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ECTOPARASITE INFESTATION ON CULTURED NILE TILAPIA (*OREOCHROMIS NILOTICUS*) IN THE KASSENA-NANKANA MUNICIPALITY, GHANA: A CASE STUDY OF BONIA

By

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Abstract

This study assessed the prevalence and intensity of ectoparasites on Nile tilapia (*Oreochromis niloticus*) cultured in earthen ponds from fish farms in Bonia, a community in the Kassena-Nankana Municipality of the Upper East Region of Ghana. Ninety *O. niloticus* samples were collected from two farms and directly transported to the laboratory for examination. All ecological data were recorded.

The results showed that overall infestations were 47.8%, as 48.8% in farm 1 and 51.2% in farm 2. These were *Ichtyophthirius multifilus*, *Trichodina* sp., *Chilodonella* sp. *Epistylis* sp., *Tetrahymena* sp., *Dactylogyrus* sp., and *Gyrodactylus* sp. on the skin, gill, and fin tissues. *Trichodina* sp. and *I. multifilus* were reported on all fish tissues in both farms. *Trichodina* sp. showed a high rate (21.3%) in F2, and *I. multifilus* showed a rate (12.8%) in F1. *Trichodina* sp. recorded an overall mean intensity (MI) of 1.21, (1.05) in F1 and (1.36) in F2. All the physicochemical factors were within optimal range for the *O. niloticus* culture and growth, except for DO.

Keywords: Ghana, Aquaculture, Fish ectoparasites, Mean intensity, Pond Management,

Introduction

Fisheries sector contributes immensely to food and nutritional security of about 200 million Africans (Heck and Béné, 2005). It generates income for over 10 million others engaged in fish production, processing, and trade (Miller, 2011). Annually, Ghana suffered from a slow growth (3%) of aquaculture sector (FAO, 2016). Ghana authorities and other organizations encouraged aquaculture production to increase fish output. But, this campaign didn't yield any significant success due to many problems, such as high feed cost, insufficient nutrition, improper handling, suboptimal water quality, and improper parasitic control (Cavichiolo *et al*, 2002).

Parasitic infections significantly affect the health and productivity of cultured species, leading to negative impacts such as economic losses and the collapse of aquaculture operations. Direct economic losses may occur through reduced growth rates, increased mortality, and the cost of treatment and prevention measures, while indirect losses may occur when infected fish are rejected and consumer confidence is reduced in farmed products (Shinn *et al*, 2015). Aquatic parasites infect fish farming causing high mortality rates, such the white spot protozoan, *Ichthyophthirius multifiliis* (Woo, 2006). Also, helminthes infect fish causing malnourishing, growth stopping, and vulnerability (Roberts and Janovy, 2009). In salmon farms, the sea lice crustacean, *Lepeophtheirus salmonis*, seriously affect skin and scales leading to secondary bacterial infections (Costello, 2009). Also, negative parasitic impact on fish survival rate was reported (Zago *et al*, 2014). Some fish parasites can be transmitted to humans and other fish-eating domestic and non-domestic animals (Klinger & Francis-floyd, 2002).

The Nile tilapia (*Oreochromis niloticus*) is one of humans' food sources (Anyamba *et al*, 2001). Fish farms became popular as to fast-growing nature, withstander various environmental factors (El-Sayed, 2006). Pavanelli *et al.* (2008) reported that ecto- & end-o-parasites infected *O. niloticus*. Lehmann *et al.* (2020) reported that *Trichodina* sp. plays a critical role in aquaculture success by causing outbreaks with economic losses. Pavanelli *et al.* (2008) reported that monogenoids, the primary ectoparasites infesting fish farming cause risky mortality rates. In Ghana, there is a paucity of information on pathogens' incidence and prevalence, which stopped feasible prevention and control measures (Baidoo *et al*, 2015).

