ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 15, Issue 9, 2022

Online - 2455-3891
Print - 0974-2441

Research Article

FORMULATION AND EVALUATION OF FAST DISINTEGRATING TABLET OF PROPRANOLOL HYDROCHLORIDE USING MODIFIED TAMARIND SEED GUM AS A NATURAL SUPERDISINTEGRANT

NISHA RANI*, DHRUV DEV

Department of Pharmaceutics, Shivalik College of Pharmacy, Nangal, Punjab, India. Email: nishusood038@gmail.com

Received: 20 May 2022, Revised and Accepted: 25 June 2022

ABSTRACT

Objective: The present study was carried out for the preparation of modified *Tamarindus indica* seed gum as a natural superdisintegrant and assessed various parameters for preparing a fast disintegrating dosage form.

Methods: The extracted gum from tamarind seeds was chemically modified by the carboxymethylation method. Then, calcium complexation of carboxymethyled tamarind seed gum was done. Fast disintegrating tablets were prepared by the direct compression method. The change in the functional groups of the extracted gum, Carboxymethyl tamarind seed gum, and the calcium complexed tamarind seed gum was studied by FT-IR spectrophotometer. DSC studies of calcium complexed tamarind seed gum showed alterations in the melting point without undergoing any modification.

Results: The pre-formulation studies such as physical appearance, swelling index, and viscosity of calcium complexed tamarind seed gum were characterized. From the studies, it was concluded that modified *Tamarind* seed gum was acidic and hydrophilic. The pH of the extracted tamarind seed gum was found to be 5.4. The fast disintegrating tablets were evaluated for hardness, friability, disintegration time, thickness, and *in-vitro* dissolution study. In the present study, the disintegration time of calcium complexed tamarind seed gum-containing tablets was compared with the marketed formulation of croscarmellose sodium as a synthetic superdisintegrant. The F5 formulation of calcium complexed tamarind seed gum showed a disintegration time of 37±2 s whereas the marketed formulation of croscarmellose sodium showed a disintegration time of 48±2 s.

Conclusion: It can be concluded that a fast disintegrating tablet prepared using calcium complexed *Tamarind* seed gum improves the disintegration time of the tablet.

Keywords: Fast disintegrating tablet, Calcium complexed gum, Croscarmellose sodium, Disintegration time, Superdisintegrant.

 DOI: http://dx.doi.org/10.22159/ajpcr.2022v15i9.45284. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

Fast disintegrating tablets are a novel type in drug delivery systems that have become popular in recent decades. These are the solid dosage form containing drug substances that disintegrate quickly within the mouth usually within a second. Various attempts have been made to manufacture fast disintegrating tablets to overcome the difficulties associated with patient compliance [1]. Superdisintegrants are used to enhance the efficacy of tablets by providing quick disintegration due to the combined effects of swelling and water absorption by the dosage forms [2]. This leads to increasing the wetted surface of the carrier which causes wettability and dispersibility of the system, thus improving the disintegration and dissolution [3]. The optimum concentration of the superdisintegrant can be determined according to the critical concentration of the disintegrant [4,5]. Mucilages and gums have been widely used in pharmaceuticals and cosmetic applications as a disintegrant, binder, emollient, gelling agent, emulsifier, granulating agent, suspending agent, lubricant, sustained release agent, and skin-soothing agent [6]. Natural gum can be utilized as a superdisintegrant in the preparation of FDTs, which results in rapid disintegration and dissolution of tablet formulation. Polysaccharides are frequently used in drug delivery systems. Polysaccharide functional groups have been researched for chemical modification to alter properties such as swelling, solubility, viscosity, and degradation [7]. In this work, Tamarind seed gum was used as a superdisintegrant. Tamarind, also known as *Tamarindus indica,* belongs to the Leguminosae (*Fabaceae*) family. It has a crude fiber content of 67.1 g/kg and a larger percentage of carbohydrates in the form of sugars. Tamarind gum is obtained from the endosperm of seeds. Seeds contain about 60–70% of polysaccharides. Chemically, it contains galactoxyloglucan as a major constituent. Modified Tamarind gum is used as a superdisintegrant. The tamarind seeds powder dispersed in water can form highly viscous solutions. Essential amino acids such as lysine, methionine, phenylalanine, and valine are found in the mucilage of tamarind [8]. Tamarind seed gum has many Pharmaceutical applications such as a binder, release retardant, and matrix former in the tablet dosage form. Tamarind gum and carboxymethylated tamarind gum can also be used in the formulation of drug-loaded spheroids, pellets, and microparticle-based drug delivery systems [9]. TG can be used in the formulation of buccal drug delivery systems such as buccal tablets, films, and patches showing mucoadhesive properties and controlling release behavior. The carboxymethylation of gum was done so, as to enhance the disintegration property whereas calcium complexation enhances the absorption ability of the gum. This would result in the rapid release and disintegration of tablets [10,11].

METHODS

Materials

Tamarind was purchased from the local market. Monochloroacetic acid, Microcrystalline cellulose sodium chloride, and calcium chloride were obtained from Thermo Fischer Scientific India, Pvt. Ltd., Mumbai. Propranolol HCL (Chemisynth Labs Uttrakhand), sodium hydroxide (Ranken Laboratory, New Delhi), croscarmellose sodium (Himedia Laboratories Pvt, Ltd., Mumbai), and ethanol were obtained from Avantor Performance Material India Ltd. Gujarat, Talc (Central drug house, Mumbai), magnesium stearate and acetone (Central drug house,

Mumbai), Lactose (CDH Laboratory reagents, New Delhi), and KBr (Himedia Laboratories Pvt, Ltd., Mumbai).

