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Original Article

Extraction and Characterization of the Starch from the Shoot of *Borassus aethiopum* as a Prospective Pharmaceutical Raw Material

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ABTRACT

The present study is aimed at extraction and characterization of the shoot of *Borassus aethiopum* starch as a prospective pharmaceutical raw material. *Borassus aethiopum* is used locally as a source of food due to its high carbohydrate content and claimed to have aphrodisiac properties. Maize starch BP was use as the reference standard. Starch was extracted using wet extraction method; physicochemical, phytochemical, proximate analyses and scanning electron microscopy were conducted on the starch as well as the reference standard. The results showed that *Borassus aethiopum* starch has a good yield and similar characteristics with maize starch BP. Therefore, *Borassus aethiopum* starch can be used as an alternative to maize starch BP in pharmaceutical industries as excipient.

Key words: Shoot, *Borassus aethiopum*, phytochemical properties, characterization, proximate analysis, maize starch BP.

INTRODUCTION

Starch is the second most abundant organic compound found on the earth. It is a polysaccharide composed of amylose and amylopectin molecules. Starch is used in a variety of industries including food, textile, cosmetics, plastic, adhessives, paper and pharmaceuticals [1]. Pharmaceutically, starch is widely used as fillers, binders, disintegrants [2], glidant [3] and lubricant [4]. Although corn starch is the most widely used starch in tablet formulation, in recent years, other botanical sources with good potential properties have been reported.

Borassus aethiopum belongs to the family Aracaceae, is an un- branched palm growing up to 20m tall characterized by a crown up to 8m wide[5]. *Borassus aethiopum* is wide spread throughout Africa like Benin, Burkina Faso, Congo, *Cote de Voire*, Democratic Republic of Congo, Ethiopia, Gambia, Ghana, Guinea Bissau, Kenya, Liberia, Mali, Mozambique, Nigeria, Senegal, Sierra Leone, South-Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe and in India and Malaysia. And its shoots, roots and fruits are utilized for medicinal purpose [6].

The aim of the present study is to extract and characterize the starch from the shoot of *Borassus aethiopum* as a prospective raw material compared to maize starch BP.

MATERIALS AND METHODS

Maize starch BP, measuring cylinder, beakers, glass funnel, test tubes, porcelain pestle, mortar, glass funnel, crucible, weighing scale, weighing balance, pH meter, centrifuge, moisture analyser, flow meter, vortex mixer, scanning electron microscope, melting point apparatus, sodium hydroxide (NaOH) pellets (BDH chemicals, Poole, England), Distilled water, N/50 Iodine, 99% Ethanol (BDH Chemicals, Poole, England), retort stand, plain sheet, hand gloves, stainless steel knife, stainless steel tray.

Shoot of *Borassus aethiopum* was obtained from Monday market, Maiduguri, Borno State was identified by a taxonomist in the Department of Botany, University of Maiduguri.

Extraction of starch from fresh shoot of *Borassusa ethiopum:* The method used in the extraction of starch by Madu *et al*., [7] was used with some modifications. The fresh shoots were peeled using a stainless steel knife, washed and all

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foreign materials were removed. The fibers on the shoots were removed, then the shoot was weighed and washed, the shoot was reduced to smaller sizes and pulverised using a grinding machine. Enough quantity of water was added to the pulp which was then passed through an 180µm sieve and allowed to stand for three hours. The filtrate was allowed to settle and decanted while the sediment (starch) was treated with 0.1N Sodium hydroxide was added to separate the starch and proteinous materials. Excess sodium hydroxide was removed by washing several times with distilled water.

The *Borassus aethiopum* starch extracted was air dried, weighed, size reduced using porcelain mortar, sieved through an 180µm sieve for uniformity of the starch particles and the percentage yield of the starch calculated.

Determination of organoleptic properties: The colour, odour, texture, and taste of the starch samples were observed by three panels consisting of six assessors and their observations were assessed and recorded.

Physicochemical tests

Solubility: Two grams of starch was poured into a test tube containing 3ml of 99% ethanol and cold distilled water separately and the solubility of each starch sample determined and recorded.

