STUDIES ON THE PREVALENCE, INTENSITY AND IMPACT OF SOME WATER QUALITY PARAMETERS ON PARASITES OF *Coptodon zilli*

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ABSTRACT
160 samples of live Coptodon zilli (Redbelly tilapia) *were bought from the earthen pond of a reputable fish farm in Makurdi, Benue State, Nigeria. The fish samples were taken to the Biological Science Laboratory for parasitological studies using standard parasitological methods while the physico-chemical parameters of the pond water were assessed in situ and ex situ, following standard procedures. Of the 160 samples, 91 samples were infested with a total prevalence of 56.88% and mean intensity of 63.98. 7 parasite species comprising of Clinostomum sp, Neascus sp, Ichthyophthirius sp, Dactylogyrus sp, Eustrongylides sp, Capillaria sp and Piscicola sp. were recovered from the infested fish samples. Of these parasites, Clinostomum sp had the highest parasitic prevalence of 20.01% (2.50 from the eye socket, 5.00% gill, 5.63% opercula, and 6.88% skin) and mean intensity of 25.94% with the eye socket, gill, opercula, and skin accounting for 4.50, 5.75, 6.78 and 8.91, respectively. Among the infested organs, while the gills had the highest parasitic prevalence of 17.51%, the least parasitic prevalence of 5.63% was recorded for the opercula. Additionally, while the highest mean intensity of 19.97 was recorded for intestinal wall/gut, the least mean intensity of 6.78 was recorded for the opercula. Mean Ammonia free nitrogen (0.73±0.03) and Dissolved oxygen (5.85±0.05) were higher than the recommended limits while the mean p^H of 7.45±0.15 and temperature of 25.60±0.30 were within the recommended limits.*

Keywords: *Aquaculture, Water quality, Clinostomum sp., Neascus sp., Lower River Benue*

INTRODUCTION

Aquaculture has experienced notable expansion an d development in recent years. Similar to the majority of Nigerian states, Benue State experiences extended warm weather, which supports the growth of ecto- and endo-parasites and increases the risk of diseases (Omudu and Amuta 2007).

Unbalanced interactions between fish-parasite factors and the aquatic environment (culture) result in fish parasitic diseases. Nonetheless, according to Hossain *et al.,* (2007), the prevalence and severity of these illnesses are directly correlated with the hygienic state of the water. Hence, the most crucial element in ensuring a successful fish production is any water quality feature. Water quality variables are those features of the water that have an impact on fish survival, development, reproduction, or management (Noga, 2010). The pathogenicity potential of ecto- and endo-parasites is thought to be influenced by water pollution (Khan and Thulin, 1991); conversely, fish are more susceptible to disease (Biswas and Pramanik, 2016) as a result of decreased immunity and immunogenic status (Noor El-Deen *et al*, 2015).

According to Ojwala *et al.,* (2018), parasitic populations and communities are more common when certain environmental conditions water temperature, dissolved oxygen content, salinity, hydrogen ion concentration, and eutrophication are met. Stress is associated with poorer water quality, which is defined as lower dissolved oxygen levels, insufficient temperature, pH, and high levels of organic matter in the water. These conditions favor the growth of protozoan parasites and the occurrence of pathogenic agents, primarily fish ecto-protozoans and other body surface parasites (Paulista *et al* 2009). According to Iwanowicz (2011), parasites are acknowledged as a significant limiting factor in the development of intensified fish culture, where they cause significant mortalities and slower growth rates.

Previous studies in other countries have examined parasitic infestations in culture fish (Omeji *et al.,* 2022; Afolabi *et al.,* 2020; Olajide *et al.,* 2020; Ogonna *et al.,* 2017) in Nigeria and (Maina *et al*., 2017; Murugami *et al*., 2018; Mukwabi *et al*., 2019; Wanja *et al*., 2020). However, most of these studies have concentrated primarily on systematics and paid little attention to establishing the relationship between water quality parameters and the presence of fish parasites. There are several natural abiotic factors that can affect the occurrence of parasites in pond culture, especially those related to water quality. In order to ascertain the prevalence of parasites and assess the impact of the physicochemical properties of the water on parasitic infestation in *Tilapia zilli* from an earthen pond of a reputable fish farm in Benue State, Nigeria this study was carried out.

