Dehulling Effects on Vitamins, Minerals and Sensory Properties of Toasted African Breadfruit (*Treculia africana)* Seeds

Comment [J1]: Please, evaluate english in main text. Some sentence are not understandable at all.

ABSTRACT

Background: Dehulled toasted bread-fruit seeds are fast replacing normal toasted dehulled seeds due to ease of production to meet demand, but they are liable to nutrient losses. To avoid hidden hunger, we evaluated their nutrient content with standard analytical methods to know the extent of destruction and sensory properties to know the effects on acceptability.

Aim: This work aimed at investigating the effects of toasting African breadfruit seeds before and after toasting of the nutrient content and acceptability.

Comment [J2]: Reorder sentence to be understandable. For example: The aim of this study was to determine the effect of toasting on nutritional composition of African breadfruit seeds

Study Design: This study was made to fit a one way Analysis of Variance

Place and Duration of Study: This research was carried out in Umuahia, Abia State capital of Nigeria between March and June, 2018.

Methodology: Procured raw breadfruit seeds were sorted and divided into two batches. One batch was parboiled at 100°C for 15 minutes, manually dehulled, winnowed to remove the hulls and toasted in a frying pan at 45°C for 30m with constant stirring to obtain crispy light brown seeds. The other batch was toasted without dehulling at same temperature-time regime and allowed to cool to room temperature before manual dehulling.

Comment [J3]: The origin of breadfruits seeds is necessary to cite

Results: Un-dehulled toasted breadfruit (UTB) sample had significant ($p<0.05$) higher vitamin A (1.62mg/100g), B1 (0.03mg/100g), B2 (0.02mg/100g), B3 (0.85mg/100g), vitamins C (2.61mg/100/g), E (0.43mg/100g) than dehulled toasted breadfruit (DTB) sample with 1.47mg/100g, 0.02mg/100g, 0.01mg/100/g, 0.76mg/100g, 2.44mg/100g and 0.37mg/100g respectively for vitamins A, B1, B2, B3 C and E. The UTB had significantly ($p>0.05$) higher calcium (48.23), phosphorous (55.35), sodium (22.72), zinc (0.93) than DTB with respective values of 43.66, 52.67, 20.09 and 0.04 all in mg/100g The DTB sample had significant ($p>0.05$) higher potassium (336.29) magnesium (35.97) and iron (1.68) than UTB with respective values of 295.86, 32.85 and 1.53 all in mg/100g. The UTB had significant ($p< 0.05$) higher general acceptability (7.51) than DTB (7.36).

Conclusion: UTB sample was higher in all the vitamins and most of the minerals than DTB and therefore better in terms of nutrient density and acceptability.

Keywords: African breadfruit seeds, dehulling, toasting, nutrient density, sensory properties.

Comment [J4]: Nutritional quality

1 INTRODUCTION

African breadfruit (*Treculia africana*) tree grows widely in the high rain forest zone of Nigeria and other African countries producing enormous seeds during its fruity season (March to April). A mature tree produces approximately fifty fruits annually [1]. The common forest tree is given many names by various locations where it is found. For instance, in Igbo it is cal "Ukwa" which is the most popular tribal name. Other local names include "afon" by Yorubas,"ize" by Benin, "Ediang" by Efik, Ibibios and Annangs and "barafutu" in Hausa [2, 3].

The seeds are highly nutritious and constitute a cheap source of vitamins, minerals, proteins, carbohydrates, fats [4]. Also, mineral compositions showed that the seeds contained 710 mg/100g sodium, 587mg/100g potassium, 166mg/100g magnesium, 1.66 mg/100g iron, 8.50mg/100g zinc and 3.67mg/100g copper [5]. Comparative study of the nutritive significance of dehulled and fresh un-dehulled African breadfruit by Arawande *et al*. [6] showed that un-dehulled seeds are richer in sodium, calcium, magnesium, and iron than dehulled seeds which was richer in zinc, copper, lead, and potassium than dehulled seeds.

