RESEARCH ARTICLE

Development and assessment of Carboxymethylated Galactomannan from Seeds of *Caesalpinia pulcherrima* as an Efficient Disintegrating Agent for Orally Disintegrating Tablet

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ABSTRACT

Current study's objective was to evaluate the disintegration potential of naturally occurring *Caesalpinia pulcherrima* seedgalactomannan and to chemically modify it for formulation of orally disintegrating tablet formulation. Galactomannan extracted from the *Caesalpinia pulcherrima* seeds received chemical modification through carboxymethylation in an effort to enhance its hydrophilic nature of galactomannan which enhances disintegration potency. Carboxymethylated *Caesalpinia pulcherrima* seed galactomannan synthesized by etherification process by using monochloroacetic acid the titrimetric method was used to measure the extent of substitution. Carboxymethyl modification of galactomannan was analysed by, various methods like Zeta potential measurement, DSC thermogramand FT-IR. Ondansetron ODT were prepared separately using isolated and carboxymethylated *Caesalpinia pulcherrima* seed galactomannan by incorporating different concentrations such as 2, 4, 6 %. Precompression and post compressional evaluation parameters for formulated batches were compared with two ethical marketed formulations. Modified *Caesalpinia pulcherrima* seed galactomannan was nearly equivalent to reference formulation in quality testing so this work makes modified galactomannan suitable disintegrating agent in tablet formulation. As a conclusion, it can be said thatcarboxymethylated galactomannan from seeds of *Caesalpinia pulcherrima* is suitable disintegrating agent for ODTs.

Keywords: *Caesalpinia pulcherrima*, galactomannan, carboxymethylation and disintegrating agent.

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INTRODUCTION

Natural polysaccharides are increasingly being considered as biopolymers due to their low cost, availability, nontoxicity, ease of modification, biodegradability, and biocompatible properties. Because of their diverse structure and features, they have numerous applications in the pharmaceutical and food industries.[1,2] Galactomannans composed of a (1-4)-d-mannan chainand a single d-galactose branch attached (Figure 1). Galactomannans are neutral heteropolysaccharides, which means they do not include uronic acid residues or other charged groups (such as sulfo groups) on their backbone. When hydrated in water, galactomannan forms a viscous colloidal dispersion. It is utilized as a viscosity former and water binder in numerous industries, including textiles, food, paper, petroleum, and medicines.[4] Pride of Barbados and Red Bird-of-Paradise are names for the prickly, bushy legume of *Caesalpinia pulcherrima*, an ancient medicinal plant. It is widespread in tropical and subtropical regions. Galactomannan and nutritional fibres make the seeds popular in the food sector as hydrocolloids and texture-modifiers.[5] The aim of the current study was to etherify the CP seed galactomannanby adding carboxymethyl group in structure of mucilage by using monochloroacetic acid. Present study also investigates disintegrating potential of isolated and modified *CP seed galactomannan*by formulating orally disintegrating Ondansetron HCl tablet.

MATERIALS AND METHOD

Chemicals and excipients were received from research laboratory store department. Ondansetron hydrochloride was obtained as a kind gift from Intas Pharmaceuticals, Ahmadabad, India.Seeds from plant *Caesalpinia pulcherrima* were collected from suburban areas of Dhule, Maharashtra. Analytical grade reagents were used for laboratory procedure.

Extraction of *Caesalpinia pulcherrima* seed galactomannan

To release the seed galactomannan, the dried seeds of *Caesalpinia pulcherrima* were steeped in filtered water for a whole day, heated for one hour, and then left for two hours. In order to separate the marc from the filtrate, the material was strained through a muslin bag. Galactomannan was then precipitated by adding an equivalent volume of acetone to the filtrate. Galactomannan underwent separation, desiccation at 50°C in an oven, pulverization, and filter mesh 80 passing. Until it was needed, the powder was kept in a desiccator.[6]

Carboxymethylation of *Caesalpinia pulcherrima* seed galactomannan

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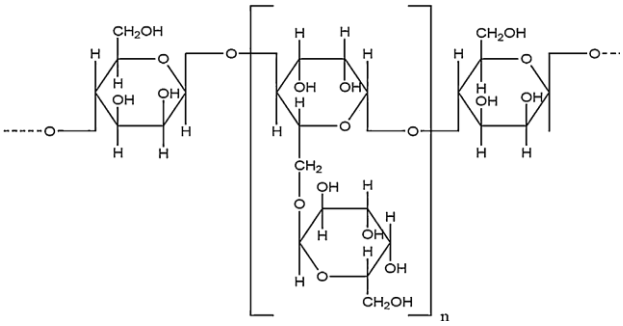

Figure 1: Structure of galactomannan.

