Effect of supplementary vitamin D on Eggshell thickness and Egg production performance

Submitted By:

Monir Hossain

Intern ID: 63

Roll: 18/72

Reg. No: 03036

Session: 2017-2018

A production report submitted in partial satisfaction of the requirements for the Degree of Doctor of Veterinary Medicine (DVM)

Chattogram Veterinary and Animal Sciences University

Khulshi, Chattogram-4224.

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Faculty of Veterinary Medicine

Chattogram Veterinary and Animal Sciences University

A Report Submitted as Per Approved Style and Content

Signature of Author

Monir Hossain
Intern ID: 63
Roll No.: 18/72
Reg. No.: 03036
Session: 2017-2018

Signature of Supervisor

Md. Akhtar Uz-Zaman
Professor
Department of Dairy and Poultry Science

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Abstract

This study looked at how three treatment groups responded to vitamin D supplementation in terms of eggshell thickness. There were three groups studied: the control group, Treatment Group 2 with moderate vitamin D dosage, and Treatment Group 3 with high vitamin D supplementation. Pre- and post-supplementation measurements of eggshell thickness were made. Ranges of eggshell thickness were given for the Control Group (0.30-0.22 mm), Treatment Group 2 (0.31-0.33 mm), and Treatment Group 3 (0.33-0.35 mm). The outcomes showed clear patterns in the treatment groups' eggshell thickness. Eggs in the control group had eggshells that were typically 0.30 to 0.32 mm thick. Eggshell thickness increased somewhat in Treatment Group 2, which received modest vitamin D supplementation, ranging from 0.31 to 0.33 mm. Notably, Treatment Group 3, which received high vitamin D supplements, showed the eggshell thickness range with the maximum value of 0.33 to 0.35 mm. These results point to a possible link between eggshell thickness and vitamin D supplementation. A possible dose-dependent effect is suggested by the increasing trend in eggshell thickness with higher supplementing levels. Enhancing eggshell thickness has a significant impact on structural integrity and protection during transportation and incubation, which is crucial for egg quality. The control group, Treatment Group 2, and Treatment Group 3 were the three different groups that this study was designed to examine in order to determine the effects of vitamin D supplementation on egg production rates. Egg production rates were reported to be 83% for the control group, 85% for Treatment Group 2, and 88% for Treatment Group 3 following the administration of vitamin D supplements.

Chapter 1

Introduction

It is generally known that vitamin D3 is crucial for poultry diets (DeLuca, H. F.) For the bird to absorb, transport, and use Ca and P, vitamin D3 is required. Egg production and shell thickness may improve in birds that use calcium properly. Vitamin D, namely its active metabolite 1,25-dihydroxycholecalciferol [1,25(OH)2D3], regulates the efficiency of Ca use. (Soares et al). The quality of laying chickens' eggs depends on many dietary parameters. Among such elements, calcium, and vitamin D3 seem to be the most pertinent and significant. In the development and preservation of the quality of eggshells, calcium is crucial. Ca makes up around 38% of the eggshell, which is mostly made of calcium carbonate. (Jeroch, H. 2011). Calcium and vitamin D3 have a relationship. For intestine absorption and subsequent calcium metabolism, vitamin D3 is essential. The production of calcium-binding protein, which is involved in the transfer of calcium in the stomach and likely the uterus, is encouraged by the active form of vitamin D3. If the calcium supply is not at its ideal level, the need for vitamin D3 increases (Bar et al., 1992; Leeson and Summers, 2001; Sreenivasaiah, 2006; Bar et al., 2008). Dietary vitamin D3 is transported to the liver where it is converted to 25-hydroxyvitamin D3 via hydroxylation. The kidney is where this metabolite is transferred, where it is further hydroxylated to create the active metabolite, 1,25-dihydroxyvitamin D3 [1,25-(OH)2 D3] (Norman, 1987). The homeostasis of calcium and phosphorus is significantly influenced by this hormone, a seco-steroid. It works to promote calcium and phosphorus absorption in the small intestine as well as calcium and phosphorus resorption in the bones. Aside from that, 1,25-(OH)2 D3 promotes the synthesis of additional enzymes, proteins that bind calcium and phosphorus, and membrane-associated molecules (UNTAWALE, G. 1990).

