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Influence of Supplemental Calcium on Production Parameters and Eggshell Quality of Laying Hens in Late Laying Period

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Abstract: This study was conducted to determine effect of dietary calcium supplementation on production performance and egg shell quality during the late laying period. 120 Lohman LSL white layers 70 wks of age were blocked according to the cage location and then assigned randomly to receive one of five diets added to 0, 1, 1.5, 2 and 2.5% Ca for 8 weeks. There were five diets, each diet was replicated in six times, each cage containing of four hens. Egg Production (EP) and Breakage Egg Ratio (BER) were recorded daily. Feed Intake (FI) and Egg Weight (EW) were measured biweekly. A sample of 6 eggs from each group were collected randomly every two-weeks for Specific Gravity (SG), Shape Index (SI), Shell Strength (SS) and Shell Thickness (ST). In this study, feed intake, Feed Conversion (FC), egg weight, Egg Production (EP) and specific gravity were not influenced from dietary treatments. However, breakage egg ratio, shell breaking strength and shell thickness were affected from dietary treatments by statistically significant ($p<0.05$). There were numerically differences among the groups in egg production, feed intake, feed conversion, egg weight, specific gravity and egg shape index but not significant by statistically ($p>0.05$). Egg production and feed intake decreased linearly as increasing dietary Ca levels. The highest egg production observed with hens fed the control diet. However, the highest egg weight obtained form hens fed containing highest level of Ca. Shell thickness and shell breaking strength increased whereas breakage egg ratio decreased dependent on increasing of dietary Ca levels. The highest shell thickness and shell breaking strength were established hens fed containing high level Ca whereas the lowest breakage egg ratio was obtained from same group. In conclusion, under the conditions of the current experiment, the use of supplemental Ca provided significant advantage for shell quality but not production parameters.

Key words: Laying hen, calcium, eggshell quality, late laying period

INTRODUCTION

Formation of eggs with inferior shell quality is a major source of economic loss to the poultry industry on a global level. It is estimated that due to inferior shell quality about 6 to 8% of eggs are lost in different phase of the egg handing system from the point of production to the point of consumption[1] sometimes the frequency of defective eggs may increase from 7 to 11% during laying collecting and packaging of egg production[2]. The monetary value of such losses is estimated to be about $ 480 million annually in the only US[1].

The influence of various factors on shell quality has been revived by a number of investigators[2-4]. Genetics, age, nutrition and environment are the major factors that influence eggshell quality[5]. Calcium is one of the key elements required for maintenance and production of laying hens. It is the most abundant inorganic component of the skeleton and plays a major role in the wide variety of biological function. It is generally accepted that the decrease in egg production rates and increase in egg size, without concurrent and equal increase in shell weight is the reason for the decrease in shell quality as the hen ages[6-9]. Eggshell quality also changes in accordance with level of production and age of layer. As age advances also, shell thickness and shell strength decrease as age advances[2]. Calcium is major macro-mineral involving shell formation is increased with shell weight resulting from increase egg weight. However, the hen's ability to absorb from the digestive system and to mobilize Ca from the medullar bones (Due to depletion of Ca of these bones) is reduced with age[10]. Among the various nutritional factors that are necessary for proper eggshell formation adequacy of Ca intake probably, plays the important role, because Ca make up about 40% of the eggshell investigation of the Ca requirement of laying hens have been the subject of numerous reports. The shell deposition

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and shell quality are directly related to the calcium level in the diet.

The value of 3.75 g Ca per hen per day or greater was determined to be necessary for optimum shell and bone formation[11]. However,[12] reported 4.73% Ca was the optimum level for shell formation in laying hens. The information from[13] indicates that specific gravity for the entire experiment (22 to 66 wk of age) was significantly greater for hens fed 3.5% than those fed 3% Ca additional improvement shell quality or tibia weight was obtained when dietary Ca was increased to 4%. It was therefore the aim of the study to gain additional different dietary Ca levels on performance and eggshell quality in during the late production laying period.

MATERIALS AND METHODS

One hundred twenty 70 weeks old white Lohman LSL laying hens were used in this experiment. Bird were randomly assigned to five groups equally (n= 24) each treatment was replicated six times, four hens were settled down per cage (50x46x46). Groups were equally distributed in the upper and lower cage levels to minimize cage-level effect.

There were five treatments (one control and four experimental groups). Control birds were fed (T1) on a basal diet (Table 1) that was formulated to meet or exceed the NRC recommendations (NRC 1994) containing 3.75 Ca %. Experimental diets were prepared by adding limestone (containing 40% ca) at the levels of 1, 1.5, 2 and 2.5% (T2, T3, T4 and T5) to basal diet. This addition provided Ca to basal diet at levels of 0.4, 0.6, 0.8 and 1% Ca, respectively. During the experiment (8 wk), hens were fed *ad libitum* once daily at 08 hrs and water was available all the times. Also, hens were exposed to 16 h of light/day. Egg Production (EP) was recorded daily, Feed Consumption (FC) and egg weight were measured biweekly. Egg weight was determined using all eggs produced during two consecutive days per two weeks. Eggshell quality parameters were specific gravity, shape index, shell breaking strength and shell thickness. Specific gravity was determined using floatation method as described by Harms[14]. Shell thickness was determined using micrometer and shell breaking strength was determined using breaking strength instrument (kg/cm^2). A sample of eggs was randomly collected from each experimental group every two-weeks to assess eggshell quality parameters.

