Tilapia parvovirus disease: An emerging threat for the tilapia aquaculture industry

Anirban Paul, Snatashree Mohanty, Samikshya Parida, Subham Biswal, Biplab Kumar Sandha and P.K. Sahoo

National Referral Laboratory for Freshwater Fish Diseases, Fish Health Management Division, ICAR-Central Institute of Freshwater Aquaculture (CIFA), Kausalyaganga, Bhubaneswar 751002, India. Email: pksahoo1@hotmail.com

Tilapia is a warm-water fish species extensively cultured in over 100 countries, with a global annual production of more than 6.5 million tonnes[1]. Tilapia farming is practiced in various states across India, including Andhra Pradesh, Tamil Nadu, Maharashtra, Kerala, Karnataka and West Bengal. The southern states, particularly Andhra Pradesh, are among the leading producers of tilapia. The intensification of tilapia aquaculture and prevailing climate change have created a stress situation in the culture environment which leads to an increasing number of emerging infectious disease occurrences[2,3,4,5]. In the dynamic world of aquaculture, where innovation and challenges often swim hand in hand, some new viruses have emerged on the scene, casting their shadow on the vibrant tilapia farming industry. In the last few years, outbreaks caused by two viruses i.e. tilapia lake virus (TiLV) and infectious spleen and kidney necrosis virus (ISKNV) have caused havoc in tilapia aquaculture industry[5,6]. Recently, a novel tilapia parvovirus (TiPV) infection was reported in red tilapia farming in Thailand for the first time[7]. Moreover, the synergistic effect of its co-infection along with TiLV has been reported subsequently causing severe mass mortality in tilapia. These unprecedented threats of TiPV have necessitated continuous screening and research investigation to study TiPV disease characteristics, pathophysiological changes, disease spread, diagnosis and management strategies. This article intends to reach out to the readers to be aware of TiPV infections and its epidemiology.

Disease incidence in the Indian subcontinent

As the culture of tilapia is gearing up in India, several emerging diseases have been reported from the culture environment causing mortality including diseases like TiLV and TiPV. During September 2022, a huge mortality of tilapia was observed in Balasore District, Odisha India. A co-infection of TiLV and TiPV was found to be the cause of this mortality[8]. Further, during the summer of 2023, mass mortalities of tilapia were also reported from several tilapia farms located at different distant locations of Odisha. TiPV was found to be the only pathogenic organism present in those infected fishes causing large-scale mortality in the pond aquaculture. The virus has already been identified as posing a threat to tilapia aquaculture in several countries and in India also it may be a great threat in the coming days.

Clinical signs observed in infected fishes are lethargy, scale loss, redness on body with haemorrhages on the operculum, base of fins and ventral part, opaqueness of eyes, swimming near the pond edge and loss of appetite before death.

Tilapia parvovirus disease characteristics

Initially, the virus was thought to be non-infectious as it was identified from the intestinal sample of healthy tilapia and faecal samples from tilapia-fed crocodiles. But subsequently, it was observed that the virus can be lethal to the tilapia and cause mortalities up to 90%. Infection can lead to a range

Typical clinical signs of tilapia infected with TiPV.

of symptoms in tilapia including lethargy, reduced feeding, discolouration, cutaneous haemorrhages, exophthalmia and severe ocular lesions and mortality on rare occasions. Infected fish also exhibit abnormal behaviours such as staying near the water surface or abnormal swimming patterns. TiPV has been reported to be the cause of mass mortality episodes in tilapia farming in association with TiLV and other bacterial pathogens. In China, an outbreak of TiPV resulted in the mortality of tilapia of 60-70% in natural conditions. In Thailand, the mortality percentage was recorded as 50–75% in all age groups of tilapia. The viral signature of TiPV was detected in various organs of tilapia including eyes, gills, heart, brain, anterior kidney, liver, intestine, spleen, dorsal muscle, and mucus with the highest load of TiPV being observed in the anterior kidney and spleen[9].