Iodine test: To a 2ml solution of starch in a test tube, 2 drops of N/50 iodine was added and shaken. The mixture was then warmed for some minutes and allowed to cool. Colour change observed was then recorded.

pH: The pH of 20% w/v slurry of each of the sample starch powder was determined using a pH meter (Jenway, Japan) and the results were recorded.

Moisture content: The moisture content of each starch sample powder was determined using a moisture analyzer (Sartorius MA 45, Germany). About 3g of each starch sample powder was evenly distributed unto the tray of the moisture balance operated at 130 °C for 3 hr. the value of three determinations was taken as the moisture content of the starches.

Angle of repose: The angle of repose of each sample of starch powder was determined using a glass funnel clamped on a retort stand 10cm away from the flat surface of the bench. Fifty (50) grams of each sample starch powder was placed into the funnel and allowed to flow freely forming a conical heap.

Bulk and tapped densities: These were carried out by measuring the volume occupied by fifty grams weight of each sample of starch powder in a dry measuring cylinder. The measuring cylinder was then tapped 50 times on a wooden table from the height of about 2cm.

Determination of Carr's Index: Carr's index was calculated from the results obtained from the bulk and tapped densities

Determination of Hauser's Ratio: Hauser's ratio was determined using the results obtained from both bulk and tapped density.

Hydration capacity: One gram (1 g) weight of each sample starch powder was weighed and poured in to a centrifuge tubes. A 10ml volume of distilled water was then added and mixed for 2 min. The mixture was then centrifuged for 10 min at 1000rpm. The supernatant obtained was decanted and the sediment weighed.

Re-dispersion time: Ten milliliter (10 ml) of water was carefully added to the sediment obtained from the determination of hydration capacity. The tubes were then shaken gently with the same intensity until the sedimented starch was completely re-dispersed. The time taken for the sediment to re-disperse was taken as the re-dispersion time.

Swelling capacity: The swelling capacity was determined by weighing 5g of each sample starch powder into a measuring cylinder and then tapped 50 times on a wooden bench from the height of about 2cm and the tapped volume recorded. The starch was then dispersed in 100ml of distilled water and allowed to stand for 18 hours [8]. The volume of the sediment formed was noted.

Ash Value: The method of Momin and Kadam [9] was used with slight medication. A 2g weight of the powder sample was poured into a nickel crucible which was initially heated at 105^{o}C to a constant weight and allowed to cool. The crucible with its content was then gently heated until it was moisture free and completely charred. The heat was increased gradually until most of the carbon vaporised. The sample was finally heated strongly at 600 ^{o}C until the residue is free from carbon (i.e. almost white). The crucible with its content was allowed to cool and weighed. The heating and cooling step was then repeated until the residue (ash) was constant.

Determination of flow rate of starch: Flow rate was determined using flow meter (Erweka, Germany) fifty grams, each, of the individual starch was allowed to pass through its orifice and

the time taken was recorded. Mean of three readings were taken as the flow rate of the starches.

Swelling capacity: A 0.1 g of starch sample was weighed into a test tube and 10ml of distilled water was added. The mixture was heated in a water bath at temperature of 50 °C for 30 min with continuous shaking. The test tube was centrifuged at 1500 rpm for 20 min in order to facilitate the removal of the supernatant which was carefully decanted and weight of the starch paste taken.

Gelatinization temperature: One gram of the starch sample was put in a 20ml beaker and 10ml of distilled water was added. The dispersion was heated on a hot plate. The gelatinization temperature was then read with a thermometer suspended in the starch slurry.

Emulsion capacity: One gram sample was dispersed in 5ml distilled water using vortex mixer for 30 sec. After complete dispersion, 5ml vegetable oil (arachis oil) was added gradually and the mixing continued for another 30 sec. The suspension was centrifuged at 1600 rpm for 5min. The volume of the oil separated from the sample was read directly from the tube. Emulsion capacity is the amount of the oil emulsified and held per the sample.

Foam capacity: One gram of the sample was homogenized in 10ml distilled water using a vortex mixer for 5 min. The homogenate was poured into a 100ml measuring cylinder and the volume recorded after 30 sec. The foam capacity was expressed as the percent increase in volume.

