Relative Oral Bioavailability of Metals in Coal Fly Ash

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Abstract:
Coal is a major source of electrical production in the United States. Coal fly ash is one of the predominant waste products formed as a result of the burning of coal for electricity. In recent years, there have been a number of coal ash spills throughout portions of the U.S. resulting in environmental and human exposure to coal fly ash and other waste products formed from the utilization of coal for electrical production. Specifically, elevated concentrations of a number of metals prominent in coal fly ash such as arsenic, chromium, lead, mercury, and thallium have been found in the water and soil around the areas where coal ash was spilled. In order to evaluate the potential health risk from coal ash-contaminated soil, an accurate characterization of the relative bioavailability (RBA) of metals in coal fly ash is necessary. Available coal fly ash RBA studies fail to utilize the standard U.S. EPA bioavailability methodologies, investigate only a limited number of metals, or do not provide data on bioavailability specifically through the route of ingestion. In the current pilot study, U.S. EPA’s validated in vitro bioaccessibility assays (IVBA) for lead and arsenic in soil and soil-like matrices were used to characterize and predict the in vivo RBA of 24 metals commonly identified as coal fly ash constituents from three different sources. Total metals analysis revealed mean concentrations of 23,780 mg/kg arsenic, 45.2 mg/kg total chromium, 21.2 mg/kg lead, 111 mg/kg mercury, and 1,860 mg/kg thallium. Results from the RBA analysis demonstrate that 1) metals such as arsenic and chromium present in coal fly ash may not be measurably bioavailable following ingestion and 2) there is limited bioavailability of certain heavy metals in coal fly ash, including zinc and thallium at percentages of 0.029 and 27, respectively. Therefore, the utilization of a modified absorption factor for metal constituents in coal fly ash could lead to more appropriate risk calculations when evaluating ingestion.