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Review Article

A Review Of Selective Natural Polymers Used In Pharmaceutical Formulations

Balasundaresan M[1*], Senthil Kumar S. K[1], Ramana A[2]

[1]*Principal, Arunai College of pharmacy, Tiruvannamalai, Tamilnadu, India.*
[1*]*Assistant professor, Department of pharmaceutics, Arunai College of pharmacy, Tiruvannamalai, Tamilnadu, India.*
[2]*B.pharmacy final year Student, Arunai College of pharmacy, Tiruvannamalai, Tamilnadu, India.*

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ABSTRACT

Polymers have been successfully employed in the formulation of solid, liquid and semisolid dosage forms and are specifically useful in the design of modified release drug delivery system. Both synthetic and natural polymers have been investigated extensively for this purpose, but the use of natural polymers 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. One of the most remarkable and useful features of a polymers swelling ability manifests itself when that swelling can be triggered by a change in the environment surrounding the delivery system. This review mainly put emphasis on description of various natural polymers used in drug delivery development process. Polymers are macromolecules which are composed of structurally similar repeated units of monomers. Natural polymers are the ones that are obtained from natural origins like plants, animals or micro-organism. Natural polymers are widely used in pharmaceutical and biochemical industries and their applications are growing at the fast pace as the basic knowledge of polymers helps us to know the function of drug product and also to develop new formulation or better delivery system.

INTRODUCTION

Polymers are a large class of high molecular weight compounds consisting of many small molecules that can be linked together to from long chains. Thus they are known as macromolecules. A typical polymer may include ten thousands of monomers. In Greek, the word poly means 'many' and mers means 'units of parts'. They consist of different functional group. Natural polymers are

***Corresponding Author:** Balasundaresan M
Address: *Assistant professor, Department of pharmaceutics, Arunai College of pharmacy, Tiruvannamalai, Tamilnadu, India*
Email : balams93@gmail.com
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widely used in pharmaceutical and biomedical industries and their application are growing at the fast pace. Basic knowledge of polymers will give us the opportunity to familiarize our self with the function of drug product and also to develop new formulation or better delivery system. Natural polymers are used in pharmaceutical formulations in the manufacture of monolithic matrix system, implants, films, beads, micro particles, nanoparticles and injectable system as well as viscous liquid formulation. Within the dosage form, polymeric material are widely used as binders, matrix formers or drug release modifiers, film coating formers, thickeners or viscosity enhancers, stabilizers, disintegrants, solublizers, emulsifiers, suspending agents, gelling agent and bio adhesives. For centuries man has made effective use of materials of nature origin in the medical and pharmaceutical field. Great variety of flora and fauna has been gifted to India by nature. Now days, the whole world is increasing interested in natural drugs and excipients. Recent years, plant derived polymers have evoked tremendous interest due to their different pharmaceutical applications such as diluents, binder, disitegrant in tablets, thickeners in oral liquids , protective colloids in suspensions, gelling agent in gels and bases in suppository, they are also used in cosmetics, textiles, paints and paper-making. These polymers such as natural gum and mucilage are biocompatible, cheap and easily available and are preferred to semi synthetic excipients because of their low cost, availability, lack of toxicity. Soothing action and non irritant nature. Because of the availability of natural polymer easily, biocompatible, non-toxic in nature the natural polymer has been used in various formulation. Furthermore, they can be modified to obtain tailor made materials for drug delivery system allowing then to compete with the synthetic products that are commercially available. Different kinds of natural gums are used the food industry and are regarded as safe for human consumption. It should be noted that many 'old' materials are still popular today after almost a century of efforts to replace them. It is usual to strike a balance between economics and performance in the face of commercial realities. Demand for these substances is increasing and new sources are being developed. In India, because of its geographical and environmental position, has traditionally been a good source for such products among the Asian countries. Still, large quantities are imported from Europe to meet increasing demand.

The introduction of new polymers has resulted in development of polymers with unique properties. Advances in polymer science have led to the development of novel delivery system. Initially polymers were used as stabilizers solubilisers, and mechanical supports for sustained release of drugs. The polymers have been synthesized for specific needs and to solve specific problems leading with development of drug delivery system. So there is need to understand the role of polymers.

The specific application of plant- derived polymers in pharmaceutical formulations include there in use the manufacture of solid monolithic matrix system, implants, films, beads, micro particles, nanoparticles, inhalable and injectable system as well as viscous liquid formulation. Within the 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, solublizers, emulsifiers, suspending agents, gelling agents.

CLASSIFICATION OF POLYMERS:

Polymer can have different chemical structure, physical properties, mechanical behavior, thermal characteristics and etc....and on the basis of these properties polymer can be classified in different ways.

CLASSIFICATION ON BASIS OF NATURE [10]

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

1. NATURAL POLYMERS:

The polymers which occur in nature are called *natural polymer*. Natural polymers are also known as biopolymers.

Examples of such polymers are natural rubber, natural silk, cellulose, starch, proteins, etc...

