Effect of Propionate Supplement on the Fatty Acid Composition of Adipose Tissue in Sheep Fed with High Concentrate Ration

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(Received July 23, 1992)

Key words : propionate, high concentrate ration, adipose tissue, fatty acid composition, sheep

The present authors reported perviously that propionate supplementation in sheep improved feed utilization when feeding a high concentrate ration¹¹⁾, and that supplementation was not effective for a high roughage ration⁹⁾. Furthermore, the desaturation of fatty acids in adipose tissue was observed at the ratios of 2 : 8⁹⁾ and 5 : 5⁵⁾ of the concentrate to roughage in growing / fattening sheep, and at the ratios of 6 : 4⁷⁾ and 5 : 5²⁾ in beef cattle given propionate supplements, respectively. However, desaturation in sheep given a high roughage ration⁹⁾ was weaker compared with those given equal ratios of concentrate and roughage⁵⁾. In the case of the hamster, which is similar to ruminant animals in nutritional characteristics such as the mechanism of fatty acid synthesis in adipose tissue³⁾, its feed utilization improved and the desaturation of its whole body was promoted as a result of high concentrate and high roughage feedings supplemented with propionate¹⁰⁾. It is thought to be of profound significance that a feeding method for meat

production from ruminant animals would simultaneously achieve the improvement of feed utilization and bring about the desaturation of fatty acids in adipose tissue.

This study was carried out to examine the fatty acid composition of adipose tissue via the biopsy method in sheep which were fed a high concentrate ration supplemented with propionate in the previous growing/fattening trial¹¹⁾.

Materials and Methods

Experimental animals and feeding : Eight castrated Suffolk sheep (53.7 kg in average body weight) were used. Four sheep constituting the control plot were fed mixed rations of concentrate (commercial formula feed for beef cattle) and roughage (chopped grass hay) in the ratio of 8 : 2 on a dry weight basis. The remaining four, constituting the experimental plot, were fed with the same mixed rations supplemented with calcium propionate. Calcium propionate was supplemented 1 mol per

濃厚飼料多給メン羊におけるプロピオン酸塩添加が体脂肪の脂肪酸組成に及ぼす影響：高橋敏能・萱場猛夫（山形大学農学部，鶴岡市 997）

790 g as dry matter in the ration. The amount of TDN was given at 37.5 g/body weight^{0.75}/day for both plots, and was corrected every four weeks based on body weight. At 60.8 kg in body weight, for example, 94 g of propionate was supplemented to the ration of 940 g concentrate and 240 g roughage. All rations were sufficiently mixed with suitable water and fed at 9:30 once a day. Water was given freely throughout the experiment. Sheep were housed in metabolic cages at a room temperature of 18–22°C for seven months; *i.e.* for one month as preliminary term and for six months as the plenary term.

On the final day of the feeding trial, the sheep were anesthetized with sodium pentobarbital, and abdominal subcutaneous adipose tissues were sampled from the right side by means of a surgical operation. Lipid extracted from adipose tissues by FOLCHS' method¹⁾ was converted into methylester with 5% HCl-methanol(W/W).

The fatty acid compositions in adipose tissue were measured in the same manner as described in a previous report⁵⁾.

The significance of the difference was evaluated via analysis of the variance F-test of SAS⁴⁾.

Results and Discussions

Propionate supplements had a tendency to show down the speed of feed intake by sheep, and the changes in feed intake showed two-phase patterns during both treatments¹¹⁾. A

comparison of fatty acid composition in subcutaneous adipose tissue is given in Table 1. There is no difference in the composition (%) of C_{16:0} acid and branched chain plus normal odd number carbon fatty acids between the two feedings. In the propionate feeding, C_{18:0} fatty acid was significantly lower and C_{18:1}, C_{18:2} and C_{18:3} fatty acids tended to be higher than in the control feeding. Consequently, propionate supplementation in a high concentrate ration led to the desaturation of fatty acids in the adipose tissue; the composition (%) of unsaturated fatty acids was 50.0 for propionate feeding to 41.1 for control feeding and the ratios of total unsaturated fatty acids of 18 in carbon number to C_{18:0} fatty acid were 2.7 to 1.8, respectively ($P < 0.05$).

Two mechanisms of desaturation in adipose tissue via propionate supplementation during high concentrate feeding are suggested; *i.e.* one is a decline of biohydrogenating ability into unsaturated fatty acids of fodder via microorganisms in the rumen with the propionate supplement⁶⁾ and the other is an increase in dehydrogenation activity from adipose tissue due to the activation of desaturase stimulated by insulin secretion¹²⁾. In pervious reports^{8,11)}, insulin secretion was stimulated more by propionate supplementation during high concentrate feeding than in high roughage feeding. The stimulation of insulin secretion may be due to the rapid feed intake in high concentrate feeding¹¹⁾ as compared with high roughage feeding⁹⁾ and the increase in propionic

Table 1. Fatty acid composition of the subcutaneous adipose tissue

Treatment	Fatty acids (weight %)									USFA/ SFA ³⁾	
	C _{14:0}	C _{16:0}	C _{16:1}	C _{17:0}	C _{18:0}	C _{18:1}	C _{18:2}	C _{18:3}	BC+NONC FA ¹⁾		USFA ²⁾
Control	2.6	21.1	1.5	2.2	22.6 ^{A4)}	32.8	4.0	2.8	12.7	41.1 ^B	1.8 ^B
+Propionate	1.6	20.1	1.5	2.8	17.7 ^B	38.3	6.3	3.8	9.4	50.0 ^A	2.7 ^A

¹⁾; Branched chain + normal odd number carbon fatty acids.

²⁾; Unsaturated fatty acids.

³⁾; C_{18:1} + C_{18:2} + C_{18:3}/C_{18:0}.

⁴⁾; Figures without common superscripts significantly differ at 0.05 probability level.

acids both in rumen liquor and in blood plasma^{8,11)}. Therefore, the desaturation of adipose tissue from C_{18:0} to C_{18:1}, C_{18:2} and C_{18:3} fatty acids might be stimulated by increased dehydrogenation activity of the adipose tissue and by the decline in biohydrogenating ability in the rumen.

From the results described above, it is obvious that propionate supplementation in a high concentrate ration is very significant for meat production from sheep because feed utilization was improved¹¹⁾ and the desaturation of fatty acids in adipose tissue was promoted, concurrently.

Acknowledgment

The authors are grateful to Mr. Hideki MOMOI for his helpful assistance during this experiment.

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