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Research Article

Evaluation of physicochemical character of *Ipomoea batata* starch as a Pharmaceutical excipient

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ABSTRACT

Ipomoea batata is commonly grown throughout India, and locally known as Sweet potato or Chilagada dumpa. In the present study, physicochemical property of sweet potato starch was comparatively with official potato and maize starch. *Ipomoea batata* starch is isolated from tubers and the yield is 13.5%. The granule shape is irregular and polygonal with the particle size diameter 10.5-26.3-40.83µm. The powders obtained were characterized for their particle size, particle size distribution. The organoleptic and physicochemical characterization such as viscosity, hydration capacity, swelling capacity, moisture sorption capacity, pH, flow rate and porosity, Carr's index and Hausner's ratio were evaluated. The total results were compared with the commercial maize and potato starch. The results suggest that the *Ipomoea batata* starch complies with the standards of maize and potato starch. The cost of production is less as compared to commercial starch as it is distributed throughout India. The powder characteristics are nearby similar to the official starches. Hydration and swelling capacity of sweet potato is approximately similar which makes this potential excipient in pharmaceutical formulation development.

Keywords: *Ipomoea batata;* Potato; Maize; Starch; Pharmaceutical excipient

INTRODUCTION

Pharmaceutical excipients are substances, other than active drug, which are included in the manufacturing process or, are contained in the pharmaceutical dosage form. Excipients play a very important role in the design of dosage forms, as the drugs cannot be administrated in pure form. Though there are number of excipients available, there is a need for new excipients with varied characteristics. This is because of introduction of novel drug delivery systems and new drug moieties. Excipients provide enhanced functionally 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 pressure to reduce costs. Starch is a polysaccharide, widely used as binder, diluent, glidant and disintegrating agent in oral solid dosage formulations and also as dusting powder and lubricant (Akhilesh V Singh.et al., 2011).

Commercially starch is obtained from maize (*Zea mays*), potato (*Solanum tuberosum*), rice (*Oryza sativa*), tapico (*Manihot utilissima*) and wheat (*Triticum aestivum*). Many Scientists working on various sources of starch and even on modified forms, so as to present a form that will be more useful in pharmaceutical manufacturing. Hence, the search for new starches is a continuous ongoing process worldwide. 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 nonfood-based industries due to easy availability, low cost and unique property. In the pharmaceutical industry starches in native form are mainly used as a disintegrant, binder and diluents. Corn, potato, Maize and cassava starches are official starches, which are extensively used as binder and disintegrant in compressed solid dosage forms (Syukri Y.et al., 2009).

Ipomoea batata is large perennial herb belongs to family Convolvulaceae, commonly known as sweet potato or chilagada dumpa. Commercially the plant cultivated for tubers in several of the country. The tubers are an important source of food. The tubers are excellent source of potassium, carbohydrate and fibers. The young leaves of sweet potato are rich in vitamin C and

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the roots are rich in starch composed of amylose (28%) and amylopectin (72%) (Anonymous The Wealth of India, 1996; Kiritikar KR and Basu BD, Indian Medicinal Plants, 2003).

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 forms Fine Chemicals, Mumbai, India. Fresh tubers of *Ipomoea batatas* were purchased from the local market in Hyderabad, Andhra Pradesh. The other chemicals used were of AR grade and water used was purified with Sartorius water purifier system.

Isolation and purification of *Ipomoea batatas*

The fresh tubers are subjected to through washings and peel off their skins. The resultant tubers were chopped and crushed in a blender to a pasty mass using sufficient amount of water. The pasty mass was diluted in water, filtered using muslin cloth to remove pulpy mass. The filtrate is collected and kept a side for 1h. The supernatant liquid is decanted to give crude starch. The crude starch was washed with water 2 times until free from fibers. The purity of starch is confirmed by homogeneity test with iodine. The resultant starch is dried in an oven, at 50ºC for 24 h.

Determination of Percentage Yield of *Ipomoea batata* Starch

The percentage yield of ipomoea starch was calculated relative to the initial weight of the tubers.

