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Isolation and Evaluation of Tamarind Seed Polysaccharide being used as a Polymer in Pharmaceutical Dosage Forms.

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ABSTRACT

Tamarind seed polysaccharide (TSP) obtained from the seed kernel of Tamarindus indica, possesses properties like high viscosity mucilage, broad pH tolerance, no carcinogenicity, mucoadhesive nature, and biocompatibility. It is used as stabilizer, thickener, gelling agent, and binder in food and pharmaceutical industries. The objective of present investigation was to search for a cheap and effective natural excipient that can be used as an effective alternative for the formulation of pharmaceutical formulations. Thus this mucilage will be a non-toxic, bio-degradable, cheap, economic and easily available option as a natural polymer.

Key words: Binder, Tamarind seed polysaccharide, Natural polymer.

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INTRODUCTION

Today we have lot of pharmaceutical excipients such as starch, agar, alginates, carrageenan guar gum, xanthan gum, gelatin, pectin, chitosan, acacia, tragacanth, celluloses, sugars, etc., and most of them are from plant origin. These natural excipients find application in pharmaceutical industry as binding agents [1] disintegrants, sustaining agents [2], protective, colloids, thickening agents, gelling agents, bases in suppositories, stabilizers and coating materials. In the design of sustained release dosage forms, they retard the drug release by forming a thick retardant gel layer. Swellable polymers that are water insoluble and commonly called as hydrogels where as those which water soluble are called as hydrophilic polymers [3]. Seed gums are important agrochemical used in various industries worldwide. The growing industrial utility of these gums in the field of paper, textile, petroleum recovery and pharmaceutical industries has resulted in an impetus in India for intensified research on new sources of gums and their modified products. Gum is a by-product obtained as a result of metabolic mechanisms of plants.

Advantages of Natural Plant-Based Excipients

1. Low cost and natural origin.
2. Free from side effects.
3. Biocompatible and bio-acceptable.
4. Renewable source.
5. Environmental friendly processing.
6. Local availability.
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.

Natural gums are either water soluble or absorb water to form a viscous solution. Natural gums are less economic, easily available. Gums have been wildly used as tablet binders, emulgents and thickeners in cosmetics and suspensions as film-forming agents and transitional colloids. Polysaccharides (gums and mucilage) are most commonly used adjuvants in pharmaceutical preparations. They find maximum use particularly in the formulation of suspensions and emulsions. The usefulness of polysaccharides as emulsifying and suspending agents has been well documented.

Some of them have also been used in tablet formulations as binding agents [4] and also to sustain the drug release. Such matrix systems belong to the third group of polymers and drug release is mainly diffusion sustained [5]**.** Gums and mucilage's are polysaccharide complexes formed from sugar and uronic acid units. They are insoluble in alcohol but dissolve or swell in water. They are usually formed from the cell wall (e.g tragacanth) or deposited on it in successive layers. Gums are natural plant colloids that may be classified as anionic or non-ionic polysaccharides or salts of polysaccharides. They are translucent, amorphous substances that are frequently produced in higher plants as a protective after injury. Gums are either

hydrophobic or hydrophilic in nature. Gums and mucilage's are obtained mainly from seeds or other plant parts. Some are obtained from various marine algae, and some from selected microorganism. Also, a number of semi synthetic gums and mucilages are used for their hydrophilic properties, and they can be considered as special hydrocolloid gums. Gums and mucilage's are typically heterogeneous in composition. Upon hydrolysis, arabinose, galactose, glucose, mannose, xylose and various uronic acids are the most frequently observed components. The uronic acid may form salts with calcium, magnesium and sulfate ester substituents.

In the present study an effort was made to isolation, characterization, evaluation and the efficacy of TSP as a natural polymer. The characteristic of TSP preformulation studies were evaluated for introduction of new plant excipient in tablet formulations.

MATERIALS AND METHODS

Materials

The seeds of Tamarindus indica were purchased from local market, Visakhapatnam. All the other chemicals, solvents and reagents used were of Pharmacopoeial and analytical grade were procured from Loba Chemical, India.

