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**PROXIMATE AND MINERAL COMPOSITIONS OF FLOURS OF ACKEE SEED
AND ARIL FROM BIDA AREA OF NIGER STATE, NIGERIA**

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ABSTRACT

Ackee is an evergreen tree known to bear edible fruit. The fruit is mostly consumed for a number of reasons such as medicinal and nutritional benefits. A number of researches has been carried out on ackee collected from different locations. In this work, determination of proximate and mineral constituents of flour of ackee pulp and seed of ackee collected from Bida area of Niger State was carried out. The results of the study show that 5.56 ± 0.17 (Seed) and $6.69 \pm 0.06\%$ (Aril) for moisture, 5.03 ± 0.22 (Seed) and $3.92 \pm 0.11\%$ (Aril) for ash, 15.41 ± 0.21 (Seed) and $6.47 \pm 0.01\%$ (Aril) for crude protein, 36.08 ± 0.07 (Seed) and $18.18 \pm 0.04\%$ (Aril) for crude fat, 16.78 ± 0.06 (Seed) and $15.41 \pm 0.21\%$ (Aril) for crude fiber and 20.61 ± 0.60 (Seed) and $49.33 \pm 0.21\%$ (Aril) for carbohydrate. Result of mineral composition include K 0.083 ± 0.001 (Seed) and 0.079 ± 0.0008 (Aril); Na 1.13 ± 0.0070 (Seed) and 0.99 ± 0.0010 (Aril); Ca 1.35 ± 0.0100 (Seed) and 1.26 ± 0.0100 (Aril); Mg 1.93 ± 0.0100 (Seed) and 2.015 ± 0.0200 (Aril); and P 16.78 ± 0.030 (Seed) and 0.54 ± 0.1000 (Aril). p-Values of 0.50 and 0.18 were obtained for t-Test carried out on proximate and mineral concentrations respectively. Results of this study indicate that ackee contain essential nutrient required for adequate functioning the body.

INTRODUCTION

Blighia sapida, commonly referred to as Ackee, Akee or vegetable brain or Akee apple is an evergreen tree more widely known for the edible part of its fruit. It is a perennial herbaceous plant that is prominently found in Western Tropical Africa (e.g. Nigeria). *Blighia sapida*, commonly known as Ackee (English), *Okpu* (Igbo; Eastern Nigeria), *Gwanja Kusa* (Hausa; Northern Nigeria), *Isin* (Yoruba; Western Nigeria) and *Yila* (Nupe; North Central Nigeria) is a soapberry plant of the family *Sapindaceae*. It grows to a height of 10 to 35 m at maturity when ripe, Ackee fruit splits to expose a fleshly cream coloured pulp (aril) attached to a shiny black oblong seed (Akintayo *et al.*, 2002). Quattara *et al.*



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(2010) also stated that the nutritional composition of the aril suggests its benefit in human diet.

Ackee Tree Agriculture

The ackee tree is an evergreen tree with a smooth gray bark and densely branched symmetrical canopy, growing as tall as 15-30 m. The tree is propagated from seeds directly on the field or transplanted later from nursery. (Stair and Sidrak, 1997; Mitchell *et al.*, 2008). When ripe, the mature fruit capsules split open to reveal cream coloured arils attached to smooth, shiny black oblong seeds. The arils are attached to the capsule by pink to red fibrous membranes (Morton, 1987).

Causes and measures for alleviating food shortages

Food shortages affect millions globally and often lead to hunger, malnutrition, and starvation as a result of inadequate supply. The increase in global population and climate change are major drivers of food shortages due to the strain on available resources (Prasad, 2013). Climate change impacts agricultural productivity through extreme weather events, water scarcity, and land degradation. Measures adopted to address food shortages include sustainable agriculture, climate change adaptation, food security systems, and reducing food waste. (Damisa *et al.*, 2011; Rosa *et al.*, 2021). International cooperation is essential for developing sustainable solutions and equitable access to food. By addressing these challenges holistically, we can combat hunger and achieve long-term food security. (Gebremedhin, 2000).

