The Effects of Dietary Olive Cake Meal on Fattening Performance, Carcass and Slaughter Traits in Japanese Quails (Coturnix coturnix japonica)

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A B S T R A C T

This study was aimed at investigating the effects of dietary supplementation with different levels of olive cake meal (0%, 2.5%, 5% and 7.5%) on the fattening performance and slaughter and carcass traits of quails. For this purpose, 400 one-day-old Japanese quail chicks were randomly assigned to 4 groups, each with 5 replicates. The quails were fed on either a basal diet alone (Control Group) or a basal diet supplemented with olive cake meal at rates of 2.5% (Group I), 5% (Group II) and 7.5% (Group III) for a period of 42 days. At the end of the fattening period, dietary olive cake meal was observed not to have caused any adverse effect on body weight, feed intake and feed conversion rate. Eviscerated hot carcass weight, eviscerated cold carcass weight, wing weight, breast weight, thigh weight and edible visceral organ weights were determined to have improved in the treatment groups that received dietary olive cake meal, when compared to the control group. In conclusion, dietary supplementation with olive cake meal, a waste product of the olive oil industry, at a level of 5%, was observed to produce the closest and most similar results to those of feeding on the basal diet. Thus, it is suggested that olive cake meal could be used as an alternative feedstuff for poultry. Furthermore, the use of olive cake meal as an alternative feedstuff would contribute to reducing both feed costs and environmental pollution.

Introduction

Olive trees, which are classified under the family Oleaceae, are considered an important species. The major olive production sites in Turkey are the Aegean, Marmara, Mediterranean and Southeastern Anatolia regions. The number of olive trees within the territory of Turkey has steadily increased between 1988-2019 and has reached a total number of 182,076,000. In 2019, the amount of table olives and olive oil produced from 154,037,000 fruit-bearing olive trees were 415,000 tonnes and 1,110,000 tonnes, respectively.

Olive oil production results in two types of end-products, which are fluid and solid wastes. Fluid wastes are referred to as black water or wash water. Solid waste resulting from the crushing of olives is referred to as pomace and is comprised of the pit, skin and pulp of olives. Olive processing generates approximately 35-45% of dry pomace. There are 3 types of pomaces with different water content. Pomace is of economic value and is generally used as a fuel. On the other hand, pomace is also reported to be used as a feedstuff for cattle and as a fertilizer for soil (Amici et al., 1991; Weinberg et al., 2008; Ghasemi et al., 2014). Thus, wet olive cake, generated as an end-product of olive oil production, once processed, serves as a valuable and valuable material for use in sustainable and/or organic animal production, given its natural origin and harmlessness to human health.

Olive cake meal contains a high level of cellulose as well as tannin and phenolic compounds. Olive cake meal is also known to be rich in essential fatty acids, including oleic acid, linoleic acid, palmioteic acid and linolenic acid (El-Hachemi et al., 2007; Dalkılıc, 2018). Reports have been published, which suggest that dietary supplementation with even small amounts of olive cake meal improves both production yields and product quality.
in milk- and meat-type cattle, sheep and goats (Chiofalo et al., 2004; Sadeghi et al., 2009; Ozdoğan et al., 2017; Cibik et al., 2016; Dalkılıç, 2018). Furthermore, several studies have been carried out to investigate the effects of olive oil industry by-products, namely olive leaves, black water and olive pomace on broiler chicken and laying hen performance (Zangeneh and Torki, 2011; Zarei et al., 2011; Ozdemir and Azman, 2013; Cayan and Erener, 2015; Tuzun and Unlu, 2016; Ibrahim et al., 2018).

This study was aimed at determining the effects of dietary supplementation with olive cake meal, an olive oil by-product, on the fattening performance of quails, and thereby, at investigating the possible use of olive cake meal as a feedstuff for poultry. In this context, the present study is expected to contribute to both reducing feed costs, which constitute three-quarters of poultry production expenses, and assessing alternative feedstuffs.

**Materials and Methods**

This study was approved by the Ethics Board for Scientific and Academic Research and Publications of Siirt University, and conducted pursuant to the 27/03/2019 dated and 2019/01 numbered decision of the Board. Fertilized eggs, supplied from the Application and Research Centre for Wildlife Conservation and Rehabilitation of Siirt University, constituted the study material. The fertilized eggs were placed in an incubator at the Centre from which they were supplied, and the hatching of chicks was achieved at the end of a 17-day-incubation period. Hatching chicks were examined macroscopically, and those confirmed to have a healthy body structure were weighed individually to determine their hatching weight. These chicks were randomly assigned to the study groups.

