

## The Effect of Processing on the Nutritional and Anti-Nutritional Factors in the Raw, Roasted and Fermented Jackfruit (*Artocarpus heterophyllus*) Seeds

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### Abstract

**Background of study:** Processing methods have been known to influence the nutrients and anti-nutrients present in food substances. Jack fruit (*Artocarpus heterophyllus* Lam.) of the family Maraceae; contains edible seeds which is added to various food recipes.

**Aim:** This study was aimed at determining the effect of processing on the proximate composition and anti-nutritional factors in the raw, roasted and fermented samples of *Artocarpus heterophyllus* seeds.

**Methodology:** The raw seeds were subjected to fermentation and roasting respectively. The samples were then later dried and milled. The proximate analysis of the raw, roasted and fermented samples was done using standard methods. The levels of the following anti-nutrients: - tannin, phytic acid, oxalate, and saponin were determined from the raw, roasted and fermented samples respectively using standard methods.

**Result:** Proximate analysis revealed that the raw sample had the highest CHO (65.31%), followed by fermented (62.75%) and the roasted (61.44%). The roasted sample had the highest protein value of (29.59%) followed by the fermented (26.92%) and the raw (24.90%). Crude fat was highest in roasted (1.68%), followed by the raw (1.63%) and the fermented (1.28%). Ash content was highest in the roasted (3.67%) followed by raw (3.56%) and the fermented (3.35%). However, the moisture content was highest in the fermented sample (3.48%) followed by raw (2.56%) and roasted (2.48%). The roasted samples had the highest percentage reduction in all the anti-nutrients (tannin, phytate, oxalate, saponin) as compared to the fermented sample.

**Conclusion:** Roasted jack fruit seed contains the lowest anti-nutrients and can therefore be incorporated into the diet as a safer nutritional supplement.

**Keywords:** *Artocarpus heterophyllus*; Anti-Nutritional Factors; Processing

### Introduction

Nutrients refer to components in foods which enables an organism to survive and grow [1]. Nutrients are categorised into macro nutrients and micro nutrients. Macro nutrients provide the greater part of the energy needed by an organism to perform various metabolic roles and they include carbohydrates, fats and proteins. Micro nutrients are also needed to provide the necessary cofactors for various metabolic processes [1]. Proximate analysis of foods is used as an index for describing the basic nutrient composition of foods in terms of protein, moisture, fat, fiber, ash (minerals) and carbohydrate [2]. Anti-nutritional factors are compounds which interfere with the utilization of nutrients [3]. These anti-nutritional factors are also regarded as anti-nutrients and they are natural or synthetic agents in foods that can interfere with the absorption of other nutrients [4]. Various parts of plants are utilised as food components since time immemo-

rial because of the diverse nutrients stored in them. Plants in addition to containing nutrients also contain some of these anti-nutritional factors [5]. Major anti nutrients mostly found in plant sources include saponins, tannins, trypsin inhibitor, cyanogenic glycosides, phytic acid, oxalates, amylase inhibitors etc [6].

Food processing refers to the various procedures employed in transforming crude materials into food or food into other forms for ingestion by humans or animals [7]. Topmost reason for food processing is the need to remove and reduce the levels of the anti-nutrients in food by subjecting food samples to different processing methods like cooking, fermentation, roasting. Food processing also increases the desirability and delectableness of food and also ensures a longer shelf-life of food products [7].

Jackfruit (*Artocarpus heterophyllus*) is a member of the family moraceae and bears the biggest fruit among the edible fruits. Its seeds are embedded in the pulp and are utilised in various recipes [8]. The fruit also contains various phytochemicals such as phenolic compounds, flavonones etc [9]. Moreover, extracts from the seeds have been used in the treatment of diarrhoea and dysentery; and have also been reported to possess cytotoxic activity against cancer cells *in vitro* [9]. Despite the highly nutritive value of jackfruit seeds, it is generally utilised as feed for animals. Of recent, there is little information available on the nutritional and anti-nutritional contents of jackfruit seed. There is therefore a dire need to look for cheaper and safer plant-based foods that can be utilised as a nutritional supplement to help meet the caloric requirements of individuals considering the high cost of synthetic food supplements. This study will provide a greater insight on the nutritional value of jackfruit seeds and the best processing method that will eliminate a greater portion of the anti-nutritional factors in it, making it safer for human consumption. This study was aimed at determining the effect of processing methods of roasting and fermentation on the nutrients and anti-nutritional factors in jackfruit seed.

