Effects of a Natural Preparation Based on Kaolin, Olive Leaf, Turmeric and Mild Paprika on the Performance of Laying Hens

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ABSTRACT

The effects of 3% of a natural preparation based on 1.8% of kaolin, 1% olive leaf and 0.2% of mild paprika or turmeric were studied on 96 H&N strain laying hens from 35 to 42 weeks through an experimental design consisting of three treatments (control group without supplementation, kaolin-olive leaf-mild paprika group and kaolin-olive leaf-turmeric group). Per treatment, 8 replicates of 4 laying hens each were assigned to each of three treatments. Egg laying performances, egg qualities, egg shell strength and dry matter of droppings were recorded. Results showed that the experimental diets did not make any significant changes in laying performances. However, the kaolin-curcuma preparation improved slightly the egg mass (+3.1%), the feed consumption ratio (-2.4%) and the egg weight (+1.4%). Moreover, the kaolin-mild paprika diet significantly improved the yolk color intensity (+11% ; P=0.001), the shell thickness (+7.9% ; P=0.003) and decreased the rate of eggs large caliber by 38%. Experimental diets significantly improve the welfare by an increased dry matter content of droppings (+25.8% and + 15.1%, P=0.01), respectively for the preparation based on kaolin-turmeric and kaolin-paprika. Results of this experiment highlight the value of the clay and phytobiotic substances to improve the egg qualities and the welfare of laying hens.

Keywords : Kaolin, Turmeric, Mild Paprika, Olive Leaf, Laying Hens

INTRODUCTION

In order to find alternatives that can replace antibiotic growth factors and improve product quality, poultry research has been focused in recent years on the use of natural additives and plant extracts. To achieve these goals and promote more favorable and less stressful conditions in the digestive tract, various clay types have been tested and recommended to enhance food efficiency, health status, growth performance and product quality (Xia et al., 2004 ; Ouachem et al., 2015a ; Ouachem et al., 2017). Clays are also recommended for their antitoxic capacity against multiple harmful substances in the intestine (biogenic amines, mycotoxins, endotoxins). In parallel. The use of plants or their extracts (thyme, oregano, rosemary, lavender, tomato powder) and some food spices (turmeric, ginger, garlic) has grown because of their potential richness in anti-oxidant and antimicrobial substances. Olive tree is a very abundant crop in Algeria, the olive harvest offers significant quantities of leaves that can be turned into animal feed. These are rich in phenolic glucosides (oleuropein and phenolic acid) known for their antioxidant and antimicrobial properties (Özdemir and Ali azman, 2016). The Turmeric is also rich in these substances as well as coloring pigment part. The major active substances in the Turmeric are curcuminoids, which act as powerful antioxidants and a colorless yellowish pigments (Huang et al., 1995 ; Gowda et al., 2008). Moreover, marigold petals, alfalfa extract, paprika extract and other substances rich in carotenoids and xanthophylls are used to improve the internal quality of the egg, in particular the yolk color.

As part of this work, we purpose to evaluate in laying hens the effects of adding 3% of a natural preparation based on kaolin associated with olive leaves, mild paprika or turmeric on laying performance, the internal quality of eggs, the shell strength and the moisture droppings.

MATERIALS AND METHODS

Animals, diets and clay. The experiment was carried out at the poultry research unit of the agronomic and veterinary sciences institute of Batna1 university (Algeria) on a total of Ninety six 34-weeks-old H&N laying hens (Super Nick strain), weighing on average 1760g. Hens were randomly distributed among three dietary treatments groups of 32 hens each (control and two experimental groups) into eight standard cages with four hens each. Through 8-week trial period, birds of control group (C) received a diet without additives, those of the experimental groups were fed with a diets supplemented with 3% of a preparation based on 1.8% of kaolin, 1% of olive leaf and 0.2% of mild paprika (KOP) or 0.2% of turmeric (KOT). Diets were prepared according to the recommendations of NRC (1994), diets ensures the needs for essential amino acids and minerals of laying hens and consist mainly of corn and soybean-meal 48, all feeding programs were isocaloric and isonitrogenous, the nutritional characteristics of diets were : 2750 kcal/kg ME, 16.6% CP, 0.78% of lysine, 0.34% of methionine, 0.73% of meth-cyst, 0.17% of tryptophan, 3.8% of calcium and 0.4% available phosphorus. 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_2O_3 = 33.00 ; Fe_2O_3 = 2.50 ; TiO_2 = 0.24 ; CaO = 0.08 ; MgO = 0.40 ; K_2O = 2.90 ; Na_2O = 0.1 ; Organic matter = 0.48 ; H_2O = 11.00. A pre-experimental period (adaptation) of two weeks was carried out. According to the management guide (H&N, 2012), The birds received 16 h of light/d throughout the experimental period, food was adjusted to 105 g/hen/day, the refusals were weighed daily and hens had free access to water supplied by a nipple drinkers system.

