ALTERNATIVE SOURCE OF CALCIUM AND PHOSPHORUS (EGGSHELL MEAL) FOR RABBIT (*ORYCTOLAGUS CUNNICULUS*) DIETS

E. N. Dalikeh[1], S. E. Alu[1*] and U. D. Matthew[2]

[1]Department of Animal Science, Nasarawa State University, Keffi
Shabu– Lafia Campus, PMB 135, Lafia, Nigeria
[2]Deppartment of Agricultural Education, College of Education,
PMB 05, Akwanga, Nigeria
*****Corresponding author: seafarms2000@yahoo.com

Received: April 10, 2012; **Accepted:** July 28, 2012

Abstract

The study aimed at investigating the effect of replacing bone ash with egg shell meal (ESM) in the diets of rabbits on growth rate, blood parameters and carcass characteristics in a 12 week experiment. Fifteen crossbred Chinchilla X Californian rabbits of about 2 weeks old with an average weight of 450.53 g were randomly allocated to 5 experimental diets; the ESM replaced bone ash at 0, 25, 50, 75 and 100 % for treatments T_1, T_2, T_3 T_4, and T_5, respectively for both weaner and grower phases. The diets were formulated to be isocaloric (2787.69 and 2692.65 kcal/kg metabolizable energy) and isonitrogenous (22 and 18 % crude protein) for weaner and grower rabbits, respectively. The performance records for weaner phase (0 –35 days) and grower phase (35 – 70 days) did not vary significantly (P > 0.05) except for daily gain (10.86 vs. 6.86 vs. 9.71 vs. 9.14 and 6.29 g/rabbit/d) and (5.71 vs. 9.14 vs. 10.00 vs. 8.29 and 7.14 g/rabbit/d) for weaner and grower rabbits, respectively which were significantly (P < 0.05) affected. The feed cost per weight gain were not influenced (P > 0.05) by the inclusion of ESM in the weaner and grower diets however, the values reduced numerically as the level of ESM increased in the diets. Similarly, the results of the blood parameters and carcasses evaluated and expressed as a percentage of live weight showed no significant (P > 0.05) difference. Average feed cost per weight gain for weaner (82.26 vs. 81.64 vs. 81.01 vs. 80.39 and 81.26 N/kg) and grower (73.66 vs. 72.86 vs. 72.06 vs. 71.26 and 72.66 N/kg) was not affected by the inclusion of ESM in the diets. There was no mortality recorded throughout the period of the experiment. It is therefore, concluded since there was no deleterious and adverse effect of including eggshell meal in the diets, rabbit farmers can use ESM as major source of dietary calcium and phosphorus for rabbits feeding.

Keywords: Eggshell meal, rabbits, growth performance, carcass quality, blood parameters

INTRODUCTION

The stiff competition between local animal farmers (small scale commercial animal farmers) and large scale commercial feed producers for mineral sources has necessitated the need to research for alternative sources of inorganic matter sources, which represent the third most expensive nutrient after energy and protein (McDonald *et al.,* 1995). Although several researches have been carried out in sourcing for unconventional agro–industrial by–products that may replace or supplement the conventional ones, very little has been documented on eggshell meal in animal nutrition. According to Aduku & Olukosi (1990), Nigeria produces about 55.9 million eggs annually; this implies that over 250 metric tonnes of the shells are produced as by–product. The mineral analysis shows that eggshell meal (ESM) contains over 94 % calcium in the form of $CaCO_3$ and $Ca_3(PO_4)_2$. Other minerals ($MgCO_3$) and organic matter was about 5 %. This mineral composition suggests that eggshell could be an excellent source of calcium for poultry nutrition. It is therefore, possible that optimum dietary calcium and phosphorus requirements for rabbits can be met using eggshell meal as a source.

Limestone and di–calcium phosphate have been found to be other major sources of calcium for livestock all over the world but are extremely expensive due to importation cost. The aim of this research therefore, is to evaluate the effect of replacing bone ash with eggshell meal on the growth rate, blood parameters and meat yield of rabbits.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Research and Teaching Farm of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu–Lafia Campus. It is located in the Guinea Savanna zone of North Central Nigeria and found on latitude 08^o 35'N and longitude 08^o 33'E (NIMET, 2008).

