Full Length Research Paper

Influence of breweries effluent discharge on the microbiological and physicochemical quality of Ikpoba River, Nigeria

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The bacteriological and physicochemical qualities of the Ikpoba River, Benin city was investigated to assessed the extent of pollution of the water due to effluent discharge from the two brewery industries in Benin City. The bacteriological parameters analyzed were total microbial population counts, which had values ranging from 1.0×10^3 to 4.8×10^3 cfu/ml and 1.3×10^7 to 5.7×10^7 cfu/ml for the fungal and bacterial isolates respectively. Total coliform counts ranged from 4.3×10 MPN/100 ml to 38.0×10 MPN/100 ml. Microorganisms isolated include *Sacchromyces cereviceae, Aspergillus niger, Penicillium* sp*., Geotrichum* sp. *Candida* sp*., Proteus* sp. *Staphylococcus* sp*, Escherichia coli, Streptococcus faecalis* and *Bacillus* sp. Physicochemical parameter studies revealed that Ikpoba river though show some parameters whose values are higher than the WHO tolerant levels. Others fall within the WHO acceptable limits. There is, therefore, contamination of the surface water due to the brewery effluent discharged, which could probably be hazardous to human health.

Key words: Brewery effluent discharged, water pollution, heavy metals.

INTRODUCTION

The water resources of our planet, a basic and most important of our existence, are the most threatened aspect in life existence. In 1978, the UN reported consumable water levels at 2.7% of earth's water, with ground water being a major contributor. Present estimates quantify consumable water levels at 1%, ground water levels also being threatened by pollution either directly or indirectly (Davis and Cornwell, 1991). However, sustainable utilization of the earth's water is therefore being defined as the use of water resources which imposes no cost whatsoever on future generations, which might arise through depletion of the resource or through a reduction in its quality (Kehinde, 1996).

Ikpoba River, a fourth order stream, is located in Benin City, Edo State in South Western Nigeria (Lat 6.5^0N, Long $5-8^0$E). Its headwater originates from North West of Benin City and flows north to south through the city

(Benka-Coker and Ojior, 1995). The river flows through a dense rain forest where the allochtonous input of organic matter from the surrounding vegetation is derived through run- off from the surface of the soil. Ikpoba River empties into the Benin River system, the third largest in Nigeria. The river serves as a source of water for domestic purpose including drinking and cooking. Fishing activities also take place in the river. The water body receives a variety of wastes ranging from industrial, agricultural, domestic and natural sources. These wastes introduce foreign microorganisms, organic and inorganic matter, in addition to indigenous microflora. The Oregbeni community flanks the river on one side behind Guinness Nigeria Plc and Bendel Breweries. The products of the brewery operations include large volumes of wastewater, conveyed over a distance of 2.5 km by an underground tunnel and discharged into the receiving river.

Increase industrial activities have led to pollutional stress on surface water both from industrial, agricultural and domestic sources (Ajayi and Osibanji, 1981). Major streams in industrial areas of some Nigerian cities are already seriously polluted by waste from industries while streams flowing through densely polluted areas of Ibadan

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Table 1. Result of physicochemical analysis of Ikpoba River, Nigeria.

Parameters	ST. 1 (EFFLUENT)			ST. 2 (UPSTREAM)			ST. 3 (DISCHARGE)			ST. 4 (100M)			ST. 5 (200M)		
	March	April	May	March	April	May	March	April	May	March	April	May	March	April	May
pH	9.05	8.75	8.81	5.52	5.98	6.15	8.89	8.70	8.51	6.10	6.16	6.93	5.90	5.55	6.00
Water temperature ^{0}C.	35.00	35.00	33.00	24.00	23.00	23.00	32.00	28.00	26.00	24.00	26.00	26.00	25.00	24.00	24.00
Turbidity (F.T.U)	148.00	142.00	138.00	8.02	8.02	12.22	110.00	136.00	114.00	32.00	28.00	16.20	12.00	9.00	11.60
Conductivity (μs/cm)	42.00	39.1	36.00	18.00	12.00	15.00	29.5	32.60	33.00	9.11	8.50	9.00	3.32	5.38	4.00
TDS (mg/1)	21.00	19.00	22.00	2.50	2.60	2.80	19.32	21.69	16.10	6.00	4.90	4.50	2.18	1.96	2.00
TSS (mg/1)	10.40	10.01	12.50	1.40	2.90	1.40	8.25	12.92	5.85	1.68	0.99	1.20	1.47	1.25	1.35
TS (mg/1)	31.40	29.10	34.50	3.90	4.50	3.20	25.57	34.61	22.95	7.68	5.58	5.70	3.65	3.21	3.35
COD (mg/1)	956	1211	823	18.00	15.00	8.00	753	617	775	22.00	20.00	14.00	20.98	15.22	10.90
DO (mg/1)	5.50	5.48	5.62	6.18	6.80	7.18	7.20	6.80	6.18	7.80	7.46	6.88	6.95	6.24	7.80
BOD$_5$ (mg/1)	610	524	689	3.80	2.80	1.00	422	408	321	1.46	2.11	1.21	1.12	1.38	0.80
Total alkalinity (mg/1)	42.00	38.00	35.00	11.00	11.02	12.00	24.00	23.00	25.55	12.11	13.02	14.82	11.80	11.11	12.00
Phosphate (mg/1)	0.25	0.36	0.27	0.05	0.04	0.04	0.23	0.28	0.15	0.16	0.15	0.10	0.14	0.11	0.06
Nitrate (mg/1)	5.48	6.13	5.96	0.8	0.72	0.59	4.52	5.11	4.62	0.97	0.92	0.80	0.91	0.68	0.64
Calcium (mg/1)	31.90	27.99	27.95	7.40	4.80	7.00	21.60	22.99	25.27	11.72	13.49	11.56	11.10	13.90	12.80
Magnesium (mg/1)	13.10	11.01	12.05	3.60	3.20	5.00	10.40	7.41	9.73	8.28	9.51	8.44	6.90	7.10	7.20
Total hardness (mg/1)	45.00	39.00	40.00	11.00	8.00	12.00	32.00	30.40	35.00	20.00	23.00	20.00	18.00	21.00	20.00

