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**WATER, SANITATION AND HYGIENE:  
SUSTAINABLE DEVELOPMENT AND MULTISECTORAL APPROACHES**

**Effectiveness of different household water treatment approaches for people living with HIV/AIDS in Africa**

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*Adults and children living with HIV/AIDS are more susceptible to microbiological contamination of water. The 2008 WHO guidelines for people with HIV state that the “lack of ... safe water and safe management of human waste exposes people with HIV to increased risk of transmission of waterborne and other enteric pathogens.” A number of different household water treatment (HWT) approaches can potentially be used depending on local availability in a particular area. Some examples of effective HWT are biosand filters, ceramic filters, SODIS, combined flocculation-chlorination and chlorination. For water sources with high turbidity (seasonally or year round) the effectiveness of the HWT approach under high turbidity conditions should be considered as part of selecting the appropriate HWT approach. Biosand filters, ceramic filters, flocculation-chlorination, and SODIS are effective at removing or inactivating *Cryptosporidium* and pathogenic bacteria commonly associated with persistent diarrhea depending on the turbidity of the water source. Combining chlorination with a preceding turbidity and *Cryptosporidium* oocyst removal step potentially provides optimal HWT for people living with HIV/AIDS.*

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## **Introduction**

Adults and children living with HIV/AIDS are more susceptible to microbiological contamination of water. For example, infants with HIV infection had an 11 times increased risk of death largely due to persistent diarrhea in a study in Africa by Thea et al. 1993. Diarrhea has been found to be four times more likely among children with HIV and seven times more likely among adults with HIV compared to HIV-negative household members (Mermin et al. 2004). Diarrhea also reduces the absorption of antiretroviral therapy medications (Isaac et al.,2008) and can even contribute to developing HIV strains that are resistant to antiviral agents (USAID and CDC, 2008). Effective water treatment is also critical for infants who may be formula fed by HIV positive mothers to prevent mother-to-child transmission after birth; without treatment safe water for infant formula is often not available in many parts of Africa. In Uganda, an 18 month study found that water treatment reduced diarrheal illness by 25% among adults with HIV (Lule et al. 2005). The 2008 World Health Organization report *Essential Prevention and Care Interventions for Adults and Adolescents Living with HIV in Resource-Limited Settings* states that diarrhoea is a major cause of illness and death in people with HIV and that the lack of safe water and safe management of human waste exposes people with HIV to increased risk of transmission of waterborne pathogens (WHO, 2008a).

## **Household water treatment approaches for people living with HIV/AIDS**

Household water treatment (HWT) technologies have been shown to significantly improve water quality and reduce diarrheal illness (Fewtrell et al. 2005). In the 2008 Addendum to its Guidelines for Drinking-water Quality, the World Health Organization (WHO) concludes that “HWT technology has the potential to have rapid and significant positive health impacts” (WHO 2008b). For people living with HIV/AIDS in Africa, treating water for pathogenic forms of *E. coli*, *Cryptosporidium* and other waterborne pathogens is essential to reduce diarrheal illness caused by poor quality drinking water. Since bacteria are very susceptible to disinfection, bacteria are efficiently removed or inactivated by HWT. However effective household water

