Volume 1 | Issue 2 | Jul - Dec 2023
ISSN: 2984-9896

Supplementation of Egg Shell Meal (ESM) In White Leghorn Chicken (*Gallus gallus domesticus*) Ration

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ABTRACT

Damaged eggs are a common problem in egg production, and adding eggshell meal to feed formulations has been proven to considerably lower the possibility of damaged eggs, enhancing egg quality. However, the amount of eggshell meal to be added to the basal diet needs to be evaluated, given its nutritional value as a mineral source. Hence, this paper determines the effect of eggshell meal supplementation on the laying performance of White Leghorn chickens. The experiment was laid out using the Completely Randomized Design (CRD) with six treatments: T1 (pure commercial feeds), T2 (3% ESM per 1000g commercial feeds), T3 (7% ESM per 1000g commercial feeds), and T4 (10% ESM per 1000g commercial feeds) replicated three times. Treatments were evaluated as to egg production, egg weight, eggshell weight, feed efficiency, damaged eggs, and cost and return analysis. Findings show that T4 obtained the best value in terms of egg production, egg weight, and eggshell weight and recorded the lowest number of damaged eggs, but was not significantly different from the other treatments. As to the parameters of feed efficiency and return on investment, T1 was the best. Based on the results of the study, it was concluded that supplementation of ESM on the basal diet of White Leghorn chickens did not significantly improve the total number of eggs produced and weight of eggs.

Keywords: *Eggshell meal, basal diet, white leghorn chicken, supplementation, damaged eggs*

INTRODUCTION

The global population has undergone rapid growth than it was in the mid-twentieth century (UN DESA, 2022). Consequently, the need for animal protein is growing and in high regard in most communities. Globally, in 2021, egg and dairy products consumption was estimated to 400.05 million metric tons (Statista, 2022), and in the Philippines, it was estimated that every Filipino consumed 4.92 kg of eggs annually (FAOStat, 2022). In Cagayan Valley, the chicken laying flock inventory was estimated to 1.96 million birds (PSA, 2021).

According to the data of the Philippine Statistics Authority (2022), a total of 170.97 thousand metric tons of chicken eggs were produced between January and March; however, despite the large number of eggs produced, constraint on egg quality is still a concern. The greatest loss to the egg industry is the quality of the eggshell (Swiatkiewicz et al., 2015). In actuality, a large percentage of eggs is damaged during transportation due to the thin eggshell, and cracked eggs may make up as much as 10% of eggs laid by young chickens and 20% of eggs laid by older hens (Pavlovski et al., 2012). Egg quality also focuses on the size of the egg, in a study conducted by Bondoc, O.L. et al. (2020), 39.7% or majority of the 315 eggs from different breeds of chicken gathered were under the small size category which means majority of the total egg produced are of small size.

In poultry production, the performance of chicken is dependent mainly on the quality of nutrition and management provided to them. Poultry require a consistent supply of water, energy, protein, vital amino acids, minerals, and vitamins for optimum performance and health. Thus, poultry diets must be contained with necessary nutrients to maintain their physiological states and also in ensuring quality of the eggs produced.

High-quality eggshells are prerequisite for first-grade eggs and production economics. Supplementing the diet of poultry animals with important macrominerals and trace minerals is necessary for healthy eggshell development. According to Arnarson (2017) and Mavromichalis (2015), calcium is an essential mineral in the formation of egg shells for laying hens and layer diets must contain calcium with an amount of 3-4 percent because in the formation of eggshell, two g of calcium is required and calcium is an important macro nutrient for shell strength (William et al., 2006). Furthermore, calcium also helps to regulate the passage of nutrients in and out of the cells (Tumara et al., 2004).

One way a poultry raiser does to improve the egg shell quality of laid eggs is the supplementation of alternative mineral additives like bones and eggshell meals in the diet of chickens. Since eggshells are abundantly available in many restaurants in Sanchez Mira, Cagayan serving the most popular dishes known as *miki, pansit batil patong, pansit cabagan,* and *lomi*, the supply of eggshell as alternative mineral source is not a problem.

Objectives of the Study

the study was carried out to determine the shell quality of eggs produced by White Leghorn Chicken supplemented with eggshell meal in their basal diet.

MATERIALS AND METHODS

Experimental Site, Design, and Treatments

The study was conducted at the poultry site, College of Agriculture, Cagayan State University, Centro 02, Sanchez Mira, Cagayan. The Completely Randomized Design (CRD) was employed and replicated three times. The treatments evaluated were as follows: T1 – Pure Commercial Feeds (CF), T2 - 3% ESM per 1000g CF, T3 – 7% ESM per 1000g CF, and T4 – 10% ESM per 1000g CF.