**Study Groups and Feed Composition**

In this study, 400 one-day-old Japanese quail chicks (Coturnix coturnix japonica) were randomly assigned to 4 study groups, each with 5 replicates of 20 animals. A chick starter feed (basal diet) and olive cake meal (OCM) were used to feed the chicks (Table 2). The control group received the basal diet alone, whilst Groups I, II and III were fed on the basal diet supplemented with 2.5%, 5% and 7.5% of OCM, respectively. The quails were fed for a period of 42 days.

Feed was prepared on a weekly basis, and the animals were provided with ad libitum feed. Throughout the study period, the drinkers and feeders were checked twice a day, and were cleaned and replenished as required.

The diets were formulated to be isocaloric and isonitrogenous, according to nutritional values published by the National Research Council (NRC) (1994). Dry matter, crude ash, crude protein and crude fat analyses were performed according to the official analysis methods of the Association of Official Analytical Chemists (AOAC) (1990), whilst crude cellulose levels and metabolic energy (kcal/kg) were determined as described by Crampton and Maynard (1983) and Larbier and Leclercq (1994), respectively (Table 1).

**Determination of Fattening Performance**

The weekly live weights of the animals were determined by individually weighing the quails each week on a precision balance accurate to 0.01 g. Weightings were performed between weeks 0-6. The weightings performed in the third week were also categorized for sex (male, female). Sex determination was based on the breast plumage colouration of the quails. Quails with speckled breast feathers were identified as female, whilst quails with brown breast feathers were identified as male.

**Determination of Feed Intake and Feed Conversion Rates**

The feed intake of each group was determined on a weekly basis. Weekly feed intake was calculated by subtracting the amount of feed remaining in the feeders from the amount of feed provided to the animals. The feed conversion rate was calculated by dividing the feed intake by the body weight gain.

**Determination of Slaughter Traits**

For the purpose of determining the slaughter traits, 30 females and 30 males were selected from each group, based on their mean live weights in week 6. Accordingly, a total of 120 (30×4) females and 120 (30×4) males were slaughtered. The slaughter traits investigated in this study included the body weight at slaughter, eviscerated hot carcass weight, liver weight, heart weight and gizzard weight. After the whole carcass was stored at +4°C for 24 h, the eviscerated cold carcass weight was determined. The whole eviscerated cold carcasses were cut into four parts, including the thigh, wing, breast and back+neck. After these parts were cut, the thigh, breast, wing and back+neck weights were also determined.

Calculation of percentage values for the slaughter and carcass traits of the study groups:

\[
\text{Hot carcass yield} = \frac{\text{Hot carcass weight (g)}}{\text{Slaughter weight (g)}} \times 100
\]

\[
\text{Thigh percentage} (%) = \frac{\text{Thigh weight}}{\text{Eviscerated cold carcass weight}} \times 100
\]

\[
\text{Breast percentage} (%) = \frac{\text{Breast weight}}{\text{Eviscerated cold carcass weight}} \times 100
\]

\[
\text{Wing percentage} (%) = \frac{\text{Wing weight}}{\text{Eviscerated cold carcass weight}} \times 100
\]

\[
\text{Back+neck percentage} (%) = \frac{\text{Back + neck weight}}{\text{Eviscerated cold carcass weight}} \times 100
\]

\[
\text{Liver percentage} (%) = \frac{\text{Liver weight}}{\text{Slaughter weight}} \times 100
\]

\[
\text{Heart percentage} (%) = \frac{\text{Heart weight}}{\text{Slaughter weight}} \times 100
\]

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\text{Gizzard percentage} (%) = \frac{\text{Gizzard weight}}{\text{Slaughter weight}} \times 100
\]

