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Pharmaceutical Applications and Formulation Based Patents of *Tamarindus indica* Seed Polysaccharide and Their Modified Derivatives

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Abstract: Natural polymers find an enormous applications and utilities in Pharmaceutical as well as Biomedical field. Tamarind seed polysaccharide and their modified forms are wiy used in pharmaceutical and food industries. This paper summarizes the applications of tamarind seed polysaccharide and their modified forms along with the patents to look forward the importance of the polymer.

Key words: Tamarind Seed · Modified Tamarind Seed · Patents · Pharmaceuticals

INTRODUCTION

Tamarind seed polysaccharide is a natural polysaccharide.Tamarind (*Tamarindus indica*) is also known as "Indian date" and obtained from theevergreen tree belonging to the family Fabaceae,with a high drought, full sunlight, grows well in clay, which is a long-lived, medium- growth, bushy tree. It is also called as Galactoxyloglucan. Tamarind seed polysaccharide was evaluated for the toxicity of its components, the results of showed no carcinogenicity. Tamarind seed polysaccharide contains monomers of galactose, xylose and glucose sugars present in a molar ratio of 3:1:2, which constitutes about 65% of the seed components. Xylose is very crucial sugar of tamarind seed, which can be used for xylitol production, a pentahydric alcohol formed by a fivecarbon chain.Bioavailability of some drug hasbeen significantly improved by the use of Tamarind seed polysaccharide [1-3].

Tamarind seed comprises the seed coat or testa (20-30%) and the kernel or endosperm (70-75%). Tamarind seed is the raw material used in the manufacture of tamarind seed kernel powder (TKP), polysaccharide (jellose), adhesive and tannin. The seeds are also used for other purposes and are presently gaining importance as an alternative source of protein, rich in some essential amino acids. Unlike the pulp the seed is a good source of protein and oil. Tamarind seed and kernels are rich in protein and the seed coats have a larger amount of fiber (20%) and tannins(20%) [4-6].

The fruits are in the form of pods 5-10cm long and 2cm broad, oblong, curved or straight, with rounded ends and indehiscent although brittle. Pod is thick and light brown gray or brown, scaly and soft pulp which is coupled to an outer epicarp.The pulp is traversed by formed seedcavities, which contains the seeds [4-7].

Composition of Tamarind Seed Polysaccharide: Tamarind pulp contains 20.6% water, 3.1% protein, 0.4% fat, 70.8% carbohydrates, 3.0% fiber and 2.1% ash. The pulp has low water content and a high level of protein, carbohydrates and minerals [5-7].

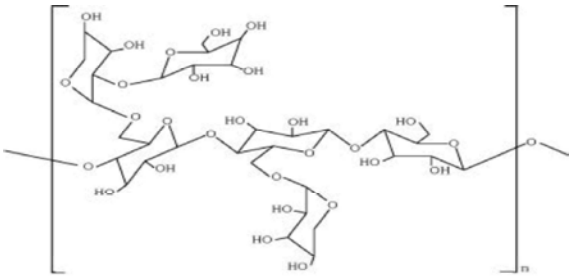

Fig. 1: Structure of Tamarind Seed Polysaccharide

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Propertiesof Tamarind Seed Polysaccharide: It is like ethanol, methanol, acetone, ether and cold water as insoluble in organic solvents, but it yields a highly viscous colloidal solution or a viscous gel at temperatures above 85°C is completely dissolved in hot water. It possess the properties such as high viscosity, adhesivity, non-carcinogenicity, broad pH tolerance and biocompatibility. It is also a potential emulsifier, nontoxic and non-irritant agent havinghaemostatic activity. It includes the high swelling index,high thermal stability and high drug holding capacity, making it a suitable excipient for drug delivery system.Tamarind seed polysaccharide is an good viscosity enhancer showing mucoadhesive, mucomimetic and bioadhesive activities.Tamarind kernel seed also have the property of forming films with high tensile strength and flexibility, making it a good excipient for ocular preparations [4,6 - 9].

Pharmaceutical Application of Tamarind Seed Polysaccharide: Tamarind kernel powder can be employed as a thickener and a sizing agent in textile and paper industries and as a thickening, gelling, stabilizing and binding agent in food and pharmaceutical industries.Tamarind Seed Polysaccharide is used as a carrier for variety of drugs for controlled release applications. It is used as a suspending and emulsifying agent in liquid oral and also as a binder agent in solid dosage form [7,8, 10,11].

