**Heteropolysaccharides (heteroglycans)**

Heteropolysaccharides (heteroglycans) consist of different monosaccharides. Heteroglycans are represented by gums, mucilages, pectins, hemicelluloses, some algae polysaccharides

Polysaccharides consisting of molecules of more than one sugar or sugar derivative are called heteropolysaccharides (heteroglycans). Most contain only two different units and are associated with proteins (glycoproteins—e.g., gamma globulin from blood plasma, acid mucopolysaccharides) or lipids (glycolipids—e.g., gangliosides in the central nervous system). Acid mucopolysaccharides are widely distributed in animal tissues. The basic unit is a so-called mixed disaccharide consisting of glucuronic acid linked to N-acetyl-D-glucosamine. The most abundant mucopolysaccharide, hyaluronic acid from connective tissue, is also the major component of jointfluid (synovia) and occurs in the soft connective tissue (Wharton’s jelly) of the umbilical cord of mammals. Glucuronic acid linked to N-acetyl-D-galactosamine is the repeating unit of chondroitin sulfate, a heteropolysaccharide found in cartilage. Heparin, a heteropolysaccharide related to the acid mucopolysaccharides, has anticoagulant properties and is present in connective and other tissues.

Complex heteropolysaccharides occur in plant gums such as gum arabic from Acacia and gum tragacanth from Astragalus. Most contain glucuronic acid and various sugars. Produced after either mechanical damage to bark(a method used in commercial production) or an attack on the bark by certain bacteria, insects, or fungi, plant gums are used in the arts (gum arabic) and as an adhesive agent and emulsifying agent (gum tragacanth). Heteropolysaccharides also occur in bacterial cell walls.

**Gum - containing medicinal plants**

Gums (Gummi) are formed resulting from the degeneration of cell wall, the content of pith cells.

Gums are the mixtures of heteropolysaccharides, consisting of uronic acids, their carboxyl groups are connected with Ca2+, K+ и Mg2+ ions.

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β-D-galacturonic acid β-D-glucuronic acid

Gums are natural plant hydrocolloids that may be classified as anionic or nonionic polysaccharides or salts of polysaccharides. They are produced in higher plants after injury as protective agents. Useful hydrocolloids occur in some seed embryos or other plant parts (pectins), may be extracted from various algae, and are produced by selected microorganisms.

Gums are divided into three groups according to the solubility in water: 1) arabinic (armeniaca and arabic)- highly soluble in water; 2) bassorinic, low soluble in water and strongly swelling in it (tragacanth); 3) cerasinic, low soluble and poor swelling in water (cherry).

Gums are polysaccharides containing calcium and magnesium salts of uronic acids and neutral monosaccharides, partially esterificated. These hydrophilic colloids are useful as emulsifiers, gelatin agent stabilizers. Gums are insoluble in organic solvents. Gums react with solution LiCl or iodine in KI to give violet colour. Gums give a pale red (gum arabic) colour or dusk-green (tragacanth) colour with Dragendorff's reagent.

Gummi Armeniacae is the dried gummy exudation of *Armeniaca vulgaris Lam., Rosaceae*.  It grows in the Caucasus, Middle Asia, is cultivated in the south of Ukraine. It yields galactose, arabinose, glucoronic acid and is used as emulsifier.

Gummi Tragacanthae is the dried gummy exudation of *Astragalus gummifer* and other Asiatic species. It contains about 60% to 70% of bassorin, a substance which swells in water and acid fraction (arabinogalacturonane). It contains arabinogalactane and tragacanthic acid. The gum is used as emulsifier. The plants are abundant in the highland of the Asia Minor, Iran, Syria, the former Soviet Union and Greece.

Gum arabic is the dried, gummy exudate from stems and branches of *Acacia senegal (L.) Willdenow* or of other related African species of Acacia. It is used as an emulsifying and suspending agent, demulcent.

Guar gum (guaran), the powdered endosperm of the seed of *Cyamopsis tetragonolobus (L.) Toubert*(Fabaceae) and locust bean gum, the hycolloid-containing powdered endosperm of the seed of *Ceratonia siliqua* (Fabaceae) are used as stabilizers of suspensions and emulsions. Ghatti (Indian) gum sometimes is used as a substitute for acacia. It is an exudate from *Anogeissus latifolia* (*Combretaceae*), a tree indigenous to India and Sri Lanka. Karaya Gum is obtained from *Sterculia* and *Cochlospermum spp*.

