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Review article

A Review on Tamarind Gum, Modifications and Pharmaceutical Applications: A Novel Polymer

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ABSTRACT:

A common natural substance for both traditional and innovative dosage forms are gums and mucilage. It is becoming more and more common for the pharmaceutical industry to include natural polymers in their formulations due to the growing interest in them. They can compete with the currently available synthetic excipients by being changed in various ways to provide materials specifically designed for drug delivery systems. The clinical advantages of controlled-release drug delivery systems have made them more significant in recent years compared to traditional oral drug administration methods. For the development of sustained-release formulations, hydrophilic matrices containing natural polysaccharides present an intriguing alternative. A byproduct of the palm pulp industry is the seeds, also known as kernels. An emerging excipient that is being used and studied for the formation of different dosage forms is the Tamarind seed polysaccharide (TSP). The native tamarind polysaccharide's degradability, hydration, viscosity, and swelling are all improved by functionalizing tamarind gum (TG). Owing to these superior qualities, scientists looked at using modified TG in several drug delivery systems. For the design of oral, nasal, ocular, colonic, and topical drug delivery systems, TG and modified TG are shown to be suitable. In light of the aforementioned information, further investigation is necessary to validate the therapeutic applications of TG and modified TG in drug delivery.

Keywords: Tamarind seed polysaccharide (TSP), Carboxymethyl -TSP, Grafting, Thiolated – TSP, Cross-linking, Controlled release.

1. INTRODUCTION

Naturally derived drugs and excipients are becoming more and more popular worldwide. A great deal of interest has been aroused in recent years by plant-derived polymers because of their many medicinal uses, including bases in suppositories, protective colloids in suspensions, thickeners in oral liquids, diluents, binders, and disintegrants in tablets[1-2]. Cosmetics, textiles, paints, and paper are among the other products that employ them. Biocompatible, affordable, and readily accessible polymers are mucilage and natural gums. Due to their non-irritating properties, calming action, low cost, availability, and lack of toxicity, they are favored over synthetic and semi-synthetic excipients [3-4]. To compete with the commercially available synthetic products, they can also be changed to provide materials specifically designed for drug delivery systems. Numerous natural gum varieties that are safe for ingestion by humans are employed in the pharmaceutical sector [5].

Mucilages are typically normal byproducts of metabolism, formed within the cell (intracellular formation) and produced without injury to the plant, whereas gums are thought to be pathological products formed through a breakdown of cell walls (extracellular formation; gummosis) in response to injury to the plant or adverse conditions, such as drought. Mucilage congeals into slimy lumps, but gums dissolve easily in water [6]. Mucilages are physiological compounds, while gums are pathological ones. While mucilages are frequently found in various plant parts, gums include those of acacia, tragacanth, and guar. In the epidermal cells of leaves (senna), barks (slippery elm), roots (marshmallow), seed coats (linseed, psyllium), and middle lamella (aloe), for instance. Given that they are both plant hydrocolloids, gums and mucilages share some characteristics [7]. These also include translucent, amorphous materials, polymers of mono- or mixed-saccharides, and several of them in combination with uronic acids. Similar in composition, gums and mucilages hydrolyze to produce a combination of sugars and uronic acids. Water can mix with hydrophilic molecules found in gums and mucilages to create viscous solutions or gels. varying gums have varying qualities depending on the type of molecules included[8]. For a given molecular weight, highly branched molecules are less viscous and take up less space than linear polysaccharides. Since there can be no substantial interaction along the chains, the branched compounds gel more readily and are more stable [9].

Although natural polymers are less common than manufactured hydrophilic polymers, researchers are currently becoming more interested in natural (non-synthetic) polymers like gums due to the high expense of

synthetic polymers [10]. Large evergreen trees that grow abundantly in the arid regions of central and south Indian states as well as other southeast Asian nations are known for producing the popular and valuable product known as tamarind (Tamarindus Indica L.). Indian cuisines primarily use the pulpy part of the fruit as an acidulant. A byproduct of the palm pulp industry is the seeds or kernels of palm. Tamarind gum (TG) is a seed gum with potential industrial uses that is extracted from the endosperm of tamarind tree seeds [11].

