Isolation and Characterization of Tamarind Seed Gum as Pharmaceutical Excipient

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Abstract

Objective: Tamarind seed gum (TSG) is a polysaccharide having galactomannans as chemical constituents, and it is extracted from the seeds of *Tamarindus indica L* (Family Fabaceae). Generally, polysaccharides play most important roles as thickening, gelling, emulsifying, hydrating, and suspending agents in pharmaceutical formulations. The purpose of this work was to investigate the film coating potential of tamarind seed gum (TSG), using paracetamol as a model drug. **Material and Method:** Tamarind seed gum, Paracetamol tablet, Hydroxypropylmethylcellulose Sodium alginate, and Distilled water. Core tablets of paracetamol were obtained from a pharmacy shop in the local market and the physicochemical properties such as weight, hardness, friability, and disintegration time were evaluated. Aqueous coating solution consists of 2% TSG hydroxypropylmethylcellulose (HPMC) (2% w/v), and sodium alginate (1% w/v) were prepared and used to coat the tablets by dip coating technique. The coated tablets were evaluated. **Result:** The coated tablets showed lower friability; increased disintegration time (14 min) as compared to the core tablet (3 min), improved hardness, and improved drug release profile. TSG film coated batches showed drug release profile up to 10 hrs and HPMC coated batches showed drug release up to 12 hrs. The results of drug release rate of TSG film is very closed to HPMC release profile. This TSG have good film formers properties. It is a promising natural, biodegradable, cheap and eco-friendly film former, particularly when masking of taste or objectionable odor in a solid dosage formulation is desired. It can be used as carrier in sustained release formulation.**Conclusion:** On the basis of result we can conclude that TSG has promising properties as pharmaceutical excipient. It could be used in the formulation of sustained release matrix as coating agent.

Keywords: Tamarind seed gum, Pharmaceutical Excipient, Natural Polymer

Introduction

Film coating is a most significant unit operation in the pharmaceutical industry.[1] Film coatings are used for various reasons like for improvement of visual qualities of dosage forms, masking disagreeable taste or odor, easing digestion, improving stability, and modifying the release characteristics of the drug. [2-3] Film coating process applies to a variety of pharmaceutical products like as tablets, beads, pellets, granules, capsules, and drug crystals. [4]

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Film layer can be formed from both polymeric solution (organic solvent or aqueous based) or aqueous polymeric dispersion (commonly called latex). Polymer is the main ingredient in the majority of film-coated formulations, and it may be from different origins (natural, synthetic or semisynthetic), including cellulosic, acrylics, vinyl, and combination polymers. [2, 3, 4] Tamarind seed gum natural gum is a natural polymer extracted from the seed of *Tamarindus indica L (Family Fabaceae)*. Natural excipient such as gums and mucilage are usually used to formulate different dosage forms as novel drug delivery system. In the present review, we have discussed tamarind naturally derived polysaccharide used as a potential candidate for novel drug delivery system. Natural polymers have advantages over synthetic ones; such as they are

chemically harmless, less costly, biodegradable and commonly available. Hydrophilic matrices involving natural polysaccharides are an interesting option for developing sustained release formulations.. To date there is no published study on the film coating potential of tamarind seed gum. The purpose of this paper is to investigation of the film coating potential of tamarind seed gum by using paracetamol tablets as the model drug [6-7]. Formulation and development of muco-adhesive controlled dosage forms has been developed by using various natural and their modified form of gum [8-9]. Fenugreek and tamarind seed gum were reported for the development of tablets, nano-particle, suspension, emulsion, controlled and topical dosage form for water soluble and insoluble drugs [10-11]. The present objective of research work to investigate promising properties of TSG as pharmaceutical excipient.

Materials and Methods

Materials

Paracetamol tablets (Nestor pharmaceuticals Ltd, were obtain from a government pharmacy shop B.N. PTTT-143, Hydroxypropylmethylcellulose E5 LV (Methocel® E5 LV premium Loba chem., India) all other chemicals were used analytical grade or Pharmacopeia standards, Fresh tamarind seed and paracetamol tablets were obtained from the Udaipur local market, India.

Methods

Extraction of tamarind gum

The seeds of tamarind were washed in water and powdered coarsely with grinder. Then this coarse powder was soaked in distilled water for 10 h, and the gum was filtered out from the bulk material by using muslin cloth. The filtrate was precipitated with ethanol several times to complete the extraction process. The gum was air dried at 60 ^{0}C, pulverized, and packaged into polythene container for further use [12].

