungs and the bronchi, relieves epigastric burning. The root has anti-inflammatory properties. Tea made from angelica roots is drunk in the morning before eating and cures chronic cough. Angelica is used in diuretic, expectorant and gastric teas. It is a valuable plant of forage and producing honey.

Angelica rhizomes are used in alcoholic beverage industry – in the production of bitter liqueurs, and the liqueur “Chartreuse” [30].

A dose of the root of angelica (up to 8%) added to balsams and flavored wines gives the drinks a specific noticeable taste that overlaps the basic taste of the active group of ingredients [9]. If the dose is lowered to 3-3.5% the drink’s flavor becomes harmonious.

European dewberry (Rubus caesius L.)

Botanical characteristics. The plant is a shrub of the Rosaceae family (Rosaceae) with outstretched assurgent shoots 50-150 cm in length, in the lower part covered with short down-curved or straight, reddish, sometimes yellowish, spines, sometimes with several stalk glands. The leaves are triple, the leaflets are broad and ovate, acute, often doublelobed, 4-10 cm long, light green, pubescent and double-serrated on the edges. Flowers are united in corymbose inflorescences 2.5-3 cm in diameter. The sepals are grayish-tomentose, the petals are white, broad and elliptical. The fruits consist of a few rather large black stone-fruits with a bluish bloom.

Geographic range. The plant grows in the Europe, Russia, Central Asia, on the whole territory of Ukraine. It grows in forests, fields, thickets, among bushes, in ravines, sometimes in fields planted with cereal crops. It has many species and varieties. European dewberry forms large thickets in the urema zones.

Chemical composition. The leaves contain tannin (14%), organic acids, flavonoids, anthocyanins chrysanthemin and inositol. The berries contain up to 10% of sugars (glucose, fructose), organic acids (citric, malic acid, oxalic acid, etc.), pectin, carotene, vitamins B, C, E, tannins, potassium, copper and manganese. The aroma of blackberries is largely determined by 2-heptanol, eugenol and methyl salicylate – the amount of these elements in dewberries is larger than in raspberries [37]. The flavonoids contained in the leaves have antioxidant properties and protect the biologically active substances from oxidation [87].

Pharmacological properties. Dewberries have anti-inflammatory, wound healing, expectorant, antiputrescent, antitussive, antibacterial, diaphoretic, diuretic and sedative properties.
**Application.** Dewberry is used for treating female menopause neuroses, diarrhea, gastritis, stomach and intestinal bleeding, can be used for treating dysentery and food poisoning, stomach and duodenum ulcer, diseases of the upper respiratory tract. It is also used to rinse the mouth and throat to cure bleeding gums, tonsillitis, inflammation of the pharynx, can be part of lotions for treating chronic ulcers, fresh and festering wounds, eczema and herpes.

Infusions of fresh and dried berries of quench thirst, have antipyretic effect, they are recommended for treating acute respiratory diseases, pneumonia. Decotions and infusions of dried berries have diaphoretic and diuretic properties. Fresh berries have a slight laxative effect, and the unripe fruit – a non-laxative. Fresh fruit and tea made from the berries are used as a general tonic and sedative.

The berries are used to make juice, jam, marmalade and various drinks, such as alcoholic balsams and liqueurs [9].

**Ginseng (Panax ginseng C.A. Mey.)**

**Botanical characteristics.** Ginseng is a herbaceous perennial plant of the Aralia family (Araliaceae) with green or greenish-brown stems to 80 cm (rarely 86 cm) in height and about 0.7 cm in diameter. In most cases the stalk is single, but there are also multicaulis plants. In exceptional cases the number of stems can be up to 6. The top of the stem bears a whorl of several (2-6) palmately compound leaves on petioles up to 10 cm long. The leaves of adult plants have 5 leaflets of obovate or oblanceolate shape, the central leaflet being the largest (4-20 cm long and 2-8 cm wide), the others – much smaller. The leaflets are serrulate, glabrous or slightly fuzzy. They are seated on petioles up to 3.5 cm long.

The peduncle rises from the middle of the whorl and reaches 24 cm (30 cm if cultured) in height and usually has an apical umbel. Mature plants with well-developed roots have several (1-4) lateral umbels. The latter often have bracts (0.8 cm long and 3 mm wide). The flowers are small, telianthus, greenish-white, about 4 mm in diameter. The umbel contains an average of 16 flowers, but sometimes the number of flowers may be up to 40, and plant growing in plantations can have more than 100 flowers. The number of flowers increases with the age of the plant.

The fruits are bright red, with yellow flesh, compressed from the top and sides, with two flat light yellow seeds.

**Geographic range.** The natural habitat of ginseng has reduced by the end of the last century, and is represented today by only two main populations. The first, and largest is in the southern half of the Sikhote-Alin, and the second is in Russia (and Nadezhdsinsky and Khasansky areas) and China (the provinces of Heilongjiang and Jilin). Blue Mountains (the Spassky district of Primorsky Krai) are sometimes considered to be a separate habitat of ginseng. Despite its small size the population in that region still exists. Outside the habitat ginseng is grown in many countries in the Northern Hemisphere.
Chemical composition. The roots contain triterpenoid glycosides of the dammar group - ginsenosides [38, 39], pectin (23%), starch, mucus, resins, alkaloids, vitamins C, B₁, B₂, essential oil (0.5%). The roots of ginseng contain a significant amount of biologically active polyacetylenes - phalcarinol, phalcarintriol, panaxydol, hepta-deca-1-ene-4,6-dyn-3,9-diol.

Pharmacological properties. Ginseng increases in brain sensitivity to stimulants - caffeine, camphor, picrotoxin, benzedrine – due to the potentiation effect of the plant. Studies of the ginseng infusion note that plants of the Aralia family obtain the ability to reduce the efficiency of certain drugs - barbiturates, chloral hydrate and ethyl alcohol. Ginseng products are used as tonic, adaptogenic elements for treating and preventing various diseases of the central nervous system, increasing efficiency and resistance to stress, adverse environmental effects. Ginseng is recommended in the periods of convalescence after serious illness, complex surgery, and protracted complications of various origins, chronic physical and mental fatigue. Ginseng is effective in the treatment of asthenic and asthenodepressive states of various etiologies, psychasthenic and hysterical reactions accompanied by stupor, various neuroses, insomnia and impotence. The plant improves the patients’ general condition, helps treat lethargy and fatigue, headaches, improves the appetite, increases the general tone [40, 41].

Application. In China and Korea ginseng is used in a large number of different dishes and food products. The biologically active substances of ginseng are used for the production of toothpastes, shampoos, perfume and cosmetic products. As a pharmacologically active-component the extract of ginseng is present in some types of soaps, lotions, creams, bath products. In China and Japan ginseng is added to products for hair growth with extracts ofaconite and hyaluronic acid. Ginseng extracts are used for the manufacture of soft drinks and tonics. It is also used in the production of balms.

Honeysuckle (Lonicera altaica Pall. Ex DC.)

Botanical characteristics. The plant is a frost-resistant low shrub of the honeysuckle family (Caprifoliaceae), up to 1.5 m tall, with brownish-gray bark. Young shoots are reddish. The leaves are small, solid, oval, elliptical, pale green, nappy, seated on short petioles. The flowers are teleianthous, small, yellowish-white, gathered in inflorescences of 2-4 flowers, fragrant. The plant gives fruit on the third-fourth year. The fruits are large oval or egg-shaped berries growing at the ends of fruitful branches, often double, black-and-blue or bluish due to the waxy coating, edible with a sweet and sour-sweet taste similar to blueberries. The plant flowers in June, gives fruits in June - August. Honeysuckle stems are black and blue. Its fruits are red, yellow or orange. The only edible species of honeysuckle is Lonicera altaica.

Geographical range. Honeysuckle grows in the Baltics and the European part of Russia, the Urals and the Altai, Siberia and the Far East, Kazakhstan and
Mongolia. It grows in the undergrowth of different forests of the taiga zone, but prefers more light. In mountainous areas it can be found on open slopes, rocks and rock streams, and sometimes above the forest belt.

*Chemical composition.* The berries contain flavonoid, pectin and tannin elements, anthocyanins, organic acids (up 3%), sugar (glucose, galactose), vitamin E, C, and phenols.

*Pharmacological properties.* Honeysuckle has styptic, diuretic, vessel-strengthening and anti-sclerotic properties.

*Application.* Branches and bark decoction is used for treating edema. Fresh berries are recommended to treat hypertension and other cardiovascular diseases, malaria, gastro-intestinal tract problems and anemia.

Honeysuckle berries are used to prepare jams, wines, and are an excellent food dye [42]. Alcoholized honeysuckle berry juice is used as a basis for sweet-sour punches of dark red color [30].

*St. John's wort (Hypericum perforatum L.)*

*Botanical characteristics.* The plant is a perennial herb of the St. John's wort family (*Hypericaceae*) with a horizontal creeping rhizome. Its stems are erect, 20-70 cm tall, rounded or dihedral, very branched at the top. The flowers are united in thyroid inflorescences at the tips of stems. It flowers from June to August.

*Geographical range.* St. John's wort grows wild in Europe, Iran, India, Mongolia, Japan and China, in Russia it is present in the European part, the Caucasus, Siberia, and the mountains of Central Asia. It grows in dry, open forests, glades and forest edges, grasslands and scrublands.

*Chemical composition.* The main active substance of the plant are the condensed anthracene derivatives - hypericin and pseudohypericin, protogipericin and protopseudogipericin [43].

The healing properties of the plant are provided by polycyclic quinone hypericin and furocoumarins: psoralene, xanthotoxin and bergapten [44].

![Chemical structures](image-url)

**Psoralene**

- $R_1$: H
- $R_2$: H

**Xanthotoxin**

- $R_1$: OCH$_3$
- $R_2$: H

**Bergapten**

- $R_1$: H
- $R_2$: OCH$_3$
These toxic substances, depositing in the animal vestiture, make them sensitive not only to UV light, but also to more long-wave radiation, causing burns and dermatitis.

Apart from the condensed anthracene derivatives the plant also contains monomeric anthracene derivatives - franguloemodin and franguloemodinantranol. St. John's wort contains complex phenolic compounds: flavonoids (quercetin, kaempferol, myricetin, rutin, quercitrin and izoquercitrin), anthocyanins and leucoanthocyanins, phenol carbonic acid.

In addition, the plant also contains: essential oils, alkaloids, tannins, sap- onins, vitamins C, PP, carotene, minerals (manganese and zinc). St. John's wort contains biflavone compounds, the main of which - amentoflavone - has anti-inflammatory and anti-ulcer effects.

**Pharmacological properties.** St. John's wort is used for treating liver and stomach disorders, it also stops bleeding. It is used as an anti-inflammatory agent and for healing wounds. Recently information has appeared about the antidepressant activity of hypericin contained in the plant (in doses of ~ 2 mg per day) [45]. Its efficiency is comparable to such drugs as imipramine and dezimipramine [46, 47]. However, scientists describe a case of developing photosensitivity in a patient receiving therapeutic doses of hypericin, which stopped after the patient stopped taking the medicine. The herb St. John's wort is used in antidiabetic teas and to stimulate the immune system.

The number of publications devoted to the study of biologically active compounds of St. John's wort, and the clinical trials of its drugs as antidepressants have been steadily increasing. The results of over 20 placebo-controlled clinical trials with double-blind control showed that the efficacy of St John's wort in the treatment of average and moderate depression is comparable to that of antidepressants - specific serotonin reuptake inhibitors (fluoxetine) with a significantly lower number of side effects. The use of St. John's wort preparations may reduce the effectiveness of other drugs (destroyed by cytochrome P-450).

Antidepressant effects of Hypericum extracts are caused by the biological activity of hyperforin, hypericin, flavonoids, procyanidins, xanthones, and possibly other components of the plant. The mechanism of action of antidepressant drugs containing Hypericum include nonspecific inhibition of the
reuptake of catecholamines, serotonin, gamma-aminobutyric acid (GABA) and glutamate, change of catecholamine metabolism, receptor modulation, direct interaction with a number of neuronal receptors and transport proteins.

Experiments with genetically selected "alcohol-preferring" rats suggest the possibility of a specific suppression of voluntary ethanol consumption after a single application of Hypericum extracts [48]. The content of the plant in food should not exceed 1 mg/kg.

**Application.** St. John's wort is collected and added to teas to treat influenza. It has a balsamic odor and a bitter taste. The infusion has a yellowish-red color, slightly astringent bitter and burning taste, peculiar, vaguely similar to honey flavor. Distillation is not applicable. Aqueous extracts of the herb lead to an increase in the binding capacity of pectin, which is important for the confectionery industry.

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**Wild strawberry (Fragaria vesca L.)**

**Botanical characteristics.** It is a perennial herb of the Rosaceae family (Rosaceae) with a horizontal or oblique rhizome, covered with scales, with long aboveground rooting shoots (flagellum). The leaves are radical, on long petioles trifoliate. Wild strawberry ripens earlier than the garden one. The berries are very fragrant.

**Geographical range.** Wild strawberry grows almost throughout the Europe, as well as in Central Asia and Siberia. Its typical is the zone of sparse forests, forest edges, clearings and deforestation, as well as forest meadows and shrubs. Despite the fact that it is widespread plant, it does not form large tangles. This is due to the depressing effect of some grass species.

**Chemical composition.** The fruits contain ascorbic acid, carotene, sugar (10-15%), malic and salicylic acid, a small amount of tannin, pectin, anthocyanin compounds: tripalantoside pelargonidine triglycoside and cyanidin. The leaves contain even more ascorbic acid than the berries.

**Pharmacological properties.** Strawberry has a tonic, anti-inflammatory, antiseptic, cholagogue, diuretic, antiscorbutic, hypoglycemic and laxative properties. It improves the processes of blood and metabolism, contributes to the excretion of cholesterol. The leaves have hypotensive, hemostatic, anti-inflammatory, astringent, antibacterial, deodorizing, bleaching and wound healing effects.

**Application.** The fruits are eaten fresh. They are also used for making jellies and compotes. The leaves are brewed and drunk as a tea. Berries are used in the manufacture of confectionery [49], vodka, and wine drinks [9,50].
Sweet-grass (*Hierochloe odorata* Beauv.)

*Botanical characteristics.* Sweet-grass is a perennial plant of the Poaceae grasses family (*Poaceae*) 25-70 cm in height. The leaves are broad, stiff, erect, with a cutting edge. Vegetative shoots are slightly rough, the tops of the generative shoots have 4-5 short horizontal branches with large triple spikelets. After flowering the stalks rise up in a form of a millet brush. The plant blossoms in April - May, the seeds fall to the ground only in late autumn or winter.

*Geographical range.* The plant can be found in the Europe, North America. It grows in meadows, sparse forests, glades. It prefers open spaces and under favorable conditions quickly forms dense thickets.

*Chemical composition.* The plant contains alkaloids, ascorbic acid, ferulic, melilotic and coumaric acid, coumarin, which gives the plant a specific flavor.

*Pharmacological properties.* In traditional medicine water and alcohol infusions are used to stimulate appetite and improve digestion during chronic diseases of the gastrointestinal tract and fever.

The plant is also used to treat intestinal diseases, tuberculosis, fever. Sweet-grass lotions are used for treating wounds and fungal diseases.

*Application.* The plant has a distinctive smell of fresh hay (due to coumarin), and a slightly astringent taste. Distillation is not applicable. The aerial part with remote basal leaves and buds is used for the production of alcoholic beverages, the most famous of which is "Zubrovka", and fruit wine beverages and balsams [9,30].

Ginger (*Zingiber officinale* Rosc.)

*Botanical characteristics.* Ginger is a perennial herb of the ginger family (*Zingiberaceae*). Its name is translated from Sanskrit as "horned", which is apparently due to the form of its root. Ginger has a fleshy branched creeping horizontal root. Its stalks are smooth, reed-like and reach a height of 2 m. The leaves are lanceolate and alternate. The flower stalks are scaly. The plant blooms with orange-yellow or brown flowers in form of an ear-like inflorescence.

*Geographical range.* Ginger’s homeland is South-East Asia and the West Indies. The plant doesn’t grow in the wild. It grows in a warm and humid climate at an altitude of 1500 m above sea level. Ginger is cultivated in tropical and subtropical regions of China, Japan, Vietnam, India, West Africa, Argentina, Brazil, Jamaica. More than 100 thousand tons or half the world's production of ginger is grown in India.
Chemical composition. The rhizome (Fig. 3) is used as a spice, which has a pleasant fragrance due to the contents of essential oils. Essential oil (minimum 1.5%) contains zingiberen, zingiberol and bitter-tasting gingerol [51]. The plant also contains para-hydroxybenzaldehyde, vanillin and esters of kaempferol. The chemical structure of gingerol is very similar to capsaicin, and therefore cannot compete with the latter in interaction with VR1-receptors which causes neuropathic pain [52].

Pharmacological properties. Ginger stimulates appetite and digestion. Contra-indications for taking ginger are diverticulitis, diverticulosis, duodenal ulcer, reflux, bile concretions, gastro-intestinal illnesses, fever, breastfeeding, pregnancy, stomach ulcer and ulcerative colitis. Side effects of overdose are diarrhea, nausea, vomiting and allergic reactions.

Ginger may increase the risk of hypertension, the effects of anti-diabetic drugs that increase the risk of arrhythmia.

Application. Use of ginger gives good results in treating stomach diseases, even stomach ulcer. Lately ginger powder has been used to treat sea-sickness.

Ginger rhizome which has a form of round and flat, squeezed, finger-like pieces is used as a spice. Depending on the method of processing scientists distinguish white ginger (white and gray in color) and black ginger. White ginger is pre-washed, peeled, and then dried in the sun. Black ginger is brown, not scalded with boiling water and dried in the sun. The latter has a strong odor and hot taste. On the inside both types of ginger are gray-white. Ground ginger (most popular form) is a grayish-yellow powder.

In food industry, ginger is used to produce bitter liqueurs and punches. In England and the United States light ginger beer, ginger ale and wine are produced. Ginger infusion has a soapy flavor and aroma similar to the smell of camphor. It is recommended to soak the root in a soda solution [9].
**Fig, fig tree** (*Ficus carica L.*)

*Botanical characteristics.* The plant is a monoecious tree of the mulberry family (*Moraceae*) with gray bark and wide spreading crown. The leaves are alternate, three- and five-lobed, dark green, light on the lower side, pubescent, with a peculiar odor. All parts of the plant contain caustic milky sap. Small staminate and pistillate flowers are seated on the inside of a pear-shaped receptacle, which after fertilization becomes a stem. The stems are edible, creamy-yellow, dark purple or reddish (known as "figs") (Fig. 4). The plant blooms in April - May.

*Geographical range.* Widespread in Central Asia, Iran, and the Caucasus. It is widespread in the Mediterranean region, Malaysia and Iran.

*Chemical composition.* Dried figs contain sugar (48-75%), starch (3%), pectin (5.4%), protein (6%), fat (3%), acids (citric, malic and acetic acid), organic compounds containing iron, calcium, vitamins A and C, and various enzymes.

*Pharmacological properties.* The fruits are used for the production of a laxative medicine "Kafiol". The drug “Psoberen”, made from the plant’s leaves, has a photosensitizing effect and is used for the treatment of vitiligo and alopecia.

*Application.* Fig decoction is used to rinse the mouth during angina and other diseases of the throat; it is also used to treat flux. Fresh fruit can be consumed during gastric diseases and anemia. The milky fig sap is used to treat wounds and acne.

Figs are valuable flavoring plants. The high-calorie fruits are eaten fresh, dried up as confectionery, they are used to make jams and alcoholic beverages [9].

**Florentine iris** (*Iris florentina L.*)

*Botanical characteristics.* Florentine iris is a bluish-green plant of the Iridaceae (*Iridaceae*) family, with the height of 30-90 cm. It has a horizontal rhizome that is branched, light brown, thick, clubly-thickened, with ring-like leaf scars and numerous threadlike roots. The stems are few, straight-standing, smooth, smooth, with tussocks on the top. The lower branch grows out of the axils of a xiphoid green leaf. The leaves are 30-60 cm long; the basal leaves are gathered in groups of 7 at the base of the stem. The bracts are dry, membranous, short, silver-white. The stem and its branches have one large flower each. The flowers are sessile, with a simple perianth corolla, usually pale blue. The outer perianth lobes are bent, wide and ovate, cuneate at the base, with a longitudinal reddish row of fiber, the inner lobes are straight-standing, almost rounded, of a lighter color on the outside. The fruit is a continuous triangular boll. The seeds are globose or slightly flattened, irregularly
cylindrical, 3-8 cm in diameter. The plant blossoms in June, the seeds ripen in August.

**Geographical range.** The plant’s homeland is the Mediterranean region. Iris is cultivated in Italy, France and other countries. In Russia the plant has been cultivated as an essential oil plant since 1929-1930.

**Chemical composition.** The rhizomes contain volatile oil (0.1-0.2%), the main component of which is monoterpane ketone irone. In addition, the rhizomes contain organic acids (myristic, hendecylic, tridecylic, and benzoic), aldehydes (decyl, nonyl and benzoic), glycoside iridin, starch (60%), fatty oil (10%) and tannins. The leaves are rich in ascorbic acid.

**Pharmacological properties.** The essential oil contained in the rhizomes has expectorant properties. It helps treating inflammations of pancreatic and salivary glands, and vegetative neurosis. The fruits are used as an antibiotic.

**Application.** In medicine iris rhizomes are used as a laxative, diaphoretic during bronchitis, and in stomatology as an infant tooth growth stimulator.

The infusion has a light yellow color, the aroma of violets and hot taste. The process of distillation improves the flavor. The plant is used for flavoring wine and vermouth [9].

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**Hyssop (Hyssopus officinalis L.)**

**Botanical characteristics.** Hyssop is shrub of the dead nettles family (Lamiaceae) with the height of 70-80 cm. The root is woody, the stems are quadrangular, branched, glabrous or short and lowered, lignified at the base and virgate. The leaves are opposite, sessile, lanceolate, short, integral, 2-4 cm long and 0.4-0.9 cm wide, the upper leaves are even smaller. The flowers are small, are gathered by 3-7 in the axils of leaves, forming inflorescences at the top of the stem. The corolla is bilabiate, blue or purple, rarely pink or white.

**Geographical range.** Hyssop’s homeland is the Mediterranean region and Central Asia. It is cultivated in the CIS, South and Central Europe and India.

**Chemical composition.** The leaves of hyssop contain ursolic and omanic acids, tannins, the flowers - glycosidic flavonoids of hysopin and diosmin. Diosmin is the predominant flavonoid of hyssop [53].

**Pharmacological properties.** In traditional medicine hyssop is used for treating angina, gastro-intestinal diseases. It stimulates digestion and appetite. Hyssop infusion is a tonic drink recommended for older people. It helps deal with chronic
diseases of the upper respiratory tract, asthma, nervousness, excessive sweating. Hyssop decoctions and infusions are used for rinsing eyes to treat conjunctivitis, mouth and throat while treating inflammatory diseases, as well as lotions for bruises, rheumatism and wounds. Preparations containing diosmin are used for treating hemorrhoids and varicose veins. Diosmin itself possesses cardioprotective properties and is used for treating sub-chronic alcoholization.

Application. Hyssop is used for the production of colorless volatile oil containing pinene, camphene, cineol, etc. It has a grassy-spicy scent with floral tones. The essential oil is used in the perfume and cosmetics industry. As a spice hyssop is used in the fishing industry.

Dried leaves of the upper third of the plant are used in cooking. In the East hyssop is added to fruit drinks. It goes well with parsley, dill, celery, fennel, mint, marjoram and basil. Due of the sharp smell of the plant it is recommended to add small quantities of it into the food.

The hyssop aqueous extract has an olive, balsamic and camphor flavor with a shade of mushroom. Aromatic elements are released with the initial distillate fractions; the smell of the first fraction is similar to the smell of spearmint, later changing to that of ginger. When used in beverages the plant can produce a mushroom odor. Hyssop is used for the production of the "Chartreuse" liqueur [30].

Calendula officinalis, pot marigold (Calendula officinalis L.)

Botanical characteristics. The plant is an annual herb of the aster family (Asteraceae), with the height of 30-60 cm. The root system is stalky and branched. The stem is erect, branching at the base, ribbed, covered with stiff fiber. The leaves are alternate, the lower are petiolate, oblong and obovate, the upper ones are sessile, oblong or lanceolate. The flower baskets are large, reaching a diameter of 4-5 cm, located at the ends of the shoots. The flowers are yellow or bright orange, pistillate, gathered in several (up to 20) lines. The fruits are bent yellowish, brown or gray achenes. The plant blossoms from June to late autumn. The fruits (seedbags) ripen in late August - September.

Geographical range. In the wild the plant is found in the Mediterranean region, Africa and Asia, spreading in the Middle East to Iran. Some botanists note that calendula officinalis is an old natural hybrid of suffrutescent calendula (C. suffruticosa), which grows in Southern Europe, and the African marigold stellate (C. stellata).

The plant is cultivated as an ornamental and medicinal plant in many countries of Western and Eastern Europe (Germany, Austria, Hungary, Poland), including Ukraine, as well as in the U.S., Central Asia and the Caucasus.

Chemical composition. Marigold flower baskets contain carotenoids - lycopene, violaxanthin, rubixanthine, citruxanthine, flavoxanthine, flavochrome, neolykopene A. Marginal flowers contain about 3% of carotenoids. The brightly colored forms of the plant are particularly rich in carotenoids. In addition, the marigold
flower baskets contain flavonoids of the hydrocarbon-paraffin line, sitosterol, resins, triterpene glycosides, mucus, bitter elements, and organic acids (ascorbic, malic, pentadecylic, salicylic). The surface part of the plant contains a bitter element calendene, saponins and tannins.

*Pharmacological properties.* The medical value is mainly due to its antiseptic, anti-inflammatory and wound-healing effects. As an external remedy marigold preparations are used in dental practice to treat diseases of the mouth. Mouth irrigation with an aqueous solution of calendula tincture relieves inflammatory conditions, reduces or stops gum bleeding, helps seal the gum tissue. Marigold is used in the treatment of tonsillitis and sore throats. Calendula tincture douching is also used for the treatment of cervical erosion and trichomonas colpitis. A positive anti-inflammatory effect of this infusion is noted in the treatment of proctitis and paraproctitis. Tinctures, ointments, emulsions and the plant’s fresh juice are used to treat minor wounds, cuts, bruises, burns, abrasions. A positive effect of the plant is also noted in the treatment of blepharitis. Providing sedative and mild hypotensive action, marigold helps to normalize the cardiac activity and reduces swelling. Marigold infusions are also used in treating gastritis, gastric and duodenal ulcers, colitis and enterocolitis. The best results were observed when using marigold with chamomile and yarrow.

*Application.* Marigold flowers are used for the production of balsams and special vodkas [9].

*Viburnum opulus* (*Viburnum opulus* **L.**)

*Botanical characteristics.* Viburnum is a large tree-like shrub of the honeysuckle family (*Caprifoliaceae*), up to 4 m in height, with brownish-gray bark. Its crown is rare and often irregular. The leaves are opposite, petiolate, 3-5-lobed with an irregularly-coarse margin, dark-green, glabrous, lusterless from beneath, gray-green, lightly pubescence. The flowers are white or pinkish-white, fragrant, clustered in loose corymbose inflorescences, located on the tops of young branches. The marginal flowers are slightly larger and irregular, with a five-bladed flat whisk, leucocarpous, the central flowers are smaller, with a campanulate corolla, telianthus. The fruit is a juicy bright red drupe of an irregular spherical shape, with one heart-shaped flat seed, which occupies most of the fruit. Its flesh is large, juicy, bitter, sour and astringent. One brush can hold up to 80-100 fruits. The plant blooms in May - July, fruits ripen in late August - September and remain on the branches until the first frost. Astringent and bitter they lose their bitter taste after the frost. The plant gives a lot of fruits starting from its 3rd-4th year.

*Geographical range.* Viburnum is mainly European, but related taxa are found in the temperate zone of East Asia, which is the centre of diversity of the section Viburnum, and in North America. It is found in shady hardwood (alder, elm, alder-in-ash) forests, pine and deciduous forests and thickets, in fresh, moist and moderately moist soils.
**Chemical composition.** The bark of viburnum contains glycoside viburine, tannins of the pyrocatechol group (2%), and resin (6.5%), the saponified parts of which contain organic acids: formic, acetic, isovaleric, capric, caprilic, oil, linoleic, ceretic, palmitic acids, the unsaponifiable containing phytosterin, phytosterol and triterpene saponins (about 6%). The plant contains iridoid glycosides (opulusiridoid, acetyl-lopulusiridoid), chlorogenic, neochlorogenic, coffee, ursolic and oleanolic acids, salts of valeric and caprylic acids, vitamins and sugar.

The fruits contain up to 32% of invert sugar, tannins (up to 3%), pectin, essential oil, phytosterols, amino acids, pro-vitamin A, vitamins E, K, isovaleric acid, acetic acid and ascorbic acid. The seeds contain up to 21% of fatty oil. Viburnum contains many volatile elements that destroy pathogenic organisms.

**Pharmacological properties.** Viburnum fruits strengthen the heart; have astringent, antiseptic, hemostatic, choleric and diuretic effects, lower blood pressure, stimulate wound and ulcer healing, stop bleeding stomach and duodenal ulcers.

Viburnum bark improves the function of the stomach, intestines, lowers blood pressure, has antispasmodic, sedative, styptic, inflammatory, antiseptic, tonic effects, increases work capacity. Viburnum bark also enhances the muscle tone of the uterus and has a vasoconstrictor action associated with glycoside viburnin contained in the bark of the plant. Preparations of berries lower blood pressure.

**Application.** Fruits of viburnum are prescribed as tonic elements, especially for recovering patients, sometimes they are used for treating skin diseases, edema of cardiac and renal origin, hypertension, gastritis and liver diseases. Berries infused in hot honey for 6-7 hours are used to treat bronchitis, pneumonia and liver diseases.

Viburnum bark is used as a styptic for treating postpartum uterine bleeding, painful and heavy menstruation. As a hemostatic and anti-inflammatory element the bark is also used for treating haemorrhoids and diseases of the gastrointestinal tract. The flowers and fruits are used to treat hypertension, dyspnea, sclerosis, tuberculosis, cancer and kidney disease. Viburnum oil stimulates the reparative tissue regeneration.

Roots decoction helps to treat insomnia.

Viburnum fruits are used in the food industry for preparing berries in sugar and puree with sugar. Viburnum berries have pleasant bitterness and a large amount of useful properties, therefore they are used as a basis for bitter tinctures, special vodkas and balsams [9].
Cardamom (Elettaria cardamomum Maton.)

Botanical characteristics. Cardamom is a tropical perennial plant of the ginger family (Zingiberaceae). It has thick creeping rhizomes and two types of stems - a leaf stalk up to 3 m tall and creeping leafless flower stems up to 0.5 m tall. The plant breeds vegetatively by dividing the roots or seeds.

The plant begins blossoming 2-4 years after planting. Cardamom flowers are white or pale green, gathered in a small brush. The leaves are pale green, oblong, integral and lanceolate.

After the plant gives flowers the fruits containing seeds – 10-20 mm long bolls – are being gathered. Sun-dried fruits become pale yellow in color (Fig. 5). The most valuable fruits are the green boxes, which are dried at a varying temperature for 35 hours in specially equipped premises. The ground seeds are used as a spice.

Geographical range. Cardamom’s homeland is India. From India it came to the Middle East and from there was spread into Europe by the ancient Greeks and Romans, who added cardamom as a spice to fruit dishes and appreciated it for the beneficial effects on the body.

Today cardamom is cultivated in China, Indonesia, Sri Lanka, East Africa and the tropical regions of America.

Chemical composition. The seeds contain essential oil (4-8%), contains α-terpinel (45%), myrcene (27%), limonene (8%), borneol, its esters and cineole [54].

Pharmacological properties. The plant stimulates the normal functioning of the gastrointestinal tract, regulates the formation of gastric juice and increases appetite. The study of the pharmacological properties of cardamom oil revealed that the antispasmodic action is caused by blocking muscarinic receptors [55]. Cardamom extract reduces inflammation of the gastric mucosa of rats, caused by taking aspirin or ethanol [56], and inhibits platelet aggregation in human blood [57].

Application. Most often, the spice is added to confectionery, which harmonizes with the smell of cardamom - very strong, yet savory, spicy, pungent, slightly camphor with a light lemon touch. The whole fruit isn’t used. The shell itself has no flavor, but protects the seeds inside it from the loss of smell. The taste and smell of cardamom is spicy, so it gives a special flavor to cookies, marzipan, honey cakes, pie dough, fruit cake, compotes and fruit dishes.

Cardamom powder is added to black coffee. In food industry cardamom is used in the manufacture of gourmet soups, mustard, sauces, nut jams. It is used for the production of "dry perfume" that is used for flavoring cakes, tarts, etc. It is also used in the production of spiced and marinated herring and spicy sardines. It is included in a spicy mixture for preparing premium class sausages and liver sausages.
It gives a nice flavor to liqueurs and soft drinks. It is used in the production of famous liquors "Cuirass", "Chartreuse" and "Angostura". With high content of cardamom its flavor strengthens the spicy tones of drinks. The allowed content of cardamom in mixtures should not be more than 3% [9].

**Portuguese chestnut (Castanea sativa Mill.)**

*Botanical characteristics.* Portuguese chestnut is a tree of the beech family (*Fagaceae*) up to 30 m tall with a broad crown. The leaves of the chestnut are palmate, oblong, elliptical, with sharp ridges. Each leaf is attached to a branch with a stem. Chestnut flowers are gathered in long spike-like inflorescences. At the lower part of the flower stem seat the pistillate flowers, and at the upper - pollen flowers, that are whitish with a yellow tinge, have a pleasant smell and are collected in three or more balls.

*Geographical range.* The plant grows on the Black Sea coast of the Caucasus region, the Mediterranean zone and the Black Sea regions of Asia and in the West and North Caucasus.

*Chemical composition.* The fruits of chestnut contain parabanic, cis-aconitic, citric, ascorbic, maleic and fumaric acids [58]. The flowers contain naringin, apigenin-7-rhamnoglycoside, quercetin.

*Pharmacological properties.* Chestnut wood and bark are rich in tannins. Chestnut leaves are used as a remedy for bronchitis, asthma and other respiratory diseases.

*Application.* The fruits ripen in October and have a distinctive chestnut color with a visible light spot at the base. Usually the fruit contains one (sometimes two or three) seeds. The fruits are very nutritious and tasty. They are consumed raw, boiled and fried. Chestnut flowers are used to produce soft drinks with medicinal properties [59].

**Dogwood (Cornus mas L.)**

*Botanical characteristics.* Dogwood is a tree or shrub of the cornel family (*Cornaceae*), from 3 to 8 m tall. Its crown often looks like a sphere. Its wood is very hard. The leaves are opposite, simple, spindle-like, 3-8 cm wide. The plant defoliates later than other trees.

*Geographical range.* Wild species grow in the Eurasia and North America, with China and Japan and the southeastern United States. It grows among shrubs and deciduous forests in Central and South-Eastern Europe. It is cultivated in many European countries and in Russia, but special plantations are rare. The trees are common in the gardens of Ukraine, Moldova, Crimea, the Caucasus. The plant gives fruit periodically.
**Chemical composition.** The fruits contain a significant amount of vitamin C, sugar (6.88-9.1%), malic (1.7-2.89%) and ursolic acid, pectin, anthocyanins (glycosides pelargonidine, delphinidin, cyanidin) tannins, cornine [60].

**Pharmacological properties.** The plant is widely used in traditional medicine as an astringent. Experiments on mice, receiving high-calorie food, showed that the inclusion of dogwood anthocyanins and ursolic acid into their diet improved their metabolic parameters [61].

**Application.** In European and Asian countries, the fruits of dogwood are used raw as a seasoning for various dishes. The plant is also used for making jellies, compotes, jams and beverages.

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**Red clover (Trifolium pratense L.)**

**Botanical characteristics.** Red clover is a herbaceous perennial plant of the legume family (Fabaceae), with the height of 50 cm and a highly branched stalky root. The stem is erect and slightly pubescent. The leaves are alternate, trifoliate, with broadly, finely serrated leaves with white spots on top. The flowers are small, red, pink, sometimes pale purple, gathered at the top of the stem into the spherical or slightly oblong clove. The fruit is an ovoid single-seeded bean. The plant blooms in June - August, and fruits ripen in August - September.

**Geographical range.** The plant grows in the meadows, field margins, grassy slopes, forest edges, clearings, among bushes, on roadsides almost throughout all countries of the Europe. It is also widely cultivated as a valuable fodder crop.

**Chemical composition.** Clover contains volatile and fixed oils, glycosides trifolin and izotrifolin, vitamins C, E, and the B group, carotene, free amino acids, tannins, flavonoids, organic acids, minerals (copper, boron, molybdenum, etc.).

**Pharmacological properties.** The inflorescences which are harvested during the flowering period are used for therapeutic purposes. They have diaphoretic, anti-inflammatory, antibacterial, spasmolytic, expectorant, diuretic, choleretic, hemostatic, desensitizing and wound healing effects. Red clover contains formononetin and genestein and therefore exhibits estrogenic activity.

**Application.** Clover is used for treating acute respiratory diseases, acute and chronic laryngitis, bronchitis, asthma, bronchiectasis, chronic pyelonephritis, cystitis, edema of cardiac and renal origin, chronic gastritis, enteritis, colitis, cholecystitis, hepatitis, various internal (especially uterine) bleeding, hypermenstruation, algodismenorrhea. It can also be used externally in the treatment of catarrhal angina, acute and chronic pharyngitis, stomatitis, gingivitis, eczema, neurodermatitis, vitiligo, ordinary acne, wounds, ulcers, burns, simple acute vaginitis. Clover flowers are used in soft immune balsams and alcoholic balsams.
**Botanical characteristics.** Cranberry is a shrub of the heath family (*Ericaceae*) with creeping aerial shoots. The leaves are green even in winter, are narrow and ovate or lanceolate, 3-8 mm long and 1-2 mm wide, acuminate, leathery, on short (less than 0.5 mm) bare stalks, blue-gray on the bottom side. The flowers are seated singularly or in twos on the final short shoots covered with bud scales. The pedicels are 1-3 cm long, glabrous, with 2 bracts in the lower half or sometimes closer to the center. The flowers are drooping, with short rounded sepals. The corolla red, divided almost up to the base into 4 oblongs 5 mm long lobes. The stamens have flattened fibers and anthers with long tubular paired ends. The ovary is inferior. The berries are red, watery, spherical or pear-shaped, 5-10 mm in diameter.

**Chemical composition.** Berries contain vaceinine glycoside, flavonoids, organic acids: citric acid (12.8%), benzoic, oxoglutaric, quinic, sugars (glucose, fructose) from 3 to 6%, pectin and pigments, vitamin C, nitrogenic and tannin elements, volatile, iron, manganese, iodine, silver, barium, lead. In addition, they are rich in potassium and iron. Cranberry also contains specific active ingredients such as vaceinine glycosides (6-benzoyleglucose) and triterpene acids - ursolic, oleanolic.

According to the content of biologically active substances and mineral salts cranberries are the most useful wild berries.

**Geographical range.** Cranberry grows in sphagnum and hypnum bogs and marshy woodlands on watersheds and river valleys, on the sedge-moss lake shores. In the mountains it grows up to the subalpine zone, in the north enters the forest-tundra zone and spreads in the shrub-tundra and sphagnum hummocks in tundra.

**Pharmacological properties.** The berries have anti-inflammatory, antipyretic, antibacterial, tonic, wound healing and refreshing effects, they increase elasticity and strength of blood capillaries, improve the appetite and digestion, stimulate the stomach and intestines. The plant also lowers the amount of prothrombin in the blood.

**Application.** The berries are widely used for treating gastritis with low acidity of gastric juice, colitis, pancreatitis and obesity. They enhance the effects of antibiotics and other drugs when treating cystitis, nephritis, gynecological inflammatory diseases and prevent urolithiasis. Berries with leaves stimulate metabolism, reduce headaches and heartburn.

Cranberries are widely used in food: for cooking jams, juices, fruit drinks and jelly. Syrup and juice quench thirst, decrease temperature, have a diuretic and bactericidal effect, improve sleep and the endocrine function, reduce headaches, fatigue, invigorate and improve the general condition of the body. Cranberry has traditionally been the base of many alcoholic beverages.
Coriander (Coriandrum sativum L.)

Botanical characteristics. Is an annual herb of the celery family (Apiaceae). It has a stalky root, a cylindrical, naked, ribbed, upright or genuflexuous stem, sometimes with anthocyanin coloration, that has a large amount of branches and reaches up to 120 cm in height. The leaves are alternate. The lower ones wither early. The basal leaves are seated on long stalks. The lower stem leaves are short, the upper – sessile and sheathing. The flowers are white or pinkish, sometimes creamy or pale purple, telianthus, with 5 petals, collected in a 4-6-beam inflorescence – a complex umbel. The calyx is gamophyllous, with five ridges: the two external ones being longer than the three internal. The outer petals of the marginal flowers of the umbel are larger than the internal. The flower has five stamens, pistils with a forked stigma and a bottom dithecal ovary. The main stem ends with the central umbel; the shoots are of the first and second order. Flowering begins with the central umbel. Flowering begins simultaneously in all umbels of the shoots of different orders. The fruit is a spherical diachenium with a diameter of 2-7 mm.

Geographical range. The plant’s homeland is the Mediterranean region. It was imported by the Romans to England, and then spread throughout Europe. In the countries of the CIS coriander is found in the wild in the Caucasus and Crimea. It is a basic culture in Russia that is used for the production of essential oil.

Chemical composition. The fruit contains coriander essential oil (1.4 to 2.1% of the dry weight basis). Coriander essential oil contains more than 20 components, including alcohols: α-linalool (60-80%), geraniol (3-5%), geranilacetate (up 5%), borneol (1.4%), the acetic esters and aldehydes of decyl, decylen and isodecylen (0.2 - 2.5%), terpenes. Coriander fruit contains from 18 to 28% fatty oil, consisting of oleic (28.5%), isoleic (52%), linoleic (13.9%), palmitic (3.5%), stearic (1.5%), and myristic (0.6%) fatty acids.

Pharmacological properties. Coriander fruit excite the appetite, increase secretory and motor activity of the stomach, increase bile secretion, exhibit a carminative effect. The hydroalcoholic extract of coriander seeds has an anthelmintic action [62].

The seed is used in medicine as an aromatic, stimulant and choleretic element. Its fruits are part of anti-haemorrhoid, laxative and choleretic medicine. Coriander essential oil has an antiseptic effect [63], increases the secretion of the glands of the digestive tract. In Jordan, coriander is used to treat diabetes, along with such plants as fenugreek (Trigonella foenumgraecum L., Lupinus albus L.), garlic (Allium sativum L.), olive (Olea europea L., Cumminum cuminum L.), sage (Salvia officinalis L.), and tillet (Tilia cordata L.) [64, 65].

Application. Essential oil is the feedstock for linalool, citral and other derivatives that are used in the manufacture of perfumes and medicines. Fatty oil is used in soap-making and textile industries. It is used for the production of oleic acid. Its bagasse is used as fodder.
**Cinnamomi Ceylon, cinnamon (Cinnamomum zeylanicum Nees. Cinnamomum cassia Blume)**

**Botanical characteristics.** Cinnamon or cassia is a tree of the Lauraceae family (*Lauraceae*) up to 15 m tall. Its cylindrical branches have oppositely arranged large oval leaves with short petioles; the smell of the leaves is similar to cloves. Its whitish-green inconspicuous flowers are collected in little panicle-shaped inflorescences. The bark of the cinnamon tree is collected almost exclusively on plantations (Fig. 6), which are created near water, as this plant needs plenty of groundwater. After several years of growth, the stems are cut down to allow spears to form on the stumps. Two years later, these spears are cut and cleaned from leaves. Then, at a distance of 20 cm from each other circular cuts are made in the bark and which are then connected together with long cuts. The bark is stripped in forms of grooves with special knives. Then it was cleaned from the outer layer. The essential oil is obtained by steam distillation.

**Geographical range.** Cinnamon’s homeland are the tropical rainforests of Southeast Asia. Ceylon cinnamon is common in Sri Lanka, India, Myanmar, Vietnam, Chinese cinnamon is cultivated in China, Vietnam, Sri Lanka and Indonesia.

**Chemical composition.** The bark of the plant contains essential oil (4%), which is a yellow, darkening during the storage, liquid with a pleasant smell of cinnamon and sweet, slightly pungent taste. The oil contains mostly cinnamaldehyde (75-90%), 2-hydroxycinnamic aldehyde and cinnamic acid acetate, and eugenol, caryophyllene, and significant amounts of coumarin (up to 7%) [66].

**Pharmacological properties.** Cinnamon oil can be used to eliminate gastric fullness, bloating, and spastic disorders of the gastrointestinal system. There is a limit on the use of cinnamon bark in compositions for cosmetics because it has a slight phototoxic effect and can cause sensitization reaction. It should not be applied to the skin. It is a strong antiseptic against gram-positive and gram-negative bacteria [67]. Cinnamon extract may be used for the correction of hypoglycemia and preventing complications caused by diabetes mellitus [68, 69]. The hydroalcoholic extract of cinnamon has anxiolytic action [70]. Cinnamon oil can be used against home and dust pyroglyphic mites *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus* that cause asthma and other allergic diseases (rhinitis, conjunctivitis, neurodermatitis, etc.) [71].

**Application.** Cinnamon sticks or powder are used for seasoning Christmas dishes, mulled wine, desserts and fruit compote. The infusion has a reddish-brown color, a sweet burning taste, and strong flavor. In the distillation of the most valuable flavor fractions make 50-70% of the distillate. The plant gives a positive effect on the flavor of drinks, when its dose is not less than 5-8%.
Adam's-rod, Jupiter's-staff, bullock's lungwort, cow's lungwort, dock mullein, flannelleaf, mullen dock, velvet mullein (Verbascum thapsus L.)

Botanical characteristics. The velvet mullein is a biennial herb of the figwort family (Scrophulariaceae). It has a powerful taproot. In the first year the plant forms only a rosette of densely pubescent rough leaves. Then it develops a large densely pubescent stem 1-1.6 m tall with seating decurrent leaves. Bright yellow flowers form a dense spicate inflorescence and not bloom all at once but gradually, with a few flowers appearing every day, and falling very quickly. It flowers from June (July) and August (September).

Geographical range. It is native to Europe and Asia is now widely distributed in the mid latitudinal parts of the world. It grows mainly in the sun: on rocky slopes, in thickets, on forest glades, and openings.

Chemical composition. The corolla of the plant contains saponins, flavonoids, iridoids and essential oil. Among the flavonoids found in the plant’s flowers scientists are quercitin, quercitrin and rutin. The above-ground mass of the plant contains saponins, glycosides, traces of alkaloids, vitamin C, traces of essential oil, malic and phosphoric acid.

Pharmacological properties. Velvet mullein is a popular traditional remedy, effective in the treatment catarrh of the upper respiratory tract. The mucus contained in it alleviates irritation and the saponins dissolve thick mucus in the bronchial tubes and ease expectoration [72].

Application. It is used to treat trigeminal neuralgia, ear pain, hoarseness and "hollow" cough. The plant has insecticidal properties.

Its flowers are used in food, are used for preparing drinks, salads and eaten raw. In Germany a drink «Baerenfang» is produced with the use of honey, lime green and mullein. The flowers are used to produce yellow dye.

Coffee tree (Coffea arabica L.)

Botanical characteristics. Coffee is a shrub or tree of the family Rubiaceae (Rubiaceae) with the height 4.5-6 m. The plant originally comes from the tropics of Asia and Africa. In plantations it is cut to a height of 1.8-2.7 m to ease harvest. The bark is thin and gray; the leaves are opposite, dark green and glossy. Fragrant white flowers are similar to jasmine and are seated in groups in axils of the leaves. The fruits are elliptical red or violet-blue berries with a thin layer of sticky, juicy, sweet pulp and two seeds adjacent to each other with their flat sides. They are covered with fine silvery skin and a parchment shell: these covers and the pulp
are removed before roasting the seeds. Abnormal single-seeded fruits called "male berries" or "bullets" usually develop at the ends of the branches. Coffee beans of different types have different caffeine content, which varies from 0% in humboltiana species from the island of Grande Comore to 2.9% in «Extra Medellin» grown in Colombia. Today coffee is cultivated in many tropical regions. It includes about 40 species, 19 of which are of commercial importance, but only 3 coffee trees – Arabian (C. arabica), Liberian (C. liberica) and powerful (C. robusta) – give the beans used for export and production of the popular tonic coffee drink.

Geographical range. The birthplace of coffee trees is Ethiopia from where the use of the coffee beverage spread to the Arab countries and Iran and then to Europe. The largest coffee producers are South America (especially Brazil), India and Sri Lanka.

Chemical composition. Raw coffee beans contain caffeine, trigonelline, chlorogenic acid, cafestrol diterpenes (0.6%) and kahweal, proteins, mineral salts [73].

Pharmacological properties. Caffeine strengthens and regulates the processes in the cerebral cortex (in appropriate doses), it enhances the positive conditioned reflexes and increases motor activity. The stimulating effect increases the mental and physical performance, reduces fatigue and sleepiness. Large doses, however, lead to the depletion of nerve cells. Caffeine reduces the effect of sleeping pills and drugs, increases the reflex excitability of the spinal cord, stimulates the respiratory and vasomotor centers. Cardiac function increases under the influence of caffeine, myocardial anastalsis becomes more intensive and more frequent.

Caffeine partially and selectively restores psychophysiological parameters and the operating abilities violated as a result of taking small and medium doses of alcohol. However, any combination of alcohol and caffeine does not lead to full normalization of human psychophysiological indicators to ensure the safe driving or other activities requiring increased attention and care. Caffeine in coffee and tea prevents the liver damage and the formation of clinically apparent evidence of the disease in individuals consuming alcohol or exposing themselves to other risk factors.

Coffee lowers blood pressure and prevents the development of alcohol hypertension in situations when people with high blood pressure (BP) consume excessive doses of alcohol. Caffeine used with alcohol reduces the risk of calcbucus formations. Moderate use of alcohol and caffeine has proven not to be a risk factor for ulcers of the stomach and duodenum, pancreatic cancer, Parkinson's disease, nicotine addiction relapse, morphometric disorders of spermatogenesis and primary infertility. It is also clinically or epidemiologically proven not to be a risk factor for sudden cardiac death. Caffeine does not affect the development of alcohol resistance and is not clinically proven to be a risk factor for the development of alcohol dependency [74]. Cafestrol and caveol are considered to raise the level of cholesterol in the blood, which may be due to the influence of the latter on the metabolism of bile acids and cholesterol [75, 76, 77].
Application. The sweet fruit pulp is edible and is used to make alcoholic beverages. The main product derived from coffee beans is the coffee drink. Coffee is also used as a flavoring component in baking, ice cream, chocolates and liqueurs.

Stinging nettle (Urtica dioica L.)

Botanical characteristics. Great or stinging nettle is a herbaceous perennial dioecious plant of the nettle family (Urticaceae), 60-170 cm tall with long creeping branched threadlike rhizomes and fine knotted roots. Its stem is erect, square, unbranched, sometimes with opposite branches. The leaves are 8-17 cm long, 2-8 cm wide, opposite, petiolate, ovate-lanceolate, gradually tapering and pointed at the ends, heart-shaped at the base, rarely rounded, serrate, with curved ends, dark green.

The petioles are shorter than leaf plates. The stipules are up to 12 mm long, oblong, membranous, integral or slightly serrate. The stems and leaves are covered with short and long stinging fiber (their touching the skin causes burning pain). The flowers are small, greenish, telianthus, with a simple four-petal perianth, collected in spike-like inflorescence growing out of the upper leaf axils. The staminate spikelets are erect, the pistillate later become drooping. The fruit is an ovoid or elliptical yellowish-gray nut (achene) with the length of 1.2-1.5 mm. The plant flowers from June to September.

Geographical range. Urtica dioica is widespread through Europe and North America, and also occurs in North Africa and parts of Asia. It grows in shady wet places, ravines, on roadides, among bushes and on wastelands near housing.

Chemical composition. Nettle contains urticine glycoside, tannins and proteins, formic acid, vitamins (up to 0.15-0.17% of ascorbic acid in fresh raw materials and up to 0.6% in dried plants), vitamin K, pantothenic acid, carotenoids (up to 13 - 14% of the fresh leaves and up to 50 mg% in dry leaves), chlorophyll (2-5%), sitosterol, histamine, violaxanthin. Nettle is rich in organic and mineral substances and trace elements. These are flavonoids, nicotine, acetylcholine, coumarin, salts of iron, manganese, copper, potassium, calcium and barium. Nettle is a multivitamin plant. Its effects are due to the presence of vitamin K.

Pharmacological properties. Nettle has been used as a medical plant since ancient times. It has antibacterial, hemostatic, wound healing, diuretic, choleretic effects and may be used as an immunosuppressive [29]. It improves the function of the heart, stomach, intestines, liver, kidneys, blood composition. Nettle alcohol extracts have high antioxidant capacity [74].

Application. Nettle is used to normalize metabolism, the content of sugar in blood, it increases blood clotting, the amount of milk during lactation, normalizes lipid metabolism in the body, raises the hemoglobin level, increases the number of
red blood cells, intestinal and cardio-vascular tone, stimulates regeneration and epithelialization of affected tissues. Nettle helps to treat liver diseases, rheumatism, diseases of the gastrointestinal tract and the bladder.

Nettle is used for the production of special vodkas, is included in the composition of balsams. Nettle is used for the production of antianemic salt seasoning for dietary treatments of iron deficiency.

*Rhaponticum carthamoides*, maral root (*Stemmacantha carthamoides* (Willd.) H. Dittrich)

**Botanical characteristics.** It is an herbaceous perennial plant of the Asteraceae family (*Asteraceae*), 40-100 cm in height. Its rhizome is thickened, short, woody, horizontal, dark brown in color, with numerous thin fragile roots. The stalks are ribbed, hollow, slightly arachnoid, a little inflated at the ends, usually ending with a large basket.

The leaves are alternate, elliptic or oblong-ovate, becoming smaller to the top of the stem, pinnate, with a larger terminal lobe and 5-8 pairs of ribbed at the edges pubescent side lobes. The lower leaves are 12-40 cm long, with short petioles, the upper ones of which are integral, coarse and sessile. The basket is covered by imbricate-located spear-shaped leaves, which form a membranous, brown, ovate, adjunct, pointed at the end and covered with soft fiber at both sides, the upper part of which is bent outward. The receptacle is densely covered with long white small bristles. The flowers are violet-purple, telianthus, with a tubular widening at the upper part, and a deeply cut five-lobed whisk. The plant has five stamens; the filaments are covered with small papillae; the anthers are fused into a tube. The pistil has an inferior ovary and two blunt flat long stigmas. The fruits are brown, ellipsoidal, slightly tapered, longitudinally ribbed achenes, 5-7 mm in length, with a tuft of feathery setae fused at the base into a complex ring. In the wild the plant flowers in July - August, while in plantations - in June. The harvest period is August - the first half of September.

**Geographical range.** This endemic plant grows in Siberia in the Sayan, Altai, Kuznetsk Alatau and reaches the Lake Baikal. Due to the difficulty of harvesting and the limited habitat of the natural resources the plant is cultivated in the humid forest areas.

**Chemical composition.** The rhizomes and roots of the plant contain β-ecdysone, glycosides, ascorbic acid (0.1%), carotene, inulin, 5% of tannin substances and essential oils, flavonoids: hesperidin, quercetin, quercetagetin, luteolin, kaempferol, phenol-carbonic acids: n-oxybenzoic, vanillic, caffeic, ferulic and chlorogenic; three-terpene saponins. Aqueous extracts contain chlorogenic acid that has the highest antioxidant activity [78].

Ecdysteroids of the plant have a strong antioxidant effect, inhibit lipid peroxidation and thus stabilize the cell membrane:

Chlorogenic acid restores the process of transforming glycogen into glucose in the liver (glycogenolysis) and thus contributes to the absorption of glucose [79,
80]. Chlorogenic acid with low toxicity and practically no side effects has notable antiviral and antibacterial properties. The application of chlorogenic acid and its derivatives can improve the efficiency of the complex chemotherapy of glioma cells - one of the most common brain tumors [81].

**Pharmacological properties.** The usage of this plant in medicine excites the central nervous system; the plant has properties opposite to those of sleeping pills, increases arterial pressure, dilates the peripheral blood vessels, increases the rate of blood flow and strengthens the heart muscle. It is used as a stimulator to treat functional disorders of the nervous system, mental and physical fatigue, low efficiency, impotence and chronic alcoholism. Its extracts exhibit high antioxidant activity [82].

![Chemical structure](image.png)

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**Application.** The plant is used to treat consequences of alcoholic intoxication and depression. Its rhizomes are part of a Russian phytotherapeutic drug used for treating and rehabilitation of alcoholics. There are numerous scientific data considering the use of the plant in treating neoplastic diseases.

Medical preparations of this plant increase the efficiency of tired skeleton muscles. Apparently, this is due to the increase (under the influence of the plant) of the content of glycogen, lactic and adenosine triphosphoric acid and creatine in the muscles. Such medicine is low toxic, and has no noted side effects. The roots are used for making alcoholic beverages and balsams.
Hazel (Corylus avellana L.)

Botanical characteristics. Hazel is a shrub of the birch family (Betulaceae) with the height of 2.7 m. Its stem is branched and covered with brown bark. The young branches are gray and glabrous; the yearly branches are yellowish-gray, covered with fiber or bristles and glands. The buds are round or ovoid, pressed from the sides, with rounded scales that are bare or thinly pubescent and ciliated at the edges. The leaves are alternate, large, petiolate, 5-12 cm long, rounded, oblique-cordate at the base and pointed at the end, irregularly-dentated, pubescent at the veins (the number of which varies from 8 to 12); its stalks are bristly and glandular, with the length of 8-15 mm, the stipules are oblong-ovate, obtuse and covered with fiber (Fig. 7).

The flowers appear before the foliage. The plant is monoecious: one bush has both - staminate catkins and are pistillate flowers. It blossoms in March – April and gives fruit (the nut) in late August - September.

Geographical range. In the wild hazel is found in the Europe, in the southern mountainous regions of Central Asia and the Caucasus. It is also cultivated in the southern region of Russia, Central Asia, the Caucasus and Ukraine. It is cultivated in gardens. In the wild it grows in the mountain areas along canyons and hillsides, along streams, in mixed and deciduous forests.

Chemical composition. The branches and leaves contain tannins, flavonoids, essential oil, triterpenoids, vitamin C, carotene, anthocyanins and palmitic acid. The fruits contain proteins (14.4-18.4%), including hazel-specific protein - corelin, carbohydrates, sugars, carotene, vitamins B₃, B₅, E, PP and a large amount of fatty oils (62.1-71.6%), which contain saturated and unsaturated fatty acids: oleic, linoleic, myristic, palmitic and stearic.

Pharmacological properties. The plant has astringent, antidysereric, vaso-constrictor, antipyretic and anti-inflammatory effects, it increases the separation of milk during lactation and strengthens the walls of blood vessels. Nut butter has laxative and choleretic action. The combination of three factors: the increase of bile secretion, acceleration of the movement of food and the increase of cholesterol binding with unsaturated fatty acids in the intestines creates the most natural physiological conditions for the removal of cholesterol from the body.

Application. The plant is used for treating colds, varicose veins, venous leg ulcers, bleeding from small capillary vessels, for the treatment of intestinal diseases, anaemia, beriberi, rickets, colitis, kidney stones and rheumatism. A powder of the dried involucrure or the decoction of the shell is used to treat colitis, the nuts are used to treat urolithiasis and in combination with honey - rheumatism, anemia and as a general tonic.
Hazel nuts are tasty and nutritious. Unsaturated fatty acids contained in the nut increase the content of phospholipids in blood. Hazel nuts are widely used in the food industry. Hazelnut kernels can be an affordable alternative to pine nuts in the production of balsams and infusions.

**Magnolia-vine (Schisandra chinensis (Turcz.) Baill.)**

*Botanical characteristics.* Magnolia-vine is a beautiful vine of the Schisandraceae family (*Schisandraceae*) with a powerful rhizome and dark green leaves, whose vines reach the height of 15-16 m. Its leaves are dark green, elliptic or oblong-ovate, large with long pink or purple stalks. There are monoecious plants with pistillate and staminate flowers and dioecious plants - with only staminate or pistillate flowers. Magnolia-vine flowers are waxy, creamy-white, sometimes pink with a delicate pleasant aroma. The pedicels are long and drooping, the flower diameter is 1.5 cm. The plant blossoms in June. Its fruit is a juicy multifoli formed by carpels. The berries ripen in late August - September.

*Geographical range.* In the wild the magnolia-vine is common in the Far East. It is grown in Japan, China and the Korean Peninsula. It grows well in the riverine parts of the rivers and streams, and on the northern and western boundary of the habitat - in the floodplain forests. In the wild the plant usually breeds with the help of root shoots and stems contacting the ground. With enough light the plant gives fruits abundantly every two or three years. The young plants prefer shade-enduring and the seeds germinate well even under heavy tree conifers. However, with age magnolia-vine increases its need for good light and therefore tall and fruiting plants are usually found on the forest edges, openings and sites forest fires.

*Chemical composition.* The plant’s berries and leaves apart from micro and macroelements contains malic, tartaric and citric acids, sugar, dyes, schisandrole, tannin, essential oils, vitamins C, E and fatty oils.

*Pharmacological properties.* Magnolia-vine stimulates the central nervous system, improves the positive reflexes, stimulates reflex excitability, increases blood pressure, decreases heart rate, increases its amplitude, quickens the rhythm quickens and increases the amplitude of the respiratory movements, improves the neuromuscular conductivity, increases visual acuity, reduces the level of sugar, increases the efficiency of the body, improves digestion, tones the uterus and skeletal muscles, improves the metabolism and male sexual function, treats infertility, venous ulcers and wounds.

*Application.* Since ancient times magnolia-vine has been a popular tonic herb in the traditional medicine of Korea, Japan and especially China. Its Chinese name "wu-wei-ci" is translated as "a fruit having five tastes": the peel and pulp of the fruits are sour and sweet, the seeds are bitter and astringent, and the whole fruit, if chewed, has a salty taste. In Primorye, the local hunters - Nanai (the Golds) – use dried fruits to maintain strength and courage during long travels in the forest. In the
early 40's of the 20th century the scientists noted that the magnolia-vine seeds contained an alkaloid that acted as a stimulant on the body. It got its name “schisandrine” from the Latin "Schizandra" (or Skhizandra). Tinctures, powders or pills of the plant are used in medicine for the excitation of the central nervous system and respiratory and cardiac activity stimulation. In addition, the fruits, leaves and shoots of plants can be used in the food industry to produce fillings for chocolates and wine liqueur. The stems and leaves are brewed into a tea to give it a lemon smell and taste.

**Small-leaved linden (Tilia cordata Mill.)**

**Botanical characteristics.** Small-leaved linden is a tree up to 20-25 m tall, with a large spreading crown, belonging to the linden family (Tiliaceae). Its bark is dark, almost black deeply chinked; its young twigs are reddish brown, usually naked. The leaves are alternate, long, heart-shaped plates 5-10 cm long; they are dark green, serrated from the top, with a long-pointed tip, usually symmetrical, (rarely oblique), the width about the same as the length. The bottom leaves are bluish-green, with tufts of yellow-brown fiber at the nodes of the veins. The plant usually blooms in May - June. The flowers are yellowish-white and fragrant, 10 mm in diameter, and are gathered in groups of 3-15 units forming semiumbels. Each inflorescence has a pale, yellowish-green, oblong-lanceolate thin bract about 6 cm in length, fused with peduncle up to a half of its length. The fruit is a brown seeded nut, 4-8 mm in diameter, round, tomentose, with a woody or leathery shell; the seeds are wide reversely ovate, 4-5 mm in length, shiny and reddish-brown in color. The flowering continues for about two weeks. The plant blooms in late June - July, the fruits ripen in August - September.

**Geographical range.** This plant grows the zone of mixed and deciduous forests of central Europe, in the Ukraine, Moldavia, the Crimea and the Caucasus.

**Chemical composition.** The flowers of linden contain essential oils, which are composed of farnesol, glycosides - hesperidin and tiliadin, saponins, flavonoid quercetin and kaempferol glycosides, tannins, vitamin C (31.6%), carotene. The leaves of linden contain a large amount of protein, 131 mg% of vitamin C and carotene. The fruit consists of about 60% of fatty oil, similar in quality to the Provence olive oil. The bark contains a triterpene element - tiliadine and up to 8% of oil. The components of the flower nectar are the so-called lime ether (2,4,5,7a-tetrahydro-3,6-dimethyl-benzofuran) and 4-(1-hydroxy-1-methylethyl)-cyclohexane-1,3-diene-1- al [83].

**Pharmacological properties.** The healing properties of lime are provided by quercetin and kaempferol. Tiliacyne has volatile effect. Lime preparations are used
as calming, soothing, bile extorting, diuretic, diaphoretic, expectorant, antimicrobial, anti-inflammatory, emollient elements, they stimulate the stomach and moderately reduce blood viscosity.

**Application.** Linden blossoms are harvested in large quantities (one young tree growing on a forest edge can provide you with 0.7-1.5 kg of fresh blossoms). They are used for the preparation of hot infusions ("tea") used as a diaphoretic remedy for colds. Such infusions are recommended for rinsing the mouth and throat due to their germicide effect.

Flowers containing up to 0.1% of fragrant essential oil are used in the production of alcoholic drinks. Lime inflorescences are used to flavor liqueurs and balsams. The extract is yellow, has a honey fragrance and a slightly astringent taste. The aromatic components are received with the first distillate fractions.

**Burdock (Arctium lappa L.)**

**Botanical characteristics.** Burdock is a large biennial herb of the aster family (Asteraceae) with a height of 60-180 cm. It has a fleshy tap subramose spindle-shaped root, up to 60 cm long. During the first year it is juicy, and in the second it becomes flabby and hollow inside. During the first year the plant forms its basal leaves, and in the second – a powerful erect ribbed, red, highly branched at the top and slightly glandular stem. The leaves are petiolate, gradually becoming smaller towards the top of the stem; they are broad, heart-shaped, ovate, serrate, covered on the top with fiber or glabrous, gray-tomentose from below. The lower leaves are large, up to 50 cm in length and width. The flowers are collected in round baskets 3-3.5 cm in diameter, located in a form of a corymbose panicle at the ends of the stem and its branches. The basket’s wrapping is bare, green and consists of imbricate-arranged, linear, pointed, rigid, curved leaves. The basket’s phoranthium is slightly convex, densely covered with rigid, linear-subulate bracts. All flowers are tubular, telianthus, with a lilac-purple rim. The cup has a form of a tuft. The flower has 5 stamens whose anthers are united into a tube with arrow-shaped appendages. The pistil has a lower unilocular ovary. The fruits are oblong, glabrous, ribbed, spotted achenes, 5-7 mm in length, with a tuft of multilayered yellowish-white hard easily abscissed fibers.

The plant flowers in June - August. The fruits ripen in September - October.  
**Geographical range.** Burdock grows in centers of population in wet wastelands and in non-arable places. It spreads everywhere from lowlands to mountain areas across Europe and Russia.

**Chemical composition.** The dry matter contains protein (18.4%), albumen (15.4%), fat (1.5%). During blooming the leaves contain 17 mg of ascorbic acid per 100 g of crude mass. In addition to ascorbic acid in the leaves also contain essential oils, tannins, etc.
Pharmacological properties. Burdock has anti-inflammatory, wound healing, blood-refining effects, regulates the metabolism. It is used for treating gastrointestinal diseases, and kidney, liver and bladder problems. Burdock is considered to be a good remedy for a variety of skin diseases, eczema, boils and ulcers. Burdock broth is used for rinsing hair to improve its growth and get rid of dandruff.

Application. Young burdock roots are used in food. They are very popular in France, Belgium, the USA and China. It is especially loved and widely used in the food industry in Japan where it is bred in gardens and plantations. Sweet and succulent roots are dug in the fall and eaten fresh, baked and fried. Burdock root extract is part of the food additives used to enhance the antitoxic function of the liver under the influence of alcohol.

Sea parsley; lovage (Levisticum officinale Koch.)

Botanical characteristics. Sea parsley is a perennial herb of the umbelliferae family (Apiaceae) up to 2 m tall. The rhizomes and roots are large, fleshy and multi-bulbed. The stems are numerous, erect, round, fistulose, longitudinally furrowed, with a bluish bloom, branched above. The leaves are alternate, large, dark green, shiny on the upper side, double- and triple-pinnatifid into obovate or rounded-rhombic lobes with and incised-dentate apex and a cuneate base; the lower leaves are long-petiolate, the central are smaller, short-petiolate, the upper are sessile, with expanded sheath and nearly undeveloped plate. The flowers are small, yellow-green, with five petals, gathered in a complex umbel located at the ends of the branches. The fruit is a yellow-brown, oval-elliptical diachenium.

The plant blooms in June - August, the fruits ripen in August - September. The plant has a peculiar odor similar to that of celery, and a sharp salty-bitter taste.

Geographical range. Lovage never grows in the wild. Its homeland is a mountainous region of southern Europe, where it has been cultivated since ancient times as a medicinal, vegetable plant and spice. Later lovage was brought to North America. In cultivated areas it can often be found in the wild state. It is assumed that the wild form can be found in the remote mountainous areas of South-West Asia.

Chemical composition. The characteristic smell of the plant is due (to a greater extent) to the presence of alkaliphilyds [84]. All parts of the plant contain essential oil (up 2%), consisting mainly of terpineol, cineole and carvacrol. The roots contain furocoumarins (bergapten, psoralen), lecithin, tannins, minerals, resin, gum, angelic and benzoic acids, myristic acid and malic acid.

Pharmacological properties. Lovage is considered to be a diuretic, choleretic, sedative, antispasmodic, analgesic, wound healing, antipruritic, anti-inflammatory, antibacterial and expectorant. It stimulates the appetite, improves digestion, reduces flatulence and stimulates menstruation. It must not to be used during pregnancy because of the risk of abortion [85, 86].
Application. The plant is cultivated as a spice, and the water-alcohol tincture of the root and the flower baskets is used in the production of alcoholic beverages.

Sweet marjoram, annual marjoram, Greek oregano (Majorana hortensis Moench)

Botanical characteristics. Marjoram is an annual or biennial – and in its homeland in the European Mediterranean region and Africa – a perennial shrub nettle family (Lamiaceae) that reaches a height of 20-40 cm. Its stem is densely covered with obovate and entire leaves. The whole plant is densely downy of a gray-green color. Flowers are gathered in verticillasters on stalks in the axils of the upper bracteal and on the ends form a stem brush. The plant blossoms in summer.

Geographical range. The plant’s homeland is South-West Asia and North Africa. Today the major producers of marjoram are France, Hungary, Austria and Germany. Marjoram of the best quality comes from the South of France and Chile.

Chemical composition. Marjoram contains essential oil (depending on the growth conditions of 0.7 to 3.5%) with a very strong flavor, the main component of which is cis-sabinene (40%) and other terpenes, tannins, bitterness, vitamin C, carotene, etc.

Pharmacological properties. The plant improves digestion, is a flatulence remedy, calms the nerves, has a diuretic effect. In traditional medicine it is used to make baths and heal wounds.

Application. Marjoram has a distinctive aroma, a very spicy burning taste (similar to thyme, but subtler and sweet). It is used as a medicinal herb and spice. Dried leaves and flower tops are used to make infusions that have dark green color, a bitter astringent taste and distinctive spicy flavor. During distillation the aromatic substances are received with the first fraction.

Red raspberry, European raspberry (Rubus idaeus L.)

Botanical characteristics. Raspberry is a branched spiny shrub of the Rosaceae family (Rosaceae), with long rhizomes and right-standing shoots and the height of 1.5-2 m. The first year shoots are green and downy, the bottom ones are covered with thin brownish spikes. In the second year of life they become wooden, lose the spikes, give fruit and after that become dry; and the roots produce new annual shoots. The leaves are alternate; the lower ones are pinnate, with 5-7 leaflets on petioles, the upper are trifoliate with broad adnate or petiole stipules. The flowers are white, small and inconspicuous, with a greenish-gray downy cup, the lobes of which are bent down with fruit, gathered in small, paniculate-corymbose inflorescences growing from the axils of the leaves. The corolla consists of 5 petals. The fruit is an aggregate drupe, purple-red in color (in cultivated forms is sometimes
yellow). In the wild the raspberry drupe easily falls apart and in cultivated forms is tightly fused. The plant blooms in June - July, the fruits ripen in July - August.

**Geographical range.** In the wild it is found in the Europe, the Caucasus, Siberia and Central Asia. It is widely cultivated as a fruit plant. Its place of origin is Central Europe. It is found in all natural areas, sometimes forming large thickets.

**Chemical composition.** The fruits contain vitamins (ascorbic acid, B₁, B₂, PP, E, carotene), sugar (glucose - 4.3%, fructose - up to 8%, sucrose - to 6.5%, dextrose), organic acids (citric, malic, salicylic, tartaric, formic, nylon acids), alcohol (wine, isoamyl, phenylethyl). In addition, the berries contain essential oils, flavonoids (catechins, anthocyanins), tannins (up 0.3%), pectin, mucus, proteins, phytosterols (sitosterol, stigmasterol), cyanidin diglycoside, benzaldehyde, dye elements, pectin, potassium, copper and other trace elements. The seeds contain found, fixed oils (15%) and phytosterols (0.7%). The dried fruits contain proteins, purine and carbohydrates. Raspberry flavor is provided by more than 200 agents, including 1-(4-hydroxyphenyl)-3-butanone (raspberry ketone), α-ionone, β-damascenone.

**Pharmacological properties.** Raspberry improves the function of the stomach and the intestines, has and antiseptic, analgesic, antipyretic, expectorant, anti-inflammatory, anti-emetic and metabolic functions.

**Application.** Raspberry is both a pharmaceutical element and a food product. The fruits have a high taste quality. They are used for food, in the dry form - in medicine as a febrifuge. The berries are used for the preparation of jellies, compotes, juices and a variety of different pastries. Raspberry can be used fresh, dry and frozen. The best form for preserving the nutrients is to freeze the berries.

