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Performance of broiler chickens supplemented with Mexican oregano oil (*Lippia berlandieri* Schauer)

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ABSTRACT - The objective of this research was to evaluate the inclusion of two qualities of Mexican oregano oil (MOO) in broiler diets on broiler weight, feed intake, feed efficiency, average daily gain, and water intake. The qualities were MOO_1 (4% thymol, 60% carvacrol) and MOO_2 (40% thymol, 20% carvacrol). Nine treatments were prepared by the combinations of MOO_1 + MOO_2 (0, 400, and 800 mg kg^{-1}; added per kg of feed) respectively: 0+0, 0+400, 0+800, 400+0, 400+400, 400+800, 800+0, 800+400, and 800+800. Eighteen chicks per treatment were divided in a completely randomized design into nine cages. Broiler weights were altered by the treatments at 21 d, when 400+400 had the highest weight, and on day 39, when the greatest weight was seen in broilers on treatments 800+0 and 800+400. Feed intake was affected by treatment on day 39, with broilers on 800+0 exhibiting the highest values. Water intake was influenced by the treatments on days 14, 21, 35, and 39, when 0+0 represented the lowest. Feed efficiency was altered by the treatments on days 14, 28, 35, and 39, whereas average daily gain was affected from days 14 to 39. Supplementation of Mexican oregano oil has beneficial effects on broiler weight, feed efficiency, average daily gain, and feed and water intakes. Combinations of thymol and carvacrol levels have varying effects on these parameters. The higher relative body weights of groups 400+0, 800+0, and 800+400 suggest positive market value effects of these combinations of Mexican oregano oil.

Key Words: carvacrol, extract, inclusion, thymol, water intake

Introduction

Antibiotics have been used as growth promoters and for disease prevention in poultry production. However, antibiotic residues have been found in poultry meat, and these residues are considered risks to human health (Castanon, 2007). Therefore, researchers are investigating natural alternatives to antibiotics to improve poultry production, e.g., oregano essential oil (OEO) (Adil et al., 2011; Khan et al., 2012). This oil is a mixture of several components, mainly the monoterpenes thymol and carvacrol (Kintzios, 2002), and is considered GRAS (Generally Recognized as Safe) by the United States Food and Drug Administration (Silva and Dunford, 2005). The chemical makeup of OEO depends on the OEO quality and is related to the phenological stage of the plant (Dunford and Silva, 2005).

Oregano essential oil, as a natural alternative to antibiotics, has potentially desirable production properties and stimulatory effects on poultry digestion (Alçiçek et al., 2004; Zhang et al., 2005). These features can improve the feed efficiency because of positive effects on the nutrient digestibility (Jamroz et al., 2003; Hernandez et al., 2004) and antimicrobial activities (Dorman and Deans, 2000). Oregano essential oil from *Origanum vulgare* L. in broiler diets has been shown in several studies to improve body weight and feed intake; however, the OEO efficacy on broiler performance remains controversial (Symeon et al., 2010).

On the other hand, little attention has been afforded to the use of Mexican oregano oil (MOO) harvested from *Lippia berlandieri* Schauer in broiler production. This plant is used as a food seasoning, as well as against respiratory and digestive diseases (Rivero-Cruz et al., 2011). Mexican oregano oil is characterized by a strong odor and its various biological activities, attributed to the high content of phenolic components carvacrol and thymol (Arcila-Lozano et al., 2004; Avila-Sosa et al., 2010). These components exhibit antibacterial, antioxidant, antiviral, anti-fungal, and insecticide activities (Silva and Dunford, 2005; Ortega-Nieblas et al., 2011). Recently, OEO was investigated in

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the production of chickens and turkeys (Gopi et al., 2013; Giannenas et al., 2014; Kirkpinar et al., 2014).

The hypothesis was that bioactive components of MOO may work as growth promoters in broiler production. The aim of the current study was to evaluate MOO supplementation on broiler weight, feed intake, feed efficiency, average daily gain, and water intake.

Material and Methods

All procedures used in this study were approved by Facultad de Zootecnia y Ecologia in the Universidad Autonoma de Chihuahua, Chihuahua, Mexico, and Laboratory Animal Care Committee. The animals used in this study were managed according to the guidelines recommended by the Mexican animal welfare standards (NOM-062-ZOO-1999).

The study was conducted in Chihuahua, Mexico. This city is located between the 28°38' N and 106°04' W parallels at an altitude of 1,440 m, with a mean annual temperature 18 °C, annual precipitation between 200-600 mm, and is in a tempered dry climate (INEGI, 2013).

