Inhibition of methane and nitrous oxide emissions associated with microbial changes in *in vitro* dairy manure by tannins

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Introduction

1.There is little information on the occurrence of methane (CH_4) and nitrous oxide (N_2O) emissions from dairy manure associated with addition of condensed (CT) and hydrolysable tannins (HT).

2. The livestock industries contribute about 18% of total global anthropogenic greenhouse gas (GHG) emissions (Steinfeld et al., 2006), including CH_4 and N_2O either directly (e.g. from enteric fermentation and manure) or indirectly (e.g. from feed production activities).

3. Emissions of CH_4 and N_2O create environmental concern due to global warming potentials that are 25 and 298 (both based on a 100-year projection) times that of CO_2, respectively (IPCC, 2007).

4. This study assessed the associative effects of three different levels [0, 4 and 8% wet weight (WW) basis] of CT (quebracho tannins) and HT (chestnut tannins) on CH_4 and N_2O emissions from manure.

Methods

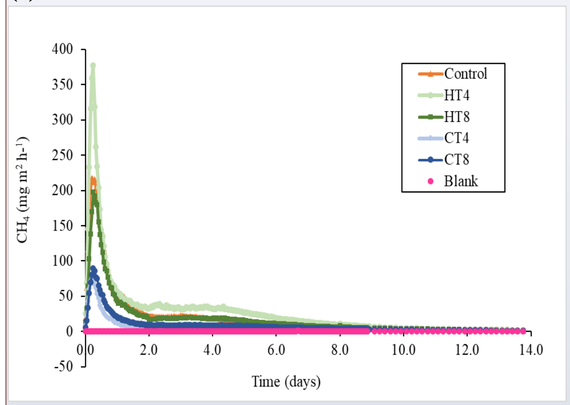
* The experiment was designed in a 2 x 3 factorial with triplicate replication. Two different sources of tannins (CT vs. HT) and three different levels of tannins (0, 4, and 8% w/w basis) at 62% final manure moisture levels were the factorial treatments.

* The dairy manure consisted of a 50:50 (vol:vol) mixture of fresh feces and dry manure scraped from the surface of an open-lot dairy in the Texas Panhandle. Control (0% tannin), 4%, and 8% of CT or HT (w/w) were added to containers and homogenized with a hand mixer for 5 min. Aliquots of 220 g (WW) manure, with or without tannins, were placed into 1 L fermentation bottles (n=3, total of 18 bottles) and incubated at 39°C for 14 days.

A second set of 18 fermenters were set up in the same manner for sample collection at 0, 2, 3, 6, and 9 h to discern changes in pH and redox status.

Results

(a)



(b)

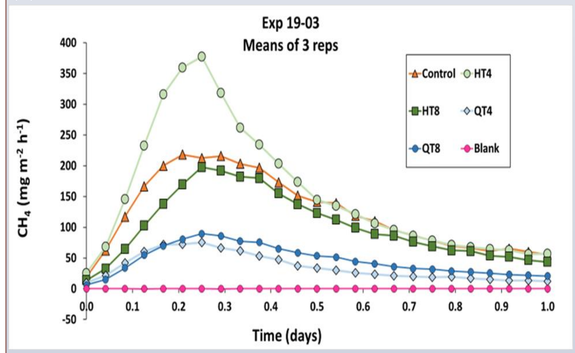


Fig. 1. Methane (CH_4) emissions during *in vitro* incubation with dairy manure for 14 days (a) and (b) 24 h composting period. CT = quebracho condensed tannins (CT), HT = chestnut hydrolysable tannins (HT).

Results

- There were no differences in redox values with the addition of either tannin type (CT vs. HT) to *in vitro* fermenters containing dairy manure. However, addition of CT reduced (P<0.05-0.01) cumulative CH_4 emissions by 68 to 63% at concentrations of 4 and 8% WW, respectively, compared with the non-tannin control group (Fig. 1a, b).

- Addition of HT caused transient increases in CH_4 production at low application levels (4% w/w), while no stimulation was observed when HT was over 8% WW (Fig. 1b). This enhancement of CH_4 production at low HT levels may be caused by structural changes in substrates for microbial metabolism (carbohydrate and protein) due to interactions with HT components.

- Both CT and HT decreased cumulative N_2O emissions (P<0.02; Fig. 2). Examination of the emission kinetics revealed a tradeoff (interchange or pollution swapping) between CH_4 and N_2O emissions when tannins were applied to manure.

- These results suggest that inclusion of 4% CT (WW) is a promising technique for reducing CH_4 and N_2O emissions from excreted dairy manure.

- Further study is warranted to investigate the effects of feeding CT and HT on manure-derived GHG in dairy systems.

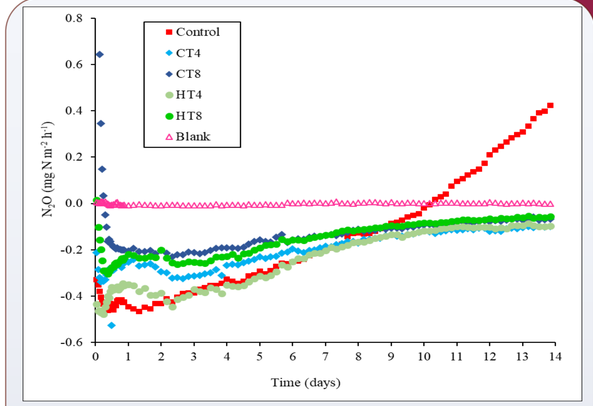


Fig. 2. Cumulative nitrous oxide (N_2O) emissions during *in vitro* dairy manure incubation for 14 days. CT=quebracho condensed tannins, HT=chestnut hydrolysable tannins.

Conclusions

Based on these results, tannins appear to be a promising strategy to reduce GHG emissions from dairy manure, particularly under semi-anaerobic conditions. In contrast to chestnut HT, quebracho CT effectively reduced CH_4 emissions, reflecting a potential decline in methanogens and fermentation activity.

These results suggest that inclusion of CT at 4% is a promising technique for reducing CH_4 emissions from dairy manure.

References

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