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A COMPARATIVE STUDY OF THE NUTRITIONAL COMPOSITION OF RAW, BOILED AND ROASTED *TRECULIA AFRICANA* (AFRICAN BREADFRUIT).

Ezennaya C. F[1]*. & Ezeigwe O. C[2].
[1]*Department of Biochemistry, Alex Ekwueme Federal University Ndufu Alike Ikwo, Abakaliki*
[2]*Departmet of Applied Biochemistry, Nnamdi Azikiwe University, Awka*
Correspondence: felicia.ezennaya@funai.edu.ng, chidinmaezennaya@gmail.com

ABSTRACT

The study investigated and compared the phytochemical analyses, proximate analysis, vitamin, and mineral composition of raw, boiled, and roasted *Treculia africana* seeds**.** The seeds were processed, manually dehulled, and divided into 3 portions; A (raw), B (boiled) and C (roasted), air-dried and ground into flour. Samples were analyzed using standard methods. There were significantly (p<0.05) higher levels of steroids, glycosides, tannins, flavonoids, saponins and reducing sugars in the raw sample compared to the boiled and roasted samples. Results of the proximate analysis showed significantly higher amount of ash, carbohydrates, and fiber content of raw samples compared to boiled and roasted samples. A significant amount of proteins and fats were observed in the roasted while moisture content of boiled were higher compared to others. Results of the mineral composition showed significantly (p<0.05) higher levels of sodium, copper, magnesium, and phosphorus in the roasted samples compared to the raw and boiled samples. Levels of potassium, iron, calcium, fluoride, and cobalt were observed higher in the raw sample compared to other samples. Although, iron and calcium were higher in the boiled samples than roasted. Vitamins A, B_2, B_3, B_6, D, E and K levels were significantly (p<0.05) higher in the boiled samples compared to the roasted one. Even though this study has shown that processing of *Treculia africana* by roasting and boiling improves its nutrient composition, roasting has shown higher levels of the most nutrients except vitamins compared to boiled sample. This is an indication that roasting reduces the vitamin content of breadfruit.

Keywords: *Treculia africana*, Proximate analysis, Vitamins, Minerals, Phytochemical analysis.

INTRODUCTION

African breadfruit (*Treculia africana*) is a member of the Moraceae family and belongs to genera *Treculia* found in many parts of West and Tropical Africa around evergreen and deciduous forest, Baiyeri, K.P. and Mbah, B.N. (2006). Breadfruit (*Treculia africana*) is found around human dwellings and farmlands. It has immense potential as a nutritional source for man Osabor *et al.,* (2009). Though the species is found within both moist and dry tropics in Africa, it is most common within the moist tropical rainforest zone, especially near streams or in swampy areas in tropical riverine forests. (Nnorom *et al*, 2014). Okafor, J.C. (1985), *Treculia africana* is one of the forest tree species that are adjudged to be of immense domestic importance to both rural and urban dwellers. It provides assortment of food necessary for nutritional diversity and survival especially during the hungry season (i.e., between November and April), when farm crops are planted. The seed of African bread fruit (*Treculia africana*) is variously named by different tribes across the continent (Africa). In Nigeria, it is known as "ukwa" by the Igbo, the Yorubas call it as "ofon" or "foo-foo", Efik, Ibibio, and Anangs do call it as "ediang", Benis call it "ize", Hausa call it "barafuta", some of the African country such as Ashanti in Ghana also have their own name, and it is known as totin Baiyeri and Mbah, (2006). It is known as African breadfruit by countries like USA, Tanzania and Zambia and African boxwood in Malawi (Fasai *et al*,2004).

In Nigeria it is widely cultivated in the southern states of Nigeria where the seeds serve as low-cost meat substitute for poor families Badifu and Akubor, (2001). When extracted the seeds are said to be nutritious when processed adequately by boiling or roasting (Ejiofor *et al*., 1998).Seeds can be cooked as porridge alone or mixed with cereals like rice sorghum (Onweluzo and Nnamuchi, 2009; Ijeh *et al*., 2010). However, it can be roasted and eaten with palm kernel or coconut as a roadside snack. The seeds could be used for pastries, weaning foods, breakfast cereals, alcohol wood production and beverages when ground into powder (Okafor, 1993; Leocha *et al.,* 2016). The seeds are reported to have an excellent polyvalent dietetic value whose biological value exceeds even that of soybeans (WAC, 2004)

