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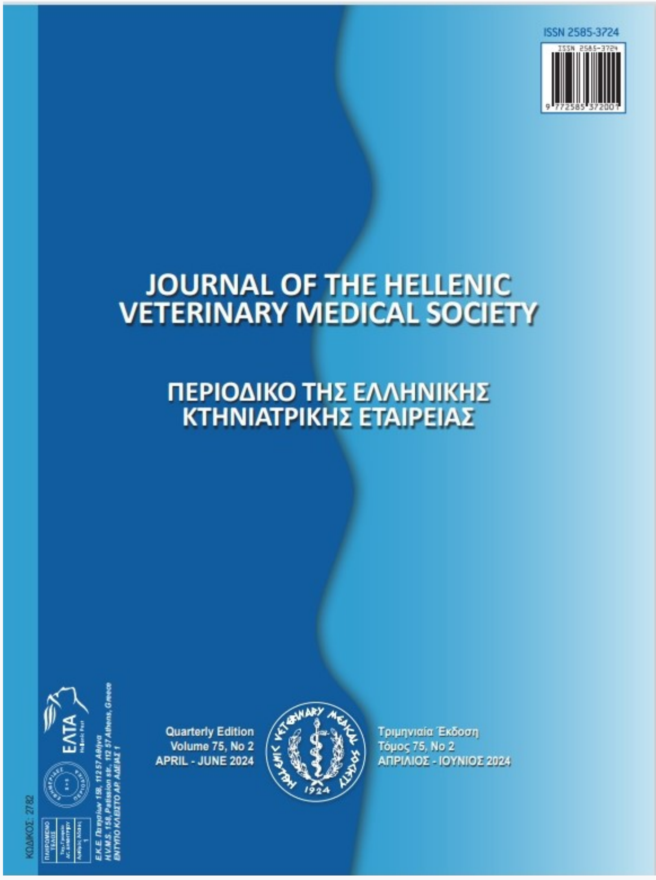

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Research article
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The effect of lavender essential oil on performance, carcass characteristics and serum parameters of broilers

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ABSTRACT: This study was carried out to investigate the effect of lavender (Lavandula angustifolia) essential oil addition to broiler diets at different levels on performance, carcass, and blood parameters. A 6-week experiment, 300 unsexed day-old broiler chicks (Ross 308) was used. Six treatments consisting of different lavender essential oil levels (0, 50, 100, 150, 200, and 250 mg/kg) were used with five replicates of fifty chicks per treatment. Body weight (BW), body weight gain (BWG), and feed conversion ratio (FCR) were linearly affected, and these parameters were improved by the addition of lavender essential oil to the diet (P<0.05). However, feed intake was not affected by the supplementation of lavender essential oil (P>0.05). The effect of lavender essential oil on carcass properties was insignificant (P>0.05). The addition of lavender essential oil to the diet linearly decreased LDL, triglyceride, and albumin levels of serum, whereas total protein level of serum linearly increased in broilers. As a result, it can be said that the addition of 250 mg/kg of lavender essential oil to the diet is beneficial in improving the performance and serum parameters of broilers.

