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The use of biogas plant fermentation residue for the stabilisation of toxic metals in agricultural soils

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Our department has been paying attention to different methods of soil decontamination, including the in situ stabilisation. Possible reagents to control the toxic metals mobility in soils include a fermentation residue (FR) from a biogas plant. Referred to as digestate, it is a product of anaerobic decomposition taking place in such facilities. The fermentation residue is applied to soils as a fertiliser. A new way of its use is the in situ stabilisation of toxic metals in soils. Testing the stabilisation of toxic metals made use of real soil samples sourced from five agriculturally used areas of the Czech Republic with 3 soil samples taken from sites contaminated with Cu, Pb and Zn and 2 samples collected at sites of natural occurrence of Cu, Pb and Zn ores. All the samples were analysed using the sequential extraction procedure (BCR) (determine the type of Cu, Pb and Zn bonds). Stabilisation of toxic metals was tested in five soil samples by adding reagents as follows: dolomite, slaked lime, goethite, compost and fermentation residue. A single reagent was added at three different concentrations. In the wet state with the added reagents, the samples were left for seven days, shaken twice per day. After seven days, metal extraction was carried out: samples of 10 g soil were shaken for 2 h in a solution of 0.1M $NH4NO_3$ at a 1:2.5 (g.ml-1), centrifuged for 15 min at 5,000 rpm and then filtered through PTFE 0.45 μm mesh filters. The extracts were analysed by ICP-OES.

Copper

The best reduction of Cu concentration in the extract was obtained at each of the tested sites by adding dolomite (10 g soil + 0.3 g dolomite). The concentration of Cu in the leachate decreased to 2.1-18.4% compare with the leachate without addition. Similar results were also shown for the addition of fermentation residue (10 g soil + 1 g FR). The Cu concentration in the leachate decreased to 16.7-26.8% compared with the leachate without addition.

Lead

The best results were achieved by adding slaked lime (10 g soil + 0.5 Ca(OH)2), where the concentration of Pb in the extract decreased to 0.2-8.3%. Adding dolomite (10 g soil + 0.3 g dolomite) achieved a reduction of Pb concentration to 0.4-9.1%. The addition of fermentation residue (10 g soil sample + 2 g FR) caused the concentration of Pb to decrease to 4.6-15.6%.

Zinc

The best reduction of Zn concentration in the extract was obtained by adding dolomite (10 g soil + 0.5 g dolomite). The concentration of Cu in the leachate decreased to 0.3-29.4%. Similar properties were obtained by adding fermentation residue (10 g soil + 2 g FR), when the Zn concentration decreased to 1.0-24.3%.

The waste product of biogas plants can be used for stabilising the bonds of some toxic metals in soils while making use of its fertilising properties to improve soil quality.

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