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Fish diversity in the Obili Aquaculture Unit (Centre Region) and relationship to organoleptic properties of the ecosystem.

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Abstract

The study evaluated water quality and fish biodiversity in four fish ponds at the Obili Aquaculture Unit, located in the Centre Region of Cameroon, from June to November 2022. Monthly sampling was carried out, with physico-chemical parameters measured following Rodier's guidelines. A multihabitat approach was used for fish capture, employing nets to sample and count fish, which allowed estimation of total fish populations in each pond. Results indicated poorly oxygenated and slightly acidic water conditions, unfavorable for aquatic species production, along with low levels of organic pollution indicators such as nitrates, orthophosphates, and nitrites. The African catfish, identifiable by barbels, absence of scales, a single long dorsal fin, and dark grey coloration with a white ventral side, was present in all ponds. Pond 4 was stocked at a density of 20 catfish per square meter, corresponding to an estimated 8,000 catfish, while only a few Tilapia were observed there. *Oreochromis niloticus*, an omnivorous grazer feeding on phytoplankton, periphyton, aquatic plants, small invertebrates, benthic fauna, detritus, and associated bacterial films, outnumbered catfish in the other ponds. Catfish stocking was aimed at controlling tilapia populations. The Global Biological Normalized Index (GBNI) indicated poor water quality across the ponds, whereas Sørensen's similarity coefficient (exceeding 50%) demonstrated good biological similarity among the ponds. Finally, the study suggests promoting macroinvertebrate cultivation as a viable alternative to fishmeal in aquaculture feed.

Key words: Biodiversity, fish, water quality, fish ponds, Obili.

Introduction

Water is a basic and primary need of all vital processes and it is now well established that the life first arose in aquatic environment. It is one of the most important compounds that profoundly influence life (Jekayinfa *et al*, 2022). Rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota." Poorly managed resources can cause water scarcity or pollution, which may lead to health, social and economic crisis. Water quality includes all physical, chemical and biological factors of water that influence the beneficial use of the water (Alley, 2007). A fish pond is defined as a stagnant artificial water mass of shallow depth of about 1 m, more or less completely drainable at a variable frequency and intended for the production of fish (Balvay, 1980). It also refers to the breeding, rearing, and harvesting of plants and animals in all types of water environments including ponds, rivers, lakes, and the ocean. Aquaculture is agriculture in water.

Aquaculture in Cameroon is primarily practiced in freshwater ponds (Satia, 1991) and most of these ponds are located in rural areas. Aquaculture in Cameroon is mostly carried out in small ponds with an average size of 350 m2. The feeding is indirect through com post cribs loaded with organic material (mainly grass and weeds) and kitchen waste. This is commonly practised by most small scale rural fish farmers without supplementary feeding. These cribs occupy an average of 10% of the pond water surface. The emerging commercial fish farmers feed their fish with supplementary feeding (single feed ingredients such as wheat bran and cotton seed oilcake) in a fertilized pond. These ponds are fertilized using organic fertilizer such as chicken manure. Extensive and semi-intensive earthen pond fish farming are the two most common aquaculture systems in Cameroon.

Aquaculture is practised in various forms using different holding units which include, ponds, pens (enclosures) and re-circulating tanks. Pond aquaculture is most like farming. With this method, areas of land are enclosed by dikes and flooded. Fish are then added to the pond and are fed on a regular schedule and a clean source of water is used to keep the pond in the proper condition for healthy growth. Re-circulating systems also use far less water than other methods and any discharge water can be thoroughly treated to make sure that no waste is released into public waters (Timmons 2002).

Aquaculture is practised at various levels namely, extensive (small-scale), semi-intensive (medium-scale) and intensive (large-scale) systems. Extensive Systems are the lowest management levels in aquaculture with very little or no input being directed into the production. Fish are stocked in earthen ponds and other water impoundments and let to fend for themselves. These systems are highly dependent on natural productivity and the physical conditions of the water (Payne, 1986, Kolek *et al,* 2023). The main cultured species are Oreochromis niloticus, Tilapia zilli, Clarias gariepinus and Cyprinus carpio. **Semi-intensive** Systems are systems also use earthen ponds for fish culture but the ponds are fertilized using both chemical and organic fertilizers at varying proportions to enhance natural productivity. Exogenous feeding using cereals bran and other locally available feeds is done to supplement pond productivity (Kolek *et al,* 2023). Polyculture of Oreochromis niloticus, Tilapia zilli, Clarias gariepinus and Cyprinus carpio is practiced with various combinations of the species.

Intensive Systems are systems use raceways and various types of tanks as the holding units. In these systems, more fish are produced per unit area by substituting the natural productivity in the culture units by exogenous feeding, aeration and both mechanical and bio-filtration where necessary (Bromage *et al*, 1990).

A fish pond is defined as a stagnant artificial water mass of shallow depth of about 1 m, more or less completely drainable at a variable frequency and intended for the production of fish (Balvay, 1980). Like any aquatic environment, it is characterized by food chains connected to each other forming a trophic network; which gives it the term multifunctional space. Its genesis and its history depend directly on man who conditions them as he sees fit in order to derive the best benefit from them (Dussart, 1992). Indeed, with a view to maximizing fish production, humans accelerate eutrophication by dumping organic and mineral fertilizers into this body of water and ensuring its maintenance (Dakwen, 2020). These different practices affect the entire ecosystem and increase fish yield (Milstein, 1995). Lamb et al. (2008) reported that poor water quality and lack of proper monitoring of the fish pond hamper its production.

