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EVALUATION OF DIFFERENT SOURCES OF PHOSPHORUS ON PERFORMANCE AND BLOOD CHARACTERISTICS OF BROILER CHICKENS

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ABSTRACT

This research was conducted to investigate the utilization of rock phosphate as an alternative phosphorus source in broiler diet. Rock phosphate is known to contain high amount of calcium and phosphorus, but its utilization has been limited due to its fluorine contents. A total of 250 Sayed broiler chicks were purchased at day old and brooded. After brooding, 210 very active and health chicks were allotted at random to 3 dietary treatments, each with 5 replicate pens such that 14 birds were assigned to each replicate and a total of 70 birds made up a treatment. The result showed that there were no significant (P >0.05) variations among all the parameters determined. Different sources of phosphorus did not show any significant difference (P>0.05) on performance of broiler at both starter (28 days of age) and finisher (56 days of age) among the dietary treatment groups for all parameters evaluated. Also, there were no significant (P >0.05) variations among all the blood parameters determined. Mean values of calcium obtained from blood serum of broiler finisher chickens in this study ranged between 2.38 mmol/l and 2.44 mmol/l (4.76 – 4.88 mEq/l or 9.52 – 9.76 mg/dl). This study has shown that, at 2.5 Kg per 100 Kg diet, rock phosphate can be utilized without adverse effect on blood and bone characteristics. This also means that diet containing rock phosphate can compete favourably with bone ash which serve as a control and therefore safe for broiler chickens production. From this finding, it is recommended that, rock phosphate can be utilized without adverse effect on performance and blood characteristics of broiler chickens.

Key words: *broilers, biochemical, calcium, performance, raw rock phosphate.*

INTRODUCTION

Alternative feed ingredients for livestock feeding especially poultry are important in term of cost of production and health concern. However, much effort has not been made on local alternative sources for the major mineral nutrients like calcium and phosphorus (Tumova *et al.*, 2004). The important minerals that are always considered in livestock rations are calcium (Ca) and phosphorus (P). Calcium sources in the country have been identified to include oyster shell, periwinkle shell, limestone and bone meal. Bone meal is valued mostly for its phosphorus content since Ca can be utilized from limestone which is often cheaper (Tion *et al.,* 2012). Phosphorus on the other hand can only be obtained in the country from bone meal.

Tion *et al*., (2012) reported that bone meal has become unattractive for animal diets in developed countries due to fear of disease transfer from animal to animal via feed. Tion *et al.,* (2012) also stated that when consumers of monogastric animal meat become aware of the inherent danger that may arise from eating meat of animals that are fed bone meal containing diets, they may shy away from such meat consumption as is the case of cholesterol stigma in fatty meats and eggs. Therefore, alternative sources of phosphorus should be found aside from bone meal. Dicalcium phosphate and other reagent grade phosphates (Mono calcium phosphate and deflourinated phosphate) are used in developed economies to supply the phosphorus requirement of animals but dicalcium phosphate is an imported resource which is very costly and will make the production cost via feed to increase in a country where an average Nigerian is unable to afford meat due to high cost.

Rock phosphate occurs in different parts of Nigeria and is mined for fertilizer manufacture. Fears about the use of rock phosphate as a source of phosphorus in animal diets especially poultry is based on its inherent content of fluorine which is toxic to poultry at levels over 40 mg per day (Godoy and Chicco, 2001). Advanced countries have the technology to process the raw rock phosphate to remove the fluorine content. Such rock phosphate is called deflourinated or soft rock phosphate. In this country, we have not acquired that technology and the utilization of raw rock phosphate in animal diets is not conventional. It is possible that varying quantities of fluorine can occur at different sites or deposits.

This study aimed at evaluating the utilization of rock phosphate as an alternative phosphorus source to bone meal and dicalcium phosphate in broiler diet. The objective is specifically to evaluate the effect of different sources of phosphorus on performance and blood biochemical indices of broiler finisher chickens.

