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Aquatic Macrophytes and Water Quality Parameters of Selected Floodplains and River Benue, Makurdi, Benue State, Nigeria.

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1 SUMMARY

Identification of aquatic macrophytes and determination of water quality parameters of the River Benue and its floodplain in Makurdi was carried out from February to July 2008. Three study sites were selected: Abattoir floodplain as Site 1, Part of River Benue as Site 2 and the Floodplain at Wurukum as Site 3. Water was sampled and analyzed to determine Physico-chemical parameters and nutrient levels. Three main aquatic macrophytes were also identified namely *Eichhornia crassipes, Ipomoea aquatic* and *Nymphae lotus*, and were analyzed to determine their levels of minerals and metal concentration. These levels were found to differ significantly (P<0.05) with sites and macrophyte species. The temperature ranged between 20.0 – 23.6^{0}C.with the mean value of 21.8±1.08. The highest temperature was recorded between March and April. Dissolved oxygen ranged between 3.6-4.9mg/1 and there was no significant difference in the three sites but the highest value was recorded in June 2008. Secchi disc visibility recorded ranged from 0.5-1.9meters. The lowest depth was found in Site 3 (0.5m) and the highest in Site 2(1.9m). pH range of 5.9-6.8 was recorded within the period of study. The highest pH mean value of 6.54±0.21 was recorded in site 1. Phosphate concentration recorded ranged from 0.07-0.20mg/1 and the level found in site 1 differed significantly with the one in site 2. The concentration of nitrate ranged from 1.0-2.10mg/1 but showed decrease from February to July as the water become diluted with rain water. The concentration of the minerals and metals found in the macrophytes were present. The potassium found in *Nymphae lotus* in Site 3was significantly higher than that found in *Eichhornia crassipes* in site 1. While Iron found in *Eicchornia crassipes* in site 1 was markedly higher than that found in *Nymphae lotus* in site3. In both cases, the concentration of both metals in site 2 was moderate.

2 INTRODUCTION

Aquatic macrophytes are plants that are larger than most algae. The general term "aquatic plants" usually refers to aquatic macrophytes; but some scientists use it to mean both aquatic macrophytes and algae. They characteristically grow in water or in wet areas and are quite a diverse group. Some are rooted in the sediment while others float on the water surface and are rooted to the bottom. The term "aquatic macrophytes" includes largely flowering plants (angiosperms),some ferns and mosses (pteridophytes) and microscopic algae (storwort,e.g. chara and alga cladophora).Cowx and Welcome (1998) listed the number of characteristics of aquatic plants which make them important to fish for conversion of toxic ammonia to usable forms(nitrates). Aquatic macrophytes are essential for a healthy fish stock to be maintained in a natural water body.

Opuszynski and Shireman (1995) pointed out that some plants or combination of plant species seems to be better fish habitats than others. Burgis et al., (1973) reported that, shallow marginal littoral with aquatic macrophytes contains a greater diversity of aquatic animals than the off shore open water areas.

