International Research Journal of Natural and Applied Sciences
ISSN: (2349-4077)
Impact Factor 5.46 Volume 6, Issue 1, January 2019
Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

Strong Metal Contact Contaminants with Earthworm and its Biological Research

Saroj Yadav[1], Dr. Krishan Pal Singh[2]
Department of Bioscience
[1,2]OPJS University, Churu (Rajasthan) – India

Abstract-Earthworms are omnipotent animals that live in soils, enhancing chemical and physical properties as well as the distribution and activity of microbes and soil. Moreover, it has been reported that the fraction distribution of heavy metals Cu, Zn, Cr, Cd and Pb is significantly altered after earthworm activity, thus affecting the bioavailability of these metals. More than 80 per cent of terrestrial invertebrates' biomass is made up of earthworms.

They play a vital role in the decomposition of organic matter in soil and form an important link in the food chain by channeling waste energy from dead and decaying organic matter to higher tropical levels through being a prey to terrestrial vertebrates and birds. They also improve soil quality nutrient uptake plant growth, and plant yield through their feeding, burrowing and casting activities. This article shows the way at finding the impact of heavy metal interaction pollutants with earthworm microorganism. Along with it, this research has following objectives of study:To assess the impact of heavy metal on environmental. It also explores the earthworms and pollutants. Moreover, to assess the heavy metal pollution: source, impact, and remedies.

Keywords: Earthworms, Microbes, Bioavailability, Energy, Terrestrial Vertebrates

1. Introduction

Earthworms have a particularly intimate soil contact, consuming large amounts of soil and having few external soil solution barriers. Earthworms have been extensively used for these and other reasons in ecotoxicological soil studies. Earthworms are one of the major soil macro invertebrates and function as consumers, decomposers, soil modulators, and other animal feed resources.

Earthworms are an important link in the food chain of numerous birds, mammals and amphibia as well as several species of beetles and carnivorous slugs showed that thrushes living near primary lead-zinc smelter accumulated cadmium in kidney tissue. The highest concentrations of cadmium in the area were found in isopods and earthworms. Cadmium accumulation in the carnivorous common shrew

(Sorexaraneus) was high compared with the omnivorous field mouse. Lead accumulates in small mammals living on roadside verges.

Ecological Classification of Earthworms

Earthworm plays an important role in aeration and break down of soil while feeding on small organic nutrients. They are one of the chief species in the food chain for small animals including birds, fishes etc. Organic matter in various stages of decay is the principle diet of earthworms the major types of earthworms found in the soil ecosystem can be classified on the basis of habitat.

Epigeic Earthworms

The term epigeic in Greek stands for"upon the earth." These compost worms don't create permanentburrows underground and spend most of the time above at uppersoil surface. They are phytophagous worms and are efficient biodegraders. For example: Eiseniafetida, Lumbricusrubellus, L.castaneus.

Anecic Earthworms

The term "anecic" means "up from the earth". Worms in this category tend to make vertical tunnels intothe ground, but their primary food source is decaying matter on top of the soil and they are considered to be geophytophagous. For example: Lumbricusterrestrisspecies has been classified asanecic.

Endogeic Earthworms

They feed on the sub soil surfaces and feed on soil organic matter and dead roots along with large quantities of soil. Hence, they are considered to be geophagus.Examples include Allolobophorachlorotica, Apporectodeacaliginosa [1,2].

2. HEAVY METAL IMPACT ON EARTHWORM

Heavy metals such as Zn and Pb are widely distributed eg in soils. From metalworking industry. Although essential trace elements, they are above certain concentrations and exposure times toxic to most organisms and can affect their abundance, diversity and distribution. It is also a matter of concern that heavy metals do not break down in soils in contrast to harmful organic compounds, although their release to the environment could be restricted. Therefore it is important to assess the effects of heavy metals on soil organisms in order to understand the contamination risk to the environment. Earthworms are key species in decomposer communities in many ecosystems, thus having a great impact on nutrient mineralization and primary production of the decomposition activity. When present in the environment at high concentration, heavy metals are well known to be toxic to most organisms.

They affect the growth, morphology, and metabolism of soil micro-organisms as they cause protein denaturation or destruction of cell membrane integrity. In addition to lithogenic metals, sources resulting from various human activities, such as mining, metallurgy, fossil-energy combustion, solid waste or sewage sludge disposal, animal effluents and agricultural fertiliser inputs are deposited on the soil. Once incorporated into the soil, they remain for up to several thousand years, for every long period of time.

