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Amino Acid Profiling and Fatty Acid Composition of African Breadfruit (*Treculia africana*)

[1]*Udiomine Brantley Akuru and* [2]*Echiya Rejoice Emmanuel*

[1,2]*Department of Biochemistry, Faculty of Science, Rivers State University, Port Harcourt, Nigeria*

ABSTRACT

Background and Objective: African breadfruit is a fruit also known as Ukwa in the Igbo in Eastern Nigeria. It can be eaten as snacks, plain, or as flour in baking bread and other foods. It is a cheap source of nutrients; hence this study investigated the amino acid profiling and fatty acid composition of raw and processed breadfruit. **Materials and Methods:** Breadfruit was gotten in the raw form and processed into the boiled and fried form (that is the samples were in the raw, boiled and fried form). Standard methods were used to determine the amino acid profiling and fatty acid composition of the breadfruit. Statistical analysis was determined at $p<0.05$ using ANOVA of the SPSS tool. **Results:** The concentration of essential and non-essential amino acids as well as saturated fatty acids was highest in the raw form of breadfruit when compared to the boiled and fried. The unsaturated fatty acids had the fried form having the highest value. **Conclusion:** The breadfruit had some nutrients which can be affected by the cooking methods, particularly frying and boiling.

KEYWORDS

Treculia africana, African breadfruit, nutritional profiling, essential nutrients, breadfruit composition

INTRODUCTION

African breadfruit (*Treculia africana*), sometimes referred to as wild Jackfruit, or African boxwood, is a tropical tree crop that is mostly grown in countries like Ghana, Sierra Leone, Nigeria and the West Indies[1]. It is known as "Ukwa" in Igbo, Nigeria[2]. The tree yields fruits that have enormous promise as a food supply for humans and other domestic animals and it stays evergreen throughout both rainy and dry seasons[1]. There are many ways to prepare breadfruit, including pounding, frying, boiling and mashing to produce porridge[2]. It can also be eaten plain as a snack or as flour to make cakes, bread and thick soups[1]. It is a well-appreciated food in many regions of the world and a good source of dietary fiber, carbohydrates, vitamins, minerals and other nutrients[3]. Ezennaya and Ezeigw[4], also affirmed that African breadfruit seeds are cheap means of getting proteins, carbohydrates, minerals and vitamins. Amino acids are necessary for life because the proteins they form are involved in virtually all cell functions. According to Ma *et al.*[5], proteins can perform many functions such as enzymes, antibodies and structural support. Lipids are made up of fatty acids[6], which are essential for the body's energy production, absorption of fat-soluble vitamins (including A, D, E and K), hormone synthesis and inflammation regulation. They are crucial for the structure and function of cell membranes and have a part in cell signalling as well[7]. Hence this study focused on the amino acid profiling and fatty acid composition of African breadfruit.

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MATERIALS AND METHODS

Study area: This study took place at the Department of Biochemistry, Rivers State University and Austino Laboratory, Alakahia Port Harcourt. It started from August to October 2023.

Sample collection and preparation: African breadfruit was bought at Mile 3 market, Port Harcourt, Rivers State, Nigeria. The (50 g) of the breadfruit sample were put into three 250 mL beakers each. The breadfruit in the first beaker was boiled, the second fried and the third had the raw form. After being peeled, the raw breadfruit weighed 37.14 g. To prepare the boiled form, 50 g of raw breadfruit was boiled for approximately an hour in 200 mL of water, peeled and weighed 44.28 g for the fried form, 10 min were spent frying 50 g of raw breadfruit, after which it was peeled and weighed (26 g).

Determination of amino and fatty acid composition: Amino Acids profiling and fatty acid composition were determined using Gas Chromatography-Mass spectroscopy (Agilent 6890 gas chromatograph with a 5973 MS detector equipped with 60 m×0.25 mm, i.d. 0.25 µm/MS DB-WAX capillary column).

Statistical analysis: All data obtained were subjected to statistical analysis and values were expressed as Mean±Standard deviation. To determine whether there was a statistically significant difference among the experiment groups, the One-way Analysis of Variance (ANOVA) was used, followed by a *post hoc* Tukey's test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the concentration of essential amino acids in raw, boiled and fried samples of breadfruit. The raw had the highest value (significant $p<0.05$) for all the essential amino acids followed by the boiled and then the fried.