Studies on aquatic macrophytes, and especially their ecology, were few in number before the 1960s (Thomaz et al 2008). Kio and Ola Adams (1987) reported the presence and spread of aquatic macrophytes on Nigerian water bodies that have aroused considerable national interest and concern especially in the Lagos lagoon and Okitiputa water ways. Man has tried for ages to control the excessive growth of aquatic macrophytes in both natural and artificial water bodies. However, eradication of the weeds has proved almost impossible. Turning these weeds to productive use will be desirable and several researches have so far been carried out Edie and Ho; (1969), Mbagwu and Adenifi (1985), Boyd (1968), Abdalla and Abdulhafeez (1969), Pirie (1960 and 1966). Several of the parameters influenced by plants that have been observed to reach lethal limits, for common fresh water fish are dissolved oxygen, acidity and ammonia. Nather Khan (1990), reported that aquatic macrophytes absorb dissolved minerals and nutrients from polluted water and enrich water with oxygen during photosynthesis. Frodge et al (1995) measured dissolved oxygen and pH values in patches of *Brasina Schreiber* in the north west of the USA and found their values ranging from above (in open water) to below (in patches of the macrophytes) lethal limits (<1.0mg.L^{-1} DO and <6.0 for pH) for rainbow trout (*Oncorhynchus mykiss*) within 10m of each other in the same lake. Rainbow trout in cages positioned at 1m depth below *Nymphae odorata* where dissolved oxygen concentration was consistently less than 4mgL^{-1} were found dead within 12 hours. Significantly mortalities of large mouth bass occurred at both the surface and at 1m depth in dense beds of the floating leaved macrophyte *Brasinia schreiber*, and in the bottom water of 2m or more depth of both floating leafed and submersed species, where oxygen concentration were less than 2mgL^{1}. The authors suggested that high densities of aquatic plants can have significant detrimental localized effects on fish and reduce the amount of habitat available to fish within the system.

Eutrophication has become a problem in many countries. De Nie (1987) has reported long term changes in aquatic macrophytes of selected water bodies under the impact of eutrophication in Finland, Germany, the Netherlands, Poland, Switzerland, UK and USA. Adesina et al (2010), discovered differences in the species of aquatic macrophytes on two lakes in southern Nigeria - the Ojirami dam and the Oguta Lake. Fewer aquatic macrophytes were encountered in the man made Lake as against the natural Oguta Lake. They reported that siltation, human activities and age of the Oguta Lake as reasons for increase presence of emergent aquatic macrophytes on the lake. Despite the threats aquatic macrophytes may pose on water bodies, they can also be useful as lakes and ponds bordered by swamps and marginal vegetations are vividly exploited for municipals, industrial and agricultural wastewater treatment. They may also be used for the removal of agriculture effluents. Between 1984 and 1985, research was carried out on the highly eutrophied Lake Apopka in the U.S.A. using water hyacinth to remove nutrients from the lake. Channels that were stocked with water hyacinth consistently provided higher nutrient removal than the channel without water hyacinths (Reddy and DeBusk, 1987). Adeyemo et al (2008) reported that the water quality of Ibadan river system in Nigeria is adversely affected and impaired by the discharge of domestic, agricultural and industrial wastes, which is the usual practice in Ibadan. This can be remedied with the use of aquatic macrophytes following the success recorded with the plant in this regard.

Boyd (1974), hinted the use of water hyacinth in the purification of water for fish culture that it can prove useful in treating effluents polluted

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JAPS

with heavy metals. In static laboratory experiments, it (water hyacinth) rapidly absorbed Gold, Silver, Cobalt, Strontium, Cadmium, Nickel, Lead and Mercury. Water hyacinth can also absorb or metabolize Phenols and other trace organic compounds of the type commonly found in the drinking water supplies of many large cities FAO report (1979). Other aquatic macrophytes that can be use for water purification include duckweeds (*Wolffia, Spirodela* and *Lemna*) and *Ceratophyllum dermesum*. Aquatic macrophytes can also be used as food for fish and other aquatic animals like the Chinese grass carp (*Ctenopharyngodon idella*) has a remarkable capacity to eat aquatic weeds and a rapid growth with a palatable and nutritive flesh. A few species of crayfish are exclusively herbivorous and appear to be promising for aquatic weed control and utilization like the red crayfish *Procambarus clarkia* that has been tried in the united state of America and it was found to eat all available vegetation if there is nothing better to eat Anon (1974). The manatee (*Trichechus* spp.) was also suggested by Allsopp, (1960 and 1969) as a potential biological method of aquatic weed control and utilization following its successful use in Guyana. This is further supported by Etherridge *et al* (1985) who investigated the consumption of aquatic plants by the West Indian Manatee. Aquatic macrophytes have been used in modern drugs and pharmaceutical industries Kio and Ola-Adams (1987). They can provide shelter or refuge to zooplankton and restrict light penetration into deeper water leading to the death of submerged macrophytes. *Daphnia spp* was discovered to persist in dense macrophyte stands after their elimination in open water hence indicating that macrophytes can act as refuge for zooplankton (Stansfield *et al.*, 1997). The aim of the study was to survey macrophytes in selected ponds and River Benue in Makurdi and to determine the water quality parameters given the presences of these macrophytes.

