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Effects of Industrial Effluents and Municipal Wastes on Water Conductivity and Total Dissolved Solids, Sulphate and Phosphate Ions Concentration of Ogba River, Benin City, Nigeria

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Abstract: The effects of industrial effluents and municipal wastes on the Water Conductivity (WC), the Total Dissolved Solids (TDS), the Sulphate (SO_4^{2-}) and Phosphate (PO_4^{3-}) ion concentrations of Ogba River, Benin City, Nigeria were studied. There were significant differences ($p<0.05$) in the values of WC and TDS of the river sampled at four stations [Waterworks (1), Off-Trade-fair Center, (2) 50m to Drainage Point (3) and Drainage Point (4)] and recorded between September 2004 and April, 2005. Whereas the values of SO_4^{2-} varied significantly ($p>0.05$) according to the months sampled (September-April), no such significant variations were recorded due to the sampled stations. The highest value of SO_4^{2-} (0.19±0.02 mg L^{-1}) was recorded in March, while those of PO_4^{3-} (0.58±0.03 mg L^{-1}), WC (66.63±0.23 µS cm^{-1}), TDS (30.57±0.15 mg L^{-1}) were recorded in January. The least mean value of SO_4^{2-} (0.07±0.02 mg L^{-1}) was recorded in January while the least value of PO_4^{3-} (0.27±0.01 mg L^{-1}) was recorded in April. Both the least values of WC (33.41±0.15 µS cm^{-1}) and TDS (15.80±0.80 mg L^{-1}) were recorded in February. The trend in the seasonal variations of WC and TDS values of the river indicates that there is a functional parity between the two water quality parameters owing to the contamination of the river with industrial effluents and municipal wastes. The high TDS values of the river at the drainage point in September might be due to a build-up of solutes arising from the inflow of effluents, wastes and surface run-offs caused by increased rainfall. The range of PO_4^{3-} values (0.12±0.01 to 0.59±0.04 mg L^{-1}) between the dry and wet seasons (January to September) were within comparable limits with the results of other workers recorded in the River Niger. The accumulation of SO_4^{2-} and PO_4^{3-} ions at Stations 3 and 4 than at Stations 1 and 2 might have resulted in some adverse effects on the physical, chemical and biotic components of the river. This might be the reason why no fishes were found in those areas.

Key words: Ogba river, industrial effluents, water conductivity, total dissolved solids, sulphate, phosphate

INTRODUCTION

The increasing industrial and agricultural activities arising from man's sophisticated technology have introduced many synthetic and organic wastes into the aquatic environment (Ogbeibu and Ezenara, 2002). These industrial effluents and municipal wastes end up in aquatic ecosystems through surface run-offs and direct discharge from waste-generating industries. The increasing emphasis on the improvement of the quality of aquatic systems and the monitoring of surface waters has highlighted the need to know what factors cause environmental deterioration (Ozmen *et al*., 2006). Pollution of water sources due to xenobiotics may play a major role in the decline of aquatic animals. Increasing awareness of the adverse effects of anthropogenic activities and pollution on aquatic environment has focused interest on health of fish populations and possibilities to utilize these health parameters for assessment of the quality of aquatic environment (Henry *et al*., 2004).

The Ogba River, Benin City, Nigeria is one of the rivers that receive effluents and sewage from the city. The Edo state Government of Nigeria constructed a drainage which empties effluents and sewage from the city into the river. Prior to the construction, the river was used for fish culture between the waterworks and the drainage point (Obasohan pers. com.); and the aftermath of this construction was a collapse of the fish culture activities headed by Mr Obasohan. Vega *et al*. (1996) stated that wastes (whether industrial or municipal) contain significant amounts of organic and inorganic substances that can produce adverse effects on the

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physical, chemical and biotic components of the environment. Victor and Tatteh (1988) reported a reduction in fish diversity associated with the discharge of municipal wastes and industrial effluents into the Ikpoba River, Benin City, Nigeria. Fufeyin (1998) investigated the heavy metal concentration in some dominant fish in Ikpoba reservoir, Benin. He observed that substances discharged into the reservoir were fatal to fish; while the discharged organic matter were transformed to such products as nitrites (0.20 mL L^{-1}) and ammonia (0.012 mL L^{-1}): which in such low concentrations were fatal to fish (Post, 1987). Egborge (1991) reported that the increasing level of industrial activity in Nigeria has created a growing awareness for rational management of aquatic resources and the control of wastes discharged into the environment. The quality of our water bodies has been degraded to such an extent that care must be taken not to worsen the situation. Against this background, this study was designed to investigate the effects of industrial effluents and municipal wastes on the water conductivity, the total dissolved solids, the sulphate and phosphate ion concentrations of the Ogba River, Benin City, Nigeria. The essence was to ascertain the consequences of the contamination of the river with wastes on the status of these four water quality parameters of the river.

