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Impact of Traditional Treatments on the Nutritional Value of Seeds of Jack Fruit (*Artocarpus heterophyllus*)

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Abstract

Impact of traditional treatments on the nutritional value of *Artocarpus heterophyllus* seeds was evaluated. Four traditional processing methods were used (boiling, roasting, soaking and fermentation). Boiled *A. heterophyllus* (BAH) samples were boiled in water for 60 minutes, roasted *A. heterophyllus* (RAH) samples were roasted in fine sand, soaked *A. heterophyllus* (SAH) were soaked in clean water for 48 hours before boiling while the fermented *A. heterophyllus* (FAH) samples were boiled and wrapped in black bag for 48 hours. The mean proximate content (%) of the unprocessed *A. heterophyllus* (UAH) seeds was; protein (15.88 ± 0.08), fibre (10.04 ± 0.09) ash (5.05 ± 0.07), moisture (29.25 ± 0.35), fat (10.26 ± 0.35) and carbohydrate (29.52 ± 0.4). Processing affected the proximate and mineral composition of *A. heterophyllus* seeds. All the processing methods used reduced the protein content. There were significant increases ($p < 0.05$) in manganese (Mn), magnesuim (Mg), potassium (K), copper (Cu), iron (Fe), iodine (I), chlorine (Cl) and phosphorous (P) BAH and SAH samples and a significant reduction ($p < 0.05$) in Mg, calcium (Ca), selenium (Se), Cu, Cl, zinc (Zn) and Mn in FAH sample. Processing increased the level of phosphorous in all the samples. *A. heterophyllus* seeds are rich in nutrient and can serve as an alternative source of nutrients for both man and animals.

Keywords

Jack Fruit, Minerals, Processing, Proximate Composition

1. Introduction

Plant based foods offer an array of nutrients that are essential for human nutrition and promotion of good health. Most third world countries depend for basic diet of carbohydrates, fats and proteins on a very limited number of crop species that are conventional [1]. The Food and Agriculture Organization (FAO) of the World Health Organization (WHO) estimated that between 1990 and 1992, 204 million sub-Saharan Africans (41% of the population of the region) were chronically undernourished.

The WHO (1995) estimates for iodine, vitamin A and iron deficiencies in Africa show that 181 million Africans were at risk of iodine deficiency, 1 million had xerophthalmia, while 206 million had iron deficiency or anaemia [2] [3].

Across the world, many of the plant species that are cultivated for food are neglected and underutilized while they play a crucial role in the food security, nutrition, and income generation of the rural poor [4] [5]

A. heterophyllus (Jack Fruit) belongs to the family of moraceae (mulberry family). Jack fruit tree bears fruits all-round the year with peak production during the months of June and December. It is one of the underutilized plant species in Nigeria. Over 90% of the seeds are wasted annually; the ripe fruits are chewed while the seeds are discarded; only few populations consume the boiled and roasted seeds.

This study aimed at assessing the effects of various traditional processing methods on the proximate and mineral composition of *A. heterophyllus* seeds, with the aim of identifying the method(s) that preserve the nutrients and minerals.

2. Experimental Section

The fresh fruits of *A. heterophyllus* were bought from Eke Umuoji market in Idemili Local Government Area of Anambra State, Nigeria. The fruits were opened; the seeds were sorted and the bad ones were discarded. The raw seeds were divided into five equal portions and each part was processed by one of the following methods: boiling, roasting, soaking and fermentation while the fifth part was unprocessed. The Boiled *A. heterophyllus* (BAH) samples were prepared by boiling the seeds in clean water for 60 minutes, the seed coats were then removed and the seeds dried. The roasted *A. heterophyllus* (RAH) samples were prepared by roasting the seeds in fine sand for 60 minutes, after which the seed coats were removed and the seeds dried. Soaked *A. heterophyllus* (SAH) were prepared by soaking the seeds in clean water for 48 hours (the water was changed at 24 hours intervals), the soaked seeds were then boiled for 60 minutes and dried. Fermented *A. heterophyllus* (FAH) samples were prepared by boiling the seeds for 60 minutes, after which the seed coats were removed and the seeds tied in black nylon and kept in a cupboard for 48 hours. Drying of seeds (to a constant weight) was done in a laboratory oven at 50˚C. The processed seeds were ground into fine powder using a laboratory mill and fractions of each were used for the analysis of their constituents

2.1. Proximate Analysis

Moisture, lipid, ash and crude fibre contents were determined following the standard methods of the Association of Official Analytical Chemists [6]. The organic nitrogen content was quantified using the micro Kjeldahl method, and an estimate of the crude protein content was done by multiplying the organic nitrogen content by a factor of 6.25 [7]. Total carbohydrate content was calculated by difference.

