SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 7 | Issue: 1 | January 2022 - Peer Reviewed Journal

NATURAL POLYMERS AND ITS APPLICATIONS-A REVIEW

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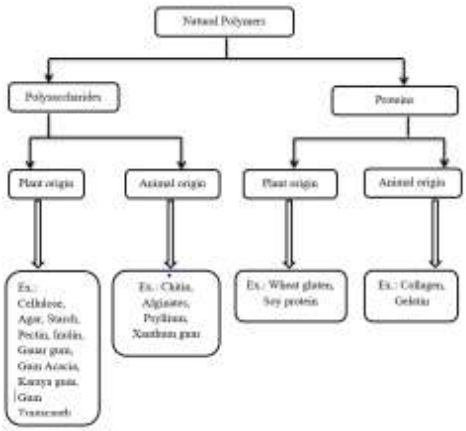
INTRODUCTION

The word 'polymer' is derived from Greek words, poly which means 'many' and meros means 'parts or units of high molecular mass'. Each molecule consists of a very large number of single structural units joined together in a regular manner by covalent bonds. Polymers are the giant molecules of high molecular weight called macromolecules which are formed by linking together a large number of small molecules, called monomers. The process by which monomers combine to form polymer is known as polymerization.

The polymerization is defined as a chemical reaction in which two or more substances combine together with or without evolution of water, heat or any other solvents to form a molecule of high molecular weight. The product obtained is called polymer and the starting material from which the polymers are made is called monomer.

CLASSIFICATION



Natural polymers

These polymers are found in nature generally from plants and animals sources. Examples are proteins, cellulose, starch, resins.

Semi-Synthetic Polymers

These polymers are obtained from natural polymers by simple chemical treatment to change the physical properties of natural polymers like Starch, silicones.

Synthetic Polymers

The fibers which are synthesized in laboratory by polymerization of simple chemical molecules are called synthetic polymers, example: Nylon, polyethene, polystyrene, synthetic rubber, PVC, Teflon etc.

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The specific application of natural polymers in pharmaceutical formulations include their use in the manufacture of solid implants, films, beads, microparticles, nanoparticles, inhalable and injectable systems as well as viscous liquid formulations.

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.

Karaya Gum

Karaya gum is obtained from Sterculia urens (Sterculiaceae) is a partially acetylated polymer of galactose, rhamnose, and glucuronic acid. Swellable hydrophilic natural gums like xanthan gum andkaraya gum were used as release-controlling agents in producing directly compressed matrices. Caffeine and diclofenac sodium, which are having different solubilities in aqueous medium were selected for gum erosion, hydration and drug release studies using a dissolution apparatus (basket method) at two agitation speeds. It was concluded that drug release from xanthan and karaya gum matrices depended on agitation speed, solubility and proportion of the drug. Both xanthan and karaya gums produced near the zero order drug release with the erosion mechanism playing a dominant role, especially in karaya gum matrices. 60 It was shown that mucoadhesive tablets prepared by karaya gum for buccal delivery, had superior adhesive properties as compared to guar gum and was able to provide zero-order drug release, but concentrations greater than 50% w/w may be required to provide suitable sustained release.

Applications

Karaya gum is used as Suspending agent and also Emulsifying agent, sustaining agent in tablets and bulk laxative.

Cordia Mucilage

Cordia Mucilage is obtained from raw fruits of Cordia Obliqua, willed family Boraginaceae. The mucilaginous substance of the fruit used as gum an expectorant and is effective in treating the disease of the lungs and the raw gum can be used beneficially in gonorrhoea. Efficacy of cordia obliqua fruit mucilage as pharmaceutical excipient as tablet binder and emulsifier was studied. 19

Applications

Cordia mucilage is used as novel oral sustainedrelease matrix forming agent in tablets.

Khaya gum

It is naturally occurring hydrophilic polysaccharide obtained from tree, Khaya grandifiola belonging to family Meliaceae. In studies khaya gum used as binding agent in tablets, for drug targeting and controlled release has been reported. Odeku et al. [48] evaluated khaya gum as a controlled release agent in tablet formulations. Paracetamol tablets were formulated by employing direct compression method. From their studies, it was found that khaya gum provide controlled release of drug for 5 hr. Also combination of khaya gum and hydroxypropylmethylcellulose showed zero-order time independent release kinetics. Thus, tablets matrices composed of khaya gum could be utilized to obtain sustain release. In another study Odeku et al. [49] studied khaya and albizia gum coating for drug targeting to the colon. Odeku et al. [50] evaluated khaya gum as binder in tablets. Paracetamol was used as model drug. All fabricated tablets possess friability value less than 1%. Tablet formulations containing khaya gum as binder had lower tensile strength values.

