INFLUENCE OF RUMEN FERMENTATION RATE ON GLUCAGON AND INSULIN BLOOD LEVELS

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The role of volatile fatty acids on the concentration of glucagon and insulin in the blood of ruminants has been reviewed by Brockman (1978). Insulin secretion was increased after their infusion into the jugular vein (Manns and Boda, 1967) or into the rumen (Trenkle, 1978). The blood concentration of insulin and glucagon also increases 2-4 hours after feeding in cattle and sheep (Basset, 1974) in relation with the digestible organic matter intake. Since the production of particular volatile fatty acids in the rumen is changeable and their participation in insulin secretion differs, we have decided to estimate changes in the glucagon and insulin blood concentrations of sheep fed fodders with different fermentative patterns but comparable in value for digestible organic matter.

Material and Methods

The experiment was carried out on two groups of 6 sheep fitted with rumen cannulae.

The animals in group I received feed (ration I) composed of sugar beet silage (51.7 %), a urea-mineral preparation (7.9 %) and meadow hay (40.4 % on dry matter basis).

The animals in group II were given a feed (ration II) composed of soybean meal (4.3 %), barley (25.1 %), oats (4.1 %), peanut meal (4.3 %), dried sugar beet pulp (21.5 %), meadow hay (40.6 %).

The animals of both groups received the rations daily, balanced according to dry matter (1.0 kg) and protein content.

On the days of estimation of pancreatic hormones, fifty percent of the daily ration was given directly to the rumen during a 15 min period. In this way the equalized amount of feed reaching the rumen could be adjusted. Rumen content samples and blood samples (permanent polyethylene catheter) were collected twice before and 30, 60, 90, 120, 180, 300 and 420 min. after feeding. The rumen fluid was tested for pH, VFA concentration (by distillation and gas chromatography method) and ammonia concentration (colorimetric method with phenol reagent). Glucose was estimated in the whole blood (enzymatic method) and serum insulin and glucagon levels by radioimmunoassay.

Results and Discussion

The average daily values for pH, VFA and ammonia in the rumen contents as well as the blood levels of glucose, insulin and glucagon are presented in table 1.
Feeding rations I and II produced significant differences in the pH and ammonia concentration in the rumen as well as the levels of insulin and glucagon in the blood. The VFA concentration did not differ significantly between the two rations (tabl. 1), but the dynamjic of the changes of particular volatile fatty acids varied (fig. 1).

Ration I produced a significant increase in the concentrations of butyrate, propionate and acetate as early as 60 min after feeding (fig. 1). The increase in VFA concentration in the rumen of sheep given ration II was smaller and slower.

Changes in the blood levels of insulin and glucagon were considerably higher after administering ration I than II (fig. 2). The highest level of glucagon appeared 30 min. after feeding and correlated chronologically with changes in the concentration of VFA in the rumen.

Correlation factors applied for insulin and VFA as well as glucagon and VFA were 0.878 and 0.811, respectively.

Data on figure 2 indicate a close interdependence of changes in insulin and glucagon blood levels (r = 0.878).

The results obtained in the experiment indicate that the rate of fermentation processes in the rumen have a significant effect on the concentrations of glucagon and insulin in the blood. Sheep fed sugar beet silage showed a marked increase in lactate, butyrate, valerate in the rumen (Leontowicz et al., 1979). In our experiments, as early as 30 min. after feeding (ration I) an increase in rumen butyrate, propionate and acetate was observed. At that time the highest level of blood glucagon appeared. The peak insulin concentration came 30 min. later without significant changes in the blood glucose concentration.

Our results indicate that a rise in the concentrations of insulin and glucagon after feeding is not proportionally dependent upon the level of digestible organic matter in the diet. Both rations I and II were isoenergetic and contained a similar level of total nitrogen. However, they influenced the pancreatic hormone secretions with different efficiency.

The parallel shifting in the blood levels of insulin and glucagon shows that mechanisms stimulating secretion of both hormones were similar. Possibly intense fermentation processes in the rumen evoked an increase in the blood flow to the visceral organs, the increased blood flow through the pancreas being a prerequisite for the release of its hormones.

Table 1. — Some estimations in the rumen liquid and blood of sheep fed different rations. The values are an average of seven samples taken during the day after administration of feed.

<table>
<thead>
<tr>
<th>Estimation</th>
<th>Ration I</th>
<th>Ration II</th>
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<tbody>
<tr>
<td><strong>Rumen content</strong>:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>5.58 **</td>
<td>6.14</td>
</tr>
<tr>
<td>VFA (mM/l)</td>
<td>90.65</td>
<td>107.35</td>
</tr>
<tr>
<td>NH₃-N (mM/l)</td>
<td>37.44 **</td>
<td>13.84</td>
</tr>
<tr>
<td><strong>Blood</strong>:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>glucose (mM/l)</td>
<td>3.40</td>
<td>2.90</td>
</tr>
<tr>
<td>insulin (μM/ml)</td>
<td>23.46 **</td>
<td>16.34</td>
</tr>
<tr>
<td>glucagon (ng/ml)</td>
<td>0.439**</td>
<td>0.310</td>
</tr>
</tbody>
</table>

n = 42.
**/* — The difference statistically significant for F₀₀₁.

Fig. 1. — The increment percent of individual VFA in the rumen content after feeding ration I and ration II. LSD — the lowest significant difference calculated for F₀₀₁.

Fig. 2. — Concentration of insulin and glucagon in the blood serum of sheep fed rations I and II. LSD — the lowest significant difference calculated for F₀₀₁.
References


