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Ph.D. DISSERTATION DEFENSE

Candidate: Sameer Neve
Degree: Doctor of Philosophy
School/Department: Schaefer School of Engineering and Science / Department of Civil, Environmental, and Ocean Engineering
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Title: Sustainable Reuse of Spent Vetiver Biomass for Production of Biochar and Bioethanol
Chairperson: Dr. Dibyendu Sarkar, Department of Civil, Environmental and Ocean Engineering, Stevens Institute of Technology
Committee Members: Dr. Christos Christodoulatos, Department of Civil, Environmental and Ocean Engineering, Stevens Institute of Technology
Dr. Raju Datla, Department of Civil, Environmental and Ocean Engineering, Stevens Institute of Technology
Dr. Rupali Datta, Department of Biological Sciences, Michigan Technological University
Dr. Teresa Bandosz, Department of Chemistry and Biochemistry, City College of New York

ABSTRACT

Vetiver grass (*Chrysopogon zizanioides*) has wide applications in the perfumery industry. Essential oil extracted from the dense, aromatic roots of vetiver is utilized in many popular perfumes, such as Chanel's No. 5 and Sycamore, Miller Harris' Vetiver Insolent, etc. However, the shoots of vetiver are not utilized in this process, and the roots find their way into waste streams after oil extraction. This leads to a potential problem of solid wastes taking up landfill space. To address this problem, we decided to explore potential reuse options of the spent vetiver biomass. The shoots were used to generate bioethanol. The yield of bioethanol and its quality was comparable to commonly used second-generation lignocellulosic biofuel feedstocks, such as Switchgrass, Miscanthus, and Elephant grass. Both vetiver roots and shoots were pyrolyzed at various temperatures and residence times to generate biochar, a carbon-rich residue remaining after pyrolysis of biomass in a low-oxygen environment. Vetiver root biochar exhibited superior yield and surface area compared to vetiver shoot biochar. The optimized root biochar, generated at 500°C and held for 60 mins was examined for its potential utilization as a "green" scavenger of metals from aqueous media. Vetiver root biochar effectively removed very high concentrations of heavy metals, such as Pb, Cu, Cd, and Zn at a dosage as low as 1% w/v. We also evaluated the possibility of utilizing the root biochar as a soil conditioner to improve fertility of a metals-contaminated sandy soil collected from a Superfund site. Biochar amendment resulted in an increase in agronomic properties of the soil by improving its water- and nutrient-holding capacities, properties that support vegetation growth. We further explored the possibility of using vetiver root biochar as an additive in "green" concrete. Not only would this practice increase concrete strength, but it would also offer a potential pathway for carbon sequestration. The physical and structural properties of "green" concrete improved with biochar addition; it was also proven to be safe from a leaching perspective, indicating that they can be successfully used as a component of concrete. Results obtained from the dissertation study showed that vetiver roots and shoots, after essential oil extraction, can be successfully reused for environmental and agronomic purposes, thus contributing to circular economy by valorizing a waste to make a resource.