To substitute starch in cotton sizing for the Indian textile market, tamarind gum, also known as tamarind kernel powder (TKP), was first produced commercially in 1943. It is also employed in the microbial synthesis of lipids. It is an essential component of textile sizing, a potent soil stabilizer due to its concentration of rubber latex, and a plentiful supply of proteins and amino acids [12]. Additionally, pigs and cattle can be fed tamarind kernel powder. It's a culinary ingredient as well. Presently, Japan approves the production of refined and purified tamarind kernel powder, which is used in the food sector as a thickening, stabilizing, and gelling ingredient [13].Tamarind gum is therefore used in the paper, culinary, textile, and other industries. The usage of tamarind gum in cosmetic and pharmacological applications has sparked contemporary research.

2. TAMARIND GUM - A VERSATILE NATURAL POLYSACCHARIDE

The dicotyledonous Leguminosae family includes the tamarind (Tamarindus indica), also referred to as Imli. Approximately 30–34% of the tamarind fruit, which accounts for 0.3 million tonnes produced annually in India, is made up of seeds. The recent possibility of tamarind exports from India indicates a healthy tamarind market [14].

Chemical composition: Similar to grains, tamarind kernels are the source of gum. In terms of protein, the values were tested on a dry basis and included 15.4% to 12.7%, 3.5% to 7.5% oil, 7-8.2% crude fibre, 61-72.2 % non-fiber carbs, and 2.45–3.3 % ash. The powdered tamarind kernel is a highly branched polymer of carbohydrates. Like cellulose, it is made up of D-glucose units connected by (1-4) b-linkages[15-16]. It is made up of a main chain of b-D-(1-4)-galactopyranosyl units and a side chain of single xylopyranosyl units connected to every second, third, and fourth D-glucopyranosyl units via an a-D-(1-6) linkage (Fig. 1). Through b-D-(1-2) linkage, one galactopyranosyl unit is joined to one of the xylopyranosyl units [17]. There is uncertainty over the precise order in which the branches are distributed along the main chain.

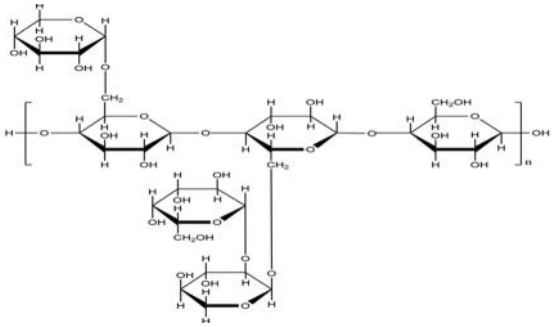

Fig 1: Structure of Tamarind gum (TG)

Physical properties: In cold water, Tamarind kernel powder dissolves and hydrates rapidly, but it takes 20 to 30 minutes to attain its maximum viscosity. The mixture displays the usual non-Newtonian flow characteristics found in the majority of other hydrocolloids. It was reported on the functional characteristics of tamarind kernel powder of protein concentrates. The rheological features of the powdered tamarind kernel suspension demonstrated that it was thixotropic and behaved like a non-Newtonian, pseudoplastic fluid with yield stresses. As concentration rises, nonnewtonian behavior increases as well[18]. For example, stress and perceived viscosity are produced in consistent latex.

TG is a branching, neutral, non-ionic polysaccharide. It is soluble in hot water to produce a very thick gel, but insoluble in organic solvents [19]. High viscosity, a wide pH tolerance, and adhesion are among the qualities of TG. It is mucoadhesive [20], non-toxic [21], biodegradable, biocompatible, and non-carcinogenic. It also has a good drug holding capacity and thermal stability [22].

Its characteristic non-Newtonian rheological behavior and pseudoplastic capabilities are demonstrated by its swelling in water and subsequent formation of a mucilaginous solution upon heating [23]. When combined with sugar or alcohol, TG can form gels that resemble pectin and can be used to make jams, jellies, and other preserves. It can also combine bio-based ionic liquids to generate ion gel. It is a useful excipient for ocular preparations because it yields films with great tensile strength and flexibility [24]. This film is clear, non-sticky, hygroscopic, and maintains its shape even after being handled roughly.

