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Effect of Alternative Calcium Sources on Performance and Eggshell Quality in Laying Hens

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Abstract

An experiment was conducted to determine the effect of different calcium sources addition to diets on performance and eggshell quality in laying hens. In the experiment, 72 laying hens (Super Nick-White) at 56 week of age were randomly assigned into 6 treatments groups. The experiment, different levels of limestone, oyster shell and egg shell were tested with 6 different diets with 12 replicates per treatments and 12 hens per experimental unit. Particle sizes of oyster shell and egg shell were between 2 to 5 mm. Different calcium sources addition to the laying hens diet were not significantly effect on egg production, egg weight, egg mass, feed intake, feed conversion ratio, egg specific gravity, egg shell weight, egg shell thickness and egg shell breaking strength (P>0.05). Dietary different calcium sources were significantly effect on feed intake (P<0.05). The result of this study that oyster shell and egg shell to the laying hens diets can be used instead of the limestone as a source of calcium without adversely affecting performance and eggshell quality.

Keywords: *Egg shell, egg quality, limestone, oyster shell, performance*

1. INTRODUCTION

Calcium (Ca) is one of the essential minerals in poultry nutrition. It is the main mineral component of the egg shells and it is also responsible of the internal egg quality. Egg shell quality is a vital factor in poultry production as large number of eggs with defective shell lead to great economic losses (Lavelin et al., 2000). Roland et al. (1996) reported that calcium deficiency lead to decreased egg production, egg weight, egg specific gravity, feed consumption and bone density and strength. While excess calcium significantly reduced egg production, egg weight, and feed consumption (Harms and Waldroup 1971).

The source of Ca might affect hen productivity and egg quality. Egg producers primarily use 2 supplemental sources of dietary Ca, oyster shell or limestone. Oyster shell and limestone both provide Ca in the form of Ca carbonate, and each contains about 38% Ca; however, limestone costs considerably less than oyster shell. In addition, egg shell may be an alternative Ca sources for layer hens. The egg shell could be an adequate Ca source in layer diets. The nutrient value of eggshells has a Ca level comparable to that of limestone and oyster shell (Scheideler, 1998). Park (1995) reported that limestone is the most common source of calcium for poultry feed containing about 37 % of this mineral, Many studies had been conducted to investigate the use of many sources of calcium such as limestone and oyster shell in layers diets (Safaa et al., 2008; Saunders-Blades et al., 2009). Particle size of calcium sources in layer rations is also of importance. Lichovnikova (2007) recommended supplying two-thirds of the Ca in the diet as large particles to ensure eggshell quality in the last third of the laying period. Zhang and Coon (1997) concluded that larger particle size limestone with lower in vitro solubility was retained in the gizzard for a longer time, which may increase Ca retention. Many authors have thus compared the effects of fine and large limestone on various qualities of eggs produced (Guinotte and Nys, 1991; Richter et al., 1999; Pavlovski et al., 2003; Koreleski and Swiatkiewicz, 2004; Lichovnikova, 2007; Safaa et al., 2008). A slower solubilisation of sources of Ca would make Ca available during the time of the eggshell calcification and diminish bone Ca and P mobilisation (Skrivan et al. 2010).

The objective of this study was to compare various combinations of Ca sources from limestone, oyster shell and eggshell for laying hens.

2. MATERIAL AND METHODS

A total of 72 laying hens (Super Nick), 56 week of age were randomly assigned into 6 treatments groups. The experiment, different levels of limestone, oyster shell and egg shell were tested with 6 different diets with 12 replicates per treatments and one hen per experimental unit. Particle sizes of the limestone, oyster shell and egg shell were between 2 to 5 mm. Sieve sizes used were as follows, from fine and large screen sizes 2 mm and 5 mm, respectively. Hens were housed in a layer house equipped with 72 metal battery cages (50 x 50 x 40 cm). Experimental diets were balanced to meet or exceed the nutrient requirements for laying hens (National Research Council, 1994) and formulated to be isocaloric and isonitrogenous (Table 1). Hens were offered feed and water ad libitum throughout the experiment (56-68 week of age). Lighting was provided for 16 h/day from 05:00 to 21:00 h throughout the experimental period. Housed in individual layer cages were environmentally controlled room (23-25 ^{o}C).