3 MATERIAL AND METHODS

The study was carried out for a period of five months (February to July 2008). Three study sites: Abattoir flood plain (site1), Part of River Benue (site2), and Floodplain at Wurukum were used as sampling sites for sampling aquatic macrophytes and water quality. At each site, water samples were collected from the surface water fortnightly for five months using 100ml reagent bottles and one liter plastic bottles. Duplicate water samples were collected from each site using two reagent bottles. Reagent bottles for dissolved oxygen (DO) determination from each site were fixed for DO on the field using acidified manganese chloride. The samples in the plastic bottles were used for the analysis of other water quality parameters which include temperature, carbon dioxide, pH, nitrates and phosphates. Temperature was determined using mercury in glass thermometer. The dissolved oxygen was determined using the Winkler's method (Winkler, 1888). To determine free CO2, 100ml of the sample was placed in a conical flask, 8 drops of phenolphthalein indicator was added and titrated against 0.01M NaOH solution until the solution turns a pale pink. The volume of NaOH used was recorded and free CO2 (mg/L) was calculated using:

$$\frac{volume\ of\ titrant \times N \times 4400}{sample\ volume\ used\ (ml)}$$

Where N = Normality of NaOH

The pH of the water samples was determined using a B. Bran Scientific pH-meter (pHS-25 model).

Nitrates and phosphates were determined using standard methods for examination of water and wastewater (APHA, et al 1998).

The aquatic macrophytes were also hand harvested fortnightly using the surface inventory method. The identification was made using a hand book of common aquatic plants of the Kainji Lake, Nigeria (Obot and Ayeni 1987). In deep areas a sampling rake was use to bring plants up from the bottom. The plant tissues were analyzed for minerals and metal composition in the soil science laboratory, University of Agriculture Makurdi using the pye-unican sp9 atomic absorption spectrophotometer method after tissue digestion was conducted using the modified Zheljazkov and Nielson (1996) trioxonitrate V acid method as described by Hseu (2004).

4 RESULTS AND DISCUSSION

The physical and chemical parameters of the three study sites are shown in Table1.

Table 1: The physical and chemical parameters of water samples

Sites	**Site1**		**Site2**		**Site3**	
Parameters	**Range**	**Mean/S.E**	**Range**	**Mean/S.E**	**Range**	**Mean/S.E**
Temperature ^{0}C	20.0-22.6	21.6^a±1.06	20.8-23.1	22.08^a±0.95	20.5-23.6	21.72^a±1.22
Dissolve Oxygen mg/l	3.90-4.80	4.34^a±0.39	4.2-4.9	4.5^a±0.27	3.6-4.1	3.84^a±0.18
Secchi Disc visibility (m)	1.0-1.4	1.2^a±0.16	1.4-1.9	1.68^b±0.22	0.5-0.9	0.7^a±0.16
pH	6.3-6.8	6.54^a±0.21	5.9-6.5	6.14^a±0.25	5.9-6.7	6.12^a±0.33
Phosphate mg/g	0.17-0.20	0.19^a± 0.02	0.07-0.11	0.084^b± 0.02	0.10-0.13	0.114^a 0.01
Nitrates mg/g	1.80-2.10	1.34^a±0.11	1.0-1.3	1.16^b±0.11	1.20-1.7	1.5^c±0.2

Means in the same row with different superscripts differ significantly (P<0.05)

There was a significant difference (P<0.05) in the amount of phosphate and nitrate found in the sites investigated. The variation of the physico-chemical parameters at the 3-study sites is shown in (table 1) with temperature ranging between 20.0 – 23.6^{0}C and mean value of 21.8^{0}C, the highest value of temperature was recorded in the dry season months of March and April which indicate the hottest month in Makurdi. Mean temperature in the three sites were not significantly different (p>0.05). Dissolved oxygen was lower (3.84mg/l) at site 3. This could be attributed to the heavy load of organic matter influx from both the abattoir and town sewage that characterize the two sites.

