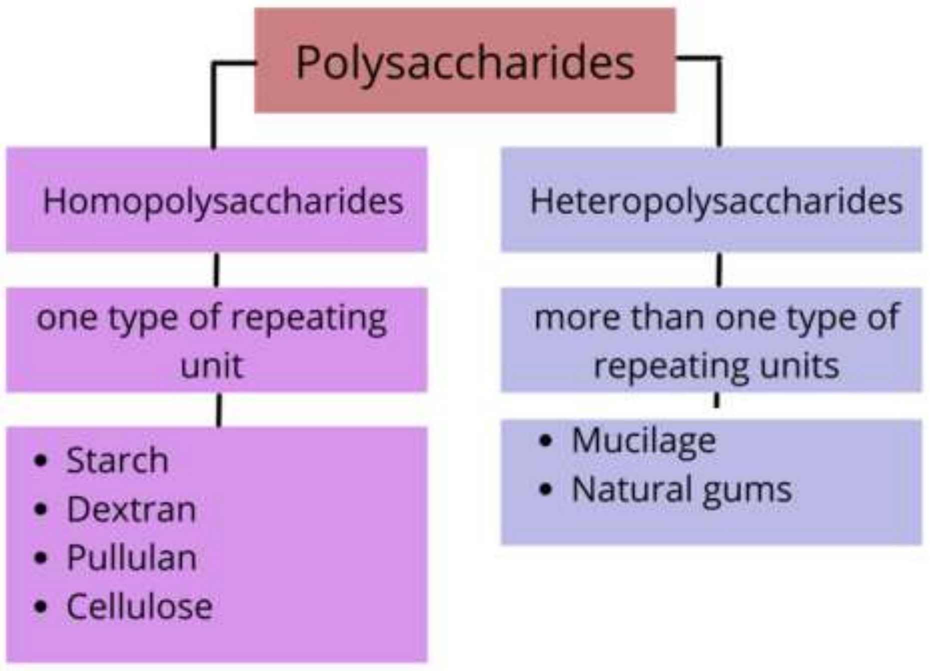
POLYSACCHARIDES

Polysaccharides (homoglycosides) are high molecular weight condensation products of more than five monosaccharides and their derivatives linked together by O-glycosidic bond, forming linear or branched chains. The molecular weight of polysaccharides varies from a few thousand to several million. Polysaccharides include about 20 monosaccharides: hexoses - glucose, galactose, fructose; pentoses - xylose, arabinose; uronic acids - glucuronic, galacturonic, mannuronic.

Monosaccharides are part of polysaccharides in pyranose or furanose form. The glycosidic bond is formed by the semi-acetyl hydroxyl of one monosaccharide and the hydrogen of one of the alcohol groups of the other monosaccharide. Their bonding occurs through bonds 1→4, 1→6, 1→3 depending on the position of the alcoholic hydroxyl that is involved in the formation of the bond. Polysaccharides can form linear or branched chains.
The hydroxyl groups can be methylated, esterified by acetic, nitric, sulphuric (agar-agar) acids, and can be replaced by metals - Mg^{2+}, Ca^{2+}.
Individual groups of polysaccharides have trivial names - starch, cellulose, mucilage, etc. In chemical nomenclature, they are named after their constituent monosaccharides: glucan, galactan, galactomannan, etc.

Classification of polysaccharides

Polysaccharides are divided into two types: homopolysaccharides (homopolymers) and heteropolysaccharides (heteropolymers).



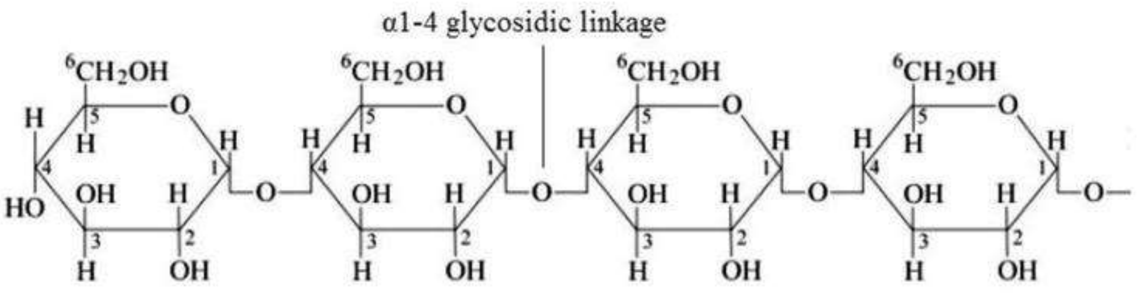
Homopolysaccharides are made of monosaccharide units (monomers) of the same type; heteropolysaccharides are made of residues of different monosaccharides and their derivatives. In medical practice, homopolysaccharides include starch and cellulose; heteropolysaccharides include inulin, pectin, gum and mucilage.

