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Dose-dependent effects of a garlic-citrus powder on methane production and fermentation parameters of rumen microbial metabolism

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Introduction

As a major contributor to greenhouse gas emission worldwide livestock agriculture has a remarkable impact on global warming and the main source are ruminants. This is not only an environmental issue, emitting methane also results in a loss of 12 % of dietary energy for the ruminant[1]. Therefore, a reduction of methane emissions is of great environmental and economic interest. To achieve this highly desirable goal, many feeding stategies have been tested. Mootral™ consists of garlic powder (*Allium sativum*) and citrus extracts (*Citrus aurantium*). Citrus fruits contain flavonoids, which have the ability to supress methane production and allicin in garlic is known for its antimicrobial properties. The methane-reducing effect of this product has already been proved[2]. In this study, we investigated the dose-dependent effects of Mootral™.

Experimental design

To investigate the effects of three different doses of Mootral™ the RUSITEC (Rumen Simulation Technique)[3] with twelve fermentation vessels was used. As an inoculum solid and liquid rumen contents were collected from two rumen-fistulated cows. All fermenters were supplemented with a basal diet of 7 g hay and 3 g concentrate per day.
The experiment consisted of three phases: equilibration (day 0-7), control (CP, day 8-10) and experimental phase (EP, day 11-18).
The twelve vessels were divided into four treatment groups (n=3): control, 0.22 g Mootral™, 0.88 g Mootral™, 1.76 g Mootral™. The compound was added to the feed bags during EP. Samples were collected as displayed in Figure 1.

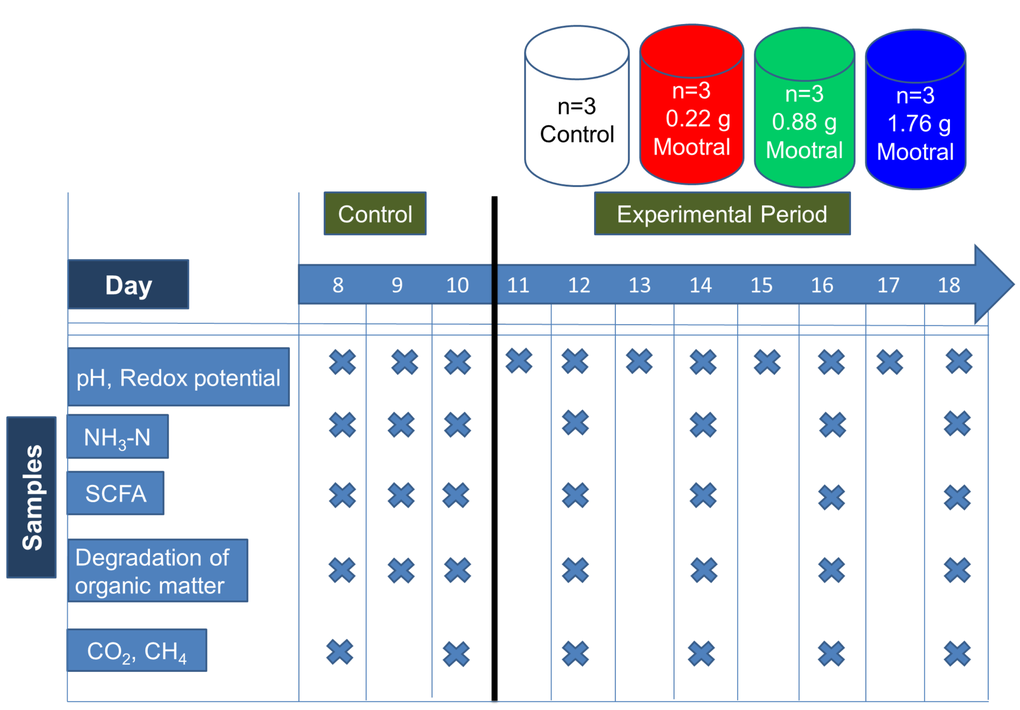
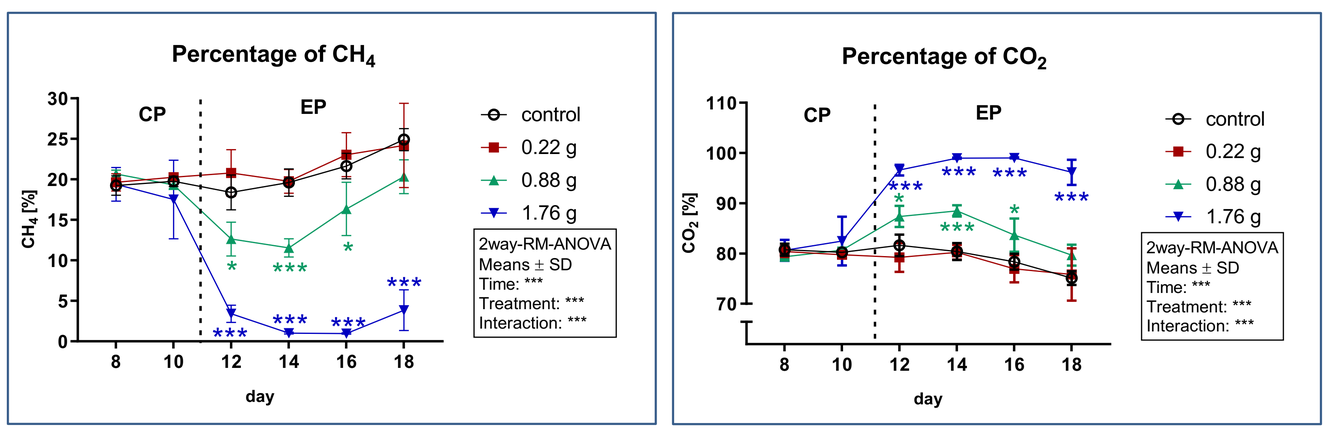


