DOI: https://doi.org/10.52973/rcfcv-e32189 Revista Científica, FCV-LUZ / Vol. XXXII, rcfcv-e32189, 1 - 6

Effects of the use of *Moringa oleífera* in the feeding of broilers on carcass and visceral yields

Efecto del uso de *Moringa oleifera* en la alimentación de pollos de engorde sobre el rendimiento de la canal y vísceras

Carlos Joel Ramirez-Rojas*[1], *Dioselina Esmeralda Pimbosa-Ortiz*[2] *and Ángel Roberto Sánchez-Quinche*[1,2]

[1]Universidad Técnica de Machala, Faculty of Agricultural Sciences, School of Veterinary Medicine and Zootechnics, Research hotbed in Animal Production (SIPA). Machala, El Oro, Ecuador. [2]Universidad Técnica de Machala, Faculty of Agricultural Sciences, School of Veterinary Medicine and Zootechnics, Research Group on Food Production and Animal Health (GIPASA). Machala, El Oro, Ecuador.
**Email: arsanchez@utmachala.edu.ec*

ABSTRACT

This research was carried out in the bird´s experimental area of the Santa Inés Farm (Faculty of Agricultural Sciences, Universidad Técnica de Machala), El Oro Province, Ecuador. The objective was to evaluate the effect of the inclusion of *Moringa oleifera* leaf meal in the feed of Cobb 500 chickens on carcass and visceral parameters. To guarantee the welfare of the chickens, all the suggestions for open-shed systems was followed, as well as a basic vaccination schedule applied in the area. The variables evaluated were: *antemortem* weight; blood, feathers, viscera, thighs, counter-thighs, breast, shoulder, wings, neck, legs, head, heart, liver, gizzard, spleen, intestines and gizzard fat expressed as a percentage, and finally abdominal fat was expressed in millimeters. A Completely Randomized Design was applied, consisting of 5 treatments (T) with 4 experimental units, containing 10 chickens each one. The T1 or control without *M. oleifera* meal, while T2, T3, T4 and T5 incorporated Moringa leaf meal at a rate of 1, 2, 3 and 4%, respectively. An ANOVA analysis was used prior to observing the assumptions of normality and homogeneity, and to discriminate among the means, the Bonferroni multiple comparison procedure was applied, with a 95% confidence level. All calculations were obtained through the statistical program *Statgraphics Centurión XV.I.* The results showed that there is no negative effect on the variables evaluated, which allows to assume that up to 4% Moringa meal can be used in feed for chickens without any restrictions since it does not affect the weight of the carcass.

Key words: *Moringa oleifera*; broiler chickens; carcass yield; viscera performance

RESUMEN

Esta investigación se llevó a cabo en el área experimental de aves de la Granja Santa Inés (Facultad de Ciencias Agropecuarias, Universidad Técnica de Machala), provincia de El Oro, Ecuador. El objetivo fue evaluar el efecto de la inclusión de harina de hojas de *Moringa oleifera* en la alimentación de pollos Cobb 500 sobre parámetros de canal y visceras. Para garantizar el bienestar de los pollos se siguieron todas las sugerencias de sistemas de galpón abierto, así como un esquema básico de vacunación aplicado en la zona. Las variables evaluadas fueron: peso *antemortem*; sangre, plumas, vísceras, muslos, contra-muslos, pechuga, espalda, alas, cuello, piernas, cabeza, corazón, hígado, molleja, bazo, intestinos y grasa de molleja expresada en porcentaje, y finalmente la grasa abdominal se expresó en milímetros. Se aplicó un Diseño Completamente al Azar, consistente en 5 tratamientos (T) con 4 unidades experimentales, conteniendo 10 pollos cada uno. El T1 o control sin harina de *M. oleifera*, mientras que los T2, T3, T4 y T5 incorporaron harina de hoja de moringa a razón de 1; 2; 3 y 4 %, respectivamente. Se utilizó un análisis ANOVA previo a observar los supuestos de normalidad y homogeneidad, y para discriminar entre las medias se aplicó el procedimiento de comparación múltiple de Bonferroni, con un nivel de confianza del 95 %. Todos los cálculos se obtuvieron a través del programa estadístico *Statgraphics Centurión XV.I.®.* Los resultados mostraron que no existe un efecto negativo en las variables evaluadas, lo que permite suponer que hasta un 4 % de harina de moringa se puede utilizar en la alimentación de los pollos sin ninguna restricción ya que no afecta el peso de la canal.

