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Effects of Adding Natural Blends of Kaolin and Spices on Broiler Performance, Meat and Bone Quality

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ABSTRACT

Background: The aim is to compare the effectiveness of 3% of natural preparations mixtures based on kaolin associated with garlic, ginger and/or their mixture on the performance, the cutting yield, carcass and bone qualities of broiler.

Methods: 192 one-day-old Cobb 500 chicks were assigned to 04 groups of 48 four-replicate chicks (C: without addition; Kgar: 3% kaolin-garlic; Kgin: 3% kaolin-ginger and Kgg: 3% kaolin-garlic-ginger).

Result: Results showed that the mixtures significantly improve body weight and feed efficiency at 42 days, with nonetheless a more marked effect for the Kgar group (BW: +4.5%; FCR: -5.5%). In addition, still in favor of the Kgar group, the same tendency was recorded for the yield of chicken ready-to-cook (+3.2%; P=0.02) accompanied by enhanced breast and thighs yields. In terms of quality, the mixtures significantly impacted the meat conservation criteria by reducing water-holding capacity by almost 50% and less abdominal fat deposition. Finally, although not significant, the indicators of bone quality measured (ash content and Seedor index) appear better in chickens receiving mixtures. The results of this study show the interest of adding a mixture of kaolin and condiments in improving broiler performance, meat quality and bone characteristics.

Key words: Bone, Clay, Condiments, Feed conversion ratio, Quality, Weight gain.

INTRODUCTION

Growth promoters have improved in the optimization of poultry performance. Unfortunately, scientists, governments and consumers have strongly opposed their usage due to concerns about anti-biological resistance and the accumulation of residues in animal products. So, various natural substances such as phytobiotics, spices, extracts, enzymes, clays and others were recommended as feed additives that improve intestinal health, feed efficiency, welfare, performance and environmental conservators (Ouachem *et al.* 2015a, Byoung *et al.* 2020). Bibliographically available results have generally been observed in studies using these additives alone and very little in mixtures. For this purpose, it is proposed to study the response of chicken to the addition of a natural preparation based on kaolin mixed with garlic, ginger and/ or ginger- garlic mixtures. Garlic and ginger are among the phyto additives commonly used in phytotherapy and poultry feeding. These condiments are characterized by their richness in bioactive components which confer antioxidant, antimicrobial and anti-inflammatory activities (Prasad *et al.* 2009, Hanieh *et al.* 2010, Mahboubi, 2019). Moreover, kaolin is abundant clay in nature, cheap, recommended in poultry feed for its opportunistic effects on weight gain, feed efficiency and its antimicrobial and detoxifying effect on the digestive tract (Ouachem *et al.* 2015a).

MATERIALS AND METHODS

Diets, clay and condiments

Starter and growth basal diets were formulated without preservatives and coccidiostats according to the nutritional recommendations of the Cobb 500 strain guide published in 2018. Foods consist mainly of corn and soybeans, the chemical composition and nutritional characteristics of the starter (J1-J14) and growth (J15-J42) diets are respectively: (3000 Kcal ME/kg; 21% crude protein; 0.87% Ca; 0.43% total P and 1.17% lysine); (3150 Kcal ME/kg; 19% crude protein; 0.76% Ca; 0.38% total P and 1.02% digestible lysine). Garlic and ginger were mixed with kaolin and incorporated in experimental diets. The kaolin is characterized by a particle size containing 64% kaolinite, 25% micaceous materials and other clays, 8% quartz and 3% feldspar. Its chemical composition is shown in Table 1.

Experimental design

This study was carried out from May 5 to June 15, 2019 at the experimental station of the Institute of Veterinary and Agronomic Sciences of Batna 1 University (Algeria) on a total of 192, 1-d-old Cobb 500 broiler chicks, randomly distributed through four treatments. Per treatment, 48 chicks were placed in four cages (04 repetitions per pen). Chicks

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of different treatments were feed the following diets: (C: without addition; Kgar: addition of 3% of kaolin-garlic mixture; Kgin: addition of 3% of kaolin-ginger mixture and Kgg: addition of 3% kaolin-garlic-ginger mixture). At 42 days, the body weight and the feed efficiency were recorded. Then, two broilers per lot (08 / treatment) were weighed individually, slaughtered (according to religious ritual by deep and rapid incision of the neck with a knife, so as to cut the jugular vein and the carotid artery bilaterally and quickly, but leaving the spinal cord, so that the convulsions drain the blood from the body of the chicken), plucked and eviscerated. The carcasses were weighed and cut to assess the yield of ready-to-cook chicken, the yields of breast, thigh and drumstick. To determine the drip loss, the right breasts were weighed, packed in freezer bags and suspended by a hook for 4 days at 2°C. At the end of the chilling, the muscle was wiped with absorbent paper and reweighed to evaluate the water loss (Ouachem *et al.* 2011).

