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Effects of dietary vitamin E supplementation on fattening performance, carcass characteristics and meat quality traits of Karya male lambs

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Abstract

The objective of this study was to evaluate the effects of dietary vitamin E supplementation on performance, slaughter-carcass characteristics and meat quality traits of Karya male lambs. Lambs weaned approximately at 10 weeks of age were divided into two groups. After the 10 days adaptation period, control group (CG, *n*=7) and vitamin E group (VEG, *n*=6) lambs were fed on with concentrates *ad libitum* and 100 g hay/lamb/day for 70 days. In addition the VEG received a supplement on concentrates of 45 mg/lamb/day vitamin E during the fattening period. The meat quality traits were determined using *m. longissimus dorsi* (LD) obtained from split between 12th and 13th ribs on both groups lambs. Daily gain and feed conversion efficiency were 259 g and 5.3 for CG and 266 g and 4.7 for VEG, respectively. There was no vitamin E supplementation effect on the average daily weight gain and feed conversion efficiency ($P>0.05$). However, VEG had 10.5% higher feed conversion efficiency than control lambs. Slaughter and carcass characteristics of lambs were not significantly affected from vitamin E supplementation ($P>0.05$). There were no effects of vitamin E supplementation on lightness (L*), redness (a*), yellowness (b*) and pH during 12-day aerobic storage. Thiobarbituric acid reactive substances (TBARS) values at day 2 were not affected by the vitamin E treatment. However, TBARS values on day 4 and 8 ($P<0.05$), and day 12 ($P<0.01$) were higher in the CG than in the VEG. Although not significant, 10% higher feed conversion efficiency in VEG animals might suggest that vitamin E supplementation is useful to improve fattening performance.

Keywords: lamb, Karya, vitamin E, carcass, meat colour, TBARS, pH

Zusammenfassung

Wirkung einer Vitamin E Futterergänzung auf Mastleistung, Schlachtkörpereigenschaften und Fleischqualität bei männlichen Karya Lämmern

Es sollte die Wirkung einer Vitamin E Futterergänzung auf Mast- und Schlachtergebnisse männlicher Lämmer der Rasse Karya untersucht werden. Nach dem Absetzen der Lämmer im Alter von 10 Wochen erfolgte die Bildung von zwei Gruppen. Beide Gruppen erhielten nach einer zehntägigen Anpassungszeit *ad libitum* Konzentratfutter und 100 g Heu über einen Zeitraum von 70 Tagen. Neben der Kontrollgruppe (CG, *n*=7 Tiere) erhielt die Versuchsgruppe (VEG, *n*=6 Tiere) 45 mg Vitamin E je Tier und Tag. Die Fleischqualitätsmerkmale wurden am *m. longissimus dorsi (LD)* zwischen der 12. und 13. Rippe erfasst. Die tägliche Gewichtszunahme

und Futterverwertung bei den Gruppen CG und VEG betrug 259 g und 5,3 bzw. 266 g und 4,7. Die Gewichtsunterschiede zwischen den Gruppen waren nicht signifikant. Die Futtereffizienz lag bei der VEG um 10,5% besser als bei der CG. Bei den Schlachtkörpereigenschaften und Qualitätsmerkmalen konnten keine signifikanten Unterschiede nachgewiesen werden. Die TBARS Werte waren bei der VEG am 4., 8. und 12. Tag höher als bei der CG. Lediglich die um 10% bessere Futtereffizient rechtfertigt eine Vitamin E Futterergänzung.

