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Rock phosphate as replacement for bone meal in rabbit diets

***Agedeson, T. J, Kuka T.T. and Kaankuka, F.G.**

Department of Animal Nutrition , Federal University of Agriculture, Makurdi, PMB 2373 Makurdi, Benue State, Nigeria.

****Corresponding Author:** joshuaagedeson@gmail.com; **Phone Number**: 07015576157*

***Target Audience**: Researchers, Students and Rabbit farmers*

Abstract

Bone meal as mineral source has become unattractive for animal diets in developed countries due to fear of diseases transfer from animal to animal. Twenty four (24) mongrel weaned rabbits weighing 291.67±3.23 g were randomly allotted to six dietary treatments with four replicates to evaluate the effect of replacing bone meal with crude rock phosphate. Feed and water were available ad-libitum. Rock phosphate replaced bone meal at levels of 0, 20, 40, 60, 80 and 100 % respectively. Performance data were monitored weekly. At the end of the study, 84 days, two rabbits per treatment were slaughtered for evaluation of carcass parameters and visceral organ. The results showed that dietary treatments significantly affected (P< 0.05) all performance parameters across the groups, rock phosphate inclusion increased growth performance and carcass at 20 % replacement and thereafter decreased performance with increased replacement levels. Growth performance, carcass characteristics and visceral parameters significantly decreased (P<0.05) with increased percentage of rock phosphate beyond 20 %. Replacement of bone meal with crude rock phosphate beyond 20 % depressed average daily feed intake and average daily weight gain but did not affect feed conversion ratio of weaned rabbits. It is therefore, recommended that since there was no deleterious and adverse effect of replacing bone meal with rock phosphate at 20 % inclusion levels, rock phosphate can replaced 20 % bone meal in diets, for optimum performance of rabbits.

***Keywords**: Calcium, Carcass, Growth Performance, Phosphorus, Visceral organs*

Description of Problem

Population growth has continued to create additional pressure on agricultural production with consequent effects on animal protein supply, thus the focus of meeting up with the protein needs for the populace in developing countries like Nigeria, should place more emphasis on short generation livestock, such as rabbits, which are prolific grows fast. Modern strains of rabbits are well adapted to tropical environments and therefore have greater potential for meeting the protein needs of Nigerians.

Animal proteins are greatly required because plant proteins are deficient in some essential amino acids such as lysine, leucine and methionine, whereas animal proteins contain all these essential amino acids. With the rapid increasing human population in developing countries especially Nigeria, more protein will be required to avoid malnutrition, thus, the need to boost livestock production at the cheapest cost is to meet protein requirement of the average Nigerian, where the estimated daily protein requirement for an adult is between 65 - 75 gram per day, out of this requirement, 35 g should be obtained from protein of animal origin (2).

In modern day farming, the nutritional requirements of farm animals are well understood and all requirements can be met through dietary supplementation of the limiting nutrients in the concentrated form (3).

In animal production, much emphasis

has been on energy and protein supplements, but insignificant or little attention is given to alternative mineral supplements. The supply of bone meal which is generally used in Nigeria is limited. With industrialization, animal bones are being diverted into other uses notably for manufacture of products such as glue, gelatin, ossein, dicalcium phosphate, fertilizer and ceramics (5). (7*)* reported that bone meal has become unattractive for animal diets in developed countries due to fear of diseases transfer from animal to animal via feed. He added that when consumers of monogastric animals become aware of the inherent dangers that may arise from eating meat of animals that are fed bone meal-containing diets, they may shy away from consuming such meat as it is the case of cholesterol stigma in fatty meats and eggs. There for, alternative sources should be sought.

