ANTIBACTERIAL PROPERTIES OF NATURAL POLYMERS

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Keywords: - Polymers, Sodium Alginate, Pectin, Anti-bacterial, Preservative

Abstract-Natural Polymers are mainly used in the formulation as a medium which hastens therapeutic properties of active ingredients in final dosage form by imparting physicochemical parameters in pharmaceutical preparation, is referred as excipients. But natural polymers have antibacterial properties apart from pharmaceutical aid. This article describes antibacterial properties of two natural polymers sodium alginate and pectin. Polymers are widely used in pharmaceutical preparation but the long term preservative efficacy makes natural polymers frequent selection in the formulation. Formulations containing Sodium alginate and pectin as a vehicle have effective preservative properties.

Index Terms— Polymers, Sodium Alginate, Pectin, Anti-bacterial, Preservative, Monomers, Polymerization

1. INTRODUCTION

The word poly means "many" (Greek) and meros meaning "parts", so the meaning of polymers is many parts having network of molecules with many repeating units and they are strung together by covalent bond to make long chain that can be either three, two or one dimensional. Polymer structure contains many small molecules or repeating unit termed as monomer. When polymers treated with chemical reaction it enhances the molecules weight, and process is termed as polymerization.

Polymers are three types.

1. **Natural Polymers**
2. **Synthetic Polymers**
3. **Semi-synthetic Polymers**

1.1 Natural Polymers- Natural polymers found in nature and can be extracted. They are often water-based.

Types of natural polymers

i). Plant Origin - Cellulose, Hemi cellulose, Glucomannan, Agar, Starch, Pectin, Insulin, Rosin, Guar gum, Locust bean Gum, Gum Acacia, Karaya gum, GumTragacanth, Aloe Vera gel.

ii). Animal Origin - Chitin, Alginates, Carageenans, Psyllium, Xanthum gum.

Natural polymers made very large market in pharmaceutical industry because plenty of properties like non-toxicity, economic, stable easily available and can easily modified by chemical reactions. Natural polymers are biocompatible, so they improve drug release, absorption and solubility of formulations. They are mainly polysaccharides, so they impart nutritional value in formulations.

1.2. Synthetic Polymers- A synthetic polymer is refereed as plastics made by human from artificial components rather than natural ones. Examples of synthetic polymers are polythene, polystyrene, poly acrylates olyamides, polyesters, polyurethanes polysulfide, polycarbonates, nylon, Teflon and polyvinyl chloride.

1.3. Semi –Synthetic Polymers-The chemical treatment of natural polymers to modify physical properties termed as semi synthetic –polymers. Examples are starch, silicons and vulcanized rubber.

2. SODIUM ALGINATE

Sodium alginate consist mainly sodium salt of alginic acid which is mixture of polyuronic acids composed of residue of D-manuronic acid and L-guluronic acids and is obtained from algae belonging to the order phaeophyceae. It dissolves slowly in water, forming a viscous solution and insoluble in ethanol and ether.

2.1 Structural Formula

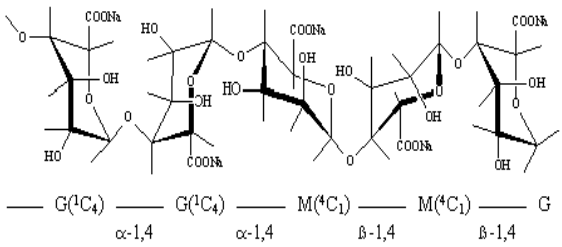

Fig. 1. Structural formula of Sodium Alginate polymer.

2.2 Application

It is used as anti reflux, dental impression material, denture fixatives, wound dressing, encapsulation and film forming properties. Alginic acid powder swells when wetted with water. This has led to its use as a tablet disintegrates for some specialized applications. Alginic acid has also been

used in some dietary foods, such as biscuits; it swells in the stomach and, if sufficient is taken, it gives a "full" feeling so the person is dissuaded from further eating.

The same property of swelling has been used in products such as Gaviscona tablets, which are taken to relieve heartburn and acid indigestion. The swollen alginic acid helps to keep the gastric contents in place and reduce the likelihood of reflux irritating the lining of the esophagus. Alginate is used in the controlled release of medicinal drugs and other chemicals. In some applications, the active ingredient is placed in a calcium alginate bead and slowly released as the bead is exposed in the appropriate environment. More recently, oral controlled-release systems involving alginate microspheres, sometimes coated with chitosan to improve the mechanical strength, have been tested as a way of delivering various drugs.