Commercial layers suffer from elevated egg loss during the second laying cycle due to low eggshell quality and weak bones due to calcium mobilization. To enhance egg quality and the productivity of the egg industry, their calcium and vitamin D requirements must be updated.

In chicken, calcium is necessary for a few metabolic processes as well as for healthy eggshells (Nunes et al., 2006). Phosphorus and vitamin D3 are also connected to its functioning. Blood calcium levels drop because of the fast mobilization that occurs during the synthesis of eggshells. To restore calcium homeostasis, the parathyroid hormone (PTH) is stimulated to be secreted, which encourages bone resorption (Pelcia et al. 2009). UV light may stimulate the skin's natural production of vitamin D3 from 7-dihydrocholesterol found in the dermis and epidermis, or it can be given to animals as a dietary supplement. Commercial layers are typically kept indoors, where they do not receive enough sun radiation to produce enough 7-dihydrocholesterol to meet their vitamin D3 needs. Due to its importance in maintaining calcium homeostasis, eggshell formation, and egg production, vitamin D3 is frequently given to layer meals (Pedrosa & Castro, 2005). Due to their immediate availability, several vitamin D metabolites may increase the effects of vitamin D by avoiding the series of events necessary for the formation of the active metabolite. The finding that giving 1-hydroxylated cholecalciferol (vitamin D3) derivatives to old laying hens increased shell thickness and decreased egg breakage, most likely as a result of increased Ca2+ absorption, provided only partial clarity (Bar,Arie et al1998). Independent of the source of vitamin D, layers maintain balanced blood levels of calcium and phosphorus for eggshell development (Junqueira et al., 2002). When measuring vitamin D sources, the amount of the metabolite 25(OH)D3 gives the greatest indication of vitamin D blood levels since the level of 1,25(OH)2 D3 reflects calcium homeostasis (Barral et al., 2007). In many species, including birds, vitamin D is essential for controlling the metabolism of calcium and phosphorus. Calcium is a key element in the development of eggshells in birds, particularly chicken. The protection of the developing embryo inside the egg depends on the thickness of the eggshell. Eggshell thickness is indirectly influenced by vitamin D due to its role in assisting with the digestion of calcium. (Kakhki et al.2019). By raising the kidney's production of the active form of vitamin D3 (1,25-dihydroxycholecalciferol; 1,25(OH)2D3), more vitamin D3 may increase the quality of eggshells. In order to move calcium across the intestinal membrane and possibly to the shell gland where it is

necessary for the formation of the eggshell, 1,25(OH)2D3 stimulated the synthesis of calcium-binding protein (Bar et al., 1992; Yoshimura et al., 1997; Bar et al., 2008).

Therefore, the purpose of this study aimed to evaluate the impact of vitamin D supplementation on eggshell thickness and egg production performance during the laying cycle.

Chapter 2

Materials and method

Layer trial with vitamin D

Laying hens were kept in a shed. They were lighted for 16 hours every day during the testing periods. The hens had full access to commercial meals. Animal welfare laws and ethical standards were followed during the experiment's conduct. Priority was given to the study's hen subjects' welfare. 650 fayoumi egg-laying hens in their second production cycle, aged 52 weeks. Diets comprising 3.5% Ca-containing feed served as the treatment's control 8000IU of vitamin D and 3.5% calcium per kilogram of feed (treatment 2) 3.5% calcium and 12000 IU vitamin D per kilogram of feed (treatment 3). A control diet was created to satisfy the fayoumi layer's calcium needs. Vitamin D was added with3.5 % Ca level for ten days. A maize- and soybean-based diet was used as the control. In Table 1, the ingredients and computed nutritional composition of the basal diet are displayed. For 10 days, all experimental diets were fed. At the beginning, the first 5 days were supplied with 3.5% Ca and 8000 IU of vitamin D. 12000 IU of vitamin D and 3.5% calcium were administrated from the 6th to the 10th day. Water was made available to all of the vitamins; However, vitamin D calculations were made using feed. Water and diet were always available during the experiment. Two daily doses of the experimental water were administered. I gave the chickens D-Balance, a product of Square, which has 5000 IU of vitamin D per millilitre. Water was distributed at 8:00 AM and 5:00 PM During the trial period, the temperature of the hen house was recorded.