The increasing presence of heavy metals in organic waste, which can accumulate heavy metals in earthworms, is known to cause toxicological symptoms within the earthworm body. Observed oozing of coelomic fluid from the body and swelling of the clitellar region and subsequent segments, and similar morphological changes involving curling, excessive bloody lesion mucus secretion and clitellar bulging.

Organic waste management is the major concern worldwide, as unempirical waste disposal can harm the environment by causing unpleasant odour, contamination of the groundwater, soil pollution and also a risk to human health. The understanding of heavy metal behaviour within the soil-plant system appears to be particularly important.

The heavy metal sources in plants are their growth media (air, soil, nutrients), from which the heavy metals from the roots or foliage are taken. Although some heavy metals such as Cu, Zn ,Mn, and Fe are essential in plant nutrition, in plant physiology, many heavy metals do not play any significant part.

The plants that are grown in the polluted environment accumulate the toxic metals in their tissues and cause serious health risks when consumed. Cadmium has an adverse effect on a number of important enzymes. If, eating the nickel-contaminated food exposes the human beings, it can cause painful osteomalacia (bone disease), red blood cell destruction, and kidney damage. Many types of physical , chemical and microbiological methods of organic waste disposal require longer duration with high cost input, but vermicoposting is an eco-friendly low cost technique for biodegrading organic waste using earthworms and microbes.

Soil contamination with metals poses a risk to the health of the ecosystem, especially to organisms that are in direct contact with the soil (i.e. plants, soil invertebrates). Interaction can be either through direct dermal contact with soil solution chemicals or ingestion of soil, and the fraction of the chemicals available to the environment with which the earthworm interacts is termed as the fraction of the bio available. It depends on the earthworm 's physiology and behaviour, and the route of exposure [3,4].

3. DETOXIFICATION OF HEAVY METALS USING EARTHWORMS

No doubt those earthworms are, with their 600 million years of existence, the most important creatures on our planet yet. Factors such as soil conditions, agricultural / industrial practises, and environmental degradation have important impacts on the dynamics of these invertebrates and their biomasses. Previous studies carried out on earthworms suggested that their eating, burrowing, and casting activities enhance soil quality and fertility. Recently there has been increasing attention to a distinctive feature of earthworms. Much research has revealed that earthworms can alter the availability, absorption, and accumulation of heavy metals by moving through their body tissues and accumulating toxic metals.

- **Ecological Classification of Earthworms**

A earthworm significantly improves soil's physical, chemical , and biological characteristics through its eating, casting, and burrowing activities. Different species of earthworms vary in their ecological strategies, which affect the principal physical characteristics of the soil (soil aggregation and porosity) in different degrees and therefore classify them as epigeic, endogetic and anecic.

Epigeic species including Lumbricusrubellus, Eiseniafetida, Dendrodrilusrubidus live in the humus zone of the soils. They are fed from organic materials collected above the layer of mineral soil and thus periodically ingest particles of mineral soil. In forest ecosystems, the typical habitats of epigeic species are manure masses and layers of plant debris. They create their burrows in organic material layer or at a depth of 0–2,5 cm of mineral soil and substantially feed on microorganism-rich

A Monthly Double-Blind Peer Reviewed Refereed Open Access International e-Journal - Included in the International Serial Directories.

organic compounds. Epigeics are tiny worms with a reddish brown colour (normally less than 7.5 cm). Anecic species such as Lumbricusterrestris, Aporrectodea longa, Dendrobaenaplatyura are reddish brown coloured worms with the greatest and longest sizes ranging from 12.5 to 20.0 cm.

They live in permanent or semi-permanent burrows reaching a depth of 2 m, feeding on decreasing organic material on the surface of the soil and leaving their castings on the mouth of their burrows on the floor. Endogeal species (Aporrectodeacaliginosa, Allolobophorachlorotica, Octolasionlacteumv.b.) live on organic compounds found in layers of mineral soil and inhabit the top 0–50 cm of soil. Their distinctive colour characteristics such as lack of red-brown skin pigmentation and presence of very pink colour on the head and grey colouron the body differentiate them from the epigeic and anecic groups. Adult endogetic species can range between 3 and 12.5 cm [5.6].

4. EARTHWORM–HEAVY METAL RELATIONSHIPS AND ACCUMULATION AND DETOXIFICATION OF HEAVY METALS BY EARTHWORMS

Although lithologically there are heavy metals in the earth, their soil concentrations increase through various industrial emissions, commercial fertilisers, and sewage sludge. Depending on the characteristics of the soil, heavy metals accumulate in the food chain and this negatively affects soil life and particularly biological-biochemical reactions. The earthworms are used as a marker when determining the impacts of heavy metals on different species. Earthworm life is affected by heavy metals by killing or inhibiting their development, coconut production, and behaviour. The concentrations of mobile or accessible heavy metals are more important in environment risk assessments than their total quantities. Earthworms may affect either usable or total soil metal concentrations as they are capable of accumulating heavy metals in their tissues, thus growing their soil food chain involvement. During their feeding activities, earthworms may alter either available or complete concentrations of metal in the soil due to their ability to accumulate metal and thus reduce their involvement in the soil food chain. Via their casting practises they also leave a portion of heavy metals to soil environment.

