Methane Reducing Feed Additives

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Summary

- The methane mitigating feed additive 3-NOP has been evaluated across a range of differing scenarios for Irish conditions
- 3-NOP is most effective in indoor settings when mixed throughout feed using a mixing wagon
- Feeding 3-NOP on commercial farms is possible during the dry period and does not increase labour requirements on-farm
- The Red seaweed (Asparagopsis) yielded a ~24% reduction in enteric methane when pulse fed twice daily during the grazing season
- Further work is required to increase the efficacy of feed additives as well as developing practical solutions for feeding additives during grazing season

Introduction

Enteric methane, which is a by-product of feed digestion, accounts for 63% of agricultural greenhouse gas emissions in Ireland (EPA, 2023). Given that the agricultural sector has a target to reduce its greenhouse gas emissions by 25% by the year 2030, relative to 2018 levels, developing strategies to reduce enteric methane will be crucial to meeting Ireland's agricultural climate targets. Several promising anti-methanogenic feed additives have been identified; however, most of the research to-date has been undertaken in indoor feeding systems, in which animals are housed year round. In these systems, additives can be easily mixed throughout the feed using a mixing wagon so that they are present in every mouthful of feed consumed by the animal and thus actively reduce methane throughout the day, achieving methane reductions of ~30%.

However, in pasture-based dairy systems, grazed grass makes up the majority of an animal's feed intake. Therefore, supplementing animals with feed additives is inherently more difficult in grazing systems, as, at present, the only practical opportunity for doing so is via supplemental feed in the milking parlour twice daily. It is therefore important that feed additives are effective in these scenarios. There is a large research programme underway in Teagasc Moorepark to identify anti-methanogenic feed additives that are effective and practical to use in pasture-based systems.

Research

3-NOP

3-nitrooxypropanol (3-NOP; Bovaer10®; 10% 3-NOP on a carrier) is one of the most consistently effective anti-methanogenic feed additives identified in a review undertaken by Hegarty et al. (2021). Reductions in enteric methane of ~30% have been consistently reported with indoor systems of dairying in which the additive is mixed throughout the basal diet using a mixing wagon (Kebreab et al., 2023). To evaluate the efficacy of 3-NOP in grazing systems, a study was undertaken in Teagasc Moorepark in which 3-NOP was fed to grazing dairy cows twice daily on exit from the milking parlour. The results demonstrated a 28.5% reduction in enteric methane for 3 hours after additive consumption, however, methane output returned to normal thereafter (Costigan et al., 2024).

The short efficacy period of the additive is due to its rapid metabolism in the rumen once ingested, meaning the cumulative reduction in daily enteric methane was only ~5%, highlighting that, in its present form, 3-NOP is unsuited to twice daily feeding during the grazing season.

Future research on feeding 3-NOP in grazing systems should focus on slow release technologies to enhance its efficacy when fed twice daily. However, it should also be highlighted that during the winter housing period, additives such as 3-NOP may be mixed throughout the basal diet.

Research by Lahart et al. (in press) has shown 3-NOP can reduce daily enteric methane by 22% when mixed throughout silage using a mixing wagon and fed to cows during the dry period. As most farmers do not have access to mixing wagons in Ireland, a follow up study was undertaken in which 3-NOP was mixed with dry cow minerals and top-dressed onto grass silage twice daily that was fed to non-lactating dairy cows (Lahart et al., under review); this study reported a reduction in enteric methane of 11%.

A study undertaken in late-lactation in which cows were buffer fed 3-NOP with silage by night, and were out grazing during the day yielded a 13% reduction in enteric methane (Costigan et al., unpublished data). This highlights further opportunities for the application of 3-NOP on farms that have mixing wagons whereby in addition to the 8-week dry period, 3-NOP may be buffer fed in early and late lactation, respectively, if grazing conditions are sub-optimal.

