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The Effect of Dried Sweet Orange (*Citrus sinesis*) Fruit Peel Meal on the Growth Performance and Haematology of Rabbits

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Abstract: This study investigated the feed value of dried sweet orange (*Citrus sinesis*) peel as a replacement for maize in rabbit diet. Twenty mixed breed male rabbit were used and randomly assigned to diets T1 (0%), T2 (20%), T3 (30%), T4 (40%) in which sweet orange peel replaced maize at 0, 20, 30 and 40%, respectively at the rate of five rabbits per dietary group. The rabbit were fed and provided drinking water *ad libitum* for the 8 weeks experimental duration. Feed intake and live weights were recorded weekly for each replicate and the relative cut-up parts were also determined. Feed conversion ratio from the data as quantity of feed per unit weight gain over the same period. At the end of the trial, the animals were slaughtered by the cut-throat method and dressed to determine the dressing percentage. During slaughtering 4 mL of blood sample was collected into bijou bottles containing the anticoagulant, disodium salt of ethylene diaminetetra-acetic acid at the rate of 2 mg mL^{-1} of blood for the determination of Packed Cell Volume (PCV), Haemoglobin concentration (Hb) total erythrocyte count and total leucocyte count and erythrocyte osmotic fragility. The performance indices, feed intake, body weight and feeds conversion ratio was not affected significantly ($p<0.05$) except water consumption and water feed ratio. None of the haematological parameters were significantly ($p>0.05$) affected. The performance and haematology of rabbits fed on sweet orange were not depressed. The study has shown that sun dried sweet orange peel can be used as a replacement feedstuff for maize in the ration of grower rabbit at a level of 40%, its optimal replacement level can only be determined by evaluating its effect at higher level of maize replacement in subsequent studies.

Key words: Dried sweet orange (*Citrus sinesis*) peel, rabbit, growth performance, haematological parameters, effect, performance

INTRODUCTION

Thomas Robert Malthus (1766-1834) predicted that human population will be growing in geometric progression while food supply will be increasing in arithmetic progression in most of the developing countries Nigeria inclusive, the state of nutrition of the population is predominantly marked by inadequate protein intake both in quality and in quantity (Taiwo *et al*., 2005). The need to increase livestock production as a means of alleviating the overwhelming shortage of animal protein is very vital to humanity (Fielding, 1981). The demand for protein of animal origin in Nigeria is greater than the supply (Njoku, 1985; Akinmutimi and Onwukwe, 2002) and there is also an acute shortage of animal protein supply in Nigeria and hence, the need to increase livestock production (Nworgu *et al*., 1999).

Rabbit sector in Nigeria if properly harnessed has the potential of improving the nation's economy and improving the health status of the poor populace by providing affordable source of protein (Taiwo *et al*., 2005; Akinmutimi *et al*., 2007; Abubakar *et al*., 2009) so as to meet the recommended daily intake of 0.8 g kg^{-1} of protein in alleviating the problem of animal protein supply in developing countries (Abubakar *et al*., 2009; Akinola, 2009). As of now rabbit production in Nigeria is yet to assume commercial production scale comparable to poultry in the country (Amao *et al*., 2011) expansion of the rabbit production holds the greatest promise of bridging the animal protein gap in the country within the shortest possible time. However, the limiting factor in achieving this is the provision of adequate cheap and affordable feed throughout the year as there is competition between man and livestock for the conventional feed stuffs like maize, soyabean and

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groundnuts. It is therefore, necessary to search for inexpensive nutritionally adequate less humanly competitive feeds for livestock (Whittermore, 1994). One of such agricultural by-product is sweet orange (*Citrus sinensis*) peel. Sweet orange (*Citrus sinensis*) production in Nigeria is significant with heavy direct consumption due primarily to few and small capacity processing industries to convert the fruit to juice, concentrate and canned fruit (Oluremi *et al*., 2007) and was reported that dried sweet peel orange contains 89.65% dry matter, 10.74% crude protein, 7.86% crude fibre, 12.60% ether extract, 11.90% ash, 56.89% nitrogen free extract and 3.98 kcal g^{-1} metabolizable energy and is a source of calorie and protein comparable with maize (Oluremi *et al*., 2005, 2007). It has been demonstrated that sweet orange (*Citrus sinensis*) peel meal obtained from ground sun dried peels can replace dietary maize in broiler chicken diet at 20% level without any adverse effect on performance (Agu, 2006; Adenkola *et al*., 2007). However, there is paucity of information on performance characteristics and haematological parameters of rabbit that are given sweet orange peel diet.

