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Groundwater fluoride levels and health hazards, Udupi Taluk, Karnataka, India

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Fluoride concentration in drinking water has a physiological significance for humans and some animals. The recommended limit of fluoride in drinking water in India is 0.6-1.2 mg/l with a maximum permissible limit of 1.5 mg/l based on average of the maximum daily air temperature (Indian Standard Institution, 1983). So potable water should have 0.6-1.5 mg/l of fluoride for substantial protection against dental caries and tooth decay. But continuous high intake of fluoride (>1.5 mg/l) will result in mottled enamel of teeth, skeletal fluorosis and sometimes severe osteosclerosis. Therefore, it is desirable to have fluoride levels in groundwater above 0.6 mg/l but below 1.5 mg/l. Hence, an attempt is made here to assess the fluoride levels in the public wells of Udupi Taluk of South Kanara District, Karnataka State.

Study Area

The study area lies between 74°71' E and 74°57' E latitude and 13°4' N and 13°31' N longitude in the coastal zone of South Kanara District (*Figure 1*). The major rock types in the area are gneisses, granites, dolerites, laterites and alluvium. Laterites and lateritic soils of varying thickness are found extensively in the study area. The aquifers in the region occur in weathered and fractured crystalline rocks. Groundwater occurs under water table conditions in laterites and in alluvium and is tapped mostly by open wells. Groundwater is in confined/semi-confined conditions in fractured gneiss and granite and is exploited by tube wells.

Groundwater samples were collected from 61 public wells (51 tube wells and 10 open wells), during pre-monsoon periods of the year 1996. Fluoride concentration is detected by using ion-selective electrode method.

Occurrence of fluoride in groundwater

Concentrations of fluoride in groundwater are controlled by so many factors: climate of the region, presence of fluoride-bearing minerals in country rock, intensity of weathering etc. The chief sources of fluoride in the groundwater are fluorite (CaF_2), fluoro-apatite ($Ca_5PO_4.CaF_2$) and fluoride replacing hydroxyl in the ferro-magnesian minerals of the country rock. The content of fluoride in ground water commonly depends on the rock types from which they originate (Voroshilov, 1960). Natural concentration of fluoride in groundwater depends on the availability of fluoride in rocks or minerals encountered by the water as it moves along its flow paths, and on solubility constraints imposed by fluoride or fluoro-apatite. The concentration of fluoride in groundwater is limited due to the low solubility of most of the fluorides. The degree of weathering and the leachable fluoride in the soil is also a significant factor rather than the mere presence of fluoride bearing minerals in the rocks (Ramesam and Rajagopalan, 1985).

Analytical results show that most of the well samples of study area have a content of fluoride lower than the desirable limit (>0.6 mg/l) prescribed by Indian Drinking Water standards. About 86.9% of the total number of groundwater samples analysed show fluoride levels below the desirable limit and 13.11% of groundwater samples have fluoride levels between 0.6 and 1.5 mg/l. It is also observed that fluoride levels in groundwater of open wells are much lower than tube-well water. The average fluoride levels in groundwater of open wells and tube wells are 0.061 mg/l and 0.39 mg/l respectively. The low concentration of fluoride in the study area may be due to very rapid fresh-water exchange, especially during the rainy season. With the result, the normal processes of concentration through evaporation or evapotranspiration are not effective in raising the fluoride level. Since water from tube wells is drawn from deep-seated fractured aquifers, it is in contact with fluoride-bearing minerals of the country rock for much longer as it moves along its flow paths, which enables the groundwater to raise the level of fluoride more than groundwater in unconfined aquifers. According to Tamta (1994), the low fluoride content in the groundwaters undersaturated in $CaCO_3$ from South Kanara, North Kanara, Chickmagalur, Hassan, Coorg and Mandya districts of Karnataka State is attributed to the effect of intensive lateritisation in the region.

