RESEARCH ARTICLE

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Species Diversity of Macrophytes and Physicochemical Parameters of Ponds of Abraka Inland, Delta State, Nigeria

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ABSTRACT

This study assessed the species diversity of macrophytes in ponds of Abraka inland, Delta State in relation to the water physicochemical parameters. The results indicated that most of the parameters studied in the ponds between October and December 2019 including temperature, pH, total hardness, alkalinity, total dissolved solids, total suspended solids, turbidity, dissolved oxygen, biological oxygen demand, nitrate, calcium, sulphate, chloride and ammonia fell within the permissible standard of World Health Organization for both drinking water and fish production. Forty eight taxa of aquatic macrophytes were encountered. Potamogetaceae and Hydrocharitaceae families had abundant species 8 each, Cyperaceae had 6 and Nyphaeaceae, Myriophylliaceae, Lentibulariaceae, Convolulaceae, Ongraceae, Ceratophyllaceae and Ranuculaceae families were represented by one species each. The percentage occurrence of the macrophytes encountered was 54.17% (submerged), 18.75% (emergent and floating) and 8.33% (embankment) species. The study concluded that the water quality of the ponds at Abraka Inland is suitable for fish production and the growth of the aquatic macrophytes encountered. The study recommends the management of water resources like streams, rivers and ponds to ensure their sustainability and it has contributed to knowledge in the area of limnology, aquatic biology biodiversity conservation and management and public health.

Keywords: Abraka Inland, Aquatic macrophytes, Physicochemical characteristics, Species diversity.

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I. Introduction

Ponds are lentic freshwater ecosystems designed for fish production to boost protein intake of the people (Agbogidi, 2015). They also perform other beneficial functions including provision of employment (Zelnik *et al*., 2012). Macrophytesare large aquatic plants that grow in or near water (Agbogidi, 2005). They vary in sizes, life forms and constitute natural components of water bodies including fresh water, salt and brackish water (Bamidele & Agbogidi, 2002). Ponds are major contributor to local ecosystems (Zelnik *et al*., 2012). Ponds vary in types including earthen or natural pond, artificial or concrete. While earthen ponds are artificial damps, reservoirs or lakes constructed for different species of fishes, artificial fish ponds are a great alternative to natural water reservoirs in which fish can also be bred in plastic, fiberglass or wooden reservoirs where fish are bred in controlled environment (Eze & Ogbaren, 2010; Olaniyi, 2013). The ponds in Abraka Inland are natural ponds that get their water from Ovwuvwe stream. The stream has its source from Umukwata (Okueshi) in Ukwuani Local Government Area of Delta State and flows into Otokutu River from where it enters the Atlantic Ocean. All the ponds receive their water supply from Ovwuvwe stream and are approximately 30metres apart from the area Abraka inland. The inhabitants of Abraka Inland depend mainly on the stream for their fishing activities which constitutes one of their major socio-economic activities outside arable farming. Abraka town took its origin from Abraka inland and most of villages in Abraka town have their base in the inland. Besides, Abraka inland supplies significant quantity of pond fish to Abraka and its environs. In the same vein, as major components of aquatic systems, macrophytes needs to be conserved for sustainability of ecosystem services and functions (Yamanouchi *et al*., 2014; Agbogidi, 2019; Agbogidi, 2021).

This study among other things was set out to document the inventory of aquatic macrophytes as influenced by physicochemical parameters of ponds in Abraka Inland, Delta State with a view to providing baseline information on the water physicochemical properties of the ponds. The study was premised on the lack of documented information on the water properties of the ponds in this community as well as their aquatic macrophytes.

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II. Materials and Methods

A. Study Location

The study was carried out at Abraka Inland in Abraka, Delta State. Abraka lies at latitude 50751N and 60111E. It is the home of the main campus of one of the State owned university, Delta State University. Abraka falls within the tropical rainforest belt of the world with a mean temperature of 300 °C. The vegetation is typically that of a rainforest. Ovwuvwe stream got its source from Umukwata River (Okumeshi) a seasonal river in Ukwuani Local Government Area of Delta State.