A total of 162 one-day-old broiler chickens of commercial genetic line Ross were used in this study. Water and feed were provided *ad libitum*. Husbandry practices were as described by Roofchaee et al. (2011). The temperature was set at 34 °C on the first day, followed by 32 °C over the remainder of the first week, and then it was reduced gradually by 3 °C per week until it reached 23 °C. The relative humidity fluctuated between 25 and 75%. Lighting was provided 22 h d^{-1}. The diet supplied (ingredients expressed on a dry matter basis) was an isoenergetic and isoproteic formulation (NRC, 1994) of poultry broiler starter diet to 21 days and finisher diet supplied for the remaining 18 days, in a total of 39 days (Table 1). It is important to stress that during the sixth week (35 to 39 days), the chicks were fed for four days and this could cause some confusions about body weight, feed intake, water intake, feed efficiency, and weight gain, which showed an abrupt change (Tables 3 and 6).

An arrangement of treatments was used by combining two variations of the Mexican oregano oil. The first Mexican oregano oil (MOO_1) contained 4% thymol and 60% carvacrol, while the second oil tested (MOO_2) consisted of 40% thymol and 20% carvacrol (the major components of MOO are presented in Table 2). Therefore, nine treatments were prepared by the combinations of MOO_1 + MOO_2 (0, 400, and 800 mg kg^{-1}; added per kg of feed) respectively: 0+0, 0+400, 0+800, 400+0, 400+400, 400+800, 800+0, 800+400, and 800+800. Each treatment consisted of 18 broilers distributed into nine cages (30 × 33 × 44 cm) with two chicks per cage. The MOO were purchased from Natural Solutions Company SMI (Jimenez, Chihuahua, Mexico) and were prepared by steam distillation of two cultivars of *Lippia berlandieri* Schauer. The oregano oil treatments were added to the canola oil as carrier and mixed slowly with the basal diets for 10 min.

The initial weight (IW, g) of each chick was determined at the beginning of the experiment. The studied variables were body weight (BW, g), feed intake (FI, g), and water

Table 1 - Ingredients of the experimental starter and finisher diets for broilers

Ingredients (g kg^{-1})[1]	Diet[2]	
	Starter (0 to 21 days)	Finisher (22 to 39 days)
Corn	467.2	556.4
Soybean (48% CP)	392.2	312.9
Corn gluten	53.3	44.4
Vitamin and mineral premix[3]	11.7	13.3
Calcium carbonate	14.4	21.4
Dicalcium phosphate	21.3	22.2
Sodium chloride	6.0	6.4
DL-methionine	1.9	0.8
Canola oil®[4]	32.0	22.2
Total	1,000.0	1,000.0
Calculated contents		
Metabolizable energy (kcal kg^{-1})[5]	3,200.0	3,200.0
Crude protein (%)	23.0	19.0
Lysine (%)	1.1	0.9
Methionine + cystine (%)	0.9	0.62
Calcium (%)	1.0	0.8
Available phosphorus (%)	0.5	0.3

[1] Ingredients were incorporated per kg of the experimental diet (expressed on a dry matter basis).
[2] Diets were formulated according to the nutrient requirements for broilers as recommended by NRC (1994).
[3] Every 10 g of premix consisted of 24.0 mg of vitamin A (500,000 IU g^{-1}); 6.0 mg of vitamin D3 (100,000 IU g^{-1}); 60.0 mg of vitamin E (500 IU g^{-1}); 6.6 mg of vitamin K3 (purity, 22.7%); 100.0 mg of vitamin B12 (purity, 0.1%); 2,000.0 mg of biotin (purity, 0.01%); 1,100.0 mg of choline chloride (purity, 50%); 1.1 mg of folic acid (purity, 90%); 65.2 mg of nicotinic acid (purity, 100%); 16.3 mg of d-pantothenate (purity, 92%); 4.5 mg of vitamin B6 (purity, 100%); 12.5 mg of riboflavin (purity, 80%); 2.5 mg of vitamin B1 (purity, 100%); 32.00 mg of $CuSO_45H_2O$; 333.20 mg of $FeSO_4H_2O$; 166.80 mg of MnO; 1.0 mg of $Na_2SeO_35H_2O$; 220.00 mg of $ZnSO_4H_2O$; 4.80 mg of $CoSO_4$ $7H_2O$; 0.56 mg of KI; 100.00 mg of ethoxyquin, and 5,742.94 mg of corn meal as carrier.
[4] Canola oil was purchased from the company Industrial Patrona, S.A. de C.V.
[5] Calculated contents according to typical values for broilers fed well-balanced diets providing 3,200 kcal ME/kg (Table 2-5, page 26; NRC, 1994).

