Effect of Traditional Processing Methods on the Proximate Composition and Carbohydrate Components of African Breadfruits (*Treculia africana*) Seeds

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Abstract
The study was carried out to determine the effect of six traditional processing methods on the proximate composition and carbohydrate components of African Breadfruits seed, with a view to elucidating their nutritional and nutraceutical potentials. In all the undehulled samples subjected to different processing methods, Toasted undehulled seed (TUS) had the highest value of all the proximate composition except the moisture content which has the lowest value. While in the dehulled samples, Toasted dehulled seed (TDS), had the highest value of all the proximate composition except the moisture content which has the lowest value. Comparing TUS and TDS, TUS had higher carbohydrate and ash than TDS, while TDS had higher protein, fat and food energy. For carbohydrate components, in the undehulled samples, TUS had the highest % starch, sugar and amylose but lowest % amylopectin, starch-sugar ratio and amylopectin-amylose ratio. While in dehulled samples, TDS took the same trend with TUS, though with lower values.

Keywords*: Traditional processing methods of African breadfruits; carbohydrate component of African breadfruits; proximate composition of African breadfruit.*

Introduction

Treculia africana is a multipurpose tree species commonly known as African breadfriut. The tree is a native of many parts of West and Tropical Africa. It belongs to the family, moraceae and grows in the forest zone, particularly, the coastal swamp zone (Agbogidi and Onomeregbor, 2008; Anthony and Offiong, 1998). It is widely grown in Southern Nigeria for its seeds. It is a common forest tree known by various tribal names in Nigeria such as "afon'' (Yoruba), "barafacta'' (Hausa), "Ize'' (Benin), "eyo" (Igala), "edikang" (Efik) and "ukwa" (Igbo) (Irvine, 1981; Keay,1989; Onweluzo and Odume, 2008). The seeds may be eaten after roasting or toasting and many delicacies, including porridges are commonly produced from the seed. The seeds are used for cooking and are highly nutritions as pointed out by various authors including; Okafor and Okolo (1974), Okafor (1990) and Onyekwelu and Fayose

(2007). It also has medicinal uses including its use as a cure for malaria, cough and rheumatism. African breadfruit is useful in the ethnomedical management of diabetes mellitus (Osuji and Owei, 2010; Irvine 1981). Nutrients both macro- and micro- play an important role in the maintenance of the body's well-being and metabolism. A balanced intake of nutrients (proteins, carbohydrates, fats, minerals and vitamins) helps in maintaining good state of health. Dietary proteins functionally promote growth, and are needed for the synthesis of enzymes, hormones and antibodies (Cheesebrough, 1987). Carbohydrates and fats provide the energy need of the body for physical, physiological and metabolic activities. Minerals serve a wide variety of essential physiological functions, ranging from structural components of body tissues to essential components of many enzymes and other biologically important molecules (Flynn, 1992). The aim of the work is to determine the effect of traditional processing methods on the proximate composition and carbohydrate components of *Treculia africana* seed and to determine the effect of dehulling on the proximate composition and carbohydrate components of *Treculia africana* seed.

Materials and Methods

Sample collection and preparation

African breadfruit seeds were purchased from Main Market in Aba, Abia State, Nigeria. The seeds were authenticated at the Department of Botany, Abia State University, Uturu, Nigeria. Thereafter, the seeds were sorted manually to remove bad seeds and other extraneous materials. The seeds were washed in clean water. The raw seeds of *Treculia africana* were divided into six (6) equal parts and each was prepared by one of the following methods: undehulling and drying (raw, sample 1); dehulling and drying (raw, sample 2); boiling, dehulling and drying (sample 3); boiling, undehulling and drying (sample 4); toasting and dehulling (sample 5); and, toasting and undehulling (sample 6). The washing and boiling were done with clean water. The dehulling of the seeds for sample 2 was done after parboiling the seeds for 15 min at 100^{o}C. The boiling was for 40 min. The toasting was done at 85^{o}C for 30 min. Drying of the seeds was done in a laboratory oven (Gallenkamp IH-100, Fistreem, UK) at 60^{o}C for 24 h. The dried samples were ground into powder with electric grinder (Sharp, EM 11, Malaysia) and sieved with a screen of 1mm mesh. The samples were put in an-airtight polyethene container, labeled and stored in the refrigerator for subsequent analysis. The entire chemicals used for the analysis were of analytical grade.

