IJPSR (2019), Volume 10, Issue 12 **(Review Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 23 March 2019; received in revised form, 12 June 2019; accepted, 17 November 2019; published 01 December 2019

A REVIEW ON NATURAL GUMS AND THEIR USE AS PHARMACEUTICAL EXCIPIENTS

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Keywords:

Natural gum, Pharmaceutical excipients, Controlled release, Nanoparticles

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ABSTRACT: Recent past has witnessed the promising roles of natural gums as pharmaceutical ingredients. Gums became important excipients in many pharmaceutical preparations owing to their abundance, biodegradability, non-toxicity and comparatively low cost. They have notable applications in pharmaceutical preparation as binders, disintegrants, suspending agents, emulsifiers. The use of these gums as gelling or matrix-forming agents to suit the requirement as excipient in novel drug delivery systems is one of the interesting fields of emerging research. The present article is focused on reviewing some important features of gums, their economic importance uses and pharmaceutical applications.

INTRODUCTION: Natural excipients are preferred over the synthetic as they are inert, safe, non-toxic, biocompatible, biodegradable, low cost, eco-friendly and abundantly available in nature [1, 2, 3]. Gums are usually pathological products and are produced when the plant is growing under unfavorable conditions or is injured [4]. Thus, they are the abnormal products of plant metabolism. The process is known as "gummosis". The term gum was probably applied to natural plant exudates that had oozed from tree barks. Gums are translucent and amorphous substances, produced by plants. Gums are soluble or partly soluble in water. They are insoluble in alcohol and most of the organic solvent. They form viscous adhesive solutions with water either by swelling or due to absorption. An aqueous solution of gum is usually levorotary, they are plant hydrocolloids and may be anionic or non-ionic polysaccharides. Pharmaceutically, important gums are gum acacia, tragacanth, gum karaya, gum ghatti, guar gum. Gums are characteristics of certain natural orders like Leguminosae, Rosaceae, Combretaceae, and Sterculiaceae. Gums in general, are used primarily as adhesives or thickening agents in printing, textiles, paper, paint, candy, food, and pharmaceutical industries. They are used as tablet binding agents, suspending agents, emulsifiers, stabilizers, and thickening agents.

Gums are grouped into three major categories namely natural gums, modified gums, and synthetic gums.

Natural Gums: They are obtained in a natural state such as the tree exudates, extracted from seeds of some legumes or seaweed hydrocolloids. Ex: gum arabica, guar gum, tragacanth.

Modified Gums: They are chemically modified natural gums or derivative of naturally occurring materials such as cellulose or starch. Ex: Carboxy methylcellulose.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.10(12).5274-83

The article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.10(12).5274-83

Synthetic Gums: They are completely synthesized chemical products. Ex: polyvinyl pyrrolidone, polyethylene oxide.

Advantages: Natural gums offer several advantages due to their natural abundance. Some of the advantages are as follows.

- They are biodegradable polymers as they are produced by living organisms.
- They are biocompatible and non-toxic.
- Relatively cheap as the production cost is very low.
- Readily available as a local source or through cultivation.
- The production is ecofriendly.
- Many of the gums are obtained from an edible source, hence they are easily acceptable.

Disadvantages: Disadvantages of natural gums are related to their production from a natural source. Some of the disadvantages are.

- Microbial contamination due to high moisture content and possible degradation.
- Environmental and seasonal factors will influence the quality variation of gums.
- The difference in collection and climatic conditions also leads to quality variation of gums.
- Natural gums are found to show a decrease in viscosity on storage [5, 6].

Natural Gums: A number of natural gums and mucilages have been investigated for a variety of applications.

Some of the recently investigated natural gums are summarized in **Table 1**.

