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NATURAL POLYMERS AS COATING MATERIAL-A REVIEW

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ABSTRACT

Active ingredient and excipients are two main ingredients of any pharmaceutical formulation. Excipients help in the manufacturing of dosage form as well as improve physicochemical parameters of the dosage form. Polymers play a vital role in any dosage form as excipients. The influencing capacity of polymers towards the drug release and should be compatible, non-toxic, and stable and economic. They are broadly classified in three categories viz. natural polymers, semi-synthetic and synthetic polymers. Natural polymers are generally used as rate controlling agents, taste masking agents, protective and stabilizing agents in the oral drug delivery system. To provide uniform drug delivery certain polymers are used to reduce the frequency of dosing and to increase effectiveness of the drug by localization at the site of action. Nowadays, due to many problems associated with drug release and side effects of synthetic polymers, manufacturers are inclined towards using natural polymers. Natural polymers being polysaccharides are biocompatible and without any side effects. Applications of natural polymers in pharmacy are large in comparison to the synthetic polymers and have wide scope in food and the cosmetic industry.

KEYWORDS: Natural polymers, Excipients, Coating, Nontoxic.

INTRODUCTION

A polymer is a large molecule or a macromolecule which essentially is a combination of many subunits. The term polymer in Greek means ‘many parts’. Polymers can be found all around us. From the strand of our DNA which is a naturally occurring biopolymer to polypropylene which is used throughout the world as plastic. Polymers may be naturally found in plants and animals (natural polymers) or may be man-made (synthetic polymers). Different polymers have a number of unique physical and chemical properties due to which they find usage in everyday life. Polymers are all created by the process of polymerization wherein their constituent elements called monomers, are reacted together to form polymer chains, i.e. 3-dimensional networks forming the polymer bonds. The type of polymerization mechanism used depends on the type of functional groups attached to the reactants. In the biological context, almost all macromolecules are either completely polymeric or are made up of large polymeric chains.

CLASSIFICATION OF POLYMERS

Polymers cannot be classified under one category because of their complex structures, different behaviors and vast applications. We can, therefore, classify polymers based on the following considerations. There are three types of classification under this category, namely, Natural, Synthetic, and Semi-synthetic Polymers. **Natural Polymers:** They occur naturally and are found in plants and animals. For example proteins, starch, cellulose, and rubber. **Semi-synthetic Polymers:** They are derived from naturally occurring polymers and undergo further chemical modification. For example, cellulose nitrate, cellulose acetate. **Synthetic Polymers:** These are man-made polymers. Plastic is the most common and widely used synthetic polymer.[1-2]

Natural Polymer

Natural Polymers are those substances which are obtained naturally. These polymers are formed either by the process of addition polymerization or condensation polymerization. Polymers are extensively found in nature. Our body too is made up of many natural polymers like nucleic acids, proteins, etc. The Cellulose is another natural polymer which is a main structural component of the plants. Most of the natural polymers are formed from the condensation polymers and this formation from the monomers, water is obtained as a by-product.[2]

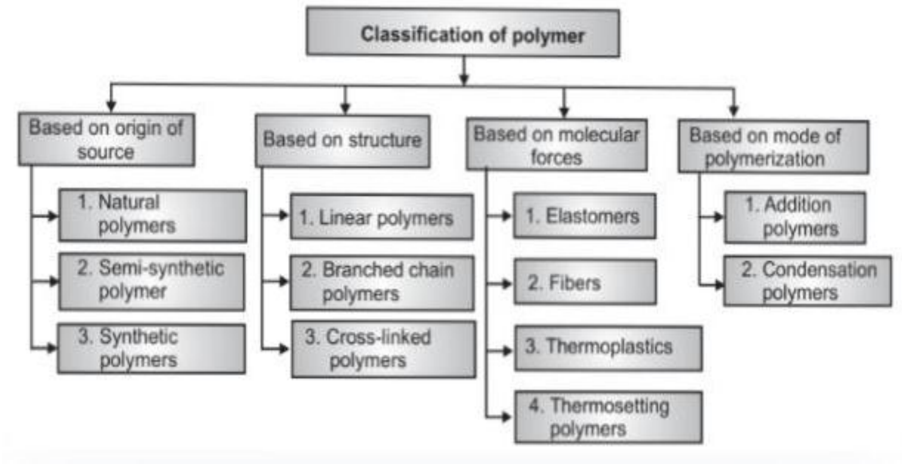

Fig. 1: Classification of Polymers.

CHARACTERISTICS AND IMPORTANCE OF NATURAL POLYMER

Homogenicity and polydispersibilty, High biocompatibility, Biodegradable, Accessibility, Stability, Lack of toxicity, Low cost, Easy availability, Economic.

