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Biosorption of Lead by *Beauveria bassiana*

Tyagi S and Tyagi A*

Department of Biotechnology, Meerut Institute of Engineering and Technology, Meerut, Uttar Pradesh, India

***Corresponding author:** Anjali Tyagi, Department of Biotechnology, Meerut Institute of Engineering and Technology, Meerut, Uttar Pradesh, India, E-mail: anjalitg22@gmail.com

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Abstract

Heavy metal pollution is now a day's one of the most important natural concerns. Anthropogenic activities like metalliferous mining and smelting, agriculture, waste disposal or industry releases are variety of heavy metals which can produce destructive impacts on human wellbeing when they are taken up in amounts that cannot be handled by the organism. Damage may cause destructive reactions in different organs and biological functions, including reproduction and birth consequences. Various techniques have been employed for the treatment of industrial effluents, which usually include precipitation, adsorption, ion exchange, membrane and electrochemical technologies but these techniques are expensive, not environment well disposed.

Keywords:* *Biosorption; Metalliferous; Anthropogenic; Microbial ecology; Unicellular; Multicellular; Metal selective

Introduction

Microbiology is derived from Greece word "micro" which reflects "small"; & "*bios"* reflects "life", Microbiology is the study of microscopic organisms, those being unicellular, multicellular, or a cellular . Eukaryotic micro-organisms possess membrane-bound cell organelles include fungi and protists. Microbial ecology [1-6] is the relationship between microorganisms and their environment. Development in Microbial ecology gives rise to relatively new field of science and technology, discussing in Pollution Control Congress July 20-22,2017 Melbourne, Australia & Environmental Toxicology October 19-20,2017 Atlanta, USA. Microbiology [7-14] covers a broad spectrum of application in various fields such as health and medicine, and environment. Biosorption can be defined as the capacity of biological materials to accumulate heavy metals from waste water through metabolically mediated or physico-chemical pathways of take up. Algae, bacteria and fungi and yeasts have proved to be potential metal bio sorbents. The increase in the contamination of the aquatic system with heavy metals through industrial activities has started the search for economic strategies for their removal like, biodegradation and biosorption.

Biosorption is a physiochemical process that happens naturally in certain biomass which allows it to passively concentrate & tie contaminants onto its cellular structure [15,16]. Algae, bacteria and fungi have proved to be potential metal biosorbents. The biosorption [17-26] process involves a solid phase (biological material) and a fluid phase (solvent, normally water) containing a dissolved species to be sorbed (metal ions). To increase the development studies in field of microbiology certain research associations are coming together to support new and challenging approaches using microbiological factors such as European Biotechnology Thematic Network Association (EBTNA) which aims to utilize Biotechnology and Microbiology tools for different applications in field of Medical, Environment, Healthcare, and Microbiology [27-35].

The pollution [36-39] of water due to heavy metals is an issue of great environmental concern. The significant advantages of biosorption over conventional treatment methods include:

- **Regenerative:** biosorbents can be reused, after the metal is recycled.
- **Cheap**: the cost of the biosorbent is low since they regularly are made from abundant or waste material.
- **Metal selective:** the metal absorbing performance of various types of biomass can be more or less selective on different metals. This relies on various factors such as type of biomass, mixture in the solution, type of biomass preparation and physicochemical treatment.
- **No sludge generation**: no secondary problems with sludge occur with biosorption, similar to the case with many other techniques, for example, precipitation.
- **Metal recovery possible**: in case of metals, it can be recovered in the wake of being sorbed from the solution.
- **Competitive performance**: biosorption is capable of a performance comparable to the most comparable procedure, ion exchange treatment.

Lead (Heavy Metal)

A heavy metal is a metallic component which is toxic and has a high density, specific gravity or atomic weight. Less commonly, any metal with a potential negative health effect or environmental impact may be termed a heavy metal [40-45], examples of heavy metals include lead, mercury, cadmium, cobalt, chromium, lithium and even iron. Of the important metals, Mercury, lead, cadmium, Arsenic and Chromium (VI) are regarded as toxic; whereas, others, such as copper, nickel, cobalt and zinc are not as toxic [46-50]. The heavy metal ions are detected in the waste streams [51,52] from mining operations, tanneries, electronics, electroplating, batteries and petrochemicals industries. They have harmful impact on human physiology and other biological systems when they exceed the tolerance levels. Lead deposited on the ground is transferred to the upper layers of the soil surface [53-56], where it may be retained for a long time (up to 2000 years). In undisturbed ecosystems, natural matter in the upper layer of soil surface retains environmental lead. In cultivated soils, this lead is mixed with soil to a depth of 25C1ll (i.e., within the root zone). To highlight innovative researches in field of microbiology and environmental concern a number of research work is published under different Journals such as Bioremediation & Biodegradation, Expert Opinion on Environmental Biology and many more. All the write-ups submitted to the Journals provide a range of individual opportunities to acknowledge internationally. Atmospheric lead in the soil will continue to move into the micro-organism and grazing food chains, until equilibrium is reached [57-60].

