www.ijarp.com ISSN 2456-9992 Page: 01-22

Research Article

International Journal Advanced Research Publications

Volume: 02
Issue: 04

EFFECT OF PROCESSING ON THE ANTINUTRITONAL COMPOSITION, MINERAL CONTENTS, AND AMINO ACID PROFILE ON FOOD APPLICATION OF AFRICAN LOCUST BEAN SEEDS FLOUR.

*Stella Chituru Ikwen Felix Ojar Ogar

Centre for Food Technology and Research, Benue State University, Makurdi, Nigeria.

Article Received: 24 February 2026, Article Revised: 14 March 2026, Published on: 03 April 2026

***Corresponding Author: Stella Chituru Ikwen**

Centre for Food Technology and Research, Benue State University, Makurdi, Nigeria.

DOI: https://doi-doi.org/101555/ijarp.1148

ABSTRACT

The study investigated the effect of processing on some quality attributes and food applications of African locust bean seeds. Flours were prepared from cooked, autoclaved and germinated African locust bean seeds. The antinutritional composition, mineral contents, and amino acids profile of the flours were determined. The flours were used to substitute 20% and 30% in plantain flour for biscuits and noodles. The antinutrients (Tannin, phytate, oxalate, saponnin and alkaloid) significantly ($p<0.05$) decreased with the values ranged from tannin 73.11 – 162.47 mg/100g, phytate 1.22-2.48 mg/100g and alkaloid 21.42-46.43 with control having the highest value. Potassium increased from 225.33mg/100g (control) to 1614.67 mg/100g with autoclaved having the highest value. Germination caused the highest increase in magnesium content with a value of 382.33 mg/100g as compared to 358.00 mg/100g (control). The total amino acids (TAA) of the treated flours and the blends ranged from 10.02 to 38.95%, while that of the control was 18.29%. Cooking increased TAA (23.48%), while the blends had the highest total amino acids as well as the highest lysine contents (38.95 and 8.64 %). The results of the study showed that cooking, germination and autoclaving had effect on the quality attributes of the flours.

KEYWORDS: African locust bean seed flour, cooking, germination, autoclaving, antinutritional factors, mineral composition and amino acid profile.

1.0 INTRODUCTION

Processing treatments given to food increase the nutritional quality of food plants and are also effective in eliminating the anti-nutritional factors in them and thus the need for proper indebt knowledge of food processing methods. A better understanding of the effect of different traditional processing methods on the functional, nutritional and anti-nutritional factors, lead to wider use of legumes in the food industry. In addition, processing methods increase the digestibility of macromolecules such as proteins, carbohydrates etc , which leads to better assimilation of their monomeric units. Subsequently, researchers have done extensive works on effect of processing methods on food. For instance, D'souza (2013) looked at the effect of traditional processing methods (germination, cooking, autoclaving) on the nutritional quality of field bean. It was observed that germination increased the moisture and protein content. Crude lipid and ash contents were reduced under the various processing methods. There was an increase in the carbohydrate content under all methods of processing except upon germination. In addition, it was observed that cooking methods resulted in decrease of raffinose, stachyose, verbascose, maltose and sucrose accompanied by an increase in glucose. It was also revealed that the processing (soaking and germination) and cooking methods (ordinary cooking and autoclaving) was more effective in eliminating the contents of oligosaccharides and phytic acid in both varieties Soybean seeds analyzed due to their volatile nature. Food processing dates back to the prehistoric a while when crude processing incorporated fermenting, solar drying, preserving with salt, and quite a lot of forms of cooking (akin to roasting, smoking, steaming, and oven baking), such general food processing involved chemical enzymatic changes to the elemental constitution of food in its traditional type, as served to build a barrier towards flour microbial activity that caused speedy decay (Shaheed, 2015).

Food processing is the set of ways and methods used to transform uncooked parts into food. Food processing improves food qualities such as flavour, texture, taste, colour. Also it improves preservation and safety especially legume products . Grain legumes are the major sources of dietary proteins in all the developing countries because animal proteins are expensive (Ramadan, 2012). Oluwale *et al.,* (2012) explained that high cost of animal protein has directed the interest towards several leguminous seed proteins as potential sources of vegetable protein for human food and livestock. They are consumed worldwide, especially in developing and under developed countries where consumption of animal protein may be limited as a result of economic, social, cultural or religious factors. However, plant protein

from legumes has the potential and ability of providing flour that is rich in nutrition. Most legume flours produced such as soybean or bambara groundnut are being utilized in terms of food applications but African locust bean remains silent in terms of food fortification or enrichment.

The African locust bean tree (*Parkia biglobosa*) is a perennial deciduous leguminous tree with pods ranging from pink brown to dark brown, when matured. The pods are reported to contain up to 30 seeds embedded in a yellow pericarp. The seeds having a mean weight of 0.26 g/seed have a hard testa with large cotyledons forming about 70% of their weight. The most popular form of consumption of African locust beans is in its traditional fermentation tasty food condiment called dawadawa which is used as a flavour intensifier for soups and stews and also adds protein to a protein-poor diet (Oluwale *et al*., 2012). Its utilization as flavour enhancer may not generally provide adequate and effective utilization in terms of economical viability and abundant nutrients as deem fit and hence the need for food applications. The traditional method for home preparation of this leguminous plant seeds consist of a water soaking period (usually overnight) followed by cooking of the dehydrated seeds after discarding the soaking water for some hours, further processing methods such as fermentation is usually carried out. Plantain (*Musa paradisiacae*) is a major starchy staple food (Odenigbo, 2012). A common method of preserving unripe plantain is by processing it into flour. Processing unripe plantain fruit into flour is a means of value addition, increasing product diversification, utilization and enhancing market price.

