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Effect of Processing Techniques on Levels of Minerals and Antinutritional Factors of *Canavalia ensiformis*

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Abstract: Proximate composition and effect of boiling, roasting and fermentation on mineral elements, Phytate, Oxalate, Tannin and Cyanide in *Canavalia ensiformis* seeds were evaluated. Raw sample was analyzed for proximate composition. The results show that the seed is high in protein and carbohydrates (23.53% and 53.57% respectively). Fermentation and vigorous roasting increased Calcium by 14.29% and 33.33% respectively. Phosphorus was increased by 0.8% with mild roasting. Potassium and Phosphorus are high in the raw sample. Two methods of roasting were employed namely: 1 hour roasting (mild roasting) and 3 hrs roasting (vigorous roasting). Mild roasting increased Phytate concentration (31%). Other processing methods significantly reduced antinutrient factors ($p<0.05$). Boiling and fermentation greatly reduced Tannin (93%and 92% respectively). Cyanide showed respective 87.5% and 88.4% reduction with boiling and fermentation. Mild roasting reduced oxalate to 0.8% from 5.9%. Combination of boiling and mild roasting will result in more reduction compared with single treatment in all the antinutrients factors studied. The seeds can effectively substitute for protein deficient food and feed for animal if the amino acids profile is studied.

Key words: *Canavalia ensiformis*, minerals, antinutritional factors

INTRODUCTION

Jack bean, *Canavalia ensiformis* is a twining legume up to 1 m in height which has been used in some parts of the world, as food, it is used as vegetable in India, Burma, Srilanka and East Asian countries (Salunke *et al*., 1985). *Canavalia ensiformis* has numerous names in English. They include Brazilian broad bean, Coffee bean, Chicksaw bean, Ensiform bean, Horse bean (*Vicia faba*), Jack bean, Mole bean, Overlook bean, Pearson bean, Wonder bean, Cut-eye bean and Pois sabe (French) (ADE, 2008). Though *Canavalia ensiformis* does not have a reported commercial importance in countries where it is found, the seeds have its application in its edibility in the young tender immature stage. Occurrence of antinutrients in plant food is a notable advantage for their utilization if not-processed or not properly processed (Taylor, 1982).

Antinutrient factors are poisonous substances found in most plants in varying concentrations and in some ways limiting the available nutrients in the body. The presence of endogenous anti-nutritional factors within plant feedstuffs is believed to be the largest factor limiting their use within compounded animal and human feed at high dietary levels (Tacon and Jackson, 1985). Unfortunately, toxicological studies have not been performed on the majority of these anti-nutritional factors; on a general basis however, their presence in untreated foodstuffs normally results in anorexia, reduced growth, poor food conversion efficiency and death when consumed at high dietary concentration (NRC, 1983).

Furthermore, many traditional methods of food preparation such as fermentation, cooking, malting increase the nutritive quality of plant food through the reduction of certain anti-nutrients such as Oxalate Phytate, Polyphenols, etc. (Hotz and Gibson, 2007). In order to ascertain the potential status of unconventional seeds, there is a need for the examination of their functional properties. A study carried out by Enujiugha (2003) on the effect of processing on the anti-nutritional and functional properties of conophor nuts (*Tetracarpidium conophorium*), showed that the seeds have high oil content. This suggested that it could be used in the commercial production of vegetable oil.

Jack bean is high in essential amino acid lysine (5.73 g/16 gN), although, fairly low in methionine, It also finds application in biological studies as a source of concanavalin A, a lectin used in biotechnological techniques such as lectin affinity chromatography (Bressani *et al*., 1987).

MATERIALS AND METHODS

Sampling and selection of seeds: Dry pods of *C. ensiformis* were harvested from a garden in Bida, Niger State, during the dry season. Collected pods were kept for five days before seeds selection were sorted for infected ones before storage and then boiled, fermented, roasted prior to analysis.

