International Journal of Research Studies in Zoology (IJRSZ)
Volume 1, Issue 2, Jul-Sep 2015, PP 56-61
www.arcjournals.org

Biotreatment of Electroplating Industrial Effluent Using Coconut Husk

S. Balaji, A. Joseph Thatheyus and D.Ramya

Postgraduate and Research Department of Zoology, The American College
Madurai, Tamil Nadu, India
jthatheyus@yahoo.co.in

Abstract: *The treatment of electroplating industrial effluent by coconut husk was carried out by analyzing the physico-chemical parameters of the effluent such as pH, salinity, calcium, magnesium, phosphates, nitrates,* BOD_3 *30°C and total solids using standard methods. The efficiency of coconut husk was tested by using it in different quantities such as 25, 50, 75 and 100 grams for five days. As a result, it was found that 100 grams of coconut husk exhibited greater treatment efficiency and significantly reduced the salinity, calcium, magnesium, phosphates, nitrates and BOD in the treated effluent. Thus, it is evident that this biological treatment using coconut husk is cost effective and eco-friendly.*

Keywords: *Biotreatment, industrial electroplating effluent, coconut husk and biosorption.*

1. Introduction

Effluents from various processing industries such as electroplating is reported to contain high amounts of heavy metal ions, such as nickel, iron, lead, zinc, chromium, cadmium and copper (Konstantinos *et al*., 2011). The presence of these heavy metals in industrial wastewaters is of serious concern because they are highly toxic, non-biodegradable, and carcinogenic and their continuous deposition into receiving lakes, streams and other water sources within the vicinity causes bioaccumulation in the living organisms. These perhaps, could lead to several health problems like cancer, kidney failure, metabolic acidosis, oral ulcer, renal failure and many more (Booker, 2000). Effluent from electroplating industry is of serious concern because just about 30-40% of the metals used during plating processes are effectively utilized i.e. plated on the articles. The remaining percentage of the metals contaminates the rinsing waters used during electroplating process.

The rinse water used during electroplating process contains about 1000 mg/L toxic heavy metals, which must be controlled to an acceptable level, in accordance to environmental regulations worldwide, before being discharged to the environment [1]. Due to different degree of hazardous problems associated with heavy metal pollution, treatment of affected wastewater is very essential in order to allow human and industrial effluents to be disposed of without bringing about any of the mentioned associated dangers to human health, aquatic life or causing avoidable damage to the natural environment [2].

Many techniques have been investigated for the removal of pollutants dyes from waste waters. Currently, the principal methods of treatment involve biological, physical and or chemical processes such as microbial degradation [3], chemical oxidation [4]and adsorption technology using activated carbon prepared from various agricultural wastes [5,6]. Adsorption on activated carbon is one of the most effective processes but the high cost of such adsorbent has motivated many researchers to search for alternative low cost adsorbents [7].

Today, attention has been focused on the development of low-cost adsorbents as alternative adsorbent materials. The successful removal of pollutants using low cost adsorbents has been carried out by Hameed and coworkers such as grass waste [8], jackfruit peel [7] chitosan/oil palm ash [9], durian peel [10], papaya seeds and rattan sawdust [11]. Besides Hameed and co-workers, other researchers have developed low cost adsorbents such as coconut mesocarp [12], guava leaf powder [13], almond shell [14] and chitosan bead [15].

In the present investigation, an attempt has been made to study the potential of coconut husk as adsorbent to treat electroplating industrial effluent. In general, coconut consists of 33–35% of husk. At present, coconut husk is used as fuel for coconut processing, as a domestic fuel and as a source of fiber for rope and mats. To make better use of this cheap and abundant agricultural waste, it is proposed to use coconut husk as an adsorbent.

2. MATERIALS AND METHODS

2.1. Collection of Sample

The electroplating industrial effluent was collected in five litre polyethylene containers from Jaihindpuram at Madurai and brought to the laboratory for analysis.

2.2. Physico-Chemical Analysis of the Collected Effluent

The samples collected were analyzed for pH, temperature, colour, odour, salinity, calcium, magnesium, phosphates, nitrates, BOD_3 30℃ and Total Solids (TS). The techniques and methods followed for collection, preservation, analysis and interpretation are those given by APHA [16].