Table 2 - Main components of the Mexican oregano oil

Component[1]	Concentration (%)	
	MOO_1	MOO_2
Carvacrol	60.02	20.06
Thymol	3.96	40.08
Cineole 1,8	23.63	15.31
P-cymene	9.57	16.03
Gamma-terpinene	0.11	4.72
Others	2.71	3.80

[1] Mexican oregano oil (MOO) components were analyzed by GC/MS Clarus SQ 8 (PerkinElmer®).

intake (WI, mL) at 0, 7, 14, 21, 28, and 39 days, during the fattening period. These measurements were used to estimate the average daily gain [ADG; (currentBW – previousBW/days)] and feed efficiency (FE; BW/FI) as weight gain/feed intake. The obtained data were analyzed with the GLM procedure of SAS (Statistical Analysis System, version 9), using the following statistical model: $y_{ijk} = \mu + T_i + \delta_j + (T\delta)_{ij} + \Phi_{k(ij)} + \lambda + \varepsilon_{ijk}$, in which y_{ijk} = variables BW, FI, WI, ADG, and FE measured during the experiment over time; μ = overall mean; T_i = effect of the *i*-th treatment; δ_j = effect of the *j*-th day (0, 7, 14, 21, 28, and 39 days) during the fattening period; $(T\delta)_{ij}$ = effect of the interaction between the *i*-th treatment and the *j*-th day; $\Phi_{k(ij)}$ = nested effect of the *i*-th treatment in each cage where the chicken was for the *j*-th day of fattening; λ = covariate effect IW; and ε_{ijk} = random error normally distributed with zero mean and variance σ^2 [$\varepsilon_{ijk} \sim N(0, \sigma^2)$]. When the effect of the interaction between treatments and days was significant (P≤0.05), the ESTIMATE statement of SAS (Statistical Analysis System, version 9) was used to compare means with a probability of 5%.

Results and Discussion

Mexican oregano oil treatments had significant effects (P≤0.05) on the broiler performance variables BW, WI, FE, FI, and ADG. Results obtained in the studies of Basmacıoğlu et al. (2004) and Symeon et al. (2009) with OEO differed in the effects found on broiler production variables and did not reveal differences in final weight, whereas Bozkurt et al. (2009) found differences in BW and FC at 42 days and Kırkpınar et al. (2011) obtained only effects on BW at 7, 14, 21, 28, and 42 days, but FI only at 42 days. Brenes and Roura (2010) identified different mechanisms of the OEO actions that were grouped into four categories: sensorial, metabolic, antioxidant, and antimicrobial, in which oronasal sensing prepares the gastrointestinal tract for food reception and stimulates digestive secretions (saliva, salivary amylase, lipase, amylase, and proteases) and gut motility. Those responses could have contributed to results obtained in the performance of broilers supplemented with Mexican oregano oils.

Treatments 400+800 and 800+0 had the lowest (P≤0.05) weights on day 7 (Table 3). Treatment 800+0 provided the lowest (P≤0.05) weight on day 14, whereas 0+0 and 800+800 had the lowest (P≤0.05) weights on day 21. From days 28 to 39 and 0 to 39 there were no differences (P>0.05) between treatment groups. However, treatments 800+0 and 800+400 resulted in the highest weights at 39 days, with nearly 100 g more weight than broilers in 0+0, which may translate into a higher market value. Similarly, other studies using OEO in broilers obtained improvements in performance (Roofchaee et al., 2011; Alali et al., 2013; El-Ghany and Ismail, 2013; Küçükyilmaz et al. 2014). The proposed action of OEO on growth promotion is due to the content of thymol and carvacrol, as these components may stimulate appetite and enhance the activity of digestive enzymes and absorption of nutrients (Cross et al., 2007; Windisch et al., 2008; Roofchaee et al., 2011). In addition, Sugiharto (2014) cited that the mechanisms of action of oregano oils on the grown performance of chickens are improvements in the flavor and palatability of the feed and the potential improvements in feed intake and performance of chickens; stimulation of the proliferation and growth of absorptive cells in the gastrointestinal tract (resulting in greater villus height and deeper crypt); and influences on the production and/or activity of the digestive enzymes, e.g., increased activities of amylase and protease. The improvements in BW in the current study could be attributed to these positive effects of thymol and carvacrol.