A pond is said to be eutrophic when it has high primary productivity and low mineralization, all of the biomass produced during the year are not being completely mineralized by bacteria; this results in an accumulation of organic slime (Angeli, 1980). On the other hand, a pond is said to be oligotrophic when it has low primary productivity, high mineralization, the total quantity of living matter produced being mineralized and taken up in the cycle, which result to the absence of formation of organic mud (Wurtz, 1958). An excessive supply of biodegradable organic compounds leads to an imbalance between productivity and mineralization as well as various damages resulting from the degradation of these compounds. In ponds as in lakes, productivity is maximum in all groups of living beings at the eutrophic stage (Zebaze, 2008). Beyond this stage, even the fish die from asphyxiation and fish production declines.

The factors that affect the development and operations of pond ecosystems are mainly biotic and abiotic factors. Abiotic factors are essentially non-living components that affect the living organisms of the freshwater community. These include basic inorganic components such as water, CO_2, O_2, Ca, N and P and their compounds as amino acid and humic acids, etc. Amounts of various organic compounds like carbohydrates, proteins, lipids, etc., are also estimated for biomass determination. The biotic factors on the other hand are those factors that relate to living organisms within the ecosystem. When a variety of species are present in such an ecosystem, the consequent actions of these species can affect the lives of other species in the area. These factors, which determine the sort of life that will suit adaptation to the conditions of the ecosystem, are referred to as biotic factors.

Every organism must acquire energy to live, grow and reproduce. In aquatic ecology, biologists often classify organisms according to how they obtain energy. Because sunlight is the ultimate source of energy used by organisms on the earth's surface, a basic distinction lies between those who use its energy directly—autotrophs—and those who receive it indirectly by consuming other organisms—heterotrophs.

The physico-chemical variables that provide relevant information on the state of the water in a fish pond are: Temperature, Suspended Solids (SS), colour, turbidity, transparency,), pH, electrical conductivity (Schumberger, 2002). The main physical variables of fish pond water are: temperature, suspended solids (SS), turbidity, color, water transparency and Total Dissolved Solids (TDS) (Rodier *et al*., 2009). Temperature, which is considered as a fundamental ecological factor, influences water density and therefore plays an important role in the phenomenon of stratification of water bodies (Gaujous, 1995). It intervenes in the distribution of biological species, because it plays an essential physiological role (Céline, 2009). Any sudden variation in this parameter causes a disturbance in the balance of the aquatic ecosystem. SS represent all the organic and mineral matter suspended in water. They come either from the decomposition of dead organisms or from detritus resulting from organic fertilizers brought to the body of water by the fish farmer, or even from the leaching of the catchment area after heavy rain. Suspended Solids produce mechanical pollution and increase water turbidity (Leynaud and Verrel, 1980). SS levels (> 30 mg/L) in the water disrupt photosynthesis by reducing transparency, thus inducing a drop in dissolved oxygen content which can lead to the death of invertebrates and fry by asphyxiation after clogging of their gills or appendages (Zébazé, 2000).

They often constitute a stock of food for invertebrates and protect them against predators (Pourriot, 1980; Leynaud and Verrel, 1980). Nutrient deprivation of pond water is indicated by low turbidity, and high water transparency (>30 cm). Turbidity also indicates the cloudy state of water. It plays a complex role by lowering the level of penetration of light into the body of water: it is the absorbing power. The colour is due to mineralization, the presence of humic substances and various pollutants. Eutrophication also causes an increase in algae and changes in water chemistry. The transparency makes it possible to appreciate the level of light penetration in the water. The depth of light penetration provides information on the zone of high photosynthetic production in ponds (Soulard, 2007). The Total Dissolved Solids (TDS) provide information on the degree of mineralization and on the catabolic activity of the microorganisms present in the medium.

Physical parameters include colour, odour, temperature, transparency, turbidity, total solid wastes etc. Chemical characteristics involve parameters such as pH, dissolved oxygen, free carbon dioxide, alkalinity, total hardness, presence of ammonia, phosphate, chlorine, calcium, magnesium etc. Likewise, biological indicators of water quality include fishes, macroinvertebrates, macrophytes and phytoplankton. Selection of parameters for testing of water solely depends upon for what purpose we are going to use that water and what extent we need its quality and purity (Patil *et al.,* 2012). Water is a natural resource and fundamental need of all organisms, plants, animals and humans; it is also the most necessary solvent for agriculture, industry, tourism and aquaculture (Aydin, 2018, Partyka *et al,* 2022)

Aquaculture depends predominantly on water and regular monitoring of water quality is a necessity. Fish cultivation also known as aquaculture consists of natural and artificial fish farming carried out in ponds (Akpotayire *et al.,* 2018). Fish and other organisms with aquacultural potential live in water, thus, it is no surprise that professional fish culturists state that "Water quality determines to a great extent the success or failure of a fish cultural operation" (Piper *et al.,* 1982). Environmental pollution is a primary burden of aquaculture as poor water quality in fish ponds will result to deteriorated fish health and eventually low production. The status of various water parameters like turbidity, pH, alkalinity, hardness, ammonia, nitrite, nitrate, biochemical oxygen demand (BOD) etc. cannot be overlooked for maintaining a healthy aquatic environment (Bhatnagar and Pooja, 2013. This is a key concern for this study especially as the result will offer valuable information to fish farmers in raising fishes efficiently. If culturists are properly guided and aware about water quality management practices, they can get maximum fish yield in their ponds to a greater extent (Bhatnagar and Pooja, 2013). This also demand the necessity for this study.

The physicochemical properties of water could be influenced by the culture systems (Mustapha, 2017). Beyond filling the gap in dearth of scope of inquiry into fish pond water quality, this study also aims to bring awareness to fish culturists about the vital water quality parameters that needs constant monitoring as a result of their impact on the health of fishes.

