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NUTRITIONAL EVALUATION OF BOILED *SENNA OBTUSIFOLIA* (LINN) SEED MEAL FOR FISH NUTRITION

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ABSTRACT

The nutritional evaluation of boiled *Senna obtusifolia* (linn) seed meal and its implication for fish nutrition was investigated. The seeds of *Senna obtusifolia* was handpicked at Shika Zaria, Kaduna State. Three portions each of 100g of the seed samples was taken for boiling as described by (Kakati *et al*., 2010) at 100^{o}C for 30, 45, 60 minutes corresponding to $B_{1,}$ B_2, B_3 respectively. The boiled seeds was sundried and grinded into fine powder and the nutrients composition was evaluated. Results shows that boiling significantly reduced the crude protein contents of the raw *Senna obtusifolia* seed meal (SOSM) from 21.12 to 15.51% as the boiling progress time from 30 to 60 min. However, the lipid contents increased from 11.14 to 12.57% as the boiling progressed. Boiling reduced the ash contents but not significantly ($p>0.05$) different as boiling progressed from 30 to 60 min. Significant ($P<0.05$) reduction of fibre contents was observed with increase in boiling time. The moisture content increased significantly ($p<0.05$) in the boiled samples. Boiling for 30, 45 and 60 min. resulted in NFE of 51.12, 51.10 and 53.34% respectively, which is significantly different ($p<0.05$) from the raw sample. The amino acid (g/100g protein) composition of the raw and differently boiled *Senna obtusifolia* shows that methionine (Met.) had the least value both in the raw and boiled seeds. Boiling significantly ($p<0.05$) reduced the amino acid composition. In conclusion, boiled *Senna obtusifolia* seed meal contains appreciable quantities of nutrients and amino acids but is limiting in methionine and lysine when compared to the established standard by FAO therefore, its use as supplementary plant protein with other feed ingredients rich in the limiting amino acids to feed fish is recommended.

Key words: Nutritional, boiled *Senna obtusifolia*, Fish, Seed.

INTRODUCTION

The utilization of many plant feedstuffs is limited due to the presence of anti-nutritional compounds, among these are phytates, polyphenols, and enzyme inhibitors (Abd El-Hady and Habiba, 2003). Attempts to increase the utilization of plant feedstuffs has employed a wide range of processing techniques such as soaking, boiling, autoclaving, radiation, cooking, roasting, dehulling, germination, fermentation, supplementation with various chemicals and enzymes and recently extrusion cooking have been described for various plant sources (Van der Poel, 1990; Gujska and Khan, 1991; Bishnoi and Khetarpaul, 1994; Fernandez *et al*., 1997; Alonso *et al*., 1998; Alonso *et al*., 2000a; Eyo, 2003).

When feedstuffs are heat treated, the anti-nutritional compounds present in them are either reduced or destroyed, thereby making them more digestible (Eyo, 2003).The cooking (boiling) of mango kernel has been proved to improve the feed utilization suggesting that its anti-nutritional

compounds were degraded (Joseph and Abolaji, 1997). Agboola (2004), reported that the boiling at 100^{o}C at varying period of time and oven drying at equivalent time periods detoxified and deactivated toxins in Castor oil seeds. Balogun *et al*. (2004) also boiled *Delonix regia* seeds at 100^{o}C at varying time intervals (0, 20, 40, 60, 80 minutes) to remove or to reduce toxins.

Anwa *et al*. (2007), subjected *Albezia lebbecks* seeds to different processing methods which include; boiling for 14, 20, 30 and 60 minutes, toasting for 1hr, 2hrs, 3hrs and roasted traditionally. The result showed that the boiling process gave the best results particularly the portion boiled for 1hr had the least concentration of the anti-nutritional compounds.

Senna obtusifolia belongs to the *Fabaceae* (Leguminoseae) or bean (pea) family, and sub-family *Ceasalpinoideae.* It is an annual weed taxonomically known as *S. obtusifolia*. This is a small fetid herb growing up to an average height of 30 to 90 cm (Parsons and Cuthbertson, 1992; Holm *et al*., 1997).

