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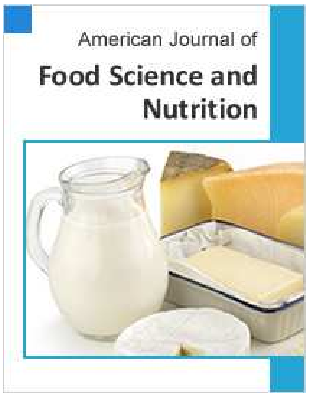

Potentials of Under-Utilized *Blighia sapida* Seed as a Source of Starch for Industrial Utilization

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Abstract

Blighia sapida fruit is cultivated for the arils which are used as meat substitute in soups while the seed is discarded and underutilized due to its anti-nutritional contents. The use of the seed is limited due to dearth of information on the properties but the seed had the potentials to be used in food and non-food industries. This study determines the potentials of under-utilized *Blighia sapida* seed starch for industrial use. Starch was extracted from the seeds using standard methods. Properties (granule size, shape of starch, pasting and swelling power) of the starch were determined. Shapes of the starch granules were oval, dome-shaped with smooth surfaces. Total dry matter of peeled *Blighia sapida* seed was 32.94% while the starch yield was 14.31% (43.44% of dry matter). Gelatinization point temperature and amylose contents were 71.50°C and 41.47% respectively. Percent transmittance values (0.53-0.70%) decreased with increase in storage periods. The starch exhibited higher peak (501.25 RVU) and final viscosities (725.08 RVU). Properties of *Blighia sapida* seed starch showed the tendency to be useful in food and non-food industries.

1. Introduction

Blighia sapida fruit (*Ackee* fruit) belongs to family *Sapindaceae*. It is a perennial plant found in Western Tropical Africa [1]. The fruit is made up of two parts namely the aril, which is the fleshy and succulent part and the seed, which is black and glassy [2]. The fruit pod split opened when matured and consists of three seeds with the arils. Arils of *Blighia sapida* fruit are yellowish in colour with high fat contents but are edible after maturity [2, 3]. The arils are eaten fresh or used as meat substitutes in soups [4]. *Blighia sapida* had only been cultivated for the arils while the seeds are discarded thereby making the seed a wasted product. More attention and research had been focused on fatty acid composition, phytochemical contents and physical properties of *Blighia sapida* aril and seed oil [1, 5-6]. The seed is under-exploited and has not been extensively researched like the aril. According to Omobuwajo et al [5] the average seed length, width and thickness of *Blighia sapida* were 24.30, 19.70 and 12.90 mm respectively. This showed that the seed is bigger than that of other crops like legumes and cereals. Major composition of seed includes the fat, carbohydrate, protein, crude fibre and ash contents. Starch is a storage carbohydrate in plant and has been reported to affect the physico-chemical properties of food. The type and uses of starch depends on its biological origin and source [7]. Production of starch from *Blighia sapida* seed provides a cheap source of starch and reduces wastage of these seeds during their season. Studying the properties of the under-exploited starch will enable us to know the area where it will be applicable for utilization. Therefore, this paper studied the potentials of under-utilized *Bligha sapida* seed as a source of starch for industrial utilization.

2. Materials and Methods

Bligha sapida seeds were obtained at a farm in Iree, Osun State, Nigeria. The seeds were peeled manually with knives and the cotyledons were separated. Moisture and dry matter contents of the seeds were determined using AOAC [8] method. Extraction of starch was done using method of Akinwande et al. [9] while the starch yield was calculated according to Balagopalan et al. [10]. Morphological structure and size analysis was done using methods of Akinoso and Abiodun [11] and Sarka [12] respectively. Methods of Juliano [13] and Singh *et al*. [14] were used for amylose and transmittance determination. The method of Iwuoha [15] was adopted for gelatinization temperature. Pasting profile of the starch sample was determined using a Rapid Visco-Analyzer (RVA) (Newport Scientific Pty. Ltd) with the aid of a thermocline for windows version 1.1 software. Swelling power was determined using method of Appiah et al. [16].

3. Statistical Analyses

The data were subjected to analysis of variance (ANOVA) and a difference was considered to be significant at $p \leq 0.05$. Means were separated using Tukey's tests through SPSS software (version16.0)

4. Results and Discussion

4.1. Starch Shape and Granule Size

The shapes of the starch granules were oval, dome-shaped and elliptical (Fig. 1). The form factor of the starch ranged from 0.75-0.93. The shapes of the starch were less than one; therefore, they were not regarded as a perfect circle. The form factor of a perfect circle is equal to one. Form factor is a measure of a grain's roundness [12]. The surfaces of the granules appear to be smooth like potato starch granules reported by Singh *et al*. [17]. *Blighia sapida* granule sizes ranged from 2.59 to 10.37 µm with average mean of 6.48 µm. Granule size showed bimodal distribution with higher frequency at 6.74 µm (Fig. 2). Starch granule size was within the range 5-40 µm reported for mung bean starches [18]. Smaller granule sizes were reported to be more digestible than lager particle size due to the large surface area [19]. Granules size is important in determining the mesh size for application and purification sieves [20] and also affects the possibilities of utilization and processing according to Capouchová *et al*. [21].

