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Effect of formulated ration with inclusion of different calcium sources on the egg quality, productivity, and blood calcium level of chicken

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Abstract

This study was conducted to determine the effect of formulated ration using locally available feedstuffs with the inclusion of different calcium sources on the performance of layer chicken. Egg quality, production performance, the blood calcium level of chicken, egg fertility, hatchability, and cost of feeds to produce a kilogram of eggs were evaluated. One hundred twenty (120) 25-wk-old birds were randomly divided into 4 groups. Treatment 1 was provided with a commercial layer feed, whereas Treatment 2, 3, and 4 were fed with formulated diets using locally available feed ingredients with limestone, ground eggshell and ground snail shell, respectively. Throughout the 3-month feeding trial, laying performance, egg weight, egg mass, egg fertility, and hatchability of eggs starting at the 25th week of age were not significantly affected by the dietary treatments. Percentages of eggshell and eggshell thickness were not affected by the treatment diets while egg yolk color in treatments using formulated ration was significantly darker than the commercial feeds. At the end of the trial, blood calcium level results were not significantly different among all treatments. Results indicate that eggshells and snail shells can be fully used as a calcium source in layer diets like limestone without detrimental effects on productive traits, egg and eggshell quality, egg fertility, hatchability, and blood calcium level. Feeding formulated feeds to layer chicken using local ingredients can reduce the cost of production and increases the sustainability of animal production.

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Introduction

Chicken (*Gallus gallus domesticus*) is popularly raised by Filipinos in their backyards. It provides an additional livelihood to about 2.5 million Filipinos PCARRD, (2007). Most chickens are raised for their meat and eggs. The importance of the chicken industry in the country cannot be overemphasized, considering its contribution to the total stock of poultry.

As feed constitutes 60 to 70 percent of the total cost of production, any attempt to reduce the feed cost may lead to a significant reduction in the total cost of production. The traditional sources of vitamins and proteins used in poultry rations such as fish meal, meat and bone meal, soybean meal, groundnut cake, etc. are becoming expensive G. Thirumalaisamy *et al.* (2016). Hence, the search for alternative feed sources has become inevitable to reduce feed costs Swain *et al.* (2014). Use of locally available feedstuffs, agricultural by-products, and forages could be used as a substitute for some expensive feed ingredients during formulation.

Poor eggshell quality resulting in broken and cracked eggs is considered the major economic loss to egg producers. There are numerous factors involved in the eggshell formation and its subsequent quality. One of the macro factors includes the source and level of calcium in the diet. Calcium is used for bone formation, eggshell production and blood clotting. It is comprised mainly of calcium phosphate with some calcium carbonate. The shell deposition and shell quality are directly related to the calcium level in the diet (Ousterhout, 1980).

Calcium is required for several metabolic functions in poultry Nunes *et al.* (2006) and to ensure good eggshell quality. Its functions are also associated with phosphorus and synthesis, blood calcium is rapidly mobilized, thereby reducing its levels. This stimulates the secretion of the parathyroid hormone (PTH), which promotes bone resorption to reestablish calcium homeostasis Pelícia *et al.* (2009). The high rates of bone resorption during lay result in bone weakness in layers by the end of their production cycle (Whitehead, 2004).

In terms of the health condition of the animals, hypocalcemia occurs when chickens' blood-calcium levels are dangerously low. It is mainly a problem in hens because egg-laying requires calcium to form the eggshell, resulting in depletion of it from her own body.

This study aims to determine the effect of formulated ration using locally available feedstuffs with limestone, dried egg shell, and golden apple snail shell as calcium sources on the blood Ca level, egg quality, and productivity of chicken.

Materials and methods

Experimental animals

A total of one hundred twenty (120), 25-week-old Black Australorp were used in the study. Black Australorps are a dual-purpose breed raised for both meat and egg production. They are large, heavy, and soft-feathered with black plumage and an intense beetle-green sheen color. They are known for their excellent egg production with an average of 200 - 250 eggs per year. Black Australorp hens lay medium-sized and light-brown colored eggs.