Palabras clave: *Moringa oleífera*; pollos de engorde; rendimiento de canal;rendimiento de vísceras

Received: 12/08/2022 Accepted: 13/09/2022 Published: 20/11/2022

INTRODUCTION

The *per capita* consumption of chicken (*Gallus gallus domesticus)* per year is 16 kilograms (kg) and this has allowed an important economic development in the poultry sector [11].

According to Fuentes *et al.* [5], none of the protein sources used in poultry feed have an adequate amino acids profile and due to this there is a need to look for local alternatives that have good characteristics of easy accessibility, and that can be added to artificial feeds.

The Cobb 500 broiler (B) is a line that has shown great benefits due to its rapid development and growth. This is largely due to the diet that is administered to it, highlighting the importance of the nutrients on it, being this a very strong reason for the poultry farmer to strengthen the nutritional resources given to the B [15].

Moringa oleifera is a widely distributed species in tropical and subtropical Countries despite its origin in South Asia [13]. It is a bushy plant, highly resistant to different soil and climatic conditions, which has made it an option for animal feed due to its many properties, among them a good forage production and quality [8], in addition to the fact that it can be harvested at any time of the year. Another of the interesting properties that Moringa presents is a rapid regrowth with little rain [10], and 23.19% protein content [2].

Therefore, the objective of this experiment was to evaluate the effect of the inclusion of *M. oleifera* leaf meal in the feed of Cobb 500 B on carcass and visceral parameters.

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" W, 3°17'16" S, with an altitude of 5 meters above sea level, with a temperature that ranges between 22 to 35°C.

Characteristics of the housing and management of the broilers

For the management of the B, the methodology described by Sánchez *et al.* [17] was adapted to maintain 200 B of the Cobb 500 line. In order to generate the adequate comfort temperature, 4 JACKWALL gas brooders of 1,200 kilocalories· hours^{-1} (kcal·h^{-1}) – 4,700 British Thermal Unit·h^{-1} reference G14818 (Quito-Ecuador) were used as a source of heat and for the lighting program, 20-watt Light Emitting Diode (LED) bulbs were used, applying 24 h of light the first 7 days (d) and from then onwards subtracting 1 h per d until reaching only 6 h of artificial light. Four h previous to the arrival of the B, the heat source was turned on and during the first 3 d vitamins plus electrolytes at a dose of 1 grame (g) per liter (L) were administered in the drinking water and the litter was covered with newspaper. To control air currents, internal and external plastic curtains were used, which were lowered 20 centimeters (cm) per d from the eighth d after the arrival of the B, so that at the d 21 they received total ventilation (without curtains) (FIG.1).

Preparation of *M. oleifera* leaf meal

To obtain this raw material, fresh leaves of *M. oleifera* were placed into the trays of a food dehydrator ("Ronco ®" EZ-Store 5 trays, USA), and were left there for a period of 6 h at 71°C, obtaining a 32,2% Partially Dry Matter (PDM). This product was allowed to cool at ambient temperature for 24 h, then was grinded twice and, finally packed and stored.

FIGURE 1. Experimental Unit observation, T3 (replication 3)

Feed formulation

For the formulation of the diets, the Excel Solver tool was used, applying the data published by De Blas *et al.* [4] of the raw materials in the Tables of the Spanish Foundation for the Development of Animal Nutrition (FEDNA) and according to the nutritional needs of the birds according to Santomá and Mateos [18], from the which three food mixtures were elaborated:

1. Initial: from 0 to 21 (adapted to the manual of nutritional needs of birds, FEDNA standards, start from 0 to 14 d) that contains the following ingredients: corn (*Zea mays*), Soybeans (*Glycine max*), rice bran (*Oryza sativa*), L-Lysine Monohydrochloride, DL-Methionine, L-Threonine , soybean oil, rovabio 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* leaves and zeolite, each according to the specific treatment. The formula was isoproteic (21.2% Crude Protein -CP-) and isoenergetic (2,860 kcal·kg^{-1} metabolizable energy –ME-).
2. Growth: from 22 to 28 d (adapted to the manual on the nutritional needs of birds, FEDNA standards, Growth from 15 to 23 d), similar to the previous one but here soybean oil is replaced by palm oil (*Elaeis guineensis*). The formula was isoproteic (20% CP) and isoenergetic (2,990 kcal·kg^{-1} ME).
3. Finisher: from d 29 onwards (adapted to the manual on the nutritional needs of birds, FEDNA standards, Finisher from 24 to 36 d). The formula was isoproteic (18.5% CP) and isoenergetic (3,050 kcal·kg^{-1} ME).

TABLE I
Nutritional content of the diets for each stage, obtained with the Excel Solver tool

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	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

The T1 or control was a feed made without *M. oleifera*, while T2, T3, T4 and T5 have Moringa leaf flour at a rate of 1, 2, 3 and 4%, respectively.

Evaluated variables

At 35 d of age, 2 B of different sex were chosen at random per Experimental Unit (EU), 8 per Treatment (T), for a total of 40 animals. These B after a 6 h fast were sacrificed, with the aim of minimizing body weight loss [19], they were sacrificed by cervical dislocation, they were immediately hung by the legs and then a cut was made in the left jugular vein , they were bled for 2 minutes -min-. Later on, they underwent the scalding process at 60°C [16] (measured with a mercury thermometer brand SKU B4006 with a range of -10 to 250 degrees Celsius "Ecuador") for approximately 30 seconds -s-, where the following quantitative variables (v) were evaluated (a total of 760 data were generated (5T×4EU×2b×19v) : *antemortem* weight (g), blood (%), feathers (%), visceral (%), abdominal fat (milimeters -mm-), thighs (%), counter-thighs (%), breast (%), shoulder (%), wings (%), neck (%), feet (%), head (%), heart (%), liver (%), gizzard (%), spleen (%), intestines (%) and gizzard fat (%). To record the weight data, a CAMRY electronic scale with a maximum capacity of 5 kg and a margin of error of ± 1 g (model EK9332-F302, China) was used. For abdominal fat thickness data, a vernier caliper (PRETUL TRUP-21455, VER-6P, México) with a capacity of 160 mm was used.

Antemortem weight *(g)*

Data obtained prior to slaughtering the B.

Blood *(%)*

This variable is obtained from the difference between the *antemortem* weight and the weight of the bled animal and taken as a percentage.

$$Blood\,(\%) = \frac{\left(antemortem\ \ weight\ \ (g) - bled\ \ weight\ \ (g)\right) \times 100}{antemortem\ \ weight\ \ (g)}$$

Feathers *(%)*

This variable is obtained by subtracting the weight of the bled bird from the weight of the plucked B and taken as a percentage.

$$Feather\ \ (\%) = \frac{\left(bled\ \ weight\,(g) - plucked\ \ weight\,(g)\right) \times 100}{bled\ \ weight\,(g)}$$

Visceral *(%)*

This data is obtained by extracting all the viscera of the B, to express it as a percentage the following formula is applied:

$$Visceral\,(\%) = \frac{\left(plucked\ \ weight\,(g) - eviscerated\ \ weight\,(g)\right) \times 100}{plucked\ \ weight\,(g)}$$

Abdominal fat (mm)

These data were obtained by measuring the thickness of the fat in the abdomen of the B, directly applying a vernier caliper with light pressure (PRETUL TRUP-21455, VER-6P, México), the results are expressed in mm (FIG. 2).

Thighs (%), Counter-thighs (%), Breast (%), Shoulder (%), Wings (%), Neck (%), Feet (%) and Head (%)

These data were obtained from the cutting of the carcass, it was carried out by a single technician, weighed in grams and converted into a percentage, based on the weight of the carcass.

$$Variable\ \ (\%) = \frac{\left(Variable\,(g) \times 100\right)}{eviscerated\ \ weight\ \ (g)}$$

Heart (%), Liver (%), Gizzard (%), Spleen (%), Intestine (%) and Gizzard Fat (%)

FIGURE 2. Caliper application on abdominal fat

Data were obtained individually from each of the organs and were processed as in the previous variables above. (FIG. 3).

