Journal of Animal and Veterinary Advances 6 (4): 485-489, 2007

Utilisation of Some Raw Tropical Legume Seeds in Diets of Exotic Adult Cockerels

[1]A.M. Akanji, [2]A.D. Ologhobo and [3]I.A. Emiola
[1]Yewa Campus, College of Agricultural Sciences, University of Olabisi Onabanjo,
Ayetoro, Ogun State, Nigeria
[2]Department of Animal Science, University of Ibadan, Nigeria
[3]Department of Animal Production and Health,
Ladoke Akintola University of Technology, Ogbomoso, Nigeria

Abstract: An experiment was conducted to examine the effects of raw jack beans, bambara groundnut and benne seeds on performance characteristics, serum metabolites and weights of organs of exotic adult cockerels. Each of the raw legumes replaced full fat soybean meal at 25 and 50% levels, respectively. The experiment ran for 8 weeks. Feed intake, weight gain and feed conversion efficiency of birds fed with 25% and 50% raw jack beans, raw bambara groundnuts and raw benne seeds were significantly ($p<0.05$) reduced, respectively. However, the reductions were marked in birds fed 50% raw jack beans. Significant ($p<0.05$) correlations were obtained between feed intake and haemagglutinin ($r = -0.68$), trypsin inhibitor ($r = - 0.58$); Weight gain and haemagglutinin ($r = - 0.76$), trypsin inhibitor ($r = -0.83$). Mortality was higher in birds fed 50% raw jack beans. Serum total protein, albumin and globulin were significantly ($p<0.05$) elevated in birds fed raw benne seed-based diets, but reduced ($p<0.05$) in those fed 25 and 50% raw jack beans and bambara groundnuts, respectively. Weights of livers and testes were significantly ($p<0.05$) reduced in birds fed raw jack beans, raw bambara groundnuts and raw benne seeds, respectively. Pancreatic enlargement was however observed only in birds fed raw jack beans and bambara groundnuts, respectively.

Key words: Raw legumes, anti-nutrients, cockerels, performance

INTRODUCTION

Legumes are important sources of protein and energy both for humans and animals. Grain legumes, according to Ustimenko-Bakumosky (1983) contain as high as 20-50% protein. However, despite the significance of legume seeds as sources of supplementary protein in cereal-based diets for poultry, their use has almost disappeared because of their increasing importance in human diets (Ologhobo, 1992). Soybean (Glycine max) has played key roles in the feeding of non-ruminant animals and human beings, but has now become increasingly scarce and consequently expensive in view of high demands arriving from its multiple uses. In the Sub-Saharan Africa, Soybean which is a major source of dietary nitrogen to the birds has not been in abundant supply due to dwindling local production and lack of foreign exchange to support importation from abroad. However, improved nutrition in the livestock industry in this part of the globe is subject to either increasing the local production of soybean or encouraging the use of lesser-known food legumes.

Moreover, the inclusion of raw food legumes in diets of rats has been reported to cause significant impairment of growth, marked alteration in the normal activities of several hepatic and extra hepatic enzymes (Apata, 1990). Ologhobo *et al.* (1993) reported alterations in haematological characters and serum biochemical values of broiler chickens fed raw jack beans. These undesirable physiological and biochemical alterations have been attributed to the occurrence of some anti-nutrients in the raw legumes.. Prominent among the anti-nutrients are the protease inhibitors which inhibit digestive enzymes (Liener and Kakade, 1980) the haemagglutinins or lectins which adversely affect the absorption of nutrient from the intestinal tracts (Jaffe, 1980) and the tannins which lower the digestibility of proteins by forming complexes with them (Bressani *et al.*, 1988). Some legumes also contain cyanogens (Montgomery, 1980) which can release hydrogen cyanide and cause death (Aykroyd *et al.*, 1982). This study was therefore designed to look at the possible effects of replacing full fat soya with raw jackbean, bambara groundnuts and benne seeds at 25 and 50% levels in diets of exotic adult cockerels. The performance characteristics, serum metabolites. organ weights and histopathology of organs of the exotic adult cockerels were investigated.