S. obtusifolia is extensively used in traditional medicine in tropical and warm sub-tropical countries; the leaves, roots and seeds are used in folk medicine in Asia (Ambasta, 1986). The proximate composition of the raw seeds show a high dry matter (92.50%), crude protein (29.54%), ether extract (2.31%) nitrogen free extract (NFE) (46.77%) and crude fibre (10.18%) as reported by Ingweye *et al*. (2010). It also contains alkaloids, saponins, tannins, oxalate and phytate contents in various concentrations. The hydrogen cyanide concentration is reported to be 6.98 mg/100g. The essential amino acids (EAA) of *S. obtusifolia* include phenylalanine, lysine, valine, leucine, isoleucine, threonine, methionine, cystine and tyrosine while the non-essential amino acids are aspartic acid serine, glutamic acid, proline, glycine and alanine. The objective of this work was to determine the nutritional value of boiled *senna obtusifolia* (linn) seed meal and its implication for fish nutrition

MATERIALS AND METHODS

Collection and Processing of *Senna obtusifolia* Seeds

The seeds of *Senna obtusifolia* were handpicked at Shika Zaria, Kaduna State. Three portions each of 100g of the seed samples was taken for boiling as described by (Kakati *et al*., 2010) at 100^{o}C for 30, 45, 60, minutes corresponding to $B_{1,}$ B_2, B_3 respectively. The boiled seeds was sundried and grinded into fine powder, packaged and labelled in a polythene bags in preparation for proximate analysis, amino acid profile, mineral elements, and determination of anti-nutritive compounds.

Biochemical Analysis of Raw and Processed Seeds

The proximate composition of the raw and boiled seeds, were determined as described by the Association of Analytical Chemistry (A.O.A.C., 2000). The Amino Acid profile in the known sample was determined using the method described by Benitez (1989). All chemical analysis was carried out in triplicate.

Determination of Anti-Nutritional Compounds

The anti-nutritional compounds such as tannins, saponins, hydrogen cyanide, was determined as described by (AOAC, 2000), while **p**hytate phosphorus and oxalate were determined by the methods of Wheeler and Ferrel (1971) using the procedures of Oke (1969).

Statistical Analysis

All data collected was subjected to one way analysis of variance (ANOVA) using General Linear Model (GLM) procedure of SAS (SAS, 2004). Duncan Multiple Range Test (DMRT) was used to separate means. Value of P<0.05 was considered significant.

RESULTS

Effect of Boiling Period on Nutrient Composition of *Senna obtusifolia*

The proximate composition of raw, and boiled *Senna obtusifolia* seed meal (BSOSM) is presented in Table 1. The crude protein content of raw SOSM sample was 21.12 ±0.05 g/100g and was significantly higher (p<0.05) than 15.51±0.06g/100g of the boiled SOSM. Boiling significantly reduced the crude protein content of the raw SOSM from 21.12% to 15.51% as the boiling time increased from 30 to 60 min.

Table 1: Effects of different boiling periods on the nutrients composition of *S. obtusifolia*

Treatment	Crude protein	Lipids	Ash	Moisture	Fibre	NFE
Raw	21.12±0.05^{a}	5.61±0.02^{c}	5.42±0.02^{a}	7.02±0.02^{a}	8.63±0.02^{a}	52.22±0.01^{b}
B 30	20.12±0.06^{b}	11.14±0.02^{c}	4.71±0.02^{b}	5.72±0.02^{d}	7.14±0.02^{c}	51.17±0.01^{c}
B 45	17.54±0.06^{c}	12.71±0.02^{a}	4.40±0.02^{c}	6.40±0.02^{c}	7.82±0.02^{b}	51.13±0.01^{c}
B 60	15.51±0.06^{d}	12.57±0.02^{b}	4.61±0.02^{b}	6.92±0.02^{b}	6.96±0.02^{d}	53.43±0.01^{a}

Means in the same column with different superscripts differed significantly (p<0.05)
B 30, 45 and 60 (Boiled seeds at different minutes)

The crude lipid content of the raw *Senna obtusifolia* seed was (5.61%) but the boiled (12.57 ±0.02 g/100 g) *Senna obtusifolia* seed meal had higher lipid content. Boiling time increased the lipid content from 11.14 to 12.57%. The ash content of the raw SOSM was (5.42 ±0.38 g/100 g). Boiling reduced the ash content but not significantly different (p>0.05) as boiling progressed from 30 to 60 min. The crude fibre content of the raw sample was 8.63±0.35 g/100g and significantly different (p<0.05) from boiled sample (7.82%). Boiling treatment significantly (p<0.05) reduced fibre contents. Boiling for 30, 45 and 60 min. resulted in crude fibre contents of 7.14, 7.82 and 6.96% respectively.

