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Japon Bıldırcını Rasyonlarına Murt Uçucu Yağı (Myrtus Communis) İlavesinin Lipopolisakkarit Uyarımlı İnflamasyonda Büyüme, Yem Tüketimi, Karkas, Bazı Kan ve Doku Özellikleri Üzerine Etkileri

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ÖZ

Bu çalışmada yeme katılan mersin (murt) uçucu yağının Lipopolisakkarit (LPS) uyarımlı inflamasyonunda bıldırcınlarda canlı ağırlık, yem tüketimi, yemden yararlanma oranı, kesim özellikleri, bazı kan ve organ parametreleri üzerine etkilerinin belirlenmesi amaçlanmıştır. Çalışma grupları, kontrol (ticari civciv başlangıç yemi), M grubu (ticari civciv başlangıç yemi +200 mg/kg Murt uçucu yağ), MLPS grubu (ticari civciv başlangıç yemi +1 mg/kg-17. Gün ve 7,5 mg/kg 24. gün intrabdominal LPS uygulanan grup) ve LPS (ticari civciv başlangıç yemi + 1 mg/kg-17. Gün ve 7,5 mg/kg 24. gün intraabdominal LPS uygulanan grup) şeklinde oluşturulmuştur. Çalışma toplam 40 adet (4x10) bıldırcın civcivinden oluşan 4 deneme grubu oluşturulmuş, besi süresi 36 gün sürmüştür. Çalışmada kan ve karaciğer Oksidatif Stress İndeksi (OSI) değerleri murt ilaveli M ve MLPS gruplarında murt ilavesiz kontrol gruplarından daha düşük saptanmıştır. Çalışma süresince canlı ağırlık değeri Murt ilaveli gruplarda murt ilavesiz gruplardan daha düşük saptanmıştır. Ayrıca yemden yararlanma oranı 5-33. günler arasında murt ilaveli M grubunda diğer gruplardan önemli derecede daha iyi olmuştur. Taşlık oranı ve göğüs+sırt+boyun+kanat oranı değerleri bakımından gruplar arasında önemli farklılık belirlenmiştir. Çalışmada ince bağırsaklarda makroskobik ve histopatolojik olarak hiperemi görülmemiş, hücre infiltrasyonunun kontrol grubuna göre murt ilave edilen diğer gruplarda artış şekillenmiş ve epitelde dejenerasyon ve nekroz daha belirgin olarak tespit edilmiştir. Çalışmada bıldırcın karma yemine murt ilavesinin büyüme performansına, yem tüketimine ve yemden yararlanma oranına etkisinin olumlu yönde olduğu sonucuna varılmıştır.

Effects of Adding Murt Volatile Oil (Myrtus Communis) to Japanese Quail Diets on Growth, Feed Consumption, Carcass, Some Blood and Tissue Characteristics in Lipopolysaccharide-Induced Inflammation

Research Article

ABSTRACT

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This study, it was aimed to determine the effects of murt volatile oil added to the diet on Lipopolysaccharide (LPS) induced inflammation on body weight, feed consumption, feed conversion ratio, slaughter characteristics, some blood and organ parameters in quails. The study groups were formed as follows: control (commercial chick starter feed), M group (commercial chick starter + 200 mg/kg Murt volatile oil), MLPS group (commercial chick starter + 1 mg/kg-17th day and 7.5 mg/kg- 24th day intrabdominal LPS administered group) and LPS (commercial chick starter feed + 1 mg/kg 17th day and 7.5 mg/kg - 24th day intraabdominal LPS administered group). The study, 4 experimental groups consisting of 40 (4x10) quail chicks were formed and the fattening period lasted for 36 days. The study, blood and liver OSI (Oxidative stress index) values were found to be lower in the M and MLPS groups with murt supplementation than in the control groups without murt addition. During the study, the body weight value was determined lower in the groups with Murt added than in the groups without Murt addition. In addition, the feed conversion ratio was significantly better in the M group with murt supplementation between the 5th and 33rd days than in the other groups. Significant differences were determined between the groups in terms of gizzard ratio and chest+back+neck+wing ratio values. In the study, macroscopic and histopathological hyperemia was not observed in the small intestines, there was an increase in cell infiltration in other groups with added murt compared to the control group, and degeneration and necrosis of the epithelium were detected more prominently. In the study, it was determined that the addition of murt to quail compound feed had a positive effect on growth performance, feed consumption and feed efficiency.

