5.7 ENVIRONMENTAL HEALTH RISK FOR THE CHRONIC RENAL FAILURE IN SRI LANKA

ENVIRONMENTAL HEALTH RISK FOR THE CHRONIC RENAL FAILURE IN SRI LANKA

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Abstract: The present study aims to establish any relationship between fluoride, aluminium utensils, and chronic renal failure. The current study was performed to assess the fluoride levels in ground water and its effect on the dissolution of aluminium from poor quality cooking utensils. The fluoride levels of water were measured using ion selective electrodes and the mean fluoride concentration of the samples was 2.3 ppm (n=27). Al concentrations were measured separately as free Al^{3+} and total Al using colorimetric method and atomic absorption method after keeping the samples two days in room temperature. The leached Al concentration was about 0.43 ppm in the absence of fluoride while it was about 3.0 ppm of free Al^{3+} and 11.87 ppm of total aluminium in the presence of 1.00 ppm of fluoride in water. In the areas of excessive fluoride in ground water, it has been shown that the fluoride contents in rock samples (drill cutting)varies from 95 to 1440 ppm [1]. There is about 25-fold enhancement of Al dissolution when 1.0 ppm of fluoride is present in the medium. It was observed that 1.00 ppm fluoride concentration gave maximum dissolution of aluminium. Here the involvement of fluoride for the formation of AlF_X has been proposed.

Introduction: Anuradhapura district is part of the dry zone of Sri Lanka. The vast majority of rural population depend both on ground water and surface water sources for their domestic water supplies. Special interest has been focused on the alarmingly high incidence of kidney failure in some parts of Sri Lanka. Since 1999 the number of incidences was 4095 while the number of deaths was 577 in one single district of the country.

At the levels of 0.4 ppm of fluoride in drinking water, renal impairment has been shown [2]. Many animal studies have reported kidney damage even at lower levels of fluoride exposure over longer periods of time. The aetiology of various clinical disorders monitored in patients with renal failure has been attributed to aluminium intoxication [3].

While the etiology of the chronic renal failure in Sri Lanka still remains a mystery some results on the geo-environmental factors of the region reveal some significant findings. A chance discovery made during field studies was that people exclusively use aluminium utensils and pits form in these utensils after continuous use. Water used by these people mostly comes from dug wells, that generally have high fluoride content in the range of 1.00-4.00 ppm with a median of around 1.3 ppm. Fluoridation of drinking water is in the midst of a controversy owing to studies showing a direct link between aluminium and fluoride to Alzheimer like symptoms in experimental animals. A cocktail of aluminium and fluoride laced water given to rats resulted in animals developing Alzheimer like symptoms, but their premature deaths were attributed to kidney failure [5]. The ability of the aluminofluoride complexes to penetrate the blood-brain barrier has been proposed as a possible explanation for this observation. The present study aims to establish any relationship between fluoride, aluminium utensils, and chronic renal failure.

Methodology: Madawachchiya, Padaviya area in the Anuradhapura district was selected for water sample collection and the field investigation. Plastic bottles, thoroughly cleaned with 15% v/v conc. HNO_3 acid were used for the sample collection. Fluoride concentrations of the water samples were measured using Orion 96-09 combination fluoride electrode (Thermo Electron Corporation, USA) and Orion model 520A pH/ mV meter. Calibration standards were prepared using AR grade NaF (BDH, England), and TISAB III concentrated with CDTA was used as ionic strength buffer.

In this study pieces of aluminium from a used aluminium pot were treated with water containing fluoride at different levels of 1.00-4.00 ppm. After two days of standing at room temperature, the amount of uncomplexed aluminium leached was measured by a colorimetric technique (aluminon reagent) and , a GBC Avanta GF 3000 graphite furnace installed in a GBC Avanta AAS with deuterium-arc background correction, and a PAL 3000 auto sampler was used to determine total aluminium. The equipment used, (vessles, Tefloan calibration flasks, pipettes, micropipette tips, and auto sampler cups) were thoroughly cleaned by soaking in 15% v/v conc. HNO_3, rinsed with deionized water and dried in dust free environment.The acids, calibration standards and chemical modifiers [$Al(NO_3)_3.9H2O$,$Mg(NO_3)$]used were of AR grade (BDH lab supplies, Poole, England). All the standards were prepared daily from 1000 mg L^{-1} stock solutions of Al^{3+} in 0.5 mol L^{-1} high purity nitric acid. These experiments were repeated with the presence of tartaric acid , and acidic ingredients like tamarind, vinegar, tomato, and lime juice in aluminium pots.

Results, Discussion and Conclusion: Fluoride concentrations of water samples varied from location to location but clear magnitude was not observed in tube wells and dug wells. In field investigation it was observed that the water levels of all the dug wells were below the weathered rock: It has been shown that the mineral constituent of the underlying rock in the dry zone contains high amounts of fluoride bearing minerals from which fluoride ions leach out into the water body [1]. Mean fluoride concentration of water in the study area was 2.3 ppm (Figure 1). Some animal studies [4,5] have reported kidney damage at lower levels of fluoride exposure over longer periods of time .

