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Bioefficacy of Laurel (*Laurus nobilis* L.) Essentials Oil on Lipopolysaccharide-Induced Inflammation in Japanese Quails

Bioeficacia del aceite esencial de laurel (*Laurus nobilis* L.) sobre la inflamación inducida por lipopolisacáridos en codornices japonesas

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ABSTRACT

The potential use of natural plants and essential oils as feed additives in poultry farming is a popular research area. In the presented study, the effects of laurel essential oil on growth and feed conversion performances, slaughter-carcass characteristics oxidative stress index and histopathological parameters in Japanese quails in LPS-induced inflammation model were investigated. The study groups were established as Control (C), laurel essential oil (LEO) group, lipopolysaccharide (LPS) group, laurel essential oil together with lipopolysaccharide (LEO+LPS) group. The live weights on the 19th, 26th and 33rd days were higher in the LEO+LPS and in the LEO group on the 36th day. Feed utilization was the worst in the LPS and the best in the LEO group. Non-eviscerated carcass yield was lower in the LPS group compared to the control, and the gizzard weight was higher in the LEO, LEO+LPS and LPS groups. The OSI value was observed as highest in the LPS group and the lowest in the LEO group. In addition, OSI value in the LEO group reduced importantly comparing with LEO+LPS group. Liver OSI values did not show any significant difference in all groups. Histopathologically, no significant difference was observed, in terms of fatty liver, congestion, degeneration necrosis and cell infiltration. The addition of laurel increased degeneration, necrosis and desquamation and cell infiltration in the lamina epithelialis in the intestine. In the intestines, cell infiltration was significantly increased in the LPS group compared to the control group. In addition, eosinophilic accumulations were detected in the brain in the LPS group. As a result, it was determined that laurel essential oil improved live weight and feed conversion rate, made a significant contribution to balancing the oxidant-antioxidant capacity ratio, and showed significant bioactivity, especially in terms of turning the negative effect of LPS into positive.

Key words: Laurel; inflammation; growth performance; poultry feed; quails

RESUMEN

El uso potencial de plantas naturales y aceites esenciales como aditivos alimentarios en la avicultura es un área de investigación popular. En el estudio presentado, se investigaron los efectos del aceite esencial de laurel en el crecimiento y el rendimiento de conversión alimenticia, las características de la carcasa de sacrificio, el índice de estrés oxidativo y los parámetros histopatológicos en codornices japonesas en el modelo de inflamación inducida por LPS. Los grupos de estudio se establecieron como Control (C), grupo de aceite esencial de laurel (LEO), grupo de lipopolisacárido (LPS), grupo de aceite esencial de laurel junto con lipopolisacárido (LEO + LPS). Los pesos vivos en los días 19, 26 y 33 fueron mayores en el grupo LEO + LPS y en el grupo LEO en el día 36. La utilización del alimento fue la peor en el grupo LPS y la mejor en el grupo LEO. El rendimiento de la carcasa no eviscerada fue menor en el grupo LPS en comparación con el control, y el peso de la molleja fue mayor en los grupos LEO, LEO + LPS y LPS. El valor de OSI se observó como más alto en el grupo LPS y el más bajo en el grupo LEO. Además, el valor de OSI en el grupo LEO se redujo de manera importante en comparación con el grupo LEO + LPS. Los valores de OSI del hígado no mostraron ninguna diferencia significativa en todos los grupos. Histopatológicamente, no se observó ninguna diferencia significativa en términos de hígado graso, congestión, degeneración, necrosis e infiltración celular. La adición de laurel aumentó la degeneración, la necrosis y la descamación y la infiltración celular en la lámina epitelial en el intestino. En los intestinos, la infiltración celular aumentó significativamente en el grupo LPS en comparación con el grupo de control. Además, se detectaron acumulaciones eosinofílicas en el cerebro en el grupo LPS. Como resultado, se determinó que el aceite esencial de laurel mejoró el peso vivo y la tasa de conversión alimenticia, hizo una contribución significativa para equilibrar la relación de capacidad oxidante-antioxidante y mostró una bioactividad significativa, especialmente en términos de convertir el efecto negativo de LPS en positivo.

