EFFECT OF EFFLUENT FROM A VEGETABLE OIL FACTORY IN SOUTHEASTERN NIGERIA ON THE *MMIRIELE* STREAM

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ABSTRACT

Environmental monitoring of effluent discharged from a vegetable oil factory and route to receiving Mmiriele stream, Nnewi Anambra State, Nigeria was conducted bi-weekly for 12 months. The physicochemical parameters examined in the effluent assessment were dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total hardness, hydrogen ion concentration (pH), and ammonia-nitrogen. Others were copper (Cu), zinc (Zn), lead (Pb) and arsenic (As). Concentration of each of the parameters at the various sampled points indicated significant variation among the points ($P < 0.05$). Comparing the results to international effluent quality standards for municipal and industrial effluents discharged into surface inland waters and the Federal Ministry of Environment (FMENV) standards for such effluents showed that the mean values of each of the parameters was within acceptable limits except for very high distribution of lead recorded in all samples. Arsenic was notably not detected. The significance of the results is discussed.

Keywords: Vegetable oil factory effluent, Physicochemical parameters, Dissolved metal pollutants

INTRODUCTION

Industrial waste contains toxic substances that damage biological activity and kill desirable forms of life (Suter and Loar, 1992). One of such was as reported by Sandra (2000) and JØorgensen and Johnsen (1989) for industrial waste waters. Very many physicochemical parameters are associated with effluent assessment most of which were considered.

From human health perspective, high levels of elements such as zinc, lead, arsenic and nitrogen are of great concern. For instance, nitrate may cause infant hemoglobinemia or blue-baby syndrome in which the oxygen-carrying capacity is blocked, causing suffocation. Lead is particularly toxic to young children and its hazards include kidney damage, metabolic interference and depressed biosynthesis of protein (Craun *et al.*, 1981; Meybeck, 1982; Meybeck *et al*, 1989). Brown blood disease due to excessive nitrite nitrogen has also been reported in fish (Lovell, 1987).

However, industrial pollutants are difficult to characterize and detailed inventories of industrial wastes are rare. In addition to organic decomposable matter of complex composition with high biological oxygen demand, the waste from industries usually contain traces or larger quantities of raw materials, intermediate products, final products, by-products and processing chemicals. From the above problems associated with industrial pollutants, there is need to monitor waters in which industrial effluents are discharged.

In Nigeria, the Federal Environment Protection Agency (FEPA), now known as the Federal Ministry of Environment (FMENV) was created in 1988. It is charged with the statutory responsibility for overall protection of the environment. Among the guidelines of FMENV is mandatory provision of on-site or contractual industrial pollution effluent monitoring facilities within the set up of any industry (Ugochukwu and Leton, 2004). This law is often breeched. FMENV and State governments' environmental protection agencies (EPAs) are also charged with crosschecking effluent characteristics from factories and companies to ascertain the degree of compliance with the law. Too often, this is not done or is poorly done. The result is that the environment suffers from likely hazardous pollution with effluent discharged from factories.

Against this background, the need for the assessment of a vegetable oil factory effluent which enters the *Mmiriele* stream, Nnewi, used domestically by the people living around it cannot be over-emphasized. There is little or no recorded information on the physicochemical parameters of this body of water. The present study was therefore an independent study conducted to determine the physicochemical parameters of the section of the *Mmiriele* stream into which a vegetable oil factory discharges its effluent. This is to establish some baseline information for this stream.

MATERIALS AND METHODS

Effluents from a vegetable oil factory were properly channeled into the receiving *Mmiriele* steam. Thus, the physicochemical parameters of the effluent that gets into the stream and the stream were monitored. Representative samples were collected from the effluent discharge route of the vegetable oil factory, Nnewi, Anambra States, Nigeria into the *Mmiriele* stream (Figure 1).

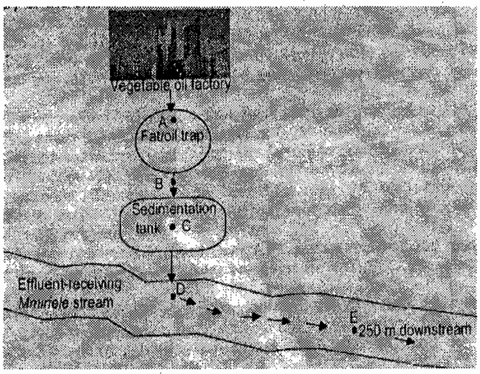

Figure 1: Effluent route from the RIMC vegetable oil factory into the receivin *mmiriele* stream showing sampled points namely; A station for collection of effluen immediately in the oil/fat trap, B oi discharge point station, C station for collection of effluent in the sedimentatio tank, D station for collection of effluent i *mmiriele*, E 250 meters downstream o *mmiriele*, • represents effluent collectio stations indicated by letters, Arrow represent direction of effluent flow.