Starch – Amylum

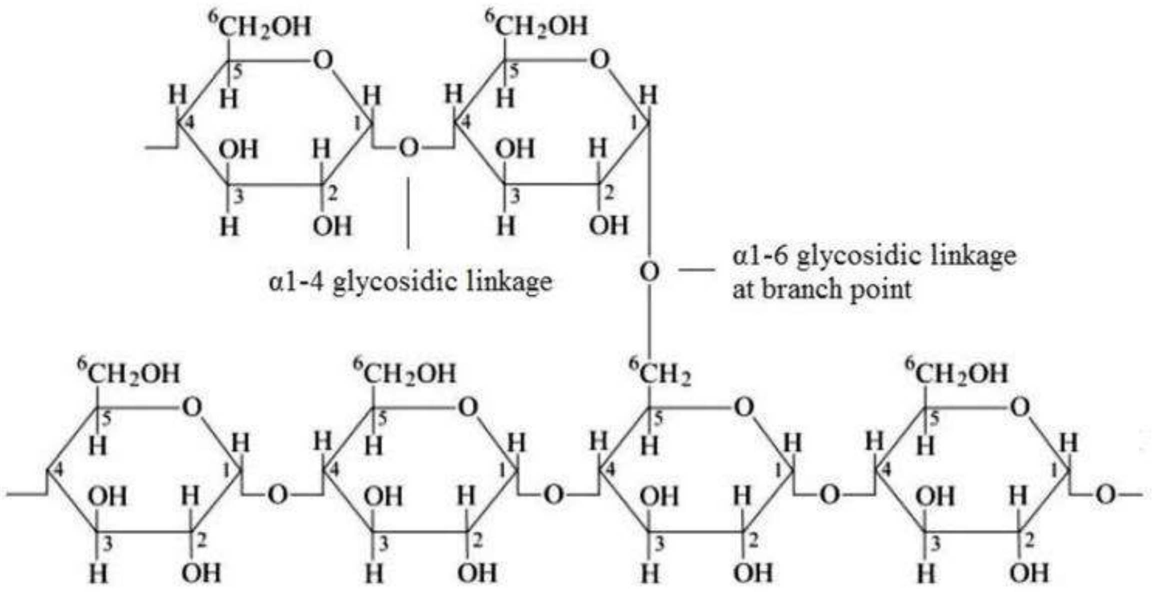
Starch is not a chemically individual substance. Starch polysaccharides are represented by two substances, ***amylose*** and ***amylopectin***. Both polysaccharides are glucans and are formed from alpha-glucopyranose residues.

Amylose is a linear glucan, with 60-300 (up to 1500) glucose residues linked by alpha-glycosidic linkage between the first and fourth carbon atoms. Amylose has a molecular weight of 32,000-160,000, is easily soluble in water and gives solutions with relatively low viscosity.

Amylopectin is a branched glucan, in which 3000-6000 (up to 20,000) glucose residues are linked by alpha-glycoside linkage, not only between the first and fourth carbon atoms, but also between the first and sixth. Amylopectin dissolves in water when heated, yielding persistent, viscous solutions. Its molecular weight is in the hundreds of millions.



Amylose



Amylopectin

Starch is formed and stored in the plastids in the form of grains. The shape and size of the starch grains are specific to the plant species. Starch grains are 96-98% polysaccharides accompanied by minerals (phosphoric acid) and solid fatty acids.

In medical practice it is used:
- potato starch - Amylum solani (Solanum tuberosum L.);
- wheat starch - Amylum Tritici (Triticum vulgare L.);
- corn (maize) starch - Amylum Maydis (Zea mays L.);
- rice starch - Amylum Oryzae (Oryza sativa L.).

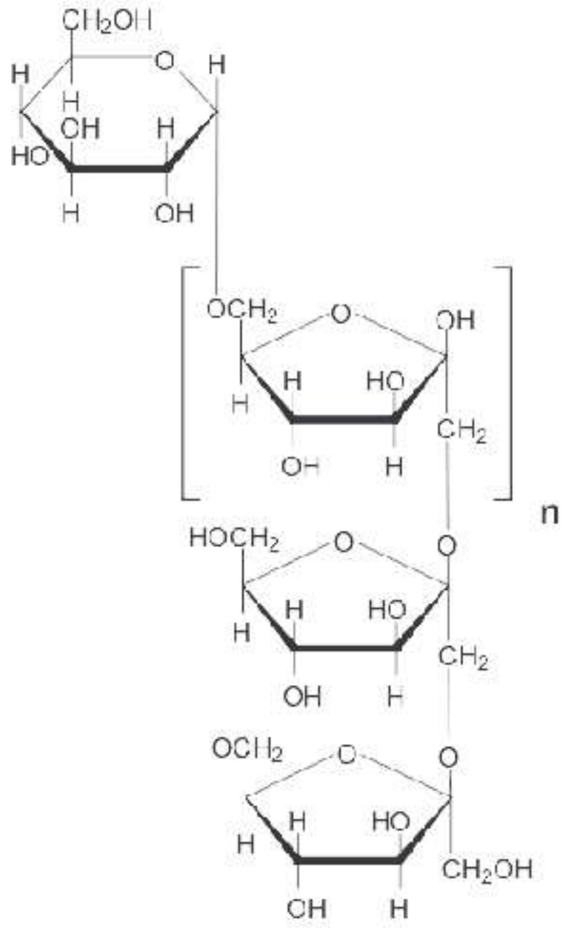
Starch is used as a filler and in surgery for the preparation of fixed dressings. It is widely used in rash, ointments, pastes together with zinc oxide, talcum. Starch is used internally as a coating agent for gastrointestinal diseases.

