African Journal of Biotechnology Vol. 10(16), pp. 3232-3236, 18 April, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.1947
ISSN 1684–5315 © 2011 Academic Journals

Full Length Research Paper

Effect of different levels and particle sizes of perlite on serum biochemical factors of broiler chicks

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Accepted 23 February, 2011

The objective of this study was to investigate the effects of different levels and particle sizes of perlite in broiler chicks' diets on serum biochemical factors. For the stated purpose, 280 day-old Ross 308 broiler chicks were allocated to seven treatments and four replications in a factorial experiment on the basis of randomized complete block design. One factor consisted of two levels (perlite particle sizes of 1.5 and 3 mm) and the other factor included three levels of perlite (1, 3 and 5% of diet). A control treatment with no perlite was also included in the experiment. Based on the results obtained, the perlite levels and particle sizes did not affect the serum Ca, P, Cl, Na and Fe, however, they influenced the serum Mg and K significantly (P < 0.05). It seems that perlite did not have any major impact on the biochemical factors of chick's serum.

Key words: Perlite, aluminosilicate, particle size, serum biochemical factors.

Introduction

Perlite is an aluminosilicate volcanic rock which is made of rapid solidification of acidic magma. The volume of perlite rock increases from 4 to 20 times at temperature of about 860 to 1200°C and produces expanded perlite (Anonymous, 2006). As displayed in Figure 1, expanded perlite has porous texture which gives it unique characteristics. Perlite chemical composition is given in Table 1.

Aluminosilicates can be used as a feed additive to increase the absorption of cations, provide minerals in diets, improve the health of gastric tract and detoxificate aflatoxins (Anonymous, 2006). One of the recent applications of perlite is its usage in livestock and poultry feed industry. However, reports in this research area are scarce. Hence, a few studies about aluminum silicates, such as Zeolite, Bentonite and Clinoptilolite have been referred to. Due to the similarity of these materials and perlite, it is expected that perlite will have similar effect on broiler chick's feeding (Tatar, 2006). Lotfollahian et al. (2004) used two types of aluminosilicates and different levels of dietary calcium (Ca) and phosphorus (P) and obtained a significant increase in broilers' serum Ca. However, they did not observe any significant difference between experimental treatments for serum P. Ward et al. (1991) examining the role of aluminosilicates in broiler chicks diet, reported a reduction in serum Ca and P levels. On the other hand, Frost et al. (1992) investigated the effect of zeolite on serum Ca and P levels of Leghorn strain laying hens and concluded that the dietary intake of this substance did not have any significant role on the dependent variables under study. Furthermore, Santurio et al. (1999) reported that the use of bentonite in broilers diet did not have any major impact on the blood biochemical variables.

The objective of this study was to investigate the effects of different levels and particle sizes of perlite in diet, on serum biochemical characteristics of broiler chickens, with the aim of finding a cheap and plentiful substitution for mineral diet ingredients in comparison with other aluminosilicates.

Materials and methods

In this study, 280 day-old Ross 308 broiler chicks were allocated to seven treatments and four replications in a factorial design on the basis of randomized complete block design. Factors were particle

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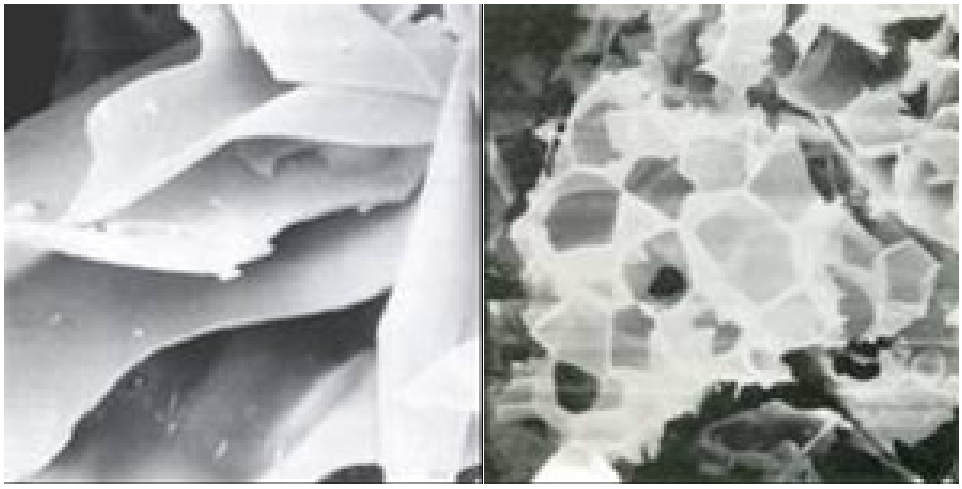

Figure 1. Microscopic image of the porous texture of perlite (Anonymous, 1993).

Table 1. Chemical composition of perlite.