Methods

Collection and identification of plant material

The seeds of Tamarindus indica were purchased from local market, Visakhapatnam. The authentication of the plant material was done by Department of Botany, Andhra University, Vishakhapatnam. A specimen sample is kept in the laboratory for future use.

Isolation of Tamarind seed polysaccharide

The seeds of Tamarindus indica were washed thoroughly with water to remove the adhering materials. Then, the reddish testa of the seeds was removed by heating seeds in sand in the ratio of 1:4 (Seed: Sand). The testa was removed. The seeds were crushed lightly. The crushed seeds of Tamarindus indica were soaked in water separately for 24 h and then boiled for 1 h and kept aside for 2 h for the release of mucilage into water. The soaked seeds were taken and squeezed in a muslin bag to remove marc from the filtrate. Then, equal quantity of acetone was added to precipitate the mucilage. The mucilage was separated. The separated mucilage was dried at temperature 50°C, powdered and passed through sieve number 80. The dried mucilage was powdered and stored in airtight container at room temperature [6].

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Characterization of selected polysaccharide

Identification tests for gum

In freshly prepared corallin soda, the sample was 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) were carried out.

Determination of purity of gum

To determine the purity of gum tests for alkaloids, carbohydrates, flavonoids, steroids, terpins, saponins, tannins and phenols were carried out [7 - 9].

Organoleptic Evaluation

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.

Physicochemical characterization of mucilage

Swelling index

Swelling index of tamarind seed polysaccharide was determined by using modified method reported [10]. 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.

$$\text{Swelling Index(SI)} = \frac{x_t - x_0}{x_0} \times 100$$

Where XO 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.

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Determination of pH of the polymer

The pH of 1% solution of the selected polysaccharide was determined using a digital pH meter.

Determination of Surface Tension of polysaccharide

The surface tension of the selected polysaccharides was determined by drop count method, using a stalagmometer [11].The stalagmometer was filled with purified water above the upper mark. Using the screw pinch cork, the flow rate was adjusted to 10-15 drops/min. Then, number of drops of water was counted between the marks of the stalagmometer (n1). The water was removed and the stalagmometer was filled with the polysaccharide solution (0.1%w/v) and number of drops was counted (n2). The surface tension of the polysaccharide was determined using formula given below.

Surface tension ($\gamma 2$) = $n2\rho2\gamma1/n2\rho1$

Where, n1=number of drops of water
n2=number of drops of sample
$\rho1$=density of water (0.9956g/mL)
$\rho2$=density of sample
$\gamma1$=surface tension of water (71.18 dynes/cm)

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.

Solubility

Solubility of TSP was checked with different solvents.

Ash values

Ash values such as total ash, acid insoluble ash and water-soluble ash were determined according to Indian Pharmacopoeia. The following procedures were used for determination of ash values.

Total Ash

About 3 g of sample was accurately weighed and taken in a silica crucible, which was previously ignited and weighed. The powder was spread as a fine, even layer on the bottom of the crucible. The crucible was incinerated gradually by increasing temperature to make it dull red hot until free from carbon. The crucible was cooled and weighed. The procedure was

repeated to get constant weight. The percentage of total ash was calculated with reference to air dried sample.

Acid Insoluble Ash

The ash obtained as described above was boiled with 25 mL of 2N HCl for five minutes. The insoluble ash was collected on an ash less filter paper and washed with hot water.

The insoluble ash was transferred into a silica crucible, ignited and weighed. The procedure was repeated to get a constant weight. The percentage of acid insoluble ash was calculated with reference to the air-dried sample.

Water-soluble Ash

The ash obtained as described for the determination of total ash was boiled for 5 min with 25 mL of water. The insoluble matter was collected on ash less filter paper and washed with hot water. The insoluble ash was then transferred into silica crucible, ignited for 15 min, and weighed. The procedure was repeated to get a constant weight. The weight of insoluble matter was subtracted from the weight of the total ash. The difference of weight was considered as water-soluble ash. The percentage of water-soluble ash was calculated with reference to the air dried sample.