Fig. 1: Experimental set-up

Results



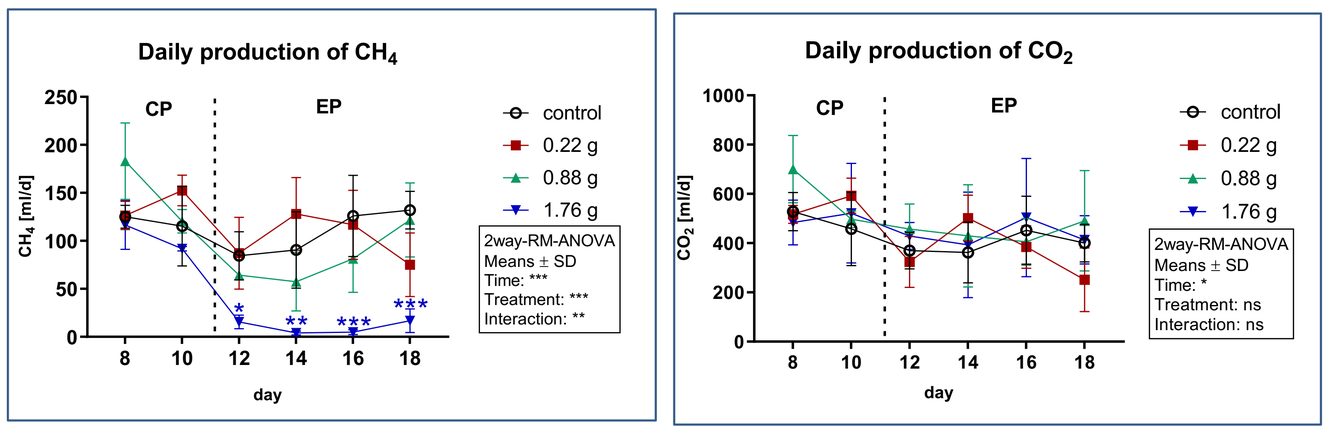


Fig. 2: Daily production rates and percentages of methane (CH_4) and carbon dioxide (CO_2) in the fermentation gas during control period (CP) and experimental period (EP). Significant alterations between control group and each dose of Mootral™ are indicated by asterisks: *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$.