Figure 1: Supplementary Vit-D3 (Liquid form)

Different feed ingredients of basal diet

Ingredients	Amount (Kg/100kg)
Maize	54
Wheat barn	3
Rice polish	8.7
Vegetable Oil	1
Soybean meal	19
Meat and bone meal	5
Limestone	7
DCP	1
Vitamin mineral premix	0.5
Common salt	0.25
L-Lysin	0.1
DL-Methionine	0.1
Toxin binder	0.25

Study Area: The Pahartuli Regional Poultry Breeder Farm was used as the research site for the eggshell thickness investigation. My study was conducted in a fayoumi shed, where

650 Fayoumi layer was reared. The investigation was conducted at this place specifically, and information about eggshell thickness was gathered there as well. As part of the study's focus on studying eggshell thickness and its implications for chicken production, the farm's infrastructure, surroundings, and management techniques were all considered.

Egg collection:

There were counted in total eggs.

15 eggs collected before supplementing with vitamin D. (Treatment 10)

15 eggs were collected on the fifth day of vitamin D supplementation. (Treatment2)

15 eggs were collected on the tenth day. Eggs were continuously and randomly collected. By using a micrometres, the thickness of the eggshell was measured at the equator.

Group 1 (Control) under Treatment:

Eggs from a flock of hens that did not receive any vitamin D supplements were used as the control group. Eggs were gathered over a predetermined time period with uniformity in timing to take into account seasonal fluctuations. The eggs were weighed, and tagged, and their unique traits were noted. Using a specialized tool like a micrometer, the thickness of the eggshell was measured. At various locations on the egg's surface, this tool delicately gauges the thickness of the eggshell.

Treatment Group 2 (Moderate Supplementation of Vitamin D):

Eggs were taken from chickens that had been given a moderate amount of vitamin D supplementation (8000IU).Eggs were gathered, labelled, and weighed just like in the control group. The procedure outlined above was used to measure eggshell thickness.

Treatment Group 3 (High Supplementation of Vitamin D):

Eggs from chickens who got more vitamin D supplementation than Group 2 (12000 IU/kg diet) would be harvested.

The procedure for gathering, labelling, and weighing eggs would be the same as it was for the other groups.

These same techniques would be used to gauge eggshell thickness

Chapter 3

Results

Three treatment groups were examined in this study on eggshell thickness: a control group, Treatment Group 2 with moderate vitamin D supplementation, and Treatment Group 3 with high vitamin D dosage. Measurements of eggshell thickness were performed both before and after vitamin D administration. The following are the findings and discussions based on the ranges of eggshell thickness provided.

