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Effect of Hemodialysis Wastewater Quality Improvement by Adsorption of Free Chlorine and Bromide Ions by Carbonized Coffee Grounds

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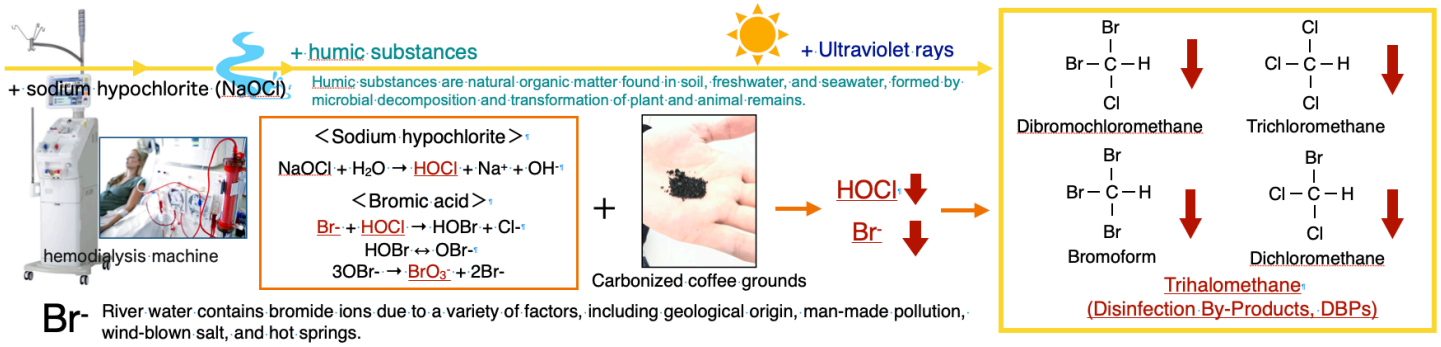
Introduction

- Recycling coffee grounds after extraction is an important issue in terms of food and environmental sustainability.
  Bromide ions (Br^-) in water can be oxidized by sodium hypochlorite (NaOCl) to form bromate (BrO_3^-) and can also react with humic substances to produce trihalomethanes (THMs) such as chloroform and bromodichloromethane, both classified by the IARC as possibly carcinogenic.
- In hemodialysis (HD) systems, sodium hypochlorite (NaOCl) is widely used for disinfection of dialysis piping, and the resulting wastewater is usually neutralized before disposal. However, neutralization systems are not yet widely implemented, allowing residual NaOCl to enter sewage and promote the formation of bromate ions, contributing to secondary environmental pollution.
- This study investigates the adsorption potential of carbonized spent coffee grounds for the removal of free chlorine and bromide ions from NaOCl-containing wastewater in HD processes, aiming to develop a sustainable and low-cost treatment method.



Methods

- Carbonization: Spent coffee grounds were carbonized at 600 °C for 1 h and cooled naturally.
- Test solution: Sodium hypochlorite (400–1000 ppm NaOCl) containing 10–200 µg/L Br^- was prepared.
- Filtration: 200 mL of the solution was passed through a carbonized coffee-ground filter (10–50 g).
- Analysis: Residual chlorine was measured by the DPD method, and Br^- was analyzed before and after filtration.

Results

- Residual chlorine: 0 mg/dL under all conditions.
- After filtration, Br^- decreased below detection limit (~0 µg/L) in all samples.
- Carbonized coffee grounds effectively removed bromide ions regardless of initial concentration.

CONCLUSIONS & PERSPECTIVES

- Carbonized coffee grounds showed high adsorption capacity for Br^- in NaOCl solutions.
- Adsorption was likely due to the porous structure and surface functional groups (–OH, –COOH).
- This eco-friendly and low-cost material may help suppress bromate and THM formation, contributing to sustainable wastewater treatment in HD systems.
- Further tests using river water containing humic substances are planned.