The moisture content of the raw SOSM was 7.02%. The moisture content ranged from 5.72% in 30 min to 6.92% in 60 min boiled sample, increasing boiling time increases the moisture content and there was a significant difference (P<0.05) in the moisture content of the boiled samples. The nitrogen free extract (NFE) of the raw sample was 52.22%. Boiling for 30, 45 and 60 min resulted in NFE of 51.12, 51.10 and 53.34% respectively, which is significantly different (p<0.05) from the raw sample.

Anti-nutritional Components of Raw and Boiled *Senna obtusifolia* Seed Meal

The anti-nutritional components of raw and differently boiled *Senna obtusifolia* seed meal (BSOSM) samples is presented in Table 2. There were significant differences (p<0.05) in anti-nutritional components between raw and the differently boiled seeds, the levels of these components reduced as boiling time increased. The phytate concentration in the raw seeds was

4.22±0.13 g/100g and reduced significantly ($p<0.05$) to 0.96±0.13 g/100g in the 60 min boiled seeds representing 77.25% reduction in phytates.

Table 2: Effects of Different Boiling Periods on the Anti-nutrient of *S obtusifolia* seeds

Treatments	Phytates	Tannins	Cyanide	Oxalates	Saponins
Raw	4.22 ±0.13^{a}	1.60±0.02^{a}	0.47 ±0.01^{a}	2.44±0.01^{a}	2.14±0.08^{a}
B_{30}	2.64±0.01^{b}	0.82±0.02^{b}	0.23±0.01^{c}	1.15±0.01^{b}	1.65±0.08^{b}
B_{45}	1.28±0.01^{c}	0.55±0.02^{c}	0.14±0.01^{d}	0.63±0.01^{c}	0.84±0.08^{c}
B_{60}	0.96±0.01^{d}	0.27±0.02^{d}	0.26±0.01^{b}	0.39±0.01^{d}	0.42±0.08^{d}
% Reduction	77.25	83.10	44.68	84.02	80.37

Means in the same column with the same superscripts are not significantly different ($p>0.05$)
B30, 45 and 60 (Boiled seeds at different minutes) % Reduction: reduction in Anti-nutritional compounds

The tannin in the raw seed was 1.60 ±0.02 g/100g was significantly reduced ($p<0.05$) by 83.1% to 0.27±0.02 g/100g in the 60 min. boiled seeds. The cyanide concentration was 0.47±0.01 g/100g in the raw seed was reduced significantly ($p<0.05$) to 0.26±0.01 g/100g in the boiled seeds at 60 min. The oxalate concentration was 2.44±0.020 g/100g in the raw seed meal, while in the boiled seeds at 60 min the concentration was reduced to 0.39±0.01 g/100g. Saponin concentration was 2.14±0.08 g/100g in the raw seeds and it was significantly ($p<0.05$) reduced in the boiled seeds at 60 min by up to 80.37% to 0.42±0.08 g/100g.

Amino Acid Composition of Boiled *Senna obtusifolia* Seeds

The amino acid (g/100g protein) composition of the raw and differently boiled *Senna obtusifolia* is presented in Table.3. Leucine (6.23 g/100g protein) had the highest value of essential amino acid while glutamic and aspartic acids (11.92 and 7.82 g/100g protein respectively) were the most available non-essential amino acids in the raw seeds. Tryptophan concentration could not be determined because it was hydrolysed by the acid. Methionine (Met.) had the least value both in the raw and boiled seeds. Boiling significantly ($p<0.05$) reduced the amino acid compositions.

Concentration of Amino Acid (g/100gcp) of Raw and Boiled seeds of *S. obtusifolia*

The evaluation of the amino acids based on the classification of the differently processed *Senna obtusifolia* seed meal is presented in Table 4. The total amino acids (TAA), total essential amino acids (TEAA) with histidine and total sulpur amino acids (TSAA) of the raw seeds were 69.93, 32.24 and 1.42 respectively. The TEAA and TSAA were reduced by boiling.