Uses of Tamarind Seed Polysaccharide: Tamarind pulp is used for making wine, preparing spiced sauces and beverages. Tamarind juiceis used to preservation of fish,up to 6 months. Tamarind kernels used as a stabilizer in ice-cream,mayonnaise, cheese and also used as amaking jellies and jams. Tamarind extract is used as a replacement of phosphoric acid,citric acid and other acids added to soft drinks. Its extract is also used as a anti-viral and anti-fungal agent. Leaves and flowers are used to make curries,salads, stews and soups. Fruits and its extract isused as fungicidal,bactericidal and anti-bacterial agent. Bark containing tannin component is used in the preparation of dyes and ink.Fresh bark and stem are used as a abdominal pain reliever.Fruit pulp and leaf juice with lemon or milk,is used as anti diarrheal and anti-dysentry agent [6,9-11].

Modification of Tamarind Seed Polysaccharide:

Carboxymethylationof Tamarind Seed Polysaccharide: It is aderivative of xyloglucan and its microbial resistance is better than comparison to other plain powder.Viscosity of the solution of carboxymethylxyloglucan is higher compared to other gum. Carboxymethylxyloglucan exposes the polysaccharide network for hydration resulting in higher viscosity due to high swelling index compared to xyloglucan. Carboxymethyl groups make the molecule more resistanttoward enzymatic attack. It is used as excipients [11,12].

Grafting of Tamarind Seed Polysaccharide: Grafting is a type of method where monomers are covalently bonded on to the polymer chain and are grafted with synthetic polymers for the production of natural product with less side effects and the mimimum loss of the initial properties of the substrate. Chemical method of grafting by potassium per sulphate and ascorbic acid redox pair can be selected. The physical property of the grafted tamarind seed polysaccharide showsno loss of viscosity on storage [11,12].

Cross-linking of Tamarind Seed Polysaccharide with Epichlorohydrin: The polysaccharide can be cross-linked with epichlorohydrin. The cross-linked derivative of tamarind seed polysaccharide exhibits wicking and swelling action. It is used as a super functionaldisintegrates. Cross-linked tamarind seed polysaccharide is more effectivein retarding the drug release as compared to un-modified tamarind seed polysaccharide [11,12].

Thiol Functionalization of Tamarind Seed Polysaccharide: Thiol functionalization can be carried out by estrification with thioglycolic acid. The confirmation of the thiolfunctionalization is done with the help of the FTIR spectra [11,12].

Patents:

- Marco. *et al*, used tamarind polysaccharide polymer obtained from the seeds of tamarind tree for protecting the epithelial cells of the respiratory tract by damages induced by tobacco smoke of cigarettes,cigars or pipes [13].
- Yukiko *et al*. prepared a gel type water absorbent system with high flexibility and elasticity. Itpossessed a less variation in strength of gel during preservation along with low viscosity of sol. It containedtamarind seed polysaccharide including 1% or less protein, 90% fibers and 1% or less ash and a good water absorbency and water solubility [14].

