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Review

Locust bean gum: A versatile biopolymer

Vipul D. Prajapati[a,*], Girish K. Jani[a], Naresh G. Moradiya[a], Narayan P. Randeria[a], Bhanu J. Nagar[b]

[a] Department of Pharmaceutics, S.S.R. College of Pharmacy, Saily-Silvassa Road, Saily, Silvassa, U.T. of D.N.H. 396 230, India
[b] Department of Pharmaceutics, Rofel Shri G.M. Bilakhia College of Pharmacy, Namdha Campus, Namdha Road, Vapi 396 191, Gujarat, India

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ABSTRACT

Biopolymers or natural polymers are an attractive class of biodegradable polymers since they are derived from natural sources, easily available, relatively cheap and can be modified by suitable reagent. Locust bean gum is one of them that have a wide potentiality in drug formulations due to its extensive application as food additive and its recognized lack of toxicity. It can be tailored to suit its demands of applicants in both the pharmaceutical and biomedical areas. Locust bean gum has a wide application either in the field of novel drug delivery system as rate controlling excipients or in tissue engineering as scaffold formation. Through keen references of reported literature on locust bean gum, in this review, we have described critical aspects of locust bean gum, its manufacturing process, physicochemical properties and applications in various drug delivery systems.

Contents

* Corresponding author at: Department of Pharmaceutics and Pharmaceutical Technology, S.S.R. College of Pharmacy, Saily-Silvassa Road, Saily, Silvassa, U.T. of Dadra and Nagar Haveli 396 230, India. Tel.: +91 09824284159; fax: +91 0260 2681104.
E-mail address: vippra2000@yahoo.com (V.D. Prajapati).

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1. Introduction

Polysaccharides have been finding, in the last decades, very interesting and useful applications in the biomedical and, specifically, in the biopharmaceutical field (Marita & Ana, 2012). The source of natural polymers is the carbohydrate molecules. These polysaccharides have been extracted or isolated from plant seed sources such as locust bean gum, guar gum, tara gum and tamarind. The polysaccharides or gums are derived from the endosperm of various plants (mainly from leguminosae) seeds, where they function as reserve materials utilized during germination. Most of these polysaccharides share basic structural similarities known as galactomanans. Thus galactomanans are polysaccharides consisting mainly of the monosaccharide mannose and galactose units. The mannose elements from linear chain linked with galactopyranosyl residues as side chain at varying distances depending on the plant origin (Cerqueira, 2009). Like other galactomanans, locust bean gum is also derived from the endosperm of the seeds of *Ceratonia siliqua* Linn. belonging to the family Fabaceae.

Polymers are macromolecules comprised of repeating units of small molecules, the monomer. The monomers can be linked together to form linear polymer or branched polymer or cross-linked polymers. Linear polymers and branched polymers are referred as thermoplastic materials as they flow on heating. They also show solubility in certain solvents. Locust bean gum is branched polymer (Paramita, Biswanath, & Sabyasachi, 2011). Biopolymers or natural polymers are an attractive class of biodegradable polymers since they are derived from natural sources, easily available, relatively cheap and can be modified by suitable reagent. The specific application of plant derived polymers in pharmaceutical formulation include their use in the manufacture of solid monolithic matrix system, implants, films, beads, micro particles, nano particles, inhalable and injectable system as well as viscous liquid formulations (Alonso, Teijeiro, Remunan, & Alonso, 2008; Chamarthy & Pinal, 2008; Pandey & Khuller, 2004). The successful formulation of stable and effective dosage form therefore depends on the careful selection of excipients. The present trend focuses on an increasing interest in the use of natural ingredients in food, drugs and cosmetics (Bhardwaj, Kanwar, Lal, & Gupta, 2000; Miyazaki, Kubo, & Attwood, 2000; Quong & Neufeld, 1999; Sultzbaugh & Speaker, 1996; Tonnesen & Karlsen, 2002). Traditionally, excipients were in drug formulations as inert vehicles that provided the necessary weight, consistency and volume for the correct administration of the active ingredient, but in modern pharmaceutical dosage forms they often fulfill multi-functional roles such as improvement of the stability, release and bioavailability of the active ingredient, enhancement of patient acceptability and performance of technological functions that ensure ease of manufacture (Beneke, Viljeon, & Hamman, 2009; Hamman & Tarirai, 2006).