Methods and analysis. The laying productive performances (egg production, egg weight, feed conversion ratio, egg mass and class of eggs), the egg quality (albumen and egg yolk percentage, Haugh units, yolk color) and the egg shell quality (shell percentage, shell index, shell thickness) were evaluated biweekly. Droppings moisture were determined three days before ending this trial. The number of eggs laid was recorded daily and their weight determined using a precision scale (Sartorius 0.01g sensitivity). The feed consumption ratio was calculated by dividing the total of feed intake (g) by the total of egg weight produced (g) in the same week. The weights of the egg yolk, albumen, and shell were measured biweekly. To measure these components, all eggs produced on a given day of the week were collected, weighed individually, then broken and the albumen and the yolk were separated before weighing. The shells were carefully washed and dried for 12 h in a drying oven at 70°C and then weighed. The shell thickness was measured using an electronic caliper and the shell index was calculated by the formula reported by Mori et al. (2007) : Shell index (g/100 cm^2) = 100 (shell weight/4.68 egg $weight^{2/3}$). The egg mass determined from the formula described by Mathlouthi et al. (2009) : Egg Mass (g) = $\frac{\text{Egg Number X Egg weight}}{\text{Hen number}}$. Egg classes were assessed biweekly from eggs laid during the last three consecutive days. Three eggs were collected from each replicate, individually weighed and then arranged according to the classes described by Mori et al. (2007): Class 1 (small eggs <53g); Class 2 (medium size eggs: 53 to 65g); Class 3 (large egg: 66 to 73g); Class 4 (extra large: > 73g). Albumen height was measured by using a tripod after spreading a broken egg on a flat area and then Haugh unit was determined by applied the formula described by Sauveur (1988) : Unit Haugh = 100 log (albumen height -1.7 egg weight $^{0.37}$ + 7.57). The egg yolk color or Roch Yolk Color Fan value (RYCF) was estimated using the color spectrum of the Roch scale (DSM nutritional Co), based on 15 shades, ranging from yellow to orange and bearing numbers 1 to 15. Moisture droppings were assessed over the last three consecutive days of week 42. Wet droppings were collected on a tray placed below the cage and weighed promptly (each two hours in order to avoid dehydration). Dry matter content (% dry matter) was determined by drying out the droppings in a forced ventilation oven for 24 h at 105°C. Statistical analysis was carried out in accordance with a completely randomised design using the GLM procedure of SAS (SAS Institute, 1994). To classify means, the Student-Newman-Keul's multiple comparison procedure (Steel and Torrie, 1980) was used when means were significant (P<0.05).

RESULTS AND DISCUSSION

The results of the effects of experimental diets on laying productive performances, egg quality, egg shell strength, egg class and moisture of droppings are shown in Table 1.

Table 1. Effects of KOT and KOP feed preparations on laying productive performances, eggquality, egg shell strength and moisture droppings of laying hens.

