African Journal of Biotechnology Vol. 7 (15), pp. 2676-2681, 4 August, 2008
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2008 Academic Journals

Full Length Research Paper

Growth and carcass characteristics of broiler chickens fed water soaked and cooked velvet bean (*Mucuna utilis*) meal

C. D. Tuleun[1]* and F. Igba[2]

[1]Animal Nutrition Department, University of Agriculture, Makurdi, Nigeria.
[2]Animal production Department, University of Agriculture, Makurdi, Nigeria.

Accepted 14 March, 2008

A 56-day feeding trial was conducted to determine the effects of dietary raw and soaked and cooked velvet beans, *Mucuna utilis* on the performance of broiler chickens. Two batches of raw *Mucuna* seeds were used. The first batch of seeds was used raw. The second batch was soaked for 24 h, subdivided into four parts and cooked for 0, 20, 40 and 60 min before sun-drying and milling. All the meals were analyzed for their proximate composition and included in the test diets at 20% dietary levels. The control diet contained no *Mucuna* meal. One hundred and eighty, 7 –day old Anak(R) broiler chicks were randomly assigned to six dietary treatments in a completely randomized design and replicated three times. At 20% dietary level, raw *M. utilis* seed meal significantly (P<0.05) depressed the performance of the birds in terms of feed intake, growth rate and feed conversion ratio. Consumption of soaked *Mucuna* seed meal reduced body weight gain similar to the raw *Mucuna* seed meal diet. However, soaking and cooking the seeds for 1 h allowed the birds to efficiently (P<0.05) utilize the feed comparable to the maize-soybean control diet. Weight of the gizzard, pancrease, liver, proventriculus as well as the lengths of small and large intestine and the caeca increased in birds fed the raw *Mucuna* seed meal diet. Most of these effects were partially or completely reversed by soaking and cooking *Mucuna* seed for 1 h.

Key words: Raw, soaked, cooked bean, growth, carcass characteristics.

INTRODUCTION

Feed accounts for 70 – 80% of the total cost of broiler production in Nigeria (Ademola and Farinu, 2006). This has invariably escalated the prices of poultry products out of the reach of the common populace, and a resultant drop in animal protein intake. The replacement of expensive conventional feed ingredients particularly those of protein origin (soybean and groundnut cake) with cheap, locally available and non-human competitive substitutes in feed formulation represents a suitable strategy at reducing the total feed cost of poultry production in Nigeria.

Mucuna utilis, commonly known as velvet bean is a highly productive (200 to 600 kg of seed/ha) tropical legume that is little known and utilized as human food or animal feed. In Nigeria, it is valuable as an excellent cover crop and soil improver (Ukachukwu and Szabo, 2003). Nonetheless, it is reported that raw *Mucuna* seed like other legumes is rich in crude protein, which ranges from 24.0 – 35.5% and a relatively good amino acid profile (Afolabi et al., 1985; Iyayi and Egharevba, 1998; Emiola et al., 2003). Despite the nutritional potential of *M. utilis,* its use has been limited by the high concentration of anti-nutritional factors like trypsin, phytates, cyanogenic glucosides, tannins, haemagglutins and L-3,4-dehydroxyphenyalanine (L-DOPA) (Afolabi et al., 1985; Iyayi and Egharevba, 1998; Josephine and Janardhanam, 1992; Emiola et al., 2003). The use of raw legumes in diets of animals as the only source of protein resulted to significant reduction in performances and other undesirable physiological alterations (Liener, 1990; Carew et al., 2003). However, Del Carman et al. (1999) and Emenalom and Udedibie (1998) reported that limited

*Corresponding author. E-mail: tuleundoo@yahoo.com.

quantities of velvet bean, if dry-heated and boiled for 60 min can be used successfully in broiler diets. Nevertheless, more research is needed to establish methods for reliably processing velvet bean for use as a feedstuff in poultry diets. This paper reports the results of a study carried out to determine the effects of dietary inclusion of soaked and cooked *M. utilis* seeds on growth and carcass characteristics.

