JASEM ISSN 1119-8362

Full-text Available Online at
www.ajol.info and
www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *March 2014*
Vol. 18 (1) 99-103

The Effect of Detergent Effluent on the Physico-Chemical Characteristics and Plankton Diversity of Osere Stream, Ilorin, Kwara State, Nigeria

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KEYWORDS*:* Physico-chemical characteristics, Osere stream, Plankon and Diversity

ABSTRACT**:** The physico-chemical properties and plankton diversity were studied in Osere stream, Ilorin, Kwara State, Nigeria from November 2009 to April 2010. Surface water and plankton samples were collected from three sampling stations. High value of Biochemical Oxygen Demand of 8.68mg/L and low value of Dissolved Oxygen of 1.23mg/L at the point of entry than at the upper flow of the stream indicate pollution stress. Also the presence of high abundance of *Anabaena* and *Oscillatoria* sp. which are pollution indicator species shows the negative effect the effluent from the detergent factory has on the stream, thus posing a potential threat to the people who live around and depend on the stream for daily use, hence the need for proper management of the stream. © JASEM

http://dx.doi.org/10.4314/jasem.v18i1.14

Introduction: Water is very important in the daily activities of man. Pielou (1998) asserted that freshwater makes up less than 3 percent of earth's water and is the source of virtually all drinking waters. Some 55 percent of that water comes from reservoirs, rivers, streams and lakes and these sources are vulnerable to pollution. Water applications in human life include; drinking, bathing, cooking, washing, farm and garden irrigation, livestock production, industrial raw materials, transportation, recreation and sport, hydroelectric power generation, building construction, fishery and agriculture (Simmons, 1999; Igbozurike, 1998). Unfortunately, our rivers and streams have been faced with various human activities, which are capable of destroying the quality of waters and organisms in them (Igbozurike, 1998; Simmons, 1999).

Plankton constitutes the foundation of the food web in aquatic ecosystems and represents one of the most direct and profound responses to pollution entering water bodies (Onyema, 2010). These microscopic plants and animals are conveniently qualified as suitable indicators because they are simple, capable of quantifying changes in water quality, applicable over large geographic areas and can also furnish data on background conditions and natural variability (Soberan *et al,* 2000; King and Jonathan, 2003; Abowei and Sikoki, 2005).

The bio-assessment of surface waters is a long practise and involves an analysis of the physico-chemical and biological parameters of a particular water body and comparing such data with known standards (Sharma, 2003). There is a detergent factory located along Osere stream, releasing its waste directly into the stream. This study provides baseline information on the effect of industrial effluent on physico-chemical characteristics and plankton abundance of Osere stream.

MATERIALS AND METHODS

*Study Area****:*** This study was carried out in Osere stream located in Ilorin West Local Government Area of Kwara State, Nigeria (Fig. 1). Osere stream lies between Latitude 8.49 N and Longitude 4.54 E. This stream is the main sources of water for most domestic needs within its locality and is used in the growing of vegetables.

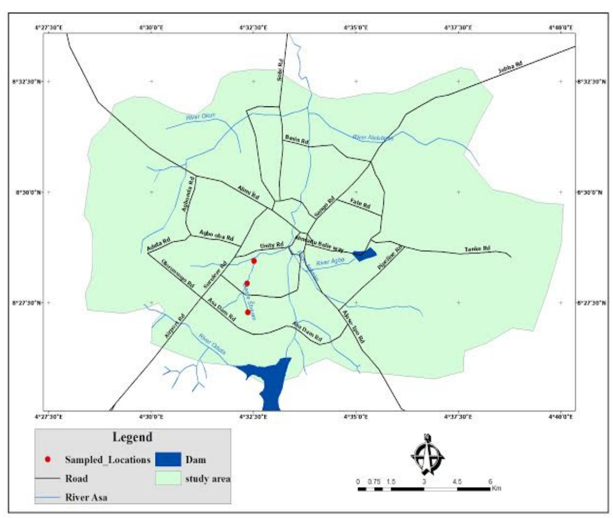

Fig 1: Map of the study area

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Samples Collection: Water samples were collected from three points, namely; the upstream, point of entry of industrial effluent and downstream from November, 2009 to April, 2010. Water samples collected were analysed to determine Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Alkalinity, pH, Nitrate, Phosphate, Sulphate, Chloride and hardness. All physico-chemical analysis were carried out using standard methods according to APHA/AWWA/WEF (1998). Plankton samples were collected using plankton net (55µm) mesh size, just below the surface water. Samples collected were immediately fixed and preserved with 4% formalin. The preserved plankton samples were allowed to settle first and 0.1mL of the sample was withdrawn using a pipette and observed under the microscope. Keys provided by Needham and Needham (1962), Jeje and Fernando (1986; 1991) and APHA/AWWA/WEF (1998) were used for identification of the plankton species. The total number of organisms per millilitre for each sample was determined after counting the number in the 0.1mL sub-sample examined. Cells of phytoplankton were counted.

