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Short Communication

Comparison of Bentonite and Illite on the Growth Performance and Litter Quality of Duck

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Abstract | In the duck industry, there has been a recent surge of interest in the use of bentonite and illite as a means of improving the growth performance and litter quality. The aim of this study was to compare bentonite and illite with respect to the growth performance and litter quality of duck. A total of 180 male Pekin ducks (1 day old) were randomly assigned to one of three groups (control, 2% bentonite powder, and 2% illite powder), with 4 replicates of 15 birds per pen in a completely randomized design. The initial body weight, final body weight, weight gain, feed intake and the feed conversion ratios was not greatly influenced by the addition of 2% bentonite and illite. For the mean litter pH, no significant differences were observed in all treatments. There was an increase ($P<0.05$) in the total nitrogen content in the litter samples of the bentonite and illite groups when compared to the control. These results show that the inclusion of 2% bentonite and illite to duck diets has a positive effect on improving the total nitrogen in the duck litter as a soil improvement additive.

Keywords | Bentonite, Growth performance, Duck, Illite, Litter quality

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INTRODUCTION

Recently, clay minerals have been evaluated as an important component of feed additives for improving the productivity and meat quality of animals (Prasai et al., 2016). One of the major reasons for these effects is the increase in the intestinal retention time of the feed, thus, allowing for increased enzymatic action on the nutrients (Karmanlis et al., 2008; Pasha et al., 2008). According to other studies, the order of magnitude for the effects of the different clay minerals on animal productions were bentonite > illite > kaolinite (Kang et al., 2002). The characteristics of these two natural products (bentonite and illite) are summarized below.

Bentonite is a clay mineral that has strong colloidal properties and a high adsorbent capability of heavy metals and bacteria (Prasai et al., 2016). For animal experiments, several studies have shown an improvement in the nutrient digestibility and enzymatic activity of gastrointestinal secretion, caused by the addition of bentonite to broiler and pig feedstuffs (Parisini et al., 1999; Alzueta et al., 2002).

Illite is a non-expanding, clay-sized mineral mixture that contains phyllosilicate or layered alumino-silicate (Sarker and Yang, 2010). It has been used as a potential feed additive as it improves production and bowel function and reduces heavy metals in the blood (Mitchell, 1993; Sarker et al., 2010). For example, illite can increase the growth performance of Hanwoo calves when supplemented with a combination of green tea and licorice (Sarker et al., 2010). In addition, the average daily gain (ADG) in Hanwoo steers has been improved with the dietary inclusion of illite (Cho et al., 2001).

In terms of feed additives, the recommended levels of bentonite and illite in feed, for the safety of all animal species, are 3% and 2%, respectively (EFSA, 2012 and 2014).

To the best of our knowledge, very few studies have been conducted on the growth performance and litter quality of duck. Thus, in this study we tested the growth performance and litter quality of duck, to compare bentonite and illite as feed additives.

MATERIALS AND METHODS

Experimental Design and Birds

The Animal Care and Use Committee of the Gilhong Farm (Geochang, South Korea) approved this experimental protocol. A total of 180 male Pekin ducks (1 day old) from a commercial strain were used. Ducks were randomly assigned to one of three groups (control, 2% bentonite powder, and 2% illite powder), with 4 replicates of 15 birds per pen, in a completely randomized design. They were equally allocated to each pen (2.0 × 1.5 m), which had sawdust for bedding as the litter materials. Each pen was equipped with 1 feed trough and 6 nipples, with a nipple watering line for food and water provision. Ducks were given free and continuous access to food and water. Subsequently, from day 0 to 21 and day 22 to 42, a starter (21% crude protein) and finisher (17% crude protein) diet were offered, respectively. A 23:1 h light-dark cycle was provided throughout the 42-day experimental period (Kwon et al., 2014). The temperature was kept at 33 °C during the first 14 days and then gradually decreased as the ducks progressed in age, with a final temperature of 20–22 °C at day 42. The ventilation and relative humidity were automatically controlled by air inlets and exhaust fans located along the side walls. The bentonite and illite, as a purified powder that was formulated for animal use, were purchased from Yusim Farm (Young Ju, South Korea). The chemical compositions of the bentonite and illite are shown in Table 1. For the growth performance, bodies were weighed on a replicate basis at the start of day 10 and the end of the 42 day test period. The feed intake was observed at each feed change interval, to determine the weight gain and feed conversion ratio.