Collection and Preparation of Eggshell Meal

The eggshells used in the study were collected from the different eateries in Sanchez Mira, Cagayan. The collected eggshells were washed until there were no albumen left in the egg shell without removing the shell membranes. After washing, these were treated in a boiling water for one and a half hours (Okpanachi et al., 2021). After the treatment, the water was drained and egg shells were sundried until the remaining water was eliminated. Thereafter, the egg shells were milled using a milling machine to obtain the egg shell meal.

Mineral Analysis of Eggshell Meal
A kilogram of egg shell meal was submitted to the Department of Agriculture, Regional Field Office No. 02, Cagayan Valley Integrated Agricultural Laboratory, Carig Sur, Tuguegarao City, Cagayan to determine the percentage calcium and phosphorus.

Procurement and Selection of Experimental Birds
The experimental birds that were used in the study were purchased in Lipa, Batangas on April 17, 2022. The experimental birds were selected based on the guidelines of selecting good stocks, such as: a large comb, red and waxy beak, and bleach ring eye, wattles are soft and smooth, large vent, oval shape, moist and bleach, thin pelvic bone, wide apart, and flexible, legs less colored in lay, and not too sharp breast bone.

Feeding and Provision of Water to the Experimental Birds
The experimental birds in all treatments were fed with their respective rations as indicated in the different treatments. An ad libitum method of feeding was adapted. Moreover, a potable drinking water was also given to the experimental birds at all times.

Collection of Laid Eggs
The collection of laid eggs was done every afternoon. The collected eggs were placed in an egg tray for weighing and sorting. The weight of an egg was used as basis in classifying egg sizes.

Statistical Tool
The data were analyzed using the Analysis of Variance (ANOVA) and the Statistical Tool for Agricultural Research (STAR Stat) software.

RESULTS AND DISCUSSION

Table 1. Weekly average egg production of experimental birds supplemented with different levels of eggshell meal.

Treatments	Week							
	1	2	3	4	5	6	7	8
T_1- Pure CF	6	6	6	6	6	7	6	5
T_2- 3% ESM per 1000g CF	6	6	7	7	6	6	6	6
T_3- 7% ESM per 1000g CF	7	7	7	7	7	6	6	6
T_4- 10% ESM per 1000g CF	7	7	7	7	7	6	7	7
Statistical Inference	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
CV (%)	9.68	5.97	0.41	0.82	9.56	9.81	5.95	10.33

Number of Eggs Produced

Table 1 displays the weekly average number of eggs produced by White Leghorn chickens supplemented with different amounts of eggshell meal. Based from the result of the study, T4 and T3 recorded the highest number of laid eggs with a mean value of 7. T4 consistently had the highest number of laid eggs until the end of the study. The Analysis of Variance (ANOVA) however testifies that the supplementation of eggshell meal in the diet of White Leghorn Chicken did not affect significantly the number of eggs produced. The result of the study on the number of eggs produced conforms to the study conducted by Okpanachi et al. (2020) which concluded that the inclusion of eggshell meal did not improve the number of the egg produced.

Egg Weight (g)

Table 2 displays the average egg weight of White Leghorn chickens supplemented with varying levels of eggshell meal. The result of the study revealed that experimental birds supplemented with 10% ESM on their basal diet obtained the heaviest egg with an average weight of 55g.
This was followed by T3 and T4 with an average weight of 52g. The eggs with no supplementation of ESM recorded the lightest egg with a mean of 51g. Despite numerical differences, Analysis of Variance (ANOVA) reveals no significant differences existed on the different treatments tested.

Table 2. Weekly average weight of egg in g of the experimental bird supplemented with different levels of eggshell meal

Treatments	Week							
	1	2	3	4	5	6	7	8
T_1- Pure CF	50.13	52.93	53.40	55.07	51.13	55.00	50.17	46.60
T_2- 3% ESM per 1000g CF	49.07	51.90	54.70	55.23	54.13	55.30	51.33	48.50
T_3- 7% ESM per 1000g CF	52.30	53.93	52.87	55.47	56.13	51.17	49.63	49.57
T_4- 10% ESM per 1000g CF	53.63	55.37	54.90	56.10	56.27	55.43	54.43	54.60
Statistical Inference	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
CV (%)	5.45	5.01	2.90	3.36	6.08	8.35	8.09	10.57

Insignificant result obtained on the weight of eggs conforms to the result of the study conducted by Nirat Gongruttananum (2011) that dietary Ca supplementation in laying hens revealed no effect on the egg weight, egg production, egg and eggshell quality. This also coincides with the reported result of the study conducted by Cufadar et al. (2011), that laying performance was not influenced by supplementing dietary Ca level of 30 g.