Plants on land tend to absorb lead from the soil and retain most of this in their roots [61]. There is some evidence that plant foliage may also take up lead (and it is conceivable that this lead is moved to different parts of the plant). The uptake of lead by the roots of the plant may be reduced with the application of calcium and phosphorus [62-66] to the soil. A few types of plant have the capacity to accumulate high concentrations of lead. Lead at the concentrations occasionally found near roadsides (i.e., 10,000 - 40,000 ppm dry weight), can wipe out populations of bacteria and fungi on leaf surfaces and in soil. This can have a significant impact, given that many of these micro-organisms are a fundamental part of the decomposing food chain. The micro-organism [67-72] populations influenced are likely to be replaced by others of the same or different species, although these may be less efficient at decomposing organic matter. Evidence also proposes that micro-organisms can make lead more soluble and hence more easily absorbed by plants. Lead affects the central nervous system of animals and inhibits their capacity to synthesize red blood cells. Lead blood concentrations of above 40µg/dl can produce observable clinical symptoms in domestic animals [73,74].

Lead has many different impacts e.g. acute abdominal pain, kidney damage, high blood pressure and adverse reproductive consequences etc. Lead salts enter the environment [75-80] through the exhausts of cars, autos. The larger particles will drop to the ground immediately and contaminate soils or surface waters, the smaller particles will travel long distances through air and stay in the atmosphere [81-84]. Part of this lead will fall back on earth when it is raining. This lead-cycle caused by human creation is much more extended than the natural lead-cycle. It has caused lead pollution to be a worldwide issue.

Lead can cause several unwanted effects, such as:

- Disruption of the biosynthesis of haemoglobin and anaemia
- A rise in blood pressure
- Kidney damage
- Miscarriages and subtle abortions
- Disruption of sensory systems
- Brain harm
- Declined fertility of men through sperm damage
- Diminished learning abilities of children
- Behavioural disruptions of children, such as aggression, impulsive behavior and hyperactivity

The presence of metal ions in final industrial effluents is extremely undesirable, as they are toxic to both lower and higher organisms. Under certain natural conditions, metals may accumulate to lethal levels and cause ecological damage.

Major lead pollution can occur through automobiles and battery manufacturing [85-89]. Lead particles that settle on the soil from leaded gasoline or paint can keep going for a considerable length of time. Lead-contaminated soil is still a noteworthy problem around highways and in some urban settings. Household dust can contain lead from lead paint chips or from contaminated soil brought in from outside. Glazes found on some ceramics, china and porcelain can contain lead that may leach into food. Heavy metals are toxic to aquatic organisms even at very low focus. Most of these minerals were present in our surroundings only in minute amounts until recent centuries, when the orientation toward industrialization and production brought about our numerous technological advances. But technology, like medicine, [90,91] has its side effects. At present, these harmful metals have polluted our atmosphere, our waters, our soil, and food chain. Approximately 98% of lead in the atmosphere is from human activities. Neumann et al. have extended the sources of lead pollution [92-95] by paints, lead wastes, cell batteries, lead solders and forms.

Beauveria bassiana

Beauveria bassiana is a fungus that grows naturally in soils throughout the world and acts as a parasite on various arthropod species, causing white muscardine disease; it thus belongs to the entomopathogenic fungi. The species is named after the Italian entomologist Agostino Bassi, who discovered it in 1835 as the cause of the muscardine ailments of domesticated silkworms. It was formerly also known as *Tritirachium shiotae*. The name *Beauveria bassiana* has long been used to describe a species complex of morphologically similar and closely related isolates. *Beauveria bassiana* is used as an inexpensive and efficient biodegradant for Pb(II) and Cd(II) from aqueous metal solutions [96,97]. The data obtained imply the potential role of *Beauveria bassiana* for heavy metal removal from aqueous solutions.

