SEmi-dynamic Nutrient In vitro ORogastrointestinal digestion for older adults

Commonly used acronym: *SENIOR*

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Organisation

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Country Belgium

Geographical Area Flemish Region

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

DESCRIPTION

Method keywords

semi-dynamic digestion

enzymatic hydrolysis

digestion kinetics

specific population

older adults

macronutrient

micronutrient

seniors

Scientific area keywords

in vitro digestion

nutrient hydrolysis

proteins

starch

lipids

bioaccessibility

digestion kinetics

Method description

Older adults are characterized by specific metabolic changes, altering their nutritional needs (i.e., lower calorie but higher protein requirement). Adapted nutrition is of crucial importance for this group. To develop foods adapted to the nutritional needs of older adults and test the impact of food design efforts (composition, processing, and structure), the Laboratory of Food Technology uses *in vitro* digestion protocols The current method is a semi-dynamic *in vitro* digestion protocol adapted to the gastrointestinal conditions of older adults. To adequately simulate these specific dynamic digestion conditions, a multireactor digestion system (MuReDi) (Verkempinck et al., 2022) was employed. MuReDi is a custom-made automated system consisting of multiple, independent small-scale reactors (BioXplorer 100, H.E.L Group). The system consists of four independent syringe pumps linked to each

of the independent reactors. As such, digestion can be studied as a function of time, under gradually changing digestion conditions (e.g., enzyme activity, gradual gastric acidification). The digestion simulation can be briefly summarized as follows. Food is first mixed with simulated salivary fluids (including salivary amylase) to simulate the oral dilution and starch digestion. Then, the gastric phase is initiated by gradually decreasing the pH from the original food pH to a relevant gastric level over the course of 2 h. Pepsin is added gradually over 2 h as well. Thereafter, the small intestinal phase can be mimicked. For this, the pH is increased to 7 and small intestinal fluids (e.g., bile salts) and enzymes (e.g., (chymo)trypsin, pancreatic lipase, and amylase) are added. Small intestinal digestion is simulated for 2 h. Exact applied dilutions, pH levels, and digestive enzyme activities in the oral, gastric, and small intestinal phases are based on those published by the INFOGEST consortium (Brodkorb et al., 2019), with specific alterations derived from *in vivo* older adult data. These changes are related to the oral phase, gastric pH profile, and applied (gastric and small intestinal) enzyme activities (Duijsens et al., 2023). A kinetic study can be performed for both the gastric and small intestinal phases. Digestion is simulated in 8 independent reactors, each representing a different kinetic time point. Digestion simulations are started simultaneously in all parallel reactors. Then, in distinct reactors, enzymes are inactivated at predetermined incubation time points. From each of these individual digests, the kinetic evolution of nutrient hydrolysis and metabolite formation can be measured. Digestive metabolites are mostly quantified through chromatographic techniques. Our analytical platform allows the identification and quantification of starch, lipid, and protein metabolites, as well as the bioaccessibility of multiple micronutrients (e.g., minerals, vitamin C, carotenoids). Structural characterization of the digested food can be performed as well, e.g., particle size, microscopy, and particle charge analyses.

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
- spectrophotometry
- 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, such as digestive enzyme and fluid addition, pH profile in the stomach phase (e.g., adapted to PPI use), gastric emptying
- Allows simultaneous digestion simulation in eight independent reactors
- Ease of use

Challenges

- Lower throughput than static *in vitro* methods (though adaptation to a higher-throughput static variant is possible)

• Higher volumes required compared to static *in vitro* methods, resulting in higher operating costs (though adaptation to a higher-throughput static variant is possible)

• Does not include an absorption step

• Does not include fermentation of the large intestine

Modifications

• To increase throughput and reduce experimental cost, older adult digestion can also be simulated using a simpler, static experiment.

• Specific time-dependent digestion conditions can be simulated. For example, the gradual gastric pH profile can be altered to relevantly represent patients using PPIs.

Future & Other applications

• Currently, a digestion protocol is implemented mimicking the conditions of healthy humans and older adults. However, there is a clear need for developing methods mimicking digestion in other population groups with altered gastrointestinal conditions, such as children, people with obesity, or people who have undergone bariatric surgery.

• This approach can be applied in the field of animal science, for example, mimicking the digestion conditions of specific animals at different life phases.

• The equipment could be further optimized by coupling it to another device mimicking the absorption of metabolites. Subsequently, colonic fermentation could be simulated in series.

• In the future, the MuReDi equipment itself could also be used to mimic colonic fermentation as well.

REFERENCES, ASSOCIATED DOCUMENTS AND OTHER INFORMATION

References

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