Effects of Green Oaks Acorns (*Quercus ilex*) Based Diets Added of Calcium Bentonite on Growth Performance of Broilers Reared in the Cages and Ground Modes

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Abstract: It is now known that the use of natural resources and food additives rich in bioactive nutrients in poultry diets offer better digestive use and have a proven health impact. In this context, the use of green oak acorn added of calcium bentonite are better suited to these tests to improve growth and enrich the meat with a some nutrients able to limiting the meat lipoperoxidation. In addition, the breeding battery mode compared to the ground mode offers better conditions and improves productivity. This study consists of evaluating the effects of diets based on green oak acorns supplemented with calcium bentonite on growth performance of broilers. The 300 broilers one day-old of the ISA F15 strain were divided into two groups, one raised on the ground and the other in cages. Each group was divided into three subgroups. Each subgroup receives either a standard diet without addition of acorn or bentonite constituting the Diet Control (DC), a diet with 19.8 g/kg of Oak Acorn (OA) without bentonite and another diet of 19, 8 g/kg of OA added of 2 g/kg of calcium bentonite (OAB). At 35 days-old, the animals reared on battery mode showed the best growth performance compared to those raised on the ground ($p<0.05$) (1239 vs. 1262 g). However, the incorporation of OA slightly affects the broilers productive performance ($p<0.05$) compared to the control (DC vs OA; 1239.2 vs. 1088 g). However, at the 56th day-old , the diet OAB diet produces the best beneficial effects on growth performance (OAB vs. OA: 2149 g vs. 1869 g) compared to the OA diet without bentonite. This experiment suggests that the use of green oak acorn in chicken feed is therefore, quite possible and the addition of 2% calcium bentonite shows the best beneficial effects on growth performance and improvement of health status.

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INTRODUCTION

In modern diets, meat is the subject of debate and criticism in a society increasingly attentive to the dietary composition and health value of its diet. Product quality has therefore, become one of the major concerns of the various links in the meat industry and the consumer. Among the factors likely to alter or improve this quality is often mentioned diet, even if other parameters have a much greater influence such as genotype and age[1].

In this context, several research carried out by Algerian researchers have shown the possibility of using the Green Oak Acorn (GOA) (naturally rich in unsaturated fatty acids and bioactive compound) in the diet of broilers without the growth performance and body composition are not altered. Interesting results have been obtained by Bouderoua, etc. on the productive performances and nutritional and dietetic qualities of white meats which are characterized by an acceptable slaughter yield.

The breeding of broilers is practiced all over the world, in very variable conditions which can be done in three ways: in battery, on the ground and mixed (ground-battery). The ground-based method of rearing is often observed in extensive village ranching and also in free-range ranching. In both of these cases, the ground is made up of greenery or dirt.

In the industrial confined type, floor rearing is more used for fattening chicks intended for meat production, but also for laying eggs. As for battery breeding, it began during the First World War in the United States, it is done in stages. Its appearance revolutionized world poultry production. It has the following advantages: Removal of the litter which constitutes the first medium which harbors infectious agents, more favorable health status; because the droppings rejected through the wire mesh reduce the risk of parasitism and infectious diseases, better growth because the chickens save energy by reducing their activity and therefore, using their food only to make meat.

Contamination of food ingredients by various mycotoxins and their effects on animal health and performance have been repeatedly reported[2-5], highlighting the need for strategies to mitigate the adverse effects of these substances.

For better control of breeding conditions, it seems necessary to enhance the feed of broilers in a few raw materials produced locally. For example, bentonite is one of these raw materials, known for its richness in minerals and capable of being used in animal feed.

About 50 years ago, scientists rediscovered clay minerals for medical purposes. The consumption of clay has been used for hundreds of years by animals and native cultures to promote internal healing and improved economic indicators and the use of marketing silicate minerals are recommended as an ingredient in the forage[6]. It is used as a feed additive in poultry feed and has no harmful effects on animal health[7, 8].

Bentonites in the animal's diet act as intestinal proteins (enterosorbents) which bind rapidly and preferentially to aflatoxins in the digestive tract and thus reduce their absorption in the body[9]. In this way, the negative effects of aflatoxins on efficiency and liver function are minimized without marked defects in mineral metabolism of animals[10, 11].

