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Chromium fractionation and plant availability in tannery-sludge amended soil

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The leather industry represents an important economic sector in both developed and developing countries. Chromium tanning is the major process used to obtain high quality leather. Within the REACH regulation the use of Cr, especially CrVI, in the tanning process is under discussion in Europe. High Cr concentration in shoes and other Cr-tanned leather products can cause contact dermatitis in sensitive population. Moreover, the high Cr concentration is the major limiting factor for the use of tannery sludge as a source of organic matter in agricultural soils. Interest in Cr, however is not limited to its potential toxic effects. Chromium III is used as a dietary supplement because there are reports, but also controversy, about the positive effects of Cr III in glucose tolerance and type-2 diabetes. Adequate intake levels for Cr by the diet have been established between 25 and 35 μg/day for adult females and males, respectively. Sufficient supply of Cr III by the diet is preferable to the use of CrIII-salt based dietary supplements. The objective of the present work was to investigate whether Cr from tannery sludge-amended soil is available to Trigonella foenum-graecum plants, a plant used both as a spice and as a medicinal herb, because of its hypoglucemic effects. For this purpose clay loam soil (pH 7.8) was sieved (2mm) and thoroughly mixed with tannery sludge from a depuration station (Igualadina Depuració i Recuperació S.L., Igualada, Barcelona, Spain). The sludge had a Cr concentration of 6,034mg kg-1 and a 0.73 % of NH4-nitrogen. All the Cr was in the form of CrIII. Three treatments were disposed. Control soil receiving no sludge, a 60 mg kg-1 Cr treatment (10 g fresh sludge kg-1 soil) and a 120 mg kg-1 Cr treatment (20 g fresh sludge kg-1 soil). Control soil and the soil treated with 10g kg-1 sludge received NPK fertilizer in the form of ammonium sulfate, superfosfate, and KCl to rise the N,P, and K concentrations to similar levels to those achieved in the soils with the highest sludge dose (20 g kg-1). Soils from the different treatments were potted (5 L) and planted with Trigonella foenum graecum seeds (1 plant per pot). Plants were harvested in the vegetative stage and processed for tissue analysis of Cr, Fe, Zn and Pb. A sequential extraction procedure was applied to the soil for getting insight into the operationally defined soil fractions that incorporate the tannery sludge derived Cr. In any of the treatments Cr was detectable in the exchangeable and easily reducible fractions. In control soils around 10% of soil Cr was in the moderately reducible fraction and the rest in the residual fraction. Contrastingly tannery sludge amended soils incorporated most Cr in the moderately reducible fraction extracted by acid oxalate. This distribution in relation to plant Cr concentrations will be discussed.
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