###### **Hydrocarbons-containing medicinal plants and material**

A large class of organic compounds, to which polyhydroxy-carbonyl compounds and their derivatives belong. Hydrocarbons are main nutrient and basic material of plant cells and tissues and constitute up to 90% of the weight of a plant.

Hydrocarbons are naturally occurring organic compounds, that constitute hydroxyaldehydes   or hydroxy-ketons or their condensation products. In the human organism they occur in the free or protein- or lipid-bound state, or as a complex in all organs or tissues. They are integral component of living organisms, one of the group of foodstuffs. Hydrocarbonss include polysaccharides, mucilages, pectin compounds, cellulose, sugar, starch, inulin and oth.

###### Hydrocarbons are primary metabolites and one of the most plentiful organic compounds. Polyhydroxyaldehydes and polyhydroxyketones with general formula (СН20)n and also the derivatives of these compounds belong to them. In the biosphere hydrocarbons are more than all the other organic compounds together. It is directly associated with 2 main polymers of D-glucose, which are widespread – cellulose and starch. Hydrocarbons range from low-molecular compounds with several carbon atoms to the compounds with the molecular weight of several millions.

Hydrocarbons, consisting of only polyhydroxy-carbonyl compounds, are called holosides, but their derivatives with the residues of other compounds, are called glycosides.

According to sizes of molecules, properties to hydrolyze and result in different amount of monomers, saccharides are divided into mono-, oligo- and polysaccharides (polyoses).



###### Monosaccharides are polyhydroxy-carbonyl compounds with continuous carbon chain, they can contain hydroxyl, carbonyl, aminogroups, thiogroups and oth. All monosaccharides in crystalline individual state are internal hemiacetals of polyhydroxy-aldehydes or polyhydroxy-ketones. and they are divided into aldoses and ketoses according to structural diversity, stereochemistry, and the type of the carbonyl group. Aldohexoses, aldopentoses and ketohexoses occupy a central position in chemistry of monosaccharides.

###### Depending upon the number of carbon atoms monosaccharides possess, as trioses, tetroses, pentoses, hexoses and oth. Monosaccharides containing 6 and more carbon atoms are called higher sugars. One of the most abundant monosaccharides in nature is glucose, it is as a source material for the synthesis of other saccharides.

**Chirality rules**

**Asymmetric (Chiral) Carbon** – has covalent bonds to four different groups

Monosaccharides contain one or more asymmetric C-atoms: get D- and **L-forms**, where D- and L- designate absolute configuration

1. D-form: -OH group is attached to the right of the asymmetric carbon
2. L-form: -OH group is attached to the left of the asymmetric carbon

###### Linear known as “Fischer” structure”

###### Ring know as a “Haworth projection”

###### Cyclization via intramolecular hemiacetal (hemiketal) formation

###### C-1 becomes chiral upon cyclization - anomeric carbon

###### Anomeric C contains -OH group which may be a or b

###### In most cases the monosaccharides have an unbranched carbo chain. Monosaccharides with a branched chain rarely occur. In addition to carbonyl and hydroxyl groups, other functional groups,for example carboxyl or aminogroup, can be included in monosaccharide molecule.

###### Pentoses and hexoses are widely distributed in nature. Glucose and fructose are most often found in plants..

###### The pentoses - L-arabinose and D-xylose, the hexoses – D-galactose and D-mannose are the constituents of many polysaccharides of plant, animal or bacterial origin, and also they components of glycosides and different from other monosaccharides for widespread prevalence in nature. The most important pentoses are: D-xylose, L-arabinose, D-Rybose, methylpentoses - L-Ramnose and L-fucose. D-xylose takes part in synthesis of gums, pectins and hemicelluloses. L-arabinose is a component of natural gums. D-rybose takes part in synthesis of nucleic acids and vitamin B. L-Ramnose forms glycosides and polysaccharides.

