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Effects of Two Kinds of Bentonite on Performance, Blood Biochemical Parameters, Carcass Characteristics and Tibia Ash of Broiler Chickens

Research Article

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ABSTRACT

This experiment was conducted to study the effects of two kinds of sodium and calcium bentonite (NaB and CaB) on performance, blood biochemical parameters, carcass characteristics and tibia ash of broiler chickens. Two hundred and sixty day old broilers of male Ross 308 strain were allocated to 5 treatments with four replicatates and 13 broilers in each. The experiment was carried out in a completely randomized design, where the treatments were: control (corn soybean meal based diet); 1% NaB; 1.5% NaB; 1% CaB; and 1.5% CaB. The results showed no significant difference between the experimental groups in starter and grower periods, but feed intake decreased, and feed conversion ratio was improved by adding 1% bentonite to the diet in finisher and total periods ($P<0.05$). Addition of bentonite to diet had not significant effect on the blood biochemical parameters, carcass characteristics and tibia ash. The results indicated that the use of each two kinds of bentonite in diets (1%) improved the broiler performance; however addition of 1.5% bentonite had no significant effect.

KEY WORDS blood parameter, calcium bentonite broiler, carcass, performance, sodium bentonite, tibia ash.

INTRODUCTION

Bentonites are clays with strong colloidal properties that absorb water rapidly, which results in swelling and a manifold increase in volume, giving rise to a thixotropic gelatinous substance (Pasha *et al.* 2008). Bentonites are white, light weight rock deposits composed mostly of salts of hydrated aluminosilicates of sodium (Na), potassium (K), calcium (Ca), and occasionally iron, magnesium, zinc, and nickel. These bentonites have a high negative charge and are balanced by cations such as Mg, K, and Na located in the cavities; therefore, they do not react with feed ingredients and act as inert material due to their neutral pH or slightly alkaline nature. Several studies showed that poultry feed supplementation with bentonite can improve growth performance and nutrient digestibility in broilers (Santurio, 1999; Southern, 1994). Kececi *et al.* (1998) reported that the levels of calcium and phosphorus were decreased by aflatoxin in broiler chicks that received aflatoxin for 21 days and at a dose of 2.5 ppm. Furthermore, some researchers reported that carcass characteristics such as relative weight of liver and spleen of broilers were increased by using aluminosilicates in diet (Yalcin *et al.* 1995; Miazzo *et al.* 2005).

On the other hand, Southern *et al.* (1994) reported that NaB had no adverse affect on growth or tibia mineral concentrations in chicks fed nutrient-deficient diets. The aim of this study was to investigate the effects of two kinds of bentonite on performance, blood biochemical parameters, carcass characteristics and tibia ash of broiler chickens.

MATERIALS AND METHODS

This experiment was conducted in a completely randomized design with 260 day-old broilers (Ross 308) distributed to 5 treatments and 4 replicate each (with 13 birds in each pen) from 1 to 42 days of age. Diets including: (A) control diet without bentonite (soybean corn based diet), (B) contained 1% sodium bentonite (NaB), (C) 1.5% sodium bentonite (NaB), (D) 1% calcium bentonite (CaB), and (E) 1.5% calcium bentonite (CaB).

Chemical compositions of these two kinds of NaB and CaB are presented in Table 2. Diets were supplemented with amino acids, minerals, and vitamins at levels recommended by the NRC (1994) for starter (0-10 days), grower (11-24 days) and finisher (25-42 days). All meals were made as mash and diets were isocaloric and isonitrogenous (Table 1). NaB and CaB were added using a mixer while preparing the feed. Chickens consumed the diets and water *ad libitum* and lighting cycle was 24 h/d.

The ambient temperature in experimental house was maintained at 32 ˚C during the first week and gradually decreased by 3 ˚C in the second and third week to be fixed at 22 ˚C thereafter.

Chicks were vaccinated against Infectious Bursal Disease, New Castle Disease (HB1) and New Castle Disease (La sota) at day 14, 21, and 28, respectively, via drinking water.