Table 1: Essential amino acid content of raw and processed breadfruit (g/100 g)

Amino acids	Raw	Boiled	Fried
Valine	2.89±0.03^a	1.64±0.03^b	1.12±0.02^c
Leucine	4.74±0.02^a	2.92±0.02^b	1.15±0.02^c
Isoleucine	2.34±0.04^a	1.72±0.02^b	0.46±0.01^c
Methionine	1.64±0.01^a	1.23±0.03^b	0.72±0.02^c
Threonine	3.61±0.01^a	2.64±0.04^b	1.46±0.02^c
Phenylalanine	1.53±0.01^a	0.84±0.01^b	0.35±0.01^c
Lysine	1.45±0.02^a	1.02±0.01^b	0.40±0.03^c
Tryptophan	1.67±0.03^a	0.73±0.01^b	0.36±0.16^c
Histidine	2.40±0.01^a	1.15±0.01^b	1.15±0.02^b

Values are expressed as Mean±Standard deviation (n = 3), mean difference is significant at the 0.05 level within the row, ^{a}Significant differences when comparing raw with boiled and fried samples, ^{b}Significant differences when comparing boiled with raw and fried samples and ^{c}Significant differences when comparing fried with raw and boiled samples

Table 2: Non-essential amino acid content of raw and processed breadfruit (g/100 g)

Amino acids	Raw	Boiled	Fried
Aspartic acid	4.96±0.02^a	2.66±0.07^b	1.52±0.02^c
Hydroxylproline	0.73±0.02^a	0.44±0.04^b	0.18±0.01^c
Cysteine	2.94±0.02^a	1.73±0.03^b	1.14±0.03^c
Glutamic acid	1.54±0.03^a	0.67±0.02^b	0.19±0.03^c
Glutamine	2.74±0.01^a	1.73±0.02^b	0.14±0.01^c
Arginine	0.82±0.01^a	0.57±0.01^b	1.03±0.01^c
Tyrosine	2.70±0.01^a	1.36±0.02^b	0.31±0.02^c
Alanine	3.54±0.04^a	2.53±0.02^b	1.15±0.02^c
Glycine	1.72±0.03^a	1.26±0.02^b	0.43±0.01^c
Proline	1.19±0.02^a	0.84±0.02^b	0.22±0.01^c
Serine	2.80±0.01^a	1.73±0.01^b	0.30±0.02^c

Values are expressed as Mean±Standard deviation (n = 3), mean difference is significant at the 0.05 level within the row, ^{a}Significant differences when comparing raw with boiled and fried samples, ^{b}Significant differences when comparing boiled with raw and fried samples and ^{c}Significant differences when comparing fried with raw and boiled samlpes

Table 3: Saturated fatty acid content of raw and processed breadfruit (%)

Fatty acids	Raw	Boiled	Fried
Caprylic acid	0.81±0.02[a]	0.74±0.02[b]	0.55±0.03[c]
Capric acid	2.18±0.01[a]	0.93±0.02[b]	0.37±0.01[c]
Lauric acid	0.58±0.05[a]	0.59±0.02[b]	0.43±0.01[c]
Myristic acid	2.21±0.02[a]	1.48±0.01[b]	0.21±0.02[c]
Palmitic acid	0.92±0.01[a]	1.23±0.01[b]	0.81±0.02[c]
Stearic acid	0.97±0.01[a]	1.94±0.01[b]	0.24±0.01[c]
Pelargonic acid	1.45±0.03[a]	1.17±0.03[b]	0.83±0.01[c]
Undecylic acid	0.93±0.01[a]	0.69±0.01[b]	1.92±0.02[c]
Tridecyclic acid	1.52±0.02[a]	0.63±0.02[b]	0.39±0.02[c]
Nervonic acid	0.77±0.01[a]	0.52±0.01[b]	0.44±0.02[c]
Tricosylic acid	0.51±0.01[a]	0.19±0.01[b]	1.55±0.01[c]
Lignoceric acid	0.85±0.01[a]	0.33±0.01[b]	1.92±0.01[c]
Margaric acid	0.14±0.01[a]	3.90±0.02[b]	0.67±0.03[c]
Pentadecyclic acid	2.73±0.10[a]	1.80±0.02[b]	0.54±0.01[c]
Nonadecyclic acid	1.31±0.01[a]	0.73±0.01[b]	0.44±0.01[c]
Arachidic acid	0.72±0.01[a]	0.96±0.01[b]	0.32±0.01[c]
Benhemic acid	0.85±0.01[a]	0.47±0.01[b]	0.23±0.01[c]
Total	19.45	18.3	11.86

