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Asian Journal of Animal and Veterinary Advances

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Asian Journal of Animal and Veterinary Advances 9 (1): 64-70, 2014
ISSN 1683-9919 / DOI: 10.3923/ajava.2014.64.70

Evaluation Usage of Kaolin and Zeolite in Broiler Diet on Litter Quality

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ABSTRACT

This study investigated usage of kaolin and zeolite in broiler diet on litter moisture, pH, Nitrogen (N), ash, Calcium (Ca) and Phosphorus (P) content. A total 320 one-day-old male Ross 308 chickens were arrayed in a completely randomized design experiment and randomly allocated into five dietary treatments with 64 birds per treatment. The chickens in each treatment were further divided into four replicates with sixteen chickens and were reared to 42 days. The birds were fed with maize-soybean meal basal diet supplemented with 0, 15 and 30 g kg^{-1} kaolin and zeolite. Moisture content of litter on day 42 and nitrogen content of litter on days 14 and 42 were significantly lower in treatments containing 30 g kg^{-1} kaolin and zeolite ($p<0.05$) compared to control treatment. The Ca content of litter on day 14 and day 28 in diet with 30 g kg^{-1} zeolite decreased significantly compared to control diet ($p<0.05$). There were no significant ($p>0.05$) differences between dietary treatments and control in the pH, ash and phosphorus content of litter. The results suggest that supplementation of kaolin and zeolite in broiler diet can effectively improve litter quality.

Key words: Kaolin, zeolite, litter quality, feed, broiler

INTRODUCTION

The poultry industry has been fast growing during the last decades due to increased in demand for poultry meat consumption in the world. Some major environmental issues faced by the industry are the reposition of high amount of wastes, especially manure and litter. Nitrogen (N) and Phosphorus (P) content in poultry waste has long been recognized as a significant environmental problem in poultry industry (Kelleher *et al*., 2002; Bolan *et al*., 2010). One of the main concerns of poultry industry is the control of litter quality, various research efforts to find methods to decrease the pollutants spread from poultry farms. The result of researches showed, important ways that could modify the quality of poultry litter is nutritional aspects and using various additives to litter (Moore *et al*., 1996; Francesch and Brufau, 2004; Karamanlis *et al*., 2008).

Kaolin and zeolite have a stable structure and by absorbing and losing of water maintain their structure. Hence, they can use as feed additives in broiler diet to improve broiler performance. Their

also can by keeping their structure egress from digestive tract and insert to the litter, as a result, able to influence the litter quality as well as improving broiler house environment (Shariatmadari, 2008; Safaeikatouli *et al*., 2010).

The considerations that chicks ceaselessly are in contacts with litter the quality of the litter affect the growth performance and health of broiler chicks (Bilgili *et al.,* 1999). According to temperature, moisture content and pH of the litter, a part of NH_4^+ produced may be turned into NH_3 (Shah *et al*., 2007). Pourreza *et al.* (2004) suggested that litter additives can be used to decrease litter pH, nitrogen and soluble phosphorus. The adsorption properties of zeolite and kaolin have been widely used to resolve litter problems. Several studies reported that zeolite can be effective to improve of litter condition (Cabuk *et al*., 2004; Eleroglu and Yalcin, 2005; Tatar *et al*., 2012). Kithome *et al.* (1999) and Turan (2008) reported that zeolite was suitable for decreasing nitrogen losses (NH3) during composting of poultry manure. Oliver (1997) and Safaeikatouli *et al.* (2012b) reported that exchange and absorption properties of zeolite increase digestibility of N in diet and also control the moisture content of manure.

This study was performed to evaluate the effects of kaolin and zeolite inclusion in broiler diet on litter quality; specifically, experiment was designed to determine the effects of kaolin and zeolite on content of moisture, pH, Nitrogen (N), ash, Calcium (Ca) and Phosphorus (P) in broiler litter.

MATERIALS AND METHODS

Experimental design: A total 320 one-day-old male Ross 308 chickens were arranged in a completely randomized design experiment and randomly allocated into five dietary treatments with 64 birds per treatment. The chickens in each treatment were further divided into four replicates with sixteen chickens and housed in pens of identical size (1.5×1.5 m, each broiler had about 0.14 m^2 spaces) in a deep litter system with study paper roll floor. Light was provided 24 h continuously with overhead incandescent lighting during the 42 day period of the experiment. The room was thermostatically controlled with temperatures maintained at 32°C for the first week and a three degree reduction in temperature every week afterwards. The birds were given an anti-stress agent from the first day of age and before, during and after the vaccinations. In order to raise their control pathogens they were vaccinated against bronchitis on days 1 and 9, Gumboro disease on days 15 and 21 and for Newcastle disease on day 9 of the experiment. The kaolin and zeolite used in this study were excellent processing to decrease metal oxide content and the chemical composition of them is demonstrated in Table 1.

