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Effect of thyme oil (*Thymbra spicata* l. Var. Spicata) on meat quality in Japanese quails

Einfluss von Thymianöl (*Thymbra spicata* l. Var. Spicata) auf die Fleischqualität von Japanischen Wachteln

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Introduction

Poultry meat has many desirable nutritional characteristics such as a low lipid content and relatively high concentration of polyunsaturated fatty acids (ATASOY et al., 2010). Increasing the degree of unsaturation of muscle membranes by dietary manipulation increases susceptibility of chicken meat lipids to oxidative deterioration during storage (ENBERG et al., 1996; BOTSOGLOU et al., 2002; SANZ et al., 2002; SARICA, 2003). Because of this relatively high content of polyunsaturated fatty acids, poultry meat is susceptible to oxidative deterioration with oxidation often impairing the shelf life of meat (BRENES and ROURA, 2010). Lipid oxidation is one of the major problems encountered in meat processing. It affects the quality of the product due to loss of desirable colour, odour and flavour and a reduced shelf life (BOTSOGLOU et al., 2003; KAYNAKCI and KILIC, 2009). Moreover, atherosclerosis, ischemic events, human cancer and inflammatory diseases are related to tissue exposure to oxidative stress (BENTINI et al., 2002). The quality of poultry meat may be affected by numerous factors associated with either the animal or its environment, such as age, sex, breed, species, rearing and feeding system, handling and slaughtering condition (BERRI, 2004; MCKEE, 2007). The phenomen which is known as sexual dimorphism in poultry is the higher carcass weight of males than of females (PETERS et al., 2002; FAYEYE et al., 2006; ILORI et al., 2010). This relation is exactly opposite in quails (YANNAKOPOULOS and TSERVENI-GOUSI, 1986; SHIM, 2005). The carcass weight of female quails is higher than that of males while carcass fat content of female quails is lower than that of males (RIEGEL et al., 2004).

Synthetic and natural antioxidants can be used to prevent lipid oxidation. They can scavenge chain-carrying peroxyl radicals or diminish the formation of initiating lipid radicals (BOTSOGLOU et al., 2002). Synthetic antioxidants (butylated hydroxytoluene, butylated hydroxyanisole, etc.) limit oxidation in meat and meat products. Nevertheless, commonly used synthetic antioxidants have come into question because of evidence suggesting carcinogenic potential. Furthermore, because consumers are increasingly rejecting synthetic food additives, several naturally occurring antioxidants including muscle dipeptides and nutritive antioxidants have been used as antioxidants in meat (BOTSOGLOU et al., 2002; BRENES and ROURA, 2010).

Understanding what colour of poultry meat is attractive to consumers and how to produce meat with that colour is obviously important to the poultry industry. Poultry skin and meat colour are affected by various factors, including production management, slaughter, processing, handling, and packaging (PETRACCI and FLETCHER, 2002). However, colour preferences vary from country to country. In addition, poultry meat colour is easily influenced by several dietary and environmental variables. Extracts of many herbs and spices have also been tested in efforts to increase the antioxidant effect, carcass characteristics, meat quality and shelf life of meat (CHAVES et al., 2008; SARICA et al., 2009). Thyme essential oils have been studied by several researchers. The essential oils are found in different

parts of Thymbra plants. This plant is also popular among herbalists because the oil contains thyme l, carvacrol and y-terpinene, which are phenols having important biological activities and pharmacological properties (DANESHVAR-ROYANDEZAGH et al., 2009). Some plant extracts are an excellent source of natural antioxidants that can improve meat shelf-life and quality mainly by retarding lipid oxidation and microbial growth. The effect of oregano essential oil on meat quality has been studied the most, whereas there is less information about *Thymbra spicata* L. plant.

The aim of the current study was to determine dose-dependent possible positive effects of dietary addition of thyme oil *(Thymbra spicata* L.*)* on the oxidative stability and meat color parameters of Japanese quail with gender interaction.

Material and Methods

Plant material

The essential oils were extracted from *Thymbra spicata* L. var. *spicata* plants, which are found naturally in the province of Hatay. Blooming plants were collected from their localization. Samples were dried at 35°C in the Laboratory of Medicinal and Aromatic Plants, Faculty of Agriculture, Mustafa Kemal University, Turkey.