Cooking as a processing method is known to reduce the antinutrients and thus, improve the nutritive value of legume grains. Germination caused the most significant reduction in phytates. The longer period of germination, led to greater reduction in phytic acid content; germination of seeds for 48 h caused a reduction of 66 to 69%. This reduction was possibly due to activation of phytase during germination (Ramadan, 2012). The reduction in the phytates provides better assimilations of mineral contents especially magnesium and calcium in food particles. Autoclaving entails cooking under pressure. The time of cooking is shortened by this method, with temperature of about 121^{o}C for 15min. Autoclaving reduces oligosaccharides, raffinose, stachyose and verbascose, common in legume seeds, are thought be the major producers of flatulence. These saccharides are comprised of one, two and three glactose units respectively joined together with sucrose in α-D linkages. Ramadan (2012) explained that, owing to the lack of α-galactosidases in mammalian digestive system, they

pass into the colon where they may produce diarrhea, flatus gas (Co_2, H_2 and small amounts of CH_4 gases). It is on this aspect that legumes undergo processing in order to retain nutrients and reduce antinutrients. When jackbeans were autoclaved for 30 minutes at 125^{o}C and 15 Ib pressure, thermo-labile inhibitory substances such as cyanogenic glycosides, saponins, terpenoids and alkaloids could not be detected after autoclaving (Akande and Fabiyi, 2010). The nutritive value of many legumes is enhanced by autoclaving and this effect is probably related to the wide destruction of haemagglutinins and other growth inhibitory factors. Preliminary soaking prior to the autoclaving is required for complete elimination of the toxicity of kidney bean (Akande and Fabiyi, 2010). Nevertheless, autoclaving alone has being proven to be insufficient, on the fact that jackbean was allowed to be used in conventional chick diets which was processed through autoclaved. It was observed that the jackbeans produced severe growth retarding effects due to the presence of heat-stable toxic factors in jackbean (Kessler *et al.,* 1990). However, processing treatments increase the nutritional quality of food plants and are also effective in eliminating the anti-nutritional factors in them and thus, the need for their proper processing to levels where they are safe for human and animal consumption.

Application of food materials or food products during food processing is for a particular purpose, either for nutritional or functional or both. The demand for the application of African locust bean seeds flour as ingredient is growing, thus, the analysis of its structural, thermal and digestibility properties are of great importance (Abdoulaye *et al*., 2013). Moreover, the understanding of the relationship between structural characteristics and functional as well as nutritional properties of African locust bean flour can help food producers in optimizing industrial applications.

African locust bean seeds (*Parkia biglobosa*) have limitation in its utilization despite the nutritional potentials in it. The only form in which it is use, being the production of *dawadawa*, a flavour enhancer. Other legumes of its kind have wider food applications and utilization. Justification of this research aims at diversifying this highly nutritive food by first and foremost bringing out suitable processing methods. Plantain, a staple food in most West Africa countries is low in protein, recommended for diabetic patients due to its low glycemic index need to be fortified with proteineous food in order to prevent protein malnutrition. The combination of the two food products will assist for wider applications in the food industries.

The broad objective of this study was to evaluate the effect that various processing methods had on the antinutritonal composition, mineral contents, and amino acid profile and food application of african locust bean seeds flour.

2.0 MATERIALS AND METHODS

2.1. Raw Materials

African Locust bean seeds were procured from Obudu market in Obudu Local Government Area, Cross river state. The unripe plantain was harvested from a local farm in Boki Local Government Area, in Cross River State.

2.2 Sample Preparation

2.2.1. Production of African Locust Bean Flour

Three methods were used for the production of African locust bean seed Flour, which is by germination, autoclaving and cooking.

2.2.1.1 Production of Flour from Germinating African locust bean seeds

The African Locust bean seeds (20kg) were sorted and soaked for 24h. The seeds were than germinated by spreading them on jute bag and were kept wet by frequent spraying of water at every morning and evening for 7 days to sprout. The germinated seeds were washed, oven dried at 60^0C for 7h, milled and sieved through 60 mesh sieve and stored at room temperature in a well sealed plastic container prior to analysis (Ijarotimi et al., 2012). The flow diagram for the production of germinated African locust bean seed flour is shown in Fig 1.

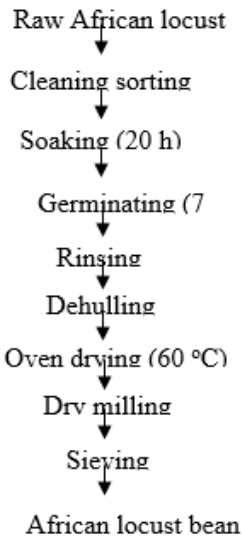

Fig 1: The flow chart for the production of African Locust bean flour.

2.2.1.2 Production of cooked African locust bean seed flour

The African locust bean seeds were sorted, cleaned and soaked for 12hrs according to the method of Audu and Aremu, (2011) . 100g of the seeds were boiled in water at 100oC for 3 hrs at the ratio of 1:10 (w/v). The seeds were considered cooked when the cotyledons were easily crushed by a gentle press between the thumb and the index fingers. The cooked sample was allowed to cool, dehulled and then oven dry at 60oC for 7h. It was then milled in hammer mill and sieved through 60 mesh size. The flour was gotten after sieving through 60 mesh sieve. It was then packed in a plastic container for further analysis.

2.2.1.3 Production of autoclaved African locust bean seed flour

The sample was soaked for 12h in distilled water. The soaking solution was discarded at the end of soaking period and the hard seeds of *P. biglobosa* were then autoclaved with their appropriate fresh soaking solution in 1:3 ratio (w/v) at 121 °C for 1h (Arumugam and Perumal, 2015).

