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Natural Polymers In Drug Delivery Development

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ABSTRACT

A pharmaceutical formulation requires two major components: an excipient and an API. Furthermore, excipients are made up of a number of components that are necessary for the manufacture of dosage forms and improve their medicinal properties. Any dosage form can use polymers as an excipient. Polymers should be compatible, stable, non-toxic, and cost-effective, with the potential to control medication release. Polymers are categorized into three types: synthetic, semi-synthetic, and natural. Because of many concerns with drug release and side effects, several pharmaceutical companies are turning to natural polymers. Polymers can be used as excipients in formulations for a variety of purposes, including consistent medicine distribution, rate control, flavor masking, stabilization, and protection.

So, this review covers Polymers are utilized as excipients in formulations for a variety of reasons, including uniform medicine distribution, rate control, flavor masking, stabilization and protection, and

more. In light of this, this paper looks at many natural polymers, their advantages over synthetic polymers, and their applications in drug delivery system design.

Keywords

Natural polymer

INTRODUCTION

Polymers are macromolecules composed of several assemblies of simple structural components that can be classified as natural or synthetic based on their origin. Polymer structural, mechanical, and functional properties can be adjusted by combining various functional groups with low- and high-molecular-weight chains for a variety of applications. Both synthetic and natural polymers are used in health sciences and many types of drug delivery systems that have qualities such as site specific targeting, controlled drug release, sustained drug release, and so on. These polymers find relevance in oral medication delivery systems because they stabilize and safeguard drug distribution while also masking the drug's flavor. These polymeric compounds can change the flow properties of liquid and solid dosage forms. In addition to their widespread use in pharmaceutical dosage forms, both natural and synthetic polymers are found in a wide variety of food products [1]. The nature and kind of polymer utilized to synthesize the drug delivery system determine its function and activity. Synthetic polymers are widely utilized in Nano medicine because they can attain the appropriate shape, size, mechanical, and chemical properties, and the technology for their production are well known. Some of the key issues faced when using manufactured polymers as carrier systems are toxicity and compatibility. However, their macroscopic and molecular structures are more ordered than those of natural polymers. They have good biocompatibility with biomolecules and are easily digested by the body. Furthermore, the fact that these polymers have less adverse effects has piqued the interest of biomedical analysts in their widespread application. The drug release rate through natural polymeric systems is determined by the physical and chemical properties of the drug and polymer employed, as well as their shape, size, structure, and thermodynamic stability[2-4], the rate of polymer degradation in vivo, and the structure of the formed device[5]. Polymers generated from plants have been widely used to design innovative pharmaceutical formulations such as microcapsules, microspheres, nanoparticles, liposomes, hydrogels, and gel globules[6,7]. Natural polysaccharides such as xanthan gum, alginate, starch, chitosan, gelatin, pectin, dextran, carrageenan, guar gum, Arabic gum, cellulose, and others are preferred in the pharmaceutical industry[8]. The development of plant resources ensures a steady supply of organic polymers[9]. Biodegradable polymers have proven their ability to create continuous release systems. The bioavailability of controlled medication release via a delivery system necessitates optimization studies that ensure chemical and physical stability. The delivery of biopharmaceutical medicines via ocular, nasal, transdermal, and oral routes allows for simple and effective administration in the body[10]. The use of naturally occurring polysaccharides for the controlled release of medicines and other bioactive chemicals was recommended due to their biodegradability and simplicity of delivery directly inside the body without surgery[11]. This study covers the important polymers used as drug administration techniques, including guar gum, gelatin, starch, pectin, chitosan, copal gum, alginate, albumin, carrageenan, inulin, hyaluronic acid, and chondroitin sulfate. Additionally, it discusses functionalizing the previously stated polymers to enhance their characteristics and provide a suitable drug release mechanism.

CLASSIFICATION OF POLYMERS

Polymers can be classified as:

1. Natural polymers
2. Synthetic polymers
3. Semi-synthetic polymer.

Natural polymers

Plants and animals found in the natural world are the source of natural polymers. These polymers are essential to life. The following is the order in which they are listed:

A. Starch
   It is a polymer of glucose and it is 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 glucose of plants and is produced during photosynthesis.

C. Proteins
   These are α-amino acid polymers, usually consisting of 20–1000 α-amino acids linked in a well-organized configuration. These are fundamental components of the animal body and are present in all of our diet.

D. Nucleic acids

These are different nucleotide polymers. Common nucleotides include DNA and RNA, for instance. It should be mentioned that biopolymers are another name for polymers like proteins, nucleic acids, and polysaccharides (cellulose, starch), which regulate many aspects of plant and animal life.

Synthetic polymers

Polymers produced in lab environments are referred to as synthetic polymers.Another name for these is man-made polymers. For instance, Teflon, Bakelite beryline, polyethylene, PVC nylon, and synthetic rubber.

Semi synthetic polymers

These polymers are mostly created by chemically modifying naturally occurring polymers. For instance, cellulose is a naturally occurring polymer that forms cellulose dictate polymers when it is acetylated with acetic anhydride in the presence of sulfuric acid. It is utilized to create thread and other materials, such as films, glasses, etc. Another example of a semi-synthetic polymer used to make tires and other products is vulcanized rubber. The cellulose nitrate used to make explosives is called "gun cotton [12].

