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EFFECTS OF POND TYPES AND WATER MANAGEMENT PRACTICES ON PHYSICO-CHEMICAL PARAMETERS OF POND WATER AND PARASITIC INFESTATIONS IN CULTURED *CLARIAS GARIEPINUS* IN ZARIA AND ENVIRONS

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ABSTRACT

Water of good quality is an important requirement for fish health. The type of pond and other management practices can affect the physico-chemical parameters of water and predispose to diseases such as parasitic infestations. This work therefore assessed pond type and water management practices as factors associated with physico-chemical parameters and parasitic infestations in cultured *Clarias gariepinus* in Zaria. Two hundred (200) fish samples from 20 farms in Zaria were assessed for parasites by floatation and microscopic techniques. Fifty percent of the farms used concrete ponds and 65% use boreholes as the source of water. Although there was no significant difference between the physico-chemical parameters of the different pond types, the P^H of earth ponds (5.8) was below the normal range of 6.5-8.5. The temperature and nitrite were within acceptable levels of 26-32^{o}C and 3mg/L respectively. Total dissolved solids (TDS) levels were too low (<1mg/L), probably requiring intervention to achieve optimum levels for fresh water fish of ≤ 120mg/L. Protozoans were the most common parasites encountered (54.68%), but coccidia were significantly low in concrete ponds.

Key words: *Clarias gariepinus, Management practices, Physico-chemical parameters, Parasitic infestations, Zaria.*

INTRODUCTION

Water is the most important factor in fish health, because it is the medium in which it breathes feeds, reproduces, excretes and carries out all of its physiologic functions. An optimum water quality is therefore essential. In addition, adverse changes in water may create conditions that are favourable for the development of diseases (Ibrahim, *et al*., 2009). Fishes are susceptible to a range of disease conditions, from non-infectious to infectious. Infectious conditions are caused by microorganisms and parasites (Noga, 2010). Adverse physico-chemical properties of water such as extreme temperatures and P^H, turbidity, total dissolved solids (TDS), levels of dissolved oxygen, nitrites as well as the presence of environmental pollutants are the important risk factors associated with fish diseases and mortality. Management factors such as pond type, stocking density, sources of water, frequency of water change, feeding and biosecurity are all important in the development of fish diseases (Bhatnagar and Devi, 2013).

Generally, infectious diseases of fish manifest when stress, due to changes in these risk factors, lead to a lowering of immunity, thus allowing the ever-present opportunistic organisms to infect or infest and cause diseases (lbrahim *et al*., 2009). Beside direct losses caused by mortality, parasites may have considerable impact on growth, resistance to other diseases, behaviour and susceptibility to predation. Their visible presence may reduce marketability of fish, while some of them are zoonotic (Woo, 1995). Helminthes are the most common

parasites of both wild and cultured fish in Africa. Nematodes, trematodes and cestodes have been reported across the continent (Noga, 2010). Reports of these helminths are many in Nigeria (Oniye *et al.*, 2004; Iyaji and Eyo, 2008; Nwabueze, 2012,). Many species of ecto-protozoans have also been known to cause diseases of fish in Africa from the genera Cryptobia, Chilodonella and Trichodina. They cause skin, gill and enteric infestations in C*larias gariepinus* (Nwabueze 2012). However, there are very few reports of parasitic diseases of cultured fish in Zaria and environs. Therefore, this study was designed to evaluate pond type, water management practices as factors that may affect physico-chemical parameters of pond water and parasitic infestations of cultured C*larias gariepinus* in Zaria and environs.

MATERIALS AND METHODS

The study was conducted in Zaria, Kaduna State of Nigeria, which lies in the Northern Guinea savannah zone, with an annual rainfall of 1000 to 1250 mm per annum and a temperature range of 17^0C to 33^0C. Agriculture is the most important economic activity with fish farming as a relatively recent addition.