Additionally, representative samples were collected from the point of entry of the effluent in the stream and from 250 m downstream. Clean dry one litre wide mouthed transparent glass bottles with Teflon covers were used to collect the samples. The glass bottles were appropriately labelled with sample location, date and time of collection. For dissolved oxygen determination, water from the bottle was siphoned through the Winkler dissolved oxygen determination bottle and the water fixed in the field for the azide modification of the Winkler's method using the Hach test kit (Model FF3, Hach Company, Loveland Co., USA). Triplicate sampling unit were used. All samples were preserved at low temperature in ice chest, and analysed within 24 hours of collection. Sampling was done bi-weekly for a period of 12 calendar months. The following physicochemical parameters were determined: dissolved oxygen (DO), biochemical oxygen demand BOD), chemical oxygen demand (COD), ammonia–nitrogen (NH_4-N), hydrogen ion concentration (pH), and total hardness. Other parameters studied include the following heavy metals: copper (Cu), zinc (Zn), lead (Pb) and arsenic. All analyses for biochemical oxygen demand, chemical oxygen demand, total hardness, and heavy metals were done by using the standard methods described in APHA (1976, 1980) and Owen (1974). Most of the characteristics were determined with unfiltered samples except dissolved heavy metals in which filtered samples were used. Values obtained from the stream were compared with Federal Ministry of Environment Standards (FEPA, 1988).

Statistical Analysis: Means and standard error of means of the physicochemical parameters of the different sampled sites were calculated using descriptive statistics. The one way analysis of variance (ANOVA) was employed to test for any significance differences ($P < 0.05$) and the Fisher's least significant differences (F-LSD) and the Duncan's Multiple Range Test were employed to partition the differences of sampled means (Steel and Torrie, 1980).

RESULTS

The results of the mean physicochemical parameter are shown in Table 1. Comparison of physicochemical parameters in the *Mmiriele* stream, Nnewi with the Federal Ministry of Environment Standards is presented in Figure 2. Table 1 showed that the highest mean COD of 720.00 ± 5.94 mgl^{-1} was obtained in the fat trap and the least mean COD of 106.20 ± 2.62 mgl^{-1} was obtained at 250 m down stream. These values were significantly different ($P < 0.05$). The values obtained within the stream were significantly different ($P < 0.05$) from each other and from the values recorded in the fat trap, discharge point and the sedimentation tank.

The mean DO concentration ranged from 1.81 ± 0.06 mgl^{-1} in the fat trap to 6.69 ± 0.07 mgl^{-1} at 250 m downstream. There was significant difference ($P < 0.05$) in the DO values recorded between the all the sampled sites with an upward increase in DO from the factory to downstream of *Mmiriele*.

On the other hand, the concentration of BOD varied from 0.97 ± 0.07 mgl^{-1} in the fat trap to 4.41 ± 0.08 mgl^{-1} in the receiving steam point. There were significant differences ($P < 0.05$) between all sampling points outside the stream but identical BOD values within the stream stations. Also, BOD values within the stream were higher than outside the stream.

The concentration of ammonia-nitrogen ranged from 2.42 ± 0.06 mgl^{-1} at 250 m downstream to 15.30 ± 0.09 mgl^{-1} in the fat trap.

Table 1: Mean distribution of physicochemical parameters along a vegetable oil factory effluent discharge route in Nnewi, Nigeria