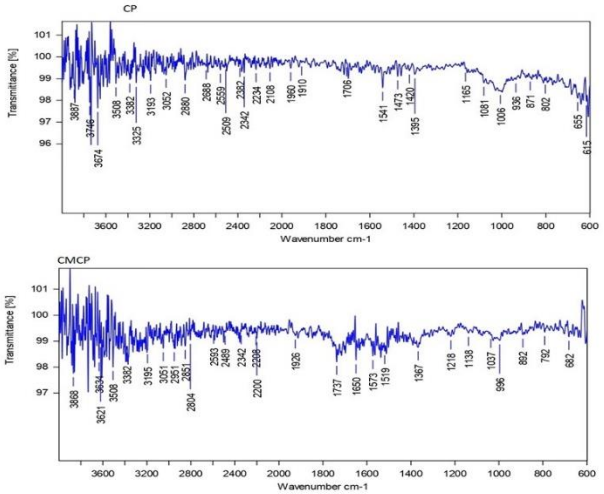

Figure 2. FTIR Spectra of CP and CMCP Galactomannan

Williamson's synthesis was used to carry out the carboxymethylation of *Caesalpinia pulcherrima seed galactomannan in* an aqueous alkaline media, using monchloroacetic acid as an etherifying agent. In a nutshell, 1 g of galactomannan was added to 70 ml 35 % w/v aqueous sodium hydroxide solution and vigorously stirred for half of an hour to create the dispersion. After that, the dispersion was progressively mixed with 20 ml 75 % w/v aqueous monochloroacetic acid while being properly stirred. After that, the mixture temperature was raised to 80 ± 1 °C for one hour. After cooling, 80 % v/v methanol wad added to precipitate the carboxymethyl *Caesalpinia pulcherrima seed galactomannan that* had been generated, glacial acetic acid was used to neutralize the mixture. Additionally, three washes were performed by using pure methanol. The precipitate was roasted for one hour at 80 °C in a hot air oven to obtain product.[7]

Phytochemical analysis and polysaccharide content estimation

Isolated and modified *Caesalpinia pulcherrima seed galactomannan* went through qualitative analysis to investigate various phytochemicals, including Ruthenium red test, Iodine test, Molisch's test, Ninhydrin test, Dragendorff"s test for glyacoside, Legal test for alkaloids and ferric chloride test for tannins. Using glucose as a standard, the phenol-sulphuric acid technique was applied for detection of polysaccharide content. In method, 1 ml galactomannan solution (100 µg/ml), a ml of 5 % phenol was added and it is followed by incorporation of 5 ml of conc sulfuric acid. Allow to interact for 10 minutes and absorbance was detected on 488 nm lambda max. Linear equation that resulted from the rotation against absorbance curve for different glucose concentrations (50–90 µg/ml) was used for calculation of polysaccharide content. The test solution and the reference polysaccharide were produced in the same way. Triplicates of the experiment were conducted.[8]

