Dynamics of rumen microbiome and methane emission during in vitro rumen fermentation.

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Introduction

- The fermentation contributes around 75% of the energy to the ruminants(Danielsson et, al., 2017).

- ~18% of global anthropogenic CH_4 emissions are ruminant-related (Mizrahi et al., 2021).

- Three is a need to develop approaches and strategies to reduce enteric methane emission.

- In-vivo vs in-vitro (pro and cons).

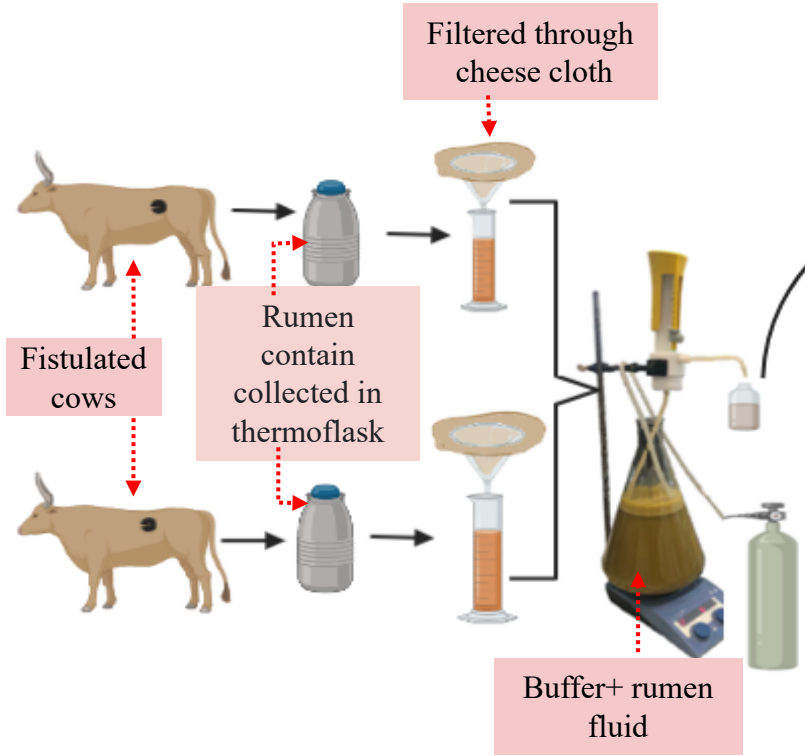
Knowledge gap

- In-vitro rumen fermentation is performed for 24-96, however earlier time intervals have not been investigated in previous trials.

Objectives

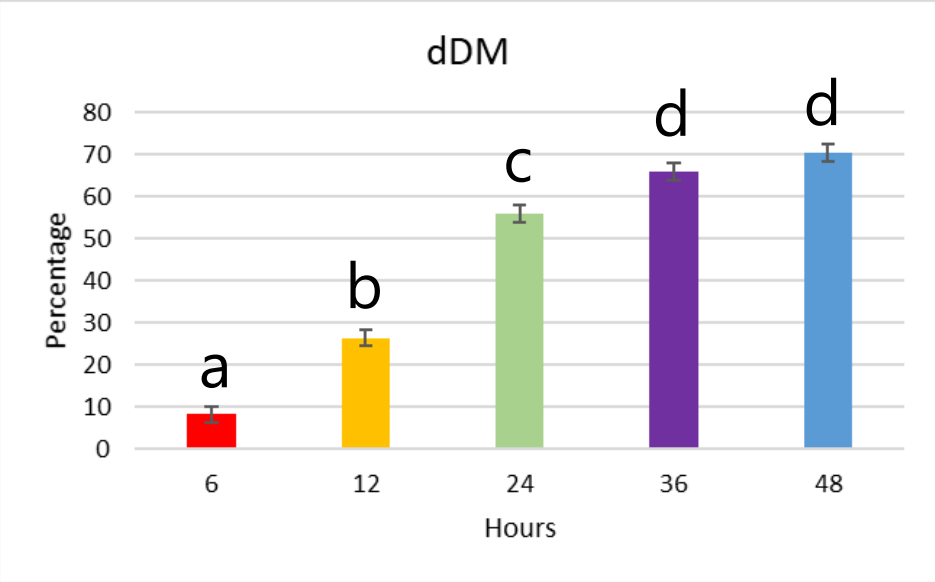
1) To quantify in-vitro rumen fermentation parameters (CH_4, VFA, dDM) from 6 to 48 h of incubation
2) To develop models to predict fermentation parameters over time.

