Restoring Alnus viridis-encroached alpine pastures using Highland cattle while providing good quality forage and reducing methane emissions

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Résumé

Alnus viridis is a shrub species that has been increasingly spreading in many European mountain chains. This nitrogen-fixing species has triggered negative agro-environmental impacts, such as a loss of agricultural land and biodiversity, as well as an increase in nitrogen leaching and soil acidification. Targeted livestock management systems have been recently investigated to reduce its encroachment and among cattle breeds, Highland cattle can feed on a higher proportion of woody species compared to production-oriented breeds. The aims of this study were to assess 1) the temporal variation of *A. viridis* leaf nutritive value along the grazing season and 2) estimate the impact of including *A. viridis* leaves in animal diet for the reduction of methane emissions.
A. viridis leaves were collected three times during the grazing seasons of 2020 and 2021 (in June, July and August), in four highly encroached sites across Italy and Switzerland, at similar elevations and with varying pedo-climatic conditions. We measured the functional traits (specific leaf area and leaf dry matter content), nutritive value (macro- and micro-elements and fibre content) and phenolic content of the leaves. The *in vitro* organic matter digestibility (IVOMD) and related gas emissions (CO2 and CH4) were also investigated using a ruminal incubation system, with a diet composed of *A. viridis* leaves and hay in 1:4 ratio in the DM, a leaf proportion representative of the animal diet assessed in the field.

Leaf functional traits and all macro- and micro-elements significantly varied during the season, with similar decreasing patterns in leaf N, P, and K values. Contrarily, leaf Ca and Mn significantly increased through the summer. Leaf N and P were on average of 32.1 ± 0.36 g.kg-1 DM and 2.3 ± 0.07 g.kg-1 DM, respectively. On the other hand, leaf neutral detergent fiber, acid detergent fiber, and acid detergent lignin significantly increased during the season. Phenols did not show a significant seasonal trend except for condensed tannins, which slightly increased along the season. Including *A. viridis* leaves in cattle diet reduced OM digestibility and CH4/digested organic matter (dOM) emissions by (about 20%) compared to a control diet of 100% hay.
These results highlighted the potential of *A. viridis* leaves as a valuable forage resource and

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identified the beginning of the summer season as the ideal grazing period. Moreover, they showed that including *A. viridis* in animal diet can significantly reduce CH4 emissions. Altogether, findings from our study could help defining targeted management strategies for silvopastoral systems to increase beef cattle productivity, while reducing greenhouse gas emissions and controlling *A. viridis*-encroachment.

Mots-Clés: Shrub encroachment, alpine pastures, forage quality, methane emissions, targeted grazing, Alnus viridis, plant functional traits