Traditional medicine uses raspberry berries, flowers and leaves. Raspberry is part of sweating, vitamin, anti-inflammatory and antitussive teas. The plant is useful as a preventive and therapeutic agent for treating metabolic disorders, particularly D-vitaminosis. Raspberries are used to improve the appetite while treating diseases of the stomach and intestines. Raspberry leaf infusion has a positive effect on female reproductive organs (treating premenstrual syndrome, nausea during pregnancy, preventing miscarriage, increases lactation and reducing postpartum pain).

Raspberries are part of numerous balsams, tinctures and berry wines. In Italy «Cordial campari» a cognac tincture is produced with the use of yellow raspberries. Raspberry leaves contain flavonoids, which have strong antioxidant activity, which may be one of the reasons for its use in the balsams and infusions [87].

**Satsuma orange (Citrus unshiu (Swingle) Marc.)**

**Botanical characteristics.** Satsuma is an evergreen tree of the rue family (Rutaceae) up to 4 m tall with branchy, grayish branches and coriaceous fragrant leaves containing numerous containers of essential oil. The flowers are axillary, small,
white and fragrant. Fruits are round-flat, orange-yellow, sweet-sour, with easily detachable thin fragrant peel, containing essential oil. The plant flowers in March-April and gives fruit in October - December.

**Geographical range.** The plant’s homeland is Japan. It is also cultivated in gardens on the Black Sea coast of the Caucasus.

**Chemical composition.** The fruit pulp contains sugar (up 10.5%), organic acids (citric, etc. - 0.6-1.1%), vitamins and volatile. The peel contains orange and yellow pigments (carotene - 12.5%), spirits (3%) and aromatic fatty oil. The oil composition includes aldehydes and methyl anthranilic acid, which gives satsuma oil a unique flavor and taste. The golden yellow ether essential oil is also found in flowers, leaves and young shoots.

**Pharmacological properties.** The fruit pulp which is a refreshing delicacy dietary product is used in the food industry. Fresh juice and fruits are popular among children, it is often used as a general tonic and improves cooked products including children's dietary rations. The volatile elements have an antimicrobial effect that allows the fruit to normalize digestion. The juice inhibits the intestine processes. The volatile activity may provoke some skin diseases. The scientists note a therapeutic efficacy of aqueous extracts of the fruit peel which is used in the treatment of acute and chronic diseases of the lungs as a cough expectorant and emollient agent. The peel is also used to increase the appetite.

**Application.** The fruit and the peel are harvested and used as expectorants to cure bronchitis. Tinctures and decoctions are taken before meals. Multiple juice applications are recommended for treating fungi, microspores and trichophytosis.

The fruit is used in the food industry for making juices, syrups, candies and jellies. The infusion has a yellow-orange color, the smell of tangerine and a bitter taste. During distillation the spicy flavor is received with the first distillate fractions.

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**Coltsfoot (Tussilago farfara L.)**

**Botanical characteristic.** Coltsfoot is a perennial herb of the aster family (*Asteraceae*) up to 20-30 cm tall. It has a creepy branched rhizome. The flowering stems appear in the early spring before the leaves and are erect, arachnoid-pubescent, densely covered with oblong-ovate, acute, brown-red scaly leaves. The green leaves appear after flowering, they are radical, big, thick, seated on long thin fiber petioles. The leaves are rounded cordate with a serrate margin; their upper side is smooth, hard and cold, and the lower white soft and warm. The flower baskets (florets) are single, seated on the tops of the stems, and droop after flowering. In the evening, as well as in wet weather, the inflorescence closes. The flowers are golden yellow, the marginal have a narrow lingular rim and are collected in the multiple layers; the central leaves are tubular with a five-dented corona and are shorter than the lingular. The fruit is a linear-oblong achene with a tuft of fiber, able to germinate within hours of falling into the soil. The plant blooms in April - May, the fruits
Ripen in May - June and are spread by the wind. It can propagate by seeds and vegetatively.

Geographical range. The plant is widespread across most of the Europe, the Caucasus, Siberia and Central Asia. It grows in moist clay soils on the steep banks of rivers and streams in wastelands, slopes of roads and embankments, forest clearings, edges, quarries, drained swamps. Quite often it forms continuous thickets, especially in disturbed habitats.

Chemical composition. The leaves of the plant contain the alkaloid tussilagine, inulin, essential oils, tannins, gums, sitosterol, gallic malic, tartaric and ascorbic acids, saponins.

The flowers contain triterpenes faradiol and arnidiol, tetraterpen taraksantin, stigmasterol and sitosterol, hydrocarbon heptacosane and tannins. Plant also contains hepatotoxic pyrrolidizine alkaloids senkirkine and senecionine [88, 89].

Pharmacological properties. Due to the content of a large amount of mucus in its leaves coltsfoot has a coating effect on the mucous membranes of the mouth, throat and larynx, protecting them from irritation. In addition, mucus, saponins and organic acids soften and liquefy the dry secretions in the upper respiratory tract, restore the natural movement of the ciliary epithelium in the trachea and bronchi, promote a more rapid evacuation of the phlegm. The tannins carotenoids and sterols have an anti-inflammatory effect: reduce hyperaemia of the mucous membranes, actively influence the different phases of the inflammation process.

Application. Leaves. In practical medicine the leaves’ infusion is used as an extortant, disinfectant and anti-inflammatory element for treating diseases of the
upper respiratory tract; as an astringent for treating diseases of the gastrointestinal tract. The leaves are part of the breast and diaphoretic “teas”. In traditional medicine decoctions, infusions and juice are used to treat pulmonary tuberculosis, bronchial asthma, bronchitis, pleurisy, pneumonia, colds, flu, inflammatory oral processes, dental pain, arthritis, myositis, allergies, epilepsy, malaria, edema, shortness of breath, gastrointestinal diseases, ulcers and gastritis, heart diseases, urinary and kidney problems. It is used externally to treat skin diseases, mastitis, boils, erysipelas, ulcers, burns; it helps strengthen the hair and cure copious dandruff. Crushed dried leaves can be smoked to treat the shortness of breath, breathing difficulties and to reduce toothache.

In traditional medicine the plant’s infusion, and powder made from the leaves are used to treat laryngitis, tracheitis, bronchitis, pneumonia, asthma, gastritis, enteritis, cystitis, nephritis, hypertension, disorders of the nervous system. It is used in form of tea to cure exudative diathesis and the general weakness of the organism.

It is a honey plant that provides nectar and pollen in early spring when there are still no other sources of honey. The plants infusion in an amount of about 2.0 kg per 100 decalitres is part of the ingredients of soft drinks.

*Lemon balm, bee lemon (Melissa officinalis L.)*

Botanical characteristics. Lemon balm is a perennial essential oil and spicy herb of the Labiatae family (*Lamiaceae*), with strong branchy rhizome. The whole plant is covered with soft fiber. The stem is branched, square, up to 120 cm in height. The leaves are opposite, cordate-ovate, coarsely serrate, petiolate. The flowers are pink or white, gathered at 3-5 in the cymes, located in the axils of the upper leaves. The fruit is large and consists of 4 ovoid black shiny nutlets. The plant blooms on the second year in July - August, the fruits ripen in September - October.

*Geographical range.* The plant’s origin is the Mediterranean region (from Italy to Syria and Iraq). It is found in the Caucasus, the Crimea, Central Asia and Europe. In Russia it is cultivated as a honey plant and essential oil plant.

*Chemical composition.* The plant contains essential oil (0.33%), which is composed of citral (55-60%), citronellal (5%), myrcene, geraniol, linalool, aldehydes, ascorbic acid (150 mg%), bitterness, mucus. The leaves contain up to 1% of essential oil, 5% of condensed tannins, caffeic, oleanolic, ursolic acids, the seeds - 20% of fatty oil.

*Pharmacological properties.* The plant has antispasmodic, analgesic, sedative, hypotensive, diuretic, carminative effects and improves digestion. Lemon balm infusion slows the respiratory rate and the heart rate, lowers blood pressure.

*Application.* The aerial part of the plant is used for medicinal purposes. In traditional medicine the plant’s infusion is used to treat diseases of the nervous system, gastric atony, cardiovascular diseases, hypertension, tachycardia, bronchial asthma, insomnia, melancholy, it is also a diaphoretic, stimulates digestion and relieves hiccups. In addition, it can treat toxemia during pregnancy, migraine, anemia
and gout. The juice excites the appetite, improves the functions of the digestive system, is used to treat constipation, flatulence, anemia, gout, acts as a painkiller for various neuralgia, severe headaches and stomach pains, treats dizziness, fatigue, apsychia, aching rheumatic fever, helps recuperate after severe debilitating diseases, treats insomnia, skin rashes, hysteria, neuroses of the heart, increased sexual excitability, arteriosclerosis, tinnitus, painful menstruation, relieves dyspnea and biliary and renal colic; can be used externally in the form of enemas to treat the exacerbation of hemorrhoids, chronic constipation, and in the form of poultices and compresses for treating boils, as a rinse - inflammations of the gums.

The herb should not be used for treating arterial hypotension. The plant is slightly toxic.

Its tincture is olive green, has a specific lemon aroma, sweet taste similar to that of tea. The first fraction obtained by distillation has an unpleasant odor. The aromatic properties are more expressed in an alcohol extract than in a tincture. The plant is used for the production of a large number of low and strong alcoholic beverages (special vodkas, liqueurs, liqueurs and balsams).

Bitter almond (Amygdalus communis L.)

Botanical characteristics. Almond is a shrub or small tree of the Rosaceae family (Rosaceae) with reddish branches. It reaches the height of up to 3-8 m. The leaves that appear after flowering are long. The flowers are pink or red. The plant blooms in March. The fruit is a leathery, villous drupe, dehiscent when mature. Its surface is smooth or wrinkled. The first fruits appear during the 3rd-4th years of life, and the plant gives fruits for 30-50 years. The age of some plants is over 100 years old.

Geographical range. Originally almonds probably come from the Caucasus and North Africa, from where it was brought to Europe. The first habitat of the plant was in the Near East and the surrounding areas, including the Mediterranean region and Central Asia. In these areas the almonds have been cultivated for many centuries before our era. Today the largest almond plantations are in the Mediterranean region, in China and in America. It is also grown in warm areas of Slovakia, mostly in the vineyards, and in South Moravia and Bohemia.

Chemical composition. Almond seeds (Fig. 8) are rich in fatty oils (40-60%), proteins (20-30%), phospholipids, sugar (2-3%) and enzyme emulsin. Almond oil contains 70-80% of monoacidic triglyceride of oleic acid, significantly less linoleic
acid triglycerides and the marginal palmitic acid. Bitter almonds contain the largest amount of glycoside amygdalin – up to 3%.

**Pharmacological properties.** Almond is used as a general tonic, anti-inflammatory, wound healing, emollient, cosmetic product and can also be used as a gentle laxative. It is noted that almonds inhibit the secretion of gastric juice, which makes them a useful drug for patients with gastric and duodenal ulcers.

**Application.** Sweet almond is different from the bitter due to the lack of amygdalin, which serves as a carrier of a typical almond taste. The seeds of sweet almond can be eaten without prior heat treatment. Bitter and sweet almonds are used in medicine, cosmetics, food industry and as a spice. In the pharmaceutical industry almond is used for the production of galenical preparations.

Mature almonds are used in confectionary industry. Bitter and sweet almonds are used in various pastries, for making liqueurs and candy. The infusion has a light yellow color, a bitter taste and almond aroma. In distillation the almond flavor transits with the first distillate fractions. Almond infusion is included in the ingredients of special vodkas, liquors and balsams.

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**Peru balsam (Myroxylon balsamum (L.) Harms)**

**Botanical characteristics.** Peru balsam is a tropical tree up to 25 meters tall with a straight trunk (up to 1 m in diameter), abundant foliage and very fragrant flowers. The plant belongs to the legume family (*Fabaceae*). Its names are: *Toluifera pereira*, *Myrosperum pereira*, *Myroxylon pereirae*, Peru balsam, Indian balsam, Black Balsam. All parts of the plant contain resinous sap. The balsam obtained via incisions in the bark.

**Geographical range.** The plant grows in Central America. The main producer of balsam is San Salvador.

**Chemical composition.** The balsam is collected when it cools into a dense mass. It consists of resins (25-30%) and essential oil (60-65%). Resin contains benzaldehyde, benzyl alcohol, ethyl benzoate, benzoic acid, vanillin, cinnamic acid, ethyl cinnamate, nerolidol, ethyl vanilate, isobutyl cinnamate, benzyl benzoate, benzyl-cis-cinnamate.

**Pharmacological properties.** The plant stimulates the heart, increases blood pressure, reduces the secretion of mucus. It is used for treating asthma, chronic cough and bronchitis. It eases rheumatic pain, can be used to treat scabies, rashes, sores, eczema and wounds. Peru balsam is a contact allergen [90]. The median lethal dose of Peruvian balsam for rats is 2.4 mg / kg.

**Application.** The bark of the tree is used to receive the Peru balsam. It is a viscous dark brown liquid that does not harden in the air. It has a mild pleasant sweet, very persistent odor similar to vanilla. Essential oil cannot be received via steam distillation, so the extraction with petroleum ether or alcohol is used after the neutralization of free acids. It is a reddish brown viscous liquid with a warm sweet balsamic and persistent odor with touches of narcissus and honey.
The balsam is used in tropical medicine and for the manufacture of cough syrup. It is used as a fixative and a fragrance in the production of cosmetics, perfumes and foods.

It is used in the manufacture of alcoholic and non-alcoholic drinks (the dose being from 6 to 27 mg / kg). It is a component of the black balsam «Riga» and other balsams.

**Juniper (Juniperus communis L.)**

**Botanical characteristics.** Juniper is a coniferous evergreen dioecious shrub or a small tree of the cypress family (Cupressaceae) with the height from 1 to 3 m. The bark on older trunks is dark gray and easily separated from the trunk and branches, the bark of the young trees is shiny reddish-brown. The leaves are narrow linear-lanceolate, are arranged in groups of three, prickly, subulate, rigid. In winter they do not fall. The pollen flowers sit in the sinuses and are oblong catkins, and pistillate flowers form green small spherical cones. The fruits are edible galberries. During the first year of the plant the galberries are green, and in the second year they become blue-black.

**Geographical range.** In the wild juniper grows in the European part of the Northern Hemisphere. In Russia it is found in the north and in the central part of European, Western and Eastern Siberia, penetrating to the east to Transbaikalia and Central Yakutia, mainly in pine and mixed forests or on dry hills and mountain slopes.

**Chemical composition.** Essential oil, consisting mainly of cadinene, camphene, etc., is found in all parts of the plant: in the fruit - 0.5-2%, in the stems - 0.25%, the needle - 0.18%, the bark - 0.5% [91]. In addition, the fruit contains invert sugar (40%) and resin (about 9.5%). The bark contains up to 8% of tannins, the needles - ascorbic acid.

**Pharmacological properties.** Juniper has diuretic, cholagogue, expectorant, disinfectant properties and improves digestion. The median lethal dose of essential oil on white mice is 750 mg / kg by oral administration [91]. The pleasant juniper smell has strong repellent properties. It was noted that the volatiles of juniper kill up to 30% of all airborne microorganisms.

**Application.** It is used with edema as a diuretic, as well as a disinfectant when treating diseases of the urinary tract (sometimes with potassium acetate). The galberry infusion is used to treat cardiac edema, pulmonary diseases involving copious purulent sputum, weakness of the gastrointestinal tract, bloating, cystitis and cholelithiasis. The infusion can be used to rinse the mouth and throat, and as an inhalation for the upper respiratory tract, in the form of baths for treating rheumatism and gout, skin diseases and diseases of the peripheral nervous system. The galberry broth is used to provoke menstruation, the decoction of the branches used to treat diathesis. In traditional medicine juniper galberries are used to treat women's diseases and fever.
The branches of juniper have a curative effect. They refresh the air and kill bacteria; baths with the infusion of juniper twigs help treat joint problems.

Juniper galberries are not used fresh for food, but they are used in the production of alcoholic beverages (balsams, liqueurs, gin) and beer. The color of the liqueur is dark brown, the flavor is resinous, the taste is bitter-sweet. The first distillation fractions have a peculiar flavor of juniper, the next have a resinous odor, becoming worse at the end of the process.

The Czech fruit brandy "Borovichka" is made from berries of black juniper. The mass of comminuted fermented berries is distilled three times (because of the high content of essential oils). As a result, the bouquet of the drink is more interesting and delicate than that of gin, while gin produced from grain alcohol is just slightly flavored by juniper galberries.

**Wild bergamot, bee balm (Monarda fistulosa L.)**

The *Monarda* sort (apart from the *Monarda fistulosa*) includes 19 other species: *Monarda citriodora* Cerv. ex Lag., *Monarda media* Willd., *Monarda fruticulosa* Epling M., *Monarda didyma* L. (geminate horsemint), *Monarda menthaefolia* Grah., *Monarda punctata* L. (dotted horsemint), etc. The leaves, stems and buds have a wide bouquet of flavors (mint, lemon, etc.).

It is a perennial rhizome plant of the Lamiaceae family with straight or branched stems 65-120 cm tall, with simple, oblong-lanceolate, serrate leaves. The flowers are small, fragrant, purple, bilabiate, gathered in dense racemose or capitulate inflorescences 5-7 cm in diameter, often located on the stem one over the other. The fruit is a nut.

The species *Monarda hybrida* is a combination of varieties and forms of *Monarda didyma* and *Monarda fistulosa*. Monarda hybrids are perennial and reach the height of 1 m. The species with pure red flowers are less tall than the ones with rose, purple and lilac flowers.

**Geographical range.** The center of speciation is Texas (USA) and northern Mexico, from where the plants were brought to Spain after Columbus discovered the new continent.

**Chemical composition.** The composition of the plant’s essential oil includes up to 40 components. Most significant elements are thymol (60-72%), γ-terpinene (16%) and carvacrol (9.6%) [92].

**Pharmacological properties.** The plant is a fragrant spice and is useful for the digestion, contains valuable substances (including vitamins C, B<sub>1</sub>, B<sub>2</sub>) and has healing properties. Its extracts have antibiotic properties, and the essential oil has bactericidal and anthelminthic effects. *Monarda fistulosa* is used for the treatment of asthma, chronic bronchitis and radiation sickness. The essential oil of this species is used for the treatment of the salmonella infection. The juice from the leaves is used for wound healing. It is recommended to treat wounds and fractures with dried or fresh monarda tea. Infusion, juice and paste of leaves and inflorescences help
heal the long-term wounds, ulcers, eczema, are used for treating acne, seborrhea, skin peeling. The major role in the healing properties of the plant is played by the essential oils that have bactericidal, anthelmintic, antibiotic, immunomodulating effects. The essential oil protects the plant from pests’ damage and attracts insect pollinators. In addition to essential oils the plant contains other biologically active compounds, such as flavonoids rutin, hyperoside, quercetin, luteolin, quercitrin that also have strong antiseptic and anti-inflammatory effects. The content of flavonoids in the flowers is more than in the leaves [93].

Application. Plants the essential oils of which contain such components as carvacrol, thymol and γ-terpinene are widely used in the production of recreational phyto-drinks and balsams. These elements give the refreshing infusion mint flavor with notes of citrus fruits. The plant is widely used in the production of aromatic wines, such as vermouth [28].

Cloudberry (Rubus chamaemorus L.)

Botanical characteristic. Cloudberry is a perennial herbous plant of the Rosaceae family (Rosaceae) reaching the height of 35 cm. It has long, creeping, rooting, woody rhizomes. The stalk is annual, erect, shortly pubescent. The leaves are entire, simple, round kidney-shaped, solitary, and develop erect stems. The flowers are crown, single, white, diclinous, with a diameter up to 3 cm. The cloud- berry fruit looks similar to a raspberry fruit – it is a false aggregate drupe. The fruits have a reddish color and when they ripen they become yellow or red. Cloudberry blossoms in May - June. The berries ripen in July.

Geographical range. The berry is common in the northern and arctic regions of the Europe, Siberia and the Far East. It grows in bogs, wetland forests, often in moss and shrub tundra in the far north.

Chemical composition. Cloudberry fruits contain proteins (0.8%), from 3 to 7% of sugars, ascorbic acid, pectin (0.5-2%), cellulose, organic acids (citric, malic and salicylic acid), carotenoids (7.0%), tannins, volatile elements, leucocyans, leucoanthocyanin. In addition, the plant contains magnesium, calcium, iron, aluminum, phosphorus and silicium.

Pharmacological properties. The roots and leaves are used as a diuretic, the leaves’ infusion is used as an anti-inflammatory and hemostatic, can act as a blood cleansing and wound healing element. The berries have diaphoretic, diuretic, anti-scrotal properties. The fruit juice has a strong bactericidal effect.

Application. The fragrant fruits have a gentle, sour-sweet taste. Ripe berries of cloudberry are used to prepare compote, jams, juices, purees, jams and liqueurs. In Canada a cloudberry liqueur «Chicoutai» is produced.
Nutmeg, mace (*Myristica fragrans* Houtt.)

**Botanical characteristics.** Nutmeg is an evergreen tree up to 20 m tall from the Myristicaceae family (*Myristicaceae*), a typical plant of the equatorial belt. The plant blooms all year round starting with the age of 5-6 years. It gives fruits up to the age of 40. One tree gives from 3 to 10 thousand nuts per year. Some plants live up to 100 years. The fruit looks like a peach, at maturity begins to crack into 2 parts. It has a massive pulp with a sour taste. The fruit has a very large seed, protected with a hard shell and covered with a fleshy aril (the actual mace). The sun-dried aril is fragile, fragrant and orange-yellow in color (Fig. 9). After removing the aril, the seeds are fire-dried, split and the kernel is extracted.

**Geographical range.** The center of origin of the nutmeg tree is the Molucca Islands and the islands of the Banda Sea. The culture is grown in Indonesia, India, Sri Lanka, Grenada and in Africa. Nutmeg and mace are known in Europe from the 8th century.

**Chemical composition.** The seeds are rich in essential oils (15%), the main components of which are safrole and myristicin. The core of the walnut contains fatty oil. It contains a poisonous substance (a phenyl-propane derivative) with a narcotic effect.

**Pharmacological properties.** Consuming large quantities of nutmeg and its flowers is dangerous and the long-term use of the nuts in food may have psychoactive effects [94], the dose at which myristicin could cause such an effect is between 6-7 mg per kg of body weight [95]. The nutmeg toxicity is due to the cytotoxicity of myristicin [96, 97].

**Application.** Nutmeg is used primarily for the manufacture of chocolate products, various sweets, fruit cakes, pear compote, jams, baked apples. It is also used for flavoring drinks and cocktails served before meals, punch, mulled wine, cocoa, milk drinks and even tomato juice. The aroma of nutmeg is slightly spicy, very vague at first and later becomes more spicy.

The infusion has a brown color, a strong nutmeg smell and a bittersweet hot taste. Aromatic substances pass into the distillate throughout the whole process of distillation. The first fractions of the distillate provide a camphor flavor, the medium - the scent of nutmeg, the final have aromatic properties of a balsamic character. The harmonious participation of the plant in the formation of the drink’s flavor is provided if its presence in the mixture of ingredients does not exceed 3%.

In Germany the contents of safrole in alcoholic beverages with a concentration of alcohol up to 25% should not exceed 2 mg/kg. The content of nutmeg flowers or nuts in food should be less than 15 mg/kg. The daily dose of safrole should not exceed 2 mg [98].
**Crisped-leaved mint, spearmint** (*Mentha spicata L. / Mentha crispa L.*)

*Botanical characteristics.* Spearmint is a perennial plant of the labiate family (*Lamiaceae*), and belongs to the cultivated forms of mint. It combines the taste of several mint varieties, but at the same time has quite a gentle and pleasant minty taste without menthol tones. It forms a shrub reaching a height of 80-90 cm. The main stem produces many shoots. It differs from the other types of mint by form – it has curly slightly covered with fiber broadly ovate leaves. It blooms with pink-purple flowers gathered in panicles in July - September. It has the same refreshing mint smell, but doesn’t have a cooling taste.

*Geographical range.* The plant grows in North America, Great Britain, Italy, China, Western Europe, Ukraine and European Russia. In the areas where it is cultivated it can also be found in the wild. It is also called crisped-leaved mint.

*Chemical composition.* It is grown for the preparation of essential oil which contains linalool (56-65%), carvone (12-13%), limonene (6%), cineol, citral, pulegone. Its essential oil is used in the pharmaceutical industry. The content of pulegone in food should not exceed 20 mg/kg.

*Pharmacological properties.* The leaves, rich in various nutrients, are boiled and used in traditional medicine for bruises pain relief, therapeutic baths and as a sedative.

*Application.* The plant has a pleasant flavor more tender than that of peppermint. It is widely used in cooking, more often than peppermint. Mint leaves are added to salads, soups, especially vegetable, and in some countries - into dairy products. It is used for preserving cabbage. Dried mint leaves are used to flavor sauces, meat dishes, confectionery, for home baking. They are used for sprinkling fowl dishes (especially hare). In Belarus mint is used for flavoring pickled apples and pickles. In Ukraine it is used for seasoning fish and mushroom dishes as well as beef and pork.

Mint gives tea a unique taste and aroma. Its infusion is dark green, fragrant, with a peculiar smell and a spicy, pungent taste. The aroma, typical of this type of mint, is received with the first distillate fractions.

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**Peppermint** (*Mentha piperita L.*)

*Botanical characteristics.* Peppermint is a perennial herb of the labiate family (*Lamiaceae*) with the height of 30-55 cm. Its rhizome is woody, whitish, thin, branched with thin fibrous roots, which are located in the ground horizontally. The stems are branched from the base, hollow or filled with loose parenchyma, densely foliate, reddish-brown, withering in winter. The leaves are sessile, oblong-ovate, pointed, short at the sides, sharply serrated (dentate). The phyllotaxy and branching
are cross opposite. The leaves are dark green on the upper side and bright on the lower side. They are covered with fine fiber and small yellowish punctate glands of essential oil. The flowers are small, pistillate or telianthus (almost sterile), are united in false whorls, forming spiky inflorescences on the tips of twigs. The calyx is pink, purple or whitish-pink, quinquedentate, regular, covered with glands.

The fruit is aggregate, consisting of four black-brown, sometimes reddish-brown nuts enclosed in the remaining cup. The flowering period lasts from late June to September.

Geographical range. Peppermint is a natural hybrid between common and water mint. It grows in Europe, America, Asia, Australia and Africa, as well as in the CIS countries, Moldova, the Baltic countries, the Far East, Belarus, Ukraine and the North Caucasus.

Chemical composition. The essential oil of peppermint contains menthol (≈30%), menthone (10-30%), menthofuran, α-pinene, limonene, cineol, dipentene, pulegon, β-phellandrene and other terpenoids, ascorbic acid, rutin, carotene, organic acids, tannins, flavonoids, betaine, hesperidin and trace elements (copper, manganese, strontium, etc.).

Pharmacological properties. Mint has antiemetic, anti-inflammatory, sedative, antispasmodic, cholagogue, antiseptic and analgesic effects and reflex coronary vasodilating activity, strengthens capillary circulation of the blood and intestinal peristalsis, reduces dental pain, refreshes the mouth, improves the appetite and increases bile secretion.

Application. It is widely used in the food industry (for the production of gum and candy), as well as in the production of alcoholic and soft drinks. In the American cuisine mint is added to cocktails to improve the taste and flavor. Its infusion has an olive green color with a characteristic smell of mint and a cooling taste. The best fractions collected in the process of distillation are the central ones.

Sea-buckthorn (Hippophae rhamnoides L.)

Botanical characteristics. Sea-buckthorn is a dioecious tree or shrub of the oleaster family (Elaeagnaceae) up to 4 m tall. The trunk is branched, with thorny branches and grayish-brown bark. The leaves are alternate, linear-lanceolate, entire, silver-green, up to 8 cm long. The pollen flowers are staminate dark brown. They have 4 stamens and are collected in groups of 10-14 flowers per one inflorescence with the length of 5-8 mm. Pistillate specimens are green and united in groups of 2-5 in racemose inflorescences. The fruit is a drupe, spherical or oval, with a diameter of 1 cm, orange-red in color. The pedicels are short; the fruits seem "stuck" to the branches. Sea-buckthorn is a polymorphic species. The plants vary in the structure of the crown, color and size of the fruits, flowers, color of the bark and stem size. The plant blooms in April - May, the fruits ripen in August - October.

Geographical range. It grows in the central region (central and northern Europe) and Siberia.

Pharmacological properties. The fruit improves digestion, normalizes metabolism, prevents blood clots, promotes growth inhibition of pathological tissues and strengthens the hair roots.

Application. The plant is used in the treatment of burns, ulcers, radiation damage to the skin and mucous membranes, internal ulcers (particularly in the stomach), scurvy, skin diseases, it helps reduce and eliminate the pain in inflammatory processes, can be used for rapid wound healing, accelerates the granulation and epithelialization tissue with beriberi, is used in gynecology, helps treat rheumatism, frostbites, eczema, and acts as a preventive and antitumor agent.

Buckthorn berries are used for the production of balsams, bitters and special vodkas.

Dandelion, cankerwort, Irish daisy (Taracsacum officinalis Wigg.)

Botanical characteristics. Dandelion is a perennial herb of the aster family (Asteraceae) with a thick taproot. The leaves are lanceolate or oblong-lanceolate, serrated, 10-25 cm in length and 1.5-5 cm in width, gathered in a rosette. The flower arrows have the height of 5-30 cm, with web-like fiber under the baskets. The inflorescence is a single basket with the diameter of 3-5 cm, the flowers are ligulate with a golden-yellow corolla. The fruit is a grayish-brown achene with the length of 3-4 cm and a long thin nose.

Geographical range. A native to Europe: it grows like weed in fallow fields, gardens, parks, among cultivated plants, in the wastelands. The resource of the rhizomes hasn’t been estimated, but if necessary, they can be harvested in large quantities. Harvesting in urban areas is not recommended. The best period for harvesting rhizomes is autumn, when the leaves begin to wither.

Chemical composition. Inflorescences and leaves contain carotenoids taraxanthyn, flavoxanthin and others, the roots contain taraxerole, taraxasterol and sterols, inulin (24%), rubber (up to 2-3%), fatty oil which contains glycerides of palmitic, oleic, linoleic, melissic and cerotic acids. Dandelion roots are inulin-containing plants.

Pharmacological properties. Roots and leaves of the dandelion are used as an appetite stimulator to treat anorexia of different etiology and anazide gastritis by increasing the secretion of digestive glands. The roots are used as a choleric and
Mistletoe (Viscum álbum L.)

Botanical characteristics. Mistletoe is an evergreen hemiparasitic shrub with the length of 20-60 cm of the loranth family (Loranthaceae). It grows on the branches of many conifers and deciduous trees (pear, apple, birch, etc.). The stems are green, forked and form a spherical cluster of branches up to 120 cm in diameter. The branches in the nodes are swollen and yellow-green.

The leaves are overwintering, 3-6 cm long, 6-15 mm wide, opposite, sessile, oblong-ovate or oblong, obtuse, entire, green, glabrous, thick, leathery, with five parallel veins. The plant is dioecious.

The flowers are inconspicuous, diclinous, arranged in groups of 3-6 in the axils of the branches, small, yellowish-green, with a simple corolla-like quadripartite perianth. The corolla of the staminate flowers has a very short tube; the number of stamens is 4. The corolla lobes of the pistillate flowers have the form of fleshy simple scales, the column is very short, and the stigma is sessile.

The fruit is a globular berry, white in color, one-seeded, rarely two-seeded, 8-10 mm in diameter, sticky from the inside and containing rubber. The seeds are oval or angular, surrounded by a layer of viscous mucus. The plant blossoms in March - April, the fruits ripen in September - October.

Geographical range. Mistletoe grows in the south-western, central and southern regions of the Europe, Crimea, Byelorussia, the Ukraine and the Caucasus.

Chemical composition. Mistletoe contains oleanolic and ursolic acid, choline and its derivatives (propionilcholine and acetylcholine), visco-toxin, α-viscole, cardenolides, polypeptides, and phenolic compounds: flavonoids, phenol carbonic acids, triterpene saponins, amines (norviscalbine, viscalbine, tyramine, phenylethylamine), inositol, vitamins (A, C), fatty oil containing oleic, linoleic and palmitic acids, rubber, resinous substances, glycoside siringinin.

Pharmacological properties. Mistletoe is used for treating hypertension, atherosclerosis, neuralgia, epilepsy, convulsions and bleeding, it retards the development of cancer, the development of metastases. Its tincture is part of the acophite drug with an antirheumatics effect. In case of overdose local irritation and even necrosis of the mucous membranes can be noted.
**Application.** The mistletoe leaves are part of the components of the balsams and several others [143].

**Primrose (Primula macrocalyx Bunge)**

*Botanical characteristics.* Primrose is a perennial herb 15-20 cm tall, belonging to the Primulaceae family (*Primulaceae*), it appears in the early spring, as soon as the snow melts. Its rhizome is oblique, unbranched, short, covered with whitish threadlike roots. The leaves are radical and ovate. The flower arrow is one (or more), and carries an inflorescence - a simple one-sided umbel. The flowers are large, bright yellow with orange spots at the base of the corolla lobes. The fruit is an allseed brown ovoid capsule. The seeds are globose, 1-1.5 mm long. The plant blooms in April - May. The fruits ripen in June - July. The seeds are dispersed only in favorable weather.

*Geographical range.* It grows in deciduous and mixed forests and forest-steppe zones of the Europe, Asiatic Turkey, Eastern European and Russia.

*Chemical composition.* The rhizomes contain saponins found in an amount of 5-10%, essential oil - 0.08% and glycosides: primulaveroside (primulaverine) primveroside (primverine). The leaves contain saponins, the flowers - saponins and flavonoids. All parts of the plant contain ascorbic acid. The dried leaves contain 5.9% of ascorbic acid (vitamin C), and the flowers – 4.7%, the leaves and roots contain a small amount of carotene.

*Pharmacological properties.* Preparations of primrose have diuretic, diaphoretic, tonic, vitaminizing, expectorative effects, improve the adrenal function and the secretion of gastric juice.

**Application.** Infusions and tinctures increase the secretion of bronchial glands and are low toxic. The plant is used to treat respiratory diseases, migraines, dizziness, insomnia, general weakness, kidney and bladder diseases, pneumonia, constipation, poor appetite, rheumatism, gout, vitamin deficiencies, scurvy. Primrose leaves in the earlier period, at the beginning of flowering, are used for the preparation of a vitamin salad.

The smell of the dried leaves is similar to that of honey. The herb is used in the production of strong alcoholic drinks and tinctures. The infusion has a brownish-yellow color, a resinous odor and a bitter, slightly hot taste.

**Allspice (Pimenta officinalis Lind)**

*Botanical characteristics.* Allspice is an evergreen tree, 6-12 m tall, belonging to the myrtle family (*Myrtaceae*). The leaves are entire, oblong-ovate, leathery, dotted with glands. The flowers are white, gathered in racemose false umbels. At first the fruits are green, and become red when ripen. Inside them are two (rarely three) cells containing one black-brown seed.
Geographical range. Allspice’s homeland is the Antilles. In the wild it grows in the West Indies, in southern Mexico, Costa Rica and Venezuela. It is cultivated in Sri Lanka, Indonesia, Vietnam, Mexico, Haiti and Cuba. The main center of allspice production is Jamaica.

Chemical composition. Allspice fruits contain essential oil (about 5%), which is composed of eugenol (80%), methyleugenol (10%) and myrcene (1%).

Pharmacological properties. Allspice is a carminative element; it relieves spasms of the intestine, increases appetite. The aqueous extract of allspice reduces the levels of cholesterol and triglycerides in blood [100].

Application. Allspice is extensively used in the food industry. It is used in the preparation of mustard, sauces, snacks, meat dishes and canned pickles.

Allspice is included in spice mixtures for meat and fish products. The spice is added to hard cheeses and bakery.

Cayenne pepper, hot pepper (Capsicum annum L.)

Botanical characteristics. Hot pepper is a perennial, (annual in the cultured form) plant of the nightshade family (Solanaceae). In its habitat it grows in the form of perennial woody shrubs.

Its stem is thin, straight or sinuous, cylindrical, branched from the base, woody at the bottom, with the height of 30-60 cm. The leaves are egg-shaped or lanceolate, acute, entire, glabrous or pubescent, with long petioles. The flowers are seated in the forks of branches, they are yellow, solitary, rarely paired or united in bunches. The fruits are thin, conical, 5-15 cm long, mostly red.

Geographical range. The plant’s homeland is Mexico, where it has been cultivated by the Indians. Today this crop is cultivated in many countries: Ukraine, North Caucasus, Transcaucasia, Moldavia and Central black earth zone.

Chemical composition. Mature fruits contain capsaicin alkaloid (0.1%), carotenoids (capsorubin, capsanthin, zeaxanthin, cryptoxanthin), vitamin C (0.1%), sugar (up 6%). Capsaicin is mainly found in the seeds. The plant also contains glycosides of the sinapic and ferulic acids. The odor of pepper is to a large extent provided by the presence alkylmetoxypyrazines.

Pharmacological properties. Hot pepper is used to stimulate digestion, is part of herbal medicines for treating rheumatism. In the pharmaceutical industry it is used for the manufacture of capsicum plaster, as well as tinctures and extracts. Pepper tincture stimulates appetite and improves digestion, when used externally acts as a warming agent. The phenolic elements found in pepper have antioxidant activity. There is a high correlation between the content of glycosides of the sinapic and ferulic acids and the antioxidant activity of the extract of cayenne pepper [101].

Application. Hot pepper is eaten as a vegetable (sweet form) and is used as a spice. The alcohol industry uses whole fruits for pepper vodkas and liqueurs. The most popular beverages are "Vodka with pepper" and the liqueur "Pepper", etc.
Black pepper (Piper nigrum L.)

Botanical characteristics. Black pepper is a treelike liana of the pepper family (Piperaceae). The leaves are ovate, leathery, gray-green in color. The flowers are small (7-15 mm), white, gathered in drooping ears. The stems are 5-10 cm long and consist of 20-30 fruits. The fruit is a globular drupe with a hard shell. When mature the seeds become red and later turn yellow.

Geographical range. The origin of black pepper is the forests of the western coast of South India. It is cultivated in India, Sri Lanka, Thailand, Vietnam, the Malay Peninsula, Sumatra, Madagascar, Sunda, West Indies, South America and West Africa. India is the world's largest producer of the black pepper spice.

By origin and quality there are several groups of black pepper. The best pepper is a more fragrant, spicy and large pepper from the Malabar coast (1000 grains of pepper weigh about 460 g). Singaporean pepper is also noted for its high quality. White pepper is also a type of black pepper.

Chemical composition. The fruits of black pepper contain piperine (4.5-7.5%), piplartine [102], piperidine, polysaccharides, essential oil (3%), including sabinene, α- and β- pinenes, myrcene limonene and other mono-terpenes (80% of the total contents); the remaining 20% contain β-caryophyllene, gumulen, bisabolon and caryophyllene oxides.

Pharmacological properties. Black pepper has bactericidal and diaphoretic properties. It promotes the excretion of harmful substances, stimulates appetite, increases salivation, stimulates digestion. Pepper alkaloids have a wide range of useful properties. Polysaccharides of black pepper and piperine stimulate the immune system [103, 104]. The extract of black pepper is included in the composition of drugs used for the treatment of allergic rhinitis [105]. Alkaloids are used in the treatment of cancer and for protection from gamma radiation [106, 107, 108].

Application. Black pepper is used in all sectors of the food industry. Black pepper is included in most spice mixtures. It is widely used in cooking and in the production of alcoholic beverages. Its infusion has a dark brown color, a strong aroma of pepper and a bitter, burning taste. During distillation the aromatic compounds are received with the first distillate fractions.

Parsley (Petroselinum crispum (Mill.) AW Hill)

Botanical characteristics. Parsley is a biennial herb of the umbelliferae family (Apiaceae). It has a fleshy, spindle-shaped root up to 30 cm long. The stems are
erect, round, bare, highly branched. The leaves are double-pinned, in general - ovate, glossy on the upper side, and matte on the bottom. The flowers are teleian-thous, small, gathered in cymes at the ends of branches. The fruit is an oblong-ovate, slightly compressed from the sides, greenish-brown diachenium. The seed is almost circular, with an oily grayish endosperm.

**Geographical range.** Parsley grows in the wild in the eastern Mediterranean, but since ancient times it has been cultivated and grown as a garden plant throughout most of Western Europe (except for the Far North), in Africa, America, Australia and many countries in Asia. Very often the plant becomes wild and is found in weedy areas.

**Chemical composition.** The fruits of the plant contain essential oil (2-6%), consisting of apiol, α-pinene, bergapten, allyltetra-anisole, coumarin, myristicin, fatty oil (22%), which contains mainly glycerides of petroselinic acid. In addition, the fruit contains flavonol glycosides. The leaves contain essential oil, luteolin, apigenin, carotene, ascorbic acid. The main components of the volatile fractions in the leaves are myristicin, apiol, β-phellandrene, n-ment-1,3,8-triene and 4-isopropenyl-1-methylbenzene. The flowers contain quercetin, kaempferol, the roots - apigenin.

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\]

**petroselinic acid**

**Pharmacological properties.** The leaves and seeds of parsley have diuretic properties and increase the excretion of salt from the body. The latter is due to the presence of epiol and myristicin in the plant. Myristicin contained in parsley seed oil has a high antioxidant activity [109]. However, it can also cause hallucinations [335].

Parsley is used in traditional medicine as a diuretic for treating kidney or heart disease. It is often used in combination with other substances, such as kidney tea and other diuretics for treating cardiac edema. Parsley is used for medicinal purposes in urolithiasis and inflammatory processes in the bladder, acute and chronic cystitis, especially accompanied by pain due to spasms of smooth muscles; liver disease, disorders of the digestive system, dyspepsia, flatulence. In Turkey parsley is used in the treatment of diabetes. The therapeutic effect of parsley extract, tested on white rats at a dose of 2 g/kg, is comparable to a known drug glibornuride (syn. glutril), with the dose of the latter being 5 mg/kg. At the same time parsley doesn’t cause hepatotoxicity like the drug does [110]. Parsley also helps to treat inflammation of the sciatic nerve and can be part of medical dressings for treating pain in the eyes.

**Application.** Alcoholic extracts of the root are used in the production of special vodkas, bitters.
**Tansy (Tanacetum vulgare L.)**

*Botanical characteristics.* Tansy is a perennial herb of the Asteraceae family (*Asteraceae*) with the height of 50–100 cm. The root has a horizontal creeping woody rhizome. The plant has numerous, erect, branching at the top stems. The leaves are alternate, oblong, twice pinnately dissected, serrate or entire, pointed at the top, the upper leaves are sessile, the lower - seated on long stalks.

The plant flowers from June to September. The flowers are teleianthous, yellow, and small, assembled in groups of 10–70 pcs in corymbose inflorescences (*anthode*). The fruit is an oblong ribbed achene. It becomes mature in August - September. The inflorescences of tansy are used as a pharmaceutical raw material.

*Geographical range.* Tansy is found in Western Europe, northern China, Japan, Mongolia, Canada and Alaska, the northern zone of the European part of Russia, Western and Eastern Siberia, the Far East, in the mountains of Central Asia. It grows on the slopes of mountains, in bushes, on the banks of rivers and lakes and along roads.

*Chemical composition.* Tansy contains essential oil (thujone, cineol, camphor, borneol), flavonoids, alkaloids, a bitter element tanacethyn, organic acids, tannins, resins, sugar, vegetable gum, vitamin B complex, carotene, vitamin C.

*Pharmacological properties.* Tansy has choleretic, anti-inflammatory, antimicrobial, diaphoretic, anthelmintic, astringent and antifebrific properties, improves digestion and appetite. Its essential oil has a very strong convulsive effect, which may cause helminthes' death and their removal from the body.

*Application.* The plant is used for treating liver diseases (giardiasis, cholecystitis, hepatitis), gallbladder, low acidity of gastric juice, inflammatory processes in the small and large intestine and the bladder, gastric and duodenal ulcers, migraines, headaches, aching joints, as well as malaria. It is used for appetite stimulation, and the removal of pinworms and roundworms. The plant is used to make bath preparations and compresses for indolent ulcers and wounds, scabies, gout, and for treating the joints’ inflammation. In case of overdose the possible disorders are nausea and vomiting.

Inflorescences of tansy are used in liquor industry for the production of alcoholic beverages such as balsams; and in the confectionery industry.

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**Peony (Paeonia anomala L.)**

*Botanical characteristics.* Peony is a perennial herb of the peony family (*Paeoniaceae*). It has a strong horizontal rhizome with spindly root tubers, thick erect stems 40–100 cm tall. The leaves are alternate, divided into 2–3 lanceolate...
segments. The flowers are solitary, large, 6-13 cm in diameter, purple-pink, with five petals. The fruits are star-arranged hoses. The seeds are quite large, elliptical, black, shiny. Peony blooms in May - early June.

**Geographical range.** Basically it is a Siberian species spreading to the north of the European part of Russia and to the south-east of the Kola Peninsula. The area also includes the regions of Mongolia and northern China. The plant grows in moisty warm and well-lit areas.

**Chemical composition.** The roots of peony and its aerial parts contain carbohydrates, tannins and aromatic substances, volatile and fixed oils (up 1.5%), resin, alkaloids, minerals and trace elements (iron, manganese, copper, magnesium, calcium, strontium, bismuth, chrome and others), organic acids, flavonoids, vitamin C, as well as glycoside salicin which, apparently, provides the healing properties of the plant.

**Pharmacological properties.** The entire plant is used as a therapeutic element. Aerial parts are cut during flowering. Peony has a sedative effect, anticonvulsant activity in convulsions caused by camphor and nicotine. It is slightly toxic, has no significant effect on blood pressure, rhythm and amplitude of heart contractions, respiration and the peripheral nervous systems, does not affect the tone of the uterus and does not have antihistamine properties. The tincture of the leaves is less active than the tincture of the roots. The scientists detected an anticoagulant effect of the peony extract [111].

**Application.** Dried material has a strong peculiar odor and a sweet, pungent, slightly astringent taste. The infusion of the roots is used in the production balsams.

**Waybread, greater plantain (Plantago major L.)**

**Botanical characteristics.** Waybread is a perennial herb of the plantain family (Plantaginaceae), with radical, ovate and lanceolate long petiolate leaves. The rhizome is short with a fibril of thin threadlike roots. The stems are 10-50 cm tall, naked, carrying a thick ear of brownish flowers. The leaves are long, collected in a rosette, broadly ovate, lanceolate, entire, with 3-9 arcuate veins, up to 20 cm long and 10 cm wide, usually located on the ground to retain moisture. If the level of moisture is too high, the leaves rise to evaporate water. The fruit is a many-seeded ovoid capsule; the seeds are angular and brown. During the rainy season the seeds form mucus membranes, so that they stick to shoes, to animals, birds and thus spread for long distances. It flowers from May to August.

**Geographical range.** The plant is distributed throughout the entire territory of Europe, with the exception of the Arctic region. It grows along roads, in fields, gardens, orchards, forest edges and near the shore. It is cultivated in France, Spain and the USA.

**Chemical composition.** Plantain leaves contain glycosides rinantin, aucubin, luteolin, bitter elements and tannins, enzymes, citric acid, vitamin K, ascorbic acid,
a small amount of alkaloids and volatile. Fresh leaves contain flavonoids (plantagines and homplantagines), iridoid glycosides, carbohydrate mannitol.

**Pharmacological properties.** Plantain leaves are used as an expectorant, anti-inflammatory, hemostatic, wound healing, anti-microbial agent. In form of a drink made from seeds or enema of its juice plantain is used for treating ulcers in the intestines and gall diarrhea. It is an effective remedy for catarrh of the stomach with low acidity, enteritis and colitis, ulcers. Experiments with aqueous extracts of plantain in Drosophila have shown the presence of mutagenic properties [112]. Its methanol extract showed antinociceptive activity in mice [113]. Giving the mice the aqueous extract of plantain leaves for 40 days at a dose of 2000 mg / kg showed signs of subchronic toxicity of the extract [114]. The observed cytotoxicity of the methanol extract of plantain in certain human cancer cells due to the action of luteolin-7-O-glucoside as the main flavonoid in plantain, questions the traditional approaches to the use of plantain. A possible mechanism for this action may be the damage of the DNA-cell caused by the tropo-isomerase influence [115, 116].

**Application.** The infusion of plantain is part the bitter, balsams and in the other beverages, including soft drinks.

**Wormwood, absinth(e), absinthium (Artemisia absinthium L.)**

**Botanical characteristics.** Absinthium is a perennial herbaceous plant up to 1 m tall, silver-gray in color, belonging to the aster family (Asteraceae). It has a strong characteristic odor and a bitter taste. The flowering stems are erect, slightly serrate, branched at the top and woody at the base. The rhizome is short, branched, ending with a taproot. The basal leaves are triply-pinnate and dissected, the stem leaves are doubly-pinnate, and the upper leaves are pinnate. The flowers are small, yellow, ball-shaped baskets up to 2.5-3.5 mm in diameter, which form a narrow panicle inflorescence. The plant flowers in July - August. The fruit is a brownish achene up to 1 mm long that ripens in August - September.

**Geographical range.** The plant is widespread in Europe and Asia. Its shrubs grow in the fields, along roads, among shrubs and on forest edges.

**Chemical composition.** The herbage contains essential oil (phelandrene, chamazulene, thujone, cineole, bitter sesquiterpene lactones absinthin, anabasinthin etc.), ascorbic acid, carotene, tannins [117], resinous and sugar substances. The leaves contain mucous and resinous substances, carotene, vitamin C, traces of alkaloids, essential oils and coumarins. The roots contain tannins, inulin and essential oil.
Pharmacological properties. Due to irritation of gustatory nerve endings in the mouth by the its ingredients the plant strengthens the function of glands of the gastrointestinal tract.

Wormwood preparations stimulate appetite and improve digestion by stimulating the secretion of digestive glands and increasing the flow of bile and pancreatic juice.

Application. The plant is used for treating digestive disorders, acidity, stomach cramps, gastritis, flatulence, liver and gall bladder disorders, anemia.

The preparations are also recommended to increase appetite after debilitating diseases. Teas and tinctures are applied during the recovery period. Wormwood has an analgesic effect for bruises, sprains, spasms and inflammations of the colon. Is used as a helminthic for the expulsion of ascarids and pinworms [74]. When mixed with thyme wormwood is used for treating alcoholism. Wormwood smoke is used as inhalation for treating asthma.

Sweet wormwood Artemisia annua L. herbage was used by Chinese scientists in 1971 to isolate a resistant and easily crystallizable sesquiterpene of the secocadaline type, called qinghaosu, or artemisinin [118]. This substance is practically non-toxic (LD₅₀ 2500-5000 mg/kg) and is widely used in the official Chinese medicine to treat malaria. The annual production of artemisinin in China is 5 tons.

The aerial parts of Artemisia glabella Kar. Et Kir., an endemic species growing in Kazakhstan, contains sesquiterpene lactone arglabin. It was noted that arglabin inhibits farnesylproteintransferase - an enzyme responsible for the formation of malignant tumors [119]. As a result of direct chemical modifications of α,β-unsaturated γ-lactone cycle, trisubstituted double bond and epoxide cycle of arglabin [120, 121] and the study of the biological activity of the resulting derivatives, a new anticancer drug "Arglabin" [74], a hydrochloride of dimethylamino-arglabin, was created.

The essential oil of wormwood is used in the alcohol production but a prolonged use of wormwood infusion causes "wormwood epilepsy."

Absinthism (French “absinthe” – absinthe) is a form of alcoholism, when patients consume mostly absinthe. There are suggestions that neurological symptoms appear at an earlier stage of absinthism and are more severe than they are in case of ordinary alcoholism. Absinthism also causes a higher frequency of epileptical seizures [119].

Wormwood herbage is used in in the production of alcoholic beverages: bitter liqueurs, flavored wines and special vodkas.
Botanical characteristics. Rhubarb is an herbaceous perennial plant of the Polygonaceae family (Polygonaceae) with hollow almost leafless stems up to 2.5m tall. The stem leaves are small, palmatisected with sockets at the base; the basal leaves are large, penta- and heptalobed. The flowers are small, whitish-pink or red, collected in paniculate inflorescences. The plant blooms in July. The fruit is a triangular nut.

Geographical range. In the wild rhubarb grows in the mountain forests of Northwest China (Qinghai province in the Datong mountains), in southern Mongolia and the eastern part of Tibet in the area between the upper Yangtze and Hwang Ho rivers. It grows at an altitude of 3000 m above sea level. Industrial plantations are located in Moscow, Voronezhskaya area and in Ukraine.

Chemical composition. The roots and rhizomes of the plant contain tannaglycosides, which include glucogalline, tetrarin and anthraglycosides: rheochrysin and chrysophanein that disassimilates into chrysophanic acid and glucose. Apart from anthraglycosides, the plant contains a free form of their aglycones: reuemodin, direin, rhabarberon, chrysophanic acid physcion and others. The leaves and flowers contain vitamin C, rutin, organic acids and a lot of potassium. Young leaves do not contain anthracene derivatives.

Pharmacological properties. In traditional medicine rhubarb is used to excite the appetite, as a choleretic and laxative element to treat intestines atony, it is also used externally for treating some skin diseases. Official medicine uses the plant to produce rhubarb powder, rhubarb pills, a dry extract of rhubarb. In small doses rhubarb has an astringent effect, in large serves as a mild laxative.

In scientific medicine the roots and rhizomes of rhubarb are used in the treatment of certain gastrointestinal diseases: the habitual constipation, intestinal atony, flatulence. The rhubarb drugs are dose-dependent. The plant also has antiseptic properties. Therefore, preparations of rhubarb can be used to treat dyspepsia and chronic inflammations of the intestine. Rhubarb is prescribed in forms of powder, dry extract, tincture and syrup. Rhubarb is also part of a choleretic tea. Side effects of rhubarb are due to, first of all, the content of anthrone compounds. Large doses of rhubarb preparations can cause vomiting, diarrhea, colicky abdominal pains, increase blood flow to the pelvic organs. Contraindications to the application of rhubarb are: acute appendicitis and cholecystitis, acute peritonitis, obstructed bowel (non-divergence, violation of the intestine), gastrointestinal tract bleeding and pregnancy (anthraquinones reflexively stimulate the contraction of the uterus).

Application. Young succulent leaves, petioles containing potassium salts, oxalic acid, citrine and vitamin C are used for food. The plant ripens early - in May it is already used in soups, salads, jellies, sweets, fillings for cakes. Rhubarb roots are part of the ingredients for the bitter balsams.
Snowdon rose, rosewort (Rhodiola rosea L.)

Botanical characteristics. Rosewort is an herbaceous perennial plant of the Crassulaceae family (Crassulaceae) with thick underground stems forming the root. The aerial shoots are 20-30 cm in height, with cataphylls at the base and green regular elliptical or lanceolate leaves on top. Diclinous tetramerous and pentamericous flowers with a yellow perianth are gathered in numerous terminal corymbose inflorescences. The plant is dioecious. Its fruits are red or green leaflets 6-8 mm long. Rosewort blooms in June.

Geographical range. The plant is found in the Arctic and in the mountains of Siberia and Kazakhstan on shingles at the bottoms of gorges, in damp sand in the tundra, seldom in stone cracks and rocky openings of pine forests. Most frequently it grows in the subalpine and alpine zones of Altai, Sayan and Baikal mountain regions at the height of 1500-2400 m above sea level: in some places it dominates in the herbage.

Chemical composition. The underground parts of the plant contain thrasol (oxyphenylethyl) and its glycoside - salidroside; tricine (a flavonoid) and its 7- and 5-O-glycosides; rosavin, rosarin, flavonoids (astragaline, kaempferol), tannins (20%), gallic acid, anthraquinones, essential oils, trace elements. The aerial parts contain salidroside (0.2%), flavonoids, coumarins, organic acids (oxalic, malic, succinic, gallic), traces of tannins and essential oils. The main active ingredients are salidroside and thrasol [74].

Pharmacological properties. An aqueous extract of rosewort roots is used as a stimulant with fatigue, recommended for people with a tendency to asthenia (particularly in work that requires increased mental work), patients in asthenic states after somatic and infectious diseases; can be used for treating functional disorders of the nervous system: the various forms of neurosis, vegetative dystonia, hypotension. Application of the extract has rare side effects. The plant’s extract is counter-indicated for marked symptoms of increased nervous excitability and exhaustion of the cortical cells of the brain, fevers, hypertensive crisis. The only side effect of rosewort is hypermineralcorticoid syndrome – a consequence of inhibiting the activity of 11-ß-hydroxysteroid-dehydrogenase and appears only if the plant is consumed in excessive doses for a long time.

Application. The plant is used in official medicine, as a food additive and in the food industry. Food additives including snowdon rose reduce fatigue, improve intellectual faculties and physical condition. Rhodiola rosea is used to produce tonic soft drinks, salves.

Damask rose (Rosa damascena Mill.)

Botanical characteristics. The Damask rose is a thornbush of the Rosaceae family (Rosaceae) reaching the height from 1 to 2 m. Its shoots are usually covered with spines. The leaves are alternate, pinnate, glabrous or pubescent, with stipules
adnate to the petiole. The flowers are single or double, with a diameter of 2-15 cm, fragrant, rarely odorless, red, pink, white or yellow, located singularly or in umbel- late-paniculate inflorescences. The receptacle has the form of a pycnium. The fruits are one-seeded nutlets enclosed in a fleshy false fruit.

**Geographical range.** The plant is said to originate in the East. There are about 400 wild species of the plant in the Northern hemisphere. The industrial use of the essential oil roses is developed in Bulgaria, Russia, France, Turkey, Italy and other countries.

**Chemical composition.** The petals of some rose species (French, Kazanlik rose, moss-rose, etc.) are used for the production of a valuable aromatic element - the essential oil (rose oil). The false fruit pulp of the rose is rich in ascorbic acid (15-18% of the dry matter) and vitamin P, it is used in the production of vitamins. Rose petals contain rose essential oil (0.02-0.04%), which is composed of geraniol (50-60%), citronellol (22.6%), nerol (10%), phenylethyl (about 2%) and eugenol, citral, cinnamon and other aldehydes, carotenoid rubixanthin.

**Pharmacological properties.** Rose preparations are used for treating liver and biliary tract diseases (gall stones, biliary dyskinesia after gall bladder removal), as well as urolithiasis and asthma. Contraindications are severe problems with the liver and other parenchymal organs and acute inflammatories of the biliary tract.

**Application.** Fruits and roots of roses are used as raw material for the preparation of tanning agents and dyes. Rose oil or tincture of rose flowers are used for the production of flavored sparkling wine, fruit wine beverages and sweets.

**Rosemary (Rosmarinus officinalis L.)**

**Botanical characteristics.** Rosemary is an evergreen shrub of the Lamiaceae family (*Lamiaceae*), 60-120 cm tall. The leaves are sessile, coriaceous, linear, with expanded margins, white-tomentose on the lower side. The flowers have a blue (rarely pink or white) bilabiate corolla 10-12 mm long and are gathered in axillary racemose inflorescences. The genus has 1-3 closely related species growing in the Mediterranean region.

**Geographical range.** The plant originally comes from the Mediterranean, where it grows in dry sunny slopes. It is grown in the southern regions of Russia, mainly in the Crimea and the Caucasus, and in more northern areas - in tub-gardening.

**Chemical composition.** The leaves and apical shoots of rosemary contain essential oil (2.5%), consisting of α-pine (30%), camphene (20%), 1,8-cineole (30%), borneol (16-20%), L-camphor (15-20%), caryophyllene (8%) and
bornyl acetate (2%). In addition, the leaves contain alkaloids (0.5%) which are used as sources of rosmaricine and ursolic, carnosolic, micromeric and rosmarinic acids [122,123].

Pharmacological properties. Rosemary tincture is used as a diuretic, for stimulating digestion and has spasmylytic and choleretic effects. Rosemary alkaloids are slightly toxic and cause a short-term raise of blood pressure, increase the heartbeat. The alcoholic extract has an anti-inflammatory effect [124].

Application. Rosemarinic and carnosolic acids are used as antioxidants in the food industry and in the production of beverages, for example. In a dose of 4-10 mg/kg increase the shelf life of beer. The leaves and flowering shoots of rosemary are used for the production of essential oil used in perfumery and medicine. The flowers and leaves are used in cooking.

Rosemary is in the food industry as well as in the production of alcoholic and non-alcoholic beverages. It gives the drink a resinous tinge and can be used for the production of vermouth.

Chamomile, horse gowan (Matricaria recutita L.)

Botanical characteristics. Chamomile is an annual herb of the aster family (Asteraceae) reaching 40 cm in height, with a highly branched single stem. The leaves are sessile, alternate, doubly pinnate, dissected into narrow filiform lobes. The flowers are gathered into a basket. The flower basket consists of marginal white semiflowers and numerous central yellow disk flowers. The fruit is an achene. The plant blooms from late May to August.

Geographical range. In nature chamomile is widespread in the Europe and the Mediterranean region.

Chemical composition. For medicinal purposes chamomile flower baskets are used. They contain essential oil, sesquiterpenes, coumarins, glycoside, chlorogenic, caffeic, salicylic acids, flavonoids (apigenin, luteolin, rutin, quercetin, patuletin), glycerides of fatty acids, carotene, mucus, gum, vitamins C, K, aneurin, etc. [125].

Pharmacological properties. Preparations of chamomile have anti-inflammatory and local anesthetic effects, increase tissue regeneration, have spasmylytic and antimicrobial effects. Currently, chamomile is used as an antispasmodic infusion for treating digestion diseases, chronic colitis, gastritis, for stimulation of biliatation, to treat flatulence and diarrhea. The plant is used externally to rinse the
mouth and throat with tonsillitis, laryngitis, gingivitis, stomatitis, vaginitis, urethritis, dermatitis and furunculosis [126]. Romazulan – a liquid containing the extract and essential oil of chamomile – has anti-inflammatory and deodorizing effect. It is used for washing, rinsing and preparing compresses. The essential oil contained in the flowers of chamomile excites the central nervous system, strengthens and increases the rate of breathing, speeds up the heart rate, expands brain vessels. Large doses cause depression of the central nervous system. Chamomile extract has antioxidant activity [82].

**Application.** Chamomile is a common component of herbal tea and high-calorie cocktails and concoctions [127]. The infusion has a dark brown color, a bitter taste and a strong odor. During distillation the aromatic substances pass into the distillate with the first fractions.

**Mountain ash, quickbeam (Sorbus aucuparia L.)**

**Botanical characteristics.** Mountain ash is a tree of the Rosaceae family (Rosaceae) up to 20 m tall and 30-40 cm in diameter. It rarely grows in form of a shrub. It can live up to 150 years or more, it is unpretentious and does not require special care, it is frost- and drought-resistant and shade-tolerant. It grows fast, in 1 year can grow by 0.5 m. It gives fruit each year starting from 5-7 years of age. A single tree can give more than 80-100 kg of fruit. There are 84 species of mountain ash. The trunk is upright. Young branches are pubescent, gray or reddish-brown in color. The bark is smooth and gray. The buds are tomentose. The leaves are alternate, petiolate, with 11-23 oblong leaves, covered with glands at the base. Young leaves from the bottom are downy, the late ones are naked.

It flowers in May - June. The flowers are small, white or greenish, gathered in multiflorous brushes, 5-10 cm in diameter, fragrant, with a bitter-almond smell.

The fruits are round, 2-5-celled, shiny, astringent, bitter, sour, with a peculiar smell. They ripen in September - October.

**Geographical range.** Mountain ash grows everywhere in the forests, on the banks of rivers, lakes, fields, along roads, it is planted in parks, gardens of almost the entire forest and forest-steppe zone of the Europe, except for the Far North, its plantations occupy forested mountainous areas of Crimea and the Caucasus.

**Chemical composition.** The fruits contain cryptoxanthin, various sugars: glucose (3.8%), fructose (4.3%), sucrose (0.7%), sorbose, acids: malic (up 2.8%), folic, tartaric and citric; cyaninchloride, a small amount of tannins (0.3%), essential oil, antibacterial substances, traces of hydrocyanic acid, trace elements (manganese, iron, aluminum). The fruits of mountain ash contain vitamin E and flavonoids: quercetin, iso-quercetin, rutin (2600 mg%), carotenoids, tocopherol, riboflavin, anthocyanins (including cyanidin) (795 mg%), tannins (610 mg%), phospholipids (cephalin, lecithin), pectin (2%). It also contains a hexatomic spirit sorbitol (25.3%) and ascorbic acid. The berries contain significant amounts of vitamin C and provitamin A (carotene), the contents of which in mountain ash is more than in carrots.
The seeds contain up to 22% of fatty oil. The leaves contain volatile, ascorbic acid, trace elements: the seeds - fatty oil suitable for cooking, glycoside, and the cortex contains tannins.

**Pharmacological properties.** In traditional medicine, fruits, flowers and leaves of mountain ash are used. They have a choleretic and diuretic properties, as well as anti-inflammatory, haemostatic, capillary restorative, vitaminizing, mild laxative, diaphoretic actions; lower blood pressure, improve blood clotting and are used as a means of lowering the fat content in the liver and the level of cholesterol in blood. Due to this property mountain ash is used in the treatment of atherosclerosis.

**Application.** The important chemical component of the berries is the pectins that are siderogenous in the presence of sugars and organic acids. Pectins prevent excessive carbohydrate fermentation manifested by suppressing gas formation in the intestine. Pararobic and sorbic acids inhibit the growth of microorganisms and fungi. They are used as preservatives in the food industry and for the purification of water.

The contained substances contained in the berries increase the body's resistance to oxygen starvation. People suffering from carbon monoxide poisoning are given rowanberries. The plant strengthens the body, promotes normalization of metabolism. Decoction of flowers is used in the treatment of diseases of the thyroid gland.

Rowanberry is used for treating chronic constipation that accompanies the disease of the biliary tract. The laxative effect is noted during the first 3 h after usage. The berries are used fresh or dried alone or in combination with nettles and wild roses for the treatment and prevention of vitamin A deficiency.

The berries are used for the production of jam, jelly, and other products. Pure rowan is rarely used in winemaking. This is due to a high content of tannins that give the wine a bitter and astringent taste. However, during long-term exposure the bitterness disappears and the wine gains extremely good quality. Rowanberry wine has a beautiful yellow-orange color. The plant is most suitable for the production of strong and sweet wines [74]. The berries are widely used in the alcoholic beverage industry. Young shoots ash are used to give almond flavor to vodka [74].

**Blueash, lilac (Syringa vulgaris L.)**

**Botanical characteristics.** Lilac is a deciduous shrub of the olive family (Oleaceae), 2-3 m tall, with branched stems and a strong root system. The leaves are opposite, ovate, acuminate, entire, petiolate. The flowers are gathered in a multiflorous raceme. The calyx is green, tetrated; the corolla is a purple (magenta) or white narrow cylindrical tube with a quadripartite limb. The fruit is a boll with a light-brown seeds. Lilac blooms in May, the fruits ripen in October.

**Geographical range.** Blueash grows in the south-eastern part of Central Europe and the Balkans. It is widely cultivated as an ornamental plant.
**Chemical composition.** Florets and leaves are used for therapeutic purposes. The flowers contain volatile oil and bitter glycoside siringin that is also found in the leaves and the bark.

**Pharmacological properties.** Lilac has antipyretic, diaphoretic, antimicrobial, expectorant, anti-inflammatory, diuretic, sedative, anticonvulsant, and analgesic effects.

**Application.** In traditional medicine the flower infusion is used for the treatment of kidney diseases and urolithiasis. The infusion of lilac flowers and lime is drunk as an antipyretic and diaphoretic for colds. The leaves are brewed as a tea for treating malaria, diarrhea, gastric ulcer, whooping cough and cough. Crushed leaves are used for treating sore wounds.

Lilac essence is used for making liqueurs, lilac flowers are used as a base for makeup.

**Bullace, garden plum, prune (Prunus domestica L.)**

**Botanical characteristics.** Prune is a tree of the Rosaceae family (Rosaceae), 6-12 m tall, with a wide or narrow-oval crown. In the north it often grows in the form of a multi-stemmed shrub 3-4 m tall. Young shoots are glabrous or tomentose, reddish-brown or yellow-green, angular: old branches and stems are dark brown and gray, with cracked bark. The leaves are elliptic or obovate, 4-10 cm long and 2.5-5 cm wide, with crenate-serrate edges, glabrous and dark green on the upper side, downy from beneath, light or gray-green and pale yellow in autumn. The flower is the criteria of *P. domestica* varieties. The flowers are up to 2.5 cm in diameter, gathered in bunches of 2, less often of 1-5. The petals are white (sometimes with a green tint). The fruit is a small (6-10 g) or large (50-70 g) drupe, 2-7 cm long, 2-4 cm wide, can be of diverse forms - from flattened-round to oblong-elliptical, with a lateral groove, purple, yellow, pale green, green, red, often with a blue-gray bloom. The fruit pulp is usually yellow or greenish, rather dense, juicy and sweet-sour.

**Geographical range.** Bullace grows in the south-eastern part of Central Europe and the Balkans, widely it is cultivated in the gardens of southern Belarus, Moldova, Ukraine and the Caucasus. It also grows in Central Asia, southern Siberia and the Far East.

**Chemical composition.** The caloric content of the plum is almost as large as the one of grapes and cherries. The fruits contain sugar (up 21%), organic acids (up to 3%), tannins (about 1%), pectin (about 1%), vitamin C, vitamin A, P. The seeds contain up to 42% of fatty oil.

**Pharmacological properties.** Garden plum has been used in medicine since ancient times. The fruits are recommended for treating prolonged constipation, heartburn, atherosclerosis, kidney disease, rheumatoid arthritis, gout, and as a diuretic that increases the appetite and as a gastric analgesic; chopped fresh steamed and dried leaves are used for healing wounds.
Application. The fruits are eaten raw, used for making compotes, marinades, jams. Usually they are eaten after freezing and are also used for the production of wines, spirits, syrups, extracts, liquor, vinegar, confectionery products with good taste and nutritional properties and a pleasant aroma. In France, pickled unripe plums are used instead of olives. Grilled fruit with leaves can serve as a coffee substitute. The plum contains a lot of pectin, therefore it is difficult to clarify and filter the juice. To speed up the process of juice secretion it is recommended to use heat and enzyme treatment of the pulp. Fermented plum juice is used as a raw material for plum brandy, a widespread alcoholic beverage in all Balkan countries as well as in the Czech Republic and Slovakia. The hydroalcoholic extract of dried plums (prunes) is included in numerous balsams. The natural plum tincture infused with cognac with the addition of apple juice and sugar is produced by the "Ussuri balsam" beverage industry. In other countries a wide range of liqueurs based on plums is produced.

Red currant (Ribes rubrum L.)

Botanical characteristics. Red currant is a small shrub of the Grossulariaceae family (Grossulariaceae) 1-1.5 m tall with cordate digitate lobed leaves, small pale green flowers and red sour berries collected in a drooping brush. There are many varieties of red currant. Its name comes from the arabic latinization «ribas» - the name of currant rhubarb (Rheum ribes Z.), which has a sour taste. When the Arabs conquered Spain in 711 and did not find «ribas», which they widely used at home, the title was transferred to the currants, which also has a sour taste of berries.

Geographical range. Red currant comes from Western Europe, where it had been cultivated as a medicinal plant and only after a large period of time was recognized as a berry plant.

Chemical composition. The berries contain sugar (8%), organic acids (gallic), pectin and polyphenol substances [128], minerals, vitamin C (8-30%), glycosides [129] which have an astringent effect and anthocyanins with antioxidant properties.

Pharmacological properties. Due to a higher content of organic acid the berry juice is good thirst quencher, it eliminates nausea, increases appetite and is a good reducing tonic after a serious illness.

Application. Red currant berries are used in traditional medicine as a diaphoretic, antipyretic, laxative, as well as an antiallergenic. Juice is used to stimulate the removal of salts from the body, is a mild laxative and choleric, anti-inflammatory and hemostatic agent. Prolonged use of red currant juice helps treat chronic constipation. The berries quench thirst, are used for preparing fruit drinks and jelly. Red berry can be used for the preparation of original high quality juice and wine [74].
Black currant (Ribes nigrum L.)

*Botanical characteristics.* Black currant is a bush of the Grossulariaceae family (*Grossulariaceae*), 1-1.5 m tall, with green puberulent young branches. The leaves are tri-, penta-palmately lobed, coarsely serrate at the edges. The flowers are teleianthous campaniforms in drooping racemes. The fruit is spherical black berry. In the wild the black currant bushes grow along the banks of rivers, lakes, streams and in rainforests. In the wild the black currant yield is very low: one bush produces only about 800 grams of berries. Black currant is highly polymorphic. It is often found in large-fruited forms.

*Geographical range.* In the wild it grows in the forests of the European part of Russia, the West Siberian Plain, the East Siberian Plateau and in the taiga zone of the mountains of southern Siberia. In the plains the black currant bushes mainly grow in the floodplains, on the banks of rivers, lakes, oxbow lakes, streams, in moist deciduous, coniferous and mixed lowland forests, among bird cherry bushes, willows and alders. In the mountainous regions of southern Siberia black currant is found in the taiga zone, growing mainly in the valleys of rivers and streams, as well as on slopes, in fir, pine, larch and mixed forests, in bushes, forest glades, clearings, burned areas, etc.

*Chemical composition.* Black currant berries contain vitamins C, A, carotene, various sugars (from 4.5 to 16.8%) (mainly glucose, fructose), organic acids (2.5-4.5%) (citric, malic), pectin elements (0.2-0.8%), tannins (0.39-0.43%), anthocyanin substances (cyanidin, delphinidin) and flavonol glycosides (derivatives of quercetin, kaempferol and myricetin), essential oils [130, 131]. The content of glycoside flavonols and anthocyanins increases with fruit maturity and reaches a maximum when the berries are fully ripe.

*Pharmacological properties.* Black currant has diaphoretic, diuretic and antilaxative properties, the leaves, buds and fruits of black currant have a disinfecting effect due to the content of essential oils. In early spring black currant leaves can be a source of vitamins. The buds if necessary are used as a disinfectant and vitamin source even in winter. The antioxidant activity of black currant berries and juice can be recommended for the treatment of cardiovascular diseases and cancer [132].

*Application.* In traditional medicine, fresh and dried fruit are recommended for treating gastrointestinal diseases (peptic and duodenal ulcer, gastritis with low acidity, etc.), and violation of cardiac rhythm. Instead of consuming berries young children can drink the berry juice.

