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Studies on functional and nutritive properties of starch isolated from muruchi

***Aguzue O. C., Akanji F. T., Tafida M. A., Adedirin O. A., Kamal M. J. and Abdulahi S. H.**

Chemistry Advanced Laboratory, Sheda Science and Technology Complex, Garki, Abuja, Nigeria

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ABSTRACT

Muruchi starch from young shoot of Borrasus aethiopum was isolated and its proximate composition, mineral composition, physicochemical properties and morphology were determined. The yield of the starch was 32.46% on a whole flour basis. Chemical composition of the starch; protein 0.31%, fat 0.64% and ash 0.33% suggests good purification during isolation. Sodium 240ug/g showed highest value and Manganese with 0.25ug/g lowest to the minerals analysed. Gelatinization temperature were 65^{o}C-75^{o}C. The starch exhibited high water binding capacity, solubility and swelling power which were all dependent on temperature.

Keywords: Muruchi, *Borrasus aethiopum*, physicochemical properties, morphology, Gelatinization.

INTRODUCTION

The plant: Borassus aethiopum has been described as a palm tree with huge fan shaped leaves. The various ethnic in Nigeria identify thus; the Hausa call it Ginginya, the Yoruba call it Agbon Olodu, the Ibos call it Ubiri and the Kanuri’s know it as Kemeletu. The uses of the root, shoot and fruits of the plant in traditional medicine for the treatment of various ailments have been reported (1,2). The profitability of the plant has also been studied (3).

The young germinating shoot or the hypocotyls known as Muruchi, which appears about two months after the seeds are grown, is harvested, being very starchy, and considered of great value in terms of famine. Muruchi is an important source of food for the rural of Northern Nigeria.

The people both young and old consume Muruchi either raw or boiled as food and they claim that it enhances libido in women and has aphrodisiac properties in men (4).

Starch is the only qualitatively important digestible polysaccharide and has been regarded as nutritionally superior to low molecular weight carbohydrate or sugar (5). The modern food processing industries are increasingly dependent on the use of both native and modified starches for manufacture of various fabricated food industries. Starches with specific properties are necessary to impact functionality desirable attributes (6).

Most reports on some lesser-known and unconventional crops indicate that they could be good sources of nutrients, starch and many have the potential of broadening the present narrow food base of the human specie (7).

This study provides information on the nutritional and some chemical composition of Muruchi starch, from a lesser-known source.

MATERIALS AND METHODS

Starch extraction

Fresh muruchi tubers were bought from a market in Kano state, Nigeria.

Starch was extracted by the method of Moorthy and Nair (8). The freshly bought raw Muruchi tubers were washed thoroughly, peeled, rewashed, cut into pieces and milled into pulp with 1% Sodium Chloride solution. The mixture was filtered through a muslin cloth and decanted starch was washed thoroughly using distilled-deionize water. The granules were allowed to settle for 5hrs and the water decanted off. The wet cakes of the starch was sun dried, ground into powder, weighed for starch yield calculation, packed in transparent sample bottles and stored at room temperature.

Proximate Composition.

The quantitative evaluations of crude fiber, moisture, crude fat and ash contents of the starch samples were determined using the standard method of AOAC (9). The nitrogen content was determined by the micro-Kjeldahl equipped with kjeltec digester and distilling system. The protein was estimated by multiplying the nitrogen content by 6.25. The crude fat was extracted with hexane for 8h in a soxhlet extractor. Carbohydrate was obtained by difference, 100% - (moisture + protein + fat + ash +fiber)%. The pH of the suspension containing the slurry of the starch in distilled-deionized water (1/10 w/v) was determined using Jenway 3510 model digital pH meter.

Chemical Composition

The method described by Wang and Kinsella (10) was used for bulk density determination. The water binding capacity was determined as reported by Akintayo (11).

Determination of the gelatinization temperature:

The method of Attama et al. (12) was used for determination of gelatinization temperature. A 1g quantity of the starch sample was put in 20ml beaker and 10ml of distilled water was added. The dispersion was heated in a steam bathe. The gelatinization temperature was read with a thermometer suspended in the starch slurry.

