UNIVERSITI TEKNOLOGI MARA

UTILIZATION OF PALM KERNEL SHELLS AND BLOOD COCKLE SHELLS BIOCHAR COMPOSITE TO IMMOBILIZE LEAD IN SHOOTING RANGE SOILS

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Lead (Pb), in shooting range soil is toxic to humans as the mobilization of Pb may contribute to contamination of groundwater and soil. The contamination may affect human health if the groundwater used as drinking water. Conventionally, ground magnesium limestone (GML) has been used to immobilize Pb in soil. However, this approach uses non-renewable sources, and the quarrying of GML may cause environmental damage. As an alternative, composite biochar (CPB) derived from palm kernel shells (PKS), and blood cockle shells (BCS) was used as an immobilizing agent of Pb in the shooting range soils located at Universiti Pertahanan Nasional Malaysia (UPNM). In this work, optimized CPB, CPB9 was prepared by a pyrolyzing homogenized mixture of PKS and BCS at PKS-to-BCS weight ratio (1:1), peak pyrolysis temperature of 900 °C and 1 hour for the heating duration. The pH values of CPB increased with decreasing PKS-to-BCS ratio, increasing peak temperature and heating duration. The increasing ratio of BCS in the composite increased the alkalinity due to the presence of calcium carbonate ($CaCO_3$). The proximate analysis showed that the CPB has a low moisture content (1.3%) and high fixed carbon content (54.5%) when the feedstock was pyrolyzed at high temperature. The physicochemical properties of CPB9 showed that the surface of CPB9 has irregular pores from FESEM analysis. Based on the XRD spectra result, $CaCO_3$ in the CPB transformed to CaO after pyrolysis, and the XRF result showed that CPB has a high content of Ca (43.17%) that contribute to the alkalinity of CPB. Shooting range soil was incubated with CPB9 at 1, 3 and 5% w/w and the soil pH was measured with pH meter every three days. Overall, the application of CPB resulted in an increase in pH value in the shooting range soil. Increasing the content of BCS has increased the pH of CPB, decreased the solubility and mobility of soil Pb, thereby, enhancing the immobilization effect of Pb in soil. These results indicated that CPB9 is effective in immobilizing Pb in shooting range soil at an application rate of 5% w/w due to the increase of soil pH (9.1 to 12.0) after incubated for 21 days and reduced the exchangeable fraction (from 7.56% in control soil to 0.01% in CPB-treated soil), and carbonate fraction (from 0.51% in control soil to 0.15% in CPB-treated soil).

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