Modulatory effects in microbiota metabolic function triggered by calcium-alginate capsules containing *Akkermansia muciniphila*

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Introduction

Probiotics are live **microorganisms**, that when consumed in suitable amounts, confer a **health benefit** on the host (Hill et al., 2014). Specifically, they may exert a **positive effect** on improving **intestinal homeostasis** by **modulating** both the microbiota profile and **metabolic** functions. This modulation may conduct to beneficial alterations in the production of specific **organic acids** and the consumption of extracellular **ammonia** (Gaisawat et al., 2020; Liu et al., 2022). Monitoring these metabolites can help to track the microbial modulation induced by a specific condition.

Objectives

Evaluate the **impact** of addition of **calcium-alginate capsules** containing the next-generation probiotic, ***Akkermansia muciniphila***, on the **metabolism** of both healthy and *Escherichia coli* O157:H7-infected **faecal** samples through quantification of **ammonia** and several **short-chain fatty acids** (SCFA).

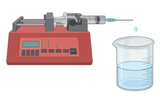
Methods

A. muciniphila loaded capsules production

Encapsulation procedure via extrusion

Strain: *Akkermansia muciniphila* DSM 22959

Matrix: Calcium-alginate hydrogel



Exposure to simulated gastrointestinal conditions

1. **Exposure to gastric and intestinal conditions**
2. **Lyophilization of the digestion products**

Faecal Fermentation

Experimental conditions:
- (A) control;
- (B) infection with *E. coli* O157:H7;
- (C) addition of encapsulated *A. muciniphila*;
- (D) treatment: infection with *E. coli* O157:H7 and addition of encapsulated *A. muciniphila*.

Total Ammonia Nitrogen and SCFA quantification

Total Ammonia Nitrogen: Using an ion-selective electrode 9663, at constant temperature (20 °C) and pH (6.7-6.9).

SCFA: An Agilent 1260 II series HPLC instrument with a refractive index detector and diode array detector at 220 nm, and an ion-exclusion Aminex HPX-87H column operated at 50ºC

Results

Total Ammonia Nitrogen concentration throughout 48-hour faecal fermentation

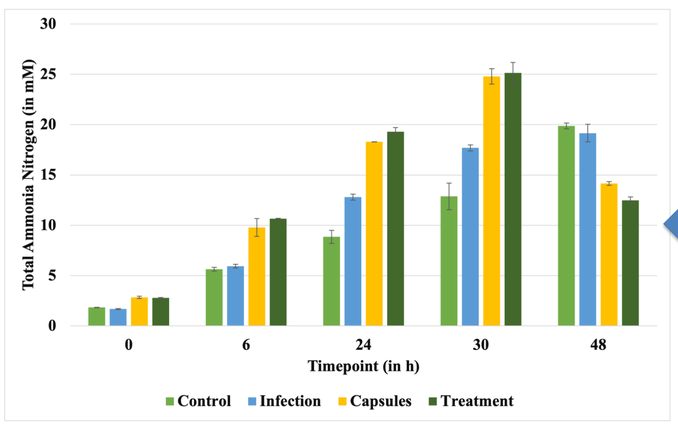


Figure 1. Evolution of Total Ammonia Nitrogen concentration (in mM) throughout the 48-hour faecal fermentation in conditions: control (■); infection with *E. coli* O157:H7 (■); capsules: addition of encapsulated *A. muciniphila* (■); and treatment: infection with *E. coli* O157:H7 and addition of encapsulated *A. muciniphila* (■).

1) Ammonia nitrogen increased in all conditions until 30h of faecal fermentation.
2) After 48h, conditions with encapsulated *A. muciniphila* showed around 50% **decrease in ammonia amount**. This event could be due to **nitrogen assimilation by *A. muciniphila*** or other species stimulated by it.

SCFA production throughout 48-hour faecal fermentation

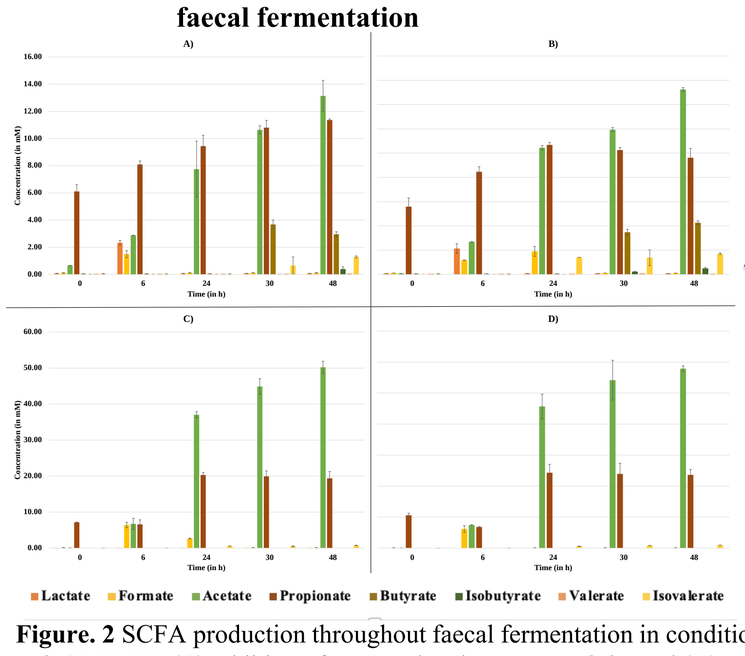


Figure. 2 SCFA production throughout faecal fermentation in conditions: (A) control; (B) infection with *E. coli* O157:H7; (C) addition of encapsulated *A. muciniphila*; and (D) treatment: infection with *E. coli* O157:H7 and addition of encapsulated *A. muciniphila*.

1) Lactate showed **undetectable** levels at **all timepoints** in conditions involving **encapsulated *A. muciniphila*** (C and D), suggesting a **beneficial shift** in **microbiota** profile.
2) In general, the amounts of acetate and propionate increased throughout 48h faecal fermentation in all conditions.

Conclusions

The addition of calcium-alginate **capsules** containing ***A. muciniphila*** resulted in **modulation** of **metabolic** profile of both **healthy** and ***E. coli* O157:H7-infected faecal** samples. This modulation was featured by a **decrease** in extracellular **ammonia**, and an **increase** in the **SCFA production**, especially **acetate** and **propionate**.

References

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Acknowledgements

This work was supported by the PROBIOCARE project (http://doi.org/10.54499/EXPL/BIA-MIC/0258/2021), financed by national funds through Foundation for Science and Technology, I.P. (FCT). We would like to thank the scientific collaboration of CBQF (UIDB/50016/2020) and the Scientific Employment Stimulus - Individual Call (https://doi.org/10.54499/CEECIND/00520/2017/CP1404/CT0001).