

Speciation Distribution of Analyzed Drinking Water in a CKDu Endemic Area in the Anuradhapura District

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Chronic Kidney Disease of Unknown etiology (CKDu) has been showing a spreading tendency among the agricultural zones in the North Central Province since the mid-1990s. Even though most of the studies have identified that the nephrotoxic heavy metal content in surface and ground water has not exceeded the permissible limits in the CKDu prone areas, long term exposure could influence on renal failures. The present study was attempted to study the chemical speciation of the contaminants in drinking water of CKDu endemic area in the Anuradhapura District. The areas selected for the study were Eppawala Grama-Niladhari division (GND) (8°8'33"N 80°24'10"E) in Anuradhapura District (Endemic site) and Dambethalawa GND (7°17'11.9"N 81°32'04.3"E) in Ampara District (Reference site). Nineteen drinking water samples from each sampling area were randomly collected. Basic physico-chemical parameters such as pH, conductivity, dissolved oxygen and Fluoride content were measured on-site. Concentrations of heavy metals (Cr, Mn, Fe, Cu, Zn, As, Cd, Pb) of the water samples were analyzed by ICP-MS (Agilent 7800) and counter-ion content (F⁻, Cl⁻, NO₃⁻, PO₄³⁻, SO₄²⁻) was analyzed by Ion chromatography (Methorm eco IC). Chemical speciation modeling was performed by using the Visual MINTEQ 3.1 software based on the obtained concentrations. According to the results, the average concentrations of Cr, Cu, Zn, As, Pb were complied with SLS values for drinking water while Mn and Fe concentrations from both areas have exceeded the SLS values which are 100.00 and 300.00 µg/L respectively. The Mn concentration of Eppawala and Ampara were 173.99 (10.39-485.59) µg/L and 129.27 (1.089-239.86) µg/L respectively and for Fe it was recorded as 383.14 (0.18-867.44) µg/L and 526.21 (0.85-897.25) µg/L. Since the samples were collected randomly, the presence of Mn and Fe as heavy contaminants in some sites might be the reason for having a wide concentration range. The mean F⁻ concentration of the Eppawala area was 1.80 (0.10-3.96) mg/L which exceeded the SLS maximum level (1.00 mg/L) while it was 0.45 (0.11-1.00) mg/L in Ampara which was below the SLS maximum limit. According to the speciation results, only species of Cr, Pb, Cd, Cu and Fe, namely Cr(OH)₃, CrOH²⁺, Pb²⁺, PbOH⁺, PbCl⁺, PbSO₄, Cd²⁺, CdCl⁺, CdSO₄, Cu²⁺, CuOH⁺, Fe(OH)²⁺, showed higher variations of percentage distributions under the tested pH range of 4 to 9. Higher percentage distribution values of CdCl⁺, CdSO₄, PbCl⁺, PbSO₄, ZnSO₄, MnSO₄, CuSO₄ were observed from the Eppawala area compared to Ampara area. Manganese, Cadmium, Zinc, Copper, Lead, Fluoride, Nitrate and Chloride species showed more tendency to exist as free ionic species such as Mn²⁺, Cd²⁺, Zn²⁺, Cu²⁺, Pb²⁺, F⁻, NO₃⁻, Cl⁻ at pH 7 while Chromium, Iron and Arsenic were found as Cr(OH)₃, Fe(OH)²⁺ and H₃AsO₃ at pH 7. Long-term exposure to different species formed by Cd, Pb, Cr, As and higher F⁻ concentrations may have some significant effects in causing CKDu.

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