REVIEW ARTICLE

# Plant Exudates and Mucilage as Pharmaceutical Excipients

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## ABSTRACT

All pharmaceutical dosage forms contain many excipients besides the active ingredients to support manufacturing and to get desired effect of pharmaceutical active ingredients. Gums and mucilages are extensively used natural materials for conventional and novel dosage forms. Natural material have been gaining lot of importance in the field of drug delivery because they are cost effective, non-toxic, stable, easily available with less regulatory issues, eco-friendly, capable of multiple chemical modifications, degradable and compatible due to their natural origin. Many natural gums are studied for use in novel drug delivery systems out of which polysaccharides, resins and tannins are most extensively studied and used. This review discusses about the polymeric compound, their sources, chemical constituents and uses in development and modification of pharmaceutical dosage form.

**Keywords:** Gums, Mucilage, polysaccharide, Pharmaceutical application.

## INTRODUCTION

Drugs cannot be administered directly as such but are almost formulated into a suitable dosage form with the help of excipients, which provide various functions such as binding, lubricating, gelling, suspending, flavouring, sweetening and bulking agent along with others, to fulfil definite functions and in some cases they directly or indirectly persuade the extent and/or rate of drug release and absorption. Excipients are the major part of any pharmaceutical formulation. They can be of natural or synthetic origin. Since the natural origin plant polysaccharides fulfil with many needs expected of pharmaceutical excipients such as non-toxicity, stability, availability and renewability and cost effectively. [1,2] Gums are abnormal products, resulting from pathological conditions brought about either by injury or by adverse conditions of growth and usually formed by changes in existing cell wall (extra cellular formation; gummosis) while, mucilage are generally normal product of metabolism, formed within the cell (intracellular formation) and/or are produced without injury to the plant.[3] Gums are pathological products and mucilage are physiological products. The plant based polymers have been studied for their use in different pharmaceutical dosage forms like matrix controlled system, film coating agents, buccal films, microspheres, nanoparticles, viscous liquid formulations like ophthalmic solutions, suspensions, implants and their applicability and usefulness has been confirmed . These have also been utilized as viscosity enhancers, stabilisers, disintegrants, solubilisers, emulsifiers, suspending agents, gelling agents, bioadhesives and binders. In this review, we describe the developments in natural gums and mucilages for use in the pharmaceutical sciences.

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## 1] AGAR

Agar is also known as Japanese Isinglass, Chinese-Isinglass or Vegetable Gelatin. It is the dried colloidal concentrate from a decoction of various red algae, particularly species of *Gelidium amansii (*Gelidaceae*).*[3,4,5,6] Agar can be separated into two major polysaccharides named as Agarose and Agaropectin. Agarose (a neutral gelling fraction)is responsible for gel strength of agar and is composed of (+) – galactose and 3, 6-anhydro-(–)-galactose moieties. It contains about 3.5% cellulose and 6% of nitrogen containing substance. Agaropectin is (a sulphated non-gelling fraction) responsible for the viscosity of agar solutions, and comprises of

sulphonated polysaccharide in which both uronic acid and galactose moieties are partially esterified with sulphuric acid. In short, it is believed to be a complex range of polysaccharide chains having alternating α–(1→3) and β–(1→4) linkages and varying total charge content. [7,8,9] Pharmaceutically it is used as Suspending agent, emulsifying agent, gelling agent in suppositories, surgical lubricant, tablet disintegrates, medium for bacterial culture, laxative. It also used in preparation of jellies.[5,10,11,12,13]

