Effect of dietary supplementation of herb essential oils on the growth performance, carcass and intestinal characteristics of quail *(Coturnix coturnix japonica)*

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Abstract

The aim of this study was to determine the effects of thyme *(Thymus vulgaris* L.*)*, black seed *(Nigella sativa* L.*)* essential oils and flavomycin added to the diets on growth performance, carcass characteristics and intestinal organ weights of quails *(Coturnix coturnix japonica)*. One hundred and sixty day-old quails were randomly allocated to four groups, with eight replicate pens per treatment and five birds per pen. The dietary treatments were: 1. Basal diet (control); 2. Basal diet + 10 mg flavomycin/kg diet; 3. Basal diet + 60 mg thyme essential oil/kg diet and 4. Basal diet + 60 mg black seed essential oil/kg diet. Body weight gain, feed consumption and feed efficiency were determined weekly. Carcass and intestinal characteristics were determined at the end of the study (38 day). There were significant effects of dietary treatments on body weight gain and feed efficiency during the first four weeks. The addition of thyme essential oil and flavomycin to the diet resulted in significantly higher body weight gains and better-feed efficiency as compared to that of control group. The supplementation of diet with thyme essential oil decreased abdominal fat weight and abdominal fat percentage. It was found that intestinal weight and length, carcass weight, carcass yield and gizzard weight were not affected by any treatment. At the end of experiment, intestinal pH was lower in groups fed the diets containing thyme and black seed essential oils. It was concluded that the addition of thyme essential oil improved growth performance and tended to decrease the abdominal fat percentage of quails.

Keywords: Herb essential oils, antibiotic growth promoter, quail, performance, carcass characteristics, intestinal characteristics
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Introduction

Throughout the world antibiotics have been used extensively as growth promoters in animal feeds for a large number of years, especially in the fields of poultry and pig production. However, objections to the use of growth-promoting antibiotics are increasing as consumers fear that their use in livestock feeds may lead to the development of antibiotic resistant bacteria which are harmful to humans. As a result efforts have been made in many countries to ban the inclusion of all types of antibiotic growth promoters in animal feeds.

In Europe the prohibition of antibiotic use in poultry feed has forced investigators to research growth promoting alternatives (Kocabagli *et al.,* 2002). These alternatives are of great interest to the poultry industry. Thyme and black seed essential oils are two important alternatives. The major components of thyme essential oil are thymol and carvacrol, which have both been shown to have potent antioxidant properties (Aeschbach *et al.,* 1994). The herb has also been reported to have antibacterial activities against a wide range of pathogenic microbial organisms (Vincent, 2002). Furthermore, Allen *et al.* (1998) reported beneficial effects in the control of coccidiosis in poultry. The black seed (*Ranunculaceae*) is a widely grown herb in various parts of the world and its seeds are used as a condiment (Khan *et al.,* 2003). The oil extracted from these seeds has been shown to have antibacterial (Hanafy & Hatem, 1991), antioxidant (Mansour, 2000; Sahin *et al.,* 2003), immunopotentiating (Swamy & Tan, 2000) and hepatoprotective (Daba & Abdel-Rehman, 1998) activities. It has also been reported that the oil extracted from the seeds of the black seed plant, malondialdehyde (MDA), prevented lipid-peroxidation induced liver damage in diabetic rats (Meral *et al.,* 2001). Furthermore, Saxena & Vyas (1986) found that the essential oil of black seeds inhibited the growth of *Escerichia coli*, *Bacillus subtilis* and *Streptococcus feacalis.*

The aim of the present study was to investigate the effect of dietary supplementation with essential oils of thyme and black seed on growth performance, carcass weight, carcass yield, abdominal fat weight, abdominal fat percentage and the internal organ weights of growing quail (*Cotunix coturnix japonica*).

Materials and Methods

One hundred and sixty, 1-day old quails were used in this experiment. The chicks were weighed and divided into four groups, each with eight replicates, using a standard randomisation technique. Birds were housed in pens (50 x 60 cm), each containing five birds . The diet (antibiotic-free) was formulated to meet the nutrient requirements of the quails during the growing periods (0 - 38 days) (NRC, 1994). The composition of the basal diet is presented in Table 1. Diets were offered *ad libitum* and water was available for duration of the trial. The four treatments were: 1. Basal diet (control); 2. Basal diet + 10 mg flavomycin/kg diet; 3. Basal diet + 60 mg thyme essential oil/kg diet and 4. Basal diet + 60 mg black seed essential oil/kg diet. The temperature in the birdhouse was controlled and continuous lighting was used throughout the experimental period. The experiment lasted for 38 days. Thyme (67.8% carvacrol, 4.9% γ-terpineol, 4.7% cymene, 3.4% thymol and 3.2% linalool) and black seed (27.8-57% thymocinene, 7.1-15.5% p-cymene, 5.8-11.6% carvacrol, 0.25-2.3% t-anethole, 2.0-6.6% 4-terpineol, and 3.5-5% linalool) essential oils were purchased from Ege Lokman San. Tic. Company, Manisa, Turkey.