FIGURE 3. Cutting of the carcass and separation of the viscera

Experimental design

A Completely Random Design (CRD) was applied, divided into 5 T, with 4 EU containing 10 B each, for a total of 200 B (40 animals per T).

Statistical analysis

The statistical analysis were based on the book by Blasco [1]. For the variables that allowed it, a parametric analysis of variance (simple ANOVA) was applied prior to observing the assumptions of normality and homogeneity. To discriminate between the means, the Bonferroni multiple comparison procedure was applied, with a 95% confidence level. All the calculations made were obtained through the *Statgraphics Centurión XV.I* statistical program ®.

RESULTS AND DISCUSSION

TABLES II and III showed the average weights obtained from the variables evaluated in which was noticed that there is no significant difference among T. These results differ from those found by Fuentes *et al.* [5], who added 10% of Moringa leaf meal to feed B of the Ross-308 line for up to 42 d and reported a decrease in the weight of the B at the end of the experiment. On the other hand, the results of Rugel and Emén [15], who included 7 to 15% of Moringa meal in the diet of 15 Cobb 500 B with an initial average weight of 45 g and were slaughtered on d 42, obtaining a higher weight when compared to those with lower Moringa meal inclusion.

In TABLE IV is showed there is no significant difference in the variables antemortem weight, blood, feathers and abdominal fat when comparing the T against the control. These results agree with Mesa *et al.* [9], who used replacement White Leghorn L33 pullets (9 to 18 weeks –wk-) and laying hens (19 to 26 wk), where two experiments were carried out by adding Moringa meal up to 20%, and reported that such inclusion did not affect live weight or live weight gain. On the other hand, these results do not agree with Paul *et al.* [12], who pointed out that 12 Cobb 500 pullets, belonging to group C, were fed a basal diet + water (with 1% fine *M. oleifera* meal) for 35 d, finding a greater body weight gain in this group and that the rest of the measured parameters were similar to group B (basal diet + antibiotics "Ciprofloxacin").

From these variables, only at the visceral level it can be seen there is a significant difference, being T4 (14.51), the one that presents the lowest value. These results agree with what was mentioned by Khan *et al.* [7], who used 100 d-old chicks (Hubbard) that were randomly divided into five groups with four replicates containing five B each. All of the B in the experimental groups received the same diet supplemented with *M. oleifera leaves* at 0.6, 0.9, 1.2 and 1.5%, for 35 d, showing that the final body weight and length of the small intestine increased as the inclusion level of *M. oleifera* rose to 1.2%, and then decreasing with supplementation to 1.5%.

The FIG. 4 corroborates there is no significant difference in the general Table and in the analysis of these variables by sex. These results agree with the report of Cui *et al.* [3] who carried out a study for 42 d with 720 male chickens of the Arbor Acres line, where it is mentioned that no effects either linear or quadratic were found in muscle performance of both the breast and the leg, in response to the levels of addition of *M. oleifera* at 1, 2, 5, 10 and 15%, in the diet. However, these data do not agree with the results of Rehman *et al.* [14] who in their research administered *M. oleifera* leaf powder at 6 $g \cdot kg^{-1}$, 9 $g \cdot kg^{-1}$, 12 $g \cdot kg^{-1}$ and 15 $g \cdot kg^{-1}$ in Hubbard chickens of 100 d of age, for a period of 35 d, and it was found that this diet increased the water retention capacity of the muscle of the B breast, causing the diameter of this fiber to be greater ($P<0.05$) in the groups of 12 $g \cdot kg^{-1}$ and 15 $g \cdot kg^{-1}$ *M. oleifera* leaf powder, which means a greater weight in the animal. Furthermore, Gómez [6] by using 90 specimens of Cobb 500 male B for up to 21 d of age, to which 8% of Moringa (leaves)

