Journal of Livestock Science and Technologies, 2018, 6 (1): 31-38 http://lst.uk.ac.ir
DOI: 10.22103/jlst.2018.10340.1195

Growth performance, intestinal microflora, and meat quality of broiler chickens fed lavender *(Lavandula angustifolia)* powder

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Abstract The aim of the current study was to evaluate the effects of lavender (*Lavandula angustifolia*) powder as an herbal feed additive on growth performance, carcass traits, meat quality, jejunal histomorphology, and ileal microbial population in broiler chickens. A total of two hundred twenty one day-old male broiler chicks were used in a completely randomized design with five treatments and four replicates (11 birds per replicate) for 42 days. Experimental diets consisted of a basal diet without any additives as control group and the basal diet containing flavophospholipol (0.02 %) or 3 levels of lavender powder (0.3, 1 or 1.7 %). Body weight, feed intake and feed conversion ratio were measured during the starter (1- 10 d), grower (11- 24 d) and finisher (25-42 d) periods. The results showed that lavender powder (at 1 % level) significantly increased feed intake during the finisher and entire rearing periods. Also, body weight gain and feed conversion ratio improved during the grower, finisher and entire rearing periods. Lavender powder significantly decreased ($P<0.01$) jejunal crypt depth and increased ($P<0.01$) villous height: crypt depth ratio compared to the control group. Malondialdehyde (MDA) content and cooking loss of meat samples were significantly decreased in birds fed 1 % lavender powder ($P<0.01$). Overall, the results of this experiment showed that lavender powder may be used to improve growth performance and meat quality in broiler chickens.
Keywords: broiler, flavophospholipol, lavender, meat quality, performance

Received: 22 May. 2017, *accepted:* 08 May. 2018, *published online:* 23 Apr. 2018

Introduction

Antibiotics are anti-microbial compounds that inhibit and even destroy bacterial and fungal growth and are also used for growth promotion in livestock and poultry (Dibner and Richards, 2005). However, the increasing pressure on the livestock industry to reduce or eliminate feed-antibiotics as growth enhancers has initiated new research to find safe and efficient alternatives. This new generation of feed additives includes the herbs and essential oils (Brenes and Roura, 2010).

Lavender (*Lavandula angustifolia L*), well known as a powerful aromatic and medicinal herb, is one of such alternatives that could be used as feed additive. This plant belongs to the '*Labiatae*' family and is a widely distributed aromatic herb. This herb has sedative, spasmolytic, antiviral, antibacterial, antifungal, and antioxidation properties (Kim and Lee, 2002; Hui et al., 2010). Composition of lavender essential oils has been widely investigated (Kim and Lee, 2002; Fakhari et al., 2005; Chemat et al., 2006; Jalali-Heravi et al., 2015). It is demonstrated that the main chemical composition of lavender essential oil depends on the genotype, environment, and processing and extraction methods (Jalali-Heravi et al., 2015). Fakhari et al. (2005) reported that lavender (all aerial parts including flower, leaves and stems) oil contained linalool (32.8%), linalyl acetate (17.6%), lavandulyl acetate (15.9%), α-terpineol (6.7%), geranyl acetate (5%), and lavandulol (4.3%). Also, it contains high levels of polyphenols such as flavonoids, which possess a broad spectrum of chemical and biological activities including radical scavenging properties (Rabiei et al., 2014).

Very little information is available in the literature on the effects of lavender on broiler performance. Nasiri-Moghaddam et al. (2012) reported that dietary supplementation of lavender essential oil (at 350 mg/kg) increased body weight gain (BWG) and decreased feed conversion ratio (FCR) at the period of 22 to 42 d age.

Because of the lack of adequate studies, the aim of the current study was to investigate the effects of adding different levels of lavender powder as an alternative to antibiotic growth promoters on growth performance, weight of visceral organs, meat quality, and intestinal histomorphology, and microflora population in broiler chickens.