MATERIALS AND METHODS

Four sampling stations were selected along the Ogba River course in Benin City, Nigeria for the study (Fig. 1). These stations which include: The Waterworks, Off-Tradefair Centre, 50 m to Drainage point and Drainage point are located north-west of Benin. The river within this area is shallow and makes the passage of boats and canoes difficult. Owing to this difficulty, no fishes were collected during the study.

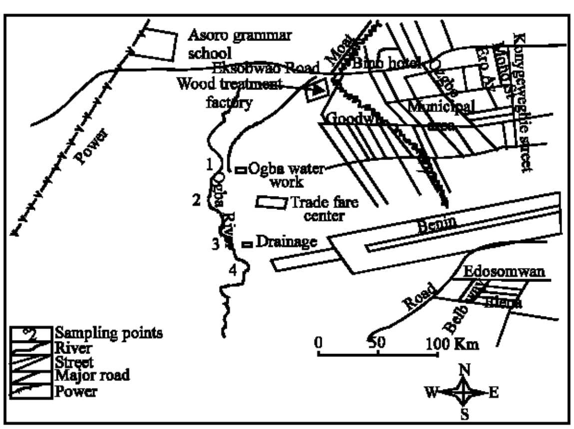

Fig. 1: Map showing the sampling point

Water samples were collected in September, January, February, March and April 2004/2005. The months of January to March corresponded with the dry season of the year while April and September corresponded with the beginning and the peak of rainfall, respectively. Water samples were collected in triplicates for each of the water parameters [Water Conductivity (WC), Total Dissolved Solids (TDS), Sulphate ions (SO_4^{2-}) and Phosphate ions (PO_4^{3-})] tested and transported to the Department of Chemistry, University of Ibadan, in collaboration with 'SOILAB', Ring Road, Ibadan, Nigeria for analysis. Clean dry 1 L wide-mouthed transparent glass bottles with Teflon covers were used to collect samples. The samples from each station were collected at a depth of 30cm. The glass bottles were appropriately labeled with sample location, date and time of collection.

The electrical conductivity (WC) values of the water samples were determined in the laboratory with the aid of a Hatch conductivity meter. The Total Dissolved Solids (TDS) were tested with 100 mL of water samples placed in 250 mL reagent bottles and shaken thoroughly. Each sample was passed via a filter paper into an evaporating dish; and both the dish and filter paper were heated for 4 hours in a Gallenkamp oven at 80°C until dryness was achieved. The dish and its contents were subsequently cooled in a desiccator and weighed in a top-loading electronic Mettler balance (Model PT 600). This process was repeated many times until a constant weight was obtained.

The Sulphate (SO_4^{2-}) and Phosphate (PO_4^{3-}) ion concentrations of the water samples were determined colorimetrically with the aid of Milton Roy spectronic 2ID spectrophotometer. All the data obtained from these analyses were subjected to Analysis of Variance (ANOVA) to test levels of significance ($p<0.05$) among treatment means (Steel and Torrie, 1990). The Duncan's (1955) Multiple Range Test was employed to partition the differences between treatment means.

RESULTS

The monthly and station values of the Water Conductivity (WC) of Ogba River, Benin City, Nigeria are shown in Table 1, while Fig. 2 and 3 show the graphical representations of the WC values of the river during the period (September to April) and among the four sampled station (Waterworks, Off-Trade-fair Center, 50 m to Drainage and at Drainage). The values of the Total Dissolved Solids (TDS) of the river are shown in Table 2.