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Introduction

The Latin name of Murt fruit (Myrtus communis L.) is in the genus Myrtus of the Myrtaceae family. Murt fruit is located in the natural flora of the Mediterranean region. It is expressed with the local names 'murt, myrtle, blueberry and wild myrtle' (Sargın 2019). The leaves and fruit of the murt fruit are used by people. Fresh fruits are consumed raw as well as being evaluated by extracting juice or making jam.

It is reported that there are 40 components in the leaves and 38 components in the fruit of Murt. The most common components in murt fruit and leaf are limonene, α-pinene, linalyl acetate and eucalyptol (Dönmez and Salman, 2017). Murt leaf contains tannins, flavonoids and volatile oils (Baytop, 1999). In addition, the fruits of the murt plant mostly contain sugars and organic acids (such as citric and malic acids) (Martin et al. 1999). Murt is a plant with high antioxidant capacity. In addition, Myrtle plant expressed as plants with antibacterial effects. (Temamoğulları et al., 2019, Önel and Aksu, 2020).

In poultry farming, research continues by adding different forms of different plants to the feed to reduce the effect of stress factors, increase performance and improve feed efficiency (Aksu et al., 2018; Petričević et al., 2018, Önel and Aksu, 2019; Şahin et al., 2020). Studies are also carried out to determine the effect of volatile oils obtained from various plants, which are feed additives, on poultry nutrition (Çimrin and Demirel, 2016, Yeşilbağ, 2017). Herbal volatile oils are considered natural, less toxic than antibiotics, and residue-free antimicrobial growth promoters (Zhai et al., 2018, Gül et al.,

2019). Volatile oils result in less exposure to growth-suppressing disorders associated with digestion and metabolism. Because volatile oils stimulate the secretion of digestive enzymes and stabilize the ecosystem of the intestinal microflora (Zhai et al., 2018). There are studies on the positive effect of volatile oils added to feed in broilers on body weight gain and feed conversion rate (Bento et al., 2013; Özsoy et al., 2017). However, Ölmez et al. (2020) reported that the volatile oil mixture did not have a significant effect on body weight gain, feed consumption, feed conversion ratio, carcass yield and edible internal organ weights in domestic Turkish geese, but increased duodenum crypt depth.

Lipopolysaccharide (LPS) is an endotoxin found in the outer membrane of gram-negative bacteria and plays a key role in pathogenesis (Whitfield and Trent, 2014). LPS, which provides an effective permeability barrier for bacteria such as antibiotics and cationic antimicrobial peptides, is an important glycolipid located on the outside of the membrane, and divalent cations stabilize the membrane, allowing a layer to form. (Nikaido, 2003, Maldonado et al., 2016). High doses of LPS increase the secretion of proinflammatory mediators that cause a detrimental state to metabolism called oxidative stress (Libby, 2007). Therefore, it is tought that reactive oxygen species (ROS) have an important place in the mechanism of LPS toxicity (Kallapura et al., 2014, Halawa et al., 2018).

In this study, it was aimed to determine the effects of murt volatile oils added to the feed on LPS-induced inflammation on body weight, feed consumption, feed conversion ratio, slaughter characteristics, some blood and organ parameters in quails.

Materials and Methods

Ethical approval

The study was accepted with the decision numbered 2021/06-04 of Hatay MKU Animal Experiments Local Ethics Committee (HADYEK). The study was carried out in Hatay MKU Experimental Research Application and Research Center-Alternative Poultry Breeding Unit.

Feed material

In the study, a standard quail diet based on corn and soymeal, in accordance with NRC (1994) standards (23.7% Crude Protein and 2850 kcal/kg Metabolizable Energy) was used. During the study, quails were given feed and water ad libitum.

Obtaining plant volatile oil

The volatile oil used in the study was obtained by water distillation method, collected during the flowering period of Myrtus communis plant, which grows naturally in the province of Hatay at 35°54'20.5"N 36°02'29.2"E location, and dried at 35 °C.