Twenty fish farms in Zaria and environs were randomly selected for the study, and from each farm 2 ponds were selected for sampling to make a total of 40 ponds. A structured questionnaire was developed and administered to assess management factors that affect water quality such as type of pond, source of water and frequency of changing water as well as visual assessments. Fifty milliliters of water was also collected in clean sample bottles from each test pond and analyzed for P^H, nitrite and total dissolved solids (TDS) according to the procedures of Bhatnagar and Devi, (2013). Pond temperatures were measured by dipping a clinical thermometer half way into the pond for 2 minutes in the morning (9:00 am), and then read according to the method of Harith and Hassan (2007).

Five fish samples were collected from each pond (n=40) to make a total of 200. The fishes were collected alive and transported to the Laboratory in clean plastic buckets containing water. The gastrointestinal tract was cut out at the level of the cardia and the rectum. It was then put in a petri dish containing physiologic saline solution. The entire length of the intestine was cut open in the petri dish and observed under a picking lamp for adult parasites and larvae. These were picked and transferred with thumb forceps into sample bottles containing 10% buffered formalin. The worms were then identified under a light microscope with x10 objective. Feces from each fish sample was transferred into a labeled test tube containing zinc sulphate-sucrose solution for floatation technique to identify parasitic eggs according to standard procedures (Noga, 2010).

The gills and skin were examined with a hand lens for ectoparasites. The gills were dissected out and each placed in a petri-dish containing 10 mls of physiologic saline. It was later placed in 2 drops of saline on a glass slide and examined with a light microscope at x10 objective.

Ecto-parasites from the gills and skins were collected and identified with a pictorial guide by the techniques of Emere and Egbe (Bichi and Yelwa, 2010).

Ethical best practices on fish research were followed as per the recommendations of Weyl e*t al.* (2016). These include small sample size, humane catching and transportation techniques and humane killing by percussive stunning. The data for pH, temperature, total dissolved solids and nitrite were subjected to One Way Analysis of Variance (ANOVA) with a computer software (GraphPad prism version 5.01) San Diego, California, U.S.A (www.graphpad.com). Values of $P < 0.05$ were considered significant. In addition, IBM-SPSS statistics 22 was used for Fishers-exact chi-square analysis where

P≤0.05 was considered significant. Other data were presented in descriptive forms and chats.

RESULTS

Of the 20 farms visited, 10 (50%) used concrete, 5 (25%) plastic and 5 (25%) were earthen ponds. Thirteen (65%) of the farms used water from boreholes, 3 (15.0%) from open-wells and 4 (20.0%) from streams (Table 1). The frequency of changing pond water ranged from once daily to once in 30 days. Three farms (15%) changed water in 1-2 days, 11 (55%) changed in 3-7 days and 5 (25%) in 30 days. Only one farm (5%) using stream water was found not to change water at all.

Table 1: Management factors in water quality

Pond type	Pond water source			Frequency of changing water (Once in)			
	Bore hole	Open well	Stream	1-2 days	3-7 days	30 days	None
Concrete	8	1	1	1	7	2	-
Plastic	5	-	-	2	3	-	-
Earth	-	2	3	-	1	3	1
Total	13(65%)	3(15%)	4(20%)	3(15%)	11(55%)	5(25%)	1(5%)

Physico-chemical characteristics of water were assessed as per the method of Bhatnagar and Devi (2013). The pH was relatively higher (mean = 7.0) in concrete ponds than in earthen (mean = 5.8) or plastic ponds (mean = 6.1). These were however not significantly different by one-way ANOVA at P≤0.05. The temperature was relatively, but not significantly higher in earthen ponds than in other pond types. Nitrites were likewise higher in earthen ponds. Total dissolved solids were not significantly different in any of the pond types, but relatively higher in plastic ponds (Table 2). Figures 1 to 4 shows the P^H, temperature, nitrite and total dissolved solid of water from fish pond in Zaria.

