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Cell wall matrices in chickpeas and their effects on starch digestion and postprandial metabolism

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The Western diet is typically high in rapidly digested starch (RDS), which can elicit a high glycaemic response that has been implicated in the development of type 2 diabetes [(1)]. Encapsulation of starch within cell wall matrices provides an approach to slow down the rates of starch digestion and attenuate postprandial glycaemia [(2)]. Resistant starch that is not digested during upper gastrointestinal (GI) digestion can enter the ileum and colon, where it can be used for intestinal fermentation and has favourable effects on glycaemic metabolism [(3)]. This study used chickpeas as a food model and aimed to investigate the effect of cell wall structures on postprandial metabolism and starch digestion throughout the human GI tract.

Thirteen healthy participants were recruited for a randomised crossover study that included four inpatient visits. Participants had three macronutrient-matched dietary interventions: chickpea with broken cell walls (BC), intact single cells (Intact-S), and intact clustering cells (Intact-C). Blood was collected at baselines and postprandially to measure levels of glucose, insulin, and Glucose- dependent insulinotropic polypeptide (GIP). Digesta was collected from the stomach, duodenum, and terminal ileum by nasoenteric tubes to investigate starch digestion and metabolites. Repeated measures ANOVA with Tukey test was performed to test the differences between groups on the iAUC of outcomes.

Postprandial glucose, GIP and insulin levels were lower in Intact-S and Intact-C than in BC (all $p < 0.01$). Metabolic profiling using $_1$H-NMR spectroscopy [(4)] showed significant differences in GI samples between groups (e.g., at 60 min postprandial, gastric: Intact-S vs BC, $R_2Y = 0.99$, $Q_2Y = 0.86$, duodenal: Intact-S vs BC, $R_2Y = 0.99$, $Q_2Y = 0.57$; at 120 min postprandial, ileal: Intact-S vs BC, $R_2Y = 1$, $Q_2Y = 0.82$). Targeted carbohydrate analysis (maltose and glucose) showed that Intact-S and Intact-C slowed down starch digestion compared to the BC group. Notably, ileal glucose iAUC in Intact-S and Intact-C were significantly higher than BC (both $p < 0.05$). Ileal glucose in the BC group was barely detectable (peak value 0.54 ± 0.24 mmol/L). This possibly suggested carbohydrates within intact cell walls but not BC could arrive at the distal ileum.

This study provides direct evidence that carbohydrate food structure can affect postprandial glycaemia by modulating starch digestion in healthy subjects. Intact cell wall matrices in chickpeas lowered starch digestion kinetics in the upper GI tract and increased the delivery of carbohydrate contents to the distal ileum.

References

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