Insights onto Se speciation in soils and the role of organic matter using SEC-UV-ICP-MS/MS

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Selenium (Se) is an important micronutrient for humans, which is mostly delivered by food consumption; the main source for crops being soil Se. As up to 1 billion people worldwide are affected by low Se intakes[1], it is crucial to better understand the factors controlling its distribution and bioavailability in soils.

Organic matter (OM) favors Se retention in soils and influences Se bioavailability[2], although the underlying mechanisms remain unclear. A better understanding of the effect of OM on soil Se cycling is impeded by the lack of methods to isolate and characterize Se associations with OM. The high detection limits of synchrothron-based techniques prevent their application on non-contaminated soils. Liquid chromatography coupled to ICP-MS is a sensitive technique, but 30 to 100 % of Se in extracts targeting "specific" soil phases (e.g., water-soluble,, exchangeable Se, Se associated with OM) cannot be identified by existing methods[3].

We developed a method that combines a separation by size exclusion chromatography (SEC) with a dual detection of OM and various elements by UV and ICP-MS/MS. It was applied to 25 soils taken along a rainfall gradient characterized by a large range in OM content (0.9-25%)[3]. For the first time, 100 % of extracted Se was identified in both aqueous and alkaline extracts. Se consists in free Se(IV) and up to 4 different fractions of Se bound to OM in alkaline extracts. Water-soluble Se exists as free Se oxyanions together with Se bound to OM and organo-mineral nanoparticles (up to 9 fractions).

These results are an important improvement in the characterization and quantification of Se-OM associations, which will advance our understanding and predictive capabilities of Se bioavailablity in soils.

[1] Haug et al. Microb Ecol Health Dis. (2007) 19: 209–228; [2] Supriatin et al. Plant Soil (2016) 408:73–94; [3] Tolu et al. Sci. Tot. Environ. (2014) 479-480 : 93-101.