The African breadfruit seeds are highly nutritious and constitute a cheap source of vitamins, minerals, proteins, carbohydrate, fats, moisture, crude protein, and Ash Olapade *et al.*, (2014; Osabor *et al.*, 2009;Enibe, 2013).Nwabueze, (2006) reported decrease in carbohydrate content and increase in moisture content during storage which can lead to fast deterioration of the seed. The seeds are relatively good source of iron, calcium, potassium, ascorbic acid, and riboflavin (ICRAF, 2010). Ejidike and Ajileye, (2007).

However, Okafor and Egbung (2009) reported that *Treculia africana* seeds contain the phytochemicals: flavonoids, polyphenols, anthraquinone, saponins and cardiac glycosides (Okafor and Egbung 2009). These phytochemicals are bioactive agents that could be used in the partial synthesis of some useful drugs(Yakubu *et al.,* 2005).

The demand for African breadfruit is affected by price, taste and preference, income level, seasonality, and age of consumers (Stanlake and Grant, 1999). Despite the dietary and economic importance of African breadfruit, it has remained an under-utilized specie till now and its potentials remain under-exploited (Olapade *et al.*, 2014); Nuga and Ofodile, 2010). This study was carried out to maximize the utilization of the seeds of *Treculia Africana* for food and medicine, investigate the presence of micronutrients and trace elements which can be exposure factor of toxic metals through our diets, as well as to determine the best preparation method for consumption.

MATERIALS AND METHODS

Collection of *Treculia Africana* seeds

Mature fruit samples of *Treculia africana* were collected from a farm in Izzi, Ebonyi State, Nigeria and properly identified at the Department of Biology, Alex Ekwueme Federal University Ndufu-Alike Ebonyi State. The seeds were manually separated from the fruits and washed. The seeds were blanched, dehulled, air dried at room temperature and packed in a sealable polyethylene bag. The dried seeds were shared into three groups.

Preparation of boiled sample

A part of the raw sample that was blanched and dehulled were boiled until they are soft and ready for consumption. Sample was drained of water with a sieve, air dried at room temperature and ground into powder using an electric blender. It was packed in a sealable polyethylene bag ready for laboratory analysis.

Preparation of roasted sample

A part of the raw sample that was blanched and dehulled were roasted in an oven at 125^{o}C until it turned golden brown ready for consumption. Sample were allowed to cool, ground into powder using an electric blender and packed in a sealable polyethylene bag ready for laboratory analysis

Preparation of the ethanolic extract of *Treculia africana*

300g of the powder were soaked in 2 litres of 80% ethanol for 24 hours for complete extraction. The extraction was sieved and filtered using Whatman(125mm)filter paper. The extract was obtained by soxhlet extractor followed by evaporation and concentration to remove the alcohol.

Qualitative Phytochemical Screening of the ethanolic extract

Chemical tests for the screening and identification of bioactive constituents in the seeds under study were carried out using the standard procedures as described by Sofowara, (1993), Trease and Evans, (2002) and Harborne, (1993).

Quantitative Phytochemical Screening

Steroids was determined by the method described by Edeoga et al., (2005);tannin determined by the method described by Akin-osanaiye and Godwin (2018);terpenoid, reducing sugars, alkaloid, saponin determined by the method of Harborne (1973).

Proximate Analysis

AOAC [Association of Official Analytical Chemist (2005)] method**.**

Mineral Analysis

Atomic absorption spectrophotometer after acid digestion.

Vitamins Analysis

Vitamins A, B1, B2, B3, B6, B12, E, and K were determined using the methods of AOAC(1990): The absorbance of vitamin A at wavelength of 620nm, vitamin E at wavelength of 520nm, vitamin K at wavelength of 635nm, vitamin B1 at a wavelength of 430nm, vitamin B2 at a wavelength of 444nm, vitamin B3 at wavelength of 450nm, vitamin B6 at wavelength of 650nm,Vitamin B6 at wavelength of 650nm, vitamin C was determined using he method based on the reduction of dye (2,6 dichlorophenol indophenol).

