Evaluation of Physicochemical character of *Trapa bispinosa* Roxb. starch as pharmaceutical excipient

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ABSTRACT

Trapa Bispinosa Roxb. is commonly grown throughout India, and locally known as Water chestnut. In the present study, physicochemical property of Water chestnut starch (WCS) was comparatively evaluated with official potato and maize starch. The granule shape is round to oval with the particle size diameter 18-130µm.The powder characteristic are nearby similar to the official starches. Hydration and swelling capacity of WCS is approximately similar which make this potential excipient in pharmaceutical formulation development.

KEYWORDS: *Trapa Bispinosa* Roxb, Water chestnut, starch, SEM, FT-IR.

INTRODUCTION

Pharmaceutical excipients are substances, other than the active drug, which are included in the manufacturing process or, are contained in the pharmaceutical dosage form. Excipients provide enhanced functionality to the pharmaceuticals; help in the drug development process. Pharmaceutical excipients make the products more functional at a lower cost, a benefit much desired by the pharmaceutical industry that is flooded with pressures to reduce costs. Starch a common constituents of higher plants, is the major form in which carbohydrates are stored. Starch is used in a wide range of food and non food based industries due to easy availability, low cost and unique property. In the pharmaceutical industry starches in native form are mainly used as binder, disintegrant and diluents. Corn, potato and cassava starches are official starches which are extensively used as binder and disintegrant in compressed solid dosage forms. In our laboratory starch from moth bean have been evaluated and established as multifunctional tablet excipients (Singh et al .,2009a;Singh et al .,2009b; Singh et al., 2009c; Singh et al., 2010a; Singh et al., 2010 b).

Water chestnut is an annual, floating-leaved aquatic plant found in freshwater wetlands, lakes, ponds, sluggish reaches of rivers in India (Rodrigues et al.,1964; Murthy et al., 1962). Water chestnut is locally known as Singhara an edible aquatic angiosperm, which belongs to the family Trapaceae. A few reports emphasized that this genus contains about 70% carbohydrates(Mazumdar.,1985) and could be used as potential alternative source for starch. Some researchers have evaluated its efficacy as tablet disintegrant(Bal et al.,1974). In our laboratory we evaluated this starch as binder in diclofenac sodium based tablets(Singh et al., In Press).

The present study describes comparative physicochemical property with those of official potato and maize starches, in respect to establish it as multifunctional excipient.

MATERIALS AND METHODS

Potato starch and maize starch were purchased from Loba Chemie, Mumbai, India. Fresh water chestnut (*Trapa Bispinosa* Roxb.) fruits were purchased from the local market of UP, India. The other chemicals used were of AR grade and water used was purified with Sartorius water purifier system.

Isolation of starch

The outer layer of water chestnut fruits were peeled off and the white part washed and cut into the pieces. The fruits were powdered in a blender and washed with distilled water. The washing steps were repeated until the supernatant was clear and the starch was free of color. The starch was then dried in an air oven at 45 ± 2^0C.

Scanning electron microscopy (SEM)

The morphology of the starch was observed using SEM. The sample was coated under argon atmosphere with gold coating and examined under the scanning electron microscope (JEOL, Japan).

Surface area and Particle size distribution

Surface area and particle size distribution were determined by laser light diffraction (Mastersizer 2000, Malvern instruments, Worcester, UK). The software from Malvern was used to calculate the surface area, median particle size (d_{50}), 10% (d_{10}) and 90% (d_{90}) particle size.