**Mucilage-containing medicinal plants**

Mucilages are a group of polysaccharides, which made up of various hexoses, pentoses, oligosaccharides, uronic acids, and also more complex polysaccharides and their derivatives. Mucilagines are hydrophilic. They create a water reserve, which is necessary for seed and tuber germination and resistance to drought. Mucilagines form a thick slimy mass in water. Seeds of flax, quince, orchis tubers, marshmallow roots, leaves of Broadleaf plantain, leaves and seeds of Sand plantain, leaves of coltsfoot and oth. contain a significant amount of mucilages (8-12% and more). They have softening and soothing actions on mucous membranes, protect from irritant and damaging effects of different chemical and physical factors, reducing the inflammatory process and pain syndrome. This effect is observed by direct impact on inflammatory or damaged tissues. Decoction and infusion of mucilage-containing plants are prescribed in the treatment of chronic gastritis, peptic ulcer, enteritis, colitis and diseases of nasal cavitiy. These substances are not sublimated with steam, that’s why the use of them in inhaled form is not justified. There is no reliable information about the extent of absorption in the gastrointestinal tract and secretion by bronchial glands, although there is a possiblity for oligosaccharides. There is empirical evidence on the positive result of the mucilage in internal use in the treatment of chronic tracheitis, bronchitis and pneumonia.

Mucilages are the mixtures of hetero- and homopolysaccharides. They are formed in plants by the degeneration of parenchyma cells. In contrast to gums mucilages are physiological products and they are produced in the process of natural development without external irritation.

Mucilages are coloured yellow in the alkaline solution, they are no coloured by iodine. In contrast ot gyms, they can be neutral, that is, they don’t contain uronic acids, and also have a lower molecular weight and highly soluble in water.

There are intercellular (seeds of flax and plantain) and intracellular (marshmallow herb and root, flowers of lindens and motherwort, coltsfoot leaves) materials according to the localization.

From the chemical point of viw mucilages are not very different from gums. However the mucilages are characterised by the predominance of pentoses over hexoses.

**Gum** - high-carbohydrate, translucent, colloid, adhesive substances of different chemical composition. Xanthan is formed as a response to the PA tissue irritation and covers the damaged areas of burns, fractures, punctures, cuts wood. Formed more often in the form of incrustations on the trunks of trees and shrubs, more rarely, PA roots and fruits as a result of degeneration of cell walls, the contents of cells and intercellular substance, and sometimes whole sections of tissue. Gum – often it is solid, amorphous pieces.

**The formation of gums is common to many plants.** In the family Rosaceae, for example, 32 kinds consist gum. Most of the gummifer families is tropical. Ability to form gums is characteristic only of long life forms plants- trees and shrubs and to a lesser extent - herbaceous perennials. Gum produce different plant organs - roots, trunk, branches (even leaf petioles), fruits and seeds. The gum is formed by the degeneration of the cell walls of parenchymal tissue core and core-rays. There have been cases of mucous degeneration and in the parenchyma of the cow.. It is believed that a significant role in forming gums of stone fruit and acacia trees belong to starch, and possibly other content of cells. Origin of the gums at the individual plant is different. In fruit semen, for example gum can be formed as in the medullary rays, and in special cavities in the parenchyma of wood and bark.

They have long been used in traditional Arabic and European medicine. Currently used in the manufacture of medicines, but also in food, textile and printing industries. Vegetable gum used as industrial adhesives, stabilizers and emulsifiers for the manufacture of artificial fibers.

Gum most characteristic plant of hot climate in which they perform a protective role. Gums are the source of the trunks of apricot, astragalus, some acacias.