Keywords: lavender essential oil; performance; carcass, serum; broiler

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INTRODUCTION

The main purpose of broiler breeding is to achieve high yield with low cost. With the prohibition of antibiotic use in 2006, the search for alternative feed additives began. Immune stimulating products, prebiotics, probiotics, organic acids, enzymes, and natural plant extracts are used as alternative feed additives (Hassan et al., 2022; Lacková et al., 2022; Amer et al., 2023). Natural plant extracts have been used more intensively in recent years because phytogenic compounds can improve growth performance, increase immune response, and prevent or decrease diseases (Çetin and Yıldız, 2004; Kang et al., 2019). Medicinal and aromatic plants have been used for a long time as analgesic, antimicrobial, anti-parasitic, digestive stimulant, anti-intestinal and anti-diarrhoeal, sedative, diuretic, curative, and breath-taking (Alçiçek, 2008; Lacková et al., 2022; Amer et al., 2023). Essential oils have been used in animal nutrition as a growth promoter instead of antibiotics for many years, contain active metabolites of the digestive system and affect the performance of animals positively by regulating the microflora of the small intestine (Besharati et al., 2021). Essential oils are natural additives that draw attention in terms of use. Lavender essential oil is one of the most widely used and popular oils in essential oil pharmacology and the food and cosmetic industry (Kara and Baydar, 2013). Lavender (*Lavandula angustifolia*) is a flowering plant from the Lamiaceae family. The leaves and flowers of the plant are very rich in essential oils (Torki et al., 2021). According to ISO 3515 (2002), lavender essential oil main component is linalool (20-45%) and linalyl acetate (25-47%). Also, carvacrol, geranyl acetate, β-caryophyllene, myrcene, camphor, lavandulol acetate, 1.8-cinelo, terpinen-4-ol, spathulenol, α-terpineol, and p-cymene other compounds found in lavender essential oil (Barbarestani et al., 2020) and it also reported contains rosmarinic acid and coumarin (Lis-Balchin, 2002). The few studies on the administration of lavender essential oil to the broiler diets appear improvement in body weight and feed efficiency (Küçükyılmaz et al., 2017; Adaszyńska-Skwirzyńska and Szczerbińska, 2019; Barbarestani et al., 2020). In addition, it was reported that the dietary addition of lavender essential oil improves blood profile by lowering blood cholesterol and LDL levels (Salari et al., 2015; Taki et al., 2015; Barbarestani et al., 2020).

The hypothesis of this study is that the addition of lavender essential oil, obtained from lavender, which covers an important area among medicinal and aromatic plants, to broiler diets at different levels will have significant effects on performance, carcass parameters, and some blood parameters. Therefore, in this research, the effects of different levels of lavender essential oil on performance (body weight, body weight gain, feed intake, and feed conversion ratio), carcass parameters and some blood parameters has been researched.

MATERIAL AND METHODS

Birds and Experimental Feeds

A total of 300 one-day-old Ross 308 chicks were assigned to six dietary treatments with five replicates each with fifty chicks. Treatments consisted of six levels (0, 50, 100, 150, 200 and 250 mg/kg) of lavender (*Lavandula angustifolia*) essential oil (LEO). The basal diet was formulated according to the recommendations of Ross 308 according to Aviagen (2019) (Table 1). The lavender essential oil used in the experiment was obtained from a commercial company and was 99% pure. Lavender essential oil was mixed with soybean oil and added to diets. The temperature of the experimental house without windows was set at 33^{o}C on the first day and was set at 24^{o}C by decreasing 3^{o}C every week. The lighting program was 23 h L:1 h D with a light intensity of 8 lux/m^2 throughout the experimental period. The birds were raised in environmentally controlled house and pens were 150×150 cm. The chicks were offered water and feed ad libitum from 0 to 6 week.

Determination of Performance

Body weight (BW) of chicks on each replicate are determined by group weighing with the precision with 1 g delicate as g/birds on the 0th and 6th week of age. The body weight gain (BWG) of birds was calculated from these measurements with *final body weight - initial body weight* formula. The feed was given by weighing to the replicates and at the end of the experiment, the remaining feeds were weighed and the feed intake was calculated as g/day/bird. The feed conversion ratio (FCR) was calculated with the formula FI (g) / BWG (g).

