

Battle of the Water Filters: Environmental Justice AND Microbiology

Kathleen A. Nolan and Alison Dell, St. Francis College, Brooklyn, NY 11201



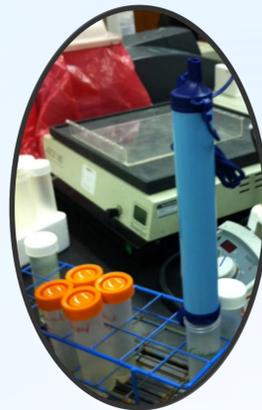
Abstract

As part of our general biology course that includes a lab, students are required to partake in a group research project that results in a lab report and a poster. An intriguing and successful project was to have a “contest” to see which water filters worked the best. The students learned about Rita Colwell’s experiment of decreasing cholera infection rates in Bangladesh by using sari cloth to filter the local drinking water. (She recorded a decrease of cholera by 48% in those who used the sari cloth.) One group tested cotton cloth (T-shirt), denim, and a LifeStraw to filter water from the East River in the Brooklyn Bridge Park in New York City. They used nutrient and MacConkey agar plates for their tests. The LifeStraw filter reduced bacteria ten-fold whereas there was no reduction in bacteria with the two types of cloth. Another group used a homemade filter made out of a coffee filter, topped with gravel and cotton. This project could be used as an inquiry-based exercise with a focus on environmental justice in which students can simulate experiments that they might conduct while living in an area where the water supply might be compromised.

Materials and Methods

Nutrient, Luria, MacConkey, EMB agars
Filters---LifeStraw, denim and cotton cloth from jeans and T shirts respectively, and “homemade” filters made from a coffee filter, topped with gravel and cotton.

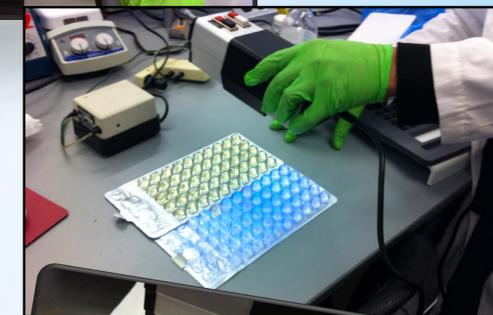
Filtered and unfiltered water was serial diluted (10⁻² through 10⁻⁵) and plated (1 ml or 100 ul) on the plates of various media as listed above. The water did not flow easily through the LifeStraw, so it was necessary to blow it through. One group did attempt to vacuum filter water through the LifeStraw. The first group used “homemade” filters, but filtered into non-sterile beakers. The second group used squares of a cotton T-shirt and denim jeans were cut and water was filtered through them into sterile test tubes.



Top row---unfiltered

Middle row---filtered with cotton

Third row---filtered with denim



Top row---unfiltered

Middle row---filtered with cotton

Third row---filtered with denim

Water from Brooklyn Bridge Park

Cfu's/ml Nutrient agar unfiltered	25
Cfu's/ml Nutr. agar filtered w/ cotton T-shirt	23
Cfu's/ml Nutr. Agar filtered w denim	19



Results from Coliform test after 24 hrs.



Results from Coliform test after 96 hrs.

Results from Coliform test—yellow is positive, red is negative.

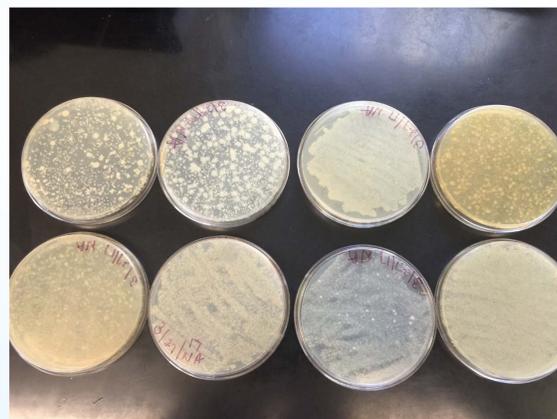
Location	Unfiltered red water After 24 hrs.	Unfiltered water After 96 hrs.	Filtered with LifeStraw After 24 hrs.	Filtered with LifeStraw After 96 hrs.	Filtered with homemade filter After 24 hrs.	Filtered with homemade filter After 96 hrs.
A. Prospect Park Pond, Brooklyn, NY	+	++	-	+	+	++
B. Hudson River, NYC	++	++	-	-	++	++
C. Shawngunk Lake	-	+	-	-	-	++
D. Twin Lake	=	++	-	-	-	++

Results—Group 2---with Life Straw

Sample site	Cfu's/ml Nutrient unfiltered	Cfu's/ml Nutrient filtered	Cfu's/ml McConkey unfiltered	Cfu's/ml McConkey filtered	Cfu's/ml EMB unfiltered	Cfu's/ml EMB filtered
Lewisville Lake outlet	252	67	180	14	150	30
Brooklyn Bridge Park (East River)	32	0	1	0	6	0

