REVIEW ARTICLE

Physiochemical Features, Qualitative and Quantitative Analysis, Present Status and Application Prospects of Polysaccharide Gums

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ABSTRACT

Gums, generally plant-derived polysaccharides, have been widely used in various fields of the pharmaceutical and food industries in recent years. Natural gums are formed as a result of a protective reaction to plant damage or due to negative conditions (drought), as a result of the destruction of cell walls (gummosis); also bacteria cultures, seaweeds can serve as gum sources. Gums are of great interest due to the wide application spectrum; it is based both on their physicotechnological (structure-forming agents) and the biological properties (inertness). This is an important factor in the development of food products and drugs. They also find applications in cosmetics, inks, paper, and textiles. The article aims to summarize the numerous obtained data and to establish current and prospects for gum quality control and application.

Keywords: Constituents identification, Gummosis, Gums, HPLC, Hydrocolloids, TLC.

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INTRODUCTION

Gums (lat. *Gummi*) are water-soluble non-starch polysaccharides (PSH), dietary fibers. Gums are hydrocolloids, hydrophilic polymers capable of forming stable hydrogels in low concentration. Gums – heteropolysaccharides, consisting of sequentially connected simple carbohydrates or D-galactomannans; they also may contain uronic acids (D-glucuronic acid and D-galacturonic acid). Carboxyl groups of uronic acids are connected to Ca^{2+}, K^{+}, Mg^{2+}. Also, gums belong to the group of soluble dietary fibers. Gums are formed as a result of the cells (walls and contents) degeneration of various tissues (duramen, rays of duramen, cortex, etc.). When cells are destructed, gums protrude from natural cracks or artificial cuts in the caudax and congeal in the lumpy, ribbon or other forms; it makes them different from mucus. Often, they form very complex plant exudates, mixing with tannins (tanno-gum), resins (gum-resins), resins and essential oils (aromatic gums-resins). Gums have been known since ancient times; they had been described by Theophrastus (IV century BC), Pedanius Dioscorides (I century), Plinius (I A.D.). They are mentioned in the "The Canon of Medicine" by Avicenna (X A.D.), and the other writings of Arabic scholars. Gums are widely used in pharmaceutical practice and various sectors of the world economy.[1-3]

Chemical and Physical Properties of Gums

The chemical composition of gums is quite complicated and varies greatly depending on many factors (biological source, weather conditions, etc.). It is not possible to give defined structural formulas for all-natural gums. The main component of every gum is carbohydrate monomers, but also natural gum can contain proteins.[4,5]

For example, apricot gum contains glucuronic acid (up to 16%), galactose (up to 44%), arabinose (up to 41%). Gums – solid amorphous substances of various colors. They are divided into three groups depending on their solubility in water: arabinic group, highly soluble in water (apricot and arabic gums); bassorin group, slightly soluble in water, but strongly swelling in it (tragacanth gum); cerazine group, slightly soluble and slightly soluble in water (cherry gum). Gums are not soluble in alcohol and non-polar solvents. They are not compatible with mineral acids, with alcohol in pharmaceutical formulations.[4,6,7]

Classification of gums (Table 1) may be presented by origin and ionization properties (uncharged or ionic polyelectrolytes); gums structural formulas can be seen in Figure 1.