**Statistical Analyses**

Data obtained from the study groups was analysed with the IBM SPSS Statistics 22 software package. Whether or not the mean values of the groups differed from each other was analysed with one-way analysis of variance (one-way ANOVA). Differences between the study groups were determined with Duncan’s multiple range test.
Table 1. The composition and nutrient content (%) of the basal diet

| Feedstuffs                  | Feed Additives | %     | %     |
|-----------------------------|----------------|-------|-------|
| Maize                       | Methionine     | 49    | 0.27  |
| Soybean Meal                | Salt           | 33.4  | 0.16  |
| Whole-fat Soybean           | Sodium Sulphate| 4     | 0.11  |
| Bonkalite                   | Mineral Premix  | 4     | 0.01  |
| Sunflower Seed Meal         | Vitamin Premix  | 2.5   | 0.01  |
| Chicken Meal                | Threonine      | 2.5   | 0.07  |
| Marble Powder               | Toxin Binder   | 1.45  | 0.1   |
| Soybean Oil                 | Choline Chloride| 1.08 | 0.05  |
| Monocalcium phosphate (MCP) |                | 0.7   | 0.07  |
| Lysine Sulphate             |                | 0.34  |       |

| Nutrient Content Determined by Analysis |       |
|----------------------------------------|-------|
| Dry Matter %                           | 91.28 |
| Crude Ash %                            | 4.75  |
| Crude Fat %                            | 5.39  |
| Crude Protein %                        | 20.69 |
| Crude Cellulose %                      | 3.33  |
| Starch %                               | 35.65 |
| Ca %                                   | 0.77  |
| P %                                    | 0.48  |
| Sugar %                                | 8.50  |
| Metabolic Energy, kcal/kg**            | 2914.80 |

1 kg of the premix contained 15,000,000 IU of Vitamin A, 5,000,000 IU of Vitamin D3, 100,000 mg of Vitamin E, 3000 mg of Vitamin K3, 5000 mg of Vitamin B1, 8000 mg of Vitamin B2, 60,000 mg of niacin, 15,000 mg of D-calcium pantothenate, 5000 mg of Vitamin B6, 20 mg of Vitamin B12, 200 mg of D-biotin, 2000 mg of folic acid, and 100,000 mg of Vitamin C.

Table 2. The analysis results of the olive cake meal supplement

| Nutrient Content of Dry Matter (DM) | Analysis Results |
|-------------------------------------|------------------|
| Dry Matter %                        | 94.20            |
| Crude Ash %                         | 6.38             |
| Crude Fat %                         | 8.34             |
| Crude Protein %                     | 10.06            |
| Crude Cellulose %                   | 32.40            |
| Ca %                                | 0.89             |
| P %                                 | 0.17             |
| Sugar %                             | 0.91             |
| Metabolic Energy kcal/kg**          | 2535             |

Table 3. The body weight values of the quails in each study group (g)

| Week | Groups       | SEM | P   |
|------|--------------|-----|-----|
|      | Control      |     | 0.038 | 0.701 |
|      | Group I      | 8.99 | 8.90 | 0.038 | 0.701 |
|      | Group II     | 18.62 | 18.62 | 0.182 | 0.000 |
|      | Group III    | 36.62 | 36.62 | 0.393 | 0.000 |
| Initial Weight | 20.09 | 20.09 | 0.182 | 0.000 |
| Week 1 | 20.19 | 20.19 | 0.182 | 0.000 |
| Week 2 | 40.21 | 40.21 | 0.393 | 0.000 |
| Week 3 | 75.61 | 75.61 | 0.591 | 0.000 |
| Week 4 | 116.90 | 116.90 | 0.733 | 0.002 |
| Week 5 | 156.87 | 156.87 | 0.809 | 0.000 |
| Week 6 | 182.45 | 182.45 | 1.309 | 0.405 |

abc: Differences between means with different superscripts in the same row are significant (P<0.05).

Result and Discussion

The mean body weights determined throughout the study period for the study groups, which were given different levels of dietary olive cake meal, are presented in Table 3. While no statistically significant difference was observed between the groups for the mean initial weights, the mean body weights determined until the 6th week of the study differed significantly (P<0.01, P<0.001). The differences detected between the control group and Group III were particularly significant (P<0.001, P<0.01).

The body weight and body weight gain values of the male and female quails in each group are presented in Table 4. When compared for mean body weight, the differences observed in weeks 3 and 5 between the male and female quails of the control group and Group III, and in week 4 between the male quails in Group III and the quails in the other groups were statistically significant (P<0.001; P<0.01). In week 6, the male and female quails of the four study groups showed no difference for mean body weight. It was ascertained that the body weight gain
of the male quails between weeks 3-6 was significantly lower in the control group, when compared to Groups II and III (P<0.001).