Secchi disc visibility was found significantly different between the site with range from 0.5 - 1.9m with the lowest value (0.5m) at site 3; this considered with the lowest acidic P.H value at the same site (5.9) and site two, which are heavily polluted by abattoir effluent and the (town sewage and solid waste dump).

The phosphate (PO_4) level showed significant difference (p<0.05) at various sites with the lowest value of (0.07mg/l) at site 2 and a mean of (0.084mg/l). The high values of phosphate at site 1 and 3 were above United States Environmental Protection Agency (USEPA) standard limit of 0.025mg/l in natural aquatic bodies. This could be due to high influx of organic burning and the influx and animal faeces being discharged directly from the abattoir floor into these sites. The level of nitrates in the water was within the limit acceptable by USEPA and EU standard for aquatic environment and were significantly different (p<0.05) at the different sites. The nitrate values in all the sites were higher than that reported by Davies *et al.* (2009) in the Minichinda stream, Niger Delta of Nigeria.

Table 2 shows the level of mineral and metal concentration in the tissue of the 3-aquatic plans that dominate the study site . There are very high levels of iron (Fe) (1.85-6.98mg/l) and lead (Pb) (0.05-1.25mg/l) in the tissue of this plant high above the USEPA and EU standard for aquatic organisms. The result is in line with the report of Okayi and Abe (2001) who reported high value of iron and lead (6.2mg/l – 21mg/l and 0.01-1.45mg/l in the water of the Benue River respectively.

Table 2: Metal and mineral concentration in aquatic plants (February to July 2008)

Metal mineral conc.(mg/g)	Site1 *Eichhornia Crassipes*	Site2 *Ipomoea aquatica*	Site3 *Nymphae lotus*
Sodium(Na)	3.90	2.06	2.46
Calcium (Ca)	4.15	2.88	1.54
Iron(Fe)	6.98	3.97	1.85

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JAPS

Potassium(K)	2.56	3.40	7.03
Lead(Pb)	1.06	0.50	1.25
Magnesium(Mg)	6.00	2.08	1.95

Table 3 – shows the distribution of the three dominant aquatic plant and others species in relation to their abundance range in/from the dry season month of March – April and from raining season month of May – July. The result indicates luxurious growth of these aquatic macrophytes throughout the 3 sites in the month of May to July especially for *Eichornia crassipes* at site 1 and 3. Table 4 indicates the various economic uses of some of the Aquatic macrophytes by the local people around Makurdi metropolis.

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JAPS

Table3: Aquatic Macrophytes of River Benue in Makurdi

		1st Sample March 2008			**2nd Sample April 2008**			**3rd Sample May 2008**			**4th Sample June 2008**			**5th Sample July 2008**		
S/N	**Aquatic macrophytes**	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**
1	*Ipomoea aquatica*	+			+		+	+ +	+	+ +	+ +	+	+ + +	+ +	+ + +	+ + +
2	*Echhornia crassipes*	+		+	+	+	+	+ + +	+	+ + +	+ + +	+	+ + +	+ + +	+	+ + +
3	*Nymphae lotus*			+			+	+		+	+		+ +	+		+ + +
4	*Coratophillum*	+		+	+		+			+	+	+ +	+ + +	+	+	+ + +
5	*Typha australis*				+			+	+	+			+			+ +
6	*Polygonium salicifolinm*					+	+			+	+		+ +	+		+ +
7	*Lemna paucicostata*		+	+			+			+	+		+	+		+ +
8	*Echhonia stagnina*		+	+			+		+	+	+		+ +	+		+ +
9	*Lemna minor*	+	+	+	+	+	+	+	+	+	+		+	+		+ +
10	*Cypeus imbracatus*		+			+		+	+	+	+		+ +	+	+	+ +
11	*Pithophora*	+	+	+	+	+			+		+		+ +	+		+ +
12	*Mithphora inermis*	+			+				+				+	+		+ +
13	*Pistra stratiotes*		+	+	+		+		+	+	+		+	+		+ + +