MATERIALS AND METHODS

Evaluation of water quality parameters

On the day of the fish sampling, the water quality of two ponds where fish samples were collected was evaluated in the early hours. The physical and chemical characteristics of the water such as pH,

temperature and dissolved oxygen were measured in situ using portable, waterproof HANNA Multi-probe meters (Hanna Instruments Inc., USA). Ammonia was measured by traditional manual methods according to Eaton *et al*., (1995).

Fish collection

A seine net was used to collect 160 live samples of *Coptodon zilli* (Redbelly tilapia) from an earthen pond of a reputable fish farm in Makurdi, Benue State, Nigeria. The live fish samples along with the source pond water were serially labelled and immediately taken to the Biological Science Laboratory for parasitological and water quality studies.

Macroscopic and Autopsied Analysis

Using techniques outlined by Ayuba *et al.,* (2018), an exterior examination of each live fish was carried out visually to look for any ectoparasites and obvious lesions. The fish under observation were put to death, and normal necropsy protocols were followed for the post-mortem assessment (Roberts 2012). A sterile scalpel blade was used to make a midline incision beginning at the anterior end of the anal aperture and ending at the operculum. The fish's abdominal organs were exposed by a lateral cut made from the anal orifice up to the upper corner of the operculum. The organs were then graphically inspected in situ utilizing techniques outlined by Amlacher (1970) after the body wall had been displaced; any pathological abnormalities were then noticed and documented. The skin and muscular flap were removed with a third incision made to join the two earlier incisions at the operculum.

Production of wet mounts, parasitological analysis, and parasite identification

Using a drop of physiological saline, wet mounts of skin scrapings, slime, and gill filaments were prepared on slides and ectoparasites at X10 and X40 were detected using a light microscope (Lucky 1977). On a sterile slide, the contents of the eyes were dissected, and ocular trematodes were examined. For parasitological analysis, the digestive system was removed and kept in 70% ethanol. Afterwards, the contents were put on a petri dish filled with regular saline (0.85% sodium chloride), and a dissecting microscope was used to check for parasites. The specimens were kept in the refrigerator until they had died and fully relaxed. Microscopic parasites were harvested using a specialized needle, and they were then repeatedly cleaned in warm saline solution. Morphological traits reported by others (Roberts, 2012) were used to identify and characterize parasites.

Data analysis

Microsoft Excel was used to verify, enter and save the collected data as well as to compute means and percentages. Using the epidemiological metrics of prevalence, and mean intensity of infestation as reported by Margolis *et al*., (1982) and Bush *et al*., (1997), parasitic infestations were assessed as thus;

$$\text{Prevalence (\%)} = \frac{Number\ of\ fish\ infected}{Number\ of\ fish\ examined} X\ 100$$

$$\text{Mean intensity} = \frac{Total\ Number\ of\ parasites}{Number\ of\ fish\ infested}$$

The correlation coefficient between some determined physicochemical parameters and parasitic infestation was determined using Pearson's correlation.

RESULTS

Composition and levels of parasitic infestation in *Coptodon zilli* from earthen ponds

160 samples of *C. zilli* were sampled for parasitic prevalence and mean intensity. Of the 160 samples, 91 samples were infested with a total prevalence of 56.88% and mean intensity of 63.98 as shown in Table 1. Also, the prevalence and mean intensity of parasitic infestation of the various organs of *C. zilli* are shown in Table 1. Also, in Table 1, 7 parasite species comprising of *Clinostomum sp* and *Neascus sp* from the eye socket accounting for 2.50% prevalence with mean intensity of 4.50 and 3.50, *Ichthyophthirius sp*, *Dactylogyrus sp* and *Clinostomum sp* with prevalence of 8.13%, 4.38%, and 5.00% with mean intensity of 5.46, 6.14 and 5.75, respectively were recovered from the gills. *Eustrongylides sp* and *Capillaria sp* were recovered from the intestinal wall/gut with prevalence of 8.13% and 3.13% and mean intensity of 9.77 and 10.20, respectively.

