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**Original**

# Essential Oil of Oregano (O*riganum vulgare* L), and Sex, as Factors in the Productive Response of Broilers

Gustavo Adolfo Campozano-Marcillo *, Ernesto Antonio-Hurtado *, Fátima Arteaga Chávez *, Alcides Pérez-Bello **, Juan Ramón García-Díaz **, Rafael Alfonso Garzón-Jarrin ***

*Manuel Félix López Higher Polytechnical Agricultural School of Manabí, (ESPAM-MFL), Ecuador.
**Department of Veterinary Medicine and Zootechny, Faculty of Agricultural Sciences, Marta Abreu Central University of Las Villas (UCLV), Cuba.
*** Technical University of Cotopaxi, Ecuador.
Correspondence: gcampozanoregion4@gmail.com

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## ABSTRACT

**Background:** The utilization of essential oregano oil is a viable growth promoter alternative in the diet of birds. The aim of this study was to evaluate the effect of adding essential oregano oils (OEO) in the diet, and sex, on the productive performance of broilers.

**Methods:** A total of 400 one-day old Cobb 500® chickens were used. The animals were distributed in five treatments (T1-control without additives; T2-300 mg/kg of bacitracin zinc; T3-100 mg/kg of OEO; T4-200 mg/kg of OEO; and T5-300 mg/kg of OEO), with four repetitions, as to live weight, accumulated weight gain, feed consumption, feed conversion, and carcass yields, in the two sexes.

**Results:** Live weight, weight gain, and feed conversion were influenced ($P<0.05$) by the treatments; T5 showed the best results. An interaction ($P<0.05$) between the treatments and sex in relation to live weight, weight increase, and accumulated feed consumption was observed. Sex had a significant influence ($P<0.05$) on breast and quarter yields.

**Conclusions:** The inclusion of oregano essential oil in the diet of chickens, combined with sex, had a positive effect on variables live weight, weight gain, and accumulated feed consumption.

**Key words**: feed additives, growth promoter, carcass yields (Source: *Agrovoc*)

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# INTRODUCTION

Chicken production in Ecuador accounts for 295.4 million animals (573.2 thousand metric tons of chicken), with a *per capita* consumption of 33.19 kg (CONAVE, 2019), 10.90 kg more than pork (ASPE, 2018), and 10 kg more than beef consumption (Castillo and Carpio, 2017). Studies indicate that it is the most economical meat production alternative; therefore, it is the most widely demanded meat choice (Rodríguez, Erazo, and Narváez, 2019), and the most commonly consumed protein in the country.

Antibiotics are used in the diet of birds to promote growth and control diseases. However, overuse has led to bacterial resistance, and their possible presence in the meat. Hence, current studies are focused on natural compounds to replace antibiotics. As a result, oregano essential oil (OEO) has been increasingly studied due to its antimicrobial and antioxidant properties that can offer hygienic and technological benefits to animal production (Zamora *et al*., 2015).

The growing social and scientific concern over the emergence of resistant bacterial strains to commonly used antibiotics in animals and humans has been the main reason to ban the utilization of growth promoter antibiotics (GPA) in animals, first in Europe (2006), and more recently in the Americas. Although in the latter, the reduction of antibiotic use has been fostered by major multinational fast-food corporations, which have adopted these restrictions as a way to create commercial contrast (Vázquez *et al*., 2019).

Plant additives for animal consumption are a promising alternative, due to their significant potential to promote growth, increase feed consumption, and stimulate immunity (Attia *et al*., 2017). Accordingly, it is important to find alternative products. Pujada Abad *et al*. (2019) mentioned that the utilization of plants with medicinal properties, such as oregano, rosemary, bay leaves, and others, may provide an alternative solution to these growth promoters.

Oregano (*Origanum vulgare* L) contains substances like carvacrol and thymol, among others, which can reduce the viscosity of digesta, improving digestion (Rumiche, Ramos, and Colca, 2018). The utilization of these essential oils from oregano is relevant considering its contents of thymol, flavonoids, tannins, triterpenes, and carvacrol, which confer antioxidant capacity, reducing the formation of free radicals. Besides, it has antibacterial, antifungal, antiparasitic, antimicrobial, antiviral, antiallergic, vasodilator, estrogenic, anti-inflammatory, spasmolytic, antitumor, and other properties (Loeza-Concha *et al*., 2019).