Biological source

Guar gum is derived from the refined endosperm of the Cyamopsis tetragonolobus L Taub seeds..

Description

Guar gum is a white to yellowish-white powder with a bland flavor that has no smell or almost no smell.

Chemical composition

Guar gum is a polysaccharide made up of the sugars mannose and galactose. Galactose residues are 1,6-linked to the backbone, which is a linear chain of β1, 4-linked mannose residues, at every other mannose to generate brief side branches[13].

COMMONLY NATURAL POLYMER USED IN DRUG DELIVERY SYSTEM:

Natural polymer are widely used in modified drug delivery system and some of them are mentioned below **–**

GUAR GUM

Nonproprietary Names:

BP: Guar galactomannan

PhEur: Guar galactomannanum.

Manufacturing Process

Stepwise process

Guar Seed

• First, the guar pods are dried in sunshine and manually separated from the seeds.

• Guar seeds are delivered to the industry for processing.

• Guar byproducts, churi and korma are used as cattle fodder.

Undehusked Guar Splits

• Guar gum is produced from guar seeds using mechanical methods such as roasting, differential attrition, filtering, and polishing.

• Seeds are split to remove the germ from the endosperm.

• Each seed yields two halves of endosperm, known as Undehusked Guar Splits.

Refined Guar Splits

Polishing removes the fine layer of fibrous material that forms the husk and separates it from the endosperm halves, yielding refined guar splits.

Guar Powder

The refined Guar Splits are next treated and polished into powders by a variety of routes and processing techniques, depending on the end product sought [13].

Natural polymers used in formulations:

Carrageenan

Carrageenan, a hydrocolloid found in red seaweeds, is extracted using water or an aqueous alkali and then recovered via drum drying, freezing, or alcoholic precipitation (Class: Rhodophyceae). It is made up of a combination of 3, 6anhydrogalactose copolymers and the ammonium, calcium, magnesium, potassium, and sodium sulphate esters of galactose. In several pharmaceutical sectors, it is frequently utilized as a prolonged release dosage form with a dissolving rate retarding polymer. Additionally, in order to test the anti-inflammatory activity, Paw edema, a solution of carrageenan (1%) was used to cause inflammation. Carrageenan is utilized as a gelling and suspending agent in the food and pharmaceutical industries. Carrageenan is also used in the preparation of tooth paste, creams, lotions, and other cosmetic items. It is used in the food sector in 0.5–1% concentrations in milk products, ice creams, chocolate, jams, and gels[14-17].

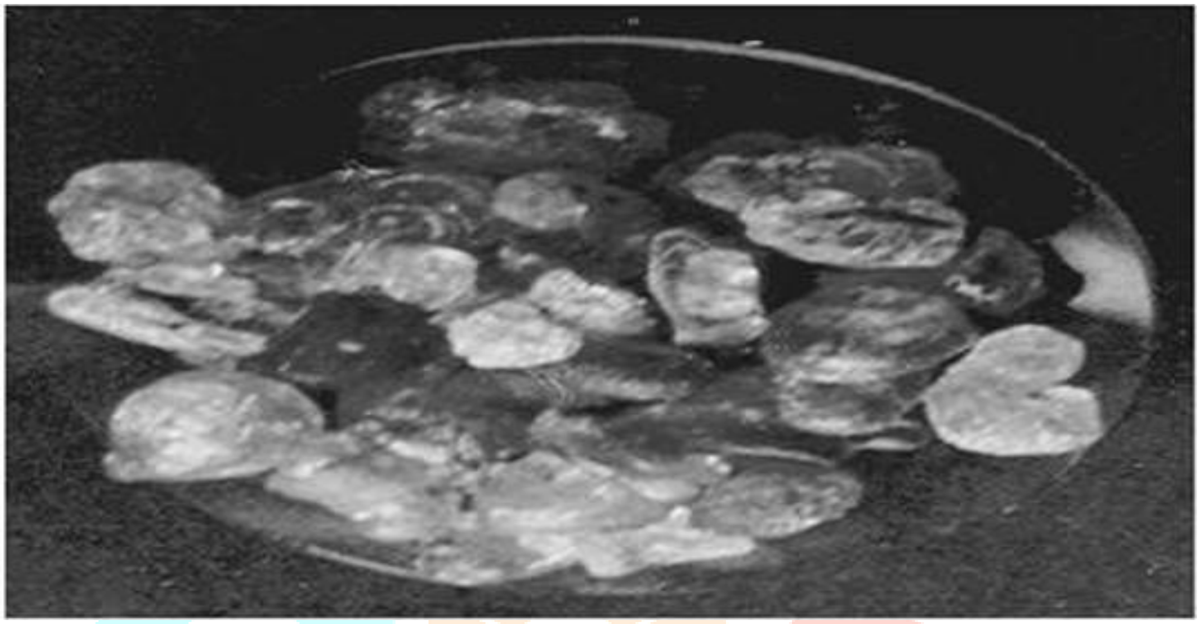
Ispaghula

The dried seeds of the shrub Plantago ovate Forsk are what make up ispaghula husk. (Family: Plantaginaceae) is also referred to as Spogel or Isabgolor seeds. It contains mucin, which is found in seeds' outer layer. Greater dosages are necessary because the lubricating effect of the mucilage and the increased bulk of intestinal contents, which mechanically increases intestinal peristalsis, are the two main mechanisms underlying their activity. Mucilage is a binding agent that is used while granulating material to make compressed tablets. Because of its high swelling factor and capacity to produce a consistent viscous solution, it is utilized as a thickening and suspending agent. In the pharmaceutical sector, it is highly sought after for usage as a tablet disintegrator, enteric coating material, and in formulations for sustained release drugs[14,17].

