A MUltiREactor DIgestion approach to study digestion kinetics in a semi-dynamic way

Commonly used acronym: *MuReDi*
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SCOPE OF THE METHOD

The Method relates to	Human health
The Method is situated in	Basic Research, Translational - Applied Research
Type of method	In vitro - Ex vivo
This method makes use of	Animal derived cells / tissues / organs

DESCRIPTION

Method keywords

in vitro digestion
semi-dynamic digestion
enzymatic hydrolysis
kinetics

Scientific area keywords

in vitro
digestion
nutrient hydrolysis
bioaccessibility

Method description

Generally, our research group aims to study the influence of food parameters (food design, food processing, food composition) on the digestive kinetics of diverse nutrients throughout the upper gastrointestinal tract. For this, we use *in vitro* digestion protocols. The current method is a semi-dynamic *in vitro* digestion protocol simulated using a multireactor system. This multireactor system is a custom-made automated system with four independent syringe pumps (BioXplorer 100, H.E.L Group). It consists of multiple, small-scale reactors allowing to study digestion as a function of time and thus to determine digestion kinetics. The digestion conditions used in the oral, gastric, and small intestinal are currently based on the digestion protocols published by the INFOGEST consortium (Brodkorb et al., 2019). Briefly, food is first mixed with simulated salivary fluids to simulate the dilution and potential starch digestion of the oral compartment. Hereafter, the gastric phase is simulated by gradually decreasing the pH from the original food pH to a pH of 2 over 2h. Additionally, pepsin was added gradually as well over 2h. If wanted, also the small intestinal phase can be mimicked. For this, the pH is increased to pH 7 and small intestinal fluids (e.g. bile salts) and enzymes (e.g. (chymo)trypsin, pancreatic lipase and amylase) are added dynamically over 2h. Enzymes are inactivated in different reactors at different pre-determined digestion moments to study the kinetic evolution of nutrient hydrolysis and metabolite formation throughout the upper gastrointestinal tract. A kinetic study can be performed both in the gastric and small intestinal phase, depending on the research question. Quantification of the digestive metabolites is mostly done by chromatographic techniques. Our analytical platform allows characterization of starch, lipid and protein macronutrient digestion

(substrate, intermediate products and metabolites) as well as bioaccessibility of a range of micronutrients (minerals, vitamin C, carotenoids, etc.). Besides, we structurally characterize our digested food during digestion by the evaluation of particle size, microstructure and/or particle charge.

Lab equipment

• BioXplorer 100 equipment (H.E.L Group, London, U.K.)
• Titrino
• Water bath
• pH meter
• vortex
• glassware
• pipettes and tips
• magnetic mixer
• centrifuge
• etc.

Optional:
• HPLC
• GC
• ICP-OES
• Particle sizing equipment
• Microscope
• Particle charge measuring device

Method status

Published in peer reviewed journal

PROS, CONS & FUTURE POTENTIAL

Advantages

• High reproducibility
• No ethical constraints
• Allows to take into account particular dynamic secretions (e.g. digestive enzyme and fluid addition, pH changes, gastric emptying)
• Allows to perform digestion simultaneously in eight independent reactors
• Ease of use

Challenges

• Lower throughput than static *in vitro* methods
• Higher volumes required compared to static *in vitro* methods, resulting in higher operating costs (e.g. enzyme amounts)
• Does not include an absorption step
• Does not include fermentation of the large intestine

Modifications

The equipment could be further optimized by coupling it to another device mimicking absorption of metabolites. Additionally, the equipment could also be used in the future to mimic colonic fermentation.

Future & Other applications

Currently, a digestion protocol was implemented mimicking the conditions of healthy humans. In similarity to static *in vitro* protocols, there is also the need to develop methods mimicking the conditions of other populations in our society with altered digestion conditions (e.g. children, adolescents, elderly, people with obesity, diabetes, cancer, anorexia, that underwent bariatric surgery) in a semi-dynamic way. Besides, this MuReDi approach can also be applied in the field of animal science, mimicking the digestion conditions of specific animals at different life phases for example.

REFERENCES, ASSOCIATED DOCUMENTS AND OTHER INFORMATION

References

https://doi.org/10.1016/j.foodres.2022.111301

Associated documents

Verkempinck et al (2022) - Studying semi-dynamic digestion kinetics of food - Establishing a computer-controlled multireactor approach.pdf

Links

Verkempinck et al (2022)

PARTNERS AND COLLABORATIONS

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