Dietary treatments: (1) Control (diet without kaolin and zeolite), (2) Diet with inclusion of 15 g kg^{-1} kaolin, (3) Diet with inclusion of 30 g kg^{-1} kaolin, (4) Diet with inclusion of 15 g kg^{-1} zeolite and (5) Diet with inclusion of 30 g kg^{-1} zeolite. The chicks were fed a commercial feed starter (corn and soybean based), contained 20.85% Crude Protein (CP), 2900 kcal ME kg^{-1}, 0.91% calcium and 0.41% available phosphorus which fed to broilers up to 21 days. The grower diets contained 18.75% CP, 3000 kcal ME kg^{-1}, 0.84% calcium and 0.33% available phosphorus which fed to broilers up to 42 days. All of the experimental diets during starter and grower periods were isonitrogenic and isocaloric and chicks were allowed access to the diets and water *ad libitum*.

Collection and analysis of samples: Five litter samples were obtained at days 14, 28 and 42 from each pen from the same area from which the moisture, pH, Nitrogen (N), ash, Calcium (Ca) and Phosphorus (P) concentration were measured. Litter samples were taken by removing the first

Table 1: Chemical composition of kaolin and zeolite

	Percentage	
Compositional profile	Kaolin	Zeolite
SiO_2	67.00	66.00
Al_2O	20.00	11.43
Fe_2O_3	0.20	1.30
CaO	0.20	3.11
MgO	0.40	0.72
Na_2O	0.50	2.01
K_2O	0.70	3.12
SO_3	0.01	-
TiO_2	-	0.21
L.O.I	10.90	12.05
pH	7.00	7.00

10 mm of the exposed surface after the top layer had been removed from centre and four corners of each pen. The samples from each pen were mixed and homogenized to make one sample and were refrigerated before taken up to the laboratory for analyses. Moisture content of samples was determined by placing them in an oven 105°C for 24 h until achieves a constant weight. Litter pH content was measured at days 14, 28 and 42 of experiment by using a pH meter (Model WTW-720 Inolab., Germany). The milled samples were then analyzed for N and ash contents using the procedures described by the AOAC (2005). The percentages of litter calcium and phosphorus were determined by colorimetric and spectrophotometric, respectively according to AOAC (2005) methods.

Statistical analysis: The results of every determination were analyzed using the general linear model procedure of the SAS (SAS Institute, 2003). Duncan's multiple range test was used to compare significant means and the level of differences were considered significant at $p<0.05$ (Duncan, 1955).

RESULTS AND DISCUSSION

The effects of experimental treatments on litter moisture and pH are given in Table 2. Litter moisture content did not differ significantly ($p>0.05$) between treatments on days 14 and 28, whereas at day 42 Litter moisture content in control diet (33.68%) was significantly ($p<0.05$) higher compared to diet containing 30 g kg^{-1} kaohn and zeohte i.e., 28.00 and 27.17%, respectively. These results are in agreement with previous studies in that silicate minerals significantly reduced litter moisture content in broiler chickens houses (Kiaei *et al.*, 2002; Karamanlis *et al.*, 2008; Tatar *et al.*, 2012). Aluminosilicates have a high capacity for swelling and absorbing water and ammonia and can improve hitter condition (Ramos *et al.*, 1996). Litter moisture plays an important role in litter quality and in a broiler house with correctly managed, litter moisture normally averages between 20-35%. Increasing the litter moisture content and temperature are two main factors that enhance ammonia volatilization from broiler litter (Miles *et al.*, 2011). Butcher and Miles (2012) reported that well managed litter and kept moisture content within the admitted range can reduced disease or other production problems. The litter pH of treated group on days 28 and 42 of experiment were decreased compared to control group but these differences were not

Table 2: Effects of experimental treatments on litter moisture and pH

	Moisture (%) (days)			pH (days)		
Treatments (g kg^{-1})	14	28	42	14	28	42
Control	25.79	26.09	33.68^{a}	6.43	6.97	7.58
Kaolin 15	27.26	26.21	30.90^{ab}	6.45	6.60	6.79
Kaolin 30	24.91	24.16	28.00^{b}	6.28	6.81	6.94
Zeolite 15	23.41	25.71	29.58^{ab}	6.36	6.92	7.30
Zeolite 30	24.50	25.58	27.17^{b}	6.32	6.59	7.19
SEM	1.91	1.34	1.45	0.21	0.30	0.48

Means within columns with no common superscripts are significantly different ($p<0.05$)

