

Effect of Roasting and Germination on Proximate, Micronutrient and Amino Acid Profile of Breadnut Seed (*Artocarpus camansi*) Flours

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Abstract: The proximate, micronutrient and amino acid profile of roasted and germinated breadnut seed flour were evaluated. Fresh mature fruits (1.5 kg) of breadnut were purchased from Relief market in Imo State, Nigeria. The breadnut seeds were divided into three portions for different unit operations, namely raw, roasted and germinated. Samples were analyzed for proximate, minerals and amino acids compositions. Statistical significance was set at $p < 0.05$. Protein (13.80%) and fat (7.90%) content were significantly higher ($p < 0.05$) in germinated breadnut seeds; fibre (2.20%) and ash (7.20%) were significantly higher ($p < 0.05$) in roasted breadnut seed while carbohydrate (75.85%) and moisture (11.05%) were significantly higher ($p < 0.05$) in raw breadnut. Micronutrient composition shows that iron (74.35 mg/100g) was higher in roasted breadnut seed, phosphorous (12.95 mg/100g) and zinc (30.4 mg/100g) were higher in germinated breadnut seed flour while calcium (0.04%), magnesium (0.05%), vitamin A (0.27%) and vitamin C (0.85%) were higher in raw breadnut. All the essential amino acids except norleucine were present in the breadnut in varying quantities. Between roasting and germination, essential acids; valine < histidine < isoleucine < threonine < tryptophan were more in germinated breadnut seeds while leucine < lysine < phenylalanine < methionine were higher in roasted breadnut seed flour. The use of roasting and germination should be used in processing breadnut seeds. The use of breadnut seed flours as composite flour in food production may help to provide protein and micronutrient among the vulnerable groups.

Key words: Breadnut seed flour, roasting, germination, amino acid profile.

1. Background to the Study

Breadnut (*Artocarpus camansi*) belongs to the family Moraceae of flowering plants. Breadnut when compared with other nuts such as almond, Brazil nut, and macadamia nut is a good source of protein with low fat [1]. Despite the nutritive value of these seeds, it had been reported to be an under-utilized food source [2]. Few research works have studied on the nutritional composition of breadnut [3], antioxidant properties [4], amino acids of the raw breadnut [5], amino acid of the boiled and fermented breadnut seed [6]. The utilization of seed flours which are high in proteins as well as functional ingredients in food

system may continue to be of research interest especially, breadnut [7]. The use of traditional processing methods could effectively be used in improving plant protein quality and mineral content of food crops [8].

Processing methods change the physical characteristics of food materials and improve the quality of foods, add value, give variety and help in extending the shelf life of the food [9]. Germination is a natural process that does not require sunlight or soil to sprout seedlings and starch is degraded into maltose and dextrin by the action of amylase [10]. Germination of food materials helps to improve protein, fibre and reduce anti-nutrients contents in food [11]. Roasting on the other hand improves quality, colour, and reduces anti-nutrients [12].

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However, there is paucity of literature on the micronutrient and amino acid composition of germinated and roasted breadnut seed. Therefore, this study sought to evaluate the proximate, micronutrient and amino acid profile of germinated and roasted breadnut seeds.

2. Materials and Methods

Fresh mature fruits of breadnut were purchased from Relief market in Owerri. It was taken to Crop Science Department, Faculty of Agriculture, Imo State University, Nigeria for identification.

2.1 Sample Preparation

The breadnut fruits were washed and opened with clean knife. The seeds were separated from the pulp and washed. One thousand and five hundred grams of breadnut was divided into three portions to be used for raw, roasted and germinated samples respectively.

2.2 Processing of Raw Breadnut Seeds

Five hundred grams of breadnut seed coat was removed. The breadnut seeds were washed and sliced into pieces. It was oven dried at 60 °C, milled in attrition burr mill and sieved using 500 micron sieve mesh to obtain breadnut seed flour. The breadnut was stored using high density polyethylene bag for further analysis.

