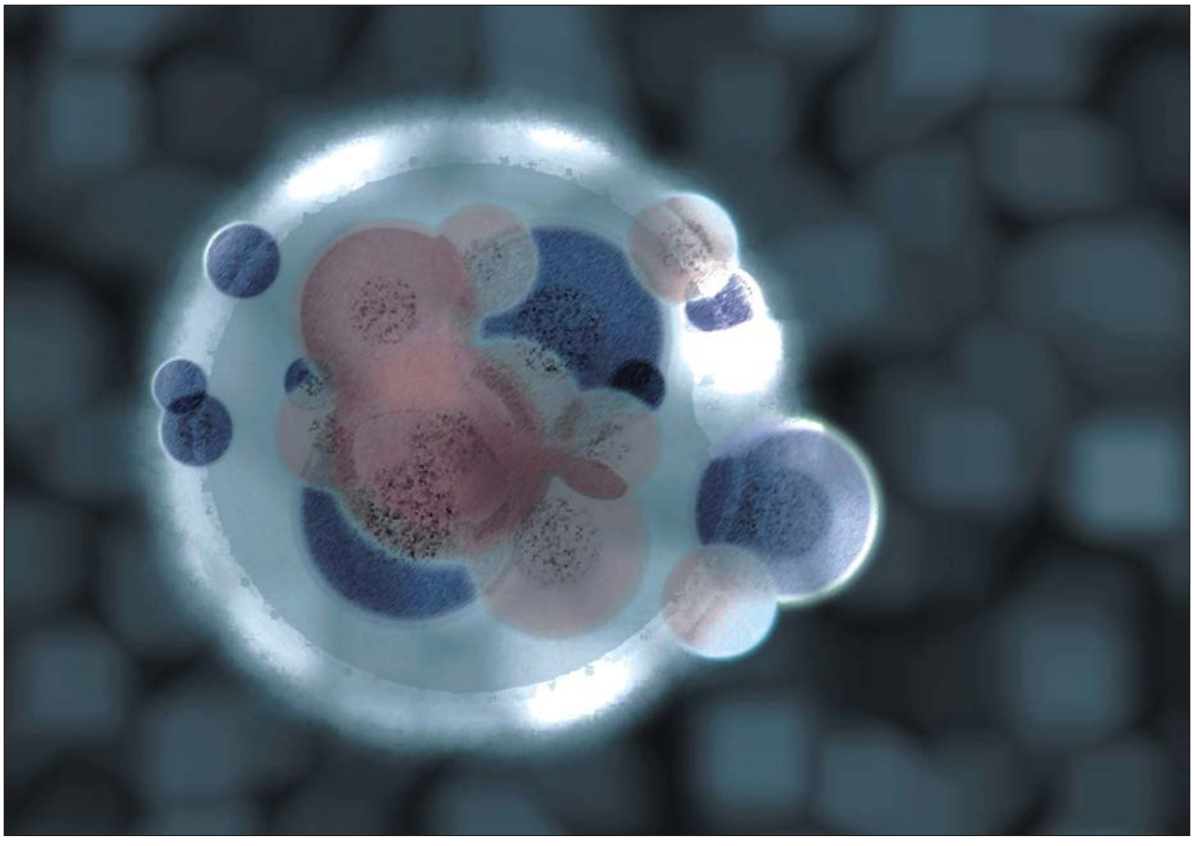

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# The Efficacy of Dietary Inclusion of Sodium Bentonite on Litter Characteristics and Some Blood Hormones in Broiler Chickens