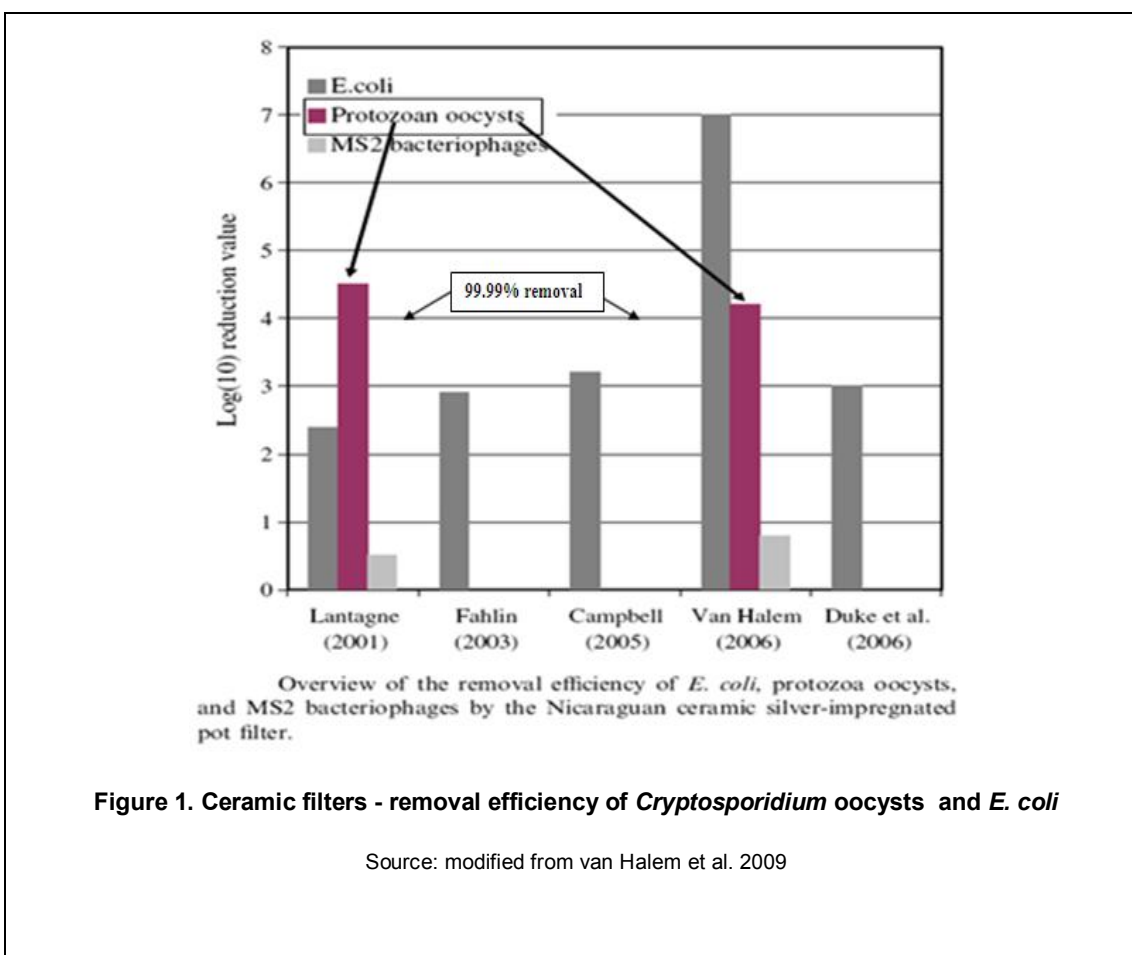
treatment for *Cryptosporidium* is also important because Cryptosporidiosis is a leading cause of persistent life threatening diarrhoea in HIV infected patients (Ajjampur et al. 2007). Despite the small size of *Cryptosporidium* oocysts and their resistance to chlorination, there are a number of HWT technologies that are highly effective at removing or inactivating *Cryptosporidium* as discussed below. In addition, boiling is highly effective at inactivating *Cryptosporidium*.

## SODIS

SODIS uses natural ultraviolet sunlight to treat water in plastic bottles and is highly effective at inactivating *Cryptosporidium* and bacteria (McGuigan et al. 2006). Since March 2004, the Kenya Water for Health Organization (KWAHO) has implemented a SODIS project that has reached 6,000 households and two schools (31,000 persons). The project covers the three villages of Makina, Kambi Muru and Kisumu Ndogo, with 180,000 inhabitants located in the large Kibera slum south-west of Nairobi.

## Ceramic filters

Ceramic filters are highly effective at removing *Cryptosporidium* oocysts (Figure 1) and bacteria. The Massachusetts Institute of Technology (MIT) is active in Ghana working with local NGO, Pure Home Water (PHW) which distributes and sells ceramic filters called Kosim filters. PHW estimates that approximately 100,000 people are being reached with the filters (Johnson et al. 2008). Research conducted by MIT (Peletz, 2006) determined that children under five in households with the *Kosim* filter had 42% less risk of diarrhoea than children under five from households without the technology. Post-distribution monitoring indicated that sustained use of the filter is related to initial education about filter use and continued presence in the community by the implementing organization (Jackson and Murcott, 2008). In a study in Zimbabwe and South Africa (du Preez et al. 2008) found the incidence rate of diarrhoea was 83% less for ceramic water filter users.



