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Assesment of Processing Methods on the Chemical Composition of Sword Bean (Canavaliagladiata)

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Abstract: *The Canavalia glandiata used for this study was cultivated for the purpose of this study in Owo, Ondo State, Nigeria. The seed flour was subjected to different processing methods, which includes cooking, roasting and autoclaving. The effects of various processing methods on the nutritional, anti-nutritional, mineral composition and protein quality of seed flours were assessed. Again, the minerals detected in all the samples were; calcium, magnesium, potassium, sodium, iron copper, and zinc. The results in several aspects, compared favourably with those reported for many conventional edible legumes. Again, there is evidence of anti-nutritional factors in the seed, which were reduced by the processing methods adopted. However, the raw and processed seed flours appeared to be unsuitable as sole sources of dietary protein especially in human diets. Their incorporation in diets along with other protein resources is therefore suggested as a way of enhancing the utilization of these differently processed legume seed flours.*

Key words: *Canavalia glandiata, processing, proximate, amino acid, antinutritional.*

I. Introduction

The high rate of at which world population is growing, the world food supply should grow at the same rate if not faster. The most affected countries were the developing countries. Therefore, it is essential that cheaper sources of protein and other nutrients be found. The role of legumes seed in the diets of animal and man in developing countries cannot be over- emphasized. They are rich in nutrients such as digestible protein with good array of amino acids and minerals [1]. The percentage crude proteins of most legumes vary from 20 to 50 [2] and been judged a good source of minerals. Leguminous seed have been reported to be excellent source of energy [3,4] in animal and human diets. This explains why researches have been directed in exploiting the importance of these seeds in the formulation of animal and human diets.

Sword bean (Canavalia gladiata) is a tropical under-utilized food legume, wildly distributed throughout tropical Asia and tropical Africa [5]. It is usually grown as an annual crop. The leaves are shining. Pod is about 30cm long and 5cm wide. It contains 10-14 seeds in a pod. Seed are elliptical and about 3cm long. It has many desirable agronomic features such as high biomass production, resistance to drought, pest and disease, high fertility index and high seed productivity, (800 to 100kg/ha) on fertile land, which enable them to grow well under tropical conditions [6]. In India, Sword bean seed are consumed by certain ethnic groups and poor village people [7]. In Asia, the young pods and seeds of Sword bean are used as green vegetable. The roasted seed are used to prepare a coffee- like drink in Latin America [8]. In Nigeria, it's usually used as an ornamental plant, grown near houses and allow to trail on the walls and trees. [9,10].However, Sword bean has potential as feeding resource that could be exploited for its forage and seeds.

There are several studies on the nutritional, anti-nutritional compositions and properties of starch extracted from the seeds; [11], little information were known about the impact of processing on the composition and nutritive quality of the seed. This study was to evaluate the chemical composition and amino acids of raw and differently processed sword bean, with a view to studying the effect of various processing methods on the chemical composition and amino acids of the seeds.

II. Materials And Methods

The seed of Sword bean (Canavalia gladiata) were harvested from an experimental garden in Owo, Ondo state, Nigeria, where it was planted for the purpose of these studies. The seed was sundried for five days; about 5kg of dried seed were thoroughly rinsed with distilled water before subjecting them to the different processing techniques.

Processing techniques

5kg of the seeds were soaked in water for about 2hours and their testas peeled off manually, the dehulled seeds were sub-divided into four parts which correspond to each of the three different processing techniques: cooking, roasting, and autoclaving, while the fourth part will be untreated and consider as raw seeds.

Cooking

The cooking was done with 100ml of water in aluminum pot containing 400g of the seeds for 2hours, after which the seeds became soft to touch on pressing between the thumb and fingers. Thereafter, the seeds were removed, sun-dried.

Roasting

400g of the seeds were roasted with hot plate and stirred until a characteristic brownish coloured seed was obtained which indicate complete roasting. Thereafter, the seeds were cooled.

