UNIVERSITI TEKNOLOGI MARA

PHYSICOCHEMICAL PROPERTIES OF ACTIVATED OIL PALM EMPTY FRUIT BUNCH (EFB) BIOCHAR AND ITS EFFICIENCY IN REDUCING ARSENIC, CADMIUM AND ZINC IN CONTAMINATED SOIL

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MSc

May 2021

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.

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ABSTRACT

Biochar from EFB was activated by using KOH under 400 ºC, 600 ºC and 800 ºC. The physicochemical characteristics of activated EFB biochars were-evaluated by using proximate and ultimate analysis, Brunauer-Emmet-Teller (BET) surface area, surface morphology using Scanning Electron Microscope (SEM) and Fourier Transform Infrared (FTIR) spectrometer. The results of activated EFB biochar that was produced at low and medium temperature (400 °C and 600 ºC) had shown high yield, well-developed pores and enriched with oxygen-containing functional groups (O-H and C-O). In contrast, biochar that was activated with high activation temperature (800 ºC) produced more total and fixed carbon, high BET surface area, total pore volume and micropore volume as well as aromatic nature.

The incubation study was conducted to evaluate the performance of activated EFB biochar produced from the previous study to immobilize As, Cd and Zn in contaminated soil for ten weeks. Four treatments (AB400, AB600 and AB800) consist of control with 20 ton ha^{-1} of each activated EFB biochar's was thoroughly mixed with 200 g of spiked soil in the plastic pots with three replications. Pots were arranged in a completely randomized design (CRD). Distilled water was added to the soil regularly to maintain the soil at 70 % field capacity. The soil solution samples were collected every week to determine soil pH, EC, Eh, soluble phosphate, DOC, As, Cd and Zn concentration. The addition of biochar, particularly AB800, had significantly ($p<0.05$) increased soil solution pH and soluble phosphate and no changes in soil DOC and redox potential. The addition of AB800 also increased As concentration in soil due to an increase in soil pH and soluble P. In contrast, the application of AB600 and AB400 had successfully reduced As concentration in soil solution due to surface complexation between As and functional groups of biochar. The results of the analysis show that the superior biochar properties such as high surface area and porosity, as well as high soil solution pH and soluble phosphate, are the main factors to immobilize Cd and Zn in soil.

The pot study was conducted to determine the influence of activated EFB biochar rates on soil properties, As, Cd and Zn mobility, and rice uptake. Plastic pots were filled with 10 kg of spiked soil sample and mixed thoroughly with four levels of activated EFB biochar (control, 2.5, 5.0, 10 and 20 ton ha^{-1}). The pots were arranged in a randomized completely block design (RCBD) with four replications. The pot was maintained flooded about 1/3 of plant height until harvest. The findings from this study revealed that soil pH, EC, CEC, SOC and available P were increased proportionally with the rate of biochar applied. Biochar also caused a significant ($p<0.05$) decreased in extractable Cd and Zn, correspondingly to the increases in soil pH, CEC and available P. Besides, biochar properties such as large surface area, high CEC, high porosity and OH functional groups also provide a greater medium for the adsorption of Cd and Zn. In contrast, As concentration had increased significantly ($p<0.05$) with the increasing application rate due to the increase in soil pH, SOC and available P. In terms of metal accumulation in rice plants, there was a significant reduction ($p<0.05$) in Cd and Zn accumulation. However, the increase of As in soil does not reflect the As accumulation in the rice plant due to co-mobilization between As and SOC, and rice plant selectively adsorbed P rather than As. The study concludes that activated EFB biochar application successfully reduced As, Cd and Zn accumulation in rice plant but the secondary environment pollutant made by As must be considered.

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful. Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis. Special appreciation goes to my supervisor, Assoc. Prof. Dr. Adzmi bin Yaacob, for his supervision and constant support. His invaluable help of constructive comments and suggestions throughout the experimental and thesis works have contributed to the success of this research. Not forgotten, my appreciation to my co-supervisor, Mdm. Norazlina binti Abu Sari for her support and knowledge regarding this topic.

I would like to express my appreciation to the Head, Centre of Postgraduate Studies Faculty of Plantation and Agrotechnology, Ts. Dr. Nor Azma binti Yusof and also to the Dean, Faculty of Plantation and Agrotechnology, Assoc. Prof. Dr. Asmah binti Awal for their support and help towards my postgraduate and academic affairs.

My deepest gratitude also goes to my beloved parents, Mr. Mohd Bakhtiar bin Haji Mohd Nawawi and Mrs. Azizah binti Alias, for their endless love, prayers and encouragement. Also not forgetting my lovely wife and kids, Khadijah binti Salehoddin, Muhammad Haziq Darwisy, Nur Hannah Sofea and Nur Helena Delisha for their love, understanding and moral support. Love them all.

Last but not least, sincere thanks to all my friends and colleagues, for their kindness and moral support during my study. Thanks for the friendship and memories. To those who indirectly contributed to this research, your kindness means a lot to me. Thank you very much.

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