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Research Article

Effect of Vitamin E Supplementation to the Diet of Morkaraman Lambs on Intramuscular and Intermuscular Fatty Acid Composition

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Abstract: This research was carried out to determine the effects of vitamin E (DL-α tocopheryl acetate) supplementation on inter- and intramuscular fatty acid composition in the meat of Morkaraman lambs. The lambs were divided into 2 groups, control (CG, n = 10) and experimental (VG, n = 10), at the beginning of the fattening period. The CG and VG lambs were fed the same concentrate and hay. The VG lambs also received a supplement of 45 mg of vitamin E per lamb per day during the 75-day fattening period prior to slaughter. Vitamin E supplementation increased margaric acid in intramuscular fat and stearic acid in intermuscular fat significantly ($P < 0.05$), while it had no influence on the other fatty acids. The unsaturated fatty acid content of intramuscular fats was higher than that of intermuscular fats ($P < 0.05$).

Key Words: Vitamin E, Morkaraman lambs, fatty acid composition

Morkaraman Kuzu Rasyonuna Vitamin E İlavesinin İntramüsküler ve İntermüsküler Yağ Asidi Bileşimine Etkisi

Özet: Araştırmada Morkaraman kuzu rasyonunda Vitamin E kullanımının, kuzu etlerinin intramüsküler ve intermüsküler yağ asidi kompozisyonuna etkileri incelenmiştir. Deney grubuna (VG, n = 10) kuzu başına günde 45 mg vitamin E (DL-α tocopheryl acetate) ilave edilen konsantre yem ve kuru çayır otu, kontrol grubuna (CG, n = 10) ise sadece konsantre yem ve kuru çayır otundan oluşan rasyon 75 gün süreyle verilmiştir. Vitamin E ilave edilen grupta kasiçi yağlarda margarik ($C_{17:0}$), kaslararası yağlarda stearik asit ($C_{18:0}$) miktarları kontrol grubundan daha yüksek bulunmuş ($P < 0,05$), diğer yağ asitleri üzerine önemli etkilerinin olmadığı ($P > 0,05$) saptanmıştır. Ayrıca, kasiçi yağların doymamışlılık düzeylerinin kaslararası yağlardan daha yüksek olduğu tespit edilmiştir ($P < 0,05$).

Anahtar Sözcükler: Vitamin E, Morkaraman kuzu, yağ asidi kompozisyonu.

Introduction

It is well known that different diet applications in animal nutrition change the content of vitamin E in meat (1). Vitamin E is present in minute amounts in every cell. The most widely accepted biochemical function for this vitamin is its role as an antioxidant. It is nature's best fat-soluble 'biological' antioxidant and functions in protecting cell membranes as well as other nutrients, such as polyunsaturated fatty acids. Many studies have shown that vitamin E has a positive effect on some quality traits and fatty acid compositions of meat and meat products (2-5).

The fatty acid compositions of fats of animal and plant origin in the human diet have an important effect on health, because humans consume different fatty acids found in plant and animal products. In order to avoid dietary risk factors in human nutrition, it has been recommended to decrease the intake of saturated fatty acids and to increase the intake of polyunsaturated fatty acids by substituting saturated fat with polyunsaturated fat (6,7). In particular, saturated fatty acids are the main cause of elevated plasma levels of LDL-cholesterol in humans but if the saturated fats are replaced with polyunsaturated fats the plasma cholesterol level falls because of a shift of cholesterol from plasma into the tissues. An elevated blood cholesterol level is a risk factor indicating a susceptibility to atherosclerotic heart disease (1,7-9).

There has apperantly been no study on the effect of vitamin E supplementation on the fatty acid composition

of fat of meat from Morkaraman lambs. However, a study concerned with the effect of vitamin E supplementation on fatty acid composition in intra- and intermuscular fats in meat from Awassi lambs was carried out, but no effect of vitamin E supplementation on fatty acid profiles was observed (10).

The objective of the present experiment was to study the effects of vitamin E supplementation on the fatty acid compositions of intramuscular and intermuscular fats in meat from Morkaraman lambs.

