Meat quality, sensory properties and oxidative stability of pork after dietary supplementation of sage, lemon balm and oregano extracts

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Abstract- **The study evaluates the effect of sage, lemon balm and oregano extracts on pork quality, sensory properties and oxidative stability of muscles. In total, eighty hybrid pigs were included in the experiment. The treatments consisted of supplementation of pig´s diet with 100 ml of lemon balm or 100 ml of sage or 60 ml of oregano per day for 10 days before slaughter. Significant influence of lemon balm extract on drip loss 24 h post mortem in comparison with control pigs was observed. This extract also improved significantly lightness L* and yellowness b* of fresh pork (24 h). In 5-days stored pork, the redness a* was improved significantly by supplementation with sage extract. All three extracts improved significantly antioxidative stability in 5-days stored pork.**

Keywords- **pork quality, oxidative stability, plant extracts**,

I. INTRODUCTION

Present demands of consumers in the modern society have been moved from high leanness of pig carcasses to such pork quality parameters as colour, water holding capacity, tenderness, juiciness, flavour etc. Improving and stabilizing meat and eating quality of pork is the focus of attention of pig producers, pork industry and scientists as well. Well-known is positive effect of some nutrients such as vitamins E, C, minerals – Mg, Se, organic acids on pork quality and antioxidative stability of muscles.

In the last years, some vegetables, spices and plants are the subject of intensive research [1-5] in effort to improve meat and eating quality of pork.

The aim of this study was to assess the effect of sage, lemon balm and oregano extracts on meat quality, sensory properties and oxidative stability of pork.

II. MATERIAL AND METHODS

A. Animals, feeding, slaughtering and sampling

In total, eighty hybrid pigs - crosses of Landrace sows and Hampshire x Pietrain boars were involved in the experiment. Pigs were determined on occurrence of mutation in RYR1 gene by DNA based test [6], and only pigs heterozygous (Nn) were selected. Animals were housed in pens in pairs and fed ad libitum. Pigs were divided to one control and three experimental groups – each of 20 animals with equal number of gilts and castrates. Control group (C) received standard diet without any supplement (Table 1).

Table 1 Composition and nutritive value of the 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		

Experimental groups were fed standard diet with 100 ml of ethanol-water extract of lemon balm (LB) or 100 ml of ethanol-propylene-glycol extract of sage (S) or 60 ml of ethanol-propylene-glycol extract of oregano (O) per day for 10 days before slaughter.

After achieving the slaughter weight of 110 ± 5.0 kg, pigs were slaughtered using electro stunning (90-100 V, 0.9-1.0 A, 50 Hz). Chilling of the carcasses (t = 2-4 °C, air velocity 0.5-1.0 $m.s^{-1}$) started 60-70 min after slaughter and was continued overnight.

After 24 chilling, the samples (200 mg) of *longissimus dorsi* muscle were removed from right half carcass and sliced into chops (2.5 cm thick) for further meat and chemical analyses. One part of sample - 100 g (taken 20 min post mortem) was wrapped in aluminium film and stored in liquid nitrogen for 24 h and five days, respectively (TBARS analyses).

B. Meat quality measurement

After slaughter, ph values 45 min and 24 h post mortem were measured on carcass in *longissimus dorsi* muscle using pH meter Ingold. Colour of pork was determined using spectrophotometer Hunter Lab MiniScan. Drip loss was measured according to [7]. Shear force was measured using Warner-Bratzler equipment on cooked samples (20 min at t = 80 °C). On the same samples was measured cooking loss (CL).

Electrical conductivity (EC) was determined 24 h post mortem in the same point as pH value. Sensory properties such as flavour, taste, tenderness and juiciness were evaluated by trained persons on five-point scale.

C. Chemical analysis

Total water, protein and intramuscular fat were determined using INFRATEC 1265. Antioxidative capacity of *longissimus dorsi* muscle was assessed by 2-thiobarbituric acid as TBARS (thiobarbituric acid reactive substances) according to [8]. TBARS were expressed as mg of malondialdehyde (MDA).

D. Statistical analysis

Data from the experiment were analysed by two-way ANOVA with fixed effects of treatment (C, LB, O, S) and sex (gilts and castrates). Two-way interactions were analysed using GLM procedure of the SAS/STAT package [9]. Comparisons between groups were done by Tukey test. There was no significant effect between sexes. Data were expressed as least square means (LSM) and standard error (SE).

III. RESULTS AND DISCUSSION

The content of total water, total protein and intramuscular fat was not influenced by plant extracts; significant differences between control and experimental groups were not found (Table 2). These findings are in agreement with results of [10].

