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Removal some types of heavy metals using kind bio-fungi

Safaa M. Sultan[1], Faten N. Mula Abed[2], Maha E. Irzoqy[3]
safaahawija@gmail.com[1], fatinnuri@uomosul.edu.iq[2], mememoda@gmail.com[3]
Northern Technical University, Mosul, Iraq[1], Department of Biology, College of science, University of Mosul, Mosul, Iraq[2], Ministry of Education , Mosul, Iraq[3]
Corresponding author: Safaa M. Sultan, e-mail: safaahawija@gmail.com
Co-authors: Faten N. Mula Abed: fatinnuri@uomosul.edu.iq, Maha E. Irzoqy: mememoda@gmail.com
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Abstract. Bioremediation is a friendly and cheap way to remove minerals from the environment. Research has been conducted over the past five decades, an enormous amount of information has been collected about the types of different bio- sorbents and their mechanism of mineral absorption. More research is needed to explore new bio-sorbent materials from the environment. Moreover, a deep insight needed not only into the method of demineralization but also its effective recovery. So that it can be get in usable form. Use of biomass to remove heavy metals which are absorbed simultaneously treating large quantities of sewage. No need for highly selective chemical additives to absorb and remove certain minerals operates over a wide range of conditions including temperature, pH, and presence other metal ions. Easy and cheaper absorption of minerals associated with biomass are essential to reduce the volume of waste or production of toxic substances.

Keywords: *M*ineral absorption; Metal ions; Waste; Bioremediation.

Introduction:

Nature has endowed our earth with four fields; Biosphere, lithosphere, hydrosphere and atmosphere. Together, these areas are important for maintaining a balanced ecosystem. The industrial revolution of the past five decades has left harmful consequences that due to different human activities and an increase in the number of population, industrialization and urbanization. Therefore, all of these have considered as polluted factors in an environment [1]. There are two main sources of introduction of heavy metals into the environment natural sources: which include volcanic emissions, forest fires, vents in the deep [2]. Seas Human resources: These include mining and smelting sites, metal fabrication plants, and paint. These heavy metals are released directly into the environment as Minerals naturally undergo cycles of bio-absorption between them and cellular compounds. For biological species there is a wide range of living and dead organisms and bacterial biomass fungi, algae and plants that are able to isolate toxic metals from the tailings streams [3]. This is the basis of bio- absorption technology.

Heavy metal contamination cases accumulation of different types of heavy metals (for example, accumulation of different types of heavy metals). Lead, cadmium, copper, nickel, zinc, and manganese (In seawater) only water pollution but it also occurred in the soil. It affects drinking sources and building making dangerous concentration of heavy metals in grains and vegetables. There are several cases Involved heavy metal pollution that occurred in Minamata Bay, Japan [4]. Its tragedy has been linked to the locals 1963 that consumed shellfish containing a high concentration of mercury near the Bay of Minamata. Exposure to these diseases [5]. Happened due to chemicals released and discharged Uncontrolled by the chemical plant operating near A high amount of mercury concentration is discharged [6] Gulf in The sea as wastewater and affects marine food chains such as shellfish and other seafood that can increase the concentration of mercury [4] Conventional methods of removing heavy metals contaminated

Several cleaning techniques have been suggested practicing to remove heavy metals from pollutants and a polluted area using chemical, physical and biological methods. There are many traditional techniques such as precipitation, Ion exchange, electrolysis techniques, chemical extraction, filtration, Hydrolysis and micro-packaging of the most common polymer all of these [8] excavation and backfilling work Chemicals Methods that pose serious health and environmental threats due to [9] its name and its mutations. steam extraction, stabilization, Annealing, verification and pre-membrane technology [3] are used to remove heavy metal ions from the pollutant area However, most of these technologies are expensive. Implementation on a large scale is also dangerous for continuous monitoring and control because sometimes it is not able to completely remove the heavy from the Contaminated minerals tend to remove all microbial organisms including Beneficial symbionts such as nitrogen-fixing bacteria as well as other animals [11].

Since the past several decades, physical various and chemical methods have been used to remove metals from the environment: Chemical methods are represented by: chemical precipitation, electrochemical treatment, oxidation/reduction. Physical methods are represented by: ion exchange, membrane technology, reverse osmosis, and evaporation recovery filtration Biological methods: Microorganisms including bacteria, fungi and algae [12].

