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RIVER WATER FLUORIDE IN KENYA

JK Gikunju,[a] KW Simiyu, PB Gathura, M Kyule, LW Kanja
Nairobi, Kenya

SUMMARY: Fluoride determinations were made with a fluoride ion selective electrode on 60 river water samples collected at readily accessible sites in Central and Nairobi provinces of Kenya. The highest fluoride concentration was 0.85 ppm in Laikipia District and the lowest was 0.08 ppm in Murang'a District. By region and district, the mean fluoride concentration ranged from 0.12 ppm for rivers in Laikipia to 0.24 ppm for rivers in Nairobi, with 0.32 ppm in the Upper Basin of the Athi River. The results indicate that the rivers are relatively low in fluoride and are therefore safe in this respect for domestic and industrial use.

Keywords: Fluoride in water, Kenya, Nairobi, River water fluoride.

INTRODUCTION

The geology of Kenya makes it one of the countries in the world where fluoride occurs in highest concentrations, not only in rocks and soil, but also in surface and ground water.[1] The highest water fluoride concentrations occur in certain springs, boreholes, and some lakes in the Rift Valley.[2] In two previous studies we have determined the fluoride levels of some of these waters.[3,4] For health safety, the Kenya Bureau of Standards recommends a maximum of 1.5 mg fluoride/L (1.5 ppm) in drinking water.[5]

Owing to rapid population growth in Nairobi City and in the rural central provinces, it has become increasingly difficult to find sufficient fresh water supplies for domestic and industrial use that have not been disturbed or contaminated by human activity.[6] As sources of fresh water, rivers are generally low in fluoride, but many factors affect the concentration of fluoride in them, such as temperature, pH, and the nature and porosity of the rocks and soils over which they pass.[2] Because of the uncertainty of these variables, the present study was undertaken to determine fluoride levels of rivers in Central and Nairobi provinces of Kenya and thereby evaluate the potential risk of fluorosis to people drinking and using these waters.

MATERIALS AND METHODS

A total of 60 water samples were collected in 1996 at convenient roadside sites: 40 from the Upper Basin of the Athi River and 20 from rivers in Nairobi and Central Kenya districts of Kirinyaga, Laikipia, Murang'a, and Nyeri. As in our earlier studies,[3,4] samples were collected in clean 500 mL polyethylene bottles, transported in a cool box to the laboratory, and then stored at -20°C before analysis. Fluoride was determined using an Orion® model 94-09 and model 96-09 combination fluoride electrodes. Millivolt

[a]For Correspondence: Dr JK Gikunju, Dept. of Public Health, Pharmacology and Toxicology, Faculty of Veterinary Medicine, College of Agriculture and Veterinary Sciences, University of Nairobi, P.O. Box 29053, Nairobi, Kenya. E-mail: phealth@nbnet.co.ke

readings were taken on 3.0 mL portions of samples adjusted to pH 5.0-5.5 after mixing with 0.3 mL of TISAB III (total ionic strength adjustment buffer, Orion® 94-09-11).

For calibration, 0.30 mL of TISAB III was mixed with 3.0 mL portions of standard solutions containing 0.02, 0.10, 1.00, and 10.0 ppm F^- prepared by diluting a 100 ppm F^- stock solution (Orion® 94-09-0) with deionized water. A nearly linear calibration curve was drawn by plotting the average millivolt reading for each standard against the fluoride concentration on semi-logarithmic paper.

RESULTS AND DISCUSSION

For the most part, fluoride levels in the river water samples showed only small zonal variations. The highest level was 0.85 ppm in Laikipia District and the lowest was 0.08 ppm in Murang'a District. Tables 1, 2, and 3 summarize the results for the two sets of samples. The mean for all samples was 0.3 ppm with a standard deviation of ± 0.2 ppm. Levels tended to be higher in the drier parts of the regions.

Table 1. Fluoride levels in water samples collected in 1996 from rivers and streams in the Upper Athi River Basin of Kenya

Range of fluoride concentration (ppm)	Number of samples (percent)
0 - 0.09	4 (10.0)
0.1 - 0.39	27 (67.5)
0.4 - 0.69	5 (12.5)
0.7 - 0.99	4 (10.0)

Table 2. Fluoride levels in water samples collected in 1996 from rivers and streams of Central and Nairobi provinces of Kenya

Range of fluoride concentration (ppm)	Number of samples (percent)
< 0.7	19 (95)
0.7	1 (5)
> 0.7	0 (0)

Table 3. Fluoride levels in river and stream water samples by region or district collected in 1996

District	Province	Mean F conc.(ppm)
Laikipia	Central	0.12
Murang'a	Central	0.16
Kirinyaga	Central	0.17
Nyeri	Central	0.19
Nairobi	Nairobi	0.24
Upper Athi River Basin	Central and Nairobi	0.32

In order for rivers to attain high levels of fluoride, special conditions must be present which usually do not occur on the surface but only in the ground. Ordinarily, a long contact time between water and fluoride-bearing minerals is needed, and therefore river waters are not expected to be high in fluoride. As already noted, the river water fluoride in this study was fairly low, with 36 (90%) of the samples from the Upper Athi River Basin and 19 (95%) of the 20 samples from rivers and streams in central and Nairobi districts being below 0.7 ppm. Our findings also agree with those of an earlier survey by Gitonga and Nair, who found that only 13 (9%) of the 150 river samples in Kenya contained more than 1.2 ppm fluoride.[7] In another early survey, Williamson examined 33 rivers and 12 lakes in Kenya and found low levels of fluoride in most of the rivers but extremely high levels in some lakes.[8] Those rivers that were high in fluoride were usually near high-fluoride lakes.

The river fluoride levels in our study are all fairly low, and the risk of fluorosis from them is therefore minimal. Thus river waters in Central and Nairobi provinces of Kenya do not pose a potential health hazard and may be used for domestic and industrial purposes. Dietary and other sources of fluoride must be taken into account, however, because water is just one of many sources of fluoride intake. Nevertheless, further fluoride surveys of rivers in other parts of the country should be made.

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