FT-IR Characterization

The FT-IR study was carried out to chemically characterize the water chestnut starch. Starch sample (5mg) was scanned from 4000-500 cm^{-1} at room temperature using FT-IR spectrophotometer (Bruker, Germany)

Micromeritics property

The tapped and bulk density of all the starches was determined using method described elsewhere. The true densities (ρ_t), of polysaccharides were determined by the liquid displacement method using xylene as the immersion fluid. The Hausner ratio was determined as the ratio of the bulk density to the tap density. Carr’s index was determined as the percentage ratio at which the WCS is packed down to the tap density. The Hausner ratio and the Carr’s index are frequently used as indication of the flowability of a powder (Aulton., 1996):-

$$\text{Bulk density } (\ell_{bulk}) = \frac{W_{bulk}}{V_{bulk}} \quad (1)$$

$$\text{Tapped density } (\rho_{tapped}) = \frac{W_{tapped}}{V_{tapped}} \qquad (2)$$

$$\text{Hausner ratio} = \frac{\rho_{tapped}}{\rho_{bulk}} \qquad (3)$$

$$\text{Carr's compressibility} = \frac{\rho_{tapped} - \rho_{bulk}}{\rho_{tapped}} \times 100 \qquad (4)$$

Flow property

To determine the flow property of all the starches angle of repose and flow rate method was used. To determine the flow rate 50 gm starch powder sample was poured through a funnel with internal diameter 9mm and the time taken was noted down. Angle of repose was determined using following formula [11]].

$$\tan\theta = h/r \qquad (5)$$

Where h is the height of powder heap, and r is the radius.

Swelling capacity

The swelling capacity of the starch powders were determined by the method described elsewhere (Lie et al.,2001) -

$$\frac{Vv}{Vx} \qquad (6)$$

Hydration capacity

This was determined according to the slight modified method described elsewhere (Komblum et al., 1973). Five gram (5g) of each of the powders (*Y*) was placed in a centrifuge tube and covered with 10mls of distilled water. The tube was shaken intermittently for about 2hours and left to stand for 30minutes before centrifuging at 3000 rpm for 10miutes. The supernatant was decanted and the weight of the powder after water uptake and centrifugation (*X*) was determined. Hydration capacity was calculated as;

$$\text{Hydration capacity} = \frac{X}{Y} \qquad (7)$$

Where (X) is weight of moist powder after centrifugation and (Y) is weight of dry powder.

Results and Discussions

The yield of starch from *Trapa bispinosa* Roxb. was 33.8%w/w (calculated based on 1 kg of fresh peeled fruit). It was found that carbohydrate was the major component of this fruit. Scanning electron microscopy revealed granular shape (Fig.1). The outer surface of most granules was smooth. The shape of starch granules appeared to be either oval or round shaped. The particle size distributions data are presented in Table 1, it states that the average particle size of WCS (18-130µm) is higher than the official starches. The range of particle size is also presented in Fig.2, which clearly reveal the higher particle size range in WCS. Due to irregular shape and higher particle size the surface area of WCS granule is lower than the official starches (Table.1). The powder characteristics of all the starches are shown in Table.2. FT-IR spectrum of native starch exhibited typical band at 3474 cm^{-1} for O-H stretching, 2850 cm^{-1} for CH2 anti-symmetric stretching, 1637 cm^{-1} for adsorption of water molecules and 1019 cm^{-1} for C-O stretching (shown in Fig.3). From the results of bulk, tapped and true density, WCS exhibited high values as compared to other starches. This could be due to its irregular shape and higher particle size, this result into less close packing of the starch powder. Similar results were found for its derived properties. The WCS showed poor flow, it could be also due to its large particle size and oval shape. The pH of the WCS is slightly acidic and nearby similar to official starches. Swelling and hydration parameter of the starches were indirect method to assess disintegrant potential of starches. The hydration capacity (Fig.4) of WCS is similar to PS but higher than MS. The swelling behavior of all the starches was changed at different temperature it could be due to gelatinization of starch at higher temperature (Fig.5). The swelling index of all the starches at different temperature is a proximally similar.

Conclusion

The starch obtained from *Trapa bispinosa* Roxb.has potential quality as an excipient in pharmaceutical formulation. As compared to potato and maize starch, it is characterized by oval shape and larger particle size, low flowability.The flow property of this starch could be improved by different means like adding lubricant. This starch possesses better hydration and swelling capacity, which make it as a potential disintegrant.

