

Role of fluoride and its enhancement by aluminium for the chronic kidney disease in the NCP, Sri Lanka

O.A.Ileperuma, KPR Pushpakumara and HA Dharmaguanwardane

*Departments of Geology and Chemistry, University of Peradeniya, Peradeniya,
SRI LANKA*

What is this problem of Chronic renal failure (CRF) ?

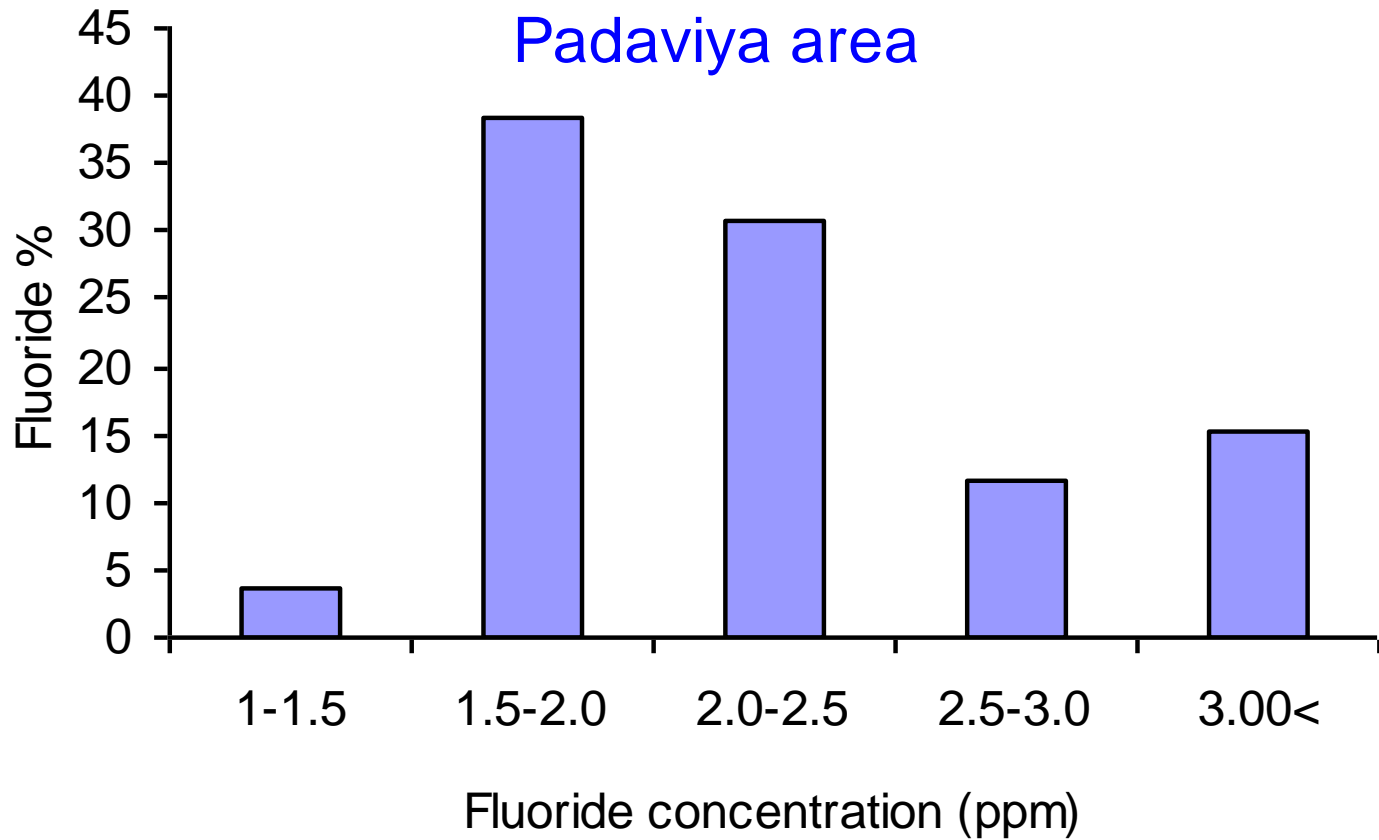
In Sri Lanka the North central province with a 6% population of the national population is facing CRF at an unprecedented proportion where the incidence of CRF has risen to 20% of all cases detected in the country

