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Assessment of Lipid Profile and Carcass Traits in Quail, Fed on Diet with Incorporation of Peppermint Leaf Powder at Various Levels.

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ABSTRACT

A study was carried out to assess the effect of dietary incorporation of Peppermint Leaf Powder (PLP) on the lipid profile and carcass quality of J.quails. Day-old Japanese quails (N=150) were distributed randomly to five dietary groups each with three replicates of 10 birds. Experiment diets were prepared with the incorporation of Peppermint Leaf Powder at 0% (T1: control), 0.75% (T2), 1.5% (T3), 2.25% (T4), and 3.0% (T5) levels by marginal adjustment of other feed ingredients. All the rations were made iso-caloric and iso-nitrogenous. Feed and water were provided *ad libitum*. The birds were housed in battery cages during the experiment period of 0-5 weeks. Two birds per replicate and a total of six birds per treatment were slaughtered at the end of 5th week. Serum total cholesterol, LDL-C, VLDL-C, triglycerides ($p<0.05$), and creatinine ($p<0.01$) was significantly decreased with increasing levels of PLP. Whereas, serum HDL-C values were increased significantly ($p<0.05$) with an increase in PLP level in the diet. Live weight, carcass weight, and dressing percentage were significantly ($p<0.05$) increased with increasing levels of PLP. Mean scores of sensory evaluations for all the parameters (color, flavor, juiciness, tenderness, and overall acceptability) of meat were increased significantly ($p<0.05$) at 3.0% PLP when compared with the other treatment groups. It is concluded that PLP can safely be incorporated up to a 3.0% level in the diet without any adverse effect on the meat quality of quail.

KEYWORDS: *J.Quail*, Meat quality, Pepper mint, Serum cholesterol, Sensory attributes

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INTRODUCTION

Increase in awareness about consumption of animal protein and increase affordability of the consumers make them to seek for variety of protein sources made the expansion of the quail farming to meet the demands of the consumers. Quail farming was increased 1.8 folds in last decade (Silva et al., 2017) due to its hardy nature, lesser the space requirement and early production, and it was fetching economically important on different continents (Abou-Elkhair et al., 2020). Meat and eggs from quail are rich in antioxidants, proteins, minerals, and numerous vitamins (Bao et al., 2020). As per NRC (1994) Quails need more protein in diet than chicken. Increased demand for protein sources, there is need to check for an alternative which available locally with higher protein percentages.

Mentha piperita (Lamiaceae), commonly known as peppermint (mint) is an aromatic perennial herb that contains large amounts of menthol (25-78%), menthone (14-36%) and iosmenthone (1.5-10%) menthyl acetate (2.8-10%) and cineol (3.5-14%) reported by Beigi et al., 2018). But this chemical composition of peppermint leaves may vary with geographical region, plant maturity, and processing conditions. Incorporation of peppermint leaf meal retard lipid oxidation in meat (Ghazaghi et al., 2014) and improve the lipid profile of blood in favor of decreasing total cholesterol and triglycerides in laying hens (Ghazaghi et al., 2014; Wareth and Lohakare, 2014). Very limited data is available on practical usage of peppermint ingredients in poultry nutrition in broilers and layers. Scientific documentation on feeding different levels of

Peppermint Leaf Powder in diets of quails and quality of meat is very limited. Hence, the present study aimed to evaluate the effects of feeding varying levels of Peppermint Leaf Powder on Japanese quail's lipid profile and carcass traits.

MATERIALS AND METHODS

Experimental design

One hundred and fifty day-old Japanese quail chicks were weighed individually wing banded and randomly divided into five equal groups of three replicates each with 10 chicks / per replicate. Each group of quail was allotted to one of the dietary treatments at random. The experiment was conducted from 0-5 weeks of age.

Management and feeding

All the Quail chicks were housed in 4-tier battery cages throughout the experiment. Feed and water were provided *ad libitum*. Experiment diets were prepared with the incorporation of Peppermint Leaf Powder at 0% (T1: control), 0.75% (T2), 1.5% (T3), 2.25% (T4), and 3.0% (T5) levels by marginal adjustment of other feed ingredients. All the rations (Table1) were made iso-caloric and iso-nitrogenous (NRC 1994).

Table 1. Ingredient and nutrient composition of experiment diets incorporated with Peppermint leaf powder at varying levels fed to Japanese Quails.

