

# In vitro digestion, absorption and colonic batch fermentation model

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## Organisation

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## SCOPE OF THE METHOD

<b>The Method relates to</b>	Animal health, Human health
<b>The Method is situated in</b>	Basic Research
<b>Type of method</b>	In vitro - Ex vivo
<b>Species from which cells/tissues/organs are derived</b>	Pigs, humans
<b>Type of cells/tissues/organs</b>	Fecal samples

## DESCRIPTION

### Method keywords

intestinal microbiota  
short-chain fatty acids  
gas production

batch fermentation  
fermentation supernatants  
enzymatic hydrolysis  
dialysis

### **Scientific area keywords**

intestinal absorption  
colonic fermentation  
batch model  
three-step *in vitro* pig gastro-intestinal tract model  
digestion  
intestine

### **Method description**

The feed undergoes an *in vitro* enzymatic hydrolysis simulating the digestion in the upper digestive tract followed by a dialysis mimicking the intestinal absorption. Finally, an *in vitro* batch fermentation is performed and simulates the fermentation occurring in the hindgut. The ingredients, ground to a 1 mm-mesh screen, are first hydrolysed with porcine pepsin in a phosphate buffer supplemented with chloramphenicol (pH 2, 39°C, 2 hours) under gentle agitation in a water bath and then with pancreatin (pH 6.8, 39°C, 4 hours) in the same environment. Then, the hydrolysed samples are dialysed in standard regenerated cellulose membranes (6-8 kD) during 24 hours under agitation and water renewal to optimise the dialysis and are thereafter lyophilized. A faecal inoculum is prepared with a buffer solution (pH 6.8) composed of salts and minerals and frozen pig faeces (2.5%). An alternative to frozen faeces is to collect the faeces directly in syringes, to remove all the air and to place the syringes in a water bath at 39°C for transportation to the laboratory. The faeces and buffer solution need to be subjected to mechanical pummelling using a stomacher and then filtered through a 250 µm-mesh screen. The fermentation starts by adding 15 ml of faecal inoculum to 0.1 g of dried hydrolysed sample in 60-ml glass bottles filled with 3 mucin carriers making up approximately 1 g of mucus-agar and closed with a rubber stopper and crimp-caps to ensure steady and continuous anaerobic conditions. These steps are performed in an anaerobic chamber. The sealed vials are then placed in a water bath at 39°C. The released gas volumes are

repeatedly recorded over 72 hours of incubation with a manometer measuring bottles' inner pressure or with pressure sensors and connected to a computer. Gas production recordings are fitted to a mathematical monophasic model. The fermentation broth is collected and stored at -20°C for metabolomics analyses and at -80°C for microbial genomic DNA analysis. The concentrations of short-chain fatty acids, branched chain fatty acids and lactic acid can be determined by HPLC or the whole metabolomics profile can be obtained by GC-MS. Bacterial communities can be determined by qPCR or 16S sequencing.

### **Lab equipment**

Laboratory glassware ;

Glass vials (fermenters) ;

pH meter;

Stomacher ;

Liquid nitrogen ;

Gas bottles (nitrogen and special mix for the anaerobic chamber) ;

Plastic microcosms (for the preparation of the mucin carriers) ;

Freeze-drier ;

Cellulose diffusion membrane ;

Anaerobic chamber ;

Water bath ;

Manometer ;

HPLC or GC (for the determination of short chain fatty acids and other metabolites) ;

qPCR or 16S sequencing (for the determination of the bacterial communities).

### **Method status**

Published in peer reviewed journal

## **PROS, CONS & FUTURE POTENTIAL**

### **Advantages**

- 1) Fast, easy to set up, reproducible, high-throughput and automatable ;
- 2) Limited ethical and economic constraints ;

3) Valuable tool for the initial investigation of the microbial modulation and metabolic activities of a wide range of feed substrates.

## Challenges

The main drawback of the method is the rapid substrate depletion, the accumulation of metabolites and the pH reduction which, in turn, can impede microbial activity.

## Modifications

The method could be further optimised by implementing the selective absorption of nutrients after the hydrolysis step. Indeed, some free mono- and disaccharides and short-chain polymers are lost during the dialysis step due to the pore size of the cellulose membrane (8000 Da). Therefore, the application of the hydrolysate residues onto intestinal epithelial cell culture transwells could allow the active and passive absorption of nutrients (via their transporters) and to obtain a digesta in the basal compartment which could, more closely, simulate intestinal conditions.

## Future & Other applications

A common limitation of the fermentation model is the lack of host response. This could be overcome by combining the *in vitro* fermentation system with intestinal cell models which would allow the assessment of the immunomodulatory and barrier-enhancing properties of substrates.

## REFERENCES, ASSOCIATED DOCUMENTS AND OTHER INFORMATION

### References

Uerlings, J., Schroyen, M., Bautil, A., Courtin, C., Richel, A., Sureda, E. A., ... Everaert, N. (2019). *In vitro* prebiotic potential of agricultural by-products on intestinal fermentation, gut barrier and inflammatory status of piglets. *British Journal of Nutrition*, 1–37. <https://doi.org/DOI: 10.1017/S0007114519002873>.

Uerlings, J., Bindelle, J., Schroyen, M., Richel, A., Bruggeman, G., Willems, E., & Everaert, N. (2019). Fermentation capacities of fructan- and pectin-rich by-products and purified fractions via an *in vitro* piglet faecal model. *Journal of the Science of Food and Agriculture*, 99(13), 5720–5733. <https://doi.org/10.1002/jsfa.9837>.