## 2] GUM ARABICA/ GUM ACACIA

Acacia gum, Indian gum or gum Arabica is the dried gummy exudates from the stems and branches of *Acacia Senegal* (Leguminosae) *or Acacia Arabica (*Combretaceae).[6,12,14,15] Synonyms are gum acacia; gummi africanum; gum arabic; gummi arabicum; gummi mimosae;and talha gum.[10] Acacia gum consist of a glycosidal acid of high molecular weight, which has been termed arabic acid, combined with potassium, magnesium and calcium. Structurally, gum arabic is a branched molecule with the main chain consisting of 1, 3-linked β-D galactopyranosyl units with other carbohydrates such as arabinose, glucuronic acid and rhamnose also present.[2,3,7,8] It is used as a general stabilizer in emulsions and used as an osmotic suspending and expanding agent to prepare a monolithic osmotic tablet system, binding agent for tablets and emollient in cosmetics. Its demulcent properties are employed in various cough, diarrhoea and throat preparations. It has widespread use in the food, drinks and other industries. Pharmaceutically, it is more applicable as a matrix microencapsulating agent for the enzyme, endoglucanase, which proofed to give slow release of the encapsulated enzyme and in addition increased its stability. [4,12,14,16,17]

## 3] GUM TRAGACANTH

Gum tragacanth is the dried gummy exudation obtained from *Astragalus gummifer* (Leguminosae).[15] Tragacanth consists of a water-soluble fraction known as tragacanthin (8-10%) and a water swellable fraction known as bassorin (60-70%). It contains about 15% of methoxy group which swell in water; this constituent of gum is responsible for its high viscosity. It has been classified as generally recognized as safe at the 0.2–1.3% level in food stuffs in the USA since 1961. [3,5,7,18] Pharmaceutically, It is applicable as sustained release agent. It is used as emulsifying and Suspending agent, demulcent, emollient in cosmetics and stabilizer, it has been used as a diluents in tablet formulations.[4,8,10,12,14]

## 4] ALBIZIA GUM

Albizia gum is obtained from the incised trunk of the tree *Albizia zygia* (Leguminosae*)*. It consists of ß -1– 3-linked D-galactose units with some ß-1-6-linked D-galactose units. Albizia gum has been investigated as a possible substitute for gum arabic as a natural emulsifier for food and pharmaceuticals. Albizia gum has use as a binding agent, suspending agent. To study Khaya and albizia gums were evaluated as compression coatings for target drug delivery to the colon using Indomethacin and Paracetamol as model drugs. The core tablets were compression-coated khaya gum & albizia gum respectively and also a mixture of khaya and albizia gum (1:1). Drug release studies indicated that khaya and albizia gums were capable of protecting the core tablet in the

physiological environment of the stomach and small intestine, with albizia gum showing greater ability than khaya gum. [19,20,21,22,23]

### 5] KARAYA GUM

Karaya gum, Indian tragacanth or streculia gum obtained from the *Sterculia urens* (Sterculiaceae). It consists of heteropolysacchrides of sugars and uronic acid. It doesnot contained methoxyl groups. Karaya gum is widely used as bulk laxative. Pharmaceutically, it is used as a Suspending agent, emulsifying agent, stabilising and thickening agent. dental adhesive, matrix forming agent in sustain release tablets and It has also been used in food,paper and textile industries. [3,5,12,24,25,26]

### 6] KHAYA GUM

Khaya gum is obtained by extraction from Khaya *senegalensis* and *Khaya grandifoliola* (Meliaceae). *Khaya senegalensis* gum is a polysaccharide with a galactan in which the 1,-3 linked β –D galactopyranosyl residues are concentrated in the inner chain. It has also been reported to contain both D-glucoronic and D-galatoronic acid. methylation of the gum and other study of the gum reveal many similarities to acacia gum. The swelling ability of *khaya senegalensis* gum may provide potential for it use as a disintegrant in tablet owing to its psuedoplastic and thixotropic properties. Pharmaceutically, It is applicable as suspending agent and binding agent in tablet formulation.[11,27,28,29]

