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EVALUATION OF PHYSICOCHEMICAL PROPERTIES AND PHYTOCHEMICAL COMPOSITION OF AFRICAN LOCUST BEAN (Parkia biglobosa) PULP

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ABSTRACT

The study aimed to explore the potential of African locust bean pulp, which is usually washed off during processing of iru, as a food and functional materials in food application. The proximate composition, pH, functional properties, pasting properties and phytochemical composition of African locust bean pulp were determined using standard methods. The pulp contained 7.96% crude protein, 2.56% crude fat, 6.97% crude fibre, 2.69% ash, 7.14% moisture and 72.68% carbohydrate. The pH, swelling power, water absorption capacity, oil absorption capacity, least gelation concentration, wettability and bulk densityof the pulp were 4.1, 4.98 g/g, 4.80ml/g, 2.40ml/g, 8.00%, 1.22 mins and 0.36g/ml, respectively. The peak viscosity (85cP), trough viscosity (80cP) and final viscosity (122cP) of the pulp were low indicating low starch content with poor pasting profile.Phytochemical analysis showed the presence of tannin (5.53mg/g), flavonoid (4.72mg/g), steroid (18.37mg/g), terpenoid (10.35mg/g), alkaloid (45.02%) and cardiac glycosides (8.22mg/g).The results suggest that African locust bean pulp could be a potential food and functional material in food processing.

Keywords: African locust bean, proximate, functional, pasting properties, phytochemical composition.

INTRODUCTION

African locust bean (Parkia biglobosa) is a multipurpose tree, which belongs to the family Leguminasae (Abdullahi and Akinyele, 2013). It is one of the indigenous plants that is not usually cultivated but can be seen in populations of two or more in the savannah region of Nigeria (Alabi et al., 2005). The trees are usually preserved because they are valuable economic fruit trees; almost all parts of the tree are utilized. The tree is especially valuable for its seeds, which are embedded in yellow pulp inside a brown pod. The fermented seed, which is called iru or dawadawa, is a popular condiment known to be rich in protein and vitamins (Tee et al., 2009). The nutritional and antioxidant properties of the seeds have been reported (Esenwah and Ikenebomeh, 2008; Omafuvbe et al., 2004; Badu et al., 2012).

African locust bean pulp, which constitutes about 60-70% of the pod (Marcel et. al., 2015), has not attracted much attention in terms of research and utilization. Inprocessing African locust bean seeds to iru, the pulp is usually washed off as waste material in order to recover the seeds. Few communities dry and preserve the pulp for use in lean season. There is little information on the chemical composition and physicochemical properties of the pulp; such information will be needed to explore the potentials of the pulp in food and pharmaceutical applications. Report on some lesser known seeds and fruits has indicated that they could be good sources of nutrients for man and livestock (Elemo etal., 2002; Adekunke and Ogerinde , 2004). African locust beans seeds contain some phytochemicals that are of health benefit to the body (Alabi et al., 2005); there is therefore the possibility that the pulp may also contain some phytochemicals. Phytochemicals are secondary metabolites inherent in plants that protect it from environmental stress, microbial attack, and insects (Daramola, 2015). The bioactivity of the metabolites is continuously being explored in the prevention and treatment of some diseases in human. This study evaluated the physicochemical properties and phytochemical composition of African locust bean pulp.

Materials and methods

Sample Preparation

African locust bean pods were harvested from its tree at a location very close to Federal Polytechnic Ado-Ekiti, Nigeria. The pods were sorted for wholesomeness and split open manually to remove the pulp with the attached seeds. The pulp with the attached seeds was oven dried at 50°C for 6 hrs in order of facilitate easy removal of the pulp from the seed. The pulp was separated from the seed manually, milled into flour in an electric blender, sieved using 0.5mm sieve, packaged in a well-labelled polythene bag and stored at ambient temperature.

Analysis of African Locust Bean Fruit Pulp

Proximate Composition and pH

Proximate composition of the pulp flour was determined according to the methods described by AOAC (2005)while, carbohydrate was calculated by difference. Determination of pH was done according to the method described by Onitilo et. al. (2007) with the use of pH meter, which had been previously standardized with buffer solution of pH 4 and 9.

