Note

Comparative Effects of Glucose, Long-chain Triglycerides and Medium-chain Triglycerides on the Protein Metabolism of Fasted Rats

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The addition of carbohydrate or fat (long-chain triglycerides, LCT) to the diet results in an increased nitrogen retention. The protein-sparing effects of carbohydrate and fat are equally effective in promoting the retention of nitrogen. However, the route followed and the rate at which this occurs are different. Nakano and Ashida have observed that the protein-sparing effect of carbohydrate, but not that of fat (LCT), was cancelled in alloxan-diabetic rats. Reeds et al. have reported that the addition of starch to the diet significantly reduced the synthesis and concentration of plasma urea within 4 hr in growing pigs, but that 18-24 hr were required for both changes when fat was added to the diet. Furthermore, they have shown that plasma glucose and insulin rose after the addition of starch, whereas neither the plasma glucose nor insulin concentration was altered by the addition of fat to the diet.

Recently, the unique nutritional attributes of medium-chain triglycerides (MCT) compared with LCT have been investigated in a number of human clinical nutrition settings. Fatty acids derived from MCT are rapidly absorbed portally and largely oxidized by the liver to CO₂ and ketone bodies. However, there is limited information available for understanding the effect of MCT on protein metabolism. Therefore, the present work was conducted to compare the effect of MCT, LCT and glucose on the protein-sparing effects.

Male rats of the Wister strain (Japan SLC Inc., Hamamatsu) were used. In the preliminary period of the experiment, the animals were allowed to eat the conventional stock diet (digestible crude protein, 18.1%; metabolizable energy, 3.35 kcal/g) and water ad libitum for 5 days or more, and then fasted overnight. At 9 a.m. on the following day, the animals initially weighing 185 g were divided into four groups, each of eight rats. All the animals were housed in metabolic cages and urine was collected for 24 hr. The first group (control) was given 1 ml of water. The second group was administered with 0.52 ml of an LCT meal, containing 0.26 g of soybean oil emulsified with 0.23 g of H₂O and 1.2 mg of sodium cholate. The fourth group was fed 0.58 ml of an MCT meal, containing 0.29 g of MCT* (C₈:0, 85%; C₁₀:0, 15%) emulsified with 0.26 g of H₂O and 1.2 mg of sodium cholate. The amounts of glucose, LCT and MCT were adjusted to be isocaloric. All meals were fed to the rats via a stomach tube. Each meal was given at 6 p.m. on the first day. At 9 a.m. on the next day, the animals were killed to obtain blood plasma. The blood was centrifuged cold at 1,500 x g and the plasma was stored at -45°C until analyzed. Plasma urea was determined by the urease indophenol method, using a kit (Wako Pure Chemical Ind., Osaka). The total nitrogen in the urine was measured with an autoanalyzer (Technicon Instruments) after Kjeldahl digestion. Urinary urea was determined by the diacetylmonoxime method with a kit (Wako Pure Chemical Ind., Osaka). All experi-

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of rats</th>
<th>Initial body wt. (g)</th>
<th>Body wt. change (g/24 hr)</th>
<th>Plasma urea (mg/100 ml)</th>
<th>Urea (mg/24 hr)</th>
<th>Total N (mg/24 hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8</td>
<td>187.5 ± 2.0</td>
<td>-12.1 ± 0.4</td>
<td>34.5 ± 1.2</td>
<td>246 ± 11</td>
<td>145 ± 5</td>
</tr>
<tr>
<td>Glucose</td>
<td>8</td>
<td>183.9 ± 1.1</td>
<td>-10.6 ± 0.5*</td>
<td>28.9 ± 0.6**</td>
<td>182 ± 9***</td>
<td>119 ± 4**</td>
</tr>
<tr>
<td>LCT</td>
<td>8</td>
<td>186.1 ± 2.4</td>
<td>-10.5 ± 0.4*</td>
<td>32.4 ± 0.9</td>
<td>220 ± 7</td>
<td>140 ± 5</td>
</tr>
<tr>
<td>MCT</td>
<td>8</td>
<td>183.5 ± 3.1</td>
<td>-10.6 ± 0.5*</td>
<td>30.6 ± 0.9*</td>
<td>190 ± 12**</td>
<td>124 ± 5**</td>
</tr>
</tbody>
</table>

Values are means ± S.E.; values are significantly different from the control value for * p < 0.05, ** p < 0.01 and *** p < 0.001.

* MCT was kindly provided by Kao Corporation, Wakayama Research Laboratories, 1334 Minato, Wakayama 640, Japan.
mental data were statistically analyzed using Student's t-test.

The results are summarized in Table I. The body weight in the control group decreased by more than that in the treated groups, although within any one treated group, there was no difference in the body weight change. Feeding glucose, but not LCT, caused a significant decrease in the level of plasma urea as well as of the urinary output of urea and nitrogen relative to those of the control group. These results are in good agreement with those observed by Nakano and Ashida. They described that a certain period was required for fat (LCT) to exert its protein-sparing effect. Recently, Reed et al. have also reported that the changes in plasma urea concentration and synthesis were delayed for 18–24 hr when fat was added to the diet of growing pigs.

Feeding MCT also caused a marked decrease in the plasma level of urea and in the urinary output of urea and nitrogen. The results obtained here clearly show that the different chain length of fatty acids affected the protein-sparing effect. Recently, Odle et al. have reported that nitrogen excretion was smaller in neonatal piglets receiving MCT than in those given LCT, although no significant difference was detected between treatments.

It has been well documented that MCT is rapidly digested and transported to the liver via the hepatic portal vein, where it is largely metabolized to CO2 and ketone bodies. Moreover, feeding MCT increases plasma insulin levels. These actions may partially explain the mechanism for the protein-sparing effect that occurs by feeding MCT, although there is no direct evidence to confirm it. Consequently, further studies will be needed to understand the mechanism by which MCT exerts this effect.

References