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Effect of Added Extra Calcium Carbonate into the Diets, One Hour Before Starting Dark Period on Performance and Egg Quality of Laying Hens

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Abstract: In order to study the effect of four levels of extra calcium carbonate as limestone (0, 1, 2 and 3 g/hen/day, laying hen size, 3-4 mm) in a finished standard diets of laying hens, one hour before starting dark period, 160 Hy-line W36 laying hens, 85 weeks of age (after force molting) were selected and tested in a completely randomized block design with four treatments and four replicates. In a period of 8 weeks, feed intake (FI), egg weigh (EW), the number of cracked eggs (CE), the number of broken eggs (BE) and hen day egg production (HDEP) recorded daily. Eggshell quality including eggshell weight (ESW) and eggshell thickness (EST) were recorded every two weeks. CE, BE, ESW and EST were significantly improved by adding extra levels of calcium carbonate into the finished diets ($P<0.05$). The highest incidence of CE and BE were seen in treatment one (control diet with no added extra calcium carbonate) and the lowest incidence of these traits were seen in treatment four (3 g/hen/day extra calcium carbonate). The best and the worst quality of ESW and EST were also seen in treatment four and one, respectively. Under the conditions of this study, it was concluded that use of 3g/hen/day extra calcium carbonate before starting the dark period in laying hens improves egg quality traits and therefore more benefits to egg producers and more healthy eggs for consumers.

Key words: Egg quality, extra calcium carbonate, dark period, laying hens

Introduction

The eggshell is an important structure because it forms an embryonic chamber for the developing chick, a control gas exchange medium and is a container for the market egg, protects the egg contents. The shell consists of about 97% calcium carbonate, approximately 6 g that must be synthesized and deposited on the shell during 18-20 hrs it takes to form the egg shell (Roland, 2000). The calcium content of blood at any given time is no more than 30 mg. Thus the shell contains over 80 times more calcium than the content of the blood (Hunton, 2005). Breakage or cracking of eggshells in market channels is a serious concern usually resulted from the shell strength and its integrity and the "insult" during handling make the egg unacceptable for consumers. The effect of calcium sources on egg shell quality frequently studied and reviewed by researchers. It is conformed that there is no intrinsic benefit of calcium sources, other than the size of the particles that provide with a continuous supply of calcium when it was most needed especially during the night, when the hen has no access to feed (Roland and Bryant, 2000).

Calcium for egg shell formation is obtained from two routes. It comes from the feed, via the intestine and the blood stream or from reserves stored in the medullary bones. These reserves are replenished during the time egg shells are not formed (Roland, 2000). The mobilization, calcification processes in the formation of eggshell is a continuous way of supplying calcium for eggshell formation. Mobilization of calcium from the medullary bones not only brings calcium but also phosphorous into the blood (Morris and Gous, 1998). A higher concentration of blood phosphorous was found at the process of egg formation after calcium mobilization from medullary bones. It is shown that phosphorous concentration of blood when the egg was laid in the morning is higher than that of when the egg laid in the afternoon (Morris and Gous, 1998). Use of larger particle size of calcium sources decreases the mobilization of phosphorous from the medullary bones, and herby decreases the blood phosphorous during the dark access and better calcium to phosphorous ratio in the blood will be maintained. Hughes (1998) suggested that use of separate large particle sizes of calcium sources will absorb gradually and reduce the need for phosphorous. The objective of this study was to evaluate surplus use of extra calcium carbonate into the diets, one hour before starting dark period on performance and egg quality of laying hens.

Materials and Methods

In a completely randomized block design, 160 Hy-line-W36 (85 weeks old, after force molting) laying hens were randomly assigned in 16 experimental units (10 laying hens in 2 cages, 50 * 50 cm each) in 4 blocks as replicate an fed a practical type diet (Table 1). The diet prepared by UFFDA software that supplied all the nutrients recommended by Hy-line W36 manual. To

Table 1: Composition of experimental diets

Ingredients	%
Corn	42.47
Wheat	20.00
Barley	8.00
Soybean meal	10.26
Meat meal	5.00
Sunflower seed meal	3.55
Dicalcium phosphate	0.80
Limestone	9.00
Vit . and Min. premix[1]	0.50
Salt	0.30
DL-methionine	0.12
Total	100.00
Calculated composition	
ME (kcal/kg)	2700
Crude protein (%)	14.00
Crude fiber (%)	3.65
Ca (%)	4.17
Avail. P (%)	0.41
Na (%)	0.19
Linoleic acid (%)	1.08
Arginine (%)	0.76
Lysine (%)	0.67
Met + Cys (%)	0.59

[1]Supplied per kilogram of diet: vitamin A, 10000 IU; vitamin D_3, 9790 IU; vitamin E, 121 IU; B_{12}, 20 µg; riboflavin, 4.4 mg; calcium pantothenate, 40 mg; niacin, 22 mg; choline, 840 mg; biotin, 30 µg; thiamine, 4 mg; zinc sulphate, 60 mg; manganese oxide, 60 mg.