Applications and limitations of using Ackee in the food industry

Ackee, primarily used in traditional Caribbean dishes, has limited application as a substitute in the food industry due to its unique flavor and texture profile (Aderinola *et al.*, 2007; Quattara *et al.*, 2010). However, it could be used as an alternative in certain food products (Adeduntan, *et al.*, 2016). Ackee's texture resembles scrambled eggs, making it a suitable



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substitute for eggs in vegan and vegetarian dishes. It can be used as a flavoring agent in dishes like omelets, quiches, or scrambled eggs. Ackee can also be incorporated into ready-to-eat meals for Caribbean-inspired flavors (Ekué *et al.*, 2010; Aloko *et al.*, 2019). However, Ackee's use as a substitute in the food industry is limited by factors such as its inadequate availability in tropical regions, food safety concerns, and unique flavor profile. Other factors include its slightly nutty taste, which has limited acceptability universally for all food applications (Odotuga *et al.*, 1992; Oladiji *et al.*, 2009). Although there are niche markets or culinary contexts where ackee is used as a substitute or alternative ingredient (Aderinola *et al.* 2007),

The aim of this was to determine the proximate compositions and mineral contents of aril and seed of ackee fruit collected from Bida, Nigeria. The results of aril and seed were compared and statistical treatment was carried out using Microsoft excel.

MATERIALS AND METHODS

Collection of Samples

Blighia sapida (ackee) used for this study were obtained from Nasarafu area of Bida town, Niger State, Nigeria and were identified by a Botanist in the Department of Biology, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria. They were screened to remove bad ones, washed, sun dried to constant weight, pulverized using pestle and mortar, sieved, put in an air-tight container and stored.

Proximate analysis

Proximate (moisture, ash, crude protein, crude fat, crude fibre and carbohydrate) analysis of the ackee flours (aril and seed flours) were carried out using the AOAC, 2000 standard method.



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Mineral Analysis

Mineral contents of the ackee flour samples were determined by flame photometry and spectrophotometry according to the method of AOAC (2005), as described in the following sections.

Sample Preparation

One (1.0) g of sample was placed in a porcelain crucible and ashed at 550 °C for 6 hr. The ash was dissolved in 2.0 mL concentrated HNO₃ and allowed to boil for 1 min. The mixture was cooled, then filtered through Whatman No. 42 filter paper into a 100 mL volumetric flask and made to the mark with distilled water. The flask was swirled for solution to mix and the minerals were determined from the resulting (ash) solution. A blank was also prepared using a similar experimental procedure (AOAC, 2005).

Determination of Sodium (Na) and Potassium (K)

Analyses of the sample for Na and K were carried out using a flame photometer (model number: FP902 PG). Solutions of the ash were used for the determination of Na and K. The concentrations of minerals (ppm) were recorded and the concentrations in mg/100 g calculated using the following equation:

Total Mineral Concentration (mg/100g) = Concentration (ppm) X Dilution factor Wt.of Sample X 1000 X 100

Determination of Phosphorus (P)

Phosphorus content was determined using a spectrophotometer (model: T60 PG UV VISIBLE). Approximately 22.5 g of aqueous ammonium heptamolybdate (NH₄)₆Mo₇O₂₄·4H₂O) was dissolved in 400 mL of deionized water to make solution A. About 1.25 g of ammonium vanadate was dissolved in 300 mL of boiling deionized water to make solution B. Solution B was added to solution A and allowed to cool to room temperature, after which 250 mL of concentrated HNO₃ was added and the mixture was diluted to 1.0 L



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to obtain the colour reagent. One (1.0) mL of each ash solution was taken and 4.0 mL deionized water added in a beaker. Approximately 5.0 mL of the colour reagent was added to this volume and the total volume of the final solution was made up to 25.0 mL. After some time, the colour of this final solution turned yellow. Sample from the final yellow solution was taken in a cuvette and introduced into the spectrophotometer. The absorbance readings from the spectrophotometer were used to determine the phosphorus concentration (ppm). Total phosphorus concentration in mg/100 g was calculated using the following equation: (AOAC, 2005)

$$\text{Total P Concentration (mg/100g)} = \text{Concentration (ppm)} \times \text{Dilution factor} \times \text{Wt. of Sample} \times 1000 \times 100$$

Statistical analysis

A t-Test was conducted to compare the results of proximate and mineral concentration of aril and seed flours of ackee plant.