To appreciate the bone quality, the right tibias of slaughtered broilers have been stripped of soft tissue, weighed and their lengths measured using an electronic caliper, degreased with ether (24 h), dried (105°C/12 h), then weighed before being incinerated in a muffle furnace (550°C /14 h) and after cooling, the ashes were weighed (Jondreville *et al.* 2007). The bone density or tibia index is the assessment indicators of bone strength. Bone density was determined by:

$$\text{Seedor Index} = \frac{\text{Tibia weight (mg)}}{\text{Tibia length (mm)}}$$

(Seedor *et al.* 1991)

Statistical analysis

The means of the various parameters studied were compared by a one-way analysis of variance (Anova) test, followed by pairwise comparisons between groups using Tukey's test. Differences at $P<0.05$ were considered significant. Statistical analysis was performed with SPSS version 23.0 for windows software.

RESULTS AND DISCUSSION

Growth performances

The results of Table 2 show that adding mixtures significantly improved body weight ($P=0.02$) and feed efficiency ($P<0.05$). Compared to the control, this effect is more pronounced for the Kgar group (BW: + 4.5%, FCR: -5.5%). Overall, this is consistent with the results of some available references on the use of mixtures of clays and phytobiotics. This consistency corroborates the responses observed in broiler by Tzora *et al.* (2017) with a mixture of natural substances based on clay (attapulgite), oregano and benzoic acid extracted from mulberry. According to these authors, addition of 4.5 g/kg of feed, significantly increases the slaughter weight (+8%) and improves FCR (-11.7%). This was attributed to the positive effect of polyphenols on the jejunal enterobacteria proliferation. Otherwise, Skoufos *et al.* (2016) report that the addition of a mixture composed of attapulgite and oregano powder, improves significantly the body weight and FCR (+8.2%, -6%) with fall in mortalities (-16.8%). This finding was explained by the buffering effect of clay (attapulgite) and the antimicrobial activity of oregano leading to a notable decrease of the total ileo caecal coliforms and lactobacilli proliferation. Furthermore, in Aigamo duck, the use of increasing doses of mixtures based on clays (zeolite and vermiculite) and extracts of tropical fruits (pineapple and papaya), stimulates body weight (+3%) and stabilizes the feed efficiency in a variable range of 3 to 4.4% (Khambualai *et al.* 2009). The results previously published by Simon *et al.* (2011) support the findings of the present study and also show that the use of 0.5% of natural extract and clay materials optimizes the 7 days weight (+ 4%) and consequently promotes a best start, while greatly reducing mortality (-15%). Similarly, in laying hens, Ouachem and Lombarkia (2017) reported that the addition of 3% of natural preparation based on kaolin and phytobiotics (mild paprika, turmeric and olive leaves) improves the FCR (-2.4%) and egg mass (+3.1%). These improvements are attributed to the physicochemical and biological properties of the bioactive molecules that make up the mixtures.

Carcass and cutting yields

Compared to the control, the addition of mixtures promotes a significantly better yield of ready-to-cook chicken in favor of Kgar group (+3.2%). Moreover, although not significant, the mixtures still stimulate the breast yield. This response doesn't differ from the results reported by Saçakli *et al.* (2015) who reported an increase in breast yield (+10%) and thigh (+4%) with 2% of a natural zeolite and yeasts mixture. However, under experimental conditions using 3% of garlic and ginger mixture, it was recorded by Olagoke *et al.* (2019) a significant improvement in the relative weight of the thigh (+13.5%) and drumstick (+4.6%). Likewise, improvements of carcass and cutting yield observed in the present study can be attributed to the clay introduced as reported by Ouachem *et al.* (2015b) with 3% of marl or kaolin. Such effects have been explained by the activity of phenolic compounds and certain ketone derivatives present in spices on the increase of serum proteins and globulins (Ogbuewu and Mbajiorgu, 2020).

