GENETIC AND DIETARY EFFECTS ON THE CHARACTERISTICS OF THE ADIPOSE TISSUE IN THE HEAVY PIG.

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S-IVA.16

SUMMARY

The effects of genotype, sex, feeding and food protein levels on lipid content and composition of the backfat tissue in the heavy pig were studied. To this purpose two different genotypes were fed with two feeding and dietary protein levels. The qualitative characteristics of the backfat tissue were significantly affected both by the genotype and dietary treatment. Sex did not influence the examined qualitative parameters. The results from this study suggest that the adipose tissue characteristics should be introduced in a selection index aiming to improve the meat quality in the heavy pig production.

Introduction

The qualitative characteristics of the pig carcass lipids can be affected by several factors, such as carcass fatness (Lo Fiego et al., 1989; Scheper, 1982; Scott et al., 1981; Wood et al., 1978; Wood et al., 1989), genotype (Bout et al., 1988; Lo Fiego, 1988; Wood,1973), sex (Barton-Gade, 1987; Geri et al., 1988; Lo Fiego, 1988; Smithard et al., 1980; Wood et al., 1989), nutrition (West and Myer, 1987) and anatomical site (Barton-Gade, 1984; Lo Fiego, 1988; Malmfors et al., 1978). In Italy, like in most European countries, the carcass fat content has been greatly reduced over the past 30 years (Ceci and Guizzardi, 1978; Lo Fiego et al., 1990a). It led to profound changes in the qualitative characteristics of the adipose depots along with an increase of the unsaturation rate (Lo Fiego et al., 1990a). The Italian heavy pig production is mainly based on Italian Large White (ILW) breed and on Italian Landrace (IL) x ILW subjects. Over the last 10 years, several studies were carried out on the qualitative characteristics of the adipose depots of these breeds (Lo Fiego, 1988; Lo Fiego et al., 1990b; Lo Fiego et al., 1992; Lo Fiego et al., 1993; Santoro et al., 1985; Santoro et al., 1992). However new genotypes have been recently introduced in the heavy pig production showing a high growth performance and a lower fat content in the carcass. The adipose tissue characteristics of these pigs, slaughtered at 160-170 kg mean liveweight, are still unknown.

The present work aimed to study the qualitative characteristics of the backfat tissue in carcasses of two different genotypes: IL x ILW crossbreds representing the "traditional" genotype reared for the production of the typical Italian products, and Commercial Hybrid Cotswold (C.H.C.) pigs, recently introduced in the heavy pig production. A further purpose was to determine eventual differences based on sex, feeding and protein level in the diet.

Material and Methods

The pigs examined are those described by Fabbri et al. (1992), who reported the data regarding the growing performances and the carcass characteristics. 80 IL x ILW and 80 C.H.C. pigs (half castrated males and half females) were allotted at an average initial liveweight of 35 kg to four dietary treatments based on different feeding and dietary protein levels. Each breed was divided into four groups of 20 animals with two lots fed *ad libitum* and the other two restricted (80% of the *ad libitum* level). Within each feeding level two dietary protein levels (14.6% (L) *vs* 16.5% (H) on average) were used. In detail, the dietary protein contents, indicated as L and H respectively, were 15.5% and 17.6% in the growing period (35-100 kg) and 13.7% and 15.4% in the finishing period (100-160 kg). The animals were slaughtered at 160.9±12.9 kg mean liveweight. After the carcass grading (Russo et al., 1989), about 30 minutes *post-mortem*, a sample of backfat tissue including the

two layers was removed at the last rib level from the left side of each carcass. Water, lipid content, iodine value (Wjis method) and fatty acid composition were determined on each sample. The water content was evaluated in duplicate by oven drying a 5 g sample for 3 hours at 103_C (Gandemer et al., 1989). The lipid content of the backfat tissue was measured by extraction using the automatized Soxterm equipment according to a slightly modified procedure previously described by Foster and Gonzales (1992). The modifications are the following: - usage of 140 ml of petroleum ether for each sample; - time of boiling position 30 minutes; - time of rinsing position 1.5 hours.

To determine the acidic composition, each fat sample was minced in presence of anhydrous sodium sulphate and melted in the oven according to the IUPAC II.A.1 method (IUPAC, 1979). Once melted, the fat was subjected to a metilation process as described by IUPAC II.D.19 (IUPAC, 1979), in order to evaluate the acidic composition of the lipids (Lo Fiego et al.,1992). The data were subjected to analysis of variance of the factors breed, sex, feeding and dietary protein levels and their interactions. There were not significant interactions.