Characterization of essential oil

The chemical composition of the essential oils obtained from *Thymbra spicata* was determined by Gas Chromatography–Mass Spectrometry (GC-MS). GC-MS analyses were carried out on HP 6890/5972 with a DB1 MS fused silica capillary column (30 m × 0.25 mm i.d., film thickness 0.25 μm). For GC-MS detection, an electron ionization system with ionization energy of 70 eV was used. The oven temperature was held at 60°C for 5 minutes, then increased to 90°C with 2°C/minute increments and held at this temperature for 45 minutes. Injection volume 1 μL split 50/1. Injector temperature was 210°C, and the carrier gas was He.

Animals, feeds and experimental design

The experiment was carried out in accordance with animal welfare standards and was conducted under the protocols (2012–01/4–1) of the Mustafa Kemal University, Animal Ethics Committee, Hatay, Turkey

A total of 192 mixed sexed Japanese quail chicks were used in the feeding trial, which lasted until the birds reached 35 d of age. Birds were randomly allocated to 4 dietary treatments comprising three experimental groups and one control group (basal diet). Each group was divided into 4 subgroups, with each containing twelve quails. Feed and water were offered ad libitum, and lighting was continuous throughout the experimental period. Basal diet was formulated according to NRC (1994) recommendations and analyzed by AOAC protocols (Table 1). Thyme oil was added daily into the basal diet at 200 (T1), 400 (T2) and 600 mg/kg (T3) levels, respectively.

Table 1. Composition and contents of nutrients of the basal diet (g/kg)

Zusammensetzung und Nährstoffgehalte der Basisfutterration

Ingredients	Composition
Maize	515.0
Wheat	77.0
Wheat bran	45.0
Extracted soybean meal	275.0
Fish meal	55.0
Vegetable oil	15.0
Limestone	10.0
Dicalcium phosphate	7.5
Sodium chloride	2.5
Vitamin-mineral premix*	5.0
Calculated nutrients	
ME, (MJ kg^{-1})**	12.6
Crude protein (g kg^{-1})	221
Ca (g kg^{-1})	9.0

Ingredients	Composition
P (g kg^{-1})	6.0
Lysine (g kg^{-1})	11.0

*: Vitamin premix provides the following per kg: all-trans-retinyl acetate, 1·8 mg; cholecalciferol, 0·025 mg; all-rac-α-tocopherol acetate, 1·25 mg; menadione (menadione sodium bisulphate), 1·1 mg; thiamine (thiamine mononitrate), 1·1 mg; riboflavin, 4·4 mg; niacin, 35 mg; Ca-pantothenate, 10 mg; pyridoxine, 2·2 mg; folic acid, 0·55 mg; cyanocobalamin, 0·02 mg; Mn, 74 mg (from MnO); Zn, 45 mg (from ZnO); Cu, 4 mg (from CuO); Fe (from $FeSO_4$), 12·5 mg; I (from KI), 0·3 mg; Se (from NaSe), 0·15 mg.
** ME: Metabolisable energy. The ME, crude protein, calcium, phosphorus and lysine contents were calculated based on their tabular values listed for the feeding ingredients (JURGENS, 1996)

Sample collection and measurements

At the end of the trial, the birds were held for 10–12 h without food and water prior to determining their final body weights. Four birds (two female and two male) from each subgroup were randomly slaughtered via a neck cut, bled for 120 s, and semi-scalded 54°C for 30 s before mechanical plucking. The birds were eviscerated manually, washed and allowed to drain for 10 min. After evisceration, the carcasses were stored at 3 ± 0.5°C for 10–12 h and then dissected according to the method utilized by BARBUT (2002). Then, breast fillets were transferred to the meat research laboratory of the food engineering department of Atatürk University under cold chain conditions. Before the analyses, the samples were thawed at 4–6°C for 24 h and then pH, TBARS and colour analyses were completed.

Analysis for pH and Thiobarbituric Acid Reactive Substances (TBARS)

The pH values of the samples were determined using a pH meter (SCHOTT L 6880, Lab Star pH). The pH value was measured using a direct probe by thrusting the probe into the breast fillets.

