Figure 2: Microbial quality of drinking water in rural Kenyan and Ethiopian households – impacts of defluoridation filters

Background
Geogenic fluoride contamination of drinking water affects the health of 100s of millions worldwide. The Great Rift Valley in Eastern Africa is particularly affected. In Ethiopia and Kenya, bone marrow, which contains calcium carbonate, is used to remove fluoride from drinking water in household and community defluoridation systems. The Catholic Diocese of Nakuru (CDN) has distributed defluoridation filters in Kenya, which removes fluoride from pure stocks measured with flow cytometry. Laboratory validation studies showed that E. coli colonies on the plates matches expectations based on dilutions from pure stocks measured with flow cytometry. Water quality deterioration between the point of collection and the point of consumption (samples collected from a household cup).

Methods
Compact Dry plates (Nassau) were used to measure microbial water quality among Ethiopian and Kenyan households using defluoridation filters. E. coli (EC), Total Coliforms (TC), and Enterococci (ETC) were measured. 1 mL samples were added directly to the plates, while larger volumes (10-100 mL) were filtered through cellulose membranes (0.45 μm). Microbial water quality was monitored in ten household filters and nineteen community filters over three months. Standard community filters, using borehole sources, showed similar microbial counts before and after treatment. In remote areas where polluted surface water was used, filters reduced bacteria levels by about 90%. However, water quality in general deteriorated between the community filter and the point of consumption (samples collected from a household cup).

Kenya
In collaboration with the Gromo Self-Help Organization (GSHO) and Swiss Interchurch Aid (HEKS), several hundred household filters and one community filter (Shibere) have been introduced to communities in the Rift Valley, where fluoride levels range from 3-18 mg/L. In Ethiopia and Kenya, bone char with calcium phosphate pellets (the "Nakuru process") is used to remove fluoride from drinking water in household and community defluoridation filters. Some of the household filters use ceramic or glass filters to remove fluoride from water. In Ethiopia, ceramic candle filters (Stefani) to remove fluoride from drinking water in households, and built more than 100 defluoridation filters in Kenya. Defluoridation filters on average have a modest positive effect on microbial quality, especially when source water is of poor quality. Neither the sand pre-filter used in Ethiopia nor the ceramic candle filters used in Kenya significantly reduced bacteria counts. Simple addition of copper coils to treated water reservoirs did not result in significant water quality improvements.

Ethiopia
The Great Rift Valley is a public health threat in East African countries. However, the disease burden posed by faecal contamination of drinking water is significant in the Ethiopian households surveyed, but gross contamination is commonplace in the Kenyan households visited. In both countries, water quality deteriorates significantly between the point of collection and household storage containers. Unclean drinking vessels further add to pathogen intake.

Conclusions
Defluoridation filters on average have a modest positive effect on microbial quality, especially when source water is of poor quality. Neither the sand pre-filter used in Ethiopia nor the ceramic candle filters used in Kenya significantly reduced bacteria counts. Simple addition of copper coils to treated water reservoirs did not result in significant water quality improvements.


diagram

Moderate faecal contamination of drinking water is common in the Kenyan households surveyed, but gross contamination is commonplace in the Ethiopian households visited. In both countries, water quality deteriorates significantly between the point of collection and household storage containers. Unclean drinking vessels further add to pathogen intake.

Widespread fluoride exposure is causing a significant public health threat in East African countries. However, the disease burden posed by faecal contamination is likely even larger. This does not mean that fluoride mitigation efforts should be shelved, but rather that they should be implemented as part of integrated efforts to improve sanitation and hygiene as well as water quality.

References


Figure 3: Household, standard community, and remote community defluoridation filters in Kenya.

Figure 4: (a) E. coli counts at 20°C, 25°C, and 45°C. (b) E. coli counts at 20°C and 45°C.

Table 1: Household water quality at point of consumption. Bacterial counts are geometric means, CFU/100 mL.

Table 2: Household water quality at point of consumption or filter tap. Bacterial counts are geometric means, CFU/100 mL.