Corresponding Author: A.M Akanji, Yewa Campus, College of Agricultural Sciences, University of Olabisi Onabanjo Ayetoro, Ogun State, Nigeria

MATERIALS AND METHODS

Samples of raw jack bean (*Canavalia ensiformis* (L.) DC), (*Vigna subterranean* (L.) *Vendc.*) and benni seed (*Sesamum indicum* L.*)* were acquired from the Department of Agronomy, University of Ibadan, Nigeria.

Chemical analysis: Proximate compositions (Table 1) of the raw legumes were determined by the procedure of the Association of Official Analytical Chemists (1984). Concentrations of lectins and trypsin inhibitors (Table 2) were determined using, respectively the haemagglutination assay (Valdebouze *et al*., 1980) and a modified Kakade method. Tannin contents were determined by methods described by Hoff and Singleton (1977).

Experimental diets: The experiment composed of seven formulated rations in which raw jack beans, bambara groundnuts and benne seeds replaced full fat soybean meal at 25 and 50% levels, respectively (Table 3). Some adjustments were made in the levels of maize and wheat bran in order to make the diets isonitrogenous. Each diet was supplemented with methionine and lysine to ensure these amino acids were not limiting for growth.

Experimental birds: Two hundred and ten exotic adult cockerels of 28 weeks old were used in this experiment. They were randomly divided into 7 dietary treatment groups at 30 birds per group. Each group each further subdivided into 10 birds per replicate group. The birds were raised in battery cages during the period of the experiment. Food and water were served ad-libitum and light was provided for 24 h daily. The experiment ran for 8 weeks.

Measurements: At the end of the eight week, shortly before the birds were slaughtered, blood samples were randomly taken by cardiac puncture from 5 birds per replicate group. Blood was collected in ice-cooled centrifuge tubes for serum analysis. Serum total protein was determined by the method of Colowick and Kaplan (1955) and serum albumin and globulin by the bromocresol method of Doumas and Biggs (1972).

At the end of the feeding trial, the birds were then fasted overnight and slaughtered. The internal organs (livers, pancreas, kidney and testis) were quickly removed and weighed on a chemical balance, respectively. The weights were expressed as percentage of eviscerated body weight.

Table 1: Proximate composition of raw jack beans, bambara groundnut and benne seeds

	Raw jack beans (%)	Raw bambara groundnut (%)	Raw benne seeds (%)
Dry matter	96.0	97.7	98.1
Crude Protein	27.7	20.3	25.2
Crude fibre	9.5	3.2	4.0
Ether extract	2.5	6.7	52.8
Ash	3.5	3.5	5.3
Nitrogen free extract	52.8	64.0	10.8

RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 2: Anti-nutritional factors of raw jack beans, bambara groundnut and benne seeds

	Raw jack beans	Raw bambara groundnut	Raw benne seeds
Haemagglutinin (Hu/mg protein)	71.6	5.0	1.3
Trypsin inhibitor (Tiu/mg protein)	41.4	9.4	-
Tannin (g 100 gDm^{-1})	0.4	0.4	2.4

RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds; Hu = Haemagglutinin units; Tiu = Trypsin inhibitor units

Table 3: Gross composition of diets (g kg^{-1} Dm)

	Control	25% RJB	50% RJB	25% RBG	50% RBG	25% RBG	50% RBG
Maize	420.0	420.0	418.0	418.0	420.0	420.. 0	422.0
Full fat soya	180.0	135.0	90.0	135.0	90.0	135.0	90.0
Jack bean	-	45.0	90.0	-	-	-	-
Bambara	-	-	-	45.0	90.0	-	-
Benne	-	-	-	-	-	45.0	90.0
Fish meal	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Wheat bran	345.0	345.0	347.0	347.0	345.0	345.0	343.0
Bone meal	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Oyster shell	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Salt	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Premix	2.5	2.5	2.5	2.5	2.5	2.5	2.5
DL-Methionine	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lysine	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0
Determined proximate analysis							
*Crude Protein (%)	16.9	16.8	16.9	16.7	16.9	16.3	16.5
*Metabolizable energy (MJ kg^{-1})	11.8	11.7	11.8	11.6	11.7	12.3	12.5

RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Statistical analyses: The data were analyzed by analysis of variance. When analysis of variance indicated a significant treatment effect, means were compared using the Duncan multiple range test (Steel and Torrie, 1980) and test of linearity was applied to assess the relationship between the anti-nutritional factors and the response indices, respectively.