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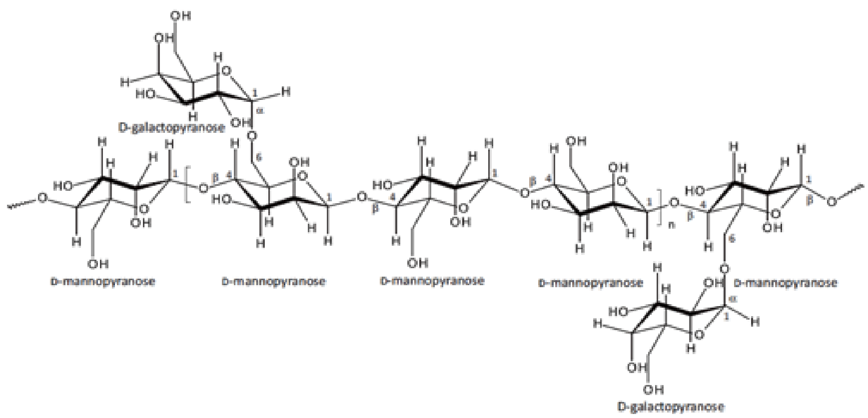
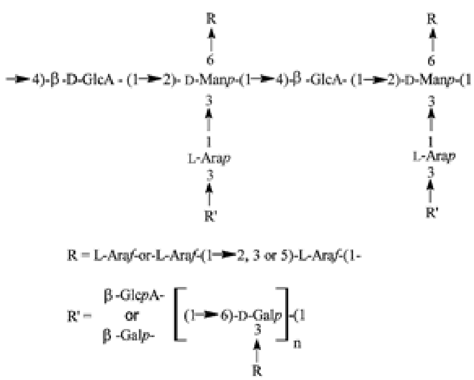
Table 1: Gums classification

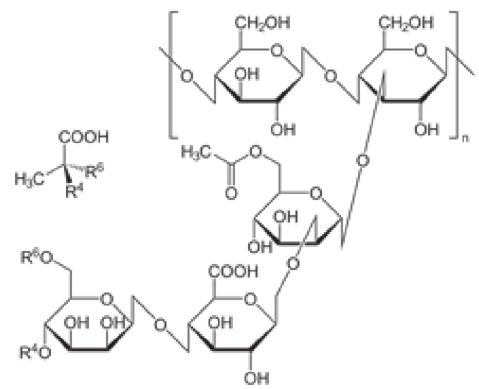
Natural gums obtained from botanical resources	
Polyelectrolytes	*Uncharged*
• Arabic gum (E414) • Tragacanth gum (E413) • Karaya gum (E416) • Ghatti gum	• Guar gum (E412), from guar beans • Carob (locust) bean gum (E410) • Konjac gum (E425) • Tara gum (E417)
Natural gums obtained from seaweeds	
Polyelectrolytes	
• Agar (E406) • Alginic acid (E400) and sodium alginate (E401) • Carrageenan (E407)	
Natural gums produced by bacterial fermentation	
Polyelectrolytes	Uncharged
• Gellan gum (E418)	• Xanthan gum (E415)



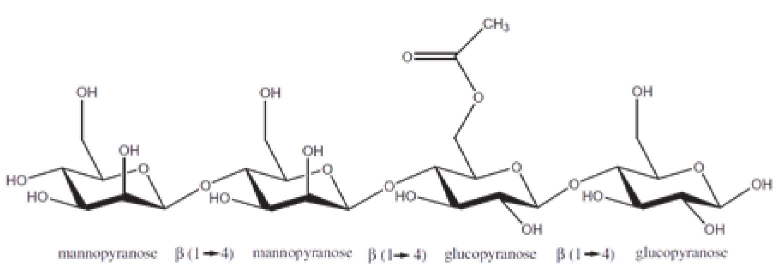
tara gum



ghatti gum



xanthan gum



konjac glucomannan

Figure 1: Structural formulas of gums

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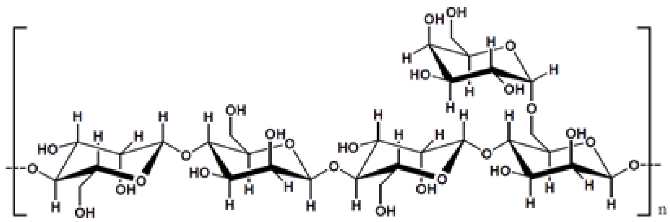
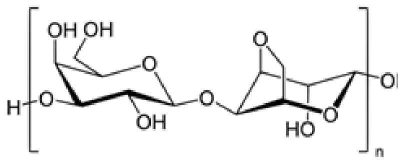
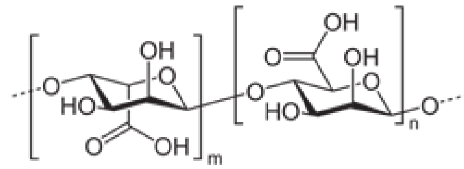


