

EVALUATION OF *MUSA ACUMINATA* FRUIT AS A NATURAL SUPERDISINTEGRANT FOR TABLET FORMULATION

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ABSTRACT

Objective: The objective of the present work was to develop and evaluate a new, low-cost effective superdisintegrant from *Musa acuminata* fruit for tablet formulation.

Methods: The study involved collection of *M. acuminata* fruit powdered and evaluated for physicochemical properties. Propranolol HCl was used as a model drug for tablet formulation. Different concentrations of *M. acuminata* powder were used as superdisintegrant, and orodispersible tablet is prepared and evaluated. In the present study, sodium starch glycolate was used as synthetic superdisintegrant for comparative study.

Result: The powder was dark brownish and did not change throughout the study. The percentage porosity of powder was found to be 42.88% and angle of repose of was found to be 33.69°. The solubility study shows that the powders are sparingly soluble in water and disperse into individual particles. Total ash and acid insoluble ash values of powder were found to be 2.61 and 2.11% w/w, respectively. The average weight of tablets was ranged from 101.42 to 103.52 mg and averaged hardness was found to be 3.4 kg/cm². Moreover, the tablets exhibited acceptable friability. Disintegration time of all formulations was found to be in the range of 22–80 s and wetting time was found to be 07–18 s.

Conclusion: From the study, it was concluded that *M. acuminata* powder in the range of 2–12% can be used as superdisintegrant in orodispersible tablet formulation and shall be preferred as having nutritive value as well as cost profit in the development of orodispersible tablet than synthetic polymer.

Keywords: *Musa acuminata*, Orodispersible, Superdisintegrant, Tablet.

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INTRODUCTION

Orodispersible or mouth dissolving or fast dissolving tablets are defined as a solid dosage form comprising a medicinal constituent, which instantaneously dissipates within seconds into the saliva when kept on the tongue [1]. Orodispersible tablets are like conventional tablets but are composed of special excipient called superdisintegrants, which facilitate them to break up the tablets within a minute in the mouth in the presence of saliva without any complexity of swallowing [2]. Disintegration plays a key role in improving the drug action and hence increases the patient compatibility. Disintegrants are the material that causes the rapid disintegration of the tablets into smaller particles that dissolve more quickly than in the absence of disintegrants. The term superdisintegrants, as its name proposes superior to disintegrants. Superdisintegrants are the substances which facilitate or increase the disintegration time (DT) even at low level, typically 1–10% by weight relative to the total weight of the dosage unit [3]. *Musa acuminata* is an evergreen perennial, not tree. The fruit bunch can have an average of 160 fingers with each finger around 2.5 cm–9 cm in size. The seeds of *M. acuminata* are around 5–6 mm in diameter. They are subglobose or angular and hard [4].

The objective of the present research work is to develop a new, low-cost effective, and easily available natural superdisintegrant from *M. acuminata* fruit to offer secure and effective drug delivery with better patient fulfillment.

MATERIALS AND METHODS

Materials

Propranolol hydrochloride was purchased from SD fine chem. Sodium starch glycolate, Microcrystalline Cellulose, Mannitol, and Magnesium stearate were purchased from Karnataka fine chem. Talc and Aerosil

were purchased from Loba chemie Pvt. Ltd.

Methods

Collection of *M. acuminata* powder

The unripened fruit was purchased from the local market. The fruit was cleaned, and the peel was removed. Then, the pulp was dried and powdered using a mixer. The powdered substance was collected and stored in well-closed container for further studies.

Physicochemical characterization of *M. acuminata* powder

The properties of *M. acuminata* powder were evaluated for percentage yield, solubility, loss on drying, total ash and acid insoluble ash, pH, angle of repose, bulk density, tapped density, Carr's Compressibility Index (CI), and Hausner's ratio (HR).

Solubility test

Solubility test was carried out using aqueous and non-aqueous solvents. In this test, various solvents are used and *M. acuminata* powder solubility was determined. A known amount of the solvent was put in a container then the *M. acuminata* powder was added and stirred vigorously.