Proximate Composition

The proximate analysis was done by AOAC method (2000). Moisture content was determined by oven-drying at 105^{o}C for 16 h. Total Nitrogen content (N) was determined by Kjeldahl method, and the protein content was calculated as N x 6.25. Ash content was determined by incinerating 2 g of samples in a pre-weighed porcelain crucible in a muffle furnace at 600^{o}C for 6 h. Crude fat (ether extract) content of the samples was determined using a Soxhlex extraction machine. Total carbohydrates were estimated as the difference of 100 and the sum of ash, protein, moisture and fat (i.e. 100 – [%ash + %protein + %moisture + %fat]). The gross food energy was estimated according to the methods of Osborne and Voogt (1978) using the equation: FE = (%CP x 4) + (%CHO x 4) + (%Fat x 9)

Where: FE = Food energy (calories/g), CP = Crude protein, CHO = carbohydrates.
The method described by Dubois *et al*., (1956) as reported by Kayisu et al., (1981) was used for Starch and Free Sugar determination. The method reported by Juliano (1971) was used for Amylose determination. % Amylopectin was calculated as 100 - % Amylose

Statistical Analysis

Data generated from the study were analyzed and the descriptive statistics presented as mean ± standard deviation of triplicate parallel measurements. Differences between means were separated using the ANOVA and multiple comparison test, with the least significant difference fixed at 0.05. Analysis of variance (ANOVA) was carried out for the results using Statistical Analysis Software (SAS) Systems for Windows at 95% confidence level. Duncan's multiple comparison procedure was used to compare the means. A probability to $p \leq 0.05$ was used to establish the statistical significance.

Results and Discussion

Table I: Proximate Composition of Undehulled African Breadfruit Seeds Subjected to Different Traditional Processing Methods

	Moisture Content %	Ash %	Protein %	Fats %	carbohydrate %	Food Energy %
RUS	19.06±0.01^{b}	1.98±0.03^{b}	11.93±0.03^{c}	8.42±0.01^{b}	58.42±0.00^{c}	357.20±0.01^{b}
BUS	19.25±0.01^{a}	1.86±0.01^{c}	13.56±0.04^{b}	7.52±0.04^{c}	58.90±0.00^{b}	354.22±0.16^{c}
TUS	5.38±0.02^{c}	2.35±0.01^{a}	15.12±0.24^{a}	11.07±0.01^{a}	66.09±0.24^{a}	424.45±0.07^{a}

Data represent the mean ± standard deviation of triplicate readings; values with the same lowercase superscript letter along the same column are not significantly different ($P > 0.05$)
Where RUS = Raw undehulled seed; BUS = Boiled undehulled seed; TUS =Toasted undehulled seed.

The Proximate composition of Undehulled African Breadfriut seeds subjected to different traditional processing methods are shown in Table 1. There was significant difference ($p<0.05$) in the percentage moisture content of the processed samples. The Boiled undehulled seed (BUS) had the highest percentage moisture content. This is attributed to the absorption of water by the seeds in the course of boiling, while the Toasted undehulled seed (TUS) had the lowest percentage moisture content. This is due to the moisture loss from the seeds during toasting. Toasting is a good method of extending the shelf life of seeds while boiling results to poor keeping quality of the seeds. Increase in the moisture content of seeds increase the chance of microorganism's invasion on the seeds. There was significant difference ($p<0.05$) in the percentage ash content of the processed samples. TUS had the highest ash content while BUS had the lowest ash content. Toasting the undehulled seeds significantly increased the ash content while boiling the undehulled seeds significantly reduced the ash content of the seeds. This may be as a result of leaching of the inorganic component of the seeds during boiling while the increase in the ash content during toasting may be as a result of the release of the bound inorganic components of the seeds during the heating process. There was significant difference ($p<0.05$) in the percentage protein content of the processed samples. The significant increase is in the order. TUS > BUS > RUS. The results imply that boiling and toasting of the seeds increased the protein content of the seeds with toasting having an edge over boiling. This could be attributed to the actions of endogenous enzymes which may act to release bound proteins from their complexes with non nutritive component of the seeds. There was significant difference ($p<0.05$) in the percentage fat content of the processed samples. TUS had the highest fat content followed by RUS while BUS had the lowest fat content. The result depicts that toasting increases the fat content while boiling reduces the fat content of the seeds compared to the raw sample in Table 1. The significant increase during toasting may be as a result of activation of the lipases in the seeds which helped in releasing the bound fat making them available. The lowering of the fat content during boiling could be attributed losses due to water absorption resulting to dilution and structural integrity of the seeds (Onyeike and Oguike, 2003). There was significant difference ($p<0.05$) in the percentage carbohydrate content of the processed samples of the seeds. The significant increase is in the order, TUS > BUS > RUS. Boiling and toasting respectively are good processing methods of increasing the availability of carbohydrate in the seed with toasting having an edge over boiling. Boiling has been implicated for gelatinization of starch and thus tends to increase the availability of starch for digestion by amylolitic enzymes (Haralampu, 2000). Increase in the carbohydrate content during toasting can be as a result of endogenous enzymes which may act to release bound carbohydrates from their complexes with non nutritive components of the seeds (Arawende *et al*., 2009). There was significant difference ($p<0.05$) in the calorific value of the processed samples of the seeds. Boiling and toasting respectively increased the calorific value of the seeds, compared to the raw undehulled seeds. While toasting resulted to higher food energy than boiling.