ST. = Station.

Table 2. Result of microbiological analysis of Ikpoba River, Nigeria.

Parameters	ST. 1			ST. 2			ST. 3			ST. 4			ST. 5		
	March	April	May	March	April	May	March	April	May	March	April	May	March	April	May
Total fungal count x 10^3 cfu/ ml	4.80	4.2	3.20	0.19	0.15	0.10	2.80	2.7	2.40	4.80	4.2	3.201	0.13	0.14	0.12
Total bacteria count x 10^7 cfu/ ml	5.70	4.8	3.70	0.016	0.016	0.010	3.3	3.0	2.8	0.046	0.041	0.038	0018	0.014	0.013
E. coli x 10MPN/100ml	21.0	19.0	15.0	2.9	2.2	2.0	19.3	16.8	12.0	4.4	4.0	3.9	3.6	3.1	2.3
Total colifrom x 10 MPN/100 ml	38.0	32.0	24.0	7.1	5.9	4.7	24.0	23.0	21.0	7.5	5.8	4.7	6.1	5.8	4.3
Streptococcus x 10 MPN/100 ml	130.0	110.0	130.0	21.00	18.0	15.0	110.0	110.0	21.69	47.0	45.4	46.0	44.0	45.1	38.0
Clostridium perfringens x 10 MAV/10 ml	23.0	20.0	21.0	2.0	1.9	1.4	21.0	18.1	12.92	2.8	2.3	1.5	2.0	1.9	1.3

ST = Station

are heavily polluted with domestic sewage (Ajayi and Adeleye, 1977). The Ikpoba River in Benin City receives a variety of wastes ranging from industrial, agricultural and domestic to natural waste. This paper reports the effect of breweries effluent discharge on the microbiological and physicochemical qualities of Ikpoba River, Benin City, Nigeria.

MATERIALS AND METHODS

Source of samples

Wastewater sample for bacteriological analyses were collected from five sampling stations along the course of the river, fortnightly between March 2004 and May 2004.

Station 1 is along the drainage pipe, 50 m to the point of discharge into the river; Station 2 is up stream; station 3 is the point where the waste from the two breweries enters the river; and stations 4 and 5 are 100 and 200 m down stream of station 3. The samples were collected in new sterile 5 liters plastic containers. Samples for BOD and DO were collected separately in presterilized bottles. The oxygen was fixed *in situ* by the addition of 1.2 ml each of Winkler's solution A and B. All samples were transported to the laboratory and analyzed within 6 hours of collection. Microbiological parameters monitored include total viable aerobic count for heterotrophic bacterial and fungal, total coliform counts, *Escherichia coli* counts, *Streptococcus faecalis* counts and *Clostridium perfringens* counts according to the methods of Gerhardt et al. (1994). The isolation and identification of bacterial and fungal isolates were carried out in accordance with Bergey's Manual of Determinative Bacteriology (Buchanan and Gibbons, 1974), Gerhardt et al. (1994) and Barnett and Hunter (1972). The physicochemical parameters studied were pH, water temperature, conductivity, turbidity, total dissolved solids total suspended solid, total solids, chemical oxygen demand, biological oxygen demand, total alkalinity, phosphate, nitrate, calcium, magnesium and total hardness. All the physicochemical parameters were studies in accordance with standard methods (APHA, 1993).

