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Editorial

Recent Research on Livestock Microbiota, Its Role in Digestion and Its Impact on Methane Emissions

Magdalena Arévalo-Turrubiarte [1,*] and Ana Isabel Roca-Fernández [2,*]

[1] School of Veterinary Medicine, University of Surrey, Daphne Jackson Rd., Guildford GU2 7AL, UK
[2] Faculty of Veterinary Science, University of Santiago de Compostela, Av. Carvallo Calero, s/n, 27702 Lugo, Spain
* Correspondence: m.arevaloturrubiarte@surrey.ac.uk (M.A.-T.); anai.roca@usc.es (A.I.R.-F.)

1. Introduction

The rumen is the largest compartment of the ruminant stomach and plays a central role in the digestive physiology of bovine, ovine, and caprine species. Within the rumen, a complex and diverse microbial ecosystem facilitates the fermentation of ingested feed, leading to the production of various gases—primarily methane and carbon dioxide. The composition and volume of these fermentation gases are mainly influenced by several factors such as dietary composition, microbial population dynamics, and the animal's overall health status, all which impact performance and production. To improve microbial fermentation efficiency and reduce gas emissions—particularly enteric methane emitted by ruminants—this Special Issue focuses on recent research related to "Ruminal Microbiota, Fermentation Process, Enteric Methane Emissions, and Animal Performance". Notably, the studies presented here examine the effects of dietary supplements, by-products, probiotic bacteria, feed additives, and specific feed ingredients on the modulation of ruminal microbiota composition. Only a few of the research papers published in this Special Issue will be highlighted here. For example, [1] demonstrated that a combination of essential oil blends and fumaric acid reduced methane gas emissions by up to 86% and increased propionate concentration by 9.5%, indicating significant shifts in the composition of the rumen microbiome. Similarly, [2] reported that using crop by-products could reduce gas emissions associated with forage production by approximately 26%. [3] investigated an acidogenic bacterial consortium derived from a brewery's waste for its potential as a probiotic. Their findings showed a reduction in methane-producing species in the rumen, along with increased daily weight gains and improved feed conversion rates in bovines fed high-forage diets, likely due to changes in the volatile fatty acid profile. Additionally, this Issue includes studies exploring various by-products, such as cashew nut shell extract and endosperm and mesocarp expellers from grugru palm, evaluating the rumen's microbial capacity to digest these byproducts. One study also identifies alterations in the ruminal microbiome, metabolome, and epithelial inflammatory response resulting from moderate feed restriction in Angus steers.

2. Conclusions

This Issue presents a variety of alternative feeding strategies involving additives, probiotics, and by-products—such as those mentioned above—that differ in composition. Their influence on the rumen microbiome, animal performance, and methane emissions has been assessed. The implementation of these recent scientific findings could significantly enhance feed efficiency and the sustainability of future ruminant production systems

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worldwide. However, further research is needed to better understand rumen ecosystems and diet interactions in ruminants raised under different environmental conditions, with the goal of reducing their methane emissions. Studying the microbiome at different stages of animal growth may offer valuable insights into whether these feeding strategies can be applied from an early age to mitigate gas emissions. Moreover, metabolic studies on rumen bacteria, as well as genetic research, will help assess their impact on ruminant nutrition. Integrating these aspects represents a promising direction for improving livestock productivity, human health, and environmental sustainability from a holistic, One Health approach to addressing climate change.

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