

In recent years, the booming essential oil industry has produced residues that, if mismanaged, can harm ecosystems by contaminating soil and water. This study introduces a sustainable solution by transforming these residues into biochar using pyrolysis. Specifically, we evaluate the potential of oregano and citronella biochars to remove methylene orange dye and assess their safety for water treatment and soil improvement.

This study evaluated the impact of oregano and citronella biochars, produced at different temperatures, on radish seed germination and root development. The control group displayed strong performance with 90-100% germination and 3.54 cm root length. Oregano biochar at 300°C was toxic to seed growth, while oregano biochar at 400°C improved germination but fell short of the control. Citronella biochar at 300°C and 400°C had better germination but still lagged behind the control group. Furthermore, our results demonstrate that Citronella biochar (BCR) at 400°C effectively removed 88.8% of the methyl orange dye. Conversely, the combination of oregano biochar (BOR) and citronella biochar (BCR) at 300°C did not substantially impact concentration reduction. In summary, applying BOR and BCR produced at 400°C to soil appears environmentally safe but does not significantly enhance plant growth. These findings underscore the critical roles played by biochar type and pyrolysis temperature in shaping the application process.