**Mucus** **-** a Nitrogen-free substance, similar in chemical composition of pectin and cellulose. Are predominantly polysaccharides – thick mucous substance, easily soluble in water. Mucus are usually in the form of aqueous, viscous and sticky colloid. They are colorless or yellowish, odorless, mucous, sometimes sweetish taste. Formed in plants as a result of degeneration of the mucous cells and intercellular substance in the course of normal metabolism, without external stimuli - these are different from the mucus of gum. Chemically, the mucus is difficult to distinguished from the gums. The main difference is the high prevalence of pentosan (their number can reach up to 90%) over hexosans. Mucus in contrast to the gum does not get in a solid form, and by extracting water. They differ from the starch grains and the absence of characteristic reaction with iodine solution, from gums - besieged spine neutral solution of lead acetate. Remove mucus from the raw material by dissolving in water. This is the main way to get a pharmacy containing mucus dosage forms. From plants containing mucus, is prepared emollient poultices, and their aqueous extract used in the treatment of inflammatory diseases of upper respiratory tract as enveloping, expectorants, gastrointestinal tract (especially with diarrhea, and hemorrhages of different nature). Treatment with drugs mucous plant gives good results in gastritis with acidity of gastric juice, gastric ulcers and duodenal ulcers, diseases of the genitourinary system, eczema, wounds, burns. Used in diseases of the nose and throat, bronchitis. Mucins, in addition to anti-inflammatory and anesthetic action, contribute mucous membranes and skin lesions. Found that certain polysaccharides enhance immunity, have hemostatic properties. More often they are prescribed in combination with other drugs. Mucins contribute to slower absorption and, consequently, longer duration of action of drugs in the body.

**Mucus rich** roots of marshmallow, plantain leaves, tubers salep, flax seeds, seeds of quince, rye, coltsfoot, thallus seaweed kelp, plants from the family of orchids (Orchis, etc.).

**Mucus accumulates** in the roots (marshmallow), fruits (flax, quince, psyllium). They play the role of replacement nutrients, and also protect the seeds from drying out and promotes germination.

**In plant gums and mucus** (when they are not a consequence of the painful transformation of the cell walls) are formed or as spare a substance affecting the processes of growth and consumed by the plant, or have a special role, for example mucus that forms on the surface of quince seeds and flax seeds attaching these to the soil and thus prevents them from blowing wind. Mucus have high water holding capacity, ie, capable of absorbing much water, not liquefying. Therefore, the mucous membranes of cellular degeneration is plant adaptation to drought and is common in many plants of deserts, which thus remain in themselves they need the water does not evaporate, even under the hot sun, such as cacti. Mucus are often formed in algae, plants of the family Malvaceae, plantain, Asteraceae, flax. Sometimes the mucus and gum are the ballast substances that hinder the provision of the necessary drugs, which they envelop a thick jelly. The maximum accumulation of mucus in the underground parts of plants falls on the autumnal phase of decay, in the seeds - for the period of their maturation. Contribute to the formation of mucus heat, humidity, and light energy. First, in the laboratory of chlorophyll, with the help of the light beam, water and carbon dioxide synthesized by a variety of simple carbohydrates, which are then transformed in the mucus and gum. Slime polysaccharides serve as a reservoir of water for plants, protective biokolloid

# Tragacanth

**Botanical**: Astragalus gummifer (LABILL.)   
**Family**: Family: Fabaceae (beans) or N.O. Leguminosae

**Synonyms---**Gum Tragacanth. Syrian Tragacanth. Gum Dragon (known in commerce as Syrian Tragacanth).   
**Part Used---**Gummy exudation.   
**Habitat---**Asia Minor, Persia and Kurdistan.

**Description---**The plant is a small branching thorny shrub, the stem of which exudes a gum, vertical slits giving flat ribbon-shaped pieces and punctures giving tears; these have a horny appearance, are nearly colourless or faintly yellow, marked with numerous concentric ridges; the flakes break with a short fracture, are odourless and nearly tasteless; soaked in cold water, they swell and form a gelatinous mass 8 or 10 per cent only dissolving.

**Constituents---**The portion soluble in water contains chiefly polyarabinan-trigalaetangeddic acid; the insoluble part is called bassorin. Tragacanth also contains water, traces of starch, cellulose, and nitrogenous substances, yielding about 3 per cent ash.

**Medicinal Action and Uses---**Demulcent, but owing to its incomplete solubility is not often used internally. It is much used for the suspension of heavy, insoluble powders to impart consistence to lozenges, being superior to gum arabic, also in making emulsions, mucilago, etc. Mucilage of Tragacanth has been used as anapplication to burns; it is also employed by manufacturers for stiffening calico, crape, etc.

