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Review Article

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# A Potential Natural gum as a polymer used in NDDS: Recent investigations

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## ABSTRACT

Natural gums are natural polymers, which mainly consists of carbohydrates sometimes with small amounts of proteins and minerals. They are made from different parts of plants seaweeds or bacteriological activity. The gums are used very much in the food industry as thickeners and they are changing the viscosity significantly already in low concentration. The natural products are normally purified from water solutions, in which they are sometimes treated for change in molecular size for obtaining other final properties. As one step in the purification filtration, membrane filtration or centrifugation can be used. After the purification the solutions are sometimes concentrated by evaporation or solidified by cooling, drum drying or spray drying.

**Key words:** Natural gum, okra gum, locust bean gum, tamarind gum, gallan gum

## INTRODUCTION

Natural gums are natural polymers, which mainly consists of carbohydrates sometimes with small amounts of proteins and minerals. They are made from different parts of plants seaweeds or bacteriological activity. The gums are used very much in the food industry as thickeners. The traditional use of excipients in drug formulations was to act as inert vehicles to provided necessary weight, consistency and volume for the correct administration of the activeingredient, but in modern pharmaceutical dosage forms they often fulfil multi-functional roles such as modifying release, improvement of the stability and bioavailability of the active ingredient, enhancement of patient acceptability and ensure ease of manufacture [1]. New and improved excipients continue to be developed to meet the needs of advanced drug delivery systems. Polymers have been successfully investigated and employed in the formulation of solid, liquid and semi-solid dosage forms and are specifically useful in the design of novel drug delivery systems. Both synthetic and natural polymers have 3 been investigated extensively for this purpose . Synthetic polymers are toxic, expensive, have environment related issues, need long development time for synthesis and are freely available in comparison to naturally available polymers. However the use of natural polymers for pharmaceutical applications is attractive because they are economical, readily available, non-toxic and capable of chemical modifications, potentially biodegradable and with few exceptions and also biocompatible The specific application of plant-derived polymers in pharmaceutical formulations include their use in the manufacture of solid monolithic matrix systems, implants, films, beads, microparticles, nanoparticles, inhalable and injectable systems as well as viscous liquid formulations [2]. 4-6 within these dosage forms, polymeric materials have fulfilled different roles such as binders, matrix formers or drug release modifiers, film coating formers, thickeners or viscosity enhancers, stabilizers, disintegrants, solubilisers, emulsifiers, suspending agents, gelling agents and bioadhesives.The natural products are normally purified from water solutions, in which they are sometimes treated for change in molecular size for obtaining other final properties. As one step in the purification filtration, membrane filtration or centrifugation can be used. After the purification the solutions are sometimes concentrated by evaporation or solidified by cooling, drum drying or spray drying [3].

## Need of herbal polymers

Biodegradable – Naturally occurring polymers produced by all living organisms. They show no adverse effects on the environment or human being.

Biocompatible and non-toxic – Chemically, nearly all of these plant materials are carbohydrates in nature and composed of repeating monosaccharide units. Hence they are non-toxic.

Economic - They are cheaper and their production cost is less than synthetic material.

Safe and devoid of side effects – They are from a natural source and hence, safe and without side effects.

Easy availability – In many countries, they are produced due to their application in many industries.

## Classification of natural gums

## 1. According to the charge

**a) Non-ionic seed gums**: guar, locust bean, tamarind, xanthan, amylose, arabinans, cellulose, galactomannans.

**b) Anionic gums**: arabic, karaya, tragacant, gellan, agar, algin, carrageenans, pectic acid.

## 2. According to the source

**a) Marine origin/algal (seaweed) gums**: agar, carrageenans, alginic acid, laminarin.

**b) Plant origin**:

i. Shrubs/tree exudates—gum arabica, gum ghatti, gum karaya, gum tragacanth,

ii. Seed gums—guar gum, locust bean gum, starch, amylose, cellulose

iii. Extracts—pectin,larch gum

iv. Tuber and roots—potato starch

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

**d) Microbial origin (bacterial and fungal):** xanthan, dextran, curdian, pullulan, zanflo, emulsan, Baker'syeast glycan, schizophyllan, lentinan, krestin,

**The natural gums are derived from the following sources:**

**Fermentation produced gums**

Beta-Glucan (1,3/1,6-beta-D-glucan),Curdlan Gum (beta-1,3-glucan polymer),Gellan Gum ,Rhamsan Gum ,Welan Gum ,Xanthan Gum