Thus, the property of this clay is to slow down the rate of passage of food for better use of food nutrients[12]. According to Tortuero Cosialls, etc., the incorporation of clay into the chicken diet increases transit time, approximately 2-3 h in 87.5% of chickens fed the feed containing 1.5% of clay against 1.5-1.75 h for 62.5% of the chickens in the control diet. Bentonite can also be used as a feed additive in the diet of broiler chickens to improve the hygienic characteristics of barns[13].

This is the context in which this study which aims to monitor the effects of adding acorn and bentonite in the diet on growth of broiler chickens, falls within this context reared in soil and battery modes.

MATERIALS AND METHODS

Animals and diets: Three hundred day-old male Hubbard ISA 15 broilers were reared conventionally and fed until 12 days of age on a standard starter diet (3,100 kcal/kg, 22% protein) were allowed free access to water and food. The 12th day, birds with initial Body Weight (BW) 360 kg±23 g were divided into six groups according to the diet distributed during growth and finishing, the first group received the control diet without addition of acorn or bentonite, constituting the control batch and reared on the ground (CG), the second group fed on the acorn-based diet and raised on the ground (OAGS), the third group fed on the acorn-based diet and supplemented with bentonite and raised on the ground (OAGBS), the fourth group received the control diet and battery-matured (TB), the fifth batch fed acorn and battery-reared (GB) feed, the sixth batch fed acorn-bentonite and battery-matured (GBB) feed. The room temperature in experimental house was maintained at 38°C during the first days of experiment and decreased gradually by 3°C in the 2nd and 3rd week to be fixed at 22°C there' after chiks were vaccinated against New Castle disease at the 3rd and 30th days, via. drinking water. Animals used in this experiment were reared and slaughtered in compliance with ethics regulations for the humane care and use of animals in research.

Table 1: Chemical composition of Maghnia bentonite

Constituents	Percentage
SiO_2	69.4
Al_2O_3	14.7
Fe_2O_3	1.2
CaO	0.3
MgO	1.1
Na_2O	0.5
K_2O	0.8
MnO_2	0.2
As	0.5

Diets: The oak acorn *Quercus ilex* was harvested in the forest of Bissa-Zeboudja W. de Chlef (latitude 36°13'N; longitude 1°20'E) during the last week of November 2017. The harvest period was decided when the tannin content is 1%, a sign of full maturity. Immediately after harvest, the acorn is spread out and dried at room temperature in a covered and well-ventilated room. To ensure proper drying, the acorns are turned daily. This drying operation is carried out for 20 days until a humidity of 18% is obtained, compatible with grinding without risk of clogging. The grinding was carried out by a hammer mill which produced a particle size of 08 mm.

The other components of the diets: , corn, and soybean meal were supplied by a feed manufacturing unit located in Mostaganem Algeria.

This study was carried out on calcium Bentonite of Maghnia (BentMag, Table 1) obtained from the western part of Algeria (35°0'36.583 "N 1°44'45.312" W) and delivered by the National Company for Non-ferrous Mining Products. The BentMag contains more montmorillonite (Mt) and fewer impurities than Bent Mostaganem and possesses the ability to retain water beyond 200°C (Arbaoui and Bouchrit, 2014). The composition of the experimental diets and of the control batch was developed so that the energy and protein levels approach as much as possible (Table 1 and 2).

Building and breeding conditions: The experiment was carried out in a breeding building belonging to the University of Mostaganem. The rearing is carried out on the ground with a density of 10 animals/m^2 on a litter composed of sawdust and straw and in battery with a density of 20 animals/m^2. Food and water are distributed *ad libitum*.

Measurements and controls: During the rearing, the weighing were carried out by an animal weighing scale on the 14th, 21th, 28th, 35th, 49th and 56th days.

Statistical analysis: The results were subjected to a two-factor block analysis of variance, followed by a two-by-two comparison of means using the newman and keuls test. The data were processed using statistical software Star Box 6.4. The results were expressed as mean values plus or minus corresponding standard deviations. The effect of the factor studied was demonstrated at two probability thresholds: $p<0.05$ and at $p<0.01$.