Palabras clave: Laurel; inflamación; rendimiento del crecimiento; alimento para aves de corral; codornices

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INTRODUCTION

The production principle of livestock enterprises is generally based on gaining live weight quickly with less feed in a short time. Therefore, feed additives are used to improve the feed conversion rate and the quality of animal products, to ensure the sustainability of animal health and to reduce product costs. Recent studies are carried out to detect the effects of herbal seeds, leaves and oils added to the feed at different rates as feed additives on growth and feed evaluation performances in poultry and on some blood and tissue characteristics [1 , 2].

The development of resistance as a result of the widespread use of antibiotics in poultry farming has led researchers to find alternative solutions. Considering the negative effects of antibiotics, the use of organic acid and essential oil mixtures obtained from natural sources in poultry, alone or in combination, has gained popularity [3 , 4]. For example, it was determined that the feed conversion ratio of broiler chickens in the groups containing probiotics, organic acids and essential oil mixtures including thyme oil, laurel oil, sage oil, myrtle oil, fennel oil and citrus oil was significantly better than the control and organic acid groups [5].

It is reported that the laurel plant, which is in the maquis flora (*Aristotelia chilensis*), has a long lifespan, is approximately two meters tall, and has dense branches. The fragrant leaves of this plant, which grows widely in countries with a Mediterranean climate, including Türkiye, are rich in bioactive components and are known to have significant anti-inflammatory potential [6]. In addition, it has been reported that the laurel plant, which is a plant of the Lauraceae family, has antimicrobial and antioxidant effects. The dominant components of the volatile oil obtained from the laurel plant are expressed as 1.8-cineole, α-terpinene, and sabinene [7]. It is stated that the addition of sage (*Salvia triloba* L.) and laurel (*Laurus nobilis* L.) oil to quail diets numerically changes live weight, feed intake, feed utilization, and carcass characteristics [8 , 9].

Lipopolysaccharides (LPS) are molecules with endotoxin properties located in the outer membrane of gram-negative bacteria [10]. It is possible to experimentally create a bacterial infection model in chickens using LPS, a powerful inflammatory agent [11]. It has been stated that LPS application caused decrease in body weight gain and feed conversion efficiency in chickens and protection against this negative effect will be provided by oil diets [11]. It has also been stated that LPS stimulates the expression of inflammatory cytokines in chickens and that different oil diets have an ameliorating effect on this situation. Therefore, regulating the immune system in poultry through different diets aims to alleviate the decreasing performance of the animals [12].

In this context, the purpose of this study was to determine the effects of adding essential oil obtained from laurel leaf as a natural feed additive to the feed and growth performances, slaughter-carcass characteristics, some blood parameters, liver and intestinal histopathological parameters in quails with Lipopolysaccharide (LPS)-induced inflammation.

MATERIAL AND METHODS

Animal groups

Ethical permission was obtained from Hatay Mustafa Kemal University Animal Experiments Local Ethics Committee to conduct this study (Approval no: 2022/07-04). In the study, 40 quail chicks (*Coturnix coturnix*) at 5 d of age were used. The study consisted of four groups and the animals were divided into groups such that the initial live weights (Ohaus NV622, USA) of the quails were weighed such that there were no significant differences in average initial live weights among the groups.

Animals were divided into 4 groups as follows; Control (C, commercial chick starter feed only), LEO group (commercial chick starter feed + 200 mg/kg laurel essential oil), LEO+LPS group (commercial chick starter feed + 200 mg/kg laurel essential oil in feed + 0.25 mL Lipopolysaccharide in water), LPS group (commercial chick starter feed + 0.2 mL lipopolysaccharide in water). The study continued until the animals reached 36 d of age. Feed and water were given to the animals *ad libitum*.

Fattening performance

A total of 40 quails in 4 groups were individually weighed each week to determine their live weights. After determining the last live weight weighing at 36 d, and then carcass characteristics were determined by slaughtering animals in each group.

