Total Solid Levels of Dairy Slurries can Affect Cumulative CH_4 Flux and Abundance of Methanogenic Archaeal Communities

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Introduction

- Livestock-related activities are major contributors of agricultural greenhouse gas (CH_4, N_2O) emissions[1]
- Stored liquid dairy manures are methane (CH_4) emission hotspots [2]

- Many strategies have been proposed to reduce emissions from these sources[1,2], including reduction of total solids (TS) prior to storage.[2]
- Reducing TS levels of stored dairy slurries could limit available substrates to methanogens, thereby reducing CH_4 flux

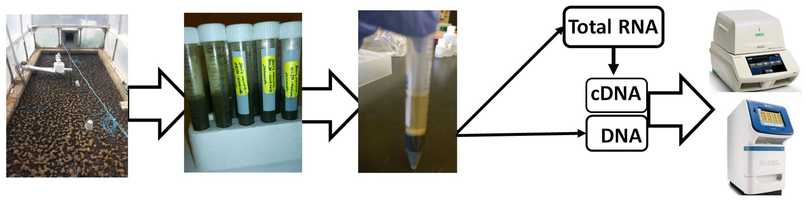
Objectives

- To link shifts in methanogen abundance and diversity to CH_4 emissions from stored dairy manures containing different levels of total solids

Methods

A pilot-scale slurry storage facility (DU, Truro, NS)

- Fresh dairy slurry (9.5-0.3%TS) stored for ~180d
- CH_4 flux monitored continuously
- Slurry samples on d30 and d120 (Top & Bottom)



- The gene encoding the α-subunit of methyl coenzyme M reductase A (*mcrA*) was targeted to study methanogens

Results

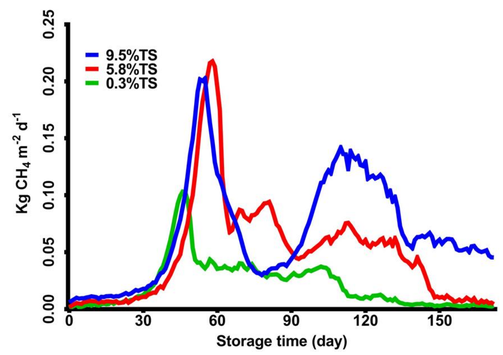


Fig 1. Daily CH_4 flux from stored dairy slurries having different TS levels (01 May 2010-16 Nov 2010)

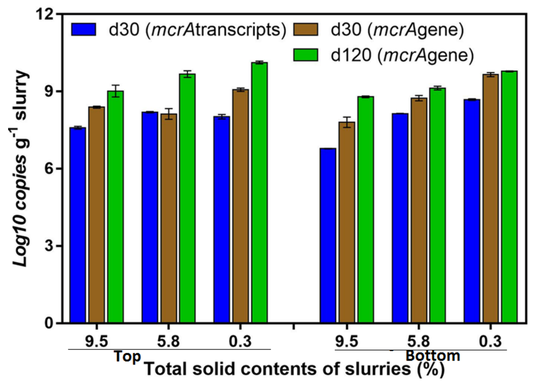


Fig 2. Impact of total solid content on the abundance and activity of methanogens in the top and bottom of tanks containing stored dairy slurries. Samples taken after 30 and 120 days of storage.

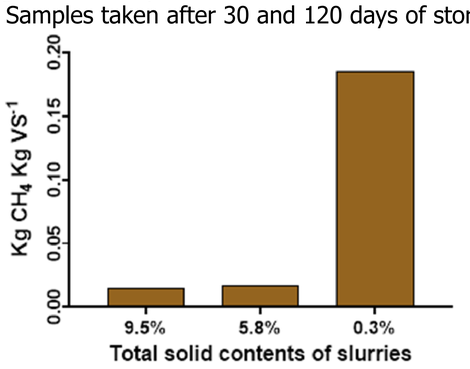


Fig 3. Calculated conversion rates of volatile solids (VS) to methane from stored dairy slurries having different TS contents.

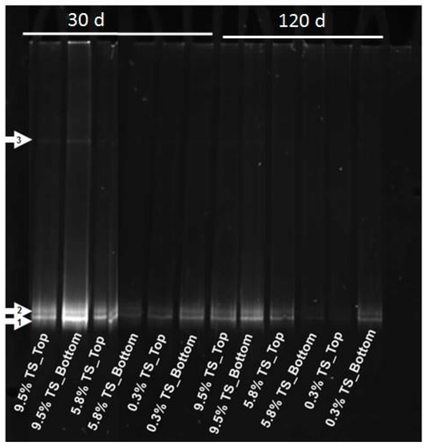


Fig 4. PCR-DGGE fingerprints of methanogens in stored dairy slurries of varying TS contents.

Discussion

- A 30 day lag phase prior to the start CH_4 flux may suggest that shorter storage times are a potential GHG mitigation strategy (Fig 1).
- Lower CH_4 flux rates (Fig 1) in dairy slurries with lower TS.
- The relatively higher abundance and activity of methanogens in tanks with low %TS (Fig. 2), coincided with higher volatile solid (VS):CH_4 conversion rates (Fig 3). Suggesting that possible reduction of inhibitory by-products, favours the functioning of methanogens[3]; and CH_4 emissions are limited by substrate limitation in these tanks.
- Despite the low diversity of methanogens in the slurries (Fig. 4), *Methanocorpusculum*-related phylotypes predominated. Previous studies have also shown that hydrogenotrophic methanogens can be detected in stored dairy manures.[5]

Conclusions

- Abundance and activity of methanogenic communities appears to be higher in lower TS slurries, consistent with the higher VS to CH_4 conversion rates
- Cumulative CH_4 flux was limited by the available TS, hence, the available carbon substrate and not methanogen population may be limiting CH_4 emissions in stored dairy slurries.

Acknowledgements

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