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Using organic biomarkers to trace the transport pathways of livestock-derived organic matter in the soil subsurface.

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We explore the use of organic biomarkers as tracers for different components of livestock-derived organic matter (LD-OM) at two different spatial scales. We conducted six small-scale rainfall simulation experiments on a 30 × 30 × 30 cm soil lysimeter, following an application of bovine slurry at a rate of 5 l m^{-2}. Throughout the experiment timed samples of leachate from the base of the lysimeter were collected, then soil cores were taken following the rainfall simulation. These samples were analysed in order to identify the most suitable biomarkers to trace dissolved and sediment-bound LD-OM respectively. The results showed that ammonium was an important tracer compound for dissolved LD-OM, along with other key low molecular weight compounds such as carbohydrates and amino acids. Analysis of the soil cores confirmed that compounds 5-β sigmastanol and 5-β epistigmastanol (5-β stanols) could be used very effectively to trace the sediment-bound and colloidal component of LD-OM. These specific organic compounds, which are identifiable by GC/MS analysis, only occur due to biohydrogenation of plant sterols in a ruminant gut, providing a unique opportunity to trace bovine faecal matter via sediment pathways.

These tracers were then applied to a larger 3-D hillslope system by using University of Bristol's TRACE (Test Rig for Advancing Connectivity Experiments) facility. TRACE is a large-scale dual axis soil-slope measuring 6 m long × 2.5 m wide × 0.3 m deep accompanied by a 6-nozzle rainfall simulator. In these experiments slurry was only applied to the top 1 m section of the hillslope, in order to trace how the LD-OM was transported in the soil system. The slope allows the collection of leachate from the soil surface, from lateral through-flow and infiltrated water which reached the soil base (indicating deeper pathways). This enabled the distinction between LD-OM transported via different hydrological pathways. Soil cores were also taken across the soil surface and analysed for 5-β stanols, this allowed the spatial distribution of LD-OM to be determined following the rainfall event.

The results showed that not only is LD-OM transported on the surface of the hillslope via overland flow, but the dissolved component infiltrates through the soil profile and is transported via deeper hydrological flowpaths. 5-β stanol analysis showed that soil erosion processes were extremely important, as LD-OM was found downslope of the application area and in eroded material lost from the base of the experimental hillslope.

These experiments provided new insights into how LD-OM interacts with the soil-water system and allows quantification of the contamination risk posed. This is important as 90 million tonnes of LD-OM is applied to land annually in the UK. It is well known that there is a potential for contamination of water courses by nitrate, ammonium and other faecal-derived pollutants such as *E. Coli* through runoff from treated land. Pollution from LD-OM has now been shown to extend to the contamination of subsurface pathways and potentially groundwater resources.