The polymer obtained from nature (plants and animal) are called natural polymers. These polymers are very essential for life.

These are various plant based materials. Plant - based material serves as an alternative to synthetic products because of following reason:

- Local accessibility
- Eco - friendliness
- Bio- acceptability
- Having renewable source and low price as compared to synthetic products.

A LIST OF NATURAL POLYMERS:

1. Gaur gum
2. Wheat starch
3. Potato starch
4. Accroides resin
5. Candelilla wax
6. Karaya gums
7. Tracaganth gums.
8. Xanthan gums
9. Gellan Gums
10. Hibiscus rosa sinensis
11. Methyl cellulose
12. Sucrose
13. Gelatin
14. Plantago ovata seed mucilage
15. Fanugreek seed mucilage

1. GUAR GUM: [(1)(10)(11)]

BIOLOGICAL SOURCE AND FAMILY:

Guar gum is derived from the seeds of the drought tolerant plant Cyamopsis tetragonoloba, a member of Leguminosa. Gaur gum is obtained from the endosperm of the leguminous plant Cyamopsis tetragonolobus. Is extraction is through drying the pods in sunlight and their manual separation from the seeds. The commercial gum extraction involves mechanical roasting, seiving, differential attrition and polishing. The seeds are then broken and the endosperm releases the germ. Gaur gum consist of 1,4-linked mannose units with 1,6-galactose as side groups. It is used as a cosmetic thickener and to prevent ice crystals in ice creams. More importantly, gaur gum tablets show a higher swelling index compared to xanthan gum and pectin. Chemically gaur gum is polysaccharides composed of the sugars galactose and mannose. The gelling property retards release of the drug from the dosage form as well as it is susceptible to degradation in the colonic environment. So it can be used for controlled release targeted drug delivery systems due to its drug release retarding property and susceptibility to intestine microbial degradation.

PHYSICO-CHEMICAL PROPERTIES:

The biological properties of gaur galactomannan and other such polysaccharides are dependent on their behavior in an aqueous medium. Gaur gum swells and or dissolves in poor solvent on dispersion and form strong hydrogen bonds. In non polar solvents it forms only weak hydrogen bonds. The rate of gaur gum dissolution and viscosity development generally increases with decreasing particle size, decreasing pH and increasing temperature. Hydrogen rates are reduced in the presence of dissolved salts and other water-binding agents such as sucrose.

USES:

1. It is utilized as thickener, stabilizer, and emulsifier.
2. AND approved in most areas of the world.
3. It is free flowing, consummately soluble; natural polymers composed ofsugar units and are approved.
4. Guar gum is also used as a binding agent in the production of tablets. In addition, guar gum–based hydro gel, micro particle, and nano particle formulations are also studied in the pharmaceutical field.
5. Guar gum is used in beverages for thickening and viscosity control because of its several inherent properties. The important property of guar gum is its resistance to breakdown under low pH conditions present in beverages. Guar gum is soluble in cold water which makes it easy to use in beverage processing plants.
6. Tablet manufacturing is a crucial segment of the pharmaceutical industry. In their production, guar gum serves as both a binder and disintegrator, which forces the tablet to break up and exert its medicinal action upon contact with moisture.

2. WHEAT STARCH :[2]

BIOLOGICAL SOURCE AND FAMILY:

Starch consists of polysaccharide granules obtained from the grains of Maize Zea mays L. or of rice Oryza sativa L or of wheat Triticum aestivum L. (Family- Graminae) or from the tubers of the potato Solarium tuberosum L. (family-Solanaceae).

Wheat is one of the most grown, consumed and traded food grains of the world with the worldwide diversity of thousands of varieties. Wheat starches contain 98 % carbohydrates 0.8-1.0% lipids, 0.2-0.5%proteins and 0.2-0.3% ash. Protein and lipid content in wheat starch have profound effects on functionality and utilization. Wheat starch is produced by physical separation from non starch constituents. The basic steps in these processes were steeping, grinding and separation of grain components. Starch is synthesized as discrete granules of varying sizes in specialized bodies. Different size and shapes of starch granules build up during the development if grain. Amylose and amylopectin are major constituents of wheat starch. Amylose is essentially a linear polymer of glucose with degree of polymerization and branching of 2000-5000 and 0.2-0.5 % respectively. Wheat starch is semi crystalline with the degree of crystalline varying from 9% for high amylose starches to 40% for waxy starches. Retro gradation is a recrystallization process in which disaggregated amylose and amylopectin molecules in gelatinized starches re-associated during cooling and storage to form ordered structures. Retro gradation in starches is commonly measured using DSC, texture analyzer and dynamic rhemeter.

APPLICATIONS:

Recently, interests in development of biopolymer based biodegradable films have increased because of the demand for natural food ingredients and their potential to increase product shelf life and decrease environment pollution. Although the blending of wheat starch with low density polyethylene also resulted in films with reduced tensile strength and flexibility, yet their strength was within the operational limits up to the incorporation level of 20%.The granular wheat starch is also used as filter material in biodegradable but costlier polymers to decrease cost and increase the rate of biodegradation. The incorporation increases the rate of biodegradation but decreased the tensile strength and flexibility of starch-PBHV films, yet the overall mechanical strength remained within the useful range.