Estimation of carboxymethyl substitution

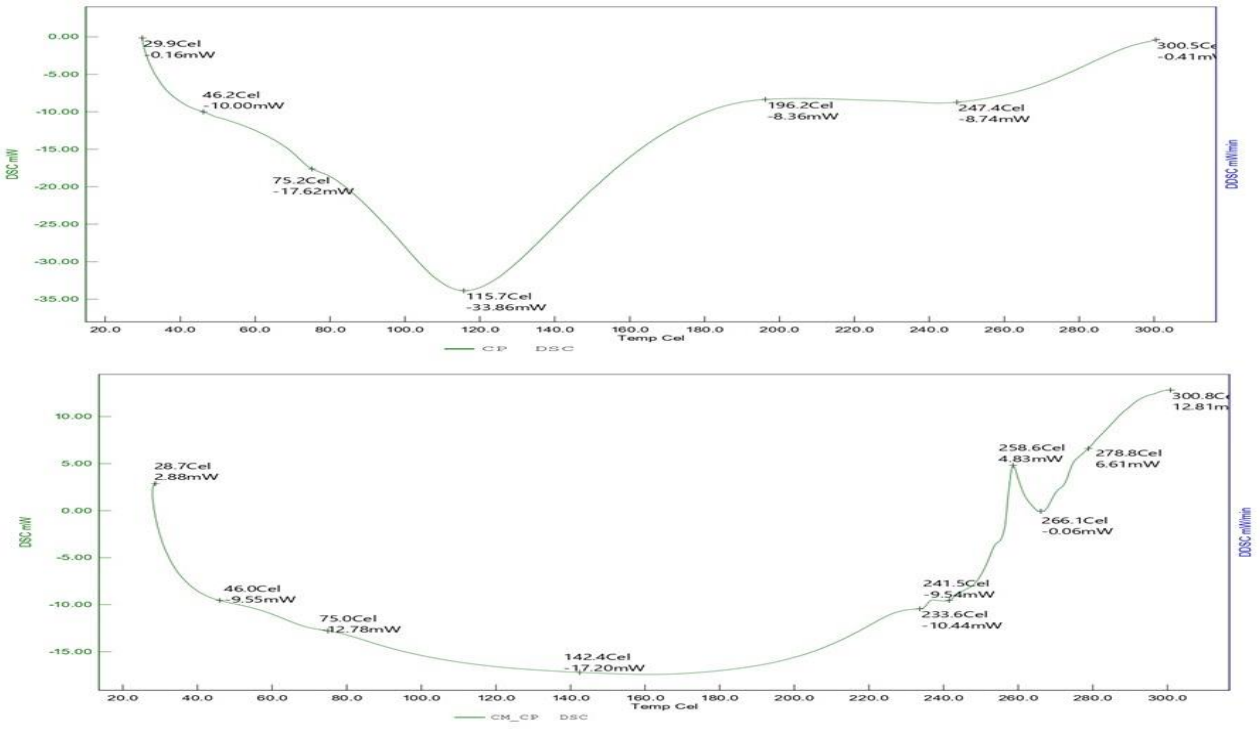

Figure 3: DSC Spectra of CP and CM-CP Galactomannan

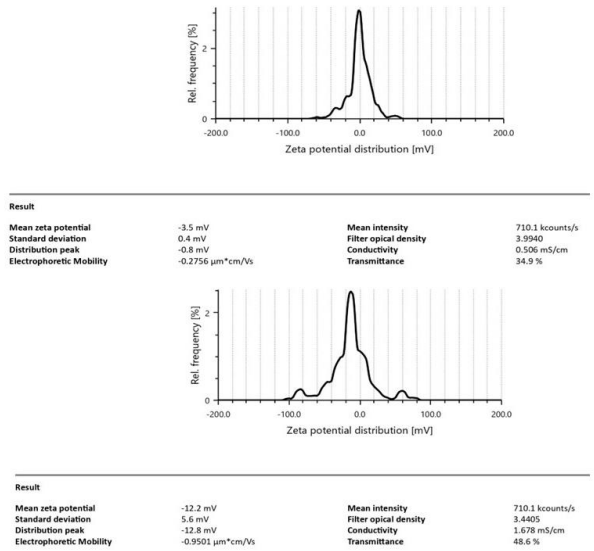

Figure 4: Zeta Potential Measurement of CP and CM-CP Galactomannan

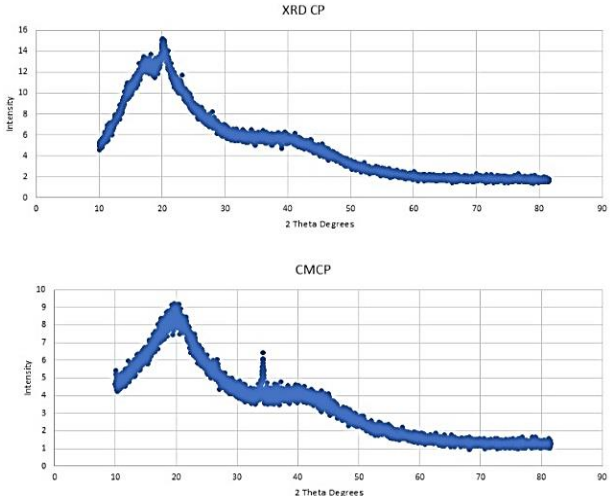

Figure 5: XRD of CP and CM-CP Galactomannan

The titrimetric approach was utilized to ascertain the degree of carboxymethyl substitution in the etherified *Caesalpinia pulcherrima*seed galactomannan.[8] Test polysaccharide was dispersed using 40 ml of strong HCl as a solvent, and the resulting mixture was agitated for two to three hours. After passing the produced mixture through filter paper, the residue washed with aqueous methanol (95% v/v). At 55 ± 10°C, the product was dried to a fix weight. A 200 mg portion of the above-dry residue was precisely weighed, and it was added in 25 ml of 0.5 M NaOH solution in aqueous methanol (70 % v/v) left it for some hours. Next, using phenolphthalein as an indicator, the resultant liquid was titrated with 0.5 M HCl. Equation was used to calculate the degree of carboxymethyl group substitution.

DS = (0.162 x A)/(1-0.058 x A)

Where, A is the ml of NaOH needed per gram of modified galactomannnan.

Characterization by FTIR

CP and CM-CP seed galactomannan FTIR spectra were captured using an FTIR (Bruker Alpha) spectrophotometer. After that, the sample was placed onto the FTIR sensor

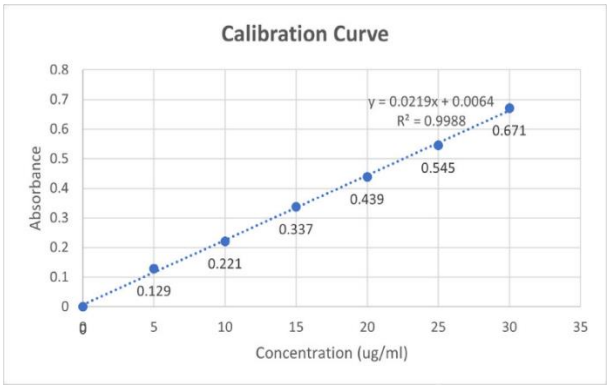

Figure 6. Calibration Curve of Ondansetron HCl

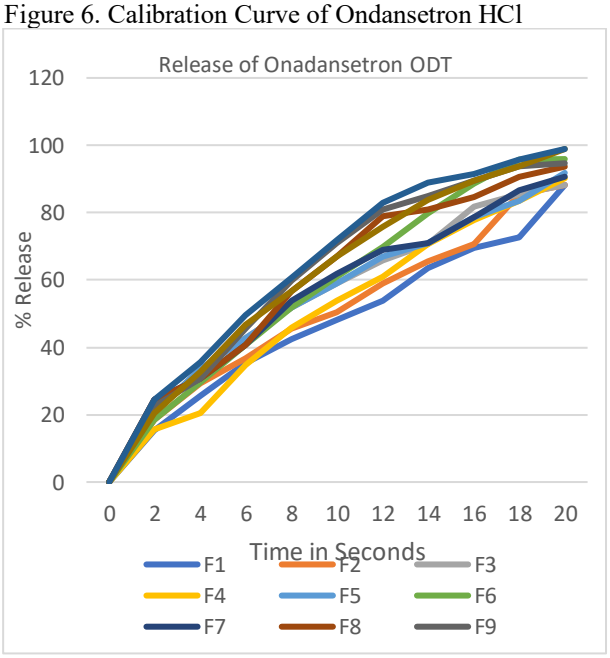

Figure 7: Drug Release Profile of Ondansetron Ondansetron ODT

Table 1: Types of Formulation

Series	Composition	Prepared At
F1 to F3	CP Galactomannan ODT	Laboratory
F4 to F6	CM- CP Galactomannan ODT	Laboratory
F7 to F9	Croscarmellose Sodium ODT	Laboratory
MF1	Ondem®- MD	Alkem Health Sciences
MF2	Vomikind®- MD	Mankind Pharma Ltd

