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Use of *Moringa oleifera* in chickens and its effect on Productive and Economic parameters

Uso de *Moringa oleifera* en pollos y su efecto en parámetros productivos y económicos

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ABSTRACT

This research was carried out at the Santa Inés farm (Faculty of Agricultural Sciences, Universidad Técnica de Machala), El Oro Province, Ecuador. The main objective was to evaluate the effect of *Moringa oleifera* leaf meal on the productive and economic parameters of Cobb 500 chickens. For the biosecurity and well-being of the birds, a pre-established managemet for open-shed systems in the area was used, applying a basic vaccination schedule to the chickens. For the experiment, a Completely Random Design (CRD) was applied, using 200 Cobb 500, newborn mixed chickens (male and female), distributed in 5 treatments and evaluated for 35 days, each treatment had 4 experimental units of 10 chickens. The disposition of the groups was as follows: control (T1) to which only the basal diet; T2, T3, T4 and T5 in which 1, 2, 3, 4% of *M. oleifera leaf* meal was administered in the feed, respectively. The variables evaluated were: live body weight, feed consumption and accumulated water, feed conversion ratio, mortality, productive efficiency factor, kilograms of meat per square meters (m^2) and economic expenses. To determine the possible differences, the statistical software *Statgraphics Centurion XV.I.*®, was used. A parametric analysis of one factor (ANOVA), prior to the assumptions of normality and homogeneity was used. In order to discriminate among the means, the Bonferroni multiple comparison procedure was applied with a confidence level of 95%. The results showed that there is an effect on live weight and feed intake, because diets with an inclusion greater than 3% were negatively influenced in the first 3 weeks of life of the animal, while the rest of the variables were not affected.

Key words: Live weight; feed conversion ratio; productive efficiency factor; economic expenses; moringa

RESUMEN

Esta investigación se realizó en la granja Santa Inés (Facultad de Ciencias Agropecuarias, Universidad Técnica de Machala), provincia de El Oro, Ecuador. El objetivo principal fue evaluar el efecto de la harina de hojas de *Moringa oleifera* sobre los parámetros productivos y económicos de pollos Cobb 500. Para la bioseguridad y bienestar de las aves se utilizó un manejo preestablecido para los sistemas de galpones abiertos de la zona, aplicando un esquema básico de vacunación a los pollos. Para el experimento se aplicó un Diseño Completamente al Azar (DCA), utilizando 200 pollos mixtos (machos y hembras) recién nacidos Cobb 500, distribuidos en 5 tratamientos y evaluados durante 35 días, cada tratamiento contó con 4 unidades experimentales de 10 pollos. La disposición de los grupos fue la siguiente: control (T1) a los que se les administró únicamente la dieta basal; T2, T3, T4 y T5 a los que se les suministró 1; 2; 3; 4 % de harina de hojas de *M. oleifera* en la alimentación, respectivamente. Las variables evaluadas fueron: peso vivo, consumo de alimento y agua acumulado, índice de conversión alimenticia, mortalidad, factor de eficiencia productiva, Kilogramos de carne por metros cuadrados y gastos económicos. Para determinar las posibles diferencias se utilizó el software estadístico *Statgraphics Centurion XV.I.* ®. Se empleó un análisis paramétrico de un factor (ANOVA), previo a los supuestos de normalidad y homogeneidad. Para discriminar entre las medias se aplicó el procedimiento de comparación múltiple de Bonferroni con un nivel de confianza del 95 %. Los resultados mostraron que existe un efecto sobre el peso vivo y el consumo de alimento, debido a que las dietas con una inclusión mayor al 3 % se vieron influenciadas negativamente en las primeras 3 semanas de vida del animal, mientras que el resto de las variables no se vieron afectadas.

Palabras clave: Peso vivo; índice de conversión de alimenticia; factor de eficiencia productiva; gastos económicos; moringa

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INTRODUCTION

The intensive rearing of broilers (B) is currently conditioned by several factors such as genetic improvement, growth speed, use of feed and the growing intensification into the rearing facilities, resulting in an increase in population density which requires proper management for this type of production [13].

The production of food species has become a primary strategy to meet the needs of animal protein, added to the demand by the consumer that has influenced producers to increase the amount of raw material they allocate for feeding the animals; therefore the diets offered to poultry must meet minimum nutritional requirements, in addition to responding to the availability and price of raw materials, all of this to obtain healthy and economically productive chickens (*Gallus gallus domesticus*) [10].

