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Effects of Dietary Oregano Essential Oil on Carcass and Meat Quality of Kivircik Lambs

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Abstract: This study was conducted to determine the effects of different levels of dietary oregano essential oil on carcass measurements, meat quality and sensorial properties of Kivircik lambs. Thirty six weaned Kivircik male lambs were randomly divided into three groups of 12 animals each and lambs were fed one of the three dietary treatments. In control group, animals were fed concentrate pellets and hay and animals in other two experimental groups were fed hay and commercial concentrate pellets including oregano oil at 250 ppm and at 500 ppm. After 9 weeks of trial period, all lambs were slaughtered, carcass characteristics and meat quality parameters were determined. The effect of oregano oil was not significant on carcass and meat quality attributes ($p>0.05$). No differences were detected between treated and control lambs by sensory panelists. These results showed that higher concentrations of dietary supplementation of oregano oil may be required to be able to observe the differences for carcass and meat assessments in lamb.

Key words: Carcass, feed, lamb, meat quality, oregano oil

INTRODUCTION

Essential Oils (EO) are extracted from aromatic plants and their form of action and their effects on rumen metabolism have been described by Calsamiglia *et al.* (2007) and Benchaar *et al.* (2008), previously. Oregano (*Origanum onites* L.) is one of the major export products in Turkey and with a wide distribution throughout the South and West of Turkey.

The main constituents of oregano essential oil are carvacrol and thymol and these components are known as antioxidant, antimicrobial and antifungal (Benchaar *et al*., 2008; Govaris *et al*., 2004; Janz *et al*., 2007). Because of antimicrobial properties, oregano oil was used to improve growth performance in poultry (Giannenas *et al*., 2005; Botsoglou *et al*., 2004a, b) and pigs (Janz *et al*., 2007). It was also showed important role of protecting against stress and on meat quality characteristics in broiler (Young *et al*., 2003) and rabbit (Botsoglou *et al*., 2004a, b). Studies with ruminant animals are limited to some feeding studies. No differences were observed for body weight and body weight gain by Simitzis *et al.* (2008) after feeding Chios lambs with oregano oil supplemented diets. Unal and Kocabagli also found no differences for live body weight and live body weight gain between control and oregano supplemented groups. On the other hand, there are no published study on quality of carcass and meat after supplementing the lamb diet with oregano oil. Therefore, the aim of the present study was to determine the *in vivo* effect of oregano essential oils addition to lamb diets on carcass measurements and meat quality and sensorial properties of Kivircik lamb meat.

MATERIALS AND METHODS

Animals and diets: Thirty six weaned Kivircik male lambs were randomly divided into three groups of 12 animals each and lambs were fed one of the three dietary treatments. In control group (group 1), animals were fed concentrate pellets and hay in other two experimental groups animals were fed hay and commercial concentrate pellets including oregano oil (NBT Eterik Yag Imalati Tarim Gida Ithalat Ihracat San. Ve Tic. Ltd. Sti.-Alanya) at 250 ppm (group 2) and at 500 ppm (group 3). Animals were housed in group pens with natural lighting and pens were 6.0×3.2 m. Hay was offered *ad libitum* with a concentrate at 0.5 kg for each lambs at the beginning of the experimental period and the amount of feed was gradually increased according to live weight and refusals recorded daily and water was offered *ad libitum*. Feed analysis were performed in a laboratory of Department of Animal Nutritional Department of Faculty of Veterinary Medicine,

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Table 1: Ingredients of lamb grower feed

Ingredients	Percentage
Barley	19.40
Corn	11.30
Corn Gluten	8.50
Wheat Bran	31.80
Soybean meal	6.50
Sunflower meal	13.90
Molasses	5.10
$CaCO_3$	2.85
Salt	0.54
Mineral premix[1]	0.10
Vitamin premix[2]	0.01
Total	100.00

[1]1 kg premix contained 10.000 mg Cu, 50.000 mg Fe, 50.000 mg Mn, 50.000 mg Zn, 50 mg Co, 800 mg I, 150 mg Se, 340.000 mg Ca. [2]1 kg premix contained 66.700.000 IU vitamin A, 16.700.000 IU vitamin D3, 167.000 IU α-tocopherol acetate, 42.000 mg vitamin B_1, 25.000 mg vitamin B_2, 125 mg vitamin B_{12}, 12.5000 mg Niasin