Eggshell Meal

The test ingredient (eggshell) was sourced locally within Lafia metropolis, washed and sun–dried and crushed into powder to form the eggshell meal (ESM). The ESM was then used to compound the weaner and grower experimental diets.

Experimental Diets and Management of Rabbits

Five isonitrogenous (22 % crude protein) and isocaloric (2787.69 kcal/kg metabolizable energy) diets tagged T_1, T_2, T_3, T_4 and T_5 for weaner rabbits were compounded. The ESM replaced bone ash at 0, 25, 50, 75 and 100 % for T_1, T_2, T_3, T_4 and T_5, respectively. Five grower experimental diets were also compounded to be isonitrogenous (20 % crude protein) and isocaloric (2865 kcal/kg metabolizable energy) with the same replacement levels as in the weaner diets. All other nutrients were included at the recommended levels to meet the requirement of the animals as prescribed by Aduku (2004). The percent and calculated chemical composition of the experimental diets for weaner and grower rabbits are presented in Tables 1 and 2, respectively. Fifteen crossbred Chinchilla X Californian rabbits of about 2 weeks old with an average weight of 450.53 g were randomly allocated to 5 experimental diets and were individually housed in cages measuring 64 cm x 62 cm x 48 cm. The rabbits were fed twice daily (8.00 am and 4.00 pm) for 6 weeks for each phase after an initial adjustment period of 2 weeks from the weaner phase; performance rerecords such as feed intake, initial weight, and final weight were recorded and used to calculate feed conversion ratio, protein efficiency ratio, feed cost/kg and weight gain.

Blood Collection

At the end of the feeding trial of the growing phase, 3 rabbits per treatment of equal live weight (1547.55±45.82 g/rabbit) were selected for the evaluation of the haematological indices and serum biochemical variables. The rabbits used were fasted for 12 h over night and bled in the morning between 0700–0800 h. Fasting was done to avoid temporary evaluation of many metabolites by feeding (Bush, 1975). Blood samples were collected from veins of the ear by using 5ml sterile disposable needles. The collection sites were sterilized with 70 % alcohol and zylene to dilate the veins. Blood samples for haematology were separately collected into sample bottles containing 1mg of dipotassium salts of ethylene diamine tetraacetic acid (EDTA–K^2) to 1 ml of blood. The haematological indices determined were Packed Cell Volume (PCV), Red Blood Cell count (RBC), White Blood Cell count (WBC) and Haemoglobin Concentration. PCV was determined by using wintrobes micro haematocrit method (Margi, 1997), haemoglobin concentration was determined by the Cyanometha–emoglobin method according to Kelly (1979). The improved Neubar haemocytometer method described by Jain (1986) was used to estimate the red and white blood cells. Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were computed according to Jain (1986). Blood samples were collected in another separate sample bottles without anti–coagulant to allow for clotting for serum biochemical analysis. Serum protein, globulin, urea and triglyceride were analyzed using sigma kits while glucose was analyzed according to Schalm *et al.* (1975).

Carcass Yield

They were then slaughtered by severing the carotid arteries and jugular veins and blood drained under gravity; the carcasses were then divided into the following parts as described by Aduku & Olukosi (1990). The relative fasted body weight (% of final live body weight) was obtained. The weight of the dressed weight which was later expressed as percentage of the final live body weight (also called dressing percentage) was calculated as outlined (Mohammed *et al.*, 2008; Grosso *et al.*, 2009) using the formula:

Dressing percentage =

$$\frac{dressed\ weight}{final\ live\ body\ weight\ of\ rabbit}\ x\,100$$

Statistical Analysis

Data obtained were subjected to One Way Analysis of Variance (ANOVA) and where significant effect (P < 0.05) were observed, means were separated using Duncan Range Multiple Test as outlined by Steel & Torrie (1960). The following statistical model was used:

$Y_{ij} = U+T_1+€_{ij}$

Where Y_{ij} = Individual observation

U = Population Mean

T_1 = Treatment Error

$€_{ij}$ = Random error

RESULTS AND DISCUSSION

The percent and energy composition of the experimental diets for weaner and grower rabbits are presented in Tables 1 & 2. The crude protein and energy values were isonitrogenous (22 and 18 % crude protein) and isocaloric (2787.69 and 2692.65 kcal/kg metabolizable energy) for weaner and grower diets respectively. The values for ether extract, crude fibre, ash, NFE, calcium (1.03–2.38 and 1.51–2.42 %) and phosphorus (0.67–1.03 % and 0.76–1.07 %) were within the normal ranges for these classes of rabbits as recommended by NRC (1979). There was no variation (P > 0.05) in the growth rate parameters (Table 3) except for weight gain (10.86 vs. 6.86 vs. 9.71 vs. 9.14 and 6.29 g/rabbit/d and 5.71 vs. 9.14 vs. 10.00 vs. 8.29 and 7.14 g/rabbit/d) for weaner and grower rabbits respectively which were parabolic (P < 0.05) and were close to 9.90–11.50 g/rabbit/d (Ijaiya & Davis, 2005) and 7.10–14.60 g/rabbit/d (Oyawoye & Nelson, 1998). The results of this present study is consistent with the earlier findings (Alu, 2010) where ESM replaced bone ash in the diets of broiler chickens and did not influence growth rate of both starter and finisher broiler birds. Similarly, rock phosphate was used to replace bone ash in the diets of chickens and was observed to have no significant variation on the growth performance indices (Emmanuel, 2008). The cost of feed per kilogram diet was in the range of 54.08–58.45 N/kg for weaner diet and 43.28–48.15 N/kg for grower diets, the feed cost per weight gain were not influenced (P > 0.05) by the inclusion of ESM in the weaner and grower diets however, the values reduced numerically as the level of ESM increased in the diets. The zero % mortality recorded throughout the period of the experiment could be attributed to safety of the diets since the eggshell was properly washed and sun–dried and devoid of debris that could harbor pathogenic organisms.

Table 1: Percent and chemical composition of experimental diets for weaner rabbits (%)

Ingredients	D T_1 0 %	I T_2 25 %	E T_3 50 %	T T_4 75 %	S T_5 100 %
Maize	37.00	37.00	37.00	37.00	37.00
Rice offal	25.00	25.00	25.00	25.00	25.00
Groundnut cake	16.0	16.0	16.0	16.0	16.0
Full–fat soybean	16.0	16.0	16.0	16.0	16.0
Blood meal	2.50	2.50	2.50	2.50	2.50
Palm oil	0.50	0.50	0.50	0.50	0.50
Eggshell meal	–	0.625	1.25	1.875	2.50
Bone meal	2.50	1.875	1.25	0.625	–
Premix	0.26	0.26	0.26	0.26	0.26
Salt	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrients and energy composition					
*Energy (kcal/kg ME)	2787.69	2787.69	2787.69	2787.69	2787.69
Crude protein (%)	22.0	22.0	22.0	22.0	22.0
Crude fibre (%)	5.45	5.45	5.45	5.45	5.45
Calcium (%)	1.03	2.04	1.71	1.37	2.38
Phosphorus (%)	0.90	0.86	0.97	1.07	0.76

***Calculated** from Pauzenga (1985)

The premix (vitamin–mineral) supplied the following per 100 kg of diet: Vitamin A 15,00 I.U, Vitamin D_3 300,00 I.U, Vitamin E 3,000 I.U, Vitamin K 2.50 mg, Thiamine (B_1) 200 mg, Riboflavin (B_2) 600 mg, Pyridoxine (B_6) 600 mg, Niacin 40.0 mg, Vitamin (B_{12}) 2 mg, Pantothenic acid 10.0 mg, Folic acid 100 mg, Biotin 8 mg, Choline chlorine 50 g, Anti–oxidant 12.5 g, Manganese 96 g, Zinc 6 g, Iron 24 g, Copper 0.6 g, Iodine 0.14 g, Selenium 24 mg and Cobalt 214 mg.