2.3 Processing of Germinated Breadnut Seeds

Five hundred grams of breadnut seeds were washed with water and steeped in water for 3 hours. It was drained of the steeped water and packed in a moistened jute bag and kept in a dark room for 72 hours. There was sprinkling of water on daily basis to enhance germination. The germinated seeds were dehulled, sliced into pieces with a sterile knife, oven dried at 60 °C, milled and sieved using 500 m sieve mesh to obtain breadnut seed flour. The breadnut was stored using high density polyethylene bag for further analysis.

2.4 Processing of Roasted Breadnut Seeds

Roasted breadnut was obtained by steady stirring of the seeds on hot cast iron pan at 80 °C for 60 minutes and allowed to cool. It was dehulled, sliced into pieces with a sterile knife, milled and sieved using 500 m sieve to obtain breadnut seed flour. The breadnut was stored using high density polyethylene bag for further analysis.

2.5 Nutritional and Amino Acid Analysis

The breadnut seed flour samples were analyzed for proximate composition using standard methods by AOAC [13]. Moisture content was determined using hot air oven method. Protein content was determined using micro-kjeldahl method. Ash was determined by weighing 1 g of each sample into a tarred porcelain crucible. This was incinerated at 600 °C for 6 h in an ashing muffle furnace until constant weight was obtained. Lipid was estimated by exhaustively extracting a known weight of flour sample with petroleum ether (B.pt. 40-60 °C,) using tecator soxhlet apparatus. Carbohydrate was calculated by difference (100-% moisture + ash + protein + fibre + fat). Mineral content was determined as described by Ranjham and Gopal [14]. After wet digestion with concentrated nitric and perchloric acids, the minerals calcium (Ca), magnesium (Mg), iron (Fe) and zinc (Zn) were determined using atomic absorption spectrophotometer (Model 3030 Perkin Elmer, Norwalk, USA). Phosphorous (P) was determined calorimetrically with spectrophotometer using phosphor-vana domolybdate method. Vitamin A was determined using spectrophotometric method described by Pearson [15] while vitamin C was determined using AOAC [13]. Amino acid composition was determined by ion exchange chromatography method using amino acid analyzer (Technicon instruments co-operation, New York, USA) as described by Benitez [16]. All analyses were done in triplicates.

2.6 Statistical Method

Means and standard deviation were calculated for all the samples. One way analysis of variance (ANOVA) and Turkey's tests were used to separate and compare the means [17].

3. Results

3.1 Proximate Composition of Roasted and Germinated Breadnut Seed Flours

The proximate composition of roasted and germinated breadnut seed flours were presented in Table 1. Crude protein (14.45%) and fat (8.30%) content were higher in roasted breadnut seed flour; crude fibre (2.20%) and ash (7.20%) were higher in germinated breadnut while moisture (11.05%) and

carbohydrate contents were higher in raw breadnut seed flours.

3.2 Mineral Composition of Roasted and Germinated Breadnut Flours

The mineral composition of roasted and germinated breadnut seed flours were presented in Table 2. Calcium (0.085%) and magnesium (0.085%) was higher in roasted breadnut seed flour than germinated breadnut seed flour though it was significantly ($p < 0.05$) higher in raw breadnut seed flour. Roasting significantly ($p < 0.05$) increased the iron (74.35 mg/100g) content of breadnut seed flour while phosphorous (12.95 mg/100g) and zinc (30.4 mg/100g) were significantly ($p > 0.05$) higher in germinated breadnut seed flour.

Table 1 Proximate composition of roasted and germinated breadnut seed flours.