Table 2: Nutrient composition of the feeds (DM, %)

Nutrient composition (%)	Hay	Lamb grower feed		
		Control	250 ppm OO	500 ppm OO
Dry matter	93.40	87.30	87.22	87.36
Crude protein	8.89	17.86	17.63	17.83
Crude fat	0.95	3.55	3.81	3.92
Crude cellulose	40.32	5.13	5.03	5.21
Crude ash	7.79	6.15	6.01	6.22
NDF	43.04	19.56	19.57	19.57
ADF	60.95	7.83	7.84	7.84
Calcium	1.31	1.05	1.10	1.08
Phosphorous	0.20	0.54	0.52	0.53

University of Istanbul. Dry matter of concentrate feed samples and hay were determined in forced-oven at 55°C for 48 h. Feed samples were ground after drying and dry matter content was determined in an oven set at 105°C for 24 h. Crude protein was determined by Micro-Kjeldahl technique using Vodopost (Gerhard, Germany). Crude lipid (EE) was determined using Soxhlet extraction procedure with petrol ether as solvent.

Neutral detergent fiber fraction was determined according to Van Soest *et al*. (1991) and acid detergent fiber was determined using the procedure described by Goering and van Soest (1970) adapted for Ankom 200 Fiber Analyzer (Ankom Technology, Fairport, NY). Dietary ingredients and nutrient composition of feeds are given in Table 1 and 2. Analysis of oregona oil was performed in Anadolu University, BIBAM Labratory and it was determined that oregano oil which was used in the current study, contained 65% carvacrol and 0.3% thymol.

Slaughter procedures and carcass measurements: On the day of 63 of the experiment, after live weight was recorded and electrical stunning, lambs were slaughtered at the Istanbul University, Faculty of Veterinary Medicine abattoir. From 12 h before slaughter animals had access to water but not to feed to minimize contamination during slaughter. The Empty Body Weight (EBW) was determined by excluding contents of the gastro intestinal tract. Non-carcass components were expressed according to proportion (%) on EBW. Carcasses were chilled at 4°C for 24 h and weighted to determine cold carcass weight and cold dressing percentages. Back fat thickness was measured according to Fisher and De Boer (1994).

Meat instrumental quality and laboratory analyses: Carcass pH levels were measured on longissimus thoracis muscle between 12-13th thoracic vertebrae by digital pH meter (Testo 205, Testo AG, Lenzkirch, Germany) at immediately after dressing (pH_0), at 45 min after slaughter ($pH_{45\ min}$) and at 24 h post slaughter ($pH_{24\ h}$). Meat colour, drip loss, cooking loss and Warner-Bratzler shear force value were assessed in M. longissimus thoracis removing from the left side of carcass at 24 h post-mortem. Meat samples were vacuum packaged and instrumental meat quality characteristics were determined after 48 h storage period at 4°C in the refrigerator. Drip loss (%) and cooking loss (%) were evaluated the method described by Honikel (1998). In order to determine shear force value sub-samples (cut parallel to the muscle fibres with a cross section of 1×1 cm) were removed from cooked samples after the measurement of cooking loss. Shear force values of sub-samples were determined using an Instron Universal Testing Machine (Model 3343) equipped with a Warner Braztler (WB) shear force apparatus. Water Holding Capacity (WHC) was measured just after kept under a pressure of 2250 g weight for 5 min and expressed as percentage of weight loss of 5 g meat samples (Ekiz *et al*., 2012). Meat colour was measured immediately on surface of M. longissimus thoracis samples after cutting at 1, 24 h and 7 days of storage. Colour was evaluated using the CIELAB colour space. L^* (lightness), a^* (redness) and b^* (yellowness) values were obtained using Minolta CR 400 colorimeter (Minolta Camera Co., Osaka, Japan) with illuminant D65 as the light source, 8 mm aperture size and 2° observation angle. Caudal subcutaneous fat colour values were taken from the tail root (Diaz *et al*., 2002) and they were recorded. M. longissimus dorsi between 1 and 5th lumbal vertebrae from the left side of carcasses was used for sensory analyses. Sensory characteristics of cooked samples were assessed by seven panelists using an eight point category scale described by Sanudo *et al*. (1998).