Schlüsselwörter: Lamm, Karya, Vitamin E, Schlachtkörper, Fleischfarbe, TBARS, pH

Introduction

All tocopherols and tocotrienols are known as Vitamin E. Biologically most active and natural form of vitamin E is α-tocopherol (AZZI and STOCKER 2000). Vitamin E is a necessary dietary supplement for growth, reproduction, immune function, disease prevention, enhancement and tissue integrity. Vitamin E is a lipid soluble and chain breaking antioxidant that protects cellular membranes against oxidative damages. Since meat is processed by mechanical tools, the risk of oxidation via air and tools is high. Therefore colour, flavour and odour characteristics of meat can be affected during mechanical processing. During storage of meat and meat products, lipid oxidation is the main factor for loss of quality. Lipid oxidation causes negative changes on structure and nutritition value as well as colour, flavour and odour of meat (LAHUCKY *et al.* 2000, 2005). The colour stability of meat is important for retailers and consumers. Changes in meat colour are interpreted as effects of improper storage conditions. It is reported that supplementation of vitamin E delays colour change, decreases drip loss and may provide lasting of meat shelf life (ASGHAR *et al.* 1991, LAHUCKY *et al.* 2005)

In recent years, many studies were conducted on effects of dietary vitamin E supplementation on various animal performances (STROHECKER *et al.* 1997, DUFRASNE *et al.* 2000, MACIT *et al.* 2003a,b, LAUZURICA *et al.* 2005, KRSKA *et al.* 2001, KOLODZIEJ and JACYNO 2005), meat quality characteristics (meat colour, pH etc.), oxidative stability and shelf life of meat products in cattle (ROBBINS *et al.* 2003), on pork (LAHUCKY *et al.* 2005), on lamb (GUIDERA *et al.* 1997, MACIT *et al.* 2003a,b, LAUZURICA *et al.* 2005). The objective of this study was to evaluate the effects of dietary vitamin E supplementation on fattening performance, slaughter-carcass characteristics and meat quality traits of Karya male lambs.

Material and methods

This study was carried out at the Research and Practice Farm of Çine Vocational High School, Adnan Menderes University, Aydın, Turkey. Karya (KARACA *et al.* 2004) male lambs (n=13) weaned at 10 weeks of age were used in the study. The lambs were randomly divided into two groups, Vitamin E (VEG, n=6) and Control (CG, n=7) lambs. After the 10 days adaptation period, the live weights of all lambs (three consecutive days after adaptation period) were recorded as initial weight. The animals were housed in groups according to treatment and were fed a concentrate mixture *ad libitum* and 100 g clover hay/lamb/day. During the 70 days fattening period, commercially available concentrate containing 90% dry matter and 167.7 g crude protein, 60,9 g crude ash and 24.4 g crude

fat/kg and 2 407 ME, kcal/kg was fed to lambs. The hay contained 91.2% dry matter and 139 g crude protein and 375 g crude fibre/kg. In addition, VEG received a supplement of 45 mg/lamb/day (MACIT *et al.* 2003a) vitamin E (DL-α-tocopherol acetate) during the fattening period. Live weights of all lambs were recorded every second week. Final weights of all lambs were recorded at the end of the fattening period after 12 h fasting and then after 24 h fasting prior to slaughter. Concentrate consumption of the groups was recorded periodically. All animals were slaughtered at the end of the fattening period. After complete eviceration and dressing, warm carcass weights were taken. The head, skin, feet, genitalia and offal were weighed. Internal fat deposited around the kidneys (perinephric fat) and around the gastrointestinal tract (gut fat) was separated and weighed. Carcasses were chilled for 24 h at 4 °C and cold carcasses were weighed. The tails were removed at its articulation and the cannon bones were dissected from the carcasses. The cold carcasses were split into symmetrical two parts along the backbone and leg depth, leg width, leg length, rump width, chest depth, chest width and shoulder width were measured on the whole and left half of the carcasses. The left half of the carcasses were cut into six parts according to the procedure given by COLOMER-ROCHER *et al.* (1987) and weighed. The surface area of a cross section of the *m. longissimus dorsi* (LD) between the 12th and 13th ribs was traced onto an acetate paper and measured using a planimeter. Dressing percentage was calculated as a ratio of 24 h fasting weight prior to slaughter and cold carcass weight. Proportional weights were calculated as the ratio of the heart, lungs and liver weights relative to slaughter weight. The proportional weights of the testes and internal fat were calculated relative to warm carcass weight and those of the other organs and carcass cuts relative to the cold carcass weight.