Browning and charring temperature: Some quantities of the starch sample were put into a capillary tube, the browning and charring was determined using a melting point apparatus (Electro-Thermal 9100, UK).

Scanning Electron Microscopy: A scanning electron microscope (SEM) model EVO/M10 was used to determine the particle size at 200X, 1KX and 2KX magnifications. The sample was imaged with the secondary electron detector at an accelerating voltage of 20kv, probe current PA and variable pressure of 50 Pa.

Phytochemical screening: Phytochemical screening was conducted as described earlier [10].

RESULTS AND DISCUSSIONS

The percentage yield of starch from fresh shoot of *Borassus aethiopum* was 36.85 % which indicates a substantial yield of starch from the sample. The yield was good for tubers and tuber-like plants growing within a year[11]. The Organoleptic properties which include colour, odour, texture and taste of the starch powders were carried out using sense organs. The starches showed similar organoleptic properties as described in compendium [12].

The iodine test which is a standard test all gave a positive result as on addition of 2 drops of iodine to the 2ml solution of the starch a blue black colouration appeared which disappeared on heating and re-appeared when allowed to cool. Thus, indicates that the samples were starch powders [12]. The moisture content of *Borassus aethiopum* starch was slightly higher than that of standard. However, they are all within the official limit [12].
Table 2 shows the results of the solubility of the starch powders in 99% ethanol and cold water which corresponded to the BP [12] specification. The starch powder samples were insoluble in both cold water and 99% ethanol.

The water hydration capacity as shown in Table 2 of the *Borassus aethiopum* starch was slightly lower than that of the maize starch BP. According to Omojola *et al*., [13], this might be attributed to its source and isolation method. Starches with high hydration capacity might have faster rate of disintegration. Caution must be taken because hydration capacity values should not be taken as an absolute indicative index of disintegrant powder [14].

According to Ohwoavworhua *et al*., [15] it was assumed that the hydration of a starch powder represents the water absorbed by the granule. This implies that the powders with high hydration and swelling capacity when incorporated in a tablet as disintegrant are expected to disintegrate rapidly. The result of hydration capacity of the starches (Table 2) shows that *Borassus aethiopum* starch has the highest hydration capacity than maize starch BP the result is also similar with emulsion capacity.
The pH of both *Borassus aethiopum* starch and Maize starch BP fall within the normal range (4.0-7.0). Angle of repose indicates the measure of flow properties, values of angle of repose ranging from 23°- 35° have poor flow properties [16]. The starch powders evaluated have low values as shown in Table 2 and considered to have good flow properties with *Borassus aethiopum* starch having the best flow property (with an angle of repose 20.80°). *Borassus aethiopum* starch has the highest bulk density than the maize starch B.P so also in the tapped density respectively. Hausner's ratio when less than 1.25 indicates good flow which *Borassus aethiopum* starch was greater while the

maize starch B.P has more than 1.5 which indicates poor flow [17]. The ash values of maize starch B.P. and *Borassus aethiopum* starch are shown in Table 2. Presence of organic salts e.g. organic salts like calcium oxalate found naturally in drugs as well as inorganic matter derived from the external sources [18]. Therefore, it's of great importance in the examination of the purity of powdered drugs.

The Swelling profile in Figure 1shows a general trend with an increase in temperature. Increase swelling power indicates that the starch is suitable as a disintegrant in pharmaceutical industries. This shows a general trend of increase with temperature and shows an indication of water absorption characteristic of starch powder as compared with maize starch BP standard which has a high swelling capacity. The solubility profile in Figure 2 shows an increase with increased temperature and hence it's indicative of how soluble the starches become when exposed to higher temperatures. Maize starch B.P. shows a high solubility profile throughout the temperature range with lower internal bonding [13].

The browning and charring temperatures (Table 3) of *Borassus aethiopum* starch was found to be higher than maize starch BP hence it can be heated to high temperatures without change in colour or charring. This quality will make it a better starch or alternative in industries that use starch at higher temperatures. The gelatinization temperature was at 68 °C which is acceptable because over heating or boiling is not required to get the starch in its gel form. Therefore, this indicates that both starches could be useful to industries like textile and adhesives which apply starch in its gel form.