Ingredients (kg) / PLP(%)	T1 (0%)	T2 (0.75%)	T3 (1.5%)	T4 (2.25%)	T5 (3.0%)
Maize	51.50	51.10	50.60	50.10	49.55
Soybean meal	38.60	38.60	38.40	38.20	38.00
Deoiled Rice Bran	6.90	6.50	6.47	6.4	6.4
Peppermint leaf powder	0.00	0.75	1.5	2.25	3.00
Stone grit	1.30	1.35	1.32	1.33	1.32
Salt	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.10	0.10	0.11	0.12	0.13
DL-Methionine	0.05	0.05	0.05	0.05	0.05
Di-calcium phosphate	0.8	0.8	0.8	0.8	0.8
Trace minerals*	0.15	0.15	0.15	0.15	0.15
Coccidiostat	0.05	0.05	0.05	0.05	0.05
Vitamins#	0.01	0.01	0.01	0.01	0.01
Total	100.00	100.00	100.00	100.00	100.00
Nutrient composition of the diets (Analysed)					
Crude protein(%)	23.86	23.90	24.13	24.21	24.30
ME (Kcal/kg)	2910	2897	2909	2909	2901
Calcium (%)	0.81	0.82	0.84	0.87	0.88
Total Phosphorus(%)	0.48	0.51	0.49	0.50	0.49

* Manganese sulphate 55000 mg, Ferrous sulphate 50000mg, zinc sulphate 50000mg, cobalt sulphate 500 mg, copper sulphate 3000mg, potassium Iodide 3000 mg, sodium selenite 500 mg in 1 Kg.

Vitamin A-12.50 MIU, D_3-2.50 MIU, E-8g, K-1.50g, B_1-1g, B_2-5g, B_6-1.50g, B_{12}-0.02g, Calcium D Pantothenate-5g, Folic acid-0.25g, Niacin-12g in a 250g pack.

Feed and water were provided *ad libitum*. Peppermint leaf was procured from local market and shade dried and powdered. Chemical composition of PPL was presented in table 2.

Table 2. Chemical composition (DM basis) of Pepper mint leaf powder

Nutrient	Composition (%)
Dry matter	90.5
Organic matter	86.9
Crude protein	17.9
ME (kcal/kg) *	3059
Ether extract	2.31
Crude fibre	14.3
Nitrogen free extract	50.5
Total ash	13.0
Acid insoluble ash	5.81
Calcium	0.04
Total Phosphorus	0.32

The experiment was conducted as per the institutional animal ethics committee guidelines.

Serum biochemical profile

Blood samples were collected from two birds/ replicate at the end of the experiment into anticoagulant-free vials and allowed to clot so that the serum got separated. The separated serum was then made clear by centrifugation at 3000 rpm for 10 minutes and stored in a refrigerator at -20! for the estimation of serum parameters. Serum total proteins and albumin were estimated and globulin was calculated by subtracting obtained albumin values from obtained total protein values (M/s. Coral clinical systems-kit). Serum cholesterol, Serum triglycerides, HDL and LDL cholesterol, SGOT, SGPT, calcium phosphorus, BUN, and Creatinine were estimated by using diagnostic kits (M/s. Erba kit).

Carcass characteristics

At the end of the trial period (5^{th} week), two birds per replicate and thus a total of six birds per treatment were randomly selected, weighed, and slaughtered by neck incision Individual weights of the eviscerated carcass (*i.e.*, carcass yield) and edible organs like liver, heart, and gizzard were collected and weighed. Thus relative weights (% of live body weight at slaughter) of carcass yield plus total edible organs were calculated.

Meat quality

pH: pH of the meat sample was determined by following the method of Trout et al. (1992) using a deluxe digital pH meter (model 101E).

Extract release volume and Water holding capacity were assessed.

$$\text{Water holding capacity (\%)} = \frac{\text{Area of expressed water x100}}{\text{Area of pressed meat sample}}$$

Sensory evaluation of meat

The meat samples were cooked and subjected to ten member taste panel for sensory evaluation of color, appearance, flavor, juiciness, tenderness, and overall acceptability on a nine-point Hedonic scale.

STATISTICAL ANALYSIS

Statistical analysis of the data was carried out according to the procedures suggested by Snedecor and Cochran (1989). The data obtained were subjected to one-way ANOVA. Differences between means were tested at the 5% probability level using Duncans, (1955) LSD test.