Growth performance of broilers was evaluated by recording body weight gain, feed intake, feed conversion ratio and mortality during the 42 d of age. Body weight (BW) and feed intake were recorded at the end of each period to calculate feed conversion ratio. At 42 days of age, blood was collected from 5 broilers per treatment; serum was separated, and mailed frozen to laboratory in order to determine total protein, albumin, glucose, triglyceride and creatinine. The serum concentrations of calcium, phosphorous, potassium, sodium and magnesium were determined using Kit (pars Azmoon Company; Tehran, Iran) by auto-analyzer (Technicon RA-1000).

At 42-d of age, carcass characteristics were assessed using Scholty Sek technique and remained tibia ash were measured through the burning method by removing the organic material Sellers *et al.* (1980). Data were analyzed by ANOVA using the General Linear Models Procedure of SAS (1996) software and means were compared by Duncan's Multiple Rang Test.

Table 1 Composition of the experimental diets at starter (0-10) grower (11-24) and finisher (25-42)*

Feed ingredient (%)	Starter					Grower					Finisher				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Corn	54/85	52.9	51.86	52.90	51.86	59.73	57.71	56.70	57.71	56.70	61.88	59.79	58.81	59.79	58.81
Soybean meal	38.75	39.11	39.32	39.11	39.32	34.83	35.23	35.42	35.23	35.42	32.67	33.07	33.26	33.07	33.26
Soybean oil	2.02	2.66	3.01	2.66	3.01	1.83	2.50	2.83	2.50	2.83	2.19	2.88	3.20	2.88	3.20
DCP	1.77	1.72	1.72	1.72	1.72	1.49	1.49	1.44	1.49	1.44	1.35	1.31	1.31	1.31	1.31
$CaCO_3$	1.31	1.33	1.32	1.33	1.32	1.08	1.07	1.08	1.07	1.08	1.07	1.06	1.05	1.06	1.05
Salt	0.30	0.25	0.25	0.25	0.25	0.30	0.25	0.25	0.25	0.25	0.30	0.25	0.25	0.25	0.25
Mineral premix**	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix**	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-met	0.33	0.34	0.35	0.34	0.35	0.23	0.24	0.24	0.24	0.24	0.16	0.17	0.17	0.17	0.17
L-lys	0.25	0.25	0.24	0.25	0.24	0.09	0.08	0.08	0.08	0.08	0	0	0	0	0
Bentonite	0	1	1.50	1	1.50	0	1	1.50	1	1.50	0	1	1.50	1	1.50
Calculated nutritive values															
ME (kcal/kg)	2900	2900	2900	2900	2900	2950	2950	2950	2950	2950	3000	3000	3000	3000	3000
Crude protein	22.14	22.14	22.14	22.14	22.14	20.62	20.62	20.62	20.62	20.62	19.73	19.73	19.73	19.73	19.73
Ca	0.99	0.99	0.99	0.99	0.99	0.84	0.84	0.84	0.84	0.84	0.79	0.79	0.79	0.79	0.79
P	0.47	0.47	0.47	0.47	0.47	0.42	0.42	0.42	0.42	0.42	0.38	0.38	0.38	0.38	0.38
Lys	1.37	1.37	1.37	1.37	1.37	1.16	1.16	1.16	1.16	1.16	1.05	1.05	1.05	1.05	1.05
Met + Cys	1.02	1.02	1.02	1.02	1.02	0.89	0.89	0.89	0.89	0.89	0.80	0.80	0.80	0.80	0.80

* For make diets experimental 2, 3, 4 and 5 added to each diet %1 sodium bentonite (NaB); %1.5 sodium bentonite (NaB); %1 calcium bentonite (CaB) and %1.5 calcium bentonite (CaB) respectively.

** Supplied per kilogram of vitamin premix: vitamin A: 4400000 IU; vitamin D: 72000 IU; vitamin E: 14400 IU; vitamin K: 2000 ; B12: 640 mg; Thiamin: 612 mg; Riboflavin: 3000 mg; pentatonic acid: 4896 mg; Niacin: 12160 mg; B_6: 612 mg; Biotin: 2000 mg and Cho line chloride: 260 g.

*** Supplied per kilogram of Mineral premix: Mn: 64.5 g; Zn: 33.8; Fe: 100 g; Cu: 8 g; I: 640 mg; Co: 190 mg; Se: 8 g.

A level of P < 0.05 was used as the criterion for statistical significance.

RESULTS AND DISCUSSION

Performance traits of broiler chickens, such as feed intake, feed conversion ratio and weight gain are presented in Table 3.