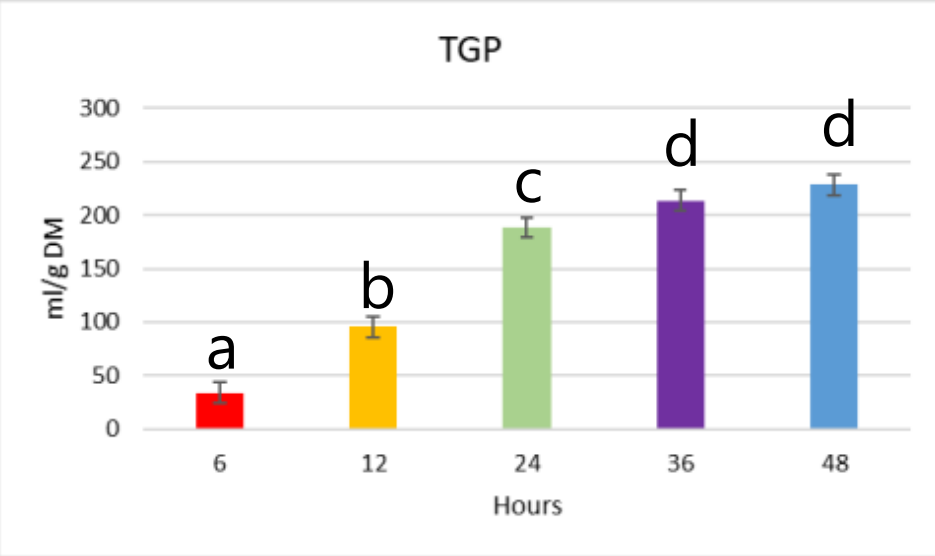
Methodology

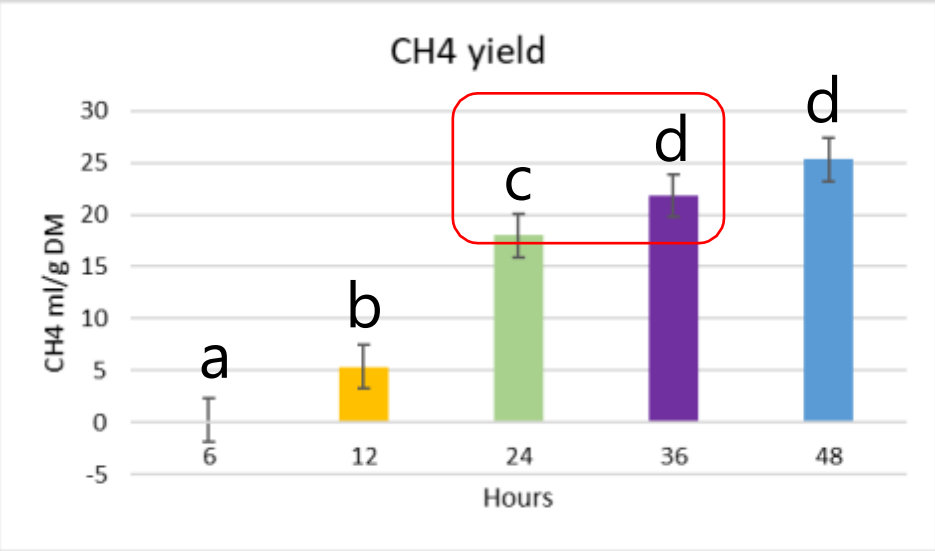


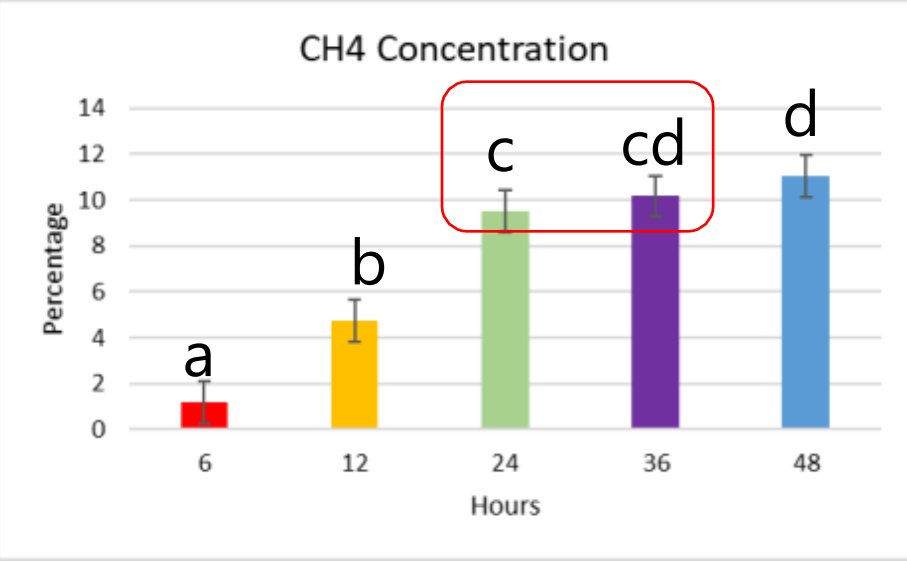
