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DESIGN AND FABRICATION OF AIRLIFT FLUIDIZED BIOREACTOR FOR WASTE WATER TREATMENT USING *MUSA PARADISIACA* FRUIT PEEL

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Abstract: Water-related problems are increasingly recognized as one of the most immediate and serious environmental threats. Discharge of untreated sewage water into lakes and oceans causes serious damage to the society. In the present study, Airlift fluidized bioreactor has been designed for treating sewage water by using *Musa paradisiaca* fruit peel as an adsorbent material and the efficacy of the same was studied. Among the possible techniques for water treatments, the adsorption process by solid adsorbents showed potential as one of the most efficient methods for the treatment and removal of organic contaminants in wastewater treatment. *M. paradisiaca* fruit peel, a discarded agricultural waste was used as a bio adsorbent through easy and environmental friendly processes. The results showed that *M. paradisiaca* fruit peel had very high specific surface area and potential functional groups for binding water for the removal of contaminants. This paper analyses the applications of Airlift fluidized bioreactor using *M. paradisiaca* fruit peel for wastewater treatment. The potential applicability of *M. paradisiaca* fruit peel based bio adsorbent could be further examined in a small-scale experiment.

Key words: *M. paradisiaca* Fruit peel; Airlift Fluidized Bioreactor; Sewage water treatment; Water binding

INTRODUCTION

Water of high quality is essential to human life and water of acceptable quality is essential for agriculture, industrial, domestic and commercial uses. This waste water is enriched with varied pollutants and harmful both to human being and the aquatic flora and fauna and its successive accumulation in the soil has adverse effect on soil productivity (Meikap and Roy 1995). Most contaminated waste water treatment techniques viz. coagulation, ion-exchanging, advanced oxidation process etc. require high capital and operating cost producing large volume of wastes (Aksu 2005)· Whether recycling will be appropriate in a given situation depends on the availability of additional water resources. Airlift reactors is well known as pneumatically contactors where the circulation is induced by a stream of air or other gases, injected through a gas sparger usually located at the base of the riser, being a consequence of the net densities differences which results between the two main zones: riser and down comer (Merchuk and Gluz, 2003). The adsorption process better occurs in Airlift fluidized bioreactor than in packed bed, fluidized bed and moving beds reactors, considering the removal efficiency of pollutants (Mohanty *et al.*, (2008).

The application of airlift reactors for wastewater treatment addresses usually the conventional biological treatment (activated sludge, biofilm systems), but they are increasingly applied for advanced wastewater treatment (tertiary stage):nitrification-denitrification (Guo *et al.,* 2005; Jianping *et al.*, 2005), biological oxidation (Jianping *et al.,*2005; Pang *et al.,* 2009), biodegradation of some refractory organic compounds (Liu *et al.,* 2007; Liu *et al.*, 2008; Mohanty *et al.,* 2008), electrocoagulation, electrofloculation (Balla *et al.*, 2010; Essadki *et al.*, 2008). Adsorption technology has the potentiality to remove, recover and recycle of metals from wastewaters (Bhattacharyya and Gupta, 2006). Biosorption can be defined as the ability of biological materials to accumulate heavy metals from wastewater through metabolically mediated or physico-chemical pathways of uptake (Fourest and Roux, 1992).

The major advantages of biosorption over conventional treatment methods include low cost, high efficiency of metal removal from dilute solution (Veglio *et al.*, 1997), minimization of chemical and/or biological sludge, no additional nutrient requirement, regeneration of biosorbent (Volesky, 1990a), effective use of agro waste and the possibility of metal recovery (Volesky, 1990b).Thus, there is a scope to discover an alternative adsorbent which has low cost and high efficiency. Many researchers have investigated low-cost adsorbents originated from agro-wastes for heavy metals removal (Gao *et al.*, 2008; Sari *et al.*, 2008; Yang and Chen, 2008). In this aspect, an agricultural waste such as *M. paradisiaca fruit peel* has been used as bioadsorbents for the copper adsorption. *M. paradisiaca fruit peels* are readily available, low cost and cheap, environment friendly bio-materials and used for Sewage water treatment.

