Effects of oregano 
(*Oregano Onites*)
on performance, hatchability
and egg quality parameters
of laying quails
(*Coturnix coturnix japonica*)

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**ABSTRACT**

This study aimed to determine the effects of different inclusion levels of oregano into the diet on daily feed consumption, feed conversion ratio, egg production, hatchability, egg palatability, egg weight, external and internal egg quality, live weight increase, serum cholesterol and yolk cholesterol level in laying quails.

A total of 216 laying quails at 42 days of age were divided into 36 cages, 6 birds in each (4 females and 2 males), 6 cages per thesis. The 1st group was left as control (OR0) without any supplementation of oregano. The other five experimental groups were OR10, OR20, OR30, OR40, and OR50 which were fed with the diets supplemented with 10, 20, 30, 40, and 50 g/kg of oregano, respectively. The experiment lasted for 63 days until the quails reached 105 days of age.

As a result of this study, 50 g/kg oregano supplementation appeared to be the best as respects taste (*P*<0.002). The inclusion level of 20 g/kg increased fertility (*P*<0.02) however, above that level fertility was reduced. This peculiarity of oregano may be taken into account by the poultry breeder companies.

For the other segments of the poultry industry, the usage of oregano up to 50 g/kg seemed to be appropriate.

**Key words:** Oregano, Laying quail, Performance, Hatchability, Egg quality.
RIASSUNTO
INCLUSIONE DI ORIGANO (OREGANO ONITES) NELLA RAZIONE ALIMENTARE DI QUAGLIE (COTURNIX COTURNIX JAPONICA) DA DEPOSIZIONE: EFFETTI SU PERFORMANCE, SCHIUDIBILITÀ E PARAMETRI QUALITATIVI DELLE UOVA

Scopo di questo studio è stato quello di determinare gli effetti di diversi livelli di inclusione di origano nella razione alimentare di quaglie da produzione di uova attraverso lo studio di alcuni parametri produttivi: consumo alimentare giornaliero, indice di conversione, produzione di uova, schiudibilità, appetibilità, peso e qualità esterne ed interne delle uova, incremento ponderale, colesterolo presente nel siero e nel tuorlo.

Duecentosedici quaglie da produzione di 42 giorni di età sono state distribuite in 36 gabbie, con 6 animali per gabbia (4 femmine e due maschi) e 6 gabbie per tesi sperimentale. Il primo gruppo è stato considerato come controllo (Oregano 0 g/kg) ed è stato alimentato senza inclusione di origano nella formula alimentare. Gli altri cinque gruppi sperimentali, Oregano 10 - Oregano 20 - Oregano 30 - Oregano 40 - Oregano 50, sono stati alimentati rispettivamente con integrazioni di origano nella razione alimentare pari a 10, 20, 30, 40 e 50 g/kg. La prova sperimentale è durata 63 giorni, fino al raggiungimento del 105° giorno di età.

I risultati indicano che il supplemento di 50 g/kg risulta essere la quantità più idonea (p<0,002) a migliorare il gusto. Il supplemento di 20 g/kg ha incrementato la fertilità (p<0,02), mentre quantità superiori hanno portato ad una riduzione di tale parametro. Questa proprietà dell’origano potrebbe essere considerata dalle aziende zootecniche. Per gli altri settori della trasformazione avicola, l’uso di origano fino a 50 g/kg sembra essere appropriato.

Parole chiave: Origano, Quaglie da deposizione, Performance, Schiudibilità, Qualità delle uova.

