

Emerging Viral Disease in Farmed Fish: Tilapia Lake Virus, Diagnosis, Surveillance and Vaccine Development

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Tilapia are among the most important farmed fish, supporting food security and livelihoods in many tropical and subtropical countries. Until recently, viral infections were not common in tilapia, and the appearance of tilapia lake virus (TiLV) represents the first major epidemic reported in this group [2]. TiLV is regarded as a newly emerging pathogen responsible for high mortality and economic losses in the global tilapia industry [2]. The first report of the disease that it causes, tilapia lake virus disease (TiLVD), dates from 2014 [4]. The case is a useful model of how an emerging aquatic disease develops: a new agent is detected in one place, spreads through trade and movement of live fish, and is recognised in new countries before diagnostics, regulation and vaccines are fully in place. This article reviews what is known about TiLV and what is needed for control.

The virus

TiLV is an RNA virus in the family Amnoonviridae, with a negative-sense single-stranded RNA genome of about 10.3 kilobases [3]. It was first isolated from naturally diseased fish, and disease was reproduced experimentally by injection and by cohabitation, which shows that the virus can spread from infected to healthy fish sharing water [8]. The virus can be propagated in primary tilapia brain cells and in the E-11 cell line, which are the basis of laboratory culture and diagnosis [3,10].

Geographic distribution and impact

TiLV has been confirmed in 17 countries, including Ecuador, Colombia, Egypt, Thailand, Taiwan, India, Malaysia, Bangladesh, Uganda, Tanzania, Peru, Mexico, the Philippines, Indonesia, the USA and, more recently, China, some of which are major tilapia producers [1]. A separate study reports that outbreaks have been officially declared in 16 countries across Asia, Africa, and South and North America, involving 6 of the 12 major tilapia-producing countries [2]. The difference between 16 and 17 reflects what is being counted (laboratory-confirmed presence versus officially declared outbreaks) and the date of the report, so authors should state which definition they use.

Table 1. Key features of tilapia lake virus disease

Feature	Detail	Source
Agent	RNA virus, family Amnoonviridae; genome about 10.3 kb	[3]
Host	Tilapia; all life stages affected	[3]
Mortality	Up to about 90 percent in affected populations	[3]
Transmission	Horizontal and vertical	[3]
Reported range	Asia, Africa, North and South America	[1,2,3]
Regulatory status	WOAH-notifiable	[3]
Commercial vaccine or therapy	None identified in the sources reviewed	[3]

Mortality can reach up to 90 percent, and all life stages can be affected [3]. Because tilapia are farmed in many small and medium-scale systems in developing countries, outbreaks can have a disproportionate effect on rural livelihoods, although the sources reviewed do not quantify this.

Clinical signs and epidemiology

Naturally occurring and experimentally induced disease share signs including skin discoloration and patches, eye lesions and lethargy [8]. High mortality combined with characteristic ocular pathology helps distinguish TiLV from other tilapia diseases, but confirmation requires laboratory diagnosis [3]. Transmission is both horizontal (between fish in shared water) and vertical (from parent to offspring) [3], and the second route is particularly important because it can move the virus with broodstock and fry in trade. Clinical signs alone cannot establish the cause, since other bacterial and parasitic diseases can produce similar mortality in stressed tilapia. For this reason a case definition based on laboratory confirmation is a core part of surveillance, a point also stressed in general biosecurity frameworks [7].

Diagnosis and surveillance

Laboratory diagnosis

Laboratory confirmation uses culture of the virus in primary tilapia brain cells or the E-11 cell line, followed by molecular assay confirmation [3]. Molecular methods based on amplifying virus-specific sequences by PCR allow rapid screening of diseased fish and form the basis for surveillance and epidemiological studies [8]. Molecular assays are faster than culture and can be used for screening, while culture confirms the presence of infectious virus.

Standards and validation

Because surveillance and trade decisions depend on test reliability, validation of diagnostic assays is important. The February 2026 report of the WOAHA Aquatic Animal Health Standards Commission describes a new chapter on validating diagnostic assays for infectious diseases of aquatic animals, together with revisions to chapters on surveillance, emergency disease preparedness and outbreak management [5]. These documents provide the framework that national authorities use to organise detection and response.

National programmes

National programmes are addressing local needs. In the Philippines, the Bureau of Fisheries and Aquatic Resources and the National Fisheries Research and Development Institute reported TiLV to WOAHA as a newly emerging pathogen in the country, and a research project funded by the national science agency aims to develop a vaccine using a baculovirus expression vector system, to screen antiviral candidates, and to create a diagnostic platform for surveillance [6]. The project illustrates that countries are linking diagnostics, antivirals and vaccines in a single research effort.

Control: response pathway and biosecurity

In the absence of effective therapy, the response to suspected TiLV depends on rapid detection and containment (Figure 1). A suspected outbreak is identified from mortality and clinical signs, confirmed by laboratory tests, reported to the competent authority, and contained through movement control, disinfection and biosecurity. Preventive measures then focus on surveillance and longer-term tools such as vaccines.

