Natural polymers and their applications

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Abstract

The products from natural sources have become an integral part of human health care system because of some side effects and toxicity of synthetic drugs. Applications of natural polymers in pharmacy are comparable to the synthetic polymers and they possess wide scope in food and cosmetic industries. The present paper gives a state-of-the-art of available information on naturally available polymers and their versatile uses.

Keywords: Natural polymers, Pharmacy, Xanthan gum, Chitosan, Ispaghula, Sterculia gum, Gelatin, Acacia, Agar, Carrageenan.

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Introduction

Protein, enzymes, muscle fibers, polysaccharides and gummy exudates are the natural polymers being used effectively in formulating the variety of pharmaceutical products. The well-known natural polymers used in pharmacy and other fields are chitosan[1], carrageenan[2], is paghula[3], acacia[5], agar[9], gelatin[8], shellac, guar gum and gum karaya[13]. These natural polymers are widely used in pharmaceutical industry as emulsifying agent, adjuvant and adhesive in packaging; and also well suited for pharmaceutical and cosmetic product development. Alginic acid[2] is a natural polymer composed of β-1,4-linked-D-Mannuronic acid and α-1,4-linked L-guluronic acid molecules and is obtained by alkali treatment of seaweeds. It serves as an excellent extragranular disintegrant when it is added before compression.

With the availability of variety of natural polymers, the manufacturers today have achieved a great success in developing the most promising therapeutic systems, namely drug delivery system, which provides an effective therapy to the patients for prolonged periods.

Natural polymers obtained from gummy exudates and plant fibres are being discussed here to take a closer look at their applications in pharmacy and other fields.

Xanthan gum[2,5,6,8,9,11]

This gum is produced by a pure-culture fermentation of a carbohydrate with ***Xanthomonas campestris*** and purified. It is also known as Corn sugar gum. It is the sodium, potassium or calcium salt of a high molecular weight polysaccharide containing D-glucose, D-mannose and D-glucuronic acid. It also contains not less that 1.5% of pyruvic acid. It is a cream coloured powder, soluble in hot and cold water and neutral to litmus. A 1% solution has viscosity of about 1000 centipoises.

Solutions of xanthan gum demonstrate maximum stability at *p*H value between 4 and 10. Compared with tragacanth, xanthan gum was found to be easier to use and capable of preparing suspensions of better quality and improved consistency.

Xanthan gum is used as a stabilizer, thickener and emulsifier extensively in pharmaceutical, cosmetic industries and in food industry for dairy products. The pseudo plastic properties of this gum enable toothpastes and ointments both to hold their shape and to spread readily.

The stability was generally good and only a small number of drugs had been found to be incompatible (Amitriptyline, Tamoxifen and Verapamil). For extemporaneous dispensing, a 1% solution of xanthan gum with hydroxy benzoate, prepared in advance, was diluted to 0.5% with water when preparing the suspension.

Xanthan gum was found to be suitable suspending vehicle for delivering antispasmodics topically along the length of the oesophagus in patients with

oesophageal spasm. Coagulation of the gum had been observed when it was used for suspension of certain film coated tablets.

In a recent study the sedimentation volume of suspension with carboxy methyl cellulose and xanthan gum for period of 45 days. Results indicated that xanthan gum in a concentration of 0.2% is superior to carboxy methyl cellulose.

Acacia[2,5,6,12]

The air dried gummy exudates from the stem and branches of ***Acacia senegal* Willd.** (Family—*Mimosaceae*) and other species of Acacia of African origin. It also known as Senegal gum. The tree is known in Kordofan as 'Hashab' and in Senegambia as 'Verek'. The gum, produced in kordofan from tapped trees is considered to be good. The Senegal and Nigerian gum is also of good quality. The Senegal gum is available in the desert areas of India like Rajasthan, Gujarat and Haryana. It is soluble in water leaving only a very small residue of vegetable particles, whereas practically insoluble in alcohol and ether.

