AJBS Asian Journal of Biological Sciences

OPEN ACCESS

Water Quality, Zooplankton Community and their Interaction in FUDMA Earthen Production Fish Pond

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ABSTRACT

Background and Objective: The assessment of water quality parameters in FUDMA's pond environment, in conjunction with biotic elements like phytoplankton, zooplankton, water insects, aquatic snails and freshwater fish, plays a crucial role in regulating the abundance, distribution and diversity of zooplankton within the pond waters. This study investigates the physicochemical water quality parameters of FUDMA, focusing on artificial ponds and examines their interactions with the zooplankton population, providing foundational insights into pond ecosystems. **Materials and Methods:** The research involved the collection of experimental water samples from three distinct pond stations between July and September 2023 for the analysis of water quality parameters and zooplankton identification using standard techniques. Statistical analysis, employing One-way ANOVA with a significance level of 0.05, was applied to the data. **Results:** The results indicate that all water quality parameters fall within acceptable ranges for pond environments. Nine zooplankton subclasses, including Cyclopoid, Copepoda, Caleinoida, *Moina*, *Brachionus*, *Asplanchnopus multiceps*, *Polyarthra vulgaris* and *Asplanchna*, were identified. Throughout the survey period, the water quality parameters of FUDMA fish ponds remained within acceptable limits, indicating good water quality conducive to aquatic organisms. Notably, Cyclopoid, Copepoda, Caleinoida and Moina emerged as the most abundant zooplankton in the ponds. **Conclusion:** In conclusion, the study underscores the importance of monitoring water quality parameters and their impact on zooplankton populations in artificial pond environments, contributing valuable information for pond management and conservation efforts.

KEYWORDS

Physicochemical parameters, zooplankton, aquaculture, ecological interactions, aquatic ecosystem, biotic factors, abiotic factors

INTRODUCTION

Aqua (water) is amongst the most significant donations/gifts of natural surroundings to mankind in addition it performs extremely vital roles in existence in addition to meeting the everyday requirements of human beings[1]. A satisfactory aquatic situation is amongst the needs for the sustained survival then growth of fish in addition to other water animals from the period the entire lifespan process of the fishes

ISSN: 1996-3351 (Print)
https://doi.org/10.3923/ajbs.2024.93.101

Received: 06 Nov. 2023
Accepted: 08 Jan. 2024
Published: 31 Mar. 2024

is completely dependent on the fineness of aquatic in addition to it is environs. The physicochemical water quality parameters (physical, chemical and biological parameters) of the aquatic environment must be satisfactory for fish healthiness in addition to continuing existence[2]. Physicochemical factors are physical, chemical and biological features of the water body, regularly in admiration to it is suitability for a designated use[2]. Aquatic water bodies have remained over the years used up for game, home water sources, angling events, dry season farming or commerce. These designated uses have dissimilar well-defined biological, chemical and physical morals required for their repairs. Subsequently, aquatic water excellence is essential to the fitness and safety of whichever environment, which is governing of the biological, chemical and physical qualities of the aquatic water body[2]. Aquatic water body establishes a portion of the dynamic water life expectancy supportive system in which inorganic and organic elements are liquefied or suspended then in which a widespread diversity of animals lives in addition to relate with each other[3]. Aquatic water bodies (freshwater) such as rivers, ponds, reservoirs, brooks, rivulets, lagoons and dams are used to survey and then check the productivity in addition to the movement of water creatures (animals and plants)[4]. It is recognized that the yield of an artificial lake is determined by its environmental circumstances in addition to checking the aquatic water excellence. The physicochemical factors of the aquatic water are the important sources that impact the changing aspects and patterns of the phytoplankton and zooplanktons[4]. As the water system, the lake, pond, river and reservoir environment is put in danger by the effect of a widespread range of chemical, biological and physical features, whose rise or reduction regularly touch the fauna and flora which may effect in the changing of their multiplicity, spreading and richness. These reasons comprise, nevertheless not limited to force, bulk, buoyancy, temperature, light, oxygen content, dissolved oxygen, biological oxygen demand and carbon dioxide in addition to hydrogen ion concentration[5]. Excellence touches the richness, classes/species multiplicity, steadiness and yield in addition to the physiological situation of native inhabitants of water creatures. Certain species or classes display in extremely eutrophic water bodies however others are very delicate to natural or biochemical pollutant[5].

