The Marl and Kaolin in Broiler Diet: Effects on the Bone Weight and the Cutting Yield

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ABSTRACT: In order to assess the effects of two clay types on bone mineralization and cutting yield, 3% of marl or kaolin were introduced in the diet of broiler chickens during a rearing cycle of 56 days. Two hundred forty old chicks, ISA 15 strain were affected to three groups of 80 chicks and four repetitions (control group without clay, 3% marl group and 3% kaolin group). Results of this experiment showed that both clay types, significantly promote an increase of bone weight of 10.4% and 8% and reduce the abdominal fat of 32.5% and 25.7%, respectively for the marl and kaolin. The cutting yield was statistically interesting in broilers fed with marl, particularly for breast yield (+ 8.3%) and an improvement of around 6% of Chicken ready to cook, of thigh and drumstick.

Keywords: Marl, Kaolin, Broiler, Cutting yield, Bone

INTRODUCTION

The clay is a natural product that can be economically used to achieve healthy digestive tract and to optimize poultry performances (Ouachem *et al*., 2015). Indeed, it is naturally abundant, cheap and so widely voluntarily used by the free range hens or through ingestion of earthworms and insects of soil fauna. Soil ingestion may have some therapeutic value. In fact, there is a hypothesis established by Engel (2002) which states that soil ingestion by hens is akin to self medication. The spontaneous consumption of clay has been shown in other situations, especially in cases of digestive disorders or for reducing a state of unrest (Andrews and Horn, 2006). As an indication, it was observed that the dry matter of soil matrix intake by free-ranging hens mainly contains 10g of soil, 7g of plants and 20g of earthworms. Clays are also recommended for their nutritional properties and healthy digestive tract and for their antitoxic capacity to many undesirable substances in the gut. It is well established that genetic progress in poultry production continuously improves muscle growth. Nevertheless, bone development fail to keep pace with overall growth, thereby generating excess physical load and predisposing bone to deformity and fragility (Rath *et al*., 2000). However, the most relevant factor for the bone weakness is nutrition. Calcium and Phosphorus are primary inorganic nutrients because they form 95% of the mineral matrix (Rath *et al*., 2000). Considering their specific absorption capacities of ions, clays are considered like a real molecular sieve. The Marl and kaolin are two clay types available in Algeria, positive effects on poultry performance, digestive efficiency and dropping moisture were reported (Ouachem *et al*., 2015). However, comparative studies and scientific reports describing their effects on cutting yield and bone quality are not sufficiently documented. Therefore, the aim of this study was to evaluate over a rearing cycle of 56 days, the effects of 3% of marl or kaolin on the carcass cutting yield and tibia bone of broiler chickens.

MATERIALS AND METHODS

Diets and clay

During this trial, three treatments were compared: Control group without supplementation (C) and two experimental diets group suplemented with 3% of Marl (M) or 3% of Kaolin (K). The diets were prepared according to the nutritional requirements recommendations of NRC (1994). The marl matrix basically contains 68% of clay, 13 % of sand, low rate of organic matter (0.6%) and its physicochemical composition (in milli equivalent/100g of soil) is: (Ca^{2+} = 4.6); (Mg^{2+} = 2.87); (Na^{+} = 0.33); (K^{+} = 0.1); (Cation Exchange Capacity = 20.5). The kaolin matrix granulometry consists of 64% of kaolin, 25% of micaceous materials and other clays, 8% of quartz and 3% of feldspar. The Cation Exchange Capacity of kaolin is 14 and it contains (in percent): SiO_3 = 49.30 ; Al_2O3 = 33.00 ; Fe_2O_3 = 2.50 ; TiO2 = 0.24 ; CaO = 0.08 ; MgO = 0.40 ; K_2O = 2.90 ; Na_2O = 0.1 ; Organic Matter = 0.48 ; H_2O = 11.00. Foods consist mainly of corn and soybean-meal 48, the chemical composition and nutritional characteristics of startup and growth diets are respectively : (3000 Kcal ME/kg ; 21% of crude proteins ; 1.20% of Ca ; 0.75% of total P and 1.10% of lysin) ; (3100 Kcal ME/kg ; 19% of crude proteins ; 0.75% of Ca ; 0.55% of total P and 0.8% of lysin).

Animals, methods and analysis

This experiment was conducted in the poultry research farm of the Agronomic and Veterinary Sciences Institute of Batna University (Algeria). A total of two hundred forty 1-d old ISA15 commercial strain broiler chiks, were individually weighed, identified and randomly allotted to three groups (C : control group ; M : marl group ; K : kaolin group) with four replicates per treatment and 20 birds per replicate. Chicks of all treatments (3 x 80) had free access to feed and water. At slaughter age (d56), body weight (BW) was determinated and sebsequently, per treatment, 32 broilers weighing a mean wheight similar to that achieved by the group were slaughtered, tapered and eviscerated in order to asses the yield of chicken ready to cook (CRC), the breast and the thigh - drumstick. To recover as mush abdominal fat, fat was removed from carcasses after cooling for 12h at 2°C. The right tibia of each slaugthered broiler was removed. Tibia bones were boiled for approximately 10 min in deionized water and all soft tissue was removed; then, the bones were dried for 12h at 105°C and weighed. The analytical methods adopted were those described by AOAC (1995). Statistical analysis was carried out using t-Student test. Values represented in the table are the means ± standard error and the statistical significance was set to $P < 0.05$.