MATERIALS AND METHODS

The experiment was carried out at Divisional Veterinary Complex, in North Bank, Makurdi, Benue State in one of the poultry houses. Makurdi is located between latitude 7.68^0North and Longitude 8.62^0East, the flood plain between 106 m to 113 m above sea level. The area is warm with a minimum temperature range of 17.3^0C to 24.5^0C and maximum temperature range of 29.8^0C to 35.6^0C. During the dry hot season between February and March, temperature may reach 35^0C to 40^0C, and rainfall is between 1500 mm to 1800 mm (Wikipedia, 2013).

The raw rock phosphate (which is the test material) was sourced from Federal Super phosphate Fertilizer Company, Kaduna. The company disclosed that, the product was procured from Sokoto State. Dicalcium phosphate was purchased from Ibadan. Bone meal and other ingredients like maize, soya bean cake, oyster shell, methionine, lysine, and iodized salt were bought from Wadata market in Makurdi, Benue State.

The chemical composition of rock phosphate was analysed at the National Geoscience Research Laboratories Centre, Kaduna using Energy Dispersive X-ray fluorescence (EDXRF) Spectrometer of model 'Minipal 4' and gravimetric methods. The samples were pulverized using auger pulverizing machine (Planetary Micro Mill Pulverisette 7). The ground samples were ensured to pass 150 micro mesh sieves. This was to ensure homogeneity of the samples.

A gravimetric method was used to determine moisture content. It is done by heating 1g of the powdered sample in a cleaned weighed crucible at 1000^oC. After which the crucible and the content were weighed to get the difference in weight before and after heating.

The birds were randomly allotted to different diets in a Completely Randomized Design. The broiler chicks for the experiment were sourced from a reputable poultry dealer in Makurdi, Benue State. A total of 250 Sayed broiler chicks were purchased and brooded using conventional brooding method as outlined by Dafwang and Ogundipe (1987). A conventional brooder house where wire mesh was used to cover openings to deprive rodents from gaining access into the house and polythene sheets were used to cover the open-sided dwarf wall to conserve heat during the brooding period. Birds were brooded on deep litter floor using a commercial broiler starter diet (Vital Feed) for one week. Then, 210 very active and healthy chicks were selected for the experiment. Chicks were allotted at random to 3 dietary treatments, each with 5 replicate pens such

that 14 birds were assigned to each replicate and a total of 70 birds made up a treatment. The starter phase of this study considered performance traits and lasted for 4 weeks (28 days). In this phase, the birds were fed broiler starter diets which contained 23 % CP and about 3000 Kcal/Kg metabolizable energy. The finisher phase also considered performance traits and lasted for 4 weeks (28 days) and the birds were fed broiler finisher diets containing about 20 % CP and 3000 Kcal/Kg metabolizable energy. Health management practices included the administration of Newcastle disease vaccine intra- ocular (i/o) at day old, infectious bursa disease (Gumboro) on the 10th and 21st day. Newcastle disease vaccine (lasota) on the 28th day. Broad spectrum prophylactic doses of antibiotics (Doxylosin) and anticoccidials (Amprolium) were given in drinking water. The birds were housed in a deep litter with partitions using wire mesh. All birds received both feed and water *ad libitum*. Records on initial weight and at the end of every week are taken and kept. Feed eaten and left over records were maintained throughout the period of the experiment. Other routine management practices were adopted as outlined by Dafwang and Ogundipe (1987).

Three experimental diets were formulated and mixed manually on the farm. Bone ash (a conventional phosphorus source used in this country), Rock phosphate (the test material) and Dicalcium phosphate 18% P (a conventional phosphorus source used in developed economies) accounted for the three dietary treatments. Oyster shell was used to balance the calcium deficiency in three dietary treatments.