Results

Fermentation parameters



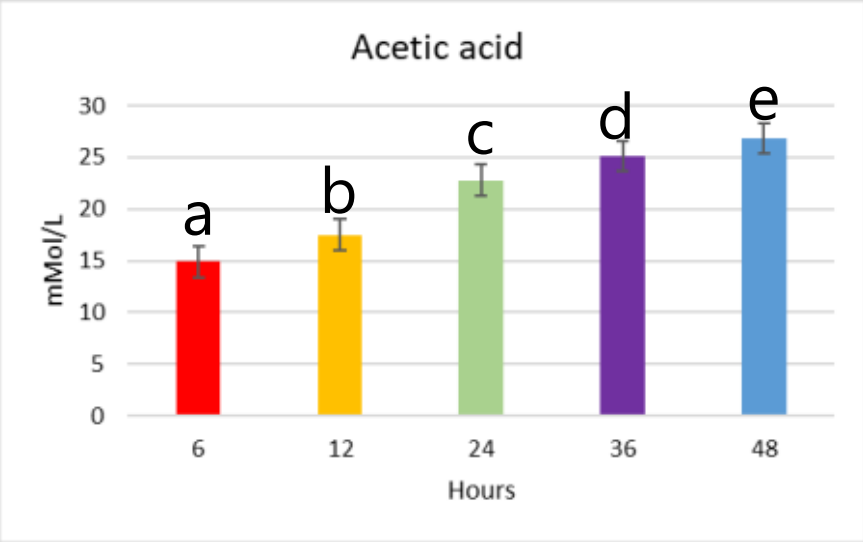


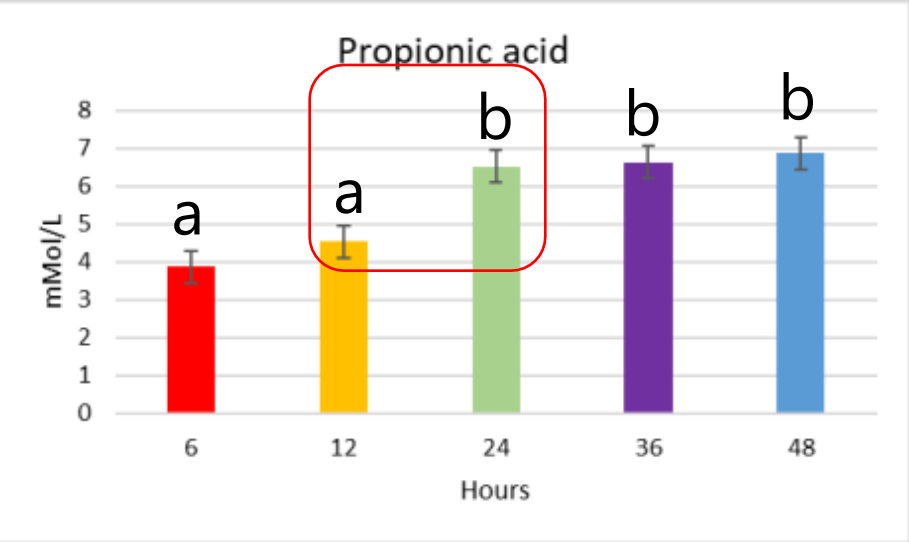