### 7] GHATTI GUM

Gum ghatti or Indian gum ghatti obtained from *Anogeissus latifolia (*Combretaceae). Ghatti gum consists of calcium salt of a complex high molecular weight polysaccharide made up of sugars and uronic acid units. One of the polysaccharide acid, ghattic acid contains mainly arabinose, galactose, mannose, xylose and galacturonic acid. On hydrolysis of ghatti gum, it also afforts aldobiouronic acid 6-0-β-D-glucopyranosyl uronic acid and D- galactose which is also found in gum acacia. Pharmaceutically it is used as binder , emulsifier, stabilizer, thickener and suspending agent it gives a stable oil in water emulsion and, therefore, used in formulation of oil soluble vitamin preparation. Gum is edible. In india it is administered as a good tonic to women after child-birth.[3,5,7,11,25,30,31]

### 8] GUAR GUM

Guar gum is a seed gum produced from the powdered endosperm of the seeds of *Cyamopsis tetragonolobus* (Leguminoseae). Water soluble part of guar gum consist mainly galactomannan which is composed of about 34.5% of galactose anhydride and about 63.4% of mannose anhydride. It is known as guaran which constitute a major part of the gum. Pharmaceutically, it is used as carrier for oral extended release drug delivery. In colon targeted drug delivery it has high potential to serve as a carrier for oral controlled release matrix systems and as cross-linked microspheres. It is used as a binder, disintegrant, thickening agent, emulsifier, bulk laxative, appetite suppressant, and sustained release agent. Triacetate

derivative of galactomannan from guar gum can be used to cast into strong, transparent, flexible films. [5,7,9,10,14,15,31,32,33,34]

## 9] LOCUST BEAN GUM

Locust bean gum also known as Carob bean gum,carob flour,ceratonia gum, Cheshire gum, gomme de caroube, algarroba.[10] which is derived from the seeds of the *Ceratonia siliqua* Linn. (Leguminosea). Locust bean gum, a non-starch polysaccharide consisting of galactose and mannose in the ratio 1:4 and hence they are known as galactomanan. Locust bean gum consists mainly of a neutral galactomannan polymer made up of 1, 4-linked D-mannopyranosyl units and every fourth or fifth chain unit is substituted on C6 with a D-galactopyranosyl unit.[13] In pharmaceutical formulations, Locust bean gum is used as a binder, flocculating agent, thickening and stabilizing agent. In the present investigation, locust bean gum is used in the form of compression coat applied over core tablets was evaluated as a suitable carrier for colonic drug delivery. Locust bean gum was used to produce matrix tablets with and without the cross-linker; it is not a good suspending agent because of ceratoniase which causes the eventual break down of the suspension.[3.5,35,36,37,38]

## 10] HONEY LOCUST GUM

The gum is obtained from the seeds of the plant *Gleditsia triacanthos* (Leguminosea) (suborder Mimoseae). The seed contains proteins, fats, carbohydrates and fibres . Pharmaceutically it is used to produce matrix tablet at different concentrations (5% and 10%) by wet granulation method.[39]

## 11] GUM COPAL

Gum copal is a natural resinous material of plant *Bursera bipinnata* (family Burseraceae). Copal, a resinous material,which is obtained from the plants of araucariaceae and caesalpinaceae, a subfamily of leguminoaceae. Copal resin contains agathic acid, a diterpenoid and related lobdane compounds along with cis-communic acid, trans-communic acid, polycommunic acid, sandaracopimaric acid, agathalic acid, monomethyl ester of agathalic acid, agatholic acid and acetoxy agatholic acid. Copal resin obtained from leguminoaceae family which contains copalic acid, pimaric acid, isopimaric acid, dehydroabietic acid, dehydroabietic acid and abietic acid.[40] Medicinally, Copal is used in the treatment of headache, fever, burns and stomach ache. In dentistry, it is used as binding media in dental products and in treatment of microleakage in teeth. Pharmaceutically it is used as matrix-forming material and coating material for sustained release and colon-targeted drug delivery. Copal resin was investigated as a film forming agent, it produces glossy films with good weather protection properties. It has excellent binding properties. It has been mainly used as an emulsifier and stabilizer for the production of colour, paints, printing inks, aromatic emulsions and meat preservatives. [41,42]

