開發蝦殼衍生複合材料作為土壤改良劑

Synthesis of Shrimp Shell Derived Composite as a Soil Amendment

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摘　要

本研究旨在開發以蝦殼為基礎生物質衍生之複合材料，結合生物炭之穩定結構性質作為基質，複合具三維交聯結構之殼聚醣水凝膠，應用作為新型土壤改良劑材料，並測試材料對於土壤中重金屬固定之效率，確保糧食品質安全。本研究一方面透過此複合材料之高重金屬吸附容量，減低重金屬於土壤中移動之能力；另一方面，以水凝膠作為土壤改良劑，實現土壤營養鹽與水分保持之功能，減少農業非點源污染，並增加作物與土壤健康程度，兼顧循環生物經濟目標。本研究主要目標包括：開發蝦殼衍生複合材料，建立生物質廢棄物資源化複合材料製備程序；評估蝦殼衍生複合材料施用於受重金屬污染土壤之固定效率，針對土壤重金屬固定建立動力學與等溫吸附模型。本研究結果顯示：從蝦殼提取殼聚醣經試驗結果，經過去礦物質化、去蛋白質化、去乙醯基化後，成功提取出殼聚醣與將乾蝦殼粉進行燒製生物炭，並將兩者做為原料製成之生物炭水凝膠複合材料。根據實驗結果顯示，此蝦殼衍生之複合材料於單一離子溶液中對 Cu^{2+}、Pb^{2+}及 Cr^{3+}之吸附容量分別為 155.90 mg/g、197.02 mg/g 及 198.15 mg/g。於混合離子溶液中對 Cu^{2+}、Pb^{2+}及 Cr^{3+}之吸附容量分別為 85.87 mg/g、168.60 mg/g 及 165.61 mg/g。綜合以上，此複合材料作為土壤改良劑不只可用於處理土壤重金屬污染，還能將廢棄物資源循環，且生物炭的使用對農業淨零碳排有其益處。

關鍵字：資源化材料、重金屬、生物炭、綠色永續韌性整治

Abstract

This research aims to develop a composite derived from biomass based on shrimp shells, combine the stable structural properties of biochar as a matrix, and combine chitosan hydrogel with a three-dimensional cross-linked structure to apply it as a new soil amendment and test it. The efficiency of the material in immobilizing heavy metals in the soil ensures food quality and safety. On the one hand, this research uses the high heavy metal adsorption capacity of this composite to reduce the ability of heavy metals to move in the soil; on the other hand, the hydrogel is used as a soil amendment to achieve the function of soil nutrients and water retention, reducing agricultural non-points. source pollution and increase crop and soil health, taking into account circular bioeconomy objectives. The main goals of this research include: developing shrimp shell-derived composite, establishing the preparation process of composite for biomass waste recycling; evaluating the immobilization efficiency of shrimp shell-derived composites in heavy metal-contaminated soil, and establishing kinetics and equations for heavy metal immobilization in soil. Thermoadsorption model. The results of this study show that: after the test results of extracting chitosan from shrimp shells, after demineralization, deproteinization, and deacetylation, the chitosan was extracted and dried shrimp shell powder was burned into biochar. Both are used as raw materials to make biochar hydrogel composite materials. The test results show that the adsorption capacity of the new composite for Cu^{2+}, Pb^{2+} and Cr^{3+} in a single ion solution is 155.90 mg/g, 197.02 mg/g and 198.15 mg/g respectively. The adsorption capacities for Cu^{2+}, Pb^{2+} and Cr^{3+} in the mixed ion solution are 85.87 mg/g, 168.60 mg/g and 165.61 mg/g respectively. As a soil amendment, this composite can not only be used to treat heavy metal contaminate in the soil, but also to recycle waste resources, and the use of biochar has its benefits for net zero carbon emissions in agriculture.

Keywords: Recycling materials, heavy metals, biochar, green sustainable resilient remediation