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Effect of the Calcium Level and Limestone Particle Size on the Performance of Semi-Heavy Layers in the Second Cycle of Egg Production

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ABSTRACT

An experiment was carried out at the Research and Development Unit of Brotas aiming at evaluating dietary calcium level and limestone particle size on the production performance of commercial (Hy-Line Brown) layers in the second lay cycle. Experiment duration was 112 days. A total number of 288 hens, with 83 weeks of age in the beginning of the experiment, were used in a completely randomized experimental design in a factorial arrangement of 2x3, with two calcium levels (3.5 and 4.0%) and three limestone particle size compositions: 100% fine limestone (FL), 30% coarse limestone (CL) + 70% fine limestone (FL), and 50% (CL) + 50% (FL), with six replicates of eight birds each. Egg weight (g), egg production (%), egg mass (%), feed intake (g), feed conversion ratio (kg/dz and kg/kg), mortality (%), and egg loss (%) were evaluated. The analysis of variance did not detect significant differences ($p>0.05$) among treatments on any of the evaluated performance parameters. It was concluded that the tested calcium levels and limestone particle composition did not influence the performance of semi-heavy layers in second production cycle.

INTRODUCTION

Second cycle layers produce larger eggs, with consequent increase in eggshell quality problems, causing expressive losses. Although forced mold is frequently used, there is little information on the nutritional levels recommended for the post-mold period. In commercial layers, there is a great interest in calcium metabolism because as the hens age, eggshell quality decreases. Consequently, there is an increase in egg loss, which has a negative impact on the farmer's income. The intake of inadequate calcium amounts may promote skeleton abnormalities, increased mortality, reduction in the size and in the number of eggs produced, and poor eggshell quality leading to high rates of cracked eggs (Maynard *et al.*, 1984).

As the bird ages, there is a decrease in 1-α-hydroxylase – the enzyme responsible for the activation of vitamin D metabolite in the kidneys –, and a reduction in the efficiency of calcium absorption. This causes poorer eggshell quality, and increase in egg loss. In addition, the larger size of the eggs produced by these older layers also results in lower eggshell quality, as the rate of egg size increase is higher than the rate of eggshell weight increase (Adams & Bell, 1998). Older layers also have diminished capacity of replacing the calcium lost during hypocalcemia periods as compared to young layers (Elaroussi *et al.*, 1994).

When there is adequate calcium intake, bird needs can be supplied by increasing its intestinal absorption. However, if intake is low, increasing intestinal absorption will not be sufficient to ensure calcium supply.

The particle size of calcium sources may influence its availability to the bird. As eggshell is usually formed during the night, when birds do not eat feed, the advantage of the use of coarser particles is its slower passage through the gastrointestinal tract. This makes calcium available for eggshell formation, with consequent lower mobilization of bone calcium by the bird (Harms, 1982). When coarser, less soluble limestone particles are added to the feed, calcium will be present in the gastrointestinal tract even during the night, due to its solubilization and availability for absorption to the blood (Miles, 2000).

From nutritional point of view, the smaller the feed particle, the larger its contact with the digestive juices, thereby favoring digestion and absorption. In contrast, from the feed mill standpoint, the higher the feed particle, the higher the energy savings and grinding efficiency (tons/hour).

This study aimed at evaluating dietary calcium level and limestone particle size on the production performance of commercial (Hy-Line Brown) layers in the second cycle of lay.

MATERIAL AND METHODS

The experiment was carried out at the facilities of the Research and Development Unit of Brotas. A total number of 288 commercial Hy-Line Brown layers, with 83 weeks at the beginning of the experiment, was used. Birds were housed in 36 cages (1.00m length, 0.45m depth, and 0.40m height), containing an internal transversal partition, each housing four birds; therefore, eight birds per cage. After forced molting, birds were submitted to the same management and feeding. At the beginning of the experiment, body weight and egg production were standardized.