Introduction

Oregano is widely known throughout the world and oregano (Kekik) is an important export commodity of Turkey (FAO, 2008). Oregano has been used extensively over the years for its antibacterial (Baratta et al., 1998; Nascimento et al., 2000; Lamberti et al., 2001; Ariana et al., 2002; Dursun et al., 2003; Harpaz et al., 2003; Uslu et al., 2003; Vigo et al., 2004; Si et al., 2008), anti-inflammatory (Youdim and Deans 2000; Choi et al., 2002), antioxidant (Akgul and Ayar, 1993; Baratta et al., 1998; Ingram et al., 2001; Botsoglou et al., 2002; Botsoglou et al., 2003; Burt and Reinders, 2003), insecticide (Choi et al., 2002), antispasmodic, expectorant, fungicide (Akgul and Kovanç, 1988; Akgul and Ayar, 1993; Nachman et al., 1995) and antiviral (Cowan, 1999) properties. Several studies in the literature are found to be related to supplementation of oregano into the animal diets either in the form of ground herb or in the form of oil. These studies state that supplementation of oregano in oil form (50 mg/kg and 100 mg/kg) (Botsoglou et al., 2002) or in herbal form (1 g/kg) (Demir et al., 2003; Sarica et al., 2005) did not have positive effects on the live weight, feed consumption and feed conversion ratio. It was also observed that there were no positive effects of oregano oil on carcass, feed consumption and feed conversion ratio (Basmacıoglu et al., 2004) although Cross et al., (2002) reported that the group supplemented with 10 g/kg oregano herb had a lower feed consumption than the control group. The same author (Cross et al., 2003) later found that different levels of oregano oil supplementation had no positive effect on the feed consumption and live weight (LW) gain. Likewise, in another study performed on quails, the addition of 20 g/kg oregano herb did not show any differences in the feed consumption and egg cholesterol oxidation products (Handl et al., 2008). However, utilization
of oregano herb at different percentages in the quail diets has not been studied so far. Therefore, the aim of this research is to determine the effects of dietary oregano herb at different levels in ground form to be used as feed additive in the quail's diet. It is a fact that plants are extracted in order to obtain chemicals (phenols, phenolic acids, guinones, coumarins, terpenoids, essential oils, lectins and polypeptides) but the extracts can vary with the chemicals used for the extraction (Cowan, 1999). In order to make use of the naturally existing chemicals in the structure of oregano, it was decided to use the herbal form rather than the processed form.

**Material and methods**

A total of 216 Japanese quails (Coturnix coturnix japonica) at 42 days of age were used in this experiment. Birds were divided into 6 groups. Each group was then divided into 6 subgroups involving 4 females and 2 male for each subgroup. The experiment lasted for 63 days until the quails reached 105 days of age. Egg production and mortalities were recorded daily at the same time period of the day. Birds were individually weighed at the beginning and at the end of the study and their body weight gains were calculated. Daily feed consumption (DFC), feed consumption rate (FCR), egg production (EP) and egg albumen (EA) were determined weekly.

Oregano was obtained from a local herbalist who bought it from Hasandede Village in the nearby Maymun Mountains in the town of Dazkırı in the Afyonkarahisar province of Turkey. The taxonomic identification of plant material was confirmed as Origanum Onites L. by a plant taxonomist, Mehmet Temel, in the Department of Biology, Afyon Kocatepe University and determined to contain 3.87% essential oil and 78.21% carvacrol. Voucher specimens (AKU-Voucher No: M.T 2080) have been deposited at the Herbarium of the Department of Biology, Afyon Kocatepe University, Afyonkarahisar/Turkey. The 1st group was left as control (OR0) without any supplementation of oregano. The other five quail groups; OR10, OR20, OR30, OR40, and OR50 were fed diets supplemented with 10, 20, 30, 40, and 50 g/kg of ground herbal form of oregano, respectively. The diets used were formulated to be isonitrogenic and isoenergetic according to the NRC (1994) recommendations. Energy and protein values of oregano herb were taken as 5.02 MJ/kg and 110 g/Kg crude protein respectively. Experimental diets were based on maize and wheat with a dry matter content of 223 g/Kg crude protein, 13.62 MJ/Kg Metabolisable Energy, as calculated basis (Table 1).