B. Sampling Period

The sampling period was between October and December, 2019.

C. Collection of Samples

The water samples used for analysis were collected from four (4) different ponds at Abraka Inland. A composite sample was collected from three points of the ponds and mixed together. The water samples were collected between 7:00 a.m. and 11:00 a.m. on each visit at a depth of about 15 cm in clean white polythene capped bottles which had been washed with detergents, rinsed three times with deionized water and twice with 1% HNO_3. The water samples were taken to the laboratory in an ice-packed container at 40 °C for analysis for physicochemical parameters. Quality control and assurance procedures were strictly adhered to, to ensure accurate results.

Each analysis was replicated three times and all reagents used were of ANALAR grade. All sampling containers and apparatus were washed, rinsed with detergent and rinsed with deionized water before use. Sterilized and disposable rubber gloves were worn during analysis. Procedural bank was used to monitor interferences and cross contamination of results were blank corrected following the procedures of FEPA (1996) and APHA (2006). Parameters studied were temperature, pH, electrical conductivity, total hardness, total dissolved solids, turbidity, total suspended solids, alkalinity, biological oxygen demand, ammonia, nitrate, acidity, phosphate, sulphate and chloride.

D. Collection of Macrophytes

Sampling of aquatic macrophytes from the four ponds designated as P1, P2, P3 and P4 was done between October and December, 2019. Each of the ponds (P1, P2, P3, P4) are 30m apart. While the free floating aquatic macrophytes were collected with sieves, the attached but floating and the submerged were collected with hand and the emergent and embankment were collected with hand and matchet. Samples were transported in air tight polythene bags and transported to the Department of Botany laboratory for identification. Identification was done by experts in the Department of Botany, Delta State University, Abraka, Delta State, Nigeria.

E. Data from Abraka Inland Ponds

The total number of macrophytes encountered was recorded. Their common names, families and life forms were also documented in Table III. The percentage of the life forms/habit of the macrophytes encountered was determined as follows:

$$\left\{\frac{\text{Total No. of aquatic macrophytes in the ponds}}{\text{Total No, of spcies representing each growth form}} \times \frac{100}{1}\right\}$$

Species richness score was developed using +++ (more abundance), ++ (sparse abundance) and + as rare abundance or just present) following the procedure of Bamidele and Agbogidi (2002).

III. Results and Discussion

The results of the physicochemical parameters of the ponds designated as P1, P2, P3 and P4 are shown in Table I. The results indicated that no significant differences ($P \leq 0.05$) existed in most of the parameters studied in the four ponds including temperature, pH, total hardness, alkalinity, total dissolved solids, total suspended solids, turbidity, dissolved oxygen, biological oxygen demand, nitrate, calcium, sulphate, chloride and ammonia. The values obtained are within the permissible standard of WHO (2010) for both drinking water and fish production (Table II). The results also showed significant differences ($P \geq 0.05$) in electrical conductivity. For example, P4 and P2 had 48.9 mg/kg^{-1} and 48.7 mg/kg^{-1} respectively while P1 had 46.5 mg/kg^{-1} and P3 had 43.6mg/kg^{-1}.With respect to alkalinity, P4 recorded 5.67 mg/kg^{-1} followed by P2 with 5.60 mg/kg^{-1} while P3 had 5.18 mg/kg^{-1} and P1 had 4.13 mg/kg^{-1}. Phosphate levels were higher in P3 (2.00) and P4 (1.80) when compared with values obtained in P1 (0.56) and P2 (0.29). In the same vein, the values of magnesium (Mg^{2+}) were higher in P2 (36.60) and P1 (35.76) as against values recorded for P4 (34.60) and P3 (33.80). These variations in the water quality could be linked to the concept of hydrological cycle which is based on the continual movement of all forms of water and continually changing state of water (Uneke & Udennaor, 2017). This could also be related to the water shed concept that states that surface water may undergo substantial variation in physicochemical quality as a result of discharge events that may flush water-soluble substances into the stream hence causing changes. Changes in water quality could also be connected to the effects of decayed vegetable matter and other anthropogenic activities. Similarly, the use of detergents for laundry activities could have accounted for the variations. In spite of the variations, the obtained values are still within the permissible standard of World Health Organisation (2010) (Table II). The favorable physicochemical properties showed that the water of the four ponds studied is suitable for fish production. This finding is in line with earlier reports (Nishihiro *et al*., 2014; Raji *et al*., 2015; Hannington & Emmanuel, 2016; Olukunle & Oyewumi, 2017; Ram *et al*., 2017). The presence of 48 taxa in the ponds also indicated that the pond water is suitable for the growth of these aquatic macrophytes which play a lot of roles in the ponds including habitat diversification, primary production water aeration, pollutant removers, stabilization of sediments, beautification of the pond among others (Agbogidi, 2014; Agbogidi *et al*., 2017; Agbogidi, 2021).

