Review Article

Pharmaceutical Applications of Natural Gums, Mucilages and Pectins - A Review

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ABSTRACT

Gums, mucilages and pectins are widely used natural excipients for conventional and novel dosage forms. With the increasing interest in polymers of natural origin, the pharmaceutical world has compliance to use most of them in the formulations. In recent years, there has been an tremendous development in natural products which are need to be used for a variety of purposes. Nature has provided us a wide variety of materials to help improve and sustain the health of all living things either directly or indirectly. These natural materials have advantages over synthetic ones since they are chemically inert, nontoxic, less expensive, biodegradable and widely available. They can also be modified in different ways to obtain tailor made materials for drug delivery systems and thus can compete with the available synthetic excipients. Moreover, the tremendous orientation of pharma world towards these naturally derived polymers has become a subject of increasing interest to discover, extract and purify such compounds from the natural origin. Gums and mucilages are potent candidate to be used in various pharmaceutical formulations as a potential candidate for novel drug delivery system (NDDS). In this review, we describe the developments in natural gums, mucilages and pectins for use in the pharmaceutical sciences.

INTRODUCTION

In recent years, plant derived polymers have evoked interest due to their diverse pharmaceutical applications such as diluents, binders, disintegrants in tablets, thickeners in oral liquids, protective colloids in suspensions, gelling agents in gels, bases in suppository and also used in cosmetics, textiles, paints and paper-making . The plant based polymers have been studied for their application 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 efficacy has been proven. These have also been utilized as viscosity enhancers, stabilizers, disintegrants, solubilizers, emulsifiers, bioadhesives and binders.[1-3]

GUMS AND MUCILAGE

Gums are considered to be pathological products formed following injury to the plant or owing to unfavorable conditions, such as drought, by a breakdown of cell walls (extra cellular formation; gummosis). Mucilage's are generally normal products of metabolism, formed within the cells of plants (intracellular formation). Gums readily dissolve in water, whereas, mucilage form slimy masses. Mucilage's are physiological products of plants.[4]

Advantages of natural gums and mucilages in pharmaceutical sciences

The following are a number of the advantages of natural plant–based materials

Local availability — In developing countries, governments promote the production of plant like guar gum and tragacanth because of the wide applications in a variety of industries.

Biocompatible and non-toxic — Chemically, nearly all of these plant materials are carbohydrates composed of repeating sugar (mono saccharides) units. Hence, they are non- toxic.

Low cost — It is always cheaper to use natural sources. The production cost is also much lower compared with that for synthetic material. India and many developing countries are dependent on agriculture.

Biodegradable — Naturally available biodegradable polymers are produced by all living organisms. They represent truly renewable source and they have no adverse impact on humans or environmental health (*e.g.*,skin and eye irritation).

Environmental friendly processing — Gums and mucilages from different sources are easily collected indifferent seasons in large quantities due to the simple production processes involved.

Disadvantages of natural gums and mucilages

Reduced viscosity on storage — Normally, when gums and mucilages come into contact with water there is an increase in the viscosity of the formulations. Due to the complex nature of gums and mucilages (mono saccharides to polysaccharides and their derivatives), it has been found that after storage there is reduced in viscosity.

Batch to batch variation — Synthetic manufacturing is a controlled procedure with fixed quantities of ingredients, while the production of gums and mucilages is dependent on environmental and seasonal factors.

Microbial contamination — The equilibrium moisture content present in the gums and mucilages is normally 10 % or more and, structurally, they are carbohydrates and, during production, they are exposed to the external environment and so there is a chance of microbial contamination. However, this can be prevented by proper handling and the use of preservatives.

Uncontrolled rate of hydration — Due to differences in the collection of natural materials at different times, as well as differences in region, species, and climate conditions the percentage of chemical constituents present in a given material may vary. There is a need to develop suitable monographs on available gums and mucilages.[5]

Classification of gums and mucilages

Gums and mucilages are present in high quantities in verities of plants, animals, seaweeds, fungi and other microbial sources, where they perform a number of structural and metabolic functions; plant sources provide the largest amounts. The different available gums and mucilages can be classified as follows:

Animal origin: chitin and chitosan, chondroitin sulfate,hyaluronic acid.

Plant origin: (1) shrubs/tree exudates — gum arabica,gum ghatti, gum karaya, gum tragacanth and khaya andalbizia gums; (2) seed gums — guar gum, locust beangum, starch, amylase and cellulose; (3) extracts — pectin and larch gum; (4) tuber and roots— potato starch.

