



## Research Article

# Prevalence and Intensity of Gastrointestinal Helminths of *Clarias gariepinus* from selected Fish Farms in Makurdi, Benue State

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### ABSTRACT

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Gastrointestinal helminth parasites of *Clarias gariepinus* from three selected Fish Farms in Makurdi, Benue State was evaluated. 90 *C. gariepinus* comprising 30 samples each were randomly obtained from three selected fish farms in Makurdi, Benue State, Nigeria designated as farms A, B, and C. They were identified based on external features and sexes were determined. The lengths and weights were measured and recorded before dissection. Parasites observed were identified using morphological characteristics. Of the 90 *C. gariepinus* examined, 51 (56.67%) samples were infected and observed to harbour 139 different helminths parasites.

Of the 139 helminth parasites belonging to 2 taxonomic groups of parasites (1 species of Cestoda – *Diphyllobothrium latum* and 3 species of Nematoda – *Capillaria spp.*, *Camallanus spp.*, and *Eustrongylides sp.*). 139 helminth parasites comprising of 49, 37 and 53 parasites were recovered from 18, 13 and 20 infected fish from fish farms A, B and C, respectively. The highest prevalence (66.67%) was recorded for fish samples from Farm C fish farm while the lowest (43.33%) was recorded for fish samples from Farm B. The prevalence of parasitic infection from Farm A (60.0%) and Farm C fish farm (66.67%) was significantly higher than that of Farm B (43.33%) ( $p < 0.05$ ). Variations in parasite prevalence existed between the male and females across the three farms being higher in females (64.71%) compared to males (53.85%) from Farm A but higher in males from Farm B (44.44%) and Farm C fish farm (93.75%) compared to the female (42.86% and 35.71%), respectively. Helminth parasites were most abundant in the stomach (40.82%) of the infected *C. gariepinus* from Farm A but least in the rectum (8.16%). In contrast, helminth parasites were most abundant in the intestine *C. gariepinus* from farm B (35.14%) and Farm C fish farm (33.96%) but least in the rectum (16.22%) and (16.98%) from Farm A and Farm C fish farms, respectively. Generally, the highest number of helminth parasites was recorded for the intestine while the least was recorded for the rectum except for Farm A where the highest number of helminth parasites was recorded for the stomach of the infected fish samples. Variation in parasite prevalence existed among the length and weight groups of *C. gariepinus* across the three farms. Generally, a higher rate of parasitic infection was observed in the larger size of *C. gariepinus* than in the smaller ones.

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## INTRODUCTION

Fish is one of the food commodities that is distributed worldwide and called a vital source of animal protein (Osuigwe and Obiekezie 2007) which also contains other essential elements that are necessary for the maintenance of a healthy human body in the developing countries. Fish is generally cheaper and has higher protein contents and products than other similar food items such as meat and eggs (Aihonsu *et al.*,2006). Also, fish provides a comparatively cheap source of animal protein for man and his livestock and attention is now being focused on its production, both from natural water and aquaculture (Komatsu and Kitanishi, 2015).

The African catfish (*Clarias gariepinus*) has been reported to be a significant aquaculture candidate in Nigeria and other countries in Africa (Eyo *et al.*,2015) due to several favourable characteristics which include its ability to tolerate a wide range of environmental conditions and high stocking densities under culture conditions, fast growth rate, acceptability of artificial feed, and high fecundity rate among others (Eyo *et al.*,2015). It is also popular with consumers in Nigeria due to its high nutritive value (Udeze *et al.*,2012). However, fish consumption is not devoid of risks due to the possibility of harbouring pathogenic parasites, especially zoonotic species (Leal *et al.*,2008). Moreover, fish are sometimes cultured under potentially stressful conditions which may proliferate existing infections to become more severe and precipitate disease outbreaks and compromise the fitness of such fish for human consumption (Danba *et al.*,2015). This study evaluated the prevalence of gastrointestinal helminth parasites of *Clarias gariepinus* from three selected Fish Farms in Makurdi, Benue State, Nigeria.

## MATERIALS AND METHODS

### Sample collection and preparation

A total number of 90 live African Catfish (*C. gariepinus*) comprising of 30 samples different total length and weight ranges were purchased randomly from three selected Fish Farms (A, B, and C) located in Makurdi, Benue State, Nigeria; designated as Farms A, B and C, respectively. The fish samples were transported live in a clean plastic container containing water to the Fisheries and Aquaculture Laboratory, Joseph Sarwuan Tarka University, Makurdi for parasitological examination. They were identified based on external features as described by Edeh and Solomon (2016).

