Fate of trace metals in soils after land application of digestate

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Social impact

During the past decades, the biotechnological process of anaerobic digestion has become one of the most cost-effective treatment to transform organic waste such as the municipal sewage sludge, the livestock waste, the organic fraction of municipal solid waste into two valuable products: the biogas and the digestate. The biogas, which is rich in methane, is used as source of renewable energy to generate heat and electricity and as fuel for vehicles, while the digestate can be used as organic fertilizer for the soils.

Regarding the digestate, its nutrient content depends primarily on the nature of the substrate which is degraded by microorganisms during the anaerobic digestion process. The digestate mainly contains macronutrients such as nitrogen (N), phosphorus (P), potassium (K) and micronutrients such as iron (Fe), cobalt (Co), copper (Cu), nickel (Ni), molybdenum (Mo) and zinc (Zn) which are all essential elements for plants growth. However, some micronutrients, such as Co, Cu, Ni and Zn should not be present in high concentration in soils since they may exert toxic effects to plants and soil microorganisms. For this reason, every European country has adopted regulations to check the quality of the digestate before it is spread on land in order to protect the animal and human health and the quality of the crops.

Technological challenges

The purpose of this research activity is to investigate the form of trace metals bound to organic matter (OM) fractions, to study the influence of oxidation on trace metal speciation once the digestate comes in contact with the air and finally to understand the fate of trace metals in soils after land application of digestate.

To this aim, a first experiment will be carried out to characterize the OM of samples of substrate and digestate and to simultaneously study the distribution of trace metals in all fractions of OM extracted by a chemical sequential extraction procedure.

Later and experiment will be carried out to study the effects of digestate oxidation on the chemical form of trace metals. This study will be performed by performing a chemical sequential extraction method for trace metals partitioning.

Finally, the last experiment will deal with a study on the bioavailability of trace metals to plants in soils amended with digestate. A diffusive gradient in thin film (DGT) technique will be used to monitor the flux of trace metals in the soil solution over time.

The outcomes of these experiments will contribute to increase the knowledge in the field of digestate utilization as fertilizer for soils. Indeed, the wished results can suggest whether trace metals present in the digestate are bound to chemical compounds potentially bioavailable to plants and microorganisms in the soil and consequently whether those trace metals will exert their nutritive or , eventually, toxic effect.