Microbial origin (bacterial and fungal): xanthan, dextran, curdian, pullulan, zanflo, emulsan, Baker's yeast glycan, schizophyllan, lentinan, krestin and scleroglucan.

Semi-synthetic:

Starch derivatives—hetastarch, starch acetate and starch phosphates.[6]

Chemical nature of gums and mucilages

Gums and mucilage, because of their polysaccharide nature, produce an indefinite number of monosaccharides on hydrolysis. Depending on the type of hydrolysis products obtained, they can be further classified into pentosans (e.g. xylan) and hexosans (e.g. starch and cellulose). Gums are pathological products consisting of calcium, potassium and magnesium salts of complex substances known as 'polyuronides'. Mucilages are physiological products related to gums, but they are generally sulfuric acid esters, the ester group being a complex polysaccharide. Both gums and mucilages are closely related to hemicelluloses in composition, except that the sugars produced by hemicelluloses are glucose, mannose and xylose, whereas those produced by gums and mucilages are galactose and arabinose.[7]

Applications of gums and mucilages

Gums and mucilages of different sources and their derivatives represent a group of polymers widely used in pharmaceutical dosage forms. Various kinds of gums are used in the food industry and are regarded as safe for human consumption. However, there is growing concern about the safety of pharmaceutical excipients derived from natural sources. Plant gums and exudates are now screened for their use as pharmaceutical adjuvants. Mucilages of different origins are also used in conventional dosage forms of various drugs for their binding, thickening, stabilizing and humidifying properties in medicine. Newer uses of different gums and mucilages in cosmetics and textiles has increased the demand and screening of gums has become an important pharmaceutical area. However, different gums and mucilages used as pharmaceutical adjuvants have stringent specifications, which few natural agents can fulfill. Gums and mucilages have the following applications. Gums and mucilages have a variety of applications in pharmacy. They are used in medicine for their demulcent properties for cough suppression. They are ingredients of dental and other adhesives and can be used as bulk laxatives. These hydrophilic polymers are useful as tablet binders, disintegrants, emulsifiers, suspending agents, gelling agents, stabilizing agents, thickening agents, film forming agents in transdermal and periodontal films, buccal tablets as well as sustaining agents in matrix tablets and coating agents in microcapsules including those used for protein delivery.[8]

PECTIN

Pectin can be described as a natural component of all edible plant material. Pectin is available in the plant cell walls and in a layer between the cells named middle lamella. Pectin gives firmness to the plants and affect on growth and water storage.

Pectin is a soluble dietary fiber. Pectin is a polymer of galacturonic acid and with that an acidic polysaccharide. Part of the acids is present as methyl ester. Pectin is a hydrocolloid and keeps a large amount of water and creates thickening and gelling properties.

Sources of pectin

The usual, profitable sources of pectin have been citrus peel and apple pomace. Regularly, this is a waste material from other industries like apple pomace from a cider producer. Citrus peel has often been the preferred material for pectin manufacturing due to its high pectin content and good color properties. Generally, lemon and lime peels are the preferred sources of citrus pectin. The peel must be unlimed and it cannot be enzymatically treated.

More recently other sources of pectin are beginning to find markets such as sugar beet pectin and sunflower pectin. Sugar beet pectin in particular is finding a niche market due to its unusual emulsification properties. The amount of pectin from these different sources varies considerably:

- Apple pomace: 10-15 %
- Citrus peel: 25-35 %
- Sugar beet: 10-20 %
- Sunflower: 15-25 %

Pectin is present in all plants but the content and composition varies depending on the species, variety, maturity, plant part, tissue, and growing condition. Pectin comprises up to 35 % of the cell wall of most terrestrial plants where alginates and carrageenans play a similar role for their marine counterparts. All green land plants contain pectin to a certain degree. Pectin content in dicotyledonous (flowering) plants far outweighs that contained in monocotyledonous (seed-bearing) plants and grasses

Pectin application

In history, Pectins have found use as general texture modifiers and gelling agents. Among the more common applications, pectin is used extensively in jams, jellies, confectionaries, deserts, and anti-diarrheal agents. Some of the more important modern uses include: 1) Ca^{2+} sequestering agent in detergents, 2) fillers in low calorie food products, 3) edible acidifying agents, 4) rheology modification, 5) biodegradable surfactants and emulsifiers, 6) edible packaging, 7) dairy stabilizers, and 8) dietary fat replacements.[9]

REASONS FOR DEVELOPMENT OF NEW EXCIPIENTS

Synthetic gums used in pharmaceutical industries possess drawbacks of toxic effects and health problems. Natural gums are currently being imported by India from other countries such as Sudan (56 %), Chad (29 %) and Nigeria (10 %). To avoid drawbacks of synthetic gums and reduce import expences, alternative natural gums are to be explored.