Statistical analyses was performed by the statistical package SPSS for windows, version 10.0 Multiple comparison of the data was done by using the Duncan test after one-way analysis of variance (ANOVA).

Table 1: Composition and calculated analysis of the experimental diets

	Calcium (%)				
Ingredients (%)	3.75	4.15	4.35	4.55	4.740
Corn	40	40	40	40	40
Soybean meal	17.5	17.5	17.5	17.5	17.5
Wheat	20	20	20	20	20
Wheat bran	5	5	5	5	5
Meat bone meal	2.5	2.5	2.5	2.5	2.5
Sunflower meal	5	5	5	5	5
Lime stone (ground)	2.5	2.5	2.5	2.5	2.5
Marble meal	5.65	5.65	5.65	5.65	5.65
Vitamin premix	0.35	0.35	0.35	0.35	0.35
Salt	0.3	0.3	0.3	0.3	0.3
Lysine	0.65	0.65	0.65	0.65	0.65
Methionin Cystine	0.55	0.55	0.55	0.55	0.55
Suplemental Ca (lime tone)	0	1	1.5	2	2.5
Calculated Analysis					
Crude protein	16	16	16	16	16
ME Kcal/kg	2650	2650	2650	2650	2650
Total Ca (%)	3.75	4.15	4.35	4.55	4.75
Total P (%)	0.5	0.5	0.5	0.5	0.5

RESULTS AND DISCUSSION

Overall results are presented in (Table 2). there were no statistically significant (p>0.05) differences in egg production, feed intake, feed conversion, egg weight, shape index and specific gravity among the treatments. But there were numerically differences among the groups. For example, egg production decreased linearly until T4 diet as increasing dietary Ca levels. The highest rate of egg production was obtained from hens fed the control diet when the lowest rate of egg production was observed with the hens fed the T4 diet. Also, the highest feed intake was established hens fed control diet whereas the lowest feed conversion rate was found in hens fed the control diet. Increasing dietary Ca levels decreased feed intake, hens fed the T4 diet consumed the least quantity of feed.

Similarly, the egg weight, specific gravity unit and shape index values were not influenced from dietary treatments by statistically significant (p>0.05). Nevertheless, there were increased linearly dependent numerically differences among the groups. Both egg weight and specific gravity units were increasing dietary calcium levels but not significant. The highest specific gravity unit and egg weight were observed with hens fed the diet containing the highest level of calcium. This results are consistent with a report of[6,10,11,13,15-17]. This information indicates that laying hens' tolerance for Ca is relatively high. In fact high Ca level of 4.75% (T5) was no adverse effects on their performances.

Shell thickness, shell breaking strength and breakage egg ratio were influenced from dietary treatments statistically significant (p<0.05) (Table 2). Both shell thickness and shell breaking strength increased, whereas,

Table 2:The Effect of calcium supplementation on production parameters and eggshell quality

Parameters dietary treatments	Egg production (%)	Feed consumption gr d^{-1}	Feed conversion Kg feed/kg egg	Breakage egg weight gr	Egg rate (%)	Shell shell thickness µm	Breaking strength Kg cm^3	Specific gravity gr cm^3	Shape index
T-1(control)	81.1	129	2.35	68.21	4.18^{a}	349^{b}	0.98^{b}	1.088	75.3
T-2	76.0	127.6	2.45	68.40	0.75^{ab}	353^{ab}	1.21^{ab}	1.089	74.4
T-3	74.76	126.8	2.45	69.20	0.71^{ab}	360^{ab}	1.24^{a}	1.090	73.9
T-4	73.40	124.0	2.46	67.30	1.20^{b}	357^{ab}	1.20^{ab}	1.089	74.8
T-5	74.43	125.5	2.42	69.90	0.63^{ab}	364^{a}	1.26^{a}	1.091	74.5
SEM	0.966	0.756	0.039	0.276	0.193	2.098	0.029	0.003	0.301
P	NS	NS	NS	NS	**	*	*	NS	NS

NS:Not Significant *: $p<0.05$ **: $p<0.01$

breakage egg ratio decreased dependent on increasing of dietary calcium levels. The highest shell thickness and shell breaking strength were obtained from eggs collected by hens fed the diet containing high level of Ca (4.75%). However, the lower shell thickness and breaking strength values were observed for birds fed control diet containing low level Ca (T1). There were similar results among the T2, T3 and T4.

Also, breakage egg ratio was highly significantly ($p<0.001$) affected by the increasing dietary Ca levels. Hens consuming the control diet produced egg with highly significant greater breakage egg ratio. Whereas, the lowest breakage egg ratio established from eggs collected by hens fed the diet containing high level Ca (T5) compared with other diets.

Also, there was a important positive linear relationship between Ca levels and breakage egg ratio. The improvement in breakage egg ratio may be related to the increase in shell thickness resulting from more calcium levels in the diet. Shell deposition and shell quality are directly related to the Ca level in the diet in late production period. Because, the hens ability to absorb Ca from the digestive system and to mobilize Ca from the medullar bones is reduce with age.

The results of this experiment are consistent with reports of[10,11,15-17] that increasing dietary calcium levels, significantly improved egg shell quality.

It suggested that it should be use high level dietary calcium to preserve eggshell quality in during late laying period.

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