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EFFECT OF BREWERY WASTEWATER DISCHARGE ON SURFACE AND GROUNDWATER QUALITY

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ABSTRACT

The brewing industry is one of the largest users of water. An attempt was made to study the impact of brewery wastewater discharge on surface and ground water quality thorough piezometer study and analyzing the Narugampally river water situated near the brewery. Piezometer study was conducted at United Breweries Ltd., Palakkad, Kerala under field condition. During rain fed cropping the leachate was collected due to high amount of precipitation. The SAR of piezowater samples ranged between 1.24 to 2.54 and RSC varied from -0.17 to -0.33. Monitoring of river water quality of Narugampally river was conducted for different seasons of a year. Water samples were drawn from upstream and downstream of discharge points of effluent. The quality parameters are getting diluted in the downstream in all the seasons. The quality parameters are within the safe level as prescribed by the Kerala State Pollution Control Board (KPCB). The coli form bacteria were recorded (1-2 MPN 100 mL^{-1}) during monsoon seasons due to run off and possibility of mixing of sewage water.

INTRODUCTION

The brewing industry is one of the largest users of water. Even though substantial technological improvements have been made in the past, it has been documented that approximately 3 to 10 litres of waste effluent is generated per litre of beer (Genner, 1988). An investigation was conducted to assess the water quality of Narugampalli River situated near UBL. One of the major environmental issues associated with the disposal of brewery wastewater is water pollution. The brewery effluent finds its way to the water bodies and due to its organic load, the oxygen budget in the receiving water body is depleted and can lead to decline of aquatic life. The indiscriminate disposal of brewery effluent in the soil may result in accumulation of salts and will lead to groundwater pollution as a result of leaching due to the presence of high concentration of sodium in the effluent (Abida and Harikrishna, 2008).

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MATERIALS AND METHODS

The treated brewery wastewater discharged into the Narugampally River in the Palakkad district was collected and analysed as per the standard methods (APHA, 1980). Two sampling stations were selected for the study. Sampling was carried out from the streams designated as upstream of effluent discharge point and downstream of effluent discharge on the water quality. Both the stations were located about 0.5 km from the effluent discharge point.

Installation of piezometers

Before installation of piezometers, a soil core of more than 50 mm diameter to the depth of 1.65 m was completely removed by employing mechanical driller or soil auger. Then, the piezometer of above structure was vertically placed in the empty soil column. The quartz particles with more than 2 mm size were packed in the sides of the empty column up to the height of just above the top of perforated portion and then a small portion was sealed with wetted white cement. After few minutes while the white cement sets, river sand was packed up to the height of just below the soil surface. Again, the unfilled portion just below the soil surface was sealed with wetted white cement. The piezometers were observed for the leachate collection at 30 days interval and also during rainy days. The collected leachate was analysed for cations and anions as per the standard procedure.

RESULTS AND DISCUSSION

Impact of Brewery Wastewater on Narugampally river water quality

The river water quality of the Narugampally was analysed at different season's viz., pre monsoon, monsoon and post monsoon. During these periods, the different water quality parameters viz., turbidity, colour, pH, EC, TDS, DO, BOD, COD, nitrate, phosphate, sulphate, chloride, Na, K, ca, Mg, Cr (VI) and total coli forms were analysed at two stations i.e., upstream 0.5 km and downstream 0.5 km of the discharge of the effluent. The results of the water quality measurement are summarized in Table 1. Wide variations were observed in the two stations. The monsoon season significantly increased the colour at 125 Pt. Co. and 130 Pt. Co. and turbidity at 19 NTU and 17 NTU was recorded in the upstream and downstream, respectively. Neutral pH were recorded in all the seasons. The EC ranged between 0.7 to 0.9 dS m-1 in all the seasons at the two streams. The total dissolved solids was more in downstream (281 and 225 mg L^{-1}) when compared to upstream (292 and 235 mg L^{-1}) in monsoon and post monsoon respectively. The dissolved oxygen and chemical oxygen demand of the river water sample recorded maximum of 2-4 mg L^{-1}. The same trend was recorded in the cations and anions ranges of nitrate (1-5 mg L^{-1}), sulphate (8-12 mg L^{-1}), phosphate (2-3 mg L^{-1}) and potassium (21-28 mg L^{-1}). But sodium recorded high in post monsoon season at upstream and downstream of 85 and 112 mg L^{-1} respectively. The chloride content was more in pre monsoon season at 62 and 72 mg L^{-1} in upstream and downstream, respectively. With reference to Ca and Mg content, the post monsoon sample recorded the highest value in upstream (46 and 22 mg L^{-1}) and downstream (52 and 25 mg L^{-1}) respectively. The Cr (VI) content was nil in all the stations. The total coliform count in monsoon season was 2 (MPN 100 mL^{-1}). In all the other seasons, the total coliforms were nil. All other physico-chemical and biological parameters including heavy metals were within the recommended limits in all stations. This is in line with findings of Abida begum and Harikrishna (2008) who reported that the impact of brewery wastewater on the quality of Cauvery river water in Mandiya district. He also recommended that apart from continuous collection of effluents for monitioring purposes, automated measuring and monitoring equipment are to be installed to check discharge parameters against stipulated standards for drinking water, aquatic life and other uses.