Microbial Count

Specified amount (10 g) of the sample was dissolved in a suitable medium to have no antibacterial activity under conditions of test and the volume was adjusted to 100mL with the same medium. The pH was adjusted to 7.

Examination for Bacteria and Fungi

To a petri dish of 10 cm diameter, 20 mL of nutrient agar was added at temperature not more than 45°C. The sample solution was spread on the surface of the solidified medium. The Petri dishes of required number were prepared and incubated at 37°C for 24 h. but, sabouraud dextrose agar medium is used for fungi and the plate was incubated at 28°C for 48 h. The number of colonies formed was counted.

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.

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Thermal stability

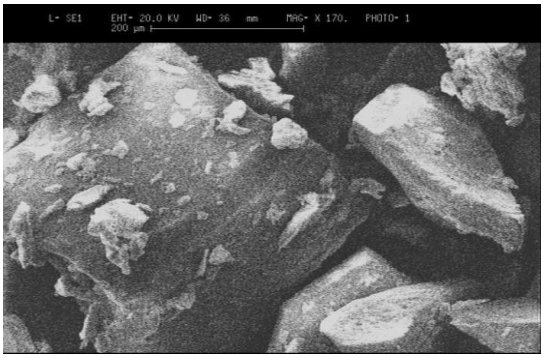
A sufficient quantity of the powdered gum was taken in a petridish and exposed to successive higher temperatures (30°C, 40°C, 50°C, etc.).The temperature at which the product showed a change in color was noted.

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.

Surface Characteristics by Scanning Electron Microscopy (SEM)

The SEM photograph of tamarind seed polysaccharide (powdered sample) was obtained by Scanning Electron Microscope (Jeol,JSM-840A,Japan) with 20Kv accelerating voltage and shown in Figure 1.

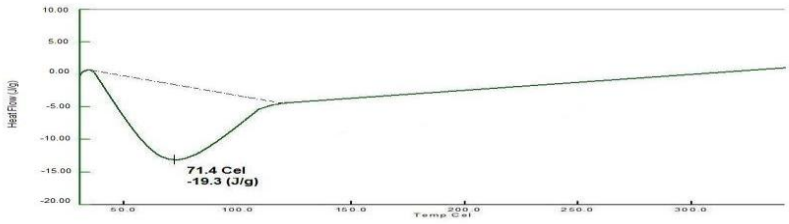
Figure 1: SEM photographs of tamarind seed polysaccharide.



Differential Scanning Calorimetry (DSC)

DSC curve of tamarind seed polysaccharide was obtained by a Differential Scanning Calorimeter at heating rate of 10°C/min from 30 to 300°C in nitrogen atmosphere (30mL/min). The DSC thermogram of tamarind seed polysaccharide is shown in Figure 2.

Figure 2: DSC Thermogram of tamarind seed polysaccharide powder.



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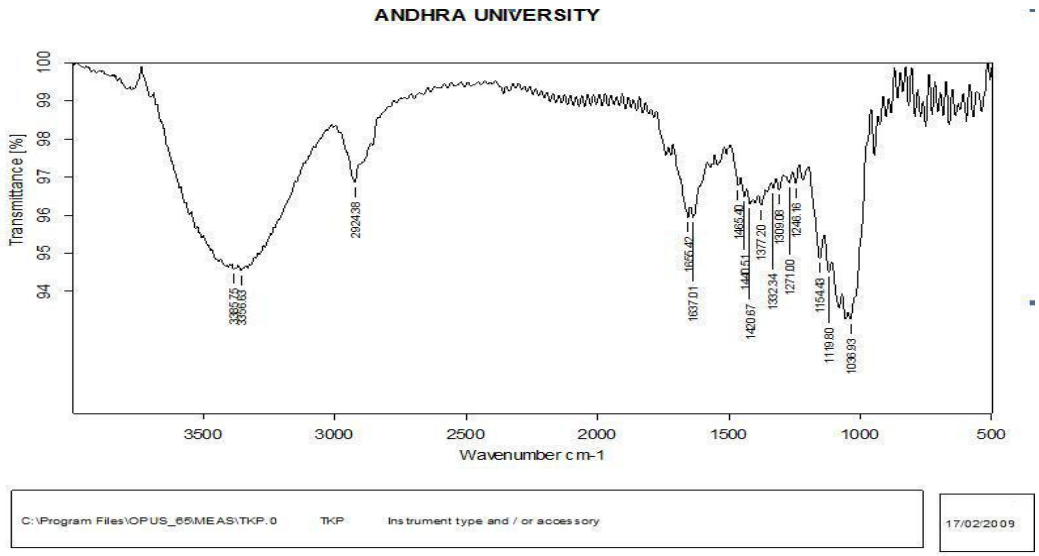
Fourier Transform Infrared Spectroscopy (FTIR)