The main objective of this study is to assess the biodiversity of fish in four fish ponds at the Obili Aquaculture Unit. The specific objectives are to measure the physico-chemical parameters of the fish ponds water, to identify fish at the Obili Aquaculture unit, and bring out the correlation between the physicochemical parameters of the water and the distribution of fish in the ponds.

Materials et Methods

II.1.1 Geographical localization

II.1.1.1 Presentation of the study zone

This study was carried out at the Obili Aquaculture Unit in Obili, a locality within the Yaounde 6 Municipality, Mfoundi Division of the Centre Region in Cameroon. The geographical coordinates are 3°51’23.1’’N and 11°29’43.5’’E, with a mean depth of 750 meters. The Obili Aquaculture Unit was established by the Ministry of Livestock, Fisheries, and Animal Industries and is managed by the ministry's staff. The climate of the area corresponds to that of Yaounde, characterized by a tropical wet and dry climate: a long dry season from November to February; a long rainy season from March to October, with the heaviest rains typically occurring between August and September.

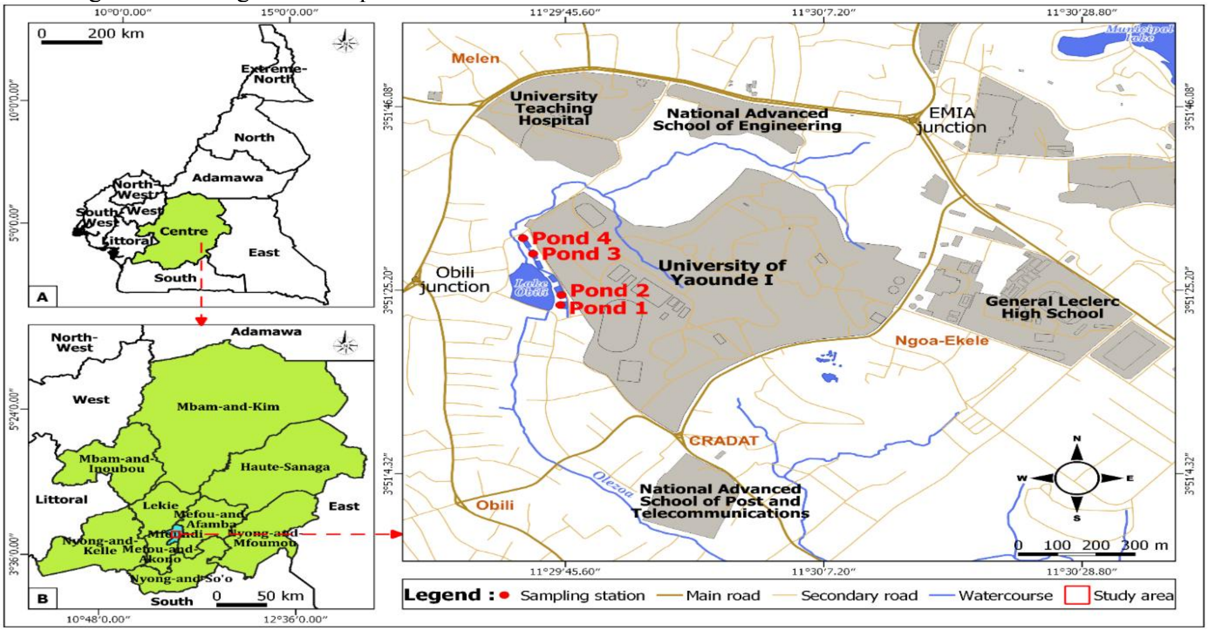

Figure 1: Location of the study area and site

II.1.2 Presentation of study site

The four fish ponds studied are located at the Obili Aquaculture Unit, adjacent to Lake Obili, one of the most well-known lakes in the city of Yaounde. Studies conducted on this lake have shown that it is hyper-eutrophic, which poses significant risks because the lake is used for aquaculture, tourism, and serves as a useful site for hydro-biological engineering research. The ponds are situated near the campus of the University of Yaounde 1, hospitals, farmlands, and are surrounded by residential houses. The water sources for Lake Obili and the ponds come from the Olezoa River and Lake Atemengue. These ponds are diversion ponds fed directly by gravity through a diversion canal, which serves as the main water feeder. Each pond has an inlet and an outlet. Only one pond among them was fully stocked. Each pond represents a station, making up four stations (Station 1, 2, 3, and 4).

II.1.3 Description of study stations

Pond 1, or Station 1, has a surface area of 150 m² and an average depth of 70 cm, located at geographical coordinates 03°51.394'N and 11°29.745'E, with an altitude of 705 meters. An extensive fish farming system, which is the least intensive and least managed type, is practiced here. This system involves large ponds with stocking densities limited to less than 5,000 fish per hectare. No supplemental feeding or fertilization is provided, and the fish depend solely on natural food sources. During the research period, this pond was partially drained and cleared once in August. Its surface was partially covered with macrophytes such as Cyperaceae and Nympheaceae. Fish species in the pond include tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*), with tilapia outnumbering catfish by approximately four to one. The ponds in the unit are connected in parallel (Figure 2).

Figure 2 : Station 1 before(A) and after(B) cleaning

Pond 2, or Station 2, has a surface area of 140 m² and an average depth of 100 cm, located at geographical coordinates 3°51.408'N and 11°29.752'E, with an altitude of 702 meters. Similar to Station 1, an extensive fish farming system is practiced here, which is the least managed form of fish farming, involving minimal care. This system includes large ponds with a stocking density limited to less than 5,000 fish per hectare. No supplemental feeding or fertilization is provided; fish depend solely on natural food sources. During the research period, this pond was partially drained and cleared once in August. The pond's surface was partially covered with macrophytes such as those from the Cyperaceae and Nympheaceae families. Fish species present include tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*), with tilapia outnumbering catfish by approximately four to one. At the unit, the ponds are connected in parallel (Figure 3).