## **Methodology**

### **Plant Collection and Identification**

Jackfruit (*Artocarpus heterophyllus* Lam) samples was gotten from the local garden of Obafemi Awolowo University Ile-Ife, Osun State, Nigeria and identified in the Herbarium of the Botany Department of the university where it was assigned the voucher specimen number -IFE/17617.

### **Processing of seed samples**

The raw seed sample was subjected to roasting and fermentation processes respectively. To obtain the roasted sample, the raw seed samples were blanched in a 250 mL conical flask respectively at 94.5°C for thirty minutes, drained through a plastic sieve, and thereafter dehulled. The samples were then roasted by heating in an oven at a temperature of 100°C until it turned brown. The roasted sample was then packed in new sealable polyethylene bag prior to laboratory analysis.

To obtain the fermented sample, the raw seed samples were air dried for three weeks and the husks were peeled and separated from the seeds. The dehulled seeds were then soaked in distilled water for one week and thereafter packed in new seal-able polyethylene bags prior to laboratory analysis.

Both the raw (unprocessed) and the processed (roasted and fermented) seed samples were later dried, crushed in porcelain mortar, homogenized and then stored in air tight plastic container prior to analysis.

### **Proximate composition analysis**

Proximate analysis of the raw, roasted and fermented seed powder samples of jackfruit was carried out to determine crude protein, crude fibre, total ash, total carbohydrate, crude lipid and moisture content and this was done in accordance to the methods described by AOAC [10].

### **Determination of the anti-nutritional factors in the raw, roasted and fermented jackfruit seed samples**

#### **Saponin**

The electrophoretic method was used for saponin analysis as described by Brunner [11]. 1g of the seed flour sample was weighed into a 250 ml beaker and 100 ml isobutyl alcohol was added. The mixture was shaken on a UDY shaker for five hours to ensure uniform mixing. The mixture was filtered through a Whatman No. 1 filter paper into a 100 ml beaker and 20 ml of 40% saturated solution of Magnesium carbonate was added. The mixture obtained was further filtered through a Whatman No. 1 filter paper to obtain a clear colourless solution. 1 ml of the colourless solution was homogenized into a 50 ml volumetric flask and 2 ml of 5%  $\text{FeCl}_3$  solution was added and made up to mix with distilled water and allowed to stand for 30 minutes for blood red colour to develop. Standard solutions (0-10 ppm) were prepared from saponin stock solution and treated with 2 ml of 5% iron chloride solution as done for experimental sample. The absorbance of the sample as well as standard saponin solutions were read after colour development on a Spectronic 21D spectrophotometer at a wavelength of 380nm and the percentage saponin was calculated.

#### **Tannin**

Tannin content of the flour sample was determined using the method described by Bate-Smith and Swain [12]. 0.2g of the respective samples was measured into a 50 mL beaker; 20 mL of 50% methanol was added, covered with homogenizer, and placed in a water bath at 77 - 80°C for 1 hour; and the contents stirred with a glass rod to prevent lumping. The mixture was filtered using a double layered Whatman No.1 filter paper into a 100 mL volumetric flask using 50% methanol to rinse. This was made up to mark with distilled water and thoroughly mixed. 1 ml of the sample extract was homogenized into a 50 mL volumetric flask, and 20 mL distilled water, 2.5 mL Folin-Denis reagent, 10 mL of 17%  $\text{Na}_2\text{CO}_3$  were added and mixed. The mixture was made up to mark with distilled water thoroughly mixed and allowed to stand for 20 minutes when a bluish-green coloration developed. Standard tannic acid solution was treated similarly as the sample above. The absorbance of the tannic acid standard solutions as well as those of the samples was read after colour development on a spintronic 21D spectrophotometer at a wavelength of 760 nm. Percentage tannin was thereafter calculated.