Dietary treatments were formulated to be essentially isocaloric and isonitrogenous at each phase of the study. Diets were chemically analysed to find out if they conform to the calculated formulation. The experimental diets are presented in Table 5.

Table 1: Proximate Analysis of formulated Broiler Starter and Finisher Diets used in the experiments

Nutrients (%)	Bone Ash	Rock Phosphate	Dicalciumhosphate
	T1	T2	T3
Starter Diets			
Crude Protein (CP)	23.1	23.2	23.4
Crude Fibre (CF)	4.60	5.10	4.80
Ether Extract (EE)	2.90	3.30	2.80
Nitrogen - Free Extract	60.4	57.8	60.3
Ash	3.80	4.00	3.90
Calcium	1.49	1.46	1.10
Phosphorus	0.70	0.70	0.75
Finisher Diets			
Crude Protein (CP)	20.3	20.3	20.3
Crude Fibre (CF)	5.35	5.45	5.30
Ether Extract (EE)	3.30	3.60	3.80
Nitrogen - Free Extract	60.48	59.99	60.3
Ash	4.12	4.21	4.40
Calcium	1.46	1.44	1.12
Phosphorus	0.66	0.66	0.70

SEM=Standard Error of Means

Parameters Measured

The performance of broiler chicks and chickens were assessed using the following parameters:

Average daily feed intake (ADFI) (g)

The birds were fed weighed feed such that they had feed free choice each day. At the end of the day, the remaining feed was weighed and recorded. The difference between the offered and left over was recorded as the feed eaten for the day.

Average daily feed intake $\text{FI} = \frac{\text{total feed cosumed/bird}}{\text{no. of days}}$

Average daily weight gain (ADWG) (g)

The birds were weighed at the beginning of the experiment (initial weight) and weekly. Therefore, the average daily body weight was calculated as follows;

Average daily weight gain = $\frac{\text{final weight - initial weight}}{\text{no. of days}}$

Feed conversion ratio (FCR)

This was calculated as the ratio of feed intake to live weight gain.

FCR = $\frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$

Protein Efficiency Ratio (PER)
This was determined as ratio of gain in body weight to the protein consumed.

$$\text{PER} = \frac{\text{protein consumed (g)}}{\text{Gain in body weight (g)}}$$

Mortality records
Records of mortality were kept throughout the experimental period as they occurred. Percent mortality was determine by recording each dead bird in each replicate and the total in each treatment was divided by the original number of birds allocated to each treatment and multiplied by 100.

Biochemical Evaluation
At the end of the finisher phase (56 days of age) birds were bled and 4 mls of blood collected to evaluate the effect of the dietary treatments on blood parameters. Two birds per replicate and 10 birds per treatment whose weights were close to the pen average were selected and properly identified by means of leg band numbers to correspond with the dietary treatment were sampled out for bleeding. Birds were fasted overnight and bled the following morning by severing the jugular veins and carotid arteries using a clean sharp table knife. The blood was collected in a marked Ethylene Diamine Tetra Acetic Acid (EDTA) bottles large enough to accommodate 4mls of blood. The blood was marked against each dietary treatment and was gently rocked to mix the EDTA and blood together. The other sample was collected in EDTA free bottles for serum separation and mineral analysis. Blood collected was taken to Federal Medical Centre Laboratories Makurdi within one hour of collection for blood analysis.

Blood Was Analysed For:
Calcium: Serum calcium was determined using Colorimetric method as outlined by Randox (2005). The principle is that calcium ions form a violet complex with O-Cresophthaleincomplexane in an alkaline medium. The reagent composition contains a standard buffer chromogen and EDTA. The absorbance of the sample, and standard read against a reagent blank after 5-50 minutes using Spectrophotometer Model.

Alkaline Phosphatase: This was determined using the Colorimetric Method as described by Randox (2005). The principle is that the substrate P-nitrophenylphosphate+ H_2O ==> Phosphate + substrate (p-nitrophenylphosphate 10mmol/l),buffer (Diethanolamine buffer/mol), PH 9.8 and $MgCl_2$ 0.5mmol/l) form a reagent. The serum sample was allowed to react with the reagent and the absorbance was read after 1, 2, and 3 minutes.