**Tragacanth** is a natural gum obtained from the dried sap of several species of Middle Eastern legumes of the genus Astragalus, including A. adscendens, A. gummifer, and A. tragacanthus. Gum tragacanth is a viscous, odorless, tasteless, water-soluble mixture of polysaccharides obtained from sap which is drained from the root of the plant and dried. The gum seeps from the plant in twisted ribbons or flakes which can be powdered. It absorbs water to become a gel, which can be stirred into a paste. The gum is used in veg-tanned leatherworking as an edge slicking and burnishing compound and is occasionally used as a stiffener in textiles. It contains an alkaloid that has historically been used as an herbal remedy for such conditions as cough and diarrhea. As a mucilage or paste it has been used as a topical treatment for burns. It is used in pharmaceuticals and foods as an emulsifier, thickener, stabilizer, and texturant additive (code E413). Also, it is the traditional binder used in the making of artist's pastels,as it does not adhere to itself the same way other gums (such as gum arabic) do when dry. Gum tragacanth is also used to make a paste used in floral sugarcraft to create life-like flowers on wires used as decorations for cakes. It makes a paste which dries brittle in the air and can take colorings. It enables users to get a very fine, delicate finish to their work. Additionally, it has traditionally been used as an adhesive in the cigar rolling process used to secure the cap or "flag" leaf to the finished cigar body.

Gum tragacanth is less common in products than other gums, such as gum arabic or guar gum, largely because most tragacanth is grown in Middle Eastern countries which have shaky trade relations with countries where the gum is to be used. Commercial cultivation of tragacanth plants has generally not proved economically worthwhile in the west, since other gums can be used for similar purposes.

Gum tragacanth is also used in incense making as a binder to hold all the powdered herbs together. Its water-solubility is ideal for ease of working and an even spread. Only half as much is needed, compared to gum arabic or something similar.

**Constituents.**—The composition of tragacanth has not yet been satisfactorily ascertained. The part soluble in water appears to consist chiefly of polyarabinan-trigalactan-geddic acid, and yields by hydrolysis arabinose, galactose, and geddic acid. The portion insoluble in water yields under the influence of baryta water isomeric α- and β-tragacanthan-xylan-bassoric acids, which yield by hydrolysis tragacanthose, xylose, and bassoric acid. Traces of starch and of altered cellulose are also to be found in the gum.

**Action and Uses.**—Tragacanth is employed in pharmacy as a suspending agent in mixtures containing resinous tinctures and heavy insoluble powders, or to emulsify volatile oils. Mucilage of tragacanth and compound powder of tragacanth are used for these purposes, the latter combining the suspending powers of tragacanth and gum acacia, while the starch present tends to prevent agglomeration of the deposit. The mucilage of tragacanth is an efficient suspending agent for the resins of tincture of jalap and tincture of myrrh; it is also employed instead of gum acacia when substances incompatible with the latter are present. In some cases, mucilage of tragacanth answers better than mucilage of gum acacia, or a mixture of the two mucilages may give the best results. It is worthy of note that the addition of mucilage of gum acacia to mucilage of tragacanth produces a thinner mixture than the addition of a similar quantity of water. Mucilage of tragacanth is preferred to mucilage of gum acacia for use in lotions for external use. With essential oils, tragacanth forms a coarse emulsion, which separates on standing, but is readily miscible; the gum should be added to the oil in a dry bottle in the proportion of 1 part of tragacanth to 10 parts of oil; shake, add 72 parts of water and agitate vigorously; then add water in successive portions to the required volume. Tragacanth is also used to form a drying liniment for the skin, which may be used as a basis for the application of ammonium ichthosulphonate, salicylic acid, resorcin, sulphur, etc. A typical preparation, known as Bassorin Paste or Linimentum Exsiccans, is made by mixing in a wide-mouthed bottle 5 of tragacanth powder with 10 of alcohol, adding 70 of water, shaking vigorously, and adding 2 of glycerin with sufficient water to make 100. It dries on the skin, forming a transparent film easily removed by washing. Tragacanth is used sparingly as an excipient to bind pill masses; glycerin of tragacanth is a useful excipient, which should be used in the smallest possible quantity, the mass being well kneaded. A useful excipient for metallic and insoluble salts consists of equal weights of manna and glycerin of tragacanth, beaten together. Glucanth is a pill excipient prepared by mixing 1 of tragacanth in powder with 1 of distilled water and 4 of syrup of glucose.

**The apricot** –

Prunus armeniaca or Armenian plum in Latin, syn.