To determine TBARS values, 1 g of ground breast meat sample was taken from each breast fillet of each treatment, and 6 ml TCA solution was added (7.5% TCA, 0.1% EDTA, 0.1% 1-propyl gallate). The mixture was homogenized for 20–30 s by Ultra-Turrax and was then filtered over Whatman one. Next, 1 ml 0.02 M TBA solution was added to the 1 ml filtrate. This mixture was kept in a boiling water bath for 40 min it was then cooled and centrifuged at 2000 rpm for 5 min. finally, absorbance was measured at 532 nm (Shimadzu, UV 160), and TBARS values were determined using the standard coefficient as μmol malonaldehyde/kg.

Determination of colour values

A Minolta model colorimeter (CR-200, Minolta Co, Osaka, Japan) was used for the colour measurement of the breast fillet samples, with a white tile as a reference [L* ¼ 0, darkness; L* ¼ 100, lightness (darkness/lightness); a*; +a* = red, -a* = green and b*; +b*= yellow, - b* = blue; hue = h* = $\tan^{-1}$ (b*/a*); and chroma = C* = $(a^{*2} + b^{*2})^{½}$].

Statistical analysis

The data were subjected to analysis using the general linear model procedure of SPSS (1996) 11.0 for Windows for a completely randomized experimental design. The model included treatments and sex, and treatments by sex interaction as main effects. Differences between means were determined by Duncan's multiple range test, at a significance level of $P < 0.05$. The results of the statistical analyses are shown in the tables as both mean values ± standard error.

The regression model used to analyze the groups which are dietary addition of thyme oil and gender was:

$Y_{ijk} = \mu + a_i + b_j + c_{ijk}$ where;

For treatments and gender, Y_{ijk} is the traits, μ is the overall mean, a_i is the effect of treatments (Control, T_1, T_2 and T_3), b_j is the effect of gender of Quails (male and female) and e_{ijk} is the random residual.

Results

The chemical component of thyme oil is shown in Table 2. Thyme oil consisted of 24 components of which main components were carvacrol (71.6%), ocimene (9.03%) and γ-terpinene (5.83%) respectively; and also formed high level of phenolic components including 72% of phenol and 21% of hydrocarbon.

Table 2. Chemical components *Thymbra spicata* L. oil

Chemische Inhaltsstoffe des Thymbra spicata L. Öls

Retention Time (RT)	Rate (%)	Components
18.04	0.67	l-Phellandrene
18.62	0.45	Delta.3-Carene
22.26	0.18	Succinaldehyde
22.64	0.77	Beta-Myrcene
24.86	1.06	Alpha-Humulene
25.59	9.03	o-Cymene
25.83	0.36	Cis-D-Dihydrocarveol
28.31	5.83	Gama-Terpinene
29.36	0.26	Trans-Sabinenehydrate
31.12	0.41	Cis-Sabinenehydrate
33.99	0.08	3-Pinanylamine
34.18	0.93	4-Terpineol
36.01	0.31	Z,Z,Z-1,4,6,9-Nonadecatetraene
36.93	0.27	Thymol
37.12	71.62	Carvacrol
39.39	1.91	Caryophyllene
39.71	0.18	Farnesol
40.01	0.11	Trans-Z-alpha-Bisaboleneepoxide
40.26	0.44	Beta-Lactose
40.58	0.33	Tetraacetyl-d-xlonicnitrile
41.77	4.75	1-Monolinoleoyglyceroltrimethylsilylether
42.30	0.09	12,15-Octadecadiynoicacid,methylester
42.44	0.53	Caryophylleneoxide
47.51	0.42	Methylperfluorobutyrate

The dietary thyme oil increased ($P < 0.01$) the pH_{24h} (5.94–6.02) of breast muscle irrespective of the supplementation level. The dietary content of thyme oil in the quails' diet also significantly affected TBARS values ($P < 0.01$). The lowest TBARS value was found in the group that received 400 mg/kg of thyme oil (T_2), averaging 14.2 ± 1.56; the highest was found in the group that received 600 mg/kg of thyme oil (T_3), averaging 18.9 ± 2.39 ($P < 0.01$). The TBARS value was significantly higher in male than female birds ($P < 0.01$). Interaction between groups and gender were significantly important for TBARS values ($P < 0.001$) and cold carcass weight ($P < 0.001$) (Table 3)