Breadnut seed flour	Moisture (%)	Protein (%)	Fat (%)	Crude fibre (%)	Ash (%)	Carbohydrate (%)
Raw	11.05 ^a ± 0.24	5.10 ^c ± 0.03	3.92 ^c ± 0.12	2.02 ^a ± 0.45	2.10 ^c ± 0.04	75.88 ^a ± 0.21
Roasted	7.90 ^c ± 0.33	13.80 ^b ± 0.01	7.90 ^b ± 0.52	2.20 ^a ± 0.21	7.20 ^a ± 0.21	61.00 ^b ± 0.01
Germinated	9.40 ^b ± 0.11	14.45 ^a ± 0.01	8.30 ^a ± 0.42	2.00 ^b ± 0.01	6.40 ^b ± 0.33	59.40 ^c ± 0.11

Values are means ± standard deviation of duplicate determination. Means with the same superscript within the column are not significantly different ($p > 0.05$) while different superscripts within the column are significantly different ($p < 0.05$).

Table 2 Mineral composition of roasted and germinated breadnut flours.

Breadnut seed flour	Calcium (%)	Magnesium (%)	Iron (mg/100g)	Zinc (mg/100g)	Phosphorus (mg/100g)
Raw	0.44 ^a ± 0.01	0.05 ^a ± 0.01	22.25 ^c ± 0.35	8.70 ^c ± 0.68	0.23 ^c ± 0.01
Roasted	0.075 ^b ± 0.07	0.085 ^b ± 0.01	74.35 ^a ± 0.01	15.0 ^b ± 0.01	12.27 ^b ± 0.01
Germinated	0.070 ^c ± 0.01	0.067 ^c ± 0.01	68.5 ^b ± 0.01	30.4 ^a ± 0.01	12.95 ^a ± 0.01

Values are means ± standard deviation of duplicate determinations. Means with the same superscript within the column are not significantly different ($p > 0.05$) while different superscripts within the column are significantly different ($p < 0.05$).

Table 3 Vitamin composition of roasted and germinated breadnut seed flours.

Breadnut seed flour	Vitamin A (%)	Vitamin C (%)
Raw	0.27 ^a ± 0.01	0.85 ^a ± 0.01
Roasted	0.07 ^b ± 0.001	0.06 ^b ± 0.01
Germinated	0.08 ^b ± 0.01	0.09 ^b ± 0.01

Values are means ± standard deviation of duplicate determinations. Means with the same superscript within the column are not significantly different ($p > 0.05$) while different superscripts within the column are significantly different ($p < 0.05$).

Table 4 Amino acids composition of roasted and germinated breadnut seed flours.

Amino acids (mg/100g)	Raw breadnut seed flour	Roasted breadnut seed flour	Germinated breadnut seed flour
Essential amino acid			
Histidine	2.23 ^b ± 0.01	2.46 ^b ± 0.01	3.34 ^a ± 0.01
Isoleucine	3.40 ^a ± 0.0	2.93 ^b ± 0.01	3.38 ^a ± 0.01
Leucine	8.64 ^a ± 0.00	5.33 ^b ± 0.01	4.55 ^b ± 0.01
Lysine	5.19 ^a ± 0.01	3.91 ^b ± 0.01	3.52 ^b ± 0.01
Methionine	1.21 ^a ± 0.02	0.075 ^b ± 0.01	0.065 ^b ± 0.01
Phenylalanine	4.17 ^a ± 0.00	3.63 ^b ± 0.01	3.34 ^b ± 0.01
Threonine	13.2 ^a ± 0.01	2.92 ^c ± 0.01	3.92 ^b ± 0.01
Tryptophan	1.32 ^a ± 0.01	0.07 ^b ± 0.01	0.09 ^b ± 0.01
Valine	3.85 ^a ± 0.03	3.70 ^b ± 0.01	4.58 ^a ± 0.01
Non-essential amino acid			
Glycerin	3.57 ^b ± 0.01	4.28 ^a ± 0.01	3.40 ^b ± 0.42
Alanine	3.93 ^a ± 0.01	2.16 ^b ± 0.01	2.16 ^b ± 0.01
Serine	3.54 ^a ± 0.00	2.39 ^b ± 0.01	2.42 ^b ± 0.01
Proline	3.36 ^a ± 0.01	1.36 ^c ± 0.01	1.43 ^b ± 0.01
Asparagine	8.97 ^a ± 0.01	6.30 ^b ± 0.01	7.55 ^a ± 0.01
Glutamine	13.17 ^b ± 0.01	13.13 ^c ± 0.01	13.98 ^a ± 0.01
Arginine	6.19 ^a ± 0.01	4.78 ^c ± 0.01	5.68 ^b ± 0.01
Tyrosine	3.09 ^a ± 0.00	1.98 ^c ± 0.01	2.20 ^b ± 0.01
Cystine	1.40 ^a ± 0.01	1.11 ^b ± 0.01	0.09 ^c ± 0.01