RESULTS AND DISCUSSION

This study was designed to assess the performance characteristics, serum metabolites and organs of exotic adult cockerels of exotic adult cockerels when fed raw jack beans, bambara groundnuts and benne seeds. The chemical compositions of the raw legumes are shown in Table 1 and 2. Crude protein contents of the three grain legumes ranged between 20.3 and 27.7%. Ether extract was higher in raw benne seeds (52.8%). These values are consistent with those reported by Apata (1990). Considerable variations were obtained in the concentrations of anti-nutrients of the raw legumes. Raw jack beans exhibited higher values of haemagglutinin and trypsin inhibitor, while raw benne seeds gave higher level of tannin. These values are however consistent with those reported by Grant *et al.* (1983), Ologhobo (1992) and Udedibie and Carlini (1998).

The performances of the birds fed on diets containing the raw legumes are shown in Table 4. Feed intake was significantly ($p<0.05$) reduced in all groups when compared with the control, but the reduction was more pronounced in birds fed 50% raw jack beans.. Significant reductions ($p<0.05$) were obtained in the weight gain and Feed Conversion Efficiency (FCE) of birds fed with the raw jack beans, bambara groundnuts and benne seeds, respectively. Regression analysis (Table 5) revealed significant correlations between feed intake and haemagglutinin ($r = 0.68$), trypsin inhibitor ($r = - 0.58$) and tannin ($r = - 0.43$), respectively; between weight gain and haemagglutinin ($r = - 0.76$) and trypsin inhibitor ($r = 0.83$). This observation corroborates the findings of Melcion *et al.* (1998) and Ologhobo *et al.* (1993). Jack bean has been reported to contain various toxic factors including canavanine and concanavalin A (lectin) which are capable of causing inhibition in feed intake (Udedibie and Carlini, 1998). In this study, a combined effects of the canavanine and haemagglutinin contents of the raw jack beans fed at 50% replacement level to the birds might have contributed to the marked reduction in the feed intake. D'Mello *et al.* (1985) reported that the canavanine content of raw jack bean is capable of inhibiting the synthesis of nitric oxide which is responsible for the regulation of feed intake. Furthermore, the relative lower feed intake in birds fed with diets containing raw bambara groundnuts and benne seeds could be attributed to the effects of haemagglutinin (lectin) and tannins, respectively. This is strongly supported by the significant correlations between feed intake, haemagglutinin and tannins, respectively. Pusztai *et al.* (1975) reported that

Table 4: Performance characteristics of exotic adult cockerels fed raw jack beans, bambara groundnut and benne seeds

	Control	25% RJB	50% RJB	25% RBG	50% RBG	25% RBS	50% RBS	Mean±SE
Feed intake (g day^{-1})	122.6^{a}	117.7^{b}	112^{d}	115.8^{c}	115.5^{c}	118.4^{b}	118.4^{b}	117.9±0.97
Weight gain (g day^{-1})	104.6^{a}	82.2^{c}	59.1^{e}	89.1^{c}	76.3^{d}	83.0^{c}	98.1^{b}	83.6±0.23
Feed conversion efficiency	0.80^{a}	0.58^{b}	0.50^{c}	0.59^{b}	0.58^{b}	0.59^{b}	0.59^{b}	0.6±0.01

a, b, c, d, e, - means with different superscript are significantly different ($p<0.05$).RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 5: Regression analysis of performance of adult cockerels fed raw jack beans, bambara groundnut and benne seeds