RESULTS AND DISCUSSION

Serum biochemical profile

The mean serum total protein (g/dl) did not show any significant difference among the treatment groups in this study (Table.3). Similarly, Dosti et al. (2014), Khursheed et al. (2017) and Witkowaska et al. (2019), reported that PLP had no significant effect on serum total protein in broilers. On contrary, Mahbuba et al. (2013) and Measem et al. (2020) reported that serum total protein was significantly (P<0.05) increased at 2% of PLP in broilers. Ameri et al. (2016) reported that serum total protein was significantly (p<0.05) increased at 1% PLP in broilers. The mean serum albumin (g/dl) did not show any significant difference among the treatment groups in this study (Table.3). Similarly, Galib.

(2010) reported that PLP had no significant effect on serum albumin in broilers. On contrary, Ameri et al. (2016) and Witkowaska et al. (2019) reported that serum albumin was significantly (P<0.05) increased at 1% PLP in the diets of broilers.

The mean serum globulin (g/dl) did not show any significant difference among the treatment groups in this study (Table.3). Similarly, Galib. (2010) reported that PLP had no significant effect on serum globulin in broilers. On contrary, Ameri et al. (2016) and Witkowaska et al. (2019) reported that serum globulin was significantly (P<0.05) increased at 1% PLP in broilers. Measem et al. (2020) reported that serum globulin was significantly (P<0.05) increased at 2% PLP in broilers. The present study revealed that incorporation of varying levels (0, 0.75, 1.50, 2.25, and 3.0%) of PLP in quails showed no significant difference (P>0.05) in A/G ratio (Table 3). The present study values ranged between 0.65 to 0.74. The obtained values were within the normal range (Agina et al., 2017).

Table 3. Mean (±S.E) serum biochemical profile of Japanese quail fed with varying levels of PLP from day old to five weeks.

Treatment/ PLP (%)	Serum Total protein (g/dl)	Serum albumin (g/dl)	Serum globulin (g/dl)	A/G ratio
T1 (0%)	6.77±0.50	2.88±0.21	3.89±0.20	0.74±0.014
T2 (0.75%)	6.27±0.45	2.45±0.19	3.81±0.32	0.65±0.05
T3 (1.50%)	5.75±0.26	2.40±0.19	3.34±0.14	0.72±0.05
T4 (2.25%)	6.77±0.66	2.85±0.30	3.92±0.36	0.72±0.01
T5 (3.00%)	6.55±0.31	2.73±0.15	3.81±0.16	0.71±0.01
SEM	0.20	0.09	0.12	0.01
n	6	6	6	6
p	0.500	0.397	0.575	0.529

Table 4. Effect of dietary inclusion of PLP at varying levels on total cholesterol, HDL-C, LDL-C, VLDL-C and triglycerides content in serum (mg/dl) of Japanese quails from day old to five weeks of age.

Treatment/ PLP (%)	Serum Total Cholesterol (mg/dl)	Serum HDL-C (mg/dl)	Serum LDL-C (mg/dl)	Serum VLDL-C (mg/dl)	Serum Triglycerides (mg/dl)
T1 (0%)	$193.7^{a}\pm0.96$	$91.7^{c}\pm2.13$	$70.6^{a}\pm2.38$	$31.3^{a}\pm0.31$	$156.5^{a}\pm1.56$
T2 (0.75%)	$191.3^{ab}\pm1.09$	$94.2^{bc}\pm1.87$	$66.2^{ab}\pm1.71$	$30.9^{a}\pm0.32$	$154.8^{a}\pm1.62$
T3 (1.50%)	$188.1^{b}\pm1.18$	$96.1^{abc}\pm1.72$	$61.7^{b}\pm1.83$	$30.3^{ab}\pm0.34$	$151.6^{ab}\pm1.70$
T4 (2.25%)	$181.1^{c}\pm2.22$	$98.1^{ab}\pm1.69$	$53.2^{c}\pm3.09$	$29.6^{bc}\pm0.41$	$148.2^{bc}\pm2.08$
T5 (3.00%)	$177.0^{c}\pm2.31$	$100.5^{a}\pm1.88$	$47.5^{c}\pm3.32$	$28.8^{c}\pm0.38$	$144.4^{c}\pm1.93$
SEM	1.35	0.96	1.89	0.22	1.10
p	0.000	0.026	0.000	0.000	0.000
n	6	6	6	6	6