Methods

The preparation of superdisintegrant from modified tamarind seed gum consists of three steps:

Isolation of gum from T. indica seeds

The gum was extracted from the tamarind seeds. Tamarind seeds were soaked in distilled water overnight. Seeds were crushed in the grinder to remove the outer coat. The white portion of the seeds was separated and crushed to make powder. The image of tamarind seed powder is shown in Fig. 1. The crushed material was boiled in distilled water of 500 ml for 5–7 h. After the complete boiling, the crude material was filtered using a muslin cloth and the gum was obtained. The marc was separated and gum was concentrated to about half of its volume. The extracted tamarind seed gum is shown in Fig. 2. Ethanol was added to cooled concentrated gum till the formation of precipitates. The precipitates were separated using the vacuum filtration method. Purification of precipitates can be done by washing with acetone. The precipitates were dried under the sunlight for 24 h [12,13].

Modification of extracted gum by the carboxymethylation method

An aqueous dispersion of tamarind seed gum (1.35% W/V) was prepared by adding an ice-cold solution of sodium hydroxide (42%, W/W). Stir constantly for about 30–35 min. Followed by the addition of 22 ml of an aqueous solution of monochloroacetic acid (42%, W/V), placed in a thermostatic water bath (70°C), and shaking occasionally for 60 min. After the completion of the reaction, obtained mass was filtered. Cooled the mixture. The image of carboxymethyled tamarind seed gum is shown in Fig. 3.

Then, the product was dissolved in water, neutralized with glacial acetic acid, precipitated in ethanol (AR grade 90%), and washed thrice with aqueous methanol solution (80%V/V) which results in the formation of precipitates. Precipitates of carboxymethylated tamarind seed gum were separated by the vacuum filtration apparatus and dried in the hot air oven at 40°C and powdered [14,15].

Calcium complexation of the carboxymethyled tamarind seed gum (CMTG)

Dissolved 3.5 g of CMTG in 50 ml of distilled water. Calcium chloride (5%, w/v, 50 ml) solution in water was added drop-wise to the carboxymethylated gum solution with constant stirring to obtain thick, gelatinous, and homogenous precipitates as shown in Figs. 4 and 5. These precipitates were repeatedly rinsed with distilled water to remove unreacted calcium and gum. These washed precipitates were freeze-dried and passed through the # 80 sieve [16].

Evaluation

Pre-formulation studies of gum

Pre-formulation studies are the studies that are done before the final preparation of the drug formulation. These types of studies are important to do before the final preparation because these studies help in finding the properties of the drug and the compatibility studies of the drug with the other ingredients [17,18].

Stability studies of gum

Prepared gum was stored in glass containers (well stoppered) for 1 month at the incubator temperature (25±1°C). This was checked after preparation throughout the week. Physical evaluation of the stability of the prepared gum formulation was carried out by appearance, odor, swelling ratio, weight loss on drying, and pH.

Swelling index

The swelling index of calcium complexed Tamarind seed gum was determined by placing gum in the 10 ml measuring cylinder up to mark 2 ml. The initial volume of the gum in a measuring cylinder was noted. The volume was made up to the 10 ml mark with 0.1N HCl (pH 1.2) at room temperature. The cylinder was stoppered shaken gently and set aside for 24 h. The volume occupied by the gum sediment was noted after 24 h.

The swelling index of the gum was calculated by the formula,

$$Swelling\,index = \frac{W_t - W_o}{W_t} \times 100$$

Where,

S.I. = Swelling index

W_t = Height occupied by swollen gum after 24 h

W_o = Initial height of the powder in a graduated cylinder.

Determination of pH of the gum

The pH of 1% w/v aqueous solution of calcium complexed tamarind seed gum was determined using a pH meter (Systronics, Model no.361).

Viscosity

The viscosity of 1% (w/v) calcium complexed solution was determined at 37±°C using a Brookfield viscometer [19].

Differential scanning calorimetry studies

DSC studies of gum were performed by taking 10 mg of sample and heating it in an open aluminum pan at a heating rate of 100C/min in a 30°C–300°C temperature range. DSC studies disclose the melting point of the calcium complexed gum to ascertain changes in the internal structure of the gum.

Fourier transforms infrared spectroscopy

FTIR is usually performed to identify the presence of the functional group and determine the presence of specific impurities in the pure compound. Pot. Bromide was crushed in the mortar pestle. After that, pure tamarind gum, carboxymethylated gum, and calcium complexed tamarind gum were mixed with the KBr in a ratio of 1:100. FTIR spectrums were recorded on samples prepared in potassium bromide disks using an FTIR spectrophotometer [20].

Pre-compression studies

These are the studies that were done before the compression of the compact mass of the tablet. These studies consist of the five steps Bulk density, Tapped density, Angle of repose, Carr's index, and Hausner's ratio (HR) [21,22].