Impact of Brewery Wastewater on the quality of leachate collected from 1.0 m depth Piezometers

Piezometer study conducted under field condition during brewery wastewater irrigation revealed that there was no leachate collection. During rainfed cropping the leachate was collected due to high amount of precipitation (Table 2).

The slight increase in pH might be due to neutral to slight alkaline and continuous release of exchangeable bases viz., Ca, Mg, Na and K into the soil solution and subsequent leaching. Corroborative results were reported by Sridharan (2007) who stated that application of distillery spentwash to maize gradually increased the pH of the leachate as the number of leachings increased. However, the pH values were within the safe limit of 7.31 to 7.92 which indicated that the groundwater is suitable for both irrigation

Table 1. The water quality parameters of the river Narugampally under different seasons

Parameters	Unit	Upstream*			Downstream*			WHO Standards
		Pre monsoon	Monsoon	Post monsoon	Pre monsoon	Monsoon	Post monsoon	
Turbidity	NTU	4	19	8	6	17	7	-
Colour	Pt. Co.	80	125	92	85	130	88	201
pH	-	7.2	7.8	7.5	7.4	7.6	7.1	7-8.5
EC	dS m^{-1}	0.41	0.45	0.34	0.38	0.44	0.38	-
TDS	mg L^{-1}	258	281	225	242	292	235	500-1500
Dissolved Oxygen	mg L^{-1}	4	3	4	3	4	2	5-6
BOD	mg L^{-1}	2	3	3	3	3	3	28-30
COD	mg L^{-1}	12	16	10	18	11	20	-
Nitrate	mg L^{-1}	3	1	3	5	2	3	20
Phosphate	mg L^{-1}	2	BDL	BDL	3	2	3	-
Sulphate	mg L^{-1}	8	10	12	10	11	12	42-45
Chloride	mg L^{-1}	62	40	51	72	38	65	200-600
Sodium	mg L^{-1}	78	65	85	92	84	112	200
Potassium	mg L^{-1}	21	23	25	22	26	28	75-200
Calcium	mg L^{-1}	32	29	46	38	31	52	150-200
Magnesium	mg L^{-1}	12	8	22	17	13	25	50-150
Chromium (VI)	mg L^{-1}	BDL	BDL	BDL	BDL	BDL	BDL	-
Total coliform count (MPN)	100 mL^{-1}	absent	2	absent	1	2	absent	-

Pre monsoon – March 2009 to June 2009, Monsoon – July 2009 to October 2009,
Post monsoon – November 2009 to February 2010
*Mean of four months (three samples per month) and statistically not analysed

Table 2. Effect of the residues of brewery wastewater irrigation on physico-chemical characteristics of the leachate: piezometer study

