The fatty acid composition of pork and beef fat

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INTRODUCTION

In the present study the fatty acid composition of pork and beef fat from different depots and tissues was analysed.

Interest was primarily centered I. on the influence of it on keeping quality and of consistency of pork fat, II. on the nutritional importance of the fatty acids in pork fat and III. on the influence of sex and age on the composition of beef fat.

MATERIALS AND METHODS

For analysing pork fat samples were taken from pigs slaughtered at Scan's slaughter house in Kävlinge. They represented the Swedish Landrace breed and were slaughtered at a live weight of about 90 kg. The thickness of the back fat did not exceed 25 mm.

The beef fat samples representing the Swedish Lawland race were taken from the ordinary cattle line at Scan's slaughter house.

Preparations of the sample

Depot fat taken from back, belly and intestines of the pork and from perirenal region, brisket, loin and round of the beef was trimmed free from lean meat. After grinding the fat was melted on a boiling water bath, gassed with nitrogen and freed from water and other non-fat impurities by filtering twice throught filter paper.

To obtain depot fat from jowls and shanks of the pork and intramuscular fat of pork and beef, the sample was ground and the fat extracted in a mixer with methanol, chloroform and water according to OSTRANDER and DUGAN (1)

Preparations of methyl esters

The methylation was carried out either according to METCALF *et al* (2), using BF_3-methanol as methylating agent or according to TÖREGÅRD (3) with methylene chloride and sodium methylate.

Gas chromatography

The methyl esters were separated by gas chromatography in an Aerograph 204 gas chromatograph with a flame ionisation detector. The following columns were used: 1. 1/8" × 5 feet stainless steel tube packed with 10 % DEGS on acid washed DMCS-treated Chromosorb W, 80/100 mesh. 2. 1/8" × 5 feet stainless steel tube packed with 3 % SE-30 on acid washed DMCS-treated Chromosorb W, 80/100 mesh. 3. 1/8" × 6 feet stainless steel tube packed with a mixture of 6 % DEGS and 4 % BDS on acid washed, DMCS-treated Chromosorb W, 80/100 mesh.

The chromatography was carried out under the following conditions: Injector temp. 225°, column temperature 195°, detector temp. 235°, carrier gas: nitrogen 25 ml per min., hydrogen gas 25 ml per min.

The quantitative determination of the different acids was performed by measuring the peak areas with an Aerograph Digital Integrator 475.

To facilitate the identification of the fatty acids part of the methyl esters

Table 1. *The fatty acids found in pork back fat and the mode of identification*

Degs rel.time ref.to $C_{18}=1$	*Degs standard fatty acids*	*After hydro-genation*	*According to ECL values*	*Lin-log-plot diagram*	*SE-30 column*	*Result*
	C_{10}			C_{10}		C_{10}
0,178	C_{12}				C_{12}	C_{12}
0,282	C_{14}	C_{14}		C_{14}	C_{14}	C_{14}
0,370		C_{15}		C_{15}	C_{15}	C_{15}
0,484	C_{16}	C_{16}		C_{16}	C_{16}	C_{16}
0,540	$C_{16}=1$		$C_{16}=1$	$C_{16}=1$	$C_{16}=1$	$C_{16}=1$
0,630		C_{17}		C_{17}	C_{17}	C_{17}
					$C_{17}=1$	$C_{17}=1$
0,704			$C_{16}=2\ C_{17}=1$	$C_{16}=2\ C_{17}=1$		
0,822	C_{18}	C_{18}		C_{18}	C_{18}	C_{18}
1,0	$C_{18}=1$		$C_{18}=1$	$C_{18}=1$	$C_{18}=1$	$C_{18}=1$
		C_{19}		C_{19}		C_{19}
1,174	$C_{18}=2$		$C_{18}=2$	$C_{18}=2$		$C_{18}=2$
1,390	C_{20}	C_{20}		C_{20}	C_{20}	C_{20}
						$C_{18}=3$
1,589	$C_{18}=3\ C_{20}=1$		$C_{18}=3\ C_{20}=1$	$C_{18}=3\ C_{20}=1$	$C_{20}=1$	$C_{20}=1$
		C_{21}		C_{21}		C_{21}
2,003			$C_{20}=2$	$C_{20}=2$	$C_{20}=2$	$C_{20}=2$
2,686	$C_{20}=4\ C_{22}=1$		$C_{20}=4\ C_{22}=1$	$C_{20}=4\ C_{22}=1$	$C_{20}=4$	$C_{20}=4$
					C_{22}	C_{22}
					$C_{22}=1$	$C_{22}=1$

were hydrogenated by passing them through a short column inserted between the injector port and the separating column and packed with a neutral palladium catalyst on Chromosorb W according to BEROZA and SARMIENTO (4).