Determination of Physicochemical properties of Starches

The following physic chemical tests were carried out on the three starches.

Organoleptic properties

The colour, odour, taste, shape and texture of Potato starch, Maize starch and Ipomoea starch determined using sense organs.

Sieve analysis

Sieve analysis was performed for knowing particle size distribution. 5 g of *Ipomoea batatas* starch, which was milled previously in ball mill and maize starch were weighed. Starch was placed in a sieve shaker (Jayanth industries, Hyderabad) which has sieves of different sizes from sieve no: 4 -170 having size range 80 µm - 1785 µm. The sieve is shaken for 10 min in definite manner. The amount of the starch retained on the each sieve was weighed separately. Finally the size distribution of *Ipomoea batatas* starch was plotted and compared with maize starch (Indian Pharmacopoeia, 1996).

Particle size distribution

The particle size distribution and shape of the starch grains were determined by observing 100 particles for each starch grain under an optical microscope, from which the values of mean particle diameter were calculated. A photograph of the starches was taken (Indian Pharmacopoeia, 1996).

Micrometry

The diameter of the *Ipomoea batata* and maize starch grains were determined by using stage and eyepiece micrometers. The calibration factor was determined at high resolution (×450). The diameter of the starch grains was individually determined by preparing slides with the help of iodine solution. The frequency distribution curve was plotted based on the number of particles lying within the range (Anonymous, Quality Control Methods for Plant Materials).

Solubility test

1 gm. of *Ipomoea batata* starch was weighed and poured into a beaker containing 1mi, 2ml.10ml, 1L AND 10L distilled water at25oc and was stirred, and the solubility was observed. Same procedure was repeated for potato and maize starch.

Iodine test

1gm of the *Ipomoea batata* starch was boiled with 15 ml of water and allowed to cool. Then two drops of 0.1 N iodine solution were added to 1ml of the mucilage and the resulting colour was noted and same procedure was repeated for potato and maize starch.

Hydration capacity

A 10 ml volume of 10%w/v starch suspension was produced, mixed on a vertical mixer for 2 min and then centrifuged for 5 min. The supernatant was decanted and the sediment weighed. The hydration capacity was calculated as ratio of W2 to W1 where W1=initial weight of starch used and W2=weight of the sediment.

Swelling index

The swelling index is the volume in ml taken for swelling of 1 g of material under specified condition. 1 g of starch was accurately weighed and transferred into a 25 ml measuring cylinder and make up the remaining with water up to the mark. Shake the mixture thoroughly for every 10 min for 1h and allowed it to stand for 24h and final volume of the starch was determined.

Moisture sorption capacity

Two grams (2g) of the individual starch powders (W) were weighed and put into a tarred petridish. The samples were then placed in desiccator containing distilled water at room temperature and the weight gained by the exposed samples at the end of five-day period (Wg) was recorded and the amount of water absorbed (Wa) was calculated from the weight difference as Wa-Wg (Adamu B et al, 2012).

Moisture content

The moisture content of excipients can also influence the physicochemical properties of the solid dosage forms. Moisture content was determined by the following procedure

An empty dried glass stopper shallow weighing bottle was weighed accurately (w_1). 3 g of *Ipomoea batatas* starch was transferred into the bottle and considered it as w_2 (weight of empty bottle + starch). Transfer 2 g of water to moisten the starch and noted it as w_3. The bottle was kept in hot air oven at 100°C for 15 min. Then the weight of the resultant was noted as w_4. Repeat the procedure till a constant weight is obtained. Moisture content in wet solid is calculated on dry weight basis.

% Moisture content = Weight of water in sample / Weight of dry weight x 100.

