The effect of plant-derived polymers on reducing the amount of *E. coli*, anions, cations, and dissolved solids in surface water

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Research Experience for Undergraduates

Introduction

Escherichia coli is a coliform bacterium that is prevalent in contaminated waters. Their quantity in a water source indicates that there is a high level of fecal matter. With knowledge of water quality, there can be greater consideration for its impact on the ecology of the area and on human health. Current treatment methods used by water treatment plants to disinfect wastewater are not cost effective. Most methods of waste water treatment and purification use synthetic materials that can be carcinogenic, such as polyacrylamide[2]. The polymers used will be an improved and efficient ecofriendly alternative to present treatment materials and methods.

Objectives

The purpose of this research project is to use plant-derived polymers to reduce amounts of *E. coli*, dissolved solids, and nutrients in surface water.

Methods

Water samples were collected from the Bosque River in Stephenville City Park and the Colorado River in Timberlake Biological Field Station.

Image 1. *Collecting samples with Whirl-Pak bags in Timberlake Biological Field Station.*

- Polymers Used: Plant-derived polysaccharides
  - Tamarind seed gum (commercially purchased)
    - Concentrations: 1g/L and 2g/L
  - Fenugreek seed gum (seeds soaked overnight, manually extracted, precipitated in alcohol, and dried)
    - Concentrations: 1g/L and 2g/L
- Samples: 500mL for control, 400mL for treatment (add 100mL of polymer solution)
- Jar Test: 100rpm for 1min, then 50 rpm for 5mins
  - Collect 50mL samples from each jar at 5, 15, 30, and 60 minutes, respectively

Escherichia coli removal

The modified mTEC method was used to filter the water samples on sterile membrane filter papers. These were then placed on pre-made modified mTEC agar plates, which were incubated at 32°C for 2 hours. They were transferred into a water bath at 44.5°C for 22 hours[3].

Total Suspended/Dissolved Solids (TSS/TDS)

The water samples were filtered through vacuum filtration with glass microfiber filters.

Anions and Cations

20mL of the 50mL samples were measured into Polyvials for placement into the Ion Chromatographer (IC).

Flocculation

The jars and 50mL beakers were left in the oven for 24 hours to allow the formation of flocs. The flocs are scraped and crushed into powder for the Fourier-Transform Infrared Spectroscopy (FTIR).

Results

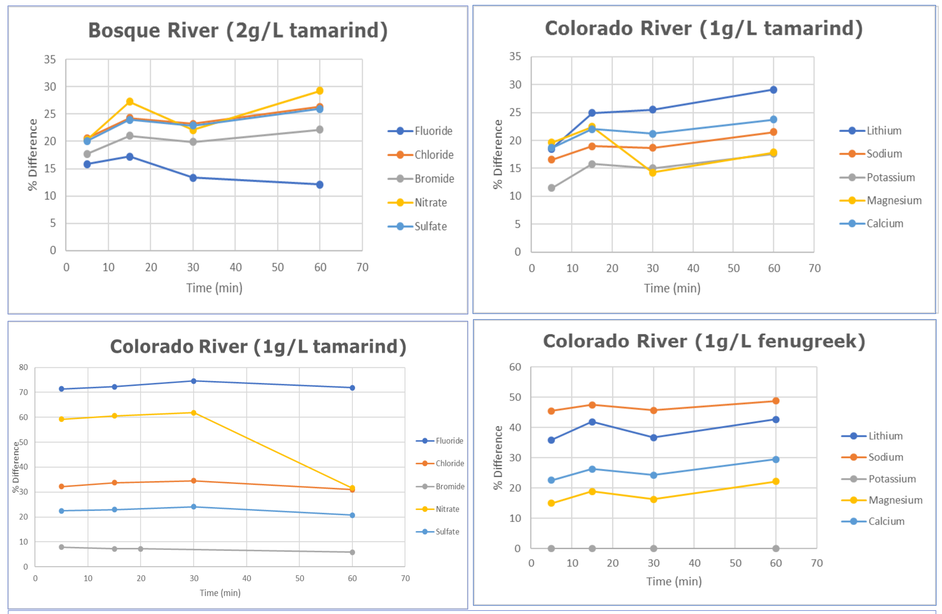


Figure 1. Anions and Cations. *These graphs illustrate the percent difference between the control and treatment groups from the two rivers within a one-hour time period with varying doses.*