Products of partial hydrolysis of starch - dextrins (Dextrinum) are also used.

Potato and maize starch are the main sources of commercially produced glucose.

Inulin

The inulin molecule is built of beta-fructofuranose residues linked by glycosidic bonds between the first and second carbon atoms. Inulin molecules are linear and end with an alpha-glucopyranose residue.

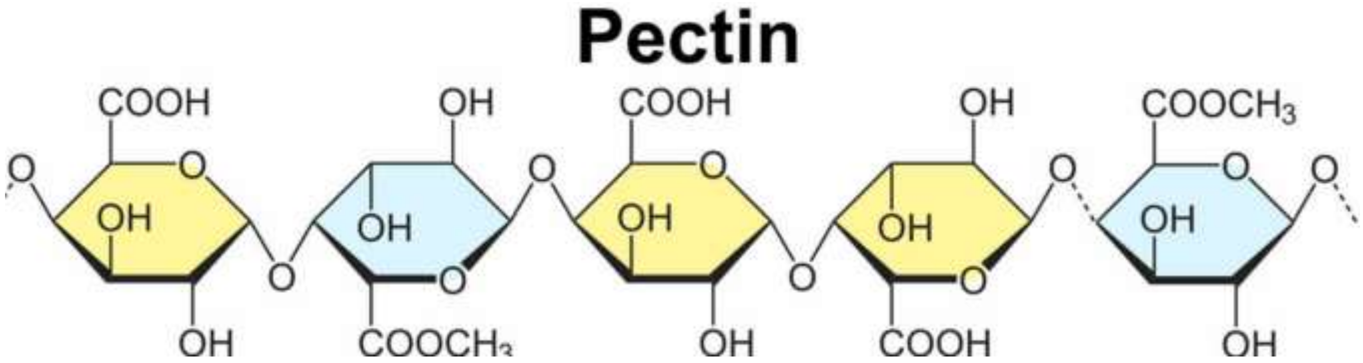


Inulin is found in large quantities in the underground organs of plants in the Asteraceae and Campanulaceae families, where it replaces starch.
Inulin-containing raw materials are used in medical practice:
- dandelion roots - Radices Taraxaci (Taraxacum officinale Wigg.);
- rhizomes and roots of elecampane - Rhizomata et radices Inulae (Inula helenium L.);
- leaves of mother-oil - Folia farfarae (Tussilago farfara L.);
- burdock roots - Radices Arctii (Arctium lappa L., A. tomentosum Mill., A. minus (Mill.) Bernh.)

Plants containing inulin are used to produce fructose. Nowadays, raw materials rich in inulin (chicory roots, tubers of topinambur (earthen pear)) are widely used in various food supplements for diabetes.

Pectin substances

Discovered in 1825; the name comes from 'pectos' (Greek), which means frozen, coagulated. The main monomer of pectin substances is alpha-galacturonic acid. Polygalacturonic acid is accompanied by galactan and araban, which are linked by covalent bonds to acidic fragments of pectins. The carboxyl group of each galacturonic acid residue can be methoxylated or form salts with Ca^{2+} and Mg^{2+} ions.



Pectin substances are found in large quantities in fruits, tubers and stems as insoluble protopectin. During ripening and storage, protopectin is converted into soluble forms, improving the taste of the fruit. Soluble pectins are present in plant juices. The presence of pectins has to be taken into account in the processing of medicinal herbs.
Pectin substances make up the intercellular substance and the primary walls of young plant cells. In brown algae this role is played by alginic acids. The monomers of alginic acids are beta-mannuronic acid and alpha-guluronic acid, linked by 1→4 glycosidic bonds. The carboxyl groups of mannuronic and guluronic acids often form salts with Na^{+}, Ca^{2+} and Mg^{2+} ions.

The use of pectin substances in medicine is due to their ability to reduce the gastro-toxicity of salicylates; pectin acids can be used as a carrier for medicines. Pectins have an anti-ulcer effect and are mild laxatives, and form complex compounds with various metals - chelates that are easily excreted from the body. For this reason products containing pectins are especially indicated for people living in radioactively contaminated areas.

Industrial raw materials for obtaining pectins are beet pulp, apple pomace, citrus fruit peel, threshed sunflower baskets, etc. Pectin substances are widely used in textile and food industries, in cosmetics.