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**Abstract:** This study was conducted to evaluate the effect of natural sodium bentonite as feed additive on litter moisture, pH, ash, nitrogen (N) and plasma thyroxine (T4), thyrotrophin (TSH), growth hormone (GH) in broiler chickens. Two hundred and fifty six 1-day-old Ross male broiler chickens were housed in pens (16 chickens per pen) for 42 days. There were 4 inclusion rates of sodium bentonite (0, 15, 30 and 45 g $kg^{-1}$). Each treatment had 4 replicates of 16 chickens. The experiment was carried out in a completely randomized design. The moisture content of the litter on 14th and 35th day was significantly ($p<0.05$) decreased in all experimental treatment compared to control. On the 14th day the litter pH in treatment containing 15 g $kg^{-1}$ sodium bentonite was significantly ($p<0.05$) decreased compared to control. The N content of the broiler litter was significantly ($p<0.05$) lower in treatment with 30 g $kg^{-1}$ sodium bentonite on 21st and 42nd day compared to the control. The content of broiler litter ash in treatment with 45 g $kg^{-1}$ sodium bentonite was decreased significantly ($p<0.05$) on 42nd day compared to the control. Plasma growth hormone in treatment with 30 g $kg^{-1}$ sodium bentonite was increased significantly ($p<0.05$) compared to the control. Plasma T4 and TSH levels were not affected by the dietary treatments. The results demonstrated that sodium bentonite can be used as a feed additive in the broiler chicken diet for improving litter characteristics and as a result performance.

**Key words:** Sodium bentonite, broilers, litter moisture, ash, nitrogen, blood hormones

## INTRODUCTION

Various researchers found that animal diet containing sodium bentonite has been shown to improve body weight gain and feed conversion ratio of chicken (Prvulovic *et al*., 2008; Safaeikatouli *et al*., 2010; Salari *et al*., 2006), pig (Thieu *et al*., 2008; Yu *et al*., 2008), lamb (Khadem *et al*., 2007; Pulsipher *et al*., 1994) and goat (Schwarz and Werner, 1990), to improve the quality of animal products such as eggs (Ambula *et al*., 2003; Hashemipour *et al*., 2010) or wool (Ivan *et al*., 1992; Walz *et al*., 1998) and the addition of bentonite to the aflatoxin-containing diet reduced the adverse effects of aflatoxin and should be helpful in a solution to the aflatoxicosis problem in poultry (Bailey *et al*., 2006; Kermanshahi *et al*., 2009; Shi *et al*., 2009).

Sodium bentonite contains a strong and stable structure and by absorbing and losing of water keeps its structure. Therefore, sodium bentonite in addition to diets effect on the digestive tract of the broiler performance, by keeping its structure and characteristics can exit from digestive tract and add to the litter and affect the characteristics of litter. Litter can significantly affect growth performance of broilers (Bilgili *et al*., 1999). Litter type affects litter consumption and litter bacteria (Toghyani *et al*., 2010), thus may affect body weight and health of broiler chicks. The consideration that birds continuously are in contacts with litter, the condition of the litter could affect the broiler performance. If litter is not kept at an acceptable level, very high bacterial loads and unsanitary growing conditions may result producing odors (including ammonia), insect problems (particularly flies), soiled feathers, footpad lesions and breast bruises or blisters.

On the other hand, today the poultry industry has been considered as a source of potential environment pollutant with N, because the amount of crude protein in poultry diet is higher than other domestic animals. Poultry manure and poultry litter are well known as excellent sources of N fertilizers, as well as other major plant nutrients (Fontenot *et al*., 1983; Sutton *et al*., 1987). Uric acid (70% of the total N) and urea are the main N components present (Koerkamp, 1994; McCrory and Hobbs, 2001). After excretion, the uric acid and urea in

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manure are quickly converted to $NH4^+$ via urease, which can be lost into the environment in gaseous form as NH3 (Wilson, 2000). Some researches on ammonia emission from poultry houses concerned particularly effects of such factors as: air temperature and humidity, litter moisture and pH, ventilation rate and air velocity at litter surface (Weaver and Meijerhof, 1991), providing for litter drying up (Groenestein, 1993; Macke and Van Den Veghe, 1997), optimizing of dietary protein level (Ferguson *et al*., 1998a; Ferguson *et al*., 1998b), using various additives to litter (Moore *et al*., 1996).