## Gums from seeds and corn

Guar Gum (galactomannans),
Konjac Gum (glucomannans),
Locust Bean Gum /Carob gum (galactomannans),
Psyllium Seed Gum, Quince Seed Gum,
Tamarind Gum,Tara Gum (galactomannans)

## Plant extracts
Arabinogalactan ,Beta-Glucan (1,3/1.4-beta-D-glucan),Pectins

## Plant exudates
Chircle Gum,Dammar Gum,Gum Arabic,Gum Ghatti,Gum Tragacanth ,Karaya Gum ,Mastic Resin

## Seaweed-derived gums
Agar-Agar Gum (galactans with little half-eater sulphate),Alginic Acid and Alginates (mixed polymers of mannuronic acid and guluronic acid),Carrageenans (galactans with half-eater sulphate.

## Some natural gums used in ndds:
## Okra gum
Okra, also known as GUMBO,and OCRA is given the scientific name of Hibiscus esculatus L., and belongs to the family Malvaceae. It was first described by Abul-Abbas el-Nebati, a Spanish botanist who found it in Egypt in 1216. In a study okra gum has been evaluated as a binder in 39 paracetamol tablet formulations. These formulations containing okra gum as a binder showed a faster onset and higher amount of plastic deformation than those containing gelatin. The crushing strength and disintegration times of the tablets increased with increased binder concentration while their friability decreased. Although gelatin produced tablets with higher crushing strength reduce okra gum produced tablets with longer disintegration times than those containing gelatin. It was finally concluded from the results that okra gum maybe a useful hydrophilic matrixing agent in sustained drug delivery devices. In another study Okra gum was evaluated as a controlledrelease agent in modified release matrices, in comparison with sodium carboxymethyl cellulose (NaCMC) and hydroxypropylmethyl cellulose (HPMC), using paracetamol 40 as a model drug . Okra gum matrices provided controlledrelease of paracetamol for more than 6 h and the release rates followed time-independent kinetics. The release rates were dependent on the concentration of the drug present in the matrix. Okra gum compared favourably with Na CMC, and a combination of Okra gum and NaCMC, or on further addition of HPMC resulted in near zero order release of paracetamol from the matrix tablet. The results indicate that Okra gum matrices could be useful in the formulation of sustainedrelease tablets for up to 6h.

**Fig.1 Okra gum**

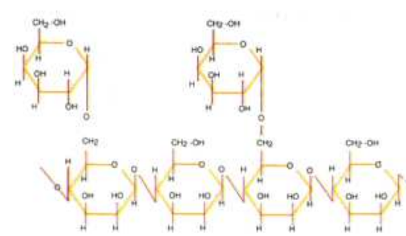

**Fig.2 Structure of Okra gum**

## Applications
Emulsifying agent
Stabilizer,
A bodying agent in soups, gravies and related products;
Flavoring material
Antioxidant

## Locust bean gum
Locust Bean Gum (LBG) (also known as Carob Gum) is obtained form the refined endosperm of seeds from the carob tree *Ceretonia Siliqua L*. It is an evergreen tree of the legume family. Carob bean gum is obtained by removing and processing the endosperm from seeds of the carob tree. Processing of the ground endosperm is accomplished by dispersing the fine powder in boiling water and filtering to remove impurities. The gum is recovered by evaporating the 46 solutions and tray or roll drying. Locust bean gum (LBG) is a plant seed galactomannan, composed of a 1-4 linked-D-mannan backbone with 1- 6- 47 linked "-D-galactose side groups . This neutral polymer is only slightly soluble in cold water; it requires heat to achieve 48 full hydration, solubilization and maximum viscosity. The physico-chemical properties of galactomannan are 49 strongly influenced by the galactose content

A controlled delivery system for propranolol hydrochloride (PPHCL) using the synergistic activity of LBG and Xanthan gum (X) was studied. Granules of PPHCL were prepared by using different drug: gum ratios of X, LBG alone and a mixture of XLBG (X and LBG in 1: 1 ratios). The XLBG matrices exhibited precise controlled release than the X and LBG matrices because of burst effect and fast release in case of X and LBG alone respectively and there was no chemical interaction between drug and polymers in the XLBG formulation as conformed by FTIR studies. The first-pass 50 effect of PPHCL can be avoided by using this formulation.