Table 3. Weekly mean of the egg shell weight in g by the experimental birds supplemented with different levels of eggshell meal.

Treatments	Week							
	1	2	3	4	5	6	7	8
T1- 1000g CF	6.13	6.27	6.40c	6.67b	6.93	6.43b	5.93b	6.20b
T2- 1000g CF + 30g ESM	6.13	6.40	6.67bc	6.73b	6.80	6.80a	6.80a	6.67a
T3- 1000g CF + 70g ESM	6.20	6.57	6.93ab	6.97a	7.00	6.93a	6.87a	6.73a
T4- 1000g CF + 100g ESM	6.33	6.67	7.0a	7.10a	7.20	7.07a	6.93a	6.87a
Statistical Inference	NS	NS	*	*	NS	*	*	*
$LSD_{.05}$			0.307	0.188		0.364	0.461	0.461
CV (%)	5.10	2.56	2.42	1.46	2.61	2.84	3.69	3.70

Egg Shell Weight (g)

Table 3 shows the egg shell weight (g) of White Leghorn chickens supplemented with varying levels of egg shell meal. During the first week of the study, experimental birds in T4 recorded the heaviest egg shell of 6.33 g. This was followed by experimental birds in T3 with a mean value of 6.20 g. The lightest egg shell weight was obtained both in T1 and T2 with a corresponding mean of 6.13 g. The Analysis of Variance (ANOVA) reveals that there was no significant difference existed among the treatments evaluated.

On the second week of the experiment, laid eggs in T4 recorded the heaviest egg shell weight of 6.67 g. This was followed by egg shells in T3 with 6.57 g. The lightest egg shell weight was obtained both in T2 and T1 with 6.40 g and 6.27 g respectively. The Analysis of Variance (ANOVA) revealed no significant difference existed among the treatments tested.

On the third week of the study, T4 consistently recorded the heaviest egg shell weight of 7.0 g. This was followed by T3 and T2 with a corresponding means of 6.93 g and 6.67 g respectively. Moreover, the lightest egg shell weight was obtained in T1 with a mean value of 6.40 g. On the fourth week of the study, the same ranking of the treatments evaluated was obtained. The Analysis of Variance (ANOVA) revealed significant differences existed on the different treatments tested. The significant result could be attributed by the amount of Ca supplementation on the layer diet and this result coincides with the findings of Clunies et al. (2019) that increasing dietary Ca increases the weight of egg shell. The findings of Okpanachi et al. (2020) in the replacement of the bone meal to eggshell meal is congruent on the result of the study conducted.

During the fifth week of the study, experimental birds in T4 recorded the heaviest egg shell of 7.20 g. This was followed by experimental birds in T3 with a mean value of 7.00, and T1 with a mean of 6.93 g. The lightest egg shell weight was obtained in T2 with a corresponding mean of

6.80 g. The Analysis of Variance (ANOVA) reveals that there was no significant difference existed among the treatments evaluated.

On the sixth week of the study, T4 consistently recorded the heaviest egg shell weight of 7.07 g. This was followed by T3 and T2 with a corresponding means of 6.93 g and 6.80 g respectively. Moreover, the lightest egg shell weight was obtained in T1 with a mean value of 6.43 g. The same ranking of the treatments evaluated was obtained in the seventh and eight week of the study. The Analysis of Variance (ANOVA) reveals significant differences existed on the different treatments tested. Significant result could be attributed from the feeding of 100 g eggshell. The result of the study coincides with Hassan et al. (2022) that a significantly higher eggshell and egg shell weight was found by adding 100 g egg shell meal on the basal diet.

Feed Efficiency

Table 4 shows the average Feed Conversion Efficiencyper kilogram egg mass of the experimental birds supplemented with increasing amount of egg shell meal. T2 recorded the best feed conversion efficiency among the other treatments with a mean of 1.95. This was followed by T1, T4 and T3 with a corresponding means of 1.99, 2.02, and 2.04 respectively. The recorded FCE was said to be advantageous for the farm since the FCE was below the acceptable FCE value of 2.2, which means a farmer only needs an approximately 2 kg of feed to produce a large size of egg (55- 61 g) (TNAU, 2008). Furthermore, the Analysis of Variance (ANOVA) however reveals no significant differences existed on the different treatments evaluated.