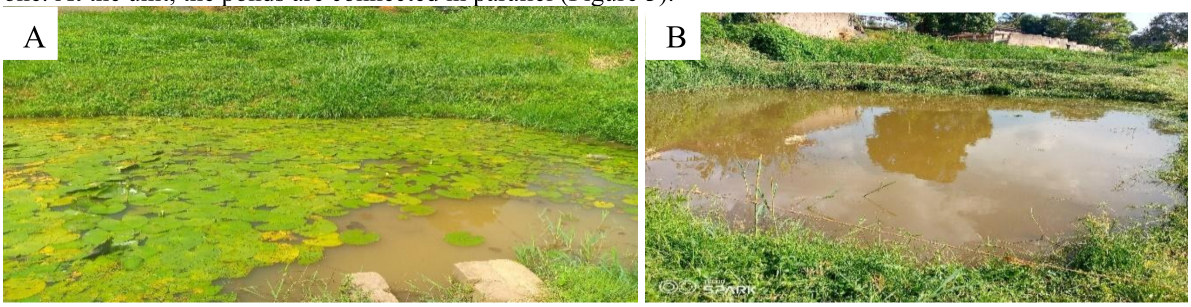

Figure 3: Station 2 before(A) and after(B) cleaning

Pond 3, or Station 3, has a surface area of 300 m² and an average depth of 100 cm, located at geographical coordinates 3°51.489'N and 11°29.715'E, with an altitude of 697 meters. Unlike Stations 1 and 2, a semi-intensive fish farming system is practiced at this station. This system involves fertilizing the pond with organic fertilizers in varying proportions to enhance natural productivity. Exogenous feeding with cereal bran and other locally available feeds is also applied to supplement pond productivity. Therefore, fish here do not rely solely on natural food sources. During the research period, this pond was partially drained and cleared twice, both times in August. The pond surface was partially covered with macrophytes such as those from the Cyperaceae and Nympheaceae families. Fish species present include tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*), with tilapia outnumbering catfish by approximately four to one. At the aquaculture unit, the ponds are connected in parallel. Pond 3 is approximately 300 meters from Stations 1 and 2 but only about two meters from Station 4 (Figure 4).

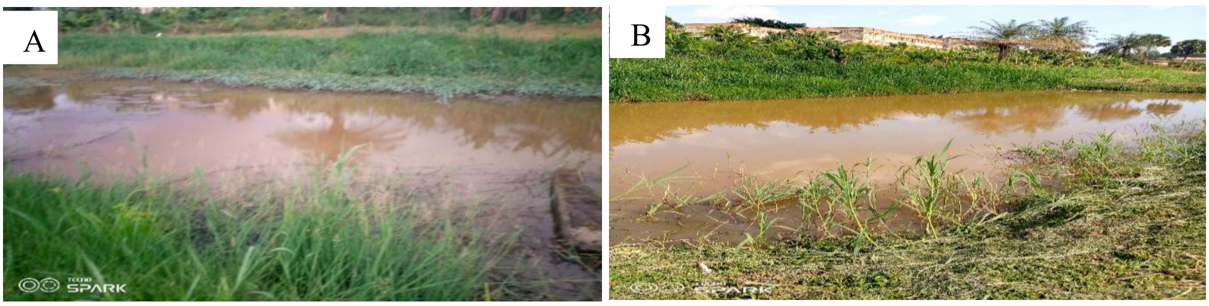

Figure 4: Station 3 before(A) and after(B) cleaning

Pond 4, or Station 4, has a surface area of 400 m² and an average depth of 100 cm, located at geographical coordinates 3°51.523'N and 11°29.699'E, with an altitude of 689 meters. Similar to Station 3, a semi-intensive fish farming system is practiced here, where the pond is fertilized with organic fertilizers in varying amounts to enhance natural productivity. Exogenous feeding with cereal bran and other locally available feeds is regularly applied to supplement pond productivity. In this station, African catfish (*Clarias gariepinus*) is the only stocked species, stocked at a density of 20 fingerlings per square meter. Catfish are primarily omnivorous bottom feeders that feed mainly at night. Their diet includes aquatic plants and seeds, fish, mollusks, insects and their larvae, and crustaceans. During the research period, several fish deaths were recorded, attributed to over-fertilization. The pond was consistently kept clean and surrounded by iron rods to prevent predators and theft (Figure 5).

Figure 5: Station 4, before(A) and after(B) cleaning

II.2 Methodology

II.2.1 Study period

This study was conducted from May 2022 to November 2022 and consisted of two phases. The first phase, lasting one month in May 2022, involved prospecting the site to gain a better understanding of the ponds and to select appropriate sampling stations. The second phase, from June 2022 to November 2022, involved monthly sampling over six months for the collection of physico-chemical and biological data from the four fish ponds.

II.2.2 Physico-chemical analyses

Water samples for chemical analysis were collected using 250 ml and 1000 ml double-capped polyethylene bottles. Care was taken to avoid introducing air bubbles by filling the bottles to the brim. The samples were then stored in a cooler with dry ice and transported to the laboratory. The chemical parameters analyzed in this study were selected based on their direct influence on the development of cultured fish or their impact on the pond's food web. These parameters were measured using standard analytical methods as described by Rodier et al. (2009).

II.2.3 Variables measured on the field

II.2.3.1 Temperature

The temperature of pond water was measured in situ, using a HANNA model thermometer by immersing the electrodes in the samples after calibration. The results are given in °C.

II.2.3.2 pH

The pH was measured in situ, using the LAQUAtwin pH.

