CHEMICAL AND PHYSICAL CHARACTERISTICS OF FRESH SUBCUTANEOUS FAT FROM ALENTEJANO PIG BREED

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Background

The Alentejano pig differs from the modern highly selected breeds regarding growth rate and body composition. Comparatively with others, this pig shows a slow rate of growth and a high lipogenesis activity at the early stages of development. The lipids are deposited mainly in subcutaneous, renal and pelvic regions. The percentages of fatty cuts can attain more than 50% of the carcass weight and the backfat thickness at the last rib level can grow to 60 mm at 120 kg live weight (LW) (Almeida et al., 1993; Neves et al., 2001). This kind of carcass is considered ideal for the manufacture of dry cured products, and was for decades the main source of meat in the diet of the people living in Alentejo region. Nowadays, the production fulfills a double function: it provides meat for the manufacture of cured products and for fresh consumption. The manufacture industry (cured hams, forelegs and sausages) requires pigs reared in traditional extensive systems, slaughtered at 140-160 kg BW and with 18-24 months of age (De Pedro and Olmo, 2000). The emerging market of the fresh meat requires animals with 90-100 kg LW, obtained at 10-12 months of age. The adipose tissue plays an important role on the characteristics of cured or cooked products and fresh meat. The animal growth implies chemical, biochemical and physical changes in the adipose tissue, mainly due to an increase on the lipids content. These changes affect the gross chemical composition or the fatty acid composition, which could determine its global quality (firmness or softness, color or oxidation sensibility) (Lebret and Mourot, 1998).

Objectives

The aim of this work was to investigate the evolution of the chemical composition of fatty tissues and its effect on chemical and physical traits.

Materials and methods

Thirty Alentejano pigs were weaned at 28 days and castrated at 60 days old. After weaning, they were transferred to open-air individual pens with a protecting roof and fed a commercial diet (15 % CP; 3100 kcal DE) at 85 % of *ad libitum*. This diet had 3 % crude fat, distributed by the following major fatty acids: C16:0 (17,7 %), C18:1 (28,9 %) and C18:2 (31,2 %). The animals were weekly weighted and after a 24 h fasting period, 5 pigs were initially slaughtered at 40 kg LW. The remaining animals were fasted and slaughtered (5 animals) at 70, 80, 90, 100 and 110 kg LW. After slaughter, the left side of each carcass was submitted to a 24 h chilling, followed by commercial cuts and sample collection of backfat at last rib level. Adipose subcutaneous backfat at the 12^{th}-13^{th} rib level and ham were also sampled. All the samples were vacuum packaged and stored (-20 ºC) until analysis. Analyses included moisture (Portuguese norm - 1614), total protein (Portuguese Norm - 1612) and lipids (calculated as 100 - [protein + water]). Color CIE L* a* b* (Minolta CR-200) and pH (Portuguese Norm - 3441) were also determined. Lipids for fatty acid determination were extracted at 50 ºC, and prepared to obtain the methyl esters to be analyzed by GC/FID. An ANOVA was carried out and the means comparison was made by SNK test. The correlations between the variables studied were determined by the Pearson coefficient. SPSS statistical software was used.

Results and discussion

Table 1 presents the results of gross chemical composition and some physical traits. The slaughter weight affected significantly the gross chemical composition and the subcutaneous color values. As the slaughter weight increased, the water and protein amount decreased and the lipids concentration increased, mainly between 40 and 70 kg LW. From 70 kg to 110 kg LW, we observed the same significant differences between the two slaughter groups, but the differences among the tree major chemical compounds were less pronounced. The evolution of the gross chemical composition was paralleled by the increase of backfat depth and the increase of this adipose depot on the Alentejano pig carcass. This evolution of the chemical