Edible Parts: Fruit; Seed.   
Edible Uses: Gum; Oil.   
Armeniaca vulgaris, is a fruit-bearing tree, native to China and spread to Europe through Armenia. It is classified with the plum in the subgenus Prunus of the Prunus genus.   
**Description---**It is a small- to medium-sized tree with a dense, spreading canopy 8–12 m tall; its leaves are shaped somewhat like a heart, with pointed tips, and about 8 cm long and 3–4 cm wide. Its flowers are white to pinkish in color. The fruit appears similar to a peach or nectarine, with a color ranging from yellow to orange and sometimes a red cast; its surface is smooth and nearly hairless. Apricots are stone fruit (drupes), so called because the lone seed is often called a "stone".   
Fruit, a drupe, velvety when young, but nearly smooth at maturity, round to oblong; diameter, 2.5 to 2.6 cm; weight, 12.6 g; volume, 11.20 ml; fruit, externally yellow; pulp, deep yellow, less juicy than that of the cultivated apricots; endocarp, flat, smooth, stony and hard   
Fruit - raw, cooked or dried for later use. The best forms are soft and juicy with a delicious rich flavour. Wild trees in the Himalayas yield about 47.5kg of fruit per year.The fruit of the wild form contains about 6.3% sugars, 0.7% protein, 2.5% ash, 2.5% pectin. There is about 10mg vitamin C per 100g of pulp. The fruit is about 5cm in diameter and contains one large seed. Seed - raw or cooked. Bitter seeds should be eaten in strict moderation, but sweet ones can be eaten freely. The bitter seeds can be used as a substitute for bitter almonds in making marzipan etc. An edible gum is obtained from the trunk. The seed contains up to 50% of an edible semi-drying oil.   
Medicinal Uses   
Analgesic; Anthelmintic; Antiasthmatic; Antidote; Antipyretic; Antiseptic; Antispasmodic; Antitussive; Demulcent; Emetic; Emollient; Expectorant; Laxative; Ophthalmic; Pectoral; Sedative; Tonic; Vulnerary.   
Apricot fruits contain citric and tartaric acid, carotenoids and flavonoids. They are nutritious, cleansing and mildly laxative. They are a valuable addition to the diet working gently to improve overall health. The salted fruit is antiinflammatory and antiseptic. The bark is astringent. The inner bark and/or the root are used for treating poisoning caused by eating bitter almond and apricot seeds (which contain hydrogen cyanide). Another report says that a decoction of the outer bark is used to neutralize the effects of hydrogen cyanide. The decoction is also used to soothe inflamed and irritated skin conditions. The seed is analgesic, anthelmintic, antiasthmatic, antispasmodic, antitussive, demulcent, emollient, expectorant, pectoral, sedative and vulnerary. It is used in the treatment of asthma, coughs, acute or chronic bronchitis and constipation. The seed contains 'laetrile', a substance that has also been called vitamin B17. This has been claimed to have a positive effect in the treatment of cancer, but there does not at present seem to be much evidence to support this. The pure substance is almost harmless, but on hydrolysis it yields hydrocyanic acid, a very rapidly acting poison - it should thus be treated with caution. In small amounts this exceedingly poisonous compound stimulates respiration, improves digestion and gives a sense of well-being.

**Xanthan gum**

Xanthan gum, water-soluble polysaccharide compound that is produced by the bacteriumXanthomonas campestris and is best known for its use as a food additive, typically as an emulsifier, a stabilizer, or a thickener. Xanthan gum often is used in conjunction with other thickening agents to improve the stability and texture of food, pharmaceuticals, and cosmetics.

Production

Xanthan gum is derived naturally from X. campestris, which is a plant pathogen, being responsible for diseases such as black rot in brassica crops (e.g., cauliflower and cabbage). The gum is produced when sugar, commonly from corn, wheat, or soy, is fermented by X. campestris. The gum is then processed, through pasteurization, drying, and milling, to create a fine white powder or, occasionally, granules. The final product, a kind of hydrocolloid, disperses and creates a gel when added to water.

Applications

Xanthan gum thickens without the application of heat, which distinguishes it from certain other thickening agents, such as cornstarch and gelatin. It also retains its thickening properties when cooled, and it is tasteless—features that make it especially useful for canned foods and shelf-stable foods like soups, sauces, gravies, and salad dressings. Xanthan gum commonly is used with other thickening agents, including guar gum, locust bean gum, carrageenan, gelatin, agar, and pectin. It may also be paired with starches, such as potato starch, which amplifies its thickening and gelling effects.