This study aimed to identify the ectoparasites infesting the Nile tilapia, *O. niloticus* in two fish farms in Bonia, a community in the Kassena-Nankana Municipality in the Upper East Region of Ghana.

Materials and Methodology

Study area: Samples were taken from the two fish farms, labeled Farm 1 (F1) & Farm 2 (F2). Bonia is located on latitude 10^{o} 51'N and longitude 1^{o}7' W, and is one of the beneficiary communities of Tono Irrigation Project (GSS, 2014). Water in both farms is from the Tono Dam by irrigation canals running via various beneficiary villages. The area is generally low-lying, with an undulating land scape and isolated hills. Harmattan is a season in West Africa occurs between the end of November and the middle of March, characterized by the dry and dusty northeasterly trade wind, of same name, blows from the Sahara over West Africa into the Gulf of Guinea (World Bank, 2020). Temperatures are in the Municipality, average 28.1°C. Annual average ones are about 25.8°C in Aug ust & 31.4°C in March or April. Farms used earthen ponds as holding systems (100ftx 70ft). Ponds in F1 held *O. niloticus*, but F2 held *O. niloticus* and *Clarias gariepinus*.

Fish collection: Ninety live *O. niloticus* (lengths 0.8 to 26cm & weights 4.0 to 180g) were collected from both farms by netting and immediately transported in labeled plast ic containers with pond water to the General Biology laboratory of C.K. Tedam University for examination. Fish were collected three times in June, July, & August, and physicochemical parameters were recorded.

Laboratory examinations: Total length & body weight were measured to nearest 0.1 cm & 0.01g respectively. Fish were divided according sizes as: small (0.1-12cm), medium (12.1-20cm), & large (20.1-30cm). Skin, fins, and gills of each were collected and examined for ectoparasites under a light microscope as wet slides of these tissues. Fish ectoparasites were identified by parasite atlas (Barker and Cone, 2000). Fish operculaum was raised with a tweezer to expose gills, a portion was cut by a scissor, put in a drop of water on glass slide, skin mucous was spread in a drop of water and fins were dissected out to snip portions mainly caudal fin and put in a drop of water on glass slide. Samples were covered with slip and counted ectoparasites in each tissue (Paperna, 1996).

Physicochemical parameters: Temperature, dissolved oxygen (DO), total dissolved solids (TDS), & pH were measured daily (July to August 2023) at 07GMT-08 GMT, by a water quality multi-parameter probe (AQUAREAD AP-700 & AP-800). The average of three replicates of each parameter taken at different water sites was calculated.

Statistical analysis: Data were analyzed for ectoparasites infestation, prevalence, mean intensity, index, and density after Bush *et al.* (1997) as followed:

$$\text{Prevalence} = \frac{Number\ of\ infested\ with\ a\ particular\ parasite\ species}{Total\ number\ of\ hosts\ examined} \times 100$$

$$\text{Mean Intensity (MI)} = \frac{Total\ number\ of\ parasite\ species\ in\ host\ species}{Total\ number\ of\ infested\ host\ species}$$

$$\text{Density of infestation (DI)} = \frac{number\ of\ parasites\ collected}{total\ number\ of\ samples\ examined}$$

$$\text{Index of infestation (II)} = \frac{Number\ of\ infested\ host \times number\ of\ parasites\ collected}{Total\ number\ of\ samples\ examined}$$

The calculations were done using Microsoft Excel (version 2021 LTSC).

Results

Of 90 fish, F1 showed 40 (44.4%), but F2 was 50 (55.6%). Infestation was 21(48.8%) in F1 and 22 (51.2%) in F2.

Small fish showed a high infestation rates; F2 (46.9%) & F1 (33.3%), medium ones showed (38.9%) in F2 & (23.8%) in F1, & large ones showed (42.9%) in F1 & 0.0 in F2.

