Effectiveness of Biofiltration in Removing Giardia Cysts in the Developing World

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ABSTRACT

Access to clean water is a basic human right and a requirement for life on this planet. 780 million people lack fresh water and 2.5 billion suffer from improper sanitation, making this a global crisis. In the US alone 7% of all foodborne illness and deaths are caused by contaminated water. 2,000,000 of those cases were caused by Giardia lamblia. This problem is only exacerbated in the global community with a 30% infection rate in the developing world. Historically, biofiltration has been proven to effectively eliminate enteric disease-causing protozoans such as Giardia lamblia and non-commensal bacterium. Through observation and application during nongovernmental organization (NGO) efforts in Peru, introducing point of use (POU) filtration into rural environments was demonstrated to be an effective method of providing clean water sources. In addition to field application a literature review was conducted to understand the effectiveness of alternative biofiltration methods. By comparing two modalities of POU filtration it is proposed that a holistic approach in implementing water filtration be used to provide rural communities longevity for sufficient potable water sources. The aim of this project is to support sustainable frameworks in reducing the global public health crisis associated with access to clean water by reducing exposure to contaminated drinking water. Empowering communities through education and incorporating proven technologies at the grass roots level clean water can be accessed by everyone.

POU WATER FILTRATION SYSTEMS

Ceramic filtration has a 99% removal rate of G. lamblia cysts and is dependent upon specific molding and chemical treatment to remain effective, as well as housing material (PV buckets), and spouts with rubber grouting.

Slow sand filtration has a 98-99% removal rate of G. lamblia cysts and initial construction of slow sand filtration systems would require limited materials that are available to most geographical areas. Sediment and soil compositions ranging in 0.15mm to 0.35mm with sediment sand bed depth of at least 60 to 120 cm and 30 to 50 cm of graded gravel (Bellamy et al, 1985).

COMPARISON OF EFFECTIVENESS AND LONGEVITY

Filtration Rates: Ceramic filtration can produce an average of 8L of drinkable water in 4 hours during optimal filtration compared to slow sand filtration that can produce an average of 0.6 liters per minute (144L in 4 hours) according to the CDC.

Total Coverage in Years: Ceramic filtration has an avg. lifespan of 3 years while slow sand filtration has a 10-year lifespan. If applied holistically in optimal conditions approx. 13 years of coverage could be achieved.

PRELIMINARY CONCLUSIONS

• Slow sand filtration requires a long initial setup time to be effective. Therefore ceramic filtration is ideal for a short-term initial intervention.
• Both modalities are effective in removing Giardia cysts, bacteria, contaminants, and decreasing turbidity. Therefore, holistically effective for improving longevity of clean water sources.
• Both methods require some financial investment and material acquisition, however most materials can be sourced locally.
• Both modalities require education in proper use and maintenance to be effective.
• Slow sand filtration has been proven to be effective in Peru by lowering the incidence of infection through contaminated water and improving confidence of the population in health outcomes. However proper education of hygiene especially amongst the pediatric population is required to eliminate reinfection (Juarez et al, 2008).
• Ceramic filtration was implemented in communities around Urubamba as well as used personally while serving in Peru; demonstrated to be an effective modality of implementation in lowering water borne illness (Gil, 2016).
• Both methods are widely accepted globally according to the CDC.

WATER STATISTICS in PERU

EPI 46.2
Unsafe drinking water is measured using the number of age-standardized disability-adjusted life-years (DALYs) per 100,000 persons (DALY rate) due to exposure to unsafe drinking water. A score of 0 indicates a country has among the lowest DALY rates in the world (15th percentile), while a score of 1 indicates a country is among the highest (95th percentile). Data for this indicator come from the Institute for Health Metrics & Evaluation’s (IHME) Global Burden of Disease (GBD) study.*

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