The lowest WC value of 12.44±0.04 μS cm^{-1} was recorded in September (Station 3) while the highest value of 60.27±0.26 μS cm^{-1} was recorded in March (Station 4)

Table 1: Water conductivity (µS cm^{-1}) values of Ogba river, benin city contaminated with industrial effluents and municipals wastes

Months of the year 2004/2005	Sampling stations 1	2	3	4	Monthly mean ($\bar{x}$)	Unit
September	13.34±0.005^{a}	15.12±0.04^{b}	12.44±0.04^{c}	172.61±0.22^{d}	53.38±0.09	µS cm^{-1}
January	56.22±0.21^{a}	53.07±0.22^{b}	76.13±0.24^{c}	81.11±0.23^{d}	66.63±0.23	µS cm^{-1}
February	45.61±0.21^{a}	29.18±0.12^{b}	31.36±0.14^{c}	27.49±0.14^{d}	33.41±0.15	µS cm^{-1}
March	34.53±0.16^{a}	48.23±0.22^{b}	51.45± 0.24^{c}	60.27±0.26^{d}	48.62±0.22	µS cm^{-1}
April	32.45±0.15^{a}	41.16±0.16^{b}	47.31±0.15^{c}	52.23± 0.21^{d}	43.29±0.18	µS cm^{-1}
Station mean ($\bar{x}$)	36.43±0.11	37.35±0.15	43.74±0.16	78.94±0.21		µS cm^{-1}

* 1= Waterworks, 2 = Off-Trade-fair Centre, 3 = 50m to Drainage point, 4 = Drainage, * F-value (monthly) = 3.26 ($p<0.05$). * F-value (Station) = 3.49 ($p<0.05$). Numbers in the same row and followed by different superscripts differ significantly ($p<0.05$)

Table 2: Total dissolved solids (mg L^{-1}) of Ogba river, benin city contaminated with industrial effluents and municipal wastes

Months of the year 2004/2005	Sampling stations 1	2	3	4	Monthly mean ($\bar{x}$)	Unit
September	6.62±0.03^{a}	7.54±0.02^{b}	6.26±0.03^{a}	86.65±0.18^{c}	26.77±0.06	mg L^{-1}
January	24.50±0.14^{a}	21.12±0.13^{b}	31.23±0.16^{c}	45.42±0.17^{d}	30.57±0.15	mg L^{-1}
February	21.56±0.12	12.55±0.06	16.15±0.05	12.95±0.04	15.80±0.15	mg L^{-1}
March	17.31±0.14^{a}	22.42±0.13^{b}	26.16±0.14^{c}	32.12±0.17^{d}	24.50±0.15	mg L^{-1}
April	16.14±0.13^{a}	25.41±0.21^{b}	23.53±0.20^{c}	27.44±0.22^{d-}	23.13±0.19	mg L^{-1}
Station mean ($\bar{x}$)	17.23±0.11	17.80±0.11	20.67±0.10	40.92±0.16		mg L^{-1}

* 1= Waterworks, 2 = Off-Trade-fair Centre, 3 = 50m to Drainage point, W = Drainage point, * F-value (monthly) = 6.24 ($p<0.05$), *F-value (Stations) = 12.56 ($p<0.05$). * Numbers in the same row and followed by the same superscripts are not significantly different ($p>0.05$); numbers in the same row and followed by different superscripts differ significantly ($p<0.05$)

Table 3: Sulphate concentration (mg L^{-1}) of Ogba river, benin city, nigeria contaminated with industrial effluents and municipal wastes

Months of the year 2004/2005	Sampling stations 1	2	3	4	Monthly mean ($\bar{x}$)	Unit
September	0.01±0.00^{a}	0.03±0.01^{a}	0.12±0.02^{b}	0.20±02^{b}	0.11±0.01	mg L^{-1}
January	0.05±0.02^{a}	0.03±0.01^{a}	0.11±0.01^{b}	0.08±0.02^{b}	0.07±0.02	mg L^{-1}
February	0.0.02±0.00^{a}	0.10±0.01^{b}	0.11±0.01^{b}	0.14±0.01^{b}	0.09±0.01	mg L^{-1}
March	0.40±0.02^{a}	0.07±0.02^{b}	0.15±0.01^{c}	0.13±0.01^{c}	0.19±0.02	mg L^{-1}
April	0.02±0.01^{a}	0.06±0.02^{b}	0.09±0.02^{b}	0.10±0.01^{b}	0.07±0.02	mg L^{-1}
Stations mean ($\bar{x}$)	0.11±0.01	0.06±0.01	0.12±0.01	0.13±0.01		