Statistical analysis: In order to determine the effect of feeding two levels of oregano oil on carcass and meat quality characteristics, one-way ANOVA was performed using SPSS 10.0 Statistical Package (Anonymous, 1999). Duncan's multiple range tests was used to evaluate the significance of the difference. General Linear Model

(GLM) was applied for statistical analyses of sensory characteristics. The mathematical model used in the analyses of sensory characteristics included feeding group, panel session, panelist as a fixed effect and also significant two-way interactions between these effects.

RESULTS AND DISCUSSION

The effect of oregano oil on slaughtering and certain carcass quality characteristics are presented in Table 3. Empty body weights and cold carcass weights were not significantly different between treatment groups. Variations among groups for cold dressing percentages according to empty body weights were also found similar. In the present study, dietary addition of oregano oil had no effect on some organ proportions. The proportion of omental and mesenteric fat and backfat thickness were not different among the groups. As presented in Table 4, no significant difference in initial and ultimate pH was observed amongst the dietary treatment groups. Drip loss, cooking loss and Warner-Bratzler shear force values were not affected by the dietary treatments (Table 4). The differences among groups in terms of meat lightness (L^* value), yellowness (b^* value) and redness (a^* value) were not significant at 0 and 1 h, day 1 and 7 after cutting (Table 5) and chroma and hue values were also similar among groups. Fat colour, chroma and hue values were not influenced by addition of oregano oil to the diet (Table 6). A difference in the meat sensory characteristics from control and oregano oil fed lamb was not detectable by sensory panelists (Table 7).

Inclusion of oregano oil to ruminant diets decreased rumen acetic acid and increased propionic acid level (Castillejos *et al*., 2006) which consequently affected positively fattening performance of lamb. Fattening performance of animal is one of the main factor affecting carcass and meat quality of meat. But this response did not occur in the present study. As indicated above, results related to empty body weights were similar among groups and cold carcass weights were also similar where the amounts of oregano oil inclusion were 250 and 500 ppm, respectively. Simitzis *et al*. (2008) also demonstrated no change in empty body weight and cold carcass weight of Chios lambs fed oregano oil supplemented diets at rate of 1 mL kg^{-1} DM. Diets in the current study did not alter the proportion of visceral organs of Kivircik lambs. Burrin *et al*. (1990) showed that visceral organ size affected by DM intake which may explain results reported in the present study. pH values were ranged between 5.60-5.62 and not higher than pH 5.8-5.9 which indicated dark, firm and dry meat. Oregano oil supplementation did not affect pH values in male lamb (Simitzis *et al*., 2008) and in chicken (Young *et al*., 2003). However, Simitzis *et al*. (2008) reported sex differences in pH values after feeding oregano oil supplemented feeds in lamb. Unaffected drip loss, coking loss and Warner-Bratzler shear force values in the present study indicated that the supplementation of oregano oil was not destructive to lamb meat quality. Shear force values in all groups were lower than 6 kg which was noted as tough by Webb *et al*. (2005). Lopez-Carlos *et al*. (2011) observed that high amount of fat caused decreases the rate of temperature decline, increased the activity of autolytic enzymes in muscle, lessened the extent of myofibrillar shortening and therefore increased tenderness of meat from a fatter carcass. Similar growth rate prior to slaughter at the same weight, age and same fatness levels caused no differences in tenderness values (Muir *et al*., 1998). Differences in cooking loss arise from intramuscular fat

Table 3: Means and Standard Errors (SE) for certain slaughtering and carcass quality characteristics of lambs fed control and Oregano Oil (OO) supplemented diets

