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REVIEW ARTICLE

Review on natural polymers and their applications

SHUBHAM R BHUSARI, JAMEEL AHMED S MULLA*

Department of Pharmaceutics, Shree Santkrupa College of Pharmacy, Ghogaon, Karad, Dist: Satara, Maharashtra – 415111

***Author for Correspondence:** *Email:* jameelahmed5@rediffmail.com

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ABSTRACT

Active Ingredients (AI) and Excipients are the two main ingredients of any formulation or product. Excipients are the components utilised to manufacture any preparation alongside the active ingredients for product stability. Active Ingredients are known to be the major ingredients that are accountable for any desired result. Polymers are commonly employed as excipients in industry and serve an important part in pharmaceutical, cosmetics, and food preparations. Natural polymers, synthetic polymers, and semi-synthetic polymers are the three sub-types of polymers, with natural polymers proving to be more suitable in preparations or formulations than synthetic and semi-synthetic polymers due to their characteristics of sustainability, biodegradability, bio-safety, lack of side effects, and lack of drug release problems, among others. Natural polymers are employed as thickening agents, rate-controlling agents, taste-masking agents, protecting or stabilising agents, and many more applications in the pharmaceutical, food, non-food, and cosmetic sectors. Guar Gum, Acacia, and Tragacanth are examples of natural polymers. Pectin, Chitosan, Agar, Carrageenan, Ispaghula, and other ingredients include sodium alginate, pectin, chitosan, agar, carrageenan, and ispaghula.

INTRODUCTION

The word polymer is obtained from two Greek terms poly, which means many, and meros, which implies units with a high molecular mass. A polymer is a big molecule, sometimes known as a macromolecule, which is composed of small structural subunits called monomers. Covalent bonds bind these sub-units together. Polymerization can be done in a variety of ways. Used for olefinic functional and having a double bond) (with reactive functional groups) monomers, respectively [1, 2]. When there are 2, 3, 4 or 5 monomers joined together, the result is Dimer, trimer, tetramer, either pentamer are the different types of molecules. An oligomer is a type of oligomer is a chain of 30 - 100 monomeric compounds units, whereas A polymer be a material that is made up of several different molecules chain of more than 200 monomeric units. The process is known as polymerization, through which monomers combine to produce polymers. Natural polymers are favoured over synthetic, semi-synthetic, and synthetic polymers because of their appealing pharmaceutical uses such as biodegradability, sustainability, bio-safety, and availability, among others. Understanding the role of polymers as excipients is critical for manufacturers, pharmacists, and pharmaceutical scientists who work daily a daily basis with pharmaceutical, food, and cosmetic goods [3-5].

Classification [6-10]

Polymers can be classified as:
1. Natural polymers
2. Synthetic polymers
3. Semi-synthetic polymer

1. Natural Polymers

Natural polymers are polymers that come from nature (plants and animals). These polymers are necessary for life to exist.

(a)Starch
It is a glucose polymer that's a food reserve of plants.

(b) Cellulose
It is also a polymer of glucose. It is a chief structural material of starch and cellulose made from the glucose of plants and is produced during photosynthesis.

(c) Proteins
These are polymers of α-amino acids; they generally have 20 to 1000 α-amino acids joined together in a highly organized arrangement. These are the building elements of the animal body, and they are a necessary component of our diet.

(d) Nucleic Acids
These are various polymers of nucleotides. RNA and DNA, for example, are common nucleotides. It should be noted that Polysaccharides, for example, are polymers. Starch, cellulose, proteins, and nucleic acids, among others, regulate a variety of life processes in plants & animals called biopolymers.

2. Synthetic Polymers
Polymers made of synthetic materials Synthetic polymers are those that are created in laboratories. Man-made polymers are another name for them. For example polyethene, PVC nylon, Teflon, bakeliteterylene, synthetic rubber and so on.