In Ecuador, the poultry industry shows a promising future due to the acceptance of its products, its demand is closely related to the nutritional contribution and affordability of its price, in addition to the consumer's criteria that considers aspects such as good appearance, characteristics sensory and a good carcass [2].

Moringa oleifera L. belongs to the Moringaceae family, native to India, Pakistan, Asia Minor, Arabia and Africa, spreading to Regions such as the Philippines, the entire American Continent and the Caribbean. The whole plant is useful, the leaves, flowers, fruits and roots, are appreciated for their nutritional value [12]. It is a fast grower with moderate altitudes, measuring between 7 to 12 meters (m) to the crown, produces strong and deep roots, adaptable to all types of soil, resistant to drought. It's ideal growth temperature is 25-35°C, although it tolerates up to 48°C. [5]; It is considered a multipurpose crop because it uses a high-yield biomass production system, rapid regrowth after pruning. Its yields are dependent on the season, weather conditions, the culture method and the application of fertilizers [15].

Moringa is used for human and animal consumption due to its high source of dietary protein and essential amino acids, being observed an increase in meat yield in animals; the leaf contains 20 to 30% protein, 5.0 to 7.5% fat, and 25 to 31% fiber, being an excellent source of iron, calcium, and vitamin C [7]. There is evidence that Moringa has hypotensive, hypoglycemic, anticancer, antiobesity, antidiabetic, antianemic and, lipid metabolism regulatory properties [8], the leaf has an antiparasitic and curative effect in animals [11].

The objective of this research was to evaluate the effect of *M. oleifera* leaf meal on the productive and economic parameters of Cobb 500 chickens.

MATERIALS AND METHODS

Research location

This research was carried out in the "Santa Inés" farm, Faculty of Agricultural Sciences of the Universidad Técnica de Machala, which is located in the coastal region of Ecuador, at kilometer 5 ½ via Machala – Pasaje; its geographical coordinates are 79°54'05" West, 3°17'16" S, with an altitude of 5 meters above sea level, with a temperature that ranges between 22 to 35°C (FIGS. 1 and 2).

Characteristics of the housing and management of the chickens

Bird management was as described by Quinche *et al.* [17] adapted to handle 200 Cobb 500 B from the "INCU-PASAJE" incubator company (Pasaje-El Oro-Ecuador); 4 JACKWAL brand gas brooders of 1200 kilocalories· hours^{-1} (Kcal·h^{-1}) – 4700 British Termal Unit·h^{-1} reference G14818 (Quito-Ecuador) were used as a heat source and internal and external plastic curtains were used to control air currents, which were lowered 20 centimeters -cm- per day -d- from the 8th d of age of the animals, in such a way that at d 10 the brooders were eliminated and,

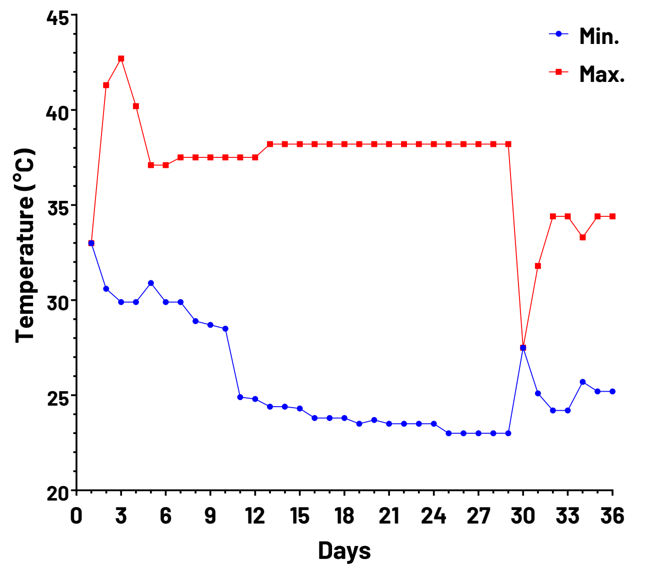

FIGURE 1. Daily temperature record (February-March 2022), maximum (orange color) and minimum (blue color) taken in the morning (8 am) through a digital thermo-hygrometer (LWH model: HTC-2), during the experiment

