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RAW ROCK PHOSPHATE AS SUBSTITUTE FOR BONE MEAL IN DIETS OF BROILER CHICKENS

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Target Audience: animal nutritionists, feedmillers, researchers

ABSTRACT

An experiment was conducted to determine the optimum replacement value of Raw Rock Phospohate (RRP) for bone meal in maize-cotton seed meal based diets. A total of 144 day old Anack 80 strain broiler chicks were used. Triplicate groups of 12 birds were randomly allotted on 4 diets containing 0, 1,1.5 and 2% RRP which contributed 0, 350, 525 and 700 mg/kg Fluorine (F) levels in the diets.
Results showed that when 1.5% RRP replaced equal amount of bone meal, weight gain and growth rate were not significantly different (P>0.05) from birds fed 3% bone meal control diet (i.e. 0% RRP). Inclusion of 1% RRP (i.e. 350mg/kg F) in the diet supported the highest growth rate during 0-4 week period, but it was not significantly different from birds fed the control or 1.5% RRP diets.. RRP at 2% (700mg/kg F) caused significantly (P<0.05) poorer performance than the other treatment groups. Feed intake was not significantly affected by dietary treatments. It was concluded from this study that 1.5% RRP appear to represent the upper limit that could subtitute equal amount of bone meal for adequate growth. This represented 50% replacement of bone meal by RRP in broiler diets. Broiler chicks appears to tolerate 525mg/kg F without detrimental effect on performance. However, 1% RRP (350mg/kg F) seemed to have stimulatory effect on growth and promoted optimum feed efficiency up to 4 weeks of age.

Key words: raw rock phosphate, substitute, bone meal, broiler chickens

DESCRIPTION OF PROBLEM

Phosphorus is an essential mineral along with calcium and magnesium in bone and egg formation and maintenance. It is also needed in energy metabolism, as a constituent of nucleic acids and phospholipids and in the synthesis of other organic compounds in the body. It is indispensable in the growth of young animals (1).

It has been reported that phosphorus represents the third most expensive nutrient following energy and protein (2). Leg weakness, with resultant increase in mortality, poor perofrmance of birds deficient in phosphorus,

pose a serious economic loss to the poultry industry (3).

Bone meal is the conventional source of dietary phosphorus in Nigeria livestock industry. There is shortage of bone meal, due in part to the loss of several thousands of cattle to rinderpest out-break in the '80s (4) and to frequent drought being experienced in the Northern part of the country, where majority of the large farm animals are located. This resulted in few number of large farm animals being slaughtered. Also, diversion of bones to other uses such as in the manufacture of porcelain, gelatin and the cutting of bones along with meat to provide bulk, which earns more revenue to butchers. This reduced avalability of bones for animal feeds has caused prohibitive price increase of bone meal in recent years from N800/tonne in 1992 to N8,000/tonne in 1995 (5). There is therfore an urgent need to explore other alternatives to bone meal as source of phoshorus supplement in farm animal diets.

Raw rock phosphate contains inorganic phosphorus and calcium in amount and proportion similar to bone meal. However, the flourine content of all calcium phosphate supplements must be considered when using them because high levels of flourine, especially in rock phosphate are detrimental to the well-being of animals (1).

Nigeria imports raw rock phosphate from Togo for the manufacture of single super phosphate fertilizer. Deposits of rock phosphate have been found in different parts of Nigeria, like Abeokuta in South West, in the Dahomeyan basin and Sokoto in the Illumedan basin (6). The discovery of rock phsphate deposit in different parts of Nigeria coupled with high cost of bone meal have stimulated this study which was aimed at:

1. Quantifying the optimum levels at which raw rock phosphate could serve as a substitute for bone meal in broiler diets.

2. Determining levels of flourine in RRP which could be tolerated by broiler birds and study the effects on body weight gain, feed intake and feed efficiency.

MATERIALS AND METHODS

Chemical analysis of raw rock phosphate and ashed bone meal were carried out before being incoporated into the various diets. A total of 144 day-old Anack 80 strain broiler chicks were used in the study. Triplicate groups of 12 birds were randomly placed on four diets, such that group average weights at day-old were similar.

