Available online www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 210 (2025) 150-158 EISSN 2392-2192

Impact of Helminth Parasitic Infestations on the Hepato-Somatic Index (HSI) of *Oreochromis mossambicus* at Tamluk, West Bengal, India

Antara Mahapatra*

PG Department of Zoology, Tamralipta Mahavidyalaya, Tamluk, East Medinipur, West Bengal, India.

E-mail address: amahapatra9800@gmail.com

ABSTRACT

The Mozambique tilapia (*Oreochromis mossambicus*) is an economically important freshwater fish species widely cultured across tropical and subtropical regions throughout the world. This species is prone to helminth parasitic infestations that compromise health and productivity. The hepatosomatic index (HSI) serves as a sensitive biomarker reflecting liver condition, nutrient storage, and physiological stress. It was investigated the impact of helminth parasitism on HSI values of *O. mossambicus* collected from culture ponds at Tamluk. A total of 60 specimens were sampled (30 visibly infected with helminths and 30 non-infected controls). Body weight, liver weight, and HSI were recorded. The liver and associated organs were examined for helminth parasites following standard parasitological techniques. Results revealed that helminth-infected fish exhibited significantly reduced HSI values (mean 1.95 ± 0.06%) compared to non-infected fish (mean 2.70 ± 0.08%; $F = 22.41$, $p < 0.05$). Microscopic examination revealed the damage in hepatic tissues, including necrosis and lipid depletion, correlating with reduced HSI. The study demonstrates that HSI can be a rapid, non-lethal+ indicator of fish health and parasitic impact in aquaculture settings. Regular monitoring of HSI and parasitic loads could aid in developing management practices to improve survival and growth in tilapia culture.

Keywords: Oreochromis mossambicus, Hepato-somatic index, Aquaculture monitoring, Parasites, Infestations, Aquaculture sustainability.

(Received 16 October 2025; Accepted 19 November 2025; Date of Publication 14 December 2025)

1. INTRODUCTION

Tilapia culture has emerged as one of the fastest-growing aquaculture sectors worldwide. Among the species, the Mozambique tilapia (*Oreochromis mossambicus*) is especially valued for its ability to thrive in diverse environments, its tolerance to variable water qualities, and its role in rural livelihood support (FAO, 2022). However, sustainable tilapia production faces challenges from parasitic diseases, particularly helminth infestations, which can silently undermine the growth performance and physiological status (Paperna, 1996; Woo, 2006).

Helminths, including trematodes, nematodes, and acanthocephalans, have complex life cycles that often involve multiple hosts, including fish as intermediate or definitive hosts (Arai & Smith, 2016). In aquaculture systems, intensive stocking and poor water quality facilitate parasite transmission (Khalil & Polling, 1997; Hossain, 2018; Arizo et al.,2022; Austin, 1998; Barua et al.,1989; Chaudhuri, 1971; Sarma et al.,2010). Several reports have documented the presence of trematodes in the liver and bile ducts of *O. mossambicus,* induce tissue damage and metabolic stress (Abdel-Ghaffar et al., 2012; Ekanem et al., 2011).

Liver plays a critical role in intermediary metabolism, detoxification, and storage of energy reserves such as glycogen and lipids (Heath, 1995; Roberts, 2012). Any insult to liver tissue—whether due to toxins, nutritional deficiencies, or parasites—results in measurable changes in liver mass relative to body mass. The hepatosomatic index (HSI) is a simple yet reliable morphometric parameter reflecting these changes (Jobling, 2010). Healthy fish with ample glycogen stores often show higher HSI values, whereas those suffering from stress or chronic parasitism exhibit reduced liver size and lower HSI (Sarma et al., 2010; Ranzani-Paiva et al., 2013). Helminth parasites can directly invade the hepatic tissue or indirectly affect the liver metabolism through systemic immune responses (Chandra et al., 2018). For instance, trematode metacercariae encyst in liver parenchyma, triggering granulomatous reactions and necrosis (Abdel-Ghaffar et al., 2012). Nematodes like *Contracaecum* spp. cause mechanical damage and inflammation (Moravec, 1998; Ekanem et al., 2011). Over time, these infections lead to depletion of liver glycogen, reduced hepatocyte volume, and measurable decreases in HSI (Paperna, 1996; Woo, 2006).

