

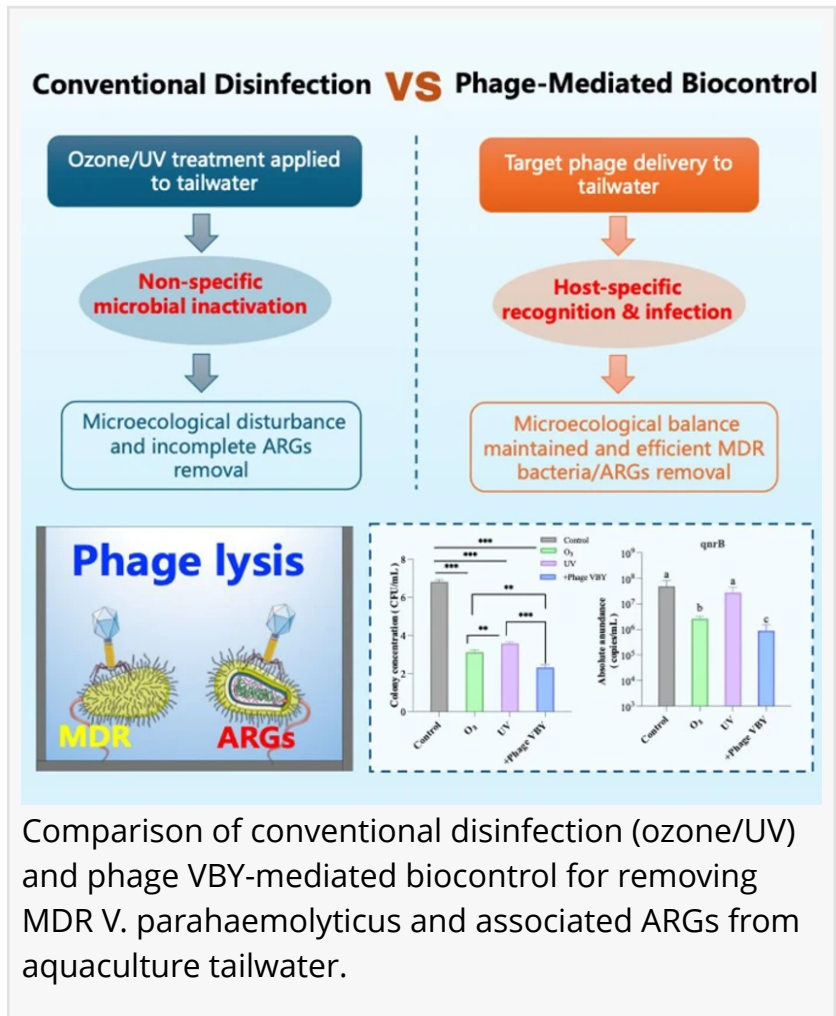
Phage VBY outcompetes ozone and UV in first-ever targeted disinfection of aquaculture tailwater

FAYETTEVILLE, GA, UNITED STATES,
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EINPresswire.com/ -- Multidrug-resistant (MDR) pathogens and their antibiotic resistance genes (ARGs) in aquaculture tailwater pose serious risks to public health and food safety. Now, researchers have developed a bacteriophage-based disinfection technique that specifically targets and eliminates MDR *Vibrio parahaemolyticus*—a leading cause of seafood-borne gastroenteritis—along with the resistance genes it carries. In real tailwater treatment systems, the newly isolated phage VBY reduced bacterial loads by 5.5 logarithmic units and suppressed four key ARGs by 4 to 6 logs over 72 hours, outperforming both ozone and ultraviolet (UV) disinfection while preserving water quality.

Conventional disinfection methods

such as chlorination and ozonation have notable limitations: they generate harmful disinfection by-products, cause non-selective damage to aquatic microbial communities, and often fail to eliminate ARGs carried by bacteria or bacterial debris. Meanwhile, *V. parahaemolyticus*—a Gram-negative bacterium widely distributed in marine and estuarine environments—has increasingly acquired MDR to critically important antibiotics including β -lactams, tetracyclines, and fluoroquinolones. The situation is further exacerbated by biofilms that enhance the pathogen's tolerance to antibiotics and facilitate horizontal gene transfer of resistance genes. Due to these challenges, there is an urgent need for alternative strategies that can effectively reduce resistant bacterial populations and mitigate the spread of resistance determinants.



A team of researchers from the Shandong Key Laboratory of Coastal Zone Environmental Processes and Ecological Security at the Yantai Institute of Coastal Zone Research, Chinese Academy of Sciences, together with collaborators from the University of Chinese Academy of Sciences, Harbin Engineering University, and the University of Florida, report (DOI: [10.1007/s11783-026-2279-5](https://doi.org/10.1007/s11783-026-2279-5)) these findings in the journal [ENGINEERING Environment](#) (Volume 20, Issue 12, Article 179, 2026;). The team isolated a novel lytic bacteriophage—named VBY—from coastal aquaculture tailwater and systematically evaluated its disinfection performance against MDR *V. parahaemolyticus*.

Phage VBY is a Caudoviricetes virus with an icosahedral capsid measuring 113 nanometers in diameter and a long, non-contractile tail of 378 nanometers. Its genome is a 30,247-base-pair circular double-stranded DNA molecule containing 42 open reading frames—and critically, no virulence factors or ARGs. The phage exhibits remarkable environmental stability, maintaining activity across a pH range of 5 to 11 and temperatures up to 60°C, though it is sensitive to UV irradiation. Host range tests confirmed that VBY is highly specific to *V. parahaemolyticus* strains, showing no lytic activity against other aquatic microbes including diverse *Vibrio* species, *Aeromonas* spp., *Klebsiella pneumoniae*, *Escherichia coli*, or beneficial *Nitrospina gracilis*. This narrow host specificity enables targeted elimination of the pathogen without disrupting the indigenous microbial community—a key advantage over ozone and UV, which cause non-selective damage. In pilot-scale tailwater systems, phage treatment not only slashed bacterial and ARG loads but also maintained stable dissolved oxygen levels and prevented the accumulation of ammonia, nitrite, total organic carbon (TOC) and dissolved organic carbon (DOC), overcoming a major limitation of conventional chemical disinfection strategies.

The authors said, “What excites us most is that phage VBY combines targeted killing with ARG suppression—something conventional disinfectants simply cannot achieve. Ozone and UV often induce bacterial stress responses that can actually promote ARG release or horizontal transfer. Phage VBY, by contrast, destroys the host cells while limiting the persistence of intracellular ARGs. And because its genome carries no virulence or resistance genes itself, there’s no risk of secondary gene dissemination. This is a fundamentally different—and safer—way to think about water disinfection.”

The implications extend beyond aquaculture. With the global expansion of aquaculture and the increasing prevalence of MDR *V. parahaemolyticus* in marine environments, phage-based disinfection offers a sustainable, targeted alternative to chemical treatments. The phage’s stability under aquaculture-relevant conditions—including tolerance to a wide pH range and temperatures up to 50°C—supports practical storage and transport. While phage VBY is sensitive to UV irradiation, the researchers suggest it could be used as a pretreatment unit before terminal UV or chlorine disinfection in practical treatment flows. This study represents the first demonstration of phage-mediated disinfection for the targeted removal of MDR pathogens and associated ARGs from recycled tailwater, opening a new pathway for environmentally sustainable water treatment.

References

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