Alginic acid is a natural "ion exchanger" and has the ability to selectively adsorb heavy metal cations and radioisotopes. Application of alginic acid prevents deposition of radioactive strontium in human and animal organisms.

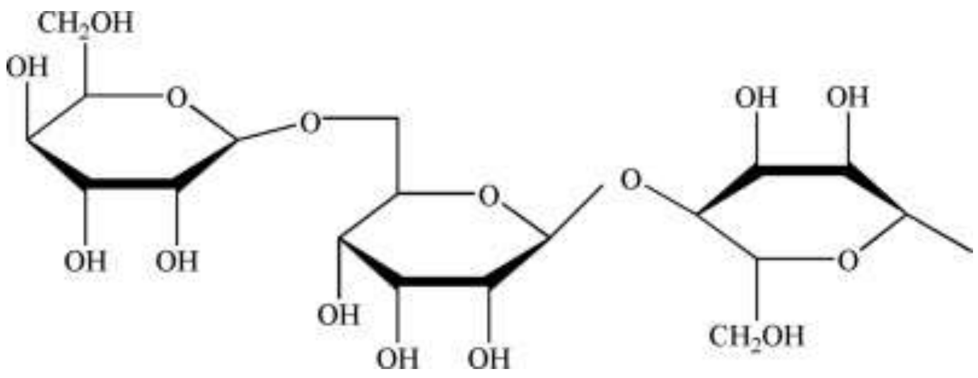
Alginate salts have been used as a basis for wound and burn treatment and haemostatic preparations for gastroenterology, which create a protective and healing coating on the affected area. In addition, alginates are used to produce dressings with a prolonged therapeutic effect.

Gum and mucus

Gummi and mucus are mixtures of homo- and heteropolysaccharides and polyuronides. They are chemically similar to each other.

Gums are usually formed in plants in arid climates as a result of degradation of the cell walls, the contents of the core cells and the heart rays. They are excreted as viscous patches from cuts and cracks in plants when they are damaged or diseased. These soft patches harden in the air.

Gum consists of hexoses (galactose and mannose), pentoses (arabinose and xylose), methylpentoses (rhamnose and fucose) and uronic acids (glucuronic and galacturonic). Uronic acids form salts with K+, Ca2+, Mg2+ ions.



Tragacanth gum, apricot gum, plum gum, cherry gum, etc. are used in medical practice. They are used in the preparation of emulsions, tablets and pills. Gum is also used in the food, textile, leather and paint and varnish industries.

Mucus is present in intact plants and is formed as a result of the normal mucilaginous rearrangement of the cell walls and cellular contents. The mucus accumulates in the intercellular spaces, in the cells and in special receptacles. A distinction is made between neutral mucus (salep mucus) and acidic mucus (mucus of marshmallow, flax, plantain). Acidic reaction is caused by the presence of uronic acids in the composition of the mucus.

Mucus is characterized by considerable prevalence of pentoses. Unlike gum, they may be neutral, i.e. contain no uronic acids.

In medicine, mucus is used as an anti-inflammatory and enveloping agent. In addition, mucus has radioprotective and immunoprotective properties.

Biological role of polysaccharides

Polysaccharides make up 80% of the organic matter of the planet, as they make up the majority of the dry matter of plants.

In plants, monosaccharides and their derivatives formed during photosynthesis are used as precursors in the synthesis of oligo- and polysaccharides. Structural polysaccharides (cellulose, pectin substances) and stored polysaccharides (starch, inulin) are synthesised. Structural polysaccharides are formed in growing tissues. The stored polysaccharide starch is temporarily deposited as starch grains in the chloroplasts and then mobilised and transported as sucrose from the leaves to other plant organs. Starch is again formed in the leucoplasts (amyloplasts) and stored in the seeds and in the underground organs, by means of which plants are renewed and propagated vegetatively (roots, rhizomes, tubers, corms and bulbs). The underground organs of the Asteraceae family store fructosans, particularly inulin, instead of starch.

Polysaccharides have the following functions in plants:

- **carcass** (skeletal) - cellulose, pectin substances, including alginic acids. Cellulose makes up the bulk of plant cell walls. Pectins act as a cementing, gluing material and a support for tissues. They protect plants from drying out, increasing the drought and frost resistance of plants, and influence the germination of seeds and cell growth;

- **protective** - gum, mucus. Gum protect plants from infection by pathogens by flooding the cracks and other damages. Mucilage prevents plants from drying out, increases their drought-resistance, promotes water absorption by seeds and their swelling during germination;

- **reserve**, or energy - starch, inulin.

Methods for the extraction of polysaccharides from plant material

The way polysaccharides are extracted depends on several factors, in particular their solubility. As a rule, the soluble ones are extracted from the herbal medicine with water at room temperature or by heating. When heated, more polysaccharides are extracted from medicinal plant material.