A completely randomized experimental design in a factorial arrangement of 2x3, with two calcium levels (3.5 and 4.0%) and three limestone particle size compositions: 100% fine limestone (FL), 30% coarse limestone (CL) + 70% fine limestone (FL), and 50% (CL) + 50% (FL), with six replicates of eight birds each.

Experimental feeds were formulated on corn and soybean meal basis, taking into consideration raw material composition as in Rostagno *et al*. (2000), and are shown in Table 1.

Eggs from each treatment were daily collected and counted for egg production evaluation. Eggs and feed residues from each treatment were weekly collected for performance evaluation. Egg weight (g), egg production (%), egg mass (%),feed intake (g), feed conversion ratio (kg/dz and kg/kg), mortality (%), and egg loss (%) were measured.

An experimental period of 112 days was determined as a function of analyses. Data were submitted to analysis of variance, and means were compared using the test of Tukey ($p<0.05$), using the software (Ferreira, 2000).

Table 1 - Percentage and calculated composition of the experimental diets.

Ingredients (%)	Calcium levels (%)	
	3.5	4.0
Ground corn	65.41	64.98
Soybean meal	20.24	20.84
Wheat midds	3.66	2.23
Dicalcium phosphate	1.29	1.31
Soybean oil	1.00	1.00
Calcitic limestone*	7.73	8.97
Mineral supplement**	0.10	0.10
Vitamin supplement***	0.10	0.10
Salt	0.35	0.35
D-L methionine	0.12	0.12
Total	100.00	100.00
Calculated composition		
ME (kcal/kg feed)	2790	2790
Crude protein (%)	15.5	15.5
Calcium (%)	3.5	4.0
Avail. phosphorus (%)	0.34	0.34
Methionine (%)	0.35	0.35
Methionine+cystine (%)	0.64	0.64
Lysine (%)	0.74	0.74

* Calcitic limestone presented fine and coarse particle size, with mean geometric diameter of 0.185mm for the fine limestone, and of 2.83mm for the coarse limestone. ** Mineral supplement per kg feed: zinc 54 mg, iron 54 mg, manganese 72 mg, copper 10 mg, iodine 0.61 mg, selenium 0.302mg.*** Vitamin supplements per kg feed: Vit A 7,520 IU, Vit D3 1,816 IU, Vit E 8.4 mg, Vit k3 1.28 mg, Vit B1 1.34 mg, Vit B2 3.0 mg, Vit B6 1.66 mg, Vit B12 8.0 mcg, nicotinic acid 20 mg , calcium panthotenate 8.0 mg, folic acid 0.300 mg, biotin 0.04 mg.

RESULTS AND DISCUSSION

Minimal and maximal environmental temperature averages recorded during the experimental period were 18.0 and 29 ^{o}C, respectively, with an average temperature of 22.3 ^{o}C.

Average performance results, according to calcium levels and limestone particle size composition are presented in Table 2.

There were no significant interactions ($p>0.05$) between calcium levels and particle size composition for none of the analyzed characteristics.

The analysis of variance did not detect significant differences ($p>0.05$) among treatments in any of the evaluated performance parameters. This result is consistent with Cheng & Coon (1990), who studied the influence of two different calcium sources (limestone), six levels of calcium intake (2.0, 2.5, 3.0, 3.5, 4.0, and

Table 2 - Production performance of semi-heavy Hy-Line Brown layers in second cycle of lay fed different calcium levels and different limestone particle size composition.