The composition of maize-cottonseed meal basal diets used in this experiment are presented in Table 1. Day-old broiler chicks were placed on four dietary treatments containing 0, 1, 1.5 and 2% RRP which contributed 0, 350, 525, 700 ppm Flourine levels, respectively. The RRP inclusion replaced equal quantities of bone meal. Levels of calcium and phosphorus in the diet were

within the range of broiler chicks requirements as recommended by N.R.C. (7).

Table 1: Experimental diets for broiler starter (0-4 weeks) and finisher (5-6 weeks) periods.

	Starter Diets				Finisher Diets			
Ingredients (%)	1	2	3	4	1	2	3	4
Maize	55.60	55.60	55.60	55.60	65.60	65.60	65.60	65.60
Cotton seed meal	40.50	40.50	40.50	40.50	30.50	30.50	30.50	30.50
Bone meal	3.00	2.00	1.50	1.00	3.00	2.00	1.50	1.00
Raw rock Phosphate (RRP)	—	1.00	1.50	2.00	—	1.00	1.50	2.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Oil	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Vitamin/TM Premix *	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis of diets								
Crude protein %	23.12	23.07	23.12	23.12	19.50	19.50	19.50	19.50
ME Kcal/kg	2907.95	2907.95	2907.80	2907.95	3007.65	3007.65	3007.65	3007.65
Crude fibre %	7.06	7.06	7.06	7.06	5.92	5.92	5.92	5.92
Calcium %	1.12	1.16	1.30	1.16	1.10	1.10	1.10	1.10
Phosphorus %	0.69	0.16	0.69	0.69	0.67	0.67	0.67	0.67
Florine (mg/kg)	—	350	525	700	—	350	525	700
Lysine %	1.17	1.17	1.17	1.17	1.10	1.10	1.10	1.10
Methionine+ Cystine	0.83	0.83	0.83	0.83	0.75	0.75	0.75	0.75

* 1kg of premix supplied the following:- Vit. A (stabilized) 6,670,000I.U., Vit. D (stabilized) 1,500,000I.U., Vit E (Stabilized) 3,340 I. U., Vit. K. (Stabilized) 1,340mg, Vit. B_2 3000mg, Vit. B_6 2000mg Niacin - 14,670mg; Calcium D-pantothenate 4000mg, Vit. B_{12} 8mg, Choline chloride 133, 400mg, Anti-oxidant - 6,600mg; Manganese 53,340mg, Iron 33,340mg; Zinc 26,670mg;Copper 1,600mg, Iodine 934mg, Cobalt 134mg, Selenium 34mg.

Each bird was tagged and weighed individually on weekly basis. The parameters measured incluse body weight gain, feed consumption, feed efficiency and mortality. The experiment was terminated when signs of newcastle disease were noticed in the test birds.

All data collected were subjected to analysis of variance (8) and means were separated using the least significantly different test (9).

RESULTS AND DISCUSSION

The chemical composition of raw rock phosphate is shown in Table 2. It contained 37.7% Ca, 15.8%P and 3.65%F. Phosphorus from this inorganic source was assumed to be totally available.

Table 2. Analysis of raw rock phosphate (RRP) and ashed bone meal

Minerals	RRP (%)	Ashed bone meal (%)
Calcium	37.70	35.94
Phosphorus	15.80	16.82
Flourine	3.65	0.362
$Fe_2 0_3$	1.20	—
$AI_2 0_3$	0.89	—
Mg	0.25	0.50
SO_3	0.64	—
$Si0_2$	2.34	—
Zn	—	0.435
Mn	—	0.047

