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Effect of diet and paternal origin on the fatty acid composition of 2 subcutaneous and 2 internal adipose tissues of intensively reared lambs

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SUMMARY – In France, a variable proportion of intensively reared lamb carcasses have a lack of firmness in the subcutaneous adipose tissues which could lead to commercial depreciation. Several factors could be responsible for this phenomenon. In this study, a beet pulp based diet and a cereal rich diet were tested on 48 "Lacaune" breed male lambs whose paternal origin was known. The incorporation of beet pulp increased the proportion of fatty acids (FA) with low melting point (odd-numbered or branched chain FA) in subcutaneous adipose tissues. It decreased the proportion of unsaturated even-numbered FA in all adipose tissues. The paternal origin seemed to have some effects on several FA but at a lower level than diet. The FA composition of adipose tissue was dependant on sampling site. Dorsal adipose tissue seemed to be the most sensitive, followed by caudal and internal adipose tissues.

Key words: Lamb, beet pulp, cereal, internal adipose tissues, subcutaneous adipose tissues, fatty acid composition, paternal origin.

RESUME – *"Effet du régime et de l'origine paternelle sur la composition en acides gras de 2 tissus adipeux sous-cutanés et 2 internes chez des agneaux sevrés précocément". En France, une proportion variable de carcasse d'agneaux de bergerie est affectée par un manque de fermeté des tissus adipeux sous-cutanés, qui altère la présentation des carcasses et peut entraîner une dépréciation commerciale non négligeable. Divers facteurs en seraient à l'origine. Dans cette étude, deux régimes à base de pulpes de betterave et de céréales ont été testés sur 48 agneaux Lacaune mâles d'origine paternelle connue. L'incorporation de pulpes de betteraves a induit une augmentation de la proportion d'acides gras (AG) à faible point de fusion (AG à chaîne carbonée impaire ou ramifiée) dans les tissus adipeux sous-cutanés. Par ailleurs, elle a diminué la proportion d'AG insaturés pairs dans l'ensemble des tissus adipeux. L'origine paternelle semble avoir eu un effet sur quelques acides gras mais de façon secondaire par rapport au régime. La composition en AG est variable selon le site de prélèvement des tissus adipeux. Le tissu adipeux dorsal semble le plus sensible suivi des tissus adipeux caudaux et internes.*

Mots-clés : *Agneau, pulpes de betteraves, céréales, tissus adipeux internes, tissus adipeux sous-cutanés, composition en acides gras, origine paternel.*

Introduction

In France, lack of firmness in subcutaneous adipose tissues (AT) is sometimes responsible for the commercial depreciation of intensively reared lamb carcasses. Bas *et al.* (1998) confirmed that fat firmness is highly correlated with fatty acid composition of AT, especially with branched-chain and odd-numbered fatty acids (FA) which have a lower melting point than straight even numbered chain FA. The synthesis of these particular FA is mainly increased in lambs fed on high carbohydrate diets (Duncan *et al*., 1972). Ruminal fermentation of these diets could produce high amount of propionate which may exceed the capacity of the liver to metabolize it into glucose (Garton *et al*., 1972). Thus, the propionate could be used as a precursor in the synthesis of this particular FA. The aim of this experiment was to study the effects of a starch-rich diet vs a high parietal carbohydrate-rich diet on the FA composition of subcutaneous and internal AT in lambs from different paternal origin.

Materials and methods

48 "Lacaune" breed male lambs, born from 8 rams and early weaned (27 ± 4 d), were reared from 15 to 40 kg (50 to 120 d). They were individually penned and allocated by paternal origin, age and weight into 2 groups. They were given a diet based on 20% grass hay and pelleted concentrate with either cereals [46% of barley, 35% of wheat, 1.07 UFV/kg dry matter (DM), group C] or beet pulp (71% of pulp, 0.92 UFV/kg DM, group P) *ad libitum*. Twice a week, the estimated food requirement of each lamb for 3 or 4 d was weighted and distributed after food residues were removed and recorded. Each time, samples of offered and refused feeds were collected. Once a week, they were dried at 103°C during 48 h. At slaughter, dorsal (DO), caudal (CA), perirenal (PR) and omental (OM) adipose tissues were sampled. After freeze-drying, the fatty acids in these samples were extracted by an adaptation of the Folch *et al.* (1957) method and analysed by gas chromatography (chromatograph Varian 3400 CX) on a capillary column (DB WAX, 60 m x 0.25 mm x 0.25 µm, J&W Scientific). The FA were identified by their equivalent chain length.