Bioabsorption and bioaccumulation of heavy metals

The process of absorption and bioaccumulation of minerals by microorganisms is not a matter newly, the accumulation of minerals by fungi has received great attention in recent years due to Its applications in environmental protection and metal recovery.

The biological removal of metals is divided into three categories:

1. Biological adsorption of metal ions on the surfaces of fungi
2. Intracellular absorption of metal ions
3. Chemical conversion of metal ions by fungi.

The living mass of fungi is required in the last two classes

The non-living fungal mass does not depend on the requirements for growth, energy and transportation Non-living biomass exhibits strong bonding with metal ions due to lack of protons that are generated during metabolism. The problem of metal poisoning does not affect this type of biomass. It is one of the main advantages of bio-absorption Fungal biomass can be generated as a by-product of waste in industrial scale fermentation. It is pretreated by washing it with acids and bases, or both, before drying it and turning it into granules, all these factors have contributed to reducing the final cost of the operation [10].

Innate biological absorption of heavy metals

Fungi is a true eukaryotic organism that includes yeasts, mushrooms, molds, etc. The cell wall structure of fungi provides good metallic binding properties. Live fungi and dead can be used [15] in both forms as a bio-absorbent. The uptake of minerals by fungi involves two processes [1] such as (active uptake, bioaccumulation, or Intracellular absorption is dependent on cell metabolism Bio sorption and passive adsorption involves the binding of metal ions to a surface [2]. The cell wall the fungal cell wall exhibits excellent metal-binding properties due to its components. The cell wall of mushrooms consists mainly of chitin, man nan, glycan, in addition to lipids Polysaccharides and pigments such as melanin have been reported to form the fungal cell wall 90% of the polysaccharides, functional groups involved in metal binding include Carboxylates, phosphates, proteins, and nitrogen. The bio-absorption capacity of the fungal cells can be manipulated by physical treatment for chemical treatment including sterilization, thermal processes and phosphoric acid formaldehyde, and sodium hydroxide. It is shown in the two tables Bioabsorption of various minerals by fungi(4).

Filamentous fungi absorb heavy metals

Filamentous fungi are included as a preferred bio sorption agent towards other organisms For biological treatment due to its ability to remove concentrated heavy metal ions from substrates Liquid Cu and Cobalt Co are among the most toxic heavy metals produced by Mining and other industrial activities. It is known that both of them pose serious environmental concerns, especially on water resources, if they are not done correct together [15] Several filamentous fungi strains have been isolated, identified and evaluated for their ability to absorb.

Table 1: Fungi and their biological properties in relation to minerals

Father No.	Metal	Fungi	Temp. (°C)	pH
1	arsenic	chrysanthemum penicillium	25	3-4
2	Cadium	Aspergillus Cristatus Aspergillus niger Hydrilla Verticllata	25 25 25	6 4.75 5
3	chrome	Aspergillus niger Ostreatus pleurisy Trichoderma Viride Rounded Canesense Penicillium	28 25 – 35 20	4.5 4.5 6 5.5 6
4	copper	Ostreatus pleurisy Fomes fasciatus Aspergillus lentils	25 25 35	
5	Leadership	Rhizopus Nigricama Trichoderma Longibrachiatum Ostreatus pleurisy	25 25 25	5.5 7 5.5
6	Mercury	Aspergillus flavus Aspergillus smoke	30 30	5.5 5.5
7	Nickel	Aspergillus niger	25	4.5

The biology of heavy metals and for potential application in the bioremediation of waste copper and its derivatives, Several works indicate that [Trichoderm, penicillium, Aspergillus] It has a higher bio sorption capacity for copper and carbon compared to the fungal species monilia, fusarium, geotrichum as others It is believed that more fungal species that have a higher absorption capacity have not yet been isolated [16]. Moreover, the application of filamentous fungi to bioremediation is environmentally friendly and effective It is highly reliable due to its low technical requirements.