The aim of this experiment was to evaluate the effect of increasing levels of sodium bentonite in broiler diet, on litter characteristics and blood T4, TSH and growth hormones.

## MATERIALS AND METHODS

The experiment was conducted at the Gorgan University of Agricultural Sciences and Natural Resources in Golestan province, Iran during May 2009 and February 2010, using two hundred and fifty six day-old male (Ross 308) broiler chicks. Chicks were randomly divided into 16 experimental units (replicates) of sixteen chicks each. Room temperature was maintained at 32°C for the first week and then gradually reduced to 18°C by the rate of 3°C per every week. Light was provided 24 h continuously with overhead incandescent lighting by 10 lux during the 6 week period of the experiment. Vaccination for Bronchitis on day 1 and 9, Newcastle disease was done on day 9 and for Gumboro disease on day 15 and 21. Before the formulation of experimental diets, the ingredients were analyzed in triplicate for their dry matter, crude protein, ether extract, crude fiber (AOAC, 2005). The treatments were: (1) diet without sodium bentonite, (2) diet inclusion 15 g $kg^{-1}$ sodium bentonite, (3) diet inclusion 30 g $kg^{-1}$ sodium bentonite and (4) diet inclusion 45 g $kg^{-1}$ sodium bentonite. The starter ration contained 20.85% crude protein and 2900 Kcal $kg^{-1}$ metabolizable energy and the grower rations contained 18.75% crude protein and 3000 Kcal $kg^{-1}$ metabolizable energy. All diets were isocaloric and isonitrogenous based on NRC (1994) recommendation. The bentonite used was prepared and provided from the South Khorasan province, Iran. The chemical composition of sodium bentonite is presented in Table 1.

Table 1: Chemical composition of bentonite

| Compositional profile | Percentage |
|---|---|
| $SiO_2$ | 66.59 |
| $Al_2O$ | 11.21 |
| $Fe_2O_3$ | 1.84 |
| CaO | 0.19 |
| MgO | 2.49 |
| $Na_2O$ | 2.50 |
| $K_2O$ | 0.12 |
| $TiO_2$ | 0.02 |
| L.O.I | 14.28 |
| PH | 7.00 |

Litter samples were taken from centre and mid way between centre and four corners of each pen at the 14, 21 28, 35 and 42 days of experiment. Five samples were taken from each pen and then combined and homogenized in plastic bags to make one sample/pen and were refrigerated until the moisture contents were determined by placing in an oven at 105°C for 24 h. The pH of litter content was measured weekly in fresh sample using a pH meter (Model WTW-720 Inolab., Germany). The dried litter was ground and then N and ash contents were measured using AOAC (2005) procedures.

At the last day of experiment prior to being slaughtered, birds were individually weighed and a blood sample of 2 mL was taken from wing vein of each bird. The blood samples were immediately centrifuged at 3000 rpm for 20 min with a centrifuge (Hettich; Germany) and the serum was stored at -20°C in sealed container till analyzed, and thyroxine (T4), thyrotrophin (TSH) and growth hormone (GH) levels in the blood were measured using radioimmunoassay.

Data were analyzed by ANOVA, using the general linear model procedure of SAS (2003) appropriate for a completely randomized design with four levels of sodium bentonite. Data were subjected to analysis of variance and significant differences ($p<0.05$) observed in means subjected to Duncan's multiple range test (Duncan, 1955).