ACKNOWLEDGEMENT
The authors are thankful to IIIM, Jammu for carrying out FT-IR and Dr. B. Majumdar, Department of Pharmaceutical Sciences, Dibrugarh University for Particle size analysis.

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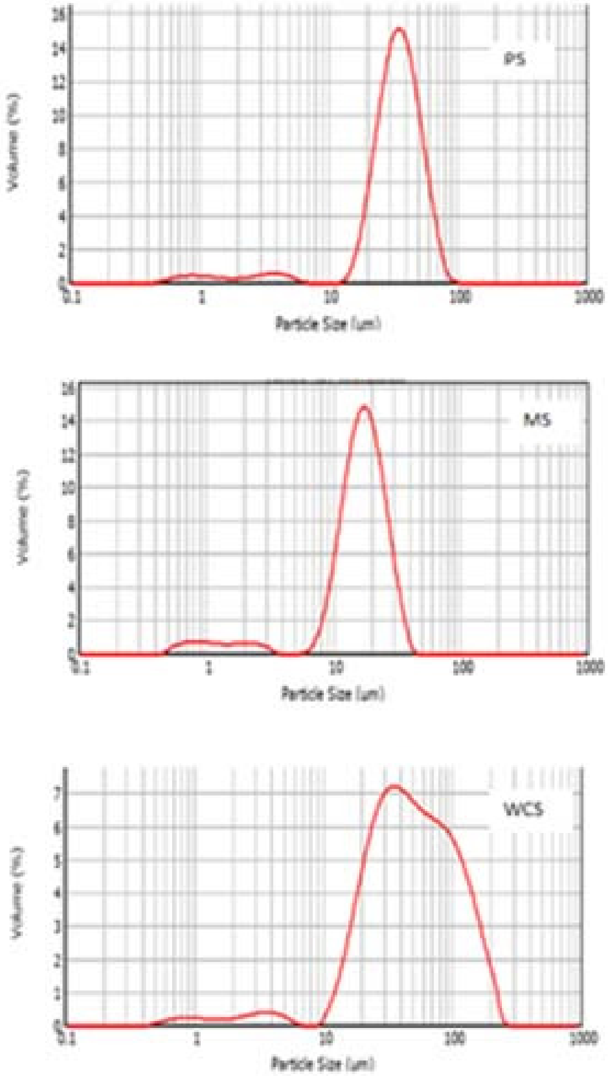

Figure.1. Comparative particle size distribution of starches.