It has become desirable that alternative sources of calcium and phosphorus which are cheaper and more readily available should be evaluated for use in livestock feeds. Calcium and phosphorus are two of the most important mineral elements required in large amount by all classes of livestock. Dicalcium phosphate (DCP) is used traditionally as phosphorus supplements in poultry diets (6). However, due to high demand and scarcity or non-availability, its cost is also increasing. Therefore, it has become imperative to use alternative and economically viable phosphorus supplements. One of the alternative sources is rock phosphate which is a natural sedimentary rock that contains high amount of calcium and phosphorus. It is available in abundance at much lower cost, but on account of high level of fluorine (6), its utilization has been limited. To reduce the fluorine content of rock phosphate, one method is heat-treatment. The heat-treated rock phosphate (HTRP) also contains fluorine but at much lower level than raw rock phosphate (6).

Large deposits of rock phosphate are also found in several West African countries notably; Togo, Senegal, Benin Republic and Nigeria. The mineral has been found in commercial quantities in Sokoto, Ogun and Imo states (5). This work takes a look at the effect of replacing bone meal with crude rock phosphate in the diets of weaned rabbit to determine the effect on growth performance, carcass and visceral parameters of rabbits.

Materials and Methods

Location of Study

The study involved laboratory assay of the mineral supplement and test diets and biological studies with the rabbits. The experiment was conducted at Akperan Orshi college of Agriculture, Yandev , Gboko Local Government, Area of Benue State, located latitude 07^0 26' North and longitude 08^0 55' East, in the Southern Guinea Savannah of Nigeria. The climate of the area is tropical with an annual rainfall spanning between 6 - 7 months and varying from 1,317 - 1323 mm (4).

Experimental Design

Twenty-four (24) cross-bred weaned rabbits were used in this study. The rabbits were from a commercial rabbitry and were taken from multiparous does at the weaning weights between 287.50–293.75 g. There were six dietary treatments with four rabbits per treatment as replicates each. The rabbits were weighed and allotted on the basis of initial live weight to the six dietary percent replacements in a completely randomized design. The six dietary treatments consisted of 0, 20, 40, 60, 80, and 100 % replacement of bone meal with rock phosphate as calcium and phosphorus source. The experiment lasted for 84 days (12 weeks). Feeds and water were given to the rabbits *ad-libitum.*

Housing and Management of Rabbits

The rabbits were housed in all-wire individual cages measuring 60 x 50 x 50 cm

located in an open sided building for easy and effective cross ventilation. The rabbits were kept for four days prior to the commencement of the experiment as pre-trial period, during which they were screened for possible ecto and endo parasites as well as served with water and feed *ad-libitum* and to get accustomed to routine handling. The temperature of 28^0 - 37 ^{0}C was observed during the experimental trails and relative humidity of about 65 % for the whole period of fattening. The animals were served with feed at 8:00 hours and 16:00 hours. Left over feeds were weighed every morning to determine feed intake. The rabbits were weighted at the beginning of the experiment and thereafter at weekly intervals.

Experimental diets

The composition of the six experimental diets is presented in Table 1. The diets which were isocalaric and isonitrogenous were maize and full fat soyabeans based with either bone meal or rock phosphate as source of calcium and phosphorous. The dietary rock phosphate replaced bone meal at levels of 0, 20, 40, 60, 80 and 100 % respectively. The experimental diets were taken at a time and stored in labeled polythene sacks for the experimental periods for laboratory analysis.

Parameters Measured

Initial body weight (g), from the beginning and final body weights of the rabbits were recorded directly. Total weight (g), was calculated as final weight minus initial weight. Average daily feed intake (g): Each animal (Rabbit) was fed *ad-libitum* on a weighed quantity of diet daily. The difference between the amount of feed served and amount of feed left over was calculated as daily feed intake. Average daily weight gain (g): The total weight gain by rabbit divided by number of experimental days.

