
The effects of limestone sources as calcium source on the performance and eggshell quality of laying chickens

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Abstract

Two hundred and twenty four pullets of shaver Star Cross 579 x Hubbard Golden Comet, that were 30 weeks of age and laying at 50% hen day production, were utilized in a completely randomized design to assess the suitability of limestone sources (procured from different cement factories) for laying hen performance and eggshell quality. Oystershell and bone meal were used in the control diet. Results showed that there were no significant ($P > 0.05$) differences between the treatment mean values for initial body weight of chicken, egg production, feed per dozen eggs, eggshell thickness and eggshell percentage. However, feed intake, final body weight and egg weight varied significantly ($P < 0.05$) among diets. Generally, diets that produced numerically higher rate of egg production resulted in significantly ($P < 0.05$) smaller egg weights.

Key Words: Limestone sources, laying hen performance, eggshell quality.

Introduction

The laying hen can metabolize large amounts of calcium (Ca) for eggshell formation. For this reason, it is able to tolerate wide Ca to phosphorus (P) ratio of diets. Since the advent of commercial poultry production in this country, the quest into local sources of feedstuff for livestock generally, and poultry in particular, has increased in order to reduce dependence on imported sources. Apparently, not much work has been carried out in the area of local sources for mineral nutrients. One of the macro-mineral that could be investigated because of its abundance locally is Ca, which abounds in limestone deposits. Other sources for this mineral resource in this country include oystershell and periwinkle shell. Nigeria has several limestone deposits, some of which have attracted cement factory

establishments. Some of these deposits include, Ashaka, Calabar, Jakura (marble), Sokoto, Ukpila and Yandev. Not much has been done to determine the quality of these deposits as Ca sources for livestock rations generally and poultry in particular, where Ca accounts for about 80% of the total mineral components of the layer diets. Limestone deposits may also contain other minerals (fluorine, selenium) that may be toxic even at low levels in poultry diets. It has been pointed out (Iowa Limestone Company, 1974) that, not all limestone sources are high enough in Ca content to be considered adequate for inclusion in poultry diets. Limestone should contain about 38% Ca (95% calcium carbonate) to be considered a good source. Spesfeed (2000) reported that South African commercial limestone is registered according to Ca content

(38%, 36%, 34%, 32%) and advised poultry farmers to go for the 38% Ca limestone. The evaluation of the country's deposits to establish good sources will certainly contribute to price reduction in feed since these deposits will be within easy of local farmers. Kuhl (1976) reported that limestone and oystershell are the primary source of calcium in the laying hen diet because they are most economical. Miller and Sunde (1972) concluded that, even though much data have shown that oystershell is equal or superior to limestone, the feed mill industry uses predominantly limestone in mixed rations for poultry because, oystershell is more expensive than limestone and small feed mills are not equipped to handle oystershell as Ca source in poultry diets.

Oystershell has gained universal acceptance as a good calcium source for poultry. It has been reported (Charles *et al* 1982 Bardley and Krueger, 1982) that oystershell is more beneficial to laying hen for eggshell quality than limestone. Roland (1986) pointed out that part of the inconsistency in the earlier experiments dealing with various limestone sources was due to variation in their physical and chemical characteristics. Tion *et al* (2005) and Wuanor (2005) stated that the solubility of Ca sources was important in determining Ca availability from such sources for metabolic functions. Tion *et al* (2005) tested the *in vitro* solubility, and bioavailability of Ca sources used in this study. They reported low solubility rate (35 to 38%) for the sources except dicalcium phosphate which had solubility rate of 78.9%. However, the

bioavailability rates of the sources were high, (87% to 92%). The objective of the study was to sample out representative limestone deposits that occur in this country, chemically analyze each sample for notable mineral content, and biologically assay the sample using the performance and eggshell quality traits of laying hens to isolate the deposit(s) that may be good calcium sources for layer diets.

