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*Full Length Research Paper*

# Effect of the incorporation of clay on feeding digestibility, nutrient retention, and digestive organ size of broiler

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Two hundred one day old Hubbard JV chicks with an average initial body weight 37.59 g ( $\pm 0, 150$ ) ( $P=0.228$ ) were used in fattening and digestibility trial. The aim was to study the effect of zeolite supplementation to diet on poultry performance. Chicks were divided into 3 treatment groups: A<sub>0</sub>, A<sub>0.5</sub> and A<sub>1</sub>, containing 0; 0.5 and 1% of zeolite, respectively. Three experiments were conducted: fattening, digestibility and carcass trial. Fattening experiment was performed for a 39 days period. Animals were fed ad libitum starter CF1 (1-17 days of age), then grower-finisher CF2 (18-39 days of age) concentrates. Feed digestibility was controlled by using reference on 24 chickens (8×3) aged of 15 days and weighing 425 g of live body weight. At the end of the essay (39 days of age), 24 chickens (8 × 3) were slaughtered to determinate hot and chilling carcass weights and yields and the proportions of breast and thigh and digestive organs in carcass. Overall results indicate that zeolite had no influence on global growth performance (48,71g). Carcass parameters studied were statistically similar for the three treatments ( $p > 0.26$ ). However it seems that abdominal fat weight for the animals received 0.5% of zeolite tends to be higher than animals of the other treatment ( $p = 0.052$ ). In conclusion, it appears that the addition of zeolite in broiler feeds does not have any impact on the different parameters studied.

**Keywords:** carcass parameters, digestibility, poultry, zeolite

## INTRODUCTION

Food safety and quality assurance have become the major concern of nations, which has led to changes in many industrial practices, considered as a technical and scientific review contributing to the evolution of livestock and the improvement of their profitability. The use of clay

supplements in animal and poultry feed manufacturing is not new. Recent studies involving the use of clays as dietary supplements have given results which suggest that some clay products may have direct beneficial effects upon animal performance. Few such studies have provided evidence that the clay products were themselves making nutritive contributions but most have demonstrated an improved caloric efficiency resulting from their use. Clay supplements have generally been used in animal diets for

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reasons other than the nutrients they supply. Recent reports have shown that low level additions of clay to poultry diets improved caloric efficiency and slowed down feed passage (Kurnick and Reid 1960; Quisenberry and Bradley 1964; Eshleman 1966; Quisenberry 1966; Almquist et al., 1967; Ousterhaut 1967).

Our work is in the use of clays, especially the zeolite and its effects on digestibility and some carcass parameters of broilers.

## MATERIALS AND METHODS

### Animal, management and feeding

The digestibility trial was conducted from April 18, 2011 on 24 chickens aged of 15 days and weighing 425 g of live body. Chicks were divided into 3 treatment groups (8×3): A<sub>0</sub>, A<sub>0.5</sub> and A<sub>1</sub>. Animals were fed *ad libitum* starter CF1 (1-17 days of age) and grower-finisher CF2 (18-39 days of age) concentrates. Concentrates used in this test were manufactured in the factory concentrated feed "SOMIPA", Tunisia. Two types of food were made: one for the start-up phase (CF1) and another for growing-finishing phase (CF2). Each type has three different diets: a control diet (A<sub>0</sub>) containing neither antibiotic growth nor any alternative product and two experimental (A<sub>0.5</sub>) containing the additive zeolite with a percentage of 0.5% (A<sub>1</sub>) containing the zeolite with 1%. Nutritional values provided by the manufacturer for CF1 and CF2 concentrates are the same and listed in Table 1.

### Concentrates sampling analysis

Physical analysis is to determine the size distribution of food. It was made May 6, 2011 in the Soil Science Laboratory, the principle is to move the samples by superimposed sieves in descending order; each sample for 5 minutes left in the sieve and the particles will be distributed in the appropriate diameter of the sample particles are well distributed over the different sieves separately. Once the analysis is completing each recovered amount of each sieve was weighed to determine its percentage share in the feeds.