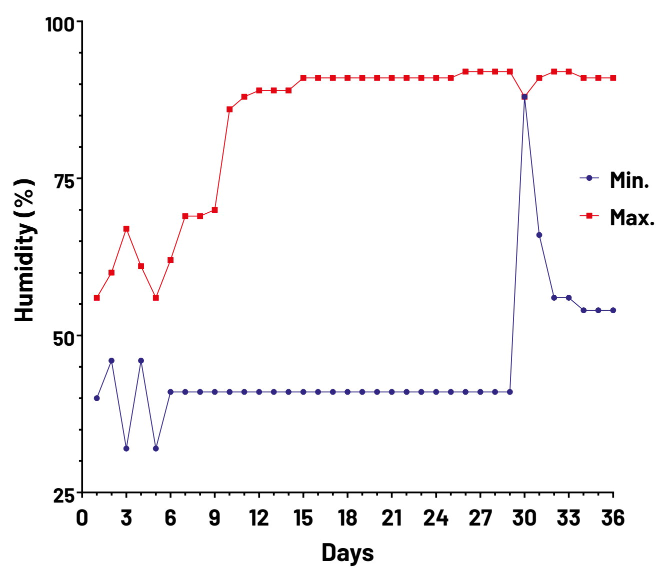

FIGURE 2. Daily record of humidity (February-March 2022), maximum (orange color) and minimum (blue color) taken in the morning (8 am) through a digital thermo-hygrometer (LWH model: HTC-2), during the experiment

on d 21 they received total aeration (without curtains). Four h before the reception of the baby chicks, the heat sources were turned on and during the first 3 d of age, vitamins plus electrolytes (1 grame -g- per liter -L-) were administered in the drinking water, in addition to covering the litter with wallpapered. The lighting scheme consisted of applying 24 h light for the first 7 d and afterwards it was reduced by 1 h per d, until the birds are given 6 h of rest (darkness), for this purpose 20 watt (W) light emitting diode (LED) bulbs were used.

During the study, the following variables were recorded: live weight, feed consumption and accumulated water, feed conversion ratio, mortality, productive efficiency factor, kilograms -kg- of live meat per m^2 and economic expenses. An electronic scale (CAMRY, model EK9332-F302, China) was used, which a maximum capacity of 5 kg ±1 g.

Feed formulation

For the feed formulation, the Excel Solver tool was applied, using the guide of the tabulated values of the raw materials that are published in the Fundación Española para el Desarrollo de la Nutrición Animal (FEDNA) tables [6], and taking into account the nutritional needs for poultry: Standards FEDNA [19], the raw materials were purchased from the BALMAR Company (El Oro – Ecuador). Three phases were carried out:

Initial diet: from 0 to 21 d (adapted from the Nutritional needs for poultry, FEDNA standards, initiation 0 to 14 d) that contained the following: Soybeans (*Glycine max*), corn (*Zea mays*), rice bran (*Oryza sativa*), L-Lysine Monohydrochloride , DL-Methionine, L-Threonine, soybean oil, robavio Max Advanced (Enzymatic preparation of endo-1,4-Xylanase, endo-1,3(4)-β-Glucanase, 6-Phytase enzyme), Iodized Salt, MIKRO-MX Prem Qsi initial broiler, Calcium Carbonate, Dicalcium Phosphate, Zinc Bacitrazine 15%, LERBEK® (Clopidol 20% + Methylbenzoquate 1.67%), dehydrated *M. oleifera* and Zeolite; each ingredient according to the specific treatment (TABLE I). The formula was isoproteic (21.2% crude protein -CP-) and isoenergetic (2.860 Kcal·kg^{-1} of metabolizable energy -ME-).

Growth diet: from d 22 to 28 d (adapted from the Nutritional needs for poultry, FEDNA standards, 15 to 23 d), similar to the previous one, except that Soybean oil was replaced by Palm oil (*Elaeis guineensis*). The formula was isoproteic (20% CP) and isoenergetic (2.990 Kcal·kg^{-1} ME).

Completion diet: from d 29 onwards (adapted from the Nutritional needs for poultry, FEDNA standards, 24 to 36 d), the same as above, except that the formula was isoproteic (18.5% CP) and isoenergetic (3.050 kcal/kg ME)

Preparation of *M. oleifera meal*

For the elaboration of this raw material, fresh leaves were harvested, the weight was recorded with a CAMRY brand electronic gram scale (model EK9332-F302,China), and then they were put in the trays of a food dehydrator ("Ronco®" EZ-Store 5 trays,USA), at a temperature of 71°C, for 6 h, obtaining 32.2% of raw material partially dried (RMPD). After this process, the material was left to cool (ambient temperature) for 24 h in a sealed container and, later on it was subjected to two grindings (FIG. 3).