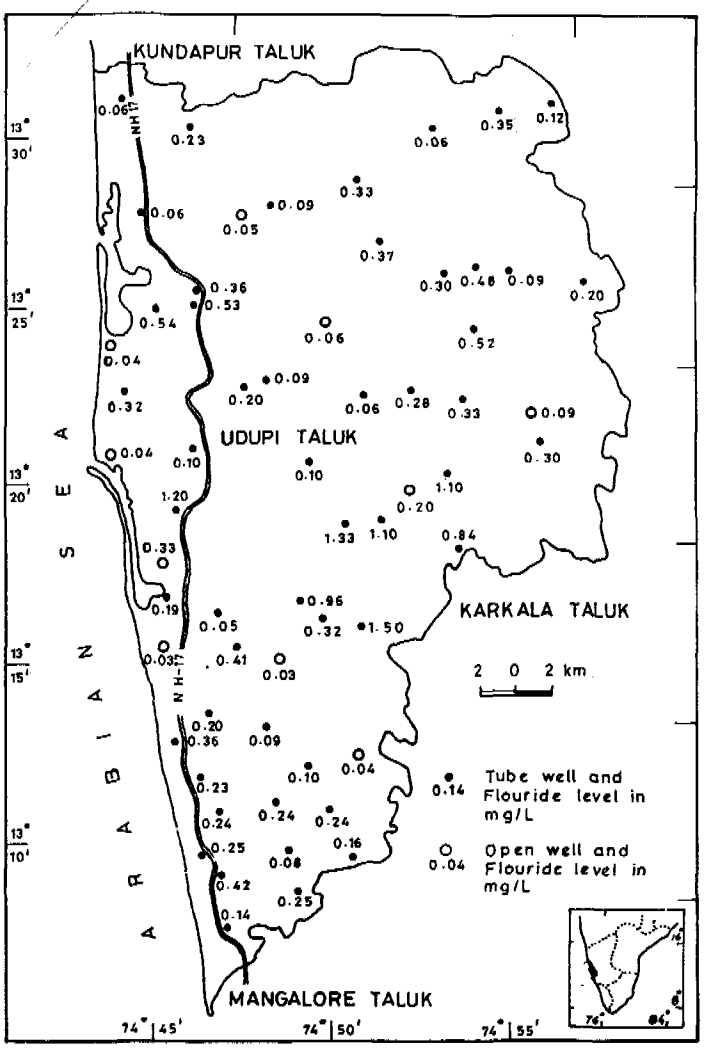


Figure 1. Locations of wells in Udupi Taluk from which groundwater samples were taken, showing the fluoride levels in mg/l. Open circles denote open wells, and filled circles are tube wells.

Fluoridation of drinking water

Fluoridation of water has substantial benefits in the prevention of denl caries among children. Commonly used compounds to fluoridate the public water supplies are NaF, CaF_2, H_2F_2, Na_2SiF_6, H_2Si_6 and $(NH_4)_2SiF_6$. All these compounds are, on hydrolysis, dissociated to fluoride ions. A study (Peng, Qi and Rubin, 1996) shows that water fluoridation with a bed packed with natural mineral fluorspar can be more practical for small communities located in warm climates with soft-water sources. It can also be done by fluoridated toothpaste and mouth rinses, professional fluoride treatments and fluoride dietary supplements. Though use of these products may be responsible for the decline in tooth decay, the inappropriate use is likely to contribute to the observed increase in the prevalence of mild forms of dental fluorosis (Frederick, 1991). Fluoride-rich foods like sea-fish and tea (EPA, 1976), which compensate for the low fluoride in groundwater, may be used.

Fluoridation of drinking water is not recommended generally in India due to the fact that surface water and almost all the food materials contain certain amounts of fluoride and about 1.70 mg/l of fluoride is injected into our body by daily consumption of food and water (Tamta, 1994).

Conclusion

The present study shows that concentrations of fluoride in most of the groundwater samples from public wells of Udupi Taluk are less than the desirable limit of drinking-water standards. The low content of fluoride in groundwater is attributed to very rapid fresh-water exchange during the monsoon period. Fluoridation of drinking water may be supplemented with fluoride-rich dietary supplements.

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The Nigerian cement industry – strategies for meeting national requirements by the year 2010

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The vast expansion of building and highway construction to provide residential and office accommodation in Nigeria, as well as roadways, has created an unprecedented demand for cement. At present, issues of provision of housing units and shelter is only surpassed by food in terms of national importance.

Cement production is a useful index of the growth of the Gross National Product of a country. In Nigeria is is estimated that annual cement production is 2.8-3.0 million tonnes, while national demand is over 7 million tonnes. Considering the local availability of raw materials and cheap sources of energy, the situation indicates that the continued importation of cement as a long-term measure of bridging this shortfall is unacceptable as it inhibits the proliferation of such a basic industry within the country.

The strategies which could be favourably adopted over the next decade to increase cement production rapidly, with a view to meeting national demand by the year 2010, include the following:

- Planned refurbishment and expansion of existing plants with a view to achieving both modernization and improved utilization of capacity;
- Concerted effort on the establishment of mini-cement plants in various parts of the country, with each plant serving its immediate environs within a radius of 200 km.