



Innovative pulse and cereal-based food fermentations for human health and sustainable diets

Health benefits of fermentation-driven changes in plant fiber structure

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Human intervention studies within Healthferm



- Subjects at risk for cardiometabolic disease
- Well characterized intervention products

Fermentation is not only about the microbes it also changes the plant's structures

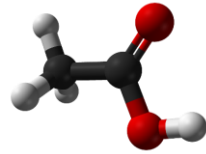
Microbes generate

Vitamins
Neurotransmitters
Phenolic compounds
Bioactive peptides
Exopolysaccharides

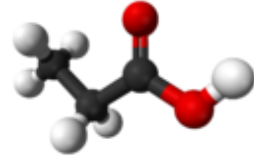
Microbes degrade

FODMAPs
Phytic acid
Fiber

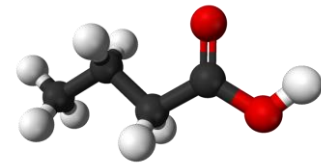
SCFA are produced in the colon from fiber



Acetic acid



Propionic acid



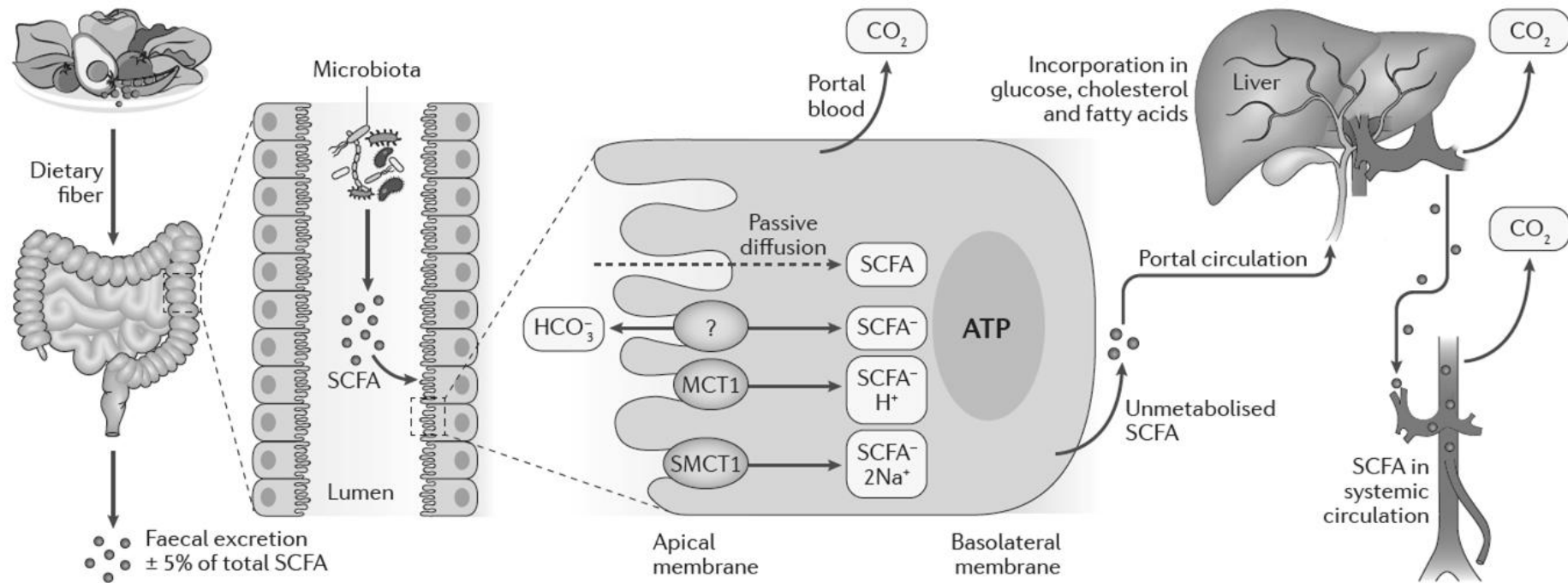
Butyric acid

SCFA are the main anions in the colon

Daily production: 500-600 mmol

SCFA act as signals that shape host physiology

Colonic SCFA, energy source for the colonocytes



SCFA that reach the circulation affect other organs



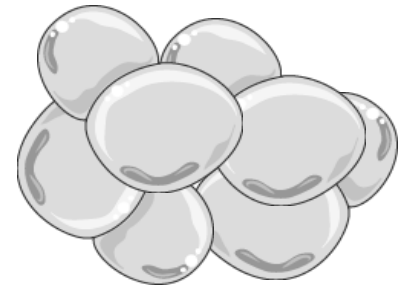
Liver



Pancreas

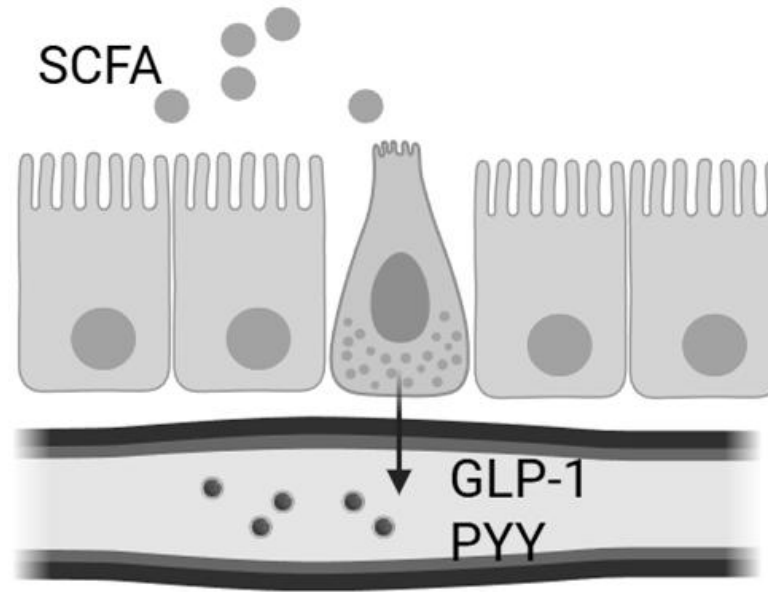


Brain

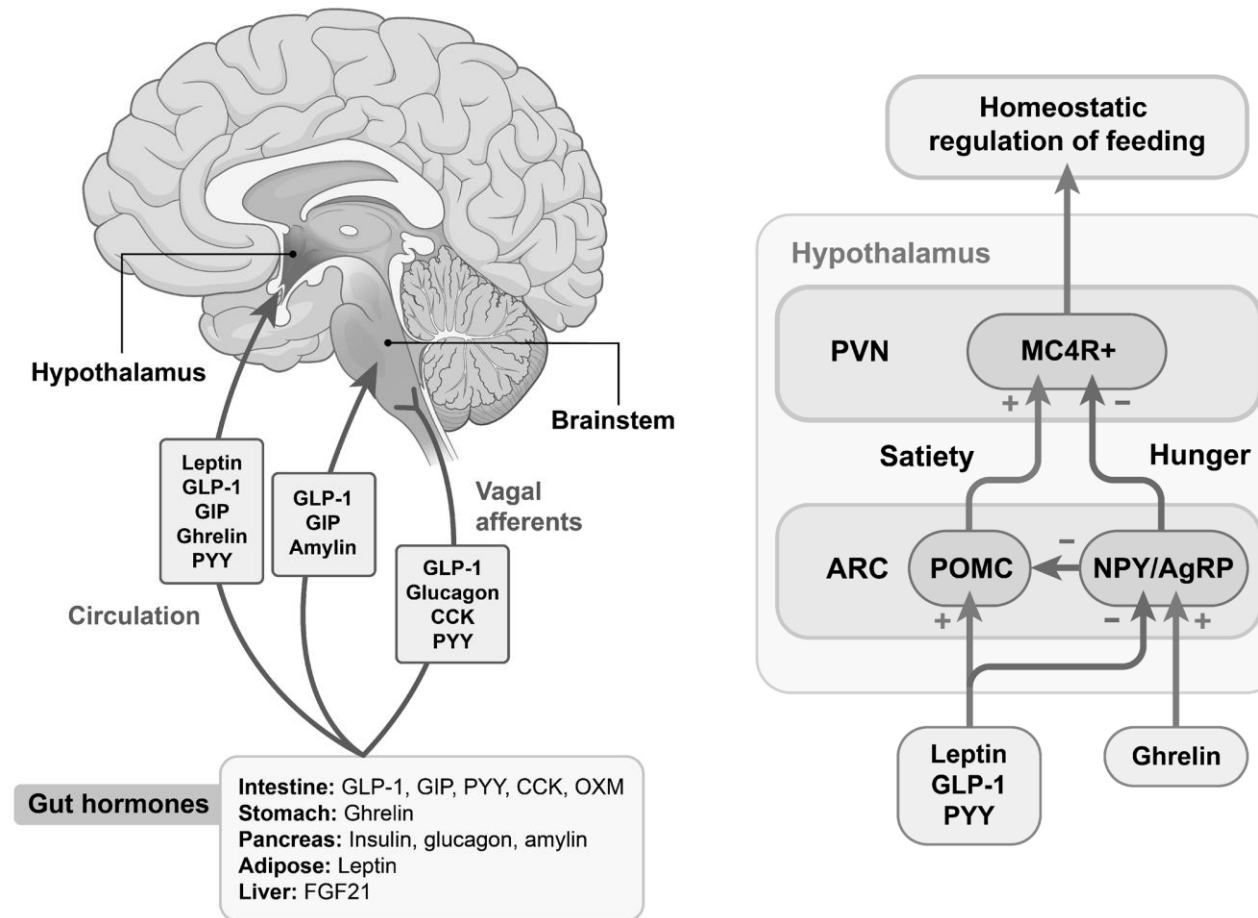


Adipocytes

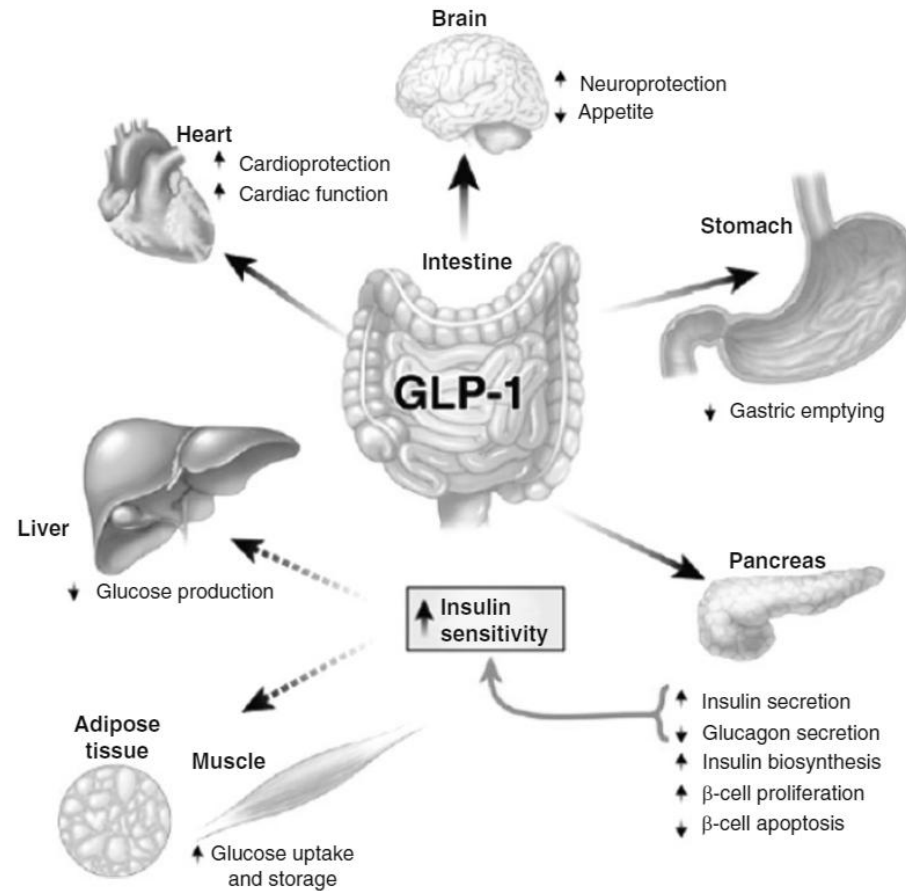
Luminal SCFA induce release of GLP-1 and PYY



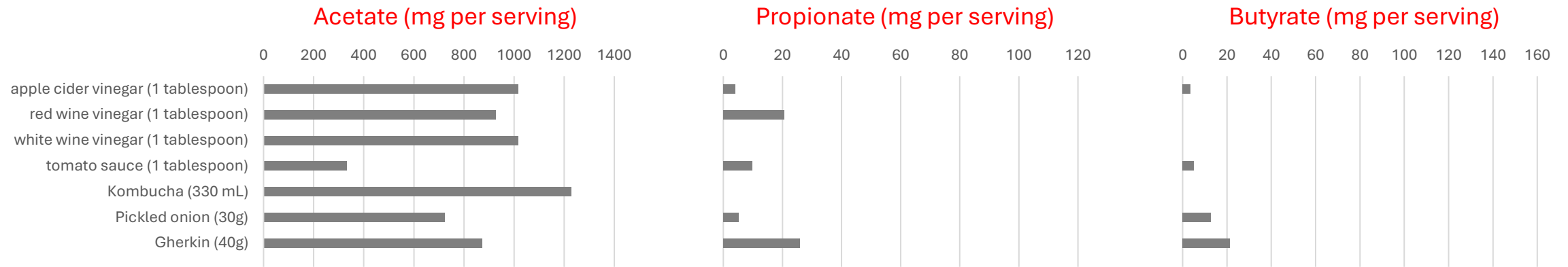
Gut hormones regulate food intake



GLP-1 acts on peripheral tissues



Fermentation of plant-based foods increases SCFA



Does it make a difference?

