*Journal of Animal and Feed Sciences, 6, 1997, 439–449*

# Influence of short-term vitamin E supplementation to bulls fed different concentrates on vitamin E content in body tissues and oxidative stability of kidney fat

**G. Flachowsky[1] , Kornelia Kuhn[2] , Astrid Schneider[2] and R. Daenicke[1]**

[1] *Institute of Animal Nutrition of the Federal Agricultural Research Centre (FAL) 38116 Braunschweig-Völkenrode, Bundesallee 50 D-38116 Braunschweig, Germany*
[2] *Institute of Nutrition and Environment of Friedrich-Schiller-University Jena Dornburger Str. 24, D- 07743 Jena, Germany*

(Received 17 July 1997; accepted 24 October 1997)

ABSTRACT

Two groups of 14 fattening bulls each were individually fed from 177 to 552 kg body weight with wilted grass silage *ad libitum* and concentrate based on maize (maize group) or wheat (wheat group), 2.7 kg per animal and day. Twenty one days before slaughter the diet of seven bulls of each group was supplemented with 1 g α-tocopherylacetate per animal and day. During slaughter, samples of blood, liver, *M. longissimus dorsi* and kidney fat were taken for vitamin E determination by HPLC. Fatty acid pattern and induction time of kidney fat were determined by the Rancimat test.

Diet did not influence silage dry matter intake (5.55 and 5.58 kg) and daily weight gain of bulls (1197 and 1203 g for maize and wheat group, respectively).

Vitamin E supply increased its content in serum (1.36/1.52 and 1.48/1.88 μg/ml), liver (9.6/13.7 and 10.1/11.8) and fat (8.3/10.3 and 9.0/9.3), but it did not influence its content in muscle (0.92/1.14 and 1.16/1.11 μg/g) in maize or wheat group, without/with vitamin E supplementation. The induction time of kidney fat increased as the vitamin E content of fat rose (from 3.82 to 5.39 h).

Kind of ration and vitamin E supplementation did not significantly influence the fatty acid proportion of kidney and intramuscular fat, pH, drip loss and and colour of meat.

Short term-vitamin E supplementation of diets for bulls may influence vitamin E content in body tissues, but longer application seems to be necessary for more pronounced effects.

KEY WORDS: fattening bulls, vitamin E, meat quality, oxidative stability, fatty acids pattern

## INTRODUCTION

Vitamin E is one of the native antioxidants. Recently many reports and reviews (e.g. Mc Dowell et al., 1996; Flachowsky et al., 1997b; Leonhardt et al., 1997) discussed the significance of vitamin E supplementation in animal nutrition. The levels of vitamin E supplementation in those studies were mostly 2 to 5 times higher than the requirements.

In contrast with to pigs (Flachowsky et al., 1997a,c; Mancini et al., 1997) there are no studies with bulls in which high amounts of vitamin E were offered for a short period before slaughter.

Therefore, the objective of the present experiment was to investigate the influence of high vitamin E doses given over a short period before slaughter on the vitamin E content in body tissue and induction time of kidney fat.

## MATERIAL AND METHODS

Twenty-eight growing Friesian bulls, initial body weight $177 \pm 7.5$ kg, in two groups of 14, were fed diets of grass silage, given *ad libitum*, and ground maize or ground wheat in amounts increasing from 1.5 to 3.5 kg/day/animal during the fattening period. Cereals were offered twice a day. The rations were supplemented with vitamin-mineral premix, 100 g per animal and day. The chemical composition of feeds is given in Table 1.

TABLE 1

Composition of feedstuffs, DM basis

| Indices | Grain | | Grass silage |
|---|---|---|---|
| | maize | wheat | |
| Dry matter, g kg fresh matter | 879 | 882 | 445 |
| Crude protein, g | 109 | 143 | 163 |
| Ether extract, g | 46 | 25 | 32 |
| Starch, g | 703 | 650 | 0 |
| MJ ME/DM | 13.48 | 13.49 | 10.03 |
| Fatty acids proportion, % of total fatty acids | | | |
| Saturated fatty acid | 12.8 | 17.1 | 17.1 |
| Monoen fatty acids | 26.3 | 22.6 | 14.4 |
| $C_{18:2}$ | 57.1 | 56.1 | 24.8 |
| $C_{18:3}$ | 1.8 | 4.0 | 43.7 |
| Vitamin E, mg per kg DM | 4.7 | 8.6 | 42.8 |

The bulls were kept individually on slatted floors. Body weight was controlled every 7 days. More details of the feeding experiment are given by Daenicke et al. (1996).

