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Influence of genetic type on the characteristics of subcutaneous adipose tissue of pig thighs destined for the PDO production

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Abstract. Italian heavy pig production is founded both on traditional breeds, such as Large White, Landrace and Duroc selected in Italy, and on hybrid pigs coming from specific plans of selection and crossbreeding. The aim of this work was to compare the characteristics of subcutaneous adipose tissue of fresh thighs obtained from pigs belonging to two genetic types and reared in the same farm. Thighs were destined to the production of PDO Italian dry-cured hams. Samples of subcutaneous adipose tissue from 46 thighs of traditional pigs (Italian Landrace x Large White cross) and from 32 thighs of Goland commercial hybrid line, were analysed for water and fat contents, fat iodine value and fatty acid composition. On the whole, hybrids showed, in comparison with traditional pigs, similar lipid content of subcutaneous adipose tissue but different lipid composition: higher levels of polyunsaturated fatty acids (141.1 *vs* 102.8 mg/g fat; P<0.001), lower levels of saturated (334.9 *vs* 371.0 mg/g fat; P<0.001) and mono-unsaturated (420.8 *vs* 452.5 mg/g fat; P<0.001) fatty acids, and greater iodine value (68.9 *vs* 62,4; P<0.001). Females showed lower fat content and higher degree of lipid unsaturation than castrated males.

Keywords. Italian heavy pig – Fresh ham – Lipid content – Fatty acid composition.

Influence du type génétique sur les caractéristiques du tissu adipeux sous-cutané des cuisses de porc destinées à la production sous AOP

Résumé. *La production italienne de porc lourd est fondée à la fois sur des races traditionnelles sélectionnées en Italie (Large White, Duroc et Landrace), et sur des sujets hybrides provenant de plans spécifiques de sélection et de croisement. Le but de ce travail était de comparer les caractéristiques du tissu adipeux sous-cutané des cuisses fraîches obtenues à partir de sujets appartenant à deux différents types génétiques élevés dans la même ferme. Les cuisses étaient destinées à la production de jambon sec italien AOP. Les échantillons de tissu adipeux sous-cutané de 46 cuisses de porc traditionnel (Landrace italien x Large White) et de 32 cuisses de porc hybride commercial Goland, ont été analysés pour la détermination des teneurs en eau et lipides, ainsi que la composition en acides gras et l'indice d'iode. Dans l'ensemble, les hybrides ont montré, en comparaison avec les porcs traditionnels, la même teneur en lipides mais des différences de composition en acides gras: le tissu adipeux sous-cutané des hybrides est plus riche en acides gras polyinsaturés (141,1* vs *102,8 mg/g lipides; P<0,001) et corrélativement plus pauvre en acides gras saturés (334,9* vs *371,0 mg/g lipides; P<0,001) et monoinsaturés (420,8* vs *452,5 mg/g lipides; P<0,001) et l'indice d'iode est plus élevé (68,9* vs *62,4 ; P<0,001). Les femelles ont montré la plus faible teneur en lipides et le plus haut degré d'insaturation des lipides par rapport aux mâles castrés.*

Mots-clés. *Porc lourd Italien – Jambon frais – Teneur en lipides – Composition en acides gras.*

I – Introduction

The quantity and quality of adipose tissue in the carcass is of utmost importance in the production of Italian heavy pigs, since fat is a basic component of raw cuts destined to processing into valuable products, such as PDO dry cured hams (Lo Fiego *et al.*, 2005; Lo Fiego *et al.*, 2010). It is well known that lipid composition of fat tissues of pigs is directly influenced by the fat composition of diets (Bee *et al*., 2002, Rossi and Corino, 2002; Kouba *et al*., 2003), by genetic type (Bout *et al*., 1988; Lo Fiego *et al*., 2005) and by carcass fatness (Scott *et al*., 1981; Lo Fiego, 1996; Lo Fiego *et al.*, 2010). In the past years Italian heavy pig