Table 4. Average feed conversion efficiency per kilogram egg mass of the experimental birds supplemented with increasing amount of egg shell meal.

Treatments	Mean
T1- Pure	1.99
T2- 3% ESM per 1000g CF	1.95
T3- 7% ESM per 1000g CF	2.04
T4- 10% ESM per 1000g CF	2.02
Statistical Inference	*NS*
CV (%)	3.39

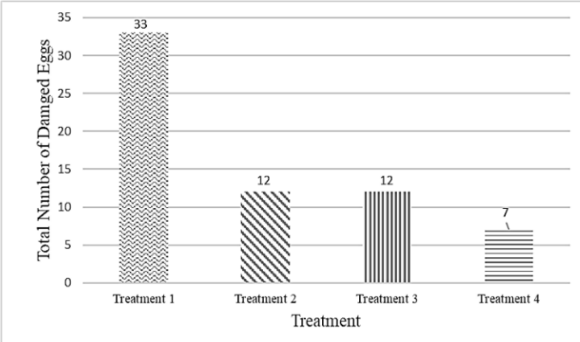

Figure 02. Total Number of Damaged Eggs in the Different Treatments after 60 days of study

Table 5. Cost and Return Analysis of White Leghorn Chicken supplemented with different levels of Egg shell meal after 1 cycle of production.

Total Variable Cost (₱)	Gross Income (₱)	Net Income (₱)	ROI (%)
51,865	85,827	33,962	65.48
53,915	85,803	31,888	59.15
54,710	85,825	31,115	56.87
56,676	85,907	29,231	51.57

Cost and Return Analysis

The cost and return analysis of White Leghorn chicken supplemented with increasing amount of egg shell meal is presented in Table 5. T4 recorded the highest total cost of production considering labor, supplies and depreciation of experimental cages and equipment having an amount of ₱56,676.00. Meanwhile, T1 recorded the lowest cost of production with ₱51,865.00.

As to the estimated sales, the total number of eggs produced was considered. T4 attained the highest gross income of ₱85,907.00. This was followed by T1 and T3 having a gross income of ₱85,827.00 and ₱85,825.00 respectively. T2 recorded the lowest gross income of ₱85,803.00. On the net income, T1 obtained the highest profit of ₱33,962.00. Meanwhile T4 obtained the lowest revenue of ₱29,231.00.

As to the Return on Investment, all treatments recorded an excellent earning capacity with T1 recording the best earning efficiency of 65.48%.

The recorded ROI means that all treatments are advantageous for egg production.

Total Number of Damaged Eggs

Figure 1 displays the total number of damaged eggs throughout the study. Based from the recorded data, experimental birds fed without ESM supplementation in their ration (T1) recorded the highest number of damaged eggs. This was followed by T2 and T3 with a total number of damaged egg of
12. The lowest number of damaged eggs were recorded in T4 with a 7 eggs.

Based on the recorded data, it was concluded that supplementing the basal diet of White Leghorn chickens with increasing levels of eggshell meal reduces the number of damaged egg laid. The highest level of supplementation, T4, led to the lowest number of damaged eggs, suggesting beneficial effect on eggshell quality.

CONCLUSION

Based on the results of the study, supplementation of ESM in the basal diet of White Leghorn chickens did not significantly improve the laying performance of White Leghorn chickens. Since there were no significant results among the treatments evaluated, the researcher therefore recommends the utilization of pure commercial feed in White Leghorn chicken production.

RECOMMENDATIONS

Based on the results and discussions presented in this study, it can be concluded that the supplementation of eggshell meal (ESM) in the diet of White Leghorn chickens did not have a significant impact on their laying performance. Specifically, there were no significant differences observed in the number of eggs produced, egg weight, and feed efficiency among the different treatments with varying levels of ESM supplementation. However, there was a noticeable improvement in eggshell weight with higher levels of ESM supplementation, particularly in the later weeks of the study.

Therefore, considering the lack of significant improvements in laying performance and the potential additional cost associated with ESM supplementation, it may be advisable for White Leghorn chicken producers to continue using a pure commercial feed for their flock. This approach can help simplify the feeding regimen and minimize expenses without compromising egg production or quality.

It's important to note that while ESM did not significantly impact the measured parameters in this study, further research could explore its potential benefits in other aspects of poultry production or with different chicken breeds. Additionally, factors such as the source and quality of ESM, as well as the specific nutritional needs of the flock, should be considered in future studies or practical applications of this supplementation.

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