Egg production, sound eggs, hair cracks, full cracks, eggs without shell and abnormal eggs were recorded daily. The collected eggs were classified as “normal” or “damaged”; the latter included the following: fully cracked eggs (an egg with broken shell and destroyed membrane), hair crack eggs (an egg with broken shell but intact membrane), and eggs without shell (an egg without shell but with intact membrane). Cholesterol analyses of the eggs were performed (Uyanık et al., 2002) and colour index of the yolk (Roche colour index), egg shape index, yolk index, egg albumen index, Haugh units were determined (Card and Nesheim, 1972). Palatability of eggs was checked at the end of the experiment by using 6 eggs boiled 5 minutes sampled from each of the 6 subgroups and evaluated from 5 to 10 points by a committee consisting of 7 individuals. Hatchability was determined by hatching 140 eggs from each group at the end of the experiment. Eggs were individually weighed and all the eggs in the groups were numbered before incubation. Eggs were set...
at random in one single-stage incubator and were incubated at a temperature of 37.8°C with 55% relative humidity for 14 days. They were then transferred at random to Hatcher trays, which were located at the bottom of the same incubator, and they were maintained at 37.2°C and 75% relative humidity until hatching. The numbers of hatched chicks were counted after 18 days of incubation and the chicks were weighed for each of

| Table 1. The ingredient and calculated composition of experimental diets. |
|---------------------------------------------------------------|
| Feed materials:                                              |
| Maize             | 34.70 | 37.00 | 34.00 | 36.00 | 35.00 | 34.00 |
| Wheat             | 30.00 | 27.00 | 28.00 | 27.00 | 27.00 | 26.00 |
| Full fat soy bean | 9.40  | 10.00 | 14.00 | 10.50 | 13.00 | 17.00 |
| Soybean meal      | 17.50 | 16.00 | 13.00 | 14.00 | 11.00 | 8.00  |
| Oregano           | -     | 1.00  | 2.00  | 3.00  | 4.00  | 5.00  |
| Fish meal         | 1.30  | 2.03  | 2.00  | 2.77  | 3.46  | 3.31  |
| Lime stone        | 5.30  | 5.35  | 5.33  | 5.20  | 5.10  | 5.20  |
| Dicalcium phosphate | 1.07 | 0.90  | 0.94  | 0.80  | 0.70  | 0.75  |
| Salt              | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  |
| Vitamin premix*   | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  |
| Mineral premix*   | 0.10  | 0.10  | 0.10  | 0.10  | 0.10  | 0.10  |
| Methionine**      | 0.13  | 0.12  | 0.13  | 0.13  | 0.14  | 0.14  |

Calculated Composition:

| Metabolisable energy | OR0 | OR10 | OR20 | OR30 | OR40 | OR50 |
|----------------------|-----|------|------|------|------|------|
| MJ/kg                | 12.13 | 12.11 | 12.12 | 12.02 | 12.04 | 12.05 |
| Dry matter           | 89.10 | 89.20 | 89.20 | 89.10 | 89.10 | 89.20 |
| Crude protein        | 19.90 | 19.90 | 19.90 | 19.80 | 19.80 | 19.80 |
| Crude fibre          | 2.60  | 2.60  | 2.70  | 2.50  | 2.50  | 2.60  |
| Crude fat            | 3.33  | 3.46  | 4.10  | 3.54  | 3.97  | 4.61  |
| Calcium              | 2.47  | 2.50  | 2.50  | 2.47  | 2.47  | 2.49  |
| Available phosphorus | 0.35  | 0.34  | 0.35  | 0.35  | 0.35  | 0.35  |
| Methionine + Cystine | 0.71  | 0.70  | 0.71  | 0.71  | 0.71  | 0.70  |
| Lysine               | 1.19  | 1.17  | 1.17  | 1.15  | 1.15  | 1.13  |
| Linoleic acid        | 1.60  | 1.70  | 2.00  | 1.70  | 1.90  | 2.20  |

*Level of vitamin and mineral supplement per kg of feed: vit. A: 4,800,000 U; vit. D3: 800,000 U; vit. E: 14,000 mg; vit. K: 1600 mg; vit. B12: 1200 mg; vit. B12: 2800 mg; vit. B6: 2000 mg; vit. B12: 6 mg; niacin: 8000 mg; D-Biotin: 18 mg; Apo Carotenoid acid ester: 200 mg; Folic Acid: 400 mg; Coline Chloride: 50,000 mg; Vit C: 20,000 mg; Ca D-Pantothenate: 4000 mg; Xanthaxantine: 600 mg; copper: 2000 mg; cobalt: 80 mg; selenium: 60 mg; manganese: 32,000 mg; zinc: 24,000 mg; iodine: 400 mg; iron: 24,000 mg.