Table 3 - Effect of inclusion of the Mexican oregano oil on body weights of broilers from hatch to 39 days of age

Treatment MOO_1+MOO_2 (mg kg^{-1} of feed)	Period (days)[1]					
	0-7	7-14	14-21	21-28	28-35	0-39
0+0	140.44ab	363.61ab	724.56b	1,304.44	1,682.78	1,945.56
0+400	139.89ab	384.03ab	805.72ab	1,351.67	1,918.89	2,160.56
0+800	142.69ab	385.69ab	776.08ab	1,295.00	1,812.78	2,161.11
400+0	146.79a	404.61a	857.36a	1,396.43	1,904.29	2,215.71
400+400	139.31ab	373.25ab	803.11ab	1,315.56	1,846.11	2,044.44
400+800	131.39b	373.75ab	798.33ab	1,317.22	1,820.00	2,136.67
800+0	128.38b	351.16b	773.88ab	1,330.00	1,958.13	2,245.00
800+400	149.56a	400.78ab	832.83ab	1,350.56	1,910.00	2,249.44
800+800	151.19a	385.47ab	743.81b	1,313.75	1,777.50	2,071.88
SEM[2]	1.50	5.11	11.54	20.51	20.02	35.56
P-value	<0.01	<0.01	<0.01	0.13	0.21	0.23

[1] Mean body weights (g) in the same column followed by different letters are significantly different (P≤0.05). Abrupt changes were observed from day 35 to 39 because the chicks were fed for four days.
[2] Pooled standard error of least squares means.

Feed intake (FI) was affected also by supplementation of MOO (Table 4). On day 14, broilers in 800+400 expressed the greatest FI, whereas the broilers on treatment 0+0 had the lowest (P≤0.05) FI.

At 21 days, 800+800 had the lowest FI (P≤0.05) compared with the other treatments. Feed intake was not different (P>0.05) at 28-35 and 0-39 days between treatments, but a difference (P≤0.05) was found at 39 days, when FI was lowest in broilers on treatment 0+0. In contrast, Lee et al. (2003) indicated that the inclusion of 200 ppm of carvacrol in the diet of chickens can have adverse responses on FI. However, the results of our study contradict this observation, possibly because the dose of MOO was higher. Conversely, the lower FI for 800+800, especially at days 14 to 35, with MOO at the highest concentration (1,600 mg kg^{-1}), may suggest adverse effects due to OEO component toxicity. Dušan et al. (2006) indicated that carvacrol at 55% can have cytotoxic effects in chickens and therefore a decrease in FI.

At 39 days, 800+0 recorded the highest relative water intake (WI), which was greater (P>0.05) than that consumed by 0+0 and 400+400, which had the lowest consumption (Table 5). From days 14 to 39, WI was relatively and statically different between the treatments, with the exception of 800+800 at day 35, lower for 0+0 when compared with the treatments that received MOO. Manning et al. (2007) commented that water consumption could be modified by the physiological states of the chicken during growth and development, influenced by breed, sex, population density, room temperature, health, and welfare and food consumption; however, in the current study, the 0-39 day period exhibited no statistical differences between the treatments (Table 5). Our results showed that WI is closely related to FI and the concentration of MOO (r = 0.824; P<0.01). The increase of MOO in the treatments increased WI and FI and, thus, the weights of the chickens.

The feed efficiency (FE) was not affected (P>0.05) at 7, 21, and 0-39 days (Table 6). However, in the periods of

Table 4 - Influence of Mexican oregano oil on feed intake of broilers from hatch to 39 days of age

Treatment MOO_1+MOO_2 (mg kg^{-1} of feed)	Period (days)[1]						
	0-7	7-14	14-21	21-28	28-35	35-39	0-39[2]
0+0	105.78	269.69b	526.67a	812.94	1,049.97	570.33b	3,335.38
0+400	99.82	292.67ab	558.72a	825.36	973.92	627.14ab	3,377.63
0+800	108.19	291.17ab	533.50a	799.75	974.97	652.44ab	3,360.02
400+0	105.64	293.25ab	550.04a	862.50	1,014.86	677.96ab	3,504.25
400+400	99.78	282.67ab	548.78a	847.14	980.72	593.19ab	3,352.28
400+800	94.00	286.89ab	541.14a	849.22	974.58	664.97ab	3,410.81
800+0	92.75	278.47ab	522.34a	871.03	1,080.65	704.31a	3,549.55
800+400	95.33	302.97a	537.08a	915.89	1,044.86	674.75ab	3,570.88
800+800	108.81	293.38ab	451.84b	806.88	957.09	617.44ab	3,235.44
SEM[3]	1.19	3.27	6.69	13.61	22.84	13.16	142.29
P-value	0.10	<0.01	<0.01	0.20	0.95	<0.01	0.79