FIGURE 3. Turbo dehydrator charged with the leaves of *M. oleifera*

TABLE I
Nutritional values of the diets for each stage, obtained with the Excel Solver tool and used in this research

Nutrients	Initiation	Growth	Ending
CP (g·kg^{-1})	212.00	200.00	185.00
CF (g·kg^{-1})	34.30	34.96	33.44
Ca (g·kg^{-1})	9.80	9.00	7.50
P (g·kg^{-1})	6.60	5.80	5.60
Na (g·kg^{-1})	1.90	1.70	1.60
Cl (g·kg^{-1})	2.95	2.54	2.31
ME (Kcal·kg^{-1})	2860.00	2990.00	3050.00
Lys (g·kg^{-1})	13.80	12.50	11.30
Met (g·kg^{-1})	5.50	5.10	5.68
Thr (g·kg^{-1})	9.00	8.30	7.50

CP: crude protein, CF: crude fiber, Ca: calcium, P: phosphorus, Na: sodium, Cl: chlorine, ME: metabolizable energy, Lys: lysine, Met: methionine, Thr: threonine

Evaluated variables

All variables were quantitative.

Live weight (g)

To generate the data, the birds were weighed individually at the beginning of the experiment and weekly until d 35 (5 Treatments -T- × 4 Experimental Units –EU– × 10 Chickens B × 5 weeks –wk-), without taking into account the mortality during the experimental phase.

Cumulative feed intake (g)

This variable was recorded wk, obtained from the difference between the feed offered and the one leftover. Obtaining a total of 100 data (5T × 4EU × 5wk).

Accumulated water consumption (mL)

The sum of daily water consumption was performed to obtain wk data. Generating 100 data (5T × 4EU × 5wk).

Feed conversion ratio (FCR)

This data is obtained from the division between the accumulated feed consumed and the weight gain of the B, recorded wk. 100 data (5T × 4EU × 5wk) were obtained.

Mortality

For this data, the number of dead B during the entire rearing period was recorded.

Productive efficiency factor (PEF)

This variable allows to evaluate the efficiency of the batches, it is obtained at the end of the handling of the B, the following formula is applied:

$$PEF = \frac{\left(Survival\ rate - \% - \times\ final\ weight - kg -\right)}{FCR \times age\ days} \times 100$$

Kg of meat per m²

This data is obtained by adding the final weight (kg) of the B in a m^2 of space.

Economic expenses

All the expenses on materials and equipment of the housing divided by the number of EU was taken into account, and to this was added the cost of the diet consumed by the B.

Experimental design

A completely randomized design (CRD) was applied, where 5T were used, each with 4EU with 10 B, for a total of 200 B evaluated. T1 or control contained a diet without Moringa meal, while T2, T3, T4 and T5 included dehydrated Moringa leaf meal at 1, 2, 3 and 4%, respectively (FIG. 4).

Statistical analysis

The data analysis was based on Blasco's book [3]. For all the variables of the experiment, an ANOVA test was used, prior assumptions of normality and homogeneity, and to discriminate between the means, the Bonferroni multiple comparison test was used with a confidence level of 95%. Everything was analyzed using the *Statgraphics Centurión XV.I* statistical program ®.

FIGURE 4. Random distribution of treatments

RESULTS AND DISCUSSION

Live body weight of the broilers

In TABLE II, it is evident that there was no significant difference at week 1, 2, 4 and 5, while at wk 3 there was a difference, when comparing T5 with the control, these results are partially similar to those found by Fuentes *et al*. [7], who reported that by adding 10% Moringa leaf meal to the diet of Ross-308 B for 42 d affected the average final weight, being lower than the control treatment, attributing this result to the increase of fiber in the diet. Similar to the results found in another species by Castillo *et al*. [4], who used meal from *M. oleifera leaves* in the diets for fattening Japanese quails (*Coturnix japonica*) showed that in the starter diet (d 1 to 14) there were significant differences, in such a way that by increasing the amount of meal (7, 14 and 21%) a reduction in weight was observed, although they also mentioned that at d 35 the inclusion level had no any effect.

