Letter to the Editor: Challenging one sensor method for screening dairy cows for reduced methane emissions

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Selective breeding is suggested as a mitigation strategy to reduce enteric methane (CH₄) emission by dairy cows. Ranking of animals for genetic selection for low CH₄ emitting potential requires reliable and cost-effective measurements from a large number of animals in farm conditions. As an international group of scientists pointed out “... the need for high throughput methodology, e.g. for screening large numbers of animals for genomic studies, does not in itself justify the use of methods that are inaccurate, imprecise, or biased” (Hammond et al., 2016). Recently, van Engelen et al. (2018) used infrared sensors installed in automatic milking systems; that is, the “sniffer” method, to measure CH₄ and carbon dioxide (CO₂) concentrations in exhaled air. However, CH₄ concentration measured by the sniffer method was poorly correlated with CH₄ flux in a study conducted on 2 research farms (Huhtanen et al., 2015). In laboratory studies, the distance from the sampling point had a strong influence on measured CH₄ concentration (Huhtanen et al., 2015; Wu et al., 2018), and in the farm-scale study, head position was strongly related to CH₄ concentration (Huhtanen et al., 2015). Wu et al. (2018) also suggested a systematic error resulting from between-cow variation in exhalation rate. van Engelen et al. (2018) tested the sensors in respiration chambers before they were installed on commercial farms. This is not an appropriate test of the sniffer method, because eructations influence gas concentrations much less in the chamber than under barn conditions. In addition, airflow from the chamber to sensors invalidates the sniffer test used. In the study of van Engelen et al. (2018), both the mean and standard deviation (SD) of the CH₄:CO₂ ratio were biologically unrealistic. The mean CH₄:CO₂ ratio of 0.17 (volume basis) was about 2-fold greater than that reported by Aubry and Yan (2015) from respiration chamber studies with lactating and growing cattle fed different diets. A dairy cow (DMI = 20 kg/d, ECM yield = 30

kg) produces about 130 MJ of heat and emits about 5,800 L of CO₂ (22.8 kJ/L), which would correspond to about 710 g of CH₄/d, if the gas ratio were 0.17. This is almost twice the expected CH₄ emission from such a cow. High CH₄:CO₂ can be due to high CH₄ or low CO₂, the latter potentially indicating high feed efficiency. The coefficient of variation of the CH₄:CO₂ ratio in van Engelen et al. (2018) was 0.71, which is about 5-fold greater than that reported by Aubry and Yan. (2015). Unrealistic mean and SD values suggest serious problems with use of the sniffer method for measuring enteric CH₄ emissions in the study of van Engelen et al. (2018). With such high SD values, most of the variation is due to random errors in measurements. Head position, sampling distance, and exhalation rate affect the CH₄:CO₂ ratio less than they affect CH₄ concentration, but interpretation is not straightforward; a high CH₄:CO₂ ratio can also result from high feed efficiency (low CO₂ production). For example, the coefficient of variation for CH₄ yield (g of CH₄/kg of DMI) for a large European data set of individual cow observations was 16% (Niu et al., 2018). In reality, selecting for low emissions can result in selecting for reduced DMI or poor efficiency of cell-wall digestion. It could be argued that the shortcoming of poor efficiency of cell-wall digestion could be solved in a breeding index. However, this may not be possible because increased digesta passage rate from the rumen is the main animal factor influencing CH₄ yield. In this case, maintaining cell-wall digestibility requires that the digestion rate increases, which is unlikely because digestion rate is a feed characteristic, not an animal characteristic. We conclude that true between-cow variation in CH₄ emissions is too small to be reliably measured by the sniffer method with its low precision.

REFERENCES

- Aubry, A., and T. Yan. 2015. Meta-analysis of calorimeter data establish relationships between methane and carbon dioxide emissions or oxygen consumption for dairy cattle. *Anim. Nutr.* 1:128–134. <https://doi.org/10.1016/j.aninu.2015.08.015>.
- Hammond, K. J., L. A. Crompton, A. Bannink, J. Dijkstra, D. R. Yanez-Ruiz, P. O’Kiely, E. Kebreab, M. A. Eugene, Z. Yu, K. J.

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- Shingfield, A. Schwarm, A. N. Hristov, and C. K. Reynolds. 2016. Review of current in vivo measurement techniques for quantifying enteric methane emission from ruminants. *Anim. Feed Sci. Technol.* 219:13–30.
- Huhtanen, P., E. H. Gabezas-Garcia, S. Utsumi, and S. Zimmerman. 2015. Comparison of methods to determine methane emissions from dairy cows in farm conditions. *J. Dairy Sci.* 98:3394–3409. <https://doi.org/10.3168/jds.2014-9118>.
- Niu, M., E. Kebreab, A. N. Hristov, J. Oh, C. Arndt, A. Bannink, A. R. Bayat, A. F. Brito, T. Boland, D. Casper, L. A. Crompton, J. Dijkstra, M. A. Eugène, P. C. Garnsworthy, M. N. Haque, A. L. F. Hellwing, P. Huhtanen, M. Kreuzer, B. Kuhla, P. Lund, J. Madsen, C. Martin, S. C. McClelland, M. McGee, P. J. Moate, S. Muetzel, C. Muñoz, P. O’Kiely, N. Peiren, C. K. Reynolds, A. Schwarm, K. J. Shingfield, T. M. Storlien, M. R. Weisbjerg, D. R. Yáñez-Ruiz, and Z. Yu. 2018. Prediction of enteric methane production, yield and intensity in dairy cattle using an intercontinental database. *Glob. Chang. Biol.* <https://doi.org/10.1111/gcb.14094>.
- van Engelen, S., H. Bovenhuis, P. P. J. van der Tol, and M. H. P. W. Visker. 2018. Genetic background of methane emissions by Dutch Holstein Friesian cows measured by infrared sensors in automatic milking system. *J. Dairy Sci.* 101:2226–2234. <https://doi.org/10.3168/jds.2017-13441>.
- Wu, L., P. W. G. Groot Koerkamp, and N. Ogink. 2018. Uncertainty assessment of the breath methane concentration method to determine methane production of dairy cows. *J. Dairy Sci.* 101:1554–1564. <https://doi.org/10.3168/jds.2017-12710>.