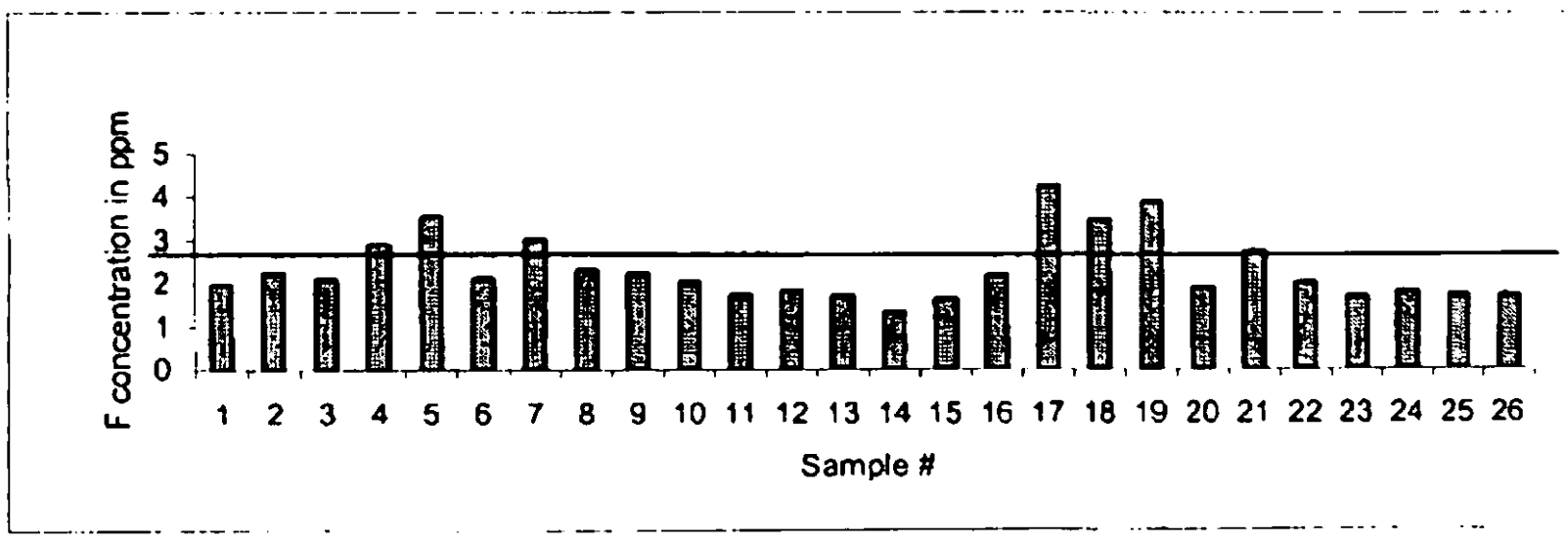

Figure 1. Fluoride levels of randomly selected drinking water sources in Padaviya.

Fluoride concentration of the area cannot be considered as low. These fluoride levels may have an affect on the kidneys with longer exposure.

The amount of aluminium leached out in the absence of fluoride was 0.43 ppm while in 1.00 ppm fluoride medium the free aluminium observed was 3.00 ppm and the total aluminium was 11.87 ppm (Table 1). Surprisingly, the amount of aluminium leached was

lower at higher concentrations of fluoride. This observation is similar to the results from studies on rats where lower concentrations of aluminium trifluoride produced more toxic effects than higher concentrations. In the presence of an acidic medium, using 2g L^{-1} of tartaric acid and 1.00 ppm fluoride, the aluminium leached was around 56 ppm which is a five–fold increase in the dissolution of aluminium. This experiment was performed owing to the widespread use of acidic ingredients like tamarind, vinegar, tomato, and lime juice during cooking in aluminium pots.

Table 1. Leached out aluminium ions from a cooking pot in the presence of fluoride ions

Applied fluoride concentration (ppm)	Uncomplexed aluminium (ppm)	Total aluminium (ppm)
0	0.431	0.42
1	3.073	11.88
2	2.239	6.717
3	0.363	3.45
4	0.175	2.949

Aluminium leaching under high fluoride stress and acidic spices results in the formation of aluminofluoride complexes such as AlF^{2+}, AlF_2^+, AlF_3, AlF_4^-, AlF_5^{2-}, AlF_6^{3-}, which are soluble and penetrate the blood-brain barrier. The stable AlF_6^{3-} complex has an overall formation constant of 6.76×10^{19}. The observation of both dental and skeletal fluorosis amongst the affected patients gives further credence to the hypothesis that aluminium and fluoride in combination could be a possible reason for the occurrence of chronic renal failure in areas with high fluoride in ground water. The current work reveals that the fluoride and aluminium contamination has high significance. Thus, the presence of fluoride in natural water and the high amount of contaminated aluminium intake through food web may be a potential factor for the prevalence of kidney disease in the dry zone of Sri Lanka, the problem that needs further attention.

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