Using Fourier Transform Infrared Spectroscopy (FTIR), a spectrum of tamarind seed polysaccharide was obtained. The sample was prepared into a pellet with one gram of KBr. The FTIR spectrum of tamarind seed polysaccharide is shown in Figure 3.

Figure 3: FTIR Spectra of tamarind seed polysaccharide powder.



Powder flow properties

Determination of particle size distribution

Tamarind seed polysaccharide was dispersed in glycerin and a smear of the dispersion was made and examined under microscope. The sizes of 500 particles were measured using a calibrated eyepiece micrometer.

Bulk Density and Tapped Density

The bulk density of tamarind seed polysaccharide was determined by the three-tap method. Weighed quantity of tamarind seed polysaccharide powder was carefully introduced into a 100 mL graduated cylinder. The cylinder was dropped onto a hard wood surface 3 times from a height of 2.5 cm at an interval of 2 seconds. The bulk density was obtained by dividing the weight of the sample by volume of the sample contained in the cylinder(Vi).

Tapped density is the ratio of weight of dry powder to its tapped volume. The weighed quantity of dry powder was taken in a graduated cylinder. The cylinder was placed on the tap density tester(Electro lab, model ETD-1020) and subjected to USP-II method i.e. 250 drops per minute and drop height is 3 mm±10%. The volume of powdered bed is measured after each increment of 250 drops until the difference of last two volume measurement is zero.

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Carr's Consolidation / Compressibility Index

This property is also known as compressibility. It is indirectly related to the relative flow rate, cohesiveness and particle size. It is simple, fast and popular method of predicting powder flow characteristics. It can be calculated by following formula:

$$\text{Consolidation index} = \frac{\text{Tapped density- Fluff density}}{\text{Tapped density}} \times 100$$

The weighed quantity of dry powder was taken in a graduated cylinder. The cylinder was placed on the tap density tester (Electro lab, model ETD-1020) and subjected to USP II method i.e. 250 drops per minute and drop height is 3mm±10%. The volume of powdered bed is measured after each increment of 250 drops until the difference of last two volume measurement is zero.

Hausner Ratio

It was determined by using the Following formula

Hausner Ratio= Tapped bulk density/ Loose bulk density

Angle of repose

Flow properties of powder were determined by the angle of repose technique. Angle of repose was determined by the fixed funnel and free standing cone method (Lachman, 1991). A funnel with the end of the stem cut perpendicular to its axis of symmetry was fixed at a given height (h) above the graph paper placed on a flat horizontal surface. The gum powder was carefully poured through the funnel until the apex of the conical pile just touched the tip of the funnel. The radius (r) of the base of the pile was determined and the tangent angle of repose (θ) was calculated by following equation.

$$\text{Tan } \theta = \frac{h}{r}$$

True density

True density was determined by liquid displacement method at 25°C. It is the weight of the solid material divided by the weight of the liquid it displaces; the material whose density has to be determined should be insoluble in the liquid. The weight (W1) of the clean, dry 50mL density bottle was determined. The bottle was filled with water and the top of the bottle was dried with filter paper and weighed as (W2). The procedure was repeated using benzene to

obtain the weight of the bottle plus benzene (W3). Benzene was used as the displacement liquid. About 3g of the tamarind seed polysaccharide powder was transferred to dried density bottle and weighed as (W4). The bottle was filled with benzene and the weight (W5) was measured. The density of the benzene used was calculated using the formula.