Table 2: Proximate Composition of Dehulled African Breadfruit Seeds Subjected to Different Traditional Processing Methods

	Moisture Content %	Ash %	Protein %	Fats %	carbohydrate %	Food Energy %
RDS	20.23±0.01^{b}	1.90±0.01^{b}	14.42±0.03^{b}	10.22±0.02^{b}	53.24±0.01^{c}	362.60±0.01^{b}
BDS	20.80±0.01^{a}	1.86±0.01^{b}	14.09±0.25^{c}	7.61±0.04^{c}	55.66±0.19^{b}	347.37±0.06^{c}
TDS	5.90±0.01^{c}	2.32±0.01^{a}	16.33±0.03^{a}	11.80±0.03^{a}	63.65±0.06^{a}	426.12±0.11^{a}

Data represent the mean ± standard deviation of triplicate readings; values with the same lowercase superscript letter along the same column are not significantly different ($P>0.05$)
Where RDS = Raw dehulled seed; BDS = Boiled dehulled seed; TDS =Toasted dehulled seed.

The proximate composition of Dehulled African Breadfruit seeds subjected to different traditional processing methods are shown in Table 2. There was significant difference ($p<0.05$) in the percentage moisture content of the processed samples of the seeds. The significant increase was in the order, BDS > RDS > TDS. In Table 2, all the three samples were dehulled while in Table I, all the three samples were undehulled. But the set of samples, RUS and RDS, BUS and BDS, TUS and TDS were processed using the same methods; Raw, Boiling and Toasting respectively. Evaluating the effect of dehulling on the moisture content of the seeds by comparing Table 1 and 2. The moisture content of the samples increased in this trend. BDS > BUS, RDS > RUS, TDS > TUS respectively. The moisture content of the dehulled samples was greater than the undehulled samples in all the processing methods employed. BDS had the highest moisture content of 20.80±0.01% while TUS had the lowest moisture content of 5.38±0.02%. This implies that dehulling the seeds reduce the shelf life of the seeds by making them susceptible to microbial attack due to the high moisture content while undehulling of the seeds will extend the shelf life of the seeds. What reduced the moisture content of the of the undehulled seeds compared to the dehulled seeds that were processed using the same processing method was the presence of hulls on the undehulled seeds which did not allow the direct escape of moisture from the seeds during drying at 60^{o}C for 24h. There was significant difference ($p<0.05$) in the percentage ash content of all the processed samples of the seeds in Table 2. The significant increase was in the order TDS > RDS > BDS. Evaluating the effect of dehulling by comparing Table 1 and 2 for ash content. All the undehulled samples had higher ash content compared to the dehulled samples that passed through the same processing method. TUS had the highest ash content of 2.35±0.01% while BDS had the lowest ash content of 1.79±0.01%. This implies that the hull contains some of the minerals contained in the seed. There was significant difference ($p<0.05$) in the percentage protein content of the dehulled processed samples of the seeds in Table 2. TDS had the highest protein content while BDS had the lowest protein content in Table 2. Evaluating the effect of dehulling on the protein content. All the samples in Table 2 had significant increase in the protein content compared to the undehulled samples in Table I which passed through the same processing method. TDS had the highest protein content of 16.33±0.03% which shows that