Loss on drying:

Weigh a glass stopper shallow weighing bottle that has been dried at 105°C. Transfer 0.2 g of starch to the bottle, cover it and accurately weigh the bottle with the contents. Distribute the starch as evenly as possible by gentle shaking. Place the starch as loaded glass stopper bottle in the oven, remove the stopper and heat the oven to a temperature at 105°C. Dry the sample to constant weight. Close the bottle and allow it to cool to room temperature in a desiccators before weighing. Weigh the bottle and the contents (Adamu et al). Loss on drying was determined by formula,

$$\%\ LOD \frac{Weight\ of\ water\ in\ sample}{Total\ weight\ of\ wet\ sample} \times 100$$

Micrometry

The diameter of the *Ipomoea batatas* and maize starch grains were determined by using stage and eyepiece micrometers. The calibration factor was determined at high resolution (×450). The diameter of the starch grains was individually determined by preparing slides with the help of iodine solution. The frequency distribution curve was plotted based on the number of particles lying within the range.

Flow properties

The flow properties of *Ipomoea batatas* potato and maize starches were characterized in terms of angle of repose, Carr's index, Flow rate and Hausner's ratio to give qualitative assessment of the internal cohesive and frictional effects under low levels of external loading as might been applied in powder mixing or in the tablet die or capsule shell filling operations.

True density

The specific gravity bottled method was adopted, and xylene used as displacement fluid. The bottle was cleaned and filled with xylene; all spilled over liquid was wiped off with absorbent cloth. The weight of the bottle filled with xylene was noted as (a), the bottle was emptied and cleaned.2g of starch was weighed in to the specific gravity bottle, the weight of the starch powder was then carefully filled with xylene and the final weight of the bottle was noted as (b). Starch true density was calculated as follows,

$$\rho = \frac{w}{[(a+w)-b]s}$$

Where ρ is the particle density of starch and s is the specific gravity of xylene=0.86 (Adamu B et al, 2012).

Viscosity

A 2% w/v starch solution was prepared in water at 25^0C and the viscosity of *Ipomoea batatas* was determined and compared with maize starch (Brooke field viscometer).

Bulk and tapped densities

A 10gm weight of each starch sample was placed in a 50 ml measuring cylinder and the bulk volume was noted. After 500 taps the volume was retaken as tapped volume. The bulk tapped densities (BD and TD) were then calculated as follows;

$$BD = \frac{Weight}{Bulk\ Volume}$$

$$TD = \frac{Weight}{Tapped\ Volume}$$

Porosity

The powder porosity (E0 was calculated by using following formula

$$E = 1 - \frac{D_b}{D_t} \times 100$$

Where D_b is bulk density, D_t is true density of starch.

Flow rate

A 20g quantity of starch was placed in a flow rate meter (Erweka flow apparatus, Germany). The time of flow was determined with the aid of a stop clock and the flow rate calculated as the ratio of weight of starch to the time of flow.

pH

5 g of starch was taken, 25 ml of carbon dioxide free water is added to it and shaken for 60 seconds allowed it to stand for 15 min, and then the pH of *Ipomoea batatas* starch was determined and compared with maize starch.

Carr's index

10 g of starch powder was filled in a measuring cylinder (250 ml) and initial volume occupied by the powder (V_O) is noted. After 100 tapping's the volume was noted (V_r).