From the opercula of the fish samples, only *Clinostomum sp* with prevalence of 5.63% and mean intensity of 6.78 was recovered while *Piscicola sp* with 9.38% prevalence and mean intensity of 3.00 and *Clinostomum sp* with 6.88% prevalence and mean intensity of 8.91 were recovered from the skin of the infested samples of *C. zilli.*

Among the infested organs, while the gills had the highest parasitic prevalence (17.51%), the least parasitic prevalence (5.63%) was recorded for the opercula. The fins and muscles of the fish samples recorded zero infestation. Additionally, while the highest mean intensity of 19.97 was recorded for intestinal wall/gut, the least mean intensity of 6.78 was recorded for the opercula.

Table 1. Prevalence and mean intensity of parasitic infestation of the various organs of *C. zilli* from the earthen pond of a reputable fish farm in Makurdi, Benue State

Fish organs	Parasite identified	Prev. of each parasite on the infested organ	Total prev. of parasite on the infested organ	Mean intensity of each parasite	Total mean intensity on the infested organs
Eye socket					
	Clinostomum sp	2.50	6.25	4.50	8.00
	Neascus sp	3.75		3.50	
Fins	Np	0.00	0.00	0.00	0.00
Gills					
	Ichthyophthirius sp	8.13	17.51	5.46	17.35
	Dactylogyrus sp	4.38		6.14	
	Clinostomum sp	5.00		5.75	
Intestinal wall/gut					
	Eustrongylides sp	8.13	11.26	9.77	19.97
	Capillaria sp	3.13		10.20	
Muscle	Np	0.00	0.00	0.00	0.00
Operculae	*Clinostomum sp*	5.63	5.63	6.78	6.78
Skin					
	Clinostomum sp	6.88	16.23	8.91	11.88
	Piscicola sp	9.35		2.97	
Total		**56.88**	**56.88**	**63.98**	**63.98**

Prev. = prevalence, Np = No parasite

The mean values of some water quality parameters of the earthen pond from a reputable fish farm in Makurdi, Benue State in comparison with the recommended limits as reported by Boyd (1982) and Bhatnagar and Devi (2013) are shown in Table 2 while Table 3 shows the correlation coefficients of total parasite prevalence to water quality parameters of the earthen pond from a reputable fish farm in Makurdi, Benue State.

From Table 2, the mean Ammonia free nitrogen (0.73±0.03) Dissolved oxygen (5.85±0.05) were higher than the recommended limits while the mean p^H of 7.45±0.15 and temperature of 25.60±0.30 were within the recommended limits.

From Table 3, while a moderate positive correlation of 0.53 existed between the parasitic prevalence and Ammonia free nitrogen, a low negative correlation of -0.40 and -0.35 existed between the parasitic prevalence and Dissolved oxygen and the parasitic prevalence and p^H, respectively. On the other hand, a negative/negligible low correlation of -0.14 existed between the parasitic prevalence and temperature. Based on the correlation analysis, it was observed that the presence of parasites in the study area was most influenced by DO, p^H and water temperature as the parameters showed negative correlation to the parasite species

Table 2. The mean water quality parameters from a reputable fish farm from Makurdi, Benue State

Water quality parameters	Mean values of the earthen pond water	Recommended limits as reported by Boyd (1982) and Bhatnagar and Devi (2013)
Ammonia free nitrogen (mgl-1)	0.73±0.03	0 – 0.2
Dissolved oxygen (mgl-1)	5.85±0.05	3-5
pH	7.45±0.15	6.5 – 8.5
Temperature (0_C)	25.60±0.30	26 – 32

Table 3. Correlation coefficients of total parasite prevalence to water quality parameters

Water quality parameters	Correlation coefficient	Degree of correlation
Ammonia free nitrogen	0.53	Moderate positive
Dissolved oxygen	-0.40	Low negative
pH	-0.35	Low negative
Temperature	-0.14	Negative/negligible low