- Consume SCFA directly
- Consume fiber

We hypothesized it does

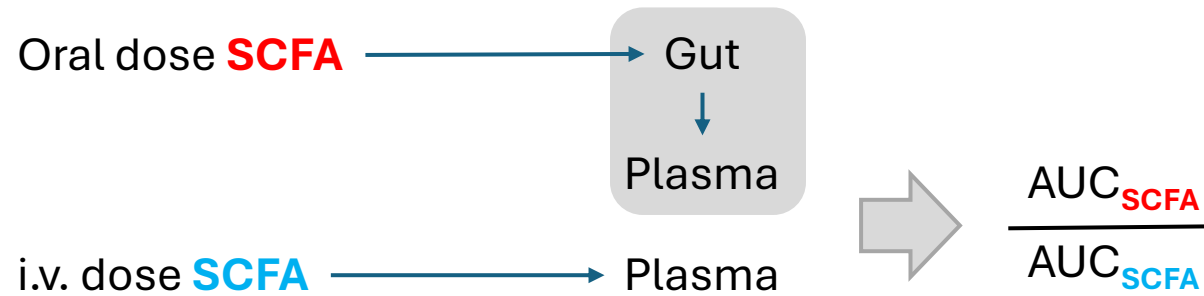
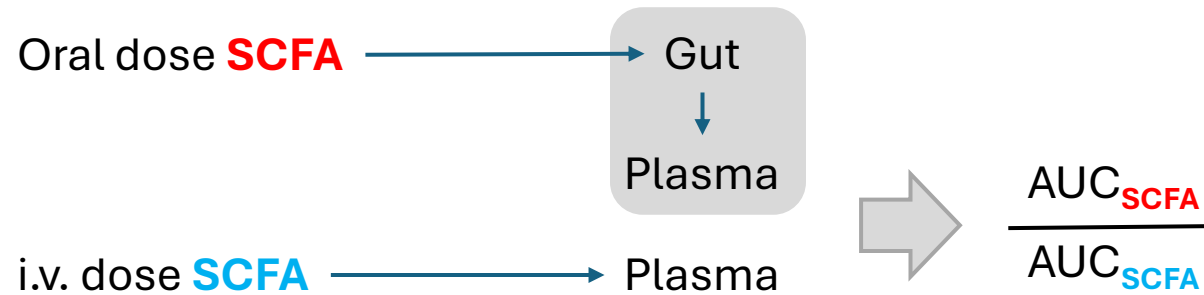
More SCFA reach the systemic circulation when you consume them directly

Small intestinal cells do not use SCFA as energy source

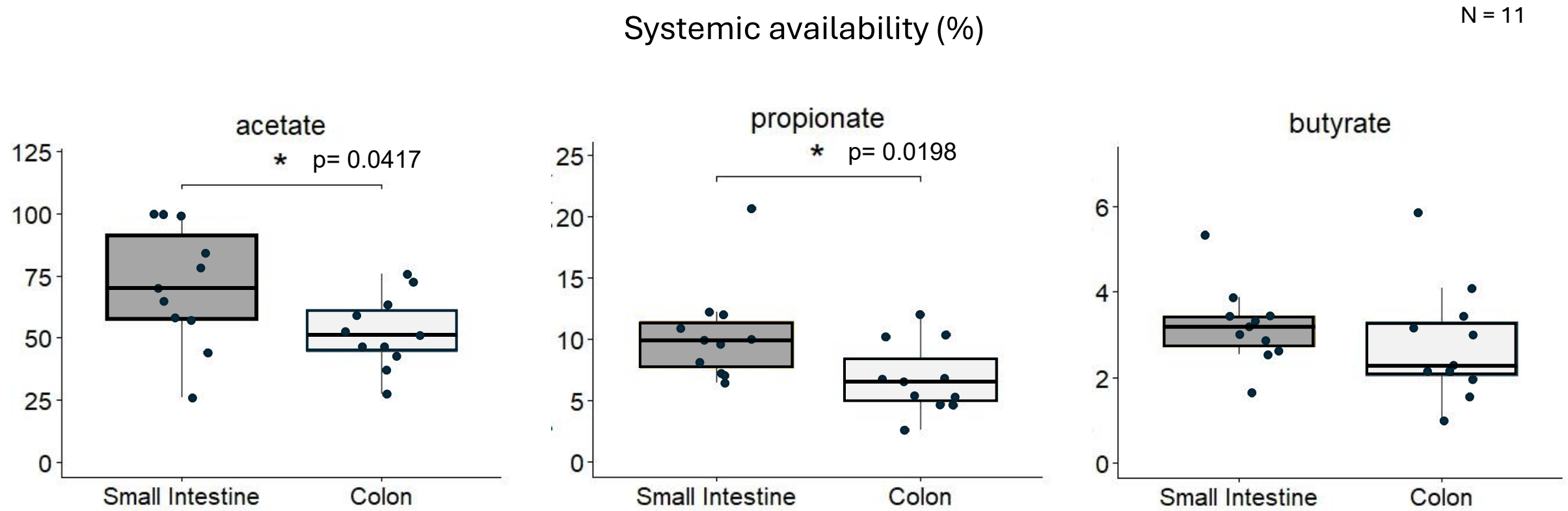
Fiber consumption induces more gut hormone release