Ectoparasites (7) in both farms were *I. multifilus*, *Trichodina* sp., *Chilodonella* sp., *Epistylis* sp., and *Tetrahymena* sp. (protozoa), *Dactylogyrus* sp. and *Gyrodactylus* sp. (monogeneans). Ectoparasites were marked as +ve (present) or -ve (absent). *Trichodina* sp. and *I. multifilus* infestations indicated well adaptation to fish environmental condition.

Trichodina sp. was (21.3%) on gills in F2. *I. multifilus* showed same rate in both farms, but slight high on F1 fins (12.8%). *Trichodina sp*. was high (24.4%), followed by *I. multifilus* (18.9%) and then *Chilodonella sp.* (16.7%).

Trichodina sp. MI was high (1.36) in F2, but (1.05) in F1 with (1.21) overall rate, *I. multifilus* followed with MI (0.86) in both.

Dactylogyrus sp. was zero MI in F1, but (0.14) in F2 with an overall rate of (0.07).

DI was high in F2 (3.5) than in F1 (1.88). II was high in F1 (39.38) than in F2 (33.88). F2 showed a high DI & II, F1with average infestation rate than F2.

Water temperatures were F1 (28.5°C) & F2 (28.3°C). PH levels were Alkaline, F1 (7.9) & F2 (7.6). DO levels were (4.63mg/l) in F1 and (4.51mg/l) in F2. TDS level in F1 was (97.25mg/l) and F2 (95.83mg/l).

Details were shown in tables (1, 2, 3, 4, 5, 6 & 7).

Table 1: Prevalence of ectoparasites infesting *O. niloticus* cultured in earthen ponds in Bonia

Farm	Infected fish		Un-infected fish		Total fish	
	No. of fish	% of fish	No. of fish	% of fish	No. of fish	% of fish
A	21	48.8	19	40.4	40	44.4
B	22	51.2	28	59.6	50	55.6
Total	43	100	47	100	90	100

Table 2: Ectoparasites infesting different sizes of *O. niloticus* cultured in earthen ponds

Size (cm)	Farm A			Farm B			Total		
	Infested	Un-infested	Total	Infested	Uninfested	Total	Infested	Uninfested	Total
Small (0.1-12.0)	7 (33.3%)	5 (26.32%)	12 (30.0%)	15 (46.9%)	17 (53.1%)	32 (64.0%)	22 (51.2%)	22 (46.8%)	44 (48.9%)
Medium (12.1-20.0)	5 (23.8%)	4 (21.05%)	9 (22.5%)	7 (38.9%)	11 (61.1%)	18 (36%)	12 (27.9%)	15 (31.9%)	27 (30.0%)
Large (20.1-30.0)	9 (42.9%)	10 (52.63%)	19 (47.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9 (20.9%)	10 (21.1%)	19 (21.1%)
TOTAL	21 (52.5%)	19 (47.5%)	40 (100%)	22 (44.0%)	28 (56%)	50 (100%)	43 (47.8%)	47 (52.2%)	90 (100%)

Table 3: Mean intensity (MI) of ectoparasite species

Ectoparasites	Farm A	Farm B	Total
Trichodina sp.	1.05	1.36	1.21
I. multifilus	0.86	0.86	0.86
Dactylogyrus sp.	0.0	0.14	0.07
Chilodonella sp.	0.52	0.68	0.6
Gyrodactylus sp.	0.57	0.23	0.4
Epistylis sp.	0.38	0.0	0.19
Tetrahymena sp.	0.14	0.23	0.19

Table 4: Occurrence of ectoparasites on tissues of *O. niloticus* cultured in earthen ponds

Ectoparasites	Fish Tissue	Farm A	Farm B
Trichodina sp.	Skin	+	+
	Fin	+	+
	Gills	+	+
I. multifilus	Skin	+	+
	Fin	+	+
	Gills	+	+
Dactylogyrus sp.	Skin	-	+
	Fin	-	-
	Gills	-	+
Gyrodactylus sp.	Skin	+	+
	Fins	+	+
	Gills	-	-
Chilodonella sp.	Skin	+	+
	Fins	-	-
	Gills	+	+
Epistylis sp.	Skin	+	-
	Fins	-	-
	Gills	-	-
Tetrahymena sp.	Skin	+	+
	Fins	-	-
	Gills	-	+