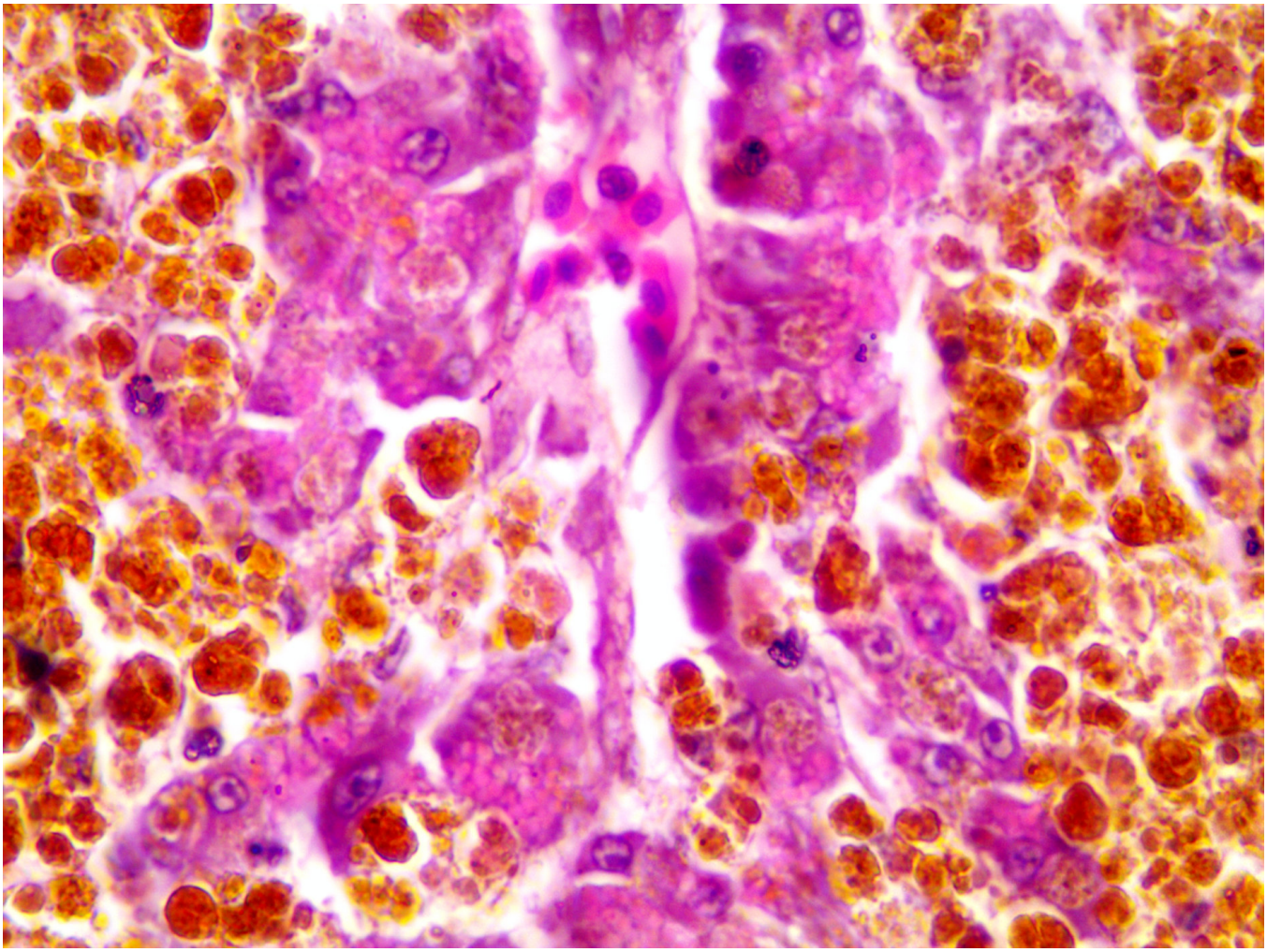
About TiPV

Tilapia parvovirus is a single-stranded DNA, spherical, non-enveloped virus with a diameter of 30 nm belonging to the genus Chapparvovirus, family Parvoviridae. The genome size of TiPV is 4269 bp which includes 208 bp 5' UTR, 396 bp ORF1 and 1875 bp non-structural protein 1 (NS1), 504 bp NS2, 216 bp ORF2 and 1665 bp capsid protein 1 (VP1), and 46 bp 3' UTR9.

Mass mortality in a tilapia farm with TiPV infection.

Transmission

The virus can spread among tilapia populations through various means, including contaminated water, infected fish, and contaminated equipment. There is a concern about the virus spreading between different fish farms and even across borders.



Augmented melanomacrophage centres in the spleen of TiPV infected tilapia (H & E x 100).

Impact

Tilapia parvovirus infection can have significant economic consequences associated with high morbidity and mortality in the aquaculture industry. Not only monetary loss, dramatically slower growth and reduced fish production are evident in a few reports. It can be devastating to tilapia farms. The disease has the potential to lead to disruptions in local and international trade of tilapia products. In Thailand and China, the disease was found to cause mass mortalities. The major drawback allied with TiPV is its association with other devastating pathogens which make it more deadly. Also, improper disposal practices could lead to the spread of the virus to wild fish populations, potentially impacting aquatic ecosystems. Hence, proper biosecurity is a must to prevent disease outbreaks. As the virus persists for a long time in the survivors and in the environment, it is essential to reduce stress factors in the culture system for its emergence leading to mass mortality.

