DOI: https://doi.org/10.36094/sc.v89.2024.Fruit_Waste_as_Novel_Biosorbent.Sardar.49

Sci. and Cult. 90 (1–2) : 49-51 (2024)

Fruit Waste as Novel Biosorbent for Heavy Metals: An Alternative Green Clean up Technology

***Abstract*: Fruit scraps are excellent bioadsorbents that are employed to remove contaminants. Heavy metals pollution has an impact on public health. There are no efficient ways to remove heavy metals from soil and water. By way of ion exchange, precipitation, coordination, complication, physical and chemical absorption, banana peels, grape skins, pineapple skins, orange peels, and coconut coir, these fruit scrap play a significant part in the remediation of heavy metals. Fruit waste can therefore serve as an excellent heavy metal adsorbent.**

Keywords: Fruit waste, Biosorbent, Heavy metals, remediation

Heavy metal effluent deposits in soil and vegetation can harm the food chain. Metal concentration in vegetables is influenced by soil, water, nutrients, and plant absorption. Accumulation factor (AF) assesses trace metal enrichment. Excess metals, such as Co, Cr (III), Cu, Fe, Mn, and Zn, can cause health problems, including nervous, cardiovascular, renal, neurological, and bone diseases [1].

In comparison to other physicochemical processes, ion-exchange resins, filtration, reverse osmosis, evaporation, and chemical precipitation are ineffective and expensive ways for eliminating contaminants. Additionally, in order to fully restore the environment, these techniques generate secondary hazardous substances that require additional treatment[2].

Biological compounds known as biosorbents are employed passively to remove contaminants from a solution. Examples of biomaterials include fruit waste, algae, bacterial waste, industrial waste, bacterial cells (active, inactive), and agricultural waste. It is an adsorption technique that makes use of biosorbent, also known as a biomass adsorbent.

The use of waste in the fruit processing industries is one of the most important and challenging tasks in the world. Fruit waste is accessible, cheap, easily burned off, and can even be rejuvenated and used again [3]. The rejected fruit's waste materials are meant for use in other industrial applications. Fruits and their derivatives have the capacity to remove metals from water[4].Some of the materials used to remove heavy metals are citrus peels, banana peels, mango peels, pomegranate peels, mandarin peels, papaya wood, yellow passion fruit shells, grape waste, orange peels, coconut coir, and coconut shells.

One kind of biomass that can be utilised as a biosorbent to remove Pb is sawdust from kapok trees [4].

The sources of heavy metals in the atmosphere are listed as geogenic, industrial, agricultural, pharmaceutical, national effluents, and atmospheric. Environmental contamination is especially common in critical infrastructure elements including mining, foundries, smelters, and other metal-based industrial operations. Metallic weathering, atmospheric statement, earth ion erosion and heavy metal leakage, sediment re-suspension, and metal evaporation from water sources to soil and pulverised water are further ways that environmental adulteration can happen [5].

It is reported that Cobalt (Co^{3+}), copper (Cu^{2+}), chromium (Cr^{6+}), iron (Fe^{3+}), magnesium (Mg^{2+}), manganese (Mn^{7+}), molybdenum (Mo^{2+}), nickel (Ni^{2+}), selenium (Se^{2+}) and zinc (Zn^{2+}) are present in waste water that have impact on public health[6].

So, the purpose of this study is to determine the role of fruit scraps for a certain heavy metals and how to remove heavy metals via bioadsorption.

Biosorbents from Fruit Waste:

Fruit wastes produced in large quantities by the food processing and agriculture industries could present issues in municipal landfills due to their high biodegradability. Waste-based adsorbents can be utilised in biosorption to remove harmful heavy metals from wastewater in an effective and affordable way[7].

It is reported that several fruits like avocado, hamimelon, and dragon fruit peels were act as natural materials to serve as straightforward, reusable adsorbents

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for water filtration[8]. Peels of orange, lemon, banana, kiwi, dragon fruit, and other fruit cortexes can be used to remove heavy metals from polluted effluents[9]. It is also reported that Anions from aqueous solutions, including phosphate, arsenate, arsenite, and chromate ions, were extracted using apple peels[10].

Mechanisms that are used by Fruit scrap during heavy metals remediation:

It is reported that, biosorption processes by fruit scraps occur by several mechanism like complexation, physical adsorption, and other physico-chemical interactions between metal ions and functional groups on the cell surface[8]. Biosorption occurred by complexation, physical adsorption that uses formation of hydrogen bonds, van der Waals interactions, static forces, ion exchange,co-ordination and precipitation[5]. After several study, it is concluded that'surface of the fruit peels contain functional groups such COOH and OH that are efficient at removing harmful metal ions from water [8] (Fig 1).