###### The hexoses, glucose and fructose, are used for medicinal purposes. According to distribution D-glucose occupies the first place among them. D-glucose is an essential component of all living organisms, form viruses to higher organisms. It is a component of sucrose, cellulose, starch, glycoprotins, and also viral RNA. D-glucose (C6H12O6) is an aldose, in free state contained in plant cell, cytoplasm; being combined it composes saccharose, starch, cellulose, glycogen, glycosides. Glucose is the main source of energy for most organisms. In medicine are used isotonic (4,5%- 5%) and hypertonic (10-40%) solution of glucose in uses of hypoglycemic, infection, intoxication, renal diseases. Glucose is a component of blood expanders.

###### D-fructose is a ketogexose, the sweetest sugar, the main component of bee honey and sugar substitute administered in diabetis.

Galactose is found in brain glycolipids, milk oligosaccharides and in many important glycoproteins.

Monosaccharides D-ribose and 2-deoxy-D-ribose play specific roles in biology. They form the basis of RNA and DNA chains.

Different monosaccharide derivatives are actively involved in metabolism of living cells. Monosaccharides are involved in photosynthesis, ensuring the cells with energy, detoxication and elimination of poisonous substances. Biosynthesis of tyrosine and phenylalanine, and other aromatic compounds, the formation of complicated biopolymers – polysaccharides, glycoproteins, nucleic acids for cellular structure formation and normal vital activity are associated with monosaccharides.

###### Monosaccharides as reactive compounds are seldom found free in nature. In living organisms they exist in forms of their derivatives, most often – as the ethers of phospharic acid, or in combined forms - glycosides, oligopolysaccharides, polysaccharides, glucoproteins, glucolipids, nucleic acids and oth. D-glucose is exception. This compound is found in free form in mammallian blood, plant juice and in some other sources. Some ketoses are also found in free form.

**Monosaccharide derivatives**

**polyatomic alcohols**: D-sorbit (20% solution) is used for energy  provision. Fructus Sorbi aucupariae and Fructus Crataegi oxyacanthae contain D-sorbit. D-mannit (mannitol) is diuretic.

###### **amino sugars:**Monosaccharides containing aminogroups instead of 1 or several hydroxyl groups are called deoxyaminosugars or simply aminosugars. D-glucose amine (2-amino-2desoxyglucose) is a structural component of glucoproteids, hialuronic acid, heparin. N-methyl L-glucosamine is a structural unit of chitin.

Monosaccharides in which the most distant carbon atom from the carbonyl group is included in carboxyl group are called uronic acids.

**Desoxysacharides:**D-mannit consists of 2-deoxy-D-ribose. Desoxysacharides are the units of cardiac glycosides, antibiotics, lipopolysaccharides.

**cyclitols: inositol.:** is a representative of cyclitols

Monosaccharides, disaccharides and their derivatives as a starch have mainly dietary significance. Disaccharides sucrose, maltose, trehalose and oth. have special importance in human nutrition. Disaccharides first are splitted, then they are absorbed in intestine. There are special enzymes in the cells of mucous membranes (for each disaccharide). There are no special enzymes for more complicated oligosaccharides, that’s why they are not absorbed by the body.

Monosaccharide fructose of ripe fruits and berries is particularly relevant, it is used for nutrition of diabetics. Hexoses galactose, mannose, glucose, rhamnose (deoxymannose) are very rapidly, others (sorbose and oth.) are very weakly or not fully absorbed. Pentoses arabinose and xylose are weakly absorbed. Most plants contain various sugar derivatives, particularly their polyhydric alcohols – sorbitol, mannitol, dulcitol and oth. As sugars, they have sweet taste, antimicrobial and anti-fungal activity, this enables to use in preservation. Sweetness value of plant hydrocarbons (the sweetness of sucrose is 100%): fructose – 173%, sucrose -100%, glucose- 74%, sorbitol – 48%, xylose – 40%, maltose – 32%, galactose – 32%, rhamnose- 32%.