Table 2: Percent and chemical composition of experimental diets for grower rabbits (%)

Ingredients	T_1 0 %	T_2 25 %	T_3 50 %	T_4 75 %	T_5 100 %
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Fulfat soybean	11.90	11.90	11.90	11.90	11.90
Groundnut cake	11.00	11.00	11.00	11.00	11.00
Eggshell meal	0.00	0.80	1.60	2.40	3.40
Maize	22.30	22.30	22.30	22.30	22.30
Blood meal	1.00	1.00	1.00	1.00	1.00
Bone meal	3.20	3.20	3.20	3.20	3.20
Palm oil	4.60	4.60	4.60	4.60	4.60
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated chemical and energy composition					
*Energy (Kcal/Kg ME)	2692.65	2692.65	2692.65	2692.65	2692.65
Crude protein	18.08	18.08	18.08	18.08	18.08
Crude fibre	7.03	7.03	7.03	7.03	7.03
Ash	5.99	5.99	5.99	5.99	5.99
Calcium	1.51	1.84	1.96	2.10	2.42
Phosphorus	1.03	1.01	0.93	0.89	0.67

***Calculated** from Pauzenga (1985)

The premix (vitamin–mineral) supplied the following per 100 kg of diet: Vitamin A 15,00 I.U, Vitamin D_3

300,00 I.U, Vitamin E 3,000 I.U, Vitamin K 2.50 mg, Thiamine (B_1) 200 mg, Riboflavin (B_2) 600 mg, Pyridoxine (B_6) 600 mg, Niacin 40.0 mg, Vitamin (B_{12}) 2 mg, Pantothenic acid 10.0 mg, Folic acid 100 mg, Biotin 8mg, Choline chlorine 50 g, Anti–oxidant 12.5 g, Manganese 96 g, Zinc 6 g, Iron 24 g, Copper 0.6 g , Iodine 0.14 g, Selenium 24 mg and Cobalt 214 mg.

The result obtained on the effect of replacing bone ash with eggshell on the haematological parameters and serum biochemical variables of growing rabbits is presented in Table 4. All the haematological parameters analyzed which included the packed cell volume (45.50 vs. 48.50 vs. 40.00 vs.52.00 and 41.00 %), white blood cells (7.80 vs. 12.00 vs.9.60 vs.10.80 and 10.60 x10^3 µl), red blood cells (6.75 vs. 7.35 vs. 6.10 vs.7.80 and 6.55 x 10^6 µl), mean corpuscular volume (67.90 vs. 66.20 vs. 66.10 vs. 65.30 and 62.20 fl), haemoglobin (14.20 vs. 15.00 vs. 12.00 vs. 16.00 and 13.00 g/dl), mean corpuscular haemoglobin (21.00 vs. 20.50 vs. 21.20 vs. 20.40 and 19.90 pg), platelets (416.00 vs. 331.50 vs. 417.00 vs. 423.50 and 331.50 x 10^9 l) and mean corpuscular haemoglobin concentration (31.00 vs. 31.00 vs. 32.10 vs. 31.20 and 31.80 g/dl) for treatments T_1 to T_5, respectively were not affected ($P > 0.05$) by the treatment groups. The values recorded in this present study were within the normal range of 26.70–47.20 %, 11.60–14.50 g/dl, 3.70–7.50 x 10^6 mm^3 and 5.20–16.50 x 10^3 mm^3 for PCV, Hb, RBC and WBC, respectively as earlier reported elsewhere (Aduku & Olukosi, 1990). Similarly, the serum constituents analyzed for treatments T_1 to T_5, namely uric acid (121.50 vs. 122.50 vs. 121.50 vs. 118.00 and 100.00 mmol/l), glucose (4.80 vs. 4.70 vs. 5.10 vs. 5.60 and 4.40 mmol/l), triglyceraldehyde (2.95 vs. 1.80 vs. 1.50 vs. 2.10 and 3.30 g/l), protein (60.30 vs. 60.50 vs. 56.80 vs. 59.60 and 59.70 g/l), creatinine (39.00 vs. 39.80 vs. 39.70 vs. 41.00 and 42.00 mmol/l) and cholesterol (5.00 vs. 4.10 vs. 4.30 vs. 5.40 and 5.00 mmol/l) were not affected ($P > 0.05$) by the inclusion of eggshell meal in the diets. This observation is an indication of the safety and adequacy of the test ingredient (Alu *et al.,* 2009), because reduction or abnormal values of haematological parameters and serum biochemistry may indicate a low protein intake, liver damage, anaemia, or parasitological infestation (Linsday, 1977; Mmereole, 1996) and may be used to determine the extent of damage to blood cells by foreign bodies (Onyeyili *et al.,* 1991). The total protein values reported were within the range of 39.45–55.53 g/l reported by Ochefu (2006) indicating that the rabbits were not under thermal stress. Kaneko *et al.* (1997) reported that thermal stress could cause an increase in adrenal activity resulting in increased turnover which could lead to decrease in total serum protein.

