Evaluation of Bioaccessibility Methods to Predict Relative Bioavailability of Arsenic in Contaminated Soils

B.N. STEVENS[1]*, N.T. BASTA[1], S.D. WHITACRE[1], S.J. NABER[1], K.G. SCHECKEL[2], S.W. CASTEEL[3], K.D. BRADHAM[4] AND D. THOMAS[4]

[1]The Ohio State Univ., Columbus, OH, USA (stevens.728@osu.edu, basta.4@osu.edu, whitacre.39@osu.edu, sjn@stat.osu.edu)
[2]USEPA, Cincinnati, OH, USA (scheckel.kirk@epamail.epa.gov)
[3]U. Of Missouri, Columbia; (casteels@missouri.edu)
[4]USEPA, Research Triangle Park, NC, USA (bradham.karen@epa.gov, thomas.dave@epa.gov)

Soil arsenic (As) is a primary human health risk driver at many DoD, DOE, and USEPA sites. A comprehensive study between solid phase As speciation and soil binding mechanisms with in vivo and in vitro gastrointestinal (IVG) models used to estimate As relative bioavailability (RBA) are reported. Twenty-nine As-containing soils that represent a wide variety of As sources including; copper chromated arsenate, orchards, glass works, copper mining, smelter, pesticide, and gold mining were studied. RBA As was determined using the adult mouse or the juvenile swine model. Bioaccessible (IVBA) As in the study soils were determined using multiple in vitro gastrointestinal tests; the Solubility Bioaccessibility Research Consortium assay (SBRC) procedure, the Unified BARGE Method (UBM), the Physiologically Based Extraction Test (PBET), the OSU-IVG method, and a slightly modified OSU-IVG method. RBA As vs. IVBA As was fitted using a weighted linear regression and evaluated for goodness of fit, slope, y-intercept, prediction error, and compared against proposed acceptance criteria. Soil properties relevant to As solubility were determined; including total As, Fe, and Al, oxalate extractable As, Fe, and Al, pH, and organic carbon content. Solid phase speciation was determined using Extended X-Ray Absorption Fine Structure spectroscopy and linear combination fitting (LCF). Results of the LCF analyses suggest that the majority of soils are dominated by the As(V) sorbed to ferrihydrite like iron minerals. Approximately eight different As mineral phases were identified by LCF analyses. RBA As ranged from 4.0% to 80.0%. IVBA As ranged from <5% to >90%. IVBA As, determined by several in vitro methods, were strongly correlated (r^2 >0.7) with RBA As. Results from this study will lead to adoption of methods to measure bioaccessible As that predict RBA As.