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Rosemary extract (*Rosmarinus officinalis* L.) supplementation into the diet of Nero Siciliano pigs: effects on lipid oxidation

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ABSTRACT: During the growing-fattening period (93 days; ILW 33.5±6 kg to FLW 67±3 kg), 30 Nero Siciliano pigs were fed on a basal diet supplemented with (ROX group) or not (CTR group) a rosemary extract (1g?kg^{-1}). At 1, 3 and 5 days after slaughtering, the oxidative stability of the *Longissimus dorsi* muscle was determined by using TBArs test. Moreover, on the individual samples of the muscle the lipid content, the fatty acid and the sterol composition were determined; the acidic composition of the lard, removed from backfat, was also studied. Data were subjected to ANOVA. The fat content of the muscle was unaffected by the dietary treatment as well as the oxidative stability whereas, significant differences (P≤0.01) were observed for the polyunsaturated fatty acid content which showed the highest values in the meat as well as in the lard of the ROX group; PUFA/SFA ratio was also significantly highest in the muscle (P=0.004) and in the lard (P=0.017) of the ROX group, testifying a possible antioxidative activity of the rosemary extract. The sterol fraction (cholesterol, cholestanol, stigmasterol, beta-sitosterol and delta 5-avenasterol) of the *Longissimus dorsi* muscle was unaffected by the rosemary supplementation; a significant difference was observed only for the campesterol (CTR group=1.08, ROX group=0.90; P = 0.021).

Key words: Nero Siciliano pig, Rosemary extract, Lipid oxidation.

INTRODUCTION – Lipid oxidation is one of the major causes of quality deterioration of meat, with adverse effect on flavour, colour, texture and nutritional value (Byrne, 2000). Efficient protection of meat products against oxidative deterioration depends on an optimisation of the process parameters identified at critical points along the production chain such as animal feeding (Nissen *et al.*, 2004). Considering the high proportion of unsaturated fats of Nero Siciliano meat (Pugliese *et al.*, 2004) and consequently its particular susceptibility to oxidative rancidity, the aim of this study was to evaluate the influence of a dietary rosemary extract (*Rosmarinus officinalis* L.) added into the diet (Liotta *et al.*, 2006), on the lipid oxidation of the meat as well as of the lard of Nero Siciliano pigs.

MATERIAL AND METHODS – The research was carried out on 30 Nero Siciliano pigs. During the growing-fattening period (93 days), the animals, 16 castrated males and 14 females, were divided into two homogeneous groups of 15 each one (8 males and 7 females, LW 33.5±6 kg), which received (3% of B.W.) the basal diet as pelletted complete feed (Dry Matter = 87.5%, on a DM basis: 18.29% Crude Protein, 3.43% Ether Extract, 6.06% Crude Fibre, 7.43% Ash) supplemented with (ROX group) or not (CTR group) 1g kg^{-1} of a rosemary extract (ROX P® – Sevecom S.p.A.). Every 21 days, the chemical composition (A.O.A.C., 2000) and the fatty acidic distribution (Table 1) of feeds were determined. After the slaughter, the lipid content (AOAC, 2000), the fatty acid (Chiofalo *et al.*, 2005) and the sterol composition (N.G.D., 1989) of the *Longissimus dorsi* muscle were determined as well as the acidic composition of the lard removed from the backfat; each fatty acid was expressed as percentage of the total identified fatty acids and each sterol as percentage of the total identified sterols. On the basis of the fatty

acid profile, the Atherogenic and Thrombogenic indices of the meat and lard were calculated using the equations proposed by Ulbricht and Southgate (1991). The oxidative stability (TBARs) of the intramuscular lipid was determined at 1, 3 and 5 days after slaughtering and measuring as absorbance (A) at 532 nm (Faustman *et al.*, 1992). The results were subjected to ANOVA (SAS, 2001), using the following model: $y_i = \mu + a_i + e_i$; where a_i = effect of diet.

Table 1. Acidic class percentages on total fatty acid content of diets (mean ± SD of 3 determinations).