II.2.3.3 Electrical Conductivity and Total Dissolved Solids (TDS)

These parameters were measured on the field using a HANNA HI 9829 multi-parameter by immersing the electrodes in the samples after calibration. The results are expressed in µS/cm and mg/L respectively.

II.2.3.4 Suspended Solids (SS), Turbidity and Colour

Turbidity, colour and SS were measured in the laboratory by colorimetry with a HACH DR/2010 spectrophotometer, at wavelengths 860, 455 and 810 nm respectively. The values are expressed respectively in FTU, Pt-Co and in mg/L.

II.2.3.9 Sampling of biological specimens

In the laboratory, the samples were put in 70% ethanol, and identified with the help of an optical microscope and also with the use of the identification keys of Nathalie (2000), Henri *et al.* (2010) and Moisan (2010).

II.3.2 Spearman rank correlation coefficient

This correlation has the formula: $r = 1 - \frac{6 \times \sum \left(Y_i^{'} - X_i^{'}\right)}{n\left(n^2 - 1\right)}$ where

X'= rank of x; Y'= rank of y; n = number of values of x with n < 10; r = Spearman correlation.

Results and Discussion

III.1. Results

III.1.1. Physico-chemical parameters of the studied fishpond waters

III.1.1.1. Temperature (°C) and suspended solids (SS)

During the study period, water temperature varied between 25.4°C in August at pond 1 (Station 1) and 26.5°C in September at pond 3 (Station 3) (Fig. 6A), with a temperature range of 1.1°C and an average of 25.82 ± 0.26°C. The Kruskal-Wallis H-test indicated no significant spatio-temporal variation in temperature ($P > 0.05$). Suspended solids (SS) concentrations ranged from 0 mg/L in September at pond 3 to 228 mg/L in August at pond 1 (Fig. 6B), fluctuating around a mean value of 49.16 ± 46.28 mg/L. Similarly, the Kruskal-Wallis H-test showed no significant spatio-temporal variations in SS levels ($P > 0.05$) (Figs. 6A and 6B).

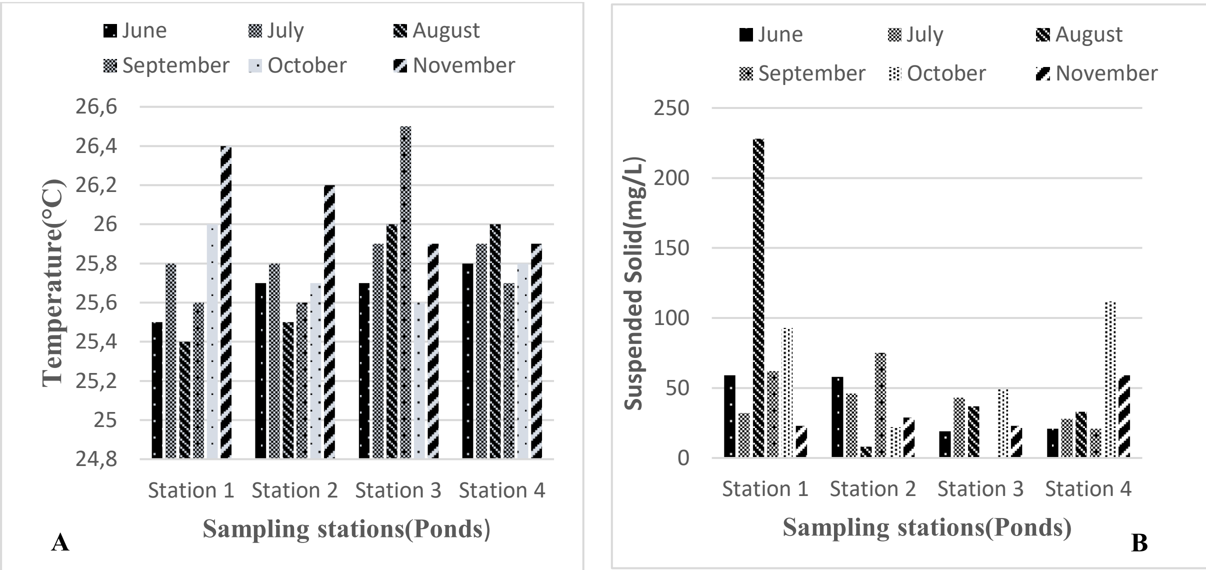

Figure 6: Spatial and temporal variations of temperature (A), SS (B) in the studied ponds

III.1.1.2. Turbidity and Colour

Turbidity shows a high value of 118 FTU in the month of August in pond 1 and a low value of 4 FTU in the

Turbidity reached a maximum value of 118 FTU in August in pond 1 and a minimum value of 4 FTU in September in pond 4 (Fig. 7A), with an average of 33.58 ± 27.53 FTU. The Kruskal-Wallis H-test showed no significant differences in turbidity measurements across different times and locations. Regarding colour, the highest value of 500 Pt-Co was recorded in August for ponds 1 and 3, and in October and November for pond 4, while the lowest value of 4 Pt-Co was observed in September in pond 4. The average colour value was 312.91 ± 155.91 Pt-Co (Fig. 7B). The Kruskal-Wallis H-test also found no significant differences ($P > 0.05$) in colour measurements over time and between ponds (Figs. 7A and 7B).