Parameter	Calcium levels	limestone particle size composition: 100% Fine	30% Coarse+ 70% Fine	50% Coarse+ 50% Fine	Aver.	CV (%)
Egg weight (g)	3,5	69,13	67,88	68,29	68,43	
	4,0	69,06	68,40	70,52	69,33	2,15
	Mean	69,09	68,14	69,40	68,88	
Egg production (%)	3,5	87,56	84,09	85,68	85,78	
	4,0	86,93	86,50	84,69	86,03	4,99
	Mean	87,25	85,29	85,18	85,91	
Egg masss(%)	3,5	60,43	57,01	58,48	58,64	
	4,0	60,02	59,15	59,76	59,65	5,02
	Mean	60,23	58,08	59,12	59,14	
Feed intake (g)	3,5	112,81	108,95	111,09	110,95	
	4,0	110,02	111,17	112,41	111,20	2,69
	Mean	111,41	110,06	111,75	111,08	
Feed conversion ratio (kg/dz)	3,5	1,55	1,57	1,56	1,56	
	4,0	1,52	1,55	1,60	1,56	4,09
	Mean	1,54	1,56	1,58	1,56	
Feed conversion ratio (kg/kg)	3,5	1,88	1,93	1,92	1,91	
	4,0	1,85	1,90	1,91	1,89	3,97
	Mean	1,86	1,91	1,92	1,90	
Mortality (%)	3,5	1,30	5,83	0,00	2,38	
	4,0	3,91	0,00	6,88	3,60	175,94
	Mean	2,60	2,91	3,44	2,99	
Egg loss (%)	3,5	0,62	0,65	0,83	0,70	
	4,0	0,66	0,97	0,70	0,78	34,14
	Mean	0,64	0,81	0,76	0,74	

4.5 g/hen/day) on egg production and egg quality of commercial layers, and concluded that these parameters were not influenced by the treatments. In the present experiment, egg weight was not influenced (p>0.05) by the treatments, which was probably due to the fact that the manipulation of other nutrients, such as protein, methionine, lysine, and linoleic acid also interfere on this parameter. Rodrigues (1995), working with layers in the second cycle of lay and two calcium levels (3.8 and 4.5%), observed that egg production, egg weight, and egg loss percentage were not affected in the initial period of lay after molting. However, at the end of this period, the lowest calcium level (3.8%), promoted higher egg production, whereas egg weight and egg loss were not affected.

In the present study, feed intake and feed conversion ratio were not influenced by calcium levels or limestone particle size composition (p>0.05). In contrast, Oliveira *et al.* (2002) observed that feed intake was lower with a diet with higher calcium level (4.5%), but did not obtain significant responses in feed conversion ratio and average egg production, which was also found by Clunies *et al.* (1992), who worked with dietary calcium levels of 3.5 and 4.5%. However, Rodrigues (1995), studying dietary calcium levels of 3.8 and 4.5% for layers in the second cycle of lay, found lower egg production with the higher calcium level, and justified this by a reduction in daily feed intake. However, no differences were found between calcium levels and bird age in terms of feed conversion ratio. The results of the present experiment do not agree with the findings of Härtel (1989), who observed that increasing calcium levels promoted higher feed conversion ratio, or with Damron & Harms (1980), who asserted that low calcium levels worsen feed conversion ratio. The layers used in the present experiment presented average feed intake of 111 g/day, which resulted in a calcium intake of 3.88 g/hen/day in its lowest dietary level, which apparently was sufficient to supply the requirements for egg production.

Particle size did not affect the studied parameters (p>0.05). Oliveira *et al.* (2002) also found that limestone particle size did not influence bird performance. Cheng & Coon (1990) evaluated six different limestone particle diameters (3.36, 2.38, 1.68, 1.02, 0.50, and 0.15 mm) on egg production and egg quality of commercial layers, and concluded that the treatments had no effect on egg production or egg weight. Larger particles may be effective when hens are fed inadequate calcium levels, or when exposed to factors that hinder calcium utilization. Therefore, uncer practical conditions, the use of large particles may de indicated, but solubility must be taken into account (Roland, 1986). Using four different limestone particle sizes for layers after forced molting to evaluate calcium retention rate in the gizzard, Rao *et al.* (1992) reported that the substitution of 2/3 pulverized limestone by large limestone particles has been applied for several years in the poultry industry; however, the partial substitution of fine limestone by larger particles in layers may not promote better eggshell quality under optimal conditions. The authors suggest that large limestone particles may be beneficial under adverse conditions, in which calcium intake or availability is reduced.

CONCLUSIONS

Under the conditions of this study, it is possible to conclude that the tested calcium levels and limestone particle size composition did not affect the performance of semi-heavy layers in the second cycle of lay.

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