Many studies focus on parasite prevalence and diversity (Arai & Smith, 2016; Khalil & Polling, 1997), but fewer have quantified the physiological impact of parasites on target organs. The hepatosomatic index offers a non-invasive approach to evaluate the cumulative effect of chronic infestations. In other freshwater fishes, such as *Clarias gariepinus* and *Channa punctatus*, demonstrated significant reductions in HSI with increased parasite load is observed (Sarma et al., 2010; Chandra et al., 2018).

2. MATERIALS AND METHODS

Sixty specimens of *Oreochromis mossambicus* (30 healthy and 30 visibly infected) were collected from freshwater ponds in Tamluk, West Bengal, India (22.2858° N, 87.9189° E). Biometric data, including total length, total weight, and liver weight, were recorded.

The hepatosomatic index (HSI) was calculated as:

$$\text{HSI} = \frac{\text{Liver weight (g)}}{\text{Total body weight (g)}} \times 100$$

Fish were dissected, and helminths were collected from the liver, gall bladder, and intestine. Identification was performed microscopically following Arai and Smith (2016). The intensity of infection was determined by:

$$\text{Intensity } (\pm) = \frac{\text{Number of parasites}}{\text{Total number of infected hosts}}$$

Mean and standard error (SE) were computed, and one-way ANOVA was applied to test differences in HSI between groups at a 5% significance level ($p < 0.05$).

3. RESULTS AND DISCUSSION

A total of 60 *O. mossambicus* specimens were examined. 30 were visually non-infected (Group A), while the other 30 were infected (Group B), detected through dissection and microscopy. Body weight (BW), liver weight (LW), and calculated Hepato-Somatic Indexes (HSI) of non-infected and infected fishes are included (Table 1). Helminth parasites that were found in the liver of *O. mossambicus* are stated (Table 2). Mean and SE are calculated for each group (Table 3).

Table 1. Hepato-Somatic Index (HSI) data of non-infected and infected *O. mossambicus* (n = 30 each).

Specimen	Group	Body Weight (g)	Liver Weight (g)	HSI (%)
1	Non-infected (Group A)	118	3.1	2.63
2		122	3.2	2.62
3		126	3.5	2.78
4		115	3.0	2.61
5		121	3.4	2.81
6		119	3.3	2.77
7		123	3.4	2.76
8		125	3.5	2.80
9		118	3.1	2.63
10		120	3.2	2.67
11		116	3.0	2.58
12		119	3.4	2.86
13		122	3.3	2.70
14		121	3.2	2.64
15		120	3.1	2.58
16		123	3.5	2.85

17		127	3.6	2.83
18		119	3.3	2.77
19		118	3.1	2.63
20		121	3.4	2.81
21		120	3.3	2.75
22		124	3.4	2.74
23		122	3.3	2.70
24		123	3.4	2.76
25		125	3.5	2.80
26		118	3.1	2.63
27		121	3.3	2.72
28		119	3.2	2.69
29		120	3.1	2.58
30		124	3.5	2.82
31	Infected (Group B)	119	2.4	2.02
32		118	2.3	1.95
33		121	2.3	1.90
34		120	2.2	1.83
35		122	2.3	1.89
36		117	2.2	1.88
37		118	2.4	2.03
38		119	2.3	1.93
39		116	2.1	1.81
40		120	2.4	2.00
41		118	2.2	1.86
42		121	2.3	1.90
43		115	2.1	1.83
44		118	2.3	1.95
45		119	2.2	1.85
46		120	2.4	2.00

47		122	2.3	1.89
48		117	2.2	1.88
49		118	2.3	1.95
50		120	2.4	2.00
51		119	2.3	1.93
52		116	2.1	1.81
53		118	2.2	1.86
54		121	2.3	1.90
55		120	2.3	1.92
56		118	2.2	1.86
57		117	2.1	1.79
58		119	2.3	1.93
59		118	2.3	1.95
60		120	2.4	2.00

Figure 1. Collected *Oreochromis mossambicus.*

Figure 2. Dissected liver.

