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in

De Pedro E.J. (ed.), Cabezas A.B. (ed.).
7th International Symposium on the Mediterranean Pig

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 101

2012
pages 315-318

Acidic profile in two different muscles of Nero Siciliano pigs as affected by different finishing diets

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Abstract. Fat and fatty acids contribute significantly and in various ways to meat quality and are central to the nutritional value of meat. Meat quality is also influenced by intrinsic factors such as muscle type. Therefore, the study examined the fatty acid composition of the white (*Longissimus dorsi* - LD) and the red (*Psoas major* - PM) muscle from 24 Nero Siciliano pigs fed with two different diets. The trial was carried out in the Nebrodi mountain area of Sicily (Italy). During the fattening period, the animals were divided into two groups, kept in two distinct wooded areas of 6 hectares each, and fed exclusively on acorn (A) and germinated barley (B). Results showed a strong interaction between diet and muscle type. The PUFA to SFA ratio was higher in PM muscle for both diets with A 0.16 LD *vs* 0.25 PM (P≤0.0001) and B 0.16 LD *vs* 0.21 PM (P≤0.001). The C18:2 n-6 amount, entirely derived from the diet, showed high statistical significance both as dietary effect and as intrinsic (muscle-type related) factor. In order to further improve strategies for pork production, more information on the effects of inherent factors (e.g. muscle type) on meat traits is needed.

Keywords. Nero Siciliano pig – Meat quality – Fatty acids.

Évaluation de l'effet de deux diètes sur le profil en acides gras de deux muscles différents chez le porc Nero Siciliano

Résumé. *Les composantes lipidique et acide jouent un rôle central dans l'évaluation nutritionnelle de la viande porcine, en contribuant à la détermination de la qualité, qui est influencée aussi par des facteurs intrinsèques à l'animal, dont le type de muscle. Pour cette raison, cette étude a évalué le profil en acides gras du muscle blanc (*Longissimus dorsi *- LD) et rouge (*Psoas maior *- PM) de 24 porcs "Nero Siciliano" nourris avec deux régimes alimentaires différents au cours de la période de finition. L'essai a été effectué en Sicile (Italie), dans le parc des Nebrodi; les animaux ont été divisés en deux groupes (A et B) homogènes et gardés dans deux parcelles boisées différentes de 6 ha chacune. Le groupe A a été nourri exclusivement avec des glands et le groupe B avec de l'orge germée. Les résultats ont mis en évidence une forte interaction entre le régime alimentaire et les types de muscle examiné; le ratio PUFA/SFA a été plus élevé dans le muscle PM dans les 2 groupes: A 0,16 LD* vs *0,25 PM (P≤0,0001) et B 0,16 LD* vs *0,21 PM (P≤0,001). La quantité de C18:2 n-6, dérivée de la ration, a été significativement corrélée à la ration et au type musculaire. Il est nécessaire d'approfondir pour définir de nouvelles stratégies de production.*

Mots-clés. *Porc Nero Siciliano – Qualité de la viande – Acides gras.*

I – Introduction

The susceptibility of pig muscles to lipid oxidation and the acidic profile in intramuscular fat depends on various factors, e.g. fatty acid composition of cell membranes, balance between antioxidants and prooxidants, amount and composition of lipids, and the activity of certain enzymes (Lauridsen *et al.,* 1999; Andrés *et al*., 2001). Numerous studies have demonstrated the correlation between diet, muscle type and acidic profile of meat. (Wood *et al*., 2004; Chang *et al*., 2003). It is also known that the fatty acid composition and the concentration of fatty acids

can influence the types and the concentration of volatiles produced in heated fat and dry-cured products (Andrés *et al.*, 2001). The aim of this study was to examine the effect of the diet and the influence of two muscles with different (oxidative or glycolytic) metabolism on the fatty acid composition of intramuscular fat of Nero Siciliano pigs, an autochthonous Italian breed reared in a traditional, free-range production system and fed on acorn and grass.