Dried leaves can be a substitute for tea; this drink has a diaphoretic and diuretic effect. In addition, black currant leaves are effective against dysentery bacilli and can be used as an auxiliary means of improving the effectiveness of antibiotics. The berries exhibit immunostimulating activity. The leaves are used as a component of vitamin teas with raspberry, cranberry and dogrose leaves. The berries of black currant, containing organic acids and pectin, are used as an adjunct in the treatment achylic gastritis, cholecystitis, and intestinal dysbacteriosis with severe putrefaction in the intestines.
Black currant is used to treat and prevent scurvy and as part of combined treatment for various diseases associated with bleeding. 15-20 g of currant berries provide the daily need for ascorbic acid, the content of which varies depending on many factors: the degree of maturity, the phase of growth and the plant variety. In times of drought the ascorbic acid content in the berries reduces by 20-30%, and increases in rainy and cold summers. In the northern areas black currant contains more ascorbic acid.

Black currant contains almost no enzymes that destroy ascorbic acid, so it is well-preserved in the frozen berries. In the beverage industry not only berries of black currant are used – its leaves are used to make special flavored vodka and infusions. In France a special black currant liqueur «Cassis de Dijon» (15% of alcohol) is produced since 1841. It is produced by infusing black currants in brandy for 2 months. There are also black currant cream liqueurs.

**Goutweed, ashweed (Aegopodium podagraria L.)**

**Botanical characteristics.** Ashweed is a perennial herb of the Apiaceae family (Apiaceae). Its basal and lower stem leaves sit on long stalks and are doubly ternate (i.e. twice divided into three parts) or ternately pinnate; the leaves are oblong-ovate with serrated edges. The flowers are small, white, gathered in corymbose umbels. The flower has five stamens. The rhizome is horizontal, underground, creeping. The stem is erect, furrowed, glabrous or slightly pubescent, hollow inside, slightly branched, the height of a flowering plant is 50-100 cm.

**Geographical range.** Ashweed is found in many regions of Europe. Goutweed, has been introduced around the world, including in North America, Australia, New Zealand, and Japan. It grows in bushes and forests (especially oak forests), clearings, in gardens. It is found in thinned deciduous forests (it doesn’t bloom under the forest canopy), meadows, forest edges, openings, sometimes forming thickets in burned areas.

**Chemical composition.** The leaves contain nitrogen compounds, including choline which plays an important role in metabolism, vitamin C, citric acid, malic acid, flavonoids - quercetin and kaempferol - which strengthen blood vessel walls, essential oil, mineral salts. The rhizomes contain essential oils, saponins, starch, resin. The flowers of the plant contain falkarindiol [133] which reduces the risk of cancer. This substance is a natural carrot fungicide that protects it from decay under the influence of soil fungi [134].
Pharmacological properties. Goutweed is used in the treatment of gout, rheumatism, kidney and bladder diseases, the fresh leaves are used as a means of healing wounds and pain. Rhizomes have antifungal activity.

Application. The young leaves and flower shoots of goutweed are used as a vegetable in food and in the beverage industry it is used to improve the taste of vodka [135]. Antianemic seasonings for dietary treatment of iron deficiency are produced using ashweed as well.

Ural licorice (Glycyrrhiza uralensis Fisch.)

Botanical characteristics. Licorice is a herbaceous perennial plant of the legume family (Fabaceae), up to 2 m tall, with a powerful rhizome and roots. It is distinguished from the Spanish (common) licorice by dense, thick flower inflorescences and larger flowers (up to 23 mm) and cup (up to 14 mm). The corolla vine pallet is rounded or slightly notched (in common licorice it is pointed). The fruit is a cordately curved, cross-winding bean. The beans are intertwined in a tight ball. The seeds are round and kidney-shaped, brown in color. The plant flowers in June - July, the fruits ripen in late September.

Geographical range. It grows in southern Siberia from the Urals to the borders of Mongolia and China, capturing the mountain valleys of the Pamir-Altai, Tien Shan, Buryatia, and the Chita region. It is collected and cultivated like common licorice. Its rhizomes are used equally with common licorice.

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Chemical composition. Ural licorice roots contain flavonoids (up 4.3%): liquiritigenin, isoliquiritigenin, neoliquiritin, neoisoliquiritin, liquiritin, isoliquiritin, isouraloside, draloside, globroside, lacraside; carbohydrates: glucose and sucrose (up 15.6%), pentose (up to 13 , 2%); starch (24.5%), pectin (4.6%), organic acids (4.6%): tartaric acid, citric acid, fumaric acid, oxalic acid, malic acid, succinic acid, glycyrrhizic (22.2 %); α-sitosterol, alkaloids, coumarins, tannins (up to 9.46%).

The rhizomes and roots also contain macronutrients; potassium, copper, zinc, iron, trace elements, manganese, cobalt, chromium, etc., concentrated iron, selenium. In terms of chemical composition Ural licorice is pretty close to common licorice.

Pharmacological properties. Licorice roots are widely used in medicine: for treating hyperacid gastritis, gastric and duodenal ulcers, bronchial asthma, allergic dermatitis, eczema, for preparing pills.

Glycyrrhizic acid is a triterpenoid saponin and has powerful anti-inflammatory action.
The plant is used for the preparations of drugs - glycercyl, dry extract, thoracic (licorice) elixirs, syrups, licorice root, licorice decoction - is part of lung, diuretic and other teas. The flavonoids received from licorice roots are part of such drugs as liquiriton and flacarbinum used to treat gastric disorders.

Application. Licorice roots are widely used in the food industry in the manufacture of sweets, alcohol and soft drinks, beer, coffee, cocoa, tea, tea substitutes, as well as in other sectors of the economy: in the manufacture of foam liquids for fire extinguishers, ink, shoe polish, watercolors, hair strengthening liquids and shampoos, for dying silk and wool, for feeding bees. The roots are part of aromatized wines and balsams. In Italy a famous alcoholic drink «Aneseone», containing licorice and anise [136] is produced. Distillation is not applicable.

Norway fir, common pine (Pinus sylvestris L.)

Botanical characteristic. Common pine is a pinaceous tree (Pinaceae), 20-40 m in height with a trunk up to 1 m in diameter, a tall coned and rounded broad crown with horizontal branches in whorls. The bark at the top of the trunk is scaly and yellow; in the lower part - the red-brown and thick. The needles are seated on short shoots in groups of 2. They are bluish-green, somewhat curved, convex on the upper side, thick, 4-7 cm long. The cones are ovoid, solitary or gathered in groups of 2-3 pc., 2.5-7 cm long. The root system is pivotal.

Geographical range. There are about 90 species described, the tree is widely distributed throughout the Northern Hemisphere. It is found in Europe, the Urals, Siberia, Mongolia and China.

Chemical composition. The buds contain essential oil (0.36%), resin, starch, tannin, the needles - ascorbic acid, tannins (about 5%), alkaloids, essential oil containing limonene, borneol, bornyl acetate, cadinene, etc. The needles and bark contain anthocyanin compounds. The content of vitamins is more in winter needles and of resinous and bitter substances - in young leaves. Pine resin contains resin acids: dextropimaric (up 18%), levopimaric (up 36%), palustric and abietic.

Pharmacological properties. Pine preparations have expectorant, diuretic, choleretic, analgesic, antibacterial and disinfectant effects.

Powder made from pine resin was used in Asian traditional medicine for the treatment of painful ulcers and other digestive disorders.

In the early 80's a group of Japanese scientists synthesized more than 70 derivatives of dehydroabietic acid - a component of pine resin. The 12-sulfodehydroabietic acid monosodium salt (TA-2711, ecabet sodium, ecabet) was patented in Japan.
as an anti-ulcer drug [137]. Ecabet reduces harmful activity of pepsin, heals ulcers and thickens the protective lining of the stomach, protecting it from the acid [138,139]. Ecabet largely suppresses damage to the mucous membrane of the stomach. This fact was used in the clinical treatment of patients with liver damage [140]. Joint application of ecabet and cimetidine in the treatment of stomach ulcers, especially in the elderly people has been approved [141].

Application. Infusions of pine buds and needles are used in the production of special vodkas.

**Sophora japonica, Chinese scholar tree (Sophora japonicum (L.) Schott)**

**Botanical characteristics.** Sophora is a deciduous tree of the Fabaceae family (Fabaceae), reaching a height of 25 m, with a broad crown. The bark of older stems is dark gray, with deep cracks, young branches and shoots are green-gray and nappy. The leaves are pinnate, 11-25 cm long, the flowers are 1-1.5 cm long, fragrant, yellowish-white seated in large loose panicles reaching a length of 20-30 cm. The bean is fleshy, glabrous, up to 10 cm long, with deep constrictions between the seeds. Immature beans are green; the mature ones are reddish. Each bean contains 2-6 oval, smooth, dark brown seeds, similar to kidney beans, but smaller.

There is a cultural weeping form of sophora, which is easier to collect buds and fruits from. Sophora japonica is distinguished by non-utricular beans and the absence of thorns.

The plant blooms in late summer, in July - August, the fruits ripen in September - October and stay on the tree all winter.

**Geographical range.** Sophora japonica’s homeland is China and Japan. It is cultivated on the peninsula of Korea, in Japan, Vietnam and other Asian countries, as well as in Europe, North America, in the Caucasus and Central Asia.

**Chemical composition.** The most valuable biologically active substance of Sophora japonica is rutin, which is a flavonol glycoside comprised of the quercetin and the disaccharide rutinose. It is found in the buds, flowers, leaves, young branches and young fruits. A lot of rutin is accumulated in young plant organs. The maximum amount of it is contained in the bud. The fruits during maturation contain 8 flavonoids, the number of which depends on the location and time of gathering. In addition to rutin the plant contains kaempferol-3-sophoroside, quercetin-3-rutinoside and genistein-4-sophorobioside. The flowers contain alkaloids and glycosides. The leaves contain rutin and vitamin C. The seeds contain up to 10% fatty oil. Sophora seeds contain toxic alkaloids matrine and oxysmatrine [142].

**Pharmacological properties.** Rutin derived from the buds of sophora reduces fragility and permeability of capillaries, exceeds the ability to absorb ascorbic acid (vitamin C).
Application. The buds are used to obtain rutin, which is available in powders and pills. Rutin, as all preparations of vitamin P, is used for the prevention and treatment of hypo-and avitaminosis P and diseases causing vascular permeability, as well as for the prevention and treatment of capillaries when applying anticoagulants, salicylates and arsenical drugs. The buds are also used to obtain quercetin, which is used in the form of tablets, for the same purpose as the rutin. Infusion of sophora japonica is used to produce alcohol beverages.

Blackthorn (Prunus spinosa L.)

Botanical characteristics. Blackthorn is a branched spiny creeping-rooted shrub of the Rosaceae family (Rosaceae). It is 1.5-4 m tall, with oblong-elliptic crenate-serrate leaves. The flowers are white, pentapetalous, with many stamens. Thru plant flowers in April - May (before the leaves appear). The fruits - black sour-sweet drupes with a bluish bloom, ripen in September.

Geographical range. It grows on the edges of forests, shrubs and steppe slopes. It is cultivated in the gardens. Blackthorn originally grows in Europe, western Asia, and can be found in Northwest Africa, the Caucasus, Western Siberia.

Chemical composition. The fruits contain tannins, vitamin C and organic acids. Fruit seeds contain amygdalin - a poisonous glycoside, which in the process the enzymatic hydrolysis becomes the source of hydrocyanic acid.

Pharmacological properties. The flowers increase perspiration and urine flow, stimulate the kidneys, suppress nausea, regulate abnormal metabolism followed by skin diseases, act as a gentle laxative and calm the nervous system. Ripe fruit has an astringent action and is effective for treating diarrhea.

Application. Blackthorn flowers are used as a means of exciting the activity of kidneys and the bladder, and for the treatment of almost all metabolic disorders.

Aromatic spirit made from dried blackthorn is used for the production of a special vodka and other alcoholic beverages [143].

Creeping thyme, wild thyme, savory (Thymus serpilium L.)

Botanical characteristics. Thyme is a semishrub of the Lamiaceae family (Lamiaceae) with a strong aromatic odor, growing in tussocks. Its stalks are thin, creeping, ending with sterile shoots and covered with multiple ascending or erect flowering shoots 2-15 cm long. The stems are roughly tetraquetrous, thin, pubescent. The leaves are opposite, petiolate, elliptic, entire, 5-10 mm long, glabrous or slightly pubescent, with numerous glands on the lower side, with sharply protruding veins; the bottom of the pallet and the petioles are covered with long ciliate fiber. The flowers are hermaphrodite and separate. Flowers are gathered in verticillasters
forming capitate inflorescences at the ends of twigs. The calyx is 4 mm long, bilabiate, pubescent outside and with a ring of fiber inside; the edges of the calyx are covered with ciliate hairs. The corolla is bilabiate, rose-purple, 5-8 mm long. The number of stamens is 4, the upper ones are shorter than the lower; the hermaphrodite flowers have stamens longer than the corolla, the stamens are shorter than the corolla and have undeveloped anthers. The pistil has a quadripartite upper ovary, located on a round glandular disk. The fruit consists of four nutlets enclosed in a remaining cup. The nuts are almost spherical or elliptical, dark-brown or brown, 0.6-1 mm long. The plant flowers in June - July, and gives fruit in August - September.


It is also cultivated in small areas in the southern regions of Russia, Ukraine, Moldova and Central Asia. It is cultivated in plantations of medicinal plants. The flowering leafy twigs (herbage) are used for medicinal purposes.

Chemical composition. Creeping thyme herbage contains essential oil (0.1-0.6%), which is composed of thymol (30%), carvacrol (20%) [144], n-cymene, γ-terpinene, α-terpineol, borneol and zingiberene, tannins, bitter elements, gum, flavonoids, ursolic and oleanolic acids. The aerial part of the plant contains macronutrients: potassium, calcium, magnesium, iron, trace minerals manganese, copper, etc. It concentrates iron, molybdenum, selenium, boron. Phenolic compounds contained in thyme possess antioxidant activity [145].

Pharmacological properties. In medicine, broth and liquid extract of thyme are used as expectorants for treating bronchitis and other diseases of the upper respiratory tract. It is also used as an analgesic in radiculitis and neuralgia. The main active element of thyme is thymol. Thyme has a noted ability to suppress the alcohol motivation, and it is a part of a plant-based preparation approved as a drug for the treatment and rehabilitation of alcoholics. It also includes the herbage and leaves of wormwood, the leaves the hazelwort, centaury herbage, tansy flowers, leaves of bearberry, sea poppy herbage, rhizomes and roots of Rhaponticum cartamoides. The biological activity of wormwood, centaury, tansy and Rhaponticum provides the stimulation of appetite, hepatoprotective, nephroprotective, antiulcer, anti-hepatitis, anti-pancreatitis, anti-inflammatory, hypoglycemic and antioxidant effects of the tea. Clinical trials show the effectiveness of the phytopreparation in relieving the somatic and vegetative symptoms of alcohol withdrawal and reducing alcoholic pathological desire [74].

Application. Thyme is used in cooking as a seasoning, in the alcoholic industry - to flavor special vodkas. Its herbage is part of kvass [146], balsams, vermouth [28, 30] recipes.

Caraway (Carum carvi L.)

Botanical characteristics. Caraway is an herb of the celery family (Apiaceae) with the height of 30-60 cm. Its root is spindle-shaped and the leaves are thrice-
pinnatisected with linear-lanceolate lobes pale green in color. The flowers are small, white or pink and gathered in a cyme. The fruit is a diachenium, which becomes brown when ripe and disintegrates into small egg-shaped mericarps that are 4-6 mm long and 1-1.5 mm in diameter, yellow or chocolate brown. The fruit of the plant has strong flavor, and a nice and sharp, slightly pungent taste.

The plant flowers from June to August, massive flowering starts in late June - early July. Fruits ripen in July - August. By the end of the first year the plant forms radical rosettes with 8-16 leaves and a fleshy taproot.

**Geographical range.** In the wild caraway grows in many countries in Europe and Asia. It is found everywhere in the forest and forest-steppe zones. It grows in the meadows, pastures, coniferous sparse forests, bushes, meadows and forest edges, near houses, along ditches, roads, railway embankments. For industrial use the crop is available in almost all areas.

**Chemical composition.** The components of the fruit differ in content depending on the particular location and the chemical composition of the soil. Caraway contains thanol (up 8%), wax (7-15%), resinous substances and sucrose.

**Pharmacological properties.** Caraway has tonic, diuretic and disinfectant effects, facilitates digestion, treats flatulence, cramps and shortness of breath. It also improves cerebral blood circulation.

**Application.** Caraway fruits are used for medicinal purposes. They are used in various preparations for treating flatulence, gastrointestinal tract diseases, particularly in cases of gastritis with low acidity, anemia. The fruits infusion is recommended for lactating mothers to increase the milk supply.

Caraway fruits are used in medicine, food, liquor and perfume industry as elements improving digestion, spicy and aromatic agents. The infusion has a golden-yellow color, a pungent taste, and a characteristic smell of carvone. During distillation the delicate fragrance of limonene passes to the distillate with the first fractions and carvone flavor appears in the following fractions.

**Bearberry (Arctostaphylos uva-ursi (L.) Spreng)**

**Botanical characteristics.** Bearberry is an evergreen, perennial, decumbent, branched shrub of the heath family (Ericaceae), with decumbent stems 25-130 cm long. The leaves are alternate, dark green, leathery, oblong-ovate, 12-26 mm long, 4-9 mm wide. The flowers are pink, 5-6 mm long, collected in short apical brushes. The fruit is a red mealy, globose pentachenium 6-8 mm in diameter. The plant flowers in May and gives fruit in July - August.

**Geographical range.** Bearberry is found almost all over Europe (except for the extreme southern areas). It is common in Asia, America, Scotland and Ireland. It grows in clearings, burned areas, in deciduous and dry pine forests, forms thickets. It often grows together with cowberries.

**Chemical composition.** The leaves contain from 8 to 2% (not less than 6%) glycoside arbutin (Ericolin), methylarbutin, 30-35% of tanning substances of the
pyrogallic group, free hydroquinone, ursolic acid (0.4-0.75%), flavonoids (hyperoside, quercetin and isoquercitrin, quercitin and myricetin), quinic, formic acid, ascorbic acid and a small amount of essential oil. The leaves contain 2.76% (of the dry solid matter) of azotic elements 57.5% of which relates to proteins, including indispensable amino acids. The leaves of bearberry also contain a large amount of iodine (2.1-2.7 mg/ kg). Glycoside arbutin influenced by the arbutase enzyme is hydrolyzed to hydroquinone and glucose.

The tannins contained in the decoction of bearberry have an astringent effect on the gastrointestinal tract. In experiments on rats, bearberry broths demonstrated anti-hypoxant properties: the animals’ survival rate under the conditions of hypoxia increased under the influence of bearberry.

Bearberry presents scientific interest being a natural source of hydroquinone, which is a labile hydrogen substance. Hydroquinone increases the activity of the redox reactions. One of its multilateral influences is the capacity to block O-methyltransferase and thus prolong the action of adrenaline. In experimental studies hydroquinone has a pronounced effect on the metabolism, tissue oxygen absorption, the blood levels of glucose, potassium, glutathione; has a positive effect on diabetic ketoacidosis, has a hypertensive effect in a number of experimental shock situations.

Pharmacological properties. Bearberry preparations have diuretic and anti-septic actions mainly in the urinary tract. The antiseptic effect is due to hydroquinone formed in the body by arbutin hydrolysis and excreted in the urine. The plant has disinfectant and diuretic effects, “washing” the products of inflammation out of the urinary tract and thus disinfecting it [147, 148, 149]. Large doses may increase inflammation in the urinary tract due to renal tubular system stimulation. Because of this the bearberry decoction is unsuitable for use in acute kidney diseases. To avoid side effects during long-term treatment, bearberry is used in teas together with other herbal remedies that possess anti-inflammatory and diuretic properties.

Consuming a decoction of bearberry containing a significant amount of tannins can irritate the mucosa of the gastrointestinal tract, which can lead to nausea, vomiting and diarrhea. Bearberry preparations irritate the muscles of the uterus, so their use is contraindicated during pregnancy.

Application. Bearberry is used for treating chronic cystitis, urolithiasis and gout. The berries are edible and are used for making beverages [135, 150].
Black poplar (Populus nigra L.)

Botanical characteristics. A tree of the willow tree family (Salicaceae) up to 25 m tall, with yellowish bark on young branches that becomes gray with time. The crown is broad and spreading. The root system is well-developed, the roots reach deep into the earth and spread many for meters in width. The leaves are alternate, long-stalked, almost triangular and serrate along the edge. The apical buds are pointed, laminated and serrate. The tree is dioecious. The flowers are small, without perianth, gathered in catkin inflorescences. Staminate catkins are 6-10 cm long and the pistillate - up to 12 cm long. The staminate flowers have 20-25 stamens with white filaments and red anthers, the pistillate only have a pistil with an upper one-celled ovary, a short column and two yellow stigmas. The flowering period of the plant is in March - April, before leafing. The fruit is an ovate naked greenish-brown box with small seeds that ripens in May - June.

Geographical range. The poplar is found in the Southern, Central and East Europe, North Africa and eastwards to Central Asia the Black or Water Poplar is almost certainly native to lowland England, the Caucasus, Western and Eastern Siberia. It grows in humid and rocky areas along the river banks almost everywhere in the temperate zone.

Chemical composition. The buds contain carbohydrates, organic acids, essential oils, tannins, coloring and resinous substances, glycosides salicin and populin, phenol carbonic acids (para-coumaric, caffeic, ferulic and their derivatives), vitamin C, phenolglycosides, chalcones, flavonoids, leucoanthocyans and fatty oil. The bark contains alkaloids, phenolglycosides, flavonoids, tannins and carbohydrates; the leaves - isoprenoids, carotenoids, alkaloids, organic and phenol carbonic acids, phenolglycosides, lignins and tannins.

Pharmacological properties. Poplar preparations have anti-inflammatory, analgesic, antipruritic, astringent, antimicrobial, sedative, antipyretic, diaphoretic and wound healing activities.

Application. Poplar is used in the form of tinctures for treating tuberculosis, rheumatism, gout, intermittent fever, inflammation of the bladder, colds and poor menstruation; in the form of an oil extract it is used for treating urolithiasis; in the form of poultices – for treating nerve and tendon ligament damages: as an ointment – for treating gout, diseases of the joints, Trichomonas colpitis, furuncles, festering wounds, burns, hemorrhoids, severe itching, cracked lips and nipples, staphylococcal and fungal diseases of the skin. The fresh juice of poplar leaves relieves toothache. According to the chemical composition the resin of poplar buds is similar to propolis – the life activity product of bees – which is widely used in medicine. The essential oil of poplar is used for aromatizing soap. Poplar buds infusion is used to flavor wines, and making appetizers.
Yarrow (Achillea millefolium L.)

**Botanical characteristics.** Yarrow is a perennial herb of the aster family (*Asteraceae*), 20-120 cm tall. Its rhizome is thick, creeping, with numerous thin fibrous roots and underground stems. The stem grows out of the rhizome, is erect, angular, furrowed, glabrous or slightly pubescent and branched at the top. The basal leaves develop from the shoots, are petiolate, lanceolate or linear-lanceolate, doubly pinnatisected, up to 15 cm long, gray-green, glabrous or pubescent, with a number of oil glands at the bottom side. The stem leaves are small, pubescent and sessile. The flowers are white, yellow, pink, red, gathered in baskets forming complex corymbs 2-15 cm in diameter. The fruit is an achene. Yarrow blooms from July to September. The tops of plants (up to 20 cm) with leaves and flowers are harvested for medicinal purposes.

**Geographical range.** In the wild yarrow grows in Europe and Asia (the Himalayas), and is cultivated in North America, New Zealand and South Australia. It grows in meadows, meadow steppes and forests. It is also cultivated in England and Australia.

**Chemical composition.** The leaves contain the alkaloid achilleine (0.05%) that increases blood clotting, essential oil (0.8%) which includes a proazulene achillicine (25-30%), complex esters (10-13%), cineole (8-10%), caryophyllene, formic, acetic and isovaleric acids, alcohols, vitamins C, K, resins, carotene, volatile, bitter and astringent substances, mineral salts, etc. The flowers contain more essential oil than the leaves [151].

**Pharmacological properties.** Yarrow herbage and its juice have styptic and anti-inflammatory properties. The blood clotting action of a 0.5% infusion of yarrow exceeds the similar action of calcium chloride solution at a concentration 1:2000-1:5000. Yarrow increases bile secretion. The yarrow blossoms are a source of complex solids including α-peroxiachifolid that, tested on mice, demonstrated a distinct hypersensitizing action. This substance may prove to be the factor that causes dermatitis after contact with the plant [152]. The essential oils of yarrow reduce vascular permeability [153]. They significantly inhibit the exudation, reducing the capillary permeability to normal level.

**Application.** Yarrow is used as a hemostatic agent in local bleeding - nose, mouth, minor wounds, abrasions, scratches, lung and uterine bleeding, fibroids, inflammation, bleeding hemorrhoids; it is also used for treating diseases of the gastrointestinal tract: colitis, peptic ulcer disease; and is also recommended for treating inflammations of the urinary tract.

Yarrow helps treat chest pain, dental pain, increases the amount of milk in nursing mothers. Its herbage is part of stomach, appetizing and other mixtures and teas.

Yarrow essential oils have antioxidant properties [74]. The plant is a component of special vodkas and various balsams. Yarrow essential oils can not only provide a therapeutic effect, but also help to preserve the quality of drinks, preventing the biologically active components from oxidation [74].
**Sulfur root, dill (Anethum graveolens L.)**

*Botanical characteristics.* Sulfur root is an annual herb of the celery family (*Apiaceae*), 40-100 cm tall. The stem is upright, rounded, spreading, and linearly ribbed. The leaves are alternate, ovate, doubly or triply-pinnate, with linear filiform terminal lobes; the lower leaves are petiolate, the upper are sessile. The flowers are small, monoclinous, pentameric, gathered in complex 20-50-beamed umbels, the petals are yellow with a tip curved inwards. The plant flowers in June - August. The fruits are ripe, elliptical, split in two cremocarps with a groove that split into two mericarps. The fruit is 3-5 cm long and 2-3 mm thick. On the outside the fruit has five ribs; the radicals are stretched into wide wings, green-gray in color, with a characteristic aromatic odor and a spicy taste.

*Geographical range.* Wild species are found in the Mediterranean countries. It is cultivated as a garden plant everywhere and in the wild it grows in the south of the European part of Russia, the Caucasus, the Baltics and Central Asia.

*Chemical composition.* The fruits contain furanochromones - visnagin and khellin. The fruits are also rich in essential fatty oils. The main components of the essential oil are carvone (40-60%) and anethole (50%). Dill fruits contain other components: terpenoids (19-40%), dihydrocarvone, carveol, dihydrocarveol, isoeugenol.

Fatty oil contains up to 93% of glycerides of fatty acids, including linoleic, palmitic, oleic, petroselinic. The fruits contain coumarin, phenol carbonic acids (chlorogenic, caffeic), flavonoids, waxes, resins, protein (14-15%), nitrogenous substances and cellulose.

The essential oil dill herbage contains less carvone than the fruit oil - only 16%. The herbage composition includes vitamins C, B1, B2, PP, P, pro-vitamin A, calcium, potassium, phosphorus, iron, folic acid, flavonoids (quercetin, isorhamnetin, kaempferol).

*Pharmacological properties.* Dill oil has anti-atherogenic properties that provide the effective use of dill in treating atherosclerosis and lipid disorders. The fruits are used for stimulating appetite, improving digestion, particularly for treating dyspepsia; the plant is used as a succagogue, choleretic, antispasmodic element for treating colic, spastic pain; dill is also a lactogenic agent. Due to the fact that dill fruit has emollient, expectorant, antimicrobial, anti-inflammatory properties, it is used for treating bronchopulmonary diseases. Khellin contained in dill, has vasodilating, antispasmodic, sedative, coronarodilating effects [44].

*Application.* Dill fruit and herbage are widely used in many areas of food industry - conservation, fish, dairy, liquor, in soap production and medicine.

The infusion has a yellow-brown color and a distinctive smell, the flavor is similar to caraway. During distillation dill flavor is received with the first distillate fractions, gradually increasing in the next fractions.
Fennel (Foeniculum vulgare Mill.)

Botanical characteristics. Fennel is a biennial or perennial plant of the celery family (Apiaceae) that reaches a height of 1-2 meters. It has a rounded striated stalk with a blue coating and branches on top, repeatedly covered with pinnate leaves. The segments of the leaves are narrow. The middle and upper leaves have a large vagina. Yellow flowers are collected in umbels; the umbels are gathered in umbels without a wrapping. The plant blooms from July to September.

Geographical range. Fennel originally comes from the Mediterranean, and now it is grown for medicinal purposes in almost all southern European countries and in America. Fennel used in food fennel has a purely cultural origin. Ripe fruits are used more often than the roots.

Chemical composition. Fennel fruit contains up to 6% of essential oil, which is mainly composed of anethole (50-80%), which has a sweet taste, and limonene (5%), methyl chavicol, safrole, pinene and other substances the aroma of which is similar to camphor. Fennel oil has a smell very similar to anise. Other components (fatty oil, protein and sugar) according to their actions are considered to be associated substances.

Pharmacological properties. Fennel is widely used in medicine as an expectorant, a sedative, especially for children, and as an element for treating flatulence. It is often used in combination with anise and cumin. Fennel fruits are part of the many tea mixtures for treating cough, diseases of the stomach, intestines, liver and biliary tract. Fennel oil has an antithrombotic effect and the ability to restore tone and the diameter of blood vessels [154].

Application. Fennel is an edible plant, a source of essential oil and spicy plant. It is used as an additive in bread and other bakery products, is added to canned fruits and salads. Fennel is a part of a vermouth recipe [28], pastry, pickles.

Cupid's-delight, pansy, garden violet (Viola tricolor L.)

Botanical characteristics. Garden violet is an annual or biennial plant of the violet family (Violaceae), with the height of 10-40 cm. The root is thin, tap and brownish. The stems are simple or branched, erect, ascending or nearly decumbent. The leaves are 0.5-7 cm long, 5-20 mm wide, alternate, stellate, bluntly dented, with large lyrate stipules, the lower leaves are broadly ovate, petiolate, the upper are oblong and subsessile.

The flowers are solitary, 2-3 cm long, seated on long (3-13 cm) peduncles, with two bracts. The corolla is made of five unequal petals. The two upper petals are obovate, mostly blue-purple, rarely pale purple, the two side ones are elliptical, with edges overlapping the upper petals, blue-purple or yellow with 1-3 dark stripes, the lower petal is triangular with rounded edges, larger than the others, always yellow at the base, with 5-7 dark stripes, purple at the edge, often with a bluish
pale spur. The fruit is an oblong-ovoid capsule that cracks at the seams into three folds when ripe. The plant blossoms from June to August, the fruits ripen in July.

Geographical range. The plant widely distributed in temperate areas in the northern hemisphere and in S. America, with centers of diversity in SE Europe, E Asia and S America; isolated endemics occur in Africa, Western and Eastern Siberia. Garden violet is a photophilous plant that grows in open spaces which provide only slight shade. It grows among bushes, in light pine, small-leaved, rarely deciduous forests. It prefers slightly moist habitats, but can also be found in dry and wet soils. It does not like competition with other plants and therefore mainly grows in spaces deprived of natural vegetation.

In all forest types the plant grows only on the edges, clearings and glades. It can also be found on the edges of peatlands and on non-turfy lake and riversides. It grows in meadows, preferring dry sandy or sabulous soils with sparse vegetation, on eroded river banks. In the forest-steppe and steppe zones violet grows on slopes and ravines. Great numbers are found in agricultural land, dry wastelands, fallow fields, in crops of different cultures, parks, gardens, roadsides and railway embankments.

Chemical composition. The violet herbage contains saponins, mucus (polysaccharides), tannins, carotenoids, ascorbic acid, ursolic acid, salicylic acid, and flavonoids. The leaves, stems and roots contain rutin (violaquerctrin). The flowers contain essential oil and anthocyanin glycosides, the roots have traces of alkaloids.

Pharmacological properties. The garden violet herbage is mainly used as an expectorant and soothing element for treating colds, acute respiratory infections, chronic bronchitis, pneumonia and whooping cough. Preparations of violet enhance the secretion of bronchial glands, help loosen phlegm. Violet herbage is also used for treating inflammatory diseases of the gastrointestinal tract, kidneys and urinary tract; it can be used in the treatment of urolithiasis, urate diathesis and other urological diseases. As an anti-inflammatory agent and an hiposensibilic it is used for treating allergic dermatitis, exudative diathesis, eczema. An overdose can cause nausea and vomiting.

Application. Violet root tincture is used to flavor wines.

Common horsetail, bottle brush, sedge grass (Equisetum arvense L.)

Botanical characteristics. Common horsetail is a perennial herb of the horsetail family (Equisetaceae). Its rhizome is long, thin, creeping, blackish, articulate, with spherical, farinaceous, edible, nutrient-containing nodules. Thin adventitious roots part from the roots. The stems are of two types: vegetative (neutral) and sporebearing. In early spring the plant forms sporebearing, not branched, succulent, reddish stems that form in the ground in autumn and are up to 25 cm tall. On the top of the stem forms a large, oval-cylindrical sporebearing "spike" - the sporangium. The spores become mature in April – May and then the stems die off. Instead of them in early summer vegetative barren stems appear from the roots. They are
10-50 cm tall, erect, branched, jointed, thick and green. The branches are located in whorls of 8-16 pc around the stem, are directed obliquely upwards. The leaves are immature and fuse into cylindrical tubular sheaths. The distinctive feature of common horsetail is the branches that point upwards and not downwards like those of sylvan horsetail. Meadow horsetail has horizontal branches and at the end of the stem there is a visible residue of the wrinkled spore spikelet. It grows in meadows, fallow fields, and among crops as a weed. In most typical habitats there are from 15 to 35 horsetail shoots found on 1 square meter. The productivity of one horsetail shoot is from 0.6 to 2.5 g of dry raw material.

Geographical distribution. Common horsetail grows almost everywhere in Europe, in deserts and semi-deserts. In the European part of Russia, it reaches the coast of the northern seas, can also be found in the southern part of the New Earth. In Siberia it doesn’t grow only in the north of Taimyr and on the coasts of the East Siberian and Okhotsk seas. It grows in meadows, coniferous, deciduous and mixed forests, among bushes, on the banks of the rivers, and as a weed in fields and orchards.

Chemical composition. Horsetail herbage contains flavonoids, glycosides, bitter elements, saponins, a large amount of silicic acid (25%), organic acids (aconitic acid, oxalic acid, malic acid), traces of alkaloids (equisetine, nicotine, trimethoxypyridine) the saponin equisetoin, tannins, resin, proteins, fats, carbohydrates, fatty oil (3-3.5%), essential oils, mineral salts, and small amounts of vitamin C and carotene. The fruit-bearing shoots contain a large amount of sugar, the nodules contain starch.

Pharmacological properties. In traditional medicine the neutral vegetative branches of common horsetail are used. They have diuretic, anti-inflammatory, hemostatic, wound healing, astringent and antiseptic effects, promote dissolution and removal of stones in urolithiasis, reduce the amount of protein in the urine, reduce swelling of various origins, improve metabolism and are part of the antidiabetic phytotneas which contain bean folds and blueberry shoots. Horsetail has hepatoprotective and antimutagenic effects [74, 155]. The hydroalcoholic extract of horsetail stems has an analgesic effect of nonopioid character [156].

Application. The plant is used as a diuretic in the decompensated heart diseases and other diseases of a stagnant character, in diseases of the urinary tract (cystitis, urethritis).

Common horsetail is considered a fine element for cleansing the body. It is indispensable for treating diseases of the kidneys and the urinary tract. Its decoction is used for poultices, washes and lotions; it cleanses the stomach, facilitates urination, removes salt, sand and dissolves stones. The high content of silicon allows the scientists to use it to strengthen teeth, nails, cartilage and bones. When used for treating joint problems, it alleviates pain and reduces inflammation. It accelerates the elimination of lead salts from the body. There is evidence that the use of horsetail gives good results in the treatment of skin and lung tuberculosis. The hydroalcoholic extract of horsetail in a dose of 200 to 400 mg / kg has a strong sedative and anti-convulsing effect [157].
Common horsetail is also used in the production of alcoholic drinks, is part of balsam recipes.

*Cinchona, bark-tree (Cinchona officinalis L.)*

**Botanical characteristics.** It is an evergreen tree of the Rubiaceae family (*Rubiaceae*) with the height of 10-15 m (rarely up to 25 m). The leaves are large, leathery, entire and opposite. The flowers are pink, red or yellow-white, fragrant, tubular, gathered in dense panicles at the ends of branches. The fruit is an oblong capsule containing winged seeds. The best known sorts of cinchona that are grown for bark are *Cinchona calisaya Wedd.* - a tall tree with large oblong leaves and reddish flowers in panicles or shields; *Cinchona pubescens Vahl.* – a tree up to 25 m tall, with large ovate leaves and purple flowers in racemes, its bark contains up to 11.6% of quinine; and *Cinchona officinalis L.* – a tree up to 15 m, with lanceolate leaves and red flowers in racemes.

**Geographical range.** In the wild the trees are found only in South America: Peru, Bolivia, Ecuador, Venezuela and Colombia, on the eastern slopes of the Andes, at an altitude of 800-3200 m above sea level.

**Chemical composition.** The bark of trunks, branches and roots contain up to 30 alkaloids: quinoline derivatives, the basic - quinine and its stereoisomer - quinidine and their 6-dimethoxyderivated - cinchonine and cinchonidine. The total content of alkaloids in the bark is at least 6.5%, of which the main ones are the alkaloids such as quinine (30-60%). Alkaloids are accumulated in the cortical parenchyma in a bound form with quinic acid. The amount of quinic acid reaches 5-8%. The other substances contained in the bark are quinovin (2%) - a bitter glycoside that via hydrolysis splits into quinic acid and a carbohydrate - quinovose. Anthraquinones that are characteristic of the *Rubiaceae* family are represented in the cortex by tetrahydroxanthraquinone.

**Pharmacological properties.** The tree became famous for its bark that can be used to treat malaria (due to the presence of quinine). Apart from this, a number of herbal preparations made with the use of the bark (cinchona wine and quinic infusion) are used as a tonic especially for children. Quinine in its pure form (currently it is produced synthetically) and quinidine are used in the preparation of many drugs for influenza that have a great effect particularly at high temperatures. These alkaloids are used as heart medicine.

Cinchona bark in herbal medicine and therapeutic doses when taken as a tea has no side action, but due to the presence of quinine should be treated with caution. At higher doses poisoning is possible; 10-15 g of quinine are life threatening. Poisoning begins with nausea and vomiting, agitation, hearing and visual impairment, dizziness, loss of consciousness and death from heart and breathing failure. The bark cannot be used in pregnancy, ulcers of the stomach and intestines and quinine allergy.
**Application.** Quinine and drinks containing it act as a bitter element: they stimulate the appetite and increase the secretion of glands of the gastrointestinal tract. In Peru, Bolivia, Ecuador produced quinine vodka is produced. In Europe bitter quinine infusions based on wine are more common. The amount of cinchona alkaloids (calculated as quinine) should not exceed 300 mg / l.

The infusion has a bitter taste, no smell, and a dark brown color. Distillation is not applicable.

**Hop (Humulus lupulus L.)**

**Botanical characteristics.** Hop is perennial climbing dioecious vine of the Cannabiaceae family (Cannabiaceae) with one or more of annual shoots. The perennial part of the plant (that lives up to 20 years or more) is the underground part, i.e. the roots, underground parts of shoots with buds and the rhizome. The aerial part of hop consists of a system of annual shoots that grow out of the generative buds each spring, pass the entire cycle of development and wither in winter.

The root system consists of 10-12 and more branched thick skeletal roots covered with a bark-like layer. The roots grow out of the main rhizome. The skeletal roots produce many thin fine roots with a dense network forming a well-developed root system. It penetrates into the soil up to a depth of 4 m and stretches up to 3 m in width. However, the main root mass is concentrated in the upper layer of the soil and reaches a depth of 1 m. The main rhizome called a caudex is a long underground element that grows out of the shoots. The roots and rhizome are the place of accumulation of nutrients. The rhizome of a fruitful plant reaches up to 15 cm in diameter. With age, the main rhizome grows and stiffens. Each year the main rhizome forms lateral roots that develop in the horizontal direction.

In the wild hop throughout the centuries has adapted to the opacity and excessive moisture of the forests. To reach the light, the plant has formed long, fast-growing (up to 20 cm per day) stems ending with a curl. The leaves are petiolate, opposite, with yellow glands and fibers scattered along the veins. The leaves are 3-5-lobed and cordate at the base. The flowers are diclinous and dioecious. Some plants develop pistillate inflorescences and some - the pollen flowers. The latter are inconspicuous and gathered in panicles. The pistillate flowers are collected in capitulate spike-like ovoid or elongated buds on 2-5 cm long stems; they are drooping, solitary or more often collected in bunches. The plant flowers from June to August. In September of the pistillate plants form fruits, called "cones". The fruit is a flattened ovoid, whitish-gray nut, covered with a cup.

**Geographical range.** In the wild the plant is widely distributed in the temperate forest zone of Eurasia: it grows across Europe (reaching the Arctic zone), the Caucasus, Western Siberia, the Altai, the Far East and Central Asia. Wild hop is distributed throughout the forest and steppe zones, where it grows in moist deciduous forests along rivers and swamps, ravines, forest edges, among shrubs, along roads and fences.
Hop has been widely cultivated in many countries, particularly in France, England, the Czech Republic, Germany, in North-East China, South Africa, the USA, Argentina, Chile, Brazil, Australia and New Zealand.

Chemical composition. The main active ingredients that determine the pharmacological activity of hop are bitter and polyphenolic compounds and essential oil. These are the most important compounds of hop that are of particular importance in the pharmaceutical production and scientific and practical medicine. Hop cones contain essential oil (0.2-1.8%), polyphenolic compounds (2-5%) and 5 to 26% of bitter elements.

Lupulin contains essential oil (1-3%), bitter elements (about 5%), resinous substances (50-70%), as well as wax, a yellow pigment, choline, hypoxanthine, adenosine, and 5 to 26% of bitter elements.

The hop essential oil, the main part of which is accumulated in the glands, contains about 230 compounds of the mono- and sesquiterpene series. Among them are the sesquiterpenes: humulene (15-25%), α- and β-selinenes, seline-3,7(11)-diene, seline-4(14),7(11)-diene, a sesquiterpene alcohol luparenol, aliphatic terpene alcohols geraniol and linalool, ketone luparone, 30 to 50% of aliphatic terpenes (β-myrcene, β-caromol, pinene, etc.), 30-40% of myrcenol esters, 2-methylbutylisobutyrate, 2-methylprophylisobutyrate, methyl esters of the decenoic acid. The essential oil also contains organic acids, aliphatic ketones (methylnonylketone, 2-tridecanone) and lupanone - a phenol ester that has a faint smell of valerian and via hydrolysis splits into isovaleric acid and phenol.

Hop α-acids are acylphloroglucides with two isoprenylic residues, and β-acids are acylphloroglucides with three isoprenylic residues. The main components of the α-acids fraction, apart from humulone, are cohumulone, adhumulone, prehumulone, posthumulone, 4-deoxyhumulone. Cohumulone and adhumulone are optically active, sinistrorse oily substances with a very bitter taste. Like humulone, they contain three active hydrogen atoms. The fraction of β-acids, apart from lupulone, contains kolupulone, adlupulone, prelupulone, postlupulone. All lupulones have similar properties and are not optically active.

The phenolic compounds of hop are presented by flavonoids, anthocyanidins, catechins and phenol carbonic acids.
Hop cones contain phenol carbonic acids - chlorogenic, gallic, protocatechuic, caffeic, quinic, coumaric, oxycoumaric, para-coumaroilquinic, neochlorogenic, ferulic, vanillic, syringic and para-aminobenzoic. The main component of these acids is chlorogenic acid. Apart from phenol carbonic acids hop cones contain other organic acids (valeric, isovaleric, etc.).

**Pharmacological properties.** Hop cones tincture is used primarily as a sedative for insomnia, neurasthenia, nervous excitement, hysteria, epilepsy, neuralgia, headache, dizziness, cardioneurosis, increased sexual excitability, frequent nocturnal emission, painful erections and other functional neurotic sexual abnormalities, climacteric neurosis, dysmenorrhea, vomiting in pregnant women and children, sickness, bed-wetting and whooping cough.

As diuretic teas, extracts and other preparations of hop are used for treating diseases of the kidneys, cystitis, prostatitis, edema and heart failure. The hop infusion is recommended for improving the appetite and the intestinal activity in gastritis and enterocolitis, liver and biliary tract diseases. Hop decoction is used as a mouth and throat antiseptic, if used with milk - as an anti-inflammatory as well as anti-asthmatic drug. It is used for treating cough, pulmonary tuberculosis, influenza and other acute respiratory diseases and metabolic disorders.

Due to its antiseptic, anti-inflammatory and analgesic properties, hop decoctions are used in the form of lotions and ointments for the treatment of sciatica, joint diseases, bruises, burns, frostbite, scabies, fungal infections of the skin, infected wounds and ulcers. Hop infusion and decoction are recommended for washing the hair to treat early hair loss and to strengthen hair. It is also used for preparing baths for treating paralysis, rheumatism and nephritis.

Cannabidiol contained in hop leaves has sedative, analgesic, antispasmodic and anticonvulsant properties. Experiments have shown that hop also has a hypotensive effect.

Hop cones have estrogeic activity. Studies have shown that the estrogenic activity of hop products is due to the content of isoprenylated flavanones, the most active of which is 8-isoprenylnaringenin [158, 159, 160]. Other flavanones also exhibit estrogenic activity: 6-isoprenylnaringenin, 6,8-disoprenylnaringenin and 8-geranilnaringenin, but they are 100 times less effective than 8-isoprenylnaringenin. The estrogenic activity of 8-isoprenylnaringenin *in vitro* is higher than that of other phytoestrogens (coumestrol, genistein) [161].

High estrogenic activity of 8-isoprenylnaringenin is confirmed in experiments *in vivo* - in a test of uterine vascular permeability. In a subcutaneous introduction the estrogenic activity of 8-isoprenylnaringenin (mitotic effect in the vaginal epithelium, uterotrophic effect) is noted in a daily dose of 15-30 mg / g.

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8-isoprenylnaringenin to drinking water for ovariectomized mice resulted in an estrogen stimulation of the vaginal epithelium. However, the effect was achieved at a concentration of 100 g/ml, which 500 times more than the amount of 8-isoprenylnaringenin in beer.

Scientists suggest that the aphrodisiac effect of hop is closely connected to its hormonal activity - its ability to reduce sexual arousal in men.

The prenylflavonoids, primarily xanthohumol and isoxanthohumol, are potential chemopreventive broad-spectrum compounds that inhibit the activation of chemical carcinogens that induce the synthesis of enzymes of the second phase of protection, preventing angiogenesis and suppressing the development of tumors in the experiment. A derivative of xanthohumol – 8-prenylnaringenin - is today the most powerful phytoestrogen, and the water-soluble oligomeric proanthocyanidins are powerful antioxidants. It should be emphasized that these properties of hop components present in the beer, do not provide the indicated health effects when consuming this drink. On the contrary, such features as the composition of the intestinal microflora may determine the risk of changes in the estrogen status in individuals even at moderate consumption [74].

Hops and its products are non-toxic substances. Literature does not describe cases of poisoning by means of hop. However, an overdose of hop herbal medicines the possible side effects are: nausea, vomiting, abdominal pain, headache, fatigue and weakness.

Application. Due to the presence of many antibacterial agents hop is noted to be a good preservative seal for storing perishable fruits and vegetables. In Germany the usage of hop as a natural preservative in the manufacture of sauces has been patented.

Hop is widely used in the food industry in the manufacture of beer, yeast, kvass. The use of hops in brewing is determined by the presence of numerous substances that give beer spumescence, biological stability, a unique bouquet of flavors and aromatic properties. These substances and their combination are so unique that hop for many centuries has been an essential raw material for making beer. The antimicrobial compounds of hop inflorescences determine their value as a preservative component for beer.

With the consumption of beer the human body gets a range of biologically active substances from hop - α-isocids, isoprenylated flavonoids (isoxanthohumol, xanthohumol, 6-isoprenylnaringenin, and a small amount of geranilnaringenin), glycosides of kaempferol and quercetin, oligomeric proanthocyanidins [162]. Beer is the main source of isoprenylflavonoids (where the concentration of these polyphenols is 4 mg/l). Due to the presence of isoprenylflavonoids beer has a significant antioxidant activity that is higher than that of green tea, red wine and grape juice [163]. However, the level of phytoestrogens in beer is low therefore the display of unwanted side effects is unlikely.
Witloof chicory, wild succory (Cichorium intybus L.)

Botanical characteristics. Chicory is a perennial herb of the aster family (Asteraceae), reaching a height of 50-120 cm. It has a taproot, reaching the length of 1.5 m. Its basal leaves form a rosette; the upper ones are entire. The plant blooms with bright blue flowers, gathered in baskets. The fruit is an oblong trihedral or pentahedral achene, light brown or brown in color. Chicory flowers from June to September, the fruits ripen until October.

Geographical range. Chicory grows in the wild in many countries in Europe, North India, North China, Central Asian states, Western Siberia, the North Caucasus. Due to its medical properties, chicory is grown in Western Europe, India, Indonesia, North Africa, the U.S. and the CIS.

Chemical composition. The roots of chicory contain a polysaccharide inulin that is soluble in hot water [164]. The main sugar contained in the plant is fructose. The characteristic component of the roots is a glycosidic substance intibine (0.032-0.2%). It is a colorless gelatinous substance of uncertain composition and a characteristic bitter taste. The plant also contains vitamin C, B1, E, choline, protein, fat, pectin, tannins, mineral salts and a wide variety of trace elements. The milky juice of chicory apart from sesquiterpene lactones also contains triterpene taraxasterol, chicoric acid, traces of essential oil, choline, rubber.

Pharmacological properties. Chicory preparations have antimicrobial, anti-inflammatory, cholagogue, sedative, diuretic, astringent and stimulating the appetite effects. They have a regulating effect on the metabolism, increase the cardiac function and reduce sweating [165,166].

Chicory has gained the highest recognition in the treatment of diseases of the gastrointestinal tract and liver. Chicory improves digestion, eliminates discomfort in the gastrointestinal tract, liver and spleen, increases the appetite, reduces sugar in the urine and reduces irritability.

Application. Chicory decoction is prescribed for treating inflammatory diseases of the mucous membrane of the stomach, small and large intestines, liver, gall bladder and kidneys, as well as gallstones and kidney stones. Preparations are used as a general tonic and edema of cardiac origin.

Due to the easily digestible elements present in the plant chicory root is considered to be a valuable food product. It is widely used in the food industry in the manufacture of sweets and cakes. It is used in the production of natural coffee, coffee and tea drinks, giving them a specific taste, aroma and color.
Sandy everlasting (Helichrysum arenarium (L.) Moench)

Botanical characteristics. Sandy everlasting is a perennial herb of the aster family (Asteraceae), with the height of 15-30 cm. Its stems are erect or ascending, branched only at the inflorescence. The leaves are alternate, entire, up to 6 cm long, the lower ones are oblong-obovate, and the upper and middle ones are sessile, linear-lanceolate or oblong. The flowers are small, yellow or orange, gathered in terminal corymbose inflorescences up to 100 flowers in a stalk. The rhizome is branchy, dark brown and woody.

Geographical range. It grows in the forest, forest-steppe and steppe zones of the Europe, in Eastern Siberia and Central Asia. It grows in sandy, sabulous and stony soils.

Chemical composition. The inflorescences contain flavonoids: salipurposide, naringenin 5-diglycoside, kaempferol 3-diglycoside, apigenin glycoside, iso-salipurposide, naringenin, apigenin, dioxyphtthalid, 5-methoxy-7-oxyphthalide, 5-methoxy-7-phthalide glucoside, diterpene alcohol, steroid compounds, campesterol, phenolic pigments, fatty acids, essential oil (0.04%) containing p-cresol and a significant amount of free fatty acids, including caproic acid. The herbage contains tannin, vitamin K and essential oil.

Pharmacological properties. In medicine, the plant is used for treating acute and chronic diseases of the liver, gallbladder and biliary tract. Everlasting preparations help weaken nausea, vomiting, pain in the liver, flatulence, jaundice, decrease liver size (if it was increased). The plant has low toxicity, it stimulates biliary excretion, reduces the concentration of bile acids and bilirubin in bile, changes the ratio of cholesterol (bile acids) by increasing the level of cholates, stimulates the tone of the gallbladder, the secretory function of the stomach and pancreas, stimulates diuresis. Studies have also shown that the plant has immunostimulatory activity [74].

Application. Sandy everlasting is used as cholagogue in acute and chronic diseases of the liver and biliary tract.

Medicinal preparations made with the used of the plant are flamin tablets (a set of flavones), tinctures and infusions; in addition, the plant is used in the preparation of choleric teas. The plant is also used in the beverage industry.

Chaga mushroom (Inonotulus obliquus (Pers.) Pil.)

Botanical characteristics. Chaga mushroom is a barren form of a polypore fungus of the Hymenochaetaceae family. It is parasitic mainly on the trunks of birches, and rarely on alder, mountain ash, beech and other deciduous trees. It propagates via spores that germinate in the affected areas of the bark. Old tree bark is more likely to be infected by the fungi, as with age the tree’s ability to form wound core that prevents the penetration of spores into the wood reduces. The vegetation conditions also play an important role (for example, the trees growing in mountain
areas are less affected by the chaga mushroom, because their wood has a denser structure). Fungal filaments penetrate into the wood and gradually destroy it (the disease called “white heart rot”). A shapeless excrescence protruding from under the cracked bark develops in the lower and middle part of the trunk (in the place of the initial spore penetration). With age the excrescences take the form hemispherical cylinders and at the ages of 10-15 years reach a weight of 4-5 kg. The surface of the fungus is black, fractured, brown, woody, with blond streaks.

**Geographical range.** It is usually found in the forests of northern and central temperate zone.

**Chemical composition.** The mycothallus of the fungus contains polyphenols, triterpenoids, resin, agoric acid, inotodon flavonoids, alkaloids, polysaccharides, sterols, lignin, a large amount of manganese and iron, silicon, aluminum, calcium, magnesium, copper, zinc.

**Pharmacological properties.** For medicinal purposes only the fungus developing on birches is used. Preparations of the plant have antispasmodic, diuretic, analgesic, antimicrobial, reparative and laxative effects; they slow the growth of tumors of different origin and normalize the activity of the gastrointestinal tract. The chaga infusion is used as a symptomatic and tonic element for treating malignant tumors of various localizations [74]. The drug represents a high-polymer humic-like chaga acid received by its precipitation from the aqueous solution of hydrochloric acid and is very effective. It should be noted that the products derived from fungus are low toxic. According to Lazovskaya, LD_{50} of the drug administered per os to white mice is 0.5 g/kg [74]. The toxic effect of the drug is consisted primarily of the central nervous system depression.

The aqueous extract of the fungus has a strong neurotropic (nootropic) effect: it increases the amount of short term memory, speeds up the learning processes [74]. During treatment, the patient is recommended to consume mainly dairy and vegetable food, to limit the reception of meat and fat and exclude canned and smoked products and spicy seasonings. Nor should the patient receive intravenously administered glucose and be treated with penicillin.

**Application.** Chaga mushroom is used in the pharmaceutical industry for the manufacture of the drug Befungin (Befunginum), which is a semi-stiff extract of birch fungus with the addition of chloride or cobalt sulfate. The main active part of the drug (60%) is the humic-like chaga acid that possess a strong physiological activity. It is used to treat chronic gastritis, psoriasis of the gastrointestinal tract with symptoms of atony, it can also treat gastric ulcer and is used as a symptomatic medicine that improves the general condition of cancer patients [167].

Chaga mushroom is used in the production of alcoholic and non-alcoholic balsams.
Trifid Bur-marigold, tree-lobe Beggarticks (*Bidens tripartita* L.)

**Botanical characteristics.** The plant is an annual herb of the aster family (*Asteraceae*). This medicinal plant has an erect, branching stem, reaching the height of 15 to 100 cm. The stems are solitary, cylindrical, ribbed, with rare fibers. The leaves are opposite, short-petiolate or sessile, tripartite, with larger central part. The lobules are lanceolate and serrate at the edges. The taproots of the plant are branched, thin and yellow.

The yellow flowers are collected in baskets of a medium size, seated single or in groups of 2-3 at the end of the stem. The flowers are tubular, monoclinous, with scarious bracts. Each basket is surrounded by a double bell-shaped wrapper, which is longer than the outer leaves of the basket. The salyx is absent. The corolla is yellow with quinquedentate limb, it has 5 stamens, one filiform column with a bifid stigma at the apex. The fruit is a flattened, greenish-brown, obovoid, four-sided achene, with 2-3, sometimes 4, aristae. The outer edges of the achene and the aristae are covered with spines.

The plant flowers in July - August. The fruits ripen in September - October. They easily attach themselves to grazing animals and humans and thus spread far from the parent plant.

**Geographical range.** It is found in the Europe, the Caucasus, Western and Eastern Siberia and the Far East. It grows all the way from the lowlands to the middle mountain zone. It grows mainly in damp places – on the banks of rivers, streams, ponds and other water sources, in wet meadows, marshes, ditches and gorges.

**Chemical composition.** The herb contains a series of at least 10 flavonoids, coumarins (umbelliferone and scopoletin), ascorbic acid (60-70 mg %), carotene (over 50 mg %), condensed tannins (to 4.46%), bitter elements, mucus, lactones, amines, a large amount of manganese and traces of essential oil.

**Pharmacological properties.** The herb has long been used as a diuretic, diaphoretic element and for treating diathesis. It is used as an infusion and tincture. Its tincture has a sedative effect, reduces blood pressure, slightly increases the amplitude of heartbeat and enhances uterine contractions. A 5%-ointment reduces exudative factors, stimulates tissue regeneration; the oral introduction of the herb extract revealed antihistamine and antiallergic action.

**Application.** The plant is used in the form of infusion for medicinal baths and as antiallergic agent for treating children diathesis.

It is used for the production of cosmetic skin balms and in the manufacture of soft drinks.

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Bird cherry tree (*Padus avium* Mill.)

**Botanical characteristics.** Bird cherry is a tree or shrub from 2 to 10 m tall, belonging to the Rosaceae family (*Rosaceae*). The trunk and branches are covered
with a cracked mat black and gray bark. The leaves are alternate, short, elliptical, mat on the upper side, and wrinkled at the bottom. The plant blooms in May. The flowers are small, white, gathered in dense, many-flowered drooping brushes. The fruits are globose black drupes, 7-8 mm in diameter, sweet, highly astringent, with a round-ovoid seed. The fruits ripen in July.

Geographical range. Bird cherry grows south of the Arctic Circle in Norway, Sweden, Finland, Russia and Ukraine. There are also some trees in Great Britain, France, Spain, Portugal and in the Balkans.

Chemical composition. The leaves, flowers, bark and seeds contain glycosides: amygdalin, prulaurasin, prunasin. Free hydrocyanic acid is found in the bark and leaves. The highest content of amygdalin is in the bird cherry bark (2%), less of it is contained in the seeds (1.8%). The fragrant smell is due to the presence of the prunasin glycoside. Bird cherry fruits contain malic and citric acids, sugars, astringents, ascorbic acid, and flavonoids.

Bird cherry cleans the air due to the volatile emitted by its leaves and flowers. The plant is a good spring honey plant.

Pharmacological properties. Mature fruits have antidiarrheal, astringent, antibacterial, vitaminizing, tonic and anti-inflammatory effects. They normalize the bowel and gastritic functions. The plant’s bark has diaphoretic, antipyretic and diuretic properties. The leaves have antidiarrheal and vitaminizing properties. Flowers are used as anti-inflammatory and wound healing agents.

Application. Due to the presence of tannins bird cherry fruits are used as an astringent for noninfectional diarrhea and other disorders of the stomach and intestines, as well as an aid in infectious colitis and diarrhea.

Preparations of bird cherry should be taken under medical supervision, with controlled doses and duration of treatment. The fruits are used for medicinal purposes.

Amygdalin, contained in the seed kernels of the berries contains a virulent poison - the hydrocyanic acid released by the enzymatic hydrolysis. The use of about 1 g of amygdalin can cause fatal poisoning.
The formation of the poisonous hydrocyanic acid is also possible via heat treatment of drupes containing cyanogenic glycosides. This happens during slowly heating to a temperature of 120°C. More crucial effects are caused by insufficient heat treatment of drupe that doesn’t lead to the inactivation of β-glycosidases. For example, apricot compote pasteurization at 86 °C for 38 min was followed by the accumulation of a 1 mg/kg of hydrocyanic acid in the fruit. During storage the amount of hydrocyanic acid in the canned products didn’t increase. In these samples the β-glycosidase enzyme was inactivated. In the case of pasteurizing the canned products at the same temperature for 20 minutes, they accumulated up to 16-17 mg/kg hydrogen cyanide during 5 months of storage. In these samples the enzyme was not inactivated. Canned products with reduced time of pasteurization are eatable for only three months after their production (according to their taste quality) [168]. Therefore, when using bird cherries for the production of various drinks via alcoholic fermentation the possibility of hydrocyanic acid accumulation should be excluded.

Bird cherry fruits are the basis of alcoholic beverages, that has a pleasant almond flavor and aroma, and are part of the ingredients of making liqueurs and balsams. Dried bird cherry blossoms are also used in the production of liqueurs [169].

**Bilberry, whortleberry (Vaccinium myrtillus L.)**

**Botanical characteristics.** Bilberry is a perennial small shrub, 15-30 cm tall, with a creeping rhizome, belonging to the cranberry family (Vacciniaceae). The stems are erect, branched and smooth. The rhizome is long and creeping. The leaves are elliptical, smooth, light green, leathery, 10-30 mm long, covered with sparse fiber and serrate-dentate edges. The plant flowers in May - June. The flowers are single, greenish-white with traces of pink. They are seated on short stalks in the axils of the upper leaves. The berries are juicy, black, with a bluish bloom, shiny, with dark red, soft flesh, and a large number of seeds. The berries ripen in July - August. Bilberry begins fruiting at the second or third year. Initially it produces a small number of large berries and later the number increases but the berries are smaller.

**Geographical range.** Bilberry grows in the area of conifers, mostly spruce, rarely deciduous forests, on the mountain slopes and in the swampy lowlands almost on the entire territory of the Europe, North America and East Asia. It is found in the meadows of the Carpathian Mountains where it forms extensive thickets.

**Chemical composition.** Bilberry contains tannins of the pyrocatechol group (up to 18%), organic acids (up to 7%), including citric, malic, succinic, quinic, benzoic, lactic and oxalic acids. It contains sugar (up to 30%), vitamin C, carotene. Bilberry leaves contain tannins (18-20%), sugar (12-18%), arbutin (0.47-0.58%), hydroquinone (0.047%), saponins (2.2-2.8%), organic acids (gallic, benzoic, citric,
malic, acetic, oxalic and tartaric acids) and minerals: potassium, sodium, magnesium, calcium, iron, sulfur, phosphorus, chlorine. Biologically important substances are neomyltitll glycoside (2%), the aglucone of which is a vitamin-like substance inositol.

**Pharmacological properties.** Bilberry leaf preparations have cardiotonic, diuretic, choleretic, astringent, anti-inflammatory and antirot effects, they lower blood sugar. They also have antiseptic, vitaminizing, astringent and antispasmodic properties.

**Application.** Berries reduce the amount of sugar in the blood, increase the acidity of gastric juice, improve digestion, metabolism, increase visual acuity, improving the blood flow to the retina. Blueberry fruits are widely known as an anti-diarrhoeal agent for treating digestive disorders of infectious origin, especially in children, as a supplementary element along with antibiotics for treating dysentery and beriberi. Myrtill – a purified extract of bilberry – contains up to 15 anthocyanins and used to treat disorders of cerebral blood flow [170]. Leaves, like the berries, are used as an astringent agent for treating acute and chronic disorders of the digestive system, accompanied by diarrhea, weight loss, appetite loss, indigestion caused by enhanced fermentation and putrefaction, colitis and enterocolitis. The plant contains vitamins and therefore is used for treating scurvy and other hypovitaminosis. It is often used for treating stomatitis and gingivitis as an astringent and antiseptic. Leaf infusions are reported to be used for treating mild forms of diabetes and senile diabetes.

The berries are used raw, dried, boiled. Bilberry is a part of anti-diarrhea teas. The berries are used for making juices, fruit drinks, syrups, jams, jellies and wine. They are also part of strong alcoholic balsams, tinctures and liqueurs.

![Carnosic acid](image)

**Garden sage (Salvia officinalis L.)**

**Botanical characteristics.** Sage is a shrub with many dasphyllous stems, up to 70 cm tall, belonging to Lamiaceae family (*Lamiaceae*). The leaves are opposite, gray-green, wrinkled, 3.5-8 cm long. The flowers are bilabiate, light purple, gathered in a loose apical spicate inflorescence. The fruit consists of four nutlets with the diameter of 2.5 cm. The plant flowers in June - July.

**Geographical range.** Sage’s homeland is the Mediterranean. It is widely cultivated in the south of the European part of Russia, the Caucasus and the Crimea. In the wild the species does not grow.

**Chemical composition.** The leaves contain essential oil (0.5-2.5%), which contains 1.8-cineole, salven, borneol, camphor, cedrene [171, 172]. In addition, the
leaves contain alkaloids, flavonoids, tannins, ursolic, oleanolic and carnosic acids. The seeds are the source of a fatty oil containing a linoleic acid glyceride.

Pharmacological properties. Sage leaves have disinfecting, astringent, hemostatic, anti-inflammatory and softening effects.

Application. Sage is used for treating inflammations of the mouth, pharynx and upper respiratory tract as an astringent and anti-inflammatory element in form of a rinse. It is also used in form of poultices. Suppurating wounds heal quicker if they are washed with sage infusion or treated with lotions made from this infusion. Sage tea cleanses the stomach, releases the phlegm. Infusions enhance the activity of the internal glands secretion. Sage is used for treating hypertension, atherosclerosis (especially in menopausal women), shaking [trembling] palsy. In Chinese medicine sage has long been used as a tonic, for treating rheumatism and chronic skin diseases.

Sage herbage has used since ancient times for coloring vodka in a nice yellow color, now the sage leaves are part of balsams and liquors [30].

**Saffron crocus (Crocus sativus L.)**

Botanical characteristics. Saffron is a perennial herbaceous plant of the iris family (Iridaceae) up to 20 cm tall. Its bulbotuber is covered with dry, stretched, reticulate-fibrous remains of leaf sheaths. The leaves are radical, narrow-linear, covered with scarious sheaths, appear together with the flowers, after flowering become longer and don’t wither throughout all winter until spring. The flowers are purple, with a pleasant odor, seated on short stalks. Each bulbotuber produces 2-3 flowers. The seed doesn’t form. The flowering period is in September - October.

Geographical range. Saffron crocus grows on sunny rocky slopes, moors and along roads in Azerbaijan and Central Asia. It is cultivated everywhere.

Chemical composition. Saffron contains about 150 volatile compounds that determine its flavor [173]. Its stigmas contain large amounts of dye – crocetin – in the form of a gentiobioside crocin, safranal (the main source of the smell), carotenoids, flavonoids, vitamin B, fatty oil, nitrogenous substances, sugar, calcium and potassium.
Pharmacological properties. Saffron crocus has antidepressant, cardio-tonic, diuretic, antiseptic, and anti-convulsive actions [174]. It is used to treat various diseases of the blood and is considered a painkiller. Its alcoholic extract reduces the negative effect of ethanol on memory and has a sedative action [175, 176].

Application. Stigmas of saffron are used in food as a seasoning. It is also used for coloring beverages. The infusion has a yellow-red color and a flavor of saffron, often unpleasant, similar to the smell of iodine vapor. When diluted the smell wears off.

Cinnamon rose (Rosa majalis Herm.)

Botanical characteristics. Cinnamon rose is a hick bush of the Rosaceae family (Rosaceae) that has the height from 60 to 200 cm. The old branches brownish, the flowering are covered with rare, downwards, curved, sickle-like, flattened spines arranged in pairs at the base of petioles; the barren branches are turions (annual sterile shoots) with thin, straight spines. The leaves are compound, pinnate, with 5-7 pairs of oblong-elliptical or ovoid, serrate leaflets with two stipules. The flowers are large, solitary or 2-3, seated on short stalks, with lanceolate bracts, are pentameric, with a pink or dark red rim and simple solid lanceolate sepals. The fruit is spherical, rarely ovate or elliptical, smooth, orange or red, fleshy, with persistant, upward-directed sepals, with a hypanthium (many pubescent fruitlets-nuts, that ripen in August - September) inside.

Geographical range. Cinnamon rose grows throughout most of the Europe, in the Russia, as well as in Western and Eastern Siberia up to Baikal Lake. Dahurian rose is different from cinnamon rose and has black-and-purple color of the branches. It grows in the southern regions of eastern Siberia and the Far East. Echinated rose has branches, thickly covered with fine straight bristles; the base of the leaf often has 2 thin spines. It grows in the forest zone, spreading to the tundra. It has a wide range - from the Pacific to Karelia. Southern boundaries of its area pass through northern Kazakhstan, the Volga River on the west to the Gulf of Finland. Ramanas rose has red flowers and very large fruits. It grows in the Far East, and is often cultivated in gardens. Dog-rose has pale pink flowers, bright red fruits; its sepals are bent down and fall off when the fruits ripen. It grows in the Ukraine and the Caucasus. Dog-rose fruits are poor in vitamin C, so during harvesting it should be distinguished (by the bent down or absent sepals) form other species of brier. All of these types of rose hips are allowed to use.

Chemical composition. The ripe fruits contain from 1,800 to 5,000 mg% of vitamin C, B1, B2, E, K.

Application. The fruits are processed into vitamin supplements. In addition, the wild rose is used in the liquor industry. Its fruits used for the production of a liqueur and other beverages.
Botanical characteristics. Tasmanian blue gum is an evergreen tree of the Myrtaceae family (*Myrtaceae*), with a height of 50-70 m, a strong root system and a straight trunk. The bark of the trunk and branches is smooth, whitish-gray, with a blue tint on the ends of the branches and a peeling outer layer. The remains of the old bark can be seen on the branches and in the upper part of the trunk between the branches. The tree grows rapidly. Young plants form swellings – the so-called wood tubers (lingnotubers) that increase with age and produce numerous shoots if the tree trunk is damaged. Young shoots are rectangular, ribbed and covered, like the leaves, with a waxy blue-green bloom with a blue tinge. The plant is heterophyllous: the leaves of young branches are opposite, non-petiolate or with short petioles, ovate or oblong-ovate, cordate at the base, with a pointed tip, thin, thick, gray-green with a bluish tinge, 7-16 cm long and 1.9 cm wide; the leaves of the old branches are alternate, petiolate, turned with their edges to the sun. The buds are conical, rectangular and single. The flowers are seated on short stalks, located in the axils of the leaves. The fruit is a flattened-spherical warty capsule, 10-15 mm long.

The plant starts blossoming in autumn on the 3\textsuperscript{rd}-5\textsuperscript{th} year of life, the seeds ripen in 1.5-2 years. Dried leaves and fresh one- and three-year-old shoots (used for the production of essential oil) are used for medicinal purposes.

Geographical range. In nature the plant grows in Australia and in Tasmania. It is also grown in a small area in the warm and humid coastal regions of Adjara and Abkhazia.

Chemical composition. The leaves contain more than 1% of essential oil, the main component of which is cineole (80%). The leaves and bark contain up to 10% tannins.

Pharmacological properties. The water extract and alcohol tincture of the leaves have anti-malarial, expectorant, strong antiseptic, anti-inflammatory and analgesic properties. The concentrated leaf infusion, essential oil, pure cineole (eucalyptol) have a detrimental effect on a number of pathogenic bacteria, staphylococci, streptococci, typhoid, dysentery and diphtheria agents. The essential oil inhibits the multiplication of tubercle bacilli, mycobacteria, *Escherichia* and *Trichomonas*. The infusion is used in gynecology for the treatment of erosion and ulceration of the cervix.

Application. Pure cineole isolated from the essential oil is a powerful antiseptic, much stronger than carbolic acid. The essential oil is an excellent repellent. The plant is used in the production of wines. Aromatic alcohol distillation of the leaves is received via distillation of a 50% water-alcohol liquid at a ratio of raw materials and the latter being 1:20. It is used for the preparation of special vodkas.
Spiny eleutherooccus, Siberian ginseng (Eleutherococcus senticosus Rupr. Et Maxim.)

Botanical characteristics. The plant is a poorly branched bush of the Araliaceae family (Araliaceae), with the height of 1.5-2 m, rarely 3-4 m. Young shoots are yellow, covered with thin spikes, the old ones are light gray with fewer spikes. The leaves are long, very similar to the leaves of ginseng, complex, five-pointed, with pointed, obovate leaflets, dark green on the upper side, light green on the lower side, with abundant reddish fiber. The flowers are small, fragrant, seated on long stalks. The monoclinous and petiolate flower petals are pale purple, the pistillate flower petals are yellow, gathered in loose globular umbels that decorate the ends of the shoots in August. The fruits are berry-like, black, slightly oblong, small, inedible, and ripen in September - October.

Geographical range. The plant grows in the forests of Primorye, the Amur region, the southern regions of Sakhalin, Korea, and China. Due to the very thin, brittle, slightly downward spikes, especially numerous in the upper part of the shoot, it is locally known as the "devil's bush."

Chemical composition. The rhizomes contain 7 glycosides (well-known are the eleutherosides D and E) of different composition. The aglycones (the non-carbohydrate part) of these compounds are triterpenes, coumarins, sterols and lignans. The associating substances are essential oils, resins, gums, starch and lipids. The stems contain coumarin derivatives. The leaves contain carotenoids, triterpene compounds, oleic acid, alkaloids and flavonoids. Unlike other Araliaceae plants, Siberian ginseng does not contain saponins.

Pharmacological properties. The plant has various effects on the body: stimulates the central nervous system, increases motor activity, conditioned reflex activity, mental and physical performance, increases visual acuity, basal metabolic rate, adaptogenic properties, improves the appetite, has a gonadotropic effect, reduces experimental hyperglycemia and moderately reduces blood pressure, reduces the content of cholesterol in the blood, promotes involvement in lipid metabolism.