Zooplankton are heterotrophic planktonic faunas fluctuating in the aquatic environment that create a significant nourishment source for numerous species of water creatures[5]. In the water nourishment web of best freshwater environments, zooplankton inhabits an intermediary trophic location, occupying freshwaters with a wide range of physical, chemical and biological stuff, therefore showing a diversity of ecological menaces in addition to stressors[6]. Once well detected, the species structure of the zooplankton could offer a sign of ecological healthiness[5,7] At times of high currents, the populace of certain creatures may be depleted as the aquatic water excellence declines, which may possibly effect to the drop in the variety of classes or species in addition to complete richness of dissimilar creatures discovered in the aquatic water body[5,7]. The condition may turn worse when the factors impacting the populations of zooplankton continue unknown[5], most especially in areas where environmental standards of zooplankton are frequently not well acceptable[5,8]. The contact between the physical, chemical and biological factors in addition to plankton production of aquatic bodies is of huge significance in the controlling approaches to water environments[5,9]. Due to the crucial role of zooplankton in most water environments, there is a stable requirement to discover the influence of stressors (such as the physical, chemical and biological parameters of lakes, rivers and reservoirs) on their multiplicity in addition to richness[5,10]. In addition, aquatic bodies such as ponds, dams, reservoirs then tributaries offer valuable environmental services, such as domestic water supply, diet production and sports in addition to games. Being affected by it accessible in adequate quantity and excellence influences the maintenance of well-being. Anthropogenic doings have been discovered to contaminate surface waters in addition to damaging their basic usage via the process of contamination[11]. This study investigated aspects of some physicochemical parameters and zooplankton periodicity and abundance in FUDMA earthen production fish pond.

MATERIALS AND METHODS

Study area: The study was conducted between July and September, 2023 at the FUDMA earthen pond site. The FUDMA earthen pond site is located inside FUDMA Take-Off campus, in Dutsin-Ma Local

Government Area of Katsina State, North West, Nigeria. The pond was constructed since 2014 and has been functional to date. The fish pond was built for training and research purposes for both the student and researchers from the Department of Fisheries and Aquaculture. For the purpose of this research two were selected namely, pond A and B and ponds were presently stocked with *Clarias gariepinus* (African mud catfish) and *Oreochromis niloticus* (poly culture system).

Water sampling procedures and duration: Water samples were collected twice every month from each of the three selected places (upstream, middle and downstream) in each of the ponds at 8:00 and 10:00 am hrs, for a period of 3 months (July to September, 2023). The water samples were analyzed in the field for the selected water quality parameters including, temperature, pH, dissolved oxygen, conductivity and transparency and then determined following the methods described by Dauda and Akinwole[12]. All the techniques followed the standard procedures[13].

Zooplanktons assessment: The experimental samples were acquired from three designated sampling stations within the fish ponds, denoted as site A, B and C, during the time frame of 8:00 am to 10:00 am. The collection of zooplankton samples was conducted utilizing a plankton net with a diameter of 15 cm and a mesh size of 70 ns, again at site A, B and C, within the specified time range of 8:00 am to 10:00 am. The zooplankton was captured using a zooplankton net featuring a fine mesh aperture ranging from 20-60 µm, equipped with a small bottle container with a capacity of 50 cm^3 attached to its narrow end. Following standard procedures outlined by Auta *et al.*[5], the water samples gathered at each site were meticulously transferred into dark screw-capped sample bottles.

Transportation of zooplankton: Zooplankton samples were conveyed in bottles from the ponds to the Biology Research Laboratory of Federal University Dutsin-Ma Take off Campus.

Identification of samples: Samples were viewed and identified in the Biology laboratory of Federal University Dutsin-Ma take off Campus, using microscope at a magnification of 4X and 40X to be identified with a key described by Balseiro *et al.*[14] and zooplankton atlas.

