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Review

Pharmaceutical applications of various natural gums, mucilages and their modified forms

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ABSTRACT

A large number of plant based pharmaceutical excipients are available today. Gums and mucilages are the most commonly available plant ingredients with a wide range of applications in pharmaceutical and cosmetic industries. They are being used due to their abundance in nature, safety and economy. They have been extensively explored as pharmaceutical excipients. They are biocompatible, cheap and easily available. Natural materials have advantages over synthetic ones since they are chemically inert, nontoxic, less expensive, biodegradable and widely available. They can also be modified in different ways to obtain tailor-made materials for drug delivery systems and thus can compete with the available synthetic excipients. Recent trend toward the use of plant based and natural products demands the replacement of synthetic additives with natural ones. In this review, we describe the pharmaceutical applications of various natural gums, mucilages and their modified forms for the development of various drug delivery systems.

Contents

1. Introduction

In recent years, plant derived polymers have evoked tremendous interest due to their diverse pharmaceutical applications such as diluents, binders, disintegrants in tablets, thickeners in oral liquids, protective colloids in suspensions, gelling agents in gels and bases in suppository (Zatz & Kushla, 1989); they are also used in cosmetics, textiles, paints and paper-making (Jani, Shah, Prajapati, & Jain, 2009). The plant based polymers have been studied for their application in different pharmaceutical dosage forms like matrix controlled system, film coating agents, buccal films, microspheres, nanoparticles, viscous liquid formulations like ophthalmic solutions, suspensions, implants and their applicability and efficacy has been proven (Alonso-Sande, Teijeiro, Remuñán-López, & Alonso, 2009; Chamarthy & Pinal, 2008; Pandey & Khuller, 2004). These have also been utilized as viscosity enhancers, stabilizers, disintegrants, solubilizers, emulsifiers, suspending agents, gelling agents and bioadhesives, binders in the

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above mentioned dosage forms (Guo, Skinner, Harcum, & Barnum, 1998).

Many natural polymeric materials have been successfully used in sustained-release tablets. These materials include: guar gum, isapghula husk, galactomannon from *Mimosa scabrella*, *Gleditsia triacanthos* Linn (honey locust gum), *Sesbania* gum, mucilage from the pods of *Hibiscus esculenta*, tamarind seed gum, gum copal and gum dammar, agar, konjac, chitosan, etc. (Efentakis & Kouttis, 2001). Industrial gums and mucilages, which, for the most part, are water-soluble polysaccharides, have enormously large and broad applications in both food and non-food industries. Their use depends in the unique physicochemical properties that they provide, often at costs below those of synthetic polymers. The gums and mucilages are frequently used as thickening, binding, emulsifying, suspending and stabilizing agents in pharmaceutical industries. They have also been used as matrices for sustained release of drugs. Gums and mucilages are interesting polymer for the preparation of pharmaceutical formulations, because of their high water-swellability, non-toxicity, low cost and free availability. Gums and mucilages are polysaccharides or complex carbohydrate containing one or more monosaccharides or their derivatives linked in bewildering variety of linkages and structures. They are condensation polymers. The term gum refers to polysaccharide hydrocolloids, which do not form a part of cell wall, but are exudates or slims and are pathological products. Mucilages are part of cell and physiological products (Kulkarni, Gowthamarajan, Rao, & Suresh, 2002; Kulkarni, Gowthamarajan, Satish, & Suresh, 2002).

Robbins has stated, "in spite of the problems which have beset the gums market in recent years, the fact remains that in many cases the gums provide a valuable source of income for many poor smallholders or itinerant laborers, either in very poor countries or in the poorest regions rather than more developed countries as such they are important commodities. . ." (Robbins, 1988). This remains true today. Tens of thousands of people worldwide, living in regions ranging from semiarid deserts to rainforests, depend on the collection of gums, resins and latexes in order to provide them with an income. Equally, many millions of people around the world make use of these products in their everyday life (Jani et al., 2009).