USES:

1. Wheat starch is occasionally used as excipients in the formulation of medicinal products such as tablets, capsules and ointments for a variety of functions: as a diluents, a disintegrant, a glidant, or as a binder. Dependent on the quality of the wheat starch, gluten can be present.
2. In many conventional tablets and capsules, starch is used as a diluents, disintegrant, binder, and lubricant. Starch has vital intrinsic properties that have made its pharmaceutical applications possible.
3. Aside from their basic nutritional uses, starches are used in brewing and as thickening agents in baked goods and confections. Starch is used in paper manufacturing to increase the strength of paper and is also used in the surface sizing of paper.

3. POTATO STARCH :[3]

BIOLOGICAL SOURCE:

Potato starch is starch extracted from potatoes. The cells of the root tubers of the potato plant contain leucoplasts (starch grains). To extract the starch, the potatoes are crushed, and the starch grains are released from the destroyed cells.

Potato starch is the extracted starch from potatoes. The starch turns to a light, powdery, flour-like consistency once it has dried out, and it is a common ingredient that features in several receipies. Potato starch is gluten-free, meaning it can work effectively as a gluten-free plain flour alternative in some recipies.

THICKENING AGENTS:

One of the main uses of potato starch is as a thickener in a variety of receipes because it absorbs water effectively. However, extreme heat may cause the starch to break down, meaning it may not absorb moisture properly, which hinders its thickening effect. Therefore, it is best to heat the starch gently and add it gradually to sauces. Potato starch as a thickening agent includes:

* Soups and gravies
* Pie fillings
* Sauces
* Stews and casseroles

BENEFITS:

Carbohydrates are the main energy source for the body. There are three main types:

* Sugars
* Starches
* Dietary fiber

The carbohydrates are in a number of plant foods and dairy products.

POTATO STARCH SUBSTITUTES:

There are several alternatives to potato starch. A person can substitute it with one of the following options.

* Corn starch is suitable for thickening sauces and frying.
* Wheat flour is useful for backing, but it contains gluten. Potato starch is not the same as potato flour. - The farmer is the extracted starch from the crushed potatoes.

USE AND APPLICATIONS:

Potato starch is frequently used as filter in standardized triturates of colorants or potent drugs to facilitate subsequent mixing or blending processes in manufacturing operations. Potato starch is also suitable for the volume adjustment of the fill matrix in dry- filled capsules. Potato starch is ideal filler in the freeze-casting process. Aqueous suspensions of theophylline and potato starch exhibit sufficient flow ability and can be poured in to the moulding form without difficulty, the sedimentation of the suspended particles being prevented during the freezing process.

USES:

1. Thickening agents. One of the main uses for potato starch is as a thickener in a variety of recipes because it absorbs water effectively.
2. Gluten-free alternative to flour. As it is gluten-free, potato starch can make a suitable gluten-free alternative for flour in baking recipes.
3. Frying food is much like cornstarch; potato starch is used to thicken soups, sauces and pie fillings. It's also an essential part of gluten free baking. Depending on which potato starch you buy, it can be gluten free, dairy free, grain free and soy free. All of which makes it a safe add-in ingredient for those with food allergies.

4. ACCROIDES RESIN:(4)

BIOLOGICAL SOURCE:

Accroides is a resin derived from Tate's grass tree, Xanthorrhoea semiplana ssp. tateana, a yacca tree native to Kangaroo Island off the south coast of Australia. Several other species of Xanthorrhoea which are distributed in all regions of mainland Australia produce a similar resin, which is commercially harvested and refined in the south. Lumps of resin collect naturally at the base of dead leaf stems found near the trunk of the tree.

Accroides is a resin derived from Tate's grass tree, tateana. The resin is harvested during the spring season and removed by beating the stem. It is then sieved and winnowed to remove the finer foreign matter before being graded. Alternatively, a steam-operated fusion process can be used, which reduces the losses inherent in the pneumatic method. Accroides is usually sold in the form of a reddish-brown powder known as Course red accroides with a particle size ranging from roughly 2mm to 5mm. The resin has a balsamic, benzoin-like odour due to its benzoic acid content. Accroides is soluble in alcohols and alkalis, and is fully compatible with cellulose nitrate and acetate, but is insoluble in water and hydrocarbons. The resin has good adhesive properties when employed as a coating, while the intense red dye has good staining power when employed in an alcoholic solution as a spirit varnish. The use of natural resin, either by themselves or as constituents of coating materials for decorative and protective purposes, has been practiced from very early times. In general, the natural resins are divided from the point of use into those which are spirit soluble- the "spirit" originally meaning alcohol but now embracing a large variety of solvents-and those which are oil soluble.

USES OF ACCROIDES RESIN:

1. WOOD TREATMENT INDUSTRY:

Accroides is used as a contituents of lacquers, varnishes, stains, sealing wax and floor polish.

