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Research Article

PHYTOREMEDIATION OF MERCURY FROM CFL LAMPS

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ABSTRACT

Phytoremediation is an emerging and effective innovative technology for treatment of a wide variety of contaminants. This work mainly focuses on removal of heavy metal mercury which has life threatening properties with respect to environment. Understanding the alarming effects of mercury on the environment and human health is the main aim of the present study and to develop a process that would facilitate the reduction of mercury emissions into the atmosphere and water bodies by phytoremediation. The ICP-MS results shows that mercury content in CFL bulbs vary significantly with brand. The amount of mercury collected from phosphor powder, glass and vapour phase are 60.8 mg/kg, 7.16 mg/kg and 7.16ppb respectively. Then the recovered mercury was subjected to phytoremediation using two different plant extracts and the result showed better bioremediation and IC_{50} at 62.5 µg using MTT assay.

Keywords: Mercury recovery, Phytoremediation, ICP-MS, Mercury toxicity.

INTRODUCTION

Mercury is the most toxic metal among heavy metals .The mercury present in the environment usually exists in three different forms such as elemental form, organic form and inorganic form. Usually they exist as elemental mercury which is a silver colour metal that exists as a thick metal at room temperature. [5]Due to the other industrial and other man-made activity mercury can chemically combine with other elements to form organic mercury (containing carbon).The most dangerous mercury compound, methyl mercury, is so toxic and the most and inorganic mercury (not containg carbon) in the form of salt such as mercury (II chloride) is also highly toxic [3].The elemental form of mercury is less toxic when compared to all the other forms of mercury. Mercury released while breaking and burning of circuit boards, CFL bulbs, switches affect the central nervous system, kidney and immune system. It impairs foetus growth and also harms infants through mother's milk. Dumping the e-waste in water bodies causes methylation by microbial activity. Methylated mercury is toxic and can enter the human by aquatic food chain [2]. Some essential processes involved in phytoremediation technology are phytostabilization and phytoextraction for inorganic contaminants, and phytotransformation/phytodegradation, rhizofiltration, and rhizodegradation [1] for organic contaminants. Currently, phytoremediation is an effective and affordable technological solution used to extract or remove inactive metals and metal pollutants from contaminated soil and water. This technology is environmental friendly and potentially cost effective.

MATERIALS AND METHODS:

Phytoremediation Of Mercury:

The mercury recovered from vapour phase, phosphor powder, and glass matrix of broken CFLs was subjected to phytoremediation using ***Tribulus terrestris*** and ***Similax zylanica.***

Phytochemical analysis

Phytochemicals in the given plant sample were screened using standard procedures [4].

Extraction of active metabolite for phytoremediation

Healthy disease free, mature, fresh leaves (from southern part of Tamil Nadu is taken) of*Tribulus terrestris.*L (fig 3.6) and *Similax zylanica(*fig 3.7*)* were taken and washed under clean tap water. Plants were then air dried for 2-3 weeks, homogenised and .The powdered material was fed into the soxhlet apparatus for extraction of active metabolites. The phytochemicals were extracted by repeated washing (percolation) with an organic solvent, usually like ethanol, under reflux.

Cytotoxicity test

Cell lines were obtained from NCCS Pune. The cells were maintained in Minimal Essential Media supplemented with 10% FBS, penicillin (100 U/ml), and streptomycin (100 µg/ml) in a humidified atmosphere of 50 µg/ml CO_2 at 37 °C.

In vitro assay for Cytotoxicity activity (MTT assay)

The anticancer activity of samples on **VERO** was determined by the MTT assay (Cells (1×10^5/well) were plated in 0.2 ml of medium/well in 96-well plates. Incubate at 5 % CO_2 incubator for 72 hours. Then, add various concentrations of the samples in 0.1% DMSO for 24hrs at 5 % CO_2 incubator. After removal of the sample solution and washing with phosphate-buffered saline (pH 7.4), 20µl/well (5mg/ml) of 0.5% 3-(4, 5-dimethyl-2-thiazolyl)-2, 5-diphenyl--tetrazolium bromide (MTT) in phosphate- buffered saline solution was added. After 4hrs incubation, 1ml of DMSO was added. Viable cells were determined by the absorbance at 540nm. Measurements were performed and the concentration required for a 50% inhibition of viability (IC50) was determined graphically. The effect of the samples on the proliferation of **VERO** cells was expressed as the % cell viability, using the following formula:

Calculation

% cell viability = A540 of treated cells / A540 of control cells × 100%

RESULT AND DISCUSSION:

PHYTOCHEMICAL SCREENING

The results of phytochemical screening for Tribulus terrestris and Similax zylanica are given in Table 1 and Table 2 respectively showing the presence and absence of tested phytochemicals.