1. **DL-Methionine: 99% pure.
the diet groups. After the artificial incubation all un-hatched eggs were cracked and classified as: 1-Infertile, 2-Early embryonic mortality, 3-Mid term embryonic mortality, 4-Late term embryonic mortality and 5-Dead embryos after external pipping. The hatchability of total eggs in the groups was determined. Serum cholesterol values were measured with a commercially available assay kit (Chema Diagnostica, Italy).

All statistical analyses were made using SPSS program designed for Windows (SPSS, 1998). For the data which did not show a normal distribution (Taste score, Hatchability and fertility) a Kruskall Wallis test was performed and significant differences among the treatment means were tested using Mann Whitney U at the 5% probability level. Another evaluation of the data was performed by one-way analysis of variance while significant differences among the treatment means were tested using Duncan at the 5% probability level.

**Results**

Throughout the study, for the male quails, no significant differences were observed between the initial and final live weights and weight gains (Table 2). On the other hand, for the female quails, although the same indifference was observed between the initial and final live weights, the live weight gain showed a significant variation that was considered due to compensation growth (Table 2).

It seems that the utilized amounts of oregano did not result in significant variations (P>0.05) in the values of DFC, FCR, EP (Table 2), egg weight, sound eggs, hair crack, fully cracked, eggs without shell, abnormal egg, egg yolk colour index, egg Haugh unit, yolk cholesterol, serum cholesterol, egg yolk index, egg albumen index, hatch of total eggs, hatchability of fertile eggs, early embryonic mortality, mid term embryonic mortality, late embryonic mortality, pipped, and chick weight (Table 3). However, the high numerical values of EP, hatch of total eggs, hatchability of fertile eggs in the control group were striking. But a significant difference was observed in the taste scores (P<0.05). While group OR50 had the highest value, group OR10 had the lowest one. When the egg shape index was assessed, a value which was near the importance level was recorded and in accordance with that observation, the control group had the largest value (Table 3). The evaluation of fertility also showed an important variation. Finally, group OR20 had the highest fertility value and it was noticed that there was a negative relationship between the values of fertility and oregano levels (Table 3).

**Discussion**

Since plant extracts were used extensively in the most of the studies regarding with aromatic plants, these studies were also discussed in this section. In this study, FCR was not significant (Table 2). Cross et al., (2002; 2003) found that the DFC and weight gain were not affected by the level of thyme oil in the diet. These findings are in accordance with the results obtained in our experiment.

It was reported that oregano oil extract supplementation to the diet did not affect the FCR in broiler chickens (Demir et al., 2003; Basmacoglu et al., 2004; Hernandez et al., 2004; Sarıca et al., 2005) and in sheep (Bampidis et al., 2005b). Furthermore, it was also reported that anti-microbial properties of oregano did not affect the live weights of broiler birds (Demir et al., 2003; Lewis et al., 2003) supporting the findings of our experiment.

Contrary to our experiment, the studies of Çabuk et al. (2006) and Alçiçek et al. (2004)
Table 2. Effects of dietary oregano on live weight and performance parameters.