Earthworms can alter concentrations of both usable and total metals in soil. Earthworms partially accumulate heavy metals in their tissues during their feeding activities, and through their casting activities often leave a portion of heavy metals to the soil environment and thereby reduce their presence in the soil food chain. High concentrations of heavy metals may be found in earthworm tissues while their excrements can contain lower metals. New generations may be passing to less contaminated or unpolluted soils in this situation. Accumulation of heavy metals by earthworms is generally correlated with factors such as mineral soil quality, organic matter content, and metal concentrations of their living environment, and has also been introduced as a result of industrial activities as biological control of various metal pollutions. The ecological group is another factor influencing the accumulation of heavy metals in earthworms. Lumbricusrubellus and Aporrectodeacaliginosa, for example, are members of various ecological groups and their metal accumulation capacities have been found to differ from each other.As far as ecology is concerned, epigeics are the species capable of accumulating the largest amount of metals in their tissues while anecics are the species with the least accumulation of metals. However, within the same ecological group, there may be variations between metal accumulation capacities of different earthworms.

Among epigeics, the most capable species is Eiseniafetida which is applied as reference earthworm during heavy metal toxicity tests due to its advantages such as being easily culturable, short regeneration, rapid reproduction, and response to various heavy metals in laboratory conditions [7,8].

5. Conclusion

The tendency of heavy metals to be microorganism stimulating or inhibitory is determined by total concentrations of metal ions, chemical components of metals, and related factors such as redox potential. Environmental factors such as temperature, pH, low molecular weight organic acids, and humic acids can alter the transition, transportation, heavy metal valance state, and heavy metal bioavailability to microorganisms.

At acid pH levels, heavy metals tend to form free ionic species, with more protons available to saturate metal-binding sites. At higher concentrations of hydrogen ions, the adsorbent surface is charged more positively, reducing the attraction between adsorbent and metal cations while increasing its toxicity. Temperature plays a major role in heavy metal adsorption. An rise in temperature increases the rate of diffusion of adsorbents through the external boundary layer. Heavy metal solubility increases with an increase in temperature which improves heavy metal bioavailability. However, microorganism activities increase with temperature rise at an acceptable range, and enhance microbial metabolism and enzyme activity which will accelerate bioremediation. The stability of the complex of microbes-metals depends on the sites of sorption, the structure of microbial cell walls and the ionisation of chemical moieties on the cell wall. Degradation process results depend on the substrate and range of environmental factors.

References

1. Sivakumar, S. (2015). Effects of metals on earthworm life cycles: a review. Environmental monitoring and assessment, 187(8), 530.
2. Shefali, B. L. J., &Yadav, R. G. J. (2018). Assessment of histological alterations induced by heavy metal exposure on earthworms. IJCS, 6(5), 1436-1438.
3. Ruiz, E., Rodríguez, L., & Alonso-Azcárate, J. (2009). Effects of earthworms on metal uptake of heavy metals from polluted mine soils by different crop plants. Chemosphere, 75(8), 1035-1041.
4. Lukkari, T., Teno, S., Väisänen, A., &Haimi, J. (2006). Effects of earthworms on decomposition and metal availability in contaminated soil: microcosm studies of populations with different exposure histories. Soil Biology and Biochemistry, 38(2), 359-370.
5. Lukkari, T., Taavitsainen, M., Väisänen, A., &Haimi, J. (2004). Effects of heavy metals on earthworms along contamination gradients in organic rich soils. Ecotoxicology and environmental safety, 59(3), 340-348.
6. Liu, X., Hu, C., & Zhang, S. (2005). Effects of earthworm activity on fertility and heavy metal bioavailability in sewage sludge. Environment international, 31(6), 874-879.

7. Lukkari, T., Taavitsainen, M., Väisänen, A., &Haimi, J. (2004). Effects of heavy metals on earthworms along contamination gradients in organic rich soils. Ecotoxicology and environmental safety, 59(3), 340-348.
8. Karaca A, Kizilkaya R, Turgay OC, Cetin SC (2010a) Effects of earthworms on the availability and removal of heavy metals in soils. In: Sherameti I, Varma A (eds) Soil heavy metals, soil biology, vol 19. Springer, Berlin, pp 369–388