Carcass and bone quality indicators

The observed decrease in abdominal fat was also found in chicken (-10%) with a mixture of sepiolite and natural beet extract (Uzunoğlu and Yalçin, 2019). Recently, Rastad (2020) recorded a significant decrease in abdominal fat with a mixture of probiotic and garlic powder (-41%) and on the other hand, the addition of garlic and ginger promotes higher protein utilization and improves the storability of meat (Adomeh and Eguaoje, 2019). With a 3% blend (50/50) of garlic and ginger, Olagoke *et al.* (2019) obtained significantly reduced fat in chickens (-57%). Moreover, the use of marl in the chicken diet has been accompanied by positive effects on the meat quality, in particular, its water holding capacity, its storage ability and a decrease in abdominal fat (Ouachem

Table 1: Chemical composition of kaolin (in per cent).

SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	OM(1)	CEC(2)
49.30	33.00	2.50	0.24	0.08	0.40	2.90	0.1	0.48	14

(1): Organic matter; (2): Cation exchange capacity in milliequivalents per 100 g of soil.

Table 2: Effects of the addition of 3% of mixtures of natural substances based on kaolin associated with garlic, ginger and / or their combination in chickens.

Variables	C	Kgar	Kgin	Kgg	SEM	Value of P
Growth performances						
Feed conversion ratio	1.82^{a}	1.72^{b}	1.79^{ab}	1.77^{ab}	0.014	P<0.05
Body weight (g)	2372^{b}	2479^{a}	2430^{ab}	2417^{ab}	12.64	P=0.02
Carcass and cutting yields (%)						
BRC	70b	72.25^{a}	71.12^{ab}	71.25^{ab}	0.27	P=0.02
Breast	20.5	22.26	22.45	21.76	0.17	No significant
Thigh	11.97	12.75	12.03	12.16	0.08	No significant
Drumstick	10.59	11.03	10.69	10.72	0.06	No significant
Carcass and bone quality indicators						
Abdominal fat (% BW)	1.05	0.88	0.86	0.95	0.029	No significant
Drip loss*	5.69^{a}	2.9^{b}	3.56^{b}	2.85^{b}	0.28	P<0.001
Bone ash %	47.83	49.61	49.48	49.07	0.28	No significant
Index of seedor (IS)	72.7	75.9	73.46	72.09	1.43	No significant

$^{a, b}$Different superscripts in a line indicate significant differences between the groups, p<0.05; (BRC): Yield of broiler ready-to-cook; (*): in % of breast weight.

et al. 2011). According to Reis *et al*. (2018), addition of thymol, carvacrol and cinnamic aldehyde also decreases the drip loss and improves the ability of meat preservation. These effects were explained by the enhanced digestive efficiency of proteins and lipids motivated by the potential effect of clays on gut health and nutrient absorption (Ouachem *et al*. 2015a). Nevertheless, referring to bibliographic data, it should be noted the lack of work on the effect of mixtures of clay and condiments on bone quality. Nonetheless, Travel *et al*. (2014) reported that the use of natural compost based on kaolin, sand and earthworms increases the egg-shell weight, while in broilers (Safaei Katouli *et al*. 2012), the addition of kaolin, bentonite or zeolite promotes better bone density. Also, Ouachem *et al.* (2017) showed that the addition of 3% marl or kaolin significantly increases the tibia index and its relative weight. These positive responses can be attributed to clays high cation exchange capacity as well as their richness of mineral content. It should be remembered that it has been shown that an excess of phosphorus tends to deteriorate the egg shell quality (Elliot and Edward, 1991), while clays interfere with the absorption of phosphorus (Zimmermann, 2014), in particular, the ability of the aluminum contained in clays to form a complex with excess phosphorus (Ma and Ryan, 2010), thereby improving the eggshell quality. In addition, these effects can be explained by the richness of clays in Al, Si, Zn, Na or K. These minerals are known to influence mineral metabolism and electrolytic balance, leading to bone development and maturity. This effect on bone is interesting because in fast growing broilers skeletal disorders are common so that bone development fails to keep pace with growth and excess muscle mass and predisposes the bone to deformation and bone fragility, leading to degradation of bedding, a drop in performance and considerable carcass defects.

CONCLUSION

The results of this trial suggest that the addition of 3% of natural preparations mixtures based on kaolin associated with condiments mixture provides positive effects to growth performance, cutting yield, carcass and bone qualities. The kaolin-garlic mixture, in particular, encourages poultry operators to reposition themselves for a possible ambitious application of the mixture investigated in poultry feed as a natural supply growth promoter and poultry welfare. Further other studies in intensive industrial breeding, in less favorable breeding conditions or even *in vitro* are however recommended to validate these results.

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