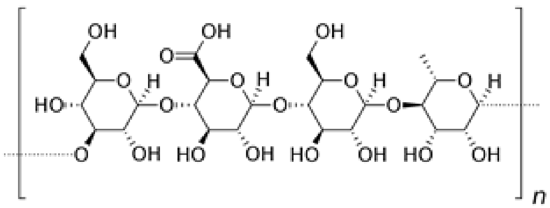
carob bean gum



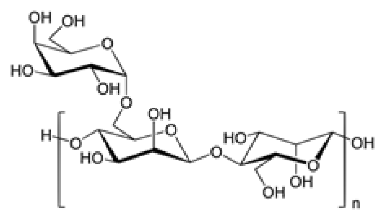
agarose



alginic acid



gellan gum



guar gum

Figure 1: Structural formulas of gums

Functional Role of Gum Formation and Exudation

It is believed that gums protect plants from infection by pathogenic microorganisms, filling in cracks and other injuries. Gum formation is common to many plants. The *Fabaceae*, *Rosaceae*, *Rutaceae*, *Anacardiaceae*, *Meliaceae* families are most rich in gums. For example, 32 genera contain gums in the *Rosaceae* family. The process of gum formation can occur in plants that grow in various climatic zones. But still, most of the families that contain gums are tropical. The ability to form gums is characteristic only of perennial forms of plants – trees and shrubs, and to a lesser extent–herbaceous perennials plants with a lignified root and base of the stem. Various plant organs – roots, trunk, branches (even petioles of leaves), fruits, seeds – produce gums. The type of tissue that forms the gum, the process of gum formation, the meaning of gum formation depend on the specifics of the plant. Gums, as a rule, are formed as a result of degeneration of the cell walls of the parenchymal tissue of the duramen and its rays. It is known cases of mucous degeneration in the parenchyma of the cortex. It is believed that starch (or other cell contents) plays a significant role in the formation of gums in stone fruit plants and *Acacia* species.[1,3,8-10]

The anatomical topography of gum formation is different in individual gum-bearing plants. For example, gum can form both in the cells of the bast and core rays and special cavities of the parenchyma of wood and bark. It is peculiar to stone fruit plants. Gum formation occurs due to the influence of external stimuli: mechanical damage, damage by insects or their larvae, bacterial or fungal diseases. The nature of the soil, fertilizers, intensive irrigation, the density of tree planting, etc. can affect the gummosis intensity. Gummosis of tissues, which is characteristic of stone fruit plants (*Prunus*, *Armeniaca*, *Persica*, *Cerasus*), occurs due to mucosal degeneration of tissues, primarily parenchyma. Moreover, in addition to tissues, assimilates are also included in the process of gum formation. This conclusion was made because the masses of gum sagging exceed in volume and mass the volume and mass of the tissues that formed the petrified lacunae. Thus, the process of gum formation resembles a "patch" for wounds. Gum nests are formed both on the trunks and the branches of the apricot tree (Figure 2).[3,6,7]

Figure 2: Gum exudation of the apricot tree

Gum exudation has different intensities. Smears can reach 80-100 g in some cases. A maximum of gum is observed in trees aged 10–15 years during the harvesting period and especially after fruit removal. Increased gummosis is not observed in trees that grow in areas with groundwater located close. Tapping increases the flow of gum. Collected from one tree that bent to gum formation, from 0.5 to 1.5 kg of gum per season in Central Asia.[6,7]

Common Usage of Gums

Gum varieties differ from each other noticeably in origin, they are produced from various types of material; the common usage is a stabilizer for the consistency of products. For example, gum arabic is a hardened sap of various acacia tree species (Figure 3), pods of Mediterranean acacia are the herb material for locust tree gum; guar gum powder is made from the endosperm of the seeds of *Cyamopsis tetraraganoloba*, known as guar. However, xanthan gum is a microbiological polymer.[4]