Cumulative feed intake

Cumulative feed intake (TABLE III) was not different during wk 1 and 2, but in wk 3, 4 and 5 a significant difference was obtained between T5 and control. This differs from the findings of Romero *et al*. [18], who experimented with semi – heavy hens of the line Plymouth Rock by including 3 levels (0, 3 and 6%) of *M. oleifera* in their diet, and found no differences in feed consumption. Furthermore, these results also differ from the research carried out by Gómez *et al*. [9], who included Moringa meal at 4 and 8% in Cobb 500 male B, and whose analysis began after 21 d, although they had significant differences, they showed a higher intake in the T that carried 4 and 8% compared to the control T, concluding that fiber (relatively high content) increased feed consumption.

Accumulated water consumption

In TABLE IV, it is observed that there were no significant differences when comparing the water consumption among T. These results were similar to the results reported by Antara *et al*. [1], who included Moringa extract fermented by a probiotics (*Saccharomyces* spp.) at 2% in the drinking water of laying hens up to 70 wk of age, and found no significant effect on water intake, at a dose of 2-4 mililiters (mL)/100 mL of drinking water.

Feed conversion ratio (FCR)

There were no significant differences on FCR (TABLE V), results that differ from those of Paul *et al*. [16], who included 1% of the aqueous extract of *M. oleifera* in the drinking water of Cobb 500 B for 5 wk and whose results showed a lower FCR when compared to the control group. On the other hand, the present results were similar to what was found in the study by Mesa *et al*. [14], who included 0.10, 15 and 20% of *M. oleifera* forage meal in the feed of White Leghorn L33 laying hens from 19 to 26 wk of age, and did not show any difference in FCR.

Mortality

The only mortality recorded during the experiment was in T3, where a B died on d 3, the necropsy showed omphalitis. On a study by Vázquez *et al*, [20] who included *M. oleifera* forage meal at 0.5, 1 and 1.5% in the diet of 28 male B ($EB_{34\ hybrid}$) for up to 42 d, when they evaluated the results of immunological indicators (spleen, thymus and bursa of Fabricius), and also hematocrit and hemoglobin, found out that by including up to 1.5% Moringa meal does not affect mortality.

TABLE II

Average weekly live weight of the chickens according to treatment (average ± confidence intervals)

Trat.	week 1	week 2	week 3	week 4	week 5
1	192.48 ± 21.39[a]	516.68 ± 23.13[a]	1046.80 ± 36.39[a]	1632.22 ± 87.45[a]	2250.75 ± 116.29[a]
2	189.70 ± 21.39[a]	493.40 ± 23.13[a]	1001.65 ± 36.39[ab]	1536.22 ± 87.45[a]	2156.82 ± 116.29[a]
3	195.35 ± 21.39[a]	511.53 ± 23.13[a]	1020.65 ± 36.39[a]	1591.72 ± 87.45[a]	2179.78 ± 116.29[a]
4	190.15 ± 21.39[a]	506.68 ± 23.13[a]	1009.38 ± 36.39[ab]	1584.30 ± 87.45[a]	2242.17 ± 116.29[a]
5	162.05 ± 21.39[a]	470.38 ± 23.13[a]	965.65 ± 36.39[b]	1566.27 ± 87.45[a]	2247.90 ± 116.29[a]

Trat.: Treatments; Weeks 1, 2, 3, 4 and 5: Weeks; [ab]: It is the representation of the statistical differences (P<0.05) found when being compared against the control

TABLE III

Average weekly accumulated feed consumption of the chickens according to treatment (average ± confidence intervals)

Trat.	week1	week 2	week 3	week 4	week 5
1	187.30 ± 9.31[a]	575.43 ± 25.64[a]	1214.97 ± 50.42[a]	2137.80 ± 67.52[a]	3318.53 ± 98.35[a]
2	184.65 ± 9.31[a]	556.03 ± 25.64[a]	1151.68 ± 50.42[ab]	2052.92 ± 67.52[ab]	3230.30 ± 98.35[ab]
3	178.50 ± 9.31[a]	550.70 ± 25.64[a]	1152.18 ± 50.42[ab]	2066.68 ± 67.52[ab]	3283.13 ± 98.35[a]
4	183.35 ± 9.31[a]	553.60 ± 25.64[a]	1145.75 ± 50.42[ab]	2039.20 ± 67.52[ab]	3253.40 ± 98.35[ab]
5	169.85 ± 9.31[a]	524.93 ± 25.64[a]	1102.88 ± 50.42[b]	1962.30 ± 67.52[b]	3065.80 ± 98.35[b]

Trat.: Treatments; Weeks 1, 2, 3, 4 and 5: Weeks; [ab]: It is the representation of the statistical differences (P<0.05) found when being compared against the control