RESULTS AND DISCUSSION

The results of proximate and mineral composition of ackee plant aril/pulp and its seed are presented in Tables 1 and 2. Results obtained revealed the presence of moisture, ash, crude protein, crude fat, crude fibre and carbohydrate and minerals (Na, K, P, Mg and Ca) respectively. From the results, ackee plant fruit contains nutrients in appreciable quantities which can supplement the nutritional needs of consumers.

Table 1: Mean proximate composition of Ackee fruit

| Parameter | aril flour | seed flour |
|------------------|--------------|--------------|
| Moisture content | 6.69 ± 0.06 | 5.56 ± 0.17 |
| Ash content | 3.92 ± 0.11 | 5.03 ± 0.22 |
| Crude Fat | 18.18 ± 0.04 | 36.08 ± 0.07 |
| Crude protein | 6.47 ± 0.01 | 15.94 ± 0.67 |
| Crude fibre | 15.41 ± 0.21 | 16.78 ± 0.03 |
| Carbohydrate | 49.33 ± 0.21 | 20.61 ± 0.60 |

Each value is a mean of two replicates ± standard deviation.



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Table 2: Mean mineral composition of Ackee fruit

| Parameter | aril flour | seed flour |
|-----------------|--------------------|-------------------|
| Potassium (K) | 0.079 ± 0.0008 | 0.083 ± 0.001 |
| Sodium (Na) | 0.99 ± 0.0010 | 1.13 ± 0.0070 |
| Calcium (Ca) | 1.26 ± 0.0100 | 1.35 ± 0.0100 |
| Magnesium (Mg) | 2.015 ± 0.0200 | 1.93 ± 0.0100 |
| Phosphorous (P) | 0.54 ± 0.1000 | 16.78 ± 0.030 |

Each value is a mean of two replicates \pm standard deviation.

Table 3: Results for statistical analyses (t-Test)

| Test | p-Value | Confidence interval (%) | Alpha value |
|------------------------|---------|-------------------------|-------------|
| Pproximate composition | 0.50 | 95 | 0.05 |
| Mineral compositions | 0.18 | 95 | 0.05 |

Moisture content

From Table 1, the moisture content obtained for aril is 6.69 ± 0.06 % while 5.56 ± 0.17 % was obtained for seed. These values are within the range of 7 % to 36 % reported by Adeduntan, (2005) for different parts of ackee plant. Similarly, Quattara et al. (2010) and Oyeleke et al. (2013) found 6.84 % and 3.95 % respectively, for aril samples

The low moisture content suggests that the aril and seed will be stable towards microbial action. Hence, flours of aril and seed of ackee plant from the sampled location can be stored without spoilage because it will have high shelf life. It also shows a slight advantage over ackee from other locations owing to its lower moisture content.

Ash

The Ash contents obtained in this work were 3.92 ± 0.11 and 5.03 ± 0.22 % for seed and aril flours respectively. These values almost double the values of 1.5 % and 2.5 % reported by Pomeranz and Clifton, (1981) for seed and aril flour respectively. Later studies by Quattara et al. (2010) and Oyeleke et al. (2013) reported 4.90 and 6.20 % for aril sample. Thus, it shows that the flours are enriched with essential minerals and can be utilized for animal feed formulation. Concentrations of these minerals depends on the location and age of plant.



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Crude Fat

Table 1, shows that crude fat is 18.18 ± 0.04 % for aril which is similar to the report of 19 % by Akintayo *et al* (2002) for aril sample and about 51.58 % for aril sample reported by Oyeleke *et al.* (2013). While the value of 36.08 ± 0.07 % for seed obtained differs with 9 % as reported by the same work. This study shows the presence of fat in high proportion especially that of the seed, hence, Ackee fruit can be utilized as a source of fat and oil in human food and dietary feeds.

Crude Protein

The values 6.47 ± 0.01 % for aril and 15.94 ± 0.21 % (Table 1) for seed were obtained as the crude protein in this study. These values differ slightly with 9 % as reported by Akintayo *et al.* (2002) for both aril and seed samples. The-results obtained therefore suggest that the protein content of these fruits can make a significant contribution to dietary intake especially in domesticated food.