Enteroendocrine cells are more dense in the colon

Isotopes to measure systemic availability

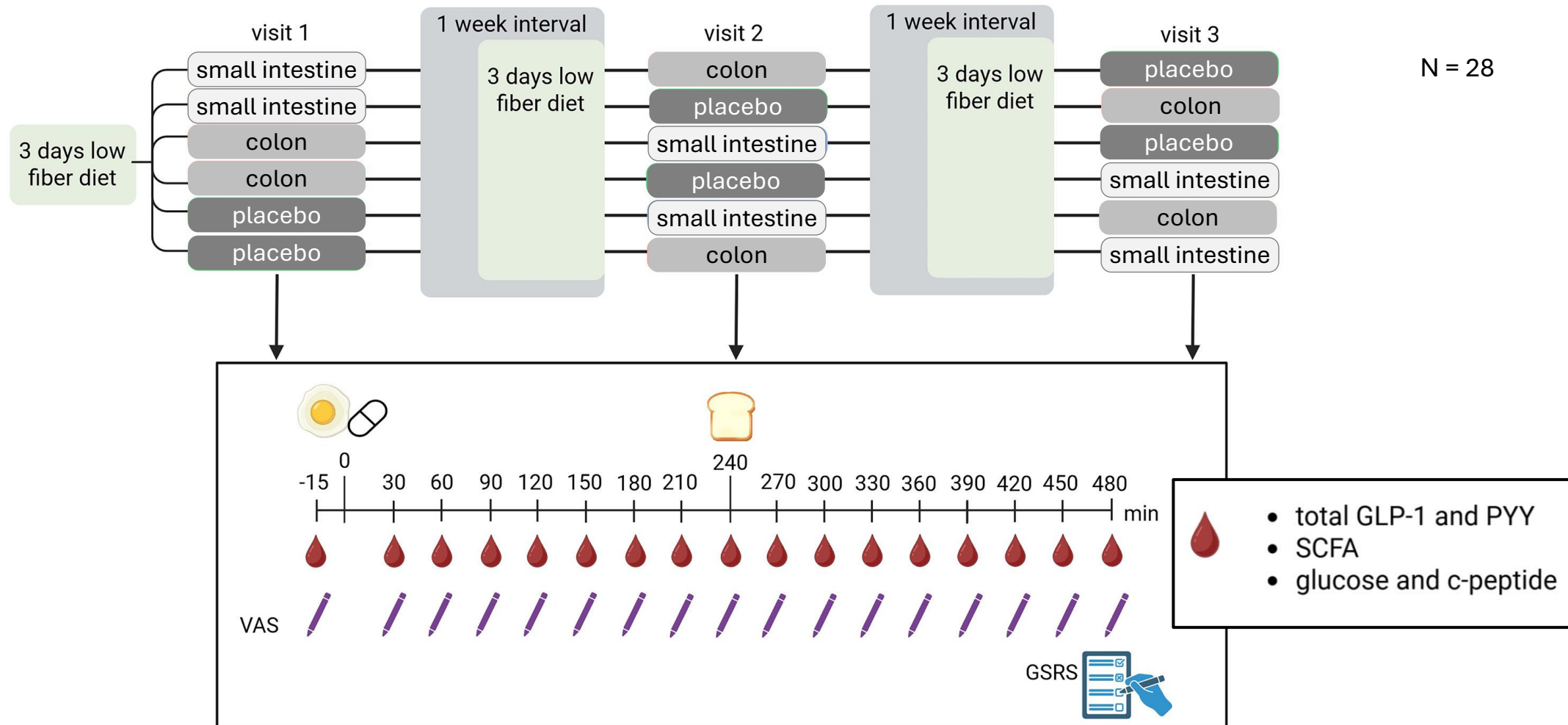


More SCFA reach the systemic circulation after small intestinal SCFA delivery



Effect of site of administration on gut hormones

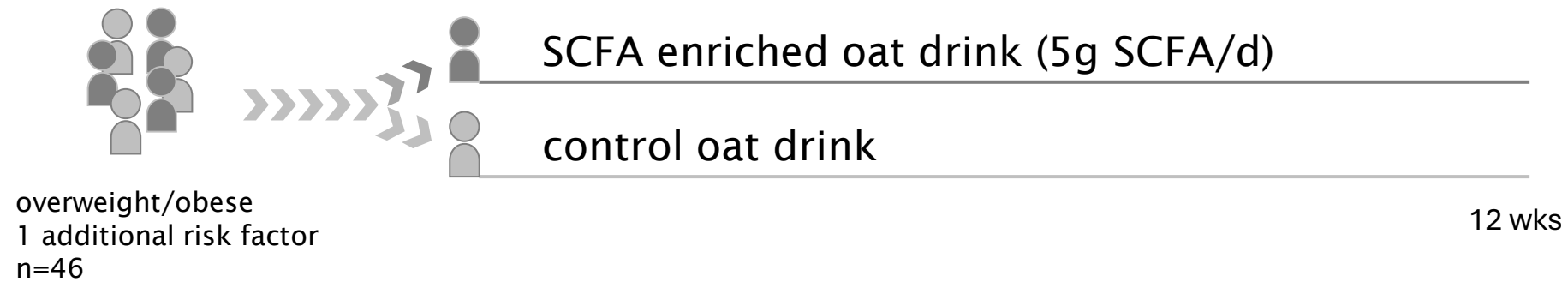
3-arm cross-over study



Be patient...



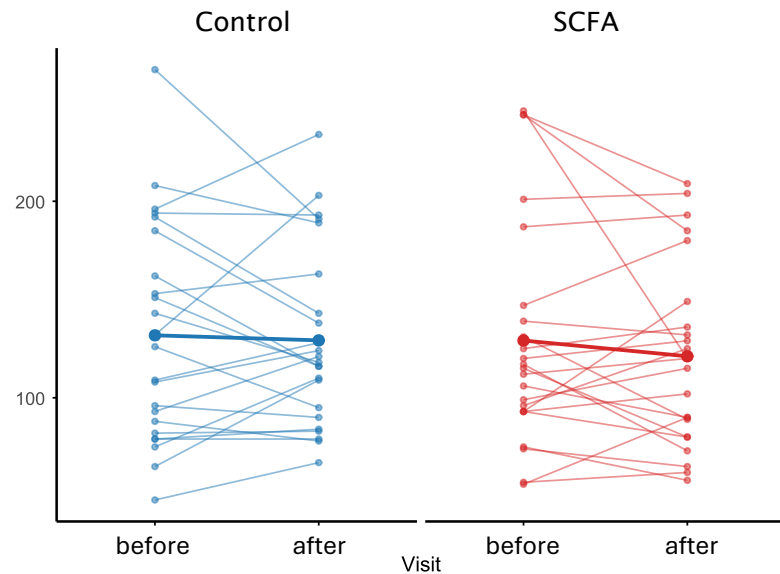
Do SCFA affect cardiometabolic risk?



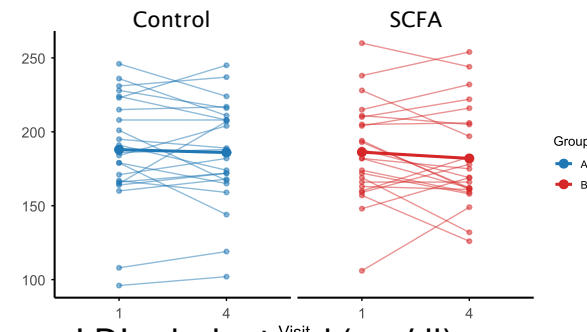
Primary outcome: Δ fasting triglycerides after 12 wks

Fasting metabolic parameters were not affected

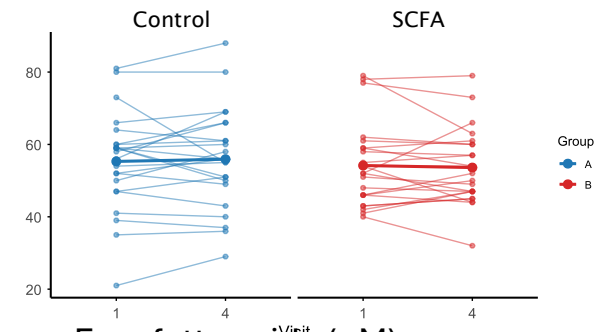
Fasting plasma triglycerides (mg/dl)



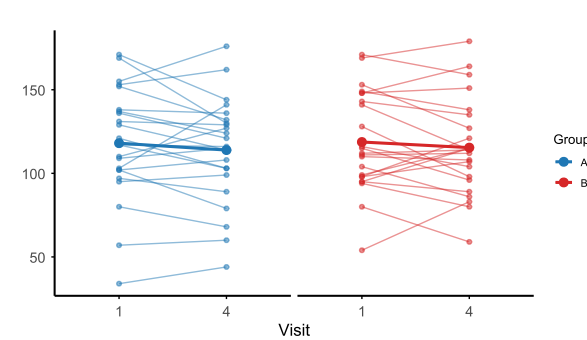
Cholesterol (mg/dl)



