Short Communication

Evaluation of Bentonite as a Feed Additive to Improve Egg Quality in 74-week Old Laying Hens

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Abstract | Bentonite is commonly used as a feed additive in poultry rations to increase growth, egg production, or nutrient digestibility. Thus, the aim of this study was to investigate the effects of bentonite supplementation on egg quality in 74-week old laying hens. A total of 300 laying hens were randomly divided into two groups (150 hens each either on a basal diets (control) or 0.5% bentonite diet) and were housed in 10 wire-caged pens for 4 weeks. The egg samples were analyzed for egg weight, shell thickness, shell color, yolk color, yolk index, albumen height, and Haugh unit. During the experimental period, there were no significant differences between the control and the bentonite treatment ($P>0.05$) in egg weight, shell thickness, shell color, yolk color, and yolk index. However, an increasing tendency in shell thickness and shell color was observed as the hens aged ($P<0.05$) at weeks 1 and 4 and shell color at weeks 3 and 4. For albumen height and Haugh unit, the differences between the control and the bentonite treatment were not statistically significant ($P>0.05$) except for a significant effect ($P<0.05$) in Haugh unit at weeks 3 and 4. The supplementation of 0.5% bentonite to the diets of 74-week old laying hens had some positive effects on shell thickness, shell color, and Haugh unit.

Keywords | Bentonite, Egg quality, Older laying hens

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INTRODUCTION

In 2006, the use of antibiotics in feed additives was banned by the European Union, because of antibiotic-resistant microbiota and the presence of residual antibiotics in poultry meat and eggs (Diarra and Malouin, 2014). Consequently, clay minerals, such as biochar, bentonite, zeolite, and illite, have been evaluated as alternatives to antibiotic growth promoters for maintaining poultry health and improving productivity (Prasai et al., 2016). Bentonite is an inorganic material with a variety of properties, such as hydration, swelling, thixotropy, and binding capacity, giving it the ability to rapidly absorb many times its volume of water (Khanedar et al., 2012). Bentonite as a feed additive in poultry rations is commonly used to increase growth performance and nutrient digestibility (Damiri et al., 2010). In pigs, the enzymatic activity of gastrointestinal secretions has been improved with the addition of bentonite (Parisini et al., 1999). In other reports, using bentonite as an adsorbent was effective in minimizing minimizing the toxic effects of aflatoxins on poultry diets and poultry health (Azizpour and Moghadam, 2015). Specifically, when a small amount of bentonite (1%) was added to the diets of laying hens, egg production and egg size increased by 15% and 10%, respectively, and egg shell hardness increased (Nasir et al., 2000). According to the EFSA (2011), the recommended maximum level of bentonite that is safe for all animal species is 0.5%. However, few data are currently available on the clearance of optimal levels from animal diets due to an inconsistency in results. Therefore, the aim of this study was to assess the effects of supplementing poultry diets with bentonite on egg quality in 74-week old laying hens.

MATERIALS AND METHODS

Experimental Design and Birds

The experiments (Reference No.18-1) were performed using 74-week-old Hyline brown laying hens (n = 300) at the Heungsaeng Farm in Euisung, South Korea for 2 months (February through March 2018). All procedures were carried out in accordance with the Animal Care and Use Committee of the Heungsaeng Farm. The hens were randomly divided into two groups (150 hens each on basal (control) or 0.5% bentonite diets) and were housed in 10 wire-caged pens (5 replicates with 30 birds per pen was one experimental unit) with a 16/8 h light/dark regime at a temperature of 22°C. Hens were offered ad libitum water and commercial diets (2,800 kcal/kg metabolizable energy, 17.5% crude protein, and 3.8% Ca) during the 4-week experimental period. The wire-caged pen was equipped with nipple drinkers that were located at the opposite side of the pen from the shared-through feeders. The pen had a provision for the automatic control of the ventilation and temperature systems. The bentonite (a purified powder that was formulated for animal use) used in this experiment was obtained from Donghae Material Co. (Gyeong San, South Korea). The bentonite was composed of 66.54% SiO_2, 20.47% Al_2O_3, 3.18% Fe_2O_3, 3.85% CaO, 2.95% MgO, 0.19% K_2O, 2.79% Na_2O, and 0.03% MnO.

Egg Quality

To determine egg quality (egg weight, shell thickness, shell color, albumen height, yolk color, yolk index, and Haugh units), 18 eggs from each replicate were randomly collected each week (between 09:00 and 11:00 h) from birds that were 74 to 78 weeks of age. Egg weight (6 eggs from each replicate) was measured by weighing all produced eggs from the experimental units. After the shell membranes were removed, shell thickness was measured using a digimatic caliper (CD-15CPX, Mitutoyo Co., Kawasaki, Japan) at 3 points from the equator (from the 2 ends and the middle). The yolk index (6 eggs from each replicate) was estimated using the following formula:

$$YI = YH / YD,$$

where YI is the yolk index, YH is the height of the egg yolk, and YD is the diameter of the egg yolk. In addition, shell color was measured using the eggshell color fan. For albumen height, egg yolk color, and Haugh units, 6 eggs from each replicate were measured at weeks 1, 2, 3, and 4 using a multi-functional egg quality analyzer (Japan). Haugh unit values were calculated with the formula below:

$$\text{Haugh unit} = 100 \log [H - (1.7\times W)^{0.37}+7.6],$$

where H is albumen height (mm) and W is egg weight (g).

Statistical Analysis

Data were examined using SAS statistical software, where pen was the experimental unit. Data variability is expressed as the standard error of the mean (SEM), and a comparison of the means between two samples was carried out by a *t*-test. A p-value of less that 0.05 was used to indicate significance.