The Biblical incense frankincense (*Gummi-resina Olibanum*) is an extract from the aromatic gum-resin of the tree *Boswellia* species. This aromatic gum-resin has long been used in Ayurvedic medicine. Myrrh is another natural aromatic gum-resin extracted from the *Commiphora* genus species. It is used in medicine (lat. *Gummi-resina Myrra*) as a means of improving digestion, astringent, antiseptic in the form of powder and tincture, and in the perfume industry.[4,11] Gums (apricot, arabinic) are soluble in water, used in pharmaceutical practice as emulsifiers in the preparation of emulsions. Gums are widely used in technology. They have found applications in the food industry as emulsifiers, stabilizers, gelling agents and thickeners. Gums are used in the manufacture of confectionery, ketchups, canned meat and fish, and various semi-finished products.[1,3,6]

Characteristics of Certain Types of Gums

Arabic Gum (E414)

Arabian gum (Gummi arabicum), gum arabic, (acacia gum) are water-soluble heteropolysaccharides and their calcium, magnesium and potassium salts. Arabinose, galactose, rhamnose and glucuronic acid are formed during hydrolysis. The basis is composed of 1,3-linked β-D-galactopyranosyl units; the side chains consist of 2-5 1,3-linked β-D-galactopyranosyl moieties, joined to the general chain by 1,6-linkages. The generak and the side chains contain moieties of α-L rhamnopyranosyl, α-L-arabinofuranosyl, 4-O-methyl-β-D-glucuronopyranosyl, and β-D-glucuronopyranosyl the latter 2 mostly as end-moieties.

Figure 3: Gum arabic

Arabic gum is a dried exudate from the trunks and branches of several species of African acacia (*Acacia senegal* (L.) Willd. and related species). The best quality category gum looks like slightly yellowish, translucent pieces. Arabian gum dissolves in a double amount of water slowly, but completely, forming a thick sticky liquid. This is a long-used emulsifier for the preparation of pharmacy emulsions. The effectiveness of emulsification depends on the sort of gum. Gum arabic is used as an emulsifier, stabilizer, and thickener in the food industry.[12-15]

Tragacanth (E413)

This gum is obtained by drying, followed by milling the exudate from the trunks and branches of *Astragalus* species (*A. tragacantha*, *A. gummifer*, *A. adscendens*, *A. brachycalyx*). It consists mainly of high molecular weight polysaccharides (galactoarabans and acidic polysaccharides). Galacturonic acid, galactose, arabinose, xylose, and fructose are formed during the hydrolysis of these polysaccharides. Small amounts of rhamnose and glucose are also formed due to trace amounts of starch or cellulose. Tragacanth gum is used as an emulsifier, stabilizer, and thickener.[12,16,17]

Karaya Gum (E416)

Also known as karaya, sterculia gum, kadaya, katilo, kulu, kateera. It belongs to water-soluble heterogeneous polysaccharides. Galactose, rhamnose, galacturonic and glucuronic acids are formed during the hydrolysis of the polysaccharide. Karaya gum is obtained by drying the exudate from the trunks and branches of *Sterculia urens* Roxb and other *Sterculia* species. Karaya gum is used as an emulsifier, stabilizer, and thickener. Karaya gum is used in food and pharmaceutical industries as an adhesive and laxative.[12,18,19]

Ghatti Gum (E419)

Also known as Indian gum; this heterogeneous water-soluble non-starch polysaccharide is calcium and sometimes magnesium salt. Arabinose, galactose, mannose, xylose and glucuronic acid are formed during the hydrolysis of the polysaccharide. Ghatti gum is obtained by drying, followed by grinding the exudate from the trunks and branches of *Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr. Ghatti gum is used as a thickener and stabilizer.[20]

Guar Gum (E412)

Guar gum has a characteristic odor. Color varies from white to yellowish. Guar gum is a water-soluble PSH; it belongs to the category of heterogeneous PSH and consists of sequentially linked D-galactomannans. The ratio of mannose to galactose is 2:1. Guar gum is obtained from the endosperm of the *Cyamopsis tetragonoloba* (L.) Taub., seeds known as guar, *Leguminosae* family. Guar gum binds water when mixed with liquid media during preparing the product; then the colloidal system becomes less mobile and the viscosity of the system increases. Guar gum disperses evenly and swells in both cold and hot water. It is not soluble in organic solvents. It is used as a thickener and stabilizer. Guar gum serves as a thickener and emulsifier in the production of sauces, ketchups, mayonnaise, dairy desserts, yogurt, soups, drinks, bakery products. Guar gum is used to hold the pulp in suspension in the production of juice drinks.[21,22]

