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Assessment of Utilization, Value addition and characterization of Tamarind: A Natural Gum of Chhattisgarh

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ABSTRACT

The objective of the present study focuses on the extraction of gum from Tamarindus indica which are naturally abundant, biocompatible, biodegradable, and nonimmunogenic polysaccharides. Chhattisgarh are known to harbour a rich wealth of medicinal plants and due to its geographical and environmental positioning has traditionally been good source for such products. The industrial use of natural gums are expanded tremendously in recent years in comparison to synthetic due to its vast availability, lower cost and having safe properties. Tamarind derived drugs containing isolated pure active compounds used to treat various human diseases. Plant polyphenolic Components, such as flavonoids isolated from the Seed of Tamarind using organic solvents which are natural antioxidant used in nutrients. Plant material, Specially in pharmaceutical industries are using as binders, thickening agent, bioadhesive, emulsifiers, film formers and suspending agents .All parts of these plant-gum, fruit, seed, bark, leaves are several medicinal and pharmaceutical application. The potential application of valuable utility for pharmaceutically and Value addition of the medicinal plants is very much essential for commercial exploitation as well as the medicinal value of the raw drugs of this region. Above strategies for overall domestic development of herbal drugs on aspects such as promotion of the use of herbal medicines in national health-care delivery systems and steps towards improvement of agricultural and industrial production. The characterization and standardization of gums and mucilage is initially achieved by only a multiple-technique approach. Standard preparations need to be developed to improve quality, efficacy and effectiveness of the traditional drugs.

Key words: Natural Polymer, Tamarind Gum, Value addition, Pharmaceutical Excipients, Antioxidant activity

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INTRODUCTION

Today, the whole world is increasingly interested in natural medicines and there is a growing demand for plant based medicines, health products, pharmaceuticals, food supplements, cosmetics, etc. in the national and international markets. In a wider context, plant derived polymers have evoked tremendous interest due to their diverse pharmaceutical applications in pharmaceutical industry as binding agents, disintegrants, sustaining agents, protective, colloids, thickening agents, gelling agents, bases in suppositories, stabilizers and coating materials. These polymers such as natural gums and mucilage are biocompatible, cheap and easily available [1]. According to World Health Organization (WHO), over 80% of the world population relies on such traditional plant based systems of medicine to obtain primary health care but in India (70%) are dependent on plant based medicines [2]. In India, Chhattisgarh is famous as Herbal state with its beautiful natural resources of forests and agricultural fields and value addition has been done so far in Chhattisgarh to maintain or improve the quality of the plants before the material reaches the industry. Presently, the herbal industry in Chhattisgarh is not very organized. There are two source of supply wild collection from forest of Chhattisgarh and cultivated by the farmers of Chhattisgarh. The main

marketing patterns in the states are Haat Bazaars in the tribal areas, but in the non-tribal areas the marketing is done in the established Mandies. The manufacturing or processing units of medicinal plants in the state are very less. The main units are established in the southern or eastern parts[3]. The units are mainly having the facilities of distillation, pulveriser or disintegrator. Processing technology of medicinal plants includes cleaning, grading, washing, drying, grinding, extraction, packaging, storage, etc. Such management is essential for getting maximum product yield from the medicinal plants [4]. Gums are natural plant hydrocolloids, which are essentially cheap and plentiful. Gums are translucent, pathological products and amorphous substances produced by the plants. Tamarind (*Tamarindus* indica Linn.) a type of non-ionic polysaccharide and Family, Leguminosae.Tamarind gum is a versatile natural polymer and its having molecular weight 52350 units and monomer of glucose, galactose and xylose in molar ratio of 3:1:2[5]. Natural gum Tamarind is very common and commercially important large evergreen tree that is grown abundantly in the dry tracks of Central and South Indian states, and also in other South East Asian countries [6]. Generally all parts of these plant-gum, fruit, seed, bark, fruit pulp, stem, leaves, etc are several medicinal and pharmaceutical applications. In C.G.,It is composed of Baster and Sarguja districts in rural areas. At present tamarind is cultivated 54% countries of the world, 18 in it's the native range and 36 other countries where it has become naturalized. Now miscellaneous uses of fruit pulp and other parts of tamarind.