The results showed that feed intake was significantly (P<0.05) lower in 1% bentonite in finisher and total periods compare to the control. The depressing trend in the feed consumption was in accordance with the results of Sellers *et al*. (1980) and Petkova *et al*. (1982). It might be due to the highly adhesive nature of the bentonite which absorbs more water and resist the flow of digesta through gastrointestinal tract, which can affect the feed intake negatively Van Olphen (1963). Several recent reports showed that the low level additions of selected bentonites to poultry diets improved calorific efficiency and slowed down feed passage (Quisenberry and Bradley, 1964; Quisenberry, 1966; Almquist *et al*. 1967). Whereas Salari *et al*. (2006) reported that chickens fed diets containing 1-2% bentonite consumed more feed (P<0.05). There was no significant effect of dietary treatments on feed intake in starter and grower periods. These findings were in agreement with Esmeralda *et al*. (1992).

No significant differences were observed among the experimental treatments for weight gain. This result was in agreement with the other reports (Kermanshahi *et al*. 2009; Xia *et al*. 2004); although the others had found that addition bentonite to the diet had significant effect on weight gain (Tauqir *et al*. 2001; Pasha *et al*. 2008; Salari *et al*. 2006; Grosicki *et al*. 2004).

There were no significant differences among treatments regarding to feed conversion ratio in starter and grower periods, however feed conversion ratio significantly (P<0.05) improved by adding 1% bentonite to the diet in finisher or in total period compared to the control.

Improving of feed conversion ratio in broilers with the use of aluminosilicates could be due to reduction in the rate of feed passage in the gastrointestinal tract as an effect of water absorption of feed, resulting in better enzymatic action for quite a long time.

Elliot and Edwards (1991) and Pasha *et al*. (2008) showed that feeding of natural zeolite and bentonite improved the feed conversion ratio. It has been reported that feed conversion ratio improved by adding silicate minerals to AF containing diets (Ledoux *et al*. 1999; Oguz and Kurtoglu, 2000; Rosa *et al*. 2001; Pasha *et al*. 2007; Shi *et al*. 2009). On the other hand, Kermanshahi *et al*. (2009) reported that the supplementation of bentonite to the diet had no effect on feed conversion ratio.

Differences of reported studies could be due to differences in used aluminosilicate material in the experiment. It was obvious that the use of different chemicals in further studies and comparison of their performance, could clarify the present uncertainty in this issue.

Mortality was low for all birds throughout the experiment and was not related to treatment (data not presented). As shown in Table 4, differences among experimental groups were not significant for blood parameters (P>0.05), whereas Rosa *et al*. (2001) showed that AF caused a decrease in blood total protein, albumin, uric acid and cholesterol levels in broiler chickens. On the other hand, Smith *et al*. (1992) observed that AF given at a dose of 3.5 ppm for 3 weeks caused a decrease in phosphorus level.

Table 2 Chemical composition of sodium and calcium bentonite (NaB and CaB)

Compositional profile	SiO_2	Al_2O_3	Na_2O	MgO	K_2O	CaO	Fe_2O_3	LOI
Percentage	%	%	%	%	%	%	%	%
Sodium bentonite (NaB)	60.55	13.1	3.2	3.7	0.2	1.9	2.1	14.1
Calcium bentonite (CaB)	56.55	13.02	2.30	2.34	0.98	8.04	2.58	13.64

Table 3 Effect of sodium and calcium bentonite (NaB and CaB) on the Performance of broiler chickens*

Treatment		A	B	C	D	E	SE**	P-value
Starter	FI (g/d)	245.47	252.16	238.15	243.13	248.33	8.15	0.7909
	WG (g)	162.3	160.18	150.55	157.63	157.1	3.63	0.2556
	FCR	1.51	1.57	1.58	1.54	1.58	0.04	0.8267
Grower	FI (g/d)	1259.95	1270.02	1294.24	1265.05	1288.33	26.82	0.8657
	WG (g)	761.13	778.48	760.30	770.34	749.47	13.05	0.5985
	FCR	1.65	1.63	1.7	1.64	1.71	0.04	0.5714
Finisher	FI (g/d)	3293.8^a	3026.6^b	3302.3^a	3041^b	3335.3^a	71.57	0.0134
	WG (g)	1485.52	1521.84	1480.51	1514.75	1482.50	55.50	0.9710
	FCR	2.23^a	1.99^b	2.23^a	2.02^b	2.24^a	0.06	0.0278
Total	FI (g/d)	4736.25^a	4540.16^b	4775.64^a	4530.46^b	4836.83^a	62.75	0.0092
	WG (g)	2383.30	2456.10	2364.64	2432.35	2375.19	43.29	0.5200
	FCR	1.99^a	1.85^b	2.02^a	1.86^b	2.03^a	0.03	0.0063

* The means within the same row with at least one common letter, do not have significant difference (P>0.05).
** SD: standard error of mean.

