Effects of intact and extracted seaweed products on methane formation during rumen fermentation

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Publication date:
2018

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Introduction:

Methane (CH_4) emission from livestock contributes immensely to climate change accounting roughly 28% of global anthropogenic CH4 emission (Beauchemin et al. 2008). CH_4 is one of the potent greenhouse gases (GHG) with 25 times more global warming potential than carbon dioxide (CO_2) (Eckard et al. 2010; Jeyanathan et al., 2014; Bai et al., 2016). Enteric CH_4 production also results in significant energy loss to the animals which amounts to 2 to 12% of the gross energy intake (Martin et al. 2010; Benchaar and Greathead, 2011; Patra, 2012). Therefore, safe and effective enteric methane mitigation strategies has positive contribution to both the environment and animal productivity.

Hypothesis:

Seaweed products can reduce enteric methane emission from ruminant livestock.
Seaweed products do not affect rumen degradability of co-fermented basal feed.

Objectives:

To assess the effect of intact and purified seaweed extracts on enteric methane emission
To assess the effect of intact and purified seaweed extracts on total gas production.
To investigate the impact of intact and purified seaweed extracts on feed degradability during *in vitro* rumen fermentation.

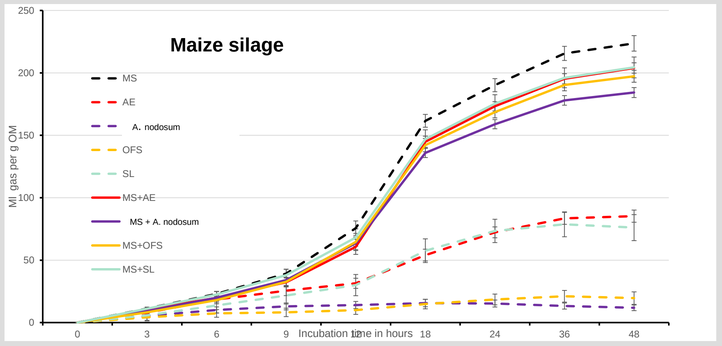
Conclusions:

- **AE, *A.nodosum,* OFS and SL reduced <u>both</u> total gas and methane production when fermented with SBP or MS -without negative effects on dry matter degradation.**
- **Alignate extract showed a tendency for reducing total gas and methane production while inceasing the dry matter degradability but fucoidan lacked both attributes.**

Materials and Methods

Intact, dried seaweed of the species *Alaria esculenta (AE), Ascophyllum nodosum (A. nodosum), Saccharina latissima (SL),* and a commercial seaweed mix (OceanFeed™ Swine, Ocean Harvest Technology, Milltown, Ireland) (OFS), and purified alginate (AL) and fucoidan (FU) extract were incubated alone (except for alginate and fucoidan extracts) or together with either sugar beet pulp or maize silage (basal feeds). The products and basal feeds were fermented anaerobically in buffered rumen fluid for 48 hours. The volume of gas produced was detected continuously by a pressure sensor system, total amount of produced gas was collected and then analyzed for content of CH4 by gas chromatography. Gas production is an indicator of microbial activity and therefore, digestion. Expected volumes for total gas and methane were calculated by adding the proportional gas produced per gram organic matter by the pure feeds or compounds in the mixes.

Results



Feed and additive		Observed	Predicted	Reduction (%)
Maize silage	AE	203.89	240.66	15.3
	A. nodosum	184.25	226.00	18.5
	OFS	197.24	227.54	13.3
	SL	204.38	238.83	14.4
Sugar Beet Pulp	OFS	216.02	248.38	13.0
	SL	237.00	259.68	8.7
	A. nodosum	194.53	246.84	21.2

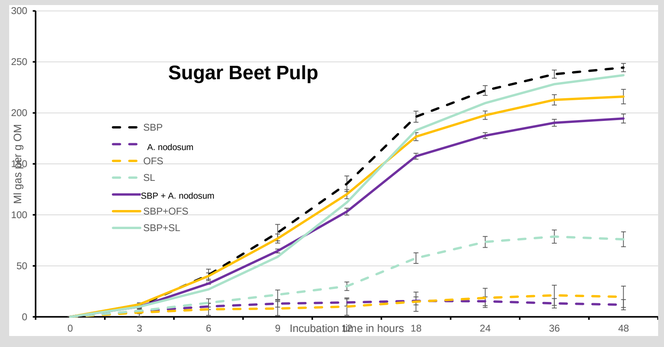


Figure 1. Effects of intact seaweed on total gas produced per gram organic matter when fermented with maize silage (MS) or sugar beet pulp (SBP) during 48 hours of incubation. (Dashed lines represent pure compounds or feeds; solid lines represent mixes)

Intact seaweeds fermented with SBP or MS

- Figure 1. shows the effects of intact seaweeds on the total gas produced when fermented with MS or SBP during 48 hours incubation.
- MS and SBP produced large amount of gas but the pure seaweeds produced only small amount (OFS and *A. nodossum* produced a negligible amount of gas while AE and SL showed moderate gas production.
- Fermentation of seaweeds with either MS or SBP reduced total gas produced (Table 1) with *A. nodossum* exerting more significant inhibition.
- Endpoint methane production was also inhibited by intact seaweed fermentation with MS or SBP with maximum inhibition being observed with *A.nodossum* (21%).
- AE significantly increased dry matter degradation when incubated with MS but did not affect dry matter degradation when incubated with SBP. All other intact seaweeed did not affect dry matter degradability when fermented with both SBP and MS.

Purified seaweed extracts (alginates and fucoidan) fermented with MS

- Total gas and methane production had a tendency to decrease while with increasing doses of alginate were feremented with MS
- Dry matter degradability had a tendency to increase when inceasing doses of alginate was fermented with MS
- Fucoidan extract did affect either total gas or methane production or dry matter degradation, This indicates that alginate may have antimethanogenic activity but not fucoidan.

Table 2. Observed and expected methane production (ml gas at STP) per gram organic matter in the sample

Feed and additive		Observed	Expected	Reduction (%)
Maize silage	AE	25.09	30.89	18.8
	A. nodosum	22.15	27.95	20.8
	OFS	22.41	27.95	19.8
	SL	23.22	28.94	19.8
Sugar Beet Pulp	OFS	25.54	27.20	6.1
	SL	25.15	28.19	10.8

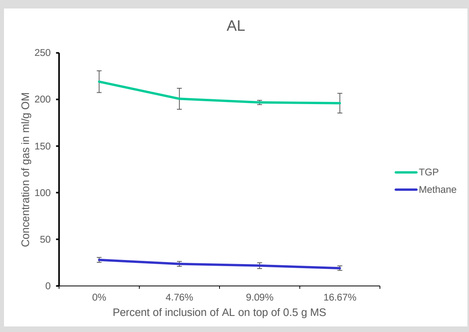


Figure 4. Effects of Alginate on total gas and methane production when fermented with maize silage in increasing doses during the 48 hours incubation.

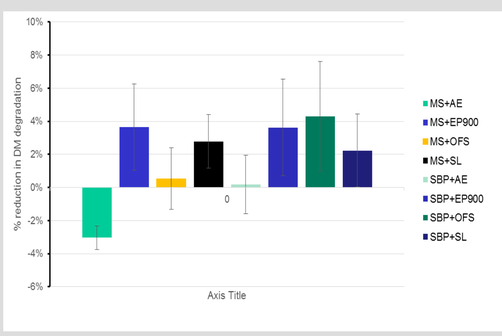


Figure 5. Dry matter degradation changes

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