Anti-nutritional factors	Performance characteristics	Prediction equation	r	SEb	S. L.
Trypsin Inhibitor (TI)	FI	118.9-0.003 X	- 0.58	0.011	*x*
	WG	92.9 -0.007 X	- 0.83	0.074	*x*
	FCE	0.65 -0.001 X	-0.92	0.103	*x*
Haemaglutinin (Hg)	FI	118.4-0.008 X	- 0.68	0.06	*x*
	WG	90.6 -0.011 X	- 0.67	0.131	*x*
	FCE	0.64 -0.005 X	- 0.58	0.071	*x*
Tannin	FI	115.6-1.003 X	- 0.43	0.038	*x*
	WG	80.2 + 0.047 X	0.30	0.013	ns
	FCE	0.62 -0.022 X	- 0. 22	0.174	ns

X = Anti-nutritional factors, SEb = Standard error of b, r = Coefficient of linearity, *x* = Significance ($p<0.05$), ns = non-significant ($p>0.05$)

Table 6: Serum metabolites of exotic adult cockerels fed raw jack beans, bambara groundnuts and benne seeds

	Control	25% RJB	50% RJB	25%RBG	50%RBG	25% RBS	50% RBS	Mean±SE
Total Protein (g dL^{-1})	3.8^{a}	2.7^{d}	2.5^{d}	3.1^{c}	3.0^{c}	3.7^{a}	3.9^{a}	3.5±0.02
Albumin (g dL^{-1})	1.6^{a}	1.3^{c}	1.1^{c}	1.5^{b}	1.5^{b}	1.6^{a}	1.6^{a}	1.5±0.01
Globulin (g dL^{-1})	2.3^{a}	1.2^{c}	1.2^{c}	1.8^{b}	1.2^{c}	2.3^{a}	2.2^{a}	2.1±0.03

a, b, c - means with different superscript across the rows are significantly different ($p<0.05$) RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 7: Organ weight as percentage of eviscerated body weight of exotic adult cockerels fed raw jack beans, bambara groundnuts and benne seeds

Organ	Control	25% RJB	50%RJB	25% RBG	50% RBG	25% RBS	50% RBS	Mean±SE
Pancreas	0.23c	0.24c	0.31a	0.30a	0.28b	0.22c	0.23c	0.26±0.01
Liver	2.70a	2.50c	2.34d	2.60b	2.58b	2.67a	2.48c	2.58±0.04
Kidney	0.39c	0.44b	0.51a	0.45b	0.49b	0.47b	0.47b	0.42±0.06
Testis	1.54a	0.71c	0.06e	0.76c	0.39d	0.88b	0.93b	0.758±0.05

a, b, c, d, e, - means with different superscript across the rows are significantly different ($p<0.05$) RJB = Raw Jack Beans, RBG = Raw Bambara Groundnuts, RBS = Raw Benne Seeds

Table 8: Regression analysis of organ weight as percentage of eviscerated body weight

Anti-nutritional factors	Organ	Prediction equation	r	SE. b	S. L
Trypsin inhibitor	Pancreas	0.25-0.001 X	- 0.95	0.003	*x*
	Liver	2.66-0.008 X	- 0.46	0.001	*x*
	Testis	0.90-0.003X	- 0.80	0.05	*x*
Haemaglutinin	Pancreas	0.25-0.006 X	- 0.58	0.013	*x*
	Liver	2.68-0.004X	- 0.66	0.004	*x*
	Testis	1.04-0.002X	- 0.71	0.001	*x*
Tannin	Pancreas	0.27-0.023X	- 0.49	0.003	*x*
	Liver	2.55 + 0.031X	0.35	0.004	*x*
	Testis	1.37-0.005X	- 0. 08	0.001	ns