Sorbitol, xylose and xylit are not digested by the body. That’s why they are used for diabetes nutrition.

The berries of Sorbus aucuparia contain to 70% sorbitol. It occurs in many furits and berries. Sorbitol and xylitol have laxative effect. Due to water retention ability they refer to osmotic laxatives. In most cases the sorbitol produced by food industry is used for this purpose. Sorbitol enhances the intestinal peristaltis not only by oral, also internal administration, facilitates the elimination of intestinal gas. Due to these properties they are prescribed in the presence of postoperative intestinal paralysis.

It was established, that sorbtiol also increase the synthesis of endogenous hormones in duodenum. These hormones regulate the activity of cells of liver, gallbladder, pancreas and intestinal glands. They activate the intestinal villi and as a result enhance the peristalsis. Cholagogum and laxative property of sorbitol is widely used in the treatment of liver disfunction, biliary dyskinesia and constipation. The fruits of Sorbus aucuparia are rich in sorbitol and they are used in the treatment of hepatitis, cholangitis and stagnation of bile. Cholagogum effect of sorbitol is enhanced by the presence of flavonoids in berries.

The structure and interaction of monosaccahrides were found in the end of XIX as a result of classic work of Kiliani, Tollens, Fitig, Fischer and their pupils. The diversity of monosaccharides is directly associated with stereochemical differences. Widely distributd monosaccharides – pentoses and hexoses – are different for the number of carbon atoms and relative disposition of functional groups. In the 1960s of XIX centrury the molecule of glucose was identified as C6H12O6.  Pentaacetate is formed through the acetylation of glucose with acetic anhydride, this points to the presence of five hydroxyl groups in molecule. Glucose reduces ammonia solution of silver oxide and Fehling reagent and forms oxime. Hexatomic alcohol –sorbitol is formed by a reverse process. Sorbitol is converted to hexacetate through the acetylation. Gluconic acid C6H12O7 with five hydroxyl groups as in glucose is formed through the oxidation of glucose with bromine water. All data points to the presence of aldehyde group in glucose.

###### Some pentoses and hexoses distributed in nature are following:

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D – glucose D - galactose

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 D – ribose D – xylose

 **Oligosaccharides**

Oligosaccharides are polymeric low-molecular-weight hydrocarbon compounds, consisting of up to 10 sugar moistures.

Sacharobiose (4-0-á-D-glucopyranosil-â-D-fructofuranoside) is a disaccharide included in medicines. Sugar syrup is a corrigent in tablet manufacture. *Syrup Rosae, Radix  Altheae, venter* (saccharobiose sulfate + Al2O3 hydrate) consist of saccharobiose. Other disaccharides are rutinose (6-C-á-L-rhamnopiranosyl- D-glucopyranose), that is a sugar unit of the flavonole rutin; lactose, maltose.

Most common oligosaccharides are sucrose, trehalose, melicitose and oth.

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Sucrose Trehalose

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Melicitose

Polysaccharides are natural high-molecular-weight hydrocarbon polymers of monosaccharides (sugars) linked together through glycosidic (ether) linkages and form linear or branched chains. In most cases polyacetal (glycosidic) hydroxyl group of one monosaccharide is linked with any hydroxyl group of other monosaccharide (usually hydroxyl group at C-4 or C-6). That is, there are 1,4 and 1,6 glycosidic bonds between them. In systematic nomenclature, polysaccharides are given the ending “-an” instead of “-ose” and another word is generic term glycan. If only one type of monosaccharide unit is present, the polysaccharide is a homoglycan, and a heteroglycan if more than one kind of monosaccharides are involved.