## 12] GUM DAMAR

Gum dammar is a whitish to yellowish natural gum of plant *Shorea Wiesneri* (*Dipterocarpaceae*). It contains about 40% alpha-resin (resin that dissolves in alcohol), 22% beta resin, 23% dammarol acid and

2.5% water. It has been mainly used as an emulsifier and stabilizer for the production of colour, paints, inks and aromatic emulsions in food and cosmetic industries. It has been used for water-resistant coating and in pharmaceutical and dental industries for its strong binding properties. It is used as sustained release matrix forming materials.[41,43]

### 13] HUPU GUM (GUM KONDAGOGU)

Hupu gum is a naturally occurring exudate from the tree *Cochlospermum gossypium*. It is composed of major neutral sugars like arabinose, galactose, rhamnose, mannose, α-D glucose, and sugar acids like D-glucouronic acid, and D-galactouronic acid. . Hupu gum is also composed of higher uronic acid content, protein, tannin and soluble fibers .Gum is sweet, cooling and useful in diarrhoea, dysentery, cough, pharyngitis, and also used as a pharmaceutical aid. It used as substitute for gum tragacanth. Pharmaceutically it is suitable polymer for sustained release gastric floating system.[44,45] It is a good emulsifying agent even at low concentrations.[46] and it shows mucoadhesive properties.[47]

### 14] TARA GUM

Tara gum is obtained from the endosperm of seed of *Caesalpinia spinosa* (*Leguminosae* or *Fabaceae).* It is a Dietary Fiber known as a polysaccharide galactomannan polymer similar to the main components of guar and locust bean gums, consist of a linear main chain of (1-4)-β-D-mannopyranose units with α-D-galactopyranose units attached by (1-6) linkages. The ratio of galactose to mannose in tara gum is 1:3 (compared to 1:4 in locust bean gum and 1:2 in guar gum). Tara gum is used as a thickening agent and stabilizer in a wide range of food applications around the world. Pharmaceutically it is used as controlled release carrier in the formulation of gastroretentive controlled release tablets and emulsions for drugs which has been claimed in patents. [48,49] Tara gum has been considered as a possible replacement for carob gum in the formulation of kappa carrageenan- galactomannan mixed gels.[50]

### 15] TAMARIND GUM

Tamarind Gum, also known as Tamarind Kernel Powder (TKP).Tamarind gum obtained from seed polysaccharide *Tamarindus indica* (Leguminoseae). Is composed of (1 4)-β-D-glucan backbone substituted with side chains of at the O-6 position of its glucopyranosyl residues with α-D-xylopyranose. Some of the xylose residues are β-D-galactosylated at O-2. Xyloglucan is a major structural polysaccharide in the primary cell walls of higher plants. gum is a polysaccharide composed of glucosyl : xylosyl : galactosyl in the ratio of 3:2:1.[51,52]Pharmaceutically, It is applicable for Hydrogels, mucoadhesive drug delivery for ocular purposes, spheroids, nasal drug delivery. It is used as binding agent, emulsifier, suspending agent, sustaining agent. The gel can be used as a thickening and stabilizing agent in food industry [53,54,55]

### 16] GELLAN GUM

Gellan gum is an anionic microbial polysaccharide, secreted from *Pseudomonas elodea*. It is (commercially available as Gelrite™ or Kelcogel™) an anionic deacetylated exocellular polysaccharide secreted by *Pseudomonas elodea* with a tetrasaccharide repeating unit of one α -L-rhamnose, one β-D-glucuronic acid and two β-D-glucose. Chemical structure of the

polysaccharide has been determined. It has a tetrasaccharide repeat unit consisting of two glucose residues, one glucuronic acid residue, and one rhamnose residue. These are linked together to give a tetrasaccharide repeat unit. The native polysaccharide is partially esterified with L-glycerate and acetate but the commercial product Gelrite® has been completely de-esterified by alkali treatment. The exact molecular formula of gellan gum may vary slightly (e.g., depending on the degree to which the glucuronic acid is neutralized with various salts). [56,57] Pharmaceutically aqueous solution of Gellan are used for ophthalmic preparation and for oral drug delivery and also in microspheres. Gellan gum is used in Ophthalmic drug delivery,as sustaining agent, beads, hydrogels, floating in-situ gelling, controlled release beads, disintegrating agent.[58,59]