Determination of swelling power:

This was determined in accordance with the method described by Daramola et al. (13). To a 0.1g of sample in a weighed test tube was added 10ml of distilled water and heated in a water bath at temperature of 85°C for 30min with continuous shaking. In the end, the test tube was centrifuged at 1000xg for 15min in order to facilitate the removal of the supernatant which was carefully decanted and the weight of the starch paste taken. Swelling power was calculated as follows: Swelling power = weight of starch paste / weight of dry starch sample

Determination of solubility index:

Solubility index was evaluated by adding 1g of starch to 20ml of distilled water in a test tube. This was subjected to heating in water bath at a temperature of 85°C for 30m in. It was subjected to centrifugation at 1200xg for 20mins. A 10ml of the supernatant was decanted and dried to constant weight. The solubility was expressed as the percent by weight of dissolved starch from a heated solution (13).

The method of Jones oxidation was used for phosphorous determination by Vogel (14). All the results were average of triplicate analysis.

Elemental Analysis:

2g of the starch flour was weighed into 100ml pyrex beaker. 5ml of aqua-regia solution was added, the beaker was covered with a watch glass and the unit was heated at 95°C. Successive additions of the aqua-regia and heating were performed until no further reaction with the sample was noted. The sample was then allowed to digest until a white fume is seen after which the sample was removed and cooled. After cooling, the sample was filtered through whatman 41 filter paper to remove insoluble particles and brought to a final volume of 50ml with distilled deionized water. The final processed sample were quantitatively analyzed using Atomic Absorption Spectrophotomer(Fe, Cu, Pb, Zn, Mn and Ca) and Flame photometer (K and Na).

Scanning electron microscopy (SEM)

The morphology of the starch isolated was observed using SEM (EVO/MA/10). Before testing, the samples were mounted on the SEM stubs with double side adhesive tapes and then put under vacuum (without coating with

Platinum or Gold) to make the sample conductive. Scanning electron photomicrographs were taken at various magnifications to assure clear images.

Table 1. Proximate composition of the starch (on dry weight basis)

Parameter	Composition
Starch Yield (%)	32.46
Moisture (%)	14.90
Ash (%)	0.33
Crude Protein (%)	0.31
Crude Fiber (%)	2.00
Total lipids (%)	0.64
Carbohydrate (%)	79.06
Phosphorous (%)	0.34
Aqueous pH (at 28.8°C)	6.34

Table 2. Selected physiochemical properties of the starch

Parameter	Composition
Bulk density (g/cm^3)	0.91
Gelatinization(°C)	65-70
Swelling power(%)	8.70
Solubility (%)	16.70
Water-binding capacity(%)	55
Wettability (secs)	3.27

Table 3. Elemental composition of the starch

Elements	concentration (ug/g)
Copper	27.77
Calcium	3.50
Iron	6.75
Lead	nil
Manganese	0.25
Potassium	55.00
Sodium	240.00

Nil-not detected

RESULTS AND DISCUSSION

Chemical Composition

Table 1 shows the result of the proximate composition. Isolation of Muruchi starch from fresh Muruchi tubers gave a yield of 32.46%. This yield indicates appreciable accumulation of starch in the fresh tubers. The analyzed proximate composition of the Muruchi starch were, fat, Protein, ash, fiber, moisture and carbohydrate. The inorganic materials in the starch appears low as shown by the low ash content after the burning off of organic content.

The crude protein of the starch (0.31%) and fat (0.64%) are comparably low and high respectively as compared to potato(0.63% & 0.12%) and corn(0.88% & 0.2%) starch (15). The low protein and fat contents suggests good purity of the isolated starch and a possible raw material in food industry for glucose and fructose production, where Maillards reactions may be absent (16). The pH measurement showed that muruchi starch is acidic and comparable with previous pH values reported for tuber starches (17).

Solubility, Swelling Power, Gelatinization, Bulk density and Water binding capacity; as shown in Table 2.

The starch molecules are held together by hydrogen bonding in the form of crystalline bundles, called micelles (18). Thus, swelling power and solubility patterns of starches have been used to provide evidence for associative binding force within the granules (19). The ability of starch to absorb water is an indication of its moisture stability more specially in the food industry (20). Water binding capacity of starche also provides evidence of the degree of intermolecular association between starch polymers due to associative forces such as hydrogen and covalent bonding (19). Bulk density is a function of particle size; particle size is inversely proportional to bulk density. The relatively high value of bulk density of Muruchi suggests its suitability as drugs binder and disintegrant in pharmaceuticals.