The aim of this study therefore was to determine the replacement value of dried orange peel meal for maize by evaluating performances and haematological parameters of grower rabbits fed diets containing sweet orange peel meal based diets.

MATERIALS AND METHODS

The study was conducted at Federal Housing Estate Makurdi (07°08°37'E) in the Southern Guinea Savannah zone of Nigeria.

Experimental animals and management: Twenty healthy rabbit buck aged 7 weeks old were used in a 56 days trial. The animals were randomly allocated to four treatments with five rabbit per treatment in a completely randomized design. The rabbits were housed individually in wire mesh cages located in an open-sided building for easy and effective cross ventilation. The animals were kept for 2 weeks prior to the commencement of the experiment during this period they were screened for possible haemo and endo-parasites and accustomed to routine handling.

Experimental design: Sweet orange (*Citrus cinensis*) fruit peel (test ingredients) was collected fresh from orange seller within Makurdi metropolis. The peel was sun dried for 48 h on concrete floor until it became crispy. It was grinded and mixed with other ingredient to formulate four iso-nitrogenous and iso-caloric experimental diets to replace dietary maize at 0, 20, 30 and 40%. The 0% inclusion level served as the control. Feed and water was provided *ad libitum* throughout the 56 days old study period. All the rabbits were subjected to standard management procedure. Feed intake and live weights were recorded weekly for each replicate. Feed conversion ratio from the data as quantity of feed per unit weight gain over the same period. At the end of the trial, the animals were slaughtered by the cut-throat method and dressed to determine the dressing percentage and the relative cut-up parts according to the procedure of Oluyemi and Roberts. During slaughtering 4 mL of blood sample was collected into Bijou bottles containing the anticoagulant, disodium salt of ethylene diaminetetra-acetic acid at the rate of 2 mg mL^{-1} of blood (Adenkola and Ayo, 2009). After collection, the samples were transferred to the Physiology Laboratory, Department of Physiology and Pharmacology University of Agriculture, Makurdi where haematological parameters; Packed Cell Volume (PCV), Haemoglobin concentration (Hb) total erythrocyte count and total leucocyte count were determined as described by Schalm *et al*. (1975).

RESULTS

The proximate composition of experimental diet and feed ingredient composition are shown in Table 1 and 2.

Table 1: Proximate composition of experimental diets constituents

Diets	T1 (0%)	T2 (20%)	T3 (30%)	T4 (40%)
Dry matter	94.66	94.70	94.63	94.98
Crude protein	19.48	21.85	21.07	19.21
Crude fibre	11.55	11.33	11.72	11.68
Ash	11.55	14.52	11.35	12.08
Ether	12.47	11.37	11.39	12.08
Nitrogen free extract	44.96	40.94	43.89	44.94

Table 2: Feed ingredient composition of the experimental diet (%)

Composition	T1 (0%)	T2 (20%)	T3 (30%)	T4 (40%)
Sweet orange peel	-	7.24	10.86	14.48
Full fat soyabean	24.00	24.00	24.00	24.00
Rice offal	20.00	20.00	20.00	20.00
Brewer's dried grain	16.00	16.00	16.00	16.00
Bone meal	3.00	3.00	3.00	3.00
Premix	0.25	0.25	0.25	0.25
Common salt	0.30	0.30	0.30	0.30
Methionine	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated nutrient				
Crude protein	18.02	18.14	18.21	18.27
Crude fibre	11.55	11.92	12.10	12.29
Metabolizable energy (kcal kg^{-1})	2708.85	2732.70	2759.78	2779.60

To provide the following: Vit. A 10,000 IU; Vit. D3-2000 IU; Vit. B1-0.75 mg; Nicotinic acid 25 mg; Calcium panthenate-12.50 mg; Vit. B12-2.5 mg; Vit. K3-2.5 mg; Cobalt-0.40 mg; Biotin 0.50 mg; Folic acid 1.00; Cholin chloride 25 mg; Coper 8.00 mg; Manganese 64 mg; Iron 32 mg; Zinc 4 mg; Iodine 0.8 mg; Flavomycin 100 mg; Spiromycin 5 mg; DL Methionine 5 mg; Selenium 0.16 mg; L-Lysine 120 mg