On the whole 48 taxa were encountered in these ponds including Typhaceae, Alismataceae, Cyperaceae, Araceae, Characeae, Potamogetaceae, Nymphaeaceae, Poaceae, Myriophyllaceae, Hydrocharitaceae, Lentibulariaceae, Salviniaceae, Ceratophyllaceae, Onagraceae, Raniculaceae,

Convolvulaceae, Convolvulaceaein (Table V). Similar reports have been made by Nishihero *et al*. 2014). While Potamogetaceae and Hydrocharitaceae families had abundant species with 8 each, Cyperaceae recorded 6 species and Nyphaeaceae, Myriophyllaceae, Ongraceae, Ceratophyllaceae and Ranuculaceae families were represented by one species each (Table V). The percentage occurrence or distribution of aquatic macrophytes encounted in the ponds at Abraka Inland is given as submerged (54.17%), emergent (18.75%) floating (18.75%) and embankment (8.33%). This study recommends the need for the management of water resources like ponds, streams, lakes, and rivers in Delta State in particular and Nigeria generally as this is paramount to ensure their sustainability because water is critical to sustainable development through environmental production and food security.

TABLE I: PHYSICOCHEMICAL PARAMETERS OF PONDS IN ABRAKA INLAND, DELTA STATE, NIGERIA

S/N	Parameters	P1	P2	P3	P4
1	Temperature	28.60a	28.18a	29.00a	27.90a
2	pH	6.24a	6.27a	6.28a	6.25a
3	Electrical conductivity m/cm	46.5b	48.7a	43.6c	48.9a
4	Total hardness	2.00a	1.89a	1.76a	20.01a
5	Alkalinity	4.13c	5.60a	5.18b	5.67a
6	Total Dissolved solids (mg/l)	72.20a	72.60a	74.80a	73.40a
7	Total Suspended solid (mg/l)	17.60a	17.80a	18.10a	18.09a
8	Turbidity NTV	10.50a	10.00a	9.48a	9.86a
9	DO	8.40b	9.60a	9.46b	9.20c
10	BOD	1.60a	1.80a	1.90a	1.70a
11	Nitrate	1.00a	0.98a	0.99a	1.10a
12	Phosphate	0.56b	0.29c	2.00a	1.801a
13	Calcium	4.28a	4.58a	4.80a	4.95a
14	Magnesium (ppm)	35.76a	36.60a	33.80b	34.60b
15	Sulphate	4.89a	5.06a	4.80a	4.90a
16	Chloride	50.10a	49.80a	49.20a	48.60a
17	Ammonia	0.17a	0.20a	0.36a	0.43a

Field survey (2019).

TABLE II: WORLD HEALTH ORGANIZATION (WHO) STANDARD FOR PHYSICAL AND CHEMICAL PARAMETERS

S/N	Parameters	WHO Standard
1	Temperature	23–27 °C (but, variable, depending on climate and volume/depth of water)
2	pH	6.5–8.5
3	Conductivity	5
4	TS (ppm)	
5	Alkalinity	200
6	TDS (ppm)	500
7	TSS (ppm)	
8	Turbidity	
9	DO	500
10	BOD	2
11	COD	20
12	Nitrate (ppm)	50
13	Phosphate	0.08
14	Sulphate (ppm)	200
15	Ammonia	0.6–2.0 mg/L

Source: WHO (2010).

