Experimental investigations show clearly that the absorption and metabolism of the short chain, water-soluble fatty acids differ in some way from those of the long chain fatty acids insoluble in water. Experiments by Lebedeff (1883), Leube (1895), Zuntz (1901), and Eckstein (1929) show no evidence of the butyryl radical in the deposited fat when fed either as a fat or in the form of tributyrin. Davis (1930) found the butyryl radical present in the body fat if tributyrin was injected subcutaneously. Powell (1932) showed that fatty acids containing 8 carbon atoms are not deposited in the animal when fed as glycerides, while fatty acids of 10 or more carbon atoms fed under the same conditions are deposited. None, so far, has suggested any satisfactory explanation for this difference in absorption. One possible explanation may be the difference in the mode of absorption of lipids and non-lipids, the non-lipids being water-soluble are absorbed by the intestinal capillaries and carried by the portal blood, while the lipids are absorbed by the lacteals and enter the blood by way of the thoracic duct. This is true of the water-soluble acetic acid which is known to be absorbed by the blood. Since butyric, caproic, and caprylic acids are all relatively soluble in water, it is quite possible that they might follow the path of absorption of non-lipids and might thus escape the glyceride synthesis. If this be true, these water-soluble fatty acids should not be found as glycerides in the lymph. It was to test the validity of this assumption that the following investigation was undertaken.

* Contribution No. 163, Department of Zoology.

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Dogs were used as experimental animals. A preliminary diet of scraps of lean meat was fed to the animals. Three types of fat were fed as experimental diets: butter fat, Crisco, and Crisco plus 7 per cent tributyrin. Crisco, since it contains no volatile fatty acids, was used as the control diet. Nembutal was used as the anesthetic. After anesthesia was complete the thoracic duct was exposed and the lymph was collected for periods varying from 5 to 19 hours.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Diet</th>
<th>Amount of fat collected</th>
<th>Reichert-Meissel No.</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>gm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Crisco, lean meat</td>
<td>1.1792</td>
<td>3.45</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>&quot;</td>
<td>0.5534</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>&quot;</td>
<td>1.6670</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>&quot;</td>
<td>14.0</td>
<td>2.0</td>
<td>4.75</td>
</tr>
<tr>
<td>5</td>
<td>40% cream, butter, lean meat</td>
<td>0.35</td>
<td>2.25*</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>20% &quot;</td>
<td>5.1966</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Corn bread, cream</td>
<td>0.9316</td>
<td>4.65</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>&quot;</td>
<td>1.1784</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>20% cream, corn bread</td>
<td>2.5859</td>
<td>3.8</td>
<td>3.48</td>
</tr>
<tr>
<td>10</td>
<td>Crisco, tributyrin, lean meat</td>
<td>4.4664</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Reichert-Meissel No. of Crisco, 0.4; of butter, 25.0; of Crisco and 7 per cent tributyrin, 34.0.
* Samples 5 and 6 were combined.

After collection the lymph was dried and kept in a desiccator until the extraction was made. The extraction of the dried lymph was accomplished with anhydrous ether in either a Soxhlet or a Bailey-Walker extractor. It was decided to use the Reichert-Meissel number as the criterion for the presence or absence of water-soluble fatty acids in the lymph of the thoracic duct. When as many as 4 to 5 gm. of fat were obtained from the dried lymph, the Reichert-Meissel number was determined by the official method of the Association of Official Agricultural Chemists (1930).
If fewer than 4 gm. of fat were extracted, the analysis was made according to a modification of the official method reported by Millig (1930). The results of the determinations are shown in Table I. It will be seen that the average of the Reichert-Meissel numbers of lymph fat from dogs whose experimental ration contained butter fat was 3.48, a Reichert-Meissel number comparable to that of the control diet of Crisco and lean meat, viz. 4.75. If the short chain acids of butter fat were carried as such by the thoracic lymph duct, the Reichert-Meissel number would be close to 25 to 30, the number for butter. Similarly the Reichert-Meissel number of the lymph fat from dogs fed tributyrin added to Crisco and lean meat was 1.6 instead of 34, the number determined for a mixture of Crisco and 7 per cent tributyrin. The Reichert-Meissel number of the lymph fat of dogs fed a diet containing tributyrin shows, therefore, that the short chain fatty acid is not present in the lymph of the thoracic duct in the form of glycerides.

When the solubility of the short chain fatty acids is considered, it is apparent that the short chain fatty acids are relatively soluble in water. Those with the shorter carbon chain, as acetic and butyric acid, are infinitely soluble. As the number of carbon atoms increases the solubility decreases; and the lipid character of the carbon chain dominates to a greater and greater degree over the non-lipid character of the carboxyl group. Thus, caprylic acid has a low degree of solubility (70 mg. per 100 cc. of water), while capric acid is practically insoluble (3 mg. per 100 cc.). It is interesting to recall that Powell (1932) reported caprylic acid deposited in small amounts in the adipose tissue, and that the shortest chain fatty acid to be deposited unchanged was capric acid. This fact is easily explained in the light of the hypothesis advanced by this paper.

It is probable, therefore, that the short chain fatty acids of fats upon hydrolysis, being water-soluble and in this respect similar to amino acids and monosaccharides, follow the path of absorption of these, are absorbed by the blood, and thus escape the glyceride synthesis. Further investigation should demonstrate the presence of the short chain fatty acids fed in the diet in some form in the portal blood.
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SUMMARY

The results of this experiment indicate that there is no increase in the amount of soluble, volatile fatty acids present in the thoracic lymph as glycerides during the process of digestion of fats which contain a soluble, volatile fatty acid such as butyric acid.

The authors wish to acknowledge their appreciation to Dr. J. S. Hughes of the Department of Chemistry for valuable suggestions and aid in conducting these experiments.

BIBLIOGRAPHY

Powell, M., J. Biol. Chem., 95, 43 (1932).
THE ABSORPTION OF SOLUBLE, VOLATILE FATTY ACIDS
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