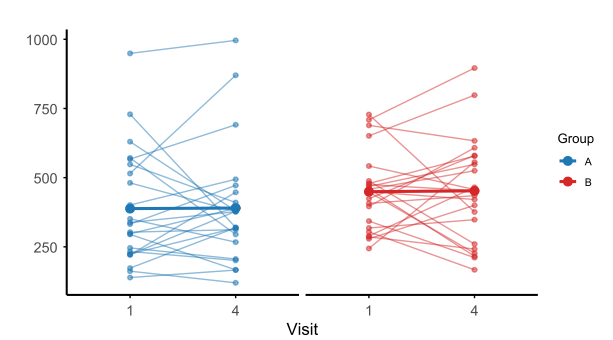
HDL-cholesterol (mg/dl)



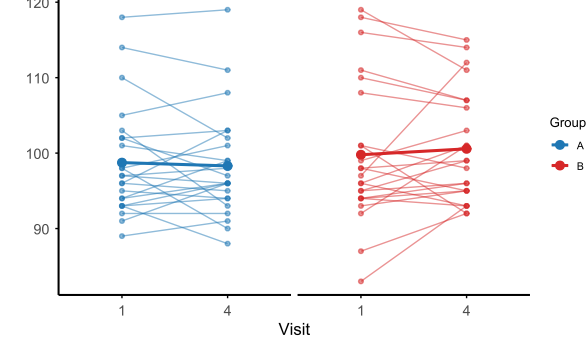
LDL-cholesterol (mg/dl)



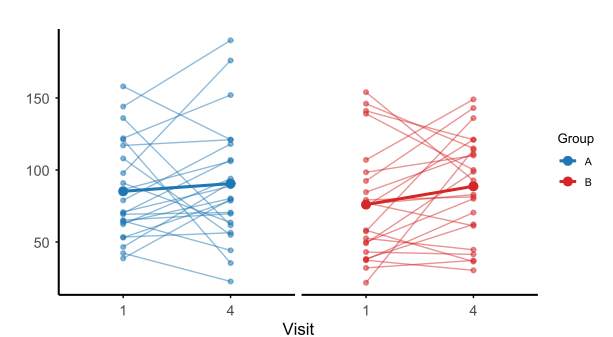
Free fatty acids (μM)



Glucose (mg/dl)



Insulin(μM)



Postprandial parameters were not affected

Cholesterol

- Total cholesterol
- HDL-cholesterol
- LDL-cholesterol

Lipids

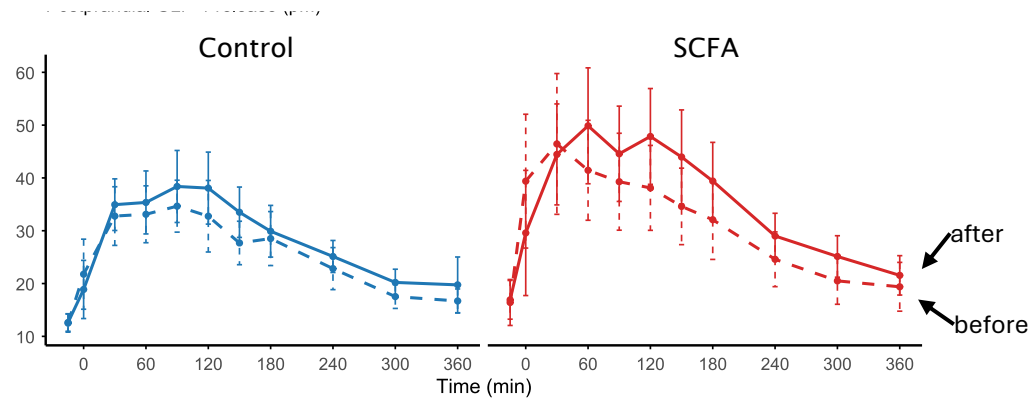
- Triglycerides
- Free fatty acids

Glucose homeostasis

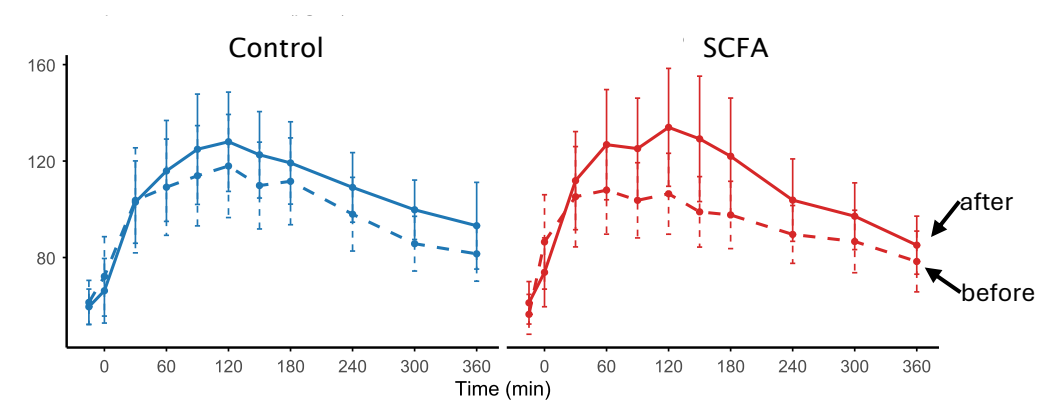
- Glucose
- insulin

Postprandial gut hormones did not differ between groups

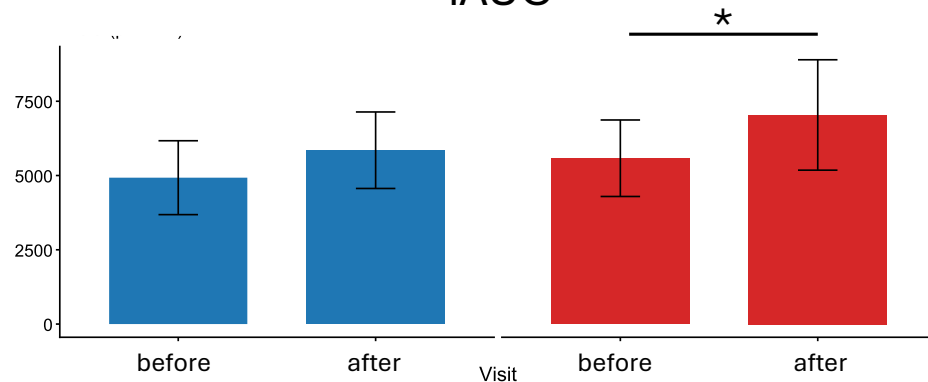
Postprandial GLP-1 (μM)