Determination of Slaughtering Parameters

At 6 weeks of age, one female and one male chicks from each subgroup were euthanized by cervical dislocation and then the carcass and cut-up parts, liver, heart, gizzard, and pancreas were weighed by a precision scale with 0.01 g delicate for the determination of carcass yield and relative organ weights. The car-

Table 1. Composition of experimental diets and calculated nutrients

Ingredients	Starter (0-21. days)	Finisher 22-42. days
Corn	473.0	539.0
Soybean oil	53.6	52.8
Soybean meal (%46 CP)	380.0	380.0
Sunflower seed meal (%33 CP)	56.4	4.8
Dicalcium phosphate	18.0	15.4
Limestone	10.5	1.0
Premiks[1]	2.5	2.5
Salt	2.0	2.0
Sodium bicarbonate	1.7	1.1
DL-Methionine	1.4	1.1
L-Lysine	0.9	0.3
Total	1000.0	1000.0
Nutrients		
Metabolizable energy (kcal/kg)	3000	3100
Crude protein (%)	23.00	21.50
Calcium (%)	0.96	0.87
Available phosphorus (%)	0.48	0.43
Lysine (%)	1.45	1.30
Methionine (%)	0.54	0.49
Methionine + Cysteine (%)	0.95	0.87

[1]Premix; per of kg diet: Vitamin A:4.000.000 IU; Vitamin D3:1.200.000 IU; Vitamin E:12.000 mg; Vitamin K3:1.600 mg; Vitamin B1:1.000 mg; Vitamin B2:2.400 mg; Vitamin B5:3.200 mg; Vitamin B6:2.000 mg; Vitamin B12:6 mg; Vitamin C:20.000 mg; Niacin amid:12.000 mg; Folic acid:400 mg; Biotin:20 mg; Choline cloride:160.850 mg; Manganese:40.000 mg; Iron:24.000 mg; Zinc:24.000 mg; Copper:2.000 mg; Iodine:400 mg; Selenium:100 mg.

cass yield was calculated by dividing carcass weight by body weight (as %). Organ relative weights were calculated by dividing organs weights by body weight (as %). Besides thigh and breast relative weights were calculated as % of carcass weight.

Determination of Serum Characteristics

On day 42nd of the study, 5 mL of blood was collected from the vena basilica of 2 broilers (one female and one male) of similar body weight from each subgroup. Blood samples were centrifuged at 3000 rpm for 10 minutes to obtain serum and stored at -80°C until analysis. The total cholesterol, LDL, HDL, VLDL, triglyceride, total protein, globulin, albumin, and glucose levels in serum were determined by spectrophotometer (Shimadzu UV-1700) in a special laboratory.

Statistical Analysis

The data were subjected to ANOVA using the General Linear Model (GLM) procedure in Minitab and differences between the group means were determined by Duncan's multiple range tests. Additionally, linear and quadratic effects of lavender essential oil levels were determined by using orthogonal contrasts. Statements of statistical significance were based on a probability of $P < 0.05$.

RESULTS

Performance

The effect of LEO supplementation on performance parameters of broiler is shown in Table 2. Body weight, BWG, and FCR were statistically affected by the addition of LEO to the diet in broilers ($P<0.05$), but not FI ($P>0.05$). The BW and BWG of the groups supplemented with LEO at 150 (3079 and 3037 g), 200 (3169 and 3128 g) and 250 mg/kg (3287 and 3245 g) levels were significantly higher than the control group (2710 and 2669 g). Compared to the control group (1.57), the FCR improved statistically with the addition of 150 mg/kg and above (1.43-1.35) LEO.

Slaughtering Parameters

The effects of the dietary supplementation of LEO on the carcass parameters are given in Table 3. Carcass yield and thigh were not affected by the addition of LEO to the diet in broilers ($P>0.05$). The minimum and maximum values for those parameters were as follows: carcass yield (73.6-76.9%) and thigh (36.6-37.8%). The breast weight was quadratically affected by the addition of LEO in the diet. The highest breast weight (41.7%) was obtained in the control group (0 mg/kg LEO), while the lowest value was obtained in the 100 mg/kg LEO group (39.9%). According to Table 4, relative organ weights of broilers had the following minimum and maximum values: liver (1.75-1.86%), gizzards (1.49-1.71 %), heart (0.53-0.58%), pancreas (0.149-0.154%), and abdominal fat (2.21-2.36%). Relative organ weights were not statistically affected by the addition of LEO to the diet (P>0.05).