Table 3: Amino Acid Composition of Differently Processed *Senna obtusifolia* Seeds

Amino acid	Ref. value	Raw	B_{30}	B_{45}	B_{60}	SEM
EAA						
Lys	5.80	3.48^{cd}	3.45^{cd}	3.56^{c}	3.48^{cd}	0.10
Hist	2.50	2.25^{b}	2.20^{b}	2.26^{b}	2.24^{b}	0.12
Arg	5.20	5.60^{b}	5.58^{b}	5.65^{b}	5.60^{b}	0.94
Thr	3.40	3.33^{c}	3.34^{c}	3.33^{c}	3.40^{c}	0.08
Val.	5.00	3.88^{abc}	3.86^{abcd}	3.82^{abcd}	3.87^{abcd}	0.04
Met	2.50	0.64^{d}	0.67^{cd}	0.63^{d}	0.61^{d}	0.02
Iso.	2.80	3.11^{b}	3.07^{c}	3.11^{b}	3.10^{b}	0.07
Leu	1.10	6.23^{bc}	6.14^{bc}	5.96^{c}	6.23^{bc}	0.94
Phe.	6.30	3.54^{bc}	3.56^{bc}	3.56^{bc}	3.64^{bc}	0.08
NEAA						
Glu.	14.70	11.97^{ab}	11.20^{b}	11.60^{ab}	11.80^{ab}	0.10
Ser.	7.00	3.09^{ab}	3.01^{ab}	2.92^{b}	2.56^{b}	0.05
Asp	7.70	7.82^{abc}	7.35^{bcd}	7.12^{cd}	6.98^{d}	0.11
Pro.	10.70	2.85^{bcd}	2.74^{cd}	2.71^{cd}	2.61^{cd}	0.06
Gly.	2.20	4.28^{ab}	3.64^{bc}	370^{bc}	3.71^{bc}	0.11
Ala.	6.10	4.03^{b}	4.01^{b}	4.06^{b}	4.00^{b}	0.05
Cys	3.00	0.79^{c}	0.65^{d}	0.68^{d}	0.66^{d}	0.05
Tyr.	1.10	2.86^{b}	2.14^{c}	2.11^{c}	186^{c}	0.11

Means in the same row with the same superscript are not significantly different ($p>0.05$)
B 30, 45 and 60: (Boiled seeds at different minutes) EAA: Essential Amino Acids NEAA: Non-Essential Amino Acids

Table 4: Concentration of Amino Acid (g/100gcp) of Raw and Differently Boiled *S. obtusifolia*

Amino acids	Raw	B_{30}	B_{45}	B_{60}
TAA	69.93	66.57	66.87	66.24
TEAA				
Histidine	32.24	31.83	31.97	31.76
No histidine	29.97	29.59	29.71	29.54
% TEAA				
Histidine	46.10	47.81	47.81	47.95
No histidine	42.86	44.45	44.43	44.60
TNEAA	37.69	34.74	34.90	34.48
%TNEAA	53.90	52.19	52.20	52.10
TSAA(met+cys)	1.42	1.30	1.30	1.77

TAA: Total Amino Acids TEAA: Total Essential Amino Acids TNEAA: Total Non-Essential Amino Acids TSAA: Total Sulphur Amino Acids B 30, 45 and 60: (Boiled seeds at different minute)

DISCUSSIONS

The reduction in the crude protein of *S. obtusifolia* seeds as the boiling time progressed may probably be due to leaching and destruction of nutrients as the processing progressed. Similar reduction in crude protein with increasing boiling time had been observed for mung bean (Fagbemi, 2007). In this study, the carbohydrate contents of the boiled seeds increased, this may be associated with softening and breaking down of the cellulose making the starch more available (Agianga *et al*., 2010).

Boiling was found to increase the fibre content, an increase that might be due to conversion of insoluble dietary fibre to short length chains or units (Yuan *et al*., 2005). High fibre content have been found to bind trace elements, thereby preventing their absorption and consequently leading to deficiencies of iron and zinc (Siddhuraju *et al*., 1996).

The high lipid content of the boiled seeds could also be linked to the disruption of the cell structures and the testa of the seeds by heat during boiling causing the fats to melt and be released (Adegunwa *et al*., 2012). The reduction in the ash content as boiling duration increased could be attributed to leaching of the mineral elements into the water (Onu and Okongwu 2006; Fasasi, 2009).

Leucine is the most concentrated essential amino acid while glutamic and aspartic acids were the most concentrated non-essential amino acids in the raw seeds of *Senna obtusifolia*. The values of glutamic and aspartic acids made up to 9.79 g/100g protein as the most abundant amino acids in seed sample; similar results have been reported by other workers (Olaofe *et al*., 1994; Oshodi *et al*., 1998; Adeyeye, 2004). Boiling reduced the concentration of most of the essential amino acids. The limiting amino acids were found to be the sulfur amino acids (methionine + cystine). The lysine and methionine contents of the raw *S. obtusifolia* seed meal is far lower than protein required for nutrition of finfish (FAO/WHO,1990) hence, this shows that there will be need for supplementation of the meal containing *S. obtusifolia* seed with lysine and methionine.

