BENTHIC MACRO-INVERTEBRATES AND PHYSICO CHEMICAL QUALITY OF RESERVOIRS IN UNIVERSITY OF IBADAN FISH FARM

Jenyo-Oni, Adetola, Akinwole, A. Olusegun and Dauda, A. Babatunde
Department of Wildlife and Fisheries Management, University of Ibadan, Ibadan, Nigeria

ABSTRACT

The composition and abundance of benthic macro invertebrates and physicochemical parameters of three reservoirs in the University of Ibadan fish farm were studied between June and July 2010 with the aim of investigating the quality of the reservoirs to support fish culture. The three reservoirs that served as sources of water for fish culture on the farm were sampled for six weeks. These reservoirs were improvised seepage fed reservoir; a temporary reservoir along a tributary of Ona river and the mini detention storage. The parameters sampled from the three stations have their means ranged between Temperature 25.25-26.67°C, pH, 7.87-7.94, Dissolved oxygen 3.53-6.54mg/L, Nitrate-nitrogen 45.27-51.56mg/L, Ammonia 0.10-0.25mg/L and Alkalinity 19.24-21.38mg/L. The benthic organisms observed are Melanoides tuberculata, Bulinus globossus,Chironomids sp, Chaetogaster sp, Lumbricus sp,Tubifex sp, Coenagrion mercurial and Gomphus vulgatissimus. The dominant species are the gastropods followed by chironomids. The study shows that the seepage fed reservoir is under slight pollution-stress, while the temporary reservoir and the mini detention storage are healthy water bodies. The water quality of all the reservoirs is suitable for culture of tropical freshwater fish species.

Keywords: Benthic macro invertebrates, Reservoirs, Physico-chemical parameters and Water Quality.

Introduction

Water is a vast natural resource of social and economic benefit to man especially when it is properly utilized. Over the years, man has been impounding water for various purposes such as domestic water supply, irrigation, hydroelectric power generation, fish production and recreation (Mustapha, 2006). Ordinarily, some changes are inevitable in the ecology of lake with time (Araoye and Jeje, 1990). The greatest change with respect to impact is the one caused by human activities generating waste which must be discharged. Maitaland (1990) reported that fertilizer application, pesticide and herbicide uses in agriculture are the commonest source of human induced pollution in water. There is need for constant monitoring of health status of surface water bodies, which will provide information on the trends and changes in the environment due to anthropogenic inputs, thus providing early warning in order that, protective measures may be taken (Odiette, 1999). Benthic organisms are those organisms that live on or inside the deposit at the bottom of a water body (Odum, 1971). They play an important role in the circulation and reconciliation of nutrients in the aquatic environments, they constitute the link between the available and unavailable nutrients in the detritus and useful protein in fish (Idowu and Ugwumba, 2005). The diversity and abundance of benthic macro-invertebrates can be influenced by water quality (Idowu and Ugwumba, 2005). Hence it is a good means of evaluating the quality of water.

Water quality includes all physical, chemical and biological factors that influence the beneficial use of water to man and other living organisms. A water quality parameter is any characteristic of water that has effect on aquatic organism in terms of reproduction, growth, survival, production and management. Physico-chemical parameters are known to affect biotic components of an aquatic environment in various ways (Nwankwo, 1998). Although, there are many water quality parameters in an aquatic environment, only a few normally play an

important role (Boyd, 1979). Macro-benthic invertebrates are useful bio-indicators providing a more accurate understanding of the changes in aquatic conditions than chemical and microbiological data, which at least give short term fluctuation (Ravera, 1998). Despite the importance of water quality to the success of fish culture, there are so many streams and reservoirs that serve as source of water to fish farms (big, medium and small) in Ibadan that have little or no research done on the status of the water quality. This paper reports finding of a study on the water quality of the reservoirs that serve as the major sources of water for fish production activities in the University of Ibadan Fish farm. The Benthic Macro-invertebrate diversity and The Physicochemical parameters of the reservoirs were used as the indicators of the water quality.

Materials and Methods

Study site

The University of Ibadan Fish farm lies on latitude 7^0 26'N and longitude 3^0 53'E. A tributary of Ona river that entered University of Ibadan and passes through the farm, serves as the main source of water supply for the activities on the fish farm while another reservoir was improvised by a seepage fed pond with water from the underground spring. This reservoir is provided with overflow pipe to let water out when it is filled up. The three sampling stations selected for this study are the improvised seepage fed reservoir, which is about 10m by 15m with a depth of 1.2m and labeled station A. The temporary reservoir along the tributary of Ona river is labeled station B and the mini detention storage located upstream (along the tributary of Ona river) in the bush before the farm, about 50meters away from the farm boundary labeled station C. It is formed by a concrete weir created along the flowing path of the stream. It has a width of 4m and height of 1.5m, it is heavily silted and the depth is well reduced to less than 1 meter. The choice of these stations was due to the fact that they serve as the main sources of water supply for the activities on the farm. All the stations were surrounded by terrestrial plants such as *Ageratum conyzoides*, *Penisetum purpureum* and *Panicum maximum*. Tilapia and African catfish are the fish species normally sighted along the stream, and in the improvised reservoir.

