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ORIGINAL RESEARCH ARTICLE

Assessment of Gastrointestinal Parasite in Silver Catfish (*Bagrus bayad*; Forskal, 1775) from Ajiwa Reservoir Katsina State, Nigeria

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ABSTRACT
Gastrointestinal parasite in Silver catfish was studied for six months between June 2022 and November 2022 to determine the prevalence of parasites infesting *Bagrus bayad* and the associated risk factors in Ajiwa reservoir Batagarawa, Katsina State, Nigeria. A total of 90 fish samples were collected and examined from Ajiwa reservoir, comprising 41 and 49 males and females, respectively. Observed parasites and their prevalence (%) in *Bagrus bayad* include: Cestode genera; *Corallobothrium solidum* 21 (23.86%), *Pleurocercoid or Coradium sp.* 8 (9.09%), Nematode genera; *Capllaria philipinesis* 31 (35.23%), *Cammallanus sp* 16 (18.18%), *Procamallanus laevichonches* 12 (13.64%). The prevalence of parasites recovered from the fish species in this study was high. In conclusion, *Bagrus bayad in* Ajiwa reservoir was susceptible to parasite infestation. It is recommended that this species of fish from the Ajiwa reservoir should be gutted before consumption to prevent zoonotic diseases.

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Ajiwa, *Bagrus bayad,* Infestation, Parasite and Prevalence

INTRODUCTION

Fish and fish products are very important sources of nutrients of animal source for changing healthy diets or nutrition. Fish is a low-priced and affordable source of animal protein and is within reach of the ordinary residents of most nations. Fish requests are continuously increasing due to the ever-increasing human inhabitants, the high price of other animal protein sources, and problems of illness and infections associated with consuming other animal protein sources (Sadauki *et al.,* 2022a). The growing inhabitants and development have caused aquatic (marine, river and sea) pollution or contamination and a corresponding occurrence or manifestation of parasites and infections in wild fish populations. Accumulative or growing aquatic environmental dynamics are key in determining where the host parasites and additional bacteriological pathogens happen (Sadauki *et al.,* 2022a). Parasites are invertebrate organisms; some are free-living and can turn out to be opportunistic parasites. However, the obligate parasites need hosts (fishes) for continued existence and reproduction.

Similarly opportunistic and obligate parasites are found in fish hosts, but most parasitic diseases in fish are mostly made happen by obligate parasites (Sadauki *et al.,* 2022b). In fisheries, certain parasites may be extremely pathogenic and contribute to high fish deaths and financial losses or threaten the abundance and multiplicity of native or indigenous fish species (Sadauki *et al.,* 2022b). Tropical freshwater fishes such as *Tilapia zillii, Bagrus bayad* and *Clarias gariepinus* serve as definitive/transport or intermediate hosts in the developmental cycle of numerous species of protozoan, metazoan and crustacean parasites (Okoye *et al*., 2014). Bagrids (*Bagrus bayad*) are freshwater fish of Africa, Southern and Eastern Asia; they are usually inhabitants in inland waters (lakes, reservoirs and rivers (Okpasuo *et al.,* 2016). *Bagrus bayad* from the family Bagridae is common in the profitable catches of those who live along the Lower River Benue. They are mostly favourite by fishermen and customers because of their relatively large sizes. The flesh is of excellent aroma, either fresh or smoke-dried. Customers very much regard it in Makurdi and its surroundings, consequently enticing a moderately high cost. Solomon *et al.* (2018) stated that *Bagrus bayad* is a benthic omnivorous feeder (bottom feeder) as they proved the presence of residue (bottom deposit) in addition to the other food items inside the alimentary tract. The importance of fish as a promising source of protein, especially with the rapidly increasing human population and the animal protein shortage problem worldwide, cannot be denied (Solomon *et al.,* 2018). They are commonly accepted on the menu card and form a much-valued delicacy that cuts across socio-economic age, religious and educational barriers

