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Effect of Some Thermal Processing Techniques on the Anti- nutritional Factors of *Canavalia plagiosperma* Piper Seeds

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Abstract The effect of some thermal processing techniques on the anti-nutritional factors of *Canavalia plagiosperma* Piper seeds was studied. Raw seeds of *Canavalia plagiosperma* Piper (Oblique- seeded Jack bean) were autoclaved (at 121°C, 15 psi for 25, 30 and 35 minutes), cooked (at 100°C for 30, 40 and 50 minutes) and roasted (at 120°C for 40, 60 and 80 minutes). The anti-nutritional factors of the processed and raw samples were determined. Six (6) anti-nutrients (alkaloid: 1.17%, haemagglutinin: 20.31 Hu/mg, hydrogen cyanide: 4.70 mg/kg, raffinose: 0.64%, stachyose: 1.09%, steroid: 0.38%) were determined in the raw seed. The three processing treatments given to the seed showed a general reduction trend on these six anti-nutrients at different rates and levels. From the results, autoclaving was the best processing method for haemagglutinin (0.05 Hu/mg), raffinose (0.06%), stachyose (0.22%) and steroid (0.02%) while cooking was the best processing treatment for alkaloid (0.04%) and hydrogen cyanide (0.83 mg/kg). Roasting had the least reduction effect on the six anti- nutrients investigated. The results, therefore, suggest that moist heat treatments (autoclaving and cooking) significantly lowered the levels of antinutrients in *Canavalia plagiosperma* Piper seeds, thereby making it safer for consumption.

Keywords: *Canavalia plagiosperma piper, autoclaving, cooking, roasting, anti-nutrients*

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1. Introduction

Legumes are good sources of cheap and widely available proteins for human consumption. They are staple foods for many people in different parts of the world [28]. Legume seeds have an average of twice as much protein as cereals and the nutritive value of the proteins are usually high [26]. Studies have shown that the lesser known legumes together with other conventional legumes can be used for combating protein malnutrition prevalent in the third world. The Protein Energy Malnutrition (PEM) problem can be alleviated by finding alternative cost effective sources of proteins. This can be achieved by the consumption of the legumes whole and in various processed forms (condiments) [4].

Oblique- seeded jack bean or giant bean (*Canavalia plagiosperma* piper) is also called *Riesenbohene* in German, *Pellarde losgentills* or *Promo gigante* in Spanish, and "ukpo Ghana" in the Eastern part of Nigeria. *Canavalia plagiosperma* belongs to the family of *leguminosae* known as *fabaceae* and subfamily of *papilionoideae*. The genus comprises of approximately 70-75 species of tropical origin. *Canavalia plagiosperma* piper is a hybrid of *Canavalia ensiformis* (Jack bean) and *Canavalia gliadiata* (sword bean) [3]. *Canavalia plagiosperma* is a high forage and seed yielding tropical legume with high energy and protein content and quality for Nigerian livestock industry [17]. Initial effort at determining the nutritional composition of the raw unprocessed dry seed of C. *plagiosperma* suggests that it has crude protein content of 35.53% which could be used to fortify cereal based diets. Recent research by Esonu *et al*. [11] showed that raw seed of *Canavalia plagiosperma* contains crude protein 36.11%, moisture 19.35%, crude fibre 5.12%, ash 1.80%, carbohydrate 51.46%, crude fat 5.48% and dry matter 80.65%. Also the nutritive and protein quality of the seed as shown by some studies seems to be similar to that of most of the edible legume grains and hence, they are advocated to be a good source for extending protein sources [15]. The use of *Canavalia plagiosperma* (raw) as a high protein food and forage crop for some countries like Mexico, Brazil and Central America has been documented [17]. In "Ikwuano" Umuahia in Abia State of Nigeria, the seed is used as soup thickener [10]. Also, the young pods and immature seeds of *Canavalia plagiosperma* are used generally as vegetables. The immature pods are made into a dish directly or often boiled with water; also the immature seeds are often consumed as curries and as a substitute for mashed potatoes [10]. Despite the desirable nutritive features of C. *plagiosperma* seed, it is not extensively

utilized as food for man and /or feed for ruminants mainly due to the presence of certain anti-nutritional substances which may have adverse effects on human or animal nutrition. These antinutrients may include alkaloid, hydrogen cyanide, lectins and flatus-producing oligosaccharides [7,10,24].

