Journal of Plant Development
Vol. **30**, Dec **2023**: 109-117
doi: 10.47743/jpd.2023.30.1.923

ISSN 2065-3158 print /e-ISSN 2066-9917
Available online: www.plant-journal.uaic.ro

BIODIVERSITY OF AQUATIC PLANTS AND MICROFLORA IN TAGWAI DAM, NIGERIA

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Abstract: Aquatic biodiversity of microflora and plants are the varieties of organisms and the ecosystems that make up the wetlands of the world and their interactions. Tagwai Dam is located in Chanchaga local government area of Niger State, Nigeria, located between longitude 60°39' to 60°44' East and latitude 34° to 90°37' North to South-west of Minna, Niger State, Nigeria. Transect sampling collection of aquatic flora and phytosociological method was adopted by using planktonic net, sterilized poly pots and plastic bottles from five sampling stations. Isolation and identification of microflora was conducted using serial dilution for bacterial species and biochemical tests for the identification. Agar pour plate method for the isolation and morphological characteristics for the identification of fungal species. The dominant families of aquatic plants included Araceae, Nymphaeaeceae, Alismataceae, Marsileaceae and Ceratophyllaceae. The identified bacterial species were *Salmonella* species, *Proteus* species, *Psuedomonas* species, *Enterobacter* species, while, the fungal species identified were *Aspergillus* species, *Mucor pusillus*, *Penicillum notatum* and *Candida albicans* were the most dominant microflora found from the sampling stations. The abundance and identification of these aquatic plants and microflora revealed there biodiversity and importance as they serve source of food and energy to the wetland. Aquatic plants and micro flora make up the ecosystem more reliable and comfortable for the aquatic animals and zooplanktons. They are the primary source of energy, the first organisms in food chain in a wetland community.

Keywords: aquatic plants, biodiversity, ecosystem, microflora, transect sampling, wetlands.

Introduction

Aquatic flora make water bodies more important, due to the introduction of non-native species from one part of the world. Some are beneficial or of horticultural interest while majority escaped cultivation leading to acid spread problems [EVERITT & al. 2011]. Documented of fresh water aquatic flora will encourage water chemistry, hydrologic regime, temperature, sedimentation and availability of biodiversity with rich species. The aquatic flora [DEGOOSH, 2014] are phytoplankton ecosystem with different descriptive morphology, importance and nutritive value for aquatic faunas and they serve as primary producer, medicinal, water purifiers, absorbance of carbon dioxide, hide out, spawning site for aquatic faunas and other terrestrial faunas.

Aquatic flora are floating and rooted flora of hydrophytes known as macrophytes and phytoplankton in the study of water ecosystem. They are herbs, shrubs, legumes, forage, fruits

Received: 28 April 2023 / *Revised*: 11 December 2023 / *Accepted*: 15 December 2023

or fruitless producing flowers, leaves with or no trichome with swollen and stolon or rhizomes Some are perennial monocot found in all types of water bodies [RODGERS, 2014]. They are also grasses, vegetables and rooted plants with smooth succulent or rough pine stem and lamina. They have mechanism in leaf and root capable of receiving oxygen, nutrient and water from aquatic environment with modified stem and leaves for storage and absorbance of photosynthetic activities. Most of their roots are feathery, blunt and shallow to the soil or attachment for dangling freely in water, for example water hyacinth with rooted leaves. Though, some are vegetative in nature with leaves and fruit [RODGERS, 2014], for example *Elodea* sp., *Cabomba* sp., *Ceratopteris thalictroides*, *Mourera fluvialitis*, micro sword and rooted algae. They are of different species which constitute macrophytes and phytoplankton. The aquatic flora are grouped into flaunting leaves, free floating, surmerged plants and emergent flora though some are tall, minutes, short in nature [DEGOOSH, 2014].

Aquatic plants and microflora can be seen growing abundantly in differ water bodies, lakes and water ways in every side of the world [MOHAMMED & al. 2013]. Some are floating, submerged and others are emerged. However, some are producers of amino acid, presence of anti-nutritional factor (ANF's), some have excess crude fibers, presence of cellulose, hemicellulose and lignin [KHAN & GHOSH, 2012]. They also have proximate composition of ash, crude protein and crude fat.