Component analyses of Myrtus communis volatile oil

Determination of volatile oil components was performed with Thermo Scientific ISQ Single Quadrupole model gas chromatography device. A column with TG-Wax MS-A model, 5% Phenyl Polysilphenylene-siloxane, 0.25 mm inner diameter x 30 m length, 0.25 µm film thickness was used. Helium (99.9%) was used as the carrier gas at a flow rate of 1 mL/min. The ionization energy was set to 70 eV and the mass range m/z 1.2-1200 amu. Scan mode was used for data collection. MS transfer line temperature was 250°C, MS ionization temperature was 220°C, injection port temperature was 220°C, column temperature was 50°C at the beginning and it was increased to 220°C with a temperature increase rate of 3°C/min. The structure of each compound is defined by the Xcalibur program using mass spectra (Mavi et al., 2021). The chemical composition and volatile oil components of Murt volatile oil used in the study are given in Table 1.

Table 1. Chemical components of Myrtus communis volatile oil

Retention Time (RT) (min)	Rate (%)	Components
13.17	25.13	α –pinene
13.22	0.40	α –thujene
16,60	0.31	Propionicacid
17,35	0.57	l-beta-pinene
19,90	0.26	3-carene
20,99	0.17	α - phellandrene
24.28	38.44	Eucalyptol
26.30	0.22	gamma-terpinene
26.79	0.22	β –ocimene
28.05	1.13	para-cymene
46.02	5.42	Linalool
46.53	1.88	Linalylacetate
48.36	0.23	β –elemene
48.82	1.47	caryophyllene
49.12	0.41	4-carvomenthenol
52.63	0.65	β -selinene
52.89	0.65	estragole
53.69	1.52	1-phenylaziridine
54.15	5.20	α -terpinylacetate
54.24	2.83	terpineol
54.55	0.21	geranylformate
55.41	0.38	nerylacetate
56.90	1.92	geranylacetate
58.58	0.90	myrtenol
60.75	1.26	geraniol
65.04	0.46	β -caryophylleneoxide

Experimental design

The study material, quail chicks, was obtained as a result of a 17-day incubation period by loading fertile eggs into incubators. In the study, 5-day-old healthy chicks were individually weighed and

randomly distributed to the experimental groups. It was ensured that the starting average body weight was similar to each other in the experimental groups. In the study, four experimental groups and a total of 40 (4x10) quail (Coturnix coturnix japonica) chicks were used. In the study, LPS (E. Coli O55-B5, Sigma) was dissolved in a phosphate buffer solution. Quails were fed up to 36 d-old. Study groups were control (commercial chick starter diet), M group (commercial chick starter diet +200 mg/kg Murt volatile oil), MLPS group (commercial chick starter diet + 200 mg/kg Murt volatile oil + 1 mg/kg-17th day and 7.5 mg/kg-24th day intraabdominal LPS administered group) and LPS (commercial chick starter diet + 1 mg/kg-17th day and 7.5 mg/kg-24th day intraabdominal LPS administered group).

For the experimental groups of the study, the feeds were prepared weekly. The quails in the study groups were fed ad libitum. During the study, the feeder and drinker were checked at least twice a day, and fresh water were provided. In the study, quails were individually weighed every week with precision scales (0.01 g) to determine weekly live weights, and the weighings were concluded with the weight on the 36th day. Gender discrimination was determined according to the feather characteristics of the breast area of the quails. Quails with spotted chest areas are classified as female, quails without spots and plain brown are classified as males.

The feed intake of the quails in the study experimental groups was determined o weekly. Weekly feed consumption was calculated by subtracting the remaining feed from the amount of feed given. The feed conversion ratio was calculated by dividing the amount of feed consumed by the body weight gain.

To determine the slaughter characteristics, quails close to the group average in the experimental groups were separated for slaughter. A total of 35 (9-10-6-10) quails were slaughtered, 19 female and 16 male quails. Slaughter body weight, full hot carcass weight, hollow hot carcass weight, breast+back+neck+wing weight, thigh weight, liver weight, heart weight, gizzard weight and abdominal fat weight were determined as carcass characteristics.