Feed intake and the feed conversion rate

The amount of feed given to quails in all groups at the beginning of the week and remaining at the end were weighed to determine weekly feed consumption. In addition, feed conversion rate was calculated using live weight gain and feed consumption amounts.

Carcass characteristics

A total of 40 (4x10) quails of mixed sex (female-male) from each group were slaughtered after cervical dislocation. Carcass characteristics were determined as slaughter live weight, no eviscerated hot carcass weight, eviscerated hot carcass weight, thigh weight, breast+back+neck+wing weight, liver weight, heart weight, gizzard weight and abdominal fat weight.

Biochemical analysis

Total antioxidant status (TAS) and total oxidant status (TOS) from blood (serum) and liver (homogenate) samples taken from quails were analyzed according to the method of Erel [13] by ready-made commercial kits (Rel Assay, Turkey). The findings obtained by using TOS (***µmol*** $\boldsymbol{H_2O_2}$ ***Eq/L***)/TAS (mmol Trolox Eq/L) ×100 formulation was given as oxidative stress index (OSI) values.

Histopathological examination

Following the necropsies of the liver, intestine and brain tissues of the quails, samples were taken and fixed in 10% formalin solution. They were routinely dehydrated in alcohol series and polished in xylene, and paraffin blocks were obtained. 5 µm thick sections were taken from the tissues using a microtome (Leica RM2235, Germany). Tissue samples were stained with Hematoxylin-Eosin [14]. They were examined with the help of a light microscope (Olympus BX50-F4, Tokyo, Japan) and photographed by using an imaging system (Olympus DP12-BSW, Tokyo, Japan).

In histopathological examination of HE-stained sections, liver congestion, necrosis, mononuclear cells, heterophil granulocyte infiltration, and lipidosis were evaluated. In the evaluation of histopathological findings in the liver, liver sections were photographed at 200x magnification to detect inflammatory foci. The number of inflammatory foci was determined by taking the average of inflammatory foci detected in 10 different areas of each liver section [15]. Lesions in the liver were scored as described by Timbermont *et al.* [16]: no lesion (0), mild lesion (1), moderate lesion (2), and severe lesion (3). The severity of the degree of hepatocellular vacuolization, characterized by small or large droplets of lipidosis in the liver, was evaluated by Trott *et al.* [17] as defined, no fat vacuoles (0), lipidosis with small and large drops containing less than half of the hepatocytes (1), lipidosis containing more than half of the hepatocytes (2) and diffuse lipidosis containing small and large drops of fat vacuoles (3). Lesions such as hyperplasia, mononuclear cell infiltration and degeneration, necrosis and desquamation in the lamina epithelialis in the small intestines were scored and evaluated according to their presence and severity, as done by Kanat and Ortatatlı [18]. In each section, 10 different areas were selected at 200x magnification and the cells in these areas were counted and their averages were calculated. The lesion was graded as no (0), mild lesion (1), moderate lesion (2) and severe lesion (3).

Statistical analysis

IBM SPSS Statistics 22 package program was used to perform statistical analyses of the data obtained from the study. In the study, Comparison of groups in terms of fattening performance and blood parameters was done by One-way Anova and the differences were determined by the Duncan test. In addition, the Kruskal-Wallis test was used to compare the groups for histopathological features related to the liver and intestine, and the Mann Whitney U Test was used to determine the different groups.

RESULTS AND DISCUSSION

According to the data obtained in the study, a numerical difference (P>0.05) was found when the control group was compared with the other groups in terms of weekly live weight throughout the study. The live weights on the 19th, 26th and 33rd d were found to be higher in the LEO+LPS group and on the 36th day in the LEO group (P>0.05) (TABLE I). Also, weekly feed consumption was highest between the days 5-12 in the control grup (P<0.001), between the days 12-19 and the d 26-33 in the LEO+LPS group (P<0.001) and between the days 19-26 in the LPS group. Feed utilization was the worst in the LPS group (P<0.001) and the best in the LEO group (P<0.001).