Bulk density = Mass/ volume

Tapped density = Mass/Tapped volume

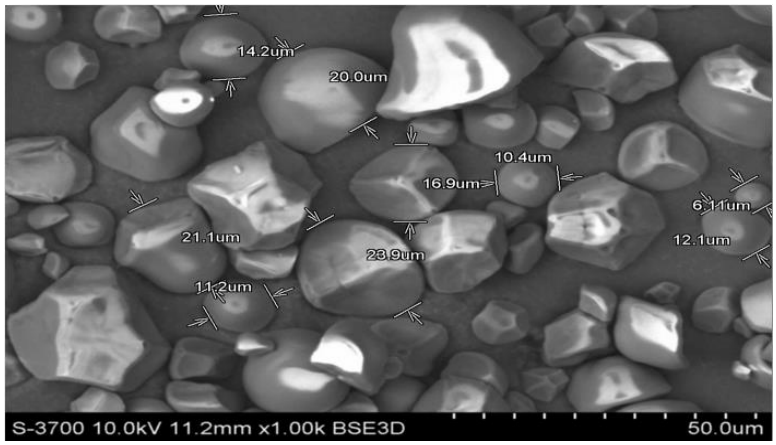

Figure 1: Represents the electronic photograph of *Ipomoea batatas* starch

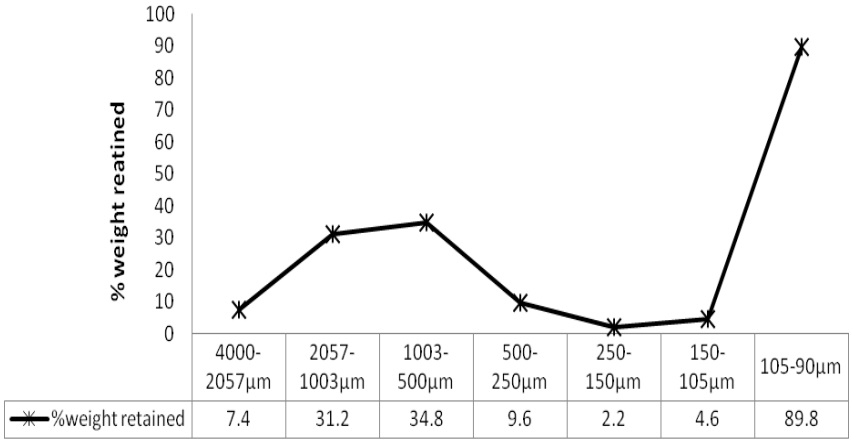

Figure 2: Represents the particle size analysis of Ipomoea starch (Sieve analysis)

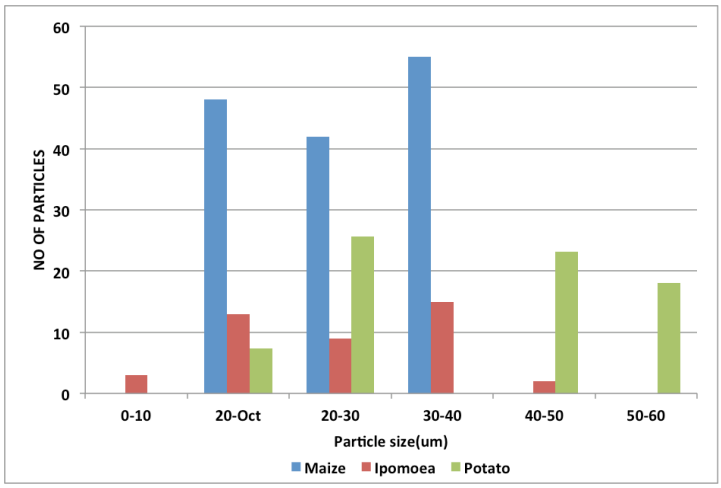

Figure 3: Represents Particle size distribution of starches by micrometry

The Compressibility index (CI) and the Hausner's ratios (HR) were determined from the bulk and tapped densities according to the relationships.

Carr's index = (Tapped density – Bulk density) / Tapped density x 100.

Hausner's ratio

It is the ratio of tapped density to bulk density

HR = Tapped density / Bulk density

Angle of repose

The dried glass funnels of 3 different sizes (small, medium, large) were taken and fixed firmly to the stand at a height of 2 cm from the orifice to the surface. After adjusting the height, graph sheet was placed on the surface and starch was transferred slowly with the help of spatula till the heap of starch touches to the orifice