Determination of true density

The true density is defined as the weight of the powder by true volume of the powder. Normally, true volume is determined as the volume of liquid it displaces; therefore, true density can be expressed as

True density, ρ_p = weight of the powder/volume of liquid it displaces by the powder [5,6].

Determination of bulk density and tap density

The bulk density of a powder is the ratio of the mass of an untapped powder sample and its volume including the contribution of the interparticulate void volume [7].

$$\text{Tapped densities: } = M/V_t$$

Where, M = Weight of powder, V_b = Volume occupied by powder without tapping, V_t = Volume occupied by powder after tapping [8].

Determination of percentage porosity

Whether the powder is porous or nonporous, the total porosity expression for the calculation remains the same. The percent porosity is expressed as

$$\% \text{ porosity, } \varepsilon = \text{true density-bulk density/true density} \times 100$$

Determination of HR and Carr's index

The CI and HR may be calculated using measured values for bulk density (ρ bulk) and tapped density (ρ tapped) as follows:

$$CI = 100 \times \rho \text{ tap} - \rho \text{ bulk} / \rho \text{ tap}$$

$$HR = \rho \text{ tap} / \rho \text{ bulk}$$

Determination of angle of repose

Angle of repose is defined as the maximum angle possible between the surface of the pile of powder and the horizontal plane. The angle of repose is designed by θ and given by equation

$$\tan \theta = h/r$$

Moisture content

The moisture content was then determined as the ratio of weight of moisture loss to weight of sample expressed as a percentage

$$\% \text{ MC} = (b-c)/b-a \times 100$$

a: Weight of weighing bottle, b: Weight of weighing bottle with 1 g of sample, c: Weight of weighing bottle with sample after drying at 105°C for 2 h [8,9].

Determination of total ash

3 g of powder accurately weighed, in a suitable tared dish. Incinerate the material by gradually increasing the heat, not exceeding 450°C, until free from carbon, cooled, and weighed. Total ash content can be calculated from

$$\% \text{ ash content} = (c-a)/b-a \times 100$$

Weight of empty silica crucible = (a), Weight of crucible with 3 g of sample = (b), and Weight of crucible with ash = (c)

DETERMINATION OF ACID-INSOLUBLE ASH

The ash was boiled with 25 ml of hydrochloric acid for 5 min, and insoluble matter was collected in a sintered crucible, or on an ashless filter-paper, washed with hot and ignited at about 500°C to constant weight [10].

Total acid insoluble ash can be determined by

$$\% \text{ Acid insoluble ash} = (W_2 - W)/(W_1 - W) \times 100$$

W: Weight of empty crucible, W₁: Weight of crucible with dried material, W₂: Weight of acid insoluble ash with a crucible.

pH determination

1% w/v solution of sample was prepared by shaking powder in water for 5 min, and pH is determined by digital pH meter.

Formulation of tablet

The calculated amounts of Propranolol HCL, superdisintegrant, microcrystalline cellulose, and mannitol as per the compositions in the table were accurately weighed, triturated well in a mortar and passed through sieve no 40. Finally, the correct amount of talc, magnesium stearate, and Aerocil was mixed with the powder blend for a further 2 min. The obtained powder blend was compressed using a compression machine with 6 mm SC punch by direct compression technique. The tablet weight was maintained to 100 mg. A minimum of 150 tablets were prepared for each batch (Table 1).

Evaluation of tablets**General appearance**

The prepared tablets were evaluated visually for their appearance, texture, and tablets defects.

Thickness

Thickness of the tablets was calculated by the use of Vernier Calipers.

Uniformity of weight

Twenty tablets were weighed individually and collectively. Average weight was calculated from the total weight of all tablets. The individual weights were compared with the average weight.

Hardness test

The hardness was tested using Monsanto hardness tester. The average of the five determinations was determined and reported.

Friability test (F)

Roche friabilator was used to measure the friability of the tablets. It was rotated at a rate of 25 rpm. 20 tablets were weighed collectively and placed in the chamber of the friabilator. After 100 rotations (i.e., in 4 min), the tablets were taken out from the friabilator and intact tablets were again weighed collectively. Permitted friability limit is 1.0%. The percent friability was determined by

$$F = (W_1 - W_2)/W_1 \times 100$$

Where, W₁ = Weight of the tablets before friability test, W₂ = Weight of the tablets after friability test [11].

