ODD-NUMBERED CHAIN FATTY ACIDS CONTENT OF IBERIAN PIGS AS AFFECTED BY FED COMPOSITION

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BACKGROUND

Odd-numbered chain fatty acids (ONCFA) are a few percentage of total fatty acids. However, they are very important because may affect fat characteristic, like fluidity and softness (Johnson *et al.*, 1988) due to their chemical structure. They arise from final products of digestive fermentations and (in ruminants) from cell membranes of ruminal microorganism (James *et al.*, 1956; Rojas *et al.*, 1994). Feeding regimen affects ONCFA content in ruminants (Webb *et al.*, 1994), however little is known about its influence in pig tissues. In Iberian pigs, González (1994) has shown a significatively increase in heptadecanoic and heptadecenoic acids during the periods in which pigs were fed essentially with pasture, and a decrease during the finish-fattening period. During this finishing phase pigs are fed extensively, intensively or half and half. Quality of meat products depends on the type of feeding in this period, and one of the causes of the different qualities is the fatty acid composition of fat. Fat quality characteristics are very different of the ones in other type of pigs (i.e., a high oiliness and softness are appreciated). The high fiber consumption of Iberian pigs produced extensively and their advanced slaughtering age, could result in high percentages of ONCFA, affecting fat characteristics and quality of meat products. So, a more detailed study about the influenced of the three type of feeding regimen on the ONCFA content of Iberian pigs fat is required.

OBJECTIVES

The present study was designed to determine the effects of the three types of feeding used commonly during finish-fattening period on the total fatty acid profile and specially on the ONCFA composition of subcutaneous and muscle fat of Iberian pig.

METHODS

Animals and Diets

Thirty Iberian pigs divided in three batches were used in this experiment. According to the type of feeding during the finish-fattening period, they were called "montanera" (MO), when fattened extensively on acorns and pasture, "cebo" (CE) when fed on a concentrate feed based on cereals, soya and pig fat, and "recebo" (RE), were fattened like MO pigs during the first 30 days of fattening, and then finished during last 30 days before slaughter with a concentrate feed . All pigs started fattening period weighing 85-90 Kg and the slaughter weight was 140-150 Kg.

Sampling

Subcutaneous fat samples were taken from subcutaneous tissue over *Vasto lateralis*. Muscular samples were removed from *Masseter* muscle. Acorn and pasture samples were obtained in the farmland where pigs were fattened. Samples were immediately frozen and kept at -80°C until analysis.

Chemical analysis

Protein, ether extract, crude fiber, ash and moisture of diets were determined according to the AOAC (1984) methods. Lipids to analyze of subcutaneous tissue, muscle, acorn, pasture and concentrate were extracted according to the method described by Bligh and Dyer (1959). The fatty acid methyl esters (FAMEs) were obtained according to the method described by Sandler and Karo (1992). FAMEs were analyzed with a Hewlett Packard mod. HP-5890A gas chromatograph equipped with a flame ionization detector (FID), using a fused-silica column (30m, 0.53mm O.D.) packed with FFAP-TPA (Hewlett Packard). Analysis were performed at 225°C, and the injector and detector temperatures were 230°C. Carrier gas was nitrogen at a flow rate of 15ml/min. Identification of fatty acid methyl esters was made by comparison with retention time of authentic standards (Sigma).

TABLE 1. Chemical composition and fatty acid percentage of feed samples.

	MO		RE and CE
	Acorn	Pasture	Concentrate
Moisture[1]	402,1	728,0	120,0
Ash[2]	25,5	239,3	39,3
Fiber[2]	70,5	168,3	39,7
Fat[2]	63,3	25,0	32,3
Protein[2]	42,9	99,2	129,5
NFE[2]	797,8	468,2	759,2
Fatty acids[3]			
C15:0	0,03	0,25	0,12
C17:0	0,14	0,25	0,10
C17:1	0,07	0,49	0.11
C16:0	14,63	21,40	19,03
C18:0	3,09	3,43	4,14
C20:0	0,33	0,45	0,29
C16:1	0,15	0,85	0.62
C18:1	63,81	11,46	23,76
C18:2	16,07	10,00	45,61
C18:3	0,77	40,09	3,68

[1]expressed as g Kg^{-1} of fresh matter
[2]expressed as g Kg^{-1} of dry matter
[3]expressed as percentage of total methylesters.

Statistical analysis

Differences in the fatty acid profiles of the subcutaneous and intramuscular fat between diets were analyzed by analysis of variance and detected by Tukey test using the General Linear Model (GLM) procedure of SAS (1989).

RESULTS AND DISCUSSION

Chemical and fatty acid composition of diets are given in table 1. ONCFA found in lard, muscle and feed samples were pentadecanoic (C_{15}), heptadecanoic (C_{17}) and heptadecenoic ($C_{17:1}$) acids. Significant increases in percentage of these fatty acids and in the total

ONCFA were observed in both subcutaneous and intramuscular fat (tables 2 and 3) of pigs fed the MO diet ($p<0.05$). However, these values are lower than those reported in ruminants (about 2%) (Johnson *et al.*, 1988; Webb *et al.*, 1994). It seems that high concentrations of propionate and methylmalonate, produced in ruminal and large intestine fermentation of fiber and carbohydrates, are not completely metabolized in the liver, but synthesized to unsaturated and/or branched and odd-numbered chain fatty acids in the subcutaneous adipose tissue (Garton *et al.*, 1972; Duncan & Garton, 1978). Imoto and Namioka (1978) found little differences in propionate production in caecum and colon of pigs fed on diets with different fiber content. However, the production system of Iberian pigs are very different to those of this experiment. The high fiber content of pig diets produced extensively could produce higher propionate concentrations in intestine than in those pigs fed on concentrates, and consequently, higher ONCFA content in fat. Another factor that could contribute to the higher content of ONCFA in pigs fed on MO diet is the relatively high content of this type of fatty acids in pasture. It is difficult to calculate pasture consumption, but due to the low fat content, is not probably that could influence animal fat composition.