Experimental treatments

Experimental treatments in the study were as follows:

T1- commercial feeds (control)
T2- formulated ration with limestone
T3- formulated ration with egg shell
T4- formulated ration with snail shell

Experimental site

This study was conducted on-station at DA-CLIARC Upland Sto. Niño, Magalang, Pampanga with an average rainfall of 75.359 mm, the dry season is from November to May and the wet season is from June to October. The average minimum and maximum temperatures during the experimental period were 22 and 31°C, with an average temperature of 26.5°C.

Experimental design and Analysis

The study was laid out in a Randomized Complete Block Design and data gathered were analyzed using statistical tools for agricultural research (STAR 2.0.1) software developed by International Rice Research Institute.

Proximate Analysis of the Formulated Ration

Proximate analysis of the treatment diets was done at the Department of Agriculture- Regional Feed Laboratory through oven-drying method (Moisture), Kjeldahl method (crude protein), Furnace ignition method (Ash), ANKOM filter bag technology (crude fat and crude fiber).

Gathering and preparation of feed ingredients

Feed ingredients such as ipil-ipil, trichantera, moringa, and mulberry used in the study were gathered inside the station and within the nearest barangays. They were processed through drying and pulverizing before mixing the experimental ration. Individual feed ingredients were submitted to the feed laboratory for proximate analysis to determine their nutrient content as the basis in feed formulation.

Preparation of calcium sources

Locally available calcium sources such as egg shells and snail shells were collected from the station chick's hatchery and rice fields, respectively. Eggshells and snail shells were washed with tap water and boiled with water for 2 hours, and then dried before pulverizing.

Preparation of experimental feeds

Feed ingredients and different calcium sources were weighed properly following the recommended formulation and mixed using a feed mixer. Treatment diets were pelletized and sundried to reduce the moisture and thus, prevent the rapid growth of molds and the development of mycotoxins. Formulated feeds were then subjected to proximate analysis in the Department of Agriculture - Regional Feed Laboratory.

Feeding trial

The feeding trial period was 3 months with fourteen days adjustment period. Animals were randomly allotted to four experimental diets to correspond to the respective dietary treatment. Feeding was done twice a day, at 8:00 o'clock in the morning and 3:00 o'clock in the afternoon while fresh drinking water was provided at all times. All diets were given ad libitum in pelleted form to laying hens from 25 to 40 week of age in which the performance of laying was monitored.

Management

Experimental animals were housed in a 6 x 7 feet pen per treatment. Each pen was equipped with a feeder and drinker which allowed chicken with ad libitum access to feed and water throughout the experimental period. Feeding and water trough were washed and disinfected every day including housing and the surroundings.

Data gathering

Feed intake, egg production, and egg weight were recorded daily. Egg yolk color and shell thickness were determined at the last week of the trial. Five (5) randomly selected eggs from each replicate were weighed and broken. Egg yolk color was measured using DSM egg yolk color fan while shell thickness was measured using a digital vernier caliper. In determining the percent egg fertility and hatchability, collected eggs from each replicate were labeled and set in the incubator every five days while feed conversion ratios, percent egg production, egg mass, and feed cost to produce a kilogram of egg were calculated at the end of the study.

Percent Egg production

Total eggs collected per day divided by the number of layers x 100

$$\frac{\text{Average Daily Egg Produce}}{\text{Total no. of hens lay}} \text{ x } 100$$

Feed conversion ratio

The feed conversion ratio of each animal was calculated as the ratio between feed intake and body weight gain.

$$\text{FCR} = \frac{\text{Total feed intake}}{\text{Total egg mass (kg)}}$$

Egg quality

This was taken before the end of the study, using a DSM egg yolk color fan, weighing scale and vernier caliper. Five sample eggs were weighed from each replication, and then they were broken to measure the parameters. The average egg yolk color and eggshell thickness were computed by dividing the total thickness of the eggs to the total number of eggs measured.

$$\frac{\text{Total Thickness of eggshells/Total no. of egg yolk color}}{\text{Total no of eggs measured}}$$

Average Egg weight

This was taken every day using a digital weighing scale. Eggs were weighed and added. The average egg weight was computed by dividing the total weight of the eggs by the total number of eggs weighed.

$$\frac{\text{Total weight of eggs}}{\text{Total no of eggs weighed}}$$

Egg Fertility and Hatchability

Collected eggs were cleaned and incubated every five days. Eggs were candled 10 – 14 days after setting to the incubator to determine the egg fertility. Numbers of chicks hatched were also recorded.