Table 5: Frequency and percentage of ectoparasites on tissues of *O. niloticus* cultured in earthen ponds

Ectoparasites	Fish Tissue	F-A		F- B		Total	
		Infested	Infested %	Infested	Infested %	Infested	Infested %
Trichodina sp.	Skin	5	12.8	3	6.4	8	9.1
	Fin	2	5.1	2	4.3	4	4.5
	Gills	3	7.7	10	21.3	13	14.8
	Total	10	25.6	15	31.9	25	28.4
I. multifilus	Skin	4	10.3	5	10.6	9	10.2
	Fin	5	12.8	2	4.3	7	8.0
	Gills	2	5.1	4	8.5	6	6.8
	Total	11	28.2	11	23.4	22	25.0
Dactylogyrus sp.	Skin	0	0.0	2	4.3	2	2.3
	Fin	0	0.0	0	0.0	0	0.0
	Gills	0	0.0	1	2.1	1	1.1
	Total	0	0.0	3	6.4	3	3.4
Gyrodactylus sp.	Skin	1	2.6	4	8.5	5	5.7
	Fins	6	15.4	1	2.1	7	8.0
	Gills	0	0.0	0	0.0	0	0.0
	Total	7	17.9	5	10.6	12	13.6
Chilodonella sp.	Skin	4	10.3	4	8.5	8	9.1
	Fins	0	0.0	0	0.0	0	0.0
	Gills	2	5.1	5	10.6	7	8.0
	Total	6	15.4	9	19.1	15	17.0
Epistylis sp.	Skin	2	5.1	0	0.0	2	2.3
	Fins	0	0.0	0	0.0	0	0.0
	Gills	0	0.0	0	0.0	0	0.0
	Total	2	5.1	0	0.0	2	2.3
Tetrahymena sp.	Skin	3	7.7	2	4.3	5	5.7
	Fins	0	0.0	0	0.0	0	0.0
	Gills	0	0.0	2	4.3	2	2.3
	Total	3	7.7	4	8.5	7	8.0
Total		39	100.0	47	100.0	88	100.0

Table 6: Density of infestation (DI) and index of infestation (II)

Farm	Density of infestation (DI)	Index of infestation (II)
A	1.88	39.38
B	3.5	33.88
Total	1.69	72.62

Table 7: Physico-chemical parameter of water from various farms

Farm	Temperature (°C)	pH	DO (mg/L)	TDS (mg/L)
A	28.5±0.3	7.9±0.2	4.6±0.5	97.3±1.5
B	28.3±0.5	7.6±0.4	4.5±0.4	95.8±2.3

Discussion

The present study showed a higher infestation rate in F2 (51.2%) compared to F1 (48.8%) with differences in environmental factors, management practices, and possibly fish inherent susceptibility, with ectoparasites infesting rate in both farms was 47.8%. Bichi and Yelwa (2010) found high farms' ectoparasites were with suboptimal control practices. Tavares-Dias *et al.* (2007) found that tilapia ectoparasites were influenced by managing environmental factors. Arthur and Bondad-Reantaso (2012) found the biosecurity was important in regular health monitoring in reducing parasitosis in aquaculture.

In the present study, ectoparasites on small fish (51.2%) were higher than on larger ones (20.9%). Smaller fish were more susceptible to ectoparasites due to poor immune systems and more fragile scales (Tavares-Dias *et al*, 2007).

In the present study, seven ectoparasites are nature diverse as *Trichodina* sp., *I. multifilus*, *Chilodonella* sp., *Gyrodactylus* sp., *Epistylis* sp., *Tetrachymena* sp., and *Dactylogyrus* sp. This agreed with both Baidoo *et al.* (2015) and Alhassan *et al.* (2018).