Values are expressed as Mean±Standard deviation (n = 3), mean difference is significant at the 0.05 level within the row, [a]Significant differences when comparing raw with boiled and fried samples, [b]Significant differences when comparing boiled with raw and fried samples and [c]Significant differences when comparing fried with raw and boiled samples

Table 4: Unsaturated fatty acid content of raw and processed breadfruit (%)

Fatty Acids	Raw	Boiled	Fried
Oleic acid	0.83±0.01[a]	0.64±0.01[b]	2.97±0.01[c]
Eicosadienoic acid	1.47±0.01[a]	0.84±0.02[b]	0.69±0.01[c]
Arachidonic acid	0.28±0.02[a]	1.19±0.02[b]	3.74±0.01[c]
Palmiticoleic acid	5.75±0.01[a]	0.92±0.01[b]	1.65±0.01[c]
Undecylenic acid	0.52±0.01[a]	0.47±0.04[b]	1.71±0.02[c]
Tridecylenic acid	0.74±0.02[a]	0.34±0.01[b]	1.46±0.02[c]
Myristolenic acid	2.68±0.13[a]	0.51±0.02[b]	2.84±0.02[c]
Eicosapentaenoic acid	0.83±0.02[a]	0.40±0.01[b]	1.84±0.02[c]
Docosahexaenoic acid	0.63±0.06[a]	0.62±0.01[b]	2.97±0.06[c]
Erucic acid	0.34±0.01[a]	0.34±0.02[b]	0.45±0.01[c]
Adrenic acid	0.62±0.02[a]	0.25±0.03[b]	0.19±0.02[c]
Margaric acid	2.34±0.01[a]	0.75±0.01[b]	3.87±0.01[c]
Paullinic acid	0.95±0.01[a]	0.43±0.02[b]	1.44±0.01[c]
Total	17.98	7.7	25.82

Values are expressed as Mean±Standard deviation (n = 3), mean difference is significant at the 0.05 level within the row, [a]Significant differences when comparing raw with boiled and fried samples, [b]Significant differences when comparing boiled raw and fried samples and [c]Significant differences when comparing fried with raw and boiled samples

Table 2 shows the concentration of non-essential amino acids in raw, boiled and fried samples of breadfruit. The table showed that the highest concentration of the non-essential amino acids was found in the raw samples. It was also observed that the values of the non-essential amino acids were higher in boiled samples than fried samples except arginine which had the fried sample having the highest value when compared to the rest forms.

Table 3 shows the concentration of saturated fatty acids in raw, boiled and fried samples of breadfruit. The table revealed that the values of caprylic acid, caproic acid, myristic acid, pelargonic acid, tridecyclic acid, nervonic acid, pentadecyclic and nonadecyclic acid were higher in raw samples than in boiled and fried samples. From the result, it was also observed that the concentration of lauric acid, palmitic acid, stearic and arachidonic acid was high in boiled samples when compared with raw and fried samples.

Table 4 shows the concentration of unsaturated fatty acids in raw, boiled and fried samples. The result revealed that the values of eicosadienoic acid, Palmiticoleic acid, benhemic acid and adrenic acid were found in higher concentration in raw samples when compared with boiled and fried samples. The result also showed that the values of oleic acid, arachidonic acid, undecylenic acid, tridecylenic acid, myristolenic acid, eicosapentaenoic acid, docosahexaenoic acid, erucic and margaric acids were higher in fried samples than raw and boiled samples.

DISCUSSION

The study evaluated the amino acid profiling and fatty acid composition of raw and processed African breadfruit. The results from this study showed that the raw sample had higher essential and non-essential amino acids when compared to the boiled and fried form except arginine which had the fried sample having the highest value when compared to the rest forms. The result of the saturated fatty acid revealed that the values of palmitic acid, stearic and arachidonic acid were higher in the boiled samples when compared to the raw and fried samples. Whereas for the unsaturated fatty acids of raw and processed breadfruit, the values of eicosadienoic acid, palmiticoleic acid and benhemic acid were higher in raw samples when compared to the boiled and fried samples. Oleic acid, arachidonic acid and docosahexaenoic acid were higher in fried samples than raw and boiled samples.