Materials and Methods

The experiment was conducted at the Application and Research Farm of the College of Agriculture, Atatürk University at Animal Science Department, Erzurum, and 26 fat tailed Morkaraman male lambs born in the lambing season 2000 were used as starting material. The lambs were divided into 2 groups, control and experimental, at the beginning of the fattening period and 10 lambs from each group were used. The control group (CG) and vitamin E group (VG) lambs were fed the same concentrate including 15 mg of vitamin E due to the vitamin mixture and raw materials in the diet and hay. In addition, the VG lambs were supplemented with 45 mg of vitamin E (DL-α tocopheryl acetate) per lamb during the 75-day fattening period. The lambs were fed a concentrate close to ad libitum by biweekly adjustment of the content offered, and average concentrate consumptions per lamb per day were determined to be 1026 and 998 g for CG and VG, respectively. Concentrate feed was composed of barley (42.0%), maize (24.0%), soybean meal (10.0%), wheat bran (4.0%), molasses (8.0%), sunflower meal (8.0%), premix (0.05%), salt (0.95%), and dicalcium phosphate (3.0%). The concentrate mixture contained 91.0% dry matter, 13.3% crude protein, 10.5% crude fibre, 3.2% ether extract, 55.9% nitrogen free extract and 2.550 MJ ME/kg. Grass hay was fed daily (300 g per lamb per day) during the fattening period to both groups. Grass hay comprised 91.70% dry matter, 6.10% crude protein, 27.50% crude fibre, 2.70% ether extract and 46.13% nitrogen free extractions.

After the 75-day fattening period, the lambs were conventionally slaughtered, pelted, eviscerated and split into halves. M. longissmus dorsi (LD) muscles were excised from the carcasses, and the intra- and intermuscular fats from the LD muscles were used as study material.

The intramuscular and intermuscular fats were extracted from the LD muscles by the ether extraction method. The samples were dried in an anaerobic incubator at 40 °C prior to ether extraction, and petroleum ether with low boiling temperature (40-60 °C) was used for total lipid extraction (11-13).

Methyl esters of fat samples obtained from the LD muscles were prepared with borontrifluoride-methanol (BF_3-methanol) to determine the fatty acid composition. Then 0.15-0.20 g of fat sample was added to 5 ml of 0.5 N methanolic-NaOH in a flask, followed by incubation for 10 min in a boiling water bath. After the saponification, 5 ml of BF_3-methanol reactive was added to the sample and boiled for 2 min, and then 5 ml of heptane was added and boiled for 1 min. The content of the balloon was removed from the water bath and cooled on the bench. The sample mixture was transferred into a 25 ml volumetric flask. The esterified samples in the volumetric flask were adjusted with saturated NaCl on the shaker. One millilitre of the heptane phase from the upper layer of the volumetric flask was used to determine the fatty acid composition (14). Fatty acid methyl esters were analysed by gas chromatography (Perkin Elmer Instrument Auto System XL gas chromatograph) with a capillary column (SGE, 60 m x 0.25 mm ID-BP x 70, 0.25), temperature increasing from 150 °C to 250 °C at a rate of 2 °C/min, FID detector (H_2 and dry air) at 240 °C, helium gas (1 ml/min, 150 kPa) and an injection block temperature of 250 °C.

Data obtained from this study were analysed using the SPSS. Statistical analysis of the results was carried out according to the nested effect including fixed effect due to groups (VG and CG) and residual error.

$$y_{ij} = \mu + a_i + e_{ij}$$

in which y_{ij}: an observation on treatment; μ = arithmetic mean; a_i = effect of the groups (VG and CG); e_{ij} = residual experimental error (15).

Results

The saturated and unsaturated fatty acid compositions determined in intramuscular fats from control and vitamin E supplemented Morkaraman male lamb groups are presented in Table 1.

The fatty acid composition determined in intermuscular fats from control and vitamin E supplemented Morkaraman male lamb groups are presented in Table 2.

Discussion

In intramuscular fats, only the effect of vitamin E supplementation on margaric acid was determined to be significant ($P < 0.05$). The content of margaric acid was 1.35 ± 0.16% for the vitamin E supplemented group and 0.83 ± 0.24% for the control group (Table 1). Bas and Morand-Fehr (16) reported that the content of margaric acid in lamb meat was 1.4%. Nas et al. (17) stated that the content of margaric acid in animal fats was approximately 2.00%.