MATERIALS AND METHODS

Velvet seeds (*M. utilis)* were obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria and processed as follows: The seeds were divided into two batches. The first batch was left raw, but the other batch was soaked in plain water for 24 h and subdivided into four parts and cooked for 0, 20, 40 and 60 min, respectively. Both the raw and the treated seeds were sun-dried and milled. The resultant meals were labeled raw (R) water soaked (WS), water soaked and cooked for 20 min (WSC_{20}), 40 min (WSC_{40}) and 60 min (WSC_{60}). Samples of the processed meals were analyzed for proximate composition according to AOAC (1995). Tannin was determined by the Folin-Denis method (AOAC, 1995) and trypsin inhibitory activity (TIA) was determined by colorimetric method of Stewart (1974).

Six experimental diets were formulated for each of starter and finisher phase such that the control diet contained no *Mucuna* seed meal (0%), diet 2 contained 20% raw *Mucuna* seed meal (RM), diet 3 contained 20% soaked *Mucuna* seed meal (MS), diet 4 contained 20% soaked and cooked for 20 min (MSC_{20}), diet 5 contained 20% soaked and cooked for 40 min (MSC_{40}) and diet 6 contained 20% soaked and cooked for 60 min (MSC_{60}).

One hundred and eighty, 7-day old Anak broiler chicks were balanced for weight and randomly assigned to the six dietary treatments in a complete randomized design (CRD). Each treatment group of 30 birds was further subdivided into three replicates of 10 chicks each and kept in a compartment measuring 3 X 4 m. Feed and water were provided *ad libitum* and the birds were subjected to standard management procedure. Feed intake and body weights were recorded weekly.

At the end of the 56 days feeding trial, two birds per treatment replicates were randomly picked, fasted overnight, then slaughtered, dressed and eviscerated according to Oluyemi and Robert (2000) procedure. Weights of the visceral organs, carcass, and cut – up parts were recorded and expressed as percentage of live weight.

Data collected were subjected to analysis of variance (Steel and Torrie, 1980) and where significant differences were observed between treatments, the means were compared using Duncan's New Multiple Range Test as outlined by Obi (2002).

RESULTS AND DISCUSSION

The proximate composition of raw and treated *Mucuna* seeds is presented in Table 1. The raw *Mucuna* seeds had higher crude protein value of 29.37%, ether extract (5.90%) and nitrogen free extract of 44.47%, but lower content of crude fibre (5.53%) and total ash (4.43%) than the soaked and cooked *Mucuna* seeds. This observation is in agreement with the findings of Emenalom and Udedibie (1998) and Emiola et al. (2003) who reported that raw *M. pruriens* seeds from Nigeria contained 29.38 – 30.33% crude protein and that from India 30.33% protein (Siddhuraju et al., 1996). Soaking and cooking in plain water irrespective of time tended to reduce the crude protein content of the seeds. Similar observations were also made by Nestares et al. (1996) and Wanjekeche et al. (2003) who reported a decreased protein content of seeds as a result of cooking and attributed this to the loss of soluble or proteinous parts of the seeds into the cooking water. The crude fat content also decreased from the raw seed as a result of all the processing treatments tested. This result agrees with the report of Udedibie et al. (1996) for jackbeans. Ukachukwu and Obioha (1997) also observed a reduction in fat contents by soaking and cooking *Mucuna* seeds in water. The loss may have been due to leaching of some fats into the cooking water or volatilization of fats during boiling.

The levels of trypsin inhibitor activity and percentage tannin in raw *Mucuna* seed were influenced by duration of cooking (Table 1). The decrease in trypsin inhibitor activity and percent tannin content with increase in duration of cooking raw *Mucuna* seeds is in agreement with earlier report of Wanjekele et al. (2003) and Udensi et al. (2005) when raw *Mucuna* seeds were cooked in plain water, respectively.

