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Research Article

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Physicochemical and heavy metal analysis of sugar mill effluent

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ABSTRACT

Industrial pollution has been and continues to be a major threat to the environment affecting the water we use, the air we breathe and the soil we live on. Among the various industries, sugar mill is one of the largest and most important agro based industries in India. In this study, the content of heavy metals in the sugar mill effluent samples were analysed quantitatively. The presence of heavy metals like arsenic, cadmium, copper, lead, mercury, zinc, chromium was detected in all the samples analyzed.

Keywords: sugar mill, effluent, heavy metal, physicochemical properties

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INTRODUCTION

In India, there are 571 sugar mills and is the major agro-industry in the country which produced 24.5 million tons of sugar during 2010-11. About 500 tons of industrial wastes (liquid and solid) are discharged daily from sugar factory during crushing season as Pressmud, boiler ash and distillery waste water (Arain *et al*., 2004). Pressmud is a solid waste by-product of sugar-mill and about 3% produced from total quantity of cane crushed. Pressmud is a rich source of organic carbon, NPK and other micronutrients (Rakkiyapan *et al*., 2001). Several studies have been conducted on Pressmud for its suitability to use in agriculture and for energy production (Yadav, 1992; Partha *et al*., 2006; Pradeep *et al*., 2007; Singh *et al*., 2007; Kalaivanan *et al*., 2008, Joshi *et al*., 2010; Gupta *et al*., 2011). The purpose of this study was to investigate the sugar mill effluent samples availability of some heavy metals.The huge demand for freshwater resources in the 21st century can be attributed to population growth, advanced agricultural practices and industrial usages (Samuel, 2012). So the need to know about the physicochemical properties of the samples is essential to get an idea about the properties of sugar mill effluent. Sugar mill contains high BOD and COD values (Saranraj and Stella, 2012).

Environmental pollution has been recognized as one of the major problems of the modern world. The problem of environmental pollution on account of essential industrial growth is, practical terms, the problem of disposal of industrial water, whether solid, liquid or gaseous. All three types of wastes have the potentially of ultimately polluting water (Barman *et al*., 2000; Kisku *et al*., 2000). Use of industrial effluent and sewage sludge on agricultural land has become a common practice in India as a result of which these toxic metals can be transferred and concentrated into plant tissues from the soil. These metals have damaging effects on plants themselves and may become a health hazard to man and animals. Above certain concentrations and over a narrow range, the heavy metals turn into toxins (Babich *et al*., 1982). The sugar industry is playing an important role in the economic development of the Indian sub-continent, but the effluents released produce a high degree of organic pollution in both aquatic and terrestrial ecosystems. They also alter the physicochemical characteristics of the receiving aquatic bodies and affect aquatic flora and fauna.

The main objectives of the present study were to know the physicochemical and biological properties of the isolated samples and concentrations of various heavy metals present in the samples.

EXPERIMENTAL SECTION

Soil, Sludge and Effluent samples were collected from the effluent treatment plant of a sugar mill at Madurai, India and the physicochemical properties of the sugar mill effluent was analysed. Heavy metals present in the samples were also detected and their concentrations were calculated. Flame atomic absorption spectrometry (FAAS) was used for the analysis. Micronutrients like sodium, potassium, calcium, magnesium and carbonates, bicarbonates were also detected and their concentrations were calculated.

RESULTS AND DISCUSSION

The physicochemical properties of the effluent samples were analyzed. The pH, EC, micronutrients like sodium, potassium, calcium, magnesium, carbonates and bicarbonates are tabulated as seen in Table-1. Sugar mill effluent collected from Cuddalore was brown in colour and acidic in nature. High amount of calcium, magnesium, chloride, sodium, potassium, sulphate, nitrogen, phosphorous and toxic heavy metals like zinc, lead, copper and manganese were recorded in sugar mill effluent (Saranraj and Stella, 2012).

