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Acute Effects of Decaffeinated Coffee and the Major Coffee Components Chlorogenic Acid and Trigonelline on Glucose Tolerance

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OBJECTIVE — Coffee consumption has been associated with lower risk of type 2 diabetes. We evaluated the acute effects of decaffeinated coffee and the major coffee components chlorogenic acid and trigonelline on glucose tolerance.

RESEARCH DESIGN AND METHODS — We conducted a randomized crossover trial of the effects of 12 g decaffeinated coffee, 1 g chlorogenic acid, 500 mg trigonelline, and placebo (1 g mannitol) on glucose and insulin concentrations during a 2-h oral glucose tolerance test (OGTT) in 15 overweight men.

RESULTS — Chlorogenic acid and trigonelline ingestion significantly reduced glucose (−0.7 mmol/l, P = 0.007, and −0.5 mmol/l, P = 0.024, respectively) and insulin (−73 pmol/l, P = 0.038, and −117 pmol/l, P = 0.007) concentrations 15 min following an OGTT compared with placebo. None of the treatments affected insulin or glucose area under the curve values during the OGTT compared with placebo.

CONCLUSIONS — Chlorogenic acid and trigonelline reduced early glucose and insulin responses during an OGTT.

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Coffee components and glucose tolerance

Table 1—Glucose and insulin concentrations during an OGTT following ingestion of chlorogenic acid, decaffeinated coffee, trigonelline, or placebo in 15 healthy overweight men

<table>
<thead>
<tr>
<th>Glucose (mmol/l)</th>
<th>Insulin (pmol/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUC (pmol/l x 100)</td>
<td>Time 0</td>
</tr>
<tr>
<td>Placebo</td>
<td>0.2</td>
</tr>
<tr>
<td>Chlorogenic acid</td>
<td>0.5</td>
</tr>
<tr>
<td>Decaffeinated coffee</td>
<td>0.7</td>
</tr>
<tr>
<td>Trigonelline</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Data are means ± SD. Differences between the treatments were not statistically significant by paired t test. Significant differences were found using the Bonferroni correction. *P < 0.05 vs. placebo, †P < 0.01 vs. placebo, ‡P < 0.001 vs. placebo.

CONCLUSIONS—In this randomized, crossover trial in healthy men, chlorogenic acid and trigonelline ingestion led to significantly lower glucose and insulin concentrations 15 min after an oral glucose load but did not significantly reduce the OGTT insulin and glucose areas under the curve compared with placebo.

Glucose concentrations tended to be lower and the OGTT insulin area under the curve tended to be lower after decaffeinated coffee compared with placebo (Table 1), but this difference was only statistically significant 15 min after the start of the OGTT (difference 0.69 mmol/l [95% CI 0.22–1.17]; P = 0.007). In addition, the mean insulin concentration was 6.6 pmol/l (95% CI 0.11–13.0; P = 0.047) lower at the start of the OGTT and 73.3 pmol/l (–7.4–142.0; P = 0.038) lower at 15 min for chlorogenic acid compared with placebo.

Trigonelline also resulted in significantly lower glucose (–0.51 mmol/l [95% CI –0.95 to –0.08]; P = 0.024) and insulin (–117.0 pmol/l [–196.5 to –37.4]; P = 0.007) concentrations at 15 min after the start of the OGTT compared with placebo. Decaffeinated coffee did not significantly change mean glucose or insulin concentrations at any of the time points following the OGTT, although the insulin concentration tended to be lower at 15 min. None of the treatments significantly changed the insulin or glucose area under the curve values (Table 1).

Several mechanisms have been suggested for effects of chlorogenic acid on glucose metabolism. In vitro, chlorogenic acid has been shown to inhibit α-glucosidase and glucose-6-phosphatase, suggesting that it may delay intestinal glucose uptake (8,14). This effect could also reduce postprandial hyperglycemia through improved glucose-induced insulin secretion as a result of increased glucagon-like peptide-1 secretion (12). Inhibition of glucose-6-phosphatase could also reduce hepatic glucose output (15), which may have contributed to the reduction of fasting insulin concentrations that we found for chlorogenic acid.

In our study, the multiple tests conducted for different time points increased the likelihood of chance findings, and confirmation of our results is therefore needed. In addition, the decaffeinated coffee supplement contained substantially less chlorogenic acid and trigonelline than the doses administered in isolation, complicating the comparison of the treatment effects.

In conclusion, chlorogenic acid and trigonelline reduced early glucose and insulin responses during the OGTT. This finding is consistent with the hypothesis that these compounds contribute to the putative beneficial effect of coffee on development of type 2 diabetes.

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R.J. Heine is currently employed at Eli Lilly and Company, Indianapolis, Indiana. No other potential conflicts of interest relevant to this article were reported.

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