2.3. Coconut Husk Preparation

The coconut husk was obtained and washed repeatedly in water. It was then sun-dried and finely chopped in order to increase the active sites for adsorption.

2.4. Sample Analysis

Five litres of the electroplating industrial effluent sample was taken in four containers each and about 25, 50, 75 and 100 g of coconut husk were added to these samples respectively. The samples were occasionally stirred well and incubated for five days. After incubation, the samples were filtered and analyzed for pH, temperature, colour, odour, salinity, calcium, magnesium, phosphates, nitrates, BOD_3 30℃ and Total Solids using standard methods [16].

3. RESULTS AND DISCUSSION

The results of physico-chemical properties of electroplating industrial effluent are shown in Table 1. The Indian Government has fixed tolerance limits for various parameters such as TS, BOD, salinity, calcium, magnesium and phosphates (Table 2). The calcium, magnesium and phosphate levels were higher when compared to tolerance limits. In general, the wastewater generated from electroplating industries is found to contain high degree of pollutants with high Total solids.

Table1. *Physico-chemical properties of electroplating industrial effluent*

S.No.	Parameter	Quantity
1	Temperature (℃)	30
2	Colour	Golden yellow
3	pH	7.5
4	Odour	Nil
5	Salinity (ppt)	3.112
6	Calcium (mg/l)	3040
7	Magnesium (mg/l)	816
8	Phosphates (mg/l)	145
9	Nitrates (mg/l)	321
10	BOD_3 30℃ (mg/l)	0.114
11	Total Solids (mg/l)	3000

Table2. *Comparison of tolerance limits and observed level of parameters in electroplating industrial effluent*

S.No.	Parameter	Tolerance limits	Observed values
1	Colour	Colourless	Golden Yellow
2	Odour	Odourless	Odourless
3	BOD_3 30℃ (mg/l)	4.0 – 6.0	0.114
4	Total solids (mg/l)	100	3000
5	Phosphates (mg/l)	0.43	2.17
6	Calcium (mg/l)	100	3040
7	Magnesium (mg/l)	30	816

The salinity values were less than 1ppt set by the World Health Organization [17] and Standard Organisation of Nigeria [18]. This implies that the waters are not saline. In the present study, the salinity value of electroplating effluent was higher than the permissible limit and after treatment with coconut husk the level was reduced. The hardness of water is not a chemical parameter, but indicates the water quality mainly in terms of calcium and magnesium. The hardness has no known adverse effect [19]. The level of calcium concentration was greater in control when compared to that of the treated samples. The highest value of calcium and magnesium were noted in untreated sample while lowest value was found in 75 and 100g of coconut husk treated effluent. The concentration of calcium is always greater when compared to that of magnesium because of its high solubility rate [20]. The concentration of calcium and magnesium declined with the increase in the quantity of coconut husk which is due to the adsorption quality of the coconut husk (Fig 1 and 2).

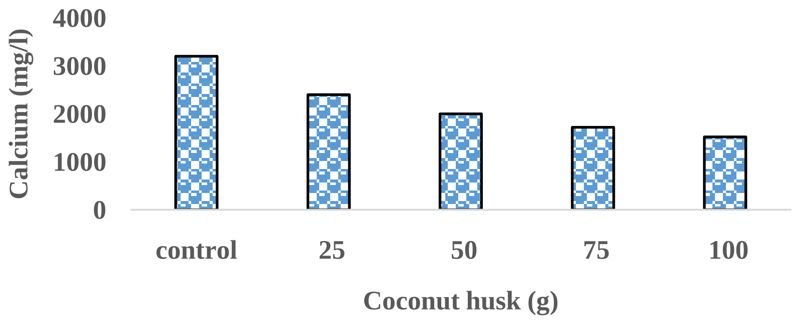

Fig1. *Changes in calcium of electroplating industrial effluent after treatment with coconut husk*