1 = Waterworks, 2 = Off-Trade-fair Centre, 3 = Close to Drainage, 4 = Drainage, F-value (monthly = 1.43 ($p>0.05$), F-value (station) = 0.43 ($p>0.05$). Numbers in the same row followed by the same superscripts are not significantly different ($p>0.05$). Numbers in the same row followed by different superscripts differ significantly ($p<0.05$)

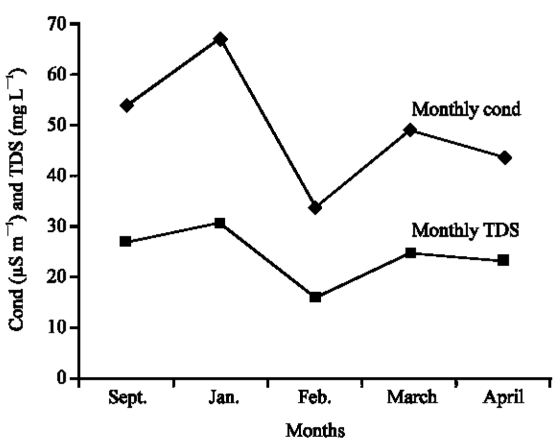

Fig. 2: Monthly conductivity (Cond.) and Total Dissolved Solids (TDS)

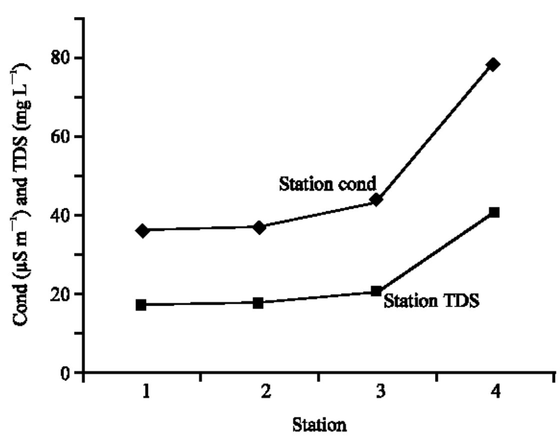

Fig. 3: Station conductivity and total dissolved solids

(Table 1, Fig. 2 and 3). The monthly WC values, however, indicated that February recorded the least value (33.41±0.15 µS cm^{-1}) while January recorded the highest value (30.57±0.15 mg L^{-1}) (Table 2, Fig. 3). Station 1 (Waterworks) recorded the least mean TDS values (17.03±0.11 mg L^{-1}) within the study period (September to April); while Station 4 (Drainage) recorded the highest

Table 4: Phosphate concentration (mg L^{-1}) of Ogba river, benin city, nigeria contaminated with industrial effluents and municipal wastes

Months of the year 2004/2005	Sampling stations 1	2	3	4	Monthly mean ($\bar{x}$)	Unit
September	0.38±0.01^a	0.17±0.02^b	0.48±0.03^c	0.47±0.04^c	0.38±0.03	mg L^{-1}
January	0.51±0.02^a	0.52±0.01^a	0.40±0.03^b	0.59±0.04^a	0.58±0.03	mg L^{-1}
February	0.40±0.01^a	0.55±0.03^b	0.34±0.02^c	0.48±0.03^a	0.44±0.02	mg L^{-1}
March	0.12±0.01^a	0.35±0.02^b	0.42±0.04^c	0.47±0.03^c	0.34±0.03	mg L^{-1}
April	0.22±0.01^a	0.25±0.01^a	0.33±0.02^b	0.28±0.01^a	0.27±0.01	mg L^{-1}
Stations mean ($\bar{x}$)	0.33±0.01	0.37±0.02	0.45±0.03	0.46±0.03		

1 = Waterworks, 2 = Off-Tradefair Centre, 3 = Close to Drainage, 4 = Drainage, F-value (monthly = 6.44 (p>0.05), F-value (station) = 2.56 (p>0.05). Numbers in the same row followed by the same superscripts are not significantly different (p>0.05). Numbers in the same row followed by different superscripts differ significantly (p<0.05)