RESULTS AND DISCUSSION

Pork fat

Pork fat was shown to contain at least 19 acids. The identification was based on retention times obtained from columns 1 and 2 in comparison with available authentic substances.

The method of equivalent-chain-length values according to HOFSTETTER *et al* (5) was used to identify the unsaturated acids. Hydrogenation was used to check the proper chain lenght. In addition we used the linear-log plot system to determine the chain length of the acids and the degree of unsaturation.

In table 1 the identified acids are recorded together with the methods used for identification. Of even-numbered acids all from C_{10} to C_{22} were

Table 2. *The fatty acid composition of back fat and and intramuscular fat from ham.*

Fatty acid	*Percent in fat from* *Back*	*Ham*
C_{10}	<0,1	<0,1
C_{12}	<0,3	0,3
C_{14}	1,8	1,9
$C_{14}=1$	<0,1	<0,1
C_{15}	<0,1	<0,1
C_{16}	24,5	23,7
$C_{16}=1$	2,7	3,2
C_{17}	0,3	0,5
$C_{17}=1$	<0,1	<0,1
C_{18}	15,4	12,5
$C_{18}=1$	40,8	38,0
$C_{18}=2$	8,5	12,8
$C_{18}=3$	1,0	1,2
C_{19}	<0,1	<0,1
C_{20}	0,2	0,2
$C_{20}=1$	1,6	1,3
$C_{20}=2$	0,4	0,6
C_{21}	<0,1	<0,1
C_{22}	<0,1	<0,1
$C_{20}=4$	0,3	2,5

Table 5. *Tentatively identified fatty acids in beef fat.*

straight chained saturated acids ..	C_{10}, C_{12}, C_{14}, C_{15}, C_{16} C_{17}, C_{18}, C_{19}, C_{20}
branched saturated acids	C_{14}, C_{15}
monounsaturated acids	C_{14}, C_{16}, C_{17}, C_{18}, C_{20}
diunsaturated acids	C_{18}(5, 11) C_{18}(9, 12)
triunsaturated acids	C_{17}, C_{18}
tetraunsaturated acids	C_{20}

Table 6. *The fatty acid composition of beef depot fat.*

Fatty acid	*Percent acid in fat from*				
	Perirenal region	*brisket*	*chuck*	*loin*	*round*
C_{12}	0,2	0,3	0,2	0,1	0,1
C_{14}Br	0,2	0,1	0,1	0,2	0,1
C_{14}	3,6	3,2	3,5	3,3	2,9
C_{14}=1	1,3	3,1	2,2	2,4	2,8
C_{15}	1,1	0,5	0,3	0,3	0,3
C_{16}Br	0,3	0,3	0,2	0,3	0,3
C_{16}	26,2	22,4	27,7	25,8	23,2
C_{16}=1	3,0	10,3	7,4	7,9	9,8
C_{17}	1,6	0,9	1,4	1,2	1,1
C_{17}=1	0,6	1,3	1,0	0,9	1,3
C_{16}=2					
C_{18}	26,8	7,4	10,6	10,0	6,9
C_{18}=1	30,4	44,8	41,0	42,9	46,5
C_{18}=2	2,5	2,6	2,3	2,4	2,2
C_{20}	0,3	0,1	0,1	0,1	0,2
C_{18}=3	1,3	2,5	1,7	1,8	1,9
C_{20}=1					
C_{20}=2	0,2	0,1	0,2	0,1	0,2
C_{20}=4	<0,1	<0,1	<0,1	<0,1	<0,1

contain more saturated acids, palmitic and stearic, and less unsaturated acids, palmitoleic and oleic, than fat from brisket and round. The linoleic acid content was about the same in the analysed samples.

The composition of perirenal fat as a function of sex and age is shown in table 7. When comparing a female calf, heifer and cow it was evident that the content of saturated acids increased with increasing age and that the content of both oleic and linoleic acid decreased.

The same comparison made for a male calf and a young bull showed that in this case only the stearic acid and oleic acid varied.