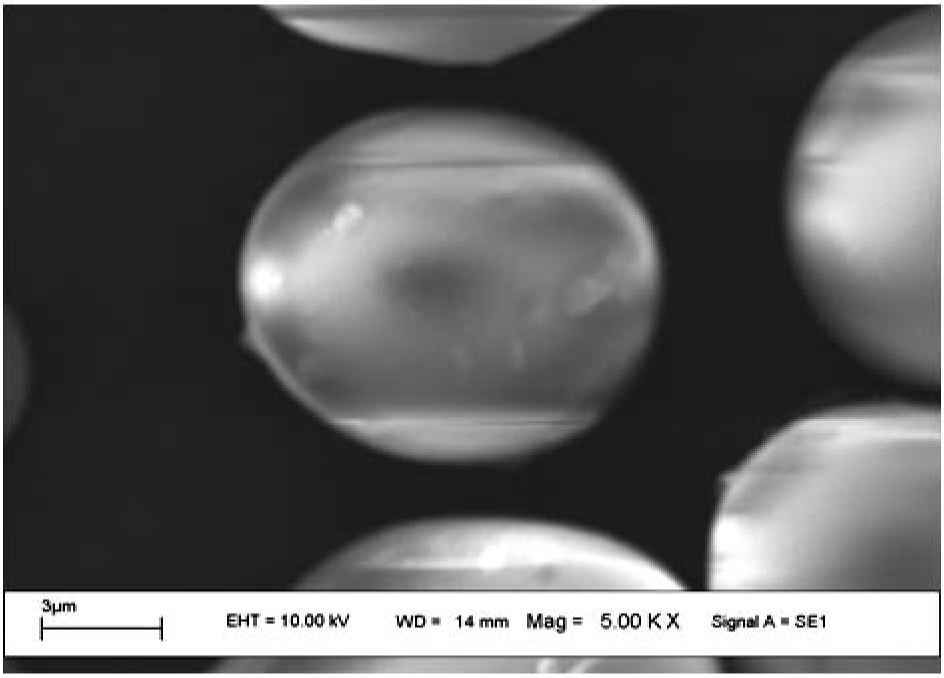

Figure.2. Scanning electron micrograph of Water chestnut starch.

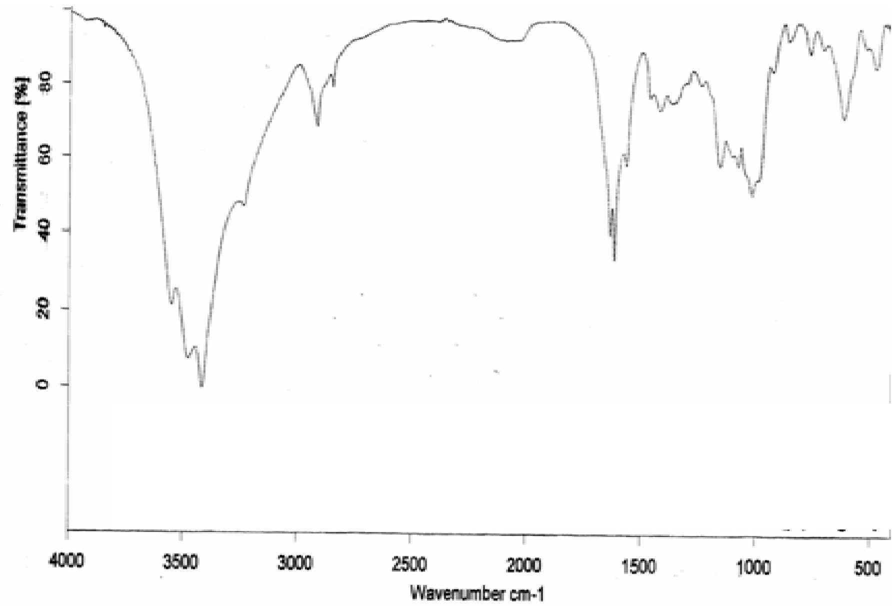

Figure.3. FT-IR of Water chestnut starch.

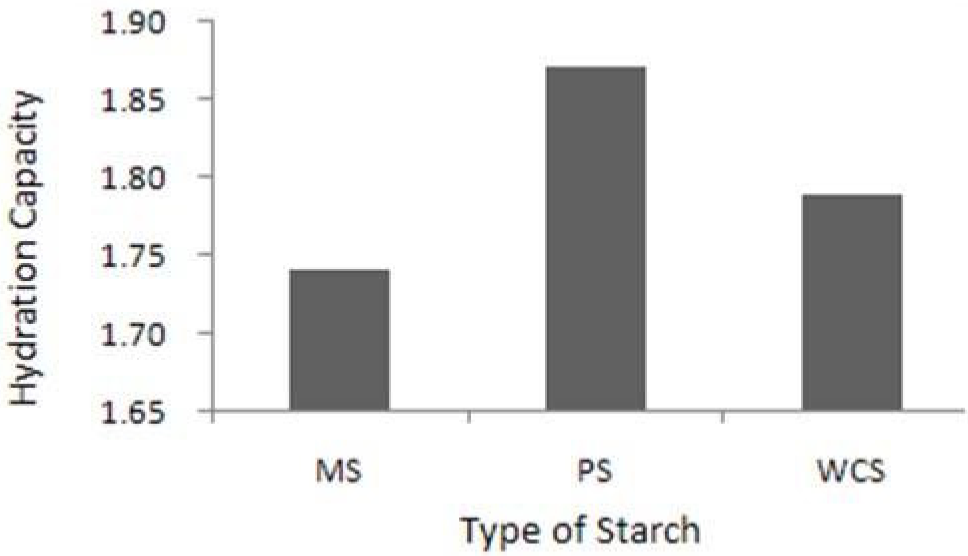

Figure.4. Comparative hydration parameter of Hydration capacity of starches.