Data Analysis

Data obtained from the experiments were analyzed using the Statistical Package for Social Sciences (SPSS) software for windows version 25 (SPSS Inc., Chicago, Illinois, USA). The data were expressed as Mean ± SD. One way ANOVA was employed to check if there were significant differences between the means. The mean is considered significant at (p<0.05).

RESULTS AND DISCUSSION

Phytochemical analyses of powdered seed extracts of *Treculia africana.*

The result of the qualitative and quantitative phytochemical analyses showed that raw, boiled, and roasted seeds of *Treculia africana* contained the following bioactive compounds: tannin, alkaloids, steroids, terpenoids, flavonoid, saponin, reducing sugars; glycoside was found in the raw and roasted seed extracts, but was not detected in the boiled.

Table1:Result of the qualitative phytochemical Analyses of seed extracts of *Treculia africana*.

Compounds	Raw	Boiled	Roasted
Steroids	+ +	+	+ +
Terpenoids	+ +	+	+ +
Alkaloids	+ + +	+ +	+ + +
Glycosides	+ + +	-	+ + +
Reducing Sugar	+ + +	+ + +	+ + +
Flavonoids	+ +	+	+ +
Saponin	+ +	+	+ +
Tannins	+ +	+	+

- = Not detected,+ = P resent in small quantity,++ = Present in moderate quantity ,+++ = Present in large quantity

Table 2:Result of the Quantitative Phytochemical Analyses on seed extracts of *Treculia africana*.

Compounds	Raw (mg/100g)	Boiled (mg/100g)	Roasted (mg/100g)

Steroids	3.82±0.03	3.64±0.29	3.29±0.79
Terpenoids	101.43± 3.82	120.22±1.06	120.81±6.14
Alkaloids	72.22±12.18	98.88±4.32	100.00±2.45
Glycosides	5.87±0.02	- 5.82±0.01	
Reducing Sugar	17.84±0.94	16.88±0.45	17.48±0.68
Flavonoids	12.46± 0.20	10.66± 0.15	11.27± 0.14
Saponin	7.78±0.03	6.57±0.01	7.64±0.07
Tannins	7.81±0.42	7.73±0.06	5.95±0.17

Mean ± SD; n=3

The results of the qualitative and quantitative phytochemical analyses shown in tables 1 and 2 showed that the seeds contain phytochemicals, some of which are known to be nutritionally beneficial while others have some antinutritional activities. Tannins found in moderate amount in the raw seeds but present in small quantity in the boiled and roasted and glycoside was abundant in the raw and roasted but completely lost in the boiled which involved water. This is because glycosides are soluble in water. However, Tannins can be used for protection of inflamed surfaces of the mouth and treatment of catarrh, wounds, haemorrhoiods, and diarrhea, and as antidote in heavy metal poisoning (Ogunleye and Ibitoye, 2003). Saponin was detected in higher amount in the raw and roasted seeds than the boiled and has been reported by Mbagwu *et al.* (2010) to have hypocholesterolemic properties and as such, consumers of saponin containing seeds may enjoy chemoprotection against heart diseases. The presence of steroids, alkaloids and tannins which have been reported to have various medicinal values such as anti-inflammatory, antidiabetic and analgesic activities and for central nervous system activity makes these seeds very valuable as nutrient supplements. Steroids and Terpenoids are known to have antibacterial activity and were found to be present in higher amounts in the roasted seeds than in the boiled. The terpenoids have also been shown to decrease blood sugar level in animal studies, glycosides may be crucial in the transduction of intracellular signals mediated by neurotransmitters, hormones, and neuromodulators receptors (Chandra, 1990).When activated, these molecules can act on different intracellular targets Ejidike, B.N. and Ajileye, O. (2007). Ushie *et al.* (2016) reported that flavonoids are super antioxidants and free radical scavengers which prevent oxidative cell damage, have strong anticancer activity, and inhibit tumor growth and are potent water-soluble compounds. Hence, the reduction of most of these phytochemicals in the boiled sample, could be as a result of their solubility in water.