TABLE IV

Average weekly accumulated water consumption according to treatment (average ± confidence intervals)

Trat.	week 1	week 2	week 3	week 4	week 5
1	4507.75 ± 118.97[a]	10600.00 ± 191.1[a]	18628.30 ± 1007[a]	33636.30 ± 9214.40[a]	36566.80 ± 2136.30[a]
2	4490.00 ± 118.97 [a]	10413.50 ± 191.1[a]	18233.00 ± 1007[a]	24318.50 ± 9214.40[a]	35590.30 ± 2136.30[a]
3	4438.75 ± 118.97[a]	10418.80 ± 191.1[a]	17715.50 ± 1007[a]	24319.50 ± 9214.40[a]	36121.30 ± 2136.30[a]
4	4452.00 ± 118.97[a]	10619.00 ± 191.1[a]	18281.00 ± 1007[a]	24903.50 ± 9214.40[a]	37192.00 ± 2136.30[a]
5	4579.50 ± 118.97[a]	10648.00 ± 191.1[a]	18422.30 ± 1007[a]	25390.50 ± 9214.40[a]	37120.30 ± 2136.30[a]

Trat.: Treatments; Weeks 1, 2, 3, 4 and 5: Weeks; [ab]: It is the representation of the statistical differences (P<0.05) found when being compared against the control

TABLE V

Average weekly feed conversion rate according to treatment (average ± confidence intervals)

Trat.	week 1	week 2	week 3	week 4	week 5
1	0.97 ± 0.17[a]	1.12 ± 0.05[a]	1.16 ± 0.04[a]	1.31 ± 0.09[a]	1.48 ± 0.09[a]
2	0.98 ± 0.17[a]	1.13 ± 0.05[a]	1.15 ± 0.04[a]	1.34 ± 0.09[a]	1.50 ± 0.09[a]
3	0.92 ± 0.17[a]	1.08 ± 0.05[a]	1.13 ± 0.04[a]	1.30 ± 0.09[a]	1.51 ± 0.09[a]
4	0.97 ± 0.17[a]	1.10 ± 0.05[a]	1.14 ± 0.04[a]	1.29 ± 0.09[a]	1.45 ± 0.09[a]
5	1.10 ± 0.17[a]	1.12 ± 0.05[a]	1.14 ± 0.04[a]	1.25 ± 0.09[a]	1.37 ± 0.09[a]

Trat.: Treatments; Weeks 1, 2, 3, 4 and 5: Weeks; [ab]: It is the representation of the statistical differences (P<0.05) found when being compared against the control

Productive efficiency factor

FIG. 5 shows that there were no significant differences among T; however, numerically it can be seen that T 5 has the best PEF.

Kg of meat per m^2

FIG. 6 shows the amount of kg of meat per m^2 and, although there are no significant differences, numerical differences can be seen when comparing the control (22.50) with T2 (21.60) and T3 (21.20), showing the lowest data.

Economic expenses

FIG. 7 shows that there was no significant difference, although there was a numeric difference. These results showed the cost for each T (40 animals).

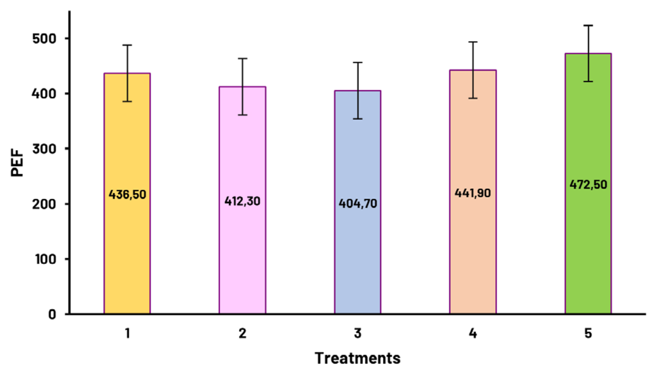

FIGURE 5. Comparison of PEF by treatments

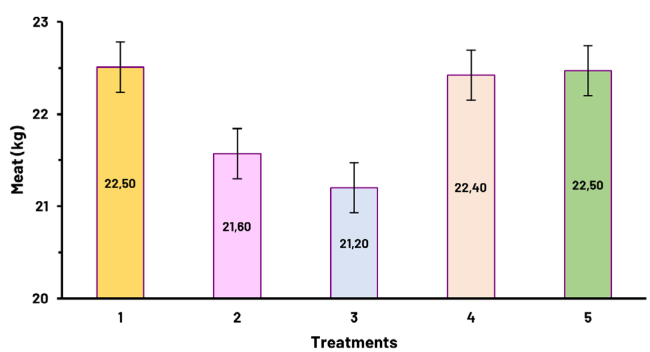

FIGURE 6. Analysis of the number of kilograms of meat (live weight) that are produced in one square meter per treatment