Locust Bean Gum (E410)

Locust bean gum, also known as carob bean gum, carob gum, carobin, is a galactomannan (sequentially connected D-galactomannans) extracted from the Carob tree seeds. Locust bean gum is similar in chemical structure to guar gum; the ratio of mannose to galactose is 4: 1. Locust bean gum is produced from the endosperm of Mediterranean acacia seeds – *Ceratonia siliqa* (L.) Taub. (*Leguminosae*). It is soluble only when heated. Locust bean gum binds to water when applicated into a liquid media during preparing; then, the colloidal system becomes less mobile, and the viscosity of the system increases. This is used as a thickener and stabilizer. But a distinctive feature of this thickener is a synergism with xanthan and other hydrocolloids. Therefore, it is most often used with xanthan as a thickener or gelling agent.[23]

Tara Gum (E417)

This water-soluble polysaccharide is a heterogeneous species and consists mainly of sequentially connected D-galactomannans, which represent a linear chain ($1 \rightarrow 4$) of β-D-mannopyranose and α-D-galactopyranose and are connected by a $1 \rightarrow 6$ binding. The ratio of mannose to galactose is 3: 1. This food additive is obtained by milling the endosperm of *Tara spinosa* (Feuillée ex Molina) Britton & Rose seeds. Tara gum, when added, can significantly increase the elasticity of gel and retain water within this structure. Tara gum keeps freeze-thaw stability by preventing the ice crystals formation in ice creams. It is used as a thickener and stabilizer.[24]

Konjac Gum (E425)

Konjac gum (glucomannan, cognac gum) is a plant polysaccharide that consists of 85-90% of glucomannan. It is a finely dispersed powder of light cream or white color. Konjac gum is obtained from corms of *Amorphophallus konjac* K. Koch, which is cultivated in the mountainous regions of Southeast Asia. Konjac gum is used as a thickener and stabilizer[25,26]

Apricot Gum (Gummi armeniacae)

Apricot gum protrudes from incisions and cracks in the trunks and branches of apricot trees. It is harvested in large quantities in Central Asia. The official apricot gum is light yellow or yellow, hard, brittle, translucent pieces with a conchoid fracture. Apricot gum is a complete analog of arabic gum, as it is completely soluble in water and looks like a white powder. Glucuronic acid (up to 16%), galactose (up to 44%), arabinose (up to 41%) are components of the gum; an admixture of protein substances does not exceed 0.6%. Apricot gum is close to gum arabic in its composition and solubility; it forms viscous solutions that have a high emulsifying and enveloping ability. Russian apricot gum completely replaces imported arabic gum in pharmaceutical practice (oil emulsions, enveloping solutions, the viscous component in some blood substituting solutions, etc.). Apricot gum is available in the form of a powder of white or yellowish color. Plum gum (*Prunus domestica* L.) and sweet cherry gum (*Cerasus avium* (L.) Moench.) are close to apricot gum in water solubility, viscosity, and emulsifying ability. Cherry gum (from *Prunus vulgaris* Mill.) refers to weakly swelling gums and cannot replace apricot gum. Silver wattle (*Acacia dealbata* Link.) acclimatized on the Black Sea coast of the Caucasus, produces gum very close in properties to arabic and apricot gums. Larch gum obtained from Siberian larch (*Larix sibirica* Ledb.) should also be attributed to this group.[7,27]

Agar (E 406)

This structural homopolysaccharide (synonyms: agar-agar, gelosa, Japanese agar, Japanese, Bengal, Ceylon or Chinese gelatin) belongs to D-galactans; it is soluble in boiling water. Agar is a galactose polymer (90% of D-form, 10% of L-form). Units of galactose (D- or L-galactopyranose) are connected by α- and β-bonds at the sites of $1 \rightarrow 3$ and $1 \rightarrow 4$ carbon atoms. Every tenth D-galactopyranose unit is esterified with one or two hydrogen atoms of sulfuric acid at the site of the CH_2OH- or CHOH- group. In the first case, the second hydrogen atom of the sulfuric acid molecule is substituted by calcium, magnesium, potassium, or sodium. Red algae of the *Rhodophyceae* family serve as materials for agar production. Agar is used as a thickener and stabilizer.[28]