Values in column bearing different super scripts differ significantly ** (p<0.01), * (p<0.05), NS (p>0.05)

Serum lipid profile

The present study indicated that there was a significant (P<0.01) decrease in serum cholesterol (mg/dl) level (Table 4) with an increase in the level of PLP from 0 to 3.0% in the diet of Japanese quails, Similarly Mahbuba et al. (2013), Dosti et al. (2014) and Ameri et al. (2016) in broilers reported that PLP at various level in the diets resulted in decreased (P<0.05) serum total cholesterol content (mg/dl) as compared to the control. Mehri et al., 2015 in Japanese quails showed that in comparison with controls, the concentrations of total cholesterol were significantly (P<0.05) decreased in birds that received graded levels of dietary peppermint. However, Khursheed et al. (2017) reported there was no effect on serum cholesterol concentration in broilers with supplementation of PLP at 1 and 2% levels in the diet.

Table 5. Effect of dietary inclusion of PLP at varying levels in diet of *J. quails* from day old to five weeks of age on serum parameters

Treatment/ PLP (%)	SGOT (AST) (IU/L)	SGPT (ALT) (IU/L)	Serum Calcium (mg/dl)	Serum Phosphorus(mg/dl)	Serum BUN (mg/dl)	Serum Creatinine (mg/dl)
T1 (0%)	246.14 ± 2.85	23.92 ± 0.58	8.02^{b}±0.31	6.85±0.53	2.17 ± 0.14	0.45^{a} ± 0.02
T2 (0.75%)	245.87 ± 1.25	23.65 ± 0.56	8.88^{a}±0.18	6.71±0.47	2.03 ± 0.13	0.42^{ab} ± 0.02
T3 (1.50%)	245.22 ± 2.49	23.50 ± 0.87	8.99^{a}±0.17	7.24±0.54	1.95 ± 0.12	0.40^{abc} ± 0.02
T4 (2.25%)	244.89 ± 2.44	23.38 ± 0.81	8.11^{b}±0.29	6.66±0.39	1.87 ± 0.08	0.37^{bc} ± 0.03
T5 (3.00%)	244.36 ± 3.53	23.21 ± 0.72	8.10^{b}±0.10	6.74±0.56	1.82 ± 0.06	0.34^{c} ± 0.01
SEM	0.30	0.05	0.12	0.21	1.09	0.01
p	0.169	0.264	0.009	0.928	0.127	0.000
n	6	6	6	6	6	6

Values in column bearing different super scripts differ significantly ** (p<0.01), * (p<0.05).

There was a significant (P<0.05) increase in serum HDL-C level (Table 4) with an increase in the level of PLP from 0 to 3.0% in the diet of Japanese quails, Similarly Mehri et al. (2015) in Japanese quails and Ameri et al. (2016) in broilers reported that PLP at various level in the diets resulted in a significant increase in (p<0.05) serum HDL-C content (mg/dl) as compared to the control.However, Toghyani et al. (2010) and Dosti et al. (2014) reported there was no effect on serum HDL-C concentration in broilers with supplementation of PLP in the diet. The present study indicated that supplementation of PLP causes a significant (P<0.01) decrease in serum LDL-C (mg/dl) level (Table 4) with an increase in the level of PLP from 0 to 3.0% in the diet of Japanese quails, Similarly Mahbuba et al. (2013), Dosti et al. (2014) and Ameri et al. (2016) in broilers reported that PLP at various level in the diets resulted in decreased (P<0.05) serum LDL-C content (mg/dl) as compared to the control. Mehri et al. (2015) in Japanese quails showed that in comparison with controls, the concentrations of LDL-C were significantly (P<0.05) decreased in birds that received graded levels of dietary peppermint.However, Toghyani et al. (2010) reported there was no effect on serum LDL-C concentration in broilers with supplementation of PLP at various levels in the diet.

