EFFECT OF DIFFERENT LEVELS OF BENTONITE SUPPLEMENTATION IN DIETS ON ZOOTECHNICAL PERFORMANCE OF BROILER CHICKEN

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Abstract. Clay is one of many other additives proposed as substitutes to optimize avian performances. This study was carried out to evaluate the effect of bentonite sodium (BS) from the Maghnia field on the zootechnical performances of the broiler chicken. For that, 490 Harbord broiler chicks were distributed into 7 lots, each comprising 70 subjects. We prepared a control lot (T) with a standard corn feed and lots 1, 2, 3, 4, 5 added 1%, 2%, 3%, 4%, 5% bentonite by corn substitution, respectively. Zootechnical performances (weight gain WG, consumption index CI) were calculated every 5 days. Our results showed a significant improvement in WG and CI of bentonite-added chickens compared to the control lot. However, in the start-up/ growth phase, there was performance degradation in chickens with 5% BS, which would mean that although BS was beneficial, chicken did not tolerate high levels of BS during young age. In addition to improving performances, BS offered a very large savings in corn (up to 5 kg/100 kg of food). Since BS is a plentiful natural product, it reduces production costs and improves performances of the broiler.

Keywords: additive, bentonite sodium, zootechnical performances, broiler chicken.

INTRODUCTION

The poultry sector and, in particular, the production of broiler chicken is now facing a new situation created by the phasing out of growth-enhancing antibiotics in poultry feed. The latter are suspected to be capable of inducing resistance in human bacterial strains. In addition, new consumer trends in the search for healthier and less polluted animal products from medical substances, as well as new standards that take animal welfare, hygiene, and the environment into account (Van Immerseelel al., 2003). Besides, many authors attribute the emergence of pathologies such as necrotic enteritis and dysbacteriosis to the removal of growth-enhancing antibiotics, since there are lots of broilers with digestion problems, resulting in poor performance associated with very wet excrement problems, following this suppression (Ducatelle et al., 2009). As a result, the poultry sector was obliged to adopt new strategies to remedy this situation. This includes the nutritional approach based on the incorporation of food additives that are effective for improving the digestibility of nutrients. Currently, there is renewed interest in substances already known but not yet widely used in poultry, especially for their zootechnical properties.

Bentonite is one of the most tested clays, due to its physical and chemical characteristics (inflating, absorbent and colloidal) and its effects on the improvement of the weight and effectiveness of the feed in broiler chicken (Quisenberry, 1968; Pasha et al., 2007; Damiri et al., 2010; Khanedar et al., 20012). However, there are differences in the amount of clay and its supplementation in the food.

The objective of this study was to determine the effect of adding amounts of bentonite, by substituting an equivalent amount of corn in the feed formula, on the zootechnical performance of broiler chickens. By using different doses of bentonite (from 1% to 5%), we aimed to deduce the ideal rate of this clay to be incorporated, based on the achieved preformances.

MATERIAL AND METHODS

I. Breeding

I.1 Study area

The current study was performed in a poultry farm in Oran, north-western Algeria. It began on 12 June 2014 and ended on 31 July 2017.

I.2. Animals

The chicks of both sexes used in the work (490 chicks) were of ARBOR ACRES Plus strain, broiler type. They were randomly selected on the first day of hatching and divided into 7 experimental batches of 70 subjects each. They were reared separately, but under identical environmental conditions. The animals were followed from the time of their arrival, from the age of one day until they were sold at 50 days of age.

I.3. Buildings

The building was of modern type with a surface area of 1000 m², equipped with an automatic ventilation, temperature and hygrometry control system. The animals were distributed in 4.5 m² parquet floors, separated by plastic screens and placed next to one of the walls of the building. The animals were raised on the ground, on straw bedding spread over a thickness of 15 cm, to limit heat loss from the animals and the absorption of moisture from the excrement. A new layer was added daily to avoid the effect of its degradation on the health and performance of the chickens. Lighting was provided by 60-watt bulbs, i.e. 5 watts/m^2.