- Elsa. *et al*. invented the treatment of dry cough in children usinga polysaccharide polymer obtained from the seeds of the tamarind tree. The polysaccharide was locally administered to the mucous membranes of the high respiratory airways of a suffering from dry cough as an aerosolized liquid preparation and commercially available as inhalation device [15].
- Andrea. *et al*.studied the use of tamarind seed polysaccharide as an anti-inflammatory agent. Anti-inflammatory compositions containing TSP were particularly used for the topical administration in the treatment of inflammatory diseases of the skin and mucosa. The invention concerns a method of treating a patient having an inflammatory disease by administering a therapeutically effective amount of Tamarind seed polysaccharide [16].
- Yuji, U. *et al*. produced modified xanthan gum, gum Arabic, tamarind seed gum by cross linking naturally occurring xanthan gum, gum Arabic and tamarind seed gum polysaccharide by irradiating them with radiation [17].
- Prete. *et al*. presented the invention of ophthalmic compositions based on tamarind seed polysaccharide and hyaluronic acid. The prepared ophthalmic solutions indicated for use as tear substitutes, containing a combination of hyaluronic acid and a polysaccharide were used in the treatment of dry eye syndrome. The tear film contained substances with high bactericide power as lysozyme and antibodies, which protected the eyes from the attack of many antigens [18].
- Marco. *et al*. described the cosmetic compositions containing a combination of functional ingredients of vegetable origin. One of them consisted of tamarind seed polysaccharide and the other possessed a beech tree bud extract with flavonoids, polyphenols, water-soluble peptide fractions, amino-acids and mineral salts. The prepared combination is useful for the manufacture of cosmetic products having conditioning, mineralizing action, moisturizing, energizing and also have a high anti-wrinkle effectiveness [19].
- Hideki S. *et al*. Prepared a dietary fiber composition that containedamorphophalluskonjacplaying a role as a ingredient for an easy to take functional food.Add it and AmorphophallusKonjac, tamarind gum, xanthan gum, pectin, gum arabic, chitosan, guar gum, Gellan gum, tara gum, Tragacanth gum and seed coat consisting of one or more members selected from polysaccharide thickeners derived from a mixture of water was suppressed polysaccharide thickeners which includes water absorbing property agent [20].
- Keith. *et al*.prepared the compositions comprising a modified starch and a carrageenan, especially iota-carrageenan suitable for use in manufacturing soft capsules [21].
- Li L.H. *et al*. prepared a encapsulated within a polymer coat the mucosal surface active agent and a water-soluble hydrocolloid enhance mucosal adhesion, film formation of dosage units. Tamarind seed polysaccharide and starch graft copolymer was mucosal adhesion enhancer where the film exhibits a dry tack value less than 3.5 g and wet tack value of greater than 35 g [22].
- Marco *et al*. Studied on the pseudoplastic rheological behavior and mucoadhesive properties used for the production of an ophthalmic solution obtained from the seeds of *Tamarindus indica* polysaccharide fraction of tamarind gum. The concentrations of tamarind seed polysaccharide preferably employed in the production of vehicles (i.e. delivery systems) for ophthalmic drugs, having the function of prolonging the time of said medicaments. The invention related to the use of a natural polysaccharide, which contained in high amounts of the material known as tamarind gum, as viscosity enhancer for preparations to be administered into the conjunctival sac. Said polysaccharide must be used for replacing and stabilizing the natural tear fluid, or as a vehicle for ophthalmic medicaments, with the function of prolonging the residence time of the site of action and it enhance their activity [23].
- Chung Wai *et al*. used to sucrose or other solubilizing bulking agents and it provided a edible formulations. The bulking agents were substantially non-digestible and have an average molecular Weight, preferably by enzymatically depolymerization naturally occurring heteropolysachharide Such as pectin, tamarind Seed gum, guar gum, locust bean (carob seed) gum, konjac gum, Xanthan gum, alginates, agar or other food gums to yield a mixture of heteropolysaccharide [24].
- Faith. *et al*. investigated the method and composition for the prevention and treatment of immunological damage to skin exposed to ultraviolet irradiation. The compositions described the biologically active tamarind seed xyloglucan

oligosaccharides obtained via treatment of tamarind xyloglucanWith a fungal glucanas. The composition included an aqueous solution of tamarind seed xyloglucan oligosaccharides having a concentration of at least 10'6 pg per ml of the solution. The method included preventing the suppression of delayed type hypersensitivity [25].

- Mark. *et al*. described the conjugation of polysachharide comprises with an attached entity having a molecular weight of at least 5000, the polysaccharide conjugate being capable of binding to cellulose. Preferred polysaccharides include tamarind seed xyloglucan, locust bean gum and enzyme modified guar. The invention thus enables targeting of attached entities to such surfaces. The invention also provided a product incorporating the polysaccharide conjugate of the invention. The invention also provided a method of targeting binding of an entity to cellulose by use of the polysaccharide conjugate of the invention [26].
- Gilles. *et al*, prepared the extracts of tamarind seeds which are enriched in xyloglycans as active agent in a cosmetic or pharmaceutical product for topical usage for the skin and other parts of the body. Xyloglucans containing product for topical use in a total Weight fraction comprised between 0.05% and 100%, preferably between 1% and 25% by Weight [27].
- Bianchini. *et al*. investigated the used of tamarind seed polysaccharide for the production of ophthalmic solution and possessed the properties of rheological and mucoadhesive behavior. The concentration of tamarind seed polysaccharide employed in the production of the vehicles such as preferably employed in ophthalmic formulation for used as artificial tears [28].
- Boris *et al*. prepared a pseudoplastic rheological behavior and mucoadhesive properties used for the production of a thickened ophthalmic solution obtained from the seeds of *Tamarindus indica* tamarind gum place and stabilizing the natural tear fluid products used in artificial tears eye tamarind seed polysaccharide concentrations employed in the preparation for the treatment of dry eye syndrome comprised between 0.7 and 1.5 % by weight. Concentrations of tamarind seed polysaccharide by weight, preferably comprised between 1 and 4% said their site of action medicine is working to increase the stability of the time, the vehicle for ophthalmic drugs (distribution system) employed in the production of ophthalmic formulation [29].
- Suguru. *et al*. used to fresh flower which were contain a polysachharide gel,such as a gellangum,dispersed at concentration of.05 wt.% to 1.50wt.% in to water and gelatinizeda method was used to preserving cut flowers using gellan gum and for transporting cut flowers having cut stems inserted into the gellan gum [30].
- Roy, I.W. *et al*. used the method of non-metabolizable additive multifunctional food tamarind polysaccharide hydrolyzate. A cellulasehydrolyzate of tamarind polysaccharide excellent organoleptic quality of processed foods to prepare low-calorie versions metabolizable carbohydrates in processed foods as a substitute for a portion of which was used in food additive [31].
- Takashi. *et al*. described the separation of tamarind seed polysaccharides. The tamarind seed polysaccharide was pulverized to form particles of less than 80 microns. Particles was dispersed in an aqueous medium consisting of water and 5-60% by weight of one water soluble organic solvent. The polysaccharides descend to thebottom of the hydrocyclone which they were discharged and particles of other components simultaneously rise to the top of the hydrocyclone, from which they were discharged [32].
- Ian. *et al*. tamarind kernel powder was blended and xanthan gum also having a high viscosity in aqueous solution [33].
- Duane.*et al*.provided a crude tamarind gum which obtained from the purified tamarind seed polysaccharide by air classification of finely ground crude. The crude gum was admixed with finely divided siliceous matter or the degree of purification was increased by the air classification [34].
- Paul. *et al*. used to clarified tamarind seed powder which produced by the treating tamarind kernel powder with a strong base by neutralization and isolation [35].