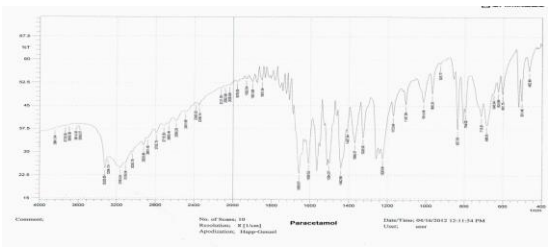

Figure 4: IR spectra of paracetamol

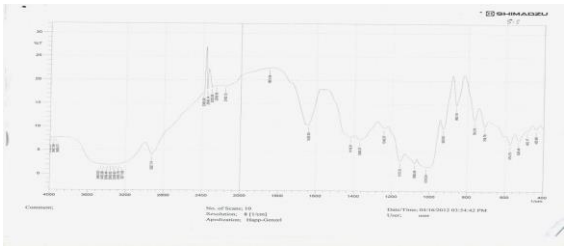

Figure 5: IR spectra of *Ipomoea batatas*

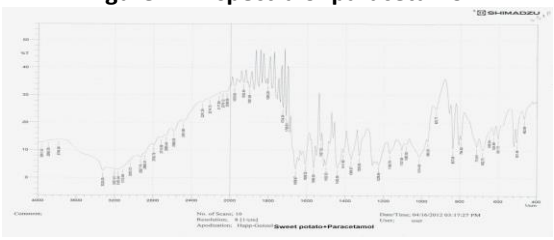

Figure 6: IR spectra of paracetamol with *Ipomoea batatas*

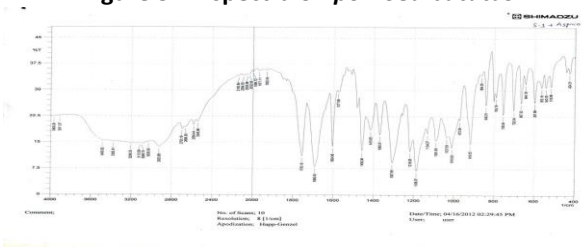

Figure 7: IR spectra of with aspirin *Ipomoea batatas*

Table 1: Shows the particle size analysis of *Ipomoea* starch (Sieve analysis)

Sieve no	Particle size range (um)	Amount of spheres retained	%Weight retained	Cumulative Percentage retained
8/16	4000-257	0.37mg	7.4%	7.4%
16/30	2057-1003	1.56 mg	31.2 %	38.6%
30/60	1003-500	1.74 mg	34.8%	73.4%
60/100	500-250	0.480 mg	9.6%	83%
100/150	250-150	0.11 mg	2.2%	85.2%
150/170	150-105	0.230 mg	4.6%	89.8%
		4.49 mg	89.8%	89.8%

Table 2: Shows Particle size distribution of starches by micrometry

Mean size range	Size range (µm)	Maize starch			*Ipomoea batata* starch			Potato starch		
		Avg. of 5 samples	%	% Cumulative	Avg. of 5 samples	%	% Cumula---tive	Avg. of 5 samples	%	% Cumulative
5	0-10	---	---	---	3	3	3	---	---	---
15	10-20	48	48	48	13	13	16	7.4	7.4	7.4
25	20-30	42	42	90	19	19	35	25.6	25.6	25.6
35	30-40	55	55	145	15	15	50	---	---	---
45	40-50	---	---	---	2	2	52	23.2	23.2	56.2
55	50-60	---	---	---	---	---	---	18	18	74.2
65	60-70	---	---	---	---	---	---	18.6	18.6	92.8

of funnel. The surface covered by the heap is marked. Same procedure was repeated by using 3 funnels. The angle of repose was calculated and determined accord---ing to the relationship (Indian Pharmacopoeia, 1996).

$$\text{Tan } \theta = 2h/d$$

Where, h = height of the cone; d = diameter of the cone.

Flow rate

A 20g quantity of starch was placed in a flow rate me---ter (Erweka flow apparatus, Germany). The time of flow was determined with the aid of a stop clock and the flow rate.

FTIR Compatibility study: The compatibility of parace---tamol, aspirin with *Ipomoea batata* starch was studied by IR spectra (Shimadzu, FTIR – 8400 s).