## 17] XANTHAN GUM

Xanthan gum is a complex microbial exopolysaccharide produced from glucose fermentation by *Xanthomonas lampestris*. It also called as corn sugar gum, keltrol, polysaccharide B- 1459, Rhodigel, vanzan NF, Xantural.[7]The primary structure of xanthan consists of repeating pentasaccharide units consisting of two D-glucopyranosyl units, two D-mannopyranosyl units and one D-glucopyranosyluronic acid . The polymer backbone is made up of (1→4)-linked β-D-glucopyranosyl units, is identical to that of cellulose. To alternate D-glucosyl units at the *O*-3 position, a trisaccharide side chain containing a D-glucuronosyl unit between two D-mannosyl units is attached. The terminal β-D-mannopyranosyl unit is glycosidically linked to the *O*-4 position of the β-Dglucopyranosyluronic acid unit, which in turn is glycosidically linked to the *O*-2 position of a α-Dmannopyranosyl unit. Approximately one-half of the terminal D-mannosyl units contain a pyruvic acid moiety as a 4, 6-cyclic acetal. Finally, the nonterminal D-mannosyl unit is stoichiometrically substituted at *O*-6 with an acetyl group. Pharmaceutically, it is applicable as sustained release agent, pellets, controlled drug delivery system. It is used as stabilizer for emulsions and suspensions. It is also used as suspending agent, emulsifier, stabilizer in toothpaste and ointments.[6,14,60,61,62]

## 18] STERCULIA FOETIDA

Sterculia is a genus colloquially termed as tropical chestnuts, (*Sterculia foetida)*. It contains a mixture of D-galactose, L- rhamnose and D-galactouronic acid. The galctouronic acid units are the branching points of the molecule. In an independent investigation Pharmaceutically it is used as a hydrophilic matrix polymer for controlled release preparation.[63,64]

## 19] MOI GUM

The gum is obtained from leaves, stems and fruits and are most abundant in the bark of the stem *Lannea coromandelica* (Anacardiaceae). Gum ducts are present in leaves, stems and fruits and are most abundant in the bark of the stem. The roots contain cluytyl ferulate; heartwood gives lanosterol; bark, *dlepi*- catechin and (+)-leucocyanidin; flowers and leaves, ellagic acid, quercetin and quercetin-3 arabinoside. Flowers also contain *iso*-quercetin and morin. Leaves in addition contain beta-sitosterol, leucocyanidin and leucodelphinidin. Pharmaceutically it used as microencapsulating agent.[65,66]

## 20] BHARA GUM

Bahera gum, extracted from the bark of *Terminalia bellerica* roxb, belonging to the family Combretaceae. Main chemical constitutents are tannins which mainly

include ß- sitosterol, gallic acid, ellagic acid, ethyl gallate, galloyl glucose and chebulaginic acid. Pharmaceutically, it is applicable in a new sustained release microencapsulated drug delivery system. It has been mainly used as a demulcent,purgative and as an emulgent in cosmetic industries.[67]

### 21] HAKEA GUM

Hakea gum is dried exudate from the plant *Hakea gibbosa* family Proteaceae. Gum exudates from this species contain L-arabinose and D-galactose linked as in gums that are acidic arabinogalactans (type A). Molarproportions (%) of sugar constituents Glucuronic acid, Galactose, Arabinose, Mannose, Xylose is 12:43:32:5:8. Pharmaceutically, it is applicable for the formulation of buccal tablets, Sustained release and peptide muco-adhesive for buccal delivery.[67,68,69]

### 22] MUCUNA GUM

Mucuna gum obtained from *Mucuna flagillepes* (Papillionaceae). Mucuna composed of mainly D-galactose along with D-mannose and D-glucose. An investigation into the suitability of microspheres of glibenclamide with mucuna gum for oral delivery was studied, they shows good in vitro properties. Mucuna gum is good suspending agent, stabiliting agent in dosage formulations such as suspensions and emulsions, a good binder in tablets and a good candidate for bioadhesive drug delivery.[70]