Material and methods

Animals and dietary treatments

Two hundred twenty one-day-old male broiler chicks (Ross 308) were used from 1 to 42 days of age. On arrival, chicks were weighed and randomly housed in wood shavings- covered floor pens (11 chicks per pen, each 1.0×1.2 m). The experiment was conducted as a completely randomized design with 5 treatments of 4 replicates each, and 11 birds per replicate. Experimental treatments consisted of a basal diet without any additives as the control and the basal diet containing antibiotic flavophospholipol (0.02 %) or 3 levels of lavender-flower powder (0.3, 1 or 1.7 %). Antibiotic and lavender powders were replaced with rice shell in the basal diet. Dried lavender flowers were purchased from a local market. The ingredients and composition of the basal diets (starter from 1 to 10, grower from 11 to 24, and finisher from 25 to 42 days of age) are shown in Table 1. Diets were fed in mash form and formulated to meet the nutrient requirements of Ross-308 broiler chickens (Aviagen, 2007). The ambient temperature was gradually decreased from 32°C on day 1 to 25°C on day 21, and was then kept constant. The lighting program was provided as 23 h of light and 1 h of darkness.

Sample and data collection

Growth performance: Body weight gain (BWG) and feed intake (FI) of birds in each pen were recorded during the starter, grower and finisher periods. The average BWG and FI was adjusted for mortality and was used to calculate the feed conversion ratio (FCR). On d 42, two birds per replicate were weighed and slaughtered. The weight of major organs including the breast, thighs, liver, spleen, proventriculus, heart, gizzard, and abdominal fat was measured individually, and expressed as the percentages of the live body weight.

Intestinal morphology: At the end of the experiment (42 d of age), two chicks per pen were randomly selected and slaughtered by severing the jugular vein. Seg-

Table 1. Ingredient and nutrient composition of the basal diets

Ingredients (%)	Starter (1-10)	Grower (11-24)	Finisher (25-42)
Corn	53.98	60.00	65.90
Soybean meal	34.50	30.75	25.89
Fish meal	2.00	1.50	1.00
Soybean oil	3.50	2.50	2.00
Rice shell	1.70	1.70	1.70
Calcium carbonate	1.22	0.97	1.00
Dicalcium phosphate	1.55	1.33	1.30
DL- methionine	0.37	0.26	0.23
L- Lysine HCl	0.34	0.16	0.15
Vitamin premix[1]	0.25	0.25	0.25
Mineral premix[2]	0.25	0.25	0.25
Salt	0.35	0.33	0.33
Chemical composition			
AME_n (kcal/kg)	2942	2958	2997
Crude protein (%)	21.40	19.72	17.80
Lysine (%)	1.39	1.16	1.02
Methionine (%)	0.50	0.42	0.38
Methionine+Cysteine (%)	1.04	0.89	0.81
Calcium (%)	1.02	0.85	0.80
Available phosphorus (%)	0.48	0.42	0.39
Sodium (%)	0.16	0.15	0.15

[1]Vitamin premix provided the following per kilogram of diet: vitamin A, 9000 IU; vitamin E, 36 IU; cholecalciferol, 2000 IU; vitamin K3, 2 mg; thiamine, 1.8 mg; riboflavin, 6.6 mg; pantothenic acid, 10 mg; niacin, 30 mg; choline chloride, 250 mg; biotin, 0.1 mg; folic acid, 1 mg; pyridoxine 3.0 mg; vitamin B12, 0.015 mg; BHT, 1 mg.

[2]Trace mineral premix provided the following in milligrams per kilogram of diet: iron, 50 mg; zinc, 85 mg; manganese, 100 mg; iodine, 1 mg; copper, 10 mg; selenium, 0.2 mg.

ments of the jejunum (2-cm tissue sample from the mid-jejunum) were dissected, washed in physiological saline solution, and fixed in 10% buffered formalin (100 mL of 40% formaldehyde, 4 g phosphate, 6.5 g dibasic sodium phosphate and 900 mL of distilled water) for 24 h. Tissue samples were dehydrated by transferring through a series of graded alcohol solution, placed into xylol and embedded in paraffin. A microtome was used to make 5 sections of 5-µm thickness. The sections were stained with hematoxylin-eosin. The villous height and width, and the crypt depth were determined at a magnification of 10. A minimum of 5 measurements per tissue section were made for each parameter and averaged into one value (Thompson and Applegate, 2006).

Microbial count: Ten-fold serial dilution method, using sterilized water, was used to determine the number of colony-forming units (CFU) in digesta (1g) harvested from the ileum of 8 chicks per treatment at 42 d of age. The lactobacillus count was determined using MRS agar after incubation in an aerobic chamber at 37°C for 72 h. The coliforms were enumerated on Mac Conkey agar, after aerobic incubation at 37°C for 24 h (Li et al., 1991).