Table 2: Physicochemical parameters of fish Ponds Cultured in Zaria

Parameters	Concrete pond	Earthen pond	Plastic pond	p* values
PH	7.0±1.20	5.8±0.68	6.11±1.16	0.7403
Temperature (C^o)	24±2.29	25.2±1.41	24.3±2.14	0.7963
Nitrite (mg/L)	0.302±0.41	0.38±0.19	0.36±0.26	0.0882
TDS (mg/L)	0.43±0.16	0.34±0.24	0.52±0.23	0.3177

p* Values ≥ 0.05 are considered to be significant by one way ANOVA

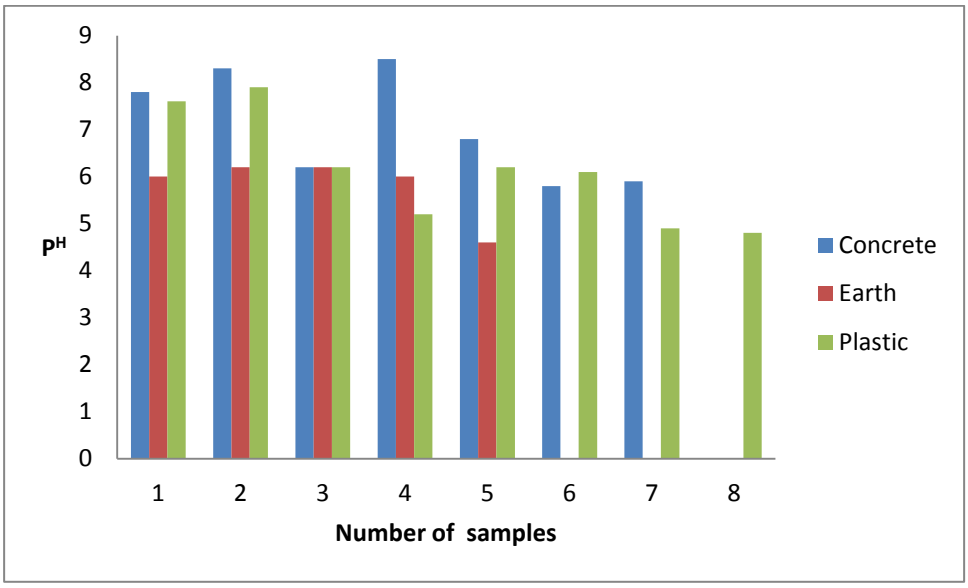


Figure 1: *P^H of water from fish ponds in Zaria*

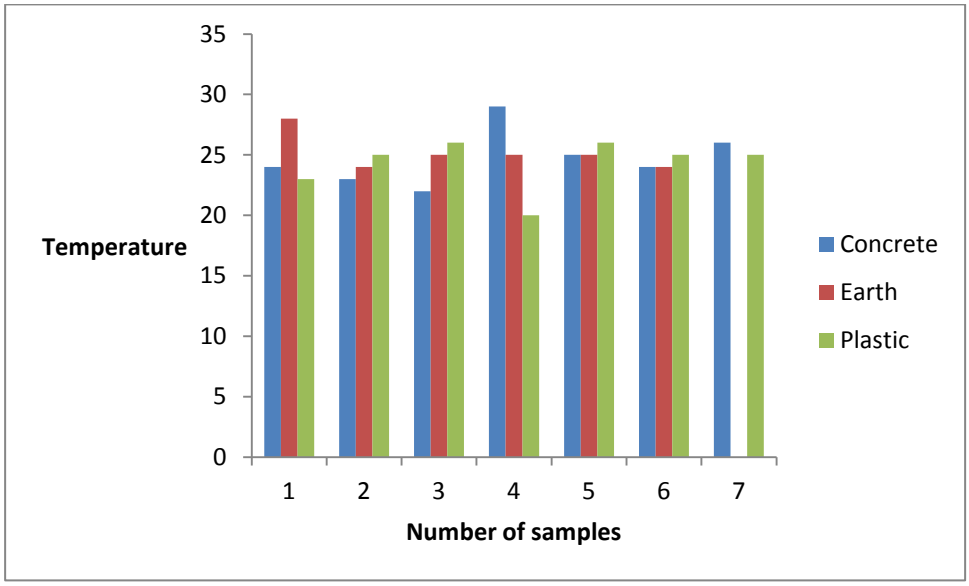


Figure 2: *Temperature of water from fish pond in Zaria*

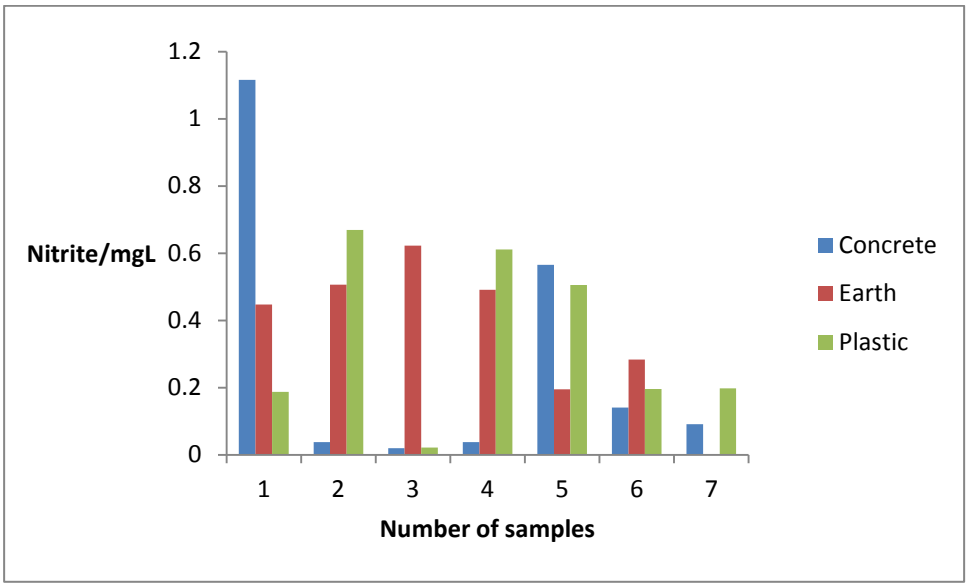


Figure 3: *Nitrite of water from fish pond in Zaria*

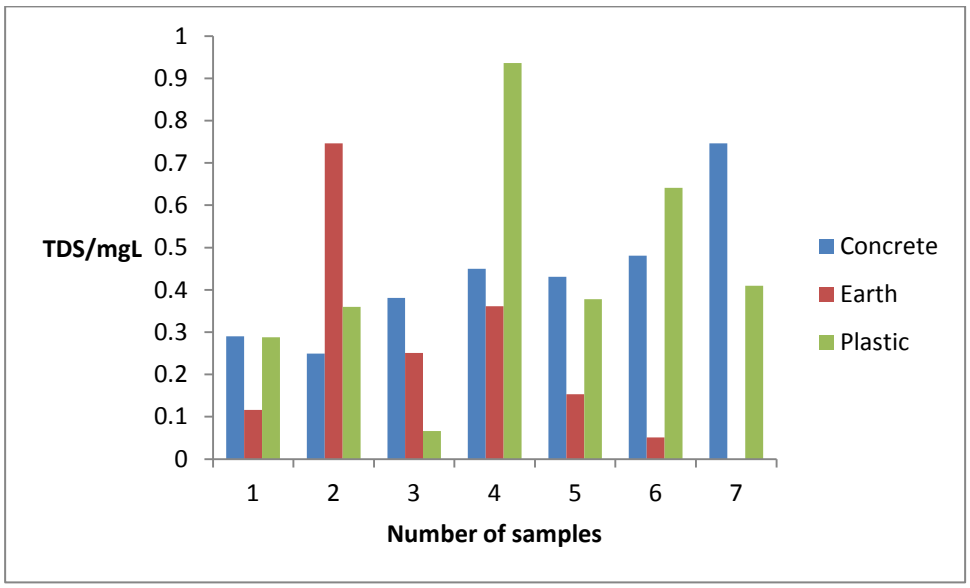


Figure 4: *Total dissolved solid of water from fish pond in Zaria*

Of the 200 fish samples, 12 genera of parasites were identified of which Thecomoeba and Trichodina (ecto-protozoans) were found on the skin and gills of the fish (Table 3). Proteocephalus and bothreocephalus (cestodes), Eustrongyloides (Larval form), Rhabdochona, procamallanus and cuculanus (nematodes) as well as coccidia were all found in the GIT of fish samples. Intestinal coccidia accounted for 14 (26.4%) of the 53 positive samples. Fifty three (53) samples were positive for both helminths and ecto parasitic protozoans (Table 3). The most common helminth identified was Eustrongyloides species in 53 samples (18.8 %), followed by Thecamoeba species in 5(9.4%).