Acacia gum

Acacia is used as a suspending and emulsifying agent and as a tablet binder. Its demulcent properties are employed in various cough, diarrhoea and throat preparations.

The principal use of gum Arabic is in confectionery as an emulsifier, for preserving flavours of soft drinks and also in the manufacture of chewing gums. It is used in the pharmaceutical industry as binding agent in the manufacture of cough pastilles and other medical preparations or as a coating for pills. The gum is also used for hair set and as a suspending agent.

Agar[2,5,9,12]

Agar (or) Agar-Agar, also known as Japanese Isinglass, Chinese-Isinglass or Vegetable Gelatin. It is the dried, hydrophilic and phycocolloidal concentrate from a decoction of various marine red algae, particularly species of ***Gelidium*** (*Gelidaceae*), ***Pterocladi*** (*Gelidaceae*), order Gelidiales and ***Gracilaria*** (*Gracilariaceae*). The dried Agar-Agar usually occurs in bundles comprising thin, membranous, agglutinated strips; or in cut, flaked or granulated forms. It may be week yellowish orange, yellowish grey to pale yellow or colourless. It is tough when damp, brittle when dry, odourless or with a slight odour and has mucilaginous taste. The Agar-Agar is insoluble in cold water, but soluble in boiling water. Agar contain two different polysaccharides named as agarose and agaropectin. Agarose is responsible for gel strength of agar and composed of D-galactose and 3,6-anhydro-L-galactose units. It contains about 3.5% cellulose and 6% of nitrogen containing

Agar-Agar

substance. Agaropectin is responsible for the viscosity of agar solutions.

It is believed to be a sulphonated polysaccharide in which galactose and uronic acid units are partly esterified with sulphuric acid. Agar is used as emulsifying, suspending, stabilizing, thickening or gelling agent and bulk laxative. It is also used in the preparation of jellies, confectionery items, tissue culture studies and in microbiology.

Carrageenan[2,6,8,9]

Carrageenan is the hydrocolloid obtained from red seaweeds by extraction with water or aqueous alkali and recovered by alcoholic precipitation, drum drying or freezing (Class *Rhodophyceae*). It consists of a mixture of the ammonium, calcium, magnesium, potassium and sodium sulphate esters of galactose and 3,6-anhydro-galactose copolymers. About 30ml water is required to dissolve 1g of it at temperature 80°C. It is widely used as dissolution rate retarding polymer in sustained release dosage form in many pharmaceutical industries. Solution of carrageenan (1%) was also used to induce inflammation (Paw

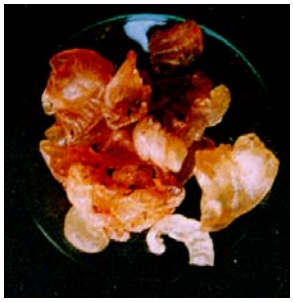
Carrageenan

oedema) for screening of anti-inflammatory activity.

Carrageenan is used in pharmacy and food industry as a suspending and gelling agent. Tooth paste, creams, lotions and other cosmetic products are also prepared by using carrageenan. In food industry, it is utilized in milk products, ice creams, chocolate, jams and gels in the concentration of 0.5-1%.

Sterculia gum[2,5,6,13]

It is the dried gummy exudate obtained from the tree ***Sterculia urens* Roxb.** (Family — *Sterculiaceae*). It is also known as Sterculia, Karaya, Indian Tragacanth or Bassora Tragacanth gum. It is produced in India, Pakistan and to a small extent in Africa. Karaya also differs from tragacanth in that it contains no starch and stains pink with solution of ruthenium red. It has low water solubility but swells to many times its original volume.



Sterculia gum

Karaya gum consist of an acetylated, branched heteropolysaccharide with a high component of D-galacturonic acid and D-glucuronic acid residues.

The granular grades are used as a bulk laxative, being only next to psyllium seed in use for this purpose. The powdered gum is used in lozenges, pastes and dental fixative powders and it has proved particularly useful as an adhesive for stoma appliances. It also acts as stimulant. It is available, with frangula, as granules.