Determining the proportional values of slaughter and carcass characteristics in experimental groups;

Full hot carcass yield (%) = (Full hot carcass weight / Slaughter weight) x 100

Hollow hot carcass yield (%) = (Hollow hot carcass weight / Slaughter weight) x 100

Leg ratio (%) = (Thigh weight / Full hot carcass weight) x 100

Breast+back+neck+wing ratio (%) = (Chest+back+neck+wing weight / Full hot carcass weight) x 100

Liver ratio (%) = (Liver weight / Full hot carcass weight) x 100

Heart rate (%) = (Heart weight / Full hot carcass weight) x 100

Gizzard ratio (%) = (Gizzard weight / Full hot carcass weight) x 100

Determination of biochemical parameters

In the study, blood and liver samples were taken from all slaughtered quails for biochemical parameters. TAS and TOS analyzes (Rel assay-TR) of blood and liver samples were carried out by

following the methods of Kucukgul and Erdogan (2014) using a ready-made commercial kit, and the Oxidative Stress Index (OSI) in the experimental groups was calculated with the ratio of these two values.

Histopathological Examination

Liver and intestinal samples of the necropsied quails were taken and fixed in 10% buffered formalin solution. After routinely passing through a series of alcohol and xylol, 5 μm thick sections were taken by embedding in paraffin. Tissue samples (Luna, 1968) stained with hematoxylin and eosin (HE) were examined under a light microscope (Olympus BX50-F4, Tokyo, Japan) and photographed with a digital imaging system (Olympus DP12-BSW, Tokyo, Japan).

In the histopathological examinations of HE-stained sections, the presence of lesions such as congestion, necrosis, mononuclear cells, heterophile granulocyte infiltrations in the liver, hyperplasia, mononuclear cell infiltrations and lamina epithelial degeneration and necrosis in the liver were evaluated according to their severity by scoring as Kanat and Ortatatlı (2011) did. In each section, 10 different areas were selected at 200x magnification, cells were counted and their averages were calculated. In the general evaluation, it was defined as no lesion (0), mild lesion/few cells (1), moderate lesion/moderate number of cells (2), and severe lesion/many cells (3).

Average mononuclear cell infiltrations at 200x magnification in 5 different areas in each section, if no cells (0), 1-20 cells (1), 21-50 cells (2), more than 50 (3). For heterophile granulocyte infiltrates, if there is no cell (0), 1-5 cells (1), 6-20 cells (2), more than 20 (3) were calculated. The degree of hepatocellular vacuolization, which is characterized by solitary or multiple clear, well-defined small or large droplets of lipoidosis, was scored according to the following criteria: (0) absent or very rare vacuolization, (1) vacuolization of any size involving less than 50% of hepatocytes, (2) vacuolization involving more than 50% of hepatocytes and (3) diffuse vacuolization involving vacuoles of variable size (Trott et al. 2014). Considering the averages, lesions in the liver and intestine were evaluated as indicated in Table 5.

Statistical analyses

IBM SPSS Statistics Version 22.0 (IBM Inc, Chicago, IL, USA) package program was used in the statistical analysis of the data. The descriptive statistical mean was used for animal performance parameters, feed and blood analysis. For these variables, the One Way Anova test was used to compare the groups, and the Duncan test was used to determine the difference between the groups. Relevant variables for histopathological values are summarized as median and minimum - maximum. The Kruskal Wallis test was used to compare the overall difference between more than two groups. The Mann-Whitney U test with Bonferroni correction was used for pairwise comparisons of the groups for cases found to be significant in these comparisons. Statistical significance level was taken as 0.05 in all F-tests.

Results

Considering the proportional sizes of the main components determined in Murt volatile oil, the main components appears to be eucalyptol (38.44%), α-pinene (25.13%), linalool (5.42%), α-terpinylacetate (5.20%), respectively.

Average body weights of quails in the experimental groups are presented in Table 2. In the study, a significant difference was found between the groups in terms of body weight only on the 33rd day ($P<0.05$). It was determined that the average body weight of quails on the 33rd day was higher in the control and LPS groups than in the M and MLPS groups.

Table 2. Experimental groups quail body weight (g)

Characteristics	Control	M	MLPS	LPS	SEM	P
5th day starting live weight	29.28	30.58	31.50	29.57	0.561	0.495
12th day Body Weight	71.34	66.68	73.42	72.65	1.206	0.215
19th day Body Weight	124.08	115.94	123.75	127.31	1.462	0.058
26th day Body Weight	171.48	162.14	164.01	173.29	2.035	0.163
33rd day Body Weight	207.13[a]	190.08[b]	189.24[b]	207.62[a]	2.859	0.035

[a,b]: The same superscripts denote significant pairwise differences.

