ON VERSATILE USES AND APPLICATIONS OF TAMARIND SEEDS.

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Abstract: **The pulp of the tropical fruit tamarind (Tamarindus indica, Fabaceae), which is grown throughout Africa and Asia, is highly prized. Due to the elevated tartaric acid and decreased sugar content, tamarind fruit pulp has a sweet acidic flavor. The tamarind pulp industries abundantly have tamarind seed as it's by product. It has a high concentration of many essential amino acids, including isoleucine, leucine, lysine, methionine, phenylalanine, and valine. It is a protein-rich food. Additionally, seeds are an excellent amount of minerals, particularly calcium, phosphorus, and potassium, which is high compared to other legumes. They are also a useful source of important fatty acids. Additionally, tamarind gum, tamarind seed polysaccharide, and tamarind kernel powder are particularly beneficial to the textile, paint, and several pharmaceutical sectors. Tamarind leaves have a high mineral. They are a decent source of beta-carotene and vitamin C. From various plant components, antioxidant, anti-inflammatory, anti- microbial, and anti-fungal action has been proven. Traditional medicine makes considerable use of tamarind. A review of the traditional applications, phytochemistry, and pharmacognosy is done to give a specific perspective on the usefulness in sub-Saharan Africa.**

Keywords: **Jellose, natural emulsifier, tamarind seed polysaccharide (TSP), tamarind kernel powder (TKP), gluten-free diet, and protein source.**

INTRODUCTION:
To treat many illnesses in both humans and animals, plants have always been essential. As more experts focus on plants and plant products in emerging nations, the popularity of natural products is rising. In both ancientand contemporary medical systems, herbal medicine plays a significant role.[1]To create new compounds for usein pharmacology, nutraceuticals, dietary supplements, and folk medicines, among other things, medicinal plantsare being investigated all over the world. One type of commonly utilized medicinal plant for health issues in various medical systems is Tamarindus indica.[2]

Classification of the Tamarindus indica
(Common name – Imli)

- ✓ Family - Leguminosae
- ✓ Kingdom - Plantae
- ✓ Phylum - Spermatophyte
- ✓ Class - Angiosperm
- ✓ Order - Fabales
- ✓ Family – Leguminosae
- ✓ Genus - Tamarindus
- ✓ Species – indica [3]

Habitat:
It can grow on a variety of soil types and does well in both semi-arid and humid monsoon areas. It is a tropical tree that can withstand temperatures of up to 47°C but is extremely vulnerable to frost. It is primarily grown in regions with 500–1500 mm (about 4.92 ft) of annual rainfall, but it may tolerate rainfall as low as 350 mm (about 1.15 ft) if it is irrigated when it is first planted. Flowering and fruit setting are reduced in the wet tropics with more than 4000 mm (about 13.12 ft) of rainfall, and in India, it is not grown in regions with more than 1900 mm (about 6.23 ft) of annual precipitation. Regardless of the amount of rainfall received annually, it yields more fruit when exposed to a very protracted dry spell.[4]

Vernacular names:
- ✓ Marathi: chinch
- ✓ Assam: Tetali
- ✓ Bengal: Ambli,Tentul, Tinturi, Nuli
- ✓ English: Tamarind tree
- ✓ Gujarat: Ambli, Amli
- ✓ Hindi: Imli, Amli,
- ✓ Malayalam: Amlam

- ✓ Odia: Tentuli
- ✓ Punjab: Imli
- ✓ Tamil: Ambilam, Amilam
- ✓ Telugu: Amlika, Chinta, Sinja, Sinta
- ✓ Urdu: Imli
- ✓ Nepal: Titri [2]

1. APPLICATIONS IN MEDICINE

TSP is a fascinating pharmacological possibility. For applications involving controlled release of pharmaceuticals, it serves as a carrier for a range of medications. The TSP-based delivery systems are produced using a variety of methodologies, which makes it an intriguing and promising excipient for the pharmaceutical industry's present and future applications. [5]

APPLICATIONS IN PHARMACOLOGY AND BIOMEDICINE:

- **Antimutagenic activity:**

There are several pharmacokinetic characteristics of xyloglucan [6-5]. Xyloglucan has substantial antimutagenic properties against 1-nitropyrene-induced mutagenicity [7]. The nontoxic properties of xyloglucan, which is derived from tamarind mucilage, have been investigated. Tamarillo seed polysaccharide was found notto be carcinogenic in research on mice. A thorough histological investigation also showed no evidence of a rise in the incidence of any non-neoplastic or neoplastic lesions associated with the treatment [8]. Skin cancer prevention and maintaining efficient immune responses to infectious disease after sun exposure require the formulation of sunscreens with high immune protection factors and SPFs. The gap between erythema protection and immunoprotecting may be filled by adding immunoprotected. substances to present sun protection solutions.Studies on animals. (5)