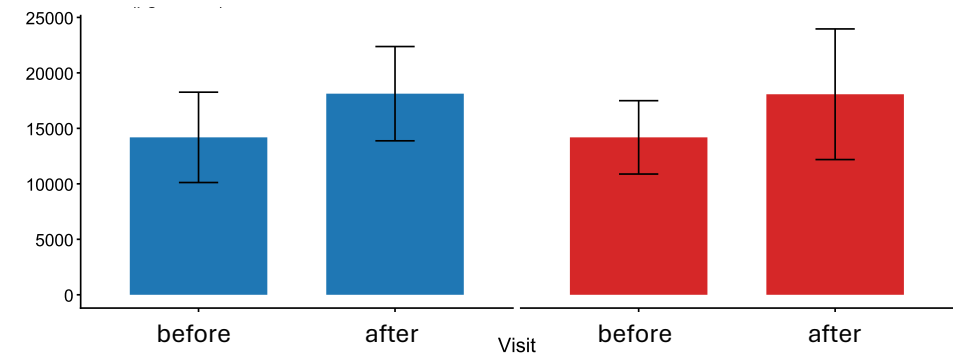
Postprandial PYY (pg/ml)



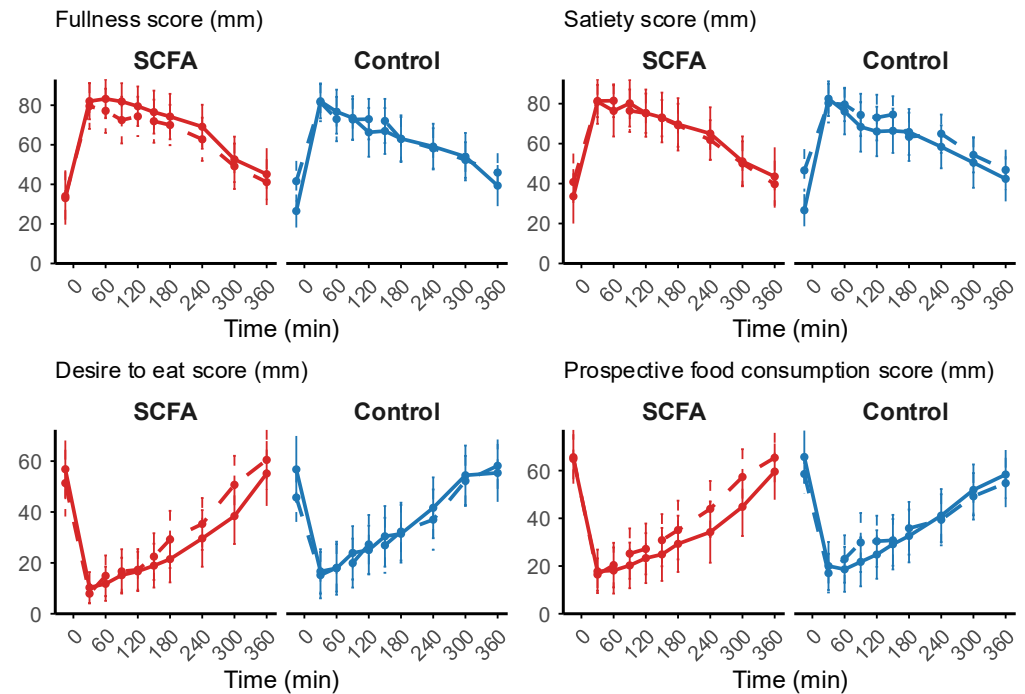
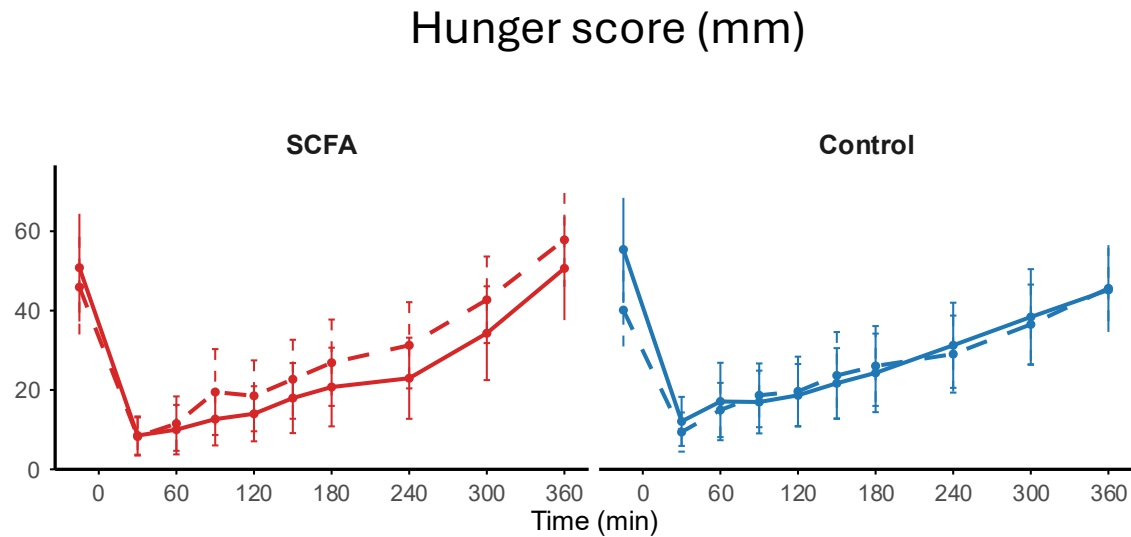
iAUC



iAUC

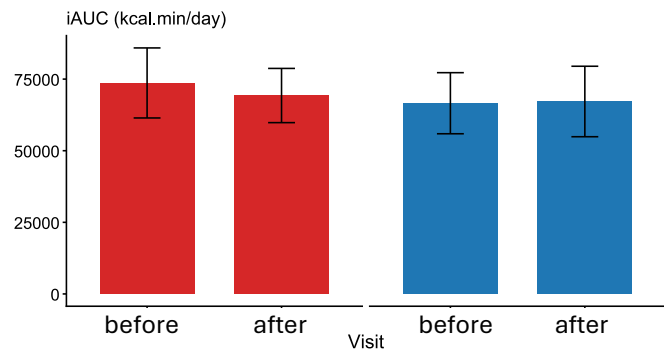
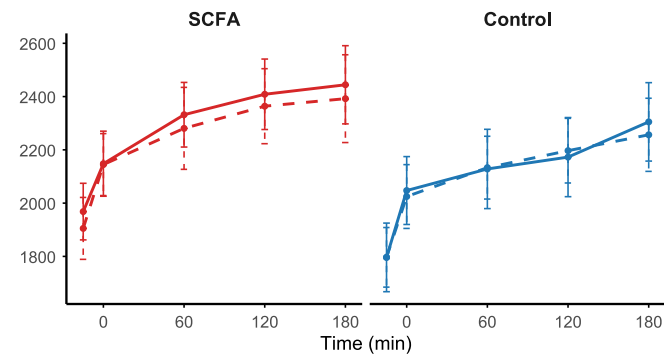