X = Anti-nutritional factors, SEb = Standard Error of b, r = Coefficient of linearity, *x* = Significance ($p<0.05$), ns = non-significant ($p>0.05$)

inclusion of pure lectin in a diet containing 5% casein depressed the feed intake of birds. Mrquardt and Campbell (1974) also reported depression in feed intake when condensed tannins purified from Vicia faba seeds were fed to broiler chickens at 3.9% of the diet. Haemagglutinin has also been reported to inhibit growth and feed conversion efficiency (D'Mello, 1991; Abbey *et al.* 1979). Apata (1990) showed that dietary lima bean haemagglutinin caused alterations in some enzyme systems and loss of weight in rats. In addition to the effect of haemaglutinin. D'Mello (1991) also reported that increased intake of canavanine by broiler chickens fed raw jack beans led to inhibition of transamidinase activity and creatine synthesis which subsequently reduced growth and FCE in the birds. The significant correlations between weight gain, FCE and trypsin inhibitor and haemagglutinin, respectively in this study support the findings of the above authors.

The serum metabolites of the adult cockerels are shown in Table 6. Serum total protein was higher in birds fed with 25 and 50% raw benne seeds over those fed with other raw legumes, respectively. Significant ($p<0.05$) reductions were also obtained in values of albumin and globulin of birds fed raw jack beans and bambara groundnuts, respectively. The observation of the higher value of serum total protein in birds fed raw benne seeds diets could be partly attributed to the marginal level of haemagglutinin and none of trypsin inhibitor. According to Kakade *et al.* (1968) reduced serum protein and albumin levels manifest an alteration in formal systemic protein utilization. This alteration can be attributed to interference in protein synthesis induced by the toxic constituents.

Data of organ weight expressed as percentage of eviscerated body weight (Table 7) showed that weights of pancreas and kidneys were significantly ($p<0.05$) elevated in birds fed raw jack beans and bambara groundnuts, respectively. Significant ($p<0.05$) reductions were obtained in the weights of liver and testis of birds with the raw legumes. Regression analysis (Table 8) showed significant correlations ($p<0.05$) between the weight of pancreas and trypsin inhibitor ($r = -0.95$), weight of liver and trypsin inhibitor ($r = -0.46$), weight of testis and trypsin inhibitor ($r = -0.80$) weight of pancreas and haemagglutinin ($r = -0.58$) weight of liver and haemagglutinin ($r = -0.66$) weight of testis and haemagglutinin ($r = -0.71$) weight of pancreas and tannin ($r = -0.49$). The observation on the pancreas in this study agrees with the findings of Liddle *et al.* (1984) that pancreatic enlargement is caused by continuous release of cholecystokinin when diets containing trypsin inhibitor activity are fed by birds. The observed depletion in the livers and testes in this study also corroborates the findings of (Lorenzson and Olsen,1992). According to the authors, haemagglutinin enhances shedding of brush border membranes and decreased villus length.

CONCLUSION

The conclusion in this study is that, although all diets containing the raw legumes impaired protein utilization, thereby leading to poor growth and feed efficiency, the inclusion of raw jack beans especially at 50% replacement level in diet of the exotic adult cockerels was more toxic. Though the three raw legumes used in this study have good potentials as protein sources, it is suggested that good processing techniques be adopted in order to enhance their utilization especially in diets of exotic meat-type chickens.

REFERENCES

Abbey, B.W., R.J. Neale and G. Norton, 1979. Nutritional effects of field bean (*Vicia faba*) Proteinase inhibitors fed to rats. Br. J. Nutr., 41: 34-38.

AOAC, 1984. Official Methods of Analysis (14th Edn.), Associations of Official Analytical Chemists, Washington, D.C.

Apata, D.F., 1990. Biochemical, nutritional and toxicological assessment of some tropical legume seeds. Ph.D thesis, University of Ibadan.

Aykroyd, W.R., J. Doughty and A. Walker, 1982. Legumes in human nutrition. FAO food and Nutrition Paper, FAO, Rome.

Bressani, R., E. Hernandez and J.E. Braham, 1988. Relationship between content and intake of bean polyphenolics and protein digestibility. Plant Foods and Human Nut., 38: 5-22.

Colowick, S.P. and N.O. Kaplan, 1955. Determination of serum metabolites. In: Methods in enzymology Vol. 1 (2nd Edn.), New York, Academic Press, New York.

