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RESEARCH ARTICLE

PHYLLANTHUS EMBLICA - A REMEDY FOR DISTILLERIES EFFLUENT TREATMENT

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ABSTRACT

The waste water discharged from distilleries unit after processing is called distilleries effluent. In a developing country like India distilleries have become a major source of pollution as 88% of its raw materials are converted into waste and discharged into the water bodies, causing water pollution. Though there are many methods to treat polluted waste water and effluent biobased treatment is considered to be the best because of its low cost and simplicity. Hence an attempt was made in this study to treat distillery effluent with plant material. The distillery effluent was collected from M/s. Trichy Distilleries Chemicals Pvt Limited, located in Senthaneerpuram, Tiruchirappalli and its physicochemical characters were analysed by standard methods. Before treatment the sample was undesirable in its physicochemical and biological properties. Distillery effluent treated with *Phyllanthus emblica* wood altered the physicochemical properties. The results suggest that the effluent after treatment with *Phyllanthus emblica* can be used for agricultural purpose particularly for irrigation.

INTRODUCTION

Organic waste waters are potent sources of water pollution. Various organic waste waters that are known to cause serious problems may be attributed to distillery effluents, pulp and paper effluents, textile effluents, and tannery effluents, among others. Among these types, distillery waste water is highly charged with organic matter, which when dumped into water sources without treatment or with inadequate treatment, causes serious pollution and its associated hazards. Among two very important raw materials that are used in distillery units are cane sugar molasses and beet sugar molasses. Cane sugar is produced in abundance in tropical and subtropical countries. Most of the sugar produced in temperate climates is from beets (Basu 1975). Sugar factory is one of the most important agro based industry in India. India is the largest sugar producing country in the world. The sugar industry plays an important role in India's economy. It is the second largest industry in the country (Waqar *et al.,* 2012). India occupies second position in the sugarcane production in the world. In Tamil Nadu, there are 35 sugar factories and distilleries with a total installed capacity of 2.4 lakh kiloliters of alcohol production. Distillery effluent, a liquid waste from the distillery industry is of plant origin contains large quantities of soluble organic matter and plant nutrients.

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In the distillery industry, for every liter of alcohol produced, about 15 L of spent wash is released as waste water (Joshi *et al.,* 1996). Distillery effluent is rich in major and minor plant nutrients. Some of these are No_3 – N, 819.6 mg/litre; P, 121.6 mg/litre; K, 2649 mg/litre; Ca, 1519 mg/litre; Mg, 700 mg/litre; Zn, 3.6 mg/litre; Cu, 8.1 mg/litre; Fe, 87.4 mg/litre and Mn, 9.4 mg/litre. Use of such enriched byproduct of sugar industries could promote crop yield without any adverse impact on soil health if crop specific dilution is maintained and managed for a particular environment (Jagdale and Sawant 1979). The main final products of sugar cane industry are crystalline sugar and bio-ethanol. The latter is obtained from the fermentation and distillation of sugar cane juice and molasses. Quantitatively, the most significant by-product is bagasse, the solid residue from sugar cane after juice extraction and stillage called vinnasse or dunder, the liquid waste effluent after the distillation process of sugar cane juice (Kolhe *et al.,* 2000). In a developing country like India distilleries have become a major source of pollution as 88% of its raw materials are converted into waste and discharged into the water bodies, causing water pollution (Nandy *et al.,* 2002). The untreated effluent was directly released to soil and it causes major problem in the environment. The most important toxic component of distillery effluent is dissolved solid, chlorides, sulphates and a high percentage of dissolved organic as well as inorganic matter (Joshi 1999 and Ganesan Selladurai *et al.,* 2010). Molasses contain distilleries effluent's dark colour and it obstructs photosynthesis and cause adverse effect on aquatic life (FitzGibbon *et al.,* 1998). Due to the presence of putriciable organics like indole and other sulphur compounds, the

molasses spent wash that is disposed in canals or rivers produces obnoxious smell (Mahimaraja and Bolan 2004). In addition, sugar factory effluent discharged in the environment poses a serious health hazard to the rural and semi-urban populations that use stream and river water for agriculture and domestic purposes (Baruah 1993). In addition, the effluent flows through the gaps in the soil stratum and reaches the ground water table, which may cause potential risk to human health as well as the surrounding environment (Grisak and Pickens, 2009). Also, the phenol compound released from distilleries cause human diseases like diarrhoea, dark urine, mouth sores and burning of the mouth (Collins *et al.,* 2005).

