Feed additives to reduce methane-emissions from cattle

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Background

- Ruminants harbors abundant diversity of microbiome in rumen
- Ruminants get around 75% of the energy through anaerobic fermentation in the rumen
- The rumen fermentation produce several gases (CO_2, H_2, CH_4), volatile fatty acids (mainly acetate, propionate and butyrate) and microbial protein
- Due to its impact on the productivity of the animal and the emission of greenhouse gases (GHGs), the importance of rumen ecosystem has raised concern in recent years

- Targeting the methanogens.
- Shifting the fermentation to produce Propionate by shifting H_2.
- We are using feed additives to manipulate the rumen fermentation in order to get desire result

Direct-fed microbials and rumen methanogenesis

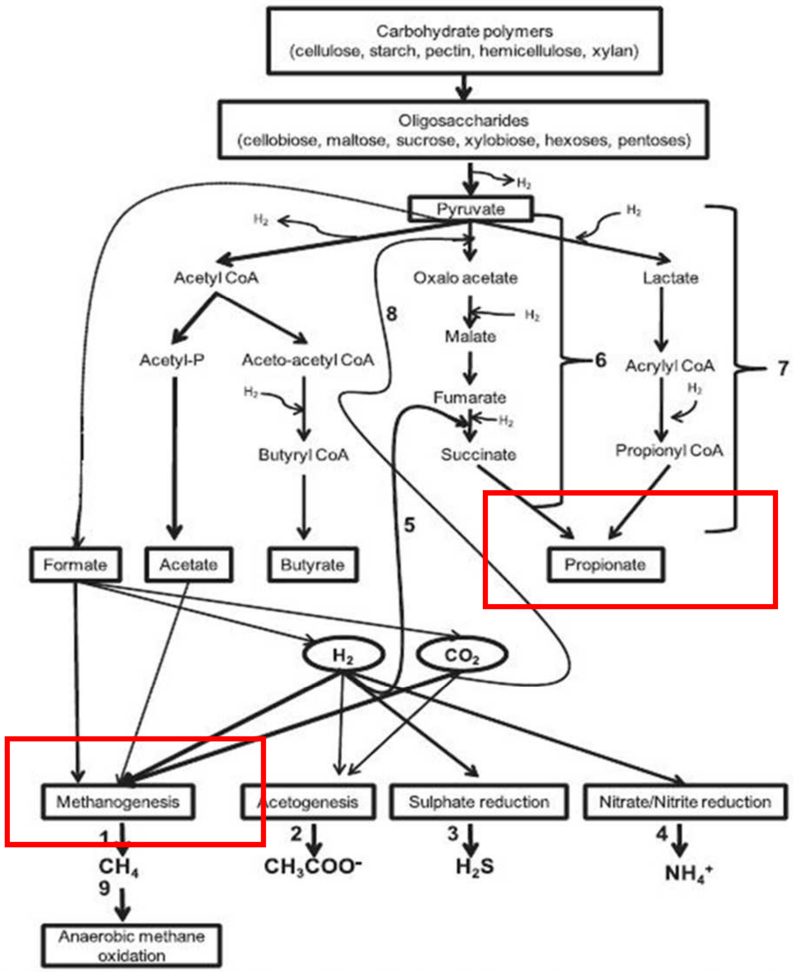


Figure 1 Rumen biochemical pathways that could be modulated by direct-fed microbials to decrease CH_4 production. 1. Methanogenesis, 2. homoacetogenesis, 3. sulphate reduction, 4. nitrate/nitrite reduction, 5. fumarate reduction, 6. propionate production (succinate/randomizing pathway), 7. propionate production (acrylate pathway) 8. capnophily (CO_2 fixation), 9. methane oxidation (methanotrophy).

Source: Jeyanathan, J., Martin, C., & Morgavi, D. (2014). The use of direct-fed microbials for mitigation of ruminant methane emissions: a review.

Objective

- To study the effect of fiber breaking enzyme on dry matter degradability, total gas production, VFA and Methane of Maize silage (MS)

Basal Feed: Maize Silage (MS)