The present study indicated that with the supplementation of PLP there was a significant (P<0.01) decrease in serum VLDL-C (mg/dl) level (Table 3) with an increase in the level of PLP from 0 to 3.0% in the diet of Japanese quails. Similarly, Ameri et al. (2016) in broilers reported that PLP at various levels in the diets resulted in decreased ($p<0.05$) serum VLDL-C content (mg/dl) as compared to the control. The present study indicated that increasing the level of supplementation of PLP in the diet had resulted in significant ($P<0.01$) decreased serum triglyceride content (mg/dl) of quails (Table 3) from 0 to 3.0 % of PLP in the diet.The results obtained in the present study agree with those of Dosti et al. (2014) and Ameri et al. (2016), who reported a significant decrease in ($P<0.05$) serum triglyceride concentration in broiler chicken with supplementation of PLP at 25g/kg and 1% respectively, in the diet.However, Toghyani et al. (2010) reported no effect ($P>0.05$) on serum triglyceride content in broiler chicken with supplementation of PLP at 0 to 8g/kg diet as compared to those fed control diet.

Results indicate that peppermint leaf powder had anti-lipidemic benefits. The decrease of serum total cholesterol, LDL cholesterol, and total triglycerides in the treatment group might have been proving that the active principle in PLP i.e. excess cholesterol protection mechanisms. This decrease in serum total cholesterol content might be due to the inhibition of HMG-COA reductive activity, which is a key regulatory enzyme in cholesterol synthesis (Mesbahzadeh et al., 2015).

Liver enzymes

Supplementation of PLP up to 3.0% level in the diet had no effect ($P>0.05$) on serum SGOT content (IU/L) of quails as compared to the control (Table 5). Corroborating the findings of the present study, Mehri et al. (2015) in Japanese quails reported that supplementation of PLP up to 40g/kg diet had no effect ($P>0.05$) on serum SGOT concentration when compared to those in the control group. Toghyani et al. (2010) and Khursheed et al. (2017) in broilers also reported similar findings that supplementation of PLP in diet had no effect ($P>0.05$) on serum SGOT concentration when compared to those in the control group.

Table 6. Mean (±S.E) carcass traits of Japanese quail fed with varying levels of PLP from day old to five weeks.

Treatment/ PLP(%)	Pre slaughter live weight(g)	Liver weight (g)	Heart weight (g)	Gizzard weight (g)	Giblet weight (g)	Carcass weight (g)	Dressing percentage
T1 (0%)	176.5^{c}±2.96	4.25±0.4	1.99±0.06	3.88±0.39	10.1±0.79	102.3^{d}±2.01	63.7^{b}±0..99
T2 (0.75%)	184.6^{b}±0.4	4.47±0.3	1.85±0.08	3.98±0.13	10.3±0.48	109.3^{c}±1.69	64.8^{b}±1.23
T3 (1.50%)	185.6^{b}±2.34	4.11±0.4	1.83±0.13	4.44±0.42	10.3±0.94	115.3^{b}±1.43	67.7^{a}±0.92
T4 (2.25%)	195.8^{a}±1.13	4.70±0.65	1.69±0.14	4.30±0.29	10.6±0.97	125.0^{a}±0.60	69.3^{a}±0.56
T5 (3.0%)	197.5^{a}±1.17	3.77±0.50	1.74±0.09	4.53±0.20	10.0±0.71	129.0^{a}±1.36	70.4^{a}±0.51
SEM	1.63	0.21	0.05	0.13	0.33	1.93	0.60
n	6	6	6	6	6	6	6
p	0.000	0.724	0.392	0.518	0.983	0.000	0.000

Values in column bearing different super scripts differ non-significantly *($p<0.05$), **($p<0.01$)

Supplementation of PLP up to 3.0% level in the diet had no effect (p>0.05) on serum SGPT content (IU/L) of quails as compared to the control (Table 4). Corroborating the findings of the present study, Toghyani et al. (2010) and Khursheed et al. (2017) in broilers also reported similar findings that supplementation of PLP in diet had no effect (P>0.05) on serum SGPT concentration when compared to those in the control group. However, Mehri et al. (2015) in Japanese quails reported that supplementation of PLP up to 40g/kg diet showed lower SGPT values (p<0.001) in PLP-supplemented groups than in negative control.