Feed Intake (FI) and Egg Weight (EW) were recorded biweekly. Egg Production (EP) was recorded daily and Egg Mass (EM) was calculated from collecting data of EP and EW at biweekly via: EM= (EP x EW) / Period (days). Feed conversion ratio (FCR; g of feed g of egg) was calculated via: FCR = FI (g of feed/hen/period) / EM (g of egg/hen/period). The eggs were subjected to determine characteristics of eggshell quality parameters (shell breaking strength, shell weight and shell thickness) on all collected eggs produced at the last two days of each period during the experiment. Eggshell breaking strength was measured using a cantilever system by applying increased pressure to the broad pole of the shell using an instrument (Egg Force Reader, Orka Food Technology, Israel). Eggshells were rinsed running water and dried in oven at 60°C for 12 h, to determine eggshell thickness (including the membrane) in three points on the eggs (one point on air cell or the randomized two points of equator) using a micrometer (Mitutoyo, 0.01 mm, Japan). Eggshells were weighed using a 0.001g precision scale. Eggshell weight was calculated via: Eggshell weight (g/100 g egg) = [Eggshell weight (g) / Egg weight (g)].

Data were subjected to ANOVA by using Minitab (2000). Duncan's multiple range tests were applied to separate means (MstatC, 1980). Statements of statistical significance are based on probability of $P<0.05$.

Table 1. Composition of experimental diets

	Experimental diets					
Ingredients (%)	**% 100 LIM**	**% 100 EGS**	**% 100 OYS**	**% 50 LIM / % 50 EGS**	**% 50 LIM / % 50 OYS**	**% 50 EGS/ % 50 OYS**
Corn	54,10	54,10	54,10	54,00	54,00	54,00
Barley	11,00	10,65	10,65	11,00	11,00	10,86
Soybean meal	21,80	21,90	21,90	21,80	21,80	21,82
Vegetable oil	1,50	1,50	1,50	1,50	1,50	1,50
Di-Ca-phosphate	1,70	1,70	1,70	1,70	1,70	1,70
Salt	0,35	0,35	0,35	0,35	0,35	0,35
Premix[1]	0,25	0,25	0,15	0,15	0,15	0,15
Methionine	0,10	0,10	0,10	0,10	0,10	0,10
Limestone	9,20	---	---	4,60	4,60	---
Egg shell[2]	---	9,45	---	4,70	---	4,71
Oyster shell[2]	---	---	9,45	---	4,70	4,71
Total	100,0	100,0	100,0	100,0	100,0	100,0
Calculated nutrients						
Metabolizable Energy (Kcal/kg)	2711	2703	2703	2707	2707	2704
Crude protein (%)	15,51	15,52	15,52	15,50	15,50	15,50
Calcium (%)	3,62	3,61	3,61	3,60	3,60	3,60
Available phosphorus (%)	0,41	0,41	0,41	0,41	0,41	0,41
Lysine (%)	0,82	0,82	0,82	0,82	0,82	0,82
Methionine (%)	0,36	0,36	0,36	0,36	0,36	0,36

[1]Premix provided the following per kg of diet: retinyl acetate, 4.0 mg; cholecalciferol, 0.055 mg; DL-α-tocopheryl acetate, 11 mg; nicotinic acid, 44 mg; calcium-D-pantothenate, 8.8 mg; riboflavine sodium phosphate 5.8 mg; thiamine hidrocloride 2.8 mg; cyanocobalamin, 0.66 mg; folic acid, 1 mg; biotin, 0.11 mg; coline, 220 mg; Mn, 60 mg; Fe, 30 mg; Zn, 50 mg; Cu, 5 mg; I, 1.1 mg; Se, 0.1 mg.

[2]Particle sizes (2-5 mm) form a Ca source.

LIM: Limestone; EGS: Egg shell; OYS: Oyster Shell

3. RESULTS AND DISCUSSION

The egg production, egg weight, egg mass, feed intake and feed conversion ratio are shown in Table 2.