The white muscardine *Beauveria bassiana* fungus is a potential bio-control agent [98] that could be used against the berry borer very successfully. This pathogen, which kills the borer can be cultured at the estate level and sprayed on the infested plants.

Beauveria bassiana in the absence of a specific insect host grows through an asexual vegetative life cycle comprises of germination, & filamentous growth. In the presence of its host insect, Beauveria conidiospores germinate on the surface of the cuticle of host and enter the insect's integument through the germinated hyphal tubes where the fungus alters its development morphology to a yeast-like phase and produces hyphal bodies by budding like growth, which circulate in the haemolymph resulting in the host death. The fungal growth [99,100] then reverts back to the typical hyphal form (the saprotrophic stage).

Beauveria bassiana, fungus, is a common pathogen of a range of insects belonging to various gatherings. This fungus often exerts a good degree of natural biological control [101] under humid conditions. In March 2013, genetically modified *Beauveria bassiana* was found in a number of research labs and greenhouses outside of a designated containment area at Lincoln University in Christchurch, New Zealand. The Ministry for Primary Industries investigated. Depending on the strain, medium, and culture parameters, the fungal biomass is increased via vegetative growth.

Figure 1: Growth of B*eauveria bassiana* on PDA

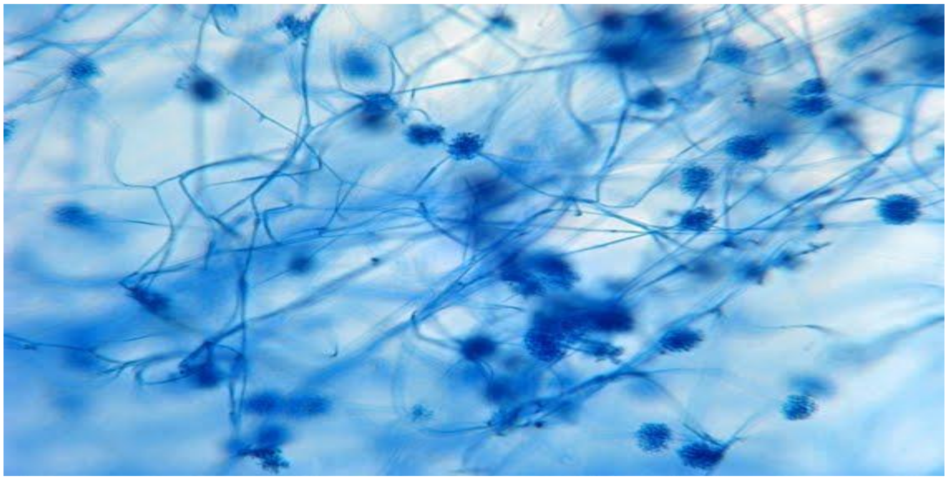

Figure 2: *Beauveria bassiana* under microscope

Mode of Action

The conidiophore forcibly discharges the conidium, which is covered with a mucilaginous sticky substance. When the conidium lands on a moist substrate other than the host, it may produce a secondary conidiophore and secondary conidium, which may produce tertiary conidiophores and conidia [101-104]. This process may continue until the protoplasm is depleted or a suitable host is found. Secondary and tertiary conidia may become resting spores. Secondary conidia (capilliconidia) may be borne on narrow capillary conidiophores. The surface of the capilliconidia has sticky substances, which adhere to the spores to objects with which they come in contact. Upon germination, the conidium produces a germ tube that penetrates the insect cuticle and enters the hemocoel. Inside the hemocoel, the fungus forms protoplasts, hyphal bodies, and hyphae. The protoplasts appear early in infection and have amoeboid movement.

Conclusion

Development of Microbial genetics in coming current years will have a broad spectrum of application, usage and can serves to save a large range of pollution. The new techniques have no side effects but will be more effective than previous techniques for removing several heavy metals from environment. Looking upon the development of Microbiology scientist and researchers need to accelerate in India. In India we should take appropriate steps to develop Microbiology such as Centre of Microbiology & Biotechnology, Research & Training Institute Bhopal, Department of Microbiology & cell biology Indian Institute of Science Bangalore, The Department of Microbiology, Bose Institute, Calcutta are making efforts to develop research and innovation in Microbiology.

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