

CHEMICAL COMPOSITION, MEAT QUALITY AND OXIDATIVE STATUS OF PORK AFTER SUPPLEMENTATION OF DIET WITH VITAMIN E AND/OR VITAMIN E + HERB EXTRACTS

I. Bahelka¹, K. Nürnberg², U. Küchenmeister², R. Lahučký¹

¹Animal Production Research Centre, 951 41 Lužianky, Slovakia

²Research Institute for the Biology of Farm Animals, 181 96 Dummerstorf, Germany

Corresponding author: bahelka@cvzv.sk

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Abstract: The effect of supplementation of vitamin E and herb extracts on chemical composition, quality traits and oxidative status of pork was evaluated. Total eighty hybrid pigs – crosses of Landrace sows and Hampshire x Pietrain boars were involved into the experiment. Pigs were divided to one control and three experimental groups (each of 20 animals with equal number of gilts and castrates). All pigs were heterozygotes on RYR1 gene. Experimental groups received diet with supplement of vitamin E (500 mg/kg feed) for 30 days before slaughter or supplement of this vitamin in combination with lemon balm extract (100 ml/pig/day) and/or oregano extract (60 ml/pig/day) for 10 days before slaughter. Supplementation of vitamin E singly or in combination with herb extracts had no effect on chemical composition of pork. Vitamin E significantly ($P < 0.05$) increased the concentration of α -tocopherol in *longissimus dorsi* muscle. Electrical conductivity in muscle 24 h post mortem was significantly lower in all experimental groups in comparison to control group (4.96 – 5.06 vs. 6.12 μ S). Significant positive effect of herb extracts on meat colour (parameter „a^o“) in stored pork was found (3.22 and 3.41 vs. 2.54). Lipid oxidation measured as TBARS value was decreased significantly in groups with vitamin E and/or vitamin E + lemon balm extract after 5-days storage of pork (0.193 and 0.190 vs. 0.267 mg/kg).

Key words: pigs, vitamin E, lemon balm, oregano, meat quality, oxidative status

Introduction

In the last decades, the efforts of pig breeding companies, meat plants and scientists as well focus attention on improving the pork quality in order to meet the demands of consumers. It is well known that one way of improving the pork

quality traits is supplementation of pig's diet with feed additives such as vitamins, minerals, organic acids, herb extracts etc.

Positive effects of vitamin E on pork quality parameters and antioxidative stability of muscles have been published in a number of studies (Monahan et al., 1994; Jensen et al., 1997; Lauridsen et al., 2000; Lahučký et al., 2000; Bahelka et al., 2004; Guo et al., 2006; Janz et al., 2008; Bahelka et al., 2010).

Recently, especially after the ban of antibiotic's application in swine nutrition, increasing interest in using of herb extracts has been registered. Some studies suggested possible beneficial impact of herb extracts on meat quality or antioxidative capacity in pigs and poultry (Young et al., 2003; Govaris et al., 2004; Botsoglou et al., 2005; Janz et al., 2007; Bahelka et al., 2010).

A few studies only were published concerning combination effects of vitamin E and herb extracts supplementation on pork quality and oxidative status of muscles. Therefore, the aim of this study was to evaluate an effect of supplementation of vitamin E alone or in combination with herb extracts on chemical composition, pork quality and antioxidative stability of pork muscles.

Materials and Methods

In total 80 pigs were used in the experiment. They originated from Landrace sows and Hampshire x Pietrain boars. The RYR1 genotype of pigs was determined by DNA based test (Lahučký et al., 1997) and only pigs tested as heterozygous were selected. Pigs were divided to control and three experimental groups (each of 20 animals with equal number of gilts and castrates). Animals were housed in pairs in boxes on the farm of Animal Production Research Centre (APRC).

The control pigs (group C) received the standard diet without any supplements (Table 1). The first experimental group (group E) received the same diet as a control but with supplement of vitamin E – 500 mg/kg feed for 30 days before slaughter. The second experimental group (group E+LB) received supplement of vitamin E – 500 mg/kg feed for 30 days with lemon balm (*Melissa officinalis*) extract – 100 ml/pig/day for 10 days before slaughter. The third experimental group (group E+O) fed the same supplement of vitamin E as other two experimental groups but with oregano (*Origanum vulgare*) extract – 60 ml/pig/day for 10 days before slaughter. Vitamin E (Rovimix® E-50SD) was provided by Slovakofarma (Hlohovec, Slovakia) and herb extracts by Calendula (Nová Ľubovňa, Slovakia).

After reaching the slaughter weight (110 ± 3.0 kg), pigs were slaughtered at experimental abattoir of APRC. After slaughter, carcasses were chilled at 4 °C for 24 h and samples of *musculus longissimus dorsi* were removed from each carcass and sliced into 2.5 cm thick pieces. One wrapped sample was stored at 4° for 5 days.