Applications

Khaya gum is used as Binding agent

Fenugreek Mucilage

Mucilageis obtained fromseeds of Trigonella foenum-graceum (family: Leguminosae). Its seeds contain a high percentage of mucilage and do not dissolve in water but form viscous tacky mass and swell up when exposed to fluids [26]. Gum contains mannose, galactose, and xylose.Themucilage obtained from fenugreek was found to be better release retardant compared to hypromellose at equivalent content [27}.

Applications

Fenugreek mucilage is used as Gelling agent.

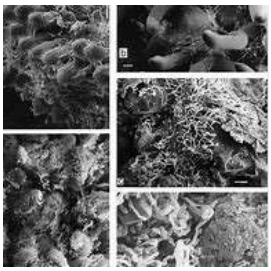
Hibiscus Mucilage

Hibiscus rosasinensis Linn of the Malvaceae family is also known as the shoe flower plant, China rose, and Chinese hibiscus. It contains L-rhamnose, D-galactose, D-galactouronic acid and D-glucuronic acid.[109] Pharmaceutically it is used for the development of sustained release t ablet.[110] It is subjected to toxicity studies for its safety and preformulation studies for its suitability as a disintegrating agent. [111].

Applications

Hibiscus is used as Emulsifying agent, sustained release agent and suspending agent.

Hakea gum



Hakea gum a dried exudate from the plant Hakea gibbosa family Proteaceae. Gum exudates from species have been shown to consist of L-arabinose and D-galactose linked as in gums that are acidic arabinogalactans. Molar proportions (%) of sugar constituents Glucuronic acid, Galactose, Arabinose, Mannose, Xylose is 12:43:32:5:8. The exuded gum is only partly soluble in water. Hakea gum was investigated as a sustained release and mucoadhesive component in buccal tablets with drug chlorpheniramine maleate . These results demonstrate that H. gibbosa, may not only be used to sustain the release but can also act as bioadhesive polymer.

Applications

Hakea gum is used as Sustainedrelease and peptide mucoadhesive for buccal delivery.

Neem gum

Neem gum is obtained from the trees of Azadirachta indica belongs to the family Meliaceae. Neem gum contains mannose, glucosamine, arabinose, galactose, fucose, xylose and glucose. [7] Pharmaceutically it used as binding agent.[99] in sustained release matrix tablets of Nimesulide using the fruit mucilage of Azadirachta indica was studied. [100].

Components

Since ancient times, neem has been associated with healing in the sub-continent of India. A large number of medicinals, cosmetics, toiletries and pharmaceuticals are now based on neem derivatives because of it's unique properties.

Applications

Neem gum is used as Binding, suspending agent and transdermal film forming agent.

Gellan gum

It is an exocellular polysaccharide secreted by Pseudomonas elodea. This gum had been investigated for pharmaceutical applications such as tablet disintegrant, binder, gelling agent and controlled release polymer [18]. Smith et al. [19] prepared enteric coated dosage form by utilizing gellan gum, sodium alginate and hypromellose. The dosage form remined intact for about two hours in HCl (pH 1.2) but when placed in buffer (pH 6.8) it was ruptured. Thus, it was concluded that these natural polymers can be used in the formulation of delayed release dosage forms. Babu et al. [18] evaluated the suitability of gellan gum macrobeads for development of gastroretentive controlled delivery of amoxicillin. They prepared gellan gum beads by using ionotropic gelation with calcium ions. The macrobeads provided release which was fitted to diffusion model. Hence, gellan gum could be used in controlled drug delivery formulation.

Applications

Gellan gum is used as Ophthalmic drug delivery, sustaining agent, beads, hydrogels, floating in-situ gelling and controlled release.

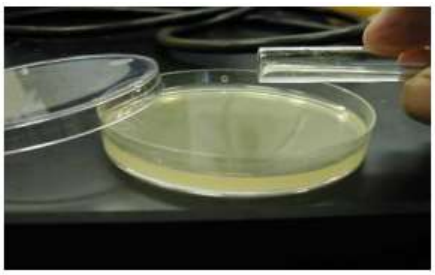
Cassia Tora Mucilage

Cassia tora mucilage derived from the seeds of Cassia tora, belongs to Caesalpiniaceae. It is locally known as charota.[112] Cassia is used as tonic, carminative and stimulant. Cassia contains 1-2 % volatile cassia oil which is mainly responsible for the spicy aroma and taste. The primary chemical constituents of Cassia include cinnamaldehyde, gum, tannins, mannitol, coumarins and essential oils (aldehydes, eugenol, and pinene); it also contains sugars, resins and mucilage among other constituents. Seed mucilage of Cassia tora was evaluated as suspending agent and binding agent. [113,114].

