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Effects of Inclusion Kaolin, Bentonite and Zeolite in Dietary on Chemical Composition of Broiler Chickens Meat

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ABSTRACT
The experiment was conducted to assess the effects of adding silicate minerals in dietary of broiler chickens on the broiler thigh meat moisture, ash, crude protein, intramuscular fat and abdominal fat. This study was accomplished in a completely randomized design with total four hundred forty eight 1 day old broilers. Chickens were randomly assigned to 7 dietary treatments (control and 15, 30 g kg^{-1} kaolin, bentonite and zeolite) with four replicates per treatment and sixteen birds per replicate. Intramuscular fat and abdominal fat were lower in treatments with 15 g kg^{-1} bentonite and kaolin compared with control treatment ($p<0.05$). The ash content of meat in treatment containing 30 g kg^{-1} zeolite was significantly ($p<0.05$) higher compared to treatment containing 15 g kg^{-1} bentonite and control. Meat moisture and protein content did not differ significantly ($p>0.05$) between experimental treatments. It may be concluded that inclusion of kaolin, bentonite and zeolite as feed additive in broiler diet have positive influence on chemical composition of meat.

Key words: Silicate mineral, diet, broiler meat, protein, fat, ash content

INTRODUCTION
Silicate minerals include about 90% of the minerals that due to their structural properties some of them can be useful as feed additives such as zeolite, bentonite, kaolin, sepiolite, perlite, illite and granite in broiler chickens diet. Zeolite, bentonite and kaolin are the utmost silicates mineral which are used in broiler chickens diets. Zeolites, bentonite and kaolin are the members of aluminosilicates which are formed mostly aluminum and silica. Zeolites are a category of crystalline hydrated aluminosilicates, contain three-dimensional structures with pores and channels that able to trap molecules of proper dimensions (Mumpton, 1999). Zeolites have special structural properties that can hold exchangeable cations electrical neutrality inside its structure and exchange own cations while absorb and desorb water without any structural changes (Tiwari, 2007). Kaolin and bentonite on the other hand, are the members of phillosilicates (Trckova *et al.*, 2004). Kaolin is constructed of two layers, one of the aluminum octahedral sheet and the other one tetrahedral silica sheet. Kaolinite is the main constituent of kaolin that belongs to hydrated silicates of aluminum.

The structure of this group constructed of two sheets of silica and a sheet of alumin (2:1) with a chemical formula $Al_2Si_2O_5(OH)_4$ (Adamis *et al.*,2005). Bentonite is a rock constituted of highly colloidal and plastic clays that attract water quickly. The principle mineral component of bentonite is montmorillonite that is constructed by devitrification of volcanic ash. The particular characteristics of bentonite are its capability to form thixotrophic gels with water, a capability to attract great amounts of water and a high ion exchange capacity which binds various cations (Walz *et al.*,1998; Adamis *et al.*, 2005).

In last century, Japanese researchers noticed that the usage of silicate minerals in diets of poultry improves their performance. Since then, several studies have been conducted on the effects of silicate minerals on the poultry production. Several studies reported that dietary usage of silicate minerals could enhance performance of broiler chickens (Miles and Henry, 2007; Rowghani *et al.*, 2007; Safaeikatouli *et al.*, 2010a). Some previous research have shown that addition of silicate minerals in broiler chickens diet would improve ileal digestibility of protein and energy (Kanto *et al.*, 1993; Acosta *et al.*, 2005; Pasha *et al.*, 2008) and bone characteristics (Yalcin *et al.*, 1995; Herzig *et al.*, 2008; Safaeikatouli *et al.*, 2012a). Some studies (Lon-Wo *et al.*, 1993; Eser *et al.*, 2012; Ouachem *et al.*, 2012) have indicated that adding silicate minerals in the diet of broiler chickens improve carcass yield and decrease abdominal fat.