2.2. Determination of Minerals

Calcium, potassium, manganese, selenium, copper, magnesium, iron, zinc and sodium were determined using FS 240 Varian atomic absorption spectrophotometry method while iodine, chloride and phosphorous were determined by colorimetric methods.

2.3. Statistical Analysis

Data generated from the study were analysed and the results presented as mean ± standard deviation of three determinations. Differences between means were separated using ANOVA and multiple comparison tests, with the least significant difference fixed at 0.05.

3. Results and Discussion

3.1. Seeds Nutritional Characterization

From the result in **Table 1**, the proximate composition of UAH and BAH differed numerically from the report of other workers; some researchers reported protein 27.57%, 4.03% and fibre 4.0% ash, for UAH and 22.93% protein, 3.65% fibre, 3.39% ash, for BAH [8]. Another researcher reported 15.10% protein, 6.09% fibre, 3.79% ash, 12.34% moisture, 1.2% fat and 61.36% carbohydrate for *A. heterophyllus* seed cake [9]. Another reported 14.81% protein, 17.90% starch, 3.83%, fibre, 2.13% ash and 42.25% moisture for UAH seeds [10]. In this study, the values obtained were; 15.88% protein, 10.04% fibre, 5.05% ash, 22.25% moisture, 10.26% fat and 36.54% carbohydrate for UAH. It has been established that nutrient and antinutrient compositions may vary depending on the variety, growing conditions, geographical location and the propagation method of the seeds. When compared with conventional seeds like African bread fruit, bread

Table 1. Nutrient composition of *A. heterophyllus* seeds subjected to different processing methods.

Percentage composition	Unprocessed (UAH)	Roasted (RAH)	Boiled (BAH)	Soaked (SAH)	Fermented (FAH)
Protein	15.88 ± 0.08	11.95 ± 0.07	9.9 ± 0.04	11.78 ± 0.06	10.75 ± 0.15
Fibre	10.04 ± 0.09	12.04 ± 0.04	4.55 ± 0.064	8.05 ± 0.05	5.06 ± 0.082
Ash	5.05 ± 0.07	6.03 ± 0.04	4.04 ± 0.05	6.70 ± 0.05	3.03 ± 0.037
Moisture	29.25 ± 0.35	20.05 ± 0.35	19.95 ± 0.8	20.46 ± 0.71	35.04 ± 0.39
Fat	10.26 ± 0.35	9.55 ± 0.7	9.98 ± 0.38	9.07 ± 0.93	8.49 ± 0.25
Carbohydrate	29.52 ± 0.4	40.38 ± 0.69	51.58 ± 0.44	43.95 ± 0.42	37.64 ± 1.27

fruit and bambara nut, *A. heterophyllus* raw/unprocessed seeds protein amounts to 15.88% this is higher than African bread (*Treculiar africana*) fruit 12%, and bread fruit (*Artocarpus atilis*) 8.42% but lower than bambara nut 23.41% and pigeon pea 21.88%.

Processing affected the proximate composition of *A. heterophyllus* seeds. All the processsing methods used reduced the protein content. BAH had the least protein content 9.9% while roasted *A. heterophyllus* (RAH) had the highest value. The significant decrease ($p < 0.05$) in protein content of BAH might be due to leaching out of soluble nitrogen into the solution, this agrees with the report of Ijeh *et al.* [3], they reported a reduction of protein content of bread fruit after boiling.

The decreased in protein content of fermented *A. heterophyllus* (FAH) seeds might be because the microbial flora used some of the protein for their metabolic activity while reduction in RAH might be due to denaturation of endogenous proteins in the seeds during processing.

The fibre content of *A. heterophyllus* seeds was high (10.04%) compared to other conventional seeds, Ijeh reported 1.3% for African bread fruit [3], Isichei and Achinewhu reported 2.5% for African oil bean and melon seeds [11], while Akpabio reported 3.11% for almond seeds [12]. High fibre could trap and protect a large proportion of nutrients such as protein and carbohydrate from hydrolytic breakdown, thus reducing digestibility and utilization of end product of digestion. Dietary fibre also slows gastric emptying time by forming a gel matrix in the small intestine, it enhances bile salt and cholesterol excretion and increase faecal bulk and faecal transit time through the bowel [13]. The gel matrix slows absorption by trapping nutrients, digestive enzymes or bile acids. This effect is a characteristic which is necessary to blunt the increase in plasma glucose after a glucose load. Thus, the high dietary fibre of *A. heterophyllus* seeds could be exploited for the therapeutic management of conditions such as hyperglycaemia and hypercholesterolaemia in humans. Roasting increased the crude fibre content of the seed to 12.04%, this agrees with the work of Ijeh *et al.* [3] in a report that showed an increase in fibre content of roasted African bread fruit.