Table 3: Effect of replacing bone ash with eggshell meal on growth performance parameters of weaner and grower rabbits

Parameters	D T_1	I T_2	E T_3	T T_4	S T_5	SEM	LOS
Weaner phase							
Av. ILW (g/rabbit)	650	630	730	750	850	64.08	NS
Av. FLW (g/rabbit)	1030	870	1070	1070	1070	70.19	NS
Av. WG(g/rabbit/d)	10.86^a	6.86^c	9.71^{ab}	9.14^b	6.29^c	1.26	*
Av. FI (g/rabbit/d)	42.19	43.87	44.60	40.22	41.10	3.05	NS
Av.FCR	4.15	3.41	3.03	4.10	3.90	0.07	NS
Av. PER	1.05	1.35	1.57	1.21	1.31	0.20	NS
Av. FC (N/kg)	58.45	57.85	56.90	55.62	54.08	–	–
Av. FC/WG (N/kg)	82.26	81.64	81.01	80.39	81.26	14.16	NS
Mortality (%)	0	0	0	0	0	–	–
Grower phase							
Av. FLW (g/rabbit)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Av. WG(g/rabbit/d)	5.71^c	9.14^a	10.00^a	8.29^{ab}	7.14^b	1.06	*
Av. FI (g/rabbit/d)	53.98	52.70	51.66	52.69	52.60	3.35	NS
Av.FCR	1.23	1.87	1.69	1.86	1.79	0.61	NS
Av. PER	2.20	3.20	3.50	2.90	2.80	0.36	NS
Av. FC (N/kg)	48.15	47.22	46.110	45.20	43.28	–	–
Av. FC/WG (N/kg)	73.66	72.86	72.06	71.26	72.66	9.56	NS
Mortality (%)	0	0	0	0	0	–	–

ILW, Initial live weight, **FLW**–Final live weight, **WG**– Weight gain, **FI**– Feed intake, **FCR**–Feed conversion ratio, **PER**–Protein efficiency ratio, **FC**–Feed cost, **LOS**–Level of significance, **NS**–Not Significantly different

(P > 0.05), a,b,c– means on the same row bearing different superscript differ significantly (P < 0.05), *–Significant at 5 %

Table 4: Effect of replacing bone ash with eggshell meal on blood parameters of grower rabbits

Parameters	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM	LOS
Haematology							
PCV (%)	45.50	48.50	40.00	52.00	41.00	3.92	NS
Hb (g/dl)	14.20	15.00	12.00	16.00	13.00	1.14	NS
RBC (x10^6 µl)	6.75	7.35	6.10	7.80	6.55	0.45	NS
WBC (x10^3µl)	7.80	12.00	9.60	10.80	10.60	2.93	NS
Platelets (x 10^9l)	416.00	331.50	417.00	423.50	331.50	136.59	NS
MCH (pg)	21.00	20.50	21.20	20.40	19.90	0.77	NS
MCHC (g/dl)	31.00	31.00	32.10	31.20	31.80	0.63	NS
MCV (fl)	67.90	66.20	66.10	65.30	62.20	1.76	NS
Serum Variables							
Uric acid (mmol/l)	121.50	122.50	121.50	118.00	100.00	20.73	NS
Glucose (mmol/l)	4.80	4.70	5.10	5.60	4.40	0.77	NS
Triglyceraldehyde (g/dl)	2.95	1.80	1.50	2.10	3.30	0.83	NS
Total Protein (g/l)	60.30	60.50	56.80	59.60	59.70	4.31	NS
Creatinine (mmol/l)	39.00	39.80	39.70	41.00	42.00	1.81	NS
Cholesterol (mmol/l)	5.00	4.10	4.30	5.40	5.00	0.63	NS