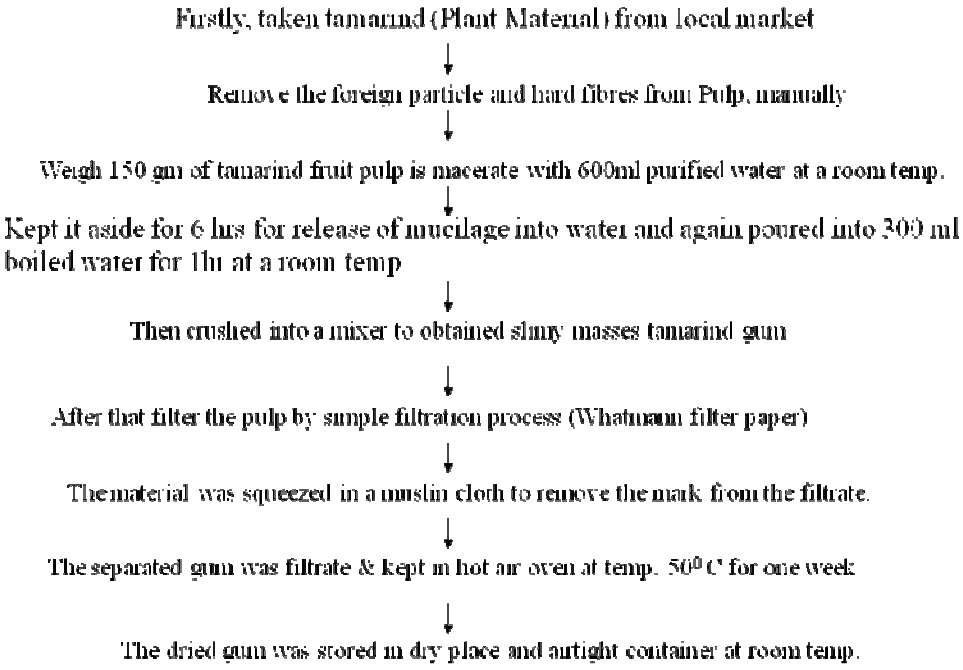
1.1 Advantages of natural gum tamarind

1. Cost effective and natural sources.
2. No side effects.
3. Biocompatible and bio-degradable.
4. Renewable source.
5. Environmental friendly processing.
6. Local availability. Non-toxic
7. Better patient tolerance as well as public acceptance.
8. They improve the national economy by providing inexpensive formulations to people, using locally available materials [6-7].

2. Methods of Extraction and Isolation

2.1 Method of Extraction: - Selection of part of Tamarind fruit Pulp for isolating gum

Flow Chart Method



2.2 Antioxidant flavones Isolated from the Seed of Tamarind using organic solvents:-

The Soxhlet methanolic extracts will determine, and indicates that Tamarind may be an important source of flavonoids antioxidant natural products in this region. After defatted by petroleum ether, the raw and processed ground seed coat samples (50 g) were extracted by stirring with 250 ml methanol at 25^0 C for 48 h and filtering

through Whatmann No. 4 filter paper. The residues were reextracted with an additional 100 ml of methanol, for 3 h. The solvent of the combined extract was evaporated under reduced pressure (34–36 kPa) using a rotary vacuum-evaporator at 40^0 C and the contents were freeze-dried, respectively[8-9]. The remaining residues, after methanol extraction and air drying, will extracted by stirring with 250 ml 70% acetone (v/v) at 25^0 C for 48 h and filtering through Whatman No.4 filter paper [10]. The solvent of the extract was removed under reduced pressure (52–56 kPa) using a rotary vacuum-evaporator at 40^0 C and the contents were freeze-dried, respectively. The freeze-dried extract thus obtained will use for the assessment of antioxidant polyphenolic flavones for nutritional foods[11-12].

2.3 Method

Tamarind seeds were collected and dried in sunlight. The kernels are then crushed to fine powder. 20 g of fine kernel powder was added to 200 ml of cold distilled water to prepare slurry. The slurry obtained is than poured into 800 ml of boiling distilled water and are boiled for 20 min on a water bath; a clear solution was obtained which was kept overnight. The thin clear solution was than centrifuged at 5000 rpm for 20 min to separate all the foreign matter. Supernatant liquid was separated and poured into excess of absolute alcohol with continuous stirring. Precipitates were obtained which were collected by a suitable method and washed with 200 ml of absolute ethanol and dried at 50°C for 10 h. Store the polymer obtained in a dessicator[10,13].

2.4 Method

This method is patented in United States by Jones *et al*. It involves the separation of tamarind kernel powder on the basis of their size distribution. Tamarind kernel powder was defatted by using C-6 or C-8 aromatic hydrocarbons or C-1 or C-2 or above halogenated lower hydrocarbons or C-1 or C-5 mono or dihydroxy alcohols, e.g. ethylene dichloride, heptanes, or toluene. (For defatting, Crude TKSP is suspended in suitable solvent to extract fat that is mechanically recovered by filtration or centrifugation and dried.) After drying, HiSil or other silicaceous materials like CaboSil improve the flow properties of powder. The powder is further grounded by using Hammer mill or Pin mill that will reduce the size of the powder below 100 mm. The powder is further air classified by using suitable air classifier (The Walther type 150 laboratory air classifier, The Alpine Mikroplex model 400, MPVI Air Classifier). Three fractions of the powder were obtained after air classifications [14-15].