Applications

Cassia tora mucilage is used as Binding agent.

AGAR



Source

Agar or agar-agar consists of dried gelatinous substance obtained from Gelidium amansi (Gelidaceae) and it is also obtained from several other species of red algae like, gracilaria (Gracilariaceae) and Pterocladia (Gelidaceae).

Composition

Agar consists of a mixture of agarose and agaropectin. The agarose is a linear polymer which is made up of the repeating monomeric unit of agarobiose. Whereas, Agarobiose is a disaccharide made up of D-galactose and 3, 6 - anhydro-L-galactopyranose. Agaropectin is a heterogeneous mixture of smaller acidic molecules.

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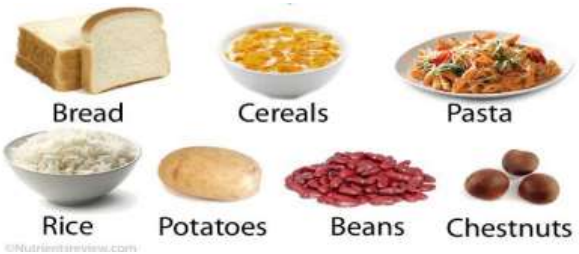
Applicatons:

Agar is used as Suspending agent, emulsifying agent, gelling agent in suppositories, surgical lubricant, tablet disintegrants, medium for bacterial culture, laxative. It is also used for the preparation of jellies, confectionary items, tissue culture studies, and in microbiology study

STARCHES



Source

Starch is the principal carbohydrate reserved material in green plants and it is mainly present in seeds and underground organs. Starch occurs in the form of granules (starch grains). A number of starches are recognized for pharmaceutical use and these include maize (Zea mays), rice (Oryza sativa), wheat (Triticum aestivum), and potato (Solanum tuberosum).

Composition

Starch or amylum is a carbohydrate consisting of a large number of glucose units joined together by glycosidic bonds. It consists of two polymers, namely amylose (a non-branching helical polymer consisting of α-1, 4 linked D-glucose monomers) and amylopectin (a highly branched polymer consisting of both α-1,4 and α-1,6 linked D-glucose monomers).

Applications

Thermoplastic starch is used in packaging, containers, mulch films, textile sizing agents, adhesives.

INULIN

Source

It is a polysaccharide obtained from the bulbs of Dehlia, Inula Helenium (Compositae), roots of Dendelion, Taraxacum officinale (Compositae). Burdock root, Saussurea lappa (Compositae) or chicory roots, Cichonium intybus (Compositae).

Applications

Inulin with a high degree of polymerization was used to prepare biodegradable colon-specific films in combination with Eudragit® RS that could withstand break down by the gastric and intestinal fluid.

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GUAR GUM

Source

Guar gum is also called guaran, clusterbean, Calcutta lucern, Gum cyamposis, and Cyamopsis gum, Guarina, Glucotard and Guyarem. Guar gum is the powder of the endosperm of the seeds of Cyamopsis tetragonolobus Linn. (Leguminosae).

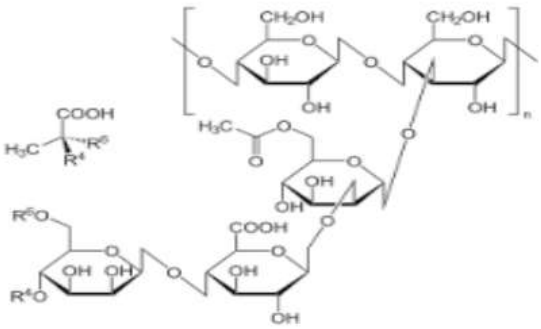
Composition

Chemically, guar gum is natural polysaccharide composed of the sugars galactose and mannose. It is a galactomannans which is a linear polysaccharide consisting of (1→4)- diequatorially linked β-D- mannose monomers, some of which are linked to single sugar sidechains of α-D-galactose attached. Guar gum has a backbone composed of β-1, 4 linkedD-mannopyranoses to which, on average, every alternate mannose an α-D galactose is linked 1→6.

Applications

Several modifications of guar gum is used for drug delivery system.• Carboxymethyl guar film is used for the formulation of transdermal therapeutic system.• www.wjpps.com Vol 6, Issue 8, 2017. 479 Rajeswari et al. World Journal of Pharmacy and Pharmaceutical Sciences Guar gum is particularly useful for colon delivery because it can be degraded by specific• enzymes in this region of the gastrointestinal tract. The gum protects the drug while in the stomach and small intestine environment and delivers the drug to the colon where it undergoes assimilation by specific microorganisms or degraded by the enzymes excreted by these microorganisms.

