

Thesis title:

Combating nephrotoxicity with a portable water purification system: An application to chronic kidney disease of unknown aetiology (CKDu) affected areas in Sri Lanka

Abstract:

Chronic kidney disease of unknown aetiology (CKDu) in Sri Lanka is a national concerning health hazard due to victims are facing a high rate of mortality per year. Pathogenesis of the disease has been supposed long-term exposure to fluoride, hardness, and cadmium in drinking water, which brings up nephrotoxic health hazards. Therefore, removal of fluoride, hardness, and cadmium is paramount important to provide safe drinking water to the community in disease prevalent areas. Available water treatment technologies in areas do not provide an appropriate solution to drinking water issues. Hence, there is a prerequisite to developing a reliable water purification unit to provide safe drinking water to the community. This study was, therefore, aligned to investigate the best combination of materials to remove fluoride, hardness, and cadmium along with faecal coliform, which brings up waterborne disease outbreaks in CKDu prevalent areas. Firstly, nephrotoxic risk factors in drinking water, their threshold levels, the level which components need to remove complying with the required drinking water guideline values were evaluated. Literature reported that fluoride (0.1–13.7 mg/L) and hardness (63.6–1921.0 mg/L) concentrations in water are very high, and the cadmium level was reported in trace level in potable water (0.003 mg/L). Different water filter units are (mainly reverse osmosis filter unit) used by people in CKDu areas to fulfil their daily potable water requirement. Therefore, the performance of available water treatment technologies in CKDu prevalent areas was evaluated to identify their effectiveness in the removal of fluoride, hardness, and cadmium. However, the treated water does not meet the required drinking water guideline values. Therefore, the risk assessment for RO treated water was conducted to identify their non-carcinogenic health effects due to long-run consumption. Long-run consumption of RO water brings non-carcinogenic health effects ($HQ > 1$) on people. Hence, the development of a new water treatment unit is of utmost essential to provide safe potable water for the community. The best combination of adsorbent materials among the industrial and nanomaterials was selected to remove fluoride, hardness, cadmium, and faecal coliform in water. The best combination of materials was investigated after conducting a series of batch and fixed-bed column studies in the laboratory. Treated water by the best combination of materials was endorsed with drinking water reference value considered in the study. The cost of 1 L of water production was calculated as Rs. 7.01 and the total cost of water production for a family with four members was calculated as Rs. 20,469.20/year. The best combination of materials in the multi-layer unit is an effective water treatment unit to remove fluoride, hardness, cadmium, and faecal coliform in drinking water.