Application. In a single dose the Siberian ginseng has a stimulatory effect and increases the efficiency of the organism, in daily use it has a tonic effect, which is expressed in a longer increasing efficiency and improving health. Its adaptogenic properties are actively used for more rapid adaptation to different environmental factors and psychological adjustment in long Arctic expeditions, working in cold or hot climates, heavy hiking, flying and mountain climbing. Siberian ginseng is also used to restore the immune status during rehabilitation after severe debilitating diseases, is part of the complex treatment of cancer patients; is used in the treatment of rheumatic heart diseases, chronic lung diseases, professional diseases of workers of hazardous industries, vibration disease, and for preventing infectious and viral diseases, including children's groups.

Essential oil obtained from the roots is used in the confectionery industry. In quantities of 1.5-2.5 kg per 1000 dekaliters the roots are used in the production of balsams, tinctures, vodkas.
**Botanical characteristics.** Ephedra is a multibranched evergreen shrub of the Ephedraceae family (Ephedraceae), 10-50 cm tall. The stems are woody, erect or decumbent, with dark gray fine-fibred bark. The branches are virgate, grassy, yellow- or grey-green, rounded, finely striated, finely tuberculate along the ribs, rough, curved at the apex, jointed, with internodes, 1.5 cm long. The leaves are opposite, reduced in knots of young twigs. The older branches have dark brown vaginas, divided in two at the base. Ephedra is dioecious plant with small monochlamydeous flowers collected in spikes. The fruit is a diachenium, an almost spherical red galberry with the diameter of 5-7 mm. The seeds are ovoid or oblong-elliptical, pointed at the top, 4-5.5 mm long, flat on the inside and convex on the outside, blackish-brown in color. The plant flowers in May - June, the fruits ripen in July. The fruit is a juicy, brick-red or yellow diachenium berry.

**Geographical range.** The plant grows in the south of Europe, in Western Siberia, the Caucasus; in the mountains of Central Asia it is replaced by related species. It grows in the steppe and desert areas, in the plains and lower mountain zone, on rocks, chalk outcrops, shingles, sandy and gravelly soils. In some places it grows abundantly.

**Chemical composition.** The green twigs contain alkaloids: ephedrine, pseudoephedrine (together they make up to 0.25-1.7%, with the prevalence of ephedrine up to 65%); all parts of the plant contain tannins (6%) [74], pyrocatechin, flobafen, the galberry contains ascorbic acid [74].

**Pharmacological properties.** Ephedra has anti-asthmatic and adrenal effects. It stimulates the cardiovascular system providing a sympathomimetic effect. Ephedrine - a drug with an anti-aminoxidase effect that increases the sympathetic tone of the system and blood pressure - increases bronchial lumen, slightly increases the sugar content in the blood. Unlike adrenaline, ephedrine has a persistent effect and stimulates the central nervous system.

**Application.** Ephedra, also known as "the Kuzmichev herb", is widely used in traditional medicine for treating rheumatism, diseases of the digestive and respiratory tracts. Green twigs during flowering or fruiting are used for medicinal purposes. A research carried out by Japanese scientists found that extracts of ephedra protect the skin from X-ray damage [177].

The berries are eaten fresh or in the form of jams, compotes and jellies [135]. Overdose may cause poisoning. In the distillery production the plant is used for the production of bitter balsams.
Gobernadora (Larrea tridentata)

Botanical characteristics. The scientific name of this plant is *Larrea tridentata* Cov, common name is gobernadora. They also can be found under the following names: *Covillea divaricata* (Cav.) Vail; *Covillea glutinosa* Rydb; *Covillea tridentata* (DC.) Vail; *Guaiacum mexicanum*; *Larrea divaricata subsp. tridentata*; *Larrea glutinosa*; *Mexican Larrea Moric*; *Larrea tridentata var. glutinosa*; *Neoschroetera glutinous*; *Neoschroetera tridentata*; Schroeterella glutinous; Schroeterella tridentata. It is a much branched shrub that measures 60 cm to 3 m high. Their leaves are divided into small flakes leather-like appearance and are covered with hairs and resin. The flowers are solitary and yellow; and it has globose fruits. Gobernadora contains leaves and stems, solitary flowers about 2.5 cm of diameter, elliptical sepals with 6 mm length and 4 mm of width. The petals are bright yellow of an oblong shape to lanceolate, at 1 cm length and from 3 to 5 mm of width. It gives a subglobose fruit to ovoid shape of 7 mm length, leathery, with white, silky hairs. The seeds are brown to black color, curved, 2 to 4 mm of length with triangular contours in the form of "boomerang" [178].

Geographic range. It grows widely in northern Mexico and the Southeast region of the United States [179]. In Mexico, the governadora is distributed abundantly in the north of the country, mainly in the states of Baja California, Baja California Sur, Coahuila, Chihuahua, Durango, Guanajuato, Hidalgo, Nuevo Leon, Queretaro, San Luis Potosi, Sinaloa, Sonora, Tamaulipas and Zacatecas, at altitudes of 400-1800 m. It is estimated that covers about 50 million hectares [180]. It is one of the main components of the arid and semiarid vegetation of Mexico.

Chemical composition. It contains volatile oils, fats esters, sterols and other hydrocarbons [181, 182]. Table 2 shows the physicochemical properties of the governadora. Table 3 lists some chemical components presented in their leaves, stems, and branches. Table 4 shows the phenolic composition of this plant.

Pharmacological properties. The resins are characterized by fungicidal activity against *Rhizoctonia solani, Fusarium oxysporum, Pythium* spp. and other pathogenic and phytopathogenic fungi. It can inhibit the growth of some insects such as brown bean weevil (*Acanthoscelides obtectus, Coleoptera: Bruchidae*); larger grain borer (*Prostephanus truncatus, Coleoptera: Bostrichidae*). This plant receives extensive use in the north of Mexico, commonly as treatment for kidney stones in the urinary track. Treatments are prepared as infusion with boiled water using the whole plant or the branches. It also is used as treatment for other discomforts like kidney pain and bladder inflammation. Its use as douching with infusions of leaves, root, branches or bark, is suggested as treatment of gynecological problems such as female infertility, postpartum problems, or menstruation regulation.
The same infusion is used as watery baths to treat hemorrhoids, fever, malaria, pimples, bumps, and rheumatism, renal gallstones, dermatitis, hepatitis and as an antiseptic treatment. It has been attributed properties and actions against gastric ailments, venereal diseases and tuberculosis. It is used as a treatment for fungal infections.

Table 2.
Physicochemical characterization of the Gobernadora [183, 184]

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity</td>
<td>8.73</td>
</tr>
<tr>
<td>Total dry matter</td>
<td>91.27</td>
</tr>
<tr>
<td>Ashes</td>
<td>8.5</td>
</tr>
<tr>
<td>Protein</td>
<td>6.34</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>19.62</td>
</tr>
<tr>
<td>Fats</td>
<td>3.89</td>
</tr>
<tr>
<td>Total sugars</td>
<td>13.5</td>
</tr>
<tr>
<td>Reducing sugars</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Application. The flower button is used as a condiment. The leaves are important because of their protein content, allowing its use for animal consumption. It requires prior removal of resins to increase their digestibility and palatability. It is used for dyeing leather. The plants are used as the basis for manufacturing paints and plastics after phenol extraction. The resin is extracted from the leaves due to containing of nordihydroguaiaretic acid (NDGA), which is used for the production of fats for footwear, oils, lubricants, varnishes, as well as treatment for boilers descaling from saline substances, pharmaceuticals, rubber, etc. The resin is used for the manufacture of soaps.
Table 3.
Chemical compounds present in the governoradora [181, 182]

<table>
<thead>
<tr>
<th>Compound</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile oils</td>
<td>0.1-0.2% (w / w *) of fresh leaf.</td>
</tr>
<tr>
<td>Hydrocarbon monoterpenes</td>
<td>Δ-3-carene, limonene, α-pinene; α-fenchene, β-ocimene, β-pinene.</td>
</tr>
<tr>
<td>Oxigenated monoterpenes</td>
<td>Borneol, bornil acetate, camperol, p-cymene, linalool; copaeno</td>
</tr>
<tr>
<td>Aromatic hydrocarbons</td>
<td>Benzaldehyde, benzyl acetate, benzyl butyrate, 1,2-dihydro-1,5,8-trimethyl-naphthalene, ethyl benzoate, o-methyl anisate, methyl naphthalene; acetophenone</td>
</tr>
<tr>
<td>Esters of fatty acids</td>
<td>Some of these compounds are alkyl esters of fatty acids (C48-C56). They are located on the surface of the branches and leaves. There are 0.1% (w / w) of fresh leaf.</td>
</tr>
<tr>
<td>Sterols</td>
<td>Campesterol, β-sitosterol, stigmasterol, colesterol.</td>
</tr>
<tr>
<td>2-Ketones</td>
<td>Probably these compounds are responsible for the plant characteristic aroma. Some of them are 2-dodecanone, 2-undecanone, 2-tridecanone, 2-tetradecanone, 2-pentadecanone, 3-hexanone, 2-heptanone, 2-nonanone.</td>
</tr>
<tr>
<td>Vinyl Ketones</td>
<td>They are also responsible for the aroma: 1-hexen-3-one, 1-octan-3-one; 1-heptan-3-one.</td>
</tr>
</tbody>
</table>

* w/w= weigth/weigth

Table 4.
Phenolic compounds of governoradora

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Sheet (%)</th>
<th>Stem (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total polyphenols</td>
<td>19.29</td>
<td>10.37</td>
<td>29.66</td>
</tr>
<tr>
<td>Total tannins (TT)</td>
<td>11.95</td>
<td>6.92</td>
<td>18.87</td>
</tr>
<tr>
<td>Hydrolyzable tannins (TH)</td>
<td>9.20</td>
<td>5.09</td>
<td>14.29</td>
</tr>
<tr>
<td>Condensed tannins (TC)</td>
<td>2.74</td>
<td>1.82</td>
<td>4.56</td>
</tr>
<tr>
<td>Gallic Acid</td>
<td>0.27</td>
<td>0.05</td>
<td>0.32</td>
</tr>
<tr>
<td>Ellagic Acid</td>
<td>5.56 E-05</td>
<td>2.79 E-05</td>
<td>8.35 E-05</td>
</tr>
<tr>
<td>Catechin</td>
<td>0.0604</td>
<td>0.00051</td>
<td>0.06091</td>
</tr>
<tr>
<td>Nordihydroguaiaretic acid (NDGA)</td>
<td>7.34</td>
<td>3.45</td>
<td>10.79</td>
</tr>
</tbody>
</table>
**Botanical characteristics.** Hojasen, is a plant belonging to the *Asteraceae* family, its name is *Flourensia cernua*. It is bush with 1 to 2 m tall, which loses its leaves from January to April. The plant produces a resinous substance that smells like tar. The leaves are oval at 6 to 11.5 cm in length, which have a bitter taste. It has small yellow flowers, coming together in axillary heads. Flowering takes place between September and October. The fruit is an achene, laterally flattened and provided with long hairs. It is used as a shade tree in rural construction and as a remedy for gastrointestinal diseases.

**Geographic range.** It is characteristic plant for Sonora and Mojave deserts, in Coahuila, Chihuahua, Durango, and Zacatecas deserts in northern Mexico, as well as Texas, Arizona and New Mexico deserts in South of the United States [185, 186, 187, 188].

**Chemical composition.** The presence of essential oil at 0.864%, a glycoside at 0.332%, and a resin was demonstrated [189]. Wall [190] found small amount of alkaloids in the plant aerial parts (leaves, branches, and flowers).

**Pharmacological properties.** It is used as a remedy for digestive problems [191]. It has potential as an agricultural fungicide: *Rhyzoctonia solani*, and *Fusarium oxysporum*, and *Pytium* sp. were totally inhibited with 1000 ppm extracts.

**Application.** The watery extracts are traditionally used to treat constipation as a stimulant laxative. Anthraquinones act on a set of nerves endings that control movement of the bowel muscles. This action allows an increase of intestinal contractions to stimulate the stool propulsion. Moreover, they increase the water concentration in the intestine and synthesis of mucus in the intestinal walls. They have been attributed other properties such as slimming property: weight loss with the fluid expense. These effects on the intestine increase intestinal motility and can treat constipation.
**Sábila (Aloe vera)**

*Botanical characteristics.* The Barbados aloe or aloe Curacao better known by its Latin Name Aloe vera (syn. *Aloe barbadensis Miller*) is a family of succulent plants. It is a perennial plant with succulent leaves in rosettes, reaching 50 cm of long and 7 cm of thick. Sometime it reaches between 2 and 3 m in height, although rarely up to 6 m. Species of the genus of Aloe are almost always woody, but with very large leaves and fleshy, arranged in large rosettes. The leaves are composed of three layers: external protection, a fibrous layer below it, and a gelatinous heart where water reserves are stored, which is applied for preparation of many pharmaceutical products. Fibrous layer contains aloin, which is the active ingredient used as a laxative in pharmaceutical preparations. Its bitter taste serves for the plant as protection against predators. The leaves are long, lance-shaped, and seem to spring directly from the soil on young plants. The old plants have a short and sturdy stem. Aloe flowers are small, tubular, and occur in dense red or yellow inflorescences. Aloe flowers usually require cross-pollination to impregnate. This is usually carried out by birds and butterflies [192]. These plants are grown as ornamentals for their attractive and resistance to water insufficiency. They form a large rosette of thick fleshy leaves and leaving a short stem (however, in some species it is very long and even branched). These leaves are usually lanceolate with a sharp apex and thorny tips. Their colors vary from gray to bright green and are sometimes striped or mottled. Tubular, yellow or red flowers are on leafless, simple or branched stalk, forming sometimes dense clusters [193].

*Pharmacological properties.* *Aloe vera* is applied as anesthetic calming all kinds of pain (especially for muscle and joint) and nerves. It has antibacterial activity against many types of virus, bacteria, and fungi. It is known as anti-inflammatory, antipyretic and antipruritic treatment, as well as highly nutritious product (containing vitamins, minerals, and sugars). Its extracts destroy dead tissue, promote normal cell growth and tissues hydration [194]. It is decongestant, soothing and an excellent sunscreen against ultraviolet radiation. It is used for irritated skin problems and soothes mild sunburn.

*Geographic range.* It is native to the northeastern coast of Africa, Eastern and Southern Africa [195]. The term Aloe comes from the Arabic word "alloeh" and Hebrew synonym "halal" uses to define a bright and bitter substance. The other name (*Aloe vera*) is attributed to deformation of the Arabic word "Kabyle" used for prickly plants [196]. They grow in the most desert areas of Africa, especially in Cape (South Africa) and in the mountains of tropical Africa [197, 198, 199].

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Fig. 12. *Aloe vera*
The genus Aloe has the ability to retain rain water, allowing it to survive for long periods in drought conditions. After three years of plant life, the gel in the green leaves has the highest nutritional content [197].

Mexico is the first Latin American country in terms of area planted aloe currently with approx. 14 thousand hectares.

**Application.** It is an excellent cleanser and natural antiseptic (containing at least six antiseptic agents: lupeol, salicylic acid, urea nitrogen, cinnamic acid, phenol and sulfur) [200]. Aloe gel has been used as an additive in edible coatings for fruits due to its effectiveness in slowing of fruits ripening, in addition to increase the nutritional quality of fruits [201]. It is used in the food industry as a part of functional foods [202].

Currently there are several known varieties of aloe, of which only three or four have significant therapeutic or medicinal properties. The most potent of them, rich in vitamins, minerals, amino acids and enzymes is *Aloe barbadensis miller*, commonly known as Aloe Vera [192].

**Chemical composition.** There are a large number of substances, which are contained in *Aloe vera*, such as: 6-10% of the plant is composed of water, a 2% ash [194], about 40 to 80 % resins, vitamin A (retinol), vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B6 (pyridoxine), vitamin C (ascorbic acid). Vitamin B12 (cobalamin). It is rich in minerals and trace elements such as: iron, calcium, phosphorus, magnesium, manganese, potassium, copper, zinc. It provides nineteen of the twenty amino acids needed for human, seven of which are essential.

**Sotol (Dasylirion spp)**

**Botanical characteristics.** *Dasylirion* is a genus described by the German botanist J. Gerhard Zuccarini in 1838. Genus Dasylirion appears to be closely related to *Nolina, Beaucarnea* and *Calibanus* genera. In traditional classification systems, this genus belongs to the family *Liliaceae* [203]. Based on the similarity of their leaves and habitat, *Dasylirion* was also placed within the *Agavaceae* family along with the agave and yucca. However, due to cytological reasons these relationships have been questioned in many researches. *Liliaceae* has recently been disintegrated into several smaller families, with *Dasylirion* placed in a family called *Nolinaceae*, well separated from the *Agavaceae*. *Dasylirion* spp. plants are characterized by the presence of a thin sheet containing numerous spines. They have a woody stem, which in some species can measure from 1.50 to 2.50 meters in height. They survive both the rawness of cold winters and hot summers. The plant contains a heart (or head) which is applied for alcoholic beverage elaboration well-known under similar name

![Fig. 13. Sotol plants](image)
"Sotol". The Sotol (Dasylirion spp) is a perennial plant, polycarpic and semicylindrical large size, with narrow leaves from the center of stem to the periphery. The green fibrous leaves have more than 20 mm wide and more than a meter length. They contain slightly appended tips, and red or yellow spines from 2 to 5 mm length, distant one to another from 10 to 15 mm [204]. Dasylirion cedrosanum is typical of the desert or near desert-like climates.

**Geographic range.** Sotol is originally from northern Mexico and growing in Chihuahua, Coahuila, Durango and Zacatecas states. It is known with different names depending on the place of growth. In Chihuahua, it is known as "sereque", an indigenous name. In other places it is called zotol, Nahuatl name that comes from the word tzotollin (the sweet of the head). In Coahuila it is known as sotol and some varieties are called varacuete [205]. This plant is perfectly acclimated to the semi-desert and can survive both cold winters and hot summers up to 150 years due to its enormous latent energy and its roots and stem structure [206]. Its natural production zone is located mainly in the Chihuahua Desert at an average from 1,000 to 2,500 meters above sea level, between the Sierra Madre Occidental and the Sierra Madre Oriental. The Mexican plant is distributed for the mainly by the states of Chihuahua, Coahuila, Durango and, to a lesser extent, by Nuevo León, Zacatecas and San Luis Potosí with common phytogeographic characteristics, for example, their soils are rich in calcium carbonate [207]. One of the main problems related with the sotol plants is that they have been exploited without any control and the great areas of mentioned states are getting depopulated of this specie. In addition, the production of seeds of the plant is not the same every year and the percentage of germination is very low, being only 8%. Moreover, these plants are consumed by rodents, lagomorphs, cattle, and goats [208].

**Application** It has been used as human food and for livestock, in the construction of roofs of houses, to manufacture handicrafts (for example, baskets) and as ornamental plant in public squares and churches. Its main use nowadays is the production of an alcoholic drink called Sotol [206]. The beginning of the Sotol production goes back to the pre-Hispanic period [206]. The use as an alcoholic beverage in Mexico is regulated by the norms NOM-005.RECNAT-1997 and NOM-007-RECNAT-1997 [209] and the NOM-159-SCFI-2004 [210, 211]. In Mexico, about 16 species of sotol have been identified: Dasylirion cedrosanum, Dasylirion palermi, Dasylirion lucidum, Dasylirion parryanum, Dasylirion leiophyllum, Dasylirion wheeleri, Dasylirion simples, Dasylirion glaucophyllum, Dasylirion acrotiche, Dasylirion graminifolium, Dasylirion duraangensi, Dasylirion serratifolium, Dasylirion berlandieri, and Dasylirion longissimum. But only some of them have economic importance in the production of liquor due to the larger diameter of their hearts and consequently to the high content of carbohydrates. Thus, only 3 species have specific characteristics and properties to be used in the alcohol industry: Dasylirion duranguense, Dasylirion cedrosanum, and Dasylirion wheeleri [212].

**Chemical composition.** Dasylirion spp. are characterized by moisture content close to 70%, and a total soluble sugars content of 25-38%. These levels may vary
depending on the time of the year. The carbohydrates present in the sotol are mainly found as polysaccharides of the family of fructosans (known as inulins). In addition, they contain a certain amount of starch, as well as glucose and fructose. The chemical composition of the Sotol heart can slightly vary according to the plant sex (Table 5) [213].

Table 5.
Chemical Composition of Female and Male Sotol Plants Heart.

<table>
<thead>
<tr>
<th>Parameter (%)</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity</td>
<td>69.27</td>
<td>69.21</td>
</tr>
<tr>
<td>Ashes</td>
<td>0.88</td>
<td>0.94</td>
</tr>
<tr>
<td>Fats</td>
<td>0.88</td>
<td>0.76</td>
</tr>
<tr>
<td>Raw fiber</td>
<td>9.31</td>
<td>10.02</td>
</tr>
<tr>
<td>Protein</td>
<td>0.47</td>
<td>0.49</td>
</tr>
<tr>
<td>Reducing sugars</td>
<td>5.27</td>
<td>6.17</td>
</tr>
</tbody>
</table>

The sugar content also varies with respect to the location: it decreases as height increases compared to sea level [211].

**Nopal (Cactus ficus indica)**

**Botanical characteristics.** The nopal (Opuntia spp., Cactaceae) are xerophilous, succulent, thorny and arborescent plants whose stems are called cladodes. The fruit (prickly pears) of this plant is known as "tuna", "fig of barbarism", and "Indian fig". Prickly pears cactus are fleshy, ovoid or peripheral berries of variable dimensions (5-10 cm length and 4-8 cm of diameter). They contain small spines in its epidermis and juicy white, yellow, red, orange or purple pulp with numerous seeds [214]. It is a plant from 3 to 5 m height or more, with well-defined woody stem from 60 cm to 1.5 meters of height, and from 20 to 30 cm of diameter. Its cladodes are dark and green, oblong 16 to 30.5 cm long, 16 to 27 cm wide and 1.7 to 2.5 cm thick. In some cases the spines are absent, in others present and of variable size. As nopal plants are often considered as different species of the genera *Opuntia* and *Nopalea* of the family Cactaceae.

**Geographic range.** Cactaceae are native to the Americas and are widely distributed from Canada to Argentina. Nowadays the nopal is a basic pillar in the subsistence and economy of peasant groups, since they consume the shoots (nopalitos) during most of the year and take advantage of their fruits (tunas - prickly pears) from June to October. The Nopal is native to the desert areas of Mexico and the northwest to
the southwest of the United States, [215]. The plant was brought to Europe by the first Spanish settlers established in Mexico and has been cultivated along the Mediterranean coast since the 17th century [216]. The plant requires minimal crop care. It is propagated mainly by vegetative means (cladodes). Its fruiting begins after 2 or 3 years and reaches its optimum at 7 or 8 years. An adult plant can yield 100 to 200 fruits. *Opuntia ficus indica* is very well suited to different textures and compositions of soils, but is best developed in calcareous, sandy soils with a medium depth, with alkaline pH and altitudes varying between 800 and 2500 meters; In their development, annual temperatures are preferably between 18 and 25 °C.

Another important producing region is the Mediterranean Basin (Italy, Spain, Egypt, Morocco, and Israel) and to a lesser extent, South Africa, South America, Southwest Asia, USA and Australia. Fruits are usually sold in the local markets of these countries, with the exception of Mexico, Italy and Chile, which are also exporters. The tuna is not grown as a regular commercial crop, but is only planted to form fencing, windbreaks and gardens. The only significant plantations are in Mexico, Italy, Spain, Chile, Israel, and South Africa. Many local crops have developed, and are usually named after the color of the fruit when it reaches its state of maturity. In Mexico, 'Reyna', 'Red Pelona', 'Esmeralda', etc., in Italy, 'Gialla', 'Rossa' and 'Bianca' and in Spain 'Verdales', 'Morados', 'Sanguinos' 'Blancos' [217, 218, 219]. The future demand for this fruit depends on the development of high quality crops, without spines and with few seeds. Due to its xerophilic habitat, the tuna does not have serious problems of parasitosis and other diseases. However, in some areas, fruit fly (*Ceratitis ceratitis*) causes some damage [217, 220]. In addition, it has been observed that the tunas present hypoglycemic effects [221] and hypochondrosumetic agents [222, 223]. The current trend shows an increase in the production of this fruit, the cladodes are not a traditional food, except in the areas of nopal origin, despite some attempts in Korea [224]. In the future, it is considered that Mexico, Italy, and South Africa will increase the production of this fruit. On marginal land in the arid parts of the world, where irrigation is not possible, they could contribute to global food production when improvements in tuna farming systems are achieved. The development of simple and robust transformation technologies is also likely to contribute to the value of this plant [215].

The properties of hydration depend mainly on the physical-chemical nature of the constituents of the fiber. The solubility, swelling, water retention capacity and viscosity of FD in foods are determined mainly by their content in soluble pectins, gums, mucilages and hemicelluloses, whereas cellulose, insoluble hemicelluloses, lignin and other fiber-related components have a limited influence on these properties [225].

**Chemical composition.** The chemical composition of the nopal on wet basis according to [226] is: water 91%; Protein 0.66%; Fat 0.11%; Carbohydrate 5.50%; Cellulose 1.15%; And ashes 1.58%. More recent studies on the composition of the tuna have reported pH (5.8-6.4), acidity (0.05-0.08% as citric acid) and soluble solids (11-17%), mainly glucose and fructose [227]. This product is very susceptible to the microbial development [228]. The most abundant components of the pulp
and the shell were soluble carbohydrates in ethanol. The pulp contained glucose (35%) and fructose (29%), whereas the shell contained essentially glucose (21%). The protein content was 5.1% (pulp), 8.3% (shell) and 11.8% (seeds). Starch was found in each of the three parts of the fruit. Pulp fibers were rich in pectin (14.4%), while the husk and seeds were rich in cellulose (29.1 and 45.1%, respectively). The peel was remarkable in its content of calcium (2.09%) and potassium (3.4%). The fruit of *O. ficus indica* is rich in taurine; Nutraceutical amino acid. Cladodes of cactus and tunas are useful for a variety of purposes, including their use as human food (fresh fruit, mash, marmalade, salads, and beverages), as forage (cattle and sheep), medicinal (anti-Diabetic) and industrial, to obtain alcohol, soap, pigments, pectins and oils [229, 230, 231]. It has been observed that the tunas present hypoglycemic effects [221] and hypocolsteromiases [222, 223]. Several authors have reviewed in detail the wide potential of the cladodium and the fruit of the cactus. In Mexico, Chile and Italy it is possible to find on a commercial scale the dietary fiber of cladodium of cactus. Chemically dietary fiber (FD) consists of complex carbohydrates that are not degraded or absorbed in the small intestine. However, in the wall of the plant cell carbohydrates are associated with other types of substances that share the common characteristic of being resistant to the digestive enzymes of man. The biological action of FD is not limited to carbohydrates, but should extend to the whole cell wall formed by complex polysaccharides (cellulose, hemicelluloses, pectin, etc.), lignin, polyphenols, starch resistant to degradation, proteins associated with the cell wall and some minerals. The proportion of each of these in the cell wall is different for each plant and depends on the type and intensity of the effect exerted by the FD in the organism [232, 225].

The physicochemical characteristics of *O. ficus* indicates that cactus cladodium fiber are: light green color, a water absorption index of 5.6 mL / g, a total dietary fiber content of 43% (insoluble fiber 28.45% and Soluble 14.5%). As for mineral composition, the calcium content is 80 mg / day and an energy intake of 145.3 kcal / 100 g. Nopal fiber has been used in the preparation of noodles [224], flans [233], and biscuits [234]. The physico-chemical or functional properties of the fiber can be grouped into four sections: 1) Hydration properties (solubility, swelling capacity, water retention and absorption capacity, viscosity and gelation); 2) Cation exchange capacity; 3) Particle size, density and surface characteristics (porosity and fat adsorption capacity); and 4) Adsorption of organic molecules.

*Applications.* Cactus cladodes are useful for a variety of purposes, including their use as human food (fresh fruit, mash, marmalade, salads, and beverages), as forage (cattle and sheep), medicinal (anti-diabetic agent) and industrial, for the preparation of alcohol, soap, pigments, pectin, and oils [229, 230, 231]. In certain supermarkets, it is possible to find juices, either of cactus or prickly pear. It is also possible to find canned and frozen nopals. In addition, nopal meal is usually prepared from mature cladodes.

To its fruit, it is known as "tuna", "fig of barbarism", "and" "Indian fig". The fruits are fleshy, ovoid or peripheral berries of varying dimensions (5 - 10 cm long and 4-8 cm in diameter), with small spines in their epidermis and juicy pulp, white,
yellow, orange red or purple, with numerous seeds [214]. Fruits ripen and are harvested by hand from July to December. The world harvest of tuna was estimated at 300,000 tons. Also, young cladodes (nopalitos) are consumed in Mexico as vegetables.

The estimated production of tuna in Mexico was approximately 500,000 tons, in an area of 54,000 hectares. It is consumed cooked, in salads, soups and in diverse dishes with diverse dressings, and constitutes by itself a complete meal. Due to the high consumption and its ease of being obtained by the population, with its calodios can be elaborated diverse products.

Dietary fiber (DF) consists of complex carbohydrates that are neither degraded nor absorbed in the small intestine. However, in the wall of the plant cell carbohydrates are associated with other types of substances that share the common characteristic of being resistant to the digestive enzymes of man. The biological action of DF is therefore not limited to carbohydrates, but should extend to the whole cell wall formed by complex polysaccharides (cellulose, hemicelluloses, and pectin), lignin, polyphenols, starch resistant to degradation, proteins associated with the cell wall and some minerals. The proportion of each of these in the cell wall is different for each food and this proportion depends on the type and intensity of the effect exerted by the DF in the organism.

Dietary fiber consists mainly of cell wall and some polysaccharides, whose function is the energy storage of plants, which cannot be hydrolyzed by human digestive enzymes. Lignin, a complex molecule of polyphenol propane units, is present only in small amounts in the human diet and is included in dietary fiber.

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Orégano (Lippia berlandieri or Lippia graveolens)

Botanical characteristics. The name Oregano comes from the Greek word "Origanum" and is derived from two words, "gold" and "mountain" joy, about the festive appearance that gives this plant to the slopes of the mountains where it grows [235]. Several species of plants belonging to the families Labiatae and Verbenaceae are known. There are about 40 herbaceous plants that are known by the popular name of oregano, and it is wild in 24 states of the Mexican Republic. Oregano is known by many names as oregano from the hill, oregano cimarron, wild oregano, Mexican oregano or marjoram [236] and has recently acquired economic importance because 90% of the production of its useful dry matter is exported to the United States and to a lesser extent Italy and Japan. In Mexico, six species of the family Labiatae, three species of the family Verbenaceae, a species of the family Compositae and a species of the family Leguminoseae [236, 237] have been recognized. Cabrera (1980) [238] identified the main types of commercial cultivars, taxa cultivated in the United States and the main types of imported oregano. European-type oregano comes mainly from subspecies of Origanum vulgare L., including hirtum (Link) letswaarp, virens, letswaart y viride (Boiss.); in contrast, Mexican
oregano, also known as Salvila mexicana, is collected from the shrub *Lippia graveolens* as well as leaves of other spices are also collected [239]. The species are found within the *Verbenaceae* family. The species *Lippia graveolens* is synonymous with the species known as *Lippia berlandieri*, are shrubs of oblong leaves, reaches 1.2 to 2 m in height, with 4 to 6 peduncles per knot, flowers in subglobose ears, white or yellow, zygomorphic corollas. Mexican oregano grows in dry and semi-dry climates over rocky ridges, valleys, streams, chaparral, deserts and mesas, it is distributed from Texas to New Mexico in the United States, as well as in Mexico and Central America [240]. Where oregano grows, the soil is 5 to 35 cm deep with a sandy loam texture (50-60%, 20-30% silt, 10-25% clay).

The communities where oregano grows (*Lippia berlandieri* Schauer) are mainly rosetófilo and submontane scrub, in some cases thrive in flat parts, on tops of hills or hills, and on the banks of intermittent streams, where oregano is mixed with some elements (*Larrea tridentata*), or jarilla (*Dodonea viscosa*) and isolated thorny individuals such as mesquite (*Prosopis glandulosa*) and *Acacia* spp. [241].

In the Potosi highlands, the slope where the oregano is found varies from 3 to 15% in the part of the hill, with a pH of 7.5 to 8.5 and the greatest abundance is in the southwest exposure having higher density of the middle part of the hill to the top of it; On the other hand, the least abundance or sometimes the null existence of the species is in the northwest exposure of the hill, and in climates where the precipitation varies from 200 to 300 mm annually [242].

In an evaluation of the flora associated with oregano in the southern state of Chihuahua, the specimens found were divided into three strata. The herbaceous stratum included *Bouteloua filiformes*, *B. curtipendula*, *Rinchelytrum roseum*, *Botriochloa saccharoides*, *Muhlenbergia monticola*, *Aristida adsencionis*. The shrub stratum, in which oregano is the dominant species, contained *Mimosa biuncifera*, *Stevia rhombifolia*, *Brickellia veronicaefolia*, *Agave* spp. The species *Ipomea intrapilosa*, *Acacia farnesiana*, *A. schaffneri*, *Bursera fagaroides* y *Ptelea trifoliata*.

There are some more species of oregano in Mexico that have been poorly studied. In the northern part of the Republic, in the states of Coahuila and Nuevo Leon, grow oregano from the hill (*Poliomintha longiflora* Gray) [243]. Oregano is considered as a non-timber resource and its export is regulated by the Mexican Regulations NOR-005-RCNAT-1997 y NOM-007-RECNAT-1997 [209].

*Geographic range* Most species of oregano in Mexico are found in arid and semi-arid regions in the states of Querétaro, Guanajuato, Hidalgo, Oaxaca, Jalisco, San Luis Potosí, Zacatecas, Chihuahua, Durango, Sinaloa, Baja California Sur and Coahuila. From the economic point of view, the most important species are *Origanum vulgare* and *Lippia graveolens* [240].

In the state of Chihuahua, the approximate surface area for the production of oregano is 41,900 has. Envolved municipalities are: Delicias, Valle de Zaragoza, Allende Valley, San Francisco de Conchos, Meoqui, Villa López, Julimes, La Cruz, Camargo, Saucillo, Jiménez and Villa Coronado [235]. In annual exports of oregano, Chihuahua has participated with an average of 21.05%, competing with other
producing states like Jalisco, Durango, Hidalgo, Querétaro, Zacatecas and Oaxaca [240].

The expectations of the world market and the physiological and morphological characteristics of oregano adapted to the scarce availability of water raise the need for research on their domestication and introduction as an alternative crop in those areas where water is the limiting factor [244]. The exploitation of oregano is based on harvesting the foliage of wild populations. This, in the long term, may result in a decrease in these populations because the harvesting season coincides with the flowering season, limiting the natural dispersion of the species [245]. Cultivated oregano may be an alternative crop diversification in Mexico and with its controlled production can release some of the over-exploitation pressure on areas where it grows naturally.

Chemical composition The essential oil consists mainly of thymol and carvacrol, in addition to some phenolic acids and flavonoids. Some of the constituents of oregano essential oil have been associated with antimicrobial properties [246, 247] Mexican oregano compared to that of the Mediterranean regions, has a stronger aroma and flavor. The leaves are longer and darker and have about 3 to 4% essential oil.

The composition of the essential oil and the percentage of each of the components present has been used as an element for the classification and genetic relationship of oregano plants [237, 248]. In Table 6, the average concentrations of some chemical compounds of different plants that are called oregano are presented. Mexican oregano has the highest percentage of carvacrol, compared to other species.

Table 6.

Chemical components of oregano essential oil. Comparative analysis with two foreign species [240]

<table>
<thead>
<tr>
<th>Components</th>
<th>Mexican orégano Lippia graveolens</th>
<th>Greek orégano Origanum vulgare, subsp. Hirtum</th>
<th>Turkish orégano Origanum vulgare, subsp. Gracite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essential oil</td>
<td>2.0 %</td>
<td>1.5 %</td>
<td>1.5 %</td>
</tr>
<tr>
<td>Thymol</td>
<td>10.4 %</td>
<td>23.9 %</td>
<td>15.1 %</td>
</tr>
<tr>
<td>Carvacrol</td>
<td>43.7 %</td>
<td>12.2 %</td>
<td>9.9 %</td>
</tr>
<tr>
<td>p-cimeno</td>
<td>6.4 %</td>
<td>15.9 %</td>
<td>8.1 %</td>
</tr>
</tbody>
</table>

Pharmacological properties. Use of spices, in addition to conferring a particular flavor to foods, aid in the increase in their shelf life [249]. Oregano is among the spices that have the highest antioxidant and antimicrobial capacity. There are numerous reports in which oregano is included as an antimicrobial, and the work shows its activity both in culture media, and when it is added to food [247, 250].

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They have a better antibacterial effect on Gram-positive bacteria than on Gram-negative bacteria [251, 246]. And antifungal effect on Aspergillus niger, Aspergillus flavus, Candida albicans, C. tropicalis and Torulopsis glabrata, obtaining variable inhibitory concentrations (650 – 1 270 ppm) [252, 250].

By using European dried oregano sterilized with ethylene oxide, Salmerón et al. (1990) [253] determined their antimycotic and anti-aflatoxigenic activity, finding that although oregano powder stimulated the growth of fungal strains, it completely inhibited Occurrence of mycotoxins. They tested the antimycotic effect of different essential oils, including oregano against Aspergillus ochraceus as well as inhibition of ochratoxin A. Kim et al. [254] studied the antibacterial activity of 11 essential oils, in addition to carvacrol and thymol, which are the main components of the essential oil of oregano. The antimicrobial activity was tested in culture medium against five food contaminating microorganisms and showed that carvacrol, citral and geraniol, have a potent bactericidal activity.

Studies carried out with Mexican oregano (Lippia berlandieri Schauer) from the Chihuahua region have shown their antimicrobial effect on different microorganisms. Álvarez [255] studied the effect of oregano powder and essential oil on S. aureus, E. coli and S. typhimurium, finding better inhibitory effects at 150-200 ppm of essential oil and 1500 ppm of oregano powder for these three bacteria. In another study, the antimicrobial effect of polar fractions (separated by column chromatography), as well as phenolic and non-phenolic fractions at 200 ppm against S. aureus, E. coli and B. cereus were evaluated; In general, these fractions had a good inhibitory effect on B. cereus and S. aureus, but a very slight effect on E. coli. The minimal inhibitory concentrations of essential oil of Lippia graveolens on S. aureus, E. coli and Ps. aeruginosa, the latter two bacteria being more resistant to being inhibited with a concentration of 250 μL/L [256].

In addition, the antimicrobial effect of organic extracts of oregano bagasse Lippia berlandieri Schauer about S. aureus, B. cereus, L. monocytogenes, E. coli 0157:H7 and S. typhimorium; Being that the alcoholic extract showed the best effect, followed by aceticone and hexanic respectively. In general, the greatest effect was on B. cereus and the smallest effect was on E. coli 0157:H7 [257]. In studies on fungi, an inhibitory effect of the essential oil of Lippia berlandieri Schauer about Phymatotricopsis omnivora [258] and about Aspergillus, Penicillium and Rhizopus isolated from different foods [259].

**Applications** Most species of oregano have remarkable medicinal properties, which are explained by the extraordinary and complex chemical composition of the plant. Oregano is used as tea or water used for cough, kidney disease, colic, in the manufacture of infusions for the control of fever and respiratory diseases. In medicine, it is used as abortive, antispasmodic and antitussive; it is also a remedy used as an expectorant and for asthma problems. The aromatic leaves are used to flavor the food and are added to canned and pickled products. In the case of agriculture, it has been used as a pesticide-insecticide, where lethality and repellency tests have been carried out on mites that affect crops as well as honey bees. Oregano is indus-
trialized by extracting its essential oil, which is used in liquor, perfumery, refreshment, etc. The fundamental importance of the spices lies in their organoleptic properties, derived from their attributes as flavorings or seasoning of foods [244, 236].

In oregano, the components with the greatest biological capacity are found in its essential oil, which is variable in its chemical composition, and will depend on the species from which it is extracted, on the phenological development of the plant and on the time of year in which it is collected.

Fats and oils undergo significant oxidative changes, especially when exposed to high temperatures, light and specifically to the presence of oxygen during storage, either by lipolysis or autoxidation. These oxidative changes reduce the nutritional quality of fats and oils [260]. One way to avoid them is by adding some antioxidants that slow down the oxidation process; synthetic antioxidants such as BHT, BHA y TBHQ to prevent oxidation processes preserving aroma, flavor, and color [261, 262]. However, safety in the use of these synthetic antioxidants has been questioned recently. The use of plants and herbs as natural antioxidants in processed foods is beginning to be a promising alternative to the use of synthetic antioxidants. Several investigations have been carried out in different species of plants, being the most studied those of the family Lamiaceae (rosemary, sage, thyme, oregano, marjoram among others) and at present this line of research is booming, especially by the increase in the number of consumers interested in natural foods [263, 264].

Oregano is a plant with great potential for applications in various areas of industry. It is also a plant that can be cultivated with minimal care and good yield. Their exploitation, however, requires a sustainable development plan, where products derived from their cultivation are developed, that can be commercially feasible.

**Lechuguilla (Agave lechuguilla)**

*Botanical characteristics.* The *Agave lechuguilla* plant has the appearance of a small maguey (Figure 15), characterized by having a crown that supports 20 to 30 thick fleshy leaves, measuring 1 to 2 inches wide and 12 to 18 inches long, are lanceolate, curved towards the center of the plant; These end up in a rather hard and sharp mucus, of brown color, of 30 to 40 mm, its edges are protected by a series of gray or brown hooked spines turned towards the base of the leaf [265, 266].

The bud is a set of leaves from which the best quality fiber is obtained, it blooms only once, from a floral scape called quiote or garrocha which reaches heights of 3 meters. The flowers are produced in pairs, protected by vigorous bracts and yellow-green with a reddish hue. Its fruit is a brown or black capsule that grows from 1.5 to 2.5 cm in length by 1.2 to 1.5 cm in diameter, often oblong to cylindrical
to triangular obtuse, with three chambers. The seeds are numerous, flat and bright, although they are viable, the plant reproduction is mainly asexually. The propagation of the seed is only achieved artificially, out of the field and under nursery care. The roots are long, fibrous and thin [267, 268, 269].

**Geographic range.** The Agave lechuguilla grows wild in the arid and semi-arid zones of southern Texas and New Mexico in the United States of North America, in Mexico it is in the semi-desert of Chihuahua, which includes the states of Chihuahua, Coahuila and Durango, but its presence extends to some states of central Mexico such as Jalisco, Hidalgo, Querétaro and Guanajuato. This plant shows latitudinal changes in floral morphology, color and nectar production throughout its distribution in northern and central Mexico [270].

**Chemical composition.** The variety of applications given to Agave lechuguilla has its origin in the compounds that are extracted mainly from the leaves that are constituted in 85% of pulp and 15% of fibrous material. The fiber contains about 80% cellulose, 5% hemicellulose and 15% lignin. The pulp is rich in thymol, carvacrol, xylitol, vitamin C and saponins. One of the saponins of the lechuguilla has been identified as smilagenina and it is found in a higher content than in any other agave [256]. The lechuguilla is considered as a poisonous plant, both for animals and for humans. Its toxicity is generally associated with two photodynamic compounds, or their combination. One of these has been characterized as a hepatotoxic saponin. Toxic saponin is known as sapotoxin.

**Pharmacological properties.** The extracts of the lechuguilla, has insecticidal, fungicidal and bactericidal properties. The biocidal activity is associated to the presence of several phenolic compounds, thymol and carvacol. It is known that the pulp of the lechuguilla contains xylitol, a kind of sweetener more "powerful" than the sucrose that is also not assimilable in human metabolism. This has been used in herbal medicine in some diabetic patients [271]. Traditional medicine uses the biocidal activity of the plant in the treatments of cutaneous lesions and pests [272, 271]. It is believed that some saponins of the Agave lechuguilla are useful in the human diet to control cholesterol, but it is known that the extracts of the plant have components that make it poisonous and can cause hives (rash) if ingested [273].

**Application.** Recent research reveals the ability of the Agave lechuguilla for the removal of chromium VI and III aqueous solutions. The capacity of this biomaterial for the adsorption of the chromium in solution is due to the fact that in the surface it has functional groups that capture the chromium [274, 275].

**Boldo (Peumus boldus)**

**Botanical characteristics.** The boldo reaches up to 20 m in height, its trunk is straight or slightly tortuous, branched up to 1 m in diameter; thin bark, grayish, slightly cracked. Its leaves are dark green on the upper face and are covered by numerous prominences that give it a granular appearance, while the lower face is smooth and yellowish green with ribs marked and rough to the touch. Leaves are 3
to 7 cm long and are characterized by being very aromatic as a result of the essential oils synthesized by this species, they have an elliptical oval limb, hard and brittle, rough at the margins and slightly retracted with an obtuse apex. Examined under a microscope, the cut of the leaf shows a thick cuticle epidermis, and single-celled hair covered protuberances [276]. The seeds are ovoid, less than one centimeter in diameter and light in color, with characteristic reticular venation. They germinate well, being easy to reproduce the tree, although it is not usually planted [277]. The edible fruit is a fleshy and juicy drupe of pleasant taste, with oval structure, 5 to 8 mm long and greenish yellow color, when ripe presents unisex flowers in short clusters, the masculine flowers are distinguished by the numerous curved stamens and the female flowers have staminodes (sterile stamen) and nectariferous flakes with flared perianth that surround the stamens of 10-12 imbricated segments which enhances their melliferous quality (flowers with nectar for the bees to produce honey) [278].

**Geographic range.** It is characteristic of the sclerophyll forest and it is distributed from the province of the Limarí to the one on Osorno in 30° to 40° south latitude, endemic of Chile. It also grows in the semiarid zones of Mexico, in the states of Tlaxcala, Sierra de Hidalgo, Nogales Sonora and in the South of the Eastern Sierra of Tamaulipas and the North of the Pánuco River; Is eventually cultivated in Italy and North Africa [279]. It develops mainly on low sunny slopes, of low humidity and stony soils, is a rustic specie, out of danger of extinction and present in zones whose annual precipitation oscillates between the 300 and 2,000 mm.

**Chemical composition.** The boldo contains more than 20 isoquinoline alkaloids present in their bark in 0.25% to 0.5%, the major component is aporphine: called boldine, which represents one third of the total alkaloids, this tetracyclic alkaloid is accompanied by other aporphines and noraporphins: Isocoridine, norisocoridine, N-oxyisocoridine, isoboldine, laurolitsine, laurotetanin and its N-methylated derivative; Also in the boldo 15 alkaloids more are present [280, 281]. Dry leaves also contain essential oils from 1% to 3%, such as monoterpene hydrocarbons: ρ-cymene, a-pinene and oxygenated monoterpenes: Cineol, linalool, terpin-eol, camphor, cimol, eugenol, eucalyptol and ascaridol. In addition, various flavonoid glycosides such as peumoside, biosteroid, fragoside, boldoglucine; And to a lesser extent citric acid, tannins, calcium oxalate, aromatic substances and resins. It contains 8% of water and mineral matter up to 12% [282].

**Pharmacological properties.** Dehydrated leaves are used in the preparation of infusions, which are attributed to stimulating, digestive, cholangic and choleretic properties [283]. The boldo has demonstrated its effectiveness especially in the symptoms related to the constipation, reason why it is used as adjuvant in such cases; it also contains ascaridol, which has anthelmintic properties, which explains that formerly it was used for this purpose. The decoction applied to the temples, stomach and belly removes migraines and inflammation. The effect of boldo on biliary flow is not only due to alkaloids, but there is a synergistic effect between the various active compounds of the plant. Boldo dissipates gas, nourishes nerves and is used against dropsy and syphilis; it is also antirheumatic, carminative, and
balsamic. It is also used against diseases of the genic-urinary system due to its antiseptic powers and diuretic qualities. *Peumus boldus* extract has been used in folk medicine over the years in the treatment of bile problems, laxative, liver failure and liver congestion. These effects are associated with the substance boldine, which is present in boldo extract due to its antioxidant mechanism. The boldine reacts with tin ions, which protects the cells against oxidation and consequently avoids the generation of reactive oxygen species [284].

**Application.** The boldo is a plant highly valued for its medicinal effects and since the last century has received the attention of naturalists and scientists. Its properties can be summarized as: stimulant of digestion; cholagogue and choleretic and sedative properties on the nervous system, also used to relieve tooth and rheumatic pain among others. Essential oil and boldine are the substances most related to the medicinal properties of this plant. Formerly a plant widely used to cure liver diseases, aid digestion or encourage the expulsion of intestinal gas.

**Damiana (Turnera diffusa)**

**Botanical characteristics.** *Turnera diffusa* is a small evergreen, wild shrub, with yellow or reddish stems, very branched, that reaches a measure of 60 centimeters to 1.0 meter of height; some varieties reach up to 30 centimeters to 2.0 meters high. Its leaves are aromatic because of their essential oils, they have lanceolate form, perennifolia or caducifolia, measure of 10-25 millimeters of length with 3-6 teeth along the margins.

Its flowers are yellow up to 8 to 12 millimeters long, solitary and are provided with five petals (Figure 16). The fruits are brown capsules that open in 3 leaflets when ripening. It flowers between July and November. This plant is also commonly known as damiana, real itamo, grass of the shepherdess or shepherdess.

**Geographic range.** This plant (*Turnera diffusa*), is produced in large quantities in Baja California Sur, specifically to the south of the peninsula, Los Cabos. The main consumers of this plant are in the states of Guadalajara, Mexico City, Tijuana, BC. [285].

**Chemical composition.** There are few studies that demonstrate the composition of this species. For this reason, it is important to mention that the extracts of the *T. diffusa* plant analyzed by Alcazar-Meléndez et al. [285] showed the presence of some oils (0.5-1%) with cineole, alpha and beta-pinenes, p-cymene, thymol, sesquiterpenes (alpha-copaene, delta-cadinene, calamene), tannins (4%), hydroquinone heterosides (0.2-0.7%): arbutoside; cyanogenic heterosides; alkaloids (7%); beta-sitosterol, damianine (bitter principle); resin (6-14%), gum (13.5%), proteins
(15%). Other studies reveal the presence of an important 5,7,4'-trihydroxy flavone compound known as Apigenin which was isolated from the leaves of this species by Suresh and Sharma [286]. Recently, 35 compounds were found, which involves some flavonoids, terpenoids, saccharides, phenols and cyanogenic derivatives.

**Pharmacological properties.** There are works that reveal that the applications for this species can be scientifically proven. In 1999 Johnson [287] reported an effect as a purgative, stimulant, astringent, diuretic, expectorant, laxative, nerve disorder treatment, treatment for venereal infants using extracts from this plant. Other benefits is to control menstrual, gastrointestinal and respiratory disorders [288, 289] due to the components present in this. Moreover, apigenin isolated from Damiana by Suresh and Sharma [286] has an anti-anxiety effect.

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**Jojoba (Simmonsia chinensis)**

**Botanical characteristics.** This specie is characterized by its trunk that branches from the base and has a growth of shrub type, being able to reach up to 4 meters in height. Jojoba is a dioecious plant, meaning female flowers and male flowers are found in different plants. Flowering occurs between May and April, depending on the area (Figure 17). If the flowers that have been pollinated by the wind, the fruits begin to swell until reaching maturity in the months of March and April of the following year. The leaves are opposite, thick, oblong or elliptic 1 to 2 cm wide by 2 to 5 cm long, blue-green when young and pale green or yellowish as they age. The leaves can live from 2 to 3 seasons, depending on the humidity and shade conditions [290]. Its thickness, shape, color, and pubescence varies as a result of environmental influence. When the fruit matures, the seed falls to the ground, falling apart on its own. The color of this can vary from dark brown to reddish brown. Its size varies between 1 and 2 cm in length. Makes approximately 50% oil [290, 291].

**Geographic range.** The Jojoba (Simmonsia chinensis) is native of the deserts of Sonora (between the Mexican-US border and Mojave) in California, Arizona, Utah and Nevada in the United States. And because in Mexico approximately 40% of the territory is desert, with the passage of time the hump has come to take paramount importance in the economy of the country [290, 291]. Due to the need to replace traditional crops with species that can produce and ensuring profitability under extreme conditions such as the desert; a rises the interest of exploiting and natural wealth, specifically jojoba.

**Chemical composition.** Jojoba seeds are a great source to produce waxes used in skin and hair care products, while it is rich in protein, it cannot be used as food for livestock and animals unless the toxic fraction called simmondsin is withdrawn.
This fraction has been characterized as a family of cyanocyclohexyl glucoside compounds [293]. The total content of this compound in the fat-free plant is almost 10% of the dry weight [294]. The fat free plant can undergo a simmondsin extraction process that could be used as animal feed. Medicinal applications for the simmondsin fraction of raw jojoba fiber have been suggested but still need to be evaluated [292]. Another compound present in the fat-free jojoba plant is ferulic acid which is a phenolic compound distributed widely throughout the plant. It has potential applications as a precursor to natural vanillin and as an antioxidant and UV absorber in skin care formulations [295, 296, 297, 298].

**Pharmacological properties.** Jojoba is increasingly being used as a carrier of medicines that need to penetrate through the skin. It also plays an important role in the application of skin treatment, for example; Psoriasis [298]. The healing properties of jojoba are appropriate for use after exposing the skin to the sun, reducing inflammation and preventing the formation of scales. Jojoba is very gentle for sensitive skin [298]. Jojoba is an excellent remover of sticky by-products of the hair products and air particles found in our scalp. Jojoba quickly penetrates the scalp, loosening and dissolving the sebum accumulation [298].

**Application.** Jojoba's virgin oil is a non-greasy waxy liquid (97% wax esters), used in cosmetics, as there are studies showing that stored jojoba oil has the same characteristics as a fresh one. From its discovery can be mentioned innumerable applications in diverse industries, for example, for the development of cosmetic products, the chemicals require the tested and safe raw materials. Thanks to its molecular stability, jojoba is not affected by prolonged storage or changes in temperature and does not facilitate microbial growth [299].

**Dragon's blood (Jatropha dioica)**

**Botanical characteristics.** Its botanical name is *Jatropha dioica* commonly known as Sangre de Drago, is grouped within the following taxonomic categories [300]. Due to their characteristics, they are considered as semi-precious plants, microphytes, helminths, decidufolia, simplicifolia [301]. In figure 18 we can observe some characteristics of this herbaceous species, from 30 to 60 centimeters in height, with black thick-stems, fleshy, cylindrical, simple or little branched and the root, generally very attached to the rocky earth, from *Jatropha dioica* a reddish milk is extracted from which the plant takes its name; it has small pale pink flowers; The fruit contains a globose black seed of 8 to 10 mm.

**Geographic range.** The drago blood plant is found in several states of the country such as Zacatecas, San Luís Potosí, Hidalgo, Tamaulipas, Guanajuato and...
also in Coahuila is distributed in the Carboniferous region (Sabinas), Allende, Arteaga, Cuatro Ciénegas, Múzquiz, General Cepeda, Ocampo, Parras, Ramos Arizpe, Sierra Mojada, Saltillo, Viesca [209].


Pharmacological properties. Existing work on the use of Jatropha dioica has been reported by Silva-Belmares et al. (2003) [303] who demonstrated that the presence of some phytochemicals obtained from the hexane fractions of this plant have an antimicrobial effect against Staphylococcus aureus and moderate activity on Escherichia coli and Salmonella typhimurium.

Application. It is used as a medicine for vaginitis, urethritis, blennorrhagia, nephritis, gastroenteritis, stomatitis, conjunctivitis, renal congestion, tonsillitis and as a local antiseptic [305]. In addition, it is used to wash wounds and as astringent. On the other hand, using as bioassay the stimulation of the endothelial cells of human umbilical veins. Pieters et al. (1993) [304] conducted a bioassay-guided fractionation, which showed that 3-4-o-Dimethylcedrusin, from Drago’s Blood, stimulates endothelial cells.

**HARVESTING AND STORAGE OF PLANTS**

Raw plant material can be obtained from both: cultivated and wild forms of plants. Normally, except for ether-oil crops, the main source of raw materials for the pharmaceutical industry and medicinal purposes are the natural resources of these plants. However, their natural habitats continuously reduce or are exhausted, due to which it is necessary to focus efforts on obtaining raw materials from cultivated plants. It is known that cultivated plants have several advantages: high yield, a high content of biologically active substances, mechanized harvesting, etc.

Aerial parts of the plant or its individual organs are collected and then processed into crude drugs.

From the moment of harvesting significant biological changes begin to occur in the plant’s organs. The nature of these changes may have a material impact on the pharmacological properties of medicinal plants. Directing these changes correctly can enrich the collected material with certain components that have strong
complex pharmacological properties. In some cases, changes occur under the influence of enzymes, especially during the process of drying. The medicinal composition of the plants is also influenced by the time of year during harvesting and the drying conditions.

Harvesting is carried out either manually or mechanically in sunny periods and at the appropriate time of the year. During manual harvesting the grass, leaves and flowers are placed in special containers (baskets, bags, boxes, etc.), making sure that they do not crush or squeeze, and then the plants are quickly moved to the drying site. If there are difficulties with transportation then the collected parts of plants are spread out in a thin layer in closed spaces on the shelves, the floor, etc. In such conditions the material can be kept for no longer than 10-12 hours.

When harvesting wild plants it is especially important to keep leave some samples in the natural growing site. For example, if rhizomes and roots are collected before the formation of mature seeds, the plant will not be able to breed and will disappear from the site. When collecting stems the whole plant shouldn’t be pulled out of the soil, and only the aerial parts should be cut off.

In order to preserve the natural habitat, the harvesting of wild medicinal plants should be periodically carried out in different areas.

If only the underground parts of herbaceous plants (tubers, roots and rhizomes) are used, the aerial part of the plant should be cut off and discarded. When only the aerial parts are needed, then, as it has already been stated, it is advisable to cut them off without damaging the roots.

The flowers, leaves and fruits are picked by hand one at a time or by using special tools (scissors, knives, etc.). If the aerial part of herbaceous plants (especially of the cultivated species) is used as medicinal raw material it should be cut with a scythe, a sickle or a reaper.

The time of the year when the harvesting takes place is also of particular importance. The plant constantly experiences various biochemical changes and the harvesting should be carried out at a time when the most favorable pharmacological effect is reached. There are some rules that need to be followed in order to achieve this goal. For example, the aerial parts (flowers, leaves, the whole aerial part) are collected during the flowering period, and the underground organs (roots, rhizomes and tubers) - in spring, when vegetation hasn’t started, or in autumn, when it is coming to an end. The enumerated medicinal plants harvesting regulations in most cases, however, do not take into consideration the specifics of individual plants and the conditions of increase or decrease of the biologically active substances in the period of vegetation. Therefore, in order to determine the period when the plant and its specific part are in the state of "pharmacological maturity", that is, when they contain the largest number of biologically active compounds, it is necessary to trace the accumulation of substances during the growing season. If the medicinal substance is classified as reserve (for example, gums and all carbohydrates) then the raw material - the underground organs - should be harvested in autumn, because during the final period of vegetation the underground organs contain the largest quantity of reserve substances. However, if the active ingredient belongs to the
group of secondary formed substances (metabolites), such as alkaloids, this rule may not be observed. For example, the belladonna roots in this period are most rich in starch, but the content of alkaloids is larger in the roots collected before autumn (compared with their content in autumn roots). This example, like many others, shows that the correct period of harvesting the medicinal plants should be determined taking into account the pharmaceutical maturity of the plant. For example, the maximum amount of flavonoid in herbaceous plants is detected during the budding period, whereas the woody plants have a more complex dependence [361].

The period of the day when the harvesting is carried out is also important. It is known, for example, that the biological activity of plants containing cardiac glycosides decreases by night due to the disassimilation of glycosides and increases again in the afternoon at the beginning of the assimilation, that is, the biosynthesis of glycosides. It reaches a maximum level in the afternoon and this period is most suitable for the harvesting of such plants.

The harvested plants or their organs are immediately exposed to preservation processing, i.e. bringing them to a state in which the storage before industrial processing or pharmacy usage does not affect their composition.

Some raw materials are not exposed to preservation, because they contain ingredients that disassimilate during the process. Such raw material is processed into pharmaceutical products while it is still fresh. Most of the different types of harvested materials are preservable; the purpose of preservation is the inactivation of the enzymes contained in the fresh plant material that may contribute to the disintegration of the biologically active substances in raw medicinal material.

Sometime after harvesting the plant organ lives, though in different metabolism conditions. Profound changes in the tissues begin when due to the loss of moisture the cells tissues gradually die and cease their function and participation in metabolism. The enzymes they contain stop taking part in the biochemical processes of tissues and spontaneously catalyze the decomposition of labile substances contained in the cell. This shows that the changes happening during the conversion of the fresh plant into medicinal material play an important role.

Enzyme activity is highly dependent on the concentration of hydrogen ions in the plant. Usually they are active at the pH-level being between 7 and 10. Some enzymes can be also activated in an acidic environment.

Sometimes the action of enzymes contained in the fresh plants is useful for their pharmacological effect, and in other cases the changes are undesirable. In the first case, this effect may be enhanced by pre-fermentation, and in the second case if it is not desirable and affects the composition and activity of medicinal plants, it is necessary to proceed to rapid drying or stabilization of the raw material. For example, due to the formation of coumarins during the enzymatic effects in plants containing them, the transformation of reduced anthraquinones into anthraquinones under the effect of oxidative enzymes, the hydrolytic decomposition of the sinigrin glycoside, etc. – are the cases of desired fermentation changes that result in the fact that the raw material acquires a therapeutic effect.
In other cases, enzymatic processes lead to the disintegration of active substances and the limitation or elimination of their therapeutic effect. The impact of enzymes has a detrimental effect on the labile glycosides that are contained in the raw material of digitalis (foxglove), on hyoscyamine alkaloids, etc. These types of disintegration are prevented by the inactivation of enzymes, resulting in the formation of stabilized crude medicinal material. Various methods of stabilization of raw material are proposed: treating fresh parts of plants in a closed space with hot vapors of alcohol or chloroform, after which the raw materials are being dried; in case that water vapor does not change the composition of raw materials stabilization can also be conducted using steam.

In stabilized raw materials the enzymes are inactivated and cannot be reactivated. Stabilization with the listed methods is a radical method of preservation of raw materials, but given that this is an expensive process, it is preferred to preserve plants via drying. This removes the water from fresh plant parts, so the action of enzymes is not eliminated, but delayed. When the material is wet again, the activation of enzymes and the decay processes become possible again.

Generally it is very difficult or almost impossible to maintain the chemical composition and biological activity of fresh plant parts fully intact in the raw material. The main aim is to prevent a serious loss of active ingredients and keep the therapeutic effect during drying and canning of the plants.

Fresh plant parts must be carefully cleaned before drying. The underground organs are cleaned from mechanical impurities by dipping them briefly into running water and shaking them strongly afterwards. When the roots and rhizomes are not subjected to such treatment a lot of minerals remain on them and reduce the efficiency of the raw materials. According to the rules of pharmacopoeia, the bark of some roots should be scraped off before drying, which can be very easily performed immediately after removing them from the soil. This manipulation facilitates their further transformation into powder, as this process removes most of the bast fiber.

Aerial parts of the plant, before being dried, should be cleaned from their own extraneous parts and pieces of different plants collected with them during harvesting.

After cleaning the raw material is subjected to drying. Proper drying should be done with regard to the chemistry of the active components of the material. Clumped or fermented material should not be subjected to drying. The herbal raw materials must be dried quickly under temperatures appropriate for the species and their composition. Experiments have shown that the most suitable temperature for drying raw materials is 50°C. At this temperature, the action of enzymes decreases or stops completely. In some cases at the beginning of drying the temperature should be higher and then dropped to 50°C.

Rapid drying is carried out in special drying chambers, elevator or vacuum drying rooms, etc., which are equipped with devices for temperature regulation. Especially quickly drying should be performed for juicy fruits that contain vitamins. The temperature can be raised to 70-90°C in order to save a larger amount of
the vitamins. Also quick drying should be performed for materials containing cardiac glycosides and alkaloids. At 50°C and good ventilation the drying is carried out without changes of the medical composition of the material.

Parts of the plants containing essential oils are dried slowly by spreading them in a thick layer at a temperature of 25-30°C. In such conditions of drying the content of essential oil may increase and the quality of the oil may improve. Slow drying is also possible when handling raw materials, the active ingredients of which are stable and do not easily start enzymatic degradation.

In direct sunlight the green leaves and colored flowers fade - become yellow, brown, pale, etc. These types of raw materials that have lost their natural color are unsuitable for consumption. Direct sunlight can be used for drying such parts of the plant that do not contain dyes - seeds, roots, bark, rhizomes, etc.

Slow drying is carried out in the open air and in rooms adapted for this purpose. With this method of drying the material good results are obtained in areas with dry and warm climate. Raw material, which is to be dried, is spread a thin layer on a wooden frame with a meshy bottom, thus providing better aeration, especially if the frames are located one over another; the plants should be dried until all parts of the plant become brittle and lose their elasticity.

The flower buds - Femmae – are dried at a moderate temperature, spread in a thin layer and frequently stirred to prevent mold and clumping.

The leaves - Folia – are spread in a thin layer during the drying process. Larger leaves are spread out separately.

The flowers - Flores – are also spread in a thin layer to avoid the necessity of mixing them during drying.

The herbs - Herbae – are usually gathered in small bunches that are hung in dry and ventilated places to dry. This is method is not always recommended because the leaf stems darken if kept in bunches. They are then dried in the same manner as the leaves and flowers.

The not juicy fruits and seeds - Fructus et semina - such as celery, mustard, flax, etc., contain a small amount of water and for their drying there is no need for special conditions. It is enough to keep them in a ventilated room after they are dried in the sun or in a drying room.

Juicy fruits - Fructus - are best dried in a drying room until they no longer stick together.

The bark - Cortices - in its fresh state contains a small amount of water in comparison with other parts of the plant and can be dried in the open air or in a ventilated area.

Roots, rhizomes, tubers and bulbs - Radices, Rhizomata, Tubera, Bulbi – are dried after cleaning. Thick roots and rhizomes, if they are not cut, must be dried at a low temperature (40°C), providing even evaporation of water from the internal and external parts without changing their color and the decay of active substances. Uncut and thick roots are dried slowly. Thin roots and sliced thick roots dry much faster.
There is a method of drying medicinal plants under the influence of infrared radiation. In this case, the infrared rays penetrate the plant material, and as a result the drying process is performed quickly. However, this method is difficult to use with large amounts of raw material.

Plants and can be dried via lyophilization (freeze-drying). This method is used for drying the plant material, the active components of which are especially easy to split. Lyophilization is carried out at a low temperature (-20°C). The moisture content in the dried material is only 2-4.5%. It was noted that this method of drying medicinal plants containing tropane alkaloids, saved a higher percentage of alkaloids than the high temperature (50°C) method.

During the drying process raw material is preserved, but its stabilization is not fully guaranteed, therefore some authors believe that the creation of galenical preparations (tinctures, extracts, etc.) is a better preservation method in which the medical factor of the material is more stable. Today highly purified preparations are also used, which are considered to be more stable than the galenical.

Pure substances derived from plants have significant advantages over raw materials or galenical preparations, because they allow to maintain and monitor the therapeutic effect of the plants. However, this effect does not always coincide with the pharmacological properties of the medicinal plants. Therefore, in therapy medicinal forms are used that (as experiments have proven) obtain the most favorable pharmacological effects. Sometimes the composition of raw materials changes during drying and under the influence of other factors that do not have a biological origin. Thus, the acidic substances formed during drying can cause racemization of optically active components contained in the fresh plant.

After drying, the raw material is subjected to additional cleaning, sorting, subsequent drying, grinding and packaging. The purpose of this post-treatment is the removal of foreign plant parts accidentally caught in the material or parts that have lost their natural dye during drying. Raw material is dried to a moisture content that meets the pharmacopeial requirements and standards. Over-drying is not allowed as raw material can be easily broken and turned into powder (especially the leaves, flowers) while packaging and shipping.

Sorting is carried out according to the recommended standards for the different qualities of the same raw material (I, II and III), and depending on the purpose of the material - pharmacological or industrial usage.

The medicinal material (except for some small fruits and seeds) is used in pharmacy or pharmaceutical industries in the cut form or crushed into a powder. Cutting the raw material is carried out in special designated places and using special machines (grinding mills, screens, etc.). Some raw materials - leaves, flowers, roots and rhizomes - are compressed for convenience and to avoid losses. Leathery leaves, small flowers, some rhizomes and roots are not compressed. During compression the plants suffer little breakage - thus molding (if the raw material contains an allowable amount of moisture) is avoided.

The packaging material is also important. Cut and grind raw materials meant for pharmacy usage are packaged according to their nature in simple or double (with
an inner layer of parchment paper) bags or well-sealed boxes. The material meant for processing is packed in bags, bales, paper bags, etc.

In pharmacies and stores the crude material needs to be maintained in such an environment in which it can stay unchanged for a period of time. It is important that the storage is dry, clean and ventilated, with pure solid wood flooring. Individual packages cannot be placed one over the other, they should be distributed on the shelves, so the contents can be inspected. However, some types of raw materials, particularly hygroscopic or the ones containing essential oils, are best stored in tightly closed containers.

When stored improperly, especially in wet, poorly ventilated, dirty rooms, with damaged floors and walls, medicinal raw materials dampen, acquire the smell of mold, and often attacked by various pests. If the rules of harvesting, drying and storage of medicinal plants are not observed, the material becomes unfit and, if shuffling and cleaning does not help to obtain the required quality, it is subjected to rejection.
Toxic substances may be received by the human body due to human impact on plants (pollution by absorbing gaseous emissions, through dust and soil) during their processing, for example, into medicinal material and food products used by man. Parts of plants and entire plants are used as raw material, but taking into consideration the human impact. The chemical composition of the plant is significantly influenced by the environment, place of growth and climatic conditions.

The study of the chemical composition of the great nettle *Urtica dioica* L., depending on its growing conditions, revealed that the chemical composition of organic origin didn’t change, but the vegetative parts of plants grown in environmentally disadvantaged areas contained a large amount of mineral components including lead that has a dangerous impact on the body [306]. The plants have to adapt constantly to the changing environment. Among such factors are the toxicological elements that appear due to the emergence of harmful substances in the soil. An example of plant adaptation is the ability of plants to survive and grow in soils containing an excessive amount of heavy metals. For example, the ash of the *Hubanthus floribundus* bush that originates from Australia contains about 20% of nickel [307]. Therefore, during the preparation of medicinal plants and their application it is necessary to take into account the environment in the areas of growth and harvesting of medicinal plants and berries.

The ability of the tea plant *Camellia sinensis* to accumulate aluminum drew the attention of researchers to the need to investigate the possible toxic effects of aluminum on tea drinkers [308].

The need to control medicinal raw materials used in the beverage industry is due to several reasons, among which is the presence of unwanted material, which may cause undesirable side effects, and the poor-quality of crude drugs due to improper storage.

Storing plant material, including fruits, berries and spices, in moist atmosphere may cause the development of a variety of molds. Their activity results in the accumulation of mycotoxins that are extremely dangerous to human health (aflatoxin B₁, ergotamine, T-2 toxin, coprine etc.) [309]. Aflatoxins that attack the liver and demonstrate a significant carcinogenic effect are produced by the Aspergillus fungi (*Aspergillus flavus* and *A. parasiticus*). Deep molding processes lead to the formation of a stagnant and putrid odor.

The most dangerous element for the human health is the aflatoxin B₁, the LD₅₀ of which is 3·10⁻⁴–1.02·1⁻¹ g per kilo [333]. The consumption of foods containing 1.7 mg/kg of aflatoxin in a short period of time can cause permanent liver damage, and 75 mg/kg may lead to death. The problem of fighting aflatoxin effects is complicated by the toxin’s decomposition resistance. According to data published in literature, mycotoxin extracts derived from plant substrates weren’t destroyed after 30-32 years of storage.
Plaster clover (*Melilotus officinalis*) has a soothing and calming effect in patients with increased nervous excitability, has a pleasant flavor and is widely used in the manufacture of balsams and infusions. Its pharmacological effect is due, above all, to the presence of coumarins. However, when the conditions in the drying and storage are violated, this leads to the formation of dicumarin that prevents the formation of prothrombin and other clotting elements, causing severe bleeding when consuming drinks made with the usage of substandard materials [85].

The study of the essential oils composition in different storage periods of the medicinal plants showed the following. It is known that the components of essential oils usually are found in three locations:

- in the cells, where they are formed (biosynthesis);
- in those parts of the plant which transport the oils from the synthesis zone to the place of storage;
- in specialized storage zones.

The majority of essential oils components consists of lipophilic compounds; therefore they cannot be present in aqueous solution in significant quantities and as they are formed they should be transported to the storage (accumulation) zone. Thus, it is thought that most of the essential oil is concentrated in these stores, and the share of oil in the places of biosynthesis and transport zones is insignificant. Consequently, the damage of structures that store essential oil should lead to significant changes in the oil composition.

Most of the components of essential oils are unsaturated compounds; therefore they are susceptible to oxidation under the influence of oxygen. It is known that the compounds most liable to such reactions are those whose molecules contain conjugated double carbon-carbonic bonds. In the studied samples of essential oils the content of conjugated diene unsaturated hydrocarbons - β-myrcene, α-phellandrene, α-terpinene, β-ocimene, β-farnesene and D-germacrene – experiences the most serious changes. This confirms that oxidative decomposition is one of the most significant factors affecting the change in the composition of essential oil during the storage of plant material.

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\begin{align*}
\text{β-myrcene} & \quad \text{α-phellandrene} \\
\text{α-terpinene} & 
\end{align*}
\]
Today the scientists have accumulated extensive data on the nature and structure of the cells and cell complexes producing and accumulating essential oil in plants. The study of the shelf life influence on three different species with significant differences in the nature of secretory structures used for the storage of essential oils revealed that the Apiaceae and Lamiaceae families are characterized by extreme uniformity in the structure of secretory systems, while the plants of the Asteraceae family demonstrated a more diverse nature and structure of the secretory structures. Accumulation of essential oil for most plants of the Umbelliferae family, including the Seseli genus, occurs in schizogenous receptacles and schizogenous channels that are secretory formations of an endogenous nature. Schizogenous containers cavities lined with epidermis, consisting of adjacent elongated cells with thin membranes, rich in cytoplasm and actively producing the terpenoid secret that is then transported into the cavity of the container. These secretory formations are formed in the early ontogenetic stages of plant development and begin to produce the secret in the embryonic state. The secretory channel is usually a continuous secretion system from the tip of the root to the flower (there are two parallel secretory systems -- a continuous system between the vegetative and generative organs and a secretory system of channels in the generative organs, isolated from the vegetative system) [310].