(Bruker Alpha). The isolated and modified galactomannan was subjected to structural and functional group identification using the spectrum acquired within range of 4000–400 cm^{-1}.[9, 10]

Characterisation by DSC

Thermal behaviour of isolated and carboxymethylated galactomannan was studied using DSC (DSC-7020, Hitachi High Tech Japan). 10 mg of each sample were put into an aluminium pan that was sealed. Sample were analysed at a rate of 20°C per minute between 40°C and 400°C. In order

Table 2: Formulation of Ondansetrn ODT's

Formula/Ingredients	Batches										
	F1	F2	F3	F4	F5	F6	F7	F8	F9	MF1	MF2
Ondansetron hydrochloride (mg)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
CP Galactomannan	2.0	4.0	6.0	-	-	-	-	-	-	-	-
CM-CP Galactomannan	-	-	-	2.0	4.0	6.0	-	-	-	-	-
Croscarmellose sodium	-	-	-	-	-	-	2.0	4.0	6.0	-	-
Microcrystalline cellulose	41	39	37	41	39	37	41	39	37	-	-
Mannitol	45	45	45	45	45	45	45	45	45	-	-
Talc (mg)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	-	-
Magnesium stearate (mg)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	-	-
T. Weight (mg)	100	100	100	100	100	100	100	100	100	100	100

to increase cooling effectiveness and baseline stability, controlled cool nitrogen gas was used.[11]

Zeta potential measurement

Anton Par DLS Litesizer 500 was used to assess zeta potential of both isolated and modified seed mucilage. Mucilage was dispersed in distilled water to create the sample (0.1% v/v). After that, the sample was moved to an Omega cuvette for measurement. 170 degrees was the fixed back scattering angle, and the measurement was performed at 25^0C.[12]

Preparation of Ondansetron Orally Disintegrating Tablet

To get a homogeneous blend, precisely weighed amounts of all the ingredients aside from the lubricants were combined by using mortar-pestle for ten minutes. The homogeneous mixture made it past sieve number 60. As a lubricant, magnesium stearate was added. A 12-station rotary compression machine (Shakti Tab Press) was used to prepare the tablets utilizing the direct-compression method with 6 mm punches (flat).[13-15] Types of formulation that can be possibly prepared are shown in Table 1 while composition of each formulation batch is shown in Table 2.

Calibration Curve Preparation

Ondansetron HCl (25 mg) was precisely measured and subsequently transferred to a 25 mL volumetric flask. Utilise a minimal quantity of pH 6.8 phosphate buffer solution to enhance dissolution and augment volume. The dilutions were analysed utilising a UV-spectrophotometer, operating within a maximum wavelength range of 310 nm.[15] The calibration curve is illustrated in **Figure 6**.

Evaluation

Pre-formulation studies of galactomannan

Studies conducted prior to formulation are known as pre-formulation studies. Before making the final preparations, it is crucial to do these kinds of research because they aid in determining the drug's characteristics, flow properties etc.[16]

Swelling index

By inserting the mucilage up to the 2 ml mark in the 10 ml measuring cylinder, the swelling index of isolate and modified *galactomannan* was calculated. Measuring cylinder was used to record original volume of mucilage 0.1N aqueous HCl was added to the volume until it reached the 10-milliliter level at room temperature. Measuring cylinder was sealed, given a little shake, and kept aside for a whole day. After 24 hours, the gum sediment's volume was measured.[17]

Table 3: Physico-chemical Parameter of Mucilage.

Parameter	*CP* seed galactomannan	*CM-CP* galactomannan
Physical Nature	Solid Powder	Solid Powder
Color	Brown	Light Brownish
Solubility	Forming colloidal solution when dispersed in heated water, insoluble in organic solvents	Forming colloidal solution when dispersed in heated water, insoluble in organic solvents
pH	7.3-7.4	7.4-7.5
Total Polysaccharide content	62.23 %	55.33 %
Swelling Index	12.5 ml	18.6 ml
Practical yield	11.66 %	60.55 %
Total Ash	1.56	1.66
Moisture content	1.30 %	1.25%
Total Ash	1.47	1.55
Angle of repose	39.88 ± 1.80	31.66 ± 2.8
Bulk Density	1.48 ±0.04	1.64 ±0.01
Carr's index	15.55 ± 1.50	12.66 ± 0.06
Housners Ration	1.33 ±0.02	1.21 ±0.03

Swelling index of mucilage was computed by following formula,

$$\text{Swelling Index} = \frac{Wt - W0}{Wt} \times 100$$

Where, Wt = Height occupied in cylinder by swollen mucilage after 24 h

Wo = Initial height of mucilage in cylinder

pH of galactomannan

A pH meter was used to measure the pH of aqueous solution of isolated and modified CP seed galactomannan (0.1% w/v).

Viscosity

Using a Brookfield viscometer, the viscosity of isolated and modified galactomannan (1% w/v) was measured at 25°C.

Bulk density

Table 4: Pre-compression parameter of formulation F1-F9.

Batch	Hauser's Ratio	Angle of Repose (Degrees)	Compressibility Index (%)	Bulk Density (gm/cc) *	Tapped density (gm/cc) *
F1	1.20	30.98±0.88	19.52	1.55±0.018	1.014±0.017
F2	1.25	28.42±0.65	18.55	1.22±0.027	0.99±0.025
F3	1.23	25.01±0.53	16.81	1.05±0.015	0.841±0.020
F4	1.15	29.12±0.70	13.61	1.00±0.014	0.964±0.034
F5	1.13	27.02±0.70	12.78	0.821±0.016	0.912±0.036
F6	1.11	25.65±0.56	11.11	0.667±0.019	0.841±0.040
F7	1.14	26.12±0.70	11.61	0.750±0.014	0.684±0.034
F8	1.12	25.41±0.52	10.06	0.636±0.035	0.660±0.037
F9	1.10	24.02±0.70	10.78	0.525±0.027	0.512±0.036

* Indicates (N=3) ± SD

Table 5: Evaluation of Ondansetron OCT.