Bulk density

It is measured by pouring the powder blend into a measuring cylinder and the initial weight was noted. This initial volume is called the bulk volume. The volume occupied by the powder blend was determined using the given formula:

$$\text{Bulk density} = \frac{\text{M(mass of powder)}}{\text{V}_\text{b}\text{(Bulk voulme of powder)}}$$

Tapped density

It may be defined as the ratio of the total mass of the powder to the tapped volume of the powder. It was determined by pouring the powder blend into the measuring cylinder. The cylinder was tapped gently about 500 times on the harder surface and tapped volume of powder was noted. When the difference between two volumes was more than 2%, tapping was repeated 1000 times and the tapped volume was recorded. In a bulk density apparatus, tapping was continued until the difference between subsequent volumes was <2%. It was expressed in g/ml [23] and calculated by:

$$\text{Tapped density} = \frac{\text{M(mass of powder)}}{\text{V}_t\text{(tapped volume of powder)}}$$

The angle of repose (θ)

The angle of repose was determined using the funnel method. The blend was poured through a funnel that can be raised vertically until a specified cone height (h) was obtained [24]. The radius of the heap (r) was measured and the angle of repose (θ) was calculated using the formula;

$$\text{The Angle of repose} = \text{Tan}\theta = \frac{h}{r}\ ;\ \theta = \text{Tan}^{-1} = \frac{h}{r}$$

Where θ is the angle of repose.

Carr's index

It determines that the flow of powder is its compressibility. Carr's index is calculated as follows;

$$Carr's\ index = \frac{D_t - D_b}{D_t} \times 100$$

Where,
D_t is the tapped density of the powder
D_b is the bulk density of the powder.

Hausner ratio

HR is an indirect index of ease of powder flow [25]. It is calculated by the following formula:

$$Hausner\ Ratio: = \frac{Tapped\ density}{Bulk\ density}$$

Post-compression studies

The fast disintegrating tablets of calcium complexed tamarind seed gum were prepared by the direct compression method. The formulation of FDTs is tabulated in Table 1. The evaluation was performed on the propranolol hydrochloride tablets of all formulations that were subjected to various parameters such as weight variation, friability, content uniformity, hardness and disintegration time, and dissolution [26].

Hardness

The hardness of tablets was determined using a Monsanto hardness tester. The tablet was held along its oblong axis in between the two jaws of the tester. At this point, the reading should be zero kg/cm^2. The constant force was applied by rotating the knob. The hardness of the tablets was measured using the Pfizer hardness tester.

Thickness

The thickness of eight tablets was determined using a Vernier caliper.

Friability

A USP-type Roche friabilator was used to test the friability of a sample of eight tablets (Pharmalab, Ahmedabad, India). Pre-weighed tablets were placed in a plastic chambered friabilator, which used a plastic chamber that revolved at 25 rpm and dropped the tablets at a distance of 6 inches with each revolution to submit the tablets to the combined action of abrasions and shock. In the Friabilator, a pre-weighed sample of eight tablets was put and spun for 100 revolutions. The tablets were weighed and powdered. The friability was determined using the following formula:

Table 1: Formulation of fast disintegrating tablet using calcium complexed tamarind seed gum

Ingredients (mg)	F1	F2	F3	F4	F5	F6	F7	F8
Propranolol HCL	40	40	40	40	40	40	40	40
Calcium complexed tamarind gum	50	65	80	95	110	125	140	155
Talc	5	5	5	5	5	5	5	5
Microcrystalline cellulose	156	146	136	126	116	106	96	86
Mag. Stearate	7	7	7	7	7	7	7	7
Lactose	90	85	80	75	70	65	60	55

Fig. 1: Tamarind seed powder

Fig. 2: Tamarind seed gum

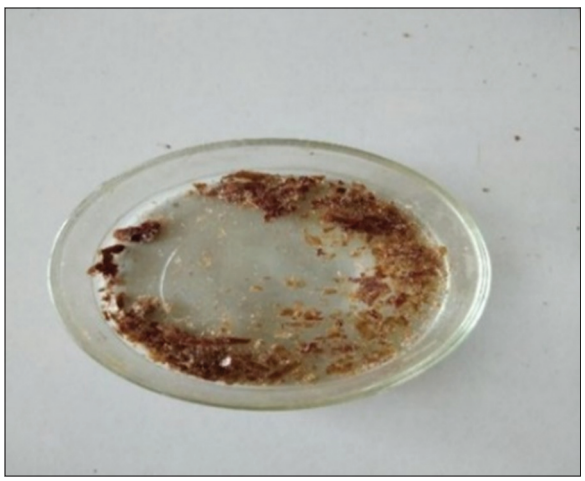

Fig. 3: Carboxymethyled tamarind seed gum

$$Friability = \frac{Initial\,weight - Final\,weight}{Initial\,weight} \times 100$$

Weight variation

A weight variation test was performed to ensure that a tablet contains the proper amount of drugs. Using analytical balance, the weight of the tablets was determined individually. From that, average weight was calculated. Then, the individual weight was compared with the average weight of the tablets [27].

% Drug content uniformity

The drug content of the F1 to F8 formulations was determined by the spectrophotometric method. The mean value and the standard deviation of all formulations were calculated.

Disintegration test

The fast disintegrating tablets of modified calcium complexed tamarind seed gum were compared with the marketed formulation of croscarmellose sodium which acts as a synthetic superdisintegrant. The dosage form was compared in the terms of disintegration and dissolution time. A cylindrical vessel was used to determine the disintegration time of the tablets, in which a 10 mesh screen was set in such a way to calculate the disintegration time, and 500 ml of buffer 6.8 pH was placed within the vessel. The tablet was placed in the sieve, the entire assembly was shaken, and the time that it took for all the particles to pass through the sieve was recorded as the tablet's disintegration time [22].