Table 3. TBARS and pH values of breast meat and cold carcass weights of Japanese quails fed diets with different levels of thyme oil

TBARS- und pH-Werte des Brustfleischs und Gewicht des kalten Schlachtkörpers der Japanischen Wachteln nach Fütterung mit Futterrationen mit unterschiedlichen Gehalten an Thymianöl

		Groups				P values		
	n	Control	T_1	T_2	T_3	Group	Gender	Group* Gender
				TBARS (µmol MDA/kg)				
Male	8	18.2 ± 1.52#	16.3 ± 1.65*	15.1 ± 1.69*	19.7 ± 2.69*	**	**	***

		Groups				P values		
	n	Control	T_1	T_2	T_3	Group	Gender	Group* Gender
Female	8	12.5 ± 1.20	15.3 ± 2.50*	13.4 ± 0.78	18.1 ± 1.79			
Total	16	15.4 ± 3.18[b]	15.8 ± 2.14[b]	14.2 ± 1.56[c]	18.9 ± 2.39[a]			
				pH				
Male	8	5.95 ± 0.14	6.00 ± 0.06	6.01 ± 0.07	6.01 ± 0.06	**	NS	NS
Female	8	5.93 ± 0.11	5.99 ± 0.10	6.02 ± 0.10	5.97 ± 0.03			
Total	16	5.94 ± 0.13[b]	6.00 ± 0.08[a]	6.02 ± 0.09[a]	5.99 ± 0.05[a]			
				Cold Carcass Weight (g)				
Male	8	195 ± 30.3	208 ± 18.1	201 ± 7.14	207 ± 13.1	NS	*	**
Female	8	215 ± 12.5	225 ± 7.40*	218 ± 12.5	225 ± 16.0*			
Total	16	208 ± 21.3	217 ± 15.8	209 ± 12.9	216 ± 17.0			

NS: Not significant, * P < 0.05, ** P < 0.01, *** P < 0.001.

* Superscript indicates significantly different from group control for each gender.

Superscript indicates significantly different from female for each group.

[a,b,c]: Means with different superscripts within the same row are significantly different.

The dietary thyme oil at 400 mg/kg level significantly increased the a* value of breast fillets in Japanese quails (P < 0.01). Interaction between group and gender was also significant for the a* value (P < 0.01). Similarly, C* value was significantly different in males of the group that received 600 mg/kg of thyme oil (T_3) compared to female of those other groups (P < 0.01) (Table 4).

Table 4. Color values of breast meat of Japanese quails fed diets with different levels of thyme oil

Farbwerte des Brustfleischs der Japanischen Wachteln nach Fütterung mit Futterrationen mit unterschiedlichen Gehalten an Thymianöl

		Groups				P values		
	n	Control	T_1	T_2	T_3	Group	Gender	Group* Gender
				L*				
Male	8	59.1 ± 5.08	57.9 ± 5.59	58.4 ± 5.32	61.3 ± 5.03	NS	NS	NS
Female	8	58.4 ± 5.25	60.1 ± 5.48	59.9 ± 6.18	60.3 ± 4.94			
Total	16	58.7 ± 5.14	59.0 ± 5.62	59.2 ± 5.78	60.8 ± 4.98			
				a*				
Male	8	6.16 ± 1.41	6.41 ± 1.47	7.53 ± 1.78#,*	6.76 ± 2.26	*	**	**
Female	8	6.87 ± 2.18	5.72 ± 1.56*	6.16 ± 1.79	5.77 ± 1.58			
Total	16	6.51 ± 1.86[ab]	6.06 ± 1.55[b]	6.85 ± 1.90[a]	6.27 ± 2.00[ab]			
				b*				
Male	8	7.02 ± 4.11	7.30 ± 4.75	6.90 ± 3.82	8.73 ± 3.40#	NS	NS	NS
Female	8	8.35 ± 4.13	7.58 ± 4.11	7.20 ± 4.86	6.43 ± 3.74			
Total	16	7.69 ± 4.15	7.44 ± 4.42	7.05 ± 4.35	7.58 ± 3.73			
				C*				
Male	8	9.84 ± 3.00	10.2 ± 3.91	10.5 ± 3.47	11.3 ± 3.15#	NS	NS	**
Female	8	11.2 ± 3.61	9.92 ± 3.29	10.0 ± 3.94	9.02 ± 3.11*			
Total	16	10.5 ± 3.37	10.1 ± 3.59	10.3 ± 3.69	10.2 ± 3.32			
				H*				
Male	8	44.0 ± 18.8	42.8 ± 18.6	39.1 ± 14.1	51.0 ± 13.5	NS	NS	NS
Female	8	47.8 ± 15.6	48.5 ± 19.6	43.1 ± 21.4	44.7 ± 16.9			