Results and Discussion

The results concerning growth performance and carcass characteristics were reported by Fabbri et al. (1992) and refered to 154 pigs since 6 subjects (2 IL x ILW and 4 C.H.C.) were discarded from the trial during the rearing period. In short, carcass traits were not statistically affected by dietary protein content. With regard to the feeding level, pigs fed *ad libitum* showed a higher content of adipose cuts in the carcass (1.8 percentage points, $P<0.01$), whereas any significant difference was found in the lean meat content. In Table 1 the mean values of the liveweight, cold carcass weight , backfat thickness and carcass lean meat content are shown. IL x ILW showed higher carcass weight, dressing percentage (80.9 *vs* 82.3, $P<0.01$) and backfat thickness (38.6 *vs* 28.5, $P<0.01$) and a lower lean meat content (44.9 *vs* 50.3, $P<0.01$). The carcasses of the castrated males had a higher backfat thickness (35.4 *vs* 31.7, $P<0.01$) and a lower lean meat content (46.6 *vs* 48.6, $P<0.01$). In Tables 2 and 3 the mean values of the lipid and water content in the backfat tissue, as well as the acidic composition and the iodine value of the lipids, are shown. C.H.C. pigs showed a higher water content in the adipose tissue. This is probably due to a lower total fat content in the carcass, in agreement with the reports by Scheper (1982) and Wood et al. (1989). Anyhow, these Authors recorded a lower lipid content in the backfat tissue of leaner pigs. However, Metz (1984) claims that in pigs of over 100 kg liveweight the decrease of the lipid content accompanied by the reduction of the adipose tissue mass can be rather small. C.H.C. pigs showed lipids containing a lower concentration of miristic, palmitic and stearic acids, as well as total saturated and monounsaturated fatty acids. The content of the polyunsaturated fatty acids, especially of the linoleic acid, was higher. Consequently, a higher iodine value and an increased polyunsaturated/saturated ratio was recorded. The Italian processing industry requires a backfat of high quality containing not more than 15% of linoleic acid and presenting a iodine number not exceeding the value of 70. In this study 46.7% C.H.C. and 7.8% IL x ILW showed a linoleic acid content above 15%, whereas 47.4% C.H.C. and 10.3% IL x ILW evidenced a iodine value above 70. The increased unsaturation rate observed in the C.H.C. pigs is probably linked to a lower fat content in the carcass. These animals, in fact, showed, when compared to the IL x ILW subjects, a thinner backfat thickness (10 mm) and a lower adipose cut content (2.8 percentage points) (Fabbri et al., 1992). The genetic influence on the lipid composition probably reflects genetic differences in the capacity for fat deposition (Wood, 1973). Genetically leaner pigs present a lower *de novo* fatty acid synthesis, a higher fat mobilization and thus a more unsaturated fatty acids in the backfat tissue (Metz, 1984; Scott et al., 1981). Comparing different breeds, Villegas et al.(1973) and Wood (1973) evidenced a higher concentration of unsaturated fatty acids, especially linoleic acid, in the backfat tissue of leaner pigs. Sex (Table 2) had no influence on the examined characteristics, except on the eicosenoic acid content resulting slightly increased in the castrated males. The pigs fed *ad libitum* (Table 3) showed a higher lipid content in the adipose tissue. As far the lipid composition, the animals fed *ad libitum* presented a higher concentration of palmitic, stearic and total saturated fatty acids, whereas the content of polyunsaturated fatty acids, i.e. linoleic acid, and the iodine number was lower. It is well known (Callow, 1937), in fact, that the reduction of the feeding intake leads to a lower fat deposition and to an increased unsaturation rate. In this trial the restricted animals showed, in fact, a reduction of 1.8 percentage points ($P<0.01$) of the adipose tissue cuts (Fabbri et al., 1992). The increased unsaturation rate observed in the restricted pigs could be due to a lower *de novo* fatty acid synthesis and to a preferential deposition of the dietary fatty acids, especially of the linoleic acid (Dahl and Persson, 1965). The animals fed the higher dietary protein level evidenced a slightly higher lipid content in the backfat tissue as well as an increased concentration of miristic and linolenic acids and a lower oleic and total monounsaturated fatty acids content. The differences, although statistically significant, were small. These results are on the whole in

agreement with those reported by Newell and Bowland (1972), although these Authors did not find any statistically significant difference in the backfat tissue characteristics according to the different dietary protein intake.

Conclusions

C.H.C. pigs, when compared to the IL x ILW crosses "traditionally" reared in the heavy pig production, showed better growth performances and a leaner carcass, but higher unsaturation rate in the lipids. From human nutritionist point of view this characteristic surely represents an advantage but, on the other hand, it can be the source of several technological problems linked to the oxidative and hydrolytic reactions occurring in the seasoning period. From this research it arises that a very high percentage of C.H.C. pigs presents concentration of linoleic acid and iodine value above the limits established by the processing industry. Since swine to be slaughtered at 160-170 kg liveweight must be fed restricted to maintain acceptable carcass quality characteristics, selecting this genotype for further reducing carcass fat content could lead to a further increase of the unsaturation rate reducing the qualitative characteristics of the seasoned products. Considering the ever increasing interest of the Italian heavy pig production towards these new genotypes, it is recommended to introduce in selection index some parameters representing the qualitative characteristics of the lipids. In this way it will be possible to avoid those problems that could interfere with the usage of these crossbreds for the heavy pig production.

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