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FABRICATION OF BREADFRUIT DEHULLER AND COMPARATIVE QUALITY ASSESSMENT OF THE DEHULLED AFRICAN BREADFRUIT (*Treculla Africana*)

Chigozie C. N. Chimee[1], Chika C. Unegbu[2] and Obinna Ajah*[3]

[1]Department of Agricultural & Bio-Environmental Engineering, School of Engineering and Engineering Technology, Federal Polytechnic Nekede, Owerri, Nigeria.

[2]Department of Chemistry/Biochemistry, School of Industrial and Applied Sciences, Federal Polytechnic Nekede, Owerri, Nigeria.

[3]Department of Biochemistry, College of Natural Sciences, Michael Okpara University of Agriculture Umudike, Umuahia, Nigeria.

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***Corresponding Author**
Obinna Ajah
Department of Biochemistry, College of Natural Sciences, Michael Okpara University of Agriculture Umudike, Umuahia, Nigeria.

ABSTRACT

The traditional methods of dehulling breadfruits is very tedious and exhausting and this drudgery has been underlined as one of the foremost challenges militating against the realization of large production of African breadfruit, despite their widespread acceptance. This study fabricated breadfruit dehuller and evaluated the quality assessment of the dehulled African breadfruit (*Treculla Africana*) in comparison with the manually dehulled African breadfruit with respect to their proximate, mineral and amino acid profile. Standard analytical methods for proximate, spectrophotometric method of mineral analysis and high performance liquid chromatographic method for amino acid profiling were employed. The results shows non-significant ($p<0.05$) difference in the proximate composition, mineral composition and amino acid profile of the mechanically and manually dehulled African breadfruit. The protein, fat, ash, moisture, fibre and carbohydrate contents ranged from 14.07 – 14.82%, 6.70 – 7.00%, 5.30 – 5.60%, 9.50 – 10.40%, 3.00 – 3.10%, and 60.08 – 60.23% respectively. The potassium content of both mechanically and manually dehulled African breadfruit is 1090 mg/100g – 1096mg/100g, calcium contents is 290.50 - 286.20 mg/100g, phosphorus content is 330.80 – 310.00 mg/100g. Copper, iron, and zinc contents are within the range of 3.90-4.30 mg/100g, 15.21 mg/100g and 18.70mg/100g respectively. The amino acid content of the analyzed ABF were appreciable with Leucine (6.11 mg/100g) as the most abundant essential amino acid. From the outcome of the analysis, the mechanical method of dehulling breadfruit does not affect the nutritional content therefore the construction and usage of mechanical breadfruit dehuller should be encouraged because African breadfruit has appreciable amount of proximate components, minerals and amino acids which are very vital to human body.

KEYWORD: fabrication, Mechanical dehuller, *Treculla Africana*, Nutrition, Traditional dehulling.

INTRODUCTION

Drudgery which is involved in the dehulling of breadfruits, by traditional methods, has been underlined as one of the foremost challenges militating against the realization of the full potential of a good number of indigenous African seeds, as veritable staple foods, despite their widespread acceptance, and has therefore led to the development of a number of abrasive disk dehullers suitable for use in small-scale milling systems (Omobuwajo et al., 1999; Anosike et al., 2016).

Dehulling of breadfruit seed is a vital method used to get rid of the outer pericarp and testa (hull) using mechanical means (Etoamaihe and Ndubueze, 2010). Normally, this method through seed material bulk density reduction provides benefits such as increased temperature distribution management and other rate transfer processes in downstream processing (Anosike et al., 2016).

According to Bassey and Schmidt, (2015) the potential of the breadfruit seed has not been fully harnessed. This is mostly due to the traditional manual means of processing the seed which produces a low yield and increases the cost of processed seeds. If the manual dehulling approach is replaced with mechanized dehulling and a storage process is adopted, the market price of the processed breadfruit will definitely be lowered for local consumption as a staple food and enough quantity of the breadfruit seed can be processed for raw material or industrial feedstock.