Utilization of African breadfruit is limited by its poor storage stability resulting from higher perishable nature. Parboiled and dehulled seeds kept up to 12 hours at room temperature [7]. Long storage time and conditions, high moisture content of the seeds and high storage temperature lead to hardening of the hulls and increase the cooking time which affect product quality [8]. Diffusion of tannins and polyphenols which are more in the seed coat into the cotyledon during storage interferes with the nutritive value [9]. Also, the hydroxyl groups of the phenol ring enable the tannins cross links with proteins and results in post harvest seed hardening and decreased digestibility [10].These limitations have made the seeds to be eaten fresh or process immediately to preserve the nutrients for availability while removing or reducing the anti-nutrients levels which interfere with nutrient digestion and absorption [11].

Dehulling is one of the primary processing methods of the seeds which involve removal of seed coat or hulls to improve the texture and other properties of the seeds. Dehulling may be manual or mechanical. In Eastern part of Nigeria where African bread is relish much, manual dehulling had been replaced by mechanical dehulling. Manual dehulling of African breadfruit seeds involves repeatedly gentle rolling of portable rectangular wooden object over the seeds on a pre conditioned floor or jute bag spread on the floor until the seeds are completely dehulled. Manual dehulling is laborious, wasteful, time consuming and yields more split than whole dehulled seeds, some undehulled seeds and hulls. Mechanical plate mill machine is used for mechanical dehulling [8]. A mechanical dehulling process for African breadfruit with over 80% dehulling efficiency had been developed [12].

Toasting of African breadfruit seeds is a heat processing method involves cooking with a combination of conductive and radiative dry heats in an open pan with constant steering. Desirable flavour and colour are developed during toasting through milliard browning and caramelization due to high toasting temperature. Also, crispy texture typical of toasted breadfruit is developed.. This work aimed at investigating the effects of dehulling on the vitamin, mineral and sensory properties of toasted African bread fruit seeds.

2 MATERIALS

2.1 Raw materials

Fresh and mature African breadfruit seeds were purchased from Ndoro market in Ikwuano Local Government area of Abia state, Nigeria.

2.2 Sample preparation

Dehulled toasted African breadfruit seeds were obtained from raw seeds according to flow chart (Fig. 1). Sorted and washed raw seeds were parboiled, manually dehulled, winnowed and toasted in frying pan at 45^{0}C for 30min with constant stirring. Toasting un-dehulled breadfruit (Fig. 1) was direct without parboiling, dehulling, and winnowing. After toasting, both samples were allowed to cool at room temperature, packed separately in clean, dry, airtight marked containers and stored for analyses.