The photomicrographs of *Borassus aethiopum* and maize starch at various magnifications in figures 3 and 4 respectively gave small to medium sized starch molecules oval in shape and arrangement. When compared to maize starch BP it agrees with the sizes observed and reported earlier [19]. It has normal particle size distribution and utilization in the food and pharmaceutical industries [13] which makes the *Borassus aethiopum* starch desirable in pharmaceutical, industrial and food applications.

CONCLUSION

It can be concluded based on the results obtained from the study conducted that, *Borassus aethiopum* starch has good properties compared to maize starch BP. It has the potentials to be used as excipient in pharmaceutical industries.

Table 1: shows the result of the organoleptic properties of starch powders

Parameters	Maize starch	Fresh shoot of *Borassus aethiopum* starch
Colour	White	White
Odour	Odourless	Odourless
Taste	Tasteless	Tasteless
Texture	Fine	Fine

Table 2: shows the result of the physicochemical tests for the three different starch powders

S/No.	Parameters	Maize Starch B.P	*Borassus aethiopum* Starch
1	pH	5.5	5.22
2	Moisture content (%)	9.67	11.26
3	Angle of repose (º)	27.89	20.80
4	Bulk density (g/ml)	0.48	0.69
5	Tapped density(g/ml)	0.63	0.86
6	Carr's index (%)	23.81	19.77
7	Hausner's ratio	1.31	1.25
8	Hydration capacity(min)	2.00	2.30
9	Swelling capacity	1.12	1.50
10	Solubility in 99% ethanol and cold water	Insoluble	Insoluble
11	Redispersion time (min)	2.40	2.50
12	Iodine test	Positive	Positive
13	Ash value	0.10	0.43

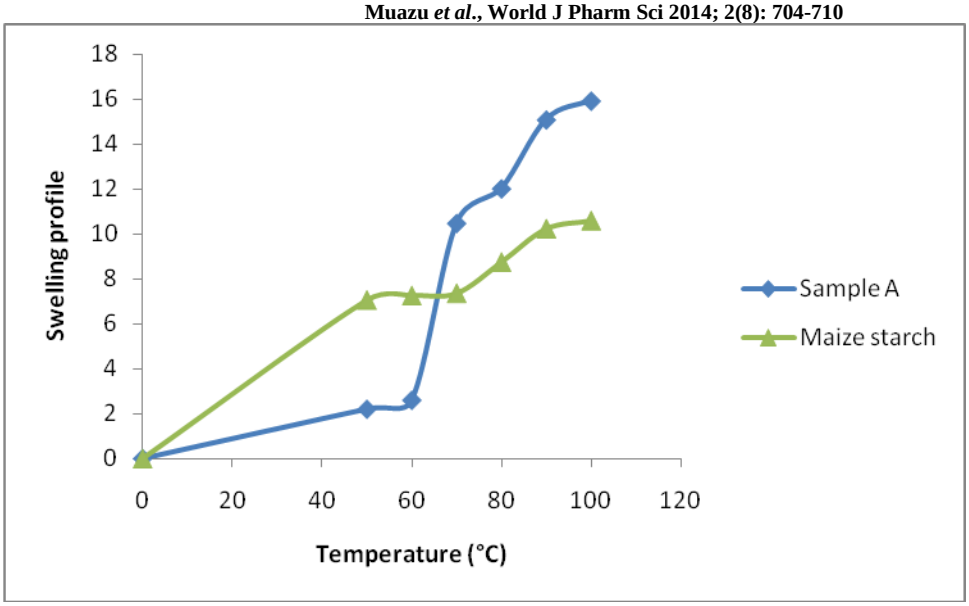


Figure 1: Swelling profile of *Borassus aethiopum* starch and maize starch BP (Sample A = *Borassus aethiopum)*