Values are means ± standard deviation of duplicate determinations. Means with the same superscript within the column are not significantly different ($p > 0.05$) while different superscripts within the column are significantly different ($p < 0.05$).

3.3 Vitamin Composition of Roasted and Germinated Breadnut Seed Flours

The vitamin composition of roasted and germinated breadnut seed flours were presented in Table 3. Germinated breadnut seed flour had higher vitamin A (0.08%) and vitamin C (0.09%) contents. However, raw breadnut was significantly ($p < 0.05$) higher than roasted and germinated breadnut seed flours.

3.4 Amino Acids Composition of Roasted and Germinated Breadnut Seed Flours

Table 4 shows the amino acid composition of raw, roasted and germinated breadnut seed flours. Raw breadnut seeds were significantly higher than roasted and germinated breadnut seed except in histidine (3.34 mg/100g) and valine (4.58 mg/100g) which was significantly ($p < 0.05$) higher in germinated breadnut seed flour. Isoleucine (3.38 mg/100g), tryptophan (0.09 mg/100g) and threonine (3.92 mg/100g) were significantly higher in germinated than roasted

breadnut seed flour. Leucine (5.33 mg/100g), lysine (3.91 mg/100g), methionine (0.075 mg/100g), phenylalanine (3.63 mg/100g), and tryptophan (0.07 mg/100g) were higher in roasted breadnut seed flour than germinate breadnut seed flour though no significant difference was observed.

4. Discussions

4.1 Proximate Composition of Roasted and Germinated Breadnut Seed Flours

Low moisture content was observed in the processed breadnut seed flours though it was lower in roasted breadnut seed flours which may be as a result of the high heat treatment that resulted in loss of moisture. The moisture content of the roasted sample was however lower than 14.77% that was reported by Okorie [18] on *Artocarpus camansi* seed flour as affected by roasting and boiling. The moisture content of the breadnut seed flour was in range of (10-14%) recommended by Butt et al [19] for flours. The

implication was that roasting may favour keeping quality of breadnut seed flour. The protein content of the germinated breadnut seed flour was higher than the roasted breadnut flour. This agrees with Kavitha and Parimalavalli [12]. However, raw breadnut seed flour was lower than both germinated and roasted breadnut seed flours. This implies that processing method via germination and roasting improves protein content [20]. A similar trend was reported by [21-23]. The increase in protein content of germinated breadnut seed flour may be as a result of loss of non protein dry matter [24] or effect of hydrolytic enzymes [25]. The protein content of the processed breadnut seed flour can contribute to the daily protein needs of younger children as recommended by FAO/WHO [26]. Therefore, roasted and germinated breadnut seed flour can be used in fortification foods against protein malnutrition.

The fat content was increased by processing method though higher in the germinated breadnut seed flour and also reported by Echendu et al. [10] on germination of ground bean. This might be due to the non-conversion of free fatty acids to carbohydrates which may lead to increase in fat composition during germination [27]. Roasting reduced the fat content and was consistent with [18]. However, it was observed that raw breadnut seed flour had lower fat content when compared to [1, 28, 29] on raw breadnut seed flour. Fats are essential in diets as they increase palatability of foods and retain their flavours [30]. They are involved in structural and biological functioning of cells and in the transport of nutritionally essential fat-soluble vitamins.