3. Semi-synthetic Polymers
Chemical changes are worn to generate these polymers, which are mostly obtained from naturally occurring polymers. For example, cellulose is a naturally occurring polymer that can be acetylated with acetic anhydride in the attending of sulphuric acid to form cellulose diacetate polymers. It's used to make the thread and other products like films and glasses. Vulcanized rubber is another semi-synthetic example of polymers that are worn to make types and other products. Guncottonis cellulose nitrate is used to make explosives.

Natural Polymers Application Over Synthetic and Semi-Synthetic Polymers [11-14]:
Biodegradable:
Natural polymers are produced by all living creatures and have no negative consequences for the environment or humans. Synthetic and semi-synthetic polymers are, on the other hand, made using chemicals and have negative impacts on the environment as well as humans.

Biocompatibility and Non-Toxicity:
Nearly all of these natural polymers are carbohydrates and are created of repeating elements monosaccharide units chemically. As a result, they are less hazardous than synthetic and semi-synthetic polymers.

Economic:
Natural polymers are cheaper and their extraction cost is less than any other synthetic materials.

Availability:
Natural polymers grow as herbs in many countries, costing less than synthetic polymers and causing no negative effects. since their widespread worn in many industries, they are manufactured in enormous quantities, ensuring their availability over synthetic as well as semi-synthetic polymers.

Excipient of Natural Polymer
Xanthan Gum
It's made by fermenting a carbohydrate along with Xanthomonas campestris in pure culture. Corn sugar gum is another name for it. It's a salt of sodium, potassium, or calcium polysaccharide with high molecular weight D-glucose, D-mannose, D-glucuronic acids acid. It also has a minimum of 1.5 percent pyruvic acid. It's a cream-coloured powder that's litmus-insensitive and soluble in both hot and cold water. A 1% solution has a thickness of roughly 1000 centipoises. Between the pH values of 4 and 10, the maximum stability of Xanthan gum solutions was discovered. Xanthan gum was discovered to be uncomplicated to utilise than tragacanth gum and capable of producing higher-quality and consistent suspensions [15-19].

Applications
- Xanthan gum is widely worn in the pharmaceutical, cosmetic, and food industries as a stabiliser, thickener, and emulsifier.
- Because of the pseudo plastic effect of this gum, toothpaste and ointments can both hold their shape as well as spread easily.
- When producing the suspension for extemporaneous dispensing, a 1 per cent solution of Xanthan gum with hydroxybenzoate, produced ahead of time, was diluted to 0.5 per cent with water.

- Xanthan gum was established to be a good suspending vehicle for transporting antispasmodics topically along the length of the oesophagus in patients with oesophageal spasms.

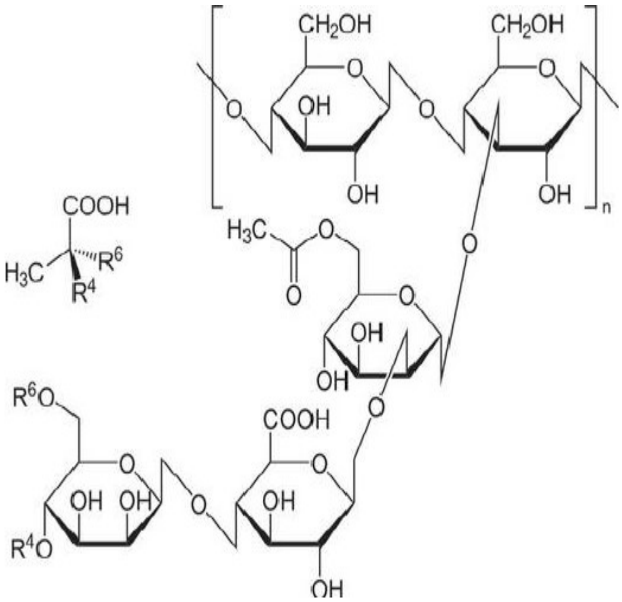

Figure 1: Structure of Xanthan Gum

Guar Gum

GUM Guar gum is created via the endosperm of the Cyamopsis tetragonoloba legume plant's seed. Guar gum is made by drying the pods in the sun and then physically extracting the seeds from the pods. The gum is extracted commercially from the seeds mostly using a mechanical process that includes roasting, differential attrition, sifting, and polishing. The germ is removed from the endosperm once the seeds are shattered. Guar Splits are two parts of the endosperm that are obtained from each seed. When the fine coating of fibrous material that constitutes the husk is detached and separated from the endosperm halves by polishing, refined guar breaks are formed. Depending on the result, the refined Guar breaks are subsequently processed and polished into powders using a number of routes and processing options procedures.