It is expected that adding silicate minerals in broiler diets, hence have an effective impact on chemical composition of broiler chickens meat. The purpose of this experiment was to investigate the effects of inclusion of kaolin, bentonite and zeolite as feed additive in dietary of broiler chickens on broiler meat moisture, ash, crude protein, intramuscular fat and abdominal fat.

MATERIALS AND METHODS

Birds and housing: A total 448 one day old broiler chickens were procured from a commercial hatchery. All the chickens were initially weighed and randomly assigned to 7 dietary treatments with four replicates per treatment and sixteen birds per replicate. The pens size was 1.5×1.5 m; therefore, each chicken had about 0.14 m^2 spaces. The temperature of the room was maintained around 32°C at the first week and then gradually reduced by 3°C per week until it reached 18°C and this temperature was kept until the end of the feeding period. Relative humidity of the room was around 60-70% and the light regime was set to provide 24 h continuous lighting. This study was accomplished in a completely randomized design with forty two days of duration.

Experimental diets: The experimental diets consisted of mostly corn and soybean meal that was formulated to meet the NRC (1994) nutrient recommendation for broiler chicken. Two phase feeding program was utilized that diets of starter phase contained 23% (CP) and 2900 kcal (ME) kg^{-1} of diet and diets of grower phase contained 20% (CP) and 3000 kcal (ME) kg^{-1} of diet. The seven treatments were: (1) Diets without silicate minerals (control), (2) Diet containing 15 g kg^{-1} kaolin, (3) Diet containing 30 g kg^{-1} kaolin, (4) Diet containing 15 g kg^{-1} bentonite, (5) Diet containing 30 g kg^{-1} bentonite, (6) Diet containing 15 g kg^{-1} zeolite and (7) Diet containing 30 g kg^{-1} zeolite. All experimental diets were isonitrogenous and isocaloric and chickens were given ad libitum access to feed and water.

Collection and analysis of samples: At 42 day of age, three randomly selected birds from each replicate were sacrificed by cutting the carotid arteries and the left tibias were collected from individual broilers and analyzed for chemical composition of meat. Moisture content was calculated by weight loss after 12 h of drying at 105°C in an oven (WTC Binder, Tutlingen, Germany) according to the following equation:

$$\text{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

W_1 = Weight of empty dish
W_2 = Weight of dish plus sample
W_3 = Weight of dish plus dried sample

The nitrogen content of thigh muscles were determined Kjeldahl method (Kjeltec 2300 Autoanalyzer, Foss Tecator AB, Hoganas, Sweden) and crude protein content was calculated by the following equation (AOAC, 2005):

$$\text{Protein} = \text{Total nitrogen} \times 6.25$$

Intramuscular fat content was determined according to the AOAC (2005) Soxhlet method (Soxtec Avanti 2050 Auto System, Foss Tecator AB, Hoganas, Sweden) by using the following equation:

$$\text{Fat (\%)} = \frac{W_1 - W_2}{W_3} \times 100$$

W_1 = Weight of empty distillation flask
W_2 = Weight of distillation flask plus sample
W_3 = Weight of sample

Ash percentage was determined according to AOAC (2005) by the following equation:

$$\text{Ash (\%)} = \frac{\text{Weight of ashed sample}}{\text{Weight of initial sample}} \times 100$$

Statistical analysis: Data collected were submitted to analysis of variance using the General Linear Models (GLM) procedure of SAS Institute (2003). Duncan's multiple range tests (Duncan, 1955) was used to rank treatments and differences were considered among means were at the 5% significant level of probability.