Field sampling

Sampling was carried out weekly in the months of June and July 2010, between the hours of 0830 and 1000 hrs, from each of the three stations.

Benthic Macro-invertebrate

The benthic samples were collected, with a corer having surface area of $0.004m^2$, three replicates were collected from each station and transferred to labeled polythene bags. The collected samples were washed down the stream using a 1mm diameter sieve to collect the benthos. The washed sediments with macro-benthos were poured into a white enamel tray, sorted using forceps and preserved in 5% formalin. The preserved animals were later brought to laboratory, counted and identified under microscope using the identification manual of Quigley (1977).

Physical Parameters

The water temperature was determined in the field using mercury-in-glass thermometer graduated in degree Celsius (^{0}C), the thermometer was inserted to a depth of 10mm and allowed to stay in the water for 2 minutes as described by Atobatele *et al.* (2005).

Chemical Parameters

Water was collected in water sampler and the analysis was done in the laboratory. The water for Dissolved oxygen (DO) was collected in Dissolved oxygen bottle with glass stopper which was used to cover the sample immediately under water making sure there was no air bubble. Each sample was fixed immediately with winkler solutions A and B and taken to laboratory for analysis as described by Mackereth (1963). Alkalinity was determined as described by Hach (1992) using phenolphthalein alkalinity. pH was measured using electric pH meter metrohm

Herisau E 520. Phenoldisulphonic method was used in the determination of nitrate-nitrogen (Ipeaiyeda, 2008), Nessler method was used to determine the ammonia-nitrogen in the sample in line with the procedure Hach (1992).

Data Analysis

The collected data were analysed using measures of central tendency and correlation analysis. The percentage occurrence and relative numerical abundance of macro benthos were calculated. Diversity of the Fauna was determined using Shannon Wiener index (H), Equitability (E) of species was used to determine how even the species are distributed in line with Ajao (1990), and Margalef diversity was used to measure the species richness in the study sites. The mathematical formulae are denoted by equations 1, 2 and 3:

$$H = \frac{N\log N - \sum f_i \log f_i}{N} \quad \ldots\ldots(1)$$

$$J = \frac{s-1}{\log S} \quad \ldots\ldots(2)$$

$$D = \frac{s-1}{\log e S} \quad \ldots\ldots(3)$$

Where;
S is number of species,
N is total number of individual in the sample
f_i is the number of individual of species i in the sample
H is Shannon-Wiener index
J is Equitability index.
D is Margalef diversity value

Results and Discussion

The mean and standard deviation of the water quality parameters for the three reservoirs are shown in table 1. The least temperature was recorded in station C while the highest was recorded in station A, The temperature did not show a wide deviation from the mean values in all the stations, this indicated that the temperature in the reservoirs were almost even. The observed temperature (between 24.5°C and 28°C) recorded during the study period was slightly below values of 26.5 and 32.8°C recorded by Adebisi (1981) for tropical rivers but it is still in line with what Akin-Oriola (2003) recorded from Awba reservoir (22.1 and 36.8°c). The highest temperature recorded in station A can be attributed to the nature of the water being a stagnant reservoir populated with aquatic plants and animals. It can also be attributed to the decomposition of organic matter in the water body, a similar observation was recorded by Tyokumbur *et al*, (2002) in Awbar stream and reservoir, Oben (2000) in man-made lakes in Ibadan and Idowu and Ugwumba, (2005) in Eleyele reservoir in Ibadan. However the temperature is within 24 – 31°C recommended for warm water fish culture by Viveen *et al*., (1985). The least pH was recorded in A while the highest was recorded in station B, the pH recorded in all the stations tend towards alkalinity and this is similar to the results of some previous researches on tropical water bodies by Adebisi, (1981), Atobatele *et al*., (2005), Idowu and Ugwumba, (2005) and Yakubu and Ugwumba, (2009). This pH is suitable for fish culture as it fell within the recommended range of 6.5 – 8.5 (Viveen *et al*., 1985) for tropical fish culture.