Accordingly, the addition of laurel essential oil to quail feed and LPS to its water did not affect the live weight of quails compared to the control group. However, in the laurel added groups, numerical differences were detected between the groups in terms of live weight and live weight gains (TABLE I). The live weight of quails improved numerically in the LEO and LEO+LPS groups compared to the LPS group. In other words, in the LEO+LPS group, laurel supplementation to the feed had a positive effect on live weight and live weight gain. Similarly, there are studies reporting that the addition of different products of the laurel plant to feed has a positive effect on growth promotion [19 , 20]. It is also stated that laurel (*Laurus nobilis* L.) leaves are used to increase gastric fluid to stop digestive disorders in poultry [21].

TABLE I. Weekly live weight and production performance of quails in the groups

Days	Control	LEO	LEO+LPS	LPS	SEM	P
	Weekly live weight (g)					
Start (5 days)	30.70	30.18	30.77	30.08	0.746	0.982
12	74.99	72.80	74.63	70.69	1.353	0.664
19	125.29	122.87	127.08	122.47	2.017	0.835
26	171.45	170.42	171.99	169.56	2.457	0.986
33	196.47	198.73	203.12	196.48	3.546	0.899
36	201.52	217.17	212.34	208.87	3.767	0.522
	Live weight gain (g)					
5-12	44.29	42.63	43.86	40.61	1.386	0.786
12-19	50.30	50.06	52.44	51.79	2.049	0.971
19-26	46.16	47.56	44.92	47.09	3.167	0.992
26-33	25.02	28.31	31.13	26.92	3.401	0.934
	Feed Consumption (g)					
5-12	98.00a	96.00b	96.00b	94.00c	0.004	0.001
12-19	136.00c	128.00d	152.00a	140.00b	0.005	0.001
19-26	166.00d	178.00c	180.00b	194.00a	0.005	0.001
26-33	196.00c	188.00d	224.00a	218.00b	0.005	0.001
	Feed conversion ratio, g/g					
5-12	2.21c	2.25b	2.18d	2.31a	0.000	0.001
12-19	2.70b	2.56c	2.90a	2.70b	0.000	0.001
19-26	3.60d	3.74c	4.01b	4.12a	0.000	0.001
26-33	7.84b	6.64d	7.20c	8.10a	0.001	0.001

LEO: laurel essential oil, LPS: lipopolysaccharide and LEO+LPS: laurel essential oil+lipopolysaccharide. ^{a,b,c,d}: Groups with different letters in the same column are different from each other (P<0.05)

The findings of this study suggest that although the addition of laurel essential oil to quail feed did not significantly increase the live weight of quails compared to the control group, it is correct to state that there was a tendency for the live weight to be improved with the addition of laurel essential oil to the feed of quails, especially those to which LPS was added to their water.

In the study, it was determined that the feed consumption and feed conversion rates of quails in the groups where laurel essential oil was added to the feed were significantly different from the control group, and the feed conversion rate was improved in the groups laurel essential oil added to the feed. While feed consumption in the LEO group decreased compared to the LEO+LPS and LPS groups, the feed conversion rate improved only in the LEO and LEO+LPS groups (TABLE I). Therefore, the results show that the addition of laurel essential oil to the feed is important to improve growth performance, especially in stress groups in terms of turning the negative effect into a positive one. In similar studies, it has been reported that laurel essential oil reduces feed consumption and increases feed utilization [22 , 23]. In studies by Çabuk *et al.* [24] and Namdeo *et al.* [25], it was reported that broiler chickens fed with laurel leaf, myrtle leaf, thyme, sage leaf, citrus peel and fennel seed essential oils showed significant improvements in feed conversion ratio.

It was determined that the non-eviscerated carcass yield was lower in the LPS group than in the control group (P<0.05), and the gizzard weight was higher in the LEO, LEO+LPS and LPS groups than in the control group (P<0.01) (TABLE II).