NS–No significant difference (p > 0.05), SEM–Standard error of means, LOS—Level of significance, PCV–Packed cell volume, RBC–Red blood cell count, WBC– white blood cell count, MCV–Mean corpuscular volume, MCH–Mean corpuscular haemoglobin, MCHC–Mean corpuscular haemoglobin concentration

Table 5: Effect of replacing bone ash with eggshell meal on meat yield of growing rabbits

Parameters	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)	SEM	LOS
LW (g/rabbit)	1457.45	1475.78	1525.32	1500.09	1449.67	338.76	NS
DW (g/rabbit)	1025.25	1100.73	1175.98	1075.47	1055.56	247.92	NS
Dressing %	70.34^b	74.58^b	77.09^a	71.69^b	72.81^b	13.98	*

NS–No significant difference (p > 0.05), a,b,– means on the same row bearing different superscript differ significantly (p < 0.05), SEM–Standard error of means, LOS—Level of significance, *–Significant at 5 %, LW–Live weight, DW– Dressed weight

The dressing percentage (Table 5) showed significant variation ($P < 0.05$) among the dietary treatments. Rabbit fed the 50 % eggshell meal had the best meat yield of 77.09 %, other treatment groups performed uniformly. The non–significant values ($P > 0.05$) for fasted and dressed weights ranged from 1449.67–1525.32 g/rabbit and 1025–1175.98 g/rabbit, respectively while the 70.34 – 77.09 % of the dressing percentages was within the normal range for rabbits in Nigeria (Aduku *et al.,* 1986). This observation is consistent with the earlier assertion (Church & Pond, 1988) that macro–minerals are a major requirement for nutrient absorption especially in the alimentary canal; the absorbed nutrients are deposited in the body as tissues which in turn result in the weight gain.

CONCLUSION

The findings on the effect of replacing bone ash with eggshell meal on the haematological parameters, serum biochemical characteristics and growth rate of rabbits indicated the safety of the test ingredient (eggshell) in the diets and can therefore, be used to completely (100 %) replace bone ash without producing negative health status or reduce growth performance of rabbits. Again, although the inclusion of ESM in the diets did not reduce cost of feed the present study has suggested an alternative source of calcium and phosphorus which would reduce the stiff competition for conventional macro–mineral sources among commercial feed compounders and backyard rabbit farmers.

REFERENCE

Aduku, A. O., Okoh, P. N., Njoku, P. C., Aganga, A. A. & Dim, N. I. (1986). Evaluation of cowpea (*Vigna unguiculata)* and peanut (*Arachis hypogea)* haulms as feed stuffs for weaning rabbits in tropical environment (Nigeria). J. Appl. Rabbit Res., 9(4): 178–180.

Feeds and Feeding, Management, Monogastic and Ruminant Nutrition, pp. 17–18.

Aduku, A. O. & Olukosi, J. O. (1990). Rabbit Management in the Tropic; Production, processing, utilization, marketing, economics, practical training, research and future prospects. Living Books Series, Abuja, F.C.T., GU Publication, 111 p.

Alu, S. E., Ruma, R. S., Umbugadu, A. A. U. & Makinde, O. J. (2009). The effects of different dietary fibre sources on the growth performance and carcass characteristics of growing rabbits. 14th Annual Conference Animal Science Association of Nigeria. (Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria), pp. 390–392.

Alu S. E. (2010). Replacement of bone ash with eggshell meal on growth performance and carcass characteristics of broiler chickens. International Journal of Food and Agricultural Research, 7(1): 229–238.

Bush, B. M. (1975). Veterinary Laboratory Manual, Withiam Heinemen Medical book limited London, UK, p. 447.