### Sex determination

The sexes of fish were identified by physical observation of the urogenital papillae located behind the anus, which is long or distended in males but round and reddish in the matured female as described by Lagrue *et al.* (2011). The fish were rendered inactive by gently hitting them on their heads for easy handling and the sexes were later confirmed after dissection by visual observation of the testes in male and ovaries in the female.

### Morphometric measurement (length and weight)

The length of each fish sample was measured from the tip of the snout to the end of the caudal fin using a calibrated meter rule to the nearest centimetre (cm) and recorded. Fish samples were also weighed to the nearest gram (g) using a manual weighing balance and recorded.

### Parasitological examination

Fish samples were gently killed by hitting them on their heads for parasitological examination. An incision was made on the ventral side of the fish from the anal opening to the lower jaw using dissecting scissors to expose the body cavity and most of the internal organs. The stomach and intestine were separated and kept in different sample plates containing 0.9% NaCl (normal saline) solution. The contents of

the oesophagus, stomach, intestine, and rectum were washed in the normal saline solution for sedimentation and floatation (The water from the washed was poured into test tube and centrifuged, using an ordinary centrifuge at 4500 rpm for 5 min. The supernatant was decanted and the sediment was examined under a light microscope). A drop of the residue was placed on the slide and the wet mount was examined for parasites under the microscope for various parasites. The parasites were identified using a standard key by Ajala and Fawole (2014) and Kawe *et al.* (2016).

Morphological identification of *Eustrongylides spp* was based on careful examination of faint characters at the anterior end of the reproductive system. These traits include the size and shape of a buccal capsules, internal and external leaf crowns and its extra-chitinous support

Morphological identification of *Camallanus spp* was based on the presence of buccal capsule with longitudinal internal ridges, some of which were very short. The oesophagus consisted of muscular and glandular portions, the middle position of the excretory pore to the muscular oesophagus, the anterior location of deirids to the nerve ring, posterior end of males

## RESULTS

### Prevalence of infection and intensity of helminths parasites from the studied fish farms

The total prevalence of infection and intensity of helminth parasites from the studied fish farms are shown in Table 1. Out of the 90 *C. gariepinus* examined, 51 (56.67%) samples were infected with 139 different helminths parasites. Out of the 139 helminth parasites recovered from fish, 49, 37 and 53 parasites

with two unequal spicules and caudal papillae; nonetheless, it is smooth and straight in females.

Morphological identification of *Diphilobothrium latum* was based on the three fairly distinct morphological segments: the scolex (head), the neck, and the lower body. Each side of the scolex had a slit-like groove, which is a bothrium for attachment to the intestine. The scolex attaches to the neck or proliferative region.

### STATISTICAL ANALYSIS

The prevalence and intensity of parasitic infection were calculated according to Poulin and Rohde (1997):

- i.  $\text{Prévalence} \% = \frac{\text{Number of fish infected}}{\text{Number of fish examined}} \times 100$
- ii.  $\text{Intensity} = \frac{\text{Total Number of Parasites}}{\text{Number of fish infested}}$

The relationships between factors such as fish sex, weight, total length, locality, and parasitic infection were obtained from pooled data using analysis of variance (ANOVA). All statistical analysis was performed using Statistical Package for the Social Science (SPSS) version 21.0.

were recovered from 18, 13 and 20 infected fish from farms A, B and C, respectively. The prevalence of parasitic infection from Farm A (60.00%) and Farm C (66.67%) was significantly higher than that of farm B (43.33%) ( $P < 0.05$ ). Generally, the total prevalence was highest in Farm C fish farm (66.67%) but lowest in Farm B (43.33%). However, intensity (parasitic load) was highest in Victory (2.85) but lowest in Farm C fish farm (2.65)

**Table 1:** Prevalence and intensity of helminth parasites of *C. gariepinus* from the three selected fish Farms in Makurdi (N=30)

Fish Farms	No. of infected fish	Prevalence (%)	No. (%) Parasites recovered	Intensity of parasite
A	18	60.00	49(35.25)	2.72
B	13	43.33	37(26.62)	2.85
C	20	66.67	53(38.13)	2.65
Total	51	56.67	139(100)	2.73

N = Total number of fish examined for each farm  
A = Farm A, B = Farm B and C = Farm C

### Spectrum of helminths parasites isolated from *C. gariepinus* from selected fish farms in Makurdi

The helminth parasites recovered from *C. gariepinus* from three fish farms in Makurdi, Benue State are shown in Table 2.