Since different polysaccharides dissolve differently in water at different temperatures, this can be used for fractional extraction of polysaccharides from medicinal plant material. For purification from associated water-soluble substances (mineral salts, monosaccharides, organic acids, tannins, etc.) the property of polysaccharides to coagulate under the action of alcohol (mainly ethanol is used) is used. Sometimes polysaccharides are precipitated by copper salts, ammonium sulphate.

For further purification, the sediments are washed with different solvents (ethyl acetate, ethanol, acetone); dialysis; electrophoresis, ultrafiltration through semipermeable membranes with a certain pore size. For the separation of polysaccharides, chromatography is commonly used (ion-exchange chromatography) as well as "gel-filtration" on Sephadex. Ion-exchange resins allow the separation of neutral and acidic polysaccharides. Ultracentrifugation is used to separate polysaccharides by particle mass. This method makes it possible to determine the mass of polysaccharide particles that form colloidal solutions.

Physical and chemical properties of polysaccharides

These are usually amorphous substances. Insoluble in alcohol and non-polar solvents. Solubility in water varies:

- cellulose, protopectins, cherry gum - insoluble in water;
- other pectin groups - form gels;
- tragacanth gum, starch - swell in water. In warm water, starch forms a viscous colloidal solution (cluster);
- inulin, mucilage, apricot gum - soluble in water.

Polysaccharides are usually colourless, tasteless and odourless.

Polysaccharides undergo acid or enzymatic hydrolysis to form mono- or oligosaccharides. The resulting monomers give rise to characteristic reactions.

Harvesting, drying and storage of raw materials containing polysaccharides

Collect the raw material after 10-11 hours, when the dew is completely dry. Collect in small, well-ventilated containers (baskets, cloth bags). Stack the raw material loosely, but do not tamp it down. The period from harvesting to drying should not exceed two hours.

Drying takes into account the activity of the enzyme systems. Usually they are dried at 50-60°C, which is a drying process with partial denaturation of the enzymes. Sometimes raw material is kept at 70-80°C for one hour, when the enzymes are fully denatured, and then dried in air-shade.

Raw material is stored at 12-15°C and 30-40% humidity. Raw material is often stored in cloth bales, cloth or jute-kenaf sacks, less often in multi-ply paper sacks, sometimes in crates of woody materials. Packed in paper bags to be placed in cartons. The shelf life of the raw material is from 2 to 5 years.

Quality control of raw materials containing polysaccharides. Methods of analysis

The authenticity of medicinal plant material is confirmed by qualitative reactions. The **pharmacopoeial reactions** are as follows:

- on starch:

when adding Lugol solution (iodine solution in an aqueous solution of potassium iodide) a blue staining appears (Sachs reaction);

- on inulin:

Stage 1 - when iodine solution is applied, there should be no blue staining (absence of starch);

Stage 2 - when applied to a 20% alcohol solution of alpha-naphthol and concentrated sulphuric acid, pink-violet staining appears (Molish reaction);

- on mucus:

1) application of ammonia or sodium hydroxide solution produces yellow staining;
2) methylene blue solution stains mucus blue;
3) microplate is placed in solution (1:10) of office ink: cells with mucus stand out with white spots on dark-grey (almost black) background;

- on pectinaceous substances:
- galacturonic acid formed after acid hydrolysis reacts with carbazole, with red-purple staining appearing.

The **quantification** of polysaccharides is done by gravimetric (by weight) method, based on the precipitation of polysaccharides from an aqueous extract with 95% alcohol. The stages of analysis are:

1) extraction of polysaccharides with water;
2) Precipitation of polysaccharides from an aqueous extraction with 95% alcohol;
3) drying of the precipitate and bringing it to a constant mass.

The content of polysaccharides in herbal raw materials is also determined spectrophotometrically (e.g. inulin content in

Medicinal plants and raw materials containing starch

Potato, wheat, corn and rice starch is used in medical practice.
Potato starch - Amilum Solani, derived from potato tubers - Solanum tuberosum L., Solanaceae family.

Wheat starch - Amylum Tritici , is derived from grains of wheat - Triticum vulgare L., family Gramineae.

Corn starch (or maize starch) - Amylum Maydis, derived from grains of corn - Zea mays L., family Grains - Gramineae.

Rice starch Amylum Oryzae, derived from grains of rice - Oryza sativa L., family Gramineae.

Let's look at the example of potato starch production.

-crushing- potatoes are washed, the tubers are sorted and shredded in special machines - potato grinders;
-rinsing with water (on sieves) - water carries away starch grains released from destroyed cells;
-settling - sedimentation of starch grains;
-drying - in chamber dryers to a residual moisture content not exceeding 20%.

Starch is used in the form of powder, as a gumming agent in gastrointestinal diseases, as a filler in tablets, in surgery for the preparation of fixed bandages. Starch enhances the synthesis of riboflavin (B2) by intestinal bacteria and promotes bile acid metabolism. Potato and maize starch is the main industrial source of glucose.

Plants and medicinal raw materials containing mucilage.