Prevalence in the affected areas is around 15%

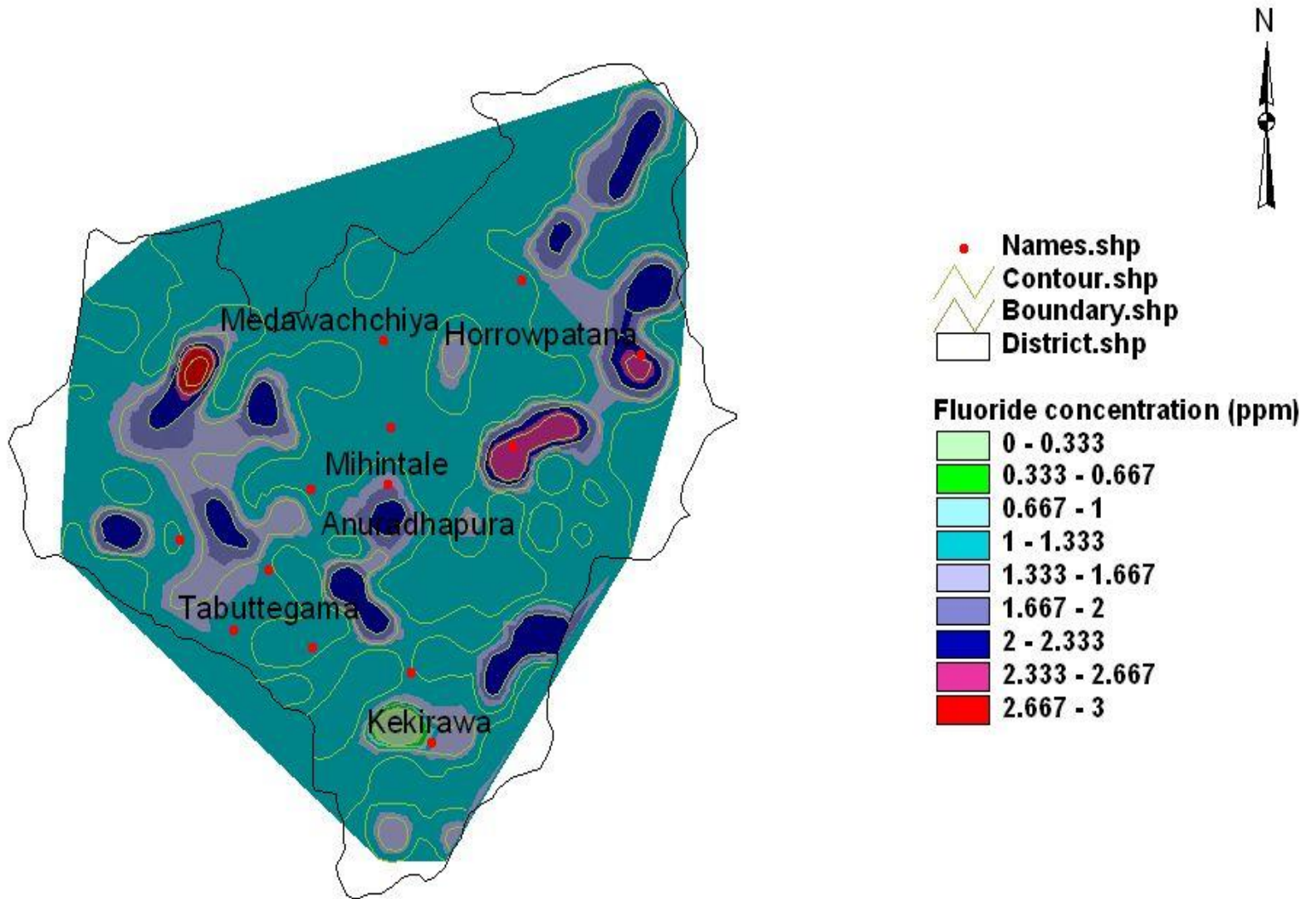
Sources of water

<u>Water source</u>	<u>%</u>
• Dug well	69.3
• Tube well	18.1
• Tap water	3.2
• Others	9.5