		Groups				P values		
	n	Control	T_1	T_2	T_3	Group	Gender	Group* Gender
Total	16	45.9 ± 17.3	45.7 ± 19.2	41.1 ± 18.1	47.8 ± 15.5			

NS: Not significant, * P < 0.05, ** P < 0.01.

* Superscript indicates significantly different from group control for each gender.

Superscript indicates significantly different from female for each group.

a,b: Means with different superscripts within the same row are significantly different.

Discussion

Meat pH has great importance in evaluation of meat quality, because it may directly affect quality characteristics, such as texture, water holding capacity, cooking loss and colour (KIRMIZIBAYRAK et al., 2011). Meat pH values are influenced by numerous factors, including age, gender, breeding methods, feed additives, preslaughter stress or hormonal status, morphology of muscles and glycogen content.

A higher muscle pH value is associated with dark meat, whereas lower muscle pH values are associated with lighter meat (FLETCHER, 1989). In the current study, the pH values were in the range previously reported for quail breast meat (GEVREKCI et al., 2009; GENCHEV et al., 2010). All dietary levels of thyme oil significantly increased pH values of breast fillets (P < 0.01). The oxidation products of unsaturated fats are mildly acidic molecules, such as hydroxyl acid, keto-acid, and other smaller fatty acid molecules (BELITZ et al., 2004). This increase can be attributed to the antioxidant effect of thyme oil on saturated fatty acid oxidation, which causes low mildly acidic molecules production. Lipid oxidation is known to be due to oxidation of unsaturated lipids in meat because saturated lipids are resistant to oxidation.

The effects of phytochemical antioxidants on lipid oxidation in meat and meat products are of major concern. Investigations into the effects of dietary administration of secondary plant metabolites on muscle and adipose tissues of farm animals are still rare. Knowledge is not readily available about the effects of secondary plant metabolites in feed on the gut, their bioavailability from absorption and metabolism, and the extent to which they might be retained in animal tissues.

Our results failed to show a superior antioxidant effect of higher levels of dietary thyme oil administration ti diets. Breast fillets of quails fed 400 mg/kg of thyme oil (T2) showed the strongest effect of dietary thyme oil administration. However, dietary thyme oil administration could not prevent an increase in TBARS value of the breast fillets of quails fed 600 mg/kg dietary of thyme oil (T3) (Table 3). In another part of this study, our group studied the effect of dietary thyme oil on biochemical parameters of quail; we observed that the T3 level (600 mg/kg) significantly increased the plasma cholesterol level in Japanese quail.

Considering this observation, we hypothesized that an increase in plasma cholesterol level caused an increase in the amount of the cholesterol oxidation products, thus TBARS formation was not delayed in the T3 group, which led to increased TBARS values (LOPEZ-BOTE et al., 1998). LOPEZ-BOTE et al. (1998) also reported that they did not find an antioxidative effect in pork when oleoresins of rosemary and sage were fed. However, feeding the same oleoresins (500 mg/kg) to broilers led to an improved oxidative stability in red (leg) and white (breast) meat measured as TBARS as well as a lower amount of cholesterol oxidation products compared to unsupplemented animals (LOPEZ-BOTE et al., 1998). TBARS concentration has a known correlation with the cholesterol and LDL-cholesterol concentration in plasma (SCHIMKE et al., 1990). Considering this finding, we speculate that after a certain level, thyme oil may have more impact on lipogenesis than on cholesterol biosynthesis. The reduction of triglycerides and cholesterol noticed with thyme in animal studies has been attributed to the lowering effect of thyme oil or carvacrol on HMG-Co A reductase, the rate-limiting enzyme of cholesterol synthesis (CASEET al., 1995; LEE et al., 2003). The main metabolic pathway of these compounds after a certain dose might be changed in the meat and, thus the antioxidant impact of essential oils might be weakened. However, it is well-known that the absence or presence of cholesterolaemic effects of dietary components in an animal depends on various factors such as breed, gender and age, and also on the composition of the feed.