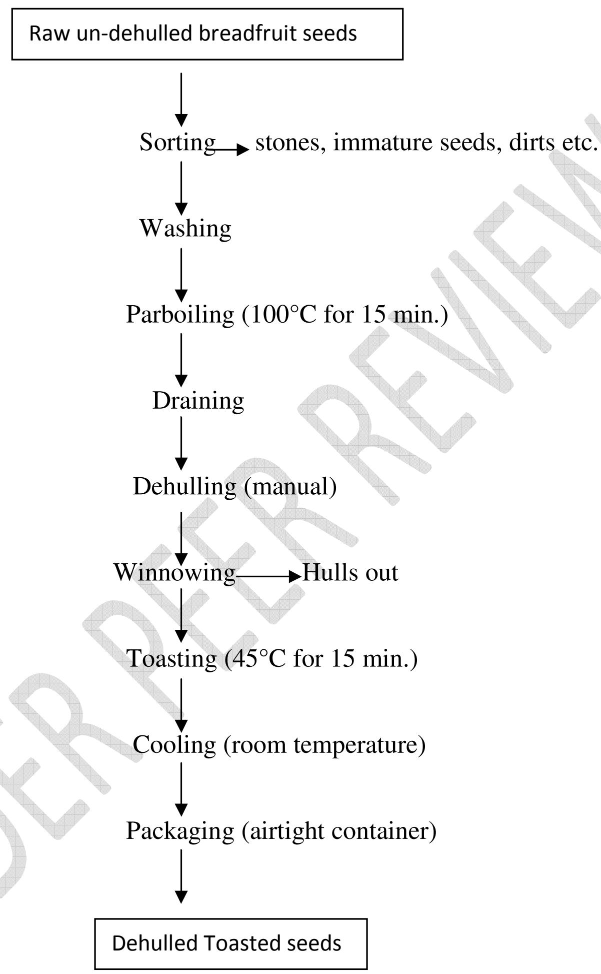

Figure 1: Flow chart for dehulled toasted breadfruit seeds

3 METHODS

3.1 Determination of vitamins:

Spectrophotometric method by Onwuka [13] was employed in the determination of vitamins A, B_1 (Thiamine), B2 (riboflavin), B3 (Niacin) and E (Tocopherol) while vitamin C (ascorbic acid) was by method described by Okwu and Josiah, [14].

3.2 Determination of mineral:

Working sample digests for analyses were prepared according to Capentar and Hendricks [15]. Five grams (5g) each of DTB and UTB samples were separately burnt to ash thereafter dry ashed in a muffle furnace at 550^0C for 5hrs. The resulting ash was dissolved in 10mls of 2M HCL solution and diluted to 100ml in a volumetric flask using distilled water and filtered. The filtrate was used for different mineral analyses.

3.3 Phosphorous:

Phosphorous in the sample digest was determined by the vanadomohybdate (yellow) spectrometry method described by James [16] using Jenway electronic spectrophotometer at a wavelength of 420nm. Absorbance of the blank at zero was given.
Percent phosphorous content (g) for both samples were calculated by the formula:-

$$\frac{g}{100g} = \frac{100}{W} \times \frac{Au}{As} \times \frac{Vf}{Va}$$

Where: W= weight of sample analyzed, Au = absorbance of test sample, As = absorbance of standard solution, Vf = total volume of filtrate, Va = Volume of filtrate analyzed.

3.4 Calcium and Magnesium:

Calcium and magnesium content of the working sample digests from both samples were determined using Versanate EDTA Complexiometric titration described by Capentar and Hendricks [15]. Percent calcium and magnesium contents were calculated separately using the formula.

$$\%\ \text{Calcium or Magnesium} = \frac{100}{w} \times EW \times N \times \frac{Vf}{Va} \times T - B$$

Where:- W= weight of sample analyzed, EW = equivalent weight, N = normality of EDTA, Vf = total volume of extract, Va = volume of extract titrated, T = titre value of the sample, B = titre value of blank..

3.5 Potassium and Sodium:

Flame photometry was used to determine the concentration of potassium and sodium in the sample digest as described by Carpentar and Hendricks [15]. The concentrations of both minerals in the samples were calculated as follows.

$$K\frac{mg}{100g}\ or\ Na\frac{mg}{100g} = \frac{100}{W} \times \frac{1}{1000} \times X \times \frac{Vf}{Va} \times D$$

Where:-W = weight of sample used, X = concentration (in ppm) from curve, Vf= total volume of extract, Va = volume of the extract (digest) flamed, D = dilution factor where applicable.

3.6 Zinc:

Zinc content was determined using atomic absorption spectrophotometer (Buck scientific 205 atomic absorption spectrophotometer) method as described by AOAC [17]. Sample digest from both ashes were aspirated into the atomic absorption spectrophotometer at different wave lengths during which they were converted into a free atom vapour. A monochromatic zinc source was directed through the flame and the amount of radiation of a specific energy absorbed by the solution was recorded. A calibration graph was then prepared for the element and from which the amount of the element present in each sample was read. Zinc content of the sample was calculated as shown below.

$$\text{Zn (mg/100g)} = \frac{100}{W} \times \frac{X}{100} \times \text{D}$$

Where:-W= Weight of the sample analyzed, X= Equivalent concentration (ppm) derived from the standard curve and D= Dilution factor.

3.6 Dietary iron:

Just like in zinc, atomic absorption spectrophotometer (Buck scientific 205 atomic absorption spectrophotometer) method by AOAC [17] was used to determine dietary iron content sample digest of both samples as shown below.

$$\text{Fe (mg/100g)} = \frac{100}{W} \times \frac{X}{100} \times \text{D}$$

Where:-W=Weight of the sample analyzed, X= Equivalent concentration (in ppm) derived from the standard curve and D= Dilution factor.