Functional Properties

The swelling power at 60°C was determined according to the method described by Kauret al. (2011). Water absorption capacity and Oil absorption capacity were determined at ambient temperature (30±2°C) according to the methods described by Sathe et al. (1982). The least gelation concentration, bulk density and wettability were determined according to methods described by Onwuka (2005).

Pasting Properties

The pasting properties were determined using Rapid Visco Analyser (RVA) (Model RVA-3D, Newport Scientific Pty. Ltd., Warriewood, Australia). Pulp sample (3g) was turned to slurry by mixing with 25 ml of water; this was then transferred into RVA canister and placed inside the RVA machine. The 12 mins profile was used with sample heated from 50 to 95°C and then cooled back to 50°C.

Phytochemical Composition

The aqueous extract of the pulp was obtained using the cold extraction method described by Ajayi and Ojelere (2013) with modifications. The aqueous extract was screened for the presence of tannin, saponin, flavonoid, steroid, phlobatanin, terpenoid, alkaloid, anthraquinone and cardiac glycosides using the methods described by Daramola (2015) and Harborne (1998). Phytochemicals that showed positive results were determined quantitatively according to the methods described by Daramola (2015) and Harborne (1998).

RESULTS AND DISCUSSION

Proximate Composition and pH

The proximate composition of African locust bean (Parkia biglobosa) pulp in this study is presented in Table1.Crude protein content ofthe pulp, 7.96%,was higher than 6.64% and 6.56% reported for African locust bean pulp by Marcel etal. (2015) and Gernah etal. (2007), respectively. The pulp had lower protein content than 31.00% reported forAfrican locust bean seeds commonly used to produce local condiment iru (Omafuvbe et. al., 2004). However the pulp,with this appreciable protein content, may be used to improve the protein content of diets especially in rural areas where protein intake is low and cases of protein malnutrition abound instead of being washed off during production of iru. Crude fat content of the pulp was low (2.56%), whichmay suggest low susceptibility of the pulp to occurrence of rancidity during storage. Crude fibre content of Parkia biglobosa pulp reported in this study was lower than 8.75% reported for the pulp by Marcel etal. (2015). This difference may be due to difference in the sizes of sieves used. In this study, 0.5mm sieve was used while Marceletal.(2015) used 40mesh (0.64mm) sieve, which allowed passage of more fibre.Fibre content of the pulp was lower than 11. 7% reported for the seeds (Omafuvbe et. al., 2004). Incorporation of African locust bean pulp into recipe of wheat flour based foods may improve the fibre content of such foods since wheat flour has low fibre content.Fibre has been noted to play significant role in the healthy functioning of bowel and in reducing the rate of sugar absorption in small intestine, which is important for diabetic and obese patients. The ash content of the pulp reported in this study was lower than 7.34-7.85% reported for Parkia biglobosa fruit pulp sourced from different region of northern part of Republic of Benin (Dahouenon-Ahoussi etal. 2012). This difference may be due to difference in geographical and soil characteristics of the location where the trees are grown. Ash content indicates the mineral element potential of African locust bean fruit pulp.

The moisture content of the pulp was 7.14%, this was comparable with 8.41% reported by Gernah etal. (2001) but lower than the range (11.30-15.83%) reported by Nadro and Umaru (2004). This difference may be as a result of difference in the method used to separate the pulp from the seeds, because in this study, pulp with the attached seeds was initially dried in an oven to facilitate easy removal of the pulp while Nadro and Umaru (2004) did not use this procedure. The low moisture content of the pulp as reported in this study will enhance the shelf stability of the pulp.The carbohydrate content of the pulp, 72.68%, was much higher than 35.0% reported for African locust bean seeds (Omafuvbe et. al., 2004). Although protein and fat give energy, carbohydrates are much cheaper, and easily digested and absorbed. The sweet taste of the pulp suggests that sugar may be a major component of the pulp carbohydrate rather than starch. The pH of the pulp (4.1) falls within the range (3.1 – 4.7) reported for some samples of African locust bean pulp (Dahouenon-Ahoussi et. al. 2012). This low pH indicates the inherent acidic nature of the pulp due to presence of organic acid.