Table 1

The formulas used for the preparation of the food

	Start-up	Growth	Finishing
Corn	57.1 %	62 %	64.3 %
Dicalcium phosphate	1.9 %	1.9 %	1.8 %
Calcium carbonate	0.5 %	1.1 %	1.2 %
Sunflower oil	0.5 %	1 %	1.5 %
CMV	1 %	0.5 %	0.5 %
Soybean meal	38.2 %	32.94 %	30.2 %
Methionine	0.24 %	0.2 %	0.15 %
Lysine	0.03 %	0.03 %	0.02 %
Salt	0.5 %	0.3 %	0.3 %
Anticoccidial	0.03 %	0.03 %	0.03 %

II. Feed and clay

II.1 Feed

The chickens were fed ad-libitum with three types of feed, consisting mainly of corn and soybeans, and distributed as crumbs. Each type of feed corresponded to a rearing phase: start-up feed (J1-J15), growth feed (J15-J30), finishing feed (J30-J50). We have carefully prepared the feed by ourselves, with the formulas mentioned below, using a 100 kg mixer, in order to avoid dosing errors, whether it was clay or different ingredients (Table 1).

II.2. Clay

The Bentonite used was that of the sodium (BS) type and came from the MAGHNIA deposit in Tlemcen region (western Algeria). It was marketed by the BENTAL Company. In a crude state (BSC), this clay was in the form of a whitish, odorless powder. A mineralogical analysis by X-ray diffraction was carried out and showed a crystalline composition with a strong presence of smectite (Na). Some illite, traces of kaolinite, feldspar (K and Na) and quartz were also identified. One of the diets (batch 6) was spiked with a damaged bentonite (DBS) containing a fat fraction. It came from a refinery of the Cevital group and it was used for the depigmentation of table oil and was usually discarded in nature.

II.3. Experimental protocol

A total of 7 batches were used in the experiment, as follows:

- A negative control lot (T), without addition of BS with a standard corn and soybean feed. The feed was prepared by the formulas already mentioned (Table 1) ;
- Five experimental batches, containing different doses of BSC: batches 1, 2, 3, 4 and 5 with the addition of 1%, 2%, 3%, 4% and 5% of BSC respectively;
- One experimental batch (6), with 3% BSC added.

Both types of clays were added by substituting an equivalent amount of corn in the feed formula (addition by substitution). This mode of supplementation is sometimes used to evaluate the capacity of the clay to compensate for the nutrient deficiency of the ration; a hypothesis has been put forward on a possible relationship between clay and the low energy ration which stated that clay can compensate for the effect of the deficiency through the improvement of the digestibility of the feed.

III. Studied parameters

Zootechnicaly, we compared feed consumption, growth, feed conversion and mortality rates in batches of animals.

Two main comparisons of zootechnical parameters were made between batches:

- The inclusion or non-inclusion of bentonite in the chicken diet: comparing the zootechnical performance of chickens on a diet containing bentonite and other chickens consuming a standard feed without any addition.
- Percentage of bentonite incorporation in the feed (from 0% to 5%): comparison of the performances of chickens according to the rate of bentonite incorporation in the feed; in this case the parameter considered is the dose of bentonite used (from 0% to 5%).

III.1. Zootechnical performances

III.1.1. Body weight

Individual weighing with an electronic scale (0-5 kg) was carried out for the chicks on arrival (d1) and then every 5 days until the end of the rearing period. The purpose of the individual weighing was to determine the body weight of each chick and thus check the homogeneity of the batches.

III.1.2. Average daily gain (ADG)

The average daily gain (ADG) was calculated every 5 days by dividing the average weight of each batch by the number of days.

III.1.3. Food consumption

The amount of feed consumed by the animals in each batch was calculated daily by subtracting the amount of feed remaining (rejected) from the amount distributed.

Consumption (g) = Amount distributed (g) - Amount rejected (g)

Nevertheless, under the conditions of our experiment, 5 chickens from each batch were taken at different times (d5, d17, d29, d50) making a total of 20 chickens taken from each batch. These sampled and sacrificed chickens were used for intestinal flora analysis.

Since the number of chickens was recorded daily, we calculated the average amount of food consumed by each chicken (average individual consumption). In fact, the amount consumed by the batch was divided by the number of the present chickens. This value was used to calculate the consumption indices.

Average individual consumption (g/d) = (quantity distributed - quantity refused)/(number of subjects).

III.1.4. Determination of the Consumption Index (CI)

The Consumption Index (CI) was determined every 5 days and for each rearing period (start up, growth, and finishing), according to the general formula:

CI= (feed intake)/ (weight gain).

In fact, the CI was calculated on the basis of the body weights at each weighing and the individual average consumptions.

III.1.5. Mortality rate (MR)

The mortality rate was the ratio of the number of deaths recorded during the rearing period to the total starting size, expressed as a percentage (%).