Materials and Methods

Samples of limestone were acquired from cement factories of Ashaka, Calabar, Jakura (marble), Sokoto, Ukpila and Yandev, and analyzed for Calcium (Ca), Magnesium (Mg), iron (Fe), Manganese (Mn), Zinc (Zn), and Copper (Cu) contents. It was not possible to analyze for Fluorine and Selenium.

Two hundred and twenty four (224) pullets of Shaver Star Cross 579 x Hubbard Golden Cement, thirty (30) weeks of age and laying at 50% hen day production rate were utilized for the study using completely randomized design. Birds were assigned at random to twenty eight pens and each pen contained eight pullets. Each pen measure 3.05 x 1.25cm². Pullets were leg banded with identification numbers and weighed individually. Seven diets were assigned at random to the 28 pens such that each diet had four replicate pens and 32 pullets. The house used was an open sided poultry house equipped with laying nests, galvanized hanging feeders and plastic drinkers. Feeders were routinely adjusted so that the based pan leveled with the back of birds to minimize feed wastage. Diets were

formulated to meet the laying bird's requirement. The 6 limestone samples accounted for the diets, the seventh diet was control. Oystershell and bone meal were used in the control diet since the ingredients are in common use in this country in layer rations. Dicalcium phosphate and limestone samples were used in the test diets. Feed and water were provided *ad libitum*. The composition of the experimental diets is provided in table 1. Eggs were collected twice daily at 8.00 and 14.00 hours. Eggs collected from each pen were weighed collectively at the end of each day using a sensitive scale. At the end of each 28-day period, two egg were selected at random from each pen's collection, thus 8 eggs per treatment

were selected each day for three successive days for eggshell quality determination (Keshavarz and Ackerman, 1984). Each egg was broken out at the equatorial region (Keshavarz 1986). Eggshells were cleaned out with toilet tissue paper and dried at 1000°C for 20 minutes, cooled in the open air of the room and shell weight and shell thicknesses were taken. Each eggshell was measured at three different places along the equatorial region with the aid of a micrometer (Ames Waltham Massachusetts). Feed intake was determined at the end of each 28-day period and efficiency of feed utilization was determined. At the end of 6 months of birds on the study, birds were weighed individually and the change in weight was determined.

Table 1: The composition of the layer diets.

Feed Ingredients	Limestone sources						
	Control	Ashaka	Calabar	Jakura	Sokoto	Ukpila	Yanadev
Decolcated							
Cotton seed cake	33.00	33.00	33.00	33.00	33.00	33.00	33.00
Maize	55.00	55.24	55.33	55.68	55.43	55.59	55.49
Bone meal	3.00	-	-	-	-	-	-
Oyster shell	7.74	-	-	-	-	-	-
Dical phosphate	-	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	-	7.50	7.41	7.06	7.31	7.15	7.25
Salt	0.25	2.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Methionine	0.18	0.18	0.18	0.18	0.18	0.18	0.18
*Premix	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	100	100	100	100	100	100	100
Determined analysis (DM basis)							
Crude Protein %	17.14	17.88	17.59	17.81	17.19	17.11	17.09
**Energy Kcal/Kg							
ME %	2620	2650	27701	2725	2660	2680	2705
Calcium %	3.65	3.56	3.61	3.79	3.71	3.71	3.52
Phosphorus %	0.66	0.71	0.72	0.68	0.75	0.69	0.80

** Calculated using Pauzenga (1985) formula Kcal/Kg ME = (37x% CP + 81.8x% EE + 33.5x% NFE)

* Premix (F. & H. and) supplied the following additional nutrients per kg of diet:

Vit. A = 10,000 IU; D₃ = 200 IU; E = 10 IU; K = 2mg; B₁ = 1.5mg; B₂ = 4mg; B₆ = 15mg;

B₁₂ = 0.01mg; Panthothenic acid = 5mg; folic acid = 0.5mg; Biotin = 0.02; Minerals, Choline chloride = 0.02mg; Nic = 0.02mg;

Co = 0.02mg; Fe = 0.02mg; Cu = 0.005mg; Se = 0.02mg; Co = 0.2mg.