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(Olorunfemi, 2014). Helminthic infestations could, in life-threatening conditions, cause death in fishes, mainly in juvenile or vulnerable fishes (Islam *et al.,* 2023). Heavy invasions may cause swimming problems, tissue injury, and augmented predation threat (Hernandez-Caballero *et al.,* 2022; Yusuf *et al.,* 2023). Helminthic infestations can cause huge economic losses in fish farm settings (Amakali *et al.,* 2023; Yusuf *et al.,* 2023). Fish growers may encounter augmented production costs and reduced productivity due to infested fish, possibly due to decreased food conversion efficiency (Kaur *et al.,* 2023). Certain helminthics that pass on a disease to freshwater fish have a zoonotic possibility, which indicates they could disseminate to the general public (Ziarati *et al.,* 2022; Yusuf *et al.,* 2023). Even though infestations from fish-borne helminthic in the general public are comparatively rare, consumption of uncooked or raw fish that has been adulterated with particular parasitic worms, such as tapeworms, may be detrimental to your well-being (Yusuf *et al.,* 2023 & Ziarati *et al.,* 2022). The impacts of parasitic worm infestation on the development or growth and eating of freshwater fishes are just one of the difficulties Nigerian local fish production looks (Obiageli *et al.,* 2022; Yusuf *et al.,* 2023). These parasitic worms, which can be Endo or Ecto parasites, are current in these freshwater organisms and might cause slow growth. Infestation by parasitic worms threatens aquatic organisms' health and a water body's productivity. Body part (organ) injury, fish populace decrease, disruption of regular organ functions, and physiological changes were entirely causes of parasitic infestation. It similarly reduces biomass since the worm drives its nourishment from the fish (host) (Adebambo *et al.,* 2020; Yusuf *et al.,* 2023). Surveys have displayed that fishes can transfer relatively numerous parasitic worms' zoonosis. *Anisakidosis* is a fish-borne zoonosis caused by parasitic worm nematodes from the Anisakidae family, predominantly from the genera *Anisakis, Pseudoterranova, Hysterothylacium*, and *Contracaecu* (Yusuf *et al.,* 2023 & Farinha *et al.,* 2022). This survey examined the gastrointestinal helminths of the Silver catfish (*Bagrus bayad*) from Ajiwa reservoir, Nigeria.

METHODOLOGY

Study Area

Ajiwa reservoir was positioned in a sub-desert area on Latitude '12° 98'N and Longitude '7° 75' E, in Batagarawa Local Government, Katsina State, Nigeria. The three (3) key mandates of the reservoir are irrigation, fishing and water supply to Ajiwa populaces. The volume of the water is estimated to be 22,730,000m^3; it helps as a source of revenue for the bordering populations (Abdulkarim and Ibrahim, 2018 SRRBDA, 1981).

Sample Collection

A total of ninety (90) were collected from the study area. Five (5) samples were collected bi-weekly from 3 dissimilar sample sites. Experimental fish samples of individual *Bagrus bayad* of different sizes were randomly collected from artisanal fishermen using various fishing gears (long line, traps, and nets) from three major landing sites of Ajiwa reservoir (Sample A, sample B and samples C) for a period of three months (October - December 2022) the beginning of the dry and cold season. They were later transported live to the fish biology laboratory of the Department of Biological Science at Alqalam University, Katsina State.

Sexing of Experimental Fish

Sexing of fish was determined by physical examination of the urogenital papillae. It is long or distended in males, while in females, it is round and reddish in mature ones. Similarly, visual observation of the male gonads and ovaries in females is confirmatory (Imam and Dewu, 2010).

Measurement of Experimental Fish

The standard lengths (cm) of the experimental fish were measured using a meter rule, while the weight was measured using top loading sensitive weighing balance using standard techniques described by Sadauki *et al.* (2022b).

Examination of Gastrointestinal Helminths

The experimental fish samples were dissected to expose the alimentary tract. The alimentary tract was removed and divided into the stomach and intestine. The gastrointestinal was used for parasite investigation because this is where nutrition is most plentiful for the parasites. Each section was placed separately in Petri dishes containing 0.9% normal saline. Each section was slit longitudinally and examined for parasites under a dissecting microscope between 10 and 30X magnification. The emergence of any worm was easily noticed by its wriggling movement in the saline solution under a microscope. Parasites found were counted, fixed, and preserved in 5% formalin afterwards. Representative parasites were stained overnight with a weak solution of Erlich's haematoxylin (Sogbesan *et al*., 2018).

