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Quantification of *in vivo* colonic short chain fatty acid production from inulin

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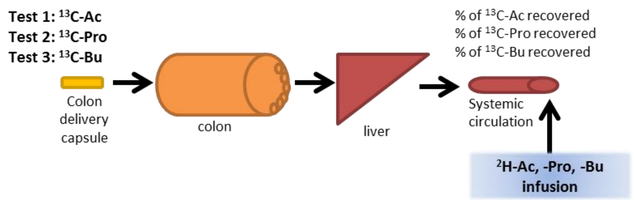
Introduction

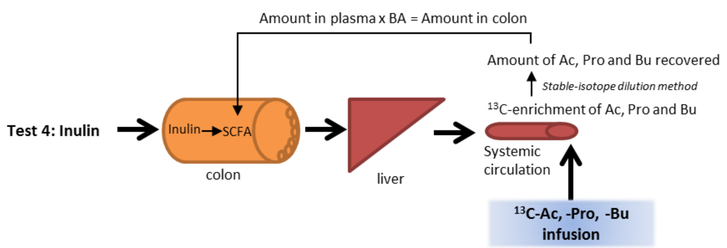
Short chain fatty acids (SCFA; acetate(Ac), propionate(Pro) and butyrate(Bu)) are produced during bacterial fermentation of undigested carbohydrates in the colon. In this study, we determined the bioavailability of each SCFA and applied a stable-isotope dilution method to quantify the colonic production of SCFA after consumption of inulin.

Study Design

- 12 healthy subjects (7F/5M; 26±6years)
- 3 test days to determine the **bioavailablility (BA)**



- 1 test day to quantify **SCFA production from inulin**



- Analysis of ^{13}C- and ^{2}H-enrichments of SCFA in blood samples using Gas Chromatography Combustion and Pyrolysis Isotope Ratio Mass Spectrometry

Calculations

- **Bioavailability:**

$$\boldsymbol{BA}\ (\%) = \frac{\text{Area Under Curve (AUC) x Clearance (Cl) x 100}}{\text{Administered dose } (D)}$$

$$\boldsymbol{Cl}\ \left(\frac{L}{h}\right) = \frac{\text{Infusion rate (i) } ^{2}\text{H–SCFA}}{\text{Steady state } ^{2}\text{H–SCFA concentration}}$$

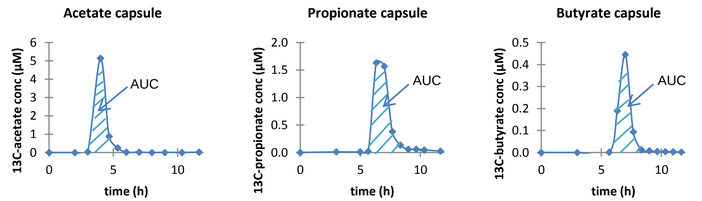


Figure 1. Example of ^{13}C-Ac, -Pro and -Bu concentrations in plasma after a ^{13}C-Ac, -Pro and -Bu capsule, respectively, in one subject.

- **SCFA production from inulin:**

^{13}C-enrichment of SCFA in plasma → $\boldsymbol{Total\ SCFA\ turnover}\ \left(\frac{\mu mol}{kg\ x\ h}\right) = \text{i x } \left(\frac{\text{Tracer } ^{13}\text{C–enrichment}}{\text{Plasma } ^{13}\text{C–enrichment}} - 1\right)$

→ AUC $\left(\frac{\mu\text{mol}}{\text{kg}}\right)$ → cumulative in plasma (mmol) → cumulative in colon (mmol) → mmol SCFA/ g inulin

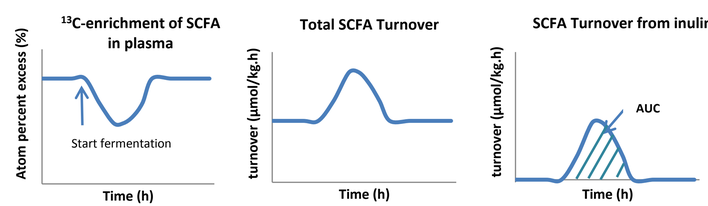


Figure 2. Principle of stable-isotope dilution.

Results

- **Bioavailability of Ac, Pro and Bu:**

	Acetate	Propionate	Butyrate
AUC (µmol.h/L)	4.4 [3.3-6.2]	1.8 [1.4-2.0]	0.5 [0.4-0.5]
Cl (L/h)	603 [430-654]	421 [369-471]	1198 [937-1427]
D (mmol)	4.8 [4.4-5.0]	3.3 [3.3-3.4]	8.8 [8.3-8.9]
BA (%)	56 [26-71]	23 [18-25]	7 [4-10]

All values are expressed as medians and interquartile ranges (n= 12).

- **SCFA production from inulin:**

	Acetate	Propionate	Butyrate
AUC (µmol/kg)	699 [535-1070]	14 [10-23]	14 [10-15]
Cum in plasma (mmol)	43 [34-78]	0.9 [0.6-1.5]	0.8 [0.6-1.1]
Cum in colon (mmol)	100 [57-174]	5 [2-7]	11 [8-25]
mmol SCFA/ g inulin	6.7 [3.8-11.6]	0.3 [0.2-0.5]	0.7 [0.5-1.7]

All values are expressed as medians and interquartile ranges (n= 12).

Conclusion

- The BA of Ac, Pro and Bu was determined in healthy human subjects and showed large interindividual differences.
- Inulin is mainly fermented into Ac followed by Bu and Pro.
- Stable isotope technology allows to quantify *in vivo* SCFA production from carbohydrate fermentation and will facilitate the evaluation of health benefits attributed to SCFA.

Acknowledgements
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