*****Nature of association adopted from Mukaka (2012)

DISCUSSION

Studies on the prevalence, intensity and impact of some water quality parameters on parasites of *Coptodon zilli* from an earthen pond of a reputable fish farm in Benue State, Nigeria has revealed the presence of 7 species of parasites comprising of *Clinostomum sp, Neascus sp, Ichthyophthirius sp, Dactylogyrus sp, Eustrongylides sp, Capillaria sp* and *Piscicola sp* infesting the different organs of *Coptodon. zilli* from the earthen pond of a reputable fish farm in Makurdi, Benue State, Nigeria. The findings of this study showed a high parasitic prevalence of 56.88%. The total parasitic prevalence recorded in this study is significantly higher than those recorded by Afolabi *et al*., (2020) who reported 20.00% prevalence of *C. gariepinus* from ponds, 35.90% prevalence recorded by Lebari *et al.,* (2016) in *Clarias gariepinus* from selected fish farms in Port Harcourt, Nigeria, 22.20% prevalence recorded by Idika *et al*., (2017) for cultured catfish (*Clarias gariepinus*) in South East, Nigeria and the 26.5% recorded by Waruiru *et al*., (2020) from the fish collected from smallholder fish farms in Kirinyaga County. Also, this finding is at variance with the study of Maina *et al*., (2017) who investigated the occurrence of parasites in farmed Nile tilapia and African catfish in Kiambu County, Kenya where lower parasitic prevalence was recorded. However, the total parasitic prevalence recorded in this study is lower than the reported total parasitic prevalence of Kawe *et al*., (2016) who recorded higher prevalence of 67.50% of gastrointestinal helminth parasites of *C. gariepinus* in Abuja.

The high stocking density used in tilapia production, which is a typical technique, may have contributed to the higher infestation of *C. zilli* samples seen in this investigation. This could have aided the rapid multiplication of parasites. Additionally, the high parasitic prevalence found in this study could be attributed to the fish's omnivorous feeding habits, unsanitary conditions, or pollution of the water body as a result of bad management practices. It could also be related to the pond's proximity to the Benue River, as most ponds flood during heavy rainfall, and the presence of intermediate hosts that harbor the infective larval stage of some parasites, making them accessible to fish in the water. This agrees with the reported works of (Kawe *et al.,* 2016; Afolabi *et al.,* 2020). The high parasitic prevalence in this study could also be attributed to the influence of DO, p^H and water temperature, as these parameters showed negative correlation to the parasite species.

Based on the correlation analysis, it was observed that the presence of parasites in the study area was most influenced by DO, p^H and water temperature. Water temperature is generally considered the most vital abiotic factor which affects fish physiology, including immune functions. However, the infection dynamics of pathogens are also strongly influenced by water pH values and in some cases ammonia level (Kolia, *et al.,* 2021, Rohlenová *et al.,* 2011).

As a bio-indicator of the health of the aquatic environment, the water quality of a body of water within an aquatic biota controls primary productivity, organism composition, diversity, and abundance (Koledoye *et al*., 2022). The present investigation revealed a substantial link between *C. zilli* and some parasites and limnological factors, including ammonia, pH, dissolved oxygen and temperature. An increase in temperature is generally associated with a higher rate of parasite infective phases (Ojwala and Otachi 2018). It is known that the quantity of monogenean parasites is influenced by the temperature of the water. A variety of human activities as well as other natural sources that may have an impact on the aquatic environment could alter the water quality parameters in an aquatic biota. The water temperature measured in this study fell within the range reported for tropical inland water bodies (Adesakin *et al*., 2020; Anyanwu *et al*., 2021). This also agreed with studies by Yusuf (2020) and Omoboye *et al*., (2022) that found a comparable range for tropical water temperature. According to Egun and Oboh (2022), the mean water temperature found in this study was within the acceptable range for fish. According to some writers such as Arnell *et al*., (2015); Bello *et al*., (2017), changes in climate may result in changes in the amount of heat transferred from the air or sunshine.