Ranges of Eggshell Thickness

Group Control 1: 0.30 to 0.32 mm

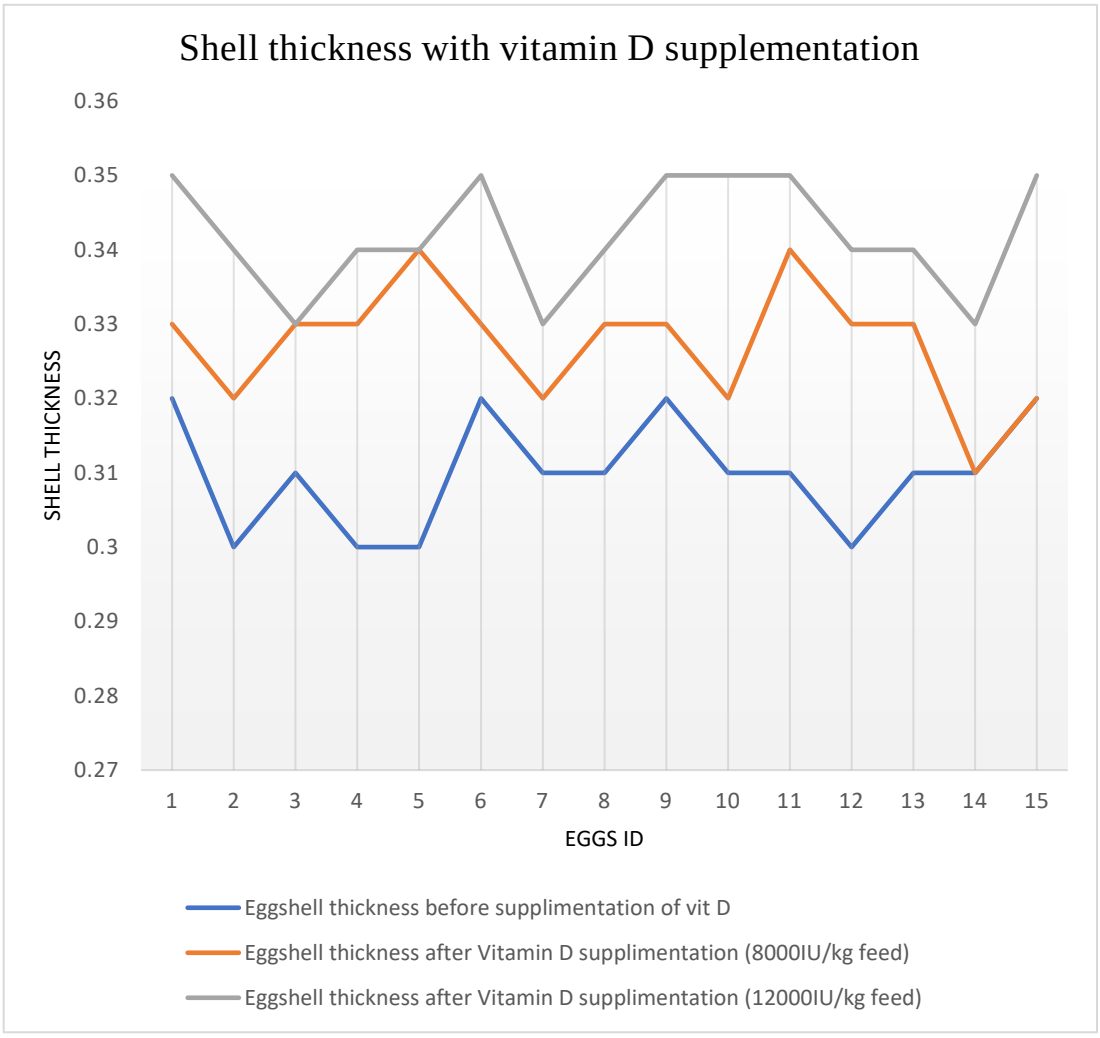
Group 2 of treatment: 0.31 to 0.33 mm

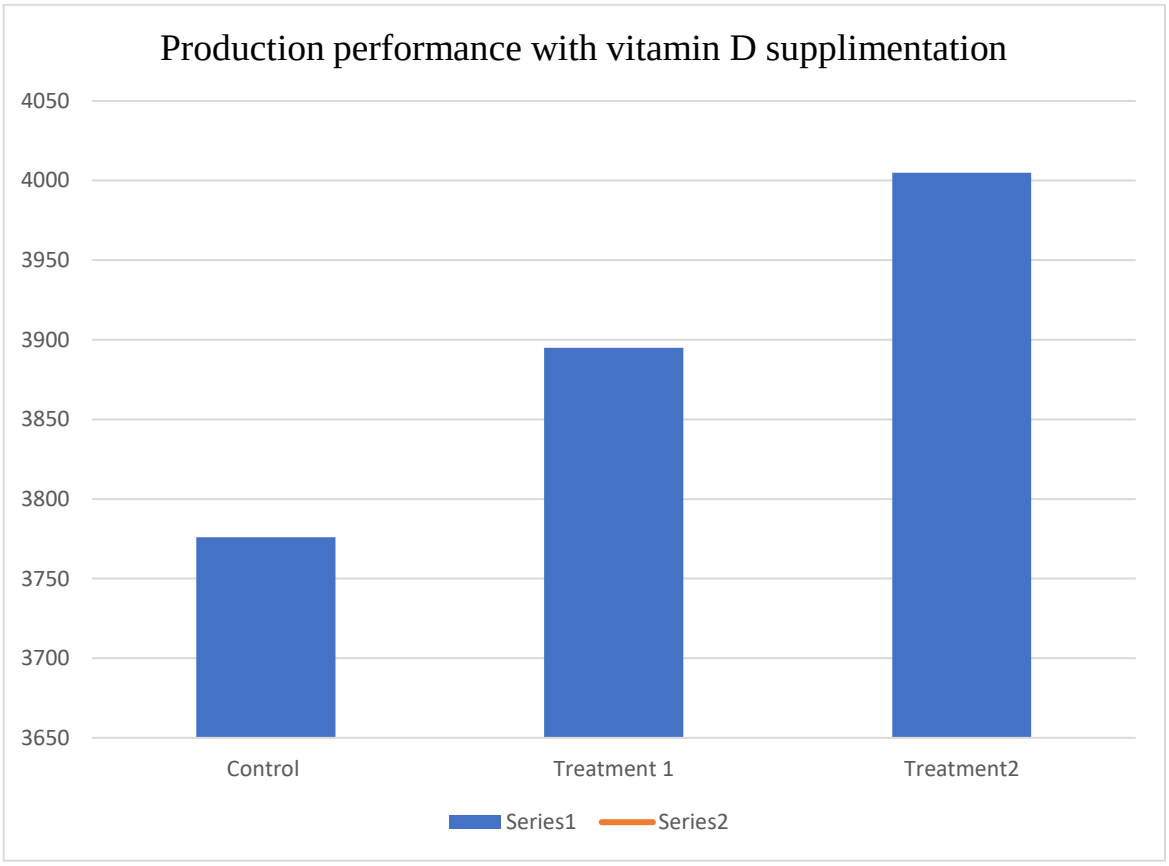
Group 3 of treatment: 0.33 to 0.35 mm

Control Group: Prior to vitamin D administration, the eggshell thickness of the control group's eggs ranged from 0.30 to 0.32 mm. For comparison, the thickness of the eggshell was evaluated once more following the supplementing period.

Treatment Group 2: Prior to supplementation, the eggshell thickness in the Treatment Group 2 eggs, which received a modest amount of vitamin D supplementation, ranged from 0.31 to 0.33 mm. Eggshell thickness measurements after supplementation were taken.

Treatment Group 3: Prior to the supplementing phase, eggs from Treatment Group 3 showed an eggshell thickness ranging from 0.33 to 0.35 mm. This group also got significant vitamin D supplementation. Eggshell thickness measurements were done following the vitamin D intervention, just like with the other groups.


Shell thickness with vitamin D supplementation
0.36
0.35
0.34
0.33
0.32
0.31
0.3
0.29
0.28
0.27
SHELL THICKNESS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
EGGS ID
Eggshell thickness before supplimentation of vit D
Eggshell thickness after Vitamin D supplimentation (8000IU/kg feed)
Eggshell thickness after Vitamin D supplimentation (12000IU/kg feed)


Production performance with vitamin D supplimentation
4050
4000
3950
3900
3850
3800
3750
3700
3650
Control
Treatment 1
Treatment2
Series1
Series2

Discussion

The variation in eggshell thickness between the treatment groups can be used to offer light on potential vitamin D supplementation effects on eggshell quality.

Eggshell thickness in the control group, which served as a benchmark for eggshell thickness without vitamin D treatment, ranged from 0.30 to 0.32 mm.

Treatment Group 2: The eggshell thickness of the eggs in Treatment Group 2 was somewhat higher, ranging from 0.31 to 0.33 mm. This shows that a mild vitamin D intake may help to slightly improve the quality of eggshells.