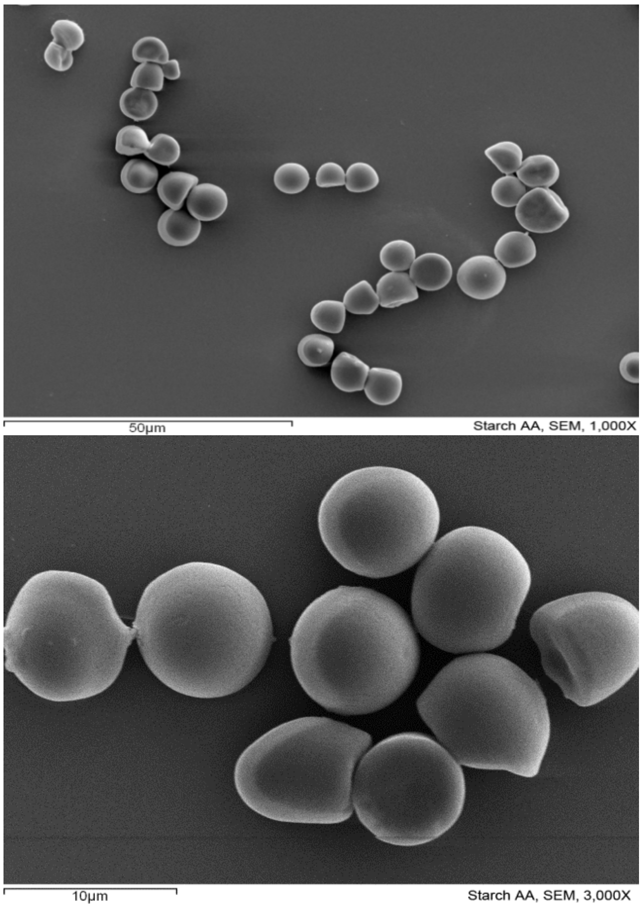

Fig. 1. *Structure of Bligha sapida seed starch using SEM at x 1000 and x3000 magnification.*

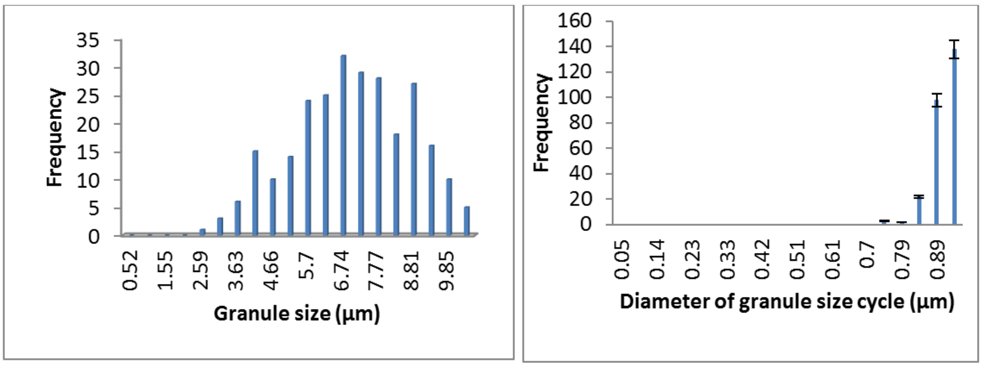

Fig. 2. *Diameter of starch granules and form factor.*

4.2. Dry Matter of Seed, Starch Yield, Amylose and Starch Clarity of *Blighia sapida*

Table 1 showed the dry matter of seed, starch yield, amylose and light transmittance of *Blighia sapida* starch. Total dry matter (wet basis) of peeled *Blighia sapida* seed was 32.94% while the starch yield was 14.31%. Dry matter of *Blighia sapida* seed was within the range observed for sweet potato (29.40-39.07%) varieties [22]. The starch yield of *Blighia sapida* seed account for 43.44% of the total dry matter which fall within the range observed for some sweet potato varieties [22]. Values ranging from 13.86-24.68% starch yield were also obtained for cassava varieties [23]. Starch yield observed for *Blighia sapida* in this study compared well with the yield of starches used in food and industrial application. This indicated that the seed could serve as a source of cheap starch for food and non-food industries.

