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Effect of shell grit on physical and nutritional properties of chicken egg

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Abstract
Modern layer flocks are fed a measured amount of nutritionally balanced feed. To meet the increased calcium (Ca) requirement for egg formation, an additional Ca source is also provided. Objective of this study were to determine the affects of the provision of shell grit (SG) on feed, water and SG intake pattern and some physical and nutritional qualities of eggs. Thirty six weeks old brown egg laying chicken (n=16) were allocated into 16 cages. Birds in eight randomly selected cages received feed and SG *ad libitum* in two separate feeders while those in the other eight cages received feed only. Water, feed and SG intakes were recorded seven times a day (6-8 am, 8-10 am, 10-12 noon, 12-2 pm, 2-4 pm, 4-6 pm and 6 pm-6 am) for a month. At the end of the experiment two eggs were selected from each cage and used to determine the egg quality parameters. When given *ad libitum*, a layer consumed 220-240 g of feed and 14 g of SG/day. Provision of SG had no effect on feed or water intake. SG intake between 4-6 pm was significantly higher than all other time intervals. When SG was given, the feed and water intakes were also significantly higher during 4-6 pm compared to all other time intervals. In the absence of SG, their feed intake was similar between various time intervals. SG had no effects on egg weight, volume, specific gravity and albumen weight and yolk weight but significantly increased the shell weight, shell ash and albumen crude protein content. Meanwhile, provision of SG significantly reduced the yolk CP content. It was concluded that when given *ad libitum* layers consume excess amounts of feed and SG than they required to meet the Ca need. SG provision had some effects on nutritional properties and keeping qualities of the eggs.

Keywords: Shell grit, layer, egg quality

Introduction

Ca is very important for layers, as egg shell consists of 90% mineral matter, out of which 98% is composed of Ca carbonate. Consequently, the Ca requirement of a non-laying bird greatly increased during the laying period. Modern layer flocks are fed a measured amount of balanced feed. The absolute Ca requirement of a laying hen has found to be around 3.4-3.7 g/bird/day (Keshavarz and Nakajima, 1993; Leeson et al., 1986; Rama Rao et al., 2003). To ensure that the increased Ca requirement for egg shell formation is met, an additional Ca source is offered separately to the layer chicken. Shell grit and limestone are among the most commonly used supplemental Ca sources offered to the layer chicken. Apart from supplying Ca, physical properties of hard particles such as shell grit and limestone has found to increase gizzard activity and thus help the digestive process (Oluyemi *et al.*, 1976). Low as well as excess Ca intakes affect the feed intake and digestion. Furthermore, when SG is provided in a separate feeder, the time budget of the birds may be affected thereby reducing the time available for other activities including feeding and drinking. The first objective of this study was to determine the feed, water and SG intake pattern of layer chicken as affectded by the provision of SG *ad libitum*. We were unable to find any study in which the effects of SG on egg quality parameters such as yolk and albumin crude protein (CP) and albumin pH which is used as an indirect measure of the freshness of eggs. The second objective of this study was to determine the effects of SG on above nutritional properties of chicken egg.

Materials and Methods

Thirty six weeks old brown egg laying chicken (n=16) were allocated into 16 cages. SG and feed were offered *ad libitum* in two separate feeders. Water, feed and SG intakes were recorded seven times per day (6-8 am, 8-10 am, 10-12 noon, 12-2 pm, 2-4 pm, 4-6 pm and 6 pm-6 am next day) for a month. At the end of the experiment one egg was selected from each cage and used to determine the egg quality parameters. Specific gravity was measured by water displacement method.

Eggs were broken separately into a petri dish and albumen was collected. The yolk was separated from the albumen and weighed. The pH of the albumen was measured using a pH meter (CORNING 430). The shells were dried at room temperature for 3d, then at 60°C for 3 d, and weighed. The weight of the albumen was calculated as the difference between the weight of the egg and the weight of the yolk and shell. The crude protein values of the yolk and the albumen were measured using micro kjeldhal method. Statistical analysis was performed with the general linear model of Minitab (Version 11.12).

Results and Discussion

When given *ad libitum*, the intake of feed was as high as 220-240g/bird/day (Table 1). Normally layers are offered a measured amount of feed. High feed consumption found in this experiment suggests that when given *ad libitum* layers show a 'luxurious feed consumption'. Provision of SG had no effect on feed or water intake. Sibbald and Gowe (1977) also found that provision of insoluble grit had no effect on feed intake. These findings suggest that, luxurious feed consumption of the layers fed *ad libitum* can not be overcome by providing SG. When given *ad libitum*, a bird consumed around 14.5 g of SG per day, which is equivalent to 5.51 g of Ca per bird per day (Assumed that SG contains 38% Ca). Barkley et al. (2004) also reported 11-12 g of limestone intake for laying hens, when given *ad libitum*. Several studies (Keshavarz and Nakajima, 1993; Leeson et al., 1986; Rama Rao et al., 2003) have reported much lower (3.4-3.7 g/bird/day) absolute Ca requirement for a laying hen. The objective of provision of additional Ca source for laying hen is to meet the excess demand for Ca for egg production that can not be met feed alone. Assuming that diet contained 3.5% Ca, it was calculated that feed intakes in the presence or absence of SG were 8.4 and 7.7 g/bird/day. Despite the fact that the intake of Ca from feed alone far exceeded the per day Ca requirement, birds consumed SG when provided. We hypothesized layers exhibit luxurious SG consumption which is less related to the actual Ca requirement, when SG is given *ad libitum*.