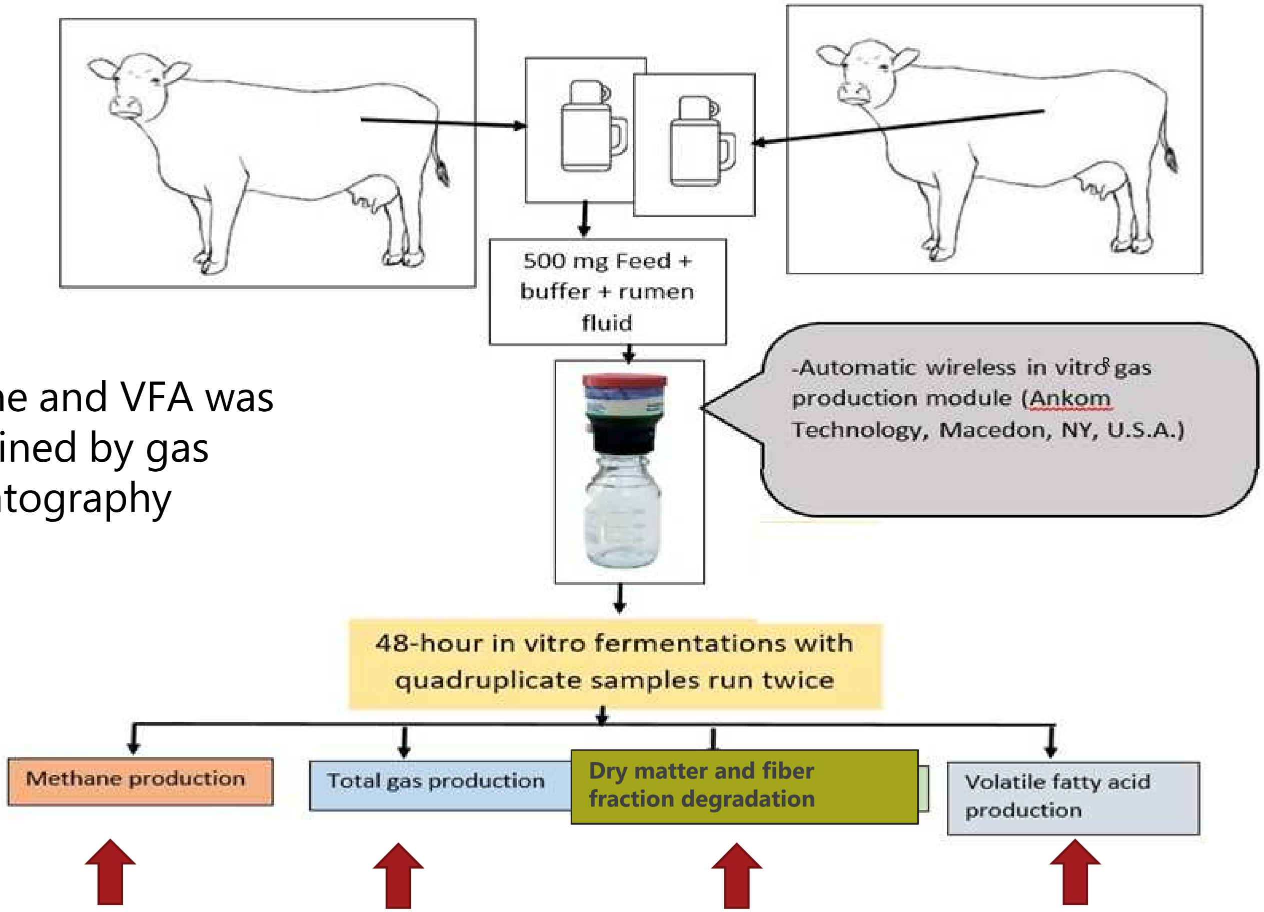
- Maize silage (MS)
- MS Incubated with Agent Y (A1)
- MS Incubated with Agent Z (A2)

Positive Controls'

- Maize silage + Additive 3 (A3)
- Maize silage + Additive 4 (A4)
- Maize silage +Additive 5 (A5)
- MS+ Additive 6 (A6)