There are several different methods for treatment of distillery effluent. They are: Physico-chemical treatment, biological treatment, aerobic treatment, anaerobic treatment, enzymatic treatment; two stage anaerobic treatment, activated sludge treatment and clarification & filtration (Rani 2013). Each method has its own advantages and disadvantages. Using herbal approaches to reduce water pollution may be cost effective and simpler than other synthetic methods (Aneez ebrahim *et al.,* 2011). In this study, Phyllathus emblica wood was chosen to treat the distillery effluent. Phyllanthus emblica belongs to the family Euphorbiaceae. Phyllanthus emblica is known as Indian gooseberry. This species is native to India and also grows in tropical and subtropical regions including Pakistan, Uzbekistan, Srilanka, South East Asia, China and Malaysia (Prabodh Shukla *et al.,* 2012). Most of the plant materials are available throughout the year at low or no cost. Phyllanthus emblica has several classes of secondary metabolites (Raghu and Ravindra 2010). It is used as antiinflammatory and antipyretic agent by the rural population and for treating several disorders such as scurvy, cancer and heart diseases and antineutrophilic. It has an antiviral, antibacterial, antiplatelet, antimutagenic, antiallergic, antiproliferative activities and gastroprotective (Chatterjee *et al.,* 2011). The dried branches of Phyllanthus emblica were found to be more effective in purifying turbid water whereas the non-dried branches showed little effect (Moramudali 1999).

MATERIALS AND METHODS

Five liter effluent was collected from M/s. Trichy Distilleries Chemicals pvt. Limited, Senthaneerpuram, Tiruchirappalli, Tamil Nadu. The effluent was collected from selected site of distillery in polythene bottles and was kept in room temperature till use. The samples were collected in the month of February, 2014. The samples were immediately brought to the laboratory to assess various physicochemical and biological characters. Temperature and pH of the effluent were recorded at the time of sample collection, by using thermometer and pocket digital pH meter respectively. While other parameters such as hardness, chlorides, alkalinity and nitrate were estimated in the laboratory by standard methods as prescribed by APHA, (1998). Biological characteristics of the collected distillery effluent was analyzed as per standard methods.

Preparation of plant material

Good quality dried Phyllanthus emblica (Nellikattai) wood were collected from local shop (Nattu Marunthu Kadai) Tiruchirappalli. Wood was cleaned and dried under shade. The coat from the wood was removed. Fine powder was prepared by using mortar and pestle and this powder was stored in an air tight container and this was used for further study.

Treatment with Phyllanthus Emblica

Distillery effluent sample for study purpose was collected from M/s. Trichy Distilleries Chemicals Pvt. Limited, Senthaneerpuram. Treatment was given directly to the waste water by using Phyllanthus emblica wood powder at a concentration of 50g/L and the treatment is for a period of a month. The physicochemical and biological parameters were checked before and after treatment at 7 days interval.

RESULTS

The collected distillery effluent was analysed for physicochemical parameters before and after treatment with Phyllanthus emblica. The results revealed that the colour of the distillery effluent was dark brown before treatment but after treatment with Phyllanthus emblica the colour became light brown (Table 1 and 2). The odour and taste of the distillery effluent remains same before and after treatment with Phyllanthus emblica (Table 1 and 2). Before treatment the temperature of distillery effluent was 32°C but after treatment with Phyllanthus emblica it was raised and at the end of 28th day the temperature was 34°C (Table 1 and 2). Before treatment the pH of the distillery effluent was 3.5 but after treatment the pH was raised gradually and at the end of the 28th day the pH 7.0 was (Table 1 and 2).