African breadfruit belongs to the family Maraceae and it is a source of highly valued and appealing traditional food in Africa including the eastern and southern regions of Nigeria. It has high nutritional value, containing about 40% carbohydrate and 17% protein with several minerals and vitamins, and is a rich source of vegetable oil. Potential commercial and industrial benefits of breadfruit include raw materials for breakfast cereals and beverages, the production of soap, pharmaceuticals, flour for making biscuits, and paints (Nwabueze et al., 2008). In order to enhance the processing of breadfruit seed and also reduce the high cost of the processed seed, this study considered the fabrication of breadfruit dehuller and comparative quality assessment of the dehulled fruits.

Design and construction

Design Approach

The breadfruit dehulling machine was considered as a low-cost, easy adjustable machine, easy to maintain and easy-to-fabricate device for removing the hull of the African breadfruit seed.

Mode of operation

In the operational principle of the breadfruit duller, the rotation of the dehulling disk is achieved with electric motor. The hopper is a channel for the introduction of the breadfruit seeds, and the spiral on the supporting shaft is for the disk to convey and compresses the breadfruit seeds into the space between the rotating disk and the fixed disk. An adjustment is provided to determine the length of the gap between the disks. After the dehulling, the seeds along with the chaff drop into the drying unit in order to reduce the moisture content and enhance the separation process in the aspiration unit. The shell of the breadfruit seed is peeled via the rubbing action of the disks and it moves along with the cracked shell in the direction of rotation to the exit channel, leading to the drying unit. The blower with a heater runs independently and it is to dry the peeled breadfruit seeds and shell of their moisture content, for efficient separation. The blower in the aspiration unit sifts the hull from the endosperm, thereby delivering a certain quantity of air which is channeled to meet the dropping shells and dehulled seed from the drying unit. The cracked shells are lighter than the dehulled seeds and are carried away by the air in a different direction while the white seeds drop into a receiver (Anosike et al., 2016).

Construction of machine

The complete dimensions of the constructed machine are 450 x 250 x 750 mm3 (Fig. 1). The machine comprises the feed hopper which is made of galvanized steel sheet and it is fitted with a feed-rate regulator, and a motor to drive the cracking, the cracking unit comprises of a cylindrical roller, shearing unit which are the two cams mounted on the roller shaft, the cam follower mounted on four helical springs, and the shearing wall, and aspiration units which comprises of a fan and a system of ducts. For the power unit, the breadfruit dehuller is powered by a 1 hp electric motor.

Figure 1: fabricated breadfruit duhuller (dimensions 450 x 250 x 750 mm3).

Experimental

Procurement of Breadfruit seeds

A batch of 20 kg of the African breadfruit seeds was purchased from the Relief market in Owerri, Imo State, Nigeria.

Parboiling of seeds

The seeds were cleaned and divided into two lots of 10 kg each. Each lot was parboiled by soaking the seeds in water maintained at 70°C for 10 min, draining the water and steaming at 100°C for 15 min, followed by drying. Processed seeds were stored temporarily. Lot one was dehulled with the constructed dehuller while the lot two was dehulled manually.

Chemical Analysis

The deshelled seeds was subjected to chemical analysis to determine the quality of the produce.

Proximate Analysis

The proximate composition (moisture content, crude protein, fat, crude fibre, ash content) of the produce from the fabricated machine and that of the manually produce were analyzed using a standard methods as described in AOAC (2000) and carbohydrate content was calculated by difference.

Determination of Mineral Composition

The minerals Composition were analyzed using standard analytical methods as described by AOAC (2000)

Amino acid profile of the seeds

A method described by AOAC, (2000) was used for this analysis. The amino acid analysis was carried out on a High Performance Liquid Chromatography (HPLC) amino acid analyzer (Sykam-S7130) and the tryptophan contents of the alkaline hydrolysates was determined calorimetrically.