The pH values were measured in the whole carcass immediately after the slaughter and again after 24 h. Meat quality traits were determined on steak cuts from LD on three lambs (according to mean live weights). The LD muscles were maintained under fluorescent light up to 12 days. The pH measured on freshly cut surfaces of LD muscle by direct probe of the pH meter (IQ 240, PH26-SS).

Meat colour was determined using a Minolta CR 300 (Minolta Camera Co., LTD, Osaka, Japan) using illuminant D65. Reflectance was determined over 400-700 nm range then L*, a* and b* values were calculated. A steak was divided into five slices and individually placed in polystyrene trays covered by oxygen permeable polyethylene film and stored at 4±1 °C for period 2, 4, 8 and 12 days (DUFRASNE *et al.* 2000, MACIT *et al.* 2003 a) after the slaughter. And then it was assessed for colour and oxidative rancidity by the thiobarbutiric acid reactive substances (TBARS) procedure. The TBARS concentrations were measured according to the procedure given by TARLADGIS *et al.* (1960) and expressed as mg malonaldehyde equivalents per kg of fresh meat.

The mathematical model for the analysis of growth performance, live weight, carcass characteristics and meat quality traits included fixed effects due to group and random effect due to residual error (SAS 1998). The Student's t-test was used to detect significant differences between means. Daily feed consumption and feed conversion efficiency were calculated on a group basis.

Results and discussion

Initial and final weight of CG and VEG lambs were 12.73 kg and 13.22 kg, and 31.37 kg and 31.38 kg, respectively. There were no significant effect of groups on the initial and final weight of lambs ($P>0.05$). The differences between the daily weight gains (266 g vs. 259 g) and feed conservation efficiency (4.7 vs. 5.3) for 70 days were found not be significant ($P>0.05$) (Table 1). However, animals in VEG had 10.5% higher feed conversion efficiency and 2.56% higher daily weight gain than those in CG. Similar results have been reported by MACIT *et al.* (2003a,b) on Morkaraman male lambs. The present results were also in agreement with the results of STROHECKER *et al.* (1997) and LAUZURICA *et al.* (2005).

Table 1
Means (±standard error) live weights, weight gain and feed conversion efficiency in CG and VEG lambs
Lebendgewicht, tägliche Gewichtszunahme und Futtereffizienz der Gruppen CG und VEG

Traits	Groups	
	CG (n=7)	VEG (n=6)
Initial weight, kg	13.218 ± 0.97	12.730 ± 0.82
Final weight, kg	31.381 ± 2.20	31.371 ± 1.27
Daily weight gain, g	259 ± 10.7	266 ± 11.5
Feed conversion efficiency	5.3	4.7

Carcass measurements, slaughter and carcass characteristics of the two groups of lambs are presented in Table 2. The leg depth, rump width, leg width and leg length of the VEG lambs tended to be higher than the CG lambs, ($P>0.05$). In the present study dietary vitamin E supplementation did not have any significant effect ($P>0.05$) on the slaughter and carcass characteristics of lambs. All examined traits were similar for both groups (Table 2). Similar results have been reported by MACIT *et al.* (2003a,b).

The changes in L*, a* and b* values over the 12 day storage period after slaughter are presented in Table 3. No significant differences were found on colour parameters (P>0.05). Changes in a* values on LD for the CG and VEG are given in Figure 1.