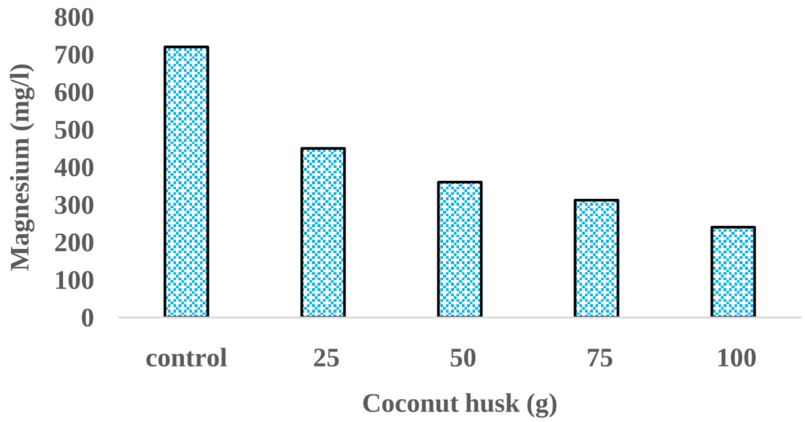

Fig2. *Changes in magnesium of electroplating industrial effluent after treatment with coconut husk*

The phosphate levels were generally high exceeding the 5 mg/L set as standard in South Africa and Nigeria [21, 18]. Persistence of high concentration of phosphates at this level in the surface water for a long time may lead to eutrophication of the water body, which can reduce their recreational use and also endanger aquatic life. The levels of phosphates declined with the increase in the quantity of coconut husk which is due to the adsorption quality of the coconut husk (Fig. 3).

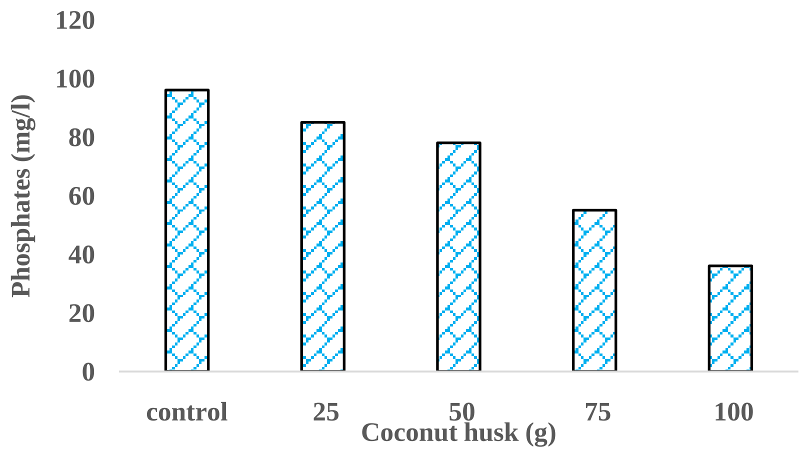

Fig3. *Changes in phosphates of electroplating industrial effluent after treatment with coconut husk*

Higher concentration of nitrates in water causes a disease called "Methaemoglobinaemia" or known as "Blue-baby syndrome" [22]. Excessive levels of nitrates in drinking water have caused serious illness and sometimes death [23]. In the present study, decrease in the levels of nitrates and total solids was observed at 100g of coconut husk treated effluent (Fig 4 and 5).

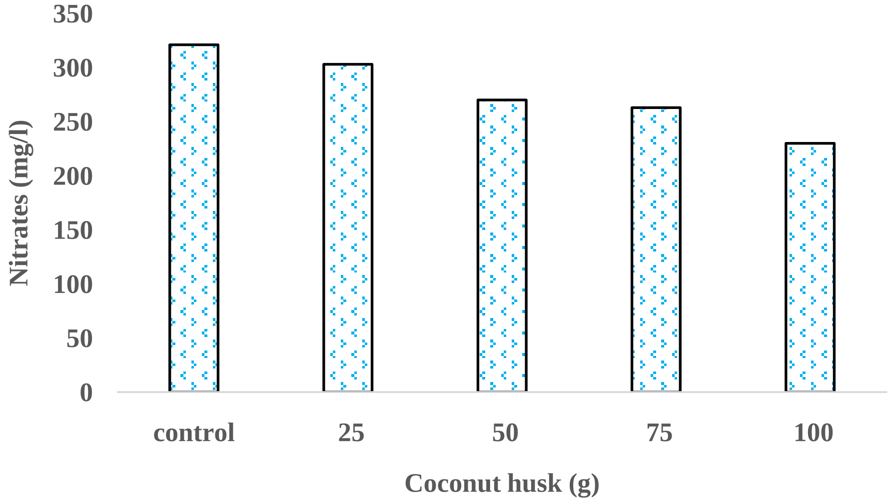

Fig4. *Changes in nitrates of electroplating industrial effluent after coconut husk treatment*