A total of 139 helminth parasites belonging to the genus Cestoda (*Diphyllobothrium latum*) and 3 species of the genus Nematoda (*Capillaria spp.*, *Camallanus spp.* and *Eustrongylides spp.*) were recovered from 51 infected fish samples from the three selected fish farms in Makurdi. *Diphyllobothrium latum*, a Cestode parasite was more prevalent (16.67%) in farm A than in farm B (10.00%). Of the three species of nematode recovered from farm A, *Eustrongylides species* had the highest prevalence (20.00%) while *Camallanus species* was the least prevalent parasite (10.00%). In farm B, *Camallanus species* had the highest prevalence (20.00%) while *Eustrongylides species* was the least prevalent (13.33%). In farm C, *Eustrongylides species* had the highest prevalence (26.67%) while *Camallanus species* had the lowest prevalence (10.00%). The result further showed that *Capillaria species* were not recovered from any fish samples from farm B.

### Prevalence of helminths parasites with the sex of *C. gariepinus*

The sex distribution of helminth parasites in *C. gariepinus* from selected fish farms in Makurdi, Benue State is shown in Table 3. The results showed that the prevalence of helminthiasis was

higher in female fish (64.71%) compared to the male counterpart (53.85%) from farm A. on the other hand, the prevalence was higher in male fish from farms B (44.44%) and C (93.75%) compared to the female counterparts with the prevalence of 42.86% and 35.71%, respectively. There was no significant difference in prevalence rates of helminthiasis between the male and female *C. gariepinus* ( $p>0.05$ ) based on Chi-square analysis.

### Distribution of helminths parasites with sites of infection in infected *C. gariepinus*

The distribution of helminth parasites with sites of infection in infected *C. gariepinus* from selected farms in Makurdi, Benue State is shown in Table 4. A total of 139 helminth parasites comprising 49 (35.25%) from farm A, 37(26.62 %) from farm B, and 53(38.13 %) from farm C were recovered from 51 infected fish samples.

In farm A, helminth parasites were most abundant in the stomach (20, 40.82%) and least in the rectum (4,8.16%) of the infected *C. gariepinus*. Conversely, helminth parasites were most abundant in the intestine of infected *C. gariepinus* from farms B (13,35.14%) and C (18,33.96%) but least in the rectum (6,16.22%) and (9,16.98%) of fish from farms B and C, respectively. Generally, the highest number of helminth parasites was recorded for the intestine of the infected fish samples while the least was recorded for the rectum except for Farm A where the highest number of helminth parasites was recorded for the stomach of the infected fish samples.

### Prevalence of helminths parasites with the body length and weight of infected *C. gariepinus*

The distribution of helminths parasites relative to the body dimensions (length and weight) of infected *C. gariepinus* from selected Fish Farms in Makurdi, Benue State is shown in Tables 5 and 6, respectively.

In Table 5, the highest prevalence of 20% and 16.7% were recorded in infected fish with a body length ranging from 35.1 to 40cm in farms A and B while the highest prevalence of 26.67 was recorded in infected fish with a body length

ranging from 40.1 to 45cm in farm C with the lowest prevalence of 3.33%, 3.33% and 10.00% being recorded in fish with body lengths of 20.1 to 25cm, 25.1 to 30cm and 30.1 to 35cm In Farms, A, C and B, respectively. In Table 6, the highest prevalence of 16.67%, 13.33% and 23.33% from farms A, C, and B were recorded in fish with body weights ranging from 340.1 to 400g, 220.1 to 280g, 340.1 to 400g and 400.1 to 460g, respectively, while the lowest prevalence of 3.33%, 6.67% and 3.33% from farms A, C, and B were recorded in fish with body weights, ranging from 100.1 to 160g.

