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Effect of the inclusion of *Medicago sativa* in feed chicken Cobb 500

Efecto de inclusión de *Medicago sativa* en el alimento de pollos Cobb 500

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ABSTRACT

The present research was carried out at the Santa Ines farm of the Faculty of Agricultural Sciences (FCA) of the Universidad Técnica de Machala (UTMACH), in the Province of El Oro (Ecuador), which objective was to evaluate the effect of the inclusion of *Medicago sativa* meal (alfarina) in broiler chicken Cobb 500 feed on productive parameters, carcass and sensory analysis. Poultry biosecurity standards established for open house systems were applied, trying to maintain comfort and well-being for the birds; a basic vaccination plan was used that consisted of the use of Gumboro "Intermediate strain" and New Castle "La Sota". A Completely Random Design (CRD) was used, distributed in 5 treatments, with 4 replicates of 10 chickens, for a total of 40 birds per treatment (T). The T1 or control received a commercial diet (without inclusion of alfarine), while in T2, T3, T4 and T5, alfarine was included in the feed at 1, 2, 3 and 4 %, respectively. The variables studied were: accumulated feed and water consumption, feed conversion, mortality, live weight gain, carcass assessment parameters, abdominal fat thickness and organoleptic indicators. The data obtained were processed in the statistical program *Statgraphics Centurión XV.I*, performing an ANOVA analysis on all the quantitative variables studied, after complying with the assumptions of normality and homogeneity. To discriminate between means, Tukey's significant difference procedure was used, with a confidence level of 95 %. The results show that alfalfa meal in the diet has no effect on the parameters evaluated, so this raw material can be used without problems in the feeding of broilers without exceeding 4 % inclusion.

Key words: Alfarina; productive parameters; carcass performance; sensory analysis

RESUMEN

La presente investigación se realizó en la granja Santa Inés de la Facultad de Ciencias Agropecuarias de la Universidad Técnica de Machala, en la Provincia de El Oro (Ecuador), cuyo objetivo fue evaluar el efecto de la inclusión de harina de *Medicago sativa* (alfarina) en la alimentación de pollos de engorde Cobb 500, sobre los parámetros productivos, de la canal y análisis sensorial. Se aplicaron los estándares de bioseguridad avícola establecidos para los sistemas de naves abiertas, tratando de mantener la comodidad y el bienestar de las aves; se utilizó un plan básico vacunal que consistió en el uso de Gumboro "cepa Intermedia" y New Castle "La Sota". Se empleó un Diseño Completamente Aleatorio (DCA), distribuido en 5 tratamientos, con 4 réplicas de 10 pollos, para un total de 40 aves por tratamiento. El T1 o control recibió una dieta comercial (sin inclusión de alfarina), mientras que en T2, T3, T4 y T5 se incluyó alfarina en la alimentación al 1, 2, 3 y 4 %, respectivamente. Las variables estudiadas fueron: consumo acumulado de alimento y agua, conversión alimenticia, mortalidad, ganancia de peso vivo, parámetros de valoración de la canal, espesor de grasa abdominal e indicadores organolépticos. Los datos obtenidos fueron procesados en el programa estadístico *Statgraphics Centurión XV.I*, realizando un análisis ANOVA sobre todas las variables cuantitativas estudiadas, luego de cumplir con los supuestos de normalidad y homogeneidad. Para discriminar entre medias, se utilizó el procedimiento de diferencia significativa de Tukey, con un nivel de confianza del 95 %. Los resultados muestran que la harina de alfalfa en la dieta no tiene efecto sobre los parámetros evaluados, por lo que esta materia prima puede ser utilizada sin problemas en la alimentación de pollos de engorde sin exceder el 4 % de inclusión.

Palabras clave: Alfarina; parámetros productivos; rendimiento de la canal; análisis sensorial

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INTRODUCTION

Poultry farming is one of the most important livestock activities in Ecuador, due to the growing demand for poultry protein, in both quantity and quality as well as safe edible products for the consumer, and the production of fattening birds is one of the productive sectors with greater economic movement. Among the most exploited poultry lines in the Country, the Cobb 500 broiler stands out, thanks to genetic improvement, growth rate, carcass performance, excellent feed conversion rate and the ability to cope with low-density and low-cost diets; qualities that give them a competitive advantage for the lower cost per kilogram (kg) or pound of live weight produced to meet the high demand worldwide [4].