The current study found seven ectoparasites in F1and six in F2. These data differed from Koyuncu and Toksen (2010), who reported *Trichodina* sp., *Tetrahymena* sp., and monogeneans on *O. niloticus* in aquaculture in the Ashanti Region. Baidoo *et al.* (2015), who reported *Trichodina* sp., *I. multifilis*, and monogeneans on *O. niloticus* from concrete ponds. Also, Alhassan *et al.* (2018), who reported *O. niloticus* ectoparasites in cage culture at Mpakadam.

The widespread presence of multiple ecto-parasite species on different tissues such as skin, fins, and gills of *O. niloticus* indicates a complex parasitic burden on fish, which can lead to significant health issues such as tissue damage, impaired respiration, and increased susceptibility to secondary infections (Thilakaratne *et al*, 2003). For instance, *Trichodina* sp. and *I. multifilus* were consistently present on skin, fins, and gills of fish in both farms, suggesting that the parasites were well-adapted to environmental conditions in the earthen ponds. *Dactylogyrus* sp. and *Tetrahymena* sp. showed a more selective pattern, with *Dactylogyrus* sp. predominantly found on gills in F2 and *Tetrahymena* sp. on skin and gills. Parasites tissue-specific distribution form targeted treatment strategies. Treating gill is indicated to control *Dactylogyrus* sp. (Tavares-Dias *et al*, 2007). Arthur and Bondad-Reantaso (2012) found that *Trichodina* sp. & *I. multifilus* were common ectoparasites in freshwater aquaculture on the skin, fins, and gills. Bichi and Yelwa (2010) found that gill parasites as *Dactylogyrus* sp. can significantly impair fish respiratory efficiency reduced growth rates and increased mortality. This parasite on gills in F2 underscores the need for specific interventions targeting gill health.

Trichodina sp. showed higher overall prevalence, infesting 28.4% of fish, followed by *I. multifilus* 25.0%. These ectoparasites were prevalent across all tissues, with a high occurrence on gills (*Trichodina* sp. 14.8%, *I. multifilus* 6.8%). The high prevalence showed a significant health concern as they cause severe tissue damage and respiratory issues decreasing growth rates and increased mortality (Thilakaratne *et al*, 2003). *Trichodina* sp. and *I. multifilus* were present on all tissues, but *Trichodina* sp. highly occurred in gills (21.3% in F-B). *Gyrodactylu*s sp. showed a high prevalence on fins (15.4% in F1), but *Chilodonella* sp. was more prevalent on skin (10.3% in F-A & 8.5% in F-B). Tissue specificity can guide treatment to effective control (Tavares-Dias *et al*, 2007).

Trichodina sp. exhibited high mean intensity (MI) overall (1.21), with a high MI in F-B (1.36) compared to F-A (1.05). *I. multifilus* had a consistent MI of 0.86 at both farms. High MI values for the parasites suggested that they didn't only widespread but caused significant parasitic loads on individual fish, which can lead to severe tissue damage and increased susceptibility to secondary infections (Thilakaratne *et al*, 2003). *Trichodina* sp. showed highest MI on both farms because most common parasite found on farmed *O. niloticus*. Trichodinid ciliates can quickly attack the whole host population because they multiply by binary fission and direct transmission, mainly if fish were housed in unfavorable environmental circumstances or under unfriendly cultivation sites (Lom and Dykova, 1995).