Total Protein: The sera obtained from clotted blood samples was analysed using the Standard Method recommended for total protein (Randox, 2005). The principle used for analysing total protein is that, the cupric ions in an alkaline medium was allowed to interact with protein peptide bonds resulting in the formation of a coloured complex.

At the end of the finisher phase, two birds per replicate and 10 birds per treatment whose weights were close to the pen average weight were selected and properly identified by means of leg band to correspond with the dietary treatment were sampled out for bleeding. Birds were fasted overnight and bled the following morning by severing the jugular veins and carotid arteries using a clean sharp table knife. The blood was collected in a marked Ethylene Diamine Tetra Acetic Acid (EDTA) bottles large enough to accommodate 4mls of blood. The blood was marked against each dietary treatment and was gently rocked to mix the EDTA and blood together. The other sample was collected in EDTA free bottles for serum separation and mineral analysis. Blood collected was taken to Federal Medical Centre Laboratories Makurdi within one hour of collection for blood analysis. Blood was analysed for: calcium, alkaline phosphatase, total protein,

Data collected were subjected to one way Analysis of Variance (ANOVA) according to Statistical Package of Social Science (SPSS) using computer programme (version 20.0 of Window 2007 model) and identified significant difference mean values were separated using the Duncan's Multiple Range Test as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Analysed Chemical Composition of Bone Meal, Rock Phosphate and Dicalcium Phosphate
The bone meal, rock phosphate and dicalcium phosphate were analysed chemically to find out their compositions and were presented in table 4.

Performance Response of Broilers at starter phase
The effect of different sources of phosphorus inclusion on performance of broiler starter chickens (28 days of age) is presented in Table 6. The result did not show any significant difference ($P>0.05$) among the dietary treatment groups for all parameters evaluated.

Performance Response of Broilers at Finisher phase
The effect of different sources of phosphorus (bone ash, rock phosphate and dicalcium Phosphate) inclusion on performance of broiler finisher chickens (56 days of age) as expressed in Table 7. There were no significant differences ($P >0.05$) among dietary treatments for all parameters measured.

Table 2: Analysed Chemical Composition of Bone Meal, Rock Phosphate and Dicalcium Phosphate

Minerals	Bone Meal %	Rock Phosphate %	Dicalcium Phosphate %
Calcium	34.5	35.3	33.1
Phosphorus	16.9	15.2	18.1
Fluorine	0.34	4.36	-
Silicon	-	3.00	-
Titanium	-	0.08	-
Iron	-	0.85	-
Manganese	0.45	0.05	-
Magnesium	0.59	0.01	-
Aluminium	-	1.09	-
Hydrogen	-	0.09	-

The analysis was done at National Geoscience Research Laboratories Centre, Kaduna.

Table 3: Effect of Different Sources of Phosphorus Inclusion on Performance of Broiler Starter Chickens (28 days of age)

Performance Indices	Experimental diets			
	Bone Meal	**Rock Phosphate**	**Dicalcium Phosphate**	**SEM**
	T1	**T2**	**T3**	
Initial weight (g/bird)	423.49	422.09	424	-
Final weight (g/bird)	1166	1107	1134	115NS
ADFI (g/bird)	74.2	73.1	75.1	0.64NS
ADWG (g/bird)	26.7	25.5	26.3	0.31NS
FCR	1.56	1.52	1.53	0.03NS
PER	1.74	1.71	1.71	0.16NS
Mortality (%)	1.43	1.72	1.14	-

SEM=Standard Error of Means, NS=Not Significantly Different (P >0.05), ADWG=Average Daily Weight Gain, ADFI=Average Daily Feed Intake, FCR=Feed Conversion Ratio, PER=Protein Efficiency Ratio