Twenty-one days before slaughter, the bulls of both groups were divided into two sub-groups that were either unsupplemented or supplemented with 1 g α-tocopherylacetate per animal and day. At a final body weight of about 550 kg the bulls were slaughtered and samples from blood, liver, muscle (*M. longissimus dorsi*; 9th-11th rib) and kidney fat were taken for vitamin E analysis. Vitamin E was determined by HPLC as described by Matthey et al. (1991). The fatty acid proportions in feeds (Table 1) and body fat were analyzed using capillary gas-chromatography.

The resistance of fat against oxidation was determined as induction time using the Rancimat-test (Pardun and Kroll, 1972). According to this method, 5 g of ether extract are heated to 100°C and aerated with 20 l air per h. The time (h) to complete oxidation is an induction time.

The pH of *M. longissimus dorsi* was measured in two replications between the 8th and 9th rib by means of a digital pH-meter 24 and 48 h *post mortem* (p.m.). Drip loss was determined with meat of the 8th and 9th rib. Meat slices were hung in plastic bags for 24 h. The weight difference before and after hanging is called drip loss (in percentage of total weight). Meat colour was measured by a Minolta instrument CR 300 as described by Feldhusen et al. (1987) and Klettner and Stiebing (1980). The L* value shows the brightness of colour, L* = 0 denotes black and L* = 100 denotes white. The a* and b* values characterize colour tones and are measured between -100 and +100. Colour in *M. longissimus dorsi* was determined between 8th and 9th rib 24, 48, 96 and 144 h p. m. Meat was stored at a temperature of +3 to +5°C and lighting of 720 Lux. All measurements were carried out in three replications.

Data were analyzed by method of variance analysis follwowed by the TUKEY-Test. Significance differences between treatments are marked in Tables (see Table 3).

## RESULTS

The kind of cereal did not influence dry matter intake, weight gain and slaughter results of bulls (Table 2). The daily weight gain was about 1200 g. Concentrate source also did not significantly influence vitamin E content in body samples, but in all samples the values were slightly higher in bulls received maize than wheat (Table 3).

Vitamin E supplementation significantly increased its concentration in the serum and liver, but there was no significant effect on vitamin E content in muscle and fat (Table 3).

TABLE 2

Fattening and slaughter results of bulls

| Indices | Grain source | |
|---|---|---|
| | maize | wheat |
| Total DM – intake, kg/animal/day | 7.89±0.73 | 7.95±0.40 |
| concentrate | 2.34±0.04 | 2.37±0.04 |
| grass silage | 5.55±0.73 | 5.58±0.37 |
| Daily weight gain, g | 1197±66 | 1203±99 |
| Dressing percentage | 53.6±1.7 | 53.4±1.2 |
| Leaf fat[1], kg | 36.5±5.2 | 37.8±6.3 |

[1] sum of channel-, kidney-, stomach- and intestinal fat

TABLE 3

Vitamin E content in various body tissues

| Grain source | Maize | | Wheat | |
|---|---|---|---|---|
| Vitamin E supplementation, g/animal/day | – | +1 | – | +1 |
| Blood serum, μg/ml | $1.48^{a}\pm0.15$ | $188^{b}\pm027$ | $1.36^{a}\pm053$ | $1.52^{ab}\pm0.46$ |
| Liver, μg/g | $10.1^{a}\pm2.0$ | $11.8^{ab}\pm1.9$ | $9.6^{a}\pm2.1$ | $13.7^{b}\pm2.8$ |
| Muscle (*M. longissimus dorsi*), μg/g | 1.16±0.20 | 1.11±0.26 | 0.92±0.23 | 1.14 ±0.26 |
| Kidney fat, μg/g | 9.0±2.3 | 9.3±2.8 | 8.3±2.6 | 10.3±1.9 |

