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Banat's Journal of Biotechnology

2014, V(10)

EFFECTS OF THE MARL ON THE PERFORMANCE, CUTTING YIELD AND MEAT QUALITY OF BROILER CHICKENS

DOI: 10.7904/2068–4738–V(10)–71

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Abstract. Following the economic and social pressures that have affected the poultry market, and after prohibition of the antibiotic growth promoter's use, various natural additives have been proposed as an alternative for the poultry feed industry. Among these products, some clay types or derivatives were used in order to improve the digestive health and to optimize the growth performances. However, studies on the effects of clays on carcass cut up pieces yield and meat quality are unavailable. The aim of this trial is to study in broiler chickens during a rearing period of 56 days, the effects of 3% of marl addition on growth performance (slaughter weight and feed consumption ratio), the carcass and cut up pieces yield and meat quality through three indicators (abdominal fat, ultimate pH and water loss).Results showed firstly, that marl increases significantly the slaughter body weight (+ 8.3%, P=0.02) and provides an enhancement to the feed consumption ratio (–5%). Parallel, marl incorporation significantly improves the ready cook chicken yield (+ 9.13%, P<0.001), the breast meat (+11%, P=0.01) and reduce the abdominal fat (–11.8%, P=0.005). Furthermore, the effect of marl on the ultimate pH was not marked statistically (5.84 vs. 5.81) and water loss of breast muscle was less important at chickens fed with marl diet (2.04 vs. 2.40). Results of this trial suggest that marl can be used as a natural supply to promote an efficient chicken's portion and to produce a technological meat quality adapted to further processing.
Keyword: Marl; Ultimate pH; Yield carcass; Growth performance; abdominal fat; Water loss; Broilers.

Introduction

Following the removal of antibiotic growth promoters and the increase in raw material prices of poultry feeds, as well as new trends in consumer looking for more natural poultry products, various alternatives based on the use of probiotics, prebiotics, plant extracts and enzymes were suggested for the poultry feed industry in order to promote digestive tract health and to optimize the poultry performance.

The clay is a natural product that can be economically used to achieve similar goals.

Indeed, it is naturally abundant, cheap and so widely voluntarily used by the free–range hens or through ingestion of earthworms and insects soil fauna.

As an indication, [DE VRIES *et al.*, 2006] estimated the consumption of soil by lying hens raised in open access to almost 10% of the total dry matter intake.

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].

Moreover, studies in recent years have shown excellent nutritional and antibacterial properties, detoxifying effects and technological aspects of various clay types like bentonite, kaolinite, sepiolite and zeolite [OUHIDA *et al.* 2000c; HESHAM *et al.*, 2004; XIA *et al.*, 2004; KATSOULOS *et al.*, 2005; MALLET *et al.*, 2005; PASHA *et al.*, 2007; OUACHEM *et al.*, 2009 and 2010].

For these reasons, clays are recommended for their pro digestive properties to increase feed efficiency and healthy digestive tract and for their antitoxic capacity to many undesirable substances in the gut (biogenic amines, mycotoxins, endotoxins).

However, clay effects on the yield of cut up pieces and the on the meat quality were not studied and the scientific information's on this subject are very few.

This contribution intends to study on chicken broilers, over a rearing cycle of 56 days, the effects of 3% of marl addition on the growth performance, the carcass yield and the meat quality.

Material and methods

Diets and Clay

During a trial of 56–days, the effects of two treatments (control without addition of marl and experimental with addition of 3% of marl in dilution) were compared. Diets (Table 1) were prepared according to the NRC (1994) recommendations.

Table 1.

Percentual and chemical composition of experimental diets

	Starter	Grower	Finisher
Corn	58.0	61.0	63.5
Soybean meal 48	31.0	27.5	25.0
Wheat bran	4.0	5.0	5.0
Marl	3.0	3.0	3.0
Premix	1.0	1.0	1.0
Dicalcium–phosphate	1.90	1.50	1.60
$CaCO_3$	0.90	0.80	0.70
Salt	0.2	0.2	0.2
Nutritional and chemical composition			
EM (Kcal/kg)	3000	3100	3150
Crude Proteins (%)	21	20	18
Lysine (%)	1.1	0.90	0.70
Methionine (%)	0.42	0.38	0.35
Methi+Cyste (%)	0.85	0.83	0.78
Ca	1.2	0.85	0.65
P	0.75	0.55	0.50

The nutritional characteristics of these foods were: 3000 kcal ME/kg and 21% CP for the starter diet (1–14 days); 3100 Kcal ME/kg and 20% CP for the grower diet (15–42 days) and 3150 Kcal ME/kg and 18% CP for the finisher diet (43–56 days).