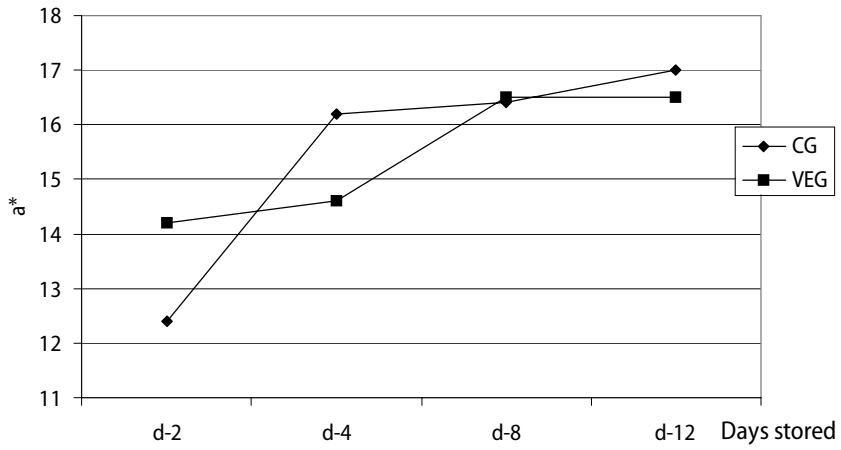

Figure1
Changes in redness (a*) in m. longissimus dorsi during storage for the CG and VEG
Veränderung der Fleischfarbe vom 2. bis 12. Tag im Vergleich der Gruppen CG und VEG

Table 2
Means (±standard error) slaughter and carcass characteristics in CG and VEG lambs
Schlachtmerkmale der Gruppen CG und VEG

Traits	Groups	
	CG (*n*=7)	V EG (*n*=6)
Carcass measurements, cm		
Chest depth	25.557 ± 0.524	24.833 ± 0.380
Leg depth	9.044 ± 0.349	9.848 ± 0.368
Shoulder width	16.471 ± 0.613	16.200 ± 0.502
Rump width	16.800 ± 0.816	17.016 ± 0.896
Leg width	6.518 ± 0.400	6.926 ± 0.369
Leg length	28.214 ± 0.730	28.416 ± 0.523
MLD area, cm^2	11.357 ± 0.752	10.183 ± 0.57
Fat thickness over LD, mm	2.11 ± 0.238	1.69 ± 0.205
Carcass weight, kg and dressing percentage, %		
Slaughter weight	31.771 ± 2.423	30.808 ± 1.501
Warm carcass weight	15.922 ± 1.183	15.630 ± 0.722
Cold carcass weight	15.524 ± 1.137	15.160 ± 0.697
Dressing percentage	48.94 ± 0.51	49.50 ± 1.91
Offal items, kg		
Head weight	1.937 ± 0.125	1.913 ± 0.059
Internal fat weight	0.224 ± 0.035	0.245 ± 0.017
4 feet weight	0.797 ± 0.052	0.825 ± 0.039
Skin weight	3.252 ± 0.279	3.470 ± 0.270
Heart, lungs and liver weight	1.357 ± 0.100	1.265 ± 0.078
Testes weight	0.175 ± 0.034	0.163 ± 0.027
Kidney weight	0.097 ± 0.006	0.103 ± 0.008
Spleen weight	0.072 ± 0.007	0.051 ± 0.003
Kidney and pelvic fat weight	0.249 ± 0.031	0.228 ± 0.017
Tail weight	0.315 ± 0.031	0.431 ± 0.090
Wholesale cuts of left half of carcass, kg		
Leg weight	2.407 ± 0.169	2.378 ± 0.120
Back-loin weight	1.580 ± 0.143	1.452 ± 0.104
Forearm weight	1.384 ± 0.095	1.358 ± 0.053
Shoulder weight	0.628 ± 0.056	0.516 ± 0.047
Neck weight	0.697 ± 0.070	0.708 ± 0.120
Flank-chest weight	0.675 ± 0.077	0.685 ± 0.056
Proportional yields (percentage ±standard error) of wholesale carcass cuts and organs to cold carcass weights		
Heart, lungs and liver	4.287 ± 0.096	4.101 ± 0.126
Testes	1.074 ± 0.197	1.025 ± 0.151
Kidney	0.628 ± 0.056	0.684 ± 0.052
Kidney and pelvic fat	1.577 ± 0.099	1.514 ± 0.109
Internal fat	1.370 ± 0.159	1.566 ± 0.083
Tail	2.034 ± 0151	2.803 ± 0.497
Legs*	15.528 ± 0.623	15.683 ± 0.329
Back-loin*	20.400 ± 0.355	19.89 ± 0.557
Shoulder*	4.056 ± 0.239	3.392 ± 0.224
Flank-Chest*	4.295 ± 0.266	4.530 ± 0.331
Fore-arm*	8.950 ± 0.147	8.978 ± 0.147
Neck*	4.518 ± 0.324	4.691 ± 0.238