Table 3: Effect of dietary replacement of maize with sweet orange peel meal on rabbit performance

Performance	T1 (0%)	T2 (20%)	T3 (30%)	T4 (40%)	SEM
Initial live weight (g)	760.00	760.00	770.00	780.00	36.04
Final live weight (g)	1480.00	1250.00	1410.00	1380.00	40.54
Feed intake (g day^{-1})	65.81	61.96	67.19	63.86	2.55
Daily water intake (mL day^{-1})	269.07	325.43	341.48	279.06	10.36
Feed conversion ratio	5.30	4.12	7.38	4.84	0.90
Water/Feed ratio	4.27	5.30	5.20	4.38	0.20
Mortality	0.00	0.00	0.00	0.00	0.00
Body weight gain (g day^{-1})	16.35	14.05	14.49	13.06	2.15

Table 4: Effect of dietary replacement of maize with sweet orange peel meal on carcass yield and visceral organ weight of rabbits (% live weight)

Effects	T1 (0%)	T2 (20%)	T3 (30%)	T4 (40%)	SEM
Dressed carcass weight (g)					
Dressed percentage	62.73	62.84	65.38	66.20	2.66^{NS}
Forequarter	18.76	17.55	17.94	18.59	1.55^{NS}
Hindquarter	18.87	20.77	19.39	20.66	1.36^{NS}
Loin	11.52	12.79	11.92	12.94	1.87^{NS}
Sides	5.43	5.86	6.59	5.97	0.74^{NS}
Visceral organs					
Liver	2.49	2.76	2.51	2.48	0.37^{NS}
Kidney	0.57	0.60	0.58	0.56	0.09^{NS}
Stomach	4.17	3.38	3.48	3.63	0.56^{NS}
Heart	0.24	0.32	0.29	0.26	0.07^{NS}
Testes	0.36	0.52	0.42	0.43	0.14^{NS}
Lungs	0.73	0.80	0.89	0.87	0.19^{NS}
Spleen	0.04^{ab}	0.05^{a}	0.03^{b}	0.02^{b}	0.01*
Gall bladder	0.07	0.04	0.08	0.05	0.03^{NS}
Intestinal tract	9.96	9.97	12.36	10.32	1.60^{NS}
Visceral fat	1.34	2.00	1.06	1.02	0.83^{NS}

The mean feed intake was practically the same as only marginal difference was observed among the treatments groups. The effect of dietary treatments on feed intake was not significant ($p>0.05$) among the treatments groups. The average weight gain of the rabbits ranged from 13.06-16.35 g. The control diet gave the highest weight gain of 16.35 g which was not significant ($p>0.05$) different from those on test diets (Table 3). Also the feed conversion ratio follows the same trend has not been significantly ($p>0.05$) different among the treatment group. The mean daily water intake increased progressively from 269.07-341.48 mL in T3 but dropped to 279.06 mL in T4. The pattern of water intake appears to show an increase as the dietary substitution of maize with sweet orange peel meal increase from 0-30%. Dietary group T2 and T3 had similar water: feed ratio of 5.30 and 5.20, respectively which was higher ($p<0.05$) significantly than the water: feed ratios of 4.27 and 4.38, respectively. The rabbit on diet T1 recorded the highest average final weight of 1480 g while rabbits on diet T2 had the lowest average final weight of 1250 g but however this was not significantly ($p>0.05$) different among treatments group (Table 4). The values for haematological parameters were as shown in Table 5. The packed cell volume

Table 5: Effect of dietary replacement of maize with sweet orange peel meal on haematological parameters of rabbit

Parameters	T1 (0%)	T2 (20%)	T3 (30%)	T4 (40%)	SEM
Packed cell count (%)	30.50	27.40	32.80	31.40	1.66
Erythrocyte count ($\times 10^6$)	3.95	3.36	3.08	3.52	0.09
Leucocyte count ($\times 10^3$)	2.20	2.60	3.16	2.88	0.21
Neutrophils ($\times 10^3$)	22.75	24.80	27.20	22.00	1.72
Eosinophils ($\times 10^3$)	1.75	2.00	2.00	2.50	0.22
Basophils ($\times 10^3$)	3.50	2.20	2.40	2.50	0.19
Lymphocyte ($\times 10^3$)	65.50	66.40	65.00	67.25	1.60
Monocyte ($\times 10^3$)	4.75	4.40	3.00	5.00	0.39