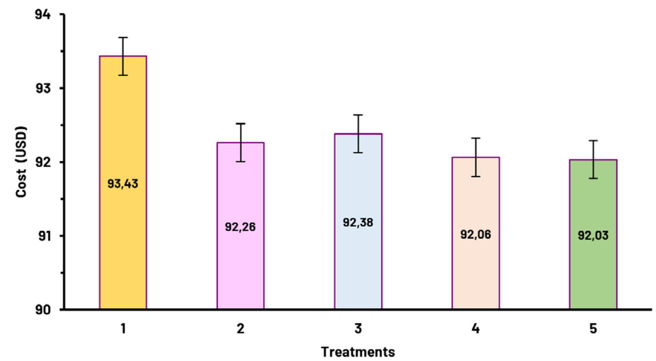

FIGURE 7. Comparison of the economic expenses per treatment

CONCLUSIONS

The inclusion of Moringa leaf flour has no effect on the variables evaluated, because at the end of the experiment, no difference was observed, only in the consumption of food, which from the third wk was influenced to be less until the end, so it is assumed that *Moringa oleífera* does not negatively affect the productive parameters.

According to the results, it is recommended to work with levels of 3% Moringa leaf meal as a maximum in the initial diets, while in the growth and finishing diets this percentage can be exceeded.

The economic parameters were not statistically affected by including Moringa in the diets, however, arithmetically speaking, the difference of cents in the diets that included the product would represent a saving for the poultry industry, due to the large number of birds that are produced.

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BIBLIOGRAPHIC REFERENCES

[1] ANTARA, I.K.; BIDURA, I.G.; SITI, N.W. Effects of *Moringa oleifera* leaf and probiotics mixed fermented extract on the egg production and cholesterol contents in egg of laying hens. **Intern. J. Fauna Biol. Stud.** 6(5): 06–12. 2019.

[2] ATTIA, Y.A.; AL-HARTHI, M.A.; KORISH, M.A.; SHIBOOB, M.M. Evaluación de la calidad de la carne de pollo en el mercado minorista: efectos del tipo y origen de las canales. **Rev. Mex. Cien. Pec.** 7(3): 321–339. 2016.

[3] BLASCO, A. Análisis de varianza. En: **Análisis de datos experimentales para proyectos fin de carrera.** Ed. Universidad Politécnica de Valencia. Pp 61–82. 2010.

[4] CASTILLO, L.; PORTILLO, L.J.; LEÓN, F.J.; GUTIÉRREZ, D.R.; ANGULO, E.M.; MUY-RANGEL, M.D.; HEREDIA, J. B. Inclusion of Moringa leaf powder (*Moringa oleifera*) in fodder for feeding japanese quail (*Coturnix coturnix japonica*). **Braz. J. Poult. Sci.** 20: 15–26. 2018. https://doi.org/jj29.

[5] CERDAS-RAMÍREZ, R. Extracción de nutrientes y productividad de moringa (*Moringa oleífera*) con varias dosis de fertilización nitrogenada. **InterSedes**. 18(38): 145-163. 2017. https://doi.org/jj3b.

[6] DE BLAS, C.; GARCÍA-REBOLLAR, P.; GORRACHATEGUI, M.; MATEOS, G. Tablas FEDNA de composición y valor nutritivo de alimentos para la fabricación de piensos compuestos. 2019. Fundación Española para el Desarrollo de la Nutrición Animal. Online: https://bit.ly/3UgLKCy. 14/04/2022.

[7] FUENTES-ESPARZA, M.K.; QUEZADA-TRISTÁN, T.; GUZMÁN-MALDONADO, S. H.; VALDIVIA-FLORES, A.G.; ORTÍZ-MARTÍNEZ, R. Efecto del consumo de *Moringa oleífera* sobre parámetros productivos y toxicológicos en pollos de engorda. **Rev. Mex. Cien. Pec.** 10(4): 1013–1026. 2019. https://doi.org/jj3c.

[8] GIUBERTI, G.; ROCCHETTI, G.; MONTESANO, D.; LUCINI, L. The potential of *Moringa oleifera* in food formulation: A promising source of functional compounds with health-promoting properties. **Current Opinion Food Sci.** 42: 257–269. 2021. https://doi.org/jj3d.