Results and discussion

Lamb growth was significantly affected by the diet. The average daily gain (ADG) was 328 and 377 g/d, respectively in C and P ($P < 0.01$). No significant effect on the calculated daily energy intake was observed between groups C and P (1.14 vs 1.15 UFV/d respectively). However, in view of the difference between the two ADG, the difference of energy intake might have been underestimated. To compensate for the lower energetic level of beet pulp concentrate, the animals of group P have ingested in proportion more concentrate and less hay than the animals of group C (hay intake, respectively, 12.3 vs 15.7% DMI). The relative weight of perirenal and omental fat (% of carcass weight) were higher in group C than in group P.

A diet effect was observed on the FA composition of the 4 AT (Fig. 1): proportions of even-numbered mono-unsaturated FA, C18:2 and C18:3 were significantly higher in group C than in group P (respectively, 42.6 vs 37.7; 2.6 vs 2.0; 0.33 vs 0.25% in DO; 45.2 vs 41.2; 3.5 vs 2.9; 0.50 vs 0.42% in CA; 40.9 vs 39.5; 3.6 vs 3.1; 0.52 vs 0.44% in OM and 41.1 vs 40.3 (NS); 3.6 vs 3.1; 0.47 vs 0.40 % in PR). The branched-chain FA content in subcutaneous AT was significantly lower with C than with P (respectively, 14.7 vs 19.8% in DO and 8.6 vs 11.4% in CA). The diet effect on the odd-numbered saturated FA content was different in subcutaneous or internal AT. In subcutaneous AT, the proportion of odd-numbered saturated FA was lower with C compared to P [respectively, 5.9 vs 6.6% in DO ($P = 0.05$) and 4.9 vs 5.5% in CA ($P = 0.07$)], whereas in internal AT, it was higher with C than with P [3.9 vs 3.3% in OM ($P < 0.01$) and 3.7 vs 3.1% in PR ($P < 0.01$)].

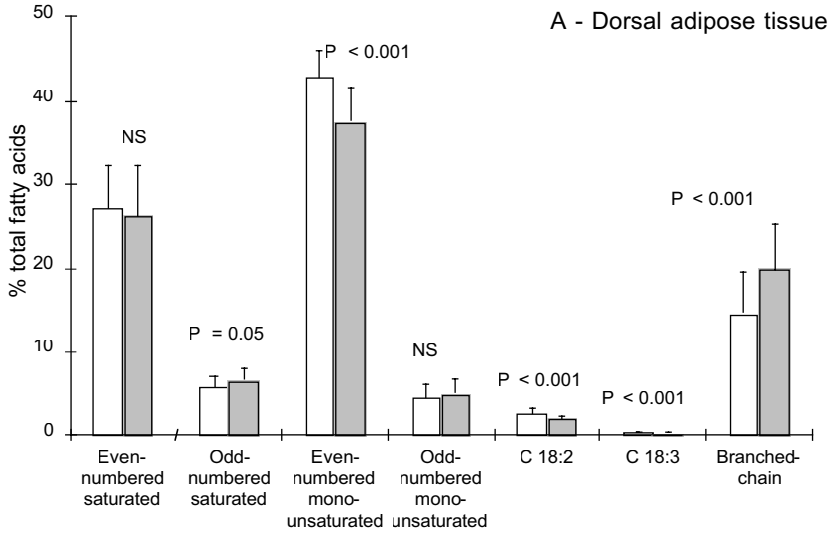

Fig. 1. Influence of cereals (□) and beet pulp (■) on fatty acid composition of dorsal (A), caudal (B), omental (C) and perirenal (D) adipose tissues.