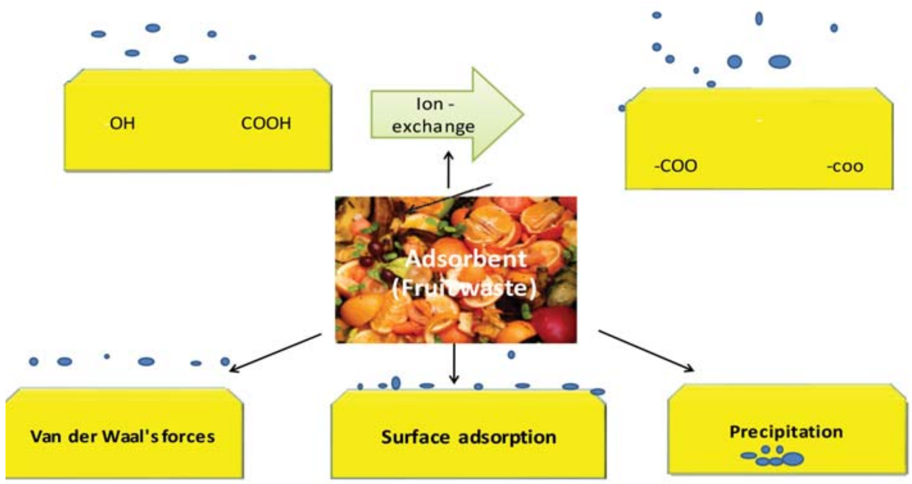

Figure 1: Several mechanisms of Heavy Metal Adsorption by Fruit Waste

It is studied that active cell of bacteria also act as bioadsorbent and remediate the heavy metals by several interactions alike ionic bond interaction and functional group present on the surface of the bacteria by FTIR study[11]. Additionally, metal can be eliminated from solutions by forming a complex on the surface of the cell after coming into touch with the active groups. The polysaccharide cell wall, which is composed of polysaccharides and bivalent metal ions, exchanges ions with the polysaccharide counter ions. The biosorption of Pb (II), Cd (II), and Co (II) by the fruit shell of *Garcinia mangostana* L. was anticipated to be taken up by the ion exchange mechanism. Van der Waal's forces are what cause it to happen in the world of physical adsorption. In certain situations, cellular metabolism may either be necessary or sufficient for precipitation. The precipitates might form independently of the solid phase of the microbial cells or they could form and remain in contact with or inside the cells [8].

Fruit scraps provide a number of benefits, including inexpensive initial investment, no intermediate harmful compounds, simple operating conditions, and the ability to recycle trash when used for the treatment of heavy metals[12].

Conclusion

Biosorption as green clean up technology by fruit waste has been shown to be effective, affordable, and environmentally acceptable for the treatment of wastewater containing heavy metals, more in-depth research is needed to improve treatment design and performance. In this study, fruit waste as biosorbent were found to be a practical approach for eliminating heavy metals from wastewater. It has been clearly established which fruit waste is important for certain kinds of heavy metals.

Acknowledgement

We are thankful to Chancellor, Brainware University, West Bengal for providing us the infrastructure. Authors are also thankful to Techno India University, West Bengal. ❐

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1. Md. Islam, M.M. Hasan, A. Rahaman, et al. *SN Appl Sci*. **2**:1315 (2020).
2. A. Ayangbenro, O. Babalola. *IJERPH*. **14**, 94 (2017)
3. H. Kumar, K. Bhardwaj, R. Sharma, E. Nepovimova, K. Kuèa, D.S. Dhanjal, R. Verma, P. Bhardwaj, S. Sharma, D. Kumar. *Molecules*. **25**, 2812 (2020)
4. K. Rambabu, G. Bharath, F. Banat, P.L. Show. *Res*.**187,** 109694. 2020.109694 (2020)
5. R.J. Nathan, D. Barr, R.J. Rosengren. *Environ. Technol*.**43**, 1935–1952 (2022).
6. K.M. Al-Qahtani. *J. Taibah Univ*. Sci. **10**, 700–708 (2016).
7. L. Verma, M.A. Siddique, J. Singh, R.N. Bharagava. *J. Environ. Manage*. **250**, 109452 (2019).
8. R. Mallampati, L. Xuanjun, A. Adin, S. Valiyaveettil*Chem. Eng*. **3**, 1117–1124 (2015).
9. Inamuddin (Ed.), 2017. *Materials Research Forum LLC*, pp. 275–293 (2017).
10. R. Mallampati, S. Valiyaveettil. *Mater. Interfaces*. **5,** 4443–4449 (2013).
11. S. Chakraborty, S. Das, S. Banerjee, S. Mukherjee,A. Ganguli, S. Mondal. *Biocatal. Agric. Biotechnol.* **38**, 102204 (2021).
12. H. Sun, Xiaoyun. Wang, R. Wang, Y. Zhang, Wang, Xiaoxiao. *Water Sci. Technol*. **80**, 1205–1212 (2019).