3.7 Sensory Evaluation

Sensory evaluation was carried out on both toasted samples within an hour after toasting. A 25 semi-trained panelists were selected from males and females staff and students of Michael Okpara University of Agriculture Umudike between the ages of 20 to 40yrs who are familiar with toasted breadfruit seeds. The samples were coded and randomly presented to the panelists in the same type of saucers with bottled water to rinse their mouths between each evaluation. They were instructed to chew one sample and rinse their mouths with water provided before the next. Thereafter, they were to evaluate their flavour, crispiness, taste, chewiness, overall acceptability, and rank the attributes according to 9-point Hedonic scale where 1 represented “dislike extremely” and 9 ‘like extremely”.

3.8 Statistical Analysis

Data obtained were subjected to T-test analysis using the statistical package for social sciences (SPSS], version 22 .0. The triplicate results obtained were presented as mean ± standard deviations. T-test analysis was used for comparison of the means. Differences between means were considered to be significant at $P< 0.05$ using the T-test analysis.

4 RESULTS AND DISCUSSION

4.1 Vitamin content

All the vitamin content results of both samples are presented in Table 1

4.1.1 Vitamin A

There was significant (*P* =.05) vitamin A increase from 1.47mg/100g in DTB to 1.62mg/100g in UTB sample. Lower vitamin A content in DTB may have resulted from parboiling and higher toasting heat due to absence of hull which resulted in more vitamin A loss. The hull may have prevented excess heat into the seeds in UTB samples. Badejo [18] had reported that losses of vitamins occur during processing operations such as soaking, boiling, toasting and others. Significant difference (*P* =.05) in vitamin A content between the samples may mean that coupled heating effects of parboiling and toasting with absence of hulls had significant destructive effects in vitamin A. Vitamin A is a fat soluble vitamin that is good for healthy vision, skin, bones and other tissues. It works as an antioxidant and fights against cell damage among others [19]. Consumption of toasted breadfruit seeds along with other vitamin A rich foods will help to meet the RDI of 600 to 700µg for adult of both sexes [20].

4.1.2 Vitamin B

Respective UTB sample vitamins B1, B2 and B3 values of 0.03 mg/100g, 0.02mg/100g and 0.85mg/100g were significantly (*P*=.05) higher than those of DTB with respective values of 0.02mg/100g, 0.01mg/100g and 0.76mg/100g. However, higher vitamin B retention of UTB sample than DTB may be attributed to presence of hull which may have protected the seeds from excess toasting heat as well as of parboiling and leaching of same into parboiling water. Vitamin B is a water soluble mineral tied to low stroke risk, good health and promotion of healthy metabolism. While vitamin B1 prevents Beriberi and B2 boosts immune system and helps the body make up red blood cells; vitamin B3 breaks food into energy [21]. Though toasted breadfruit is not a good source of B vitamins, but will help to meet the RDI when taken as an adjunct [22].

Table 1: Vitamin content of dehulled and un-dehulled toasted African bread fruit seed (mg/100ml).

	Vitamin A	Vitamin B1	Vitamin B2	Vitamin B3	Vitamin C	Vitamin E
DTB	$1.47^{b} \pm 0.01$	$0.02^{b} \pm 0.00$	$0.01^{b} \pm 0.00$	$0.76^{b} \pm 0.01$	$2.44^{b} \pm 0.02$	$0.37^{b} \pm 0.01$
UTB	$1.62^{a} \pm 0.03$	$0.03^{a} \pm 0.00$	$0.02^{a} \pm 0.00$	$0.85^{a} \pm 0.01$	$2.61^{a} \pm 0.02$	$0.44^{a} \pm 0.02$

Data represent the mean ± standard deviation of the readings. All the values on the same column with the same superscripts are not significantly different (P< 0.05). DTB = de-hulled toasted breadfruit, and UTB = un-dehulled toasted breadfruit.