II – Materials and methods

Twenty-four "Nero Siciliano" pigs were in outdoors reared in the Nebrodi mountain region of Sicily. Animals were assigned to two groups called Acorn (A) and Barley (B), consisting of 12 animals each, homogenous for sex (castrated males) and body weight (BW, 79.48 ± 0.15 kg). Animals of group A were kept in a wooded area of 6 hectares, appropriately enclosed, and fed with acorn during the fattening period (90 days). Animals of group B were reared within an open-air system in the same rural region and fed with germinated barley on a basis of 2.5 kg/pig/d during the fattening period. After 90 days and a fasting period of 18 hours (ASPA, 1991), animals were slaughtered. A sample of *Psoas major* (PM) and *Longissimus dorsi* (LD) muscle tissue was taken from each of the 24 carcasses. Each sample was examined for its crude fat (AOAC, 2005), followed by an analysis of its acidic composition. The fatty acid composition was determined on lipids extracted by an automatic extractor Foss Model Soxtec. Fatty acids methyl esters of the intramuscular fat were prepared by direct transesterification with sulphuric acid : methanol 1:2 (Christie, 1993) and analysed using an Agilent Technologies 6890N (U.S.A) gascromatograph operated with a fused silica capillary column OMEGAWAX 250 (Supelco, U.S.A.), 30m x 0.25mm I.D., 0.25 µm film thickness. Column temperature was programmed: initial isotherm of 160°C (6 min.), increment of 3°C/min and final isotherm of 250°C (30 min.). Carrier gas: helium (1 m L/min). Peak areas were expressed in percentage of the total fatty acid identified. On the basis of the fatty acid identified, the quality indices were calculated using the equations proposed by Ulbricht and Southgate (1991). Diets (acorn or germinated-barley), muscles (LD or PM) and their interaction were compared by a two-way ANOVA, using the GLM procedure of SAS (2001).

III – Results and conclusions

The FA composition of *Psoas major* (PM) and *Longissimus dorsi* (LD) muscle is shown in Table 1. The two experimental groups showed statistical differences for most of the FA detected. However, the diet did not produce a consistent effect on the proportions of some FA in the tissues examined. In the Acorn group (A) total saturated FA (SFA) was found to be higher in the LD muscle, whereas in the Barley group (B) SFA was higher in the PM muscle. The levels of stearic acid (C18:0) showed high statistical differences for the LD muscle ($P \leq 0.0001$) (12.75% *vs* 8.40% in A and B, respectively) and no statistical differences for the PM muscle (13.23% *vs* 13.66% in A and B, respectively). These different results could be explained by the fact that a high proportion of SFA comes from de novo synthesis, and only a small proportion of total SFA is directly accumulated from dietary fatty acids (Monahan, *et al.*, 1992). In the B, total monounsaturated FA (MUFA) was higher in both muscles. In the A, the level of oleic acid (C18:1n-9) showed a high statistical difference for the LD muscle ($P \leq 0.0001$) (48.23% *vs* 37.14% in A and B, respectively), whereas in the B a statistical difference was found for the PM muscle ($P \leq 0.01$) (39.57% *vs* 43.06% in A and B, respectively). The apparently different influence of the diet on the oleic acid (C18:1 n-9) content in the muscles examined in this work could be explained by the reported effects of muscle fibre types (Andrés *et al.*, 1999; Muriel *et al.,* 2002). In the A, the level of PUFA was higher in both muscles. In detail, the content of PUFA in the LD muscle was ($P = 0.03$) 6.09% *vs* 5.24% in A and B and the content of PUFA in the PM muscle resulted ($P= 0.001$) 9,49% *vs* 8.16% in A and B respectively. These differences might be cleared by the high content of poliphenols in the acorn, reducing the oxidation of lipids. However, neutral lipids from the oxidative muscle PM contained higher percentages of linoleic

acid (C18:2 n-6), (7.11 in PM *vs* 4.77 in LD for the A and 6.19 in PM *vs* 4.01 in LD for the B respectively) and arachidonic acid (C20:4 n-6), (1.30 in PM *vs* 0.56 in LD for the A and 0.98 in PM *vs* 0.49 in LD for the B respectively).

Table 1. Principal fatty acid profiles (% methyl esters listed) of intramuscular fat of *Psoas major* (PM) and *Longissimus dorsi* (LD) muscles from Nero Siciliano pigs fed with different fattening diets