MATERIALS AND METHODS

Sample Collection

Sewage Water: The sewage sample was collected from Sewage Treatment Plant at Bannari Amman Institute of Technology, Sathyamangalam, Erode District, Tamilnadu in a pre-sterile container. (Fig. 1)

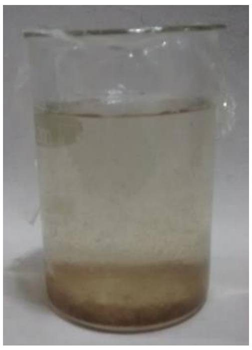

Figure 1: Sewage Water Sample

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***Musa paradisiaca* Peel (Adsorbent Material):** *M. paradisiaca* fruit peel was collected from Sapphire Men's Hostel Dining Hall of Bannari Amman Institute of Technology, Sathyamangalam. The samples were dried for 15 days at room temperature under shade and used as adsorbent in wastewater treatment process.(Figure 2).

Figure 2: *M. paradisiaca* fruit peel

Analysis of the properties of sample before treatment

Physical Separation

(i). Total Dissolved solids (TDS): The Total dissolve solids is measured as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**

(ii). Turbidity: The measurement of turbidity is a key test of water quality. The turbidity of given water sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

Chemical Examination

(i). pH: The pH of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.5ml of sample was used for the pH measurement.

(ii). Total Alkalinity test $CaCO_3$: The Alkalinity of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(iii). Total Hardness as $CacCO_3$: The Hardness of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(iv). Chloride Test: The chloride of sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(v). Calcium as Ca: The Calcium of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(vi). Magnesium as Mg: The Magnesium of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(vii). Iron Total as Fe: The Iron of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(viii). Manganese as Mn: The Manganese of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(ix). Free Ammonia as NH3: The Ammonia of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(x). Nitrite as NO2: The Nitrite of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(xi). Nitrate as NO3: The Nitrate of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(xii). Fluoride as F: The Fluoride of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(xiii). Sulphate as SO4: The Sulphate of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

(xiv). Phosphate as PO4: The Phosphate of the sample was determined as per the guidelines of Bureau of Indian Standard **(BIS 10500:2012)**.

Results and Discussion

Design and Fabrication of Airlift Fluidized Bioreactor-Laboratory Setup

Airlift reactors have found applications in processes where their features lead to advantages comparative to other types of reactors (Gavrilescu *et al.*, 2008; Klein *et al.*, 2001). The Airlift Fluidized bioreactor consisting of 2 litre pet bottle with a hole punched on the bottom of the cap. The inverted pet bottle was held with the burette stand. The tube from adaptor was sent through the hole for aeration purpose. A thermometer was partially placed inside the pet bottle which measures the temperature of the sample. 2 litre of Sewage water sample was poured inside the reactor and adsorbent material as *M. paradisiaca* fruit peel were placed at the bottom of the reactor. (Fig 3) A reactor was made to run continuously for about 24 hours and sample was collected from the reactor for further analysis. (Kamesh and Kannan 2015).

Figure 3: Airlift Fluidized bioreactor- Laboratory Setup

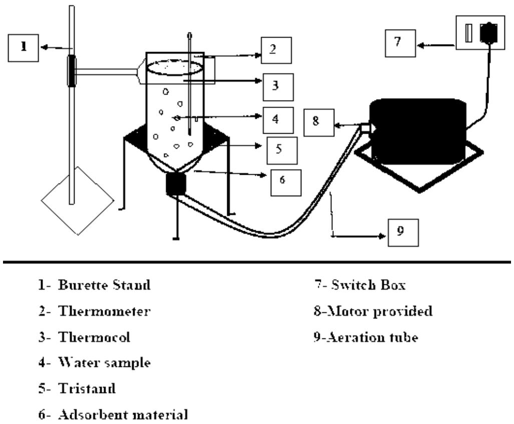

Figure 4: Schematic Representation of Airlift Fluidized Bioreactor

Treatment of Sewage Water Sample using Airlift Fluidized Bioreactor

An Airlift combined with semi fluidized bed reactor was used for this water treatment. In this Reactor, *M. paradisiaca* fruit peel were used as an adsorbent materials to adsorb impurities of wastewater.

