Application of nanobubbles technology in mitigating antimicrobial resistance (AMR) in aquaculture

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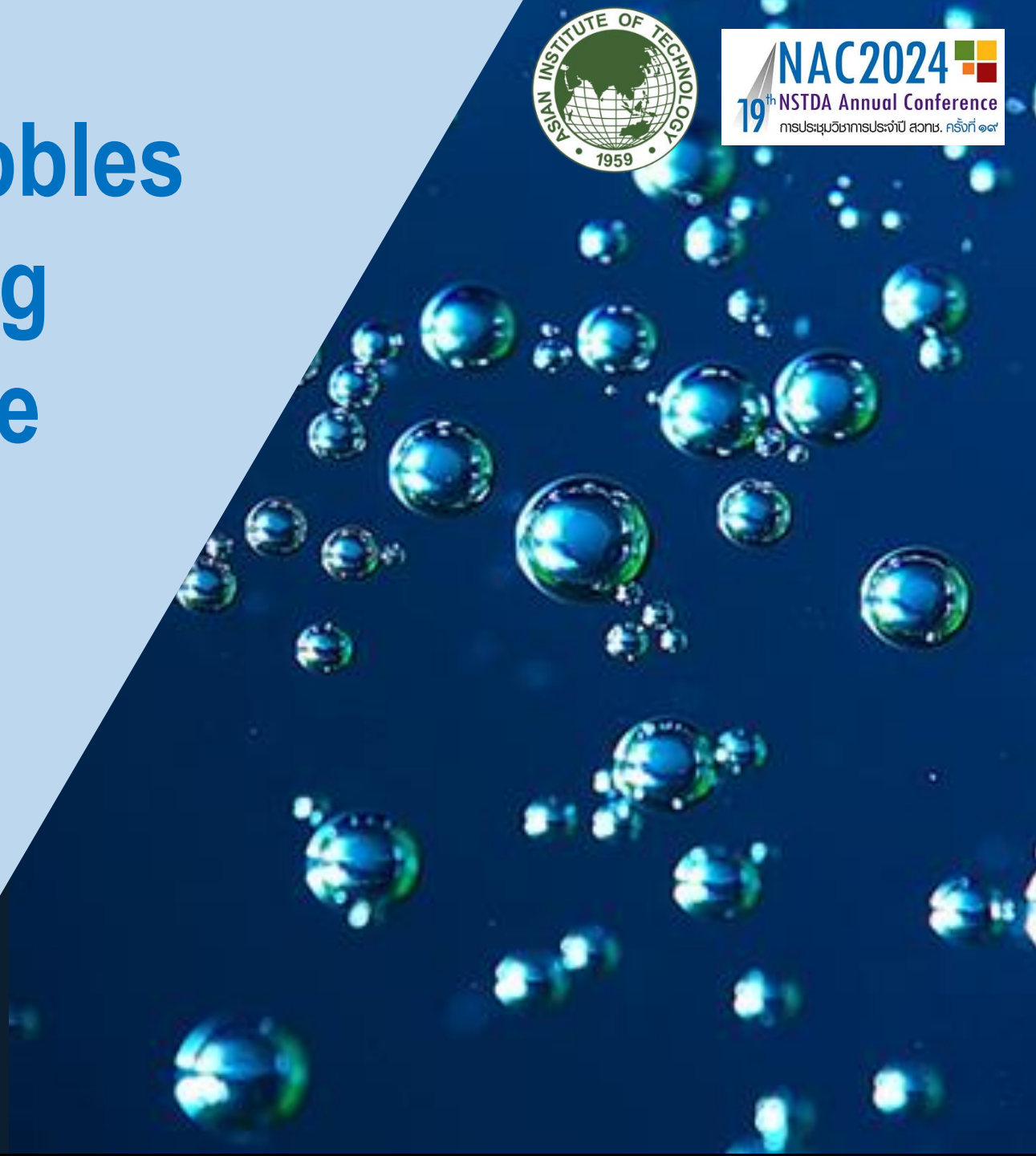
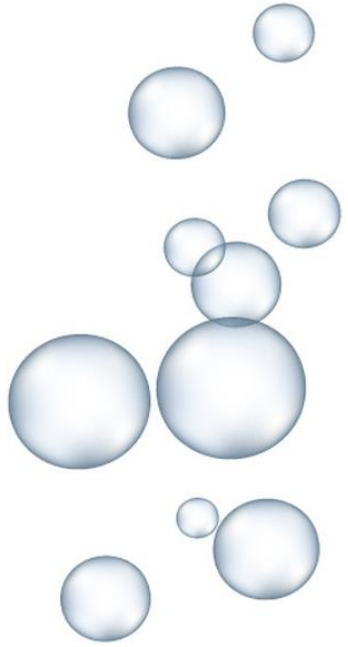


Tiny bubbles - big impact

What is nanobubble?