Litter Collection and Analytical Procedure

Litter samples were obtained from four random sites inside each pen at the end of day 42. First, the litter was collected using one glove per sample, to avoid cross contamination, and mixed thoroughly. After being separated into approximately 100 g each, individual plastic bags were used to seal the litter samples as quickly as possible, which were immediately stored in a refrigerator (4 °C for one day) for analysis. Litter samples were analyzed for their pH and total nitrogen content by the procedures as described in the AOAC methods (1990).

Statistical Analysis

All statistical analyses were performed using a one-way ANOVA and the GLM procedure of SAS (SAS Institute, Version 9.2, 2008), where pens were the experimental unit for growth performance and litter quality. The means were compared using Duncan's multiple range test, with a statistical difference only considered significant if the P values were 0.05 or below.

RESULTS

Table 2 shows the growth performance of ducks that were supplemented with 2% bentonite and 2% illite during the experimental period, according to group and age. The initial body weight, final body weight, weight gain, and feed intake were not influenced ($P>0.05$) by the addition of bentonite or illite. The only difference ($P<0.05$) in the growth performance was the feed conversion ratios, but there were no remarkable effects among the treatments regarding the feed conversion ratios. Data of the pH and total nitrogen content in the duck litter, after 42 days, are presented in Table 3. The addition of bentonite and illite had no great effect ($P>0.05$) on the mean litter pH. As expected, the total nitrogen in the litter samples for the bentonite and illite groups significantly increased ($P < 0.05$), when compared to the control.

DISCUSSION

In general, bentonite, illite, and zeolite are used as alternative materials in poultry production systems because of their positive effects on the health and performance of broilers (Christaki et al., 2001). In this study, it is important to note that using 2% bentonite or illite in duck diets had no positive effects on their growth performance. These results are surprising as the use of a natural clay as a feed additive would be expected to have additional beneficial effects on duck production, including the slowing of the digesta transit, which leads to more efficient use of nutrients (Karamanlis et al., 2008). Similar to our findings, Choi (2018) reported no improvements in the economic indicators or duck production when 1% and 1.5% of illite were added to duck diets. However, other studies have reported that the use of sodium bentonite improves weight gain in broilers (Prvulovic et al., 2008; Safaeikatouli et al., 2010). Salari et al. (2006) also indicated that broilers fed diets containing 1% and 2% sodium bentonite could show improvements in their weight gain and feed conversion ratio. Considering the recommended maximum dose of these clays (EFSA, 2012 and 2014), little information is currently available on the type of materials used, purity levels, physicochemical properties, and levels of supplementation as feed additives, due to inconsistencies in the results from other studies.

The litter quality of the bentonite and illite groups showed a remarkable increase in the total nitrogen content when

Table 1: Chemical compositions of bentonite and illite

Sample	Chemical compositions (%)										
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	MnO	TiO_2	P_2O_5	IOI
Bentonite	50.95	20.47	5.18	1.83	2.95	0.19	2.79	0.03	0.94	1.00	13.20
Illite	49.55	29.55	1.50	0.24	0.32	6.40	0.32	0.07	0.56	0.26	6.22

Table 2: Growth performance of ducks that were supplemented with bentonite and illite

Item	Group			*p*-value
	Control	2% bentonite powder	2% illite powder	
Initial body weight (at day 8, g)	200.00±5.77	212.33±6.17	204.00±4.93	0.0570
Final body weight (at day 42, g)	3,642.00±36.29	3,652.33±27.42	3,688.67±19.06	0.6271
Weight gain (g)	3,442.00±42.00	3,440.00±21.39	3,484.67±23.96	0.4956
Feed intake (days 8 to 42, g)	5,917.67±46.69	6,005.00±67.64	5,991.00±012.29	0.7984
Feed conversion (feed: gain, g:g)	1.72±0.01[b]	1.75±0.01[a]	1.72±0.01[b]	0.0338

[a-b]Means with different superscript letters in the same row are significantly different (P<0.05).
Mean values are expressed as the mean ± SE.