Feeding represents approximately 70 % of the production costs in the economic structure of a poultry farm, so it is of utmost importance to consider an economic feeding plan, so that it positively influences the costs in the farm [5, 25]. This has prompted researchers to improve feed management standards, taking interest in studies on the inclusion of protein-fibrous sources in the diets of broiler chickens (*Gallus gallus domesticus*), which have shown influence on the welfare of the bird, in addition to avoiding cannibalism [17]. España-Castillo *et al.* [8] stated that modern producers have the tendency to incorporate alternatives for the fattening bird like grazing, thereby reducing stress, pecking and cannibalism, main causes of mortality in chickens.

Due to this and other physiological reasons related to the animals, feeding alternatives are being implemented and also achieving lower production costs, finding studies at nutritional level with the inclusion of various raw materials, among them those carried out with protein-fibrous products like *Medicago sativa* (alfalfa); a forage legume commonly used as feed in different species of animals [10], due to its high content of protein (17.4 %), fiber (24.5 %) and xanthophylls (40 to 620 mg·kg^{-1}) [9], as well as the natural pigmenting capacity that it possesses and that helps to favor the characteristic coloration of the chicken skin and the yolk of the eggs [10]. It can be consumed in a dry, ensiled, hay or dehydrated form, the latter giving rise to a higher quality product [9]. Alfalfa, given its nutritional value, has been implemented in both human and animal nutrition [23].

Therefore, the objective of this research was to evaluate the effect of the inclusion of *M. sativa* meal in broiler chicken feed on the productive parameters, the carcass performance and sensory analysis.

MATERIALS AND METHODS

This research was carried out at the experimental farm "Santa Ines" belonging to the Faculty of Agricultural Sciences of the Universidad Técnica de Machala (UTMACH), which is located at kilometer 5½, via Machala – Pasaje, coastal region of Ecuador, whose geographical coordinates are 79°54'05" West, 3°17'16" South, with an altitude of 5 meters above sea level. Its temperature fluctuates between 22 and 35°C.

In order to maintain an optimal environment for the birds, all biosecurity standards specified for open houses were implemented. The disinfection of the installation was carried out by liming (Cal P24) and 37 % formaldehyde diluted in water and applied directly by spraying to floors and walls before the arrival of the experimental animals. Coarse wood chips were used as litter. A basic vaccination plan was used that consisted of vaccines according to the diseases present in the area, therefore administering GumboVac Intermediate strain, orally on day (d) 6 and its reinforcement on d 14 and by ocular route, and New Castle "La Sota "on d 9 and its revaccination on d 23.

In order to maintain the comfort temperature of the animals, plastic curtains were used over the mesh walls and yellow 100-watt bulbs that served as a source of illumination as well. For the experiment, 200 mixed newborn chickens of the Cobb 500 line were used, and evaluated for 35 d.

Throughout the study, the following variables were recorded: feed and water consumption, feed conversion, mortality, live weight of the birds, carcass data, abdominal fat thickness and organoleptic indicators (color, flavor, tenderness and juiciness). To record the weight data, a CAMRY brand electronic gramera scale (model EK9332-F302 "China") was used with a maximum capacity of 5 kg and a margin of error of ± 1 gram (g). The volume data were recorded with a 4 liter (L) container with minimum measurements of 50 mililiter (mL), and to obtain abdominal fat thickness data, a digital caliper 0-150 milimeter (mm) brand TACTIX was used.