Gums attain from plants were used in India as excipients in food, pharmaceutical and cosmetic industries. India is the hub of medicinal plants and these are not commercially exploited much. Indian industries depend on the imported gums. Since common man will be involved in collecting the gums the society will be benefited.

Table 1: Characterization of Gums and Mucilages[10]

Test	Observation	Inference
Molish test: 100 mg of dried gum/mucilage powder + Molisch's reagent+ concentration H_2SO_4 on the side of the test tube	Violet color observed at the junction of the two layers	Carbohydrate are present
Ruthenium test: Take a small quantity of dried mucilage/ gum powder, mount it on a slide with ruthenium red solution, and observe it under microscope.	Pink color observed	Mucilage present
Iodine test: 10 mg of mucilage/gum powder add 1 ml 0.2 N iodine solution	No color observed in solution	Polysaccharide present
Enzyme test: Dissolve dried mucilage/gum powder in 20 ml distilled water, add 0.5 ml of benzidine in alcohol.	No blue color produced	Enzyme absent

Table 2: Pharmaceutical applications of Gums, Mucilages and Pectin[11]

Common name	Botanical name	Family	Pharmaceutical applications
Neem gum	*Azadiracta indica*	Meliaceae	Binding, suspending agent and transdermal film forming agent.
Orange peel pectin	*Citrus aurantum*	Rutaceae	Binding, suspending and sustained release dosage form.
Banana peel mucilage	*Musa paradisiaca*	Musaceae	Binding and suspending agent.
Hibiscus mucilage	*Hibiscus esculentus Linn*	Malvaceae	Emulsifying agent, sustained release agent and suspending agent.
Ispagol mucilage	*Plantago psyllium, Plantago ovata*	Plantaginaceae	Cathartic, lubricant, demulcent, laxative, sustaining agent, binder, emulsifying and suspending agent.
Satavari mucilage	*Asparagus racemosus*	Aapocynaceae	Binding agent and sustaining agent in tablets.
Ocimum seed mucilage	*Ocimum gratissimum Linn*	Labiatae	Suspending agent and binding agent.
Leucaena seed gum	*Leucaena leucocephata*	-	Emulsifying agent, suspending agent, binder in tablets and disintegrating agent in tablets.
Khaya gum	*Khaya grandifolia*	Meliaceae	Binding agent and
Karaya gum	*Sterculia urens*	Sterculiaceae	Suspending agent. Emulsifying agent, sustaining agent in tablets and bulk laxative
Fenugreek mucilage	*Trigonella foenum*	Leguminoseae	Gelling agent.
Cassia tora	*Cassia tora Linn*	Leguminosae	Binding agent.
Cashew gum	*Anacardium occidentale*	Anacardiaceae	Suspending agent.
Abelmoschus mucilage	*Abelmoschus esculentus*	Malvaceae	Binder in tablets and sustained release.
Albizia gum	*Albizia zygia*	Leguminoseae	Tablet binder.
Tamarind seed polysaccharide	*Tamarindus indica*	Leguminoseae	Binding agent, emulsifier, suspending agent and sustaining agent.
Bhara gum	*Terminalia bellerica roxb*	Combretaceae	Microencapsulation.
Cordia gum	*Cordia obliqua willed*	Boraginaecae	Novel oral sustainedrelease matrix forming agent in tablets.
Hakea	*Hakea gibbosa*	—	Sustainedrelease and peptide mucoadhesive for buccal delivery.
Mucuna gum	*Mucuna flagillepes*	Papillionaceae	Microspheres.
Gellan gum	*Pseudomonas elodea*	—	Ophthalmic drug delivery, sustaining agent, beads, hydrogels, floating in-situ gelling and controlled release.
Leucaena seed gum	*Leucaena leucocephata*	Fabaceae	Emulsifying agent, suspending agent, binder in tablets and disintegrating agent in tablets.
Badam gum	*Prunus amygdalus*	Rosaceae	Binding, sustaining and transdermal film forming agent.
Grewia gum	*Grewia mollis*	Malvaceae	Suspending agent and binder.
Sesbania gum	*Sesbania grandiflora*	Leguminosae	Gelling agent.
Hupu gum (gum kondagogu)	*Cochlospermum gossypium*	Cochlospermaceae	Gastric floating drug delivery.
Katira gum	*Cochlospermum religiosum*	Bixaceae	Colon drug delivery.
Malva nut gum	*Scaphium scaphigerum*	Sterculiaceae	Stabilizer and thickening agent.
Welan gum	*Alcaligenes species*	Alcaligenaceae	Thickening agent.