2.3 Cross-Linking of Sodium Alginate

Sodium alginate is a polymer which can be extracted from brown seaweed and kelps. It is one of the structural polymers that help to build the cell walls of these plants. It has some unusual properties and a wide variety of uses. The polymer can be represented like this:

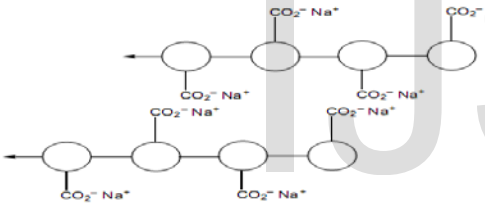

Fig. 2. Sodium Alginate

When sodium alginate is put into a solution of calcium ions, the calcium ions replace the sodium ions in the polymer. Each calcium ion can attach to two of the polymer strands. This is called cross-linking and can be represented like this:

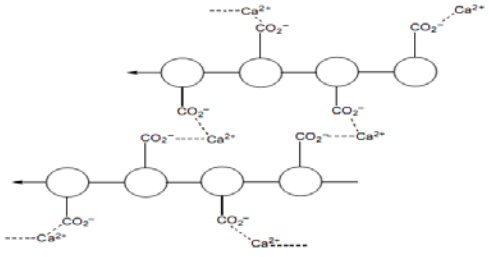

Fig. 3. Cross-linking of sodium alginate

3. PECTIN

Pectin is a purified carbohydrate product obtained from the dilute acid extract of the inner portion of the rind of citrus fruits or apple pomace. It comes chiefly of partially methoxylated polyglactouronic acids. It has been used successfully for many years in the food and beverage industry as a thickening agent, a gelling agent and a colloidal stabilizer. Pectin also has several unique properties that have enabled it to be used as a matrix for the entrapment and/or delivery of a variety of drugs, proteins and cells.

3.1 Structure

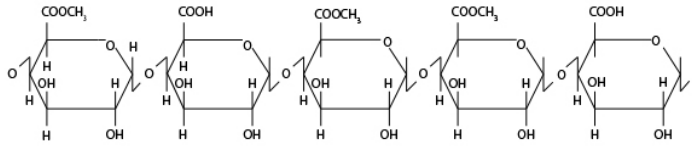

Fig. 4. Structural formula of Pectin polymer.

3.2 Gel Formation Properties of Pectin

The most important use of pectin is based on its ability to form gels. High methoxy pectin forms gels with sugar and acid. This can be seen as a partial dehydration of the pectin molecule to a degree where it is in a state between fully dissolved and precipitated. The particular structure of pectin imposes some specific constraints. High methoxy pectin, unlike low methoxy pectin, does not contain sufficient acid groups to gel or precipitate with calcium ions, although other ions such as aluminium or copper cause precipitation under certain conditions. It has been suggested by Oakenfull (1991) that hydrogen bonding and hydrophobic interactions are important forces in the aggregation of pectin molecules. Gel formation is caused by hydrogen bonding between free carboxyl groups on the pectin molecules and also between the hydroxyl groups of neighbouring molecules.

In a neutral or only slightly acid dispersion of pectin molecules, most of the unesterified carboxyl groups are present as partially ionised salts. Those that are ionized produce a negative charge on the molecule, which together with the hydroxyl groups causes it to attract layers of water. The repulsive forces between these groups, due to their negative charge, can be sufficiently strong to prevent the formation of a pectin network. When acid is added, the carboxyl ions are converted to mostly unionized carboxylic acid groups.

3.3 Pharmaceutical Uses of Pectin

Pectin has applications in the pharmaceutical industry. Pectin favorably influences cholesterol levels in blood. Pectin acts as a natural prophylactic substance against poisoning with toxic cations. It has been shown to be effective in removing lead and mercury from the gastrointestinal tract and respiratory organs (Kohn, 1982). Pectin has a promising pharmaceutical uses and is presently considered as a carrier material in colon-specific drug delivery systems (for systemic action or a topical treatment of diseases such as ulcerative colitis, Cohn's disease, and colon carcinomas). Pectin is an interesting candidate for pharmaceutical use, e.g. as a carrier of a variety of drugs for controlled release applications. Pectin reduces rate of digestion by immobilizing food components in the intestine. This results in less absorption of food.

4. PRESERVATIVE PROPERTIES OF NATURAL POLYMERS

Polymers are important excipients used in formulation like tablets, controlled release formulations (buccal patches and transdermal patches), solutions, microsphere and emulsion gel beads. The specific application of plant-derived polymers in pharmaceutical formulations include their use in the manufacture of solid monolithic matrix systems, implants, films, beads, micro particles, 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. A formulation containing sodium alginate and pectin and other natural polymers free from bacterial infection for a very long period of time, and shelf life is greater than formulation not containing natural polymers. These formulations need not any other preservatives or very little amount of preservatives to preserve the formulation because natural polymers have excellent anti bacterial properties for very long period of time. In case of patches either buccal or transdermal natural polymers used as drug containing layer, apart from this, presence of natural polymers(sodium alginate, pectin) impart preservatives properties in films for great amount of time.

5. CONCLUSION

Today polymers have very large market, whether it is synthetic or natural polymers. In pharmaceutical industry natural polymers are extensively used but most commonly it is used as additives not as preservatives. Most important properties of sodium alginate and pectin are its bacterial resistant properties. A preparation containing natural polymers as backing layer or drug containing layer can also work as preservative for that formulation. Whatever the type of formulation either buccal patches, transdermal patches and tablets natural polymers also imparts antibacterial properties to that formulation, but it shows best results of antibacterial properties in controlled release formulations.

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