Table 4 shows the performance of broiler chickens on the dietary treatments. There were significant ($P<0.05$) differences in all the performance characteristics measured at both phases of the experiment. At the starter phase the inclusion of 20% raw *Mucuna* seed meal significantly ($P<0.05$) reduced the efficiency of feed utilization, which is reflected in reduced weight gain (Table 2). The same trend was observed when 20% raw *Mucuna* seed meal was included in the diet of the finisher broiler chickens (Table 3). The marked reduction in performance of the broiler observed at all the phase with raw *Mucuna* seed meal diet could be a reflection of the stringent requirement for essential nutrients (protein and energy) at these stages of life. The general reduction observed in performance of broilers fed raw *Mucuna* seed meal further confirms the works of Emenalom and Udedibie (1998), Del Carmen et al. (1999) and Carew et al. (2003) who reported that broiler chicks on 10% raw *M. pruriens* in balanced commercially- formulated ration had depressed growth due to limitation imposed on them by the antinutritional factors (ANFs) nature of the diets. However, soaking alone had insignificantly improved the efficiency of feed utilization compared to the raw *M. utilis* diets. Nevertheless, a combination of soaking and cooking *Mucuna* seeds at 40 and 60 min significantly ($P<0.05$) improved growth rate and feed conversion efficiency similar to the maize-soybean control diet (typically values were 2.52 and 2.38 vs 2.12). The observed improvement in growth rate and feed conversion efficiency of broilers fed soaked and cooked *Mucuna* seed meal diet in this study had also been reported by Emiola et al. (2003) and Nyirenda et al. (2003) when raw *Mucuna* seed was cooked for 1 h without soaking and when soaked for 12/48 h and cooked for 1 h, respective-

Table 1. Proximate analysis gross energy and antinutritional factor content of raw, soaked and cooked *Mucuna utilis* (%DM).

Parameters	Treatment				
	R	WS	WSC_{20}	WSC_{40}	WSC_{60}
Dry matter	89.70	90.14	89.55	90.19	89.31
Crude protein	29.37	29.62	27.95	28.27	27.93
Crude fibre	5.53	5.97	6.63	6.61	6.87
Ether extract	5.90	5.78	4.53	4.08	3.17
Ash	4.43	5.56	6.68	8.78	7.76
NFE	44.47	43.20	43.76	42.45	43.75
Gross energy (Kcal/g)	3.49	3.46	3.65	3.47	3.67
Tannin (%)	1.41	1.24	1.01	1.16	0.99
TIA (Tiu/mg)	33.59	34.01	23.03	20.40	17.77
ME (Kcal/kg)	3135	3006	3003	3024	3002

NFE: Nitrogen free extract.

Table 2. Composition of broiler starter diets (%).

Ingredient	Dietary treatment					
	1	2	3	4	5	6
Maize	48.58	42.81	42.99	41.80	42.01	41.30
Soyabean	39.52	33.29	33.11	34.30	34.09	34.80
Maize offal	10.00	-	-	-	-	-
Mucuna seed meal	-	20.00	20.00	20.00	20.00	20.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
DL.methionine	0.15	0.15	0.15	0.15	0.15	0.15
Premixes	0.25	0.25	0.25	0.25	0.25	0.25
Chemical analysis						
Crude protein	22.00	22.00	22.00	22.00	22.00	22.00
Available phosphorus (%)	0.74	0.79	0.77	0.83	0.80	0.83
Calcium (%)	1.22	1.23	1.22	1.24	1.23	1.24
Methionine (%)	0.49	0.45	0.45	0.45	0.45	0.45
Lysine (%)	1.24	1.21	1.20	1.24	1.21	1.22
ME (Kcal/kg)	3135	3006	3003	3024	3002	3026

Each Kg feed contained: Vitamin A, 5000 I.U., Vitamin D_3 1000,000 I.U., Vitamin E 15,000 mg; Vitamin K_3, 100 mg; Vitamin B_1,1,200 mg; Vitamin B_2,2,400 mg Biotin, 32 mg; Vitamin B_{12}10 mg; Folic acid, 400 mg; Choline chloride, 120,000 mg; Manganese, 40,000 mg; Iron, 20,000 mg; Zinc 18,000 mg; Copper, 800 mg; Iodine, 620 mg; Cobalt, 100 mg; Selenium 40 mg.

ly. These were attributed to better protein absorption, detoxification of the ANFs, higher palatability and availability of the amino acids in the diets.