Average feed consumption, body weight gain and feed conversion rates of quails in the study groups are given in Table 3. The difference between the groups in terms of the characteristics determined was significant ($P<0.001$).

Table 3. Body weight gain, feed consumption, and feed conversion rate values of quails in the experimental groups

Characteristics	Body weight gain (g)					
	Control	M	MLPS	LPS	SEM	P
5th- 19th days	94.81[b]	85.36[d]	92.25[c]	97.74[a]	0.003	<0.001
19th -33rd days	83.05[a]	74.15[c]	65.49[d]	80.31[b]	0.003	<0.001
5th -33rd days	177.86[b]	159,51[c]	157,74[d]	178,06[a]	0.003	<0.001
	Feed Intake (g)					
5th- 19th days	257.50[a]	177.50[d]	235.50[b]	229.50[d]	0.323	<0.001
19th -33rd days	397.50[a]	345.50[d]	377.50[c]	389.25[b]	0.352	<0.001
5th -33rd days	655.50[a]	523.50[d]	613.50[c]	619.50[b]	0.323	<0.001
	Feed conversion ratio, g/g					
5th- 19th days	2.72[a]	2.08[d]	2.55±0.01[b]	2.35±0.01[a]	0.004	<0.001
19th -33rd days	4.79[c]	4.66[d]	5.77±0.01[a]	4.85±0.01[b]	0.005	<0.001
5th -33rd days	3.69[b]	3.28[d]	3.89±0.00[a]	3.48±0.00[c]	0.002	<0.001

[a,b,c,d]: The same superscripts denote significant pairwise differences.

In the study, the difference between the groups was insignificant ($P>0.05$) in terms of slaughter and carcass piece values, except for the mean breast+back+neck+wing ratio ($P<0.05$) of the quails in the experimental groups (Table 4).

Table 4. Slaughter and carcass part characteristics of experimental groups of quails.

Characteristics	Control	M	MLPS	LPS	SEM	P
Slaughter Body Weight (g)	222.26	204.66	198.55	210.69	3.756	0.184
Full carcass weight (g)	167.05	153.70	150.39	157.50	2.975	0.254
Hollow carcass weight (g)	138.54	128.79	124.66	130.48	2.241	0.211
Heart weight (g)	2.04	1.91	1.80	1.95	0.051	0.466
Liver weight (g)	6.54	5.51	5.99	6.20	0.289	0.601
Gizzard weight (g)	5.43	4.26	4.86	5.13	0.161	0.058
Chest+back+neck+wing weight (g)	85.1	78.50	74.20	77.2	1.496	0.099
Leg Weight (g)	48.36	44.02	43.06	46.09	0.808	0.127
Abdominal fat weight (g)	1.96	2.08	2.30	2.27	0.171	0.882
Full carcass Yield (%)	75.12	75.14	75.68	74.68	0.163	0.251
Hollow carcass Yield (%)	62.27	63.11	62.89	61.97	0.334	0.555
Heart rate (%)	1.23	1.24	1.19	1.24	0.022	0.878
Liver rate (%)	3.92	3.54	3.92	3.89	0.140	0.680
Gizzard rate (%)	3.26^{a}	2.74^{b}	3.22^{a}	3.27^{a}	0.078	0.045
Chest+back+neck+wing rate (%)	51.04^{a}	51.11^{a}	49.34^{ab}	49.05^{b}	0.300	0.025
Leg rate (%)	28.92	28.71	28.69	29.35	0.220	0.661
Abdominal fat rate (%)	1.18	1.33	1.50	1.45	0.104	0.706

^{a,b}*: The same superscripts denote significant pairwise differences.*

Blood and liver OSI values are given in Table 5. In the study, the difference between the groups in terms of blood OSI value was significant ($P<0.05$), with the highest LPS group (14.76), the lowest murt added M and MLPS groups (2.44 and 4.65). While the liver OSI value was high in the control and LPS groups without murt supplementation, it was low in the M and MLPS groups with murt supplementation ($P>0.05$).

Table 5. Oxidative Stress Index values in the experimental groups

Characteristics	n (pcs)	Control	M	MLPS	LPS	SEM	P
Blood OSI Value	6	8.67^{ab}	2.44^{b}	4.65^{b}	14.76^{a}	1.393	0.027
Liver OSI Value	6	9.13	7.87	7.74	8.24	0.291	0.355

a,b: The same superscripts denote significant pairwise differences.