Acacia

The sticky exudates that are air dried and come from the stem and branches of Acacia Senegal Willd. (Family – Mimosaceae) and other African-originated acacia species. Another name for it is Senegal gum. The tree is referred to as "Verek" in Senegambia and "Hashab" in Kordofan. In Korea, gum made from tapped trees is valued for its quality. The gum from Senegal and Nigeria is likewise of high caliber. Senegal gum can be found in India's desert regions, including Rajasthan, Gujarat, and Haryana. It is nearly insoluble in ether and alcohol but soluble in water, leaving behind very little vegetable particle remnant[14-17].

Agar



Agar-Agar is sometimes referred to as vegetable gelatin, Chinese isinglass, or Japanese isinglass. It is the dry, hydrophilic, and phycocolloidal concentrate obtained by decoctioning different species of marine red algae, specifically those belonging to the orders Gelidiales, Gracilaria (Gracilariaceae), Pterocladi (Gelidaceae), and Gelidium (Gelidaceae). The dried Agar-Agar is typically found in granulated, flaking, or sliced forms, or in bundles made up of thin, membranous, agglutinated strips. It could be colorless, pale yellow, yellowish grey, or weak yellowish orange. It has a mucilaginous flavor, is odorless or has a faint odor, is brittle when dry, and is tough when wet. In boiling water, the Agar-Agar becomes soluble, but it remains insoluble in cold water. Agarose and agaropectin are two distinct polysaccharides found in agar. Agarose, which is made of D galactose, gives agar its gel strength [14,17,18,19].

Gelatin

Gelatin is a naturally occurring macromolecule that dissolves in water when heat is applied and partially hydrolyzes collagen. Two varieties of gelatin exist: Collagen with an isoelectric point of 7.0 to 9.0 can be treated acidically to yield type-A gelatin; collagen with a pI of 4.8 to 5.0 can be hydrolyzed alkaline to yield type-B gelatin. Gelatin is a very desired material for use as a carrier molecule due to its several advantages over other synthetic polymers, such as its non-irritability, biocompatibility, and biodegradability.

It is a naturally occurring macromolecule with low immunogenicity and antigenicity, and it is not poisonous or carcinogenic. Gelatin's surface has a high number of functional groups that facilitate derivatization and chemical cross-linking[14,15,16,17].

Xanthan gum

Xanthomonas campestris ferments a carbohydrate in a pure culture to produce this gum, which is then purified. Another name for it is corn sugar gum. It is a high molecular weight polysaccharide that contains D-glucose, D-mannose, and D-glucuronic acid as its sodium, potassium, or calcium salt. Additionally, it has 1.5% or more of pyruvic acid in it. This powder has a cream color and dissolves in both hot and cold water. The viscosity of a 1% solution is approximately 1000 centipoises. Maximum stability is shown by xanthan gum solutions at pH values between 4 and 10. It was discovered that xanthan gum was easier to utilize and could produce suspensions with greater consistency and quality than tragacanth. In the food, cosmetic, and pharmaceutical industries as well as in the pharmaceutical business for dairy products, xanthan gum is widely used as an emulsifier, thickener, and stabilizer. Because of this gum's pseudo plastic qualities, toothpastes and ointments spread easily and maintain their shape. Amitriptyline, Tamoxifen, and Verapamil were among the few medications that were discovered to be incompatible; overall, stability was good. When making the suspension for impromptu dispensing, an earlier-prepared 1% solution of xanthan gum and hydroxyl benzoate was diluted to 0.5% with water. In individuals experiencing esophageal spasm, xanthan gum was proven to be an appropriate suspending vehicle for topically administering antispasmodics along the length of the esophagus. When the gum was employed to suspend some film-coated pills, coagulation of the gum was noted. Sedimentation volume of suspension with xanthan gum and carboxymethyl cellulose, left for 45 days. The outcomes showed that 0.2% of xanthan gum is preferable to carboxymethyl cellulose[14,15,16,17,18].

CONCLUSION

Polymers are essential to the design of different dosage forms. Drug delivery methods can be tailored to the needs of the natural polymers. Natural polymers are widely used in the creation of innovative drug delivery systems, such as gastro-retentive dosage forms, bio adhesive systems, and microcapsules, in addition to being employed in conventional dosage forms. Research on innovative natural polymers derived from plants has enormous potential, and these polymers may be used in the future to produce novel drug delivery systems for the pharmaceutical sector.

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