|| Volume 6 || Issue 4 || April 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
AND ENGINEERING TRENDS

TREATMENT OF WASTEWATER BY USING PHYTOREMEDIATION TECHNIQUE: REVIEW

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Abstract: - Heavy metal contamination has increased rapidly since the early 21th century. Water contamination is a major problem, a large part of the world has been contaminated by organic and inorganic pollutants. Phytoremediation converts this wastewater into usable water with the help of plants. This is a very ecofriendly technique which decontaminate the wastewater in a very economical way. Phytoremediation involves the use of plants to remove, transfer, stabilize and degrade contaminants in soil, sediment, and water. Phytoremediation reduce the pollutant concentration, such as Biochemical Oxygen Demand, Chemical Oxygen Demand, Total dissolved solid, Total Solids solid, Total Phosphorus, plants play a great role in the removal of pollutants. This paper focused on the treatment of domestic sewage.

Keywords: *Domestic sewage, Phytoremediation, Ecofriendly, Sewage treatment, Low cost treatment.*

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I INTRODUCTION

Supplying clean and affordable water to fulfil the human needs of the ever-growing population is one of the greatest challenges of the 21st century. In India, the Central Pollution Control Board (CPCB) provides standards with their limiting concentrations for discharge of environmental pollutants from any industry before or after treatment of effluent. Wastewater treatment may be of three types physical, chemical and biological. In general, a variety of wastewater treatment processes are employed which includes primary: physical and physicochemical, secondary: biological process and tertiary.

Phytoremediation is one of biological wastewater treatment methods and it is based on the concept of using plant based systems and microbiological processes to eliminate contaminants from natural system naturally. In the phytoremediation process, selective plant roots helps in breaking the contaminants present in the soil or in absorbing the contaminants and store it in the plant body. Application of phytoremediation process includes the agricultural field especially for removing the contaminants and land preparation for cultivation, or wasteland site remediation and environmental restoration. This process can be effectively used for the remediation of pesticides, heavy metals, chlorinated compounds, hydrocarbons, explosives, excess nutrients etc., (Stanley Rungwa,2013). Aquatic plants have drawn more attention because of its rapid growth even in the polluted water and its capability to remove varieties of pollutants from domestic and industrial effluents.

II.PLANTS ROLE IN PHYTOREMEDIATION:

The plants play an important role in purifying wastewater by removing organic and inorganic contaminants. The aquatic plants are harvestable as well as economic product. The plants provide a large surface area for the better results and growth of micro- organisms. The aquatic plants remove of pollutants and up taking of nutrients and breakdown the organic and in organic matter from wastewater. The capacity of wetland plants uptake for nutrients depend on the species of plants, quality of sewage, the growth rate and depth of roots .The oxygen carrying capacity and water conduction of root zone are related to the development of root system. The plants fit for local condition and fast developed of root system, those have economic values and decontamination efficiency. A dense root system has a high potential to reduce the pollutants by controlling water table.

III.FILTER MEDIA ROLE IN PHYTOREMEDIATION:

Gravel and soil is the most commonly used growth media in phytoremediation processes. Gravel is an extremely effective filter media, it hold the ability to precipitate the contaminated water. Sand and gravel layer remove the bacteria and other small practical from wastewater. Gravel filters are very effective in removing sediment and heavy metals from contaminated water and less effective in removing dissolved nutrients. Gravels are used for purification of water.

IV.MECHANISM OF PHYTOREMEDIATION:

There are various forms of phytoremediation technology which are applicable in treatment of wastewater. Uptake mechanisms of plant help in remediating organic and inorganic contaminants from wastewater in Phytoremediation method. (Barceló and Poschenrieder2003).

4.1 Phytoextration: In this processes plants uptake the contaminants by the root and translocate it to the above parts of the plants by absorbing, concentrating and precipitating the pollutant from contaminated zone.

4.2 Phytodegradation: In this metabolic process breakdown the pollutants in the soil. Microorganisms consume nutrients from the organic substances.

4.3 Phytovolatization: Plants absorb pollutants from water as well as soil and then release or supply to the atmosphere in the form of vapour at low concentrations through the leaves.