Statistical analysis: Data obtained during the study were presented in Tables and Figures, expressed as Mean±Standard Deviation. One-way Analysis of Variance (ANOVA) was used to test for differences in means of physicochemical parameters with months and points of sampling, at $p<0.05$ level of significance and 95% confidence interval (CI). Pearson correlation analysis was used to test for a relationship between physicochemical parameters and the abundance of freshwater zooplankton.

RESULTS

The result presented as mean, standard deviation and range value of water quality parameters measured during the survey period, in months, was displayed in Table 1. Outcomes of the physicochemical water parameters measured during the study period, in months, are shown in Table 2. The water temperature was higher in July (29.55±0.64°C), with a significant difference in the mean temperature of the lake among the sampling months ($p = 0.000$). The mean transparency was higher in July and August (0.300±0.00 NTU and 0.300±0.00) and also had a significant difference in mean turbidity among the months of sampling ($p = 0.000$). The mean values of dissolved oxygen (DO) were higher in July (6.0210±0.3068 mg L^{-1}) and the lower value were recorded in August (5.7380±0.106 mg L^{-1}), this had a significant difference among the months of sampling ($p = 0.000$). The mean electrical conductivity (EC) was higher in July (0.55±0.01 mS cm^{-1}) and lowest in August (360.0000±55.77 mS cm^{-1}), with no significant ($p = 0.1020$) difference among the months during which the samples were obtained. Mean values of pH were higher in July (7.3000±0.0816) and lowest in August (7.1000±0.1309), with no significant ($p = 0.0010$) difference among the months of sampling. As shown in Table 3 the mean water quality parameters of FUDMA fish pond between July and September. Table 4 shows the correlation coefficient of physicochemical

Table 1: Mean values of physicochemical parameters of FUDMA fish pond showing mean, Standard Deviation (SD) and range values between July to September 2023

		Range values	
Parameter	Mean±SD	Minimum	Maximum
pH	7.1790±0.1424	7.0000	7.4000
Water temperature (°C)	28.4290±1.0690	26.5000	31.0000
Conductivity (μs cm^{-1})	331.0700±57.3710	200	420
Dissolved oxygen (mg L^{-1})	6.0070±0.2827	5.6000	6.4000
Transparency (NTU)	0.2790±0.0418	0.2000	0.3000

Table 2: Mean monthly physicochemical parameters of FUDMA fish pond A and B between July to September 2023

Parameter	July	August	September	p-value
Water temperature (°C)	29.5500±0.64	27.6250±0.6944	27.9500±0.6433	0.0000
pH	7.3000±0.0816	7.1000±0.1309	7.1200±0.1229	0.0010
Conductivity (μs cm^{-1})	360.0000±55.7770	303.7500±60.9300	324.000±47.1880	0.1020
Dissolved oxygen (mg L^{-1})	6.280±0.0789	5.7380±0.1061	5.9500±0.2718	0.0000
Transparency (NTU)	0.3000±0.0000	0.3000±0.0000	0.2400±0.0516	0.0000

Table 3: Mean samplimg station physicochemical parameters of FUDMA fish pond A and B between July to September 2023

Parameter	Station A	Station B	p-value
Water temperature (°C)	28.7140±1.0869	28.1430±1.0082	0.1610
			0.1610
pH	7.1860±0.1512	7.1710±0.1383	0.7960
			0.7960
Conductivity (μs cm^{-1})	295.7100±43.803	366.4300±47.1670	0.0000
			0.0000
Dissolved oxygen (mg L^{-1})	6.0210±0.3068	5.9930±0.2674	0.7950
			0.7950
Transparancy (NTU)	0.2790±0.0426	0.2790±0.0426	1.0000
			1.0000

Table 4: Correlation coefficient of physicochemical parameters and heavy metal in FUDMA fish pond A and B between July to September 2023

	Water temperature	pH	DO	Conductivity
pH	0.7080**			
DO	0.7190**	0.7220**		
Conductivity	0.1340	0.2980	0.4330*	
Transparency	0.3790*	0.5430**	0.4840**	0.2260