Carcass Parameters

At the end of the experiment (84 days), two rabbits per treatment of similar live body weights were selected randomly and properly identified by means of leg band number to correspond with the dietary treatment. The rabbits were starved of feed for 6 hours, they were slaughtered by severing the jugular veins, using sharp knife in the morning between 9:00 – 10:00 hours after hand stunning. Carcass evaluation was carried out according to the methods of (1). The weight of primal cuts such as; loin, fore limb, hind limb, ribs/rack and other cuts of carcass such as feet, head and neck were determined by electronic balance. Also, weight of visceral parts such as; small intestine, large intestine, liver, spleen, lungs, Gall bladder, kidney, heart, caecum and stomach weight were determined.

Statistical Analysis

Data obtained from this experiment were subjected to analysis of variance using statistical package for social science (SPSS), treatment means were compared using Duncan's Multiple Range Test (DMRT). Variations were considered to be significant at (P<0.05).

Table 1: Composition of diets containing Rock Phosphate as a replacement for bone meal in weaned rabbits

	Percent Replacement					
Ingredients	**0**	**20**	**40**	**60**	**80**	**100**
Maize	40.00	40.00	40.00	40.00	40.00	40.00
Full fat soybean	36.20	36.20	36.20	36.20	36.20	36.20
Rice Offal	17.00	17.00	17.00	17.00	17.00	17.00
Blood Meal	3.10	3.10	3.10	3.10	3.10	3.10
Rock Phosphate	-	0.60	1.20	1.80	2.40	3.00
Bone meal	3.00	2.40	1.80	1.20	0.60	-
Methioninc	0.20	0.20	0.20	0.20	0.20	0.20
Vitamin-Premix*	0.20	0.20	0.20	0.20	0.20	0.20
Common Salt	0.30	0.30	0.30	0.30	0.30	0.30
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Nutrients						
D.E(kcal/kg)	2702.00	2702.00	2702.00	2702.00	2702.00	2702.00
Crude Protein	18.00	18.00	18.00	18.00	18.00	18.00
Crude fibre	9.24	9.24	9.24	9.24	9.24	9.24
Fat	3.91	3.91	3.91	3.91	3.91	3.91
Calcium	1.17	1.14	1.12	1.10	1.08	1.05
Phosphorus	0.90	0.90	0.91	0.91	0.92	0.93
Methionine	0.46	0.46	0.46	0.46	0.46	0.46
Lysine	0.79	0.79	0.79	0.79	0.79	0.79

*Vitamin/Mineral- Premix Supplied the following additional Micro nutrients: Vitamin A, 10,000 i.u,D, 32,000i.u,E,20 I u,Vitamin K 3mg, Vitamin B12,0.05 mg, and Riboflavin 6mg, Panthothenic 1mg, Nicotinic acid 35mg, folic acid 1mg Chorine Chloride 500 mg, and Se 0.15 g,Cu 12mg, Mn 55mg antioxidant (BTH)70 mg, Iron 48mgm, Zn 96mg, Iodine 1.8mg, Cobalt 0.48mg, and anticaking. D.E – Digestible Energy (kcal/kg)

Results and Discussion

Chemical composition of rock phosphate and bone meal

The result of the chemical composition of crude Rock Phosphate and Bone meal as determined at Federal Super Phosphate Fertilizer Company, Kaduna, showed that the calcium and phosphorus levels were 37.00 and 16.10 percent while that of Bone Ash indicated 34.64 percent calcium and 16.98 percent phosphate. The fluorine content of the test diets were 3.65 percent in Rock Phosphate and 0.36 percent in Bone ash. Other minerals determined in Rock Phosphate were Fe_2O_3, Al_2O_3, SiO_3, SO_3, Mg and CO_2 which had values of 1.19, 0.48, 2.34, 0.64, 0.25 and 1.61 percent respectively. Meanwhile, other Bone ash minerals determined were Zn, Mn and Mg which had values of 0.44, 0.05 and 0.50 percent respectively.

