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Evaluation of Dietary Calcium Requirements in Fayoumi Laying Hens

Research Article

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ABSTRACT

The experiment was carried out in poultry experimental station belonging to NRC, Cairo, Egypt. A total of 120 Fayoumi layers, 45 weeks old, were randomly divided into four equal groups. Each group included three replicates (10 hens in each). The first group was fed the control diet containing 3.3% gram Ca, whereas, the other three received diets containing 2.8, 2.6 and 2.4% gram Ca, respectively. Calcium was added to the ration in the form of limestone. The results of the present study clearly indicated that there were no significant differences among groups fed diets containing different levels of Ca (2.4 up to 3.3 g %) in egg production, egg weight, egg mass, daily feed consumption and feed conversion efficiency (P>0.05). The control group displayed the lowest percentage of fertility (59.33) and hatchability (42), and the highest percentage of embryonic mortality (17.33), while the best results of the reproductive performance were recorded from the fourth group fed diet containing 2.4% Ca. Measurements of egg characteristics indicated no significant differences among groups (P>0.05); however, yolk color was slightly improved in the fourth group at six weeks of treatment. Shell percentage and thickness tended to increase in the fourth group particularly after 12 weeks of treatment. In conclusion, dietary calcium levels (2.4 up to 3.3%) did not significantly influence egg production, egg mass, feed conversion efficiency and egg quality (P>0.05). However, low level of dietary calcium (2.4%) has improved egg fertility, hatchability and shell percentage and thickness. A percentage of 2.4% of calcium in the diet is recommended for Fayoumi laying hens.

KEY WORDS calcium, egg production, egg quality, Fayoumi layers, fertility, hatchability.

INTRODUCTION

The local breed of chickens is considered one of the important sources of animal protein in this country. It is characterized by its large capacity to tolerate harsh environmental conditions of Egypt and its nutritional requirements are limited compared to those of the world breeds.

In this respect, there are many investigations aimed to improve local breeds of laying hens in Egypt. Animal Production Department of NRC in Egypt has adopted the plan of improving Fayoumi laying hens. This project has continued for 13 years till now and aimed to improve egg production and to determine feed requirements of this breed.

Calcium is an important mineral element in the diet of laying hen, which plays an important role in different biological functions such as skeleton and egg shell development, blood coagulation, muscle contraction, transmission of nerve impulses, catalyst of enzymes and mediator of some hormone actions. Together, the low cost of calcium, with the fact that calcium is a limiting factor in egg production and egg shell quality, may lead to excessive use of this element in the laying hens' diets and this may be adversely reflected on the productive and reproductive performance of the laying hen (Celebi and Bolukbasi, 2006). These authors concluded that the use of supplemental Ca provided significant advantage for shell quality but not for productio-

n parameters.

Therefore, the present study was conducted to determine the actual requirements of calcium in the diet of Fayoumi laying hens to cover their needs for egg production, quality and hatchability.

MATERIALS AND METHODS

Experimental design and management

A total of 120 Fayoumi layers were randomly housed from 45 to 57 weeks of age in individual battery cages located in poultry experimental station belonging to NRC, Cairo, Egypt. The birds were distributed into four treatments each containing 30 hens. All groups were fed yellow corn, soybean, protein concentrate, wheat bran and limestone (Table 1). Calcium content (%) of rations was 3.3, 2.8, 2.6, and 2.4 for groups 1, 2, 3 and 4, respectively. The first group served as control. Each experimental group was divided into three replicates, each consisting of 10 hens. Feed was provided in an individual feeder ad-libitum and water was supplied through automatic nipples. The twelve weeks experimental period was divided into three stages of 4 weeks each. The traits were calculated at each interval and for the entire experimental period.

Productive performance

Egg weights (in grams) were recorded daily for each hen throughout the experimental period (12 weeks). Average egg weight and egg production percentage were calculated at 4 weeks intervals for each treatment group. Average egg mass was calculated as gram egg/hen/4weeks.