Batch	Thickness (mm)*	Hardness (Kg/cm^2) *	% Weight variation	% Friability	Disintegration Time Seconds	Wetting time	Drug content (%)*
F1	2.38±0.01	1.12±0.17	2.032	1.17	245	46.80±0.33	94.76±0.17
F2	2.42±0.03	1.05±0.24	1.099	1.05	125	38.55±0.45	95.69±0.21
F3	2.17±0.03	1.04±0.21	1.036	0.93	88	28.60±0.55	96.33±0.15
F4	2.16±0.04	1.05±0.22	1.088	0.99	111	42.60±0.29	97.42±0.18
F5	2.18±0.01	1.07±0.15	1.023	0.78	58	32.75±0.28	95.26±0.16
F6	2.20±0.01	1.08±0.18	1.001	0.66	29	25.87±0.28	98.64±0.12
F7	2.17±0.03	1.05±0.25	1.36	0.88	79	46.76±0.26	95.45±0.19
F8	2.18±0.01	1.07±0.15	1.006	0.66	51	35.57±0.25	96.26±0.16
F9	2.38±0.03	1.04±0.21	1.036	0.52	30	29.76±0.49	96.33±0.15
MF1	2.646±0.071	1.05±0.151	1.37	0.88	25	21.73±0.32	94.42±0.19
MF2	3.00±0.071	0.97±0.216	2.089	0.51	28	22.77±0.22	95.42±0.19

The powder blend is filled into a measuring cylinder, and the starting mass is recorded to get the measurement. The bulk volume is the original volume.[18]

The volume occupied by the powder blend was determined by following formula:

Bulk density = Mass /Bulk volume

Tapped density

It is the ratio of the powder's tapped volume to its overall mass. Filling blend into the graduated cylinder allowed for its determination. On the tougher surface, the cylinder was gently tapped 500 times, and the amount of powder that emerged was recorded. Tapping was done 1000 times, and the tapped volume was recorded whenever there was a change of greater than 2% between two volumes.[19]

Tapped density = Mass/volume of powder (Tapped)

The angle of repose (θ)

Powder flow test apparatus was used to calculate this flow property. A vertically adjustable funnel was used to pour the mixture through until the desired cone height (h) and cone radius (r) was reached. Angle of repose, Carr's index and Hausner's ratio was determined using standard formulas.

Post-compression studies

Ondansetron tablets for oral disintegration were formulated from isolated and modified CP seed galactomannan using the direct compression method. Table 2 presents the composition of the tablet. The evaluation of each formulation underwent a series of tests.[20]

Hardness

Tablets' hardness was tested by Monsanto Hardness tester. The tester's two jaws were positioned between the tablet's oblong axes. The value should be 0 kg/cm2 at this stage. The uniform stress was applied while rotating the knob.

Thickness

Vernier caliper used for thickness determination of the formulated tablets.

Friability

Eight tablets were tested for friability using a friabilator, Crosslab. Previously weighed tablets were put within friabilator chamber, which subjected them to the combined effects of shock and abrasion by spinning a friability chamber at 25 rpm speed and falling the tablets six inches away with each revolution for 100 revolutions, final weight of eight tablet was recorded and the tablets were pulverized. The % friability determined by the formula as follows,

Friability (%) =

[(Initial Wt-Final Wt)/Initial Wt] X 100

Wetting time

Wetting time was determined and reported.[21]

Disintegration time

The digital tablet disintegration tester from Electro Lab was used to conduct the in vitro disintegration test. In order to keep the tablets from escaping the tubes while they were in use, six tablets from each code were put into the six tubes of the basket. A disk was then placed over the tablet. The baskets were dipped in one litter beaker filled with 750 ml of distilled water at temperature 37±0.5 °C. The assembly was adjusted vertically by 2-3 inches, and the time at which the crushed tablets completely passed through the basket was noted.[22]

Dissolution

Dissolution study apparatus USP- paddle type was used for in vitro dissolution investigations in compliance with official guidelines. The 900 ml of 0.1N HCl having pH 1.2 dissolution medium was kept at temperature 37±0.5 °C. A tablet was kept in dissolution beaker and the paddle was allowed to rotate at 50 revolutions per minute at constant temperature 37±0.5 °C. Five millilitre aliquots were taken at intervals of thirty, sixty, ninety, one hundred, and eighty-one seconds, respectively, by heating the previously heated dissolving media to 37±0.5 °C. UV absorbance was taken used to evaluate the medication concentration.[22]

RESULTS AND DISCUSSION

Extraction and etherification of seed galactomannan

Extracted *CP* seed galactomannan was amorphous and brownish in colour. Percentage yield of extracted seed galactomannan was 11.66 %. Light brown colouredCM-*CP* seed mucilage chemically synthesized (% yield = 60.55 %).

Results of phytochemical screening

Phytochemical screening for for extracted and carboxymethylated *CP* seed galactomannan identified that tannins, alkaloids, glycosides, and starch were absent and test for mucilage and carbohydrates was present. Polysaccharides content was determined to be 62.23 ± 3.5% w/w for extracted galactomannan and 55.33 ± 2.5 % w/w for carboxymethylated galactomannan (**Table 3**).

