Association of nitrate and linseed oil effectively reduces methane emission in ruminants

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Association of Nitrate and Linseed Oil Effectively Reduces Methane Emission in Ruminants

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Using linseed oil or nitrate in diets are long-term viable strategies for mitigating enteric methane (CH_4) emission from ruminants (Hristov *et al* 2013). These additives individually reduce methanogenesis by affecting the rumen hydrogen (H_2) pool: linseed oil reduces H_2 production through its toxic effect against rumen protozoa (Doreau and Ferlay 1995) and nitrate acts as a H_2 sink through its reduction into nitrite then ammonia (Van Zijderveld *et al* 2010). As the mechanisms of action of these additives in the rumen are different, we hypothesized that their combination would lead to lower CH_4 emissions than when they are fed individually.

Four multiparous dry Holstein cows fitted with rumen cannulas were randomly assigned to 4 dietary treatments in a 4 x 4 Latin square design. Each experimental period lasted 5 weeks with measures performed in the last 2 weeks (wk1 and wk2). Diets were on a dry matter (DM) basis: 1) control diet (CON, 50% natural grassland hay and 50% concentrate), 2) control diet with 4% linseed oil (LIN), 3) control diet with 3% calcium nitrate (NIT), and 4) control diet with 4% linseed oil and 3% calcium nitrate (LIN+NIT). Diets were offered twice daily and formulated to have similar amounts of crude protein (12.2%), starch (25.5%) and neutral detergent fiber (NDF, 39.5%). Feed availability was restricted to 90% of voluntary intake (average 9.2 kg DM/day). Total tract digestibility of organic matter (OM) and NDF was determined from total feces collection for 6 days in wk1. Daily CH_4 emissions were determined in kinetics using open chambers for 4 days in wk2. Methane was expressed as a function of gross energy (GE) intake, DM intake and digested OM. Data were analyzed using the MIXED procedure of SAS (SAS, 2009) with a model including period and diet as fixed effects, and cow as random effect.

Table 1. Digestibility and CH_4 emission of dry cows fed linseed oil and/or nitrate

	Diet					
	CON	LIN	NIT	LIN+NIT	s.e.	P Value
CH_4 (% of GE intake)	7.2[a]	5.6[b]	5.8[b]	4.8[c]	0.20	<0.001
CH_4 (g/kg DM intake)	25.0[a]	20.7[b]	19.4[b]	17.0[c]	0.70	<0.001
CH_4 (g/kg digested OM)	46.2[a]	37.6[b]	35.1[bc]	31.4[c]	1.31	<0.001
OM digestibility (%)	66.6	66.9	67.2	66.4	1.19	0.891
NDF digestibility (%)	42.6	42.2	43.2	38.1	2.67	0.109

[a,b] Within a row, means without a common superscript differ (P<0.05).

Linseed oil and nitrate fed individually decreased CH_4 emissions by 17 and 22%, respectively (Table 1). These results are in accordance with previous data (Van Zijderveld *et al* 2010; Grainger and Beauchemin 2011). The association of these two additives induced the lowest CH_4 emissions (-32%), which can be explained by their different mechanisms of action throughout the day. Indeed, daily pattern of CH_4 emissions showed that LIN decreased emissions throughout the day, NIT strongly reduced production during the 3 hours postfeeding and LIN+NIT combined the two effects (data not shown). For the first time, we demonstrated the partial additivity of nitrate and linseed oil on methanogenesis in ruminants, without altering diet digestibility.

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