The types of parasites (*Clinostomum sp, Neascus sp, Ichthyophthirius sp, Dactylogyrus sp, Eustrongylides sp, Capillaria sp,* and *Piscicola sp.*) recovered from the different organs of *C. zilli* in this study have been previously recorded by other researchers from same or related fish species. For example, the previous studies of Mavuti *et al.,* (2017), Waruiru *et al.,* (2020) and Murugami *et al.,* (2018) have reported the occurrence of metacercariae of *Clinostomum sp*. In this study, *Dactylogyrus sp* was recovered from the gills of the infested fish samples. Recovery of this parasite from the gills is at variance with the reported work of Waruiru *et al.,* (2020) who recovered *Dactylogyrus sp* from the skin and fins of *C. zilli,* respectively. Recovery of *Eustrongylides sp* and *Capillaria sp* from the intestinal wall/gut of *T. zilli* in this study is in agreement with the reported work of Omeji *et al.,* (2022) who recovered same parasite species from the stomach and intestine of *Clarias gariepinus* from selected fish Farms in Makurdi, Benue State. *Piscicola sp* were recovered from the skin of the infested *C. zilli* at a prevalence of 9.35%. The 9.35% prevalence recorded for *Piscicola sp* on the skin of *C. zilli* in this study is at variance with the findings of Waruiru *et al.,* (2020) who reported a prevalence of 0.1% of *Piscicola sp* on the skin of tilapia. Also, recovery of *Piscicola sp* from the skin of the infested samples of *C. zilli* is contrary to the findings of Mavuti *et al.,* (2017) where *Piscicola sp* was recorded in the gills of catfish and tilapia at an overall prevalence of 2.7%.

When it comes to managing fish health, water quality is crucial. The study's elevated ammonia level may have resulted from overfeeding of fish, particularly with highly proteinous diets and high pond stocking densities, which can cause fish to accumulate nitrogenous wastes, primarily ammonia. The alkalinity of the soil and/or pond liming may be the cause of the slightly elevated pH (alkaline). The study's measured water temperature was somewhat below the ideal range for raising fish. The significant amount of dissolved oxygen found in this experiment may be the cause of the study's somewhat lower temperature. Temperature and vice versa have a favorable impact on dissolved oxygen levels (Bhatnagar and Devi, 2013).The occurrence of parasites was positively correlated with ammonia free nitrogen (mgl-1). This finding is in agreement with the reported works of Waruiru *et al.,* (2020) and Ojwala *et al.,* (2018) who reported a positive correlation of various parasitic assemblage and some physicochemical characteristics of pond water including nitrates and soluble reactive phosphates. However, the present findings showed a negative correlation of parasitic prevalence with the dissolved oxygen, p^H and temperature of the pond water. This finding is contrary to the findings of Puinyabati *et al.,* (2013), who reported a positive correlation of prevalence of trematode parasites in *Channa punctata* (spotted snakehead) with dissolved oxygen, pH, conductivity and water temperature.

Conclusively, seven parasite species comprising of *Clinostomum sp* and *Neascus sp* from the eye socket *Ichthyophthirius sp, Dactylogyrus sp* and *Clinostomum sp* from the gills, *Eustrongylides sp* and *Capillaria sp* from the intestinal wall/gut were recovered from the infested samples of *C.. zilli* used for the study. Among the infested organs, while the gills had the highest parasitic prevalence (17.51%), the least parasitic prevalence (5.63%) was recorded for the opercula. The mean Ammonia free nitrogen and Dissolved oxygen were higher than the recommended limits while the mean p^H and temperature were within the recommended limits. A moderate positive correlation existed between the parasitic prevalence and Ammonia free nitrogen while a low negative correlation existed between the

parasitic prevalence and Dissolved oxygen and the parasitic prevalence and p^H, respectively. On the other hand, a negative/negligible low correlation existed between the parasitic prevalence and temperature.

CONCLUSION

The results of this research will provide the knowledge required to comprehend the relationship between fish parasites and water quality features, which will aid in the development of non-therapeutic measures for the future prevention or management of fish diseases in aquaculture facilities. Farmers are advised to take better care of their fish ponds by regularly checking the water quality, fish behavior, and water color for any unusual changes.

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