With exception of myristic acid ($C_{14:0}$) in subcutaneous tissue and pentadecanoic, myristic and arachidonic ($C_{20:4}$) acids in muscle, diets significantly affected the fatty acid profile of Iberian pigs. Pigs fed MO had greater proportions of total monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids, but lower of total saturated fatty acids (SFA). Flores *et al.*(1988) and de la Hoz *et al.* (1993) also reported that feeding on acorns and pasture (MO diet) increased the MUFA and reduced SFA in liver and subcutaneous fat respectively. Mottram & Edwards (1983) reported that intramuscular triglycerides and phospholipids are the major source of volatile compounds. In this sense, FA composition of intramuscular fat will be the responsible of the volatile substances formed during the oxidation phenomena occurred during the processing of products from Iberian pig meat (García *et al.*, 1991; Antequera *et al.*, 1992). The higher oleic acid percentage in MO fat would be responsible of high appreciate flavour of dry hams from Iberian pigs fed extensively.

TABLE 2.- Fatty acid profile of subcutaneous tissue from pigs fed the MO, RE and CE diets[1].

Fatty acid	MO[1]	RE[1]	CE[1]	SEM[2]	Level of significance
C15:0	0.08[a]	0.05[b]	0.06[a]	0.00	*
C17:0	0.41[a]	0.22[c]	0.33[b]	0.02	***
C17:1	0.43[a]	0.23[c]	0.30[b]	0.02	***
ΣOCFA	0.92[a]	0.50[c]	0.70[b]	0.04	***
C14:0	2.01	1.68	1.88	0.06	NS
C16:0	24.84[b]	25.18[b]	28.71[a]	0.45	***
C18:0	9.53[b]	10.38[b]	14.30[a]	0.46	***
C20:0	0.12[b]	0.19[a]	0.19[a]	0.01	**
ΣSFA	36.51[b]	37.42[b]	45.08[a]	0.88	***
C16:1	3.57[a]	2.81[b]	2.83[b]	0.11	**
C18:1	49.31[a]	46.90[a]	43.92[b]	0.59	***
ΣMUFA	52.88[a]	49.71[b]	46.75[c]	0.88	***
C18:2	8.84[ab]	11.44[a]	6.91[b]	0.40	***
C18:3	0.64[a]	0.69[a]	0.39[b]	0.03	***
C20:4	0.10[ab]	0.13[a]	0.06[b]	0.01	*
ΣPUFA	9.58[b]	12.27[a]	7.35[c]	0.43	***

[1] Mean / [2]Pooled standard error of the mean
a,b,c in this and following table, means with different superscript in the same row are significantly different at the $P<0.05$ level of probability at least.
Results expressed as percentage of total methylesters.
Levels of significance in this and following table: NS = not significant ($P>0.05$); * = $P<0.05$; ** = $P<0.01$; *** = $P<0.001$.

CONCLUSIONS

Extensively fed Iberian pigs on acorn and pasture produces high levels of ONCFA and MUFA. This could be very important in the sensorial characteristics of high quality dry meat products derived from this pig breed.

TABLE 3. Fatty Acid Content of intramuscular fat from pigs fed the MO, RE and CE diets.

Fatty acid	MO[1]	RE[1]	CE[1]	SEM[2]	Level of significance
C15:0	0.05	0.04	0.05	0.00	NS
C17:0	0.26[a]	0.14[c]	0.18[b]	0.01	***
C17:1	0.33[a]	0.15[b]	0.19[b]	0.02	***
ΣONCFA	0.65[a]	0.33[c]	0.43[b]	0.03	***
C14:0	1.38	1.35	1.52	0.03	NS
C16:0	23.90[b]	25.91[a]	26.73[a]	0.30	***
C18:0	9.80[c]	11.68[b]	12.74[a]	0.28	***
C20:0	0.17[b]	0.18[b]	0.21[a]	0.00	***
ΣSFA	35.26[a]	39.13[b]	41.21[a]	0.53	***
C16:1	4.13[a]	3.45[b]	3.81[a]	0.10	*
C18:1	51.82[a]	49.12[b]	47.46[b]	0.44	***
ΣMUFA	55.96[a]	52.57[b]	51.27[b]	0.47	***
C18:2	7.17[a]	7.01[a]	5.99[b]	0.69	**
C18:3	0.41[b]	0.30[b]	0.54[a]	0.03	***
C20:4	0.49	0.58	0.49	0.03	NS
ΣPUFA	8.07[a]	7.89[ab]	7.02[b]	0.18	*

[1]Mean / [2]Pooled standard error of the mean
Results expressed as percentage of total methylesters.

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