Serum Characteristics

Table 5 provides data on the changes in serum parameters with the addition of LEO to the broiler diet. Serum LDL level decreased significantly in the 250 mg/kg the LEO (34.72 mg/dL) supplemented group compared to the control group (38.15 mg/dL) (P<0.05). The triglyceride (P = 0.008), total protein (P=0.012) and albumin (P = 0.008) levels of serum were linearly affected by the treatment. The triglyceride (37.19-33.74 mg/dL) and albumin (1.87-1.75 g/dL) levels of serum decreased linearly with the addition of LEO in the diet. In both cases, the dietary of 250 mg/kg level of LEO had the lowest value. On the contrary, the total protein level (3.27-3.75 g/dL) was highest in this group (250 mg/kg LEO). The total cholesterol (124.9-126.4 mg/dL), HDL (109.7-111.8 mg/dL), VLDL (21.89-23.47 mg/dL), globulin (1.94-2.05 g/dL) and glucose (252.5-256.1 mg/dL) levels of serum were not affected by the addition of LEO (P > 0.05).

Table 2. The effect of lavender (*Lavandula angustifolia*) essential oil addition to broiler diets at different levels on performance in broilers from 0 to 6 weeks, g/bird

Parameters	Lavender essential oil, mg/kg						Anova	Linear	Quadratic
	0	50	100	150	200	250			
Hatching	41.66±0.200	41.56±0.670	41.68±0.410	42.22±0.230	40.78±0.210	41.42±0.100	0.168	0.323	0.443
BW	2710±101.0^{c}	2865±38.9^{bc}	3005±66.9^{abc}	3079±104.0^{a}	3169±86.0^{a}	3287±187.0^{a}	0.012	0.001	0.698
BWG	2669±101.0^{c}	2823±38.8^{bc}	2964±67.0^{abc}	3037±104.0^{a}	3128±86.1^{a}	3245±187.0^{a}	0.012	0.001	0.699
FI	4173±81.6	4170±85.3	4238±123.0	4253±215.0	4298±148.0	4394±280.0	0.941	0.305	0.799
FCR	1.57±0.038^{a}	1.48±0.047^{ab}	1.43±0.026^{b}	1.40±0.048^{b}	1.38±0.066^{b}	1.35±0.012^{b}	0.021	0.001	0.293

a, b, c, values in rows with different letters differ significantly (P< 0.05).

BW: Body weight, BWG: Body weight gain, FI: Feed intake, FCR: Feed conversion ratio.

Table 3. The effect of lavender (*Lavandula angustifolia*) essential oil addition to broiler diets at different levels on carcass parameters

Lavender essential oil, mg/kg	Carcass Yield, %[1]	Thigh, %[2]	Breast, %[2]
0	76.9±1.550	36.6±0.605	41.7±0.372
50	74.2±0.530	37.2±0.214	40.7±0.334
100	74.9±1.220	37.8±0.719	39.9±0.504
150	74.6±0.930	37.6±0.358	40.9±0.441
200	74.6±1.160	37.4±0.343	41.1±0.434
250	73.5±1.160	37.5±0.144	41.0±0.299
Anova	0.442	0.470	0.099
Linear	0.107	0.209	0.654
Quadratic	0.611	0.147	0.035

[1] as % of body weight, [2] as % of carcass weight.

Table 4. The effect of lavender (*Lavandula angustifolia*) essential oil addition to broiler diets at different levels on relative organ weights, as % of body weight.