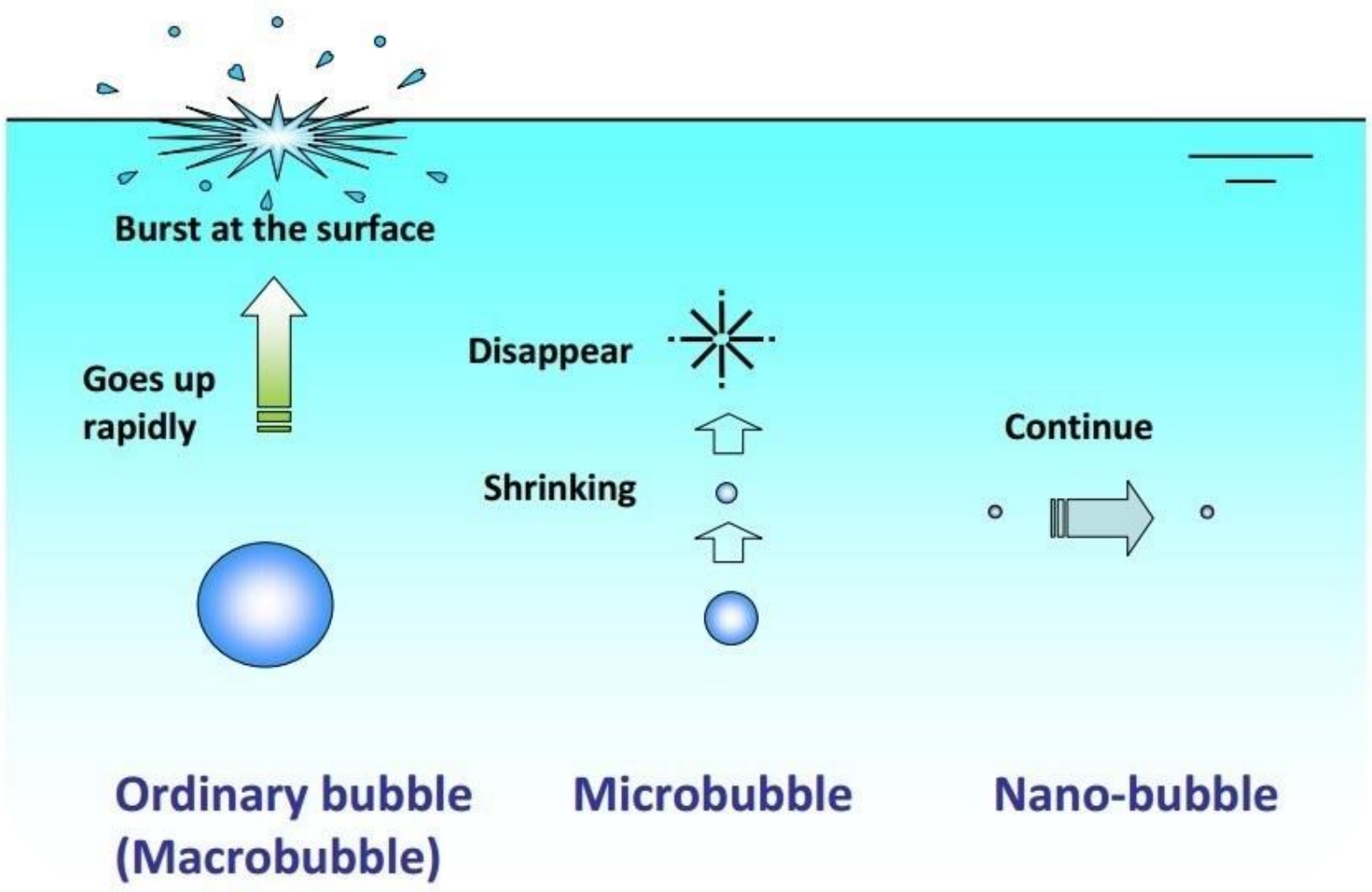
How are nanobubble produced?