The different diet ensures the needs for essential amino acids and minerals of chickens.

The clay used in this trial is a gray marl, used in the artisan making of pottery, abundant in the area of study (Aures–Algeria), it contains 65% of clay, low rate of organic matter (0.6%) and its physicochemical composition (in milli equivalents/100g of soil) is: (Ca^{2+}=4.6); (Mg^{2+}=2.87); (Na^{+}=0.33); (K^{+}=0.1); (Cation Exchange Capacity=20.5).

Animals, Methods and Analysis

This experiment was carried out in an open sided house, in the research poultry unit of Agronomic and Veterinary Sciences Institute, Batna University–Algeria. A total of 240–day–oldchicks ISA15 commercial broilerwere individually weighed, identified and randomly allocated to two treatments groups (Control and Experimental) with six replicates of 20 birds each group.

From 1 to 56 days, chicks were raised ground on a wood shavings litter.

All chicks (2X120) were given ad–libitum access to feed and water, feed intake (FI), slaughter body weight (SBW) and feed consumption ratio (FCR) were recorded at the end of the trial (d56).

At the age of 56 days, the marl effects on the cut up pieces yield and the meat quality were also determined.

For this purpose, by each repetition, eight broilers having the mean body weight of the group (48 broilers per flock) were slaughtered, bled, feathered and eviscerated.

The carcass were weighed and dissected in order to measure the ultimate pH and the yields of chicken ready to cook (CRC), the breast and the thigh–drumstick.

To assess the chicken breast meat quality, three indicators were used: ultimate pH, the chilling drip loss and the abdominal fat. In order to recover the full fat, abdominal fat were withdrawn after cooling carcasses for 12 hours at 2ºC.

The breast pH was measured according to the method described by [BERRI *et al.*, 2005] by insertion of the pH meter electrode into the thickest portion of the pectoral muscle.

The breast muscle was subsequently weighed, packaged in a polyethylene–zipped bag and suspended by a hook for 4 days at 2ºC.

At the end of chilling, the muscle was dried and reweighed in order to assess the chilling drip loss.

The analytical methods used were those described by [AFNOR, 1985 and CARRE *et al.*, 2002].

Statistical analysis was carried out using T–Student test.

Values represented in the tables are the means ±standard deviation.

Statistical significance was set to P≤0.05.

Results and discussion

The effects of dietary treatments on broilers slaughter body weight, feed intake and feed consumption ratio data obtained from one to 56 days are presented in Table 2.

Table 2.

Growth performances of broiler at 56 days of age (n = 6)

Performances	Control	Experimental	P value
Live Body Weight (g)	3222[b] ± 90	3491[a] ± 122	P = 0.02
Feed Intake (g)	6489 ± 230	6457 ± 213	NS
Feed Consumption Ratio (g/g)	2.03 ± 0.07	1.93 ± 0.17	NS

(a, b): The means affected of different letters in the same line are statistically different at the 5% significance level; (NS): Not Significant.

Results of the yield of cut up pieces and the meat quality in Table 3.

The broilers growth performance of the experimental group are characterized by a significant increase of body weight at slaughter age (+8.5%, P=0.02).

Marl improves the feed conversion ratio by a decrease of about 5%.

Table 3.

Yield at slaughter and meat quality of broiler at 56 days of age (n = 6)

Performances	Control	Experimental	P value
Slaughter yield (% of LBW)			
CRC	69[b] ± 3.09	75.3[a] ± 1.7	P < 0.001
Breast	18[b] ± 1.87	20[a] ± 2.54	P = 0.01
Thigh	14 ± 1.73	15 ± 1.94	NS
Drumstick	10.04 ± 0.84	10.8 ± 1.84	NS
Meat Quality			
Abdominal Fat (% CRC)	2.54[a] ± 0.45	2.24[b] ± 0.74	P = 0.05
Ultimate pH	5.81 ± 0.08	5.84 ± 0.05	NS
Drip Loss (% of breast weight)	2.40 ± 0.13	2.04 ± 0.66	NS

(a, b): The means affected of different letters in the same line are statistically different at the 5% significance level; (LBW): Live Body Weight; (CRC): Chicken Ready to Cook; (NS): Not Significant.