Autoclaving

400g of the seeds were autoclaved at 121^0C at 1.2kg/cm^3 pressure for one hour and thereafter cooled and sundried. At the end of the processing, the entire processed samples and the raw sample were milled using a laboratory hammer mill. The samples were kept in airtight container for analytical works.

Methods

Proximate analysis

The raw and processed samples were analysed for proximate composition according to [12] methods. Crude protein was calculated by multiply the nitrogen content of the samples with the factor of 6.25. The carbohydrate content of the sample was obtained by difference in which all the proximate analysis that is moisture, content, Ash content, crude protein and fat content were added together and subtracted from 100. Each sample was analysed three times.

Determination of amino acid profile

The amino acid profile in the sample was determined using methods described by [13]. The sample was dried to constant weight, defatted, hydrolysed and evaporated in a rotary evaporator and loaded into the Technicom Sequential Multi-sample amino acid analyzer (TSM).0.5g of defatted samples was hydrolysed by refluxing for 22 hours in a heating block preset at 105^0C ± 5^0C. The hydrolysate was cooled and quantitatively transferred to 50 ml flask and diluted with water. After filtration, a 10mL aliquot of the filtrate was heated in a rotary evaporator at 40^0C under vacuum. 10mL was dispensed into the cartridge of the analyzer. The TSM analyzer is designed to separate and analyze free acidic, neutral and basic amino acids of the hydrolysate. The amino acids were calculated based on the net height of each peak produced by the chart recorder of TSM (each representing an amino acid). The half-height of the peak on the chart was found and width of the peak on the half-height was accurately measured and recorded. Approximate area of each peak was obtained by multiplying the height with the width at half-height. The norcleucine equivalent (NE) for each amino acid in the standard mixture was calculated using the formula.$\mathrm{NE} = \frac{\text{Area of norcleucine peak}}{\text{Area of amino acid}}$

Determination Of Anti-Nutrients

Tannin

0.2g was weighed into 50ml sample bottle, 10ml of 70% acetone was added, and the mixture was shaken in water-bath for 2hours at 30^0C using Gallenkamp orbit shaker (Surrey, UK) at 120 revolutions per minute. Pigments and fat were initially removed from the samples by extracting with normal hexane containing 1% acetic acid. Thereafter, the total polyphenols (as tannin equivalent) was determined in 0.05ml aliquot in test tubes by the addition of distilled water to make it to 1.0mL, followed by the addition 0.5ml of the Folin Ciocaltean reagent (Sigma) and then 2.5mL of the sodium carbonate solution. The tubes were vortexed and the absorbance recorded at 725nm after 40min as described by [14]. The amount of total polyphenols (as tannin equivalent) was calculated from the standard curve. Repeat analysis was carried out on duplicate samples.

Oxalate

1.0g of the sample was weighed into 100ml conical flask, 50ml of 1.5M sulphuric acid was added and it was stirred with a magnetic stirrer for 1hour for complete extraction of oxalate from the samples. The mixture was filtered. 25ml of the filtrates were titrated hot against 0.1M potassium permanganate solution until a faint colour appeared that persisted for 35 seconds. Oxalate was calculated according to [15].

Saponin

10g of the samples were placed into 250ml conical flask and 100ml of 20% ethanol was added to it, it was heated on a hot water bath for 1hour with constant stirring using magnetic stirrer at 55^0C. The residue was filtered and re- extracted with 20ml of 20% ethanol, then the extract was concentrated to 40ml over a water bath at about 55^0C. The concentrate was transfer into 250ml separating funnel and 20ml of diethyl ether was added and it was shaken vigorously, the ether was discarded and the aqueous layer was retained and 20ml of n-butanol

was added in 100ml beaker and it was decanted. The residue was washed twice with 5% sodium chloride and it was decanted, then, the residue was dried with a known weight of 100ml beaker in an oven to a constant weight. Saponin was calculated according to [16].