Disadvantages of Natural polymer

1. Microbial Contamination
2. Batch to Batch variation
3. The uncontrolled rate of hydration
4. Complex structures
5. Costly extraction processes

Classification of Natural polymer

They are classified into three categories,

1. Plant Origin
2. Animal Origin
3. Microbes Origin

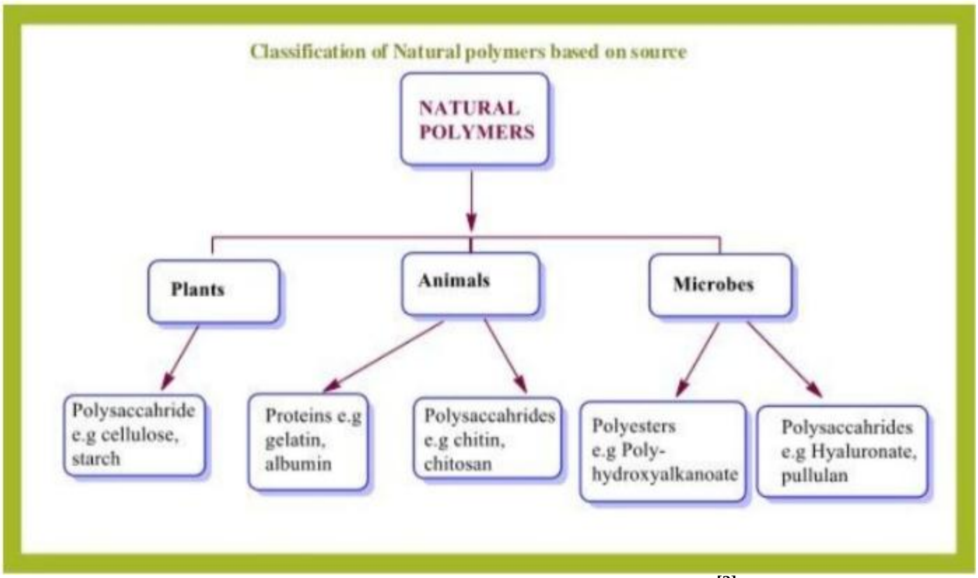

Fig. 2: Classification of Natural Polymers.[2]

Fibers from Natural polymers

Natural polymers can be made into fibers through dissolution of the polymer in an appropriate solvent and then extrusion of the polymer solution into a coagulation bath. As an example, cellulose can be made into viscose rayon fibers, cuprammonium rayon, cellulose acetate and triacetate fibers, lyocell, and modal fibers depending on the processes used to make the fibers. Other natural polymers such as rubber, chitosan, alginic acid, and protein can also be made into fibers in an appropriate fiber-forming process.

Cellulose

Cellulose is an organic polysaccharide consisting of a linear chain of several hundred to over ten thousand linked D-glucose units having the formula. Cellulose is the major component of plant cell walls, which helps plants stay stiff and upright. Even though humans cannot digest cellulose, it is an important source of fiber in the diet. Cellulose aids digestion by allowing food to pass more readily through the intestines and pushing waste out of the body. The primary components of the plant cell wall are cellulose, hemicelluloses, and pectin. In the pharmaceutical sector, cellulose is primarily utilized as a diluent/ binder in tablets for both the granulation and direct compression processes. Carboxylated methylcellulose is utilized in medication formulations as a binder, film-coating agent, and an ointment base.

The main cellulose derivates used for coatings are methylcellulose, hydroxypropyl methylcellulose, hydroxyl ethylcellulose, and carboxymethyl cellulose. They have been mixed with other polysaccharides, such as starch, to improve their water solubility. Hydroxypropyl cellulose and methylcellulose films and coatings are efficient barriers to oxygen, carbon dioxide, and lipids, but with poor resistance to water vapor transport. Although, the water vapor barrier properties can be improved by adding hydrophobic materials such as lipids into the film or coating forming solution. Cellulose derivates have been widely used to develop films and coatings due to their great film-forming properties, high availability, biodegradability, and biocompatibility.[3-4]

Rubber

Rubber, also known as latex, is an elastomer, a polymer that is prominently known for its elastic properties. Natural rubber is primarily harvested in the form of the latex from the rubber tree (*Hevea brasiliensis*). Latex is a stable dispersion (emulsion) of polymer microparticles in water that is extracted from the bark by cutting incisions and collecting the fluid in vessels, a technique known as "tapping." After that, the latex is refined into rubber, which is ready for commercial use. Latex is allowed to agglomerate in the collection cup in large places. The coagulated lumps are collected and dried before being sold. Although 20,000 species of plants produce latex, only 2,500 species have been found to contain rubber in their latex. Natural rubber is widely employed in a variety of applications and products, both individually and in conjunction with other materials. It is an essential raw material used in the creation of more than 40,000 products including medical equipment, surgical gloves, aircraft/car tires, pacifiers.[5-6]

