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Development of a digestion technique for the determination of selected heavy metals in soil and sediments

K. Wekasinghe* and S. S. Subramaniam

Department of Chemistry, Faculty of Science, University of Kelaniya, Sri Lanka

*kwekasinghe13@gmail.com

The objective of this study was to develop a new method on soil digestion techniques because some metal ions such as Cd, Pb, Cu, Cr and Zn are chelated by many soil-organic matter and complexes are inaccessible using previously studied techniques. This method development as well as the analysis of total contents of Cd, Pb, Cr, Cu and Zn in soil and sediment were conducted in selected areas in Medawachchiya, Sri Lanka which is an area that is mostly affected with Chronic Kidney Disease of unknown etiology. In this regard, the random soil samples were taken from cultivated and uncultivated paddy fields and the banks of the tanks. Sediments were collected randomly from the banks of the tanks. Three different digestion methods were used to analyze the heavy metals in soil to select the best digestion method for heavy metal analysis in soil for further studies. All three digestion methods have different combinations and quantities of concentrated acids (i.e., HNO₃ and HCl) and H₂O₂. The heating methods were varied by using hot plate for one of the techniques (i.e., Gallenkamp) and microwave (i.e., Mars6 microwave digester) for the other two techniques. The digestion timing and temperature programming used are different in the three techniques. The results obtained using the Flame absorption spectrometer (i.e., GBC 2000, SavantAA) were analyzed. The results obtained for each technique were compared. Method spike recovery was conducted for the three methods to compare the difference, accuracy and effectiveness of each digestion processes. The concentration variation of heavy metals were as follows; Cd 1.0 mg/kg - 2.0 mg/kg, Cr 20 mg/kg - 60 mg/kg, Pb 10 mg/kg - 24 mg/kg, Zn 20 mg/kg - 110 mg/kg and Cu had the highest variation 20 mg/kg -170 mg/kg. Variation of the above values occur due to the variation of sample areas and environmental factors surrounding them. Further, the spiked method recovery for Zn suggests that the microwave-based digestion is more suitable for the analysis in soil. Results showed that the concentrations of Cu, Cr, Pb and Zn in soil were recorded within the permissible limits set by WHO. The Method LOD and LOQ suggests that the values obtained for Cd were not on the detectable limits and the use of GFAAS or any other sensitive analytical instrument is required for the analysis.

Keywords: Digestion, heavy metals, method development, sediment, soil

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