Alginic Acid (E 400)

Alginic acid or align $(C_6H_8O_6)_n$ is a heteropolysaccharide distributed widely in the brown algae cell walls; hydrophilic salts form a viscous media when mixed with water. It is a linear polymer of D-mannuronic acid with its partial substitute with L-guluaronic acid. The units of these acids (β-D-mannanopyroase and β-L-guluropyronase) are connected by a β-bond at the site of $1 \rightarrow 4$ carbon atoms. Various types of brown marine algae serve as materials for alginic acid production. Alginic acid is used as a thickener and stabilizer. Besides, salts slightly soluble in water are used: sodium (E 401), potassium (E 402), ammonium, (E 403) and calcium (E404) salts, propylene glycolginate (E 405) for practical purposes. Propylene glycolginate is a 1,2 - propanediol ester of alginic acid. These salts are emulsifiers, stabilizers and anti-foaming agents.[29]

Carrageenan (E407)

This name is a generic term for structural, water-soluble homopolysaccharides such as D-galactans. Carrageenans are highly flexible, large molecules forming curly helical structures. It provides the ability to form a different gel varieties at room temperature. These homopolysaccharides are obtained by extraction with water or low alkali solutions from various species of red seaweed of the *Rhodophyceae* class, such as *Furcellaria*, *Gigartinaceae*, *Hypnaeceae*, *Phyllophoraceae,* and *Solieriacaeae*. Carrageenan (carrageenin) is a copolymer of sulfate esters of ammonium, calcium, magnesium, potassium and sodium galactose and 3,6-anhydro-D-galactopyranose. Units of D-galactopyranose and 3,6-anhydro-D-galactopyranose are connected by alternating α and β bonds at the sites 1 → 3 and 1 → 4 carbon atoms, respectively. The cation content in carrageenan may vary until one of them prevails during processing. The prevailing copolymers are kappa, lota, and lambda carrageenans in food forms of carrageenan. Kappa-carrageenan is the main polymer of D-galactose-4-sulfate and 3,6-anhydro-D-galactose; lota-carrageenan is an analogue of kappa-carrageenan, but anhydro-D-galactose is sulfonated at the second carbon; in lambda, D-galactose-2-sulfate (1,3-bond) and D-galactose-2,6 disulfate (1,4-bond) are basically carrageenan monomer units. The final product is standardized with sucrose. Then it is mixed with salts to obtain specific gelling properties. In this form, it is used as a gelling agent, thickener and stabilizer.[30,31]

Gellan Gum (E418)

This high molecular weight heterogeneous anionic water-soluble polysaccharide; it is obtained by fermenting carbohydrates with a pure *Sphingomonas elodea* culture. Then it is purified with isopropyl alcohol, dried and ground. Gellan gum consists of linearly linked tetrasaccharides. Tetrasaccharides include rhamnose and glucuronic acid unit and two glucose units, substituted in an amount of 0-5% with acyl groups which form O-glycosylated esters. Glucuronic acid is neutralized by a mixture of potassium, sodium, calcium and magnesium salts during the manufacturing process. Gellan gum is used as a thickener, stabilizer, and gelling agent.[32]

Xanthan Gum (E415)

This high molecular weight polysaccharide is obtained by fermenting carbohydrates in a pure *Xanthomonas campertis* culture, followed by purification with ethanol or isopropanol, drying and grinding. This polysaccharide contains a large number of side chains. Electrostatic repulsion during the interaction of chains occurs due to the presence of acid groups. Xanthan gum consists of β-glucose and D-mannose (the main hexose units). Xanthan gum also contains D-glucuronic, pyruvic acids, and derivatives in the form of sodium, potassium and calcium salts. Xanthan has an excellent thickening ability; it increases the shelf life of finished products and prevents delamination. This gives resistance to acids and high temperatures. Xanthan gum is used as a thickener and stabilizer. It is synergistic with guar and other hydrocolloids enhancing the gelling ability of carrageenans and carob gum. Xanthan gum is used in a mixture with locust bean gum as a thickener and gelling agent due to the above-mentioned properties.[33]