2.2.2 Production of unripe Plantain Flour

Plantain flour was produced according to method of Omolara et al. (2016) with a little modification. Matured unripe plantain fruits were washed, hand peeled and the edible portion (pulp) was sliced with stainless knife into 2.5cm thick slices (6.0 x 4.0 cm). The slices were immersed in 1.25% sodium metasulphite at 30^0C for 10 min. The slices were dried at 60^0C in an oven for 7h and milled using attrition mill and sieved through a 60 mesh sieve. The flour samples was then passed through 60 mesh sieve to obtain the flour. The flour was poured into plastic containers with lid and store at ambient temperature (25^0C) prior to analysis. The flow diagram for unripe plantain flour is shown in Fig 2

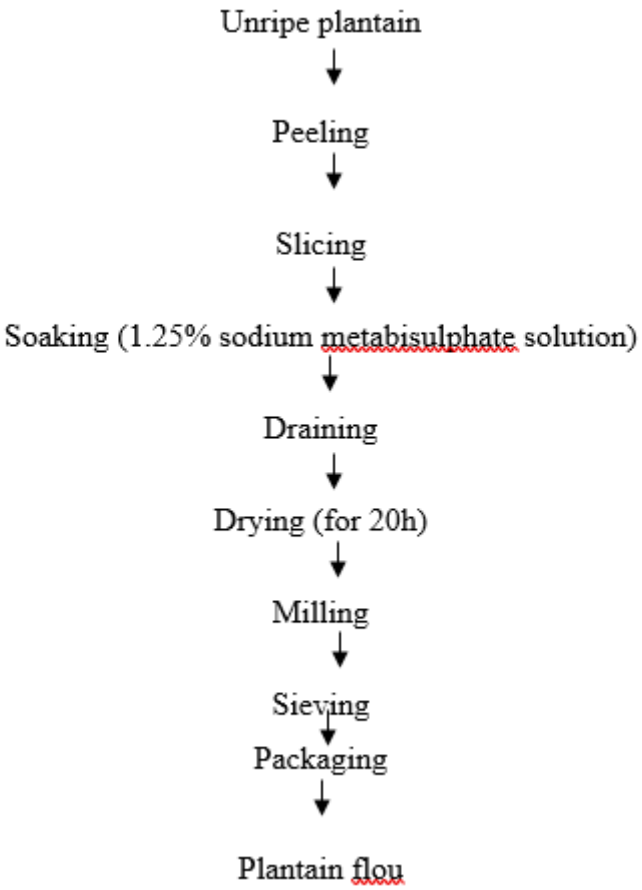

Fig 2: The flow diagram for unripe plantain flour.

Source: Omolara *et al*. (2016)

2.3 Experimental design

A completely randomized design was adopted to study the effect of processing methods of African locust bean seeds on the chemical, functional and antinutrients properties of the flours and their blends.

Table 1: Blended ratios of treated African locust bean flour and unripe plantain flour.

Sample	**A**	**C**	**G**
P_1	P_1A_2	P_1C_2	P_1G_2
P_2	P_2A_3	P_2C_3	P_2G_3
A_0			
C_0			
G_0			
L_0			

Key:

P_1A_2 = plantain 80% :20% African locust bean flour.

P_2A_3 = Plantain 70% :30% African locust bean flour.

P_1C_2 = plantain 80%: 20% African locust bean flour.

P_2C_3 = plantain 70% : 30% African locust bean flour.

P_1G_2 = plantain 80% : 20% African locust bean flour.

P_2G_3 = plantain 70% : 30% African locust bean flour.

L_0 = 100% raw African locust bean seed flour.

A_0 = 100% Autoclaved African locust bean flour.

C_0 = 100% Cooked African locust bean flour.

G_0 = 100% germinated African locust bean flour.

Subsequently the coded values for processing methods are;

G = Germination

C = Cooking

A = Autoclaving

2.4 Food applications

2.4.1 production of biscuit

The biscuits were produced according to method of Nwosu (2013). The treated flours of the African locust bean seed were substituted 20% and 30% into plantain flour. The ingredients used were baking fat, granulated sugar, baking powder, milk powder, salt, whole egg. Sugar and baking fat were creamed together. 200g of the blend flours and other ingredient were mixed for 10min to form dough, kneaded into stiff dough. The dough was rolled out on a sheeting board to a sheet of uniform thickness of about 0.5cm diameter. The sheet was stamped out in a circular shape of about 5.0 diameter using a biscuit cutter. The biscuit cuts were placed on greased baking trays, covered, rested for 15mins and baked for 30min at 180^{o}C. The biscuits were removed and allowed to cool on a racker, packaged in low density polyethylene bags and placed in an air-tight container for further analysis.

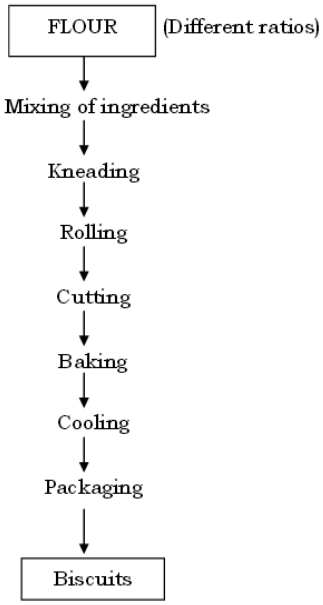

Fig 3: Production of biscuit.

Source: Nwosu (2013)

2.4.2 Production noodles

The noodle samples were produced according to the method of Ojure and Quadri, (2012) with slight modification. 200g of blended flours were separately mixed with 150ml distilled water, 0.2% NaCl, 3ml vegetable oil and 2.5g guar gum. The resultant dough was kneaded with hand for 5min and allowed to rest for 20mins, then folded and sheeted through a noodle machine with the gap set at 4. The sheet was cut into strips. The noodle strips were dried in an oven for 1h, packed and sealed in high density polyethylene film and kept for further analysis.

2.4.2.1 Determination of Quality attributes of Noodles

2.4.2.1.1Determination of cooking time

About 10g of noodles was cooked in 300ml of deionised water in a covered 500ml beaker. Cooking time was determined by the removal of a piece of noodle every 2min and pressing the noodle between 2 pieces of watch glasses. Optimum cooking was achieved when the center of the noodles became transparent or when the noodle was fully hydrated. Cooking was stopped by rinsing briefly in deionised water.

2.4.2.1.2 Determination of cooking loss

Approximately 10g noodles were cooked in 300mL of distilled water in a 500 mL beaker until the central opaque core in the noodle strand disappeared. Cooking loss (%) was

measured by transferring the cook water to a preweighed beaker and evaporating the water in a conventional oven overnight at 100°C, then reweighing the beaker with left over solids. Cooking quality analysis was performed in triplicate.

Cooking loss = dried residue in cooking water/noodle weight before cooking×100.