The molecular weight ranges from several thousand to several millions. Polysaccharides are very diverse. They have a support function, play a role in energy storage, and serve as water reservoir in swelling. Polysaccharides are composed of 85-90% of a dry weight of plant. They don’t either dissolve in water, or form gels with greater or less density. A small part of hydrocarbons that appear as part of polysaccharides and plants, is digested in human organism and it is nutrient material. Polysaccahrides that are not splitted sufficiently under the digestive enzyme – amylase, are not digested in gastrointestinal tract. Only some groups of polysaccharides, certain monosaccharides and their derivatives have medical significance. Polysaccharides have ambient, laxative and anti-inflammatory activity. They stimulate the secretion of gastric glands.

Sources of Polysaccharide

* microbial fermentation
* higher plants
* seeds,
* tree exsudates,
* marine plants,
* chemical modification of other polymers

###### In recent years, hydrocarbon structures are depicted in various conformations. For example:

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 α-D-mannose α-D-galactose α-D-glucose

*Physical and chemical properties of polysaccharides.* In pure form,polysaccharides are amorphous, rarely crystalline substances and high-molecular compounds. They contain a large number of hydroxyl groups, that’s why they are polar compounds, they are insoluble in alcohol and organic solvents. The solubility of polysaccharides in water is various. Some unbranched homoglycans (cellulose, chitin, xylans, mannans) are insoluble in water due to strong intermolecular forces; complex and unbranched polysaccharides (glycogens, dextrans) are soluble in water or form gel (glycogen, agar, alginic acid and oth.). In solutions, glycans sometimes form structured systems and may precipitate.

*Extraction of polysaccharides from plant material.* Hot or cold water (mucilagins, some bacterial polysaccharides, sulfated galactan, fructans amd oth.), acid or alkali solutions are used to extract polysaccharides from natural material. Dialysis, fractional precipitation with alcohol or ammonium compounds (IV), ultrafiltration, enzymolysis and oth. are used for purification of extracts from proteins, mineral salts, watersolubl pigments. Polysaccharides can be purified from proteins by denaturation or preferential adsorption on bentonite, calcium phosphate and oth. The substances accompanying cellulose (hemicelluloses, lignin, mineral salts) are dissolved in alkali, sulfuric and nitric acids under heat. After this process only pure cellulose remains.

 *Qualitative reactions*. Variety of polysaccharides, their ability to form homologous series of glycans with different molecular weight don’t enable to use unified reaction for their determination. The reactions that are used in laboratory exercises, are divided into 2 types:

1. reactions of polysaccharides
2. reactions for the products of hydrolysis of polysaccharides - monosaccharides, isolated in pure form, and uronic acids

**Hystochemical reactions used to identify individual polysaccharides**

* **Cellulose**is detected with the solution of zinc chloride and iodine. Cell walls containing cellulose stained dark bluish-violet.
* **Starch**grains produce dark blue colour in Lugol’s solution.
* **Inulin** treated with Molish’s reagent (20% ethanolic solution of á-naphtol with sulfuric acid, prepared ex tempore ) results in violet colour.
* **Mucilages** are identified by means of ethanolic solution of methylen blue (1:5000) resulting in blue colour.)

**Identification of subunits**

The study of [polysaccharide](https://www.britannica.com/science/polysaccharide) structure usually focuses on the chemical [composition](https://www.merriam-webster.com/dictionary/composition), the linkage between the [monosaccharide](https://www.britannica.com/science/monosaccharide)units, and the size and shape of the molecule. The size and shape of a polysaccharide can be [ascertained](https://www.merriam-webster.com/dictionary/ascertained) by techniques that are usually applied to large molecules; e.g., the most accurate [molecular weight](https://www.britannica.com/science/molecular-weight) determination measures the sedimentation properties of the molecule in an applied gravitational field (e.g., the rate at which a solid material is deposited from a state of suspension or [solution](https://www.britannica.com/science/solution-chemistry) in a liquid). Indications of the shape of polysaccharide molecules in solution are obtained from [viscosity](https://www.britannica.com/science/viscosity) measurements, in which the resistance of the molecules to flow (viscosity) is equated with the end-to-end length of the molecule; the viscosity of [hyaluronic acid](https://www.britannica.com/science/hyaluronic-acid), for example, shows a marked dependence on both concentration of the acid and the salt content of the solution, and, under conditions approximating those found in biological systems, a hyaluronic acid molecule may be thought of as occupying a great deal of space. Alternatively, the compact nature of a [glycogen](https://www.britannica.com/science/glycogen) molecule of molecular weight equal to that of a molecule of hyaluronic acid results in its accommodation to a much smaller space than the latter molecule.