SCFA do not affect appetite ratings

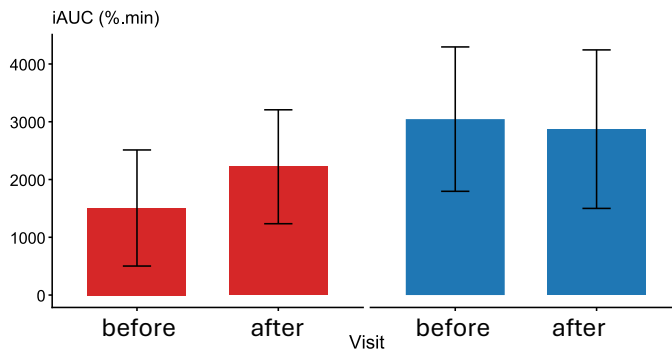
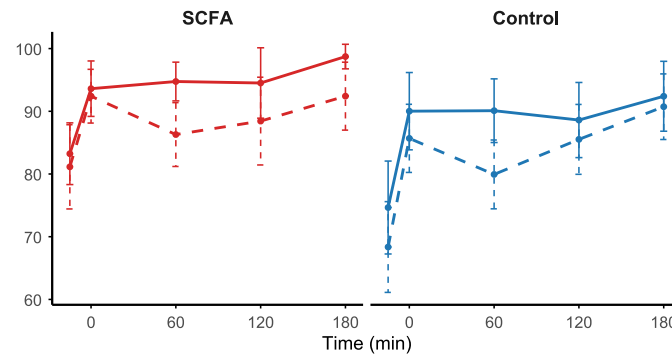


Energy expenditure was not affected

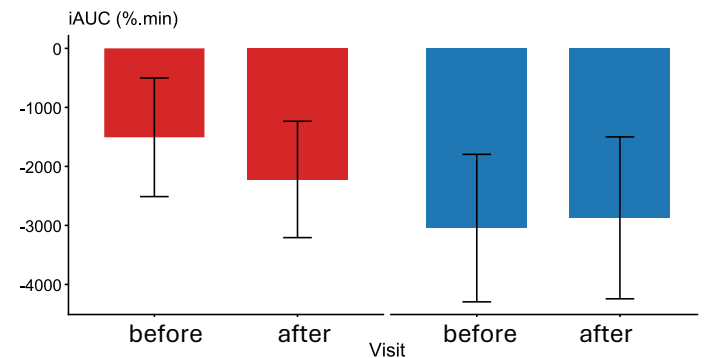
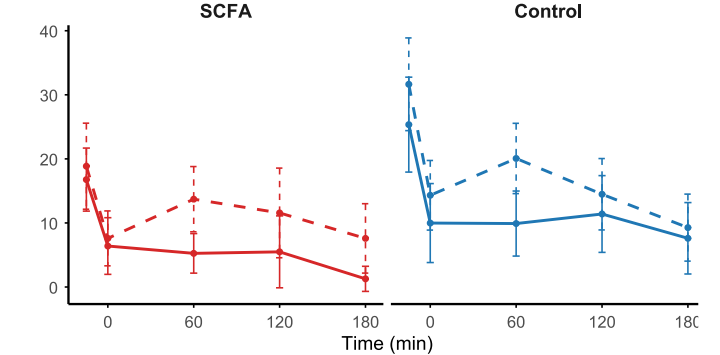
Resting energy expenditure



Fat oxidation

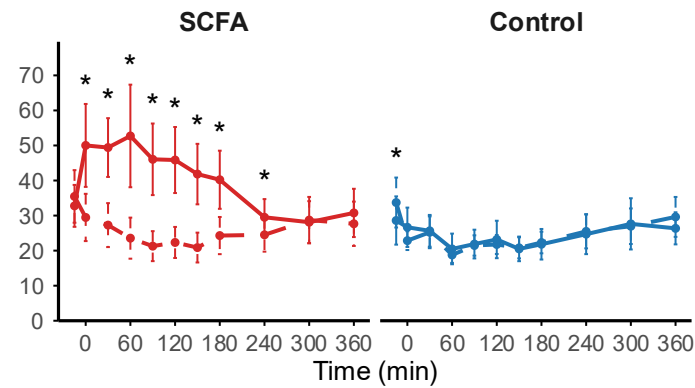


Carbohydrate oxidation

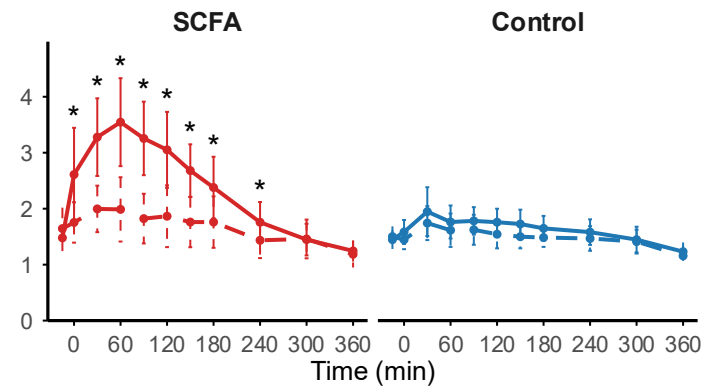


Postprandial SCFA increase after intervention

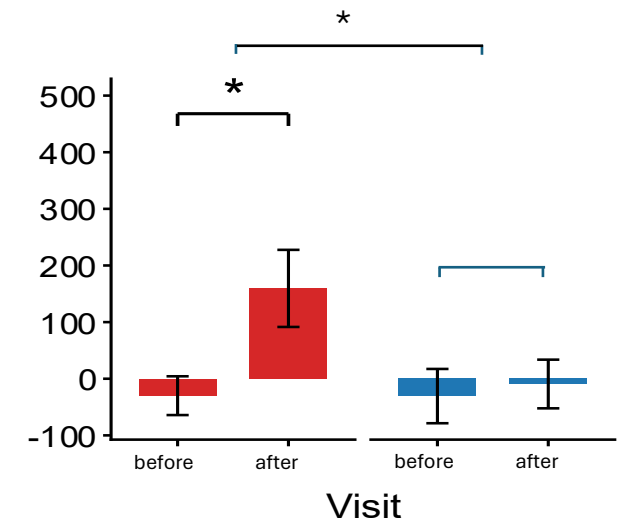
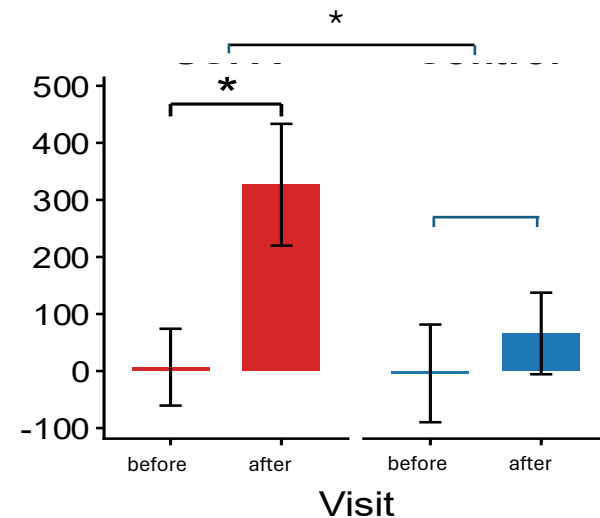
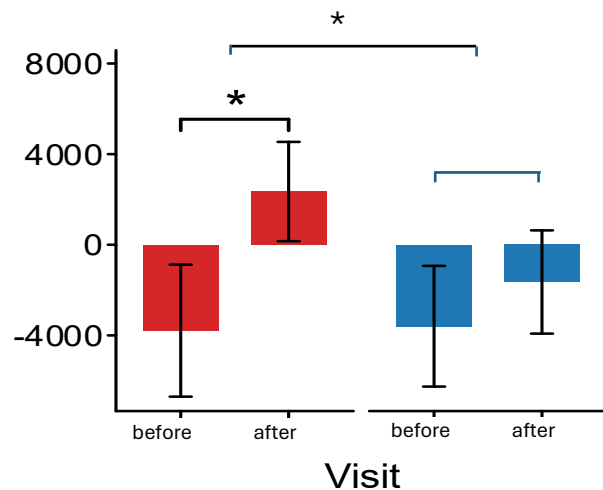
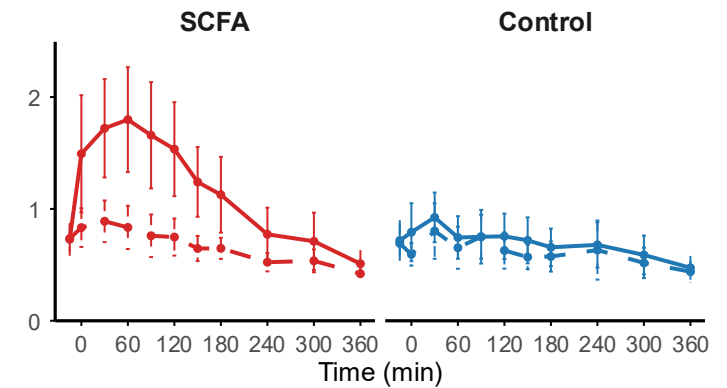
acetate