Table 2: Effect of dietary extra calcium carbonate on performance of laying hens from 85-93 weeks of age

Treatments	HDEP[1] (%)	FI (g)	EW (g)
Control (no added extra limestone[2])	67.72	112.95	65.32
Control+1 g/hen/d limestone	61.18	110.55	62.92
Control+2 g/hen/d limestone	64.99	110.12	63.73
Control+3 g/hen/d limestone	67.22	108.95	64.97
P value	0.2909	0.3615	0.2752
± SEM	2.238	0.0762	2.127

[1]HDEP, hen day egg production; FI, daily feed intake; EW, egg weight. [2]Calcium carbonate as limestone, laying hen size (3-4 mm).

avoid mixing of the diet in each block, the feeder separated with suitable partitions between cages. Laying hens had access to light for 15 hours (15L: 9D). Four levels of extra calcium carbonate as limestone (0, 1, 2 and 3 g/hen/day, laying hen size, 3-4 mm) were added into the diet, one hour before starting dark period, and in a period of 8 weeks, feed intake (FI), egg weigh (EW), the number of cracked eggs (CE), the number of broken eggs (BE) and hen day egg production (HDEP) recorded daily. Eggshell quality including eggshell weight (ESW) and eggshell thickness (EST) were recorded every two weeks. Data were analyzed based on a general linear model procedure of SAS (SAS, 1997) and treatment means when significant, were compared using Duncan's multiple range test (Duncan, 1955).

Results and Discussion

There was not a significant difference among treatments for FI, EW and HDEP (Table 2). However, a deceasing trend for feed intake was observed (112.95 *vs* 108.95 g). There are some reports clearly show that by increasing or decreasing the amount of Calcium in the diet, feed intake decreases or increases, respectively (Farmer *et al.*, 1986; Scott *et al.*, 1999). It seems that the extra amount of calcium has not been too far from the laying hen requirements that didn't change the intake. However, CE, BE, ESW and EST (Table 3) were significantly improved by adding extra levels of calcium carbonate into the finished diets ($P<0.05$). The highest incidence of CE and BE were seen in treatment one (control diet with no added extra calcium carbonate) and the lowest incidence of these traits were seen in treatment four (3 g/hen/day extra calcium carbonate). The best and the worst quality of ESW and EST were also seen in treatment 4 and 1, respectively. Clunies *et al.* (1992) pointed out that by increasing the calcium level from 3.5 to 4.5 percentage , eggshell weight increases. Keshavarz and Nakajima (1993, 1995) have shown a positive correlation between the calcium level in the diet and its retention into the body and the result is improving the quality of eggshell. Atteh and Lesson (1983) also reported that the quality of eggshell improves when the amount of calcium into the diet increases. There are also some reports indicating that by increasing the amount of calcium into the diet, shell thickness and its strength increases (Hill *et al.*, 1998; NRC, 1994; Scott *et al.*, 1999). Under the conditions of this study, it was concluded that use of 3g/hen/day extra calcium carbonate before starting the dark period in laying hens improves egg quality traits and therefore more benefits to egg producers and more healthy eggs for consumers can be achieved.

Table 3: Effect of dietary extra calcium carbonate on egg quality of laying hens from 85-93 weeks of age

Treatments	ESW[1] (g)	EST (mm)	CE (%)	BE (%)
Control (no added extra limestone[2])	5.690^{b}	0.338^{b}	0.283^{a}	0.404^{a}
Control + 1 g/hen/d limestone	5.741^{b}	0.345^{ab}	0.230^{a}	0.321^{a}
Control + 2 g/hen/d limestone	5.837^{a}	0.351^{a}	0.164^{b}	0.228^{b}
Control + 3 g/hen/d limestone	5.884^{a}	0.356^{a}	0.104^{b}	0.081^{b}
P value	0.0075	0.0003	0.0001	0.0015
± SEM	0.0477	0.0063	0.0034	00025

[1]ESW, eggshell weight; EST, eggshell thickness; CE, cracked eggs; BE, broken eggs. $^{a-b}$Means with different superscripts in each column are significantly different ($P<0.05$). [2]Calcium carbonate as limestone, laying hen size (3-4 mm).

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