Shellac

Shellac is the name given to a material secreted by a parasitic female insect name Lac bug (*Laccifer lacca*). This insect is mainly found in the tropical rainforests of India and Thailand, making these countries two of the biggest exporters of Lac products in the world. These insects secrete a resinous material on the bark of the tree to form tunnels as they transverse the branches. This material is s cultivated and refined because of the commercial value of the finished product known as lac or shellac. The name "lac" is derived from a unit in the Indian numbering system for 100,000 and presumably refers to the huge numbers of insects that swarm on host trees. Typically, 50,000 to 300,000 female lac bugs are required to produce just 1 kg (2.2lb) of shellac. The chemical structure of shellac is very much like plastic, and hence, it is considered to be natural plastic with a melting point of 75°C. It is used in the food industry as a glazing agent for several food items, particularly sweets. Shellac is a natural polymer, which is used as enteric coating material in pharmaceutical applications.[7]

Starch

Starch is another plant-derived natural polymer. It is a polysaccharide carbohydrate consisting of a large number of glucose molecules joined together by glycosidic bonds and found especially in seeds, bulbs, and tubers. Starch is the principal source of dietary calories to the world's human population. Pure starch is a white, tasteless, and odorless powder that is insoluble in cold water or alcohol. Starch and its derivatives are frequently used as additives in food, cosmetics, and pharmaceuticals, for example as thickeners, gelling agents, and encapsulating agents.[8]

Chitin

Chitin is a natural and abundant mucopolysaccharide, the structural component of crustaceans, insects, and fungal mycelia, consists of 2-acetamido-2-deoxy-β-D-glucose linked by β-bonds (1→4). Chitosan is the N-deacetylated derivate of chitin obtained in the presence of concentrated alkali. Chitin and chitosan are similar to cellulose in their high insolubility degree and low chemical reactivity. Chitosan solubility depends on N-acetylation degree and molecular weight; however, it can be dissolved in acid solutions (pH < 6.3), even at concentrations above 2% (w/v). Solubility, appearance, rheological properties, among other properties of chitosan properties also depend on the N-acetylation degree. Chitin and chitosan are very important due to their high nitrogen content (6.89%), biocompatibility, biodegradability, non-toxicity, adsorption, and chelator properties. For these reasons, it has been widely used in the biomedical, pharmaceutical, and food industry.[9]

Xanthan Gum

Xanthan gum is a high molecular weight extracellular polysaccharide produced by the fermentation of the gram-negative bacterium Xanthomonas campestris. 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.[10-11]

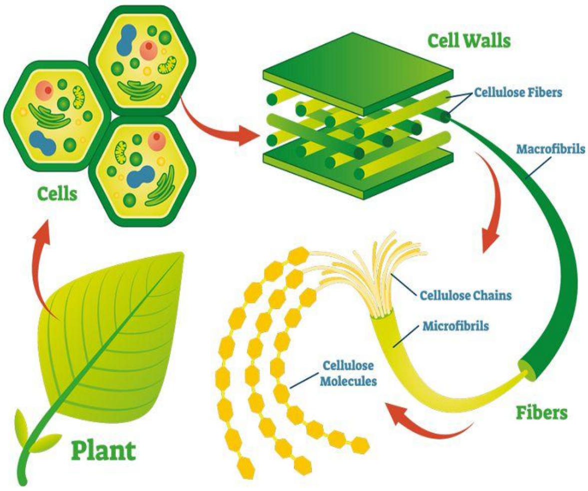

Fig.3 A. Fibers from Plants

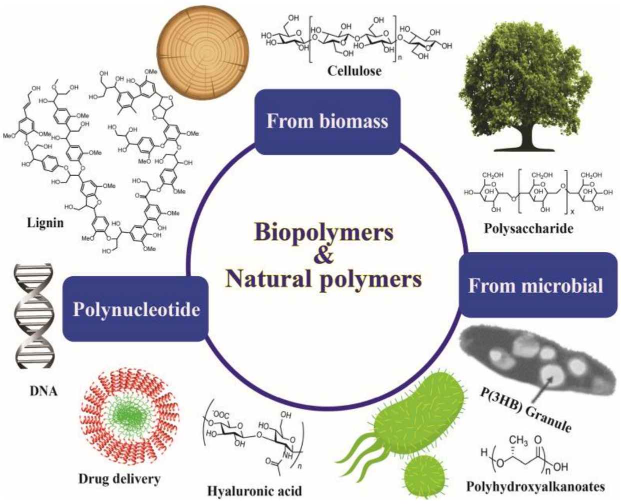

Fig.3 B Biopolymers and Natural polymer

Fig.3 C. Natural rubber latex from the rubber tree.