$$\text{Density of benzene } (\rho) = \frac{(w_3 - w_1)\ 0.9971}{(w_2 - w_1)}$$

(Density of water at 25°C = 0.9971 g/cc)

The true density of tamarind seed polysaccharide was calculated from the following formula,

$$\text{Density of sample} = \frac{(w_4 - w_1)}{\left[\frac{(w_3 - w_1)}{\rho}\right] - \left[\frac{(w_5 - w_4)}{\rho}\right]}$$

Determination of rheological properties of tamarind seed polysaccharide

Rheological properties are much useful in behaviour and predictive information for various products, as well as to get the knowledge of the effects of processing, formulation changes and ageing phenomena [12].

In particular to the gum materials, viscosity is the main parameter to predict the quality of the material and rheological behavior is a useful tool for its applicability in various pharmaceutical dosage forms.

The rheological properties of tamarind seed polysaccharide were evaluated using Brookfield cone and plate viscometer model RVDV II+ with spindle S28, using a constant temperature bath maintained at 25°C. Tamarind seed polysaccharide concentrations of 0.5, 1.0, 1.5, 2.0% (w/v) with distilled water were prepared and allowed to swell overnight. Each concentration of sample 0.5mL was placed separately in the plate of viscometer and analyzed for its viscosity, percent torque, shear stress, shear rate at various speeds and was also tested for its thixotrophy phenomena at 25°C. The analysis of viscometer data may be enhanced through the use of mathematical models. Non-Newtonian behavior can be simply expressed through an equation and in some cases; the coefficients of a model can be used to infer performance of a fluid under conditions of use. Newtonian flow is defined by a proportional response in shear stress for a change in shear rate (a linear relationship). Non-Newtonian fluids will exhibit a nonlinear stress/rate relationship. Newton's equation for viscosity has been modified many times in an attempt to characterize Non-Newtonian behavior. Some of the more widely used equations include Bingham, Cassion, NCA/CMA Cassion, Power law and IPC paste equation.

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Bingham equation: $\tau = \tau 0 + \eta D$, Cassion: $\sqrt{\tau} = \sqrt{\tau 0} + \sqrt{\eta D}$

NCA/CMA Cassion: $(1+a)\sqrt{} = 2\sqrt{\tau 0} + (1+a)\sqrt{\eta D}$

Power law: $\tau = kDn$, IPC paste: $\eta = kRn$

Where , τ = Shear stress, D = Shear rate, η = Viscosity, $\tau 0$ = Yield stress
K = Consistency index, n = Flow index and, a = Aspect ratio

The above mathematical models were analyzed by using Brookfield RHEOCALC software version 2.4.

Accelerated stability studies of tamarind seed polysaccharide powder

Tamarind seed polysaccharide was subjected to accelerated stability studies according to ICH guidelines to predict the stability of tamarind seed polysaccharide. The samples were analyzed at regular intervals as per the stability protocol.

Stability protocol for tamarind seed polysaccharide

Gum: Tamarind seed polysaccharide
Date of starting: 15-03-2009
Quantity loaded: 20g approx. in each petri dish
Quantity Sample: 2g approx.

Accelerated stability protcol of tamarind seed polysaccharide powder.

Duration	40°C+75%RH	Test
Initial	15-03-2009	1.Organoleptic Evaluation
6 Month	14-09-2009	2.pH 3.Moisture content 4.Microbial count 5.FTIR

RESULTS AND DISCUSSION

The polysaccharide from tamarind seeds were purified using water and precipitated with acetone. The percentage yield of mucilage obtained from the seeds of Tamarindus indica was found to be 78% (w/w).