2. LEATHER INDUSTRY:

Accroides is used in low cost paper coatings. It is sometimes used as a substitute for rosin in inks and paper sizing.

3. OTHER INDUSTRY:

Accroides is used as an additive in the manufacture of paint, lacquers for metal, foil and glass, and as a black brown dyes.

5. CANDELILLA WAX :(5)

BIOLOGICAL SOURCE:

Candelilla Wax (CW) is a wax obtained from the leaves of a small shrub native to northern Mexico and the southwestern United States, Euphorbia cerifera and Euphorbia antisyphilitica, from the family Euphorbiaceae.

Candelilla wax is a natural plant wax derived from the Euphorbia antisyphilitica Zucc., which in grown in the arid regions of northern Mexico. Candelilla wax based emulsion, edible films and coatings, oleo gels, among others. Furthermore, as food additives, Candelilla wax application may guarantee safe and high- quality foods. Therefore, these innovations clearly illustrate that candelilla wax can be of great value within the food field, thus potentializing its usage.

It has two properties. Candelilla wax is a complex material, hard, shiny easy spray that is derived from plant with the same name through a "traditional" extraction of candelilla wax using a boiling solution of sulfuric acid in which the plant is submerged and the wax is recovered as foam on the boiling water surface. However, this process is highly polluting generates low quality wax and high health damage. Its color varies from light brown to yellow depending on the degree of refining.

CHEMICAL COMPOSITION:

Chemically, are esters of fatty acids and long chain fatty acids Characterized by a high content of hydrocarbons and a relatively low amount of volatile esters. It is insoluble in water, but soluble in acetone, chloroform benzene and other organic solvents.

PROPERTIES:

Candelilla wax is hard and brittle. It is insoluble in water, but soluble in many organic solvents. Lipsticks contain waxes, oils, emollients, antioxidants and pigments. Common ingredients include beeswax, candellila wax.

USES:

1. As a food additive, candelilla wax has the E number E 902 and is used as a glazing agent. It also finds use in the cosmetic industry, as a component of lip balms and lotion bars. One of its major uses is as a binder for chewing gums. Candelilla wax can be used as a substitute for carnauba wax and beeswax.
2. It is mostly used mixed with other waxes to harden them without raising their melting point. As a food additive, candelilla wax has the E number E 902 and is used as a glazing agent. It also finds use in the cosmetic industry, as a component of lip balms and lotion bars. One of its major uses is as a binder for chewing gums.
3. Candelilla wax can be used as a substitute for carnauba wax and beeswax. It is also used for making varnish.

6. KARAYA GUMS :(6)(12)

BIOLOGICAL SOURCE:

Gum karaya is a gum obtained from Sterculia urens trees found in the highlands of central and northern India. It is a heavily acetylated polysaccharide composed of chains of α-d-galacturonic acid and α-l-rhamnose.

Gum karaya is a vegetable gum produced as exudates by trees of the genus Sterculia. Chemically, gum karaya is an acid polysaccharide composed of the sugars galactose, rhamnose, and galacturonic acid. The high viscosity nature of gum limits its uses as binder and disintegrant in the development of conventional dosage form. Gum karaya has been investigated for its potential as a tablet disintegrant. Different results showed that modified gum karaya produces rapid disintegration of tablets. Gum karaya can be utilized as an alternative super disintegrant to commonly available synthetic and semi synthetic super disintegrants due to its low cost, biocompatibility as well as facile availability. Gums are polysaccharides built from multiple simple-sugars units named monosaccharides, this are linked by intermolecular glycosidic bounds to produce big molecules. The karaya gum, also known as sterculia, kadaya, katilo, kullo and kuterra, is native from India that is the main producer and exporter.

pH stability

pH has an important role in karaya gum dispersions stability. These preparations are relatively stables at acid pH values; 1% dispersion is stable at pH range of 4.5-4.7.Viscosity is diminished when an acid or an alkali is added to the dispersion and it can be raised if gum is totally hydrated before make any pH adjust. At pH values above 8, karaya gum can suffer irreversible conversions, dispersion characteristics are damaged because the gum lose its acetyl groups.Karaya gum has a strong capacity to fix with water molecules, gum particles are not fully solubilized, instead it present a phenomenon called swelling that consist in an increment in total volume with relation to dry mass that can be about the 60 times the original volume.

CHEMICAL STRUCTURE AND COMPOSITION:

The gum karaya has a ramnogalacturonane typepartially acetylated ramified structure and is commercially obtained form of and/or magnesium salt. 8% of acetyl groups and 37-40% of acid residues. Gum main chain is formed by á-D-galacturonic acid and L-ramnoseunits. Side chains are linked to main chain by 1, 2-â-D-galactose bounds or 1, 3-â-D-glucoronic bound for galacturonic acid

USES:

1. Karaya gum is a sap-like material taken from a tree that grows in India. People use it to make medicine. Karaya gum is used as a bulk-forming laxative and to increase sexual desire (as an aphrodisiac), but there is no good scientific evidence to support its use.
2. Chemically, gum karaya is an acid polysaccharide composed of the sugars galactose, rhamnose and galacturonic acid. It is used as a thickener and emulsifier in foods, as a laxative, and as a denture adhesive. It is also used to adulterate Gum tragacanth due to their similar physical characteristics.