Table 1: Physicochemical properties of the samples

Parameters	Effluent in	Effluent out	Sludge	Soil
pH	5.7	7.1	7.6	6.9
EC (dS/m)	1.26	1.46	2.3	3.83
Sodium (ppm)	82.8	65.4	83.3	-
Potassium (ppm)	36.7	20.5	83.4	3615(Kg/ha)
Calcium (meq/100g)	8.48	7.28	10.48	16.4
Magnesium (meq/100g)	0.50	0.37	1.08	5.76
Carbonates (me/L)	Absent	Absent	Absent	NA
Biocarbonates (me/L)	4.2	4.0	11.2	NA
Bulk density (gm/cc)	-	-	-	0.6
Organic carbon (%)	-	-	-	4.62
Available Nitrogen (Kg/ha)	-	-	-	87.6
Available Phosphorus (Kg/ha)	-	-	-	34
Texture	-	-	-	Loamy sand

Heavy metal concentrations of the samples

The heavy metals like arsenic, cadmium, copper, lead, mercury, zinc, chromium were found in the samples (Table-2, Figure-1). The concentration of zinc was found to be almost equal in all the samples. Lead was present in the least amount in the sample got from effluent out. Copper, cadmium, chromium, arsenic were found in almost the same concentrations throughout. Mercury was however found in the least concentration in the soil sample.

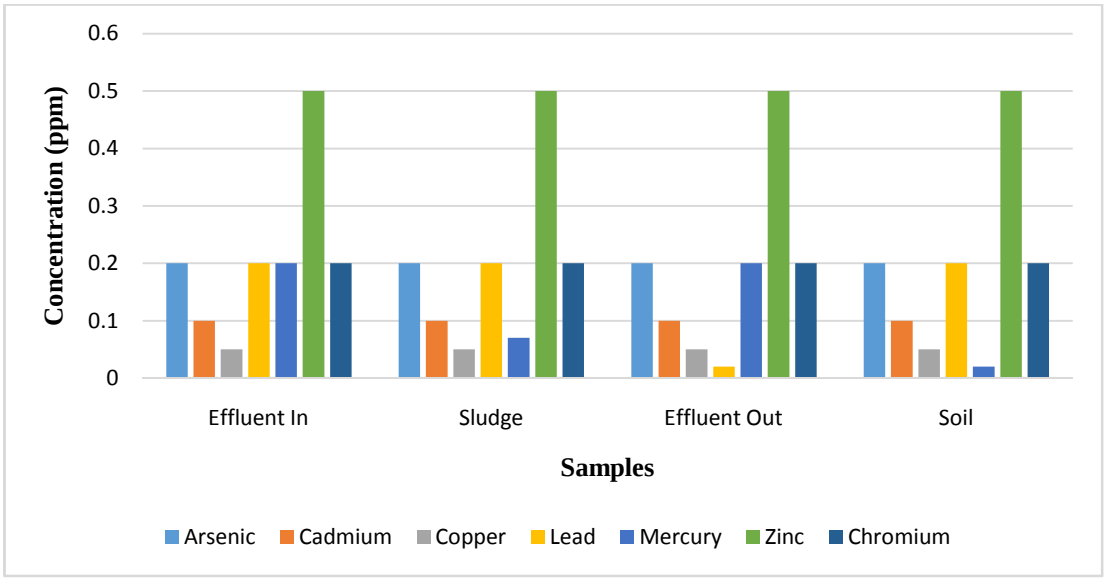

Figure 1: Comparison of heavy metal concentrations in samples

Table 2: Heavy metal concentration of the samples

Heavy Metal / Sample	Soil	Effluent In	Sludge	Effluent Out
Arsenic	0.2ppm	0.2ppm	0.2ppm	0.2ppm
Cadmium	0.1ppm	0.1ppm	0.1ppm	0.1ppm
Copper	0.05ppm	0.05ppm	0.05ppm	0.05ppm
Lead	0.2ppm	0.2ppm	0.2ppm	0.02ppm
Mercury	0.02ppm	0.2ppm	77ppb	0.2ppm
Zinc	0.5ppm	0.5ppm	0.5ppm	0.5ppm
Chromium	0.2ppm	0.2ppm	0.2ppm	0.2ppm

CONCLUSION

The present study has shown that sugar mill effluent has slightly elevated levels of toxic heavy metals and is not fit for irrigation or for other methods of disposal without carrying proper remedial measures.

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