**Table 2:** Taxonomic classification of helminth parasites recovered from *C. gariepinus* from selected fish farms in Makurdi, Benue State

Parasitic groups	Parasite species	FARMS								
		A			B			C		
		NIF	PSP	TNPR	NIF	PSP	TNPR	NIF	PSP	TNPR
Cestode	<i>Diphillobothrium latum</i>	5	16.67	18	3	10.00	17	4	13.33	12
Nematode	<i>Capillaria sp</i>	4	13.33	9	0	0.00	0	5	16.67	9
	<i>Camallanus sp</i>	3	10.00	7	6	20.00	11	3	10.00	7
	<i>Eustrongylides sp</i>	6	20.00	15	4	13.33	9	8	26.67	25
	Total	18	60.00	49	13	43.33	37	20	66.67	53

N: Number of fish samples from each fish farm; NIF: No. of infected fish; PSP: Parasite species prevalence; TNPR: Total number parasite recovered.

A = Farm A, B = Farm B and C = Farm C fish farms

**Table 3:** The sex distribution of gastrointestinal helminths parasites of *C. gariepinus* in from selected farms in Makurdi

Farms	Sex of the fish	NFE	NIF	TNP	PRV	Intensity
A	Male	13	7	17	53.85	2.43
	Female	17	11	32	64.71	2.91
B	Male	9	4	15	44.44	3.75
	Female	21	9	22	42.86	2.44
C	Male	16	15	41	93.75	2.73
	Female	14	5	12	35.71	2.40

NFE: Number of fish examined; NIF; Number of infected fish; TNPR: Total number of parasites recovered; PRV: Prevalence

A = Farm A, B = Farm B and C = Farm C fish farms

**Table 4:** Distribution of helminth parasites in relation to sites of infection in *C. gariepinus* from selected fish farms in Makurdi

Helminths in different Farms	NIF	PRV	No. of parasites isolated from different infection sites				TNPR	Intensity
			Oesphagus	Stomach	Intestine	Rectum		
<b>Farm A</b>								
<i>Capillaria spp.</i>	3	10.00	1	3	4	1	9	3.00
<i>Eustrongylides spp.</i>	8	26.67	3	11	1	0	15	1.88
<i>D. latum</i>	5	16.67	4	2	9	3	18	3.60
<i>Camallanus spp.</i>	2	6.67	0	4	3	0	7	3.50
<b>Total</b>	<b>18</b>	<b>60.00</b>	<b>8</b>	<b>20</b>	<b>17</b>	<b>4</b>	<b>49</b>	<b>2.72</b>
<b>Farm B</b>								
<i>Capillaria spp.</i>	2	6.67	0	1	3	1	5	2.50
<i>Eustrongylides spp.</i>	3	10.00	2	3	3	1	9	3.00
<i>D. latum</i>	3	10.00	6	0	5	4	15	5.00
<i>Camallanus spp.</i>	4	13.33	2	4	2	0	8	2.00
<b>Total</b>	<b>13</b>	<b>43.33</b>	<b>10</b>	<b>8</b>	<b>13</b>	<b>6</b>	<b>37</b>	<b>2.84</b>
<b>Farm C</b>								
<i>Capillaria spp.</i>	5	16.67	0	4	4	2	10	2.00
<i>Eustrongylides spp.</i>	3	10.00	3	2	1	1	7	2.33
<i>D. latum</i>	9	30.00	7	3	10	5	25	2.78
<i>Camallanus spp.</i>	3	10.00	4	3	3	1	11	3.67
<b>Total</b>	<b>20</b>	<b>66.67</b>	<b>14</b>	<b>12</b>	<b>18</b>	<b>9</b>	<b>53</b>	<b>2.65</b>

**Table 5:** The Prevalence of helminth parasites in relation to body length (Cm) of *C. gariepinus* from selected Fish Farms in Makurdi

Range in body Length	Fish Farms											
	A				B				C			
	No. of fish examined	No. of Fish infected	No. of Parasites recovered	Prevalence (%)	No. of fish examined	No. of Fish infected	No. of Parasites recovered	Prevalence (%)	No. of fish examined	No. of Fish infected	No. of Parasites recovered	Prevalence (%)
20.1-25	9	1	3	3.33	4	0	0	0	7	0	0	0
25.1-30	4	3	11	10.00	10	1	7	3.33	6	5	5	16.67
30.1-35	6	4	9	13.33	3	4	8	13.33	5	3	14	10.00
35.1-40	7	6	7	20.00	5	5	15	16.67	9	4	7	13.33
40.1-45	4	4	19	13.33	8	3	7	10.00	3	8	27	26.67
Total	30	18	49	59.99	30	13	37	43.33	30	20	53	66.67