Table 2: Composition and biochemical characteristics of diets (g/kg) food

Ingredients%	CS diet	OA diet	OAB
Corn	60	48.12	46.92
Green oak acorn	-	19.80	19.80
Calcium Bentonite	-	-	2.00
Soya bean meal	30	24.06	23.46
Wheat bran	7.0	5.62	5.48
Calcium (%)	1.0	0.80	0.78
Phosphorus (%)			
Calculated composition	1.0	0.80	0.78
Méthionine(%)	0.31	0.27	0.26
Lysine (%)	1.10	0.90	0.89
Met +Cys (%)	0.68	0.57	0.56
Calcium (%)	0.79	0.64	0.65
Phosphorus (%)	0.6	0.51	0.53
CMV	1	0.80	1.08
ME(kcal/Kg)	2835	2936.66	2879.96
Protein%	20.21	17.50	17.09
Energy/protein	140.27	161.26	162.16

11Vitamin premix: provided (in mg per kg of diet); vitamin E, 6; vitamin K3,0.80; vitamin B1, 1; vitamin B2, 3; Pantothenate of Ca, 6; vitamin B6, 1.5;vitamin B12, 0.006; folic acid, 0.2; nicotinic acid, 12; copper, 5; cobalt,0.65; manganese, 65; zinc, 65;selenium, 0.25; iron, 50; iode, 0.8;magnesium, 100; EM = Metabolisable energy, C = Control diet, GO = Green oak acorn diet, OAB = Diet based on Green oak acorn diet+2% calcium bentonite

RESULTS

Growth performance

Body weight: The cumulative results of the weekly change in body weight, weight gain and consumption index during the 6 weeks of rearing of each batch carried out either on the ground or in a battery are shown in Table 3.

The body weights obtained during the first weeks reveal a significant difference between the batches. However, from the 14th to the 28th day, the groups of chickens which received the oak acorn diet and reared in a cage (GCVS) show higher body weights ($p<0.05$) than the other groups. Then from the 35th day, they are the chickens of the control group reared in cages which outclass the other groups, even if it is observed that from the 42nd to the 56th day that the animals reared on the ground register higher live weights than those reared in battery. We can also note overall that up to 35 days of rearing, that rearing in cages impacts the growth by increasing it by 2% ($p<0.05$) compared to the soil mode (CS vs. CB :1239, 2 g vs. 1262 g) and acorn incorporation slightly affected the performance of chickens ($p<0.05$) (CS vs. OAS; 1239.2 g vs. 1088 g). Indeed, it was noticed that the association of acorn bentonite and breeding on the ground suggests that the addition of 2% of calcium bentonite has the best beneficial effects on growth

Table 3: Effects of the breeding method and diets supplemented with acorn and bentonite on growth performance

	Days						
BW (g)	14	21	28	35	42	49	56
CS	380.00	587,15	890.3	1239.2	1558.80	1779.25	2150.75
OAS	361.00	530.25	823.00	1088	1397.80	1622	1869
OABS	403.00	562.75	814.00	1228	1528.50	1808	2149
CB	406.00	640.00	897.50	1262	1492	1755	2061
OAB	363.75	656.25	907.50	1195.7	1372.70	1596.7	1889
OABB	363.76	611.75	875.25	1147.7	1386.50	1579	1802
SEM	23,01	29.05	12.89	11.89	17.62	22.96	21.59
Dietary effect	p<0.05	NS	p<0.05	p<0.05	p<0.05	NS	p<0.05
Breeding effect	NS	p<0.05	NS	NS	p<0.05	NS	p<0.05
WG (g)							
CS	196.44	207.75	302.50	349.00	319.50	280.50	371.00
OAS	156.45	169.00	292.70	265.00	309.00	224.50	247.70
OABS	151.22	159.75	251.70	413.00	300.50	280.50	341.00
CB	221.65	233.25	257.50	365.00	299.50	265.00	306.00
OAB	250.40	292.50	251.50	288.00	177.00	221.00	293.00
OABB	211.60	248.00	282.33	272.50	238.75	192.60	223.50
SEM	16.74	17.35	17.98	18.54	18.96	17.52	17.33
Dietary effect	NS	p<0.05	NS	NS	p<0.05	p<0.05	NS
Breeding effect	NS	p<0.05	p<0.05	NS	p<0.05	NS	NS
CI							
CS	1.21	1.36	1.47	1.38	1.27	1.18	1.30
OAS	0.91	0.90	0.94	0.95	0.87	0.85	0.89
OABS	0.59	0.67	0.74	0.67	0.65	0.67	0.71
CB	0.50	0.54	0.60	0.55	0.56	0.61	0.60
OAB	0.50	0.51	0.55	0.50	0.51	0.55	0.64
OABB	0.41	0.43	0.49	0.43	0.45	0.48	0.51
SEM	0.25	0.22	0.34	0.31	0.26	0.32	0.31
Dietary effect	NS	NS	P<0,05	P<0,05	NS	NS	NS
Breeding effect	NS	NS	NS	P<0,05	P<0,05	NS	NS