* relative to cold half carcass weights

Table 3
Mean (±standard error) colour parameters of *m. longissimus dorsi* during storage for the CG and VEG
Fleischfarbmerkmale am M. longissimus dorsi am 2. bis 12. Tag nach der Schlachtung

	N	L*		a*		b*	
		CG	VEG	CG	VEG	CG	VEG
Day 2	3	42.0 ± 1.60	43.5 ± 1.34	12.4 ± 2.15	14.2 ± 1.73	10.8 ± 1.04	10.1 ± 0.10
Day 4	3	47.0 ± 1.52	48.3 ± 1.01	16.2 ± 0.99	14.6 ± 0.88	12.9 ± 0.69	12.3 ± 0.88
Day 8	3	47.7 ± 1.35	47.7 ± 1.28	16.4 ± 1.23	16.5 ± 1.48	14.8 ± 0.65	14.6 ± 1.31
Day 12	3	46.0 ± 1.44	47.0 ± 1.14	17.0 ± 0.69	16.5 ± 1.44	14.5 ± 0.52	15.7 ± 1.12

Colour stability can be affected by many factors such as muscle type, diet, storage period, storage temperature and oxygen availability.

Many studies were conducted on the effects of vitamin E on meat colour although those studies were differed in terms of storage period, packaging, and amount of vitamin E supplementation (KRSKA *et al.* 2001).

These results are in agreement with those of MACIT *et al.* (2003 b) who found no differences in L*, a* and b* values on LD during 12 day storage period between vitamin E supplemented (45 mg/ lamb/ day for the 75 day before slaughter) and control Awassi lambs.

However, GUIDERA *et al.* (1997) reported that colour stability of α-tochopherol supplemented (1 000 mg/kg) group lambs had more favourable than control group lambs. Researchers also reported that vitamin E supplementation delayed metmyoglobin formation on lamb patties under modified atmosphere condition (KERRY *et al.* 2000), and increased oximyoglobin formation of lamb meat stored under modified atmosphere during 14 days, in Manchego breed (LAUZURICA *et al.* 2005).

TBARS values during storage are given in Table 4 and Figure 2. TBARS values of fresh meat were low in both groups at day 2 and did not differ significantly. However, TBARS values increased after day 2 and differed significantly on days 4, 8 ($P<0.05$) and 12 ($P<0.01$) between CG and VEG animals.

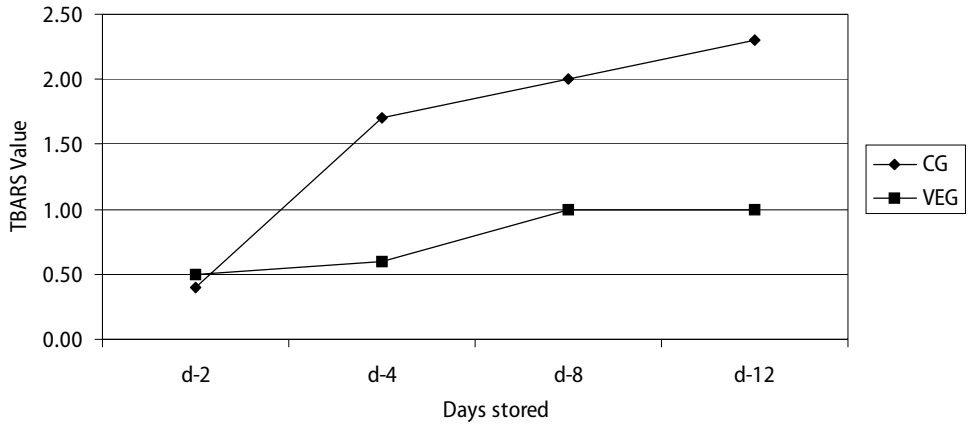

Figure 2
Changes in TBARS values in *m. longissimus dorsi* during storage for CG and VEG
Veränderung der Fleischfarbe vom 2. bis 12. Tag im Vergleich der Gruppen CG und VEG