Identification and Quantification of Gums

Normative documentation (ND) governing the authenticity, quality, and safety of gums may be different since gums are used as food additives and as pharmaceutical substances. Nevertheless, the tests are quite similar and differ slightly. The following sources regulate the gums as food additives: Food Chemicals Codex (FCC), Japan's Specifications and Standards for Food Additives, Compendium of food additive specifications. Joint FAO/WHO Expert Committee on Food Additives and others.[10,34,35]

The identification of gums in food products is based on rather laborious, low-specific methods. Qualitative reactions for the identification of gums are based on the different solubility of the gums in alkaline solutions, the formation of precipitates with salts of calcium, iron, lead, copper, aluminum, ammonium.[36]

The identification of acid hydrolysis products (monosaccharides) is carried out by thin-layer chromatography in comparison with saccharides standard samples. According to the "Gum Constituents Identification" sugar profile analysis is carried out by TLC after acid hydrolysis. In this procedure mixture of gum sample and 10% sulfuric acid is boiling for 3 h, purified with barium.[8]

FAO JECFA monographs for gums have the following structure: "Synonyms", "Definition" (appearance, source, composition), "C.A.S. number", "Description" (physic-chemical properties), "Functional uses", "Characteristics", "Tests". "Characteristics" section regulates the identification of some gum properties (solubility, gum constituents, optical rotation, precipitate formation), purity (loss on drying, total ash, acid insoluble ash, lead, microbiological criteria). "Tests" section includes identification tests (determination of gum constituents). Characterization of gums monomers is presented in Table 2.[10]

Monographs on gum are presented in the leading pharmacopeias of the world. On the example of the European Pharmacopoeia, we consider the structure of a typical monograph. It includes A. Appearance (external signs); B. Microscopy; C. TLC; D. Qualitative reactions. The test section includes TLC for monomers (mainly sugars and uronic acids); special tests may also be indicated here to distinguish certain gum from other types of gums and polysaccharides. Other indices are foreign matter, flow time, total ash, microbial contamination.[37]

HPLC with the pulsed amperometric detector (PAD) is on of promising methods for gum quality control. HPLC-PAD procedure includes Dionex DX-50 or equivalent, an anion-exchange column (Carbopack PA1, 250 mm × 4 mm, 5 µm). Conditions: column temperature – 30 °C; mobile phase – 5 mM NaOH (A) and 1.0 M NaOH (B), use 100% A from 0 - 30 min and 100% B from 30 - 50 min and return to 100% A until 70 min.[9]

One of the methods of identification is the determination of the IR spectra of the purified fractions from the product. Gas chromatography with a flame ionization detector after