	Basal diet	Basal diet + Rosemary extract
Saturated (SFA), %	16.28±0.01	17.31±0.11
Monounsaturated (MUFA), %	27.10±0.14	27.07±0.05
Polyunsaturated (PUFA), %	56.62±0.14	55.62±0.17
n3-PUFA, %	3.91±0.16	3.44±0.20
n6-PUFA, %	52.71±0.02	52.18±0.37

RESULTS AND CONCLUSIONS – The lipid content of the *Longissimus dorsi* muscle was unaffected by the dietary treatment (ROX: 3.00 g/100g vs. CTR: 3.12 g/100g; P=0.629) as well as the oxidative stability (P=0.589) even if, TBARs mean values of ROX group (A_{532nm}=0.035) were slightly lower than those of CTR group (A_{532nm}=0.038). The rosemary extract added into the diet, thanks to its natural phenolic antioxidant compounds, has determined an antioxidative activity on the fatty acid composition of the meat as well as of the lard. The most significant differences in the acidic composition of the *Longissimus dorsi* muscle, from a nutritional point of view, were observed for total PUFA (Table 2) and in particular for $C_{18:2n6}$ (ROX: 9.08% vs. CTR: 6.21%; P=0.001), $C_{20:4n6}$ (ROX: 2.70% vs. CTR: 1.38%; P=0.001), $C_{22:6n3}$ (ROX: 0.27% vs. CTR: 0.14%; P=0.012) and PUFA/SFA ratio (Table 2).

Table 2. Acidic composition and quality indices of the meat in relation to the diet (LSM ± SE).

	Groups		
	CTR	ROX	SE
Saturated (SFA), %	41.42	41.13	0.62
Monounsaturated (MUFA), %	49.52A	44.75B	0.56
Polyunsaturated (PUFA), %	9.05A	14.11B	0.87
n3-PUFA, %	0.79	1.15	0.13
n6-PUFA, %	8.11A	12.64B	0.74
Polyunsaturated/Saturated (PUFA/SFA)	0.22A	0.35B	0.02
Atherogenic Index (AI)	0.49	0.44	0.02
Thrombogenic Index (TI)	1.11	0.99	0.04

^{A,B}= P<0.01.

As regards the fatty acid distribution of lard (Table 3), positive effects were observed for the total and n6 PUFA and for some of the n3 series; in particular for $C_{18:2n6}$ (ROX: 11.11% vs. CTR: 9.69%; P=0.019), $C_{18:3n3}$ (ROX: 0.69% vs. CTR: 0.56%; P<0.001), $C_{20:4n6}$ (ROX: 0.17% vs. CTR: 0.14%; P=0.002) and PUFA/SFA ratio (Table 3). No significant differences were observed for Atherogenic and Thrombogenic indices of meat as well as of lard (Table 2 and 3).
The sterol fraction of the *Longissimus dorsi* muscle (Table 4) showed no significant differences for the most represented animal and plant sterols: cholesterol, cholestanol, stigmasterol, beta-sitosterol and delta 5-avenasterol; a significant difference (P=0.021) was observed only for the campesterol. Data have shown that the rosemary extract added into the diet, thanks to the inhibition of the lipid peroxidation, could be used to protect the shelf-life of meat products (El-Alim *et al.*, 1999) and as antioxidant nutrient to provide a greater stability of polyunsaturated fatty acids of nutritional interest for the control of lipid oxidation as suggested by the essential fatty acid content (Tedesco, 2001). For these reasons, rosemary extract could represent a valid alternative to synthetic antioxidants.

Table 3. Acidic composition and quality indices of the lard in relation to the diet (LSM ± SE).

	Groups		
	CTR	ROX	SE
Saturated (SFA), %	40.98	39.96	0.62
Monounsaturated (MUFA), %	47.63	47.06	0.60
Polyunsaturated (PUFA), %	11.38a	12.96b	0.38
n3-PUFA, %	0.77A	0.91B	0.02
n6-PUFA, %	10.62a	12.07b	0.37
Polyunsaturated/Saturated (PUFA/SFA)	0.28a	0.33b	0.01
Atherogenic Index (AI)	0.50	0.48	0.01
Thrombogenic Index (TI)	1.08	1.01	0.03

a,b= P<0.05; A,B= P<0.01.

Table 4. Sterol composition of the meat in relation to the diet (LSM ± SE).

	Groups		
	CTR	ROX	SE
Cholesterol, %	95.26	95.79	0.27
Cholestanol, %	0.30	0.23	0.06
Campesterol, %	1.08a	0.90b	0.04
Stigmasterol, %	0.49	0.67	0.10
Beta – Sitosterol, %	1.73	1.65	0.18
Delta 5 – Avenasterol, %	1.15	0.77	0.15

a,b= P<0.05.

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