

# Appropriate Technology

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Prathip Phantumvanit, Yupin Songpaisan, & I. J. Möller

## A defluoridator for individual households

Excessive amounts of fluoride in the water of northern Thailand cause dental and skeletal fluorosis. A cheap and simple defluoridator has been developed which reduces the fluoride content and provides water that is clean, colourless and odourless and has an improved taste.

In the developing countries many people, especially in rural areas, are still consuming untreated water from lakes, rivers, surface wells, boreholes or artesian wells, which often contains biological or chemical agents detrimental to health. In over 95% of drinking-water sources the fluoride content is below the level needed for the prevention of dental caries; on the other hand, in some areas the water supplies contain excess fluoride, which causes dental and skeletal fluorosis.

Sea water contains fluoride at concentrations of 0.8–1.4 mg/litre. The fluoride content in water obtained from lakes, rivers or artesian wells is mostly below 0.5 mg/litre, although concentrations as high as 95 mg/litre have been recorded.

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Dr Phantumvanit is Associate Professor in the Dental Faculty, Chulalongkorn University, Henri Dunant Road, Bangkok 10500, Thailand. Dr Songpaisan is Senior Officer with the Intercountry Centre for Oral Health, Ban Nong Hoi, Chiangmai-Lanphun Road, Muang, Chiangmai 50000, Thailand. Dr Möller is Regional Officer for Oral Health, WHO Regional Office for Europe, 8 Scherfigsvej, DK-2100 Copenhagen Ø, Denmark.

Water with a high fluoride content is usually found at the foot of high mountains and in areas with certain geological formations, particularly those of marine origin. Typical examples are belts extending from Turkey through Syria, Jordan, Egypt, Libya and Algeria to Morocco, from Egypt through Sudan and Kenya to Tanzania, and from Turkey through Iraq, Iran, Afghanistan, India and northern Thailand to China. Since fluoride, as it occurs in drinking-water, is colourless, odourless and tasteless, its presence in excess only becomes evident if chemical analysis is performed or if cases of dental or skeletal fluorosis are found.

The shortcomings of most defluoridation methods are:

- high cost of plant;
- high operational and maintenance costs;
- low capacity for removing fluoride;
- lack of selectivity for fluorides;
- undesirable effects on water quality;
- generation of sludge that is difficult to handle;

- complicated procedures.

Our objective was to develop a defluoridation device suitable for use by individual households in villages of northern Thailand. The requirements for such a device are that:

- the capital investment and the maintenance and treatment costs should be small;
- it should be simple in design;
- villagers should be able to prepare and change the active ingredients;
- it should have the capacity to reduce fluoride content from approximately 5 mg to less than 0.5 mg/litre;
- it should improve water quality in general;
- the ingredients should maintain their activity for an acceptable period of time.

### The ICOH defluoridator

The ICOH defluoridator was developed by the Inter-country Centre for Oral Health, Chiang Mai, the Dental Faculty of

**The filter remains active for 1–3 months, depending on the initial fluoride level and the amount of water consumed.**

Chulalongkorn University, Bangkok, and the World Health Organization. It is based on the filtration and absorption principle and uses charcoal and charred bone meal (1). Several experiments were performed to determine the required amounts and proportions of the active ingredients in relation to the amount of water that could

be defluoridated before they had to be replaced, the amount of fluoride retained, and the flow rate of the water.

The device consists of a container and a filter (see figure). The container is made of a piece of polyvinyl chloride pipe, 75 cm long and 9 cm in diameter, with an outlet tap at the bottom and a cap with a small hole for water intake at the top. The filter comprises a bottom layer of 300 g crushed charcoal, mainly for absorption of colour and odour, a middle layer of 1000 g charred bone meal, and a top layer of approximately 200 g clean pebbles to prevent the intermediate layer from floating.

The middle layer is prepared using bone meal of 40–60 mesh size, as produced for agricultural or industrial purposes, which is activated by heating in an electric furnace to a temperature of 600° C for 20 minutes. After the material has cooled, batches of 1000 g are weighed out.

In order to assemble the filter column, 300 g of crushed charcoal are placed in the bottom of a plastic bag measuring 10–12 cm in diameter and 80 cm in length. It is important that the bag is slightly wider than the polyvinyl container because it has to be folded over the rim so that water cannot enter the drinking-water jar without having the excess fluoride removed. A hole is cut at each of the two corners at the base of the bag so that filtered water can pass out. The filter bag is placed in the container and 1000 g of charred bone meal, followed by 200 g of pebbles, are poured into the bag. A hole is then made in it at the level of the tap.

Well water, usually stored in a clay jar, is siphoned to the top of the defluoridator by means of a small plastic tube and a flow rate of 4 litres an hour is obtained. The defluoridated water is collected in another jar directly under the tap.

In the prototype, the ingredients were packed directly into a column made from a piece of bamboo stem, which eventually cracked, allowing the growth of fungi and bacteria.

defluoridator also retains impurities such as sand, clay and dust, so the treated water is clean, colourless and odourless and has an improved taste.

### Laboratory studies

Laboratory investigations were conducted into:

- the most practical dimensions for the container;
- the type and volume of the filter ingredients;
- the flow rate of the water through the filter;
- the quantities of water of different fluoride concentrations that could be defluoridated using one filter bag;
- the chemical and biological content of water before and after defluoridation.

