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Use of natural polymers as excipients in the pharmaceutical industry

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Abstract
The word polymer has a Greek origin, which means many units (parts). Polymer is defined as a chemical substance of a high molecular mass formed by the combination of a large number of simple molecules called monomers. Natural polymers and their derivatives are commonly used in medicine and pharmacy. Recently, special attention has been paid to natural polymers because they are biocompatible and biodegradable, so that they can be hydrolyzed to removable and non-toxic products. The use of natural polymers as excipients in the pharmaceutical industry is expanding every day. Low costs, safety, availability and biodegradable problems are the main reasons that set them apart from other sources. Natural resources have a wide range of varieties and properties. Therefore, they can be used in many pharmaceutical products as excipients for the desired purpose.

Keywords: natural polymer, cost effective, biocompatible, biodegradable, excipient

Introduction
Natural Polymers due to its importance as excipients in the preparation of pharmaceutical doses forms, optimization of drug delivery and development of new pharmacological agents, polymeric materials are necessary for the pharmaceutical industry, for example for biodegradable products polymeric nanoparticles[1-2], biomimetic polymers[3], polymeric drug vesicles and gene delivery[4], nonwoven polymeric nanofibers as new delivery carriers Non-invasive insulin delivery systems for therapeutic molecules[5], effective diabetes treatment [6]. Excipients such as inert vehicles are traditionally added to drug formulations to provide the necessary weight, consistency and volume for proper administration of the active ingredient, but in modern dosage forms they often perform multifunctional tasks such as improving stability, release and bioavailability. Active substance, increased patient acceptance and performance of technological functions that guarantee easy production [7]. Natural Polymer Excipients can be used in a variety of formulations, such as solid, liquid and semi-solid dosage forms, to act as disintegrants, binders, film-forming agents, matrix formers, release modifiers, thickeners, stabilizers, emulsifiers, suspending agents, sweeteners and mucoadhesive [8]. Starch, dextran, cellulose, agar, gums, chitosan, pectins, alginates, hyaluronic acid, collagen, and gelatin are the main natural nontoxic polymers, obtained through sustainable, simple and low-cost methods [9]. The aim of this article is to give an over view of the application of natural polymeric substances that can be used as excipients in pharmaceuticals.

Natural polymers used in pharmaceutical industry
Starch It is a polymer which forms the food reserve for all the plants. The monomer of starch is D-Glucose. When a polymer of starch is formed hundreds of D-Glucose molecules are joined through a linkage known as glycosidic linkage. It is obtained mainly from wheat (*Triticum aestivum*), maize (*Zea mays*) and rice (*Oryza sativa*) grains, and also from potato (*Solanum tuberosum*) tubers or tropical roots [10]. Most common cereal starches contain 15-30% amylose, but discovery of a recessive gene responsible for production of starch enriched with amylose led to the use of a genetically modified crop for the production of different starches for specific purposes. This has led to the creation of corn producing high amylose starch with a content of 50%, 70% and even up to 90% amylose [11-13]. In pharmaceutical industry they are mainly used as binder, disintegrant, aiding drug delivery and film coating material.

Dextran
It is a hydrophilic polysaccharide which is composed of α-1, 6-linked d-glucopyranose. Dextran is achieved from sucrose and maltodextrins with dextransucrase and dextranase, respectively. Dextran can be degraded using dextranase which is available in mammalian tissue. Dextran is a biocompatible and nontoxic polysaccharide which is widely used in pharmaceutical and biomedical applications [14]. Dextran as a reactive oxygen species scavenger and excess platelet activation reducer has been widely used to reduce inflammatory responsive, vascular thrombosis and hinder ischemia–reperfusion damage in organ transplantation. It is reported that dextran can be used as a blood supplement in emergency cases. Moreover, dextran has been used as a coating to improve the biocompatibility of the substrates [15].

Cellulose
It is an organic polysaccharide consisting of a linear chain of several hundred to over ten thousand β(1→4) linked D-glucose units[16].The plant cell wall mainly consist of cellulose, hemicelluloses and pectin. A recent study evaluated bacterial cellulose produced form Acetobacter xylinum as a pharmaceutical excipient for tablet formulations. Due to its good flowability, compressibility and compatibility, microcrystalline cellulose (MCC) is widely used as an excipient for direct compression (granules, inert spheres, hydrophilic matrices [17].

Pectin
Pectin is a complex family of heteropolysaccharides that constitute a large proportion of the primary cell wall plants that use to applications in the pharmaceutical and biotechnology industry. Pectin is divided into two main categories on the basis of its different gelling properties, High methoxyl pectin (HM pectin), which is characterized by a degree of esterification (DE) above 50%, and low methoxyl pectin (LMP) has a DE below 50%. HM pectin forms gels [18]. Pharmaceutical application includes Colon specific drug delivery, controlled release drug delivery, patch and transdermal drug delivery and nano particle drug formulation [19].

Agar
Agar or agar-agar consists of dried gelatinous substance obtained from *Gelidium amansii* (Gelidaceae) and it is also obtained from several other species of red algae like, gracilaria (Gracilariaceae) and Pterocladia (Gelidaceae). Agar-Agar is a unique natural polymer that increasingly preferred over synthetic materials in addition to be considered alternative sources of raw materials for pharmaceutical applications [20-21].