Ground water Fluoride distribution in Padaviya area



FLUORIDE DISTRIBUTION IN ANURADHAPURA DISTRICT



Some chance observations

- People exclusively use locally fabricated sub-standard aluminum utensils for cooking
- These develop holes through them after sometime
- Holes are soldered with a lead based solder

Previous studies linking aluminium and fluoride to kidney failure

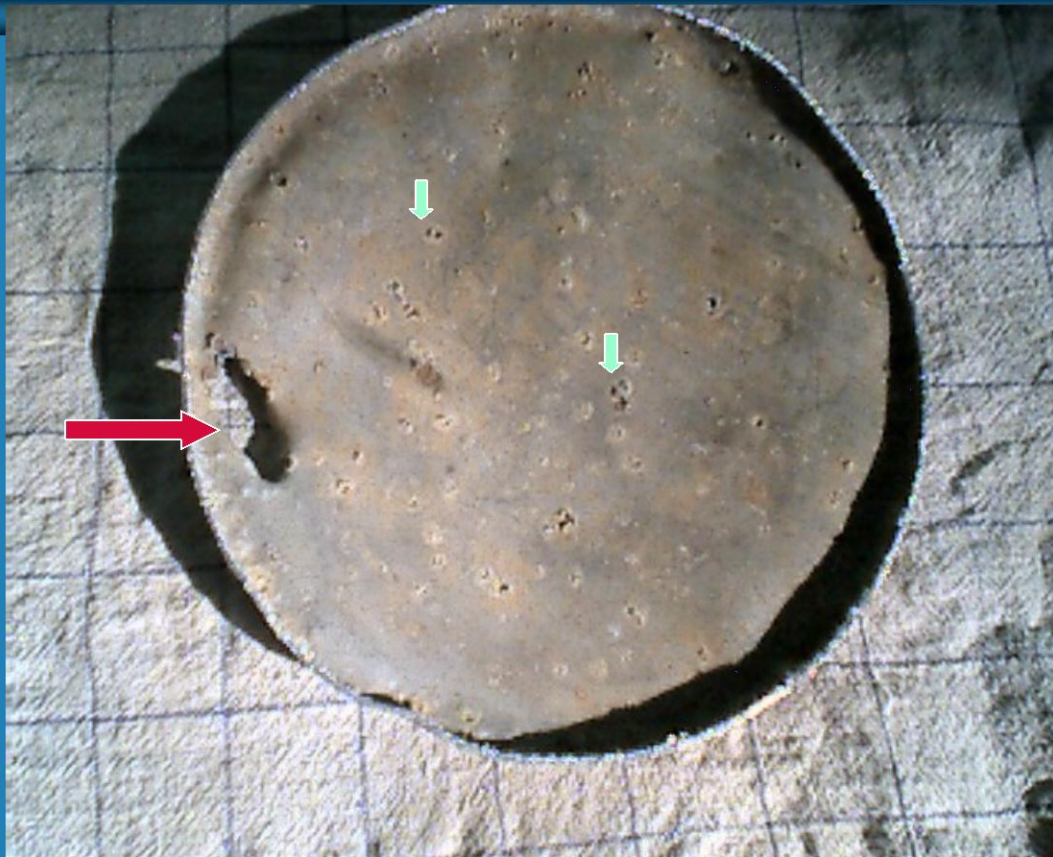
- Varner et al (Proc. NY Acad. Sci, 825(1997)152-166.)
- Al and F levels of 0.5 ppm (Aluminium) and 1 ppm(Fluoride) given to rats caused the death of animals after 45 weeks with only few deaths in the control group.
- Brain aluminium levels were much higher in rats given Al+F.
- Pathological changes in the kidneys with aluminium containing deposits located in blood vessels of the kidney
- **Rats died due to kidney failure**

Chemical analysis of a sample

Aluminium pot

<u>Element</u>	<u>Percentage</u>
• Cu	1.17
• Lead	0.82
• Zinc	1.52
• Ni	0.06
• Traces of Sb, As, Cr and Tl	

