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

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Abstract: This experiment was conducted to study the effects of two kinds of sodium and calcium bentonite (SB and CaB) on the performance, blood biochemical parameters, carcass characteristics and tibia ash of broiler chicks. Two hundred and sixty day-old broilers of male Ross 308 strain were allocated to 5 treatments with four replications and 13 broilers in each pen. The experiment was carried out in a completely randomized design. Treatments were: soy-corn based diet (control); 1% sodium bentonite (SB); 1.5% sodium bentonite (SB); 1% calcium bentonite (CaB); and 1.5% calcium bentonite (CaB). The results showed there was not any significant difference between experimental groups in starter and grower periods, but feed intake decreased, as well as 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 not any significant effect in this study.

Key words: Sodium Bentonite · Calcium Bentonite · Broiler · Performance · Blood Parameter · Carcass · 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 [1]. 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, nickel, etc. 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 food/feed ingredients and act as inert material due to their neutral PH or slightly alkaline nature. Several studies showed that poultry feed supplemented with bentonite can improve growth performance and nutrient digestibility in broilers [2,3]. Kececi *et al*. [4] determined 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 dietary rations [5,6].

On the other hand, Southern *et al.* [3] reported that NaB did not adversely affect 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 the 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) in 5 treatments and 4 replicates (with 13 birds in each pen) from 1 to 42 days. Diets included:

- control diet without bentonite (soybean-corn based diet),
- contained 1% sodium bentonite (SB),
- 1.5% sodium bentonite (SB),

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

	Starter					Grower					Finisher				
Feed ingredient(%)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Corn	54.85	52.90	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 analysis															
(kcal/kg) ME	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 (SB), %1.5 sodium bentonite (SB), %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, 14400IU; vitamin k 2000; B12, 640 mg; Thiamin, 612 mg; Riboflavin, 3000 mg; pentatonic acid, 4896 mg; Niacin, 12160mg; b_6, 612mg; Biotin, 2000mg; Cho line chloride, 260g;

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

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

Compositional profile	SiO_2	Al_2O_3	Na_2O	MgO	K_2O	CaO	Fe_2O_3	LOI
Percentage	%	%	%	%	%	%	%	%
Sodium Bentonite (SB)	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

- 1% calcium bentonite (CaB) and
- 1.5% calcium bentonite (CaB).

Chemical compositions of these two kinds of sodium and calcium bentonites (SB and CaB) are presented in Table 2.

Diets were supplemented with amino acids, minerals and vitamins at levels recommended by the National Research Council [7] 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 food. Chickens consumed the diets and water ad libitum and lighting cycle was 24 h/d maintained. 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, 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 experimental period. Body weight (BW) and feed intake were recorded in the end of each period to calculate feed conversion ratio.

At 42 d, blood was collected from 5 broilers per treatment; sera were 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 also measured. Kit package (pars azmoon Company; Tehran, Iran) were used for determination of the blood biochemical parameters using auto-analyzer (Technicon RA-1000) system.

At 42-d-old, carcass characteristics were assessed using Scholty Sek technique and remained tibia ash were measured through the burning method by removing the organic material [8].

Data were analyzed by ANOVA using the General Linear Models Procedure of SAS software [9] and means were compared by Duncan's Multiple Rang Test. 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 of trial 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.* [10] and Petkova and Ivanov [11]. It might be due to the highly adhesive nature of the bentonite which absorbs more moisture and resist the flow of digesta through gastrointestinal tract (GIT), which can affect the feed intake negatively [12].

Several recent reports showed that the low level additions of selected bentonites to poultry diets improved caloric efficiency and slowed down feed passage [13-17]. Whereas Salari *et al*. [18] reported that chickens fed diets containing 1-2% bentonite consumed more feed ($p<0.05$). There was not any significant effect of dietary treatments on feed intake in starter and grower periods. These findings were in agreement with Esmeralda *et al*. [19].

No significant differences were observed among the experimental treatments for weight gain. This result was in agreement with other reports Kermanshahi *et al*. [30] and [20, 21], although the others had found that addition bentonite to the diet had significant effect on weight gain ($p<0.05$) Tauqir *et al*. [22] and [1,18, 23].

There were not any significant differences between 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.

Decrease of feed conversion ratio in broilers after use of aluminosilicates could be due to reduction in the rate of food passage in the gastrointestinal as an effect of water absorption of food, which led to subjecting of nutrients to enzymatic action for quite a long time.

Elliot and Edwards [24] and Pasha *et al.* [1] 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 [25-29] On the other side, Kermanshahi *et al.* [30] reported that the supplementation of bentonite to the dite had no effect on feed conversion ratio.

Differences of reported studies could be due to differences in used aluminosilicate material in the experiment. It is obvious that the use of several kinds of these chemicals in next 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.* [27] showed that AF caused a decrease in blood total protein, albumin, Uric Acid and Cholesterol levels in broiler chicks. On the other hand, Smith *et al.* [30] observed that AF given at a dose of 3.5 ppm for 3 weeks caused a decrease

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

	Treatment	A	B	C	D	E	SE**	P-value
Starter	FI	245.47	252.16	238.15	243.13	248.33	8.15	0.7909
	WG	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	1259.95	1270.02	1294.24	1265.05	1288.33	26.82	0.8657
	WG	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	3293.8^a	3026.6^b	3302.3^a	3041^b	3335.3^a	71.57	0.0134
	WG	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	4736.25^a	4540.16^b	4775.64^a	4530.46^b	4836.83^a	62.75	0.0092
	WG	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

*Means within rows with different letters are significantly different ($P<0.05$)

** Standard error of mean

Table 4: Effect of sodium and calcium bentonite (SB 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

* Standard error of mean

Table 5: Effect of sodium and calcium bentonite (SB and CaB) on carcass characteristics (percentage of live weight) and tibia ash of broiler chickens

Treatment	A	B	C	D	E	SE*	P-value
Carcass yield	53.54	56.27	54.75	54.94	55.98	1.60	0.7584
Thigh	26.25	27.51	26.16	26.84	27.30	0.84	0.6215
Breast	29.37	30.05	29.59	30.44	29.84	0.77	0.7976
Liver	9.56	8.81	9.26	8.82	9.49	0.25	0.1417
Abdominal fat	5.28	4.92	5.32	5.22	5.70	0.51	0.8440
Tibia Ash	44.94	47.83	44.89	46.86	44.47	1.42	0.1873

* Standard error of mean

in phosphorus level. Similarly, Huff *et al.* [31] showed that AF caused a decrease in blood calcium level in broiler chicks chicks, which were given at a dose of 2.5 ppm for 3 weeks. It was understood that there was not any correlation between the this results compared to previous studies.

There were not significant differences ($p>0.05$) in internal organs between trial groups and control (Table 5). These findings correspond with the results of Bailey *et al.* [32] who concluded that using bentonite in broilers diets did not affect the heart and liver weight. However, in the other study examining the use of bentonite in diets contaminated with mycotoxins, reduced damage to the liver tissue and decreased its weight Miazzo *et al.* [6]. 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.* [33]. 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 [34]. 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 isn't any significant variance regarding tibia ash among groups ($p>0.05$), which is consistent with the observations of Mirabdolbagi *et al*. [35]. 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*. [5] 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 either kinds of bentonite in diets at one percent could improve the broiler performance; however addition of 1.5 % bentonite had not any significant effect in this study.

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