Table 3: Effects of experimental treatments on litter nitrogen and ash

	Nitrogen (%) (days)			Ash (%) (days)		
Treatments (g kg^{-1})	14	28	42	14	28	42
Control	2.62^{a}	3.05	3.99^{a}	9.55	9.83	10.13
Kaolin 15	2.49^{ab}	2.87	3.92^{ab}	9.40	9.79	10.11
Kaolin 30	2.29^{b}	2.74	3.73^{b}	9.57	9.67	10.04
Zeolite 15	2.37^{ab}	2.92	3.89^{ab}	9.33	9.69	9.95
Zeolite 30	2.31^{b}	2.76	3.71^{b}	9.28	9.49	9.86
SEM	0.09	0.09	0.07	0.15	0.12	0.13

Means within columns with no common superscripts are significantly different ($p<0.05$)

statistically significant ($p>0.05$). No significant differences in pH content of the broiler litter due to dietary silicate minerals supplementation in the present study is in agreement with some earlier studies (Maurice *et al*., 1998; Loch *et al*., 2011; Safaeikatouli *et al*., 2011).

The nitrogen and ash content of litter in broilers supplemented with kaolin and zeolite in diets are shown in Table 3. Litter nitrogen content on day 14 and day 42 was significantly ($p<0.05$) lower in treatments containing 30 g kg^{-1} kaolin and zeolite compared to control treatment. Litter nitrogen content on day 28 did not show any significant ($p>0.05$) difference between experimental treatments. Result further showed that control diet has highest nitrogen content of litter during the days 14, 28 and 42 (2.62, 3.05 and 3.99%, respectively). On the other hand, treatment containing 30 g kg^{-1} kaolin on days 14 and 28 and treatment with 30 g kg^{-1} zeolite on day 42 have lowest nitrogen content of litter (2.29, 2.74 and 3.71%, respectively). This finding is in agreement with the result of Tatar *et al*. (2012) that showed litter nitrogen content in diet containing high level of zeolite (4%) decreased significantly compared to diet supplementation with low level of zeolite (2%) and control. High nitrogen levels in the broiler litter can increase NH_3 in the poultry house that lead to reduce broiler performance and health and use of some litter additives can decrease these nitrogen levels. Zeolite is a cation-exchange composition that has high ability for absorb NH^{+}_{4} ions because of its hydrated properties resulting from its structures (Mumpton and Fishman, 1977).

Previous studies show that the use of aluminosilicates in broiler diet would decrease ammonia concentration in poultry houses (Amon *et al*., 1997; Li *et al*., 2008; Loch *et al*., 2011). Ash content of litter showed no significant differences between dietary treatments and control ($p>0.05$).

Nevertheless litter ash content in treatments with kaolin and zeolite on day 28 and day 42 was numerically better in comparison to control diet. Cabuk *et al*. (2004) suggested that the addition of zeolite in broiler diet led to decrease in fecal crude ash.

Table 4: Effects of experimental treatments on litter calcium and phosphorus

	Calcium (%) (days)			Phosphorus (%) (days)		
Treatments (g kg^{-1})	14	28	42	14	28	42
Control	4.26[a]	6.45[a]	10.12	2.32	3.04	3.42
Kaolin 15	3.73[ab]	6.08[ab]	9.73	2.07	2.74	3.37
Kaolin 30	3.53[ab]	6.00[ab]	9.17	2.31	2.95	3.34
Zeolite 15	3.64[ab]	6.16[ab]	9.90	2.06	2.76	3.21
Zeolite 30	3.41[b]	5.59[b]	9.29	2.11	2.68	3.09
SEM	0.25	0.18	0.37	0.08	0.11	0.13

Means within columns with no common superscripts are significantly different ($p<0.05$)

Table 4 shows the effects of dietary treatments on Ca and P content of litter. Result showed that the Ca content of litter on days 14 and 28 in control diet (4.26 and 6.45%, respectively) was significantly ($p<0.05$) higher as compared to treatment containing 30 g kg^{-1} zeolite (3.41 and 5.59%, respectively). Litter Ca content did not differ significantly ($p>0.05$) among experimental treatments on days 42. In diet containing kaolin and zeolite litter P content during the overall period (days 14, 28 and 42) was lower than control diet but this difference was numerically not statistically ($p>0.05$). Herzig *et al.* (2008) and Safaeikatouli *et al.* (2012a) reported that adding 3% of zeolite to broiler diet can increase Ca content in blood and tibia and did not any significant effect on P content. Therefore, it can be concluded that zeolite might enhance absorption of Ca and decrease excretion of it.

CONCLUSION

It is concluded that using kaolin and zeolite in broiler chicken diets caused decreased content of moisture, nitrogen and calcium in broiler litter as well as can reducing environmental pollution. Thus, kaohn and zeolite can be use as a feed additive in the broiler chickens diet for improving litter quality and performance.

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