The body weight gain, feed intake and feed conversion rate values of the study groups for the selected time periods are presented in Table 5. The study groups did not differ for body weight gain and feed intake (P>0.05). On the other hand, the feed conversion rates of the groups differed and body weight gain between weeks 0-3, and the control group showed significant differences in comparison to Groups I - III and Groups III, respectively (P<0.05).

**Slaughter and Carcass Traits**

The slaughter traits determined for the study groups at the end of the fattening period are presented in Table 6. The study groups differed for the mean values determined for eviscerated hot carcass weight (P<0.001), gizzard weight (P<0.05), and heart and gizzard percentages (P<0.01).

The comparison of the female quails in the study groups for slaughter traits revealed that no difference existed, except for the gizzard percentage (P<0.05) (Table 7). On the other hand, male quails significantly differed for body weight at slaughter (P<0.05), eviscerated hot carcass weight (P<0.01), heart weight (P<0.001), gizzard weight (P<0.05) and heart percentage (P<0.01).

The comparison of the study groups for the weights and percentages of the carcass parts demonstrated that, excluding those detected for the breast percentage, all differences were statistically significant (P<0.05, P<0.01, P<0.001) (Table 8).

While the female quails were determined to show statistically significant differences for wing weight, thigh weight (P<0.01) and thigh percentage (P<0.05), the male quails significantly differed for all carcass traits, excluding the thigh percentage (P<0.05, P<0.01, P<0.001) (Table 9).

Group III, which received 7.5% of dietary OCM, displayed lower mean body weight values during the first 5 weeks of the study, when compared to the control group and the other two treatment groups (2.5% and 5% of dietary OCM) (Table 3). In view of the crude cellulose content of OCM (32.40%) (Table 3), the body weight values of the quails in Group III, which were fed on a higher level of crude cellulose, being lower was considered normal. Similarly, in their study on the dietary supplementation of broiler chickens with different levels of olive pulp (0%, 2.5%, 5%, 7.5% and 10%), Rabayaa et al. (2001) reported that the body weight values of the chickens that received 10% of olive pulp were significantly lower throughout the 35 day-fattening period. However, in the present study, the groups did not show any statistically significant difference in week 6. It is known that the digestive tract of poultry species is short with respect to their body size, thus, their digestive capacity is limited and characterized by weak cellulose activity. Therefore, feed containing low amounts of cellulose are preferred to be used in poultry nutrition. However, in the present study, despite its high crude cellulose content (32.40%), olive cake meal did not cause any statistically significant difference for body weight between the control and treatment groups throughout the study period. This result agrees with several literature reports. Dietary supplementation with olive cake and olive mill wastes has been reported to cause statistically insignificant differences for mean body weight values in broiler chickens (Al-Harthi, 2016; El Hachemi et al., 2007). Similarly, in nutritional research conducted on various olive industry by-products, growth parameters have been reported not to be affected (Shafey et al., 2013). Differently, Hadi and Al-Khalisy (2018) reported that the mean weekly body weight values of broiler chickens increased directly proportional to the level of dietary olive oil supplementation.

**Table 4. The weekly body weight and body weight gain values of the male and female quails in each study group (g)**

| Groups | Week 3   | Week 4   | Week 5   | Week 6   |
|--------|----------|----------|----------|----------|
| Control F | 76.67<bc | 116.83<bc | 159.01<bc | 200.36<bc |
| Control M | 79.67<bc | 118.63<bc | 152.91<bc | 167.11<bc |
| Group I F | 72.53<bc | 114.04<bc | 157.32<bc | 198.10<bc |
| Group I M | 75.58<abc | 114.01<bc | 147.14<bd | 170.94<bc |
| Group II F | 74.55<abc | 115.14<bc | 157.63<bc | 194.78<bc |
| Group II M | 77.38<abc | 117.08<bc | 155.91<bc | 176.27<bc |
| Group III F | 70.81<c | 112.69<bc | 149.91<bd | 192.91<bc |
| Group III M | 65.56<cd | 106.99<bc | 145.90<bc | 170.63<bc |
| SEM     | 0.597    | 0.744    | 0.807    | 1.156    |
| P       | 0.000    | 0.009    | 0.000    | 0.000    |