TABLE III: AQUATIC MACROPHYTES ENCOUNTERED IN PONDS AT ABRAKA INLAND, DELTA STATE, NIGERIA

S/N	Macrophytes	Common name	Family	Habit
1	Typha latifolia	Cat tail	Typhaceae	Emergent
2	Alisma plants-aquatic	European water plantain	Alismataceae	Emergent
3	Alisma lanceolatum	Lance leaved water plantain	Alismataceae	Emergent
4	Eleochari spalustris	Common spike rush	Cyperaceae	Emergent
5	Typha angustifolia	Narrow leaved cattail	Typhaceae	Emergent
6	Lemna minor	Lesser duckweed	Aracea	Free floating
7	Chara vulgaris	The common stonewort	Characeae	Submerged
8	Nymphaea alba	White waterlily	Nymphaeaceae	Floating
9	Potamogeton natans	Broadleaved pondweed	Potamogetaceae	Floating
10	Najas minor	Brittle waternymph	Hydrocharitaceae	Submerged
11	Najas indica	Guppgrass	Hydrocharitaceae	Submerged
12	Hydrill aventiculata	Water thyme	Hydrocharitaceae	Submerged
13	Najas marina	Spiny water nymph	Hydrocharitaceae	Submerged
14	Myriophyl lumverticulatum	Two leaved water milfoils	Myriophyllaceae	Submerged
15	Eleocharia acicularis	Least spike rush	Cyperaceae	Emergent
16	Sagittaria sagittifolia	(shrimp farm) Arrow heads	Alismataceae	Embankment
17	Scripus acutus	Tule rush	Cyperace	Embankment
18	Pragmite saustralis	Common reed	Poaceae	Emergent
19	Pragmites distinctus	Pondweed	Potamogetaceae	Submerged
20	Pragmites gramineus	Variable leaved pond weed	Potamogetaceae	Submerged
21	Pragmites actandrus	Needle leaf	Potamogetaceae	Submerged
22	Spirodela polirhiza	Greater duck weed	Araceae	Free Floating
23	Pistia stratiotus	Water lectuce	Araceae	Free Floating
24	Ultricularia Australia	Bladderwort	Lentibulariaceae	Floating

TABLE III: AQUATIC MACROPHYTES ENCOUNTERED IN PONDS AT ABRAKA INLAND, DELTA STATE, NIGERIA

S/N	Macrophytes	Common name	Family	Habit
25	Chara aspera	Fough stonewort	Characeae	Submerged
26	Chara contraria	Opposie stonewort	Characeae	Submerged
27	Valisneria spiralis	Tape grass	Hydrocharitaceae	Submerged
28	Chara vigata	Delicate stonewort	Characeae	Submerged
29	Valisneria natans	Natans	Hydrocharitaceae	Submerged
30	Potamogeton crispus	Curly leaved pondweed	Potamogetaceae	Submerged
31	Potamogeton persoliatus	Clasping leaf pondweed	Potamogetaceae	Submerged
32	Potamogeton pusillus	Lesser pondweed	Potamogetaceae	Submerged
33	Azolla Africana	Water fern	Salviniaceae	Free floating
34	Azolla pinnata	Water velvet	Salviniaceae	Free floating
35	Salvinia molesta	Giant duckweed	Salviniaceae	Free floating
36	Echinochloe stagnina	Burgu grass	Poaceae	Submerged
37	Elodea Canadensis	Water weed	Hydrocharitaceae	Submerged
38	Ranuculus fluitans	River water crowfoot	Raniculaceae	Submerged
39	Ranuculu spenltalus	Pond water crowfoot	Raniculaceae	Submerged
40	Cyperus rotundus	Nut grass	Cyperaceae	Emergent
41	Leersia hexandra	Club cut grass	Convolvulaceae	Embankment
42	Alternanthera sessilis	Sessile joyweed	Amaranthaceae	Embankment
43	Ludwigia stolonifera	Water primrose	Onagraceae	Emergent
44	Cypreus haspan	Haspanflatsedge	Cyperaceae	Embankment
45	Scripus pendulus	Pendulous bulrush	Cyperaceae	Embankment
46	Ludwigia repens	Creepy primrose willow	Alismataceae	Submerged
47	Ceratophyllum dermersum	Horntail	Ceratophyllaceae	Submerged
48	Salvinia natans	Floating water moss	Salviniaceae	Free floating

Field survey (2019).