Crop/ Month	Plots	pH	EC (dS m^{-1})	Ca	Mg	Na	K	Cl	HCO_3	CO_3	SAR	RSC
Maize						No leachate collection						
						Crop period - Sunflower 19.05.2009 to 17.08.2009						
May 2009	P_1	7.28	0.28	1.0	0.3	1.0	0.45	0.9	0.83	0.30	1.24	-0.17
	P_2	7.30	0.32	1.1	0.4	2.0	0.30	1.4	0.80	0.31	2.31	-0.39
	P_3	7.35	0.39	1.1	0.4	2.2	0.42	1.8	0.85	0.32	2.54	-0.33
June 2009	P_1	7.28	0.20	0.9	0.5	0.8	0.40	0.4	0.81	0.28	0.96	-0.31
	P_2	7.30	0.30	1.0	0.5	2.0	0.42	1.2	0.90	0.26	2.31	-0.34
	P_3	7.32	0.32	1.1	0.6	2.0	0.45	1.6	0.92	0.31	2.17	-0.47
July 2009	P_1	7.20	0.24	0.9	0.4	1.1	0.30	0.6	0.85	0.30	1.36	-0.15
	P_2	7.24	0.28	1.0	0.5	2.4	0.32	1.4	0.90	0.32	2.77	-0.28
	P_3	7.30	0.35	1.2	0.4	2.9	0.30	1.5	0.91	0.32	3.24	-0.37
August 2009	P_1	7.25	0.21	0.9	0.5	0.9	0.42	0.7	0.90	0.31	1.08	-0.19
	P_2	7.29	0.24	1.2	0.5	2.6	0.38	1.5	0.85	0.26	2.82	-0.59
	P_3	7.32	0.25	1.2	0.5	2.9	0.35	1.6	0.92	0.31	3.15	-0.47
Sesame						No leachate collection						

(All values in meq L^{-1} except pH, SAR and RSC)
P_1 – Control plot; P_2 – 50 per cent brewery wastewater applied plot; P_3 – 100 per cent brewery wastewater applied plot

and recreational purposes as per Indian Standards for industrial effluent discharge (IS: 2490-1982).

The brewery wastewater applied treatments recorded the slight increase in EC than control in all leachings. Residual effect of brewery wastewater irrigation resulted in considerable amounts of cations viz., Ca^{++}, Mg^{++}, Na^{+} and K^{+} in the leachate collected from piezometer of 1m depth. Cooroborative results were given by Nunes *et al.* (1982) who reported the contents of Ca^{++}, Mg^{++} and K^{+} in each perlocate volume tended to increase with increasing rates of vinasse.

The SAR value ranged from 1.24 to 2.54 in the first leaching and gradually got decreased between 1.08 and 3.15 in the fifth leaching. The some amount of Ca and Mg in the leachate supplied through organic amendments might have significantly decreased the SAR of the leachate. Similar results were reported by Anandakrishnan *et al*. (2007) who revealed that the SAR got decreased in the leachate. The SAR values of leachate collected were within the safer limit of <3. The RSC values of the leachate collected at four different leachings showed the negative value indicated that the application of brewery wastewater did not induce any sodium hazard to the groundwater.

In general, EC, anions, cations, SAR and RSC of the leachate collected at fourth leaching were reduced compared to first leachate. This might be due to the fact that brewery wastewater was applied to crop field as continuous irrigation to the first crop and also the salt present in the brewery wastewater might get diluted through the intermittent rain water. There was no marked difference in the water quality parameters of the leachate collected at four different intervals due to the brewery wastewater irrigation to the crop.

CONCLUSION

Monitoring of river water quality of Narugampally river was conducted for different seasons of an year. Water samples were drawn from upstream and downstream of discharge points of effluent. The results indicated that the quality parameters getting diluted in the downstream in all the seasons. The quality parameters are within the safe level as prescribed by the Kerala State Pollution Control Board (KPCB). The coli form bacteria were recorded (1-2 MPN 100 mL^{-1}) during monsoon seasons due to run off and possibility of mixing of sewage water.

Piezometer study conducted under field condition revealed that the minimum amount of cations and anions were leached down from the soil irrigated with brewery wastewater. The leachate characteristics indicated that all the chemical parameters are within the prescribed limits. The SAR of piezowater samples ranged between 1.24 and 2.54, and RSC varied from -0.17 to -0.33 with the low value of SAR and RSC in amendment incorporated soil, there is less chances of sodicity hazards in the soil.

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