Table 1. *Dry matter of Blighia sapida seed, starch yield and paste clarity of starch.*

Parameter	Value
Total dry matter (peeled seed) (%)	32.94±1.36
Starch yield (peeled seed) (%)	14.31±1.92 (43.44% of dry matter)
Gelatinization point temperature (°C)	71.50±0.14
Amylose (%)	41.47±1.01
Light transmittance (%) 24 hours	0.70±0.11
Light transmittance (%) 48 hours	0.62±0.05
Light transmittance (%) 72 hours	0.53±0.07

Gelatinization point temperature was 71.50°C. Gelatinization temperature observed for *Blighia sapida* starch was in the range reported for legume starches [24]. Gelatinization temperature of starch is the temperature at which the starch forms a completely transparent gel [25]. Gelatinization is the result of hydration, with solubilization of starch molecules, and disruption of double helical structures in the crystalline phase leading to the loss of crystallinity [26]. *Blighia sapida* starch had higher amylose content (41.47%) than sweet potato, yam, cassava, maize, rice and wheat [22, 27-29]. Higher amylose content observed could affect the textural quality of the starch. High amount of amylose has traditionally been linked to a greater retrogradation tendency in starches [30] and low swelling power [24].

The transmittance values of 1% gelatinized starch suspensions are presented in Table 1. The values ranged from 0.53-0.70%. Transmittance values observed in this study were low when compared to corn, potato, wheat and rice as reported by Nemţanu and Braşoveanu [31]. Lower transmittance values were also observed for emmer and einkorn wheat starches (0.27-0.75%) [32]. Percent transmittance values decreased with increase in storage periods. Gani *et al*. [33] observed similar decrease in transmittance in varieties of chestnut fruit starches with storage days. Nemţanu and Braşoveanu [31] define clarity as one of the most important attributes of starch and it influences the brightness and opacity of the products. The higher the transmittance value, the more transparent the starch paste becomes however, the lower the transmittance, the more opaque the starch paste becomes [34]. *Bligha sapida* starch paste had low transmittance values and therefore was opaque in nature.

