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Bioleaching - Eco-Friendly Approach for Management of Electronic Waste

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Abstract

The different types of wastes viz., food, electronic, household, medical, etc. accumulate in large amount. The electronic waste is a serious problem which needs an urgent solution. The chemical process has disadvantages which is costly and causes soil and water pollution. Bioleaching using the microorganisms is a two-step process which can be used for the management of electronic wastes. The bioleaching is economical, eco-friendly and easy process in this. Bioleaching which is a biological process is very important. It is a sustainable approach. The metals leached during bioleaching can be used for making of precious jewellery and ornaments.

Keywords: Biological; Chemicals; Degradation; Environment; Fungi

Abbreviations: MR: Methyl Red; VP: Voges' Proskauer; AAS: Atomic Absorption Spectrophotometer.

Introduction

The accumulation of different wastes is a serious global issue. Electronic wastes (e-waste) accumulate in huge amount [1]. The management of such wastes is the need of the hour. Chemical methods for the treatment of e-wastes are costly and cause hazardous effects on the environment. Bioleaching is the method for the treatment of these wastes [2]. This is very eco-friendly, economical and fast method. The metals leached can be used in the making of important jewellery. The paper here mentions the treatment of e-waste by bioleaching method.

Materials and Methods

Collection of Soil Sample for Isolation of Bacteria

The soil samples were collected from Pimpri-Chinchwad area, Pune, Maharashtra, India. The samples were collected in clean bags and labeled properly.

Isolation and Identification of the Bacteria

The morphological characters and Gram staining and motility, enzymes oxidase and catalase as well the biochemical tests viz., Indole, Methyl red (MR), Voges' Proskauer (VP) and citrate utilization tests were done for the identification of bacteria [3].

Collection of e-waste Sample

The e-waste sample computer board RAM were collected from Pimpri-Chinchwad MIDC area, Pune, Maharashtra, India in bags and labelled. It was finely grind into powder using a small motor and used for bioleaching process.

Bioleaching Process

The two-step bioleaching process was used as per the method of [2]. The metals bioleached were analysed using atomic absorption spectrophotometer (AAS) (AAS - Varian Spectra A, Germany). The metals gold (Au), chromium (Cr), silver (Ag), copper (Cu), platinum (Pt), titanium (Ti) and iron (Fe) bioleached was calculated using the equation:

$$Q = \left[\left(C_i - C_f\right) / m\right] x V$$ [4] ---------- (Eq.1), where

Q = metal ion bioleached (mg/g)
C_i = initial metal ion concentration (mg/l)
C_f = final metal ion concentration (mg/l)
m = biomass in the reaction mixture (g)
V = volume of the reaction mixture (l)

Results

Total three isolates No. 1, 2 and 3 were selected for bioleaching process. All the isolates were Gram -ve rods and motile. The isolate No. 3 found to be was oxidase positive. The isolates No. 1 and 3 were catalase positive. The isolate No. 1 was positive for indole and MR test and showed citrate utilization. The isolates No. 1, 2 and 3 were identified as *Pseudomonas*, *Bacillus* and *Chromobacterium* sp. respectively based on morphological and biochemical tests and comparing with Bergy's Manual of Determinative Bacteriology [5].

Metals Bioleached

The % of metals Au, Cr, Ag, Cu. Pt, Ti and Fe bioleached are represented in Table 1.

Table 1: Metals bioleached.

Bacteria	Metals bioleached (%)						
	Au	Cr	Ag	Cu	Pt	Ti	Fe
Pseudomonas sp.	97.0±0.01	73.0±0.01	82.0±0.01	20.0±0.02	60.5±0.00	38.0±0.01	67.5±0.02
Bacillus sp.	96.5±0.02	74.5±0.01	82.0±0.00	21.0±0.01	61.0±0.00	38.0±0.01	67.5±0.00
Chromobacterium sp.	97.0±0.00	74.0±0.01	82.5±0.01	21.0±0.01	61.5±0.00	38.0±0.01	67.5±0.00

Data is average of triplicate ± SD

Conclusion

The bioleaching is very cheap and clean process for the management of e-waste. It is also a sustainable approach. The metals bioleached can be used in the making of some precious jewellery. Such bioleaching process can be used on a large-scale which will help in the management of various e-wastes. The bioleaching is a rapid process with the use of use of microorganisms and also is very effective.

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