Growth performance of rabbits

The performance of rabbits fed crude Rock Phosphate as a replacement for bone ash is presented in Table 3. The result showed that with the exception of feed conversion ratio (FCR), dietary treatment significantly (P>0.05) influenced all the parameters measured. Rock phostphate inclusion significantly (P<0.05) increased performance parameters in 20 %

replacement group and thereafter reduced all the parameters as the replacement increased. Mean values of final weigh, average daily feed intake and average daily weight gain were highest for 20 % Rock Phosphate replacement and lowest at 100 % rock Phosphate replacement. This could be due to the increased fluorine contents in the diets from rock phosphate which resulted to the depression. (6), reported that inclusion of heat treated rock phosphate (HTRP) increased weight gain of birds up to 80 percent inclusion. However this study utilized untreated rock phosphate.

Carcass characteristics of rabbits

The effect of replacement of bone meal with rock phosphate on carcass characteristics of rabbit is presented in Table 4. With the exception of carcass length and ribs weights, all other parameters examined were significantly (P<0.05) higher in 20 % rock phosphate and decreased with increase in rock phosphate replacement. Carcass characteristic is a measure of growth, hence the depressed weight here has no other explanation but that which was observed on growth.

Internal organ weights and lengths of rabbits

The effect of replacement of bone meal with rock phosphate on the internal organs weights and lengths of rabbits is presented in Table 4. Significant variations (P<0.05) were observed between the control and the treated groups except on stomach, gall bladder and heart, small and large intestine. Values of internal organs were higher in 20 % rock phosphate but similar to those of the control group. However 100 % incorporation of rock phosphate in the dietary treatments reduced organs characteristics which could as well affect their functions. The possible increased amount of flourine in the diet is implicated in the results of this study. Unfortunately there was no flourine toxicity assessment carried out on the animals.

Table 2: Effect of replacing bone meal with rock phosphate on growth performance of rabbits

	Percent Replacement						
Parameters	**0**	**20**	**40**	**60**	**80**	**100**	**SEM**
Initial Weight(g)	293.75	293.75	293.75	287.50	293.75	287.50	-
Final Weight (g)	1658.33^{ab}	1831.25^{a}	1475.00^{bc}	1318.75^{c}	1310.00^{c}	1262.50^{c}	49.22
TWG (g)	1364.58^{ab}	1537.50^{a}	1181.25^{ab}	1031.25^{ab}	1016.25^{ab}	975.00^{b}	49.40
ADFI (g)	51.76^{bc}	60.43^{a}	52.88^{ab}	48.91^{bcd}	43.63^{cd}	41.32^{d}	1.70
ADWG (g)	15.77^{ab}	18.30^{a}	14.06^{bc}	12.28^{cd}	12.10^{d}	11.61^{d}	0.59
FCR	3.28	3.30	3.76	3.98	3.64	3.56	0.18

TWG = Total Weight Gain; ADWG = Average Daily Weight Gain; ADFI = Average Daily Feed Intake; FCR = Feed Conversion Ratio; SEM = Standard Error of Mean

^{a,b,c} Means in the same row with different superscripts are significantly different (P<0.05

Table 3: Effect of replacing bone meal with rock phosphate on carcass characteristics of rabbits