toasting of dehulled seeds is the best processing method of maximizing the protein content of the seeds. RUS had the lowest protein content of 11.93±0.03% which. Dehulling the seeds increased the protein content because the hulls which have been removed contain cellulose thereby shooting up the protein content and reduced the carbohydrate content of the seeds. There was significant difference ($p<0.05$) in the percentage fat content of all the dehulled processed samples of the seeds in Table 2. TDS had the highest fat content followed by RDS and BDS respectively. Evaluating the effect of dehulling on fat content by comparing the undehulled and dehulled samples in Table 1 and 2 respectively, there was significant increase in the fat content of the dehulled samples in Table 2 compared to the undehulled samples in Table I which passed the same processing method. Toasting of dehulled seeds gave the highest fat content of 11.80±0.03% while boiling without dehulling the seeds gave the lowest fat content of 7.52±0.04%. This implies that the activities of the lipases in the seeds to release the bound lipids could be increased by dehulling the seeds. There was significant difference ($p<0.05$) in the percentage carbohydrate content of the dehulled processed samples of the seeds in Table 2. The significant increase was in this order, TDS > BDS > RDS. Evaluating the effect of dehulling on the carbohydrate contents comparing the undehulled samples in Table 1 and the dehulled samples in Table 2; dehulling significantly decreased the carbohydrate content of the seeds in all the processing methods employed compared with undehulling in Table 1. This was as a result of the hulls removed during dehulling which contain cellulose, a part of carbohydrate. The carbohydrate content of the seeds can be mostly harnessed by toasting the undehulled seeds while boiling the dehulled seeds gives the least carbohydrate content. There was significant difference ($p<0.05$) in the calorific value of the dehulled processed samples of the seeds in Table 2. The significant increase is in the order, TDS > RDS >BDS. Evaluating the effect of dehulling the seeds on the food energy; this is as a result of the increase in fat and protein contents of the dehulled seeds over the undehulled seed which is in agreement with Osborne and Voogts (1978). Toasting of dehulled seeds is the best method of maximizing the food energy of the seeds.

The result of the carbohydrate components of undehulled African bread fruit seeds subjected to different traditional processing methods is shown in Table 3. There was significant difference ($p<0.05$) in the percentage starch content of the undehulled processed samples of the seeds.

Table 3: Carbohydrate components of Undehulled African Breadfruit Seeds subjected to different traditional processing methods

	Starch %	Sugar %	Amylopectin %	Amylose %	Starch: Sugar Ratio	Amylopectin: Amylose Ratio
RUS	51.47±0.46[c]	1.87±0.03[b]	88.27±0.08[a]	11.74±0.08[b]	27.52±0.25[b]	7.52±0.06[a]
BUS	54.56±0.47[b]	1.90±0.00[b]	88.11±0.15[a]	11.90±0.07[b]	28.74±0.30[a]	7.41±0.10[a]
TUS	59.91±0.15[a]	2.84±0.04[a]	85.76±0.07[b]	14.24±0.07[a]	21.16±0.31[c]	6.03±0.07[b]

Data represent the mean ± standard deviation of triplicate readings; values with the same lowercase superscript letter along the same column are not significantly different (P >0.05)