7. TRACAGANTH GUM :[7]

BIOLOGICAL SOURCE:

Gum tragacanth is obtained from shrubs of the Astragalus species notably A. gummifer and a microcephalus, which are found in the dry mountainous areas in Iran and Turkey. It consists of a water-swellable fraction called tragacanthic acid (or bassorin) (60–70%) and a water-soluble fraction called tragacanthin.

Gum tragacanth is a heterogeneous highly branched polysaccharide obtained from Asiatic species of Astralogus. Tragacanth has traditionally used as emulsifier as well as a thickening, suspending and binding agent. Gums are known to be pathological products generated after plant injuries or due to unfavorable conditions through the breakdown of cell walls. Polysaccharide gums are ones of the most abundant raw materials in nature. Besides being renewable sources, they are easily accessible, relatively affordable, non-toxic, and environmentally friendly, causing their worldwide usage from the food industry to health care systems. Among different well-characterized gums, gum tragacanth is recognized as a versatile material in biomedicine. Generally, Gum Tracaganth, also known as Katira, is sourced from Central Asia and Eastern countries, and Iran is the largest producer and exporter of this natural gum. The relevant information on the Gum tracaganth was obtained from scientific data bases, including Web of Science, Scopus, and PubMed. Tragacanthin is composed of tragacanthic acid, which contains residues of d-galacturonic acid, d-xylose, l-fucose, and d-galactose, and an arabinogalactan, containing residues of l-arabinose, d-galactose, and d-galacturonic acid.

Uses:

1. Gum tragacanth has been used as a stabilizer, emulsifier, and thickener in food products. Its superior water-absorbing qualities make it an excellent thickening agent. Gum tragacanth is used in many everyday commercial products of low viscosity as jellies and pourable dressings.
2. Tragacanth is stable at a pH range of 4-8. It is a better thickening agent than acacia. Tragacanth is used as a suspending agent, emulsifier, thickener, and stabilizer.
3. Tragacanth Gum was used as a natural surfactant in combination with optimum salinity of smart water.

8. XANTHAN GUM :[9][11]

BIOLOGICAL SOURCE:

Xanthan gum is made from bacteria found on the leaf surfaces of green vegetables, including broccoli, Brussels sprouts, cauliflower, cabbage, kale, rutabaga and turnip. The bacteria are fermented.

Xanthan gum is produced by a pure culture fermentation of a carbohydrate with Xanthomonas campestris and purified. 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 contain not less that 1.5% of pyruvic acid. Xanthan gum is an extracellular hetero polysaccharide produced by fermentation of the bacterium. The primary structure of this naturally produced cellulose derivative contains a cellulose backbone and a trisaccharide side chain of D- mannose- D gluronic acid – -D-mannose attached with alternate glucose residues of the main chain. Solutions of xanthan gum demonstrate maximum stability at pH 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 was found to be suitable suspending vehicle for delivering antispasmodics topically along the length of the esophagus in patients with esophageal spasm. Coagulation of the gum had been observed when it was used for suspension of certain film coated tablets. Sedimentation volume of suspension with Carboxy methyl cellulose and xanthan gum, keep for period of 45 days. Results indicated that xanthan gum in a concentration of 0.2% is superior to Carboxy methyl cellulose. Xanthan gum, which is produced from aerobic fermentation by Xanthomonas campestris, is composed of a β-1,4-glycosidic bond-linked main chain and a trisaccharide side chain successively containing mannose, glucuronic acid, and mannose.

USES:

1. Xanthan gum is used as a stabilizer, thickener and emulsifier extensively in pharmaceutical, cosmetic industries and in food industry for dairy products.
2. 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 few drugs had been found to be incompatible.
3. Xanthan gum is used for diabetes constipation, dry eye, and many other conditions, but there is no good scientific evidence to support most of these uses. In manufacturing, xanthan gum is used as a thickening and stabilizing agent in foods, toothpastes, and medicines.
4. A thickening agent for sauces, to create light foams and to keep ingredients from separating when making smoothies, dough and batter.
5. Constipation. Xanthan gum seems to reduce constipation, trouble swallowing. Xanthan gum seems to improve swallowing and reduce the risk of aspirating food.

9. GELLAN GUMS :[11]

BIOLOGICAL SOURCE:

Gellan gum is a linear anionic high molecular weight exopolysaccharide, commercially produced by microbial fermentation of the Sphingomonas paucimobilis microorganism comprised of tetrasaccharide. Gellan gum is a bacterial exo polysaccharide commercially prepared by aerobic. It consists of about 50,000 residues and it is normally de-esterified by alkali treatment before use. Gellan gum forms a 3- fold double helix from two left-handed chains with the acetate residues on theperiphery, and glyceryl groups and hydrogen-bonds stabilizing the inter chain associations.