Groups	Control	KOT	KOP	Signification
Laying Productive Performances				
Egg weight (g)	61.55 ± 0.8	62.40 ± 0.5	61.03 ± 0.3	NS
Egg Mass (g)	58.8 ± 1.6	60.6 ± 0.9	58.6 ± 1.7	NS
FCR	1.67 ± 0.03	1.63 ± 0.04	1.68 ± 0.04	NS
Laying rate	92.6 ± 4	92.8 ± 3	93.0 ±7	NS
Egg quality				
Albumen (%)	57.95 ± 3.1	59.07 ± 3.6	57.55 ± 3.6	NS
Haugh units	90.66 ± 4.3	90.36 ± 5.7	91.28 ± 6.0	NS
Yolk (%)	28.50 ± 0.9	27.76 ± 1.7	28.33 ± 1.1	NS
Yolk coloration	7.8^b ± 0.3	8.36^a ± 0.3	8.66^a ± 0.1	P = 0.01
Egg shell quality & moisture droppings				
Egg shell weight (g)	5.98 ± 0.3	5.96 ± 0.2	5.92 ± 0.3	-
Egg shell (%)	9.65 ± 0.4	9.64 ± 0.3	9.67 ± 0.4	NS
Egg shell thickness (μm)	318^b ± 13	338^a ± 50	343^a ± 60	P = 0.02
Shell index	8.09 ± 0.4	8.08 ± 0.3	8.23 ± 0.3	NS
Dry matter of droppings (%)	25.2^c ± 1.5	31.7^a ± 2.0	29.0^b ± 1.8	P = 0.01
Class of eggs				
Class 1 (<53g)	-	-	-	-
Class 2 (53 to 63g)	60.3^c ± 7.6	68.2^b ± 8.5	75.5^a ± 8.1	P = 0.001
Class 3 (64 to 73g)	39.7^a ± 6.8	31.8^b ± 9.8	24.5^c ± 5.1	P = 0.03

(a,b,c) : Means with different letters in the same line are statistically different; (NS) : not significant ; (KOT) : diet based on kaolin-olive leaf-turmeric ; (KOP) : diet based on kaolin-olive leaf-mild paprika.

Overall, although not significant, the kaolin-turmeric (KOT) diet seems to favor slight improvements in egg mass (+3.1%), feed consumption ratio (-2.4%) and egg weight (+1.4 %). Furthermore, experimental diets provide a significant response to the yolk coloration, which increases from the value 7.8 to 8.36 with turmeric preparation (KOT : +7.2%) and 8.66 with paprika preparation (KOP : +11.0). In addition, the paprika diet (KOP) significantly increased shell thickness (+7.9% ; P=0.003), while improving the shell index (+1.7%) and the egg shell percentage (+1.4%). The rate of normal size eggs (class 2) was significantly higher (KOP : 75.5% and KOT : 68.2 vs. Control : 60.3% ; P=0.001), this statistically translates into a smaller proportion of (Class 3: 24.5 and 31.8 vs 39.7% ; P=0.03). The dry matter content of droppings was significantly improved with experimental diets (KOT : 31.7% and KOP : 29.0% vs Control : 25.2% ; P=0.01).

Laying performances. It should be recalled that the effects of preparations of clays and phytobiotics are non-existent in previous studies, the available results are related to the effects of the addition of clays or phytobiotics alone. Thereby, comparisons have been adapted to this context. A part from the small improvements in egg mass, feed consumption ratio and egg weight, no significant effect on productive performances was noted by the experimental preparations.

A similar finding has been reported by Miles and Henry (2007) in laying hens fed with a food supplemented with aluminosilicate. However, 2% of clinoptilolite improves the egg weight (Rizzi et al., 2003), whereas, 1.5% of sepiolite, significantly enhances the feed consumption ratio and slightly increases the egg number and egg mass (Mizrak et al., 2014). Moreover, addition of diatomaceous clay (clay associated with algae and sea fossil skeletons) in laying hens favors an improvement in the feed consumption ratio (Bennett et al., 2011). While, with kaolin and sand supplemented diet, Travel et al. (2014) reported an improvement in egg weight. Moreover, in breeding Campbell ducks, Fatouh et al. (2012) showed a particular impact of sodium bentonite on egg number, feed index, egg mass, fertility and hatchability.

The significant decreases in the proportion of class 3 eggs (size : 64 to 73g) in hens of experimental diets are interesting because this class of eggs accentuates the phenomenon of cloacal prolapse and increases mortalities. This effect can be partially attributed to the antimicrobial effect of clays and the antioxidant activity promoted by phenols and tumoric acid contained in turmeric and paprika which appear to be favorable to the control of yolk growth and the formation of normal eggs. On the other hand, according to Ramirez et al. (1999) cited by Radwan et al. (2008), the antioxidant effect of the major components of turmeric (curcumin and tumoric acid) induces better uterine synthesis conditions and favorable calcium deposition.