They are the main source of freshwater retention, and their chemical constituent need adequate growth of aquatic flora for optimum concentration of much needed nutrients (nitrogen and phosphorus) with calcium and other nutrient element [MANAHAN, 2005]. Some aquatic macrophytes are used for aesthetics, drainage, fishing, flood control, hydropower generating, irrigation, navigation, recreation and ultimately land values. Assessment of aquatic flora is of more important in the previous years over the implementation of National Pollutant Discharge Elimination System (NPDES) to regulate aquatic plants management, mostly the qualitative assessment of nuisance plant. Aquatic flora might help in reducing floods, contribute to the development of climate and weather that will supply enough dissolved oxygen (DO) to the ecosystem and may tend to reduce the deflection of ozone layer. Many microscopic organisms infect fishes, causing spoilage of aquatic environment and loss of income either by the cost of medication treatment or direct loss of the organism to infectious diseases; while some are of zoonotic potential, causing diseases in animal and human, and some may produce metabolites that can cause positive effect to man and animal [KEDDY, 2010].

The aquatic flora have some new importance but undiscovered. Marine flora are consumed by human as macro-algae, used in pharmaceutical, use as biomass feedback while freshwater flora are demanded in water garden and aquarium planting [BHARATHIRAJA & al. 2015]. Hydrophytes are used as food source notably in south east Asia but uncooked ones are involve in transmission of Fasciolopsiasis and they are source of animal nutrition, for example *Eichornia* sp. (water hyacinth), *Lemna minor* (duckweed) and *Trichanthera gigantea* (suiban) [HILL & al. 2011].

Identification of aquatic plants and microflora are broadly disturbing in Tagwai Dam, Niger State due to poor management of the water body and destruction of native flora, over grassing and water pollution. The aquatic plants and microflora are the modest of ecosystem hence they are the primary producer and ecosystem repairer. The aim of this study is the assessment of biodiversity of aquatic plants and micro flora in Tagwai Minna, Niger State, Nigeria.

Material and methods

Study Area

The study was carried out at Tagwai Reservoir, Minna, Niger State, Nigeria. Tagwai reservoir has a total surface area of 44 hectares, and storage capacity of 28.3 million m^3 of water. It has a depth of 25 meters and a length of 18 km. The reservoir was constructed in 1980 on longitude 60°39' to 60°44' East, and latitude 34° to 90°39' North to South-West of Minna [MUHAMMED & al. 2019].

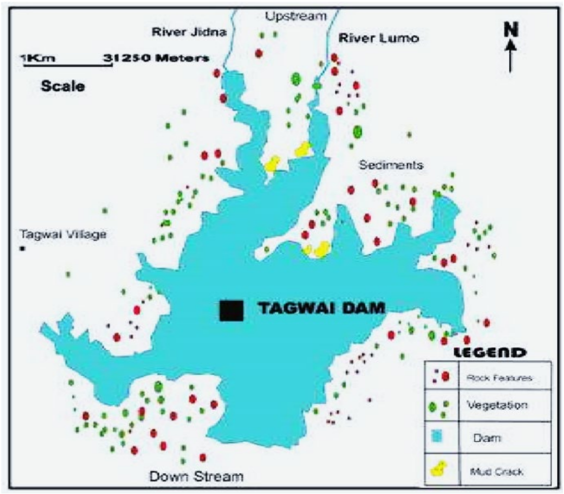

Figure 1. Map of Tagwai Dam. Source: Niger State water Board, Minna, Nigeria

Samples Collection

Transect sampling collection of aquatic flora and physical characteristic (Phytosociological) method of collection was adapted by using planktonic net, polypots and plastic bottles in five different locations of the dam with labeling p01a, p02b, p03c, p04d and p05eon weekly basis in the morning and evening for a period of four months. The map of the study area as shown in Figure 1. A 20 ml syringe Horst was attached at the bottom of the planktonic net with about 30 centimeters radius of iron rod which the net was hanged on and along (8 ft) foot stick in length for handling and taking water sample from the located point. The samples were used for the identification of aquatic flora in the Dam. More than 200 square meters away from each sampling point was use in order to avoid over distribution of aquatic the same aquatic flora species in any sampling point MADSEN & WERSAL (2017).