46 genera of the Lamiaceae family accumulate essential oils only in glandular trichomes. Respectively, the species of the Origanum and Schizonepeta genera have characteristic exogenous (surface) structures (glandular trichomes) [311]. Exogenous glandular structures come in different shapes and morphologies. Glandular trichomes are epidermal secretory formations, consisting of one or more cells which produce and simultaneously accumulate secret.

For the Artemisia genus is characterized by three types of glandular structures: schizogenous containers, glandular trichomes and unspecialized parenchymal cells. It is known that different structures can accumulate terpenoid mixtures of different composition. For example, the essential oils of the schizogenous channels and glandular hairs contained in the leaves of Artemisia dracunculus have a different component structure [312].

Secretory structures of the Origanum and Schizonepeta genera are least exposed integrity violations and, therefore, their essential oil is better preserved and its components are more resistant to oxidation. All other examined species have secretory channels that are violated if the plants are broken (or grind), which results,
firstly, in the acceleration of volatilization of low-boiling components due to damage to the protective shells of the oil receptacles and, secondly, in a significant change of composition due to the penetration of atmospheric oxygen into the secretory channels. The breakage of plants into pieces (by grinding) leads to strong changes of the part of essential oil that is contained in the secretory channels, due to the fact that any breaking of the plant in the first place violates the integrity of the schizogenous channels.

The researches of the content changes of the essential oil in a number of essential oil plants of the Asteraceae, Lamiaceae and Apiaceae families showed that the composition of the oil in the transition from a fresh plant to dried raw material change for several reasons; and the changes can be both minor (e.g., for plants of the Lamiaceae family) and very serious (for the aster and celery families), due to differences in the nature and structure of the secretory structures. During standardization of the essential oil raw materials used as for pharmacopoeia purposes specific techniques of production and storage of raw materials should be specified. Essential oil raw materials after harvesting should not be exposed to strong grinding in order to preserve maximum integrity of the secretory reservoirs.

When using essential oils as the flavors for different drinks, one must keep in mind that during storage of raw materials the composition of the oil changes greatly, which is primarily due to volatilization of low-boiling components and processes of oxidation of unsaturated, mainly polyunsaturated, compounds [313].

Another important reason for the need to control the content of bioactive compounds in plants and fruits used for the manufacture of drinks is the dependence of the content of any pharmacologically active substances in the raw materials on the growing area, even within the same locality. For example, scientists of the Department of Pharmaceutical Chemistry and Pharmacognosy of the Kaunas Medical University noted that the total contents of flavonoids in the flowers and leaves of blood red hawthorn grown in different regions of Lithuania vary greatly, ranging from 1.30 to 2.77% [74].

It is recommended to carry out the analysis of the purity of medicinal herbs and berries used in the manufacture of drinks in the food industry in accordance with the rules of the Pharmacopoeia and State standards [314].

**Leaves (Folia)**

Leaves are medicinal material consisting of dried or fresh leaves or individual leaflets of a complex leaf. The leaves are harvested usually when they are fully developed, with or without the stem.

*External features.* During the analysis of external features the small and leathery leaves are usually investigated in the dried form; large, thin leaves which are crumpled are previously softened in a humid chamber or by placing them for a few minutes into hot water, then they are spread on a glass plate and carefully straightened. During the analysis attention is paid to the shape and size of the leaf
blade and petiole, the leaf pubescence (the abundance and location of fibers), the type of the edges and veins, the presence of essential oil glands and other structures on the leaf surface or the presence of receptacles in the mesophyll. Fresh leaves are examined without pretreatment. The dimensions - length and width of the leaf blade, the petiole length and diameter - are measured with a ruler. The color is identified on both sides of the dry leaf in daylight, the smell - by grinding the leaf, the taste – by trying a piece of dry leaf or its broth (only for non-poisonous samples).

Microscopy. Whole, crushed and cut raw material. Microslides (preparations) for the analysis of thin leaves are prepared from the surface material, cross sections are made (if necessary) from thick and leathery leaves. For the preparation microslides of the leaf surface scientists use small leaves as a whole, and separate parts of large leaves taking into consideration the distribution of the most important diagnostic elements: the edge of the leaf, the leaf denticle, part of the midrib, the top part of the leaf and its base. For the analysis of cut leaves several parts are used: the midrib and the edge of the leaf. When analyzing the surface microslide attention is paid to the following diagnostic features: the structure of the epidermis, the type of stomata, the nature of trichomes (fibers, glands), the presence and shape of crystalline inclusions, mechanical tissue, various containers, lacticifers, secretory channels, etc.

The leaves epidermis is characterized by a particular cell form - isodiametrical or long with straight or wavy lateral walls, with thin or thick membranes, often with beaded bulges of the lateral (anticlinal) walls. The characteristic type of stomata is determined by the number and location of the subsidiary epidermal cells. The dicotyledons have four main types of the stomatal complex: - anomocytic – the stomata are surrounded by an indefinite number of cells, which do not differ in size and shape from the other cells of the epidermis; - anisocytic - the stomata are surrounded by three subsidiary cells, one of which is much smaller than the other two; - paracytic - each side of the stomata, along its longitudinal axis, has one or more subsidiary cells; - diacytic - the stomata are surrounded by two subsidiary cells, the adjacent walls are perpendicular to the stomatal slit. The monocotyledons have 5 types: - aperigenous– the stomata do not have typical subsidiary cells; - biperigenous – the stomata are surrounded by two subsidiary cells located laterally to the guard cell; - tetrapерigenous - the stomata are surrounded by subsidiary cells: two cells are located laterally and the other two - polarily or all cells are lateral, two on each side of the stomata; - hexaperigenous– the stomata have six subsidiary cells, two of which are polar and four lateral; - multiperigenous– the number of subsidiary cells is more than six, and they are located around the stomata in a ring or no particular order. The leaves of some plants are characterized by water stomata, which have a large size and are usually located on the top of the leaf or the dentate, over the water gland. The epidermis may contain secretory cells or cells containing cystoliths. The epidermal cells surrounding the fiber often form a rosette, which is an important diagnostic feature. Attention is also paid to the nature of the cuticle layer covering the surface of the leaf. Usually the cuticle is a thin even layer, sometimes
it is thick and in some places it forms fold-like bulges. The trichomes have an important diagnostic significance due to the large diversity of their structure. The most common type of trichomes are hairs (fibers). They are divided into single-and multi-celled, simple and capitate (glandular). Simple hairs can be single-rowed, double-rowed, multi-rowed, fascicular, linear or branched (star-shaped, branched, T-shaped), with thin or thick walls. Their surface is smooth, warty or folded longitudinally, depending on the characteristics of the cuticle covering the hair. Capitate hairs have even more varieties, which differ in both: the structure of the stems (single-, double- or multi-cellular), and the shape and structure of the head (spherical, oval or any other form, single-, double- or multi-cellular, with a contents or without). Another type of epidermal formations (trichomes) is the glands. They are common in many plants and whole families are characterized by a certain form and structure. Typically, the glands contain essential oil, but sometimes they contain other substances or have no content. In the analysis of leaf matter various containers of essential oils, mucus, resins and other hydrophobic substances are important: - schizogenous or schizo-lysigenous containers located in the mesophyll leaf - lacticifer, secretory channels usually accompanying the conducting bundles, veins and having a diverse content. The leaves have special cells – idioblasts – that contain calcium oxalate crystals, cystoliths and other crystalline inclusions. Calcium oxalate crystals can be of various shapes and sizes: single crystals of prismatic, rhombohedral, octahedral or other forms, in the form of separate long needles or small needles collected in bunches (raphides), aggregates of crystals (druses, spherocrystals), clusters of tiny crystals (crystal sand). Cells with crystals are located among the mesophyll cells or form a crystalloid sheath around the conducting bundles or groups of fibers. Less frequent are deposits of other minerals - calcium carbonate, silica and others. When preparing a cross section, scientists select a leaf piece containing the main vein; small leaves are used as a whole. The microslide is prepared in a way that it contains a cross-section of the main vein and part of the mesophyll. Attention is paid to the shape of the main vein, the number, shape and location of the conducting bundles in the vein. In the structure of the conducting bundles specialists mark the location of the phloem and xylem, the presence of mechanical tissue, the crystalloid sheath and other markable factors of the structure of the mesophyll – whether the leaf is dorsoventral (palisade tissue is present on one side and the cancellous – on the other) or isolateral (palisade tissue located on both sides); the presence of aerenchyma, calcium oxalate crystals, containers, secretory cells and channels, lacticifers, etc. Thick or wrinkled cuticle, hairs, glands, etc. are clearly visible on the leaf surface.

**Powder.** The powder microslide demonstrates veins in the longitudinal section. Individual pieces of leaf blades are seen mainly on the surface, they contain all the diagnostic elements specified for whole leaves. Cross-section pieces of the leaf can also be found in such preparations, where the mesophyll structure and structural features of the epidermis are clearly visible. The powder contains pieces
of tissue and separate elements: the hairs and their fragments, glands, separate calcium oxalate crystals and fragments of the crystalloid sheath, mechanical cells – fibers, sclereids, parts of secretory channels, receptacles, lacticifers, etc.

Fluorescence microscopy. For the performance of the analysis specialists use dry powder, rarely cross-section of a leaf prepared from whole or shredded raw material after preliminary softening in a humid chamber. Intrinsic (primary) fluorescence of the material is observed in ultraviolet light. The brightest glow is produced by the cuticle, the cell walls of mechanical tissues, xylem elements, the hairs, the contents of individual cells or tissues of the leaf’s mesophyll and epidermis, depending on their chemical composition. The leaves of some plants are characterized by a bright and specific glow of the glands, secretory channels and receptacles, depending on their chemical composition. Histo-chemical reactions are carried out in cross-sections and in the powder to distinguish the presence of essential oil, thick cuticle, mucus, etc. The procedures of the reactions are described in specific normative-technical documentation. Qualitative reactions are carried out with the extractions from raw materials. The procedures of the reactions are described in specific normative-technical documentation.

Indexes. The indexes noted in raw material are: the content of reactant substances, biological activity; the methods of indication are described in specific normative-technical documentation; humidity, the content of total ash and ash insoluble in a 10% solution of hydrochloric acid; decomposition of the material and the impurity content.

Herbs (Herbae)

Herbs are dried or fresh aerial parts of herbaceous plants. Herbs are collected during the flowering period, sometimes during budding or fruiting. Raw material consists of stems with leaves and flowers, sometimes with buds and immature fruits. Raw material is produced from tops of some plants, entire aerial parts of others, and of the aerial part and roots of other plants.

External features. During the analysis of the external features attention is paid to the structure of stems, leaves, flowers (fruit), examining them with naked eye or with a magnifying glass (×10). If necessary raw material is soaked by putting it for a few minutes into hot water and then spreading on a glass or other smooth surface, straightening the stem, leaves and flowers. If the herb is crushed, then pieces of stem, leaves and flowers are chosen optionally for soaking. In the structure of the stem the following features are noted: simple or branched nature of ramifications (branching); shape of the cross-section – whether the stem is cylindrical, ribbed, square, etc.; pubescence; size (length and diameter at the base), the positioning of leaves on the stem (regular, opposite, whorled); type of inflorescence; structure of leaves, flowers and fruits. The color of the dry raw material is identified in the daylight, the smell - by grinding, the taste – by trying a piece of dry material or broth (only for non-poisonous samples).
**Microscopy. Whole and cut raw material.** The microslide is prepared using the surface material. In some cases, microslides of the stem are prepared. In stem preparations attention is paid to the shape of the epidermal cells, the type of stomata, trichome varieties (hairs, glands) and peculiarities of their structure. Also, attention is paid to the presence of mechanical tissue, crystalline inclusions, receptacles, secretory channels, lacticifers, etc. In stem cross sections the location and structure of the vascular (conducting) bundles, the presence of other features of diagnostic value are noted.

**Powder.** In herb powders apart from the leaves elements of flowers, pieces of fruit and seeds tissue, stem fragments - fragments of vascular bundles, large vessels, mechanical fibers, etc. – can be also found.

**Fluorescence microscopy.** Dry herb of leaf powder is analyzed. An intrinsic (primary) fluorescence of the material is observed in ultraviolet light. In the powder bright fluorescence is noted not only in the leaf elements but also in the fragments of vascular bundles of the stem (xylem vessels and mechanical fiber); pollen is clearly visible, the seed endosperm fragments usually have a bright blue glow (fatty oil). Histo-chemical reactions are carried out in cross-sections and in the powder to distinguish the presence of essential oil, thick cuticle, mucus, etc. The procedures of the reactions are described in specific normative-technical documentation. Qualitative reactions are carried out with the extractions from raw materials. The procedures of the reactions are described in specific normative-technical documentation.

**Indexes.** The indexes noted in raw material are: the content of reactant substances, biological activity; the methods of indication are described in specific normative-technical documentation; humidity, the content of total ash and ash insoluble in a 10% solution of hydrochloric acid; decomposition of the material and the impurity content.

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**Flowers (Flores)**

Flowers are raw material made from separate dried flowers or buds and their parts. The flowers are usually harvested in the period of early blooming, some - in the budding stage.

**External features.** In the raw material the following features are determined: the type of inflorescence and pubescence; then the material is soaked by placing it for 1 minute into hot water, and then the structure of the flower (or inflorescence) is examined with the naked eye or with a magnifying glass (×10). The flower is placed on a glass slide and under a magnifying glass it is then parted with dissecting needles into separate parts. Attention is paid to the structure of the perianth – whether it is simple (calyciform or corollaceous) or double, the structure of the cup and corolla (regular – actinomorphic or irregular - zygomorphic), the number and shape of the sepals (or corolla denticle), the number and shape of petals (or corolla denticle), the number and structure of the stamens, the number of pistils, structural features of the ovary. The diameter of the flowers (florets) is measured using a ruler
or graph paper on soaked material. The color of the dry raw material is identified in the daylight, the smell - by grinding, the taste – by trying a piece of dry material or broth (only for non-poisonous samples).

**Microscopy. Whole and cut raw material.** Microslides are prepared using the surface parts of the inflorescence (flowers, covering leaflets) or flower parts (petals, sepals). Attention is paid to the structure of the epidermis, the presence and structure of hairs, glands, crystalline inclusions, mechanical elements (in the covering material), the shape and size of pollen grains, etc.

**Fluorescence microscopy.** Dry powder or separate parts of the inflorescence or flower are analyzed; intrinsic (primary) fluorescence of the raw material is observed in ultraviolet light. The most characteristic luminescence is performed by the cuticle, different trichomes (hairs, glands), mechanical elements, pollen grains, including cells, depending on their chemical composition. Qualitative reactions are carried out with the extractions from raw materials. The procedures of the reactions are described in specific normative-technical documentation.

**Indexes.** The indexes noted in raw material are: the content of reactant substances, biological activity; the methods of indication are described in specific normative-technical documentation; humidity, the content of total ash and ash insoluble in a 10% solution of hydrochloric acid; decomposition of the material and the impurity content.

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**Fruits (Fructus)**

Fruits can be simple and complex, false, collective fruits and their parts. Mature fruits are picked and dried. Some juicy fruits are processed fresh.

**External features.** Fruits are examined when dry, analyzing them with the naked eye or with a magnifying glass (×10). Juicy fruit that changed their form during drying are considered dry and then analyzed after soaking them in hot water or boiling them for 5-10 minutes. The fruit consists of a pericarp and seeds contained in it. The pericarp can be dry (dry fruits) or fleshy (succulent fruits). The features that have diagnostic value are the color, the nature of the pericarp surface, the dimensions (length, width, diameter of the fruit), smell and taste. In some cases scientists determine the number of fruit parts, the presence of essential oil channels or receptacles. In juicy fruits after their softening scientists examine the form and features of the structure of the pericarp, the seeds are separated from the pulp and their number, shape, size, surface texture, etc. are analyzed. The size is determined by a ruler or graph paper. The color of the raw material is identified in the daylight, the smell - by grinding or breaking, the taste – by trying a piece of dry material or broth (only for non-poisonous samples).

**Microscopy. Whole raw material.** In order to identify the plant cross sections are prepared. The part that has diagnostic importance is the structure of the plod-pericarp. In the pericarp are three layers: the outer layer – exocarp (epidermis), the middle layer - mesocarp, and the inner layer – endocarp. Attention is paid to the
shape, structure of the cells of the epidermis, to the presence and structural specifics of the hairs; in the mesocarp great diagnostic value is attributed to the mechanical parts, their shape and location, the number and location of essential oil channels, vascular bundles, the presence of crystalline inclusions, cell shape of the parenchyma, etc. The endocarp of some fruits is fused with the tests; sometimes the endocarp is presented by mechanical tissue in the form of cells with beaded thickenings.

**Cut and crushed raw materials.** The greatest diagnostic value is attributed to the cells of the exocarp and endocarp and to the seed coat, the mechanical elements of the mesocarp, structural features of the endosperm, reserve nutrients and crystalline inclusions.

**Powder.** Diagnostic value is possessed by the same elements as in the cut and crushed raw materials.

**Fluorescence microscopy.** Scientists analyze the cross-section after moistening the fruit in a humid chamber, rarely dry powder is examined. Intrinsic (primary) fluorescence of the raw material is observed in ultraviolet light. The visible elements are: the structure of the pericarp where the mechanical elements, secretory channels and their content, vascular bundles are most clearly distinguished. The seed endosperm and embryo tissue fluoresce brightly. Fluorescence is due to the chemical composition of tissues and is specific for each type of cells. Histo-chemical reactions are carried out in the powder to distinguish the presence of fat and essential oils, the lignified elements, etc. The procedures of the reactions are described in specific normative-technical documentation. Qualitative reactions are carried out with the extractions from raw materials. The procedures of the reactions are described in specific normative-technical documentation.

**Indexes.** The indexes noted in raw material are: the content of reactant substances, biological activity; the methods of indication are described in specific normative-technical documentation; humidity, the content of total ash and ash insoluble in a 10% solution of hydrochloric acid; decomposition of the material and the impurity content.

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**Seeds (Semina)**

Seeds are whole seeds and individual cotyledons. Seeds are harvested ripe and then are dried.

**External features.** Seeds are analyzed when dry, examining them with the naked eye or with a magnifying glass (×10). The seeds consist of the seed coat, endosperm (some plants have seeds without the endosperm) and the embryo. Diagnostic value is possessed by the shape, size (length, width or diameter) of the seed, its surface texture, color, smell and taste, shape, size and location of the embryo, the presence and form of the hilum, etc. Dimensions were measured by a ruler or graph paper; spherical seeds are sifted through a sieve with round holes. The color
is identified in the daylight, the smell - by breaking or grinding, the taste – by trying a piece of dry material or broth (only for non-poisonous samples).

_Microscopy. Whole raw material._ In order to identify the plant cross sections are prepared. Attention is paid to the overall structure of the seed, the nature and structure of the seed coat, the size and shape of the endosperm reserves, the shape and structure of the embryo – the cotyledons, the root, stem and the plumule. The greatest diagnostic value is possessed by the tests which consists of several layers of a distinguished structure. The mechanical layer of the skin is formed by elongated elements (a type of fiber) or isodiametrical cells. Some seeds are characterized by the presence of mucus in the epidermal cells of the skin, others – by a pigment layer. The shape of the endosperm cells, the reserves of nutritive material and crystalline inclusions also have diagnostic value.

_Powder._ The elements that have diagnostic importance are: the structure of the individual layers of the seed coat, especially the mechanical and pigment layers. Most often, the layers of the peels in the microslides of the seed powder form layers that correspond to the microscopic picture of the surface of the skin preparations; sometimes stone cells (small groups or single cells) can be also noted. Often the powder contains a mixture of two or three layers of the seed coat, which is also a characteristic feature. The content of the endosperm and the embryo cells (fat oil, mucus, crystalline inclusions, etc.) are of diagnostic importance.

_Fluorescence microscopy._ The cross-section is analyzed after softening the seed in a moist chamber. Intrinsic (primary) fluorescence of the raw material is observed in ultraviolet light. The individual layers of the seed coat are clearly distinguished, bright fluoresce is performed by the lignified tissues; the fluorescence of the endosperm and the embryo is dependent on the chemical composition of the cells; fat oil effects the bright blue fluorescence of the endosperm and embryo. Histo-chemical reactions are carried out in the powder to distinguish the presence of fat and essential oils, mucus, lignified elements, etc. The procedures of the reactions are described in specific normative-technical documentation. Qualitative reactions are carried out with the extractions from raw materials. The procedures of the reactions are described in specific normative-technical documentation.

_Indexes._ The indexes noted in raw material are: the content of reactant substances, biological activity; the methods of indication are described in specific normative-technical documentation; humidity, the content of total ash and ash insoluble in a 10% solution of hydrochloric acid; decomposition of the material and the impurity content.

_Bark (Cortices)_)
The bark is the outside part of the trunks, branches and roots of trees and
shrubs located on the periphery of the cambium. The bark is usually collected in
spring, during the sap flow, and dried.

*External features.* Solid bark has the form of tubular, fluted or flat pieces of
different sizes. Specialists define its color, size (length and width), features of the
exterior and interior surfaces and of the fracture. The outer surface of the bark with
brown or gray cork is usually smooth or has longitudinal (or transverse) folds and
sometimes cracks. The bark of branches and trunks has rounded or oblong lenticels,
sometimes it can bear leafy lichens (that should be removed during collection). The
inner surface of the bark is usually lighter, smooth or ribbed. Transverse fracture is
usually uneven: splintery, fibrous or granular. The length and thickness of the bark
is measured using a ruler. The color of the outer and inner surface is identified in
daylight, the smell - by scraping the inner surface of the fresh facture of dried or
wet bark, the taste – by tasting the dry bark or its broth (only for non-poisonous
samples).

*Microscopy. Whole raw material.* Transverse and longitudinal sections of the
pre-softened material are prepared. During analysis attention is paid to the outer
cortex, located towards the periphery from the end of the wood rays, and consisting
of the primary cortex (if remaining) and the periderm, and the internal cortex
(phloem), located between the cambium and the wood rays. Also attention is paid
to the thickness, color and character of the cork, the presence of the collenchyma,
thickness ratio of primary and secondary cortex, width of the wood rays. The diag-
nostic features of the crust are the mechanical elements - bast fibers (stereids) and
stone cells (sclereids), their number, location and structure. Mechanical elements
are located by one or in groups, sparsely or in belts. The membranes of bast fibers
or stony cells are usually very thick and lignified. Diagnostic value is also obtained
by the calcium oxalate inclusions, lacticifers, cells with essential oil. Calcium oxa-
late crystals have a different shape (druses and single crystals). Individual crystals
are often found in individual cells of the parenchyma or in the parenchyma cells
surrounding bast fibers and forming crystal sheaths. Starch grains found in the bark
are small and have no diagnostic value.

*Cut material.* For microscopic examination of sliced barks longitudinal or
transverse shears or scrapings are prepared. In these preparations almost all ele-
ments are visible in the longitudinal section. The diagnostic value is possessed by
the same elements as in shears.

*Powder.* Microslides of powder are prepared. The most important diagnostic
features in bark powders are: the mechanical elements (bast fibers, stone cells),
their location (singly or in groups), calcium oxalate inclusions, lacticifers, and con-
tainers. Attention is paid to the layers of cork cells, consisting of polygonal cells
(as seen from the surface). The parenchyma cells usually contain starch grains, cal-
cium oxalate crystals, sometimes essential oil.

*Fluorescence microscopy.* The bark cross-sections or powder (scrape) are
analyzed in ultraviolet light. Bright luminescence is produced by the lignified ele-
ments (bast fibers, stone cells); the fluorescence of the parenchyma cells depends
on the chemical composition of the bark. Histochemical reactions are carried out with the bark cross sections or powder. In this case, most of the reaction is carried out in order to distinguish the presence of active ingredients, in some cases – of accompanying elements. The procedures of the reactions are described in specific normative-technical documentation. Qualitative reactions are carried out with the dry raw materials, scrapings, powder or extractions. The procedures of the reactions are described in specific normative-technical documentation.

**Indexes.** The indexes noted in raw material are: the content of reactant substances, biological activity; the methods of indication are described in specific normative-technical documentation; humidity, the content of total ash and ash insoluble in a 10% solution of hydrochloric acid; decomposition of the material and the impurity content, as well as the contents of lichen-bearing bark pieces.

**Roots, rhizomes, bulbs, tubers, bulbotubers (Radices, Rhizomata, Bulbi, Tubera, Bulbotubera)**

Specialists use dried, sometimes fresh, underground organs of perennial plants, collected in autumn or early spring, peeled or washed from the soil, cleaned from dead parts, remnants of the stems and leaves. Large underground organs are cut into pieces before drying (lengthwise or crosswise). Raw materials can be presented by the roots - radices, rhizomes - rhizomata, rhizomes and roots - rhizomata et radices, rhizomes with roots - rhizomata cum radicibus, bulbs - bulbi, tubers - tubera and bulbotubers - bulbotubera.

**External features.** Specialists identify the shape of the underground organs, characteristic features of the outer surface and the fracture, the size, the color of the surface and the fresh fracture, smell and taste. The roots can be cylindrical, less often - conical, simple or branched. Rhizomes can be simple or branched, multiple-headed, cylindrical or oval, lenticular, solid or hollow inside, straight, curved or twisted, etc. Bulbs and bulbotubers can be spherical, ovoid, oblong, flattened, etc. The tubers can be spherical, oval, sometimes flattened, spindle-like, etc. The surface of the untreated underground organs can be even or (more often) wrinkled. For roots usually have a longitudinally wrinkled surface, the rhizomes - longitudinal and transverse wrinkling, often with traces of roots, dead leaves and stems. The fracture can be smooth, granular, fibrous or splintery. The fracture or a cross-section of large roots, rhizomes and tubers is analyzed in order to identify the location of conducting elements with the naked eye or under a microscope (×10) or stereomicroscope. The roots can have a primary and secondary structure. In the primary structure the central axial cylinder is visible in the center, in the secondary structure wood is located in the center. The rhizomes can have a fascicular or anti-fascicular structure. In rhizomes of monocot plants have vascular bundles scattered in no particular order in the cortex and in the central cylinder. In dicotyledonous plants with fascicular structure the vascular bundles are arranged in a ring closer to the surface.
of the roots, with a broad pith in the center. Rhizomes with the anti-fascicular structure differ from the roots due to the presence of the pith in the center (in some species it is destroyed - the rhizome is hollow). The bulbs are made of more or less thickened succulent slices sitting on a shortened stem (stems), and usually a few dry outer scales. Tubers often have a wrinkled surface and a fascicular structure. Bulbotubers have only external dry scales. The length, diameter and thickness of the material is determined using a ruler or graph paper. The diameter and thickness are measured in the widest place. The color is identified in the daylight, the smell - by breaking or grinding, the taste – by trying a piece of dry material or broth (only for non-poisonous samples).

Microscopy. Whole raw material. To determine the authenticity of the underground organs cross sections, less often longitudinal sections, are prepared.

Roots. In cross-sections of roots with the primary structure the following is visible: ground tissue - the epidermis (outer skin, rizodermis) the cells of which often form the root hairs. Under the epidermis is the primary cortex. In monocots the inner layer of the cortex (endoderm) has a characteristic structure: it consists of a single row of cells with thickened inner and radial membranes (U-shaped thickening). In the center of the root is the central axial cylinder with radial vascular bundles. In cross-sections of roots with the secondary structure the following is visible: ground tissue – the periderm, cortex and wood. The periderm is composed of a more or less thick layer of cork, phellogen and phelloderm. The cortex consists of parenchyma cells, phloem conducting elements, often mechanical elements are present: bast fibers, stone cells. Some raw materials have secretory containers, channels, lacticifers in the cortex. The cambium line is more or less clear. Usually wood has a radiant structure. Vessels, tracheids, parenchyma are visible in it, in some species - wood fiber (libriform).

Rhizomes. In the cross section of a monocot plant rhizome the ground tissue is presented by the epidermis; often the epidermis is destroyed, and the outer parenchyma layers of the cortex are suberized. Some rhizomes have the hypodermis below the epidermis. Rhizomes of dicots are covered with periderm. Conducting bundles, in both - monocots and dicots – are collateral, b collateral, concentric; in monocots they are closed, in dicots - open. The anti-fascicular structure of the rhizomes is characterized by the same elements as the roots of the secondary structure, but the center of the rhizome contains the pith that is sometimes destroyed. In tubers and bulbotubers the predominant tissue is the parenchyma with reserves of nutrients, where conducting bundles are located. The most important diagnostic features for underground organs are the location and nature of the conductive and mechanical elements, the presence of a variety of containers, channels, lacticifers, calcium oxalate crystals, nutrient reserves (starch, mucilage, inulin, fat oil), etc.

Cut and crushed raw materials. During microscopic examination scientists note the nature the thickening of vessels and tracheids, the presence and shape of mechanical elements (fibers, stone cells), calcium oxalate crystals, lacticifers, secretory receptacles, channels, etc. In the scraping the nature of reserve nutrients, shape and size of the starch granules are determined.
**Powder.** Diagnostic elements in the powder of the underground organs are vessels and tracheids with typical thickness of the walls, the mechanical elements that are located in groups or singly, calcium oxalate crystals, secretory channels, containers, spare nutrients and lacticifers.

**Fluorescence microscopy.** A cross-section (or saw-cut), dry powder or scraping of the underground organs is analyzed. Intrinsic (primary) fluorescence of the material is noted in ultraviolet light. The brightest glow is produced by lignified elements (vessels, tracheids, bast and wood fibers, stony cells) and the contents of the secretory structures (containers, channels, lacticifers); fluorescence of the parenchyma cells depends on the chemical composition. Histochemical reactions are carried out with cross sections or powder raw material mostly to determine the presence of active ingredients and nutrient reserves. The procedures of the reactions are described in specific normative-technical documentation. Qualitative reactions are carried out with the dry raw materials, scrapings, powder or extractions. The procedures of the reactions are described in specific normative-technical documentation.

**Indexes.** The indexes noted in raw material are: the content of reactant substances, biological activity; the methods of indication are described in specific normative-technical documentation; humidity, the content of total ash and ash insoluble in a 10% solution of hydrochloric acid; decomposition of the material and the impurity content.
**CLASSIFICATION OF BILOGICALLY ACTIVE PLANT SUBSTANCES**

**Alkaloids**

Alkaloids are biologically active substances mainly of plant origin, which have a marked physiological activity, containing nitrogen in their structure [315]. The name "alkaloid" is derived from two words: Arabic «al-gali» for alkali and Greek «eidos» - meaning -like. The content of alkaloids in plants is generally small - from traces to several percent; only a few plants, such as cinchona, barberry, corydalis and some others contain up to 10-15%. It should be noted that, as in many other cases, the amount of alkaloids in the plant is subject to various fluctuations, including seasonal: the content of ephedrine in ephedra during the year can vary from 0.3 to 2.5%.

Alkaloids are present in plants in the form of salts of carboxylic acids: citric, oxalic, acetic, malic, succinic, etc. Less often alkaloids can be found in the form of basic elements dissolved in fat (ergot) and ether (common rue) oils, as well as in the form of salts of mineral acids [315].

Many alkaloids in the individual form are crystalline or amorphous materials, discolored or colored, but some of them, such as nicotine, in their basic form are quite volatile fluids. Most alkaloids have a bitter taste [316].

According to experts, the number of alkaloids with an established structure extracted from plants is currently about 10,000. Alkaloids are classified primarily by the nature of heterocycles that they contain, such as: pyrrolidine and piperidine derivatives, derivatives of pyridine, quinoline, isoquinoline, indole, imidazole, purine, and alkaloids of diterpene structure, steroid alkaloids and glycoalkaloids, acyclic and peptide alkaloids, alkaloids containing sulfur, and, finally, urea derivatives. In the overwhelming majority of cases the alkaloids are heterocyclic nitrogen-containing basic elements. The chemical structure of alkaloids may be both: relatively simple and rather complex.

One of the elementary alkaloids is hygrine that is found in the leaves of the coca bush *Erythroxylon coca* Lam. and is a derivative of pyrrolidine:

![Pyrrolidine derivative](image)

Stachydrine is also a pyrrolidine derivative. This alkaloid determines the biological activity of lucerne. An intravenous solution of stachydrine at doses of 0.005, 0.01 and 0.1 g/kg accelerated clotting time in animals.
A dry extract of lucerne in the form of a medicinal preparation "Erakond" is used as an additive in alcoholic beverages. The ability of the components of the lucerne extract (added as part of "Erakond" into alcoholic beverages) to neutralize the toxic compounds in the body, including the products of ethanol metabolism, and to protect the liver cells helps reduce the negative impact on health and significantly reduce the severity of the alcohol withdrawal syndrome [317].

Alcoholic beverages can be made on the basis of 25-40% of alcohol with the addition of 2.5 g to 4 g of "Erakond" to 1 liter of the drink, with no need for any additional flavorings and colorings. A drink with the addition of "Erakond" has a nice cognac color and a characteristic aroma and taste.

Alkaloids have a wide range of pharmacological activity. Thus, lobeline and cytisine (contained in lobelia and thermopsis respectively) stimulate the respiratory center. Both alkaloids are used to eliminate the effects of carbon monoxide, morphine and sleeping pills poisoning, as well as to eliminate the nicotine hunger and the nicotine withdrawal syndrome – an unpleasant painful condition that accompanies the process for quitting smoking.

Racemate (a mixture of two optical isomers in equal proportions) of atropine and hyoscyamine contained in belladonna and platyphyllin in ragwort have antispasmodic action. They are widely used for the treatment of peptic ulcer disease, cramps, colic and in ophthalmology to widen the pupil in the study of the retina.

The alkaloid reserpine, containing an indole fragment in its molecule, is an example a complex structure. Reserpine was first isolated from snakewood (Rauwolfia serpentina L.). This plant is widely used by the local population of India for the treatment of snake bites. Reserpine lowers blood pressure and reduces the agitation of the central nervous system.
Vinblastine and vincristine - the most valuable alkaloids extracted from *Catharanthus roseus* - have antitumor activity. Preparations from these alkaloids - rosevium and onkovin – are successfully used for the treatment of leukemia, especially in pediatric practice.

One of the main toxic substances obtained from calabar-beans *Physostigma venenosum* (Balf.) is an indole alkaloid physostigmine, that was first extracted in 1865; its structure was determined in 1925; and in 1935 it was first synthesized and obtained a trivial name eserine.

This substance became known due to a tradition that existed in a number of the ancient tribes in Guinea: a criminal tribe-member sentenced to death was tested by the tribal leaders and was supposed to chew calabar-beans. The criminal, who considered himself innocent, eat them quickly. Thus, the toxic substances contained in the beans, once in the stomach, caused vomiting (cholinergic response), and that saved the person’s life. The guilty criminal was paralyzed with fear and he ate beans very slowly, trying to postpone the punishment. Thus, he would eat the lethal dose that, being consumed in small quantities slowly didn’t cause vomiting.

Berberine is one of the most common alkaloids and can be found in plants of different families [318]. From the chemical point of view, is a quaternary ammonium salt and a derivative of isoquinoline [315]. Berberine has a choleric action.
Morphine and codeine are isoquinoline alkaloids received from opium poppy *Papaver somniferum* L. that, influencing the opiate receptors of the central nervous system, disorder the pain impulse conduction and thus relieve pain. Fast and slow pain sensations are passed via two major classes of nociceptors. Nerve fibers covered with a thin myelin coating conduct a signal to a distance of 5-30 m per second and are used for conducting fast pain fast. This type of pain is felt for one tenth of a second after the occurrence of a painful stimulus. Slow pain is conducted through slower, unmyelinated fibers that send signals over a distance of 0.5 to 2 m per second. Such pain is felt like aching, throbbing or burning. Chemical pain (food poisoning, the accumulation of alcohol, drug, medical metabolites in the body, radiation effects, etc.) is an example of slow pain.

Morphine effectively weakens slow pain, but does not affect the fast pain, which is the body's reaction to injury or other damage and is usually strictly localized. However, the usage of these preparations can cause the development of drug dependence.

Quinine, one the most important of quinic alkaloids that represent a specific group typical for certain types of the cinchona tree (*Cinchona*) and remijia (*Remija*) of the *Rubiaceae* family. Quinine is toxic to many bacteria and other single-celled organisms. It has a multifaceted effect on the human body: depresses the central nervous system and the thermoregulatory centers by lowering the temperature in feverish conditions; reduces the excitability of the heart muscle; excites muscles of the uterus and increases its contraction, shrinks the
spleen. The characteristic property of quinine is the antimalarial action. It should be noted that racemates and synthetic enantiomers of quinine have the same effect.

Quinine is part of tonic – a bitter-sour fizzy drink. It often used to thin alcohol, especially gin cocktails. The drink was invented to combat malaria in India and Africa. The British soldiers who fought in India mixed tonic with gin to eliminate the sharp bitterness of quinine and thus the popular cocktail "Gin and tonic" was invented. The content of quinine in alcoholic beverages should not exceed 300 mg/kg [319].

Caffeine, theobromine and theophylline are the major alkaloids of the purine series that are found in coffee, cocoa, tea (Table 7):

Table 7
Alkaloids content in coffee, tea, cocoa and coke.

<table>
<thead>
<tr>
<th>Product</th>
<th>Caffeine (%)</th>
<th>Theobromine (mg/100 g)</th>
<th>Theophylline (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee</td>
<td>1,5</td>
<td>2</td>
<td>0,6</td>
</tr>
<tr>
<td>Tea</td>
<td>2,5</td>
<td>65</td>
<td>1,5</td>
</tr>
<tr>
<td>Cocoa</td>
<td>0,2</td>
<td>2000</td>
<td>1</td>
</tr>
<tr>
<td>Coke</td>
<td>2,5</td>
<td>50</td>
<td>5</td>
</tr>
</tbody>
</table>

This group of alkaloids has a strong stimulating effect on the human central nervous system (CNS), enhances mental and physical performance, increases the cardiac function. The most pronounced effect on the CNS is performed by caffeine, followed by theophylline and theobromine. The effect of caffeine on the higher nervous activity is dependent on the dose and type of the nervous system. In small doses, caffeine increases the activity of the cortex, and large - suppresses it. In small doses,
it helps to speed up the process of thinking and makes it more concise, provides clarity in thinking, reduces sleepiness, fatigue, and provides the ability to perform intelligently difficult tasks. It reduces the reaction time, increases motor activity and strengthens conditioned reflexes. These effects can be observed after 1-2 cups of coffee.

Higher doses cause nervousness, confused thoughts, insomnia, headache and tremor. Theophylline in high doses can even cause seizures. These alkaloids inhibit the absorption of sodium, chloride and water in the kidney tubules and increase diuresis.

Vegetable elements containing the nitrogen atom in the side chain form a group of protoalkaloids. Ephedrine - the main active element of the herb *Ephedra distachya* L. It has a vasodilator effect and is used in the treatment of bronchial asthma and other allergic diseases. Ephedrine can increase the contractile activity of the skeletal muscles and improve physical performance. On this basis it is used (as well as its synthetic analogues) as doping that reinforces muscle activity for a short period of time. The inclusion of herbs containing ephedrine, in to a variety of health phytodrinks requires careful monitoring in case of their use by athletes.

![Ephedrine](image)

Capsaicin – an alkaloid of plant origin – belongs to the benzylamine group. This substance determines the burning taste of Mexican, Spanish and other types of hot peppers.

![Capsaicin](image)

Piperine is the active element of black and white pepper *Piper nigrum* L. Black pepper is obtained by fermentation of immature fruits with the addition of the fungus *Glomerella cingulata*, followed by drying [320]. Black pepper is widely used in the food industry as a spice and in the production of special vodkas and bitters. Piperine and pipilartine inhibit the proliferation of cancer cells [321].
Researchers at the Sumitomo company isolated four more dienamides from *Piper nigrum* which proved to be highly active insecticides [322, 323]. Black pepper has been used successfully as a cardioprotective agent in the treatment of cough.

Alkaloids are used primarily in medicine. The nature of the biological activity of alkaloids greatly limits their use in the food industry or in the distillery production and requires careful monitoring.

**Vitamins**

Vitamins (from Lat. *vita* - life) are low molecular bioregulators necessary for the normal functioning of the body. Most of them are obtained with food in the form of vitamins as such or their predecessors - provitamins. They are involved in all processes of metabolism, increase resistance to diseases, have anti-inflammatory effect, help detoxify the body - remove and dispose of toxic substances, are involved in the vision mechanism, etc. At present, there are about 30 known vitamins, about 20 of them obtained with vegetable and animal food. Vegetable raw materials are a valuable source of vitamins for the human body; its use virtually eliminates the risk of overdose and adverse effects that are inevitable during prolonged and uncontrolled use of synthetic vitamins.

Thiamine (vitamin B₁) is formed from substituted pyrimidine and thiazole that are bonded together by a methylene bridge. Thiamine is rapidly converted into its active form in the brain and liver by the enzyme thiamine diphosphotransferase.

The daily intake of thiamine is 1-1.5 mg. The lack of thiamine leads to an inability of the cells to generate energy in sufficient quantities.

The earliest symptoms of thiamine deficiency are constipation, loss of appetite, nausea, depression, peripheral neuropathy and fatigue. Chronic thiamine deficiency leads to such severe neurological symptoms such as ataxia, dizziness and loss of eye coordination.

Severe thiamine deficiency causes the development of the beriberi disease. This occurs in case the diet is rich in carbohydrates or non-sufficient in thiamine.
some cases the Wernicke-Korsakoff syndrome can also develop. The disease can often accompany alcoholism.

Riboflavin (vitamin B_2) is the precursor of the coenzymes of flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD). Enzymes that require FMN or FAD as cofactors are called flavoproteins. Some flavoproteins contain metal. The normal daily requirement for riboflavin is 1.2-1.7 mg. Insufficiency of riboflavin is rare among most residents of the European countries, as it is contained in the right quantities in bread, eggs, milk, meat, etc. Riboflavin deficiency is often observed in chronic alcoholics. Symptoms associated with riboflavin deficiency include glossitis, seborrhea, angular stomatitis and photophobia. Riboflavin is destroyed in daylight.

Niacinamide (nicotinic acid, nicotinamide) is known as vitamin B_3. Both nicotinic acid and niacinamide can serve as food sources of vitamin B_3. Niacin is required for the synthesis of the active form of vitamin B_3. Niacin can be synthesized from the amino acid of tryptophan. However, this possibility is limited: 60 mg of tryptophan are used for the production of only 1 mg of niacin, and, in addition, this synthesis requires the presence of vitamins B_1, B_2 and B_6, that are not always present in the body in sufficient amounts.

The recommended daily dose of niacin is 13-19 mg. Poor consumption of niacin (and tryptophan) leads to glossitis, dermatitis, weight loss, diarrhea, depression and dementia. Depression, dermatitis, diarrhea are symptoms of one state called pellagra.

Nicotinic acid (not nicotinamide) prescribed in pharmacological doses (2-4 g/day) lowers the level of cholesterol in the blood and is therefore used for the treatment of hypercholesterolemia. Nicotinic acid also accelerates the rate of glycogen, which leads to an increase in blood glucose levels, so nicotinic acid therapy is not recommended for diabetics and patients with gout.

Pantothenic acid (vitamin B_5) is synthesized from alanine and pantoic acid. Pantothenic acid is essential for the synthesis of coenzyme A (CoA) and a component of the acyl-conducting protein, which is used for the synthesis of fatty acids. Pantothenic acid deficiency is rare, because it is widely presented in foods.
Pyridoxal, pyridoxamine and pyridoxine are generally known as vitamin B6. All three components are converted into the biologically active form of vitamin B6 – pyridoxal phosphate. This transformation is catalyzed by pyridoxal kinase. Pyridoxal phosphate is used as a cofactor in transamination reactions of amino acids, as well as in glycogenolysis as a cofactor of glycogen phosphorylase. The daily requirement for vitamin B6 is 1.4-2.0 mg. During pregnancy and lactation, the need for vitamin B6 increases of 0.6 mg per day. Vitamin B6 deficiency is rare and is usually associated with the deficiency of other vitamins of group B. The lack of this vitamin may arise during the use of isoniazid (used to treat tuberculosis) and penicillinamine (used to treat rheumatic arthritis).

Biotin is found in many food products, but is also synthesized the normal intestinal microflora, so its failure is very rare, but can occur with the use of medicine that affect the flora, as well as with excessive consumption of raw eggs. The latter is due to the fact that the eggs contain protein avidin, which prevents the absorption of biotin.

Cobalamin (vitamin B12) is composed of the tetrapyrrrole ring and the cobalt ion in the center. Vitamin B12 is synthesized exclusively by microorganisms, can be found in the liver of animals, and is bonded with protein in the form of methylcobalamin or 5-deoxyadenosylcobalamin. The vitamin can be released from protein and then it becomes active. This process is carried out in the stomach under the action of gastric juice or trypsin consumed with meat.

The liver can store vitamin B12, so its failure is very rare. The deficiency of vitamin B12 causes the development of megaloblastic anemia, which in this case is called pernicious anemia. This is observed with a deficiency of the Castle factor which is required for B12 absorption. Anemia is the result of changes in the synthesis of purine and pyrimidine bases, and, consequently, the synthesis of DNA.

Folic acid is composed of three parts: the pteridine ring, p-aminobenzoic and glutamic acids. The name of the acid is due to its isolation from spinach leaves. Folic acid is found in yeast, leafy vegetables, animal liver, etc. This vitamin plays an important role in the metabolism of nucleic acids and proteins.
In the cells under the influence of the enzyme of dihydrofolate reductase folic acid is converted to tetrahydrofolic acid. Folic acid deficiency is associated primarily with the violation of DNA synthesis.

Folic acid deficiency due to its presence in food products is rare. It is often observed in alcoholics. Individuals who do not abuse alcohol, the main reasons for such deficiency are: violation of absorption, metabolism or increased vitamin needs. For example, during pregnancy, the need for the vitamin increases. Some medicine preparations, such as anticonvulsants and oral contraceptives, lead to a disruption of absorption of folic acid.

Ascorbic acid is more commonly known as vitamin C. Ascorbic acid is synthesized from glucose in the glucuronic process. The enzyme L-gulonolactonoxydase, responsible for transforming gulonolactone in ascorbic acid, is absent in pri-mates and therefore ascorbic acid has to come from food. Ascorbic acid is involved in the restoration of various substances in a variety of reactions. The main reaction that requires vitamin C as a cofactor is the hydroxylation of proline remains in collagen. Therefore, vitamin C is required for the normal state of the connective tissue, as well as for healing scars. Since collagen can be found in the organic matrix of the bones, vitamin C is also necessary for normal bone health.

There are other reactions that require the presence of vitamin C as a cofactor. Such reactions are, for example, the catabolism of tyrosine and the synthesis of epinephrine from tyrosine. In addition, it is believed that vitamin C influences the process of steroidogenesis because it is found in large quantities in the adrenal cortex.

The lack of vitamin C causes the disease called scurvy. Scurvy is characterized by muscle weakness, bleeding gums, osteoporosis, brittle bones, anemia, etc. Vitamin C deficiency develops due to the lack of its consumption by the body, or due to an increased need for this vitamin. Increased consumption may be caused by severe stress (or injury). This happens because stress leads to the depletion of the adrenal cortex which contains a lot of vitamin C.

Vitamin A has three biologically active molecules: retinol, retinal (retinaldehyde) and retinoic acid. Each of these three components is derived from vegetable precursor β-carotene (referring to the carotenoids). After the contact of β-carotene with the intestinal lumen it is disintegrated by β-carotenedioxydase and transforms into retinal. Retinal then is rebuilt to retinol by retinaldehyreductase. Retinol is esterified with palmitic acid and enters the blood as part of chylomicrons. Chylomicron remnants are then consumed by the liver, where the accumulation of vitamin A takes place. Vitamin transportation from the liver to extrahepatic tissues is carried out by the bound form of retinol with aporetinol-binding protein. In the cell, retinol is bonded with cellular retinol-binding protein. For blood transportation retinol is bound to albumin.

Vitamin A has a great influence on our vision. Light reception is a function of two types of cells in the retina: rods and cones. The rods and cones contain a photo-receptor pigment in their membranes. The light-sensitive component of the eyes of
mammals is a protein opsin, which is covalently bound to an aldehyde of vitamin A. Rhodopsin – a serpentine receptor – is the photoreceptor of the rods. Retinol is also involved in the synthesis of certain glycoproteins and mucopolysaccharides necessary for the regulation of growth and secretion of mucus.

Vitamin A is stored in the liver and therefore its failure is very rare. An early symptom of vitamin A deficiency is night blindness. The next syndromes are there are follicular hyperkeratinization, increased susceptibility to infection, cancer and iron deficiency anemia. Prolonged vitamin A deficiency leads to xerophthalmia (keratinization of the cornea). Increased susceptibility to cancer is due to the fact that β-carotene is a powerful antioxidant [324].

Vitamin D is a steroid hormone that regulates the expression of specific genes. The active form of the hormone is 1,25-dihydroxycalcitriol. The main function of calcitriol is the regulation of the homeostasis of calcium and phosphorus. Active calcitriol is synthesized from ergosterol (produced by plants) and 7-dehydrocholesterol. Ergocalciferol (vitamin D₂) is formed from ergosterol under the influence of ultraviolet light (UV). In the skin, 7-dehydrocholesterol is converted into cholecalciferol (vitamin D₃) also influenced by UV. Cholecalciferol is absorbed in the intestine and then transported to the liver bonded with a specific protein.

In countries where vitamin D is added to milk, its insufficiency is rare. The main symptoms of deficiency are rickets in children and osteomalacia (softening of the bones) in adults. Rickets is characterized by malmineralization during bone development, which makes them soften. Osteomalacia is characterized by demineralization of formed bones; the consequence is softening and increased susceptibility to fractures.

Vitamin E is a mixture of tocopherols. The most common tocopherol is the α-tocopherol. Vitamin E is absorbed from the intestine as part of the chylomicrons. It is delivered to the tissue via the transportation of chylomicrons and then is consumed by the liver as part of the remnants of chylomicrons. Due to its lipophilic nature, vitamin E is stored in the cell membranes, fat depots and circulating lipoproteins. The main vitamin E storage place is the adipose tissue.

Vitamin E is a powerful antioxidant that binds free radicals and molecular oxygen [325, 326]. In particular, vitamin E prevents the fatty acids of the membrane from peroxidation and excessive desaturation. α-tocopherol can bind two peroxide
free radicals and then, interacting with the glucuronic acid, is excreted from the organism with bile. The main symptoms of vitamin E deficiency are the increase of red blood cells fragility, muscle weakness and infertility.

Vitamin K is presented in the form of K₁ (phytylmenaquinone) in green vegetables, in the form of K₂ (multiprenylmenaquinone) in the intestinal microflora and in the form of K₃ in synthetic menadione. The main function of vitamin K is the maintainance of normal levels of proteins that are essential for blood clotting. These proteins are synthesized in the liver in an inactive state. The transformation of inactive forms into the active clotting factors requires post-translational modifications of glutaminic acid remanants.

Vitamin K is absorbed in the intestine only in the presence of bile salts. Part of vitamin K is synthesized by intestinal microflora; therefore all medicinal preparartions affecting the microflora may lead to its deficiency. The main symptom of vitamin K deficiency is the hemorrhagic syndrome.

Table 8 shows plants that are capable to make up the deficit of vitamins in the body.
**Table 8**

**Phytocorrection of hypovitaminosis**

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Diseases caused by lack of vitamin</th>
<th>Plants compensating hypovitaminosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Reduced vision, dermatitis, eczema, seborrhea, colitis</td>
<td>carrots, pepper, buckwheat, nettle</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Sterility, muscular dystrophy, pregnancy pathology</td>
<td>Vegetable oils, carrots, chokeberry, wild rose</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Bleeding, hemophilia</td>
<td>Nettles, needles of pine and spruce, horse chestnut, shepherd’s purse, water pepper, cranberry, blueberry</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Frequent diseases, poor wound healing, fractures, bleeding tissue</td>
<td>Rosehip, blackcurrant, rhodiola, buckthorn, needles of pine and spruce, primrose, nettle</td>
</tr>
<tr>
<td>Vitamin B₁</td>
<td>Neuritis, hepatitis, myocardial dystrophy</td>
<td>Tomatoes, carrots, cabbage, corn, beans</td>
</tr>
<tr>
<td>Vitamin B₂</td>
<td>Reduced vision, wounds, ulcers</td>
<td>Rye, peas, beans, soy, spinach, carrots, cabbage, tomatoes</td>
</tr>
<tr>
<td>Vitamin B₆</td>
<td>Radiation sickness, eczema, hepatitis, growth retardation, deafness</td>
<td>Sprouts of wheat, rye, beans, bananas</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>Anemia, radiation sickness, polyneuritis migraine, sciatica, dermatitis</td>
<td>Algae, fungi, animal liver</td>
</tr>
<tr>
<td>Vitamin B₁₅</td>
<td>Myocardial infarction, pulmonary emphysema, atherosclerosis, steatosis</td>
<td>Seeds of many plants</td>
</tr>
<tr>
<td>Folic acid</td>
<td>Anemia, the impact of radio-nuclides, drugs, alcoholism, drug-induced hepatitis</td>
<td>Carrots, spinach, kale, lettuce, parsley, nettle, dandelion, plantain</td>
</tr>
<tr>
<td>Vitamin PP</td>
<td>Bleeding, radiation sickness</td>
<td>Wheat, buckwheat, cabbage, peas, sophora, green tea</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Fractures, rickets, dwarfism</td>
<td>Mushrooms, some taller plants</td>
</tr>
<tr>
<td>Vitamin P</td>
<td>Anemia, bleeding, hypertension</td>
<td>Green tea, pepper, rose, sophora</td>
</tr>
</tbody>
</table>
**Glycosides**

Glycosides are compounds widespread in the plant kingdom containing most of the physiologically active substances of plants. Glycoside molecules are composed of sugar (glycone) and non-sugar (aglycone) parts bound via atoms of carbon, oxygen, sulfur or nitrogen. Below is the structure of coniferin (abietene) – a simple phenol glycoside contained in many plants, but yet with no serious application.

Glycosides have different aglycon structures and structures of the sugar chain. Glycosides are disintegrated into sugar and the corresponding aglycones under the influence of enzymes, acids and in some cases even when boiled in water.

Individual glycosides are amorphous or crystalline, colorless or colored substances that are soluble in water and alcohol. Below is the classification of glycosides contained in medicinal plants, depending on the chemical nature of the aglycone:

- Cardiac glycosides, whose aglycones are derivatives of cyclopentane perhydro phenanthrene containing five- and six-membered lactone ring as essential substituents;
- Saponins, whose aglycones are compounds of steroid and triterpene nature;
- Anthraglycosides – yellow or red substances whose aglycones are derivatives of anthracene in different oxidation states;
- Coumarin and flavonoid glycosides;
- Bitter glycosides, or iridoids, - elements with a very bitter taste and sweet glycosides which are derivatives of cyclic monoterpenes;
- Cyanogenic glycosides, aglycons of which are compounds containing hydrogen cyanide in the bound state;
- Thioglycosides or glucosinolates, which form nitriles and isothiocyanates during hydrolysis.

Cardiac glycosides of medicinal plants have been used in England and France for more than 300 years. These compounds have a strong and specific effect on the heart muscle, increasing the force of contraction. The only source of these compounds is medicinal plants.
Plants containing cardiac glycosides, due to their specific effect are not used in the food industry and especially in the distillery production.

Saponins are plant compounds, aqueous solutions of which possess a number of characteristic properties: hemolytic activity, toxicity in cold-blooded animals, the ability to form sturdy foam if shaken.

The carbohydrate part of saponins is represented by one, rarely two, simple or branched chains, the composition of which can contain up to 10 monosaccharides. The non-sugar part (aglycone) is called sapogenin. According to the structure of sapogenins saponins are divided into two groups that differ significantly from each other in properties: steroid and triterpene.

Steroidal saponins have detergent properties; provide a complex with cholesterol membranes, thus causing hemolysis of erythrocytes. This group of compounds is widely distributed in nature.

Triterpene saponins are typically derived from cycloartane, dammarane, α- and β-amiryn and other compounds.

Dammarane derivatives include, in particular, ginseng saponins, and β-amiryn derivatives - liquorice root saponins. Licorice root is one of the oldest medical plants. It was known to the Indians and widely used in Chinese and Tibetan medicine, and
since the times of Homer was referred to as in all European medical books. Ammonium salt of glycyrrhizic acid is the basis of an anti-inflammatory and anti-allergic medicine glyceryl, glycyrrhizic salt is 300 times sweeter than sugar.

![Ammonium salt of glycyrrhizic acid](image)

In plants, saponins are localized in the cell sap. They are characterized by an increase in biological activity with a decreasing degree of saponin glycosidation. For example, the main saponin of ivy - hederasaponin C with nine sugar residues - is inactive, while the product of its partial deglycosidation - hederin - shows high antibiotic activity. During drying, the plant material containing saponins shows an increase of permeability of the tonoplast. Glycosides, passing through to the tonoplast to the saponins separate the glucosidic residues of sapogenins. This increases the biological activity of these compounds. Therefore, in contrast to cardiac glycosides the drying process has a positive impact on the saponins.

Saponins have a peculiar diverse pharmacological activity. For example, calendula and astragalus saponins have antiarrhythmic and sedative effects, clove saponines - analgesic and anti-inflammatory activities, cyanosis - antifungal, chestnut - cardiotonic and vessel-strengthening; snakeroot, cyanosis and primrose - expectorant effects; the steroidal saponins found anticancer, antioxidant, bactericidal and fungicidal activity.

Anthraglycosides are natural compounds, whose aglycones are the derivatives of anthracene with varying degrees of oxidation. In its pure form it is a crystalline substance of yellow, orange or red color, very soluble in water, and light alcohol and alkali solutions. In freshly harvested raw materials anthraglycosides are presented mainly by monomers containing one core anthracene. However, during natural drying, the recovered anthraderivatives (anthraolines, anthrones, oxyanthrones) are oxidized, turning into anthraquinones, accompanied by the condensation of anthracene nuclei in dimers and polymers.

Due to these changes the pharmacological properties of materials also transform. For example, freshly harvested buckthorn bark has an emetic effect (due to the reduced forms of anthraderivatives), whereas dried at room temperature and stored for a year it obtains a laxative effect (caused by anthraquinones). The pharmacological activity of anthraglycosides also depends on the presence and location of functional groups the anthracene core - methyl, hydroxymethyl, hydroxyl and carboxyl.

A clear illustration of this are the derivatives of chrysacin and alizarin, the difference in the structure of which is the location of the OH-groups:
Such differences in the position of the OH-group lead to the fact that plants and raw materials containing anthraglycosides of the chrysacin type (cassia, buckthorn, rhubarb, sorrel) are used as laxatives in chronic constipation, and plants and raw materials derived from alizarin (e.g. madder) are used in patients with kidney stones as solubilizers and for the removal of stones from the urinary tract.

Coumarin and flavonoid glycosides are glycosides of heterocyclic phenols of coumarin and flavone series. Among these glycosides are many materials with useful properties, some of them can reduce the fragility and permeability of capillary blood vessels, which can be the result of radiation damage. The most common and studied are quercitrin and rutin.

The glycoside rosavin contained in the roots of *Rhodiola rosea* has a tonic and wound healing effect [74].

Bitter glycosides, which are derivatives of cyclopentanoid monoterpenes, have another name - iridoids - due to the structure of their aglycone, the basis of
which is hemiacetal of iridial. In the pure form, iridoid glycosides are colorless crystalline or amorphous materials, mostly soluble in water and lower alcohols, but their main feature is a very bitter taste. The characteristic sign of the presence of iridoids in plants is their darkening during drying. The reason for this is the enzymatic cleavage of iridoids (e.g. aukubin) into free aglycones, which, because of their high reactivity, are easily polymerized to form dark-colored pigments.

The plants that have a pronounced bitter taste, have been used since ancient times to increase the appetite and improve the digestive activity of the stomach. But today iridoid glycosides attract special attention of experts, because in addition to the known properties they showed many new and valuable effects and the following biological activities: hormonal (agnuside), diuretic (catalop, aucubin), sedative and tranquilizing (valepotriates), wound healing, antitumor (asperuloside), antihypertensive, coronary widening, inflammatory and antiarrhythmic (oleuropein), antibiotic (aucubin, plumericin), etc.

Stevioside belongs to a class of diterpene glycosides and is contained in the Brazilian plant *Stevia reaudiana* Bertoni, which has been well known in Paraguay since ancient times. The leaves of this plant are traditionally used by the local population to sweeten drinks. Stevioside sweetness is 300 times sweeter than sucrose. The aglycon steviol produced by enzymatic hydrolysis of the glycoside is tasteless [327, 328].
It has been noted that a form of pharmacological activity may be performed not by the iridoid glycoside as such, but by its aglycone or their transformation products. For example, the gentian glycoside genciopercin is a classic bitter agent used for treating digestive disorders, accompanied by achylia, lack of appetite, elements of dyspepsia, etc. At the same time genciogenol formed by the removal of glucose and subsequent isomerization of genciopercin is characterized by antifungal activity that is as effective as that of well-known antibiotics, such as nystatin and amphotericin B.

Cyanogenic glycosides are a group of natural compounds, the aglycons of which are different hydroxynitrile derivatives, containing prussic acid, known as a strong poison, but not showing these properties as long as they stay in a bound form. The most widely known cyanogenic glycosides are noted in plants of the Rosaceae family, plum subfamily, concentrating primarily in their seeds. During long term storage or reprocessing of raw materials under the influence of two types of enzymes - β-glycosidase and oxynitrilase a graduated deep hydrolysis of cyanogenic glycosides to hydrocyanic acid and other compounds takes place. The entire range of products forming during the conversion of cyanogenic glycosides is used in medicine.

Application of cyanogenic glycosides in oncology is based on the fact that tumor cells split cyanogenic glycosides much more rapidly than the healthy sells, thus accumulating prussic acid. As a result, their growth slows down and they gradually die. Healthy cells are virtually not damaged. This mechanism of anti-cancer action of the cyanogenic glycosides is unique.

The CN-ions formed by the hydrolysis of amygdalin reversibly inhibit tissue respiration and thus reduce the level of metabolism – this is a valuable feature for the prevention and treatment of radiation injuries. This is due to the fact that in the mechanism of the damaging effects of ionizing radiation on cellular structures the leading role is played by the water radiolysis products (H₂O₂, HO₂, O, OH, etc.) that oxidize most macromolecules, including enzymes of tissue respiration. Cyanides reversibly blocking these enzymes, protect them from the action of biologically active substances formed under the influence of radiation. In other words, the complex "cyanide - enzyme" is relatively resistant to radiation. After exposure to radiation it is dissociated due to the lowering of the concentration of CN-ions in the biofaze due to their blood clearance and elimination from the body [329]. In this regard, amygdalin is widely known as a cyanide radioprotective agent.
Cyanidin glycoside from the berries of black elderberry *Sambucus nigra* L. has a distinct color and is used to falsify red wines [330]:

The fruit and bark of horse chestnut contain triterpene glycoside (saponin) with a complex chemical structure - escin (during hydrolysis is split into escigenin and three sugar residues - the total sum formula C_{55}H_{88}O_{24}), the coumarin esculetin and its glycoside esculin [331, 332].

Thioglycosides or glucosinolates are one of the groups of natural glycosides that has a double name, each of which reflects the level of our knowledge of their structure in different periods of time. Previously it was thought that these compounds are cyclic forms of thiosugars connected to the aglycone (first name), but today they are considered derivatives of the hypothetical anion – glucosinolates (their second name).

Glucosinolates are especially characteristic for the cabbage family and are found in such of its representatives, as mustard, horseradish, radish, etc. The plants contain them in the form of salts with alkali metals, usually potassium, accumulated predominantly in the vacuoles of special "myrosinase" cells. Under the action of specific enzymes (myrosinase) localized in the cytoplasm of these cells, glucosinolates easily split to form, along with sulfate and glucose, such components as nitriles, elemental sulfur, thiocyanates and iso-thiocyanates. The latter are quite volatile corrosive liquids with a pungent characteristic odor with a strong irritant effect.
noted even in small quantities. Due to this property medicinal plants containing glucosinolates (eg, mustard) have long been used in medicine as exciting and distracting means. But due to the fact that the stimulating effect is possessed not by the native glucosinolates but by their transformation products, the preservation of enzymes (in raw materials) that split these compounds is a precondition for the manifestation of specific pharmacological activity.

Isomeric dianthronic glucosides - sennosides isolated from several species of *Cassia* (*Caesalpinaceae*) - are potent laxatives and one of the most widely used in pharmaceutical substances of plant origin [333].

![Chemical structure of a glucosinolate](image)

**Fatty oils**

Usually fatty oils of plants are esters of triatomic glycerin alcohol and high fatty carboxylic acids.

![Diagram of fatty acid esters](image)
Vegetable oils are generally used as a basis for ointments and food purposes. However, as it turned out, the biological function of fatty carboxylic acids is significantly greater. Essential fatty carboxylic acids and their metabolites play an important role in the pathology of heart disease, diabetes and hypertension.

Flaxseed *Linum usitatissimum* L. oil contains glycerides of linolenic acid. In the human body as a result of complex metabolic processes, this carboxylic acid is converted to arachidonic - a precursor of eicosanoids, which play a significant role in the regulation of vital processes.

Saturated fatty carboxylic acids contained in the glycerin hydrides of animal fats, are used for the synthesis of cholesterol in the human body. Cholesterol, in turn, is a precursor of various steroid hormones used to build cell membranes and for the formation of bile.

Unsaturated fatty acids contained in grain, under the action of lactic-acid bacteria are transformed into hydroxy acids. As a result of cyclization of hydroxyl acids \(\gamma\)-deca-and \(\gamma\)-dodecalactones are formed, that give malt whiskey a sweet fat flavor [334].

A strong laxative effect is performed by croton oil, a mixture of diterpene compounds, produced from the plant *Croton macrostachis*. Most of them are miristate cetate and tetra decanoate acetate – complex esters, not of glycerin but of phorbol. These substances are extremely strong stimuli. Applied to the skin of a mammal, even a nano-gramme amount of these compounds causes rapid and vigorous inflammatory response and prolonged bleeding dermatitis [335].
Oil from the seeds of chaulmoogra *Hydnocarpus kurzii* Warb is practically the only cure for such a terrible disease as leprosy. Its action is due to the presence in the seed oil of this plant of the chaulmoogra and hydnocarpic acids in their free state and in the form of glycerates [336].

![Chaulmoogra acid](image1)

![Hydnocarpic acid](image2)

Sea buckthorn oil is widely used in medicine as a necrotic and painkiller for burns, bedsores, skin affections, gastric and duodenal ulcers, venous ulcers, allergies, skin diseases, and to eliminate the adverse effects of radiation therapy. Coriolic acid is found in the mitochondria of cardiac tissue of people who recover from Marseilles fever. (R)-coriolic acid is involved in the control of thrombosis, which is due to its ability to block the transport of calcium ions [337].

![Coriolic acid](image3)

In medical practice, fatty oils are used in ointments as emollients for the skin; they serve as solvents for camphor and hormone preparations, and are used for the production of plant oil extracts (black henbane, hypericum perforatum). Some oils have a strong physiological effect on the body. These include, for example, castor oil, whose laxative effect and bad taste is known to many people. The main acid component of castor oil, extracted from the fruit of castor bean *Ricinus communis*, is ricinoleic acid [338].

![Ricinoleic acid](image4)
**Coumarin and its derivatives**

Coumarins are distributed in the plant world virtually everywhere. Coumarins are derivatives of the *cis*-coumaric acid lactone [364].

\[
\text{R}_1 \quad \text{R}_2 \\
\text{COOH} \\
\text{OH}
\]

\[
\text{COOH} \\
\text{R}_1 \quad \text{R}_2 \\
\text{OH} \\
\text{H}_2\text{O}
\]

*coumarin R}_1=R}_2=\text{H} \\
\text{umbelliferone R}_1=\text{H}; \text{R}_2=\text{OH} \\
\text{esculetin R}_1=R}_2=\text{OH} \\
\text{scopoletin R}_1=\text{OCH}_3; \text{R}_2=\text{OH}

The simplest and most accurate classification of natural coumarins is based on the number and nature of cycles, fused to the coumarin nucleus.

Coumarins are compounds whose coumarin nucleus is not fused with an aromatic, heteroaromatic or saturated cycle. As a rule, in the positions of 3-8 compounds hydroxy, alkoxy and alkyl groups are set.

Coumarin is a volatile component of many plants with an odor of freshly cut hay. Umbelliferone is found in plants of the celery family (*Apia ceae*). Esculetin is contained in the pericarp of the horse chestnut as a glycoside esculin, scopoletin - in the roots of the Japanese scopolia (mandrake). The drug "Aeron", containing alkaloids of mandrake, is used to prevent and treat motion sickness. Scopoletin has fungitoxic action and antimicrobial activity. Scopoletin is excreted by oat roots into the soil and inhibits the growth of weeds. This compound together with the abscisic and caffeic acids inhibits germination and regulates biochemical reactions in the tubers of stored potatoes [335].

Coumarin dimer is an anticoagulant that is produced in violation of storage conditions of coumarin-containing plant material, so the use of faulty melilot raw material (the main source of coumarins) in the production of alcoholic beverages may lead to serious consequences.

\[
\text{bishydroxycoumarin}
\]

Furocoumarins are compounds in which the coumarin nucleus is fused to a furan ring.
Depending on where the condensation of furan cycle is and its location in relation to the basic nucleus, scientists single out: linear 2',3': 6,7-furocoumarins (psoralen derivatives) and angular - derivatives of 2',3: 7,8-furocoumarin (isopso-ralen).

Pyranocoumarins are compounds in which the coumarin nucleus is fused to a 2,2-dimethylpyranic cycle. As with furocoumarins there are linear compounds according to the 6,7-positions (xanthyletin derivatives) and angular, in which the 2,2-dimethylpiranic cycle is fused to the coumarin cycle in the 5,6- (sezelin derivatives) or 7,8-positions. 3,4-Benzocoumarins have a benzene ring fused to coumarin in the 3,4-positions

Dihydrofurocoumarins have a 4',5'-dihydrofuranic cycle fused to the couma-rin nucleus at positions 3, 4; 5, 6; 7, 6; 7, 8.

Dihydropyranocoumarins are derivatives of 3,4-dihydropyranocoumarins.

Coumestans contain a system of benzofuran fused with coumarin in the 3,4-positions:
Furocoumarins are characterized by a photosensitizing action, presumably this is due to the direct inclusion of furocoumarins in the biochemical mechanism of the formation of melanin pigmen. The photodynamic activity of furocoumarins is manifested in the fact that, being relatively inert in the dark, these compounds acquire biological activity under UV irradiation. In this sense the most active element is 8-methoxypsoralen or xanthotoxin. Being exposed to enough light it becomes toxic for the human blood leukocytes at a concentration of $10^{-9}$ mol/l. Photodynamic properties of xanthotoxin, bergapten and other derivatives of psoralen are used to treat vitiligo and psoriasis. Plants containing coumarin and its derivatives are used as flavoring in the production and distillery in confectionery products [339].

**Polysaccharides**

Polysaccharides make up the main part of the organic matter on the planet. Most of the dry weight of higher terrestrial plants and algae is composed of polysaccharides. Some polysaccharides (starch, glycogen) serve as energy reserves of the living organisms. A part of polysaccharides, primarily cellulose, performs skeletal functions, providing the rigidity of vegetable cells.

Another polysaccharide - chitin - is the basis of the exoskeleton of arthropods.
Polysaccharides are natural polymers of monosaccharides joined by glycosidic bonds in a linear or branched chain. Depending on the number of types (one or more) of monosaccharide units that form the polysaccharide molecule, scientists distinguish homo- and heteropolysaccharides. Homopolysaccharides include such mannans as inulin, amylase and amylopectin. Mannans are often found in the peel of nuts, the homopolymer galactan is the basis of agar used in the food industry for creating jelly. Inulin, which is a reserve plant polysaccharide, being a monomer contains furanose, which is quite rare [340].

According to their distribution in the plant kingdom heteropolysaccharides are in the same row with homopolysaccharides. Heteropolysaccharides include pectin, gums and mucus. These substances are of the greatest interest in the food and pharmaceutical industry [364].

Pectic substances are polyuronides that are present in soluble or insoluble forms in almost all terrestrial plants and some algae. Pectin gels, contained in the primary cell walls of plants, being hydrophilic excipients, do not allow cell walls to shrink, even in drought conditions [341, 342]. The characteristic property of pectin that is used in the food and pharmaceutical industry is the ability to form gels in the presence of sugars and acids. In their pure form they are amorphous powders with colors ranging from white to yellow, brown or gray, almost odorless, but soluble in cold water, forming colloidal solutions when heated. Pectins are applied widely in different areas of the food industry and pharmacology as emulsifiers, stabilizers, as well as a basis for ointments.

Pectins are the main reactants in drugs used for the treatment of bleeding. Medicinal forms containing pectin, stimulate wound healing, reduce blood cholesterol, influence the exchange of bile acids, have an anaphylactic effect, reduce the toxicity of antibiotics and effect positively on their validity. Pectins contained in the intercellular spaces of fruits and vegetables are enterosorbents that promote the excretion of toxic substances, particularly heavy metals [343]. During blending liquors fruit pectins cause the formation of turbidity and feculence removed by filtration [344]. Polysaccharides of algae possess anti-cancer effects and increase the body's immunity.

Gums are polysaccharides exuded by many plants in the form of viscous solutions that form a glassy mass in case of bark damage. Initially soft and viscous sinters gradually harden under the influence of air and turn into an amorphous mass of various shapes and sizes. An example gum is the so-called cherry glue that is formed in the cherry bark cracks.

From the chemical point of view, gum is a complex set of neutral and acidic heteropolysaccharides whose acidity is due to the presence of uronic acids. The latter are colorless or colored, solid or amorphous materials, usually tasteless, rarely sweet or bitter, insoluble in alcohol and other organic solvents, but partially or completely soluble in water forming viscous and sticky colloidal solutions. Due to the high emulsifying and coating abilities gum is widely used in medical and pharmaceutical
practice in the preparation of oil emulsions, coating solutions, as well as in the distillery production to stabilize emulsion liqueurs [345, 346, 347].