TABLE II
General averages obtained after slaughtering the birds on day 35, with their respective confidence interval

Treatments	weight ant. (g)	blood (%)	feathers (%)	viscera (%)	fat. abd. (mm)
1	2163.00 ± 185.46^{a}	4.27 ± 0.73^{a}	3.10 ± 0.53^{a}	15.45 ± 1.03^{a}	1.69 ± 0.57^{a}
2	2235.63 ± 185.46^{a}	4.02 ± 0.73^{a}	3.38 ± 0.53^{a}	15.97 ± 1.03^{a}	1.31 ± 0.57^{a}
3	2233.50 ± 185.46^{a}	4.10 ± 0.73^{a}	3.13 ± 0.53^{a}	15.79 ± 1.03^{a}	1.94 ± 0.57^{a}
4	2220.25 ± 185.46^{a}	4.56 ± 0.73^{a}	3.73 ± 0.53^{a}	14.88 ± 1.03^{a}	1.50 ± 0.57^{a}
5	2263.50 ± 185.46^{a}	3.90 ± 0.73^{a}	3.23 ± 0.53^{a}	16.57 ± 1.03^{a}	1.88 ± 0.57^{a}

Treatments: weight ant., *antemortem* weight; fat. abd., abdominal fat; ^{ab}: It is the representation of the statistical differences ($P<0.05$) found when being compared against the control.

TABLE III
Averages obtained from the slaughtering of male chickens on day 35, with their respective confidence interval

Treatments	weight ant. (g)	blood (%)	feathers (%)	viscera (%)	fat. abd. (mm)
1	2405.50 ± 130.06[a]	4.63 ± 1.49[a]	2.86 ± 0.97[a]	14.18 ± 1.70[a]	2.13 ± 0.89[a]
2	2470.75 ± 130.06[a]	4.39 ± 1.49[a]	3.49 ± 0.97[a]	15.17 ± 1.70[a]	1.50 ± 0.89[a]
3	2361.25 ± 130.06[a]	4.26 ± 1.49[a]	3.43 ± 0.97[a]	15.60 ± 1.70[a]	1.88 ± 0.89[a]
4	2453.75 ± 130.06[a]	4.98 ± 1.49[a]	3.62 ± 0.97[a]	15.25 ± 1.70[a]	1.75 ± 0.89[a]
5	2443.00 ± 130.06[a]	3.69 ± 1.49[a]	3.16 ± 0.97[a]	17.06 ± 1.70[a]	1.38 ± 0.89[a]

Treatments: weight ant., *antemortem* weight; fat. abd., abdominal fat; [ab]: It is the representation of the statistical differences (P<0.05) found when being compared against the control

TABLE IV
Averages obtained from the slaughtering of female chickens on day 35, with their respective confidence interval

Treatments	weight ant. (g)	blood (%)	feathers (%)	viscera (%)	fat. abd. (mm)
1	1920.50 ± 140.86[a]	3.91 ± 0.60[a]	3.35 ± 0.73[a]	16.72 ± 1.08[a]	1.25 ± 0.81[a]
2	2000.50 ± 140.86[a]	3.66 ± 0.60[a]	3.26 ± 0.73[a]	16.77 ± 1.08[a]	1.13 ± 0.81[a]
3	2105.75 ± 140.86[a]	3.95 ± 0.60[a]	2.82 ± 0.73[a]	15.98 ± 1.08[ab]	2.00 ± 0.81[a]
4	1986.75 ± 140.86[a]	4.15 ± 0.60[a]	3.83 ± 0.73[a]	14.51 ± 1.08[b]	1.25 ± 0.81[a]
5	2084.00 ± 140.86[a]	4.10 ± 0.60[a]	3.31 ± 0.73[a]	16.08 ± 1.08[ab]	2.18 ± 0.81[a]

Treatments: weight ant., *antemortem* weight; fat. abd., abdominal fat; [ab]: It is the representation of the statistical differences (P<0.05) found when being compared against the control

