BVG Trust

J. Sci. Trans. Environ. Technov. 10(2), 2016: 72-74

Scientific Transactions in Environment and Technovation

Physico-chemical analyses of raw and biologically treated sugar mill effluent

https://doi.org/10.56343/STET.116.010.002.005

http://stetjournals.com

T.Vaithiyanathan and P. Sundaramoorthy*

*Department of Botany, Annamalai University, Annamalai Nagar - 608002, Tamil Nadu, India.

Abstract

Pollution of our environment has become a serious problem. Rapid industrialization is the main cause for the environmental problems. India is an agriculture based country and a major user of water resource for irrigation. But, there is a great demand in water for irrigation. A large volume of untreated or partially treated effluents are discharged from industries into water bodies. Use of these industrial effluent and sewage sludge on agricultural land has become a common practice in India. These industrial effluents containing heavy metals pose a serious threat to the ecosystem. It affects plant growth, yield and also soil fertility when it is used for irrigation. Sugar industry is one of the most important agro based industries in India and it plays a major role in creating rural economy of the country. It released large amount of wastewater into nearby water bodies which affect the water and soil ecosystems. Phytoremediation is a simple, cost effective, eco-friendlier technology for removing the pollutant from the contaminated water. In the present study, bioremediation of sugar mill effluent by aquatic plant and physico-chemical analysis of raw and biologically treated sugar mill effluent has been made.

Keywords: Agriculture, environmental pollution, phytoremediation and sugar mill effluent analyses

INTRODUCTION

Environmental pollution is an undesirable change in physical, chemical and biological aspects of our environment that will harmfully affect the living organisms. It is one of the primary issues of the world and it caused many ill-effects to the human beings, animals and plants. Increasing pace of industrialization along with urbanization, population explosion and green revolution are reflected in varying degree of pollution of water, soil and air. The industrial development is necessary for development of any country and it provided all facilities to modern life. On the other hand, the rapid industrialization plays a significant role in creating all kinds of pollution in our environment. Industries released large amount of the wastes in the form of solids, liquids and gases into the environment which not only affect the physical, chemical and biological characteristics of the environment but also affects the components of ecosystem of that area (Barman *et al.,* 2000). The industries consumed large amount of the fresh water for production process and released equal amount of wastewater as effluent into nearby water bodies. The industrial effluents invariably contained acids, alkaline, high amount of organic and inorganic substances, heavy metals and toxic substances which alter the properties of water as well as soil. The pollution load of the effluent is varying from one industry to another industry which depends upon the raw materials and chemicals used in the manufacturing processes involved and the methods of effluent treatments employed in the industry (Kaushik *et al.,* 2004).

India is an agricultural country and it stands the second position in its world population next to China. Most of the people depend upon the agriculture. Water is essential for agricultural irrigation. In arid and semi-arid regions of our country, where shortage of water becomes limiting factor in agriculture, the effluent or polluted water is used for irrigational purpose by farmers. When these effluents are being used for irrigation continuously, the higher amount of organic and inorganic elements deposited in the soil and they become toxic to the soil ecosystem. These elements may be transferred and translocated into the plant tissues from polluted soil. It reduced growth and yield of the crop and may cause health problems to the consumers (Ayyasamy *et al.,* 2008). Sugar industry is one of the most important agro based industries in India and it plays an important role in rural economy of our nation and it falls under the red category (Kumar and Chopra, 2010). There are nearly 716 sugar mills in India which are potentially produced about 26 million tons of sugar during the period 2015-2016. The operation of sugar mill is seasonal and it operates only for 120 to 200 days in a year (early November to April) which depends upon the availability of sugarcane, a raw material for sugar production. It discharges large amount of effluent with partially or without any treatment into nearby water bodies. It contain higher amount of organic and inorganic compounds which affects the water and soil properties

*Corresponding Author :
email: *ppsmoorthy@gmail.com*

Table 1. Physico-chemical analyses of raw and biological treated sugar mill effluent with it's tolerance limits for agricultural irrigation. **(**All parameters except pH, EC and temperature are expressed in mg/l.)