Table 2 Chemical composition of pork

Item	C	S	LM	O	SE	Sign
Total water, %	73.65	73.85	73.94	74.08	0.34	-
Total protein, %	22.56	22.62	22.65	22.66	0.28	-
Intramuscular fat, %	2.84	2.49	2.38	2.21	0.27	-

Meat quality is showed in Table 3. Tendency of positive improving the pH_1 and pH_{24} and electrical conductivity after supplementation of diet with plant extracts was suggested but differences between control and the three experimental groups were not significant ($P>0.05$). [10] also did not find significant effect of these three plant extracts on pH values.

Table 3 Meat quality of fresh and stored pork

Item	C	S	LM	O	SE	Sign
pH_{45}	6.18	6.34	6.39	6.39	0.24	-
pH_{24}	5.44	5.52	5.53	5.59	0.17	-
24 h post mortem						
Drip loss, %	4.24[a]	3.59	3.21[b]	3.44	0.32	*
Colour – L*	50.29[a]	48.75	46.78[b]	48.33	0.22	*
a*	2.23	2.24	2.13	1.73	0.15	-
b*	8.96[a]	8.16	7.81[b]	7.93	0.50	*
EC, µS	6.12	5.48	5.71	5.63	0.39	-
5-days post mortem						
Colour – L*	50.81	51.27	51.41	49.82	0.41	-
a*	2.54[a]	4.09[b]	3.40	3.47	0.32	*
b*	9.02	9.52	9.12	8.93	0.18	-
CL, %	34.56	34.63	35.92	34.46	0.28	-
Drip loss, %	8.94	8.61	8.74	8.54	0.32	-
Shear force, N	4.91	5.23	5.26	5.34	0.35	-

[a,b] $P<0.05$

Significant influence of lemon balm extract on drip loss 24 h post mortem in comparison with control pigs was observed. No significant effect of plant extract on this parameter was found by [10].

Very important trait, mainly for consumers, is intensity and stability of pork colour. Lemon balm extract improved significantly lightness L* and yellowness b* of fresh pork (24 h). In 5-days stored

pork, the redness a* was improved significantly by supplementation with sage extract. No positive effect of plant extracts on L*, a* and b* parameters in fresh pork was reported by [10]. However, in 5-days stored pork these authors found a* value improved ($P<0.05$) by all three extracts (oregano, melissa and salvia) and yellowness b* by salvia extract ($P<0.05$). Similar results for a* value were reported by [11] and [12] who used other plant extracts.

Intensity and stability of colour on raw and cooked pork patties have been investigated in the experiment of [13]. They found that treatments of patties with clove, rosemary and cassia bark extracts did not completely inhibit the colour change, however the a* value loss was significantly reduced in comparison with control group. After cooking, red colour rapidly dwindled during storage, mainly in control patties. Discoloration in patties treated with rosemary and clove was significantly slower.

The supplementation with plant extracts slightly improved almost all senzory properties but differences were not significant when compared with control group (Table 4). These results agree with findings of [10]. Lower rancidity and off-flavour scores and higher overall acceptability in cooked pork patties after treated with clove, rosemary and cassia bark extracts comparing to control samples were found by [13].

Table 4 Senzory properties of pork

Item	C	S	LM	O	SE	Sign
flavour	3.9	4.1	4.2	4.0	0.21	-
taste	3.9	4.1	4.1	3.9	0.17	-
juiciness	3.1	3.1	3.0	3.1	0.15	-
tenderness	3.4	3.5	3.6	3.6	0.19	-

No significant influence of plant extracts on antioxidative stability expressed as TBARS values in fresh pork was found (Table 5). However, all three extracts improved significantly antioxidative stability in 5-days stored pork.

Table 5 Oxidative stability (TBARS, $mg.kg^{-1}$) of pork

Item	C	S	LM	O	SE	Sign
24 h p.m.	0.20	0.19	0.17	0.18	0.03	-
5-days p.m.	0.27^{a}	0.21^{b}	0.20^{b}	0.21^{b}	0.03	-

^{a,b} $P<0.05$

Testing the antioxidative capacity of muscle can be done using lipid stability test (peroxidation of muscle homogenate stimulated by Fe^{2+}/ascorbate). Results of some studies suggest that antioxidative capacity of muscle depends on concentration of plant extract in diet and time of incubation of muscle homogenate [10].

Positive effect of plant extracts on antioxidative stability of meat was reported in study of [14] using sage and rosemary, and of [11]. However, no antioxidative effect of rosemary was found by [15]. Significant reduced lipid oxidation during refrigerated storage was found after supplementation of pork patties with 0.05 % clove, rosemary and cassia bark extract [13].

IV. CONCLUSION

Study suggest the possibilities to use sage, lemon balm and oregano extracts for feed supplementation in pigs nutrition. Plant extracts improved some meat quality parameters and have a potential as antioxidant sources for meat quality preservation.

Further research is needed to optimize level and time supplementation of natural extracts.

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