Some of the problems associated with *Canavalia plagiosperma* is unavailability due to poor utilization and unfamiliarity. There are also uncertainties concerning the appropriateness of heat treatment and the degree/timing of such treatments. *Canavalia plagiosperma* has been noted by Esonu [10] to contain some anti- nutrients. Also, Odoemelam [17] and Moreina *et al*. [15] documented that the raw seed contains 35.53% of crude protein. Despite the high protein content of the seed, yet it is not generally utilized as food or in food formulations for human consumption. This could be as a result of anti-nutrients contained by the seed [15].

The aim of this work was to evaluate the efficacy of some processing techniques (autoclaving, cooking and roasting) on the removal or manipulation of antinutritional factors in oblique-seeded jack bean seeds (*Canavalia plagiosperma* piper).

2. Materials and Method

2.1. Materials

2.1.1. Source of Materials

The fresh seeds of *Canavalia plagiosperma* for this study were obtained from Ikwuano Umuahia in Abia State of Nigeria.

All equipment and chemicals used were available at reliable research laboratory services Umuahia, Abia state; National Root Crops Research Institute (NRCRI) Umudike; and Federal University of Technology (FUTO), Owerri, Imo State, Nigeria. All the chemicals used were of analytical grade.

2.2. Methods

2.2.1. Sample Preparation

The healthy seeds of *C. plagiosperma were* dehulled by parboiling at the temperature of 100°C for 5 min to ease decoating of the seeds, after which the coats were removed manually. Then, the dehulled /decoated seeds were dried in a hot air oven (IPro75.xx1.5, Gallenkamp, USA) at 60°C for 3 h.

The decoated seeds were divided into 4 batches:

Cooking

One batch was further divided into 3 portions, the 3 portions were cooked in distilled water (100°C) in a bean: water ratio of 1:10 (w/v) for different times of 30, 40, and 50 min. The cooked seeds were rinsed with distilled water and dried at 60°C for 3 h in a hot air oven (IPro75.xx1.5, Gallenkamp, USA).

Autoclaving

The second batch was also divided into 3 portions. The 3 portions were autoclaved at 15 psi (121°C) in distilled water in the bean: water ratio of 1:10 (w/v) for different time intervals of 25, 30 and 35 min, respectively. After treatment, the seeds were rinsed with distilled water and dried at 60°C for 3 h in a hot air oven (IPro75.xx1.5, Gallenkamp, USA).

Roasting

The third batch was divided into 3 portions. The 3 portions were roasted at 120°C for 40, 60 and 80 min, respectively.

The Fourth batch was left raw as control.

The processed dried seeds were milled and stored in airtight containers. Samples were taken from the airtight containers for anti-nutritional factors determination.

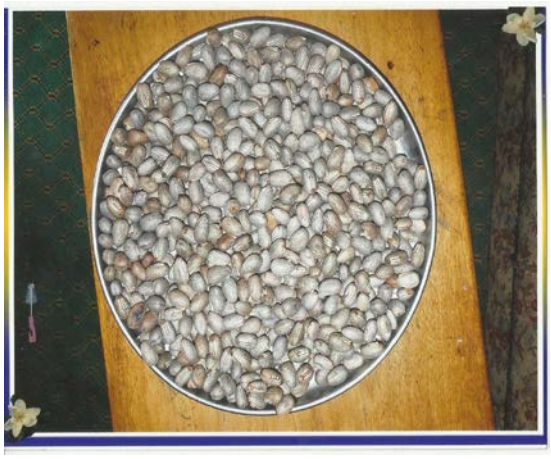

Plate 1. UNDEHULLED, RAW *CANAVALIA PLAGIOSPERMA* SEEDS

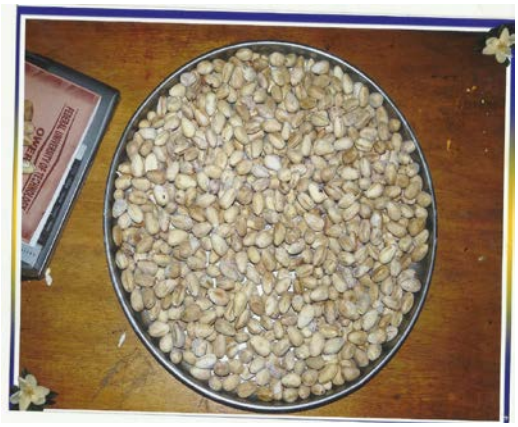

Plate 2. DEHULLED, RAW *CANAVALIA PLAGIOSPERMA* SEEDS

2.2.2. Determination of Anti-Nutritional Factors

Determination of alkaloids

The gravimetric method [14] was used.

