Quantitation of Water-soluble Acylcarnitines and Carnitine Acyltransferases in Rat Tissues*

Y. R. Choi, P. J. Fogle, P. R. H. Clarke, and L. L. Bieber

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The water-soluble acylcarnitines isolated from rat heart, skeletal muscle, liver, and testis have been characterized. The following acyl residues derived from the acylcarnitine fraction were found: acetyl, propionyl, isobutyryl, butyryl, \( \alpha \)-methylbutyryl, isovaleryl, tiglyl, caprylyl, \( \beta \)-methylcrotonyl and methacrylyl. The amounts of these acylcarnitines in heart, liver, testis and skeletal muscle from fed rats were determined. Acetylcarnitine was the most abundant acylcarnitine; however, appreciable quantities of propionyl-, isobutyryl-, isovaleryl-, and tiglyl-carnitine were found. The levels of carnitine octanyltransferase, carnitine acetyltransferase and carnitine palmityltransferase activities were determined in several tissues. In addition, carnitine isovaleryltransferase and isobutyryltransferase activities were measured in heart, skeletal muscle, liver, testis, and kidney. In all instances the specific activity of isobutyryltransferase was similar to the specific activity of acetyltransferase. The results are consistent with the proposal that carnitine is involved in the catabolism of branched-chain amino acids.

Carnitine acetyltransferase and carnitine octanyltransferase activities are associated with peroxisomes and microsomes as well as with mitochondria in rat liver (1-5). This multiganelle distribution of the octanyl- and acetyltransferase activities indicates that carnitine has roles other than the well-established one of translocating long chain acyl residues across the acyl-CoA barrier of mitochondria (6-9).

As part of an effort to determine whether carnitine has additional roles in intermediary metabolism, we recently reported the occurrence of 4-carbon and 5-carbon acyl esters of carnitine in beef heart (10-12). Herein, we show that these 4-carbon and 5-carbon acyl esters of carnitine occur in rat heart, liver, skeletal muscle, and testis and that these tissues also contain carnitine octanyltransferase as well as carnitine isovaleryl- and isobutyryltransferase activities.

**DISCUSSION**

The volatile fatty acids associated with carnitine in rat muscle, liver, heart, and testis are qualitatively similar to those found in beef heart. The presence of branched chain 4-carbon and 5-carbon acyl derivatives of carnitine in rat muscle, liver, heart, and testis is consistent with the previous suggestion that carnitine is involved in branched chain amino acid catabolism (10-12). The presence of large amounts of acetylcarnitine in rat heart, in beef heart (12), in piglet heart (>600 nmol/g of tissue) indicates that acetylcarnitine may function as an immediately available supply of acetyl units that could serve as an energy source during the initial phases of increased energy demands.

The occurrence of carnitine octanyltransferase activity in all of the tissues tested indicates a general role in metabolism for this enzyme activity. The finding that the levels of carnitine isobutyryltransferase activity in heart, muscle, kidney, testis, and liver were similar to the levels of carnitine acetyltransferase activity while the carnitine isovaleryltransferase activity was much lower is surprising. It could mean that the isobutyryltransferase and acetyltransferase activities are due primarily to the same enzyme, namely, carnitine acetyltransferase, while the isovaleryltransferase activity might be attributable to a different enzyme. This is in contrast to the commercial preparation of carnitine acetyltransferase in which the isobutyryl- and isovaleryl transferase activities were much lower than the acetyltransferase activity.1

1 Y. R. Choi, P. J. Fogle, P. R. H. Clarke, and L. L. Bieber, unpublished data.
Short Chain Acylcarnitines

TABLE 1

<table>
<thead>
<tr>
<th>Acylcarnitine</th>
<th>T1 (ms)</th>
<th>T2 (ms)</th>
<th>T2* (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyrylcarnitine</td>
<td>41.2±1.8</td>
<td>32.3±1.9</td>
<td>69.3±2.6</td>
</tr>
<tr>
<td>Valeryl carnitine</td>
<td>34.0±2.2</td>
<td>30.6±2.0</td>
<td>69.3±2.6</td>
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<tr>
<td>Palmitoylcarnitine</td>
<td>23.0±1.7</td>
<td>13.0±1.5</td>
<td>35.0±2.0</td>
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<tr>
<td>Hexanoylcarnitine</td>
<td>12.0±1.7</td>
<td>8.0±1.6</td>
<td>15.0±1.4</td>
</tr>
<tr>
<td>Octanoylcarnitine</td>
<td>8.0±1.7</td>
<td>5.0±1.5</td>
<td>10.0±1.4</td>
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</tbody>
</table>

TABLE 2

<table>
<thead>
<tr>
<th>Labeled CARNITINES</th>
<th>ACTIVITY IN HEART, MUSCLE, BRAIN AND LIVER</th>
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REFERENCES

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