Table 6: Effect of dietary replacement of maize with sweet orange peel meal on serum chemistry of rabbit

Parameters	T1 (0%)	T2 (20%)	T3 (30%)	T4 (40%)	SEM
Total protein (g dL^{-1})	9.50	7.80	9.00	9.00	0.35
Albumin (g dL^{-1})	3.05	3.03	3.00	3.20	0.98
Globulin (g dL^{-1})	6.45	5.63	6.00	5.30	0.28
Aspartatetransaminase	18.50	17.93	21.90	17.80	0.25
Alanine transaminase	8.50	23.50	11.50	12.50	0.27

value ranged from 27.40% in T1 to 32.80% in T3 while the red cell blood count was highest in T1 with a value of 3.95×10^6-3.08×10^6 μL^{-1} however, these values and other haematological parameters determined were not significantly ($p>0.05$) different. The total protein in the serum of the experimental rabbits ranged from 7.8-9.8 g dL^{-1} and was affected significantly ($p<0.05$) by the experimental diets. The biochemical enzyme determined was aspartate transaminase and alanine transaminase was not significant ($p<0.05$) among the treatments group (Table 6).

DISCUSSION

The crude protein content of the experimental diets range of 19.21-21.85 is within the required level for post weaning rabbit (Cheeke, 1986). The crude fibre content of the experimental diets is within the range of 10-20% recommended by Anugwa *et al.* (1998) and Aduku and Olukosi (1990). Also the metabolizable energy of the diets used in this study is within the value recommended by Aduku (1992). The average daily weight gain obtained in this study is in agreement with the range of 10-20 g growth rate in the tropics for weaner rabbits as reported by Owen (1976) and also agrees with the study conducted by Adenkola *et al.* (2009) in the same environment with a record of average weight gain of 13.35-15.42 g. The average daily feed intake in this study (61.97-67.19 g) was similar to that of Adenkola *et al.* (2009) who reported an average daily feed intake of 67.69-69.75 g however, the feed intake in this study was higher than that obtained by Oluremi *et al.* (2005) who obtained 48.83-52.13 g day^{-1} with Sweet Orange Rind (SOR) in the diets of growing

rabbit at 0-15% replacement of maize. The feed conversion ratio among the treatment groups was not significantly different indicating that reduction of the amount of maize by its replacement with dried sweet orange peel meal up to 40% has no negative effect on feed conversion. Earlier study conducted by Oluremi *et al.* (2005) in which maize was replaced with sweet orange rind up to 15% in broiler diet had feed efficiency conversion ratio of 4.22-4.73 which was <4.12-7.38 obtained in rabbit in this study when maize was replaced with sweet orange rind at the rate of 20-40%.

As the quantity of maize replaced SOPM increased from 20-30%, daily water consumption increases most probably as a response to the diets which agrees with the results obtained by Oluremi *et al.* (2005) where water intake increased when maize was replaced from 5-15%. The water: feed ratio followed the same trend. It has been reported that rabbit can consume drinking water between 5-10 times more than their corresponding feed intake Oluremi *et al.* (2005). However, the average water consumption is higher than that obtained by Oluremi *et al.* (2005) most likely because of higher inclusion rate of SOPM in the diets of rabbit in this study. The fact that no significant difference existed in the haematological parameters values agrees with the findings of Tuleun *et al.* (2007), Adenkola *et al.* (2009) and Adenkola *et al.* (2010). These values give an indication that the experimental diets are in no way inferior to other conventional feeds of rabbits. Good adequate nutrition has been recognized an important factor that enhances erythropoiesis. The percentage haemolysis recorded was highest in the T4 group; this could be as result of higher inclusion rate of sweet orange peel in this diet and the fact that sweet orange peel contain phytonutrients like oxalate, flavonoid, saponin, tannin and phytate (Oluremi *et al.*, 2010) which possibly affect the erythrocyte membrane stability thereby rendering them more fragile and easily susceptible to haemolysis as the membrane of erythrocyte is rich in polyunsaturated fatty acids which is susceptible to lipid peroxidation which result in the loss of membrane fluidity and cellular lysis (Brzezinska-Slebodzinska, 2003) hence higher value of percentage haemolysis in animals on diet T4 (Fig. 1).