RESULTS AND DISCUSSION

The results of the physico-chemical parameters measured are shown in Table 1.

Table 1: Mean and standard error of the physico-chemical parameters measured

Parameter	Upstream	Point of entry	Downstream
Temperature (^{0}C)	23.25±0.62	23.50±0.64	22.75±0.75
pH	6.80±0.12	7.15±0.23	7.19±0.23
DO (mg/L)	2.24±2.84	1.23±1.75	2.42±3.20
BOD (mg/L)	3.58±3.16	8.68±0.91	4.64±3.02
COD (mg/L)	5.17±0.17	4.25±0.09	3.65±0.09
Alkalinity (mg $CaCO_3$/L)	31.67±2.39	43.90±3.54	45.00±2.31
Phosphate (mg/L)	.70±0.80	1.32±0.10	1.47±0.06
Sulphate (mg/L)	631.25±83.15	1669.50±57.12	1899.37±22.29
Nitrate (mg/L)	2.72±0.11	3.95±0.09	4.35±0.09
Chloride (mg/L)	1.98±0.60	2.00±0.54	1.98±0.50

Water temperature was within range as stipulated for aquatic organisms. The slightly alkaline values in pH might be caused by the industrial effluent entering the water body. Dissolved oxygen was low, while Biological oxygen demand values were very high at the point of entry and likely pointers to pollution stress in the stream. High organic content from the industrial wastes may be responsible for low dissolved oxygen at the point of entry. Similar reports on organic pollution with reduction in Dissolved Oxygen level include Ogidiaka *et al.* (2012) in Ogunpa River caused by organic rich domestic waste. Nitrate, phosphate and especially sulphate values were high, probably a reflection of the high amount of bio-degradable waste discharges into the stream.

The abundance and diversity of phytoplankton and zooplankton encountered during the study period is shown in Tables 2 and 3.

Plankton abundance in Osere stream varied remarkably. In the upstream, the most abundant phytoplankton was Cyanophyceae 50.74%, followed by Chlorophyceae 29.75% while Protozoa accounted for less than 10%. At the point of entry, the most abundant was Cyanophyceae 44% followed by Chlorophyceae 34% while Protozoa accounted for 10%. In the downstream, Cyanophyceae accounted for 45.97% followed by Chlorophyceae 32.25% while Protozoa was 10.75% (Table 2).

Blue-green algae mainly *Anabaena circularis* dominated the river. *Anabaena*, a filamentous form of blue-green algae was reported to dominate phytoplankton in Lake Rudolf, Kenya (Fish, 1955). It is also reported that *Anabaena sp*. can be found in non-polluted waters (Cander-Lund and Lund, 1995). However, the presence of this species in areas where they are not expected, might be a sign of the enrichment of the water, a term referred to as eutrophication. The current aquatic community structure would likely change with the onset of eutrophication, perhaps altering water quality and rendering the stream unsuitable for human uses as they currently stand. One particular risk of the Cyanophyceae group is the fact that most of the species (especially *Anabaena sp.*) contain toxic substances that can be obvious whenever their blooms occur, especially in hyper-eutrophic ecosystems. They have nitrogen-fixing sites (heterocysts) and are therefore able to fix nitrogen; which means that they can proliferate rapidly. *Anabaena* is, particularly, known to produce neurotoxins that affect the human central nervous system and hepatotoxins that affect human liver (Cander-Lund and Lund, 1995).