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Seed treatment

Boiling: 100 g of the whole seeds was weighed and soaked in a distilled water for overnight. Soaked seeds were boiled for 1 hr and then rinsed with distilled water. Further boiling was done for another 2 hrs before the seeds were dried in hot air oven at 40°C. Dried seeds were milled using Thomas Willey mill to obtain a particle size of 1 mm.

Roasting: With the aid of digital weighing balance, 100 g whole seeds were weighed in two places. A portion was roasted in hot air oven at 120°C for 1 hr and the other proportion for 3 hrs. The two roasted portions were cooled and milled to obtain 1 mm particle size.

Fermentation: Fermentation was done by boiling 100 g whole seeds for 1 hr in distilled water, rinsed and then boiled for another 1 hr. Boiled seeds were drained and spread in air for 30 min before wrapping in clean dry banana leaves and incubated at 37°C for 72 hrs. Fermented samples were dried in hot air oven at 40°C and milled into flour to obtain a particle size of 1 mm.

Raw sample: Raw processing was done by drying 100 g whole seeds in hot air oven at 40°C and milling with the Thomas Willey mill to obtain a particle size of 1 mm. All processed samples were stored in the desiccators prior to use.

Determination of proximate composition: Raw *C. ensiformis* was analyzed for proximate composition using standard procedures recommended by the Association of Official Analytical Chemists (AOAC, 1990). Analysis of each parameter was done in triplicate determination.

Crude protein: This was determined by Kjedahl Nitrogen Method reported by Pearson (1979).

Crude lipids: This was determined by soxhlet extraction. A known weight of sample was exhaustively extracted with petroleum ether (boiling point 40-50°C). The ether was volatilized and the residue quantified gravimetrically and calculated as percentage lipid.

Crude fiber: This was obtained from the digestion of a known weight of defatted sample and refluxing 1.25% Sulphuric acid and 1.25% Sodium hydroxide. Carbohydrates content was estimated by subtracting the sum of the weight of protein, fiber, ether extract and ash from the total dry matter and reported and Nitrogen-free extractives (NFE by difference).

Ash content: This was estimated by incineration of known weight of sample in a muffle furnace at temperature of 550°C for a complete decarbonization to obtain white ash. The weight of the ash was obtained by difference and expressed in percentage.

Moisture content: This was obtained by drying to a constant weight. Percentage moisture was estimated from differences in weight.

Quantitative determination of processing effects on mineral composition of *c. ensiformis*: Method used was the standard procedures recommended by the Association of Official Analytical Chemists (AOAC, 1990)

Evaluation of processing effects on anti-nutritional factors in *C. ensiformis* seeds phytate: The method of Wheeler and Ferrel (1971) was used for phytate determination.

Oxalate: Oxalate was analyzed using colorimetric method (AOAC, 1990).

Tannin: Lowenthal permanganate titration method was used for the determination of total tannin.

Cyanide: Wang and Filled Alkaline picrate method was used.

Table 1: Proximate composition of raw *C. ensiformis* seeds

Parameter	Composition (%)
Crude protein	23.53±0.59
Crude fiber	16.65±0.00
Carbohydrates	53.57±0.61
Lipids	3.31±0.02
Ash	2.97±0.05
Moisture	2.30±0.25

Figures are mean standard deviation, n = 3

RESULTS AND DISCUSSION

The proximate chemical composition (% dry weight) of raw C. *ensiformis* seeds is presented in Table 1. Protein composition was high, higher than that of Bambara groundnut (Akaninwor and Ogechukwu, 2004). Crude fiber content was also high and higher than that obtained for different variety of soybean (Akaninwor and Ogechukwu, 2004). Carbohydrate composition was very high. This is attributed to its major store as found in other legumes which are essential in human and animal diets (Aranda *et al*., 2001) Moisture constituted only 7.3% of the dry weight which may be advantageous in view of sample's shelf life. The low ash content is reflective of the low level of some mineral elements. The low lipids content (3.31%) of C. *ensiformis* suggested Bambara groundnut and soybean as more promising source of lipid in supplemented for animals.

