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太原市污灌区土壤镉存在形态与生物可利用性研究

Chemical speciation and bioavailability of cadmium in sewage-irrigated farm soils in Taiyuan关键词: [太原市](#) [污水灌溉](#) [镉](#) [形态分析](#) [生物可利用性](#)基金项目: [国家自然科学基金\(No.30740037\)](#); [国家公益性行业\(农业\)科研专项\(No.201103024\)](#); [太原市环保局资助项目](#); [山西省自然科学基金\(No. 201401103\)](#)

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摘要: 为了了解太原市污灌土壤镉污染现状,研究其存在形态特征与生物可利用性,本文采用 Tessier A 连续提取、石墨炉原子吸收等方法,测定了太原市污灌区土壤重金属镉的总量,研究了不同功能区、不同分层、不同化学形态的分布特征,并对生物可利用性进行了评价.结果表明,与太原市土壤背景值相比,污灌区土壤中重金属镉含量已达太原市土壤背景值的3倍,镉在土壤表层含量明显高于其它分层,均表明表层土壤有明显的镉累积.不同功能区土壤镉的含量大小不同,具体排序为:小店区>晋源区>清徐县.总体来看,研究区5种化学形态含量从大到小排序为:铁锰氧化物结合态>有机物结合态>碳酸盐结合态>残余态>可交换态.高的铁锰氧化物结合态与灌溉区土壤偏碱性且铁锰含量较高直接相关.分层土壤形态分析结果表明,镉在表层土壤含量最高,随深度增加镉含量逐渐降低,该变化与分层土壤pH值的变化相反,与上一层相比,各分层土壤不同形态分布变化,统计学检验无明显差异.生物可利用性评价结果表明,太原市污灌区土壤中镉相对比较稳定,但由于其潜在利用态的含量很高,因此,镉对环境的影响不能忽视.研究表明,太原市污灌区镉含量虽然没有超出土壤质量二级标准,但有积累趋势,形态分布特征表示的潜在生物可利用性应引起高度重视.

Abstract: To characterize the current cadmium pollution status, chemical species and bioavailability in sewage-irrigated farm soils in Taiyuan, Cd concentrations were analyzed using Tessier A sequential extraction followed by graphite furnace atomic absorption spectrometry. The distributions of different Cd species in different soil depths across different functional areas were investigated. The results showed that Cd concentration in sewage-irrigated farms was 3 times the background in Taiyuan. Most Cd was found at the surface layer, suggesting the main terrestrial sink for Cd accumulation. The variations were noted in Cd distribution in the functional areas with the following order: Xiaodian > Jinyuan > Qingxu district. The concentration of 5 Cd species generally declined in the order of: Cd bound to Fe and Mg oxides > Cd bound to organic matter > Cd bound to carbonates > Cd residual > Cd in exchangeable state. The high concentration of Cd bound to Fe and Mg oxides is directly related to the slightly alkaline soil with elevated Fe and Mg in the sewage-irrigated farmland. The morphological study demonstrated the highest Cd content at the surface layer, which declined along the soil depth. This is opposite to the trend of pH changes. No statistical difference in Cd species was observed in the other layers. The bioavailability assessment showed that Cd remained rather stable in the sewage-irrigated soils in Taiyuan. However, due to the high concentration of the Cd species of potential bioavailability, further environmental impacts should be addressed. In conclusion, although Cd concentration in the sewage-irrigated soils has not exceeded the Grade-II limits as defined in the Chinese Environment Quality Standard for Soils, the local Cd tends to accumulate with potential bioavailability and therefore should be preferentially controlled.

Key words: [Taiyuan](#) [sewage irrigation](#) [cadmium](#) [speciation analysis](#) [bioavailability](#)

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