Formulation of fast disintegrating tablet containing calcium complexed tamarind seed gum as natural superdisintegrant and croscarmellose sodium as synthetic superdisintegrant

The fast disintegrating tablets of propranolol HCl and calcium complexed tamarind gum were prepared by the direct compression method [28]. All the weighed quantity of ingredients was passed through sieve no. 80 and mixed for 10 min. Tablets were made by compressing the powder in the tablet punching machine. The tablets were prepared in eight formulations. F1–F5 contains calcium complexed tamarind gum, and in F6–F10 the disintegrating agent was croscarmellose sodium [29]. The formulations of FDTs are shown in Table 2.

RESULTS AND DISCUSSION

Pre-formulation studies of gum

The fast disintegrating tablet was successfully formulated and it showed satisfactory results. The swelling index of various modified gums is tabulated in Table 3. The pH of 1% w/v aqueous solution of pure extracted tamarind seed gum and calcium complexed tamarind seed gum was found to be 5.4 and 6.8. The viscosity of 1% (w/v) calcium complexed solution was found to be 9.41pa.

FTIR of pure tamarind seed gum

The main component of *T. indica* seed gum is the carbohydrates portion which contains Galactose, Glucose, Xylopyranose, Xylose, Galactopyranosyl, Glucuronic acid, and Galacturonic acid. A medium peak at 1107.94 cm^{-1} was found in the spectrum, indicating the presence of aromatic sugar groups with O-H as the main functional group present in the tamarind seed gum. The existence of O-H groups represents the hydrophilic characteristic that is present in the polysaccharide. The small peak that is visible at 1107.94 cm^{-1} represents the C-H stretch that exists in galactose and rhamnose. The broad peak at 3431.44 cm^{-1} shows the presence of O-H stretches which indicates the presence of intermolecular bonding while the identical small peak at 3279.12cm^{-1} indicates the C-H bend which is a constituent of galactose and rhamnose. This indicates the presence of carbohydrates in the gum. The small peak at 1627.32 cm^{-1} indicates the C=O stretching. FT-IR spectra of pure tamarind seed gum are shown in Fig. 6.

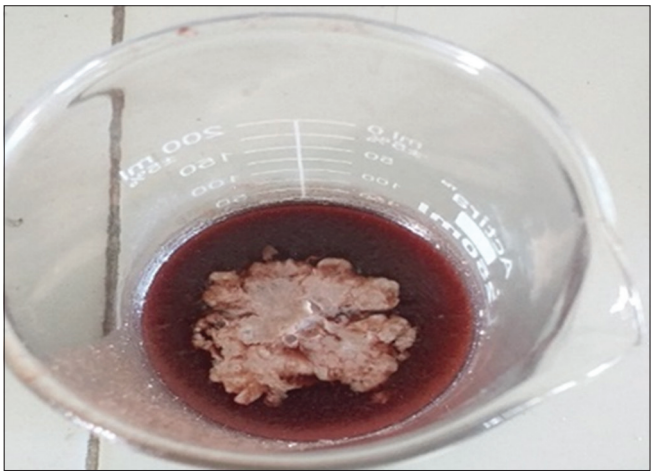

Fig. 4: Calcium complexation of Carboxymethyled Tamarind seed gum

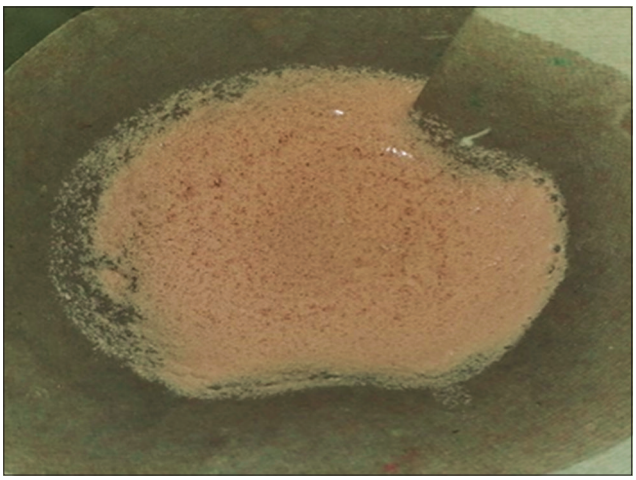

Fig. 5: Calcium complexed *Tamarind* seed gum

Table 2: Formulation of fast disintegrating tablet containing calcium complexed tamarind seed gum as natural superdisintegrant and croscarmellose sodium as synthetic superdisintegrant

Ingredients (mg)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Propranolol HCL	40	40	40	40	40	40	40	40	40	40
Calcium complexed tamarind gum	2.5	5	7.5	10	12.5	-	-	-	-	-
Croscarmellose sodium						2.5	5	7.5	10	12.5
Talc	5	5	5	5	5	5	5	5	5	5
Microcrystalline cellulose	100	100	100	100	100	100	100	100	100	100
Magnesium stearate	2	2	2	2	2	2	2	2	2	2
Lactose	43.5	41	38.5	36	33.5	43.5	41	38.5	36	33.5

The carboxymethylation of extracted tamarind seed gum using NaOH and monochloroacetic acid results in the addition of methyl group to the carbohydrate group (COO^-). Thus, the gum becomes completely hydrophilic in nature and this property helps in the rapid disintegration of drug formulation. As a result, dissolution also occurs rapidly. After modification by carboxymethylation, shifts the peak at 2924.79cm^{-1} indicates the presence of a methyl group. FT-IR spectra of CMTG are shown in Fig. 7. The (FT-IR) characteristic peaks with their frequency for carboxymethyled tamarind seed gum are tabulated in Table 4.