The effect of dietary thyme oil administration on male quails was superior to female birds ($P < 0.01$) according to TBARS formation. This increased effect can be ascribed to the higher fat content of musculus pectoralis superficialis of male quails compared to those of females (RIEGEL et al., 2004).

CCW were unaffected by dietary administration of OEO, but CCW for gender ($P < 0.05$) and interaction between group and gender ($P < 0.01$) were significantly different. These differences may be caused by the phenomen which is known as sexual polimorphism in poultry, i.e. the higher carcass weight of females than of males (PETERS et al., 2002; FAYEYE et al., 2006; ILORI et al., 2010).

At the point of purchase of meat at market, the consumer takes into consideration a number of factors including price, sensory quality, product safety and nutritional quality. The display and colour are the most important quality characteristics that determine product preference (KIRMIZIBAYRAK et al., 2011). The meat colour is easily influenced by gender, age, species, myofibre composition and several dietary and environmental variables (DINGBOOM and WEIJS, 2004; AKSU et al., 2011). In the current study, some meat color parameters (L*, b*, H* values) were not affected by dietary treatments while C* value was significantly different in males of the T3 group ($P < 0.01$) and, the a* value of males of the T2 group was significantly higher than for females for each other groups ($P < 0.01$). However, the breast meat of male quails had redder colour than that of female quails in terms of group ($P < 0.05$), gender ($P < 0.01$) and, interaction between group and gender ($P < 0.01$). DINGBOOM and WEIJS (2004) expressed that males have darker muscle fibres, rich in myosin that build up in the meat, than females. Given this finding, the detected difference between the gender on a* values could be physiological rather than an antioxidant effect of OEO.

In a previous study where the effect of different levels of dietary medicinal herb extract (MHEM) mix (0.3 and 1%) on antioxidative potential and meat color of raw breast meat from broilers were examined, it was reported that MHEM administration significantly decreased L* values compared to the control while it did not change the a* and b* values (JANG et al., 2008). Dietary garlic decreased L*, a*, and b* values in pork (CHEN et al., 2008) but dietary oregano extract showed greater a* and b* values in chicken meat of the treatment group than in the meat of control chickens (YOUNG et al., 2003). SIMITZIS et al. (2008) explained that dietary oregano essential oil supplementation indirectly modified the meat color, probably by decreasing hemoglobin oxidation and activating mechanisms that modify pigment distribution in animal tissues.

Changes in meat color are due to oxidation of red oxymyoglobin to metmyoglobin (MMG), which give meat an unattractive brown color (NERÍN et al., 2006). Dietary essential oil can indirectly modify the meat color, probably by decreasing hemoglobin oxidation and activating mechanisms that modify pigment distribution in animal tissues (SIMITZIS et al., 2008). Some reports demonstrate that natural antioxidants can retard meat color loss by extending the red color (a*) and delaying metmyoglobin formation. One example of dietary natural antioxidants affecting meat color is the higher color parameters (a* and yellowness b*) of meat from lambs fed with oregano essential oil supplementation (1 ml oregano essential oil kg^{-1}) (SIMITZIS et al., 2008). Another example is the reduction of metmyoglobin formation and intense red color obtained in fresh beef steaks whose surface was sprayed with a rosemary and ascorbic acid solution during refrigeration (DJENANE et al., 2003). CARPENTER et al. (2007) noted that the color parameters (lightness L*, b*, and a*) of raw pork patties did not vary by adding grape seed and bearberry extracts. The same results were obtained for fresh chicken breast meat (CHOULIARA et al., 2007).

