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Low-Cost Adsorbent for Disinfection Byproduct Removal from Drinking Water

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Abstract

Disinfection byproducts (DBPs) are harmful contaminants that are unintentionally created in disinfected water after chlorination. Activated carbon, often expensive and difficult to acquire in low-income and rural areas, has previously been used to remove DBPs from drinking water. Biochar is made from agricultural waste (i.e. feedstock) and has been identified as a low-cost yet effective adsorbent to remove contaminants from drinking water. This work focuses on the efficacy of biochar and activated carbon to remove DBPs from drinking water for the purpose of treating drinking water after emergency chlorination. This study has the potential to help water distributors and disadvantaged communities improve water quality and prevent unintentional harm caused by DBPs.

Introduction

- Globally, more than 884 million people **lack access to safe water to drink**
- Humanitarian organizations provide aid by treating contaminated water through **disinfection**, most commonly through **chlorination**
- Chlorine is added to water and reacts to form hypochlorous acid. Hypochlorous acid and naturally occurring organic matter dissolved in the water create **unintentional disinfection byproducts (DBPs)**

- Trihalomethanes (THMs) are **carcinogenic** and are federally regulated by the Environmental Protection Agency (EPA). THMs have **public health concerns** such as bladder cancer, liver, kidney, central nervous problems, and reproductive effects
- Common THMs consist of chloroform (TCM), bromoform (TBM), bromodichloromethane (BDCM), and dibromochloromethane (DBCM)
- Granular activated carbon can be used to remove THMs from drinking water; however, it is often **expensive** and **difficult to acquire in rural or low-income areas**

Research Focus

- Biochar is a **low-cost yet effective adsorbent** to remove contaminants from drinking water
- Biochar is made from agricultural waste (i.e. feedstock) – **sustainable & cost effective**

Purpose:
- To study the feasibility of removing THMs from potable water using biochar

Project Objectives:
- To compare the adsorption capacities of biochar and activated carbon for the adsorption of THMs from drinking water
- To create and characterize a corn cob biochar produced at two different temperatures, 500° C and 700° C

Methodology

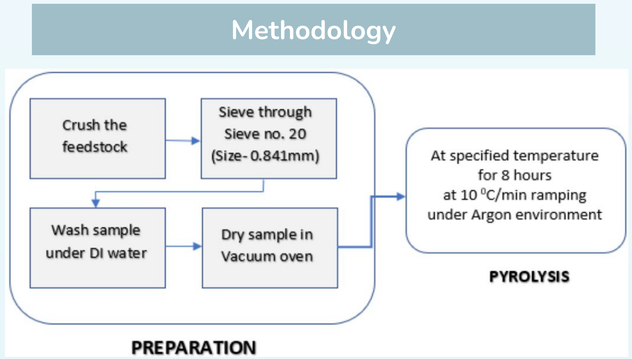


Fig. 1 - Biochar Preparation Steps

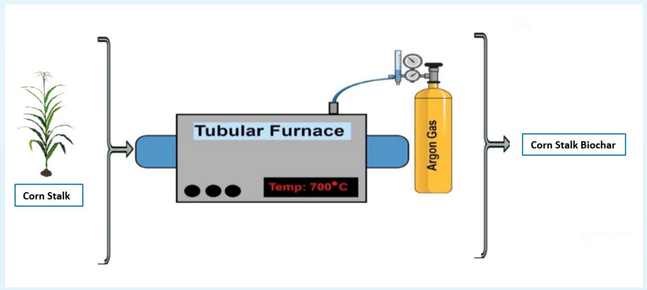


Fig. 2 - Biochar Pyrolysis Process

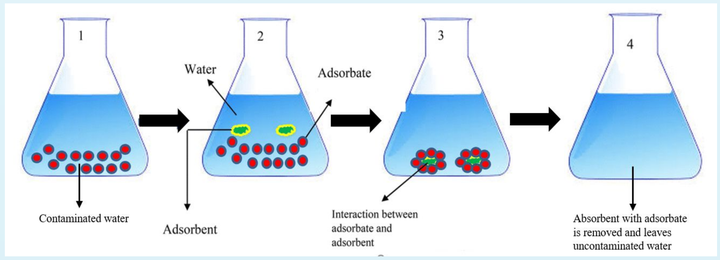
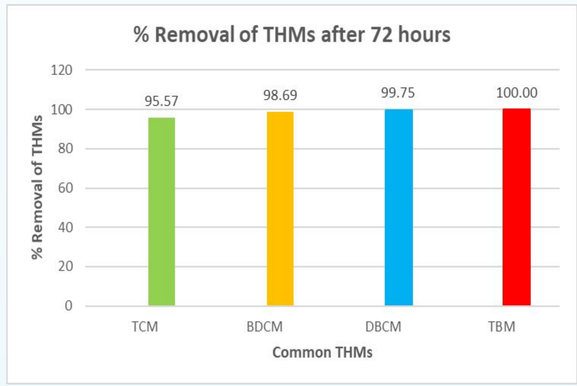


Fig. 3 - Batch Adsorption Testing

Results



For batch adsorption testing, the initial concentration of TCM was 136 ppb, BDCM was 30 ppb, DBCM was 8 ppb, and TBM was 1 ppb. Total THM (TTHM) values add up to 217 ppb, which is the average concentration of TTHMs found in drinking water due to emergency chlorination[1]. 40 mg of activated carbon per 60 ml of water was used in testing. Batch adsorption tests were performed for 72 hours.

Potential Significance

- This study will help promote the use of a **low-cost, sustainable adsorbent** for disinfection byproduct removal from drinking water
- Can aid water distributors to **improve water quality** and **prevent unintentional harm**
- Can aid in humanitarian crises where THM levels are high due to emergency chlorination

Fig. 4 - Emergency Chlorination Tanks[2]

Future Work

- Characterization of the corn cob biochar will be completed to determine which temperature of biochar is best for THM removal
- Batch adsorption tests will be conducted with corn cob biochar
- Results of batch adsorption tests will be analyzed by a gas chromatograph mass spectrometer to quantify the amount of THMs left in the water
- Adsorption capacities of biochar and activated carbon will be compared to determine the efficacy of the biochar to remove THMs from drinking water

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Acknowledgements

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