Lavender essential oil, mg/kg	Liver	Gizzard	Heart	Pancreas	Abdominal Fat
0	1.86±0.046	1.64±0.072	0.58±0.011	0.152±0.0088	2.35±0.090
50	1.83±0.065	1.65±0.045	0.54±0.010	0.152±0.0034	2.29±0.033
100	1.85±0.056	1.71±0.092	0.55±0.014	0.152±0.0024	2.36±0.050
150	1.81±0.025	1.49±0.075	0.54±0.013	0.154±0.0022	2.21±0.042
200	1.81±0.039	1.49±0.046	0.53±0.014	0.151±0.0065	2.21±0.049
250	1.75±0.030	1.58±0.016	0.54±0.019	0.149±0.0032	2.31±0.064
Anova	0.581	0.095	0.209	0.990	0.315
Linear	0.103	0.059	0.060	0.700	0.229
Quadratic	0.577	0.820	0.197	0.654	0.361

Table 5. The effect of lavender (*Lavandula angustifolia*) essential oil addition to broiler diets at different levels on serum parameters

Lavender essential oil, mg/kg	Cholesterol, mg/dL	LDL, mg/dL	HDL, mg/dL	VLDL, mg/dL	Triglyceride, mg/dL	Total Protein, g/dL	Globulin, g/dL	Albumin, g/dL	Glucose, mg/dL
0	126.4±0.50	38.15±0.315^{A}	109.7±1.16	23.47±0.378	37.19±1.330	3.27±0.126	2.05±0.068	1.87±0.024	256.1±2.04
50	126.0±0.26	37.67±0.710^{A}	110.1±1.12	22.64±0.723	36.64±1.300	3.44±0.148	2.02±0.069	1.83±0.030	253.0±3.36
100	125.7±1.00	36.77±0.278^{A}	110.9±0.68	22.60±0.447	34.80±0.753	3.50±0.170	2.01±0.057	1.83±0.045	252.9±2.69
150	125.5±0.57	36.55±0.524^{A}	111.2±0.22	22.34±0.709	34.30±0.686	3.58±0.128	2.00±0.065	1.80±0.041	252.9±1.74
200	125.3±1.04	36.48±0.600^{A}	111.2±1.02	22.27±0.791	33.83±1.320	3.60±0.081	1.98±0.046	1.76±0.032	252.9±2.41
250	124.9±0.46	34.72±0.630^{B}	111.8±0.59	21.89±0.702	33.74±0.909	3.75±0.127	1.94±0.063	1.75±0.039	252.5±2.53
Anova	0.699	0.003	0.546	0.641	0.139	0.215	0.887	0.171	0.919
Linear	0.098	0.001	0.062	0.098	0.008	0.012	0.222	0.008	0.396
Quadratic	0.993	0.531	0.756	0.722	0.440	0.829	0.892	0.957	0.550

$^{A, B,}$ values in columns with different letters differ highly significantly (P < 0.01).

DISCUSSION

Performance

The body weight of broilers improved with the addition of LEO to the diet. Similar results were found in previous studies; Barbarestani et al. (2020) reported that the addition of 600 mg/kg LEO to broiler diets increased BW. Similar results have also been reported by Salarmoini et al. (2019). In another study, Adaszyńska-Skwirzyńska and Szczerbińska (2019) stated that the addition of 0.4 mL/L lavender oil to drinking water improved BW in their study on broilers. However, Kıyma et al. (2017) and Mokhtari et al. (2018) reported that the addition of LEO (24 and 800 mg/kg) to the diet did not change the BW in broilers. Additionally, Hertrampf (2001), Jamroz and Kamel (2002), and Sirvydis et al. (2003) stated that it increased the daily BWG in broilers. The active substances contained in aromatic plants, which were not examined in this study, stimulate the digestion (Yeşilbağ, 2007). The positive effect of LEO on BWG and therefore on BW may have been achieved by the active ingredients of lavender, an aromatic plant, by reducing pathogens and/or increasing the release of digestive juices. When Table 2 is examined, it is seen that the addition of 250 mg/kg LEO to broiler diets is sufficient in terms of BW. In addition, as another result of this study, it is seen that the addition of LEO at higher levels (over 250 mg/kg) may have a possible positive effect on BW. It can be said that further studies are needed to examine the effects of diets containing high levels of LEO in broilers. Feed intake was not statistically affected by the addition of LEO to the diet. Kıyma et al. (2017), Mokhtari et al. (2018), Skwirzynska (2018) and Adaszyńska-Skwirzyńska and Szczerbińska (2019) reported that the FI of broilers did not change when lavender essential oil was added to water or feed, and the results of the current study are similar. However, Salarmoini et al. (2019) by adding 200, 300, and 400 mg/kg LEO to broiler diets, it is partially in line with the result of the study where they reported that FI increased. These differences between studies may be due to factors such as poultry house conditions and the type of feed and lavender used. Feed efficiency improved with the addition of LEO to the diet. Skwirzynska (2018), Salarmoini et al. (2019) and Barbarestani et al. (2020) reported that as the LEO level added to the diet and drinking water increased, the FCR improved significantly. These study results are consistent with the present study results. However, Kıyma et al. (2017) and Mokhtari et al. (2018) the results of the study, which reported that the addition of LEO at 48-800 mg/kg to the diet had no effect on the FCR in broilers, and the results of the current study do not show any similarity. When Table 2 is examined, it is seen that adding LEO at 100 mg/kg level to the diet is sufficient and the best FCR is obtained in broilers with 250 mg/kg LEO added to the diet.