Many gums are of practical value and can be obtained in large quantities. Due to the tendency to form highly viscous solutions, gum is used in medicine, pharmaceutical and food industries, for the production of paper, fabric finish, in metallurgy, etc.

As a food additive the following gums are used: guar, algarroba gum, Arabic gum, ghatti, karaya, tragacanth, etc. Galactomannans of two plants have the largest application spheres: guar and algarroba. These gums have a similar chemical structure. The polymer chain is formed from the remains of mannopyranose linked with 1,4-β-glycosidic bond.

Guar gum is used in the production of milk products, sauces, baked goods, ice cream and other products. Agarroba gum is used in the manufacture of dairy products (cheese, yogurt), baked goods and frozen desserts.

Mucus, like gum, are complex mixtures of acidic and neutral heteropolysaccharides. They differ from the gums in their origin, localization, and some physicochemical properties. Thus, mucus, as opposed to gum, is formed in plants during their natural development without external stimuli (damage). Mucus is more water-soluble than gums.

It was long thought that the gum and mucus are formed in the process of "slimy" degeneration of the cell walls. Currently, it has been shown that gum and mucus are the products of cellular metabolism in the cells where the function of forming and secretion of polysaccharides (gums and mucus components) became predominant. Secreted polysaccharides can be deposited on the inside surface of the cell membrane. Polysaccharide deposition leads to gradual marginalization of the cell protoplast to the center and the reduction of its volume. As a result, the lumen is filled with polysaccharides (mucus) and the protoplast dies. This is the origin of mucus-containing cells, in, for example, the marshmallow root. In the case of gums, the cell secreted polysaccharides penetrate the cell membrane and excrete in the process of gumming.

Mucus is the product of normal metabolism of plants and serves as a food reserve or as an element that retains water, especially in the tissues of succulents. Succulents (Lat. succulentus juicy) are a group of plants with succulent, juicy leaves (agave, aloe) or stems (some types of spurge, cacti) rich in water.

A large group of mucus is formed by the glucomannans, found in various types of Araceae and Liliaceae, in iris seeds and orchid tubers. The source of mucus less complex in structure is flax seed, psyllium, some crucifers, etc. [340, 348]. Mucus is also used to mask and reduce the irritation of certain medications.

Chitosan, derived in the process of chitin deacetylation, can be successfully used to cleanse red and white wines from heavy metals [349].
Alginic acids are polysaccharides that are found in the cell walls of brown algae. The molecular weight reaches up to 600 thousand. They are built from D-mannuronic and L-guluronic acids with 1,4-β-glycosidic bonds. The distribution of monomer units in the polymer chain of regular copolymers can vary depending on the raw material. The polymer chain may include blocks from the remnants of β-D-mannuronic and α-L-guluronic acids, as well as areas with a regular alternation of the residues of both acids.

In the algae the alginic acid is found in the form of salts of calcium, magnesium and sodium. Due to the presence of carboxyl and hydroxyl groups the alginic acid forms a variety of esters and ethers.

Alginic acid derivatives are widely used in the food industry, medicine and cosmetics. Sodium alginate extracted from algae is used for immobilization of yeast and their implementation in the champagne production, as well as to stabilize the emulsion in the manufacture of ice cream and paint. Status of food additives is obtained by the alginic acid, sodium alginate, potassium, ammonium, calcium and propylene glycol.
**Terpenoids**

The structure basis of terpenes and terpenoids is presented by the molecule of isoprene [350, 364]. In these compounds, the number of carbon atoms is multiple to number of isoprenoid groups (C₅H₈)- the main structural fragments that are part of their molecules.

\[
\text{isoprene}
\]

According to the number of these units scientists distinguish mono- (contain two isoprene units):

sesqui- (contain three isoprene units):

 di- (contain four isoprene units), tetra- and polyterpenes:
Terpenoids are used in various fields of human activity, including medicine and the food industry. Some polyterpenes have a supporting application (rubber, gutta), some - di- and tetraterpenes – are represented by vitamins and provitamins and are not therapeutic agents but basic components of food (vitamin A and carotenoids), and others – triterpenes - are extremely important in medicine, but as is customary in pharmacognosy, are more commonly referred to a glycosides, since these representatives of terpenoids are aglycons of triterpene or steroid saponins.

Terpene alcohols - farnesol, linalool and β-ionone ketone contained in grapes or produced during alcoholic fermentation, define the taste and aroma of cognac spirits [351].

The sap of the Siberian cedar Pinus sibirica, whose nuts are widely used in the manufacture of salves and tinctures, contains terpenes: α- and β-pinenes, myrtenal, caryophyllene, isoabienol, etc., that have a pleasant smell [352]. All of them are of interest as starting materials for the chemical transformations in the biologically active substances, including medical supplies.

Muscadines, grown in the Crimea, contain more terpenoids than the same types grown in Armenia, which is the cause of a lower quality of Armenian muscat wines if compared to the Crimea wines. The levels of terpenoids in sweet and white muscadines, grown in the Crimea and Armenia are given in Table 9.

The Thai plant Vernonia cinerea L. is used for obtaining sesquiterpene lactones vernolide-A and vernolide-B [353]. This plant is used in traditional Thai medicine for the treatment of skin lesions in diabetes, lowering blood sugar. The aqueous extract of V. cinerea added to the cigarette filter helps people quit smoking [354].
### Table 9

The content of terpene compounds in essential oils of muscadines, mg/kg

<table>
<thead>
<tr>
<th>Terpenoid</th>
<th>Sweet muscadine</th>
<th>White muscadine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Armenian</td>
<td>Crimean</td>
</tr>
<tr>
<td>Myrcene</td>
<td>0.15</td>
<td>0.03</td>
</tr>
<tr>
<td>Limonene</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>Linalool</td>
<td>1.70</td>
<td>2.65</td>
</tr>
<tr>
<td>α-Terpineol</td>
<td>0.75</td>
<td>0.55</td>
</tr>
<tr>
<td>Nerol acetate</td>
<td>1.10</td>
<td>4.42</td>
</tr>
<tr>
<td>Geranyl acetate</td>
<td>0.75</td>
<td>0.49</td>
</tr>
<tr>
<td>Nerol</td>
<td>0.10</td>
<td>0.85</td>
</tr>
<tr>
<td>Total</td>
<td>6.39</td>
<td>11.61</td>
</tr>
</tbody>
</table>

**Phenol and its derivatives**

Phenol derivatives are one of the most wide-spread and multiple classes of biologically active natural compounds. The characteristic feature of phenolic compounds is the presence of a free or bound hydroxyl in its molecule [364].
This is an extremely diverse group of organic compounds, very heterogeneous in its chemical structure.

Phenolic compounds may be present in plants in the form of glycosides or in their free state. In plants, phenol in its free state is extremely rare, it is found in the pine cones and needles, tobacco and black currant leaves. 1,2-Dihydroxyphenol is found in the leaves of ephedra. In their pure form, they are crystalline or amorphous materials, colorless or colored, soluble in water and alcohol. In plant cells, phenolic compounds are accumulated in the form of glycosides, mainly in vacuoles, and in the free state - in special formations, often with a rather complex structure (resin and essential oil passages, channels, storage places, glands, etc.

Phenolic compounds with one or two aromatic rings have the most diverse pharmacological effects:

- antimicrobial - hydroquinone, arbutin (leather bergenia, bearberry, cowberry) are used for treating kidney and urinary tract diseases as diuretics and disinfectants;

- adaptogenic and stimulating the central nervous system - salidroside (snowdon rose - golden root) is used as a stimulant, similar in its action to ginseng and eleuterococcus;
P-vitamin - rutin (Sophora japonica), catechins (tea), vitamin E (the fruits of mountain ash and wild rose, black currants and black chokeberry) – are used as capillary-strengthening means;

![rutin - glycoside between the flavonol quercetin and the disaccharide rutinose](image)

adaptogenic - lignans (magnolia-vine) is used as a tonic element.

![schisandrin B from Schisandra chinensis](image)

Large range of useful properties characteristic of phenolic compounds with one or two aromatic rings, their relatively low toxicity, along with selective pharmacological effects make these natural compounds especially promising for the development of new medicine. Since a new phenolic antioxidant [356] - resveratrol - was found in the skin of red grapes, scientists began numerous studies of the effect of this substance on human health. (Antioxidants – elements that disturb the free radicals formation process in the organism and prevent its negative effect on the cell.) Resveratrol (3,5,4-trihydrotoluylene) - is a phytoalexin, which is synthesized in certain plants (pine, grapes, peanuts) under stress, injury, insect attacks and UV- radiation, is also a polyphenol and has a mild tanning action [357].

The best source of resveratrol is red wine, while in grape juice its quantity is almost 2 times less.
White grapes and white wine contain a small amount of resveratrol. 1 liter of red wine contains an average of 4.4 mg of toluylene, and white wine contains only 0.7 mg. The largest quantity of resveratrol is found in red wines of Pinot and Merlot. Like all polyphenols, resveratrol is a potent antioxidant which is more effective than vitamin E. In addition, resveratrol exhibits estrogenic activity by binding to the same receptors as oestradiol, one of the main human oestrogens. Despite the fact that the hormonal activity of resveratrol is significantly lower than that of oestradiol (3-10 nM of resveratrol corresponds to 0.1 nM oestradiol), its contents in the body can be so large that it effect it more significantly than oestradiol in its physiological concentrations.

Unlike oestradiol or diethylstilboestrol that accelerate the development of certain hormone-dependent tumors and the excess of which is associated with an increased risk of breast cancer, resveratrol exhibits a multifaceted antitumor effect. Experiments show that it inhibits ribonucleotide reductase and inhibits the synthesis of mammalian DNA, directly blocking the proliferation of tumor cells.

Another antitumor mechanism of resveratrol is its competition with oestradiol for the receptor binding sites that reduces the stimulatory effect of oestradiol on cell hormone-dependent tumors. Like all phytoestrogens, resveratrol may reduce the risk of osteoporosis which is often due to the decline in oestrogen level in women during menopause. Resveratrol also has a beneficial effect on the skin, stimulating the synthesis of collagen and preventing it from cross-linking. This effect is due to the combined antioxidant and oestrogenic effects of resveratrol. Experimental study also noted the cardioprotective properties of red wine. It was noted that grape juice and red wine make low-density lipoproteins extremely resistant to oxidation in vitro. Since the oxidation of low-density lipoproteins in the blood is a major cause of atherosclerosis, grape polyphenols, preventing such oxidation, should significantly reduce the risk of cardiovascular diseases. Oxidation of lipoproteins is prevented by many antioxidants, not only resveratrol and other polyphenols. The problem is that not all antioxidants received from food will work well in our body, and not all of them can be absorbed in the digestive process. In vivo experiments showed that the antioxidant activity of human blood plasma and the lipoproteins resistance to oxidation increased significantly after the consumption of red wine, which proves the effective absorption of polyphenols in the intestines. Red grape juice does not have such action, which made the researchers come to a conclusion that the polyphenols in grape juice are absorbed by the human body less effectively than the polyphenols in red wine.
Ferulic acid is oxidized by the action of the cell wall peroxidase and forms dimers. The formation of diferulates leads to binding of polysaccharides and to the decrease of elasticity of the cell walls, which is observed in aging cells [341].

\[
\text{ferulic acid}
\]

Tannins are polymeric phenolic compounds. Historically they were used to convert the skins of the animals into leather that is resistant to moisture and microorganisms. Tannin substances are divided into two groups: hydrolyzable and condensed.

\[
\text{hamamellitannin from } \textit{Quercus rubra}
\]

Hydrolysable tannins are formed like esters of sugars and phenolic acids (gallic, tannic, ellagic acids and their oligomers). Tannin molecules constructed with gallic acid, in many cases, have the shape of a flat disk, the periphery of which is composed of phenolic hydroxyl groups. On the contrary, tannins built with ellagic acid, have a molecule with the shape close to spherical, with phenolic groups located on the surface.

\[
\text{ellagic acid}
\]

Condensed tannins are polymer derivatives of catechin, leucanthocyanins and other reduced forms of flavonoids. As a rule, they are linear polymers, whose individual monomers are capable of limited rotation around their bond, which results in the fact that the molecule can obtain a relatively stable helical conformation with phenolic groups located on the periphery this spiral.

Location of the phenolic groups on the "surface" of the tannin molecule is important from the point of view of the possible formation of multiple hydrogen
bonds with natural substrates, such as proteins, which is the basis of the pharmacological action of tannins.

Natural tannins, with a few exceptions, are known only in their amorphous state, because are often a mixture of substances that are similar in structure, poorly soluble in cold water and relatively well-soluble in hot water.

Tannins are used as astringent, anti-inflammatory and antibacterial agents (tormentil cinquefoil, serpent grass, greater burnet, leather bergenia, speckled alder cones, etc.) for treating acute and chronic diarrhea, enterocolitis, as well as stomatitis, gingivitis and other inflammatory processes in the mouth, larynx, pharynx, etc.

Polyphenolic substances of unknown structure, typical for the parasitic fungus growing on the trunks of birch trees in the form of tumors, called chaga mushrooms or shelf fungus, are used as a symptomatic treatment of malignant tumors of different localization. Tannins and polyphenols form the taste of many alcoholic beverages, the most famous of which is brandy.

**Flavonoids**

Flavonoids are common virtually everywhere in the plant world. They are found in all fruits, vegetables, grains, in red wine, etc. Flavonoids are oxygen-containing heterocyclic compounds, derivatives of pyran or flavan:

Flavonoids have a C$_6$–C$_3$–C$_6$ molecular group of the carbon skeleton, and they are referred to as substances of the diphenylpropanoic group. According to the structure fragment propane (–C$_3$–), flavonoids are divided into 14 classes (Table 10). The presence of hydroxyl groups in the aromatic rings attributes them to phenolic compounds [364].

The variety of flavonoids is due not only to the structural changes of the propane fragment, as shown in Table 4, but also due to the presence of different radicals in the aromatic part of the molecule - the rings A and B, the degree of glycosidation, the joint point of the carbohydrate residues and the nature of these residues, the size of the sugar cycles, the configuration of glycosidic bonds and the nature of the glycoside joint to the aglycone (O-glycosides, C-glycosides). In addition flavonoids as such, there are also dimers called biflavonoids. Flavans that have a hydroxy group at the third carbon atom of the pyran ring are called catechins.
Catechins are colorless substances, which, under the influence of intracellular enzymes oxidize and condense, leading to plant tissue staining.

Flavonoids attract the researchers’ attention as physiologically active substances with a versatile range of activity. Today in many countries of the world flavonoid compounds are studied by chemists, pharmacologists and clinicians, physiologists and plant genetics, phytopathologists and other specialists [358, 359, 360]. Flavonoids have a spasmolytic effect on the smooth muscle of the intestine, the uterus and the bronchial tubes [364]. The flavonoid hypericin widens coronary vessels and vessels of the internal organs. This is a characteristic feature of hypericin and some other flavonoids, due to the fact that antihypertensive activity is noted in the flavonoids of some representatives of legumes. Flavonoid glycosides strengthen the vessel wall and reduce capillary fragility. Flavonoids can reduce the heart rate and increase the amplitude of the heart beats [361]. The most pronounced flavonoid effect of is their choleretic action. This mechanism is rather complicated and, most likely, is due to the changes in the redox processes in the mitochondria of liver cells. Most flavonoids have also a mild diuretic effect. Japanese scientists have proposed the use of the flavonoid kaempferol to prevent mutations possible due to the use of foods containing heterocyclic amines [362]. In addition, as it is noted by many researchers, flavonoids themselves are low toxic [363].

Table 10
Classification of flavonoid compounds according to the propane fragment structure [364].

<table>
<thead>
<tr>
<th>Class</th>
<th>Structure of the propane fragment</th>
<th>Main representatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Name</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Class</td>
<td>Structure</td>
<td>Examples</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Flavones</td>
<td><img src="image" alt="Flavones" /></td>
<td>Apigenin, Luteolin</td>
</tr>
<tr>
<td>Flavone-3-ol</td>
<td><img src="image" alt="Flavone-3-ol" /></td>
<td>Kaempferol, Quercetin, Myricetin</td>
</tr>
<tr>
<td>Flavanones (dihydroflavones)</td>
<td><img src="image" alt="Flavanones (dihydroflavones)" /></td>
<td>Naringenin, Butin, Eriodictyol</td>
</tr>
<tr>
<td>Flavanone-3-ol (flavanonoles)</td>
<td><img src="image" alt="Flavanone-3-ol (flavanonoles)" /></td>
<td>Dihydrokaempferol, Taxifolin</td>
</tr>
<tr>
<td>Flavan-3-ol (catechins)</td>
<td><img src="image" alt="Flavan-3-ol (catechins)" /></td>
<td>Catechin, Gallic catechin</td>
</tr>
<tr>
<td>Flavan-3, 4-diol (leucocyanidin)</td>
<td><img src="image" alt="Flavan-3, 4-diol (leucocyanidin)" /></td>
<td>Leucocyanidin</td>
</tr>
<tr>
<td>Anthocyanines</td>
<td><img src="image" alt="Anthocyanines" /></td>
<td>Pelargonidin, Cyanidin, Delphinidin</td>
</tr>
<tr>
<td>Chalcones</td>
<td><img src="image" alt="Chalcones" /></td>
<td>Butein, Isoliquiritigenin</td>
</tr>
</tbody>
</table>
Flavonoids have a pronounced antispasmodic effect and their glycosides strengthen the vascular wall and reduce capillary fragility. The most potent choleretic action is performed by the flavanones; flavanols are less effective in this matter. The latter mainly stimulate the neutralizing functions of the liver. Most flavonoids have a mild diuretic effect. Flavonoids are practically nontoxic [364]. Only quercetin-6-sulfonate, injected into the stomach at a dose of 500 mg/kg causes diarrhea, and 7-oxyflavon at a dose of 400 mg/kg causes acute gastritis and liver diseases in rats. This fact makes these compounds moderately toxic (see Table 11).

Other flavonoids (quercetin, rutin, catechin, etc.) during long-term consumption (for 1-2 years) with food in large doses - 1% of the diet - did not have any harmful effects. Toxicity occurs only after the inclusion of chlorine, bromine or iodine into the structure of these substances. When injected into the peritoneal cavity, subcutaneously or intravenously flavonoids cause no toxic effects as well - only a brief and weak depressor response of the body is noted [365]. The flavonoids myricitrin, quercitrin, morin, rutin, apigenin have a weak antitumor activity [366, 367].

Dihydroquercetin obtained from the crushed wood of larch is used as an antioxidant in canning fruit juices, [368, 369, 370], milk powder, confectionery

<table>
<thead>
<tr>
<th>Flavonoid Class</th>
<th>Compound</th>
<th>Structural Formula</th>
<th>Substituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dihydrochalcones</td>
<td>Floretin</td>
<td><img src="image" alt="Floretin" /></td>
<td>4, 2’, 4’, 6’</td>
</tr>
<tr>
<td></td>
<td>Hydroxylfloretin</td>
<td><img src="image" alt="Hydroxylfloretin" /></td>
<td>3, 4, 2’, 4’, 6’</td>
</tr>
<tr>
<td>Isoflavones</td>
<td>Genistein</td>
<td><img src="image" alt="Genistein" /></td>
<td>5, 7, 4’</td>
</tr>
<tr>
<td></td>
<td>Orobol</td>
<td><img src="image" alt="Orobol" /></td>
<td>5, 7, 3’, 4’</td>
</tr>
<tr>
<td>Isoflavanones</td>
<td>Podmaxethine</td>
<td><img src="image" alt="Podmaxethine" /></td>
<td>5, 4’-dioxy-7-methoxy</td>
</tr>
<tr>
<td>Aurones</td>
<td>Sulfuretin</td>
<td><img src="image" alt="Sulfuretin" /></td>
<td>6, 3’, 4’</td>
</tr>
<tr>
<td></td>
<td>Aureusidin</td>
<td><img src="image" alt="Aureusidin" /></td>
<td>4, 6, 3’, 4’</td>
</tr>
<tr>
<td>Homoisoflavanones</td>
<td>Punctatin</td>
<td><img src="image" alt="Punctatin" /></td>
<td>5, 7, 4’</td>
</tr>
<tr>
<td>3,9-dihydro-homoisoflavanones</td>
<td>dihydropunctatin</td>
<td><img src="image" alt="dihydropunctatin" /></td>
<td>5, 7, 4’</td>
</tr>
</tbody>
</table>
and fats. It is used to reduce the toxic effects of alcoholic beverages on the human liver.

Dihydroquercetin as part of the medicinal drug "Flukol-A" is used as a food additive that reduces the toxicity of vodka and other alcoholic beverages. Dihydroquercetin neutralizes free radicals $RO_2$ that are formed in the body during the metabolism of ethanol and acetaldehyde; inhibits lipid peroxidation and thus normalizes the structure and function of cell membranes. This prevents the release of acetaldehyde in the blood stream, and thus prevents its spreading and accumulation in the body, recovers the amount of antioxidants in the liver exposed to acetaldehyde. Thus, dihydroquercetin protects the body from the damaging effects of acetaldehyde, while helping significantly improve the organoleptic quality of alcoholic beverages.

Table 11
Classification of xenobiotics according to the toxicity level. (Xenobiotics are alien (not involved in the plastic or energy metabolism) substances introduced into the internal environment of the body.)

<table>
<thead>
<tr>
<th>Toxicity level</th>
<th>Enteral Introduction</th>
<th>Inhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$LD_{50}$ (mg/kg)</td>
<td>$LC_{50}$ (mg/l)</td>
</tr>
<tr>
<td>Extremely toxic</td>
<td>less than 15</td>
<td>less than 1</td>
</tr>
<tr>
<td>Highly toxic</td>
<td>15–150</td>
<td>1–10</td>
</tr>
<tr>
<td>Moderately toxic</td>
<td>151–1500</td>
<td>11–40</td>
</tr>
<tr>
<td>Low toxic</td>
<td>More than 1500</td>
<td>More than 40</td>
</tr>
</tbody>
</table>
Isoflavones obtained from the roots of *Pueraria lobata* Willd. Ohwi (genistein, daidzein and puerarin) are today one of the few herbal remedies that do not have their own addictive effects, but are able to change alcohol behavior of animals in experiments. (Addictive process - the word "addictive" (accustomed, addicted) acquired a significance that goes beyond the definition of addiction, given by the WHO as a state of periodic or chronic intoxication caused by the use of natural or synthetic substances to which the subject is irresistibly (compulsively) driven to, followed by a tendency to increase the dose, increased tolerance and the withdrawal syndrome, during which there is always a psychological and physical dependence on the effects of the substance).

Isoflavones of the pueraria flowers – kakkalide and tectoridin - in mammals are transformed into irizolidon and tectorigenin that are able to modify the metabolism of ethanol and acetaldehyde and have hepatoprotective activity. Given the long-term experience in using pueraria products for the treatment of alcohol dependence and the encouraging results of modern clinical researches, pueraria can become one of the most promising plants in the addiction treatment practice [371].

The study of the metabolism of genistein and tangeretin – the basic flavonoids found in citrus fruits, revealed that the main mechanism of the flavonoids transformations in the human body is the hydroxylation of the aromatic ring to form compounds of polyphenolic nature. These structures have a high ability to inhibit the radical oxidation processes in the cells of living organisms and thus prevent the development of cancer cells [372, 373, 374].
**Essential oils**

Many plants used in the food and liquor industry, have a specific odor, especially noticeable when leaves or other plant parts are broken. The smell of the plants is provided by the essential oils that are accumulated in special formations or on the surface of plants (glandular hairs of different types, essential oil glands, glandular spots) or inside plants (secretory cells, containers, tunnels and secretory tubules.

Such essential-oil plants as mint, lemon balm, marjoram, oregano, sage, lavender, tarragon, basil, hyssop, catnip, fennel, cumin, coriander, and others are used in the distillery production [375].

Essential oils are complex mixtures of volatile aromatic substances, most of which belong to monoterpenes, sesquiterpenes, aromatic elements and their derivatives [376]. The number of components of essential oil per plant can reach a few dozen. For example, the essential oil of silky wormwood *Artemisia dracunculus* L. includes 60 compounds [377].

Substances, for example, in the silky wormwood essential oil exist in a free state or in the form of glycosides, making it easy to transport them from one part of the plant to another. The yield of essential oils increases during slow drying of raw material, which is due to the splitting of glycosidated forms of terpenoids under the influence of cellular enzymes. In the drying process the chemical transformations lead to the formation of new essential oils. In this connection, in order to increase the yield of essential oils from raw material, it is recommended to dry it slowly, preferably pre-drying it under temperatures optimal for the enzyme action (30-35°C). Strict observance of the temperature regime is also important because at higher temperatures evaporation of essential oils occurs due to their high volatility.
The loss of essential oils also occurs during storage of dried material, and there is also a certain dependence on the ripeness of the fruits which accumulate essential oils. For example, the seedless hops cones contain essential oils in larger quantities than the hops of the same class with seeds, and during an 18-month storage period lose from 30% to 80% of α-acids that compose the hop aroma and flavor of the beer [378].

Some components of the essential oils are not natural, but are formed during processing of raw materials. The commercial essential oil of chamomile and wormwood contains chamazulene, which is formed in the sesquiterpene lactones of these plants (matricin and absinthin) during the processing of the raw material with steam [379].

Numerous experimental studies have shown that noticeable anti-inflammatory action is demonstrated by the essential oils of yarrow, due to the presence of sesquiterpene lactones and their transformation products - chamazulene and the total amount of flavonoids, including apigenin, luteolin, quercetin, rutin, hyperoside, quercitrin, isoquercitrin and their glycosides [380, 381]. Essential oils have astringent, antibacterial and anti-inflammatory action. They are used for gargling, in the
treatment of stomatitis (sage, eucalyptus, peppermint, pine, Siberian fir), in the preparation of ointments and drops for treating colds (menthol from peppermint leaves), they are used as expectorants for treating acute chronic tracheitis, bronchitis, pharyngitis and pertussis (elfwort, Ledum palustre). Essential oils of hops have antimicrobial activity against gram-positive bacteria and some fungi [382]. One of the oldest anti-inflammatory preparations is the flowers of small-leaved lime. Yarrow has similar characteristics; it is used for treating gastritis, inflammations of the mucous membranes.

Some essential oils have a sedative effect. The best known is the valerian root a traditional remedy used in states of nervous excitement and for treating the nervousness of the cardiovascular system.

Essential oils have a choleretic and diuretic effect. They are used for treating cholecystitis (leaves and herbage of wormwood, birch buds, rhizomes of sedge cane), for the treatment and prevention of kidney stones (juniper berries, birch buds), as a means of improving digestion, for treating atony and pain in the bowels, flatulence (fruits of caraway and cumin oil).

In clinical practice, individual components of essential oils are used: menthol (obtained from peppermint used in validol), ledol (obtained from *Rhododendron tomentosum*) are used for treating cough; chamazulene (obtained from chamomile) has an anti-inflammatory and wound-healing effect [379]. Menthol stimulates the receptors that respond to low temperatures, so warm objects that have the temperature of the mouth in the presence of menthol evoke the feeling of cold.

Sesquiterpene lactones belong to the most numerous and structurally variable class of terpenoids of sesquiterpene origin [383]. The molecule of sesquiterpene lactones (C15-compounds) has one (at least - two) lactone ring. Most of sesquiterpene lactones are crystalline, solid, rarely oily and liquid, insoluble in water and soluble in organic solvents - alcohol, chloroform, ether. The spectrum of sesquiterpene lactones’ biological activity is very wide, they perform:

- Anti-inflammatory and wound-healing effect (matricin);
- Uterine haemostatic (arnifolin);
- Anthelmintic (santonin, gelenin, alantolactone and its isomers, see characteristics of *Inula helenium*);
- Cardiotonic (tauremisin);
- Anti-cancer (cnicin, gelenalin).
Plants containing sesquiterpene lactones [383, 384], are used in the form of infusions and decoctions to stimulate the appetite, digestion, they are used in the distillery industry, applied as a means of normalizing the secretion of gastric juice, used for the treatment of inflammatory diseases of the gastrointestinal tract (chamomile, elfwort), in obstetric practice as uterine hemostatics (mountain arnica) and for treating allergic diseases (chamomile, bur-marigold).

**Macro- and microelements**

Minerals are presented in plants in the form of macro-and microelements (trace elements). Trace elements are a group of chemical elements contained in the human or animal body or in very small quantities, within $10^{-3} - 10^{-12}$ % [385]. Macroelements include potassium, sodium, calcium, magnesium, phosphorus, iron and chlorine; microelements include manganese, copper, zinc, iodine, cobalt, molybdenum, etc. The content of macroelements in plants, although it varies depending on the type specificity, is characterized by relatively similar doses, while the differences in the concentrations of selected trace elements are so large that provide the chemical uniqueness of each type. Plant species specificity of the microelement composition and their quantitative content are of considerable interest, both from the theoretical point of view and in their medical usage.

In the etiology of many diseases an important role is played by the violation of the trace element equilibrium in the human body: scientists have established a correlation between their imbalances and pathological manifestations [386].

Insufficient or excessive intake of trace elements with food and water can lead to serious metabolism diseases called microelementoses.
Zinc deficiency can cause various anomalies in the human development. Excessive content of zinc causes anemia. Alcohol dehydrogenase, which is present in the liver and other organs, oxidizes ethanol and other alcohols, steroids, and is involved in the primary mechanism of detoxification of alcohol. Alcohol dehydrogenase present in horse and human liver contain four zinc atoms per molecule, and zinc performs both: catalytic and structural functions [385].

The lack of lithium is noted in patients with manic depression, schizophrenia and other mental illnesses.

The lack of cobalt in the body leads to insufficient synthesis of vitamin B₁₂ and anemia, and burdening of the endemic goiter. At the same time, the excess of cobalt inhibits the synthesis of vitamin B₁₂ and also inhibits the synthesis of key enzymatic reactions of thyroxine. Special attention to the toxic effects of cobalt was drawn after it was noted that the addition of cobalt chloride to beer in the amount of 1.2-1.5 mg/l to improve foaming leads to cobalt cardiomyopathy with severe heart failure and death [385].

Lack of iodine causes thyroid disease, and its excess, same as that of cobalt, leads to the weakening of the synthesis of iodine compounds in the thyroid.

Obviously, any violation of the microelement balance as a result of a disease or their excessive or insufficient reception needs to be corrected using appropriate products.

All formulations containing trace elements that are used today can be divided into three groups.

The first is the soluble mineral salts. These preparations are relatively obtainable, but they are poorly absorbed: in oral (by mouth) administration the majority (90%) is removed from the body. In addition, as a result of significant individual differences in the degree of assimilation, they can cause overdose and, particularly long-term, adverse effects.

The second group includes medical preparations which include microelements in the form of organometallic compounds (cobamid, ferroascorbinate). Compared with mineral salts these elements are absorbed much better. A clear illustration of this is chrome that is necessary in patients with diabetes mellitus. This element, present in brewer's yeast in the form of a natural complex, is absorbed almost completely, while only 3% of it is absorbed if appointed orally in the form of mineral salts.

Another example of this type of preparations is the drug used for the treatment of iron deficiency anemia. The structural features of the cyclodextrins promote the formation of "guest - host" inclusion complexes, when the internal cavity of the cyclodextrin...
molecule as a 'host' interacts with a variety of organic and inorganic ions and neutral molecules (Fig. 19).

Thus the macromolecular complex Fe(OH)$_3$ is formed, which is stable with dextrin and under physiological conditions does not produce iron in the form of free ions. Therefore, in oral reception, iron, which is part of this complex, enters the bloodstream of the intestine only via active absorption. There is a correlation between the degree of iron deficiency and the amount of absorbed iron (the higher the iron deficiency - the better the absorption). This feature of the preparation explains the impossibility of poisoning due to drug overdose, even in contrast to the simple salts of iron, the absorption of which is performed according to the concentration gradient.

And, finally, the third group includes the natural complex of mineral macro- and microelements received from plants. This complex of minerals has significant advantages, especially because it goes through a sort of biological filter and therefore has the most favorable ratio of core components for the body. The latter is difficult to achieve when creating artificial mixtures due to insufficient knowledge of the physiological significance of the variety of synergistic and antagonistic relationships between the numerous elements that form the basis of all living creatures. The significant advantage of plants is the fact that the minerals are present in the organically bound, i.e., the most accessible and digestible form, as well as in combinations appropriate for wildlife in general.

The therapeutic effect of trace elements may increase the activity of the main active elements of medicinal plants. The enrichment of medicinal plants by trace elements can be carried out during plant cultivation. For example, iodine treatment with of Digitalis purpurea enhances the biological activity of the raw material and reduces its toxicity.

There is a correlation between the plants' accumulation of certain groups of physiologically active compounds and the concentration of trace elements in these plants. For example, plants that produce cardiac glycosides selectively accumulate manganese, molybdenum and chrome; plants producing alkaloids accumulate cobalt, zinc, manganese, rarely copper; plants that produce saponins accumulate molybdenum and tungsten; and plants producing terpenoids accumulate manganese.

The reason for this specific assimilation of some chemical elements may be the fact that in centers of origin over millions of years of evolution the plants, one after another, gradually acquired a special composition that reflects the identity of the mineral composition of their environment. Those trace elements which were widely available in the plants' habitat were inevitably accumulated in high quantities. As a result, the plants gradually developed an ability to accumulate these elements in certain combinations and concentrations. The concentration of elements in plants inevitably led to increased synthesis and increased activity of biological catalysts – metal-dependent enzymes. In response to their activation the number of basal metabolism compounds in the formation of which the enzymes were involved inevitably increased. However, the concentration of a substance, even of the most useful one, can cause disruption of the homeostasis and become harmful in vivo.
This fact has been generally accepted and proven on different levels of organization of living things.

Exceeding the optimum over-concentration, even such essential compounds as vitamins, may also lead to very serious consequences. Literature describes numerous cases of fatal poisoning caused by an overdose of provitamin A, provoked by the ingestion of large amounts of carrots or polar bear or shark liver that have a high content of provitamin A.

In the process evolution the concentration of certain elements in plants could lead to an excessive accumulation of certain metabolites of the basal metabolism, which became toxic. In response to this situation, it seems, the plants developed an ability to neutralize such elements by binding their surplus in specific products, originally called secondary metabolites. Most of the physiologically active compounds mentioned above belong to this group. During evolution the plants selected compounds or, to put it exactly, biosynthetic pathways that gave real advantages in the struggle for existence, and in the end, it obviously resulted in plants forming an ability to accumulate certain elements on the one hand, and in the formation of a specific type of secondary metabolism - on the other.

It should be noted that the current point of view on the role of trace elements in the metabolism can change significantly during the development of modern science. A convincing illustration of this is the example of zinc. Not so long ago it was considered to be a harmful element. Today, however, views on the role of zinc and its effect on the human body have changed. Scientists have proven the involvement of zinc in the formation of immunity, as well as its role in the growth and normal functioning of the sex glands. Although the molecular mechanisms of zinc action are still far from being deciphered, scientists have proved the existence of 24 Zn-dependent enzymes that are involved in all major metabolic processes. They catalyze the biosynthesis and metabolism of nucleic acids, proteins, energy production, and trigger the activation of vitamin A and folic acid.

Due to the great role of zinc in the metabolism it is natural that when imbalances arise serious diseases may be caused, such as: dwarfism, sterility, sexual infantilism, various forms of anemia, dermatitis, increased growth of tumors, pathology of nails and hair, etc. These symptoms demonstrate the extreme the degree of pathology. At the same time pathology may be less expressed, but the extent of its distribution among the population is much wider. The latter is due to zinc deficiency in soils, water, plants and animal organisms, i.e., in the food chain. One of the indicators of a minor zinc deficiency in the human body is the appearance of white spots on the nail surface. Special attention should by paid to the fact that among plants that accumulate zinc there are those that accumulate it selectively and can be used for treatment and prevention of zinc deficiency. Superconcentrators of zinc are aloe vera, birch, datura, common laurel cherry, tormentil cinquefoil, mouse-ear and ground burnut. Among the plants considered zinc concentrators scientists are most interested in field pansy, bur-marigold and celandine. Most of these plants are used in traditional medicine for the treatment of skin diseases of different etiologies and as wound healing agents. It is obvious
that in the use of these plants the physiologically active compounds and zinc sum up and this result enhances the pharmacological activity of these plants.

Iron plays a very important biological role the life of all living elements. Suffice it to say that this element is the major structural component of hemoglobin and of hem-containing enzymes: catalase, peroxidase and cytochrome oxidase - the main catalysts of redox reactions. Imbalance of this element leads to severe anemia and other blood disorders. Excessive amounts of iron cause siderosis. Particular attention is drawn to siderosis among men of the Bantu tribe that develops in 40-88% of South Africa aborigines. The cause of this disease is the excessive amount of iron in their diet. A particularly large amount of metal is found in various types of alcoholic beverages which are made using iron cookware. Calculations have shown that the Bantu consume from 50 to 100 mg of iron daily just with homemade beer [385].

Among the medicinal plants there are species that accumulate iron in large amounts. These include, in particular, the following: Italian Helichrysum, puke-weed, dyer's-madder, great valerian and mouse-ear. Alongside with iron copper is also involved in redox processes in any living organism. It is part of the ceruleplasimne of animals and humans, as well as the plant plastocyanin and is also a cofactor of important enzymes such as cytochrome oxidase, polyphenol-, di-, amino- and ascorbic oxidase. No wonder that the demand for copper increases in case of any inflammation, its use is natural for the treatment of arthro-infectious diathesis (terminology of Henry Picard) in all its forms. Superconcentrators of copper include the following types: tormentil cinquefoil, pukeweed, Gerogian dyer's-madder, mouse-ear and Chinese tea-plant.

However, an excess of copper can lead to serious diseases. The reason for the excessive amount of copper in the human body in some African countries could be the consumption of beer and spirits produced in handicraft conditions. This is due to the fact that during fermentation and subsequent distillation of the drinks the locals do not use traditional pottery, but handmade ware made of various non-food alloys; and as a result the copper content in the beverage can reach 58 mg/L and the content of zinc - 68 mg/l [387].

Individual plant species are able to accumulate not one, but several elements at a time. For example, tormentil cinquefoil is a superconcentrator of two elements - copper and zinc, and pokeweed and dyer's-madder accumulate copper and iron. A sort of champion among medicinal plants of this type is mouse-ear that accumulates three elements - zinc, copper and iron. These elements can increase the effects of each other. The mechanism of these interactions is not well understood, but it was noted that copper is essential for better absorption of iron and it also enhances the action of zinc. When it is necessary to eliminate iron deficiency in clinical practice, as well as its deficit in agricultural production copper should be used along with iron preparations.

The combined effect of zinc and copper, probably, is performed at the level of biochemical processes that lead to the strengthening of protective functions. It is also possible that it is caused by the presence of these two elements in the superoxide
dismutase - an enzyme neutralizing the highly toxic anion radical of oxygen (superoxide radical). It is obvious that the simultaneous concentration in medicinal plants of zinc, copper and iron increases the pharmacological value of these plants.

Many species of medicinal plants are concentrators and superconcentrators of manganese. One of the representatives of the first groups is bogbean, and of the second - marsh tea, tormentil cinquefoil, Chinese tea-plant, bilberry and manna gum. Manganese plays an important role in the life of all living cells: the numerous reactions of carbohydrate, protein and phosphorus metabolism are catalyzed by enzymes which are activated by manganese ions, including carboxylase, aminopeptidase galacto transferase, arginase, alkaline phosphatase, etc. Manganese is essential for normal functioning of the gonads and musculoskeletal system. Its deficiency affects the stability of the membranes of nerve cells and the nervous system.

It is believed that with age the absorption of manganese decreases while the demand for it remains the same. As a result, elderly people may experience prerequisites for the development of various diseases, such as cancer and cardiovascular disease. For the prevention and treatment of such diseases it is recommended to use medicinal plants that synthesize cardiac glycosides, which are characterized by the presence of high doses of manganese. For people of other age categories the best source of manganese is the Chinese tea-plant.

One of the elements, which are concentrated in plants, is molybdenum. It is accumulated by marsh tea, periwinkle, knot-grass, rhineberry, nettle and peppermint. Molybdenum is the cofactor of some enzymes, such as aldehyde dehydrogenase, sulphite oxidase, nitrate reductase and xanthine oxidase. It was noted that this element counteract the development of dental caries by fixing fluorine. For the prevention of this widespread disease medicinal plants can obviously be used.

Many medicinal plants accumulate cobalt, but only five species have the ability to store it in large quantities - brandy-bottle, mouse-ear, bird cherry and wild rose. The role of cobalt cannot be overestimated: it is involved in the exchange of fatty acids and folic acid and in carbohydrate metabolism, but its main function is the participation as part of vitamin B12 in hematogenesis. Violations in this process, as we know, can lead to serious consequences, therefore cobalt is the only element that can be accumulated in the body for seven years for future use. Dogrose is the best source of cobalt that can correct its imbalance.

Among the medicinal plants there are species that can accumulate nickel. These include papaya, belladonna, cheese-bowel, motherwort, passion-flower and lanceolate thermopsis. It was noted that certain enzymes involved in the splitting and the use of glucose are activated by this element, and therefore with the increase in sugar consumption the demand in nickel also increases.

Insulin regulates the level of sugar in the blood, keeping it in optimal concentrations. It is believed that chromium, positively influencing the activity of insulin, at the same time counteracts the development of serious diseases such as atherosclerosis and cardiovascular disorders. Indeed, its introduction decreases cholesterol and triglycerides levels in the blood. Although the allowed daily dosage of chromium is very small (50-200 mg), American experts calculated that about half the
population suffers from a lack of this important element, especially elderly people. One of the reasons for the observed deficit is the redundant refining of food products. Suffice it to say that the content of chromium, in refined sugar, for example, is only 0.1% of the amount in the original – unrefined sugar.

The best source of chromium is brewer's yeast, about one tablespoon of which fulfills the human daily need in this element. Medicinal plants that concentrate chrome are rare. The most valuable of them is yam (*Dioscorea*). The medicinal drug "Polisponin" made with the use of this plant has a noticeable antiscerotic effect and is recommended as a preventive agent against atherosclerosis. The type of yam used for its production obviously contains a summed pharmacological activity of triterpene saponins and chromium due to the unidirectional nature of their actions on the human body. The only superconsentrator of chromium – pukeweed which could be used to correct the deficiency of this element in the human organism has not yet found practical application.

A number of medicinal plant species concentrate cadmium: touch-and-heal, may lily, jimson weed, lion's-mouth, podophyllum, mouse-ear and ground burnut. The useful properties of this element have not been established, but, on the contrary, there are reports of harmful effects that cadmium on the body. The reason for the presence of an increased amount of cadmium in plants is obviously caused by man-made pollution. Therefore, harvesting medicinal plants, especially superconsentrators of cadmium should be carried out away from roads and intensive industrial production.

Among the medicinal plants there is a large group of strontium superconcentrators, including anise, leather bergenia, aloe vera, lingonberry, serpent grass, common oak, jimson weed, rhineberry, greater burnet, devil's-club, common laurel cherry and ground burnut. Strontium is involved into the metabolism of the most important macronutrient – calcium, it performs similar functions, is used in the treatment of osteoporosis, prevents dental caries, etc. According to foreign experts, in areas of strontium deficit the intake of this element from food is much lower than the optimal level; and this element is particularly necessary for the elderly people and for treating fractures. The use of medicinal plants accumulating strontium to correct to the imbalances, obviously, can be promising.

In recent years, there has been an increasing number of reports of the important biological role of selenium. It is believed that, in certain doses, it has anticancer activity. It was noted that selenium affects the cardiovascular system. Molecular mechanisms of its action are not analyzed, but it is possible that this element in conjunction with vitamin E stimulates the production of antibodies and thereby increases the body immunity. In addition, it controls the formation of red blood cells. Its consumption doses are low: 150-200 mcg daily. However, in Russia there are many areas where there is a clear deficiency of this element, which is manifested slowly and gradually.

There are about 30 species of medicinal plants that accumulate selenium, including such valuable in the therapeutic practice as swallowwort, devil's-apple, European wood strawberry, foxglove, chamomile, catharanthus, dogrose, licorice,
redhaw hawthorn, aloe vera and others. Selenium in extreme quantities is present in coltsfoot, magnolia-vine, black currant, eucalyptus, pumpkin, dill, parsnip, rhodiola rosea, etc.

It should also be noted that the nature of microelement action on the human body is not always similar to the nature of physiologically active compounds present in plants. On the contrary, there is quite a number of species, whose pharmacological activity of physiologically active compounds does not coincide with the pharmacological activity of the concentrated trace elements. An example of such discrepancies is the fruits of bird cherry that contain tannins and are used as astringent, and also accumulate cobalt which plays an important role in hematopoiesis. The diversity of action of the physiologically active compounds and the concentrated element in this case is obvious, but it is not taken into consideration in the use of cherry preparations.

Thus, the data on concentration of certain elements in plants helps us note new aspects of their practical application, which will obviously contribute to a deeper understanding of the already known, as well as identifying new medicinal properties of these species.
FUNCTIONAL NUTRITION PRODUCTS

The composition of foods has a great influence on the human body. Depending on the quality and food safety assurance, food can be a guarantee of health and disease, because the substances received by the body affect every cell, every organ of the entire system. In recent years, many people, especially the poor, are constantly exposed to the health risks due to adverse environmental factors and junk food.

The rapid development of science and technology, environmental pollution and urbanization have played a fatal role in human nutrition in this century. The daily diet of every person has become richer in taste sensations, but less balanced in composition.

Modern life is closely connected to technological progress, the declining share of manual labor and the increase of mental stress intensity, which leads to the reduction of energy consumption and, consequently, reduces the amount of consumed food. However, the human need for essential micronutrients - vitamins, minerals and biologically active substances - remains at the same level, which is not provided by the reduced amount of consumed food. Therefore, the amount and quality of consumed food, its composition and nutritional value are paramount in the normal life of the human body.

The results of extensive research on the actual nutritional and health status of people living in various regions indicate a persistent violation of the nutritional status. The most significant role in the degree of negative impact on public health is played by the lack of micronutrients - vitamins, minerals, fatty acids – that causes malfunction of the antioxidant defense system of the body, the development of immunodeficiency states and, as a consequence, a sharp decline in the body's resistance to adverse environmental factors.

The most important factors of eating disorders are:

- vitamin deficiency, a particularly unfavorable situation is noted with vitamin C, the lack of which has been noted in 80-90% of the population. 40-80% of the population is not provided with vitamins B₁, B₂, B₆, folic acid, more than 40% of the population lacks carotene, etc. The vitamin deficiency disease is characterized by the lack of vitamins C, B and carotene at the same time, i.e. is actually polyhypovitaminosis. This permanent non-favorable factor has an all-season nature and is noted in almost all populations in all regions of the country;
  - lack of minerals (calcium, iron);
  - lack of trace elements (selenium, zinc, iodine, fluorine). A well-known problem is iodine deficiency that leads to serious diseases (goiter, cretinism, etc.);
  - lack of dietary fiber. The need for the production of dietary fiber and fiber rich food is connected with the increased consumption of refined products. It is estimated that the diet of a modern man has only 15-20 grams of dietary fiber whereas the daily rate of fiber is 40-70 g.
Dietary fiber is a complex consisting of polysaccharides - cellulose, hemicellulose, pectin, lignin and associated proteins, phenolic compounds, etc. Its main feature is poor digestibility in the initial parts of the digestive tract and its destruction in the colon.

The lack of dietary fiber in the diet leads to a decrease of the body’s resistance to the environment. As the environmental conditions on Earth are deteriorated, food is contaminated with toxic substances, and their separation from the digestive tract is, to some extent, dependent on the content of fiber in food. However, the development of hypodynamia, in turn, leads to a deterioration of the motor activity of the human intestine.

Scientists have noted a direct correlation between the lack of dietary fiber in the human diet and the massive development of a number of diseases, such as: 
- obesity, bowel disease, diabetes, atherosclerosis, coronary heart disease, etc.

One way to combat these ills is by filling food with dietary fiber;
- excessive consumption of animal fat and, as a result, the deficit of polyunsaturated fatty acids;
- lack of animal proteins.

Food is the source of proteins, carbohydrates, fat, vitamins, mineral substances, fibers, etc. A special role in the human body is played by the so-called essential nutrients. These include 8 essential amino acids, more than 15 vitamins and their precursors and about 20 mineral elements.

Per day a human should consume about 80 grams of protein with a complete set of essential amino acids, 75 g of fat, including saturated fatty acids, 300-320 g of carbohydrates, 2.5 liters of water, 12 g of sodium chloride, potassium, calcium, phosphorus, sulfur, and vitamins and minerals the total amount of which should be 0.5 g.

One of the main components of food is proteins. In the stomach, proteins are split into amino acids which are then absorbed into the blood and used by the body to build its own protein molecules. Plants and yeast, as well as microorganisms, are able to synthesize independently all the amino acids needed to build protein molecules. However, humans and some animals synthesize only a part of the 20 amino acids, while the rest should be consumed with food. These amino acids are called essential amino acids. Absolutely indispensable amino acids are: valine, isoleucine, lysine, methionine, leucine, phenylalanine, tryptophan and threonine. Despite the fact that the human diet usually contains a high proportion of animal products, the constant use of animal protein is not always beneficial for the human health, due to the fact that together with the protein the body receives a significant amount of saturated fatty acids, which could lead to a violation of the metabolic processes and, consequently, to the development of obesity, various diseases of the cardiovascular, digestive and other systems.

At the same time, bad health may be due to both: a lack of nutrition and its excessive consumption. Thus, today overweight and related serious diseases, such as diabetes, are referred to as diseases of the civilization. Therefore, the problem of
body weight correction is now one of the priorities of the State policy Concept in the field of healthy eating in the Russian Federation.

According to modern researches, a diet should provide us with the balance between food consumption and energy expenditure, and supply the body with necessary organic and inorganic nutrients.

Given the fact that the energy expenditure of modern man has declined significantly due to a number of objective reasons, the demand for energy derived from human food has also declined. As a result, it has become impossible to make up the deficit in certain nutrients with the help of a usual diet. This fact was the main reason for the creation and development of the production of a new group of products, called functional nutrition products.

One of the most important tasks in the process of improving the population’s nutrition structure is to increase the number of consumer products with high nutritional and biological values, including foods fortified with protein, vitamins and minerals.

The human body consists of about $10^{14}$ functioning cells that are constantly in need of essential nutrients that the body cannot produce itself.

More than 10 trillion cells are quantitatively constant throughout the human life period. Every day about 70 billion cells of the body die, and the body requires additional expenditures of biologically active substances to compensate its loss.

The minimal duration of the life of some human cells is 1-2 days. The intestinal epithelial cells and an average of 2 billion erythrocytes die every day. At the same time all cells experience intensive renewal of their elements and structures. All cells in the human body are functionally united with metabolic and regulatory processes. Their constant inner renewal ensures the security of the organs’ and systems’ functioning of our multicellular organism.

Insufficient amounts or lack of essential biologically active substances causes violation of biochemical reactions and functional processes. As a result, our body experiences irreversible or reversible changes which cause a number of diseases and disorders in human body.

It is known that food must supply the body with more than 600 different substances (nutrients), fully meeting the man’s need not only for energy, essential nutrients, macro- and micronutrients, but also for a number of non-food components.

The threat to human health arises not only when the body lacks essential nutrients, but also when it consumes alien and toxic substances. Therefore, optimally balanced foods are the main source of protective reactions of the body and its active functions. It should be borne in mind that unfavorable environmental factors cause a significant increase of the body’s expenditure of essential amino acids, vitamins and minerals to detoxify the organism. This causes larger deficit and therefore the body requires additional natural complexes in its diet, such as: amino acids, vitamins and minerals, but this fact is not always taken into account by the social and health services.
In addition, the current methods of food processing, the creation of the conditions for long-term storage have led to the reduction of the consumption of biologically active components, consumed directly with food. Therefore, the most promising way to eliminate micronutrient deficiencies is artificial food fortification.

As part of the development of the balanced diet concept a new direction in science was formed - functional nutrition, this includes the development of the theoretical footing of the production, sale and consumption of functional foods. The functional foods sector is the most comfortable, natural form of enriching the human body with micronutrients, including vitamins, minerals, trace elements and other components.

Practice shows that it is impossible to overcome the negative trends in health rate simply by declaring a healthy lifestyle and optimizing the nutritional status of the population only by means of propaganda, advertising and market development.

Modern food must not only meet the physiological needs of people in nutrients, but it should also perform preventive and curative functions.

Extensive international research shows that the most effective and affordable way to improve the population’s consumption of micronutrients is further enrichment of food products of mass consumption up to a level corresponding to their physiological needs. In most countries of the world this purpose is reached by adding vitamins, minerals and trace elements to flour, bread, pasta, soft drinks, milk and dairy products, etc.

In the recent years medical science and practice have greatly increased their attention to the nutrition problems. This is due to the understanding of the negative health effects that are caused by the violation of diets and the nutritional status of the population of EU, on the one hand, and the success of a number of basic sciences (eg, biochemistry, cell biology, nutrition studies), that have identified the role of individual macro-and micronutrients, nonfood bioactive food components in the functioning of human organs and systems, reducing the risk of developing a number of alimentary-dependent diseases - on the other.

At the same time the point of view on human food has changed. Today people have a stronger perception of the idea "Health comes with food". The modern man understands that food is necessary not only to supply the organism with nutrients and energy, but can also provide a directional effect on the body, increasing its resistance to adverse environmental factors, reducing the risk of heart disease, cancer and other diseases, eventually contributing to the extension of the active period and the duration life in general. This becomes possible with the consumption of so-called minor compounds with high biological activity, that are mostly found in raw materials of plant origin.

According to some researches, 700-1,000 species of wild fruit, berry and nut plants and over 250 species of mushrooms are potentially suitable for food. In addition to that, in the last decade, people again demonstrate interest to herbaceous plants, many of which are traditionally used in the pharmaceutical industry and pos-
sess certain food value. At the same time, the list of actually harvested and commercially important species is many times smaller and, in total, contains no more than 40-50 species of plants and about 10 species of mushrooms.

Despite the apparent "burst" of business activity in the field of wild raw material maintenance, its processing is restrained by insufficient knowledge about most of the species. As a result, the so-called raw material waste (left over after processing), often having a very low energy value, includes a number of biologically and physiologically valuable components, mostly represented by dietary fiber, minerals and polyphenolic compounds. The imperfection of the technologies used in the industry leads to tonnage losses of these essential nutrients.

Subject to the gradual elimination of the deficit of knowledge in the field of processing technologies and taking into consideration the biological resources, many of the wild growing plants can meet the basic requirements for the plant raw materials used in the production of functional foods:

- the real and potential supply, with the possibility of harvesting and processing;
- the acceptability of the flavor and other organoleptic properties;
- the degree of scientific research of the physical, chemical and biochemical properties;
- the natural ability to maintain qualitative and quantitative chemical supply, in the complex technological processing of raw materials and during the subsequent storage in the form of semi-finished or final products.

Wild plant material can be a promising source of essential nutrients. It is of great value, primarily due to specific combinations of biologically and physiologically active substances that are difficult to create artificially, and that are well accepted by the human body, having a therapeutic and/or preventive effect.

All parts of fruit and herbaceous raw materials, including leaves, stems, roots, rhizomes, flowers and seeds are a natural source of many biologically active forms of natural compounds. However, despite the obvious natural potential and the availability of raw material, the data of socio-economic development of the food industry suggests that the consumption of the main suppliers of polyphenols and polyunsaturated fats (fresh vegetables, fruits and berries, nuts) in the last 25 years hasn’t reached even half of the norm; a similar situation can also be noted with the physiologically active components of wild mushroom products. To some extent, this shortage in supply can be eliminated if we take into account that the current researches (eg, sparing methods of drying fruit and herb raw material [388]), allow to preserve not only the taste and aromatic properties of the material, but also a high quantitative supply of biologically and physiologically active substances. If necessary, antinutritive specific components of the raw material chemical composition can be destroyed, the best studied of which today are the proteinase inhibitors and antivitamins - polyphenol and ascorbate oxidases. These same techniques can help destroy or significantly change the content of compounds that have a poorly marked toxicity.

Taking into consideration the ratio and the quality of protein, fat and carbohydrates, the products of primary processing (extracts, juices, oils, oilcakes and s,
freeze dried powders, etc.) - with rare exceptions - cannot be regarded as final functional products. However, the highly specific composition of the physiologically functional ingredients makes most species of wild raw material appropriate for industrial processing and the production of a wide range of functional products and bioactive elements, the demand for which today has a tendency to increase.

The main method of application of herb and wild fruit material is still the production of beverages, despite the fact that this material is quite promising for the production of a wide range of confectionery products and functional food concentrates. Due to the widest range of valuable substances – macro-and micronutrients, dietary fiber, polyphenols, organic acids, vitamins, etc., - the introduction of wild raw material to formulations should help obtain functional foods and dietary supplements, that not only have acceptable organoleptic characteristics and nutritional value, but also a number of set properties - tonic, antioxidant, adaptogenic, detoxicant, etc., - that cause a direct physiological effect of the final product onto the human body. Some experience in this field of research is already available, but in general it describes the use of plants with distinct pharmacological properties.

Another promising sphere of research is the enrichment of oils, spreads, mayonnaise, pastes with herbal extracts and products of fruit and oil vegetables processing. The introduction of oil extracts from plant material into the composition of these products contributes not only to fortification and/or stable oxidation, but also enriches them with other components, the effect of which is noted at the physiological level of the cells and tissues of the human body, - with polyunsaturated fatty acids, phospholipids, sterols, etc.

Another problem that needs to be solved is complex processing of ferns and fungi, whose chitin, protein and lipid complexes have attracted the attention of pharmacists and nutritionists for many years. The isolation of the chemical composition of these groups of wild plants, expressed in a significant content of insoluble dietary fiber and isoprenoids, determines the perspective of using them as a basis for the productions of functional canned products and semi-products used in the canned industry.

The concept of functional foods as an independent scientific and applied sphere of healthy nutrition was developed in the early 1990s. According to modern views, the term "functional food" means food intended for regular use in diets of all age groups of the healthy population, that reduces the risk of diseases connected with diets, maintains and improves health due to the presence of physiologically functional food ingredients in its composition.

Fortified food products - functional food products produced by adding one or more physiologically functional food ingredients into traditional foods in order to prevent or improve the nutritional deficiency in the human organism.

A physiologically functional food ingredient is a substance or complex of animal, plant, microbial or mineral origin or identical to natural, or live microorganisms that are part of functional foods, that (with the systematic use in amounts of from 10% to 50% of the daily physiological needs) have the ability to provide a beneficial effect on one or more physiological functions, metabolic processes in the
human body. Physiologically functional food ingredients include biologically active and/or physiologically valuable, safe ingredients that possess exact physical and chemical characteristics, identified and scientifically based properties, set standards of daily consumption as part of food products, and are useful for maintaining and improving health: dietary fiber, vitamins, minerals, fatty acids, probiotics, prebiotics, and synbiotics.

**Probiotic food products** - functional food products that contain (as physiologically functional food ingredients) specially selected useful strains (nonpathogenic and non-toxic) of live microorganisms which have a positive effect on the human body through the normalization of the digestive tract.

**Probiotic** is a physiologically functional food ingredient in the form of useful strains (nonpathogenic and non-toxic) living organisms, which, if used systematically in the form of medical preparations or biologically active additives to food or as part of food products, have a positive effect on the human body as a result of normalization of the composition and/or excitation of the biological activity of the normal intestinal microflora.

**Prebiotic** is a physiologically functional food ingredient in the form of a substance or combination of substances, which, if used systematically as part of food products, provides a beneficial effect on the human body by selectively stimulating the growth and/or excitation the biological activity of the normal intestinal microflora. The main types of prebiotics are di- and trisaccharides, oligosaccharides and polysaccharides, polyols, amino acids and peptides, enzymes, organic low molecular and unsaturated higher fatty acids, antioxidants, beneficial to human microbial and herbal extracts, etc.

**Synbiotic** is a physiologically functional food ingredient, which is a combination of probiotics and prebiotics in which probiotics and prebiotics have a synergistic effect on the physiological functions and metabolic processes in the body.

**Food additives** are natural or artificial substances or mixtures, generally not used as a food product, intentionally introduced into the foods during their production process in order to give them specific properties or maintain the quality and extend their shelf life.

**Biologically active additives (BAA)** are an additional source of nutritional and biologically active substances, used to optimize the carbohydrate, fat, protein, vitamin and other types of metabolism in different functional states, to normalize and improve the functional status of organs and systems of the human body; including products with a tonic, diuretic, sedative and other types of activities in different functional states, that reduce the risk of disease and normalize the microflora of the gastrointestinal tract.

**Nutrients** are chemical substances, parts of food that the body uses to build and repair its organs and tissues, as well as energy sources.

**Nutraceuticals** are biologically active food supplements, which are used to correct the chemical composition of human food. The purpose of the introduction of nutraceuticals into the diet (as food additives or part of food products) is to improve the nutritional status of a person, improve health and prevent diseases by correcting
the content of natural essential macro- and micronutrients in the daily diet to a level corresponding to the physiological needs of a healthy person. The functional role of nutraceuticals requires fulfilling the following tasks:

- compensating the deficiency of essential nutrients;
- carrying out directed changes in the metabolism of substances;
- increasing resistance to environmental factors;
- performing immunomodulatory effects;
- binding and excretion of xenobiotics;
- supplying with healthy nutrition.

**Macronutrients** are the main class of nutrients, which are sources of energy and structural materials. They are present in food in relatively large quantities (1 g), e.g.: carbohydrates, proteins, and lipids.

**Micronutrients** are a class of nutrients that have pronounced biological effects on various body functions. They are found in food, usually in small amounts (milligrams, micrograms). This class includes: vitamins, precursors of vitamin and vitamin-like substances, as well as minerals.

**Parapharmaceuticals** are biologically active food additives used for prevention, supportive care and support (in physiological limits) of the functional activity of organs and systems. Parapharmaceuticals are so-called "minor" (included in the relatively small quantities) food components, which include organic acids, bioflavonoids, biogenic amines, caffeine, certain oligosaccharides, di-and oligopeptides, etc. Their daily dose should not exceed a single therapeutic dose defined in the application of the substance as a medicine. The sources of these elements are food and medicinal plants, which have been widely used since ancient times for the prevention of various diseases and improving health. The main condition for the use of plants as parapharmaceuticals is the permission for their use in the food industry as well as part of the dry raw material for preparation of drinks and teas in accordance with the requirements of pharmacopoeia.

**Eubiotics** are dietary supplements, which contain live microorganisms and/or their metabolites. They have a normalizing effect on the structure and biological activity of the microflora in the digestive tract.

According to the current classification, all foods can be divided into 5 groups:

1. Traditional and new products of mass use.
2. Functional foods of mass use.
3. Special foods for special groups of population.
5. Baby food.

According to the characteristics of the contents and properties of functional food products, if compared to traditional, and taking into consideration the specificity of their production, scientists name three main categories of functional foods:

- Traditional foods containing significant amounts of one or more physiologically functional ingredients in their native form;
• Traditional foods, in which the amount of harmful components that hinder biological activity or the physiological effect of their beneficial ingredients is technologically reduced;
• Traditional foods enriched with additional functional ingredients via different technological methods.

Initially, the main categories of physiologically functional ingredients, proposed by Japanese researchers for the production of functional foods were lactic acid bacteria and bifid bacteria, oligosaccharides, dietary fiber and omega-3 fatty acids.

The fact that Japan the world’s leader in life expectancy is closely connected to the widespread use of probiotic and prebiotic products.

All functional food products contain ingredients which determine their directional effect. Today there are seven main types of functional ingredients: dietary fiber (soluble and insoluble), vitamins, minerals, polyunsaturated fats, antioxidants, oligosaccharides (as substrates for useful bacteria), and a group that includes trace elements, bifid bacteria, etc.

Scientists propose the following classification of functional foods:
• Enriched/fortified - containing certain micronutrients;
• Dietary and used for nutritional therapy - aimed at the treatment of alimentary-dependent human diseases;
• Therapeutic and preventive - aimed at the prevention of common diseases (cardiovascular diseases, obesity, etc.);
• Special – used for the treatment of specific body functions (radioprotective, immunomodulatory, detoxification, used to power the body in extreme conditions);
• Used for treating children and for geriatric use.

In recent years, much attention is paid not only to the nutrients (28-32) that the human body cannot synthesize (essential nutritional factors): essential amino acids, their balance, polyunsaturated fatty acids (the ratio between individual acids), vitamins, dietary fiber, but also to the content of alien material (harmful substances) that enters the food in the following chain: field - raw material - processing of raw material - food. The range of such substances is very wide: heavy metals, pesticides, antibiotics, etc., as well as sources of radioactive contamination of raw materials and finished products. Recent studies show that food products may contain genotoxicants, mutagens, carcinogens and other elements that are harmful and hazardous for the human health. They may also have a negative impact on future generations.

Equally important is the task to increase the resistance of the human body to adverse environmental conditions. A large role in this process is played by the valuable and safe food products and natural biocorrectors of the new generation.

Due to different approaches in classification and systematization of functional food products there are classifications based on the target groups of the products and those that are based on types of raw material used for the production of the functional foods. Taking into consideration the fact that this material is aimed at students, studying the subject “Producing food from plant raw material”, the authors have deliberately narrowed the amount of analyzed components that can be used for the production of functional foods. The authors lay emphasis on the usage of plant material
as a source of biologically active components that can transform ordinary foods into functional products.

**METHODS OF FUNCTIONAL FOODS PRODUCTION**

**GRAIN PRODUCTS**

Cereal products (cereals, pasta and bakery products) are the main products used for food. They contain almost all essential components that are necessary for nutrition and normal life. Consuming grain products in different forms meets the energy needs of a person by 40-50%, protein requirements by 30-40%, vitamins of the B-group by 50-60%, and the needs in vitamin E up to 80%.

The nutritional value of cereals is determined primarily by their carbohydrates which are the basis of these products. Carbohydrate complexes of grain and flour, which are used in the production of cereals, contain a large amount of higher polysaccharides (starch, cellulose, hemicellulose, pentosans). Flour also contains small quantities of sugar-like polysaccharides (di- and trisaccharides) and simple sugars (glucose, fructose).

Starch is the most important carbohydrate contained in flour in the form of grains with the size from 0.002 to 0.15 mm. The size, shape, swelling and gelatinization capacity of starch grains is different for different types of flour. The size and integrity of the starch granules influence the consistency of dough, its moisture content and the content of sugar. Small and damaged starch grains saccharify faster than large and dense grains in the process of baking bread.

Starch grains, apart from starch itself, contain small amount of phosphorus, silicon, fatty acids and other substances.

Starch is characterized by a strong adsorption capacity, therefore it can bind large amounts of water at 30°C, i.e., at a temperature when dough is formed.

The structure of starch grain is fine and crystal. The grains are not heterogeneous, they consist of two polysaccharides: amylose, which forms the interior of the starch grains, and amylopectin, which forms its outer part. The quantitative ratio of amylose and amylopectin in the starch of various cereals is 1:3 to 1:3.5.

Fiber (cellulose) is located in the peripheral parts of the grain, and therefore is found in greater quantity in low grade flour, that is characterized by high yield. Therefore wholemeal flour contains about 2.3% of fiber, whereas premium class wheat flour contains 0.10-0.15%. Fiber is not digested by the human body and reduces the nutritional value of flour. However, in some cases, the high content of fiber is useful, because fiber improves the peristalsis of the intestinal tract.

Hemicellulose that is also part of the grain is a polysaccharide related to pentosans and hexosans. According to its physical and chemical properties, it is an intermediate between starch and cellulose, and is an indigestible carbohydrate. The
main component of hemicellulose is pentosan, the content of which depends on the type of flour.

Thus, premium class wheat flour contains 2.6% of the total amount of pentosans in the grain and the flour of the II grade - 25.5%. Pentosans can be soluble and insoluble. Insoluble pentosans swell in water, absorbing the amount at least 10 times larger than their mass.

Soluble pentosans or carbohydrate slime give very viscous solutions that transform into dense gels under the influence of oxidants. Wheat flour contains 1.8-2.0% of mucus, rye flour- almost twice as much, hence the difference between the structural and mechanical properties of wheat and rye dough.

The total lipid content in whole wheat grain is about 2.7% and in wheat flour – 1.6-2.0%. In flour the lipids are present both in their free state and in the form of complexes with proteins (lipoproteins) and carbohydrates (glycolipids). Scientists estimate that the proportion of bound lipids is about 7% of their total content in flour. Recent studies have shown that lipids bound with gluten proteins significantly affect its physical properties.

Fat, which is present in flour in its free state, has a liquid consistency. It consists primarily of the glycerides of unsaturated fatty acids: oleic, linoleic (mainly) and linolenic that have a high nutritional value.

During storage and processing flour experiences fat hydrolysis; and the further transformations of the forming free fatty acids significantly affect the acidity, taste and gluten properties of the flour.

Phosphatides are flour lipoids – they are esters of glycerol and fatty acids, containing phosphoric acid bound with any basic nitrogen.

The content of phosphatide in flour is 0.4-0.7%. Flour phosphatides belong to the lecithin group, in which the basic nitrogen is presented by choline. Lecithins have a high nutritional value and are of great biological importance. They easily form compounds with proteins (lipoprotein complexes), which play an important role in the life of every cell. Being hydrophilic colloids, lecithins swell in water and are used in food industry as emulsifiers and bread improvers.

Flour consists mainly of organic matter and some of quantity of mineral elements (ash constituents). Minerals in the grains are concentrated mainly in the aleurone layer, membranes and the bud. An especially large amount of minerals is found in the aleurone layer, the mineral content in the endosperm is low (0.3-0.5%) and increases from the center to the periphery, therefore the ash content is considered to be the indicator of the flour class. The higher the grade, the fewer minerals it contains.

Most of the minerals present in flour are phosphorus (50%), potassium (30%), magnesium, and calcium (15%).

Trace elements (copper, manganese, zinc, etc.) are present in very small amounts. The content of iron in the ash of different kinds of flour is 0,18-0,26%. A large proportion of phosphorus (50-70%) is present in the form of phytin - Ca-Mg-salt of the inositol phosphoric acid.
Despite of the high energy value caused by the significant amount of carbohydrates, grain products are not considered adequate – they have a non-balanced amino acid composition due to little contents of lysine and methionine, which are essential amino acids. Cereals have a deficiency in certain vitamins and minerals. In this regard, one of the ways of increasing the nutritional value of cereals is their artificial enrichment with vital food components by adding raw material that contains a variety of useful components in an amount sufficient to provide the daily needs of people in key nutritional elements, subject to regular use of these products at recommended doses.

Usually raw material of plant origin is used as an additive, enriched with biologically active substances, in the process baking bread. For these purposes, specialists use crushed to powder, previously dried herbs or fruit: the leaves and flowers of primrose, dandelion leaves, peppermint and thyme herbage, collected in the period of maximum accumulation of biologically active substances, and dog rose fruits.

Traditionally, fruit and vegetable semi-products are recommended for use in the manufacture of wheat flour products. In this case, these additives do not only improve the nutritional value, but also perform an aesthetic function, giving the products a characteristic color and flavor, such as yellow (using carrots). Samples of bakery products made with 1% of primrose leaves have a nice golden color. Bakery products with the powder of primrose flowers obtained the color of amber.

In addition to color, the taste characteristics of foods also change. Bakery products with a 0.5 and 1% content of peppermint and thyme, a 2 and 3% content of primrose leaves and flowers acquire pleasant herbaceous tones in taste and smell, samples with primrose flowers obtained a subtle honey flavor, and those with peppermint leaves - a refreshing taste and flavor of menthol. Dandelion leaves give the finished product a weak bitter taste.

Baked goods with "Erakond" - a concentrated plant extract of alfalfa - have a uniform, thin, fine porosity, an elastic and tender crumb and a smooth golden crust. Such goods demonstrated a slow process of the staling. When baking bread with phytoextracts of "Erakond" the yeast expenditure is reduced by 25-50%. Bakery products with "Erakond" have a pleasant taste and light aroma of herbs. The expenditure of "Erakond" is 0.1% of the finished product (1 g per 1 kg of bread). The phytoextract of alfalfa has a therapeutic and healing effect (recommended by the Ministry of Health of the Republic of Bashkortostan, is included in the anti-cancer program of the Republic of Bashkortostan and regional programs for the prevention of diseases of children).

The enrichment of white bread with dog rose powder not only improves the preventive functions of the product, but, as it turned out, due to the relatively high content of ascorbic acid dog rose powder serves as a natural baking improver, as it intensifies dough fermentation.

A promising source of biologically active compounds for the production of functional bakery products is the secondary products of liquor production. The main semi-finished products in the distillery are fruit drinks obtained by infusing water-alcohol mixtures and dry fruits and berries: dog rose, black currant, mountain ash,
lingonberries, cranberries, blueberries, dried apricots, prunes, raisins, etc. The fruits and berries left after the process of infusion are dumped. However, only 15% of plant material extractives is transmitted into the drinks, so that the wastes turn out to be a valuable raw material, promising for use in bread making. Trial bread and the tasting of finished products showed a high quality of bread and the maintenance of the characteristic color, smell and taste of the products.

Certain interest is shown in the prospect of using semi-manufactured goods on the basis of fruits and vegetables in the manufacture of products from rye flour and a mixture of rye and wheat flour.

Adding vegetable powders to the bread recipe can increase the content of indigestible carbohydrates - cellulose and pectin substances. The good sorption capacity of pectin reduces the content of heavy metals, including lead, cadmium, etc. in the digestive tract, which is especially important in unfavorable ecological situations. In addition, pectin elements remove radionuclides, excess cholesterol and other harmful substances from the body. A rich source of pectin is apple flesh. In this regard, specialists develop bread recipes with the addition of apple powder or dried apples.

Seaweed Laminaria japonica Aresch. (L.) Edmon. in blends with pectin can be the source of pectin and iodine. The plant contains a high molecular polysaccharide laminarin (up to 21%), mannitol (up to 21%), fructose (4%), alginic acid (up to 25%), a significant amount of iodine, most of which is present in the form of iodide (40-90%) and iodorganic compounds (diiodotyrosine - 2.7-3.0%).

Bakery products with a preventative effect can be produced on the base of leavened dough, yeast, water and an aqueous 5% solution of the extract of beggars-ticks. The extract is prepared by mixing herbs with distilled water in a ratio of 1: 12, infusing it for 6 hours at 85°C and then boiling the extract at a low temperature and reduced pressure for 10-12 hours and adding it to flour at an amount of 1.0-4.2% of the flour weight. The use of the extract provides the products with high organoleptic properties, enriches the diet with macro-and micronutrients at a low cost and use of available raw materials.