Properties	Raw effluent	*Eichhornia*	*Pistia*	*Salvinia*	*Lemna*	Tolerance limits for Agricultural irrigation as suggested by TNPCB
pH	4.04	6.8	6.3	6.2	5.4	5.5-9.0
EC	4745	1895	2468	2656	2968	-
Temperature (^{o}C)	36.0	32	33	33	34	40.0
Suspended solids	180.0	70	90	110	126	200
Total dissolved solids	3725.0	1280	1670	1750	1960	200
Total solids	3905.0	1350	1760	1820	2086	2100
BOD	3480.0	1320	1510	1590	1780	30
COD	7880.0	3760	3920	4130	4570	250
Chloride	314.0	168	176	179	184	600
Sulphate	290.88	132	148	154	170	12
Magnesium	286.0	136	148	152	158	100
Phosphorus	7.2	4.5	4.9	5.2	5.4	10
Nitrogen	1250	620	680	730	920	600
Fluoride	1.88	0.72	0.86	0.92	1.04	1.0
Silica	99.0	56	62	65	68	-
Calcium	124.8	65	78	82	86	200
Zinc	0.89	0.21	0.34	0.38	0.45	0.01
Iron	16.00	5	8	10	10.8	1.00
Copper	0.420	0.17	0.21	0.23	0.27	0.01
Lead	0.52	0.18	0.23	0.28	0.33	0.05
Manganese	0.068	0.01	0.03	0.042	0.052	0.01
Oil & grease	19	9.2	9.8	10.3	14	0

as well as living organisms. The water pollution is very serious problem in many countries. Bioremediation is a new technique for remedy of this pollution by using microbes and plants. It is a simple, cost effective and eco-friendly technology and it is accepted worldwide. Some aquatic plants can be used for biological treatment of the effluent. Therefore, the present research was planned to analyses of raw and biologically treated sugar mill effluent.

MATERIALS AND METHODS

Effluent samples

The sugar mill effluent was collected in plastic containers from the outlet of N.P.K.R. Ramasamy Co-operative sugar mill in Thalainayar, Mayiladuthurai Taluk, Tamil Nadu, India. They were brought to the Ecology Laboratory, Department of Botany, Annamalai University, Chidambaram, and stored in refrigerator at 4 ^{o}C for further analyses.

Aquatic plants

The aquatic plants *viz., Eichhornia crassipes, Pisita stratiotes, Salvinia natans* and *Lemna minor* were collected from fresh water ponds of village Kali, Mayiladuthurai Taluk, Nagapattinam District, Tamil Nadu, India. The plants of same size and weight of each species were selected and used in the experiment designed for biological treatment and phtoremediation. They were washed thoroughly with tap water and distilled water. Five liters of raw effluent was taken in plastic containers separately. 500 g of aquatic plants were allowed to grow in separate containers of the effluent upto 21 days. After 21st day, the biologically treated effluents were collected and stored in refrigerator at 4 ^{o}C.

Analyses of sugar mill effluent sample

The raw and biologically treated sugar mill effluent were analysed for their various physico-chemical properties in the Ecology Laboratory, Department of Botany, Annamalai University as per the routine

Standard methods mentioned in American Public Health Association (APHA, 2005).

RESULTS AND DISCUSSION

In the present experiment, the aquatic macrophytes such as *Eichhornia crassipes*, *Pistia stratiotes, Salvinia natans* and *Lemna minor* were used in the biological treatment in order to remove the pollutants from the sugar mill effluent. These macrophytes were allowed to grow in the sugar mill effluent for 21 days. Among them, *Eichhornia* reduced higher amount of the pollutants from the effluent than the other plants employed. The physico-chemical analysis of biologically treated effluent was carried out (Table-1). The results showed that a considerable amount of pollutants were found to be reduced in Biologically Treated Effluents (BTE). Similar results were already reported in the biological treatment of various industrial effluents by growing different aquatic plants (Dhir, 2010; Ajayi and Ogunbayo, 2012; Kannadasan *et al.,* 2013). The variation in the ability of different aquatic plant species in the removal of pollutants could be due to variation in the cellular organization and membrane potentialities to absorb, adsorb and accumulate the pollutants.

Water hyacinth (*Eichhornia crassipes*) is a flowering aquatic macrophyte and acts as a good bioaccumulator and also reported that it is a good biological filter and efficient pollutant absorber (Lakshmanaswamy and Sivakumar, 1992). It has high tolerance to pollution and absorption of heavy metal and nutrient capacities (Singhal and Rai, 2003). It is used in cleaning up municipal and agricultural wastewater. It has an ability to accumulate heavy metals which makes it the potential for phytoremediation (Axtell *et al.*, 2003). It played a major role in reduction of BOD, COD, nitrogen, sodium, phosphorus, suspended solids, phenols, pesticides, heavy metals, etc from the wastewater (Mishra *et al.,* 2013). It removed nutrients and heavy metals from wastewater which reduce pollution to an adequate level (Jayaweera and Kasturiarachchi, 2004; Akinbile and Yusoff, 2012).

CONCLUSION

It is concluded that the aquatic plants removed pollutants from the effluent. It was easy and low cost method. Among these plants, *Eichhornia sp.* was highly effective for removal of the pollutant from the effluent. So, it is suggested that the sugar mill effluent can be given biologically treatment to reduce its toxicity.

