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Modified brewer's spent grain as an adsorbent and carbon source for sulfate-reducing bacteria in mine drainage remediation

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Mine drainage threatens water quality through the release of heavy metals and sulfate. Sulfate-reducing bacteria (SRB) facilitate precipitation of heavy metals through metal-sulfide formation. SRB growth in mining environments is often limited by a lack of quality carbon sources. Brewer's spent grain is a lignocellulosic by-product of beer manufacturing, and acidic and basic treatments have shown to enhance this waste product's metal adsorption potential. The ability of treated grains to serve as the bacteria's carbon source, however, is unknown. In this project, we chemically modify and characterize spent grains for metal adsorption and capacity to promote SRB growth.

Spent grains were obtained from breweries in central Missouri (n=3). These grains contained 15.3 ± 2.9% cellulose, 22.9 ± 2.8% hemicellulose, 7.2 ± 0.8% lignin, 22.2 ± 2.1% protein, 4.1 ± 2.9 % ash, and 74.7 ± 1.2 % moisture content. Sulfuric acid (1% v/v) and basic calcium oxide (2% w/w) treatments were performed to convert the material to more bioavailable and sorptive forms. Base-treated grains exhibited 19.3% less hemicellulose by weight when compared to untreated grains, while acid-treated grains showed no major changes in solid composition. Optical spectroscopy of leached grains revealed that peak ratios of UV and visible wavelengths shifted, suggesting that both treatments transformed water-soluble humic and fulvic acid-like dissolved organic matter.These changes in dissolved and solid carbon indicate that grain treatments can convert bioavailable carbon.

Long-term microbial incubations using field-isolated strains and synthetic mine water are underway to assess how treated grains affect microbial growth. Sulfate, lead, and zinc are being measured to follow heavy metal removal. Polyphenolic compounds and reduced sugars are being monitored to provide insight for the type of carbon utilized by SRB. Sorption experiments will also be performed to explore abiotic sorptive capacity of treated grain. Overall, our goal is to identify biogeochemical and physical responses to the chemical treatment of brewer's spent grain for optimized mine drainage remediation.

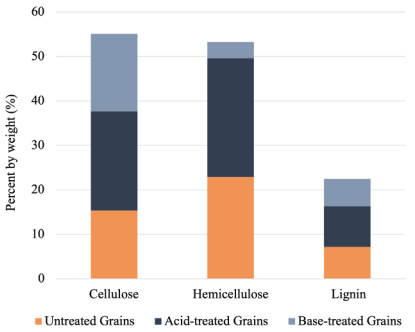

Figure: Composition comparison between untreated, acid-treated, and base-treated brewer's spent grain