Provision of SG had no significant effect on production parameters such as egg weight, volume, specific gravity. These findings are in agreement with the of Sibbald and Gowe, (1977) found that SG provision had no effects on production parameters such as body weight, food conversion ratio, feed consumption, mortality, age at first egg and egg production. Rama Rao *et al.* (2003) reported that dietary Ca levels higher than 3.2% had no significant effect on production parameters and some egg quality parameters such as shell weight and shell thickness. Though not determined we did not notice reduction in egg production in the absence of SG. However, SG significantly increased the shell weight and shell ash contents. SG provision had interesting effects on some of the nutritional properties of the eggs. Albumin pH of the eggs of the birds who did not receive SG was significantly higher than that of the birds given SG. Albumin pH increased with increasing egg storage time and thus can be used to measure the freshness of the eggs (Silversides and Scott, 2001).

Table 1. Effect of SG on feed and water intake and on Egg quality parameters

Parameters	**Dietary treatment**		**SEM**	***P***
	With SG	**Without SG**		
Feed Intake	244.4	220.8	13.82	0.247
Water Intake	501.9	559.1	30.03	0.200
SG Intake	14.53	0.000	1.346	0.000
Water:Feed ratio	2.086	2.607	0.191	0.074
Feed + SG intake	258.9	220.8	14.25	0.079
Egg quality Parameters				
Weight	61.51	61.23	1.530	0.900
Volume	57.13	54.50	2.328	0.439
Specific Gravity	1.073	1.073	0.012	0.992
Albumen pH	8.974	9.224	0.014	0.000
Yolk Weight	14.22	13.19	0.356	0.060
Albumen Weight	40.58	39.22	2.084	0.652
Yolk CP (DM basis)	14.43	14.79	0.106	0.030
Albumen CP (DM basis)	18.20	11.55	0.913	0.000
Shell Ash (%)	16.94	9.088	1.447	0.002
Shell Weight	6.459	5.901	0.157	0.025

Diffusion of the Co2 through the shell is found to be the major reason for egg quality deterioration (Benton and Brake, 2000). The shell ash content and shell weight significantly reduced when birds were not offered SG. Above conditions may have increased the porosity of egg shell allowing rapid Co2 outflow from the egg. Findings of this study suggest that the provision of SG is important to maintain the freshness of the eggs.

Albumin CP content was significantly higher with SG whereas the yolk CP content significantly increased when SG was not given. Yolk weight was also tend (P=0.06) to be higher when SG was given. It is not clear as to why yolk and albumin CP contents altered due to the provision of SG. One possibility is that due to the high porosity of the egg shell, some nitrogen present in the albumin might have converted in to gaseous form and left the egg and thus reduced the CP content.

SG intake of the birds between 4-6 pm was significantly higher than all other time intervals (Table 2). When SG was given, the feed and water intakes were also significantly higher during 4-6 pm compared to all other time intervals. This finding is in line with the well known fact that layers consume more feed during late afternoon to meet the additional Ca requirements associated with egg shell formation. Feed intake of the birds who did not receive SG was similar among different time intervals. However, their water intake was significantly high during 10 am-2 pm period compared to other time intervals (Table 3).

It was concluded that when given ad libitum layers consume excess amounts of feed and SG than they required to meet the Ca need. SG provision had some effects on nutritional properties and keeping qualities of the eggs.

Table 2. Effect of SG on feed Intake and intake

Parameter	Time							SEM	*P*
	6- 8am	8-10am	10-12 am	12-2 pm	2-4 pm	4-6 pm	6pm-6am		
Feed Intake	29.53[bcd]	22.03[d]	34.22[abcd]	36.07[abc]	26.72[cd]	44.84[a]	42.03[ab]	4.218	0.004
Water Intake	55.36[bc]	62.50[b]	81.25[a]	80.00[a]	43.44[c]	81.88[a]	56.41[bc]	4.976	0.000
SG Intake	1.094[b]	2.344[b]	1.875[b]	1.562[b]	2.500[b]	5.156[a]	0.000[b]	0.920	0.014

[abcd] different letters in the same raw are significantly ($P<0.05$) different at different time durations

Table 3. Feed Intake and Water Intake in layers fed without SG

Parameter	Time							SEM	*P*
	6- 8am	8-10am	10-12 am	12-2 pm	2-4 pm	4-6 pm	6pm-6am		
Feed Intake	34.06[a]	20.94[a]	35.78[a]	30.63[a]	24.38[a]	35.78[a]	39.22[a]	5.768	0.261
Water Intake	81.72[b]	68.44[b]	109.22[a]	130.63[a]	40.00[c]	74.06[b]	55.00[bc]	8.967	0.000

[abcd] different letters in the same raw are significantly ($P<0.05$) different at different time durations

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