Carbohydrate

From the Table 1, carbohydrate content of the aril was 49.33 ± 0.21 % which doubled the carbohydrate value of 24.43 ± 2.24 % aril reported in Quattara *et al.* (2010). Oyeleke *et al.* (2013) reported a lower value of 6.86 % for aril sample. For seed sample about 20.61 ± 0.60 % was found compared to the value of seed 24.43 ± 2.24 % also reported by Quattara *et al.* (2010). From these results, the carbohydrate content in ackee fruit is high, thereby making it a potential source of energy for the body.

Crude fibre

The values of fibre content of ackee plant obtained in this study were 15.41 ± 0.21 % and 16.78 ± 0.04 % for aril and seed respectively. These values are doubled the values reported by Oyeleke *et al.* (2013) which were 4.23 % for aril and 16.14 % for seed. Also, Quattara *et al.* (2010) found about 3.21 % for aril samples. The high content fiber reported in the work



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shows the aril tree in the sampled location will have health benefits such as reduction of body cholesterol and risk of cardiovascular diseases.

Mineral Content

The results of mineral composition of ackee plants are shown in Table 2. The most abundant mineral is magnesium with values 2.015 ± 0.02 % for aril and 1.93 ± 0.01 % for the seed. This figure reported for aril is ten-fold lower than values found by Oyeleke *et al.* (2013) and Quattara *et al.* (2010). Magnesium is of high benefit to health because it helps in lowering blood pressure, cardiac arrest, stroke and relaxation of muscles (Atolani *et al.*, 2013).

Calcium is the second most abundant element in the samples with values of 1.26 ± 0.01 % (aril) and 1.35 ± 0.01 % (seed). An earlier analysis by reported about 0.025 – 0.139 % % in aril sample (Quattara *et al.*, 2010; Oyeleke *et al.*, 2013). Calcium is important in bone formation, blood clotting, and helps the nerves to convey messages (Oyeleke *et al.*, 2013). Results obtained also indicate that calcium content in From the results of calcium, it shows that calcium is high in Ackee fruit (aril pulp). Therefore, consumption of aril pulp will aid in accumulation of calcium in the body.

From this study, the concentration of sodium in ackee fruit is moderate, having the values of 0.99 ± 0.001 % (aril) and 1.13 ± 0.007 % (seed) as presented in Table 2. Sodium plays an important role in diets as it controls blood pressure. Studies have suggested that consumption of sodium in low amount helps in reducing high blood pressure in hypertensive patients (Atolani *et al.*, 2013). Continuous consumption of ackee aril by hypertensive will require monitoring and regulation.

Concentrations of phosphorus Obtained in this study were 0.54 ± 0.10 % (aril) and 0.48 ± 0.003 % (seed). Similar value of 0.49 % was reported by Oyeleke *et al.* (2013). Phosphorus



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is always found with calcium in the body both contributing to the blood (Atolani *et al.*, 2013). Calcium and Phosphorus ratio help to increase the absorption of calcium in the small intestine. Researches have shown that, if the Calcium and Phosphorus ratio of the ackee fruit is greater than 1; hence it would serve as a good source of mineral for bone formation (Oyeleke *et al.*, 2013).

Potassium is the least abundant of the mineral composition of ackee fruit with values 0.079 ± 0.0008 % (aril) and 0.083 ± 0.0005 % (seed). Potassium concentration in aril flour in the range of reported about 0.030 – 1.503 % have been found by earlier research concentration for aril flour (Quattara *et al.*, 2010; Oyeleke *et al.*, 2013). The concentration of potassium in this work shows that high consumption of diets containing potassium will help in controlling high blood pressure diseases.

Statistical Analysis

The result of statistical analysis gave a p-value of 0.50 for tail t-Test of proximate composition of aril and seed flours. This shows that the results of proximate composition of aril and seed were not statistically different since p-value found was greater than 0.05. Similarly, a p-value of 0.18 was obtained for t-Test carried out on the mineral compositions of aril and seed. The finding showed that results of mineral composition were not significantly different at 95 % confidence interval.

CONCLUSION

Blighia sapida contains essential nutrients that are necessary for good functioning of the body. The results of proximate and mineral compositions suggest that inclusion of ackee flours in the diet could contribute an appreciable amount of nutrients to help meet nutritional needs. *Blighia sapida* is rich in minerals such as Ca, Mg, Na, K, and P; hence it is recommended for consumption.



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