Міністерство освіти і науки України
Національний університет «Полтавська політехніка імені Юрія Кондратюка»
Інститут ботаніки імені М. Г. Холодного НАН України
University of Natural Resources and Life Sciences Vienna (BOKU), Austria
Bialystok University of Technology, Faculty of Civil Engineering and Environmental Sciences, Department of HVAC Engineering
Sindh Madressatul Islam University, Karachi, Pakistan
Deutsche Gesellschaft Für Internationale Zusammenarbeit (GIZ) GmbH
Gemeinde Filderstadt, Deutschland
Національний технологічний інститут, Делі
Муніципалітет м. Фільдерштадт, Німеччина
Сільськогосподарський коледж, Університет Волайта Содо
Державна екологічна академія післядипломної освіти та управління
Національний університет «Львівська політехніка»
Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського»
Одеський національний університет імені І. І. Мечникова
Сумський національний аграрний університет
Сумський державний університет
Національний технічний університет «Харківський політехнічний інститут»
Харківський національний університет імені В.Н. Каразіна
Вінницький національний технічний університет
Запорізький національний університет
Національний університет кораблебудування імені Адмірала Макарова
Харківський національний автомобільно-дорожній університет
Кременчуцький національний університет імені Михайла Остроградського
ТОВ «НЬЮФОЛК НТЦ»
ПрАТ «Природні ресурси»
СП «Полтавська газонафтова компанія»
ТОВ «Системейр»
ТОВ «Інвертер Експерт»
ТОВ «Вентсервіс»
Енергоконсалтингова компанія «АЙТІКОН»
Компанія A-Clima

V Міжнародна науково-практична конференція «Екологія. Довкілля. Енергозбереження»

Полтава, НУПП, 19 грудня 2024 року

УДК 502/504+620.9](2.064)
Е40

Відповідальна за випуск: завідувачка кафедри прикладної екології та природокористування, к.т.н., доцент Оксана ІЛЛЯШ

«Екологія. Довкілля. Енергозбереження» – 2024»: Збірник матеріалів V Міжнародної науково-практичної конференції «Екологія. Довкілля. Енергозбереження» (19 грудня 2024 року, Полтава). Полтава: НУПП, 2024. 201 с.

Учасники конференції – міжнародні експерти, почесні гості, науковці, шкільна й студентська молодь та освітяни – розглядають проблеми раціонального використання природних ресурсів, захисту довкілля та енергозбереження, подолання екологічних ризиків та загроз для довкілля в умовах надзвичайних ситуацій та воєнних дій.

Матеріали подано мовами оригіналів. За викладення, зміст і достовірність матеріалів відповідають автори.

Оргкомітет конференції.

УПРАВЛІННЯ ГЛОБАЛЬНОЮ ТА РЕГІОНАЛЬНОЮ ЕКОЛОГІЧНОЮ БЕЗПЕКОЮ ТА АДАПТАЦІЯ ДО ЗМІН КЛІМАТУ

УДК 502/504

IMMOBILIZATION OF Ni, Cu, Pb AND Cr IN SOIL BY IMPROVED BIOCHAR MODIFICATION

***Altaf Hussain Lahori**, PhD, Assistant Professor, Department of Environmental Sciences, Sindh Madressatul Islam University, Karachi 74000, Pakistan*
***Monika Mierzwa-Hersztek**, Prof. Dr. hab. eng., Department of Agricultural and Environmental Chemistry, University of Agriculture in Krakow, al. Mickiewicza 21, 31-120 Krakow, Poland*
***Irfan Saleem**, Department of Environmental Sciences, Sindh Madressatul Islam University, Karachi 74000, Pakistan*
***Ambreen Afzal**, PhD, Senior researcher, National Institute of Maritime Affairs, Bahria University Karachi Campus, Karachi 75260, Pakistan*
***Maria Taj Muhammad**, PhD, Assistant Professor, Department of Chemistry, Jinnah University for Women, Karachi 74600, Pakistan*
***Viola Vambol,** Prof., Dr. of Eng. Sc., Department of Applied Ecology and Nature Management, National University «Yuri Kondratyuk Poltava Polytechnic», Poltava, Ukraine*

Any man-made activity, including mining, has a negative impact on the environment. This is especially evident in the accumulation of toxic metals in the soil, such as nickel, copper, lead and chromium [1-3]. Excessive accumulation of these metals in the soil, in terms of impact on the population, through the food chain contributes primarily to the development of anaemia, as well as damage to the kidneys and nervous system [4, 5]. In terms of impact on plants, excess heavy metals interfere with ecosystem processes, contribute to stress conditions of vegetable plants and reduce the efficiency of agricultural activities [6]. Violations of the physiological and biochemical aspects of plants due to poisoning with toxic metals makes these plants dangerous for consumption, which contradicts the principles of industrial safety [7].