Applications of Tamarind Seed Polysaccharide: Tamarind seed derived polymer can be used as:

Gelling Agents: Tamarind seed polysaccharides are used as gelling agent who increases the viscosity of the solution or liquid/solid mixture without modifying its other properties. Gelling agent are food additive used to thicken and stabilize several food product such as jellies and candies. Gelling ability is an important property as Texture modifier and some polysaccharides can form a gel at low concentrations [36-38].

Table 1:Investigated Formulations of Tamarind Seed

S.NO.	Formulation	Drug Name
1.	Tablet	Metformin HCL [39],Propranolol HCL [40], Ketoprofen [41], Acyclovir sodium [42], Lornoxicam [43], Levocitrizine Di hydro chloride [44], Tramadol HCL [45], Diltiazem HCL [46],Lamivudin [47], Prednisolone [48], Acetaminophen [49], Ibuprofen [50]
2.	Sustained release matrix tablet	Lamivudine [51], Aceclofenac [52],Diclofenac sodium [53]
3.	Solid dispersion	Aceclofenac [54]
4.	Mucoadhesive tablets	Repaglinide [55],Ciprofloxacin [56], solbutamolsulphate [57]
5.	Microspheres	Mesalamine [58]
6.	Mouth dissolving tablet	Pioglitazone [59]
7.	Buccal patch	Metronidazole [60], Nifedipine [61]
8.	Buccal tablet	Metoprolol Succinate [62]
9.	Suspension	Paracetamol [62],Nimesulide [64]
10.	*In situ* gel	Venlafaxine HCL [65], Nizatidine [66]
11.	Transdermal film	Alfuzocin HCL [67]

Suspending Agents: Tamarind seed polysaccharide are used as suspending agent because It is necessary to include in the dosage form as suspending agent Which reduces the rate of settling and permits easy redispersion of any particulate matter both protective of any colloidal action and by increasing the consistency of the suspended medium12, [38,64].

Film Former: Tamarind kernel seed polysaccharides are also used as film former agent. Film forming agent consist polyvinylpyrrolidone, acrylates, acrylamides and copolymers [39].

Solubility Enhancement: Tamarind seed polysaccharides are act as solubility enhancement. Tamarind kernel powder is evaluated for its suitability as a carrier to improve the dissolution rate of poorly water soluble drug.Solubility behavior of a drug is one of the key determinants of its oral bioavailability. Solid dispersion is one of the most promising methods for solubility enhancement [11.39,55].

Controlled Drug Delivery: Nanoparticles of the tamarind seed polysaccharide are used in controlled drug delivery system. Natural excipients and their application in the pharmaceutical industries are imposed by the presence of synthetic excipients. There is a great demand for controlled drug delivery system and its significant increase in the approval of controlled drug delivery system. Natural polysaccharides are used in the design of controlled drug delivery such as target delivery of the drug to specific site in the gastro intestinal tract [39, 40, 43].

Some of the investigated formulations of tamarind seed polysaccharide are summarized in Table 1.

CONCLUSIONS

In the present review tamarind seeds and their modifications were studied in terms of their use in various pharmaceutical formulations. Natural polymers such as tamarind seed polysaccharide have advantages over synthetic and semi-synthetic polymers like low cost, natural origin, less side effects, locally available and better patient tolerance. The modification of the polymer has increased its applicability in pharmaceutical and food industries. The modified forms can be used in the formulation of tablets, transdermal patches, in situ gels, suspensions etc.

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