composition seems to agree with the three phases of development of the adipose tissue: hyperplasia between 7 and 20 kg, hyperplasia and hypertrophy between 20 and 70 kg, and finally an exclusive hypertrophy after 70 kg LW (Anderson and Kauffman, 1973). The higher increase between 40 and 70 kg LW could be explained by a predominant hypertrophy of the adipocytes, accompanied by a decrease of the amount in protein and water in the tissue, whether the amount of lipids increased (Camara *et al*., 1994).
Between 40 and 70 kg LW the backfat became less colored and mainly less red. The a* (red) value decreased (7,4 to 3,7), the b* (yellow) increased (1,39 to 4,2), the hue angle increased (from 10,45 º to 49,00 º) and the cromatocity decreased (7,6 to 5,6). These results could be explained by a dilution effect of the connective network and capillary infiltration, as a result of the lipids synthesis and deposition. The pH values showed large variations among the six groups studied, and no trend was identified. The results from the correlation matrix showed a high correlation between lipids and pH (0,88; P>0,05). As known, the lipids have a neutral pH, and an increase of their concentration implies an increase of the pH value. The deposition of lipids in adipose tissue (adipocytes) seemed to produce a great change in color backfat evidentiated by the high correlation between lipids and the chromatic coordinates a* and b* (-0,85 and 0,82; P>0,05); and in hue angle (0,94; P>0,05) and croma (-0,59).

Table 2 presents the results of fatty acid composition. The slaughter weight affected greatly the amount of the major fatty acids between 40 and 70 kg LW, showing a slight difference between 70 and 100 kg LW. At 40 kg LW, subcutaneous tissue presented less C16:0, C18:0 and total saturated, and C18:1 and total monounsaturated fatty acids, but more C18:2 and total polyunsaturated fatty acids. After 70 kg LW the slaughter weight affected the amount of C16:1, C18:1, C18:2, total monounsaturated and total polyunsaturated fatty acids. This heavier group registered a significantly great amount of C16:1, C18:1 and total monounsaturated fatty acids, and a lower content of C18:2 and total polyunsaturated fatty acids. However, quantitatively, the differences between the upper and the lower values were rather small. In general, the adiposity increase during the growth process induced a reduction of the unsaturation degree of the fat depots (Nürnberg, 1995). This could be explained by the greater participation of the metabolic pathway synthesis *de novo,* mainly saturated. In our experiment, we didn't observe a reduction in the unsaturation degree, but a change in the proportions of poly and monounsaturated fractions was detected (increase of monounsaturated and decrease of polyunsaturated fractions). Since the diet used in our trial had only a 3% crude fat, the increase of the saturated fatty acids through a *de novo* synthesis is suggested. In another study with Alentejano pigs slaughtered at 95 kg LW, Neves (1998) found less amounts of C16:0 (23,50%) and C18:1 (44,45%) and a greater amount of C18:2 (12,06%) than the ones obtained in this study. However, although the diet used had a similar fatty acid composition, it was richer in crude fat (6%) which could have stimulated the exogenous synthesis (Mourot *et al*., 1994) and a great deposition of C18:2.

Conclusions

- The Alentejano pig revealed a great adipogenic capacity at early developmental stages. Lipid concentration in subcutaneous fat showed a high increase between 40 and 70 kg LW and only a slight increase between 70 and 100 kg LW.

- The high adipogenic activity in the backfat at early development stages was accompanied by a large change in the fatty acid profile, with the increase of total saturated and monounsaturated fatty acids, and a decrease of total polyunsaturated fatty acids. After 70 kg LW, the differences found in fatty acid composition didn't seem to be important enough to change the global quality of the Alentejano pig subcutaneous fat.

- The evolution of gross chemical composition had a great effect on the backfat color attributes.