How do nanobubbles mitigate AMR in aquaculture?

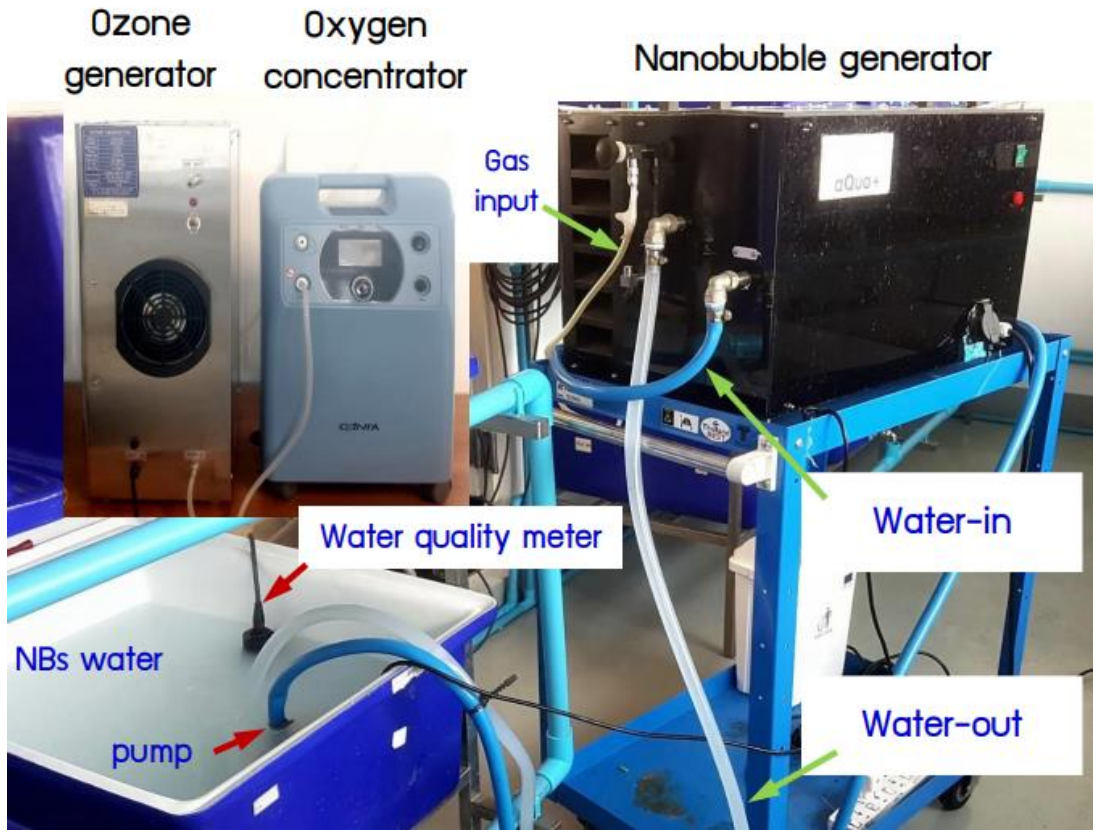
Final remarks & perspectives

What is nanobubble?