Table 3: Swelling index of modified *Tamarindus indica* seed gum

Type of *Tamarindus indica* seed gum	Swelling index (%)
Pure *Tamarindus indica* seed gum	85.66
Carboxymethyled Tamarind seed gum	122.85
Ca2+complexed Tamarind seed gum	298

Table 4: FTIR characteristic peaks for carboxymethyled tamarind seed gum

S. no.	Characteristic peak	Frequency (cm-1)
1	Carboxylic acid O-H stretching	3431.28
2	C-H stretching	2924.28
3	C=O stretching	1629.67
4.	O-H bending	1382.65

Table 5: FTIR characteristic peaks for calcium complexed tamarind seed gum

S. No.	Characteristic peak	Frequency (cm-1)
1	Carboxylic acid O-H stretching	3433.62
2	C-OH stretching	1080.20
3	C-H stretching	292.87
4	Presence of Carboxylic acids	1732.60

After adding a methyl group, it was further complexed with Ca^{2+} ion which result in increasing its swelling property. Carboxymethylated gum (COOCH-) was reacted with calcium chloride to enhance its property. As a result, the -CH- group was replaced by Ca^{2+} to form $COOCa^{2+}$, and shifting in the IR peak was observed. The precipitates obtained after the calcium complexation were porous in structure. The presence of pores helps in increasing the swelling property of the gum and disintegrates rapidly. FT-IR spectra of calcium complexed tamarind seed gum are shown in Fig. 8. FT-IR spectra of propranolol HCl and calcium complexed tamarind seed gum are shown in Fig. 9. The (FT-IR) characteristic peaks with their frequency are tabulated in Table 5.

DSC studies

DSC studies showed the melting point for calcium complexed carboxymethyled tamarind seed gum. A prominent endothermic peak was observed at 68.22°C as shown in Fig. 10. A small exothermic peak was found at 267.23°C due to heat absorption during the reaction process. DSC studies revealed that variations in the peak showed an addition of the carbonyl group resulting in enhanced swelling properties of the gum and disintegration occurs quickly.

Pre-compression evaluation

The bulk density of different powder blends varied between 0.38 and 0.49 g/cm^3. The tapped density was found in the range of 0.52–0.62 g/cm^3.The Carr's index was found in the range of 15.67–29.9%. The powder blends of all formulations had HR between 0.95 and 1.38 indicating good flow characteristics. The results of the pre-compression evaluation for different blends of powder are tabulated in Table 6. Then, the mixed blends were compressed using a rotary tablet punching machine to produce the fast disintegrating tablets [30].

Post-compression evaluation

The compressed tablets were evaluated for various parameters such as hardness, friability, thickness, weight variation, and disintegration time. The values of tablet thickness and diameter showed uniformity in die fill, good flow characteristics, and powder compressibility. All

Table 6: Pre-compression parameters for different blends of powder using modified gum

Parameters	Formulation code							
	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6	Formula 7	Formula 8
Bulk density (g/cc)	0.45	0.48	0.42	0.41	0.47	0.49	0.38	0.45
Tapped density (g/cc)	0.52	0.57	0.56	0.60	0.55	0.57	0.58	0.62
Angle of repose (°)	27.37	30.34	25.21	25.33	28.39	26.29	27.10	24.01
Carr's index (%)	21.4	22.8	15.67	22.8	25.66	22.6	27.7	29.9
Hausner's ratio	0.95	1.34	1.29	1.38	1.29	1.28	1.30	1.35