Results of carcass characteristics of broilers fed experimental diets are shown in Table 5. There were significant (P<0.05) differences in most of the measured parameters. The lower plucked weight, dressed weight and dressing percentages of broilers fed the raw *Mucuna* seed meal diets resulted from their smaller live weight (Broadbent et al., 1981), since the surface area and the weight determine the amount of feathers and visceral required, respectively. The inferior performance response noticed in the raw *Mucuna* seed meal fed birds could be attributed to inhibitory activity of the toxic factors in the seed.

This growth depressing effects were similarly observed in finisher broilers (Emenalom and Udedibie, 1998) and starter broilers (Esonu, 2001) fed raw or urea toasted *Mucuna* seed meals.

The higher percent weight of drumstick, thigh, breast, back and wings observed with soaked and cooked *Mucuna* seed meal at the finisher phase emanated from feed and nutrient utilization, the effect of ANFs were less evident, and a deficiency of essential nutrients were less

Table 3. Composition of broiler finisher diet (%).

Ingredients	Dietary Treatments					
	1	2	3	4	5	6
Maize	50.70	49.93	50.10	48.92	48.13	48.55
Soyabean	32.40	26.17	26.00	27.18	26.97	27.55
Maize offal	10.00	-	-	-	-	-
Blood meal	3.00	-	-	-	-	-
Mucuna seed meal	-	20.00	20.00	20.00	20.00	20.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
DL.methionine	0.15	0.15	0.15	0.15	0.15	0.15
*Premixes	0.25	0.25	0.25	0.25	0.25	0.25
Chemical Composition (calculated)						
Crude protein	20.00	20.00	20.00	20.00	20.00	20.00
Available phosphorus (%)	0.71	0.76	0.73	0.79	0.77	0.80
Calcium (%)	1.21	1.21	1.21	1.21	1.21	1.21
Methionine (%)	0.46	0.42	0.42	0.43	0.43	0.43
Lysine (%)	1.10	1.05	1.05	1.06	1.06	1.06
ME (Kcal/kg)	3145	3015	3012	3034	3012	3036

*Each feed contained nutrients as in Table 2.

Table 4. Effects of dietary treatments on performance of experimental birds.

Parameter	Dietary treatment						
	1	2	3	4	5	6	SEM
Starter Phase (7-35 days)							
Average daily weight gain (g)	42.49 [a]	24.63 [d]	27.84 [c]	30.35 [c]	34.27 [b]	35.70 [b]	
Average daily feed intake (g)	73.00 [a]	63.43[b]	65.63 [b]	61.77 [c]	63.35 [b]	70.01[a]	1.22
Feed conversion ratio	1.72 [a]	2.58[c]	2.36 [bc]	2.04[ad]	1.85 [a]	1.96 [ab]	0.10
Finisher Phase (35-56 days)							
Average daily weight gain (g)	46.93 [a]	26.32 [e]	31.22[d]	34.68[c]	37.13 [bc]	39.79 [bc]	0.73
Average daily feed intake (g)	99.65 [a]	84.93 [c]	89.06 [bc]	87.53 [c]	93.47 [b]	94.62[b]	1.81
Feed conversion ratio	2.12 [a]	3.23 [c]	2.85 [bc]	2.52 [ab]	2.52[ab]	2.38 [a]	0.18
Final body weight (kg) (7-56 days)	2.40 [a]	1.39 [c]	1.63 [c]	1.80 [bc]	1.92 [bc]	2.05 [b]	0.08

SEM: Standard error of mean.
[a,b,c,d,e]Means on the same row with different superscripts are significantly ($P<0.05$) different.