The water samples in the five sampling station were transported to the laboratory of Biological sciences department at Ibrahim Badamasi Babangida University Lapai for microbial analysis. The preserved samples were allowed to settled at room temperature for three days and the samples was shake for free phytoplankton and siphoned for the sample to be minimized to 10 ml for modified form for counting of cell and mount on Stereo microscope. The phytoplankton were counted identified and placed on their groups [KOLOANDA & OLADIMEJI, 2004].

Identification and the distribution of aquatic flora in Tagwai Dam

The aquatic flora were identified based on their root and leaves with the help of an atlas by [SPALDING, 2010]. The aquatic flora were identified, classified according to their species and types and also the rate of their percentage distribution / percentage frequency distribution of aquatic flora was determined by: sum = (no. of flora at a location x 100) / total number of flora.

Serial dilution of water samples

The water samples collected in the five different locations (p01a to p05e) were serially diluted in accordance to [ANDERSON, 2011].

Microbial analysis of the water samples

Prepared Potato Dextrose Agar (PDA) and Nutrient Agar were poured into 30 petri dishes, 15 petri dishes were used for each media in a sterile and conducive environment. After pouring of the medium, it was allowed to solidify and then spread plate the medium by inoculating the 10^{-3}, 10^{-4} and 10^{-5} test tube samples into the media in 3 petri dishes for each sample as described by [EFUNTOYE & al. 2012].

Characterization and identification of the microbial isolates

The fungal and the bacterial isolates from the water samples were characterized and identified based on their morphological characteristics, biochemical properties such as mannitol salt agar test, oxidase test, indole test, citrate utilization test, triple sugar iron test, gram staining and microscopic characteristics as described by CHEESBROUGH (2005).

Data analysis

The method adapted for the collection of aquatic flora was survey and transect sampling [JOHNSON & NEWMAN, 2011] where collection of data involved using of chart and tables assessment in field and laboratory. The determination of data was obtained using excel: formula = Average, mean (total number of species). The average percentage of aquatic plants distribution average was 3.1%, bacteria was with the average of 9, while fungi has average of 12% in frequency distribution.

Results

Identification and the distribution of aquatic flora

Thirty five (35) aquatic plants were identified and classified into ten (10) families, nine (9) orders and twelve (12) species and into habitat in accordance to plants habitat with *Mimosa pigra* and *Cyperus* species having the higher percentage of distribution while *Persicaria senegalensis* was less though invasive and nuisance flora accumulated into the eastern axis of the reservoir (Table 1). The distribution of aquatic flora in Tagwai Dam were: *Mimosa pigra*, *Persicaria senegalensis*, *Wolfia* sp., *Nymphaea* sp., *Ludwigia* sp., *Pistia stratiotes*, *Hydrocleys nymphoides*, *Ceratophyllum demersum*, *Lagarosiphon* sp., *Marsilea* sp., *Cyperus* sp., *Schoenoplectus* sp. (Table 2).

Table 1. Identification of aquatic flora of Tagwai Dam

Common name	Family	Order	Genus	Species
Giant sensitive tree	*Fabaceae*	*Fabales*	*Mimosa*	*pigra*
Snakeroot	*Polygonaceae*	*Caryophyllales*	*Persicaria*	*senegalensis*
Duckweed	*Araceae*	*Alimatales*	*Wolffia*	sp.
Water lily	*Nymphaeaceae*	*Nymphaeales*	*Nymphaea*	sp.
Alligator weed	*Onagraceae*	*Myrtales*	*Ludwigia*	sp.
Water lettuce	*Araceae*	*Alismatales*	*Pistia*	*stratiotes*
Water poppy	*Alismataceae*	*Alismatales*	*Hydrocleys*	*nymphoides*
Coontail	*Ceratophyllaceae*	*Ceratophyllales*	*Ceratophyllum*	*demersum*
Oxygen weed	Hydro*charitacea*	*Alismatales*	*Lagarosiphon*	*major*
Water clover	*Marsileaceae*	*Salviniales*	*Marsilea*	sp.
Giant sedge	*Cyperaceae*	*Poales*	*Cyperus*	*ustulatus*
Water reed	*Cyperaceae*	*Poales*	*Schoenoplectus*	*subterminalis*