a, b – $P<0.05$

TABLE 4

Fatty acids pattern of intramuscular fat, percentage of measured fatty acids

| Grain source | Maize | | Wheat | |
|---|---|---|---|---|
| Vitamin E supplementation, g/animal/day | – | +1 | – | +1 |
| Fatty acids | | | | |
| $C_{14:0}$ | 3.1±0.3 | 3.2±0.3 | 2.8±0.2 | 2.7±0.3 |
| $C_{16:0}$ | 29.9±1.3 | 29.8±1.4 | 29.1±1.2 | 28.8±1.8 |
| $C_{16:1}$ | 2.8±0.4 | 2.7±0.3 | 2.7±0.5 | 2.8±0.3 |
| $C_{18:0}$ | 20.4±1.6 | 20.7±1.7 | 20.2±1.3 | 19.4±1.3 |
| $C_{18:1}$ | 38.3±3.4 | 38.1±3.2 | 39.0±2.5 | 40.4±2.6 |
| $C_{18:2}$ | 2.3±0.3 | 2.2±0.4 | 2.2±0.2 | 2.1±0.3 |
| $C_{18:3}$ | 0.8±0.1 | 0.8±0.1 | 1.0±0.2 | 1.0±0.1 |

Grain source and vitamin E supply did not significantly influence the fatty acids proportions of intramuscular (Table 4) and kidney fat (Table 5). Intramuscular fat contained more oleic acid and less stearic acid (39.0 and 20.2%) than depot fat (29.0 and 32.8%; Figure 1). Other differences in fatty acid

TABLE 5

Fatty acids pattern and oxidative resistence of kidney fat, percentage of masured fatty acids

| Grain source | Maize | | Wheat | |
|---|---|---|---|---|
| Vitamin E supplementation, g/animal/day | – | +1 | – | +1 |
| Fatty acids | | | | |
| $C_{14:0}$ | 2.8±0.2 | 3.3±0.2 | 2.9±0.3 | 2.8±0.2 |
| $C_{16:0}$ | 24.9±1.2 | 26.5±1.4 | 26.3±1.7 | 26.5±1.1 |
| $C_{16:1}$ | 1.1±0.2 | 1.2±0.3 | 1.2±0.3 | 1.2±0.3 |
| $C_{18:0}$ | 33.3±3.3 | 33.2±3.0 | 32.6±2.6 | 32.3±2.1 |
| $C_{18:1}$ | 29.4±2.4 | 28.2±2.0 | 29.1±1.5 | 29.5±2.4 |
| $C_{18:2}$ | 4.7±0.7 | 4.0±0.3 | 4.2±0.1 | 4.0±0.3 |
| $C_{18:3}$ | 1.2±0.1 | 1.1±0.1 | 1.3±0.1 | 1.2±0.2 |
| Induction time, h | $4.16^{b}$±0.44 | $3.42^{a}$±0.69 | 5.12±1.44 | $5.66^{c}$±1.46 |

