Dietary inclusion of Hermetia illucens oil in dairy cows: effects on rumen microbiota and fermentation parameters

L. Rastello[1], S. Colombini[2], I. Ferrocino[3], X. Dai[2], P. Toral[4], M. Battelli[2], M. Coppa[3], L. Gasco[3], M. Gerbelle[5], L. Vernetti-Prot[5], A. Galli[6], C. Trespeuch[7], M. Renna[1]

[1] University of Turin, Dept. Veterinary Sciences, L.go Braccini 2, 10095 Grugliasco, Italy, [2] University of Milan, Dept. Agricultural and Environmental Sciences, Via Celoria 2, 20133 Milan, Italy, [3] University of Turin, Dept. Agricultural, Forest and Food Sciences, L.go Braccini 2, 10095 Grugliasco, Italy, [4] Instituto de Ganadería de Montaña (CSIC-ULE), Finca Marzanas S/N, 24346 Grulleros, Spain, [5] Institut Agricole Régional, La Rochère 1/A, 11100 Aosta, Italy, [6] Ferrero Mangimi SpA, Via Fornace 15, 12060 Farigliano, Italy, [7] Mutatec, Chemin du Mitan, 84300 Cavaillon, France

Including lipids in the diet of dairy cows is a common practice aimed at increasing the dietary energy density while also modulating rumen microbiota to reduce CH4 emissions. However, traditional lipid sources are often criticized for their high environmental footprint, highlighting the need for more sustainable alternatives. This study aimed to assess whether the oil extracted from Hermetia illucens (HIO) larvae, which has a potentially lower footprint, could serve as a viable alternative to fractionated palm oil (FPO) in dairy cow nutrition without causing negative effects on rumen fermentation parameters and microbiota in dairy cows. A 50-day trial was conducted with two equivalent groups of thirteen lactating Valdostana Red Pied cows each. The two groups were fed a diet characterized by a 70:30 forage:concentrate ratio, which differed only for the concentrate lipid source, being either HIO or FPO (0.9% of the diet DM). Individual rumen fluid samples were collected on the last day of the trial. In vivo analysis included microbiota composition (DNA sequencing), and protozoal counts. Rumen fluids were also used as inocula for in vitro incubations (24 h) to determine total gas and CH4 production, pH, ammonia and volatile fatty acids. Statistical analysis was performed using the MIXED procedure of SAS software ($P<0.05$). Spearman correlation evaluated associations between bacterial genera and fermentation profile. No differences in the tested fermentation parameters were observed, with the only exception being butyrate production, higher with the HIO diet compared to the FPO diet (16.9 vs. 12.0 mol/100 mol, respectively; $P<0.001$). This higher production was concomitant with a greater abundance of large Entodiniomorphs protozoa (9.14×103 cells/mL vs. 1.17×103 cells/mL in the HIO group and FPO group, respectively; $P=0.001$), which are known to directly contribute to butyrate production. Interestingly, C12:0, the main individual fatty acid in HIO, is known for its antimicrobial properties and therefore a protozoal reduction was expected. However, literature suggests this effect being dose dependent. Consistent with a higher abundance of protozoa, an enrichment in other archaeal or bacteria genera typically associated with them, such as Methanobrevibacter ($P<0.01$) and Treponema ($P<0.05$), was observed in rumen fluid of HIO-fed animals. To add, several fiber-degrading Firmicutes, including Pseudobutyrivibrio, were less abundant in the HIO group ($P<0.05$). No differences in α- or β-diversity were observed between the two groups ($P>0.05$). Spearman correlation analysis further revealed positive associations between C12:0 intake and Methanobrevibacter and Treponema abundance ($P<0.05$), suggesting that the C12:0 content of HIO promoted the observed microbial shifts. These findings highlight that a low dose of HIO only exerts modest effects on rumen fermentation parameters and microbiota shifts, suggesting the possible use of HIO in dairy cow diets as an innovative and alternative lipid source. Research supported by Hi-Ga project; Green Era Hub on Agri Food and Biotechnology.