Dissolution of the utensils





**Welded Aluminium pot
using Pb**



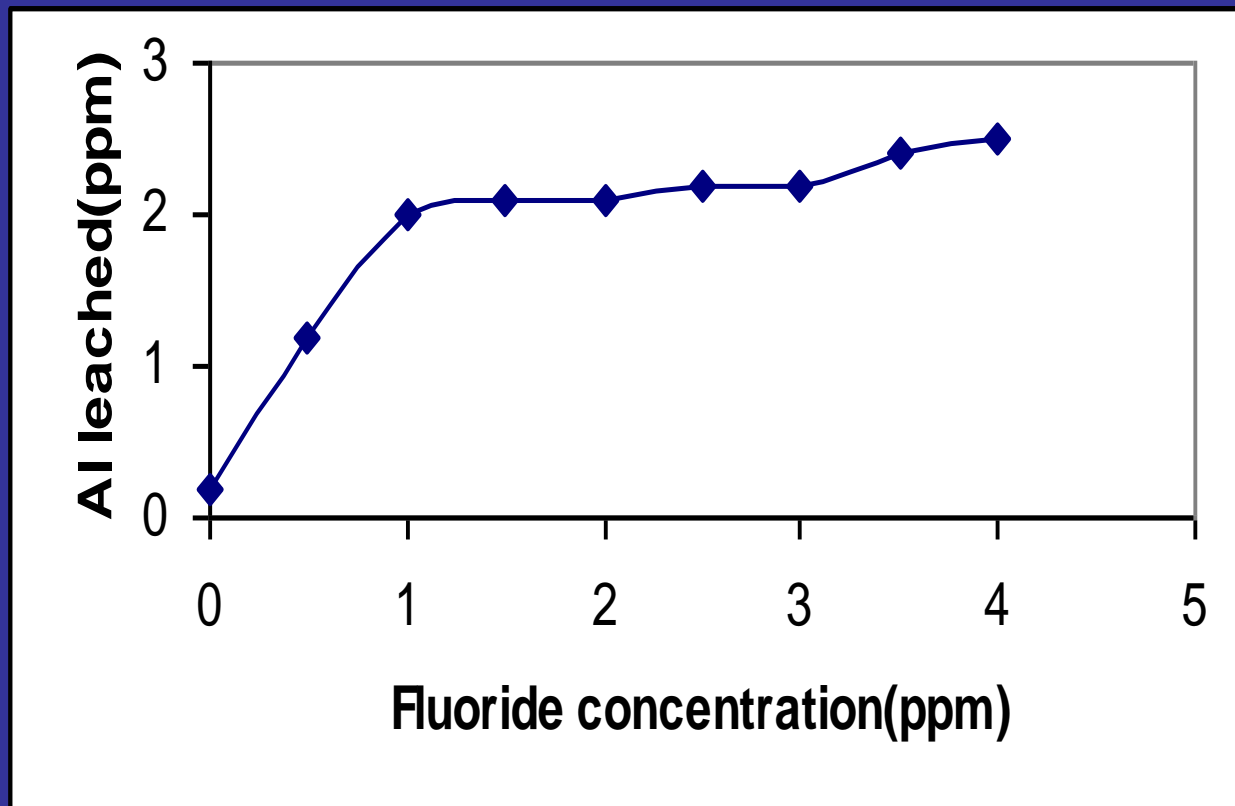


Raw materials

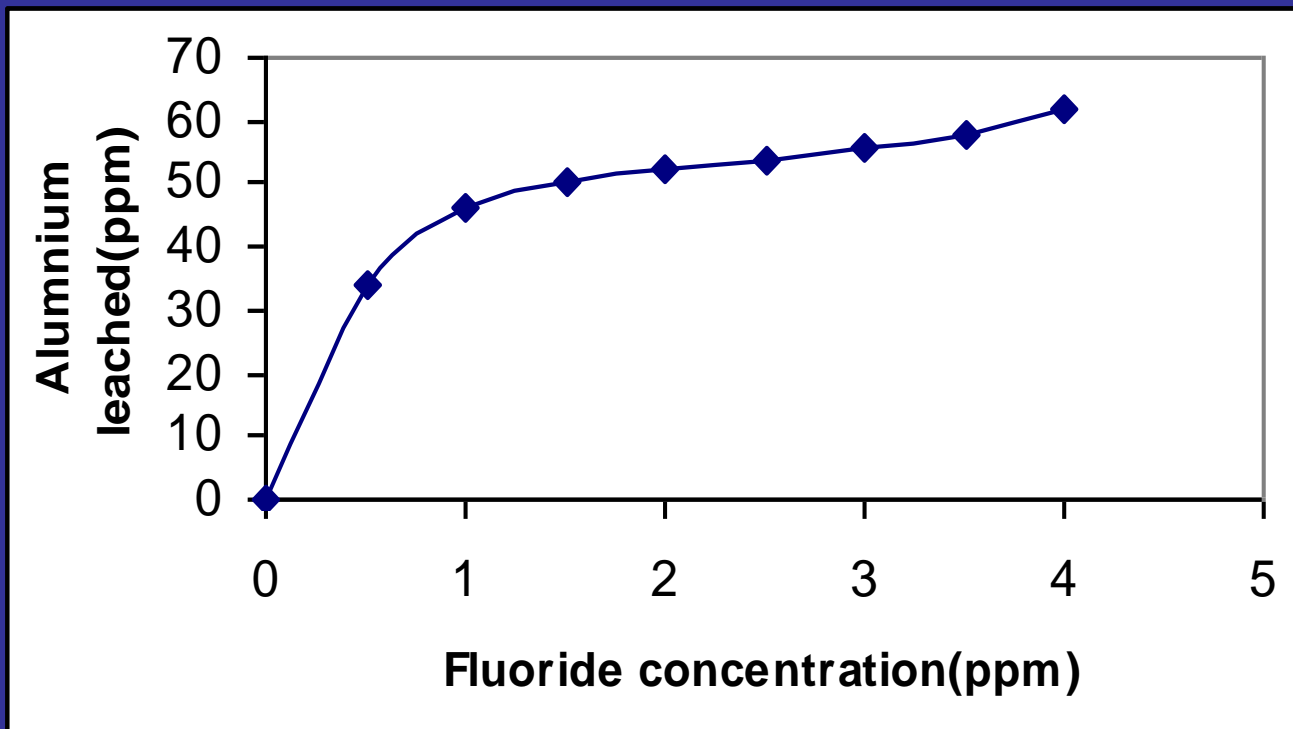
Working hypothesis

- Both aluminium and fluoride are essential factors in causing Chronic renal failure
- Fluoride enhances leaching of aluminium from cooking utensils
- In the presence of acidic components of food this combined effect is further enhanced