RESULTS

The egg quality of 74-week old laying hens that were supplemented with bentonite is shown in Table 1. During the experimental period, there were no significant differences between the control and the bentonite treatments ($P>0.05$) for egg quality (egg weight, shell thickness, shell color, yolk color, and yolk index). However, there was an increasing tendency in shell thickness and shell color as hens aged ($P<0.05$) at weeks 1 and 4 and 3 and 4, respectively, when compared to that of the control. Table 2 shows albumen height and the Haugh unit of the hens that were supplemented with bentonite over time. For albumen height, the differences between the control and the bentonite treatments were not statistically significant ($P>0.05$). However, there was a significant effect ($P<0.05$) in Haugh unit between the two groups at 3 and 4 weeks (but not at 1 and 2 weeks).

Table 1: Egg quality of 74-week old laying hens that were supplemented with bentonite

Item	Week	Treatment[1)]		Significance
		Control	T1	
Egg weight (g)	1	57.0±0.32	55.2±1.21	NS[2)]
	2	58.5±0.79	56.5±0.63	NS
	3	59.1±0.39	58.4±0.53	NS
	4	60.5±1.55	57.8±0.89	NS
Shell thickness (mm)	1	0.42±0.005	0.47±0.005	*
	2	0.39±0.007	0.42±0.004	NS
	3	0.41±0.010	0.42±0.010	NS
	4	0.38±0.010	0.40±0.010	*
Shell color	1	11.01±0.89	11.07±0.83	NS
	2	10.13±0.63	12.13±0.23	NS
	3	11.27±0.25	13.07±0.39	*
	4	10.46±0.49	12.20±0.23	*
Yolk color	1	8.0±0.42	8.0±0.29	NS
	2	7.5±0.14	6.9±0.47	NS
	3	7.1±0.48	7.1±0.49	NS
	4	5.7±0.32	5.7±0.28	NS
Yolk index (mm)	1	0.42±0.01	0.41±0.01	NS
	2	0.42±0.01	0.43±0.01	NS
	3	0.41±0.01	0.42±0.01	NS
	4	0.42±0.01	0.41±0.01	NS

Mean ± SE (Standard error). [1)]Control: basal diets; T1: 0.5% bentonite powder.[2)]NS: not significant. *p<0.05.

Table 2: Haugh unit of 74-week old laying hens that were supplemented with bentonite

Item	Week	Treatment[1)]		Significance
		Control	T1	
Albumen height (mm)	1	3.9±0.21	3.4±0.14	NS[2)]
	2	4.6±0.47	4.0±0.67	NS
	3	5.3±0.52	4.2±0.17	NS
	4	4.2±0.41	4.5±0.46	NS
Haugh unit	1	57.5±2.12	52.5±1.54	NS
	2	64.0±2.70	55.3±3.74	NS
	3	70.1±2.89	59.2±2.03	*
	4	54.9±1.79	60.9±2.05	*

Mean ± SE (Standard error).
1)Control: basal diets; T1: 0.5% bentonite powder.
2)NS: not significant.
*p<0.05.

DISCUSSION

The present study shows no influence on egg quality when 0.5% bentonite was added to the diet. Among egg quality, bentonite can also promote calcium absorption in hens, which affects shell thickness rather than albumen and egg yolk. Overall, the differences found in shell and yolk could be related to the interactive effects of the calcined shell and bentonite, where there is a high ion exchange capacity that binds cations (Adams et al., 2005). Similarly, Lim et al. (2017) found that using a silicate based complex mineral from 0.2% to 0.8% increased eggshell thickness in laying hens. In addition, Kermanshahi et al. (2011) reported that using a clay mineral (natural zeolite) had no remarkable effect on yolk or albumen mass but, instead, affected yolk color. In general, one of the main concerns in the egg industry is a decrease in eggshell quality with aging hens (Arpasova et al., 2010). Therefore, supplying optimal calcium for embryonic development in 74-week old laying hens is important for the function of the eggshell (Narushin and Romanov, 2002). For example, insufficient eggshell quality (low breaking strength or the presence of shell defects) negatively affects the economic profitability of egg production, but it also reduces egg hatchability (S´wiątkiewicz et al., 2015). Our study suggests that an efficient way to improve the shell is to add bentonite to the feed of 74-week old laying hens. Although there was no significant difference in albumen height (Table 2), there was a consistent pattern for albumen height and Haugh unit of the two groups over time. From weeks 1 to 3, the control had higher albumen height and Haugh unit than that of the bentonite treatment. At week 4, there was an increase in albumen height and Haugh unit in the bentonite treatment group when compared to that of the control. This result suggests that improvements in albumen height and Haugh unit in laying hens with advancing age was the result of the properties of bentonite (Adam et al., 2005). Similarly, Lim et al. (2017) showed that adding 0.2% to 0.8% of a silicate-based complex mineral to the diets of laying hens resulted in significantly higher albumen height and Haugh unit when compared to that of the control groups. Albumen height and Haugh unit are important indices for determining the quality of eggs. In this study, the Haugh unit values of the eggs were classified as A, or good quality, according to the quality control recommended by the USDA (2000). The USDA guidelines divide Haugh unit values into four groups, which include AA (72 to 100), A (60 to 71), B (30 to 59), and C (under 29). Based on the findings of this study, supplementation of the diets of 74-week old laying hens with 0.5% bentonite had no influence on egg weight, yolk color, yolk index, or albumen height over the 4-week period. However, adding 0.5% bentonite to the diets of 74-week old laying hens had some positive effects on shell thickness, shell color, and Haugh unit.

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CONFLICT OF INTEREST

The author declares there is no conflict of interests.

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