VITAMIN D_3 SUPPLEMENTATION FEEDING IMPROVES TENDERNESS OF BEEF BUT NOT OF PORK

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Introduction

Improving and stabilizing meat quality parameters is an area attracting increasing attention from all segments of the meat chain. Results from a number of studies showed that feeding of supra/nutritional levels of some nutrients may improve the antioxidative capacity and meat quality parameters. These nutrients include magnesium, vitamin E and others (Buckley *et al.*, 1995; Swigert *et al.*, 2004). A major factor in determining consumer satisfaction with meat is tenderness. The association of calcium with meat tenderness is well defined and increasing muscle calcium increases the activity of calpains, which are intracellular proteases responsible for postmortem meat tenderness (Koohmaraie, 1992). Montgomery *et al.* (2000) have reported that feeding very high concentrations of vitamin D_3 to cattle results in increased levels of plasma and muscle calcium. But vitamin D_3 supplementation did not affect quality characteristics (Swigert *et al.*, 2004) or tenderness of pork but changes in L* and a* values were positively influenced (Wiegand *et al.*, 2002). Results of the further study (Wilborn *et al.*, 2004) indicated that L* values can be reduced, and subjective colour and firmness scores increased. The objective of this research was to characterize the effects of dietary supplementation with vitamin D_3 individually, and in combination with vitamin E on meat quality characteristics of beef and pork.

Materials and Methods

Thirty bulls (*Spotted breed*) were fed standard feed (control group, group C, n=10) and experimental groups (each n=10) were supplemented with vitamin D_3 (7.5 x 10^6/animal/day, for 7 days, D group) or with vitamin D_3 (7.5 x 10^6/animal/day, for 7 days) and vitamin E (2.500 α – tocopherylacetate/animal/day, 6 weeks, DE group) before slaughter. In total 36 pigs *(Slovak White Meaty)* were genotyped *(RYR1*, DNA based test*)*. The control group (group C, n=12) received a standard diet. The experimental groups (each n=12) received a supplemental level of vitamin D_3 (500,000 IU/kg of feed intake for 5 days, D group) and a supplemental level of vitamin D_3 (500,000 IU/kg of feed intake for 5 days) and vitamin E (ROVIMIX® E-50 SD, 500 mg α-tocopherol/kg of feed for 30 days, DE group) before slaughter.

Animals (bulls at average weight of 550 kg, pigs 110 kg) were slaughtered according to standard commercial procedures in an Institute abattoir. Blood was collected and calcium determined (atomic absorption). The pH value (45 min) of the carcass, colour (24 h and 5 days, by Miniscan) and drip loss (24 h) were measured. The *Longissimus dorsi* (LD) was removed for further analyses. Vitamin E (α-tocopherol) level was measured by HPLC. Lipid oxidation and antioxidant capacity (muscle homogenate stimulated by Fe^{2+}/ascorbate) were assessed by the 2-thiobarbituric acid method (TBARS, expressed as malondialdehyde – MDA). Shear force was determined in cooked samples (internal temperature 75°C) with Warner-Bratzler (W-B) manufacturer apparatus. Statistical analyses were calculated as mean values and standard deviations and differences were evaluated by t-test.

Results and Discussion

Vitamin D_3 supplementation exhibited plasma calcium concentration in bulls (2.60 vs 2.78 mmol.l^{-1}) and was greater in pigs (2.71 vs 3.90 mmol.l^{-1}) as was shown also by Wiegand *et al.* (2002). Feeding supplemental vitamin E increased ($P<0.05$) levelsof α-tocopherol in beef (2.81 vs. 4.18 mg.kg^{-1}) and in pork (2.01 vs. 3.21 mg.kg^{-1}). The results are in agreement with those published earlier (Buckley *et al.*, 1995). Meat quality characteristics (pH, drip loss) were not significantly ($P>0.05$) influenced. Colour data (a^* value) were higher ($P<0.05$) for LD muscle (5 d) from vitamin D_3 and vitamin E treated pigs (Table 1). Similar results were reported also by Wiegand *et al.* (2002).

Table 1: Meat quality values ($\bar{x} \pm s$) of pigs.

Trait	Control		Vit. D_3		Vit. D_3 + E	
pH_1	6.24	0,33	6,33	0,16	6.32	0,28
Drip loss, %	3,42	1,25	3.20	1,06	3,04	1,00
Colour L^*	48.85	3,12	46,72	2,32	46,59	4,15
24 h a^*	2,19	2,09	2,44	1,21	2,51	0,44
Colour L^*	49,20	2,05	49,16	2,15	48.30	4,47
5d a^*	2.73^a	0,76	$3,74^b$	1,15	$3,63^b$	0,81
W-B, kg	4.86	1,04	4,77	0,83	5.00	0,72

^{a,b} ($P<0.05$)

Results from measures of tenderness (W-B, kg) indicated that feeding of vitamin D_3 to bulls improves shear force value ($P<0.05$) for 14 d (5.98 vs.4.22 and 4.11 kg) but not in pigs for 5 d (Table 1). The results obtained in this study are similar to those reported by other workers (Montgomery *et al.*, 2000, Wiegand *et al.*, 2002). Antoxidant capacity measured as MDA (nM/mg protein) after muscle homogenate incubation (120 min) with Fe^{2+}/ascorbate was improved ($P<0.05$) by vitamin E and partially by vitamin D_3 in beef (0.09 and 0.27 vs. 0.57) and in pork (0.11 and 0.28 vs. 0.43) when compared to control animals.

Conclusions

Vitamin D_3 supplementation increases blood calcium and improves tenderness of beef but not in pork. Colour (a^* value) can be improved in pork. Supplementation vitamin E increases α-tocopherol in beef and pork. Antioxidant capacity was improved in beef and pork by vitamin E and partially by vitamin D_3 supplementation.

References

Buckley, D. J., Morrissey, P. A., Gray, J. I. (1995). Influence of dietary vitamin E on the oxidative stability and quality of pig meat. Journal of Animal Science, 73: 3122-3131.

Koohmaraie, M. (1992). The role of Ca^{2+} - dependent proteases (calpains) in postmortem proteolysis and meat tenderness. Biochemie (Paris), 74: 239-245.

Montgomery, J. L, Parish, F. C. Jr., Beitz D, C., Horst, R.L., Huff-Lonergan, E.J., Trenkle, A.H. (2000). The use of vitamin D_3 to improve beef tenderness. Journal of Animal Science, 78: 2615-2621.

Swigert, K.S., McKeith, F.K., Carr, T.C., Brewer, M.S., Culbertson, M. (2004). Effects of dietary vitamin D_3, vitamin E, and magnesium supplementation on pork quality. Meat Science, 67: 81-86.

Wiegan, B. R, - Sparks J. C., Beitz D. C., Parish, F.C.,Jr., Horst, R.L., Trenkle, A.H., Ewan, R.C. (2002). Short-term feeding of vitamin D_3 improves color but does not change tenderness of pork-loin chops. Journal Animal Science, 80: 2116-2112.

Wilborn, B.S., Kerth, C.R., Owsley, W.F., Jones, W.R., Frobish, L.T. (2004). Improving pork quality by feeding supranutritional concentrations of vitamin D_3. Journal of Animal Science, 82: 218-224.