Specialists have created recipes of "Buckthorn" muffins using sea buckthorn puree and juice, "Snowball" muffins with the addition of snowball puree, "Ashberry" muffins with the addition of ashberry puree for the usage in preventive nutrition.

Bakery products with the addition of fatless sea buckthorn cake and cowberry marc and cranberries are able to bind heavy metals and remove them from the human body, due to the contents of pectin, a significant amount of fiber and hemicellulose, which are natural ion exchangers. It was found that 1 g of sea buckthorn cake can bind 1678 mg/g of lead ions, 1 g of fresh cowberry and cranberry marc - 1344 mg/g - 1 557 mg/g, respectively, drained and chopped berry marc bind slightly more lead ions - up to 1 405 and 1 595 mg/g for cowberry and cranberry, respectively.

These results were confirmed by studies in vivo, by a 30-day addition of dishes, culinary, pastry and bakery products with sea buckthorn berry cake and marc to the diet of workers at number of industrial enterprises with a high content of lead in the working atmosphere. After the experiment the lead content in the workers’
urine declined considerably. This function of cake and marc can be used in developing new products and recommendations for diet corrections in areas with high levels of anthropogenic pollution.

A number of studies have shown that it is possible to replace 5-20% of flour and 5-10% of sugar in main semi-finished biscuit, short, gingerbread, yeast and wafer dough with sea buckthorn cake. The introduction of buckthorn cake has a positive effect on the change in the organoleptic quality of semi-finished products (depending on the amount added cake):

- changes the color of semi-finished products (from golden to dark brown);
- gives finished products taste and aroma of sea buckthorn (from gentle to pronounced);
- slows down staling processes, because of the high water-holding capacity of its components - cellulose, hemicellulose, pectins.

This allows eliminating completely (or reducing) the addition of cocoa powder and artificial flavors during the production of biscuits, short pastry semi-products, cakes, breads and wafers. In this case, the energy value of products is reduced by 3-6%. The use of sea buckthorn cake enriches pastry and bakery products with food fibers by 2.5-6.0 times, with minerals and vitamins: the calcium content increases by 1.3 times, magnesium by 1.9 times, phosphorus - 1.2, iron - 2.3-2.5, vitamin B1 - 1.3-2.0; PP – by 2.6 times.

One of the promising areas of enriching bakery products is to add amniotic membranes of pine nuts (the so-called "jacket") into their composition. The membranes are a source of dietary fiber, fatty acids, protein and a number of trace elements. This not only increases the nutritional value of the products, but also improves the rheological properties of the dough, increases the shelf life of products, due to the introduction of fats present in the "jacket" into the recipes.

Pasta, enriched dietary supplements of plant origin, can also be used as preventive food products. Of particular interest are the pasta made using leaf and seed proteins of amaranth. Prior to the discovery of America amaranth Amaranthus cruentus L. was for thousands of years one of the main foods of the Native Americans. Later this plant was undeservedly forgotten, but now amaranth is widely used in many countries as an effective nutritional supplement that has a set of useful features. At the same time the improvement of the nutritional value of pasta with the introduction of such additives as amaranth is accompanied by the worsening of the appearance of finished products, for example, the color of pasta darkens. This can be avoided by introducing a color-corrective element β-carotene when kneading dough together with ground amaranth seeds at a dosage of 0.1% of the flour weight in the form of a water-in-oil emulsion.

The most popular pastry is flour confectionery, because the products have good taste characteristics and high energy value, due to a high content of digestible carbohydrates.

Traditional confectionery recipes in recent years are being improved in order to receive a finished product with high protective properties. New products are de-
veloped: sugar cookies with maltitol and sorbitol, with lactoserum, cakes and muffins with vegetable and berry puree, biscuits with soy protein and triticale flour that have preventive properties.

However, their significant disadvantage is a low protein content and incomplete fat from the point of view of biological effectiveness. Due to this fact it is considered perspective in the development of formulations of pastry to enrich them with a protein-fat complex, for example, contained in pine nut oilcake. Oilcake is the second most important product in pine nut processing. It contains 31.6% of protein, 21.4% of fat, 0.4% of minerals in scaled in terms of dry matter. Pine nut proteins are highly digestible if compared to other types of plant material - the coefficient of their utility is 60-70%, the lipid fraction is rich in polyunsaturated fatty acids, tocopherols and phospholipids; digestible carbohydrates (starch, sucrose) and fiber are present in the ratio of 5:1, among the water-soluble vitamins the dominating position is held by group B vitamins and the mineral composition includes about 20 macro- and microelements.

The introduction of pine nut oilcake into the dough in an amount of 12.5-25% of flour weight significantly impacts and improves the organoleptic quality of the confectionery products - they acquire a characteristic nutty smell and taste, and has a positive effect on the nutritional value of the products: increases the mass fraction of protein and fat, approaching rational ratio of protein and carbohydrate intake, and enriches the diet with polyunsaturated fatty acids.

Stevia presents practical interest for the confectionery industry – it is a natural herbal sweetener that has unique curative and healthy properties.

Stevia harmonizes all systems of the body, stimulates tissue breathing, normalizes the enzyme systems, restores carbohydrate, lipid and protein metabolism, lowers cholesterol, provides immunomodulatory, anti-stress and anti-inflammatory effects, neutralizes and removes toxins, nourishes the endocrine system, stabilizes blood pressure, restores blood circulation, stimulates the digestive and urinary system.

Powder made from stevia leaves contains complex physiologically beneficial nutrients: diterpene glycosides, proteins, lipids, fiber, vitamins, macro- and micronutrients, amino acids, fatty acids, flavonoids, essential oils. Therefore, the products with the addition of stevia can be recommended not only for patients with diabetes and obesity, but also for children and the elderly.

The introduction of stevia leaf powder into the recipes of pastry products helps ensure a high organoleptic and physic-chemical quality and has no negative impact on the consumer properties of the finished products in standard conditions and during the allowable storage period.

Therefore the production of semi-finished biscuit products with the replacement of sucrose by a sweetener made from stevia leaf powder, results in obtaining low calorie, high-protein products with a larger amount of fiber, minerals and vitamins than in the ordinary products. These products are essentially free of mono- and di-saccharides, is contraindicated in patients with diabetes and obesity.
DAIRY PRODUCTS

Among the vast variety of products of animal and vegetable origin the most perfect, that is most valuable in the nutritional and biological sense, are milk and dairy products.

Milk is a product of clinical and preventive nutrition. A milk diet can reduce the incidence of common diseases such as diabetes, arthritis, cardiovascular disease.

However, not all people can consume dairy products due to hypolactasia – an eating disorder, in which the intestine does not produce the lactase enzyme, which breaks up milk sugar. This disease affects about one third of the adult population. The fact is that initially the production of this enzyme stopped after the breastfeeding period and the ability to digest milk came in adults as a result of mutation. In the Netherlands, Denmark and Sweden, where they breed dairy cows, 90% of the population drinks milk without any harm to health, and in China, where dairy farming is not developed - only 2-5% of adults.

In cases of lactose intolerance milk should be replaced with cultured milk foods in which this disaccharide is fermented by the action of lactic acid microorganisms and breaks up.

Milk contains a wide range of inorganic and organic substances. The inorganic elements are sodium, potassium, calcium, magnesium, manganese, iron, cobalt, copper, zinc, derivatives of phosphoric acid, chloride, iodide, carbonate, dissolved carbon dioxide. Milk also contains proteins (casein, albumin, globulins, lactoferrin, protein membranes of fat globules), lipids (fats, phospholipids, cholesterol esters, fat-like substances), carbohydrates (the main of them is lactose, that belongs to disaccharides, and small amounts of glucose and galactose), vitamins (A, B₁, B₂, B₆, B₁₂, С, Е, D, H, K, PP). This is the reason why milk is so valuable in terms of nutrition. Its biological activity and uniqueness is also caused by the presence of a small amount of enzymes. Milk from healthy animals provides more than 20 enzymes. The composition of milk and some dairy products is presented in Table 12.

One of the most characteristic features of milk and dairy products is the mineral content. The average content of trace elements in milk (mg%) is: calcium - 120, phosphorus - 95, potassium - 140, sodium - 50, magnesium - 12, chlorine - 100.

Calcium salts. Calcium salts are of great importance for humans, especially for children. In milk calcium is present in an easily digestible and well balanced with phosphorus form. Thus, the ratio of calcium and phosphorus in milk is 1:1, while in meat and fish, it is, respectively, 1:13 and 1:11. About 80% of the man’s daily requirement for calcium is met by consuming milk and dairy products. About 22% of calcium in milk is bound with casein; the remaining amount is present as phosphate and citrate. Calcium phosphates are found mainly in the colloidal state; and only a small proportion (30%) - in the form of a true solution. During fermentation the main amount of calcium is transmitted into whey.

Magnesium salts have an important role in the development of immunity of newborn children. The magnesium content in the milk is small - about 12-14 mg%.
The proportion of magnesium salts that are present in milk in the form of a true solution is about 65-70%.

Table 12
The composition of milk and certain milk products

<table>
<thead>
<tr>
<th>Product</th>
<th>Contents, %</th>
<th>Contents, mg %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protein</td>
<td>Fat</td>
</tr>
<tr>
<td>Pasteurized milk</td>
<td>2,8</td>
<td>3,2</td>
</tr>
<tr>
<td>Kefir (fatty)</td>
<td>2,8</td>
<td>3,2</td>
</tr>
<tr>
<td>Sour cream, 20%</td>
<td>2,6</td>
<td>20</td>
</tr>
<tr>
<td>Cottage cheese (semi-fatty)</td>
<td>16,7</td>
<td>9</td>
</tr>
<tr>
<td>Butter</td>
<td>0,6</td>
<td>82,5</td>
</tr>
<tr>
<td>Cheese</td>
<td>26,8</td>
<td>27,3</td>
</tr>
</tbody>
</table>

**Phosphoric acid salts.** Phosphorus is present in milk in the ionic form and is part of caseinogen and the composition of salts (PO$_4^{3-}$, HPO$_4^{2-}$, H$_2$PO$_4$). Phosphates, as well as citrates, regulate the amount of ionized calcium in milk, which affects the size and stability of casein micelles.

According to digestibility and balanced amino acid composition milk proteins are among the most biologically valuable. Their absorption is 96-98%.

The protein content in the milk is 2.9-4.0%. They ensure the normal development of the growing organism and adult nutrition; differ in structure, physical and chemical properties and biological functions.

Milk proteins are divided into three groups:
- casein proteins (78-85%) - α-casein, β-casein, γ-caseins, χ-caseins;
- whey proteins (19%) - β-lactoglobulin, α-lactalbumin, immunoglobulins, lactoferrin;
- proteins of the membranes of fat globules (1%).

Casein (caseinogen) - the main milk protein - is a complex protein. It is a complex of calcium caseinate with colloidal calcium phosphate - the so-called casein calcium phosphate complex. The formation of such a complex is due to the presence of large amounts of serine phosphate groups in the casein molecule, which are capable of forming calcium caseinate. Due to the structure-forming ability of calcium caseinogenes are self-associated into micelles:
Calcium caseinate in the interaction with the colloidal calcium phosphate forms a bridge of inorganic calcium phosphate:

bridge of calcium phosphate

The so-called casein calcium phosphate complex

Caseinogen is present in milk in the form of water-soluble calcium salt. At the isoelectric point (pH being 4.6) caseinogen enters an unstable state and precipitates.

Dried casein is a white odorless, tasteless powder, almost insoluble in water and organic solvents, soluble in aqueous salt solutions and dilute alkalis that precipitate when acidified.

Casein is capable of curdling. This process has an enzymatic nature. Due to this fact casein is easily accessible to digestive proteases in its native state, while all globular proteins acquire this property during denaturation. In case of partial proteolysis of casein, which occurs during the assimilation of milk by the newborn, physiologically active peptides regulating such important functions as digestion, blood flow to the brain, the central nervous system activity, etc. are formed.

In order to separate casein milk is acidified to a pH of 4.7, which causes the precipitation of casein. Precipitated casein contains almost all amino acids required by the body (including the essential ones) and is the main component of yogurt and
cheese. Casein lacks only sulfur-containing amino acids, but they present in whey milk proteins.

After precipitation of casein 15-22% of all proteins (called whey proteins) are left in the whey. The most important are: α-lactalbumin, β-lactoglobulin, immunoglobulins and components of the proteose-peptone faction. Apart from them, whey also contains lactoferrin and enzymes.

Whey proteins are the most valuable part of milk according to the content of essential amino acids, surpassing casein in terms of biological value. They are globular proteins, which in contrast to casein are not able to associate and precipitate at the isoelectric point. They are heterogeneous and have important biological functions.

β-Lactoglobulin (β-Lg) is the most important protein in terms of quantitative content; it is thermostable. Its biological function is that it moves macro- and micro-nutrients, vitamins and lipids into the intestines. Its thermal denaturation leads to the coagulation of aggregated protein (it coagulates almost totally at 85-100°C) and the formation of complexes with χ-casein.

α-Lactalbumin (α-La) is second according to the quantitative content (2-5% of the total protein in milk). It is involved in the synthesis of lactose (is part of the lactose-synthesizing system). As immunoglobulins, it is transmitted into milk from the circulatory system of the animal. It is the most heat stable of all the whey proteins due of the presence of disulfide bonds. If cooled and in the presence of calcium ions α-La is able to restore its native structure by 80-90%.

Immunoglobulins are complex proteins (glycoproteins). They are heat-labile proteins that coagulate at temperatures above 70°C. They have the properties of antibodies and perform protective functions.

Lactoferrin is a red iron-binding protein. Its main feature is the transportation of iron, it also has a bacteriostatic effect on the intestinal microflora, binding iron and making it inaccessible to the action of microorganisms.

Whey proteins contain more amino acids than milk casein. They are used by the body for structural exchange, mainly for protein synthesis of the liver, the formation of hemoglobin and blood plasma. The composition of whey protein is similar to the protein composition of human milk and human muscle, which makes them more digestible. Whey helps the body to remove excessive fluid and split and remove waste products; it perfectly quenches thirst and contains water-soluble vitamins and mineral compounds that allow the body to function normally with any diet. Therefore, whey and products derived from it are essential in the diet of the elderly, and people who have a sedentary lifestyle and suffer from overweight. These properties of whey allow make it possible to use it as the basis for the production of functional beverages by enriching it with the addition of fruit and berry juices and extracts of medicinal plants.

Milk albumins and globulins have all the properties of their protein groups: they coagulate during boiling and salted out by saturated (albumin) and half-saturated (globulins) solutions of ammonium sulfate.
The lipid fraction of milk is a source of biologically valuable polyunsaturated fatty acids and fat-soluble vitamins. The fat content in milk ranges from 2.8 to 5%.

Milk fat compared to other animal fats is better absorbed by the body. The coefficient of milk fat digestibility is 97-99%. The high degree of its assimilation is due, firstly, to a relatively low melting point of fat (28-33 °C) and, secondly, to its presence in the milk in a finely dispersed form.

Milk is a natural emulsion of fat in water. The fat phase is present in water in the form of small droplets of fat, covered with a protein-lecithin membrane. According to the chemical structure milk fat is a complex mixture of acyl glycerines with a different fatty acid composition that determines its properties. Among the saturated fatty acids in milk fat are: oil, caproic, lauric, palmitic, myristic and stearic acids; among the unsaturated are: oleic, linoleic, linolenic and arachidonic acids. The low-molecular fatty acids (butyric, caprylic and caproic) form the specific taste of milk fat. The total content of saturated acids ranges from 58 to 77%. In the summer their amount is smaller and in winter it increases; the amount of unsaturated acids increases and decreases the other way round. This is due to differences in the diets and physiological characteristics of the animal organism.

During storing milk experiences fat hydrolysis under the action of lipase, the amount of free fatty acids increases due to the emergence of oil, caproic acid and other acids, and as a result milk obtains a rancid taste and its quality becomes poor.

Milk fat contains 0.30-0.55% of concomitant substances that are presented by sterols (mainly cholesterol in its free state or in the form of ether) and phospholipids (lecithin, cephalin) that have emulsifying properties. The yellow color of milk fat is due to the presence of tetraterpenes - carotenoids. The content of carotenoids in milk varies from 0.05 to 0.09 mg/kg, in the summer their amount increases.

The perspective of using lipids in the food industry is connected with the idea of using them for partial or complete replacement of commonly used ingredients that are harmful to the physiological processes in the body, and the idea of fortifying foods with essential phospholipids and creating new functional food products with preventive and curative properties.

The use of phospholipids in the production of functional foods is also important due to their antioxidant properties, which are manifested in the inactivation of heavy metals that enter the body from the atmosphere and food. Furthermore, phospholipids react with peroxide radicals to form inactive compounds and exhibit synergy to other antioxidants, such as tocopherols.

Practically all minerals, macro- and micronutrients milk (macro: K, Na, Ca, Mg; microelements: Fe, Rb, Br, Zn, Cu, Ag, Au, Mn) and water soluble vitamins pass into whey.

Milk contains almost all vitamins necessary for normal human development. They are transferred into the milk from the fodder and are also synthesized by the fisting bag microflora. The average content of vitamins in milk is following (mg%): retinol (vitamin A) - 0.03, thiamine (vitamin B₁) - 0.04, riboflavin (vitamin B₂) - 0.05, niacin (vitamin PP) - 0.10, ascorbic acid (vitamin C) - 1.50. The vitamin content in milk varies depending on the season, stage of lactation, the diet of the animals
and their individual characteristics. The dependence of the vitamin content on the food composition is especially typical for fat-soluble vitamins A, D, E and K. Their content in milk in the summer increases by 4-8 times, when animals eat a lot of green fodder. During milk storage and heat treatment the content of some vitamins can be reduced by 30-70%.

The most important indicator which determines the freshness of milk and its suitability for further processing on the dairy plants is acidity. Scientists distinguish titratable acidity, measured in Turner degrees (°T), and active acidity, measured in units of pH.

Titratable acidity is determined by acid salts - dihydrogen phosphate and dihydrogen citrate, carbonic acids, proteins and other components. Turner degrees indicate the amount (cm$^3$) of 0.1% sodium hydroxide solution required to neutralize the acid reacting substances contained in 100 cm$^3$ of milk. The acidity of fresh milk is about 16-18 °T, and if the acidity reaches 27-30 °T the milk curdles during boiling.

Active acidity demonstrates the concentration of hydrogen ions. Whole milk’s active acidity is within 6.55-6.75. The constant pH index is maintained by the buffer systems of phosphates and citrates in the milk.

The acidic environment prevents active reproduction of microorganisms in milk, particularly in the first few hours after milking. During long term storage in inadequate conditions the activity of microorganisms (not only lactic-acids but also pathogenic) and other factors causes an increase of the acid content in milk. This results either in the "souring" of milk, or, as technologists say, in the loss of its thermal stability - when heated (during pasteurization or sterilization) such milk curdles (i.e. experiences protein coagulation). The increase in acidity is typical of dairy products (cottage cheese) and beverages (yogurt, sour clotted milk, etc.) that are initially acidic. Such results indicate the inobservance of the storage conditions.

For the fortification, i.e. enrichment of dairy products with vitamins A, B, E, and in order to expand their variety (yogurt, margarine, light oil, mayonnaise, processed cheese) specialists use a whole range of plant extracts with aromatic, coloring, antioxidant, stabilizing and therapeutic properties.

Juices perfectly enhance the organoleptic properties of whey, giving additional useful properties of beverages, enriching them with vitamins, organic acids, trace elements, etc.

In this case, stevioside is interesting not only as a natural sweetener, but also as a synergistic of flavor compositions, which is particularly important in the beverage industry.

Functional milk drinks have qualitatively new organoleptic properties, high physiological value and a low calorie level. They contain a wide range of vitamins ($B_1$, $B_2$, $B_6$, choline) which play an important role in the removal of toxic substances, and macronutrients (calcium, phosphorus, magnesium, sodium, etc.), free amino acids, polyunsaturated fatty acids, flavonoids and other compounds; have a positive effect on the digestive, nervous, cardiovascular system of the human organism and increase the body's resistance to disease.
Scientists constantly develop new types of cultured milk beverages, improve the types of bacterial yeast, and create highly effective complexes of pro- and prebiotics.

Examples of a new generation of dairy drinks are: a drinking yoghurt 2Bio of the Neo series (produced by the Wimm-Bill-Dann company), containing a soluble dietary fiber Fibregum (obtained from acacia gum) as a prebiotic and a set of bifid bacteria and lactobacteria - as a probiotic; a kefir Bio-Max (Wimm-Bill-Dann), containing a prebiotic complex of insulin and pectin; a drink Actimel (the French company Danone), containing a probiotic complex (lactobacteria \textit{L. casei defensis}) and prebiotics (pectin, guar gum, algarroba gum). These drinks significantly enhance the immunity and the organism’s resistance to various diseases.

Today, the food industry produces a variety of milk-based beverages using recipes presented in Table 13. However, in order to fully meet the taste preferences of a maximum number of different population segments the variety of such drinks should be at least ten times larger.

One of the factors hindering the mass introduction of milk-based drinks into the everyday human diet is the fairly rapid decline of their consumer properties. This decrease is due to the tendency of such beverages to spontaneous exfoliation that is caused by an extreme instability of the protein complex in milk and cultured milk products, especially during the medium reaction that inevitably takes place when the diary base is mixed with a subacid (or acid) fruit or berry or a nearly neutral (up to slightly alkaline) vegetable mass.

Therefore, in order to stabilize such drinks and prevent their exfoliation during production and storage specialists add apple pectin with a degree of esterification of 60-70% into the beverage [389]. While increasing the stability of the product, this component also enhances its functionality due to the pectins’ ability to bind cations of polyvalent metals into insoluble complexes.

The special means of producing such drinks is based on the following order of mixing the individual components: sugar syrup, pectin solution and concentrated vegetable puree are added into constantly stirred milk. If the major component of the vegetable puree is pumpkin, then, in order to improve its consumer properties, it is additionally flavored with a 5 mg% vanilla powder and a 0.5 mg% aqueous extract of cinnamon. In most cases, a cold drink is produced as chilled milk is mixed with the semi-finished puree. Therefore, before sterilization, the drink is either heated to 70-80°C, or the puree, pre-heated up to 80-90°C, is added during production. The heated mixture is then homogenized at a pressure of 15-20 MPa.
### Table 13
Recipes of fruit and vegetable milk drinks [390]

<table>
<thead>
<tr>
<th>Drink type</th>
<th>Contents %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>puree</td>
</tr>
<tr>
<td>Apple milk</td>
<td>35</td>
</tr>
<tr>
<td>Quince milk</td>
<td>35</td>
</tr>
<tr>
<td>Pear milk</td>
<td>35</td>
</tr>
<tr>
<td>Peach milk</td>
<td>35</td>
</tr>
<tr>
<td>Apricot milk</td>
<td>35</td>
</tr>
<tr>
<td>Plum milk</td>
<td>35</td>
</tr>
<tr>
<td>Strawberry milk</td>
<td>35</td>
</tr>
<tr>
<td>Raspberry milk</td>
<td>10</td>
</tr>
<tr>
<td>Grape milk</td>
<td>20</td>
</tr>
<tr>
<td>Carrot milk</td>
<td>20</td>
</tr>
<tr>
<td>Pumpkin milk</td>
<td>20</td>
</tr>
<tr>
<td>Tomato milk</td>
<td>30</td>
</tr>
<tr>
<td>Orange milk</td>
<td>15</td>
</tr>
<tr>
<td>Blackcurrant milk</td>
<td>10</td>
</tr>
</tbody>
</table>

Therefore, the beverage produced is characterized by the following physicochemical parameters (Table 14).

### Table 14
The physico-chemical properties of vegetable milk drinks

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Pumpkin</th>
<th>Carrot</th>
<th>Tomato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids (according to the refractometer), %</td>
<td>12,8</td>
<td>13,0</td>
<td>12,7</td>
</tr>
<tr>
<td>Sugar (total), %</td>
<td>10,4</td>
<td>10,6</td>
<td>10,0</td>
</tr>
<tr>
<td>Total acidity, %</td>
<td>0,52</td>
<td>0,55</td>
<td>0,46</td>
</tr>
<tr>
<td>pH</td>
<td>3,94</td>
<td>4,03</td>
<td>4,09</td>
</tr>
<tr>
<td>Carotenoids (total), mg %</td>
<td>1,90</td>
<td>3,10</td>
<td>3,18</td>
</tr>
<tr>
<td>Proteins, %</td>
<td>1,83</td>
<td>1,83</td>
<td>1,92</td>
</tr>
<tr>
<td>Soluble pectin, %</td>
<td>0,20</td>
<td>0,24</td>
<td>-</td>
</tr>
<tr>
<td>Expiration time, starting from</td>
<td>374,0</td>
<td>315,0</td>
<td>88,0</td>
</tr>
<tr>
<td>Exfoliation, cm</td>
<td>none</td>
<td>none</td>
<td>5,5</td>
</tr>
<tr>
<td>Calorie, cal/100 g</td>
<td>50</td>
<td>51</td>
<td>50</td>
</tr>
</tbody>
</table>

Fruit and vegetable milk drinks in glass jars can be stored at room temperature for up to 2 years.

The enrichment of milk - the most common and indispensable baby food - with fluoride is effective in preventing caries. Fluoride strengthens the structure of...
the tooth enamel, providing it with mineral nutrition, restoring lime contents, reducing the influence of bacterial acids. Fluorinated milk can be pasteurized and sterilized. Mostly, for fluorination, scientists use sodium fluoride, and sometimes - sodium monofluorophosphate.

The use of sea buckthorn fruits containing a set of water- and fat-soluble vitamins and vitamin-like compounds, polyunsaturated acids, organic acids, pectin, minerals and other substances, in the dairy industry is very promising.

Milk-fat products with the addition of sea buckthorn have a delicate aroma and taste formed by mixing the flavors of milk and sea buckthorn fruits.

The specialists of the Kemerovo Technological Institute of Food Industry have developed a complex technology of processing sea buckthorn and producing sea buckthorn juice, and oil-vitamin product with antioxidant properties, a food additive from sea buckthorn cake and biological supplements from the pulp. These products can be used as essential dietary supplements in the production of butter for special and medical purposes.

The usage of sea buckthorn for the enrichment of butter is a new direction in the production of functional milk-fat products the consumption of which is recommended for people of all age groups as well as for people suffering from various diseases caused by diet violations. The introduction of buckthorn-based biologically active additives into butter satisfies the body's need for vitamins, minerals, proteins and polyunsaturated fatty acids, because the lipid fraction in sea buckthorn products is similar to that of ideal butter in terms of fatty acid composition - it contains up to 32.5% of saturated, up to 55% monounsaturated and 16.5% polyunsaturated fatty acids.

Among high-protein milk products the main role is played by cheeses which are essential in the human diet due to their biological properties. Despite the balanced amino acid composition, the disadvantage of these products is the predominance of saturated fatty acids in the lipo-complex, therefore, the combination of materials that include milk and vegetable oils results in a good food balance according to the fatty acid composition. For example, the introduction of the pine nut cake into cheese products not only gives them a delicious taste, but also promotes a significant increase in the degree of unsaturation of fatty acids in the lipo-complex of product; this increases the content of omega-3 and omega-6 acids, which is particularly important. Along with the pine nut cake, in order to increase the biological value of cheese products, specialists use boiled cep mushrooms, dried aromatic herbs, smoked salmon, honey.

One of the most promising types of raw material used as a component of functional products is dietary milk protein. In this regard, a series of health-care milk-protein products were developed, the main components of which are dietary milk protein and a prophylactic emulsion with the addition of β-carotene and aspartame.

Milk protein is characterized by properties such as the absence of chemical stimuli of the gastrointestinal tract, low acidity and soft texture, as well as curative properties, expressed in anti-hypocalcemic, hypocholesterolemic and protective effects on the human body.
MEAT PRODUCTS

Meat is one of the most valuable foods. It is necessary for humans as material used for the construction of tissue, synthesis and metabolism and as a source of energy.

Meat is the carcasses and their parts that are received in result of slaughter; the composition of meat includes muscle, fat, bone, connective tissue and blood. Tissue is the group of cells, identical in their morphological structure, that have specific functions and are united by the intercellular substance. The ratio of muscle, fat, connective tissue and bone varies widely not only in different kinds of meat, but also within the same type. The structure, composition and properties of the tissues are different. The properties and proportion of tissues determine the quality of meat.

The nutritional value of meat and meat products depends on the content of protein, fat, carbohydrates, extractives, vitamins, macro- and micronutrients, as well as the variety and content of the essential amino acids in the proteins and of unsaturated fatty acids in the fat.

Thus, the chemical composition of the meat is very complex and is generally characterized by the composition of the basic tissue.

In the living organism the muscle tissue occupies the first place in terms of mass; so its amount is over 40% of the body weight. Muscle tissue is involved in blood circulation, breathing and other important bodily functions.

Muscle tissue contains (in %): water - 70-75, proteins - 18-22, lipids - 2-3, extractives - 1.7-3.05 (including nitrogen-free - 0.7-1.35), inorganic salts - 1-1.5, carbohydrates - 0.5-3, enzymes and vitamins.

Proteins. The share of proteins is 60-80% of the solid weight or 18-22% of the muscle tissue mass. Muscle proteins are used for the creation of structural cell components: the sarcoplasm, myofibrils and organelles.

Muscle proteins are divided into proteins soluble in water (sarcoplasmic proteins), proteins soluble in salt solutions (myofibrillar proteins), and proteins insoluble in aqueous or salt solutions (the so-called stroma proteins that are part of the sarcolemma and the intramuscular connective tissue, as well as proteins of the nuclei).

Sarcoplasmic proteins make up 20-25% of the muscle proteins. These include myogen, myoalbumin, globulin X and myoglobin. Except for myoglobin, they are mixtures of proteins with important physical, chemical and biological properties. In terms of solubility and salting-out myoalbumin is a typical albumin and myogen is quite close to albumin. Globulin X is a pseudoglobulin as it dissolves well enough in a low salt concentration (1-1.5%) in the muscle tissue and can be transmitted into the solution via water extraction. Myoglobin is also a water-soluble protein. Thus, sarcoplasmic proteins are mainly water-soluble.

Myogen, myoalbumin and globulin X are simple, whole, well-digestible proteins. The isoelectric point of the myogenis fraction is 6.0-6.7 pH; that of myoalbumin is 3-3.5, and globulin X - 5.2.
Myoglobin can be easily bound with some gases (O₂, CO, NO, etc.). During this process the valence of iron, which is part of the protein, does not change and the following derivatives of myoglobin are formed: scarlet red oxymyoglobin (MbO₂), cherry red carboxymyoglobin (MbCO) and red nitrosomyoglobin (MbNO). Under the influence of strong oxidants (oxygen, hydrogen peroxide, etc.) heme iron loses one electron and becomes trivalent. Due to such oxidation myoglobin becomes brown methmyoglobin (MMb). Methmyoglobin can be restored to myoglobin only by strong restorative agents, such as ascorbic acid. In the interaction with hydrogen sulfide in the presence of oxygen sulfomyoglobin - a green pigment - is formed. Table salt accelerates the process; therefore salted muscle tissue loses its natural color and becomes gray-brown in color with various shades.

Despite the small amount (about 1% of the total protein) of myoglobin in the muscles, it plays an important role in the transfer of oxygen from the blood cells to muscle tissue. Myoglobin is a whole protein, and its isoelectric point is 7.0 pH.

**Myofibrillar proteins** - myosin, actin, actomyosin, tropomyosin, etc. - make up to 80% of the muscle proteins and are involved in the process of muscle contraction.

The share of myosin is about 40% of the proteins in muscle tissue; it belongs to fibrous proteins that are long fibrillar threads with a globular head and are made up of two large and two small polypeptide chains. Large polypeptide chains wound in α-helix and twisted relative to each other, form a double helix. At the end of the myosin molecule two shorter polypeptide chains are attached to the helix extending it. But they are not united into a singular helix, but form a spherical bulge - the head. A large number of polar groups and the fibrillar form of the molecule are responsible for the significant hydration of myosin (the ability to hold a lot of water). Myosin molecules easily interact with each other and with other proteins, such as actin, forming the actomyosin compounds. Myosin is an adequate, well-digested protein. The isoelectric point of myosin is 5.4 pH.

Actin makes up 12-15% of the muscle proteins and exists in two forms: globular (G-actin) and fibrillar (F-actin) that transform one into another. Their physical and chemical properties differ dramatically. G-actin molecules are spherical, their weight is 47,000; G-actin can polymerize to form F-actin. Such aggregation happens during small changes in the salt content and the pH level of the medium. Polymerization is accelerated in the presence of adenosine triphosphate (ATP). When salts are removed, e.g. in dialysis, the opposite process happens.

F-actin consists of two G-actin chains that form a double helix, each spiral carrying 200-300 globule-like beads. The molecular weight of F-actin reaches 1,500,000. Actin is a whole, well-digested protein.

Actomyosin is a complex protein. It is formed when the myosin molecule heads are attached to the actin beads in the myosin H-groups and the actin OH-groups. Due to the fact that the actin chain contains a large number of G-actin molecules, each F-actin thread can bind a large amount of myosin. One of the important properties of the actomyosin complex is its ability to dissociate in the presence of ATP and Mg²⁺. Actomyosin is poorly soluble in water, and its solution has a high
viscosity, which depends on the ratio of actin and myosin: the larger the amount of actin, the higher the viscosity. The molecular weight of actomyosin varies widely, since the ratio of actin and myosin in the actomyosin complex may be different.

Tropomyosin is a fibrillar protein with a highly elongated shape. It accounts for 10-12% of myofibrillar proteins or 2.5% of muscle proteins. It is soluble in water, but cannot be removed from the muscle tissue with water, indicating that it is bound with water-insoluble proteins of the myofibrils. Tropomyosin is composed of two similar polypeptide chains that form a double helix; it interacts with F-actin and is involved in muscle contraction. Tropomyosin is a partial protein, as it doesn’t contain tryptophan. Its isoelectric point is 5.1 pH and the molecular weight is 130,000.

Contractile proteins also include troponin, actinin and other proteins contained in the myofibrils.

Stromal proteins are part of the sarcolemma and the loose connective tissue uniting muscle fibers into bundles and nuclear proteins. These proteins are not soluble in aqueous salt solutions. They include connective tissue proteins: scleroproteins - collagen, elastin and reticulin, and glycoproteins - mucins and mucoids. The latter are mucous proteins with protective properties that facilitate muscle bundles sliding. These proteins are removed by alkaline solutions.

Lipids. Muscle lipids are represented by fats and phospholipids and the ster-ides - by free and bound cholesterol. Lipids that make up the muscle tissue have several functions. Some of them, mainly phospholipids, are the plastic material, and are components of the mitochondria, myofibrils and cell membranes. Other lipids act as a backup energy source. These lipids, mostly fats, are found in the sarcoplasm of the muscle fiber in the form of tiny droplets, due to which the sarcoplasm has a cloudy form. A large amount of lipids is found in the intercellular space between the muscle bundles in the layers of connective tissue. The contents lipids and their components in the muscle tissue varies widely and depends on the nutritional status, species, age, sex of the animal and other factors.

Carbohydrates. The amount of carbohydrates in the muscle tissue is relatively large. They consist mainly of glycogen (animal starch) and glucose. The content of glycogen in the muscles depends on the nutritional status of the animal: the muscles of poorly fed, exhausted, hungry and sick animals contain 2-3 times less carbohydrates than the muscles of animals in the normal physiological state. In addition, hardworking animal muscles contain 1.5 times as much glycogen than non-working. The muscles of animals immediately after slaughter contain 0.3-0.9% (sometimes up to 2%) of glycogen and 0.5% of glucose.

Minerals. Muscle tissue contains mineral substances the amount of which in the muscles of cattle is given in Table 15.
Table 15
The mineral content in the muscle tissue of cattle

<table>
<thead>
<tr>
<th>Chemical element</th>
<th>Content in the muscles, in%</th>
<th>Chemical element</th>
<th>Content in the muscles, in%</th>
</tr>
</thead>
<tbody>
<tr>
<td>phosphorus</td>
<td>0,20</td>
<td>potassium</td>
<td>0,34</td>
</tr>
<tr>
<td>sodium</td>
<td>0,065</td>
<td>calcium</td>
<td>0,01</td>
</tr>
<tr>
<td>copper</td>
<td>0,00011</td>
<td>manganese</td>
<td>0,000024</td>
</tr>
<tr>
<td>cobalt</td>
<td>0,000004</td>
<td>molybdenum</td>
<td>0,0075</td>
</tr>
<tr>
<td>Nickel</td>
<td>0,008</td>
<td>Magnesium</td>
<td>0,019</td>
</tr>
<tr>
<td>iron</td>
<td>0,0027</td>
<td>zinc</td>
<td>0,0034</td>
</tr>
<tr>
<td>aluminum</td>
<td>0,0005</td>
<td>lead</td>
<td>0,008</td>
</tr>
<tr>
<td>chromium</td>
<td>0,011</td>
<td>fluoride</td>
<td>0,03</td>
</tr>
<tr>
<td>iodine</td>
<td>0,014</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In comparison with other micronutrients, the largest amount of minerals contained in the muscle tissue is that of potassium and phosphorus. A large proportion of potassium and calcium is bound with proteins. The interaction of potassium, magnesium and calcium with actin, myosin and ATP is essential in the process of contraction and relaxation of the myofibrils. The content of trace elements depends on the type of animal. For example, the mutton contains almost 2 times more fluoride than beef; it has a more beneficial physiological ratio of fluoride and chromium (120 mcg of fluoride in mutton and 63 mcg in beef per 100 grams of edible meat). The consumption mutton increases the resistance of tooth enamel to caries and, to some extent, protects the body from disorders of the carbohydrate metabolism.

**Vitamins.** Muscle tissue contains almost all water-soluble vitamins except for vitamin C. The fat-soluble vitamins A ($2 \times 10^{-4}$%) and D ($10^{-6}$%) are present in small amounts in the lipid part of the muscles. The amount of vitamins depends on the animal species and their nutritional status.

**Extractives.** When the muscle tissue is treated with water, in addition to proteins and lipids, a number of organic substances (called extractives) is also extracted. Scientists distinguish nitrogen and nitrogen-free extractives. Nitrogen-free extractive substances include carbohydrates, products of their metabolism, vitamins and organic phosphates. Products of the metabolism of carbohydrates are glucose, maltose and organic acids: lactic acid, pyruvic acid, succinic acid and others, most of which are accounted for by lactic acid.

Nitrogen extractives are substances containing nitrogen, but not related to proteins. Among them are the final products of protein metabolism (urea, uric acid, ammonium salt), intermediate products (purine bases, amino acids, etc.), and substances which perform specific functions in element and energy metabolism of the animal.
After slaughter extractives and their transformation products are responsible for the specific taste and smell of meat that appears during its maturation.

Meat maturation is an autolytic process that takes place after the termination of the life of the animal, during which the meat becomes tender, juicy and obtains the specific taste and aroma.

The meat quality obtained during its maturity depends on the complex of the enzymatic processes leading to changes in the composition and the condition of the major meat components.

Changes of meat consistency play an important role in the transformation of connective tissue proteins, mainly collagen. It is believed that the effect of acids produced in the process of meat maturation, causes loosening of the collagen bundles and weakening of the intermolecular cross-links, which gives the meat additional tenderness.

In the process of meat maturation the levels of the following free amino acids significantly increase: histidine, aspartic acid, glycine, threonine, tyrosine, phenylalanine, etc. The content of monosaccharides - glucose, galactose, ribose - also increases.

Changes in protein elements, flavoring and aromatic properties of meat during its maturation and autolysis influenced by tissue enzymes make the product more accessible for the action of digestive enzymes, therefore, mature meat is better digested and absorbed.

An important role in this process is played by cathepsins. This is a group of tissue intracellular enzymes - endopeptidases that split the internal peptide bonds of protein molecules. Among cathepsins special attention should be paid to the so-called serine proteases: elastase that hydrolyzes elastin and cathepsin and splits collagen; and collagenase that also splits collagen. These enzymes are active at neutral pH. In contrast, cathepsin B₁ splits collagen and proteoglycans at pH 5.0-6.0 (the value of meat maturation). Softening of collagen causes an increase of meat tenderness.

The process of meat maturation can be significantly sped up by the addition of flavonoids in combination with ascorbic acid into meat semi-finished products [361].

Meat products can be enriched with dietary fibers and bioactive substances by processed products of plant origin. Dietary fibers that are indigestible carbohydrates - cellulose, ballast substances - are a large group of nutrients that are derived from plant products: grains, fruits and vegetables. Dietary fibers adsorb significant amounts of bile acids, as well as other metabolites, toxins and electrolytes, and thus help to detoxify the body. Due to their ion-exchange properties fibers can exteriorize ions of heavy metals and radionuclides. In addition, they have a positive effect on the treatment of functional diseases of the colon, reduce the level of cholesterol in the blood, have a hypolipidemic action, which allows them to be used for the prevention and treatment of various diseases, including cardiovascular.

For example, sea buckthorn flour left after the extraction of sea buckthorn oil is used for the production of meat products. This supplement enriches the product
with a complex of essential vitamins B, C and nicotinic acid and, in addition, the meat is enriched with fiber.

Apple pectins can be effective sorbents and are used in the production of bologna. The expenditure of dry apple powder is 2.5 kg per 100 kg of meat. Exceeding the specified application rate affects the organoleptic properties of the finished product. Apple powder is added last to avoid its darkening in the light. The presence of ascorbic acid in apple powder stabilizes the color of finished products and reduces the amount of nitrites.

A promising source of mineral supplements for meat products is dog rose cake, containing vitamins (C - 14.78%, thiamine, riboflavin), carbohydrates (glucose - 0.75%, fructose - 18.5%), flavonoids, carotenoids (2.87%), pectins (3.1%). The water extract of dog rose seeds has anabolic and adaptogenic effects.

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The addition of dried nettle improves the nutritional quality of sausages. Dry nettle ground to particles with the size of 6×6 mm and soaked in water to its native state is introduced into the finished minced beef at the rate of about 2 kg per 100 kg of meat.

Bologna obtains its spicy taste with the addition of thyme the essential oil of which contains thymol (30%) and carvacrol (20%) that have a specific flavor. Medicinal plants are very perspective in terms of their use as spicy and aromatic supplements. These plants contain significant quantities of essential oils, known for their bacteriostatic effect.

Minced meat is most convenient for the production of prophylactic products. It is made from raw meat and fat material ground in a meat grinder, with the addition of a dietary supplement in the amount of 2.7-4.0%, which is a mixture containing equal amounts of oilcake of the following medicinal plants: Siberian ginseng root, valerian root, peppermint leaves, thyme and motherwort. The cake mixture has particles with the size of 0.1 mm and is pre-soaked in water for 30 minutes. After that salt is added, the mixture is stirred and ground for the second time. N the meat is battered and shaped into semi-finished products in the form of round or oval-flat cutlets. The use of medicinal plants oilcake in the meat product enriches it with fiber, essential oils, magnesium and therefore improves the intestinal peristalsis. In addition, the introduction of this dietary supplement improves the structural and mechanical properties, color and organoleptic properties of the finished product.

During the long-standing practice of using protein preparations from various plant materials scientists have noted a possible reduction of the biological value of combined products due to the presence of trypsin inhibitors, hemagglutinins, the lysine-alanine complex, and the deterioration of certain organoleptic characteristics of finished products, such as taste, aroma. A cause for serious concern is also the fact that the soy proteins widely used in the production of meat products are mainly supplied by the U.S. producers and might be obtained from raw materials subjected to genetic modification. An alternative to soy protein in the manufacture of meat products is the use of milk protein-carbohydrate products.
Today the formation of gels in the meat industry includes the usage of carrageenans, gum, animal protein products created via enzymatic hydrolysis of connective tissue proteins and starch (including modified). Such technologies help specialists create the dense structure of products. These elements also have poor emulsifying properties, and therefore can be used in the production of meat.

The inclusion of meat products containing milk proteins into the human diet helps maintain their high nutritive and biological value, including the balance of their amino acid composition, reduce the calorie content and the level of saturated fatty acids and cholesterol. Such products can be recommended for preventive and nutritional use in all population groups, including children of preschool and school age.

According to their content and ratio of essential amino acids milk proteins are biologically complete proteins that contain a large amount of sulfur containing amino acids, which can be used to adjust the amino acid composition of meat products. Today, among the produced milk protein products special interest is paid to the demineralized whey protein concentrates, a milk protein concentrate and milk-vegetable protein preparations.

Milk-vegetable protein preparations are produced from skim milk, a whey protein concentrate, whey and a soy-based element called "Soy milk" via condensation and drying with spraying plants.

The introduction of demineralized whey protein preparations into food products increases their nutritional and biological value. Whey protein preparations have high emulsifying properties; they can be used in the manufacture of meat products. The production modified whey products from whey and the creation of new foods on their basis enables the multilateral usage of milk parts and increase the production of food with a balanced protein-carbohydrate and mineral composition.

Studies of the effect of alcohol extracts and infusions of some aromatic herbs and plants (oregano, St. John's wort) showed that they contribute not only to the formation of flavoring characteristics, but also influence such processes as secondary structure formation, dehydration, selective growth of microflora, which is especially important in the production of smoked and salted meat. These studies showed perspective of using a number of medicinal plants that contain significant amounts of essential oils in the development of new formulations of meat products and semi-finished products.

**SEAFOOD**

Fish and processed food products are the main seafood consumed by most of the world population. Fish proteins contain all the essential amino acids. This determines the value of fish as one of the most high-quality sources of protein. Fish contains muscle tissue proteins, connective tissue proteins, gonad proteins (reproductive products of caviar and milt), bone tissue proteins. Muscle tissue proteins are repre-
Presented by myofibrillar proteins (myosin, actin, actomyosin, etc.), sarcoplasmic proteins (myoglobin, albumin, globulin, etc.), sarcolemmal proteins (proteins of the muscle fiber membrane and its connective tissue endomysium and perimysium (collagen, elastin), muscle fiber core proteins (nucleoproteins, phosphoproteins). Myofibrillar proteins are salt-soluble. They are biologically valuable and have a high water-holding capacity. Their content reaches 75-80% of the total protein in the muscle tissue. The high content of hygroscopic proteins explains the low moisture loss during heat treatment and makes fish dishes (broiled, fried fish, etc.) juicy and digestible. Sarcoplasmic proteins (cytoplasm) are water soluble. Most of these are enzymes and accelerate biochemical processes during storage. Their content in muscle tissue is 18-20% of the total protein.

The sarcolemmal muscle fiber proteins (proteins of the membrane), proteins of the connective tissue organically linked with the membrane (endomysium), and the septa proteins (proteins of the stronger connective tissue - perimysium) are collagen and elastin. These are partial proteins and their structure does not contain the essential amino acid tryptophan. The content of elastin is very low (0.1%) and, therefore, connective tissue in fish is represented only by collagen. These proteins are resistant to different solutions. But under the influence of heat collagen breaks down and becomes a more soluble substance - gluten - is well absorbed by the body and in a form of an aqueous solution. Fish broth (like meat broth) is rich in gluten and its actual form is a sol that turns into a gel when cooled. Collagen is the source of some amino acids contained in complete proteins in small amounts, which provides collagen with a specific nutritional value. It is believed that glutenized collagen solutions strengthen the human heart muscle. Glutenized collagen has a very high hydrophilicity. Therefore, during heat treatment fish does not lose moisture, which provides the product with a delicate structure and a juicy texture.

Fresh fish contains 1.5-3 times more extractives than the meat of warm-blooded animals, and because of the high enzyme activity of fish the amount of nonprotein nitrogen compounds, which form the basic extractive properties of broth, grows rapidly during storage. Therefore, frequent consumption of fish products "tires" human taste receptors, which makes people seek for alternative sources of protein. The high content of extractives reduces the dietary value of fish.

The content of non-fish seafood in the total world production of aquatic food items is 10-15%. Today greatest commercial value is obtained by the following non-fish seafood products: crustaceans (crabs, shrimp, lobster, crayfish), bivalve mollusks (mussels, oysters, scallops), cephalopods (squid, cuttlefish, octopus) and gastropods (Latridiopsis), echinoderms (trepangs, holothurians (sea-cucumbers), sea-urchins, starfish), algae and seaweeds.

The high consumer value of the crustaceans has determined the people’s strong demand for them and the high prices. Among them crab, shrimp, lobster, crayfish and krill are of industrial importance. The most nutritionally valuable crustaceans are crabs. Their meat from the extremities and abdomen (partly) are used for consumption. The yield of edible meat in a male crab, depending on the weight, is
Crab meat is rich in proteins and minerals (iodine, copper, etc.). The specific feature of the amino acid composition of crab meat proteins is the high content of sulfur-containing amino acids (cystine, cysteine) and tyrosine, which affects the color change of the crab meat products during storage and preservation. Crab blood contains hemocyanin (not hemoglobin) which contains copper, not iron (in the hemogroup). Crabs are mainly used for canning, and are rarely used in the living form for the manufacture of frozen, cooked and dried meat.

Shrimp fishing represents more than half the volume of the total world crustaceans’ fishery. The edible meat of the shrimp is located in its tail. The yield of the edible shrimp meat is 30-40% depending on the weight. Shrimp meat contains protein - 19%, fat - 1%, carbohydrates - 1.4%, ash constituents - 1.3%, water - 77%. The specific feature of the amino acid composition of shrimp meat proteins is the high contents of essential amino acids - 36.5% of the total protein weight (this ratio in the egg white is 31.5%, in beef - 29.6%, in crab meat - 34.3%). Shrimp meat is tender and tasty; it is rich not only in protein, copper salts, iodine, vitamins, but also in salts of calcium, phosphorus, sulfur, and vitamins A, D. Shrimp meat is used in the production of canned and frozen raw and cooked products.

Increasingly important in the crustaceans’ fishery is krill (from the Dutch krill - “baby, tiny”). It is a small (length - 2.5-6.5 cm, weight - 0.3-1.2 g) red marine crayfish. Due to its similarity with shrimp krill is considered to be a minor Antarctic shrimp. It serves as food for whales, seals, penguins and fish. Krill contains 15% of protein, 3.5% of fat, 0.5% of carbohydrates, 3% of minerals and a large amount of pro-vitamin A and active enzymes. Immediately after fishing the proteolytic enzymes of krill initiate the hydrolysis of proteins, which leads to a change in color, taste and smell. In order to preserve the quality of krill and its products it is important to organize its proper storage and rapid manufacture. Krill is used for the production of protein paste and dry protein concentrate that are used in the preparation of tasty and nutritious food products, and in the production of sausages. Protein paste contains 17% of protein, 7% of fat, 2% of carbohydrates and 2% of ash constituents.

Crayfish are night aquatic crustaceans. Mollusks take the first place in the non-fish sea-food fishery. Today the share of shellfish artificial propagation (mari-culture) is increasing rapidly. The most widespread mollusks are bivalves (mussels, oysters, scallops) and cephalopods (squid, octopus, cuttlefish). Bivalves are shells with two valves containing the body of the mollusk. The valves are connected by the fixation muscle. The body of the mollusk is covered with a pallium - a meaty film in the form of large folds. The muscle and the pallium, as well as roe and milt are consumed as food. The edible part of the mollusk is 20-40%. The meat of the bivalves is rich in proteins (the scallop muscle), carbohydrates (mussels, oysters), minerals, especially iodine and copper.

Mollusk proteins contain up to 38% of essential amino acids. Their meat is valuable for its high contents of micronutrients: 7.5-12.5 mg%. For comparison: cod meat, which has a distinct iodide flavor and is considered to be a product with a high content of trace elements, contains 1.3 mg% of micronutrients. Another feature of
Scallop is the largest bivalve that reaches 20 cm in length and weighs up to 400 grams. The edible parts of the scallop (muscle, pallium, roe and milt) are used to produce natural canned food and culinary products. Oysters are sold and consumed only in their live form. The tissues of oysters contain many active enzymes, which have beneficial effects on the human body, but this leads to their rapid deterioration. The most popular cephalopod is the squid, whose reserves exceed those of fish; less valuable for the fishery are octopus and cuttlefish. The yield of edible parts of the squid (pallium, head with tentacles, liver) is 73-75%, that of octopus - 78%. Nutritionally squid meat is similar to the meat of fish.

The most popular product is salted fish. Spicy salted fish is in demand and is produced from small uncut fish with the fat content exceeding 14%. This fish has a particularly gentle and relatively fast maturing meat. Spicy fish prepared using the barrels and can method. Spicy salted fish in barrels is sold by weight or is used as a semi-finished product is the production of canned food. Sweet brine products are similar to spicy and pickled fish. They are produced using herring, sardines and salmon. Often these products are available for sale in 3-5 liter cans and are called specially salted herring, whereas in fact these are sweet brine products. One must keep in mind that some consumers prefer salted fish in the form of well matured herring that has a natural fish (not spicy) flavor. Therefore, it is necessary to develop sweet brine products both in barrels and cans. The use of sugar in salting makes the texture of finished products tender and oily and provides the products with a strong odor of mature fish. This is due to the fact that sugar promotes the development of aroma-forming bacteria. In addition, sugar softens the salty taste. The method os marinating is still used in the production of salted fish, i.e. fish is processed with salt and acetic acid. This method is often used to improve the consistency of heavy salted fish (Table 16). During heavy salting fish loses a lot of moisture and dissolved organic matter; its texture becomes thick, dense and does not provide a good taste. To loosen the muscles acetic acid is used. Usually marinating is carried out in barrels, but it is also used in the production of canned products. For marinating herring, sardines and anchovies are used. Maturation of marinated fish takes up to 20 days at 10.7°. The amount of salt is 6-10%, and the mass fraction of acetic acid is 0.6-1.0%. The second large group of salted maturing fish products is salmon. Salted salmon fishes, according to modern standards, are divided into the following groups: 1) salted salmon (salmon, Caspian salmon, Baltic salmon, lake salmon); 2) salted Pacific salmon (chum salmon, hunchback salmon, blueback salmon, Chinook salmon, loach, coho, cherry salmon); 3) salted white salmon and Siberian white salmon (backs and bellies) - balyk products; 4) salted chum salmon fished out in the lower regions of the Amur River; 5) whitefish (whitefish, Arctic cisco, grayling, broad whitefish, peled). According to the method of cutting salted salmon can be gutted and salmon cut, gutted, beheaded or presented as separate parts: back, belly, one piece or in slices. Salmon is fished mainly in the rivers of Murmansk and Arkhangelsk regions. Its meat is tender, fatty, boneless, pink and red. The fat content is up
to 20% or more. European salmon taste characteristics are due to the great tenderness of muscles and more numerous (than in other salmonids) layers of fat within the muscle tissue. Fat content of meat reaches 27%. The meat color is nice, yellow-pink, a bit little paler than the flesh of the Atlantic salmon. The meat of the Pacific light salted salmon is pink-red at the cut (blueback salmon is red) and has a tender meat texture. Heavy salted salmon has a more layered dry meat texture.

Salted chum salmon is produced in the form of gutted cut fish with the weight of at least 3.0 kg. The fat content in the flesh is at least 9%. Salted white salmon and Siberian white salmon are produced in the form backs and bellies. Their meat is white. According to their weight the backs and bellies (the abdominal part) are divided into large (the back of white salmon - 4.8 kg or more, the belly of the Siberian white salmon - 1.2 kg or more, the back of white salmon - 0.5 kg or more) and medium (the back of white salmon - less than 4.8 kg and the belly of white salmon - less than 1.2 kg). Whitefish belong to the *Salmonidae* family. Specialists distinguish European whitefish (whitefish of the Neva and Volkhov regions, lake whitefish, etc.) and Siberian (whitefish, pydschjan, broad whitefish, Arctic cisco, etc.). Among the Siberian whitefish only salted whitefish of the Ob region has relatively average gastronomic virtues, while the rest of salted fish are considered to be a delicacy. They contain 9-15% of fat in the meat and according to their food values and commercial qualities exceed the European whitefish. In terms of salt content in meat whitefish are divided into light salted (4-10%) and medium salted (over 10% to 14%). When the content of salt and fat reaches 4-8% and not less than 8%, respectively, fish is released for sale as a delicacy. It is made taking into account the fatness, proper dressing and salt content. The fat content in Kuril mackerel is at least 12%.
Table 16
Recopies spices (combined) and subsidiary products (gr.) used for spicy salting of 100 kg of small fish

<table>
<thead>
<tr>
<th>№</th>
<th>Components</th>
<th>Sprinkling</th>
<th>Black Sea anchovy, sardelle and anchovy</th>
<th>Cisco and white-fish</th>
<th>Filling for all types of fish</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sprat, Baltic herring and small herring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Anise (fruit)</td>
<td>–</td>
<td>75</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>Coriander (fruit)</td>
<td>38</td>
<td>150</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>Bay laurel (leaves)</td>
<td>110</td>
<td>20</td>
<td>150</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>Cumin (fruit)</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>Hops (cones)</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td><strong>Russian spices in total</strong></td>
<td><strong>148</strong></td>
<td><strong>345</strong></td>
<td><strong>350</strong></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cloves</td>
<td>75</td>
<td>12,5</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>Ginger</td>
<td>35</td>
<td>–</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>8</td>
<td>Cinnamon</td>
<td>75</td>
<td>12,5</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>9</td>
<td>Nutmeg</td>
<td>34</td>
<td>–</td>
<td>50</td>
<td>–</td>
</tr>
<tr>
<td>10</td>
<td>Mace</td>
<td>20</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>11</td>
<td>Allspice</td>
<td>190</td>
<td>50</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>12</td>
<td>Black pepper</td>
<td>110</td>
<td>125</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td><strong>Total import of spices</strong></td>
<td><strong>539</strong></td>
<td><strong>200</strong></td>
<td><strong>800</strong></td>
<td><strong>450</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total of all kinds of spices</strong></td>
<td><strong>687</strong></td>
<td><strong>545</strong></td>
<td><strong>1150</strong></td>
<td><strong>450</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Sugar (granulated)</td>
<td>445</td>
<td>800*</td>
<td>300</td>
<td>1500</td>
</tr>
<tr>
<td>14</td>
<td>Salt</td>
<td>14500**</td>
<td>14000</td>
<td>15000</td>
<td>16000</td>
</tr>
</tbody>
</table>

**ANIMAL FATS AND VEGETABLE OILS**

The major category of functional ingredients in food fats is presented by polyunsaturated fatty acids, phospholipids, sterols, vitamins, minerals, plant enzymes, dietary fiber, alcohol, etc. Thus, dietary fats can be considered to be a group of functional nutrition products.

In their chemical composition animal fats differ from most of the vegetable oils: they are rich in molecules of triglycerides of the following saturated fatty acids:
stearic, palmitic, myristic. Unsaturated fatty acids in animal fats are presented by a large quantity of oleic acid and to a lesser extent by the linoleic, linolenic and arachidonic acids. The specific feature of the fatty acid composition of rendered fats of land animals is the presence of arachidonic acid and of fish oils - nisinic and clupadonic acids. The arachidonic acid has four double bonds; the clupadonic and nisinic acids have five and six double bonds, respectively, and therefore are considered to be more biologically active. The physiological role of these acids is determined by their participation in the synthesis of hormones.

\[
\begin{align*}
\text{clupadonic acid} & \quad \text{CH}_3 \\
\text{nisinic acid} & \quad \text{CH}_3
\end{align*}
\]

One of the fat sources of the human body is fowl. The level of linoleic and arachidonic acids in bird fat makes the product highly biologically valuable. Thus, the broiler meat contains 5-20 times more fatty acid than beef or lamb.

Apart from triglycerides, animal fats, as well as vegetable oils, contain a large number of accompanying substances called lipids - phospholipids, vitamins, carotenoids, sterols.

One of the problems of preserving vitally important components in fats and oils is the protection of unsaturated fatty carboxylic acids from radical oxidation during processing, storage and preparation of food. This tendency is particularly strong among the most dietary valuable fats and oils containing unsaturated fatty acids [391]. Fat oxidation aggravates their organoleptic properties as well. For example, when butter becomes rancid it obtains an unpleasant odor of butanoic (butyric) acid; its nutritional and biological value reduces. The introduction of antioxidants not only improves the shelf life of fats and fat-containing products, but also gives them preventive properties.

The use of synthetic antioxidants is limited by their toxicity, high cost, the need for strict monitoring of their residues in foods. Natural antioxidants greatly simplify the process of their application because of complete absence of their adverse effects on the human body. For example, many plants contain antioxidants that are perspective for application in the food industry. Table 17 shows the antioxidant properties of alcoholic extracts of leaves and bark of certain plants [392], successfully used as antioxidant supplements.
Table 17
The antioxidant properties of alcoholic extracts of leaves of some plants

<table>
<thead>
<tr>
<th>Plants</th>
<th>Peroxide number of fats during oxidation</th>
<th>Pig fat</th>
<th>Sunflower oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control figure</td>
<td></td>
<td>2,5</td>
<td>2,5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Leaf extracts</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jasmine</td>
<td></td>
<td>22,1</td>
<td>44,6</td>
</tr>
<tr>
<td>Bird cherry</td>
<td></td>
<td>21,6</td>
<td>42,3</td>
</tr>
<tr>
<td>Gooseberries</td>
<td></td>
<td>18,9</td>
<td>37,5</td>
</tr>
<tr>
<td>Dog rose</td>
<td></td>
<td>18,7</td>
<td>28,5</td>
</tr>
<tr>
<td>Hazel</td>
<td></td>
<td>17,5</td>
<td>24,4</td>
</tr>
<tr>
<td>Currants</td>
<td></td>
<td>9,6</td>
<td>18,8</td>
</tr>
<tr>
<td>Lime</td>
<td></td>
<td>6,8</td>
<td>11,8</td>
</tr>
<tr>
<td>Oak</td>
<td></td>
<td>6,4</td>
<td>13,4</td>
</tr>
<tr>
<td>Apple tree</td>
<td></td>
<td>5,3</td>
<td>10,7</td>
</tr>
<tr>
<td>Birch</td>
<td></td>
<td>4,2</td>
<td>7,7</td>
</tr>
<tr>
<td><strong>Bark extracts</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bird cherry</td>
<td></td>
<td>20,5</td>
<td>40,5</td>
</tr>
<tr>
<td>Dog rose</td>
<td></td>
<td>13,6</td>
<td>22,5</td>
</tr>
<tr>
<td>Gooseberries</td>
<td></td>
<td>8,3</td>
<td>17,2</td>
</tr>
<tr>
<td>Currants</td>
<td></td>
<td>7,6</td>
<td>15,0</td>
</tr>
<tr>
<td>Oak</td>
<td></td>
<td>5,8</td>
<td>10,5</td>
</tr>
<tr>
<td>Lime</td>
<td></td>
<td>5,5</td>
<td>10,6</td>
</tr>
<tr>
<td>Apple tree</td>
<td></td>
<td>4,7</td>
<td>9,5</td>
</tr>
</tbody>
</table>

Alcoholic extracts are introduced into the fat samples in such an amount, so that the content of antioxidant substances is equivalent to their content during the administration of 5% of dry powdered bark or leaves into the fat.

Maximum antioxidant activity is demonstrated by herbs with high contents of phenolic and polyphenolic compounds, as well as vitamins A, E, K and C [393]. In addition, antioxidant activity is demonstrated by such biologically active compounds as terpenoids, carnosol, chamazulene, coumarin, quercetin and others that provide essential oils and the fatty acid complex with antioxidant properties.

table 18 shows the inhibition rate constants of extracts of several plants [394].
<table>
<thead>
<tr>
<th>Plants</th>
<th>Compounds providing antioxidant properties</th>
<th>Amount of antioxidants, $10^{-2}$ mol/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sage (herbage)</td>
<td>Terpenoids - up to 60% (camphor - 6.9, borneol-1.4, isothujone - 6.9% caryophyllene - 3%, ledol - 6%, epimaneol - 40.9%), steroids up to 7 %, tocopherols - 2.15%</td>
<td>10.1</td>
</tr>
<tr>
<td>Rosemary (herbage)</td>
<td>Terpenes and terpenoids up to 30.3% (borneol, camphor, verbenol, caryophyllene, cadinene, steroids), wax up to 24%</td>
<td>5.3</td>
</tr>
<tr>
<td>Chamomile (flowers)</td>
<td>Flavonoids up to 30% (farnesene, chamazulen, bisabolol, coumarin); sterols - up to 14%; tocopherols - up to 3%,</td>
<td>~2</td>
</tr>
<tr>
<td>Arrowwood (fruits)</td>
<td>Carotenoids, tocopherols - up to 1%</td>
<td>1.4</td>
</tr>
<tr>
<td>Carrot (fruits)</td>
<td>Terpenes - up to 16%, flavonoids - up to 9%, sterols -up to 2%</td>
<td>1.2</td>
</tr>
<tr>
<td>Hawthorn (fruits)</td>
<td>Triterpenes - up to 14%, tocopherols - up to 1%, carotenoids - up to 80 mg %</td>
<td>0.8</td>
</tr>
<tr>
<td>Pomegranate (seeds)</td>
<td>Benzoic acid - up to 0.1%, sterols - 1.3% tocopherols - 0.19%</td>
<td>0.6</td>
</tr>
<tr>
<td>Walnut (leaves)</td>
<td>Terpenoids up to 38%, quinones - up to 20%, sterols - 4.4%, tocopherols - 0.6%</td>
<td>0.5</td>
</tr>
<tr>
<td>Dog rose (seeds)</td>
<td>Carotenoids up to 70mg%, tocopherols - up to 2%</td>
<td>0.2</td>
</tr>
<tr>
<td>Parsley (seeds)</td>
<td>Terpenes - up to 23%, flavonoids (elemicin, apiol, germacrone) - up to 50%, tocopherols - 0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Green tea (leaves)</td>
<td>Terpenoids – up to 25% (catechins)</td>
<td>No noted presence of strong antioxi-</td>
</tr>
<tr>
<td>Milfoil/yarrow (herbage)</td>
<td>Terpenoids - up to 24% (including flavones), sterols - 12.3%; wax - 38.6%</td>
<td>dants, completely inhibiting oxida-</td>
</tr>
<tr>
<td>Rowan (fruit)</td>
<td>Flavonoids - up to 1%, carotenoids - up to 80 mg%, wax - up to 2.8%</td>
<td>No noted presence of strong antioxi-</td>
</tr>
</tbody>
</table>

262
<table>
<thead>
<tr>
<th>Plants</th>
<th>Compounds providing antioxidant properties</th>
<th>Amount of antioxidants, $10^{-2}$mol/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common wormwood (herbage)</td>
<td>Terpenes and terpenoids - up to 19% (flavonoids - up to 9%), steroids - 11.2%; vitamins A, E - up to 1%; wax - up to 60% of lipid peroxidation without the induction period</td>
<td></td>
</tr>
<tr>
<td>Grape (fruit)</td>
<td>Tocopherols - up to 3%, sterols - up to 0.1%</td>
<td></td>
</tr>
<tr>
<td>Sea buckthorn (fruit)</td>
<td>Terpenes (guaian - up to 1%), carotenoids - up to 300 mg%, wax - 1%</td>
<td></td>
</tr>
<tr>
<td>Fennel (fruit)</td>
<td>Terpenes - up to 50% terpenoids - up to 10%, tocopherols - up to 0.4%</td>
<td></td>
</tr>
</tbody>
</table>

High antioxidant activity is also demonstrated by extracts of nettle and black currant leaves and of the bark of young birch and oak shoots.

A promising direction in the development of functional foods is the usage of rowan tree fruits to enrich butter with biologically active components of preventive action. Rowan fruits contain cryptoxanthin, various sugars: glucose (3.8%), fructose (4.3%), sucrose (0.7%), sorbose, acids: malic (up 2.8%), folic, tartaric and citric; cyanine chloride, a small amount of tannins (0.3%), essential oil, antibacterial substances, traces of hydrocyanic acid, trace elements (manganese, iron, aluminum). The fruits also contain flavonoids: quercetin, iso-quercetin, rutin (2600 mg %), carotenoids, tocopherol, riboflavin, anthocyanins (including cyanidin) (795 mg %), tannins (610 mg %), phospholipids (cephalin, lecithin), pectin (2%). The plant also contains a hexatomic alcohol - sorbitol (25.3%). The berries contain significant amounts of vitamin C and provitamin A (carotene) present in rowan in a larger amount than in carrots. Rowan seeds contain up to 22% of fatty oil.

Phenolic compounds in rowan exhibit antioxidant, anti-inflammatory, antimicrobial, antiviral, capillary-protective, radioprotective, anticancer and immune-stimulating action. They are of low toxic or nontoxic at all, and in terms of the antioxidant activity are generally superior to the known synthetic antioxidants.

The value of biologically active substances of rowan increases many times because the substances present in the plant form biological complexes with a synergistic* effect.

For the enrichment of butter with biologically active substances and in order to increase its shelf life, specialists have obtained a rowan fruit concentrate by means

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* Synergism - The interaction of various biochemical and/or physiological processes that determines an optimal final effect.
of extraction of the berries with 75% ethanol. The introduction of 1.3% of this concentrate into butter enriches it with active ingredients, provides high resistance to oxidation and extends its shelf-life.

There is also a composition based on the extract of pumpkin oil that is used to enrich butter with biologically active substances.

**SOFT DRINKS**

Drinks are an integral part of the diet of modern man. New food requirements and a tendency towards healthy lifestyle have set modern scientists the task of selecting a drink useful not only for quenching thirst, but also for the general improvement of health.

Non-alcoholic beverages, depending on the raw material used for their production, the production technology and their purpose, are generally divided into the following groups: fruit juice drinks, beverages made from grain raw materials, beverages made from aromatic plant material, flavored drinks (with the use of essences and aromatic alcohols), fermented beverages, beverages for special purposes, mineral water, artificially mineralized water, drinking water.

**FUNCTIONAL DRINKS**

Drinks are considered the most easy to produce basis for the creation of new functional products. Besides the fact that fruit and vegetable juices (which often serve as the main component of soft drinks) contain vitamin C, β-carotene and the vitamin B complex, the introduction of new functional ingredients to these juices, is not of great complexity. This feature is used in the production of soft drinks with the help of biologically active ingredients: vitamins, minerals, trace elements, some vitamin-like substance, water-soluble plant extracts (flavonoids, glucosides), which increase the adaptive potential of the organism.

In terms of functional food serious attention is paid to special soft drinks containing physiologically valuable, safe and healthy, exact physical and chemical characteristics of the ingredients, whose properties are defined and scientifically based. These beverages can be fortified, tonic, manufactured especially for athletes, isotonic, diabetic, etc.

Special drinks, along with enriched drinks, are considered to be functional beverages.

Enriched drinks are functional beverages prepared by adding one or more physiologically functional food ingredients to traditional foods in order to prevent or make up the nutritional deficiency in the human organism.

In their structure such drinks contain biologically active substances (or rather physiologically active substances) in the form of individual micronutrients (vitamins, macro-and microelements, essential amino acids, fiber and other substances),
specially selected balanced mixes of micronutrients (premixes), concentrates of physiologically active substances from medicinal and other raw materials. Enriched drinks may additionally contain juices, extracts and infusions of herbs, whey and other raw materials.

The large variety of functional beverages causes difficulties of their systematization, so the existing classification is rather relative. The same drinks can be part of different groups.

In the classification based on the drinks’ purpose there are four groups of functional beverages (Fig. 20): health-improving, preventive, drinks of adaptogenic action and special-purpose drinks.
Fig. 20. Classification of functional soft drinks

The health-improving function of soft drinks is provided by the essential nutrients present in their composition.

Preventive drinks ensure the prevention of chronic diseases and the development of new diseases by correcting the negative impacts.
Drinks of adaptogenic action contribute to optimal functioning of the body at high intellectual and physical activities.

Functional special-purpose drinks increase the organism’s resistance to extreme factors and are used for the prevention and treatment of certain diseases.

Scientists suggest a classification according to which functional drinks are divided into consumer beverages and special-purpose drinks.

Foreign specialists divide functional beverages into four main groups: sports drinks, energy drinks, healthy drinks and nutraceuticals (Fig. 21).

Fig. 21. Classification of functional drinks suggested by foreign scientists

Sports drinks are aimed to provide the working muscles with energy, maintain or improve the efficiency of the body and make up the fluid loss during exercise. In addition to water, they should also contain easily digestible carbohydrates and minerals (sodium, calcium and magnesium). Sometimes this group of drinks is enriched with amino acids (eg, glutamine), caffeine, carnitine, choline and taurine.

International classification divides the group of sports drinks into three types of beverages: isotonic, hypertonic and hypotonic.

Energy drinks are produced mainly for young people. They are characterized by the contents of sugar - the source of energy, vitamins, caffeine, taurine and other ingredients.
The most popular functional beverages of mass consumption are the so-called healthy drinks enriched with vitamins, minerals, unsaturated fatty acids and dietary fiber that help prevent cardiovascular, gastrointestinal, oncological and other diseases. The main components of such drinks are water (often mineral), fruit and vegetable juices or their mixtures, milk-based elements.

In Europe and North America the most famous drinks belong to the ACE-series that received its name from the contained vitamin complex: provitamin A (β-carotene) and vitamins C and E. Such drinks contain not less than 20% of juice in the form of various juice mixtures: orange-carrot-lemon, orange and cherry, apple and cranberry, etc. The ACE-series drinks can also contain dietary fiber and unsaturated ω-3-fatty acids derived from highly purified fish oil.

Milk-based beverages contain skim milk and buttermilk.

The composition of beverages containing stimulants includes caffeine. Energy drinks («Red Bull», «Burn», etc.) - their ingredients have long been used to stimulate the nervous system. These are caffeine, theobromine, ginseng, taurine, glucuronolactone, carnitine, vitamins of the B-group, guarana, glucose, etc.

All energy drinks can be divided into two categories: coffee-based and vitamin-carbohydrate. The first are designed for people with increased mental and physical activity, and the second - for active people who prefer to spend their free time in the gym.

There are restrictions on usage: such drinks are not to be consumed by pregnant women, children, adolescents, the elderly, people suffering from hypertension, heart diseases, glaucoma, sleep disorders, irritability and sensitivity to caffeine, etc.