[1] Mean feed intake values (g) in the same column followed by different letters are significantly different (P≤0.05). Abrupt changes were observed from day 35 to 39 because the chicks were fed for four days.
[2] Recorded consumption from day 0 to 39.
[3] Pooled standard error of least squares means.

Table 5 - Influence of Mexican oregano oil on water intake of broilers from hatch to 39 days of age

Treatment MOO_1+MOO_2 (mg kg^{-1} of feed)	Period (days)[1]						
	0-7	7-14	14-21	21-28	28-35	35-39	0-39[2]
0+0	479.19	718.56ab	1,027.94b	1,871.08	1,998.03c	1,183.39b	7,278.19
0+400	469.94	760.78ab	1,106.42ab	1,978.19	2,265.31abc	1,377.33ab	7,957.97
0+800	480.89	726.00ab	1,087.25ab	1,935.44	2,152.22abc	1,471.67ab	7,853.47
400+0	501.46	766.61ab	1,133.75ab	1,945.57	2,228.75abc	1,305.07ab	7,881.21
400+400	479.44	686.08b	1,108.17ab	1,982.33	2,298.39abc	1,270.83b	7,825.24
400+800	496.00	754.67ab	1,096.03ab	1,946.36	2,391.14abc	1,430.00ab	8,114.20
800+0	467.25	785.81ab	1,108.47ab	2,058.16	2,642.19a	1,687.19a	8,749.07
800+400	475.58	804.92a	1,104.75ab	1,986.19	2,437.42abc	1,522.78ab	8,331.64
800+800	472.88	789.84ab	1,180.59a	2,019.28	1,998.75c	1,321.25ab	7,782.59
SEM[3]	6.27	11.51	11.03	26.81	40.76	39.77	314.07
P-value	0.21	<0.01	<0.01	0.81	<0.05	<0.01	0.12

[1] Mean values for water intake (mL) in the same column followed by different letters are different (P≤0.05). Abrupt changes were observed from day 35 to 39 because the chicks were fed for four days.
[2] Recorded consumption from day 0 to 39.
[3] Pooled standard error of least squares means.

14, 28, 35 and 39 days, FE was different (P≤0.05). At 14 days, 400+0 and 800+800 had the best FE and 800+0 had the lowest. At day 28, the best FE was obtained by 0+800, while 800+400 was the least efficient, but at 35 and 39 days 0+0, 0+400, and 400+400 achieved the most efficient FE. Kirkpinar et al. (2011) saw similar improvements in broiler FE. Supplementation of 150 and 300 ppm of oregano essential oil in the diet improved the performance of the chickens, because of the growth-promoting effect of the oil levels in the diet and the age of the chickens. In our study, the improvement in FE can be attributed to the levels of MOO used. These results agreed partially with those of Cho et al. (2014), who reported no significance at 0-21 d in BW, but at 35 d found substantially improved FE with the addition of the phytogenic additives thyme and anise star compared with a commercial antibiotic and the control.

Conflicting results were found in other studies (Botsoglou et al., 2002; Basmacıoğlu et al., 2004; Cross et al., 2007), which reported that supplementation of 100, 150, and 1,000 ppm of OEO in chicken diets did not have an effect on their production performance, while Symeon et al. (2010) concluded that the supplementation of broiler feed with oregano essential oil had significant negative effects on the feeding and drinking behavior as well as on the activity of these broilers. In addition, Cross et al. (2007) reported that phenolic terpenes give a flavor to the diet and it can be unpleasant to chickens during the first weeks. This observation could explain why 0+0, 0+400, and 400+400, with the absence or lower levels of carvacrol, presented the best FE, and these doses may not affect the taste of diets as much as higher levels, and could be accepted by chickens. However, this observation does not explain the results for 400+0 and the corresponding increase in carvacrol levels.