Performance of chicks during 0 - 4 Weeks

Performance of chicks during 0-4 weeks is presented in Table 3. Body weight gain and growth data showed that the groups on diets containing 1% and 1.5% RRP were not significantly different ($P > 0.05$) from the group on the control diet, but were significantly superior to the chicks that were fed on 2% RRP diet. However, groups on 1.5% and 2% RRP diets were not significantly different ($P > 0.05$) in weight gain. Birds on the highest flourine level (700gm/kg F) had the least weight gain values. This observation tended to implicate the toxic effect of high flourine level contained in the diet at the early growth period of broiler chicks. The highest weight gain recorded by chicks on 1% RRP diet compared with those observed for turkey chicks (0-4 weeks) fed diet containing concentrated super-phosphate 670mg/kg F (10). The super phosphate diet was not toxic to turkeys during the short period (0-4 weeks) of feeding. In another study (11), no significant differences ($P > 0.05$) were observed in early growth (0-8 weeks) of growing pullets fed 0.6, 1.2 and 1.8% RRP in the diets.

Table 3. **Performance of 0-4 week old broiler chicks under various RRP supplemented diets.**

RRP in diet (%)	Mean body wt. at 4 weeks (g)	Body wt. gain (g)	Wt. Gain /bird/ day (g)	Mean feed consumption (g)	Feed intake/ bird/day (g)	Feed conversion (feed/gain)
0	634.10	588.16[a]	21.01[a]	1111.68	39.70	1.89b
1(35mg/kg F)	671.89	626.03[a]	22.36[a]	1058.03	37.77	1.53a
1.5(525mg/kg F)	611.60	561.59[ab]	20.06[ab]	1084.38	38.73	1.93b
2(700mg/kg F)	563.0	507.92[b]	18.14[b]	1248.00	44.59	2.46c
SEM[1]	37.58	34.33	71.22	78.03	2.79	0.11

a,b,c, Means in the same column with the same superscripts are not significantly different (P>0.05)
[1]SEM: Standard Error of Means

Feed intake showed no significant differences (P>0.05) with the varying levels of raw rock phosphate in the diets during the 0-4 weeks period (Table 3). However, feed conversion data showed that the group on 1% raw rock phosphate were significantly (P<0.01) superior to the groups on other other dietary treatments. There was no significant difference between birds on 1.5% raw rock phosphate and those fed the control diet, but the group that was on the 2% RRP diet (700mg/kg F) significantly (P<0.01) had the poorest feed conversion ratio compared to the other dietary treatments. It had earlier been reported that no apparent differences were noticed in feed efficiency of growing pullets fed 0, 0.6,1.2 and 1.8% raw rock phospphate in the diets during 0.-8 weeks of age (11). The contrast in the results could be due to the fact that pullets which were used in their study might have had highertolerance level (700mg/kg F) than broiler chicks (400mg/kg F) to flourine toxicity (12). The superior feed effciency noticed in the group on 1% raw rock phosphate could be related to their high body weight gain (626.026g) and growth rate per day (22.356g). This observation seems to suggest a stimulatory effect of flourine at low level on rate of growth during early growing period (0-4 weeks).

Performance of Chicks during 5-6 weeks

The results of the effects of varying raw rock phosphate levels on body weight gain, feed consumption and feed conversion at six weeks of age are presented in Table 4.

Table 4: Performance of 5-6 weeks old broiler chicks under various RRP supplemented Diets.

RRP in diet %	Body wt. Gain (g)	Wt Gain/ bird/day (g)	Mean feed consumption (g)	Feed intake / bird/day (g)	Feed conversion (feed/ gain)
0	270.12[a]	19.29[a]	566.88	40.49	2.10[a]
1(350mg/kg F)	221.55[b]	15.83[b]	513.60	36.68	2.32[b]
1.5(525 mg/kg F)	215.48[b]	15.39[b]	551.48	39.39	2.56[c]
2(700mg/kgF)	188.97[c]	13.50-[c]	548.90	39.21	2.90[d]
SEM[1]	10.16	0.72	27.48	1.96	0.00

a,b,c,d, Mmeans in the same colum with the same superscripts are not significantly different (P>0.05)

[1]SEM: Standard Error of Means

Results showed the group that were fed on 2% RRP (700mg/kg F) significantly (P<0.05) had the lowest value for body weight gain (188.966g) compared to other groups. However, the group on diets containing 1.5% RRP were not significantly different, but were both significantly inferior to the group on the control diet. Growth stimulatory effects observed in the group fed 1% RRP diet during the early period of growth were not observed during this stage. Rather, growth depression was noticed with increasing levels of added RRP in the diets (Table 4).