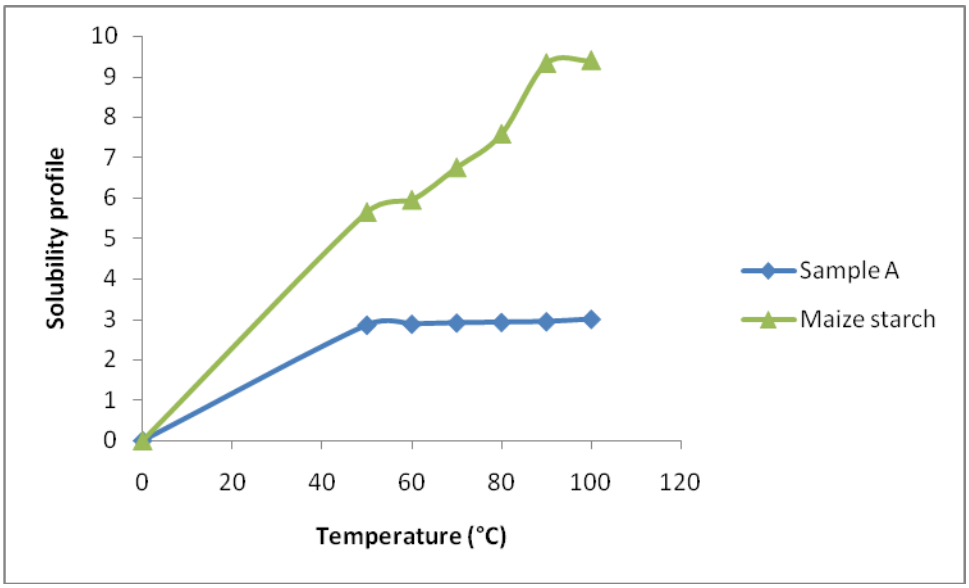


Figure 2: Solubility profile of *Borassus aethiopum* starch and maize starch BP (Sample A = *Borassus aethiopum)*

Table 3: Results of the Browning, charring, gelatinization temperature, foam and emulsion capacities of the Starch Powders

S/No.	Tests	*Borassus aethiopum*	Maize Starch
1	Browning temperature (°C)	250.6 - 251.8	223.5 – 230.8
2	Charring temperature (°C)	280.4 – 293.1	256.5 – 260.5
3	Gelatinization temperature (°C)	68	65
4	Foam capacity (%)	3	2.1
5	Emulsion capacity (%)	7.5	46

Table 4: Results of the phytochemical screening of starch powders

S/No	Test Screening	*Borassus aethiopum* starch	Maize Starch BP
1	Carbohydrate	+	+
2	Alkaloids	+	+
3	Tannins	–	–
4	Glycosides	–	–
5	Saponins	+	+
6	Sterols	+	+
7	Flavonoids	–	–
8	Resins	–	–
9	Cardiac Glycoside	–	–
10	Phenol	–	–
11	Terpenoids	–	–
12	Phlobatannin	–	–
13	Balsams	–	–
14	Volatile oil	+	+

Scanning Electron Microscopy (S.E.M)

Results of the analysis of the shoot of *Borassus aethiopum* starch and maize starch BP showing the morphology of the samples at different magnifications.