Meat quality: At the end of the experiment (d 42), two birds from each pen were slaughtered and the thigh muscles were kept frozen at -21°C for 30 days to assess the meat quality characteristics. Concentration of thiobarbituric acid-reactive substances (TBARS) was measured as an indicator of thigh muscle lipid peroxidation (Tarladgis et al., 1960). Values were reported as the concentration of malondialdehyde (MDA). Meat pH was determined by blending a 10 g sample in 100 mL distilled water, and the pH was measured using a digital pHmeter[1] (Ensoy et al., 2004). The water holding capacity (WHC) measured in approximately 2 g of deboned thigh (Hamm, 1960), is based on measuring water loss when a pressure is applied to the muscle. Meat cubes were placed between two filter papers and two glass plates, and a 10-kg-weight was placed on the top glass plate for 5 minutes. The difference in thigh muscle weight before and after the procedure represents the water loss. The results were expressed as a percentage of exudate water in relation to the initial sample weight. Cooking loss was determined as thigh muscle samples were weighed and put in trays which were placed inside an oven until the sample core temperature reached 75 ºC. Samples were cooled at room temperature; reweighed and the cooking loss was calculated as the difference between the initial and the final sample weights (Pelicano et al., 2003). Dripping loss was also measured according to Christensen (2003).

Statistical analysis

Data were subjected to analysis of variance procedures for a completely randomized design using the General Linear Model procedures of the SAS Institute (2005). The pen means served as the experimental unit. Differences between means were separated by Tukey's multiple range tests at P<0.05.

Results and discussion

Growth performance

The effects of the experimental treatments on FI, BWG

Table 2. Effect of flavophospholipol and lavender powder on growth performance in broiler chicks

	Age	T1	T2	T3	T4	T5	SEM	P-value
Feed intake (g/bird/d)	1-10	16.15	16.42	16.40	16.46	16.32	0.211	0.851
	11-24	77.54	79.30	77.78	76.94	77.23	1.706	0.370
	25-42	145.05^{b}	157.98^{a}	147.27^{b}	158.83^{a}	146.45^{b}	4.448	0.0006
	1-42	91.86^{b}	98.05^{a}	93.62^{b}	95.25^{a}	98.60^{b}	2.091	0.001
Body weight gain (g/bird/d)	1-10	12.94	14.20	13.95	14.23	12.94	0.552	0.479
	11-24	51.66^{b}	56.48^{a}	52.08^{ab}	55.88^{a}	54.21^{ab}	2.388	0.039
	25-42	70.17^{c}	86.59^{a}	75.22^{bc}	87.27^{a}	77.50^{b}	3.346	0.0001
	1-42	50.55^{b}	59.32^{a}	52.92^{ab}	59.41^{a}	54.39^{ab}	3.207	0.0042
Feed conversion ratio	1-10	1.27	1.16	1.17	1.16	1.26	0.059	0.700
	11-24	1.50^{a}	1.40^{b}	1.49^{a}	1.37^{b}	1.42^{ab}	0.029	0.032
	25-42	2.07^{a}	1.83^{b}	1.96^{ab}	1.82^{b}	1.89^{ab}	0.057	0.044
	1-42	1.81^{a}	1.65^{b}	1.75^{ab}	1.64^{b}	1.70^{ab}	0.035	0.017

[a–c] Mean values with common superscripts within each row are not different (P>0.05).
T1: basal diet without any additives as control, T2: basal diet supplemented with antibiotic flavophospholipol (0.02%), T3: basal diet supplemented with 0.3 % lavender powder, T4: basal diet supplemented with 1 % lavender powder, T5: basal diet supplemented with 1.7 % lavender powder.

[1] Elmetron, model CP-103

and FCR are shown in Table 2. Adding lavender powder to the basal diet did not affect (P>0.05) the performance of broilers during the starter period. Flavophospholipol and lavender powder (at 1% level) significantly improved (P<0.01) FI during the finisher and entire rearing periods. During the grower, finisher and entire rearing periods, birds fed with 1 % lavender powder and flavophospholipol showed significantly higher BWG and lower FCR compared to the birds fed the control diet.

Very little information is available in the literature on the effects of lavender on broiler performance. Nasiri-Moghaddam et al. (2012) reported that supplementation of lavender essential oil (350 ppm) to the broiler diet increased BWG and decreased FCR at the period of 22 to 42 d age. Moreover, it has been reported that dietary supplementation of the herbs belonging to the *Labiatae* family such as oregano (Giannenas et al., 2003, 2005; Bampidis et al., 2005) and rosemary extract (Spernakova et al., 2007) stimulated growth performance in broilers. Improvement in FCR was also observed when phytogenic substances were fed as supplements (Brenes and Roura, 2010). It seems that in most studies on the influence of feeding medicinal plants, the improvement in FCR is a consequence of a reduction in FI without changes in BWG (Brenes and Roura, 2010). Interestingly, in the current study, an increase in FI with the lavender diet was accompanied by an increase in BWG, ultimately leading to improvements in FCR (Table 2).