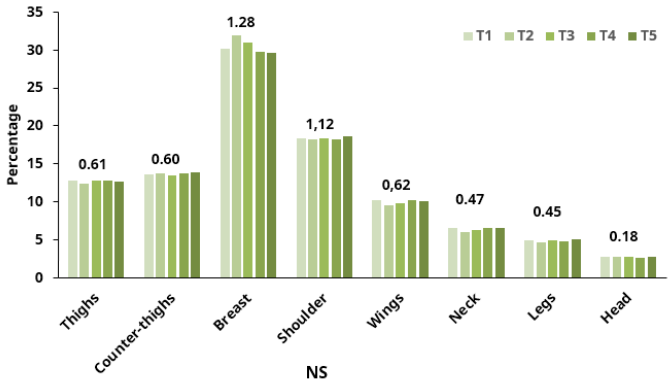

FIGURE 4. General averages obtained with the cutting of the carcass after slaughtering the chickens on day 35, with their respective confidence intervals

meal was included, whose results showed no adverse effects on the productive performance, nor the yield of the carcass and cuts of commercial value.

Furthermore, the FIG. 5 corroborates there is no significant difference in the general Table and in the analysis of these variables by sex. These data do not agree with Vázquez *et al.* [21] who used 28 male hybrid B of the line EB-34. Those authors reported that when using Moringa meal at 0.5, 1 and 1.5%, for a period of 42 d, they found an increase in the weight of the spleen, thymus and Fabricio's bag with respect to the control. Likewise Valdivié *et al.* [20] reported that when experimenting with 36 laying hens L-33, the weight of the liver did not present differences on the diets with up to 10% Moringa, but, it did decrease in the diet containing 20% of this meal, concluding that it was due to the lower contribution of EM and EE in the diet.

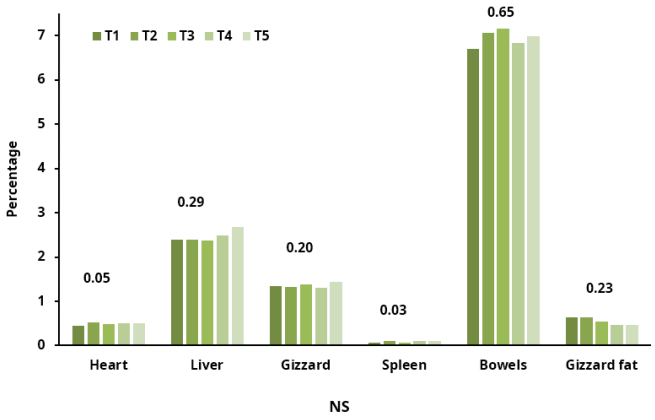

FIGURE 5. General averages obtained after the slaughtering of the chickens on day 35, with their respective confidence intervals

CONCLUSIONS

Adding *M. oleifera* (leaves) meal showed nor positive effects on the parameters of the carcass of Cobb 500 B, neither when analyzing the variables by sex, which allows to mention that it can be included in the diets up to 4%, being safe to use it as an alternative raw material.

Regarding the viscera variable (%), there was no generalized effect in males, but it was in females from 2% inclusion of Moringa flour in the diet, which tends to have lower percentages in the weight of it, without affecting the performance of the carcass.

ACKNOWLEDGEMENT

To the Authorities of the Faculty of Agricultural Sciences of the Universidad Técnica de Machala for providing unconditional support to research in food production and animal health.

BIBLIOGRAPHIC REFERENCES

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

[2] CHANA, W.F. Characterization of the Leaf and Flour of *Moringa oleifera*. **Latin Sci. Multidiscipl. Scientif. J.** 5(3): 2590–2604. 2021. https://doi.org/jmxn.

[3] CUI, Y.M.; WANG, J.; LU, W.; ZHANG, H.J.; WU, S.G.; QI, G.H. Effect of dietary supplementation with *Moringa oleifera* leaf on performance, meat quality, and oxidative stability of meat in broilers. **Poult. Sci.** 97(8): 2836–2844. 2018. https://doi.org/gnqk2j.

[4] 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.