Different dietary Ca sources had no significant effect on egg production, egg weight, egg mass and feed conversion ratio (P> 0.05), but feed intake was significantly affected by the treatments (P<0.05). The sources of Ca did not affect the performance of laying hens, which agrees with the report of Scheideler (1998), who did not find any effect on performance when 25 or 50% fine limestone in the diet was substituted with either oyster shell or large limestone in laying hens. Moreover, Keshavarz et al. (1993) did not observe any effect on performance when 33% fine limestone was substituted with oyster shell in the diets of laying hens. Koreleski and Swiatkiewicz (2004) observed a non-significant increase in egg production when one half of the fine limestone (<0.4 mm) was replaced with particulate limestone grit (2.0–4.0 mm). Saunder-Blades et al. (2009) reported that feed intake, body weight, egg production did not differ among hens fed the different Ca sources. In support to the present study, Pelicia et al. (2009) reported that three limestone particle size (distributions 100% fine, 50% fine+ 50% coarse, 30% fine + 70% coarse) did not influence the most of evaluated performance parameters. Cheng and Coon (1990) and Guinotte and Nys (1991) concluded that larger particles limestone had no beneficial effect on egg production.

Table 2. Effect of different calcium sources addition to diets on performance in laying hens from 56 to 68 weeks of age

Diets	Egg production (%)	Feed intake (g/hen/day)	Egg weight (g)	Egg mass (g/hen/day)	Feed conversion ratio (g feed/g egg)
% 100 LIM	91,28±2,09	128,6±0,70^{ab}	65,53±1,19	59,69±1,35	2,16±0,04
% 100 EGS	91,40±2,04	128,9±0,66^{a}	66,13±0,68	60,43±1,45	2,15±0,05
% 100 OYS	89,59±2,36	126,3±1,13^{abc}	65,99±0,92	59,00±1,41	2,15±0,04
% 50 LIM / % 50 EGS	92,33±1,46	125,4±0,87^{c}	66,69±1,61	61,42±1,09	2,05±0,04
% 50 LIM / % 50 OYS	91,56±2,48	125,9±1,30^{bc}	65,02±1,41	59,43±1,77	2,14±0,06
% 50 EGS / % 50 OYS	91,90±2,32	127,3±0,71^{abc}	65,24±1,02	59,90±1,65	2,14±0,07

$^{a, b, c}$; values within a column with different superscription are significantly different (P<0.05).

LIM: Limestone; EGS: Egg shell; OYS: Oyster Shell

In the present study, egg specific gravity, eggshell weight, eggshell thickness and eggshell breaking strength are presented in Table 3.

Different dietary Ca sources had no significant effect on egg specific gravity, eggshell breaking strength, eggshell weight and eggshell thickness (P> 0.05). Skrivan et al. (2010) reported that, limestone particle size had no effect on shell breaking strength, and a statistically significant but limited effect on shell thickness, shell weight. Safaa et al. (2008) reported that the substitution of 40% fine limestone with coarse limestone had no significant effect on egg quality traits.

Table 3. Effect of different calcium sources addition to diets on eggshell quality in laying hens from 56 to 68 weeks of age

Diets	Egg specific gravity (g/cm^3)	Eggshell breaking strength (kg)	Eggshell weight (g)	Eggshell thickness (mm)
% 100 LIM	1,0778±0,0011	3,68±0,01	5,69±0,08	0,348±0,003
% 100 EGS	1,0775±0,0016	3,61±0,19	5,86±0,09	0,352±0,006
% 100 OYS	1,0787±0,0013	3,65±0,11	5,78±0,08	0,348±0,004
% 50 LIM / % 50 EGS	1,0768±0,0008	3,58±0,17	5,68±0,10	0,345±0,003
% 50 LIM / % 50 OYS	1,0815±0,0018	3,60±0,10	5,80±0,07	0,353±0,005
% 50 EGS / % 50 OYS	1,0796±0,0087	3,63±0,08	5,78±0,08	0,351±0,003

LIM: Limestone; EGS: Egg shell; OYS: Oyster shell

Saunder-Blades et al. (2009) observed that egg specific gravity did not differ among hens fed the different Ca sources. The results of the present study are consistent with the findings of Pelicia et al. (2009), who also did not observe any difference in eggshell quality feeding layers with different limestone particle sizes. Cheng and Coon (1990) and Guinotte and Nys (1991) concluded that larger particles limestone had no effect on eggshell quality**.**

4. CONCLUSION

The result of this study that oyster shell and egg shell to the laying hens diets can be used instead of half of the limestone as a source of calcium adversely affecting performance and eggshell quality.

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