Feed intake and feed conversion efficiency

Feed intake in grams/hen/4 weeks and daily feed intake (g/hen/day) per treatment group was calculated. Feed conversion (g feed/g egg) per each treatment group was also calculated.

Reproductive performance

Fertility and hatchability percents for each treatment were recorded at the end of the experimental period. Percentage of un-hatched eggs (percentage of dead embryos) was also calculated at the end of the experiment.

Egg characteristics (egg quality)

Egg quality was assessed every six weeks, including egg weight, shape index, yolk (%), albumen (%), shell (%), shell thickness, yolk color, yolk index (%) and Haugh units.

Statistical analysis

Statistical analysis was carried out using SAS (2001) and Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Egg production

The present results indicated that dietary calcium level (2.4 up to 3.3%) did not significantly influence daily egg production, egg weight and egg mass (Table 2) in Fayoumi laying hens (P>0.05). In agreement with the present results, Saleh and El-Naggar (1983) reported that dietary calcium levels (1.5 up to 3.5%) for 8 weeks had no significant effects on egg production in Dokki-4 fowls. Similar results were obtained by Kuhl *et al*. (1977) in Hy-line hens given 2.5 up to 3.5% dietary calcium. More recent results of Pizzolante *et al*. (2006) also, showed that calcium levels of 3.5 and 4% in the diet did not affect egg production of semi-heavy layers. However, opposing results were obtained by Pakdel *et al*. (2003) in native laying hens in Iran. They found that decreasing calcium levels from 3.27 to 1.96% in the diet caused a significant linear increase in egg production and egg weight. Similar results were reported by Lim *et al*. (2003).

On the contrary to these results, Sunder *et al*. (1990) and Mohammed and Mohammed (1991) found that egg production was improved in laying hens when dietary calcium increased and the optimum dietary level of calcium for layers was found to be 3.2% and 3.1%, respectively. Results reported by Behl *et al*. (1995), Burling (2002), Celebi and Bolukbasi (2006) and Costa *et al*. (2008) concluded to the same trend of higher EP. These results may be attributed to the genetic capacity characterized by each hybrid (El-Sayed *et al*. 1995), or to differences in the rate of Ca absorption (El-Gendi *et al*.1999). These conflicting results may be due to differences in the breeds and consequently the feed requirements for each breed beside differences in the climatic and nutritional conditions and other environmental factors.

Feed intake and feed conversion efficiency

Daily feed intake and feed conversion efficiency (FCE) were not significantly influenced by the dietary calcium levels experimented in this study (P>0.05) (Table 3).

Feed requirements given in this study are sufficient for Fayoumi laying hens since feed consumption did not significantly change according to change in dietary calcium levels (P>0.05).

Some investigators showed that higher calcium levels in layers diet decreased feed consumption (Herbert *et al*. 1977; Mohamed and Mohammed, 1991 and Celebi and Bolukbasi, 2006). In agreement with the present results, Leeson *et al*. (1993) reported that diets containing 2.8 up to 4.2% calcium had no effect on egg production, egg size and feed intake, and they concluded that the brown–egg layer requires no more than 3.4 g calcium/day. Similar results were reported by Pakdel *et al*. (2003) but they found dcrea-

Table 1 Composition and calculated analysis of the experimental rations

Ingredients	Experimental groups			
	Control (G_1)	G_2	G_3	G_4
Yellow corn	65	66	65	65
Soybean meal (44% CP)	10	10	9.5	9
Concentrate*	10	10	10	10
Wheat bran	8	8.5	10.5	11.5
Limestone	7	5.5	5	4.5
Total	100	100	100	100
Calculated analysis:				
Crude protein (CP%)	16.00	16.10	16.07	1600
Metabolizable Energy(Kcal/Kg)	2765	2780	2780	2770
Calcium (Ca%)	3.30	2.80	2.60	2.40
Available Phosphorus (AP%)	0.38	0.38	0.38	0.38
L- Lysine (%)	0.69	0.69	0.69	0.68
Methionine (%)	0.33	0.33	0.33	0.33
Methionine+Cysteine	0.67	0.67	0.67	0.67

* Concentrate (%): Crude protein 50.20, Fibers 1.62, Crude fat 5.29, Calcium 6.20, Available Phosphorus 2.80, Methionine 1.26, Cystine 2.01,L- Lysin 2.40, Sodium 1.42, Metabolizable Energy 2554 Kcal/kg.