#### **Phytic acid**

An indirect colorimetric method of Wheeler and Ferrel [12]. was used for phytate determination. This method depends on an iron to phosphorus ratio of 4:6. 5g of the test samples were extracted with 3% trichloroacetic acid. The phytate was precipitated as ferric phytate and converted to ferric hydroxide and soluble sodium phytate by adding sodium hydroxide. The precipitate was dissolved in hot 3.2N  $\text{HNO}_3$  and the colour read immediately at 480 nm. The standard solution was prepared from  $\text{Fe}(\text{NO}_3)_3$  standard curve. The phytate concentration was calculated from the iron result assuming a 4:6 iron: phosphorous molecular ratio.

#### **Oxalate**

Oxalate was determined according to the guideline of AOAC [10] method. 1g of the sample was weighed in 100 mL conical flask. 75 ml of 3 mol/L  $\text{H}_2\text{SO}_4$  was added and the solution was stirred intermittently with a magnetic stirrer for about 1 hour and then filtered using Whatman No. 1 filter paper. 25 mL of the sample filtrate was collected and titrated against hot 0.1N  $\text{KMnO}_4$  solution to the point when a faint pink colour appeared. The concentration of oxalate in each sample was obtained from the calculation:

1 mL 0.1 permanganate = 0.006303g oxalate.

#### **Statistical analysis**

Simple statistics such as mean and standard deviation (SD) were used for the analysis of data. Analysis of variance (ANOVA) was also used to determine levels of significance among parameters determined using SPSS version 2.0 software. Significant levels were at  $p < 0.05$ . Values were expressed as mean  $\pm$  standard deviation (SD).

## Results

### Proximate analysis

The result of the proximate analysis of the raw, roasted and fermented jack fruit seed as shown in table 1 reveals that the roasted jackfruit seed had the significantly ( $p < 0.05$ ) highest protein content, followed by the fermented jackfruit seed as compared to the raw. Moisture content was found to be significantly ( $p < 0.05$ ) higher in the fermented seed when compared to the roasted and raw jackfruit seed. The roasted jackfruit seed had the highest significantly ( $p < 0.05$ ) crude fat content, followed by the raw jackfruit seed as compared to that of the fermented sample. Ash content was found to be significantly ( $p < 0.05$ ) higher in roasted jackfruit seed when compared to the raw and fermented jackfruit seed.

Sample Code	Crude Protein (%)	Moisture (%)	Crude Fat (%)	Ash (%)	Crude Fiber (%)	CHO (%)	Dry Matter (%)
Raw Jack fruit seed	24.90 <sup>c</sup> ± 0.18	2.56 <sup>b</sup> ± 0.04	1.63 <sup>b</sup> ± 0.06	3.56 <sup>b</sup> ± 0.2	2.66 <sup>a</sup> ± 0.04	65.31 <sup>a</sup> ± 0.15	97.50 <sup>c</sup> ± 0.05
Fermented Jackfruit seeds	26.92 <sup>b</sup> ± 0.09	3.48 <sup>a</sup> ± 0.02	1.28 <sup>c</sup> ± 0.01	3.35 <sup>c</sup> ± 0.2	2.58 <sup>b</sup> ± 0.2	62.75 <sup>b</sup> ± 0.2	96.56 <sup>b</sup> ± 0.02
Roasted Jackfruit seeds	29.50 <sup>a</sup> ± 0.4	2.48 <sup>c</sup> ± 0.02	1.68 <sup>a</sup> ± 0.02	3.67 <sup>a</sup> ± 0.04	1.80 <sup>c</sup> ± 0.03	61.44 <sup>c</sup> ± .02	97.77 <sup>a</sup> ± 0.17

**Table 1:** The proximate composition of the raw and the processed (fermented and roasted) jack fruit (*Artocarpus heterophyllus*) seed samples

Values are Mean ± SD of three determinations. Means with different superscripts on the same column differs significantly at ( $p < 0.05$ ).