pronounced. Feeding of raw *Mucuna* seed meal resulted in increased ($P<0.05$) liver weight (Table 6). This result contradicts the earlier findings of Carew et al. (1998b) which indicated that raw velvet bean had no effect on liver size, whilst decreased liver weight was reported by Ukachukwu et al. (2003a), but agrees with that of Emenalom and Udedibie (1998). Liver size is known to increase in response to several factors, especially deficiencies of protein and amino acids, associated with ANFs in raw velvet bean. The weights of the pancreas, kidney, caecum proventriculus, large and small intestines of birds fed raw *Mucuna* seed meal were consistently heavier than those fed soaked and cooked *Mucuna* seed meal diets. This confirms the earlier reports of Carew et al. (1998a). The consistent effect of raw velvet bean on pancreatic weight is most likely a consequence of the well known presence of antitrypsin factors in the beans that prevent adequate function of pancreatic enzymes, thus forcing the pancreas to work harder. However, trypsin inhibitor can readily be reduced from 4.41 trypsin inhibitor units (TIU) to zero by heating (Del Carmen et al., 1999) and potential toxicants remain relatively innocuous until they are acted upon by enzymes of the endogenous origin (Ravindran and Ravindran, 1988). The results of this trial showed that soaking and cooking reduced the pancreatic hypertrophy with a consequent reduction in endogenous loss of essential amino acids and hence the better performance evidenced.

Table 5. Effects of dietary treatments on carcass characteristics and organ weight of finisher birds.

Measurement	Dietary treatment						
	T1	T2	T3	T4	T5	T6	SEM
Lw (before slaughter, kg)	2.37 [a]	1.70 [c]	1.73 [c]	1.80 [c]	1.90[bc]	2.09[b]	0.10
Plucked weight (kg)	2.17	1.37	1.44	1.56	1.72	1.83	0.70
Dressed weight (kg)	1.80 [a]	1.15 [e]	1.29 [de]	1.35[cd]	1.47 [bc]	1.59 [b]	0.05
Dressing (%)	75.95 [a]	69.65 [b]	74.61[a]	75.29[a]	77.28[a]	75.83[a]	1.69
Wt of Breast (% of LW)	20.41	18.48	18.87	20.52	19.38	20.63	0.67
Wt of Back (% of LW)	9.01 [ab]	7.89 [c]	8.14 [c]	8.62[abc]	8.34 [bc]	9.15 [a]	0.32
Wt of Thigh (% of LW)	13.05	12.49	12.03	12.84	12.54	13.08	0.45
Wt of Drumstick (% of LW)	12.42	11.11	11.01	11.38	11.49	11.51	0.41
Wt of Wings (% of LW)	12.65 [a]	10.07 [c]	11.05 [bc]	11.24 [b]	11.94[ab]	12.11 [ab]	0.43
Wt of Shank (% of LW)	5.12	5.08	5.05	4.80	4.98	5.06	0.29

SEM: standard error of mean, LW: live weight.
[abcd]Means within the same row with different superscripts are significantly different (P<o.05).

Table 6. Effects of dietary treatments on organ weight and gut dimension as % body weight.