| Treatments | OR0   | OR10  | OR20  | OR30  | OR40  | OR50 | P  |
|------------|-------|-------|-------|-------|-------|------|----|
| Body weight of male quail at 42 day of age | 161.5 ± 4.0 | 165.8 ± 5.8 | 168.0 ± 3.7 | 167.5 ± 5.1 | 165.5 ± 5.4 | 165 ± 5.4 | 0.943 |
| Body weight of male quail at 105 day of age | 184.2 ± 6.3 | 191.0 ± 10.9 | 189.3 ± 4.7 | 198.0 ± 5.0 | 195.7 ± 5.9 | 192 ± 3.6 | 0.730 |
| Body weight change of male quail | 22.7 ± 2.6 | 25.2 ± 6.8 | 21.3 ± 3.5 | 30.5 ± 2.9 | 30.2 ± 3.6 | 26 ± 5.3 | 0.587 |
| Body weight of female quail at 42 day of age | 190.8 ± 1.9 | 182.5 ± 3.5 | 198.2 ± 5.7 | 193.3 ± 6.0 | 190.0 ± 4.7 | 192.7 ± 5.6 | 0.354 |
| Body weight of female quail at 105 day of age | 230.7 ± 3.4 | 230.0 ± 4.7 | 226.8 ± 5.6 | 224.3 ± 4.6 | 234.5 ± 3.6 | 227.7 ± 4.8 | 0.683 |
| Body weight change of female quail | 39.9 ± 3.1abc | 47.5 ± 3.2a | 28.6 ± 3.4d | 31.0 ± 2.8cd | 44.5 ± 2.8ab | 35.0 ± 4.6bcd | 0.002 |
| Mortality | 0 | 0 | 0 | 0 | 0 | 0 | ------ |
| Daily feed consumption | 21.3 ± 0.5 | 21.6 ± 0.7 | 20.2 ± 0.6 | 22.1 ± 0.5 | 22.1 ± 0.5 | 21.1 ± 0.4 | 0.183 |
| Feed conversion ratio | 2.0 ± 0.05 | 2.3 ± 0.13 | 2.0 ± 0.10 | 2.3 ± 0.13 | 2.4 ± 0.14 | 2.1 ± 0.07 | 0.063 |
| Egg production | 90.1 ± 1.5 | 86.6 ± 3.4 | 86.8 ± 3.8 | 83.5 ± 4.2 | 84.3 ± 4.7 | 87.4 ± 1.1 | 0.792 |

Means in the same column with no common superscript differ significantly (P<0.05). 
OR0 = Control treatment; OR10 = Treatment with 10 g grounded oregano leaves/kg of diet; OR20 = Treatment with 20 g grounded oregano leaves/kg of diet; OR30 = Treatment with 30 g grounded oregano leaves/kg of diet; OR40 = Treatment with 40 g grounded oregano leaves/kg of diet; OR50 = Treatment with 50 g grounded oregano leaves/kg of diet.
### Table 3. Effects of dietary oregano on internal, external egg quality, hatchability and fertility.