A measured weight (5.0 g) of each sample was dispersed in 50 ml of 10% acetic acid solution in ethanol. The mixture was shaken and allowed to stand for 4 h at room temperature. At the end of this period, the mixture was filtered through Whatman No. 42. The filtrate was evaporated to one-quarter (1/4) its original volume. The extract was treated with dropwise addition of concentrated NH_4OH solution to precipitate the alkaloid. The alkaloid precipitate was filtered off and washed with 1% NH_4OH solution. The filtering was done with a weighed filter paper. The precipitate in filter paper was dried at 60°C in

an oven (IPro75.xx1.5, Gallenkamp, USA) and weighed after cooling in a desiccators and reweighed.

The alkaloid content was calculated as shown below:

$$\% \text{ Alkaloids} = \frac{W_2 - W_1}{W} \times \frac{100}{1}$$

Given that;

W = weight of sample

W_1 = weight of empty filter paper

W_2 = weight of paper + alkaloid precipitate

Determination of Hemagglutinin

Hemagglutinin was determined using the procedure of Onwuka [20]. One gram (1 g) of the sample was weighed out and dispersed in a 10 ml normal saline solution buffered at pH 6.4 with a 0.01M phosphate buffer solution. The mixture was allowed to stand at room temperature for 30 min and was centrifuged afterwards to obtain the extract. 1 ml of 2% (v/v) trypsinized rabbit blood erythrocyte suspension in saline phosphate buffer (pH 7.0) was added to 0.1 ml of the extract diluents in a test tube. A control sample was also prepared containing only the blood cells. The test tubes containing the sample mixture and the ones containing the control sample were allowed to stand for 4 h at room temperature. 1ml of normal saline was added to all the test tubes and they were allowed to stand for 10 min, after which their absorbance were read in a colorimeter (Model 6051, Jenway Company, UK) at 600 nm. The hemagglutinin units per milligram of the sample was thus calculated:

$$\text{Hemagglutinin unit / mg} = (b - a) \times \text{F}$$

Where b = Absorbance of test sample solution

a = Absorbance of the blank control

F = Experimental factor given by:

$$F = \frac{1}{W} \times \frac{V_f}{V_a} \times D$$

Where V_f = Total volume of extract

V_a = Volume of extract used in the essay

W = Weight of the sample used

D = Dilution factor

Determination of hydrogen cyanide (HCN)

The method described by Ezegbe [12] was used. One gram (1 g) of the sample was dispersed in 50 ml of distilled water in a 250 ml conical flask. An alkaline picrate paper was hung over the sample mixture and the blank in their respective flasks.

The set up were incubated overnight at room temperature and each picrate paper was eluted (or dipped) into 60 ml distilled water. A standard cyanide solution was prepared and diluted to a required concentration. The absorbance of the eluted sample solution and of the standard were measured colourimetrically at 540 nm against a blank reagent at zero.

The hydrogen cyanide content was determined by the formula shown below:

$$\text{HCN(mg / kg)} = \frac{1000}{W} \times \frac{au}{as} \times C \times D$$

Where W = weight of sample analyzed

au = absorbance of test sample

as = absorbance of standard HCN solution

C = Concentration of standard in mg/dl

D = Dilution factor where applicable

Determination of oligosaccharides

The method of Ezegbe [12] was used. One gram (1 g) of sample was boiled in 100ml of 2M HCl solution until it was negative to iodine starch test. It was centrifuged and the hydrolysate (supernatant) used for the analysis. 1ml of the hydrolysate was mixed with 4 ml of anthrone reagent in a test tube and boiled for 10 min in a water bath while covering the test tubes. After boiling, the mixture was filtered and diluted with distilled water. Similarly, a standard sugar solution (glucose) was prepared and treated as described above and the absorbance of both the sample and sugar solutions were read with (Model 6051, Jenway Company, UK) at 432 nm against a blank reagent at zero.