Some authors have pointed out that herbs, plant extracts, essential oils, and their components (carvacrol, thymol) do not affect ADG (Demir et al., 2003; Bampidis et al., 2005; Cross et al., 2007; Najafi and Torki, 2010); in this case the 0-39 range had no significant statistical difference between treatments, but 0+0 was lower, while 800+0 was greater.

Table 6 - Effect of Mexican oregano oil on feed efficiency of broilers from hatch to 39 days of age

Treatment MOO_1+ MOO_2 (mg kg^{-1} of feed)	Period (days)[1]						
	0-7	7-14	14-21	21-28	28-35	35-39	0-39
0+0	0.76	0.75ab	0.74	0.65ab	0.57a	0.29b	0.59
0+400	0.71	0.76ab	0.69	0.62b	0.51b	0.29b	0.64
0+800	0.75	0.76ab	0.70	0.61b	0.53ab	0.30ab	0.64
400+0	0.72	0.73b	0.65	0.62b	0.54ab	0.31ab	0.63
400+400	0.71	0.76ab	0.69	0.64ab	0.53ab	0.29b	0.61
400+800	0.71	0.77ab	0.68	0.65ab	0.53ab	0.31ab	0.62
800+0	0.71	0.80a	0.68	0.66ab	0.56ab	0.31ab	0.63
800+400	0.70	0.76ab	0.70	0.67a	0.55ab	0.33ab	0.63
800+800	0.72	0.74b	0.67	0.62b	0.54ab	0.34a	0.63
SEM[2]	0.01	0.01	0.01	0.01	0.01	0.003	0.02
P-value	0.89	<0.05	0.25	<0.05	<0.05	<0.05	0.33

[1] Mean values for feed efficiency (body weight (g)/feed intake (g)) in the same column followed by different letters are significantly different (P≤0.05). Abrupt changes were observed from day 35 to 39 because the chicks were fed for four days.
[2] Pooled standard error of least squares means.

Table 7 - Effect of Mexican oregano oil on weight gain of broilers from hatch to 39 days of age

Treatment MOO_1+ MOO_2 (mg kg^{-1} of feed)	Period (days)[1]						
	0-7	7-14	14-21	21-28	28-35	35-39	0-39
0+0	15.02	26.84ab	46.52abc	77.80ab	49.01ab	45.50ab	48.98
0+400	14.94	29.83ab	55.20b	72.95a	75.99a	41.27a	54.49
0+800	15.34	29.67ab	50.73abc	69.09ab	68.93ab	62.61ab	54.50
400+0	15.92	31.79a	59.64a	71.97a	67.51a	55.22a	55.90
400+400	14.85	28.38ab	56.37abc	68.16ab	70.75ab	32.61ab	51.51
400+800	13.72	29.58ab	55.61abc	69.08ab	66.78ab	56.27ab	53.88
800+0	13.29	26.78b	55.35abc	74.40a	84.69a	50.31a	56.65
800+400	16.32	30.85ab	56.68abc	68.92a	74.88a	60.83a	56.77
800+800	16.55	28.43b	46.15c	76.38b	61.21b	51.82b	52.22
SEM[2]	0.65	1.90	4.55	7.91	11.24	13.27	2.79
P-value	0.24	<0.0001	<0.01	<0.01	<0.01	<0.05	0.54

[1] Mean values for average daily gain (current BW – initial weight/Days (0-7, 0-39); current BW – previous BW – initial weight/days (7-14, 14-21, 21-28, 28-35, 35-39) in the same column followed by different letters are significantly different (P≤0.05). Abrupt changes were observed from day 35 to 39 because the chicks were fed for four days.
[2] Pooled standard error of least squares means.

However, in this investigation ADG was affected from 14 to 39 days, in which 400+0 resulted in the maximum ADG, and the minimum was found with 800+800 (Table 7). These effects could mean that MOO thymol and carvacrol could act as growth promoters and improve digestibility, balance the microbial ecosystem of the gut, and stimulate endogenous secretion of digestive enzymes (Williams and Losa, 2001; Hernandez et al., 2004; Ocak et al., 2008). Thus, these results and the results obtained by Hong et al. (2012) suggest that the Mexican oregano oil can be considered a natural growth promoter, and evidence indicates that the MOO plant extracts (thymol, carvacrol) could have intrinsic biological activity in the broiler physiology and metabolism.

Conclusions

Mexican oregano oil supplementation in diets for chickens affects their weight, water consumption, feed intake, feed efficiency, and average daily gain. Mexican oregano oil can be used as a supplement in the diet to improve broiler production.

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