TG is more affordable, non-irritating, eco-friendly and non-polluting than other synthetic or semisynthetic polymers. TG finds application as a polymer in the food and cosmetic industries because of its unique benefits [25]. Recent research has demonstrated that TG can be used for topical medication administration since it physically crosslinks to generate an effective hydrogel.

Isolation and purification of TG

To remove the gum from the tamarind seeds, several techniques have been documented in the literature [26]. Tamarind seeds are first made brittle and friable by heating and washing them in water. Crushing separates the endosperm from the seed coat. To make TKP, the

decorticated seed is powdered. The proteins and fibers are then allowed to precipitate and settle out for 12 hours by boiling TKP in 30–40 times its weight in 2% w/v citric acid for 30–40 minutes while stirring continuously. By using decantation, the supernatant is extracted and concentrated to around half of its original volume. To precipitate seed polysaccharide, the resultant concentration is combined 1:1 with ethanol. Washing TG with ethanol and acetone can help to further purify it. The resulting tamarind gum is pulverized, dried at 50 ℃ for 24 hours, and then kept in a container [27].

CHEMICAL MODIFICATION OF TG

TG has certain possible disadvantages even if it is highly suited for therapeutic applications. TG smells bad and is drab in color. Scientists have been forced to chemically change its functional groups due to its insolubility in water and deterioration in an aqueous environment. To date, changes such as carboxymethylation, acetylation, hydroxyl-alkylation, and thiolization have all been carried out [28]. The solubility, viscosity, swelling, and stability of TG have all changed as a result of these adjustments.

3.1 Carboxymethylation of TG

The derivative of TG containing carboxymethyl (CH2 - COOH) groups is carboxymethyl tamarind gum (CMTG). It functions as a sodium salt and is anionic. With the addition of a carboxymethyl group at position C6, which gives the polymer an anionic character, its chemical structure is comparable to that of TG. The CMTG structure is shown in (Figure 2). CMTG has a greater inherent viscosity of 9.0 dL/g and a molecular weight of roughly ~9.14 x 105 g/mol than TG [29]. CMTG's molecular weight and viscosity can change depending on how much of the carboxymethyl group is substituted. By adding a carboxymethyl group, TG becomes more hydrophilic and more resistant to biodegradation [30]. In cold water, CMTG dissolves easily. With sodium hydroxide acting as a catalyst, monochloroacetic acid can be used to carboxymethylate TG. By improving its natural TG's unpleasant odour, dull color, water solubility, swelling, viscosity, adhesion, and biodegradability, carboxymethylation of TG makes it suitable for use in pharmaceutical applications.

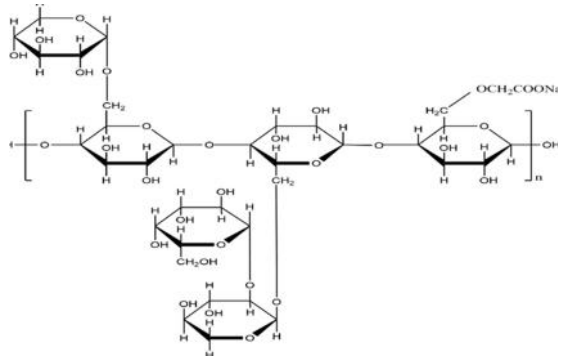

Fig 2: Structure of Carboxymethyl tamarind gum (CMTG)