a, b, c – $P<0.05$

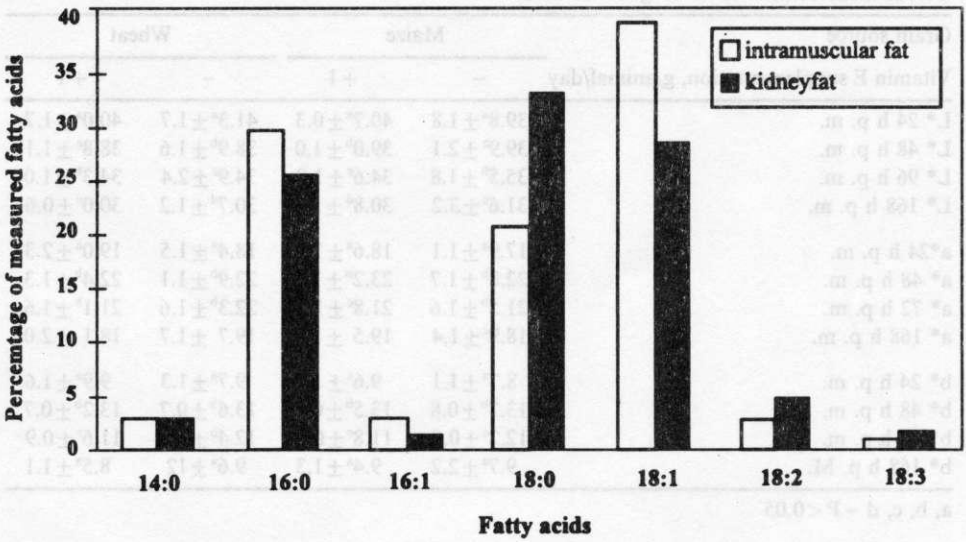


Figure 1. Fatty acids of intramuscular and kindey fat average of all animals, n=28

proportion between intramuscular and kidney fat concerned the $C_{16:0}$, $C_{16:1}$, $C_{18:2}$ and $C_{18:3}$ (Tables 4 and 5). Kidney fat contained more polyunsaturated fatty acids, but less $C_{16}$ fatty acids than intramuscular fat. The induction time was shorter in bulls receiving wheat (Table 5). Vitamin E supply significantly increased the induction time in both groups (Table 5).

The kind of ration and vitamin E supplementation did not significantly influence pH and drip loss of muscle (Table 6). Meat colour was not significantly

TABLE 6

pH and drip loss of *M. longissimus dorsi*

| Grain source | Maize | | Wheat | |
|---|---|---|---|---|
| Vitamin E supplementation, g/animal/day | – | +1 | – | +1 |
| pH 24 h p.m. | 5.56±0.10 | 5.54±0.09 | 5.41±0.28 | 5.54±0.09 |
| pH 48 h p.m | 5.54±0.07 | 5.56±0.07 | 5.52±0.06 | 5.56±0.07 |
| Drip loss, % | 0.38±0.17 | 0.41±0.22 | 0.63±0.29 | 0.41±0.22 |

influenced by kind of grain and vitamin E addition. The L* value decreased significantly with storing time, a* and b* values increased from 24 to 48 and 96 h and declined to initial values after 168 h p. m. (Table 7).

TABLE 7

Colour measurement of *M. longissimus dorsi*

| Grain source | Maize | | Wheat | |
|---|---|---|---|---|
| Vitamin E supplementation, g/animal/day | – | +1 | – | +1 |
| L* 24 h p. m. | $39.8^{a}$±1.8 | $40.7^{a}$±0.3 | $41.3^{a}$±1.7 | $40.0^{a}$±1.7 |
| L* 48 h p. m. | $39.9^{a}$±2.1 | $39.0^{b}$±1.0 | $38.9^{b}$±1.6 | $38.8^{a}$±1.1 |
| L* 96 h p. m. | $35.5^{b}$±1.8 | $34.6^{c}$±1.9 | $34.9^{c}$±2.4 | $34.3^{b}$±1.0 |
| L* 168 h p. m. | $31.6^{c}$±3.2 | $30.8^{d}$±1.6 | $30.7^{d}$±1.2 | $30.0^{c}$±0.6 |
| a*24 h p. m. | $17.9^{a}$±1.1 | $18.6^{a}$±1.9 | $18.4^{a}$±1.5 | $19.0^{a}$±2.3 |
| a* 48 h p. m. | $22.8^{b}$±1.7 | $23.2^{b}$±1.2 | $22.9^{b}$±1.1 | $22.4^{b}$±1.3 |
| a* 72 h p. m. | $21.5^{b}$±1.6 | $21.8^{c}$±1.1 | $22.3^{b}$±1.6 | $21.1^{b}$±1.6 |
| a* 168 h p. m. | $18.9^{c}$±1.4 | 19.5 ±1.5 | 19.7 ±1.7 | 18.1 ±2.0 |
| b* 24 h p. m. | $8.7^{a}$±1.1 | $9.6^{a}$±1.4 | $9.7^{a}$±1.3 | $9.9^{a}$±1.6 |
| b* 48 h p. m. | $13.7^{b}$±0.8 | $13.5^{b}$±0.5 | $13.6^{b}$±0.7 | $13.2^{b}$±0.7 |
| b* 72 h p. m. | $12.2^{c}$±0.9 | $11.8^{c}$±0.7 | $12.4^{b}$±1.4 | $11.6^{c}$±0.9 |
| b* 168 h p. M. | $9.7^{a}$±2.2 | $9.4^{a}$±1.3 | $9.6^{a}$±12 | $8.5^{a}$±1.1 |