The raw jackfruit seed had the highest significantly ( $p < 0.05$ ) crude fibre content, followed by the fermented jackfruit seeds with the roasted having the least. Carbohydrate content was found to be significantly ( $p < 0.05$ ) higher in the raw jack fruit seed when compared to the fermented and roasted Jackfruit seed. Dry matter was found to be significantly ( $p < 0.05$ ) higher in the roasted jackfruit seed as compared to the fermented jackfruit seed.

### Analysis of the anti-nutritional factors in the raw, roasted and fermented jackfruit seed samples

As shown in table 2, the raw jackfruit seed contains the significantly ( $p < 0.05$ ) highest content of all the anti-nutrients followed by the fermented sample while the roasted jackfruit seed samples were found to contain the least amount of anti-nutrients. As shown in table 3, the roasted jackfruit seed sample had a higher percentage reduction in the levels of the anti-nutrients when compared to the fermented sample using the raw sample as the reference standard.

Sample Code	Tannic (mg/100g)	Phytic acid (mg/100g)	Oxalates (mg/100g)	Saponin (mg/100g)
Fermented	1.00 <sup>b</sup> ± 0.01	1.42 <sup>b</sup> ± 0.02	1.46 <sup>b</sup> ± 0.04	0.64 <sup>b</sup> ± 0.07
Roasted	0.88 <sup>c</sup> ± 0.02	0.96 <sup>c</sup> ± 0.02	1.16 <sup>c</sup> ± 0.03	0.48 <sup>c</sup> ± 0.02
Raw	1.24 <sup>a</sup> ± 0.02	1.56 <sup>a</sup> ± 0.06	1.48 <sup>a</sup> ± 0.03	0.76 <sup>a</sup> ± 0.01

**Table 2:** The anti-nutritional factors in the raw and processed (fermented, roasted) jackfruit seeds

Values are Mean ± SD of three determinations. Means with different superscripts on the same column differs significantly at ( $p < 0.05$ ).

Sample Code	Tannic (%)	Phytic (%)	Oxalates (%)	Saponin (%)
Fermented Jackfruit	19.35	8.97	1.35	15.79
Roasted Jackfruit	29.03	38.46	21.62	36.84

Table 3: Percentage (%) reduction in the anti-nutritional factors in fermented and roasted jackfruit seed.

## Discussion

Proximate analysis of food is used to describe the basic nutrient composition of foods in terms of protein, moisture, fat, fiber, ash (minerals) and carbohydrate [2]. There was a significant ( $p < 0.05$ ) difference for all the parameters considered. Roasted jack fruit seed contained the highest ash content while the fermented seeds had the lowest ash content. The ash content is the organic residue remaining after the organic matter has been burnt away. The ash values obtained for the raw seed in this study was higher when compared with the value obtained in a similar study by Tukura and Obliva, [14]. but lower when compared to that of the initial study by Akinmutimi [15]. The difference may be attributed to different sources of seeds climatic factors, soil and environmental factors [15].

The moisture content of the fermented seed of jack fruit was higher as compared to that of the roasted seed which is in consonance with the results reported for bread fruit (*Artocarpus altilis*) seeds from parent plant in a study conducted by Tukura and Obliva [15]. Moisture level of food is usually an index of its stability and susceptibility to microbial contamination. An elevated level of moisture content is indicative of its high perishability. Variation in moisture contents of any food could be ascribed to the phase of maturity at which the crop was harvested, environmental and storage factors at the time of harvest. Low moisture content of food samples is of immense benefit age in the storage and preservation of nutrients [15].

The crude protein content of the roasted jack fruit seeds was higher than those of the fermented seed and the raw seed. The removed outer coats contain cellulose, thereby shooting up the crude protein. A food regime is nutritionally acceptable if it contains high calorie value and a sufficient amount of protein. Protein helps growth, reproduction and is used for repair of worn-out tissues or cell [16]. Carbohydrate content of the roasted seed was reduced as a result of the shooting up of crude-protein content and this value agrees with the result reported by Tukura and Obliva [14]. Crude fat and fibre were also present in small amounts. The highest crude fat and crude fiber was recorded in the roasted and raw seeds of jack fruit respectively. The fibre present reduces absorption of glucose from the consumption of food. Low fat content has been reported to increase the shelf life of the samples by decreasing the chances of rancidity and will also contribute to low energy value of the sample [14].