Al leaching in deionised water



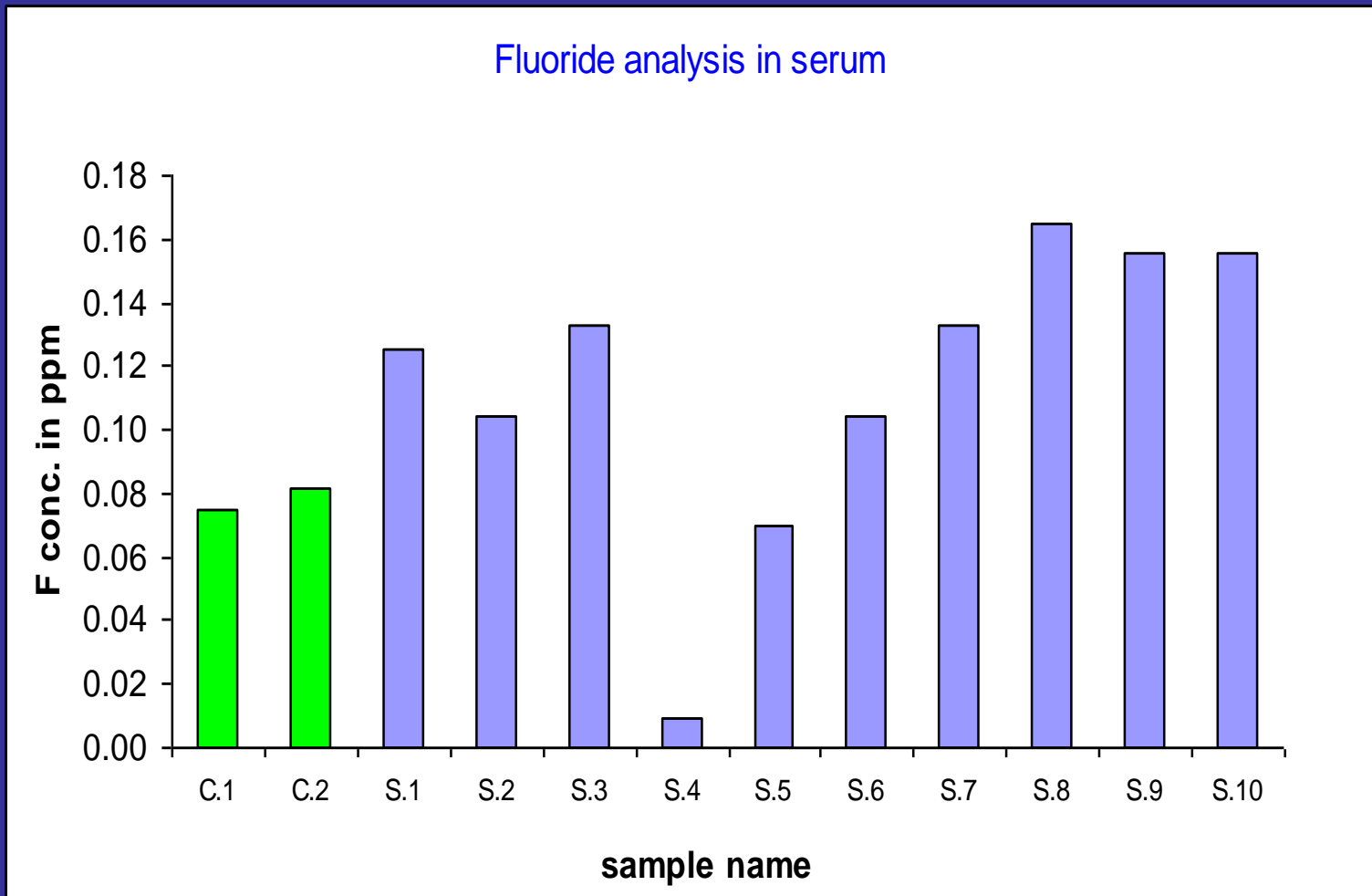
Al leaching in tamarind media



Al-F equilibria

- $\text{Al}^{3+} + \text{F}^- \rightarrow \text{AlF}^{2+}$ $K_1 = 10^{7.8}$
- $\text{AlF}^{2+} + \text{F}^- \rightarrow \text{AlF}_2^+$ $K_2 = 10^{4.9}$
- $\text{AlF}_2^+ + \text{F}^- \rightarrow \text{AlF}_3$ $K_3 = 10^{4.1}$
- $\text{AlF}_3 + \text{F}^- \rightarrow \text{AlF}_4^-$ $K_4 = 10^{2.6}$
- $\text{AlF}_4^- + \text{F}^- \rightarrow \text{AlF}_5^{2-}$ $K_5 = 10^{1.2}$
- $\text{AlF}_5^{2-} + \text{F}^- \rightarrow \text{AlF}_6^{3-}$ $K_5 = 10^{0.2}$

Fluoride analysis in Serum



Important clinical finding

- All renal failure patients at the Kandy nephrological unit suffer from dental and skeletal fluorosis

Studies from other countries

- Andrapradesh (Nalgonda district) has high fluoride content in drinking water often reaching over 7 ppm.
- A similar kidney disease has been reported from this district very similar to our CRF not attributed to hypertension or diabetes.

Arsenic and cadmium?

- WHO report does not explain why this disease is prevalent only in certain areas since all other areas use the same agrochemicals.
- It has exorbitantly high urine arsenic levels of 45 ppm while no other group in Sri Lanka found such values!
- No. of samples too small to make general conclusions.
- Urinary excretion of heavy metals is compromised at such high GFR values (< 50)
- No arsenic poisoning symptoms in any of the CKD cases
-

Arsenic and cadmium in Sri Lanka

- Wet zone and dry zone have the same arsenic levels
- There is no arsenic in rice.
- Arsenic in sea fish is about 3000 $\mu\text{g}/\text{kg}$
- Arsenic in air is about 1 ppb

Conclusions

- There is a positive correlation between high fluoride in water and kidney disease
- Aluminum may act as a carrier to transport fluoride through the blood-brain barrier and other biological membranes.
- Observation of skeletal fluorosis confirms our theory
- Importance of the fluoride filter assumes added significance