The body weight gain, feed intake and feed conversion rate values of the study groups for the selected time periods are presented in Table 5. The study groups did not differ for body weight gain and feed intake (P>0.05). On the other hand, the feed conversion rates of the groups differed and body weight gain between weeks 0-3, and the control group showed significant differences in comparison to Groups I - III and Groups III, respectively (P<0.05).
Table 5. The body weight, feed intake and feed conversion rate values of the quails in each study group

| Weeks | Control | Group I | Group II | Group III | SEM  | P    |
|-------|---------|---------|----------|-----------|------|------|
|       | Mean body weight gain, g |        |          |           |      |      |
| Weeks 0-3 | 22.94a | 21.76a | 22.23a | 19.81b | 0.263 | 0.004 |
| Weeks 3-6 | 36.87 | 36.25 | 36.92 | 37.93 | 1.033 | 0.951 |
| Weeks 0-6 | 29.91 | 29.01 | 29.57 | 28.87 | 0.475 | 0.851 |
| Mean feed intake, g/week |        |          |          |           |      |      |
| Weeks 0-3 | 57.70 | 59.92 | 60.51 | 57.61 | 0.740 | 0.408 |
| Weeks 3-6 | 168.95 | 166.29 | 177.89 | 167.61 | 1.740 | 0.119 |
| Weeks 0-6 | 113.33 | 113.11 | 119.20 | 112.61 | 0.970 | 0.091 |
| Feed conversion rate, g/g |        |          |          |           |      |      |
| Weeks 0-3 | 2.52b | 2.75a | 2.72ab | 2.91b | 0.038 | 0.016 |
| Weeks 3-6 | 4.70 | 4.64 | 4.86 | 4.44 | 0.153 | 0.808 |
| Weeks 0-6 | 3.82 | 3.91 | 4.04 | 3.91 | 0.078 | 0.796 |

*abc* Differences between means with different superscripts in the same row are significant (P<0.05).

Table 6. Slaughter traits of the quails in each study group

| Traits | Control | Group I | Group II | Group III | SEM  | P    |
|--------|---------|---------|----------|-----------|------|------|
| Live weight at slaughter (g) | 182.57±3.03 | 184.42±2.51 | 186.60±2.32 | 181.76±2.74 | 1.331 | 0.678 |
| Eviscerated hot carcass weight (g) | 122.76±1.75b | 130.56±1.35c | 128.92±1.53a | 123.45±1.61b | 0.783 | 0.001 |
| Heart weight (g) | 1.65±0.03bc | 1.75±0.03ab | 1.84±0.04a | 1.56±0.04c | 0.024 | 0.000 |
| Liver weight (g) | 4.02±0.19 | 4.14±0.20 | 4.29±0.19 | 4.26±0.19 | 0.098 | 0.752 |
| Gizzard weight (g) | 3.37±0.10ab | 3.37±0.08bc | 3.60±0.10ab | 3.72±0.10ab | 0.042 | 0.025 |
| Heart percentage (%) | 0.91±0.02bc | 0.96±0.02ab | 0.99±0.04a | 0.86±0.02bc | 0.012 | 0.002 |
| Liver percentage (%) | 2.18±0.08 | 2.22±0.09 | 2.30±0.09 | 2.32±0.08 | 0.038 | 0.628 |
| Gizzard percentage (%) | 1.85±0.04b | 1.83±0.04b | 1.94±0.05ab | 2.05±0.05a | 0.022 | 0.003 |

*a*b*c* Differences between means with different superscripts in the same row are significant (P<0.05).

Table 7. Mean slaughter trait values of the study groups with respect to sex

| Traits | Control | Group I | Group II | Group III | SEM  | P    |
|--------|---------|---------|----------|-----------|------|------|
| Female | Body weight at slaughter (g) | 199.28 | 198.24 | 196.75 | 194.47 | 0.927 | 0.300 |
| Eviscerated hot carcass weight (g) | 127.40 | 133.20 | 129.94 | 125.09 | 1.144 | 0.085 |
| Heart weight (g) | 1.69 | 1.82 | 1.94 | 1.66 | 0.042 | 0.077 |
| Liver weight (g) | 4.84 | 5.14 | 4.94 | 5.02 | 0.119 | 0.836 |
| Gizzard weight (g) | 3.75 | 3.70 | 3.89 | 4.08 | 0.062 | 0.146 |
| Heart percentage (%) | 0.85 | 0.92 | 0.99 | 0.85 | 0.021 | 0.072 |
| Liver percentage (%) | 2.42 | 2.59 | 2.52 | 2.58 | 0.059 | 0.719 |
| Gizzard percentage (%) | 1.88b | 1.78ab | 1.99bc | 2.10a | 0.032 | 0.053 |