Blood Calcium Level

Blood samples for every experimental birds were collected and subjected to blood calcium analysis to determine the blood calcium level of the birds during the trial at the Vet Central Lab, San Juan City, Manila.

Cost of Feeds to Produce a Kilogram of Eggs

Cost of every feed ingredient were calculated and computed. Computed cost of feeds per kilograms was multiplied with the amount feed conversion ratio or amount of feeds to produce a kilogram of eggs.

Results and discussion

Percent Egg Production, Egg Weight, and Egg Mass

Table 2 shows the mean percent egg production, egg weight, and egg mass of chicken per treatment. Results showed that the average percent egg production of experimental animals starting from 25th week up to 40th week of age was not significantly affected by the dietary treatments.

However, significant interactions in egg production were observed in the second month of the laying period during the duration of the study, as formulated feeds using locally available ingredients with either limestone, eggshell, or snail shell showed a significant decrease in egg production. This result agrees with Sipe *et al.* (2002) who stated that egg production was slightly lowered during the second month after feed changes. No significant differences were observed among treatments in terms of egg weight and egg mass/hen.

Table 1. Proximate analysis of treatments.

Parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4
% Crude Protein	17.8 ± 1.9	22.5 ± 0.4	23.1 ± 0.3	22.6 ± 1.1
% Moisture Content	8.3 ± 0.3	4.1 ± 0.3	4.5 ± 0.1	3.9 ± 0.9
% Ash Content	16.1 ± 0.4	15.3 ± 0.2	16.2 ± 0.6	16.4 ± 0.1
% Crude Fat	3.9 ± 0.1	4.9 ± 0.1	4.6 ± 0.3	4.6 ± 0.3
% Crude Fiber	7.5 ± 0.9	8.5 ± 0.2	9.0 ± 0.8	7.7 ± 0.6
Metabolizable Energy, kcal/kg	2578.5	2768.5	2690.5	2760.5

Table 2. Mean Egg Production, Egg weight and Egg Mass/Hen at 25 to 40 weeks old.

Treatment*	Egg Production%	Egg Weight (grams)	Egg Mass/hen (kilograms)
T1	37.50	54.23	2.73
T2	34.95	52.95	2.52
T3	34.15	52.59	2.45
T4	32.80	54.40	2.40

Feed intake and feed conversion ratio

The average feed intake of birds per treatment and feed conversion ratio is presented in Table 3. Significantly higher daily feed intake was recorded in treatments 2, 3, and 4 where birds are fed with formulated feeds with different calcium sources as compared to the control. However, birds fed with commercial feeds (control) showed a significantly better feed conversion ratio of 4.17 kilograms among other treatments. According to Reddy (2019), the lower the feed conversion ratio the more efficient the animal is in converting feed to eggs or meat.

Table 3. Mean Daily Feed Intake and Feed Conversion Ratio.

Treatment*	Feed Intake/day/head (grams)**	FCR (ratio)**
T1	103.29b	4.17 b
T2	125.37a	5.61a
T3	123.11a	5.68a
T4	122.66a	5.79a

*T1- commercial feeds (control); T2- formulated ration with limestone; T3- formulated ration with egg shell; T4- formulated ration with snail shell

***a,b - Means with different superscript indicate significant (P< 0.05) differences

Egg yolk color, shell thickness, and shell proportion

The average egg yolk color, shell thickness, and shell proportion are shown in Table 4.

The treatment diets did not affect the shell thickness and shell proportion of eggs. Hens in all groups produced eggs that had a similar quality of eggshell in terms of shell proportion (11.41 to 11.59%) and shell thickness (0.31 to 0.37 mm). This finding agrees with Gongruttananun (2011) and Houndonougbo (2012) who reported hens fed with powdered eggshell and snail shell based-diets did not significantly affect the eggshell thickness and shell proportion.