| Treatments | OR0 | OR10 | OR20 | OR30 | OR40 | OR50 | P   |
|------------|-----|------|------|------|------|------|-----|
| Egg weight | g   |      |      |      |      |      |     |
| 11.9 ± 0.2 | 11.8 ± 0.2 | 11.8 ± 0.2 | 11.6 ± 0.2 | 12.0 ± 0.2 | 11.8 ± 0.2 | 0.779 |
| Sound eggs | %   |      |      |      |      |      |     |
| 99.4 ± 0.2 | 98.8 ± 0.4 | 99.0 ± 0.3 | 97.3 ± 1.6 | 98.5 ± 0.6 | 99.5 ± 0.1 | 0.309 |
| Egg hair cracks | |      |      |      |      |      |     |
| 0.0 ± 0.0 | 0.3 ± 0.2 | 0.7 ± 0.5 | 1.3 ± 0.8 | 0.3 ± 0.3 | 0.0 ± 0.0 | 0.236 |
| Egg fully cracked | |      |      |      |      |      |     |
| 0.5 ± 0.2 | 0.8 ± 0.3 | 0.2 ± 0.1 | 1.7 ± 0.8 | 1.0 ± 0.5 | 0.5 ± 0.2 | 0.235 |
| Egg without shell | |      |      |      |      |      |     |
| 0.2 ± 0.1 | 0.3 ± 0.2 | 1.0 ± 0.4 | 0.7 ± 0.5 | 0.3 ± 0.3 | 0.3 ± 0.3 | 0.586 |
| Egg abnormal | |      |      |      |      |      |     |
| 0.7 ± 0.3 | 1.2 ± 0.6 | 0.5 ± 0.3 | 1.3 ± 0.9 | 1.2 ± 0.4 | 0.3 ± 0.2 | 0.698 |
| Egg yolk colour index | |      |      |      |      |      |     |
| 10.1 ± 0.3 | 10.2 ± 0.4 | 10.8 ± 0.3 | 9.6 ± 0.3 | 10.7 ± 0.2 | 9.8 ± 0.4 | 0.108 |
| Egg Haugh Unit | |      |      |      |      |      |     |
| 88.3 ± 0.9 | 88.2 ± 0.8 | 86.8 ± 1.3 | 87.5 ± 0.8 | 87.4 ± 1.0 | 88.8 ± 0.7 | 0.657 |
| Egg taste score | |      |      |      |      |      |     |
| 7.7 ± 0.3<sup>abc</sup> | 6.7 ± 0.3<sup>c</sup> | 7.3 ± 0.4<sup>bc</sup> | 8.1 ± 0.2<sup>ab</sup> | 7.6 ± 0.3<sup>ab</sup> | 8.4 ± 0.3<sup>a</sup> | 0.003 |
| Egg yolk cholesterol | |      |      |      |      |      |     |
| 10.9 ± 0.9 | 12.3 ± 1.0 | 10.0 ± 0.8 | 12.2 ± 1.0 | 10.6 ± 0.9 | 13.6 ± 1.3 | 0.122 |
| Egg shape index | |      |      |      |      |      |     |
| 76.9 ± 11 | 90.6 ± 9.9 | 113.7 ± 4.3 | 98.1 ± 4.4 | 116.0 ± 27 | 91.7 ± 4.6 | 0.272 |
| Egg yolk index | |      |      |      |      |      |     |
| 78.8 ± 0.9 | 78.4 ± 0.8 | 78.3 ± 0.4 | 76.1 ± 0.9 | 78.6 ± 0.5 | 78.6 ± 0.6 | 0.059 |
| Egg albumen index | |      |      |      |      |      |     |
| 44.9 ± 1.0 | 43.6 ± 0.6 | 43.5 ± 0.8 | 44.0 ± 0.7 | 42.8 ± 0.9 | 42.8 ± 0.8 | 0.682 |
| Hatch of total eggs | |      |      |      |      |      |     |
| 64.4 ± 4.0 | 57.9 ± 3.1 | 61.4 ± 1.9 | 61.8 ± 6.3 | 56.4 ± 5.3 | 60.3 ± 5.5 | 0.851 |
| Hatchability of fertile eggs | |      |      |      |      |      |     |
| 71.9 ± 3.7 | 64.9 ± 4.0 | 62.8 ± 2.0 | 64.7 ± 6.3 | 65.3 ± 5.5 | 66.2 ± 5.2 | 0.809 |
| Fertility | |      |      |      |      |      |     |
| 89.8 ± 2.8<sup>bc</sup> | 89.9 ± 2.8<sup>bc</sup> | 98.7 ± 1.3<sup>a</sup> | 95.7 ± 1.6<sup>bc</sup> | 86.1 ± 2.9<sup>c</sup> | 90.6 ± 2.6<sup>c</sup> | 0.016 |
| Early embryonic mortality | |      |      |      |      |      |     |
| 2.6 ± 0.7 | 4.3 ± 1.3 | 6.5 ± 0.8 | 5.6 ± 2.7 | 4.7 ± 1.6 | 3.8 ± 1.3 | 0.565 |
| Mid term embryonic mortality | |      |      |      |      |      |     |
| 4.2 ± 2.0 | 2.5 ± 0.7 | 5.2 ± 1.2 | 9.8 ± 3.6 | 5.5 ± 1.9 | 3.1 ± 1.1 | 0.163 |
| Late embryonic mortality | |      |      |      |      |      |     |
| 7.6 ± 2.4 | 14.4 ± 3.3 | 12.4 ± 2.4 | 7.4 ± 2.7 | 12.9 ± 4.2 | 15.0 ± 2.9 | 0.347 |
| Pipped | |      |      |      |      |      |     |
| 12.0 ± 2.9 | 11.6 ± 1.6 | 13.3 ± 1.8 | 12.4 ± 4.5 | 7.4 ± 2.1 | 9.4 ± 1.9 | 0.645 |
| Chick weight | |      |      |      |      |      |     |
| 8.0 ± 0.1 | 8.0 ± 0.1 | 8.0 ± 0.1 | 7.9 ± 0.1 | 8.1 ± 0.1 | 8.0 ± 0.1 | 0.521 |