Mineral Analysis

The minerals content are presented in Table 3. Sodium, Potassium and Copper gave the highest contents of 240, 55 and 27.77ug/g respectively. A significant amount of calcium(3.5ug/g) and Iron(6.75ug/g) was obtained, while on trace amount Zinc and Manganese was observed. Lead was not detected in the starch sample.

Scanning electron microscope analysis (SEM)

The morphology of the starch sample was studied using a scanning electron microscope. SEM images with different magnifications of the starch sample are presented in Figure 1a and 1b. It was observed that the shape of the granule ranged from round to elliptical.

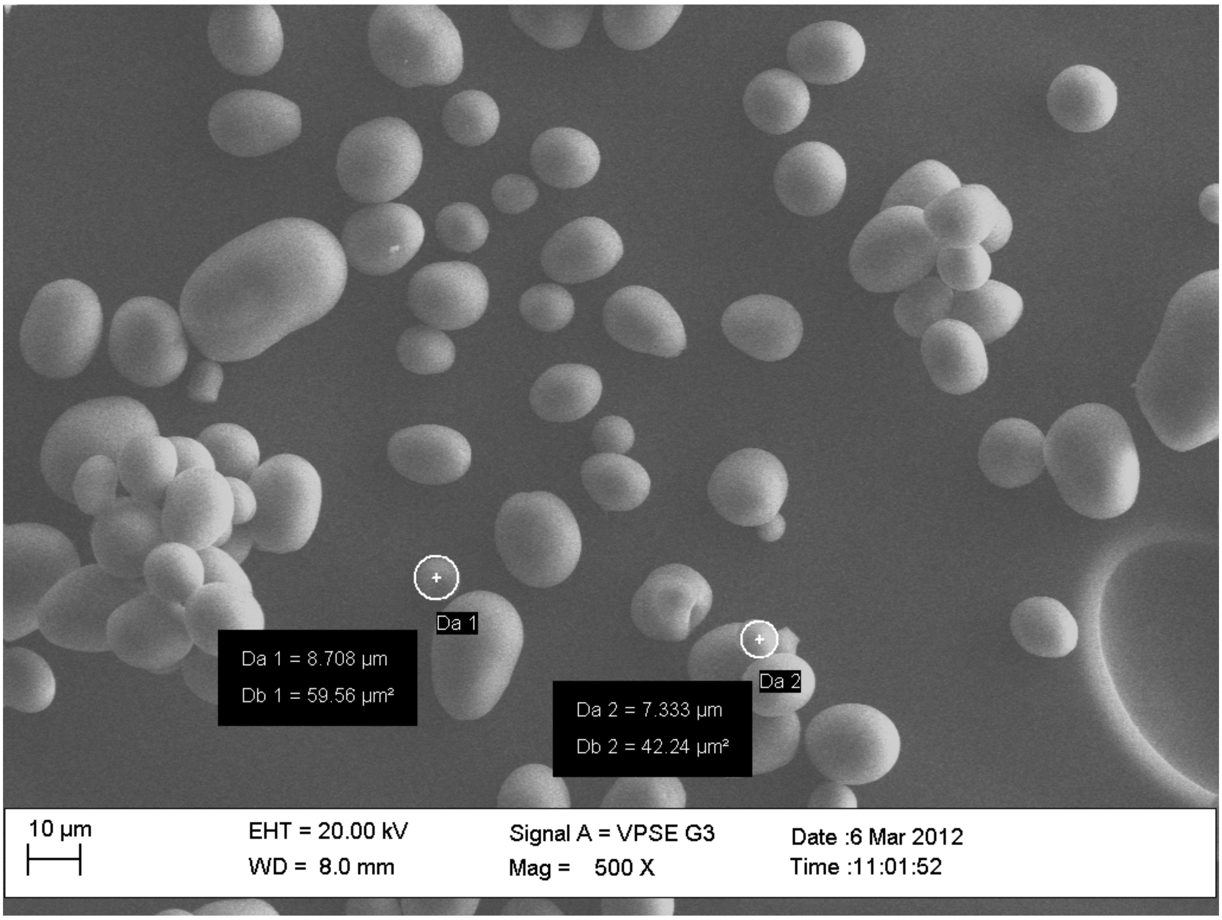

Fig1a. SEM image of starch x500

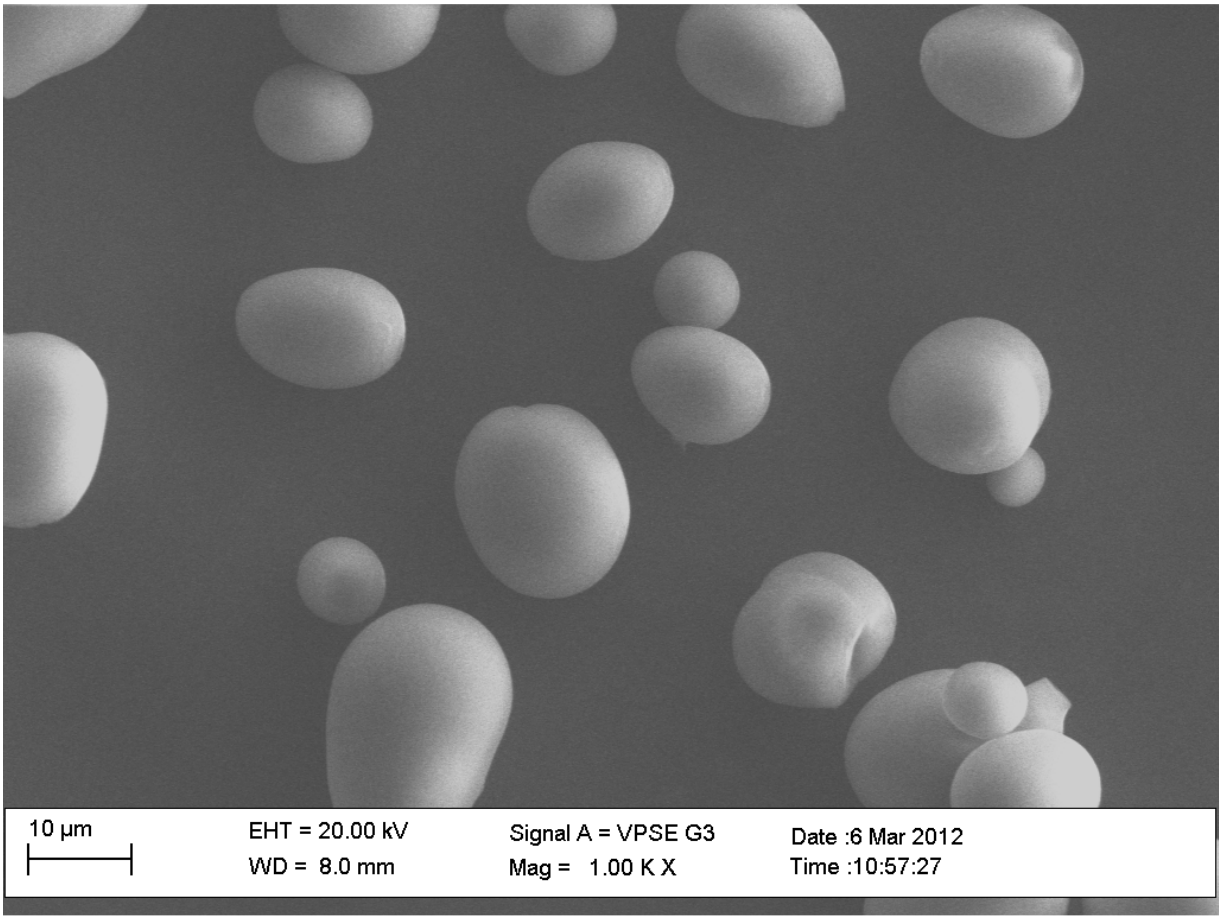

Fig 1b. SEM of starch x1000

CONCLUSION

The starch isolated from young shoot of *Borrasus aethiopum*; mucruchi starch, could be used in a variety of application and possibly even more when modified. The increased use of starch in various production has led to isolation of starch from lesser known sources.

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