Table 7. *The variation of the fatty acid composition of perirenal fat from beef. The influence of sex and age.*

Fatty acid	*Percent acid in fat from*					
	cow 4 years	*heifer 18 months*	*steer 18 months*	*bull 18 months*	*calf male*	*calf heifer*
C_{12}	0,2	0,2	0,3	0,2	0,2	0,2
C_{14} Br	0,2	0,1	0,3	0,1	0,1	0,1
C_{14}	4,7	3,2	3,4	3,1	5,2	4,9
$C_{14}=1$	1,4	2,4	1,9	2,0	1,3	1,3
C_{15}	1,1	0,8	0,9	0,6	0,5	0,3
C_{16} Br	0,3	0,2	0,1	0,1	0,1	0,1
C_{16}	27,6	25,4	22,4	23,8	24,4	21,6
$C_{16}=1$	4,7	3,9	3,6	4,0	3,7	5,2
C_{17}	1,6	1,2	1,1	1,1	0,8	1,1
$C_{17}=1$	0,6	0,9	0,8	0,5	0,3	0,5
$C_{16}=2$						
C_{18}	25,3	23,1	29,7	29,5	19,8	19,2
$C_{18}=1$	28,7	30,7	25,5	26,5	38,3	39,7
$C_{18}=2$	2,3	3,5	4,1	3,2	3,1	4,1
C_{20}	0,2	0,1	0,2	0,2	0,2	0,1
$C_{18}=3$	1,1	1,7	2,6	1,5	0,8	1,6
$C_{20}=1$						
$C_{20}=2$	<0,1	0,2	0,2	0,2	0,2	0,2
$C_{20}=4$	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1

Perirenal fat from the bull differed from that of the heifer by containing more stearic acid and less oleic acid. The fat from the steer ressembled bull fat more than heifer fat.

The fatty acid spectrum of intramuscular fat is illustrated by the values obtained from the loin (longissimus dorsi) as shown in Table 8.

Differences in the composition were found both concerning sex and age. The most interesting ones relating to sex were those in the content of linoleic and arachidonic acid. The fat from young bulls contained about twice the amount of linoleic acid than fat from steers and heifers and two to three times the amount of arachidonic acid.

These two acids were also found to vary with age. The linoleic acid content decreased from 10,5 % in calves (3 weeks old) to 4 % in heifers (18—20 months old) but remained at this level as shown by the value found in cows (4 years old). Arachidonic acid showed the same trend as it fell from 4 % in young calves to 0,8 %—0, 6 % in heifers and cows. The cause of the differences in fatty acid composition relating to sex and age is not quite clear.

The differences may lie in the differences in the fat content as bulls

generally are leaner than heifers and steers. MILLER (9) has found that the percentage of arachidonic acid in the fat was higher in tissues with a low fat content than in tissues with a high fat content.

An explanation is given by O'KEEFE (10) who pointed out that the phospholipid content varied very little in the same muscle from animal to animal. As linoleic and arachidonic acid are mainly localised in the phospholipids, their percentages in the total fat will diminish when the total fat content is raised by increasing the amount of triglycerides.

The fact that the percentage of linoleic and arachidonic acid increased with increasing age in pork instead of decreasing as in beef can, however, not be explained by this theory.

Table 8. *The fatty acid composition of intramuscular fat from the loin. Influenced of sex and age.*

Fatty acid	*Percent in fat from*					
	bull 18 months	*steer 18 months*	*heifer 18 months*	*calf 3 weeks*	*calf 4 months*	*cow 4 years*
C_{10}	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
C_{12}	0,2	0,2	0,2	0,2	0,2	0,2
C_{14}	3,1	2,9	3,3	5,3	3,2	4,1
$C_{14}=1$	1,1	1,6	1,3	0,6	1,1	1,9
C_{15}	0,5	0,6	0,5	0,4	0,4	0,5
C_{16}	22,8	25,1	25,4	26,1	22,6	29,0
$C_{16}=1$	3,7	4,8	4,6	3,2	4,8	5,9
C_{17}	1,6	1,5	1,3	0,9	0,9	0,5
$C_{17}=1$	2,1	1,3	1,2	0,8	0,9	1,6
C_{18}	17,6	15,0	15,4	12,4	12,1	17,1
$C_{18}=1$	31,8	37,2	38,6	32,2	37,5	32,4
$C_{18}=2$	8,1	4,5	4,1	10,5	9,0	3,9
C_{20}	0,2	0,2	0,2	0,2	0,2	0,2
$C_{18}=3$	2,1	2,1	1,6	1,3	2,0	1,6
$C_{20}=1$	0,5	1,1	0,5	1,2	0,6	0,5
$C_{20}=2$	0,2	0,2	0,2	0,2	0,2	0,2
$C_{20}=4$	2,5	1,3	0,8	4,0	2,7	0,6

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