Linalool, linalyl acetate, and several other mono- and sesqui-terpenes, flavonoids like luteolin, triterpenoids like ursolic acid, and coumarins like umbelliferone and coumarin were the main components of the aerial parts and flowers of lavender (Renaud et al., 2001). It seems likely that the active principles of herbal essential oils act as a digestibility enhancer, balancing the gut microbial ecosystem and stimulating the secretion of endogenous digestive enzymes and thus improving growth performance in poultry (Cross et al., 2007; Brenes and Roura, 2010). For example, it was shown that linalool had appetizing properties and stimulated the digestion processes in animals (Cabuk, 2003).

However, other studies did not found a significant beneficial effect of herbal byproducts from the *Labiatae* family on overall broiler performance (Hernández et al., 2004; Reisinger et al., 2011; Akbarian et al., 2013). Several active metabolites of medicinal plants may have intensive smell or taste (Windisch et al., 2008), and can lead to a decreased FI and thus, limit their application in animal nutrition. However, in the present study feeding up to 1.7 % lavender powder in the present study did no adversely affect the FI in broilers.

The variability in the efficacy of phytogenic feed additives on poultry performance could be attributed either to the bird and management conditions (e.g., composition of the basal diet, sanitary and environmental conditions) or to the herb (e.g., genotype, environment, processing and extraction methods, harvesting time, and method and duration of storage).

Carcass traits

The relative weight of breast, thighs, proventriculus, gizzard, liver, pancreas, spleen, heart, and bursa of broilers at 42 days of age were not affected (P>0.05) by the dietary treatments (Table 3). Our results are in agreement with Nasiri-Moghaddam et al. (2012), who did not report any significant differences in the relative weight of proventriculus, gizzard, liver, pancreas, large and small intestine in chicks fed lavender essential oil. Also, other studies carried out with herbs from the *Labiatae* family (oregano essential oil), did not find a significant effect on carcass traits (Hernández et al., 2004; Kirkpinar et al., 2010). In contrast to our finding, Bampidis et al. (2005) showed that the relative weight of the gizzard and small intestine decreased linearly with increasing dried oregano leaves (1.25, 2.5, and 3.75 g / kg), but no effect was observed on the relative weight of carcass, liver, and heart in turkeys.

Intestinal morphology

The effect of different dietary treatments on jejunal morphology characteristics (villous height, villous width, crypt depth and the villous height: crypt depth ratio) at 42 days of age is shown in Table 4. Lavender powder significantly decreased the crypt depth but increased the villous height: crypt depth ratio compared to the control group (P<0.01). The crypt depth and villous height: crypt depth ratio in birds fed with flavophospholipol were significantly lower and higher than the other treatments, respectively (P<0.01).

No consistent changes in the villous length and crypt depth in the jejunum and colon for broilers and pigs treated with phytogenic feed additives were reported (Oetting et al., 2006; Hong et al., 2012). Garcia et al. (2007) showed that addition of 200 mg/kg plant extract comprising a blend of oregano, cinnamon, and pepper essential oil increased the villous height. Hashemipour et al. (2013) reported that broilers fed 100 or 200 ppm carvacrol and thymol (major compounds of oregano) in the diet had higher villous height but not the villous width. In general, phytogenic feed additives could increase the villous height and villous height: crypt depth ratio in the small intestine that could increase the absor-

Table 3. Effect of flavophospholipol and lavender powder on carcass traits and the relative weight of internal organs in broiler chicks

Treatments	Gizzard	Spleen	Proventriculus	Heart	Bursa	Abdominal fat	Liver	Pancreas	Thighs	Breast
T1	1.37	0.10	0.33	0.45	0.22	1.35	1.97	0.19	17.4	24.6
T2	1.56	0.09	0.32	0.45	0.18	1.36	1.82	0.20	17.6	22.0
T3	1.48	0.08	0.34	0.45	0.20	1.34	1.95	0.19	17.8	26.2
T4	1.45	0.10	0.33	0.45	0.16	1.33	1.95	0.21	17.3	25.6
T5	1.47	0.09	0.34	0.45	0.14	1.35	2.08	0.20	17.6	22.9
SEM	0.106	0.004	0.005	0.003	0.019	0.0202	0.111	0.033	0.178	2.260
P-value	0.799	0.082	0.270	0.727	0.1001	0.771	0.618	0.995	0.512	0.647

T1: basal diet without any additives as control; T2: basal diet supplemented with antibiotic flavophospholipol (0.02%); T3: basal diet supplemented with 0.3 % lavender powder; T4: basal diet supplemented with 1 % lavender powder; T5: basal diet supplemented with 1.7 % lavender powder.