Table 1. Composition and nutritional value of standard diet

Item	%	Item	%
wheat	25.0	organic matter	83.07
barley	35.0	crude protein	16.85
soybean meal	16.0	crude fat	3.12
oat	10.0	crude fibre	4.65
wheat meal	4.0	N-free extract	55.82
lucerne meal	5.0	ash	6.46
mineral supplement	3.0	metabolisable energy, MJ	12.43
fish meal	1.0	lysine	0.92
fodder salt	0.4		
biofactor supplement	0.6		

The concentration of vitamin E in muscle was measured by HPLC (Berlin *et al.*, 1994). Total water, protein and intramuscular fat were analysed by INFRADEC 1265 Meat Analyzer. The pH values were measured in *musculus longissimus dorsi* 45 min and/or 24 h post mortem by pH electrode Ingold. Electrical conductivity (EC) was measured 24 h post mortem by Biotech apparatus. Meat colour was determined in fresh (24 h) and 5-days stored pork using Hunter Lab MiniScan spectrometer. Drip loss was estimated according to method of Honikel (1998) after 24 h and 5-days storage of pork. Tenderness expressed as shear force was analysed by Warner-Bratzler instrument. Antioxidative stability of muscle was assessed by the 2-thiobarbituric acid reactive substances – TBARS (Salih *et al.*, 1987) and was expressed in terms of malondialdehyde (MDA, mg/kg tissue).

Data were analysed by GLM procedure of the statistical package SAS/STAT (2002-2003, version 9.1.3). All comparisons were done by Tukey test. Data in tables are expressed as least square means (LSM).

Results and Discussion

Supplementation with vitamin E resulted in significantly higher α -tocopherol level in *longissimus dorsi* muscle in all experimental groups in comparison with control (Table 2). It is in agreement with results of Lahučký *et al.* (2001) and Harms *et al.* (2003).

Table 2. Chemical composition and vitamin E concentration in pork muscle

Item	Group C	Group E	Group E+LM	Group E+O	Significancy
Total water, %	73.65	73.45	73.92	74.16	-
Total protein, %	22.56	22.48	22.68	22.56	-
Intramuscular fat, %	2.84	2.65	2.34	2.41	-
Vitamin E, mg/kg	2.53 ^a	5.15 ^b	4.86 ^b	4.74 ^b	^{a,b} P<0.05

The tendency of increased initial pH in experimental groups was observed, however differences were not statistically significant (Table 3). Similar effect of vitamin E (200 mg/kg feed) on pH was reported by *Mason et al. (2005)*. Colour and drip loss in fresh pork in the present study were not improved by supplements in comparison to control group. It is interesting that vitamin E alone or in combination with herb extracts had no effect mainly on drip loss and shear force whereas positive effect of this vitamin was reported in a lot of studies (*Monahan et al., 1994; Dirinck et al., 1996; Kerth et al., 2001; Lahučký et al., 2005*). On the other hand, some studies suggest none effect of vitamin E on meat colour and drip loss (*Honikel et al., 1998; Waylan et al., 2002; Ohene-Adjei et al., 2004; Guo et al., 2006; Janz et al., 2008*). These discrepancies in the results may be due to different incidence of allele „n“ in RYR1 gene, different composition of muscles and their metabolism.

Table 3. Meat quality in fresh and 5-days stored pork

Item	Group C	Group E	Group E+LM	Group E+O	Significancy
pH ₄₅	6.18	6.30	6.34	6.31	-
24 h post mortem					
pH ₂₄	5.44	5.45	5.37	5.36	-
El. conductivity, μ S	6.12 ^a	4.96 ^b	4.98 ^b	5.06 ^b	^{a,b} P<0.05
Colour – L*	50.29	49.73	50.46	49.84	-
a*	2.23	2.44	2.19	2.38	-
b*	8.96	9.22	8.86	9.11	-
Shear force, N	4.91 ^a	5.09 ^a	4.67	4.07 ^b	^{a,b} P<0.05
Drip loss, %	4.24	3.82	4.15	4.07	-
5 day post mortem					
Colour – L*	50.81	51.25	50.94	51.32	-
a*	2.54 ^a	2.43 ^a	3.22 ^b	3.41 ^b	^{a,b} P<0.05
b*	9.02	9.11	9.73	9.25	-
Shear force, N	4.30	5.01	4.84	5.10	-
Drip loss, %	8.94	8.48	8.36	8.52	-

In the present study, significantly positive effect of supplements on electrical conductivity in muscles was observed. It is obvious that this effect was due to vitamin E supplementation. Supplement of oregano or lemon balm had no extra-effect on EC. However, supplement of vitamin E with oregano significantly improved shear force of fresh pork in comparison with control and vitamin E supplemented groups. This extra-effect may be charged on account oregano since pigs supplemented only vitamin E did not have improved shear force. Similarly, positive influence of both herb extracts on colour parameter „a“ in stored pork in comparison with groups C and E was found.