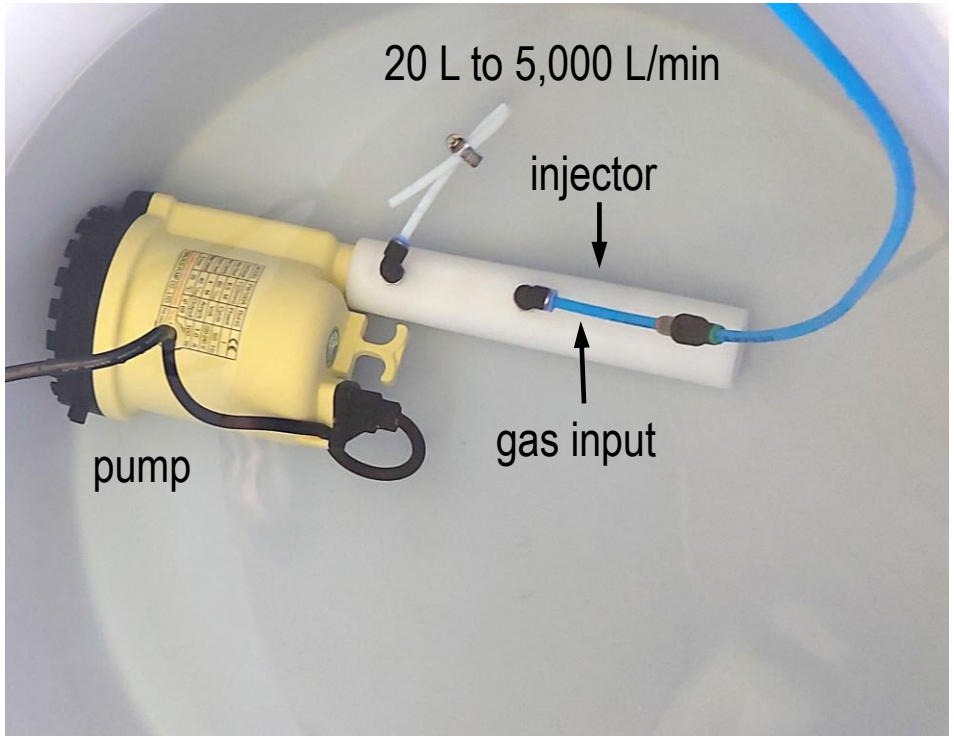


- Size <200 nm (size of virus)
- The high internal pressure permits efficient gas transfer
- Negatively charged, and low buoyancy
- Long residence in water (days to months)
- Various application in different fields

How are nanobubbles produced?