Table 4. Effects of flavophospholipol and lavender powder on intestinal morphology (micrometer) and microflora population (log CFU/g) in broiler chicks

Treatments	Villous length	Villous width	Crypt depth	Villous length / Crypt depth	*Coliform*	*Lactobacilli*
T1	1340.75	182.25	151.18[a]	8.87[c]	6.5	6.25
T2	1342.50	182.25	137.04[c]	9.80[a]	5.97	6.30
T3	1348.75	184.00	144.17[b]	9.35[b]	5.95	6.81
T4	1349.50	181.75	143.64[b]	9.39[ab]	5.70	7.18
T5	1346.75	183.00	143.65[b]	9.37[b]	6.22	7.10
SEM	2.829	3.075	1.399	0.094	0.295	0.335
P-value	0.169	0.593	0.0001	0.0001	0.411	0.201

[a–c] Mean values with common superscripts within each column are not different (P>0.05).
T1: basal diet without any additives as control; T2: basal diet supplemented with antibiotic flavophospholipol (0.02%); T3: basal diet supplemented with 0.3 % lavender powder; T4: basal diet supplemented with 1 % lavender powder; T5: basal diet supplemented with 1.7 % lavender powder.

ptive surface area and efficiency of digestion and absorption of nutrients (Reisinger et al., 2011; Hong et al., 2012; Khattak et al., 2014) leading to better BWG and FCR, as found in the current study.

Ileal microflora

There were no significant differences among treatments regarding total C*oliforms* and *Lactobacillus* in the ileal digesta in comparison to the control diet (Table 4). This finding is in agreement with Cross et al. (2007), who did not report any significant differences in the intestinal microflora populations in chicks fed phytogenic feed additives. However, there are on lavender exhibiting a broad spectrum of activity against gram-positive and gram-negative bacteria and fungi (Alexopoulos et al., 2011; Benabdelkader et al., 2011; Djenane et al., 2012). Although, these observations support the hypothesis that phytogenic feed additives may favorably affect gut microflora, but the results are quite inconsistent. These discrepancies in results may be attributed to the kind and variety of herb, dietary inclusion levels of herbs and plant processing conditions.

Meat quality

In the current study, no significant differences (P>0.05) were observed between different dietary treatments with regard to WHC, dripping loss and pH of thigh meat (Table 5). The concentration of TBARS was significantly improved (P<0.01) by supplementing the basal diet with different levels of lavender flower powder. The cooking loss in birds fed with 1 and 1.7 % lavender powder was significantly lower (P<0.01) than the other treatments (Table 5).

The potential of the *Labiatae* plants containing phenolic compounds to improve the oxidative stability of animal-derived products has been extensively demonstrated (Giannenas et al., 2005; Florou-Paneri et al., 2006; Rodrigues et al., 2012; Djenane et al., 2012; Lauren and Soheil, 2016). A possible reason for improved meat quality, found in the present study, may be related to the antioxidative properties of the chemical components such as linalool and linalyl acetate in lavender. Moreover, this plant contains high levels of polyphenols such as flavonoids, which possess a broad spectrum of chemical and biological activities including radical

Table 5. Effects of flavophospholipol and lavender powder on thigh meat quality in broiler chicks

Treatments	PH	TBARS*	WHC† (%)	Cooking Loss (%)	Dripping Loss (%)
T1	6.16	1.02[a]	0.55	39.66[a]	12.29
T2	6.16	1.00[ab]	0.57	38.07[b]	11.90
T3	6.13	0.97[bc]	0.55	39.27[a]	11.47
T4	6.27	0.95[c]	0.58	36.37[d]	11.95
T5	6.09	0.98[bc]	0.58	37.25[c]	12.27
SEM	0.378	0.009	0.013	0.153	0.294
P-value	0.998	0.0009	0.444	0.001	0.317

[a–d]Mean values with common superscripts within each column are not different (P>0.05).
*Thiobarbituric acid-reactive substance (mg malondialdehyde/ kg)
†Water holding capacity
T1: basal diet without any additives as control; T2: basal diet supplemented with antibiotic flavophospholipol (0.02%); T3: basal diet supplemented with 0.3 % lavender powder; T4: basal diet supplemented with 1 % lavender powder; T5: basal diet supplemented with 1.7 % lavender powder.

scavenging properties (Rabiei et al., 2014).