However, the effect of phytonutrients on erythrocyte membrane stability is needs more investigation. The total protein level in this study was higher than the value reported by Talis *et al.* (2005) for rabbits while the albumin level was within the normal range (Talis *et al.*, 2005). Thus, the replacement of maize with SOPM in the diet did not adversely affect nutrient quality of the experimental diet. The transaminse enzymes were not significantly

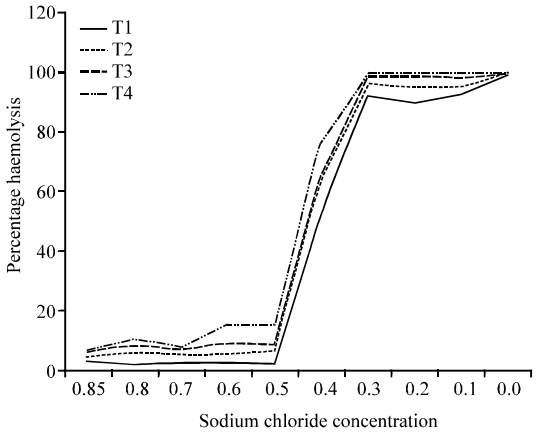

Fig. 1: Effect of dietary replacement of maize with sweet orange peel meal on erythrocyte membrane stability of rabbit

different among the groups an indication that the replacement is not in any way posing any health challenge to the rabbits.

CONCLUSION

In this study SOPM has no effect on body weight gain, final live weight and haematological parameters because the mean values were not different from values for the same indices for rabbit on the control diet, an indication of nutritional adequacy and safety of the experimental diets. It is thus recommended that sweet orange fruit peel can be used to replace maize up to 40% level in rabbit diet without producing any adverse effects on performance and health of rabbit. Its optimal replacement level can only be determined by evaluating its effects at higher levels of maize replacement in subsequent studies.

REFERENCES

Abubakar, M., M.B. Gummi, B.S., Malami, Y.A. Bashar and B.R. Olorede, 2009. Supplemental vale of Avizyme in diets of rabbits containing graded levels of wheat offal. J. Anim. Produc. Res. Adv., 5: 94-97.

Adenkola, A.Y. and J.O. Ayo, 2009. Effect of road transportation on erythrocyte osmotic fragility of pigs administered ascorbic acid during the harmattan season in Zaria, Nigeria. J. Cell Anim. Biol., 3: 4-8.

Adenkola, A.Y., F.G. Kaankuka, T.T. Ikyume, I.F. Ichaver and I.D.I. Yaakugh, 2010. Ascorbic acid effect on erythrocyte osmotic fragility, haematological parameters and performance of weaned rabbits at the end of rainy season in Makurdi, Nigeria. J. Anim. Plant Sci., 9: 1077-1085.

Adenkola, A.Y., J.A. Ayoade, D.R. Babadusi and S.G. Igorche, 2009. Growth performance, carcass and haematological characteristics of rabbits fed graded level of tiger nuts (*Cyperus esculentus*). Anim. Prod. Res. Adv., 5: 128-133.

Adenkola, A.Y., O.I.A. Oluremi and P.M. Mou, 2007. Effect of fermentation of sweet orange (*Citrus sinensis*) fruit peel on its maize replacement value in broiler diet. J. Anim. Vet. Adv., 6: 1017-1021.

Aduku, A.O. and J.O. Olukosi, 1990. Rabbit Management for the Tropics: Production, Processing, Utilization, Marketing Economics, Practical Training, Research and Future Prospect. Living Books Series, Abuja.

Aduku, A.O., 1992. Tropical Feedstuff Analysis Table. Ahmadu Bello University, Zaria, Nigeria.

Agu, P.N., 2006. Nutritional evaluation of sweet orange (*Citrus sinensis*) peel as a feed resource for Broiler chickens. M.Sc. Thesis Department of Animal Production, University of Agriculture, Makurdi, Nigeria.

Akinmutimi, A.H. and C.C. Onwukwe, 2002. Effects of cooking with various concentrations of potash on nutrients composition of potash. J. Agric. Biotech. Environ., 1: 1-3.