	Percent Replacement						
Parameters	**0**	**20**	**40**	**60**	**80**	**100**	**SEM**
Carcass length (cm)	33.00	36.75	34.75	35.50	35.50	34.00	0.85
Carcass Weight (g)	778.31^{ab}	928.80^{a}	735.00^{ab}	700.82^{ab}	634.62^{b}	620.25^{b}	36.58
Dressing %	53.24^{bc}	59.80^{ab}	63.36^{a}	59.59^{ab}	51.52^{c}	55.21^{bc}	1.39
Eviscerated Weight (g)	1260.94^{ab}	1404.40^{a}	1151.64^{ab}	1111.99^{b}	1078.27^{b}	1025.91^{b}	44.79
Singed Weight (g)	961.56^{ab}	1146.72^{a}	898.42^{ab}	874.23^{b}	795.24^{b}	782.04^{b}	43.07
Forelimb Weight(g)	156.12^{ab}	168.24^{a}	132.90^{ab}	129.89^{ab}	118.56^{b}	116.77^{b}	7.01
Hindlimb Weight (g)	254.54^{a}	264.02^{a}	217.24^{ab}	207.23^{ab}	188.59^{b}	185.02^{b}	10.38
Loin/back Weight (g)	249.83^{ab}	360.42^{a}	256.99^{ab}	258.83^{ab}	232.70^{b}	213.18^{b}	16.87
Ribs Weight (g)	117.38	136.13	127.87	104.88	94.78	105.29	6.40
Neck Weight (g)	36.98^{a}	42.28^{a}	21.66^{c}	29.90^{b}	22.11^{c}	27.61^{bc}	2.33
Feet Weight (g)	30.44^{ab}	33.66^{a}	30.89^{ab}	31.30^{ab}	21.55^{b}	24.62^{ab}	1.48
Head Weight (g)	116.29^{ab}	142.99^{a}	110.88^{b}	112.22^{b}	116.97^{ab}	109.57^{b}	4.15

^{a,b,c} Means in the same range with different superscripts are significant different ($p<0.05$).

Table 4: Effect of replacement of bone meal with rock phosphate on internal organ of rabbits

	Percent Replacement						
Parameters	**0**	**20**	**40**	**60**	**80**	**100**	**SEM**
GIT (g)	164.06^{a}	170.60^{a}	123.36^{b}	113.01^{b}	119.23^{b}	104.10^{b}	7.89
Small Intestine (g)	26.24^{ab}	27.48^{a}	21.38^{bc}	21.58^{bc}	21.11^{bc}	19.15^{c}	1.02
Large intestine (g)	20.09^{a}	14.83^{b}	12.97^{cd}	10.43^{e}	14.45^{bc}	12.63^{d}	0.91
Caecum (g)	19.02^{a}	16.65^{ab}	14.52^{ab}	12.27^{ab}	12.66^{ab}	11.28^{b}	1.01
Stomach (g)	20.16	18.03	16.16	18.45	19.12	18.95	0.17
Liver (g)	35.48^{ab}	44.81^{a}	33.63^{ab}	29.98^{b}	30.94^{ab}	27.38^{b}	2.04
Lungs (g)	8.25^{a}	9.34^{a}	5.58^{b}	5.26^{b}	5.12^{b}	4.15^{b}	0.5
Gall bladder (g)	0.43	0.60	0.67	0.45	0.31	0.63	0.05
Kidney (g)	10.55^{a}	10.83^{a}	9.97^{ab}	8.69^{ab}	9.36^{ab}	6.99^{b}	0.48
Visceral fat (g)	18.38^{ab}	25.77^{a}	4.65^{bc}	3.11^{c}	2.64^{c}	0.00^{c}	3.13
Spleen (g)	0.68^{a}	0.49^{ab}	0.23^{bc}	0.15^{bc}	0.26^{bc}	0.05^{c}	0.07
Heart (g)	4.29	4.29	35.3	2.79	3.28	2.58	0.26
GIT (cm)	416.95^{ab}	446.55^{a}	391.50^{ab}	372.75^{b}	432.50^{a}	410.75^{ab}	8.75
Small intestine (cm)	264.75	298.50	255.00	250.00	292.50	276.00	6.77
Large intestine (cm)	113.50	103.40	90.00	85.00	106.50	96.50	3.88
Caecum (cm)	39.70^{ab}	45.65^{a}	35.50^{c}	37.75^{abc}	34.50^{bc}	38.00^{abc}	1.35

GIT – Gastro intestinal tract; SEM = Standard Error Means

^{a,b,c} Means in the same row with different superscripts are significantly different ($p<0.05$).

Conclusion and Application

1. The research has shown that rock phosphate can replace bone meal in rabbit diets up to 20 % without any adverse effect on growth performance, carcass characteristics and visceral organs, indicating the efficacy of rock phosphate in diets.

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