Table 1: The Physico-chemical parameters at the three sampling stations at the University of Ibadan fish farm

Parameters	Station A (Seepage Fed Reservoir)	Station B (Temporary on stream Reservoir)	Station C (Detention Storage)	Ranges Recommended for Tropical fish Culture *
Temperature (^{0}C)	26.67±0.75	25.67±0.54	25.25±0.82	24 – 31
pH	7.88±0.06	7.94±0.02	7.89±0.05	6.5 – 8.5
Dissolved Oxygen (mg/L)	3.53±0.78	6.53±0.41	5.27±0.59	> 4
Nitrate-nitrogen (mg/L)	45.81±1.11	54.80±0.80	51.88±1.02	< 250
Ammonia-Nitrogen (mg/L)	0.25±0.06	0.10±0.00	0.12±0.04	< 1
Alkalinity (mg/L)	21.38±0.00	19.24±.34	20.67±1.75	< 200

*Viveen *et al.*, (1985)

The Dissolved Oxygen was highest in station B while the least was recorded in station A. The dissolved oxygen in stations B and C can be regarded as normal for tropical water and is suitable for culturing warm water fishes (Viveen *et al.*, 1985). The result is similar to that recorded by Idowu and Ugwumba (2005), Ikomi *et al*, (2005) and Atobatele *et al*, (2005). The low dissolved oxygen in station A is not within the range (above 4mg/L) reported by Adebisi (1981), this can be attributed to organic decomposition and high temperature in the water body. Temperature has been noted to be inversely related with dissolved oxygen (Fakayode, 2005), also the deep green colouration of the water body at the time of the study, which reduces light penetration and hence photosynthesis can also reduce the dissolved oxygen especially when the sampling is done early in the morning (King and Nkanta 1991). Nitrate-nitrogen was highest in station B while the least was recorded in station in A. The high nitrate-nitrogen level recorded in all the stations can be attributed to high organic effluent and waste that are released and decomposed in the water body. The nitrate-nitrogen reported in all the stations is still within the range that is considered safe for fish culture by Viveen *et al.*, (1985). Ammonia-nitrogen was highest in station A while it was least in station B, the Ammonia –nitrogen level recorded in all the stations is normal for an healthy water body as stated by Boyd (1979) and it is suitable for culturing tropical fishes (Viveen *et al.*, 1985). The Ammonia level is very low compared to that of water body classified to be under pollution-stress by Fagade *et al.*, (1993) and Atobatele *et al.*, (2005). The least Alkalinity was observed in station B while the highest was recorded in station A. The Alkalinity recorded during the study is normal and suitable for culturing of warm water fishes, though higher than the one reported by Ikomi *et al*, (2005) but far below that of Ogunpa River recorded by Atobatele *et al.*, (2005). The variation in the Alkalinity among the stations can be associated with inverse relationship between Alkalinity and pH, whereby the station with highest pH has the least alkalinity and vice versa, this agreed with APHA (1992).

Benthic Macro-invertebrates

Composition and abundance of benthic Macro-invertebrates in the reservoirs are shown in table 2, a total of 925 individual species was recorded from eight species that belong to four taxa. The four taxa recorded during the period of the study were Dipteran, Odonata, Gastropoda, and Annelida. The Dipteran recorded was larvae of Chironomid *sp*, it was recorded in all stations with the highest in station A and least in station B.

The Odonata (Insecta) recorded during the study period were *Coenagrion mercurial* and *Gomphus vulgatissimus*, none of the Odonata was recorded in station A, while they were both present in stations B and C. The Gastropoda (Mollusca) was recorded in all the stations and it represents the most abundant taxa in the reservoirs, two species recorded were *Bulinus globossus* and *Melanoides tuberculata*, station A has highest number while the least abundance was recorded in station C. Also station C has no record of *Bulinus globossus*. The Annelida recorded during the study are *Chaetogaster sp*, *Tubifex sp*, and *Lumbricus sp*. *Chaetogaster sp* is found in stations A and B but not in C, with station B having higher number, *Tubifex tubifex* was recorded in all the stations during the study period with highest number in station A and the least in station B. *Lumbricus sp* was recorded in station A alone and not in the two other stations. The organisms recorded reflected those of tropical freshwater, the presence of Odonata in stations B and C indicated that the water quality is healthy, though *Chironomus sp* is pollution tolerant it does not mean it could not be found in healthy water body as well. The domination of the gastropods in all the stations can be attributed to the ability of the two observed gastropods to tolerate environments with wide range of physical and chemical characteristics, a similar observation was observed by Ajao and Fagade, (2002).

