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REPOSITORY RECORD

Johnson, Sophie M., Rachel Peletz, and Susan Murcott. 2019. “Results from Household Ceramic Filter Evaluation in Northern Ghana”. figshare. https://hdl.handle.net/2134/30034.

REFEREED PAPER

**33rd WEDC International Conference, Accra, Ghana, 2008**

ACCESS TO SANITATION AND SAFE WATER:
GLOBAL PARTNERSHIPS AND LOCAL ACTIONS

# Results from household ceramic filter evaluation in northern Ghana

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*This paper outlines Pure Home Water's efforts to promote household drinking water treatment and safe storage (HWTS) products to low income customers in the Northern Region of Ghana and describes the research performed to improve upon PHW's success. Epidemiological surveys and water quality testing were conducted in January 2006 and January 2007 in order to obtain baseline data on drinking water and sanitation practices and to evaluate the effectiveness of PHW's program. It was found that traditional communities have a great need for access to improved water supplies, and PHW is effectively reaching these households by offering ceramic filters at a segmented market price and by managing several marketing campaigns. The surveys found that users are satisfied with the product. According to the water quality tests, the filters are performing well in the field; in traditional households, for example, E. coli removal rates averaged 99.7% when tested with membrane filtration.*

## Introduction

### The northern region of Ghana

Ghana is located in West Africa and has a total area of about 240,000km$^2$ and a population of approximately 22.5 million. The Northern Region is less developed than districts further south in Ghana; the under-five childhood mortality rate is significantly higher in the Northern Region, at 154 deaths per 1,000 live births (GSS 2004). The major causes of diarrheal disease are a lack of appropriate hygiene, safe and sufficient drinking water, and adequate sanitation. Fifty percent (900,000 out of 1.8 million) of people in the Northern Region lack access to an improved water supply (GSS 2004).

### Pure home water

Pure Home Water (PHW) is a social enterprise established in 2005 to promote household drinking water and safe storage (HWTS) products to low income customers in the Northern Region of Ghana. Currently, PHW's main focus is on the promotion and sale of the Potters for Peace-type ceramic pot filters, locally known as *Kosim* filters. In the first year, PHW planned to breakeven after two years and therefore sold the *Kosim* filters at almost US$20/system. This led to low sales of only 556 systems in the first year, and customers were exclusively urban and middle class. In the second year, PHW targeted the poor in rural areas by setting two prices for the filter: a "retail price" (US$12) for urban areas and a "subsidized price" (US$6) for rural areas. Additionally, free filters were provided for hospital wards and school classrooms to promote awareness. As a result of this new strategy, 57% of sales in the second year were to poor rural customers, and a total of 1,224 filters were sold. In August 2007 of the third year, torrential rains in Ghana were an unexpected opportunity for PHW to distribute filters to flood disaster victims. At the time of writing, PHW has sold 5,000 filters to UNICEF-Ghana, and another 2,000 filters to a PHW salesperson from Tolon District at filter cost. Once the situation in the Northern Sector returns to normal, PHW expects to resume plans to sell 6,000 additional filters in the third year.

## Research objective

Household surveys and water quality testing were conducted in January 2006 and January 2007 in order to help PHW better understand its market and to assess the program's effectiveness. Survey questions determined filter acceptability for the users, highlighted any problems, and obtained baseline data on hygiene practices, sanitation access, and water use. Water quality tests assessed the ability of the filters to improve water quality. The results are intended to enable PHW to spread the *Kosim* filter more effectively.

## Methods

In order to perform the epidemiological analysis, Peletz developed a household questionnaire by reviewing over ten existing surveys including the WHO IWG Household Survey Tool (Baffrey, 2005). Prior to implementation, the questionnaire was reviewed by Dr. Julie Buring at the Harvard School of Public Health, Dr. William Duke at University of Victoria, and the Pure Home Water team.

In January 2006, Peletz interviewed 28 traditional households[1] and 22 modern households; 15 of these households used PHW products. Using the same questionnaire in January 2007, Johnson surveyed 35 traditional households, of which 19 were *Kosim* filter users, and six modern households, of which all were *Kosim* filter users. The surveys collected information on household demographics, diarrheal disease knowledge and prevalence, hygiene, sanitation practices, water sources, water storage, and household water treatment. Participants with a PHW product were asked for product feedback, and participants that had not purchased a product were asked whether they were interested in treating their drinking water.

In addition to conducting surveys, water samples were taken from each surveyed household. Respondents without filters were asked for a drinking water sample, and those with filters were asked for both an unfiltered and filtered water sample. To analyse bacterial contamination, membrane filtration using Millipore portable field equipment and m-coli blue media (HACH), 3M™Petrifilm™ tests, and hydrogen sulfide presence/absence tests (HACH Pathoscreen) were conducted. Samples were also tested for turbidity using a HACH 2100 P portable turbidimeter.

## Results

### Survey results and epidemiological analysis

The surveys conducted in January 2006 identified great differences between traditional and modern communities. None of the respondents in the traditional households had attended school, compared to an average of 12 years for modern households. The average expenses per person per month were significantly lower for traditional households, at the equivalent of $7 per month compared to $55 per month in modern households. Traditional households suffer from a higher prevalence of diarrheal illness, particularly for children under five (18% for traditional versus 5% for modern), which may be partially attributed to sanitation and water use practices. Most striking is the difference between access to sanitation facilities: 7% for traditional compared to 95% for modern. The water sources of the traditional communities surveyed include standpipes, boreholes, and dams, while the modern communities surveyed all had household taps.