LIST OF GUMS AND MUCILAGES WAS USED IN THE PHARMACEUTICAL DOSAGE FORMS

1. Neem Gum

Neem gum is obtained from the trees of *Azadirachta indica* belongs to the family Meliaceae. Each and every part of the tree (bark, leaves, root and fruit) serves a certain purpose. Neem gum contains mannose, glucosamine, arabinose, galactose, fructose, xylose and glucose. In a study Neem gum used as a binder in pharmaceutical dosage forms. A sustained release matrix tablets of

Nimesulide using the fruit mucilage of *Azadirachta indica* was studied.[12-14]

2. **Moringa Oleifera Gum**

Moringa oleifera is a small genus of quick growing tree distributed in India. The stem of the tree exudates a gum which is initially white in colour but changes to reddish brownish black on exposure. It is sparingly soluble in water but swells in contact with water giving a highly viscous solution. 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 as gelling agent , binder, release retardant in tablet formulations, and the effect of calcium sulpha dehydrate, lactose diluents on release of propronolol hydrochloride. Another study was made moringa gum used as a disintegrant.[15]

3. Bhara Gum

Bhara Gum is a yellowish natural gum of plant *Terminalia bellerica* belonging to family Combretaceae. Bahara gum, extracted from the bark of *Terminalia bellerica*, is a waste material. Main chemical constitutents are tannins which mainly include ß- sitosterol, gallic acid, ellagic acid, ethyl gallate, galloyl glucose and chebulaginic acid. A new sustained release microencapsulated drug delivery system employing bhara gum has been proposed .The microcapsules were formulated by ionic gelation technique using Famotidine as the model drug[16].

4. **Hakea Gum**

Hakea gum a dried exudate from the plant *Hakea gibbosa* family Proteaceae. Gum exudates from species have been shown to consist of L-arabinose and D-galactose linked as in gums that are acidic arabinogalactans. Molar proportions (%) of sugar constituents Glucuronic acid, Galactose, Arabinose, Mannose, Xylose is 12:43:32:5:8. The exuded gum is only partly soluble in water. Hakea gum was investigated as a sustained release and mucoadhesive component in buccal tablets with drug chlorpheniramine maleate . These results demonstrate that H. gibbosa, may not only be used to sustain the release but can also act as bioadhesive polymer.[17]

5. Mango Gum

Mango gum is a dried gummy exudate polysaccharide obtained from the bark of *Mangifera indica*, belongs to the family Anacardiaceae. Physical, thermal, sorption and functional properties of a mango gum were characterized. The results obtained in this study establish the fundamental characteristics of mango gum. Gum of mangifera indica (mango) as a tablet binder employing paracetamol as a model drug,resin of mangifera indica (mango) as a tablet retardant polymer in the formulation development of sustained release of drugs, employing diclofenac sodium as a model drug was studied. Mouth dissolving tablets of metformin hydrochloride was prepared using mango gum powder as disintegrant.[18]

6. Cordia Mucilage

Cordia Mucilage is obtained from raw fruits of *Cordia Obliqua*, willed family Boraginaceae. The mucilaginous substance of the fruit used as gum an expectorant and is effective in treating the disease of the lungs and the raw gum can be used beneficially in gonorrhoea. Efficacy of *cordia obliqua* fruit mucilage as pharmaceutical excipient as tablet binder and emulsifier was studied.[19]

7. Hibiscus Mucilage

Hibiscus rosasinensis Linn of the Malvaceae family is also known as the shoe flower plant, China rose, and Chinese hibiscus. Mucilage of *Hibiscu rosasinensis* contains L-rhamnose, D-galactose, D-galactouronic acid and D-glucuronic acid.[20]

8. Alginates

Alginates are natural polysaccharide polymers isolated from the brown sea weed (Phaeophyceae). Alginic acid can be converted into its salts, of which sodium alginate is the major form currently used. Alginates offer various applications in drug delivery, such as in matrix type alginate gel beads, in liposomes, in modulating gastrointestinal transit time, for local applications and to deliver the bio molecules in tissue engineering applications.[21]

