EVALUATION OF BAMBOO BIOCHAR AS A SUSTAINABLE HYDROPONIC GROWTH MEDIUM

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ABSTRACT

Hydroponics is a growing system absent of soil that utilises appropriate growth media to facilitate root formation, sustain water–air equilibrium, and optimise nutrient absorption.Traditional substrates including rockwool,cocopeat,clay pebbles and sponge are frequently utilised but encounter constraints concerning environmental sustainability, disposal, cost and structural integrity.Bamboo biochar, generated via pyrolysis, possesses significant porosity, advantageous physicochemical characteristics, and renewable potential, making it a viable sustainable alternative growth medium for hydroponic development. This study systematically evaluates the potential of locally sourced bamboo biochar as a sustainable hydroponic growth medium for Romaine lettuce (*Lactuca sativa var. longifolia*), benchmarked against prevalent commercial substrates including cocopeat, rockwool, clay pebbles, and sponge. Bamboo biochar was produced via pyrolysis at 600°C for 30 minutes and characterised for physicochemical properties such as moisture content, volatile matter, ash content, fixed carbon, pH, electrical conductivity, bulk density, water holding capacity, porosity, cation exchange capacity (CEC), and total nitrogen. Spectroscopic analyses (FTIR and XRD) confirmed the presence of oxygenated functional groups and a largely amorphous carbon structure conducive to nutrient adsorption and retention.The biochar exhibited high porosity, elevated CEC (18 cmol/kg), alkaline pH (~10), and superior water retention capacity, properties advantageous for hydroponic plant support. Bamboo biochar's porous microstructure promotes root aeration and moisture availability, while its nutrient-rich mineral content contributes to improved nutrient delivery and reduced fertilizer dependency. A germination test on Romaine lettuce seeds showed a high germination percentage (90%), indicating biochar's compatibility with seedling establishment.While comprehensive growth trials were hindered by unforeseen disruptions, preliminary observations and literature evidence substantiate bamboo biochar's promise in enhancing plant biomass, root development, and yield metrics comparable to or exceeding conventional substrates. Additionally, bamboo biochar offers ecological and economic benefits through renewable feedstock use, carbon sequestration, reduced environmental footprint relative to synthetic media, and potential reuse within circular agricultural models.This study fills a crucial research gap by providing detailed physicochemical analysis and early-stage horticultural validation of bamboo biochar for use in hydroponic systems. It advocates bamboo biochar as a cost-effective, sustainable alternative to traditional hydroponic media, capable of supporting high-value crop production while aligning with environmental sustainability goals.

Keywords: Bamboo biochar, hydroponic growth medium, pyrolysis, porosity, Romaine lettuce

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