Vitamin E supplementation had no influence on other fatty acids. The proportions of palmitic and stearic acids from saturated fatty acids in intramuscular fats were 27.67 ± 0.10% and 17.32 ± 2.63%, respectively (Table 1). Oleic acid constituted the highest proportion (45.70 ± 3.43%) of unsaturated fatty acid content in intramuscular fats (Table 1). Enser et al. (18) reported 22.5% and 18.1% for palmitic and stearic acids from saturated fatty acids and 32.5% for oleic acid from unsaturated fatty acids in lamb meat. Enser et al. (19) determined that palmitic (20.9%) and stearic (17.5%) acids from saturated fatty acids and oleic (30.3%) acid from unsaturated fatty acids were high in the LD muscles of lambs. These results from the present study agree with the findings of Enser et al. (18) and Enser et al. (19). The same investigators also indicated that the myristic, palmitoleic, linoleic and linolenic acid contents of LD muscles from the lamb carcass were 3.99%, 2.19%, 3.24% and 0.02%, respectively. Bas and Morand-Fehr (16) reported that palmitic (22.5%), stearic (15.6%) and

Table 1. Fatty acid composition in intramuscular fats of LD muscle.

Fatty Acid	Control	Vitamin E	Mean values
	Saturated fatty acids, %		
Capric ($C_{10:0}$)	0.22 ± 0.10[1]	0.17 ± 0.04[1]	0.19 ± 0.07[2]
Lauric ($C_{12:0}$)	0.19 ± 0.07	0.16 ± 0.04	0.18 ± 0.05
Myristic ($C_{14:0}$)	3.45 ± 0.42	3.31 ± 0.47	3.38 ± 0.41
Palmitic ($C_{16:0}$)	27.65 ± 1.23	27.68 ± 0.10	27.67 ± 0.10
Margaric ($C_{17:0}$)	0.83 ± 0.24 *	1.35 ± 0.16 *	1.09 ± 0.34
Stearic ($C_{18:0}$)	17.66 ± 1.29	16.98 ± 3.91	17.32 ± 2.63
Arachidic ($C_{20:0}$)	0.30 ± 0.26	0.42 ± 0.36	0.36 ± 0.29
Total saturated	50.30 ± 2.97	50.07 ± 3.33	50.18 ± 2.83
	Unsaturated fatty acids, %		
Palmitoleic ($C_{16:1}$)	1.67 ± 0.35	2.08 ± 0.71	1.88 ± 0.56
Oleic ($C_{18:1}$)	45.61 ± 3.24	45.78 ± 4.35	45.70 ± 3.43
Linoleic ($C_{18:2}$)	2.39 ± 0.34	2.13 ± 0.68	2.26 ± 0.50
Linolenic ($C_{18:3}$)	0.03 ± 0.03	0.15 ± 0.19	0.09 ± 0.14
Total unsaturated	49.70 ± 2.97	49.93 ± 3.33	49.81 ± 2.83

[1] ± Standard deviation of 10 samples.

[2] ± Standard deviation of 20 samples.

* $P < 0.05$

Table 2. Fatty acid composition in intermuscular fats of LD muscle.

Fatty Acid	Control	Vitamin E	Mean values
	Saturated fatty acids, %		
Capric ($C_{10:0}$)	0.52 ± 0.42 [1]	0.20 ± 0.22 [1]	0.36 ± 0.35 [2]
Lauric ($C_{12:0}$)	0.12 ± 0.07	0.14 ± 0.14	0.13 ± 0.10
Myristic ($C_{14:0}$)	3.83 ± 1.71	4.53 ± 1.03	4.18 ± 1.32
Palmitic ($C_{16:0}$)	30.34 ± 2.22	26.99 ± 4.63	28.67 ± 3.73
Margaric ($C_{17:0}$)	2.42 ± 0.60	1.40 ± 0.43	1.91 ± 0.72
Stearic ($C_{18:0}$)	13.67 ± 1.43*	19.20 ±2.81*	16.44 ± 3.63
Arachidic ($C_{20:0}$)	0.27 ± 0.38	0.00 ± 0.00	0.14 ± 0.28
Total saturated	51.17 ± 3.42	55.11 ± 3.53	53.14 ± 3.78
	Unsaturated fatty acids, %		
Palmitoleic ($C_{16:1}$)	4.02 ± 0.74	3.37 ± 0.46	3.70 ± 0.66
Oleic ($C_{18:1}$)	43.55 ± 2.73	40.65 ± 2.29	42.10 ± 2.76
Linoleic ($C_{18:2}$)	1.22 ± 0.33	0.88 ± 0.82	1.05 ± 0.59
Linolenic ($C_{18:3}$)	0.03 ± 0.06	0.00 ± 0.00	0.02 ± 0.04
Total unsaturated	48.73 ± 3.34	44.89 ± 3.53	46.81 ± 3.72