Researchers from different countries around the world are interested in studying the methods and possibilities of remediation of the negative impact of mining activities in the form of the spread and accumulation of toxic metals in the environment, and much attention from researchers in this problem is attracted by the study of the role of biochar for soil restoration [8]. The use of MgO-modified biochars has been mainly studied for the treatment of water bodies and wastewater

[9, 10], and has not been sufficiently studied for the restoration of metals from soil [11]. At the same time, the properties of biochar and, accordingly, its effectiveness depend on the raw materials for its creation.

A group of authors in [12] investigated the efficiency of different MgO-modified biochars in immobilizing Ni, Cu, Pb and Cr in soil contaminated by rock crushing and mining, as this has not been properly studied.

The main objective of the study was to investigate MgO-modified biochars at 0.5 and 1% concentrations for the immobilization of Ni, Cu, Pb and Cr in rock crush contaminated soil, mining contaminated soil, and the reduction of the uptake of these metals by pearl millet. The biochars used were:

– from tea waste;

– from wood waste;

– from water lily peel;

– from pomegranate peel.

In addition, an attempt was made to evaluate the effect of the above mentioned biochars on soil EC, pH, $CaCO_3$, CEC, OM, PD, BD, and DOC.

Soil samples were collected from different locations in the contaminated areas from a depth of 0–20 cm to determine the physicochemical properties and contamination levels. Sample preparation for analysis and experimental determination of the studied parameters were carried out in accordance with traditional practices.

The most effective for reducing the mobility of Ni and Pb in soil contaminated by mining activities was wood waste MgO-modified biochar (1%), which provided 70.71 and 76.67% for Ni and 76.78 and 74.21% for Pb, although the stabilization of Cu was recorded at 59.73%, while the use of water chestnut peel MgO-modified biochar provided 73.45%. Water chestnut peel MgO-modified biochar (1%) was the most effective for stabilizing Cr, which provided the result of 76.78 and 74.21%.

According to the Redundancy analysis, the soil pH, cation exchange capacity and calcium carbonate were negatively correlated with the soil Cu, Pb and Cr, and the shoot and root biomass of switchgrass in the mining-disturbed soil; it was found that the soil pH, cation exchange capacity and calcium carbonate were negatively correlated with the soil Cu, Pb and Cr, and the shoot and root biomass of switchgrass in the mining-contaminated soil.

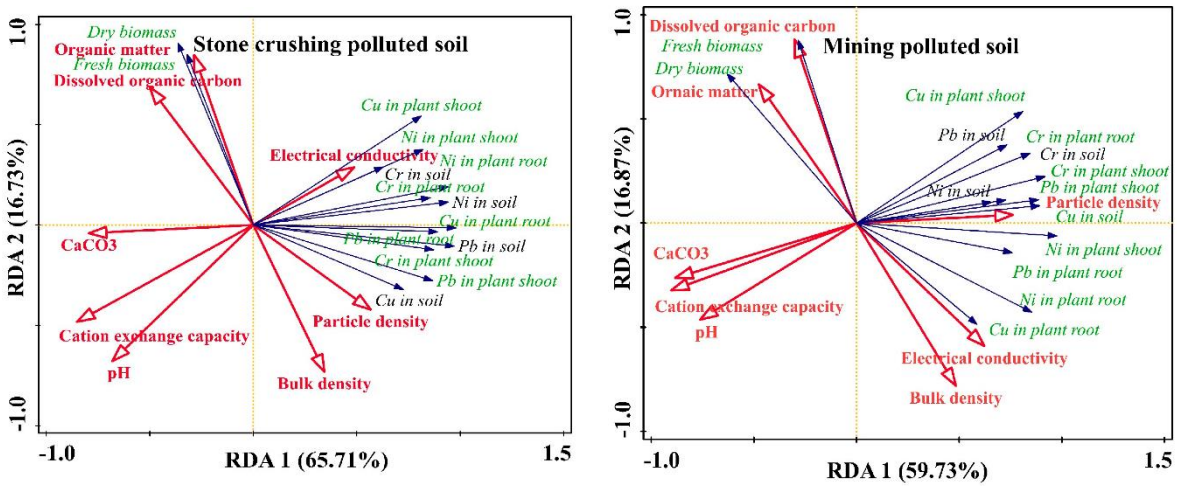

Figure 2. Results of the redundancy analysis among the studied parameters after the addition of biochar modified with MgO [12]

The study demonstrates the positive effect of MgO-modified biochar as an additive for immobilization of Ni, Cu, Pb and Cr in contaminated soil. At the same time, different types of MgO-modified biochar show high potential for different purposes, such as: from tea waste at a concentration of 1% – to increase fresh and dry biomass of millet; from wood chips at a concentration of 1% and from water chestnut at a concentration of 1% – for immobilization of Ni, Cu, Pb and Cr in the soil of the mining industry. This study provides original findings that are practically important for farming activities, as well as for researchers and scientists in the field of environmental science and technology.