Boiling the undehulled seed increased the starch content to 54.56±0.47% as well as toasting the undehulled seed which had the highest of 59.91±0.15% compared to the raw undehulled seed with the starch value of 51.47±0.46%. The increase was as a result of the release of the bound starch by hydrolysis and action of heat respectively. There was significant difference ($p<0.05$) in the percentage sugar content of TUS but there was no significant difference ($p>0.05$) between the RUS and BUS. Toasting the undehulled seeds increased the sugar since TUS had the highest sugar content of 2.84±0.04%. There was no significant difference ($p>0.05$) in the percentage amylopectin, amylose, and amylopectin-amylose ratio of RUS and BUS respectively, while significant difference ($p<0.05$) existed in the above parameters in TUS. There was significant difference ($p<0.05$) in the percentage starch-sugar ratio of all the undehulled processed samples of the seeds. RUS had the highest amylopectin, and amylopectin-amylose ratio with the lowest percentage sugar in Table 3. TUS had the highest values of sugar and amylose respectively. TUS also had the lowest percentage amylopectin value, amylopectin-amylose ratio and starch-sugar ratio respectively. BUS had the highest starch-sugar ratio. According to Chung et al. (2006), starch is the main carbohydrate source in a variety of diet and a good control glycemic response plays a role in preventing a varied disease such as diabetes, indirectly. Amylopectin is the major component in most starch. Amylopectin is being more digested than amylose because of its high surface area. This can produce sharper increase in the blood postprandial glucose level (Nik Shanita et al., 2011). Hence, Toasted undehulled seed with the lowest amylopectin-amylose ratio, will be a better food for diabetic patient than boiled or raw undehulled seeds which had high amylopectin-amylose ratio.

Table 4: Carbohydrate components of Dehulled African Breadfruit Seeds subjected to different traditional processing methods

	Starch %	Sugar %	Amylopectin %	Amylose %	Starch: Sugar Ratio	Amylopectin: Amylose Ratio
RDS	59.55±0.45[b]	1.95±0.04[c]	86.65±0.30[a]	13.35±0.30[c]	30.58±0.76[a]	6.49±0.17[a]
BDS	60.37±0.47[b]	2.24±0.04[b]	86.16±0.07[b]	13.82±0.07[b]	27.05±0.21[b]	6.24±0.04[b]
TDS	62.7±0.16[a]	3.47±0.07[a]	82.22±0.08[c]	17.79±0.08[a]	18.09±0.32[c]	4.63±0.02[c]

Data represent the mean ± standard deviation of triplicate readings; values with the same lowercase superscript letter along the same column are not significantly different (P >0.05)

The result of the carbohydrate components of dehulled African bread fruit seeds subjected to different traditional processing methods is shown in Table 4. There was no significant difference (p>0.05) in the percentage starch of RDS and BDS, but significant difference (p<0.05) existed in the percentage starch of TDS, and RDS and BDS. TDS had the highest percentage starch and RDS had the lowest percentage starch in Table 4. There was significant difference (p<0.05) in the percentage sugar, amylopectin, amylose, starch-sugar ratio and amylopectin-amylose ratio respectively of all the dehulled processed samples. RDS had the highest percentage amylopectin, starch-sugar ratio and amylopectin-amylose ratio respectively, with the lowest percentage sugar and amylose respectively. TDS had the highest percentage sugar and amylose respectively, with the lowest percentage amylopectin, starch-sugar ratio and amylopectin-amylose ratio respectively, all in Table 4. Toasting increased the percentage starch, amylose and sugar respectively, but reduced the percentage amylopectin, starch-sugar ratio and amylopectin-amylose ratio respectively, than boiling did. Toasted dehulled seeds serve as better source for decrease in blood postprandial glucose level compared to boiled and raw seeds. Hence, it will have the lowest glycemic index. Evaluating the effect of dehulling the seeds on the carbohydrate components, by comparing Table 3 and 4. Dehulling the seeds increased the percentage starch, sugar and amylose respectively, but decreased the percentage amylopectin, starch-sugar ratio and amylopectin-amylose ratio in all the processing method employed. Deducing from the results obtained, toasting and dehulling of the seeds respectively, reduced the starch-sugar ratio and amylopectin-amylose ratio which help in reducing glycemic index of the seeds.

Conclusion and Recommendation

The result of the study showed that toasting is the best processing method of preserving the nutrient composition of African breadfruit seeds. While the Toasted undehulled seed (TUS) gave the highest source of carbohydrate and minerals in the form of ash, Toasted dehulled seed (TDS) gave the highest source of protein, fat and food energy. Therefore, attention should be given to toasted African breadfruit seed as the best form of processing the seed for proper utilization of the nutrients in the seed, both dehulled and undehulled. Toasted dehulled seed had the highest percentage amylose, lowest percentage amylopectin, starch-sugar ratio, and amylopectin-amylose ratio, respectively, which helps in reducing glycemic index of seed should be used in the management of postprandial blood glucose level in type 2 diabetic patients. It is therefore recommended that the obese should dehull the toasted seeds of African breadfruit before eating in order not to increase the problem of obesity.

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