Table 2 Effect of dietary calcium levels on egg production, egg mass and egg weight in Fayoumi laying hens at four weeks intervals*

Exp. Period (Treat-ment)	Egg production (%) egg/hen/day				Average daily egg weight (g)				Egg mass/hen/4 weeks (g)			
	0-4 week	5-8 week	9-12 week	0-12 week	0-4 week	5-8 week	9-12 week	0-12 week	0-4 week	5-8 week	9-12 week	0-12 week
Control 3.3 % Ca	72.33^{a}	73.53^{b}	68.87^{c}	71-60	42.70	43.10	43.40	43.03	863.3^{a}	887.7^{ab}	837.00c	862.70
2.8% Ca	67.07^{b}	71.43^{c}	75.97^{a}	71-77	42.73	43.20	44.37	43.43	812.3^{b}	863.7^{b}	944.00a	872.70
2.6% Ca	63.07^{d}	76.10^{a}	75.27^{a}	71.47	42.63	42.67	44.20	43.13	752.7^{c}	908.7^{a}	931.7a	863.30
2.4%Ca	66.00^{c}	74.63^{b}	71.70^{b}	70.77	42.80	42.97	43.67	43.17	790.7^{b}	897.7^{a}	876.7^{b}	855.70
SE	1.03	0.53	0.88	0.19	0.16	0.24	0.19	0.24	12.98	7.57	13.75	5.27

*The means in the same column that have at least one common letter, do not have significant difference (P>0.05).

Table 3 Effect of dietary calcium levels on daily feed intake and feed conversion efficiency in Fayoumi laying hens at four weeks intervals*

Exp. Period (Treatment)	Daily feed intake (g/day/hen)				Feed conversion ratio (g feed/egg mass)			
	0-4 week	5-8 week	9-12 week	0-12 week	0-4 week	5-8 week	9-12 week	0-12 week
Control 3.3% Ca	105.00^{a}	105.00^{b}	104.00^{d}	105.00^{b}	3.41	3.33^{a}	3.47	3.40
2.8% Ca	100.00^{b}	109.00^{a}	118.00^{a}	109.00^{a}	3.45	3.53^{b}	3.50	3.50
2.6% Ca	95.00^{d}	111.00^{a}	115.00^{b}	107.00^{b}	3.52	3.41^{ab}	3.46	3.46
2.4%Ca	98.00^{c}	110.00^{a}	107.00^{c}	105.00^{b}	3.47	3.43^{ab}	3.43	3.44
SE	1.16	0.78	1.76	0.58	0.03	0.03	0.02	0.02

*The means in the same column that have at least one common letter, do not have significant difference (P>0.05).

Table 4 Effect of dietary calcium level on reproductive performance in Fayoumi laying hens[1]

Item	Experimental rations				SE
	3.3% Ca	2.8% Ca	2.6% Ca	2.4% Ca	
Fertility* (%)	59[d]	72[c]	77[b]	83[a]	2.72
Hatchability** (%)	42[d]	60[c]	71[b]	78[a]	4.24
Embryonic mortality (%)	17.33[a]	11.67[b]	5.33[c]	5.00[c]	1.74

[1]The means in the same row that have at least one common letter, do not have significant difference (P>0.05).
* Fertility (%)=(Fertile egg/total egg number)/100.
** Hatchability (%)=(Number of hatched chicks/total egg number)/100.

sing dietary Ca levels caused a significant improvement in FCE.