The utilization of oregano essential oil is a viable alternative in the diet of birds, since feed ingestion, weight gain, feed conversion index, and mortality, are unaffected (Fonseca *et al*., 2017). It has also been used as an additive in the diet of meat-producing birds, due to the beneficial effects in terms of antibacterial activity of the intestinal tract of broiler chickens, thus bringing advantages to poultry farming (Loeza-Concha *et al*., 2019). However, further research is needed as to the inclusion dose of oregano in the diet, particularly in Ecuador, where there is little knowledge in this area.

The aim of this study was to evaluate the effects of sex, and the addition of essential oils from oregano (*Origanun vulgare* L) in the diet, as a growth promoter on broiler carcass yields.

# MATERIALS AND METHODS

The trial was done at Manuel Félix López Higher Polytechnical Agricultural School of Manabí, (ESPAM-MFL), Calceta, Ecuador, in March and April, 2019.

A number of 400 one-day old Cobb 500$^{TM}$ previously sexed chickens (200 females and 200 males), were distributed in five treatments with four repetitions. Each repetition included 10 birds in 1m$^2$. The study factors considered for a factorial experiment were sex and inclusion of oregano essential oil (OEO) at different levels, in the following treatments: T1- Control without the additive; T2- 300 mg/kg of bacitracin zinc; T3-100 mg/kg of OEO; T4-200 mg/kg of OEO; and T5-300 mg/kg of OEO. The experiment lasted 42 days. The animals were fed *ad libitum* on phased diets (Table 1), according to the requirements established in the manual on yields and nutrition of Cobb 500 broiler chickens (Cobb-Vantres, 2018). The equations suggested by Rostagno *et al.* (2017). were used to calculate the nutritional requirements.

**Table 1. Ingredients and nutritional composition of the experimental diet**

| Ingredients | Pre-start (1-7 days) | Start (8-21 days) | Finishing (22-42 days) |
|---|---|---|---|
| Yellow corn | 61.68 | 64.36 | 67.94 |
| Soymeal 48% | 30.50 | 28.4 | 23.64 |
| Plant oil | 1.00 | 2.00 | 3.20 |
| Fishmeal 65% | 3.00 | 1.50 | 1.83 |
| Calcium carbonate | 1.27 | 1.15 | 1.03 |
| Dicalcium phosphate | 1.50 | 1.40 | 1.04 |
| DL-methionine (99%) | 0.15 | 0.15 | 0.13 |
| L-lysine HCL (78%) | 0.10 | 0.17 | 0.19 |
| Vit-Min pre-mix for birds | 0.15 | 0.15 | 0.15 |
| Salt | 0.35 | 0.36 | 0.38 |
| Sodium bicarbonate | 0.30 | 0.36 | 0.47 |
| Total | 100.00 | 100.00 | 100.00 |
| **Composition calculated in %** | | | |
| Dry matter % | 87.57 | 87.40 | 87.02 |
| ME Birds, MJ/kg | 3.09 | 3.08 | 3.14 |
| Crude protein % | 20.93 | 20.03 | 17.88 |
| Crude fiber % | 2.41 | 2.38 | 2.35 |
| Calcium % | 0.96 | 0.85 | 0.69 |
| Phosph. Disp., % | 0.45 | 0.40 | 0.32 |
| Sodium | 0.25 | 0.28 | 0.30 |
| Lysine % | 1.28 | 1.20 | 1.06 |
| Methionine % | 0.53 | 0.50 | 0.44 |

The first dose of vaccines against Gumboro and New Castle diseases were administered at seven days of age, the second dose was given on days 14 and 21, respectively.

### Productive variables

**Live weight (LW) and weight gain (WG)** A digital balance (± 0.1 g precision) was used to weigh the animals individually, on the start day, and on days 7, 14, 21, 28, 35, and 42. Weekly weight gain was estimated by the difference between weekly weights, and accumulated weight gain was estimated by the difference between the final weight and the start weight.