The cross linked Tragacanth (Epichlorhydrin) exhibits superior wicking and swelling action and hence can be used as a potential disintegrant.

Gelatin[2,5,6,8]

Gelatin is a product obtained by partial hydrolysis of collagen derived from skin, white connective tissue and bones of animals. The process converts insoluble collagens into soluble gelatin, the solution of which is then purified and concentrated to a solid form. It is soluble in a hot mixture of glycerol and water and in 6N acetic acid, whereas it is practically insoluble in alcohol, chloroform, fixed oils, volatile oils and ether.

Gelatin is used in the preparation of pastes, pastilles, suppositories, coating of tablets and manufacturing of hard and soft capsule shells. It is also used for the microencapsulation of drugs and other industrial materials. Specially purified and pyrogen free gelatins are available for intravenous injection and a grade with big 'Bloom strength' is used for making gelatin capsules and for bacteriological culture media.

Gelatin

Chitosan[1,2,6,7]

Chitosan is a natural polymer obtained by deacetylation of chitin. It is present in shell fish. Chitosan is a linear polymer of β(1-4) linked 2-amino-2-deoxy-D-glucopyranose. Chitin is isolated from the exoskeleton of crustaceans such as crabs, krill and shrimps. It gives no reactions for cellulose or lignin. When heated with 50% potash at 160-170° C for one hour, it is converted into chitosan, $C_{14}H_{26}O_{16}N_2$, ammonia and acids such as acetic and oxalic.

Chitosan with a concentration of 1.25% in dilute acetic acid has very high viscosity, i.e., 120 cps. Its molecular weight is 1,43,000 to 2,10,000. It is a cationic polysaccharide and contains approximately 6.5% of nitrogen.

Chitosan

Chitosan is a novel drug carrier material and it improves the dissolution rate of controlled release matrix tablets. The additional uses of chitosan are as coating agent, gel former, and to induce desirable properties such as mucoadhesion and permeation enhancement to improve oral bioavailability of a drug.

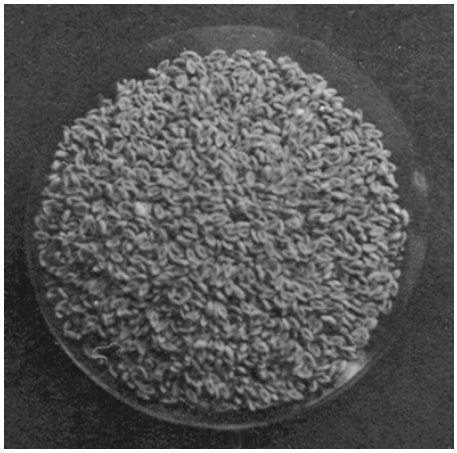
Microcapsules were prepared from Gum Karaya and Chitosan using the principle of complex coacervation for the first time with a continuous oil-phase and they were also evaluated for their *in vivo* performance.

Ispaghula[3,4,6,8,10]

Ispaghula husk consist of dried seeds of the plant ***Plantago ovata* Forsk.** (Family — *Plantaginaceae*) commonly known as *Isabgol* or *Ispaghula* or Spogel seeds. It contains mucilage, which is present in the epidermis of seeds.

It contains no toxic principles and when taken with water or milk most of it pass out of gastro-intestinal tract in 6 to 12 hours. Larger doses are essential as their action is produced partly by lubricating action of mucilage and partly by the increase in bulk of intestinal contents, which mechanically stimulates the intestinal peristalsis.

Mucilage is used as binding agent in the granulation of material for preparation of compressed tablets. It is used as a suspending and thickening agent due to its high swelling factor and ability to give a uniform viscous solution. It is much sought in pharmaceutical industry as enteric coating material, tablet disintegrator and also used in sustained release drug formulations.



Ispaghula

Conclusion

This article highlights the numerous uses of natural polymers in pharmacy and various fields. 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.

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