The identification of sugars in a mixture resulting from the hydrolytic breakdown of a heteropolysaccharide is most often carried out by chromatography of the mixture on paper, [silica gel](https://www.britannica.com/science/silica-gel), or [cellulose](https://www.britannica.com/science/cellulose). Ready separations can be achieved between pentoses, hexoses and, for example, deoxy sugars; closely related [compounds](https://www.merriam-webster.com/dictionary/compounds) such as D-glucose and D-galactose also can be separated using chromatographic techniques. The linkage positions in polysaccharides are usually determined using the methylation procedure described previously. The various monosaccharide methyl [ethers](https://www.merriam-webster.com/dictionary/ethers) produced by the methylation are separated by gas–liquid chromatography.

Detailed statements about polysaccharide structure and function are limited by the statistical nature of some measurements (e.g., branching frequency), the biological variability of [parameters](https://www.merriam-webster.com/dictionary/parameters) such as size and molecular weight, and incomplete information about associative interactions in living things.

**Preparation and**[**analysis**](https://www.britannica.com/science/chemical-analysis)

In general, monosaccharides are prepared by breakdown with acids of the polysaccharides in which they occur. Sugars usually are difficult to obtain in crystalline form, and the crystallization process usually is begun by “seeding” a concentrated [solution](https://www.britannica.com/science/solution-chemistry) of the [sugar](https://www.britannica.com/science/sugar-chemical-compound) with crystals. The techniques employed for separation of monosaccharides depend to some extent on their physical and chemical properties; chromatographic procedures are often used.

[Oligosaccharides](https://www.britannica.com/science/oligosaccharide) and polysaccharides are prepared from natural sources by techniques that take advantage of size, alkaline stability, or some combination of these and other properties of the [molecule](https://www.britannica.com/science/molecule) of interest. It should be noted that preparation of an [oligosaccharide](https://www.britannica.com/science/oligosaccharide) or [polysaccharide](https://www.britannica.com/science/polysaccharide) usually results in a range of molecular sizes of the desired molecule. The purity of a carbohydrate preparation, which is frequently based on an analysis of its [composition](https://www.merriam-webster.com/dictionary/composition), is more easily established for monosaccharides and disaccharides than for large, insoluble molecules such as [cellulose](https://www.britannica.com/science/cellulose).

**Analytical techniques**

A variety of organic chemical [analytical](https://www.merriam-webster.com/dictionary/analytical)techniques are generally applicable to studies involving carbohydrates. Optical rotation, for example, once was frequently used to characterize carbohydrates. The ability to measure the rotation of the plane of polarized [light](https://www.britannica.com/science/light) transmitted through a solution containing a carbohydrate depends on finding a suitable solvent; water usually is used, with light at a [wavelength](https://www.britannica.com/science/wavelength) of 589 mμ (millimicrons). Optical rotation is no longer widely used to characterize monosaccharides. The magnitude and sign of the [optical rotation](https://www.britannica.com/science/optical-activity) of glycosides, however, is useful in assigning [configuration](https://www.britannica.com/science/configuration)(α or β) to the hydroxyl group at the anomeric centre; glycosides of the α-configuration generally have rotations of higher magnitude than do the same glycosides of the β-configuration. Optical rotation is not a completely [additive](https://www.britannica.com/topic/food-additive)property; a trisaccharide composed of three [glucose](https://www.britannica.com/science/glucose) residues, for example, does not have a rotation three times that of one glucose molecule. Sugar alcohols cannot form ring structures; their rotation [values](https://www.britannica.com/dictionary/values) are extremely small, suggesting a relationship between ring structure and the ability of a carbohydrate to rotate the plane of polarized light. Certain types of reactions (e.g., [glycoside](https://www.britannica.com/science/glycoside) hydrolysis) can be monitored by measuring the change in optical rotation as a function of time. This technique is frequently used to examine the breakdown of disaccharides or oligosaccharides to monosaccharide units, especially if a large change in the net optical rotation may be expected, as occurs in the [hydrolysis](https://www.britannica.com/science/hydrolysis) of [sucrose](https://www.britannica.com/science/sucrose).