Table 1. Physical Characteristics of the Distillery Effluent Before Treatment

S.No	Parameters analysed	Physical character
1	Colour	Dark Brown
2	Odour	Alcoholic
3	Taste	Sweet
4	Temperature	32^{o}C
5	pH	3.5

The alkalinity was found to be 1200mg/L before treatment (Table 3), after treatment with Phyllanthus emblica, it was reduced and on 28th day it was found to be 550 mg/L (Table 4). The acidity was found to be 110mg/L before treatment (Table 3), but after treatment the acidity was increased gradually and on 28th day it was found to be 400mg/L (Table 4). The total hardness was found to be 304mg/L before treatment (Table 3) and after treatment with plant material, the total hardness got reduced day by day and on 28th day it was found to be 100 mg/L (Table 4). The calcium content was found to be 120mg/L before treatment (Table 3), after treatment it was reduced and at the end of 28th day the calcium content was to 80 mg/L (Table 4). The magnesium content was found to be 184mg/L before treatment (Table 3) and after treatment it was reduced gradually and on 28th day it was found to be 70 mg/L (Table 4). Initially the chloride content was 199mg/L (Table 3), but after treatment it was reduced and on 28th day it was 50 mg/L (Table 4). Before treatment the DO content was 8 mg/L (Table 3), after treatment it was reduced and on 28th day it was found to be 3 mg/L (Table 4). The BOD content was 12 mg/L before treatment (Table 3), after treatment the BOD content

Table 2. Physical Characteristics of the Distillery Effluent after Treatment with Phyllanthus Emblica

S.No	Prameters analysed	Duration and physical character				
		1st Day	8th Day	15th Day	21st Day	28th Day
1	Colour	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown
2	Odour	Alcoholic	Alcoholic	Alcoholic	Alcoholic	Alcoholic
3	Taste	Sweet	Sweet	Sweet	Sweet	Sweet
4	Temperature	30°C	33°C	33°C	34°C	34°C
5	pH	3.42	4.53	5.79	6.10	7

Table 3. Chemical Characteristics of the Distillery Effluent Before Treatment

S.No	Parameters analysed	Chemical character (mg/L)
1	Alkalinity	1200
2	Acidity	110
3	Total hardness	304
4	Calcium	120
5	Magnesium	184
6	Chloride	199
7	Dissolved oxygen (DO)	8
8	Biochemical oxygen demand (BOD)	12
9	Chemical oxygen demand (COD)	10

Table 4. Chemical Characteristics of the Distillery Effluent after Treatment with Phyllanthus Emblica

S.No	Parameters analysed	Duration and chemical character (mg/L)				
		1st Day	8th Day	15th Day	21st Day	28th Day
1	Alkalinity	920	880	740	680	550
2	Acidity	110	220	280	370	400
3	Total hardness	262	230	200	182	100
4	Calcium	160	130	120	100	80
5	Magnesium	132	110	102	82	70
6	Chloride	139	120	99	79	50
7	Dissolved oxygen (DO)	7	6	4.5	4	3
8	Biochemical oxygen demand (BOD)	9	7.5	6	5.4	4
9	Chemical oxygen demand (COD)	8	6.5	5	4.1	3

Table 5. Biological Characteristics of the Distillery Effluent before and after Treatment with Phyllanthus Emblica

S.No	Sample Code	Before treatment	Duration and Microbial load after treatment (No. of colony)				
			1st Day	8th Day	15th Day	21st Day	28th Day
1	TDE	Innumerable	200	140	110	100	60

was reduced gradually and on 28th day it was 4 mg/L (Table 4). Before treatment the COD content was found to be 10 mg/L (Table 3), but after treatment it was reduced and on 28th day it was 3 mg/L (Table 4). Before treatment the distillery effluent had innumerable microbial colonies but after treatment with Phyllanthus emblica, the number of microbial colonies got reduced gradually. At the end of 28th day the number of microbial colonies was only 60 (Table 5).