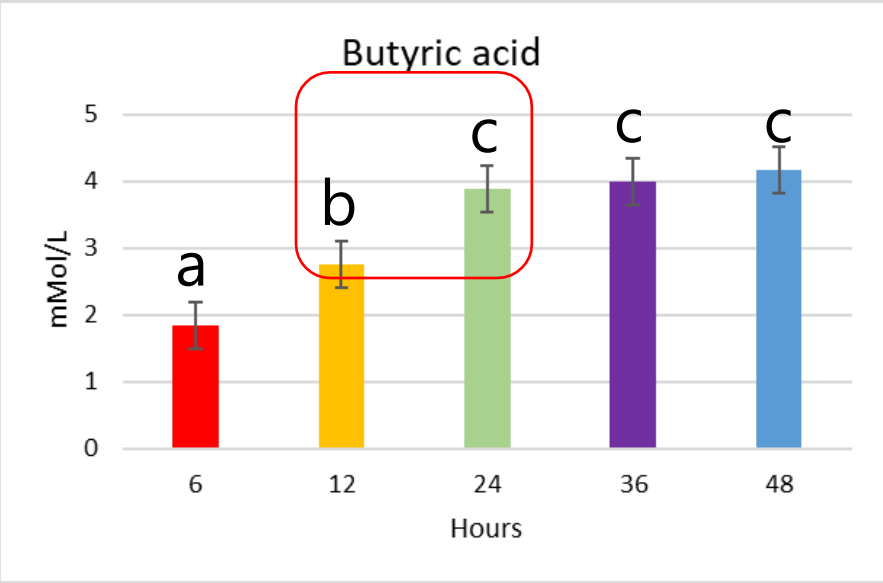


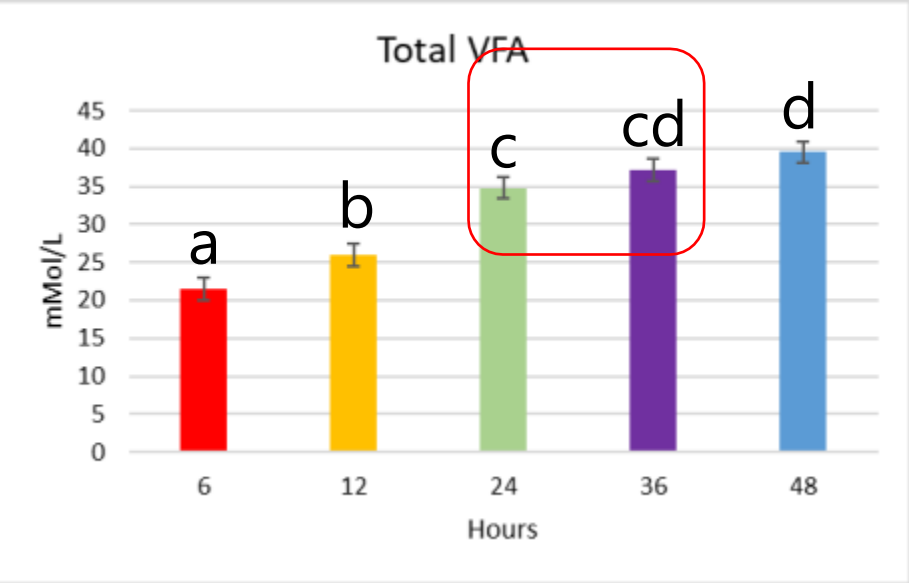
dDM: degraded dry matter, DM: Dry matter, TGP: Total gas production