Evaluation of physicochemical properties of tamarind seed gum powder

Organoleptic evaluation:

Organoleptic properties such as color, odor, taste, fracture, and texture, these properties were determined.

Qualitative tests

Preliminary tests were performed to confirm the nature of mucilage obtained. The qualitative chemical tests that were conducted are: test for carbohydrates (Molisch's test), test for tannins (Ferric chloride test), test for proteins (Ninhydrin test), test for alkaloids (Wagner's test), test for glycosides (Keller – Killaini test), test for mucilage (Ruthenium red test), test for flavonoid (Shinoda test), and test for reducing sugar (Felhing's test).

Identification tests of isolated gum

The identification of the isolated gum was carried out by using the following tests:

a. The powder was mounted on a slide with ruthenium red solution and covered with a cover slip. After a few seconds, it was irrigated with lead acetate and the excess stain was sucked off with a blotting paper. (Lead acetate solution was added to prevent undue swelling of the test solution). The color of the particles was noted.
b. The powder sample was mounted on a slide with freshly prepared corallin soda solution and covered with a cover slip. After a few seconds it was irrigated with 25% sodium carbonate solution. The color of the particles was noted.
c. Gum was heated with distilled water and then cooled. Formation of gelatinous mass was noted.
d. To 2 ml of gum solution, 2-3 drops of N/50 iodine solution was added and the color of the particles was noted.

Determination of purity of Gum

To determine the purity of gum, tests for alkaloids, carbohydrates, flavonoids, steroids, amino acids, terpins, saponins, oils, fats, tannins and phenols were carried out.

Percentage yield

10 gm of tamarind seed was extracted and isolated. The isolated gum was then dried and percentage yield was calculated by following formula.

% Yield = Practical Yield x 100 /Theoretical Yield

Solubility

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

Swelling index

Accurately weighed amount (1g) of the fine TSG gum was introduced into a 25 ml glass-stoppered measuring cylinder. 25 ml of water was added and mixture was shaken thoroughly at every 10 min for 1 h. It was then allowed to stand for 3 h at room temperature. Then the volume occupied by the gum, including any sticky mucilaginous portion was measured. The same procedure was repeated thrice and the mean value was calculated, using the following formula**.**

$$\text{Swelling index} = (W_2 - W_1) \times 100/W_2,$$

Where W1 is the initial weight of tablet and W_2 is the weight of hydrated tablet.

Bulk density, Tapped density

The TSG powder (10 g) was accurately weighed into a 100 ml measuring cylinder and without disturbing the cylinder, the volume of powder was read to give the bulk volume. Then the volume of the powder was read after at every 50 taps till the volume of powder was constant. This represents the tapped volume of the powder. The bulk density and tapped density was calculated using equation 1 and 2 respectively.

Eq 1 Bulk density (ρ) = $\frac{\text{Weight of sample}}{\text{Tapped volume}}$

Eq 2 Tapped density (ρ_b) = $\frac{\text{Weight of sample}}{\text{Bulk volume}}$

Hausner quotient

Hausner ratio or quotient was calculated as the ratio of tapped to bulk densities (Equation 3)

Hausner's quotient (ratio) = $\frac{\text{Tapped density}}{\text{Bulk density}}$

Angle of repose

Angle of repose measured the flow characteristics. Improper flow of powder is due to frictional forces between the particles. Angle of repose quantifies these frictional forces. It can be calculated by following formula:

$$\text{Tan } \theta = h/r \text{ or } \theta = \tan^{-1} h/r$$

Where, h= height of pile; r= radius of the base of the pile and θ = angle of repose.

A dry and clean funnel was fixed on to a burette stand at height (2-3 cm). A graph paper was placed on the flat surface and a sufficient quantity of the powder (10 g) allowed to flow slowly through the funnel until the heap touched the tip of the funnel. The circumference of the heap was drawn and the midpoint was located and its radius was measured. The experiment was repeated thrice and the average height and radius were calculated. Using these readings and the above formula, the angle of repose was calculated.