9. Tamarind gum

Tamarind gum is obtained from endosperm of seeds of the tamarind tree, which is a seed gum. Chemically tamarind kernel powder is highly branched carbohydrate polymer. Its backbone consists of D-glucose units joined with (1-4) b-linkages similar to that of cellulose. It consists of a main chain of b-D- (1-4)-galactopyranosyl unit with a side chain of single xylopyranosyl unit attached to every second, third and fourth of D-glucopyranosyl unit through a-D- (1-6) linkage. Tamarind kernel powder disperses and hydrates quickly in cold water but does not reach maximum viscosity unless it is heated for 20-30 mins. Tamarind gum was also evaluated in controlled release bioadhesive tablets. It was showed that lactoferrin tablet prepared with tamarind gum showed longest residence time in oral cavity as compared with xanthan gum and carboxymethyl cellulose but an unpleasant taste gradually developed.

It is used as potential polysaccharide having high drug holding capacity for sustained release of verapamil hydrochloride. The release pattern was found to be comparable with matrices of other polysaccharide polymers such as ethyl cellulose, hydroxyethyl cellulose and hydroxypropylmethyl cellulose, as well as the commercially available sustained release tablets (isoptin SR). It is also used as suitable polymer for sustained release formulations of low drug loading. Sustained release behaviors of both water soluble (acetaminophen, caffeine, theophylline and salicylic acid) and water insoluble (indomethacin) drugs on tamarind seed polysaccharide was examined. Studies showed that tamarind seed polysaccharide could be used for controlled release of both water-soluble and water insoluble drugs[22].

10. Tragacanth

This gum is obtained from the branches of *Astragalus gummifer*, Family Leguminosae. Tragacanth when used as the carrier in the formulation of 1 and 3 layer matrices produced satisfactory release prolongation either alone or in combination with other polymers[23].

11. Honey locust gum

It is known botanically as *Gleditsia triacanthos*, and belongsto the order Leguminosea (suborder Mimoseae). The gum is obtained from the seeds of the plant. The seed contains proteins, fats, carbohydrates and fibers. Honey locust gum (HLG) was used to produce matrix tablets at different concentrations (5% and 10%) by wet granulation method Theophylline was chosen as a model drug. The matrix tablets containing hydroxyethylcellulose and hydroxypropyl methylcellulose as sustaining polymers at the same concentrations were prepared and a sustained release (SR) tablet containing 200 mg theophylline was examined for HLG performance. No significant difference in *in-vitro* studies was found between SR tablet and the matrix tablet containing 10 % HLG.[24]

12. Albizia gum

Albizia gum is obtained from the incised trunk of the tree *Albizia zygia*, family *Leguminosae* and is shaped like round elongated tears of variable color ranging from yellow to dark brown. It consists of 1– 3-linked D-galactose units with some ß1-6-linked D-galactose units. The genus *Albizzia* containing some twenty-six species is a member of the Mimosaceae, a family which also includes the gum-bearing genera *Acacia* and *Prosopis.* Only two species of *Albizia, A.zygia* and *A. sassa,* are however, known to produce gum. Albizia gum has been investigated as a possible substitute for gum arabic as a natural emulsifier for food and pharmaceuticals. These gums were tried as coating materials in compression-coated tablets, which degraded, by the colonic microflora, thereby releasing the drug[25].

13. Lepidium sativum

In a different study a gel forming husk powder obtained from *Lepidium sativum* seeds was used to prepare solid controlled release oral unit dose pharmaceutical composition, comprising one or more of therapeutic agent/drug. The gel forming husk powder obtained from Lepidium stivum seeds is present in the range of 10 to 70 % of the total weight of dosage form, the cross-linking enhancer selected from xanthan gum, karaya gum and the like in amounts of between 3 to 10 % by weight of the dosage form to give a release profile between 4 to 20 hours. The total excipients present are between 10 to 40 % by weight of the total dosage form[26].

CONCLUSION

Now-a-days natural polymers play a very important role almost in all kind of formulations. The pharmaceutical scientists have achieved a great success in developing the most therapeutic systems with suitable natural polymers. The use of natural gums for pharmaceutical applications is attractive because they are economical, readily available, non-toxic, and capable of chemical modifications, potentially biodegradable and with few exceptions, also biocompatible. They have a major role to play in pharmaceutical industry. Therefore, in the years to come, there is going to be continued interest in the natural excipients to have better materials for drug delivery systems.

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