### Protocol of the experiment

The digestibility trial is based on the method of Bourdillon *et al.*<sup>7</sup>. The protocol is to adapt the animals for a certain period and then collect and analyze droppings. During the adaptation phase (6 days), the food was distributed *ad libitum* to follow the daily consumption and to achieve a stable level of intake. A digestion study of 25 days duration, involving quantitative collection of feeds, refusals and faeces was conducted to determine the apparent digestibility of the diet. Representative samples of

concentrate, refusals and faeces were collected, bulked, mixed, dried at 105°C to determine daily intake of DM for each animal and then ground to pass a 1 mm sieve for subsequent laboratory analysis to determine DM, OM and CP.

### Carcass parameters

The slaughter of chickens took place on 12/05 at an age of 39 days after a water diet 24 hours. From each batch, 2-3 animals were taken, weighed and slaughtered. The average weight of the animals was 1982 ± 100 g. Each animal had a card on which all measures will be graded.

### Statistical analysis

The statistical analysis aims to determine, from the collected data the effect of zeolite supplementation on the digestibility of foods and some carcass parameters for broiler. We carried out an analysis of variance using the general linear model (GLM) of the SAS software Version 9.14<sup>8</sup> and compared the averages calculated by the "Student" test.

## RESULTS AND DISCUSSIONS

### Chemical composition of mixed feeds

Compared to the theoretical values (Table 1) CF and CP given by the manufacturer and the results of chemical analyzes in the laboratory of Animal Production of the Higher Institute of Agronomy of Chott-Mariem, Sousse, Tunisia, are in the standards (2.98 % CF and 20.88% CP and 2.89% CF and 20.71% CP, respectively, for the crumbled and pelleted food). However, the chemical compositions between A<sub>0</sub> concentrates, A<sub>0.5</sub> and A<sub>1</sub> are close. This indicates that the addition of zeolite additive has not changed the DM, OM, and CF in the mixture during the manufacturing process, while a slight decrease was observed in CP with the zeolite doses. Therefore, the animals of the three treatments have received identical contents of fiber and protein (table 2).

The granulometric composition of the concentrate crumbled and granulated food appears homogeneous<sup>9</sup> and the coarse fraction is the major fraction of each food in the range of 76.24, 67.1 and 58.38% for A<sub>0</sub>, A<sub>1</sub> and A<sub>0.5</sub> for crumbled food (table 3).

It is noted that control food is more homogeneous than fortified foods (figure 1).

From Figure 2, the heterogeneity between the different size fractions of crumbled and granulated food is low except for a difference of 9 and 18% (crumbled food) and 5 and 10% (granulated food) for the size fraction > 1 mm. According (Cheeke 1991), clays are probably the most used binders in the production of concentrates. (Mateos et

**Table 1.** Nutritive values concentrate feed

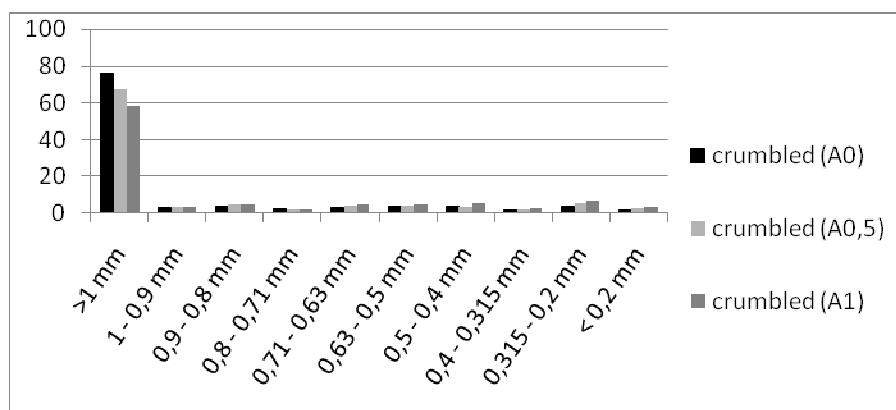
| Nutritive values   | %    |
|--------------------|------|
| Protein            | 19   |
| Fat                | 3    |
| Energy (Kcal / kg) | 2900 |
| Crude fiber        | 5    |
| P                  | 0,6  |
| Ca                 | 1    |
| Ash                | 7    |

