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Assessment of Asa River: Impact of Waste Discharge from soft drink plant into Asa River, Ilorin. Nigeria

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ABSTRACT: Some physical and chemical analysis was carried out on samples collected at various distances from the effluent discharge from a soft drink plant in Ilorin into Asa River. The pH was found to range between 7.2 – 7.8 with a mean temperature of 25.25°C. Experimental results obtained on replicate samples showed that the standard deviation was generally below 10%. The total organic matter ranged between 21 – 22.9% while the nitrate concentration ranged between 5.81 – 15.41 mg/l; these were high and could lead to eutrophication of the water body into which it empties. The cation and anion concentrations all fall within safe limits except for zinc and in some cases, NO_3^- concentrations which was higher than the standard set by regulatory bodies. A Pearson's correlation study showed correlations between different parameters at both 1 % and 5 % probability levels. @JASEM

Asa River is a major river that practically divides Ilorin city into two as it passes through. It receives effluents from industries located along its course apart from domestic wastes and other activities carried out along it that contributes to it pollution. Apart from the fact that it is aesthetically not okay, rapid growth of water hyacinth could be observed downstream of the effluent discharge point. It is also noticed that those living along the course of the river use the water for some domestic chores including drinking when portable water is not readily available.

Effluent is a waste product, which could be in any of the three states of matter, discharged from boundary of manufacturers to the environment [Bridgewater and Mumfod, 1979]. They are wastes resulting from processes employed in industrial establishments to the environment; they could be re – used after recovery. Water, which has been described by many as the most essential commodity required for man's survival has received enormous environmental abuse. Process industries and sewage systems are particularly guilty of pollution of water systems [Asubiojo et al., 1993]. Drinking water plays a major role in the intake of trace metals in humans [Nkono and Asubiojo, 1999]. The pollution of water brings undesirable changes in the environment [Eniola and Olayemi, 1999], which affects man directly or indirectly. Shortage of pipe borne water has necessitated that man finds solace in surface waters surrounding him; into these water bodies are discharged, wastes from various industries; treated and untreated alike forgetting that in many places, especially along a river, one town's waste water may form part of the next town's water supply [water analysis]. The fact that trace metals in drinking water could lead to a potential health hazard had prompted statutory bodies to establish ceilings for these elements in waters that are to be consumed by man (WHO, 1984 and Asubiojo et al., 1997). Wastewaters from industrial processes represent important point sources of heavy metals and in the last few decades, rapid industrialization has been experienced in the nation. This informed the need to find out the impact of these industrial growths on water bodies and man eventually (Ogunfowokan and Fakankun, 1998}. In this study, a report is made on some physical and chemical characteristics of effluents discharged from a soft drink processing plant in Ilorin city in Nigeria using various analytical techniques.

EXPERIMENTAL

Wastewater samples were collected at various distances from source of waste discharge over twelve months. The polyethylene bottles used for sample collection were first washed, rinsed with dilute nitric acid solution, and rinsed two to three times with some of the water being sampled. Composite samples were prepared and analyzed for some cations and anions. Results got were compared with recommended standards. Samples were refrigerated prior to analysis; Atomic Absorption Spectrophotometer (AAS) was used for cation determinations, gravimetric method was used to determine SO_4^{2-} levels, spectrophotometry method was used to determine PO_4^{3-} and NO_3^- while argentiometric titration was used to determine the Cl^- in the effluent samples.

MATERIALS AND METHODS

Na^+, K^+, $Mg^{2+}$and Zn^{2+} determination: The effluent was analysed using AOAC method. The Atomic Absorption Spectrometer (Phillip PUG100X model) was used for the determination of Na^+, K^+, Mg^{2+} and Zn^{2+}.: Cl^- and SO_4^{2-} determination: The sample was titrated against 0.014 N $AgNO_3$ solution using bromophenol as indicator to determine the Cl^- in the sample. The end point being a persistent blue colour [Merian, 1991]. The SO_4^{2-} concentration was

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determined using gravimetric method. The method described in AOAC was employed. Spectrophotometric determination of PO_4^{3-} and NO_3^-: The AOAC method of determination of phosphorous was used. In this method, the reducing agent used consisted of, sulphuric acid, ammonium molybdate, ascorbic acid and potassium tatarate. A visible spectrophotometer (Spectronic 20D) was used to measure the absorbance at a wavelength of 680nm. The nitrate concentration was determined using Spectronic 20D at 520nm.

RESULTS AND DISCUSSION

The results of the analysis for the quality parameters of the effluent course from the bottling company are presented on table 1. The table reveals the presence of all the ions tested for. The pH was almost neutral for all samples and this falls within the accepted range of 6.0 – 8.5 recommended by WHO [WHO, 1984].