2.5 Analytical methods

2.5.1. Determination of Selected Anti-Nutrients

The anti-nutrients that were determined in the samples included tannins, phytate, oxalate, alkaloid and saponin.

2.5.2 Determination of tannin content

This was carried out using the method of Price and Buttler, (1977). Two grammes (2 g)of each sample was weighed into a 250 ml flask followed by addition of 200 ml of0.004M $K_3Fe(CN)_6$ and 10 ml of 0.008 M $FeCl_3$ in 0.008 M HCI. The flask was allowed to stand for 20 minutes but stirred occasionally at 10 minutes interval and 1ml aliquot is removed. To this aliquot, 2 ml of 0.008M $FeCl_3$ in 0.008M HC1 and 10 ml of 0.0015 M $K_3Fe(CN)_6$ were then added in the final reagent, the absorbance was read at 720 nm after 30 seconds against a blank. The tannins content was calculated as:

$$\text{Tannin (mg/100 g)} = \frac{\text{Absorbance of the sample x concentration of the standard x Df}}{\text{Absorbance of standard x sample size}}$$

Where Df = Dilution factor

2.5.3 Determination of phytate content

This determination was done using the method described by Abulude (2004). Each sample (8 g) was dispersed in 200 cm^3 of 2 % HCl and extraction was carried out. Following extraction, the dispersion was filtered and 50 cm^3 of the filtrate was mixed with 10 cm^3 of 0.3 % ammonium cyanide (NH_4SCN) and diluted with 107 ml of distilled water. The extract was then titrated against 0.00195g/cm^3 of Ferric chloride solution until a brownish yellow colour persist. Phytate content was estimated with the expression:

Phytate phosphorous = iron equivalent x 1.95 g of titre

Phytate = phytate phosphorous x 3.65 g

2.5.4 Determination of oxalate content

The method described by Oke (1969) was used. The sample (2 g) was digested with 10 ml 6M HCl for one hour and was made up to 250 ml in a volumetric flask. The pH of the filtrate need was adjusted with Conc. NH_4OH solution until the colour of the solution changed from salmon pink colour to a faint yellow colour. Thereafter, the filtrate was then treated with 10 ml of 5 % $CaCl_2$ solution to precipitate the insoluble oxalate. The suspension was centrifuged at 2500 rpm, after which the supernatant was decanted. The precipitate was dissolved in 10ml of 20 % (vlv) H_2S0_4 and the solution was made up to 300ml. An aliquot (125 ml) was heated until near boiling point and then titrated against 0.05 M standardized $KMnO_4$ solution to a faint pink colour which persisted for about 30 seconds after which the burette reading was taken and used to estimate the oxalate content.

$$N = \frac{\text{Titre value x } 0.0025\text{x Df}}{5}$$

$$\text{Oxalate (\%)} = \frac{N}{samplesize} x\ 100$$

Where Df = Dilution factor

0.0025 = Volume of $KMnO_4$

2.5.5 Determination of alkaloid content

The alkaloid content was determined gravimetrically according to Haborne, (1973). 5 g of each sample was weighed using a weighing balance and dispersed into 50 ml of 10% acetic acid solution in ethanol. The mixture was well shaken and then allowed to stand for about 4 h before it iwas filtered. The filtrate was evaporated to one quarter of its original volume on hot plate. Concentrated ammonium hydroxide was added drop wise in order to precipitate the alkaloids. A pre-weighed filter paper was used to filter off the precipitate and it was washed with 1% ammonium hydroxide solution. The filter paper containing the precipitate was dried on an oven at 60^{o}C for 30 min, transferred into desiccators to cool and then reweighed until a constant weight was obtained. The constant weight was recorded. The weight of the alkaloid was determined by weight difference of the filter paper and expressed as a percentage of the sample weight analyzed. The experiment was conducted in 3replicates for each food stuff sample.

2.5.6 Determination of saponin content

The method of AOAC (2010) was used for the determination of saponin in the sample. Each sample (5g) was mixed with ethanol and allowed to stand for 10 minutes, it was centrifuged, transferred into a tube and then allowed to evaporate to dryness in a water bath. It was then cooled. After cooling, 2ml of ethyl acetate was added followed by addition of 1ml of reagent consisting of 0.5ml anisol aldehyde and 99.5ml ethyl acetate. Then1ml of concentrated sulphuric acid and 50ml of ethyl acetate wwas added. The solution is stirred and incubated for 20 minutes in a water bath at 60 °C, allowed to cool for 10 minutes and the absorbance taken at 470 nm against a blank. Saponin content was calculated using the expression:

$$\text{Saponin (\%)} = \frac{\text{Saponin + evaporating dish - evaporating dish}}{\text{Sample size}} \text{ x } 100$$

2.5.6 Mineral contents determination

The method described by Association of Official Analytical Chemists (AOAC, 2010) was used for mineral analysis. The samples were ashed at 550°C.The ashed samples were boiled with 10 ml of 20% hydrochloric acid in a beaker and then filtered into a 100 ml standard flask. This was made up to the mark with deionized water. The minerals were determined from the resulting solution. Sodium (Na) and Potassium (K) were determined using the standard flame emission photometer. NaCl and KCl were used as the standards (AOAC, 2005). Phosphorus was determined colorimetrically with KH_2PO_4 as the standard. Calcium (Ca), Magnesium (Mg) and Iron (Fe) were determined using Atomic Absorption Spectrophotometer. All values were expressed in mg/100 g.

2.6 Determination of Amino acid composition

Amino acid composition of samples was measured on hydrolysates using amino acid analyser (Sykam-S7130) based on high performance liquid chromatography technique. Sample hydrolysates was prepared following the method of Ijarotimi *et al*. (2012). Each of the defatted samples was weighed (200 mg) into glass ampoule, 5 ml of 6M HCl added and hydrolyzed in an oven preset at 105 ±5°C for 22 h. Oxygen was expelled in the ampoule by passing nitrogen gas into it. Amino acid analysis was done by ion-exchange chromatography [Spackman *et al*. 1958] using a Technicon Sequential Multisample Amino Acid Analyzer (Technicon Instruments Corporation, New York, USA). The period of analysis was 76 min, with a gas flow rate of 0.50 ml/min at 60°C, and the reproducibility was ±3%. integrator and express as percentages of the total protein.