- **Antioxidant, lipid-lowering, anti-diabetic:**

T. indica seed extracts that are hydroalcoholic and aqueous exhibit strong antidiabetic properties.The results of antioxidant activity on Streptozotocin-induced diabetic rats [9] clearly show the antioxidant property of the ethanolic extract of T. indica.On rats fed a cholesterol-rich diet, T. indica pulp and fruit extract exhibits hypolipidemic and antioxidant properties [10]Aqueous acetone extract exhibits the best antioxidant activity whencompared to other extracts of methanol [11]. Ethanolic extract from T. indica fruit pulp demonstrated hypolidemicand weight-reducing action in obese rats fed a cafeteria meal and given sulpiride [12].T. indica leaf hydroalcoholicand aqueous extracts have antioxidant activity like Fe+3. (2)

- **Antimicrobial**:

T. indica exhibits broad-spectrum antibacterial activity and may be a source of novel antibiotic classes forthe treatment and management of infectious diseases [13]

Hydroalcoholic and aqueous extracts of T. indica leaves have antimicrobial activity against some gramme positive and negative bacteria, including S. aureus, B. subtilis, E coli, and P. aeruginosa [14]. Ethanolic extract ofleaf and stem T. indica extracts shows antibacterial activity against some gramme negative bacteria [15]. T. indicaseed hydroalcoholic and aqueous extracts had antibacterial effects on several gramme positive and gramme negative bacteria, including S. aureus, B. subtilis, E. coli, and P. aeruginosa [16-2]

- **As dietary fiber:**

Enzymatic hydrolysis of xyloglucan can produce oligosaccharides that can be used as prebiotic dietary ingredients. Since it is not metabolized, it functions as a soluble dietary fiber that might slow down the absorptionof nutrients by thickening the digestive juices in the stomach and small intestine. A dietary fiber would act as prebiotics for fermentable gut flora. In low-calorie food items, enzyme depolymerized XG oligosaccharides havebeen employed in place of sugar [17]. It has been shown that XG speeds up the metabolism and excretion of endocrine disrupting substances [18]. The intestinal bacteria can break down XG as soluble dietary fiber [19]. The octa saccharide and Nona saccharide derived from XG may reduce cholesterol levels in addition to serving as a soluble dietary fiber with low molecular weight. (5)

- **Anticancer activity:**

Scientific research has identified numerous therapeutically significant bioactive molecules from the Tamarindus indica plant that have a strong anticancer effect. T. indica seeds can boost cancer cells' antioxidant capacities, which can shield them from oxidative harm. [20]. The cytotoxicity potential of a methanolic extract of
T. indica seed is investigated by Hussien et al. [21] in two cancer cell lines, rhabdomyosarcoma cancer (RD) and human lymphoma cell line (SR). The investigation's findings indicated that seed extract has a high ability to causecancer in cancer cell lines. To assess the antitumor potential of T. indica bark ethanolic extracts The in vitro effects of ethanol bark extract on human colorectal cancer cell line were investigated by Srinivas et al. [22-3]

- **Healing of Wounds**

Tamarindus indica is frequently used to treat abscesses, cuts, and wounds. Tamarindus indica leaves and bark aretypically administered to wounds as a powder, decoction, or poultice, either alone or in combination with other species. Tamarind bark is primarily marketed in Dakar's medicinal plant market for use in treating wounds. Whileother tamarind plant components like fruit, gum, or pod husks are used to make medicinal products. A decoctionof Tamarindus indica leaves is another effective remedy for cleaning wounds caused by Guinea worm infestations. [23-24]

- **Fungicide activity:**

According to Guerin and Reveillere (1984), Ray and Majumdar (1976), Bibitha et al. (2002), Metwali (2003),and John et al. (2004), all of which were mentioned by El-Siddig et al. (2006), tamarind fruits are said to have both anti-fungal and anti-bacterial properties. As a potential fungicidal agent against cultures of *Aspergillus niger*and Candida albicans, fruit extracts show promise (El-Siddig et al., 1999; El-Siddig et al., 2006). (25)

- **Cytotoxic Function:**

According to Al-Fatimi et al. (2007), methanol extracts of T. indica shown exceptional cytotoxic action against FL-cells with IC50 values under 50 µg/m (25)

- **Enhancer of immunity:**

Tamarind seeds have immunity-boosting qualities and can guard against a wide range of illnesses and conditions. TSP improved hemoglobin (Hb), red blood cells (RBCs), white blood cells (WBCs), and platelets ona preventative basis. Following TSP treatment, the enhanced expression of CD4+ and CD8+ cells indicated a high preponderance of TH1 cytokine-producing T cells (Aravind et al., 2012).