	Control		250 ppm OO		500 ppm OO		
Items	Mean	SE	Mean	SE	Mean	SE	F-value
Empty body weight (kg)	25.68	1.39	24.84	0.86	25.34	1.43	0.113[NS]
Cold carcass weight (kg)	13.46	0.89	13.04	0.56	13.08	0.77	0.096[NS]
Cold dressing percentage[a] (%)	52.10	0.67	52.34	0.64	51.57	0.72	0.327[NS]
Proportions (% on EBW)							
Head (%)	6.69	0.08	6.94	0.09	6.84	0.06	2.552[NS]
Lung and trachea (%)	1.53	0.07	1.61	0.09	1.59	0.06	0.302[NS]
Liver (%)	1.94	0.05	1.89	0.08	1.96	1.66	0.317[NS]
Heart (%)	0.53	0.01	0.53	0.01	0.50	0.04	0.441[NS]
Spleen (%)	0.24	0.03	0.21	0.02	0.20	0.01	0.596[NS]
Omental and mes. fat (%)	1.04	0.20	1.08	0.13	0.93	0.08	0.276[NS]
Testicles (%)	0.65	0.07	0.63	0.05	0.67	0.10	0.091[NS]
Empty stomachs (%)	3.42	0.08	3.33	0.12	3.50	0.12	0.653[NS]
Empty intestines (%)	5.41	0.17	5.84	0.28	5.53	0.18	1.052[NS]
Kidney (%)	0.69	0.03	1.14	0.49	0.71	0.03	0.773[NS]
KKCF[a] (%)	1.13	0.18	1.17	0.13	1.08	0.10	0.119
Bach fat thickness (mm)	1.56	0.47	1.17	0.25	0.98	0.10	0.924[NS]

NS: Not Significant (p>0.05; [a]dressing percentage based on empty body weight; [b]Kidney knob and channel fat

Table 4: Means and Standard Errors (SE) for pH, WHC, cooking loss and WB shear force values of lambs fed Oregano Oil (OO) supplemented diets

	Control		250 ppm OO		500 ppm OO		
Items	Mean	SE	Mean	SE	Mean	SE	F-value
pH_0	6.35	0.05	6.30	0.04	6.37	0.03	0.917^{NS}
$pH_{45\ min}$	6.44	0.07	6.30	0.05	6.40	0.04	1.750^{NS}
$pH_{24\ h}$	5.60	0.03	5.60	0.02	5.62	0.03	0.089^{NS}
$pH_{0\text{-}45\ min}{}^{\beta}$	-0.09	0.03	-0.00	0.04	-0.03	0.03	1.655^{NS}
$pH_{45\ min\text{-}24\ h}{}^{\beta}$	0.84	0.05	0.70	0.04	0.78	0.04	2.627^{NS}
$pH_{0\text{-}24\ min}{}^{\beta}$	0.75	0.02	0.69	0.03	0.75	0.03	1.471^{NS}
WHC (%)	3.29	0.29	3.00	0.25	2.73	0.25	1.096^{NS}
Cooking loss (%)	29.09	0.55	30.02	0.56	29.50	0.50	0.761^{NS}
Shear force values (kg)	4.33	0.29	4.48	0.22	4.32	0.17	0.148^{NS}

NS: Not Significant ($p>0.05$); $^{\beta}pH_{0\text{-}45\ min} = pH_0\text{-}pH_{45\ min}$; $pH_{45\ min\text{-}24\ h} = pH_{45\ min}\text{-}pH_{24\ h}$; $pH_{0\text{-}24\ h} = pH_0\text{-}pH_{24\ h}$

Table 5: Means and Standard Errors (SE) for M. longissimus thoracis muscle colour characteristics of lambs fed control and Oregano Oil (OO) supplemented diets