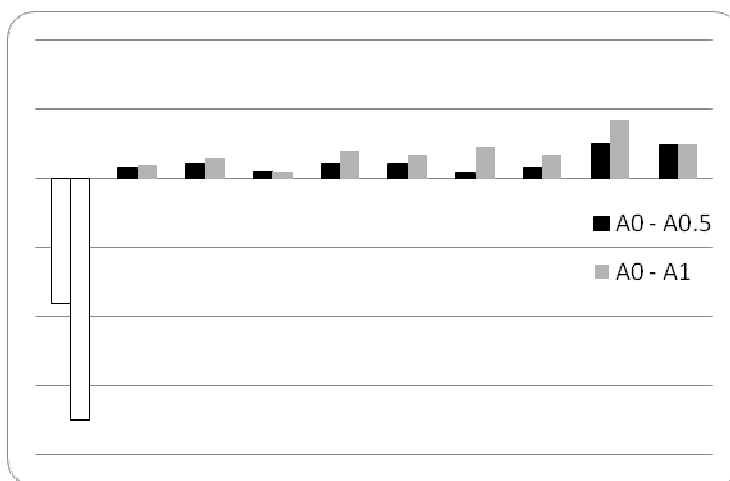
**Table 2.** Results of the chemical analysis concentrate

| chemical analysis    | CF1            |                  |                | CF2            |                  |                |
|----------------------|----------------|------------------|----------------|----------------|------------------|----------------|
|                      | A <sub>0</sub> | A <sub>0,5</sub> | A <sub>1</sub> | A <sub>0</sub> | A <sub>0,5</sub> | A <sub>1</sub> |
| Dry matter (%)       | 91.32          | 91.97            | 92.36          | 92.01          | 92.34            | 92.37          |
| Organic matter(% DM) | 94.45          | 94.44            | 94.64          | 94.39          | 94.58            | 95.03          |
| Crude fiber (% DM)   | 2.91           | 3.27             | 2.77           | 2.68           | 3.34             | 2.65           |
| Crude protein (% DM) | 21.37          | 21.47            | 19.81          | 21.36          | 20.95            | 19.84          |

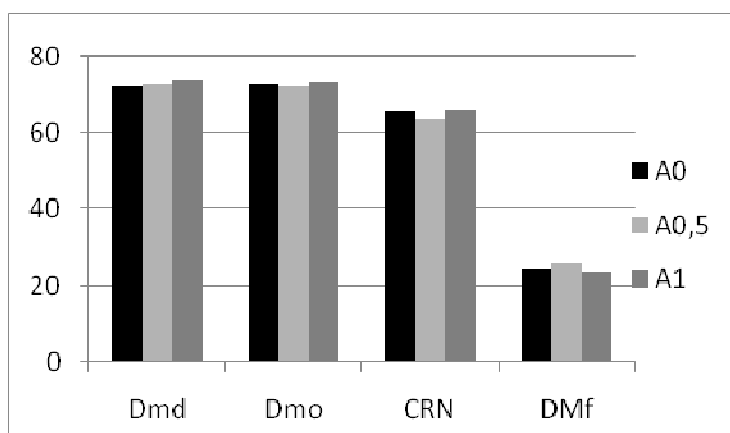
**Table 3.** Results of the sieve analysis concentrated feed

