AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 05 Issue: 03 March 2024 Article No: 32

Waste Management, Biofuel and Bioremediation

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SUMMARY

Global mechanization, urbanization, and various natural processes have led to the increased release of toxic compounds into the biosphere. These hazardous toxic pollutants include a variety of organic and inorganic compounds, which pose a serious threat to the ecosystem. The contamination of soil and water is the major environmental concern in the present scenario. This leads to a greater need for remediation of contaminated soils and water with suitable approaches and mechanisms. Environmental pollution is today one of the most important problems in the world. Biotechnology is one among the methods to overcome this problem.

INTRODUCTION

Biotechnology can even help convert industrial and other wastes into useful products. Environmental biotechnology helps us to avoid hazardous pollutants and wastes, which can affect the natural resources and our environment. Environmental biotechnology includes a broad range of applications such as bioremediation, prevention, detection and monitoring, and genetic engineering for sustainable development and better quality of life.Environmental Biotechnology includes the use of bacteria to break down pollutants in water and soil, the use of algae to absorb excess nutrients from wastewater, and the use of fungi to decompose organic matter in the soil.

Waste Management:

The methods based on biotechnology in wastewater management are activated sludge, trickling filters, oxidation ponds, biofilters and anaerobic treatment. solid waste composting techniques, trickling filters and biosorption are examples of biotechnology applications in waste management.

- One example is the Black soldier fly, the residual frass of insects is considered to be an ideal organic fertilizer, high in nutrient content (nitrogen, phosphorus, and potassium), increasing the soil's organic carbon storage and quality, nutrient availability in the soil, and crop yield.
- Black Soldier Fly Frass is rich in macro and micronutrients for plant growth and contains all groups of valuable microbes. As a soil amendment, frass creates soil conditions beneficial to microorganisms for plants.
- Accelerate plant growth, flowering & fruiting, improve soil structure and accelerate plant growth with a balance of fast and slow-release nutrients, calcium and 10+ trace elements.

Phyto /bioremediation

The conventional remediation of contaminated sites commonly involves the physical removal of contaminants and their disposition. Physical remediation strategies are expensive, and non-specific and often make the soil unsuitable for agriculture and other uses by disturbing the microenvironment. Owing to these concerns, there has been increased interest in eco-friendly and sustainable approaches such as bioremediation, phytoremediation and rhizoremediation for the cleanup of contaminated sites. Several recent studies have attempted to unravel the mechanism of heavy metal and metalloid transport and accumulation in plants using transcriptomic and proteomics approaches (Cvjetko et al., 2014). Additionally, metabolomic analysis can help to identify the metabolites associated with heavy metal and metalloid stresses, which can be further mapped to its metabolic pathways to identify the related candidate genes (Kumar A et al., 2014). One intriguing approach to enhance our knowledge about heavy metal and metalloid metabolism in plants is to develop suitable techniques for imaging. Efforts have been made to employ Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), Matrix-Assisted Laser Desorption Ionization (MALDI) and Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR-MS) to enable imaging visualization and determination of metal and metalloid localization and distribution in plant tissues.

Despite recent progress in biotechnological applications and the availability of complete genome sequences of several plant species, the potential of phytoremediation has still not been fully exploited for the successful application of this technology on a commercial scale for the cleaning of contaminated soil and water. Another major factor for the lack of progress in this area is inadequate funding for phytoremediation research.Mass spectrometry-based proteomics is extensively used to study heavy metal and other forms of stress in candidate organisms including plants), bacteria and marine organisms (Muralidharan et al., 2012). Furthermore, proteogenomic, the alliance between proteomics and genomics is being used to study the genomic and proteomic properties of microorganisms that tolerate high concentrations of contaminants and high levels of stress. Collectively, these efforts promise an upcoming generation of tailored organisms with higher bio/phytoremediation efficiencies with lower costs.

Biofuel:

Biofuels such as ethanol are derived from food crops, biomass, or lignocellulosic materials through biochemical and thermochemical conversion processes. First-generation biofuels (*i.e.* corn ethanol and biodiesel) are made largely from food crops such as cereals, sugar crops, and oil seeds. The technologies to produce the first-generation biofuels from edible sugars and starches are mature and well understood, and production is primarily limited by environmental and social concerns such as competition for land and water used for food and fiber production causing an increase in world commodity prices for food and animal feeds (Sims et al. 2010). Owing to these important limitations the “next-generation”, or second- and third-generation biofuels are being developed from non-edible lignocellulosic materials using advanced technologies. These lignocellulosic feedstocks include woody biomass and wood wastes, crop residues, dedicated energy crops such as switchgrass, municipal wastes, and algae. These next-generation feedstocks do not compete directly with food production and can often be produced on marginal or unused croplands. Furthermore, lignocellulosic biomass is an abundant renewable energy source, with the potential to displace a large portion of conventional energy resources such as fossil fuels and natural gas for the future production of liquid biofuels with improved environmental benefits. As a result, lignocellulosic biomass holds promise as a feedstock for a biorefinery where sugars can be transformed into building-block chemicals through fermentation, enzymatic, and chemical transformations. Hence Biotechnology is being used to produce new advanced biofuels that perform more like gasoline, providing better fuel economy and fewer blending issues than ethanol.

Microbial Biotechnology:

Microbial biotechnology is the application of biotechnology principles and techniques to the study and utilization of microorganisms and their products. It involves the use of bacteria, fungi, and other microorganisms to perform various tasks that are beneficial to human health, industry, and the environment. Microorganisms are important cell factories for the synthesis of proteins, small and large metabolites and for the production of single-cell proteins. The field of microbial biotechnology includes methods and strategies for the production and use of prokaryotic and eukaryotic microorganisms (*eg*. yeasts, fungi, algae) and archaea for substance synthesis and the use of the microorganisms or their substances in applications in the fields of white (industrial), red (pharmaceutical/medical) and green (agro-environmental) biotechnology. It also considers the application of microorganisms or their products in the fields of energy, food and feed, biocatalysts, mining and new materials. Examples of microbial biotechnology applications include the use of bacteria to produce antibiotics and other pharmaceuticals, the use of yeast to produce food and beverages, and the use of fungi to decompose organic matter in landfills. Microbial biotechnology can also involve the use of genetically modified organisms (GMOs) to perform specific tasks, such as the development of crops that are more resistant to pests or that can grow in challenging environments. Aside from these application areas, the section also focuses on the methodology of bioprocess development, including high throughput screening and process technologies, design of experiments (DoE) and modelling approaches, and technologies for scale-up and scale-down.

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