Powder compressibility (Carr's consolidation index)

The gum powder (5 g) was transferred into a 10 ml measuring cylinder with the help of a funnel and the measuring cylinder was placed on the bulk density apparatus. The initial volume occupied by the powder was noted (fluff volume, V0). The measuring cylinder was then tapped until a constant volume was obtained. After completing the tapping the final volume was noted (tapped volume, Vt) and the compressibility was calculated using the below formula:

Consolidation Index = [(Tapped density – Fluff density)/Tapped density] × 100

Moisture content (MC) %

An evaporated dish containing 10 g of TSG was heated to 105ºC in hot air oven, till a constant weight was obtained. The average for three readings was obtained

$$MC(\%) = \frac{Wf - Wi}{W_i} \times 100 \quad (5)$$

Where Wf is the final weight sample and Wi initial weight of sample.

pH of gum

Sample (5 g) was weighed in triplicate in a beaker, mixed with 20 ml of distilled water, the resulting suspension stirred for 5 minutes and the pH was measured using a calibrated digital pH meter

Ash content %

Accurately weighed gum (3 g) was taken in a silica crucible, which was previously ignited and weighed. The powder was spread as a fine, even layer at the bottom of the crucible. The crucible was incinerated gradually by rising temperature to make it 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 drug.

Viscosity

Viscosity of gum was determined, by preparing different concentration of gum suspension, initially 0.4%, 0.8%, and 1% w/v concentration were prepared at 25ºC. The viscosity of the prepared suspension was measured in 1st day and next day, using Brookfield Rheometer (Model No. R/S- PI).

FTIR Study

100mg of the gum powder was mixed with potassium bromide (400 mg) and was compressed in a hydraulic press to form a pellet at 15 tons pressure. The pellets were scanned from 4000 to 400 cm^{-1} in a Perkin Elmer FTIR spectrophotometer.

X-ray diffraction analysis (XRD)

An X-ray diffraction spectrum was recorded on an X-ray diffraction spectrometer (Bruker, AXS/8, Berlin, Germany). The dry gum powder was pressed into pellets. The X-ray diffraction spectra were recorded using Cu-ka radiation (40 kV, 60 mA). Diffractograms were run at a scanning speed of2°/min and chart speed of2°/2 cm per 2<j>.)

Preparation of coating suspension

2 % w/v tamarind seed gum and 1% sodium alginates were dispersed in distill water at 40-50ºC with continuous stirring on a magnetic stirrer, and allowed to mix, up to 2 h. Similarly, HPMC coating suspension was also prepared using 2% w/v HPMC.

Viscosity of coating suspension

The viscosity of prepared coating suspensions was determined with Brookfield LVDV-IV+ digital rheometer at 100 RPM using spindle 4.

Preparation of coated tablets

The purchased paracetamol tablets were dipped into prepared coating suspension of TSG for 5min, and then coated tablets were dispersed 5% solution of $CaCl_2$ for 5min. The film coated tablets were dried in hot air oven. Similarly, HPMC coated tablets were also prepared.

Evaluation of core and film coated tablets

Weight uniformity

The evaluation was carried out on 20 tablets selected randomly and their individual weights were taken on an analytical balance (Shimadzu, EL 300, USA) [12-13].

Friability

Friability of the tablets was determined using Roche Friabilator. This device subjects the tablets to the combined effect of abrasion and shock in a plastic chamber revolving at 25 rpm and dropping the tablets at a height of 6 inches in each revolution. Pre weighed sample of tablets, place in the friabilator and were subjected to 100 revolutions. Tablets will then e-dusted using a soft muslin cloth and reweighed.

The friability (f) is given by the formula.

$$\% \text{ Friability} = \frac{(w1-w2)}{w1} \times 100$$

Where'W1 'is weight of the tablets before the test and 'W2' is the weight of the tablet after the test. Limit: It should be not more than 1%.

Hardness test

The resistance of tablets to shipping or breakage under the conditions of storage, transportations and handling before usage depends on its hardness. The hardness of tablet, will measured by Pfizer hardness tester. The hardness was measured in terms of Kg/cm^2.

Disintegration test

The disintegration time test was determined according to USP method in 0.1N HCl.

Dimensions

The diameter and the thickness of tablets were determined by using vernier caliper.

Evaluation of coated tablets

The physicochemical properties of the coated tablets such as weight uniformity, hardness, friability, and disintegration time were evaluated as described above for uncoated tablets.