This response confirms the results observed in broiler chickens at the age of 56 days by [MEKAOUSSI, 2007; HADDAD, 2009] with the same clay type and the same level of incorporation.

Similar effects have also been reported by [NOWAR *et al.*, 1989] with kaolinite, [TRCKOVA *et al.*, 2004; SALARI *et al.*, 2006] with bentonite and [TAUQIR *et al.*, 2001; XIA *et al.*, 2004] with montmorillonite.

The Enhancement in growth performance was explained by the positive effects of antimicrobial [XIA *et al.*, 2004] and detoxifying [PASHA *et al.*, 2007] clay properties on the gut pathogenic flora and through improving digestive efficiency and nutrient absorption in the gastrointestinal tract [OUACHEM *et al.*, 2009].

The response on growth rehabilitates muscle growth observed across the meat yield and in particular, the chicken ready to cook (+9.13%, P<0.001) and the breast (11%, P=0.01).

Results are also in conformity with the positive correlation (+0.73) described by [GUERDER *et al.*, 2009] between the yield of chicken ready to cook and breast meat.

Furthermore, this performance can be assigned to the improved mineral metabolism balance as explained by [CASTAING *et al.*, 2003].

According to these authors, the supply of minerals as premix induces a significant increase of the chicken ready to cook and the breast meat yield.

Thus, it is not excluded that this effect be observed in our conditions.

In fact, clays are considered as a real sieve able to regulate mineral exchanges [OUACHEM et al., *in press* World Poultry Science Journal].

Moreover, these yields may be partially explained by the positive effect of the clay on the digestibility of proteins previously described by [XIA *et al.*, 2004, OUACHEM *et al.*, 2009 and 2010].

This effect does probably not exclude improvement digestibility of some amino acids such as lysine.

In fact, according to many authors, the lysine constitutes a limiting factor for yields of breast meat and chicken ready to cook [KIDD and FANCHER, 2001; QUENTIN *et al.*, 2004; BERRY *et al.*, 2005; DOUSSAT *et al.*, 2005].

Regarding the quality of meat, the use of marl significantly reduce the rate of abdominal fat (–11.8%, P=0.005).

This confirms the previous results achieved in chicken with marl [OUACHEM *et al.*, 2009 and 2010] or in pigs fed on a diet containing sepiolite [LUCA *et al.*, 2004].

The reduce of abdominal fat may be explained by a better availability of protein [JLALI *et al.*, 2009].

Moreover, although not significant, the marl effect seems to be better on reducing water losses of breast meat (2.04 vs 2.40) than on the value of the ultimate pH (5.84 vs 5.81).

Anyway, this pH value coincides with the optimum value (5.8) and is situated in the interval (5.7–6.2) required to produce a light–colored meat suitable for processing [GIGAUD *et al*, 2009].

Indeed, according to these authors, the meat acid with an ultimate pH less than 5.7 have a very pale colour, low water–holding capacity and therefore are poorly suited for processing.

According to the sepiolite effect on producing of light–colored meat reported by [PARASINI *et al.*, 1993], we can retain the possible effect of marl on the ultimate pH and the lightness of meat.

In terms of quality, the combined effects of marl on the breast pH and the decreased drip loss provide an interesting contribution to the meat ability for processing which depends mainly on its water holding capacity.

Conclusions

The results of this trial confirm the marl effects on broilers performance described in previous experiments and highlighted its importance on yield of chicken ready to cook and the breast meat.

Moreover, marl helps to improve the technological meat quality and seems to provide solutions to the current consumer preferences looking for leaner meats and health requirements.

However, to validate these first observations, it would be interesting to pursue additional studies testing amino acid digestibility.

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Received: September 30, 2014
Accepted: October 29, 2014
Accepted: Last modified on November, 17, 2014