Nutritive value of a protein depends primarily on its capacity to satisfy the needs for nitrogen and essential amino acids (Oshodi *et al*., 1998). The reduction in the concentration of amino acids in the boiled seed could be associated with denaturation at high temperature which may lead to loss of toxic substances, particularly of the protein toxins such as trypsin inhibitors and haemaglutinins (Liener, 1980).

Comparatively, the total values of essential and non-essential amino acid profiles of the boiled samples were lower than the raw sample. Trans-amination and deamination reactions might be responsible for the slight changes in the amino acids of the raw and boiled seeds of *S obtusifolia* seed meal (Aremu *et al*., 2009).

CONCLUSIONS AND RECOMMENDATION

Boiled *Senna obtusifolia* seeds meal contains appreciable quantities of nutrients and amino acids but it is limiting in methionine and lysine when compared to the established standard by FAO therefore, its use as supplementary plant protein with other feed ingredients rich in the limiting amino acids to feed fish is recommended.

REFERNCES

Abd-Elhady, E.A.A. and Habiba, R.A. (2003). Effects of soaking and extrusion condition an anti-nutrients and protein digestibility of legume seeds. *Journal of Food Science and Technology*, 36, 285-293

Adegunwa, M.O., Adebowale, A.A. and Solano, E.O. (2012).Effect of thermal processing on the biochemical composition, anti-nutritional factors and functional properties of beniseed (*Sesamum indicum*) flour. *American Journal of Biochemistry and Molecular Biology*, vol. 2, (3): 175-182.

Adeyeye, E.I. (2004). The chemical composition of liquid and solid endosperm of ripe coconut. *Oriental Journal of Chemistry*, 20(3):471-476.

Agboola, O.E. (2004). Growth performance and feed utilization of *Clarias gariepinus* and *Oreochromis niloticus* fed different levels of treated castor seeds (*Ricinus cumminis* L). Unpublished MSc. Thesis, ABU, Zaria. 33pp

Agiang, M.A., Umoh, I.B., Essien, A.I. and Eteng, M.U. (2010). Nutrient changes and anti-nutrient contents of beniseed and beniseed soup during cooking using a Nigerian traditional method. *Pakistan Journal of Biological Sciences*, 13(20): 1011–1015.

Alonso, R., Aguirre, A. and Marzo, F. (2000). Effect of traditional processing methods on anti-nutritionals and *in vitro* digestibility of protein and starch in faba and kidney beans.*Journal of Food Chemistry*. 68: 159-165.

Alonso, R., Orue, C. and Marzo, F. (1998). Effect of extrusion and conventional processing methods on protein and anti-nutritional factor content in pea seeds. *Journal Food Chem*istry, 63:505-512.

Ambasta S.P. (1986). The Useful Plants of India. Publication and Information Directorate, CSIR, New Delhi, p. 302.

Anwar, F.S., Latif, M. and Gilani, A.H. (2007). *Moringa oleifera*: a food plant with multiple bio-chemical and medicinal uses- a review. *Phytochemical Research*, 21:17-25.

AOAC (2000). Association of Official Analytical Chemists Official Methods of Analysis.17th edition, Washington, D.C. USA.

Aremu, M.O., Olayioye, B.O., and Ikokoh, P.P. (2009). Effects of processing on nutritional quality of kerstings groundnuts (*Kerstingiella geocarpa* L.) seed flours. *Journal of Chemical Society* 34: 140-149.

Balogun, J.K., Abdullahi, S.A., Auta, J. and Ogunlade, O.P. (2004). Feed conversion, protein efficiency, digestibility and growth performance of *Oreochromis niloticus*fed *Delonix*

*regia*Seed meal. *Proceedings of the National Conference of Fisheries Society of Nigeria* (FISON). Pp23-29.

Benitez, L.V. (1989). Amino acid and fatty acid profiles in aquaculture nutrition studies. P.23-35: In S.S. De Silva (ed). Fish Nutrition Research in Asia.*Proccedings of the Third Asian Fish Nutrition Network Meeting*.Asian Fisheries Society Special Publication. Asian Fisheries Society, Manila Philippines. 4(1): 166 .

Bishnoi, S.N., Kneta, P. and Yadav, R.K. (1994).Effects of domestic processing and cooking methods on phytic acids and polyphenol contents of pea cultiva (*Pisum sativum*). Plant food for human. *Nutrition,* 43: 381-388.