Diagnosis

Diagnosis of TiPV involves a combination of clinical signs, histopathological examination and molecular techniques such as polymerase chain reaction (PCR) and real-time PCR-based detection to detect the presence of viral genetic material in fish tissues. Histological findings in relation to TiPV are extensive infiltration of lymphocytes, augmented melanomacrophage centres in the spleen and anterior kidney, and erythrocyte depletion in the spleen and hepatic syncytial cells. Recently, Dong et al.[10] demonstrated that the pancreas as a prime target of TiPV infection for histopathological diagnosis in Nile tilapia. In the pancreas, Cowdry type A inclusion bodies were identified as a histopathological diagnostic feature in adult Nile tilapia naturally infected with TiPV. Moreover, TiPV-diseased fishes were found to be co-infected with secondary pathogen *Streptococcus agalactiae* and exhibited multifocal granulomas in tissues.

Prevention and control

Preventing the spread of TiPV involves a combination of biosecurity measures, such as proper disinfection of equipment and facilities, controlling the movement of fish, reducing stress factors in the culture environment and avoiding the introduction of infected fish into new areas. The upkeep of optimum water quality parameters is also key for the management of TiPV outbreaks. In the case of fish mortality, the farmers are also advised not to throw fish in an open area as birds may act as vectors for the transmission of the disease. Stringent quarantine protocols, continuous screening and reporting should be activated to minimise incidences in the aquaculture system. Fish with symptoms should not be left unattended in pond water which to help to break the synergism between viral pathogens and subsequent bacterial infections. If a potential outbreak of tilapia parvovirus infection is suspected, farmers are recommended to consult with fish health experts, aquatic veterinarians, or local fisheries authorities for the most up-to-date and relevant information on diagnosis, prevention, and control strategies.

Acknowledgements

The authors wish to thank the Director, ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, India for providing the necessary facilities during this study.

Funding support by the Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India under the National Surveillance Programme for Aquatic Animal Diseases is duly acknowledged.

References

1. FAO. (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action (p. 244). FAO.
2. Ferguson, H. W., Kabuusu, R., Beltran, S., Reyes, E., Lince, J. A., & del Pozo, J. (2014). Syncytial hepatitis of farmed tilapia, *Oreochromis niloticus* (L.): A case report. Journal of Fish Diseases, 37(6), 583–589.
3. Eyngor, M., Zamostiano, R., KembouTsofack, J. E., Berkowitz, A., Bercovier, H., Tinman, S., Lev, M., Hurvitz, A., Galeotti, M., Bacharach, E., & Eldar, A. (2014). Identification of a novel RNA virus lethal to tilapia. Journal of Clinical Microbiology, 52(12), 4137–4146.
4. Dong, H. T., Senapin, S., Jeamkunakorn, C., Nguyen, V. v., Nguyen, N. T., Rodkhum, C., Khunrae, P., & Rattanarojpong, T. (2019). Natural occurrence of edwardsiellosis caused by *Edwardsiella ictaluri* in farmed hybrid red tilapia (*Oreochromis* sp.) in Southeast Asia. Aquaculture, 499, 17–23.
5. Ramírez-Paredes, J. G., Paley, R. K., Hunt, W., Feist, S. W., Stone, D. M., Field, T. R., Haydon, D. J., Ziddah, P. A., Nkansa, M., Guilder, J., Gray, J., Duodu, S., Pecku, E. K., Awuni, J. A., Wallis, T. S., Verner-Jeffreys, D. W., & Biologicals Limited Ceva Santé, R. (2020). First detection of infectious spleen and kidney necrosis virus (ISKNV) associated with massive mortalities in farmed tilapia in Africa. Transboundary and Emerging Diseases, 68, 1550–1563.
6. Machimbirike, V. I., Jansen, M. D., Senapin, S., Khunrae, P., Rattanarojpong, T., & Dong, H. T. (2019). Viral infections in tilapines: More than just tilapia lake virus. Aquaculture, 503, 508–518.
7. Yamkasem, J., Tattiyapong, P., Gorgoglione, B. and Surachetpong, W., 2021. Uncovering the first occurrence of Tilapia parvovirus in Thailand in tilapia during co-infection with Tilapia tilapinevirus. Transboundary and Emerging Diseases, 68(6), 3136-3144.
8. Paul, A., S. Mohanty., Parida, S., Padhiary. S., Biswal, S. and Sahoo, P.K. 'First report of Tilapia Parvovirus (TiPV) infection and associated mortality in tilapia' CIFA NEWS (January-March, 2023).
9. Liu, W., Zhang, Y., Ma, J., Jiang, N., Fan, Y., Zhou, Y., Cain, K., Yi, M., Jia, K., Wen, H., Liu, W., Guan, W., & Zeng, L. (2020). Determination of a novel parvovirus pathogen associated with massive mortality in adult tilapia. PLoS Pathogens, 16(9), e1008765.
10. Dong, H.T., Sangpo, P., Dien, L.T., Mai, T.T., Linh, N.V., del Pozo, J., Salin, K.R. and Senapin, S., (2022). Usefulness of the pancreas as a prime target for histopathological diagnosis of Tilapia parvovirus (TiPV) infection in Nile tilapia, *Oreochromis niloticus*. Journal of Fish Diseases, 45(9), 1323-1331.