Table 1: Proximate Composition of African Locust Bean Pulp

Parameters	Values (%)
Crude Protein	7.96±0.22
Crude Fat	2.56±0.15
Crude Fibre	6.97±0.30
Ash	2.69±0.20
Moisture	7.14±0.25
CHO	72.68±0.20
pH	4.1±0.10

*Values are means of triplicate determination ±standard deviation
* Values are on dry weight basis
*CHO: Carbohydrate

Functional Properties

The result of functional properties is presented inTable 2. The swelling power of African locust bean pulp at 60°C was 4.98 g/g, this was higher than 4.25 reported by Marcel *etal.* (2015). Swelling power is influenced by temperature, water availability and the hydrophilic components of the pulp such as carbohydrate and protein. The water absorption capacity of the pulp was 4.80ml/g. The water absorption capacity may be due to starch and fibre contents of the pulp;the hydroxyl groups on the molecules of these pulp components could easily form hydrogen bonds with water and thereby contribute to water absorption. The water absorption capacity of the pulp was higher than 1.60ml/g reported (Arinola *et al.*, 2016) for unripe plantain flour.The relatively high swelling power and hydration capacity suggest that the pulp could be incorporated in aqueous food formulation such as custard and doughfor improved yield and consistency (Osundahunsi *et al.,* 2003). The oil absorption capacity of the pulp was 2.40ml/g; the ability of the pulp to absorb oil may contribute to the sensory properties of flavor retention and improvedpalatability when the pulp is used in food (Sankhon *et al.,*2014). Oil absorption capacity of the pulp was lower than its water absorption capacity, which indicates that the pulp components have higher affinity for water than oil. However, such hydrophilic and lipophilic properties of the pulp would enhance its utilization in both aqueous and lipid based foods. The least gelation concentration of the pulp was 8.00%. Least gelation concentration, which is essentially influenced by starch and protein components, affects digestibility and textures of food materials (Lawal *et al.,*2005). The intermediate least gelation concentration of the pulp suggest that it may be used in products such as weaning foods where intermediate gelation concentration is required for good energy and nutrient density without the need for dilution to reduce gel consistency. The bulk density of the pulp was relatively low (0.36g/ml). It is comparable with the bulk density of defatted *Parkia biglobosa* seed flour (Ogunyinka *et al.,*2017). Bulk density is important in handling, packaging and transportation of food material (Adepeju *et al.,*2011); generally materials with high bulk density are desirable in terms of packaging as large quantity (weight) can be packaged within a constant volume. However, low bulk density has been reported to promote easy digestibility of food materials (Osundahunsi and Aworh, 2002).

Table 2: Functional Properties of African Locust Bean Pulp

Parameters	Values
Swelling Power	4.98±0.21g/g
Water Absorption Capacity	4.80±0.20 ml/g
Oil Absorption Capacity	2.40±0.10 ml/g
Least Gelation Concentration	8.0±0.00 %
Wettability	1.22±0.09mins
Bulk Density	0.36±0.03g/ml

*Values are means of triplicate determination±standard deviation
* Values are on dry weight basis

