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A RESEARCH ON MICROBIAL DEGRADATION OF INDUSTRIAL POLLUTANTS FROM DIFFERENT ENVIRONMENTS

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Abstract: **Microbial degradation is nature's primary scavenger, responsible for recycling most natural waste materials into harmless compounds. Given an increase in particular synthetic compounds such as various chlorinated compounds produced by the chemical industry for use as herbicides, pesticides, industrial solvents, and coolants. The microorganisms try to develop new genes, especially for simple, low-chlorinated compounds that code for enzymes that use the chlorinated compounds as the main component. An understanding of how new biodegradable genes evolve in nature is therefore of paramount importance to improve the rate and scale of biodegradable processes. The various parameters affecting both natural and selective evolutionary processes are discussed. Microorganisms and plants have been extensively studied for their role in the biotransformation of such hazardous pollutants into non-toxic chemicals, with a wide range of biotechnological implications. The bioremediation of metal-contaminated sites is understood as the molecular mechanics of metal accumulation. Contamination of water and food with various types of chemicals and metals such as nickel, copper, gold, lead, arsenic, cadmium, zinc, chromium, and mercury has been widely reported. Human activities such as metal smelting and mining, and the disposal of agricultural and industrial effluents release these metals, which can be harmful to human health when ingested in amounts that an organism cannot handle. Bioremediation is another form of waste management those other organisms can use and reuse as a result of the biological waste recycling mechanism. Various chemical wastes and hazardous materials from around the world are heavily involved in degradation, immobilization, eradication, and detoxification through the all-encompassing actions of microorganisms. Various applications of microorganisms in the bioremediation of hazardous pollutants were presented in detail in this chapter.**

Keywords: **Microorganism, Chlorinated, Pesticides, Herbicides, Industrial solvents.**

1. INTRODUCTION

Microorganisms are widespread and widespread in the biosphere because their metabolic ability is extremely impressive and they can easily grow in a wide range of atmospheric conditions. Microorganisms have been used in atmospheric remediation for decades. Phytoremediation is defined as the use of biological agents such as bacteria, fungi, or green plants to remove precarious substances in polluted soil or water. The nutritional sophistication of microorganisms can also be used for the biological breakdown of pollutants. This type of process is called phytoremediation. It is advanced comprehensively based on the ability of certain microorganisms to transform, modify and utilize toxic pollutants to obtain energy and biomass. Instead of simply collecting and storing the pollutant, phytoremediation is a microbiologically well-organized process activity used to convert contaminants into less toxic or non-toxic elemental and formed composite substances. Bioremediations are biological agents used for bioremediation to remediate contaminated sites. Bacteria, Achaea, and fungi are typical primary bioremediations. The application of phytoremediation as a biotechnological process uses microorganisms to dissolve and remove many dangerous pollutants through biodegradation from the environment of everything that surrounds us. The terms phytoremediation and biodegradation are rather interchangeable words. Microorganisms are important tools for removing pollutants from soil, water, and sediment; mainly due to their advantage over other protocols for remediation procedures. Microorganisms are restored to the novel natural environment and further pollution is prevented. The textile industry generates a large amount of wastewater with the potential for water pollution. Some of the many chemicals found in textiles, wastewater, and dyes are major pollutants. The review aims to express the current trend in the application of microorganisms for phytoremediation and to provide relevant background to the identified gaps in this subject area. Giving to others as ownership is a point of discussion in a more specialized field of research because microorganisms are environmentally friendly and promise valuable genetic material to solve environmental crisis problems.

ABBREVIATIONS

BOD Biochemical oxygen demand

COD Chemical oxygen demand

WHO World Health Organization

Environmental crises such as the aspect of color in discharges from various industries, connect with the increasing cost of water for the industrial sector, have made the treatment and reuse of effluent increasingly attractive to the industry.

2. BACKGROUND

It is produced and discharged by any industry have been responsible for the decadence of the aquatic environment in many parts of the world, especially in developing countries. Enlargement industrialization and urbanization have resulted in the release of large amounts of waste into the environment, resulting in high pollution loads. Implementation of microbes such as fungi and bacteria have been used for pollution degradation.

OBJECTIVES

The aim of this research aimed microbial agents such as fungi and bacteria to reduce pollutant loads such as heavy metals in trade effluent samples.