Estimation of carboxymethyl substitution

The *CP* seed galactomannan was carboxymethylated by alkalizing the kernel powder and then carboxylation using an aqueous solution of monochloroacetic acid and NaOH. Increased temperatures during reaction up to 80°C have an impact on the carboxymethylation reaction process. Enhanced the degree of substitution by successful reactant collisions, which promotes reaction molecule diffusion and mixing.[23]

As the temperature rises, the degree of carboxymethyl substitution drops, possibly as a consequence of a competitive mechanism involving the production of glycolate. Degree of substitution, 0.542 ± 0.050 was obtained from a reaction at 75 °C, confirming the effective synthesis of etherified *CP* seed galactomannan.

FTIR study for CP and CM-CP Galactomannan

Figure 2 displays the distinctive absorption bands for galactomannans as documented in the literature. The existence of the (polysaccharide) carbohydrate moiety in the mucilage is confirmed by these distinctive peaks. The region between 3062 and 2800 cm1 is indicative of -C-H stretching modes, while bands at 3746 and 3325 cm-1 are ascribed to O-H stretching. The broadband between 802 cm-1 and 1165 cm-1 is caused by the closely linked C-C-O and C-O-C stretching modes of the polysaccharide chain, whereas the region between 1395 cm1 and 1541 cm-1 relates to -CH2 deformation modes.[24] The modification of CP through carboxymethylation led to a broadening and a minor shift in the reduced intensity of absorption bands linked to OH stretching, suggesting that multiple OH groups underwent carboxymethylation. A new peak at 1037 cm^{-1} has emerged, which can be attributed to C-O-O stretching. A new carboxylic group was introduced into the CO structure, observed at 1573 cm^{-1}, which corresponds to the asymmetrical CO stretching of ether. The widening of absorption bands for the OH group, along with the appearance of new peaks associated with C-O-C and C-O stretching of ether, indicates that the protons of the hydroxyl group have been substituted by the carboxymethyl group. Figure 2 illustrates the IR spectra for CP and CMCP.

DSC study of modified mucilage

DSCendotherm at 247.40°C and exotherm at 115.70°C with a heat of fusion of 81.23J/g were visible on the CP DSC curve (Figure 5). CM-CP's DSC thermogram revealed an endotherm of 142.40°C, a glass transition temperature of

Table 6: Drug Release Results of Ondansetraon ODT.

Time (min)	F1 (%)	F2 (%)	F3 (%)	F4 (%)	F5 (%)	F6 (%)	7 (%)	F8 (%)	F9 (%)	MF1 (%)	MF2 (%)
2	15.3 ± 1.2	18.4 ± 1.3	20.5 ± 1.3	15.5 ± 1.3	20.5 ± 1.3	18.5 ± 1.3	24.5 ± 1.4	24.5 ± 1.4	22.5 ± 1.2	20.5 ± 1.4	24.5 ± 1.4
4	25.5 ± 1.4	29.2 ± 1.5	33.6 ± 16	20.6 ± 16	33.6 ± 16	29.6 ± 16	30.6 ± 1.6	30.6 ± 1.6	30.6 ± 1.6	32.6 ± 16	35.6 ± 1.6
6	35.4 ± 1.6	36.8 ± 1.7	42.7 ± 1.8	34.7 ± 1.8	42.7 ± 1.8	40.7 ± 1.8	40.7 ± 1.8	40.7 ± 1.8	45.7 ± 1.8	46.7 ± 1.8	49.7 ± 1.8
8	42.3 ± 1.8	45.7 ± 1.9	51.8 ± 2.0	45.8 ± 2.0	51.8 ± 2.0	51.8 ± 2.0	53.8 ± 2.0	56.8 ± 2.0	59.8 ± 2.0	56.8 ± 2.0	60.8 ± 2.0
10	48.2 ± 1.9	50.3 ± 2.0	58.9 ± 2.2	53.9 ± 2.2	58.9 ± 2.2	60.9 ± 2.2	61.9 ± 2.2	66.9 ± 2.2	70.9 ± 2.2	66.9 ± 2.2	71.9 ± 2.2
12	53.90 ± 2.2	58.90 ± 2.2	65.90 ± 2.2	60.90 ± 2.2	66.90 ± 2.2	69.90 ± 2.2	68.90 ± 2.2	78.90 ± 2.2	80.90 ± 2.2	75.90 ± 2.2	82.90 ± 2.2
14	63.60 ± 2.2	65.60 ± 2.2	70.60 ± 2.2	70.60 ± 2.2	70.90 ± 2.2	79.90 ± 2.2	70.90 ± 2.2	80.90 ± 2.2	84.90 ± 2.2	83.90 ± 2.2	88.90 ± 2.2
16	69.65± 2.0	70.65± 2.0	81.65± 2.0	77.65± 2.0	78.55± 2.0	88.55± 2.0	78.55± 2.0	84.55± 2.0	89.55± 2.0	89.55± 2.0	91.55± 2.0
18	72.56 ± 2.0	85.56 ± 2.0	85.56 ± 2.0	83.56 ± 2.0	83.56 ± 2.0	90.66 ± 2.0	86.66 ± 2.0	90.66 ± 2.0	93.66 ± 2.0	93.66 ± 2.0	95.66 ± 2.0
20	88.20± 2.00	88.20± 2.00	88.20± 2.00	90.20± 2.00	91.80± 2.00	90.90± 2.00	90.66 ± 2.0	93.66 ± 2.0	94.66 ± 2.0	98.90± 2.00	98.90± 2.00

241.50°C. Consequently, a drop in the heat of fusion and endothermic transition temperature along with modifications in thermal behaviour suggest that CP galactomannan undergone for carboxymethylation[25](Figure 3).