Carrageenan
It is located in the cell wall and intercellular matrix of the seaweed plant tissue. It is obtained from red algae Chondrus crispus family Rhodophyllaceae. It is a high molecular weight polysaccharide with 15% to 40% of ester-sulfate content. Its Pharmaceutical application includes Gelling agent, stabilizer, demulcent and laxative [22-23].

Gelatin
It is protein obtained by partial acid or alkaline hydrolysis of animal collagen tissues like bone, skin, tendon and ligaments. Chemically it contains glycine, alanine, glutamic acid, proline, arginnine, aspartic acid, hydroxyl proline, isoleucine, leucine, phenyalanine and tryptophan. It is water soluble. Elastin, albumin and fibrin are other proteins from animal sources. Gelatin is an important excipient for the production of hard and soft capsules as well as film-coated and effervescent tablets. Manufacturers make use of its unique adhesive, gelling and film-building functionalities [24-25].

Chitosan
It is a long chain polymer of N-acetylglucosamine is a derivative of glucose. It is a primary component of cell wall in fungi, the exoskeletons of anthropoids such as insects, mollusk, scales of fish. It is a modified polysaccharide that contain nitrogen, it is synthesized from units of N-acetyl-D-glucose mine. These units from covalent ß-(1-4) linkage (like the linkages between Glucose units forming cellulose). Chitin may be described as cellulose with one hydroxyl group on each monomer replaced with an acetyl amine group. In Agriculture, It is a good inducer of plant defense mechanisms for controlling diseases. In Industry, it is used in food processing include the formation of edible films & as an additive to thicken and stabilize foods. The pharmaceutical uses of chitosan are coating agent, gel former, and to induce mucoadhesion and permeation enhancement to improve oral availability of drug [26-27].

Hyaluronic acid
It is a naturally occurring, water soluble, polysaccharide that is widely distributed throughout the ECM of all connective tissues in human and other animals. Its viscous solutions have unusual rheological properties (pseudoplasticity) and are exceedingly lubricious to improve the mechanical properties and control the degradation rate, HA can be chemically modified or crosslinked to form a hydrogel. The gel is dependent upon a number of factors including the length of the chain, cross-linking and pH. They are used in the preparation of gels for delivery of drugs to eye and installation into other cavities. Microparticulate HA carrier: Sustained-release formulations (e.g. protein drugs) have been developed using spray-dried HA microparticles which act as a protein reservoir. Also protects the drugs from denaturation and increases their bioactivity Ocular drug delivery. Its viscosity and pseudoplastic behavior which provide mucoadhesive property can increase the ocular residence time [28-29].

Wheat Gluten
It is a protein by-product of the starch fabrication. Their molecular weight is at least ten times higher than that of gliadins. It has been proven to be an excellent film forming agent [30].

Soy Protein
These are soy protein isolate, soy protein concentrates and textured soy protein. It has been used since 1959 as an ingredient in a variety of foods for its functional properties, which include emulsification and texturizing [31].

Xanthan Gum
It is product of gram-negative bacteria Xanthomonas Campestris. It is cellulose derivative contain a cellulose backbone (-D-glucose residue) & a trisaccharide side chain of -D-mannose, D-gluronic acid. It is used in oral & topical formulations, cosmetics, food industry as a suspending and stabilizing agent [32].

Alginate
Alginate is a water-soluble linear polysaccharide extracted from brown seaweed. It is used as suspending agent, stabilizer, coating material, bioadhesive, Microsphere and Gelating agent [33-34].

Guar Gum
Guar gum is the powder of the endosperm of the seeds of *Cyamopsis tetragonolobus* Linn. (Leguminosae). It is natural polysaccharide composed of the sugars galactose and mannose. The pharmaceutical uses are suspending agent, emulsifier, laxative, gelling agent, surgical lubricant, disintegrates and in bacterial culture media [35-36].

Tragacanth Gum
It is the exudate of the Astragalus bush which grows close to the ground and which has a long root that is tapped. is a mixture of substances. The active component seems to be tragacanthin, a soluble polysaccharide. The main fraction, bassorin (60%–70%), contains methyl ether groups and only swells in water, forming gel particles. The exudate also contains cellulose fibers and protein. Its pharmaceutical application includes emulsifier, demulcent, emollient, Suspending agent and sustained release agent [35].

Inulin

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). It is mainly used in Colon specific drug delivery [36].

Psyllium mucilage

Psyllium husk is obtained from the seed of the Plantago ovate plant. The husk of Plantago psyllium used as the raw material to obtain the psyllium mucilage. It has Binder, controlled release property [37].

Rosin

It is yellowish to amber, translucent, hard, brittle, fragmented resin left after distilling the oil of turpentine from the crude oleoresin of the pine. Its pharmaceutical application includes Microencapsulation, film former, coating material, sustained release property, nano particle drug delivery [38].

Acacia

Indian gum is the dried gummy exudation obtained from the stem and branches of Acacia arabica belonging to family Leguminoseae. Main constituent is arabin which is mixture of calcium, magnesium, potassium salts of Arabic acid. Its pharmaceutical application includes Suspending agent, emulsifier, binder, demulcent, emollient and in the osmotic drug delivery system [39-40].

Conclusion

This article highlights natural polymer and its pharmaceutical application. As they are low costs, safety, availability and biodegradable problems are the main reasons that set them apart from other sources. Natural resources have a wide range of varieties and properties. Therefore, they can be used in many pharmaceutical products as excipients for the desired purpose.

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