4.4 Rhizofiltration: Removal of the pollutants in surface water by precipitation and adsorption using plant roots.

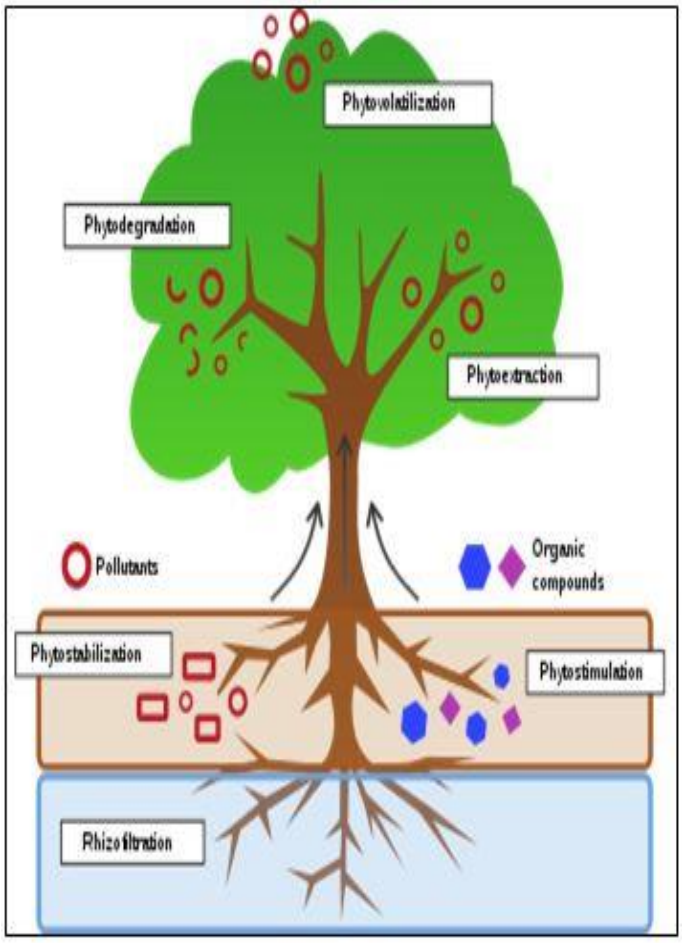

Figure 1 Phytoremediation techniques.

4.5 Phytostabilization: Plantsimmobilize orsolidify the pollutants in the water and soil through accumulation and absorption in plant.

4.6 Phytotransformation: The use of plant to the uptake and transformation ofcontaminant from soil. The plants release natural enzymes that cause fast chemical reaction to take place. Break down contaminated by metabolic processes.

4.7 Hydrolic control: To control the water table. Dense root large volume of water absorbs and reduces infiltration of precipitation.

V.MATERIALS AND METHODS-

Phytoremediation is a method which green plants use for cleaning up contaminated hazardous wastes sites. Phytoremediation has applied Ex-situ and In-Situ, continually and induces to clean up contaminated terrain of toxic metals. The following are the steps involved in the phytoremediation process .

1.Identification of area.

2.Chemical analysis of the soil before application of the phytoremediation.

3.Sowing the plant phytoaccumulators.

4.Usage of agricultural and technical measures and Inspection of vegetative development.

5.Picking and drying the plants.

6.Chemical analysis of the soil near the root after finished phytoremediation.

7.Chemical analysis of green leaves of plants.

8.Determination of co-efficient (Concentration factors) of plants.

VI.PROPER PLANT SELECTION:

As a plant based technology, the success of phytoextraction is inherently dependent upon proper plant selection. Plants used for the phytoextraction must be fast growing and have the ability to accumulate large quantities of environmentally important metal contaminants in their shoot tissue (Blay lock et al. 1994).

Researches initially envisioned using hyper accumulators (Salt and Kramer, 2000) to clean metal polluted sites. At present, there are nearly 400 known hyper accumulators but majority are not appropriate for phytoextraction, because of their slow growth and small size. Several researches are screened fast-growing, high-biomass-accumulating plants, including agronomic crops, for their ability to tolerate and accumulate metals in their shoots (Banuelus et al. 1997).