Measurement	Dietary treatment						
	T1	T1	T1	T1	T1	T1	T1
Empty gizzard (wt.)	2.12[b]	3.25 [a]	2.57 [b]	2.29 [b]	2.25 [b]	2.11 [b]	0.18
Liver (wt.)	2.13[cd]	2.65 [a]	2.34 [b]	2.25 [bc]	2.12 [cd]	2.08[d]	0.05
Pancrease (wt.)	0.25 [d]	0.63 [a]	0.34 [bc]	0.38 [b]	0.28 [cd]	0.26 [d]	0.02
Kidney (wt.)	0.79[c]	1.22 [a]	1.06 [b]	0.86 [c]	0.85 [c]	0.97 [bc]	0.03
Spleen (wt.)	0.14	0.10	0.09	0.12	0.12	0.15	0.04
Proventriculus (wt.)	0.43 [c]	0.75[a]	0.68 [a]	0.71[a]	0.55 [b]	0.53 [bc]	0.02
Lungs (wt.)	0.68[bc]	0.86 [a]	0.80 [ab]	0.72 [abc]	0.66 [c]	0.67 [bc]	0.06
Caecum (wt.)	0.47 [c]	0.83 [a]	0.82 [a]	0.81 [a]	0.78 [a]	0.54 [b]	0.03
Large intestine (wt.)	0.18 [d]	0.26 [a]	0.25 [b]	0.26[a]	0.24 [c]	0.25 [b]	0.003
Small intestine (wt.)	3.13 [c]	4.83 [a]	3.46 [b]	3.50 [b]	3.22 [b]	3.31 [b]	0.12
Length of Caecum (cm)	20.57	23.07	20.51	22.24	20.56	20.73	0.95
Length of large intestine (cm)	11.00 [b]	14.71 [a]	12.01 [b]	11.31 [b]	11.34 [b]	10.56 [b]	0.75

SEM: standard error of mean.
[abcd]Means on the same row with different superscripts are significantly (P<0.05) different.

Feeding raw *Mucuna* seed meal significantly (P<0.05) increased gizzard weight by 35% compared to maize-soybean diets. This agrees with Carew et al. (1998a, b) where feeding 20% raw velvet bean increased gizzard weight. Increase in gizzard weight may reflect the extra muscular or secretory work required to process velvet bean, which are higher in fibre than the soybean meal and corn in the control diet. This soaking and cooking for 60 min partially reversed the gizzard size by 92% compared to the control diet. Carew et al. (2003) showed that oven cooking 10% velvet bean but not 20% at 96°C for 60 min appeared to restore organ weight to normal. It is unknown why heat may partially reverse these effects, although alteration of fibre structures is a possibility as well as destruction of other factors in the raw velvet bean.

Consumption of 20% raw *Mucuna* seed meal diet significantly (P<0.05) increased the weights of small and large intestines compared to birds fed with soaked and cooked *Mucuna* seed meal diets. This also confirms results reported with growing chicks (Carew et al., 1998b) who suggested that the increase size of segments of the gastrointestinal tract in chicks fed raw velvet bean represents increase muscular work imposed by the increase fibre of these diets. But the fact that heating velvet bean at times reversed this effect may suggest the presence of a growth factor in the raw velvet bean.

In conclusion, the results support the view that heat treatment is essential in improving the nutritional quality of *Mucuna* seed meal. Chicks fed 20% raw *Mucuna* seed meal showed a marked reduction in growth rate, efficiency of feed utilization and a consistent increase in weights of gizzard, liver, proventriculus, pancreas and the intestinal lengths. Soaking without cooking is not an efficient method of detoxifying the seeds. The use of 20%

Mucuna seeds soaked and cooked for 60 min in broiler diets would have the advantages of on-farm application and of serving as both protein and energy source.

REFERENCES

Ademola SG, Farinu GO (2006). Performance of laying birds fed diets containing forage Meal of *Tithonia diversifolia* (Hemsl AG) and antibiotics. Niger. J. Anim. Prod. 33(1): 58-68.

Afolabi OA, Oshuntogun BA, Adewusi SR, Fopowo OO, Ayoride FO, Grisson FE, Oke DL (1985). Preliminary nutritional and chemical evaluation of Raw *Mucuna solanica;* and underutilized food source. J. Agric. Food Chem. 33: 122-124.

AOAC (1995). Association of Analytical Chemists, Official methods of Analysis. (16th Edition) Washington D.C.

Broadbent LA, Wilson BJ, Fisher C (1981). The composition of broiler chickens at 56 days of age: Output components and chemical composition. British Poultry Science. 22: 4-10.

Carew L, Alster FA, Gernat AG (1998a). Blood chemistry including cholesterol, glucose and thyroid hormones of broilers fed raw velvet bean (*Mucuna pruriens)*. J. Anim. Sci. 76(supplement 2): 82.