Reproductive performance

Present results (Table 4) revealed that higher fertility (83.67%) and hatchability (78.67%) were observed in group (4) which fed diet containing 2.4% calcium level, higher dietary level of calcium (3.3%) induced lowest fertility and hatchability and highest embryonic mortality. The same results were reported by El-Kloub and El-Mostafa (2006). Regarding to this, the improvement in hatchability (%) may be attributed to the improvement in egg–shell quality, since the poor hatchability in hot climate may be partially due to thin shell egg (Daghir, 1995).

On the contrary to the present result, other investigators have shown that low calcium levels tended to decrease percentage of fertility and hatchability (Borling *et al*. 2002).

In Japanese quail, Hanna *et al*. (1992) reported that 3 and 3.5% calcium in the diet gave hatchability percent higher than lower calcium levels. El-Kloub and Abdel-Mageed (2006) also reported that 3% dietary calcium induced significant improvement in hatchability as compared to the other dietary treatments.

Egg characteristics

The current results indicated that most of the egg characteristics studied were not significantly influenced by the dietary calcium levels adopted in this study (P>0.05). However, yolk color, shell weight and shell thickness tended to be improved as a result of lower levels of dietary calcium (Table 5 and 6). Similar results were reported by Sunder *et al*. (1990) and Lim *et al*. (2003). Accordingly, Pakdel *et al*. (2003) reported that dietary calcium levels (1.96, 2.62 and 3.27%) had no significant effect on shell thickness and shell strength. They also showed that lower level of calcium (1.96%) induced maximum calcium retention in the shell. While, Celebi and Bolukbasi (2006) concluded that 1 to 2.5% calcium dietary level provided significant advantage for shell quality in Lohman. An LSL white layers. The improvement of egg shell quality may be attributed to the high level in serum Ca concentration (El-Kloub and El-Mostafa 2006). Moreover, there was a relationship between increasing the levels of calcitonine hormone, increasing egg production and improving egg quality. The low level of this h-

Table 5 Effect of dietary calcium levels on egg quality at 6 weeks of experiment in Fayoumi Laying hens

Item	Experimental rations				SE
	2.8% Ca	2.6% Ca	2.4% Ca	2.4% Ca	
Egg weight	42.33	43.00	42.67	43.33	0.37
Shape index	78.38	77.09	76.30	77.33	0.46
Yolk%	34.36	33.98	34.99	34.89	0.33
Albumen%	53.94	53.92	52.28	52.86	0.38
Shell%	11.70	12.10	12.73	12.25	0.19
Shell thickness	31.67	31.67	31.33	31.73	0.21
Yolk color	9.07[c]	9.52[b]	9.77[a]	10.13[a]	0.13
Yolk index	47.19	47.64	47.30	47.51	0.33
Haugh unit	77.67	79.00	76.67	79.00	0.86

[a]The means in the same row that have at least one common letter, do not have significant difference (P>0.05).

Table 6 Effect of dietary calcium levels on egg quality at 12 weeks of experiment in Fayoumi Laying hens*

Item	Experimental rations				SE
	3.3% Ca	2.8% Ca	2.6% Ca	2.4% Ca	
Egg weight,(g)	44.00[ab]	43.00[b]	43.00[b]	44.33[a]	0.23
Shape index	76.74	75.91	76.74	77.74	0.42
Yolk (%)	33.08	34.82	34.05	34.05	0.31
Albumen (%)	53.91	52.00	53.68	52.25	2.32
Shell (%)	12.68	13.18	12.27	13.09	0.18
Shell thickness (mm)	31.67	32.87	32.07	33.68	0.39
Yolk color	8.80[b]	9.40[ab]	9.73[a]	9.50[a]	0.13
Yolk index	47.75	57.35	47.80	47.49	2.38
Haugh unit	79.67	79.00	80.00	79.67	0.15

*The means in the same row that have at least one common letter, do not have significant difference (P>0.05).

ormone resulted in higher egg shell, less number and lower immune response (Hassan *et al*. 2006).

CONCLUSION

From the aforementioned results it can be concluded that dietary calcium level (2.4%) is optimal level for Fayoumi laying hens.

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