### 23] CORDIA GUM

Cordia gum (Indian cherry) obtained from *Cordia oblique willed* (Boraginaecae). *Cordia* gum as a novel sustained release matrix forming material in tablet formulations using diclofenac as model drug. Gum *Cordia* can be used for enteric resistant, controlled release agent, tablet binder, emulsifier,in Microparticulate drug delivery. *Cordia* gum used as novel polymer-surfactant nanoparticles for ophthalmic delivery of fluconazole using response surface methodology. It also used as preparation of transdermal Films.[71,72,73,74]

### 24] LEUCAENA LEUCOCEPHATA GUM

Leucaena gum obtained from *Leucaena leucocephata* Fabaceae. *Leucaena leucocephala* leaves and seeds contain lipids, crude protein and carbohydrates. The seeds contain tannin and oxalic acid. The leaves and seeds also contain a toxic and non-protein substance known as mimosine. A seed contains 25 percent gum and are highly viscous solutions at low solute concentrations. The seeds of leucocephala have great medicinal properties and are used to control stomachache, as contraception and abortifacient. Seed oil shows antimicrobial activity. Sulfated glycosylated form of polysaccharides from the seeds was reported to possess significant cancer chemo-preventive and anti-proliferative activities. The extracts of the seeds has reported as anthelmintic, antidiabetic and has a broad spectrum antibacterial activity. Seed gum used as emulsifying agent, suspending agent, binder in tablets, disintegrating agent in tablets.[75,76,77]

### 25] GREWIA GUM

It is obtained from *Grewia mollis (*Malvaceae) *Grewia mollis*as a potential pharmaceutical excipient has been on since the last decade and has been investigated for its phytochemical, toxicological and histopathological properties. The study showed that tannins, saponins, flavonoids, glycosides, balsam, phenols, terpenes, steroids were present while alkaloids were absent. The gum has been isolated and reported to contain glucose, galactose, rhamnose, arabinose and xylose as the monosaccharide components. The study further demonstrated that the plant is safe for human consumption with LD 50 of 1500 mg/kg body weight. The extracts showed no structural effects on the liver and heart. Pharmaceutically it is used as film coating and binding agent.[78,79,80,81,82]

### 26] CASHEW GUM

Cashew gum obtained from *Anacardium occidentale (*Anacardiaceae). Cashew gum is chemically composed of 61 % galactose, 4 % arabinose, 7 % rhamnose, 8 % glucose, 5 % glucuronic acid and < 2 % other sugar residues 3, 4 while hydrolysis of the gum yields L-arabinose, L-rhamnose, D-galactose and glucuronic acid. The gum has a highly branched galactan framework comprising of chains of (1→3)-linked β–Dgalactopyranosyl units interspersed with β-(1→ 6) linkages. Pharmaceutically it is used as binding agent and suspending agent. The ionotropic gelation was prepared by polymeric floating system composed of Alginate and Cashew gum loaded with an essential oil (*Lippia sidoides*–Ls) and also characterized regarding its physical-chemical properties and evaluated on its potential as a controlled release system.[83,84,85,86]

### 27] BALANGU GUM

Balangu gum obtained from *Lallemantia royleana* Labiatae.*]* Balangu seed gum (BSG) contains 61.74% carbohydrates, 0.87% proteins, 29.66% crude fiber and 8.33% ash. Because of high mucilage content, the seeds adsorb water quickly by hydration and produce a sticky, turbid and tasteless liquid, which can be used as a new source of food hydrocolloid in food formulations. [87]