3. Value addition of Medicinal Plants in Chhattisgarh

Chhattisgarh –A strong base of natural resources, a peaceful workforce and surplus power along with an added advantage of being located closer to the markets of eastern and western India. However, the State has not yet been able to leverage these strengths to its fullest. Also in order to realize the true potential of the natural resources in the State, it is important to focus on value added industries. As a part of the study, to assess the extent of value addition of medicinal plants, which is being done in the state, village level collectors of MAPs, members of local community, traders and wholesalers were contacted. It is quite disappointing to note that the information obtained revealed that no attempt of value addition has been done so far to maintain or improve the quality of the plants before the material reaches the industry [2, 16].

The World Health Assembly has emphasized the need to ensure the quality of medicinal plant products by using modern control techniques and applying suitable standards. Value addition of the medicinal plants is very much essential for commercial exploitation as well as the medicinal value of the raw drugs. Even authenticated plant material may not be of desired quality and strength and not conforming to the physicochemical parameters or the concentration of the active constituents or marker compounds as per the pharmacopoeial standards or the consumer / industry requirements. Such material is liable to be rejected or accepted at very low price causing not only economic loss to the cultivators or collectors of the medicinal plants but also entails doubtful efficacy or curtails the potency of the raw drug in the alleviation of the human suffering[2,4] .

Chhattisgarh should exploit its strengths as a predominantly agrarian economy and a State rich in bio-diversity to create more wealth for itself by developing value-added agro and forest based industries. The focus should be on horticulture, food processing, gums, oil-seeds, cotton, sugar, cereals, spices and floriculture and on the forest based industries like Sal, Tamarind, herb, olive, bran and amla Processing industries. The potential for the growth of agro and forest based industries should be identified in each district of the State. This should be done considering the climatic and the soil conditions. The bio-diversity of the forests should be mapped by the systematic classification of the rare flora and fauna [17-18]. In the state of Chhattisgarh this is an area of lacunae as there are certain gaps which need to be fulfilled in order to achieve value addition of medicinal plants. Direct value addition is not achieved because of the following reasons

- Collection doesn't take place in specific season.
- Poor harvesting and processing of plant material
- Improper grading and sorting

• Improper cleaning, packaging and storage
• Indirect value addition is also not achieved due to presence of moisture, foreign matter, ash content, extractives, pesticide residue and microorganism.

Value addition of the medicinal plants can be achieved directly by improving the quality of the cultivated or collected plant material and indirectly by quality assurance of the plant material or the semi-processing of the material to a value added product [19-20].

3.1 Direct Value Addition

• Collection in the proper seasons

Seasonal variation in the concentration of secondary metabolites present in the plant and which are of medicinal importance is found to be a common phenomenon and consequently the efficacy or the potency of the raw drugs may not be the same all round the year or at different stages of plant growth. This fact need to be very much considered and the collection of the material should be made in the appropriate season [2,21].

Medicinal plant materials should be collected during the appropriate season or time period to ensure the best possible quality of both raw materials and finished products. It is well known that the quantitative concentration of biologically active constituents varies with the stage of plant growth and development. This also applies to non-targeted toxic or poisonous indigenous plant ingredients. The best time for collection (quality peak season or time of day) should be determined according to the quality and quantity of biologically active constituents rather than the total vegetative yield of the targeted medicinal plant parts [22].

• Harvesting and processing of the plant material

At the time of harvesting, collection practices should ensure the long-term survival of wild flora and their associated habitats. First, the density of the target species at the collection site(s) should be determined and it should be ensured that species which are rare or scarce are not to be collected. To encourage the regeneration of source of medicinal plant materials, a sound demographic structure of the flora has to be ensured. Management plans should refer to the species and the plant parts (roots, leaves, fruits, etc.) to be collected and should specify collection levels and collection practices. It should also specify collection levels and collection practices [23]. It is incumbent on the government or environmental authority to ensure that buyers of collected plant material preserve it with maximum caution. While collecting the material, ecologically non-destructive systems of collection alone should be employed and they vary widely from species to species. For example, when collecting roots of trees and bushes, the main roots should not be cut or dug up, and severing the taproot of trees and bushes should be avoided. Some of the lateral roots should be identified and collected. When collecting species whose bark is the primary material to be used, the tree should not be girdled or completely stripped of its bark; long strips of bark should be cut along one side of the tree for collection [24-25]. If more than one part of medicinal plant is to be collected, the different plant species or plant materials should be gathered separately and transported in separate containers [26-27]. Cross-contamination should be avoided at all times. Collecting implements, such as machetes, shears, saws and mechanical tools, should be kept clean and maintained in proper condition. Those parts that come into direct contact with the collected medicinal plant materials should be free from excess oil and other contamination. After collection, the raw medicinal plant materials may be subjected to appropriate preliminary processing, including elimination of undesirable materials and contaminants, washing (to remove excess soil), sorting and cutting[28]. The collected medicinal plant materials should be protected from insects, rodents, birds, other pests, from livestock and domestic animals. If the collection site is located at some distance from processing units, it may be necessary to air or sun-dry the raw medicinal plant materials prior to transport [29].

