

OBSERVATIONS

Artificial Sweeteners Have No Effect on Gastric Emptying, Glucagon-Like Peptide-1, or Glycemia After Oral Glucose in Healthy Humans

Intestinal exposure to glucose stimulates the release of glucagon-like peptide-1 (GLP-1), slows subsequent gastric emptying, and reduces appetite. These responses are signaled, at least in part, by intestinal “sweet taste receptors” (STRs), including taste receptor type 1 members 2 and 3 (T1R2, T1R3), and their cellular signaling partners α -gustducin and transient receptor potential cation channel subfamily M member 5 (TRPM5) (1). A recent study by Brown et al. (2) in healthy humans reported that oral ingestion of “diet soda,” containing both sucralose (46 mg) and acesulfame potassium (AceK) (26 mg), augmented GLP-1 release by more than one-third after an oral glucose load given 10 min later compared with carbonated water, suggesting a potential synergy between artificial sweeteners and glucose in stimulating GLP-1 secretion. The design of that study was, however, suboptimal, as the diet soda contained a number of substances (including caramel color, gum acacia, natural flavors, citric acid, potassium benzoate, phosphoric acid, and potassium citrate) that were not controlled for. Therefore, we evaluated whether oral administration of sucralose and AceK in doses comparable with those used by Brown et al. (2) would augment the GLP-1 response to oral glucose and modulate gastric emptying or glycemia in healthy humans.

Ten healthy males (mean age 33.6 ± 5.9 years; BMI: 25.5 ± 1.0 kg/m²) were studied on four occasions each, separated by ≥ 3 days, in single-blinded randomized fashion. Informed consent and ethics approval were obtained. After an overnight fast, each subject consumed either 240 mL water alone or equivalently sweetened with 1) 52 mg sucralose, 2) 200 mg AceK, or 3) 46 mg sucralose plus 26 mg AceK (3). Ten minutes later, each drank 75 g of glucose, made up to 300 mL with

water, and containing 150 mg ¹³C-acetate. Blood glucose (glucometer), plasma insulin (ELISA), total GLP-1 (radioimmunoassay), and gastric emptying (breath test) were evaluated over 240 min.

Blood glucose, plasma insulin, and total GLP-1 concentrations did not change after either water or sweetened drinks, prior to glucose ingestion, but all increased after oral glucose ($P < 0.001$ for each), without any difference between the 4 days (Fig. 1A–C). Neither the ¹³CO₂:¹²CO₂ ratio nor the half-emptying time (T_{50}) differed between the 4 days (Fig. 1D and E).

These observations differ from those of Brown et al. (2), although the doses of sucralose and AceK and the load and timing of the subsequent glucose drink were identical in our study. It is unclear whether other components of diet soda that were not controlled for by Brown et al. may have had the capacity to stimulate GLP-1 secretion. Our findings are, however, consistent with previous reports that sucralose or AceK alone has no effect on GLP-1 secretion, insulin, or blood glucose concentrations (3,4) and our observations that sucralose had no effect on GLP-1 secretion or the glycemic response to intraduodenal glucose in healthy humans (5). That the STR antagonist, lactisole, attenuates glucose-stimulated GLP-1 secretion suggests that activation of STRs is necessary, but not sufficient, to stimulate L-cell secretion (1). In conclusion, sucralose and AceK, either alone or in combination, have no acute effect on gastric emptying, GLP-1, or glycemic responses after oral glucose in healthy humans.

TONGZHI WU, MBBS^{1,2}

MICHELLE J. BOUND, B MED RAD (NUC MED)^{1,2}

SCOTT D. STANDFIELD, BSC^{1,2}

MAX BELLON, DIP MED TECH AD NUC MED³

RICHARD L. YOUNG, PHD^{1,2,4}

KAREN L. JONES, PHD^{1,2}

MICHAEL HOROWITZ, MBBS, PHD^{1,2}

CHRISTOPHER K. RAYNER, MBBS, PHD^{1,2}

From the ¹Discipline of Medicine, University of Adelaide, Royal Adelaide Hospital, Adelaide, Australia; the ²Centre of Research Excellence in Translating Nutritional Science to Good Health, University of Adelaide, Adelaide, Australia; the ³Department of Nuclear Medicine, Royal Adelaide Hospital, Adelaide, Australia; and the ⁴Nerve-Gut Research Laboratory, Royal Adelaide Hospital, Adelaide, Australia.