MR (%) =(number of deaths during the rearing period)/(starting size)×100

Other data were recorded daily, including temperature inside and outside the building, humidity and ventilation (air velocity).

IV. Statistical analysis

Statistical analysis was conducted using the STATISTICA software (Version 10, Stat Soft France, 2003). Data of the various experiments and analyses were processed by the EXCEL software for the calculation of the mean (X) and the standard deviation (S). The same software was used for the graphs. The measured parameters were subjected to an ANOVA analysis of variance, followed by a comparison of means, according to the NEWMAN and KEULS tests at the 5% significance level.

RESULTS AND DISCUSSION

I. Zootechnical performances

I.1 . Consumption

The evolution of individual consumption in each batch is shown in Figure 1.

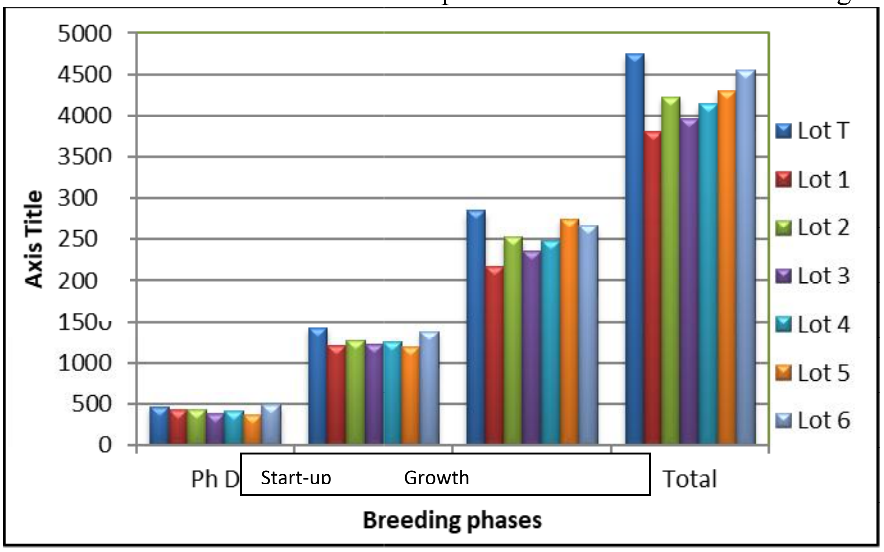

Fig. 1. Evolution of average individual consumption

Considering the whole rearing period, the total consumption in the experimental lots was lower than that of the control lot (T) by 52 kg (- 21%), 33 kg (- 13%), 52 kg (- 21%), 23 kg (- 10%), 33 kg (- 13%) and 11 kg (- 4%) for lots 1, 2, 3, 4, 5 and 6 respectively. However, this difference was statistically significant only for lots 1 and 3 ($p < 0.05$).

The same finding was obtained by comparing the average individual consumptions for the total rearing period. The average intake decreased by 949 g (- 20%), 524 g (-11%), 792 g (- 17%), 609 g (- 13%), 442 g (- 9%) and 206 g (- 4%) for lots 1, 2, 3, 4, 5 and 6 respectively. Lots 1 and 3 had the lowest average individual consumption, then to a lesser extent lots 2, 4 and 5, and finally lot 6. Statistical analysis, however, does not reveal any significant differences.

Analysis of each rearing period showed that the finishing period was characterised by a decrease in consumption of all experimental batches. A significant difference ($p<0.01$) was found for the consumptions of batches 1 and 3 and the average individual consumptions of these same batches. The chickens from batches 1 and 3 therefore consumed less during this period compared to the controls. Lot 4, with a dose of 4% BSC, was at an intermediate level, between lots containing a dose of 3 and 5%. Lot 2 was between lots 1 and 3.

If lots 1, 3, 4 and 5 were considered, the dose effect could be seen. Indeed, when the dose was increased, the chicken increased its consumption to compensate for the energy deficit caused by the substitution of a significant amount of corn by BS; nevertheless, the intake remained lower compared to controls.

I.2. Mean weight (MW), weight gain (GP) and average daily gain (ADG)

Figure 2 shows the evolution of weights during the main phases of rearing. The increase ranged from 5.5% for lot 1, to 10% for lots 2, 3 and 4. It was 8% in lot 5. For lot 6, with a DBS containing a fat fraction, the improvement was 15%. These improvements were statistically significant ($p < 0.01$).