Statistical analysis

Statistical analysis of the data was carried out with SPSS version 22.0 using One Way Analysis of Variance (ANOVA). The statistically analysed data was reported as Mean+SEM. Significant difference was accepted at 95% confidence level of probability ($P < 0.05$).

RESULTS AND DISCUSSION

Proximate composition of mechanically and manually dehulled bread fruit

The proximate composition of mechanically and manually dehulled African bread fruit (ABF) is shown in Table 1. The result shows non-significant ($p<0.05$) difference in the proximate composition of the mechanically and manually dehulled ABF. The protein, fat, ash, moisture, fibre and carbohydrate contents ranged from 14.07 – 14.82%, 6.70 – 7.00%, 5.30 – 5.60%, 9.50 – 10.40%, 3.00 – 3.10%, and 60.08 – 60.23% respectively. The protein content of the mechanically dehulled ABF (14.82%), and manually dehulled ABF (14.07%) is high compared to 10.06% and 12.27% as reported by James and Nwabueze (2013). However, low compared to 17.97% (James *et al.*, 2020), 17.72% (Appiah *et al.*, 2017), and 25.62% (Nwaigwe and Adejumo, 2015). The fat content of the mechanically dehulled African bread fruit (McDABF) (6.90%) and the manually dehulled African bread fruit (MaDABF) (7.00%) is in agreement with the fat (7.00%) reported by James *et al* (2020), although low compared to 13.00% reported by Ejimofor and Oledibe (2022). The ash, moisture, fibre, and carbohydrate contents of both the MeDABF and MaDABF are in line with the findings of James *et al* (2020).

Proximate components are vital aspects of nutritional evaluation of food. Moisture content provides information on food storage form and spoilage capacity (Ejimofor and Oledibe, 2022). Fibre gives idea of the mineral content in food, fat improves the flavor and aid in satiety. The high carbohydrate content in ABF suggest that it is a good source of energy and could be used in the production of cookies and snacks.

Table 1: Proximate composition of mechanically and manually dehulled bread fruit.

Proximate	Mechanically dehulled (%)	Manually dehulled (%)
Protein	14.82 ± 0.04	14.07 ± 0.06
Fat	6.90 ± 0.94	7.00 ± 0.26
Ash	5.60 ± 0.02	5.30 ± 0.08
Moisture	9.50 ± 0.11	10.40 ± 0.05
Fibre	3.10 ± 0.02	3.00 ± 0.07
Carbohydrate	60.08 ± 2.80	60.23 ± 3.00

Values are mean±SEM of triplicate determination.

Mineral Composition of Mechanically and Manually Dehulled African Bread Fruit

The mineral composition of the African bread fruit is shown in Table 2. The result shows that there was non-significant (p>0.05) difference in the mechanically dehulled African bread fruit (McDABF) and manually dehulled (MaDABF) in the mineral elements analyzed.

Potassium is very vital element that helps in the maintenance of body fluid electrolyte balance. The potassium in association with sodium, plays crucial role in nerve and brain functioning, and muscle development (James *et al*., 2020). The potassium content of 1090 mg/100g – 1096mg/100g in this study is low compared to 1243.45mg/100g reported by James *et al.* (2020), but higher than 587.00 mg/100g reported by Oyeleke *et al.* (2014).

The most abundant macro element in the body is calcium, in addition with phosphorus. Both plays a role in the process of bone formation and blood coagulation (Miller *et al.*, 2001; Cormick and Belizan, 2019). In this study, the calcium contents for McDABF and MaDABF are 290.50 mg/100g and 286.20 mg/100g respectively, while the phosphorus content is 330.80 – 310.00 mg/100g.

The human body needs magnesium for regulation of blood sugar and blood pressure, as well as maintaining proper functionality of the muscle and nerve (Grober *et al.*, 2015; Schwalfenberg and Genius, 2017). The magnesium content obtained from the McDABF and MaDABF is appreciable and not much different from that obtained by James *et al.* (2020).

