The Effects of the Interaction between Nitrate and Protozoa on Methane Production in Continuous Culture Fermenters

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Methane (CH_4) is a greenhouse gas produced by ruminants, including dairy cattle, primarily as a byproduct of neutral detergent fiber (NDF) degradation. Hydrogen (H_2) is produced by rumen microbes fermentatng glucose to volatile fatty acids (VFAs), especially acetate. Methanogens then produce CH_4 from CO_2 and H_2 (aqueous phase (aq)). Nitrate serves as an alternative sink for H_2(aq), producing ammonium and thereby decreasing CH_4 production. Some previous studies suggest removal of protozoa from the rumen (defaunation) may decrease CH_4 production. In this trial, a 2x2 factorial treatment arrangement in a 4x4 Latin square design was used in continuous culture fermenters (n=4). Treatments were control (CON; faunated, no nitrate), nitrate (NO_3; faunated, NO_3 at 1.5% of diet (DM basis)), defaunated factorialized without (DEF) and with NO_3 (D+N). Fermenters were fed once daily (40 g DM; a 50:50 concentrate:forage diet). Periods lasted 12 d, with 3 d of sample collection. Buffer dilution and solids passage rate were maintained at 7.0 and 5.0%/hr, respectively. Defaunation was achieved by lowering temperature to 34°C, increasing rotor speed to 100 rpm, and using a wire mesh filter for a 4-d duration before returning back to 39°C and 50 rpm. There were no main effects of DEF or NO_3 ($P>0.05$). The main effect of NO_3 increased ($P<0.05$) H_2(aq) compared with CON by 11.0 µM H_2(aq). The main effect of NO_3 also decreased ($P<0.05$) daily CH_4 production compared with CON by 8.17 mol CH_4/d. Because there were no treatment effects on NDF digestibility ($P>0.05$), the main effect of NO_3 also decreased ($P<0.05$) CH_4 production compared with CON by 1.43 mol CH_4/g NDF degraded. Results document that methanogens persist without protozoa, and nitrate has the potential to decrease methane emissions from dairy production. However, further factors such as nitrite toxicity and VFA stoichiometry should be considered before implementing nitrate feeding.