Table 3: Changes in the pH and total nitrogen of the duck litter after 42 days

Item	Group			*p*-value
	Control	2% bentonite powder	2% illite powder	
pH	8.44±0.22	8.63±0.10	8.72±0.08	0.7668
Total nitrogen	1.41±0.15[c]	1.87±0.07[a]	1.60±0.22[b]	0.0206

[a-c]Means with different superscript letters in the same row are significantly different (P<0.05).
Mean values are expressed as the mean ± SE.

compared with that in the control. This increase acts as a soil improvement additive rather than organic fertilizer because of the basic pH (above 8.5, Table 3) of duck litter. The reason for the total nitrogen increase with natural clay additives (bentonite and illite) was not previously documented, but it could possibly be related to the ammonia binding effect in the duck litter (Karamanlis et al., 2008). For example, it is reported that poultry litter is a valuable fertilizer source that has the potential to supply the organic nutrients needed for optimum crop growth because of its high nitrogen content (Fontenotet et al., 1983). Thus, the ammonia produced in the litter builds up quickly at a pH that is greater than 8 (Delaune et al., 2004). Thus, strategies to decrease the pH and ammonia, or increase the total nitrogen in poultry litter, are the use of litter amendments (alum and aluminum chloride) as acidifying agents (Choi et al., 2011). In other words, the bentonite and illite could prevent the acidification of agents in the duck litter. In conclusion, the results of this study show no beneficial effects from diets supplemented with 2% bentonite or 2% illite, on the growth performance (excluding the feed conversion ratio) of ducks. However, there were beneficial effects regarding the duck litter quality, with the increase in the total nitrogen contents, which can act as a soil improvement additive.

CONFLICT OF INTEREST

The author declares there is no conflict of interests.

AUTHORS CONTRIBUTION

All authors contributed equally.

REFERENCES

- Alzueta C, Ortiz L, Rebole A, Rodríguez M, Centeno C, Treviño J (2002). Effects of removal of mucilage and enzyme or sepiolite supplement on the nutrient digestibility and metabolyzable energy of a diet containing linseed in broiler chickens. Anim. Feed. Sci. Technol. 97(3): 169-81. https://doi.org/10.1016/S0377-8401(02)00030-5.
- AOAC (1990). Official Methods of Analysis. Vol. I. 15th ed. AOAC, Arlington, VA.
- Cho WM, Paek BH, Kang SW, Kim JS, Kim YK (2001). Effects of dietary supplements of clay mineral on the growth performance and immunity in growing Hanwoo steers. Korean. J. Anim. Sci. 43(2):203-210.
- Choi, IH, Choi JH, Ko SH, Moore PAJr (2011). Reducing ammonia emissions and volatile fatty acids in poultry litter with liquid aluminum chloride. J. Environ. Sci. Health. Part B. 46(5): 432-435. https://doi.org/10.1080/03601234.2011.572525.
- Choi IH (2018). A study on duck growth performance and

economic benefits on using illite as a feed additive -a field study-. J. Environ. Sci. Int. 27(9):803-807. https://doi.org/10.53 22/JESI.2018.27.9.803.