From the standards recommended for industrial effluents, the chloride, sulphate, phosphate magnesium and calcium all fall within the acceptable limit [Merian, 1991]. The zinc level was however above the $1 mg.l^{-1}$ limit recommended in all the samples. The nitrate levels were high through out and, this might not be unconnected with the fact that the drain from the bottling plant is just a depression on the bare ground where irrigation farming is being carried out apart from the fact that a major source of nitrate is, industrial and domestic effluents. Variations of concentration of Zn and NO_3^-, which were found to be high with time, were also shown with the aid of graphs in figures 1 and 2. Fig1 shows the variation of nitrate levels with time. The highest level of 15.41 mg/l is at time six and the lowest level of 5.81mg/l was observed at time ten. Figure 2 shows the variation of zinc with time. The highest level of 5.15 mg/l is also detected at time 6 and the lowest level of 1.61 mg/l was observed at time 3.

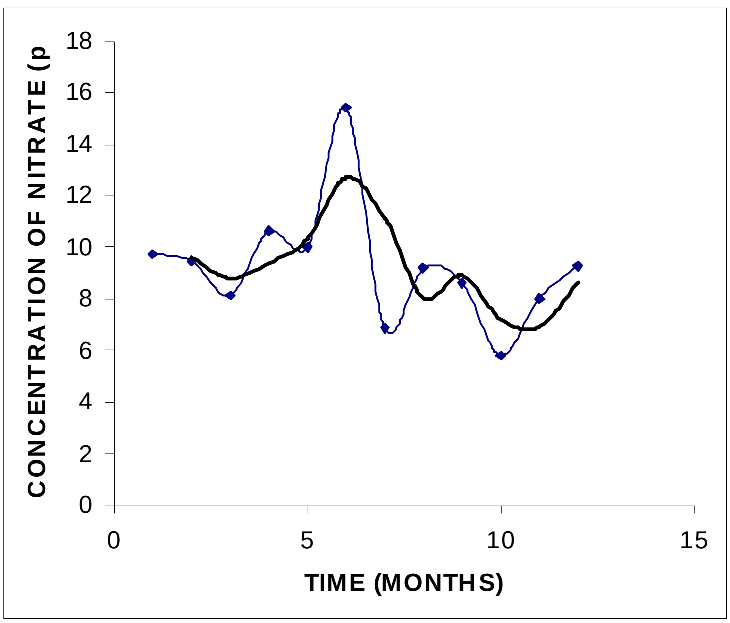

Fig 1: Variation of nitrate ions with time

The fact that there were variations in concentration with time informed the use of the SPSS statistical package to carry out a linear regression analysis in order to find possible associations between the various parameters determined. The result of the Pearson's two-tailed test is displayed on table 2 below. There was significant correlation between time, temperature and sodium at 1 % probability level. Sodium was significantly correlated with phosphate and nitrate at 1 % probability level while, phosphate and nitrate concentrations are also significantly correlated at 5% probability level. Significant correlations are observed between zinc, sodium and phosphate levels at 5 % probability level and between zinc and nitrate concentrations at 1 % probability level. Significant correlations between pairs suggest the same source; in this case the effluent discharge from the soft drink plant. Zinc is a common pollutant, which is widely distributed, in the aquatic environment.

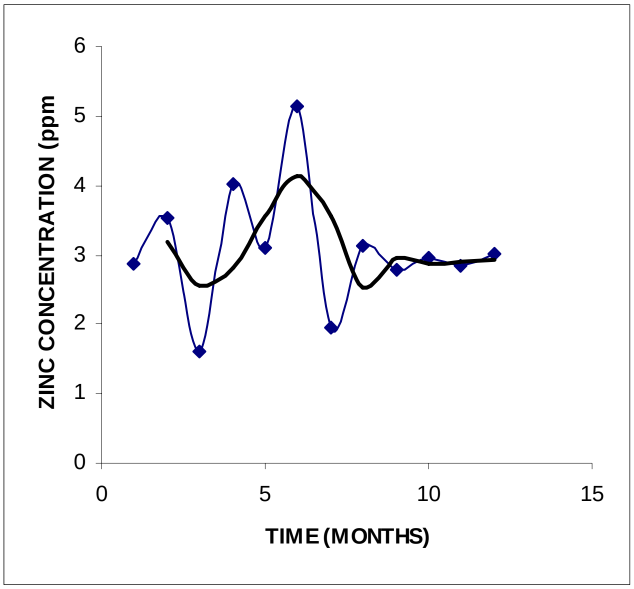

Fig 2: Variation of zinc ions with time

Its source is mainly from weathering of minerals and soils, atmospheric deposition, industrial and domestic effluents [Ogunfowokan and Fakankun, 1998, Merian, 1991]. The aquatic toxicity of Zn and especially its toxicity in fishes have been reviewed and, it has been concluded that, it has a high toxicity to fish even though it has very little effect on man. Zn is likely to have increased detrimental environmental effects as a result of lowered pH [Fatoki et. al, 2002]. The water body into which this effluent is emptied is used for fish farming. Zn, which is not biodegradable, is very lethal to fishes while the nitrate level would encourage eutrophication and therefore reduction in dissolved oxygen levels, leading to fish mortality.