Characterization of selected polysaccharide

The identification of the isolated and purified polysaccharide was confirmed by corallin soda, tests recommended by FAO and gum was stained pink colour and shown in Table 1.The purity of polysaccharide was determined by prescribed phytochemical tests, which indicated the absence of alkaloids, steroids, flavonoids, saponins, tannins and phenols. Only carbohydrates were found to be present, which confirms the purity and results as shown in

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Table 2. The polysaccharide was characterized by various organoleptic properties such as colour, odour, taste, shape, touch and texture as shown Table 3.

Table 1: Identification tests as recommended by FAO.

Test	Result
Swelling by Ethanol solution	Negative
Color reaction with conc.Hcl	Yellow
Color reaction with 5N NaOH	Yellow

Table 2: Determination of purity of polysaccharide.

Tests	**Tamarindus indica**
Tests for steroids: Salkowski test, Libermann-burchard test	-
Tests for triterpenoids: Salkowski test, Libermann-Burchard test	-
Tests for saponins: Foam test, Haemolysis test	-
Tests for carbohydrates: Molisch test, Barfoed's test Benedicts test	+
Tests for alkaloids: Mayer's test, Hager's test, Dragendorff's test	-
Tests for flavonoids(after hydrolysis) Shinoda test, Zinc/HCL reduction test	-
Tests for Phenolic nucleus and Tannins: Ferric chloride test, Gelatin test	-

+ Present; - Absent

Table 3: Organoleptic evaluation of selected polysaccharide.

Parameter	Tamarind seed polysaccharide
Color	Cream
Odour	Odourless
Taste	Tasteless
Shape	Irregular
Touch andTexture	Hard and rough

Swelling index of the tamarind seed polysaccharide was found to be 1700%. High value of swelling index revealed the high swelling ability of tamarind seed polysaccharide. The swelling ability of any polysaccharide depends upon its water retention capacity or water absorption capacity. The water absorption capacity of tamarind seed polysaccharide was found to be 20mL. The pH of the 1% w/v tamarind seed polysaccharide was found to be 6.81. The surface tension and melting point of polysaccharide were found to be 83.26 dynes/cm and 240°C-260°C, respectively. Moisture content of excipients used can influence the tableting and

stability properties of formulations. Moisture content of tamarind seed polysaccharide was found to be 8.10 % (w/w).

The solubility behaviour of the polysaccharide indicates that it is quickly soluble and forms viscous colloidal solution in warm water, sparingly soluble in cold water, whereas insoluble in ethanol, methanol, acetone and ether. Results were shown in Table 4.

Table 4: Solubility behavior of the selected polysaccharide.

Solvent	Solubility behavior
Cold water	Sparingly soluble
Warm water	Quickly soluble forming a viscous colloidal solution
Ethanol	Insoluble
Methanol	Insoluble
Acetone	Insoluble
Ether	Insoluble

The ash values such as total ash acid, insoluble ash and water–soluble ash of tamarind seed polysaccharide was found to be 1.6050, 0.0996, and 0.8218, respectively.

The microbial studies of tamarind seed polysaccharide proved that tamarind seed polysaccharide does not support microbial growth and is free from all the pathogen organisms.

The thermal stability testing showed that the polysaccharide could withstand higher temperature as shown in Table 5. Tamarind seed polysaccharide was highly stable under solid conditions and liquid conditions. Also the hydrolysis occurred at 145°C, which indicates that this could be used for liquid formulation without any physical stability problems.

Table 5: Thermal stability values of selected polysaccharide.