### 28] BEAL FRUIT

Gum is obtained from fruits of *Aegle marmelos* belonging to family Rutaceae. The pulp contains carbohydrates, proteins, vitamin C, vitamin A, angelenine, marmeline, dictamine, O-methyl fordinol and isopentyl half ordinol. The neutral oligosaccharides were characterized as 3-0-beta-Dgalactopyranosyl- Larabinose, 5-0-beta-D-galactopyranosyl-L-arabinose, and 3-0-beta-Dgalactopyranosyl- D-galactose, and the acidic oligosaccharides. *Aegle marmelos* gum is used as Mucoadhesive in sustained release matrix tablet.[88,89,90]

### 29] PSYLLIUM

Psyllium seed husks, also known as ispaghula, isabgol, are portions of the seeds of the plant *Plantago ovata*, (genus plantago).the muscilage of isabgol consist pentosan and aldobionic acid which hydrolysis yield arabinose, galactose, galactouronic acid and rhamnose. The gel forming fraction of the alkaliextractablepolysaccharides is composed of arabinose, xylose and traces of other sugars. It is very well known and widely used from the times of ayurveda as laxative to relive constipation. It also used for the treatment of diarrhea, crohns disease (inflammatory bowel ulcerative colitis disease), colon cancer, obesity in children and adolescents high cholesterol and diabetes. Psyllium seed husk has been successfully evaluated as binder, disintegrant, release retardant, hydrogels, gastroretentive agent, microparticals.[91,92]

### 30] OKARA

The Okra gum obtained from the fresh fruits of the plant *Abelmoschus esculentus* belongs to the family Malvaceae, is a polysaccharide consisting of D-galactose, L-rhamnose and L-galacturonic acid with some fractions of glucose, mannose, arabinose and xylose. Okra has been used as food and it has been evaluated as a binder in paracetamol tablet formulation [93], control release [93], film coating [94], bio-adhesive [95] and suspending [96] agent. Okra gum maybe useful as hydrophilic matrixing agent in sustained drug delivery devices. Polymer for the development of a gastric floating dosage form [97]. Okra polysaccharide is also used as a microbially

triggered material for Colon targeted tablet formulation and also as the carrier. [98]

### 31] NEEM GUM

Neem gum is obtained from the trees of *Azadirachta indica* belongs to the family Meliaceae. Neem gum contains mannose, glucosamine, arabinose, galactose, fucose, xylose and glucose. [7] Pharmaceutically it used as binding agent.[99] in sustained release matrix tablets of Nimesulide using the fruit mucilage of *Azadirachta indica* was studied. [100]

### 32] ALOE MUCILAGE

Aloe mucilage is obtained from the leaves of *Aloe barbadensis* Miller. Aloe vera leaves and the exudate arising from the cells adjacent to the vascular bundles. The bitter yellow exudate contains 1, 8 dihydroxy anthraquinone derivatives and their glycosides.[101]Many investigators have identified partially acetylated mannan (or acemannan) as the primary polysaccharide of the gel, while others found pectic substance as the primary polysaccharide. Other polysaccharides such as arabinan , arabinorhamnogalactan, galactan, galactogalacturan, glucogalactomannan, galactoglucoarabinomannan and glucuronic acid containing polysaccharides have been isolated from the Aloe vera inner leaf gel part.[102] A controlled delivery system of glibenclamide using aloe mucilage was studied.[103] Dried *Avera* gel polysaccharide component therefore showed excellent potential to be used as an excipient in the formulation of direct compressible sustained- release matrix type tablet.[104]

### 33] MORINGA OLEIFERA GUM

A natural gum obtained from plant *Moringa oleifera* gum was extracted by using water as solvent and precipitated using acetone as non-solvent. It is a polyuronide constituting of arabinose, galactose and glucoronic acid in the preparation of 10:7:2, rhamnose present in traces. In a study potentials of *moringa olifera* gum was used as gelling agent[105], binder, release retardant in tablet formulations, and the effect of calcium sulpha dehydrate, lactose diluents on release of propronolol hydrochloride.[106] Another study moringa gum used as a disintegrant.[107]