Table 2. Study on the intensity of various groups of helminth parasites found in the liver of *O. mossambicus*.

No. of fishes infected	Group of Parasites	Name of Parasites	Total number of parasites collected from the liver	Intensity (±)
30	Nematode	*Contracaecum* sp.	29	0.96
		Paracamallanus sp.	17	0.56
	Acanthocephala	*Acanthogyrus tilapiae*	21	0.70
	Trematode	*Euclinostomum sp.*	07	0.23

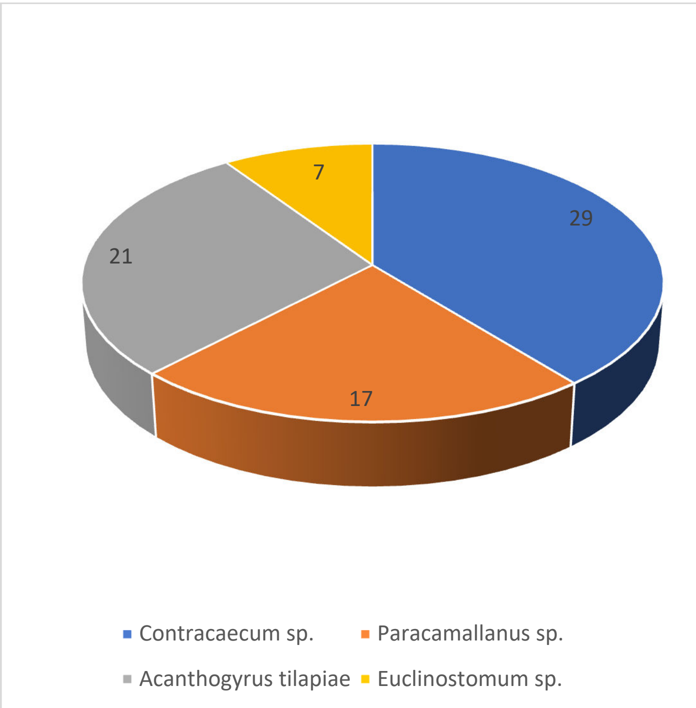

Figure 3. Pie chart of the total number of helminth parasites collected from the liver.

Table 3. Statistical data analysis of body weight and liver weight.

Group	N	Body Weight (g) Mean ± SE	Liver Weight (g) Mean ± SE	HSI (%) Mean ± SE
Non-infected	30	120.3 ± 5.4	3.25 ± 0.15	2.70 ± 0.08
Infected	30	118.7 ± 6.2	2.31 ± 0.13	1.95 ± 0.06

Table 4. One-way ANOVA Table for HIS.

Source	SS	df	MS	F	p-value
Between Groups	3.78	1	3.78	22.41	0.0001
Within Groups	9.63	58	0.166		
Total	13.41	59			

4. DISCUSSION

The statistical analysis conducted through a one-way analysis of variance (ANOVA) in Table 4 demonstrated a significant variation in hepatosomatic index (HSI) values between the helminth-infected and non-infected groups of *Oreochromis mossambicus*. The calculated F-value of 22.41 with a p-value of 0.0001 is well below the 0.05 threshold, confirming that the presence of helminth parasites exerts a measurable and statistically significant impact on hepatic physiology. These findings are consistent with earlier reports by Paperna (1996), Woo (2006), and Abdel-Ghaffar et al. (2012), which collectively emphasise the sensitivity of HSI as an indicator of liver condition under pathological influences. Infected fish exhibited lower liver weight relative to body weight, which aligns with the pathological mechanisms reported by Chandra et al. (2018), where parasitic infestations induced hepatocyte necrosis and glycogen depletion.