Zeta potential

Zeta potential values of CP and CM-CP (Figure 4) were -3.5 mV and −12.2 mV, respectively, suggesting anionic nature. The outcome demonstrated that the zeta potential changed to a more negative value could be because the anionic structure has a lot of -OH groups in it.

X- ray diffractometry (XRD)

The CP and CM-CP X-ray diffraction spectra are displayed in Figure 5. Two Theta Degrees of CP is identical to material with amorphous nature with distinct peaks emerging at 19.46◦(2θ). CM-CP XRD patterns show one distinctive or strong, concentrated peak on 35.74◦(2θ) showing crystalline nature. Consequently, the mucilage has undergone physical change as a result of chemical alteration.

Pre-compression evaluation parameter of formulation

In comparison to extracted galactomannna, the etherified galactomannnan had better compressibility and flow. The F1–F9 (**Table 4**) ready compression blend, which was created for direct compression exhibited ideal powder flow characteristics (Carrs Index and angle of report). Good free flowing qualities of the powder blend were shown by the pre compression parameter evaluation results (Table 4).

Post-compression evaluation parameter of formulation

Every tablet has a thickness and diameter that range from 3.00±0.071 to 2.16±0.04. Very tiny variations in thickness indicate that the powder blend was properly formulated and processed during the tablet-making process. (Table 5)**.** It was discovered that the tablets' hardness ranged from 0.97 to 1.12 kg/cm2. Friability was less than 1%, ranging from 0.97% to 1.17 percent, suggesting the tablets had better mechanical opposition except F1 and F2 formulated by using natural unmodified CP seed galactomannan. The range of the percentage drug content for bactches was 94.42 percent w/w to 98.64 percent w/w. Understanding the disintegrant's ability of swelling in aqueous environment requires an understanding of the wetting period. All formulations had a wetting time that ranged from 21.73 to 46.80 seconds.Table 5 also summarizes the disintegration time for all formulated batches F1–F9, MF1 and MF2. It shows that F6 exhibited DT equivalent to MF1 and MF2, while the unmodified CP tablet displayed DT in the range of 88–245 seconds, meaning that it is not appropriate for an instant release mouth dissolving tablet.

Compared to both ethical marketed formulation (MF1 and MF2) and formulations using croscarmellose sodium (F9) release rate of carboxymethyalated galactomannnan was nearly identicle makes it applicabledisintegrating agent for orally disintegrating tablet. Table 6 shows the release characteristics for the tablet batches F1-F9, MF1, and MF2. In vitro drug release rate from the formulations containing extracted and modified CP seed galactomannan was found comparatively equivalet to batches formulated with croscarmellose sodium as a disintegrating agent. *In-vitro* release profiles of the formulations F1-F9, MF1 and MF2 are represented in Figure 7 and Table 6.

CONCLUSION

In this work, CP seed galactomannan was subjected to a carboxymethylation chemical modification process. With the aim of enhancing the disintegration by synthesizing etherified CP seed galactomannan this study also extends its application in disintegrating agent ability forODT. For etherification of mucilage monochloroacetic acid in alkaline media was used. A variety of evaluation parameter such as spectral, thermal, microscopical, and crystallographic parameters, including DLS Particle size, zeta potential, FTIR, DSC, XRD, and other preformulation investigation parameters, were assessed for both extracted and chemically modified CP seed galactomannan. Ondansetron ODT was formulated in the laboratory by direct compression method by using extracted and modified galactomannan was under specified IP limits. Tablets based on CM-CP galactomannan exhibits good aqueous swelling ability lower disintegration time than unmodified galactomannan tablet. So, it was found that etherified CP seed galactomannan was a better disintegrating agent as compared with that of isolated natural galactomannan. Modified galactomannan possesses potent disintegrating action as nearly similar to that of that of sodium croscarmellose sodium (F9). The experimental findings demonstrated that tablet based on carboxymethylated CP seed galactomannan showed equivalent post compressional parameters with equally reduced disintegration time with that of two marketed formulations MF1 and MF2. The ethical marketed tablets results were superior to isolated raw galactomannan batches, while batches formulated with carboxymethylated CP seed galactomannan were nearly equivalent to marketed formulation in quality testing so this work suggested modified galactomannan as a suitable disintegrating agent for orally disintegrating tablet.

REFERENCES

1. Pawar H, Varkhade C, Jadhav P, Mehra K. Development and evaluation of orodispersible tablets using a natural polysaccharide isolated from *Cassia tora* seeds. Integrative Medicine Research. 2014; 3:2:91–98. doi: 10.1016/j.imr.2014.03.002.
2. Verma S, Rimpy, Ahuja M. Carboxymethyl modification of *Cassia obtusifolia* galactomannan and its evaluation as sustained release carrier. International Journal of Biological Macromolecules. 2020; 164:3823–3834. https://doi.org/10.1016/j.ijbiomac.2020.08.231
3. Tosif MM, Najda A, Bains A, Kaushik R, Dhull SB, Chawla P, Walasek-Janusz M. A Comprehensive Review on Plant-Derived Mucilage: Characterization, Functional Properties, Applications, and Its Utilization for Nanocarrier Fabrication. *Polymers*. 2021; 13:7:1066. doi: 10.3390/polym13071066
4. Dey P, Sa B, Maiti S. Carboxymethyl ethers of locust bean gum-a review. International Journal of Pharmaceutical Sciences; 2011;3:4–7.