In conclusion, the present study showed that lavender powder, especially at 1 percent level, might improve the growth performance, enhance meat quality, and modulate the intestinal microbial counts in broilers fed on a corn-soybean meal based diet.

References

Akbarian, A., Golian, A., Gilani, A., Kermanshahi, H., Zhaleh, S., Akhavan, A., DeSmet, S., Michiels, J., 2013. Effect of feeding citrus peel extracts on growth performance, serum components, and intestinal morphology of broilers exposed to high ambient temperature during the finisher phase. *Livestock Science* 157, 490–497.

Alexopoulos, A., Kimbaris, A.C, Plessas, S., 2011. Antibacterial activities of essential oils from eight Greek aromatic plants against clinical strains of *Staphylococcus aureus. Anaerobe* 17, 399‑402.

Aviagen, 2007. *Nutrition Specification for Ross 308*. Aviagen Limited, Newbridge, Scotland, UK.

Bampidis, V.A., Christodoulou, V., Florou-Paneri, P., Christaki, E., Chatzopoulou, P.S., Tsiligianni, T., Spais, A.B., 2005. Effect of dietary dried oregano leaves on growth performance, carcass characteristics and serum cholesterol of female early maturing turkeys. *British Poultry Science* 46, 595–601.

Benabdelkader, T., Zitouni, A., Guitton, Y., Jullien, F., Maitre, D., Casabianca, H., Legendre, L., Kameli, A., 2011. Essential oils from wild populations of Algerian *Lavandula stoechas L*: composition, chemical variability, and in vitro biological properties. *Chemistry and Biodiversity* 8, 937-953.

Brenes, A., Roura, E., 2010. Essential oils in poultry nutrition: main effects and modes of action. *Animal Feed Science and Technology* 158, 1–14.

Çabuk, M., Alçiçek, A., Bozkurt, M., Imre, N., 2003. Antimicrobial properties of the essential oils isolated from aromatic plants and using possibility as alternative feed additives. *II.* In: *Proceedings of the 11th National Animal Nutrition Congress*. Konya, Turkey, pp. 184–187.

Chemat, F., Lucchesi, M.E., Smadja, J., Favretto, L., Colnaghi, G., Visinoni, F., 2006. Microwave accelerated steam distillation of essential oil from lavender: A rapid, clean and environmentally friendly approach. *Analytica Chimica Acta* 555, 157‑160.

Christensen, L.B., 2003. Drip loss sampling in porcine meat. *Meat Science* 63, 469-477.

Cross, D. E., McDevitt, R.M., Hillman, K., Agamovic, T., 2007. The effect of herbs and their associated essential oils on performance, digestibilities and gut microflora in chicken to 28d of ago. *British Poultry Science* 4, 496-506.

Dibner, J.J., Richards, J.D., 2005. Antibiotic growth promoters in agriculture: history and mode of action. *Poultry Science* 84, 634–643.

Djenane, D., Aïder, M., Yangüela, J., Idir, L., Gómez, D., Roncalés, P., 2012. Antioxidant and antibacterial effects of lavandula and mentha essential oils in minced beef inoculated with *E. coli* and *S. aureus* during storage at abuse refrigeration temperature. *Meat Science* 92, 667–674.

Ensoy, U., Candogan, K., Kolsarici, N., Karslioglu, B., Cizmeci, M., 2004. Influence of acetic acid and lactic acid treatment on lipid changes and color of chicken legs. In: *Proceedings of 22nd World's Poultry Congress*. Istanbul, Turkey, pp: 874-874.

Fakhari, A.R., Salehi, P., Heydari, R., Ebrahimi, S.N., Haddad, P.R., 2005. Hydro-distillation-headspace solvent micro-extraction, a new method for analysis of the essential oil components of *Lavandula angustifolia* Mill. *Journal of Chromatography* 1098, 14‑18.

