EFFECTS OF DIETARY VITAMIN E SUPPLEMENTATION ON MEAT QUALITY, VITAMIN E CONTENTS AND OXIDATIVE STABILITY OF RABBIT MEAT

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ABSTRACT

One hundred and twenty weaned meat rabbits were randomly allocated to one of six diets. The diets contain 0, 40, 80, 160, 320 and 640 mg/kg α-tocopheryl acetate. Forty-eight rabbits were slaughtered at age of 90 days. Effects of dietary vitamin E (VE) supplementation on meat quality, α-tocopherol contents and oxidative stability were evaluated. The α-tocopherol contents in the serum, liver and meat increased when the dietary VE levels increased (p□0.0001). The dietary VE supplementation significantly affected the pH of the *Biceps femoris* (BF) 45 min *post-mortem* and day 1 ($p<0.05$). The dietary VE supplementation significantly increased the tenderness of meat and decreased the contents of malondialdehyde (MDA) in serum, liver and meat ($p=0.005$, $p=0.014$ and $p<0.0001$).

Key words: Rabbit meat, vitamin E, meat quality, oxidative stability

INTRODUCTION

Recently, human resources have been expended to widely study the effects of various biological and zootechnical factors on rabbit carcass and meat quality (Dalle Zotte, 2002). Dietary vitamin E (VE) increases muscle VE concentrations, protects muscle polyunsaturated fatty acids against oxidative deterioration and improves meat quality. In recent years, many experiments have been carried out to study the effects of dietary supplementation of various animal species with supranutritional doses of VE on the deposition of VE in tissues, on meat quality, on oxidative stability and on the shelf life of products (Guidera *et al*., 1997, lamb meat; Eikelenboom et al., 2000, beef; Lo Fiego *et al*., 2004, Dalle Zotte and Szendrő, 2011, rabbit). Therefore, the aim of this work was to evaluate the effects of different levels VE supplementation (up to 640 mg/kg of feed) on the meat quality, α-tocopherol contents and oxidative stability of rabbit meat.

MATERIALS AND METHODS

Animal and diets

One hundred and twenty weaned New Zealand White rabbits were allocated to six groups according to the average body weight and sex. There were 20 rabbits in each group and the animals with each group have similar weights. Rabbits were individually housed in self-made digestibility cages (60×40×40 cm). During the trials, rabbits were housed in a closed and ventilated building in which the maximum temperature is 28 °C and the minimum temperature is 18 °C. A cycle of 12 h of light and 12 h of dark was used throughout this trial. The diets were formulated according to the values from NRC (1977) and de Blas and Mateos (1998) and were pelleted. The main feed ingredients were corn, wheat bran, peanut vine, soya bean meal (crude protein, 16%, crude fiber, 15%, crude fat 3.0%, ash 9.2%). The VE supplementation levels of the six experimental diets were 0, 40, 80, 160, 320 and 640 mg/kg of feed

(original matter basis), respectively. Diets differed only in VE (dl-α-tocopheryl acetate). The trial lasted for 55 days which included a 7-day adjustment period and a 48-day experimental period. Feeds were provided *ad libitum* and the feeder was refilled at 8:30 and 17:30 daily.

Sampling

Immediately before slaughter, blood samples from 48 animals were drawn from the marginal ear vein and the serum were gotten. The animals were stunned and killed by cervical dislocation 1 h before dark. At slaughtering, the liver, whole *Longissimus lumborum* (LL) and *Biceps femoris* (BF) were removed from each carcass. The pH of LL and BF were measured. The drip loss and tenderness of LL and BF were measured. The α-tocopherol contents of LL, liver and plasma were measured.

Analyses

The pH values of the LL and BF were determined from each rabbit 45 min post-mortem and day 1 with a pH meter equipped with a pH probe. The drip loss and water loss ratio were determined according to the method of Blasco *et al*. (1993). Shear force was evaluated on cores (1.25×2 cm) obtained from the mid-portions of the cooked samples (80 °C, 10min) of the LL by cutting them perpendicular to fiber direction, using the Warner-Blatzler meat shear apparatus (C-LM, Harbin, P. R. China). One gram of tissue (muscle or liver) homogenate with 9 ml of 1.15% KCl was incubated at 37 °C in 40 mmol Tri-maleate buffer (pH 7.4) with 1 mmol $FeSO_4$ (to catalyse lipid peroxidation). After 300 min, an aliquot was removed for measurement of the superoxide dismutase (SOD) activity and malondialdehyde (MDA) concentration with commercial kits (Nanjing Jiancheng Bioengineering Institute, Nanjing City, P.R. China). α-tocopherol was determined in serum as described by Vuilleumier *et al*. (1983) and in muscle and liver as described by Zaspel and Csallany (1983).

Statistical analysis

Data collected from the experiments were subjected to analysis of variance using the one way-ANOVA Procedure of SAS (1985). When a significant effect (p<0.05) occurred, data were further subjected to compare using the Scheffe's Multiple Range Test.

RESULTS AND DISCUSSION

The α-tocopherol contents of tissues and serum increased with dietary VE supplementation (P<0.0001) (Table 1).

VE is stored throughout all body tissues; major deposits are in adipose tissue, liver, and muscle, with the highest storage in the liver. In this study, the liver exhibited the greatest concentration of α-tocopherol, followed by the meat, and the serum.