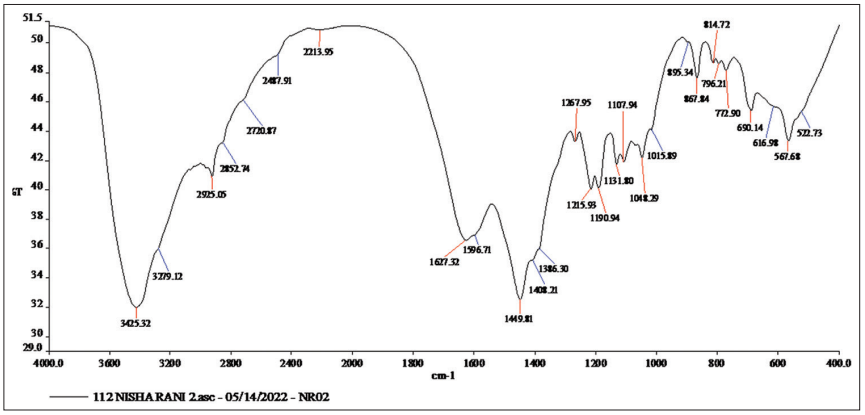

Fig. 6: FTIR Characteristic peaks for extracted Tamarind seed gum

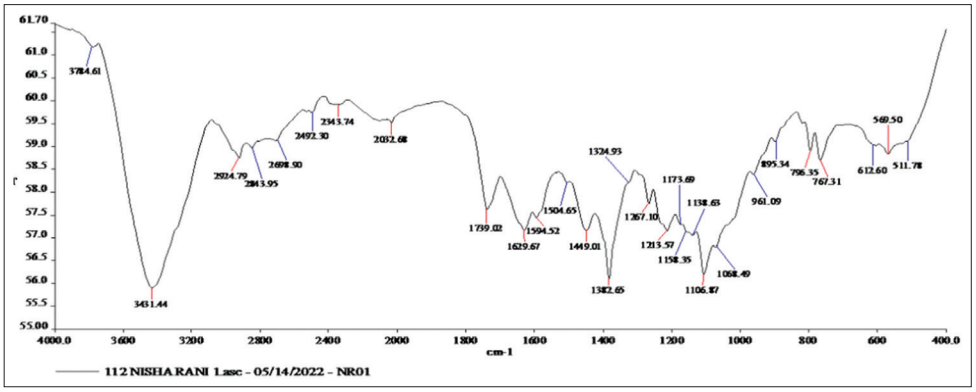

Fig. 7: FTIR of carboxymethyled Tamarind seed gum

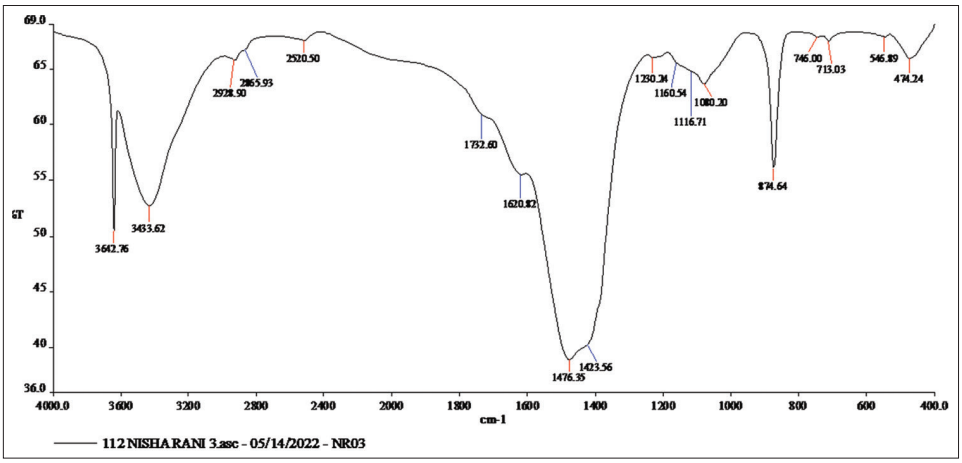

Fig. 8: FTIR of calcium complexed tamarind seed gum

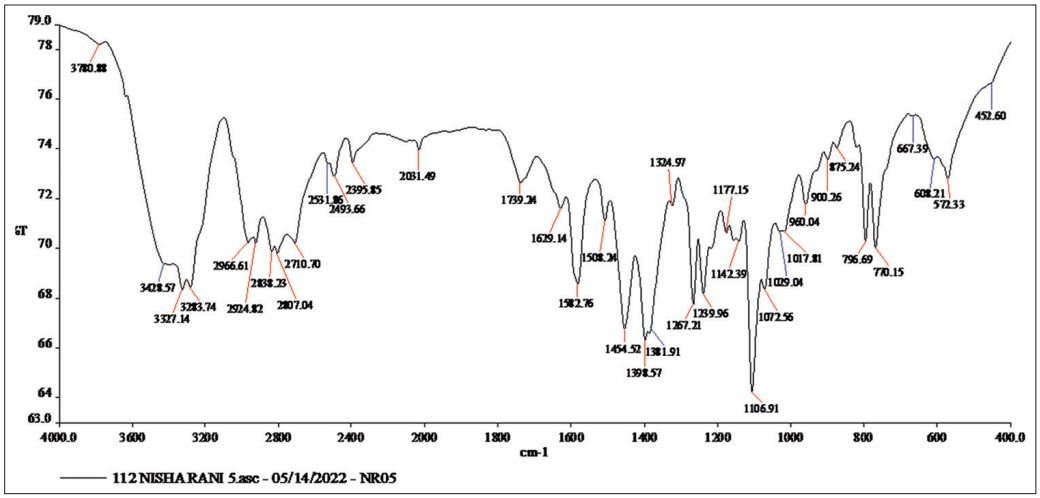

Fig. 9: FT-IR spectra of propranolol HCL and calcium complexed tamarind seed gum

Table 7: Post compression evaluation of Fast disintegrating tablets

Parameter	Formula							
	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6	Formula 7	Formula 8
Hardness (kg/cm3)	5.8±0.39	5.0±0.38	5.6±0.40	5.2±0.21	5.7±0.60	5.2±0.54	5.3±0.57	6.6±0.55
Thickness (mm)	4.1±0.34	4.5±0.21	4.9±0.25	4.5±0.01	3.9±0.67	5.22±0.50	4.5±0.42	5.29±0.81
Friability (%)	0.29	0.55	0.51	0.58	0.60	0.43	0.68	0.70
Weight variation	198±05	200±05	201±03	199±05	201±05	200±05	198±04	201±1.0
Wetting time (s)	37±3	48±1.6	45±2.6	48±0.8	53±0.8	62±2.7	51±2.8	47±0.8
Disintegration time (s)	33.00±1.0	28.66±0.57	24.66±1.5	31.33±0.57	20.32±1.5	19.33±1.5	22.35±0.57	15.00±1.0

Table 8: Drug content of propranolol HCL in fast disintegrating tablet

Formula	Drug content (%)
Formula 1	89.32
Formula 2	90.82
Formula 3	97.93
Formula 4	93.76
Formula 5	98.90
Formula 6	89.51
Formula 7	95.11
Formula 8	91.76

Table 9: Comparison of disintegration time of fast disintegrating tablet prepared from modified calcium complexed tamarind seed gum (natural superdisintegrant) with the marketed formulation of croscarmellose sodium as synthetic superdisintegrant

Contents	Formula									
	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6	Formula 7	Formula 8	Formula 9	Formula 10
Calcium complexed Tamarind seed gum	42±2s	45±6s	39±2s	41±5s	37±2s					
Croscarmellose sodium						47±2s	45±3s	44±3s	49±5s	48±2s