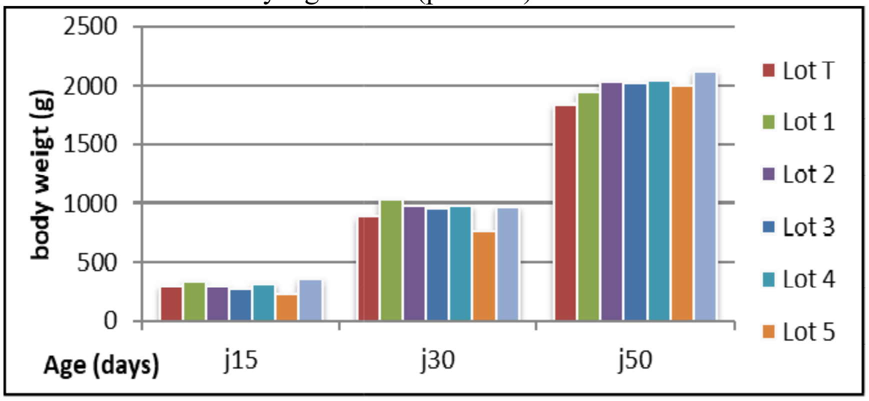

Fig.2. Evolution of body weight during the different phases of rearing

By following the evolution of the average body weight (ABW), WG and ADG of the animals during the whole period of the experimentation, some observations were noted:

- At D5: the addition of 1, 2 and 4% BS or 3% DBS had no effect on the body weight of the chickens; on the other hand, according to the data collected, the consumption of a feed with 3% or 5% BS resulted in a significant decrease ($p < 0.01$) of the weight during the same period;
- At D10: the application of the ANOVA test on the weights of all batches revealed a significant difference ($p < 0.01$) between batches. However, after verification of the means by the Fisher test, the difference was found between lot T and lots 3 and 5, the latter having lower weights than the controls, with a statistically significant difference ($p < 0.01$). The only weight improvement was observed for the lot ingesting 3% DBS ;
- At D15: at this period, which corresponded to the end of the start-up phase, chickens consuming 1 and 4% raw BS or 3% DBS showed a significant ($p < 0.01$) improvement in weight, compared to controls; weights in lots 3 and 5 remained lower than controls and the difference was again significant ($p < 0.01$) ;
- At D20: analysis of the data showed that performance remained unchanged from D15, with significant differences ;
- At D25 and at D30, the performance was the same: the changes observed at these two weigh-ups were in the chickens from lots 2 and 3 that regained weight, which became higher than the controls; the difference was significant ($p < 0.05$). The weights of lots 1, 4 and 6 remained higher than the controls and the difference was significant ($p < 0.01$). However, the chickens from lot 5 showed lower weights than the controls and the other experimental lots, with a significant difference ($p < 0.01$) ;
- At D35: comparison of the weights of lots 1, 2, 3, 4 and 6 showed a very significant improvement ($p < 0.01$) compared to the controls (T). The weights

of the chickens in lot 5 were lower than those of the controls, but the difference was not significant ;

- At D40and D45, there was a weight recovery for the chickens in lot 5, which were higher than the controls. The weights of the chickens from all experimental lots were thus higher than those of the controls, with a significant difference ($p < 0.01$).

Considering the total rearing period, it can be seen that the addition of bentonite to the chicken feed had a positive effect on the average body weight. Nevertheless, in the start-up and growth phase, the 5% dose (lot 5) was not beneficial for the chicken, compared to controls and other lots. The average WG and ADG were the lowest during these periods. Figures 3 and 4 showed the evolution of these two parameters according to the age of the chicken.