RESULTS AND DISCUSSION

The effects of dietary treatments on body weight, carcass ready to cook, abdominal fat, tibia weight and the cutting yield data obtained are presented in Table 1.

Results of growth perfomance show that marl significantly improves slaughter body weight (+6.6% ; P = 0.04). Both clay types have improved significantly the yield of chicken ready to cook (+6% and +2.8% respectively for marl and kaolin) and reduces the rate of the abdominal fate . The cutting yield was statistically interesting in broilers fed with marl, particularly for breast yield (+ 8.3%) and it should be noted an improvement of around 6% of thigh and drumstick. Furthermore, data of Table 1 indicate that both clay types, significantly promote an increase of bone weight of 10.4% and 8% and reduce the abdominal fat of 32.5% and 25.7% (P = 0.001) respectively for the marl and kaolin.

Overall, the marl effects on growth performances, carcass yield and abdominal fat observed in this study confirms our previous findings attended by 3% of marl (Ouachem, 2011; Ouachem and Kaboul, 2012). The response on body weight agree those of Ouhida *et al*. (2000b) and Hadj Ayed *et al*. (2011) with sepiolite and those of Xia *et al*. (2004) with montmorillonite. This results can be attributed to the discribed clay effects on gut efficiency and the intestinal health of broilers receiving clay diets (Ouachem *et al*, 2015). According to Hadj Ayed *et al*. (2011), increased digestive performances by chicken might be explained by the fact that the specific physical structure of clay may lengthened transit of nutrients, enhances digestibility and mineral absorption.

The positif effect of marl may be also attributed to its high cation exchange ability and the sand contents into the marl matrix. Indeed, Travel *et al*. (2014) found that addition of sand to a matrix composed of kaolin and earthworm compost, increases laying hens performance and enhances the organic matter retention. Van Der Meulen *et al*. (2008) reported that the retention coefficient of energy varies from 0.69 to 0.78, respectively, when 0 and 30% of sand-clay matrix were introduced. The significant effect of marl and kaolin on the quality of tibia bone observed in this experiment can partially be explained by the richness of clay in minerals. The clays are considered as a regulator and can be assimilated to a real efficient molecular sieve upon transfer and cations exchange (Ouachem *et al*., 2015). Similar finding was reported with zeolite by Roland *et al*. (1993) and Utlu *et al*. (2007) in Eleroğlu *et al*. (2011). According to these authors,, the beneficial effects may be related to the Al, Si, Zn, Na or K concentrations of zeolite, because these minerals have been shown to influence mineral metabolism and electrolyte balance, leading to an increased formation of bone. Although several studies cited by Eleroğlu *et al*. (2011) claimed that the addition of zeolite increased Ca utilization and the rate of bone ash deposition during growth.

Table 1. Results of body weight (BW), carcass ready to cook (CRC), abdominal fat (AF), tibia ash and the cutting yield.

Diets Performances	Control (C)	Marl (M)	Kaolin (K)	P value
BW (g)	$2900^{b} \pm 356$	$3090^{a} \pm 388$	$2906^{b} \pm 404$	P = 0.04
CRC (% BW)	$69.05^{c} \pm 1.24$	$73.4^{a} \pm 3.6$	$71.0^{b} \pm 1.02$	P = 0.02
AF (% CRC)	$1.44^{a} \pm 0.38$	$0.97^{b} \pm 0.25$	$1.07^{b} \pm 0.11$	P = 0.001
Tibia (g)	24.60	28.13	26.97	
Tibia (% BW)	$0.8579^{b} \pm 0.09$	$0.9474^{a} \pm 0.06$	$0.9265^{a} \pm 0.1$	P = 0.001
		Cutting Yield (% CRC)		
Breast	$25.2^{b} \pm 2.08$	$27.3^{a} \pm 1.45$	$25.6^{b} \pm 1.9$	P = 0.01
Thigh	$7.74^{b} \pm 0.35$	$8.24^{a} \pm 0.60$	$7.77^{b} \pm 0.51$	P = 0.06
Drumstick	$7.36^{b} \pm 0.27$	$7.83^{a} \pm 0.20$	$7.32^{b} \pm 0.14$	P = 0.03

The means affected of different letters in the same column are statistically different.

CONCLUSION

This experiment shows that the effects of marl is not so different than that reported with other clay types. We can therefore conclude that marl used in rate of 3% provides an overall positive effect on broiler performances and bone quality. However, the kaolin effect, remains lower, probably due to the higher cation exchange capacity and the presence of sand in the marl matrix. it is also important to specify that, through nutritional supply of marl and kaolin, it my be possible to enhance bone quality and to make it less brittle. Further studies under other experimental conditions are however necessary to bring further information making it possible to validate these results.

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