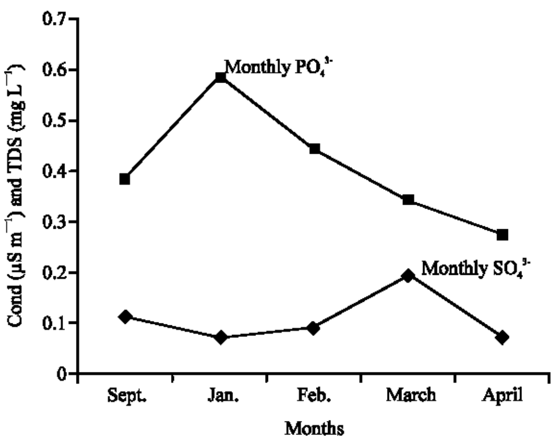

Fig. 4: Monthly suphate and phosphorus concentration (Conc.)

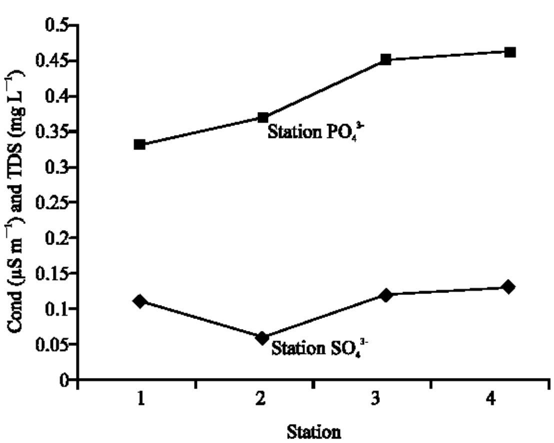

Fig. 5: Station Sulphate and Phosphate Concentration

mean TDS values (40.92±0.16 mg L^{-1}) (Table 2, Fig. 3). The results also showed that significant differences (p<0.05) existed in the TDS values of the river within the study period (September to April) and among the four sampled stations (Table 2).

Table 3 shows the monthly and station values of the Sulphate ion (SO_4^{2-}) concentration of Ogba River, Benin City, Nigeria, (Fig. 4 and 5). These values were recorded between September, 2004 and April, 2004 among the 4 sampled stations (1-4). The values of the phosphate ion (PO_4^{3-}) concentration of the river are also shown in Table 4, Fig. 4 and 5.

The lowest SO_4^{2-} value of 0.01±0.00 mg L^{-1} was recorded in September at Station 1 (Waterworks); while the highest value (0.15±0.01 mg L^{-1}) was recorded in March at Station 3 (50 m to Drainage point) (Table 3, Fig. 4 and 5). The mean monthly SO_4^{2-} value also indicated that January and April recorded the least value (0.07±0.02 mg L^{-1}); while March recorded the highest value (0.19±0.02 mg L^{-1}) (Table 3, Fig. 4). Among the 4 sampled stations along the river course, Station 2 (Off-Tradefair Centre) recorded the least mean SO_4^{2-} value (0.13±0.01 mg L^{-1}) within the study period (September to April); while the highest mean value (0.13±0.01 mg L^{-1}) was recorded at Station 4 (Drainage point) (Table 3, Fig. 5). Statistical analyses of the data obtained indicated that there were no significant differences in the values of the SO_4^{2-} concentration of the river due to the months of water sampling and due to the various stations sampled (p>0.05) (Table 3) (Table 4, Fig. 4 and 5). The mean monthly PO_4^{3-} value however indicated that April recorded the least value (0.27±0.01 mg L^{-1}); while January recorded the highest value (0.58±0.03 mg L^{-1}). Among the four sampled stations, the Waterworks (Station 1) recorded the least mean PO_4^{3-} value (0.33±0.01 mg L^{-1}) between September and April; while the Drainage point (Station 4) recorded the highest value (0.46±0.03 mg L^{-1}). Whereas the values of PO_4^{3-} varied significantly (p<0.05) owing to the period (months) of water sampling, no significant variations in the values of the above ions were recorded owing to the stations sampled (Table 4).

DISCUSSION

The increasing level of industrial activity in Nigeria has created a growing awareness of rational management of aquatic resources and the control of wastes discharged from the environment (Egborge, 1991). Environmental contamination with pesticides more commonly results in chronic exposure of aquatic organisms to pollutants and aspects of the biology of these organisms (including fish) possibly affected include growth and reproduction, both of which are important considerations for fish farmers (Lamai *et al.*, 1999). These authors highlighted the consequences of bio-concentration of pollutants in fish which ultimately get to the consumer. During chronic exposures, fish take up and lose organic pollutants through the gills by passive exchange diffusion with the surrounding water (Holding, 1973; Walker, 1985).