The oligosaccharides content was calculated thus:

$$\text{Percentage sugar} = \frac{Au}{As} \times C \times F$$

Where Au = Absorbance of test sample

As =Absorbance of standard sugar solution

C = Concentration of sugar solution

$$\text{F = Experimental factor given by } \frac{V_f}{V_a} \times D \times \frac{100}{W}$$

Where V_f =Total filtrate volume

V_a =Volume of aliquot analyzed

D = Dilution factor (where applicable)

W = Weight of sample used

$$\text{Raffinose} = \frac{1}{4} \times \%Sugar$$

$$\text{Stachyose} = \frac{3}{4} \times \%Sugar$$

Determination of total steroid

The total steroid was determined colorimetrically with reference to the saponin content [16]. The saponin crystals were dissolved in a 50 ml formaldehyde- Conc. H_2S0_4 mixture (1:1 v/v) and the absorbance was measured at 500 nm with a colorimeter (Model 6051, Jenway Company, UK).

The steroid content was calculated as follows:

$$\%\text{Steroid} = \frac{Absorbance}{Weight\ of\ sample} \times \frac{100}{1}$$

2.3. Statistical Analysis

All analyses were carried out in triplicate and results were expressed as mean ± SD. Analysis of variance (ANOVA) using general linear model procedure of the Statistical Analysis System [22]. Means comparisons were performed using the Duncan's Multiple Range Test.

3. Results and Discussion

3.1. Effect of autoclaving on the anti-nutritional factors in *Canavalia plagiosperma* piper seeds

The effect of autoclaving on the anti-nutritional factors in *Canavalia plagiosperma* seed was presented in Table 1. Autoclaving significantly reduced (P≤0.05) the alkaloid content of *Canavalia plagiosperma* piper seed as processing time increased (Table 1). The autoclaving for 35 min had the highest reduction effect on alkaloid, followed by autoclaved at 30 min and lastly autoclaving for 25 min. Autoclaving reduced alkaloid by 95.73%. This finding agrees with the work of Odoemelam [17] who reported that moist heat treatment (autoclaving and boiling) was the best processing method for *Canavalia plagiosperma* seed. Alkaloid causes gastro-intestinal and neurological disorders [23].

Table 1. Effect of autoclaving on the anti-nutritional factors in *Canavalia Plagiosperma* seed

Sample	Alkaloid (%)	Haemagglutinnin(Hu/mg)	Hydrogen cyanide (mg/kg)	Raffinose (%)	Stachyose(%)	Steroid(%)
Raw Seed	1.17a ±0.01	20.31a ±0.01	4.70a ±0.06	0.64a ±0.00	1.09a ±0.05	0.38a ±0.00
Autoclaved, 25min	0.12e ±0.01	14.38g ±0.72	1.25e ±0.02	0.23f ±0.01	0.52c ±0.01	0.10cd ±0.01
Autoclaved, 30 min	0.13e ±0.06	10.34h ±0.02	1.24e ±0.01	0.11h ±0.00	0.33e ±0.02	0.05gh ± 0.03
Autoclaved, 35 min	0.05f ±0.01	4.11i ±0.00	1.05g ±0.01	0.06I ±0.01	0.22f ±0.02	0.02g ±0.00

Values are means ± SD of triplicate determinations; Values followed by different superscripts in the same row are significantly *(p <0.05)* different

The raw seed of *Canavalia plagiosperma* was found to contain haemagglutinin level of 20.31 Hu/mg (Table 1) which is in line with the work of Esonu *et al*. [11] which said that raw C. *plagiosperma* piper has haemagglutinin content of 20.10 Hu/mg. Autoclaving significantly reduced the haemagglutinin level with the processing time increased. Autoclaving for 35 min had the highest reduction effect on haemagglutinin content of *Canavalia plagiosperma* piper seed. Autoclaving reduced haemagglutinin content of the seed by 79.76% (Table 1). Among the various processing techniques employed, the autoclaving was more effective in reducing the maximum level of haemagglutinin (79.76%) (Table 1). Similarly, significant reduction in level of haemagglutinin by autoclaving was reported for *Abrus precatorius*, *Mucuna pruriens* var. utilis, *Entada scandens*, *Vigna aconitifolia*, V. *sinensis*, *C. plagiosperma* piper and *Bauhinia purpurea* [11,21,27]. There was a significant different (p≤0.05) on the haemagglutinin content of all the autoclaved samples.

