THE EFFECT OF DIETARY E VITAMIN ON FATTY ACID COMPOSITION AND LIPID OXIDATIVE STABILITY IN PIGS: A REVIEW

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Abstract

The pork meat is the most frequently consumed meat in the Czech Republic. The quality of pork meat mainly depends on the genotype, age, slaughter weight and nutrition in pigs. Lipid oxidation in meat is an important responsible factor for quality losses including flavour, texture, nutritive value and colour. Dietary vitamin E has positive effect on oxidative stability of fresh and stored meat and products.

Key Words: Pig; vitamin E; fatty acid; oxidative stability

Pork meat is an important part of the European diet as well as in the Czech Republic. Pork consumption remains on high level on long term basis. For many consumers, pork meat is often controversial concerned of an excess of fat, saturated fatty acids and cholesterol. Hovewer, several studies documented that pork meat is a valuable source of polyunsaturated fatty acids (PUFA) with an important concentration of n-6/n-3 fatty acids (Cameron and Enser, 1991, Morgan *et al*., 1992, Enser *et al*., 1996). The composition of pork, respectively its fatty acid content, mainly depends on the genotype, age, slaughter weight and nutrition in pigs (Hernández *et al.,* 1998). There are many reports concerning of the benefits of vitamin E supplementation the diets for fattening pigs (Cheah *et al.* 1995, Canon *et al.* 1996, Jensen *et al.* 1997, 1998). Although vitamin E is known as an essential nutrient for reproduction since 1922, we are far from understanding the mechanism of its physiological functions till now. Vitamin E is part of tocopherols and tocotrienols, from which α-tocopherol has the highest biological activity (Brigelius-Flohé and Traber, 1999) and is the main lipid-soluble antioxidant in the body. As antioxidant it prevents the free radical multiplications in the cell membranes. Also, vitamin E shows pro-oxidant activity (Herrera and Barbas, 2001). It is known that metabolic function of the vitamin E is related to hormone metabolism and membrane antioxidant (Voet and Voet, 1990). The recommended daily level of dietary α-tocopheryl acetate supplementation in growing pigs is 15-40 mg/kg (Albers *et al.,* 1984), however, certain parametres of meat quality, respectively oxidative stability, can be improved when dietary α-tocopheryl acetate levels are 200-500 mg/kg in the diet (Buckley *et al.,* 1995, Cheah *et al.,* 1995, Lauridsen *et al.,* 1999, Lahučký *et al.,* 2001). Daza *et al.* (2005) also studied the effect of feeding of the α-tocopheryl acetate (40 vs. 200 mg/kg) on antioxidant accumulations and oxidative stability in Iberian pigs. They founded that the level of vitamin E has no influence on muscle lipid profile (neutral and polar lipids). These results are in agreement with López-Bote *et al.* (2002). Also Monahan *et al.* (1992) concluded that dietary α-tocopheryl acetate supplementation did not influence the deposition of fatty acids in the muscle but dietary α-tocopheryl acetate supplementation (200 mg/kg feed) increased significantly the oxidative stability of muscle given especially by oleic acid concentrations in polar lipids, as mentioned Rey *et al.* (2001). Lipid oxidation, a major cause of meat quality deterioration, results with autoxidation products of unsaturated fatty acids which affected desired and nutritional value (Pearson *et al.,* 1983). Lipid oxidation in meat is an important responsible factor for quality losses including flavour, texture, nutritive value and colour. This oxidation causes free radicals in meat but also with different pro-oxidants (Kanner, 1994). Post-slaughter biochemical changes involve the conversion of the muscle to meat which causes the loss of cellular antioxidant defence and increasing sensibility of meat lipids to oxidation (Morrisey *et al.,* 1994). However, the presence of polyunsaturated fatty acids (PUFA) in the diets in pigs increases the risk for lipid-oxidation in the living organism and in the carcass (Jakobsen, 1995). Oxidation of unsaturated fatty acids in the cell membranes leads to disruption of normal membrane structure and function (Storey, 1996). It is generally accepted that the oxidative stability of muscle lipids dependents on the α-tocopherol concentration presented in the tissue (Sheldon *et al.,* 1997), which depends on the α-tocopheryl acetate concentration in the feed (Wen *et al.,* 1997). Vitamin E and antioxidant enzymes, such superoxide dismutase and glutathione peroxidase presented in the skeletal muscle, are able to inhibit the lipid oxidation in the living tissue and in the muscle as a food. The amount of α-tocopherol, deposited in the muscle tissue, depends on the fiber type distribution and its metabolic characteristics.