Macroscopically, the livers of the animals in the K, M, MLPS and LPS groups were found to be pale yellowish-white in color, crispy and swollen to varying degrees. In the histopathological examination of the liver, dissociation, enlargement of the sinusoids, and congestion were commonly observed, while hydropic degeneration, necrosis, mononuclear cell infiltrations and heterophile granulocytes, especially around the v.centralis and portal area were observed to be more intense. In the cytoplasm of

hepatocytes, oil vacuoles with varying degrees, sharp edges, and commonly small and large droplets were observed (Figure 1A-G). F In the intestines, hyperplasia especially in the epithelium, degeneration and necrosis in the lamina epithelial mononuclear cell infiltrations as well as hyperemia, vacuoles in the villus epithelium and a few heterophile granulocyte infiltrations were observed (Figure 1H-I).

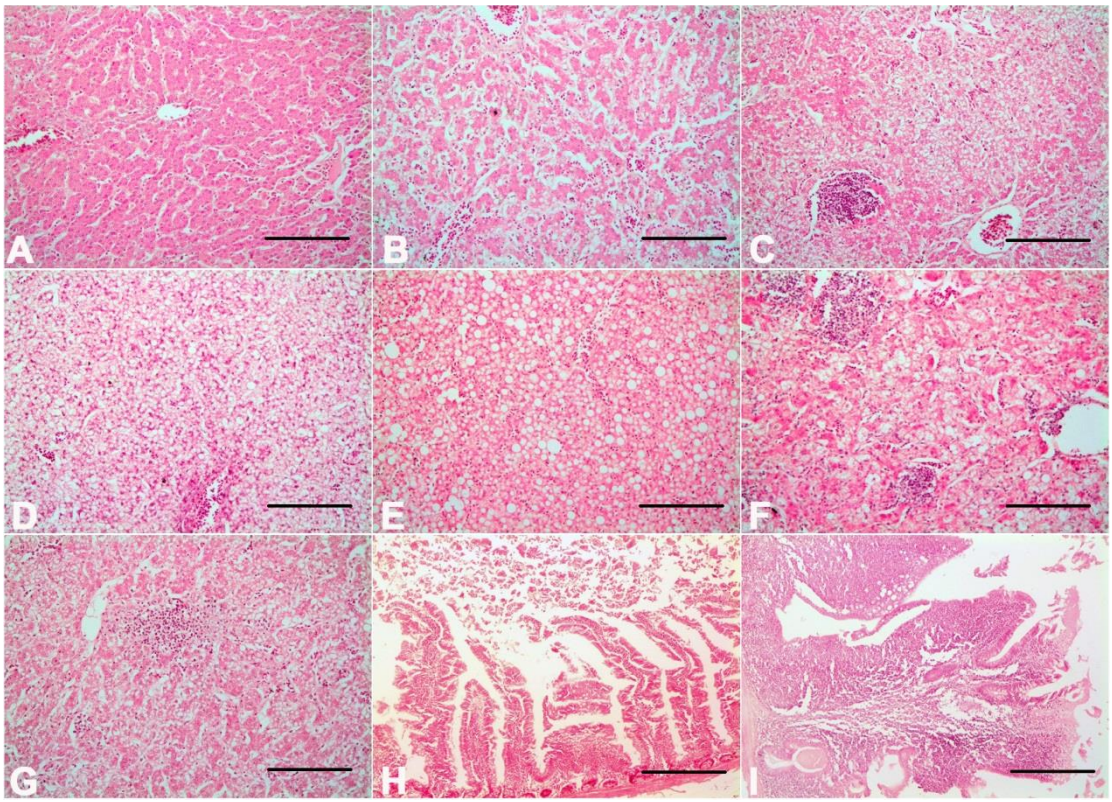

Figure 1. A) Normal liver tissue. B) 1. Congestion, enlargement of sinusoids, fatty vacuoles in hepatocytes, liver, 1st degree. C) Congestion, fatty vacuoles in hepatocytes, degeneration and necrosis, focal cell infiltration, liver, 2nd degree. D) Diffuse adiposity, liver, 3rd degree. E) Large and small dropsy lipoidosis, liver, 2nd degree. F) Congestion, multifocal degeneration, necrosis, liver. G) Multifocal degeneration and necrosis, fat vacuoles, liver. H) Hyperplasia of the bases of the villus, degeneration and desquamation of the lamina epithelial, intestine. I) Lamina epithelial necrosis, cell infiltration in the propria, HE staining, bar= 100 µm (A-G), 200 µm (H, I).