Guar gum is a type of polymer composed of galactose and mannose sugars. in its chemical form. The backbone is made up of a series of linear links 1, 4-linked mannose residues with galactose residues 1, 6-linked at each other mannose, generating small side branches. Guar gum dissolves better than locust bean gum and possesses more galactose branch points, making it a better emulsifier. It degrades under pH and temperature extremes (for example, pH 3 at 50°C). Over a pH range of 5-7, it remains steady in solution. Strong acids promote hydrolysis and viscosity loss, while alkalies in high concentrations lower viscosity as well. In most hydrocarbon solvents, it is insoluble [18, 20-22].

Applications

- Guar gum is worn in cosmetics as a thickener, sauces.
- It's used to ice crystals from developing in ice cream.
- It's a fat cover that has the same "mouth feel" as real fat.
- Guar gum can be used in a tablet binder or as a disintegrator.
- It can also be used in the preparation of sustained-release tablets.

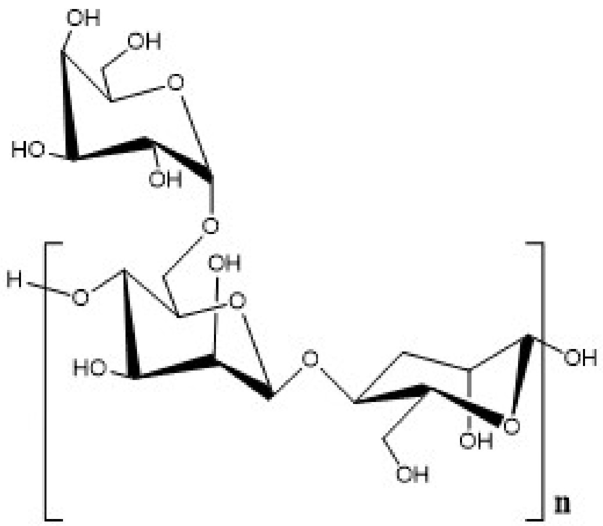

Figure 2: Structure of Guar Gum

Acacia

Acacia Senegal Wild (Family Mimosaceae) and other Acacia plants of African provenance exude gummy exudates that are air-dried. Senegal gum is another name for it. The tree is called 'Hashab' in Kordofan and 'Verek' in Senegambia. The gum produced in Kordofan from tapped trees is thought to be of high quality. Gums from Senegal and Nigeria are likewise of high grade. It is water-soluble, leaving only a trace of vegetable particles behind, but practically insoluble in alcohol and ether [23-25].

Applications

- Acacia is worn as a suspending and emulsifying agent
- It is worn as a tablet binder.

- Its demulcent qualities are used to treat coughs, diarrhoea, and sore throats.
- It's utilised as a tying agent in cough pastilles and other medical treatments, along with a coating for pills, in the pharmaceutical business.
- The gum is also used for hair sets and as a suspending agent.

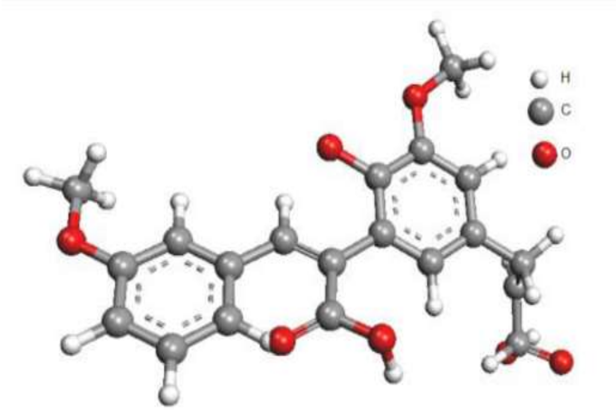

Figure 3: Structure of Acacia

Tragacanth

This polymer is made from the branches of Astragalus gummier, which belongs to the Leguminosae family. Bassorin, a water-insoluble component, accounts for 60-70 per cent of the total. D-galacturonic acid, D-xylose, L-fructose, D-galactose, and another sugar make up tragacanth acid. Tragacanthin, which is the calm of uronic acid and arabinose, dissolves in water to form a sticky colloidal solution (sol), whereas bassorin swells to form a thick gel [26-28].