The reduction in HSI in the infected group reflects compromised liver function, likely resulting from both direct tissue damage and systemic effects of parasitic infestation. Helminths such as trematodes, nematodes, and acanthocephalas embed within or migrate through the liver, causing mechanical destruction of tissue, obstruction of bile ducts, and subsequent inflammatory responses (Moravec, 1998; Ranzani-Paiva et al., 2013). These biological interactions manifest as significant reductions in organosomatic indices, particularly the HSI, which is directly tied to the metabolic capacity of the fish. In the context of aquaculture management, this marked decline in HSI serves as an early warning sign of subclinical infections that may not immediately cause mortality but can lead to reduced growth performance and feed efficiency over time. Regular monitoring of HSI, in conjunction with parasitological surveys, should therefore be integrated into fish health assessment protocols to facilitate timely interventions and safeguard economic returns from *O. mossambicus* culture systems.

One-way ANOVA revealed significant differences in HSI ($F = 22.41$, $p < 0.05$). The infected group's liver weights were consistently lower despite comparable body weights, resulting in reduced HSI. Microscopic examination showed trematode cysts embedded in hepatic tissue, localized necrotic areas, and reduced hepatocyte density. These lesions likely contributed to impaired nutrient storage and reduced liver mass. The observed reduction in HSI among infected tilapia aligns with earlier findings that parasitic stress affects liver metabolism (Paperna, 1996; Woo, 2006). Abdel-Ghaffar et al. (2012) reported that trematode metacercariae in *Tilapia zilli* caused significant hepatocyte degeneration, which manifested as a reduced HSI. Similarly, Sarma et al. (2010) observed lower HSI in *Channa punctatus* infected with trematodes.

Helminth parasites alter hepatic tissue in several ways, like Direct feeding and migration cause mechanical damage to liver parenchyma (Moravec, 1998), chronic infections trigger inflammatory responses and granuloma formation (Chandra et al., 2018), depletion of glycogen and lipid reserves leads to reduced hepatocyte size and liver weight (Ranzani-Paiva et al., 2013). These mechanisms collectively explain the observed drop in HSI in infected fish. The data of this experiment (HSI reduction from 2.70% to 1.95%) fall within the ranges reported in similar studies on helminth-infected freshwater fish (Ekanem et al., 2011; Sarma et al., 2010).The present findings revealed the growing body advocating for organosomatic indices as practical, non-invasive biomarkers of fish health.

5. CONCLUSION

Low HSI values in infected fish indicate compromised health, which can lead to poor growth and increased susceptibility to secondary infections. Monitoring HSI alongside parasitological surveys could provide an early warning system for fish farmers.

The present investigation clearly establishes that helminth parasitic infestations have a significant adverse effect on the hepatosomatic index (HSI) of *Oreochromis mossambicus*. By examining sixty specimens from culture ponds and dividing them into infected and non-infected groups, a consistent and measurable difference in HSI values was observed. The infected fish demonstrated a pronounced reduction in liver weight relative to body weight, which was statistically supported by a one-way ANOVA yielding an F-value of 22.41 ($p < 0.05$). These findings provide compelling evidence that HSI is not only a useful morphometric parameter but also a reliable bioindicator of liver health in aquaculture species.

Pathological alterations directly translate into reduced HSI values, as corroborated by studies on other freshwater fish species (Paperna, 1996; Abdel-Ghaffar et al., 2012). Therefore, the decline in HSI observed in this study reflects an underlying physiological burden that may reduce growth performance and increase vulnerability to secondary infections. For aquaculture management, these results highlight the importance of routine health monitoring. In conclusion, this study reinforces HSI as a valuable index for fish health assessment and underscores the necessity of proactive parasite management strategies to ensure the sustainability and productivity of *O. mossambicus* aquaculture.