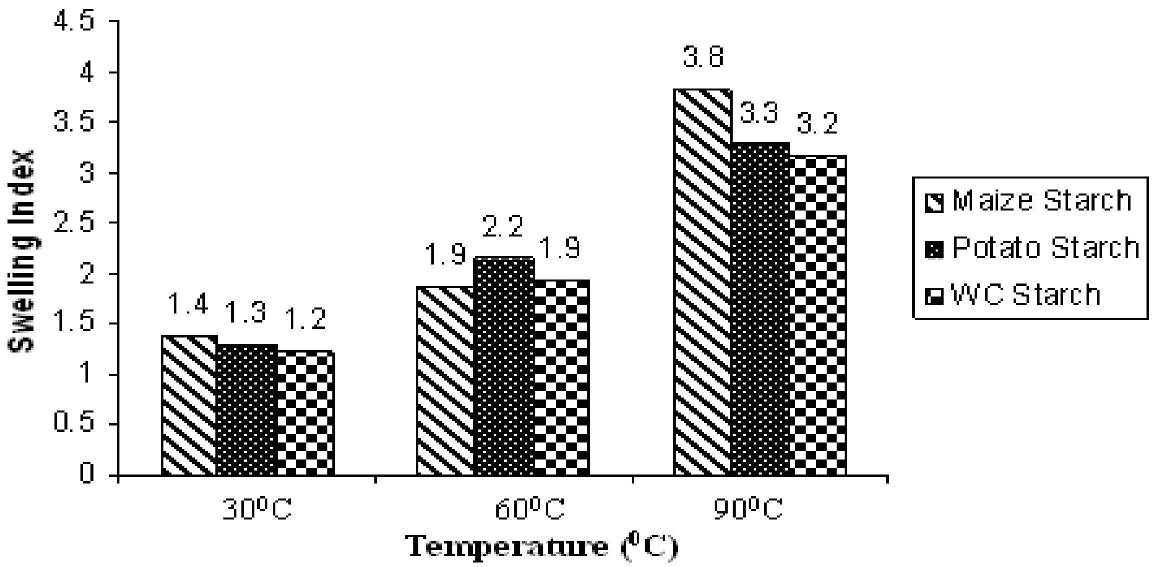

Figure.5. Effect of temperature on Swelling Index of starches.

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Table.1. Particle size distribution and surface area of starches.

Starch	$d_{10\%}$ (µm)	$d_{50\%}$ (µm)	$d_{90\%}$ (µm)	Surface area (m^2/g)
Maize	8.900	16.873	27.450	0.734
Potato	19.520	34.559	56.066	0.398
Water chestnut	17.966	47.275	131.563	0.282

Table.2. Comparative physicochemical parameter of starches.

Parameter	Starch		
	Potato	Maize	Water chestnut
Bulk density (g/ml)	0.58±0.20	0.44 ±0.15	0.59±0.15
Tapped density (g/ml)	0.83±0.15	0.68±0.20	0.88±0.28
True density (g/ml)	1.32± 0.23	1.29± 0.16	1.36±0.25
Hausner ratio	1.43±0.34	1.54±0.24	1.49±0.10
Compressibility index (%)	30.12±0.25	35.29±0.30	32.95±0.20
Angle of repose (θ)	43±0.20	46±0.41	51±0.32
Flow rate (g/sec)	0.52±0.10	0.58±0.24	0.71±0.21
pH	6.48±0.13	6.53±0.21	6.69±0.15

(All the values represents Mean±SD;N=3)