Common Flax (Linseed) - Linum ussitatissimum L.
family Linaceae
Flax seeds - Lini usitatissimi semina

Flax is an annual herbaceous plant, very smooth, with a slender fibrous root, and 1 or more straight, round, leafy corymbose stems, 30 or 60 cm in height. Leaves are small, alternate, sessile, acute, narrow-lanceolate and rather glaucous. The lowermost leaves are short and blunt.

The flowers are five-parted, with a sky-blue corolla, gathered in a sparse cymoid inflorescence. Fruit is a capsule with 10 seeds.

It blooms in June-August and bears fruit from July to August. Various varieties of flax are widely cultivated: flax for fiber has a nonbranched stem 60-150 cm high; flax for seeds has an oilseed crop with a branched stem up to 50 cm high.

Flax is grown in the non-black-soil regions of Russia, Belarus, the Baltic States, some varietys are cultivated in Kazakhstan, Western Siberia, the Volga region, the steppe regions of Ukraine, the North Caucasus and Central Asia.

Flax seed harvesting is now mechanical.

External features.

Seeds flattened, ovate, pointed at one end and rounded at the other, unequal, up to 6 mm long and 3 mm thick. Seed surface smooth, glossy, with a light yellow, clearly visible seed scar (magnifying glass 10×). The colour of the seeds is light yellow to dark brown. There is no odour. The taste is slimy and oily.

Chemical composition.

Seeds contain mucus 5-12%; fatty oil 30-48%; protein 18-33%. During mucus hydrolysis galactose, galacturonic acid, xylose, arabinose and rhamnose are formed.

According to the State Pharmacopoeia (Russia) XIV the sum of polysaccharides in the whole raw material should not be less than 7%.

Pharmacotherapeutic group. Enveloping agent**.**

Pharmacological properties. Flax seed, soaked in water, after 2-3 hours, swell and release mucus. Taken internally, it has a coating effect, covers the mucous membrane of food pulp and the mucous membrane of the digestive tract. Flax seed swells in the intestine, increases in volume, which enhances peristalsis. Flaxseed oil has analgesic and choleretic properties. Like other vegetable fats, it contains minimal cholesterol and large amounts of unsaturated fatty acids. "Linetol derived from linseed oil reduces blood cholesterol levels and inhibits the development of vascular wall lipoidosis, acts synergistically with thyroidin, favourably affects the blood coagulation and anticoagulation systems in patients with coronary atherosclerosis, activates fibrinolysis and reduces blood coagulation properties.

Uses. Flax seeds, linseed oil and Linetol derived from linseed oil are used in medical practice. Mucilage of seeds is used internally for gastric and duodenal ulcers, enteritis, colitis. Mucilage enemas are administered to patients with dysentery, proctitis, and hemorrhoids. The seeds are also used as a gentle laxative, adding 1 teaspoon to the food. Linetol is used for the prevention and treatment of atherosclerosis. Outwardly linetol is used for radiation damage to the skin, chemical and thermal burns. The drug promotes faster regeneration of the affected tissues.

Marshmallow - Althaea officinalis L.
Malvaceae family - Malvaceae
Althaea (Marshmallow) roots - Althaea radices

The marshmallow is a perennial herbaceous plant, 60-150 cm high. The rhizome is multi-headed, short, woody, with branched, fleshy, whitish roots. Stems are pubescent, weakly branched, erect. Leaves are alternate, petiolate, usually 3-5-lobed, rounded or ovate, simpler towards the top.

Flowers are pentamerous, large, aggregated in the upper part of the stem in a spike-like inflorescence called thyme. Corolla whitish or pinkish, petals obovate. Pistil with upper multicompartment ovary, enclosed in a tube of numerous filaments of purple stamens. Calyx is double, with 5 inner leaflets and 8-12 outer (subcalyxes). The fruit is fractional, splitting into individual one-seeded, dark brownish-brown buds. The entire plant has soft velvety pubescence

An unacceptable impurity in the harvesting of the raw material of marshmallow is Lavatera thuringiaca L.

The herb is widespread in the forest-steppe and steppe zones of the European part of the country, in the Caucasus, as well as in the mountainous steppe and semi-desert regions of the south of Western Siberia, Kazakhstan and Central Asia.
It usually grows in small groups or in thinned thickets. It is cultivated on a number of farms in the Krasnodar Territory and Ukraine. The roots of the plants are harvested at the age of 2-3 years.

Harvesting. Roots are harvested in the fall, after the above-ground parts of the plant have died off (September-October) or in the spring, before the start of regrowth (April-early May). After digging, the roots are thoroughly cleaned from the soil, the rhizomes and small roots are cut off, and the top part of the main root that has become woody is removed; the roots are left to dry for 2-3 days in the air, then the cork is removed. Long roots are cut crosswise into pieces up to 35 cm long, thick roots are cut lengthwise into 2-4 pieces.
To obtain raw materials, after digging up and shaking off the soil, the roots are placed in baskets and washed quickly in cold running water. The roots should not be soaked as the mucilage is highly soluble in water and easily washed out of the raw material.
The marshmallow herb is harvested during flowering (within a month of flowering), mowed, removing the yellowed leaves and the admixture of other plants.