Applications

- It is worn as a suspending agent, thickening agent, an emulsifier, among other things.

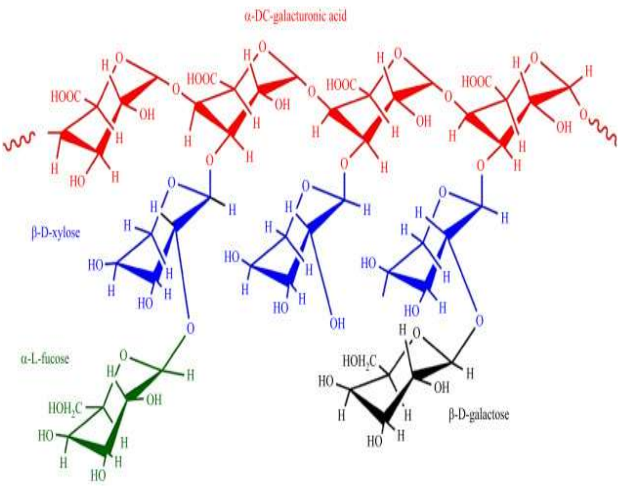

Figure 4: Structure of Tragacanth

Sodium Alginate

Alginates, it's called as alginic acid, is an anionic polysaccharide established in brown seaweed and marine algae such as Laminaria Hyperborea, Ascophyllum nodosum, & Macrocystis pyrifera. It is a linear, unbranched polymer. Alginic acid can be altered into its salts, the most common of which is sodium alginate. These polymers are created of two distinct monomers in various quantities, namely D-mannuronic acid and L-guluronic acid, which are linked in 1,4glycosidic linkages as homopolymeric blocks of solely D-mannuronic acid or L-guluronic acid or heteropolymeric blocks of both. The molecular weights of alginates range from 20 to 600 kDa [5, 18, 29- 31].

Applications:

- Alginates have been worn and studied as emulsion stabilisers, suspending agents, tablet binders, and tablet disintegrants.

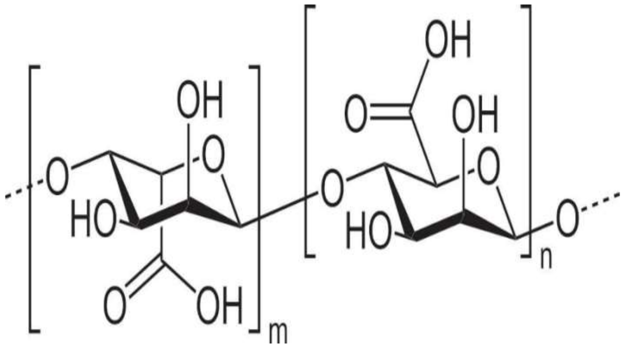

Figure 5: Structure of Sodium Alginate

Pectin

Pectin is a refined carbohydrate product derived from the inside portion of the rind of citrus peels, such as Citrus Simon or citrus Aurantium, by acid hydrolysis (Rutaceae). Pectin is a polysaccharide that is linear in structure. -1,4-linked D galacturonic acid residues interspersed with 1,2-linked L-rhamnose residues, with a few 100 to about 1,000 building blocks per molecule and an average molecular weight of around 50,000 to about 1,80,000. Galacturonic acid polysaccharides contain a lot of the neutral sugars rhamnose, arabinose, galactose, xylose, and glucose [32, 33].