Polysaccharide hydrocolloids including mucilages, gums and glucans are abundant in nature and commonly found in many higher plants. These polysaccharides constitute a structurally diverse class of biological macromolecules with a broad range of physicochemical properties which are widely used for various applications in pharmacy and medicine. Although mucilages can occur in high concentrations in different plant organs, their physiological function in most cases is unclear. Mucilages found in rhizomes, roots and seed endosperms may act primarily as energy reserves whereas foliar mucilages appear not to serve as storage carbohydrates (Clifford, Arndt, Popp, & Jones, 2002). Due to the high concentration of hydroxyl groups in the polysaccharide, mucilages generally have a high water-binding capacity and this has led to studies of their role in plant water relations. It has been suggested that the ability of mucilage to hydrate may offer a mechanism for plants to resist drought (Clarke, Andreson, & Stone, 1979). By the term "mucilage in plants" is meant those substances which are soluble or at least swell very perceptibly in water and which, upon the addition of alcohol, are precipitated in a more or less amorphous or granular mass. Mucilage originates in the plant either as a part of the contents of the cell or as a part of the wall thereof.

The fact for increase in importance of natural plant based material is that plant resources are renewable and if cultivated or harvested in a sustainable manner, they can provide a constant supply of raw materials. However, substances from plant origin also pose several potential challenges such as being synthesized in small quantities and in mixtures that are structurally complex, which may differ according to the location of the plants as well as other variables such as the season. This may result in slow and expensive isolation and purification process. This review gives an insight of applications of natural gums and mucilages in pharmaceutical science as an excipient. Specific references are also made to the use of natural gums, mucilages and their modified form in the design of novel dosage form.

2. Chemical nature of gums and mucilages

Gums and mucilage, because of their polysaccharide nature, produce an indefinite number of monosaccharides on hydrolysis. Depending on the type of hydrolysis products obtained, they can be further classified into pentosans (e.g. xylan) and hexosans (e.g. starch and cellulose).

Gums are pathological products consisting of calcium, potassium and magnesium salts of complex substances known as 'polyuronides'. Mucilages are physiological products related to gums, but they are generally sulfuric acid esters, the ester group being a complex polysaccharide. Both gums and mucilages are closely related to hemicelluloses in composition, except that the sugars produced by hemicelluloses are glucose, mannose and xylose, whereas those produced by gums and mucilages are galactose and arabinose.

Identification of constituent sugar units in a polysaccharide is done by hydrolysis using dilute mineral acids, followed by separation of liberated monosaccharides using different chromatographic techniques. Estimation of total carbohydrate content of a polysaccharide and also the content of monosaccharides can be done by phenol–sulfuric acid method.

The mode of linkage between the monosaccharides can be determined by methylation, periodate and lead tetra-acetate oxidation. Graded hydrolysis technique can be used to get a spectrum of oligosaccharides, which can be further analyzed to get information on sequence of different sugar residues. NMR and mass spectroscopy techniques can also be used for structural elucidation of gums and mucilages.

3. Classification of gums and mucilages

Gums and mucilages are present in high quantities in verities of plants, animals, seaweeds, fungi and other microbial sources, where they perform a number of structural and metabolic functions; plant sources provide the largest amounts. The different available gums are classified in Table 1 (Jani et al., 2009; Vikas et al., 2011).

The different available mucilages are classified in Table 2 (Rishabh, Pranati, & Kulkarni, 2011).

4. Pharmaceutical applications of gums and mucilages

Gums and mucilages possess a complex, branched polymeric structure because of which they exhibit high cohesive and adhesive properties. Such properties are highly useful in pharmaceutical preparations. Hence, gums and mucilages find diverse applications in pharmacy. They are ingredients in dental and other adhesives and as bulk laxatives. These hydrophilic polymers are useful as tablet binders, disintegrants, emulsifiers, suspending agents, gelling agents, stabilizing agents, thickening agents, protective colloids in suspension and sustaining agents in tablets (Deore & Khadabadi, 2008). Pharmaceutical applications of some gums and mucilages that are used commercially as adjuvants in pharmaceutical formulations are summarized in Tables 3–5.