Bioresource Technology Reports 17 (2022) 100902

Contents lists available at ScienceDirect

Bioresource Technology Reports

journal homepage: www.sciencedirect.com/journal/bioresource-technology-reports

The application of agricultural wastes for heavy metals adsorption: A meta-analysis of recent studies

Muhammad Imran-Shaukat *, Rafeah Wahi, Zainab Ngaini

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

ARTICLE INFO

Keywords:
Adsorbent
Adsorption behaviour
Agricultural waste
Biosorption
Wastewater treatment

ABSTRACT

Numerous studies have been carried out to investigate the suitability of various agricultural wastes as biosorbent for heavy metals removal. Previous published reviews on heavy metal removal by agricultural waste-based biosorbent were limited to narrative and systematic reviews, with no statistical analysis to compare outcomes across different biosorbents sources. In this work, meta-analysis technique was applied to identify gaps in contemporary biosorbents research. A meta-analysis was undertaken using several packages of R programme on publications over the last five years to evaluate the capability of eleven different types/components agricultural wastes for the adsorption of eight heavy metal. Based on the findings, agricultural wastes have the potential to be employed for heavy metal adsorption from aqueous media in general. However, the disparities in the findings suggest that when utilising different types of raw biomass as adsorbents, modifying the biomasses into carbon-enriched forms would be a preferable option.

1. Introduction

Heavy metals can be found in water, the atmosphere and sediments through a variety of natural and anthropogenic causes such as inadequate water treatment, urbanisation, industrialisation and the intensification of agricultural output (Rhaman et al., 2020). Heavy metal concentrations in the environment have been reported to be elevated in the wastewater generated by numerous industries like mining, textiles, fertiliser production, pharmaceuticals (Mustapha et al., 2019), pesticide production, smelting (Liu et al., 2019), electroplating (Surendran and Baral, 2018), leather tanning, wood preservation, metal cleaning, processing, alloy preparation (Sinha et al., 2015), photography, mining, battery storage operations (Mohammed and Ibrahim, 2016), stainless-steel welding, construction, structure demolition, lead piping and fittings (Shilawati Ehishan and Sapawe, 2018), electronic–circuit production, steel and nonferrous processes and chemical industries (Gupta et al., 2015).

Heavy metals bioaccumulate rapidly in living tissues through the food chain (Bendjeffal et al., 2018; Zhang et al., 2018). Human exposure to excessive Cadmium can cause nausea, diarrhoea, yellowing of the teeth, lung defects and hypertension (Ali et al., 2020), Itai-itai disease and bone-softening (Gupta et al., 2015). Excessive human ingestion of chromium results in kidney damage, capillary damage, gastrointestinal issues and irritation of the central nervous system (Ali et al., 2020; Bayuo et al., 2019). Prolonged subjection to Ni can result in cancer and lung fibrosis, together with dermatitis (eczema) after it comes into contact with the skin (Fawzy et al., 2016). Copper ingestion can cause mucosal inflammation, renal injury, gastrointestinal issues, depression and kidney damage (Banerjee et al., 2019; Kebede et al., 2018). Long-term contact with high concentrations of manganese may lead to damage to the central nervous system, including Parkinson's disease (Kul et al., 2016). Long term exposure to Lead, even in limited quantities, can cause severe health conditions such as cancer, semi-permanent brain stroke, and renal and lung ailments (Alhogbi, 2017). Central nervous system and peripheral nervous system manifestations, elevated blood pressure and haemolytic anaemia are typical signs of Pb (II) poisoning (Ali et al., 2020). Higher concentrations of zinc can cause stunted growth to living organisms, reductions in immunisation, increased risk of tumour formation (Liu et al., 2019), fever and gastrointestinal disturbances (Ferreira et al., 2019).

A large array of technology is used in the physicochemical and biological treatment techniques used in industry for heavy metal extraction from water and wastewater. These include filtration, ion-exchange, reverse osmosis (Abdolali et al., 2015), chemical and electrochemical precipitation, membrane filtration (Semerjian, 2018), ultra-filtration, solvent extraction (Basu et al., 2017a) electrolysis and coagulation

* Corresponding author.
E-mail address: imranchemi@gmail.com (M. Imran-Shaukat).

https://doi.org/10.1016/j.biteb.2021.100902
Received 8 September 2021; Received in revised form 28 November 2021; Accepted 28 November 2021
Available online 30 November 2021