Properties of Sewage Water Sample -After treatment

After treating the wastewater in the developed bioreactor, the treated water was collected into 1 litre beaker and filtered by using filter paper. The properties of waste water before and after treatment has been analysed in Tamilnadu Water Supply and Drainage Board, Erode (Annexure). *M. paradisiaca* fruit peels were photographed using fluorescent microscope to observe the morphogical changes of the *M. paradisiaca* fruit peels before and after treatment (Fig. 3 & 4). The sewage water treated with *M. paradisiaca* fruit peel shows low pH and increased levels of turbidity. It is observed that the water is chemically potable.

Table 1: Changing of Sewage Water Sample properties- Before and After Treatment

S. No	Parameters	***M. Paradisiaca* Peel**		
		Before Treatment	**After Treatment**	**Acceptable Limit**
1.	pH	7.49	7.17	6.5 to 8.5
2.	Total dissolved solids	1033.0 mg/I	1017.0 mg/I	2000.0 mg/I
3.	Total Suspended solids	10.0 mg/I	-	300.0 mg/I
4.	Chloride as Cl	134.0 mg/I	152.0 mg/I	1000.0 mg/I
5.	Total Hardness as Caco$_3$	460.0 mg/I	424.0 mg/I	600.0 mg/I
6.	Odour	Unpleasant smell	None	Agreeable
7.	Turbidity	12.0NTU	2.0 NTU	1.0 NTU
8.	Total Alkalinity	416.0 mg/I	384.0 mg/I	600.0 mg/I
9.	Calcium as Ca	88.0 mg/I	82.0 mg/I	200.0 mg/I
10.	Magnesium as Mg	58.0 mg/I	53.0 mg/I	100.0 mg/I
11.	Iron total as Fe	1.20mg/I	0.00 mg/I	0.3 mg/I
12.	Manganese as Mn	0.0 mg/I	0.0 mg/I	0.3 mg/I
13.	Free Ammonia as NH_3	31.06 mg/I	0.00 mg/I	0.5 mg/I
14.	Nitrite as NO_2	0.08 mg/I	0.03 mg/I	-
15.	Nitrate as NO_3	2.0 mg/I	44 mg/I	45.0 mg/I
16.	Fluoride as F	0.5 mg/I	0.9 mg/I	1.5 mg/I
17.	Sulphate as SO_4	97.0 mg/I	70 mg/I	400.0 mg/I
18.	Phosphate as PO_4	10.91 mg/I	0.12 mg/I	-

1 mg/I=1 ppm/BDL-Below detectable level (Detectable level-0.0001 mg/I)

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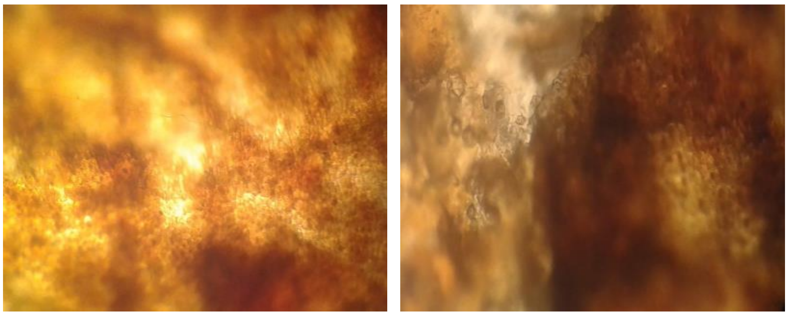

a) Before Treatment b) After Treatment

Figure 5: Microscopic view of adsorbent material *Musa paradisiaca* fruit peel

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