	Control		250 ppm OO		500 ppm OO		
Items	Mean	SE	Mean	SE	Mean	SE	F-value
L^{0}	38.24	0.53	38.12	0.52	39.25	0.67	1.163^{NS}
$L^{1\ h}$	39.17	0.52	39.44	0.43	40.11	0.64	0.811^{NS}
$L^{1\ day}$	41.61	0.52	41.71	0.33	42.25	0.62	0.472^{NS}
$L^{7\ days}$	40,77	0,48	40,01	0,86	40,76	1,05	0,273
$(a^*)^{0}$	14.98	0.22	15.23	0.23	15.21	0.20	0.397^{NS}
$(a^*)^{1\ h}$	16.62	0.41	16.32	0.39	16.59	0.21	0.225^{NS}
$(a^*)^{1\ day}$	16.35	0.38	16.87	0.59	16.61	0.39	0.301^{NS}
$(a^*)^{7\ days}$	14,86	0,48	15,65	0,75	15,49	0,60	0,463^{NS}
$(b^*)^{0}$	1.42	0.18	1.43	0.23	1.64	0.27	0.295^{NS}
$(b^*)^{1\ h}$	3.40	0.54	2.80	0.42	3.74	0.21	1.333^{NS}
$(b^*)^{1\ day}$	7.12	0.15	7.59	0.26	7.57	0.22	1.501^{NS}
$(b^*)^{7\ days}$	6,41	0,25	6,48	0,26	6,30	0,70	0,038^{NS}
$Chroma^{0}$	15.06	0.22	15.31	0.24	15.33	0.20	0.452^{NS}
$Chroma^{1\ h}$	17.03	0.50	16.59	0.46	17.02	0.22	0.367^{NS}
$Chroma^{1\ day}$	17.85	0.37	18.50	0.62	18.27	0.40	0.487^{NS}
$Chroma^{7\ days}$	16,19	0,51	17,00	0,66	16,86	0,66	0,493^{NS}
Hue^{0}	5.38	0.66	5.32	0.81	6.17	1.02	0.316^{NS}
$Hue^{1\ h}$	11.12	1.58	9.40	1.18	12.67	0.66	1.857^{NS}
$Hue^{1\ day}$	23.60	0.55	24.28	0.57	24.55	0.67	0.677^{NS}
$Hue^{7\ days}$	23.35	0.64	22.95	1.41	21.54	2.48	0.318^{NS}

Table 6: Means and Standard Errors (SE) for fat colour characteristics of lambs fed control and Oregano Oil (OO) supplemented diets

	Control		250 ppm OO		500 ppm OO		
Items	Mean	SE	Mean	SE	Mean	SE	F-value
L^*	73.29	0.50	72.81	0.59	70.62	1.95	1.389^{NS}
a^*	3.58	0.22	3.95	0.27	3.73	0.14	0.726^{NS}
b^*	7.91	0.37	8.06	0.37	7.33	0.33	1.176^{NS}
Chroma	8.71	0.38	9.00	0.43	8.25	0.31	1.004^{NS}
Hue	65.54	1.37	64.11	1.03	6.71	1.41	1.215^{NS}

Table 7: Mean and Standard Errors (SE) for meat sensory characteristics of lambs fed control and Oregano Oil (OO) supplemented diets

	Control		250 ppm OO		500 ppm OO		
Items	Mean	SE	Mean	SE	Mean	SE	F-value
Lamb odor intensity	4.61	0.13	4.27	0.13	4.69	0.13	2.815^{NS}
Tenderness	5.26	0.13	5.54	0.13	5.42	0.13	1.299^{NS}
Juiciness	5.13	0.11	5.16	0.11	4.85	0.11	2.698^{NS}
Flavor intensity	4.83	0.12	4.66	0.12	4.75	0.12	0.541^{NS}
Flavor quality	5.15	0.10	5.21	0.10	5.05	0.10	0.637^{NS}
Overall acceptability	5.11	0.12	5.11	0.12	5.07	0.12	0.043^{NS}

NS: Not Significant ($p>0.05$)

content (Solomon *et al*., 1980). May *et al*. (1992) found that intramuscular fat content increased with increasing carcass weight. Therefore, in the present experiment it appears that similar growth rate and energy intake led to similar cooking loss values. According to published results to the present shows that many factors like animal age, fatness and ultimate pH, carcass weight are affects colour of meat (Priolo *et al*., 2001) but level and content of concentrate in feeding ruminants may be the most important factor determining the colour of meat (Huuskonen *et al*., 2010). These results are may be explain the absence of differences in colour of meat in current study which is consumed similar amount of concentrate feed. There is very limited information on effects of oregano essential oils on the flavor and aroma effects of lambs. Sensory characteristics were not affected by experimental diets in the current study. Chaves *et al*. (2008) observed no difference in sensory evaluation of lambs fed diet corn or barley based diets supplemented with 0.2 g kg^{-1} DM of carvacrol.

CONCLUSION

In the current study, dietary oregano oil supplementation did not negatively affect carcass and meat quality characteristics and sensory evaluations. However, since the dietary effects not readily affect by ruminants, supplementation level could be use higher levels and changes can be observed clearly.

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