This result tends to be in agreement with that reported for turkey fed diets containing 400 and 800ppmF from sodium floride added to the diets which gave significantly lower body weight at 8 weeks than turkey fed on 500mg/kg F diet (3). The reason for this growth depression could possibly be due to the cumultive toxic effect of flourine as the broiler chicks advanced in age.

There were no significant differences (P>0.05) among the four dietary treatment groups in feed intake. This observation was in agreement with earlier findings (11). However, the feed conversion showed a significantly (P<0.01) higher feed-to-gain ratio with increasing levels of RRP added to diets indicating poor feed utilization. This observation could be explained by the report that approximately 99% of the flourine retained in the normal body is stored in the bone (13). Sequestering of flourine by the skeleton is influenced by previous flourine exposure, skeletal fluorine concentration and age of the individual. Hence, as the chicks advanced in age with continous raw rock phosphate intake, there was cumulative flourine toxic effect on their feed utilization efficiency.

Performance of Chicks during 0-6 Weeks

Summary data on overall performance of chicks from day old to the end of experimental period is presented in Table 5. Body weight gain was not significantly different (P >0.05) from the control when RRP was used at 1 or 1.5 % in diet contributing 350 or 525 mg/kg F respectively, in the diet. Weight gain was significantly depressed when 2% RRP (700mg/kg F) was fed to broiler chicks. About 500mg/kg of flourine in diets of broiler chicks had been reproted to depress growth but that 350mg/kg had no ill effect (14). The result of this experiment was in agreement with their observation except that birds that were on the diet containing 525mg/kg F performed well.

Table 5: Performance of 0-6 weeks old broiler chicks under various RRP supplemented Diets.

RRP in diet %	Mean body wt. at 6 weeks (g)	Wt. gain 0-6 Wks (g)	Wt Gain bird/ day (g)	Mean feed consumption (g)	Feed intake/ bird/day (g)	Feed conversion (feed/gain)
0	.904.23^{a}	860.88^{a}	20.50^{a}	1619.16	38.55	1.88^{a}
1(350mg/kg F)	893.11^{a}	874.57^{a}	20.18^{a}	1574.19	37.48	1.89^{a}
1.5(525 mg/kg F)	823.58^{ab}	779.48^{ab}	18.56^{ab}	1658.18	39.48	2.12^{b}
2(700mg/kgF)	752.00^{b}	705.80^{b}	16.80^{b}	1627.18	38.74	2.31^{c}
SEM[1]	40.10	37.77	0.90	82.18	1.96	0.01

a,b,c (g) Means in the same coloum with the same superscripts are not significantly different (P>0.05)
[1]SEM: Standard Error of Means

Feed intake was not significantly different (P>0.05) from the control when RRP at 1,1.5 and 2% levels were added to diets. However feed conversion was significantly (P<0.01) depressed compared to the control when 1.5 and 2% RRP were fed to broiler chicks. This observation was in agreement with the poor feed efficiency / conversion observed among growing pullets on high dietary flourine level (684mg/kg) at 20 weeks of age (11). The study also reported a reduced feed efficiency / conversion in turkey fed 800mg/ kg dietary flourine from sodium flouride. Mortality recorded during the entire experimental period (0-6 weeks) is showned that the highest mortality percentage (11.1 %) was recorded in the group fed on 2% RRP (700mg/kg F) and was followed by the group on 1.5% RRP (525mg/kg F) diet. Mortality recorded for the group on 1% RRP (350mg/kg F) and control diets were the same. On the contrary, the mortality records reported in the experiment with growing pullets were not related to the level of flourine in the treatments (11). The highest percent age mortality noticed with the group on the highest flourine level in this study could be due to the broiler strains used which might have lower tolerance for flourince toxicity than pullets. Also, feed intake of broilers is higher than that of pullets, and thus, more flourine accumulation in the body would be expected, which could lead to toxicity.