**Feed consumption (C)** The feed remaining on the feeders in every area was weighed weekly. The weight of the remaining feed was subtracted from the weight of the total feed supplied, and the result was divided by the number of birds, in order to estimate weekly consumed feed, and consumed feed accumulated by bird.

**Feed conversion (FC)** It was estimated by dividing the accumulated food consumption by the final weight gain.

### Carcass variables

At the end of the growing period (42 days), a total of 40 chickens were slaughtered per treatment (four females and four males). The feed was removed 12 hours before slaughtering, according to the method described by Symeon *et al.* (2009), Gámez Piñón *et al.* (2015); Madrid, Lopez, and Parra (2018). Throughout the process, a label was attached to each chicken with the live weight (LW), and a number was assigned in an ascending order.

### Experimental design and statistical analysis

The experiment was done following a 2x5 factorial design (sexes and inclusion levels), distributed at random in the ten factor combinations. Each combination had four repetitions. SAS GLM, version 9.4 (2013) was used to perform the statistical analysis, and the Tukey test was done to detect significance among the means ($p<0.05$).

## RESULTS AND DISCUSSION

The productive indicators studied for different levels of oregano oil and sex are shown in table 2. T5 (300 mg/kg of OEO) had the best live weight, weight gain, and feed conversion averages ($P<0.05$), with 2815.10 g, 2770.39 g, and 1.59 kg/kg, respectively. The control treatment, without the additive (T1) showed the lowest averages; similar to the effects found by Cho, Kim, and Kim (2014), and by Méndez Zamora *et al.* (2017). The latter also added that feed consumption decreases with the addition of OEO, as in this research.

**Table 2. Effects of oregano essential oil and sex on the productive indicators of broiler chickens (0-42 days of age)**

| | LW, g | WG, g | C, g | FC |
|---|---|---|---|---|
| **Treatment** | | | | |
| 1 | $2674.05^{b}$ | $2629.90^{b}$ | 4725.64 | $1.81^{a}$ |
| 2 | $2807.70^{a}$ | $2763.89^{a}$ | 4519.00 | $1.64^{b}$ |
| 3 | $2762.10^{ab}$ | $2717.11^{ab}$ | 4538.00 | $1.67^{ab}$ |
| 4 | $2756.75^{ab}$ | $2711.80^{ab}$ | 4588.00 | $1.70^{ab}$ |
| 5 | $2815.10^{a}$ | $2770.39^{a}$ | 4389.00 | $1.59^{b}$ |
| **Standard E.** | ± 27.71 | ± 27.51 | ± 90.62 | ± 0.04 |

| | | | | |
|---|---|---|---|---|
| **Sex** | | | | |
| M | 3021.43[a] | 2976.72[a] | 4891.93[a] | 1.65[b] |
| F | 2504.85[b] | 2460.51[b] | 4211.92[b] | 1.71[a] |
| **Standard E.** | ± 17.53 | ± 17.40 | ± 57.31 | ± 0.02 |
| **Interaction** | | | | |
| 1M | 2915.43[b] | 2870.94[b] | 4932.67[ab] | 1.72 |
| 1F | 2432.66[c] | 2388.87[c] | 4518.61[abcd] | 1.89 |
| 2M | 3187.70[a] | 3143.38[a] | 5042.00[a] | 1.60 |
| 2F | 2427.70[c] | 2384.40[c] | 3996.00[d] | 1.68 |
| 3M | 2964.30[b] | 2918.78[b] | 5024.00[a] | 1.72 |
| 3F | 2559.90[c] | 2515.45[c] | 4052.00[d] | 1.61 |
| 4M | 3005.60[ab] | 2962.15[ab] | 4789.00[ab] | 1.62 |
| 4F | 2507.90[c] | 2461.44[c] | 4387.00[bcd] | 1.78 |
| 5M | 3034.10[ab] | 2988.37[ab] | 4672.00[abc] | 1.56 |
| 5F | 2596.10[c] | 2552.40[c] | 4106.00[cd] | 1.61 |
| **Standard E.** | ± 39.19 | ± 39.90 | ± 128.16 | ± 0.05 |
| **Significance** | | | | |
| **Treatment** | 0.0088 | 0.0083 | 0.1539 | 0.0048 |
| **Sex** | 0.0001 | 0.0001 | 0.0001 | 0.0487 |
| **Interaction** | 0.0007 | 0.0006 | 0.0387 | 0.0735 |