Corresponding author: Christopher K. Rayner, chris.rayner@adelaide.edu.au.

DOI: 10.2337/dc13-0958

© 2013 by the American Diabetes Association. Readers may use this article as long as the work is properly cited, the use is educational and not for profit, and the work is not altered. See <http://creativecommons.org/licenses/by-nc-nd/3.0/> for details.

Acknowledgments—This work was funded by a grant awarded by the National Health and Medical Research Council (NHMRC) of Australia (no. 627139). K.L.J.’s salary is provided by an NHMRC Senior Clinical Career Development Award (NHMRC 627011).

No potential conflicts of interest relevant to this article were reported.

T.W. was involved in study design and coordination, subject recruitment, data collection and interpretation, statistical analysis, and the drafting of the manuscript; critically reviewed the manuscript; and approved the publication of the final version of the manuscript. M.J.B. assisted with data collection, critically reviewed the manuscript, and approved the publication of the final version of the manuscript. S.D.S. performed insulin and GLP-1 assays, critically reviewed the manuscript, and approved the publication of the final version of the manuscript. M.B. performed the gastric emptying analysis, critically reviewed the manuscript, and approved the publication of the final version of the manuscript. R.L.Y., K.L.J., and M.H. were involved in the conception of the study and data interpretation, critically reviewed the manuscript, and approved the publication of the final version of the manuscript. C.K.R. was involved in conception and design of the study and data interpretation, had overall responsibility for the study, critically reviewed the manuscript, and approved the publication of the final version of the manuscript. C.K.R. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

The authors thank Kylie Lange (Centre of Research Excellence in Translating Nutritional Science to Good Health, University of Adelaide) for her expert statistical advice.

References

- Steinert RE, Gerspach AC, Gutmann H, Asarian L, Drewe J, Beglinger C. The functional involvement of gut-expressed sweet taste receptors in glucose-stimulated secretion of glucagon-like peptide-1 (GLP-1) and peptide YY (PYY). *Clin Nutr* 2011;30:524–532
- Brown RJ, Walter M, Rother KI. Ingestion of diet soda before a glucose load augments glucagon-like peptide-1 secretion. *Diabetes Care* 2009;32:2184–2186
- Steinert RE, Frey F, Töpfer A, Drewe J, Beglinger C. Effects of carbohydrate sugars and artificial sweeteners on appetite and the

Downloaded from <http://diabetesjournals.org/care/article-pdf/36/12/e202/614481/e202.pdf> by guest on 08 December 2022