| Fraction size (%) | CF2 crumbled   |                  |                | CF2 pelleted   |                  |                |
|-------------------|----------------|------------------|----------------|----------------|------------------|----------------|
|                   | A <sub>0</sub> | A <sub>0,5</sub> | A <sub>1</sub> | A <sub>0</sub> | A <sub>0,5</sub> | A <sub>1</sub> |
| >1mm              | 76.24          | 67.10            | 58.38          | 98.86          | 93.81            | 89.10          |
| 1 - 0.9mm         | 2.60           | 3.28             | 3.50           | 0.08           | 0.54             | 1.05           |
| 0.9 - 0.8mm       | 3.68           | 4.59             | 4.91           | 0.04           | 0.42             | 1.01           |
| 0.8 - 0.71mm      | 1.78           | 2.22             | 2.18           | 0.02           | 0.26             | 0.59           |
| 0.71 - 0.63 mm    | 3.08           | 4.10             | 4.85           | 0.03           | 0.46             | 0.08           |
| 0.63 - 0.5 mm     | 3.19           | 4.20             | 4.68           | 0.03           | 0.43             | 1.07           |
| 0.5 - 0.4 mm      | 3.70           | 3.62             | 5.53           | 0.02           | 0.46             | 0.89           |
| 0.4 - 0.315 mm    | 1.40           | 1.87             | 3.01           | 0.002          | 0.29             | 0.59           |
| 0.315 - 0.2 mm    | 3.16           | 5.22             | 7.03           | 0.05           | 1.09             | 1.64           |
| < 0.2 mm          | 1.18           | 3.08             | 3.13           | 0.01           | 0.99             | 0.97           |

**Figure 1.** Distribution of particles of crumbled food



**Figure 2.** Deviation in the size distribution of the crumbled food supplemented with zeolite compared to the control



**Figure 3.** Variation of Dmd, Dmo, CRM and DMf as a function of diets A0, A0.5 and A1

al., 2012), reports that if proportion of the coarse fraction is important there will be an increase in the size of the gizzard and an improvement in its functioning since these particles remain longer in it, increasing the pH and provide a good mix of nutrients and enzymes as well as the homogeneity of the finished product.

### Digestibility trial

Statistical analyzes show that levels of digestibility of dry matter and organic matter for animals of different diets are identical ( $p = 0.202$  and  $p = 0.227$ ) (figure3).

For dry matter of faeces chickens of control diets and those supplemented diets are identical (24.47 and 24.79

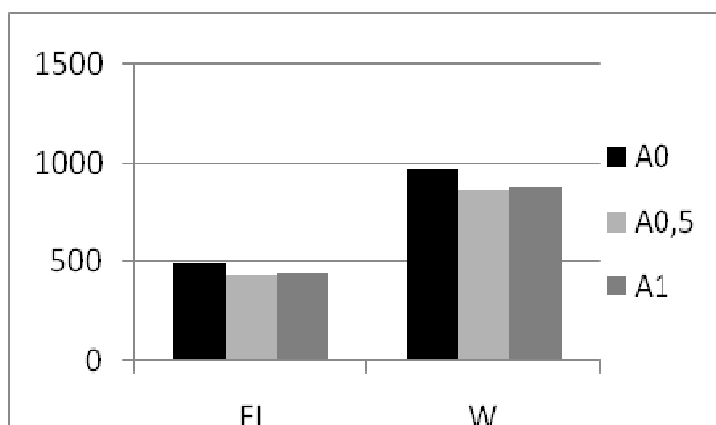
respectively). The zeolite used in doses 0.5 and 1% did not improve the digestibility of food. These values were averaged 73.08, 72.81 and 64.65% respectively for Dmd, Dmo and CRM (table4).

Incorporation of zeolite showed a significant effect on the valorization of food for diets A<sub>0.5</sub> and A<sub>1</sub> ( $p = 0.01$ ). However, water consumption is significantly different ( $p = 0.329$ ). This consumption is proportional to that of the food for subjects receiving the additive. Despite this difference in consumption of dry matter of faeces chickens of A<sub>0</sub>, A<sub>0.5</sub> and A<sub>1</sub> are identical (24.47, 25.93 and 23.66 respectively). ( $p = 0.661$ ). These results partially explain the low incidence of food supplement on growth, consumption, feed intake, mortality rates as well as the parameters of