| Male | Body weight at slaughter (g) | 183.75 | 170.29b | 175.25b | 168.33a | 1.153 | 0.033 |
| Eviscerated hot carcass weight (g) | 119.12b | 127.91a | 127.90b | 121.71b | 0.992 | 0.001 |
| Heart weight (g) | 1.62b | 1.69ab | 1.75b | 1.46b | 0.021 | 0.000 |
| Liver weight (g) | 3.20 | 3.14 | 3.64 | 3.44 | 0.080 | 0.111 |
| Gizzard weight (g) | 3.00 | 3.04b | 3.31ab | 3.34b | 0.050 | 0.028 |
| Heart percentage (%) | 0.98a | 0.99a | 1.00a | 0.87b | 0.013 | 0.002 |
| Liver percentage (%) | 1.93 | 1.85 | 2.07 | 2.05 | 0.046 | 0.275 |
| Gizzard percentage (%) | 1.81 | 1.79 | 1.90 | 1.99 | 0.031 | 0.105 |

*a*b*c* Differences between means with different superscripts in the same row are significant (P<0.05).

Table 8. Traits of the carcass parts in the study groups

| Traits | Control | Group I | Group II | Group III | SEM  | P    |
|--------|---------|---------|----------|-----------|------|------|
| Eviscerated cold carcass weight | 122.41b | 129.91b | 128.36ab | 124.33bc | 0.894 | 0.012 |
| Wing weight | 8.35b | 9.79a | 10.21b | 9.87a | 0.121 | 0.000 |
| Breast weight | 37.22b | 40.20a | 41.46b | 39.13ab | 0.412 | 0.003 |
| Back + neck weight | 50.49a | 50.80c | 48.00bc | 46.30a | 0.527 | 0.008 |
| Thigh weight | 25.60b | 28.54a | 28.28b | 26.72b | 0.203 | 0.000 |
| Wing percentage | 6.82b | 7.54a | 8.00a | 7.99a | 0.098 | 0.000 |
| Breast percentage | 30.47 | 30.99 | 32.28 | 31.80 | 0.315 | 0.179 |
| Back + neck percentage | 41.19a | 39.07b | 37.43ab | 37.30a | 0.328 | 0.000 |
| Thigh percentage | 20.91b | 21.98b | 22.06b | 21.60a | 0.118 | 0.002 |

*a*b*c* Differences between means with different superscripts in the same row are significant (P<0.05).
The comparison of the study groups for sex revealed that, throughout the study period, the mean body weight values of the male and female quails in Group III were lower than those of the quails in the control group and the two other treatment groups (Table 4). Similarly, in a recent study, it has been reported that body weight gain was lowest in the group that was fed on the highest amount of olive pulp (Papadomichelakis et al., 2019).

No adverse effect was determined for dietary olive cake meal supplementation on the feed intake of quails between weeks 0-6 (Table 5). In this respect, although olive cake meal has been suggested to be more favourable for ruminants due to its high crude cellulose content (Amici et al., 1991; Weinberg et al., 2008; Ghasemi et al., 2014), the results of the present study have shown that OCM has no negative impact on poultry nutrition. Although the feed conversion rate was determined to have decreased with dietary OCM supplementation between weeks 0-3, no such effect was observed in the late periods of the study (weeks 3-6, weeks 0-6). The decrease detected in the feed conversion rate in association with dietary OCM supplementation between weeks 0-3 could be attributed to the acclimatisation of the birds to OCM. Indeed, in the following weeks, no negative effect was observed on body weight, feed intake and feed conversion rate. In this respect, the results of the present study are in agreement with those reported in some previously conducted research (Rabaya et al., 2001; Ozdemir and Azman, 2013; Zhang et al., 2013; Cayan and Erener, 2015; Tuzun and Unlu, 2016). On the other hand, some studies suggest that olive mill wastes do not affect feed intake, but improve the feed conversion rate (Shafeey et al., 2013; Al-Harthi, 2016; Sateri et al., 2017; Amini et al., 2019; Erener et al., 2020).