DISCUSSION

Initially the colour of distillery effluent was found to be dark brown and it could be due to presence of a derivative of caramelized sugar termed melanoidin formed during the process of distillation (Ramachandra and Pandey 2000). Colour is very a important factor for aquatic life for making food from sun rays. The photosynthetic activity is found to be reduced due to dark coloration. Dark colour will affect other parameters like temperature, DO and BOD (Waqar *et al.,* 2012). Molasses contain distilleries effluent's dark colour and it obstructs photosynthesis and cause adverse effect on aquatic life (FitzGibbon *et al.,* 1998).

Due to the presence of putriciable organics like indole and other sulphur compounds, the molasses spent wash that is disposed in canals or rivers produces obnoxious smell (Mahimaraja and Bolan 2004). Odour of the distillery effluent was offensive. Odourous compounds from distillery waste water mainly consist of volatile fatty acids such as butyric and valeric acids that have a high odour index**.** Distillery effluent has distinct organic compounds. Various anaerobic bacteria ferment these compounds and generate products such as volatile fatty acids for example glycerol which is fermented into butyric acid by Clostridium butyricum (Collins *et al.,* 2005). Distillery effluent is rich in major and minor plant nutrients. Use of such enriched byproduct of sugar industries could promote crop yield without any adverse impact on soil health if crop specific dilution is maintained and managed for a particular environment (Jagdale and Sawant 1979).

Initially the pH of the distillery effluent was acidic in nature i.e. 3.5 and it became neutral (pH 7) 28 days after treatment with Phyllanthus emblia wood. Phytochemicals of the Phyllanthus emblia wood would have reacted with the organic matter of the effluent and brought the pH to neutral. (Goodwin

et al., 2001) also showed pH range from 3.5 to 5.0 in distillery effluent treated by Upflow sludge blanket filter reactor (USBR). The temperature of untreated effluent was recorded as 32^0C in this study and it was 30^0C one month after treatment. This reduction in temperature may be due to the plant materials action on the effluent. 28 days after treatment the temperature was raised to 34^0C and the reason could be the raise in temperature of the environment (February to march). But Goodwin *et al.,* (Goodwin *et al.,* 2001) reported 40^0C and 38^0C before and after treatment. Alkalinity was reduced and acidity was increased which was evidenced by pH. According to Sathish *et al.,* (2012), alkalinity at varying distance during winter season is of the order 83 to 90 mg/L.

Magnesium and calcium was reduced after treating the distillery effluent with Phyllanthus emblia. Again this reduction may be due to the action of the chemicals of Phyllanthus emblia wood on the organic matter of distillery effluent. The total hardness was high in an untreated effluent and after treatment it was dereased (Farid Ansari *et al.,* 2012). The phytoconstituents of the Phyllanthus emblia wood may the reason for the removal/lowering of total hardness. The most important toxic component of distillery effluent is dissolved solid, chlorides, sulphates and a high percentage of dissolved organic as well as inorganic matter (Joshi *et al.,*1996 and Ganesan Selladurai 2010). In this present study, the untreated distillery effluent had high amount of salts and minerals. Phyllanthus emblica stem was treated with the effluent and the it was found that the acidic pH became neutral pH initial undesirable color became desirable. Alkalinity was reduced and acidity was increased. Total hardness, magnesium, DO, BOD, COD and chloride was decreased after treatment with Phyllanthus emblica wood but calcium level was increased. Initially but latter reduced to $1/3^{rd}$ and the reason could be the action of secondary metabolite's of Phyllanthus emblica wood on distillery effluent.

Conclusion

The physicochemical characters of the distillery effluent was assessed and it was found that the distillery effluent was dark brown, turbid and had an offensive odour with alcoholic smell and nature initially. The pH of the effluent was found to be acidic initially and became neutral one month after treatment. The chemical parameters namely COD, BOD, carbonate, total hardness, magnesium and chloride, was high before treatment. Industrial effluent treatment is a most essential one and the methods adopted currently are difficult and very costly. Hence an eco friendly biobased method was tried in this work. From the preliminary results of this study it is evident that Phyllanthus emblica treatment could be an effective means of distillery effluent treatment thereby it can control water pollution.

