An inter-laboratory comparative study of fluoride determination in water

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Abstract

South Africa is on the brink of implementation of mandatory fluoridation of municipal water following the final approval by Parliament in 2001. The ability to accurately measure fluoride in water is an obvious prerequisite for the safe and effective implementation of water fluoridation. This paper evaluates the current status of fluoride determination in water in South Africa. The study was undertaken by the University of Johannesburg in collaboration with the South African Bureau of Standards as part of their ongoing Water-Check Programme. River water, borehole water, and synthetic water samples were sent to 66 participating laboratories in South Africa in March 2004. The results obtained from the analysis of 7 fluoride-containing samples with varying matrix composition, show that 50% of the laboratories could achieve results that fall between a lower limit of -20% and an upper limit of +20% relative to the true value. The precision (%RSD) for the determination of samples with fluoride concentration at the important level below 0.5 mg/ℓ was poor, ranging from ±20% at 0.5 mg/ℓ to ±100% at 0.1 mg/ℓ. The two major analytical techniques used by the participating South African laboratories were ISE (40%) and IC (36%).

Keywords: fluoride determination, inter-laboratory study, water fluoridation

Introduction

The Department of Health in South Africa has legislated regulations in respect of fluoridation of potable water supplies in September 2000 (Department of Health, 2000). The final regulations were approved by Parliament in September 2001. South Africa is therefore awaiting the implementation of mandatory fluoridation of municipal water up to a level of 0.7mg/ℓ. The addition of F^- to drinking water up to this level has been approved because of its much publicised beneficial effects on reducing the incidence of dental caries (Underwood, 1977; Murray et al., 1991). The possible negative effects of over-exposure to F^-, dental and skeletal fluorosis (Liu, 1995; Chen et al., 1993, 1996; Butler et al., 1985; Richards et al., 1967) are also well known. F^- has a relatively narrow range between intake associated with beneficial effects and exposures causing negative effects. As levels of fluoride are increased, the risk of dental fluorosis increases more rapidly than the decrease in dental decay. Because of the small margin of safety between beneficial and toxic levels of F^-, the consequences of accidental overdosing could be serious. The ability to accurately measure fluoride concentration in water is therefore an obvious prerequisite for the safe and effective implementation of water fluoridation. In a recent paper (Haarhoff, 2003) it was pointed out that any measurement error, e.g. a modest systematic underestimation of fluoride before and after dosing, will be compounded during the required feedback loop in the dosing procedure resulting in a significant overdose.

The purpose of this study was to evaluate the current status and proficiency of South African laboratories with regard to fluoride determination in water. The study was undertaken in collaboration with the South African Bureau of Standards (SABS) as part of their ongoing Water-Check Programme. Water-Check is a high-frequency inter-laboratory proficiency testing programme with the objective of providing a rapid report-back service to participants for self evaluation. A set of F^--containing solutions with different matrix compositions and some containing elements that could interfere with the fluoride determination, was included in the test samples sent out to the participating laboratories. This was done to evaluate the effect of matrix composition and common interferences on routine F^- determination in South Africa. A secondary aim was to collect information with regard to the types of analytical technique currently used in South Africa for F^- determination and to compare their performance capabilities.

Test samples

The SABS despatched test samples to 66 participating laboratories on 1 March 2004. The return date for results was set as 31 March 2004. The set of 7 samples used in the fluoride proficiency study contained two unpreserved natural water samples, a river water (Sample 2004/03/1) and a borehole water (Sample 2004/03/2) sample, and 5 synthetic water sample concentrates (Samples 2004/03/4/5/6/7 and 8). The composition of the synthetic samples is given in Table 1. The synthetic samples were prepared using AR grade chemicals. The sample compositions were designed to assess the effect of Al interference (Sample 2004/03/4)the F^- concentration level(Sample 2004/03/4/6/7), and varying matrix composition such as the inclusion of formate ions (Sample 2004/03/6 and 7) on F^- determination.

Samples for analyses were prepared by pipetting 20 mℓ of the concentrate solutions into 500 mℓ volumetric flasks and diluting to volume with deionised water.

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