Lesions such as fatty liver, congestion, necrosis, mononuclear cells, heterophile granulocyte infiltrations, small intestine hyperplasia, mononuclear cell infiltrations and lamina epithelial degeneration and necrosis of the quails in the experimental groups and their level scores are statistically presented in Table 6.

Table 6. Descriptive statistics and P value for experimental groups

Characteristics	Control	M	MLPS	LPS	P value
Liver Congestion	1.00 (1-2)	2.00 (1-2)	2.00 (1-2)	1.00 (1-2)	0.376
Liver Necrosis	0.00 (0-3)	1.00 (1-3)	2.00 (0-3)	1.50 (0-2)	0.266
Liver lipoidosis	1.00 (0-3)	2.00 (0-3)	1.00 (0-2)	1.00 (0-2)	0.292
Liver Cell Infiltration	0.00 (0-2)	1.00 (0-2)	1.00 (0-2)	0.50 (0-2)	0.315
Intestinal Hyperplasia	2.00 (1-3)	2.00 (1-2)	2.00 (1-2)	2.00 (1-3)	0.192
Intestinal Lamina epithelial degeneration and necrosis	0.00 (0-1)	1.00 (1-2)	2.00 (0-3)	1.00 (0-2)	0.001
Intestinal Cell Infiltration	0.00 (0-1)	0.00 (0-2)	1.00 (0-2)	1.00 (0-2)	0.017

Although there was a numerical difference between the groups in terms of fatty liver, congestion, necrosis and cell infiltration, the findings were statistically insignificant (P>0.05) in 4 groups.

When the intestinal hyperplasia of quails in the experimental groups was examined, the difference between the groups was not statistically significant (P>0.05). However, the level of degeneration and necrosis in the lamina epithelial between the groups was significant (P < 0.001). The difference between the K group and the MLPS group is significant for lamina epithelial degeneration and necrosis in the intestine. Also, when the intestinal cell infiltration level values in the experimental groups were examined (Table 6), the difference between the groups was found to be significant (P<0.01). According to the multiple comparison test performed to determine the groups causing this difference, the median value of the LPS group was higher than the K and M groups (p < 0.05).

The findings for liver congestion, liver necrosis, fatty liver and liver cell infiltration did not yield statistically significant results in the 4 groups (p > 0.05) (Table 6). The comparison of 4 groups for intestinal hyperplasia was not statistically significant (p < 0.192). However, degeneration necrosis in intestinal lamina epithelialis was significant (p < 0.001). The difference between the K group and the MLPS group was significant for intestinal lamina epithelial degeneration and necrosis (p < 0.001). This significance is due to the fact that the MLPS median value is higher than that of the K group. Finally, the difference was significant for intestinal cell infiltration (p < 0.017). According to the multiple comparison test performed to determine the groups causing this difference, the median value of the LPS group was higher than the K and M groups (p < 0.041 and 0.046).

Discussion and Conclusion

Although the initial body weight values were higher in the M and MLPS groups to which murt was added, compared to the control and LPS groups, they were found to be lower in other periods when the body weights were determined (Table 3). In addition, especially on the 33rd day of the study, it was determined that the body weight value of the quails in the M and MLPS groups was significantly lower than the control and LPS group quails (P<0.05). However, it was reported that the addition of

murt oil to Japanese quail feed (1000 mg/kg/day, Biricik et al. 2012) and broiler feed (500 mg/kg, Sadeghi et al. 2013; Goudarzi et al. 2016) had a positive effect as a potential growth promoter. Animal performance characteristics and the dose difference of the herbal antioxidant added to the basal diet can be expressed as an important reason for the differences in the study results.

In the current study, the amount of feed consumption was found to be lower in the groups (M and MLPS) to which murt oil was added to the diet than in the control and LPS groups (Table 3). In addition, improvement in feed conversion ratio was significantly better in the M group with murt supplementation than in the other groups. Similarly, Biricik et al. (2012), Sadeghi et al. (2013) and Salehifar et al. (2017) reported an improvement in feed efficiency of quail and chicks fed with murt oil added the diet. Similarly, Goudarzi et al. (2016) stated that the addition of 500 mg/kg murt oil extract to the diet reduced feed intake and improved feed conversion ratio of Ross and Cobb broiler chickens.