- **Hepatoprotective:**

Wister rats exposed to liver damage caused by isoniazid and rifampicin showed hepatoprotective effects fromethanol extracts of T. indica flower [26-2].

INDUSTRIAL USES:

- **The paper sectors**

Due to its widespread availability, XG can be used to make paper and can replace starch or galactomannan[27]. Experiments with xyloglucan as a wet end addition have recently been conducted to further explore this theory[28]. By reducing the friction of the fibres in the pulp, the addition of xyloglucan may enhancesheet formation[29-30]. The mechanical strength of paper coated with xyloglucan in a spray application was enhanced[31]. In various adhesive applications, as well as as a binder in books, corrugated board, and particle board, XG can replace starch.(5)

- **The textile sectors**

The production of textile sizing powder is the main application for tamarind seeds. It is frequently used tosize cotton and jute yarns. It costs only 50 percent as much as starch[32-33]. Textile sizing uses tamarind kernel powder of the lowest quality. Additionally, it is occasionally used with other polysaccharides when printing polyester with disperse colours, and the outcomes are generally acceptable. Due to the development of insolublecompounds with dyes, it is inappropriate for printing cotton with vat dyes. Additionally, it is inappropriate for cotton printing using fibre reactive colours. It has been demonstrated that XG anionic derivatives have various advantages over pure XG when used as print paste thickeners. Textile applications for XG-polyacrylic acid adducts.[5]

- **The food sectors**

In the food sector, polysaccharides are frequently utilized as functional additives for rheological regulationof the aqueous phase. Numerous polysaccharides serve as straightforward thickeners. These components are inexpensive commodities, and typically the most effective solutions are the most affordable. The polysaccharideswith the ability to give the aqueous phase new rheological properties are the most useful. While the features of disordered polymer chains interacting through entanglements are connected to thicker polysaccharide solutions, the basis of rigid and weak gel qualities is particular molecular association of the polymer chains. The link between polysaccharide structure and rheological functional characteristics has recently become better understood. As a result, it is currently understood that polysaccharide customization by biotechnology [5]

Formulation Applications :

- **Tablet dosage for a binder**

Both the direct compression and wet granulation methods of tablet dosage forms were used to evaluate tamarind seed polyose as a binder. The findings suggested that tamarind seed polyose might be employed as a binder for direct compression and wet granulation methods of tableting. [34-5]

- **Release Modifiers for Ophthalmic Drugs**

To determine the effectiveness of TSP for ocular preparations, scientists are presently running numerous trials. Due to its pseudoplastic rheological behavior and mucoadhesive qualities, some investigations suggest thatTSP can be effective as an artificial tear for the treatment of dry eye syndrome.[35-36]TSP was chosen as a potentialcontender because of its high mucoadhesive and viscosity strength, which could prolong the period that powerfulmedications remain on the cornea. On the intraocular pressure (IOP), rabbits were used to test the impact of an eye preparation comprising 0.5% timolol (adrenergic blocker solution) and 1 or 2% TSP. In cases with excessiveIOP, timolol in combination with TSP was shown to be appropriate for ocular administration because to its longerduration of action, which lasted up to 12 h.[37-38]

- **Nanoparticles**

The originality of TSP is demonstrated by a patent filing on the production of metal oxide nanoparticles employing an iron nitrate-based metal precursor and a natural polymer as a sacrifice template. Metal salt and TSPwere subjected to a controlled calcination process that produced nanoscale particles.[39]In a study, tamarind seedkernel polysaccharide-silica (TKP-Si) nanohybrids were created using a base-catalyzed sol-gel reaction employing tetraethyl orthosilicate (TEOS) as the precursor and tamarind kernel polysaccharide as the template. The nanohybrids effectively removed Hg (II) from a synthetic aqueous solution and were photoluminescent. Different ratios of the reactants (polysaccharide:TEOS:H2 O:EtOH) were utilized to create the sample with the highest Hg (II) binding efficiency, and the best sample was then calcined at 200°C.[38]