Element	Percent	Element	Percent
Si	33.8	Ca	0.6
Al	7.2	Mg	0.2
K	3.5	Trace elements	0.2
Na	3.4	O_2	47.5
Fe	0.6	Water	3.0

Anonymous (1993).

size (1.5 and 3 mm) and levels (1, 3 and 5% of diet) of perlite. In addition, a treatment with no perlite was included as the control group. Therefore, experimental treatments consisted of seven treatments. In order to control the possible differences in environmental factors such as light, they were divided into four complete blocks and the treatments were randomly allocated to each block. The perlite used in this study was extracted from Azerbaijan perlite mine and its purity was proved by chemical analysis based on the recommendations of the relevant factory.

At day 42, blood samples were randomly collected from two chickens per cage (experimental unit) and the remaining chickens were sent to slaughterhouse at day 49. serum levels of calcium (labtest method), phosphorus (basques-lustosa's method), magnesium (tonks' method), sodium (ion-selective method), potassium (ion-selective method) and chlorine (labtest method) were determined by commercial kits (labtest) using a clinical chemistry analyzer (au 5000 olympus, hamburg, germany). serum iron concentration was determined by colorimetric method with a commercial kit (boehringer mannheim) using an automatic analyzer (hitachi 911, boehringer mannheim, germany). energy and protein content of the diets were similar and they only differed for the levels and particle sizes of perlite. nutritional requirements of broiler chickens during the growing periods were balanced according to the tables of nutritional requirements of national research council (NRC) (1994) and were balanced by the user friendly feed formulation done again (uffda) software. the diets used in this research and supplied nutrients in starter and grower periods are given in table 2, respectively. analysis of variance and mean comparisons by duncan's new multiple range test (5% probability level) were performed using mstatc 11 and spss 16.0 softwares. performance traits such as body weight, body weigth gain and feed conversion rate were published elsewhere (ebadi et al., personal communication).

Results and Discussion

Statistical analysis of data obtained from blood serum biochemical examination (Table 3) indicated that different levels and particle sizes of perlite did not affect serum concentrations of calcium (Ca) and phosphorus (P). Ward et al. (1993) also, examining the effect of zeolite on broilers' blood elements, showed that adding this substance to diet, did not have any significant influence on blood serum Ca and P. Santurio et al. (1999) added 0.25 and 0.5% bentonite to dietary ration of broilers and did not observe significant change in blood calcium. Some other researchers also reported that using aluminosilicates in dietary rations had no effect on serum phosphorus levels of broiler chicks (Roland et al., 1990; Scheideler, 1993; and Dwyer et al., 1997). Scheideler (1993) found that adding an aluminosilicate substance called zeobrite reduced serum Ca in broiler chicks. Furthermore, Tatar (2006) added 2.5 and 5% perlite to broilers' diets and examined serum biochemical characteristics. It was found that despite a non-significant difference between treatments in terms of blood serum Ca, serum P increased when a diet containing 5% perlite was used.

In broilers' diets, decreased the Cl levels of blood serum. Scheideler (1993) in the study of effects of four diffe-rent types of aluminosilicates in diets impregnated by aflatoxin on serum characteristics of broilers, also indicated that regardless of the existence or lack of aflatoxin in the diet, aluminosilicate substance decreased the serum Cl level.

Based on the results of serum biochemical analysis (Table 3), it could be seen that the amount of serum

Table 2. Composition of the experimental diets in the experiment.

Ingredient	Starter diet (day 1 to 21)				Grower diet (day 22 to 42)			
Corn	43.91	44.26	46.86	49.36	54.74	54.92	54.30	56.72
Soybean meal (44% P)	33.93	34.58	35.91	37.31	25.66	26.25	27.42	28.96
Wheat	7.00	7.00	7.00	0.00	5.50	5.50	4.00	1.00
Barley	3.00	3.00	0.06	0.00	5.00	4.00	2.50	1.20
Wheat bran	5.03	3.02	0.00	0.00	4.00	3.00	2.50	0.50
Sunflower oil	3.50	3.50	3.50	4.65	1.75	1.98	2.92	3.25
Calcium carbonate	1.33	1.31	1.29	1.28	1.27	1.25	1.24	1.22
Dicalcium phosphate	1.27	1.30	1.34	1.35	1.12	1.14	1.16	1.19
Salt	0.25	0.25	0.25	0.25	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
Vitamin premix†	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.15	0.15	0.15	0.15	0.06	0.06	0.06	0.06
Vitamin E	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Cocsidio acetate (Salinomycin)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Perlite	0.00	1.00	3.00	5.00	0.00	1.00	3.00	5.00
Calculated nutritive values								
ME (kcal/kg)	2900	2900	2900	2900	2900	2900	2900	2900
CP (%)	20.85	20.85	20.85	20.85	18.125	18.125	18.125	18.125
P:ME ratio	139.09	139.09	139.09	139.09	160.00	160.00	160.00	160.00
Ca (%)	0.89	0.89	0.89	0.89	0.818	0.818	0.816	0.816
Available P (%)	0.40	0.40	0.40	0.40	0.362	0.362	0.362	0.362
Cl (%)	0.20	0.20	0.19	0.19	0.197	0.195	0.193	0.190
K (%)	0.92	0.91	0.89	0.90	0.77	0.77	0.77	0.77
Na (%)	0.13	0.13	0.13	0.13	0.126	0.125	0.124	0.122
Lysine (%)	1.16	1.17	1.19	1.22	0.95	0.95	0.97	0.98
Methionine (%)	0.45	0.44	0.45	0.45	0.35	0.35	0.35	0.36
Methionine + Cysteine (%)	0.82	0.81	0.81	0.82	0.67	0.67	0.67	0.68