TABLE IV: DIVERSITY OF MACROPHYTES ENCOUNTERED IN PONDS AT ABRAKA INLAND, DELTA STATE, NIGERIA

		Study stations			
S/N	Macrophytes	P1	P2	P3	P4
1	Typha latifolia	+	+	+	+
2	Alisma plants-aquatic	+	+	+	+
3	Alisma lanceolatum	+	+	+	+
4	Eleocharis palustris	+	+	+	+
5	Typha augustifolia	+		+	
6	Lemna minor	+	+	+	+
7	Chara vulgaris	+			
8	Nymphaea alba		+		
9	Potamogeton natans			+	
10	Najas minor				+
11	Najas indica	+			
12	Hydrill aventiculata		+		
13	Najas marina			+	
14	Myriophyllum verticulatum	+	+		
15	Eleocharia acicularis			+	
16	Sagittaria sagittafolia		+		
17	Scripus acutus	+			
18	Pragmites australis		+		
19	Pragmites distinctus	+	+	+	
20	Pragmites gramineus				+
21	Pragmites actandrus				+
22	Spirodela polirhiza	+		+	+
23	Pistia stratiotus		+		
24	Ultricularia australia		+		+
25	Chara brauniis		+	+	
26	Chara globularis (virgata)	+			
27	Valisneria spiralis	+			
28	Chara vigata		+		+
29	Valisneria natans				+
30	Potamogeton crispus	+		+	
31	Potamogeton persoliatus	+	+	+	+
32	Potamogeton pusillus	+		+	
33	Azolla africana		+		+
34	Azolla pinnata	+			
35	Salvinia molesta		+		
36	Echinochloe stagnina	+		+	
37	Elodea canadensis	+			
38	Ranuculus fluitans		+		
39	Ranuculus penltalus	+			
40	Cyperus rotundus		+		+
41	Leersia hexandra			+	
42	Alternantherasessilis				+
43	Ludwigia stolonifera	+			
44	Cypreus haspan		+		
45	Scripus pendulus			+	
46	Ludwigia repens				+
47	Ceratophyllum dermersum			+	
48	Salvinia natans				+

Field survey (2019).

TABLE V: SPECIES OF THE AQUATIC MACROPHYTES ENCOUNTERED IN ABRAKAINLAND PONDS, DELTA STATE, NIGERIA

S/N	Families	Species	Species richness
1	Typhaceae	2	+
2	Alismataceae	4	++
3	Cyperaceae	6	++
4	Araceae	3	+
5	Characeae	4	++
6	Nymphaeaceae	1	+
7	Potamogetaceae	8	+++
8	Hydrocharitaceae	8	+++
9	Myriophyllaceae	1	+
10	Poaceae	2	+
11	Lentibulariaceae	1	+
12	Salviniaceae	3	+
13	Convolvulaceae	1	+
14	Onagraceae	1	+
15	Ceratophyllaceae	1	+
16	Convolvulaceae	1	+
17	Raniculaceae	1	+
	Total	48	

Field survey (2019).

IV. CONCLUSION

The study concluded that the water quality of the ponds at Abraka Inland is suitable for fish production and the growth of the aquatic macrophytes encountered. This study recommends the management of water resources like streams, rivers and ponds to ensure their sustainability. The study recommends the need for continuous monitoring of physicochemical parameters of ponds. The usefulness of aquatic macrophytes in ponds and fish production should be emphasized to pond owners because of their multifaceted roles in water bodies including pondswa.

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