Identification of Parasite

The parasites were morphologically identified to a species level using standard identification keys and pictorial guides (Paperna, 1980; Scholz *et al.,* 2004; Pouder *et al.,* 2005).

Parasite Prevalence and Intensity Estimation

Prevalence of parasite infection

The prevalence of parasite infection was calculated for sex, location, length and weight using the model described by Sadauki *et al.* (2022b):

i- Prevalence of parasite infection

The prevalence of parasite infection was calculated using the model described by Sadauki *et al.* (2022b):

$$\text{Prevalence (\%)} = \frac{\textit{No of fish host infected}}{\text{Total no.of fish hosts Examined}} \times 100$$

ii- Prevalence Based on Sex

The prevalence of parasite infection based on the sex of fish was estimated using the model described by Sadauki *et al.* (2022b):

$$\text{Prevalence (\%)} = \frac{No.of\ particular\ sex\ of\ fish\ infected}{Total\ no.of\ particular\ sex\ of\ fish\ examined} \times 100$$

Data Analysis

The collected data was subjected to SPSS (version 20) for descriptive statistics; a simple percentage was used to present the prevalence and distributions of parasites. On the other hand, the Chi-square test of independence was used to examine the relationship between infection and the risk parameters for the prevalence.

RESULTS AND DISCUSSION

Results

Out of the ninety (90) fish samples of individual *Bagrus bayad* examined, the overall percentage of infection, 52 (57.77%) were infested, as shown in Table 1. Of the 90 fish samples examined, 52 were infected. Female fish samples were 49, and males were 41. According to (Table 1) the Chi-square result shows no significant association between sex and prevalence of gastrointestinal helminths. Female fish samples had the highest number of infections, 33 (67.34%); however, male fish samples documented 19 (46.35%), as displayed in Table 1. All the parasites recovered were nematodes and cestodes found in the experimental samples' stomach and intestine. The species of parasites were *Corallobothrium solidum*, *Pleurocercoidor Coradium sp.*, *Capllaria philipinesis*, *Cammallanus sp* and *Procamallanus laevichonches* (Table 2). The highest parasite incidence was *Capllaria philipinesis* 31(35.23%), followed by *Corallobothrium solidum.* 21(23.86%), followed by *Cammallanus sp* 16(18.18%), followed by *Procamallanus laevichonches* 12(13.64) and *Pleurocercoid* or *Coradium sp.* 8(9.09%) as the least parasitic infection as shown in Table 3. Out of 90 *Bagrus bayad* samples collected from three (3) sample stations from Ajiwa and examined, *Bagrus bayad* gotten station B harboured the highest percentage (70.00%) of infection, followed by station A (56.66%) while station C had the least of per cent of infection 46.66% (Table 4). The result of Chi-square (p=0.185) showed a significant association between the prevalence of gastrointestinal parasites and the sample location. Fish samples from Ajiwa showed that *Bagrus bayad* within the length of 10.1 - 15.0 cm harboured more worms 23(57.34%), followed by 20.1-25.0 cm had 12(63.15%), followed by 15.1-20.0 had 11(52.38%) while those within the length of 25.1 - 30.0 cm had lesser worm invasion 6(60.00%) Table 5. Between 90 fish samples from Ajiwa indicated that *Bagrus bayad* within the weight of 10 - 20.9g harboured more intestinal parasites 30(78.94%), followed by 2 - 50.9g 15 (62.50%), followed by 51 - 80.9g 4(40.00%), while those within the weight of 81 - 110.9g had less worm burden 3(37.50) (Table 6). The prevalence in relation to the size length (Table 5) and (Table 6) did not show any significant association according to the chi-square test (p=0.0919 and p=0.013, respectively).