As an emusifier, xanthan gum affects viscosity by aiding emulsification and keeps particles from clumping and settling. It also allows pourable foods, such as salad dressings and barbecue sauces, to flow consistently from their containers. A very small percentage of xanthan gum—as little as 0.1 percent by weight of the finished product—is needed to produce thickening and emulsifying effects.

Research has suggested that in some instances xanthan gum may have health benefits. For example, by increasing the viscosity of fluids in the stomach, it may slow the absorption of sugar in the digestive tract. By limiting the rate at which sugar enters the bloodstream, xanthan gum potentially helps moderate blood sugar levels. The laxative effect of xanthan gum may also be beneficial in some persons.

**Pectins**

Pectines are polyuronids, widely spread in aboveterranean parts of seed-bearing plants and some algae. Fruits (apple, plum, lemon, orange), bulbs (beet, carrot), stalks (line) yield a great amount of pectins. Pectins in combination with cellulose and hemicellulose act as an intracellular converting material. Function of hydrophylic colloids is a turgor of plant tissues.

Pectins consist chiefly of partially methyoxylated polygalacturonic acids; the main carbohydrate component is a linear 1,4 linked D-galacturonan. Many of the carboxyl groups of the galacturonan are esterified with methanol. A grade of esterification is a number of methoxylated COOH-groups in polygalacturonic acid. Monoesterified pectins form gels at the presence of bivalent cations, but highly esterified ones need sucrose addiction at the same conditions. Pectins form gels at the presence of sugars and acids in some proportions (the most suitable pH 3.1-3.5 with the addition of sucrose or glucose).

Pectins are polysaccharides which mainly (80-90%) made up of methylated derivatives of galacturonic acid (pectic), small amount of monosaccharides and olygosaccharides. They are present in unripe fruits and vegetables in the form of protopectin – water insoluble, in relation to the evolution of maturing they are converted into soluble pectins. Pectins sorb water and form viscous gels, this property is widely used in food industry. In plants they are involved in cell wall construction and formation of intercellular cementing material- water storage. Pectins have sorption properties and can accumulate and hold ions of heavy metals (zinc, lead, cobalt, copper, radionuclides and oth.), cholesterol and other hazardous substances in intestine. Pectins are not splitted to monosaccharides and absorbed in the gastrointestinal tract. That’s why absorbed pectins are removed by intestine. Due to the swelling they form mass in the gastrointestinal tract, which enhance motility, that’s why plant pectins are used for these purposes. Fruits and berries (apples, plums, aprictos, currants, cowberries and oth.), and root-crops (sugar-beet, carrot and oth.) contain significant amounts of pectins. The content of pectins in plant material is 0,8-3%. Red algae contain specific substance, which is distinguished by the similarity with pectic substances. But its polysaccharide is composed of alginic acid. The pharmaceutical companies produce “Laminarid” based on the laminaria polysaccharide, the amount of polysaccharides is 30% of solid residual. Laminaria contains enough amount of iodine and brom (in comparisation to land plants), that’s why it is used as a laxative and also in treatment of atherosclerosis and elimination of iodine deficiency in organism. For swelling and absorption properties Laminarid which isolated from seaweed is higher than pectins.

Pectic compounds are high-molecular substances (molecular weight reaches 200 000), and fruits, tubers and stems of plants as insoluble protopectin contain large amounts of pectin.

Pectic substancs are found in 2 forms in plants: 1) insoluble protopectin, which is contained in the cell wal matrix and intercellular material; 2) dissolved pectin in fruit and vegetable juices. Calcium and magnesium salts of D-galacturonic acid form the basis of pectin. D-galacturonic acid residues are joined by 1,4-glycosidic linkage, they form polymer chain (pectic acid). So, the term “pectic substances encompasses pectic acids and their salts (pectac). The term “pectic substances” also encompasses ethers, which obtained by methylation of carboxyl groups of pectic substances.

Protopectin is a polymer of methoxylated polygalacturonic acid with galactan and arabinane of the cell wall, occasionally interrupted by rhamnose residues. Polyuronid chains is connected with Ca2+ and Mg2+ ions.

*Pectic acid*

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O

O

R

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O

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H

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H

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H

H

*Pectic acid*

Pectinate – R = Me+ и CH3

Pectic acid – R = H

Pectate – R = Me+

Pectovic acid – R = H и CH3

Protopectin occurs in large amounts in unripe fruits. Poliuronide chains are splitted and partly depolymerised during fruit ripening, and protopectin is converted to pectin, which turns into gel with sugars and acids.