Table 4. Mean Egg Yolk Color, Shell Thickness and Shell Proportion.

Treatment*	Egg Yolk Color	Shell Thickness (mm)	Shell Proportion (%)
T1	3.13b	0.31	11.45
T2	9.33a	0.34	11.42
T3	8.20a	0.31	11.41
T4	9.87a	0.37	11.59

*T1- commercial feeds (control); T2- formulated ration with limestone; T3- formulated ration with egg shell; T4- formulated ration with snail shell

***a,b - Means with different superscript indicate significant (P< 0.05) differences.

According to Yamak et.al, 2015, eggshell thickness ranged between 0.24 to 0.42 mm where ≤ 0.30mm considered thin, 0.30 to 0.36mm as a medium, and ≥0.36mm as thick-shelled eggs. Thus, the results of the study indicated that shell thickness in treatments 1,2, and 3 were classified as medium-shelled eggs while eggs in Treatment 4 were recorded as thick-shelled.

The color of the egg yolk of birds was measured using DSM Yolk Color Fan with 15 scales. The control group was significantly paler than that of formulated feeds using local feedstuffs. Vats, (2017) stated that the darker color of egg yolk indicates the presence of xanthophyll pigment and is the typical color of lutein or zeaxanthin of the xanthophylls, a division of carotenoids group which are found in the highest quantity in the leaves of most green plants like forages.

Percent egg fertility and hatchability

Table 5 shows that mean percent egg fertility and hatchability during the entire feeding trial were not significantly affected by the dietary treatments. According to the indicative performance records for scientific hatchability (> 93% excellent, >90% very good, >87% good, >83% average, and <83% poor), results of the study indicated that eggs in every treatment have a very good to excellent hatchability.

Table 5. Mean Percent Egg Fertility and Hatchability

Treatment*	Fertility,%	Hatchability,%
T1	88.71	90.44
T2	94.36	91.85
T3	86.97	90.73
T4	80.67	94.13

*T1- commercial feeds (control); T2- formulated ration with limestone; T3- formulated ration with egg shell; T4- formulated ration with snail shell

Mean blood calcium level of chicken and cost to produce a kilogram of eggs

Table 6 shows the mean blood calcium level and feed cost to produce a kilogram of eggs. The results of the blood calcium level analysis of chicken were not significantly different among treatments.

This finding indicates that calcium in eggshells and snail shells can be utilized by birds without adverse effects on blood calcium levels. This is in agreement with the results of Vandepopuliere *et al.* (1975) and Ulep and Buenafe, (1991).

Table 6. Mean blood calcium level and feed cost to produce a kilogram of eggs.

Treatment*	Blood Calcium Level mg/dl	Feed Cost, Php
T1	6.73	91.83a
T2	5.96	75.34b
T3	5.62	71.14b
T4	5.93	72.44b

*T1- commercial feeds (control); T2- formulated ration with limestone; T3- formulated ration with egg shell; T4- formulated ration with snail shell

***a,b - Means with different superscript indicate significant (P< 0.05) differences

The cost of every kilogram of diet consumed by the hens fed with formulated ration was much cheaper than that of commercial feeds. Thus, the feed cost to produce a kilogram of eggs for Treatments 2, 3 and 4 was significantly lower by about 17.96%, 22.53% and 21.11% respectively as shown in Table 6. The use of locally available feedstuffs has the potential to lower the total cost of production in layer chicken.

Conclusion and recommendation

It was concluded that eggshells and snail shells can be used as the sole calcium source in layer chicken diets as comparable to limestone without adverse effects on feed consumption, egg weight, egg production, egg and eggshell quality, egg fertility, hatchability, and blood calcium level. However, appropriate sterilization should be considered when using these shells for chicken's diet as these feed ingredients may introduce harmful microorganisms to the birds.

It is recommended to utilize locally available feed ingredients, forages, agricultural by-products, and minerals through proper processing when raising layer chicken, particularly those dual–purpose breeds to reduce the cost of production and improve the sustainability of animal production.

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