RESULTS AND DISCUSSIONS

Ipomoea batata starch was isolated from tubers and the yield is 13.8%w/w. It was found that carbohydrate was the major component of tuber. The size of the particle was expressed by the sieve number, which indicates the sieve number, which describes the diam-eter of the spheres that passes through the sieve aper---ture as asymmetric particle. The percent distribution of particle was tabulated in Table-1 and Figure 1**.**The *Ip---omoea* starch was, simple and compound, irregular and polygonal in structure and measures 10.5 – 26.3 -40.83

Table 3: Shows comparative results of physicochemical characters of *Ipomoea batata, potato* and maize starches

Parameter	Sweet potato starch	Potato starch	Maize starch
Source	*Ipomoea batatas*	*Solanum tuberosum*	*Zea mays*
Description	Coarse, fine, colorless powder	Coarse, colour less, Granular powder	Very fine colour less powder
colour	Colour less	Colour less	Colour less
odour	Odour less	Odour less	Odour less
Taste	Tasteless	Tasteless	Tasteless
Solubility	Insoluble in water and 95% ethanol	Insoluble in water and 95% ethanol	Insoluble in water and 95% ethanol
Iodine test	Positive	Positive	Positive
Hydration capacity	1.4	1.36	1.37
Swelling capacity	0.64	0.5	0.6
Moisture sorption ca---pacity (%w/w)	24	21	20.00
Moisture content (%)	4	6	5
Loss on drying (%w/w)	8	10.8	11.4
Size (µm)	10.5-26.3-40.83	15-38.6-74.6	14.7-19.5-29.4
Shape	Irregular polygonal	Ovoid/pear shaped pear shaped	Polyhedral or sub spher---ical

Table 4: Shows comparative results of flow characters of *Ipomoea batata, potato* and maize starches

Parameters	Sweet potato starch	Potato starch	Maize starch
Density (g/cm3)	1.022	1.4	1.5
Viscosity (mpa)	11.8	12.3	14.8
Porosity	22	26	30
Moisture content (%)	2.6	5.0	2.5
Flow rate (gm/sec)	0.8	0.52	0.58
PH	6.6	6.48	6.5
Carr's index (%)	24.7	13.4	31.02
Hausner's ratio	1.32	1.16	1.45
Angle of repose (Ø)	25.69	38.73	40.66
Bulk density (gm/cm3)	0.7	0.64	0.40
Tapped density (gm/cm3)	0.89	0.86	0.57

µm. The particle size distributions data are presented in table-2, Figure 2 and Figure 3. Some physicochemical properties of PS, MS and IBS are shown in table-3 and 4.The coarse texture of IBS an indication that it might possess a higher kinetic energy during mixing and hence, better flow compared to the MS and PS. A dark blue-black coloration of 3 materials on addition of 0.05 ml of 0.01M iodine is an indication that they are three starches as specified by I.P.

The most common feature of all theories of disintegra---tion is that water penetration must precede disintegra---tion 'The ability of material to take up water can be evaluated by hydration capacity; swelling capacity moisture sorption capacity. IBS had higher hydration capacity, swelling capacity and moisture sorption ca---pacity. Therefore, it might possess higher disintegrant property. IbS having low value of % LOD is an indication that it might form stable tablet compared to the MS and PS.

A low value of moisture content is also an indicative of suitability for formulation of hydrolysable drugs such as aspirin. For such drugs, IBS will be more suitable excipient. An evaluation study of *Ipomoea batatas* starch reveals that it complies with monograph of starches specified in I.P and is comparable with maize starch.

The density, viscosity and porosity of IBS were found to be1.022 m/sec^2, 11.8 mpa and the pH of IBS is slightly acidic and nearby similar to official starches.

The angle of repose of IBS (25.69) corresponds to a excellent flow while that of PS (38.73) and MS (40.66) corresponds to a poor flow. Also, the flow rate of IBS was higher than MS and PS. Therefore IBS has a better flow.