Table 2: Gums characterization

Name	*No INS, CAS*	*Characterization*	*Monomers*
Natural gums obtained from botanical resources			
Arabic gum	E414, 9000-01-5	polyelectrolyte, insoluble in ethanol, 1 g is soluble in 2 ml of water	arabinose, galactose, mannose, rhamnose, galacturonic acid, glucuronic acid, xylose
Tragacanth	E413, 9000-65-1	polyelectrolyte 1 g in 50 ml forms an opalescent dispersion. Insoluble in ethanol; does not swell in 60% ethanol solution	galactose, fructose, galacturonic acid, arabinose, xylose Residual amounts of rhamnose and glucose may be presented.
Karaya gum	E416, 9000-36-6	polyelectrolyte, forms a granular, hard, slightly opalescent gel after adding 2 g to 50 ml of water; the gel gives a reaction with litmus; insoluble in ethanol	galactose, rhamnose, galacturonic acid, glucuronic acid (less than 1,0%)
Ghatti gum	E419, 9000-28-6	polyelectrolyte, insoluble in ethanol, forms a dispersion in water (1 g in 5 ml), contains calcium and magnesium salts	L-arabinose (40%), D-galactose (25%), D-glucuronic acid (20%), D-mannose (7%), L-rhamnose (1%), D-xylose (1%) can be detected after hydrolysis. (calcium, less often magnesium salt)
Guar gum	E412, 9000-30-0	uncharged, insoluble in ethanol	mannose: galactose (2 : 1)
Carob (locust) bean gum	E410, 9000-40-2	uncharged (from land plants) Insoluble in ethanol. forms a gel when sodium borate is added to an aqueous solution	mannose: galactose (4 : 1)
Tara gum	E417, 39300-88-4	uncharged (from land plants) forms a gel when sodium borate is added to an aqueous solution	mannose: galactose (1 : 2)
Konjac gum	E425	uncharged (bacterial fermentation), dispersible in hot and cold water, forming a viscous solution with pH 4.0 - 7.0)	mannose : glucose (1,6 – 4 : 1)
Natural gums obtained from seaweeds			
Agar	E406	polyelectrolyte (from algae); insoluble in cold water; soluble in boiling water	D- and L- galactose (agarose and agaropectin)
Alginic acid	E 400	polyelectrolyte; salts – sodium alginate (E401), potassium alginate (E402) and calcium alginate (E404); potassium and sodium alginates in water form colloidal solutions, in contrast to insoluble alginic acid.	polyuronic acids (D-mannuronic and L-guluronic) in different proportions, varying depending on the particular type of algae
Carrageenan	E407	polyelectrolyte, insoluble in ethanol; soluble in water at a temperature of about 80 °C; forms a viscous, clear or slightly opalescent, easily flowing solution; It is more easily dispersible in water if you first moisten it with alcohol, glycerin or a saturated aqueous solution of glucose or sucrose.	2 residues of galactose (in sulfated form and anhydrous)
Natural gums produced by bacterial fermentation			
Gellan gum	E418, 71010-52-1	polyelectrolyte (bacterial fermentation), soluble in water, forms a viscous solution; insoluble in ethanol	rhamnose, glucuronic acid, glucose (1 : 1 : 2)
Xanthan gum	E415, 11138-66-2	uncharged (bacterial fermentation) soluble in water; Insoluble in ethanol	D-glucose, D-mannose, D- glucuronic acid, pyruvic acid (not less than 1.5%)

derivatization (silylation) of hydrolysis products is a more accurate and specific method. Quantitative assessment is carried out by the gravimetric method after processing the sample with enzymes (α-amylase, protease, amyloglucosidase). Then, the insoluble and soluble dietary fiber fractions are determined.[36-39]

In study, the procedure was described for galactomannan analysis in the seed of guar (*Cyamopsis tetragonolobus* (L) Taub) by HPLC-RID (Bio-Rad HPX-87P column at 85°C). The dry seeds were grounded, free sugars were removed by ethanol; the residue was hydrolyzed with 2 M trifluoracetic acid; it serves as a simple measuring procedure of gum contents in guar.[40]

In arabic gum a selective and sensitive assay of galactose, arabinose, and rhamnose was presented; samples were fractionated by hydrophobic affinity chromatography, hydrolyzed (4%w/w sulphuric acid, 100°C for 4 h), and analyzed by normal bonded phase HPLC-RID (Supelcosil LC-NH_2, 5 µm, 4.6 mm ID, 25 cm column; mobile phase–80/20 acetonitrile-water, 30°C).[41]

CONCLUSION

Gums belong to an extensive type of natural food and pharmaceutical stabilizers. Gums are thickeners, stabilizers, gelling agents, and a resource for encapsulation. Gums are widely used in the production of processed cheeses, ice cream, and dairy products, canned fruits and vegetables, smoked sausages, sauces, kinds of ketchup, mayonnaise, baked goods, canned fish, low-fat margarines and spreads. Gums are also used in conjunction with other thickeners and gelling agents to regulate the process. In particular, guar gum is used to produce cheese in combination with carrageenan. Exudate and other types of gums exhibit unique properties in a wide variety of applications in the pharmaceutical and food industries.

For quality control, the most promising physicochemical analysis method is HPLC with various types of detection after hydrolysis of a gum sample. This method allows a qualitative assessment of the gum monomer composition, as well as assesses the content of components, allowing to determine their ratio.

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