Using the gravimetric method in pure water, the swelling property of CMTG matrix tablets was investigated. Compared to TG, CMTG displayed more edema. According to the findings, CMTG's swellability grows as its degree of substitution (DS) does. Carboxymethylation might be the cause of the swelling profiles' amplification. Polymer swelling and wetting are both enhanced by the hydrophilicity that is increased when a polymer is carboxymethylated[31]. Swelling in CMTG is pH-dependent. It exhibits minimal edema in an acidic environment and significant swelling in a basic environment. Given that CMTG is an anionic polysaccharide, its carboxylic acid group is protonated at an acidic pH, reducing the forces that repel negatively charged carboxylate ions. Thus, there is a decrease in CMTG's swelling ability. To prevent acid-labile medication release in the stomach environment, this CMTG characteristic is preferred [32]. Conversely, the basic environment leads to the deprotonation of carboxylic acid, which in turn results in the negatively charged carboxylate ions restraining one another electrostatically. This leads to an increase in the swellability of the polymer, which allows its network structure to expand and absorb a lot of medium. Drug delivery systems targeted at specific oral sites may benefit from this pH-dependent swelling of CMTG.The increased hydrophilicity of the polymer is the reason why CMTG exhibits better bioadhesion than TG. To create non-covalent interactions with biological tissue, hydroxyl, and carboxyl groups found in CMTG might lead to bioadhesion [33].

Cynoethylation of TG

Acrylonitrile is used to cynoethylate TG while sodium hydroxide is present. The characteristics of TG such as its viscosity, cold water solubility, and biodegradation are all enhanced by cynoethylation. It is applied to non-food purposes [34].

Acetylation of TG

It is possible to acetylate TG using anhydrous sodium acetate and glacial acetic acid. Hydrophobicity is present in the acetyl derivative of TG [35].

Amination of TG

Elevated ethylene diamine combined with sodium borohydride as a reducing agent is used to create an amine derivative of TG. According to, it is cationic. Enhancements to TG include increased swelling, mucoadhesion, and hydrophilicity. Because NH2 groups and water molecules bind to create NH3 + -OH−, aminated trifluoroacetate (TG) forms a strong gel in water. The water molecules inside the aminated xyloglucan matrix are helped to stay there by this interaction. Antimicrobial action is also shown by aminated TG[36]. Compared to carboxymethylated and sulfated TG, aminated TG exhibits greater bioadhesion. A mucoadhesive pentazocine patch has been developed using it.

Sulfonation of TG

With the use of sodium hydrogen carbonate and DMF, a sulfur trioxide-pyridine combination is used to form a sulfated derivative of TG. In the bioadhesive drug delivery process, sulfated TG can be employed as a release retardant.

3. FORMULATION APPLICATIONS

Binder in tablet dosage form

The wet granulation and direct compression approaches were used to evaluate the tamarind seed polyose as a binder for tablet dosage forms. According to the findings, tamarind seed polyose could be utilized as a binder in direct compression tableting and wet granulation techniques [37].

As a mucoadhesive polymer

TSP is utilized in the manufacturing of thickened ophthalmic solutions with mucoadhesive and pseudoplastic rheological characteristics. The solution serves as both a tear substitute and a delivery system for the steady release of eye medications. Unlike other eye preparations, TSP is an adhesive, extending the period that the formulation is retained on the surface of the eye. Furthermore, problems blinking, ocular burning, and the feeling of something in one's eye were among the primary subjective symptoms of dry eye syndrome that the TSP drops substantially better relieved[38]. Additionally, it lengthens the duration a medication, like α-blockers, stays in the cornea. Timolol and TSP were combined in an ophthalmic solution, and the result was a significant drop in intraocular pressure in rabbits.

In sustained drug delivery

Verapamil hydrochloride was sustained in its release by a possible polysaccharide with a high drug-holding capacity. In addition to the commercially available sustained-release tablets, the release pattern was shown to be similar to matrices of various polysaccharide polymers, including hydroxyethyl cellulose, hydroxypropyl methylcellulose, and ethyl cellulose. The study investigated the sustained release behavior of medicines that are water-soluble (acetaminophen, caffeine, theophylline, and salicylic acid) and water-insoluble (Indomethacin) on TSP[39]. Research indicated that TSP might be applied to the controlled release of medications that were both water-soluble and water-insoluble. Choosing sparingly soluble drugs, like indomethacin, in addition to TSP can result in zero-order release. Diluents like lactose and microcrystalline cellulose are good examples of how to adjust the rate of release[40]. In the case of water-soluble medications, partial matrix cross-linking can also regulate the release quantity. By adjusting the degree of cross-linking, the release can be tailored to varying degrees[41]. It was discovered that cross-linking was the abnormal method of release caused by the influence of diluents.