Roasting significantly ($p < 0.05$) increased the crude fibre of the breadnut seed flour than germinated breadnut seed flour and was consistent with [18]. This disagrees with Joshi and Varma [31]; they reported increased fibre content in germinated soybean than roasted soybean. Effect of germination on fibre was reported to be dependent on the type of food crop [32]. Roasting of the breadnut seed flour had higher ash

content than germinated breadnut seed flour. This study was in agreement with Kavitha and Parimalavalli [12] who reported that roasting increased ash content of groundnut than germination.

4.2 Micronutrient Composition of the Roasted and Germinated Breadnut Seed Flours

The processing methods (germination and roasting) increased all the minerals studied except calcium and magnesium which were higher in raw breadnut seed flour. The study was consistent with Atlaw et al. [33] on germination of fenugreek seed flour. Roasting was observed to be higher in roasted breadnut seed flour than germinated breadnut seed flour. This was in contrast with other literatures on roasting and germination of food materials [21, 31, 34]. This can be explained by the proximate composition of the processed breadnut seed flour which revealed that ash content was more improved by roasting and agrees with [34, 35] on fluted pumpkin and bambara groundnut respectively. On the contrary, Obiakor [36] reported that roasting decreased the ash content of breadfruit compared with other treatments. The study was consistent with Norm et al. [37] that zinc, iron, calcium and magnesium increased after roasting when compared with the raw breadfruit in their study. Zinc, iron and magnesium are involved in carbohydrate metabolism because they act as co-factor and co-enzyme in carbohydrate metabolism and thus are very essential in biological system. The zinc content of the present study was higher than (4.40 mg/100g) on roasted breadfruit and disagrees with [38] that roasting method reduced zinc content. The finding supports previous study by [18] that processing methods reduced the magnesium content of breadnut seeds. Although roasting and germination decreased the magnesium content, roasted breadnut was significantly ($p < 0.05$) higher than germinated breadnut seed flour. Vitamin C and vitamin A contents of germinated breadnut seed flour were higher than the roasted breadnut seed flour, though not

statistically ($p > 0.05$) different. The decrease in vitamin C content of roasted breadnut seed flour could be attributed to temperature used because vitamin C is a heat liable vitamin. The vitamin C content was consistent with [22, 39] on germinated soybean and cowpea respectively and thus could be associated with vitamin C synthesis reactivation in the breadnut seeds [40].

4.3 Amino Acids Composition of Roasted and Germinated Breadnut Flour

All the essential amino acids were contained in breadnut seeds of the present study [22] that also reported same except that threonine and valine were not detected in their study on raw breadnut seeds. Roasted breadnut seeds had higher amino acid content except in isoleucine, tryptophan and threonine which were higher in germinated breadnut seeds. On the other hand germinated breadnut seed flour had higher quantities in non-essential amino acids except glycerine and cystine that were higher in roasted breadnut seed flour. This was consistent with Zuwariah et al. [41] on amino acid profile of jackfruits seeds which reduced after 72 hours of germination and could be as a result of protein storage hydrolysis [42] and cotyledon mobilization of protein in forming new roots and shoots [43]. The study also observed that predominate amino acids include leucine, valine, asparagines, glutamine and arginine while the limiting amino acids are methionine, tryptophan, proline and cystine. This was similar with the study and also supported the assertion that breadnut contains amino acids than some animal and plant source of protein [44].

5. Conclusion

Processing of breadnut by roasting and germination improved the protein content, fat and ash content while carbohydrate was reduced. Micronutrient content was also improved by processing. The study showed that roasted and germinated breadnut seeds

contain all the essential amino acids needed by the body. The use of roasting and germination should be encouraged as composite flours in culinary uses.

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