Overall, survey questions found that *Kosim* filter owners are satisfied with the product. All households surveyed in 2007 (25/25) said that the filter is used seven days a week. Also, 88% (22/25) claimed that they treat all the water that the family uses for drinking. One hundred percent of users (25/25) said that they are happy with the technology, that it is easy to use, and that they would recommend it to others. Some problems were cited, including a few broken spigots in the filters in use for over one year, slow flow rates, and one broken receptacle.

With data from 2006 and 2007 combined, a relative risk assessment was conducted by calculating an odds ratio and checking for significance with a chi-square test. Households with filters were 76% less likely to have a member with diarrhea than non-filter households ($p=0.008$). Also, people in traditional households with a filter were 70% less likely to have diarrhea than people in traditional households without a filter ($p=0.016$). The diarrheal rates for children under five showed less contrast between filter and non-filter households; children under five may be more likely to be exposed through additional contamination pathways. Brown and Sobsey (2006) carried out a longitudinal prospective cohort study in Cambodia for 80 households with pot-shaped ceramic filters and 80 without. This larger study found that households with the filters had a 46% reduction in diarrheal disease compared to the control households.

### Water quality testing results

Water quality tests conducted in January 2007 assessed the effectiveness of the *Kosim* filters in the field. Results for three bacterial tests and for turbidity are summarized below in Table 1 and Table 2 for traditional and modern communities. The percent removals are for paired samples from households with filters. Source water from traditional communities, which was primarily from dams, had much higher levels of bacterial contamination compared to the water from modern communities, which was primarily from household taps.

As shown below, the filters reduced *E. coli* by 99.7% in traditional households and by 85% in modern households. The lower reduction in modern households was likely due to cleaner source water. In a longitudinal study that included 80 households with pot-shaped filters, Brown and Sobsey (2006) found that the filters reduced *E. coli* by a mean of 95.1%, which is similar to the traditional household result.

**Table 1. Traditional communities**

| Water quality test | | Source water | Filtered water | Percent removal (paired samples) |
|---|---|---|---|---|
| Membrane filtration | Average *E. Coli* CFU/100mL | 690 (35 samples) | 2.5 (18 samples) | 99.7% |
| | Average Total Coliform CFU/100mL | 23,000 (27 samples) | 170 (17 samples) | 99.4% |
| 3M Petrifilm (25 samples) | Average *E. Coli* CFU/100mL | 330 | 0 | 100% |
| | Average Total Coliform CFU/100mL | 5700 | 180 | 94% |
| Hydrogen Sulfide Bacteria Presence/Absence | Positive for H2S Bacteria | 97% (30/31) | 13% (2/16) | 87% (13/15)* |
| | Negative for H2S Bacteria | 3.2% (1/31) | 88% (14/16) | |
| Turbidity | Average NTUs | 190 (33 samples) | 11 (19 samples) | 92% |

*Percentage of samples that tested positive in the source water and negative in the filtered water.

**Table 2. Modern communities**

| Water quality test | | Source water | Filtered water | Percent removal (paired samples) |
|---|---|---|---|---|
| Membrane filtration (7 samples) | Average *E. Coli* CFU/100mL | 1.4 | 0.21 | 85% |
| | Average Total Coliform CFU/100mL | 1500 | 150 | 90% |
| 3M Petrifilm (7 samples) | Average *E. Coli* CFU/100mL | 0 | 0 | n/a |
| | Average Total Coliform CFU/100mL | 440 | 57 | 78% |
| Hydrogen Sulfide Bacteria Presence/Absence | Positive for H2S Bacteria | 29% (2/7) | 0% (0/7) | 100% (1/1)* |
| | Negative for H2S Bacteria | 71% (5/7) | 100% (7/7) | |
| Turbidity | Average NTUs | 4.5 (7 samples) | 1.4 (7 samples) | 68% |

*Percentage of samples that tested positive in the source water and negative in the filtered water.

## Conclusions and future plans

From the data on filter users in traditional communities, it is clear that the ceramic filter is providing far superior water quality than that obtained from the source. Surveys indicated that filters are acceptable to users and that non-users were interested in treating their water with the filters. The pricing scheme works well for most traditional households, and community liaisons in rural villages are providing an effective link between the communities and Pure Home Water. Additionally, though the filters achieve 99.7% *E. coli* removal in traditional communities (from 690 to 2.5 CFUs/100mL), there is still some *E. coli* in some of the filter-treated water, based on the most sensitive of the three bacteriological tests performed, the membrane filtration test. However, the filters are providing significantly safer water to communities; people in a traditional household with a filter were 70% less likely to have diarrhea than people in a household without a filter (p=0.016). To date, PHW estimates that 100,000 people are being reached with the filters.

PHW hopes to provide HWTS products to reach the 900,000 people in the Northern Region who currently lack access to safe water by the Millennium Development Goals' target year of 2015.

**Acknowledgements**
The authors would like to extend thanks to the entire Pure Home Water team for their support in this research and to the Hilton Foundation and the Global Entrepreneurship Lab for project funding.

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**Note/s**

[1] The traditional communities included mud homes arranged in circles, whereas the modern communities consisted of households constructed of cement.

**Keywords**
ceramic filtration, household-centredhousehold surveys, water testing, water treatment

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