In ocular drug delivery

Antibiotic concentrations in the aqueous humor and cornea were considerably higher after administering vicosified formulations compared to when the medications were used alone. The effectiveness of TSP as an ocular delivery method for topical antibiotic administration is indicated by the longer drug elimination phase and improved drug absorption obtained with vicosified formulations [42]. The dry eye condition is treated with TSP eye drops. TSP was utilised to treat experimental Pseudomonas aeruginosa and Staphylococcus aureus keratitis in rabbits by ocular administration of 0.3% rufloxacin.

For eyes that were neither infected nor infected, the polysaccharide dramatically boosted the intraocular penetration of rufloxacin. The use of polysaccharides made it possible to reduce S. aureus in the cornea over a longer time, even between doses. The aforementioned studies indicate that TSP extends the antibiotic's precorneal residence time and improves drug accumulation in the cornea, most likely by decreasing the washout of topically applied medications [43]. TSP is recommended to be used in ophthalmic preparations between 0.7% and 1.5% by weight to replace and stabilize natural tear fluid. These products are intended to be used as artificial tears and are specifically indicated for the treatment of dry eye syndrome.

When producing vehicles (i.e., delivery systems) for ocular pharmaceuticals, concentrations of tamarind polysaccharides compromised between 1 and 4% by weight are preferred because they extend the duration that medications are prevalent at their site of action [44]. Using the extrusion spheronization technique, TSP was employed as a release modifier to prepare diclofenac sodium spheroids with microcrystalline cellulose acting as a spheronization enhancer. It was discovered that the emission lasted for 7.5 hours. Between the in vitro dissolution profile of spheroids and the swelling index, viscosity, and surface roughness of the polysaccharide particles, a strong association was observed. According to comparative bioavailability research, the created spheroids have been shown to enhance the degree of medication absorption and bioavailability, including diclofenac sodium and caffeine, while also maintaining drug release [45].

Nasal drug delivery

Drug absorption can occur quickly in the nasal mucosa due to its high perfusion rate. Mucociliary clearance (MCC) occurs quickly in nasal drug delivery, which restricts the amount of time the drug can absorb from the administered dosage form [46]. This is the primary downside, though. Thermoreversible in situ mucoadhesive gel formulation, which produces a gel at nasal mucosal temperatures, is a feasible approach in the context of the previously defined problem. Improved nasal medication bioavailability results from the mucoadhesive polymer's prolonged residence time at the mucosal surface.

Pulmonary drug delivery

Since this route avoids the hepatic first-pass metabolism, has a large alveolar surface area available for drug absorption, a thin epithelial barrier, extensive vascularization, and relatively low proteolytic activity in the alveolar space compared to other routes of drug administration, researchers have extensively studied the pulmonary delivery of drugs, especially for the delivery of proteins, peptides, and genes [47]. A number of the drawbacks of inhaled formulations, such as undesired drug loss from oropharyngeal deposition, have been addressed by recent developments in dry powder inhalation (DPI) technology [48].

An antiasthmatic medication called montelukast sodium (MS) has been utilized as a model medicine. The formulation of the MS-loaded microsphere was designed and optimized using a 32-factorial design. In the range of 75–90%, the formulations demonstrated good entrapment efficiency; in the region of 74–91%, the angle of repose indicated satisfactory flow characteristics. The spherical form of the microspheres, along with their smooth surfaces and particle sizes between 0.9 and 6 µm, make them ideal for drug delivery through inhalation. Powder inhalation into the lower parts of the lungs is safe due to the microspheres' mass median aerodynamic diameter of 2.53 µm, which is less than 5 µm. An increase in the bioavailability of XG-based microspheres as DPIs compared to plain MS at 6 hours after pulmonary injection was validated by pulmonary pharmacokinetics conducted on Wistar rats.This could be explained by the XG-based microspheres' extended stay in the lungs[49].