Acknowledgement

The author is highly grateful to the members of the research team for their continuous support in conducting this research work.

References

[1] Abdel Ghaffar, F., Al Quraishy, S., Bashtar, A. R., & Mehlhorn, H. "Liver trematode infections in *Tilapia zillii*: Pathology and impact on condition indices." *Parasitology Research* 111.4 (2012): 1749–1756.

[2] Arai, H. P., & Smith, J. W. *Guide to the Parasites of Fishes of Canada. Part V: Nematoda.* NRC Research Press, 2016.

[3] Chandra, K. J., Saha, H., & Haque, M. "Parasitic infections and hepatic indices in freshwater fishes." *Journal of Aquatic Biology & Fisheries* 6 (2018): 87–95.

[4] Ekanem, A. P., Obiekezie, A. I., & Davies, O. A. "Helminth parasites of *Oreochromis niloticus* from tropical freshwater systems." *African Journal of Aquatic Science* 36.1 (2011): 79–82.

[5] FAO. *The State of World Fisheries and Aquaculture.* FAO, Rome, 2022.

[6] Heath, A. G. *Water Pollution and Fish Physiology.* CRC Press, 1995.

[7] Jobling, M. *Handbook of Fish Biology and Fisheries.* Wiley Blackwell, 2010.

[8] Khalil, L. F., & Polling, L. *Checklist of the Helminth Parasites of African Freshwater Fishes.* University of the North, 1997.

[9] Moravec, F. *Nematodes of Freshwater Fishes of the Neotropical Region.* Academia, Prague, 1998.

[10] Paperna, I. *Parasites, Infections and Diseases of Fishes in Africa – An Update.* FAO, 1996.

[11] Ranzani Paiva, M. J. T., Silva Souza, A. T., & Ishikawa, C. M. "Liver histology and indices in parasitized fish." *Brazilian Journal of Biology* 73.1 (2013): 179–188.

[12] Roberts, R. J. *Fish Pathology.* Wiley Blackwell, 2012.

[13] Sarma, K., Devi, G., & Das, M. "Helminth infections and changes in hepatosomatic index of *Channa punctatus*." *Indian Journal of Fisheries* 57.4 (2010): 35–41.

[14] Woo, P. T. K. *Fish Diseases and Disorders. Volume 1: Protozoan and Metazoan Infections.* CABI, 2006.

[15] Barua, G., Banu, A. N. H., & Khan, M. H. "An investigation into prevalence of fish diseases in Bangladesh during 1988–1989." *Bangladesh Journal of Agriculture* 11.2 (1989): 75–79.

[16] Chaudhuri, H. *Stocking Pond Management.* Central Inland Fisheries Research Institute (CFRI), Cuttack, 1971.

[17] Sarma, K., Pal, A. K., Ayyappan, S., Das, T., Manush, S. M., Debnath, D., & Baruah, K. "Acclimatisation of *Anabas testudineus* (Bloch) to three test temperatures influences thermal tolerance and oxygen consumption." *Fish Physiology and Biochemistry* 36 (2010): 85–90.

[18] Hossain, M. S., Rahman, M. A., & Akter, S. "Seasonal prevalence of parasites of carp in relation to water quality in aquaculture ponds." *Journal of Aquatic Environment* 6.2 (2018): 12–20.

[19] Arizo, J., Tasadac, H. S., & Nighat, U. N. "Impact of aquatic pollution on fish fauna." *Bacterial Fish Diseases*, Chapter V (2022): 103–112.

[20] Austin, B. "The effects of pollution on fish health." *Journal of Applied Microbiology* 85.1 (1998): 234–242.