VFA


Acetic acid
mMol/L
30
25
20
15
10
5
0
a
b
c
d
e
6
12
24
36
48
Hours


Propionic acid
mMol/L
8
7
6
5
4
3
2
1
0
a
a
b
b
b
6
12
24
36
48
Hours

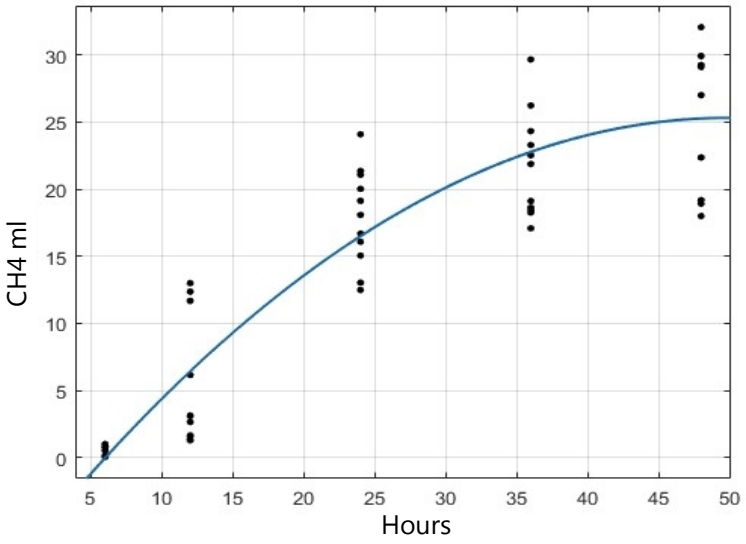

Butyric acid
mMol/L
5
4
3
2
1
0
a
b
c
c
c
6
12
24
36
48
Hours


Total VFA
mMol/L
45
40
35
30
25
20
15
10
5
0
a
b
c
cd
d
6
12
24
36
48
Hours

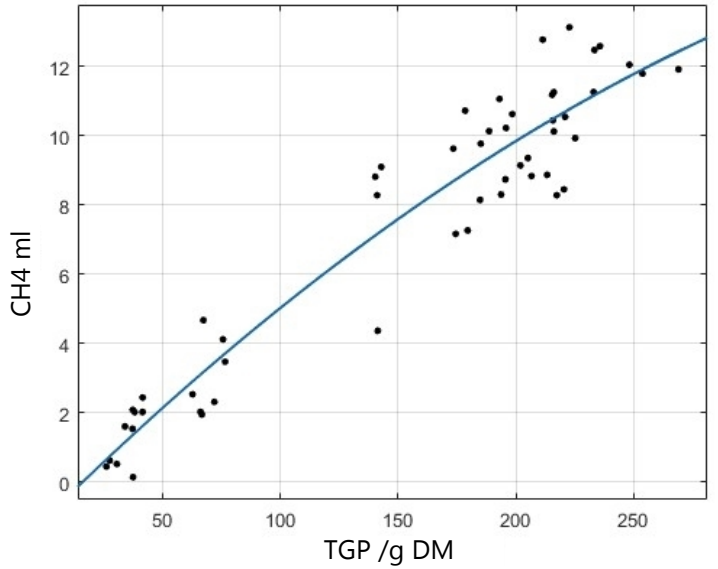
Predictive equations

X	Y	Equation	R-squared	RMSE
Hours	CH_4 ml	$Y = -0.0132x^2 + 1.31x - 7.412$	0.85	4.0615
Hours	CH_4 %	$Y = 0.0002x^3 - 0.0262x^2 + 1.0583x - 4.2813$	0.82	1.7642
TGP	CH_4 ml	$Y = -0.0001x^2 + 0.0673x - 1.0749$	0.91	1.231
dDM	CH_4 ml	$Y = -0.0028x^2 + 0.0907x - 0.0119$	0.87	0.0914
Hours	acetic acid	$Y = -0.0059x^2 + 0.6x + 11$	0.81	2.327
Hours	Propionic	$Y = -0.0027x^2 + 0.2149x + 2.59$	0.67	0.893
Hours	n-butyric	$Y = 0.0001x^3 - 0.0077x^2 + 0.2916x + 0.3249$	0.71	0.6196
Hours	tVFA	$Y = -0.0110x^2 + 1.0151x + 15.7164$	0.89	2.556