Rectal drug delivery

Despite its uncommon use, the rectal route is a productive substitute for parenteral and oral medication delivery. Rectal administration presents a number of potential benefits for drug delivery, including the ability to retain a significant volume of formulation in the rectum, escape partial hepatic first-pass metabolism, absorb numerous tiny molecules quickly, and potentially enter the lymphatic system [50].

Buccal drug delivery

Among other transmucosal methods, the buccal route has two main advantages: faster drug uptake into the systemic circulation and better drug bioavailability, which results in a quicker beginning of action [51]. Buccal medication delivery techniques additionally circumvent the hepatic first-pass metabolism by facilitating absorption via the cheek venous system. The buccal mucosal membrane also has several unique benefits, including the ability to create unidirectional or multidirectional release systems with flexibility for local or systemic action, quick and rich blood flow, and reduced thickness of the buccal mucosa[52].So far, several forms of buccal-adhesive medication delivery have been developed, including films, wafers, tablets, and gels. Compared to buccal tablets or gels, a mucoadhesive buccal film has better patient compliance, is thinner, and has various other advantages.

Oral drug delivery

It has proven possible to create gel formulations with appropriate properties for elderly people to use, especially those who have trouble swallowing the more traditional dose forms like tablets or capsules, by experimenting with different types of polymers. Because oral gel formulations are easier for patients to handle and swallow, especially for older patients, they are a great way to increase patient compliance. Based on agar, gelatin, gellan, pectin, and XG, Miyazaki et al.created gel compositions. Prescription gels meant to be taken orally that included paracetamol[53]. The gel strength of the prepared gel compositions was assessed. Gellan (1.5% w/w) and XG gels (1.5% w/w) appeared to have adequate gel strength, according to the results. The commercial gel composition was too pliable for analytical purposes. All generated gels' in vitro and in vivo release properties were compared to those of Kazepitan TM jelly (150 mg/30 g), a commercially marketed paracetamol oral administration product in Japan that contains agar as a gelling agent. While XG gel released roughly 75% of the medication after 5 hours, suggesting a longer sustained drug release, the commercial formulation's in vitro drug release was seen to be quick and complete within 3 hours. Gellan-based gel (1.5% w/w) showed a comparable rate of degradation. The commercial gel and 1.5%w/w gelatin gel completely vanished, which could be related to the paracetamol's quick release from both vehicles [54].

Periodontal drug delivery

Bacterial periodontosis is a serious gum infection that damages the gums, periodontal ligaments, alveolar bones, and dental cementum, which are tissues that support teeth. Additionally, as a result of periodontosis, the alveolar bone around the teeth gradually disappears, creating contaminated pockets between the gums and teeth[55]. Scaling and root planing can be used to treat it, although painful needle therapy is required to create anaesthesia. Gel application is a practical substitute for this anesthetic medication. Despite being simple to use, these topical gels have certain disadvantages, such as decreased retention in plaque-prone locations, a propensity to disseminate, and a potential for gel ingestion. Because in situ gels are more viscous and mucoadhesive, they have a quicker beginning of action and show promise in extending the residence period at the site of action. In situ gel loaded with lidocaine hydrochloride (LH) for the treatment of periodontosis was created by Pandit et al. using XG technology[56]. Optimizing the gel formulation involved using a 32-complete factorial design tool. The gel's viscosity increased noticeably at 37°C as a result of the sol-to-gel transition, according to the viscosity research. Near body temperature, the mixture gelled. It was found that XG is an effective mucoadhesive polymer that helps to keep the gel in dental pockets at the application site for extended periods. Additionally, the created gel formulation showed good gel strength, confirming the gel's ability to stay in the periodontal pockets. 90% of the drug was released after two hours, according to in vitro drug release experiments, which showed a quick start of pharmacological action. After two hours, there was a good (98%) level of LH permeability, according to in vitro investigations done on sheep oral mucosal tissue that had been removed. The best sample for periodontal application was proposed via experimental design-assistedoptimization, which involved a gel formulation with 1% XG and 18% Lutrol F127. As a whole, LH-loaded thermoreversible in situ gel provided a feasible substitute for the uncomfortable injection therapy used during dental procedures.