DO: Dissolved oxygen, **Correlation is significant at the 0.01 level (2-tailed) and *Correlation is significant at the 0.05 level (2-tailed)

Table 5: Number of phytoplankton collected and their distribution with month and sampling station at FUDMA fish pond A and B between July to September 2023

	Sampling month				
Zooplanktons	July	August	September	Station A	Station B
Cylopoid	114	120	114	212	136
Copepoda	99	88	103	173	117
Caleinoida	34	55	39	72	56
Moina	80	77	93	144	106
Brachionus	122	90	117	200	129
Asplanchna	139	53	95	177	110
Polyanthra	8	4	6	11	7

parameters and heavy metal in FUDMA fish ponds A and B between July to September. Table 5 shows the number of zooplankton collected and their distribution with month and sampling station at FUDMA fish ponds A and B between July to September. Table 6 presents the Pearson correlation coefficient of physicochemical parameters with the zooplankton at FUDMA fish pond between July and September.

Table 6: Pearson correlation coefficient of physicochemical parameters with the zooplankton at FUDMA fish pond between July and September 2023

	Water temperature	pH	DO	Conductivity	Transparency
Cylopods	-0.0010	-0.0890	-0.3590	-0.6710**	-0.0100
Copepods	0.1440	-0.0800	-0.1720	-0.7440**	-0.0640
Caleinoids	-0.2150	-0.2130	-0.5480**	-0.4660**	0.0160
Moina	0.2160	-0.2260	-0.0340	-0.2680	-0.1520
Brachionus	0.3220	0.1240	0.1520	-0.4880**	0.0120
Asplanchna	0.3770	0.3760*	0.3300	-0.0940	0.0470
Polyanthra	-0.0410	-0.0790	0.1980	0.0420	0.0280

DO: Dissolved oxygen, **Correlation is significant at the 0.01 level (2-tailed) and *Correlation is significant at the 0.05 level (2-tailed)

DISCUSSION

The study presented a comprehensive analysis of water quality parameters measured monthly in FUDMA fish ponds, revealing noteworthy variations. Physicochemical water factors (water quality parameters) of a lake, pond and river environment are extremely reliant on the geological and physical structures of the streams that channel into it[5]. Aquatic (water) is a main essential that maintenances survival of life expectancy, the requirements go beyond aquatic (water) only nonetheless also for the properties within amongst which are water creatures that help as nourishment for human beings. Corresponding to Sadauki *et al.*[1] blocking of river to construct an artificial lake is one of the ways of producing supplementary aquatic (water) accessible for the requirements of humans as the water is put in storage and ready accessible all the time. Nevertheless, water is only able to be of maximum benefit if it is of the most favorable excellence. Aquatic organisms such as fish and other water resources deserve a suitable equilibrium of chemical, physical and biotic properties of water for their optimal production[1]. Physicochemical water factors are vital for the existence and production of the water animals that are influenced by it. Physicochemical water factors checking is capable of assisting scientists in forecasting in addition to learning from natural processes in the environs and ascertaining human influences on an environment[4]. On the above, Chapman and Sullivan[15] concluded that it is a vital factor that ascertains the existence and sustainability of the water organisms, the capability of the fishes to nourish and use the nutrients for growth in size, number and worth. Characteristics of physicochemical water factors such as (pH, temperature, color, taste, conductance and flavor) could be noticed by the common sense of touch, vision and scent. Temperature is a significant element, which impacts the development, breeding and maturity of fishes[2]. Consequently, Masood *et al.*[16] stated that the physical, chemical and biotic parameters of the water are basic towards a successful propagation procedure. Consequently, the chemical, physical and biotic properties of the water are significant for the fish to have optimal yield. The entire water quality parameters are vital for the performing and continued existence of the water organisms which comprises fishes, phytoplankton and zooplanktons[4]. Amongst the most significant physicochemical water factors are DO, pH, temperature, alkalinity and nitrogenous metabolites[17]. The variation in the water temperature may be attributed to the changeability in the atmospheric temperature, weather variation in addition to the period of the year which comprises a hot period, dry period in addition to the rainy season[4].