Table 1 Main characteristics of phytoremediation processes [11]

Process	Process goal	Contaminants	Media	Selection criteria of plant species
Phytoextraction	Contaminant extraction and capture	Organic and inorganic pollutants	- Soils; - Sediments; - Water; - Sludges.	Tolerance to high concentrations metals; - High metal -accumulation capability; - Rapid growth rate; -Accumulation of trace elements in the above ground parts; - Easy to harvest; - Extended root system for exploring large soil volumes; -High translocation factor; -Easy agricultural management; -Good adaptation to prevailing environmental and climatic conditions; -Resistance to pathogens and pests; -Rrepulse herbivores to avoid food chain contamination.
Phytostabilization	Contaminant containment	Heavy metals; Chlorinated solvents	- Soil; - Sediments; - Sludges.	-The ability to develop extended and abundant root systems; -The ability to keep the translocation of metals from roots to shoots as low as possible; -The capacity to retain the contaminants in the roots or rhizosphere (excluder mechanism) to limit the spreading through the food chain.
Phytovolatilization	Contaminant extraction from media and release to air	Chlorinated solvents; Inorganic compounds	-Grouwndwater - Soil - Sediments - Sludges	
Rhizofiltration	Contaminant extraction and capture	Heavy metals; Ogranic compounds	- Surface Waters; - Wastewaters.	- Metal-resistant plants; - High adsorption surface; - Tolerance of Hypoxia; -Terrestrial plants are preferred because they have a fibrous and much longer root system, increasing the amount of root area.

VII.TYPES OF VEGETATION USED:

Some of the plants used in phytoremediation are,

•Sunflower:

The sunflower(helianthus annuus) is an annual plant in the family asteraceae has thus been identified as one of the target species that has great potential as a Phytoextraction due the fact that it produces large amount of biomass, capable of hyper accumulating heavy metal in its harvestable parts (stems, leaves and roots) and it grows quickly. This study therefore investigated the ability of sunflower plant to phytoremediation soils of abandoned dump sites containments with heavy metal by determining the presence of pollutants in impacted soil, determining the presence of pollutants in plants tissues and determining the main plant part of pollutants accumulation.

•Sugarcane:

Heavy metal pollution is a world wide problem. Phytoremediation is an effective and low cost interesting technology. Sugarcane could be a promising candidate for phytoremediation on metal contaminated soils due to its high biomass, faster growth and moderate take up and accumulation of heavy metals such as Cu, Cd, Se, Pb, and Mn.as the follow-up processing of sugarcane, bagasse could adsorb heavy metal ions in aqueous solutions and some new directions for further such as plant microorganisms associations phytoremediation were also prospected.

•Indian mustard:

Brassicaceae species are rarely useful to accumulate certain metals while producing high quantities of biomass in the process. It removes three times more Cd than others, reduce 28% of Pb, upto 48% of Se, and it is effective against Zn, Hg and Cu as well. Phytoremediation of radiocesium-cotainments soil in the vicinity of Chernobyl in 80's as well.

•Heavy metals (Essential metals)-

1.Copper (Cu):-

Functions in plant are

- Constituent of enzymes.
- Role in photosynthesis and several physiological processes.
- Involved in reproductive and in determining yield and quality in crops (disease resistance)
- Effects on plant-
- Disruption of photosynthesis, plant growth and reproductive processes.
- Decreases thylakoid surface area.

2.Nickel (Ni):-

Functions in plant are

- Constituent of enzymes
- Activation of urease Effects on plant-

Reduction of:

- oseed germination
- oprotein production
- ochlorophyll and enzyme production
- oaccumulation of dry mass

3.Zinc (Zn):-

Functions in plant are

- Constituent of cell membranes
- Component of a variety of enzymes
- DNA transcription
- Involved in reproductive phase and in determining yield and quality of crops
- Resistance against biotic and abiotic stress
- Legume nodulation and nitrogen fixation Effects on plant-
- Reduces nickel toxicity and seed germination

•Heavy metals (Nonessential metals)-

1.Cadmium (Cd):-

Effects on plant-

- Decreases seed germination, lipid content and plant growth
- Disturb enzyme activities
- Inhibit the DNA-mediated transformation in microorganisms
- Interfere in the symbiosis between microbes and plants
- Increase plant predisposition to fungal invasion

2.Chromium (Cr):-

Effects on plant-

- Causes decrease in enzyme activity and plant growth
- Produces membrane damage, chlorosis and root damage.