The biological activity of polysaccharides is being increasingly recognized for human applications (Rinaudo, 2008). Polysaccharides have been marking a strong position in the biomedical field, as their different chemical structure and physical properties comprise a large source of materials that can be used in different applications, varying from tissue engineering and preparation of drug vehicles for controlled release, to imagine techniques and associated diagnosis. In general, polysaccharides play leading role as a thickening, gelling, emulsifying, hydrating and suspending agent, finding diverse applications in the above mentioned areas (Rinaudo, 2008). The most common basic unit of polysaccharides is the monosaccharide D-glucose although D-fructose, D-galactose, L-galactose, D-mannose, L-arabinose and D-xylose are also frequently present. Some polysaccharides comprise monosaccharide derivatives in their structure, like the amino sugars D-glucosamine and D-galactosamine, as well as their derivatives N-acetylneuraminic acid and N-acetylmuraminic acid, and simple sugar acids (glucuronic acid and iduronic acid). In some cases, polysaccharides are collectively named for the sugar unit they contain, so glucose-based polysaccharides are called glucans, while mannose-based polysaccharides are mannans (D'Ayala, Malinconico, & Laurienzo, 2008).

Locust bean gum (Fig. 1) is a popular natural polymer which is mostly used in food industry as well as in pharmaceutical industry. This natural polymer is conventionally used as an excipients in manufacturing different formulation which mainly depends on its thickening and gelling property (Paramita et al., 2011). Locust bean gum is a non starch polysaccharides consisting of galactose and mannose in the ratio 1:4 and hence they are known as galactomanan (Parvathy, Susheelamma, Tharanathan, & Gaonkar, 2005). The mannose elements from a linear chain linked with galactopyranosyl residues at side chain at varying distance depending on the plant origin (Sharma, Dhuldhoya, & Merchant, 2008). Being a galactomanan, locust bean gum has a wide application in pharmaceutical field. It is also known as carob bean gum and is derived from the seeds of the leguminous plant *C. siliqua* Linn. belonging to family Fabaceae. This gum is widely cultivated in the Mediterranean region and to smaller extent also in California. The brown pods or beans of the locust bean tree are processed by milling the endosperms to form locust bean gum (Beneke et al., 2009).

Locust bean gum mainly consists of a neutral galactomanan polymer made up of 1,4-linked D-mannopyronosyl units and every fourth of fifth chain is substituted on C6 with a D-galactopyranosyl unit (Dea & Morrison, 1975; Venkataraju, Gowda, Rajesh, & Shiva, 2007). The ratio of D-galactose to D-mannose differs and this is believed to be due to the varying origins of the gum materials and growth conditions of the plant during production. The physicochemical properties of galactomanan are strongly influenced by the galactose content and distribution of the galactose units along the main chain. Longer galactose side chains produce stronger synergistic interaction with other polymers and greater functionality. Since it is a neutral polymer and its viscosity and solubility are therefore little affected by pH changes within the range of 3–11 (Deuel & Neukom, 1954; Yang, Zhou, & Deng, 2004).

Locust bean gum has a wide potential in drug formulation due to their extensive application as food additives and their recognized lack of toxicity. It can be tailored to suit the demands of applicants in both the pharmaceutical and biomedical areas. In this context, it has been showing its application in the design of drug delivery systems, providing the delivery of a defined dose, at a chosen rate, to a targeted biological site. This review article is prepared to focus on the present use and the diversified application of locust bean gum in both the pharmaceutical and biotechnological fields.

2. Processing of locust bean gum

Locust bean gum is extracted from the seeds of the carob tree (*C. siliqua*), which is very abundant in the Mediterranean region although its localization also extends to various regions of North Africa, South America and Asia.

2.1. Manufacturing principle

Carob seeds, which represent approximately 10% of the weight of the fruit, are industrially processed by hull cracking, sifting, and milling operations to isolate and grind the endosperms, which are then sold as crude flour (Bouzoita et al., 2007; Dakia, Blecker, Robert, Whatelet, & Paquot, 2008). The endosperms are recovered after separation of the husk and the germ and milled. The clarified gum is obtained by dissolution in hot water and then recovery by precipitation in ethanol or isopropanol. Fig. 2 shows the processing flow chart of locust bean gum.