## RESULTS AND DISCUSSION

The moisture content of the litter on 14th and 35th day was significantly ($p<0.05$) decreased in all experimental treatments compared to control. Also treatments with 15 and 30 g $kg^{-1}$ sodium bentonite on 28th and 35th day significantly ($p<0.05$) decreased litter moisture compared to the control treatment. Moisture content did not significantly differ among dietary treatments on 21st and 42nd day (Table 2). The results of the present study are in agreement with previous studies in which silicate mineral significantly decreased litter moisture in broiler chicks houses (Eleroglu and Yalcin, 2005; Karamanlis *et al*., 2008; Kiaei *et al*., 2002). Litter moisture is an important litter quality factor. In a well managed broiler house, litter moisture normally averages between 20 to 35%. Litter that is managed correctly with the moisture content kept within the acceptable range can be reused if no disease or other production problems occur. Aluminosilicates have a high capacity for

Table 2: Litter moisture (%) as influenced by different levels of sodium bentonite

| | Days | | | | |
|---|---|---|---|---|---|
| Treatments | 14 | 21 | 28 | 35 | 42 |
| Control | 25.85$^{a}$ | 25.03 | 26.03$^{a}$ | 28.72$^{a}$ | 33.02 |
| Sodium bentonite 15 g kg$^{-1}$ | 22.63$^{b}$ | 24.25 | 22.92$^{b}$ | 25.41$^{b}$ | 31.15 |
| Sodium bentonite 30 g kg$^{-1}$ | 23.08$^{b}$ | 23.08 | 20.97$^{b}$ | 23.75$^{b}$ | 29.98 |
| Sodium bentonite 45 g kg$^{-1}$ | 21.96$^{b}$ | 24.99 | 23.58$^{ab}$ | 24.94$^{b}$ | 30.31 |
| SEM | 0.89 | 0.67 | 0.84 | 0.83 | 0.97 |

Means within columns with dissimilar superscripts are significantly different ($p<0.05$)

Table 3: Litter pH as influenced by different levels of sodium bentonite

| | Days | | | | |
|---|---|---|---|---|---|
| Treatments | 14 | 21 | 28 | 35 | 42 |
| Control | 6.39$^{a}$ | 6.62 | 7.02 | 7.07 | 7.63 |
| Sodium bentonite 15 g kg$^{-1}$ | 5.89$^{b}$ | 6.35 | 6.57 | 6.88 | 7.47 |
| Sodium bentonite 30 g kg$^{-1}$ | 6.03$^{ab}$ | 6.58 | 6.72 | 7.10 | 7.14 |
| Sodium bentonite 45 g kg$^{-1}$ | 5.96$^{ab}$ | 6.59 | 6.81 | 6.96 | 7.20 |
| SEM | 0.14 | 0.13 | 0.22 | 0.25 | 0.23 |

Means within columns with dissimilar superscripts are significantly different ($p<0.05$)

Table 4: Litter Nitrogen and ash as influenced by different levels of sodium bentonite

| | Nitrogen (%) | | Ash (%) | |
|---|---|---|---|---|
| Treatments | 21 | 42 | 21 | 42 |
| Control | 3.54$^{a}$ | 4.01$^{a}$ | 9.37 | 10.09$^{a}$ |
| Sodium bentonite 15 g kg$^{-1}$ | 3.31$^{ab}$ | 3.87$^{ab}$ | 9.20 | 9.96$^{ab}$ |
| Sodium bentonite 30 g kg$^{-1}$ | 3.15$^{b}$ | 3.69$^{b}$ | 9.09 | 9.61$^{ab}$ |
| Sodium bentonite 45 g kg$^{-1}$ | 3.27$^{ab}$ | 3.73$^{b}$ | 9.06 | 9.44$^{b}$ |
| SEM | 0.08 | 0.06 | 0.15 | 0.19 |

Means within columns with dissimilar superscripts are significantly different ($p<0.05$)

Table 5: Effect of different levels of sodium bentonite on T4, TSH and growth hormones

| | $T_4$ | TSH | GH |
|---|---|---|---|
| Treatments | ------(μg dL$^{-1}$)---- | | (ng ML$^{-1}$) |
| Control | 2.74 | 1.48 | 2.20$^{b}$ |
| Sodium bentonite 15 g kg$^{-1}$ | 2.86 | 1.63 | 2.48$^{ab}$ |
| Sodium bentonite 30 g kg$^{-1}$ | 2.94 | 1.55 | 2.69$^{a}$ |
| Sodium bentonite 45 g kg$^{-1}$ | 2.90 | 1.69 | 2.65$^{ab}$ |
| SEM | 0.13 | 0.15 | 0.14 |

Means within columns with dissimilar superscripts are significantly different ($p<0.05$)

swelling and absorbing moisture and ammonia but might exhibit less adsorbent selective additive, antagonistic or synergistic interaction with other compounds (Ramos *et al*., 1996).