Table 1: Prevalence of parasites of *Bagrus bayad* in relation to sex in Ajiwa reservoir

Sex	No of examined	No of infected	%of infection
Male	41	19	46.35
Female	49	33	67.34
Total	**90**	**52**	**57.77**

X^2 (1, N= 90) = 4.037, P = 0.045

Table 2: Prevalence of *Bagrus bayad* parasites in relation to parasites in Ajiwa reservoir.

Parasite	Rate of parasite infection	% of infection
Capllaria philipinesis	31	35.23
Cammallanus sp	16	18.18
Procamallanus laevichonches	12	13.64
Corallobothrium solidum.	21	23.86
Pleurocercoid	8	9.09
TOTAL	**88**	**(100)**

Table 3: Prevalence of parasites of *Bagrus bayad* in relation to site of infestation in Ajiwa reservoir.

	ENDOPARASITE	
Parasite	**Intestine**	**Stomach**
Capllaria philipinesis	22 (31.42)	9(50.00)
Cammallanus sp	12 (17.42)	4(22.23)
Procamallanus laevichonches	10 (14.28)	2(11.11)
Corallobothrium solidum	21 (30.00)	0(0)
Pleurocercoid	5 (7.42)	3(16.66)
TOTAL	**70(79.55)**	**18(20.45)**

Table 4: Prevalence of parasites of *Bagrus bayad* in relation to sample location in Ajiwa reservoir

Location	No of examined	No of Infected	% of Infection
Sample A	30	17	56.66
Sample B	30	21	70.00
Sample C	30	14	46.66
TOTAL	**90**	**52**	**57.77**

X^2 (2, N=90) = 3.370, P=0.185

Table 5: Prevalence of parasites of *Bagrus bayad* in relation to length in Ajiwa reservoir

Fish length	No of examined	No of Infected	% of Infection
10.0-15.0	40	23	57.34
15.1-20.0	21	11	52.38
20.1-25.0	19	12	63.15
25.1-30.0	10	6	60.00
TOTAL	**90**	**52**	**57.77**

X^2 (3, N=90) = 4.098, P=0.919

Table 6: Prevalence of parasites of *Bagrus bayad* in relation to weight in Ajiwa reservoir

Fish weight	No of examined	No of Infected	% of Infection
10-20.9	38	30	78.94
21-50.9	24	15	62.50
51-80.9	10	4	40.00
81-110.9	8	3	37.50
TOTAL	**90**	**52**	**57.77**

X^2 (3, N=90) = 10.8,05 P=0.013

Discussion

Remarkable is the fishes' susceptibility to parasitic infestation (disease). An observation that depends on species of fish and type of water inhabited as well as certain water quality parameters such as dissolved oxygen content, increased organic matter content, etc. Poor ecological situations also increase fish weakness/vulnerability to these parasitic infections (Ahmed-Hamid *et al.,* 2012). Kawe *et al.* (2016) mentioned that parasitism differs in many water ecosystems, and the connection between biotic and abiotic factors determines this. Fish species in healthy environmental situations scarcely come down with sicknesses or infections (Kawe *et al.,* 2016). Abiotic factors such as increased water temperature may change the resistant status of fish supporting infection and parasite setting up (Onyishi and Aguzie, 2018). Akinsanya and Otubanjo (2006) speak out that geo-climatic dissimilarities might be the most important factor in influential not just the occurrence of parasites in freshwater bodies such as rivers, reservoirs and lakes nevertheless too the parasite populations located in freshwater fishes. Additional significant issues/matters that contribute to parasite occurrence, intensity and diversity comprise parasite classes and their biology together with the presence of suitable intermediary hosts, fish host environment, wandering/migratory and nourishing behaviour, host nourishment and age (Hussen *et al.,* 2012). Information has shown that helminths are frequently located in all freshwater fishes, with their incidence and intensity reliant on the parasite species and their ecology, host and its nutritious habits, physical factors and sanitation of the water body and attendance of intermediate hosts where needed (Hussen *et al.,* 2012). The outcome obtained from this study revealed that nematodes and cestodes are the parasites observed in *B. bayad* from the Ajiwa reservoir, Katsina State, Nigeria. The species of parasites include: Cestodes are *Corallobothrium solidum. Pleurocercoid* or *Coradium* and nematodes are *Capillaria philipinensis Cammallanus sp* and *Procamallanus laevichonches.* The nematode, *Capllaria philipinesis,* makes happen or causes intestinal *capillariasis* (Solomon *et al.,* 2018). The result of Chi-square (p=0.185) showed a significant association between the prevalence of gastrointestinal parasites and the sample location.