Wetting time

The wetting time for the tablets is used as an indicator of the ease of tablet dissolution in the buccal cavity [12]. Six tablets were used for wetting time determination. A piece of tissue paper folded twice was placed in a small Petri dish (internal diameter = 6.5 cm) containing 10 ml of distilled water. A tablet was placed on the paper and the time for complete wetting of the tablet was determined.

DT

The *in vitro* DT of a tablet was estimated using disintegration test apparatus as per I.P. specifications. The time taken for the entire disintegration of the tablet with no residue remaining on the screen of basket rack was observed and noted [11].

In vitro drug release

In vitro, drug release studies of all the formulations were carried out using tablet dissolution test apparatus No 1 (as per I.P) at 100 rpm. 900 ml of 0.1 M hydrochloric acid was used as the dissolution medium with the temperature maintained at 37±2°C. Samples were withdrawn

Table 1: Formulation of tablet

Formulation ingredient	PTM1	PTM2	PTM3	PTM4	PTM5	PTM6	PST7
Propranolol HCL	20 mg						
<i>M. acuminata</i> powder (%)	2	4	6	8	10	12	-
Sodium starch glycolate (%)	-	-	-	-	-	-	12
Microcrystalline cellulose	24 mg	18 mg	16 mg	14 mg	12 mg	10 mg	10 mg
Mannitol	50 mg						
Talc	2.8 mg	4.7 mg					
Magnesium stearate	1 mg	3 mg					
Aerocil	0.2 mg	0.3 mg					
Each tablet weight	100 mg						

M. acuminata: *Musa acuminata*

Table 2: Physicochemical characterization of *M. acuminata* powder

Parameter	Result
Description	Dark brownish powder
True density	1.2 g/cm ³
Bulk density	0.714 g/cm ³
Tap density	0.769 g/cm ³
HR	1.0770
Carr's index (%)	7.15%
% porosity	42.88%
Angle of repose	33.69
Moisture content	6.64%
Total ash	2.61%
Acid-insoluble ash	2.11%
Loss on drying	7.64%
PH	7.1-7.6
Solubility	Sparingly soluble in water and glycerine. Insoluble in ethanol, chloroform, and ether. Practically insoluble in acetone.

M. acuminata: *Musa acuminata*, HR: Hausner's ratio

at a different time interval, diluted suitably with the same medium and analyzed at 290 nm using Shimadzu ultraviolet (UV) spectrophotometer. Limit: Not <80%.

Assay

A total of 20 tablets were crushed and weighed accurately a quantity of the powder containing about 20 mg of propranolol hydrochloride and shaken with 20 ml of water for 10 min. To this, 50 ml of methanol was added and shaken for a further 10 min and final volume was made to 100 ml by adding a sufficient amount of methanol and filtered. From the filtrate, 10ml was withdrawn and made to 50 ml with methanol and absorbance was measured at 290 nm using UV spectrophotometer [8].

RESULTS AND DISCUSSION

Physicochemical characterization of *M. acuminata* powder

The powder of the *M. acuminata* was dark brownish and did not change throughout our studies. The bulk and tapped density gave an insight on the packing and arrangement of the particles and the compaction profile of the materials. Porosity is estimates of the void (empty) spaces in solid substances and is a fraction of the volume of voids over total volume. Percentage porosity of *M. acuminata* powder was found to be 42.88%. The angle of repose, a conventional characterization technique for pharmaceutical powder flow was evaluated. Height of the granules forming the cone h and the radius r of the base were measured and calculated. Flowability is indicated based on the angle of repose. A value of <30° indicates "excellent" flow whereas >56° indicates "very poor" flow. The intermediate scale indicates "good" (θ between 31 and 35°), "fair" (θ between 36 and 40°), "passable which may hang up" (θ between 41 and 45°), and "poor which must be agitated or vibrated" (θ between 46 and 55°). Based on this, the angle of repose of powder was found to be 33.69 implying that *M. acuminata* powder had good flow property (Table 2).