Source: Authors collection

Table 2. Distribution of aquatic flora in Tagwai Dam

Aquatic flora	Number	Percentage (%)
Mimosa pigra	5	13.5
Persicaria senegalensis	1	2.7
Wolffia sp.	2	5.4
Nymphaea sp.	3	8.1
Ludwigia sp.	4	10.8
Pistia stratiotes	3	8.1
Hydrocleys nymphoides	1	2.7
Ceratophyllum dermersum	4	10.8
Lagarosiphon sp.	2	5.4
Marsilea sp.	3	8.6
Cyperus ustulatus	5	13.5
Schoenoplectus subterminalis	3	8.1
Total	37	99.9

Source: Authors collection

The total viable counts of the bacterial isolates from the five sampling stations of the Tagwai Dam was shown in Table 3.

Table 3. Total viable count of bacteria isolates

Location	Dilution factor	Number of colonies	Population (cf/ml)
P01a	10^{-3}	108	1.8^{5}
P01b	10^{-4}	64	6.4^{5}
P02a	10^{-3}	90	0.9^{5}
P02b	10^{-4}	47	4.7^{5}
P03a	10^{-3}	43	0.43^{5}
P03b	10^{-4}	19	1.9^{5}
P04a	10^{-3}	96	0.96^{5}
P04b	10^{-4}	50	5.0^{5}
P05a	10^{-3}	92	0.92^{5}
P05b	10^{-4}	40	4.0^{5}

Keys: P01a to P05e = station

The bacterial species identified, total number of colonies and the percentage distribution of the bacterial species in Tagwai Dam as shown in Table 4.

Table 4. Total number of colonies and percentage distribution of bacteria in Tagwai Dam

Bacteria species identified	Number of colonies	Morphology	Percentage (%)
Salmonella sp.	3	Rods	5.3
Proteus sp.	7	Rods	12.5
Escherichia coli	14	Rods	25
Pseudomonas sp.	8	Rods	14.3
Enterobacter sp.	16	Rods	28.6
Staphylococcus sp.	4	Cocci	7.1
Shigella sp.	4	Rods	7.1

Source: Authors collection

The fungal species identified and their frequency of occurrence from the sampling stations during the period of collection was shown in Table 5.

Table 5. Identification and their frequency of occurrence fungal isolates

Fungal species identified	First	Second Dish	Total count.	Percentage (%)
Aspergillus niger	4	8	12	16.9
Aspergillus flavus	5	10	14	19.7
Aspergillus fumigatus	6	3	9	12.7
Mucor pusillus	4	9	13	18.3
Penicillum notatum	3	7	10	14.0
Candida albicans	7	6	13	18.3

Source: Authors collection

Discussion

The percentage distribution of *Mimosa pigra* of the family Fabaceae, and *Cyperus ustulatus* of the family Cyperaceae as the most dominant hydrophytes with 13.5% each while, the least species of distribution was observed in *Persicaria senegalensis* of the family Polygonaceae and *Hydrocleys nymphoides* of the family Alismataceae with 2.7% each during the period of collection. This might probably be as a result of environmental factors such as rainfall and vegetation type of the plants habitat in Tagwai Dam. This is in agreement with the findings of ADESINA & al. (2011), who reported that hydrophytes with free floating and emergent plants such as the Fabaceae and Cyperaceae formed the highest frequency distribution of 93.3% with dominant species irrespective of season in Jebba Lake, the dominant species are being *Mimosa pigra* and *Vossia cuspidata*. DIENYE (2015) reported that Cyperaceae had the highest species abundance and lowest were recorded in other families in New Calabar River. Also, the findings of IDOWU & NGAMARJU (2011) reported that high abundance of species composition of aquatic hydrophytes at Lake Alau in Nigeria during the rainy season has increased the water level which had favoured the increased in aquatic free floating and emergent vegetation. The presence of *Nymphaea* sp. and *Pistia stratiotes* in some of the sampling stations might be due to the effects of transportation of wastes from domestic and industrial sources from the surroundings of the dam into these stations, these activities could enhanced the growth of these plants. ALFRED & al. (2014) reported that soil erosion, flooding, transportation of nutrient-rich industrial and domestic sources can provide rich nutrients that can boost *Nymphaea* sp. and *Pistia stratiotes* plant growth parameters and there propagules. OBOT & MBAGWU (1988) also reported that anthropogenic changes caused eutrophication of lakes, altering aquatic vegetation species and abundance in water bodies.