Table 1 Composition of basal diets during the experiment (g/kg)

Ingredients	0-38 days
Maize	546.6
Soyabean meal	320.0
Meat-bone meal	20.0
Fish meal	91.5
Dicalcium phosphate[a]	8.1
DL-methionine	1.5
Salt	2.5
Vitamin premix[b]	3.5
Mineral premix[c]	2.5
Lysine	1.6
Choline-Cl	2.2
Total	1000
Calculated analysis	
Crude protein	234.2
ME (MJ/kg)	12.82
Calcium	9.0
Phosphorus	6.7
L-lysine	14.2
Methionine+cystine	9.5

[a]Contains 240 g Ca and 17.5 g P/kg;
[b]Provided per kg of diet: Vitamin A - 12000 IU; vitamin D_3 - 1500 IU; vitamin E - 50 IU; vitamin K_3 - 5 mg; vitamin B_1 - 3 mg; vitamin B_2 - 3 mg; pyroxidine - 30 mg; vitamin B_{12} - 0.3 mg; pantothenic acid - 12 mg; niacin - 25 mg; D biotin – 0.5 mg; folic acid - 1 mg ; choline cloride-400 mg ; apo caretenoic asit ester- 2.5 mg.
[c]Provided per kg of diet: iron - 80 mg; zinc - 40 mg; manganese - 60 mg; iodine - 0.8 mg; copper - 8 mg; selenium - 0.2 mg; cobalt - 0.4 mg

The body weight gains of birds were measured individually and feed consumption per pen was measured weekly. Feed consumption per pen and body weight gain per pen were used to calculate the feed efficiency. Mortality was recorded as it occurred and percentage mortality was determined at the end of the study. At the end of the experimental period eight birds from each treatment group were weighed and killed through cervical dislocation, followed by exsanguination. Carcass yield was calculated by dividing eviscerated weight by live weight. The weight of the abdominal fat pad was measured and abdominal fat as a percentage of carcass weight was calculated.

At the end of the study, eight birds from each treatment were selected, based on the average weight of the group and sacrificed. After the intestinal organs were carefully excised, the weight and length of intestine were recorded. The other organs, including the liver and gizzard were also removed and weighed. The intestine was collected and the pH of the content determined immediately with an electronic pH meter.

All data were subjected to analysis of variance by using the statistical analyses system, SPSS (1993). If appropriate, *post-hoc* analyses were carried out using the Duncan's test for multiple comparisons. Statements of statistical significance are based on $P < 0.05$.

Results

The effects of dietary supplementation with either flavomycin or the essential oils of thyme or black seed on the body weight gain, feed consumption and feed efficiency of quails on days 28 and 38 of the experiment are given in Table 2. Dietary supplementation with flavomycin and thyme essential oil positively influenced body weight gain and feed efficiency during the first four weeks of the study. However, there were no differences ($P > 0.05$) in feed consumption between treatment groups. At the end of the experiment the results showed that birds offered the diet containing flavomycin at 10 mg/kg feed or thyme essential oil at 60 mg/kg feed exhibited increased ($P < 0.05$) body weight gains and improved feed efficiency as compared with the control group ($P < 0.05$).

Table 2 The effect of the dietary inclusion of thyme and black seed essential oils or an antibiotic (flavomycin) on body weight gain, feed consumption and feed efficiency of quails (0-38 d)

Treatments	Body weight gain (BWG, g)		Feed consumption (FC, g)		Feed efficiency (FC/BWG)	
	0-28 days	0-38 days	0-28 days	0-38 days	0-28 days	0-38 days
Control	149.4[a]	194.7[a]	406.8	662.6[a]	2.72[b]	3.40[b]
Flavomycin (10 mg/kg)	158.3[b]	209.6[c]	399.4	683.1[b]	2.52[a]	3.24[a]
Thyme essential oil (60 mg/kg)	156.9[ab]	206.3[bc]	393.1	660.2[a]	2.50[a]	3.20[a]
Black seed essential oil (60 mg/kg)	150.4[ab]	198.6[ab]	400.8	665.8[a]	2.66[b]	3.40[b]
s.e.m.	1.45	1.60	3.12	2.90	0.02	0.03

Pooled s.e.m. - pooled standard error of the mean
[a,b,c]Means within column with different superscripts differ significantly $P < 0.05$

Table 3 The effect of the dietary inclusion of thyme and black seed essential oils or an antibiotic (flavomycin) on carcass weight, carcass yield, abdominal fat weight and percentage in quails (0-38 d)

Treatments	Measurement			
	Carcass weight (CW, g/bird)	Carcass yield (%)	Abdominal fat weight (g/bird)	Abdominal fat percentage (% of CW)
Control	137.6	70.9	2.77[a]	2.0[a]
Flavomycin (10 mg/kg)	141.1	70.0	2.49[ab]	1.76[b]
Thyme essential oil (60 mg/kg)	141.6	71.1	1.77[b]	1.25[c]
Black seed essential oil (60 mg/kg)	144.7	70.4	2.55[ab]	1.76[b]
Pooled s.e.m.	1.77	0.43	0.15	0.12

Pooled s.e.m. - pooled standard error of the mean
[a,b,c]Means within column with different superscripts differ significantly $P < 0.05$

The measures for carcass yield, carcass weight, abdominal fat weight and abdominal fat percentage are given in Table 3. No significant differences were detected for carcass yield and carcass weight, whereas, abdominal fat weight and abdominal fat percentage were significantly lower in quails fed with thyme essential oil ($P < 0.05$).