Used information sources:

1. Omoyajowo, K. O., Adewunmi, M. A., Omoyajowo, K. A., Ogunyebi, A. L. Njoku, K. L., Makengo, B. M., Babalola, O. O., & Ojo-Emmanuel, G. (2024). Transitioning to a Climate-Resilient Society: Empirical Evidence on What Drives the Adoption of Green Computing Policies in Nigerian Organisations. Trends in Ecological and Indoor Environment Engineering, 2(1), 28–34. https://doi.org/10.62622/TEIEE.024.2.1.2–34.

2. Helios-Rybicka, E., & Wójcik, R. (2012). Competitive sorption/desorption of Zn, Cd, Pb, Ni, Cu, and Cr by clay-bearing mining wastes. Applied Clay Science, 65, 6-13. https://doi.org/10.1016/j.clay.2012.06.006.

3. Yerima, E. A. & Atoshi, M. A. (2023). Assessment of Drugs Production Operations Impact on Minerals and Heavy Metals Levels of Soils Around the Facilities. Trends in Ecological and Indoor Environment Engineering, 1(1), 1–6. https://doi.org/10.62622/TEIEE.023.1.1.01-06.

4. Sebei, A., Helali, M. A., Oueslati, W., Abdelmalek-Babbou, C., & Chaabani, F. (2018). Bioavailability of Pb, Zn, Cu, Cd, Ni and Cr in the sediments of the Tessa River: a mining area in the North-West Tunisia. Journal of African Earth Sciences, 137, 1–8. https://doi.org/10.1016/j.jafrearsci.2017.09.005.

5. Paithankar, J. G., Saini, S., Dwivedi, S., Sharma, A., & Chowdhuri, D. K. (2021). Heavy metal associated health hazards: An interplay of oxidative stress

and signal transduction. Chemosphere, 262, 128350. https://doi.org/10.1016/j.chemosphere.2020.128350.

6. Alazaiza, M. Y., Albahnasawi, A., Copty, N. K., Bashir, M. J., Nassani, D. E., Al Maskari, T., ... & Abujazar, M. S. S. (2022). Nanoscale zero-valent iron application for the treatment of soil, wastewater and groundwater contaminated with heavy metals: a review. Desalination and Water Treatment, 253, 194-210. https://doi.org/10.5004/dwt.2022.28302.

7. Aborisade, M. A., Oba, B. T., Kumar, A., Liu, J., Chen, D., Okimiji, O. P., & Zhao, L. (2023). Remediation of metal toxicity and alleviation of toxic metals-induced oxidative stress in Brassica chinensis L using biochar-iron nanocomposites. Plant and Soil, 493(1), 629-645. https://doi.org/10.1007/s11104-0238.-06256-4.

8. El-Naggar, A., Shaheen, S. M., Ok, Y. S., & Rinklebe, J. (2018). Biochar affects the dissolved and colloidal concentrations of Cd, Cu, Ni, and Zn and their phytoavailability and potential mobility in a mining soil under dynamic redox-conditions. Science of the total environment, 624, 1059-1071. https://doi.org/10.1016/j.scitotenv.2017.12.190.

9. Garcıa, M.A.; Chimenos, J.M.; Fernández, A.I.; Miralles, L.; Segarra, M.; Espiell, F. Low-grade MgO used to stabilize heavy metals in highly contaminated soils. Chemosphere 2004, 56, 481–491. https://doi.org/10.1016/j.chemosphere.2004.04.005.

10. Ahmed, M. B., Zhou, J. L., Ngo, H. H., Guo, W., & Chen, M. (2016). Progress in the preparation and application of modified biochar for improved contaminant removal from water and wastewater. Bioresource technology, 214, 836-851. https://doi.org/10.1016/j.biortech.2016.05.057.

11. Yang, X., Zhang, S., Ju, M., & Liu, L. (2019). Preparation and modification of biochar materials and their application in soil remediation. Applied Sciences, 9(7), 1365. https://doi.org/10.3390/app9071365.

12. Saleem, I., Lahori, A. H., Mierzwa-Hersztek, M., Afzal, A., Muhammad, M. T., Ahmed, M. S., ... & Vambol, S. (2024). The Application of MgO-Modified Biochars for the Immobilization of Ni, Cu, Pb, and Cr in Stone Crushing and Mining-Polluted Soil. Agronomy, 14(7), 1423. https://doi.org/10.3390/agronomy14071423.