### 34] PHOENIX MUCILAGE

Phoenix mucilage is obtained from the dried fruit of *Phoenix dactylifera* was brown colour date fruit composed of amino acids and proteins, carbohydrates, fatty acids, salts and minerals, and dietary fibre. Carbohydrates make up to 44 - 88% of the fruit which include mainly reducing sugars such as fructose, sucrose, mannose, glucose and maltose in addition to small amounts of polysaccharides such as pectin (0.5 - 3.9%), starch and cellulose . The protein content is approximately 2.3 - 5.6% with 23 amino acids which include alanine, aspartic acid, serine, glutamic acid, threonine, proline and glycine. Binding properties of date palm mucilage was successfully evaluated.[108]

### 35] HIBISCUS MUCILAGE

Hibiscus rosasinensis Linn of the Malvaceae family is also known as the shoe flower plant, China rose, and Chinese hibiscus. It contains L-rhamnose, D-galactose, D-galactouronic acid and D-glucuronic acid.[109] Pharmaceutically it is used for the development of sustained release tablet.[110] It is subjected to toxicity studies for its safety and preformulation studies for its suitability as a disintegrating agent. [111]

### 36] CASSIA TORA MUCILAGE

Cassia tora mucilage derived from the seeds of *Cassia tora*, belongs to Caesalpiniaceae. It is locally known as charota.[112] Cassia is used as tonic, carminative and stimulant. Cassia contains 1-2 % volatile cassia oil which is mainly responsible for the spicy aroma and taste. The primary chemical

constituents of Cassia include cinnamaldehyde, gum, tannins, mannitol, coumarins and essential oils (aldehydes, eugenol, and pinene); it also contains sugars, resins and mucilage among other constituents. Seed mucilage of *Cassia tora was* evaluated as suspending agent and binding agent. [113,114]

### 37] DELONIX REGIA GUM

A natural polysaccharide was isolated from the seeds from the plant Delonix regia belonging to family leguminosae (sub family: Fabaceae). In India, it is referred to as Gulmohar. Delonix regia seed gum used as a binder, its use in low concentration will improve the balance between the binding and disintegration properties of tablets, while its use at a high concentration could serve the desire for a modified or sustained release tablet formulation.[115,116]

### 38] GREVILLEA ROBUSTA GUM

This gum under study, newly explored pharmaceutically by the plant of grevillea robusta belonging to family Proteaceae, is being explored in extended release formulation as a binder. Total 37 gums and mucilages were studied of which grevillea robusta was found promising candidate to be used as pharmaceutical excipient. Upon injury to epithelial cells in the bark of the mature (6 to 10 yr old) Grevillea robusta tree produces a gum exudate at the point of injury. The gum also exudes naturally. Average production per tree can be estimated at 1 kg per annum and tapping can be carried out for about 10 month of the year. The gum generally exudes in the shape of tear with a sticky when fresh with a slight aromatic smell and dries gradually. The gum is yellowish brown when fresh and blackens upon ageing on the tree. Sometimes tears are bright red probably due to the presence of tannins or other impurities. Grevillea robusta gum readily dissolves in water & solution is highly viscous with a pH of 6.5. It is insoluble in either hot/cold ethanol or benzene. Grevillea robusta gum and resin by virtue of their solubility, viscosity, and relatively high resistance to hydrolysis, may have industrial applications. The grevillea exudates were found to be much more resistant to acid hydrolysis than those of the acacia genus. Chemical constituents of the gum can be obtained by partial acid hydrolysis of Grevillea robusta gum, which causes removal of most of the L-arabinose residues (44% of the total carbohydrate), yields a polysaccharide containing the galactose, arabinose, mannose and uronic acid in the molar ratios 3:1:1:2. The gum of grevillea robusta is natural calcium and magnesium salt of a complex polysaccharide acid composed of D-glucuronic acid attached to D-galactose and L-arabinose. [117,118,119]

## CONCLUSION

Natural polymers play an important role in the drug delivery. While selecting polymers care has to be taken regarding its toxicity and compatibility. By this review, author wanted to explore natural polymers which can be a good substitute for the synthetic polymers.

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