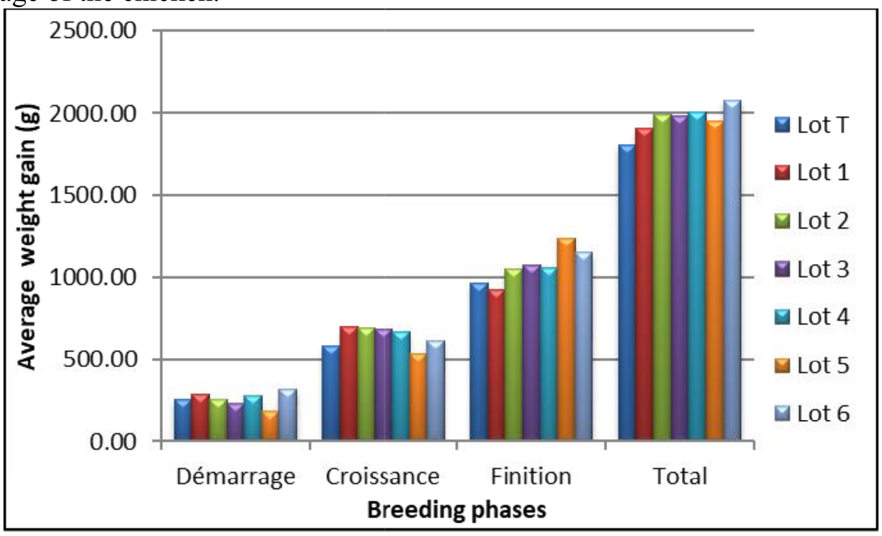

Fig. 3. Average weight gain during the rearing phases.

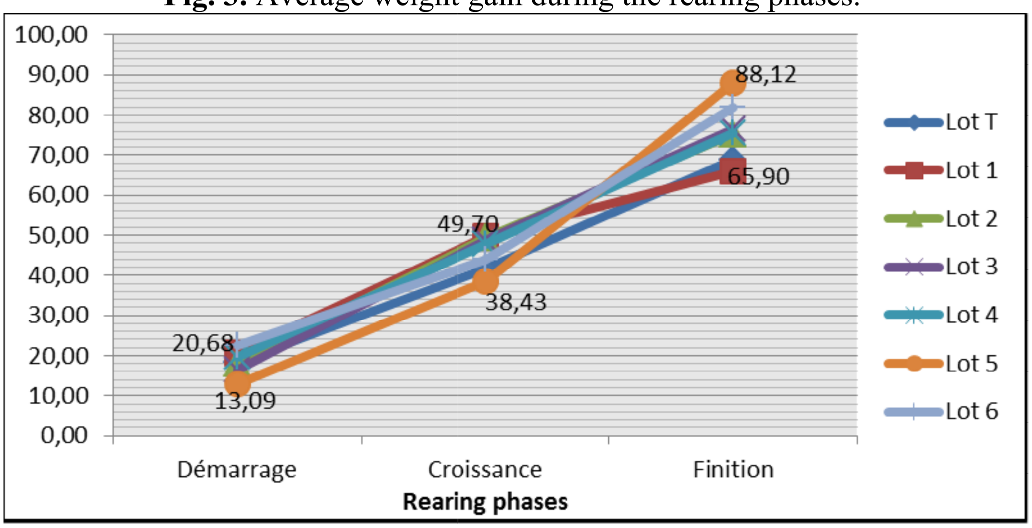

Fig. 4. Evolution of average daily gains (ADG) during rearing.

The data obtained showed a variability in the body weight obtained in the different batches depending on the age of the chicken. It appears that a high dose (5%) of BSC led to degradation of WG and ADG parameters during the start-up and growth phases of the chicken. On the other hand, a positive effect of this dose was observed in the finishing period; in fact, the mean WG, which was estimated at 183 g and 538 g in the start-up and growth phases respectively, increased to 1234 g in the finishing phase against control GP values estimated at 258, 583 and 965 g for the three periods, successively.

The ADG in batch 5 was 13 g/d between D1 and D15, then 38 g/d between D15 and D30 and 88 g/d during the rest of the work, compared to values in the control batch estimated at 18, 42 and 69 g/d for the same periods, successively. Batch 5 achieved the best average WG and ADG performance during the finishing period. The ADG was equivalent to that indicated in the strain's rearing guide during the same period.

By following the evolution of WG and ADG parameters, we revealed that a low dose of BSC (1%) had the best effect during the young age of the chicken, contrary to a high dose (5%). The chickens in batch 1 performed best during the first two phases of rearing (start up and growth), with average WG values of 290 and 696 g and an ADG of 21 g/d and 50 g/d during the first two phases, successively. Degradation was observed during the finishing period, with an average WG value of 913 g and an ADG of 66 g/d.

The performance of WG and ADG of chickens fed with intermediate doses (2, 3 and 4%) was between those achieved by chickens fed with extreme doses (1 and 5%).

The results concerning the weight performance recorded during the different rearing phases and the evolution of the feed conversion rate were summarized in tables 2 and 3.