Pasting Properties

The peak and final viscosity of African locust bean pulp were 85 and 122 cp, respectively (Table 3); the pulp exhibits low peak and final viscosity.This low viscosity suggests that the proportion of starch in the pulp carbohydrate may be low. The presence of other proximate components like protein and fat, which may interact with starch, may have also caused the low peak and final viscosity of the pulp. Pasting viscosity is influenced by starch concentration, size of starch granules, ionic charge on starch, ratio of amylose and amylopectin, branching of amylopectin, kind and degree of granules crystallinity, size and strength of hydrogen bonds, interaction within the granules and presence of other non starchy components (Alcazar-Alay and Meireless, 2015; Sankhon *et al.,*2014). The low final viscosity indicates that the pulp may not form viscous paste after cooking and cooling; therefore it cannot be used as thickener in food application. The breakdown viscosity, which measures the extent to which starch paste can withstand shear thinning during heating (Karim *et al.,* 2007), was very low (5 cP). The low breakdown viscositycompared with peak viscosity suggeststhat the starch granules of African locust bean fruit pulp do not readily disintegrate under shear and heat. The setback viscosity of the pulp was 42 cp, setback viscosity indicates the extent that starch molecules can re-associate or retrograde during cooling, for instance, the lower the setback viscosity the lower the tendency to retrograde (Sanni *et al*., 2004). The peak time of starch pasting analysis is a measure of cooking time (Adebowale *et al.,* 2005). The peak time of the pulp, 5.67 mins, was lower than the peak time (4.52 mins) reported (Oluwalana *et. al*., 2011) for plantain flour. The pasting temperature, which is a measure of the minimum temperature required to gelatinized food sample, was 74°C. This relatively high pasting temperature when compare with that of corn could be as a result of strong associative forces within the starch granules of the pulp. These results suggest that African locus bean pulp has low starch content with very low inherent viscosity.

Table 3: Pasting Properties of African Locust Bean Pulp

Parameters	Values
Peak Viscosity	85 cP
Trough Viscosity	80 cP
Breakdown Viscosity	5 cP
Final Viscosity	122 cP
Setback Viscosity	42 cP
Peak Time	5.67 mins
Pasting Temperature	74.0°C

* 12% (dry weight basis) pulp slurry was used

Phytochemical Composition

The phytochemical screening of African locust bean pulp shows that it contained tannin, flavonoid, steroid, terpenoid, alkaloid and cardiac glycosides (Table 4). This agrees with the result of phytochemical screening of the pulp reported by Badu *et al.*(2012). The presence of these phytochemical, due to their antioxidant bioactivity, suggests the possibility that the pulp may exhibit antioxidant property (Adetunji and Aladesanmi, 2006).

The tannin content of the pulp, 5.53mg/g (Table 4), was higher than 1.27mg/g reported (Bello *et al*., 2008) for *Cola milleni* seed but lower than 13.3g/kg reported (Fagbemi *et al*., 2005) for cashewnut. Tannin has been reported to have anticancer and antimicrobial activities (Li *et al.,*2003). It contributes to the astringent taste of some fruits and also forms an insoluble complex with protein, thereby reducing protein digestibility. However, tannin content of the pulp was low to be of any nutritional disadvantage. Moreover, thereducing effect of tannin on protein digestibility can be eliminated during processing as a result of solubility and heat sensitive nature of tannin (Esenwah and Ikerebimeh, 2008).The flavonoid content of African locust bean pulp was 4.72mg/g. Flavonoids are polyphenolic molecules that provide health benefit due to their antioxidant activity on hydroxyl radicals and superoxide anion radicals (Ferguson, 2001). The alkaloid, steroid, terpenoid and cardiac glycosides contents of the pulp were 45.02%, 18.37, 10.35 and 8.22mg/g, respectively. Cardiac glycosides increase the output force of the heart and reduce its rate of contractions, which helps to prevent congestive heart failures (Yukari *et al*., 1995). The qualitative and quantitative phytochemical analysis of African locust bean pulp shows that it contains an array of phytochemicals.

Table 4: Phytochemical Composition of African Locust Bean Pulp

Phytochemical Components	Qualitative	Quantitative
Tannin	+	5.53±0.03mg/g
Saponin	-	-
Flavonoid	+	4.72±0.05mg/g
Steroid	+	18.37±0.32mg/g
Phlobatanin	-	-
Terpenoid	+	10.35±0.02mg/g
Alkaloid	+	45.02±0.85%
Anthraquinone	-	-
Cardaic glycosides	+	8.22±0.02mg/g

*Values are means of triplicate determination±standard deviation

CONCLUSION

This preliminary study revealed that African locust bean pulp has appreciable food and functional properties that may qualify it for use in food application. However, the values of pasting properties of the pulp were low, which suggest that the pulp has low starch content with poor pasting properties.

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