2.7 Statistical Analysis

The experiment that was adopted was complete randomization design (CRD). The data that generated from all analyses were subjected to statistical analysis of variance (ANOVA) using the Statistical Package for Social Statistics (SPSS) version 20.0. The analysis of variance (ANOVA) was performed to determine significant differences between the means, while the means were separated using Duncan Multiple Range Test. Significance was accepted at $p<0.05$.

3.0 RESULTS AND DISCUSSION

3.1 Effect of Processing Methods on the Anti-Nutritional Components

The anti-nutrients in the test samples analyzed included tannin, phylate, oxalate, saponin and alkaloid. There was a significant ($p<0.05$) differences in all the samples. The tannin contents of the processed samples, AALF, CALF, GALF were 105.44mg 118.75 and 117.11mg/100g, while control (RALF) was 162.4mg/100g. Autoclaved had the highest reduction of 35.1%, followed by germinated sample (GALF) 27.92% while the ordinary cooked sample had the least reduction of 26.9%. These values were similar to the work of Eshraq *et al*. (2016) who reported 28% in reduction of tannin after cooking black bean for 2 hours. While there was 49% reduction in the germinated product contrary to the value for the present study. Similar contrary value results were equally obtained (62.9% & 89%) for cooked African locust bean seed meal and soaked and fermented African locust bean seed in their tannin contents, (Mu'azu, 2014; Tamburawa *et al.* , 2017). This might be due to seed varieties and type of processing involved. Generally tannins are classified as anti-nutrient because they bind and precipitate proteins. However, they have anticarcinogenic and anti-mutagenic which is related to their anti-oxidative property, these are important in protecting cellular oxidative damage, including lipid per- oxidation (Akubor *et al*., 2017).

There was significant ($p<0.05$) differences in the alkaloid contents of the samples. Sample AALF and its blends have values ranging from 22.42--38.66mg/100g, cooked sample and its blends 27.77--38.97, samples $GALP_2$ (21.42), GALF (32.87), $GALP_3$ (23.37mg/100g), while the control was 46.43mg/100g. There was significant decrease in the alkaloid contents of all the blends. The processed (Autoclaving, boiling and germinating) flours showed appreciable decrease with significant differences in their value. Sample CALF decreased by 16.51%. The alkaloids of the germinated sample decreased by 29.02%, while that of autoclaved decreased by 16.75%. Similar decrease was reported for cooked Lupin Bean 23.71% and germinated

0.66% (Yadesa and Biadge, 2017). However, the values for the alkaloids were within the safe margin of 52.02mg/100g reported by World Health organisation (WHO Agriculture Science Bulletin, 2003).

The phytate, oxalate and saponin contents of the samples were significantly ($p>0.05$) low, both in the processed flours, their blends and the control. Phytate values ranged from 2.48-1.22mg/100g, oxalate ranged from 0.58-0.89mg while saponin values ranged from 1.22-0.42mg/g respectively. The same low value was obtained for fermented African locust bean seed in relation to the oxalate (0.189g/100g) and phytate (0.17g/100g) (Bolajoko *et al.,* 2016). Also Mu'azu, (2014) had a similar reduction in the phytate, oxalate and saponin values of African locust bean seed that was cooked for 2h with these values phytate (0.15mg/100g), saponin (0.46mg/100g and oxalate (0.21mg/100g). The values were lower than the values obtained for the present study. This might be as a result of varieties of the seed, nature of the soil, analytical method and geographical location.

Table 2: Effect of processing methods on the anti-nuritional components.

Sample	Tannin (mg/100g)	Phytate mg/100g	Oxalate mg/100g	Saponin mg /g	Alkaloid mg/100g
AALF	105.44^{h}±0.00	1.34^{e} ± 0.00	0.77^{c} ± 0.00	0.63^{c} ± 0.01	38.66^{c}± 0.00
$AALP_2$	113.04^{g}±0.47	1.43^{d} ± 0.00	0.66^{e} ± 0.00	0.42^{f} ± 0.00	22.42^{i} ± 0.00
$AALP_3$	116.45^{f}±0.01	1.56^{c} ± 0.00	0.73^{d} ± 0.01	0.51^{def}± 0.00	24.13^{g} ± 0.01
CALF	118.75^{d}±0.01	1.42^{d} ± 0.00	0.82^{b} ± 0.02	0.78^{b} ± 0.16	38.97^{b} ± 0.01
$CALP_2$	120.81^{c}±0.01	1.58^{c} ± 0.00	0.74^{d} ± 0.00	0.53^{de} ± 0.01	27.77^{f} ± 0.00
$CALP_3$	121.83^{b}±0.01	1.69^{b} ± 0.00	0.77^{e} ± 0.00	0.54^{cd} ± 0.00	27.94^{d} ± 0.01
GALF	117.11^{e}±0.01	1.22^{g} ± 0.00	0.68^{e} ± 0.00	0.57^{cd}±0.00	32.87^{d} ± 0.00
$GALP_2$	73.11^{j} ± 0.00	1.23^{g} ± 0.01	0.59^{f} ± 0.00	0.44^{ef} ± 0.00	21.42^{j} ± 0.01
$GALP_3$	85.23^{i} ± 0.01	1.26^{f} ± 0.04	0.58^{f} ± 0.00	0.52^{def}± 0.00	23.37^{f} ± 0.00
RALF	162^{a}.47±0.00	2.48^{a} ±0.01	0.89^{a} ± 0.01	1.22^{a} ± 0.00	46.43^{a} ± 0.00

Values are means of triplicate determination of ±SD. Mean with different superscript within the same column are significant ($p<0.05$) different

AALF: Autoclave African Locust bean seed flour.

$AALP_2$: Autoclave African locust bean seed flour (20%) blend with plantain (80%)

$AALP_3$: Autoclave African Locust bean seed flour (20%) + 70% plantain flour

CALF: Cooked African Locust bean seed flour

$CALP_2$: Cooked African Locust bean seed flour (20%) + 80% plantain flour.

