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Review

Natural Viscosity Modifiers: A Review, Source, Properties and Applications

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Abstract

Natural viscosity modifiers are gaining attention due to their potential to replace the synthetic additives in various pharmaceutical industries. This review article explores the use of natural viscosity modifiers, focusing on their source, properties, and application. We can talk about the use of natural viscosity modifiers such as xanthan gum, guar gum, acacia, cellulose, starch, and pectin. Their gelling, thickening, and stabilising qualities have been thoroughly investigated; all things considered, natural viscosity modifiers have shown encouraging promise as sustainable substitutes in contemporary formulation science.

Keywords: viscosity modifier, polysaccharides, natural gums.

1.INTRODUCTION

Viscosity builders are hydrophilic substances that ensure uniform medication dispersion and ease of administration. They also increase the thickness and stability of liquid formulations, such as syrups, gels, and suspensions. The natural gelling capabilities of herbal viscosity builders give them valuable properties and safety, which makes them useful.[1] The purpose of viscosity modifiers is to change the thickness or viscosity of medicinal substances. Viscosity modifiers include products such as gelation agents, thickeners, texturizers, and stiffening agents. By converting liquids into gels, pastes, or powders, a range of viscosity modifiers can assist formulators in producing the ideal product for final consumers. Nature has a variety of thickeners, or they are derived from natural thickeners. These components are polymers that stretch and become more viscous when they absorb water. In many shampoos and body cleansers, polyose derivatives such as hydroxyethyl cellulose are present. Another naturally occurring thickening is gum. In sensible applications, plants and other gums are mostly used to control water and thicken or gel binary chemical systems. Together, they will function as foam stabilisers, adhesives and impart various unique qualities. Any recipe that calls for a lot of water will need these thickeners. Because transparent solutions tend to get hazy and feel sticky on skin, they are usually inconsistent. The fermentation of the gram-negative bacterium species Campestris produces xanthan gum, an extra cellular saccharide with a high relative molecularmass.[2]

1.1 Viscosity

The resistance of a system to flow when a tension is applied is measured by its viscosity. The more effort is needed to get a liquid to flow at a specific rate, the more viscous the liquid is. The unit of viscosity commonly used in pharmacy is the centipoise (cp; plural, cps), which is equal to 0.01 poise [3].

2. TYPES NATURAL VISCOSITY MODIFIERS[4]

1.Polysaccharides:

- Xanthan gum
- Gum tragacanth
- Gum Arabic
- Guar gum
- Locust bean gum (LBG)

2.cellulosics:

- Hydroxy ethyl cellulose (HEC)
- Hydroxy methyl cellulose (HMC)
- Hydroxy propyl methyl cellulose (HPMC)
- Sodium carboxymethyl cellulose

3.Others:

- Starch
- Pectin

Table 1: overview of natural viscosity modifiers

S.no	Viscosity modifier	Biological sources	Part used	Chemical constituents	Family	References
1.	guar gum	Cyamopsis tetragonolobus	seeds	Galactomannan polysaccharide	Leguminosae	5
2.	Xanthan gum	Xanthomonas campestris (bacterial sources)	Fermented polysaccharides	Glucose, mannose	-(microbial)	6
3.	Gum tragacanth	Astragalus gummifer	Exudate from stem	Bossorin, tragacanthin	Leguminosae	7,8
4.	Gum Arabic	Acacia Senegal	Exudate from stem	L-arabinose, D-galactose,	Leguminosae	9
5.	Locust bean gum	Ceratonia siliqua	seeds	Galactomannan	Fabaceae	10
6.	Starch	Zea mays (corn) solanum tuberosum, Oryza sativa (rice)	Seeds, tubers	Amylose Amylopectin	Solanaceae	11
7.	Pectin	Citrus fruits, apples	Peel or pomace	Pectic polysaccharides	Rosaceae	12

3. POLYSACCHARIDES

3.1 xanthan gum

Xanthan gum is a polysaccharide that serves as a food ingredient and rheology adjuster. The Xanthomonas campestris bacterium ferments glucose or sucrose to make this compound. Following fermentation, isopropyl alcohol is used to extract the polysaccharide from a growth medium, which is then dried and ground into a fine powder. To create the gum, it is subsequently combined with a liquid medium. Xanthan, a free-flowing powder that ranges in colour from white to cream, dissolves in hot or cold water to form viscous solution at minimal levels. Its capacity to regulate water-based systems' rheology accounts for its industrial significance. Even at low engrossment, xanthan gum solutions have a high viscosity in comparison to other polysaccharide solutions. Because of this characteristic, it works incredibly well as a thickening and stabiliser [13]

Fig 1: xanthan gum [14]

3.1.1. Description [15]

Colour: white to cream -coloured.