Group 1

Filtered with:	Hudson River Cfu's	Prospect Park Pond—cfu's	Schroon Lake (NY)—cfu's	Twin Lake (NY)—cfu's
LifeStraw	25 lg. white 240 sm. white	104 lg. 400 sm. white	Too many to count	320 small
Homemade filter	350 sm. white	lawn	Too many to count	Too many to count



Introduction

Water quality in New York City has been compromised for a long time. We feel that students who grow up in New York City take clean drinking water for granted. After all, we have the best-tasting water in the country, according to many taste tests (and by us!). However, the bodies of water that surround us are less than pristine. A lawsuit against utilities dumping pollution into the Hudson River created the Hudson River Foundation (HRF) in 1981. This organization funds projects that attempt to mitigate pollution and understand living organisms and processes in this estuary. The HRF runs a striped bass tagging program, which has shown that the fish have returned to the river. The billion oyster project is an attempt to restore this mollusk to the river. However, Superfund sites still lurk, such as the Gowanus Canal, and Newtown Creek.

Water supplies globally have also been in jeopardy. Our students have learned about water-borne illnesses such as cholera. Huq et al. (1996 and 2010) showed that old sari cloth (with its tighter weave) filters better than old sari cloth in Bangladesh. Students also learned that compliance is also a huge issue in public health---in other words, the citizens in a country have to actually execute the proper filtering project (Clasen et al. (2007). Often students do not understand that the easily-curable diarrhea that occurs in their world is a large threat and is often the biggest killer in third world countries. They also do not know that the answer to “Why don’t they just boil their water?” lies in economics. “They” either do not have or cannot afford to buy fuel with which to boil the water. Poor people need to come up with ingenious ways to filter their water to protect against disease such as cholera, that we in the USA do not encounter. We introduce the concept of environmental justice as being something for all, not just the rich.

The Battle of the Water Filters project was an attempt to make students think about environmental justice in the world as well as in our city. In the process, they learned some key concepts in microbiology such as serial dilution and the use of selective media.

Discussion

This project was a way to connect environmental justice to biology for the students. The students learned about the plight of people who do not have clean drinking water, and how we take our drinking water sources for granted. They learned how filters such as sari cloth can indeed reduce the incidence of water borne illnesses such as cholera in countries such as Bangladesh. They are challenged to create their own water filters, in addition to a LifeStraw, of which we tell them the story. When they looked at the results of their own homemade filters they were puzzled as to why they did not work that well, at least on coliform bacteria, that was present in several unfiltered water samples. We asked them to generate a list of reasons why their filters might not work as well. We pointed out to them that Rita Colwell folded her sari cloth filters several times to produce the maximum filtering capacity. We drew out of them that perhaps gravel is not the best filter, as it might harbor much bacteria. This was truly an exciting “battle” that we hope we will be able to “fight” again next year!

Acknowledgements

We thank the students who helped conduct these experiments: Karishma Kalloo, Aaliyah Williams, Amy Tsang, Merna Abdelhalem, and Professors Roy Lee and Michelle Batchu and Leah Kovenat for their help and guidance in this project.

References

Clasen T., Schmidt W. P., Rabie T., Roberts I., Cairncross S. 2007. Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis. *BMJ* 334:782-792.

Huq A., Xu B., Chowdhury M., Islam M., Montilla R., Colwell R. 1996. A simple filtration method to remove plankton-associated *Vibrio cholerae* in raw water supplies in developing countries. *Appl. Environ. Microbiol.* 62:2508-2512.

Huq, A., Yunus, M., Sohel, S. S., Bhuiya, A., Emch, M., Luby, S. P., Russek-Cohen, E., Nair, G. B., R. Sack, R. B., and R. R. Colwell. 2010. Simple Sari Cloth Filtration of Water Is Sustainable and Continues To Protect Villagers from Cholera in Matlab, Bangladesh. *mBio* 1:1-19. (an open access journal published by the American Society for Microbiology.

Examples of Enterolert-Idexx trays used with the LifeStraw. The top picture shows what the Enterolert trays look like just after filling. The middle picture shows distilled and unfiltered water from the Brooklyn Bridge Park. (BBP) The bottom pictures shows BBP water filtered with the LifeStraw on the left and unfiltered on the right.

New Citizen-science Water Quality Project

Two students, Zanna and Maria Shapiro (they are two of triplets!) are now participating in a New Citizen Science water quality testing project sponsored by the NYC Water Trails Association that is testing for enterococci. The IDEXX method is being utilized. Students collect the water from a beach in the Brooklyn Bridge Park and take it to the River Project where it is tested. The results are posted weekly on the New York Water Trails website. The testing began six years ago in response to a fire at the North River Sewage Treatment plant in which an unknown amount of sewage was released into the Hudson River. This independent water testing by citizen scientists is hoped to bring transparency to any future water pollution problems. St. Francis College is aspiring to be a future testing site.