External features.

Roots, stripped of cork, almost cylindrical in shape or split lengthwise into 2-4 parts, slightly tapering towards the end, 10-35 cm long and up to 2 cm thick. The root surface is longitudinally bearded, with peeling long, soft bast fibres and dark dots - traces of fallen off or severed thin roots. The fracture is granular-rough in the centre and fibrous on the outside. Roots are white, yellowish-white (marshmallow) on the outside and in the fracture. The smell is faint, peculiar. Taste is sweet with a feeling of mucous.

Chemical composition.

Roots of marshmallow contains polysaccharides: mucus 10% - 30%, consisting of pentosans, hexosans and uronic acids, sugars (up to 8%), starch (up to 37%), pectin substances, fatty oil, organic acids, tannins, mineral salts.

According to GF XIV in whole, milled raw materials, in powder extractive substances extracted with water should be not less than 15%

Pharmacological action - expectorant.

Roots are used as a mucilaginous, softening and coating agent in respiratory tract catarrh, especially in children practice (expectorant), also used in the treatment of acute gastritis, enterocalitis. The roots are used in the form of powder, infusion, dry extract and syrup, and as part of a chest herbal tea (number 1 and 3). Factories produce "Mucaltin", which is made from grass containing a mixture of polysaccharides; used as an expectorant for bronchitis, pneumonia, and bronchiectasis. It is especially indicated for children. Infusions are made with cold water, which extracts only mucus, and with hot water, which also extracts starch, making the infusion thicker but murkier and more likely to spoil.

Plantain - Plantago major L.
family Plantaginaceae
Plantain leaf - Plantaginis majoris folia

A perennial herbaceous plant with a short rhizome and numerous ligneous roots. The leaves are arranged in a root rosette, petiolate. Petioles equal in length to or longer than the leaf lamina. Leaves elliptic, succulent, glabrous, smooth-edged or weakly dentate, with 3-7 parallel veins, which extend in long threads when torn. Flower stalks are erect, ascending at the base, up to 50 cm high, ending at the apex in a long cylindrical inflorescence, a simple spike.

Flowers are tetramerous, small, brownish, small, set in axils of filmy bracts. The fruit is an elliptic capsule with small dark brown shiny seeds (up to 16).

Distribution. Widespread, except in the Far North and the desert zone. A ruderal and weedy plant. Does not form extensive thickets and does not grow over large areas. The plant is cultivated.

The raw plantain may contain an admixture of other plantain species, which grow everywhere as weeds. They also have rosellate leaves and long flowering arrows.
Plantago media is difficult to distinguish from Greater Plantain. The leaves have the same shape and veins, but the petiole is much shorter and the lamina is covered on both sides with scabrous hairs. The flowers are pale pink.
Plantago lanceolata has lanceolate leaves with 3 to 7 main veins. The flowers are white with light yellow anthers.

Plantago major

Plantago media

Plantago lanceolata

Chemical composition.

Plantain leaves contain polysaccharides, including mucilage (up to 12%), iridoid glycoside aucubin, bitter substances, carotenoids, ascorbic acid, choline.

According to GF XIV in the whole, milled raw materials, powder polysaccharides should be at least 12%; extractive substances extracted in 70% alcohol - at least 20%.

Pharmacological action - expectorant.

Uses. Dry crushed leaves are used as an anti-inflammatory and expectorant in bronchitis, whooping cough, asthma and other respiratory diseases. Dried leaves are used to produce Plantaglucid, used to treat chronic hypacidal gastritis and gastric and duodenal ulcers with normal and reduced acidity. Plantain leaves are part of the chest herbal tea number 2 (expectorant, which also includes licorice root, leaves of mother and stepmother, marshmallow root).

Plantain leaves (fresh) are used to obtain sap, which is mixed 1:1 with the juice of the fresh plantain grass serve for the production of "Plantain Juice", which is used in anacidic gastritis and chronic colitis.

Plantain leaf infusion is used to wash wounds and ulcers.

Coltsfoot - Tussilago farfara L.
family Asteraceae
Coltsfoot leaves - Tussilaginis farfarae folia

Coltsfoot is a wild, perennial herbaceous plant that blooms before the leaves open. Flowering shoots 10-25 cm tall with single heads appear in early spring.