TABLE II. Slaughter, carcass and internal organ characteristics

Characteristics	Control	LEO	LEO+LPS	LPS	SEM	P
Slaughter weight (g)	200.45	218.24	208.86	200.04	4.133	0.370
Non-eviscerated carcass weight (g)	150.38	165.32	156.40	148.93	3.093	0.244
Non-eviscerated carcass yield (%)	75.04^{ab}	75.76a	74.87^{ab}	74.47^{b}	0.159	0.049
Breast+back+neck+wing weight (g)	77.66	82.24	77.07	73.70	1.369	0.196
Thigh weight (g)	45.36	46.11	44.36	43.49	0.887	0.743
Heart weight (g)	1.92	1.93	1.80	1.83	0.049	0.715
Liver weight (g)	4.56	6.61	5.72	5.46	0.293	0.122
Gizzard weight (g)	4.34^{b}	5.14^{a}	5.52^{a}	5.47^{a}	0.129	0.009
Abdominal fat weight (g)	2.37	3.10	2.33	2.09	0.190	0.284

LEO: laurel essential oil, LPS: lipopolysaccharide and LEO+LPS: laurel essential oil+lipopolysaccharide. $^{a, b}$: Groups with different letters in the same row are different from each other (P<0.05)

Addition of laurel essential oil to the feed did not affect slaughter weight, non-eviscerated carcass weight, non-eviscerated carcass yield, breast+back+neck+wing weight, thigh weight, heart weight, liver weight and abdominal fat weight compared to the control group. However, in the LPS group, non-eviscerated carcass yield was found to be the lowest. In terms of gizzard weight, laurel essential oil and LPS supplemented groups were significantly higher than the control group (TABLE II). Similar to the results of this study, Al-Rubaee [19] reported a positive effect of adding laurel leaf flour to the feed on carcass weight and yield in quails. However, the high gizzard weight determined as a result of the study is not consistent with the statement of Gwaad and Gwaad [26] that there is no difference in terms of liver and gizzard weight.

According to the findings, it was determined that the blood OSI value increased significantly in the LPS group compared to the control group. In the LEO group including laurel essential oil only this value decreased significantly compared to the control group (TABLE III). It was also found that laurel essential oil added to the feed in the LEO+LPS group caused the OSI value to decrease by 27% compared to the LPS group (p<0.01). However, no statistically significant difference was detected between the control group and the application groups in terms of liver OSI value (P>0.05).

TABLE III. Blood and liver oxidative stress index values of quails in the study groups

Characteristics	Control	LEO	LEO+LPS	LPS	SEM	P
Blood OSI value	4.45bc	2.54c	7.34ab	10.08a	0.732	0.009
Liver OSI value	11.02	9.02	9.17	9.32	0.311	0.120

LEO: laurel essential oil, LPS: lipopolysaccharide and LEO+LPS: laurel essential oil+lipopolysaccharide, OSI: oxidative stress index

Oxidative stress increases as a result of increased production of free radicals in the body or inadequate elimination due to disruption of the oxidant-antioxidant balance. Oxidative stress levels of poultry can be negatively affected by various factors such as heat, feed changes, and drug use [27]. Therefore, it has been reported that the addition of supplementary nutrients, especially natural plants and essential oils obtained from them to the feed has significant effects in preventing the negative effects of stress factors [28 , 29]. In the study conducted by D'Alessandro *et al.* [30], it was reported that although the mixture of olive, laurel and rosemary leaf powders did not affect body weight and egg quality, it had positive effects on oxidative stress and inflammation parameters.

In another study, it was reported that the addition of sage and bay leaf oils to quail diets increased serum antioxidant capacity, and that laurel oil had a significant antioxidant effect in reducing oxidative stress [31]. In addition, it has been reported that the addition of laurel leaves to the diets of Japanese quails has an effect on triglyceride, palmitic and oleic acid levels in quail eggs without adversely affecting performance and egg quality [32]. Oxidative stress index is one of the main parameters used to determine the level of oxidative stress that develops due to the increase in free radicals or the decrease in antioxidant capacity. In this study, it was observed that OSI values were reduced in the group to which laurel oil was added compared to the control group. In addition, it was determined that OSI values were significantly reduced in the group to which LPS was given together with laurel compared to the group to which only LPS was applied. In conclusion, it was observed that the addition of laurel essential oils to the diets of Japanese quails showed a significant antioxidant activity in maintaining or improving the antioxidant-oxidant balance.