4.1.3 Vitamin C (ascorbic acid)

The UTB sample recorded a significant (*P*=.05) higher vitamin C value of 2.62mg/100g than DTB with a lower value of 2.44mg/100g. The difference just like other vitamins may be attributed to heating effects of parboiling and toasting which were more severe due to absence of hull resulting in more vitamin C content loss in DTB than in UTB sample. Vitamin C is heat labile [23] and a major water soluble antioxidant within the body [24] that is required in small amount (few mg to a 100mg). Due to general low vitamin C in both samples, toasted bread fruit seeds should be eaten with other vitamin C rich foods or snacks. Vitamin C is generally used for protein metabolism and collagen synthesis. Antioxidants such as vitamin C and carotenoids coupled with dietary fiber have been associated with prevention of nutritionally related diseases such as obesity, coronary heart disease [25]. Vitamin C also contributes to several key oxidative and reductive enzyme system and also has the ability to regenerate other biologically important antioxidants such as glutathione and vitamin E into their reduced state [26].

4.1.4 Vitamin E:

Vitamin E content of UTB sample (0.44mg/100g) was significantly (*P*=.05) higher than DTB (0.37mg/100g). The difference may stem from significant loss due to excess heat resulting from parboiling and toasting as a result of absence of hulls in DTB sample. This may mean that the hulls in UTB may have provided significant protection against parboiling and toasting heat. Vitamin E is a fat soluble vitamin that is used among others for respiratory infections, infertility, impotence, chronic fatigue syndrome, prevention of allergies and heart diseases [27]. Regular consumption of toasted breadfruit along with vitamin E rich fatty foods will aid in meeting vitamin E RDI of 20µg [28] .

4.2 Mineral composition:

Mineral content results of DTB and UTB samples were presented in Table 2.

4.2.1 Calcium

The UTB had a significant (*P*=.05) higher calcium content of 48.23mg/100g than DTB with a value of 43.66mg/100g. The difference may have stemmed from leaching of calcium into cooking water during parboiling [29]. Also, it may mean that the hulls may have contained calcium which was removed in DTB sample. Calcium constitutes a large proportion of the bone, blood and extracellular fluid and is necessary for normal functioning of cardiac muscles, blood coagulation, milk clotting and regulation of cells permeability [30]. Though toasted breadfruit is not a good calcium source but can complement calcium content of some foods to meet the RDI of 1000 to 1300mg/day [31] when taken as adjunct.

Table 2: Mineral composition of dehulled and undehulled toasted African breadfruit seeds (mg/100g)

Samples	Calcium	Phosphorous	Magnesium	Iron	Potassium	Sodium	Zinc

DTB	43.66^{b}±0.18	52.67^{b} ± 0.18	35.97^{a}±0.18	1.68^{a}±0.06	336.29^{a}±11.75	20.09^{b}±0.7	0.83^{b}±0.04
UTB	48.23^{a}±0.81	55.35^{a}±1.27	32.85^{b}±0.07	1.53^{b}±0.01	295.86^{b}±1.41	22.72^{a}±0.09	0.93^{a}±0.01

All the values represent the mean ± standard deviation of the readings. Values on the same column with the same superscripts are not significantly different (P< 0.05). DTB = dehulled toasted breadfruit and UTB = un-dehulld toasted breadfruit.

4.2.2 Phosphorous:

Phosphorous content of UTB (55.96mg/100g) was significantly (*P*=.05) higher than 52.67mg/100g from DTB probably during toasting as phosporous had been advanced as volatile element liable to loss during heating [32]. Leaching of phosphorous into the parboiling water may have contributed to the difference as well. Phosphorous may be present in the hulls which were removed during dehulling. Phosphorous is an essential mineral primarily needed for growth and repair of body cells and tissues and can complement other phosphorous rich foods in meeting the RDI of 700mg/day [33].