Polysaccharide	Solid powder	1% Solution
Tamarind seed polysaccharide	210°C	145°C

The properties such as bulk density, tapped density, compressibility index, hausner ratio and angle of repose are often referred to as the derived properties of powder which depend mainly on particle size distribution, particle shape and tendency of the particles to adhere together results shown in Table 6, Table 7 and Figure 5. Compressibility index (I) values up to 15% usually result in good to excellent flow properties and indicate desirable packing characteristics. Compressibility index above 25% are often sources of poor tableting qualities. The values between these two indices may result in less than the optimum performance and modification of the particle size distribution could be advisable. The bulk density, tapped density, compressibility index and hausner ratio of tamarind seed polysaccharide were found to be 0.651 g/cc, 0.781gm/cc, 16.64% and 1.02, respectively. The values of bulk density, compressibility index and hausner ratio infer that the tamarind seed polysaccharide powder has

good flow properties and compressibility. When angle of repose is less than 30°, it indicates that material is free flowing and values greater than 40° suggest a poorly flowing material. The static angle of repose value for tamarind seed polysaccharide was found to be 29.50° indicating good flow properties. The SEM photographs of tamarind seed polysaccharide (Figure 1) grains have revealed that the shape of the tamarind seed polysaccharide was irregular and fragmented.

Table 6: Particle size distribution of tamarind seed polysaccharide.

Size (µ m)	Number of particles
0-30	10
30-60	52
60-90	258
90-120	170
>120	18

Table 7: Characterization of tamarind seed polysaccharide powder.

Property	Results
True density (g/cc)	1.015 ± 0.04
Tapped density(g/cc)	0.781 ± 0.02
Bulk density (g/cc)	0.651 ± 0.04
Angle of repose (°)	29.50 ± 0.12
Compressibility index (%)	16.64 ± 0.04
Hausner Ratio	1.02 ± 0.09
pH	6.81 ± 0.21
Swelling index (%)	1700 ± 0.56
Surface tension(dynes/cm)	83.26 ± 0.62
Moisture content (%)	8.10 ± 1.23
Water retention (%)	20.00 ± 1.34
Melting point (°C)	240 -260

Viscosity is the main parameter to assess the quality of natural gums. The applications of any natural gum are dependent on its viscosity and other rheological properties. For any polymer to be used in slow release hydrophilic matrix systems, it should possess certain characteristics like fast hydration of the polymer, high gel strength and should be stable during the shelf life of the product. The results indicate that the polysaccharides possess pseudo plasticity and they do not possess thixotrophy. Viscosity data clearly indicates that tamarind seed polysaccharide in aqueous solution obeys Power law with correlation coefficient values ranging 98.8-99.0.Tamarind seed polysaccharide hydrates quickly and swells rapidly and forms a thick viscous layer around it. This is the most important criterion required for hydrophilic matrix tablets. The viscosity and other rheological properties confirmed its suitability in the development of sustained release delivery systems.

FTIR spectroscopy is a useful tool in identification as well as purity of a compound. The principal absorption peaks of tamarind seed polysaccharide were found at 1036 cm-1 (C-O-C, ether group absorbance), 1637 and 1655 cm-1 (C=O, aldehyde absorption), 2924 cm-1 (C-H

stretching), 3356 cm-1 (primary OH), 3385 cm-1 (secondary OH), which indicate that isolated product was polysaccharide.

Differential Scanning Calorimetry (DSC) measures the heat loss or gain, resulting from physical or chemical changes within a sample as a function of temperature. A sharp symmetric melting endotherm can indicate relative purity, whereas broad asymmetric curve suggests impurities or more than one thermal process. The endothermic peak usually indicates the loss of water present in the compound. The seed polysaccharide exhibited broad endothermic peak at 71.4°C. The produced peak may be due to loss of free/bound water present in the tamarind seed polysaccharide.

The results of accelerated stability studies on tamarind seed polysaccharide powder showed that there is no significant difference between the initial and final samples withdrawn at time interval 6 months at 40°C /75% RH. Slight changes in pH and moisture content values were observed. The studies proved that the tamarind seed polysaccharide is stable for a long period of time as shown in Table 8 and Table 9. FTIR study reveals that degradation does not occurred as shown in the Figure 4.

Table 8: Tamarind seed polysaccharide after storage of 6 months at 40°C/75% RH.

Condition	Duration (Months)	Parameters		
		Description	Moisture content	pH
Initial	Initial	Cream, odorless, hard and rough and free flowing powder	8.10	6.81
40°C/75%RH	6	Cream, odorless, hard and rough and free flowing powder	8.66	6.95

Table 9: Microbial load after storage of 6 months at 40°C/75% RH.