The dry matter which consist of the dry particles of organic matter/solid, waste and vegetable materials composition in jack fruit seed were observed to be highest in the roasted seed ( $97.77 \pm 0.17\%$ ) and least in the fermented seed of jack fruit. This indicates the high organic matter and materials in jack fruit seeds. This value is in line with the result reported by [15].

Jack fruit seeds are rich in carbohydrate as seen from the results with the raw seed containing the highest amounts as compared to the roasted and fermented seed samples. This implies that jack fruit seed is a good source of energy as carbohydrates are energy giving food [14]. Carbohydrates are the main source of energy for the body's metabolic activities [17]. The lower values obtained for the carbohydrate content in the roasted and fermented jackfruit seed samples as compared to that of the raw may be due to the effect of processing which led to the removal of the seed coat which also contains small amount of carbohydrates.

Anti-nutritional factors or anti-nutrients are molecules that affect the absorption of other nutrients in the body [3]. Raw jackfruit seeds contain anti-nutritional factors like tannic acid, phytic acid, oxalates and saponins. It was pre-treated by fermentation and roasting and as shown in table 2, there was a significant ( $p < 0.05$ ) reduction in the levels of the four anti-nutrients considered in this study in the roasted jackfruit seed sample as compared to the fermented. Roasting as a food processing technique has been found to lead to the greatest reduction in the levels of the different anti-nutritional factors as compared to other pre-treatment methods like cooking, boiling and fermentation and this is in agreement with the report of Adeyemo and Onilude [18]. Also, in a study conducted by Cheriff, *et al.* [19] on *moringa oleifera* leaves; it was observed that roasting the leaves at a high temperature led to a significant reduction in the levels of the anti-nutrients present.

Tannins are water soluble phenolic compounds that form insoluble complexes with proteins, precipitating them from aqueous solutions; thereby interfering with their bioavailability [4]. The roasted sample contains the least amount of tannins as compared to the fermented sample. This confirms that tannin is thermostable [20].

Phytic acid is also regarded as an anti-nutrient because of its high binding affinity to minerals such as calcium, magnesium, iron, copper and zinc [4]. The lowest level of phytic acid was recorded in the roasted sample. High levels of phytic acid may result in formation of insoluble complexes with minerals like calcium and magnesium, sequestering them and making them inaccessible for metabolic processes [20].

As regards oxalate, the highest percentage reduction was observed in the roasted sample. Oxalate is also considered an anti-nutrient because it has a strong binding affinity to minerals e. g calcium [14]. Ingestion of raw sample of jackfruit high in oxalate can result in the formation of insoluble complex of calcium oxalate which might result in shortage of available calcium, leading to reduced bone formation and energy utilization especially the regulation of pyruvate dehydrogenase complex which is an enzyme required for the conversion of pyruvate to acetyl coA [20].

Saponin content was also significantly reduced in the roasted jackfruit seed sample as compared to the fermented sample. Saponins are glycosides that possess foaming characteristics and have been reported to be responsible for bitter taste and haemolytic effect on red blood cells observed when ingested in high amounts [15]. High amounts of saponin have been implicated in the aetiology of hypocholesterolaemia which is attributed to the ability of saponins to bind cholesterol and reduce its absorption in the body system [21].

## **Conclusion**

Roasting as a food processing method employed in this study led to a significant reduction in the levels of the anti-nutrients in jackfruit seed which resulted in a greater bio availability of the nutrients. Hence, the roasted jackfruit seed can be incorporated into human diet as a viable and safe nutritional supplement. More research on jackfruit seed is still recommended to discover the best processing method that can still conserve the nutrients more efficiently and also reduce the level of the anti-nutrients to the barest minimum.

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