Project AquaeSCOPE

Project Description

All communities need access to a safe water distribution network. However, over 2 million people, just in the United States, do not have a reliable water source. Many samples of tap water contain both bacterial and chemical contaminants from incomplete testing, unregulated industrial and agricultural waste, faulty wastewater treatment, and poor distribution infrastructure, leading to many major health risks. This problem is prevalent in many marginalized and low-income communities, which additionally lack the resources for proper water contaminant testing. [1]

Nationwide attention towards these water crises have led to misinformation about the safety of all water sources. 55% of the American population is concerned and unaware about the reliability of their tap water networks. 42% are unsure of the necessary steps to filter and treat drinking water in their homes. [2] The United States contains some of the highest regulated water testing for microbial and chemical contaminants, yet the complex layers of this issue have caused confusion across the nation, even with communities able to access safe potable water.

Bottled water companies have capitalized on this distrust to advertise purer products containing many health and safety benefits. As a result, 60 million individuals have shifted to bottled water as their primary source of drinking water as of 2018, and this number has only continued to rise. [1] While people lacking a clean water source do need alternative water sources, many consumers of bottled products are potentially avoiding safe municipal water networks. The unnecessary use of bottled water can lead to a variety of negative environmental effects:

Resource Depletion

- 86% of the plastic from bottled water ends up not being recycled.
- Bottled water is $0.64 per gallon, a 3000% increase in inaccessibility and price from tap water sources.
- Approximately 17 million gallons of oil and fossil fuels are used to create plastic bottles for the massive industry.
- 3 Liters of Water are used to manufacture and package 1 Bottle of Water [3]

Environmental Harms

- The 86% of unrecycled plastic translates to 60 million bottles in our environment releasing harmful toxins into our soil and groundwater and contributing to accumulation of ocean pollution. [4]
- The plastic storage used to ship bottled water is rarely recycled and also contributes to harmful landfills.
- Bottled Water transportation leads to carbon dioxide emissions, contributing to the greenhouse effect. [5]

In order to tackle these problems, communities need an in-depth resource to make informed decisions regarding the safety of their potable water. We need a system to differentiate between households avoiding safe sources and households with access to potentially contaminated water- a system that can analyze any water network. From there, an investigation on implemented regulations, additional safety measures, and improved contaminant testing could be conducted and applied to water distribution systems globally.

CHS_Missouri_US aims to approach this solution using the power of a synthetic biology system. Focusing specifically on the in-depth analysis of the dynamics of different microbiomes, which would help us thoroughly identify all microbiota within a given water source, we looked at the potential of metagenomic sequencing. Through its utilization, we could build sequencing libraries targeting the V4 region of 16S rRNA genes extracted from any water sample. With the attachment of unique molecular barcodes, we could then comprehensively identify the taxonomic profile and relative abundance of all genera within the sample in parallel. Our team aimed to test both a tap and bottled water source from our community for comparative analysis. [5] From there, we then could conduct research to determine the pathogenic risk of the microbiota detected in both the tap and bottled sample. Combined with research on existing water system regulations, home safety measures, and of contaminant sources, our team could then provide a detailed resource to inform our community.

Our project also aimed to think about the global application of our findings. In the future, we want to expand the scope of our project by developing a prototype for a system that could be applied to characterize the biodiversity of microbiota in water microbiomes globally, and provide insight towards targeted contaminant testing towards different distribution networks. In order to set up a good direction for the future implementation for our project, we want to continue human practices, engineering, and safety research past the iGEM season to analyze the theoretical functionality, impact, and flaws in our experimental design. We hope that the progress we have made on our project this season will be continued and improved by us and many other iGEM teams in the future.

Sources:

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