During the *pos mortem* metabolism of muscles, which differ among muscle types, the process of lipid oxidation may no longer be tightly controlled due to the weakness of the antioxidative defense systém. This may affect the fresh pork meat quality (Lauridsen *et al.,* 1999). Jensen *et al.,* (1998) founded that dietary α-tocopheryl acetate supplementation was effective for reducing lipid oxidation in meat. The favourible effect of dietary supplementation of vitamin E on certain aspects of meat quality in red and white meat was reported by various studies. The stability of lipids and colour in beef (Faustman *et al.,* 1989, Arnold *et al.,* 1993), pork (Monahan *et al.,* 1992), turkey (Sante and Lacourt, 1994), broilers during refrigeration and deep-freezing (Coetzee and Hoffman, 2001), reduction of drip losses of pork (Asghar *et al.,* 1991) is achieved by supplementation of the dietary vitamin E. The stability and improvement in meat colour by vitamin E was principally due to its ability to prevent the oxidation of myoglobin and/or oxymyoglobin to metmyoglobin (Mitsumoto *et al.,* 1993). Houben *et al.* (1998) studied the effect of supplementation of vitamin E (200 IU/kg feed) in the diet of pigs on colour stability and lipid oxidation in minced pork. They founded that the meat from vitamin E-supplemented animals was relatively resistant to oxidation, even at the increased O_2 concentrations prevailing in the gas packages, oxygen concentrations which clearly induced lipid oxidation in the control meat. The protective effect of vitamin E on lipid stability in fish (Fang and Wada, 1993), chicken (Lin *et al.,* 1989), turkey (Higgins *et al.,* 1998) veal (Engeseth *et al.,* 1993), beef (Mitsumoto *et al.,* 1993), pig (Lauridsen *et al.,* 1999, Daza *et al.,* 2005, Lahučký *et al.,* 2005) and cooked pork (Monahan *et al.,* 1992) was the attribute of the significant reduction in the rate of lipids oxidation. Dietary supplementation of approximately 20 times of normal requirements of vitamin E could also inhibit the enhanced lipid peroxidation, reduce the plasma creatine kinase and pyruvate kinase activities and prevent the antioxidant abnormality of hepatric microsomes in stress-susceptible pigs (Duthie *et al.,* 1989, 1992; Duthie and Arthur, 1993). Buckley *et al.* (1995), Asghar *et al.* (1991) focused on the antioxidant function of vitamin E and its influence on lipid peroxidation activity and colour stability, water-holding capacity, and cholesterol oxidation in meat. However, a little attention was attended to the effects of dietary enrichment with vitamin E on the quality of cured products, or to the effects of illumination in combination with commercial low-oxygen packaging during the display of sliced products. Vitamin E has an effect on oxidative stability of fresh meat but also treated meat (packed with low-oxygen, chill-stored, cooked and frozen meat). Lahučký *et al.* (2005) studied the effect of dietary vitamin E on the antioxidative status and meat quality pigs. They found that the positive effects of vitamin E on oxidative stability, measured as thiobarbituric acid reactive substances (TBARS, MDA), were observed mainly in chill-stored meat (P<0.05). It confirmed that oxidative stability of meat lipids can be improved by vitamin E supplementation into the feed. Also Kerry *et al.* (1998) confirmed that dietary vitamin E supplementation is very effective for inhibiting lipid oxidation and it is much less susceptible to warmed-over flavour development than any other treatment. Studies concerning of vacuum-packed ham (Houben and Gerris, 1998), low-oxygen modified atmosphere of packaged ham (Houben and Gerris, 1998), minced pork (Houben *et al.,* 1998) and cured pork sausage (Zanardi *et al.,* 2000) show a limiting ability of vitamin E supplementation to improve the color stability of the product.

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