Dissolution studies

The in vitro release of TSG, and HPMC film coated tablets was studied, using eight station (USP) Type II dissolution apparatus at 37 ± 0.5°C and at 50 rpm speed in 0.1 N HCL as dissolution media for 2hrs. From the dissolution medium 5 mL of the sample was withdrawn at the specific time intervals and replaced with an equal volume of fresh medium (5mL) to maintain constant media volume. After filtration, each sample was analyzed using double beam UV visible spectrophotometer at selected 249 nm max. This study was performed in triplicate for each batch. After 2hrs dissolution media were replaced by phosphate buffer pH 7.2.

Results and Discussions

After hot water extraction and ethanol treatment, tamarind seeds yielded 18.90% w/w gum. The isolated gum was subjected to identification tests using ruthenium red, and by dissolving them in hot distilled water. With ruthenium red, the particles stained pink and a gelatinous mass was formed. All others tests indicated that the isolated gum were polysaccharide in nature [14]. The results of purity tests of TSG showed the presence of carbohydrates. Other phytoconstituents were absent in the isolated powder. This indicates the purity of the isolated gum. Results was shown in Table1

Further characterization of isolated gum was identified by organoleptic properties test as color, odor, taste, fracture and texture. The FSP was yellowish in color, characteristics bitter in taste. The fracture was rough and texture was irregular for the isolated TSG gum. Result was shown in Table 2.

The solubility of TSG was determined, using warm water, organic solvents such as ethanol, benzene, butanol, chloroform, and ether. The TSG formed viscous colloidal dispersions with warm water, and were insoluble in organic solvents such as ethanol, benzene, butanol, chloroform, and ether. The result was shown in Table 3.

Results of evaluated physicochemical properties of tamarind seed gum were showed in table 4. All these

values found within the limits, as per the reference values of natural gum. Isolated TSG have ash values of 6.22mg, pH 6.7,moisture content 12.64%, melting point 247-254^{0}C, bulk density 0.701, tapped density 0.841, cars inex 16.64%, H.R 1.99 and angle of repose 29.48.

The pH values of 2% solution of the TSG were found to be slightly acidic or near neutral, which indicated that the TSG is non-irritating to the mucous membrane of buccal cavity and gastrointestinal tract, and can be used for the development of buccal and oral drug delivery systems.
The swelling index of TSG were found 10.2 ml, which is an indication of good water absorption, and hence, it forms a hydrated three-dimensional network from which drug can efficiently releases through diffusion.

The absorption of moisture by any substance represents hygroscopic nature of the substance. If excipient is hygroscopic, it can alter many properties of the dosage forms. Hence, it is necessary to determine the hygroscopic nature of the excipient and the amount of moisture that can be absorbed by the excipient. The result of the present study indicated that the TSG were hygroscopic and need to be stored in air-tight containers.

The FSP exhibited poor to passable flow. Hence, to improve the flow, it needs addition of glidants. Viscosity of isolated TSG was found to 33cp, 34cp, 43cp at concentration 0.4, 0.8, and 1% respectively on 1st day and on next day viscosity was found to 33cp, 35cp, 45cp at concentration 0.4, 0.8, and 1% respectively. It indicated that as the concentration increased, drug released rate will be reduced due to swelling or gelling property of TSG.

The FTIR spectra of the TSG were given in Fig 1, which indicated that the TSG were carbohydrates in nature. These spectra can be used as standard spectra for quality control and determination of the purity of the TSG range of peak shown in Table 6.
The absence of sharp peak at 1750–1800 cm-1 in the FTIR spectrum shows that there is no carboxyl group in the extracted sample. On the other hand, the presence of peak at 1000–1200 cm-1 indicates the presence of alcoholic group mostly secondary alcohols. These peaks of FTIR proved that there were no uronic sugars or esters in the structure. The range of wave numbers 1000 to 1200 cm-1 represents carbohydrates nature.