A = Farm A, B = Farm B and C = Farm C fish farms

**Table 6:** The Prevalence of helminth parasites in relation to body weight (grams) of *C. gariepinus* from selected Fish Farms in Makurdi

Range in body weight	Fish Farms											
	A				B				C			
	No. of fish examined	No. of Fish infected	No. of Parasites recovered	Prevalence (%)	No. of fish examined	No. of Fish infected	No. of Parasites recovered	Prevalence (%)	No. of fish examined	No. of Fish infected	No. of Parasites recovered	Prevalence (%)
100-160	5	1	2	3.33	5	2	2	6.67	6	1	1	3.33
160.1-220	8	3	4	10	3	0	0	0	5	3	4	10.00
220.1-280	3	2	11	6.67	9	4	13	13.33	4	4	6	13.33
280.1-340	5	4	9	13.33	2	3	15	10.00	8	2	5	6.67
340.1-400	6	5	8	16.67	4	4	7	13.33	3	3	22	10.00
400.1-460	3	3	15	10.00	7	0	0	0	4	7	15	23.33
Total	30	18	49	60	30	13	37	43.33	30	20	53	66.67

A = Farm A, B = Farm B and C = Farm C fish farms

## DISCUSSION

The results of this study have revealed the presence of species of cestode and nematode helminth parasites in the oesophagus, stomach, intestine and rectum of farmed *C. gariepinus* from in Makurdi, Benue State, Nigeria. The findings indicated a very high helminth parasite prevalence of 66.67%, 60.00% and 43.33% among *C. gariepinus* from fish farms C, A and B, respectively. Generally, prevalence recorded in this study from each of the three selected fish farms is higher than that recorded by Afolabi *et al.*, (2020) who reported 20% prevalence of *C. gariepinus* from ponds. High prevalence recorded from farm C may be due to many factors such as feeding habit of the fish due to their omnivorous nature, pollution of water body as a result of poor management practices or low sanitary conditions and the proximity of the ponds to river Benue as most of the ponds get flooded during heavy down pour, and availability of intermediate hosts which harbour the infective larval stage of some of these parasites making them available to fish in the water (Kawe *et al.*, 2016; Afolabi *et al.*, 2020). The (66.67%) prevalence recorded in this study is significantly higher than 35.90% prevalence recorded by Lebari *et al* (2016) in *Clarias gariepinus* from selected fish farms in Portharcourt, Nigeria and 22.20% prevalence recorded by Idika *et al.*, (2017) for cultured catfish (*Clarias gariepinus*) in southeastern Nigeria. Also, the (66.67%) prevalence recorded in this study is significantly higher than the prevalence (20.00%) recorded for *C. gariepinus* by Afolabi *et al.* (2020) in cultured habitat. In contrast, the (66.67%) prevalence recorded in this study agrees with the work of Onyedineke *et al.* (2010) who reported 59.2% prevalence of helminth parasites from fish obtained from the river at Illushi, Edo State, Nigeria, Kawe *et al.* (2016) who recorded high prevalence (67.5%) of gastrointestinal helminth parasites of *C. gariepinus* in Abuja,

Nigeria and Absalom *et al* (2018) who reported 63.00% prevalence of gastrointestinal helminth parasites of *Clarias gariepinus* at River Gudi, Akwanga Local Government Area Of Nasarawa State, Nigeria.

On the other hand, the lowest prevalence recorded from farm B may be due to the management practices of the fish such as reduction in overcrowding of fishponds and the use of screen net around fish ponds to guide against piscivorous birds which may serve as host to some of these parasites which could disseminate parasite eggs to fish ponds (Aliyu and Solomon, 2012). However, the result in study is at variance with the reported work of Anosike *et al.* (1992) who reported heavy infection of 52% for cultured *C. gariepinus* in Plateau State, Nigeria.