**Spectroscopic techniques**

Several other optical techniques used in [chemistry](https://www.britannica.com/science/chemistry) have been applied to the analysis of carbohydrates. Infrared [spectroscopy](https://www.britannica.com/science/spectroscopy), used to measure vibrational and rotational excitation of molecules, and [nuclear magnetic-resonance spectroscopy](https://www.britannica.com/science/nuclear-magnetic-resonance), which measures the excitation of certain components of molecules in a [magnetic field](https://www.britannica.com/science/magnetic-field)induced by radio-frequency radiation, are valuable, although the similarity of the functional groups (i.e., the hydroxyl groups) limits use of the former technique for most sugars. [Proton](https://www.britannica.com/science/proton-subatomic-particle) magnetic-resonance spectroscopy, [nuclear magnetic resonance](https://www.britannica.com/science/nuclear-magnetic-resonance)applied to protons (H atoms), is employed to identify the relative spatial arrangements of individual [hydrogen](https://www.britannica.com/science/hydrogen) atoms in a [molecule](https://www.britannica.com/science/molecule). When they are precisely placed, the corresponding positions of the hydroxyl groups attached to the same [carbon](https://www.britannica.com/science/carbon-chemical-element) [atom](https://www.britannica.com/science/atom)can be deduced. An extension of this technique utilizes the [resonance](https://www.merriam-webster.com/dictionary/resonance)spectroscopy of carbon-13, a nonradioactive isotope of carbon, so that ring structures can be established with great accuracy. Both the proton and carbon [magnetic resonance](https://www.britannica.com/science/magnetic-resonance)methods are best applied to monosaccharides; they are less valuable in studying polysaccharides because an individual hydrogen atom in a large molecule is too small for accurate detection.

*Biological significance*

Perfect classification is impossible due to the absence of pattern between chemical structure and biological significance. Although the same polysaccharid can be obtained from different sources, the source of isolation underlies the classification. According to this classification polysaccharides can be divided into three groups: a)phytopolysaccharides; b) zoopolysaccharides; c) microbial polysaccharides. Polysaccharides are classified according to their physiological functions into storage and structural; according to acidity – neutral and acidic; according to character of skeleton – linear and branched; according to the type of their monosaccharide units – homopolysaccharides and heteropolysaccharides. Homopolysaccharides are composd of the same monosaccharide units, but heteropolysaccharides are composed of more than one type of monosaccharide units. The main sources of phytopolysaccharides are higher plants and algae. Thesee polysaccharides include cellulose, pectins, gums, mucilage, inulin, starch and oth.

Taking into account the biological activity of polysaccharides, new sources have been detected recent years. Polysaccharides have various valuable properties, that open up the prospect for practical use in medicine, pharmacy, chemistry, food industry and other fields. Polysaccharides are distinguished by anti-tussive, anti-inflammatory and antiviral action, immunologic activity, anticoagulant and hypoglycemic effect. Inulin and pectin isolated from topinambur tubers are prescribed for diabetics. Polysaccharids are essential substances in manufacturing of some dosage forms. Several new medicinal preparations are proposed on the basis of plant polysaccharides. Many antitussive medicinal preparations are produced on the basis of plant polysaccharides.