Sites	Water quality parameters								
	Chemical oxygen demand (mgl^{-1})	Dissolved oxygen (mgl^{-1})	Biochemical oxygen demand (mgl^{-1})	Ammonia nitrogen (mgl^{-1})	Total hardness (mgl^{-1})	pH	Copper (mgl^{-1})	Zinc (mgl^{-1})	Lead (mgl^{-1})
Fat trap	720.00 ±5.94[a]	1.81 ±0.06[a]	0.97 ±0.07[a]	15.30 ±0.09[a]	18.30 ±0.63[a]	7.53 ±0.02[a]	0.41 ±0.04[a]	0.54 ±0.02[a]	14.38 ±0.17[a]
Oil discharge point	196.00 ±3.57[b]	2.00 ±0.08[a]	1.82 ±0.08[b]	4.68 ±0.06[b]	20.00 ±0.82[b]	6.86 ±0.09[b]	0.46 ±0.05[a]	0.56 ±0.02[a]	15.43 ±0.46[b]
Sedimentation tank	148.70 ±2.27[c]	3.43 ±0.07[b]	2.94 ±0.04[c]	2.62 ±0.04[c]	24.00 ±0.68[c]	6.69 ±0.02[b]	0.47 ±0.04[a]	0.64 ±0.03[b]	16.73 ±0.31[c]
Effluent-receiving stream (*Mmiriele*)	117.30 ±2.36[d]	5.00 ±0.08[c]	4.41 ±0.08[d]	3.67 ±0.06[d]	11.20 ±0.04[d]	6.94 ±0.04[c]	0.31 ±0.06[b]	0.56 ±0.02[a]	14.61 ±0.21[a]
250 m downstream	106.20 ±2.62[e]	6.69 ±0.07[d]	4.28 ±0.09[d]	2.42 ±0.06[e]	16.40 ±0.62[e]	7.29 ±0.06[d]	0.18 ±0.03[a]	0.57 ±0.02[a]	14.68 ±0.29[c]

[1]Mean values in a column followed by the same superscripts are not significantly different (P > 0.05).

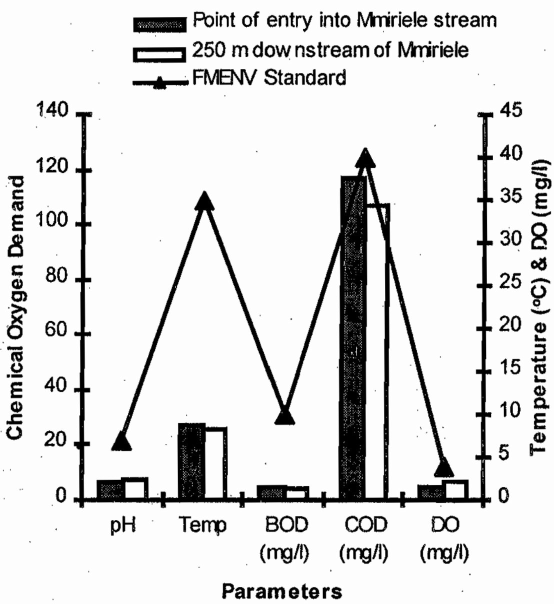

Figure 2: Water quality parameters of Rimco vegetable oil factory effleunts receiving mmiriele stream compared with Federal Minbistry of Environment Standards.

There were significant variations (P < 0.05) in the values recorded for the parameter at all stations sampled.

In addition, the mean values for total hardness ranged from 11.20 ± 0.53 mgl^{-1} in the receiving stream to 24.00 ± 0.53 mgl^{-1} in the sedimentation tank. As with ammonia-nitrogen, there were significant variations (P < 0.05) in the values of total hardness recorded at all stations along the effluent route sampled.

The pH values along the effluent route ranged from 6.69 ± 0.02 pH to 7.53 ± 0.02 pH in the sedimentation tank. For the pH, all points outside the stream were not significantly different but were different form the values of sampling points within the stream. The 250 m downstream station had a significantly different pH value from the pH at the effluent receiving point in *Mmiriele* stream (P < 0.05).

The highest mean value of dissolved copper recorded was 0.47 ± 0.04 ppm in the sedimentation tank and the least value was 0.18 ± 0.03 ppm at 250 m down stream. All points outside the stream were not significantly different (P > 0.05) in values but were significantly different from the values of the stations within the stream. The 250 m downstream station of the *Mmiriele* stream and the effluent receiving station recorded significantly different (P < 0.05) value of copper.

Dissolved zinc concentration ranged between 0.64 ± 0.03 ppm in the sedimentation tank to 0.54 ± 0.02 ppm in the fat trap (Figure 3). The F-LSD separation of means showed that there were no significant difference (P > 0.05) between values recorded in the discharge point of the receiving stream and 250 m downstream but these were significantly different (P < 05) from the values got in the fat trap and sedimentation tank.

The values for dissolved lead differed between 14.33 ± 0.17 ppm in the fat trap and 16.73 ± 0.31 ppm in the sedimentation tank. There were significant variations (P < 0.05) in the values of lead recorded in the effluent route stations (Figure 3). The value in the fat trap station was however not significantly different (P > 0.05) from the values of lead from the *Mmiriele* stream stations. No trace of arsenic was recorded in any of the sampled points.