The liver is reported to contain enzymes like SGOT and SGPT, it releases these enzymes into the bloodstream when damaged (Sherwin, 2003). Elevation of serum SGOT and SGPT can occur with states of altered hepatocellular membrane permeability either due to circulatory hypoxia, exposure to toxins and toxemia, inflammation, metabolic disorders, or proliferation of the hepatocyte. Further, in the stunting syndrome of broiler chickens, increased activities of SGOT and SGPT were also associated with liver and intestinal damage (Rani et al., 2011). Thus, no effect (P>0.05) on SGOT and SGPT levels in the present study may collectively reflect the normal liver and intestinal functions of chickens fed diets supplemented with PLP. This further indicates that PLP supplementation in diets did not have a detrimental effect on Japanese quail's health.

Serum calcium and phosphorus (mg/dl)

Supplementation of PLP up to 3.0% in the diet of quails showed that significant (P<0.01) increase in serum calcium content (Table 5) up to 1.50% of PLP in the diet. The serum calcium content ranged from 8.02 to 8.99 mg/dl among different treatments. Corroborating the results, many researchers reported that feeding herbs and spices *viz.* Black pepper (Divya, 2017), Coriander (Reddy, 2017), and Fenugreek (Vamsidhar, 2015) as natural feed additives in the diet of quails resulted in increased serum calcium content.In contradiction, to the results observed in the present study, Deepthi (2018) reported that the inclusion of ajwain powder up to 1.0% level in the diet of Japanese quails had no effect (P>0.05) on serum calcium content. Priyanka (2017) also reported similar findings upon feeding cinnamon powder into the diet of Japanese quails.

The present study revealed that supplementation of PLP up to 3.0% in the diet of quails had no effect (P>0.05) on serum phosphorous content (Table 5). However, in contrast to the findings of the present study, many researchers reported that feeding herbs and spices *viz.* Black pepper (Divya, 2017), Cinnamon (Priyanka, 2017), Coriander (Reddy, 2017), Fenugreek (Vamsidhar, 2015), and Garlic powder (Bhavani, 2018) as natural feed additives in the diet resulted in increased serum phosphorous content in Japanese quails.

Serum creatinine (mg/dl)

The present study indicated that increasing the level of supplementation of PLP from 0 to 3% shows a significant reduction (P<0.01) in serum creatinine content (mg/dl) value ranging from 0.34 to 0.45 mg/dl. (Table 5). In contradiction to the present findings, Measem et al. (2020) reported that broilers supplemented with PLP up to 3% in the diet, showed there was no statistical difference in levels of creatinine in broiler serum between treatments. Creatinine is a waste molecule that is generated from protein metabolism. Normal values of creatinine suggest a good function of nephrons. Significant increases in serum creatinine levels are indicative of nephrotoxicity in broiler chickens (Huff et al., 1988). Thus, no effect (P>0.05) on serum creatinine content observed in the present study indicated that there was no adverse effect on kidney health in terms of filtration rate when supplemented with PLP up to 3.0% level in the diet of Japanese quails.

Carcass traits

Significant increase in body weights was observed with an increase in supplementation of PLP in diets of quails. Zargari. (2002) reported that adding herbal plants, stimulates appetite, by increasing the secretion of gastrointestinal fluids and improves digestion and absorption, ultimately improving body weight. Whereas, feeding varying levels (0, 0.75, 1.50, 2.25, and 3.0%) of PLP showed no significant effect (p>0.05) on liver, heart, gizzard, and giblet weight in quails (Table 6). These findings corroborated with those of Khursheed et al. (2017) who fed broilers with PLP at 2%. Similarly, Ahmed et al. (2019) and Petricevic et al. (2021) in broilers observed no effect (P>0.05) on liver weight upon feeding PLP at different levels.In contrast in broilers, PLP was incorporated by Galib. (2010) at 1.5%, Mahbuba et al. (2013) at 2%, and Nematollah et al. (2017) at 1.5 to 6g/kg and reported that there was a significant (p<0.05) increase in liver weight.

Carcass weight (g) showed a significant (P<0.01) increase with the increase in PLP level (0.00, 0.75, 1.50, 2.25, and 3.0%) when compared with control (Table.6). Higher carcass weights were observed at 3% level and lower carcass weights observed in the control group. On the other hand, Ocak et al. (2008), Aminzade et al. (2012), and Petricevic et al. (2021) observed no significant difference (P>0.05) in carcass weight in broilers when fed with PLP. In the present study, feeding varying levels (0, 0.75, 1.50, 2.25, and 3.0%) of PLP showed a significant effect (P<0.01) on dressing percentage in quails (Table. 6). The results were similar to observations of Galib. (2010), Mahbuba et al. (2013) and Nematollah et al. (2017) in broilers who reported a significant increase (P<0.05) in dressing percentage when fed with PLP at 1%, 2%, and 4.5g/kg respectively. In contradiction, Khursheed et al. (2017), Ahmed et al. (2019) and Petricevic et al. (2021) showed that PLP had no significant effect (P>0.05) on dressing percentage in broilers.