In conclusion, the results of the present study showed that the efficacy of EO from *Thymbra spicata* L. on oxidative stability and meat color parameters was dependent on dosage. Dietary thyme oil at 400 mg/kg improved the oxidative stability and meat quality in Japanese quails. Interaction between groups and gender were significantly important for TBARS values and cold carcass weight. The diet supplemented with thyme oil significantly affected a* and C* values of breast fillets in Japanese quails. More research is needed to identify the main metabolic pathway of these compounds and the key essential oil antioxidant compounds deposited in meat.

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Summary

The effects of thyme oil on meat quality in Japanese quails were investigated. A total of 192 mixed sexes Japanese quail chicks were used in the feeding trial, which lasted until the birds reached 35 d of age. Birds were randomly allocated to 4 dietary treatments comprising three experimental groups and one control group (basal diet). Each group was divided into 4 subgroups, with each containing twelve quails. Basal diet was formulated according to NRC recommendations. Thyme oil was added daily to the basal diet at 200 (T1), 400 (T2) and 600 mg/kg (T3) levels, respectively. After slaughtering and evisceration, the carcasses were stored at 3 ± 0.5°C for 10–12 h and then the breast fillets were removed from carcass.

All dietary levels of thyme oil increased significantly the pH values of the breast fillets ($P < 0.01$). Dietary thyme oils significantly affected the Thiobarbituric Acid Reactive Substances (TBARS) values. The TBARS value was significantly higher in male quails than in females ($P < 0.01$). Interaction between groups and gender has been significant for TBARS values and cold carcass weight ($P < 0.01$). The supplementation of thyme oil to diets significantly affected a* and C* values of breast fillets in Japanese quails ($P < 0.01$) while no differences were observed among all groups for L*, b*, H* values. Interaction between group and gender was also significant for a* and C* values ($P < 0.01$).

Key words

Japanese quail, thyme oil, antioxidant, meat quality

Zusammenfassung

Einfluss von Thymianöl (*Thymbra spicata* l. Var. Spicata) auf die Fleischqualität von Japanischen Wachteln

In der vorliegenden Studie wurde der Einfluss eines Zusatzes von Thymianöl zum Futter auf die Fleischqualität von Japanischen Wachteln untersucht. Für den Fütterungsversuch wurden 192 nicht nach Geschlecht sortierte Wachteln verwendet. Die Versuchsdauer betrug 35 Tage. Die Wachteln wurden zufällig auf 4 Behandlungsgruppen mit jeweils 4 Wiederholungen verteilt: Kontrolle (Basisration ohne Zusatz), T1 (Basisration mit 200 mg Thymianöl/kg), T2 (Basisration mit 400 mg Thymianöl/kg), T3 (Basisration mit 600 mg Thyminaöl/kg). Der Nährstoffgehalt der Basisration entsprach den Empfehlungen des NRC. Das Thymianöl wurde täglich frisch zugesetzt. Nach dem Schlachten der Tiere und dem Ausnehmen der Schlachtkörper wurden diese bei 3 ± 0,5°C für 10–12 Stunden gelagert und danach das Brustfleisch für die weiteren Untersuchungen entfernt.

Alle Zulagestufen des Thymianöls führten zu einer signifikanten Erhöhung des pH-Wertes im Brustfleisch ($P < 0,01$). Das Thymianöl beeinflusste ferner die Gehalte an Thiobarbitursäure Reaktiven Substanzen (TBARS). Die TBARS-Werte waren bei den männlichen Wachteln signifikant höher als bei den weiblichen ($P < 0,01$). Ferner lagen signifikante Behandlung × Geschlecht Interaktionen für die TBARS-Werte und das kalte Schlachtkörpergewicht vor ($P < 0,01$). Die Zulage von Thymianöl zum Futter beeinflusste signifikant die a*- und C*-Werte des Brustfleischs ($P < 0,01$), während keine Effekte auf die L*-, b*- und H*-Werte beobachtet wurden. Für die a*- und C*-Werte lag eine signifikante Behandlung × Geschlecht Interaktion vor ($P < 0,01$).

Stichworte

Wachtel, Thymianöl, Fleischqualität, Oxidation

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