The Carr's index and Hausner's ratio are reflective of the difference in the bulk and tapped densities. While the Carr's index shows the aptitude of a material to diminish in volume, The Hausner's ratio is indicative of inter particulate friction. As the values these indices

decrease, the flow of the powder increases. Generally Hausner's ratio less than 1.25 corresponds to a good flow, and Carr's index of 10-20 corresponds to good flow. Based on these two indices IBS had better flow compared to the MS and PS.

IR studies confirmed the compatibility of *Ipomoea ba---tata* starch with the drug and excipients showed in Figure 5.*Ipomoea* starch appears to be promising excip---ient in preparation of tablet manufacturing as the yield of starch is more, cost of production is less and availa---bility of raw material is abundant. This suggests the *Ipomoea batata* starch can be explored commercially.

CONCLUSION

The starch obtained from *Ipomoea batata* has poten---tial quality as an excipient in pharmaceutical formula---tion. The physicochemical properties of IBS are compa---rable with those of MS and PS starch might be suitable for use as a diluent, binder and disintegrant. While the physicochemical properties of IBS are indicative of bet---ter flow and better disintegrant property as compared to potato and maize starch, it is characterized by irreg---ular shape and medium particle size, low flowability. The flow property of this starch could be improved by different means like adding lubricant. This starch pos---sesses better hydration and swelling capacity, which make it as a potential disintegrant.

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REFERENCES

Adamu B.I., Emmanuel O., Adamu B.I. Emmanuel O.Physicochemical character of *Borassus aetthiopum* starch. Asian J Clin Res, 5 (3), 2012 pp 132-134.

Akhilesh V Singh., Rakesh Kumar., Anudwipa Singh. Evaluation of Physicochemical character of Trapabispinosa Roxb. Starch as pharmaceutical excipient, Jounal of science and technology, 2 (3), 2011 pp 73-81.

Anonymous *The Wealth of India*: A Dictinary of Indian Raw Materials and Industrial Products, (Council of Scientific and Industrial Research (CSIR) New Delhi), pp. 238-247.

Anonymous, Indian Pharmacopoeia, (Controller of Publications, Govt of India), 1996 pp. A7, A-44, A-47, A-80, A-84, 711.

Carstensen, JT., Rhodes, C T, Drug Stability Principles and Practices, 3rd Edn, vol 107, Marcel Dekker publications: 2000, 612-613.

Kiritikar KR and Basu BD, Indian Medicinal Plants, (International Book Distributors, Dehradun) III. pp. 1714-1729.

Kokate, Practical Pharmacognosy, 4th Edn, vol10, VallabhPrakashan publications: 2004, 113-114.

Lachman L, Lieberman H and Keing JL, Theory and Practice of Industrial Pharmacy, 3rd Edn, vol 1, 1991: 685.

Liberman A, Lachman L and Schwartz B, Pharmaceutical Dosage Forms, *Tablets,* 2nd Edn, vol.2, 1999:896.

Raju, P. Y., Jayasri., Yasmeen R B, Chowdary H V, Satyanandam, Significance of Pharmaceutical Excipients, Journal of Innovative Trend: Pharmaceutical Science, 2 (6), 2011pp 191-201.

Singh, A.V. and Nath, L.K.2009. Evaluation of native Mothbean (*Phaseolusacontifolius* Jacq.) starch as tablet disintegrant, J Pharmacy Res. 2 (5), 878-880.

Singh, A.V., Nath L.K., Evaluation of moth bean starch as binder in compressed solid dosage form, Int. J.Pharm. Tech. Res, 1 (2), 2009pp 365-368.

Sink P J, Martin, Physical Pharmacy and Pharmaceutical Sciences, 5th Edn, New Delhi Wolters Kluwar Ltd: 2007, 424.

Syukri Y., Ratnadevi., The physic chemical characterstics of corn starch as excipients in slid dosage form formulation.Proceeding ISSTEC, Jogijakarta, 2009.

Wade A, Weller PJ, Hand book of Pharmaceutical Excipients, 2nd Edn. American Pharmaceutical Association:1994, 483-488.

Wallis TE, Text book of Pharmacognosy, 5th Edn, CBS Publications: 1985, 7-19.