5. Rodríguez-González S, Martínez-Flores HE, Chávez-Moreno CK, Macías-Rodríguez LI, Zavala-Mendoza E, Garnica-Romo MG, Chacón-García L. Extraction and Characterization of Mucilage from Wild Species of Opuntia. Journal of Food Process Engineering. 2014; 37:3:285–292. DOI:10.1111/jfpe.12084
6. Gheybi N, Pirouzifard MK, Almasi H. Ornithogalum cuspidatum mucilage as a new source of plant-based polysaccharide: Physicochemical and rheological characterization. Journal of Food Measurement and Characterization, 2021; 15:3:2184–2201. DOI:10.1007/s11694-021-00814-z
7. Nazir S, Wani IA. Functional characterization of basil (Ocimum basilicum L.) seed mucilage. Bioactive Carbohydrates and Dietary Fibre.2021;25:100261.
8. Bi YX, Sunada H, Yonezawa Y, Danjo K. Evaluation of Rapidly Disintegrating Tablets Prepared by a Direct Compression Method. Drug Development and Industrial Pharmacy. 1999; 25:5:571–581. doi: 10.1081/ddc-100102211.
9. PandaS, Nodagala H, Panchagnula US, Srinivasa RB. Formulation And Evaluation of Orodispersible Tablets (Odts) Of Diclofenac Sodium by Using Superdisintegrant from Natural Origin. International Journal of Applied Pharm. 2019; 11:6:190-197.
10. Sravanthi M, Srinivasa RB. Design and evaluation of ondansetron fast disintegrating tablets using natural polymers and modified starches as super disintegrants for the enhancement of dissolution. Journal of young pharmacists.2017; 9:519-524. DOI:10.5530/jyp.2017.9.101
11. Puri A, Dev D, Prasad DN, Hira S, Sharma R. Modified Okra gum with silica: A novel superdisintegrant for fast disintegrating tablet. Journal of Drug Delivery and Therapeutics; 2019;9:206-211.
12. Killedar SG, More H, Nadaf S, Pishawikar S. Optimization of Method for Determination of Swelling Factor of Ispaghula Seeds. Journal of Drug Metab Toxicol. 2016;7:3. DOI:10.4172/2157-7609.1000212
13. Motiwala, M. N, Dumore MN, Rokde VV, Bodhe MM, Gupta RA, Dumore NG, Danao KR. Characterization and antioxidant potential of Coccinia indica fruit mucilage: Evaluation of its binding properties. Bioactive Carbohydrates and Dietary Fibre, 2015;6:2:69–74.
14. Pawar H, Varkhade C. Isolation, characterization and investigation of Plantago ovata husk polysaccharide as super disintegrant. International Journal of Biological Macromolecules. 2014;69:52–58. doi: 10.1016/j.ijbiomac.2014.05.019.
15. Patro CS, padhy SK, dash A, sahu PK. Comparative study on effect of natural disintegrates in the formulation of cetirizine HCL oral disintegrating tablets. pharmanest, 7 (5) (2016), 3140-3150.
16. Chaudhari PD, Chaudhari SP, Kohle SR, et al. Formulation and evaluation of fast dissolving tablets of famotidine. Indian Drug Bombay 2005; 42: 641-649.
17. Ravi K, Swati P, Patil MB, Patil SR, Paschapur MS. Isolation and Evaluation of Disintegrant Properties of Fenugreek Seed Mucilage. International Journal of PharmTech Research. 2009; 1:4:982-996.
18. Patel NC, Shah VN, Mahajan AN, Shah DA. Isolation and Evaluation of Disintegrant Properties of Fenugreek Seed Mucilage. Journal of Applied Pharmaceutical Science.2011; 1:4:110-114.
19. Sharma BR, Kumar V, Soni P, et al. Carboxymethylation of Cassia tora gum. Journal of applied polymer science. 2003; 89:3216–3219. DOI:10.1016/S0144-8617(03)00132-2
20. U S A Pharmacopeial Convention. National Formulary 35. United States Pharmacopeia 40. Rockville: United States Pharmacopeial Committee; 2017;2886-8.
21. Cerqueira MA, Bourbon AI, Pinheiro AC, Martins J T, Souza BWS, Teixeira J A, et al. Galactomannans use in the development of edible films/coating for food applications. Trends in Food Science and Technology. 2011; 22:662-671. doi:10.1016/j.tifs.2011.07.002
22. Shobha MS, Vishu Kumar AB, Tharanathan RN, Koka R, Gaonkar AK. Modification of guar galactomannan with the aid of Aspergillus niger pectinase. Carbohydrate Polymers. 2005; 62:267-273.
23. Deore UV, Mahajan HS, Surana SJ, Wagh RD. Thiolated and carboxymethylated Cassia obtusifolia seed mucilage as novel excipient for drug delivery: Development and characterisation. Materials Technology. 2020;1–11. DOI:10.1080/10667857.2020.1800307
24. Kurra P, Narra K, Puttugunta SB, Kilaru NB, Basaveswara R. Development and optimization of sustained release mucoadhesive composite beads for colon targeting. International Journal of Biological Macromolecules. 2019;139:320–331
25. Agi A, Junin R, Abbas A, Gbadamosi A, Azli NB. Influence of Ultrasonic on the Flow Behavior and Disperse Phase of Cellulose Nano-particles at Fluid–Fluid Interface. Natural Resources Research. 2019; 29:1427-1446. DOI:10.1007/s11053-019-09514-4