The lowest Water Conductivity (WC) values (12.44±0.04 μS cm^{-1}) (Table 1) of the river recorded 50m to the Drainage point (Station 3) in September, 2004 corresponded with the lowest value of Total Dissolved Solids (TDS) (6.26±0.03 mg L^{-1}) (Table 2) recorded at the same station during the same month. Similarly, the least monthly mean WC value of the river of 33.41±0.15 μS cm^{-1} was estimated for Stations 1-4 in February, 2005 just as the least monthly mean TDS values of 15.80±0.15 mg L^{-1} (Table 2) estimated for the four stations during the same month (Table 2). These results imply that there was a functional parity between the 2 water chemical parameters (WC and TDS) of the river due to its contamination with industrial effluents and municipal wastes. The seasonal variation in the WC values of Ogba River, Benin City as exemplified by the lowest WC value of 12.44±0.04 μS cm^{-1} in September, 2004 (Station 3) and the highest values of 60.27±0.26 μS cm^{-1} in March, 2005 (Table 1) (Fig. 2 and 3) is consistent with report of other workers. Panday *et al.* (2005) reported an increasing trend in the variation of the specific water conductivity of Kaithkola Lake, India from 223.60-278.60 μS cm^{-1} and of Bishurphur Lake, India from 315.30-407.30 μS cm^{-1} between the summer and the monsoon-to-winter seasons. However the lowest TDS values (6.62±0.03 mg L^{-1}) (Station 1), (6.26±0.03 mg L^{-1}) (Station 3) and the highest TDS values (86.68±0.18 mg L^{-1}) (Station 4) recorded in September, 2004 negated the seasonal variation in WC values recorded for the Ogba River, Benin City in this study and those recorded for Kaithkola and Bishurpur Lakes in India by Panday *et al.* (2005). The reason for this anomaly could be attributed to the amount of industrial effluents and municipal wastes that entered the river course at this period. The high TDS values at the drainage end of the river (Station 4) could to due to a build-up of solutes arising from the influx of industrial effluents and municipal wastes occasioned by increased rainfall in September around Benin City and exacerbated by the inflow of surface run-offs of organic wastes and industrial effluents via the Drainage. Similarly, the low TDS values of the Waterworks end of the river (Station 1) in September despite the rains might also be due to the protection of the water inside the Waterworks from direct discharge of industrial effluents and municipal wastes. However, differences in the values of the TDS between Waterworks (Station 1) (6.62±0.03 mg L^{-1}) and 50m to the Drainage point (Station 3) (6.26±0.03 mg L^{-1}) (Table 2) cannot be explained from this study. More research is needed to investigate why relatively lower values of TDS were obtained at 50m to the Drainage point in September than at the Waterworks, despite the obvious propensity for wastes to build up at 50m to the Drainage point of the river than at the Waterworks end.

The range values of SO_4^{2-} concentrations obtained from the four stations during this study (Table 3) indicate that irrespective of season, the sections of the river course 50m to Drainage point (Station 3) (0.09±0.02-0.15±0.01 mg L^{-1}) and the Drainage point (Station 4) (0.08±0.02-0.20±0.02 mg L^{-1}) had higher SO_4^{2-} values than the other stations sampled. The implication of these results is that the incidence of SO_4^{2-} arising from the contamination of the river with industrial effluents and municipal wastes was more pronounced at Stations 3 and 4 than at Stations 1 and 2. The accumulation of this ion after the construction of the drainage system by the Edo State Government might have resulted in some adverse effects on the physical, chemical and biotic components of the aquatic environment. This might explain why no fish species were found especially at the Drainage section of the river. Working on the biological and chemical tools in the toxicological risk assessment of the Jarama River, Madrid, Spain, Vega *et al.* (1996) stated that the contamination of aquatic resources with industrial and municipal wastes resulted in the deterioration of water quality and in the loss of productivity of the natural water. Besides, changes in water quality due to industrialization and technological development are known to affect fish and many benthic communities (Patil, 1976).