Gas:

Evaluating gas volume and composition (Fig 2.), vessels supplemented with 0.22 g Mootral™ were not significantly different to control group. The 0.88 g Mootral™ group exhibited a change in the composition of produced gas: from day 12 - 16 the percentage of methane decreased and carbon dioxide increased significantly. Treating the vessels with the highest dose of Mootral™ led to a significant reduction in both, the percentage and the production rate of methane throughout the experimental phase. In contrast, the production rate of carbon dioxide was not affected by the application of Mootral™.

Conclusion

This study has confirmed the ability of Mootral™ to reduce methane production without impairing rumen fermentation. The effects were dose-dependent with the 1.76 g dose resulting in a persistent methane reduction. Therefore, Mootral™ has the potential to decrease the amount of methane emitted by ruminants and make livestock more climate-friendly and sustainable. Based on these results the 1.76 g dose should be used for further evaluation of long-term effects and impacts on the microbial community.

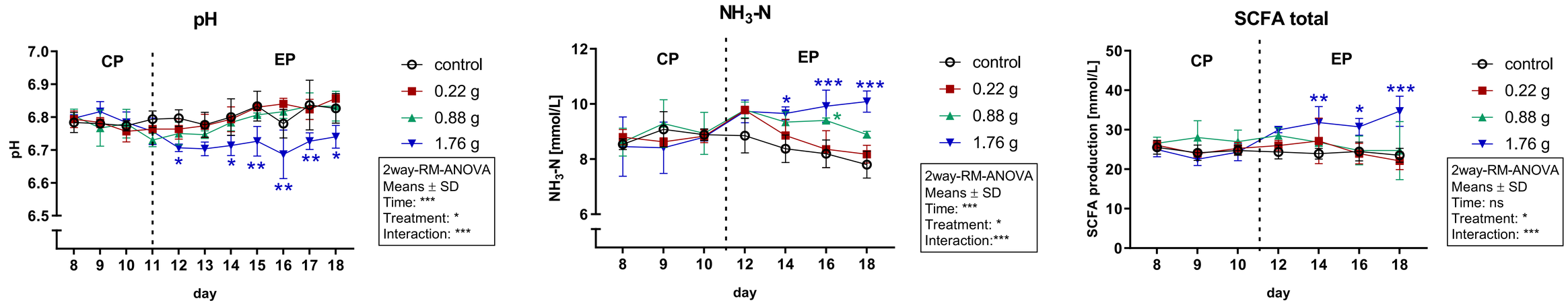


Fig. 3: Fermentation parameters during control period (CP) and experimental period (EP). Significant alterations between control group and each dose of Mootral™ are indicated by asterisks: *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$.

Biochemical Parameters :

During control period, the measured parameters remained unchanged (Fig. 3). In the experimental period, the concentration of NH_3-N increased significantly from day 14 – 18 in fermentation vessels treated with 1.76 g of Mootral™. In contrast, the group treated with 0.88 g Mootral™ was significantly different compared to the control group only at day 16. Due to higher production rates of butyrate, valerate and isovalerate in fermentation vessels treated with the highest dose of Mootral™ a significant increase in total SCFA production was observed in the experimental period. The other groups were not significantly different from the control group. In the 0.88 g Mootral™ group, the production rate of butyrate and isovalerate increased, however, this effect was transient. Redox potentials and degradation of organic matter were not effected by Mootral™ (data not shown).

References:
[1] Johnson, K. A., and Johnson, D.E. (1995). Methane emissions from cattle. J. Anim. Sci. 73(8), 2483-2492
[2] Eger, M., Graz, M., Riede, S., & Breves, G. (2018). Application of MootralTM Reduces Methane Production by Altering the Archaea Community in the Rumen Simulation Technique. 9(2094)
[3] Czerkawski, J. W., & Breckenridge, G. (2007). Design and development of a long-term rumen simulation technique (Rusitec). British Journal of Nutrition, 38(3), 371-384