a, b, c, d – $P<0.05$

## DISCUSSION

Concentrate sources did not significantly influence fattening and slaughter results of bulls (Table 2) or the fatty acids proportions in body fat (Tables 4 and 5). A higher proportion of linolenic acid in maize oil (Table 1) was saturated in the rumen but showed no influence on body fat. In agreement with some references (Leat, 1983; Flachowsky et al., 1994, 1995a) intramuscular fat (Table 4) contained more palmitinic (29.4), palmitoleic (2.7) and oleic acids (39.0%) but less stearic (20.2), linoleic (2.2) and linolenic acids (0.9) than kidney fat (26.0; 1.2; 29.0; 32.8, 4.2 and 1.2%, respectively; Table 5) as shown in Figure 1.

Short-term vitamin E supplementation did not significantly influence body fatty acids proportions (Tables 4 and 5). There are some data indicating that vitamin E supplementation affected the fatty acid proportion (e.g. Kies et al., 1991; Schwarz, 1996; Baker and Davies, 1997; Lopez-Bote et al., 1997). In some of those experiments addition of oxidized oils or vitamin E was able to reduced losses of polyunsaturated fatty acids. In animals given fresh-oil diets, in agreement with present results, no beneficial effects of vitamin E supplementation were obtained (Baker and Davies, 1997).

Vitamin E content in body samples was influenced by kind of grain in the diet and vitamin E supplementation (Table 3). The content of tocopherol was insignificantly higher in all body samples of bulls received maize than wheat ($P > 0.05$). Vitamin E intake of unsupplemented animals was nearly constant (265 and 272 mg/per animal/day for bulls fed maize and wheat, respectively). The higher fat content in the maize ration (Table 1) may be responsible for the higher vitamin E content in body samples because of close relationship between fat and tocopherol absorption (Cohn, 1993; Kayden and Traber, 1993).

Vitamin E supplementation significantly increased the α-tocopherol concentration in liver and serum, but not significantly in muscle and kidney fat (Table 3). After absorption (Cohn, 1993) vitamin E is transported by chylomicrons and tocopherol-binding proteins to the liver (Dutta-Roy et al., 1994; Arita et al., 1995), stored and later transported to the fat and muscles. Liver and serum therefore showed the most important increase in the content of this vitamin after short-term its supplementation (Table 3).

In the present study the vitamin E content was the highest in the liver, followed by kidney fat, serum and muscles. Similar sequences are described for poultry and pigs fat (e.g. Jensen et al., 1990; Sheehy et al., 1991; Buckley and Morrissey, 1994; Nepp et al., 1996; Flachowsky et al., 1997a). Vitamin E concentration in body tissues depends on amounts and duration of vitamin E supplementation as well as the animal species. Hoppe et al. (1993) found the highest tocopherol concentration in backfat of pigs. The sequence of vitamin E content in body samples of pigs changed from backfat > liver > serum > muscle to liver > backfat > serum > muscle, if 1 g vitamin E per day was added (Flachowsky, 1997c).

Induction time, determined as oxidative resistance of depot fat, increased when vitamin E was added. Induction time in the present experiment (Table 5) was much lower compared with earlier experiments with beef cattle (Flachowsky et al., 1994; 10.9-19.5 h). The reasons for the differences are measuring conditions (temperature, amounts of air) and fatty acids proportion in kidney fat (Table 5). The potential of fatty acids for oxidation depends on the number of double bounds. Holman (1954) gives the relations for oxidation 0.025 : 1 : 2 : 4 : 6 : 8 for 1 to 6 double bounds in fatty acids. Grosch (1970) describes the following

proportion of disposition for oxidation between stearic : oleic : linoleic : linolenic acids amounting to 1 : 100 : 1200 : 2400. From this data it can be stated that fats high in polyene fatty acids, like pigs backfat, show a higher tendency towards a shorter induction time. Vitamin E may act as an antioxidant and increase induction time (Table 5), as reported earlier (Flachowsky et al., 1995b). Increased oxidative resistance of fat of tocopherol-supplemented animals has been observed in many studies (Flachowsky et al., 1997b).