The monthly water temperature of the rainy period documented in this survey is related to the water temperature stated for Zobe reservoir in Katsina State, Nigeria, where the temperature was higher in July and September than in August[4,5,18]. The temperature of FUDMA pond is optimum and will aid zooplanktons well-being in the water body. The turbidity stated in this research is relatively lower than the turbidity of other water bodies formerly stated by Auta *et al.*[18] for Zobe Dam. The low turbidity in ponds might be recognized as low turbulence which transports mud, deposits and other particles into the pond waters. Extreme turbidity or muddiness in consumption water is visually unpleasant in addition may also represent a healthiness concern[18]. Dissolved oxygen is a significant water quality pointer/indicator of seasonal variations. Even though dissolved oxygen is required by all types of lifetime forms in water bodies[2]. Dissolved oxygen was steadily higher than the suggested minimum of 5 mg L^{-1} as optimal dissolved oxygen for surface waters[19].

The findings of current study align with a previous investigation by Sadauki *et al.*[4], in which the highest recorded value for dissolved oxygen was 6.70 mg L^{-1}, while the lowest was 6.90 mg L^{-1}. The observed outcome in the current study may be explained by the dilution effect influenced by the physical characteristics of the study area. This phenomenon is particularly associated with areas exhibiting increased photosynthetic activities and reduced turbidity, resulting in elevated oxygen levels within the artificial lake, as discussed by Nababa *et al.*[2].

A lower dissolved oxygen was stated from Eleyele reservoir, Ibadan, which was classified to be under pollution stress[20]. On the other hand, the best pH range for supportable water life ranges from 6 and 9. Sediments from cultivated farmlands around the water and waterlogged waters from bordering human habitats may change the pH concentration in water and become more alkaline or more acidic depending on the kind of pollutants and biochemical matters contained in it[2].

A slightly alkaline pH (6.5-8.5) is recommended for the optimal performance of water organisms[12], in addition, the outcomes in this research were within the range. Conductivity levels below 50 µmhos cm^{-1} are viewed as low, those between 50-600 µmhos cm^{-1} are medium while those above 600 µmhos cm^{-1} are high conductivity[21]. Thus, the range of 303.7- 360.0 µs cm^{-1} electrical conductivity gotten in this survey indicates high conductivity of the ponds when associated with discoveries of Anago *et al.*[21] and Momota *et al.*[22]. Electrical conductivity is a significant measurement of salt content in water. High salt concentration could result in adverse influences on water biota. The low EC here implies low salt concentration in the freshwater[18]. The monthly in addition to seasonal dissimilarity of composition and richness of zooplanktons might be due to the variations of aquatic and physicochemical parameters in the artificial lake[23]. The high richness of zooplankton in dry period could be attributed to the escalation in photic depth due to solar radioactivity intensity as well as the decrease in input muddled/turbid materials from other tributaries of the river[24]. Zooplankton spreading has been stated to serve precisely as pointers/indicators of the prevailing water quality circumstances of pond[10,19]. Numerous authors reported on the significance of zooplankton in the efficiency of self-cleaning developments[24]. Zooplankton is an important link in the transformation of energy from manufacturers to consumers[25]. Zooplankton plays a main role as efficient filter feeders on the phytoplankton and as a food source for other invertebrates, fish larvae and fish[24]. In this study, copepods were the most plentiful recorded when compared with rotifers. This discovery is related to the results earlier reported by Auta *et al.*[5], Oparaku *et al.*[10], Zabbey *et al.*[26] and Obot *et al.*[27] who reported copepods as the most abundant species in freshwaters of South East Nigeria. Their abundance could be attributed to their successful adaptation to freshwaters in the tropics and the favorable water quality parameters. And this disagreed with Aquino *et al.*[28], who discovered that the highest frequently appearing in addition to plentiful zooplankton belong to the Rotifera, which comprised 11 species the highest number of species belonging to a lone/single group amongst the three that was examined.

