Effect of composting on the mobility of arsenic, chromium and nickel contained in kitchen and garden waste

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The study was focused on evaluation of possible changes in As, Cr, and Ni mobility and fractionation during composting of kitchen and garden waste. Fresh bio-waste taken up seasonally was thoroughly mixed with woodchips in the wet weight portion of 3:1 and the mixture was put into batch-wise aerated fermenters under 3 air flow rates. An increased drop in exchangeable Cr and Ni was found in kitchen and garden waste after 12 weeks of composting, respectively. The exchangeable content of As decreased only during kitchen waste composting. The order of fractions in the final compost was as follows: residual > oxidizable > exchangeable > reducible. The proportion of Cr and Ni in exchangeable fraction decreased after composting more than 3- and 4-fold, respectively. Results proved that an intensive composting process is a suitable method for immobilization of Cr and Ni, and for decreasing total As contained in household bio-waste.

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1. Introduction


In most European countries, municipal solid waste contains about 50% of organic material basically consisting of a combination of kitchen and garden waste. Composting is one of the most efficient methods of handling bio-waste and enables recycling of organic matter to make use of the nutrients present in the waste (Epstein, 1997). Many countries introduced compost standards regulating product quality, including maximum total trace elements or potentially toxic elements concentrations (Madrid, 2010). For instance, Czech Decree No. 341/2008 Coll., on details of bio-waste handling regulates these elements in compost: As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, and Zn. Two groups of composts were established, based on qualitative parameters. The first group is intended for agricultural land, the second for non-agricultural purposes. The maximum total content of As, Cr and Ni for the first group is 10 mg/kg, 100 mg/kg and 50 mg/kg, respectively. Arsenic is a major concern, because its maximum concentration in compost intended for agricultural purpose is difficult to meet. The maximum levels in compost of the second group are mostly less strict and depend on type of use.

Compost standards throughout the world refer to the total concentration of these potentially toxic elements. However, the elements associated with different fractions have dissimilar impacts on the environment and their phytotoxicity connects to some forms rather than the total content. The sequential chemical extraction of elements can provide an understanding of chemical fractions and a predicting mobility, bioavailability and leaching rate (Tessier et al., 1979). For a better understanding of the potentially toxic element mobility in composts, the observation of potential changes in total and mobile element contents during composting were provided. Leita and DeNobili (1991) determined the water-extractable fractions of Cd, Zn, Cu, and Pb and investigated changes in water-soluble organic C during the complete composting of a pile of ground municipal solid waste. A progressive increase in total heavy metals concentrations during the composting period was not accompanied by a corresponding increase in the water-extractable amounts of metals. The influence of municipal solid waste composting on the concentration, water solubility, and phase association of Pb, Cd, Zn, and Cu at high concentrations in the starting materials, was studied more recently by Castaldi et al. (2006). They demonstrated that during composting, the heavy metals in the starting materials were redistributed from more labile and soluble forms to more stabilized ones.

The potential for excessive amounts of potentially toxic elements to contaminate food chains through municipal solid waste compost additions is thought to depend on the source material used in the compost and the final concentrations of potentially toxic elements in the compost (Veeken and Hamelers, 2002). Manual sorting of bio-waste by producers is more effective than dowline sorting of mixed waste (Richard and Woodbury, 1992). Amlinger et al. (2004) concluded that the potentially toxic element contents in manually source-segregated compost were

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