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FULL LENGTH ARTICLE

Conversion of Waste Paper into Useful Bio-Products

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ABSTRACT

Major share of municipal solid waste is taken by organic materials. Waste paper generated in day to day life is recycled,although at last it is either dumped or incinerated. Instead it can be reused to produce bio-products like cellulase and reducing sugar. In this paper the conversion of waste paper into useful bio-products using biotechnological approach and use of wastepaper as bio adsorbent for the removal of heavy metals from the polluted water is discussed.
Keywords— Waste Paper, De-inking, Fermentation, Cellulase, Waste paper as bio adsorbent.

INTRODUCTION

INCREASE in population is adversely affecting the balance in nature by the destruction of forests for the production of paper. Paper mills contribute to air, water and land pollution. Discarded paper is a main component of many landfill sites, accounting to about 35% by weight of municipal solid waste [1]. Recycling of paper has its own limitation as the cellulose fibres lose its strength on an average of 4 recycling cycles. An alternative can be conversion of waste paper into high value products of at most importance in the market. Recently the removal of heavy metals is gaining scope due to its ill effects on the health of human beings,animals, plants as well as on environment. Existing technologies such as ion exchange, membrane filtration and activated carbon adsorption are expensive and are not available to economically backward communities. Heavy metal removal using natural resources are economically feasible and sustainable and can be easily adopted.

Literature survey

Before fermentation it is necessary for the paper to be de-inked since the ink present may cause the hindrance for bacterial growth. The process of de-inking involve ink particles dislodgement from the fibre surface and the separation of dispersed ink from fibre suspension by washing or floatation .The efficiency of this method depends on the technique, printing conditions, kind of ink and kind of printing substrate. The photocopier printers used thermosetting toners, consisting of non dispersible synthetic polymers, as ink for printing the paper. This ink is physically bonded to the fibres because of high heat. Chemical agents used in de-inking are sodium hydroxide, sodium carbonate, diethylenetriaminepentacetic acid, sodium silicate, hydrogen peroxide and surfactants (Prasad *et al.* 1993; Putz *et al.* 1994).

Aspergillus niger is one of the most important micro organism used in biotechnology. It has been in use already for many decades to produce extracellular (food) enzymes and citric acid. In addition *A.niger* is used for biotransformation and waste treatment. In the last two decades, *A.niger* has developed as an important transformation host to over express food enzyme. *A.niger* like other filamentous fungi should be treated carefully to avoid the formation of spore dust. However compared with other filamentous fungi it doesn't stand out as a particular problem concerning allergy or mycopathology (E. Schuster *et al*. 2002).

METHODOLOGY

Collection and sorting

Waste paper collected were sorted into newspaper, magazine, printed paper, photocopied paper and written paper.

De-inking

Two methods were tested for comparing de-inking efficiency.Method one incorporated the use of 1% sodium hydroxide(NaOH).5g each of paper pieces were soaked in 1% NaOH for an hour followed by agitation at 100 rpm for an hour.Samples were then washed and dried. Method two incorporated use of 2% NaOH,heat treatment and hydrogen peroxide.Paper pieces were first introduced with 2% NaOH for

15 minutes followed by heating at 70 degree Celsius for 30 minutes and 1% hydrogen peroxide treatment for 15 minutes[2].

Fermentation

Stagnant and shake flask studies were carried out using *Aspergillus niger*.Two sets were prepared each having five subsets so that all the de-inked paper types can be analyzed.5g each of the de-inked samples from method two were used as carbon source in cellulose production media.DNSA test and cellulase activity were determined at different time intervals.Crude cellulase was extracted at the end of the process.

Waste paper as bio adsorbent

Treated waste paper can be used as an bio adsorbent for removing heavy metal ions from aqueous solution.Two types of studies were carried out. Adsorption of cadmium from synthetically prepared cadmium solution was tested using waste paper treated with disodium hydrogen phosphate[3]. Chemically treated printed and newspaper samples were taken separately in chromatography columns and 100ppm cadmium solution was introduced. Atomic Absorption Spectroscopic(AAS) analysis was carried out. Removal of lead from 100ppm synthetic lead solution was tested using the fermented waste paper residue that was left behind from the fermentation process followed by AAS analysis.

RESULTS AND CONCLUSIONS

De-inking using method two visually showed better results when compared to method one. Better growth of *A. niger* was observed in shake flask culture when compared to stagnant culture. Reducing sugar produced by de-inked photocopy paper incorporated stagnant culture was the highest amongst the five paper types(0.825mg/ml).Amongst the shake flask cultures, de-inked magazine paper containing fermentation resulted in highest reducing sugar production(0.09mg/ml). 0.09 IU of cellulase activity was seen in de-inked magazine incorporated stagnant culture which was the highest amongst the five.0.014 IU of cellulase activity was seen in the de-inked magazine paper containing media and proved to be the highest.

TABLE 1: ABSORBANCE VALUES OF CADMIUM IONS

SAMPLE NAME	ABSORBANCE			
	RAW (100ppm)	T1*	T2*	T3*
NEWSPAPER	0.049	0.001	0.002	0.001
PRINTED	0.049	0	0.001	0.002

T1= First use of the treated paper
T2= First reuse of adsorbent
T3= Second reuse of adsorbent
T1, T2, T3 conducted on the same chemically treated waste paper.

We can conclude that the cadmium ions have been adsorbed by the treated waste papers in the trials conducted. It shows that the waste paper can be used as bio adsorbent.

TABLE 2:ABSORBANCE VALUES OF LEAD IONS

SAMPLE NAME	ABSORBANCE			
	RAW (100ppm)	T1*	T2*	T3*
PHOTOCOPY	0.023	0.002	0.001	0
PRINT	0.023	0	0	0
NEWSPAPER	0.023	0	0	0
WRITTEN	0.023	0	0	0

T1= First use of the treated paper
T2= First reuse of adsorbent
T3= Second reuse of adsorbent
T1, T2, T3 conducted on the same fermented waste paper residue.

Lead ions have been adsorbed by fermented waste papers through 3 trials conducted on each.

SCOPE FOR FUTURE WORK

Since *A.niger* is already most utilized organism for the production of cellulase, the culture conditions can

be optimized and enhancers can be used to obtain higher yield of reducing sugar and cellulase with the de-inked substrate.Use of bio adsorbents can also be extended to the treatment of industrial effluents and waste water containing heavy metals.

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