MICROBIAL DEGRADATION OF INDUSTRIAL POLLUTANTS FROM DIFFERENT ENVIRONMENTS

METHODS

Three types of commercial effluents (pharmaceutical, textile effluents, and dyestuffs) were received from Baddi in the metropolitan area of Himachal Pradesh, India. The heavy metal evaluation was performed using a flame atomic absorption spectrophotometer according to standard procedures. The samples were scientifically examined for microbes and identified. Bacterial samples were infused onto nutrient agar and incubated at 37°C for 24 hours. Fungi to find the total number of units involved were performed using potato dextrose agar and incubated at 28°C for 35 days. The isolated organism was identified based on its morphological and biochemical properties. Then 100 ml of the effluents were distributed into 250 ml flasks and the pH of the medium was adjusted to 7.2 by adding either sodium hydroxide or hydrogen chloride and autoclaved at 121°C for 15 minutes. The autoclaved flask was inoculated with 1 ml of bacteria and fungi for 21 days and the pH was accurately catalogued every 48 hours.

- Waste water necessitates being processed before it can be reused or released into a water body.
- Sewage treatment is the step-wise proceeding that involves the removal of wastes from the water. sewerage treatment is also called wastewater treatment.
- Waste Water Treatment Plants (WWTP) - Wastewater treatment involves the physical, chemical, and biological treatment of water. Wastewater is allowed to pass straight through different steps in a sequence.

STEP 1

Bar Screens: Bar screens are the screens that prevent the flow of large objects in wastewater. These screens help to extract large objects like rags, plastic bags, cans, napkins, and sticks from sewage.

References: https://www.google.com/url?sa=i&url=https%3A%2F%2F

Fig 1: Bar Screen for waste water treatment

STEP 2

Grit vortex chambers: Waste water from the bar screens are allowed to pass through grit chambers slowly. The moderate movement of water makes grit, sand, and dust particles settle down.

References: https://www.google.com/url?sa=i&url=http%3A%2F%

Fig 2: Grit vortex chambers for wastewater treatment

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STEP 3

Clarifier: A clarifier is a tank with its central part inclined downwards to allow feces to settle down. The waste determined at the bottom is termed sludge. Sludge is transferred to a separate tank where it is decomposed using bacteria. Eventually, ultimately, a skimmer is used to remove oils and grease. explicate water is obtained after the detachment of all physical contaminants from the sewage.

References: https://www.google.com/imgres?imgurl=https%3A%2F%2F

Fig 3: Clarifier for wastewater treatment

STEP 4

Aerator: The clarified water is passed into an aerator. Ventilation pumps air into the water to settle the bacteria to the substratum of the tank as activated sludge. Bacteria under aerated circumstances consume impurities left in the water. The water present in the top is 95% clean and is let out into a water source while the activated sludge is dried in a sand bed and is used as manure.

References: https://www.google.com/imgres?

Fig 4: Aerator for wastewater treatment

- Chemical delicacy treatment - Chlorine tablets or chlorine gas is used to treat wastewater chemically. Ozone is also used in the chemical purifying of water.

- It is recommended that Eucalyptus trees are planted along with the sewage ponds into which water is released. Eucalyptus trees accepted, wastewater from the pond and released pure water vapor into the atmosphere.

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- Precautionary of clogging of drains:

- Oils and fats released from the kitchen can harden along with detergents to block water pipes. In open drainage, fats entering the soil clog the soil pores. This reduces the effectiveness of water seeping.

- We should circumvent throwing tea leaves, solid food remains, and napkins into the drain. These can block the drains and block the flow of oxygen to useful microorganisms. Useful microorganisms bring about the decay of organic wastes from wastewater.

- Chemicals like paints, medicines, motor oil, and many other dissolvable kill the microbes that help in water treatment. Awareness must be created in people about the ill effects of throwing pollutants into the drain.

ENVIRONMENTAL FACTORS

The metabolic predictabilities of the microorganisms and the Physico-chemical properties of the target contaminants determine possible interactions during the process. The actual successful interaction between the two; however, depends on the environmental conditions at the site of interaction. The growth and activity of microorganisms are determined by pH, temperature, humidity, solubility in water, nutrient and oxygen content, lack of informed human resources in this field, and physicochemical bioavailability of pollutants (concentration, type, solubility, chemical structure, and pollutants harmful to the environment) influenced). Phytodegradation can occur over a wide pH range; However, a pH of 6.5 to 8.5 is consistently optimal for phytodegradation in most aquatic and terrestrial systems.