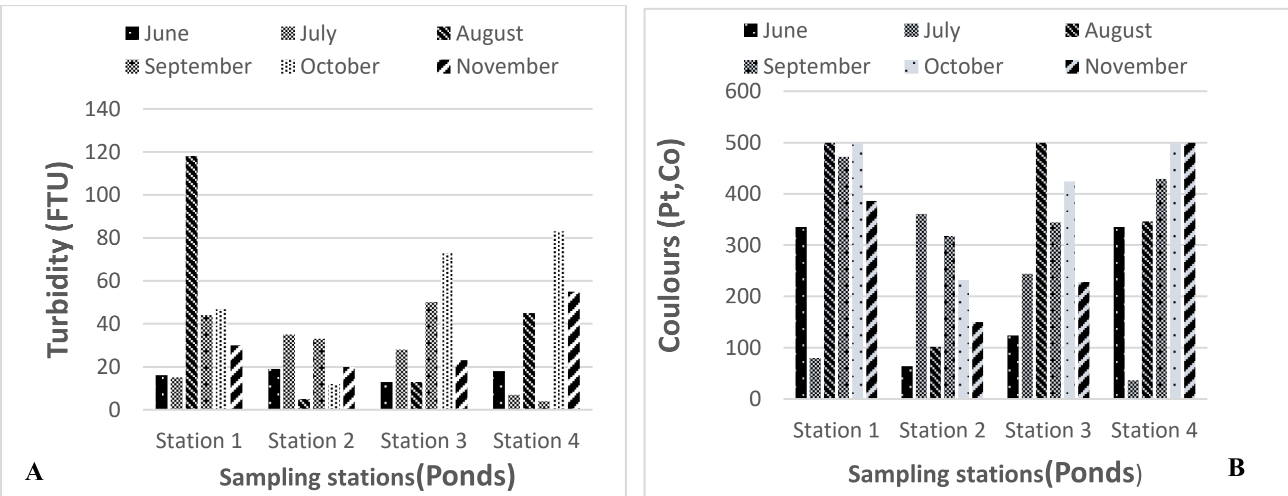

Figure 7: Spatial and temporal variations of turbidity (A), colour (B) in the studied ponds.

III.1.1.3. Electrical conductivity and pH

Turbidity reached a maximum of 118 FTU in August in pond 1 and a minimum of 4 FTU in September in pond 4 (Fig. 8A), with an overall average of 33.58 ± 27.53 FTU. The Kruskal-Wallis H-test revealed no significant differences in turbidity values across different ponds and sampling months. For colour, the highest value of 500 Pt-Co was recorded in August for ponds 1 and 3, as well as in October and November for pond 4. The lowest color value, 4 Pt-Co, was observed in September in pond 4. The average colour value was 312.91 ± 155.91 Pt-Co (Fig. 8B). Similarly, the Kruskal-Wallis H-test indicated no significant differences ($P > 0.05$) in colour measurements among ponds or over time (Figs. 8A and 8B).

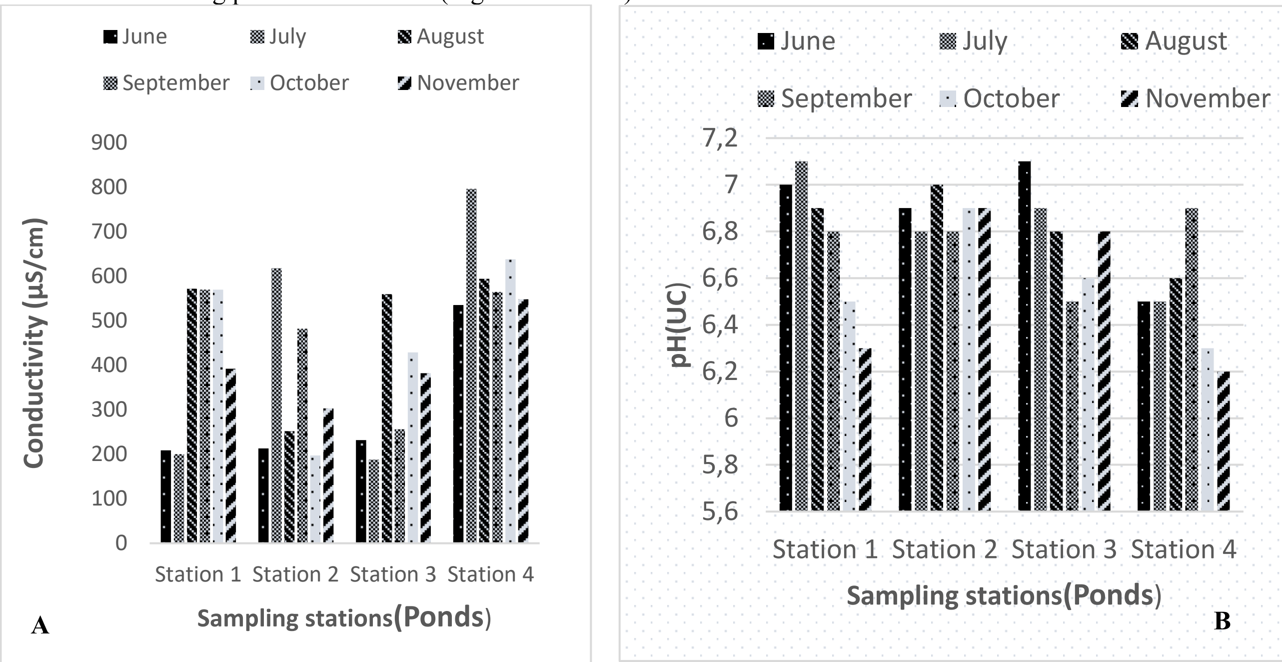

Figure 8: Spatial and temporal variations of conductivity (A), pH (B) in the studied ponds.

III.1.5 Correlations between the different parameters measured

III.1.5.1 Correlation between the physico-chemical data of the studied ponds

The Spearman rank "r" correlation test revealed significant correlations between some physico-chemical parameters during the whole study period. On the other hand, there exist a positive correlations between electrical conductivity and total dissolved solid ($r=0.939$; $p=0.000$) and colour ($r=0.557$; $p=0.005$); Total Dissolved Solids with colour ($r=0.495$; $p=0.014$); total dissolved solid and suspended solid ($r=0.412$; $p=0.045$), Ph and alkalinity ($r=0.877$; $p=0.000$).