Phytate

4g of the samples were weighed and soaked in 100cm^3 of 2% hydrochloric acid (HCl) for three hours and it was filtered, 25ml of the filtrate was transferred into 100ml conical flask, and 5ml of 0.3ml ammonium thiocyanate (NH_4SCN) was added as indicator. 50ml of distilled water was added for proper acidity, and it was titrated against standard Iron chloride ($FeCl_{3)}$ which contain 0.00195gm Fe/mL until a brownish yellow colour persists for 5 min. Phytin-phosphorous was determined and the phytin content was calculated by multiplying the value of phytin-phosphorous by 3.55 [17].

Mineral Determination

The sodium and potassium in the samples were determined by Flame photometry (Jenway Ltd, Dunmow, Essex, UK), and phosphorous by Vanado-molybdate method [12]. Calcium, Magnesium, Iron, Zinc and Copper were determined after wet digestion with a mixture of nitric, sulphuric and hydrochloric acids, using atomic adsorption spectrophotometer (Buck Scientific, East Norwalk, CT, USA).

III. Results And Discussion

Results

Table1: Shows the proximate composition of the differently processed sword bean in g/100g

Composition	Raw	Cooked	Roasted	Autoclaved
Crude Protein	29.82±0.30	28.71±0.30	28.33±0.50	29.73±0.50
Fat	9.78±0.10	8.09±0.20	9.85±0.50	8.37±0.10
Moisture	8.34±0.50	7.92±0.50	6.58±0.10	6.97±0.20
Ash	3.93±0.50	2.56±0.40	3.82±0.60	3.90±0.67
Crude Fibre	7.40±0.00	7.16±0.00	7.36±0.30	7.31±0.20
Carbohydrate	40.73±0.20	46.56±0.10	44.06±0.50	44.13±0.30

Mean ± standard deviation of triplicate determination

Table 2: Shows the mineral composition of raw and differently processed Sword bean flour in g/100g

Mineralsg/100g	Raw	Cooked	Roasted	Autoclaved
Calcium	0.52	0.39	0.36	0.47
Sodium	1.58	1.73	0.72	0.83
Potassium	0.92	0.40	0.51	0.45
Magnesium	0.54	0.28	0.16	0.34
Iron mg/100g	8.05	5.03	4.06	5.08
Phosphorous	0.60	0.40	0.27	0.27
Zinc mg/100g	72.01	64.01	57.32	57.02
Copper mg/100g	5.51	3.41	3.23	3.01

Table 3: Shows the Amino acid composition of protein in raw and differently processed sword bean in mg/g protein.

Amino Acid	**Raw**	**Cooked**	**Roasted**	**Autoclaved**
Lysine*	51.5	32.2	37.8	37.6
Histidine*	22.6	21.3	21.9	23.2
Arginine	56.2	40.8	51.2	47.7
Aspartic Acid	56	72.9	79.2	79.8
Threonine*	23.3	17.8	22.8	20
Serine	32.4	32.1	39.7	24.3
Glutamic Acid	134.1	113.2	126.6	101.3
Proline	34.0	27.6	31.9	29.7
Glycine	35.0	30.1	10.6	32.1
Alanine	37.8	37.1	35.5	30.2
Cysteine	11.9	7.60	10.6	9.30
Valine*	34.3	30.2	32.0	30.2
Methionine*	13.0	8.90	12.0	10.4
Isoleucine*	35.1	27.0	30.8	25.7
Leucine*	82.4	67.0	77.4	70.8
Tyrosine	25.8	19.3	22.5	22.5
Phenylalanine*	49.0	33.8	44.0	40.6
Total essential Amino Acids	311.2	238.2	288.7	258.5

*Essential amino acids

Table 4: shows the anti-nutritional composition of raw and differently processed Sword bean.