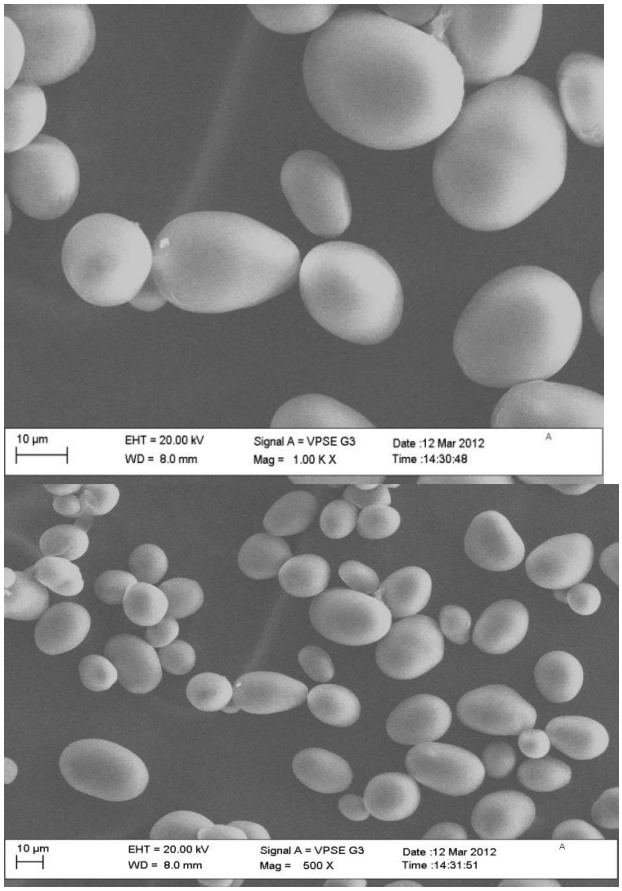
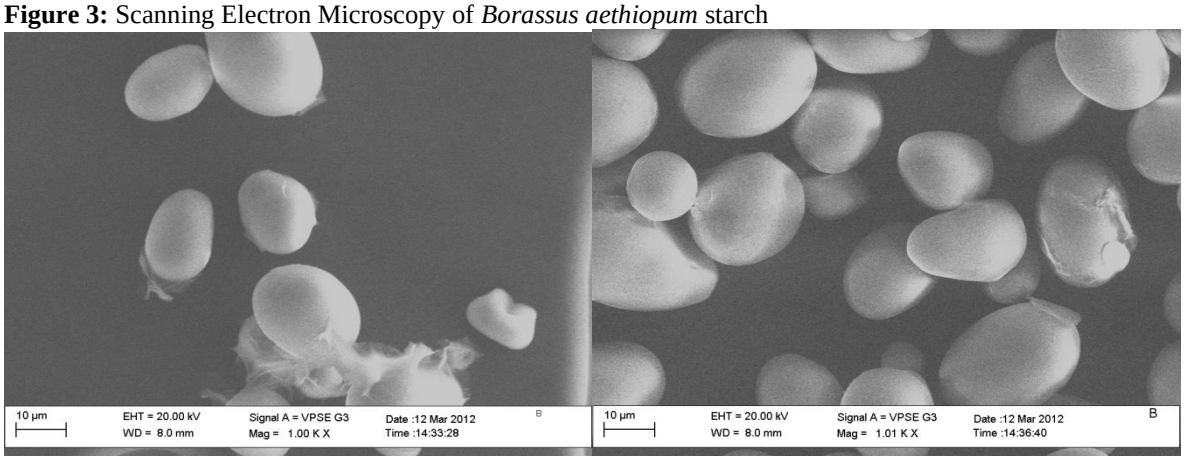


Figure 3: Scanning Electron Microscopy of *Borassus aethiopum* starch



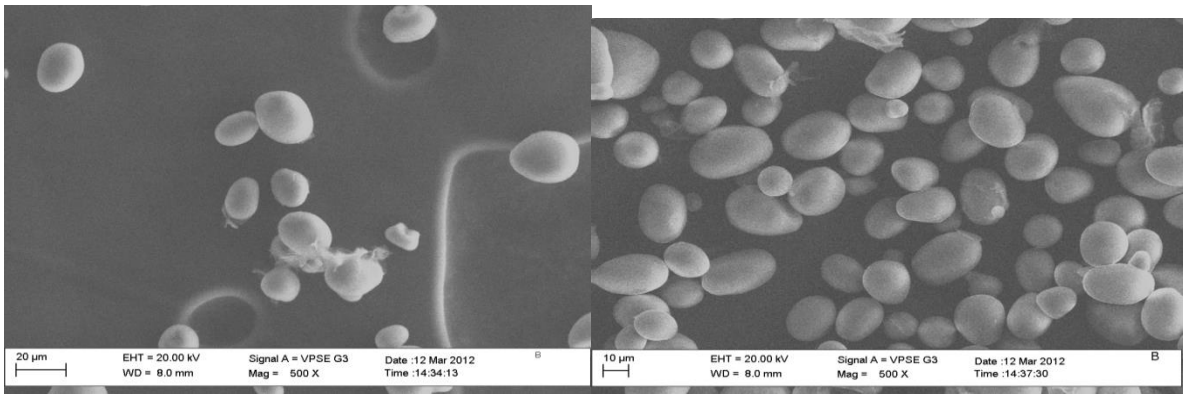


Figure 4: Scanning Electron Microscopy of maize starch BP

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