It was found that the values of the groups with the addition of murt oil (M and MLPS) were numerically lower than the groups without the addition of murt oil (K and LPS) in terms of slaughter body weight, full, hollow carcass weight and edible internal organ weights. However, in terms of abdominal fat weight, it was found that MLPS and LPS groups were higher than the other groups (Table 4). The abdominal fat weight result of the study is similar to the result of Sadeghi et al (2013) that it was higher in the group fed with murt oil+AFB1 supplemented feed than in the group fed with only murt. Contrary to the findings of the study, Biricik et al. (2012) stated that quail slaughter body weight, hot carcass weight, heart weight, liver weight and gizzard weight were numerically higher in the groups with 1000 and 2000 mg/kg/day murt oil added. Again, Salehifar et al. (2017) reported that carcass weight, liver weight, wing weight and gizzard weight were positively affected in groups fed with different doses of murt oil.

In the study, it was determined that the blood OSI value of the groups with murt oil added was lower than the groups without murt oil. Likewise, liver OSI value was found to be numerically lower in groups with added murt than in groups without murt (Table 5). It has been stated by the results of the study that the addition of herbal additives to the diet improves blood oxidative stress parameters, and the addition of different amounts of sumac (Kırar et al., 2020) and peppermint oil (Doğan et al., 2020) to quail feed reduces OSI values in the blood. Alishah et al. (2013) reported that sumac supplementation did not affect blood antioxidant values during the growth period.

In the histopathological examination, although there are numerical differences in terms of fatty liver, congestion, necrosis and cell infiltrations, the results obtained are statistically insignificant. Despite the nutritional difference between the groups in the present study, liver morphology was not significantly affected. It was determined that the addition of murt increased intestinal cell infiltration and degeneration and necrosis in the lamina epithelium in quails compared to the control group. Murt addition significantly increased intestinal degeneration and necrosis and caused intestinal inflammation in the groups (Table 6). Some researchers have reported that in fatty liver hemorrhagic syndrome, bleeding and hematomas in the subcapsular and parchyma of the liver, small and large

droplets of fat in hepatocytes, degeneration and necrosis, fibrosis and cell infiltrations in the portal areas occur (Spurlock and Savage, 1993; Trott et al. 2014). In this study, hydropic degeneration in the liver, multifocal necrosis and cell infiltrations in the parenchyma, as well as small and large droplet lubrication of varying severity, were observed, but fibrosis, cell infiltration in the portal area, subcapsular hemorrhage and hematomas were not observed. Studies on the pathological lesions of murt in organs are very limited. The small intestine is the organ where the digestion and absorption of dietary fats take place. Bile salts and phospholipids play an important role in the emulsification of dietary fats (Magubane et al. 2013). Volatile oils of some species of the Myrtaceae family are used as an antioxidant, antimicrobial, antidiarrheal, analgesic, anti-inflammatory and to reduce blood cholesterol (Stefanello et al. 2011). However, in this study, an increase in cell infiltration was observed in Murt added groups. It has been reported that quails are relatively resistant to infections and do not show specific symptoms. It is stated that hyperemia can be seen in the intestinal mucosa. It has been reported that there may be mucus similar to coffee (Monte et al. 2015). In this study, macroscopic and histopathological hyperemia was not observed in the small intestines, cell infiltration increased in other groups with murt added compared to the control group, and degeneration and necrosis of the epithelium were detected more prominently. In our study, it was concluded that these histopathological lesions in the intestines were due to infection rather than the addition of murt.

In the study, it was determined that the addition of murt to quail compound feed under oxidative stress had a positive effect on growth performance, feed intake and feed efficiency. It was also found that stress factors have a positive effect on the oxidative stress value. Therefore, it has been determined that the use of murt volatile oils as an additive to the diet of quails under oxidative stress can be applied to reduce feed intake and reduce the effect of stress factors without causing weakness in animal performance.

Statement of Conflict of Interest

The author has declared no conflict of interest.

Author's Contributions

The contribution of the author's is equal.

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