Groups I and II, which had quantitatively higher slaughter body weights that were of no statistical significance, displayed significantly higher eviscerated hot carcass weights in comparison to the control group and Group III (Table 6). The heart weight and percentage were highest in Group II and significantly differed from the values determined in the control group and Group III. The gizzard weight and percentage were highest in Group III and significantly differed from the values detected in the control group and Group I. Similar to the present study, a previous study conducted by Al-Harthi (2016) demonstrated that dietary olive pulp increased the heart percentage, when supplemented at a level of 5%, and increased the gizzard percentage, when supplemented at a level of 10%. In another study carried out by Al-Harthi and Attia (2016) on different levels of dietary olive pulp supplementation (0%, 10%, 20%), it was ascertained that 10% of the supplement increased the heart percentage and 20% of the supplement increased the gizzard percentage, when compared to the other groups. As is the case in the present study, it can be said that the level of olive pulp incorporated in the diet was correlated with the increase observed in the gizzard percentage in the studies previously conducted by Al-Harthi (2016) and Al-Harthi and Attia (2016). Thus, it is considered that an increase in the amount of relatively less digestible nutrients in the composition of feed (basal diet) induces the physical activity of the gizzard, which eventually reflects on the weight of this organ.

The comparison of the female quails in the study groups for slaughter traits showed that, differences existed only for the gizzard percentage with the values being higher in Group III, compared to the control group and Group I (Table 7). With respect to the traits of the carcass parts, it was observed that wing weight was higher in Group I, and thigh weight and percentage were higher in Groups I and II, when compared to the other groups (Table 9). In the male quails, all slaughter traits, excluding liver weight, liver percentage were observed to have been affected by dietary OCM supplementation, and the most favourable slaughter traits were determined in Group II (Table 7). As regards the traits of the carcass parts, excluding the back+neck weight and percentage, all traits were determined to have increased with dietary OCM supplementation (Table 9).

In comparison to the control group, eviscerated cold carcass weight, breast weight and thigh weight were determined to be higher in Groups I and II. Wing weight, wing percentage and thigh percentage were higher in all treatment groups, compared to the controls. The back+neck

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Table 9. Carcass part traits of the study groups with respect to sex

| Traits                        | Control | Group I | Group II | Group III | SEM  | P       |
|-------------------------------|---------|---------|----------|-----------|------|---------|
| Eviscerated cold carcass weight | 126.64  | 132.73  | 130.15   | 126.87    | 1.467| 0.408   |
| Wing weight                   | 8.61bc  | 9.70a   | 9.38bc   | 8.36c     | 0.144| 0.004   |
| Breast weight                 | 39.90   | 41.29   | 41.24    | 40.24     | 0.608| 0.801   |
| Back + neck weight            | 50.96   | 51.84   | 50.09    | 47.97     | 0.757| 0.317   |
| Thigh weight                  | 26.26b  | 29.28a  | 28.74a   | 26.83b    | 0.308| 0.002   |
| Wing percentage               | 6.82    | 7.31    | 7.26     | 6.62b     | 0.108| 0.077   |
| Breast percentage             | 31.58   | 31.17   | 31.62    | 32.40     | 0.499| 0.850   |
| Back + neck percentage        | 40.17   | 39.04   | 38.65    | 38.03     | 0.495| 0.483   |
| Thigh percentage              | 20.73b  | 22.05b  | 22.12a   | 21.33ab   | 0.187| 0.029   |

Differences between means with different superscripts in the same row are significant (P<0.05, P<0.01, P<0.001).
weight was lowest in Group III (Table 8). Based on these results, it is suggested that dietary supplementation with OCM, in particular at a level of 5%, positively affects the highly consumed breast, thighs and wings. Indeed, it has been reported that dietary supplementation with various olive industry by-products (olive leaf, olive cake) positively affects breast, thigh and wing weights in broiler chickens (Shafeey et al., 2013, Sateri et al., 2017). It has also been reported that dietary olive leaf extract does not have any effect on breast percentage and thigh percentage in broiler chickens (Sarica and Ürkmez, 2016).

**Conclusion**

In conclusion, in view of the high feed costs challenging the poultry sector, it is significant that dietary supplementation with olive cake meal, particularly at a level of 5%, yields body weight values closest to those achieved with a standard basal diet, and shows no adverse effect on other performance parameters. Thus, the use of olive cake meal, an olive industry by-product, as an alternative feedstuff rather than a feed supplement in poultry nutrition would not only reduce feed costs, but also contribute to reducing environmental pollution.

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