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Table 1. Chemical and physical characteristics of the backfat of Alentejano pigs at a various live weights

Slaughter weight groups	40	70	80	90	100
Water	18,76± 3,7 [a]	5,29 ± 0,3 [b]	5,37 ± 0,5 [b]	5,14 ± 0,6 [b]	5,05 ± 0,5 [b]
Protein	3,80 ± 1,3 [a]	1,19 ± 0,3 [b]	0,92 ± 0,1 [b]	0,94 ± 0,4 [b]	0,86 ± 0,2 [b]
Lipids	77,44 ± 5,0 [a]	93,53 ± 0,5 [b]	93,72 ± 0,6 [b]	93,92 ± 0,9 [b]	94,09 ± 0,7 [b]
pH	6,32 ± 0,2 [a]	7,00c ± 0,1	6,76 ± 0,1 [b]	6,91 ± 0,1 [bc]	6,84 ± 0,04 [bc]
L*	80,46 ± 0,1 [a]	79,38 ± 1,0 [b]	80,09 ± 1,0 [b]	80,06 ± 1,5 [b]	79,24 ± 1,2 [b]
a*	7,43 ± 0,3 [a]	3,70 ± 0,9 [b]	4,16 ± 0,6 [b]	3,94 ± 1,2 [b]	3,66 ± 0,8 [b]
b*	1,39 ± 0,6 [a]	4,20 ± 0,8 [b]	4,98± 0,5 [b]	4,21 ± 0,5 [b]	4,23 ± 0,4 [b]
Hue	10,50 ± 4,2 [a]	49,00 ± 3,7 [b]	50,20 ± 1,8 [b]	47,99 ± 8,0 [b]	49,57 ± 3,6 [b]
Croma	7,58 ± 0,3 [a]	5,61 ± 1,19 [b]	6,49 ± 0,8 [ab]	5,80 ± 1,1 [b]	5,60 ± 0,8 [b]
Saturation	0,09 ± 0,004 [a]	0,07 ± 0,002 [b]	0,08 ± 0,01 [ab]	0,07 ± 0,01 [b]	0,07 ± 0,01 [b]
Backfat depth (cm)	1,3 ± 0,4 [a]	3,0 ± 0,6 [b]	4,1 ± 0,5 [c]	5,1 ± 0,3 [d]	5,6 ± 0,4 [d]

Means within the same line with same letter were not significantly different (P>0,05)

Table 2. Fatty acids composition of the backfat of Alentejano pigs at a various live weights

Slaughter weight groups	40	70	80	90	100
C14:0	1,46 ± 0,1	1,33 ± 0,1	1,43 ± 0,1	1,39 ± 0,1	1,51 ± 0,1
C16:0	22,07 ± 1,1[c]	24,34 ± 0,5 [ab]	24,46 ± 1,0 [ab]	24,19 ± 0,4 [ab]	24,92 ± 0,5 [ab]
C16:1	1,77 ± 0,1[c]	2,18 ± 0,2 [a]	2,12 ± 0,1 [a]	2,31 ± 0,3 [ab]	2,57 ± 0,3 [b]
C18:0	11,41 ± 0,7 [b]	12,57 ± 0,7 [a]	12,75 ± 0,6 [a]	12,52 ± 1,4 [a]	12,29 ± 0,4 [a]
C18:1	41,75 ± 1,0 [c]	46,61 ± 0,6 [ab]	45,90 ± 0,5 [a]	46,38 ± 0,6 [ab]	47,11 ± 0,7 [b]
C18:2	13,60 ± 0,7 [c]	9,60 ± 0,4 [b]	9,87 ± 0,7 [b]	10,13 ± 0,7 [b]	8,65 ± 0,6 [a]
C18:3	1,02 ± 0,04	0,84 ± 0,1	1,01 ± 0,3	0,88 ± 0,3	0,74 ± 0,1
Total Saturated	36,96 ± 1,7 [a]	38,67 ± 1,0 [b]	39,01 ± 1,6 [b]	38,50 ± 1,0 [b]	39,15 ± 0,8 [b]
Total monounsaturated	44,88 ± 0,9 [c]	50,19 ± 0,6 [ab]	49,34 ± 0,6 [b]	49,89 ± 0,8 [ab]	50,93 ± 0,8 [a]
Total Polyunsaturated	15,87 ± 0,8 [c]	11,05 ± 0,5 [a]	11,50 ± 1,0 [a]	11,63 ± 0,8 [a]	9,98 ± 0,8 [b]

Means within the same line with same letter were not significantly different (P>0,05)