Vitamin E - influence on antioxidant and oxidant status of pigs *in vivo* and at slaughter

Charlotte Lauridsen & Martin Tang Sørensen, Department of Animal Nutrition and Physiology, Danish Institute of Agricultural Sciences, Research Centre Foulum, DK-8830 Tjele

Background

High levels of fat are added to commercial pig diets in order to increase feed energy density. Vegetable oils rich in polyunsaturated fatty acids (PUFA) are very digestible for pigs, and the fatty acid pattern of the dietary lipids is reflected in the fatty acid profile of pig fat. PUFA are sensitive to oxidation both in the feed, in the live animal and in the carcass. Oxidation processes may lead to reduced growth and feed utilisation and unwanted changes in the carcass and meat products such as reduced storage stability, discolouration and disagreeable flavour. Dietary intake of unsaturated fat is known to increase the requirement for vitamin E, which in its role as a membrane-associated antioxidant, effectively protects the organism against oxidative processes in lipids (Schaefer et al., 1995). Vitamin E does not function as the only antioxidant *in vivo*, but rather as an integrated part of a network of antioxidants including non-enzymatic molecules such as ascorbic acid and β-carotene, and enzymes such as superoxide dismutases (SOD), catalase and the peroxidases (Machlin and Bendich, 1987). In recent years, there has been a growing interest to maintain the antioxidant balance of the live animal and to deposit sufficient α-tocopherol in muscles for maximising the protection of muscle lipids against oxidative deterioration.

Objective

The purpose of the present study was to investigate the effect of dietary supplement of vitamin E on the antioxidant and oxidant status of the pig *in vivo* and at slaughter.

Methods

Landrace x Yorkshire female pigs were assigned to one of three dietary treatments, i.e. a basal feed with 6% rapeseed oil supplemented with three levels of vitamin E (0, 100, and 200 mg dl-α-tocopherylacetate/kg feed). The pigs were given ad libitum access to feed and water from 25 to 100 kg live weight (slaughter). Three days before slaughter, blood samples were taken from *vena jugularis*. Immediately after slaughter, samples of liver and two muscles LD (*longissimus dorsi*) and PM (*psoas major*) representing different oxidative capacity, were obtained. In this paper, the main effects on the antioxidant status, the susceptibility to lipid oxidation, and the water-holding capacity of the muscles are presented. The other methods and results of the study are described elsewhere (Lauridsen et al., 1998a; Lauridsen et al., 1998b).

Results and discussion

In agreement with other studies (e.g. Jakobsen et al., 1995), increasing dietary levels of vitamin E, provided as dl-α-tocopheryl acetate, increased the concentration of α-tocopherol in plasma, muscle and liver tissue (Fig. 1). The α-tocopherol concentrations in the liver were higher than those of the skeletal muscle. The storage capacity for α-tocopherol was greater in the muscle with highest oxidative capacity (PM), as oxidative fibres i) have a high capillary supply, whereby the availability of vitamin E may increase, ii) contain a high number of mitochondria, in which α-tocopherol accumulates, and iii) contain more lipid, whereby the storage capacity of the fat-soluble vitamin E may be improved (as discussed by Jensen et al., 1998).

The rate of iron-induced oxidation of LD from pigs fed a vitamin E supplemented diet was lower than that of pigs fed the diets without vitamin E (Fig. 2), as also demonstrated previously (Monahan et al., 1990). Likewise, addition of vitamin E to the feed reduced the oxidative changes in the liver even before iron-induction, whereas no influence was seen on the rate of oxidation of PM (Lauridsen et al., 1998a,b). No parallel effects were seen on the antioxidant enzymes (GSH-Px and SOD) in the liver or muscle cytosolic fraction (Lauridsen et al., 1998a,b).

Following vitamin E supplementation, the post-mortem water-holding capacity of both LD and PM, estimated as the weight of fluid loss per g wet muscle tissue (Cheah et al., 1993), was improved (Fig. 3). Although the mechanism is not clear, this may indicate a membrane-stabilizing effect of vitamin E, which at least partly may be due to the inhibition in the activity of phospholipase A_2 (Douglas et al., 1986).

Conclusion

Supplementation of vitamin E to feed for pigs improves the antioxidant potential of the muscles. The results are of importance to the pig industry as the quality of the muscle food may be improved by altering feed composition.

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Literature

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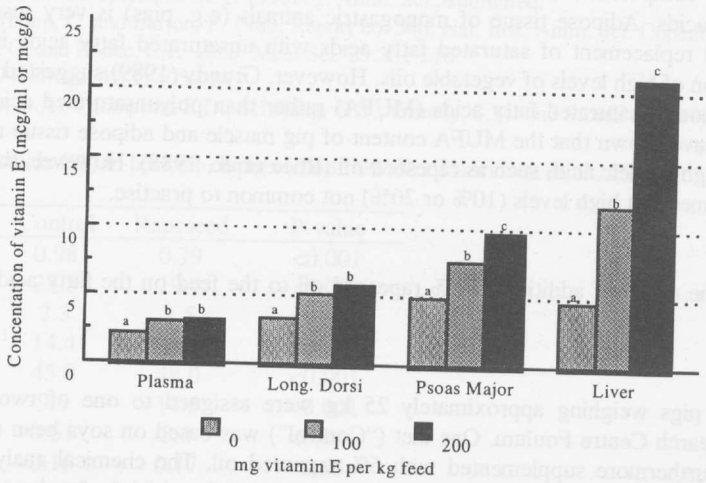

Fig. 1: Concentrations of vitamin E in plasma and tissues.

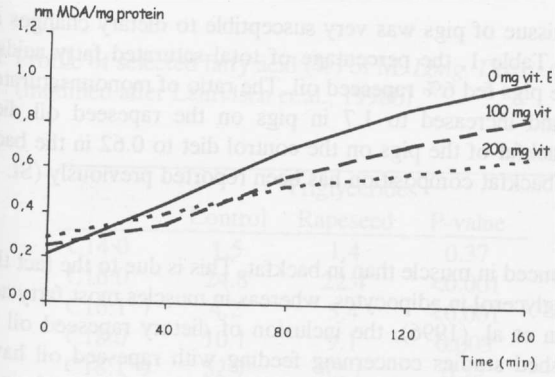

Fig. 2: The effect of dietary vitamin E on Fe^{2+}-induced oxidation of M. Long. Dorsi

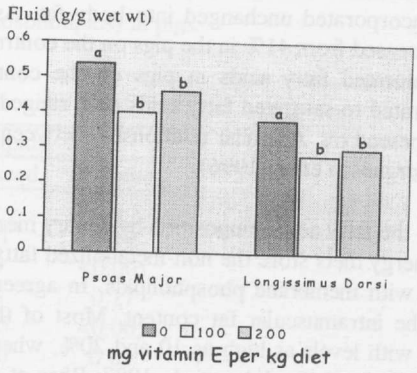

Fig. 3: The effect of dietary vitamin E on the amount of fluid in muscles