RESULTS AND DISCUSSION

Effects of dietary kaolin, bentonite and zeolite supplementation on meat moisture content are presented in Fig. 1. The meat moisture content did not differ significantly ($p>0.05$) between dietary treatments and control. Nevertheless meat moisture content in all dietary treatments containing silicate minerals was numerically better in comparison to control diet. It is well known that moisture content is one of the main determinants of chicken meat quality and diet is an important factor that influences moisture content of the meat (Castellini *et al.*,2002). Prvulovic *et al.* (2008) indicated

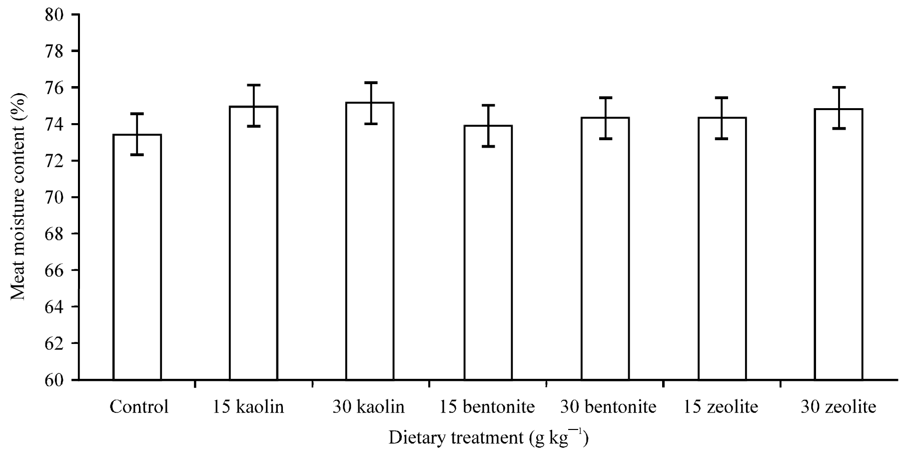

Fig. 1: Effect of dietary kaolin, bentonite and zeolite supplementation on meat moisture content. Means with different letters on each treatment are significantly different ($p<0.05$)

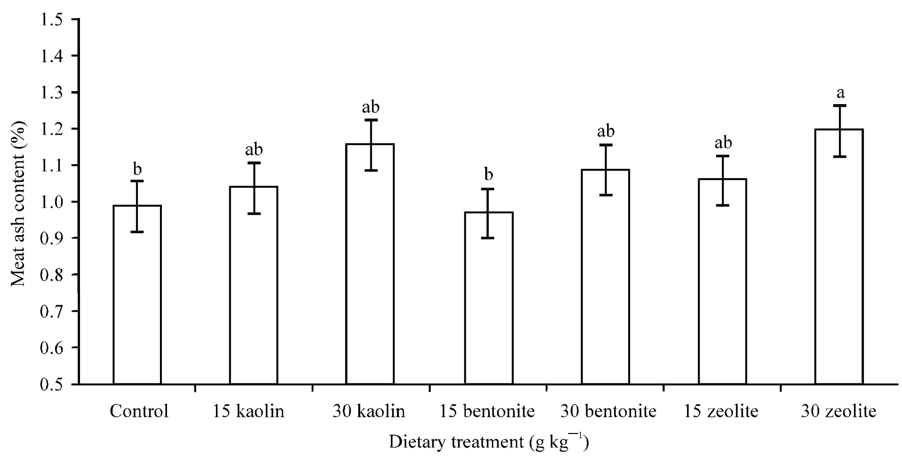

Fig. 2: Effect of dietary kaolin, bentonite and zeolite supplementation on meat ash content. Means with different letters on each treatment are significantly different ($p<0.05$)

that supplementation of broiler diet with hydrated aluminosilicate did not significantly affect meat moisture content. Figure 2 indicates the effects of dietary kaolin, bentonite and zeolite supplementation on meat ash content. The ash content of meat in treatment containing 30 g kg^{-1} zeolite was significantly ($p<0.05$) higher than compared to treatment containing 15 g kg^{-1} bentonite and control. These results were similar with finding of Prvulovic *et al.* (2008) that showed broilers fed with hydrated aluminosilicate has an increased in meat ash content. However, Mallek *et al.* (2012) reported that the use of zeolite in diet did not significantly affect on ash content of broiler meat. The divergency among the results of different studies may be due to use of different kinds and levels of mineral silicates.