Table 3.2:

CYTOTOXICITY ANALYSIS

The recovered mercury chloride was phytoremediated with both **(sample B and sample C)** plant species and the non-phytoremediated mercury chloride **(sample A)** which acts as a control were tested for its toxicity against the Vero cell lines. Further the viability of the cells in plant solvent extract with mercuric chloride was checked and the inferred results are interpreted in ***Table3.***

After the MTT assay, it has been inferred that the phytoremediation of mercury chloride with *Smilax zylanica* shows a potent result when compared to *Tribulus terrestris***.** This in turn confirms that the viability of cells can be improved by increasing the plant extract concentration to further reduce the recovered mercury from CFLs bulbs. The effect of varying concentration on recovered mercury chloride on cell lines for sample A, B and C and percentage of viability of the cells at different concentrations is also represented graphically as shown in (***Fig 3.5).***

Table 3: Table showing the % of cell viability on sample A, B and C.

S.No	Concentration µg/ml	Dilution	SampleA (control) *Mercuric chloride*		*Sample B Tribulus terrestris*		Sample C *Smilax zylanica*	
			Absorbance 540nm	% cell Viability	Absorbance 540nm	% cell Viability	Absorbance 540nm	% cell Viability
1	1000	Neat	0.08	6.9	0.05	4.3	0.18	15.6
2	500	1:1	0.13	11.3	0.09	7.8	0.29	25.2
3	250	1:2	0.18	15.6	0.15	13.0	0.35	30.4
4	125	1:4	0.27	23.4	0.27	23.4	0.51	44.3
5	62.5	1:8	0.38	33.0	0.38	33.0	0.73	63.4
6	31.2	1:16	0.51	44.3	0.69	69.0	0.87	75.6
7	15.6	1:32	0.71	61.7	0.86	74.7	0.93	80.8
8	7.8	1:64	0.80	69.0	0.95	82.6	1.01	87.8
9	Control	-	1.15	100	1.15	100	1.15	100

Table 1: Phytochemical analysis of Tribulus terrestris

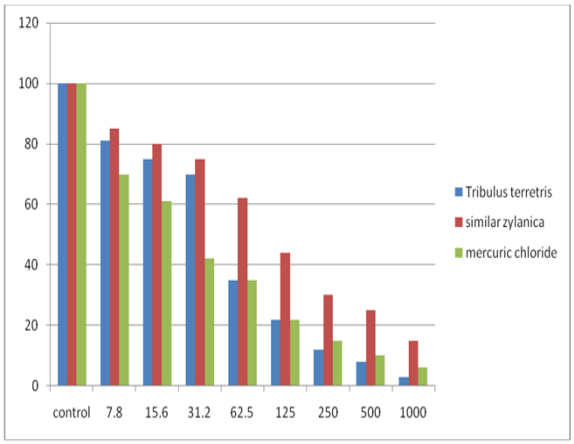
Phytochemicals	Aqueous	Ehanol
Quinones	+	_
Cardenalides	+	+
Carbohydrate	+	+
Phenols	+	_
Saponine	+	+
Tannine	+	+
Proteins and Amino acid	_	_
Terpenoids	_	+
Flavonoids	+	+

Table 2: Phytochemical analysis of Smilax zylanica

Phytochemicals	Aqueous	Ehanol
Quinones	_	_
Cardenalides	+	+
Carbohydrate	+	_
Phenols	_	+
Saponine	_	_
Tannine	+	+
Proteins and Amino acid	_	+
Terpenoids	+	+
Flavonoids	+	+

CONCLUSION

Stringent environmental regulation causes serious concern on heavy toxic metal like mercury which enters into a food chain and causing environmental pollution. The common source containing mercury was extracted and three samples of mercury in vapour, phosphorous and glass matrix were subjected to phytoremediation using two different plant extracts and the result showed better bioremediation on equal concentration with mercury chloride at 62.5 µg using MTT assay. Future work will be carried out to find the active metabolite responsible for reducing the toxic effect on recovered mercury chloride dissolved in aqua regia which is acidic in nature.



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