Treatment Group 3: Treatment Group 3 displayed the highest range in eggshell thickness, ranging from 0.33 to 0.35 mm. This group got high vitamin D supplements. This suggests that increasing vitamin D intake may result in more notable improvements in eggshell thickness. Kaetzel et al. (1978) and Soares et al. (1988) both observed that feeding vitamin D3 metabolites to chickens improved the quality of their eggshells. According to Soares et al. (1982), toxic levels of vitamin D3 metabolites were greater than 5 mic g/kg. The current study did not find any evidence of toxic effects.

The noticeable rise in egg production rates after vitamin D supplementation across all treatment groups is one of the study's noteworthy findings. With an initial egg production rate of 83%, the control group saw a little increase to 85% in Treatment Group 2. The third treatment group showed the greatest improvement, with an egg production rate of 88%. These findings point to a link between increased egg production rates and vitamin D supplementation.

The observed increase in egg production rates after vitamin D administration is consistent with vitamin D's well-established role in preserving poultry productivity and health. It is well recognized that vitamin D plays a crucial part in calcium metabolism, which is necessary to produce strong eggshells. Increased egg production and greater eggshell quality may result from increased calcium absorption and utilization brought on by optimal vitamin D levels.

Implication:

The findings of the study suggest that vitamin D administration might enhance eggshell thickness. There may be a dose-dependent link between the ascent in eggshell thickness and rising vitamin D supplementation doses. To potentially increase egg production while guaranteeing hen welfare and egg quality, farmers and producers might take into consideration integrating vitamin D supplementation solutions into their management practices.

Chapter 4

Conclusion

The study concludes that vitamin D supplementation may improve eggshell thickness, with higher supplementation levels perhaps resulting in more notable changes. To completely understand the underlying mechanisms and make useful suggestions for managing poultry based on these findings, though, more thorough investigations are required. The study also shows how vitamin D supplementation increases egg production rates. The observed increases in egg production rates in Treatment Groups 2 and 3 point to the potential advantages of including vitamin D supplements in poultry management techniques. However, more investigation is required to improve supplementing methods and clarify the precise mechanisms by which vitamin D affects the rates of egg production in chickens.

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Acknowledgement

All praise is given to Almighty Allah, the creator and ultimate ruler of the universe, who made it possible for the author to complete the task successfully.

The author expresses his gratitude, respect, and debt of gratitude to her supervisor **Professor Dr. Md. Akhtar Uz-Zaman** of the Department of Dairy and Poultry Science at Chattrogram Veterinary & Animal Sciences University for her guidance, cordial cooperation, sincere assistance, insightful recommendations, constructive criticism, and active participation in this report since its inception. The author would also like to extend his gratitude and admiration to all of his friends and well-wishers for their support and encouragement during the course of the study as well as during the writing of this report. Sincere appreciation and respect are extended by the author to Professor **Dr. A. K. M. Saifuddin**, Director of External Affairs, Chattogram Veterinary and Animal Sciences University and **Professor Dr. Md. Lutfur Rahman,** Dean, Faculty of Veterinary Medicine, Chattrogram Veterinary & Animal Sciences University for allowing her to continue this internship program.

Appendix

Table 1: Eggshell thickness of collected sample.

	Eggshell thickness before supplementation of vit D	Eggshell thickness after Vitamin D supplementation (8000IU/kg feed)	Eggshell thickness after Vitamin D supplementation (12000IU/kg feed)
	0.32	0.33	0.35
	0.3	0.32	0.34
	0.31	0.33	0.33
	0.3	0.33	0.34
	0.3	0.34	0.34
	0.32	0.33	0.35
	0.31	0.32	0.33
	0.31	0.33	0.34
	0.32	0.33	0.35
	0.31	0.32	0.35
	0.31	0.34	0.35
	0.3	0.33	0.34
	0.31	0.33	0.34
	0.31	0.31	0.33
	0.32	0.32	0.35
	Avg=0.31	Avg=0.327	Avg=0.342

Table 2: Egg production per week

Control 1	Treatment 2	Treatment 3
3776	3895	4005