Cumulative feed intake (g)

It was recorded weekly and expressed in g, it was obtained by subtracting the excess food from the offered one, and this was done throughout the duration of the experiment. This variable is quantitative. One hundred data were obtained 5 Treatments (T) x 4 Experimental Unit (EU) x 5 weeks (wk). The formula is as follows:

$$Accumulated\ feed\ consumption\ (g) = Feed\ offered - Leftover\ feed$$

Cumulative water intake (mL)

This variable is of a quantitative type, expressed in mL, and to obtain it, the sum of the water offered daily was considered and subtracting the sum of the unconsumed water. One hundred data were obtained (5T x 4EU x 5 wk). The applied formula is the following:

$$Accumulated\ water\ consumption\ (mL) = Water\ offered - Unconsumed\ water$$

Feed conversion ratio

This numerical data was calculated by dividing the feed consumed by the weight of the birds in g, this variable being of a quantitative type. One hundred data were obtained (5T x 4EU x 5wk). The applied formula was the following:

$$Feed\ conversion\ ratio = \frac{Feed\ consumption\ (g)}{Weight\ of\ birds\ (g)}$$

Mortality

The number of dead birds was recorded throughout the experiment. This variable is quantitative and is expressed as a percentage (%). The formula used was the following:

$$Mortality\,(\%) = \frac{Number\ of\ starting\ birds - Number\ of\ finishing\ birds}{Numbers\ of\ starting\ birds} \times 100$$

Live weight gain (g)

To obtain this variable, the weekly weight data of each of the birds in the experiment was recorded, ordered in such a way that each data is recorded in its respective repetition and therefore in its treatment. This variable is quantitative. Approximately 1,000 data were obtained (5T x 4EU x 10 chickens(c) x 5 wk). The formula used was the following:

$$\textit{Live weight gain (g)} = \textit{Live weight recorded} - \textit{Live weight at the beginning of the experiment}$$

Carcass data, abdominal fat thickness and organoleptic indicators

The data on the carcass and fat thickness were obtained after slaughter, using the methodology described by Sánchez *et al.* [19]. To obtain the data from the sensory analysis, a consumer tasting test was used after applying the respective discrimination, so that the selected individuals respond to a previously designed survey, this was repeated after 1 d, it was applied to the employees and students of the Faculty of Agricultural Sciences (UTMACH), with a total of 112 people.

Experimental design

For the present experiment, a Completely Random Design (CRD) was used, distributed in 5 T, with 4 replicates of 10 chickens, for a total of 40 birds per treatment (T). The T1 or control was fed a normal commercial diet (without inclusion of alfarine), while in other treatments T2, T3, T4 and T5, alfarine was included in the feed at 1, 2, 3 and 4 %, respectively. The feed mixtures were provided by the company BALMAR (El Oro-Ecuador).

Statistical analysis

The statistics used in the present investigation were based on the book by Blasco [1]. To determine which factors presented a statistical effect, after complying with the assumptions of normality and homogeneity, an analysis for one factor (ANOVA) was used in all the quantitative variables studied. To discriminate between the means, the honest Tukey significant difference procedure was used, with a 95 % confidence level. Contingency tables were prepared to assess the qualitative data and the Chi-square test was used to establish the differences among the treatments. Everything was executed in the statistical program *STATGRAPHICS Centurión XV.I.*

RESULTS AND DISCUSSION

Feed and water consumption and feed conversion

In TABLE I, it can be seen that during the experiment there was not a statistically significant difference for cumulative feed consumption, this trend was maintained until the end of the research, which agrees with the results by Paredes and Risso [16], who carried out the evaluation of the effects of alfalfa flour inclusion in the feed, on the productive parameters, carcass and weight of digestive and lymphoid organs from organic type broilers, using 240 Hubbard females from 35 to 84 d of age, demonstrating that feed consumption is not affected by the inclusion of dehydrated forage in the diet.

Interesting data regarding alfalfa were reported by other authors, Tkáčová *et al.* [23], advise using this product in amounts that do not exceed 6 %, because higher percentages produce negative effects on production, in addition Ponte *et al.* [18], mention that alfalfa flour is very palatable for broiler chickens, which was corroborated by the results from Wüstholz *et al.* [27], who demonstrated that the inclusion of alfalfa produces an improvement in the silage that was given to organic chickens and laying hens.