Table 4 Effect of sodium and calcium bentonite (NaB and CaB) on blood biochemical parameters

Treatment	Total Protein	Albumin	Glucose	Creatinine	Triglyceride	Calcium	Phosphorous	Magnesium	Sodium	Potassium
	(g/dL)		(mg/dL)					(mEq/L)		
A	3.12	2.37	161.75	0.72	84.5	10.42	6.57	2.1	135	4.07
B	3.47	2.57	159.25	0.7	87.75	10.72	7.1	2.4	141.25	4.37
C	3	2.22	162.5	0.62	89.5	10.22	6.37	2.02	138.5	4.07
D	3.52	2.55	158.75	0.65	85	10.9	6.92	2.27	140.5	4.40
E	2.9	2.42	164.25	0.6	103.5	10.22	6.42	1.82	138.25	4.1
SE*	0.25	0.11	14.48	0.07	14.07	0.65	0.35	0.19	1.95	0.18
P-value	0.3610	0.2180	0.8638	0.7766	0.8692	0.9256	0.5417	0.3241	0.2390	0.5453

* SD: standard error of mean.

Similarly, Huff *et al.* (1998) showed that AF caused a decrease in blood calcium level in broiler chicks, which were given at a dose of 2.5 ppm for 3 weeks. It was understood that there was no correlation between this results compared to previous studies.

There were not any significant difference (P>0.05) in internal organs between experimental groups and the control (Table 5).

Table 5 Effect of sodium and calcium bentonite (NaB and CaB) on carcass characteristics (relative weight) and tibia ash (%) of broiler chickens

Treatment	A	B	C	D	E	SE*	P-value
Carcass yield	53.5	56.2	54.7	54.9	55.9	1.6	0.75
Thigh	26.2	27.5	26.1	26.8	27.3	0.8	0.62
Breast	29.3	30.0	29.5	30.4	29.8	0.7	0.79
Liver	9.5	8.8	9.2	8.8	9.4	0.2	0.14
Abdominal fat	5.2	4.9	5.3	5.2	5.7	0.5	0.84
Tibia ash	44.9	47.8	44.8	46.8	44.4	1.42	0.18

* SD: standard error of mean.

These findings correspond with the results of Bailey *et al.* (2006) who concluded that using bentonite in broilers diets did not affect the relative weight of heart and liver. However, in the other study examining the use of bentonite in diets contaminated with mycotoxins, reduced damage to the liver tissue and decreased its relative weight Miazzo *et al.* (2005).

This seemed to be due to aluminosilicates' role in capturing heavy cations and radioactive elements in their structural pores and canals, thereby decreasing the poisoning effects of mycotoxins Mirabdolbagi *et al.* (2007a).

Additionally, the effect of aluminosilicates in forming stable complexes with aflatoxins and decreasing their availability seemed to be another factor in detoxification of gastrointestinal tract and subsequently liver weight reduction (Kubena and Harvey, 1993).

The controversy between the results of the current study and the above mentioned report might be due to the lack of toxins in the present research. Table 5 shows that there is not any significant variance regarding tibia ash among groups (P>0.05), which is consistent with the observations of Mirabdolbagi *et al.* (2007b). According to the reports of these researchers, using clinoptilolite in diets did not affect the tibia ash of broilers.

On the other hand, Yalcin *et al.* (1995) declared that adding zeolite to broilers rations, caused an increase in tibia ash, which could be possibly because of aluminosilicates more calcium absorption regarding their high capacity in bivalent cations exchange.

CONCLUSION

The results showed that the use of both kinds of bentonite in diets at 1% could improve the broiler performance; however addition of 1.5% bentonite had not any significant effect in this study.

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