$CALP_3$: Cooked African Locust bean seed flour (30%) + 70% plantain flour

CALF: Germinated African Locust bean seed flour

$GALP_2$: Germinated African Locust bean seed flour (20%) + 80% plantain

$GALP_3$: Germinated African Locust bean seed flour (30%) + 70% plantain

RALF: Raw African Locust bean seed flour (control)

3.2 Effect of Processing Methods on the Mineral Contents

The mineral contents of both the processed flours and their formulated blends are shown in Table 4. There were a significant differences between the processed flours (i.e. AALF, CALF AND GALF) and the control ((RALF) in the mineral contents. Potassium was the most abundant mineral in all the samples with the highest value found in AALF (1614.67mg/100g), while CALF, GALF had 237.33 and 1341.33 mg/100g, respectively. The high potassium value was in agreement with Aremu *et al.,* 2015; Ijarotimi *et al*.,2012. Mu'azu, (2014) reported that potassium was the most predominant mineral in Nigeria agricultural products. The high level of this mineral element in the seed indicates that the seeds could be utilized beneficially in the diets of those who take diuretic medicine for the treatment of hypertension and those suffering from excess loss of potassium through fluids (Aremu *et al.,* 2015). However there was no significant ($p>0.05$) difference in the potassium content of sample CALF (237.33mg/100g) and that of the control RALF (225.33mg/100g). This may be due to processing, which resulted in leaching of the mineral in the water during cooking. This showed that there was no effect in the potassium content by the ordinary cooking method.

There were significant differences in the calcium contents of the sample RALF (control) and those of the processed flours and the blends. While the calcium content of the sample (RALF) was 706.53mg/100g, those of the processed flours and the blends ranged from 114.33mg/100g -194.33mg/100g. These values were different from that of Aremu *et al.* (2015) which showed a significant increase in the processed African locust bean flours, but was in agreement with Abdulrahman *et al*., (2016). The significant decrease of calcium in processed flours and the blends could be attributed to leaching out of solid matter into the

soaking water. It could also be caused by removal of hull portion which may contain some amounts of calcium.

There were a significant ($p<0.05$) differences in the magnesium contents of all the samples. The germinated sample (GALF) had the highest value of 382.33mg/100g. This was followed by the autoclaved (330.55mg/100g) and cooked (327.33mg/100g). The results were similar to other investigations who reported that germination increased the retention of all minerals, B-complex, vitamins compared to other processing methods (Malik, *et al*, 2016). The blends showed a slight reduction in their magnesium contents. Similar result was obtained for sweet potato, plantain, and pigeon pea flour blends (Ehizua *et al*., 2017). The reduction could as a result of compensation to the plantain flour, which is sensitive to loss of nutrients during processing. Magnesium is an activator of many enzyme systems and maintains the electrical potential in nerves (Ehizua *et al*.,2017).

There were significant ($p<0.05$) differences in sodium contents of sample RALF and other samples. Most of the processed flours and their blends were not significantly ($p>0.05$) different in the sodium content. Their values ranged from 222.33mg to 294.oomg/100g. The high increase was similar to the report by Echendu *et al*. (2009), who evaluated germination of ground beans with respect to time. But it was contrary to that of Aremu *et al*. (2015) who reported reduction in value of sodium due to effect of fermentation on African locust bean and Mesquite bean seeds.

Table 3: Effect of Processing Methods on the mineral contents.

Sample (mg/100g	Calcium	Sodium	Potassium	Magnesium	Iron	Phosphorus
AALF	$197.33^{b}\pm11.93$	$222.33^{c}\pm18.92$	$1614.67^{a}\pm8.14$	$330.66^{c}\pm1.52$	$4.66^{c}\pm0.17$	$252.33^{a}\pm1.52$
$AALP_2$	$136.66^{de}\pm37.54$	$257^{b}\pm11.53.00$	$879.66^{d}\pm5.13$	$227.33^{f}\pm0.57$	$3.27^{ef}\pm0.04$	ND
$AALP_3$	$114.33^{e}\pm3.51$	$227^{c}\pm3.06.33$	$634.67^{f}\pm7.63$	$208.33^{g}\pm0.57$	$2.52^{h}\pm0.11$	ND
CALF	$194.33^{b}\pm5.68$	$229.00^{c}\pm5.56$	$237.33^{g}\pm5.85$	$327.33^{c}\pm17.92$	$5.01^{b}\pm0.14$	$95.33^{c}\pm1.52$
$CALP_2$	$119.67^{e}\pm17.78$	$232.00^{c}\pm8.18$	$736.00^{c}\pm9.16$	$201.33^{g}\pm0.58$	$3.41^{e}\pm0.05$	ND
$CALP_3$	$158.66^{cd}\pm3.51$	$289.00^{a}\pm5.56$	$851.67^{d}\pm15.31$	$280.33^{de}\pm5.85$	$4.06^{d}\pm0.03$	ND
GALF	$166.00^{c}\pm4-00$	$265.00^{b}\pm8.89$	$1341.33^{b}\pm57.49$	$382.33^{a}\pm1.52$	$3.03^{fg}\pm0.26$	$125.23^{b}\pm0.77$
$GALP_2$	128.00^{e}	$294.00^{a}\pm22.$	$1160.66^{c}\pm4.$	$290.33^{d}\pm4.$	$3.44^{e}\pm0.$	ND

	±3.00	86	93	93	14	
$GALP_3$	128.66^{e}±4-00	276.67^{ab}±7.50	1130.33^{c}±16.07	277.33^{e}±0.57	2.87^{g}±0.04	ND
RALF (Control)	706.33^{a} ±4.16	81.33^{d}±0.50	225.33^{g}±15.04	358.00^{b}±7.21	4.66^{c}±0.45	48.33^{d}+0.15

Values are means of triplicate determination of ±SD. Mean with different superscript within the same column are significant ($p<0.05$) different

AALF: Autoclave African Locust bean seed flour.