TABLE 1: SOME REPORTED NATURAL GUMS AND THEIR USES

S. no.	Gum	Botanical Name	Family	Uses	Geographical Source
1	Albizia gum	*Albizia zygia*	Leguminosae	Used in Food industry	Southeast Asia [7, 8]
2	Almond gum	*Prunus amygdalus*	Rosaceae	Used for hair and skin	Kashmir valley [9]
3	Albizia odoratissima	*Mimosa odoratissima*	Leguminoseae	Used for indoor construction	North East India [7]
4	Asafoetida	*Ferula foetida regel*	Umbelliferae	Used as a powerful nervine stimulant	Eastern Persia and western Afghanistan [10]
5	Agar gum	*Gelidium amansii*	Gelidaceae	Used in the preparation of jellies, confectionery	Japan, Australia, New Zealand, USA and India [10]
6	Abelmoschus	*Abelmoschus esculentus*	Malvaceae	Used as a polymer for gastric floating dosage form [11]	-
7	Aegle gum	*Aegle marmelos*	Rutaceae	Used in printing and used Medicinally [12]	-
8	Ayoyo gum	*Cochorus olitorius*	Tiliaceae [13]	-	-
9	Acacia gum	*Acacia Senegal*	Leguminoseae	Used as pigment binder and adhesive in painting	Sudan, Central Africa and India [14]
10	Bhara gum	*Terminalia billerica*	Combretaceae	Used in medicinal purpose [15]	-
11	Bengal Kino (butea gum)	*Butea monosperma*	Leguminosae	Used internally for diarrhea and dysentery [16]	-
12	Baheda gum	Bibhitaki *(Terminalia Billerica)*	Combretaceae	Used as the herb of triphala	Southeast Asia, India [17]
13	Cordio gum	*Cordio oblique*	Boraginaceae	Used as anti-fungal	Africa, Asia, America [18, 19]
14	Copal gum	*Bursera bipinnata*	Burseraceae	Used in the printing ink, paints, and films	East Africa and Indonesia and South America [20]
15	Cashew gum	*Anacardium occidentale*	Anacardiaceae	Used as a jelling agent in canned food	Mexico and the West Indies [21, 22, 23]
16	Chicle gum	*Manikara zapata*	Apocynaceae	Used in chewing gum	Mediterranean region of South America [16]
17	Carob gum	*Ceratonia siliqua* Linn.	Leguminosae	Used in the food industry for calico printing [16]	East Mediterranean region
18	Cumbi gum	*Gardenia gummifer*	Rubiaceae	Used as insecticide [16]	-
19	Carragennan	*Chondrus cryspus*	Gigarginaceae	Used in the Food industry, medicinal and industrial [24]	-
20	Cassia tora	*Cassia tora* Linn.	Leguminoseae	-	Europe, Japan, India [25, 26]
21	Dammar gum	*Shorea wiener*	Dipterocarpaceae	Used in foods and glazy agent	India and East Asia [27]
22	Ferula gum	*Ferula gummosa*	Apiaceae (or) Umbelliferae	Used in the treatment of chronic bronchitis asthma [28]	-
23	Grewia gum	*Grewia mollis*	Liliaceae	Used as	Middle belt region of