To study the surface characteristics of TSG, using XRD of the powder was taken. The XRD of TSG exhibited rough surface with pores and crevices on it, (Fig 2). Earlier, it has been reported that the drug release from the dosage form depends on surface characteristics of excipient. If the surface is rough, drug release will be retarded because of the entrapment of drug particles in the pores and crevices. Hence, it can be stated that the TSG can sustain the drug release because of their rough surface.
From the XRD, it was also evident that the particle size of the powders was not uniform and the size distribution was not within a narrow range. The powder contains larger to ultra-fine particles. This might be the reason for the 'heavy' nature of the powders. The powders exhibit a 'closet' packing arrangement, in which, the smaller particles fill the voids between larger particles and reduce the bulkiness. The low porosity values also indicate this packing arrangement. The close packing can also be responsible for poor flow properties of TSG.
Viscosities of coating suspensions were found to 237cp and 202 cp, for TSG and HPMC respectively. Results were shown in table 7.
The evaluations results of film coated paracetamol tablets were shown in Table 8.
The physiochemical properties of film coated tablets with TSG and HPMC was found satisfactory as per official guideline. The dissolution profile results shown in Figure 3,
All the formulations had a low friability profile <1%. The coated paracetamol tablets with HPMC had better hardness compared to those coated with tamarind seed gum, and the disintegration time of core tablets increased from 3 min (core) to 13.57 min after coating with TSG. The order of disintegration time of formulation was found: HPMC> tamarind seed gum >core.
The dissolution profile of the coated tablets was shown in Figure 3.
In TSG and HPMC film coated tablets, 95% drug was released into dissolution medium in 10 hrs, and 12 hrs respectively. Hence drug release rate of TSG film coated tablets was sustained as compare to core tablets. So TSG can be used for sustained release of drugs from tablets.

Table 1: Phytochemical properties of TSG gum powder

Test	Results
Test for mucilage (Ruthenium red test)	+
Monosaccharide Test	-
Test for Tannins (Ferric chloride test)	-
Test for proteins (Ninhydrin test)	-
Test for alkaloids (Wagner's test)	-
Test for glycosides (Keller – Killaini test)	-
Test for Carbohydrates (Molisch's test)	+
Test for flavonoid (Shinoda test)	-
Test for reducing sugar (Felhing's test)	-

Table 2: Organoleptic properties of isolated TSG powder

Gums	Colour	Odour	Taste	Fracture
TSG	Yellow	Characteristics	Bitter	Irregular

Table 3: Solubility profile of isolated TSG powder

Solvents	Results
Cold water	Slightly soluble
Hot water	Viscous colloidal dispersion
Ethanol	Insoluble
Benzene	Insoluble
Acetone	Insoluble

Table 4: Some physicochemical properties of TSG powder

Parameter	TSG
Percentage yields	18.90%
Solubility	Slightly soluble
Swelling Index%	8.1ml
Bulk Density	0.701
Tapped Density	0.841
Angle of repose	29.49
Carr's index	16.64%
H.R	1.199
Moisture Content%	12.64
pH of mucilage	6.7
Ash content	6.22
Melting point	248-254^{0}C

Table 5: Determination of viscosity of isolated TSG (spindle 4 speed 100rpm) powder

S.N.	Days	**0.4%** TSG	**0.8%** TSG	**1% TSG**
A	1	33cp	34 cp	43 cp
B	2	33 cp	35 cp	45 cp

Table 6: FTIR Interpretation of isolated TSG powder

FTIR range of peak	Presence of functional groups in TSG
3615.07-3564.88	O-H, Glucan backbone

2922.42-2853.43	C-H aliphatic Stretching
2422.73	COOH
2250.44-2175.76	C=C stretching
1751.24-1685.05	CH OH stretching vibration
1546.09-1516.30	CH_2 Stretching
1395.58-1339.66	Alkane
1162.34	Glycoside CO Stretching
1053-997.01	CH stretching vibration

Table 7. Viscosity of coating suspension

Coating suspensions	Viscosity(cP)	RPM Spindle-4
Tamarind seed gum	237	100
HPMC	202	100

Table 8: Evaluation of film coated paracetamol tablets

Description	Core	TSG	HPMC
Hardness kg/cm^2	6.5 kg/cm^2	12.3kg/cm^2	13 kg/cm^2
Friability (%)	5.23	.521	.690
Disintegration time (min)	3.1	13.57	15.16
Diameter (mm)	10.9	11.33	11.4
Thickness (mm)	2.5	2.65	2.63