The addition of either thyme or black seed essential oils to the basal diet increased ($P < 0.05$) intestinal weight and intestinal length. However, gizzard weight was not affected ($P > 0.05$) (Table 4). At the end of the study the group receiving flavomycin in the diet showed significantly higher liver weights than the control and the other treatment groups ($P < 0.05$). The intestinal pH of birds fed the diets containing 60 mg thyme and black seed essential oils/kg feed was lower ($P < 0.05$) than that of the control and the flavomycin groups.

Table 4 The effect of the dietary inclusion of thyme and black seed essential oils or an antibiotic (flavomycin) on liver weight, gizzard weight, intestinal weight, length and pH in quails (0-38 d)

	Measurement				
Treatments	Intestinal weight (g/bird)	Intestinal length (cm/bird)	Intestinal pH	Liver weight (g/bird)	Gizzard weight (g/bird)
Control	6.3[a]	54.8[a]	6.05[a]	4.2[a]	4.3
Flavomycin (10 mg/kg)	6.3[a]	57.5[a]	6.06[a]	5.1[b]	4.3
Thyme essential oil (60 mg/kg)	7.5[ab]	59.5[ab]	5.73[b]	4.2[a]	3.9
Black seed essential oil (60 mg/kg)	7.8[b]	61.5[b]	5.81[b]	4.5[ab]	4.2
s.e.m.	0.36	0.97	0.04	0.12	0.15

Pooled s.e.m. - pooled standard error of the mean
[a,b,c]Means within column with different superscripts differ significantly $P < 0.05$

Discussion

The results of this experiment showed that supplementation of the diet with thyme essential oil at a level of 60 mg/kg feed significantly improved feed efficiency compared with controls, and gave similar responses to that of flavomycin on body weight gain during the 38-day feeding period. The improvement in body weight gain and feed efficiency achieved with thyme essential oil could be attributed to its positive effect on nutrient digestibility, as reported by Langhout (2000). Other factors which could have contributed to the beneficial effects of the plant extracts on the growth performance of birds, were their probable antioxidant and antibacterial effects in the intestine (Nascimento *et al.*, 2000).

Our findings are in agreement with those of Demir *et al.* (2003) who studied the effects of thyme and garlic powder; those of Koh *et al.* (2003) who investigated a hot-water extract from mycelia of cordyceps; those of Alcicek *et al.* (2003) who used a 48 mg essential oil combination (EOC)/kg feed in a broiler diet; those of Burt & Reinders (2003) who used oregano (origanum vulgare) and thyme essential oils and those of Urbanczyk *et al.* (2002) who used a herb mixture (*Thymus vulgaris, Origanum mairana, Coriandrum satıvum* and *Taraxacum vulgare*) in a pig diet. This could be interpreted that plant extracts or oils could affect intestinal microflora and thus digestion. In contrast to our results, De-Freitas *et al.* (2001) found that the addition of garlic extract to the diet had no beneficial effect on broiler growth performance. However, during the extraction, active components of plant oils may vary because different methods of extraction of the plant oil could have different effects on the activity of the oil.

The supplementation of the diet with thyme essential oil significantly decreased abdominal fat weight and abdominal fat percentage. However, carcass yield and carcass weight were not affected. It is possible that the antioxidant properties of thyme essential oil (Youdim & Deans, 1999) are utilised by the cells, thus having a sparing effect on the intracellular antioxidant systems. Similar results were reported by Alp *et al.* (1999) and Kırkpınar *et al.* (1999) in their studies on the effects of adding organic acid mixtures to broiler diet.

A significantly higher intestinal weight and length, which was observed in the quails fed the thyme and black seed essential oils may have a positive effect on the intestinal microflora. The results of our study are in agreement with the findings of Jamroz & Kamel (2002). Supplementing the diet with thyme and black seed oils did not only decrease the intestinal pH, but also liver weight. These results are similar to the findings of Denli *et al.* (2003) who reported that a mixture of organic acids in the diet reduced the intestinal pH of broilers. Contrasting results have been reported by Siriken *et al.* (2003) who reported that a mixture of probiotics (Protexin and Biosacc) added to the diet did not change the intestinal pH in Japanese quails. These results may be interpreted that essential oils and organic acid or probiotic supplementation to a diet may have different effects on the intestinal system of chickens.

Conclusions

The results of this study showed that the addition of 60 mg/kg of thyme oil to quail diets significantly improved the body weight gain and feed efficiency of quails. Furthermore, the addition of thyme oil significantly decreased carcass abdominal fat content and intestinal pH of quails. However, more experiments are needed to explain whether herb essential oils can be used as a growth promoter or as an alternative to antibiotics in poultry diets.

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