AVAILABILITY OF NUTRIENTS

The addition of nutrients adjusts the essential nutrient balance for microbial growth and reproduction and affects the rate and effectiveness of biodegradation. Nutrient balancing, especially the intake of essential nutrients like N and P, can improve biodegradation efficiency by optimizing the bacterial C: N:P ratio. To survive and continue their microbial activities, microorganisms require a range of nutrients such as carbon, nitrogen, and phosphorus. At small concentrations, the extent of hydrocarbon degradation is also limited. Biodegradation in water bodies is limited by the availability of nutrients. Similar to the nutritional needs of other organisms, oil-eating microbes require nutrients for optimal growth and development. These nutrients are available in the natural environment but are found in small amounts.

TEMPERATURE

Among the physical factors, the temperature is the most important in determining the survival of microorganisms and the composition of hydrocarbons. In cold environments like the Arctic, natural processes break down oil very slowly, putting more pressure on microbes to clean up the spilled oil. In addition, the degradation process for a specific compound requires a specific temperature. The temperature also speeds up or slows down the bioremediation process, since it strongly influences the microbial physiological properties. The rate of microbial activity increases with temperature and reaches its maximum at an optimal temperature. With a further increase or decrease in temperature, it suddenly decreases and finally stops after reaching a certain temperature.

MOISTURE CONTENT

Microorganisms need sufficient water for their growth. The moisture content of the soil hurts bio-degradants.

pH

The pH of the compound, acidity, basicity, and alkalinity of the compound have their influence on the microbial metabolic activity and also increase and decrease the removal process. Measuring soil pH could indicate the potential for microbial growth. Higher or lower pH values showed worse results; Metabolic processes are very sensitive to even small changes in pH.

SITE CHARACTERIZATION AND SELECTION

At Baddi in the metropolitan region of Himachal Pradesh, India, effluents from various industries were collected from their main sites. Baddi is a commercial area where many manufacturing industries are located. The coordinates of the sample locations are shown in Table 1. The Baddi metropolitan area is a mega city and contains 70% of the industries of Himachal Pradesh, India. Sufficient microbial degradation investigation work must be carried out before proposing a remedy for microbial degradation of industrial pollutants from different environments to adequately characterize the extent and scope of the contamination. This work should include at least the following factors: a complete determination of the horizontal and vertical extent of the contamination, a listing of the parameters and locations to be sampled and justification of their choice, a description of the sampling methods, and an analysis to be performed.

TABLE 1. COORDINATES OF THE SAMPLE LOCATIONS.

INDUSTRY	**GPS READING IN HIMACHAL PRADESH.**
Pharmaceuticals	Baddi has a latitude of **30º57’28.17” N** And a longitude of **76º47’28.88” E**
Textiles	Ponta Sahib has a latitude of **30º26’60.00” N** And a longitude of **77º37’12.00” E**
Dyes	Baddi has a latitude of **30º57’28.17” N** And a longitude of **76º47’28.88” E**

PHYSICOCHEMICAL AND HEAVY METAL ANALYSIS OF MICROBIAL DEGRADATION

All samples were analyzed for heavy metals (zinc, cadmium, and nickel) and physicochemical parameters according to internationally recognized procedures and standard methods. Parameters analyzed included temperature, chemical oxygen demand, dissolved oxygen, biochemical oxygen demand, turbidity, odor, color, total suspended solids, pH, conductivity, and total dissolved solids. In addition, pH, temperature, and dissolved oxygen were determined on-site using appropriate measuring equipment (pH meter, TDS, HM digital for temperature and DO analyzer model JPSJ-605). Heavy metal concentrations were determined using an atomic absorption spectrophotometer. Metals are important for bacteria and fungi in small quantities, but inhibit the metabolic activity of the cells in large quantities. Metal compounds have a direct and indirect impact on the rate of degradation.

TOXIC COMPOUNDS

In high concentrations of a toxic nature, some pollutants can have toxic effects on microorganisms and slow down decontamination. The level and mechanisms of toxicity vary with specific toxins, their concentration, and the microorganisms exposed.

3. MICROBIAL ANALYSIS

TOTAL BACTERIAL COUNT

The collected samples were analyzed for the presence of microorganisms. First, 1 mL of each wastewater sample was transferred to 9 mL of sterile saline in a test tube and shaken vigorously. The solution was serially diluted and a 10^{-3} dilution was taken and plated onto Petri dishes using the pour plate technique. The bacteria were inoculated onto nutrient agar and incubated at 37°C for 24 hours. This was done using methods previously reported.

TOTAL FUNGAL COUNT

Fungal counts were performed using potato dextrose agar with 10% tartaric acid using the spread plate method. This was performed according to previously reported procedures. The microbial count of the effluent samples was reported as colony-forming units per gram (cfu/g).