XANTHAN GUM



Source

Xanthan gum is a high molecular weight extracellular polysaccharide produced by the fermentation of the gram-negative bacterium Xanthomonas campestris.

Composition

The primary structure of naturally produced cellulose derivative contains a cellulose backbone (-D-glucose residues) and a trisaccharide side chain of D-mannose - D gluronic acid -D-mannose attached with the main chain of alternate glucose residues.

Applications

Xanthan gum is widely used in oral and topical formulations, cosmetics, and in food• industry as a suspending and stabilizing agent. It has also been used to prepare sustained release matrix tablets

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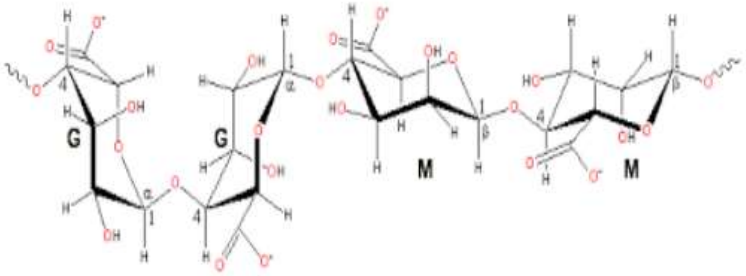
ALGINATE



Source

Alginate is a water-soluble linear polysaccharide extracted from brown seaweed.

Composition

It is composed of 1–4 linked -L-glucuronic and –D - mannuronic acid residues.

Applications

Alginate based mesalazine tablets are used for intestinal drug delivery system.• Alginate is also as encapsulation materials for controlled drug delivery to mucosal tissue.• It is also used to prepare mucoadhesive drug delivery systems.

PSYLLIUM

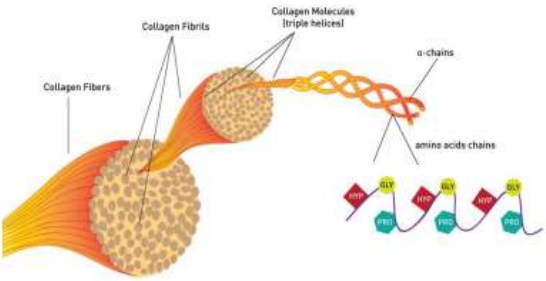
Source

Psyllium mucilage is obtained from the seed coat of Plantago ovata by milling the outer layer of the seeds.

Applications

It has tablet binding properties.• Psyllium husk was used in combination with other excipients such as hydroxypropyl• methylcellulose to prepare a novel sustained release, swellable and bioadhesive gastro retentive drug delivery systems for ofloxacin. www.wjpps.com Vol 6, Issue 8, 2017. 482 Rajeswari et al. World Journal of Pharmacy and Pharmaceutical Sciences

COLLAGEN



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Source

Collagen is the primary protein component of animal connective tissues. The most abundant sources of collagen are pig skin, bovine hide and pork and cattle bones.

Composition

There are 27 types of collagen exist and composed of different polypeptides, which contain mostly glycine, proline, hydroxyproline and lysine. The flexibility of the collagen chain depends only on the glycine content.

Applications

Collagen films are used in ophthalmology as drug delivery systems for slow release of• incorporated drugs. It was also used for tissue engineering including skin replacement, bone substitutes, and• artificial blood vessels and valves

WHEAT GLUTEN

Wheat gluten is a protein by-product of the starch fabrication.

Composition

Wheat gluten contains of two main groups of proteins, gliadin and glutenin. Gliadins are proteins molecules with disulphide bonds and have low molecular weight and a low level of amino acids with charged side groups. Glutenins are more sophisticated proteins, with a three dimensional structure. Their molecular weight is at least ten times higher than that of gliadins.

Advantages

Wheat gluten materials have the fastest degradation rates.

- Gluten is fully biodegradable and the products obtained are non-toxic.
- It is readily available in high quantity and at low cost.

Applications

Wheat gluten has been proven to be an excellent film forming agent.

CONCLUSION

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. The use of natural gums for pharmaceutical applications is attractive because they are economical, readily available, non-toxic, and capable of chemical modifications, potentially biodegradable and with few exceptions, also biocompatible. They have a major role to play in pharmaceutical industry. Therefore, in the years to come, there is going to be continued interest in the natural excipients to have better materials for drug delivery systems.

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