As can be seen in TABLE II, the water consumption in the 1st and 2nd wk shows a significant difference, with T3 being the one that differs from T1, although in wk 3, 4 and 5 when compared to the control T there is a higher water consumption in chickens that received alfarine. These results might indicate an effect of alfalfa on the cumulative water consumption, although these values coincide with the normal gastrointestinal maturity of the bird. This could be explained because the absorption mechanisms in birds at birth are not fully mature, therefore the digestive capacity is not fully functional [14, 21, 26]. At an early age, these animals prioritize their needs and the allometric coefficient is higher for the organs that contribute than for those that demand nutrients [13].

Mortality

When analyzing the data in TABLE III, it is observed that, in wk 1, 2, 4 and 5 there is no significant difference, although in wk 3, T (3, 4 and 5) differ from the control, these results are probably due to the adjustment of gastrointestinal maturity that occurs in the birds in that wk and that is why at the end of the experiment there is no difference as such. Similar results were reported by Paredes and Risso [16], who in their study included alfalfa flour (HA) at 5 and 10 % in the diet of female broilers, not registering an effect on the feed conversion

TABLE I
Cumulative feed intake in Cobb 500 chickens (averages ± confidence intervals)

Tr.[1]	Week.[2] 1	Week.[2] 2	Week.[2] 3	Week.[2] 4	Week.[2] 5
1	1,373.0 ± 43.9 [a]	5,935.0 ± 97.5 [a]	11,925.8 ± 92.0 [a]	21,860.3 ± 294.1 [a]	34,453.0 ± 544.6 [a]
2	1,323.5 ± 43.9 [a]	5,804.3 ± 97.5 [a]	11,776.5 ± 92.0 [a]	21,751.8 ± 294.1 [a]	34,419.8 ± 544.7 [a]
3	1,378.5 ± 43.9 [a]	5,963.5 ± 97.5 [a]	11,958.5 ± 92.0 [a]	21,735.0 ± 294.0 [a]	34,296.0 ± 544.6 [a]
4	1,367.0 ± 43.9 [a]	5,957.8 ± 97.5 [a]	11,948.8 ± 92.0 [a]	21,915.3 ± 294.1 [a]	34,626.5 ± 544.6 [a]
5	1,343.3 ± 43.9 [a]	5,893.8 ± 97.5 [a]	11,861.8 ± 92.0 [a]	21,776.8 ± 294.1 [a]	34,465.5 ± 544.6 [a]

Tr.[1]: Treatments 1 control, 2, 3, 4, and 5 alfarine inclusion in the feed at 1 %, 2 %, 3 % and 4 %; Week.[2] 1, 2, 3, 4, 5: weekly accumulated feed data; [abc]: It is the representation of the statistical differences ($P<0.05$) found when comparing with T1

TABLE II
Accumulated water consumption in Cobb 500 chickens

Trt.[1]	Week[2] 1	Week[2] 2	Week[2] 3	Week[2] 4	Week[2] 5
1	4,118.8 ± 381.7 [a]	13,056.3 ± 825.7 [a]	24,643.8 ± 2,231.6 [a]	37,312.5 ± 5,669.8 [a]	50,462.5 ± 10,822.0 [a]
2	4,581.3 ± 381.7 [ab]	13,137.5 ± 825.6 [a]	26,418.8 ± 2,231.6 [a]	42,906.3 ± 5,669.7 [a]	64,968.8 ± 10,822.1 [a]
3	5,048.8 ± 381.7 [b]	148,76.3 ± 825.7 [b]	28,976.3 ± 2,231.6 [a]	47,301.3 ± 5,669.7 [a]	68,138.8 ± 10,822.1 [a]
4	4,703.8 ± 381.7 [ab]	14,416.3 ± 825.7 [ab]	28,428.8 ± 2,231.6 [a]	46,641.3 ± 5,669.7 [a]	68,378.8 ± 10,822.1 [a]
5	4,400.0 ± 381.7 [ab]	13,456.3 ± 825.7 [ab]	26,462.5 ± 2,231.5 [a]	42,687.5 ± 5,669.8 [a]	60,912.5 ± 10,822.0 [a]