Table 1: α-tocopherol content of serum, liver and meat of different dietary Vitamin E levels (n=8)

	Control	40mg/kg	80mg/kg	160mg/kg	320mg/kg	640mg/kg	R-MSE	*p*-value
Serum (μg/ml)	0.0671^{B}	0.0766^{B}	0.186^{A}	0.192^{A}	0.228^{A}	0.246^{A}	0.052	□0.0001
Liver (mg/kg)	1.16^{D}	7.95^{D}	10.5^{CD}	12.6^{BC}	22.0^{AB}	29.7^{A}	8.795	□0.0001
Muscle (mg/kg)	0.65^{D}	1.65^{D}	3.83^{C}	3.88^{C}	5.93^{B}	7.45^{A}	1.113	□0.0001

Values in a row with different superscript differ significantly within treatment p<0.01 (A, B, C, D).

When the dietary VE level increased, the pH value of the BF 45 min post-mortem significantly increased (p=0.015) and the pH value of the BF day 1 significantly decreased (p=0.006), the pH value of the LL day 1 shown a decrease trend (p=0.051) (Figure 1). In the same dietary VE level, the pH values of the LD and BF day 1 were lower than those of 45 min post-mortem, the pH values of the BF day 1 and 45 min post-mortem were also lower than those of the LD.

As shown in Table 2, the drip loss has a decrease trend (p=0.062) when the dietary VE supplementation levels increased and dietary VE levels have significantly effects on shear force (p=0.027).

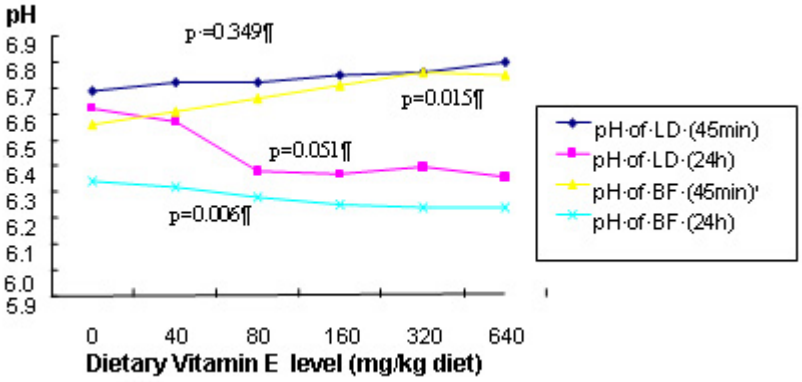

Figure 1: The pH values of the LD and BF of different VE supplementation levels (n=8)

Table 2: The meat quality of different Vitamin E supplementation levels (n=8)

	Control	40mg/kg	80mg/kg	160mg/kg	320mg/kg	640mg/kg	R-MSE	*p*-value
Water loss (%)	12.31	12.77	12.46	11.75	11.71	11.68	2.595	0.917
Drip loss (%)	2.56	2.29	2.19	2.07	1.95	1.70	0.324	0.062
Shear force (N/cm^2)	43.71^a	45.18^a	34.10^b	33.81^b	34.01^b	33.61^b	7.722	0.027

Values in a row with different superscript differ significantly within treatment P<0.05 (a, b).

The dietary VE levels have no effects on SOD activities in serum, liver and meat (Table 3).

Table 3: The SOD activities in serum, liver and meat of different VE supplementation levels (n=8).

	Control	40mg/kg	80mg/kg	160mg/kg	320mg/kg	640mg/kg	R-MSE	*p*-value
Serum (IU/ml)	344.12	343.40	352.13	365.24	371.54	361.14	95.45	0.239
Liver (IU/mg prot)	199.97	176.85	183.48	143.98	172.61	183.90	35.32	0.355
Meat (IU/mg prot)	41.16	39.49	40.11	37.32	40.01	42.19	7.86	0.767

As shown in Table 4, when the dietary VE supplementation levels increased, the contents of MDA in serum and meat decreased (p=0.005 and p<0.0001). The content of MDA in the liver after induction of 40, 80, 160, 320 and 640 mg/kg VE groups were lower than that of control group (p<0.05).

Table 4: The content of MDA after induction in serum, liver and meat of different VE levels (n=8).

	control	40mg/kg	80mg/kg	160mg/kg	320mg/kg	640mg/kg	R-MSE	*p*-value
Serum (nmol/ml)	3.38^A	2.90^A	2.50^{AB}	2.34^{AB}	1.76^B	1.70^B	0.571	0.005
Liver (nmol/mg prot)	7.72^a	4.43^b	3.51^b	3.78^b	3.32^b	3.56^b	2.507	0.014
Meat (nmol/mg prot)	3.19^A	2.22^B	1.88^B	1.77^B	1.23^C	1.04^C	0.389	<0.0001

Values in a row with different superscript differ significantly within treatment p<0.05 (a, b). Values in a row with different superscript differ significantly within treatment p<0.01 (A, B, C).

Recent research conducted in cattle, pigs, poultry and other species has shown the benefits of including high doses of VE (>200 mg/kg) on the maintenance of the quality of the meat after slaughter. Many researches illustrated that the α-tocopherol levels in serum and muscle of rabbits were significantly higher in the supplemented group and the oxidative stability in meat increased with dietary VE levels, meanwhile, the higher VE level improved the physical traits of the meat such as reducing shear value and increasing water-holding capacity (Castellini *et al.*, 1998; Corino *et al*., 1999; Dal Bosco *et al.*, 2001; Lo Fiego *et al*., 2004). But, Dal Bosco *et al.* (2004) showed that the sensory quality of the fresh muscle of 85 days old rabbits was slightly affected by the dietary treatment, even though final tenderness of the treatment rabbits showed significantly higher scores.

CONCLUSION

The dietary VE supplementation significantly increased the α-tocopherol content of serum and tissue and improved the tenderness of meat, meanwhile increased the anti-oxidative capacity of growing meat rabbits. Using a ration mainly consisting of corn, wheat bran and peanut vine, the optimal VE supplementation concentration was 80 mg/kg which can improve the tenderness of muscle and anti-oxidative capacity of growing meat rabbits.

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