Anti-nutritional Compositions	Raw Seeds	Cooked	Roasted	Autoclaved
Saponin[1]	5.20±0.05	5.17±0.08	4.37±0.01	2.50±0.40
Tannin[2]	0.03±0.03	0.02±0.00	0.02±0.0	0.02±0.00
Oxalate[2]	2.70±0.10	2.02±0.06	2.61±0.04	0.68±0.06
Phytate[2]	21.44±0.05	12.90±0.01	13.19±0.50	13.43±0.04

[1]Values expressed on g/100g
[2]Values expressed on mg/g
Mean ± standard deviation of triplicate determination

IV. Discussions

Table 1 depicts the proximate composition of raw and differently processed sword bean flour. The crude protein ranges between 28.33±0.50 and 29.73±0.50 g/100g compared to 29.82±0.30g/100g obtained for raw sword bean. This implies that the processing methods employed affected the crude protein content of the seed, but to significant level. The crude protein compared favourably with values reported for some common legumes such as Pisum sativum, Phaseolus vulgaris, Cicer urietinum, Lens culinaris, different varieties of Cowpea, Cajana cajan, Pegeon peas, Bambara groundnut and some leaf vagetables [18, 19, 20, 21,22]. However, the crude protein was less than 43.1% reported for Luffa cylindrical which equally underutilized leguminous plant [19].

The values obtained for moisture content of the raw and differently processed seed flours were in the range of 6.58±0.10 and 8.34±0.50g/100g. The moisture content though higher than those reported for gourd seed Bambcapsis glabra (3.46%) [18], fluted pumpkin seed (5.02%) [23] and Luffa cylindrical (5.8%) [19,24], but still low that makes the seed not highly susceptible to microbial attack. Therefore, the seed could be kept for long period of storage and transportation. The fat content was in the range of 8.09±0.20 and 9.85g/100g. The fat content of roasted sample was higher than the remaining samples; this might be as a result of oil cells been exposed for extraction.

The oil contents were low; this implies that the seed was not a good source of oil which means that it could not be commercially extracted and refined to edible vegetable oil. The oil contents were less than 18-20%

reported for some selected seeds and nuts such as Soy bean, Sunflower and Peanut [25,26]. However, the oil contents were higher than 1.40-4.00% reported for processed Vigna unguiculata and 2.60% reported for Cajanus cajan [27,28]. The ash contents give an insight of the amount of inorganic content of the samples where the mineral contents could be obtained.

The values obtained for the ash content was in the range of 2.56±0.40 and 3.93g/100g. The values of differently processed sample were less when compared with raw sample, which implies that some minerals were destroyed in the course of processing. These values obtained for ash contents were within the range 1.63 and 8.53g/100g reported for some commonly consumed fruits and some selected varieties of Cowpeas [29,30,31]. The values obtained for ash contents were evidence that the seed could provide essential minerals needed for body metabolism.

The crude fibre contents were in the range of 7.16±0.00 and 7.40±0.00g/100g. These values were higher than those reported for Luffa cylindrical (2.50%), Cowpea (2.40%), Soy bean (4.80%), gourd seed (2.8);[27,19,32]. It suggests that the seed would provide additional dietary fibre in the diet. The carbohydrate contents of the samples were high. It was within the range of 40.73±0.20 and 46.56±0.10g/100g. High carbohydrate feed is desirable; deficiency causes weakness and depletion of body tissues [33]. The high carbohydrate content implies that the seed might be a good source of energy. The carbohydrate contents were higher than 33.00% reported for Bombcapsis glabra [22].

The raw and differently processed sword bean contained both major and minor minerals. The major minerals include Calcium, Sodium, Potassium, Magnesium and Phosphorous, while the minor minerals include Iron, Zinc and Copper. The mineral contents were relatively low when compared with those reported for some common legumes [20,34]. The raw sample has the higher level of minerals when compared to processed bean. This implies that different processing methods reduced the level of minerals in the samples. These observations confirm the report of [35].

The low level of potassium and sodium in the processed flours makes the seed nutritionally significant, as high dietary sodium is implicated in cardiovascular and renal disorder. However, calcium, magnesium and phosphorous required for bone mineralization is relatively low in the seed flours, meaning that dietary formulae based on the seed would require their supplementation. Iron contents was relatively high, it was in the range of 4.06 and 8.05mg/100g. Iron is required for blood formation and also important for normal functioning of central nervous system [36].