Table 4: Effect of Different Sources of Phosphorus Inclusion on Performance of Broiler Finisher Chickens Performance

Performance Indices	Experimental diets			
	Bone Meal	**Rock Phosphate**	**Dicalcium Phosphate**	**SEM**
	T1	**T2**	**T3**	
Initial weight (g/bird)	1676.08	1672.12	1697.79	-
Final weight (g/bird)	2327.27	2290.12	2499.08	57.83NS
ADFI (g/bird)	94.36	92.66	94.66	0.30NS
ADWG (g/bird)	28.68	28.25	29.86	0.25NS
FCR	3.29	3.28	3.17	0.09NS
PER	1.52	1.52	1.58	0.04NS
Mortality (%)	3.72	5.72	4.29	-

SEM=Standard Error of Means, NS=Not Significantly Different (P>0.05), ADWG=Average Daily Weight Gain, ADFI=Average Daily Feed Intake, FCR=Feed Conversion Ratio, PER=Protein Efficiency Ratio, T1, T2, T3 = Dietary Treatment.

Blood Characteristics

The effect of different sources of phosphorus on blood characteristics of broiler finisher chickens (56 days of age) is presented in Table 5. The result showed that there were no significant (P >0.05) variations among all the parameters determined.

Table 5: The Effect of Different Sources of Phosphorus (Bone Ash, Rock Phosphate and Dicalcium Phosphate) Inclusion on Blood Characteristics of Broiler Finisher Chickens (56 days of age)

Parameters	EXPERIMENTAL DIET				
	Bone Meal Phosphate	Rock phosphate	Dicalcium	SEM	Normal value
	T1	T2	T3		
Calcium (mmol/l)	2.38	2.38	2.44	0.04NS	2.25 - 2.5
Phosphorus (mmol/l)	1.56	1.56	1.59	0.01NS	1.30 - 2.60
Alkaline Phosphatase (i.u)	1793.00	1773.60	1808.40	22.71NS	–
Total Protein (g/dl)	5.30	5.07	5.06	0.05NS	4.0 – 5.20

There were no significant differences (P>0.05) in all parameters measured, SEM= Standard Error of Means

NS= Not Significantly Different (P>0.05), T1, T2, T3 = Dietary Treatment, *= William and Melvin (2005)

Chemical Composition of Bone Ash, Rock Phosphate and Dicalcium Phosphate

The analysis of bone meal, rock phosphate and dicalcium phosphate in this study for calcium and phosphorus are lower than the one reported by Kaankuka (1990). He reported that bone meal and rock phosphate contain 34.64 % calcium, 16.98 % phosphorus and 37.11 % calcium, 16.10 % phosphorus respectively for bone meal and rock phosphate. He also reported on the fluorine content of bone meal and rock phosphate to be 0.36 % and 3.65 %. The result of this study showed slight higher content of fluorine in bone meal and rock phosphate as compared to that of Kaankuka (1990). Although the rock phosphate material used was obtained from the same source (Super phosphate company, Kaduna) but at difference period of time. This difference in the amount of chemical composition may be that the raw rock phosphate procured by super phosphate company might be from different geographical locations. For this study, it was procured from Sokoto state of Nigeria.

Fluorine in the sample of rock phosphate of this study showed higher percent (4.36 %) more than 3.46 % reported by Kaankuka, (1990). Rock phosphate contained other elements such as magnesium, aluminium, etc, which have been shown to reduce fluorine toxicity in rat (NRC, 1980). This may be the reason why the rock phosphate has been successfully utilized in this study.

Performance of broiler starter

The final body weight in this study did not show significant (P>0.05) effect among dietary treatments. However, this finding is fairly higher than the report of Thomas *et al.,* (2007) who reported daily mean value of between 51.1 g and 58.2 g.