Table 2: Composition and abundance of macro-invertebrates in the reservoirs at the University of Ibadan fish farm

Species	Taxa	STATION A (Seepage Fed Reservoir)		STATION B (Temporary Reservoir)		STATION C (Detention Storage)	
		NO	%	NO	%	NO	%
Chironomids larvae	Dipteran	67	7.82	2	5.00	5	17.86
Tubifex sp	Annelida	47	5.48	1	2.50	4	14.29
Chaetogaster sp	,,	1	0.12	2	5.00	-	-
Lumbricus Sp	,,	6	0.70	-	-	-	-
Melanoides tuberculata	Gastropoda	447	52.16	26	65.00	16	57.14
Bulinus globosus	,,	289	33.72	7	17.50	-	-
Coenagrion mercurial	Odonata	-	-	1	2.50	2	7.14
Gomphus vulgatisimus	,,	-	-	1	2.50	1	3.57
Number of species (S)		6		7		5	
Total number of individuals		857	100	40	100	28	100

The diversity and richness index is shown in table 3, the Shannon Wiener Index shows that, highest species diversity occurs in station A and the least occur in station C, the Equitability Index also shows that the dominance and even distribution of the organism is highest in station A and as well least in station C, while the Margalef Value is least in station A and highest in station C. The least Margalef Value indicates lowest species richness in station A and high Equitability Value indicates high dominance (Table 3). The species diversity and dominance are affected by physical and chemical variations in the environment.

Table 3: Diversity and richness of the organisms observed during the study period

	A Seepage Fed Reservoir	B Temporary Reservoir	C Detention Storage
Shannon-Wiener Index	0.475384	0.016637	0.013132
Equitability Index	0.265317	0.00855	0.00816
Margalef Value	0.740364	1.62651	1.200407

The high abundance of organisms in station A can be attributed to the fact that stagnant waters tend to have higher species diversity than flowing water. Nelson and Lieberman, (2002) also noted that flow velocity influences the type of river bed and amount of silt deposit which in turn negatively affects the abundance of macro invertebrates in lotic systems.

The interdependence between the water quality parameters and the macro invertebrates is shown in Table 4. Temperature has a strong and significant correlation with only the abundance of *Melanoides tuberculata*, this implies that *Melanoides tuberculata* is tolerant to high temperature. This can be attributed to the ability of the species to withstand a great range of environment, as reported by Idowu and Ugwumba (2005). The dissolved oxygen is negatively correlated with abundance of *Melanoides tuberculata* and *Bulinus globossus* though it is strong and significant, this indicated that these organisms can thrive in water with low dissolved oxygen, this is similar to the observation of Tyokumbur *et al.*, (2002).

Table 4: Interdependence of macro invertebrates abundance and selected physico-chemical parameters of reservoirs in the University of Ibadan Fish farm

Parameters	A^-	B^+	C^+	D^+	E^+	F^+	G^+	H^+
Temperature (^{0}c)	0.249	0.301	.00	-1.000	0.597*	-0.198	.00	.00
Dissolved oxygen - (mg/L)	0.555	-0.475	.00	1.000**	-0.824**	-0.900**	.00	.00
pH	0.165	0.312	.00	1.000**	-0.442	-0.405	.00	.00
Ammonia-Nitrogen (mg/L)	0.687*	0.749*	.00	.	0.833**	0.588	.00	.00
Alkalinity (mg/l)	0.245	0.256	.00	1.000**	0.393	0.889**	.00	.00
Nitrate-nitrogen (mg/L)	-0.825**	-.708*	.00	-1.000**	-.860**	-0.746	.00	.00

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

KEY: A is *Chironomids larvae*, B is *Tubifex sp*, C is *Coenagrion mercurial*, D is *Lumbricus sp*, E is *Melanoides tuberculata*, F is *Bulinus globossus*, G is *Gomphus vullgatissimus*, *H is Chaetogaster sp.*

Ammonia-nitrogen has a strong, positive and significant relationship with *Chironomids sp*, *Tubifex sp* and *Melanoides tuberculata*, these organisms are pollution tolerant and any environment that has abundance of these can be said to be under pollution-stress. This finding is similar to that of Atobatele *et al.*, (2005) and Idowu and Ugwumba, (2005). Alkalinity has a significant, strong and positive correlation with *Bulinus globossus* alone. Nitrate-nitrogen has a strong but negative significance with *Chironomids sp*, *Tubifex sp* and *Melanoides tuberculata*, this is an inverse relationship therefore an increase in the nitrate-nitrogen level will not favour the abundance of these organisms.

Conclusion

The water quality parameters in all the three reservoirs do not revealed that any of the station is under pollution-stress, though stations B and C are healthier than A. The presence and abundance of macro-invertebrates implicated station 'A' not to be as healthy as other stations. It can be concluded that reservoirs storing flowing water bodies tend to be healthier with respect to supporting fish farming activities than those storing subsurface water.

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