Mini Review
Volume 12:6, 2022

Journal of Environmental & Analytical Toxicology

ISSN: 2161-0525 Open Access

Using Safflower for Phytoremediation of Heavy Metal Contaminated Soils

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Abstract

The battle between food and fuel is intensifying as renewable energy sources are promoted and gradually replace fossil fuels. Therefore, due to unfavorable circumstances like restrictions in fertilizer and water availability or the presence of contaminants like hydrocarbons or heavy metals, energy crops may be produced on unproductive marginal land. Phytoremediation, or the use of plants to extract or immobilise toxins from soil that is contaminated with heavy metals, is one possibility. The oil derived from the seeds of the annual herbaceous plant *Carthamus tinctorius L*. makes superior oil for use in biofuel production. It also has a deep root system.

Keywords: Marginal lands • Zinc • Cadmium • Nickel • Lead

Introduction

It seems appropriate to be utilized in the phytoremediation procedure, enhancing the possibility of valuing polluted areas and decreasing the risk of these lands being abandoned. In order to assess the impacts on yield and heavy metal content in various plant components, *C. tinctorius* was tested in soils contaminated with zinc, cadmium, lead, and nickel at varying concentrations. The experiment demonstrates how safflower may be grown on heavy metal-polluted soil with little to no change in biomass yield. With regard to the examined heavy metals, zinc and cadmium showed the most susceptibility at the highest concentrations. Safflower typically accumulates heavy metals in the biomass below ground [1].

Description

A non-renewable resource, soil must be protected in order to continue to deliver ecological, economic and social benefits for present and future generations. As a result, it needs to be utilized sustainably. Accordingly, there is a need to clean up heavy metal contamination over 137,000 km^2 of agricultural land in Europe. In general, chemical elements in polluted soils are considered as heavy metals if their density is greater than 7 g/cm^3 or, depending on their atomic weight, is larger than 20.

The bioavailability of heavy metals is influenced by the pH, climatic conditions, organic matter, and rhizospheres of plants. Metals in soils may therefore be present, absent, or interchangeable, facilitating the rehabilitation of these soils. The crop choice must meet a number of requirements, including the crops' tolerance to heavy metals, high biomass output, deep and broad root systems, well-known agronomic procedures, and a minimal demand for agronomic input. An additional advantage of phytoremediation crops is the potential to convert biomass for the generation of bio-energy, such as ethanol, biogas, and biodiesel [2].

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Date of submission: 01 June, 2022, Manuscript No. jeat-22-76995; **Editor assigned:** 02 June, 2022, PreQC No. P-76995; **Reviewed:** 08 June, 2022, QC No. Q-76995; **Revised:** 15 June, 2022, Manuscript No. R-76995; **Published:** 22 June, 2022, DOI: 10.37421/2161-0525.2022.12.662

Safflower, an oilseed plant from the Asteraceae family that is thought to have its origins in southern Asia, seems to be a good candidate crop in this situation for badly polluted soils. It is an annual or biennial herbaceous plant that is grown in a variety of climates, including the Mediterranean region, because of its exceptional tolerance to salinity and drought. It is a long-day, spring-to-summer plant that is cultivated in high temperatures and intense light during the entire biological cycle. Currently, it is grown in Russia, Asia, and North America.

In this study, the idea that safflower may both grow in and clean up heavy metal-contaminated soils was tested. These skills were tested in two different concentrations of each element while being contaminated with cadmium, lead, nickel, and zinc. Due to their significantly greater distribution than other heavy metals and their detrimental effects on the environment and human health, the remediation of these elements is thought to be of utmost importance. These components pollute the environment in a variety of ways, including through mining, smelting, industry, and agriculture. The buildup of heavy metals in the various plant sections has been measured in order to determine whether biomass may be reused for bioenergy applications [3].

In general, heavy metals can be found in soils in a variety of ways, such as free metals, soluble metal complexes, oxides, hydroxides, carbonates, or incorporated into silicate mineral formations. They can also be found in association with the organic matter in the soil as these compounds. Heavy metals need to be bioavailable in soil for them to be absorbed by plants. pH, soil organic matter, redox potential, soil texture, structure, water flux, and soil microbes are some of the variables that affect bioavailability. This experiment was carried out on sand-rich soil with a high Fe content and neutral Ph. Accordingly, pH plays a significant part in regulating the availability of heavy metals in sandy soils and, consequently, the concentration of metal ions. This is because pH also affects the presence of other metals in soil [4].

As explored the potential for bioenergy production of contaminated biomass, our work shows the possibility of additional research into bioenergy production utilising contaminated safflower as a feedstock. Safflower oil derived from the seeds has been suggested for use in the manufacturing of biodiesel, while some research have already explored using safflower biomass for the production of biogas or bioethanol. In order to manufacture bioenergy from polluted safflower biomass, a number of techniques for producing biogas or bioethanol have been studied [5].

Conclusion

Safflower was found to be suitable for producing biomass under heavy metal pollution, according to the results. The plant's potential for the phyto extraction method is also highlighted by its capacity to accumulate heavy

metals and transfer them to the aerial biomass. Safflower seeds may be used in the bioenergy conversion process without raising concerns about pollutant dispersion due to their minimal buildup of heavy metals. The potential for turning safflower leftovers, like stems and leaves, into biofuels or other goods has increased interest in this crop. It is crucial to investigate whether using it for phytoremediation is economically feasible.

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How to cite this article: Cassini, Servio Tulio. "Using Safflower for Phytoremediation of Heavy Metal Contaminated Soils." J Environ Anal Toxicol 12 (2022): 662.