Florou-Paneri, P., Giannenas, I., Christaki, E., Govaris, A., Botsoglou, N.A., 2006. Performance of chickens and oxidative stability of the produced meat as affected by feed supplementation with oregano, vitamin C, vitamin E and their combinations. *Archiv fur Geflugelkunde* 70, 232–240.

Garcia, V., Catala-Gregori, P., Hernández, F., Megias, M. D., Madrid, J., 2007. Effect of formic acid and plant extracts on growth, nutrient digestibility, intestine mucosa morphology, and meat yield of broilers. *Journal of Applied Poultry Research* 16, 555–562.

Giannenas, I., Florou-paneri, P., Botsoglou, N., Christaki, E., Spaisn, A.B., 2005. Effect of supplementing feed with oregano and/or a-tocopheryl acetate on growth of broiler chickens and oxidative stability of meat. *Journal of Animal Feed Science* 14, 521-535.

Giannenas, I., Florou-Paneri, P., Papazahariadou, M., Christaki, E., Botsoglou, N.A., Spais, A.B., 2003. Effect of dietary supplementation with oregano essential oil on performance of broilers after experimental infection with *Eimeria tenella*. *Archives of Animal Nutrition* 57, 99–106.

Hamm, R., 1960. Biochemistry of meat hydratation. *Advances in Food Research* 10, 335-443.

Hashemipour, H., Kermanshahi, H., Golian, A., Veldkamp, T., 2013. Effect of thymol and carvacrol feed supplementation on performance, antioxidant enzyme activities, fatty acid composition, digestive enzyme activities, and immune response in broiler chickens. *Poultry Science* 92, 2059-2069.

Hernández, F., Madrid, J., Garcia, V., Orengo, J., Megias, M.D., 2004. Influence of two plant extracts on broilers performance, digestibility, and digestive organ size. *Poultry Science* 83, 169-174.

Hong, J.C., Steiner, T., Aufy, A., Lien, T.F., 2012. Effects of supplemental essential oil on growth performance, lipid metabolites, immunity, intestinal characteristics, microbiota and carcass traits in broilers. *Livestock Science* 144, 253–262.

Hui, L., He, L., Huan, L., XiaoLan, L., Ai-Guo, Z., 2010. Chemical composition of lavender essential oil and its antioxidant activity and inhibition against rhinitis related bacteria. *African Journal of Microbiology Research* 4, 309-313.

Jalali-Heravi, M., Moazeni-Pourasil, R.S., Sereshti, H., 2015. Elimination of chromatographic and mass spectrometric problems in GC–MS analysis of lavender essential oil by multivariate curve resolution techniques: Improving the peak purity assessment by variable size moving window-evolving factor analysis. *Journal of Chromatography B* 983-984, 83-89.

Khattak, F., Ronchi, A., Castelli, P., Sparks, N., 2014. Effects of natural blend of essential oil on growth performance, blood biochemistry, cecal morphology, and carcass quality of broiler chickens. *Poultry Science* 93, 132–137.

Kim, N.S., Lee, D.D., 2002. Comparison of different extraction method for the analysis of fragrance from *Lavandula* species by gas chromatography-mass spectrometry. *Journal of Chromatography A*, 982, 31-47.

Kirkpinar, F., Bora Unlu, H., Ozdemir, G., 2010. Effects of oregano and garlic essential oils on performance, carcass, organ and blood characteristics and intestinal microflora of broilers. *Livestock Science* 137, 219-225.

Lauren, A.E., Soheil S.M., 2015. Lavender (*Lavandula angustifolia*) oils. In: Preedy, V. (ed.), *Essential Oils in Food Preservation, Flavor, and Safety*. Academic Press.

Li, Y.L., 1991. Culture Medium Manual, Changchun, China: Jilin Science and Technology Press.

Nasiri-Moghaddam, H., Hassanabadi, A., Bidar, N., 2012. Effects of increasing levels of lavender essential oil (*Lavandula angustifolia*) on performance and hematological traits of broilers. *Iranian Journal of Animal Science Research* 4, 115-121. (In Farsi).

Oetting, L.L., Utiyama, C.E., Giani, P.A., Ruiz, U.D., Miyada V. S., 2006. Effects of herbal extracts and antimicrobials on apparent digestibility, performance, organs morphometry and intestinal histology of weanling pigs. *Brazilian Journal of Animal Science* 35, 1389–1397.

Pelicano, E.R.L., Souza, P.A., De Souza, H.B.A., Oba, A., Norkus, E.A., Kodawara, L.M., Lima, T.M.A., 2003: Effect of different probiotics on broiler carcass and meat quality. *Brazilian Journal of Poultry Science* 5, 207-214.

