In vitro digestion procedures to estimate the (micro)nutrient bio-availability of foods

Identification

Key words
in vitro digestion, bio-availability, bio-accessibility, nutrient, carbohydrate, starch, fat, protein, allergen, vitamin, antioxidant, carotenoid, mineral

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How does it work?

Primary objective Analytical tool
In vitro digestion procedures are rapid, cost-effective and high through-put analysis methods to measure the bio-accessibility of (micro)nutrients in food systems, that is an estimation or prediction of the (micro)nutrient bio-availability in those food systems.
The **bioavailability of (micro)nutrients**, (the fraction of ingested nutrients available for utilization in normal physiological functions or storage), depends on many host- and diet-related factors. The **food matrix** in which the (micro)nutrient is incorporated affects (micro)nutrient release, a critical step for (micro)nutrient absorption. In this context, the (micro)nutrient bio-accessibility has been defined as the fraction of ingested (micro)nutrients that is released from the food matrix (to mixed micelles) and thereby made available for absorption.

By **simulation of human digestion**, (micro)nutrient bio-accessibility can be measured **in vitro**. Hereto, numerous digestion models have been developed to simulate the physiological conditions and sequence of events that occur during digestion in the human gastrointestinal tract. Most of these **in vitro** models include an oral, gastric and intestinal phase, but the model complexity varies. The most simple, basic models, are called **static or biochemical models** and involve the use of digestive enzymes (most commonly amylases, proteases and lipases) and fluids to simulate and measure the release of (micro)nutrients or the transfer of (micro)nutrients to micelles during gastric and intestinal digestion. To simulate **in vivo** absorption of (micro)nutrients, divers models such as Caco-2 human intestinal cells can be used. More complex, **multicompartmental models**, such as the TNO intestinal model (1) and the dynamic gastric model (2), take into account the dynamic character of the physiological digestion process. Recently, also models, critically taking into account mechanical disintegration during oral and gastric digestion have been developed (3, 4). **In vitro** digestion procedures have been shown very useful to estimate or to predict the (micro)nutrient bio-accessibility. As the models are cost-effective and in general rapid methods, they are increasingly used for high through-put analysis to screen the bio-availability for large numbers of samples. It is however difficult to accurately simulate human digestion as **in vivo** digestion will be dependent on the host and on the amount and type of food that is consumed. No standard **in vitro** digestion procedure is thus available. Because **in vitro** tests are moreover being developed depending on the (micro)nutrient and on the food matrix that are studied, experimental parameters across **in vitro** models can differ remarkably. Therefore, it is advised to carefully interpret results obtained by **in vitro** digestion analysis and to avoid comparison of the absolute values (5). For comparing differently processed samples, **in vitro** digestion methods however have been shown extremely useful. Most predominant food systems tested by **in vitro** digestion analysis include plant-based foods, meat, fish, dairy, and emulsion-based foods (6). **In vitro** digestion research has been shown very useful in the context of for example targeted release of bio-active micronutrients, structural design for tailored fat digestion, understanding the fate of proteins to comprehend the basis of food allergies which is for example important in the context of GM crops (7), analysis of glycaemic properties of foods (8)...
Solutions for shortcomings
Product development for personalized nutrition. Cost-effective and high through-put analysis

What can it NOT be used for?

Products: None
Operations: Not applicable
Other limitations: These systems remain *in vitro* approximations of *in vivo* digestibility. Incomplete knowledge on human digestion processes can limit accuracy of *in vitro* procedures.

Risks or hazards

Implementation

Maturity: Different *in vitro* digestion procedures (for specific (micro)nutrients in specific types of food matrices and with different degrees of complexity) are available. Continuously, models are further developed and new models are developed. Validation of different *in vitro* procedures under a variety of conditions and critical evaluation of the procedures could further improve the methods.

Modularity: Not applicable

Consumer aspects: Not applicable
Legal aspects: Not applicable
Environmental aspects: Not applicable

Facilities that might be interesting for you

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<tr>
<th>Title</th>
<th>Institute/company</th>
</tr>
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<tbody>
<tr>
<td>Auditorium IRTA</td>
<td>IRTA</td>
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<tr>
<td>Clean room - Histocell</td>
<td>Noray</td>
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<td>Video observation system for market research and product development tasks - Keki</td>
<td>NAIK EKI</td>
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Further Information

Institutes: KU Leuven LFT, IFR, TNO Institute, University of Massachusetts Amherst
Companies
References