- Christaki E, Florou-Paneri P, Tserveni-Gousi A, Yannakopoulos A, Fortomaris P (2001). Effects of dietary inclusion of a natural zeolite on broiler performance and carcass characteristics. Proceedings of the 13th International Zeolite Conference: "Zeolites and mesoporous materials at the dawn of the 21st century", Montpellier, France, pp. 1-7.
- DeLaune PB, Moore PAJr, Daniel TC, Lemunyon JL (2004). Effect of chemical and microbial amendments on ammonia volatilization from composting poultry litter. J. Environ. Qual. 33(2):728-734. https://doi.org/10.2134/jeq2004.7280.
- EFSA (2012). Scientific opinion on the safety and efficacy of bentonite as a technological feed additive for all species. EFSA J. 10(7): 2787.
- EFSA (2014). Scientific opinion on the safety and efficacy of Friedland clay (montmorillonite–illite mixed layer clay) when used as technological additive for all animal species. EFSA J. 12(11):3904.
- Fontenot JP, Smith LW, Sutton AL (1983). Alternative utilization of animal wastes. J. Anim. Sci. 57(Suppl.2): 221–233. https://doi.org/10.2527/animalsci1983.57Supplement_2221x.
- Kang SW, Kim JS, Cho WM, Ahn BS, Ki KS, Son YS (2002). Effect of domestic clay minerals on growth performance and carcass characteristics in growing-fattening Hanwoo steers. J. Anim. Sci. Technol. (Kor.) 44(3): 327-340. https://doi.org/10.5187/JAST.2002.44. 3.327.
- Karamanlis X, Fortomaris P, Arsenos G, Dosis I, Papaioannou D, Batzios C, Kamarianos A (2008). The effect of a natural zeolite (clinoptilolite) on the performance of broiler chickens and the quality of their Litter. Asian-Australas. J. Anim. Sci. 21(11): 1642-1650. https://doi.org/10.5713/ajas.2008.70652.
- Kwon HJ, Choo YK, Choi YI, Kim EJ, Kim HK, Heo KN, Choi HC, Lee SK, Kim CJ, Kim BG, Kang CW, An BK (2014). Carcass characteristics and meat quality of Korean native ducks and commercial meat-type ducks raised under same feeding and rearing conditions. Asian-Australas. J. Anim. Sci. 27(11): 1638-1643. https://doi.org/10.5713/ajas.2014.14191.
- Mitchell JK (1993). Fundamentals of Soil Behaviour, 2nd edn. John Wiley and Sons, New York.
- Parisini P, Martelli G, Sardi L, Escribano F (1999). Protein and energy retention in pigs fed diets containing sepiolite. Anim. Feed. Sci. Technol. 79(1): 155–62. https://doi.org/10.1 016/S0377-8401(99)00008-5.
- Pasha TN, Mahmood A, Khattak FM, Jabbar MA, Khan AD (2008). The effect of feed supplemented with different sodium bentonite treatments on broiler performance. Turk. J. Vet. Anim. Sci. 32(4):245-248.
- Prasai TP, Walsh JB, Bhattarai SP, Midmore DJ, Van TTH, Moore RJ, Stanley D (2016). Biochar, bentonite and zeolite supplemented feeding of layer chickens alters Intestinal microbiota and reduces campylobacter load. Plos One. 11(4): 1-13. https://doi.org/10.1371 /journal.pone.0154061.
- Prvulovic D, Kogic D, Lasic GG, Kosarcic S (2008). The effects of dietary inclusion of hydrated aluminosilicate on performance and biochemical parameters of broiler chickens. Turkish J. Vet. Anim. Sci. 32(3):159-166.
- Safaeikatouli M, Boldaji F, Dastar B, Hassani S (2010). Effect of different levels of kaolin, bentonite and zeolite on broilers performance. J. Biol. Sci. 10(1): 58–62. https://doi.org/10.3923/jbs.2010.58.62.
- Salari S, Kermanshahi H, Nasiri MH (2006). Effect of sodium bentonite and comparison of pellet vs mash on performance of broiler chickens. Int. J. Poult. Sci. 5(1):31-34. https:// doi.org/10.3923/ijps.2006.31.34.
- Sarker MSK, Ko SY, Lee SM, Kim GM, Choi JK, Yang CJ (2010). Effect of different feed additives on growth performance and blood profiles of Korean Hanwoo calves. Asian-Aust. J. Anim. Sci. 23(1): 52-60. https://doi.org/10.5713/ajas.2010.90280.
- Sarker MSK, Yang CJ (2010). Propolis and illite as feed additives on performance and blood profiles of pre-weaning Hanwoo calves. J. Anim. Vet. Adv. 9(19): 2526-2531. https:// doi.org/10.3923/javaa.2010.2526.2531.