Table 2

Weight performances during the different rearing phases

	Paramete r (g)	Lot T	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
Start-up	**MW**	299.44	330.59	295.34	272.33	317.12	224.06	358.53
	MWG	258.36	289.45	255.02	232.01	276.87	183.19	317.66
	ADG	18.45	20.68	18.22	16.57	19.78	13.09	22.69
Growth	**MW**	882.77	1026.33	984.51	954.67	987.90	762.07	973.10
	MWG	583.33	695.74	689.17	682.34	670.78	538.00	614.57
	ADG	41.67	49.70	49.23	48.74	47.91	38.43	43.90
Finishing	**MW**	1847.88	1948.95	2035.75	2025.08	2044.07	1995.78	2122.22
	MWG	965.11	922.61	1051.24	1070.41	1056.17	1233.72	1149.12
	ADG	68.94	65.90	75.09	76.46	75.44	88.12	82.08

MW: Mean Weight; MWG: Mean Weight Gain; ADG: Average Daily Gain

Table 3

Evolution of the consumption index (CI) during rearing.

Rearing period	Lot T	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
Start-up	1.55	1.31	1.42	1.41	1.25	1.78	1.30
Growth	2.43	1.73	1.84	1.80	1.87	2.20	2.22
Finishing	3.03	2.40	2.47	2.24	2.40	2.27	2.40
Cumulus	2.63	1.99	2.12	1.99	2.06	2.20	2.18

The comparison of feed conversion indices, for the overall rearing period, indicated an improvement in feed efficiency of the experimental batches compared to the controls. Indeed, all CI of chickens fed BS were lower than those fed a conventional feed. Statistical analysis of the CI, calculated on the basis of mean individual consumptions and body weights of the chickens, showed that at the end of the rearing period (D50), the difference was significant ($p < 0.001$). However, a difference existed between experimental lots fed with different doses of BSC and DBS. Indeed, lots 1 and 3, with 1 and 3% BSC, presented the best CI (1.99). This value was close to that given by the breeding guide for the strain used, which was 1.93, at the same period (D50). Lot 4 also provided good results, with a CI of 2.06. Lots 2, 6 and 5 had CI of 2.12, 2.18 and 2.2, respectively. The improvement in feed efficiency was 24, 19, 24, 22, 16 and 17% by adding 1, 2, 3, 4 and 5% BSC or 3% DBS, respectively, to the broiler feed.

By following the evolution of the CI since the beginning of rearing (figure 18), we noted a degradation of this parameter following the consumption of a starter feed with a high dose (5%) of BSC. This effect was however not significant ($p > 0.05$) at D5, then became significant ($p < 0.01$) at D10 and clearly significant at D15 and D20 ($p < 0.05$). At the end of the growth phase (D30), there was an improvement in CI for the same dose of BSC, but the difference was not significant ($p > 0.05$). At the end of the finishing period, the CI in Batch 5 was lower than that of the controls, with a significant difference ($p < 0.01$).

In all other experimental batches, the CI was lower than the control throughout the entire test period with a statistically significant difference. At D5, a statistically significant difference was observed only for lots 2 and 3. At the end of the growth phase, the difference was significant for lots 1, 3, 4, and 6. For the rest of the experimentation, the difference was significant and then very significant in lots 1, 2, 3, 4 and 6. We noted earlier that the addition of BSC had a different effect on consumption and average weight of chickens, depending on the age of the animals. The changes influenced directly CI, especially in young chicks.

The start up and early growth period was characterized by a lower average weight in lot 5 compared to controls, with a significant difference. Consumption, on the other hand, was not significantly modified, resulting in a significantly higher CI. Although the consumption was not modified in the chickens of lots 1, 4 and 6, their average weight was significantly improved, giving a significantly lower CI than the controls.

It has been shown that an increase or decrease in consumption was not an accurate reflection of the level of efficiency of a feed. In the finishing period, the changes observed were decisive for the final performance of the whole study. Indeed, consumption was reduced in all experimental batches, especially in batches 1 and 3, where the difference was statistically significant ($p < 0.05$). On the other hand, the mean weight was very significantly improved ($p < 0.01$), with a stronger effect after 35 days. These parameters gave very significantly low CI compared to controls during this phase (Figure 5 and 6).