The highest number of parasites recorded in the intestine was the most infected compared to the stomach, possibly because most digestion activity takes place in the intestine, which possibly will lead to the discharge of parasite ova in nourishment stuff. This agrees with Solomon *et al.* (2018) and Sadauki *et al.* (2022b) stated higher number of parasites in the intestine than in the stomach and attributed that to several influences, among which is the presence of breakdown nourishment there or due to the larger/greater surface region presented by the intestine. The reduced number of parasites in the stomach of the fish samples associated with the intestine might be due to the muscular movement of the stomach hydrochloric acid nature of the stomach (Solomon *et al.,* 2018). Female fishes were detected to have a higher proportion of parasites than the male. This might be attributed to the biological/physiological state of the females' fish samples, and their augmented amount of nutrient consumption to meet their nutrient rations for the growth of their egg might have unprotected them from additional interaction with the parasites, subsequently improving their chance of being diseased or infected. Abdel-Gaber et al., 2015 & Sadauki et al., 2022a, stated comparable observations in their works. This statement differs from the reported work of Kawe *et al.,* 2016 on *Clarias gariepinus,* who stated more parasites in male samples than in females. However, the female sex documented more infections, which could be due to differences in nutrition, either by quantity or quality of nourishment consumed and due to dissimilar degrees of immunity or resistance to infestation/infection (Sadauki *et al.,* 2022a). The contemporary findings show that the highest rate of parasitic invasion in the experimented fishes was documented in the smaller fishes. This conforms with (Akinsanya *et al.,* 2008; Shehata *et al.,* 2018 & Sadauki *et al.,* 2022b), who stated that smaller fish were more infested compared to larger ones, perhaps due to their nature of acquired immunity and resistance with age. In dissimilarity, the current study differs from the outcomes of reliable/certain scholars who stated that bigger (mature or adult) fish have more parasites associated with small fish because they feed additional on different food sources in that way uncovering them to more parasitic invasion (Ashade *et al.,* 2013 & Mgbemena *et al.,* 2020). This investigation shows that helminthic parasitic worms are prevalent in the *Clarias gariepinus* inhabitant in Zobe artificial lake. Influences of environmental conditions of matters on parasitic worms may perhaps be negative or positive; contamination may perhaps augment parasitic infestation, and on the other hand, it could be disastrous for some parasitic worm species, causing to decrease in parasitism (Eissa *et al.,* 2014 & Sadauki *et al.,* 2022a). Seasonality may disrupt/disturb parasitic worms' incidence. Generally, the occurrence of infestation in freshwater fishes is greater in the dry season as the decrease/reduction in water volume augmented the rate of interaction/contact of fish with parasitic worms (Mikheev *et al.,* 2014 & Sadauki *et al.,* 2022a).

CONCLUSION

In conclusion, *Bagrus bayad* in the Ajiwa reservoir has shown a significant level of parasite infestation. The infestation was observed across sexes, ages, and sizes of the fish and location of capture. The parasites could have public health implications for consumers from the study areas. Some fish parasites observed can secondarily infect their host consumers, such as *Anisakiasis, opisthorchiasis, clonorchiasis and gnathostomiasis*. This disease can have serious consequences for human health, such as abdominal pain, nausea, intestinal obstruction, peritonitis, diarrhoea, allergic reactions, liver damage, and neurological disorders.

RECOMMENDATION

Researching fish parasites on dissimilar species is recommended to improve the understanding of their biology, ecology, epidemiology, pathology, diagnosis, treatment, prevention and control.

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