The range values of PO_4^{3-} i.e. 0.12±0.01 mg L^{-1} (Station 1) to 0.59±0.04 mg L^{-1} (Station 4) were recorded in the four sampled stations of this study (Table 4). Mackereth (1963) reported that a lake which consistently contains more than 0.15 mg L^{-1} orthophosphate may experience algal bloom. Apart from the PO_4^{3-} value of 0.12±0.01 mg L^{-1} recorded in March at Station 1 (Table 1), all the values recorded during the study were higher than the 0.15 mg L^{-1} value reported by Mackereth (1963) for algal growth. This implies that despite the contamination of the river with industrial effluents and municipal wastes, the PO_4^{3-} component of the river water was generally up to the reported value for aquatic productivity.

Comparing the PO_4^{3-} concentrations of borehole water samples (trace levels) in Onitsha Metropolis Anambra State with those of three rivers {River Niger (0.20-0.85 mg L^{-1}), River Idemili (0.09-0.15 mg L^{-1}) and River Nkisi (trace levels)} transversing the area, Okoye *et al.* (2006) reported that the range values of PO_4^{3-} in the rivers were higher than those of borehole waters. The range values of PO_4^{3-} concentration (0.12±0.01-0.59±0.04 mg L^{-1}) between January and September (dry and wet season) in this study were within comparable limits with the 0.20-0.55 mg L^{-1} PO_4^{3-} recorded by Okoye *et al.* (2006) for the River Niger but at variance with the PO_4^{3-} values recorded for the Idemili (0.09-0.15 mg L^{-1}) and the Nkisi (trace levels) Rivers. Nonetheless, the similarity between the high PO_4^{3-} values recorded during the rainy season in the rivers within the Onitsha metropolis and the Ogba River, Benin City could be attributed to the large volume of surface run-offs entering the aquatic systems. However, increase in industries especially small and medium scale has its own share of waste generation and disposal problem (Ajiwe, 1996). In the case where these are not properly handled, the wastes (domestic and industrial) end up at the very sources of drinking water through direct contact, leaching or seepages to cause pollution. Studies on waste management revealed that most industries still choose the cheapest means, which are not necessarily the most adequate disposal methods (Ajai and Osibanjo, 1981; Martins, 1978; Jegede, 1977). Bottom soils have a large capacity to adsorb phosphorus, but this capacity has limits (Masuda and Boyd, 1994; Boyd and Munsiri, 1996). By reducing phosphorus inputs into water bodies for instance, through proper effluents/wastes treatment, the number of years necessary to saturate the reservoirs' soil with phosphorus can be extended.

CONCLUSION AND RECOMMENDATIONS

The construction of a drainage system by the Edo State Government of Nigeria to empty waste materials from parts of Benin City into the Ogba River was a technological measure adopted by the state government with insufficient scientific considerations of the aftermath of such an action. Although the ever increasing global industrial growth has led to greater concern for a cleaner environment, the methods adopted to ameliorate environmental degradation should be carried out in conjunction with inter-disciplinary consultations, studies and analyses. And although various Environmental Protection Agencies (EPAs), have been established by various state governments, problems of environmental pollution on land and in water still remain unabated. However, the values of PO_4^{3-} concentrations of the river in this study (Table 4) were higher than the 0.15 mg L^{-1} PO_4^{3-} recommended by Mackereth (1963) for algal growth. Similarly, the concentration of SO_4^{2-} (Table 3) fell below the detrimental level of 2.40 mg L^{-1} stated by Hutchinson (1967) for tropical lakes. It is therefore, concluded that despite the contamination of the Ogba River with industrial and municipal wastes, its water is still amenable for aquaculture activities. The only problem is that of silt which come in through effluents and surface run-offs. The state government should therefore construct settling ponds and reservoirs to desilt the water before entering the river. Some aquatic and terrestrial fungi might be introduced into the settling ponds/reservoirs, so that the pollutants might be taken up and broken into harmless residues. The organic matter component of the effluents and municipal wastes could be broken down with time due to self purification of the river (Nwokedi and Obodo, 1993; Ogbeibu and Ezenara, 2002). With these procedures, the lower reaches of the river could be used for fish culture. In addition, the Edo State Government should encourage industries whose effluents are emptied into the Ogba River to install biological and chemical effluent treatment plants to facilitate water treatment before discharge into the river.

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