Applications:

- It has a lot of potential as a hydrophilic polymeric material for controlled release matrix drug delivery systems.

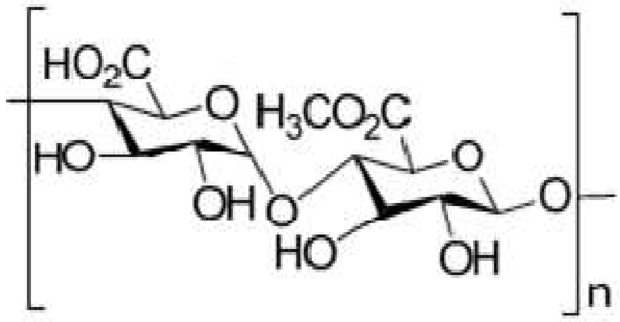

Figure 6: Structure of Pectin

Chitosan

Chitin is the bulk rich organic constituent in invertebrates' skeletal material and is a polysaccharide derivative with amino and acetyl groups. Mollusks, annelids, and arthropods all contain it, as well as mycelia and spores from various fungi [34, 35].

Applications:

- Chitosan and its derivatives (N-trimethyl chitosan, mono-N-carboxymethyl chitosan) are effective and guarded mucosal absorption enhancers (nasal, peroral).

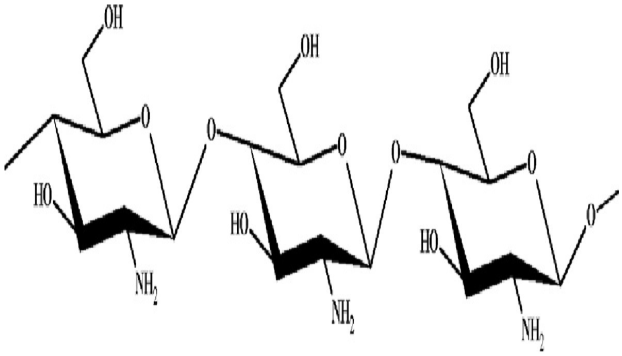

Figure 7: Structure of Chitosan

Agar

AGAR or agar-agar is a dried gelatinous substance derived from Gelidium mansion (Gelidaceae) & several other red algae species such as Grailaria (Gracilariaceae), Pterocladia (Pterocladiaceae) (Gelidaceae). Agar is made by combining agarose and agaropectin. Agarose, the most important component, is a chain polymer created by Agarobiose's repeating monomeric unit. D-galactose and 3,6-anhydrous-Lgalactopyranose combine to form agarose, a disaccharide. Agaropectin is a mixture of tiny acidic molecules that do not gel well. Its high gelling power in a watery environment permits it to generate gels that are extra resistant (stronger) than any other gel-forming agent, given that concentrations are the same. It can be utilised at pH levels ranging from 5 to 8, and in some situations even higher. It withstands thermal treatments well, even at temperatures above 100°C, allowing for successful sterilisation. A 1.5 per cent aqueous solution gels between 32 and 43 degrees Celsius and does not melt below 85 degrees Celsius. When compared to other gelling agents, agar has this unique feature. Agar produces flavourless gels and does not require the addition of strong-flavouring cations (potassium or calcium). It can be utilised without difficulty to produce soft-flavouring food products. Its gel is extremely reversible, allowing it to be gelled and melted multiple times without losing any of its original qualities [36-38].

Applications:

- Agar is worn as a Suspending agent, emulsifying agent.
- It's utilised in suppositories as a gelling agent.
- It's utilised in surgery as a lubricant.
- It's a disintegrant for tablets.
- It helps as a bacterial culture medium.
- It's a laxative that's been around for a long time.