Methods

Methane and VFA was determined by gas chromatography



Methods

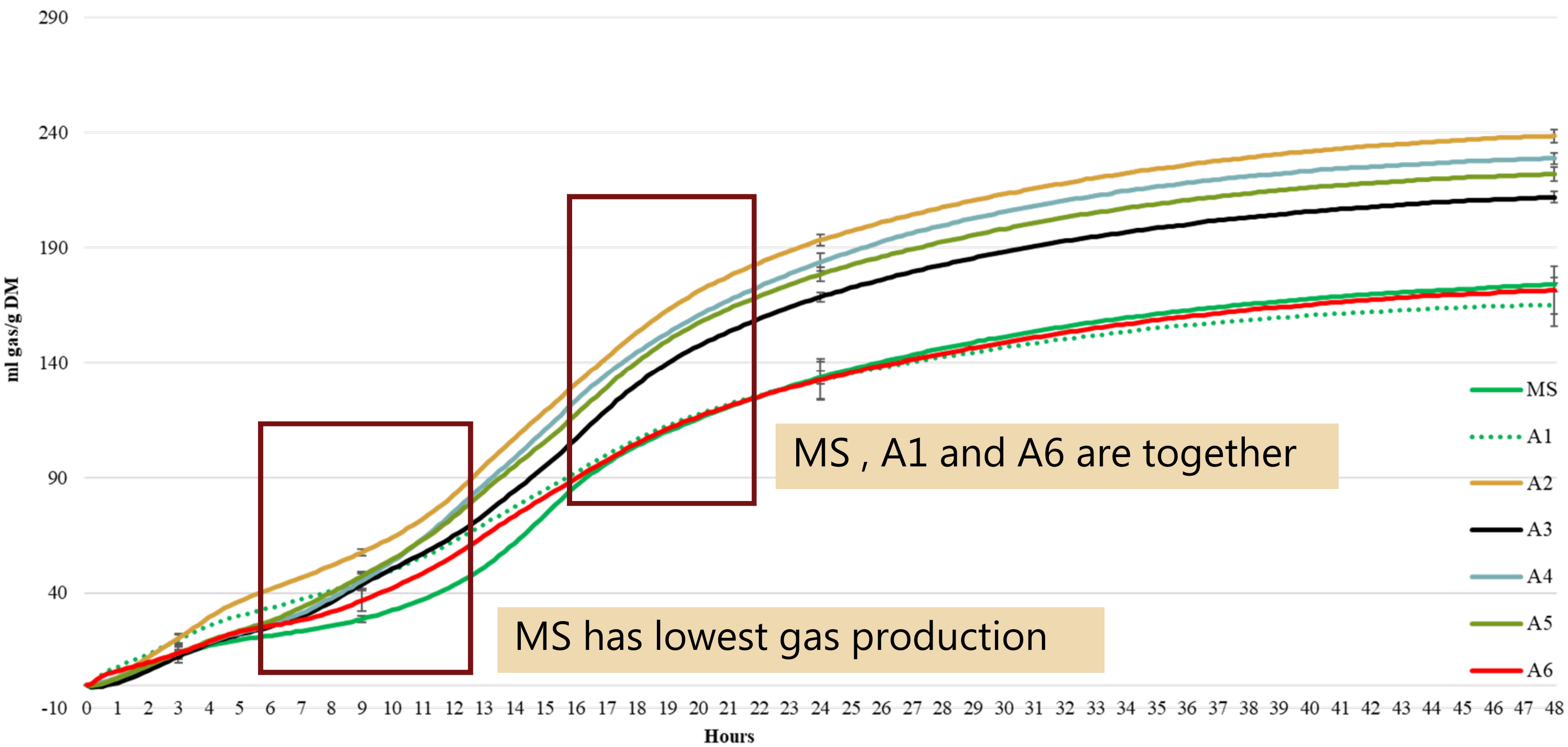
- Dry matter degradability (dDM), total gas production (TGP), methane, VFA and fiber composition was measured

- For all responses the following model was used to compare the means of the treatments.

  Y = Treatment + (random=Fermentation run) + Error

- Significance declared $p<0.05$

Gas production during 48 hours in-vitro rumen fermentation



Dry matter degradability (dDM), total gas production(TGP) and methane (CH4%) after 48 hours in-vitro rumen fermentation

	MS	A1	A2	A3	A4	A5	A6
dDM	76.13	76.58	75.64	75.82	74.93	75.49	76.46
TGP (ml/g DM at STP at 48 h)	173.9[a]	165.8[a]	238.5[c]	208.7[b]	228.2[bc]	221.9[bc]	170.6[a]
CH4%	10.0[ab]	7.8[a]	9.0[ab]	10.4[ab]	11.4[b]	10.8[ab]	9.1[ab]
CH4 ml/g DM	17.3[ab]	13.8[a]	21.0[bc]	21.4[bc]	26.5[c]	23.7[c]	16.2[ab]

VFA (mMol/L) production after 48 hours in-vitro rumen fermentation

mMol/L	MS	A1	A2	A3	A4	A5	A6
Total	69.7[a]	76.0[b]	78.0[b]	76.1[b]	76.1[b]	76.9[b]	75.0[b]
Acetic	46.1[a]	52.2[bc]	[illegible]	[illegible]	[illegible]	50.2[bc]	51.6[bc]
Propionic	13.2[a]	13.8[ab]	16.5[cd]	17.1[d]	14.3[b]	15.9[c]	13.3[ab]
Isobutyric	0.90	0.88	[illegible]	[illegible]	[illegible]	0.91	0.89
Butyric	7.0[ab]	6.7[a]	7.9[c]	6.8[a]	7.7[c]	7.3[b]	6.7[a]
Isovaleric	1.12[b]	1.06[a]	1.10[ab]	1.12[b]	1.13[b]	1.14[b]	1.08[ab]
Valeric	1.14[a]	1.13[a]	1.27[c]	1.19[b]	1.19[b]	1.2[b]	1.13[a]
Caproic	0.30[a]	0.28[a]	0.40[c]	0.29[b]	0.30[b]	0.30[b]	0.29[a]

major source of acetyl CoA for synthesis of lipids

Propionate serves as a major substrate for gluconeogenesis

Conclusion

- We have one product that reduces methane by 20% compared to MS
- All additives increased the efficiency of the feed increase (VFA (minimum 7%))

- Using the fibre breaking enzyme in in-vitro stage has promising result and has future for the field study and one additive can be recommended for in-vivo studies.