Effects of Colloidal Silver and Flow Rate on Bacterial Disinfection in Ceramic Water Filters

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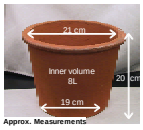
Background

- 1 billion people globally lack access to adequate water and sanitation
- Diarrheal diseases cause 3.7% of total deaths worldwide, and 88% of these deaths can be attributed to "unsafe water, inadequate sanitation, and poor hygiene" (UNICEF 2009)
- 2.2 million deaths are caused by diarrheal diseases, 1.8 million of those in low-income countries
- Diarrheal diseases are the fifth leading cause of death in the world, and the third-leading cause of death in low-income countries

http://www.conserveafrica.org.uk/main/index.php?option=com_content&view=article&id=1&Itemid=76

Ceramic Pot Filter

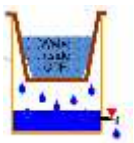
- Point-of-Use Water Treatment System
- Made locally – clay and combustible materials
- Low-cost
- Effective
  - Hunter 2009 – most effective treatment for reducing diarrheal diseases when compared to households not treating their water



Approx. Measurements

Objectives

- How does the presence of silver affect the removal of *E. coli*?
- How does flow rate affect the *E. coli* removal?



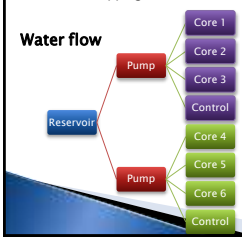
Ceramic Water Filter

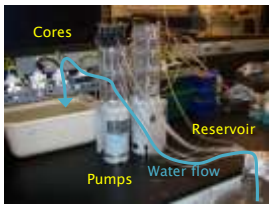
Enhanced Ceramic Water Filter

Experimental Set-up

Teflon tape and Parafilm wrapping

Rubber sleeve, plastic cap, metal sleeve, and metal clamps





Analytical Methods

- Core characterization
  - Physical size
  - Porosity
  - Hydraulic conductivity
- Plating – Spiral Plater
  - Tryptic Soy Agar Plates
  - MacConkey Plates
- Total Organic Carbon

TSA

MacConkey

Conductivity and Porosity

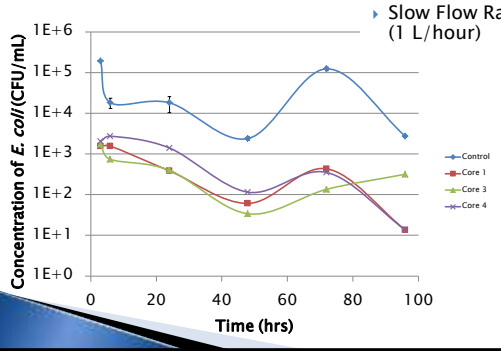
Core	Age	Flow Rate	Silver	Porosity	Conductivity
1	Old	Slow Fast	None Reapplied	0.371	6.4
3	Old	Slow Fast	None Reapplied	0.407	6.2
4	Old	Slow Fast	None Reapplied	0.419	6.5
2	Old	Fast	Reapplied	0.372	5.2
6	Old	Fast	Reapplied	0.391	5.3
7	Old	Fast	Reapplied	0.407	6.3
2B4	New	Fast	New	0.405	7.8
3B4	New	Fast	New	0.387	3.2
4B4	New	Fast	New	0.406	6.4
2B3	New	Slow	New	0.396	5.4
2B2	New	Slow	New	0.398	7.9
4B2	New	Slow	New	0.405	6.7

Experimental Outline

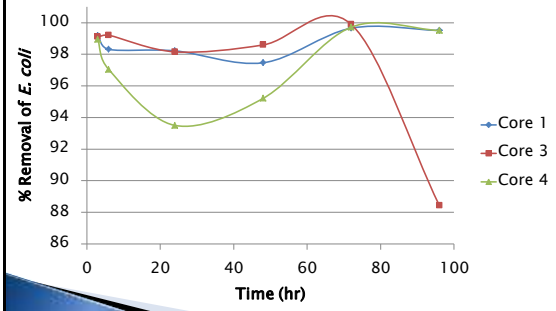
Test	Age	Silver	Flow Rate
Experiment 1	Old	None	Slow
Experiment 2	Old	Reapplied	Slow Fast
Experiment 3	New	New	Slow Fast

Experiment 1

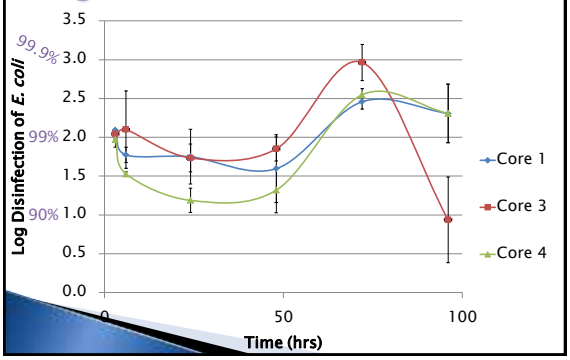
- Old Cores
- No Silver
- Slow Flow Rate (1 L/hour)