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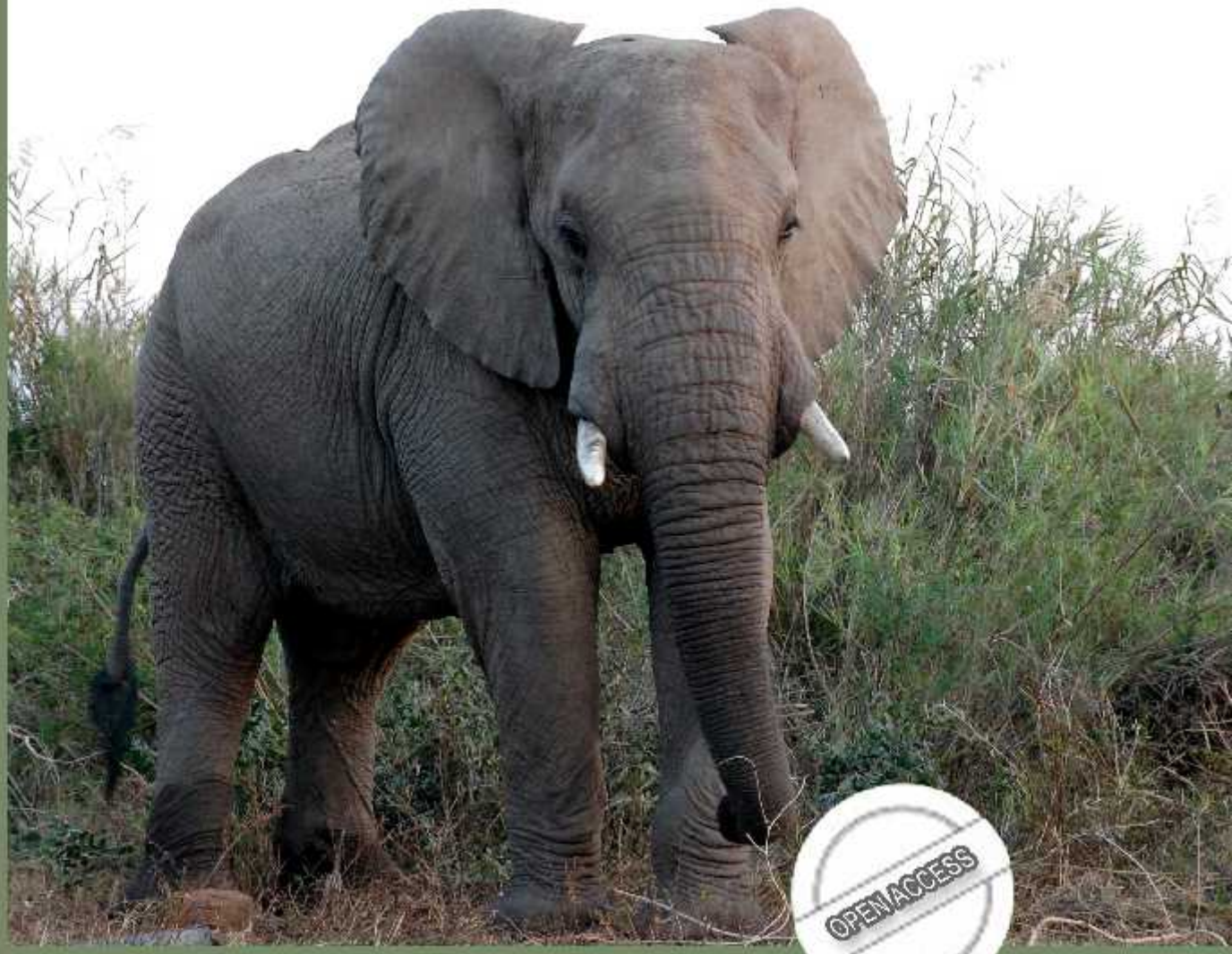

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