CONCLUSION AND APPLICATIONS

1. This study showed that young broiler chicks (0-4 weeks) tolerated RRP up to 1.5% (525mg/kg F) and performed well. When 2% RRP (700mg/kg F) was in diet, growth and feed efficiency/conversion were depressed significantly ($P<0.05$) compared with the group on the control diet.

2. During five to six week period, inclusion of RRP at 1,1.5 and 2% significantly depressed growth compared with the control group. Feed conversion/efficiency was also depressed with increasing levels of added RRP in the diets.

3. Overall results during 0-6 weeks showed no significant differences ($P>0.05$) among treatment groups up to 1.5% RRP (525mg/kgF) in the diets, with respect to body weight gain and growth.

4. RRP at 2% (700mg/kgF) significantly ($P<0.05$) reduced weight gain. Feed conversion/efficiency was significantly depressed by inclusion of RRP at 1.5 and 2% levels during the 0-6 weeks period.

5. Based on this result, raw rock phosphate at 1.5% level can replace equal amount of bone meal for adequate growth. This level represent 50% replacement of bone meal in broiler diets.

6. Dietary flourine level for optimum perfomance apperar to be 350mg/kg F in broilers. However, 525mg/kgF could be tolerated with no adverse effect.

REFERENCES

1. **Olomu, J.M.** 1995. Monogastric nutrition: principles and practice. University of Benin. AJACHEM Publications, Nigeria.
2. **Potchanakorn, M.and Potter, L.M,** 1987. Biological values of phosphorus from various sources for young turkeys. Poult. Sci. 66(3): 505-513
3. **Nahorniak, N.A.; Waibel, P.E.; Olson, W.G; Walser, M.M and Dziuk, H.E.** 1983. Effect of dietary sodium flourine on growth and bone development in growing turkeys. Poult. Sci 62:2048-2049.
4. **NLPD,** 1982. National Livestock Project Department Annual Report, 1982. Federal Livestock Department, Nigeria.
5. **Abubakar, B.Y.** 1997. Towards Sustainable peri-urban poultry production in Nigeria. An invited paper presented at the 22nd Annual Conference of Nigerian Society for Animal Production, held at ATBU, Bauchi, 23-27 March, 1997.
6. **Kogbe, C.A.** 1981. The geology of the Sokoto East (Sokoto) sector of the Illemmedan Basin. Bulletin, Dept. of Geology, Ahmadu Bello University, Zaria, Vol. 2 No.1.
7. **National Research Council,** 1984. Nutrient requirement of poultry. 8th Ed. National Academy Press Washington, D.C.
8. **Snedecor, G.W. and Cochran, W.G.,** 1967. Statistical methods. 6th Ed. Iowa State University Press, Ames, Iowa.

9. **Steel, R.G.D. and Torrie, J.H.** 1980. Principles and procedures of Statistics. A metrical approach. 2nd Ed. Mc Graw Hill Book Company Inc. New York, Toronto and London.

10 **Cakir, A, Sullivan, T.W., and Mather, F.B.,** 1978. Allevation of flourine toxicity in Starting turkeys and chicks with Aluminium. Poult. Sci 57:498-505.

11. **Said, N.W.; Sunde, M.L.; Bird, H.B. and Suttie, J.W.** 1979. Raw rock phosphate as phosphorus supplement for growing pullet layers. Poultry Sci. 58: 1557-1563.

12. **Agricultural Research Council (ARC)** 1975. The nutrient requirement of farm livestock No. 1 Poultry, London HMS Office.

13. **National Research Council (NRC)** 1974. Effects of flourides in Animals. National Academy of Sciences, Washington, D.C. P.3-10.

14. **Weber, C.W. Doberenz, A.R. and Reid, B.L.** 1969. Flouride toxicity in the chick. Poult. Sci. 48:230-235