*Supplying per kg food: 333 mg MnO, 220 mg $ZnSO_4$ $7H_2O$, 450 mg ferric citrate, 35 mg $CuSO_4$ $4H_2O$, 2 mg KIO_3, 1 mg $CoSO_4$ $8H_2O$: 0.35 mg Na_2SeO_3. †Supplying per kg food: 900 µg retinol, 15 µg cholecalciferol, 2 mg menadione sodium bisulphate, 2 mg thiamine, 5 mg riboflavin,15 mg calcium pantothenate,30 mg niacin: 3.5 mg pyridoxine, 0.2 mg biotin, 0.6 mg folic acid, 0.02 mg vitamin B_{12}, 200 mg choline chloride.

magnesium (Mg) and potassium (K) of broilers were influenced by the dietary perlite and the levels of these two elements reached the highest value by adding 3% perlite. Although in an investigation by Pond and Yen (1983), Mg level was not affected by the use of zeolite in swine's diets, Kayongo Male and Jia (1999) observed that adding zeolite to the diet, increased blood Mg of turkeys. Furthermore, according to the results of Santurio et al. (1999), serum Mg increased by feeding broilers with 0.25% bentonite. It seems that the Mg in the structure of perlite is absorbed from gastrointestinal tract of broilers which increases the serum content of Mg. In addition, perlite having ion exchange properties and the ability of bivalent cations absorption, increases blood Mg. Meanwhile, Rabo (1976) stated that aluminosilicates are thermodynamically unstable and tend to generate insoluble aluminate and soluble silicate in acidic and water environments and this transformation easily occurs in chicks' gastrointestinal tract with pH 5. It seems that in the condition of increasing dietary perlite level to 5%, silicate produced in the gastrointestinal tract, combines with Mg ions and prevents their absorption.

Santurio et al. (1999) reported that adding 0.25% bentonite to the diet, caused an increase in blood K but the amounts more than 0.25% decreased blood K. Kleiner et al. (2000) in an investigation on the effects of aluminosilicates on serum biochemical characters, found that the use of these substances in diets of mice increased serum K. This seems to be due to the existence of K in aluminosilicates' structure and due to its

Table 3. Mean values of some serum biochemical parameters in 42-day old broiler chickens fed on diets containing different levels and particles sizes of perlite.

Treatment		Ca (mg/dl)	P (mg/dl)	Mg (mg/dl)	Na (mEq /l)	K (mEq/l)	Cl (mEq/l)	Fe (µg/dl)
Particle size (mm)	**Level (%)**							
-	0 (control)	8.70	7.98	0.72	150.00	4.23	156.00	77.00
1.5	1	8.50	8.28	0.73	150.50	4.13	156.75	83.50
1.5	3	8.03	7.95	0.88	154.50	4.58	151.75	78.25
1.5	5	8.68	7.58	0.58	155.00	4.45	153.50	61.75
3	1	8.63	7.45	0.76	152.75	3.85	150.50	78.00
3	3	8.65	8.03	0.81	154.00	5.20	145.50	74.00
3	5	8.73	7.80	0.69	154.75	4.35	156.75	62.00
SEM		0.25	0.33	0.09	2.07	0.42	4.11	8.42
Control diet versus the other diets								
Control diet		8.70	7.98	0.72	150.00	4.23	156.00	77.00
Other diets		8.53	7.85	0.74	153.58	4.43	152.46	72.92
Main effects								
Particle size	1.5 (mm)	8.40	7.93	0.73	153.33	4.38	154.00	74.50
	3 (mm)	8.67	7.76	0.75	153.83	4.47	150.92	71.33
Level	1 (%)	8.56	7.86	0.74^{ab}	151.63	3.99^{b}	153.63	80.75
	3 (%)	8.34	7.99	0.84^{a}	154.25	4.89^{a}	148.63	76.13
	5 (%)	8.70	7.69	0.63^{b}	154.88	4.40^{ab}	155.13	61.88

In each column and for each factor, the numbers which are not marked with the same characters, are significantly different ($P < 0.05$).

absorption from the gastrointestinal tract. On the other hand, based on some studies, aluminosilicates used in diets had no effect on serum content of K of broiler chicks (Pond and Yen, 1983;Roland et al., 1993).