PRINCIPLE OF MICROBIAL DEGRADATION OF INDUSTRIAL POLLUTANTS FROM DIFFERENT ENVIRONMENTS

Microbial degradation is defined as the process by which organic waste biodegrades under controlled conditions to a benign state or below concentration limits set by regulatory agencies. Microorganisms are suited to the task of destroying pollutants because they possess enzymes that enable them to use environmental pollutants as food. The microbial breakdown is designed to stimulate them to work by providing optimal levels of nutrients and other chemicals essential to their metabolism to break down/detoxify substances that are hazardous to the environment and living beings. All metabolic reactions are mediated by enzymes. Microbial decomposition takes place naturally and is additionally promoted by living beings and fertilizers.

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THE ADVANTAGE OF MICROBIAL DEGRADATION

- It is a natural process; it takes a little time, and is an acceptable waste treatment process for contaminated material such as soil. Microbes can degrade the contaminant and increase in number when the contaminant is present. When the contaminant is degraded, the biodegradative population become declines. The residues for the treatment are usually harmless products including water carbon dioxide and cell biomass.
- It requires very less effort and can often be carried out on-site, often without causing a major disruption of normal activities. This also eliminates the need to transport quantities of waste off-site and the potential threats to human health and the environment that can arise during transportation.
- It is applied in a cost-effective process as it lost less than the other conventional methods (technologies) that are used for the clean-up of hazardous waste.
- It also helps in the destruction of pollutants, many of the hazardous compounds can be transformed into harmless products, and this feature also eliminates the chance of future liability associated with the treatment and disposal of contaminated material.
- Simple, less labor-intensive, and cheap due to their natural role in the environment.
- Eco-friendly and sustainable.
- Contaminants are destroyed, not simply transferred to different environmental media.
- Nonintrusive, potentially allowing for continued site use.
- Relative ease of implementation.
- Effective way of remediating natural ecosystems from several contaminates and acts as environment-friendly options.

THE DISADVANTAGE OF MICROBIAL DEGRADATION

- It is limited to those compounds that are biodegradable. Not all compounds are susceptible to rapid and complete degradation.
- There are some concerns that the products of biodegradation may be more persistent or toxic than the parent compound.
- Biological processes are often highly specific. Important site factors required for success include the presence of metabolically capable microbial populations, suitable environmental growth conditions, and appropriate levels of nutrients and contaminants.
- It is difficult to extrapolate from the bench and pilot-scale studies to full-scale field operations.
- It often takes longer than other treatment options, such as excavation and removal of soil or incineration.
- Regulatory uncertainty remains regarding acceptable performance criteria for bioremediation. There is no accepted definition of "clean", and evaluating the performance of bioremediation is difficult.

4. RESULTS

The results of the physicochemical parameters indicated that conductivity, total suspended solids, total dissolved solids, turbidity, chemical oxygen demand, and the biochemical oxygen demand for all three industrial effluents were higher than the World Health Organization (WHO) permissible limits. Heavy metal analysis results show that the effluents had high values for cadmium, above the WHO limit of 0.003 mg/L. Concentrations of zinc ranged from 0.136–1.690 mg/L, and nickel ranged between 0.004–0.037 mg/L for the three effluents, within the WHO limit.

Table 2

Sr. No.	World Health Organization (WHO)	Industrial Effluents	
1.	Permissible Limits 0.003 mg/L	Concentrations of Zinc	0.136–1.690 mg/L
2.		Concentrations of Nickel	0.004–0.037 mg/L

The identified bacteria were *Bacillus subtilis*, *Klebsiella pneumonia*, *Salmonella typhi*, and *Bacillus cereus* and the isolated fungi were *Aspergillus flavus* and *Penicillium chrysogenum*. All the physicochemical parameters and heavy metal concentrations were reduced after the biodegradation study in the effluents.

5. SUMMARY AND CONCLUSIONS

Microbial degradation of industrial pollutants from different environments is a very fruitful and attractive option for remediating, cleaning, managing, and recovering techniques for solving polluted environments through microbial activity. Due to these factors, biodegradation in the natural condition is not more successful leading to being less favorable. As bioremediation can be effective only where environmental conditions permit microbial growth and activity. Bioremediation has been used in different sites globally with varying degrees of success. Mainly, the advantages are greater than the disadvantages which are evident by the number of sites that choose to use this technology and its increasing popularity over time. Generally, different species are explored from different sites and they are effective in control mechanisms.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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