Table 3:The Proximate Composition of raw, boiled, and roasted *Treculia africana.*

Samples	Protein (%)	Ash(%)	fat(%)	Fibre (%)	CHO (%)	Moisture(%)

Raw	0.77	2.17	5.69	2.50	83.08	5.79
Boiled	3.07	1.76	5.10	1.99	81.56	6.52
Roasted	3.76	1.68	6.84	1.80	82.04	3.88

Table 3 above shows the proximate composition of processed African breadfruit samples. Protein has the highest value in roasted ***Treculia africana*** (3.76%)]. It is also high in the boiled African (3.07%); this could be as a result of leaching of proteins into the boiling water. And least in raw sample this could be as a result that the endogenous protein in the ***T. Africana*** is highly bound as such their protein content are not freely circulated and some of its structures are not altered. Protein content of raw and boiled were within the values reported by Ejidike, B.N. and Ajileye, O. (2007), however the low protein in raw ***T. Africana*** confirms the report made by Ejiofor, (1988). High protein content in roasted and raw samples had negative correlation with the moisture content. This means that decrease in moisture can subsequently lead to increase in protein content of African breadfruit.

Fat was significantly higher in roasted African breadfruit (6.84%), than that of raw (5.69%) and boiled (5.10%).Decrease in fat maybe as a result of breakdown of fat molecules over time due to steeping of the sample and the concentration of chemical acids, thereby enhancing its leaching into the solution. (Fasasi *et al*, 2004) The low-fat content in the boiled ***T. africana*** shows that African breadfruit is preferably consumed by cooked. Except for low fat content in the cooked African breadfruit, other breadfruit samples showed values within as reported by Ejiofor, (1988). The total ash content varied significantly among different method of processing African breadfruit. Since determination of ash content indicate the minerals present in a sample, hence it could be used to assess the physiochemical properties and retardation of microbial growth. Ash was significantly higher in raw (2.17%) compared to roasted(1.68%) and boiled (1.76%)***T. Africana*** seeds. These was within the ranges reported by Adewusi *et al.,* (1991) and Amusa *et al.,* (2000).

Fiber was higher in raw ***T. africana*** (2.50%) compared to the boiled (1.99%) and roasted samples (1.80%). High fiber content in the raw sample may be attributed to the processing method employed. Cooking of the sample encourages flour-water interaction thereby increasing the absorption of water and decreases the fibre content of the sample(). Moisture content of a given sample is the measure of its stability and susceptibility to microbial contamination (Frazier and Westhoff, 2005), the low content indicates the perishability of the sample. Moisture was significantly higher in boiled *T. africana* (6.52%) when compared to raw (5.79%); this value falls significantly within the range reported by Osabor *et al.,* (2009), and it was very low in roasted African breadfruit (3.88%). The higher moisture content in the cooked African breadfruit is as a result of absorption of water during cooking by the starch component and its subsequent gelatinization. High content of moisture encourages microbial growth, hence the cooked African

breadfruit should be consumed or preserved immediately after cooking.

Carbohydrate level was highest in the raw (83.08%) and had a relative value in all other samples [boiled(81.56%) and roasted (82.04%)]. The decrease could be as a result of some chemical reaction, leaching over time or changes in other proximate components which were not steady; since carbohydrate value is dependent on them (Obiakor- Okeke and Nnadi, 2014 ; Fasasi et al, 2004).

Table 4: **The essential mineral composition of raw, boiled, and roasted *Treculia africana*** .

ESSENTIAL MINERAL	RAW SAMPLE (ppm)	BOILED SAMPLE (ppm)	ROASTED SAMPLE (ppm)
SODIUM	6.02±2.11	6.33±1.23	6.89±1.89
SELENIUM	0.036±0.13	0.09±0.15	0.05±0.20
POTASSIUM	11.67±1.15	4.41±1.21	5.03±0.91
COPPER	0.06±0.23	0.03±0.19	0.09±0.32
COBALT	0.54±1.46	0.18±2.33	0.35±1.09
MAGNESUIM	12.47±1.87	12.22±1.24	12.49±0.65
IRON	5.62±0.45	3.91±0.27	3.79±1.04
CHROMIUM	Not detected	0.23±0.33	Not detected
CALCUIM	90.00±0.02	45.33±0.31	41.33±0.29

Mean ± SD; n=3

Table 5: The non-essential mineral composition of raw, boiled, and roasted *Treculia africana*.

