Validation of the sulphur hexafluoride tracer technique for estimating methane emissions from dairy cows using respiration chambers: preliminary data

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Introduction Accurate methane (CH_4) emissions have traditionally been measured using indirect calorimeters. However, respiration chambers restrict the number of cows that can be evaluated simultaneously and their results might not be extrapolated to grazing animals. A technique that makes use of an inert tracer gas (sulphur hexafluoride, SF_6) has been developed for determining CH_4 emissions under production conditions (Johnson *et al*., 2004). This technique, accounts only for CH_4 exiting through the mouth and nostrils. The objective of this study was to validate the SF_6 tracer technique for measuring CH_4 emissions from dairy cows using respiration chambers and to determine the proportion of CH_4 that is excreted through the mouth and nostrils compared to that excreted by the rectum.

Material and methods Twenty dairy cows of 3 breeds (4 Norwegians (N), 4 N X Holstein-Friesian (HF) and 12 HF) were used in this study: 4 primiparous and 16 multiparous cows with a mean body weight (± SD) at the start of the study of 515 ± 17 and 642 ± 79 kg, respectively. This cross-over study had a 2 X 2 factorial arrangement consisting of 2 levels of concentrates (300 and 600 g/kg DM), with or without yeast supplement. All diets were based on grass silage and concentrates offered *ad libitum* once daily as total mixed rations. Intakes and refusals were weighed and recorded. A permeation tube containing SF_6 was placed in the rumen of each cow. Four 6 week experimental periods were evaluated from early to late lactation. A 3 week washout phase was used between periods (concentrate level: 300 g/kg DM). On the last 12 days of each period, CH_4 emissions were measured using the SF_6 technique in 3 locations: before chamber measurements (Byre 1), in respiration chambers (Chamber) and after chamber measurements (Byre 2). Pairs of cows were placed in individual stalls and fitted with a halter and evacuated canister (adapted from Johnson *et al*., 2004) on the last 3 days in each location. For the Chamber location, each pair was taken to open-circuit respiration chambers, with CH_4 output being measured simultaneously by both the calorimetry and SF_6 techniques. The canister was located in the back of each chamber with the nosepiece placed inside an air duct through which air was circulated towards gas analysers. Measurements done in the chambers by both techniques account for all CH_4 emissions produced by the animals, including those respired, eructated and released through the rectum. Data collected in the chambers were analysed by repeated measures using GenStat REML examining the effects of technique, period, day, concentrate level and yeast supplementation, while adjusting for breed, parity, chamber, bolus release rate, pair and individual cow. The SF_6 data collected in the three locations were similarly analysed but included the effect of location instead of technique and excluded chamber. The data presented correspond to the first two periods of the ongoing study. Results for concentrate level and yeast supplementation are not included.

Results There were no interactions between treatments; therefore, only main effects are presented. There were small but significant differences between CH_4 measurement techniques over the 2 periods, with the total CH_4 and CH_4 per kg of DM intake (DMI) and milk yield (MY) measured using the SF_6 technique being higher than those using respiration chambers (Table 1). There was no effect of period on the ratio of the CH_4 emissions measured using the SF_6 technique to the emission measured using the respiration chambers with mean values of 103 for period 1 and 108 for period 2 (SED 3.5; $P > 0.05$). Similarly, there was no effect of day of measurement on methane SF_6 to calorimeter ratio (day 1 = 106, day 2 = 105 and day 3 = 105; SED 2.4; $P < 0.05$), which highlights the relatively low variation of the SF6 and calorimetry techniques between days. Using the SF_6 technique only, CH_4 output measured in the byre tended to be lower than in the calorimetry chambers for total CH_4 and for CH_4 per kg of DMI , while CH_4 per kg of MY was significantly lower in the byre (Table 2). This gives an indication of the proportion of methane being excreted through the rectum. Methane emissions per kg of DMI measured by the SF_6 technique were lower in period 1 than in period 2 (23.8 *vs*. 26.4; SED 0.56; $P < 0.001$) and were not affected by day of measurement (day 1 = 25.4, day 2 = 25.0 and day 3 = 25.0; SED 0.45; $P > 0.05$).

Table 1 Effect of measurement technique on methane (CH_4) emissions collected in respiration chambers

	Technique				
	SF_6	Chamber	SE	*P*	Ratio
CH_4 g/d	455	415	14.9	<0.00	110
CH_4 g/kg	25.	23.9	0.65	0.026	107
CH_4 g/kg MY[2]	19.	17.9	0.66	<0.00	109

[1]Dry matter intake; [2]Milk yield

Table 2 Effect of location on methane (CH_4) emissions collected by the SF_6 technique

	Location				
	Byre	Chamber	SED	*P*	Ratio
CH_4, g/d	423	441	9.8	0.082	96
CH_4, g/kg DMI[1]	24.6	25.6	0.58	0.122	96
CH_4, g/kg MY[2]	18.2	19.2	0.45	0.043	95

[1]Dry matter intake; [2]Milk yield

Conclusion Over the 2 periods, the SF_6 technique slightly overestimated CH_4 emissions compared with respiration chambers, with relatively low variation within cows between days. Methane output measured by the SF_6 technique only, tended to be slightly higher in the chambers (accounting for all CH_4 sources) compared with the byre (CH_4 excreted by the mouth and nostrils only).

Acknowledgements This study was funded by Department of Agriculture and Food (ROI) through the Research Stimulus Fund Programme (RSF 07-517)

References

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https://doi.org/10.1017/S2040470010003997 Published online by Cambridge University Press