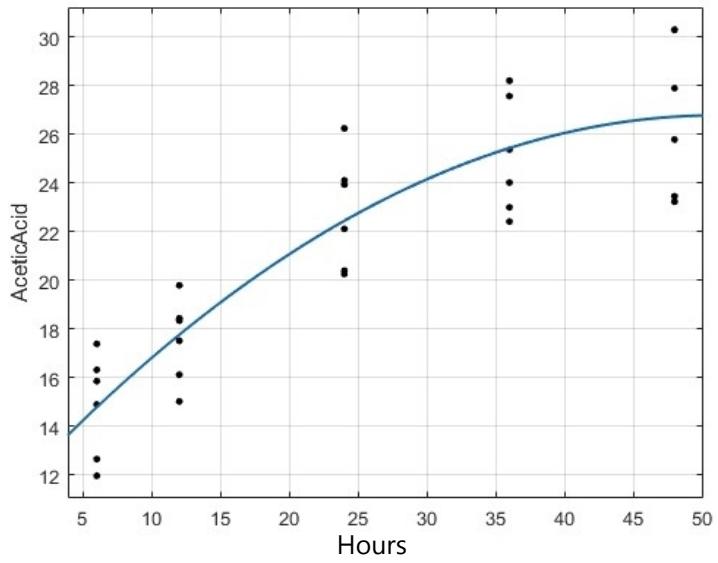
$Y = -0.0132x^2 + 1.31x - 7.412$, $R^2=0.85$



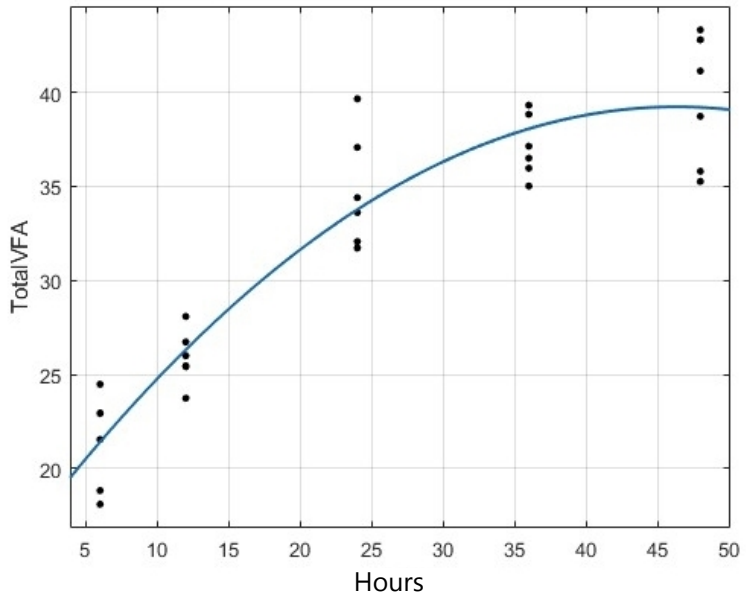
$Y = -0.0001*x^2 + 0.0673*x - 1.0749$, $R^2=0.91$



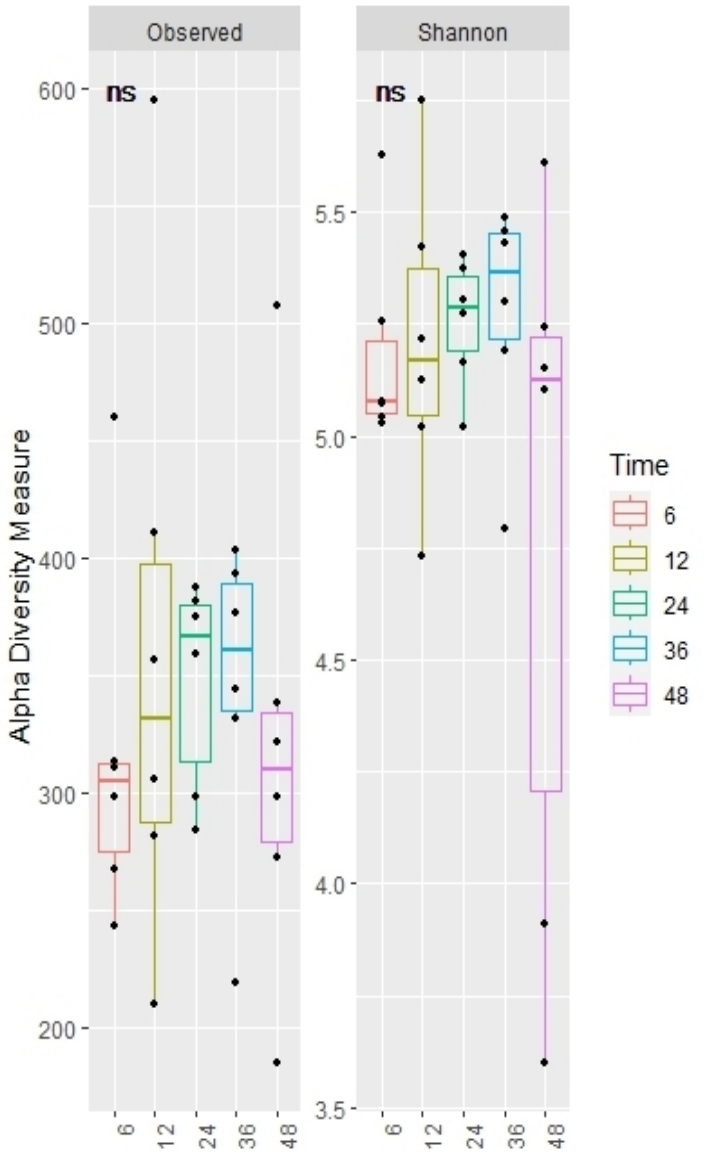
$Y = -0.0059*x^2 + 0.6*x + 11$, $R^2=0.81$