Alkaline solution or enzyme pectase split methoxyl groups and methanol and free pectic acid are formed which represents polygalacturonic acid.

It is easily precipitated as calcium pectate from solution. It is used for quantitative determination of pectic substances.

Fruit ripening is associated with conversion of protopectin into soluble pectin. Pectic substances reduce gastrotoxicity of salicylates. Pectic acid can be used as an agent of pharmaceutical substance. Pectins have antiulcer and laxative action, and form complex compounds with various metals – chelates which are easily removed from organism.

Pectin- containing products are for people living radioactive contaminated territory and provide elimination of radionuclids, heavy metals from organism.

Pectin content in ripening fruits of lemon is 20-40%, in apple furits is 10-20%.

Pectin is soluble in water, and form viscous weak-acid (pH 3-4) colloid solutions and it does not dissolve in organic solvents and alcohol.

The gelling ability and duration are the main quality indicators of pectin. Pectin forms Pectin can form the minute- (20-70 seconds) and gradually forming (180-250 sec.) compositions.

The main producers of pectin are the USA, England, France and Germany.

**Hemicelluloses.**

This is an important group of compounds since they occur in association with cellulose in plant cell walls. Hemicellulose seems to be less resistant to degradation than cellulose.

hemicellulose, any of a group of complex carbohydrates that, with other carbohydrates (e.g., pectins), surround the cellulose fibres of plant cells. The most common hemicelluloses contain xylans (many molecules of the five-carbon sugar xylose linked together), a uronic acid(i.e., sugar acid), and arabinose (another five-carbon sugar). Hemicelluloses have no chemical relationship to cellulose.

Hemicelluloses are a complex mixture of different polymers of various monosaccharides, including glucose, xylose, mannose, arabinose, galactose, and uronic acids. The most common form is a linear polymer of b-1, 4 linked D-xylose, bearing side chains of methyl glucuronic acid and arabinose. There are 2 basic types:

a. Xylans and Xyloglucans

b. Gluco – Galactomannans

Xylans are polymerized b-1, 4 xylose

Xyloglucans are b-1, 4 linked glucose with a-1, 6 cross linkages of xylose chains. They may also have methyl glucuronic acid side chains and some arabinose side chains with both a-1, 6 and b-1, 6 linkages. They are obviously very complex materials.

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| Hemicelluloses are defined as those plant cell wall polysaccharides that are not solubilzed by water or chelating agents but are solubilized by aqueous alkali. With this definition hemicelluloses include xyloglucan, glucomannan, mannan, xylan, arabinoxylan, and arabinogalactan. Hemicelluloses are also defined chemically as cell wall polysaccharides that are structurally homolgous to cellulose because they have a backbone composed of 1,4-linked β-D-pyranosyl residues. Xyloglucan, glucomannan, mannan, xylan, arabinoxylan, but not arabinogalactan are included using this chemical definition of hemicellulose. |

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| **Xyloglucan**  Xyloglucan is the most abundant hemicellulose in the primary walls of non-graminaceous plants, often comprising 20% of the dry mass of the wall. Xyloglucan has a backbone composed of 1,4-linked β-D-Glcp residues |

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| Dicot xyloglucan |

|  |
| --- |
| Solanaceous xyloglucan |

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| **Galactoglucomannan**  Mannose-containing polysaccharides including mannans, galactomannans, and galactoglucomannans are present in the walls of many plants. These polysaccharides all have a backbone containing 1,4-linked β-D-Man residues. Galactoglucomannans, which are particularly abundant in the walls of solanaceous plants, have a backbone composed of both 1,4-linked β-D-Man and β-D-Glc residues. Some of the mannose residues are substituted at C6 with mono- and disaccharides (see structure below). |

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| Galactoglucomannan |

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| **Xylans and Substituted Xylans**  Xylans, including arabinoxylan, glucuronoxylans, and glucuronoarabinoxyalans, are quantitatively minor components of the primary walls of dicots and non-graminaceous monocots but are abundant in the walls of the Poaceae and secondary walls of woody plants. These polysaccharides all have a backbone composed of 1,4-linked β-D-Xyl residues. |

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| glucuronoarabinoxylan |

**Marine algae** contain large amounts of polysaccharides, notably cell wall structural, but also mycopolysaccharides and storage polysaccharides. Polysaccharides are polymers of simple sugars (monosaccharides) linked together by glycosidic bonds, and they have numerous commercial applications in products such as stabilisers, thickeners, emulsifiers, food, feed, beverages etc. The total polysaccharide concentrations in the seaweed species of interest range from 4-76 % of the dry weight. The highest contents are found in species such as Ascophyllum, Porphyra and Palmaria, however, green seaweed species such as Ulva also have a high content, up to 65 % of dry weight.