To evaluate the practical application of feeding additives on commercial farms, 3-NOP was fed to ~3,500 dry cows (across 18 Signpost farms) in a pilot study that took place over the winter of 2023/2024. Enteric methane was not measured as part of the pilot study, the 22% reduction achieved in the aforementioned study on dry cows was instead assumed. Focus groups were held with the participating farmers before and after the pilot study to share their experiences of feeding the additive. Each participating farmer's milk processor, together with the Signpost Programme collaborated to fund the purchase of the 3-NOP for their respective farmer. The ultimate objective

of the study to show that we, as an industry, are harnessing the technologies available to us to reduce our methane emissions.

Asparagopsis

Asparagopsis is a red seaweed that contains the active ingredient bromoform. It is reported to have promising methane reduction potential (Hegarty et al., 2021), with reductions of between 27% and 67% in TMR feeding systems (Alvarez-Hess et al., 2024). To evaluate its efficacy in pasture-based systems, a trial was undertaken in Teagasc Moorepark in which grazing dairy cows were supplemented with freeze dried Asparagopsis twice daily at morning and evening milking. This trial was the first of its kind in grazing systems, and tested two different dietary inclusion rates of Asparagopsis (20 g/day and 40 g/day, respectively mixed with 2 kg of concentrate). The cows offered the higher inclusion rate of 40 g/day had higher refusals of the Asparagopsis and concentrate mix, therefore, there were similar reductions in daily enteric methane of ~24% across all cows offered the Asparagopsis.

Although milk solids were slightly lower in cows supplemented with Asparagopsis, this is likely due to the high concentrate refusals whereby the cows consumed up to 1 kg less concentrate per day. Milk samples were taken weekly throughout the trial and analysis is ongoing to ensure that there are no residues in the milk produced by the cows consuming the Asparagopsis.

Further work is being conducted to incorporate Asparagopsis within concentrate pellets to reduce feed refusals and improve the practicalities of its supplementation during the grazing season.

Conclusion

At present, 3-NOP has low efficacy when pulse fed to grazing dairy cows in concentrate feed at milking, however, the additive is effective during the winter housing period when it can be mixed throughout the basal diet using a mixing wagon.

Research with the red seaweed Asparagopsis has demonstrated high efficacy in reducing enteric methane when pulse fed twice daily to grazing dairy cows in concentrate during milking. Work is ongoing to improve the practicalities of feeding additives on commercial farms and to evaluate the effect of feed additives on animal performance, milk residues and economics. It is necessary to establish funding models for the use of anti-methanogenic feed additives on pasture-based farms.

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References

Alvarez-Hess, P.S., Jacobs, J.L., Kinley, R.D., Roque, B.M., Neachtain, A.S.O., Chandra, S., Russo, V.M. and Williams, S.R.O., 2024. Effects of a range of effective inclusion levels of Asparagopsis armata steeped in oil on enteric methane emissions of dairy cows. Animal Feed Science and Technology, 310, p.115932.

Costigan, H., Shalloo, L., Egan, M., Kennedy, M., Dwan, C., Walsh, S., Hennessy, D., Walker, N., Zihlmann, R. and Lahart, B., 2024. The impact of twice daily 3-nitroxypropanol supplementation on enteric methane emissions in grazing dairy cows. Journal of Dairy Science.

Hegarty, R.S., Passetti, R.A., Dittmer, K.M., Wang, Y., Shelton, S.W., Emmet-Booth, J., Wollenberg, E.K., McAllister, T., Leahy, S., Beauchemin, K. and Gurwick, N., 2021. An evaluation of emerging feed additives to reduce methane emissions from livestock.

Kebreab, E., Bannink, A., Pressman, E.M., Walker, N., Karagiannis, A., van Gastelen, S. and Dijkstra, J., 2023. A meta-analysis of effects of 3-nitrooxypropanol on methane production, yield, and intensity in dairy cattle. Journal of dairy science, 106(2), pp.927-936.

Lahart, B., Shalloo, L., Dwan, C., Walker, N. and Costigan, H., 2024. Evaluating the impact of 3-nitroxypropanol supplementation on enteric methane emissions in pregnant non-lactating dairy cows offered grass silage. JDS Communications.