• Grading and sorting

Instead of assorted material, which may include infested, immature and other kinds of unacceptable material, sorting and grading will be a means of value addition and market potential. In the course of collection, efforts should be made to remove parts of the plant that are not required and foreign matter, in particular toxic weeds. Decomposed medicinal plant materials should be discarded[30-31].

• Cleaning

Any soil, stones, sand, dust and other foreign inorganic matter must be removed before medicinal plant materials are cut or ground for testing. In general, the collected raw medicinal plant materials should not come into direct contact with the soil. In the case of underground parts of plants (such as the roots), any adherent soil should be removed from the plants immediately after collection. Collected material should be placed in clean baskets, mesh bags, other well aerated containers or drop cloths that are free from foreign matter, including plant remnants of previous collecting activities [32-33].

• Packaging

The container and its closure must not interact physically or chemically in any way that would alter its quality. A well-closed container must protect the contents from extraneous matter or from loss of the material under normal conditions of handling, shipment or storage. Different categories of the plant material need different packaging practices to prevent spoilage and also to maintain the quality [34-35].

• Storage

Medicinal plant materials must be stored under specified conditions in order to avoid contamination and deterioration. Avoid formation of moulds, which may produce aflatoxins. Materials that need to be stored at temperatures other than room temperature should be stored at low temperatures to avoid decomposition of phyto constituents or deterioration of quality. Low humidity may be maintained using a desiccant in the container if necessary. Medicinal plant materials requiring protection from light should be kept in a light resistant container or the container may be placed inside a suitable light-resistant (opaque) covering [36-38].

Macroscopic and Microscopic examination

Medicinal plant materials are categorized according to sensory, macroscopic and microscopic characteristics. Visual inspection provides the simplest and quickest means to establish identity, purity and possibly, quality. Macroscopic identity of medicinal plant materials is based on shape, size, color, surface Characteristics, texture, fracture and appearance of the cut surface. However, since these characteristics are judged subjectively and substitutes or adulterants may closely resemble the genuine material, it is often necessary to substantiate the findings by microscopy or physico chemical analysis[39]. Microscopic inspection of medicinal plant materials is indispensable for the identification of broken or powdered materials.ues, which accumulates from agricultural practices such as spraying and treatment of soils and fumigation during storage. Since many medicinal preparations of plant origin are taken over long periods of time, the intake of residues from medicinal plants should not be more than 1% of the total intake from all the sources including food and drinking water [39-40].

Microorganisms:

While a large range of bacteria and fungi form the naturally occurring micro flora of herbs, aerobic spore forming bacteria frequently predominate. Current practices of harvesting, handling and production may cause additional contamination and microbial growth. The determination of *Escherichia coli* and moulds may indicate the quality of production and harvesting practices.

3. 2 Indirect Value Addition

Testing for the Physico-chemical standards (Moisture, FOM, Ash Content, Extractives)

• Moisture

An excess of water in medicinal plant materials will encourage microbial growth and also causes deterioration following hydrolysis. This is especially important for materials that absorb moisture or deteriorate quickly in the presence of water. The test for *loss on drying* can be carried out either by heating to 100-105^0 C or in desiccators over phosphorus pent oxide for a specified period of time[41].

• Foreign matter

Medicinal plants should not be collected in or near areas where high levels of pesticides or other possible contaminants are used or found, such as roadsides, drainage ditches, mine tailings, garbage dumps and industrial facilities which may produce toxic emissions. Apart from this, the collection of medicinal plants in and around active pastures, including river banks and downstream from pastures, should not be done in order to avoid microbial contamination from animal waste. Macroscopic examination can conveniently be employed for determining the presence of foreign matter in whole or cut plant materials. However, microscopy is indispensable for powdered materials[42].

• Ash Content

Ignition of medicinal plant material yields total ash constituting both physiological (from the plant tissue) and non-physiological (extraneous matter adhering to the plant) ash. Acid insoluble ash represents sand and siliceous earth.

• Extractives

It is the amount of soluble constituents (active or otherwise) extracted using solvents like alcohol and water from a given amount of medicinal plant material.

• Pesticide residues

Medicinal plant materials are liable to contain pesticide residues, which accumulate from agricultural practices such as spraying and treatment of soils and fumigation during storage. Since many medicinal preparations of plant origin have to be taken over long periods of time, the intake of residues from medicinal plants should not be more than 1% of the total intake from all the sources including food and drinking water [43].

• Micro organisms

While a large range of bacteria and fungi form the naturally occurring micro flora of herbs, aerobic spore forming bacteria frequently predominate, current practices of harvesting, handling and production may cause additional contamination and microbial growth.