**Fig.3 Locust bean gum**

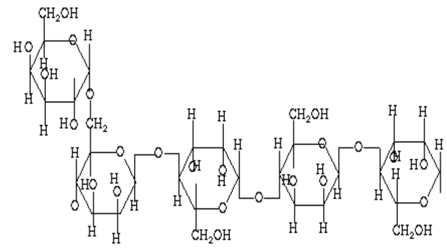

**Fig.4 Structure Locust bean gum**

## Applications

The ancient Egyptians used locust bean gum to bind the wrapping of mummies.
In more recent times is used as a thickener in salad dressings, cosmetics, sauces, as an agent in ice cream that prevents ice crystals from forming, and as a fat substitute.
In pastry fillings, it prevents "weeping" of the water in the filling, keeping the pastry crust crisp.
It has a very high viscosity (thickness) even when very little is used.

## Tamarind Gum

Tamarind xyloglucan is obtained from the endosperm of the seed of the tamarind tree, *Tamarindus indica*, a member of the 21 evergreen family. Tamarind Gum, also known as Tamarind Kernel Powder (TKP) is extracted from the seeds.

**Fig. 5 Tamarind Gum**

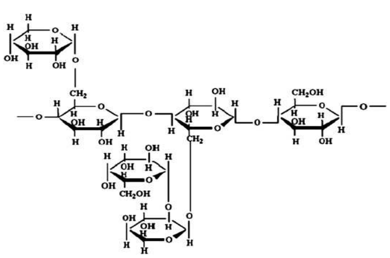

**Fig. 6 structure of tamarind gum**

## Applications:

Dissolution improvement
Nasal Mucoadhesion
Bioadhesive Tablet
Binder in tablet dosage form
In Ophthalmic drug delivery
In sustained drug delivery
In Ocular drug delivery
In controlled release of spheroids
To improve the extent of absorption and bioavailability of drug.

## Tara Gum

Tara gum is obtained from the endosperm of seed of *Caesalpinia spinosa*, commonly known as tara. It is small tree of the family *Leguminosae* or *Fabaceae.* Tara gum is a white, nearly odorless powder. It is produced by separating and 56 grinding the endosperm of the mature black color seeds . The major component of the gum is a galactomannan polymer similar to the main components of guar and locust bean gums, consist of a linear main chain of (1-4)-!-Dmannopyranose units with "-D-galactopyranose units attached by (1-6) linkages. The ratio of mannose to galactose in tara gum is 3:1. produce highly viscous solutions, even at 1% concentration. Tara gum requires heating to disrupt aggregation and full dissolution, whereas guar gum is soluble 57 in cold water. Tara gum is used as a thickening agent and stabilizer in a wide range of food applications around the world. The use of tara gum as a controlled release carrier in the formulation of gastro 58 59 retentive controlled release tablets and emulsions for drugs like metformin hydrochloride, ciprofloxacin hydrochloride nimodipine, nifedipine, carvedilol, clozapine has been claimed in patents.

**Fig.7 Tara Gum**

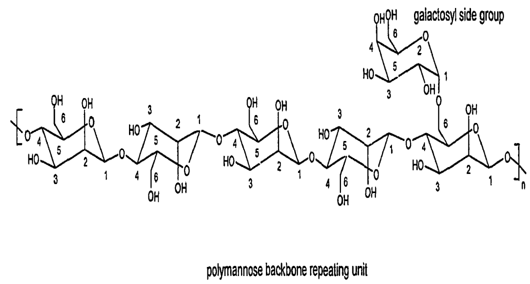


**Fig.8 Structure of Tara Gum**

## Applications:

Manufacture of furniture leather,
As a food additive and dark blue dye can be obtained from the roots.
As a thickening agent
Enhanced stabilization and emulsification properties
These are used in the preparation of convenience foods, such as ice cream.

## Gellan Gum

Gellan Gum is a water-soluble polysaccharide produced by fermentation. This multifunctional gelling agent can be used alone or in combination with other products to produce a wide variety of interesting textures. Gellan gum is extremely effective at low use levels in forming gels, and are available in two types, high and low acyl content. Low acyl gellan gum products form firm, non-elastic, brittle gels, whereas high acyl gellan gum forms soft, very elastic, non-brittle gels. Varying the ratios of the two forms of gellan produces a wide variety of textures. The uniqueness of gellan gum is the ability to suspend while contributing minimal viscosity via the formation of a uniquely functioning fluid gel solution with a weak gel structure. Fluid gels exhibit an apparent yield stress, i.e., a finite stress which must be exceeded before the system will flow. These systems are very good at suspending particulate matter since, provided the stress exerted by the action of gravity on the particles is less than the yield stress, the suspension will remain stable.Other important properties of gellan gum fluid gels are the setting temperature, degree of structure and thermal stability. All of these properties are, as with normal unsheared gels, dependent upon the concentration of gellan gum and the type and concentration of gelling ions.This multi-functional hydrocolloid can be used at low levels in a wide variety of products that require gelling, texturizing, stabilizing, suspending, film-forming and structuring.