Table 4
Mean (±standard error) TBARS values of *m. longissimus dorsi* during storage for CG and VEG
TBARS-Werte des M. longissimus dorsi vom 2. bis 12. Tag nach der Schlachtung

Days	*N*	TBARS, mg malanoaldehyde/kg fresh meat		
		CG	VEG	*P*
Day 2	3	0.4 ± 0.06	0.5 ± 0.17	ns
Day 4	3	1.7 ± 0.35	0.6 ± 0.09	*
Day 8	3	2.0 ± 0.35	1.0 ± 0.14	*
Day12	3	2.3 ± 0.15	1.0 ± 0.57	**

ns not significant ($P>0.05$), *within rows differences were significant at $P<0.05$, **within rows differences were significant at $P<0.01$

These findings are consistent with those of STROHECKER *et al.* (1997) who found a delay in lipid oxidation during storage in lamb meat supplemented with 2000 IU a-tocopheryl acetate.

Similarly, LOPEZ-BOTE *et al.* (2001) reported the TBARS value of meat from under refrigerated and dark conditions during 9 days as 0.45 mg MDA/kg muscle for lambs supplemented with 1 000 mg of vitamin E/kg, whereas the TBARS value for non-supplemented lambs was 3.1 mg MDA/kg muscle.

MACIT *et al.* (2003a) found that TBARS values on LD of Morkaraman male lambs fed vitamin E supplemented diet were lower ($P<0.05$) at days 2, day 4, day 8 and day 12, than those of controls.

Similarly, protective effect of dietary vitamin E supplementation against lipid oxidation under various conditions in lamb (KERRY *et al.* 2000, MACIT *et al.* 2003b, LAUZURICA *et al.* 2005) and pork (BUCKLEY *et al.* 1989, ASGHAR *et al.* 1991, LAHUCKY *et al.* 2005) was reported. The results presented here are in consistent with those mentioned above.

In this study, pH values of whole carcass at slaughter and 24 h after slaughter were not different between groups. Similarly, pH values of LD muscles on days 2, 4, 8 and 12 (Table 5) were not different between groups.

Table 5
Mean (±standard error) pH values in whole carcass at slaughter and after 24 h and *m. longissimus dorsi* during storage for CG and VEG
pH Werte im m. longissimus dorsi und dem Gesamtschlachtkörper bei den Gruppen CG und VEG

Days	*N*	pH		
		CG	VEG	*P*
Day 2	3	5.7 ± 0.08	5.5 ± 0.05	ns
Day 4	3	6.0 ± 0.26	5.8 ± 0.17	ns
Day 8	3	5.9 ± 0.19	5.5 ± 0.06	ns
Day 12	3	5.2 ± 0.18	5.7 ± 0.06	ns
In whole carcass				
At slaughter	3	6.21 ± 0.25	6.24 ± 0.27	ns
24 hr	3	5.50 ± 0.07	5.61 ± 0.04	ns

ns not significant

LAUZURICA *et al.* (2005) found that dietary vitamin E supplementation had no effect on pH 24 h after salughter. Similar results have been reported by MACIT *et al.* (2003b) at different storage periods.

In conclusion, dietary 45 mg/lamb/day vitamin E supplementation during 70 days resulted more favourably TBARS values of meat than those of nonsupplemented group lambs. Although not significant, 10% higher feed conversion efficiency in VEG animals might suggest that vitamin E supplementation is useful to improve fattening performance. Meat colour, pH, slaughter and carcass characteristics were not influenced by vitamin E supplementation. In the vitamin E supplementation studies it has been reported that, lipid oxidation of meat, especially during the long storage periods was reduced by vitamin E. However, the results obtained in studies related to the effects of vitamin E supplementation on meat colour and pH values were contradictory. In general, in studies related to the effects of vitamin E supplementation on performance, slaughter and carcass characteristics were found that performance was not affected by vitamin E supplementation.

Nevertheless, since the number of animals used in the studyis relatively low, the absence of significant differences between groups should be further evaluated using more animals, different vitamin E doses and different storing and evaluating conditions of meat.

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