Data collected from all parameters were subjected to the ANOVA using the Completely randomized design, and significant treatment mean values were separated using the Duncan's New Multiple Range Test as outlined by Steel and Torrie (1980), for both procedures.

Results and Discussion

The result of analysis of some mineral composition of the limestone sources is presented in table 2. Result show in general that the minerals analyzed for, would not present apparent problems of toxicity at the levels of inclusion in the diets. The analyzed minerals including those not analyzed for (fluorine and Selenium), have been shown to be toxic mostly to immature chickens and hatchability at practical levels (Scoot *et al* 1982, Guenter and Hahn, 1986, and NRC 1994). Moreover, the fact that there was no mortality due to the diet during the period of the study on all diets attests to the fact that the levels of the minerals incorporated in the diets were nonlethal. The influence of all sources on performance was similar to that of the control (diet 1) that contained no limestone.

The result of hen day production (Table 3) was not significantly different ($P>0.05$) among

the different calcium sources although numerical differences existed. Contrary to published reports that oystershell was superior to limestone in enhancing egg production (Duke and Charles 1981, Charles *et al* 1982, and Hamilton *et al* 1985), there was no significant difference between limestone diets and the oystershell containing diet (control). Finding in this study are similar to those reported by Kuhl and Sullivan (1977), and March and Amin (1981). They reported that, there was no significant difference between sources (limestone and oystershell) on egg production.

Feed intake was not significantly ($P>0.05$), affected by limestone and oystershell calcium sources generally, and among the different limestone sources studied. All the limestone sources and oystershell were in pulverized forms, but some limestone sources were more powdery as procured than others. Therefore, diet 5 (Sokoto source) was highly pulverized and this made the feed bulkier. Birds fed this diet selected feed particles resulting in physical separation which caused the limestone flour to settle at the bottom of the feeders. The same effect of feed separation was not apparent on other diets. Generally, feed consumption values reported in the study are

Table 2: Mineral composition of the limestone samples

Limestone Deposits	Ca %	Mg %	Fe Mg/Kg	Mn Mg/Kg	Zn Mg/Kg	Cu Mg/Kg
Ashaka	37.5	0.3	150.8	557.1	-	-
Calabar	37.8	0.7	761.7	703.5	-	-
Jakura	39.5	0.2	258.3	354.3	28.1	-
Sokoto	38.2	0.5	254.9	-	-	-
Ukpila	38.8	0.3	232.4	400.9	18.2	-
Yandev	38.5	0.4	338.5	-	74.3	-

Table 3: The effect of calcium sources on performance and changes in body weights of laying chickens

Calcium Source	Diet no.	Average hen day Production %	Average feed intake/hen/day (g)	Average feed (g)/dozen eggs	Average initial body weight	Average final body weight
Oystershell	1	67.49	102 ^d	1917	1.54	1.73 ^b
Ashaka	2	67.37	105 ^b	1975	1.56	1.77 ^b
Calabar	3	62.94	110 ^a	2120	1.64	1.89 ^{ab}
Jakura	4	67.41	111 ^a	1976	1.57	1.87 ^{ab}
Sokoto	5	61.03	97 ^e	2004	1.58	1.80 ^b
Ukpila	6	65.31	104 ^{bc}	1997	1.58	1.93 ^a
Yandez	7	66.13	103 ^{cd}	2023	1.53	1.88 ^{ab}
	SEM	2.63	0.5	35.20	0.04	0.04

Mean values within a column with similar or without superscript do not differ significantly ($P > 0.05$). SEM = Standard Error Means.

lower than values reported on deep litter floor experiments in this country. This may be due in part, to the more efficient feed management system employed.