Seaweeds are low in calories from a nutritional perspective. The lipid content is low and even though the carbohydrate content is high, most of this is dietary fibres and not taken up by the human body. However, dietary fibres are good for human health as they make an excellent intestinal environment.

The cell-wall polysaccharides mainly consist of cellulose and hemicelluloses, neutral polysaccharides, and they are thought to physically support the thallus in water. The building blocks needed to support the thalli of seaweed in water are less rigid/strong compared to terrestial plants and trees. The cellulose and hemicellulose content of the seaweed species of interest in this review is 2-10 % and 9 % dry weight respectively. Lignin is only found in Ulva sp. at concentrations of 3 % dry weight.

Green algae contain sulphuric acid polysaccharides, sulphated galactans and xylans, brown algae alginic acid, fucoidan (sulphated fucose), laminarin (β-1, 3 glucan) and sargassan and red algae agars, carrageenans, xylans, floridean starch (amylopectin like glucan), water-soluble sulphated galactan , as well as porphyran as mucopolysaccharides located in the intercellular spaces. Contents of both total and species-specific polysaccharides show seasonal variations. The mannitol content varied markedly in the fronds of Saccharina and Laminaria species with maximum amounts found during summer and autumn, from June to November. The laminaran showed extreme variations during the year with very small amounts or none at all in February to June and maximum in September to November. The maximum content of alginic acid in the fronds of Saccharina and Laminaria species was generally found from March to June and the minimum from September to October. However, highest contents of alginic acid were found during winter in other seasonal studies on Laminaria species from the same areas in Norway.

Further investigations on the hydrolysates of some brown algae showed complex mixtures of monosaccharides. The components of galactose, glucose, mannose, fructose, xylose, fucose and arabinose were found in the total sugars in the hydrolysates. The glucose content was 65 %, 30 % and 20 % of the total sugars in an autumn sample of 50 individual plants of Saccharina, Fucus (serratus and spiralis) and Ascophyllum, respectively.

Several other polysaccharides are present in and utilised from seaweed e.g. furcellaran, funoran, ascophyllan and sargassan, however these are not described in this chapter.

Seaweed polysaccharides are separated into dietary fibres, hydrocolloids etc. in the following paragraphs, even though the polysaccharides belong to more than just one of the functional groups.

Polysaccharides obtained from algae are critically important for industrial and nutritional purposes. Various industrial applications include their use as thickeners, stabilizers, emulsifiers, feed, beverages, food, pharmaceuticals, etc. From nutrition point of view, seaweeds are low in calories and lipid content but high in indigestible carbohydrate content which is good for the intestine. Alginates, ulvans, carrageenans, fucoidans, and chitin have numerous industrial, especially pharmaceutical and biomedical, applications with rapidly increasing usage and commercial value.

Seaweed-derived polysaccharides including agar and alginate, have found widespread applications in biomedical research and medical therapeutic applications including wound healing, drug delivery, and tissue engineering. Given the recent increases in the incidence of diabetes, obesity and hyperlipidemia, there is a pressing need for low cost therapeutics that can economically and effectively slow the progression of atherosclerosis. Polysaccharides such as fucoidan, laminarin sulfate and ulvan have shown promise in reducing atherosclerosis and its accompanying risk factors in animal models. However, others have been tested in very limited context in scientific studies. In this review, we explore the current state of knowledge for these promising therapeutics and discuss the potential and challenges of using seaweed derived polysaccharides as therapies for atherosclerosis.

 Polysaccharides with marine origin constitute one type of these biochemical compounds that have already proved to have several important properties, such as anticoagulant and/or antithrombotic, immunomodulatory ability, antitumor and cancer preventive, antilipidaemic and hypoglycaemic, antibiotics and anti-inflammatory and antioxidant, making them promising bioactive products and biomaterials with a wide range of applications. Their properties are mainly due to their structure and physicochemical characteristics, which depend on the organism they are produced by. In the biomedical field, the polysaccharides from algae can be used in controlled drug delivery, wound management, and regenerative medicine.