III.1.7 Distribution of fish (Catfish and Tilapia) at the obili aquaculture unit during the study period

The distribution of catfish and tilapia in a fish pond depends on several factors, including their habitat The distribution of catfish and tilapia in fish ponds is influenced by factors such as habitat preferences, feeding behaviour, water quality, and pond management. Catfish are bottom dwellers, usually found in deeper areas or near the pond floor where they can burrow and prefer locations with sufficient dissolved oxygen. Tilapia, in contrast, occupy shallower regions and the edges of ponds, often among aquatic vegetation and with less need for cover.

To estimate fish quantity, several methods were applied depending on pond size and species. Visual observation was used in clear, small ponds to estimate fish numbers directly. Sampling with nets allowed for capturing and counting a sample, which was used to estimate total populations. Additionally, pond owners contributed data on stocking density, average size and weight, and provided historical records to improve count accuracy.

The food web within the pond can be indirectly affected by the food source, as macroinvertebrates are crucial for nutrient cycling and ecosystem balance. Throughout the study, ponds 3 and 4, which hosted the most fish species, had fewer macroinvertebrates compared to ponds 1 and 2, illustrating the interaction between fish populations and macroinvertebrate abundance.

Table 1: Distribution of fish (Catfish(C) and Tilapia(T)) in the obili aquaculture unit during the study period (Number Fish/sampling).

Ponds	June		July		August		September		October		November	
	C	T	C	T	C	T	C	T	C	T	C	T
1	250	1000	250	1000	225	900	225	900	225	900	180	750
2	250	1000	250	1000	233	932	233	932	233	932	196	802
3	500	2000	500	2000	487	1981	487	1981	487	1981	467	1930
4	8000	100	8000	100	7760	80	7760	45	7760	23	7321	10

Table 2: Identified fish species at the sampling ponds

Clarias gariepinus(African catfish)

Kingdom: Animalia
Phylum: Chordata
Superclass: Gnathostomata
Class: Osteichthyes
Order: siluroidei
Family: Claridae
Species*: Clarias gariepinus*

The African catfish is a fast growing farmed fish species. It is native to most water bodies in Africa The adult's diet is essentially fish-eating and tilapia constitutes most of the time the major part of its ration. The external noticeable features of the African Catfish are presence of barbels, lack of scales, presence of one long dorsal fin, and dark grey in colour with a white ventral section. Pond 1 to 4 had African catfish during my research period but pond 4 was stocked at the rate of 20 catfish per metre square which implies that the said pond had 8000 catfish. Only few Tilapia could be seen in pond 4.

The young are planktivorous. This species has a nocturnal feeding habit. The African sharptooth catfish is a large, eel-like fish, usually of dark gray or black coloration on the back, fading to a white belly. In Africa, this catfish has been reported as being second in size only to the vundu of the Zambesian waters, although FishBase suggests the African sharptooth catfish surpasses that species in both maximum length and weight. It is a nocturnal fish like many catfish. It feeds on living, as well as dead, animal matter (such as insects, plankton, snails, crabs, shrimp, other invertebrates, birds, reptiles, amphibians, small mammals, other fishes, and eggs) and plant matter such as fruit and seeds. Because of its wide mouth, it is able to swallow relatively large prey whole. It has been known to take large waterbirds such as the common moorhen. It is also able to crawl on dry ground to escape drying pools. Further, it is able to survive in shallow mud for long periods of time, between rainy seasons.

Environmental tolerance ranges Clarias gariepinus can endure extremely harsh conditions (Skelton 2001). It is able to tolerate very low oxygen concentrations and even survive for considerable periods out of water, via the use of a specialised suprabranchial organ (Safriel & Bruton 1984, Hecht et al. 1988). This organ is a large paired chamber with branches above the gill arches specifically adapted for air breathing (Maina & Maloiy 1986) and allows it to move over land even when not forced to do so by drought (Welman 1948, Johnels 1957). Water temperatures between 8 and 35°C, salinities of 0 to 10‰ and a wide pH range are all tolerated (Safriel & Bruton 1984). C. gariepinus exhibits high growth rates between 25 and 33 °C, with optimum growth recorded at 30°C (Britz & Hecht 1987). The ability of the fish to be able to tolerate

	these extreme conditions allows it to survive even in moist sand or in borrows with an air water interface (Bruton 1979c, Van der Waal 1998).
 *Oreochromis niloticus* (Nile Tilapia)	Phylum: Chordata Superclass: Gnathostomata Class: Actinopterygii Order: Perciformes Family: Cichlideae Species: *Oreochromis niloticus* *Oreochromis niloticus*, is an omnivore-grazer, which feeds on phytoplankton, periphyton, aquatic plants, small invertebrates, benthic fauna, detritus and bacterial films related to detritus. In the other three ponds, Tilapia outnumbered catfish. Catfish were stocked to control the population of tilapia.**Environmental tolerance:**The **Nile tilapia** (***Oreochromis niloticus***) is a species of tilapia, a cichlid occurring naturally in parts of Africa (such as its namesake Nile River) and the Levant, though numerous introduced populations exist outside its natural range. This current wide range is caused by its high commercial value as a food fish, where it is marketed as **mango fish** (not to be confused with the mango tilapia, or *Sarotherodon galilaeus*), **nilotica**, or **boulti**, along with many other names, both local and foreign. Due to its value, the Nile tilapia is widely aquacultured across the world due to its hardiness and a mode of reproduction conducive to mass rearing, namely mouthbrooding, and various attempts have been made to increase production yields, including hybridization with other tilapias.The Nile tilapia can be found in most types of freshwater habitats, such as rivers, streams, canals, lakes, and ponds, and ranging from sea level to an altitude of 1,830 m (6,000 ft). It also occurs in brackish water, but is unable to survive long-term in full salt water. The species has been recorded at water temperatures between 8 and 42 °C (46 and 108 °F), although typically above 13.5 °C (56.5 °F), and the upper lethal limit usually is at 39–40 °C (102–104 °F). Also, some variations occur depending on the population. For example, those in the northern part of its range survive down to the coldest temperatures, while isolated populations in hot springs in the Awash Basin and at Suguta River generally live in waters that are at least 32–33 °C (90–91 °F). Although Nile tilapia can survive down to relatively cold temperatures, breeding generally only occurs when the water reaches 24 °C (75 °F)