HR is a measure of the interparticulate friction and important consideration in pharmaceutical powder flow properties. The HR of powder was found to be 1.07 implying that *M. acuminata* powder had excellent flow property. CI is significant in scale-up progression involving the materials as an excipient in pharmaceutical formulations. CI of *M. acuminata* powder was 7.15% implying that the powder had good flow property.

Moisture content of *M. acuminata* powder was found to be 6.64%. The total ash and acid insoluble ash values of *M. acuminata* powder were found to be 2.61 and 2.11% w/w, respectively. Ash value reflects the level of adulteration or handling of the drug. Adulteration by soli or other foreign is immediately identified as the total ash is usually composed of inorganic mixtures of carbonates, phosphates, silicates, and silica, therefore, the low value of total ash and acid insoluble ash obtained in this study indicated low level of contamination during the gathering and handling of crude *M. acuminata* powder.

1% w/v suspension of *M. acuminata* powder in water gives a pH of 7.1-7.6. The near neutral pH of *M. acuminata* powder implies that when used in uncoated tablets it may be less irritating to the GIT. It may be a useful application in the formulation of acidic, basic, and neutral drugs.

Knowledge of pH of an excipient is an important parameter in determining its suitability in formulation since the stability and physiological activity of most preparation depends on pH. The solubility of *M. acuminata* was performed using different polar and non-polar solvent, and the result shows that which are sparingly soluble in water and glycerin, insoluble in ethanol, chloroform, and ether, and practically insoluble in acetone.

Evaluation of blended powder

HR of blended powder was found to be in the range of 1.07-1.20 and for the optimized formulation code PTM6 the value was found to be 1.10 implying that powders have excellent flow property. HR is a measure of the interparticulate friction and important consideration in pharmaceutical powder flow properties. Carr's Index was found to be in the range of 7.31-16.67% and for the optimized formulation code PTM6 the value was found to be 9.50 implying that powders have excellent flow property. CI is significant in scale-up progression involving the materials as an excipient in pharmaceutical formulations. Angle of repose of blended powder was found to be in the range of 28.36°-36.68° and for the optimized formulation code PTM6 the value was found to be 28.36° implying that powders have excellent to flow property (Table 3).

Evaluation of tablets

The measured tablet weights ranged from 101.42 to 103.52 mg implying that tablets are within uniform weights and low deviations from the official specifications. Crushing strength has been said to be the ability of tablets to withstand pressure or stress during handling, packaging, and transportation and the average tablet hardness was found to be 3.4 kg/cm². Moreover, the tablets exhibited acceptable friability that was <1% in all tablet formulations. Tablet thickness has been said to vary with the density of the granules, applied pressure, and the speed of compression which, in turn, affects tablet disintegration

and dissolution and from the results, the tablets were observed to have uniform thickness across the concentrations used and this can be attributed to their similar bulk and tapped densities and to the same compression force used during compression.

DT is very important for an oral dispersible tablet which is desired to be <30 s. This quick disintegration supports swallowing and plays a role in drug absorption in a buccal cavity, thus helps bioavailability. DT of all formulations was found to be in the range of 22–80 s and wetting time was found to be 07–18 s from these result it was concluded that as the concentration of superdisintegrant increases DT and wetting time decreases. Among all formulations, PTM6 contain 12% of *M. acuminata* as superdisintegrants was best than all other formulation and suitable for oral dispersible tablet formulation as they have minimum DT and wetting time. *In vitro*, dissolution studies of the prepared tablet were performed in 0.1 N HCl, at 37±0.5°C and 100 rpm by paddle method. All the formulations are complies with the limit of not <80%. Form the dissolution study, it was concluded that as the concentration of superdisintegrant increases, the percentage release drug release also increases (Tables 4 and 5, Figs. 1 and 2).