Egg quality. Results of experimental diets did not show responses on the percentages of yolk and albumen or Haugh units. Over other studies, an improvement of albumen weight was reported with 2% of clinoptilolite (Rizzi et al., 2003), 1% of zeolite (Fendri et al., 2012), or with addition of diatomaceous earth (Bennett et al., 2011). The significant effect of turmeric (KOT) and paprika (KOP) diets on yolk color is in agreement with the response observed with clinoptilolite (Rizzi et al., 2003 ; Kermanshahi et al., 2011). However, this effect was not observed with natural zeolite (Öztürk et al., 1998), sodium bentonite (Fatouh et al., 2012) or with sepiolite (Mizrak et al., 2014). This response may attributed to the probable improvement of the efficiency of the pigment transfer motivated by the antimicrobial and detoxifying effects of clays (Ouachem et al., 2015a) or to the adsorption and the affinity of red pigments to clays (Rizzi et al., 2003). It is well known that growth and yolk coloration are under hepatic control. So, according to Gerber (2006), yolk discoloration may be induced by factors such as mycotoxins which may reduce the activity and normal funtioning of the liver. Similarly, according to Zaghini et al. (2005), inhibitory factors of liver function and lipid metabolism (mycotoxins) tend to degrade the yolk color and the yolk weight.

Egg shell quality . The significant increase (+7.9% ; P=0.02) of the shell thickness induced by kaolin-paprika diet (KOP) is consistent with the improvement of the shell thickness and relative egg shell weight observed by Fatouh et al. (2012) with sodium bentonite in campbell duck. According to Rizzi et al. (2003), 2% of clinoptilolite improves the shell strength. Previously, in laying hens exhausted by the intensive laying rhythm, Roland et al. (1985) and Rabon et al. (1995), reported that zeolite improve the shell strength. Similarly, depending to Mizrak et al. (2014), addition of 1.5% of sepiolite, increase the calcium content of the egg shell.

Furthermore, during a trial based on the addition of sand and kaolin in order to simulate the soil ingestion phenomenon as it occurs in nature, Travel et al. (2014) reported a significant increase in the relative shell weight. Various research have hypothesised that the beneficial effect of clays on egg-shell quality may be related to their high affinity for calcium and their high ion–exchange capacity (Roland, 1988 ; Miles et al., 1983 ; Willis et al., 1982). Moreover, it has been shown that excess phosphorus tends to degrade the egg shell quality (Arscott et al., 1962 ; Elliot and Edward, 1991 cited by Ouachem et al., 2015a) and that, on the other hand, the high level of aluminum that clays contained promotes the formation of a complex with the phosphorus in excess (Roland and Harms, 1976; Roland., 1990; Elliot and Edward 1991 cited by Ouachem et al, 2015a), thus contributing to improve the egg shell quality (Roland and Harmes, 1976, Ousterhout, 1980 cited by Ouachem et al., 2015a).

Moisture droppings. Compared to the control group, both experimental preparations promote excretion of dried droppings. This response is in agreement with results showed in broiler chickens with marl (Ouachem et al., 2011, Ouachem et al., 2015b) and laying hens with clinoptilolite (Öztürk et al., 1998). Moreover, Safaei et al. (2010) reported that the addition of bentonite, kaolinite or zeolite may improve the state of droppings by increasing the dry matter level of 20.9% towards rates situated in the range of 24% to 27%. Further, in laying hens, Öztürk et al. (1998) reported that clinoptilolite promotes a significant increase in dropping dry matter level by 19.4%. In addition, according to Schneider et al. (2016), the use of 100 g of natural zeolite per kg of sawdust litter reduced litter moisture and ammonia volatilisation. Therefore, the use of zeolite is presented as an alternative to NH_3 and litter moisture control in poultry houses because of the ammonium adsorption, NH_3 absorption and water retention properties of zeolite. Thereby, under our experimental conditions, probably intestinal health and absorption sites are more favorable by the ingestion of kaolin in admixture with natural additives known for their antimicrobial and antioxidant activities such as olive leaves, turmeric and The paprika. On the other hand, the water absorption capacity which characterizes the clays is sufficient to justify the hypothesis of water absorption and improvement of the intestinal viscosity.

CONCLUSIONS

In the nutshell, admixture of kaolin and phytobiotics to the laying hens diets contributed in reduction of the moisture droppings, enhanced the yolk color, egg shell thickness and egg shell strength, reduced the proportion of large and extra large eggs. This study will provide a strong foundation for laying hens farmers to use those natural substances as a biological supply in poultry feed. Nonetheless, further finer studies under other field conditions are recommended to validate such results.

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