D'Mello, J.P.F., 1991. Toxic amino acids. In: Toxic substances in crop plants. The Royal Society of Chemistry, New York.

D, Mello, J.P.F., I. Acamovic and A.G. Walker, 1985. Nutritive value of jackbean (*Canavalia ensiformis* (L.) DC.) For young chicks. Trop. Agric. Trinidad, 62:145-150.

Doumas, B.T. and H.G. Biggs, 1972. Determination of Serum Albumin. In: Standard Methods Of Clinical Chemistry (Cooper, G.R. Ed.), Academic Press, New York, pp: 175-188.

Grant, G., L.J. Moore, N.H. Mckenzie, J.C. Stewart and A. Pusztai, 1983. A survey of the nutritional and haemagglutinin properties of legume seeds generally available in the U.K. Br. J. Nut., 42: 207-214.

Hoff, J.E. and K.I. Singleton, 1977. A method for the determination of tannin. J. Food Sci., 42: 1566-1574.

Jaffe, E.G., 1980. Haemagglutinin. In: Toxic Constituents of Plant Foodstuffs (Liener, I.E) (Ed.), Acad. Press, N. Y, pp: 69-101.

Kakade, M.L., J.E. Smith and R. Borchers, 1968. Effect of a navy bean fraction on protein synthesis in rats. Proc. Soc. Exp. Biol., 128: 811-815.

Kakade, M.L., J.E. Rachis, C. McChee and G.A. Puski, 1974. Determination of trypsin inhibitor activity of soy products: A collaborative analysis of improved procedure. Cereal Chem., 51: 376-382.

Liener, I.E. and M.L. Kakade, 1980. Protease Inhibitors in Toxic Constituents of Plant Foodstuffs (Liener, I.E) (Ed.), Academic Press, New York, 1: 7-71.

Lorenzson, V. and W.A. Olsen, 1992. *In vivo* responses of rat intestinal epithelium to intraluminal dietary lectins. Gastroenterology, 82: 838-848.

Mrquardt, R.R. and L.D. Campbell, 1974. Chick performance as assessed by autoclave treatment of tannin-containing and tannin free cultivars of faba beans. Can. J. Anim. Sci., 42: 781-789.

Melcion, J.P., M. Koclaira, A. Leon, C. Michelangelli, R.E. Vargas and M. Picard, 1998. Detoxification of jackbean with pilot scale roasting (1). Technological conditions and analytical data. Anim. Feed Sci. Tech., 73: 277-230.

Montogomery, R.D., 1980. Cyanogens. In: Topic Constituents of Plant Foodstuffs. (Liener, I.E. Ed.), Academic Press, New York, pp: 143-153.

Ologhobo, A.D., 1992. Nutritive values of some tropical (West African) Legumes for poultry. J. Applied Anim. Res., 2: 93-104.

Ologhobo, A.D., D.E. Apata and A. Oyejide, 1993. utilization of raw jackbean (*Canavalia ensifirmis*) and jackbean fractions in deits for broiler chicks. Bri.Poult. Sci., 34: 323-337.

Pusztai, A., C. Grant and R. Palmer, 1975. Nutritional evaluation of kidney bean (*Phaseolus vulgaris*), the isolation and partial characterization of toxic constituents J. Sci. Food Agric., 26: 149-156.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of statistics. A biometrical approach. International students edition. Mcgrawhill, New York. pp: 107-109.

Udedibie, A.B.I. and C.K. Carlini, 1998. Questions and answers to edibility problems of the Canavalia ensiformis seeds-A Review. Anim. Feed Sci. Tech., 74: 95 -106.

Ustimenko Bakumousky, G.V., 1983. Plant growing in the tropics and subtropics. Macmillan Publishing Company. New York, pp: 121-151.

Valdebouze, P., E. Bergezone, T. Gaborit and J. Desort-Laval, 1980. Content and distribution of trypsin inhibitors and haemmaggltinins in some legume seeds Canadian. J. Plant Sci., 60: 695-701.