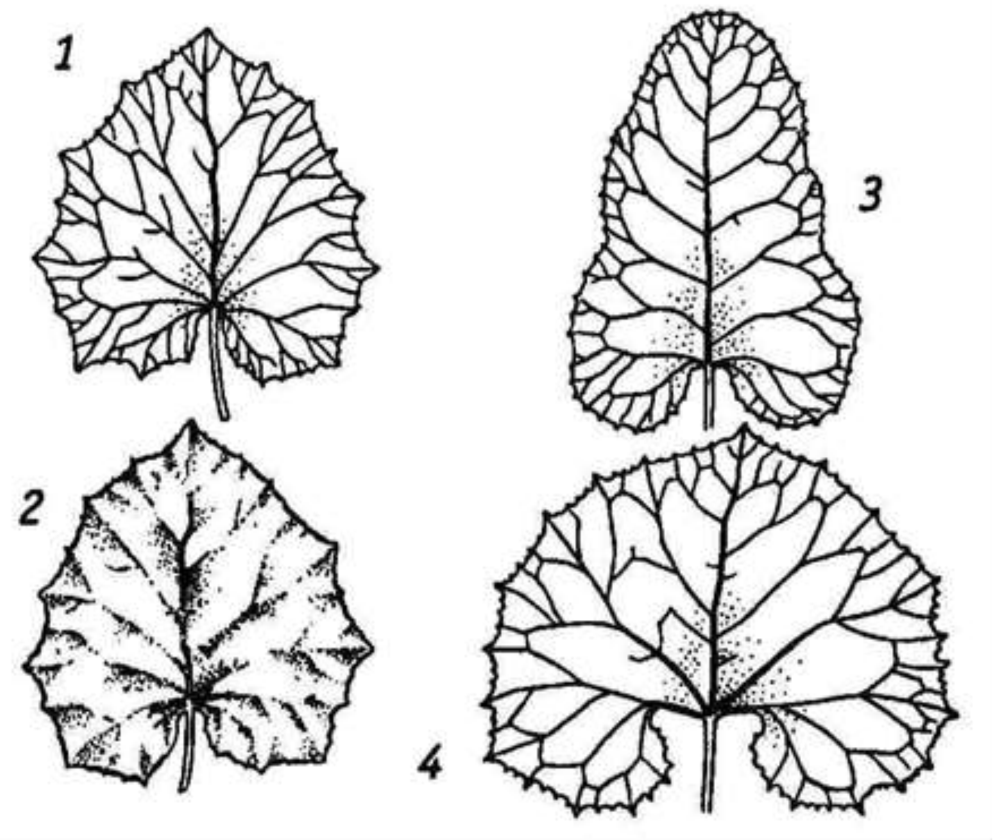
The root leaves, used as raw material, grow after flowering. They are long-petioled, angular in cross-section, irregularly dentate, fairly dense, naked from above, with white, soft tomentose pubescence from below. The upper surface of the leaves is hard and cold.

The scientific generic name comes from the Latin word tussis - cough, agere - to expel, indicating its use in coughing.

Coltsfoot is a Eurasian species widespread in all areas of the European part of the country; in Siberia it is common to the south of 60 N, in the east it reaches Lake Baikal. In the Caucasus it grows almost everywhere. In Central Asia it is absent from the zone of deserts and semi-deserts, but widely distributed along river valleys in the mountainous regions of eastern Kazakhstan, Uzbekistan and Tajikistan. It inhabits the banks of rivers and streams, coastal bluffs, screes, damp ravines, railway embankments and along roads. The main harvesting areas are Krasnodar Krai, Voronezh Oblast, Sverdlovsk Oblast and Sverdlovsk Region.

An unacceptable impurity in the harvesting

1. *Petasites frigidus* (L.) Friese.
2. *Petasites radiates* (J. F. Gmel).
3. Burdock wormwood - *Arctium tomentosum* Mill.
4. Burdock - *Arctium lappa* L.



Coltsfootand possible impurities:
Coltsfoot: 1 - upper leaf; 2 - lower leaf; 3 - *Arctium tomentosum* leaf;
4 - *Petasites frigidus* leaf

Harvesting.

Harvested from wild-growing plants. Leaves are harvested in the first half of summer, when they are still relatively small, tearing off a part of the petiole no longer than 5 cm. Avoid harvesting leaves that are too young, have pubescence on top, those affected by rust and those beginning to turn yellow.

Dry the leaves in attics under an iron roof or outdoors under a shelter, spreading them in thin layers (1-2 leaves) on a cloth or plywood. For the first few days turn them over 1-2 times to ensure even drying. It is allowed to dry in dryers with artificial heating at a temperature of 50-60 C. Raw materials easily absorb moisture and become brown, so they need to be protected from humidity.

Chemical composition.
Leaves contain 7-8% mucus (whose hydrolysis produces glucose, galactose, pentoses and uronic acids), bitter glycosides (2.6%), saponins, carotenoids, inulin, malic and tartaric acids.

According to GF XIV the sum of polysaccharides and free sugars converted into glucose in whole, milled raw material should not be less than 10%.

Pharmacological action - expectorant, anti-inflammatory.

Uses. Expectorant, enveloping and anti-inflammatory effects are realized at the expense of mucus. Leaves of mother-and-mother is used in the form of infusion, included in the chest collection number 3, syrup (coltsfoot + plantain). The preparations have a soothing, expectorant and anti-inflammatory effect in bronchitis, laryngitis, tracheitis, bronchiectasis, bronchial asthma.

Thank you for your attention