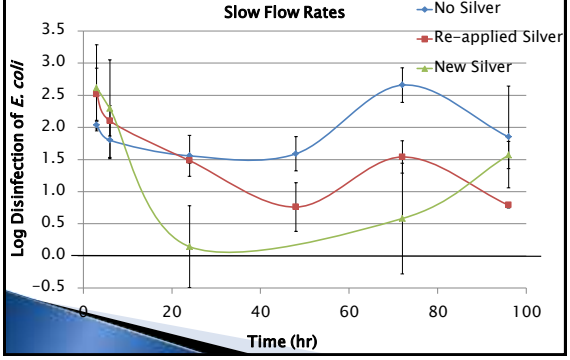
Percent Removal of E. coli



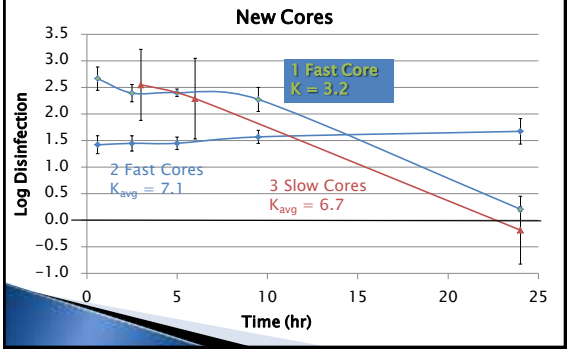
Log Disinfection



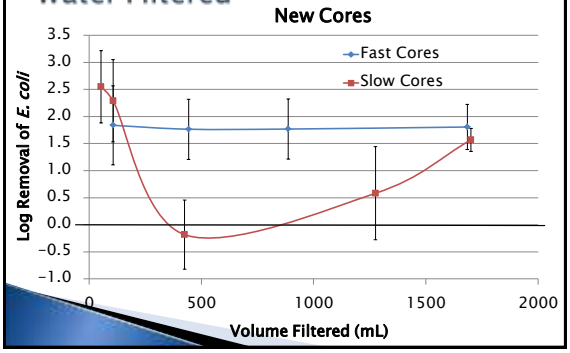
Effect of Silver over Time



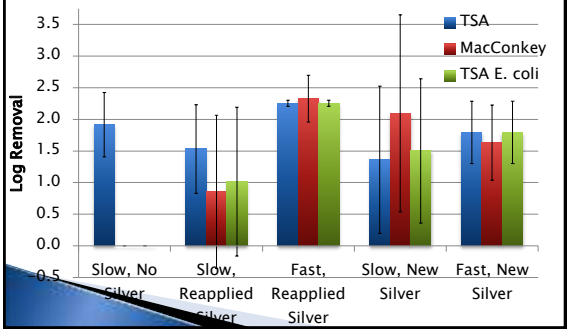
Effect of Flow Rate Over Time



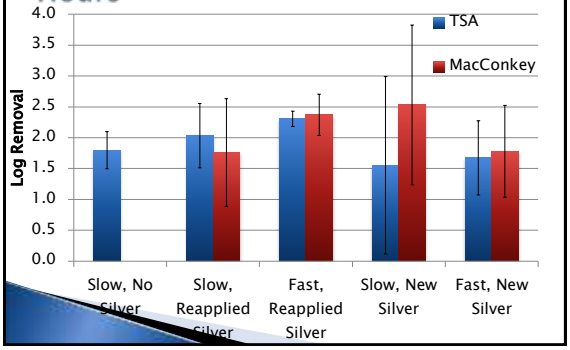
Effect of Flow Rate over Volume of Water Filtered



Average Disinfection over 2 Liters of Spiked Water filtered



Average Disinfection over 24 Hours

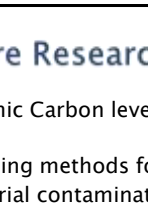


Results

- Silver
  - 0 – 6 hours: No apparent effect
  - t > 6 hours: Cores without silver removed more *E. coli* than those with any form of silver
  - No statistical difference between cores with new silver and those with reapplied silver
- Flow Rate
  - On a volume basis, the fast cores removed more E. coli than the slow cores after the first 200 mL.
  - 0 – 6 hours: Slow cores removed more *E. coli* (93% statistically confident)
  - t > 6: No statistical difference
- Overall
  - 1.89 log (98.7%) removal in 24 hours
  - 1.77 log (98.3%) removal for the first 2 L of water filtered

Future Research

- Organic Carbon level
- Silver
- Cleaning methods for filters
- Bacterial contamination – identify unusual colonies
- Longer term experiments
- Field studies



Acknowledgments

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