Table 4. Antioxidative capacity of longissimus dorsi muscle

Item	Group C	Group E	Group E+LM	Group E+O	Significancy
TBARS - 24, mg/kg	0.203	0.170	0.178	0.192	-
TBARS – 5, mg/kg	0.267 ^a	0.193 ^b	0.190 ^b	0.220	^{a,b} P<0.05

Lipid oxidation in fresh pork was not significantly influenced by any supplement (Table 4). However, vitamin E alone or in combination with lemon balm significantly increased oxidative stability of stored pork. Positive effect of vitamin E or plant extracts on lipid oxidation in muscles was reported by various authors (*Lauridsen et al., 2000; Lahučký et al., 2001; McCarthy et al., 2001; Mason et al., 2005; Guo et al., 2006; Estévez et al., 2006*). Significant improvement of antioxidative capacity of muscles after supplementation with vitamin E and oregano and/or lemon balm compared to control group at 60 and 120 min incubation of muscle homogenate with Fe^{2+} /ascorbate was reported by *Lahučký et al. (2010)*.

Conclusion

Supplement of vitamin E increased the level of α -tocopherol in muscle and had positive effect on electrical conductivity in fresh pork. Antioxidative capacity of stored pork was significantly improved after vitamin E supplementation. Additive effect of oregano extract on shear force in fresh pork was found. Both oregano and lemon balm extracts partially improved meat colour in stored pork. Combination of vitamin E and herb extracts could be useful for improvement of pork quality, however further research is needed to examine different times and levels of supplementation in order to accomplish more beneficial impact on pork quality.

Hemijski sastav, kvalitet mesa i oksidativni status mesa svinja hranjenih obrokom sa dodatkom vitamina E i/ili vitamin E + biljni ekstrakti

I. Bahelka, K. Nürnberg, U. Küchenmeister, R. Lahučký

Rezime

Cilj ovog istraživanja bio je da oceni efekat primene biljnih ekstrakata na hemijski sastav, kvalitet mesa i antioksidativni status svinjetine, u kombinaciji sa vitaminom E i u poređenju sa pojedinačnim efektom vitamina E. U ogledu je korišćeno ukupno 80 svinja. DNK testom utvrđeni su RYR1 genotipovi svinja (*Lahučký et al., 1997*) pri čemu su odabrane samo heterozigotne jedinke. Svinje su podeljene u kontrolnu i tri eksperimentalne grupe (svaka sa po 20 životinja sa jednakim brojem nazimica i kastrata). Svinje iz kontrolne grupe dobijale su standardne obroke bez ikakvih dodataka. Eksperimentalne grupe dobijale su iste obroke kao i kontrolna ali sa dodacima vitamina E – 500 mg/kg hraniva, vitamina E i 100 ml limun balzama/svinji/dnevno, i/ili vitamin E i 60 ml

origana/svinji/dnevno. Vitamin E dodavan je tokom 30 dana a biljni ekstrakti tokom 10 dana pre klanja. Nakon klanja ocenjivan je hemijski sastav, osobine kvaliteta mesa i antioksidativni status sveže (24 h post mortem) i pet dana skladištene svinjetine. Suplementacija vitaminom E rezultovala je u značajno većem nivou α -tokoferola u *longissimus dorsi* mišiću kod svih eksperimentalnih grupa u poređenju sa kontrolnom. Utvrđen je značajan pozitivan efekat suplemenata na električni konduktivitet mišića. Za ovaj efekat očigledno je zaslužna suplementacija vitaminom E. Vitamin E sa origano ekstraktom značajno je poboljšao silu sečenja sveže svinjetine u poređenju sa kontrolnom grupom i sa vitamin E suplementiranom grupom. Ovaj dodatni efekat mogao bi se pripisati origanu, pošto kod svinja suplementiranih samo vitaminom E sila sečenja nije bila poboljšana. Utvrđen je pozitivan uticaj ekstrakata origana i limun balzama na parametar boje „a“ kod skladištene svinjetine u poređenju sa kontrolnom i vitamin E suplementiranom grupom. Vitamin E pojedinačno ili u kombinaciji sa limun balzomom značajno povećava oksidativnu stabilnost skladištene svinjetine. Kombinacija vitamina E i biljnih ekstrakata može se koristiti za unapređenja kvaliteta svinjetine ali su ipak potrebna dalja istraživanja kako bi se ispitalo različito vreme i nivoi suplementacije u smislu poboljšanja kvaliteta svinjetine.

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