In some animals in the control, LPS, LEO and LEO+LPS groups, the livers were observed to be macroscopically enlarged to varying degrees, pale yellowish white in color and friable in consistency. Gas accumulation was observed in the small intestines of a few quails. No pathological changes were observed in the brain. Histopathological examination of the liver showed dissociation, enlargement of sinusoids, congestion, varying degrees of small-drop and large-drop fat vacuoles in hepatocytes, hydropic degeneration, necrosis, mononuclear cell and heterophil granulocyte infiltrations. It was determined that hydropic degeneration, necrosis and cell infiltrations were more intense around the vena centralis and portal area (FIG. 1A-B). Hyperplasia, especially in the epithelium, degeneration, necrosis and desquamation in the lamina epithelialis, mononuclear cell infiltrations in the propria and a small number of heterophil granulocytes were observed in the intestines (FIG. 1C). Histopathologically, edema, hyperemia, and a pinkish-red accumulation in the neuropil tissue were detected in the brains of 2 quails in the LPS group (FIG. 1D).

Congestion, degeneration and necrosis, lipidosis, cell infiltrations in the liver, hyperplasia, cell infiltrations in the small intestines, degeneration, necrosis and desquamation in the lamina epithelialis and level scores of the quails in the experimental groups are statistically indicated in TABLE IV.

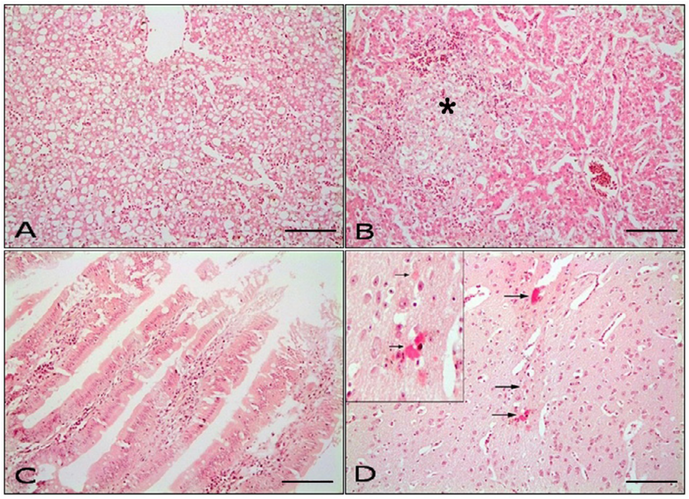

FIGURE 1. Histopathological analysis of liver, intestine and brain tissues of quails. A) Congestion, small and large droplets of lipidosis in hepatocytes, liver. B) 1. Hydropic degeneration and necrosis (star) in hepatocytes, liver. C) Degeneration, necrosis and desquamation in lamina epithelialis, intestine. D) Accumulation of eosinophilic structure (arrows) brain. HE staining. bar= 100 µm

TABLE IV. Descriptive statistics and p value for liver and intestinal characteristics

Tissue	Lesions	Control	LEO	LEO+LPS	LPS	P value
Liver	Congestion	1.00(0-2)	1.00(1-3)	1.00(0-2)	1.00(1-2)	0.465
	Degeneration and necrosis	1.00(0-2)	0.50(0-2)	0.00(0-2)	0.00(0-2)	0.288
	Lipidosis	1.00(0-3)	2.00(0-3)	1.00(0-2)	2.00(1-3)	0.135
	Cell infiltration	0.00(0-2)	1.00(0-2)	1.00(0-1)	1.00(0-3)	0.376
İntestinal	Hyperplasia	2.00(2-2)	2.00(1-3)	2.00(2-3)	2.00(1-3)	0.287
	Degeneration and necrosis in the lamina epithelialis	0.00(0-1)	1.00(0-1)	1.00(0-1)	0.00(0-1)	0.041
	Cell infiltration	0.00(0-2)	1.00(0-1)	1.00(0-1)	1.00(0-2)	0.016