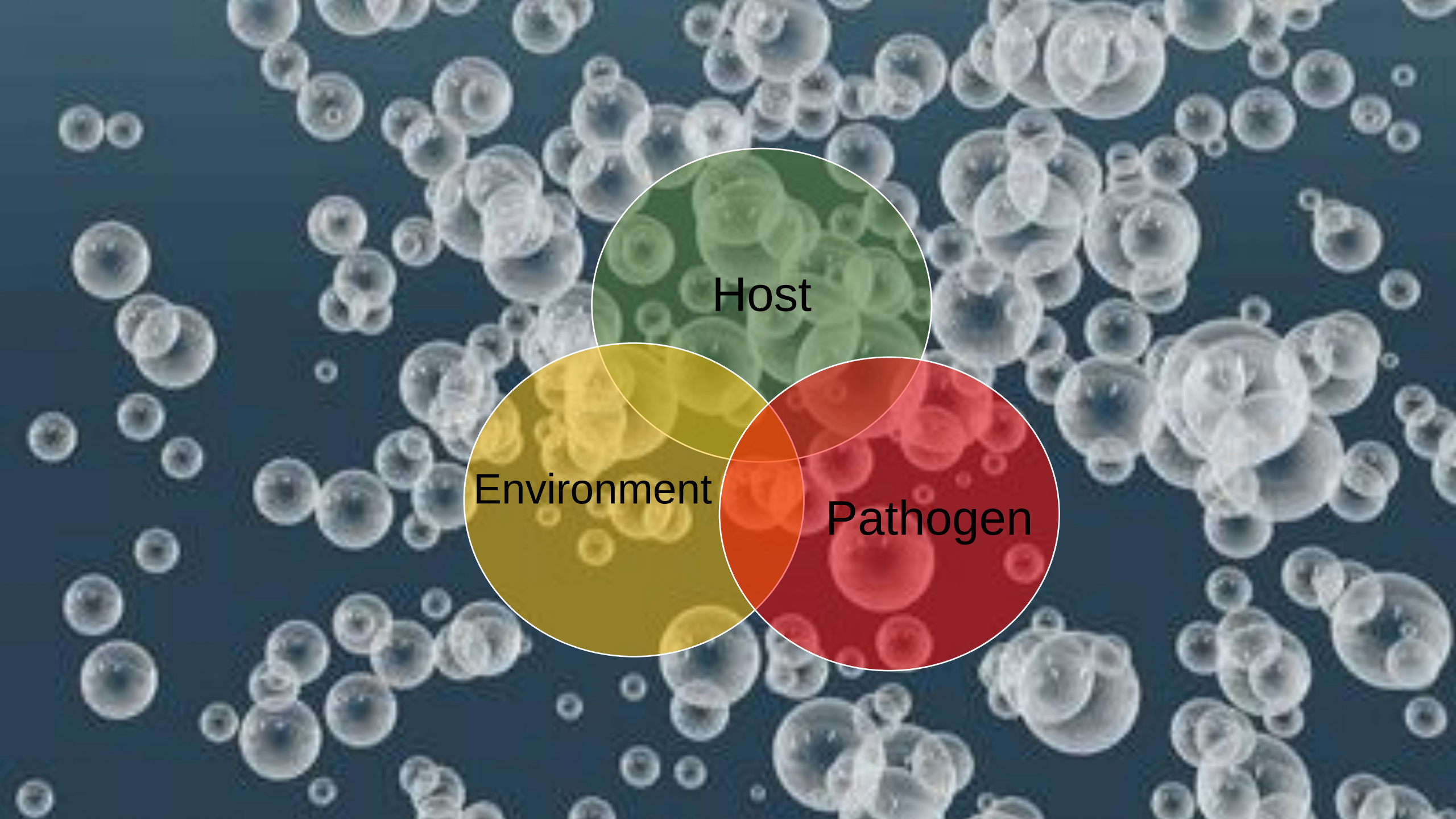


AquaPro (Singapore)



ChucaoTec (Chile)

- ✓ Air nanobubbles
- ✓ **Oxygen nanobubbles**
- ✓ **Ozone nanobubbles**

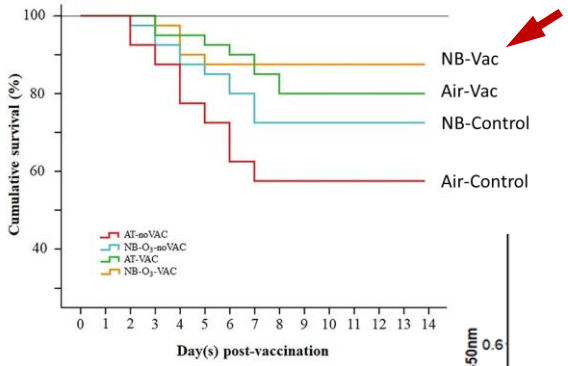

Host
Environment
Pathogen

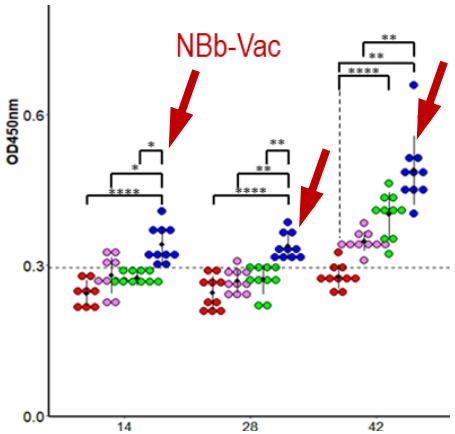
How do nanobubbles mitigate AMR in aquaculture?