Odour: distinctive.

3.1.2 Pharmaceutical application of xanthan gum:[16]

Gelling, thickening, emulsifying, stabilizing or matrixing agent.

3.2 Gum tragacanth

Gum tragacanth swells quickly in hot and cold water. Due to its stability over a broad pH and temperature range, similar to gum Arabic, and its efficacy as an emulsifier, it is utilised commercially as a natural thickening and emulsifier within the pharmaceutical industry and related sectors. Additionally, it thickens, stabilises emulsions, and exhibits exceptional resilience against microbial attack. These qualities make it commonly used in the culinary industry. The button mushroom's shelf life in cold storage settings was increased when gum tragacanth and aloe vera were combine [17]. Gum tragacanth is also utilized as a binder to keep all of the powdered plants together when creating incense. Among the greatest gums for retaining particles in suspension, its water solubility makes it easy to work with and ensures a uniform spread. Only half as much is needed, compared to gum Arabic or something similar [18]

Fig 2: gum tragacanth [19]

3.2.1Description:[20]

Colour: white or yellowish powder.

Odour: odourless

Taste: slimey taste.

3.2.2Pharmaceutical application of gum tragacanth:[21]

Suspending agent, emulsifying agent, demulcent.

3.3 Guar gum

The terms "Indian cluster bean," "guar," and "guaran" are frequently used in scientific literature to refer to the bean, guar gum flour, and the galactomannan fraction, respectively. Guar gum, like complex carbohydrate polymer of galactose, mannose make up the majority of locust bean gum though in different proportions. Guar flour is said to be useful as an improved component to boost the potency of particular paper types. Furthermore, it has been proposed that gum qualities that could be helpful in printing pastes, warp sizing, and some finishing processes.

The gum-containing endosperm of the seed must be separated from the outer, mostly fibrous sections in order to extract the gum [22]. Guar gum is a low-cost stabiliser and thickening. When compared to other hydrocolloids, it hydrates quite quickly in cold water to produce highly viscous pseudoplastic solutions with a low-shear viscosity that is significantly higher than locust bean gum. “Lower concentrations (~0.3%) are far less thixotropic than high concentrations (~1] %).” [23]

Fig 3: Guar gum [24]

3.3.1Description:[25]

Colour: white to yellowish white.

Odour: odourless

3.3.2Pharmaceutical application of guar gum:[26]

Binder, disintegrant, suspending agent, emulsifier.

3.4 Gum Arabic

The rip is encased in gum as a spherical tear, which enlarges as additional gum is extruded in the inside. As it emerges from the tree, the gum is gooey and mushy, but it hardens quickly. Gum Arabic is a polysaccharidic acid (Arabic acid) that occurs naturally as a mixed calcium, magnesium, and potassium salt. Galactopyranose, arabinopyranosearabino pyranose, arabinofuranoMse, rhamnopyranose, glucuropyranosyl uronic acid, and 4-0 methyl glucuropyranosyl uronic acid are its six carbohydrate moieties. A tiny amount of protein is also an essential component of the structure.[27].

The viscosity of dispersions is partially determined by the molecular interactions between AG as well as the solvent. In addition to being influenced by temperature and pressure, viscosity is also controlled by the concentration, size, and shape of molecules. Given that AG macromolecules are weak polyelectrolytes, the viscosity should be significantly impacted by pH, ionic strength, and ion type (per the Hofmeister series) This is seen in the case of Arabic acid, where a pH between 5.5 and 6.3 produced the highest viscosity. [28]

Fig 4: gum Arabic [29]

3.4.1 Description:[30]

Colour: pale to orange brown colour.

Odour: odourless.

3.4.2Pharmaceutical application of gum Arabic: [31]

Gelling agent, thickener, emulsifier.