NON-ESSENTIAL MINERAL	RAW SAMPLE (ppm)	BOILED SAMPLE (ppm)	ROASTED SAMPLE (ppm)
PHOSPHOROUS	0.62±0.12	0.10±0.14	0.77±0.22
SULPHUR	5.06±1.13	5.89±1.08	1.52±0.99
FLUORIDE	0.93±2.45	0.16±1.18	0.30±2.33
IODINE	0.17±0.11	0.50±1.19	0.44±0.30
CHLORIDE	0.09±0.04	0.14±0.02	0.07±0.21

Mean ± SD; n=3

Table 4and 5 above showed higher levels of sodium, copper, magnesium, and phosphorus in the roasted samples compared to that of the boiled sample and raw samples. This could be caused by the leaching of the minerals into the water used in boiling or dissociated by heat during the period of boiling. However, the level of sodium in the boiled samples were significantly higher compared to raw sample. Higher levels of selenium, chromium, iodine, and chloride were also observed in the boiled samples compared to that of raw sample and roasted samples. This is because the processing period or the time duration for the processing stage attributed to the increase in values of boiled sample more than raw and roasted sample. On the same vein, the levels of Selenium and iodine were significantly higher in the roasted sample compared to that of raw sample. The levels of potassium, iron, calcium, fluoride, and cobalt were observed to be higher in raw sample compared to that of boiled s and roasted samples. The levels of iron and calcium were higher in the raw samples compared to the boiled and roasted sample. This could be caused by the leaching of the minerals into the water used in boiling or dissociated by heat during the long period of boiling when processing stage *Treculia Africana* diet. This might be the reason some people in the south- eastern Nigeria serve the water used in boiling the food separately. The above result is comparable to report of Nnorom *et al*, 2015; Osabor et al, 2009

Most of the above minerals levels can be compared to the RDA (Required Daily Allowance) when 300g of breadfruit diet is consumed. The presence of iron in the diet shows that the meal can decrease incidence of anemia as the RDA for adults is 15-18 mg (Nnorom *et al*, 2015).

Table 6:Result of the vitamin analysis of raw, boiled, and roasted *Treculia africana.* (µg/g)

Vitamins	Raw(µg/g)	Boiled(µg/g)	Roasted(µg/g)
Vitamin A	8.28 ± 1.23	8.33 ± 0.55	7.53 ± 0.68
Vitamin B1	0.78 ± 0.36	0.72 ± 0.04	0.31 ± 0.50
Vitamin B2	0.87 ± 0.13	2.25 ± 0.05	0.74 ± 0.17
Vitamin B3	2.44 ± 0.09	1.66 ± 0.11	0.50 ± 0.36
Vitamin B6	1.18 ± 0.11	3.21 ± 0.09	0.97 ± 0.04
Vitamin B12	3.27 ± 0.69	3.17 ± 0.69	4.30 ± 0.55
Vitamin E	7.60 ± 0.12	8.48 ± 0.09	8.37 ± 0.07
Vitamin D	8.12 ± 1.64	3.12 ± 1.98	2.05 ± 0.41

Mean ± SD; n=3.

Table 7: Result of the vitamin analyses of seed extract of African breadfruit expressed in

Vitamins	Raw (mg/100g	Boiled (mg/100g)	Roasted (mg/100g)
Vitamin C	0.653 ± 0.115	0.572± 0.116	0.327 ± 0.115
Vitamin K	0.188 ± 0.327	1.118 ± 0.056	0.130 ± 0.034

Results expressed as mean ± SD; n=3.

Table 6 above showed higher levels of vitamins A (8.33 ± 0.55); B2 (2.25 ± 0.05); B6 (3.21 ± 0.09); E (8.48 ± 0.09) and K (1.12 ± 0.06) in the boiled *Treculia Africana* compared to the raw and roasted. However, higher levels of Vitamins B3 (2.44 ± 0.09); D (8.12 ± 1.64) and C (0.65 ± 0.12) were observed in the raw sample compared to the boiled and roasted samples. Obiakor-Okeke, and Nnadi, 2014 reported that losses of vitamins occur during processing operations such as milling, soaking, and blanching. Vitamin B12 (4.30 ± 0.55)mg/100mg was higher in the roasted compared to the boiled and and the raw *T. africana.* The decrease in Vitamins B1, B12, and K contents of the boiled breadfruit is might have resulted from chemical reactions and effects of the long processing time which causes these vitamins to be leached easily into the processing water. Some of the water-soluble vitamins are readily destroyed during boiling. These results can be compared results of Abiodun and Umeonuorah (2013)

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