Table 2: Mushrooms and Bio absorption

Father No.	Fungi	Metal
1	Volvariella volvacea Mycelia,sporcarps	Cadium Lead copper chrome
2	Ganoderma Lucidum	Chrome
3	Coriolopsis strumosa	Copper
4	Daedalea tenuis	Copper
5	Lentinus strigosus	Copper
6	Lenzites malaccensis	Copper
7	Phellinus xeranticus	Copper
8	Rigidoporus lineatus	Copper
9	Rigidoporus microporus	Copper
10	Teametes lactinea	Copper
11	Ganoderma Lucidum	Copper
12	Agaricus macrospores	Cadmium Mercury Copper

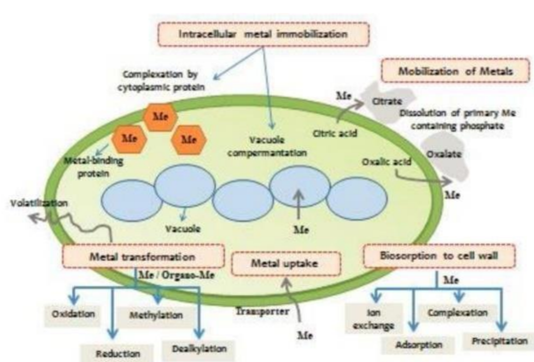
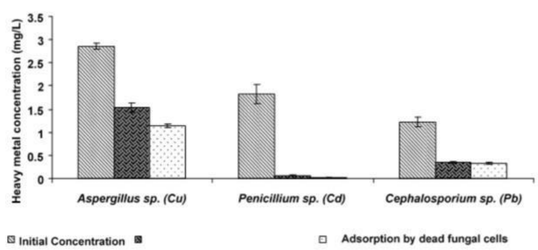


Fig (1): bioremediation of fungi

Bioabsorption of heavy metals by dead fungal cells

Bioabsorption is done on a laboratory scale though development a few decades ago [17] In this study, dead fungal cells were found Aspergillus sp. Penicillium sp. Cephalosporium sp. They were used as copper absorbent sorbents, Cadmium and lead respectively sp Aspergillus. sp Penicillium. Cephalosporium showed max. sp for absorption 91.46% of copper, 27.95% cadmium, 67.70 % of lead respectively adsorption capacitiesThese organisms were expressed as Cu > Pb > Cd



Heavy metal remaining after biosorption by fungi

Fig (2): Heavy metal remaining after biosorption by fungi

Conclusion

The biosorption process is affected by the following factors:

Temperature: To efficiently remove metal ions from the environment, the optimum temperature must be checked. It is generally assumed that biosorption is carried out between 20 and 35 °C. grades High temperature above 45 degrees Celsius may lead to protein damage, which in turn affects themetal absorption process

pH: It is a very important parameter. Affects the solubility of metal ions and sites. Biomass correlation. At low pH, the bioabsorption of minerals is affected. The general range of pH for mineral absorption is between 5.2-6. Above this limit, the biosorption capacity of minerals is compromised

Nature of sorbents: Mineral adsorption is reported in various forms such as membranesVital, freesuspending microbial cells or freezing microbial cells. can be changed for Through physical or chemical treatments. Physical treatments include sterilization, drying, Boiling, sonication, etc. Chemical treatment as the name indicates includes chemicals such as. Acids or alkalis to improve the bioabsorption capacity. The fungal cells are not fertilized, resulting in affects the structure of chitin, which leads to the formation of chitosan-glycan complexes, which have high results of metallic affinity. About the effect of age and components of growth medium on biosorption because they may lead to cell wall formation, cell size and formation.

Surface area to volume ratio: This property plays an important role in the effective removal of minerals Heavy from the middle. The surface area property plays an important role in the case of biomembranes The binding of metal ions to the microbial cell wall has been previously reported although The absorption of minerals into cells is an energyconsuming process, but microorganisms do not

Still prefer it to absorb walls Biomass Concentration: The biomass concentration is directly proportional to the absorption of the mineral [18] states that the electrostatic interaction between cells plays an important role in the absorption of minerals. At a certain equilibrium, biomass absorbs more mineral ions at a cell density Low compared to high densities Mineral absorption depends on wrinkle sites. more of Concentration of biomass or more metal ions restricts the access of metal ions to sites Connectivity Primary Metal Ion Concentration: The initial concentration provides an important driving force to overcome all resistance The mass transfer of metals between the aqueous and solid phases will increase the amount of minerals absorbed by Biomass with an initial concentration of minerals. The optimum percentage of metal removal can be taken at a concentration of Low elemental metal. Thus, at a certain concentration of biomass, the uptake . increases metal with increasing initial concentration.

Metal affinity with bio-adsorbent: physical/chemical pretreatment influences on the permeability and surface charges of biomass and make metallic bonding groups available for linking. It can be manipulated by pre-treatment of biomass with alkali, detergents Acids and heat, which may increase the amount of mineral absorption[18].