III.2 Discussion

Water quality evaluation is an important part of environmental monitoring since it plays significant role for survival of aquatic organisms and other ecosystems process. When water quality is poor, it affects not only aquatic life but the surrounding ecosystem as well. These sections detail all of the parameters that affect the quality of water in the environment.

During the course of this study, water temperature values in the sampling stations were not high (25.4-26.5°C) and varied slightly from month to month and from station to station. These values are close to those recorded by Tuan *et al* (2021). According to Tuan *et al* (2021) it is caused by changes in weather conditions such as rainfall, wind, and cloud cover and according to Zhou et al. (2021), low dissolved oxygen levels can also affect water temperature in fish ponds by reducing the rate of oxygen consumption by aquatic organisms, which in turn can result in a decrease in heat production.

The suspended solids values are positively correlated with colour (r=0.688; p=0.002) and finally with turbidity (r= 0.622; p=0.001) which would be inputs through excretion, benthivorous species like common carp (Cyprinus Carpio) stir up the sediments while foraging, leading to increased turbidity and according to (Scheffer *et al,* 2003) it is due to the contamination of the water by poorly soluble organic waste coming from the clogging of the fish ponds with macrophytes. Rodier *et al* (2009) also emphasises that the higher the density of suspended particles, the more turbid and coloured the water. In this light, Arfi *et al*. (2003) state that, the main part of aquatic turbidity is linked to the presence of particles in suspension in the water. These values drop considerably after the cleaning of macrophytes in these fish ponds in September which would explain the role that weed control plays in eliminating undissolved pollutants contained in the water.

The average pH value (6.7 ± O.25 UC) shows that the pond waters are slightly acidic. The slightly acidic character of water would be, according to Zébazé (2000), influenced by the acid nature of the soils of the region because the pH of the waters depends on the nature of the substrate crossed. These values are similar to the result of Nziéleu (2006) obtained in two ponds in Yaoundé (6.83 CU). Nevertheless, this pH remains within the pH range (6.5 - 9.0) recommended by the MDDELCC (2014) for the protection of aquatic life. The presence of dissolved oxygen is essential to maintain the higher forms of biological life and to keep proper balance of various pollutions thus making the water bodies healthy. The chemical and biochemical process undergoing in water body are largely dependent upon the presence of oxygen. Estimation of dissolved oxygen is a key test in water pollution and waste treatment process control.

Electrical Conductivity ranged from 188 – 796 µs/cm in the study area. The average values of electrical conductivity (429.20± 179.89 µS/cm) and TDS (429.20±106.31mg/L) were obtained in the sampling stations and according to Ajeagah et al. (2018) would be related to high mineralization of organic matter in the waters. Furthermore, it appears that electrical conductivity is positively and significantly correlated with TDS (r=0.939; p=0.000).

Conclusion

At the end of this study, which had as general objective to evaluate the water quality and macroinvertebrates biodiversity carried out in four (04) ponds or sampling stations at the Obili Aquaculture Unit, the physico parameters of the fish ponds were measured and was found out that the pond are poorly slightly acidic which are not favourable for the production of aquatic species. Secondly, it was noticed that pond 3 and 4 which had the highest number of fish species due to the fact that there is an important food source for fish.From the results obtained during the study period, and with the aim of improving and preserving the water quality and faunal diversity of the Obili Aquaculture Unit, the following recommendations were given: The Nile tilapia, *Oreochromis niloticus*, is a highly valued fish species in Africa for subsistence and commercial purposes. However, overfishing activities in non-supervised lakes or reservoirs threaten its availability. ***Oreochromis*** is a large genus of oreochromine cichlids, fishes endemic to Africa and the Middle East. A few species from this genus have been introduced far outside their native range and are important in aquaculture. Many others have very small ranges; some are seriously threatened, and *O. ismailiaensis* and *O. lidole* possibly are extinct.[1] Although *Oreochromis* primarily are freshwater fish of rivers, lakes and similar habitats, several species can also thrive in brackish waters and some even survive in hypersaline conditions with a salinity that far surpasses that of seawater.[1] In addition to overfishing and habitat loss, some of the more localized species are threatened by the introduction of other, more widespread *Oreochromis* species into their ranges. This is because they—in addition to competing for the local resources—often are able to hybridize

The Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) has to provide the unit and other decentralised services with sufficient means to enable the implementation of all the regulatory provisions for the protection of the ponds; ensures the strict application of the regulatory measures already adopted for the protection of the ponds, facilitates access to funds for fish farmers for the purchase of equipment for pond water analysis. The said ministry also has to supply manuals on pond water quality standards. Fish farmers should be trained on pond water quality management and how to manage water before it enters the ponds. We recommend that hydro biologists should take a greater interest in macroinvertebrate studies of peri-urban and rural fish ponds in order to build up a protein database for fish nutrition in extensive farming.

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