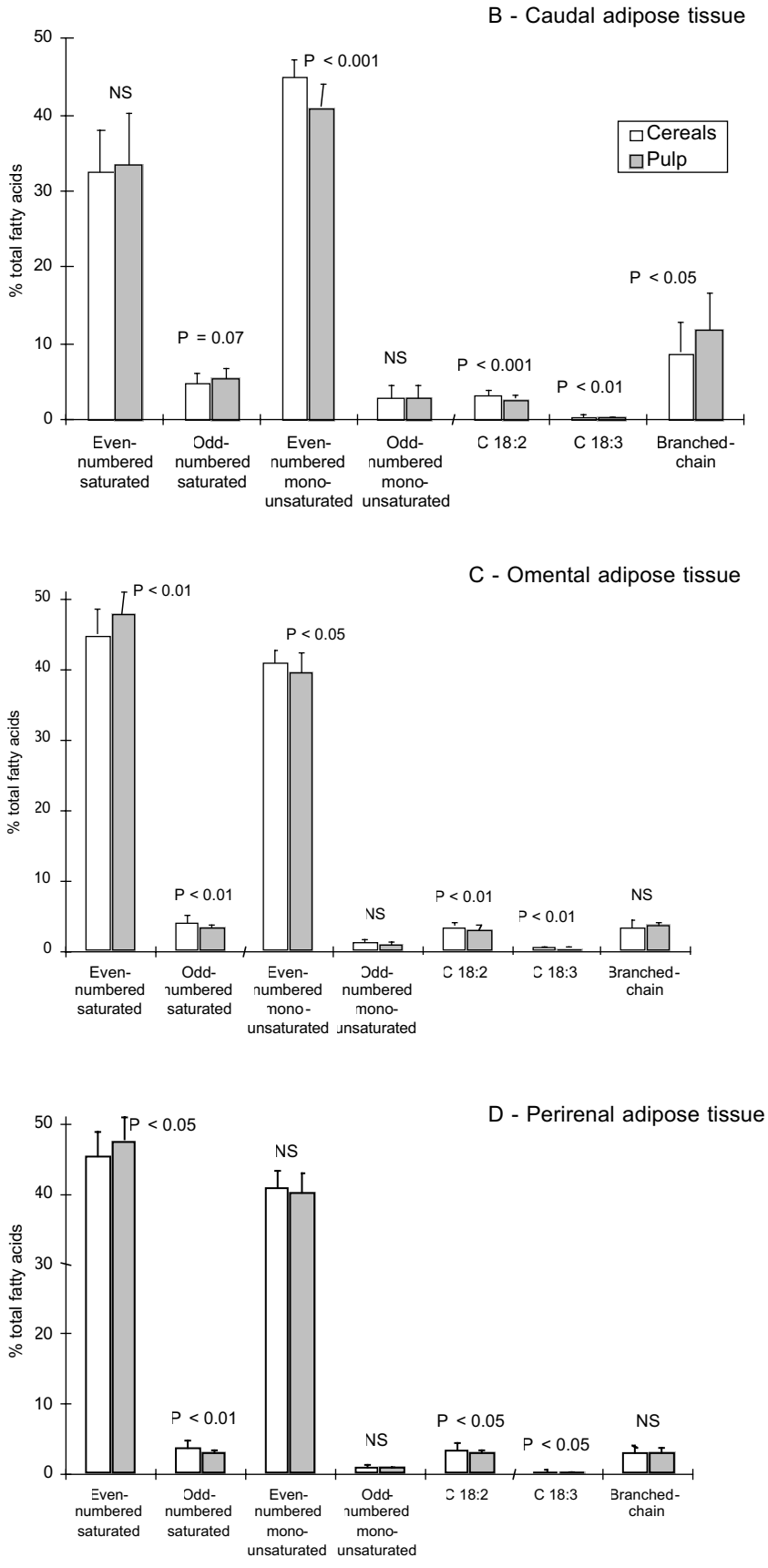

Fig. 1 (cont.). Influence of cereals (□) and beet pulp (■) on fatty acid composition of dorsal (A), caudal (B), omental (C) and perirenal (D) adipose tissues.

The proportion of FA with low melting point increased with high energy intake or high ADG as Busboom *et al.* (1981) and Bozzolo *et al*. (1990) had already shown. The proportion of these FA was more important in subcutaneous AT than in internal AT. It confirmed the results of Garton *et al*. (1972).

The beet pulp had a negative effect on the FA composition of AT. It could be partially due to the high ADG induced by this diet or to the volatile fatty acids produced by ruminal fermentations. Such a diet could produce as much propionate as a cereal diet (Schmidely *et al.*, 1996) and more butyrate. The butyrate could inhibit the hepatic propionate conversion (Aiello *et al.*, 1989) and so increase his availability for AT.

The paternal origin had a significant effect on DO and CA odd-numbered mono-unsaturated FA, C18:2 and C18:3, on CA, OM and PR odd-numbered saturated FA and on OM and PR branched-chain FA. The effects from diets were more important than the effects of paternal origin, particularly on branched-chain and odd-numbered FA of subcutaneous AT.

Conclusion

The diet and the paternal origin had an influence on subcutaneous AT composition, and at a lower level, on internal AT composition. The dorsal AT, which was the most important site for evaluating fat firmness seemed to be the most sensitive AT to the synthesis of particular FA. Caudal or internal AT presented a similar pattern than dorsal AT, but sampling AT on these sites damaged less the carcasses than on dorsal site.

In this study, the beet pulp-based diet seemed to have negative effect on fat firmness with higher proportions of branched-chain and odd-numbered FA than with cereals.

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