				anti-inflammation	Nigeria [29, 30]
24	Guar gum	*Cyamompsis tetraganolobus*	Leguminoseae	Used in appetite suppressant & Medicine for constipation.	India, Pakistan, North-Western Country [31]
25	Ghatti gum	*Anogeissus latifolia*	Combretaceae	Used in non-petroleum waxes	India and Sri Lanka [10]
26	Guggal gum	*Commiphora weightii*	Burseraceae	Used as anti-inflammatory Used in essence sticks	India, Arabia, Bangladesh, and Pakistan[10]
27	Gellan gum	*Pseudomonas eloder*	-	Used in ice cream and sorbet recipes	America [32, 33]
28	Gamboge	*Garcinia henburii*	Guttiferae	Used as a hydragogue cathartic	Cambodia, Slam, Cochin and China [10]
29	Hakea gum	*Hakea gibbosa*	Proteaceae	-	Australia, Italy & America[34]
30	Honey locust gum	*Gleditsia tricanthus*	Leguminosae	Used as insecticides	Europe and Southern England [35]
31	Khaya gum	*Khaya grandifolia*	Meliaceae [36]	-	-
32	Kondagogu gum	*Cochlospermum religiosum*	Bixaceae	Used in the paper, textile, paint and ink products	India [37]
33	Kino gum	*Pterocarpus marsupium*	Fabaceae	Used to treat boils and other skin diseases	India and Pakistan [16]
34	Katira gum	*C. religiosum*	Bixaceae	As a gelling agent [16]	-
35	Leucaena seed gum	*Leucaena leucocephata*	Leucocephata	Used to control stomach ache and contraception	Southern Mexico, and Northern Central America [38, 39]
36	Lemon-scented gum	*Eucalyptus citriodora*	Myrtaceae	Used to treat bladder inflammation	Tropical and subtropical region [10]
37	Locust bean gum	*Ceratonia siliqua* Linn.	Leguminosae	Used in the food industry	Europe and Africa [10]
38	Mango gum	*Magnifera indica*	Anacardiaceae	Used to treat laxative and antioxidant	India [40]
39	Mimosa scabrella gum	*mimosa scabrella*	Mimosaceae	Used in paper industry	South Africa and Brazil [41]
40	Moi gum	*Lannea coromandelica*	Anacardiaceae [42]	-	-
41	Moringa oleifera gum	*Moringa oleifera*	Moringaceae	Used in herbal medicine	India, Africa, Central and South America [43]
42	Mucuna gum	*Mucuna flagillepes*	Papillionaceae	Used in herbalism and food crop [44]	-
43	Mastic gum	*Pistacia lentiscus*	Anacardiaceae	Used for intestinal ulcers and muscle aches	Portugal, Greece, Turkey and Africa [45]
44	Myrrh gum	*Commiphora mol mol*	Burseraceae	Used in uterine stimulant.	Africa, Arabia. [10]
45	Malva nut gum	*Scaphium scaphigerum*	Sterculiaceae	Used as Chinese medicine as a coolant	southeast Asia [46]
46	Neem gum	*Azadirachta indica*	Anacardiaceae	Used in Insects repellant,	India [47]
47	Olibanum gum	*Boswellia serrate*	Burseraceae	Used in plasters and fumigating pastilles	Southern Arabia and Somaliland [48]
48	Okra gum	*Hibiscus esculenta*	Malvaceae	-	India, turkey, Iran, Malaysia and Pakistan [49, 50, 51]
49	Odina gum	*Odina wodier*	Anacardiaceae	Used as anti-inflammatory, respiratory irritation.	India [52]
50	Prunus gum	*Prunus domestica*	Rosaceae	It is used medicinally	Europe [53]
51	Red gum (eucalyptus Kino)	*Eucalyptus rostrata*	Myrtaceae	Used as astringent	Australia [10]
52	Rosin gum	*Pine pix stylvestris*	-	Used as photocopying and laser printing paper	Indonesia, Southern China [16]
53	Salai gum	*Boswellia serrata roxb*	Burseraceae	Used for lighting fires	India and Pakistan [16]
54	Tara gum	*Caesalpinia spinosa*	Leguminosae (or) Fabaceae	Used in the food industry	Geographic north Africa and East Africa [54]
55	Tragacanth gum	*A. gummifer labill*	Leguminosae	Used as confectionery	India, Pakistan and Africa [10]
56	Tamarind gum	*Tamarindus indica*	Fabaceae	Used in textile, paper, pet food, mining industry	Eastern tropical Africa, India [55]
57	Xantham gum	*Xanthomonas lempestris*		Used in food industry	USA and Canada [56]

Classification of Gums: Gums are present in high quantities in certain plants, animals, seaweeds, fungi, and other microbial sources, where they perform several structural and metabolic functions. Various classification systems are available for gums as shown in **Fig. 1**.

Characterization of Gums: Gums are complex substances. A suitable strategy is required to characterize gums, as summarized in **Table 2**. Gums and mucilages are polysaccharides, and they contain sugars. Preliminary confirmatory tests are conducted for dried gums and mucilage powders

for some important structural components. To determine the purity, tests for alkaloids, glycosides, steroids, carbohydrates, flavonoids, terpenes, amino acids, saponins, oils and fats, and tannins and phenols are carried out. The physicochemical properties such as color, odor, taste, shape, texture, touch, solubility, pH, swelling index, loss on drying, hygroscopic nature, angle of repose, bulk, and true densities, porosity, and surface tension can be estimated. The microbial load and presence of specific pathogens are also determined. Gums and mucilages are highly viscous.