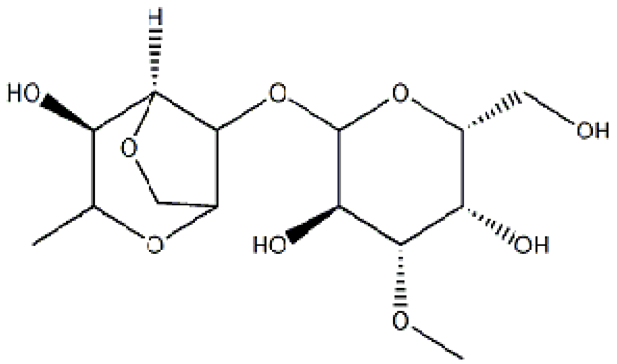

Figure 8: Structure of Agar

Carrageenan

Carrageenan is a hydrocolloid, which is withdrawn from red seaweeds using water or an aqueous alkali and then retrieves drying, either freezing (Class: Rhodophyceae). It's made up of ammonium, calcium, magnesium, potassium, and sodium sulphate galactose esters, as well as 3, 6-anhydrogalactose copolymers [39, 40].

Applications:

- In many pharmaceutical industries, it is widely worn as a dissolution rate delaying polymer is the sustained release dosage form.

- In order to test anti-inflammatory action, A 1% carrageenan solution was used to generate inflammation (Paw oedema).
- Carrageenan is used in the pharmacy and food industry as a suspending and gelling agent.
- Carrageenan is also used to make toothpaste, creams, lotions, and other cosmetic items.
- In the food industry, it is utilized in milk products, ice creams, chocolate, jams and gels in the concentration of 0.5-1%.

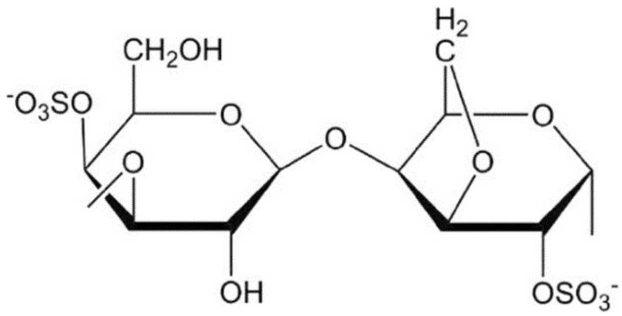

Figure 9: Structure of Carrageenan

Ispaghula

The dehydrated nuts of the plant Plantago ovate Forsk (Family-Plantaginaceae), also known as Isabgolor, Ispaghula, or Spogel seeds, makeup Ispaghula husk. Mucilage, which is found in the epidermis of seeds, is present in it. Larger doses are required because their activity is mediated in part by mucilage's lubricating action and in part by the bulking up of intestinal contents, which mechanically increases intestinal peristalsis [41, 42].

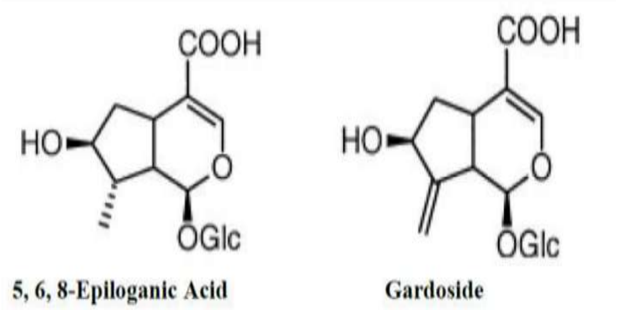

Figure 10: Structure of Ispaghula

Applications:

- Mucilage is worn like a binding agent in the granulation of material for the formulation of compressed tablets.
- Since its most swelling index and capacity to produce a homogenous viscous solution, it is utilised as a suspending and thickening agent.
- It is much sought in the pharmaceutical business as an enteric coating substance, tablet disintegrator and in the formulation sustained- release drugs.

CONCLUSION

Currently, worn polymers in various industries & products are essential and common as well to regulate the properties of products and minimize stability related issues and many additional. Based on analysed data natural polymers are to be proven additional compatible substitutes amongst synthetic and semi-synthetic polymers because of the number of their application over them in industries & products. Any product which is prepared with synthetic polymers may be upgraded in terms of quality, less toxicity and high drug delivery responses if, replaced with required essential polymers. Essential polymers are also suitable to overcome side effects arising due to synthetic polymers in any formulation.

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