Essential amino acids are the amino acids that the human body is unable to synthesize on its own and are sourced from diets. They are essential for the synthesis of proteins, tissue growth, tissue healing and general bodily functions. A diet rich in protein and well-balanced helps guarantee that these vital amino acids are consumed in sufficient amounts[8]. The result showed that the highest value of the essential amino acids was found in the raw samples. The concentration of the essential amino acids was in the order: Raw>boiled>fried. Raw foods often maintain higher levels of nutrients typically because they undergo minimal or no processing and that could account for the high level of amino acid in the raw breadfruit samples. Adeyeye[9] mentioned in his research that cooking or processing food can occasionally degrade or alter their amino acid composition. They added that eating food in its raw state maintains the proteins' integrity, but heating or processing can denature proteins and their availability and structure. This study was consistent with the findings of Adeyeye[9], who examined the effect of cooking and roasting on the amino acid composition of raw groundnuts and reported that when compared to the cooked and roasted groundnuts, raw samples had the highest concentration of amino acids. The concentrations of methionine and lysine in the raw and boiled breadfruit in this investigation were greater than those reported by Oladunjoye *et al.*[10]. Compared to this study, Mbah *et al.*[11] had higher concentrations of lysine, threonine, tryptophan and methionine. Adeyeye and Adesina[12] also had a higher lysine concentration compared to those of this study when they worked on the nutritional composition of the flour of African breadfruit seeds testa.

Non-essential amino acids are those amino acids the body can produce on its own, thus they are not obtained directly from the diet. They help produce collagen, precursors to other molecules and are constituents of neurotransmitters[9]. The raw samples had the highest concentration of amino acids. Additionally, it was noted with the exception of arginine, that the non-essential amino acid values in the boiled samples were higher than the fried ones. In contrast to Mbah *et al.*[11] the concentration of aspartic acid in the raw form in this investigation was higher, while that of the boiled and fried was lower. The glutamic acid concentration of this study was lower than that of Mbah *et al.*[11] and Adeyeye and Adesina[12].

Saturated fatty acids are a type of fat molecule when ingested in excess, have traditionally been linked to an elevated risk of cardiovascular illnesses by provoking an increase of low-density lipoprotein/high-density lipoprotein-cholesterol ratio[2]. The raw breadfruit had a higher saturated fatty acid content in comparison to the boiled and fried. The Stearic acid concentration of this study was within the range obtained by Golden and Williams[13] but lower than those of Adeyeye and Adesina[12].

For the unsaturated fatty acids, this study had the fried breadfruit with the highest concentration. The reported results for oleic was in contrast to the findings of Golden and Williams[13] and Adeyeye and Adesina[12] who had higher values when they determined the fatty acid composition of breadfruit.

This study shows that the preparation techniques have a major impact on the amino and fatty acid profiles of African breadfruit. When African breadfruit is raw, it retains more of its amino acid content than when it is boiled or fried. On the other hand, frying raises certain unsaturated fatty acids. This implies that African breadfruit's nutritional content varies based on how it is prepared, which may have an impact on one's health and dietary planning. From the findings, the benefits of eating African breadfruit might be highlighted in culinary practices and nutritional planning. The study also offers guidance for creating breadfruit-based products by selecting methods of preparation that maximize targeted nutritional attributes. For instance, when looking for more essential amino acids, raw or minimal processed breadfruit may be preferable. To completely understand how different cooking processes affect the nutritional profile of African breadfruit, it is recommended to investigate additional preparation methods other than boiling and frying. This would provide a detailed overview of the most effective techniques for maintaining or boosting specific nutrients. The study looked at two cooking procedures (boiling and frying) and did not investigate other possible preparation methods. Furthermore, the study did not look at the effects of these approaches on other critical nutrients or the overall health benefits of African breadfruit. In order to gain a more comprehensive understanding of how different preparation methods affect the nutritional profile of African breadfruit, it is recommended that studies be expanded to include a wider range of preparation methods and a broader nutritional analysis.

CONCLUSION

The results obtained in this study indicate that breadfruit is a good source of amino acids. It may be inferred that the cooking processes, especially boiling and frying, may have resulted in a decrease in the number of amino acids in the breadfruit, given that the raw sample showed a higher amino acid than the boiled and fried samples. For the fatty acids composition, the fried samples had a higher concentration of unsaturated fatty acids than the raw and boiled. Thus, the preparation methods affected the amino and fatty acid composition of breadfruit.

SIGNIFICANCE STATEMENT

The study on the amino acid profiling and fatty acid composition of breadfruit offers crucial information regarding its nutritional composition, enhancing dietary assessment and advancing human health. This information is essential for promoting food security since breadfruit is a sustainable food source. The results can also be used to guide product development and culinary application, enabling the production of creative and nourishing breadfruit-based food products. In this study, there was deterioration in the amino acid and fatty acid components (except the unsaturated) of breadfruit when processed, thus to further understand how different preparation methods alter the amino and fatty acid content of breadfruit, more preparatory methods should be explored to give a better nutritional value of the breadfruit.

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