Ozone nanobubbles – synergistic effect

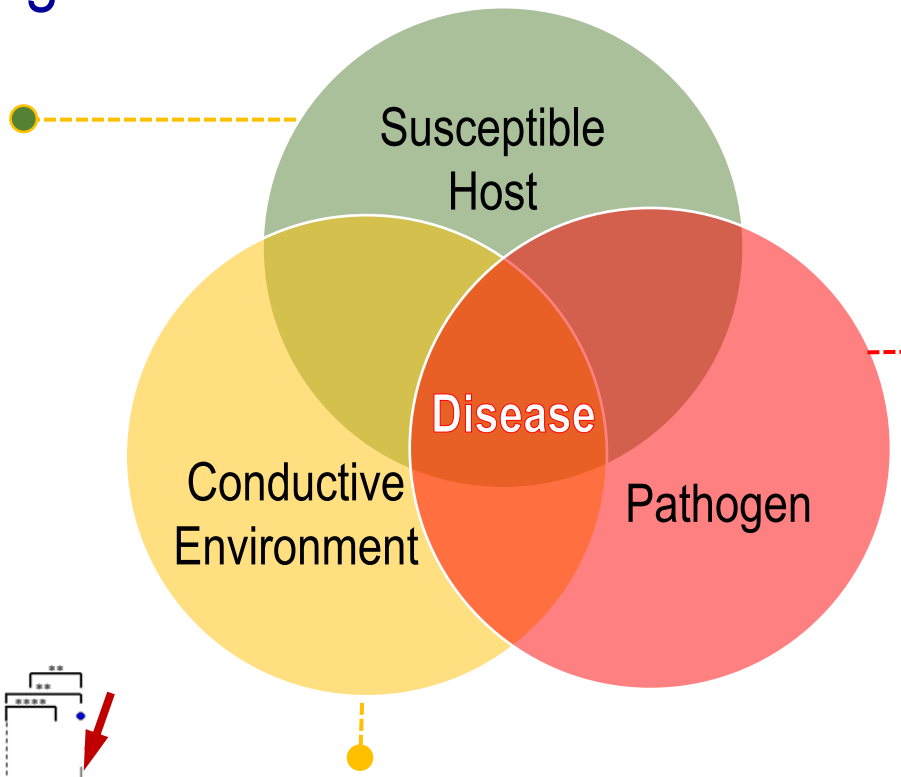
Improve fish immunity

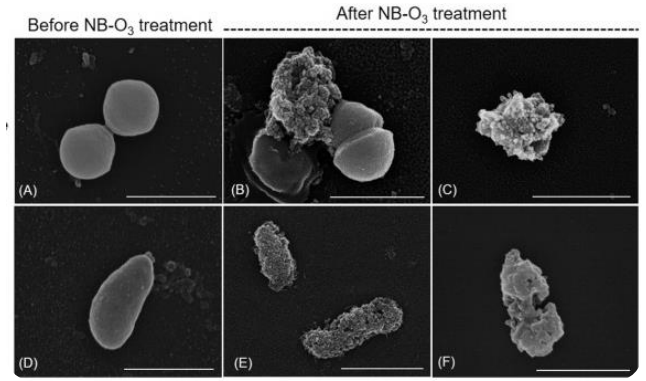
- Enhance innate immunity (2-4 fold)
- Improve survivability during bacterial infection (i.e. 35-40%)
- Improve efficacy of vaccine





Better antibody response & higher protection





Reduce pathogen loads

- Bacteria: reduce 96.11–97.92% after 10 min treatment
  - *Streptococcus agalactiae*
  - *Aeromonas veronii*
  - *MDR A. hydrophila*
  - *Vibrio parahaemolyticus*
  - *MDR Mycobacterium sp.*
- Virus: reduce 100% after 5 min treatment