Fatty Acids	Muscle	Diet		P-value
		Acorn	Barley	
C14	LD	1.19	1.24	ns
	PM	1.23	1.17	ns
C16	LD	21.49	22.18	ns
	PM	22.87	23.74	***
C16:1	LD	3.93	4.61	***
	PM	3.44	3.50	ns
C18	LD	12.75	8.41	***
	PM	13.23	13.66	ns
C18:1 n-9	LD	48.23	37.14	***
	PM	39.58	43.06	**
C18:1 n-7	LD	4.31	19.05	***
	PM	7.82	4.61	*
C18:2 n-6	LD	4.77	4.01	**
	PM	7.11	6.19	**
C18:3 n-3	LD	0.24	0.26	ns
	PM	0.36	0.26	***
C20	LD	0.22	0.30	***
	PM	0.26	0.27	ns
C20:4 n-6	LD	0.56	0.49	ns
	PM	1.30	0.98	**
∑SFA	LD	36.22	32.47	***
	PM	38.42	39.51	ns
∑MUFA	LD	57.73	62.23	***
	PM	52.21	52.39	ns
∑PUFA	LD	6.09	5.25	*
	PM	9.50	8.16	**
∑PUFA n-3	LD	0.44	0.39	ns
	PM	0.61	0.53	*
∑PUFA n-6	LD	5.66	4.85	*
	PM	8.89	7.63	**
PUFA/SFA	LD	0.16	0.16	ns
	PM	0.25	0.21	**
AI	LD	0.41	0.40	ns
	PM	0.45	0.47	ns
TI	LD	1.07	0.92	***
	PM	1.16	1.22	ns

Results are expressed as percentage of total fatty acid methyl esters identified. AI, atherogenic index; TI, thrombogenic index; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids); * P≤ 0.05; ** P≤ 0.01; *** P≤ 0.0005.

So, contrarily to Leseigneur and Gandemer (1991), the results of this study indicate a clear effect of the muscle type on the fatty acid profiles of neutral lipid fractions. In conclusion, muscle quality characteristics differed significantly according to their respective metabolic patterns. These variations are of interest because they might produce a different behaviour of the muscles during refrigeration display, freezing or culinary practices on the oxidative and lipolytic changes and their shelf-lives; therefore, these variations should not be ignored when studying the effects of feeding strategies on meat quality.

Acknowledgements

The authors wish to acknowledge the financial support received by MIUR- PRIN 2005 and by PRA 2005 (Prof. A. Zumbo).

References

Andrés A.I., Cava R., Mayoral A.I., Tejeda J.F., Morcuende D. and, Ruiz J.,2001. Oxidative stability and fatty acid composition of pig muscles as affected by rearing system, crossbreeding and metabolic type of muscle fibre. In: *Meat Sci.*, 63: 533-541.

Andrés A. I., Ruiz J., Ventanas J., Tejeda J. F. and Mayoral. A. I., 1999. Muscle fibre types in Iberian pigs: influence of crossbreeding with Duroc breed and rearing conditions. In: *Annales de Zootechnie*, 48: 397–405.

A.O.A.C., 2005. Official Methods of Analysis, 18th ed. Association of Official. Analytical Chemists, Arlington, VA, USA.

ASPA. Associazione Scientifica Produzioni Animali., 1991. *Metodologie relative alla macellazione*. Ed. ISMEA. Roma.

Chang K.C., da Costa N., Blackleya R., Southwood O., Evans G., Plastow G., Wood J.D. and Richardson R.I., 2003. Relationships of myosin heavy chain fibre types to meat quality traits in traditional and modern pigs. In: *Meat Science*, 64: 93-103.

Christie W.W., 1993. Preparation of Ester Derivatives of fatty acids for chromatographic analysis. In: *Advanced in Lipid Methodology*-Two: 69-111.

Hulbricht T.L.V. and Southgate D.A.T., 1991. Coronary heart disease: seven dietary factors. In: *The Lancet*, 338: 985-992.

Lauridsen C., Nielsen J. H., Henckel P. and Sorensen M. T., 1999. Antioxidative and oxidative status in muscles of pigs fed rapeseed oil, vitamin E, and copper. In: *Journal of Animal Science*, 77: 105–115.

Leseigneur-Meynier A. and Gandemer G., 1991. Lipid composition of pork muscle in relation to the metabolic type of the fibres. In: *Meat Science*, 29: 229–241.

Muriel E., Ruiz J., Ventanas J. and Antequera T., 2002. Free-range rearing increases (n-3) polyunsaturated fatty acids of neutral and polar lipids of swine muscles. In: *Food Chemistry*, 78: 219-225.

Wood J.D., Nute G.R., Richardson R.I., Whittington F.M., Southwood O., Plastow G., Mansbridge R., da Costa N. and Chang K.C., 2004. Effects of breed, diet and muscle on fat deposition and eating quality in pigs. In: *Meat Sci.*, 67: 651-667.

SAS, 2001. Statistical Analysis System user's guide (vers. 8.2). SAS Institute Inc., Cary, NC