Rabiei, Z., Rafieian-Kopaei, M., Mokhtari, S., Shahrani, M., 2014. Effect of dietary ethanolic extract of *Lavandula officinalis* on serum lipids profile in rats. *Iranian Journal of Pharmaceutical Research* 13, 1295-1301.

Reisinger, N., Steiner, T., Nitsch, S., Schatzmayr, G., Applegate, T.J., 2011. Effects of a blend of essential oils on broiler performance and intestinal morphology during coccidial vaccine exposure. *Journal of Applied Poultry Research* 20, 272–283.

Renaud, E.N.C., Charles, D.J., Simon, J.E., 2001. Essential oil quantity and composition from 10 cultivars of organically grown lavender and lavandin. *Journal of Essential Oil Research* 13, 269–273.

Rodrigues, N., Malheiro, R., Casal, S., Manzanera, M.C.A., Bento, A., Pereira, J.A., 2012. Influence of spike lavender (*Lavandula latifolia*) essential oil in the quality, stability, and composition of soybean oil during microwave heating. *Food and Chemical Toxicology* 50, 2894–2901.

SAS Institute, 2005. *SAS User's Guide*. Version 9.1 ed. SAS Institute, Cary, NC.

Spernakova, D., Mate, D., Rozanska, H., Kovac, G., 2007. Effects of dietary rosemary extract and tocopherol on the performance of chickens, meat quality, and lipid oxidation in meat storage under chilling conditions. *Bulletin of the Veterinary Institute in Pulawy* 51, 585–589.

Tarladgis, B.G., Watts, B.M., Younathan Dugan, M.T., 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. *Journal of the American Oil Chemists' Society* 37, 44-48.

Thompson, K.L., Applegate, T.J., 2006. Feed withdrawal alters small intestinal morphology and mucus of broilers. *Poultry Science* 85, *1535-1540.*

Windisch, W., Schedle, K., Plitzner, C., Kroismayr, A., 2008. Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science* 86, E140–148.

Communicating editor: *Mojtaba Zaghari*

بررسی تاثیر پودر اسطوخدوس بر عملکرد رشد، جمعیت میکربی روده و کیفیت گوشت جوجه‌های گوشتی

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چکیده هدف از این مطالعه بررسی تاثیر پودر گل اسطوخدوس (*Lavandula angustifolia*) بر عملکرد رشد، خصوصیات لاشه، کیفیت گوشت، مورفولوژی ژژونوم و جمعیت میکروبی ایلئوم در جوجه‌های گوشتی بود. در این آزمایش ۲۲۰ قطعه جوجه خروس گوشتی در قالب یک طرح کاملا تصادفی در ۵ تیمار و ۴ تکرار برای هر تیمار مورد استفاده قرار گرفتند (۱۱ جوجه در هر تکرار). تیمارهای غذایی عبارت بودند از جیره پایه بدون هیچ افزودنی به عنوان گروه شاهد و جیره پایه حاوی آنتی‌بیوتیک فلاوفسفولیپول (۰/۰۲ درصد) و یا ۳ سطح مختلف پودر اسطوخدوس (۰/۳، ۱ و ۱/۷ درصد). وزن بدن، مصرف خوراک و ضریب تبدیل در دوره‌های آغازین (۱ تا ۱۰ روزگی)، رشد (۱۱ تا ۲۴ روزگی) و پایانی (۲۵ تا ۴۲ روزگی) مورد مطالعه قرار گرفت. استفاده از پودر اسطوخدوس (در سطح ۱ درصد) سبب افزایش مصرف خوراک در دوره پایانی و کل دوره پرورش گردید. همچنین، اضافه وزن و ضریب تبدیل در دوره‌های رشد، پایانی و کل دوره بهبود یافت. استفاده از این گیاه دارویی سبب کاهش عمق کریپت و افزایش نسبت طول پرز به عمق کریپت در ژژونوم شد($P<0/01$). میزان مالون‌دی‌آلدهاید و افت ناشی از پخت و پز گوشت پرندگانی که از جیره حاوی یک درصد پودر اسطوخدوس تغذیه کرده بودند به طور معنی‌داری کمتر از سایر تیمارها بود ($P<0/01$). به طور کلی، براساس نتایج استفاده از پودر اسطوخدوس در بهبود عملکرد رشد و کیفیت گوشت جوجه‌های گوشتی می‌تواند مفید باشد.