Hydrogen cyanide (HCN) level of *Canavalia plagiosperma* reduced as the processing times increased (Table 1). Autoclaving for 35 min showed the highest reduction effect on hydrogen cyanide. Autoclaving reduced the HCN content of C. *plagiosperma* by 77.66% (Table 1). These results agree with the work of Odoemelam [17] who reported that moist heat treatments (cooking and autoclaving) were the best processing methods for *C. plagiosperma* seed. Hydrogen cyanide causes gasping, convulsion and staggering [16]. The increase in the autoclaving time caused a significant reduction effect (p≤0.05) on the content of raffinose of *C. plagiosperma* seed (Table 1). Autoclaving for 35 min reduced raffinose content of *C. plagiosperma* piper by 90.63%. Similar results were reported by Ibrahim *et al.* [13] found that cooking caused complete removal of raffinose and about 60-80% of stachyose depending on cooking method. They also attributed this loss to the thermal hydrolysis of oligosaccharides to simple disaccharides and monosaccharides.

The stachyose content of *C. plagiosperma* piper seed increased as the durations of autoclaving increased (Table 1). Autoclaving caused significant reduction effects (p≤0.05) in the stachyose content of *C. plagiosperma* (Table 1). Autoclaving for 35 min had the highest reduction effect, followed by 30 min (Table 1). Autoclaving reduced stachyose by 79.82 % (Table 4). Autoclaving is the best processing method to eliminate stachyose (Table 1) when compared with cooking and roasting (Table 2 and Table 3). These decreases in levels of oligosaccharides (stachyose) due to autoclaving might be attributed to heat hydrolysis of the oligosaccharides with the formation of simple sugars [13,19]. These results coincide with the findings of Ugwu and Oranye [25] where autoclaving for 60 min totally eliminated stachyose in African breadfruit. Oligosaccharides (stachyose and raffinose) are the major contributory factors of flatulence [18]. The steroid level of *C. plagiosperma* piper reduced significantly (P≤0.05) as the processing time increased (Table 1). Autoclaving 35 min had the highest reduction effect on steroid content of *C. plagiosperma* piper seed (Table 1). Autoclaving reduced the steroid levels by 94.74% (Table 4). This finding agrees with the work of Odoemelam [17] who reported that moist heat treatment (autoclaving and boiling) was the best processing method for *C. plagiosperma* seed.

3.2. Effect of cooking on the anti-nutritional factors in *Canavalia plagiosperma* piper seeds

The effect of cooking on the anti-nutritional factors in *C. plagiosperma* piper seeds was shown in Table 2. Cooking had significant decreasing effect (P≤0.05) on alkaloid content of *C. plagiosperma* piper seeds (Table 2). The alkaloid levels reduced significantly (P≤0.05) as the processing (cooking) time increased (Table 2). Cooking for 50 min showed the highest reduction effect on alkaloid content of the seed. Cooking reduced the alkaloid level by 96.58% (Table 4). From (Table 2) cooking had the highest reducing effect on alkaloid when compared with autoclaving and roasting. This finding agrees with the work of Odoemelam [17] who reported that moist heat

treatment (autoclaving and boiling) was the best processing method for *C. plagiosperma* seed.