CONCLUSION

From the present studies, it can be concluded that natural superdisintegrants are suitable for the orodispersible tablet formulation. *M. acuminata* as 12% w/w superdisintegrants showed better DT and percentage drug release than synthetic superdisintegrants. This study also concluded that *M. acuminata* can be preferred as superdisintegrants as they have nutritive value as well as cost-benefit in the development of orodispersible tablet than synthetic polymer.

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AUTHOR'S CONTRIBUTIONS

The author designed the work, developed the methodology, collected the data, and performed analysis work. The work was carried out at T. John College of Pharmacy, Bengaluru, Karnataka.

Table 3: Evaluation of blended powder

Formulation code	Angle of repose (θ)	Bulk density (g/cm^3)	Tapped density (g/cm^3)	HR	Carr's Index (%)
PTM1	36.68	0.476	0.571	1.20	16.67
PTM2	28.36	0.476	0.526	1.10	9.53
PTM3	37.47	0.500	0.571	1.14	12.49
PTM4	28.36	0.487	0.526	1.07	7.31
PTM5	29.61	0.526	0.588	1.11	10.49
PTM6	28.36	0.476	0.526	1.105	9.50
PST7	29.62	0.512	0.571	1.110	10.39

HR: Hausner's ratio

Table 4: Evaluation of tablets

Formulation code	AVG weight (in mg)	Hardness (kg/cm^2)	Friability (%)	Thickness (mm)	DT (s)	Wetting time (s)	Assay
PTM1	102.62±1.51	3.4±0.51	0.32	3.5	80±1.32	18±1.53	99.24
PTM2	101.42±2.08	3.2±0.42	0.47	3.5	65±1.21	14±1.50	98.44
PTM3	103.42±1.92	3.5±0.12	0.51	3.5	58±0.28	13±0.31	100.23
PTM4	101.42±1.73	3.7±0.17	0.58	3.5	42±0.23	11±0.28	101.42
PTM5	102.42±2.23	3.4±0.12	0.60	3.5	37±0.21	09±0.21	100.46
PTM6	101.42±2.12	3.4±0.18	0.61	3.5	22±0.24	05±0.18	100.43
PST7	103.52±2.12	3.4±0.17	0.73	3.5	27±0.22	07±0.20	103.65

DT: Disintegration time

Table 5: Comparative *in vitro* dissolution study

Formulation code	0 (min)	3 (min)	6 (min)	9 (min)	12 (min)	15 (min)
PTM1	0.0	54.22	61.11	72.23	76.25	80.42
PTM2	0.0	59.24	68.19	72.12	78.17	81.31
PTM3	0.0	64.14	72.19	78.20	81.26	85.29
PTM4	0.0	73.12	78.22	81.41	83.44	86.23
PTM5	0.0	80.14	84.19	88.16	88.34	89.39
PTM6	0.0	85.45	89.98	92.38	92.49	93.31
PST7	0.0	86.35	89.42	91.43	91.98	92.24

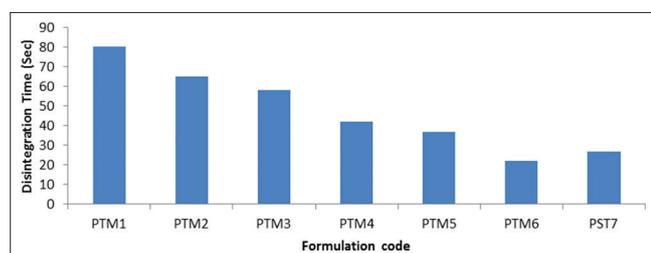


Fig. 1: Disintegration time for different formulation

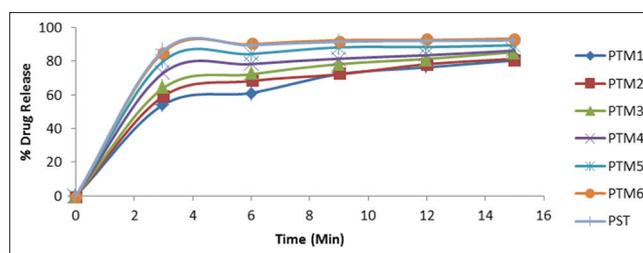


Fig. 2: Comparative *in vitro* dissolution study

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