4.2.3 Magnesium:

Magnesium content of DTB (35.79mg/100g) was significantly higher than 32.85mg/100g from UTB. The values were lower than 166mg/100g reported by Osabor *et al*. [4] for the raw breadfruit seeds may be due to processing methods employed, variety and source. Higher magnesium content of DTB than UTB may be due to more loss of moisture thereby increasing the proportion of magnesium. Magnesium functions as a co-factor of more than 300 different enzyme systems of the body. It is indispensable in the formation and use of high energy phosphate bonds known as ATP. It is needed for healthy bones and blood vessels, and essential in nerve and muscle activity [34]. Toasted breadfruit especially UTB sample could be a complementary source of magnesium if taken along with other magnesium rich foods to meet magnesium RDI of 310 to 420mg/day [35].

4.2.4 Iron:

The DTB sample had significant (*P*=.05) higher iron value of 1.68mg/100g than 1.53mg/100g from UTB which may stem from the differential processing methods employed which may have prevented iron loss. Exposure to higher heat in DTB samples may have decreased the moisture more thereby increasing the iron proportion. The DTB iron value obtained was slightly higher than 1.66mg/100g reported by Makinde *et al*. [5] while that of UTB was lower probably due to variety and methods employed. Iron is a micro mineral necessary for formation of hemoglobin that carries oxygen in the blood and myoglobin to muscle tissues. Iron also helps in energy production and healthy immune system. The DTB is a better complementary iron source than UTB. When taken as a snack after meal will complement iron RDI of 10 to 18mg/d [36].

4.2.5 Potassium:

The DTB had potassium content of 336.29mg/100g is significantly higher than 295.86 mg/100g from UTB sample. All the results were lower than 587mg/100g reported by Makinde *et al* [5] probably due storage period before procuring them, processing methods and seed variety. Ihekeronye and Ngoddy [8] and Ekpenyong [9] had earlier reported effects of storage on breadfruit quality. Dehulling, variety and source may have contributed to the cause of increase. Proportional increase due to more loss of water may not be left out. Potassium, the most abundant mineral compare to others plays the role of controlling skeletal muscle contraction, nerve impulse transmission, helps to relief strokes, high blood pressure, kidney disorder, anxiety and stress. Potassium helps to balance body fluids, enhances muscle strength, metabolism and proper metabolism [37].Toasted breadfruit especially DTB when taken as adjunct food will aid to regulate body fluid balance and proper metabolism.

4.2.6 Sodium:

Significant (*P*=.05) higher sodium content of UTB sample (22.77mg/100g) than DTB sample (20.08mg/100g) may be due to leaching into parboiling water and dehulling. The hulls may have contained some sodium. Both values obtained were lower than 710mg/100g reported by Makinde *et al*. [5] for breadfruit seeds probably due to the processing methods adopted storage period before processing and variety of seeds used. However, the body requires a small amount of sodium to help maintain normal blood pressure, osmotic pressure, transmission of impulse, absorption of glucose and acid-base balance [38]. The levels of sodium in both samples will contribute to the above health benefits.

4.2.7 Zinc:

Zinc content from UTB sample (0.93mg/100g) recorded significant (*P*=.05) higher value than 0.82mg/100g from DTB. Higher zinc value of UTB than DTB may mean that hulls may have contributed significantly in retaining zinc. Volatile nature of zinc in dry ashing had been acknowledged [32]. Also, zinc may have leached into parboiling water in DTB sample. Both values obtained were relatively lower than 8.50mg/100g reported by Makinde *et al.* [5] for raw breadfruit seeds which may have validated that variety, source, dehulling and parboiling have significant influence in retaining zinc in toasted breadfruit. Storage effects may have contributed too. Zinc plays a significant role in cell division, cell growth, wound healing and in breakdown of carbohydrate. It is needed for the senses of smell and taste during pregnancy, infancy and childhood. Body needs zinc for growth and proper development [39]. Zinc is needed for the body's defensive (immune) system to work properly and protects liver from chemical damage. Zinc deficiency may decrease the ability of the immune system to function [40]**.**

5 Sensory scores of the breadfruit seeds

Results of sensory scores of the toasted breadfruit are presented in Table 3.