Effects of dietary kaolin, bentonite and zeolite supplementation on meat protein content are shown in Fig. 3. In considering the effect of silicate mineral on the amount of meat protein, it was observed that the amount of meat protein in all treatments containing silicate minerals increased compare to control treatment but this difference was not significant ($p>0.05$). Pasha *et al.* (2008)

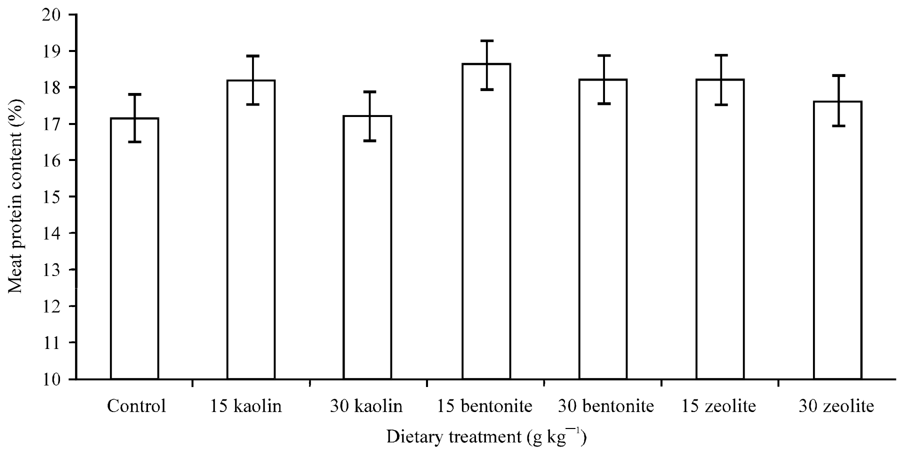

Fig. 3: Effect of dietary kaolin, bentonite and zeolite supplementation on meat protein content. Means with different letters on each treatment are significantly different (p<0.05)

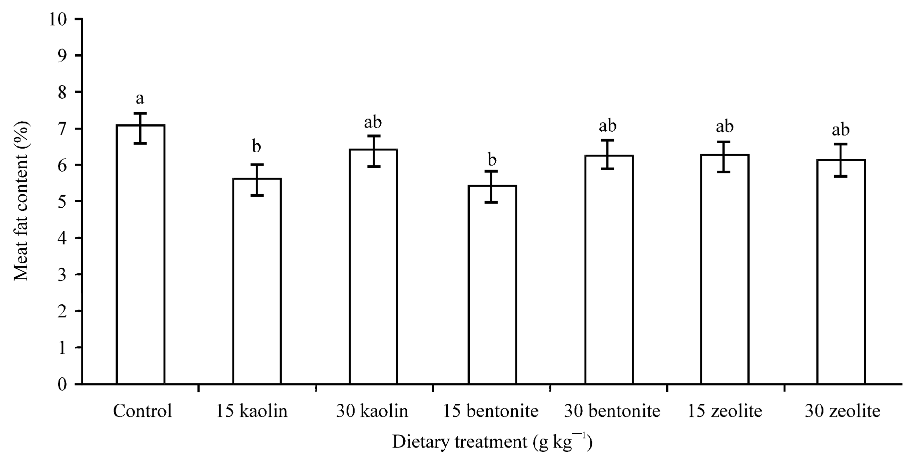

Fig. 4: Effect of dietary kaolin, bentonite and zeolite supplementation on meat fat content. Means with different letters on each treatment are significantly different (p<0.05)

and Safaeikatouli *et al.* (2012b) reported that inclusion of silicate minerals in broiler chickens diet would improve ileal digestibility of protein. Some earlier research have shown that supplementation of broiler diet with silicate minerals significantly (p<0.05) increased blood total protein compared to control (Bailey *et al.*, 2006; Safaeikatouli *et al.*, 2010b; Safaeikatouli *et al.*, 2011). Prvulovic *et al.* (2008) reported that adding hydrated aluminosilicate in broiler diet significantly increased protein content of breast meat but did not affect the protein level of drumstick meat.