4. Characterization / Standardization of gums and mucilages

A strategy for desirable characterization of Chhattisgarh natural gums & mucilages is required to save money and time. Over-characterization is not desirable, because excessive use of time and resources could actually delay the launch of innovative excipients. The characterization of gums and mucilages is initially achieved by only a multiple-technique approach [44]. For excipients analysis, analytical techniques can be classified according to the type of information generated. Structural—Gums and mucilages are polysaccharides and contain sugars. So, confirmation of the different sugars is carried out by chromatography and structure elucidation can be carried out by NMR and mass spectroscopy [45].

Gums and mucilages are highly viscous in nature. So, the rheological properties of excipients are important criteria for deciding their commercial use. The flow behaviour of the samples is determined. Finally, gums and mucilages are added to pharmaceutical formulations. So a compatibility study is important. The compatibility studies of gum/mucilage/drugs are performed using spectrophotometry/FTIR/DSC [46]. There are following strategies given for particular interest of gums and mucilages that

Identification tests for gum

In freshly prepared corallin soda, the sample is mounted, covered with a cover slip and after a few seconds it was irrigated with 25% sodium carbonate solution. Identification tests for gums as recommended by FAO (1991) are carried out [6].

Determination of purity and Impurity of gum

To determine the purity of the select gum and mucilage, tests for alkaloids, glycosides, carbohydrates, flavonoids, steroids, amino acids, terpenes, saponins, oils and fats, and tannins and phenols are carried out.

Impurity profile—testing for impurities must be carried out using suitable analytical techniques.

Organoleptic Evaluation of gum

The Organoleptic evaluation refers to the evaluation of color, odour, shape, taste and special features which include touch and texture. The majority of information on the identity, purity and quality of the material can be drawn from these observations [47].

Determination of pH of the polymer

The gums are weighing and dissolve in water separately to get a 1%w/v solution. The pH of 1% solution of the selected polysaccharide was determined using a digital pH meter.

Determination of Solubility

One part of dry gum powder was taken with different solvents and the solubility was determined.

Melting point

The powdered sample of tamarind seed polysaccharide was transferred into a capillary tube and by using Besto melting point apparatus melting point was determined [48].

Powder Flow Property

The flow characteristics were measured by angle of repose. The experiment was repeated thrice. Using the readings and the formula, the angle of repose was calculated.

Powder Compressibility

This property is also known as compressibility. The finely powdered mucilage (5g) was transferred into a measuring cylinder and calculations were done using bulk density apparatus.

Swelling index

Swelling index of tamarind seed polysaccharide was determined by using modified method reported [48]. One gram of TSP powder (#100 mesh passed) was accurately weighed and transferred to a 100mL stoppered measuring cylinder. The initial volume of the powder in the measuring cylinder was noted. The volume was made up to 100 mL mark with distilled water. The cylinder was stoppered, shaken gently and set aside for 24 h. The volume occupied by the gum sediment was noted after 24 h.

Swelling index (SI) is expressed as a percentage and calculated according to the following equation.

$$\text{Swelling index (I)} = \frac{Xt - X_0}{X_0} X100$$

Where X_0 is the initial height of the powder in graduated cylinder and Xt denotes the height occupied by swollen gum after 24 h. The content from the measuring cylinder from the above test were filtered through a muslin cloth and the water was allowed to drain completely into a dry 100mL graduated cylinder. The volume of water collected was noted and the difference between the original volume of the mucilage and the volume drained was taken as water retained by sample and was referred to as water retention capacity or water absorption capacity.

Determination of moisture content

Moisture content was determined by using Karl Fischer auto titrator M/s Met Rhom and the moisture content of tamarind seed polysaccharide.

Thermal stability

A sufficient quantity of the powdered gum was taken in a petridish and exposed to successive higher temperatures (30°C, 40°C, 50°C, etc.).The temperature at which the product showed a change in color was noted. For thermal stability under liquid conditions, 1% solution of gum was exposed to successive higher temperatures (30°C, 40°C, 50°C, etc...) and the temperature at which the product showed a change in viscosity.

Micromeritic properties

Powders were characterized for Micromeritic properties, such as particle size, true density, tapped density, compressibility index, and flow properties. The size was measured using an optical microscope, and the mean particle size was calculated by measuring 600 particles with the help of a calibrated ocular micrometer. The tapping method was used to determine the tapped density and percentage compressibility index as follows:

Tapped density = Mass of powders / Volume of powders after tapping

% Compressibility index = [1- V/Vo] x 100

Where V and V_0 are the volumes of the sample after and before the standard tapings, respectively. True density was determined using a Helium densitometer

Angle of repose

The powder flow characteristics are measured by angle of repose. Angle of repose (θ) of the microspheres, which measured the resistance to particle flow, was determined by the fixed funnel method.