propionate



butyrate



Interested in more?

Cardiometabolic effects of 12-weeks small intestinal SCFA supplementation via an enriched oat drink

Introduction

- SCFA exert cardiometabolic health effects in peripheral organs via the systemic circulation.
- Yet, only a small fraction of colonic-derived SCFA reaches the systemic circulation.
- Fermented foods provide SCFA that are absorbed in the small intestine.
- We have shown that small intestinal SCFA delivery increases systemic availability and may therefore enhance health benefits (Figure 1).

Study objective

To investigate how daily SCFA administration in the small intestine for 12 weeks affects cardiometabolic health.

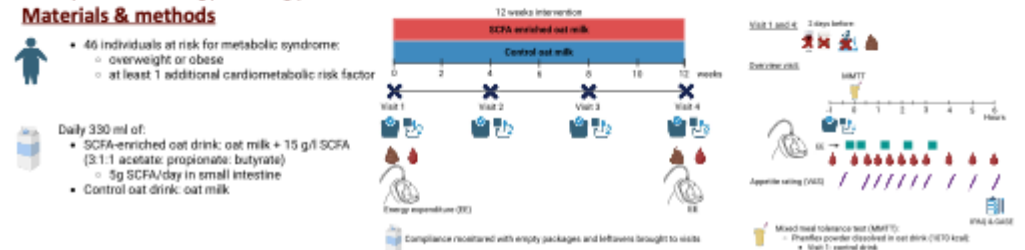
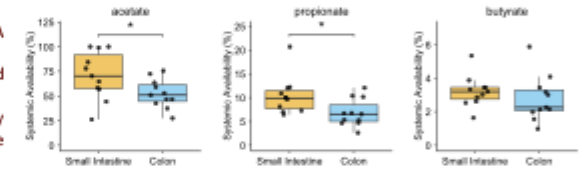
Primary outcome: fasting plasma triglycerides.

Materials & methods

- 46 individuals at risk for metabolic syndrome:
 - overweight or obese
 - at least 1 additional cardiometabolic risk factor

- Daily 330 ml of:
 - SCFA-enriched oat drink: oat milk + 15 g/l SCFA (3:1:1 acetate: propionate: butyrate)
 - 5g SCFA/day in small intestine
 - Control oat drink: oat milk

Figure 1:



Results

Anthropometrics:

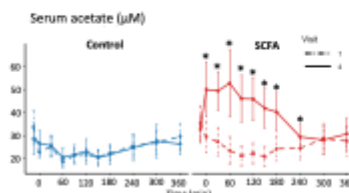
There were no changes in body weight, body composition and blood pressure (BP).

Parameter	Group	Visit 1	Visit 2	Visit 3	Visit 4	P-value
Body weight (kg)	SCFA	86.0 ± 12.7	86.2 ± 12.3	86.3 ± 12.4	86.8 ± 12.3	0.90
	Control	85.3 ± 12.7	85.2 ± 12.3	85.3 ± 12.4	85.8 ± 12.3	
Fat mass (kg)	SCFA	27.1 ± 7.5	26.5 ± 7.5	26.5 ± 7.7	27.1 ± 7.7	0.51
	Control	27.1 ± 7.5	26.5 ± 7.5	26.5 ± 7.7	27.1 ± 7.7	
Fat free mass (kg)	SCFA	58.9 ± 12.5	59.7 ± 12.3	59.8 ± 12.7	59.7 ± 12.6	0.90
	Control	58.2 ± 12.7	58.7 ± 12.3	58.8 ± 12.7	58.7 ± 12.6	
Systolic BP (mmHg)	SCFA	122 ± 14	122 ± 14	122 ± 14	122 ± 14	0.43
	Control	122 ± 14	122 ± 14	122 ± 14	122 ± 14	
Diastolic BP (mmHg)	SCFA	80 ± 11	80 ± 11	80 ± 11	80 ± 11	0.90
	Control	80 ± 11	80 ± 11	80 ± 11	80 ± 11	

Postprandial SCFA:

Serum acetate, propionate and butyrate were increased for 4 hours with the SCFA-enriched MMTT.

Acetate for illustration:

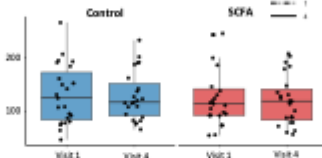


Fasting and postprandial blood:

Fasting and postprandial lipid and glucose metabolism did not change.

Primary outcome:

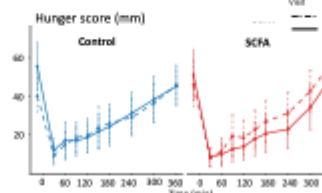
Fasting triglycerides (mg/dl)



Appetite rating:

SCFA-enriched drink did not change subjective appetite.

Hunger for illustration:

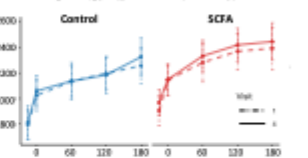


Fasting and postprandial EE:

Resting energy expenditure (REE) and substrate oxidation did not change.

REE for illustration:

Resting energy expenditure (kcal/day):



Conclusion

- Circulating SCFA concentrations increased following the consumption of the SCFA-enriched oat drink.
- Yet, 12 weeks of small intestinal SCFA administration did not improve cardiometabolic parameters.

Take home messages

Oral SCFAs achieve higher systemic availability than colonic SCFAs

Increased circulating SCFA concentrations
did not translate into measurable metabolic benefits

Other mechanisms beyond SCFAs likely contribute
to the health effects of fermented plant-based products

Science advances through collaboration



Riet Rosseel