Trt.[1]: Treatments 1 control. 2. 3. 4. and 5 alfarine inclusion in the feed at 1 %. 2 %. 3 % and 4 %; Week[2] 1. 2. 3. 4. 5: weekly accumulated water data; [abc]: It is the representation of the statistical differences (P<0.05) found when comparing with T1

TABLE III
Feed conversion ratio in Cobb 500 chickens

Trt.[1]	Week[2] 1	Week[2] 2	Week[2] 3	Week[2] 4	Week[2] 5
1	0.91 ± 0.07 [a]	1.28 ± 0.08 [a]	1.38 ± 0.05 [a]	1.55± 0.06 [a]	1.71± 0.12[a]
2	0.86 ± 0.07 [a]	1.27 ± 0.08 [a]	1.41± 0.05[ab]	1.53± 0.06 [a]	1.70 ± 0.12[a]
3	0.94 ± 0.07 [a]	1.36 ± 0.08 [a]	1.49 ± 0.05[bc]	1.57± 0.06 [a]	1.91 ± 0.12[a]
4	0.95 ± 0.07 [a]	1.39 ± 0.08 [a]	1.52 ± 0.05[cd]	1.62± 0.06 [a]	1.80 ± 0.12[a]
5	0.88 ± 0.07 [a]	1.33 ± 0.08 [a]	1.50 ± 0.05[bc]	1.61± 0.06 [a]	1.84± 0.12 [a]

Trt.[1]: Treatments 1 control. 2. 3. 4. and 5 alfarine inclusion in the feed at 1 %. 2 %. 3 % and 4 %; Week[2] 1. 2. 3. 4. 5: weekly accumulated water data; [abcd]: is the representation of the statistical differences (P<0.05) found when comparing with T1

index. In an experiment conducted by Elkomy *et al.* [7], used alfalfa seeds at 1 % in the feeding of broilers in order to counteract the toxicity of carbofuran, however, at the end of the study, an effect in the conversion index was registered.

Two dead birds were registered in T2 on d 25, the necropsy showed possible intoxication, for which, the natural toxin entrapment (Zeolite) was duplicated in the food of all T until the end of the experiment. The evidence is that Zeolite has positive effects on feed efficiency, nutrient utilization, the prevention of aflatoxicosis and the reduction of humidity and odor in the litter of birds [22, 24].

Live weight of birds

TABLE IV shows the data corresponding to the average weights per wk, obtained for each T, with no significant difference. These results were similar to those found by Laudadio *et al.* [11], who pointed out that when administering 15 % of alfalfa in laying hens, adverse effects on weight gain were not determined. On the other hand, the results of Mateos *et al.* [15], showed that the incorporation of alfalfa in the feed of broilers, favors a decrease in weight, because its digestibility is reduced through simple encapsulation, low assimilation of fats and the high fiber content. This would explain that, the higher the inclusion percentage, the lower the live weight gain of the birds

TABLE IV
Difference in weights

Trt.[1]	Week[2] 1	Week[2] 2	Week[2] 3	Week[2] 4	Week[2] 5
1	151.8 ± 10.5 [a]	464.3 ± 21.4 [a]	866.2 ± 25.0 [a]	1,410.8 ± 107.5 [a]	2,032.7 ± 265.8 [a]
2	155.2 ± 10.5 [a]	458.7 ± 21.4 [a]	835.4 ± 25.0 [a]	1,427.1 ± 107.5 [a]	2,024.2 ± 265.8 [a]
3	147.4 ± 10.5 [a]	438.6 ± 21.4 [a]	804.2 ± 25.0 [ab]	1,385.7 ± 107.5 [a]	1,809.6 ± 265.8 [a]
4	145.3 ± 10.5 [a]	428.5 ± 21.4 [a]	784.8 ± 25.0 [bc]	1,356.4 ± 107.5 [a]	1,925.1 ± 265.8 [a]
5	153.5 ± 10.5 [a]	444.4 ± 21.4 [a]	789.2 ± 25.0 [c]	1,454.1 ± 107.5 [a]	2,129.3 ± 265.8 [a]

Trt[1].: Treatments 1 control. 2. 3. 4. and 5 alfarine inclusion in the feed at 1 %. 2 %. 3 % and 4 %; Week[2] 1. 2. 3. 4. 5: weekly accumulated water data; [abc]: is the representation of the statistical differences (P<0.05) found when comparing with T1