$\text{Tan}\Theta = h/r$, $\Theta = \text{Tan}^{-1} h/r$

Where, h = height of Pile, r = radius of the base of the pile, Θ = Angle of repose

5. Physico-chemical Properties and Structure of tamarind gum

The composition of tamarind kernel, the source of gum, resembles the cereals. With 13.35 % to 12.7 % protein, 3-7.5 % oil, 7-8.2 % crude fiber, 61-72.2 % nonfiber carbohydrates, 2.45-3.3 % ash; all were measured on a dry basis. Chemically tamarind kernel powder is highly branched carbohydrate polymer [49,50]. Its backbone consists of D-glucose units joined with (1-4) b-linkages similar to that of cellulose. Tamarind gum is a polysaccharide composed of glucosyl : xylosyl : galactosyl in the ratio of 3:2:1 . Xyloglucan is a major structural polysaccharide in the primary cell walls of higher plants [51]. Tamarind xyloglucan has a (1 4)-!-D-glucan backbone that is partially substituted at the O-6 position of its glucopyranosyl residues with "-D-xylopyranose. TSP is a high-molecular-weight, neutral branched polysaccharide consisting of cellulose like backbone that carries xylose and galctoxylose substances. It is

insoluble in organic solvents and dispersible in hot water to form a highly viscous gel such as a mucilaginous solution with a broad pH tolerance and adhesivety [52].

6. Phytochemical composition of *Tamarindus indica*

Phytochemical investigation carried out on *T. indica* revealed the presence of many active constituents, such as phenolic compounds, cardiac glycosides, l-(-)mallic acid, tartaric acid, the mucilage and pectin, arabinose, xylose, galactose, glucose, and uronic acid. The ethanolic extract of *T. indica* showed presence of fatty acids and various essential elements like arsenic, calcium, cadmium, copper, iron, sodium, manganese, magnesium, potassium, phosphorus, lead, and zinc[53,54,55]. The pulp contains organic acids, such as tartaric acid, acetic acid, citric acid, formic acid, malic acid, and succinic acid; amino acids; invert sugar (25-30%); pectin; protein; fat; some pyrazines (trans-2-hexenal); and some thiazoles (2-ethylthiazole, 2-methylthiazole) as fragrant; and the seed polysaccharides are found with a main chain consisting of β-1,4-connected glucose molecules together with xylose (alpha-1,6) and galactose; total protein; lipids with fatty oils; and some keto acids. In the leaves of the plant, two triterpenes, lupanone and lupeol were found [14,56].

The chemical composition of amino acids, fatty acids, and minerals of tamarind plant parts have been reported. Differences in values found in the literature are likely to be due to differences in genetic strains, stages of maturity at which the plant parts were harvested, growing conditions (Glew *et al.*, 2005), harvesting and handling techniques as well as to differences in analytical methodologies. Nevertheless, a review of the phytochemistry will provide insight into the relative value that this species provides when used [57].

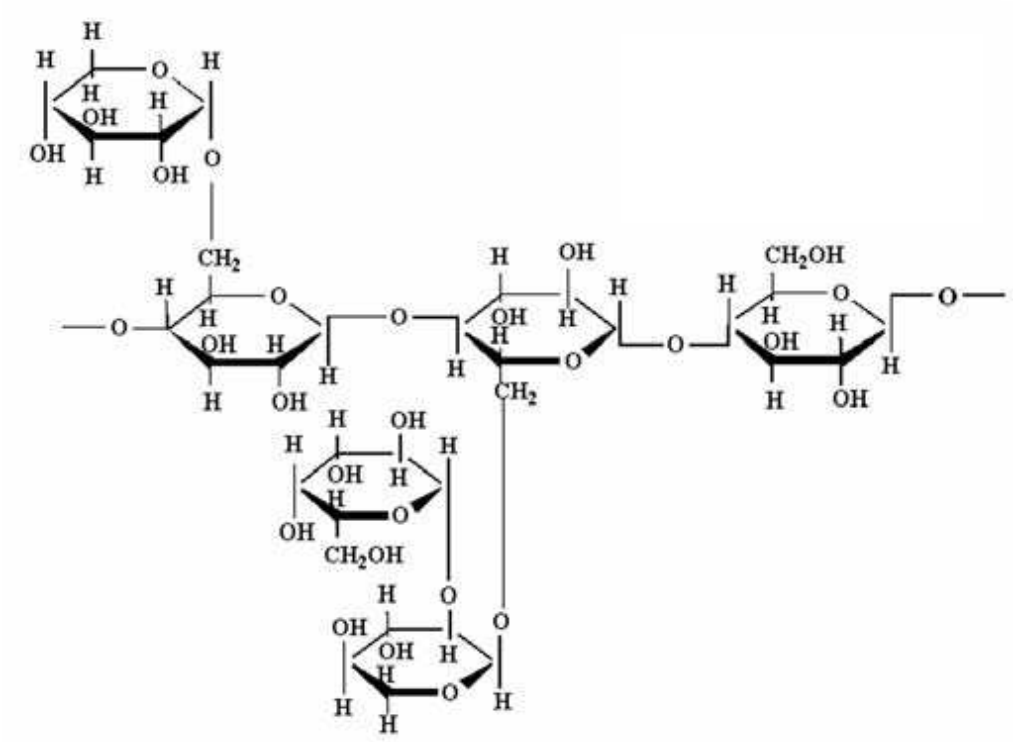


Figure 1. Chemical structure of tamarind gum [52]