Table 3: Distribution of helminths and ectoprotozoan parasites in *Clarias gariepinus* in relation to number of parasites, predilection sites and pond types

Helminths	Predilection site	Prevalence of Parasites in Ponds			Overall (%)
		Earth	Concrete	Plastic	
		Number of positive (%)			
CESTODES					
Bothriocephalus	Intestine	0.00	0.00	2 (3.77%)	2 (3.77)
Proteocephalus	Intestine	0.00	0.00	2 (3.77%)	2 (3.77)
		0	0	4	4 (7.54)
NEMATODES					
Eustrongyloides	Intestine	4 (7.54%)	2 (3.77%)	4 (7.54%)	10 (18.85)
Procamallanus	Intestine	2 (3.77%)	0.00	2 (3.77%)	4 (7.54)
Cucullanus	Intestine	0.00	1(1.88%	0.00	1(1.88)
Rhabdochona	Intestine	0.00	0.00	1(1.88%)	1(1.88)
Strongylides	Intestine	1(1.88%)	0.00	2 (3.77%)	3 (5.65)
Oxyuris	Intestine	0.00	1(1.88%)	0.00	1 (1.88)
		7	4	9	20 (37.68)
PROTOZOA					
Coccidia	Intestine	7(13.20%)	2 (3.77%)	5(9.43%)	14 (26.40)
Thecomoeba	Gills/skin	3(5.66)	1(1.88%)	1(1.88%)	5 (9.42)
Trichodina	Gills/skin	0.00	6 (11.32%)	0.00	6 (11.32)
Entamoeba	Intestine	0.00	4 (7.54%)	0.00	4 (7.54)
		10	13	6	29 (54.68)
Total		17 (32.05%)	17(32.05%)	19 (35.81%)	53(100)

DISCUSSION

Most (50%) of the fish ponds sampled in Zaria were of concrete. This is probably because concrete ponds are durable and easy to clean (Olaoye, *et al*., 2014). The P^H was not significantly different for all pond types, and was within normal range except for earthen ponds that had a mean P^H of 5.8; below the optimal range of 6.5-8.5 (Makori *et al*., 2017). Normally, one expects earthen ponds to be alkaline, because they contain algae, phytoplankton and decaying vegetation. The acidity of earthen ponds in this study may be

due to local soil conditions, water run-off containing acidic agrochemicals like phosphate fertilizer which is in common use in the area, or some other chemicals (Caipang *et al*., 2012). These possibilities need to be investigated in order to establish the actual reasons. Addition of lime is therefore required for earthen ponds in the study area to reduce their acidity (Keremah *et al*., 2014). Plastic ponds (P^H = 6.1), were slightly acidic and may therefore not give the best results in fish production. The acidity may be due to the presence of polyvinyl chlorides (PVCs) that normally leach from plastics. Polyvinyls may induce poor immune responses and chemical toxicity in fish (Boyle *et al*., 2020).

Fish are cold blooded and assume the temperature of the water they live in. Water temperature controls all activities of the fish, the optimum being from 25°C to 32°C for tropical fishes. The temperature profile for this study was within normal range. Nitrites are used as the measure of ammonia in the ponds (Njoku *et al*., 2015), which if in excess is toxic to fish. A nitrite concentration of 3mg/L is indicative of water pollution from nitrogenous wastes and or bacterial activity (Bhatnagar and Devi, 2013). Nitrite levels in this study were within the acceptable limit of less than 3ppm (Svobodova *et al*., 2005) for all pond types. Though concrete ponds had much lower values, these were not significantly different. These low values are therefore indicators of good water quality, especially for concrete and plastic ponds in which the source of water was boreholes (65%), and the frequency of changing water was once in 1- 7 days as seen in 70% of the ponds.

