EFFECT OF DIETARY PROPIONATE ON INSULIN RESPONSE WITH FEEDING OF DIFFERENT CONCENTRATE-ROUGHAGE RATIOS IN SHEEP

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Introduction

Main energy source of ruminant animals is volatile fatty acids (VFA), while that of non-ruminant animals is glucose. It is well known to ferment in the rumen, predominantly acetic acid in case of high roughage ration and propionic acid in case of high concentrate ration, respectively. Propionate supplement to fodder stimulates insulin secretion (Jenkins and Thonney, 1988; Sano and Takahashi, 1988). But there is no report concerning relationship between concentrate-roughage ratio and propionate supplement. This study was carried out to examine the effect of dietary propionate on insulin response with feeding of different concentrate-roughage ratios.

Materials and Methods

Four Suffolk sheep which averaged 30 kg in body weight were used for this experiment. Four types of rations were prepared as the two weight ratios, i.e. 8:2 and 2:8 of concentrate (commercial concentrate) and roughage (grass hay 4: alfalfa hay cubes 6) and as the rations supplemented calcium propionate to each ratio. The amount of supplemented calcium propionate corresponded to physiological level which was 1 mol as propionic acid produced in the sheep rumen from 900 g of ration (Bergman et al., 1965). The amount of total digestible nutrients were 48.7 g/BW($kg^{0.75}$)/day among all rations. The sheep were fed each of the four rations in a balanced Latin square design for 28 days at an room temperature of 18-22°C. Blood samples were taken 8 times during 24 hours from jugular catheter at final day of each experiment. Plasma insulin concentration was assayed by a radioimmunoassay kit (Eiken Chemical Co., Ltd.). Glucose and non-esterified fatty acids (NEFA) concentrations in the plasma were determined in according with the NEFA-Test and Glucose-Test kits (Wako Junyaku Kogyo Co., Ltd.), respectively. Individual VFA values in plasma were measured via gas chromatography after steam distillation. The significance of difference was evaluated by analysis of variance and F-test, comparing among the treatments.

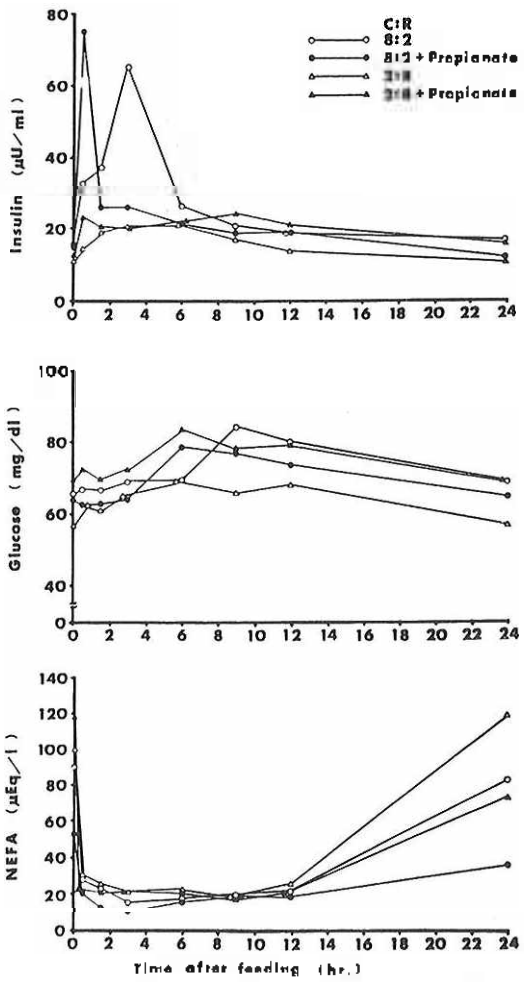

Figure 1. Charges in concentrations of insulin, glucose and non-esterified fatty acids (NEFA) in the blood plasma in response to feeding in sheep (C: concentrate, R: roughage).

Results and Discussion

Concentrations of insulin, glucose and NEFA in blood plasma were given in figure 1. Insulin concentration (μU/ml) in plasma increased significantly ($p < 0.05$) after feeding in case of high concentrate rations; i.e. those peaks were 75 at 30 min in case of high concentrate plus propionate ration and 65 at 3 hours in the case of high concentrate ration after feeding, respectively. In the case of high roughage rations, however, increases of insulin concentration after feeding were slow regardless of existence of propionate supplementation. Glucose concentration in plasma is not different significantly among all treatments from 30 min after feeding up to 3 hour, and was found to that increase at 6 to 12 hours after feeding while almost no changing in case of high roughage ration. NEFA content in plasma decreased immediately and rapidly after feeding in all rations, and was tendency to be lower in case of high concentrate plus propionate ration than three other rations from 30 min to 6 hours after feeding. VFA contents in blood plasma were given in figure 2. Acetic acid was lower in case of propionate supplement rations than unsupplemented rations after feeding. Propionic and butyric acids in high concentrate rations increased significantly after feeding. It was observed to be the high peak values (mmol/l) of 0.48 (propionic acid) and 0.082 to 0.088 (butyric acid) at 1.5 and 1.5-6 hours after feeding in the treatments of high concentrate plus propionate and high concentrate rations, respectively, which decreased rapidly thereafter.

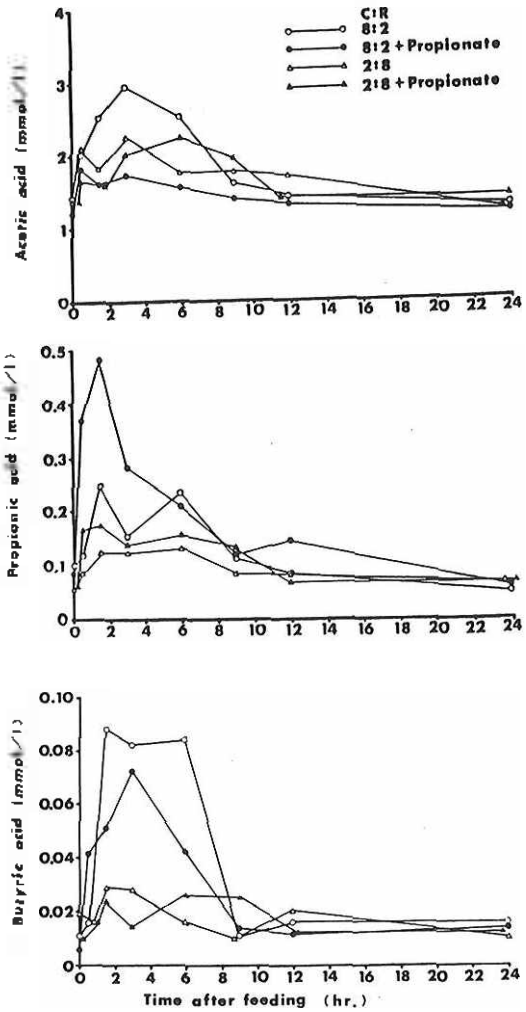

Figure 2. Changes in concentrations of acetic acid, propionic acid and butyric acid in the blood plasma in response to feeding in sheep (C: concentrate, R: roughage).

From these observations, high glucose concentration in plasma after feeding was not appeared because gluconeogenesis from surplus propionic acid might be limited (Jenkins and Thonney, 1988). Insulin secretion was therefore stimulated by propionic acid supplemented or fermented and butyric acid fermented in the rumen. In case of high roghage rations, however, insulin response was hardly to cause regardless of existense of propionate supplementation because of slow feed intake in sheep.

(Key Words: Insulin, Propionic Acid, Sheep)

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