**Application**

Methane emissions from dairy cattle are a significant contributor to agricultural greenhouse gases (GHG), with implications for climate change and sustainability. This study evaluates bacteriocin-producing lactic acid bacteria (LAB) as silage inoculants for methane reduction, offering a practical and scalable solution for dairy farmers. The LAB inoculants reduced methane emissions by 5.7% on average, with a significant 7.74% reduction observed in week 5, while maintaining milk yield, dry matter intake (DMI), and animal health. This approach aligns with national and international climate targets, providing environmental and economic benefits for the dairy industry.

**Introduction**

Methane, a potent GHG, contributes significantly to climate change, with dairy cattle responsible for a large share of emissions due to enteric fermentation (Wójcik-Gront, 2020). Methane also represents a loss of feed energy, reducing animal efficiency. Addressing these emissions is critical for achieving climate targets, particularly in countries like Ireland, where enteric fermentation accounts for 63% of agricultural methane emissions (Kamyab et al., 2024). This study aimed to evaluate the potential of LAB-based silage inoculants containing *Lactococcus lactis* subsp. *lactis* SL242 (*L. lactis* SL242) and *Lactiplantibacillus plantarum* LP58 (*L. plantarum* LP58) to reduce methane emissions and assess their impact on dairy cow productivity and health.

**Materials and Methods**

Thirty late-lactation Holstein dairy cows were randomly assigned to treatment (LAB-inoculated silage) and control (non-inoculated silage) groups (n = 15/group). Silage was treated with LAB inoculants at a dose of ~10¹¹ colony-forming units (CFU)/cow/day and fed ad libitum over a seven-week period, including a two-week adaptation phase. Methane emissions were measured weekly using the GreenFeed system, while DMI, milk yield, and body condition score (BCS) were monitored. Microbial composition of rumen samples was analyzed using 16S rRNA gene sequencing. Statistical analyses, including mixed models and Wilcoxon tests, were performed, and results were considered significant at p < 0.05.

**Results**

Methane emissions were reduced by an average of 5.7% in the LAB-treated group from weeks 5 to 7, with the greatest reduction observed in week 5 (7.74%, p < 0.001). On average, treatment cows produced ~20 g less methane per day than controls (~360 g/day vs. ~380 g/day). DMI, milk yield, and BCS did not differ significantly between groups. Microbial analysis revealed no significant differences in alpha diversity (Shannon and Chao1 indices), but beta diversity analysis identified significant clustering between groups at weeks 4 (p = 0.045) and 7 (p = 0.042). Taxonomic shifts were observed in bacterial families linked to fiber degradation, while archaeal communities dominated by *Methanobrevibacter* remained stable.

**Conclusions**

The results demonstrate that LAB-based silage inoculants can reduce methane emissions in dairy cattle without compromising productivity or animal health. The observed 5.7% reduction aligns with climate targets, providing a cost-effective, practical strategy for mitigating GHG emissions in dairy systems. Further research should explore the long-term effects of LAB inoculants on rumen microbiota and methane production under varying conditions to optimize their use for methane mitigation.

**References**

KAMYAB, H., SABERIKAMARPOSHTI, M., HASHIM, H. & YUSUF, M. 2024. Carbon dynamics in agricultural greenhouse gas emissions and removals: a comprehensive review. *Carbon Letters,* 34**,** 265-289.

WÓJCIK-GRONT, E. 2020. Analysis of sources and trends in agricultural GHG emissions from annex I countries. *Atmosphere,* 11**,** 392.