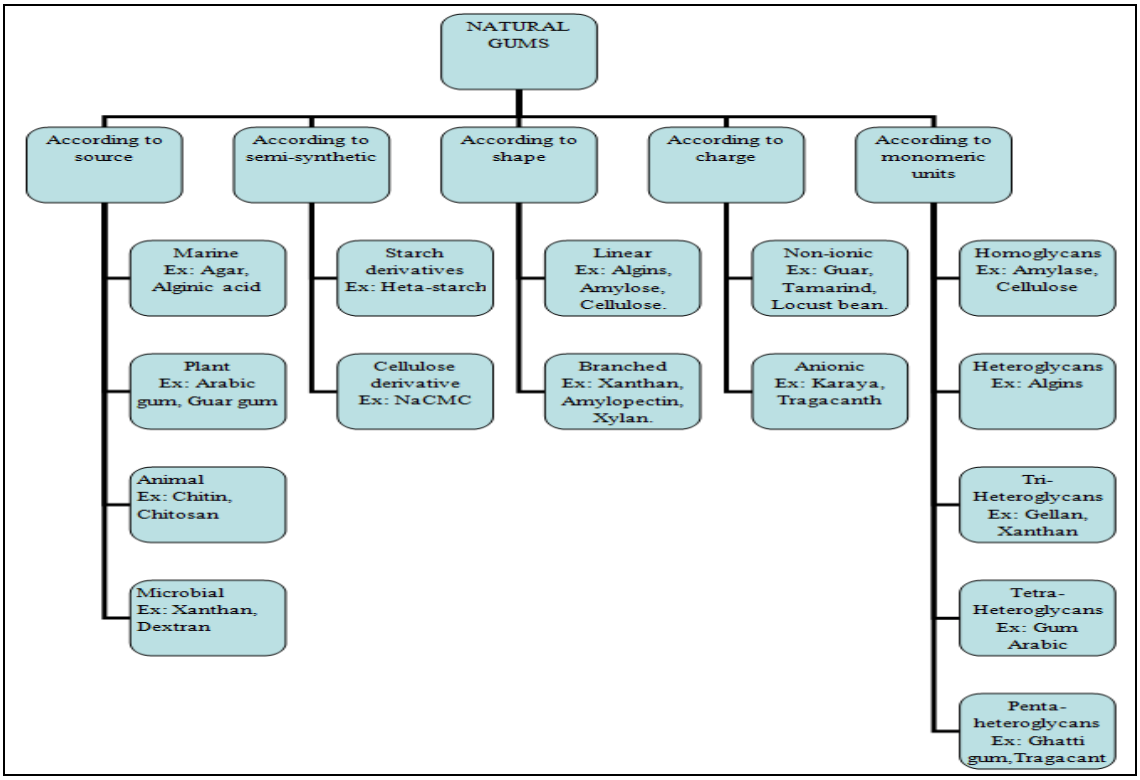

FIG. 1: CLASSIFICATION GUMS

TABLE 2: CHARACTERIZATION OF GUMS

Preliminary Test	Physicochemical Properties	Instrumental Characteristics	Chemical Characteristics
Carbohydrates	Solubility test	Nuclear magnetic resonance	Structural
Mucilage	Swelling index	ATR-FTIR spectroscopy	Purity
Polysaccharides	Loss on drying	Thermogravimetric analysis	Impurity profile
Enzymes	Total ash and acid insoluble ash determination	Differential Scanning Calorimetry	
Alkaloids	Ph determination	Particle size analysis	
Flavonoids	Angle of repose	Flow rheological measurements	
Terpenoids	Bulk and tap densities	Thermal analysis	
Tannins	Hausner's index		
Steroids	Compressibility index (c%)		
Proteins and amino acid	Viscosity (1%w/v solution)		
Glycosides	Average particle size		
Phenolic compounds	Melting point		

So, the rheological properties of excipients are important criteria for deciding their commercial use. The chemical and structural composition can be determined by using analytical characterization. The acute toxicity of gums and mucilages are determined by the fixed-dose method as per OECD guideline no.425 [11].

Economic Importance: The hydrocolloids market is appraised to a value of 8.8 billion USD in 2018 and is expected to increase and to reach a value of 11.4 billion USD by 2023. [57] The demand for hydrocolloids is attributed to the increased utilization in food, pharmaceutical industry. India is one of the largest producers of natural resins, gums,

and gum-resins (NRGs) along with China, Indonesia, Russia, and Brazil. Our country is the world leader in production of guar, karaya and psyllium gums as well as lac. The total production of NRG has been increased from 1160314 tons in 2013-14 to 1196308 tons in 2014-15. The production in 2016-17 was reported to be 566230 tons.

The average exported quantity of all-natural resins and gums during 2016-17 was reported to be 329045.55 tons and valued Rs. 289060.92 Lakh [58]. Realizing the strategic importance of these natural gums ICAR-Indian Institute of Natural Resins and Gums continuously making efforts to strengthen the sector in the country.

Pharmaceutical Application of Gums: Gums posses a complex, branched polymeric structure because of which they exhibit high cohesive and adhesive properties. Gums have a variety of applications in pharmacy, and some are summarized in **Table 3**. They are used in medicine for their demulcent for cough suppression, dental, and other adhesive and as bulk laxatives [59, 60]. These polymers are useful as tablets binder, disintegrating agent, stabilizing agent protective colloids in suspension, and sustain agent in tablets.

