Polyamide microplastics effects on digestive system of lambs

SESSIONE: ***Sessione II: Contaminazione da micro e nanoplastiche e salute***

POLYAMIDE MICROPLASTICS EFFECTS ON DIGESTIVE SYSTEM OF LAMBS

Sonia TASSONE[1], Khalil ABID[1], Sara GLORIO PATRUCCO[1], Rabeb ISSAOUI[2], Hatsumi KAIHARA[1], Salvatore BARBERA[1]

[1]Department of Agricultural, Forest and Food Sciences, University of Turin, 10095 Grugliasco, Italy; [2]Microbiologist Consultant, Tunisia.

Microplastics (MPs) are an emerging pollutant also in the livestock sector (Ramachandraiah et al., 2022). Originating from the fragmentation of various plastic polymers (Wang et al., 2022), which are extensively used on farms (such as covers for horizontal silos, silage bags, bale nets and wraps, veterinary drug packaging, as reported by Borreani and Tabacco, 2017), and from atmospheric agents, MPs became easily ingestible via diet and water (Dong et al., 2023). Once inside the animal's digestive system, MPs may potentially impair ruminal-gastro-intestinal functionality (Tassone et al., 2024), interfere with gastro-intestinal epithelium (Chang et al., 2024) and cause toxic effects due to the adhesion of harmful molecules, such as persistent organic pollutants, heavy metals, pesticides and additives used in the plastic production, as bisphenol (Urli et al., 2023). This study investigated the effects of concentrate contamination with polyamide (PA) MPs at different dosages (0, 0.6, and 1.8% dry matter) on *in vitro* lamb rumen activity. Samples of 200 mg of concentrate, fortified with PA MPs (dimensions < 2 mm) were inoculated with 30 mL of buffered rumen fluid and incubated in triplicate into serum bottles under anaerobic conditions for 96 h in a sharing water bath at 39°C and 120 rpm. The rumen fermentation profile and gas production at 2,4,6,8,12,24,48,72, and 96 h were measured. Compared to the control, ammonia-nitrogen concentration increased linearly with rising MPs concentration, showing a 5.7% increase at the highest dose. Dry matter degradability was reduced by 3% only at the highest level of contamination. Microbial efficiency decreased linearly with increasing PA MPs concentration, while the ruminal protozoa population dropped by 13% at the highest dose. No effect was observed on pH. The presence of PA MPs in the concentrate at the highest dose, compared to the control, increased total gas production by 5%, with an average fermentation rate increase of 20% mL/hour. Additionally, it accelerated the initial gas formation, reducing the lag time of 0.68 h, thereby shortening the time required to initiate the gas production process.

The presence of PA MPs in concentrate negatively affected lamb rumen activity. It reduced nitrogen utilization, lowered ruminant performance, and posed ecological challenges, impairing environmental sustainability. The negative effects on rumen degradability could reduce feed intake, animal performance, and feed efficiency, leading to higher feed costs and economic losses (Oba & Allen, 1999). Moreover, it could lead to digestive and metabolic disorders in ruminants. Incomplete feed fermentation in the rumen, could increase gas emissions (mainly greenhouse gases) per unit of degraded feed and escalate nutrient waste in feces, contributing to environmental pollution (Blümmel et al., 2003).

In conclusion, the adverse effects of PA MPs on lamb rumen activity and concentrate degradability were dose-dependent. Increasing the dose of PA MPs ingested led to a significant linear decrease in the efficiency of rumen microbiota.

Ramachandraiah et al, 2022 https://doi.org/10.1016/j.scitotenv.2022.157234.
Wang et al., 2022 https://doi.org/10.1016/j.scitotenv.2022.154881
Borreani and Tabacco https://doi.org/10.1016/B978-0-08-102170-5.00009-9
Dong et al., 2023 http://dx.doi.org/10.1016/j.scitotenv.2022.158686.
Tassone et al., 2024 https://doi.org/10.3390/ani14152139
Chang et al., 2024 https://doi.org/10.1016/j.ecoenv.2024.116389
Urli et al., 2023 https://doi.org/10.3390/ani13071132
Oba & Allen, 1999 https://doi.org/10.3168/jds.S0022-0302(99)75271-9.
Blümmel et al., 2003. https://doi.org/10.1079/bjn2003934.