Table 2: Relative abundance of Phytoplankton species

Point of collection	Plankton Taxa	Species	No of cells/ml	% Abundance
Upstream	Cyanophyceae	*Anabaena circularis*	1875	13.12
		Aphanacapsa delicatissima	500	3.50
		Coelastrum sphaericum	750	5.25
		Microcystis aeruginosa	625	4.37
		Nostoc planetonicum	500	3.50
		Oscillatoria tenius	1500	10.50
		Phormidium mucicola	1000	7.00
		Spirulina major	500	3.50
	Chlorophyceae	*Ankistrodemus falcatus*	1750	12.25
		Cladophora glomerata	250	1.75
		Closterium setazeum	250	1.75
		Oocystis eremosphaeria	500	3.50
		Secenedesmus quadricauda	750	5.25
		Spirogyra sp.	750	5.25
	Bacillariophyceae	*Chaetoceros affine*	750	5.25
		Coscinodiscus centralis	875	6.12
		Navicula perrottetti	625	4.37
		Synedra fasculata	500	3.50
Point of Entry	Cyanophyceae	*Anabaena circularis*	1750	14.00
		Aphanocapsa delicatissima	500	4.00
		Coelosphaerium kuetzinglianum	750	6.00
		Oscillatoria tenius	1000	8.00
		Phormidium mucicola	500	4.00
		Microcystis aeruginosa	500	4.00
		Spirulina major	500	4.00
	Chlorophyceae	*Ankistridesmus falcatus*	1250	10.00
		Cladophora glomerata	1500	12.00
		Pediatstrum duplex	500	4.00
		Staurastrium limneticum	250	2.00
		Spirogyra sp.	750	6.00
	Bacillariophyceae	*Nitzschia sigmoidea*	1250	10.00
		Synedra fasculata	750	6.00
Downstream	Cyanophyceae	*Anabaena circularis*	1250	10.75
		Aphanizomenon flos-aquae	750	6.45
		Coelosphaerium kuetzinglianum	750	6.45
		Microcystis aeruginosa	500	4.30
		Phormidium mucicola	666	5.72
		Spirulima major	1500	12.30
	Chlorophyceae	*Chaetophora sp.*	1000	8.60
		Cladophora glomerata	500	4.30
		Staurastrium limneticum	750	6.45
		Spirogyra sp.	500	4.30
		Spirotaenia condensate	500	4.30
		Xanthidium fasciculatum	500	4.30
	Bacillariophyceae	*Coscinodiscus centralis*	500	4.30
		Nivacula perrottetti	500	4.30
		Nitzschia sigmoidea	500	4.30
		Synedra fasculata	875	7.52

Table 3: Relative abundance of Zooplankton species

Point of collection	Plankton group	Species found	No/ml	% Abundance
Upstream	Rotifer	*Keratella tropica.*	500	66.7
	Protozoa	*Arcela costata*	375	2.62
		Askenasia volvox	750	5.25
		Euglypha tuberculata	250	1.75
Point of Entry	Rotifer	*Lepadella patella*	375	60
	Protozoa	*Didinium bolbianii*	500	4.00
		Epistylis sp.	250	2.00
		Tokophrya sp.	250	2.00
		Vorticella mayerii	250	2.00
Downstream	Rotifer	*Keratella tropica.*	250	33.3
		Lepadella patella	250	33.3
	Protozoa	*Arcela costata*	250	2.15
		Carchesium sp.	250	2.15
		Spirostomum sp.	250	2.15
		Vorticella mayerii	500	4.30

At the point of entry, green algae, *Cladophora glomerata, Ankistrodesmus falcatus* and blue-green algae, *Anabaena circularis* were dominant. While at the downstream, green algae, *Spirulina major* and *Anabaena circularis,* green algae, *Chaetophora sp*. and *Staurastrium limuticum*, diatom *Synedra fasculata* were dominant. *Spirulina sp*. and *Phormidium sp*. are indicators of the alkaline nature of the river, its high nutrient status and presence of toxic contaminants (Nwankwo, 2004; Vanlandingham, 1982; Nwankwo and Akinsoji, 1992). According to Patrick (1973), communities affected by toxic pollution have a low diversity and low number of species; whereas, a community affected by organic pollutant has a fairly high number of species but low diversity.

Rotifers and Protozoan were encountered during the study period (Table 3). Zooplankton species like *Arcela, Didinium, Vorticella, Epistylis, and Keratella* were recorded but their occurrence was low when compared to those of the phytoplankton. The lower abundance of zooplankton might be explained by high rate of wastes discharges from the surrounding industry into the stream. Probably, this could also be responsible for the absence of fish in the stream.

Therefore, the presence of high pollution indicator species of *Anabaena* and *Oscillatoria*, low Dissolved Oxygen and high Biochemical Oxygen Demand revealed that Osere stream is polluted.

Acknowledgement : We acknowledge the efforts of Ajibade Oluremi and Owonubi Niyi in samples collection.

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