Church, D. C., & Pond, W. G. (1988). Basic Animal Nutrition and Feeding. John Wiley & Sons, New York, Chichester Brisbane, Toronto, Sing Apore, pp. 27 – 55.

Emmanuel, S. S. (2008). Effect of replacing bone ash with rock phosphate on the nutrient digestibility by broiler finishing birds. B.Agric. (Animal Production) Project, University of Agriculture, Makurdi.

Grosso, J. L. B. M., Balieiro, J. C. C., Eler, J. P., Ferraz, J. B. S., Mattos, E. C., Filho Michelan, T., Feicio, A. M. & Rezende, F. M. (2009). Estimates of genetic trend for carcass traits in a commercial line. Genetic and Molecular Research, 8: 97–104.

Iyayi, E. A. & Davis, B. I. (2005). Effect of enzyme supplementation of palm kernel meal and brewer dry grain on the performance of young broilers. International Journal of Poultry Science, 4(2):76–80, 2005.

Jain, C. N. (1986). *Schalms Veterinary Haematology*.4th edition, Philadephia. Lea and Febiger Publishers, pp. 564–575.

Kaneko, J., Harvey, J. & Bruss, M. (1997). Clinical Biochemistry of Domestic Animal 5th Edition, Academic Press New York, 932 p.

Kelly, W. R. (1979). Veterinary Clinical Diagnosis. 2nd edition, London. Bailliere Tindall Publishers, pp. 47–56.

Linsday, D. B. (1977). The effect of feeding patterns and sampling of blood parameters. Brit. J. Nutr., 56: 99–120.

Margi, S. (1997). Veterinary Clinical Laboratory Procedures. Mosby Publishing Excellence, USA, p. 157.

McDonald, P., Edwards, R. A. & Green Halgh, J. F. D. (1995). Animal Nutrition. Fifth Edition. Longman Publ., pp. 221 – 235.

Mmereole, F. U. C. (1996). The study of haematological parameters in the Nigerian local chickens. Nig. J. Anim. Prod., 23(1): 94–97.

Mohammed, M. A., Hassan, H. M. A. & EL–Barkouky, E. M. A. (2008). Effect of mannan oligosaccharide on performance and carcass characteristics of broiler chicks. Journal of Agriculture and Social Sciences, 4: 13–17.

NIMET (2008). Nigerian Meteorological Agency, Lafia, Nasarawa State.
National Research Council (NRC) (1979). Nutrient requirement of swine. Eighth Revised Edition, 1979. National Academy Press, Washington, DC, 1979.
Ochefu, J. (2006). The effect of Kapok (C*eiba pentandra*) seed meal–based diets on growth, carcass yield and blood chemistry of weaner rabbits. M.Sc. Thesis. Dept. of Animal Breeding and Physiology, Univ. of Agric, Makurdi.
Olomu, J. M. (2011). Availability of amino acids. In: Monogastric Animal Nutrition; Principles and Practice, p. 52.
Oyawoye, E. O. & Nelson, F. S. (1998). Utilization of graded levels of rice offal by rabbits. In: Animal Agriculture in West Africa: The Sustainability Question. Oduguwa, O. O., Fanimo, A. O. and Osinowo, O. A. (eds) Proceedings of the 25th Annual Conference of Nigeria Society for Animal Production and the Inaugural Conference of the West African Society for Animal Production. Adset/CASLP–UA (Abeokuta, Nigeria), pp. 143–144.
Onyeyili, P. A., Egwa, G. O., Jibike, G. I., Pepple, D. J. & Chaegbulan, J. O. (1991). Seasonal variations in haematological indices in the gray–breasted guinea fowls (*Numida meleagris Gallata pallas*). Nig. J. Anim. Prod., 18(2): 108–111.
Pauzenga, U. (1985). Feeding Parentstock. Zootecnica International. December, 1985, pp. 22–24.
Schalm, O. W., Jain, N. C. & Caroll, E. J. (1975). Textbook of Veterinary Haematology, 2nd Edition, Published by Lea and Febiger, Philadelphia, Pp. 129 – 250.
Steel, R. G. D. & Torrie, J. H. (1960). Principles and Procedures of Statistics. Mc Graw Hill Book Company, New York.