**[a, b, c, d:] unequal superscripts on the column and factor differ according to the Tukey test (P < 0.05)**

Regarding the doses administered, Hernández-Coronado *et al.* (2019), using 400 mg/L of oregano essential oils as natural alternative additives, achieved satisfactory results in broiler chicken production, and meat quality. Pujada Abad *et al.* (2019) found that the optimum level of oregano inclusion in the diet was 0.71%, producing higher final live weight, better feed conversion, and less feed consumption. Both doses were very similar to the one achieved in T5 (300 mg/kg of OEO).

These results corroborate the reports of Adaszyńska-Skwirzyńska and Szczerbińska (2017), who said there is strong evidence that essential oils have a positive effect on the yields of broiler production, which is observed in reduced feed ingestion, higher weight gain, and improved immunity and health.

The effect of the oregano essential oil tested on growth may be linked to the antibacterial properties of its phenolic components (carvacrol and thymol) (Abdel-Wareth, Kehraus, Hippenstiel, and Südekum, 2012; Alagawany *et al.*, 2018), which modify the permeability of the bacterial membrane, permitting the exit of inorganic ions (Betancourt López, 2012; Alagawany *et al.*, 2018), as well as the capacity to stimulate digestive secretion and immunological state (Galal, El-Araby, Hassanin, & Omar, 2016).

All the productive variables were observed to be influenced (P<0.05) by sex, with males showing a better performance, evidenced in sexual dimorphism. This behavior had been already predicted by Vega and Aguirres (2013), and Cobb-Vantres (2018), which was caused by the characteristic sexual dimorphism of birds.

The interaction or combined effects of the factors studied (sex and inclusion of different levels of oregano essential oil) was significant (P<0.05) to live weight, weight gain, and accumulated feed

consumption. The combination of OEO in males was observed to have the best averages. The combined effects of accumulated feed consumption was relevant, with similar averages (P<0.05), for OEO inclusion.

The averages achieved due to the interaction (P<0.05), seen in the variables that caused a higher effect than acting separately, evidenced a synergistic interaction. This response mainly owes to the effect of males

### Carcass yield

The effects of bacitracin zinc and essential oregano oil inclusion in the diet of chickens in the sacrifice variables (Table 3) were insignificant (P<0.05), with no significant interaction observed between treatments and sex (P<0.05). Similar results were seen by Eler *et al*. (2019); Kirkpinar *et al.* (2014), and Méndez Zamora *et al.* (2017). Sex had a significant influence (P<0.05) on breast and quarter yields. In previous studies, Fernandes *et al.* (2013), and Hussein *et al.* (2019), saw that yields from the breast and quarters were higher in 42-day old males, and observed no differences between sexes at 47 and 49 days of age.

**Table 3. Effects of supplementation with essential oregano oil and sex on carcass parameters (% LW), of 42-day old broilers**

| | Carcass | Breast | Quarter | Abdominal fat |
|---|---|---|---|---|
| **Treatment** | | | | |
| 1 | 72.37 | 26.52 | 20.39 | 1.61 |
| 2 | 72.18 | 26.69 | 19.97 | 1.60 |
| 3 | 71.90 | 26.83 | 19.88 | 1.80 |
| 4 | 72.16 | 26.59 | 19.99 | 1.45 |
| 5 | 72.23 | 26.90 | 19.93 | 1.34 |
| **Standard E.** | ± 0.29 | ± 0.22 | ± 0.29 | ± 0.14 |
| **Sex** | | | | |
| M | 72.30 | 26.94[a] | 20.34[a] | 1.50 |
| F | 72.04 | 26.47[b] | 19.73[b] | 1.63 |
| **Standard E.** | ± 0.18 | ± 0.14 | ± 0.18 | ± 0.09 |
| **Significance** | | | | |
| Treatment | 0.8466 | 0.7297 | 0.7196 | 0.2182 |
| Sex | 0.3129 | 0.0225 | 0.0231 | 0.3021 |
| Interaction | 0.0564 | 0.1209 | 0.6880 | 0.7339 |

**[a, b]: unequal superscripts on the columns and factor differed, according to the Tukey test (P < 0.05)**

# CONCLUSIONS

The inclusion of oregano essential oil in the diet of broilers increased live weight, accumulated weight gain, and feed use efficiency (feed conversion), compared to the control treatment. Besides, no significant effect was observed on feed consumption, and the carcass parameters studied. However, sex had a significant influence on breast and quarter yields. The outcome of this study shows that the combined addition of OEO in the diet of broilers, along with sex had a positive effect on live weight, weight gain, and accumulated feed consumption.