TABLE 3: PHARMACEUTICAL APPLICATIONS OF NATURAL GUMS

S. no.	Gum	Pharmaceutical Applications	References
1	Agar gum	Suspending agent, emulsifying agent, gelling agent in suppositories, surgical lubricant, tablet disintegrant, medium for bacterial culture, laxative	61
2	Albizia gum	Tablet binder	62
3	Abelmoschus gum	Binder in tablets	63, 64
4	Acacia gum	Suspending agent, emulsifying agent, the binder in tablets, demulcent and emollient in cosmetics	65
5	Almond gum	Binding, sustaining and transdermal film-forming agent	66
6	Bhara gum	Microencapsulation	15
7	Cashew gum	Suspending agent	67
8	Cassia tora	Binding agent	68
9	Carrageenan	Gelling agent, stabilizer in emulsions and suspensions, in toothpaste, demulcent, and laxative	69, 70, 71
10	Cordio gum	Novel oral sustained release matrix-forming agent in tablets	72
11	Guar gum	Binder, disintegrant, thickening agent, emulsifier, laxative	73,74, 75, 76
12	Gellan gum	Disintegrating agent	77
13	ghatti gum	Binder, emulsifier, suspending agent	78
14	Grewia gum	Suspending agent and binder	79, 80
15	Hakea gum	Sustain release and peptide mucoadhesive for buccal delivery.	34
16	Karaya gum	Suspending agent, emulsifying agent, a dental adhesive, sustaining agent in tablets, bulk laxative	81
17	Khaya gum	Binding agent.	82
18	Katira gum	Colon drug delivery	66
19	Kondagogu gum	Gastric floating drug delivery	83, 84
20	Leucaena seed gum	Emulsifying agent, suspending agent, the binder in tablets, disintegrating agent in tablets	85, 86
21	Malva nut gum	Stabilizer and thickening agent	66
22	Mucuna gum	Microspheres	44
23	Moringa gum	Gelling agent, binder, release retardant in tablet formulations	87
24	Neem gum	Binding, suspending agent and transdermal film forming agent	88
25	Sesbanic gum	Gelling agent, Sustained release Formulation	89, 90
26	Tragacanth gum	Suspending agent, emulsifying agent, demulcent, emollient in cosmetics	91
27	Tamarind gum	Binding agent, emulsifier, Suspending agent, sustaining Agent	92
28	Welan gum	Thickening agent	66
29	Xanthan gum	Suspending agent, emulsifier, stabilizer in toothpaste and ointments, sustained-release agent	93

Application of Gums in Tablets Formulation: Natural gums have a wide range of pharmaceutical applications that include their use as binder, disintegration in tablets and used as sustaining agents in tablet. Natural polymer, gums modify the drug release from formulations. Natural gum has good binding property in wet granulation for the manufacturing of tablets. Some reported are *Cassia roxbughii* seed gum as a binder in paracetamol tablets [94], *Magnifier indica* gums as binder in

paracetamol tablets [95], cashew gum as binder in metronidazole tablets [96].

Gums as Emulsifying and Suspending Agent: Gums are widely used in pharmacy as thickeners, suspending agents and emulsifying agents. Natural gums are hydrophilic colloids that form dispersion with water and increase the viscosity of the continuous phase so that solid particle suspended is sufficient for long time to measure the uniform dose. The use of *Ocimum gratissimum*, *Butea monospermama*, *Leucaena leucocephala* seed gum, and *Cordia gharaf* gum as suspending agent [97] has been reported.

Gums as Sustaining Materials in Dosage Form: Natural gums are used widely in pharmaceutical dosage forms, their use as biodegradable polymeric materials. The use of several natural gums such as Guar gums, xanthan gums and karaya gum [98] has been explored for the development of sustained-release dosage forms.

Gums as Coating Agent: Plant-based materials can be modified and has been widely used for functional and non-functional purposes, to coat tablets, capsules, granules, powders, and pellets. Grewia Gum as a film coating agent in theophylline tablet formulation [99].

Application of Gums in Microencapsulation: Microencapsulation is defined as a process to entrap one substance with another substance**.** The gums because of their ability as a coating and matrix-forming agent can be utilized for microencapsulation of drug particles for sustaining the drug release. Several gums such as Kondagogu, Xanthan, gum guar [100] has been utilized in microencapsulation.