Carew L, Alster FA, Gernat AG (1998b). Consumption of raw velvet bean (*Mucuna pruriens)* alters organ weights and intestinal lengths in broilers. Poult. Sci. 77(supplement 1): 56.

Carew LB, Hardy D, Weis J, Alsters F, Mischler SA, Gernat A, Zakrzewska FI (2003). Heating raw velvet beans (*Mucuna pruriens)* reverses some anti-nutritional effects on organ growth, blood chemistry, and organ histology in growing chickens. Trop. Subtrop. Agroecosyst, 1: 267-275.

Del Carmen J, Gernat AG Myhrman R, Carew LB (1999). Evaluation of raw and heated velvet beans *(Mucuna pruriens)* as feed ingredients for broilers. Poult. Sci. 78: 866-872.

Emenalom OO, Udedibie ABI (1998). Effect of dietary raw, cooked and toasted *Mucuna pruriens* seed (velvet bean) on the performance of finisher broiler. Niger. J. Anim. Prod. 25(2): 115-119.

Emiola IA, Ologhobo AD, Akinlade J, Adedeji OS, Bamigbade OM (2003). Effects of inclusion of differently processed *Mucuna* seed meal on performance characteristics of broilers. Tropical Animal Production Investigations. 6:13 -21.

Esonu OO (2001). Comparative evaluation of raw and urea/roasted Velvet been (*Mucuna pruriens)* for broiler chicks. Niger. J. Anim. Prod. 28(1): 40-44.

Iyayi EA, Egharevba JI (1998). Biochemical evaluation of seeds of an under utilized legume *(Mucuna utilis).* Niger. J. Anim. Prod. 25 (1): 40-45.

Josephine RM, Janardhanan K (1992). Studies on chemical composition and Anti-nutritional factors in three germ plasm seed materials of the tribal pulse *(Mucuna Pruriens)* (2) Dc Food Chem. 43: 13-18.

Liener IE (1990). Implication of anti-nutritional components in soybean foods. Crit. Rev. Food Sci. Nutr. 34: 31-67.

Nestares T, Lopez–Friars M, Barrionuevo M, Urbano G (1996). Nutritional assessment of raw and processed chick pea *(Cicer arietnum*) protein in growing rats. J. Agric. Food Chem. 44: 2760-2765.

Nyirenda D, Musukwa M, Jonsson IO (2003). The effects of different processing methods of velvet beans *(Mucuna pruriens)* on L-DOPA content, proximate composition and broiler chicken performance. Trop. Subtrop. Agroecosyst. 1: 253-260.

Obi IU (2003). Statistical methods of detecting Differences between Treatment Means and Research Methodology Issues in Laboratory and field Experiments. (2nd Edition) Ap Express publication. Ltd. Nsukka-Nigeria.

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

Steel RGD, Torrie JH (1980). Principles and Procedures of Statistics. A Biometrical Approach 2nd edition, Mc Graw-hill Book co. New York.

Udensi EA, Onwuka GI, Onyekwere CR (2005). Effect of autoclaving and boiling on Some Anti-nutritional factors in *Mucuna sloanie*. Nigerian Food J. Vol. 33: 53-58.

Ukachukwu SN, Szabo NJ (2003). Effects of processing, additives and vitamin B_6 Supplement on *Mucuna pruriens var cochinchinesis* on broiler. Trop. Subtrop. Agroecosyst. 1: 227-237.

Ukachukwu SN, Obioha FC (1997). Effects of time duration of thermal treatments on the nutritive value of *Mucuna cochinchinesis*. J. Applied Chem. Agric. Res. 4: 39-43.

Wanjekeche E, Wakasa V, Mureithi JG (2003). Effects of germination, alkaline and acid soaking and boiling on the nutritive values of matured and immature mucuna *(Mucuna Pruriens)* beans. Trop. Subtrop. Agroecosyst. 1(2-3): 183-192.