Fish Jacuzzis (!) as a Way to Reduce Infectious Diseases in Aquaculture

Ha Thanh Dong

Aquaculture and Aquatic Resources Management Program (AARM), Department of Food, Agriculture and Bioresources, School of Environment, Resources & Development (SERD), Asian Institute of Technology (AIT), Pathum Thani, Thailand

Corresponding author, e-mail: htdong@ait.ac.th

ABSTRACT:

The aquaculture sector, especially in Asia, plays a vital role in global food security. It supplies protein to approximately 4.5 billion people and employs 19.3 million people worldwide. Similar to other food sectors, aquaculture has faced increasing challenges with infectious diseases. Control of these diseases has led to an increase use of antimicrobials. Of particular importance to public health concerns has been the increase in antimicrobial resistance (AMR). Alternatives to products to control bacterial infections in all food production sectors are therefore urgently needed. Here, we reported our investigation on the application of an emerging nanobubble technology in aquaculture. This technology involves the injection of nano or ultrafine bubbles (size ≤ 200 nm) with a chosen gas into water. Unlike macro- and microbubbles, these nanobubbles have neutral buoyancy, and thus remain in water for days to weeks. What happens to fish and microbes swimming in water containing huge number of these tiny bubbles (~10^{10} bubbles/L). Someone might compare this treatment as fish jacuzzis in the sense of humor. Investigation of three bubble gases (air, oxygen and ozone) showed that ozone nanobubbles (ONBs) at the safe level for fish was not only effective at reducing bacterial and viral concentration, but also improving dissolved oxygen (DO) in water. Interestingly, we also found that such a safe level of ONBs treatment induced vast arrays of immune-related genes of Nile tilapia, which might assist the fish respond more effectively to subsequent infections, thereby improving fish survivability (RPS = 60-70%) compared to that of untreated fish. On the other hand, air- and oxygen nanobubbles were insufficient in reducing concentration of bacteria and viruses in water, however, oxygen nanobubbles improved DO in water similar to that of ONBs. Although single, direct ONBs treatment was safe for fish, multiple direct treatments resulted in some damages on the fish gills. The modified recirculation system (MRS) assembled with an ONBs device (MRS-ONBs) was then set up to allow repeat treatments without negative impact to the fish health. The modified system reduced 15.9 to 35.6% concentration of multi-drug resistant (MDR) *Aeromonas hydrophila* in water and improved survivability of the challenged Nile tilapia with relative percent survival (RPS) of 64.7-66.7%. All the survivor fish developed specific antibody against the challenged pathogen. Protection levels conferred by ONBs were considerably comparable with other non-antibiotic approaches e.g. vaccines, immunostimulants and probiotics. This impressive protection might be the result of synergistic balancing effects of ONBs to "host-pathogen-environment" of aquaculture system, including reducing pathogenic bacterial load, improving fish immunity, and supplying more DO in water. In summary, the findings suggest that ONBs is a promising "alternative to antibiotics" to control bacterial diseases, including MDR bacteria, and has high

potential for disease control in modern aquaculture, especially for super-intensive recirculation systems.

KEYWORDS:
Nanobubble technology, ozone, AMR, alternatives to antibiotics, diseases

REFERENCES:

1. Jhunkeaw C, Khongcharoen N, Rungrueng N, Sangpo P, Panphut W, Thapinta A, Senapin S, St-Hilaire S, Dong HT (2021) Ozone nanobubble treatment in freshwater effectively reduced pathogenic fish bacteria and is safe for Nile tilapia (*Oreochromis niloticus*). Aquaculture 534, 736286
2. Linh NV, Dien LT, Panphut W, Thapinta A, Senapin S, St-Hilaire S, Rodkhum C, Dong HT. Ozone nanobubble modulates the innate defense system of Nile tilapia (*Oreochromis niloticus*) against *Streptococcus agalactiae*. Fish & Shellfish Immunology 112, 64-73.
3. Dien LT, Linh NV, Sangpo P, Senapin S, St-Hilaire S, Rodkhum C, Dong HT (2021) Ozone nanobubble treatments improve survivability of Nile tilapia (*Oreochromis niloticus*) challenged with a pathogenic multi-drug-resistant *Aeromonas hydrophila*. Journal Fish Diseases, in press.