Apart from oxidative resistance of depot fat, other parameters of meat quality such as pH, drip loss and meat colour were not significantly influenced by kind of cereal or vitamin E supplementation (Tables 6 and 7). Some authors observed improved colour stability when vitamin E was added (e.g. Faustman et al., 1989; Chan et al., 1995; Lavalle et al., 1995; Vega et al., 1996). The antioxidant may prevent oxidation of myoglobin to metmyoglobin and improve membrane stability (Williams et al., 1992; Arnold et al., 1993; Buckley et al., 1995).

The presented results demonstrate that short-term vitamin E content of diets (1 g/d for 21 d) for fattening bulls influences the vitamin E content in some body tissues and oxidative resistence of kidney fat, but may be too short to improve other parameters of meat quality.

REFERENCES

Arita M.Y., Sato A., Miyata A., Tanabe T., Takahashi E., Kayden H.J., Arai H., Inone K., 1995. Human alpha-tocopherol transfer protein. CDNA cloning, expression and chromosal localization. Biochem. J. 306, 437-443

Arnold R.N., Arp S.C., Scheller K.K., Williams S.N., Schaefer D.M., 1993. Tissue equilibration and subcellular distribution of vitamin E relative to myoglobin and lipid oxidation in displayed beef. J. Anim. Sci. 71, 105-111

Baker R.T.M., Davies S.J., 1997. Muscle and hepatic fatty acid profiles and a-tocopherol status in African catfish (*Clarius gariepinus*) given diets varying in oxidative state and vitamin E inclusion level. J. Anim. Sci. 64, 187-195

Buckley D.J., Morrissey P.A., 1994. Vitamin E and meat quality. Proccedings of the Meeting on Shelf Live of Meat and Meat Products. Quality Aspects, Chemistry and Microbiology. Vienna, pp. 6-20

Buckley D.J., Sheehy P.J.A., Morrissey P.A., 1995. Advances in research and application of vitamin E as an antioxidant in poultry meat. Worlds Poultry Association. Proccedings of 10th European Symposium on Poultry Nutrition, Antalaya (Turkey), pp. 86-93

Chan W.K.M., Hakkarainen K., Faustman C., Schaefer D.M., Scheller K.K., Lin Q., 1995. Colour stability and microbial growth relationship in beef as affected by endogenous α-tocopherol. J. Food Sci. 60, 966-971

Cohn W., 1993. Tocopherol – Transport and Absorption. Procceedings of 4th Symposium on: „Vitamine und weitere Zusatzstoffe bei Mensch und Tier", Jena (Germany), pp. 71-82

Daenicke R., Gädeken D., Lebzien P.,1996. Weizen oder Körnermais als Erganzung zur Grassilage in der Bullenmast. Tagungsband 108. VDLUFA-Kongreß, Trier, pp. 139-142

Dutta-Roy A.K., Gordon M.J., Campbell F.M., Duthie G.G., James W.P.T., 1994. Vitamin E-requirements, transport and metabolism: Role of α-tocopherol binding-proteins. J. Nutr. Biochem. 5, 562-570

Faustman C., Cassens R.G., Schaefer D.M., Buege D.R., Williams S.N., Scheller K.K., 1989. Vitamin E supplementation of Holstein steer diets improves sirloin steak color. J. Food Sci. 54, 485-490

Feldhusen F., Neumann-Fuhrmann D., Haser O., Wenzel S., 1987. Farbmessung im Rahmen der Fleischqualitätsprüfung mit dem Minolta Chromameter. Züchtungskunde 59,146-157

Flachowsky G., Langbein T., Böhme H., Schneider A., Aulrich K., 1997a. Effect of false flax expeller combined with short-term vitamin E supplementation in pig feeding on fatty acids pattern, vitamin E concentration and oxidative stability of various tissues. J. Anim. Physiol. Anim. Nutr. 78, (submitted)

Flachowsky G., Richter G.H., Wendemuth M., Möckel P., Graf H., Jahreis G., Lübbe F., 1994. Einfluß von Rapssamen in der Mastrinderernährung auf Fettsäurenmuster. Vitamin E-Gehalt und oxidative Stabilität des Körperfettes. Z. Ernährungswiss. 33, 277-285

