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Chemical Speciation Comparison of Drinking Water in North Central Province: An Affected Area of Chronic Kidney Disease of Unknown Etiology (CKDu) in Sri Lanka

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Abstract

Chronic Kidney Disease of Unknown Etiology (CKDu) is an increasing health issue in Sri Lanka. It is prominent in the North Central Province (NCP), Sri Lanka. This study mainly focuses on Chemical speciation modeling of drinking water in Padaviya, Madawachchiya, Kebethigollewa, Ruwanpura and Nuwaragampalatha central as affected areas in the NCP and Ampara as the reference area of CKDu. Chemical speciation is important for understanding bioavailability, chemical toxicity and environmental fate. Concentrations of major elements in water bodies were analysed and then how chemical speciation change according to the temperature, pH and ionic strength in water bodies were determined. Concentration of Ca^{2+} , Mg^{2+} , Fe^{2+} , Cd^{2+} , Cr^{3+} , Cu^{2+} , Mn^{2+} , Ni^{2+} , Zn^{2+} , Pb^{2+} , Al^{3+} and dissolved PO_4^{3-} , SO_4^{2-} , F^- , CO_3^{2-} and NO_3^- were used for chemical speciation modelling of drinking water in Ampara and affected areas. Visual MINTEQ version 3.0 software was used for the determination of the species distribution. Temperature varied from 25°C to 32°C and pH varied from 5.0 to 8.0. Among the metal ions considered above, only chemical species of Pb^{2+} , Al^{3+} , Cu^{2+} , Cr^{3+} and Cd^{2+} showed higher variations with pH and temperature change. AlF_2^+ , AlF_3 and AlF_2^{2+} species were formed only in affected areas. Ionic strength changed from 0.001 mol/kg to 0.01 mol/kg and the chemical species distribution of drinking water was also obtained from the software. The percentage of total concentration of Pb^{2+} , $\text{Pb}(\text{OH})^+$, $\text{Al}(\text{OH})_3$, $\text{Al}(\text{OH})_4^-$ and Fe^{2+} changed slightly. According to the results obtained, there can be formation of some species Al^{3+} , Cu^{2+} , Cr^{3+} and Cd^{2+} with the variations of the temperature and pH, which may have an effect on CKDu. Formations of different species were higher with the pH change than the temperature change. Different species which were formed mainly with F^- ion in affected areas may also have some significant effect on CKDu.

Keywords: Chronic kidney disease, Chemical speciation, Temperature, pH, Ionic strength