# REFERENCES

Abdel-Wareth, A. A. A., Kehraus, S., Hippenstiel, F., & Südekum, K. H. (2012). Effects of thyme and oregano on growth performance of broilers from 4 to 42 days of age and on microbial counts in crop, small intestine and caecum of 42-day-old broilers. *Animal feed science and technology*, *178*(3-4), 198-202. https://doi.org/10.1016/j.anifeedsci.2012.10.006

Adaszyńska-Skwirzyńska, M., & Szczerbińska, D. (2017). Use of essential oils in broiler chicken production–a review. *Annals of Animal Science*, *17*(2), 317-335. DOI: https://doi.org/10.1515/aoas-2016-0046

Alagawany, M., Abd El-Hack, M. E., Farag, M. R., Shaheen, H. M., Abdel-Latif, M. A., Noreldin, A. E., & Patra, A. K. (2018). The usefulness of oregano and its derivatives in poultry nutrition. *World's Poultry Science Journal*, *74*(3), 463-474. https://doi.org/10.1017/S0043933918000454

Asociación de Porcicultores del Ecuador [ASPE]. (2018). Datos porcícolas. DOI: http://www.aspe.org.ec/index.php/informacion/estadisticas/datos-porcicola-2011

Attia, Y. A., Al-Khalaifah, H., Ibrahim, M. S., Al-Hamid, A. E. A., Al-Harthi, M. A., & El-Naggar, A. (2017). Blood Hematological and Biochemical Constituents, Antioxidant Enzymes, Immunity and Lymphoid Organs of Broiler Chicks Supplemented with Propolis, Bee Pollen and Mannan Oligosaccharides Continuously or Intermittently. *Poult Sci*, *96*(12), 4182-4192. https://www.sciencedirect.com/science/article/pii/S0032579119312106

Betancourt López, L. L. (2012). Evaluación de aceites esenciales de orégano en la dieta de pollos de engorde. *Facultad de Medicina Veterinaria y Zootecnia*. https://repositorio.unal.edu.co/handle/unal/9594

Castillo, M. J., & Carpio, C. E. (2017). Beef Quality Perceptions and Preferences in Ecuador. https://ideas.repec.org/p/ags/aaea17/258241.html

Cho, J. H., Kim, H. J., & Kim, I. H. (2014). Effects of phytogenic feed additive on growth performance, digestibility, blood metabolites, intestinal microbiota, meat color and relative organ weight after oral challenge with Clostridium perfringens in broilers. *Livestock Science*, *160*, 82-88. https://doi.org/10.1016/j.livsci.2013.11.006

Cobb-Vantres. (2018). Broiler Cobb-500. Broiler performance & nutrition supplement. https://www.cobb-vantress.com/assets/Cobb-Files/product-guides/bdc20a5443/70dec630-0abf-11e9-9c88c51e407c53ab.pdf

Corporación Nacional de Avicultores del Ecuador [CONAVE]. (2019). Asamblea General Ordinaria de Socios. DOI: https://doi.org/10.18268/bsgm1908v4n1x1

Eler, G., Gomes, A. V. C., Trindade, B. S., Almeida, L. S. L., Dilelis, F., Cardoso, V. S., & Lima, C. A. R. (2019). Oregano essential oil in the diet of broilers: performance, carcass

characteristics, and blood parameters. *South African Journal of Animal Science*, *49*(4), 753-762. DOI: http://dx.doi.org/10.4314/sajas.v49i4.17

Fernandes, J. I. M., Bortoluzzi, C., Triques, G. E., Garcez Neto, A. F., & Peiter, D. C. (2013). Effect of strain, sex and age on carcass parameters of broilers. *Acta Scientiarum. Animal Sciences*, *35*(1), 99-105. https://www.scielo.br/scielo.php?pid=S180786722013000100015&script=sci_abstract&tlng=es