$AALP_2$: Autoclave African locust bean seed flour (20%) blend with plantain (80%)

$AALP_3$: Autoclave African Locust bean seed flour (20%) + 70% plantain flour

CALF: Cooked African Locust bean seed flour

$CALP_2$: Cooked African Locust bean seed flour (20%) + 80% plantain flour.

$CALP_3$: Cooked African Locust bean seed flour (30%) + 70% plantain flour

CALF: Germinated African Locust bean seed flour

$GALP_2$: Germinated African Locust bean seed flour (20%) + 80% plantain

$GALP_3$: Germinated African Locust bean seed flour (30%) + 70% plantain

RALF: Raw African Locust bean seed flour (control).

3.3 Amino acid profile

The table shows the amino acids profile of the processed flours and their blends with unripe plantain flour. The total amino acids of the samples AALF, $AALP_2$, $AALP_3$, CALF, $CALP_2$, $CALP_3$, GALF, $GALF_2$, $GALP_3$ were 18.43%, 22.41%, 26.25%, 23.97%, 30.39%, 38.76%, 10.02%, 11.29%, 14.63% respectively, while that of the control (RALF) was 18.29%. The processing methods had effect on the amino acids of all the samples. The samples AALF, CALF , had increase in the content of the total amino acids while sample GALF had reduced value of total amino acids. Ijarotimi *et al.* (2012) made similar observation where fermented ALBS flour had higher value than the germinated flour, where the total non-essential amino acids of the fermented were 48.85mg/100g, while that of the germinated was 44.975mg/100g. The reduction in the germinated samples may be due to breakdown of seed reserves such as carbohydrates and proteins during sprouting and subsequent utilization of these amino acids during that process.

Sample $CALP_3$ (38.955%) had the total amino acids, followed by sample CALP (30.385%) while the least was Sample $GALP_2$. It was observed also that the processed flour (ordinary cooking) with the highest value of total amino acids equally produced blends with the highest

value of total amino acids. Subsequently all the amino acids (20) were detectable in all the samples.

Lysine had the highest values (5.06, 6.66, 8.54) % for both the processed flour (cooked) CALF and its blends ($CALP_2$, $CALP_3$). This followed by sparagine and serine. Generally, legumes contain reasonable amount of lysine but lack sulphur containing amino acids such as methione and cysteine which are abundant in cereals. The high content of lysine in the processed flour (cooked) and the blends was in agreement with the result (190mg/100g) reported in fermented maize meal (Ogi) fortified with unfermented locust bean seeds, as reported by Makanjuola (2017). Other essential amino acids such as tryptophan, arginine, phenyalanine, isoleucine, threonine were all present in all the samples. Awada *et al*. (2008), had reported that fortification of wheat flour with soy protein increased protein quality by increasing amino acid profile.

Table 4: Amino acid profile.

Sample(s) Parameter (%)	**AALF**	**AAL P_2**	**AAL P_3**	**CAL F**	**CAL P_2**	**CAF P_3**	**GA F**	**GA P_2**	**GA P_3**	**RAL F**
Threonine	1.796	2.184	2.558	2.249	2.961	3.796	0.976	1.100	1.426	0.266
Leucane	0.2253	0.273	0.320	0.281	0.370	0.475	0.122	0.137	0.178	0.438
Isoleuane	1.347	1.638	1.919	1.687	2.221	2.847	0.732	0.825	1.069	0.308
Lysine	4.042	4.913	5.756	5.060	6.663	8.542	2.197	2.475	3.208	4.100
Methionine	0.577	0.702	0.822	0.723	0.902	1.220	0.314	0.354	0.458	0.560
Phenylatmine	3.144	3.821	4.477	3.935	5.1182	6.644	1.708	1.925	2.395	3.470
Tyrosine	0.222	0.270	0.317	0.278	0.366	0.470	0.121	0.136	0.176	0.277
Valine	0.445	0.540	0.633	0.557	0.733	0.940	0.242	0.272	0.353	0.470
Arqinine	0.898	1.092	1.279	1.124	1.481	1.898	0.488	0.530	0.713	0.342
Histidine	0.225	0.273	0.320	0.281	0.370	0.475	0.122	0.137	0.178	0.115
Alanine	0.086	0.104	0.122	0.107	0.141	0.181	0.046	0.052	0.068	0.479
Aspartic acid	0.003	0.003	0.004	0.003	0.004	0.005	0.001	0.002	0.002	2.279
Asparagine	2.749	3.339	3.912	3.439	4.528	5.805	1.49	1.68	2.18	0.599

s							3	2	0	
Glutamic acid	0.028	0.034	0.040	0.035	0.046	0.059	0.015	0.017	0.022	1.490
Glutamine	0.004	0.005	0.005	0.005	0.006	0.008	0.002	0.002	0.003	0.008
Glyane	0.419	0.509	0.597	0.525	0.691	0.886	0.228	0.257	0.333	0.362
Proline	0.038	0.046	0.053	0.047	0.062	0.079	0.020	0.023	0.030	0.446
Serine	1.301	1.582	1.583	1.629	2.145	2.750	0.707	0.797	1.033	0.391
Tryptophane	0.846	1.028	1.205	1.059	1.394	1.788	0.460	0.578	0.671	0.298
Cystine	0.042	0.051	0.060	0.053	0.069	0.089	0.023	0.026	0.033	0.172
Total A As (%)	18.43	22.41	26.25	23.08	30.38	38.95	10.02	11.28	14.63	18.29

ALBSF:African Locust bean seed flour

AALF: Autoclaved African Locust bean seed flour

$AALP_2$: Autoclaved African locust bean seed flour (20%) + 80% unripe Plantain flour

$AALP_3$:Autoclaved African Locust bean seed flour(30%)+70% unripe Plantain flour.

CALF: Cooked African Locust bean seed flour

$CALP_2$:Cooked African Locust bean seed flour(20%)+80% unripe Plantain flour

$CALP_3$:Cooked African Locust bean seed flour(30%)+70% unripe Plantain flour

GALF: Germinated African Locust bean seed flour

$GALP_2$:Germinated African Locust bean seed flour(20%)+80% unripe Plantain flour

$GALP_3$:Germinated African Locust bean seed flour(30%)+70% unripe Plantain flour

RALF: Raw African Locust bean seed flour. (Control

A.A: Amino Acids.