[5] FUENTES-ESPARZA, M.K.; QUEZADA-TRISTÁN, T.; GUZMÁN-MALDONADO, S.H.; VALDIVIA-FLORES, A.G.; ORTÍZ-MARTÍNEZ, R. Effect of *Moringa oleifera* consumption on productive and toxicological parameters in broilers. **Mex. J. Livest. Sci.** 10(4): 1013–1026. 2019.

[6] GÓMEZ, N.I.; RÉBAK, G., FERNÁNDEZ, R.; SINDIK, M.; SANZ, P. Productive behavior of broiler chickens fed *Moringa oleifera* in Formosa, Argentina. **Vet. J.** 27(1): 7–10. 2016.

[7] KHAN, I.; ZANEB, H.; MASOOD, S.; YOUSAF, M.S.; REHMAN, H.F.; REHMAN, H. Effect of *Moringa oleifera* leaf powder supplementation on growth performance and intestinal morphology in broiler chickens. **J. Anim. Physiol. Anim. Nutr.** 101: 114–121. 2017.

[8] LOZANO, M.K.; PELÁEZ, F.R.; ESPINOZA, V.G.; VASCONEZ, F.D. Moringa forage production and quality system in Ecuador. **Social Sci. J.** 27(3): 459–470. 2021. https://doi.org/jmxp.

[9] 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): 445–454. 2020.

[10] ONTIVERO-VASALLO, Y. Characterization of five promising protein shrubs for Cuban livestock. **Pastures Forages**. 44: 1–10. 2021.

[11] ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACIÓN (FAO). Meat and meat products. In: **Food Outlook – Biannual report on global food market**s. Italy. Pp 8–10. 2019.

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

[13] PÉREZ, A.; SÁNCHEZ, T.; ARMENGOL, N.; REYES, F. Characteristics and potentialities of *Moringa oleifera*, Lamark: An alternative for animal feed. **Pastures Forages.** 33(4): 1–1. 2010.

[14] REHMAN, H.; ZANEB, H.; MASOOD, S.; YOUSAF, M.; ASHRAF, S.; KHAN, I.; REHMAN, H. Effect of *Moringa oleifera* Leaf powder supplementation on pectoral muscle quality and morphometric characteristics of tibia bone in broiler chickens. **Brazilian J. Poult. Sci.** 20: 817–824. 2018.

[15] RUGEL, D.; EMEN, M.F. Inclusion of *Moringa oleifera* meal in diets for broilers. **Vet. J.** 31(1): 74–77. 2020. https://doi.org/jmxq.

[16] SÁNCHEZ-QUINCHE, A.; SOLÓRZANO-SALDARRIAGA, J.; QUEVEDO-GUERRERO, J.; PALADINES-ROMERO, J.; PÉREZ-BAENA, I. Effect of *Mentha spicata* L. infusión on the productive performance and organoleptic characteristics of Cobb 500 broilers. **Rev. Acta Agronómic.** 68(4): 312–318. 2019. https://doi.org/jmxr.

[17] SÁNCHEZ-QUINCHE, A.; CHUQUISALA-PINZA, D.; POGO-TROYA, G.; CHALCO-ORTEGA, A.; PELÁEZ-RODRÍGUEZ, H.; ÁLVAREZ-DÍAZ, C. Effect of the inclusion of *Medicago sativa* in feed chicken Cobb 500. **Rev. Científ. FCV-LUZ**. XXXII (32): e32108. 2022. https://doi.org/jmxs.

[18] 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.

[19] SANZ-GIMENEZ, M. Algunas consideraciones sobre el rendimiento de canal de pollos broiler. **Rev. aviNews.** 2021**.** Online: https://bit.ly/3Xlh3hN. 15/02/2022.

[20] VALDIVIÉ, M.; MESA, O.; RODRÍGUEZ, B. Use of diets with *Moringa oleifera* (stems + leaves) meals in laying hens. **Cuban J. Agricult. Sci.** 50(3): 445–454. 2016.

[21] VÁZQUEZ, Y.; RODRÍGUEZ, B.; VALDIVIÉ, M. Effect of *Moringa oleifera* forage meal as an additive on health indicators of broilers. **Cuban J. Agricult. Sci.** 54(2): 229–236. 2020.