None of the blood elements were influenced by the particle size of perlite (Table 3). Kasim and Edwards (2000) also reported that particle size of diet do not play any role on serum Ca and P in broilers. It is possible that the perlite structure is destroyed in the upper parts of the gastrointestinal tract, particularly the gizzard. Furthermore, only 7% of aluminosilicates appears unsolved, maintaining its primary structure in terminal parts of the digestive tract (Roland et al., 1993).

In conclusion, the results of the present research showed that adding 3% of perlite to diet increased the Mg and K content of serum. Overall, different levels and particle sizes of perlite did not have any major impact on the serum biochemical values in broilers.

References

Anonymous (1993). Perlite applications in filtration. Cooperative of Azerbaijan regional mineral mines.

Anonymous (2006). Conversation with Iranian and Asia perlite association managers. J. Cultivation Ind. World, 33: p. 3.

Dwyer MR, Kubena LF, Harvey RB, Mayura K, Sarr AB, Buckley S, Bailey RH, Phillips TD (1997). Effect of inorganic adsorbents and cyclopiazonic acid in broiler chicken. J. Poult. Sci. 76: 1141-1149.

Frost TJ, Roland DA, Barnes DG, Laurent SM (1992). The effect of sodium zeolite A and cholecalciferol on plasma levels of 1, 25 dihydroxycholecalciferol, Ca, and P in commercial Leghorns. J. Poult. Sci. 71(5): 886-893.

Kasim AB, Edwards HM (2000). Effect of sources of maize and maize particle sizes on the utilization of phytate P in broiler chicks. Anim. Feed Sci. Technol. 86: 15-26.

Kayongo-Male H, Jia X (1999). Silicon bioavailability studies in young rapidly growing rats and turkeys fed semi purified diets: a comparative study. Biol. Trace Elem. Res. 67: 173-186.

Kleiner IM, Mestric ZF, Zadro R, Breljak D, Janda SS, Stojkovic R, Marusic M, Radacic M, Boranic M (2000). The effect of the zeolite clinoptilolite on serum chemistry and hematopoiesis in mice. Food Chem. Toxicol. 39: 717-727.

Lotfollahian H, Shariatmadari F, Shiva Azad M, Mirhadi A (2004). Effect of using two types of natural zeolite in diet on blood biochemical factors, the relative weight of internal organs, and broiler performance. J. Res. Construct. 64: 18-34.

National Research Council (1994). Nutrition requirements of poultries. National Academy Press, Washington, D.C.

Pond WG, Yen JT (1983). Protection by clinoptilolite or zeolite NaA against cadmium-induced anemia in growing swine. Proc. Soc. Exp. Biol. Med. 173: 327-337.

Rabo JA (1976). Zeolite chemistry and catalysis. Am. Chem. Soc., Washington D.C. pp. 285-331.

Roland DA, Rabon HW, Frost TJ, Laurent SM, Barnes DG (1990). Response of commercial Leghorns to sodium aluminosilicates when fed different levels and sources of available phosphorous. J. Poult.

Sci. 69: 2157-2164.
Roland DA, Rabon HW, Rao KS, Smith RC, Miller JW, Barnes DG, Laurent SM (1993). Evidence for absorption of silicon and aluminum by hens fed sodium zeolite A. J. Poult. Sci. 72: 447-455.
Santurio JM, Mallmann CA, Rosa AP, Appel G, Heer A, Dageforde S, Bottcher M (1999). Effect of sodium bentonite on the performance and blood variables of broiler chickens intoxicated with aflatoxins. Brit. Poult. Sci. 40(1): 115-119.
Scheideler SE (1993). Effects of various types of aluminosilicates and aflatoxin B1 on aflatoxin toxicity, chick performance, and mineral status. J. Poult. Sci. 72(2): 282-288.
Tatar A (2006). Comparison of the effects of different levels of perlite and zeolite on broiler chicks performance. MSc thesis on animal science. Department of Animal Science, University of Agricultural Science and Natural Resources of Gorgan, IRAN.
Ward TL, Watkins KL, Southern LL (1993). Interactive effects of sodium zeolite A and *Eimeria Acervulina* on growth and tissue minerals in chicks. J. Poult. Sci. 72: 2172-2175.
Ward TL, Watkins KL, Southern LL, Hoyt PG, French DD (1991). Interactive effects of sodium zeolite A and copper in growing swine: growth and bone and tissue mineral concentrations. J. Anim. Sci. 69: 726-733.