<sup>abc</sup>= Means in the same column with no common superscript differ significantly (P<0.05).  
OR0= Control treatment; OR10= Treatment with 10 g ground oregano leaves/kg of diet; OR20= Treatment with 20 g ground oregano leaves/kg of diet; OR30= Treatment with 30 g ground oregano leaves/kg of diet; OR40= Treatment with 40 g ground oregano leaves/kg of diet; OR50= Treatment with 50 g ground oregano leaves/kg of diet.
in broiler chickens and the studies of Denli et al. (2004) and Parlat et al. (2005) in quails found that the FCR improved with the usage of oregano oil as compared to the control groups. Similarly, in the study performed by Bampidis et al. (2005b) 3 different levels of oregano leaves (1.25 g/kg, 2.5 g/kg, 3.75 g/kg) were supplemented into turkey’s rations and the groups with added oregano had better FCR value than the control group.

The figures for the egg production (Table 2), egg weight, sound eggs, eggs with hair cracks, fully cracked eggs, eggs without shells, abnormal egg percentages and yolk colour index were not different among the groups (Table 3). The differences in the taste scores were significant between the groups (P<0.05). The highest taste score was observed in the group supplemented with 50 g/kg oregano while the smallest one was obtained in the group supplemented with 10 g/kg oregano. There are no studies in the literature mentioning the effect of oregano on the colour index and taste score of eggs.

There was no difference in the Haugh unit, yolk index, albumen index, serum cholesterol level, and yolk cholesterol level of the eggs. Likewise, it was reported that there was no difference in the Haugh unit of the eggs laid by hens, the diets of which were supplemented with rosemary (Florou-Paneri et al., 2006). In the study performed in quails, the addition of 20 g/kg oregano herb into the ration did not show any changes in the egg cholesterol oxidation products and researchers indicated that it would be useful to investigate it by the addition of oregano at higher amounts than the level above (Handl et al., 2008). Although relatively higher amounts of oregano were used in this study, no changes were observed in the total and plasma cholesterol levels. When the egg shape index value was evaluated, a value at the statistical importance boundary (P=0.059) was recorded. However, it was noticed that the control group had a larger value than the remaining groups. The serum cholesterol level was reported as not being affected in the turkey (Bampidis et al., 2005a) and broiler birds (Sarıca et al., 2005) fed diets supplemented with oregano oil supporting the result of this experiment.

Florou-Paneri et al., (2006) found no differences in the shape index, yolk index and albumen index of the eggs laid by hens fed a diet supplemented with rosemary and the results support the findings of this experiment.

The differences in the hatching of total eggs, hatchability of fertile eggs, early midterm and late embryonic mortality, pipped and chick weights were not significant. When an evaluation was performed, the difference in the fertility between the groups was significant. Based on the measurements, the highest fertility was in the group supplemented with 20 g/kg oregano and the lowest in the group supplemented with 40 g/kg oregano. The control and group OR10 were very similar regarding fertility. These results indicate that group OR20 supplemented with 20 g/kg oregano had the optimum value in terms of fertility. Likewise in another experiment, significantly improved fertility was also reported in pigs supplemented with the natural form of oregano (Allan and Bilkei, 2005).

Conclusions

As a result of this study, supplementation of oregano up to 50 g/kg level did not result in any negative effects. Oregano supplementation 50 g/kg appeared to be the best regarding taste. The optimum supplementation rate was 20 g/kg in terms of fertility. This peculiarity of oregano may be taken into account by the poultry breeder companies. For the other segments of the poultry industry, the usage of oregano up to 50 g/kg
the effects of oregano in Japanese quails seemed to be appropriate. Further studies will aid in better shedding light on these effects.

This study was reviewed and approved by the Animal Ethics Committees of the University of Afyon Kocatepe, Afyonkarahisar, Turkey.

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