[1] ± Standard deviation of 10 samples.

[2] ± Standard deviation of 20 samples.

* $P < 0.05$

oleic (40.4%) acids were dominant in the intramuscular fats of lamb meat. A similar study was carried out to determine the effect of vitamin E supplementation (45 mg of vitamin E/day) on the fatty acid compositions of intramuscular fats from Awassi lambs, but no effect was observed. Findings pertaining to fatty acid compositions in the intramuscular fats of LD muscles from Morkaraman lambs were comparable with those given by Aksu et al. (10), who found the proportions of palmitic, stearic, oleic and linoleic acids in LD muscles from Awassi lambs to be 28.52%, 18.64%, 44.62% and 2.22%, respectively.

The effect of vitamin E supplementation on the fatty acid compositions of intermuscular fats was not statistically significant ($P > 0.05$) except for on stearic acid ($P < 0.05$).

When intermuscular fats were investigated in terms of saturated fatty acid composition, the proportions of myristic and stearic fatty acids in vitamin E supplemented samples and the proportions of capric, palmitic, margaric and arachidic acids in control samples were determined to be relatively high.

The most remarkable difference between control and vitamin E supplemented samples was determined in the proportion (approximately 6%) of stearic acid. The content of stearic acid in vitamin E supplemented samples and control samples was 19.20 ± 2.81% and 13.67 ± 1.43%, respectively (Table 2). In contrast to these findings, Aksu et al. (10) reported that the content of stearic acid in intermuscular fats of LD muscles from vitamin E supplemented Awassi lambs was lower (3%) than that of the control samples. Enser et al. (18) stated that the proportions of lauric, myristic, palmitic, stearic and palmitoleic acids in the fatty acid composition of lamb adipose tissue were 0.37%, 4.11%, 21.9%, 22.6% and 2.40%, respectively.

The proportion of oleic acid (mean values: 42.10 ± 2.76%) in the unsaturated fatty acid composition of

intramuscular and intermuscular fats was higher than those of other unsaturated fatty acids. Although the rate of oleic acid in control and vitamin E supplemented samples was 43.55 ± 2.73% and 40.65 ± 2.29%, respectively, the difference between control and vitamin E supplemented samples in the rate of oleic acid was not significant (Table 2). An investigation carried out by Enser et al. (18) revealed that oleic, linoleic and linolenic acids constituted 28.7%, 1.31% and 0.97% of the unsaturated fatty acid composition in lamb adipose tissue. The proportions of total fatty acids in intramuscular and intermuscular fats from Morkaraman lambs were 49.81 ± 2.83% and 46.81 ± 3.72%, respectively. The difference between the control and vitamin E supplemented groups in contents of unsaturation was not significant (49.70 ± 2.97% and 49.93 ± 3.33%) in intramuscular fats (Table 1). In intermuscular fats, while the total unsaturated fatty acid content of the control group was 48.73 ± 3.34%, this value was 44.89 ± 3.53% in the vitamin E supplemented group (Table 2).

In conclusions, palmitic, stearic and oleic acids were dominant in the fatty acid composition of intramuscular and intermuscular fats. The difference in terms of margaric acid between the intramuscular fats of the control and vitamin E supplemented groups was significant, and the vitamin E supplemented group had higher margaric acid than the control group. The difference in terms of stearic acid between the groups was significant ($P < 0.05$) and the stearic acid content in the intermuscular fats of the vitamin E supplemented group was also higher than that of the control group. In addition, unsaturated fatty acid content in intramuscular fats was higher than that in intermuscular fats ($P < 0.05$).

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