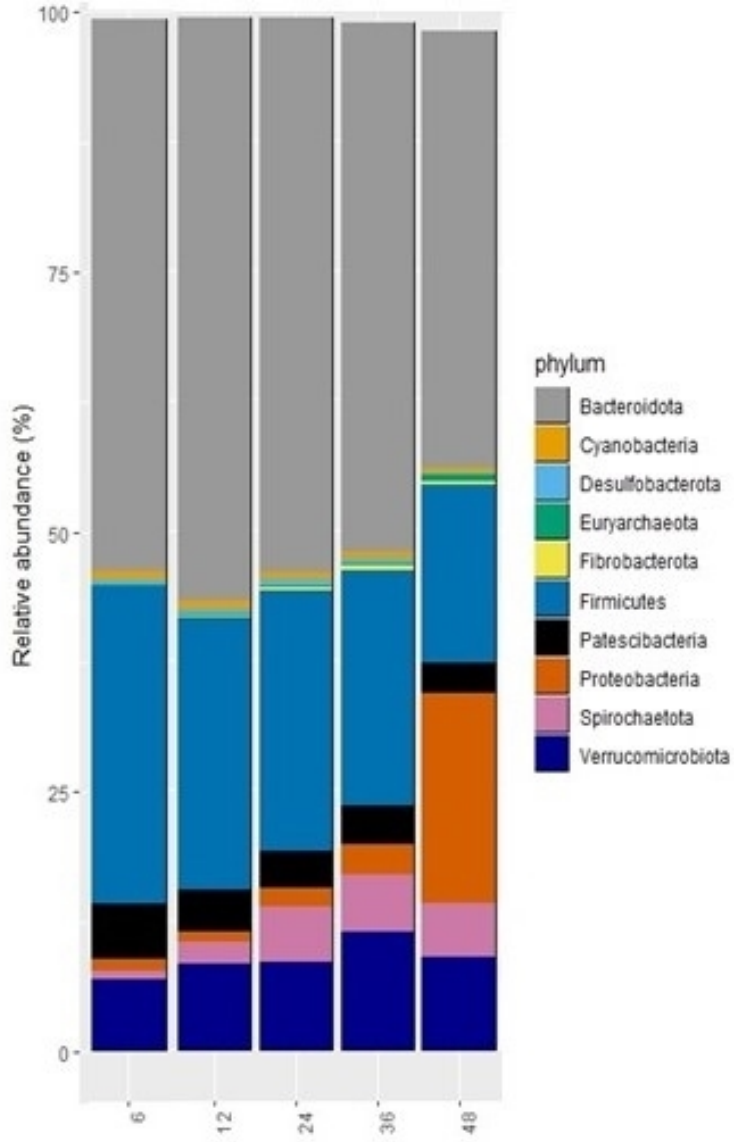


$Y = -0.0110*x^2 + 1.0151*x + 15.7164$, $R^2=0.89$

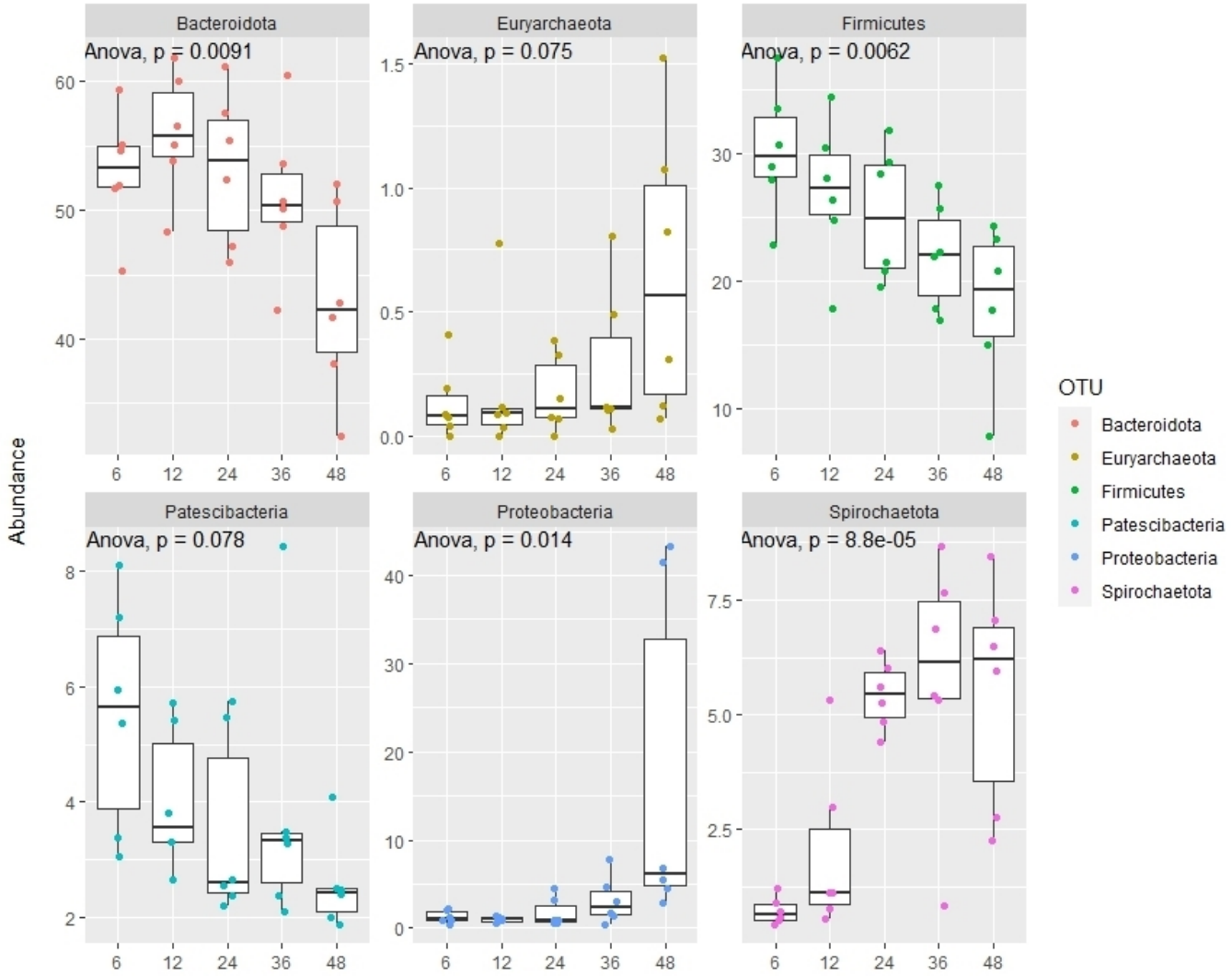


Microbiome overview





Differential abundance analyses



Take home message

- Sampling time points from 12 h to 24 h are crucial and must be considered.
- Alpha diversity of microbes remains similar; however, the relative abundance changes with the time.
- CH_4% and yield, volatile fatty acid can be predicted in temporal basis.

Future perspectives

- Need to test the models with diverse feed types.
- Need to validate models in-vivo.

Acknowledgements

- University of Copenhagen, Section of production nutrition and health - Funding PhD
- Aarhus University, Department of Environmental Science, Roskilde- Microbiome work
- Anni Christiansen and Lotte Ørbæk for theirs contributions during the experimental procedures

Thank you ☺