The F2 showed a significantly higher infestation density (3.5) compared to F1 (1.88), indicating that F2 fish were on average infested with a greater number of parasites. The high DI in F2 showed more favorable conditions for ectoparasites due to water quality, stocking density, and practices management (Arthur and Bondad-Reantaso, 2012). Despite a lower DI, F-A had a high infestation index (39.38) as compared to F-B (33.88). The II integrates both prevalence and mean intensity of infestations, suggesting that although Farm A has fewer parasites per fish, the infestations are more severe or widespread. This could imply that while fe-wer fish were infested, those that infestation carried a high parasitic load (Mugisha *et al*, 2020). Total DI (1.69) & II (72.62) showed a substantial ectoparasites burden on the Nile tilapia population in the studied area. These values reflect the cumulative impact of parasitic infestations on fish health and underscore the importance of effective parasite management strategies in aquaculture operations (Bichi and Yelwa, 2010). The critical attention must be given to farms by using the best and safe aquaculture management practices to prevent ectoparasites infectious diseases (Bichi and Dawaki, 2010). The management practices carried out in farms was parallel to the aquaculture industry success. Orina *et al.* (2005) in Ghana confirmed that the low fish production detected by the aquaculture industry might probably be a result of poor management and the siting of ponds. Thus, there must be an improvement in internal husbandry practices on farm, as it could reduce the rate of fish handling during transportation and grading, as these practices tern fish susceptible to parasitic infestation. Infested equipment used in fish farms must be treated before being used (Roberts, 2012).

Water temperature in F1 & F2 is similar, with mean values of 28.5±0.3°C & 28.3± 0.5°C, respectively, which were within optimal temperature for Nile tilapia culture between 25°C and 30°C (El-Sayed, 2006). The pH values were slightly alkaline, with F1 at 7.9±0.2 and F2 at 7.6±0.4. These values fell within the acceptable range for tilapia culture, which is between 6.5 and 9.0 (Boyd, 2018). Slight variations in pH were unlikely to cause significant differences in parasite loads; however, maintaining a stable pH is important for overall fish health and reducing stress, which could make fish more susceptible to parasites (Wedemeyer, 1996).

However, DO levels were slightly lower than the optimal range for tilapia, with F1 at 4.6±0.5 mg/l and F2 at 4.5±0.4mg/l. Optimal DO levels for *Tilapia* were generally above 5mg/l (Boyd, 2018). Low DO levels stressed fish and made them more susceptible to parasites by reducing immune response (Boyd, 2018). The slight DO deficiency may in part explain relatively high infestation rates in both farms. TDS levels were 97.3±1.5mg/l in F1 & 95.8±2.3mg/l in F2, which favor the acceptable range for *Tilapia* culture, generally below 2000mg/l (Boyd, 2018). Generally, the values for abiotic factors measured on farms were within optimal ranges ideal for culture and growth of *O. niloticus* in freshwater systems (Barker and Cone, 1990). The physicochemical properties recorded didn't influence ectoparasites intensity of *O. niloticus* in both farms, except for the DO.

The present high ectoparasites rates were due to internal husbandry operations in F1 & F2, as shared location, reptiles' presence and fish-eating birds. This agreed with Suliman and Al-Harbi (2016). Chappell *et al.* (1994) reported that fish-eating faunae carry parasites on mouths while feeding and expel them into water body with feces. Moraes and Martins (2004) reported a high relation between ectoparasites and water ponds quality managed.

Conclusion

Both farms were infested with ectoparasites, but differed in prevalence and intensity. *Trichodina* sp. & *I. multifilus* were common in both farms. F2 showed a high infestation rate (3.5) than F1 (1.88), with more ectoparasites. But, F1 had a higher infestation index (39.38) than F2 (33.88) with a risky of prevalence and ectoparasitic load.

Small-sized fish were more infested in F2. Mean ectoparasites intensity varied, F2 showed high *Trichodina* sp. and *Chilodonella* sp. rates. F1 showed high *Gyrodactylus* sp. and *Epistylis* sp. rates. All physicochemical factors in farms were within ideal optimal range for *O. niloticus* except DO.

Recommendations

Ectoparasites control is a must for fish health and productivity mainly in F2, Slightly low DO levels in both farms were due to optimize fish health and growth by aeration or improved water circulation. Farms showed promising data for tilapia culture, regular monitoring, and tailored control strategies to optimal fish health and productivity in the earthen pond systems.

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