Average daily weight gain which is a measure of growth rate of chicks was not significantly (P>0.0) affected among the dietary treatments. The result of this study was similar to the finding reported by Thomas *et al.,* (2007) to be between 25.97 g/bird and 30.26 g /bird.

Feed conversion ratio (FCR) did not show significant different (P>0.05) among dietary treatments. This finding differs slightly from mean values of 1.80 – 1.96 reported by Tion *et al.,* (2012).

The result of Protein efficiency ratio (PER) showed no significant (P>0.05) variation among dietary treatments. The value obtained in this finding is slightly lower than value reported by Aduku (1993) who reported PER of broiler (0 – 4 weeks) to be 1.9. Mortality recorded in this study was below the Assured Chicken Production (ACP) life bench mark standard of 5% mortality in broiler production irrespective of age as reported (Tion *et al.,* 2012).

Performance of broiler finishers

Final body weight in this study did not show significant (P>0.05) effect among dietary treatment groups. This finding is similar to that reported by Tionet al. (2012) with values of between 2311 g and 2469 g at 56 days of age.

Average daily feed intake did not varied (P>0.05) among dietary treatments. The mean values for this study was higher to that reported by Tionet al. (2012) who indicated range values of between 61.50 g/day and 65.36 g/day.

Average daily weight gain which is a measure of growth rate was not significantly (P>0.05) affected among the dietary treatments. Tion et al., (2012) reported lower mean values range of 25.20 – 26.14 g/day.

Feed conversion ratio of this study did not show significant different (P>0.05) among dietary treatments. Tion et al., (2012) reported a lower mean value range of 2.36 – 2.53.

The result of PER in this study showed no significant (P>0.05) variation among dietary treatments. This finding had similar mean values reported by Tion *et al.,* (2012) who reported range values of 1.55 - 2.10.

Mortality recorded in this study ranged from 3.72 – 5.72 % which is slightly above the Assured Chicken Production (ACP) life bench mark standard of 5 % mortality in broiler production irrespective of age as reported (Tion *et al.,* 2012). Mortality above ACP (5 %) as observed here could be due to excessive temperature as at the period (February – April) of conducting this research in the study area. Mean values of calcium obtained from blood serum of broiler finisher chickens in this study was in agreement with that of William and Melvin (2005) who reported normal serum calcium values range of adult chicken to be 4.5 – 5.0 mEq/l (2.25 – 2.5 mmol/l or 9 – 10 mg/dl). The finding of this study also agreed with that of Tion and Njoku (2009) who reported values ranged of 9.83 – 10.87 mg/dl (2.46 – 2.62 mmol/l) for broiler finisher chickens.

Phosphorus level obtained from blood serum in this study agreed with that of William and Melvin (2005) who reported normal serum phosphorus of adult chicken to ranged 3 – 6 mEq/l (1.3 – 2.6 mmol/l or 4 – 8 mg/dl). Babington (2006) reported that the content of inorganic phosphate in blood is about 4 – 9 mg per 100ml depending on species and age. The mean values obtained for alkaline phosphatase in this study agreed with that of Tion and Njoku (2009) who reported values range of 1547.80 – 1796.30 iu/l.

The total protein mean values in this study agreed with that of McDonald (2005) who reported mean values of total protein for broiler chickens to range from 2.5 – 5.5 g/dl. Ugwuene (2011) reported mean values for broiler turkey to range from 4.70 – 5.80 g/dl.

CONCLUSION

The result of this study showed that at 2.5 Kg per 100 Kg diet, rock phosphate can be utilized without adverse effect on growth performance, carcass yield, blood, and bone characteristics. This also means that diets containing rock phosphate compete favourably with bone meal which served as a control and therefore is safe for broiler chicken production. All efforts should be promoted in finding out the effect of higher quantities of inclusion in broiler chicken diet and also finding procedures or techniques of removing/reducing fluorine content as the case may be from raw rock phosphate in order to increase its potential feed value for poultry industry.

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