4.3. Pasting Properties *Blighia sapida* Starch

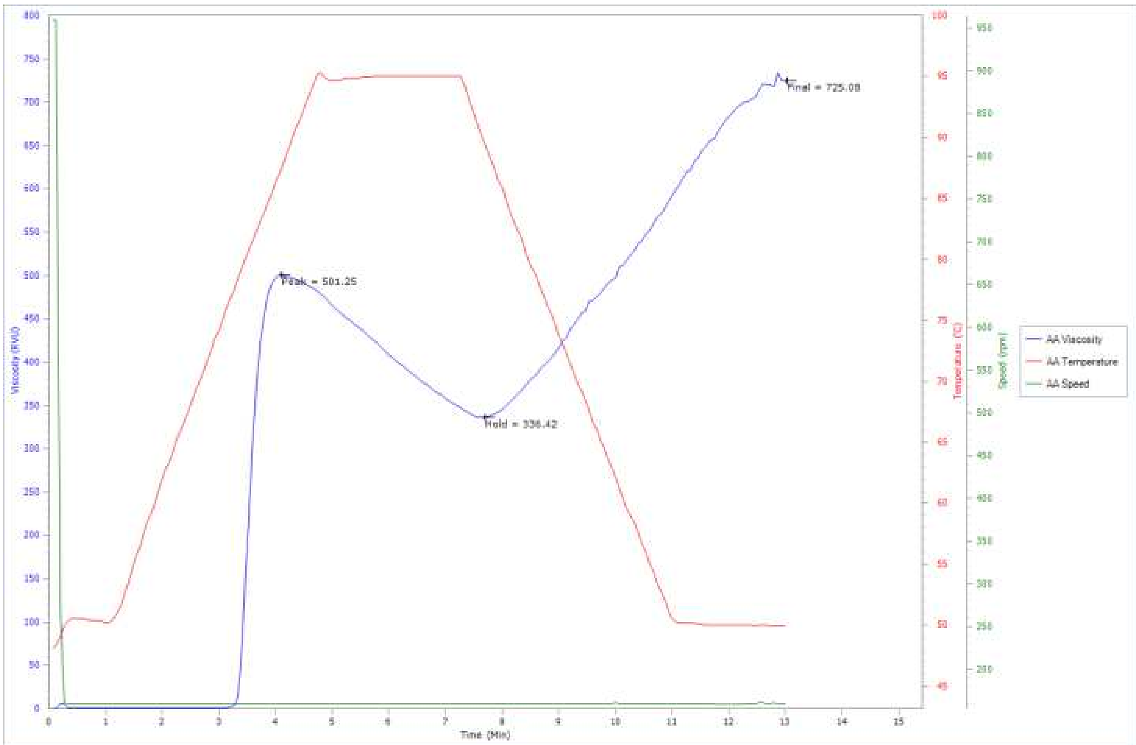

Fig. 3. *Pasting properties of Blighia sapida starch.*

Pasting properties of *Bligha sapida* seed starch are shown in Fig. 3. The starch had higher peak, holding strength and breakdown viscosities of 501.25, 336.42, 164.83 RVU respectively. The peak viscosity of *Bligha sapida* seed starch was higher than values reported for cowpea starches [35] and chestnut fruit [33]. Peak viscosity occurs at the equilibrium point between swelling and polymer leaching and rupture, and polymer alignment. High amylose content contributed to high peak viscosity due to rupturing and leaching of the linear molecules into the cooking medium. Higher final viscosity (725.08 RVU) and setback (388.67 RVU) was observed for *Bligha sapida* seed starch. High final viscosity of the starch signified high resistance to shear thinning and also indicated the ability of the starch to form high viscous gel after cooking and cooling. Higher setback value observed in the starch may be as a result of higher amylose content which caused retrogradation of the starch. Short time (4.05 min) was required to cook the starch at 78.45°C. *Bligha sapida* seed starch pasting temperature value was within the range (71.4-84°C) reported for chest nut fruit starches [33].

4.4. Swelling Properties of *Blighia sapida* Flour and Starch

Swelling properties of *Bligha sapida* seed starch are shown in Fig. 4. At low temperatures (60-70°C), there were gradual swelling of the starch but at 80-90°C, the starch increased in swelling drastically. Starch had higher swelling power value (9.68) at 90°C due to increase in temperature. High temperatures gelatinize the starch and rupture the swollen starch granules thereby releasing amylose into the cooking medium. Charles *et al*. [27] observed higher swelling power (27.2-42.3) for varieties of cassava starches with low amylose at 90°C. This corroborates the finding of Kaur *et al*. [28] that starches with lower amylose content swell more than those with higher amylose content. Swelling power according to Iwuoha [15] depends on the amylose/amylopectin ratio of the starch. Low swelling power was as a result of internal rigidity imparted by high contents of amylose and its complex with other non-starch compounds such as lipid, led to restricted swelling of the starch.

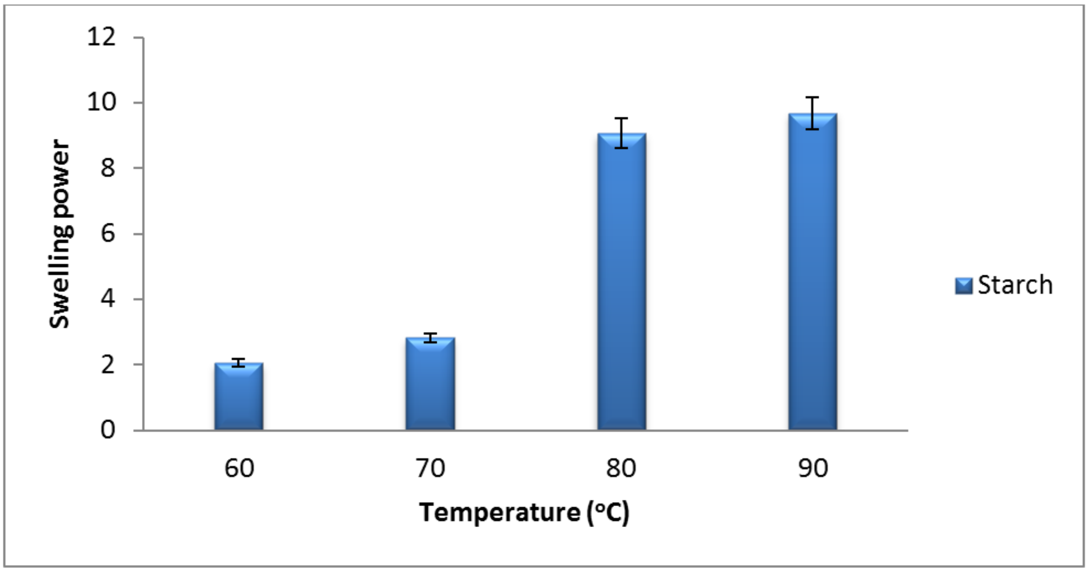

Fig. 4. *Swelling power of Bligha sapida starch.*

5. Conclusions

Blighia sapida seed is among the wasted and under-utilized crops. Properties of the starch were comparable to other crops in granule sizes. High pasting properties observed in the starch indicated its potential use in high viscous products. The use of this wasted seed in starch production could also be a mean of generating another source of raw material for food, textile and adhesive industries.

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