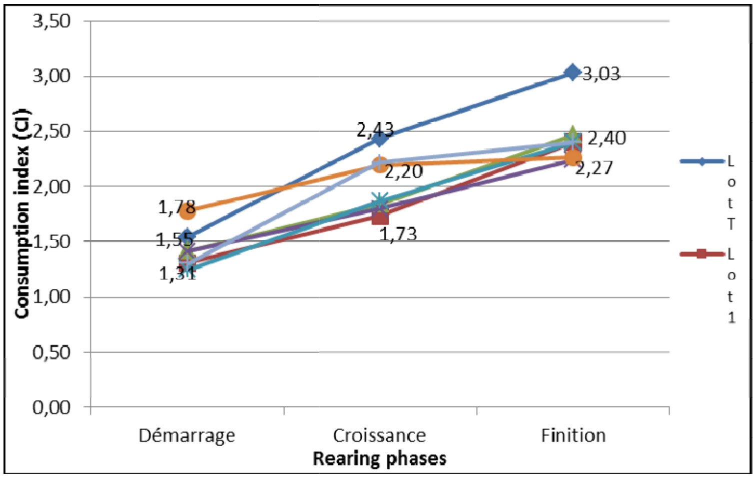

Fig. 5. Changes in the Consumption Index (CI) during rearing

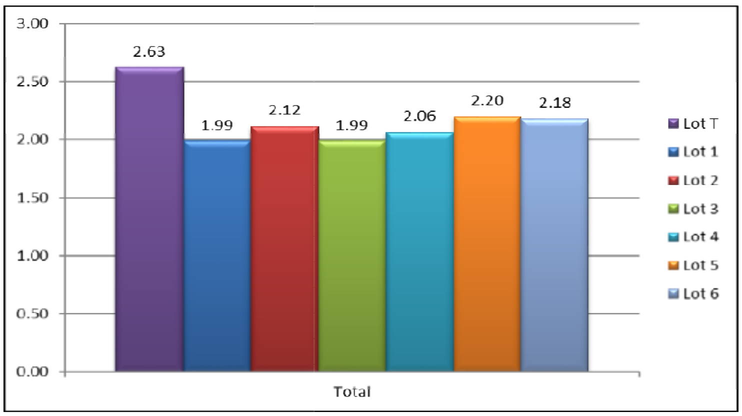

Fig. 6. Consumption indices (CI) recorded at the end of the test

I. Zootechnical performances

I.1 Consumption

Chicken consumption decreased as a result of the addition of bentonite to the feed, with variability in statistical significance. For the total rearing period, the 1% and 3% doses (low and medium dose) of BS, significantly decreased the consumption of the chickens, and this effect was more pronounced during the finishing period. It seems that the increase in dose to 4% and 5% caused an increase in ingestion, without exceeding the control. This could be due to the energy deficit, caused by the substitution of a high amount of corn by clay. It is known that even direct supplementation, by adding the clay as an additive that does not fit into the formula, generates a dilution of the ration and induces an increase in consumption to compensate for the effect of the dilution (Mallet et al., 2005). Our results are in perfect conformity with those obtained by Khanedar et al., (20012), with 1% sodium bentonite or calcium bentonite. Similar results were obtained by Damiri et al., (2012), who found a decrease in the ingestion by adding 3.75% BS in the chicken feed ration. They suggested that the decrease in ingestion was related to the viscous and colloidal nature of BS, which slows transit and therefore decreases ingestion. The study conducted by Reichardt (2008) on rats, indicated that voluntary supplementation with kaolinite up to 5% of the solid ingested fraction results in a 7% decrease in feed intake. This author found an increase in the expression of plasma factors that lead to the regulation of food intake and digestive phenomena. Indeed, plasma leptin concentrations increase. This peptide hormone, secreted mainly by adipose tissue, acts on energy metabolism and body mass regulation by reducing food intake and stimulating energy expenditure. Proteomic analyses of the jejunal mucosa of these rats also revealed the overexpression of apolipoprotein A-IV known as a satiety factor.

The reduction of ingestion cannot be considered as a consistent effect of clay supplementation of the chicken feed. Opposite results were obtained in other studies (Southern et al., 1994; Mallet et al., 2005; Pasha et al., 2008). These authors observed an increase in chicken consumption following clay supplementation. Tauqir et al. (2001) tested several doses (1%, 2%, 3%, and 4%) of BS; only the 1% dose had an effect on consumption, increasing the latter; the other intake levels had no significant effect on this parameter. Others reported that clay included in poultry feed did not influence ingestion, as in the case of previous experiments (Garcia., 1997; Ouhida et al., 2000; Tauqir et al., 2001; Rowghani et al., 2007; Ouachem et al., 2009).