Table4: Major Uses of some Aquatic Macrophytes of River Benue in Makurdi

		Parts used								Uses and products									
S/No		**Leave**	**Stem/bank**	**Flora parts**	**Root**	**Fruit**	**Tuber**	**Seed**	**Whole plant**	**Medicine**	**Food**	**Fertilizer**	**Thatching**	**Mat-making**	**Fodder**	**Socio-cultural**	**Fuel**	**Pulp&paper**	**Oil**
1	*Lemna paucicostata*		*	*			*									*			
2	*Typha australis*		*	*											*				
3	*Cyperus papyirus*	*	*											*	*	*		*	
4	*Echinochloa pyramidalis*							*	*		*		*		*		*		
5	*Echinochloa stagnina*		*					*	*		*		*		*				
6	*Cerato phillum*	*							*					*	*				
7	*Nymphae lotus*		*	*	*	*	*			*	*					*			
8	*Sorghum amndinaceum*							*	*		*				*				

5 DISCUSSION

From the study conducted of the three sites, the application of inorganic fertilizer during dry season farming and the flow of blood and animal waste matter from abattoirs into the water body explains the eutrophication of water at site 1 and 3. This results into high growth of *Eichhornia crassipes* occurring in a solid mass over the entire lake surface. This is in agreement with a study carried out by Okayi and Abe (2001). This is evident in the fact that the Secchi disc visibility in site3 was lowest compared with those found in site1 and 2.

Site 1 was over flooded and engulfed by the river thereby forming a continuous water body reconnecting the river with floodplain lakes. This provides the fish of the river the channel with the opportunity to access the areas covered with aquatic macrophytes; and where such lakes were under a high fishing pressure during the low water level, to repopulate such lakes with fish. The increase in living space, together with the release of nutrients associated with the submersion of soil and from the decaying plants produces an annual surge of plankton and periphyton, encouraging an explosion in the level of oxygen were recorded in the lakes when there were still large open water spaces; the lowest level were recorded when there was a large-scale plant decomposition in progress especially in site 3. Junk et al, (1983) reported that fish are forced to expend much energy and time in the search for oxygen when gasping for oxygen-rich air as a consequence of low dissolve oxygen concentrations. This may increase the danger of fish being caught by predators.

Variations in the metal contents of aquatic macrophytes at the three sites is in line with the findings of Muramato and Oki (1983) that water hyacinths and other aquatic plants can readily absorb heavy metals such as Cu, Zn, Pb, Cd, Hg and Ni. The Nitrate contents in these three sites investigated were quite higher than those reported by Chia and Bako (2008) for four freshwater pond ecosystems in Zaria, Nigeria. However, phosphate values in these freshwater ecosystems in Zaria are higher than the values reported in the present study. Aquatic vegetation represents an important habitat for fish, which they may use for feeding, reproduction and escape from predators. It also plays a vital role in bringing nutrients trapped in bottom sediments back up into the aquatic environment and organic matter generated by aquatic macrophytes may boost the production of benthic organisms. They can also serve in water treatment systems and help in the removal of Agricultural effluents.

6 CONCLUSION

Ipomoea aquatica can serve as a very good agent for the removal of lead from contaminated water bodies. The presence of nutrients in these sites causes eutrophication but with the emergence of aquatic macrophytes, absorption of these nutrients is possible. Finally, Site 2 is less eutrophicated and has a lesser density of aquatic macrophytes than sites 1 and 3.

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