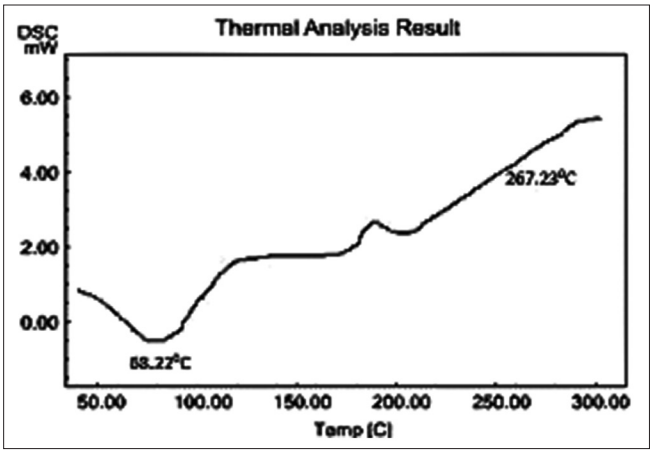

Fig. 10: DSC of calcium complexed tamarind seed gum

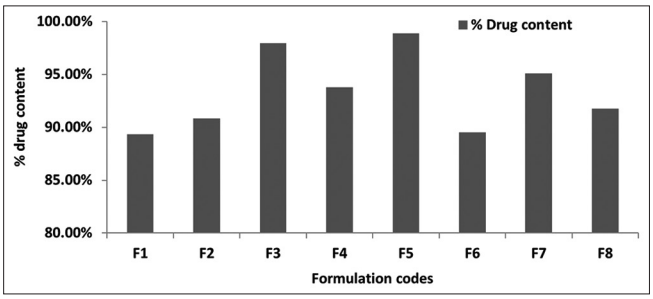

Fig. 11: Drug content of propranolol HCL

the formulas produce tablets of proper thickness and diameter [31]. The weight variation for all the formulated tablets was in the range of 198±04–201±05. The wetting time for all the formulated tablets was in the range of 37±3–62±2.7 s. The faster wetting time results in the rapid disintegration of tablets [32]. Drug content of all formulations is shown in Fig.11. and observed between 89.32% and 98.90%. The drug content of all formulations was observed between 89.32% and 98.90%. The drug content in all formulations met the specification of propranolol content which has been stated in compendia (90.0–110.0%) [30]. The results of the post-compression evaluation and drug content are tabulated in Tables 7 and 8. The disintegration time of the ten formulations was compared and it was found that formulation F5 has shown the lowest disintegrating time which means that the calcium complexed tamarind seed gum works better than the marketed formulation of croscarmellose sodium as a synthetic superdisintegrant and it is shown in Table 9.

CONCLUSION

The present investigation study showed that the modified tamarind seed gum has a high super disintegration potential. Disintegration time of modified calcium complexed tamarind seed gum was found best in F5 formulation, that is, 37±2s, whereas F10 marketed formulation of croscarmellose sodium showed disintegration time of 48±2s. The purpose of comparing the disintegration time of both formulations was to find out the best disintegrating properties between them. Moreover, as from the observations, it was found that calcium complexed tamarind seed gum works better in comparison with the marketed formulation of croscarmellose sodium. It was clear in the observations that modified tamarind seed gum takes lesser time to get disintegrate. This superdisintegrant will be used in the future for the formulation and development of fast disintegrating tablets with desired physicochemical characteristics.

ACKNOWLEDGMENT

The author wishes to acknowledge the Principal, Shivalik College of Pharmacy, Nangal for providing the chemicals and infrastructure and also Registrar, IKG Punjab Technical University, Jalandhar, Punjab.

AUTHORS' CONTRIBUTION

Guidance for the work, disintegration time study, data interpretation and corrections, physicochemical analysis and characterization, experimental design of formulation, consideration of manufacturing process parameter, and writing of the manuscript were done by the first author Nisha Rani. Data generation and reporting of data summary were done by second author Dhruv dev.

CONFLICT OF INTEREST

None.

AUTHORS FUNDING

None.

REFERENCES

1. Desai PM, Liew CV, Heng PW. Review of disintegrants and the disintegration phenomena. J Pharm Sci 2016;105:2545-55. doi:

10.1016/j.xphs.2015.12.019, PMID 27506604
2. Battu SK, Repka MA, Majumdar S, Madhusudan RY. Formulation and evaluation of rapidly disintegrating fenoverine tablets: Effect of superdisintegrants. Drug Dev Ind Pharm 2005;33:1225-32.
3. Mangal M, Thakral S, Goswami M, Ghai P. Superdisintegrants: An updated review. Int J Pharm Pharm Sci Res 2012;2:26-35.
4. Pahwa R, Gupta N. Superdisintegrant in the development of orally disintegrating tablets: A review. IJPSR 2011;2:2767-80.
5. Available from: https://www.pharmatutor.org/articles/overviewsuperdisintegrants
6. Alam MT, Parvez N, Sharma PK. FDA-approved natural polymers for fast dissolving tablets. J Pharm (Cairo) 2014;2014:952970. doi: 10.1155/2014/952970, PMID 26556207
7. Shihora H, Panda S. Superdisintegrants utility in dosage forms: A quick review. J Pharm Sci Biosci Res 2011;1:148-53.
8. Singh R, Malviya R, Sharma PK. Extraction and characterization of tamarind seed polysaccharide as a pharmaceutical excipient. Pharmacogn J 2011;3:17-9. doi: 10.5530/pj.2011.20.4
9. Dash KD, Meher B, Roy A. A review on: Phytochemistry, pharmacology and traditional uses of *Tamarindus indica*. World J Pharm Pharm Sci 2014;10:229-40.
10. Mali K, Dhawale S, Dias R, Ghorpade V. Delivery of drugs using tamarind gum and modified tamarind gum: A review. Bull Fac Pharm 2019;57:1-24. doi: 10.21608/BFPC.2019.47260
11. Minkal AM, Ahuja M, Bhatt DC. Carboxymethyl gum katira: Synthesis, characterization and evaluation for nanoparticulate drug delivery. RSC Adv 2018;5:82363-73. doi: 10.1039/C5RA11702J
12. Reddy KM, Teja PB, Priya SM, Kumar KR, Govardhan UV. Extraction and evaluation of tamarind kernel mucilage powder for hydrocolloidal properties. Int J Adv Eng Res Sci 2018;5:177-82.
13. Ameena K, Dilip C, Saraswathi R, Krishnan PN, Sankar C, Simi SP. Isolation of the mucilages from *Hibiscus rosa-sinensis* L. and Okra (*Abelmoschus esculentus* L.) and studies of the binding effects of the mucilages. Asian Pac J Trop Med 2010;3:539-43. doi: 10.1016/S1995-7645(10)60130-7
14. Ahuja M, Singh S, Kumar A. Evaluation of carboxymethyl gellan gum as a mucoadhesive polymer. Int J Biol Macromol 2013;53:114-21. doi: 10.1016/j.ijbiomac.2012.10.033, PMID 23178342
15. Dhruv D, Diksha R, Prasad DN. Calcium salt of carboxymethyled *Aegle marmelos* (bael fruit) gum: A novel superdisintegrant for fast disintegrating tablets. Asian J Pharm Res Dev 2018;6:67-72.
16. Rai PR, Tiwary AK, Rana V. Superior disintegrating properties of calcium cross linked cassia fistula gum derivative for fast dissolving tablet. Carbohydr Polym 2012;87:1098-104. doi: 10.1016/j.carbpol.2011.08.050
17. Puri A, Dev D, Prasad DN, Hira S, Sharma R. Modified Okra gum with silica: A novel superdisintegrant for fast disintegrating tablet. J Drug Deliv Ther 2019;9:206-11.
18. Bhatia NM, Salunkhe SS, Mali SS, Gadkari SS, Hajare AA, *et al*. Extraction and characterization of mucilage from *Lepidium sativum* L. Seeds. Sch Res Lib Pharm Lett 2014;6:65-70.
19. Waigh MP, Yewale CP, Zate SU, Kothawade PI, Mahale GH. Formulation and evaluation of fast dispersible tablets of aceclofenac using different superdisintegrant. Int J Pharm Sci 2010;2:154-7.
20. Kazarian SG, Chan KA. Applications of ATR-FTIR spectroscopic imaging to biomedical samples. Biochim Biophys Acta 2006;17:858-67.
21. Venkateswarlu K, Preethi JK. Formulation development and *in-vitro* evaluation of mouth dissolving tablets of pioglitazone hydrochloride. Pharm Tutor 2016;4:37.
22. Jadhav D, Kharat R, Jhadav S, Patil MK. Design and evaluation of sustained release matrix tablet of propranolol hydrochloride. Indo Am J Pharm Res. 2015:1109-17.
23. Rowe RC, Paul JS, Sian CO. Handbook of Pharmaceutical Excipients. 6th ed. Washington, DC: Pharmaceutical Press; 2009. p. 45, 404, 424.
24. U S A Pharmacopeial Convention. National Formulary 35. United States Pharmacopeia 40. Rockville: United States Pharmacopeial Committee; 2017. p. 2886-8.
25. Aulton ME, Aulton's Pharmaceutics the Design and Manufacture of Medicines. Philadelphia: Churchill Livingstone; 2013. p. 187-99.
26. Dnyaneshwar J, Kharat R, Jadhav S, Patil M. Design and evaluation of sustained release matrix tablet of propranolol hydrochloride. Indo Am J Pharm Res 2015;6876:2231.
27. Preethi GB, Banerjee S, Shivakumar HN, Kumar MR. Formulation of fast-dissolving tablets of doxazosin mesylate drug by direct compression method. Int J Appl Pharm 2017;9:22-8. doi: 10.22159/ijap.2017v9i5.18168
28. Rajeshvar V, Ramana Mv. Formulation and evaluation of orodispersible rovustatin tablets: A comparative study on natural and synthetic superdisintegrants. Int J Pharm 2016;7:39-43.
29. Pandit V, Kashive D, Sharma TK. Formulation and evaluation of novel formulation for diabetes induced hypertension using modified innate superdisintegrant. J Drug Deliv Ther 2020;10:240-50. doi: 10.22270/jddt.v10i5.4412
30. Shirshand SB, Ramani RG, Swamy PV. Novel co-processed super disintegrants in the design of fast dissolving tablets. Int J Pharm Biol Sci 2010;1:1-11.
31. Lachman L, Lieberman H, Kanig JL. Drying. In: Pharmaceutical Dosage Forms Tablet. Vol. 2. New York: Marcel Dekker; 1991. p. 4764.
32. Mohapatra S, Pattanaik P, Sudam C. Role of superdisintegrants for *in-vitro* characterization of loratadine orodispersible tablets. Int J Pharm Pharm Sci 2012;4:319-23.