Eyo, A.A. (2003). Fundamental of fish nutrition and diet development: An overview. In Fish Feed Development and feeding Practices in Aquaculture, Eyo, A.A. (Ed.). FISON, Lagos Nigeria.

Fagbemi, T.N. (2007). Effects of processing on the nutritional composition of fluted pumpkin (*Telfairia occidentalis*) seed flour. *Nigerian Food Journal,* 25: 1-22.

Food and Agriculture Organization/World Health Organization. (1990). Protein quality evaluation: In report of a joint FAO/WHO expert consultation. Rome: *Food and Agriculture Organization of the United Nations,* 23.

Fasasi, O.S. (2009). Proximate anti-nutritional factors and functional properties of processed pearl millet (*Pennisetum glaucum*).*Journal of Food Technology,* 7(3):92-97.

Fernández, F., Miquel, A.G., Martínez, R., Serra, E., Guinea, J., Narbaiza, F.J., Caseras, A. and Baanante, I.V. (1999). Dietary chromic oxide does not affect the utilization of organic compounds but can alter the utilization of mineral salts in gilthead sea bream *Sparus aurata. Journal of Nutrition,* 129:1053-1059.

Gujska, E. and Khan, K.(1991).Functional Properties of Extrudates from High Starch Fractions of Navy and Pinto Beans and Corn Meal Blended with Legume High Protein Fractions. *Journal of Food Science,* 56(2): 431-435.

Holm, L. G., Pancho, J. V., Herberger, J. P. and Plucknett, D. L. (1979). A Geographical Atlas of World Weeds. *John Wiley and Sons*, New York. 391 pp.

Ingweye, J.N., Kalio,G.A.,Ubua, J.A. and Umorem, E.P. (2010). Nutritional Evaluation of Wild Sickle Pod (*Senna obtusifolia*) Seeds from Obanliku South-Eastern Nigeria. *American Journal of Food Technology,* 5(1): 1-12.

Joseph, J.K. and Abolaji, k. (1997). Effects of replacing maize with graded levels of cooked Nigerian mango seeds kernels (*Magnifera indica*) on the performance carcass yield and meat quality of broilers chickens. *Bio-resource Technology,* 61: 99-102.

Kataki, P., deka, SC., Kotoki, D., Saiki, S. (2010). Effects of traditional methods of processing on the nutrients contents and some ant-nutritional factors in newly developed cultivas of green gram (*Vigna radiate* (L) and black gram (*Vigna mungo* L) Hepper of Assam, India. *International Journal of Food Resources*, 17:377-384.

Liener, I. E. (1980). Toxic Constituents of Plant Foodstuffs. Academic Press, New York. 502pp.

Oke, O.L. (1969). Oxalic acids in plants and in Nutrition.*World Review Nutrition Diets*, 10:263-303.

Olaofe, O., Adeyemi, F.O. and Adeniran, G.O. (1994).Amino acid and mineralcompositions and functional properties of some oilseeds. *Journal of Agricultureand Food Chemistry*, 42**:**878-881.

Onu, P.N. and Okongwu, S.N. (2006). Performance characteristics and nutrient utilization of starter broilers fed raw and processed pigeon pea (*Cajanus cajan*) seed meal. *International Journal of poultry Science,* 5: 693-697.

Oshodi A. A., Esuoso K. O., and Akintayo E. T. (1998). Proximate and amino acid composition of some underutilized Nigerian legume flour and protein concentrates. *La Rivista Italiana delle Sostanse grasse,* **75**:409-412.

Parsons, W. T. and Cuthbertson. E. G. (1992). Noxious Weeds of Australia. Inkata Press, Melbourne. 698pp.

Siddhuraju P, Vijayakumari K, Janardhanan K (1996). Chemical composition and protein quality of the little-known legume, velvet bean (*Mucuna pruriens* (L.) DC). *Journal of Agriculture and Food Chemistry*, 44: 2636-2641.

Vander Poel, A.F.B, and Liener, I.E. (1990).Recent advances of Research in Anti-nutritional factors in legume seeds. Pudoc, Wageningen Pp 6-14.

Yuan X., Wang, J., Yao, H. and Venant N. (2005). Separation and identification of endoxylanases from *Bacillus subtilis* andtheir actions on wheat bran insoluble dietary fibre, *Process Biochemistry*, 40**:** 2339-2343.