5.1 Appearance:

The appearance of the UTB sample was scored 7.75 by the panelists which is significantly (*P*=.05) higher than 6.52 from.DTB. Higher preference of UTB sample than DTB may be attributed to higher heat exposure to tannin content of DTB sample than UTB resulting in undesirable deep brown colour. Farquar [41] had earlier reported that tannins cause browning or other pigmentation in both fresh foods and processed products. This may have given the UTB sample desirable uniform browning that attracted higher rating. Besides, sudden higher moisture loss in DTB than in UTB sample due to absence of hulls may have resulted in shrink seed surfaces thereby affecting the general seeds appearance.

Table 3: Sensory scores of DTB and UTB African breadfruit seeds samples:

Samples	Appearance	Flavor	Crispiness	Taste	Chewiness	General A
DTB	$6.51^{b} \pm 0.01$	$6.48^{b}\pm0.02$	$7.15^{b} \pm 0.05$	$7.07^{b}\pm0.03$	$7.25^{b} \pm 0.04$	$7.36^{b} \pm 0.02$
UTB	$7.75^{a}\pm0.02$	$7.51^{a}\pm0.02$	$7.51^{a}\pm0.02$	$11.03^{a}\pm0.03$	$7.23^{a}\pm0.03$	$7.51^{a}\pm0.98$

All the values represent the mean ± standard deviation of the readings, Values on the same column with the same superscripts are not significantly different (P< 0.05), DTB = dehulled toasted breadfruit and UTB = un-dehulled toasted breadfruit. A = acceptability

5.2 Flavour:

The UTB sample was rated 7.51 by the panelists which was significantly higher than 6.48 rating of DTB. The difference may be attributed to hulls in UTB sample which may have prevented the volatile compounds from escaping during toasting. The hulls also may have imparted some desirable flavor to the seeds of UTB samples during toasting. Besides, more volatile components of DTB sample may have escaped during parboiling and toasting. Dry rendered fat in UTB sample was not lost but was retained by the hulls to add to the flavour.

5.3 Crispiness:

The test panelists rated UTB sample 7.51 which was significantly (*P*=.05) higher than 7.15 from DTB. This implies that UTB sample was most preferred by the test panelist. However, this may be due to the presence of the hulls which may have prevented the seed from loosing excess during toasting or gaining moisture from the environment after toasting. On the other hand, excess water loss by DTB sample resulted in dried product with relatively undesirable crispiness.. Moisture has an inverse relationship with crispiness which is a major index of acceptability in toasted breadfruit without which it may not be acceptable.

5.4 Taste:

The taste of UTB was more preferred by the panelists with a rating of 7.67 which was significantly (*P*=.05) higher than 7.07 from DTB sample. Preference of UTB sample to DTB could be attributed to higher flavour recorded by UTB. Flavour is a combination of taste and aroma. The hulls of UTB sample may have prevented the escape of volatile components and dry rendered fat of the UTB sample thereby increased the flavour.

5.5 Chewiness:

Higher chewiness score of UTB (7.32) by the panelists was significantly (*P*=.05) higher than 7.25 from DTB sample. This may be due to significant higher crispiness of UTB than DTB which was harder and brittle to chew due in part to relatively higher moisture loss during toasting. Desirable chewiness hinges on crispiness which in turn has an inverse relationship with moisture.

5.6 General Acceptability:

The UTB sample was preferred to DTB by the panelist with 7.51 rating which was significantly (*P*=.05) higher than 7.36 from DTB. Preference of UTB to DTB could be better explained by higher significant ($p<0.05$) difference of UTB than DTB in all the attributes tested.

6 CONCLUSION

The results obtained in this study showed that toasting breadfruit seeds before dehulling is the best processing method as regards nutrient preservation, shelf stability and acceptability. Ash, fat, fiber, protein, carbohydrate vitamins and minerals content were higher in the un-dehulled toasted seeds.

Comment [J5]: Please rewrite the conclusion since the main results are not in agreement with this conclusion. Both seeds was toasted but one group of samples was not dehulled so this un-dehulled samples had higher content of analyzed vitamis, minerals and better sensory characteristics. Also, suggestion is to expand the conclusions.

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