The high fat content of UAH seeds (10.25%) makes it a potential source of vegetable oil. The fat content is higher than that of African bread fruit (4.23%). It was observed that processing reduced the fat content of all the samples, this might be because some of the oil might have leached out in cooking water and some lost during roasting. The observation is in line with the report of Ijeh [3], where reduction in fat content was observed following boiling and roasting, Oyeike also reported reduction in fat content of boiled and fried groundnut seeds [14].

The moisture content showed that RAH seeds had the least value (19.95%) while the fermented samples had the highest value (35.04%). This suggests that roasted samples can be stored for a long time without spoilage since higher water activity can enhance microbial action thereby causing food spoilage [15].

Total carbohydrate value was increased in all the samples when compared with UAH seeds. Fermentation had the least value 37.64% while the boiled sample had the highest value 47.89%.

3.2. Seeds Mineral Characterization

The mineral compositions of *A. heterophyllus* seeds in **Table 2**, showed that magnesium level (mg/kg) was highest in UAH (29.51), followed by calcium; UAH (16.61). Among the trace element, selenium was the highest; UAH (5.3), followed by zinc; UAH (16.61).

Processing affected the levels of minerals in *A. heterophyllus* seeds. There was reduction in Mg, Ca, Se, Cu, Cl, Zn and Mn in FAH. These decrease observed with fermentation method could be due to the probability of the mineral being used for microbial metabolism. This is in line with the report of Afify, they reported reduction in Mg, Cu, Zn and Mn levels of fermented white sorghum varieties. There was increase in Mn, Mg, K, Cu, Mg, Fe, I, Cl and P in BAH and SAH samples. This might be attributed to the source of water for processing. Adane reported increase in Fe, Ca, Na, Mg, Cu and P levels of boiled Colocasiaesculenta [16]. There was increase in Mn, Mg, Cu, I, Cl and P in RAH sample. This result is in agreement with Ijeh report's of an increase in Ca, Mg, Cu and I in roasted *Treculia africana* seeds [3]. Fe was not detected in FAH while K and Fe were not detected in RAH. Processing increased the level of phosphorous in all the treatments, these increase might be due to breakdown of phytate by phytase to release more phosphorous. Fermentation increased the phosphorous level more than other treatments (**Table 3**).

Table 2. Mineral content of *A. heterophyllus* SEEDS (Mg/G) subjected to different processing methods.

Minerals (mg/kg)	Unprocessed (UAH)	Boiled (BAH)	Roasted (RAH)	Soaked (SAH)	Fermented (FAH)
Manganese	0.42 ± 0.01	1.13 ± 0.03	1.08 ± 0.13	1.63 ± 0.041	0.11 ± 0.0
Potassium	0.09 ± 0.01	0.68 ± 0.01	0.00	0.62 ± 0.023	0.68 ± 0.01
Calcium	16.61 ± 0.021	16.27 ± 0.01	7.06 ± 0.01	16.5 ± 0.17	13.88 ± 0.11
Selenium	5.3 ± 0.01	1.4 ± 0.021	2.11 ± 0.02	3.11 ± 0.56	2.2 ± 0.05
Copper	0.25 ± 0.01	0.31 ± 0.01	0.67 ± 0.02	0.58 ± 0	0.06 ± 0.01
Magnesium	29.51 ± 0.02	30.41 ± 0.02	29.76 ± 0.03	30.13 ± 0.18	30.41 ± 0.21
Iron	0.13 ± 0.01	5.2 ± 0.01	0.00	8.94 ± 0.15	0.00
Zinc	4.34 ± 0.01	4.28 ± 0.01	3.67 ± 0.02	4.35 ± 0.062	0.38 ± 0.01
Sodium	4.78 ± 0.01	2.31 ± 0.01	3.88 ± 0.02	3.89 ± 0.06	4.92 ± 0.09

Table 3. Mineral content of *A. heterophyllus* seeds (Mg/L) subjected to different processing method.

Mineral (mg/l)	UAH	BAH	RAH	SAH	FAH
Iodine	10.39 ± 0.31	12.86 ± 0.42	12.11 ± 0.52	14.82 ± 1.1	13.31 ± 1.09
Chloride	19.15 ± 0.7	22.48 ± 0.61	38.33 ± 1.4	43.49 ± 1.4	11.49 ± 0.83
Phosphorous	0.75 ± 0.02	0.94 ± 0.03	1.00 ± 0.01	0.89 ± 0.05	1.33 ± 0.081

4. Conclusion

In conclusion, the results showed that *A. heterophyllus* seeds are high in nutrients. Among the different traditional processing methods used, roasted samples had the highest nutrient compositions while the boiled samples had the least nutrient content. For the mineral elements, soaking of seeds preserved the mineral elements better than the other processing methods. Consumption of *A. heterophyllus* fruit should be encouraged and promoted. When promoted, they could contribute to poverty reduction mainly in rural areas, and to the improvement of nutritional status of the entire population. This will help to reduce over dependence on some conventional foods thus enhancing food availability and alleviating poverty.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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