ACKNOWLEDGEMENTS

One of the authors, T. Vaithiyanathan acknowledges the University Grants Commission, New Delhi, India for providing financial support in the form of UGC-BSR research fellowship and the authors are thankful to Professor and Head, Department of Botany, Annamalai University for providing laboratory facilities to carry out these experiments.

REFERENCES

Ajayi, T.O. and Ogunbayo, A. O. 2012. Achieving environmental sustainability in wastewater treatment by phytoremediation with water hyacinth (*Eichhornia crassipes*). *J. Sustain. Develop.,* 5(7): 80–90. https://doi.org/10.5539/jsd.v5n7p80

Akinbile, C. O. and Yusoff, M. S. 2012. Water hyacinth (*Eichhornia crassipes*) and lettuce (*Pistia stratiotes*) effectiveness in aquaculture wastewater treatment in Malaysia. *International Journal of Phytoremediation,* 14: 201-211. PMid:22567705 https://doi.org/10.1080/15226514.2011.587482

APHA, 2005. Standard methods for the examination of water and wastewater. *American Public Health Association,* 21st ed., Washington, DC.

Axtell, N.R., Sternberg, S. P. K. and Claussen, K. 2003. Lead and nickel removal using Microspora and *Lemna minor*. *Biores. Technol.,* 89: 41–48. https://doi.org/10.1016/S0960-8524(03)00034-8

Ayyasamy, P. M., Yasodha, R., Raja Kumar, S., Lakshmanaperumalsamy P., Rahman, P.K.S.M. and Lee, S. 2008. Impact of sugar factory effluent on the growth and biochemical characteristics of terrestrial and aquatic plants. *Bull. Environ. Contam. Toxicol.,* 81: 449–454. PMid:18784897 https://doi.org/10.1007/s00128-008-9523-5

Barman, S.C., Kisku, G.C. and Bhargava, S. K. 2000. Distribution of heavy metals in wheat, mustard and weed grown in field irrigated with industrial effluents. *Bulletin of Environmental Contamination and Toxicology,* 64(4): 489-596. PMid:10754044 https://doi.org/10.1007/s001280000030

Dhir, B. 2010, Use of aquatic plants in removing heavy metals from wastewater. *Int. J. Environ. Engr.,* 2: 185-201. https://doi.org/10.1504/IJEE.2010.029827

Jayaweera, M.W. and Kasturiarachchi, J.C. 2004. Removal of nitrogen and phosphorous from industrial wastewaters by phytoremediation using water hyacinth (*Eichhornia crassipes* [Mart.] Solms). *Water Science and Technology,* 50: 217-225. https://doi.org/10.2166/wst.2004.0379

Kannadasan, T., Thirumarimurugan, M., Sowmya, K. S., Sukanya, K. and Vijayashanthi, M. 2013. Dye industry effluent treatment using cactus (*Opuntia*) and water hyacinth (*Eichhornia crassipes*) IOSR. *J. Environ. Sci. Toxicol. Food Technol.,* 3(4): 41–43. https://doi.org/10.9790/2402-0344143

Kaushik, A., Kadyan, B.R. and Kaushik, C.P. 2004. Sugar mill effluent effects on growth, photosynthetic pigments and nutrient uptake in wheat seedlings in aqueous medium and soil medium. *Water Air and Soil Poll.,* 87: 39–46. https://doi.org/10.1007/BF00696827

Kumar, V. and Chopra, A. K. 2010. Influence of sugar mill effluent on physico-chemical characteristics of soil at Haridwar (Uttarakhand), India. *J. Appl. and Nat. Sci.,* 2(2): 269-279. https://doi.org/10.31018/jans.v2i2.134

Lakshmanaswamy, M. and Sivakumar, A. A. 1992. Accumulation of heavy metals Cu and Zn from industrial effluents in some plants. *Him. J. Env. Zoo.,* 6: 164-166.

Mishra, S., Mohanty, M., Pradhan, C., Patra, H. K., Das, R. and Sahoo, S. 2013. Physico-chemical assessment of paper mill effluent and its heavy metal remediation using aquatic macrophytes-a case study at JK Paper mill, Rayagada, India. *Environ. Moni. and Asses.*, 185: 4347-4359. PMid:22993029 https://doi.org/10.1007/s10661-012-2873-9

Singhal, V. and Rai, J. P. N. 2003. Biogas production from water hyacinth and channel grass used for phytoremediation of industrial effluents. *Bioresour. Technol*., 86: 221–225. https://doi.org/10.1016/S0960-8524(02)00178-5