The types of parasites recovered from the different body parts of *C. gariepinus* used for this study have been previously recorded by other researchers for instance, Okoye *et al.* (2016) recovered *Camallanus spp.* from *C. gariepinus* in Imo State, Afolabi *et al.* (2020) also recovered *Camallanus spp.* from *C. gariepinus*. Solomon *et al.* (2018) in their reported work recovered *Capillaria spp.*, *Camallanus spp.* and *Eustrongylides spp.* from *Bagrus bayad* in Lower River Benue Makurdi, Nigeria. Also, recovery of *Diphyllobothrium latum* from the studied fish in the present work is not surprising as it has been recovered by Omeji *et al.* (2018) from *Synodontis euptera* and *Auchenoglanis occidentalis* in Lower River Benue, Nigeria.

Higher prevalence was recorded for female fish (64.71%) compared to the male counterpart (53.85%) from farm A however, prevalence was higher in male fish from farm B (44.44%) and Farm C fish farm C (93.75%) compared to the female counterpart with prevalence of 42.86% and 35.71%, respectively. The higher prevalence recorded for female fish compared to the male counterpart from Farm A could be

due to the physiological state of the females in this farm as most gravid females in the farm could have had reduced resistance to infection by parasites; this is because the immune system of the females is highly compromised during pregnancy. This agrees with the reported work of Ayuba et al. (2016), Ogonna et al. (2017) and Solomon et al. (2018) but disagrees with the findings of Kawee et al. (2016), Afolabi et al. (2020) who reported higher prevalence in male *C. gariepinus* than the female. In contrast, the higher prevalence recorded in male fish from farms B and C compared to the female counterpart could be attributed to their quest for survival and differential feeding either by quantity or quality of food. Also, the higher prevalence recorded in male fish from farms B and C compared to the female could be due to the random selection of the specimens from farms B and C compared to farm A. This observation is in line with the reported work of Akinsanya et al. (2008).

According to Ogonna et al. (2017), feeding in catfish is generally attributed to their quest for survival and differential feeding either by quantity or quality of food and not by sexes (Ogonna et al., 2017).

Variation in number of parasites harbored by the different parts of the studied fish from the different farms under study existed. Generally, highest number of helminth parasites was recorded for the intestine of the infected fish samples while the least was recorded for rectum except for Farm A where highest number of helminth parasites was recorded for stomach of the infected fish samples. The highest number of helminth parasites was recorded for the intestine of the infected fish samples in this study could be attributed to the favourable nutritional advantage presented by the host's intestine to the parasites; this assertion is supported by the findings of Akinsanya et al. (2008). On the other hand, the highest number of helminth parasites recorded for stomach of

the infected fish samples from farm A could be due to the presence of an acidic medium in the stomach which might make the stomach unfavorable for these parasites. This observation agrees with the reported work of Ajala and Fawole (2014).

In addition, the peristaltic movement of the stomach muscle during digestion may also hinder the proliferation of parasites in the stomach as opined by Akinsanya and Hassan (2008).

Variation in parasite prevalence existed among the length and weight groups of *C. gariepinus* across the three farms. Generally, higher rate of parasitic infection was observed in the larger size of *C. gariepinus* than the smaller ones across the farms. An increase in size as suggested by Oniye et al. (2004) is an indication of an increase in length and weight of fish and this could also be a function of age. Therefore, this observation may be attributed to the fact that larger size *C. gariepinus* provide a larger surface area for parasitic infection than the smaller ones and the ability of larger size fish to cover wide areas in search of food, and as a result of these aforementioned, they take in more food than smaller ones which may expose them to parasitic infections (Tachia et al., 2010 and Bichi and Dawaki 2010). Bichi and Dawaki (2010) reported that the prevalence was found to increase as the fish grows and could be attributed to the longer time of exposure to the environment by body size.

#### **CONCLUSION**

This study showed the presence of parasites across the three farms where the fish samples were randomly purchased. Samples of *C. gariepinus* from the three farms were observed to be infected. However, samples of *C. gariepinus* from Farm C fish farm were most infected than those from farms A and B. Samples of *C. gariepinus* with larger size were more infected compared to the smaller size counterpart. On the basis of this present study,

it is important that the sanitary conditions in fish ponds should be improved through the use of quality water free of contamination, vegetation surrounding fish ponds should be reduced in order to eliminate potential intermediate hosts of parasites like birds and other organisms. Fish from other sources should be quarantined to eliminate the

possibility of parasitic infection especially fish from the wild environments. Education of fish farmers and sellers on the potential risk of parasitic infection in fish in order to avert economic losses should always be carried out and most importantly, fish should be properly cooked before consumption so as to avoid zoonosis.

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