Table 1. Chemical composition of tamarind seeds and tamarind fruit pulp powder [58]

Constituents	Tamarind seed %	Tamarind fruit pulp %
Moisture	30.0	3.5-8.8
Tartaric acid	13.0	8.7-11.1
Invert sugars	50.0	15.8-25
Proteins	13.35	2.40
Starch		20.0-41.3
Ash	2.15	2.1-3.3
Fat	2.90	0.14
Energy, Kcal/100g	324.10	216.86

7. Pharmaceutical applications or uses of natural Tamarind gum in CDDS / NDDS

Gums and mucilages have a variety of applications in pharmacy. Tamarind seed powder is a suitable candidate for pharmaceutical use. It is used as a carrier for variety of drugs for Sustained / Controlled release and different

pharmaceutical excipients applications. Many techniques have been used to manufacture the TSP-based delivery systems [Table. 2], which makes it exciting and promising excipients for the pharmaceutical industry for the present and future applications [59].

Table 2. Pharmaceutical applications or uses of natural Tamarind gum in CDDS / NDDS [51, 52]

S.N.	Gum	Dosage Form	Pharmaceutical applications	Drug
1.	Tamarind gum	topical hydrogel	gelling agent	Diclofenac sodium
2.	Tamarind gum	Matrix tablet	sustained-release	Lamivudine
3.	Tamarind gum	Solid Dispersion	Solubilizer	Aceclofenac
4.	Tamarind gum	bioadhesive tablets	controlled release	Lactoferrin
5.	Tamarind gum	Tablet dosage form	Sustained release	Metformin hydrochloride
6.	Tamarind gum	Buccal patches	Mucoadhesive	Metronidazole
7.	Tamarind gum	Matrix tablet	Release modifier	Diclofenac sodium
8.	Tamarind gum	Matrix tablet	Biodegradable carrier	Ibuprofen
9.	Tamarind gum	Suspension	suspending agent	Nimesulide
10.	Tamarind gum	Suspension	suspending agent	Paracetamol
11.	Tamarind gum	Emulsion	Emulsifying activity	Castor oil
12.	Tamarind gum	Gel formulation	Gelling behaviour	Pectin
13.	Tamarind gum	Matrix Tablet	sustained release	Lornoxicam
14.	Tamarind gum	Gel Bead	Controlled release	Borax
15.	Tamarind gum	Mucoadhesive Buccal tablet	sustained release	Nifedipine
16.	Tamarind gum	Emulsion	Antioxidant activity	Linoleic acid
17.	Tamarind gum	Mucoadhesive buccal patches	controlled release	Benzydamine, Lidocaine
18.	Tamarind gum	Matrix Tablet	Sustained release	Acetaminophen, Caffeine, Theophylline and Salicylic acid) Indomethacin

7.1 Traditional use of Tamarind (*Tamarindus indica Linn.*)

Natural sources of gums are the back bone of Traditional medicine. Medicinal plants have been used in various systems, as they have potential against numerous diseases. It has numerous chemical values and is rich in phytochemicals, and hence the plant is reported to possess antidiabetic activity, antimicrobial activity, antivenomic activity, antioxidant activity, antimalarial activity, hepatoprotective activity, antiasthmatic activity, laxative activity, and anti-hyperlipidemic activity. Every part of the plant from root to leaf tips is useful for human needs. Medicinal plants sector has traditionally occupied an important position in the socio-cultural, spiritual and medicinal arena of rural and tribal lives of India [14,58]. The global thrust areas for drugs from medicinal plants include disease conditions, whose incidence is increasing and where the modern drugs are either unavailable or unsatisfactory.