Fonseca, I., Escalera, F., Martínez, S., Carmona, C., Gutiérrez, D., Ávila, F. (2017). Effect of oregano oil dietary supplementation on production parameters, height of intestinal villi and the antioxidant capacity in the breast of broiler. *Austral journal of veterinary sciences, 49*(2), 83-89. DOI: http://dx.doi.org/10.4067/S0719-81322017000200083

Galal, A. A. A., El-Araby, I. E., Hassanin, O., & Omar, A. E. (2016). Positive impact of oregano essential oil on growth performance, humoral immune responses and chicken interferon alpha signalling pathway in broilers. *Adv. Anim. Vet. Sci.*, *4*(1), 57-65. doi: http://dx.doi.org/10.14737/journal.aavs/2016/4.1.57.65

Gámez Piñón, J. R., Monterrubio, A. L. R., Meléndez, L. A. D., Martínez, A. C., Rojo, A. D. A., Palma, N. G. A., & Vázquez, R. S. (2015). Efecto del aceite esencial de orégano en el rendimiento y las propiedades fisicoquímicas y microbiológicas de la carne de pollo. *Investigación y Ciencia*, *23*(66), 5-11. https://dialnet.unirioja.es/servlet/articulo?codigo=6137835

Hernández-Coronado, A. C., Silva-Vázquez, R., Rangel-Nava, Z. E., Hernández-Martínez, C. A., Kawas-Garza, J. R., Hume, M. E., & Méndez-Zamora, G. (2019). Mexican oregano essential oils given in drinking water on performance, carcass traits, and meat quality of broilers. *Poultry Science*, *98*(7), 3050-3058. https://doi.org/10.3382/ps/pez094

Hussein, E. O. S., Suliman, G. M., Al-Owaimer, A. N., Ahmed, S. H., Abudabos, A. M., Abd El-Hack, M. E., ... & Swelum, A. A. (2019). Effects of stock, sex, and muscle type on carcass characteristics and meat quality attributes of parent broiler breeders and broiler chickens. *Poultry science*, *98*(12), 6586-6592. https://doi.org/10.3382/ps/pez464

Kirkpinar, F. İ. G. E. N., Ünlü, H. B., Serdaroğlu, M., & Turp, G. Y. (2014). Effects of dietary oregano and garlic essential oils on carcass characteristics, meat composition, colour, pH and sensory quality of broiler meat. *British Poultry Science*, *55*(2), 157-166. https://doi.org/10.1080/00071668.2013.879980

Loeza-Concha, H., Salgado-Moreno, S., Ávila-Ramos, F., Gutiérrez-Leyva, R., Domínguez-Rebolledo, A., Ayala-Martínez, M., & Escalera-Valente, F. (2019). Revisión del aceite de orégano spp. en salud y producción animal. *Abanico Agroforestal*, *2*(1). https://abanicoacademico.mx/revistasabanico/index.php/abanicoagroforestal/article/view/229

Madrid Garcés, T. A., López Herrera, A., & Parra Suescún, J. E. (2018). Efecto de la inclusión de aceite esencial de orégano (Lippia origanoides) sobre perfil lipídico en carne de pollos de engorde. *Vitae*, *25*(2), 75-82. DOI: https://doi.org/10.17533/udea.vitae.v25n2a03

Méndez Zamora, G., Durán Meléndez, L. A., Hume, M. E., & Silva Vázquez, R. (2017). Performance, blood parameters, and carcass yield of broiler chickens supplemented with Mexican oregano oil. *Revista Brasileira de Zootecnia*, *46*(6), 515-520. https://www.scielo.br/scielo.php?pid=S1516-35982017000600515&script=sci_arttext

Pujada Abad, H., Vega-Vilca, J., Velásquez Vergara, C., & Palacios-Rodríguez, B. (2019). Niveles de orégano (Origanum vulgare) en la dieta y su influencia en el rendimiento productivo del pollo de engorde. *Revista de Investigaciones Veterinarias del Perú*, *30*(3), 1077-1082. http://www.scielo.org.pe/scielo.php?pid=S1609-91172019000300010&script=sci_arttext&tlng=pt

Rodríguez, D. F., Erazo, J. C., & Narváez, C. I. (2019). Técnicas cuantitativas de investigación de mercados aplicadas al consumo de carne en la generación millennial de la ciudad de Cuenca (Ecuador). *Espacios*, *20*.