**Table 4.** Digestibility of dry matter (Dmd), digestibility of organic matter (Dmo), coefficient of nitrogen retention (CRN), water consumption (W), feed intake (FI), dry matter of faeces (DMf) by treatment

| Treatment | Dmd (%) | Dmo (%) | CRN (%) | DMf (%) | W (ml) | FI (g)             |
|-----------|---------|---------|---------|---------|--------|--------------------|
| A0        | 72.18   | 71.97   | 65.27   | 24.47   | 965    | 491.92             |
| A0.5      | 72.51   | 72.23   | 63.66   | 25.93   | 867.37 | 428.1 <sup>b</sup> |
| A1        | 73.66   | 73.40   | 65.64   | 23.66   | 885    | 437.1 <sup>b</sup> |
| Prob      | 0.202   | 0.227   | 0.631   | 0.661   | 0.329  | 0.017              |
| CME*      | 0.592   | 0.602   | 1.538   | 0.018   | 48.037 | 73.894             |

\*CME: Mean Square of Error. The average of the same column with different letters are significantly different ( $p < 0.05$ ).



**Figure 4.** Evolution of ingested and the quantity of water consumed depending on diet

chicken carcasses. The composition of the zeolite, its purity, its origin and nutritional characteristics and centesimal of concentrate feed are missing elements in this study and that could explain the level of effectiveness of the clay (figure4).

#### Carcass parameters

With the exception of the weight of abdominal fat ( $p=0.052$ ), no significant difference was observed ( $p > 0.222$ ) on the different parameters analyzed. The percentages of the weight of abdominal fat of animals of each treatment were significantly different. It appears that the zeolite tends to show a positive effect on reducing fat accumulated in

animals consuming 0.5% of zeolite. These results are identical to those obtained by (Castaing 1994), who have shown that the effect of the addition of the clay on the reduction of body fat of the carcass and the increased rate of muscle (table5). (Rotermel et al., 1964), reported an increase in chest width and carcass fat of two groups of swine fed diets containing 1% of clay, suggesting an increase in calorie retention.

(Ousterhout 1967), reported that the inclusion of various clays at levels as high as 16% in practical broiler rations improved caloric efficiency with no apparent effect upon growth or carcass quality.)

**Table 5.** Different parameters measured carcass after slaughtering

|                                    | A <sub>0</sub> | A <sub>0.5</sub> | A <sub>1</sub> | Prob  |
|------------------------------------|----------------|------------------|----------------|-------|
| Body weight (g)                    | 1933.33        | 2054.03          | 1980.98        | 0.221 |
| Carcass weight (g)                 | 1675.15        | 1748.74          | 1721.58        | 0.394 |
| Hot carcass weight eviscerated (g) | 1475.75        | 1527.70          | 1510.73        | 0.572 |
| Cold carcass weight (g)            | 1437.00        | 1514.09          | 1486.08        | 0.267 |
| Liver weight (g)                   | 41.65          | 43.35            | 45.65          | 0.446 |
| Weight gut (g)                     | 143.17         | 160.07           | 153.05         | 0.110 |
| Gizzard weight (g)                 | 28.67          | 31.60            | 31.40          | 0.431 |
| Gizzard fat weight (g)             | 8.02           | 9.62             | 7.57           | 0.565 |
| Weight of abdominal fat (g)        | 15.37          | 12.13            | 16.61          | 0.113 |
| Duodenum Weight (g)                | 14.85          | 15.17            | 14.15          | 0.662 |
| Juojunum weight (g)                | 25.15          | 24.25            | 25.00          | 0.783 |
| Ileum Weight (g)                   | 18.72          | 19.50            | 20.47          | 0.331 |

\* CME: Mean Square of Error.

The average of the same column that does not contain the letters is not significant ( $p > 0.05$ ).

## CONCLUSION

The results of our study show that clay tested and incorporated with 0.5 to 1% in concentrates starter for broilers are not very conclusive and do not allow us to crown the effect of zeolite on digestibility and some of carcass parameters that is why we have to investigate other levels of zeolite supplementation to confirm its effects on feeding digestibility, nutrient retention, and digestive organ size of broiler.

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