production has undergone significant changes due to the massive introduction of more recent genetic types, for the largest part commercial hybrids. Moreover, the “traditional” breeds, thanks to constant and continuous selection programs, optimized diets and improved rearing techniques, have themselves been modified, and carcass fat content has been reduced. Both traditional breeds, such as Large White, Landrace and Duroc selected in Italy, and hybrid pigs, coming from specific plans of selection and crossbreeding, have been used since many years for typical productions. Hybrids offer appreciable performance traits, but often show different composition of fat depots in comparison with traditional types: in particular, their growing use in heavy pig production produced an increase of the degree of lipid unsaturation, which is not desired for typical productions. Due to the necessity of constantly monitoring the quality of raw materials obtained from animals which are subject to continuous evolution, the aim of this work was to compare the characteristics of subcutaneous adipose tissue of fresh thighs destined to the production of PDO Italian dry-cured hams, and obtained from pigs belonging to two genetic types and reared in the same condition in the same farm.

II – Material and methods

For this research, a total of 78 left thighs destined to the PDO Italian ham dry-curing production were used. Samples of subcutaneous adipose tissue from 46 thighs of traditional pigs (Italian Landrace x Large White cross, 34 castrated males and 12 females) and from 32 thighs of Goland commercial hybrid line (22 castrated males and 10 females), reared in the same farm and fed with a standard cereals-soybean meal based commercial feed, were analysed for water content, fat content and fat iodine value as reported by Lo Fiego *et al*. (2005). Moreover, fatty acid composition of lipid was determined using a TRACE™ GC Ultra (Thermo Electron Corporation, Rodano, Milano, Italy) equipped with the Ultra Fast Module (UFM), a Fast Flame Ionization Detector and a UFM-Carbovax column, 5 m long, 0.1 mm i.d, 0.2 µm film thickness as described in a previous paper (Ficarra *et al*., 2010). The FAME were identified by comparison of each retention time with the known retention times of the corresponding pure standards (Supelco 37 Component FAME mix and PUFA standard n. 2, animal source, Supelco, Bellafonte, PA, USA). For quantification purposes, the response factor was calculated and the method of the internal standard was used. The results were expressed as mg of each fatty acid methyl ester/g of lipids. Data were subjected to analysis of variance using the GLM procedures of the SAS statistical package (SAS, 1996) and a factorial model that considered genetic type and sex as fixed effects.

III – Results and discussion

Table 1 shows carcass and raw ham weights and fat thickness measurements according to genetic type. The mean values shown in Table 1 for both genetic types represent the optimum for Italian heavy pig production. No statistical difference was found between genetic types as regard both carcass and raw ham refrigerated weight and carcass backfat thickness. The latter was, however, slightly higher in traditional pigs, whose subcutaneous ham backfat thickness was lower in comparison with hybrids (- 4 mm, $P<0.01$), with subsequent lower trimming loss ($P<0.01$). This shows how the dislocation of fat depots in the carcass may vary in different genetic types, and consequently carcass backfat thickness might be not suitable for the estimation of fatness in other cuts. About the effect of sex (data not reported in the tables), females showed lower carcass weight (-10.4 kg; $P<0.01$), lower refrigerated (-0.9 kg; $P<0.01$) and trimmed ham weight (-0.7 kg; $P<0.05$), and thinner subcutaneous fat (- 4.3 mm; $P<0.05$) in comparison with castrated males. Table 2 shows the water and ether extract content and fatty acid composition of the subcutaneous adipose tissue of raw ham according to genetic type. Genetic type did not affect water and ether extract: on the opposite, in a previous work, hybrids, belonging to a different genetic type, showed higher water and lower lipid content in comparison

with traditional pigs reared in the same condition (Lo Fiego *et al.*, 2005). The fatty acid composition of the lipids was significantly influenced by genetic type.

Table 1. Effect of genetic type on carcass and raw ham traits

	Genetic type		
	Traditional	**Commercial Hybrid**	**R -MSE**
Refrigerated carcass weight (kg)	127.8	128.6	10.96
Carcass backfat thickness† (mm)	25.9	24.0	4.83
Refrigerated ham weight (kg)	16.8	16.4	1.34
Trimmed ham weight (kg)	13.9^{a}	13.2^{b}	1.09
Subcutaneous ham fat thickness†† (mm)	33.9^{A}	37.9^{B}	7.23
Trimming loss (%)	17.9^{A}	18.5^{B}	2.47

†Measured between the ¾ last rib at 8 cm from the splitting line of the carcass.
††Measured beneath the femur head.
$^{A, B}$ = P≤0.01, $^{a, b}$ = P≤0.05.

