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in

Ledin I. (ed.), Morand-Fehr P. (ed.).
Sheep and goat nutrition: Intake, digestion, quality of products and rangelands

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 52

2000
pages 133-135

Effect of dietary propionate on fatty acid composition of lamb adipose tissues

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SUMMARY – The aim of this experiment was to study the effect of dietary propionate supplementation on the proportion of odd-numbered and methyl-branched chain fatty acids in different subcutaneous adipose tissue sites. These fatty acids are responsible, in part, for abnormally soft subcutaneous adipose tissue. Twelve male lambs were fed two rich carbohydrate diets based mainly on barley, *ad libitum*, one of which was supplemented with 5% of sodium propionate. The fatty acid compositions of 3 adipose tissue sites (dorsal, caudal and sternal) were analysed. The animals fed with the propionate diet showed a significant increase in the proportion of odd-numbered fatty acids in all 3 sites, and a trend for an increase in the methyl-branched chain ones for the dorsal adipose tissue. This experiment confirms the role of propionate as a precursor of odd-numbered and methyl-branched chain fatty acids. Moreover, the dorsal adipose tissue seems to be the most sensitive adipose tissue to dietary increment in propionate ruminal content.

Key words: Lambs, carcass quality, adipose tissue, propionate.

RESUME – *"Effet du proprionate alimentaire sur la composition en acides gras des tissus adipeux de l'agneau". L'objectif de cette expérience est d'étudier l'effet d'une surcharge alimentaire de propionate sur l'apparition d'acides gras à chaîne carbonée impaire ou ramifiée au niveau de différents sites de prélèvement de tissus adipeux sous-cutanées, ces acides gras étant responsables en partie de la présentation anormale du tissus adipeux à consistance molle. Douze agneaux mâles ont été nourris, à volonté, avec deux régimes hautement énergétiques dont l'un était enrichi avec 5% de propionate de sodium. La composition en acides gras de 3 sites sous-cutanés différents (dorsal, caudal, sternal) a été analysée. Les agneaux nourris avec le régime enrichi en propionate présentent une augmentation significative de la proportion d'acides gras à chaîne carbonée impaire pour les trois sites, et une tendance à l'accroissement de la teneur pour les acides gras à chaîne ramifiée dans le tissu adipeux dorsal. Cette expérience confirme le rôle du propionate comme précurseur des acides gras à chaîne carbonée impaire voire ramifiée. De plus, le tissu adipeux dorsal semble être le plus sensible aux variations de concentrations de propionate dans le rumen.*

Mots-clés : *Agneau, qualité de la carcasse, tissu adipeux, propionate.*

Introduction

Nowadays, some French lambs carcasses are of poor quality because of abnormally soft (lack of firmness) subcutaneous adipose tissue. This problem is mainly observed with lambs fed carbohydrate-rich diets. Adipose tissues from these carcasses show high proportions of odd-numbered and methyl-branched chain fatty acids. These fatty acids induce a lower melting point compared to straight even numbered chain fatty acids. They are possibly responsible for the lack of firmness. These types of fatty acids seem to be related to high amounts of propionate produced in the rumen by fermentation of high-carbohydrate diets by ruminal microorganisms. The liver capacity to metabolize propionate into glucose may be exceeded. Propionate which is not metabolized in the liver may be used as a primer unit for the synthesis of these fatty acids in lambs adipose tissue dorsal and perirenal (Garton *et al*., 1972). The aim of this experiment was to study the effect of dietary propionate supplementation with a diet high in carbohydrate on the frequency of odd-numbered and methyl-branched chain fatty acids of different subcutaneous adipose tissue sites.

Materials and methods

Twelve crossed bred (Berrichon du Cher or Suffolk) x INRA 401 male lambs were reared in individual pens from 19.5 $\pm$ 3.4 kg of live weight. The animals were fed a carbohydrate-rich diet *ad*

libitum. Six animals (Control: C) were fed a pelleted diet containing mainly barley, dehydrated alfalfa and soyabean meal while the remaining lambs were reared on the same diet including 5% of sodium propionate (Propionate: P) (Table 1).

Table 1. Composition and nutritive value of the experimental diets

	Control (C)	Propionate (P)
Composition (% FW†)		
Dehydrated alfalfa	27	26
Barley	49	46
Soyabean meal 48	17	16
Molasse	4	4
Minerals and vitamins	3	3
Sodium propionate	–	5
Calculated nutritive value††		
Metabolisable energy (ME) (Mcal/kg DM) †††	2.36	2.42
MAT (g/kg DM) ††††	200	189

†FW = Fresh weight.
††Tables of feed value (Jarrige, 1989).
†††DM = Dry matter.
††††MAT = Mesenteric adipose tissue.

The animals were slaughtered at a fixed date (PV = 34.2 ± 3.4 kg). Dorsal (Do), caudal (Ca) and sternal (St) subcutaneous adipose tissue were sampled at slaughter. The fatty acid composition of these tissues was analyzed by gas chromatography after freeze drying and lipid extraction (Folch *et al*., 1951). One lamb of the P group was withdrawed from the experiment due to seizure of the carcass at the slaughter house, without any link to the experiment.

Results and discussion

No significant effect of the treatment was observed on the calculated metabolizable energy intake, weight gain, and weight at slaughter between the two groups of animals. There was a significant difference between site of sampling of adipose tissue on the content of odd-numbered fatty acids, on the methyl-branched chain fatty acids content and therefore on the polyinsaturated fatty acids (Table 2).

Table 2. Effect of propionate treatment and site of sampling of adipose tissue on the odd numbered, methyl branched and polyunsaturated fatty acids (n=11)

	Dorsal		Caudal		Sternal		SEM	P		
% total fatty acid	P	C	P	C	P	C		Treat	Site	Treat X Site
Odd-numbered FA	8.52	5.92	6.64	5.84	5.48	4.51	0.644	**	**	NS
Branched-chain FA	10.48	7.8	6.36	6.92	4.52	3.9	0.988	NS	***	NS
Polyinsaturated FA	4.71	6.1	4.87	5.95	4.71	6.1	0.588	+	**	NS

***P < 0.001, **P < 0.01, +P < 0.07, NS = non significant.

The P animals had significantly higher proportion of odd-numbered fatty acids than the control animals. There was no effect of treatment on methyl-branched chain fatty acid content.

These results obtained with a supplementation of only 8% of the metabolizable energy (ME) as propionate confirmed in part those found by Garton *et al*. (1972). He observed an increase in the proportions of odd-numbered and methyl-branched chain fatty acids in dorsal adipose tissue when

lambs were fed a diet supplemented with sodium propionate (21% of the ME). Our treatment effect on the methyl-branched chain fatty acids is no significant due to a great variability of the data between sites. But if we had analysed the dorsal adipose tissue alone, we would have found also the increase in these fatty acids. In addition, our results showed that there is a difference between adipose tissue sites in either their ability to uptake the propionate or either to metabolize it.

Conclusions

This experiment seemed to confirm the role of propionate as a precursor of odd-numbered and methyl-branched chain fatty acids. The effect of dietary propionate was greater on the dorsal adipose tissue which is a very important site for the scoring of the firmness of the carcass adipose tissues than on other subcutaneous adipose tissues. The dorsal adipose tissue seemed to be the most sensitive tissue to high amounts of propionate in the rumen.

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