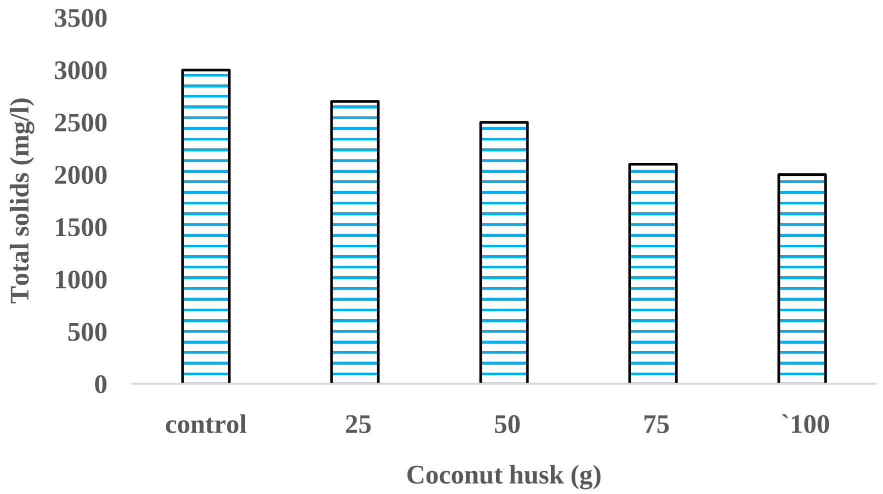

Fig5. *Changes in total solids of electroplating industrial effluent after coconut husk treatment*

4. Conclusion

Coconut-based agricultural wastes have been extensively studied as biosorbents for the removal of diverse types of pollutants from water and found to be the most effective absorbents among several agricultural wastes. Coconut husk, which is regarded as a waste, can be converted into a value added product, which has an extensive application for removing pollutants from effluents produced by various industries.

Acknowledgment

The authors thank the authorities of the American College, Madurai for facilities and encouragement.

References

[1] Konstantinos C., Valsamidou. A. V., Removal of Nickel, Copper, Zinc and Chromium from Synthetic and Industrial Wastewater by Electrocoagulation. Int. J Environ. Sci. 1(5), 698-703 (2011).

[2] Li P. J., Ke X., Zhou Q. X., Zhang Y., Sun T.H., Removal of Heavy Metals from a Contaminated Soil Using Tartaric Acid. J Environ. Sci. China. 18, 727-733 (2006).

[3] Lourenço N.D., Novais J.M., Pinheiro H.M., Kinetic studies of reactive azo dye decolorization in anaerobic/aerobic sequencing batch reactors. Biotechnol. Letters. 28(10), 733-739 (2006).

[4] Nunez L., García-Hortal J.A., Torrades F., Study of kinetic parameters related to the decolourization and mineralization of reactive dyes from textile dyeing using Fenton and photo-Fenton processes. Dyes and Pigments. 75(3), 647-652 (2007).

[5] Tan I.A.W., Ahmad A.L., Hameed B.H., Adsorption of basic dye using activated carbon prepared from oil palm shell: batch and fixed bed studies. Desalination. 225(1-3), 13-28.

[6] Santhy K., Selvapathy P., Removal of reactive dyes from wastewater by adsorption on coir pith activated carbon. Biores. Technol. 97(11), 1329-1336 (2006).

[7] Hameed B.H., Removal of cationic dye from aqueous solution using jackfruit peel as non-conventional low-cost adsorbent. J. Hazard. Mater. 162(1), 344-350 (2009).

[8] Hameed H., Grass waste: A novel sorbent for the removal of basic dye from aqueous solution. J. Hazard. Mater. 2009, 166(1), 233-238.

[9] Hasan M., Ahmad A.L., Hameed B.H., Adsorption of reactive dye onto cross-linked chitosan/oil palm ash composite beads. Chem. Eng. J.136(2-3), 164-172. (2008).

[10] Hameed B.H., Hakimi H., Utilization of durian (Durio zibethinus Murray) peel as low cost sorbent for the removal of acid dye from aqueous solutions. Biochem. Eng. J. 39(2), 338-343 (2008).