Total dissolved solids are a measure of dissolved inorganic salts and organic matter in water. The most common cation is sodium, while chlorides and sulphates are the common anions. It is a measure of salinity (Ibrahim *et al.*, 2009). The mean TDS in fresh water rivers is 120mg/L which is considered the maximum limits for fresh water fishes (Ibrahim *et al.*, 2009), such as *Clarias gariepinus.* The TDS values for all pond types in this study fall below normal. These very low levels in TDS are probably because most of the ponds are watered from boreholes which have been shown to have low TDS in Zaria area (Ayodeji, *et al*., 2017). The lower levels recorded in earthen ponds could be due to the large volume of water possibly added by precipitation and run-off which has a diluting effect (Weber-Scannell *et al.,* 2007).

The parasites identified in this study were intestinal helminths, ecto and endoprotozoans. The ectoparasitic protozoans affect the skin and gills, while the helminths and endoprotozoans were in the gastro intestinal tract. Many genera of ectoprotozoans of fish have been reported in Africa, especially in wild fish (Waruiru, *et al*., 2020). The important genera included Cryptobia, Chilodenella, and Trichodina. In this study, Trichodina and Thecomoeba have been identified in the gills and skin of *Clarias gariepinus*. The two had a prevalence of 20.7%. This high prevalence is not surprising because they are said to be ubiquitous in Africa. The main sign of infestation with ectoprotozoans is said to be fleshing or rubbing against objects (Waruiru, *et al*., 2020). These were not observed, and no lesions were visible with thecomoeba and trichodina even with the high levels of infestation in this study.

Coccidia (26.4%) and Entamoeba (7.5%) were the two types of intestinal protozoans detected in this study. Cases of active fish coccidiosis are said to be rare and lesions; which may include white blisters and thickening of the intestinal wall are few. Even though these parasites were detected in this study, no lesions were seen. This is in agreement with the report of (Dykova and Lom, 1981), who reported that lesions are seen only when there is heavy infestation associated with water pollution. *Clarias gariepinus* from earth ponds had the highest infestation rate for coccidia and concrete ponds had the least which was statistically significant by the Fisher- exact Chi-square test. This is probably because earth ponds have higher levels

of biomass from dead and decaying matter. Concrete ponds on the other hand had lowest rate of coccidial infestation (3.8%), probably as a result of better water quality.

Entamoeba species were detected in the GIT of *Clarias gariepinus* in this study at the prevalence rate of 7.5%. No signs or lesions were detectable as a result of their presence. These parasites are normally free living in fish ponds, but can cause heavy infestation and mortality in fish as a result of poor water quality. In addition, they are zoonotic (Chai *et al.*, 2005).

Helminth parasites have been reported by many researchers in Nigeria in both wild and cultured fish. Oniye *et al.,* (2004) reported the presence of 1 genus of nematode, 3 cestodes (60%) and 1 Acanthocephala among wild fishes in Zaria with a total prevalence of 11.96%. This study, within the same area and among cultured fish, also had a prevalence of 12 % of assorted nematodes and cestodes. The work however identified eight genera of helminthes out of which only 2 (25%) were cestodes. The lower prevalence of cestodes could be attributed to a probable low contact between the fish and intermediate hosts in the culture environment. Paperna and Dzikowski (2006) similarly noted that cestodes had a higher prevalence in earthen ponds. The relatively higher prevalence of nematodes (37.68%) in this work may be because monoxenous (single host) nematodes such as oxyuris, have omnivorous fish such as Clarias as their host. In addition, fishes acting as intermediate hosts can transmit the parasites to other fish, piscivarous birds, reptiles and mammals including man when they are consumed dead or alive without the need for other intermediate hosts (Paperna and Dzikowski, 2006). In this work, no zoonotic helminths were identified and all the nematodes identified were enteric.

CONCLUSION

Although there were no significant differences in the physicochemical properties of water from different pond types, the P^H in earth ponds was below acceptable levels (too acidic) in Zaria and environs. Twelve (12) genera of parasites were identified in the gills, skin and gastro intestinal tract of *Clarias gariepinus*. The most common helminth was Eustrongyloides species in 53 positive samples (18.8 %). Fish from plastic ponds had the highest prevalence of parasites, while concrete had significantly low levels of coccidia.

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