Rostagno, H. S., Teixeira Albino, L. F., Hannas, M. I., Lopes Donzele, J., Sakomura, N. K., Perazzo, F. G. & Oliveira Brito, C. (2017). Tabelas brasileiras para aves e suínos (4 ed.). Departamento de Zootecnia, UFV, Viçosa.

Rumiche, E. M. O., Ramos, P. A. D. C., & Colca, I. S. C. (2018). Suplementación alimenticia con orégano (Origanum vulgare) y complejo enzimático en pollos de carne: I. Indicadores Productivos. *UCV-HACER: Revista de Investigación y Cultura*, *7*(1), 31-44. https://dialnet.unirioja.es/servlet/articulo?codigo=6317321

Symeon, G. K., Zintilas, C., Ayoutanti, A., Bizelis, J. A., & Deligeorgis, S. G. (2009). Effect of dietary oregano essential oil supplementation for an extensive fattening period on growth performance and breast meat quality of female medium-growing broilers. *Canadian Journal of Animal Science*, *89*(3), 331-334. https://www.nrcresearchpress.com/doi/abs/10.4141/CJAS09027

Vázquez, O. V., Ortiz, M. A., Vázquez, P., & Velasco, L. (2019). Butirato sódico, una alternativa para sistemas de producción de pollo libre de antibióticos promotores de crecimiento. Memorias, Décimo Segundo Congreso Aviespecialistas de México.

Vega, J., & Aguirres, R. (2013). Comparacion de variables productivas entre macho y hembra en la produccion de pollos parrilleros en el departamento de santa cruz. Universidad, Ciencia y Sociedad, 39. https://www.google.com/search?client=firefox-b-d&q=Vega%2C+J.%2C+y+Aguirres%2C+R.+%282013%29.+Comparacion+de+variables+productivas+entre+macho+y+hembra+en+la+produccion+de+pollos+parrilleros+en+el+departamento+de+santa+cruz.+Universidad%2C+Ciencia+y+Sociedad%2C+39.+

Zamora, G. M., Macías, J. A. G., Estrada, E. S., Meléndez, L. A. D., & Vázquez, R. S. (2015). Aceite de orégano sobre la calidad de pechuga de pollos de engorda. *Investigación y Ciencia: de la Universidad Autónoma de Aguascalientes*, (65), 5-12. https://dialnet.unirioja.es/servlet/articulo?codigo=5450121

## AUTHOR CONTRIBUTION

Gustavo Adolfo Campozano-Marcillo: Research related to bird rearing, formulation of diets in the Feed Manufacturing Workshop at ESPAM-MFL, and the extraction of oregano (*Origanum vulgare*) essential oil in the Chemistry Laboratory of ESPAM-MFL.

Ernesto Antonio-Hurtado: management of financial resources for research, at the Research Unit of the Higher Polytechnical School of Agriculture in Manabi, ESPAM-MFL. Support with data tabulation and processing, and redaction of the manuscript for submission.

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Alcides Pérez-Bello: research planning and interpretation of the results. Redaction of the manuscript and design of result tables, and discussions to submit the manuscript. Research related to bird rearing, formulation of diets in the Feed Manufacturing Workshop at ESPAM-MFL, and the extraction of oregano (*Origanum vulgare*) essential oil in the Chemistry Laboratory of ESPAM-MFL.

Juan Ramón García-Díaz: research planning, analysis and interpretation of results. Redaction of the manuscript, and results tables, discussions to submit the manuscript.

Rafael Alfonso Garzón-Jarrin: Research related to bird rearing, formulation of diets in the Feed Manufacturing Workshop at ESPAM-MFL, and the extraction of oregano (*Origanum vulgare*) essential oil in the Chemistry Laboratory of ESPAM-MFL.

## CONFLICT OF INTERESTS

The authors declare no conflict of interests.