Akinmutimi, A.H., S.F. Abasiekong and C.O. Osuagwu, 2007. Growth performance of weaner rabbits fed sweet potato peels in place of maize base diet. Proceedings of the 32nd Annual Conference of Nigerian Society of Animal Production, March 18-21, University of Calabar, Calabar, Nigeria, pp: 345-346.

Akinola, L.A., 2009. Economics of rabbit production in Gokana Local Government area of Rivers State, Nigeria. Proceedings of the 34th Annual Conference of Nigerian Society of Animal Production, March 15-18, University of Uyo, Cross River State, Nigeria, pp: 70-72.

Amao, A.O., D.O. Adejumo and V.A. Togun, 2011. Effect of cottonseed cake based diets with or without vitamin E supplementation on gonadal and extra-gonadal sperm characteristics of rabbits bucks. Proceedings of the 36th Annual Conference of Nigerian Society of Animal Production (NSAP'11), Abuja, pp: 261-266.

Anugwa, F.O.I., M. Adsesua and S.A. Ikurior, 1998. Effects of dietary crude fiber levels on performance, nutrient digestibility and carcass characteristics of weanling-growing rabbits. Proceedings of the 25th Silver Conference of the Nigerian Society of Animal Production (NSAP'98), West African Society of Animal Production, Abeokuta, Nigeria.

Brzezinska-Slebodzinska, E., 2003. Species differences in the susceptibllity of erythrocytes exposed to free radicals *in vivo*. Vet. Res. Comm., 27: 211-217.

Cheeke, P.R., 1986. Potential of rabbit production in tropical and subtropical agricultural systems. J. Anim. Sci., 63: 1581-1586.

Fielding, D., 1981. Rabbits: The Tropical Agriculturalist. Macmillan Press, London, pp: 61-69.

Njoku, O.O., 1985. Why animal health and diseases investigation in Nigeria. Proceedings of the 10th Annual Conference of the Nigerian Society of Animal Production, March 24-28, 1985, Ile-Ife, Nigeria, pp: 26-27.

Nworgu, F.C., E.A. Adebowale, O.A. Odredin and A. Oni, 1999. Prospects and economic of broiler production using two plant protein sources. Trop. J. Anim. Sci., 2: 159-166.

Oluremi, O.I.A., F.N. Okafor, A.Y. Adenkola and K.T. Orayaga, 2010. Effects of fermentation of sweet orange (*Citrus sinensis*) fruit peel on its phytonutrients and the performance of broiler starter. Int. J. Poult. Sci., 9: 546-549.

Oluremi, O.I.A., J.I.A. Andrew and Ngi, 2007. Evaluation of the nutritive potential of the peels of some citrus fruit varieties as feeding stuffs in livestock production. Pak. J. Nutr., 6: 653-656.

Oluremi, O.I.A., V.O. Ojighen and E.H. Ejembi, 2005. Response of growing rabbits to dietary replacement of maize with sweet orange (*Citrus cinensis*) rind. PAT., 1: 130-136.

Owen, J.E., 1976. Rabbit production in the tropical countries. Trop. Sci., 18: 203-210.

Schalm, O.W., N.C. Jain and E.J. Caroll, 1975. Textbook of Veterinary Haematology. 2nd Edn., Lea and Febiger, Philadelphia, pp: 129-250.

Taiwo, A.A., A.D. Adejuyigbe, E.A. Adebowale, J.S. Oshotan and O.O. David, 2005. Performance and nutrient digestibility of weaned rabbits fed forages supplemented with concentrate. Nig. J. Anim. Prod., 32: 74-78.

Talis, D., O.S. Luiz, C.K.L. Jose, B. Auren and S. Cleverson, 2005. Reference values for Chinchillaq (Chinchilla laniger) blood cells and serum biochemical parameters. Cienc. Rural, 35: 1-8.

Tuleun, C.D., A.Y. Adenkola and O.I.A. Oluremi, 2007. Performance characteristics and haematological variables of broiler feed diet containing mucuna (*Mucuna utilis*) seed meal. Trop. Vet., 25: 74-81.

Whittermore, T.C., 1994. Alternative feedstuff for pigs what are they really worth?. Feed Mix, 2: 16-18.