3.5 locust bean gum

A naturally occurring hydrophilic plant colloid, locust bean gum (LBG) is taken from the body and nutritional organs of Robinia pseudoacacia L. It is a polysaccharide molecule derived from plants that contains to form a residue of mannose and galactose as structural components. You can dissolve locust bean gum in either hot or cold water. which can be used as a viscosity builder, gelling agent, adhesive, and other applications in the food, petroleum, textile, paper, explosives, and coal mine industries. [32]

Fig 5: locust bean gum [33]

3.5.1Description:[34]

Colour: white to creamy white.

Odour: odourless

3.5.2 Pharmaceutical application of locust bean gum:

Thickening and stabilizing.

4. CELLULOSICS

4.1 hydroxy ethyl cellulose

Cellulose derivatives more especially, those made from wood or plant sources have grown in popularity as substitute thickening agents for oral liquid dosage forms. hydroxyethyl cellulose is a non-ionic a common water-soluble polymer found in pharmaceutical formulations because of its thickening and viscosity-modifying qualities. It's a desirable excipient for use in oral liquid formulations due to its capacity to conceal the taste of active pharmaceutical ingredients (APIs), enhance suspension stability, and increase viscosity. In addition to being non-toxic and safe, HEC is also non-glycogenic and non-cariogenic, making it appropriate for patients.[35]

4.2 hydroxy propyl methyl cellulose

Hydroxypropyl Methylcellulose (HPMC) is a chemical modification of cellulose that finds widespread use in a variety of industries, including construction, food, cosmetics, and pharmaceuticals. This water-soluble polymer has unique qualities that make it exceedingly versatile, including gelation, film formation, emulsification, and thickening. In addition to being etherified to improve its water retention and thermal gelling qualities, HPMC is derived from natural cellulose.[36]

5. OTHERS

5.1 starch

A carbohydrate called starch hydrolyses to release glucose. Granules are tiny particles that contain starch [37]. Changes in starch viscosity are made possible by its ability to hydrate and Most of the starches and starchy foods used in food preparation come from cereals (rice, wheat, maida, sago, maize, and barley), roots (cassava, tapioca, and arrowroot), and tubers (sweet potatoes, potatoes). swell. Amylose, which in normal starches inhibits water binding, decreases swelling power, and produces low viscosity at high temperatures, may combine with the phospholipids in the starch granules.

because of the amylose-lipid complex and low amylopectin levels, high amylose starches have poor viscosity and minimal swelling power, even at high temperatures. Conversely, at low temperatures, a higher viscosity and greater swelling power are caused by a high amylopectin level [38]

Fig 6: Starch [39]

5.5.1 Description:[40]
Colour: white to creamy colour
Odour: odourless

5.5.2 Pharmaceutical application of starch:
Binder, disintegrant, diluent,

5.2 Pectin

Citrus peel and apple pomace, which are leftovers from juice production facilities, are currently the main sources of pectin used in traditional, commercial processes. Because of its high pectin concentration and desirable colour characteristics, citrus peel typically that of lemons and limes is one of the most widely used sources for pectin production. When lime peel is hydrolysed and then treated with enzymes to facilitate peel removal, pectin can transform into pectic acid. Citrus peel has a relatively greater pectin content (20–30%) than apple pomace, which has a pectin content of 10-15%. Sugar beetroot waste from sugar production, sunflower heads (seeds used to make edible oil), and mango waste are additional sources of pectins that have recently started to look for a market [41]. numerous hydroxyl groups (-OH) found in pectin can improve its ability to bind water molecules. It can result in colloid dispersion, which alters the food system's rheological characteristics, including both flow and solid behaviour [42]

Fig 7: pectin [43]

5.2.1Description:[44]
Colour: pale brown
Odour: neutral to slightly acidic.

5.2.2Pharmaceutical application of pectin:
Gelling, stabilizer and thickening agent.

CONCLUSION

A viable substitute for synthetic additives, natural viscosity modifiers provide a sustainable and environmentally responsible solution for a range of sectors. Due to their renewable nature, non-toxicity, and biodegradability, these natural polymers have the potential to significantly influence the direction of enterprises looking to produce more environmentally friendly goods.

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