Table 2. Effect of cooking on the anti-nutritional factors in *Canavalia plagiosperma* seed

Sample	alkaloid (%)	Haemaglutinin (Hu/mg)	Hydrogen cyanide (mg/kg)	Raffinose (%)	Stachyose (%)	Steroid (%)
Raw Seed	$1.17^{a}\pm0.01$	$20.31^{a}\pm0.01$	$4.70^{a}\pm0.06$	$0.64^{a}\pm0.00$	$1.09^{a}\pm0.05$	$0.38^{a}\pm0.00$
Cooked, 30 min	$0.10^{e}\pm0.01$	$18.01^{d}\pm0.00$	$1.24^{e}\pm0.01$	$0.27^{e}\pm0.01$	$0.47^{c}\pm0.02$	$0.14^{d}\pm0.01$
Cooked, 40 min	$0.06^{f}\pm0.01$	$17.13^{e}\pm0.06$	$0.18^{f}\pm0.02$	$0.22^{f}\pm0.02$	$0.32^{e}\pm0.01$	$0.14^{d}\pm0.03$
Cooked, 50 min	$0.04^{f}\pm0.01$	$15.79^{f}\pm0.11$	$0.83^{h}\pm0.01$	$0.13^{g}\pm0.00$	$0.23^{F}\pm0.01$	$0.08^{ef}\pm0.03$

Values are means ± SD of triplicate determinations; Values followed by different superscripts in the same column are significantly *(p < 0.05)* different

The data in Table 2 shows the effect of cooking on haemagglutinin content of raw seeds. The reduction in haemagglutinin level increases as the cooking time increases. Cooking for 50 min significantly reduced (P≤0.05) the haemagglutinin concentration of raw seed to 15.79 Hu/mg as shown in Table 2. This coincides with the work of Enwere [8], who noted that traditional method of household cooking and industrial autoclaving or retorting are capable of detoxifying haemagglutinin using moist heat.

Cooking remarkably reduced the hydrogen cyanide (HCN) level of *Canavalia plagiosperma* piper seeds as the processing time increased (Table 3). The initial level value of HCN (4.70 mg/kg) was reduced to 0.83 mg/kg after 50 min cooking which indicates very significant (P≤0.05) reduction of the HCN content. This indicates that boiling could therefore be employed for total destruction of the toxins without destroying the nutrient. Odoemelam [17] who reported that moist heat treatments (cooking and autoclaving) were the best processing methods for *C. plagiosperma* seed. Cooking for 50 min gave hydrogen cyanide value of 0.83 mg/kg which is far lower than the fatal dose level of 50 mg/100g which is equivalent to 500 mg/kg [16]. Cooking reduced the HCN level by 82.34% (Table 4). This result agrees with the work and staggering [16] and also inhibits the cytochrome oxidase through combination with their copper and iron ions, respectively [20].

The oligosaccharides (stachyose and raffinose) content in raw *C. plagiosperma* piper and the effect of cooking on them were presented in Table 2. The increase in the durations cooking caused a significant reduction (p≤0.05) in the content of stachyose and raffinose of *C. plagiosperma* (Table 2). The cooking reduced them by 78.90% and 79.69% (Table 4), respectively. Cooking for 50 min showed the highest reduction effect in stachyose and raffinose. This results agree with Ibrahim *et al.* [13] who reported that cooking caused complete removal of raffinose and about 60-80% of stachyose depending on cooking method. Ordinary cooking of pre-soaked seeds did not increase the removal percentage of stachyose, whereas pressure cooking of presoaked seeds relatively increased stachyose loss from 59.8 to 66.17%. Steroid levels reduced significantly (P≤0.05) as the processing time increased (Table 2). Cooking for 50 min reduced steroid content of the seed by 78.95% (Table 4), this finding agrees with the work of Odoemelam [17].

3.3. Effect of roasting on the anti-nutritional factors of *Canavalia plagiosperma* piper seeds

The effect of roasting on the anti-nutritional factors in *C. plagiosperma* piper seeds was shown in Table 3. Roasting significantly reduced the alkaloid content of *C. plagiosperma* piper. The level alkaloid increased significantly (P≤0.05) as the roasting time increased (Table 3). Roasting for 80 min showed the highest reduction effect (70.09%) (Table 4). When compared the level of reduction in alkaloid in Table 3 with those of Tables 1 and 2, it is established that moist heat treatment is better in reduction of alkaloid, which is in accordance with the work of Odoemelam [17]. Also, studies by Esonu *et al.* [9] have demonstrated that dry heat treatment alone as a method of processing jack bean seeds did not appreciably reduce the level of toxic factors.