Parenteral (intraperitoneal) drug delivery

For carcinomatous peritonitis, intraperitoneal (i.p.) injections of mitomycin C (MMC), a clinically significant

antineoplastic antibiotic, have been administered in solution form. Unfortunately, MMC solution absorbs quickly into the blood plasma, which makes it impossible to maintain an adequate concentration of MMC in the intraperitoneal cavity. Hagiwara et al.'s development of MMC-adsorbed activated carbon particles as sustained-release vehicles was a solution to this issue. Miyazaki et al.'s evaluation of Pluronic F127 gel's potential as a sustained release medium for intraperitoneal (i.p.) administration of MMC in the management of Sarcoma-180 ascites [57].

Transdermal drug delivery

When delivering non-steroidal anti-inflammatory medicines (NSAIDs), topical treatment has various advantages over oral administration, including the avoidance of stomach discomfort and hepatic first-pass effects. Pluronic F127 gel has been the subject of several investigations that have looked into its potential as a topical NSAID delivery mechanism. Oral, intraperitoneal, ocular, and rectal drug administration have also been investigated using XG gels. The potential of XG and Pluronic F127 gels as possible delivery systems for topical NSAIDs (ibuprofen and ketoprofen), both in vitro and in vivo, was later compared by Takahashi et al [58]. The results indicate that when heated to 37 ℃, the XG aqueous solutions, which have been partially degraded by galactosidase, gel at a concentration of 1-2 wt%. The in vitro release of ketoprofen and ibuprofen at pH 7.4 from the XG gels followed root-time kinetics over 12 hours following an initial lag time, according to release experiments. In comparison to when they were released from Pluronic F127 gels (25% w/w), both medications had greater diffusion coefficients when released from XG gels (1.5% w/w). It was shown that when released from XG gels as opposed to Pluronic F127 gels, the bioavailabilities of both ibuprofen and ketoprofen were dramatically increased. This work, in summary, showed that XG-based in situ gels might be used as sustained-release vehicles for NSAIDs applied percutaneously.

Colon targeting

It has been established that TSP may be used as a carrier for colonic medication delivery. Ibuprofen was used as a model drug to create matrix tablets by wet granulation techniques. TSP was shown to be able to release the medication at pH 6.8 in vitro release experiments that replicated the mouth-to-colon transit. The rat colon showed remarkable degradation of TSP, suggesting that TSP could be employed as a carrier for colonic drug delivery [59].

Bio-adhesive tablet

In comparison to tablets made from xanthan gum and carboxycellulose, those made from TSP and tamarind gum had the longest duration of residence in the oral cavity. However, with time, the unpleasant taste of the former gradually became more pronounced.

As a suspending agent

The polysaccharide found in Tamarind seeds (TSP) has several characteristics, including mucoadhesive nature, broad pH tolerance, high viscosity, and biocompatibility. It is also non-carcinogenic. Suspensions require a suspending agent to slow down the pace of settling and make it easier for any settled particle matter to redisperse since they are thermodynamically unstable. The use of this polysaccharide as a suspending ingredient in the production of a Nimesulide suspension has been attempted by R. Deveswaran et al. They discovered that using TSP powder as an efficient suspending agent is possible [60].

4. CONCLUSION

In India, tamarind seeds are a raw material that is not used enough. The people who harvest or even nurture the tree may benefit from the right usage of the tamarind seed, which might bring in more money for the pulp processing firms. The need to find new excipients arises from the need to address issues with compatibility, toxicity, availability, and processing costs. Nowadays, TG is becoming more and more well-known for its use in creating different pharmacological dosage forms. A review of the literature indicates that TG and modified TG show significant promise for the creation of different drug delivery systems, and more studies may shed information on how well they work as excipients in the industry. The review highlights the potential applications of TG as a pharmaceutical excipient in a range of formulations.

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