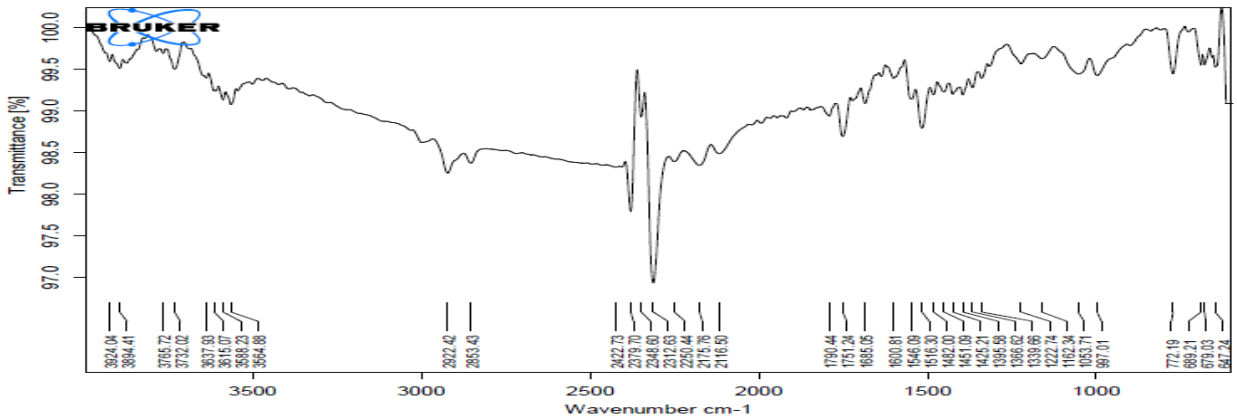

Figure 1. FTIR spectra of TSG

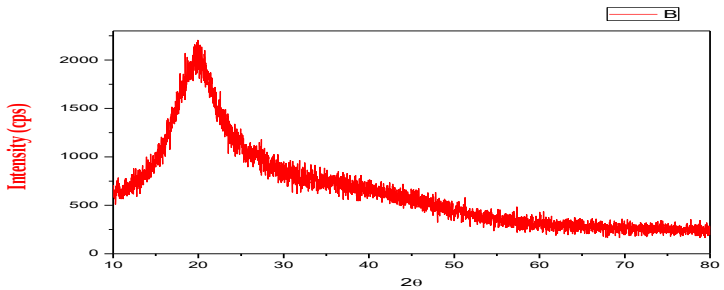

Figure 2. Xrd spectra of TSG

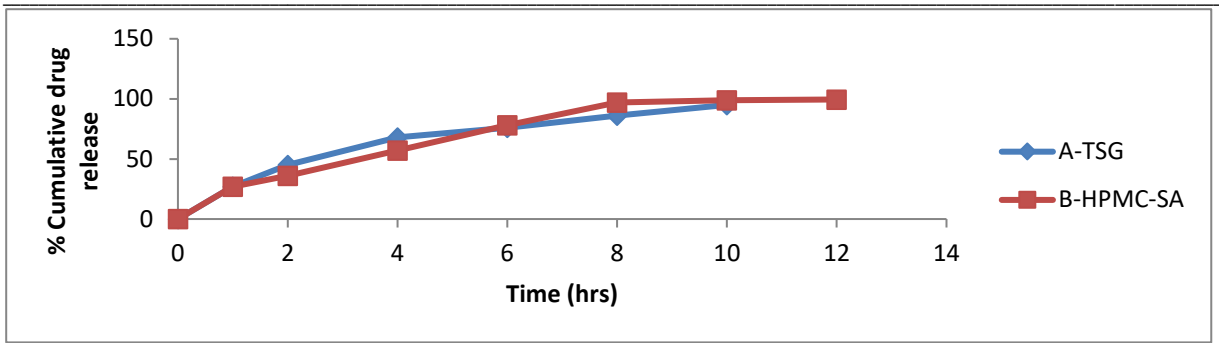

Figure 3: Dissolution profile of tamarind seed gum and HPMC coated paracetamol coated tablets

Conclusion

The potential of tamarind seed gum as a film-coating agent was investigated, using paracetamol tablets as model drug. The tablets were evaluated for various parameters such as uniformity of weight, friability, disintegration time, and dissolution profiles. tamarind seed seed gum can be used for improvement of visual qualities of dosage forms, masking disagreeable taste or odor, easing digestion, improving stability, and modifying the release characteristics of the drug.

Future perception

TSG has been successfully isolated from water extraction procedure, and could be used as pharmaceutical excipients in the formulation of various drug delivery dosage forms. TSG has been used as release retarding agent in matrix tablet formulation with water soluble and insoluble drugs. Water soluble drug release rate can be better controlled by cross-linking derivative of TSG. The extent of release can be varied by controlling the degree of cross-linking. Natural cross-linking derivative can play an important role for the development of sustained release dosage with water soluble drug. So, further research required in development of novel cross-linked derivative of TSG [15].

Conflict of Interest: None declared.

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