Nutraceuticals are characterized by high nutritional value and/or stimulate biological activity if enriched with additional nutrients: vitamins, minerals, phospholipids, essential fatty acids, fiber and other components.
A promising direction in the development of functional drinks is the use of infusions and extracts from domestic plant material containing a wide range of substances of different pharmacological orientation. Plant extracts in drinks increase the tone of the body, the adaptive capabilities of the nervous system, the body's resistance to adverse environmental factors, have antioxidant properties.

**FRUIT AND BERRY JUICES**

Canned fruit and berry juice is an important component for the production of fine soft drinks, it is found in many dietary food products [395]. Juice is obtained from fruits and berries by squeezing them under presses or in the process of diffusion.

Fruit juices are produced in three forms: natural juices (juice of one sort of fruit or a mixture of fruits), juices with additives and concentrated juices.

Natural juices (with or without pulp - according to the presence of particles of fruit tissue and the degree of transparency) are unfermented juices produced from one or more types of healthy ripe fruit (blended juices) with no added sugar or other ingredients. The soluble solid elements in their content are similar to the fruit they are made from.

Juices with additives (with pulp or without pulp) are juices with up to 25% of sugar (or an equivalent amount of sugar substitutes), vitamins, flavors, carbon dioxide, etc. These juices are obtained from fruits and berries with high acidity or raw material with low sugar content (usually immature).

Concentrated juices are juices with the moisture content reduced (using such physical methods as evaporation, freezing and reverse osmosis) at least twice in relation to the raw material. They can be mixed with citric acid, sugar, and L-ascorbic acid.

Juices without pulp and concentrated juices are divided into clarified and unclarified juices.

According to the method of preservation juices are divided into pasteurized juices, juices of aseptic canning and of cold storage. In the production frozen cranberries and sea-buckthorn can be used. Wild apples and pears are only used for the production of blended juices.

Changes in the color of fruit products are due to the enzymatic and non-enzymatic reactions. Usually, significant color changes during fruit processing at temperatures up to 50°C are caused by enzymatic processes and changes at higher temperatures - by nonenzymatic.

The glycosidase enzyme (isolated from the mold Aspergillus niger) is a good example showing that at 0°C in a 60% solution of alcohol the color intensity of black currant products reduces [396]. Enzymes intact by temperature cause the discoloration of frozen fruit during storage [397].

Phenolic substances have an inhibitory effect on enzymes by binding to protein carrier enzymes. Oligomeric forms of flavonoids inhibit pectolytic enzymes.
Experiments with enotanin show that the hydrolysis of pectin slows down with the addition of 200 mg/l of enotanin obtained from grape seeds, and stops when the dose reaches 1500-2000 mg/l. A large number of oligomeric forms of flavonoids is contained in the leaves of apples, pears, plums and cherries. The enzymes contained in the fruit catalyze the oxidation of polyphenols, which leads to the darkening of the fruit.

The stability of anthocyanins that color the fruit is heavily influenced by sugars. Studies of the effect of glucose, fructose and sucrose (used separately or in mixtures) on color changes of raspberry and cherry juice showed the following. Fructose (alone or in a mixture) causes the greatest destruction of anthocyanins. If sucrose is replaced by glucose the decomposition rate of anthocyanins reduces [397].

Oxygen also causes the destruction of anthocyanins. Therefore, to preserve their natural color, fruit products must be handled and stored in the absence of oxygen. Partial removal of oxygen from the environment, in which the fruit is stored, does not provide the desired results. Oxygen has less impact on the flavonols of fruits; on the contrary, they are able to inhibit the oxidation of anthocyanins and vitamins contained in fruit.

For non-alcoholic and alcoholic beverage industries natural juices are preserved by adding rectified alcohol to the juice in a special sealed mixer. The amount of alcohol is calculated in order to obtain juice fortified to strength of 16 or 25%. After adding alcohol to the fruit or berry juice it is stored for 15-20 days depending on the type of raw material, and then drained (decanted) from the sediment. If the juice remains turbid, it is filtered or treated with bentonite.

Alcoholized juices are stored in containers in a specially equipped room at a temperature of -10 to +20°C and humidity of 80%. In order to preserve the taste and aroma of juices it is recommended to store them for less than a year. Fruit juice is transported in oak barrels with a capacity of 200-500 liters.

**FRUIT AND BERRY DRINKS**

Beverages from wild fruits and berries are produced by leaching the extractives from raw material with water (diffusion method). In this case, sugars, organic acids and other water-soluble substances pass into the solution; whereas proteins, some pectins and coloring agents remain in the squash. Therefore the composition of the diffusion juice is different from that of the cell sap, obtained by pressing. The diffusion method is widely used in the production of cranberry and blackcurrant drinks from pomace remaining after the manufacture of canned products. Cranberry pomace is fairly rich in anthocyanin pigments, which are contained in the skin, and organic acids. It was noted that 100 liters of this solution replace 22.7 kg of citric acid.

Published data on the study of the quality of pomace extracts of cranberries, cowberries and blueberries are presented in Table 19. Extraction was carried out with hot water (70-80°C) applied for 60 minutes.
Table 19
The chemical composition of extracts of cranberries, cowberries and blueberries

<table>
<thead>
<tr>
<th>Index</th>
<th>Cranberries</th>
<th>Cowberries</th>
<th>Blueberries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble solids, %</td>
<td>0.95</td>
<td>1.30</td>
<td>0.80</td>
</tr>
<tr>
<td>Fructose, g/kg</td>
<td>1.42</td>
<td>3.10</td>
<td>1.20</td>
</tr>
<tr>
<td>Glucose, g/kg</td>
<td>1.01</td>
<td>3.55</td>
<td>2.02</td>
</tr>
<tr>
<td>The ratio of D-glucose and D-fructose</td>
<td>1.41</td>
<td>0.87</td>
<td>0.59</td>
</tr>
<tr>
<td>Sucrose, g/kg</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.0002</td>
</tr>
<tr>
<td>Total amount of sugars, g/kg</td>
<td>2.43</td>
<td>6.65</td>
<td>3.22</td>
</tr>
<tr>
<td>Citric acid, g/kg</td>
<td>0.83</td>
<td>1.39</td>
<td>0.63</td>
</tr>
<tr>
<td>L-malic acid, g/kg</td>
<td>0.74</td>
<td>0.07</td>
<td>0.20</td>
</tr>
<tr>
<td>D-isocitric acid, mg/kg</td>
<td>5.1</td>
<td>not determined</td>
<td>not determined</td>
</tr>
<tr>
<td>Total amount of pectin, mg/l</td>
<td>22</td>
<td>not determined</td>
<td>not determined</td>
</tr>
</tbody>
</table>

The rosehip drink, prepared by water extraction of useful substances from dried fruit and the addition of sugar and citric acid to the diffusion juice is in good request. Vitamin C, pigments and other water-soluble substances also pass into the solution.

Rose hips used for the manufacture of beverages, must be well dried, not burnt or mouldy and having no other damage. The fruits are inspected on the conveyor belt or table, selecting all defective ones and alien impurities, then the fruits are washed by washing shaking machines or under showers to completely remove the dirt from the surface of the fruit. For better extraction of useful substances hips are ground in roller crushers and then filled with water at a ratio of 1: 20 and boiled for 10-15 minutes. Vitamin C is better preserved not by boiling, but by passing steam through the water-fruit mixture. The extraction is carried out in closed stainless steel tanks without oxygen for 12-24 h. After extraction the infusion is decanted from the sediment and filtered. The squash (residue) is pressed in basket presses to extract the remaining liquid, which is also filtered and then mixed with the main infusion.

The infusion is then mixed with sugar and citric acid to improve the taste of the finished drink. The mixture was deaerated, heated and sent for packaging in glass bottles. The drink is immediately sealed with lacquered lids and pasteurized in an autoclave. The prepared drink has a specific taste and aroma characteristic of dried rosehips, has a nice amber color and contains 25 mg/100 g or more of vitamin C. This drink is particularly useful in the springtime, when the body desperately needs vitamin C. This drink can be produced throughout the year, which also reduces the seasonality of processing plants, and increases the returns on assets.
Recently, there has been an increased interest in the use of functional beverages produced from natural juices with the use of spicy plants. These plants, having a complex chemical composition, have a beneficial therapeutic effect on the human body and can be used for the creation of products that have a tonic effect and antioxidant properties.

Scientists have developed formulations and manufacturing technologies for the production of fruit juice syrups with the addition of spicy plants. The basis of such syrups is apple juice that reinforces the resistance impact of the syrups on the human body. The main material used for flavoring drinks is peppermint, oregano, sage, tansy, coriander, tarragon, lovage, etc. Essential oils of mint and oregano limit the excessive putrid fermentation processes in the gastrointestinal tract, increase the secretion of the digestive glands, contributing to the rapid emptying of the intestine, thus preventing the absorption of toxic and radioactive substances. Chemical components of sage have anti-inflammatory, disinfectant and astringent properties. Thyme essential oil, containing mainly thymol and carvacrol, has an expressed bactericidal effect. The essential oils of sulfurwort contain terpenes, terpeniol and cineole. The plant is widely used in diets. Melissa, except for antiseptic properties, also is considered a diaphoretic. The specific taste of spicy plant extracts can help create original flavors that can be combined with fruit and vegetable syrup bases. The presence of natural preservatives (such as polyphenols, carboxylic acids and essential oils) in the extracts increases the biological resistance of the syrups during their storage, and the coloring agents of the plants create a variety of natural dyes. Scientists have created such drinks - a blend of water extracts of lovage, hyssop, lemon balm and oregano, another drink is a blend of water extracts of dried marjoram, peppermint, sage, tarragon, giant-hyssop and melissa, one more drink - with the aqueous extracts of dried lovage, hyssop, lemon balm and oregano.

Scientists have developed and tested a balsam, consisting of aqueous alcoholic extracts of hawthorn, rose hips, wild pears, nettle, yarrow, pine needles, oak bark, shoots of mountain ash, dog rose, horseradish, an extract of chokeberry and concentrated apple juice. This balsam is used as a therapeutic and prophylactic element in treating periodontal diseases, has antimicrobial, anti-allergic and pronounced tonic effects that make it a natural bioprotector.

**DRINKS FROM SPICY AND AROMATIC RAW MATERIAL. TEAS. CONCENTRATED BASES (BALSAMS)**

Drinks produced from spicy and aromatic materials, teas and balsams may become the most affordable and popular health products containing active substances of plant origin.

Natural plant material allows scientists to create drinks with a wide range of effects on the human body: toning, anti-stress, dietary, diabetic, improving the functioning of the cardiovascular system and the gastrointestinal tract, etc. Apart from meeting the body's need for fluids, beverages made from spicy and aromatic raw materials supply it with some biologically active substances necessary for normal
life. The raw materials used for the production of these drinks show us their true value. For example, the toning soft-drink "Baikal" includes a wide range of restorative and aromatic components: St. John's wort, licorice root, eleutheroococcus, the infusion of pine buds, natural oils of lemon, eucalyptus and laurel. The drink "Tarhoo" is produced from the tarragon infusion, the main raw material used for the preparation of which is the green mass of tarragon that contains vitamins C, B, B₁, PP, calcium, magnesium, iron, potassium, and essential oils. This culture contains a large amount of rutin (170 mg) and phosphorus (225 mg). The drink "Sayany" contains an extract of *Rhaponticum carthamoides* (maral root), which has a stimulating effect during mental and physical exhaustion.

With the help of aromatic plant materials specialists can significantly extend the range of both soft and alcoholic drinks with properties of functional beverages. Recently, much attention is paid to the production of food rich in antioxidants that inhibit radical oxidation processes in the body. Radical oxidation can lead to the development of cancer. Many medicinal plants contain significant amounts of natural phenolic compounds, known for their strong antioxidant properties. Table 20 shows some of the plants used for the production of such drinks [398].

Aqueous extracts of the dried rose hips and St. John's wort with the addition of sugar syrup and citric acid are used to produce a drink with medicinal properties. Dried rose hips and St. John's wort are washed in fan type washing machines to completely remove all sorts of contaminants. Then hips are ground in fruit crushers or grinders; crushed fruit and St. John's wort are loaded into the boilers, filled with water according to the recipe, are boiled for 30 minutes and left for extraction for 12-24 hours. The extract is pressed and filtered in filter presses. Then it is mixed with 18% sugar syrup in the ratio of 1:1, deaerated at 35°C and a vacuum of 690-700 mm Hg. Art. (9.5-8.0 kPa), heated to a temperature of 85°C and then packed into prepared jars and bottles with a capacity of 0.5-3.0 liters and sealed with lacquer lids in canning machines and pasteurized at 85°C in for 15-60 min, depending on the volume of containers.

Unfortunately, the share of high quality tonic drinks made from extracts and concentrates of plant material is only about 3-5%. The absence of a sufficient quantity of cultivated and harvested plant material is one of the reasons for the low production of these products.
Table 20
The chemical composition of some medicinal plants

<table>
<thead>
<tr>
<th>Raw plant material</th>
<th>Extractives, %</th>
<th>Vitamin C, мг %</th>
<th>Total amount of phenol compounds, %</th>
<th>Total amount of catechines, мг/г</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypericum perforatum</td>
<td>29,4</td>
<td>135,0</td>
<td>13,6</td>
<td>43,62</td>
</tr>
<tr>
<td>Matricaria chamomilla</td>
<td>18,2</td>
<td>46,0</td>
<td>6,4</td>
<td>37,8</td>
</tr>
<tr>
<td>Immortelle</td>
<td>15,7</td>
<td>37,0</td>
<td>3,6</td>
<td>22,7</td>
</tr>
<tr>
<td>Linden, flowers</td>
<td>18,7</td>
<td>245,0</td>
<td>7,3</td>
<td>22,5</td>
</tr>
<tr>
<td>Red clover</td>
<td>46,3</td>
<td>260,0</td>
<td>6,7</td>
<td>26,5</td>
</tr>
<tr>
<td>Blueberries (leaves and fruit)</td>
<td>39,2</td>
<td>6,0</td>
<td>10,8</td>
<td>39,3</td>
</tr>
<tr>
<td>Corn silk</td>
<td>42,0</td>
<td>68,0</td>
<td>12,0</td>
<td>56,2</td>
</tr>
<tr>
<td>Basil</td>
<td>14,5</td>
<td>28,0</td>
<td>8,6</td>
<td>15,7</td>
</tr>
</tbody>
</table>

Tea drinks

At present there are more than 400 tea recipes of different kinds: black tea and tea with the addition of various medicinal and aromatic plants, as well as nutritional tea drinks made from wild and cultivated plants. In the preparation of teas with the addition of plant material the following species are used: the herbage of marjoram, St. John's wort, thyme, willow-herb, rosemary; the leaves of mint, Siberian Ginseng, coltsfoot, cranberry, blackberry, black currant, cowberry; the fruits of caraway, aronia, viburnum, dogrose, black currant, cranberry, etc.

The use of this group of teas has deep historical roots. Unfortunately, these tea drinks are produced occasionally and in a very limited range. One of the main reasons for this is the lack of high quality raw materials from cultivated and wild plants and poor promotion of national tea drinks.

Scientists have developed new prophylactic drinks taking into consideration the nature of infusions and extracts of medicinal plants and their required amount.
Particular attention is given to complexes of medicinal herbs that reduce depression and have sedative and antioxidant effects. In terms of creating healing juices and fruit drinks the most perspective is the use of viburnum, dogrose, buckthorn and aronia - the plants that normalize blood pressure, stimulate the cardiovascular system, and have antiseptic, healing and restorative properties. Unfortunately, their production is very limited so far, but given the current trends in nutrition, it has great potential in the canning industry.

An especially popular drink is a beverage created from the extract or culture liquid of the so-called tea sponge or Kombucha - a symbiont of *Saccharomyces cerevisiae* yeast, acetic and lactic acid bacteria (Fig. 22). Many years of using this drink showed its pronounced therapeutic effect. Kombucha culture liquid contains enzymes, vitamins B, C and D, it inhibits the growth and development of pathogenic microorganisms and stimulates the resistance to infections.

Experiments on growing Kombucha with the addition of various sugars carried out with the initial sugar concentration of 15 g/l, showed that the most rapid decline in pH occurs when using sucrose, glucose and fructose; the process is slower when using lactose and glycerol (fig. ). It should be noted that the use of lactose as a carbon source does not increase the mass of the symbiote, and during the use of glycerol the substrate was covered with mold on the 5th day of the experiment.

![Fig. 22. Kombucha, tea sponge](image)
The graphs of pH dependence on the duration of the organism’s growth if fed with sucrose and glucose are virtually identical. In the case of using fructose the pH level is higher during the entire period of cultivation if compared to glucose and sucrose usage. These data correlate with the results of measurements of the angle of rotation of the polarization plane during cultivation of the organism in the infusion of green tea and sucrose. Sucrose is a disaccharide consisting of the remains of two monosaccharides - glucose and fructose. The specific rotation of glucose is \([+52.7^\circ]\) and that of fructose is \([-92^\circ]\). When cultivating the organism using sucrose the sign changes and the angle of rotation of the polarization plane in the fluid changes from \((+14.7)\) to \((-4)\) in 16 days. Thus, the organism consumes glucose quicker whereas fructose is accumulated in the culture fluid.

Since the main carbohydrates used in food technology are sucrose and fructose, scientists have studied in more detail the effect of these particular sugars on the life of Kombucha in a wide concentration range from 5 to 125 g/l.

Although sugars are different in their chemical nature, the nature of pH change is the same - in both cases, the pH curve flattens out on the 7-8\(^{th}\) day of cultivation. The following dependence has also been revealed: the higher the concentration of carbohydrate in the original substrate, the lower the pH in the finished tea drink (fig.).
Fig. 24. Kombucha culture fluid pH dependence on the concentration of sucrose.

Studies of the influence of sugars’ nature and concentration on the weight gain of the symbiote have revealed that the optimal concentration of fructose is about 25 g/l, while that of sucrose is about 50 g/L (i.e., in the detection of optimal concentrations the structure of the carbohydrate must be taken into account). This may be due to the fact that fructose is a monosaccharide that is quickly removed from the body, because its absorption occurs without the hydrolytic processes that accompany the absorption of sucrose (fig. ).

Fig. 25. Biomass growth in the presence of different carbohydrates

Studies of the Kombucha growth in medicinal herbal infusions (4 g/l of dry grass) with the addition of sucrose (20 g/l) revealed that the symbiont’s biomass in infusions of hypericum, oregano, sage, chamomile, hops, mint and thyme grows
slower than in the check sample (fig.). In the control experiment the tea sponge was cultivated in the infusion of black tea.

Another series of experiments carried out with the addition of extracts of lemon balm, St. John's wort, marjoram, sage to the culture fluid containing tea, has shown that extracts of these herbs caused an increase of the organism’s biomass if compared to the control sample, while the addition of celandine and licorice caused a decrease in growth.

The acidity of the culture fluid on the basis of medicinal herbs has become substantially higher (according to the pH data) than that of the control sample (4 g/L of tea + 20 g/l of sucrose) only in the first 5-7 days. Similar relations were noted when adding extracts of oregano, sage, chamomile, hops and thyme.

![Bar chart showing dependence of biomass growth on the plant type](image)

Fig. 26. Dependence of biomass growth on the plant type

On the 7th day the acidity of Kombucha infusions decreases in the following sequence: St. John's wort, thyme, mint, control, chamomile, marjoram, tarragon, hop.

It has been proved that if tea is not added to the Kombucha fluid, its growth stops. Presumably tea is the source of nitrogen-containing connections for the symbiont. Therefore, in the search for an alternative to the tea infusion, scientists tried adding caffeine at a concentration of 0.5 g/l, which is known as an activator of bacterial cellulose production.

However, the increase in weight was insignificant; the organism didn’t form a dense cartilage formation. It can be assumed that tea is a source of nitrogen and other substances (aromatic, tanning) which are practically not consumed, but vital for the organism.
The cultivation simplicity allows scientists to recommend Kombucha drinks for widespread use as domestic prophylactic agents.

*Soft balsams*

Specialists of medical institutions have noticed that concentrates, including concentrated balsamic type bases, have a positive effect on the human body and activate the internal defense systems of the organism. These food elements with specific health-improving functions can be most effective in the system end ecological rehabilitation, particularly in health centers, medical institutions and rehabilitation centers. Balsams with tonic, anti-stress, anti-inflammatory and antitoxic properties contain most valuable medicinal and spicy plants and biologically active products of beekeeping.

The prototypes of soft balsams are alcoholic balsams. Therefore the technology of their production is based on the key stages of the technological scheme of alcoholic balsam production (Fig. 27), but has a number of important features.
The preparation of the components of the blend and the order of their introduction into it play an important role in ensuring the quality of soft balsams; and therefore are considered to be key operations in the production of balsams (Fig. 28).
Sugar syrup and the color are prepared using a standard technology - the hot method, in order to prevent the microbial spoilage of the finished drink.

Fig. 28. A block diagram of the soft balsams’ production
The blend is mixed with natural fruit and berry juices. It is recommended to use whole fruit and berry material of domestic manufacture with strict quality control of both - the raw material and the manufactured juice, due to the fact that these juices have are of highest biological value.

According to the technology the blend can be mixed with clarified and unclarified natural juices. When clarified juice is used, the amount of residue that remains after blending and settling (the fuzz) and is removed later on, is small, which explains the higher yield of the finished soft balsam. When using unclarified juice the manufacturer loses in volume of the finished product, but - according to many experts - gets a more intense taste and aroma of the balsam.

If the quantity of the required natural juices is insufficient, they can be replaced by the corresponding juice concentrates or aqueous extracts (fruit drinks) or decoctions of dried fruits and berries without distorting the organoleptic properties of the drink.

The manufacturer can add spirited juices into the soft balsam formulations, but, depending on their content there may be a significant increase in the volume of ethyl alcohol, which is undesirable, because its content in the finished product must not exceed 0.5%.

A perspective method of soft balsam production is the introduction of thick extracts of fruits and berries, extracted from sea buckthorn and cranberry cake, chokeberry and cranberry marc, etc. The use thick extracts can significantly reduce the ethyl consumption ratios and a balsam with organoleptic properties and biological value.

Despite of the known dependence of the extractives’ amount from the granulometric characteristics of raw materials, the plants used for the preparation of water-alcohol infusions are not exposed to significant grinding. This is done to avoid the appearance of a hardly deluted fine-dispersed suspension in the infusion, that worsens the transparency of the drink and shortens its storage period.

The settling process is conducted at a temperature of 30ºC, which helps to preserve the biologically active components of the raw materials. After decantation the swollen parts of plants are squeezed in presses, and the resulting concentrate (which contains nearly ten times more solids than the main infusion) is added to the main infusion. Immediately after this process the infusion is not always clear, but if all rules of blending, storing and settling are observed, the beverage becomes clear.

Honey and velvet antler extract (or pantogematogen solution) are components of animal origin, not used in the classic liqueur production, but included in the formulations of individual alcoholic balsams.

Only natural honey is used for the production of balsams. The preparation of its aqueous solution is carried out without significant heating (the solution temperature being 30-35ºC), a few minutes before mixing the components of the blend. The solution is prepared only in glass containers and put into the blend when heated.

If physiologically significant amounts of pantogematogen are added into the blend, the drink does not stand the resistance test. After 7 days or more an opalescence appears in the blend, flakes are formed and the color gradually fades due to
the coagulation of blood proteins under the influence of polyphenol compounds and organic acids of the plant material. Therefore, it is preferable to use the antler extracts in the preparation of alcoholic balsams.

Softened water is not involved in the production process as a component of the blend: the required amount of water is used to prepare all the blend ingredients. The necessary amount of balsam is usually reached by adding juices.

The blending of the soft balsam components is carried out using the cold method. If there antler extracts and honey are present in the formulation the component introduction must be carried out in the order shown in fig. . Untimely introduction of a honey solution (before herbal infusions) promotes the formation of a viscous opalescent mass that is hard to filter, the appearance of which is caused by the coagulation of honey proteins.

The infusion time of the blend is determined by the achieved constant value of the mass fraction of solids and is in direct proportion to the input of honey: the less honey is present in the blend, the shorter is the time of infusion, whereas the taste and aroma characteristics of the drink become worse. The duration of the infusion period is also reduced by using clarified fruit juices. The duration of the infusion period is usually two days. A prolonged infusion does not improve the quality of the balsam, and therefore is not appropriate.

Due to the high acidity of the fruit and berry juices used in balsams, an inversion of the color sucrose and syrup occurs in the blend and increases the absorption of the carbohydrate component of the balsam.

The seasoned blend is characterized by high density (from 1.26 to 1.32 g/cm³), which makes the filtering process difficult and not cost-effective; therefore, the finished blend is separated from the viscous fuzz mostly by decanting. Before filling the consumer containers the quality of the final product can be adjusted, if necessary, according to the total mass concentration of the extract and the mass concentration of acids.

Given the fact that soft drinks usually provide a good breeding ground for microorganisms (yeast, bacteria, fungi), the primary defect of soft balsams is their microbiological instability that leads to defects in their visual appearance: the formation of turbidity, color change, appearance of turbid rings and films on their surface, precipitation. In good sanitary conditions of the equipment the received beverage retains its durability without the addition of preservatives. This can be explained by the anti-microbial properties of organic acids, tannins and bitternesses that are contained in the extracts of plant material used in the production of balsams: sedge cane, chokeberry, bergenia, cloves, bird cherry, yarrow, etc.

Balsam properties

The modern consumer market is characterized by a certain system of relations: the manufacturer of the goods produces them in accordance with the regulations indicated in normative documents, and the consumer wants to receive them with a certain amount of properties that meet his real needs.
The defining property of food products is their **purpose** that is indicated by their **nutritional value**. The elements of nutritional value appropriate for the analysis of balsams are: energy value, physiological and organoleptic value, digestibility and safety.

The **energy value** of soft balsams, which are multiple-component syrups with no less than 50 g/100 cm³ of sugar, depends on the content of easily absorbed carbohydrates (51-82 g/100g). According to their caloric content, which ranges from 204 to 329-380 kcal/100g, balsams can be considered semi-caloric foods. The energy value of alcoholic balsams ranges from 224 to 298 kcal/cm³ and is due not so much to the carbohydrate content but to their alcohol content - about 30-45%.

The **physiological value** of balsams is determined by the quantity and composition of its physiologically active compounds (PAC). It is mostly influenced (as well as the physiological value of other plant-based beverages) by the phenolic compounds - flavonoids and tannins. Flavonoids, having P-vitamin activity, affect many physiological functions of the human body: they strengthen the capillaries, promote the excretion of heavy metal salts, radionuclides and, as natural antioxidants, reduce the risk of cancer (this property is also demonstrated by tannins that are involved in the balsams’ taste formation [9].

In the balm samples scientists identified two groups of flavonoids that are most stable in the water-alcohol solutions [397]: flavonols (rutin, quercetin, myricetin, kaempferol, etc.) and flavones (luteolin, apigenin, etc.). The flavonoid content in soft balsams and cough syrups of the balsamic type is not less than 10 15 mg/100ml, in alcoholic balsams it ranges from 0.03 mg/100 ml in one-year-old balsams to 20 - 55 mg/100 ml and more in freshly produced beverages. The balsams also vary greatly in the content of tannins: soft balsams contain from 0.49% of tannins to 2.49%; and alcoholic balsams - from 0.66% to 1.50%.

Differences in the content of PAC in balsams are directly related to the recipe: the difference in the sets of plant material in their compositions and the blending materials. The phenolic compounds and essential oils of plant raw materials (as the main components of the alcoholic balsams blends) pass completely to the alcohol and water-alcohol extracts due to the specifics of the solubility of this group of PAC.

However, the formulations of alcoholic balsams differ from the recipes of soft balsams by a more frequent use of spicy and aromatic raw materials (cinnamon, cloves, ginger, nutmeg, coriander, etc.) and dried fruit (prunes, apricots, etc.), which is why they are considered liquors and demonstrate better tasting characteristics. In the production of soft balsams, on the contrary, tinctures and extracts of medicinal raw materials (hawthorn fruits, calendula and chamomile flowers, rhizomes and roots of *Rhodiola rosea* and *Rhaponticum carthamoides*, the herbage of yarrow and motherwort, etc.) are used.

We have analyzed 40 recipes of alcoholic balsams produced in Russia. The analysis allowed us to identify the most common types of raw materials of plant origin used in their production: the buds of St. John's wort (*Hypericum perforatum* L.), oregano (*Origanum vulgare* L.), plaster clover (*Melilotus officinalis* (L.) Pall.), yarrow (*Achillea millefolium* L.), fruits of wild rose (*Rosa majalis* Herm. // *Rosa
cinnamomea L.), mountain ash (Sorbus aucuparia L.), coriander (Coriandrum sativum L.), roots of calamus (Acorus calamus L.), angelica (Archangelica officinalis Hoffm.), birch buds (Betula pendula Roth.), juniper galberries (Juniperus communis L.), peppermint herbage (Mentha piperita L.) and calendula flowers (Calendula officinalis L.).

The diagrams in Fig. 29, Fig. 30 and Fig. 31 show the information about the frequency of use of those components in balsam recipes.

![Diagram showing frequency of use of components in balsam recipes.](image)

**Fig. 29.** Frequency of using the component in balsam recipes (more than in 40% of all analyzed formulations)
Fig. 30. Frequency of using the component in balsam recipes (less than in 40% of all analyzed formulations)

Fig. 31. Frequency of using the component in balsam recipes (less than in 25% of all analyzed formulations)
One can note the great popularity of using St. John's wort and oregano in the balsam formulations. This can partly be explained by the prevalence and availability of these herbs and the number of their positive qualities in their correct use. St. John's wort is used for treating diseases of the liver, stomach disorders and bleedings. It is used as an anti-inflammatory element for treating wounds. In recent years, scientists report about the antidepressant activity of hypericin in doses of ~2 mg per day [399]. Its efficiency is comparable to that of the well-known drugs imipramine and desipramine [400, 401]. However, a case of photosensitivity was also noted in patients receiving therapeutic doses of hypericin, the manifestations of which have passed after the patient stopped taking the drug. St. John's wort is part of antidiabetic teas and is also used to stimulate the immune system.

Oregano inflorescences are used for treating women's diseases as a hemostatic, especially useful after childbirth; it is also used to enhance lactation, relieve the condition of women in menopause and relieve menstruation pain. It is also used for treating insomnia, as a sedative for nervous disorders, can be used for treating gastritis, gastric and duodenal ulcers, flatulence, enterocolitis, intestinal atony. It is used as an expectorant for bronchitis and bronchiectasis, and as a means of stimulating the appetite. It is used in the treatment of hemorrhoids, migraines, asthma, pulmonary tuberculosis, jaundice, cholecystitis and biliary dyskinesia, as a sedative. Strong tea made from this herb causes profuse sweating. It is also used in the preparation for aromatic baths treating rheumatism, paralysis, epilepsy, allergy and rickets in children; it can be used in the form of compresses for abrasions, suppuration, inflammations of lymph nodes, and some skin diseases (scrofula and various rashes).

St. John's wort tincture has a balsamic odor and a bitter taste. The infusion has a yellowish-red color, a peculiar, slightly astringent, bitter, burning taste, vaguely similar to honey flavor. The infusion of oregano inflorescences has a brown color, a specific, not very strong smell and a slightly bitter taste. The expenditure of these components is very different: the expenditure of St. John's wort can reach 17 kg per 1000 dekaliters of balsam, while that of oregano is usually less than 5 kg per 1000 dekaliters [30]. These two components form the extractive basis of the balsam and its organoleptic properties.

Two other commonly used components are peppermint herbage and tormentil roots, which have a strong distinctive taste and aroma and can greatly affect the taste of the finished drink.

The peppermint infusion is olive green with a characteristic smell of mint and cooling taste. The infusion of tormentil or galangal (Alpinia officinarum L.) is reddish-brown, with a pungent peppery taste and aroma reminiscent of the taste and aroma of ginger and cinnamon.

Peppermint has antiemetic, anti-inflammatory, sedative, antispasmodic, cholagogue, antiseptic and analgesic effects, provides a reflexive coronary dilator effect, increases microcirculation and intestinal peristalsis, reduces dental pain, refreshes the mouth, improves the appetite and increases bile secretion.

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Galangal stimulates gas separation, prevents relapses in chronic diseases of the internal organs, stimulates the saliva flow and increases the functional activity of the stomach. It exhibits antioxidant activity and inhibits the genotoxicity of certain chemicals, which is promising for further research and usage of galangal as a prophylactic agent against cancer [402]. Gingerol and diarylheptanon isolated from the rhizomes of galangal are able to inhibit the biosynthesis of prostaglandins in the body [403].

The first group of plants includes plants that form the basis of the balsam. These plants contain organic compounds with different physiological properties: alkaloids, essential oils, tannins, flavonoids and glycosides. Their multidirectional physiological properties indicate the prevalence of organoleptic qualities of such plants’ extracts, which contribute to their mass use in recipes of balsams and their ability to influence the organoleptic qualities of the drink.

The second group includes plants such as sedge cane, English oak, pine buds, garden angelica, rosewort, elecampane, nutmeg, cinnamon and a number of other plants.

These herbs are used in balsams as auxiliary materials to emphasize the aromatic bases, and also as sources of vitamins and biologically active substances.

The third group includes the following plants and their parts: tansy, ginger, fennel, lemon-balm, pine nut, anise tree, chamomile, lemon and thyme.

Given the specific aroma and distinct taste of extracts of these plants, it can be assumed that their use in the formulation of balsams can correct the imbalances in taste and aroma of the blend formed by the basic components included in the previous two groups of plants.

Despite the relatively low content of phenolic substances in the non-alcoholic and alcoholic balsams, we can talk about the expected physiological effect, because flavonoids and tannins are considered to be minor components of food, the physiological effect of which is manifested at the level of micro-doses.

The organoleptic value of the balsams is due to their clarity, color, smell and taste. It should be noted that the organoleptic properties are important in the formation of consumer preferences: thus, according to market research, organoleptic characteristics are important to 24.1% of consumers, and these products are often used just as flavoring additives to strong alcoholic and soft drinks.

Usually balsams are transparent liquids with deep red-brown (for soft balsams) and dark brown, dark brown with reddish or dark tones, close to black (for alcoholic balsams) color, with a pronounced glitter, no sediment and impurities. The consistency soft balsams is slightly sticky, syrupy, that of alcohol balsams os more liquid, slightly thick. Both types have complex, original, harmonious taste and smell, many dominated by notes of three or four major components used in the recipe; alcoholic balsams also have an expressed balsamic aroma and a pleasant, bitter, spicy (rarely - buttery) taste.
The uniform color and transparency indicate the stability of the balsams’ marketable state, and the organoleptic properties influence the formation of their psychological properties and are an indication of good quality, as a mandatory component of the nutritional value.

The digestibility of balsams is ensured by their liquid consistency, the presence of aromatic (essential oils) and taste (organic acids, tannins, bitternesses) substances that stimulate the absorption of PAC balsams; and the presence of soluble components (sucrose, honey, juice, etc.) that are easily digested.

In the terms of safety given the fact that virtually the entire range of such products is made from wild growing materials, harvested in areas distant from the sources of pollution, the balsams tend to meet the health standards for toxic elements, radionuclides and pesticide residues. Alcoholic balsams, like all alcoholic beverages should be considered as potentially dangerous products, since, if consumed in unlimited doses, they may have toxic effects on the human body, both through the content of ethyl alcohol and its stimulating influence on the PAC activity of the balsams.

The storageability is the indicator of durability of the products, manifested during the storage of balsams. Balsams are products of long-term storage if stored at the following rated parameters: temperature - 10-20°C, relative humidity - not exceeding 85%, and illumination - it is recommended to store balsams in a dark place and avoid direct sunlight. The shelf life of soft balsams is from one to two years, of alcoholic balsams - one year (the labeling of many balsams states "minimum shelf life - 12 months. Storage period is not limited if storing rules are observed"). Such long-term storage is due to the fact that soft balsams contain large amounts of sugar, organic acids, and also due to the natural ability of a number of raw materials to demonstrate a preservative effect (bird-cherry and bergenia tannins, essential oils of oregano, peppermint, St. John’s wort, etc.); whereas the alcoholic balsams contain about 30-45% of alcohol. Typically, during the warranty period of storage balsams maintain their taste qualities and physiological value. However, one must keep in mind the possibility of chemical interaction of individual components of the recipe and, therefore, select optimum combinations that ensure maximum safety of the PAC during production and storage of balsams. Improper storage may lead to a significant loss of active substances and reduce the nutritional value of the product.

In order to trace the possibility of reducing the amount of preservatives (benzoic and sorbic acids), we studied in vitro the antiseptic effect of active plant ingredients on the growth and development of the main contaminants of soft drinks - yeast of the Saccharomyces cerevisiae species in individual extracts and in combination with traditional chemical preservatives.

For the experiments scientists chose widespread plants: chamomile, marjoram, thyme, mint, dogrose, hops, sage, wormwood, calendula, birch buds, Siberian ginseng, St. John's, hibiscus, black tea and green tea - plants that are available and often used in the manufacture of soft drinks.
Aqueous extracts were prepared as follows: dried plants were cut into particles of 2-3 mm, filled with hot water (95-100°C) and let to brew at 85-90°C for 2 h. After that the material is wrung out to separate the liquid phase.

The yeast suspension - the test microorganism - was prepared from dry baker's yeast *Saccharomyces cerevisiae*. This choice of a model object for research is due to the fact that 90% of the microbial spoilage of soft drinks is caused by the *Saccharomyces* yeast. In addition, the pure culture of the microorganism helps trace the influence of biologically active plant substances. The number of cells in the yeast suspension was 1000 in the first series, and 100 cells/ml of suspension the second.

The nutrient medium was created from a mixture of hopless wort and an extract of appropriate plants in the ratio of 1:1 with the total volume of 40 cm³.

The sensitivity of individual yeast to water extracts of plants was identified with the help of the plate method. The generation of yeast was conducted for 36 hours at a temperature of 28ºC; then the number of colonies was counted. The results are shown in Table 21 and Table 22. Fig. 32 shows the control experiment of yeast cultivation without the addition of extracts and preservatives.

<table>
<thead>
<tr>
<th>Type of raw material</th>
<th>Control example</th>
<th>Nutrient media with the addition of sodium sorbate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>+10% of sorbate</td>
</tr>
<tr>
<td>Oregano</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Wormwood</td>
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<td>13</td>
</tr>
<tr>
<td>Peppermint</td>
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<td>2</td>
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<td>Thyme</td>
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<td>105</td>
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<tr>
<td>Chamomile</td>
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<tr>
<td>Hops</td>
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<td>0</td>
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<tr>
<td>Dog rose</td>
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<td>4</td>
</tr>
<tr>
<td>Wort</td>
<td>172</td>
<td>268</td>
</tr>
<tr>
<td>Sage</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Birch buds</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Calendula</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>St. John's wort</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Black tea</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Green tea</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hibiscus</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 22.

Amount of colonies in the nutrient medium after 36 hours of generating yeast at suspension inoculation of 100 cl/ml

<table>
<thead>
<tr>
<th>Type of raw material</th>
<th>Amount of colonies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control example</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Oregano</td>
<td>4</td>
</tr>
<tr>
<td>Wormwood</td>
<td>11</td>
</tr>
<tr>
<td>Thyme</td>
<td>87</td>
</tr>
<tr>
<td>Chamomile</td>
<td>14</td>
</tr>
<tr>
<td>St. John's wort</td>
<td>10</td>
</tr>
<tr>
<td>Dog rose</td>
<td>2</td>
</tr>
<tr>
<td>Wort</td>
<td>173</td>
</tr>
<tr>
<td>Sage</td>
<td>0</td>
</tr>
<tr>
<td>Birch buds</td>
<td>0</td>
</tr>
<tr>
<td>Peppermint</td>
<td>0</td>
</tr>
<tr>
<td>Hibiscus</td>
<td>0</td>
</tr>
<tr>
<td>Calendula</td>
<td>15</td>
</tr>
<tr>
<td>Black tea</td>
<td>0</td>
</tr>
<tr>
<td>Green tea</td>
<td>1</td>
</tr>
<tr>
<td>Hops</td>
<td>0</td>
</tr>
</tbody>
</table>

The fact that the yeast colonies multiplied quicker in wort without the addition of extracts in both series of experiments suggests that the extracts of the studied plants still have a bacteriostatic effect and to some extent inhibit the growth of yeast.

A significant reduction in the number of colonies was observed when adding extracts of birch buds, dog rose, sage, hibiscus, black tea, green tea, mint, oregano and wormwood.
A more significant bactericidal effect on yeast is demonstrated by the extract of hop: the colonies didn’t multiply in the nutrient media even after a month of yeast generation.

The extracts of thyme and calendula have a smaller inhibitory effect on yeast. Fig. 33 shows the experiment of culturing yeast in a medium treated with extracts of thyme.

The counting of colonies in experiments with the addition of eleutherococcus extract to wort was not feasible because after 20 hours the medium was covered with a continuous dense yeast layer.

Experimental results show that the preservative has no inhibitory effect on the yeast. This is, apparently, due to the fact that, according to the technical regulations, the amount of yeast cell in, for example, soft balsams, should not exceed 50 in 1 ml, i.e. the maximum dose of preservatives was calculated according to this number of contaminants, and in our experiments, where the inoculation of the substrate was higher, sodium sorbate was used by the yeast as a source of carbon nutrition. This suggestion is confirmed by experiments with extracts of dogrose, where the 2 colonies grew in the control medium, and 17 colonies - in the medium treated with a 100% dose of sorbate. This hypothesis is also confirmed by the fact that the addition of a 400% dose of sorbate the yeast developed very actively.

The inhibition of growth of the test organism by plant extracts is probably due to the rather high content of bitter substances in hops, alkaloids - in sage and St. John's wort, anthocyanins - in hibiscus, tannin - in tea, and organic acids in dogrose. Oregano demonstrates this depressing effect due to the high of the content of tannins, but not due to the content of thymol; because thyme also contains thymol in high concentrations, but does not have a strong inhibitory effect on the yeast. Glycosides contained in wormwood and carotenoids contained in calendula do not inhibit the development of yeast. Eleutherosides - active substances of eleutherococcus can be considered to be yeast stimulants.

Apart from the recipes, the factors influencing the shelf-life and transportability of balsams are the materials of consumer and transport packaging, the sealing quality and the quality of production.
The set of consumer properties is not limited by the nutritional value of the products, their shelf-life and transportability, and therefore, balsams should also be described from the point of view of their ergonomic and aesthetic properties.

The **ergonomic properties** of balsams are manifested through their anthropometric and psychological characteristics. The first group of properties determines the ease of balsam consumption and is provided by a comfortable and secure consumer packaging. Usually, soft balsams are packed in flat bottles of colorless glass with a capacity of 100 and 250 ml. Most alcoholic balsams are also bottled into colorless glass (rarely - brown), with bottles of traditional shape: 250 ml - flat, 500 ml - flat and cylindrical. Some manufacturers pack their products into “shaped” bottles - ceramic, porcelain and glass jars. Glass bottles have screw threads on the neck for sealing them with aluminum caps that secure the consumer package, provides the dosing and makes the balsam easy to store after opening; jars are sealed with corks with a lining of parchment, or ceramic, porcelain and glass stoppers. Home storage and use of balsams is provided by meeting the requirements for the storage regime - the temperature of 10-25°C and relative humidity of 70-78%, i.e. "room conditions". To avoid the drink’s exposure to direct sunlight, the consumer packaging is often supplemented by a cardboard box.

**Psychological properties** of balsams are manifested through their ability to provide the consumer with a certain mental rest, due to their pronounced organoleptic characteristics. In addition, the consumption of balsams, as well as of some other foods, can be related to national, religious, family and other customs. Soft balsams, presented by a wide assortment, are oriented on different segments of consumers, regardless of gender, age and physical ability.

**Aesthetic properties** of balsams, like of most provisions, are demonstrated in their consumer packaging with an etiquette and a collar label of high print quality. The cardboard box, protecting the balsams from light, has a decoration.

It should be noted, that sometimes the names of balsams have a geographical origin, describing the place of their manufacture and making balsams act as souvenirs. For example, each balsam of the "Legendy Altaya" series has poems printed on the box and dedicated to Mount Belukha, the Babyrgan Mountain, the river Biya, etc. There are products available for sale in a beautifully decorated sets (balsams of the "Sizhan" and "Spectrum-balsam" companies, etc.), in special glass jars ("Mordovskiy", "Khabarovskiy", "Ayanskiy", "Scyfskiy kurgan", "Satriy Kashin", "Velikiy Ustyug", "Tsarskiy vybor" in the decanter, etc.) or a ceramic package ("Riga Black balsam", "Tverskoy", "Stariy Rostov", "Stariy Lekar", etc.). Some manufacturers of alcoholic balsams ("Ussuriyskiy Balsam", "Crystal", "Veda", etc.) choose a durable and convenient packaging for their products - a tube. A bottle in such a strict and elegant package has a different value: it is a prestigious gift, appropriate in any situation. In addition, a well-designed tube stands out on the shelves, attracting the attention of buyers.

Like other types of food products, apart from functional properties, balsams also have **social properties** that characterize the goods’ compliance with the requirements of the public and make them appropriate for production. The key factors here
are the necessity of the product, the demand, the product’s impact on the "quality of life", its security (including environmental), etc. The main reason of the development of balsam production and the demand for balsams is the desire of consumers to lead a healthy way of life in the conditions of the deteriorating environmental situation in world.

Taking into account the common opinion of nutritionists, that the best form of food for the rehabilitation and treatment of the body is a soft drink with a science-based composition and high organoleptic properties, balsams (herbal balsams, concentrated bases of balsamic type) can truly be called health drinks. Practice shows that such drinks are in demand since 1994.

With regard to the social orientation of alcoholic balsams it should be noted that in terms of the tradition of alcohol consumption, Russia belongs to the countries of the so-called "northern" type, which have a focus on spirits - vodka, brandy, sweet and bitter liqueurs, etc. Balsams, as an independent group of liquors, are the most valuable from the consumer point of view, as their consumption in prescribed doses provides the people with a number of positive effects.

Therefore, according to the sum of analyzed properties, balsams are socially-oriented drinks and are useful for the society.

The role of raw plant material in the formation of the nutritional value of balsams

The physiological value is an important part of the nutritional value of foods and beverages, which defines their purpose and usefulness to consumers. This term refers to the ability of foods and beverages to revitalize the major body systems due to the presence of physiologically active compounds (PAC).

Soft drinks based on vegetable raw materials have a special status and are regarded as one of the best forms of products used to meet the needs of the human body in the PAC. In addition, the consumers still prefer beverages produced with the use of natural raw materials, initially rich physiologically active substances.

It is well known that the effect of many types of products made from medicinal raw materials for pharmaceutical usage is based on the conjunction of the individual classes of PAC:

• the increase of the physiological efficiency of glycosides and alkaloids is achieved by using the properties of saponins to improve the solubility and absorption of the glycosides;
• tannins contribute to the prolongation of the physiological and therapeutic effects of other active ingredients;
• the physiological activity of saponins and flavonoids of licorice are often used in the production of pharmaceutical products of various kinds;
• the physiological effect of diuretics and kidney teas is determined by the anti-inflammatory, antibacterial and moderate antispasmodic effects of glycosides, essential oils and saponins;
• the effect of choleretic and hepatoprotective products is determined by the use of raw materials containing flavonoids, essential oils, sterols and saponins: the mechanism of action of these products is based on the reflexes of the intestinal mucosa and the reduction of inflammation under the influence of these PAC, etc.

The physiological value of soft balsams and balsamic syrups depends on the content and composition of the so-called minor components of food - terpenes, phenols, organic acids, etc., that is, it is dependent mainly on the action of the PAC of the raw materials that are widely used in the production of these beverages. In this regard, balsams and syrups, being used as flavors, often have a specific purpose: eg., sedative or health-improving, tonic, antiinflammatory, antistress, adaptogenic, antioxidant, improving the functioning of the gastrointestinal tract, etc. Therefore, the use of medicinal raw material in this case proves the necessity of certain restrictions on the classes of PAC used.

Best known are the restrictions on alkaloids and cardiac glycosides. Alkaloids of some plants have hemostatic effect; and some species of plants are sources of alkaloids and saponins and are therefore used as a pulmonary surfactants and mucus-lytic elements (leaves of coltsfoot, marshmallow roots). However, prolonged usage of medicine based on plant materials containing significant amounts of alkaloids can lead to the opposite physiological effect. Cardiac glycosides exhibit antiarrhythmic properties, affect the contractile function of the myocardium. Glycosides used for diseases of the cardiovascular system, if used in high doses can cause nausea and vomiting, which is due to their direct influence on chemo-sensitive receptors and to the reflexes caused by the irritation of the mucous coat of stomach. The following side effects are also possible: loss of appetite, disorders of the central nervous system (headache, insomnia, depressive effects, visual disturbances); prolonged consumption can also cause cumulative effect. In some cases, infectious diseases can be a contraindication to the use of cardiac glycosides (the immune defense of the organism is weakened). Contraindications for the use of glycosides contained in bitters (herbage and leaves of wormwood and some other plants), whose functions are based on the reflexory increase of the secretion of gastric juice, include increased gastric secretion, ulcer of stomach and duodenal ulcers and other diseases. Saponins, as solubilizers, exhibit an irritating effect on the lining of the digestive tract, increasing the intestinal motility and the gland secretion, demonstrating a choleretic and diuretic effect and improving the sputum from the bronchi (leaves of coltsfoot, birch and foxglove, rhizomes and roots of licorice). But some diseases can cause bleeding and even the development of necrotic processes in the mucous; in the blood, saponins destroy blood cells; therefore, long-term consumption of raw materials containing saponins can lead to an electrolyte imbalance. Perceptions about the therapeutic properties of anthraglycosides (hypericin in Hypericum perforatum, istizin in senna and rhubarb, etc.) have changes so much in recent years, that today the plants with a high content of these elements are not considered as raw material for the production of beverages for general use.
**Coumarins**, as a class of phenolic compounds, also have a number of contra-indications and use limitations. For example, coumarins present in melilot demonstrate a depressing effect on the central nervous system and have narcotic properties. The effectiveness of treatment with drugs containing coumarins is usually temporary, and their toxic effects can occur when they are used in small doses.

There are no such restrictions on the use of **flavonoids**, which have a very wide range of activity. The number of noticed and identified flavonoids reaches more than two thousand varieties. Most of them have a capillary strengthening, anti-inflammatory and estrogenic effects. There are flavonoids that have antispasmodic (licorice), hypotensive and cardiotropic (fruits of hawthorn, chokeberry), sedative (Scutellaria baicalensis root), hemostatic, choleretic, diuretic (flowers of cornflower and immortelle), sugar-reducing and anti-tumor properties.

**Tannins** are used therapeutically as binders and coating agents. The PAC of these elements affects the sensory nerve endings and is used for treating diseases of the intestine, the upper respiratory tract and oral mucosa. However, tannins form insoluble compounds with polyvalent metals (this is why they are used in medicine as antidotes), affecting the mineral elements’ exchange and in case of prolonged consumption causing their deficiency in the body. Due to the fact that tannins cause a precipitation of proteins with the formation of dense albuminates, during systematic consumption they primarily interact with proteins of the gastric mucosa, causing irritation and indigestion. There are other limitations for the use of tannins, so the plant material containing tannins should not be used for long periods of time.

**Essential oils** are complex mixtures of terpenes of diverse structures, which contain ten and even hundreds of chemical compounds (Eg, peppermint oil contains 107 elements), and are a kind of natural regulators of different functions. They demonstrate distracting, analgesic, anti-inflammatory effects, based on reflex reactions caused by the stimulation of the sensory nerve endings of the mucous membranes of the mouth, respiratory tract and gastrointestinal tract. Therefore, essential oils of oregano, dill, fennel and many other plants stimulate the secretion of gastric juice, and thus increase the appetite; oil of fennel, mint and dill positively affect the function of the pancreas. Rose essential oil, on the contrary, inhibits gastric acid and can be used in the treatment of some forms of gastric hyperacidity. Essential oils of rose and oregano have choleretic, antispasmodic and anti-inflammatory effects, they not only increase the bile formation, but also correct abnormal chemistry by reducing the secretion of cholesterol and bilirubin, increasing the biosynthesis of bile acids and phospholipids in the liver, reducing the risk of gallstone formation. Essential oils of chamomile, yarrow and clove, along with an anti-inflammatory and antispasmodic effect on the intestine, also have a rather active antimicrobial and analgesic effect; they normalize the function of the gastrointestinal tract. Essential oils containing alcohols, phenols and oxides (menthol, terpineol, borneol, anethole, carvacrol, thymol and cineole) have an expectorant effect, and therefore peppermint, sage, oregano, anise, elecampane and juniper are widely used for treating inflammatory diseases of the lungs and upper respiratory tract.
Essential oils and raw materials containing them have a general resorptive effect - they influence various regulatory processes, including neurotransmission and immune reactions: the irritation of the receptors of mucous membranes is accompanied by the stimulation of the synthesis and release of enkephalins, endorphins and other substances that play an important role in the regulation of pain and vascular permeability, stimulate the immunological processes and affect blood clotting. But long-term use of medicine containing essential oils may lead to general weakness, dizziness, low blood pressure and allergic reactions. In large doses, the essential oils provoke hematuria; dose-dependently, they stimulate or depress the central nervous system; when removed from the organism they cause irritation of tissues. When describing the composition of essential oils, it should be noted that their toxicity (and allergenicity) decreases from sesquiterpenes, bicyclic and aromatic terpenes to aliphatic monoterpenes; the accompanying compounds of some raw materials have their own characteristics that may also influence the general effect. Given this wide range of therapeutic effects, products based on raw plant materials rich in essential oils, have many common limitations and contraindications, and therefore should not be consumed continuously in physiologically relevant doses.

Along with the undesirable effects of various groups of PAC, one must keep in mind their possible combinations. For example, the composition of the essential oil, tannins and other PAC of oregano has an astringent and anti-inflammatory effect, giving the medicine produced on its basis mucolytic and expectorant properties. At the same time if a person suffers from a lung or respiratory disease and hyperacid gastritis at the same time, the consumption of oregano in this case will cause a lot of pain in the stomach. In all cases with an increased risk of blood clots (preinfarction angina, heart disease, endocarditis, thrombophlebitis, alcohol intoxication, hypercoagulable state of blood, etc.), the PAC contained in coriander, basil and black chokeberry become dangerous, because they accelerate blood clotting. Therefore, despite the pleasant flavoring properties of these raw materials, their addition to drinks, especially alcoholic beverages, is not desirable.

Of course, the intensity of the PAC properties in balsams and syrups of balsamic types is many times less than in pharmaceutical products and food supplements due to their concentration in these drinks, only a few soft balsams and syrups are included in the official list of biological supplements. Moreover, a number of medicinal plants, characterized by the specificity of pharmacological effects caused by the presence of cardiac alkaloids, cardiac glycosides and coumarins, cannot be used in the production of balsams and syrups.

We have studied the effect of three brands of alcoholic balsams, currently produced in Russia, on some of the life indicators of laboratory animals. We investigated the effect of a 45-day consumption of these balsams on the central nervous system (CNS), the functional activity of the liver of the experimental animals, the urinary system and the integral indicators of animals (behavior, appearance, increase or decrease in body weight).

The effect on the central nervous system was analyzed using the following behavioral methods:
• analysis of orientation and motor response (uprights, mink behavior);
• analysis of stereotyped behavior (number of cleaning-licking acts);
• analysis of the body's reaction to barbiturate.

Specialists conducted surveillance of the external manifestation of intoxication of animals - manifestations of aggression or depression.

The effect on the urinary system was studied by the number of released urine during three hours without an additional water load.

The effect of balsams on the functional activity of the liver was evaluated by the following criteria:
• bile secretion (mg/min per 100 g. of body weight), and biliary excretion (total bile produced in mg. per 100 g. during 3 hours) of the hepatocytes;
• the level of enzyme activity - alanine aminotransferase (ALT) and aspartate aminotransferase (ACT) in blood serum; bilirubin in serum and in bile using «Lachema» sets;
• the intensity of lipid peroxidation (LPO) in liver homogenates of TBA-reactive agent (MDA). The number TBAR products was determined by reaction with 2-thiobarbituric acid. The optical density of biosubstrates was determined using Specord-40 M at 532 nm, the content was calculated using a molar extinction coefficient of $1.56\times10^5 \text{ M}^{-1}$.

Investigations were carried out on Wistar rats weighing 180 - 200 g. All animals were kept in the same conditions on a normal diet. To obtain statistically reliable results, groups of 8 animals were formed. The control and experimental groups had animals of the same age. The spread of initial mass in groups was less than 10%. All studies were performed in compliance with the principles set out in the Convention on the protection of animals used for experimental purposes (Strasbourg, France, 1986).

The investigated balsams and the comparator "Vodka Hlebnaya" (product of "Bashspirt") were administered orally to the stomach in doses of 0.2 ml per 200 g of body weight for 45 days. The dosage of administered alcohol products corresponded to the human dose of 50 ml per 70 kg of weight per day.

At the end of the experiment the animals were anesthetized with urethane and laparoscopy was performed on the white line of the abdomen, producing a bandage of the duodenum above and below the exit of the bile duct. Bile was collected through a cannula for 3 hours. Then the animals were decapitated, blood and the organs were extracted (stomach and liver) for biochemical studies. The liver of the animals was weighed; its relative weight (the ratio of liver weight in grams to the weight of the animal in grams) was calculated. During the examination of the stomach the presence of erosive and ulcerative lesions was fixed.

Two of the studied balsams did not have a significant effect on the central nervous system (according to the behavioral responses and the duration of sleep). The first balsam has a strong choleretic and diuretic effect, but has no effect on the gastrointestinal mucosa. In case of a 45-day introduction into the stomach it does not alter biochemical parameters of blood and bile. The second balsam is a diuretic and affects the hepatic parenchyma, increasing the level of MDA.
The third balsam affects the central nervous system (prolonging the effect of barbiturates, apparently violating the dopaminergic neurotransmission). It changes the biochemical indices of blood and bile and MDA (compared with the intact control data), that seems to be due to the presence of toxic-allergic hepatitis in animals and the pronounced choleric action of the balsam.

Thus, it became clear that alcoholic balsams, despite the small content of plant material, however, can have a strong influence on the human body that should not be taken into account when creating balsams.

To find out the reason of the varying effects of balsams on the experimental animals’ organisms, we have analyzed the components of the formulations for their compatibility in terms of the known pharmacological properties of the plant material. We have established that 14 balsams (35%) of 40 analyzed recipes are composed of plant extracts that have a tonic effect on the body, of which 6 (15%) - also contain components that have a sedative effect, and only two balsams have expressed tonic orientation, these are "Taezhniy lekar" and "Ussuriyskiy".

The most common tonic component is *Rhodiola rosea* L.; it is included in the formulations of 14 balsams, but mostly it is combined with sedative components - valerian *Valeriana officinalis* L., sometimes motherwort *Leonurus quinquelobatus* L. or *Leonurus cardiaca* L.

The second most commonly used plant that has a tonic effect on the body is *Stemmacantha carthamoides* (Willd.) H.Dittrich (used in 8 balsams), the third most frequently used is lemongrass *Schisandra chinensis* (Turcz.) Baill. (used in 4 balsams), followed by peony *Paeonia anomala* L., ginseng *Panax ginseng* C.A. Mey., eleutherooccus *Eleutherococcus senticosus* (Rupr. et Maxim.) Maxim., which are used in the preparation of 3 balsams.

The presence of components with opposite effects on the nervous system in one drink can cause dysregulation of the CNS. Such effect was demonstrated by the third balsam, which was tested on laboratory animals and contained components with both exciting and sedative effect on the central nervous system.

It is not possible to analyze all balsams including such mutually exclusive components in the laboratory due to the high cost of experiments and the amount of time needed to conduct them. However, one should bear in mind that such beverages can adversely affect the central nervous system, and their effect is more pronounced than the effect of pure alcohol in the form of traditional vodka, which is also indicated in our research. It should also be taken into account that the plants that are traditionally perceived by most people as a tonic, have different mechanisms of action on human health and the appropriateness of their joint application in one drink is questionable.

All three balsams studied in the laboratory influence choleresis and the diuretic activity of the organism. Such impact is predictable, since all three balsams contain plants that are traditionally used in herbal medicine as diuretic and choleragogue plants.

We analyzed other known formulations of balsams and found that most of them also contain herbal ingredients that have diuretic and choleric or, sometimes
hepatoprotective, action. Consciously or not, many balsam producers used plants known for protecting the liver from toxic damage caused by ethanol. For example, the balsam "Noel" contains components that have marked hepatoprotective effect: chicory (rhizomes) *Cichorium intybus* L., immortelle *Helichrysum arenarium* (L.) *Moench*, corn silk, dandelion *Taraxacum officinale* Wigg. (rhizomes), knot-grass (knotweed) *Polygonum aviculare* L., tansy *Tanacetum vulgare* L., nettle *Urtica dioica* L., St. John's wort *Hypericum perforatum* L. However, one should bear in mind that these plants have a different nature of action on the liver. As shown in experiments on laboratory animals, some components can cause allergic reactions, hepatic injuries.

The balsam "Arskiy kamen" contains chamomile *Matricaria recutita* L., St. John's wort *Hypericum perforatum* L., cornflower *Centaurea cyanus* L., licorice *Glycyrrhiza uralensis* Fisch. which have a characteristic diuretic effect [85].

In order keep in mind the pharmacological properties of some aromatic plants during the production of alcoholic balsams we suggest making functional profiles, which would include plants with known effects on the human body (Fig. 34, Fig. 35, Fig. 36).

This will help avoid the inclusion of components with antagonistic properties in balsam formulations and thus enhance their quality and safety.

It should also be borne in mind that some plants can have a broad spectrum of action. For example, St. John's wort is widely used for treating diseases of the bile ducts and can be included in teas used for the treatment of diseases of the hepatobiliary system, but one should not forget about the antidepressant activity of hypericin - the main active ingredient of St. John's wort [399]. Its efficiency is comparable to that of the known drugs imipramine and desimipramine [46]. Therefore, its combination with such components of the balsam "Khabarovsk" as lemongrass, ginseng and Rhodiola rosea may cause a potentiation of tonic properties.

The appearance of three functional profilograms of the balsams "Bugulma", "Belbeevsky elitniy" and "Khabarovsk" suggests the different orientation of their possible effects on the human body. In "Bugulma" the dominating components have digestive and antispasmodic actions, which, in combination with the carminative effect, can be very useful in the treatment of some digestive problems. Less exact is the profile of "Belbeevsky elitniy" which has a more or less expressed digestion-stimulating effect and can be recommended as an aperitif. The functional profile of "Khabarovsk" demonstrates an imbalance in the recipe because of the presence of plants with antagonistic properties - tonic and sedative.

Of course, it should be borne in mind that the functional profilograms do not allow scientists to make exact conclusions about the properties of balsams and the nature of their impact on the human body. For such judgments lengthy and costly study researches in the laboratory are needed. But, of course, the use of such profilograms will help identify the possible antagonism between the components of the balsams and choose the most promising properties for biological research.
It may seem that the small amount of medicinal plants used for the production of balsams (Eg, for the production of the well-known balsam "Agidel" 700 g of yarrow herbage is used per 1000 dekaliters of the finished drink) gives grounds to ignore the absence of useful properties and the possible influence of the biologically active components of these beverages on the health of consumers. However, it should be noted that in recent years the biochemistry of ultra-low doses is developing very intensively.

Let us calculate, for example, the concentration of flavonoids in the balsam "Agidel". A simple calculation shows that during the extraction of yarrow with 70% ethanol (according to the recommendations of the State Pharmacopoeia) approximately 0.158% mg of flavonoids passes into the extract [47]. At the expenditure of yarrow in an amount of 700 g per 1000 dekaliters and average molecular weight of flavonoids being 250 g-mole, the concentration of flavonoids in the balsam solution can reach $5 \cdot 10^{-9}$ mol/l. Such content of flavonoids in the drink can be achieved only when strictly controlling the quality of the raw material, complying with the extraction rules and other parameters. It is natural to assume that in the production environment the real flavonoid content in soft drinks may be significantly lower. In any case, the concentration of bioactive component reaches the limits, after which other mechanisms of interaction of the receptors with biologically active substances begin acting. Therefore, the selection of ingredients for recipes of alcoholic balsams should be carefully considered and analyzed in terms of the antagonism of various ingredients and the potentiation of their biological effects on the body.

Fig. 34. Functional profile of the balsam “Bugulma”
However, when producing and systematically consuming balsams it is recommended to keep in mind the available information on contraindications and limitations in terms of the connection of the chemical composition of the raw material used in the recipe and the expected physiological effect (special cases of limitations
and contraindications are due to individual characteristics of the consumer’s body: eg, diseases or predispositions to them).

**ALCOHOLIZED AND FERMENTED ALCOHOLIZED JUICES**

In recent years the production of fruit wines, soft drinks and alcoholic beverages has increased significantly. The main type of raw material used for these products are alcoholized and fermented alcoholized fruit and berry juices. For the production of these juices the following wild and cultivated fruits and berries are used: cherry plums, cherries, plums, bird cherries, barberries, cowberries, blueberries, pears, blackberries, strawberries, viburnum, dogwood, cranberries, red and black currants, honeysuckle, magnolia, raspberries, cloudberries, buckthorn, mountain ash and chokeberries, blackthorn, bilberries, dog rose, apple, juniper.

The fruits and berries ready for processing are lifted into the washing machines. The gentle berries are washed on inspection conveyors with shower units. The clean fruits and berries are then inspected to eliminate mold and rotten fruit.

The level of grinding of raw materials strongly influences the yield of juice. Thus, pome fruit evenly cut into pieces with the size of 4-6 mm increases the yield of juice during pressing by 10% compared to the non-ground fruit. It is recommended to crush stone fruit and berries to 10 mm sized pieces.

For better extraction of the juice, pulp used for the production of fermented alcoholized juice is slightly fermented with a 2-3% dilution of pure culture yeast before pressing; it is then stirred and stored for 24-48 hours. The pressing technology is the same as for the production of fruit and berry juices. Juices are clarified by centrifugation or settling, and then sent for canning. In the production of alcoholized juices alcohol is added to clarified juice at a ratio of 16 liters per 1 dekaliters for non-alcoholic products, and 25 liters per 1 dekaliters for alcoholic beverages. In the production of fermented alcoholized fruit juices clarified juice is subjected to preliminary fermentation to reach the alcohol content of 5%, and then to alcohol fortification to reach 16% of alcohol.

Natural alcoholized and fermented alcoholized fruit juices have good taste, wonderful aroma and allow to produce soft drinks, wines and spirits of excellent quality.

**CONFECTIONARY PRODUCTS WITH THE USE OF MEDICINAL HERBS AND BERRIES**

In recent years, specialists note an intensive development of functional confectionery production, which softens the effect of technological factors and provides the body with the necessary daily amount of essential components. The addition of herbal supplements (ginseng, Jerusalem artichokes, sea buckthorn, etc.) to flour and sugar confectionery can create a product with a directed functional effect. They are
recommended as adaptogenic products used to improve the organism’s performance and its resistance to stress.

Herbal drugs in the confectionery industry are used as healing components in the production of kissel (marshmallow, elecampane, magnolia-vine, sea buckthorn), fruit jelly (hawthorn, arrowwood, mountain ash), syrups (licorice, ash, elderberry, cranberry), jellies and jams (dogrose, buckthorn, mountain ash, magnolia-vine, arrowwood, elecampane) and other products. Such products are especially important for the nutrition of children, diet, diabetic and special nutrition of people employed in industries that are harmful to health. However, the production of these products is constrained due to insufficient knowledge of plant materials and the lack of financial resources of processing enterprises.

Thus, the high nutritional and biological value combined with wonderful organoleptic qualities made cranberries an invaluable material for confectionery production. The most popular are natural cranberries coated in powdered sugar. They retain the flavor and aroma of fresh cranberries in harmony with sugar.

Specialists have elaborated a technology of production of arrowwood in powdered sugar. Arrowwood fruits are smaller than cranberries, with a solid small seed and specific bitter taste. In order to remove the bitterness, soften the seed and firm the skin, the washed and sorted fruits are blanched in a boiling 3% solution of salt for 10 minutes, then are immediately cooled in cold water and blanched again for 20 minutes in boiling 55% sugar syrup with the addition of citric acid. Then the fruits are cooled, lightly rinsed with cold water, defective fruits are removed and the fine ones are powdered with sugar. The sweets have a pleasant sweet-sour slightly bitter taste and aroma characteristic of natural arrowwood fruits.

A product with a pleasant and original taste, containing cereal, nuts, raisins or other dried fruits, with sugar used as a binder, can be prepared with the addition of an aromatic additive - sage.

A syrup with sugar, pectin and the water extract of a mixture of bur marigold, corn silk, yarrow, nettle and plantain leaves is the basis of a jelly marmalade with a wide range of vitamin activity and an unusual combination of pleasant organoleptic properties. Syrup containing a mixture of water extracts of chamomile flowers, peppermint leaves, yarrow, bur marigold, plantain and knotweed leaves, marigold and burdock flowers is a different kind of flavor base for jelly marmalade.

In the production of chocolate and sweets the biologically active extracts of ginseng and rhodiola rosea are widely used. For the production of chocolate specialists use grated grape seeds, rich in minerals, prolonging shelf life of the product and enriching it with unsaturated fatty acids, tannins, caffeine, theobromine, and vitamin E. In addition to nuts and natural cocoa butter the recipe contains such non-traditional supplements as fruit puree or Jerusalem artichoke that are rich in pectin and normalize the potassium-sodium exchange. People suffering from diabetes can consume cranberry powdered with sugar made of sorbitol. The caramel “Sibirskaya”, produced with the use of a 20-23% alcohol extract of stems, flowers and fruits of Salsola collina, is used for preventive and therapeutic purposes. Another confectionery product contains aqueous extracts of rose hips, marigold and leaves of black
currant, peppermint, bush-clover and the herbage of St. John's wort, linden and chamomile flowers, parsley and licorice root.

Frozen fruits and berries are products with high nutritional value which preserve the taste and biologically active substances almost completely. The use of frozen fruits and especially medicinal plants as a filling in confectionery products can significantly increase their useful properties.

However, the use of frozen fruit and berries by their direct addition into the dough before baking confectionery products reduces the quality of the product: due to the diffusion of moisture from the plant material into the dough soggy zones appear around the berries (fruits). These processes occur in the frozen fruit and berries more intensively than in the fresh ones, due to the destruction of the cell walls by ice crystals. Therefore, in the production of pastry dehydrated fruits and berries (candied fruits, dried apricots, raisins, etc.) are usually used as fruit additives. However, their biological value cannot be compared with the fresh raw materials used to produce these products. For example, during the production of raisins almost all polyphenolic compounds are lost, which leads to a loss of color and to a decrease in P-vitamin activity.

The sublimation drying technology maintains the biological value of plant material, its color, taste and at the same time significantly reduces the water content, hindering the product’s leakage. The maintenance of the surface temperature of frozen fruits from minus 12 to minus 14°C and a pressure of 240-280 Pa (corresponding to the normal pressure in the industrial sublimation dryers) for 4-5 hours optimizes the product’s moisture, which makes it suitable for use as a fruit filler in confectionery products. Another important factor is the fact that the storage of frozen fruit sharply reduces the risk of their microbial contamination.

The lichen Cetraria islandica L. (Ach.) belongs to the Parmeliaceae family and grows in different climatic zones. It is an ingredient of many national dishes of the North. These lichen species contain 70-80% of carbohydrates similar in their chemical nature to cellulose, ascorbic and folic acids, sugars, minerals and vitamins, 3% of protein, 2% of fat, wax, lichen acids with high antimicrobial properties. It was noted that the viscosity of broths made from the plant reaches its highest point at the hydromodulus of 1:0.8. At the hydromodulus of 1:0.7 jelly is formed, which can then be used for culinary purposes.

Specialists have elaborated a method of using the plant as a substrate for the production of sweet jelly-like dishes and desserts (with the addition of extracts of bilberry, cranberry, mint, and hips’ broth), sour cream and jelly. Along with the recipes of mousse prepared with the use of sugar, there are recipes in which sugar is replaced with xylitol. This will further expand the range of dishes for preventive nutrition. Specialists have created a technological scheme of the production of a jelly "Polyarnaya sov" with various fillings: cowberries, cranberry, sugar and Cetraria islandica L. broth.

A review of the literature shows that the advantages of using medicinal fruits and berries in the confectionery industry are not all taken. The confectionery industry does not use berries of mountain ash, hazel nuts and aromatic plants that can
significantly enrich the taste palette of confectionery products, while making up the deficit of mineral salts, vitamins and biologically active substances of preventive action.

**CONCLUSION**

Unfortunately, examples of the successful production of the listed and other products with the addition of valuable spice, aromatic and medicinal plants are scarce. The main limitations are the lack of the desired range and sufficient amount of certified plant material and of modern facilities for its processing. Agricultural enterprises and private farms, which could receive high profits, are practically not engaged in the cultivation of medicinal, aromatic and other valuable plants due to the lack of financial resources. The same situation is noted among the processing factories. Due to lack of financial resources they cannot advance long-term processes of raw material production, especially of perennial plants.

However, only the production of soft drinks containing St. John’s wort needs 1500 - 1600 tons of the plant to be harvested per year. In recent years, the harvesting did not exceed 50 - 70 tons in dry weight. Thus, for development of bioactive products the following amount of raw materials (t) is needed annually: thyme - 180 (actual amount harvested - 15 - 20), mint - 240 (20 - 30), oregano - 100 (8 - 15), tarragon - 1500 (10 - 25), etc. The lack of biologically active plant material hinders the increase of the production of other valuable phytoproducts as well. Given the development of all sectors of the food industry that use medicinal and other plant material (liquor, fruit and vegetable, wine, confectionery, tea, food concentrates, beer and soft drinks, fat and oil industries), in the early 21st century, the needs of production could reach 130-150 thousand of tons per year, including 60-70 thousand of tons of medicinal plants, and 70-80 thousand of tons of ether oils, respectively. The production of such volumes is possible only on an industrial basis via cultivation of introduced medicinal and other plants in a controlled environment that allows to produce certified environmentally safe raw materials of high quality. Wild plants in this context are considered as auxiliary for certain types of production due to the fact that their harvesting is expensive and the raw material is difficult to identify. Besides, wild resources are represented by different natural populations and thus plants of one species differ greatly in their biochemical composition. The analysis of the food industry’s provision with raw plant material confirms the need for substantial measures to be taken in order to create new and develop the existing sources of raw materials and processing factories across the country. The development of appropriate capacities is possible with the participation of enterprises with all forms of ownership, including farms, involving both regional and private investments.
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