4.0 CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

The results of the study showed that cooking, germination, autoclaving had effect on the chemical composition of the flours of African locust bean seed flour. The three methods used in this study increased the potassium, sodium and protein contents of flours. Only cooking increased the lysine. However, all the processing methods reduced the antinutrients in the African locust bean seed flour.

4.2 Recommendation

Based on the results of the study, it is recommended that: Concentrates and isolate should be produced from the seed.

REFERENCES

1. A.O.A.C. (2010).Official method of analysis. Association of official chemists. (18th edition). Washington D.C., U.S.A.
2. Abdoulaye, S., Issoufou, A. and Wei-Rong, Y (2013). Application of Resistant starch in bread: processing, proximate composition and sensory quality of functional bread products from wheat flour and African locust bean flour. Journal of Agricultural Science, 4 (5B): 122-127.
3. Abdulrahman, B. O., Osibemhe, M., Idoko, A. S. (2016). The status of Mineral and Anti-Nutritional composition of Raw and fermented seeds of African locust bean. International Journal of current Research in Biosciences and plant Biology, 3 (2): 1-4.
4. Akande, K.E. and Fabiyi, E.F. (2010). Effect of processing methods on some anti-nutritional factors in legume seeds for poultry feeding. International Journal of Poultry Science, 9 (10): 996 – 1001.
5. Akubor, P. T. (2017). Effect of processing methods on the chemical composition and functional properties of Pigeon pea seed, Asian journal of Advances in Agricultural Research, 2(2): 1-8.
6. Aremu, M. O., Opaluwa, D. O., Awala, E. Y., Odoh, R and Bamindele, T. O. (2015). Effect of processing on nutritional composition of African locust bean and Mesquite Bean seeds. Journal communications in Applied Sciences, 3 (1): 22-41.
7. Bolajoko, O. I., Babatunji, E. O., Foluso, U. O., Abidemi, P. K. and Adrew, R. (2016). Comparative study on proximate, functional mineral and anti-nutrients composition of fermented, defatted and protein isolate of *parkia biglobosa* seed. Food Science and Nutrition , 5(1): 31-36.
8. D' souza, M. R. (2013). Effect of Traditional processing methods on Nutritional quality of field bean. Advances Bioresources, 4(3): 29-33
9. Echendu, C. A., Obizoba, I. C. and Anyika, J. U. (2009). Effects of Germination on chemical composition of Ground bean seeds. Pakistan Journal of Nutrition, 8 (12):1849-1854.

10. Eshraq, B. K., Mona, A. M and Emam, A. A. (2016). Effect of soaking, cooking and Germination on chemical constitutes of Black bean. Journal of Natural Products chemistry and Research, (6): 60-65.
11. Ijarotimi, S.O. and Keshinro, O.O. (2012).Comparison between the amino acid, fatty acid, mineral and nutritional quality of raw, germinated and fermented African locust bean flour. Actasa. Poland, Aliment 11(2): 156-165.
12. Kessler, M., Belmar, R. and Ellias, N. (1990). Effects of autoclaving on the nutritive value of the seeds of jackbean for chicks. Tropical Agriculture, 67 (1): 10 – 20.
13. Makanjuola, O. M. (2017). Amino acids profile of powdered fermented maize (ogi) fortified with powdered unfermented locust Bean seeds. 1OSR Journal of Environmental Science, Toxicology and food Technology, 11 (11): 28-32.
14. Malik, A. A., Anju, B. and Afshan (2016). Effects of various Traditional processing methods on the quality parameters of corn and peanut flour. International Research Journal of Natural and Applied sciences, 3(9): 115-120.
15. Mu' Azu, T. S. (2014). Effect of processing methods of African locust Bean seed meal on Nutrient composition and utilization by Broiler chickens. Ph.D. dissertation. Unpublished. Submitted to the department of Animal Science, Ahmadu Bello University. Available on http: //kubanni.abu.edu.ng> jspui>bitstream. Accessed on 6/6/2018.
16. Nwosu, J. N. (2013). Production and evaluation of biscuits from blends of Bambara groundnut and Wheat flours. International Journal of Food and Nutrition Science, 2(1): 2165-2171.
17. Odenigbo, A.M., Asumgha, V.U., Ubbor, S. and Ngadi, M. (2012). In vitro starch digestibility of plantain and cooking – banana at ripe and unripe stages. International Food Research Journal, 20 (6): 3027 – 3031.
18. Ojure, M. A. and Quadri, J. A. (2012). Quality Evaluation of Noodles produced from unripe plantain flour using Xanthan gum. IJRRAs 13(3). Available on www. Arpapress.com/volumes/vol3issues3/IJRRAS-13-3. Accessed 20/5/2018
19. Oluwale, O., Akinwale, T., Owolabi, F. and Odediran, O. (2016). Some functional properties of flours from commonly consumed selected Nigerian food crops. International Research Journal of Agriculture and Food Sciences, 1(5): 92-98.
20. Omolara, R.O., Abosede, M. and Oludumila, A. (2016). Quality characteristics of cookies produced from composite flours of unripe plantain, wheat and watermelon seed. Indian Journal Nutrition, 2 (2): 117 – 123.

21. Ramadan, E.A. (2012). Effect of processing and cooking methods on the chemical composition, sugars and phytic acid of soybeans. Food and public health, 2 (1): 11 – 15.
22. Sheheed, U.S. (2015). Emergence and development of new food processing techniques in the last decade. Journal of Food and Dairy Technology, 2 (1): 28 – 32.
23. WHO (2003). Postharvest and processing Technology of staple foods: Technical compendium. WHO Agriculture Science Buletin. 88:171-172.
24. Yadesa, A. and Biadge, K. (2017). Effect of some Traditional processing methods on Nutritional composition and Alkalia content of Lupin bean. Journal of Natural Sciences Research, 7 (21) pg 20 – 25.