Meat quality parameter

The present study revealed that incorporation of PLP up to 3.0% in the diet had no effect on pH, extract release volume, and water holding capacity of meat in quails (Table 6). The pH ranged from 5.41 to 6.25. This is within the normal range. The results were similar to the findings of Mehri et al. (2015) and Ahmed et al. (2019) who reported a non-significant difference (P>0.05) when PLP was included in the diets of broilers.

Table 7. Mean (±S.E) meat pH, ERV and WHC of Japanese quail fed with varying levels of PLP from day old to five weeks.

Treatment/ PLP (%)	pH	ERV	WHC
T1 (0%)	6.25±0.53	20±0.40	23.3±0.14
T2 (0.75%)	6.10±0.38	21±0.60	23.1±0.34
T3 (1.50%)	5.41±0.30	20±0.40	23.1±0.34
T4 (2.25%)	5.41±0.30	20±.040	23.4±0.04
T5 (3.00%)	5.42±0.29	21±0.60	24.3±0.86
SEM	0.36	0.56	0.34
n	6	6	6
p	0.217	0.116	0.497

Values in column bearing different super scripts differ significantly **(P<0.01) NS -Non Significant

Sensory evaluation of meat

Sensory parameters are important that make purchase decision of meat products (Font-i-Furnols and Guerrero, 2014). The mean sensory evaluation scores of Japanese quail meat were significantly (P<0.05) increased in treatment groups about color, flavor, juiciness, tenderness, and overall acceptability (Table 7) over the control group in this study.

Table 8. Mean (±S.E) sensory evaluation of meat of Japanese quail meat fed with PLP at different levels from 0-5 weeks of age.

Treatment/ PLP (%)	Colour	Flavour	Juiciness	Tenderness	Overall Acceptability
T1(0%)	$7.44^{c}\pm0.18$	$8.22^{b}\pm0.15$	$7.56^{b}\pm0.18$	$7.89^{c}\pm0.11$	$8.22^{c}\pm0.15$
T2(0.75%)	$7.78^{bc}\pm0.15$	$8.33^{b}\pm0.17$	$7.67^{b}\pm0.17$	$8.11^{bc}\pm0.11$	$8.56^{b}\pm0.18$
T3(1.50%)	$7.67^{bc}\pm0.17$	$8.33^{b}\pm0.17$	$7.89^{ab}\pm0.11$	$8.00^{bc}\pm0.00$	$8.33^{b}\pm0.17$
T4(2.25%)	$8.00^{ab}\pm0.17$	$8.56^{ab}\pm0.18$	$8.00^{ab}\pm0.17$	$8.33^{ab}\pm0.17$	$8.56^{ab}\pm0.18$
T5(3.00%)	$8.22^{a}\pm0.15$	$8.89^{a}\pm0.11$	$8.22^{a}\pm0.15$	$8.44^{a}\pm0.18$	$8.89^{a}\pm0.11$
SEM	0.08	0.08	0.09	0.06	0.08
n	6	6	6	6	6
p	0.012	0.021	0.041	0.039	0.021

Values in column bearing different super scripts differ significantly *(p<0.05) **(p<0.01).

The highest score for overall acceptability was recorded in T_5 in this study. Similarly, Cetingul et al., 2016 in layer quail meat PLP up to 5% in diet , Toghyani et al. (2010) in broiler meat at 8g/kg of PLP in the diet. On contrary**,** Khursheed et al. (2017) in broilers reported that PLP had no significant effect on sensory evaluation scores.

CONCLUSION

Based on the results obtained from the present study it can be concluded that PLP can be used as feed additive up to 3% level in diets of *J. Quails* for the production of low cholesterol and highly acceptable meat without having any adverse effects on the health of quails. More detailed studies are still needed to elucidate the mode of action and optimum levels of peppermint ingredients on nutritional and physiological response of quails under various circumstances.

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