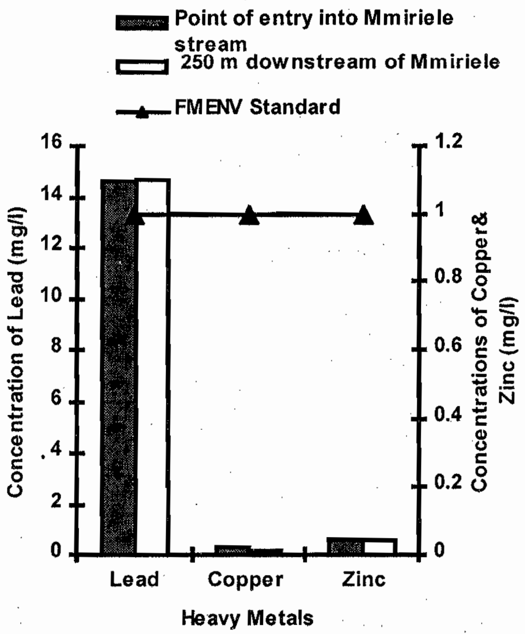

Figure 3: Concentration of heavy metals in the Rimco vegetable oil factory effluent receiving mmiriele stream compared with Federal Ministry of Environment Standards

DISCUSSION

The COD, BOD and DO levels at the point of entrance of the effluent into *Mmiriele* stream and at 250 m downstream compared to International Standards for water (GESAMP, 1988) and the Federal Ministry of Environment standards for municipal and industrial effluents discharge into surface inland waters (Figure 2) showed that the values are within acceptable limits. Maitland (1990) reported that clean cold water holds only about 12 mgl^{-1} of oxygen. Thus the results of DO in *Mmiriele* represent usable oxygen in the effluent. However, high temperature around 30 ^{o}C in Nigeria, not only reduced the amount of oxygen which can dissolve in water, thereby minimizing the oxygen supply available to micro-organisms. Also, increase in the rate at which oxygen is utilized by micro-organisms is exacerbated by the high temperature. According to the traditional dissolved oxygen sag curve, a high rate of oxygen use might result in low or zero dissolved oxygen concentration in a particular stream reach. This would impair the stream's subsequent capacity to received further polluting discharges. Kolo and Yiza (2000) observed that increased organic matter decomposition in water can reduce the BOD to less than 4 mgl^{-1}. As can be seen from the values of BOD in the effluent entry point (4.41 ± 0.08 ppm) and the value at the 250 m downstream (4.28 ± 0.09) the stream was tending to the marginal 4 mgl^{-1} BOD.

In addition, the pH, ammonia-nitrogen and total hardness concentration were within Nigeria Federal Ministry of Environment set guidelines for waste disposal (FEPA, 1988). The source of hardness in the effluents could be through wash-offs from the machines with soap. Whatever source, hardness is an important factor for fish production. The recommended level for total hardness in fish pond is 20 mgl^{-1} (Boyd and Lichtkopler, 1979). The hardness level in this effluent may be adequate for fish production.

On the other hand, the levels of zinc and copper were considerably low while arsenic was notably absent. The level of lead was very high and remained stable throughout the study period. The lead in the stream may be contributed by effluent from either a battery factory located upstream or mobilization from the soil. This high level of lead may have resulted mainly from a lead-acid accumulator (battery) manufacturing activity in the vicinity, and from washings of leaded containers and high traffic density in the stream in this heavily industrialized city. The battery factory is located in the upstream section of the town. The GESAMP (1988) observed that low lead concentration of less than 0.02 mgl^{1} may affect photosynthesis, delay embryonic development, and reduce growth in adult fish, mollusks and crustaceans. Mombeshora *et al.* (1983), however, reported a lower level of lead in their studies of stream and lakes and Ibadan, Nigeria indicating that the level of lead in the *Mmiriele* stream was high indeed.

From the above result it becomes necessary that factory wastes into the aquatic environment be monitored, to put a check on pollution. Furthermore, the quality requirements of water use could be the only constraints governing the choice of stream standards for particular surface water. Although, there was no direct link of lead to the Rimco Vegetable Oil factory, we strongly recommend that the high lead levels in the stream be reduced forthwith through reduced loading of the stream with lead.

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