Effect of Traditional Processing Techniques on the Proximateand Mineral Compositions of Jack Fruit (*ArtocarpusHeterophyllus)*Seeds

O.E. Okafor, L.U.S. Ezeanyika, and C.U.O Ujowundu.

Abstract—The effect of processing methods on the proximate and mineral compositions of *Artocarpus heterophyllus* seeds were evaluated. Four traditional processing methods were used (boiling, roasting, soaking and fermentation). The boiled samples were boiled in tap water, roasted sample were done in fine sand, soaking was in tap water for 48 hours before boiling while the fermented samples were boiled and wrap in black bag for 48 hours .The mean proximate content (%) of the unprocessed *Artocarpus heterophyllus* (UAH) seeds were; 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 and pulp. 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) in the boiled *Artocarpus heterophyllus* (BAH) and soaked *Artocarpus heterophyllus* (SAH) samples and a significant reduction ($p<0.05$) in Mg, calcium (Ca), selenium (Se), Cu, Cl, zinc (Zn) and Mn in the fermented *Artocarpus heterophyllus* (FAH) sample. Processing increased the level of phosphorous in all the treatments. *A.heterophyllus* seeds can be an alternative source of nutrients for both man and animals.

Index Terms—Jack fruit, minerals, processing, proximate**.**

I. 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[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].

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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].

Artocarpus heteropyllus (Jack Fruit) plant is one of the underutilised plant species in Nigeria. Over 90% of the seeds are wasted annually, the ripe fruit bulbs are chewed while the seeds are discarded, only few populations consume the boiled and roasted seeds.

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

II. MATERIAL AND METHODS

The fresh fruits of *Artocarpus heterophyllus* were bought from Eke Umuoji in Idemili Local Government Area of Anambra State, Nigeria. The fruits were sliced opened, the seeds and pulp were extracted manually. The raw seeds were shared into five equal parts and each part processed by one of the following methods: boiling, roasting, soaking and fermentation. The fifth part was unprocessed. The boiled sample was prepared by boiling in a clean tap water until the seeds were soft, the seed coats were removed and the seeds dried. The roasted samples were roasted in fine sand for sixty (60) minutes, the seed coats were removed and the seeds dried. The soaked samples was prepared by removing the seed coats and soaking for forty eight (48) hours (the water was changed at twenty four (24) hours intervals), they were boiled for 60 minutes and the seeds dried. Fermented samples were boiled for 60 minutes, the seed coats were removed and the seeds were tied in black nylon and kept in a cupboard for 48hours. Drying of seeds (to a constant weight), was done in a laboratory oven at 50°C. The processed seeds and pulp were ground into fine powder using a laboratory mill and fractions of each were used for the analysis of their constituents.

A. 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.

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B. Determination Of Minerals

Calcium (Ca), potassium (K), manganese (Mn), selenium (Se), copper (Cu), magnesium (Mg), iron (Fe), zinc (Zn)and sodium (Na) were determined using atomic absorption spectrophotometry method while iodine (I), chloride (Cl) and phosphorous (P) were determined by colorimetric methods.

C. 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 the ANOVA and multiple comparison tests, with the least significant difference fixed at 0.05.

III. Results And Discussions

TABLE I
NUTRIENT COMPOSITION OF THE *A. HETEROPHYLLUS* SEEDS SUBJECTED TO DIFFERENT PROCESSING METHOD

Percentage concetration	Unprocessed	Roasted	Boiled	Soaked	Fermented
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

TABLE II
MINERAL CONTENT OF SEEDS AND PULP (MG/G) SUBJECTED TO DIFFERENT PROCESSING METHOD

Minerals (mg/kg)	Unprocessed	Boiled	Roasted	Soaked	Fermented	pulp
manganese	0.42±0.01	1.13±0.03	1.08±0.13	1.63±0.041	0.11±0.0	0.64±0.01
potassium	0.09±0.01	0.68±0.01	0.00	0.62±0.023	0.68±0.01	1.21±0.01
calcium	16.61±0.021	16.27±0.01	7.06±0.01	16.5±0.17	13.88±0.11	16.48±0.02
selenium	5.3±0.01	1.4±0.021	2.11±0.02	3.11±0.56	2.2±0.05	2.4±0.01
copper	0.25±0.01	0.31±0.01	0.67±0.02	0.58±0	0.06±0.01	3.52±0.02
magnesium	29.51±0.02	30.41±0.02	29.76±0.03	30.13±0.18	30.41±0.21	29.16±0.03
iron	0.13±0.01	5.2±0.01	0.00	8.94±0.15	0.00	0.00
zinc	4.34±0.01	4.28±0.01	3.67±0.02	4.35±0.062	0.38±0.01	0.97±0.001
sodium	4.78±0.01	2.31±0.01	3.88±0.02	3.89±0.06	4.92±0.09	5.11±0.02

TABLE III
MINERAL CONTENT OF SEEDS AND PULP (MG/L) SUBJECTED TO DIFFERENT PROCESSING METHOD

Mineral (mg/l)	UAH	BAH	RAH	SAH	FAH	pulp
iodine	10.39±0.31	12.86±0.42	12.11±0.52	14.82±1.1	13.31±1.09	8.46±0.63
chloride	19.15±0.7	22.48±0.61	38.33±1.4	43.49±1.4	11.49±0.83	18.3±0.91
phosphorous	0.75±0.02	0.94±0.03	1.00±0.01	0.89±0.05	1.33±0.081	3.81±0.24

From the result in table I, the proximate composition of unprocessed *Artocarpus heterophyllus* (UAH) and boiled *Artocarpus heterophyllus* (BAH) differed numerically from the report of other workers;some researchers reported protein 27.57%, 4.03% 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, *A. heterophyllus* raw/unprocessed seeds protein amounts to 15.88% which is higher than African bread (*Treculiar africana*) fruit 12%, and bread fruit (*Artocarpus atilis*) 8.42%. But is found to be 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 *Artocarpus 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[3], they reported a reduction of protein content of bread fruit after boiling.

The decreased in protein content of fermented *Artocarpus 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, 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 to 12.04%, this agrees with the work of Ijeh[3]. They reported 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 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 were lost during roasting. This agrees 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 suggested 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%.

The mineral compositions of *A. heterophyllus* seeds and pulp in table II, showed that magnesium level (mg/kg) was highest in UAH (29.51), pulp (29.15) followed by calcium; UAH (16.61), pulp (16.48). Among the trace element, selenium was the highest; UAH (5.3), pulp (2.41) followed by zinc; UAH (16.61), pulp (16.48).

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 could be due to the minerals being used for microbial metabolism. This agrees 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 agrees with the report of Ijeh, they reported an increase in Ca, Mg, Cu and I in roasted *Treculia africana* seeds[3]. Fe was not detected in FAH and pulp 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 treatment.

In conclusion, our data showed that *Artocarpus 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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