Table 3 depicts the result of amino acid composition of protein in raw and differently processed sword beans. The results indicated that the raw and differently processed flours contain essential amino acids. The most concentrated amino acid in all the samples was glutamine; it was within the range value of 101.3 and 134.1mg/100g. Next to glutamine was Leucine* an essential amino acid with the range values of 67.0 and 82.4mg/100g. The level of arginine was high; noting that arginine was an essential amino acid for the growth of children [37]. The amino acids profiles in raw sample were higher than differently processed samples. This implies that different processing methods reduced the amino acid profile of the seed flour. However, the seed is of dietary important. Comparison between the amino acid content and the [38] amino acid reference values shows that leucine, lysine, phenylalanine, isoleusine and valine in the seed were on the high side of the recommended range of amino acid requirement for infants and significantly higher than the values recommended for pre-school children. The value range of 8.90 and 13.00mg/100g obtained for Methionine was higher than 3.2mg/100g reported for Cajnus cajan [27,38].

Table 4 gives the anti-nutritional composition of raw and differently processed sword bean. The anti-nutrients detected in all the samples include saponin, tannin, oxalate, phytate, and alkaloid. Tannin ranged between 0.02 and 0.03mg/100g in the studied samples. Tannin is known to inhibit the activities of digestive enzymes and nutritional effects of tannin are mainly related their interaction with protein. The values reported for tannin were very low to be nutritional importance. The values obtained were low to be of any nutritional importance. These values were however low when compared to 13.3mg/g, 19.1mg/g and 99.2mg/g tannin reported for cashew nut, fluted pumpkin and raw breadnut respectively [39]. Studies on rats, chicks and livestock revealed that high tannin in diet adversely affects digestibility of protein and carbohydrates, thereby, reducing growth, feeding efficiency, metabolizable energy and bioavailability of amino acids [40].

The values obtained for phytate ranged between 21.44±0.05 and 12.90±0.01mg/g, from the result, processing methods applied reduces the level of phytate, cooking was the most effective method that reduces the phytate level. This confirms the previous reports of [41]. The value obtained for raw sample was higher than 18.5mg/100g reported for Canavalia ensiformis [42]. Phytate was reported as decreasing the bioavailability of minerals in monogastric animals [40] if consumed over a long period of time, its presence in food is also beneficial because it have positive nutritional role as an anti-oxidant and anti-cancer agent [43].

Oxalate is a concern because of its negative effect on mineral availability. High oxalate diet increases the risk of renal calcium absorption and has been found to be as a source of kidney stone [44]. The values obtained for oxalate were in the range of 0.68±0.06 and 2.7mg/100g. However, the level of oxalate in the

samples might not play important role in their nutritive values. Of all the processing methods, autoclaving was more effective in reducing the level of oxalate.

Saponin ranged from 2.50±0.40 to 5.20±0.05g/100g. Saponins are suspected to exhibit a wide spectrum of biological activity as antifungal and antibacterial agents. Saponin rich food may also contribute to lowering of blood cholesterol and inhibits the growth of cancer cell. Saponin acts by binding with bile acids and cholesterol, so it was reported that this chemical potentially has the ability to clean or purge this fatty compound from body, thus, lowering the blood cholesterol level [45].

V. Conclusion

The assessment indicates that these seeds have potential for human and animal feed judging from their proximate composition, mineral contents and amino acid profile of the seed. The results in several aspects, compared favourably with those reported for many conventional edible legumes. Again, there is evidence of anti-nutritional factors in the seed, which were reduced by the processing methods adopted. However, the raw and processed seed flours appeared to be unsuitable as sole sources of dietary protein especially in human diets. Their incorporation in diets along with other protein resources is therefore suggested as a way of enhancing the utilization of these differently processed legume seed flours.

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