The aforementioned reports have recognized that species of copepods share some things in common with other zooplankters, such as viscous, nutritionally dilute and hazardous environments, which have given rise to numerous of them evolving specialized and efficient adaptations in an attempt to survive the main challenges of nourishing and living in water. Possession of special body form which ensures efficient prey hunting with the ability to move swiftly at high speed. The speed ability also enhances its chances of escape from predators such as fish[29]. Altering all chemical, physical and biotic conditions disturbs the dispersal and incidence of zooplankters indirectly or directly. The ecological characteristics of zooplankton in ponds and reservoirs in Turkey are widely recognized, yet there is a scarcity of studies conducted in flowing environments. To comprehensively comprehend the factors influencing population distribution, it is imperative to take into account all chemical, physical and biological properties[25].

The study underscores the importance of monitoring and managing water quality parameters in fish ponds. It highlights the significant role of physicochemical factors such as dissolved oxygen, pH and conductivity in sustaining aquatic life. The findings contribute to the understanding of the health of the aquatic ecosystem in FUDMA fish ponds. The study suggests that the physicochemical parameters within the optimal range support the well-being of zooplankton, a crucial component of the aquatic food web. The research implies that maintaining optimal water quality conditions is essential for the success of aquaculture practices. This knowledge can be applied to enhance the sustainability of fish farming operations by ensuring suitable conditions for fish and zooplankton production.

The study provides valuable insights for aquaculturists, guiding them in optimizing water quality conditions for the production of fish and zooplankton. Practical applications may include adjusting factors such as temperature and dissolved oxygen levels for optimal fish growth. The research emphasizes the use of physicochemical water factor checks as tools for environmental monitoring. These measurements can help scientists predict natural processes, identify human impacts and ensure the overall health of aquatic environments.

Based on the study, recommendations can be made for aquaculture practitioners to regularly monitor and optimize water quality parameters. This includes maintaining appropriate pH levels, dissolved oxygen concentrations and conductivity to support the growth of aquatic organisms. The study suggests the importance of conserving the natural balance of physicochemical factors in aquatic ecosystems. The variation in zooplankton composition and richness with changes in aquatic and physicochemical parameters warrants further investigation. Future research can focus on understanding the intricate relationships between environmental factors and zooplankton dynamics for more informed aquatic ecosystem management.

CONCLUSION

The study on water quality and zooplankton community interaction in FUDMA earthen production fish ponds provides valuable insights. The analysis of water quality parameters, including physical and chemical attributes, indicated that they were within acceptable ranges for pond environments. The presence of various zooplankton subclasses, such as Cyclopoid, Copepoda, Caleinoida, *Moina*, *Brachionus*, *Asplanchnopus multiceps*, *Polyarthra vulgaris* and *Asplanchna*, suggests a diverse zooplankton community in the ponds. The study's findings highlight the favorable water quality conditions for aquatic organisms in the FUDMA fish ponds. Furthermore, the identification of the most common zooplankton, including Cyclopoid, Copepoda, Caleinoida and Moina, contributes to our understanding of the zooplankton composition in the studied ponds. The temporal variations observed in the zooplankton community, with fluctuations in abundance across the sampling months, provide valuable information on the dynamic nature of these aquatic ecosystems. Overall, the study underscores the importance of considering both water quality parameters and zooplankton dynamics for effective pond management. The results contribute to the broader knowledge of ecological interactions in earthen production fish ponds, emphasizing the need for comprehensive assessments to ensure the sustainability of these aquatic environments.

SIGNIFICANCE STATEMENT

This study's findings are of paramount significance as they provide a detailed assessment of the physicochemical parameters in FUDMA fish ponds, shedding light on the intricate dynamics that influence water quality. The observed variations in temperature, transparency, dissolved oxygen, electrical conductivity and pH across the three-month survey period offer valuable insights into the seasonal fluctuations within the aquatic environment. The identified correlations between these parameters and heavy metals further enrich our understanding of potential environmental influences. This research

provides a foundational dataset for future studies aiming to optimize fish pond conditions, enhance aquaculture practices and mitigate potential environmental stressors. The insights gained have implications for both ecological research and practical applications in aquaculture and environmental conservation.

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