Effects of dietary kaolin, bentonite and zeolite supplementation on meat fat content are given in Fig. 4. The intramuscular fat was lower in treatments with 15 g kg^{-1} bentonite and kaolin in compared with control treatment (p<0.05). These findings tally with the results of Prvulovic *et al.* (2008) who reported that adding hydrated aluminosilicate in broiler diet reduce intramuscular fat. On the other hand, Mallek *et al.* (2012) indicated that inclusion of zeolite in broiler diet were unaffected on intramuscular fat but increase level of polyunsaturated fatty acids and

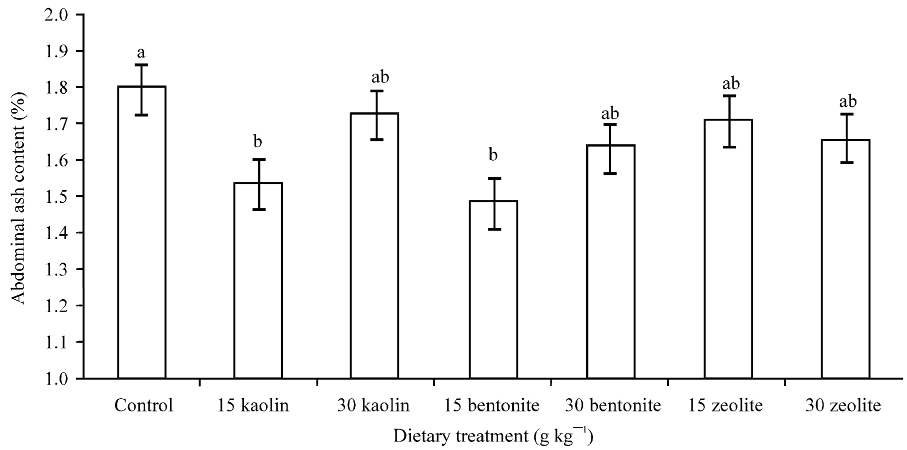

Fig. 5: Effect of dietary kaolin, bentonite and zeolite supplementation on abdominal fat content. Means with different letters on each treatment are significantly different ($p<0.05$)

Omega 3 fatty acid in broiler meat. Figure 5 shows effects of dietary kaolin, bentonite and zeolite supplementation on abdominal fat content. In diets containing 15 g kg^{-1} kaolin and bentonite abdominal fat content significantly ($p<0.05$) decreased compared to control diet. Christaki *et al.* (2006) and Eser *et al.* (2012) reported that percentage of abdominal fat was reduced with inclusion of silicate minerals in broiler chickens diet. Lotfollahian *et al.* (2004) declared that using of 2% of zeolite in broiler chicken diet resulted in reduce in abdominal fat but with increase in zeolite level (4 and 6%) resulted in enhance percentage of abdominal fat. The abdominal fat and intramuscular fat amounts difference among low and high concentrations of silicate minerals in the diet maybe due to their effect on feed intake. Increasing level of silicate minerals in diet enhance the feed intake, abdominal fat and intramuscular fat. On the other hands, some previous studies done by Moghadam *et al.* (2005), Salari *et al.* (2006) and Azar *et al.* (2011) use silicate minerals in dietary of broiler chickens and found no differences in percentage of abdominal fat of broilers fed diets contained silicate minerals and control.

CONCLUSION

Based on the results of this experiment, supplementation of broiler chickens diet with silicate minerals was effective in the decrease of intramuscular fat and abdominal fat. It may be concluded that inclusion kaolin, bentonite and zeolite as feed additive in broiler diet have positive influence on chemical composition of meat and further research into these effects of silicate minerals on broiler meat quality is recommended.

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