[9] GÓMEZ, N. I.; RÉBAK, G.; FERNÁNDEZ, R.; SINDIK, M.; SANZ, P. Comportamiento productivo de pollos parrilleros alimentados con *Moringa oleifera* en Formosa, Argentina. **Rev. Vet.** 27(1): 7–10. 2016. https://doi.org/jj3f.

[10] GUTIÉRREZ-CASTRO, L.L.; HURTADO-NERY, V.L. Uso de harina de follaje de *Tithonia diversifolia* en la alimentación de pollos de engorde. **Orinoquia**. 23(2): 56–62. 2019. https://doi.org/jj3h.

[11] GUZMÁN-MALDONADO, S.H.; ZAMARRIPA-COLMENARES, A.; HERNÁNDEZ-DURAN, L.G. Calidad nutrimental y nutraceútica de hoja de moringa proveniente de árboles de diferente altura. **Rev. Mex. Cien. Agríc.** 6(2): 317–330. 2015.

[12] MAHATO, D.K.; KARGWAL, R.; KAMLE, M.; SHARMA, B.; PANDHI, S.; MISHRA, S.; KUMAR, P. Ethnopharmacological properties and Nutraceutical potential of *Moringa oleifera*. **PhytoMed. Plus**. 2(1): 100168. 2022. https://doi.org/jj3k.

[13] MENDOZA-RIVADENEIRA, F.A.; VARGAS-ZAMBRANO, P.A.; VIVAS-ARTURO, W.F.; VALENCIA-LLANOS, N.F.; VERDUGA-LÓPEZ, C.D.; DUEÑAS-RIVADENEIRA, A.A. Sustitución parcial de maíz por harina integral de *Cucurbita moschata* y su efecto sobre las variables productivas de pollos Cobb 500. **Cien. Tecnol. Agrop.** 21(2): e1298. 2020. https://doi.org/jj3m.

[14] MESA, O.; VALDIVIÉ, M.; RODRÍGUEZ, B.; RABELLO, C.B.; BERRIO, I.; COUSO, Z. Use of diets with *Moringa oleifera* forage meal for White Leghorn L33 laying hens and replacement pullets. **Cuban J. Agricult. Sci.** 54(2): 219–227. 2020.

[15] NOUMAN, W.; ANWAR, F.; GULL, T.; NEWTON, A.; ROSA, E.; DOMÍNGUEZ-PERLES, R. Profiling of polyphenolics, nutrients and antioxidant potential of germplasm's leaves from seven cultivars of *Moringa oleifera* Lam. **Industr. Crops Products.** 83: 166–176. 2016. https://doi.org/gnxknv.

[16] PAUL, T.K.; SARKER, Y.A.; TARAFDER, M.; RIMON, M.A.; HAQUE, M. A.; SIKDER, M. H. Water supplementation of *Moringa oleifera* as a substitute for antibiotics on performance and blood parameters of broiler chickens. **J. Bangladesh Agricult. Univ.** 16(2): 266–270. 2018. https://doi.org/jj3n.

[17] QUINCHE, A.; IZQUIERDO, C.; CORREA, J.; ARMIJOS, E.; ORTIZ, D. Efecto de una dieta sin antibióticos, coccidiostatos y aminoácidos sintéticos en pollos sexados Cobb 500. **Rev. Cien. Agricult.** 18(3): 63–77. 2021. https://doi.org/jj3q.

[18] ROMERO-YERENA, A.; ARELLANO-PEREZ, L.M.; POSADA-SOSA, M.L.; RODRIGUEZ-MURILLO, B.; PALACIOS, A. Effect of the addition of moringa (*Moringa oleifera*) in the diet of semi-heavy hens on the post-moult recovery and egg quality. **Trop. Subtrop. Agroecosyst.** 25(2): e070. 2022.

[19] SANTOMÁ, G.; MATEOS, G. Necesidades Nutricionales en Avicultura. 2018. Fundación Española para el Desarrollo de la Nutrición Animal. Online: https://bit.ly/3WnUicB. 10/02/2022.

[20] VÁZQUEZ, Y.; RODRÍGUEZ, B.; VALDIVIÉ, M. Efecto de la harina de forraje de *Moringa oleifera* como aditivo en indicadores de salud de pollos de ceba. Cuban J. Agric. Sci. 54(2): 229–236. 2020.