Routine application of fertilizers for agriculture and indiscriminate disposal of both domestic and industrial wastes have been recognized as significant sources of water pollution. The application of fertilizer over time and leaching action might contribute to the high concentration. This might require that farm practice in the area be regulated to forestall a bloom of aquatic plants and subsequent reduction in the dissolved oxygen concentration in the receiving Asa River.

Currently the effluent flows out through a depression on the bare ground from the industry into the receiving Asa River. A proper channeling of effluent from industrial set ups would go a long way in isolating the contents of waste discharges. In this study, the effluent had been collected from the rear of the bottling plant where extensive irrigation farming is being practiced. The fishing activities in the Asa river into which this and other wastes are indiscriminately emptied has dwindled over the years as a result of the near extinction of fishes on the stretch of the river.

Table 2: Correlation between various parameters

parameters	Correlation at 1% level	Correlation at 5% level
Time / Temp	- 0.777	
Time / Na	- 0.713	
Zn / NO_3^-	0.821	
Zn / $PO4^{3-}$		0.590
Zn / Na		0.593
Na / $PO4^{3-}$	0.737	
Na / NO_3^-		0.578
$PO4^3$ / NO_3^-		0.700

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Table1: concentrations of cations and anions in mg /l in effluents discharged from a soft drink plant in Ilorin, Nigeria.

Time	Temp	pH	Ca^{2+}	Zn^{2+}	Mg^{2+}	K^{+}	Na^{+}	Cl^{-}	SO_4^{2-}	PO_4^{3-}	NO_3^{-}
1	27.5	7.5	14.76 ± 1.04	2.86 ± 0.09	32.02 ± 2.34	16.29 ± 1.00	4.19 ± 0.05	54.81 ± 3.82	92.70 ± 8.15	0.21 ± 0.01	9.76 ± 0.58
2	26.0	7.8	24.13 ± 1.31	3.52 ± 0.06	29.05 ± 1.98	18.02 ± 1.12	5.26 ± 0.36	45.91 ± 3.04	29.87 ± 2.03	0.36 ± 0.02	9.48 ± 0.52
3	26.0	7.2	15.03 ± 0.97	1.61 ± 0.07	23.84 ± 1.58	14.64 ± 1.08	2.91 ± 0.03	43.60 ± 1.00	63.86 ± 5.29	0.27 ± 0.01	8.14 ± 0.39
4	26.5	7.6	26.32 ± 1.24	4.01 ± 0.03	30.16 ± 1.62	21.39 ± 1.23	4.73 ± 0.25	35.07 ± 3.91	32.31 ± 2.81	0.33 ± 0.03	10.65 ± 0.85
5	25.0	7.3	31.52 ± 1.20	3.10 ± 0.23	28.80 ± 1.34	15.01 ± 0.98	3.60 ± 0.14	53.20 ± 4.84	64.30 ± 5.36	0.23 ± 0.01	10.00 ± 0.74
6	25.0	7.4	21.09 ± 1.16	5.15 ± 0.26	24.62 ± 1.22	18.35 ± 1.11	4.43 ± 0.15	39.57 ± 3.01	38.71 ± 2.99	0.35 ± 0.02	15.41 ± 1.36
7	26.3	7.4	28.00 ± 1.58	1.95 ± 0.23	24.00 ± 1.35	15.35 ± 1.41	3.12 ± 0.22	31.42 ± 4.05	52.71 ± 7.24	0.12 ± 0.01	6.87 ± 0.81
8	24.0	7.5	16.52 ± 1.30	3.12 ± 0.09	30.36 ± 2.14	25.50 ± 1.05	2.95 ± 0.09	33.80 ± 2.63	67.98 ± 5.66	0.24 ± 0.01	9.20 ± 0.70
9	25.0	7.6	25.73 ± 1.34	2.78 ± 0.11	25.67 ± 1.60	18.61 ± 1.02	3.64 ± 0.13	30.63 ± 2.87	42.01 ± 3.76	0.31 ± 0.02	8.63 ± 0.74
10	25.2	7.4	30.49 ± 2.16	2.95 ± 0.14	27.63 ± 1.82	13.82 ± 0.97	2.69 ± 0.16	47.42 ± 3.67	30.90 ± 2.72	0.13 ± 0.01	5.81 ± 0.46
11	24.0	7.5	19.25 ± 1.37	2.83 ± 0.16	32.16 ± 2.18	17.52 ± 1.27	2.76 ± 0.21	36.48 ± 2.42	50.02 ± 4.83	0.19 ± 0.01	8.02 ± 0.73
12	24.5	7.6	26.41 ± 1.53	3.02 ± 0.31	31.33 ± 2.41	26.38 ± 1.38	2.57 ± 0.26	51.14 ± 4.39	67.73 ± 5.77	0.22 ± 0.01	9.29 ± 1.38

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