-Efficiency of feed utilization was not affected in the different diets used. Feed (g)/dozen eggs was generally within reported values for the tropics (1.8:1, Oluyemi and Roberts, 1988; 1.91-2.62:1, Ezieshi *et al* 2001). Efficiency of feed conversion following the trend of egg production. Birds fed diets that had numerically higher rate of egg production tended to have better feed/dozen eggs. Other workers (Olomu 1979, and Nwazotá, 1987) have reported feed/dozen egg values similar to the value reported in this study. Body weight at the start of the study did not differ significantly, indication the level of uniformity among the different dietary groups. At the end of the study, body weight

showed significant difference among the different dietary regimes. Birds fed diets contain most limestone sources were significantly heavier ($P < 0.05$) than the oystershell (control diet 1). Generally, the average body weights of all birds were within the mean values for such crosses in this country, indicating that birds fed all diets utilized feed for egg production quite efficiently. There was also an indication that birds fed oystershell diets (control diet 1) changed the least, which indicated that these birds were more efficient in maintaining body weight during the period of the study. Laying chickens are not expected to change much during the laying period. Much of the change in body weight of laying chickens is attributable to fat deposition, which is not a desirable characteristic for layers.

Egg weight showed significant ($P < 0.05$) differences among the treatment mean values.

The effect of limestone sources on performance of layers

Table 4: The effect of calcium source on external egg traits of laying chickens

Calcium source	Diet no.	Egg weight	Eggshell thickness	% eggshell
Oystershell	1	56.11 ^b	0.372	9.07
Ashaka	2	56.92 ^b	0.368	9.12
Calabar	3	58.13 ^{ab}	0.382	9.26
Jakura	4	55.93 ^b	0.378	9.37
Sokoto	5	58.35 ^a	0.379	9.16
Ukpila	6	57.04 ^{bc}	0.362	9.04
Yandez	7	58.73 ^a	0.372	8.92
	SEM	0.42	0.01	0.32

Mean values within a column with similar or without superscript do not differ significantly ($P>0.05$).
SEM= Standard Error Means.

Birds fed diet 3 (Calabar source), 5 (Sokoto source) and 7 (Yandez source) laid eggs with significantly ($P<0.05$) heavier weights. Generally, diets that had numerically lower production values produced heavier eggs. Kuhl and Sullivan (1977) observed a similar effect. They suggested that, the heavier egg weight was not a dietary effect but a function of egg number. As such, birds that have fewer numbers of eggs in the clutch will lay heavier eggs. Contrary to reports that oystershell improved egg weight over limestone (Quinsenbeny *et al* (1969), the incorporated oystershell (control, diet 1) produced eggs that had lower egg weight than some limestone sources.

Shell thickness represents eggshell and membrane. There were no significant ($P>0.05$) differences among the treatment means values. The values reported in this study are better than the 0.34mm reported for the tropical environment (Oluyemi and Roberts 1988). Tion and Orga

(2004) observed that reported values for shell thickness in this country vary considerably but are generally within the 0.35 mm – 0.40mm suggested as adequate for shell thickness values (USDA as cited by North, 1981).

Conclusion/ Recommendation

The study indicates that the limestone sources produced from the cement factories can be used effectively for egg production and eggshell quality provided that the calcium content of limestone is high enough (38% Ca or 95% calcium carbonate). The limestones which occur in different parts of this country would be within close proximity to some poultry farmers in these localities, and the use of these limestone sources will reduce the cost of procurement of calcium source and make feed production for layers less costly in such areas. The use of local limestone sources will have beneficial effect on especially small scale egg producers who are home made

feed and this will translate into better profit margin on investment in egg production.

Ashaka limestone is located in Gombe State and may serve farmers from the North East. Calabar limestone is located in Cross Rivers State and can serve poultry farmers from the South-South and parts of the South East. Jakura (Lokoja) is located in Kogi State where farmers from this and neighbouring States can benefit. Sokoto in Sokoto State may serve poultry farmers of North West State. Ukppila in Edo State can serve poultry farmers from the nearby areas, and Yandev in Benue State can serve poultry farmers in the North-Central State.

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