LEO: laurel essential oil, LPS: lipopolysaccharide and LEO+LPS: laurel essential oil+lipopolysaccharide

The difference in terms of liver congestion, necrosis, lipidosis level and cell infiltrations in the control, LEO, LEO+LPS and LPS groups is not statistically significant (P>0.05). When intestinal hyperplasia was examined, the difference between the groups was not statistically significant (P>0.05), while the degeneration, necrosis and desquamation levels and cell infiltration in the lamina epithelialis between the groups were significant (P<0.05). According to the multiple comparisons, the difference for the LPS and LEO+LPS groups was found to be statistically significant (P<0.05). This significance is in the direction of the LPS group being lower than the LEO+LPS group. Other pairwise group comparisons were not found to be significant. In the multiple comparison for intestinal cell infiltration, the difference between the control group (0.00(0-2)) and the LPS group (1.00(0-2)) was statistically significant (P<0.05). Other multiple comparisons were not found to be significant.

In this study, despite the nutritional differences between the groups, no significant difference was observed histopathologically in terms of the level of lipidosis, congestion, degeneration, necrosis and cell infiltration in the liver. It was determined that the addition of laurel increased degeneration, necrosis and desquamation and cell infiltration in the lamina epithelialis in the intestine. Cell infiltration was significantly increased in the groups to which LPS was added compared to the control group (TABLE IV). Studies on the pathological lesions caused by laurel in organs are quite limited. The liver plays a central role during metabolism and is an organ that produces bile, which helps in the breakdown of fats. In bird species, fats, especially triglycerides, accumulate in adipocytes and hepatocytes. Hepatic lipogenesis causes steatosis in the liver when it exceeds the capacity of lipoprotein secretion. Researchers have also reported that heat stress causes vacuolar steatosis in the liver [33, 34]. Some researchers have reported that steatosis, degeneration and necrosis in hepatocytes, hemorrhage and hematomas in the parenchyma, fibrosis and cell infiltration in portal areas occur [17, 35]. In the presented study, hydropic degeneration, multifocal necrosis, steatosis and cell infiltration in hepatocytes were observed, along with hemorrhage in the liver of only one quail in the LEO+LPS group. Hematomas and fibrosis were not observed. As reported by Malik *et al.* [36], fats are a high energy source and although depletion of fats in cells occurs during periods when growth is very rapid, fats may begin to accumulate in cells when the growth rate of animals slows down with growth. Similar to what Jacobsen *et al.* [37] reported, it was not possible to determine whether the fatty liver observed in this study was due to the fat storage characteristics of the livers of bird species or due to the laurel in the diet.

It has been reported that quails are resistant to infections and do not have any obvious symptoms. It has been reported that the intestinal content may change from seromucous to dark brown depending on the infection [38 ,39]. In the present study, although no other findings other than gas were observed macroscopically in the small intestines, histopathological, it was observed that cell infiltration in the LPS group was significantly increased compared to the control group. Degeneration, necrosis and desquamation in the epithelium were significantly observed in the LPS and LEO+LPS groups compared to the control group. It is thought that the histopathological lesions observed were caused by exposure to a fatty diet with the addition of laurel as well as infection. No previous article has been found regarding the accumulations of eosinophilic structure in the brain in the LPS group.

CONCLUSION

In the study, histopathological changes were observed in the liver, intestine and brain tissue between the groups, but it was determined that they were not statistically significant. However, the intensity of cell infiltration in the intestines, especially in the LPS group, is remarkable when compared to the other groups. Again, the presence of eosinophilic accumulations in the brain tissue is another remarkable finding. In the light of all these findings, it can be said that Laurel has antioxidant and fattening performance effects in the experimental inflammation model, but its anti-inflammatory activity is limited. However, further and detailed studies are needed to fully elucidate the issue.

Conflict of interests

The authors declare that there is no conflict of interest with the publication of this manuscript.

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