Gellan gum is a water-soluble polysaccharide produced by Pseudomonas elodea, a bacterium. Gellan gum is an anionic, high molecular weight, deacetylated exocellular polysaccharide gum produced as a fermentation product by a pristine culture of Pseudomonas elodea with a tetra saccharide reiterating unit of one α-L-rhamnose, one β-D-glucuronic acid, and two β-D-glucose residues. Antony and Sanghavi 1997 studied the gellan gum as a disintegrant and the efficiency of gum was compared with other conventional disintegrants. The disintegration of tablet might be due to the instantaneous swelling characteristics of Gellan gum when it comes in contact with water and owing to its high hydrophilic nature. The consummate disintegration of tablet was has proved itself as superior disintegrant. It is an anionic polysaccharide composed of a tetrasaccharide repeating unit of one α-L-rhamnose (Rhap), one β-D-glucuronic acid (GlcpA) and two β-D-glucoses (Glcp).

USES:

Gellan gum is used as a thickener, binder, and stabilizer in different food applications. It mainly stabilizes the water-based gels, such as desserts and drinking jellies. Even gellan replaces gelatin in some dairy products, such as yogurt and sour cream in vegan items.

10. HIBISCUS ROSA SINENSIS:[7][12][13]

BIOLOGICAL SOURCE:

Endemic to south East Asia, Hibiscus rosa-sinensis is grown ornamentally worldwide, and is one of the most common plants to use in labratories for its flower.

It is withal called shoe flower plant, China rose, and Chinese hibiscus and belongs to the family Malvaceae. Mucilage's are utilized as thickeners, suspending agent, water retention agent, and disintegrants. The plant is facilely available and its leaves contain mucilage and is present in mucilage L-rhamnose, D-galactose, D-galacturonic acid, and D-glucuronic acid. Treated agar is yare by treating it with water for one day.

Traditionally, Hibiscus flowers has been reported to possess antitumor properties, as well as have been used as analgesic, antipyretic, anti-asthmatic, and anti-inflammatory agents. Several studies have proved the presence of anti-oxidant, anti-fungal, and antimicrobial properties in flowers of Hibiscus rosa-sinensis. Research on extracts of stems, roots, leaves, and flowers from Hibiscus have revealed that its photochemical components contributed to beneficial findings to human's health such as antioxidant activity, which is the removal of free radicals that can lead to DNA damage.Hibiscus rosa-sinensis belongs to phylum 'Magnoliophyta', because it is a flowering plant that has true leaves, stems and roots, as well as carpels enclosing ovules, and to the 'class' Magnoliopsida, as it is a eudicot type of plant meaning that it flowers in groups of four/five, its leaves display netlike veins, and its seeds contain two cotyledons.

Each part of Hibiscous rosa sinensis contains a wide range of compounds. It was reported that phlobatannins, glycosides, saponins, flavonoids, terpenoids including other compounds such as thiamine, riboflavin and niacin are present in leaves, flowers, stem and roots. According to Patel and Adhav, whose their study was conducted on four different morphotypes of Hibiscous rosa sinensis , glucosides,flavonoids, phytosterols, terpenoids, tannins, and phenolic compounds contributed to the pharmacological effects of the plant as they were present in all of them. This suggested that although the flower color differed, the phytochemical constituents were very similar. These findings also correlates with those of another study carried out by thin layer chromatographic analysis. The phytochemical analysis showed that Hibiscusrosa-sinensis contained tannins, anthraquinones, quinines, phenols, flavanoides, alkaloids, terpenoids, saponins,

Cardiac glycosides, protein, free amino acids, mucilage, essential oils and steroids.

USES:

1. This plant has various important medicinal uses for treating wounds, inflamation, fever and coughs, diabetes, infections caused by bacteria and fungi, hair loss, and gastric ulcers in several tropical countries.
2. Hibiscus is used for treating loss of appetite, colds, heart and nerve diseases, upper respiratory tract pain and swelling (inflammation), fluid retention, stomach irritation, and disorders of circulation; for dissolving phlegm; as a gentle laxative; and as a diuretic to increase urine output.

11. METHYL CELLULOSE :[8]

BIOLOGICAL SOURCE:

Methyl cellulose does not occur naturally and is synthetically produced by heating cellulose with caustic solution (e.g. a solution of sodium hydroxide) and treating it with methyl chloride.

Methyl cellulose is the methyl ether of cellulose with laxative activity. Methylcellulose is one of the most important commercial cellulose ethers and it has been used in many industrial applications. Methyl cellulose is the simplest cellulose derivative, where methyl groups substitute the hydroxyls at C-2, C-3 and/or C-6 positions of anhydro-d-glucose units.This cellulose derivative has amphiphilic properties and original physicochemical properties.