For each group n = 15 the results are expressed as the mean and the standard error of the mean (SEM); BW= Body weight; WG = Weight gain, CI = Consumption index; CS: soil control, OAS: acorn-based diet, OABS: acorn diet supplemented with soil bentonite; CB: battery indicator, OAB: diet based on battery acorn, OABB: acorn diet supplemented with battery bentonite F1: factor studied (breeding mode); F2: factor studied type of experimental diet p<0.05 = Significant effect, NS = Insignificant effect

performance (OABS vs. OAS; 2149 g vs. 1869 g) during the 56th days from the acorn only. On the other hand, the examination of the weekly weight gains shows better weight gains during the 14th, 21th, 28th and 35th day for the lots of acorns. At the 42nd day and until the end of the experiment on control group raised on the ground outclasses the other groups followed by chickens fed with the GCVS diet supplemented with bentonite and raised on the ground. However, we did not observed any significant differences between treatments regarding the consumption index from the 14th to the 56th day. The consumption index was nevertheless increased but slightly with the addition of acorn and bentonite at 1 and 5% compared to the control diet during the growth phase (OAS vs. CS; 1.47 vs. 1.36), (OABS vs. CS; 1.38 vs. 1.36).

DISCUSSION

Body weight and weight gain: During rearing, the chickens from the control group performed better than the other experimental animals. It is well established that this forest product contains a significant proportion of tannins (the main anti-nutritional factors in animal feed) and many other biactive compounds not yet identified. These substances have effects mainly directed against the digestibility of proteins; either by inhibiting certain proteolytic enzymes (trypsin and chymotrypsin in particular) found in the digestive juice, or by forming an insoluble complex with food proteins[14, 15]. This may partly explain the weak growth observed in subjects fed an acorn-based diet compared to the control.

The slight superiority of the weight gains of the animals in the control group is probably explained by the high protein diet. In this regard, Jarrige, etc., report that the more the food is rich in protein, the better the performance.

The use of bentonite appears to be particularly beneficial in the case of poultry. The performance of battery chickens is relatively poorer than that breeding in ground. This can be explained by the difference in density of animals undertaken in the study; of the order of 10 squared animals in ground rearing mode and 20 squared animals in battery rearing. Although, the diets tested were served in *ad libitum* for all the batches throughout the experimental period, due to this difference in density, the feed was less accessible for all the animals reared in cages, some of which consequently accused stunted growth and low carcass weights compared to those raised on the ground.

CONCLUSION

At the end of this study and through the results obtained, it appears that during rearing, the chickens fed on the control diet exhibited better performance ($p<0.01$) than, the other experimental animals.

In view of the improvement in the health value of chicken meat by the additional addition of bentonite, the use of Holm oak acorn in chicken feed is therefore, quite possible as the acorn is probably acting on the quality and health value of meat thanks to its richness in bioactive ingredients.

The performance of caged chickens is poorer than that of animals raised on the ground. During the experiment, cage rearing as opposed to floor rearing showed slightly more extensive fibrosis on Fabricius bursa; lesions of steatosis and megalocytosis as well as lesions of lysis and more marked degeneration.

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