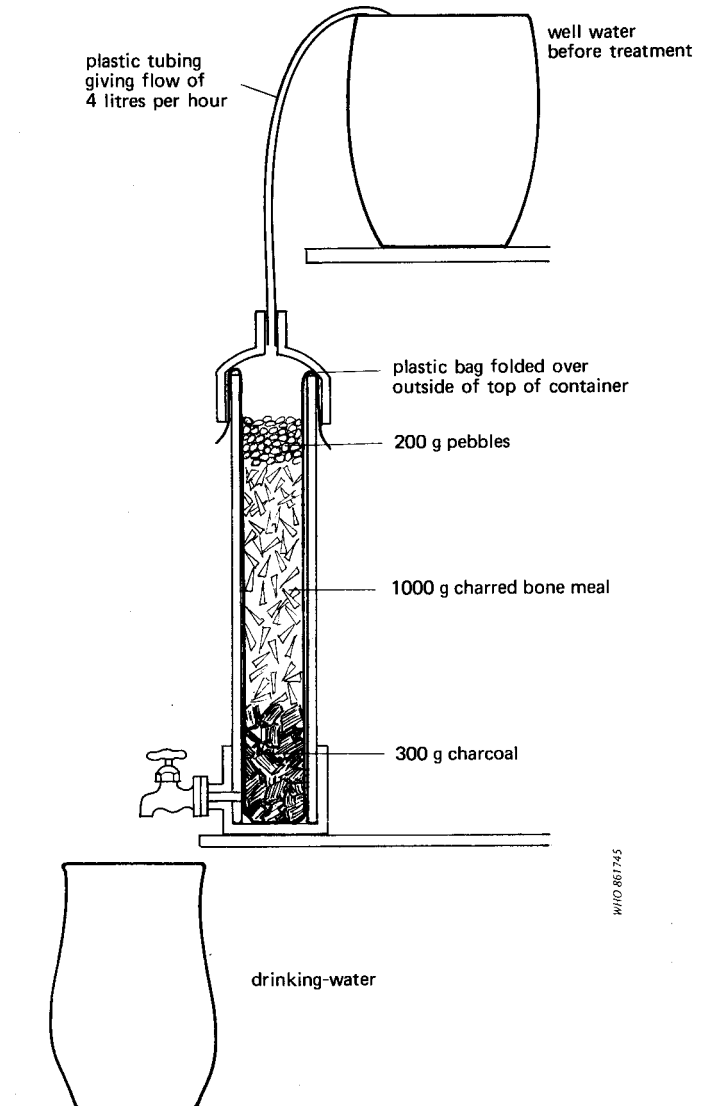
With a flow rate of 4 litres an hour the defluoridator reduced the fluoride content of 480 litres of water from 5 mg to less than 1 mg/litre. The first 20 litres of filtered water are normally discarded, after which the water is clean, odourless and ready to be used for drinking or cooking.

The chemical and biological constituents of filtered water were within the limits recommended by the World Health Organization (2). The

### Field testing

The ICOH defluoridator has been tested in 100 households in two districts of Chiang

The ICOH defluoridator



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Mai Province in northern Thailand, where the natural fluoride content in the water is between 3 and 7 mg/litre (3). The filter remains active for 1–3 months, depending

**With a flow rate of 4 litres an hour the defluoridator reduced the fluoride content of 480 litres of water from 5 mg to less than 1 mg/litre.**

on the initial fluoride level and the amount of water consumed. It is requested that the defluoridated water be used only for drinking and cooking. The daily handling of the defluoridator and the periodic changing of the filter cause no problems for villagers. No special persuasion is necessary in order to get villagers to use the defluoridator; the provision of cleaner water with a better taste is incentive enough. In fact, the defluoridator has become so popular that many villagers not in the trial are inquiring about its commercial availability or asking permission to share the treated water.

The initial capital cost of the ICOH defluoridator is approximately US\$ 4.00 and the cost of the ready-to-use filter bag is approximately \$ 0.70. It is intended to provide the villagers with a high-temperature furnace so that they can prepare the filter ingredients themselves and thereby reduce running costs, and to design a defluoridator that can provide safe water for a whole village or community.

A problem connected with the present method of preparation of charred bone meal is presented by the disagreeable smell of burning fats released from bone meal in the furnace. However, it is hoped to design a high-temperature furnace with a continuous feed mechanism that will allow the preparation of larger quantities of charred bone meal, with a drainage system permitting the removal of fats as they are deposited and thus reducing the smell. □

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2. *Guidelines for drinking-water quality*. Geneva, World Health Organization, 1984.
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# General Surgery at the District Hospital

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for the district hospital conclude this richly illustrated text.

## **General Surgery at the District Hospital**

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World Health Organization 1988,

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*General Surgery at the District Hospital* is the second of three handbooks to be published by the World Health Organization for the guidance of doctors providing surgical and anaesthetic services in small district hospitals with limited access to specialist services. The first handbook, *Anaesthesia at the District Hospital*, was published in May 1988. The final volume, on orthopaedics and traumatology, and obstetrics and gynaecology, will appear in 1989.

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