Flachowsky G., Sander-Hertzsch L., Augustini C., Richter G.H., Möckel P., 1995a. Fettsäurenmuster und Kennzahlen der Fleischqualitat bei Mastbullen der Kreuzungen Limousin x Schwarzbuntes Milchrind, Fleckvieh x Schwarzbuntes Milchrind und der Rasse Gelbvieh. Züchtungskunde 67, 220-229

Flachowsky G., Schaarmann G., Sünder A., 1997b. Bedarfsübersteigende Vitamin E-Gaben in der Tierernährung. Übers. Tierernähr. 25, 87-136

Flachowsky G., Schöne F., Möckel P., Schaarmann G., Gottschalk K., Lübbe F., 1995b. Beurteilung der Oxidationsneigung von Schweinefett unter der Berücksichtigung von Fettsäurenmuster und Vitamin E-Gehalt. Fat Sci. Technol. 97, 305-310

Flachowsky G., Schöne F., Schaarmann G., Lübbe F., Böhme H., 1997c. Influence of oilseeds in combination with vitamin E supplementation in the diet on backfat quality of pigs. Anim. Feed Sci. Technol. 64, 91-100

Grosch W., 1970. Der oxidative Fettverderb. Chemie unserer Zeit 4, 121-126

Holman R.T., 1954. Antioxidation of fats and related substances. In: R.T. Holman, T. Holman, W.O. Lundburg, T. Malkin (Editors). Progress in the chemistry of fats and other lipids. Vol. 2, Academic Press, New York, pp. 51-98

Hoppe D.P., Schöne F.J., Wiesche H., Stahler-Geyer A., Kammer J., Hochadel H., 1993. Effect of grade dietary α-tocopherol supplementation on the concentration in plasma and selected tissues of pigs from weaning to slaughter. J. Vet. Med. A 40, 219-228

Jensen M., Lindholm A., Hakkarainen J., 1990. The vitamin E distribution in serum, liver, adipose and muscle tissues in the pig during depletion and repletion. Acta Vet Scand. 31,129-136

Kayden H.J., Traber M.G., 1993. Absorption, lipoprotein transport, and regulation of plasma concentrations of vitamin E in humans. J. Lipid Res. 34, 343-358

Kies A., Girard J.P., Hutter N., Kienert T., Grimaldi J.L., Denoyer C., Refaitin Y., 1991. Effect d'une supplementation en vitamine E dans la ration sur la qualité des viandes de porcs. J. Rech. Porcine-en-France 23, 349-356

Klettner P.G., Stiebing A., 1980. Beitrag zur Bestimmung der Farbe in Fleisch und Fleischerzeugnissen: I. Einführung in die Grundlagen der Farbmessung. Fleischwirtschaft 60, 1970-1976

Lavalle C.L., Hunt M.C., Kropf D.H., 1995. Display live and internal cooked colour of ground beef from vitamin E-supplemented steers. J. Food Sci. 60, 1175-1178

Leat W.M.F., 1983. The pools of tissue constituents and products: adipose tissue and structural lipids. In: P.M. Riis (Editor). Dynamic biochemistry of animal production. Elsevier, Oxford, pp. 109-136

Leonhardt M., Gebert S., Wenk C., 1997. Vitamin E content of different animal products: Influence of animal nutrition. Z. Ernährungswiss. 36, 23-27

Lopez-Bote C., Rey A., Ruiz J., Isabel B., Sanz Arias R.,1997. Effect of feeding diets high in monosaturated fatty acids and α-tocopherol acetate to rabbits on resulting carcass fatty acid profile and lipid oxidation. Anim. Sci. 64,177-186

Mancini V., Berk A., Vemmer H., Rosenbauer H., Lübbe F., Schaarmann G., Flachowsky G., 1997. Einflußunterschiedlich hoher Vitamin E-Gaben an Mastschweine auf den Vitamin E-Gehalt in Geweben und die Fleischqualität. Proc. Soc. Nutr. Physiol. 6,149