Table 2. Effect of genetic type on water and ether extract contents (%), lipid fatty acid composition (mg/g of lipids) and iodine value of covering adipose tissue of raw ham

	Genetic type		
	Traditional	**Commercial Hybrid**	**R -MSE**
Water content %	6.57	6.96	1.64
Ether extract content %	90.11	90.91	3.12
Fatty acids composition† mg/g			
C14:0	12.55	11.93	1.68
C16:0	220.78^{A}	209.48^{B}	15.14
C18:0	131.40^{A}	108.13^{B}	11.28
C20:0	1.95^{A}	1.59^{B}	0.34
Total saturated	371.04^{A}	334.93^{B}	22.10
C16:1	21.21	22.96	3.58
C18:1	417.96^{A}	386.10^{B}	22.30
C20:1	9.13^{A}	7.69^{B}	1.51
Total monounsaturated	452.53^{A}	420.77^{B}	24.34
C18:2	91.81^{A}	125.33^{B}	14.60
C18:3	4.27^{A}	5.56^{B}	0.78
C20:2	4.50^{A}	5.65^{B}	0.80
C20:4	1.43	1.59	0.40
Total polyunsaturated	102.84^{A}	141.12^{B}	15.63
Iodine value	62.39^{A}	68.91^{B}	2.95
Total fatty acids %			
Saturated	40.18^{A}	37.46^{B}	1.82
Monounsaturated	48.66^{A}	46.80^{B}	1.92
Polyunsaturated	11.16^{A}	15.74^{B}	1.55

$^{A, B}$ = P≤0.01; $^{a, b}$ = P≤0.05.
†Other fatty acids detected: $C_{17:0}$, $C_{17:1}$, $C_{18:3\_n6}$,$C_{20:3}$.

Traditional pigs produced lipids with a higher content of palmitic ($C_{16:0}$), stearic ($C_{18:0}$) and eicosanoic ($C_{20:0}$) fatty acids (P<0.01) and showed, consequently, a higher level of total

saturated fatty acids (SFA) (452.5 *vs* 420.8 mg/g of lipids; P< 0.01). Total monounsaturated fatty acids (MUFA) were also significantly higher in these subjects (P< 0.01) and the differences were mainly due to oleic ($C_{18:1}$) and eicosenoic fatty acids ($C_{20:1}$). The hybrid pigs were found to have a significantly higher polyunsaturated fatty acid content (PUFA) (141.1 *vs* 102.8 mg/g of lipids; P< 0.01), mainly linoleic ($C_{18:2}$) (125,3 *vs* 91,8 mg/g of lipids), linolenic ($C_{18:3}$) (5,6 *vs* 4,3 mg/g of lipids) and eicosadienoic ($C_{20:2}$) (5,7 *vs* 4,5 mg/g of lipids). Consequently, the hybrids also showed a higher iodine value (68.9 *vs* 62.4; P< 0.01). Linoleic and stearic fatty acids are the main components which may influence technological characteristics of lipids, such as firmness and cohesiveness; moreover an excessive content of $C_{18:2}$ may favor oxidative phenomena during seasoning period. Based on the mean of $C_{18:0}$ and $C_{18:2}$ content and iodine value, it can be stated that both genetic types fall within the limits set by Italian PDO ham Consortia (Lo Fiego *et al.*, 2005). As regard the sex (data not reported in the table), females showed lower ether extract content and higher content of total polyunsaturated fatty acids, mainly $C_{18:2}$, $C_{18:3}$ and $C_{20:2}$, than castrated males (P< 0.01).

IV – Conclusions

The results show that the fatty acid composition of subcutaneous adipose tissue of fresh ham from heavy pigs may be considerably influenced by genetic type. The hybrid pigs, confirming the results of previous research on heavy pigs, were found to have a significantly higher polyunsaturated fatty acids content respect to the traditional pigs coming from the national selection programs; but the subjects examined in this research are anyway suitable for PDO production. Thus, taking into account the excellent on-farm performance of hybrids, it seems necessary a strict control of fat depots traits, in order to avoid an excessive increase of unsaturation degree.

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