[11] Hameed B.H., El-Khaiary M.I., Malachite green adsorption by rattan sawdust: Isotherm, kinetic and mechanism modeling. J. Hazard. Mater.159(2-3), 574-579 (2008).

[12] Vieira A.P., Santana S.A.A., Bezerra C.W.B., Silva H.A.S., Chaves J.A.P., De Melo J.C.P., Da Silva Filho E.C., Airoldi C., Kinetics and thermodynamics of textile dye adsorption from aqueous solutions using babassu coconut mesocarp. J. Hazard. Mater.166, 1272-1278 (2009).

[13] Ponnusami V., Madhuram R., Krithika V., Srivastava S.N., Effects of process variables on kinetics of methylene blue sorption onto untreated guava (*Psidium guajava*) leaf powder: Statistical analysis. Chem. Eng. J.140(1-3), 609-613 (2008).

[14] Ardejani D., Badii K., Limaee N.Y., Shafaei S.Z., Mirhabibi A.R., Adsorption of Direct Red 80 dye from aqueous solution onto almond shells: Effect of pH, initial concentration and shell type. J. Hazard. Mater. 151(2-3), 730-737 (2008).

[15] Bekçi Z., Ozveri C., Seki Y., Yurdakoç K., Sorption of malachite green on chitosan bead. J. Hazard. Mater.154(1-3), 254-261 (2008).

[16] APHA (American Public Health Association), Standard Methods for Estimation of Water and Wastewater, 19th edn, American Water Works Association, Water Environment Federation, Washington. 1995.

[17] WHO, Sodium Chloride and Conductivity in Drinking Waters. World Health Organization, Copenhagen. (1979).

[18] Son, Standard Organization of Nigeria, Nigerian Standard for drinking water quality, (2007). pp. 15-16

[19] Mohabansi N.P., Tekade P.V., Bawankar S.V., Physico-Chemical and microbiological ananlysis of textile industry effluent of Wardha Region, Water Research & Development. 1, 40-44 (2011).

[20] Kamala and Rao D.L.K., Environmental Engineering, McGraw Hill Publishing Company, New Delhi, pp 45 – 53 (1999).

[21] Morrison, O.S. Ekberg F.A. Assessment of the impact of Point Source Pollution from Keiskammahoek Sewage Treatment Plant on the Keiskamma River – pH, Electrical Conductivity, Oxygen Demanding Substances (COD) and Nutrients. Water SA. 27, 475- 480 (2001).

[22] Agrawal K.C., Environmental Biology. Botanica Publishers, (1999) pp: 289 – 300.

[23] Reimann K., Bjorvatn B., Frengstad Z., Melaku R., Haimanot T., Siewers U., Drinking water quality in the Ethiopian section of the East African Rift Valley I –data and health aspects, Sci. Total Environ. 311, 65-80 (2003).

AUTHORS' BIOGRAPHY

Dr. A. Joseph Thatheyus, The American College, Madurai.

Dr. A. Joseph Thatheyus is well known internationally for his research contributions in the field of Aquatic Toxicology and Environmental Biotechnology. He has worked on the effects of heavy metals, pesticides, industrial effluents and detergents on aquatic fauna especially fish and aquatic insects.

In his work Dr. Thatheyus combines the utility of fish, plants, microbes and bioproducts towards the remediation of effluents and waste water from industries. He has also ventured into the studies concerned with the biodiversity of plankton, butterflies and birds in a conservation perspective. He is incessantly exploring several promising possibilities to develop anticancer drugs from seaweeds and nanoparticles synthesized from marine algae.

D. Ramya, The American College, Madurai.

D. Ramya, completed her B.Sc Degree in Applied Microbiology at Meenakshi Mission Hospital, Madurai, Tamil Nadu, India in 2007. She attained her M.Sc Degree in Immunology and Microbiology at The American College, Madurai, in 2009. She was awarded M.Phil Degree in Biotechnology by Karunya University, Madurai, in 2011. She has worked us Junior Research Fellow in University Grants Commission sponsored Major Research Project on"Bioremediation of effluents from electroplating industries using chosen bacteria" during 2011 - 2014. So far she has published sixteen research papers in both International and National Journals.