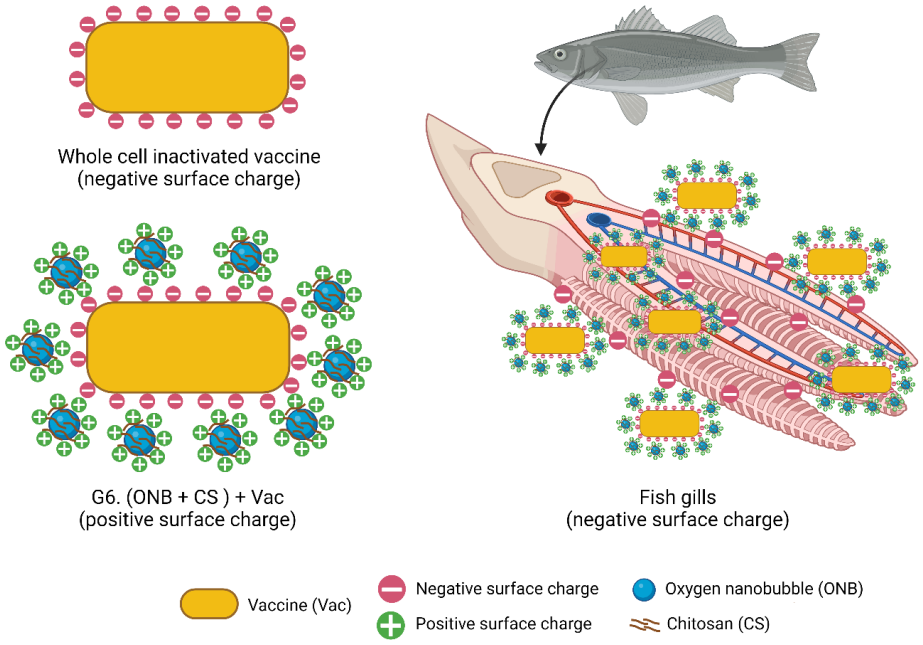
Improve water quality

- Improve DO
- Reduce organic loads
- Reset microbial community in water

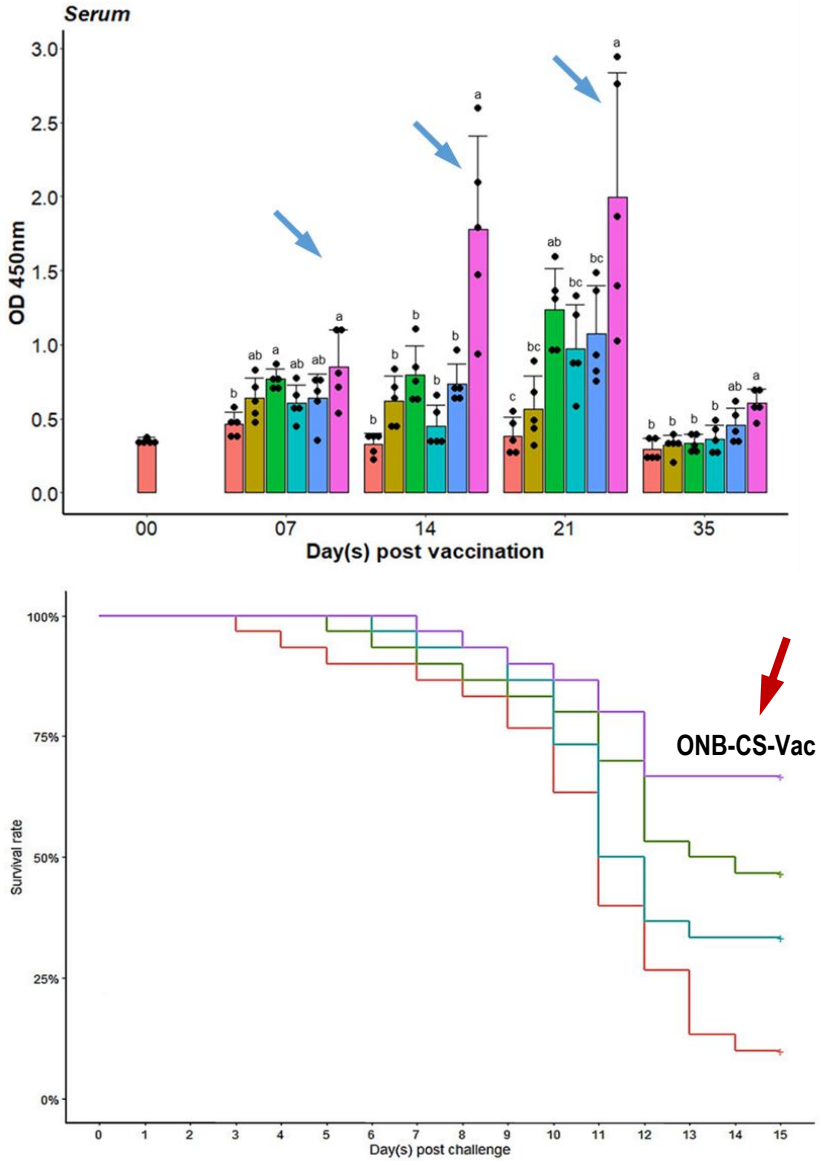
How do nanobubbles mitigate AMR in aquaculture?

Oxygen nanobubbles

- Improve phage uptake and efficacy of phage therapy (see Dien et al., 2021)
- Enhance antigen uptake, antibody response, and efficacy of immersion in Asian seabass (Lan et al., 2024)



The introduction of oxygen nanobubbles and chitosan converted the Zeta potential of the vaccine from negative to positive, making it adhere more effectively to the gills



Final Remarks & Perspectives

- The use of nanobubbles has become more common in aquaculture
- There is an increasing number of companies offering nanobubble devices specifically designed for aquaculture at lower prices (e.g. Chucaotec and Moleaer)
- Nanobubble technology, incorporated with solar cells, may replace common aeration practices in intensive aquaculture farms within the next five years
- Nanobubble technology may transform health management practices in aquaculture towards reducing antibiotics, such as enhancing fish immunity, reducing harmful pathogens in water, **improving vaccination**, and implementing phage therapy

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Thank you for your kind attention

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