**Figure 1. Ceramic filters - removal efficiency of *Cryptosporidium* oocysts and *E. coli***

Source: modified from van Halem et al. 2009

## Biosand filters

The Biosand Filter (BSF) is a slow sand filter adapted for use in the home and is highly effective at removing *Cryptosporidium* oocysts (Logan et al. 2001) and bacteria. The U.S. Environmental Protection Agency has granted slow sand filters a 3 log (99.9%) removal credit for removal of *Cryptosporidium* oocysts. BSFs have been installed in households in many countries in Africa (see Table 1). The Centre for Affordable Water and Sanitation Technology (CAWST) has provided BSF trainings in a number of countries in Africa, usually partnering with African NGOs. In 2007, CAWST conducted household water treatment trainings in Kenya, Namibia, Nigeria, Sudan, Tanzania, Uganda and Zambia.

## Flocculation-chlorination

Turbidity can be a problem for surface water sources during the rainy season when *Cryptosporidium* is a particular risk. In 1995, the U.S. Centers for Disease Control (CDC) signed an agreement with the Procter & Gamble Company that led to the development and evaluation of PuRTM, a household water treatment option for sale at no profit to users and NGOs. Use of PuR results in high removal rates of bacteria and *Cryptosporidium*, even in highly turbid waters (Souter et al., 2003). The small sachet contains powdered ferric sulfate (a flocculant) and calcium hypochlorite (chlorine). PuR has been distributed in Kenya through SWAK-Nyanza which was first introduced to PuR during pilot studies conducted by the CDC between 2002 and 2004. PuR comes in a very small plastic sachet and each sachet can treat 10 L of water. Since 2004, Population Services International (PSI) has included the marketing of PuR in Uganda as part of its program there. The introduction of PuR is part of a safe water education program that includes targeting vulnerable groups including people living with HIV/AIDS. PuR is available in retail outlets and pharmacies in Uganda. In 2006, in response to hundreds of infant deaths from diarrhoea, PSI/Botswana introduced PuR in Botswana and promotes it through commercial retail outlets with special targeting of persons living with HIV/AIDS.

## Chlorination

Household water treatment chlorination projects, liquid chlorine and more recently chlorine tablets, have been implemented in a number of countries in Africa (Table 1). The London School of Hygiene and Tropical Medicine is currently conducting research on an assessment of a household chlorination project implemented by Kenya Red Cross targeting a population with HIV/AIDS. A study in Uganda found that the CDC Safe Water System reduced diarrhoea illness by 25% (Lule et al. 2005). Since chlorine alone is not effective against *Cryptosporidium*, it is possible that adding another household treatment technology to remove *Cryptosporidium* prior to chlorination could result in an even greater reduction in diarrheal illness.

<b>Treatment method</b>	<b>Performance and Operation &amp; Maintenance Issues</b>	<b>Examples of countries where the technology has been used in Africa</b>
Biosand Filters	If water is very turbid (> 50 NTU) either more frequent cleaning or pre-filtration is needed	Cameroon, Ethiopia, Kenya, Namibia, Niger, Nigeria, Sudan, Tanzania, Uganda, Zambia
Ceramic Filters	Needs frequent cleaning if water is very turbid	Burkina Faso, Ghana, South Africa, Zimbabwe
Flocculation-chlorination	Excellent for very turbid waters but costs may be more than some other options. Needs regular supply of chemical packets	Cote d'Ivoire, Democratic Republic of the Congo (DRC), Ethiopia, Kenya, Liberia, Malawi, South Africa, Uganda, Zimbabwe
Solar Disinfection (SODIS)	Requires relatively clear water (< 30 NTU). Needs 2 days to adequately treat if > 50% cloudy	DRC, Ethiopia, Ghana, Kenya, Mozambique, Togo, Uganda, Zambia, Zimbabwe
Chlorination	Reduced effectiveness for very high turbidity water unless preceded by filter or used with flocculant	Angola, Cameroon, Ethiopia, Guinea, Kenya, Madagascar, Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda, Zambia

## Conclusions

People living with HIV/AIDS in Africa are very vulnerable to waterborne diseases in general. *Cryptosporidium* causes persistent diarrhoea and can cause increased mortality in people with HIV/AIDS in Africa, the majority of whom don't have access to antiretroviral medications. A number of household water treatment (HWT) systems are effective at removing or inactivating *Cryptosporidium* and/or pathogenic bacteria commonly associated with persistent diarrhoea depending on the turbidity of the source. Examples include biosand filters, ceramic filters, flocculation-chlorination, and SODIS.

For water sources with high turbidity (seasonally or year round) the effectiveness of the HWT approach under high turbidity conditions should be considered as part of selecting the appropriate HWT approach.

Combining chlorination with a preceding turbidity and *Cryptosporidium* removal or inactivation step potentially provides an optimal HWT for people living with HIV/AIDS.

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