The bacteria species identified in the sampling stations were *Salmonella* sp., *Proteus* sp., *Staphylococcus* sp., *Esherichia coli*, *Pseudomonas* sp., *Enterobacter* sp. and *Shigella* sp. The presence and abundance of some of these bacteria species could be attributed to human domestic activities such as wastes disposal, washing at the water banks, fishing with hazardous chemicals. This corroborated with the findings of CHUKWUEMAKA & al. (2019) who reported *Salmonella* sp., *Staphylococcus* sp. and *Esherichia coli* in Tagwai Lake, as responsible for water borne disease. Also, the reports of ADAMU & al. (2022) , reported *Esherichia coli* and *Pseudomonas* sp. as the common encountered species in water and other aquatic products in Lake Dangana, Nigeria. *Esherichia coli*, *Pseudomonas* sp. and *Staphylococcus* sp. identified in this study, have been previously reported by OBIRE & AGUDA (2015), ADAMU & al. (2022) as bacterial species that are actively involved in organic materials decomposition which might have been as a result of the water through the surface run-off from the lake surroundings. SINGLETON & SAINSBURY (2001) in their findings reported these bacteria species as causative agents of gastrointestinal disorders such as diarrhea and upper respiratory infections.

The fungi species isolated and identified in the sampling stations were *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Mucor pusillus*, *Penicillum notatum* and *Candida albicans*. The presence and abundance of some of the fungi species could be as a result of organic materials degradation in the water body. ADAMU & al. (2022) reported that *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Mucor pusillus*, and *Penicillum* sp. as waste degraders in Dangana Lake, Nigeria. Similar findings were reported by ARIYO & OBIRE (2016), SOKOLO & al. (2018), ADAMU & al. (2018) as waste degraders in aquatic environments.

Conclusion

The identification and determination of the aquatic plants distribution in Tagwai Dam revealed that *Mimosa pigra* and *Cyperus ustulatus* are the dominant distributed flora with 13.5% while *Persicaria senegalensis* and *Hydrocleys nympoides* are the least with 2.7%. Though, more abundance species of plants are in Station one (p01a), the eastern axis of the dam with high rate of invasive and nuisance flora species accumulating the site which might lead to eutrophication of the reservoir. Also in the isolation and identifying of microflora (fungal and bacterial species) from the five different locations of Dam showed that *Enterobacter* species have the high rate of distribution of 28.6%, while *Salmonella* species has the low distribution of 5.3%. For the fungi *Aspergillus flavus* have higher percentage of 19.7% and the *Aspergillus fumigatus* distributed at low percentage of 12.7%. The dam has average of 1% of aquatic flora distribution.

Acknowledgments

We are grateful to the entire staff of the Laboratory of Biological sciences Department of Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria for providing technical assistance during this research.

Conflict of interest

Authors declare that they have no conflict of interest. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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How to cite this article:
MUHAMMED H. M., HAMZA U. I., HANI D. G., ALIYU A. D., GABI A. U., YAHAYA I., NDAYAKO H. H. & MONDAY M. 2023. Biodiversity of aquatic plants and microflora in Tagwai Dam, Nigeria. *J. Plant Develop*. **30**: 109-117. https://doi.org/10.47743/jpd.2023.30.1.923