**Fig.9 Gellan gum**

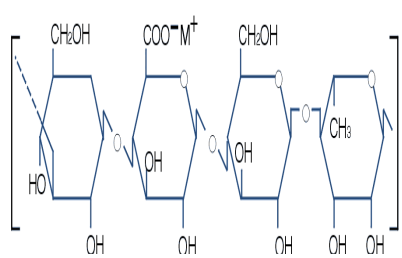


**Fig.10 Structure of Gellan gum**

## Welan gum

**Source:** Biofermentation using a sugar source
**Function:** Thickening, suspension, thermal stability
**Description:** Welan gum is a specialty fermentation polysaccharide produced by fermentation of *Sphingomonas sp.* A key feature of this novel, water-soluble polysaccharide is its excellent stability and viscosity retention at temperatures up to 150°C (300°F). In addition, this hydrophilic colloid thickens, suspends, and stabilizes water-based systems while imparting rheological control. Welan gum is stable in the presence of calcium ions, even under high pH conditions, and in solutions containing high levels of glycols. A solution of welan gum in water is highly pseudoplastic (shear thinning). At rest and under low shear conditions it exhibits a very high viscosity. By contrast, under high shear conditions it exhibits a low viscosity. The viscosity changes immediately when the shearing conditions change, for example, when the solution comes to rest after being pumped.

**Fig.11 Welan gum**

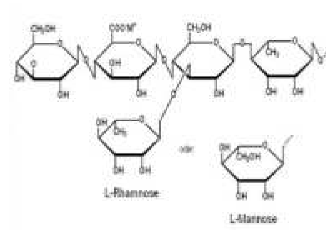

**Fig.12 Structure of Welan gum**

## Isapgulla husk (Psyllium)

Psyllium seed husks, also known as ispaghula, isabgol, or simply as psyllium, are portions of the seeds of the plant *Plantago ovata*, (genus *plantago*), a native of India and Pakistan. Gel forming fraction of the alkali-extractable polysaccharides is composed of arabinose, xylose and traces of other sugars.They are soluble in water, expanding and becoming mucilaginous when wet. Seeds are used commercially for theproduction of mucilage. It is white fibrous material,hydrophilic in nature and forms a clear colorless mucilaginous gel by absorbing water. Psyllium seed husk is 51 used as binder, disintegrant and release retardant . In an attempt, psyllium and acrylic acid based pH sensitive novel hydrogels using N, N methylenebisacrylamide (N, 0 NMBAAm) as crosslinker and ammonium persulfate (APS) as initiator for model drugs (tetracycline hydrochloride,insulin and tyrosine), for the use in colon specific drug delivery was studied. The hydrogel was evaluated for the swelling mechanism and drug release mechanism from the polymeric networks. The effects of pH on the swelling kinetics and release pattern of drugs have been studied by varying the pH of the release medium. It has been observed that swelling and release of drugs from the hydrogels occurred through non-Fickian or anomalous diffusion mechanism in distilled water and pH 7.4 buffer. It shows that the rate of polymer chain relaxation and the rate of drug 52 diffusion from these hydrogels are comparable.

**Fig.13 Isapgulla husk (Psyllium)**

## 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 variousapplications in drug de-livery, 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.


Fig.14 Alginates

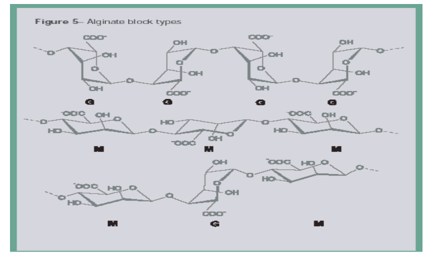


Fig.15 Structure of Alginates

## Applications

Alginates have proven to be effective for the symptoms of malignant wounds. Bleeding in malignant wounds is caused by the absence of platelets and the abundance of friable capillaries. Because bleeding occurs easily, it is essential that dressings do not adhere or cause trauma. Alginates are ideal for bleeding wounds as they have haemostatic properties. Alginates are thin, self-adhesive and conform well to contours. This increases the freedom to carry out normal daily activities.

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