I.2 Weight

The current study showed a significant improvement in the final weight of the chicken with the addition of bentonite to the feed; however, it appears that the high dose (5%) of BSC, leads to a degradation of WG and ADG parameters during the start-up and growth phases. It appears that the low dose (1%) had the best effect during the young age of the chicken, in contrast to the high dose (5%); the performance of WG and ADG of the other chickens fed with intermediate doses (2%, 3% and 4%) was between those achieved by the chickens fed with extreme doses (1% and 5%).The majority of the literature data indicated a positive effect of clay on weight. However, there is a discrepancy in the level of incorporation of clay in the feed. Tauqir et al, (2001) and Damiri et al, (2012), using variable doses (from 0.75 to 4%) of the same clay tested in our study, observed an improvement in weight; nevertheless, Tauqir et al, (2001), reported that the high dose (4%), decreased the weight of the chicken and the dose of 1% was the most economical based on the performance achieved. Weight improvement was observed with doses below 3.75% by Damiri et al. (2012).

I.3 Consumption Index

For the CI at the end of the rearing, an improvement was observed with all levels of BS incorporation. The best result was obtained with the doses of 1% and 3%, which was 20% compared to the control, despite the reduction of ingestion as well as the deficit caused by the substitution of a quantity of energy (1% or 3% of corn). Overall, we believe that bentonite has the capacity to improve chicken growth and feed utilization efficiency. Our supplementation method was therefore beneficial for the improvement of these production parameters, despite the energy deficit caused by the substitution method. Nevertheless, it would be recommended to adapt this supplementation to the age of these animals to avoid the negative effect of a high dose of bentonite (5%) during the young age. This effect could be a consequence of the immaturity of the digestive system of the broiler during this period, which cannot compensate for the effect of substitution and/or because of possible bentonite toxicity in young chickens. Therefore, it would be more appropriate to use doses below 4% during the start-up and growth period and to add bentonite directly to the ration with the feed formula balanced in different nutrients. Our data are in agreement with many research studies (Quisenberry, 1968; Suchy et al., 2006; Safaeikatouli et al., 2011; Damiri et al., 2012). According to Pasha et al. (2007), the addition of 0.5% sodium bentonite in chicken feed significantly improved all zootechnical parameters negatively affected by aflatoxin, and corrected the relative weights of liver, heart, gizzard and mortality increased significantly with the addition of 100 mcg/kg aflatoxin in the feed.

The mechanisms by which the clay included in the feed improving performance have attracted the interest of researchers in recent years. These studies have focused on certain parameters responsible for production performances, and the slowed intestinal transit is one of the effects most often mentioned to explain the improved efficiency of the feed. Clay minerals and bentonite in particular, are known for their viscous, swelling and colloidal nature. They absorb water and increase in volume. These characteristics are, in large part, responsible for slowing down transit and decreasing the rate at which food passes through the intestinal lumen (Damiri et al., 2012, Quisenberry, 1968). The increase in the transit time of food in the intestine allows for better assimilation and absorption of nutrients. It also allows for better enzymatic action and therefore improved food efficiency. These effects result in an increase in the use of energy and protein in the ration, which is manifested in the blood by an increase in total protein, glucose, bilirubin and growth hormone (Safaeikatouli et al., 2011).

CONCLUSIONS

Our main objective was to determine the effect of adding different doses of bentonite, in the feed formula, on the zootechnical performance of the broiler chicken. At the end of this study, we believe that this supplementation is beneficial, given the obtained results. Overall, our experience has shown an improvement in the studied parameters. Indeed, the final weight of the chickens was considerably better with the addition of bentonite at any dose, despite the reduction in consumption observed. These results were expressed as a significantly improved feed efficiency index. Our results support the suggestions of previous authors for the use of a dose that can go up to 5% of the ration. Nevertheless, a negative effect of a high dose (5%) of bentonite in young chicks is underlined. It seems, therefore, that the age of the chicken is an important factor to consider when determining the dose to be used. During the start-up and growth phase, it is recommended to use a low dose estimated at 1% to 3%. Furthermore, this study showed a beneficial effect of utilizing a bentonite from oil refineries. In addition to the already observed effects of this substance in its raw state, this product, usually discarded in nature, contains a percentage of energy in the form of lipids, and its use would be a way of enhancing the value of the latter.

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