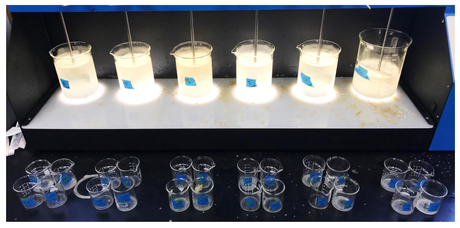


Image 3. *A jar test set-up for the Bosque water with 50mL beakers for samples.*

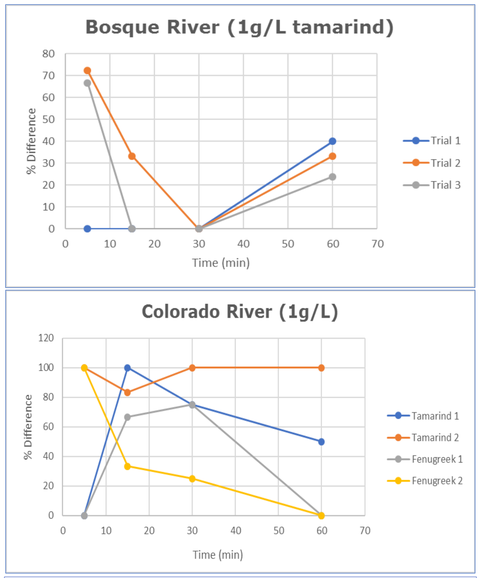
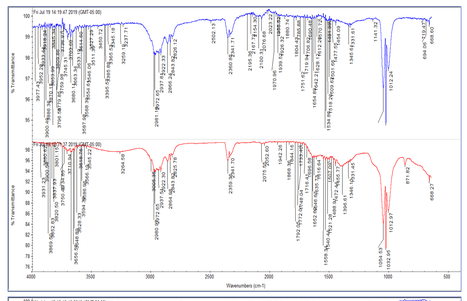


Figure 2. Bacterial Removal. *The percentage removal of the E. coli over a 60-minute period using the two polymers.*



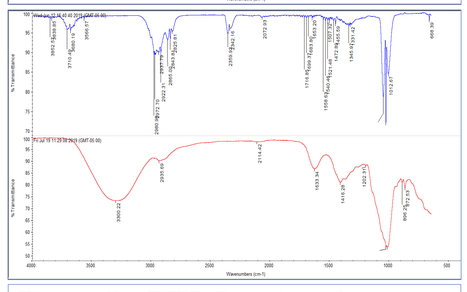


Figure 3. FTIR Results. *A comparison of polymer and treated sample.*

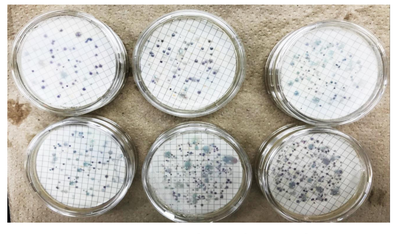


Image 2. *E. coli cultured on modified mTEC agar plates.*

- The application of polymers in contaminated waters reduces the *E. coli* count by at least 50% (Figure 2). Tamarind seed gum has tested to be more effective in bacterial reduction with 1g/L dose in 60 minutes.
- The success of the bacteria experiments were dependent on the weather conditions in and around the area. Different dilutions (x5, x10, x20, and x50, respectively) were attempted to yield countable *E. coli* colonies.
- Ion chromatography was used to measured the anions and cations present in the water samples, which have standards set by the Environmental Protection Agency for the maximum contaminant level considered safe for human health[1]. Both rivers primarily contained chloride, sulfate, and sodium. Bosque also had relatively high levels of magnesium and calcium.
- The FTIR in Figure 1 reflects how the polymers impacted the anion/cation levels after treatment. The two polymers each adsorbed the contaminants in the water samples, as shown in Figure 3.

Conclusion

The polymers used in this experiment successfully reduced the amount of bacteria, anions, cations, and dissolved solids. These natural, eco-friendly alternatives can be used to replace synthetic materials; however, there are further tests that must be performed using higher doses and more polymers.

References

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Acknowledgments

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