Slaughtering Parameters

Relative breast weight was quadratically affected by the addition of LEO to the diet. In the study of Kıyma et al. (2017) and Salarmoini et al. (2019) were reported that the addition of LEO to the diet at 24-600 mg/kg levels did not affect the breast rate, while Mokhtari et al. (2018) stated that the addition of 400 mg/kg LEO to the diet causes a decrease in breast rate. These results are comparable to the present results by Mokhtari et al. (2018) report is partially similar to the current study, but other results are not similar to the results of the current study.

Serum Characteristics

The serum LDL cholesterol level was significantly reduced in the 250 mg/kg LEO group. Similarly, Barbarestani et al. (2020) noted that the supplementation of 600 mg/kg LEO to the diet reduces serum LDL concentration in broilers, but this effect is not seen at lower levels (300 mg/kg). Salari et al. (2015) reported that the addition of 200 mg/kg LEO to the diet of laying hens is sufficient to reduce the serum LDL concentration. However, Mokhtari et al. (2018) stated that the addition of 100 to 800 mg/kg of LEO to the diet does not change the serum LDL concentration. Active ingredients in LEO, such as linalool, are known to have cholesterol-lowering effects (Eissa et al., 2017). On the issue, Cho et al. (2011) stated that 3-hydroxy-3-methyl glutaryl-CoA reductase protein expression decreased in mice receiving linalool orally, leading to decreased total cholesterol and LDL-C concentrations. Similar to serum LDL concentration, serum triglyceride concentration in broilers decreased linearly with the addition of LEO to the diet and was minimum at 250 mg/kg LEO supplementation ($P<0.01$). These results reported by Mokhtari et al. (2018), Barbarestani et al. (2020), Adaszyńska-Skwirzyńska and Szczerbińska (2019), and Salari et al. (2015) in broilers are inconsistent with results of Tatlı and Olgun (2021) that LEO does not affect serum triglyceride levels in laying quails. With the addition of LEO to broiler diets, serum total protein concentration increased linearly ($P<0.05$) and reached maximum with the administration of 250 mg/kg LEO to the diet. On the contrary, serum albumin concentration decreased linearly ($P<0.01$) with the addition of LEO to the diet and was minimum at 250 mg/kg LEO. It has been reported that the addition of LEO to the diet in previous years did not affect the serum total protein concentration in growing (Barbarestani et al., 2020) and laying birds (Salari et al., 2015; Tatlı and Olgun, 2021). These results are not similar to the results of the current study.

CONCLUSIONS

According to the results obtained from the study, it is seen that the addition of 250 mg/kg LEO to broiler diets improves performance and serum parameters, and the effect on improving performance parameters is more pronounced. As a result, considering the results obtained from this study, it was concluded that 250 mg/kg LEO addition to broiler diet would be appropriate.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest to disclose.

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