Methyl cellulose becomes water soluble or organo soluble when the degree of substitution varies from 0 to 3.It shows a singular thermal behaviour in which aqueous solution viscosity is constant or slightly decreasing when temperature increases below a critical temperature point. If temperature continues to increase, viscosity strongly increases resulting in the formation of a thermo reversible gel. These characteristics classify Methyl cellulose as a lower critical solution temperature polymer. Methylcellulose is usually synthesized by etherification of cellulose. The hydrophilic character of the hydroxyl groups provides its solubility in aqueous systems and the methyl substituent prevent chain–chain packing forming in the cellulose crystalline phase. It is known that the solubility of methyl cellulose depends on the degree of substitution and the distribution of methoxyl group. Methyl cellulose does not occur naturally and is synthetically produced by heating cellulose with caustic solution and treating it with methyl chloride. In the substitution reaction that follows, the hydroxyl residues are replaced by methoxide. Different kinds of methyl cellulose can be prepared depending on the number of hydroxyl groups substituted.

Cellulose is a polymer consisting of numerous linked glucose molecules, each of which exposes three hydroxyl groups. The Degree of Substitution of a given form of methyl cellulose is defined as the average number of substituted hydroxyl groups per glucose. The theoretical maximum is thus a degree of substitution of 3.0; however more typical values are 1.3–2.6. Different methyl cellulose preparations can also differ in the average length of their polymer backbones

USES:

1. Methyl cellulose is used to treat constipation. Effects generally occur within three days. It is taken by mouth and is recommended with sufficient water. Side effects may include abdominal pain. It is classified as a bulk forming laxative. It works by increasing the amount of stool present which improves intestinal contractions.
2. It is available over the counter. It is sold under the brand name Citrucel among others.
3. Methyl cellulose is used in the manufacture of drug capsules; its edible and nontoxic properties provide a vegetarian alternative to the use of gelatin.

12. SUCROSE :[11]

BIOLOGICAL SOURCE:

Sucrose occurs naturally in sugarcane, sugar beets, sugar maple sap, dates, and honey. It is produced commercially in large amounts (especially from sugarcane and sugar beets) and is used almost entirely as food.

Sucrose is a molecule composed of two monosaccharides, namely glucose and fructose. This non-reducing disaccharide has a chemical formula of $C_{12}H_{22}O_{11}$. Sucrose is commonly referred to as table sugar or cane sugar. Sucrose is the end product of photosynthesis and the primary sugar transported in the phloem of most plants. Sucrose synthase is a glycosyl transferase enzyme that plays a key role in sugar metabolism, primarily in sink tissues.Sucrose synthase belongs to the glycosyltransferase-4 subfamily of glycosyltransferases, a large family that includes a wide variety of glycosyltransferases, including SPS, trehalose synthase, and trehalose phosphorylase.

USES:

1. It is often used in medications to impart a pleasant taste to often unpalatable chemicals. Sucrose can be found in many medical dosage forms such as chewable tablets, syrups, lozenges, or gums. Sugar-free formulations of many of these dosage forms exist as well.
2. An excipient is an inactive substance that acts as the dosage vehicle for an active drug. In the pharmaceutical industry, sugar often occupies this role, performing functions ranging from adding bulk and consistency to tablets, to making unpleasant tasting medicines palatable.

13. GELATIN :(10)(11)

BIOLOGICAL SOURCE:

Gelatin is a protein obtained by thermal denaturation of collagen, the main constituent of connective tissue. Being a derivate product of collagen, gelatin has similar structural features and properties

Gelatin is obtained it is a translucent, colorless, brittle, flavorless solid substance. It is commonly used as a gelling agent in food and pharmaceuticals. The approximate amino acid composition of gelatin is

- glycine 21%
- prolin12%
- hydroxyproline 12%
- glutamic acid 10%
- alanine 9%
- arginine 8%
- aspartic acid 6%
- lysine 4%
- serine 4%
- valine 2%
- phenylalanine 2%
- threonine 2%
- isoleucine 1%
- hydroxylysine 1%
- methionine
- histidine<1%
- tyrosine<0.5%

Gelatin is used in nanoparticles as drug carrier system for uptake in lymphocytes, agar modified gelatin A and gelatin B, this modified gelatin nanoparticles for intracellular DNA delivery , hydrophobic hexanoyl anhydrides grafting to the amino groups of primitive gelatin cationiced gelatin ,DNA-loaded gelatin nanoparticles ,modified gelatin microspheres impregnated collagen scaffold. Gelatin is produced by partial hydrolysis of collagen extracted from the boiled bones, connective tissues, organs and some intestines of animals such as domesticated cattle and pigs. Gelatin is a natural water-soluble macromolecule resulting from the heat dissolution and partial hydrolysis of collagen. There are two types of gelatin:

Type-A gelatin is obtained by acid treatment of collagen with the iso electric point between 7.0 and 9.0, whereas.

Type-B gelatin is produced via alkaline hydrolysis of collagen with the pH between 4.8 and 5.0. Gelatin offers a number of advantages over other synthetic polymers including non-irritability, biocompatibility and biodegradability, which makes it one of the desirable materials as carrier molecule. Gelatin has large number of functional groups on its surface which aid in chemical cross-linking and derivatization. These advantages led to its application for the synthesis of nanoparticles for drug delivery during the last thirty years.