Polysaccharides have antimicrobial activity. Oligosaccharides are used in liquid or solid dosage forms in the prevention and treatment of gastric ulcer due to the ability to inhibit of *Helicobacter pylori* cells. Plant polysaccharides are used in the treatment of various diseases of skin and mucous memebranes. Polysaccharides have antioxidant activities.

*Biological activity of polysaccharides.* Polysaccharides have expectorant, laxative, absorbing, detoxifying, anti-inflammatory, wound healing and oth. activities.Dextran solutions are used as plasma extenders. Many polysaccharides act as excipients (starch and its modifications, gums, pectins, cellulose and its derivatives), filler, stabilizer, emulsifier and oth.

#### **MPM, containing polysaccharides**

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| **MPM name** | **Source** | **Constituents** | **Action, use** |
| **Semen Lini** | *Linum ussitatissimum L*.,(linseed, flaxseed), *Linaceae* | fixed oils, containing linoleine, mucilage, linamarine | demulcent, emollient (atonias and ulcer treatment), laxative |
| ***Radices Taraxaci*** | *Taraxacum officinale Wigg* (dandelion), *Asteraceaea* | inulin (40%), bitters (sesqui-and  triterpenoids), taraxasterol | extract chiefly used as a simple bitter; component of appetite, laxative and choleretic teas |
| ***Radices Altheae, Herba Althaeae*** | *Althaea officinalis L., A.armeniaca Ten*(marsh mallow), *Malvaceae* | mucilage, pectins, starch | emmolient, mucolytic (bronchitis, cough; gastric ulcers), anti-inflammatory action |
| ***Folia Plantaginis majoris, Herba Plantaginis majoris recens*** | *Plantago major L*. (plantain), *Plantaginaceae* | pectins, glycans, mucillage; allantoin, aucubin; flavonoids; vitamins C and K | mucolytic (bronchitis), wound-healing, anti-inflammatory(gastritis, ulcers, colitis) |
| ***Semina Psylii, Herba Plantaginis psylii recens*** | *Plantago psylium (*psyllium*), Plantaginaceae* | mucilages (10-30%) of neutral and acidic fractions, oils | cathartic, emmolient |
| ***Folia Farfarae*** | *Tussilago farfara L*.(coltsfoot), *Asteraceae* | mucilages, carotenoids, organic acids, tussilagin, flavonoids. | emmolient, mucolytic, anti-inflammatory (in upper respiratory diseases) |
| ***Rhizomata et Radices Inulae*** | *Inula helenium L*. (elecampane), *Asteraceae* | inulin (40 %), alantol, volatile oil, helenine,bicyclic sesquiterpenoids (alantolactone, iso- and dihydroalantolactone) | mucolytic, stimulating gastric activity and appetite, choleretic action. Volatile oil is an antiseptic and antihelmintic |
| ***Flores Tiliae*** | *Tilia cordata Mill,T. platyphyllos Scop.,*(lime)*Tiliaceae* | mucilages, flavonoids, farnesole, monoterpenoids | anti-inflammatory(colds, angina, stomatitis, gingivitis treatment) |
| ***Fructus Rubi Idaei*** | *Rubus idaeus L. (european raspberry), Rosaceae* | fructose, glucose, sucrose, pectins; organic acids, vitamins, flavonoids | infusion cures colds (decreases temperature). *Sirupus Rubi idaei* is used as *corrigens* |
| ***Thalii Laminariae*** | *Laminaria japonica Aresch, L. saccharina(L.)Lam.,*(brown sea weed), *Laminariaceae* | polysaccharides (alginic acid), organic brome and iodine, vitamins of -group, 23 aminoacids | Prophylactic remedy for endemic thyreocele and atherosclerosis; laxative |