References:

[1] Abbas S, Ismail I, Mostafa T, Abbas S (2014) Biosorption of heavy metals: review. J ChemSciTechnol 3:74–102

[2] Alarcón A, Delgadillo-Martínez J, Franco-Ramírez A, Davies FT, Ferrera-Cerrato R (2006) Influence of two polycyclic aromatic hydrocarbons on spore germination, and phytoremediation potential of Gigaspora margaritaEchynochloapolystachya symbiosis in benzo[a]pyrene-polluted substrate. Rev IntContam Ambient 22:39–47

[3] Alegbeleye OO, Opeolu BO, Jackson VA (2017) Polycyclic aromatic hydrocarbons: a critical review of environmental occurrence and bioremediation. Environ Manag 60:758–783

[4] Chen M, Xu P, Zeng G, Yang C, Huang D, Zhang J (2015) Bioremediation of soils contaminated with polycyclic aromatic hydrocarbons, petroleum, pesticides, chlorophenols and heavy metals by composting: applications, microbes and future research needs. Biotechnology Adv 33:745–755

[5] Dixit R, WasiullahMalaviya D, Pandiyan K, Singh UB, Sahu A, Shukla R, Singh BP, Rai JP, Sharma PK, Lade H, Paul D (2015) Bioremediation of heavy metals from soil and aquatic environment: an overview of principles and criteria of fundamental processes. Sustainability 7:2189–2212

[6] Hlihor RM, Gavrilescu M, Tavares T, Fvier L, Olivieri G (2017) Editorial bioremediation: an overview of current practices, advances, and new perspectives in environmental pollution treatment Hindawi. Biomed Res Int 2:3–5

[7] Bayat, Z., Hassanshahian, M., Cappello, S. (2015) Immobilization of microbes for bioremediation of crude oil polluted environments: A mini review. The Open Microbiology Journal, 9, 48– 54.

[8] Camacho, M., Boada, L.D., Oros, J., et al. (2014) Monitoring organic and inorganic pollutants in juvenile live sea turtles: results from a study of Chelonia mydas and Eretmochelys imbricata in Cape Verde. Science of the Total Environment, 481C, 303–310.

[9] Deng, L., Su, Y., Su, H., et al. (2007) Sorption and desorption of lead (II) from wastewater by green algae Cladophora fascicularis. Journal of Hazardous Materials, 143 (1–2), 220–225. Diels, L., De Smet, M., Hooyberghs, L., et al.

[10]Hu, G., Li, J., Zeng, G. (2013) Recent development in the treatment of oily sludge from petroleum industry: a review. J. Hazard. Mater. 261, 470–490.

[11]Igwe, J.C., Abia, A.A., Ibeh, C.A. (2008) Adsorption kinetics and intraparticulate diffusivities of Hg, As and Pb ions on unmodified and thiolated coconut fiber. International Journal of Environmental Science and
Technology, 5, 83–92.

[12]Kanmani, P., Aravind, J., Preston, D. (2018) Remediation of chromium contaminants using bacteria. International Journal of Environmental Science and Technology, 9, 183–193

[13]grounds. Environ. Technol. Lett. 7, 431–444. Machado, M.D., Soares, E.V., Soares, H.M. (2019) Removal of heavy metals using a brewer's yeast strain of Saccharomyces
cerevisiae

[14]Mohamed, A., El-Sayed, R., Osman, T.A. et al. (2016) Composite nanofibers for highly efficient photocatalytic degradation of organic dyes from contaminated water. Environmental Research, 145, 18–25.

[15] Ortiz-Hernández, M.L. (2019) Removal of methyl parathion and coumaphos pesticides by a bacterial consortium immobilized in Luffa cylindrica. Revista internacional de contaminación ambiental, 30, 51–63

[16]Okoffo, E.D., Mensah, M., Fosu-Mensah, B.Y. (2016) Pesticides exposure and the use of personal protective equipment by cocoa farmers in Ghana. Environmental Systems Research, 5, 1–15.

[17]Vazquez, M., Calatayud, M., Jadan Piedra, C., et al. (2015) Toxic trace elements at gastrointestinal level. Food and Chemical Toxicology, 86, 163–175.

[18]Wasilkowski, D., Mrozik, A., Piotrowska-Seget, Z., et al. (2014) Changes in enzyme activities and microbial community structure in heavy metal contaminated soil under in situ aided phytostabilization. Clean Soil Air Water, 42, 1618–1625.