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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were no drop-outs during the trial, and no adverse events were reported.

Glucose concentrations tended to be lower after chlorogenic acid ingestion compared with those after 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 (4.7–142.0; \( P = 0.038 \)) 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).

### 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.

Battram et al. (11) found a significantly lower OGTT glucose area under the curve after decaffeinated coffee compared with that after placebo, but no significant effect was found in the current study or two smaller previous studies (12, 13). Further research is needed to elucidate whether these differences in study results are due to chance or to differences in study methods. Trigonelline (5) and chlorogenic acid (6–8) have been shown to reduce blood glucose concentrations in rats, but data in humans are sparse. In a study of 10 diabetic patients, intake of 500 mg trigonelline had mixed and non-significant effects on glucose concentrations (9).

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 increased glucagon-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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### References


3. Clifford MN. Chlorogenic acids and other cinnamates: nature, occurrence and di-