Condition	Duration (Months)	Parameters					
		Total bacteria	Total fungal count	Pathogens			
				Staph. Aureus	E.Coli	Pseudo. Aeruginosa	Salmonella
Initial	Initial	32 CFU	28 CFU	Absent	Absent	Absent	Absent
40°C/75%RH	6	39 CFU	33 CFU	Absent	Absent	Absent	Absent

The above results, i.e. good flow and compatibility, high swelling index and stability of tamarind seed polysaccharide suggests that in sustained release system, in particular to hydrophilic matrix tablet formulations, “Tamarind seed polysaccharide” could be used as an excipient.

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Figure 4: FTIR spectra of tamarind seed polysaccharide powder after stability studies.

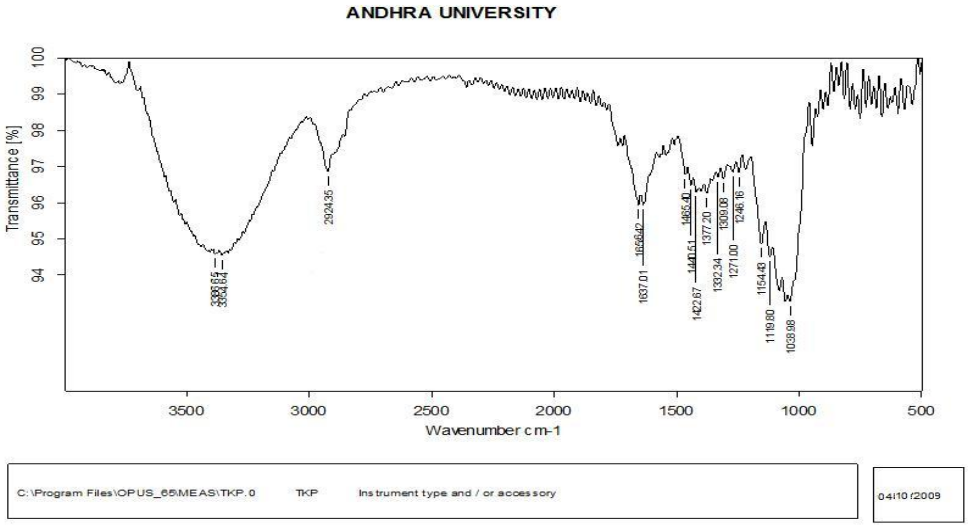
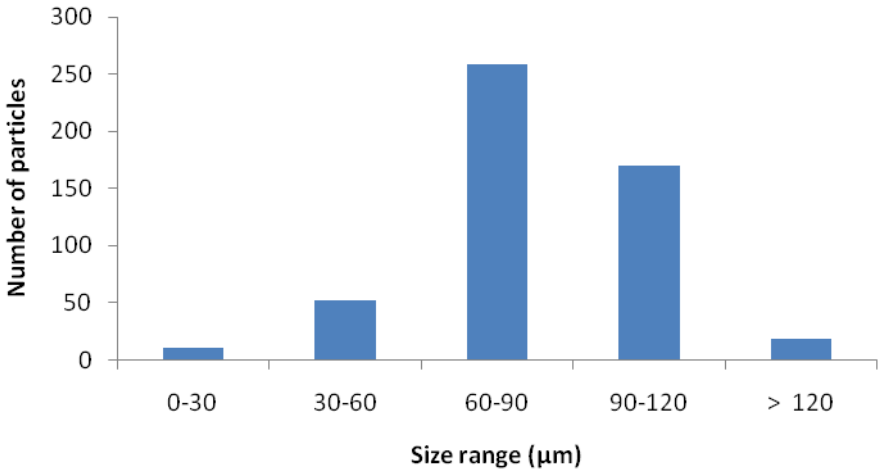


Figure 5: Particle size distrubution of tamarind seed polysaccharide powder.



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