The effects of dietary treatments on litter pH are presented in Table 3. Litter pH during the overall period was lower for sodium bentonite treatments compared to control treatment, but this difference was not significant ($p>0.05$). Only on the 14th day, the litter pH in treatment 15 g kg$^{-1}$ sodium bentonite was significantly ($p<0.05$) decreased compared to control. The low litter pH has an important role in decreasing ammonia production of litter and above pH 7.0 ammonia production increases and it reaches a maximum at pH 8.0 (Reece *et al*., 1979).

The N content of the broiler litter was significantly ($p<0.05$) lower in treatment 30 g kg$^{-1}$ sodium bentonite on 21st and 42nd day compared to the control. Also different was significant ($p<0.05$) between treatment with 45 g kg$^{-1}$ sodium bentonite and control on 42nd day. The content of broiler litter ash on 21st day did not significantly differ among dietary treatments and control. While in treatment with 45 g kg$^{-1}$ sodium bentonite litter ash was decreased significantly ($p<0.05$) on 42nd day compared to the control (Table 4). A decrease in N content of the broiler litter due to dietary aluminosilicate supplementation found in the present study was in agreement with the results of Karamanlis *et al*. (2008). Past investigations reported that aluminosilicates can assist in manure and litter management, and in controlling air quality in poultry house and improving litter quality (Eleroglu and Yalcin, 2005; Maurice *et al*., 1998). High nitrogen levels in the poultry house can reduce bird performance, health and profits to the grower and integrator. Using some litter additives can reduce these nitrogen levels. Aluminosilicates is a cation-exchange compound that has high affinity and selectivity for $NH_4^+$ ions because of its crystalline, hydrated properties resulting from its infinite, 3-dimentional structures (Mumpton and Fishman, 1977). Some studies show that the use of aluminosilicates in broiler diet would reduce ammonia concentration in poultry houses (Amon *et al*., 1997; Cabuk *et al*., 2004; Li *et al*., 2008). Also, it has been reported that aluminosilicates can absorb the nitrogen of some amino acids, thus stabilizing them; they can reduce the energy required for the production of meat and also increase the utilization of calcium in the body (Eleroglu and Yalcin, 2005). Cabuk *et al*. (2004) indicated that the use of aluminosilicates in broiler diet led to decrease in fecal crude ash compared to the control group.

Table 5 shows the effect of different levels of sodium bentonite on Plasma T4, TSH and growth hormones. Growth hormone (GH) in treatment with 30 g kg$^{-1}$ sodium bentonite was increased significantly ($p<0.05$) compared to the control. GH content in other dietary treatments was higher compared to control, however this difference was not significant ($p>0.05$). Plasma T4 and TSH levels were not affected by dietary treatments. In this regard, Eraslan *et al*. (2005) used 0.25 and 0.5% of sodium bentonite in the broilers diet and found that there were no significant ($p>0.05$) differences in TSH and growth hormone content among dietary treatments, but observed a significant difference in the content of T4 between control and dietary treatment. The differences between their results and the results of this study may be due to the different levels of sodium bentonite which were used in the two studies.

## CONCLUSION

In conclusion, based on the results of this experiment, supplementation of sodium bentonite in broiler chickens diet decreased litter moisture, pH, ash and N, while increased plasma growth hormone of broiler chicken. Therefore, sodium bentonite can be used as a feed additive in the broiler chicken diet for improving litter characteristics and as a result performance.

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