Effect of level of dietary soy oil supplementation and concentrate to forage ratio on feed intake, methane production and rumen fermentation variables of beef steers

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Introduction Agriculture currently accounts for 12% of total global green house gas (GHG) emissions with enteric fermentation being the largest biogenic source of agricultural methane (CH_4) and accounting for almost 13% of total Irish GHG emissions (McGettigan *et al*., 2008). Ruminal methanogenesis represents a loss to the animal of up to 8.5% of gross energy intake (GEI) (Tamminga *et al.,* 2007) therefore a reduction in enteric CH_4 production should reduce this inefficiency as well as the environmental impact of ruminant production. Soy oil (SO) is a natural source of unsaturated long chain fatty acids and it has been shown previously that dietary SO supplementation can substantially reduce ruminal methanogenesis of beef cattle on a high concentrate diet (Jordan *et al.* 2006). However little is known on how this effect is mediated or whether it is consistent across lower concentrate to forage ratio (C:F) diets. The aim of this study, therefore, was to investigate the effect of dietary SO inclusion and C:F ratio on feed intake, CH_4 emissions, rumen fermentation variables and rumen microbial measurements in beef cattle.

Materials and methods Eight mature Limousin X steers with a mean body weight (BW) (± S.E.) of 521 (± 11.7) kg and 4 ruminally cannulated Limousin X steers with a mean BW (± S.E.) of 484 (± 26.4) kg were allocated at random to a 2 x 2 factorial, latin square design with four, 28 d periods. Animals were allocated within period to one of two levels of dietary C:F ratio (50:50 v 90:10; barley straw as the forage source) and one of two levels of dietary SO inclusion (0 v 60 g/kg dry matter (DM)). Diets were offered at 95% of voluntary DMI and formulated to be isonitrogenous (140 g/kg DM). Feed intake was measured daily, with CH_4 determined using the sulphur hexafluoride tracer (SF_6) gas technique on d 21 - 25 of each period on the 8 non-cannulated steers. Rumen fluid was sampled from the ruminally cannulated steers on d 27 and 28 for analysis of ruminal VFA, ammonia and microbial profile. The mcrA gene and 16S rRNA gene were quantified using specific genomic primers and real-time quantitative polymerase chain reaction (PCR) for both liquid and solid phases of rumen digesta. Data were analysed using the MIXED procedure (PROC MIXED) of SAS.

Results The effect of C:F ratio and SO supplementation on CH_4 emissions is presented in Figure 1. There were no oil x C:F interactions detected ($P > 0.05$). Inclusion of SO reduced ($P < 0.001$) daily CH_4 by 51%, intake corrected CH_4 by 45% and GE intake corrected CH_4 by 51%. At the higher C:F ratio, dry matter intake (DMI) corrected CH_4 was reduced ($P = 0.006$) by 27%, CH_4 corrected for GE intake was reduced ($P = 0.003$) by 32% and there was also a trend ($P = 0.07$) towards decreased overall daily CH_4. Dry matter intake was greatest ($P < 0.001$) at the higher C:F ratio but was reduced by 7.5% following SO inclusion ($P = 0.02$). Apparent whole-tract digestibilities of DM ($P = 0.04$), OM ($P = 0.03$) and GE ($P = 0.008$) were reduced after SO inclusion, with the higher C:F ratio increasing DM ($P = 0.02$), OM ($P = 0.03$) and GE ($P = 0.04$) digestibility. Treatment had no effect on total ruminal concentrations of VFA. However, acetate to propionate ratio was decreased ($P < 0.001$) by the higher C:F ratio and by SO inclusion. Ammonia was lower at both the higher C:F ratio ($P < 0.001$) and following SO inclusion ($P = 0.002$). There was a tendency towards a reduction ($P = 0.0539$) in the relative abundance of the mcrA gene in digesta of animals fed SO in the ruminal liquid phase.

Conclusion This study demonstrated that the addition of SO, at 60 g/kg DM, to the diet of beef steers dramatically reduces daily and GEI adjusted CH_4 by over 50% and DMI corrected CH_4 by 45%. Increased C:F ratio also reduced CH_4 when corrected for DMI and GEI (by 26 and 32% respectively) and it tended to reduce daily CH_4 emissions whilst increasing DMI. This suggests that if both strategies were utilised with finishing cattle the potential exists to significantly reduce the total lifetime emissions from beef cattle.

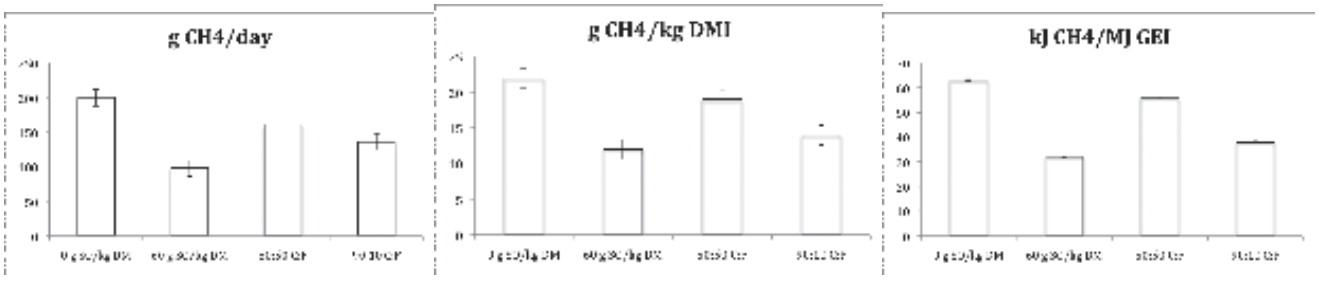

Figure 1 Effect of dietary SO supplementation and C:F ratio on daily ruminal CH_4 emissions expressed on a daily, per kg of DMI and per MJ GEI basis

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