Introducing Fluoride Removal Filters to Ethiopia

Bone char-based filters, developed by the Catholic Diocese of Nakuru, Kenya, are being tested in rural Ethiopia in a collaborative project between Eawag, Addis Ababa University and Kenyan, Ethiopian and Swiss NGOs. Annette Johnson[1], Lars Osterwalder[1], Feleke Zewge[2], Raymond Rohner[3], Peter Maina Mutheki[4], Esayas Samuel[5]

According to estimates of the Ethiopian Ministry of Water and Energy, more than 14 million people in the Ethiopian Rift Valley region rely on fluoride-contaminated drinking water. The basaltic rocks in that region are the main sources of fluoride. Over 40 % of deep and shallow wells are contaminated with up to 26 mg/L of fluoride, a value significantly higher than the current WHO guideline of 1.5 mg/L [1]. Mitigation of this health problem has been hampered mainly by the lack of a suitable and inexpensive removal method. A switch to treated surface water for drinking is being discussed. Yet, fluoride removal systems in rural communities are necessary since successful implementation of such systems is still inexistent in Ethiopia.

A collaborative project between Eawag, technical and social scientists at Addis Ababa University, Oromo Self-Help Organization (OSHO), the Catholic Diocese of Nakuru Water Quality Section (CDN WQ), and Swiss Interchurch Aid (HEKS) mitigates fluorosis in rural Ethiopia. We are assessing technical performance, user acceptance and optimal institutional setting of bone char-based community and household filters for sustainable implementation. Two filters are being tested: the first contains bone char (BC), the second a mixture of BC and calcium-phosphate pellets (known as contact precipitation (CP) or the Nakuru Technique) [2]. The pellets prolong filter life by additionally precipitating insoluble fluorapatite. With the substantial support from the Ethiopian government's National Fluorosis Mitigation Project Office, we expect to reveal the potentials and limitations of fluoride removal technologies.

In April 2010, a CP community filter was built by OSHO in Wayo Gabriel, and 200 fluoride removal household filters (BC and CP) were distributed in three villages around Wayo Gabriel. The water price for the community filter was set with the local WASH committee, village and Woreda officials at 0.50 Birr per jerry can (current exchange rate: 18 Ethiopian Birr/USD). This water price should allow the water committee to cover around 50 % of the replacement costs of filter material, the caretaker's salary and raw water fee. The household filter price was set at 40 Birr, covering only 10 % of total filter cost. Weekly water measurements of fluoride, pH, turbidity, and arsenic were conducted at the community filter and at seven household filters. Dataloggers were used to monitor water consumption (cf. page 4). While the fluoride content of the treated water at the community filter is still below 1.5 mg/L, household filters containing BC have already been replaced with CP. In some household filters, filled with CP material, the media was replaced for 120 Birr (50 % of total filter material cost).

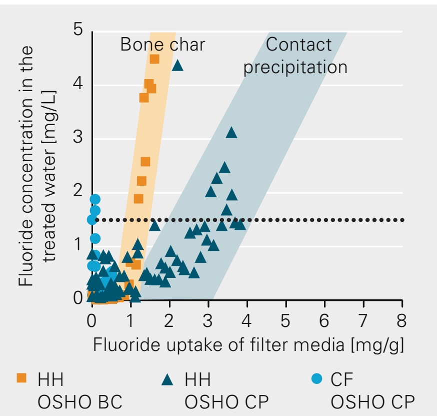

Figure 1: Fluoride uptake capacity from field tests in Ethiopia of one CP community filter (CF CP), seven CP household filters (HH CP) and three BC household filters (HH BC). Shaded areas show ranges for BC and CP obtained from previous tests in column, household and community filters at CDN WQ and Eawag [3].

Filter performance

Uptake capacity of Ethiopian BC and CP household filters, and CP community filter correlates with average uptake capacities for BC and CP filters tested in laboratory columns and in the field in Kenyan household and community filters (Fig. 1). The high fluoride concentrations in the community filter at the beginning were caused by initial operational problems.

For BC and CP filters, the average uptake capacity is about 1.2 and 3 mg F/g, respectively, before treated water exceeds 1.5 mg F/L. The greater variability of the uptake capacities of CP filters is attributed to factors contributing to calcium and phosphate concentrations available for fluoride co-precipitation within the filters [3]. Fluoride uptake capacity is critical for the economic viability of filters. Higher fluoride uptake capacities of CP filters result in lower costs for treated water, though the price for pellets produced and sold by CDN WQ is higher than that for bone char.

Outlook

Monitoring, filter material and construction costs appear to favour CP community filters. OSHO has constructed a furnace and started BC production with support from CDN WQ. OSHO plans to implement additional CP community filters and eventually produce pellets in Ethiopia. Our collaborative project will allow to support these activities. We hope that bone char-based technologies will soon turn into viable fluoride mitigation options in Ethiopia.

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[2] Müller, K. et al. (2008): Improving fluoride removal efficiency, Sandec News No. 9, p. 6.

[3] Mutheki, P.M. et al. (2011): Comparative performance of bone char-based filters for the removal of fluoride from drinking water. 35th WEDC Int. Conference, Loughborough, UK.

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This is an Eawag cross-cutting project on WRQ aiming to develop a framework to mitigate drinking water contaminated by arsenic and fluoride (www.wrq.eawag.ch)

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