Raw seed was high in Potassium (Table 2) which is necessary for cell formation, transmission of nerve impulse and fluid balance (Ezeagwu and Ologbodo, 1995). Phosphorus concentration is also high in raw

Table 2: Mineral composition as affected by treatments

Sample	Potassium [mg/g]	Phosphorus [mg/g]	Sodium [mg/g]	Calcium [%]	Magnesium [%]
Raw seeds	10.0	7.19	1.75	0.36	0.40
Boiled seeds	4.5	5.31	1.00	0.40	0.44
Roasted seeds (1hr)	10.0	7.25	1.00	0.36	0.38
Roasted seeds (3hrs)	10.0	6.48	1.25	0.48	0.28
Fermented seeds	6.0	4.48	1.75	0.42	0.32

Table 3: Antinutrient factors as affected by treatments

Sample	Phytate [mg/100 g]	Tannin [mg/100 g]	Oxalate [mg/100 g]	Cyanide [mg/100 g]
Raw seeds	2.17±0.04	41.15±12.66	5867.0±252	3.45±0.05
Boiled seeds	2.04±0.04	2.49±00.00	5200.0±0.00	0.43±0.01
Roasted seeds (1hr)	3.19±0.02	28.26±03.81	800.0±0.00	2.86±0.01
Roasted seeds (3hr)	0.33±0.03	13.72±01.25	3667.0±5.8	2.53±0.06
Fermented seeds	0.68±0.18	2.91±00.91	5600.0±0.00	0.40±0.00

sample. However, boiling and fermentation brought about reduction in the two minerals due to leaching. Mild roasting increases phosphorus by 0.8%. Sodium, Calcium and Magnesium are quite low compared with African oil bean seeds (Enujiugha and Akanbi, 2005). Boiling increased Calcium and Magnesium level, along with vigorous roasting and fermentation.

Table 3 shows the effects of different processing methods on the level of antinutrients in the seeds. Cyanide was high in the raw sample compared with some legume seeds (Liener, 1989) Oxalate was high in the raw sample compared with African walnut and oil seeds. Raw seed will cause great bio-unavailability and decreased palatability of protein as a result of its high tannin content (Enujiugha and Akanbi, 2005).

Each processing method reduced the concentration of cyanide, oxalate and tannin. Mildly roasted seeds showed >31% increase in Phytate level. This accounted for the increase in phosphorus concentration in this processing method since Phytate is the major store of phosphorus in mature seeds. Significant reduction in Phytate level as a result of vigorous roasting and fermentation accounted for the increase in divalent Calcium and high Sodium level because effects of Phytate in terms of bioavailability of nutrients is directed towards chelation of these minerals. On the other hand, mild roasting caused 86% reduction oxalate compared with vigorous roasting and fermentation. Boiling and fermentation reduced tannin by >92%. Consumption of unprocessed *C. ensiformis* can lead to reduced absorption of Iron as a result of its high tannin content, leading to normocytic anemia (Liener, 1989). Cyanide is reduced by boiling and fermentation as a result of alkaline condition of the reaction which breaks down cyanodrin to Hydrogen cyanide which in turn is readily reduced by soaking and fermentation (Liener, 1989).

From the above results, it can be deduced that all the treatments contributes significantly to change in the antinutrient factors in the raw seeds of *C. ensiformis*. From the table of significant difference between treatment effects and one-way ANOVA tables, it was established that no two treatments affects the parameters the same way. Post hoc tests showed that treatment pairing can improve the reduction of anti-nutritional factors in the seeds. Boiling along with mild roasting is more fit for handling all the studied anti-nutritional factors as well as fermentation with mild roasting. This confirms the validity of the earlier statement of Aykroyd *et al.* (1982), that complete removal of antinutrient factors may not be achieved from a single processing method. This also accounted for fermentation technique in cassava processing before heat treatments in several Nigerian food items such as fufu and garri.

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