The haemagglutinin content of raw seed of *C. plagiosperma* was found to be 20.31 Hu/mg (Table 3) which is in line with the work of Esonu *et al.* [11] which said that raw *C. plagiosperma* piper has haemagglutinin content of 20.10 Hu/mg. Roasting significantly reduced the haemagglutinin level. The level of haemagglutinin reduced as the processing time increased. Roasting for 80 min reduced the haemagglutinin level by 15.46%. The percentage reduction is low when compared with moist heat treatments: autoclaving (79.76%) and cooking (22.25%) (Table 4). The reduced percentage decrease in haemagglutinin by roasting agreed with the work of Esonu *et al.* [9].

Table 3. Effect of roasting on the anti-nutritional factors in *Canavalia plagiosperma* piper seeds

Sample	alkaloid (%)	Haemaglutinin (Hu/mg)	Hydrogen cyanide (mg/kg)	Raffinose (%)	Stachyose (%)	Steroid (%)
Raw Seed	$1.17^{a}\pm0.01$	$20.31^{a}\pm0.01$	$4.70^{a}\pm0.06$	$0.64^{a}\pm0.00$	$1.09^{a}\pm0.05$	$0.38^{a}\pm0.00$
Roasted, 40 min	$0.48^{b}\pm0.00$	$19.21^{b}\pm0.02$	$2.46^{b}\pm0.01$	$0.52^{b}\pm0.00$	$0.85^{b}\pm0.00$	$0.33^{b}\pm0.01$
Roasted, 60 min	$0.44^{c}\pm0.01$	$18.39^{c}\pm0.36$	$2.17^{c}\pm0.01$	$0.45^{c}\pm0.00$	$0.82^{b}\pm0.02$	$0.25^{c}\pm0.01$
Roasted, 80 min	$0.35^{d}\pm0.00$	$17.17^{e}\pm0.07$	$1.84^{d}\pm0.01$	$0.37^{d}\pm0.01$	$0.40^{d}\pm0.05$	$0.24^{c}\pm0.03$

Values are means ± SD of triplicate determinations; Values followed by different superscripts in the same column are significantly *(p < 0.05)* different

Table 4. Reduction (%) of some anti-nutritional factors in *Canavalia plagiosperma* piper for the best processing treatments

Anti- nutritional factors	Autoclaving (35 min)	Cooking (50 min)	Roasting (80 min)
Alkaloid (%)	95.73	96.58	70.09
Haemagglutinin (Hu/mg)	79.76	22.25	15.46
Hydrogen cyanide (mg/kg)	77.66	82.34	60.85
Raffinose (%)	90.63	79.69	63.70
Stachyose (%)	79.82	78.90	42.19
Steroid (%)	94.74	78.95	36.84

The oligosaccharides (raffinose and stachyose) content in *C. plagiosperma* piper increased decreased as the processing (roasting) time increased. The increase in the durations roasting caused a significant reduction (p≤0.05) in the content of stachyose and raffinose of *C. plagiosperma* (Table 3). Roasting reduced stachyose and

raffinose by 63.70% and 42.19% (Table 4), respectively. Roasting for 80 min showed the highest reduction effect on the two oligosaccharides (Table 3), but they are low when compared to the reductions given by autoclaving (Table 1) and cooking (Table 2). This coincides with the work of Akande and Fabiyi [2] who reported superiority of cooking (moist heat) to dry heat for improvement of growths promoting action in soybeans and in Jack beans [5,6].

The hydrogen cyanide content of *C. plagiosperma* piper reduced significantly ($p \leq 0.05$) as the processing (roasting) time increased (Table 3). Roasting for 80 min reduced hydrogen cyanide level by 60.85 % (Table 4). The reduction effect of roasting was lower when compared with that of cooking and autoclaving. This result agrees with the work of Odoemelam [17].

The steroid level reduced significantly ($P \leq 0.05$) as the processing (roasting) time increased (Table 3). Roasting for 80 min reduced steroid content of raw seed by 36.84%. This reduction on steroid caused by roasting is low when compared with the level of reduction caused by autoclaving (Table 1) and cooking (Table 2). This result agreed with the work of Ahamefule *et al.* [1] who reported that boiling, roasting and soaking are some of the processing methods employed but they do not completely eliminate anti-nutritional factors but inactivate them.