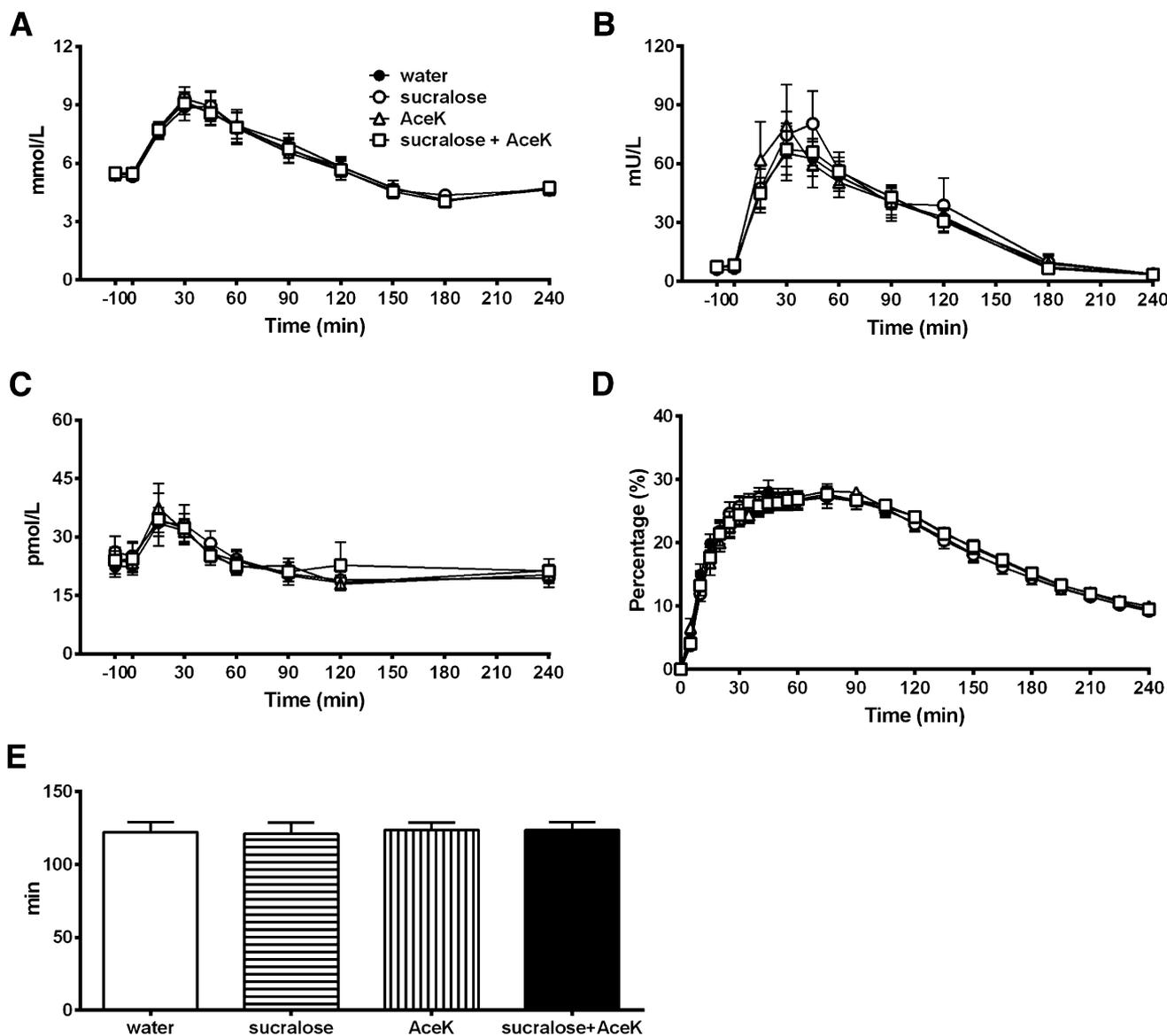


Figure 1—Effects of ingestion of either water or artificial sweeteners (sucralose, AceK, or sucralose plus AceK) (at $t = -10$ min) on (A) blood glucose, (B) plasma insulin, (C) GLP-1, (D) ¹³CO₂-to-¹²CO₂ ratio, and (E) T₅₀ in response to 75-g oral glucose (at $t = 0$ min) in healthy humans ($n = 10$). Data are means \pm SEM. The area under the curves for blood glucose, plasma insulin, ¹³CO₂-to-¹²CO₂ ratio, and T₅₀ did not differ between the 4 study days before and after 75-g oral glucose (one-factor repeated-measures ANOVA). There was a time effect ($P < 0.001$) but not a treatment effect or treatment \times time interaction for blood glucose, plasma insulin, and ¹³CO₂-to-¹²CO₂ ratio (two-factor repeated-measures ANOVA with treatment and time as factors).

secretion of gastrointestinal satiety peptides. *Br J Nutr* 2011;105:1320–1328

4. Ma J, Bellon M, Wishart JM, et al. Effect of the artificial sweetener, sucralose, on gastric emptying and incretin hormone release in healthy subjects. *Am J Physiol Gastrointest Liver Physiol* 2009;296:G735–G739

5. Ma J, Chang J, Checklin HL, et al. Effect of the artificial sweetener, sucralose, on small intestinal glucose absorption in healthy human subjects. *Br J Nutr* 2010;104:803–806

Downloaded from <http://diabetesjournals.org/care/article-pdf/36/12/e202/614481/e202.pdf> by guest on 08 December 2022