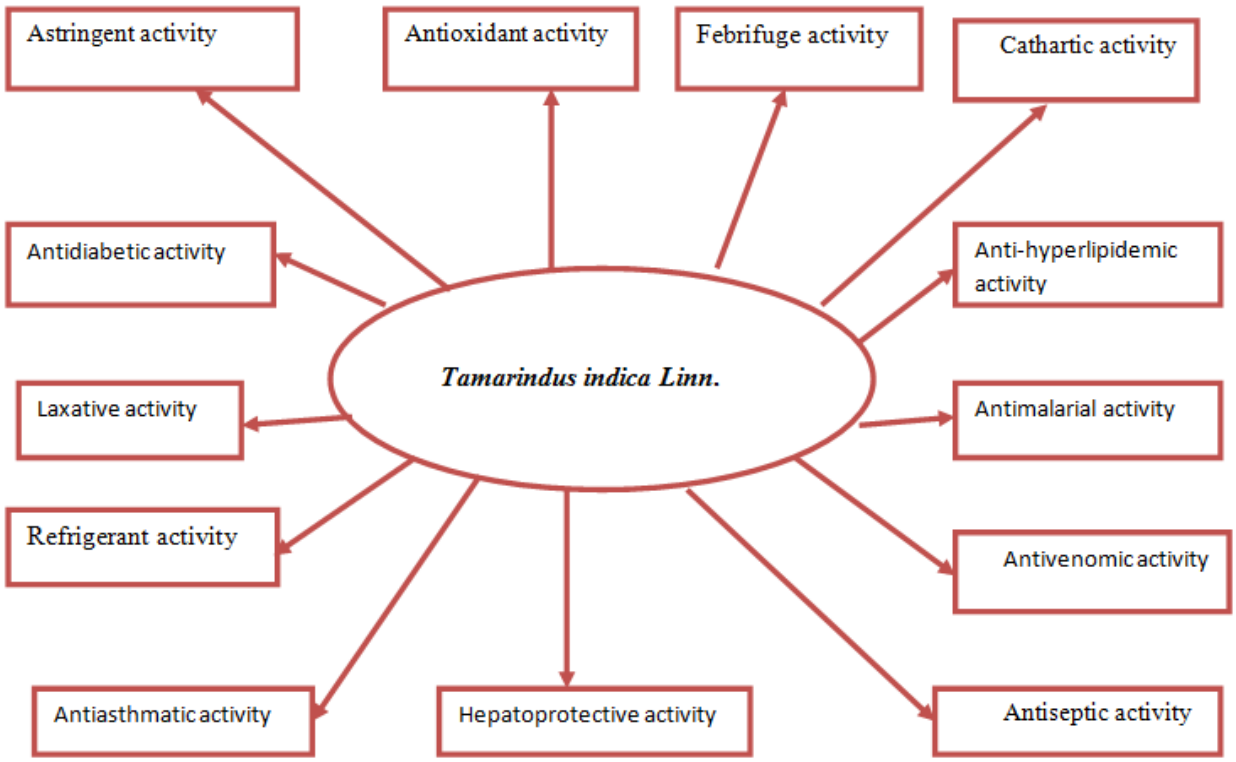


Figure 2: Medicinal properties of Tamarind (*Tamarindus indica Linn.*)

7.2 Nutritional *value of Tamarindus indica*

The fruit of *Tamarindus indica linn* possess high nutritional value. Tamarinds in Indian cookery is an important ingredient in curries and chutneys, and makes a delicious sauce for duck, geese and water fowl, and in Western India is used for pickling fish, Tamarind fish being considered a great delicacy[59,60]. Tamarind Concentrates and other Tamarind Products are used as a souring agent. It is food-grade and largely used in the manufacture of beverages, seasonings, juices, to flavour confections etc. Indian dishes like vindaloo, sambar, rasam, curry, puliogare, panipuri, many snacks, chutneys and sauces. Fish, meat, seafood preservation and as a taste enhancer for any food or beverage[61].

7.3 Pharmacological studies of tamarind

Tamarindus indica linn is one of the most widely used medicinal and neutricuitical plant in the family, Leguminosae. In recent history this plants is reported for various medicinal properties (Figure 2) [62, 63].

CONCLUSION

Now-a-days, natural polymers play a very important role almost in all kind of formulations.

To achieve this objective the plant derived drugs to isolate a natural pharmaceutical excipients from tamarind and to check its Valuable utility of versatile excipients for pharmaceutical formulations and Value addition of the medicinal plants is very much essential for commercial exploitation as well as the medicinal value of the raw drugs of this Chhattisgarh region and Thus, the modern social context and economic view of health services, the needs of the pharmaceutical market and the recognition that research on medicinal plants used in folk medicine represents a suitable approach for the development of new drugs. The traditional uses, its phytochemistry and pharmacognosy is reviewed to provided with a particular orientation to its value in Chhattisgarh region. This can be tremendous contribution to improving self reliance in primary health care for humans and gives supplementary income to the livelihoods and prevent the loss of our traditional plants and heritage. Tree trunk is used as timber. Its taste is sour, sweet, cool and astringent, due to its ingredients. Many parts of the Tamarind tree have been used in traditional medicines to treat diseases as well as symptoms. Natural gums are promising biodegradable polymeric materials. Many studies has been carried out in fields including food technology and pharmaceuticals using gums and mucilages. It is clear that gums and mucilages have many advantages over synthetic materials. Various applications of gums and mucilages have been established in the field of pharmaceuticals. However, there is a need to develop other natural sources as well as with modifying existing natural materials for the formulation of novel drug delivery systems, biotechnological applications and other delivery systems. Therefore, in the years to come, there will be continued interest in natural gums and their modifications aimed at the development of better materials for drug delivery systems. Considering the overall benefits of the plant, it can be advocated as a safe, highly important, medicinal plant for mankind. It is maintaining the health of local communities, besides generating productive employment for the poor with the objective of poverty alleviation in tribal and rural areas.

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