Application of Gums as Gelling Agent: Some thickening agents are gelling agents (gellants), form a gel which dissolve in the liquid phase a colloid mixture that forms a weakly cohesive internal structure there are various types of junction zones in polymer gels like stacked double helix junctions in carrageenans, partly stacked triple helices in gelatin and 'egg-box' junction in alginate. Galactomannan interacts synergistically with xanthan gums and carrageenan to form as elastic gel.

Application of Gums as Film Formers: Film-forming systems is a novel approach to conventional topical and transdermal systems. They became a promising method for drug reservoirs in transdermal, buccal drug delivery systems. Various film modifiers like Xanthan gum, carrageenan gum, and locust bean gum was provided with proper texture to film and reduce recrystallization of drug.

Natural Polymers for Intelligent Drug Delivery: Some natural polymers respond to certain environmental factors such as ions, pH, enzymes, temperature, and electromagnetic field. Such polymers are known as intelligent, smart, stimuli- and environmental-responsive polymers. These polymers in response to certain environmental factors trigger specific drug release to affected tissues or cells [101].

Cross-linked *Plantago psyllium* gum (with methacrylamide) was employed as colon-specific drug delivery system due to its response to pH [102,] and they produced hydrogels that respond to ions as well as pH [103]. Pectin derived from plant cell walls depends on its degree of esterification responds to ions, pH and enzymes. While cellulose derivatives respond to ions, pH and temperature [101] and have been utilized for colon-specific drug delivery [104].

Natural Polymers for Nano Drug Carriers: Natural gums have also been utilized for the development of nanoparticles [105]. Recent reports have shown on development of nanoparticles using guar gum, kondagogu, gum ghatti [106, 107, 108]. Development of polyelectrolyte nanoparticles using *Moringa* gum has shown complexation techniques [109] for controlled and extended-release of molecularly entrapped drug.

Natural Polymers for BioMEMS: BioMEMS refers to biomedical or biological microelectro mechanical systems. The process of utilizing and customization of microfabrication technologies for biomedical applications. Microneedles are fabricated for transdermal delivery. Carboxymethyl cellulose (CMC) and amylopectin for fabrication of Microneedles using photolithography for the micro molds [110]. Plant polymers should be explored for the fabrication of microneedles and other BioMEMS.

Natural Polymers for Theranostics: A theranostic is a delivery system fabricated to deliver both medicine and imaging agent(s) in a single dose, bridging the gap between imaging and therapy, thereby facilitating real-time monitoring of therapeutic efficacy of the incorporated drug [111]. The multi-functionality of nanoparticles confers the ability to deliver medicine and imaging agents. Metallic nanoparticles have been used as theranostics as well as synthetic and natural polymeric nanoparticles.

Natural polysaccharides due to their excellent biocompatibility, low toxicity, biodegradability and functionalities that the body can identify which, make them excellent materials for theranostics. The nanoparticles were then characterized for *in-vitro* cellular uptake, *ex vivo* tissue distribution, *in-vivo* distribution, and tumor targeting. Other natural polymers such as alginate, dextran and chitosan [111, 112] have been used. Plant polysaccharides should be explored in fabrication of theranostics as they exhibit functionalities recognized by the body as compared to those of the polymers in biological systems. Polysaccharides are the materials for drug targeting and concentration at the site of action. Considering cancer therapy, some polysaccharides have exhibited anti-tumor activity [113]. Incorporation of chemotherapeutic into a polysaccharide carrier may enhance cancer therapy.

CONCLUSION: The advent of natural gums as pharmaceutical excipients is attractive because they are economical, abundant, non-toxic, and capable of chemical modifications, potentially bio-degradable and biocompatible. Applicability of gums and mucilages has been well established in the fields of pharmaceuticals. However, there is a need to develop other natural sources as well as with modifying existing natural materials for the formulation of novel drug delivery systems, biotechnological applications, and other delivery systems. Therefore, in the years to come there will be continued interest in natural gums and their modifications aimed at the development of better materials for drug delivery.

ACKNOWLEDGEMENT: The authors are thankful to GITAM Institute of Pharmacy, GITAM Deemed to be University for providing necessary facilities for a review article.

CONFLICTS OF INTEREST: Authors declare no conflicts of interest.

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How to cite this article:
Lankalapalli S and Sandhala D: A review on natural gums and their use as pharmaceutical excipients. Int J Pharm Sci & Res 2019; 10(12): 5274-83. doi: 10.13040/IJPSR.0975-8232.10(12).5274-83.