USES:

1. Gelatin is widely used to create the shell for both hard and soft capsules, providing an effective means of protecting the contents from

light, atmospheric oxygen, contamination and microbial growth as well as masking taste and odor. Hard capsules represent 75% of the gelatin capsule market.

2. Gelatin is a common ingredient in soups, broths, sauces, gummy candies, marshmallows, cosmetics, and medications. This common thickening and gelling agent is an animal-based product that contains high levels of protein.

14. PLANTAGO OVATA SEED MUCILAGE :(12)(13)

BIOLOGICAL SOURCE:

The biological source of plantago is plantago psyllium. It is the dried ripe seeds of this tree. It belongs to the plantaginaceae family.

Psyllium or ispaghula is the prevalent name utilized for several members of the plant genus Plantago whose seeds are utilized commercially for the production of mucilage. Mucilage of Plantago ovata has different characteristics like **binding, disintegrating, and sustaining properties.**

In an investigation fast disintegrating tablets of amlodipine besylate was yare by direct compression method utilizing different concentrations of Plantago ovata mucilage as natural super disintegrants. All formulations were evaluated for weight variation, hardness, friability, disintegration time, drug content, and dissolution. The optimized formulation shows less in vitro disintegration time of 11.69 seconds with rapid in vitro dissolution within 16 minutes. In vitro disintegration time decreases with increase in concentration of natural super disintegrant.

Plantago ovata mucilage is used as natural superdisintegrant. The mucilage also has various properties like binding, disintegrating and sustaining property. The dried seeds of Isapghula husk of a plant called as plantago ovata. The swelling index of the tablets is around 89+ 2.2%v/v. FDTs are rapidly disintegrated due to the presence of mucilage which create hydrodyanamic pressure. The mucilage is clear, colourless gel. It is obtained from the seed coat of psyllium. Milled seed mucilage is white fibrous material which is hydrophilic in nature. Carbamazepine is poorly soluble drug its solubility, bioavailability and effectiveness increases by adding plantago ovata seed powder and mucilage as super disintegrating agent.

USES:

1. Plantago ovata mucilage also has economic relevance, in that in its dry state it constitutes the basis of a dietary fibre supplement, called psyllium, that is widely consumed by humans to assist with laxation, relieving constipation and to treat metabolic disorders like hypercholesterolaemia.
2. Blond psyllium (Plantago ovata) is an herb. Its seed husk is used as a laxative and stool softener and to help reduce cholesterol. Psyllium seed husks absorb water in the stomach and form a large mass. This mass stimulates the bowel in people with constipation.

15. FENUGREEK SEED MUCILAGE:(12)(13)

BIOLOGICAL SOURCE:

Fenugreek seed mucilage (FSM) was basically isolated from Trigonella foenum-graecum L. seeds known as methi, commonly used for culinary purpose. A high percentage of mucilage was obtained from fenugreek seeds.

Trigonella foenum-graceum commonly kenned as fenugreek, is an herbaceous plant of the leguminous family. Fenugreek seeds contain a high percentage of mucilage. Albeit it does not dissolve in water, mucilage forms a viscous tacky mass when exposed to fluids. Like other mucilage containing substances, fenugreek seeds swell up and become slick when they are exposed to fluids. Hence, the study revealed that this natural disintegrant (fenugreek mucilage) showed more preponderant disintegrating property than the most widely used synthetic super disintegrants like Ac-di-sol in the formulations of FDTs. Studies betokened that the extracted mucilage is a good pharmaceutical adjuvant and concretely a disintegrating agent.

USES:

1. Trigonella Foenum-graceum (Fenugreek) mucilage is derived from the endosperm of the seeds. It consists of galactose and mannose. It gives high viscosity in aqueous solution. The fenugreek gum is used for thickening, stabilizing and emulsifying food agents.
2. Fenugreek is used as an ingredient in spice blends and a flavoring agent in foods, beverages, and tobacco. Fenugreek extracts are also used in soaps and cosmetics. In North Africa, Asia, and southern Europe, fenugreek was traditionally used for diabetes and to increase milk supply in women who were breastfeeding.

CONCLUSION

The challenge of using natural polymers or developing new biomaterials is not only to understand their mode of action in nature but also to correctly coordinate the complex interplay between chemistry, biology, physics, and engineering. The number of possible parameters seems to be endless because not only pure polymers on their own are considered but also different blends thereof, with the possibility to even include chemical steps to further functionalize and tailor the final material properties. However, the main challenges that are currently faced are the low-cost manufacturing and the scale-up of surface modifications to mimic nature's choice of material and to use them in a different environment to provide new solutions in biomedicine and tissue engineering. However, novel materials are to be expected in future. The marine environment shares similarities with the human body, with both are water-based saline systems. As a result, the sea has to represent a prolific source of inspiration for various biomedical applications, from scaffolds for tissue engineering to adhesives in drug delivery systems.

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