3.Lead (Pb):- 0

- Reduces chlorophyll, chlorosis, necrosis;
- Inhibit root and shoot growth
- Less biomass production
- affecting seed germination

VIII RESULT:

From above mention literature paper we concluded that phytoremediation is a plant based eco-friendly and sustainable technology which treat sewage water by using plant species. Phytoremediation is one of the effective method for the removal of pollutants from water and soil. Phytoremediation consist of media beds, plants, micro-organisms which is mainly depends on physical , chemical & biological activity to the contaminats. Functions and effects of heavy metals on plant growth are explained below [12]-

Table 2 Phytoaccumulation efficiency of different plant species against heavy metals [12]

Plant species	Metal (s)	Metal accumulation (mg/ kg)	Metal-accumulated part of plant	Duration of treatment	Concentration of metal	metal Medium	Reference
Horedeum vulgare	As	126 469	Shoots, Roots	-	-	Soil	Mains et al. (2006a, b)
Solanum photeincarpum	Cd	544,132	Roots, stem	60 day s	100 mg k g^{-1}	Soil	Zhang et al. (2011)
Euphorbia cheiradenia	Zn	1873	Shoots	Fully ripe plants	2400 ppm	Soil of waste pool	Chehregani and Malayeri (2007)
H. hirta	Pb, Zn, Cu	150	Roots, shoots	-	-	Soil	Conesa et al. (2007)
Z. fabago	Pb	750	Shoots	-	-	Soil	Conesa et al. (2007)
Thlaspi caerulescens	Cd	263	Shoots	391 days	19 mg/kg	Soil	Lombi et al. (2001)
Sedum alfredii	Zn	13,799	Leaves	8 days	1000 µM	Soil	Jin et al. (2009)
B. juncea	Cd	12.4	-	-	-	Soil	Bolan et al. (2003)
Corrigiola telephiifolia	As	2110	Above-ground plant plants	-	3–104 µg g^{-1}	Soil (mine)	García-Salgado et al. (2012)
Alyssum heldreichii	Ni	1441	Above- ground plant plants	-	2000–3000 mg/ kg	Soil	Bani et al. (2010)
Schima superba	Mn	62,412.3	Stem	90 days	150 mmol L^{-1}	Quartz	Yang et al. (2008)
Arabis Paniculata Franch	Pb	33,900	Roots	4 months	386 µM	Water	Tang et al. (2009)
Lolium italicum	Pb	218 7232	Shoot, Root	-	-	Soil	Rizzi et al. (2004)
Alyssum	Ni	1180	Leaves	-	1070–	Soil	Bani et al.

heldreichii					3280 mg/ kg		(2010)
Brassica junea	Ni	3916	Shoots	60 days	254 mg/kg	Soil	Saraswat and Rai (2009)
Eleocharis acicularis	As	1470	Shoots	-	-	Water	Sakakibara et al. (2011)
Pteris cretica	As	2200–3030	Frond and roots	30 days	100 mg/kg	Compost	Zhao et al. (2002)
Isatis pinnatiloba	Ni	1441	Above- ground plant parts	-	2000–3000 mg/ kg	Soil	Altinozlu et al. (2012)
Pteris vittata	As	5947	Frond and roots	198 days	357 mg/kg	Soil	Kalve et al. (2011)
Arabis paniculata Franch	Cd, Zn	8400, 12,400	Roots	4 months	267, 1223 µM	Water	Tang et al. (2009)

IX CONCLUSION:

From these few success studies mentioned above, it could be concluded that, Phytoremediation is a yet another emerging technology with good efficiency for treating effluents and should be encouraged, so that it can be applied practically so that water and soil resources can be restored in situ. It is green technology which uses plants for remediation and thus would prove to be a safe technology for restoring environment. Compared to the expensive conventional techniques solar driven Phytoremediation is ecologically a better and promising choice with bright future. Efforts should be focused on exploring and utilizing this technology to get treated water meeting the standards and thus conserve the environment aiming a sustainable development and reduce stress on natural resources.

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