- **As a halting mechanism**

The Tamarind Seed Polysaccharide (TSP) is a mucoadhesive polysaccharide with high viscosity, a wide pH tolerance, and biocompatibility. Since suspensions are thermodynamically unstable, a suspending agent is neededthat can easily redisperse any settled particle matter and slow the pace of settling. This polysaccharide has been tried to be used as a suspending ingredient in the formulation of nimesulide suspension by R. Deveswaran et al. They discovered that the TSP powder works well as a suspending agent [40-41-5]

- **Bioadhesive tablet,**

When TSP and tamarind gum-based tablets were compared to those made of xanthan gum and carboxycelluloseas bio-adhesive tablets, it was shown that the latter had a more gradual development of an unpleasant taste, whilethe former demonstrated the longest residence time in the oral cavity.[5]

- **Transporter for Colon-Specific Delivery**

When in vitro tests were conducted on rat caecal contents to investigate the utility of TSP as a carrier forcolon medication delivery using ibuprofen as the model drug, substantial findings were made. The TSP-made ibuprofen matrix tablets successfully delivered the medication into the colon while preventing its release in the upper gastrointestinal tract. By conducting a biodegradability investigation of TSP in the rat caecal content, whichrevealed breakdown of TSP after the 7-day enzyme induction, the experiment proved the release of drug from TSP matrix tablets to the colon. As a result, this study offers proof that TSP is susceptible to enzymatic degradation, which results in the medication being released when it breaks down in the colon.

Other Uses :

- **Xyloglucan aids in the production of tannase:**

Aspergillus niger was used to test the generation of tannase from tamarind seed powder that was obtainedafter the fruit pulp was removed from tamarind fruit pods. Tannic acid is hydrolyzed by the enzyme tannase to produce .Aspergillus and Penicillium cultures contain gallic acid. Without any preparation, the fungus strain develops on the substrate. The study's findings are encouraging for the commercial utilization and value enhancement of this significant agro-residue, which is widely accessible in many tropical and subtropical nations[42].

- **As a biotic pesticide**

A substance with elicitor activity may be used as a biotic pesticide. xyloglucan-oligosaccharide has elicitor activity and is notably useful as an agent for inducing a phytoalexin[43].This application of a xyloglucan-oligosaccharide to a plant can be carried out by the following routes—mixing a xyloglucan oligosaccharides intothe soil where a plant is grown; a liquid fertilizer sprinkling a xyloglucan-oligosaccharide while a plant is grown;coating a seed of a plant with a xyloglucan-oligosaccharide by a procedure such as immersion, spraying, etc.; coating a plant itself, for example, whole vegetable or chopped vegetable, with a xyloglucan-oligosaccharide bya process such as immersion, spraying, etc.; preparing a capsule of a synthetic seed by way of mixing an adventive embryo of a plant with a xyloglucan oligosaccharide, and, if necessary, with added nutrients and coating the resulting mixture with a water-soluble polymer such as sodium alginate, etc. Induction of a phytoalexin by applying a xyloglucan oligoaccharide to a plant as mentioned above results in reduction of withering caused by pathogens. Accordingly, the growth of the plant can be promoted, and the freshness of a crop such as a vegetablecan be maintained during transportation and storage.[5]

DISCUSSION:

Drug loss by way of "drug inactivation through either degradation or loss of drug by its transformation into a less advantageous physical or chemical form." Combining two or more API and/or excipients can result inif their antagonistic effects negatively impact safety, therapeutic efficacy, aesthetics, or elegance, they are referredto as being incompatible. It is possible to increase the dose form's stability. Drug bioavailability and stability maybe impacted by any physical or chemical interactions between the drug and excipient. It aids in avoiding unpleasant surprises. Drug excipient compatibility studies (DECS) allow us to predict potential reactions prior to developing the final dosage form. For an IND (investigational new drug), DECS data is crucial.

CONCLUSION:

This review report presents a study on tamarind seed gum for more effective drug delivery methods. Thepharmaceutical industry will always favour natural excipients like tamarind seed gum. This review focuses on the potential industrial applications for this polysaccharide, paying particular attention to its physical and chemical attributes for the development of novel drug delivery methods. The results of all these investigations demonstrate that TSP has numerous uses and is a viable additive for the food and pharmaceutical industries.

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