UNIVERSITI TEKNOLOGI MARA

MODIFICATION OF BIOCHAR WITH MAGNESIUM COMPOUND FOR PHOSPHORUS REMOVAL AND LEAD IMMOBILIZATION IN SOIL

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Environmental Science And Technology)

Faculty of Applied Sciences

June 2022

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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Thesis Title	:	Modification Of Biochar with Magnesium Compound For Phosphorus Removal and Lead Immobilization in Soil
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Date	:	June 2022

ABSTRACT

Biochar converted from carbon-rich wastes and modified with magnesium (Mg) provide method on solving Phosphate pollution through struvite precipitation. In this study, laboratory experiments were conducted to optimize the modification parameters of Sawdust Biochar (SD) modified with two types of magnesium (i.e. $MgCl_2$ and MgO_2) for phosphorus (P) recovery to produce Mg-impregnated biochar (i.e. MC300 and MO700). After P removal using MC300 and MO700, samples were further modified with Phosphate from artificial human urine (AHU) to offer an alternative approach for treating Lead (Pb) contaminated soils. The parameters that has been optimized for producing $MgCl_2$ modified biochar (MC300) and MgO_2 modified biochar (MO700) with the highest P sorption capacity were concentration of AHU, optimum dosage of biochar, temperature pyrolysis of biochar, contact time and concentration of Mg. To characterize the physical and chemical properties of MC300 and MO700, CEC, elemental analysis, SEM-EDX, BET analysis, FTIR and TGA analysis were done for the entire samples. To study the immobilization of Pb in soil with biochar, leaching test (i.e. below 1.69 mg/L of Pb concentrations) and selective sequential extraction (i.e. decreased exchangeable Pb to 9% and 0% respectively.) were done using P modified biochar (i.e. P300 and P700). To support the result of study, isotherm and kinetic studies were investigated. MO700 have the highest sorption capacity for total P (i.e. 9554.20 mg/g) compared to MC300. Next, the contact time for MC300 and MO700 were 80 min and 120 min respectively. The optimum sorbent/solution ratio were 0.1g/L and the optimum mg concentration used to modify biochar (i.e. B300 and B700) were at 5% w/v. Adsorption isotherm for Phosphorous indicated that adsorption process of MO700 happens on a heterogeneous surface by several layer adsorption mechanism while MC300 happens on homogenous bound number of active site. Kinetic study results suggesting that the entire adsorption process for both MC300 and MO700 were better described by chemisorption process. For the characterization by SEM-EDX analysis showed after undergo pyrolysis to formed B300 and B700, the surface morphology has more pores formed on its surface compared to raw sawdust. The blue colour on the surface of the particles by the spot EDX analysis indicates the presence of Magnesium on the surface of the MC300 and MO700. For struvite biochar (P300 and P700), it can be seen that a small crystal called struvite were seen to formed on the surface and the presence of P in the EDX analysis. Other than that, BET study proved that high pyrolysis temperature gives better surface area for B700 but decrease surface area for MO700. From FTIR analysis, functional groups of P-O stretching vibration, aromatic C-H, NH_2 stretching bands, C=C alkene, C=O amide, C=C aromatic ring, and C=N aromatic ring were mainly involved in the Mg and P adsorption. Lastly, for TGA results, there are four different mass loss phases that has been separated by the lines for specific temperature intervals. For the biochar sample, the first decomposition stage happened to all the samples at < 300 °C.There were two decomposition stages between 250°C and 350°C at phase 2 that correspond to the sharp peak of DTG at 350°C for both MC300 and MO700. Lastly, stage 3 and 4 at 450°C and 800°C, respectively were attributed to the slow decomposition of residual solids. This study cover the findings of gap, between the modification of biochar with two different source of Mg and Phosphate removal using Mg biochar that may immobilize Pb in soil that can contribute to the greening and reclamation of soil and river. This study is important for future research that will contribute way forward in the area of nature restoration.

ACKNOWLEDGEMENT

Alhamdulillah, first and foremost, praises to Allah SWT, the Almighty, for His showers of blessings throughout my research work to complete this challenging research successfully.

I would like to express my deep and sincere gratitude to my main research supervisor, Dr. Yong Soon Kong, for giving me the opportunity to do research and providing invaluable guidance throughout this research. His dynamism, vision and motivation have inspired me and have taught me how to carry out and present the research works as clearly as possible. It was a great privilege and honor to work and study under his guidance. Next, I am extending my heartfelt thanks to my co-supervisor, Puan Nurul' Ain Binti Jamion for financial management and supporting my research until this level. Furthermore, thank you to all the lab assistance Mr. Rosmi Abdullah, Mrs. Nabilah Nudin, Mr. Rozaini Manah and Mrs. Julia Kasim, for providing technical support during lab sessions and ensure my safety during conducting my lab works.

On the other hand, I owe a debt of gratitude to my parents for their love, prayers, caring and sacrifices for educating and preparing me for my future. The countless time they helped me throughout my journey in master study. Their encouragement and support when the times are rough are very much appreciated. It was a great comfort and relief to know that they were willing to provide anything and everything they can give even though I know that they have struggled a lot. Their love and compassion are like the flowers that bloom forever.

My completion of this thesis could not have been accomplished without the support of my friends and research colleagues, Nor Aishah Malek, Nor Fateha Azuan and Nurlieyana Abu Hassan Asha'ari for their kindness and their constant encouragement. Special thanks to my late friend, Noor Mohamad Amin Salleh for his intelligent, humble and guidance in this research work even for a short time.

Besides that, thanks to UiTM for giving me the opportunity in pursuing my Master in Science (Environmental Science and Technology) here and for providing the facilities and equipment through out my master's journey. Lastly, my thanks go to all the people who have supported me to complete the research work directly or indirectly.

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