Matthey M., Graf H., Flachowsky G., 1991 Die Bestimmung fettlöslicher Vitamine in der Milch mittels HPLC. Proceedings of 3rd Symposium on „Vitamine und weitere Zusatzstoffe bei Mensch und Tier", Stadtroda, pp. 143-146

Mc Dowell L.R., Williams S.N., Hidroglou N., Njeru C.A., Hill G.M., Ochoa L., Wilkinson N.S., 1996. Vitamin E-supplementation for the ruminant. Anim. Feed Sci. Technol. 60, 273-296

Nepp A., Schaarmann G., Schulze E., Richter G, Flachowsky G., 1996. Untersuchungen zur Verträglichkeit hoher Vitamin E-Gaben bei Mastküken. Proc. Soc. Nutr. Physiol 5, 138

Pardun H., Kroll E., 1972. Bestimmung der Oxidationsstabilität von Ölen und Fetten mit Hilfe einer automatischen Version des Swift-Test. Fette, Seifen, Anstrichmittel 74, 366-373

Schwarz F., 1996. Influence of dietary fatty acid composition and vitamin E on fatty acids and α-tocopherol in carp (*Cyprinus caprio* L.). Arch. Anim. Nutr. 29, 63-71

Sheehy P.J.A., Morrissey P.A., Flynn A., 1991. Influence of dietary α-tocopherol on tocopherol concentration in chick tissues. Brit. Poultry Sci. 32, 391-395

Vega L., Enser M. , Richarson R.I., Wood J.D., 1996. Effects of supranutritional vitamin E on meat quality in dairy cross steers given grass silage and concentrates. Anim. Sci. 62, 653

Williams S.N., Frye T.M., Frigg T.M., Schaefer D.M., Scheller K.K., Liu Q., 1992. Vitamin E. Meal Int. 3, 22

STRESZCZENIE

**Wpływ krótkotrwałego podawania witaminy E buhajom, otrzymującym różne pasze treściwe, na zawartość witaminy E w tkankach ciała i odporność na utlenianie tłuszczu nerkowego**

Dwadzieścia osiem buhajków, w dwóch grupach po 14, żywiono indywidualnie od 177 do 522 kg masy ciała kiszonką z przewiędnietych traw do woli oraz paszą treściwą, zawierającą kukurydzę (grupa kukurydziana) lub pszenicę (grupa pszenna), po 2,7 kg dziennie. Na 21 dni przed ubojem siedmiu buhajom z każdej grupy podawano dziennie po 1 g octanu α-tokoferolu. Podczas uboju pobierano próby krwi, wątroby, mięśnia najdłuższego grzbietu i tłuszczu nerkowego dla oznaczenia w nich zawartości witaminy E przy pomocy HPLC. Udział kwasów tłuszczowych oraz czas całkowitego utlenienia (godz.) tłuszczu nerkowego oznaczono przy użyciu testu Rancimat.

Rodzaj dawki nie miał wpływu na pobranie s.m. kiszonki (5,55 i 5,58 kg) ani na przyrosty masy ciała buhajów (1197 i 1203 g w grupach kukurydzianej i pszennej, odpowiednio).

Dodatek witaminy E zwiększył jej zawartość w osoczu (1,36/1,52 i 1,48/1,88 μg/ml), wątrobie (9,6/13,7 i 10,1/11,8) i tłuszczu (8,3/10,3 i 9,09/9,3), ale nie w mięśniach (0,92/1,14 i 1,16/1,11 μg/mg) w grupie kukurydzianej lub pszennej, bez lub z dodatkiem witaminy E. Czas całkowitego utlenienia tłuszczu nerkowego zwiększał się w miarę zwiększania się zawartości witaminy E w tłuszczu (z 3,82 do 5,39/godz.).

Rodzaj dawki oraz dodatek witaminy E nie wpłynął istotnie na udział kwasów tłuszczowych w tłuszczu nerkowym i międzymięśniowym, pH, ubytek spowodowany wyciekiem i barwę mięsa.

Krótkotrwały dodatek witaminy E do dawek może wpływć na zawartość witaminy E w tkankach ciała, lecz podawanie jej przez dłuższy czas wydaje się być konieczne dla spowodowania wyraźniejszego efektu.