RESULTS

The physicochemical and microbiological parameters of Ikpoba River, Benin City were studied from March to May, 2004. The choice of months of the year was to examine the effect of setting out and setting in of dry and rainy seasons. Water temperature varied from 23 to 35°C and the pH was between 5.55 and 9.05. Stations 1 and 3 shows high concentrations of calcium 21.60 – 31.90 mg/l, stations 1 and 2 shows low concentration of magnesium, which increased in stations 3 to 5. Stations 1 and 3 show high nitrate concentrations, while the phosphate concentration was low in all stations sampled. There was gradual decrease in conductivity, hardness, total alkalinity, COD, BOD from March to May (Table 1). Station 1 recorded the highest values, which decreased along the sampling stations.

Data in microbiological properties of Ikpoba River are presented in Table 2. At stations 1 and 3 the total heterotrophic bacterial recorded was high in March to May and thereafter decreases along the sampling

stations. Stations 1 and 4 also recorded high fungal population. The population of total coliforms in all water samples obtained from the river was generally high (Table 2). The total coliform population was lowest (4.3 x 10 MPN/100 ml) in May at station 5 while the highest density (38.0 x 10 MPN/100 ml) was recorded in March at station 1. Dry season months March to April recorded the highest coliform population in stations 1 and 3. Similar trend was noted in population densities of faecal *Streptococci* and *C. perfringens* in all the sampling stations. The population of *E. coli* in all the water-sampling stations was moderate but significantly lower than that of coliforms. Ten microorganisms were isolated; this includes five bacterial isolates and five fungal isolates.

DISCUSSION

This research has showed the various effect of breweries effluent on the bacteriological and physico-chemical parameters of Ikpoba River. There was an observed increase in most of the parameters studies with little fluctuations in some of the parameters. The introduction of wastewater, high in organic matter and essential nutrients brings about changes in the microflora (Rheinheimer, 1991). The heterotrophic bacteria and aerobic pathogenic bacteria make up the total bacterial load of river systems. Sayler et al. (1975) reported that high microbial population in an aquatic system is a reflection of the input of microorganisms from extraneous sources and availability of growth supporting organic matter. Anson and Ware (1974) noted that high counts of bacterial load reflected the level of water pollution as it gave indication of the amount of organic matter present. These findings are agreeable with the results of the effect of breweries discharge into Ikpoba River, Benin City, Nigeria in this study.

Comparatively low microbial counts were observed at stations 2, 4 and 5 for both bacterial and fungal population (Table 2). This indicates the dilution effect of the flowing river. Anson and Ware (1974) attributed this to the flushing action of deep water and also this site of the river is not surrounded by trees and therefore is exposed to bactericidal effect of sunlight. Okoronkwo and Odeyemi (1985) reported similar findings. The relatively high counts obtained in stations 1 and 3 could be attributed to the incidence of human activities such as defecation, washing and bathing in station 3 and the high organic matter of the breweries effluent at station 1.

The presence of total coliforms, *E. coli,* faecal *Streptococci* and *Clostridium perfringens* in the water samples during sampling period indicated faecal pollution of the water. The high densities of these faecal indicator organisms observed at all the stations in March/April is indicative of faecal pollution due to reduced volume of water in river in the late dry and early rainy (wet)

seasons. Akpata and Ekundayo (1978) reported high faecal load with high concentration of *E. coli* in the Lagos Lagoon. The general increase in heterotrophic and faecal indicator organisms in the month of May is an indication that the early rainy season is the period of high risk to the down stream users, since the possibility that other faecal pathogens are washed down in the same manner.

The physico-chemical parameters investigated showed some variation along the sampling stations (Table 1). There were slight variations in the temperature and pH, with the highest recorded for stations 1 and 3. The high temperature values could be attributed to discharges of hot liquor and steam condensates in the receiving water. Nkwodimah (1993) reported that temperature difference at any particular habitat is affected by weather and the extent of shade from direct exposure to sunlight. The high pH value recorded for station 1 could be as a result of the brewery operation, which employs the use of detergents like caustic soda. The conductivity range of the various stations was wide and varied considerably between inhabited and non-inhabited stations. Station 1 showed the highest value and therefore decreases along the sampling stations, probably due to effect of dilution and removal of soluble salts by biological utilization Egborge and Fagade (1999) and Nkwodimah (1985) reported similar results. Station 1 showed high nitrate concentrations, which decreased along the sampling stations. Phosphate concentration was low in all sampling stations. These ions, especially phosphate is limiting nutrients in aquatic ecosystem (Atlas and Bartha, 1993).

There was gradual decrease in DO, BOD, and COD from March to May. Biological activities influence the concentration of oxygen in water in addition to the weather and changes in the physical factors. Photosynthetic processes increased the concentration of oxygen in water, while microbial activities place demand on oxygen levels for their metabolism.

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