The copper, iron, and zinc contents of the analyzed ABF is within the range of 3.90-4.30 mg/100g, 15.21 mg/100g and 18.70mg/100g respectively. Copper and zinc are important for body metabolic processes. They mainly serve as cofactor of metabolic enzymes (Mustafa and

Alsharif, 2018). This study revealed that ABF contains reasonable amount of copper, iron and zinc.

Table 2: Mineral Composition of Mechanically and Manually Dehulled African Bread Fruit.

Mineral (Mg/100g)	Mechanically Dehulled (Mg/100g)	Manually Dehulled (Mg/100g)
Potassium	1096.50 ± 5.80	1090.80 ± 7.20
Sodium	240.00 ± 2.10	248.20 ± 3.50
Calcium	290.50 ± 1.40	286.10 ± 2.40
Magnesium	125.00 ± 4.20	120.40 ± 1.80
Phosphorus	330.80 ± 8.00	310.00 ± 5.20
Iron	15.20 ± 1.10	15.00 ± 1.00
Cupper	4.30 ± 0.05	3.90 ± 0.10
Zinc	18.70 ± 2.08	18.60 ± 1.20

Values are mean±SEM of triplicate determination.

Amino Acid Profile of Mechanically and Manually Dehulled African Bread Fruit

Table 3 shows the amino acid profile of mechanically and manually dehulled African bread fruit. The results showed non-significant ($p>0.05$) difference in the mechanically and manually dehulled African bread fruit in all the analyzed amino acid. The most abundant amino acid from the study are glutamic acid alanine (6.10-6.80 mg/100g), aspartic acid (5.20-5.40 mg/100g), arginine (5.40-5.90 mg/100g), glycine (5.20-5.60 mg/100g), leucine (5.82-6.11 mg/100g) and (4.80-5.00 mg/100g). Leucine is the most abundant essential amino acid in African bread fruit as shown from the record of this study.

Table 3: Amino Acid Profile of Mechanically and Manually Dehulled African Bread Fruit.

Amino acid	Mechanically dehaulled (Mg/100g)	Manually dehaulled (Mg/100g)
Valine	5.86 ± 0.12	5.80 ± 0.05
Methionine	1.92 ± 0.05	2.10 ± 0.08
Lysine	4.22 ± 0.80	4.00 ± 0.12
Leucine	6.11 ± 0.50	5.82 ± 1.00
Isoleucine	3.90 ± 0.15	3.60 ± 0.07
Threonine	2.06 ± 0.05	2.10 ± 0.10
Tryptophan	5.90 ± 0.20	5.40 ± 0.52
Phenylanine	2.85 ± 0.08	2.90 ± 0.10
Histidine	3.00 ± 0.10	2.80 ± 0.05
Cysteine	2.90 ± 0,20	2.92 ± 0.08
Serine	4.00 ± 1.30	3.70 ± 0.50
Arginine	5.40 ± 1.00	4.90 ± 0.60

Aspartic acid	5.20 ± 1.08	5.40 ± 0.80
Tyrosine	3.08 ± 0.07	3.00 ± 0.02
Glycine	5.60 ± 0.30	5.20 ± 0.50
Alanine	6.80 ± 1.50	6.10 ± 0.90
Glutamic acid	5.00 ± 1.20	4.80 ± 0.08
Proline	2.80 ± 0.50	2.10 ± 0.05

Values are mean±SEM of triplicate determination.

CONCLUSION

The mechanical method of dehulling bread fruit does not affect the nutritional content. Construction of bread fruit dehuller is easy and dehulls very fast, which leads to more produce, and probably, would reduce cost of bread fruit in the market. Hence, the construction and usage of mechanical breadfruit dehuller should be encouraged because African breadfruit has appreciable amount of proximate components, minerals and amino acids which are very vital to human body.

Conflict of interest

The authors declare that no conflict of interest exists with respect to this work.

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