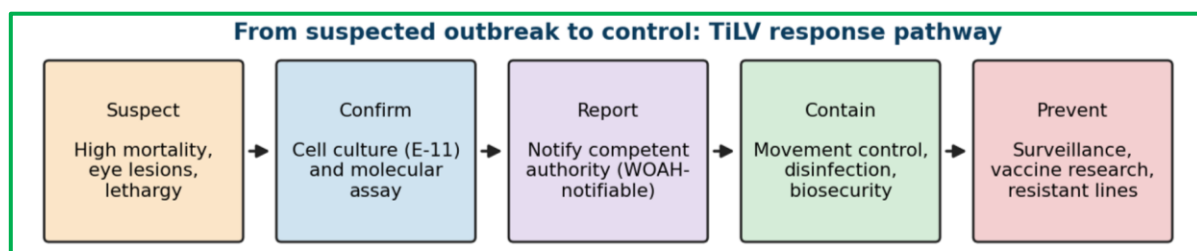


Figure 1. Response pathway for a suspected TiLV outbreak (schematic prepared for this article, based on [3,5]).

A conceptual framework on aquatic health economics includes the emergency biosecurity response to an outbreak of TiLV in tilapia farms as an example of preparedness and response actions [7]. Key actions include restricting movement of live fish and eggs from affected sites, sourcing seed and broodstock of known health status, disinfecting equipment, and avoiding mixing of fish from different sources. These measures follow general principles of aquatic biosecurity, and details should be taken from national guidelines. A review of vaccine strategies concludes that the absence of effective treatment and inadequate biosecurity mean the virus is likely to continue spreading [4]. Prevention therefore needs both better biosecurity and better tools.

Vaccine research

Vaccination has proven effective for preventing and controlling disease in finfish aquaculture, and the suitability of the delivery system is as important as the vaccine itself [4]. Four vaccine types (inactivated, live attenuated, subunit and DNA) are already commercially available for other fish diseases, including live attenuated vaccines against haemorrhagic disease of grass carp and cyprinid herpesvirus 3, subunit vaccines against infectious pancreatic necrosis and infectious salmon anaemia, and a DNA vaccine against infectious haematopoietic necrosis virus [2]. This shows that each technology is feasible for fish, which supports the approach for TiLV.

Table 2. Vaccine approaches under investigation for TiLV.

Vaccine approach	Evidence reported	Limitation or open question
Inactivated whole virus	A cell-culture-derived vaccine inactivated with beta-propiolactone and given with the adjuvant Montanide IMS 1312 VG, plus booster doses, gave a high level of protection against virus challenge in tilapia [2]	Laboratory challenge only; field performance and cost not established
DNA and recombinant protein	Combining viral segments 9 and 10 gave better protection in hybrid red tilapia than single-segment vaccines [4]	Delivery to large numbers of small fish is difficult
Newer strategies	Prime–boost regimens, codon optimisation and reverse vaccinology may increase effectiveness [1]	Mostly at research stage

Inactivated vaccines are considered a reasonable choice for an emerging disease because of their stability, safety and ease of preparation [2]. Their main drawbacks are that they often need adjuvants and booster doses, which increase cost and handling stress. Other reviews identify the factors that affect vaccination efficacy in tilapia and the main challenges of TiLV vaccine development, including vaccine administration routes [1].

Discussion

Three themes emerge. First, detection is a bottleneck: clinical signs are suggestive but not specific, so validated laboratory diagnosis is needed for surveillance and for notification. Second, movement of live fish, and vertical transmission, make biosecurity at hatcheries and in fish trade especially important. Third, vaccine development is promising but incomplete. Laboratory challenge studies show that protection is achievable, but the sources reviewed do not report a commercial product, and the practical problems of delivery and cost remain. This review is limited by its reliance on a small number of reviews and experimental studies. Counts of affected countries change with time, and readers who need current figures should consult the latest WOA disease information and national reports before publication.

Priorities for research and management

- Validate and harmonise diagnostic assays and make them available in all major tilapia-producing countries.
- Establish health certification for broodstock and fry to limit vertical transmission and trade-related spread.

- Evaluate vaccine candidates in field conditions, including delivery methods suited to small fish.
- Investigate genetic resistance and its use in tilapia breeding programmes.
- Strengthen surveillance and reporting so that the true distribution of TiLV is known.

Conclusion

TiLV shows how a single emerging virus can threaten an entire sector of aquaculture. Current control relies on early detection, laboratory confirmation, notification, containment and strict biosecurity, because no commercial vaccine or therapeutic was identified in the sources reviewed. Promising vaccine candidates exist, but field validation is needed. The experience with TiLV argues for investment in diagnostics, surveillance and biosecurity before the next emerging pathogen appears.

References

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