Carcass data

When analyzing the data in TABLES V and VI with respect to the *antemortem* and bleeded weights, without feathers, without viscera, without head and legs, no significant difference was found, as well as for the abdominal fat thickness. These results differ from those found by Castellini *et al.* [2], who demonstrated that by including 2.8 % dehydrated HA, chickens obtain less abdominal fat. Laudadio *et al.* [12] in their study mentioned that the increase in crude fiber (CF) in the diet from 3.19 to 3.52 % in guinea chickens resulted in an increase in abdominal fat in the birds whose diets contained HA, without finding different carcass yields. Paredes and Risso [16], obtained similar results to the aforementioned work. Furthermore Dong *et al.* [6], mentioned that the greater accumulation of abdominal fat in birds that consumed *M. sativa* flour may be due to the fact that alfalfa strengthens the immune system, and this regulates lipid metabolism, therefore as the birds did not face any health challenges, there was no lipolysis, but an increase in abdominal fat deposition.

TABLE V
Data obtained with the slaughter of the birds on day 35

Trt.	*Ante-Mortem* Weight (g)	Bleeded Weight (g)	Weight W/O Feathers (g)	Weight W/O Viscera (g)	Weight W/O Head & Legs (g)	Abdominal Fat (mm)
1	1,732.38 ± 208.03 [a]	1,687.00 ± 206.56 [a]	1,630.38 ± 199.23 [a]	1,398.50 ± 178.41 [a]	1,273.63 ± 169.17 [a]	1.73 ± 0.41 [a]
2	1,701.38 ± 208.03 [a]	1,602.38 ± 206.56 [a]	1,571.13± 199.23 [a]	1,360.88 ± 178.41 [a]	1,240.5 ± 169.17 [a]	1.68 ± 0.41 [a]
3	1,502.63 ± 208.03 [a]	1,451.38 ± 206.56 [a]	1,393.63± 199.23 [a]	1,196.88 ± 178.41 [a]	1,087.38 ± 169.17 [a]	1.53 ± 0.41 [a]
4	1,649.50 ± 208.03 [a]	1,586.63 ± 206.56 [a]	1,518.13± 199.23 [a]	1,322.00 ± 178.41 [a]	1,209.25 ± 169.17 [a]	1.76 ± 0.41 [a]
5	1,478.75 ± 208.02 [a]	1,407.38 ± 206.56 [a]	1,355.88± 199.23 [a]	1,187.25 ± 178.41 [a]	1,077.13 ± 169.17 [a]	1.32 ± 0.41 [a]

Trt.: Treatments 1 control, 2, 3, 4, and 5 alfarine inclusion in the feed at 1 %, 2 %, 3 % and 4 %; Bird slaughter data at day 35; [abc]: It is the representation of the statistical differences (P<0.05) found comparing with Treatment 1

TABLE VI
Data obtained with the slaughter of the birds on day 35

Trt.	Breast Weight (g)	Frozen Breast Weight (g)	W/O Bone (g)	Juice (mL)	Juice (%)
1	398.87 ± 55.34 [a]	432.75 ± 55.14 [a]	250.25 ± 37.88 [a]	66.62 ± 10.25 [a]	26.92 ± 5.32 [a]
2	385.25 ± 55.34 [a]	395.75 ± 55.14 [a]	228.62 ± 37.88 [a]	50.37 ± 10.25 [a]	22.67 ± 5.32 [a]
3	340.75 ± 55.34 [a]	354.87 ± 55.14 [a]	204.50 ± 37.88 [a]	50.25 ± 10.25 [a]	26.48 ± 5.32 [a]
4	378.37 ± 55.34 [a]	386.62 ± 55.14 [a]	231.25 ± 37.88 [a]	59.75 ± 10.25 [a]	26.56 ± 5.32 [a]
5	343.87 ± 55.34 [a]	349.25 ± 55.14 [a]	208.37 ± 37.88 [a]	60.87 ± 10.25 [a]	30.25 ± 5.32 [a]