Fig.3 D. Shellac commercial resin marketed in the form of amber flakes

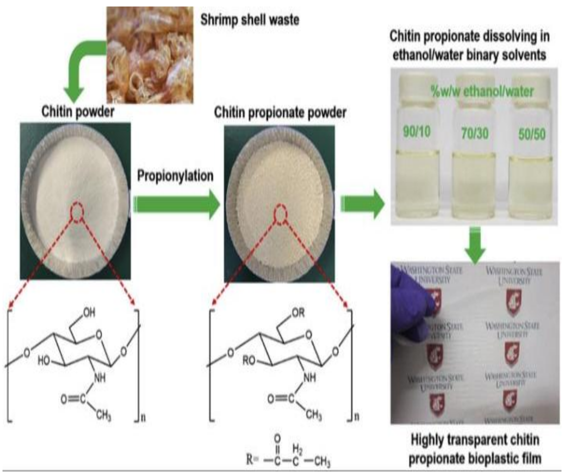

Fig.3 E. Chitin abundant mucopolysaccharide.

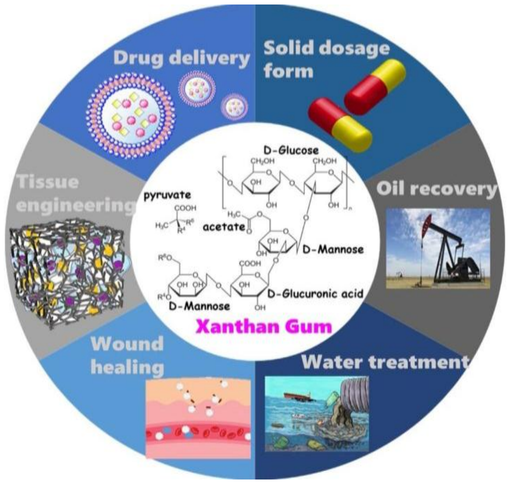

Fig.3 F. Xanthan gum extracellular polysaccharide

Role of Polymers in Pharmaceutical Drug Delivery System

Immediate Release Dosage Forms

Tablets: Microcrystalline cellulose is often used as an alternative to carbohydrates as diluents in tablet formulations of highly potent low-dose drugs. Polymers including polyvinyl-pyrrolidone and hydroxypropyl methylcellulose (HPMC) find uses as binders that aid the formation of granules that improve the flow and compaction properties of tablet formulations.[12]

Capsules

Many of the polymeric excipients used to bulk out capsule fills are the same as those used in immediate release tablets. Gelatin has been used almost exclusively as a shell material for hard (two-piece) and soft (one-piece) capsules. HPMC has recently been developed and accepted as an alternative material for the manufacture of hard gelatin capsules.

Modified-Release Dosage Form: To achieve gastro retention, mucoadhesive and low-density polymers have been evaluated, with little success so far, for their ability to extend gastric residence time by bonding to the mucus lining of the stomach and floating on top of the gastric contents respectively.[13-14]

Extended Release Dosage Forms: Extended and sustained release dosage forms prolong the time that systemic drug levels are within the therapeutic range and thus reduce the number of doses, the patient must take to maintain a therapeutic effect thereby increasing compliance. The most commonly used water-insoluble polymers for extended-release applications are the ammonium ethacrylate copolymers (Eudragit RS and RL), cellulose derivatives ethyl cellulose, and cellulose acetate, and polyvinyl derivative, polyvinyl acetate.[15-16]

Gastro retentive Dosage Forms: Gastro-retentive dosage forms offer an alternative strategy for achieving extended release profile, in which the formulation will remain in the stomach for prolonged periods, releasing the drug in situ, which will then dissolve in the liquid contents and slowly pass into the small intestine.[17]

CONCLUSION

This review paper summarized different aspects of the use of natural products as functional coatings for various applications, highlighting their importance in the production of coatings as they have the advantage of enhancing the physical and chemical properties of the products. From the discussion, it can be concluded that by incorporating drugs in natural polymers, dosage forms that release the drug over a prolong length of time can be prepared in variety of shapes and sizes. Polymers play a vital role in the drug delivery so; the selection of polymer plays an important role in drug manufacturing. But while selecting polymers care has to be taken regarding its toxicity, drug compatibility and degradation pattern. By this review, we can say that natural polymers can be good substitute for the synthetic polymers and many of the side effects of the synthetic polymers can overcome by using natural polymer.

However, it is essential to select the appropriate substrate material, polymer, coating method, and most importantly, the area of the material to be used in clinical applications. Hence, it is important to understand the underlying mechanism, and preferable to use theoretical strategies for the development of such coatings.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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