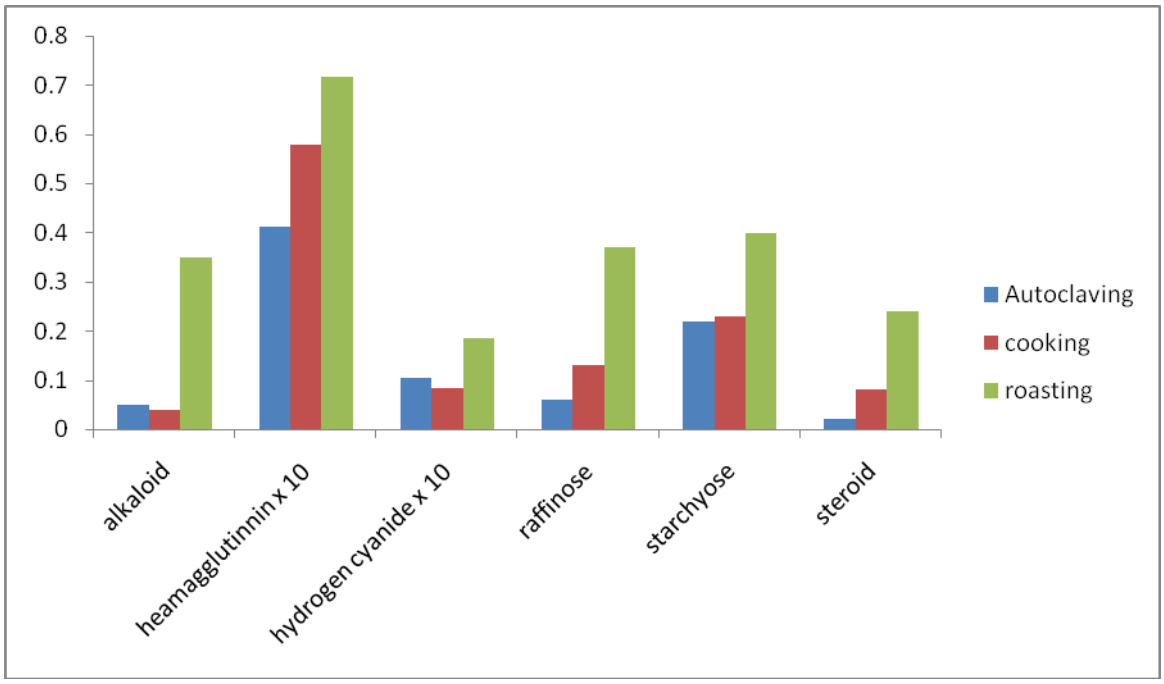

Figure 1. The effect of some processing techniques on the anti-nutritional composition of *Canavalia plagiosperma* piper seed

Table 4 presents the percentage reduction of some anti-nutritional factors in *C. plagiosperma* piper seeds after processing. Generally, the three processing treatments reduced the anti-nutrients levels at different rates. Autoclaving was the best processing method for stachyose, raffinose, haemagglutinin and steroid while cooking was the best processing treatment for hydrogen cyanide and alkaloid. It could be deduced therefore that moist heat treatments (autoclaving and cooking) were the best in reducing anti-nutritional factors when compared with dry heat treatment (roasting). Figure 2 clearly shows the highest reduction caused by each of the three processing methods on the six different anti-nutritional factors investigated.

4. Conclusion and Recommendations

The results revealed that moist heat treatments (autoclaving and cooking) are good in reducing anti-nutrients. The three treatments drastically reduced the level of anti-nutritional factors; autoclaving and cooking reduced it to the level that is safe for human consumption. The seed when processed can be used as a good plant protein source for this teaming population in the world since animal protein is very expensive. It could also be used to fortify cereal based diets such as pap. The processing treatments used in this work caused reduction at different rates in the level of anti-nutrients present in the raw seed of *C. plagiosperma* to tolerable level safe for consumption; it is therefore recommended that slightly increasing the processing time may totally eliminate the anti-nutrients in the seed. It is also recommended that increasing the processing time of roasting will be more efficient in reducing the anti nutrients to tolerable levels. Also, other methods of reduction of anti-nutrients in foods other than heat (such as malting, fermentation etc) should be carried out on *C. plagiosperma* seed so as to know their own suitability and rate of reduction of the anti-nutrients in the seed.

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