Trt.: Treatments 1 control, 2, 3, 4, and 5 alfarine inclusion in the feed at 1 %, 2 %, 3 % and 4 %; Bird slaughter data at day 35; [abc]: It is the representation of the statistical differences (P<0.05) found comparing with Treatment 1

Abdominal fat thickness

Sensory Analysis

The results shown in TABLES VII and VIII were obtained through the sensory analysis (consumer tasting) from people of the Faculty of Agricultural Sciences (UTMACH), responding to two surveys with an interval of 1 d, prior to a discrimination process. It can be noted that there is no significant difference when comparing all the treatments with the control, both in smell, taste, tenderness and juiciness. The total participants in the consumer tasting were 112 people.

These results could be explained in base to what was mentioned by Scott *et al.* [20], who state that the inclusion of alfarine generates good organoleptic qualities. In another study, Chamba-Ochoa *et al.* [3] determined that the inclusion of 10 % alfalfa and carrot extract supplied in the drinking water of broilers improved skin pigmentation, and therefore returns more attractiveness of the product to the consumer.

CONCLUSIONS

The inclusion rates of *M. sativa* flour in the feed of broiler chickens did not show any effect on the live weight, feed and water consumption, mortality and feed conversion ratio at the end of the experiment.

In the same way, the *ante-mortem* and *post-mortem* carcass parameters did not show an effect due to the inclusion of alfalfa in the feed either.

TABLE VII
Data of the acceptance responses obtained from the consumer tasting

Trt.	Smell	Flavor	Tenderness	Juice
1	96.66 ± 30.21 [a]	94.72 ± 15.54 [a]	74.86 ± 9.94 [a]	87.50 ± 12.37 [a]
2	97.91 ± 30.21 [a]	97.22 ± 15.54 [a]	74.30 ± 9.94 [a]	86.11 ± 12.37 [a]
3	95.83 ± 30.21 [a]	94.44 ± 15.54 [a]	74.02 ± 9.94 [a]	92.64 ± 12.37 [a]
4	92.50 ± 30.21 [a]	88.75 ± 15.54 [a]	60.55 ± 9.94 [a]	78.75 ± 12.37 [a]
5	77.08 ± 30.21 [a]	86.94 ± 15.54 [a]	68.19 ± 9.94 [a]	90.97 ± 12.37 [a]

Trt.: Treatments 1 control, 2, 3, 4, and 5 alfarine inclusion in the feed at 1 %, 2 %, 3 % and 4 %; [abc]: It is the representation of the statistical differences (P<0.05) found when comparing them with Treatment 1

TABLE VIII
Data of the rejection responses obtained from the consumer tasting

Trt.	Smell	Flavor	Tenderness	Juice
1	3.33 ± 30.21[a]	5.28 ± 15.54 [a]	24.86 ± 9.82 [a]	12.50 ± 12.37 [a]
2	2.08 ± 30.21[a]	2.78 ± 15.54 [a]	25.69 ± 9.82 [a]	13.89 ± 12.37 [a]
3	4.16 ± 30.21[a]	5.55 ± 15.54 [a]	25.97 ± 9.82 [a]	7.36 ± 12.37 [a]
4	7.50 ± 30.21[a]	11.25 ± 15.54 [a]	39.44 ± 9.82 [a]	21.25 ± 12.37 [a]
5	22.91 ± 30.21[a]	13.05 ± 15.54 [a]	31.80 ± 9.82 [a]	9.03 ± 12.37 [a]

Trt.: Treatments 1 control, 2, 3, 4, and 5 alfarine inclusion in the feed at 1 %, 2 %, 3 % and 4 %; [abc]: It is the representation of the statistical differences (P<0.05) found when comparing them with Treatment 1

To further confirm these results, the sensory analysis indicates that even at the maximum inclusion rate (4 % HA), it showed acceptance by the tasters, therefore it can be said that it does not negatively affect the organoleptic parameters. Considering the preceding lines, this raw material can be included without any problem in the feed formulation for broilers.

Considering these results, a higher HA inclusion rate should be studied and its effects on the different parameters evaluated.

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