



Alternatives to Antimicrobials (ATAs) towards Mitigation of Antimicrobial Resistance (AMR) in Aquaculture

Regional Workshop for WOAHP Focal Points for Aquatic Animals

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World Organisation
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Department of Agriculture,
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Aquatic Animal Diseases



Main reason for the use of antimicrobials in aquaculture.

- Still a bottleneck in the sustainability of aquaculture in the region;
- Include important and emerging diseases;
- Spread is directly correlated to transboundary movement of live aquatic animals and aquatic animal products.

Antimicrobial Resistance (AMR) in Aquaculture

- A significant global challenge where important bacterial pathogens develop resistance to antibiotics, posing threats to aquatic animals, human health, and the environment.
- Driven by the widespread, often, prophylactic use or misuse of antimicrobials; creates a selective environment for resistant bacteria to thrive and share resistance genes;

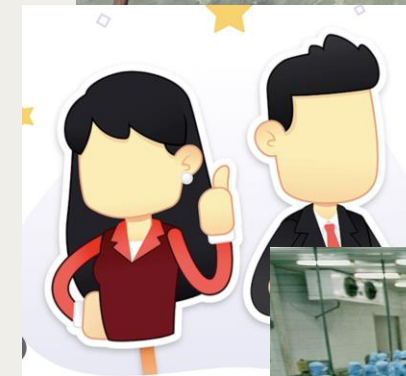


<https://www.linkedin.com/pulse/antimicrobial-resistance-aquaculture-john-hargreaves>



Antimicrobial Resistance (AMR) in Aquaculture

- Emerging as a systemic risk to aquaculture, threatening not only aquatic animal health and productivity, but also food safety, trade, environmental integrity, and human health under the One Health framework:
 - **Farm production:** higher costs, lower survival and failed treatments;
 - **Public Health:** transfer of resistant genes to human pathogens;
 - **Market and Trade:** export restrictions/rejections of shipments; food safety issues;
 - **Food Security:** long term risk to sustainability of aquaculture





Alternatives to Antimicrobials (ATAs)

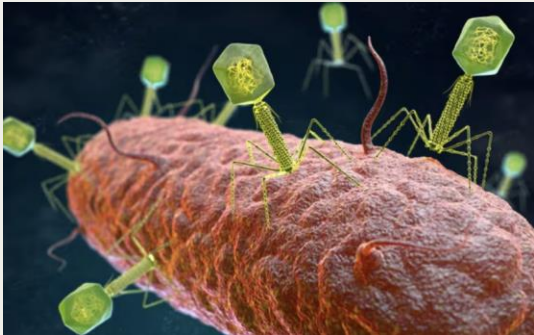
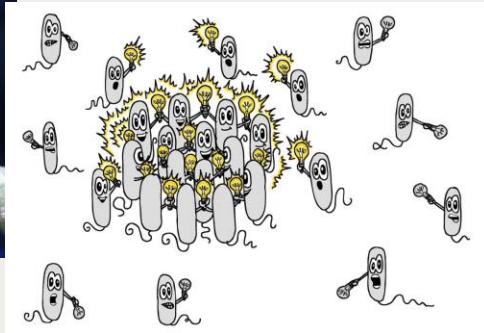


Established:

- Vaccines
- Immunostimulants and phytochemicals
- Probiotics, prebiotics and synbiotics
- Systemic enclosures and ecological management (biofloc technology; RAS; improved biosecurity)

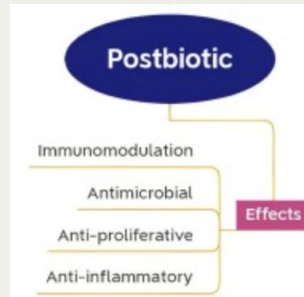
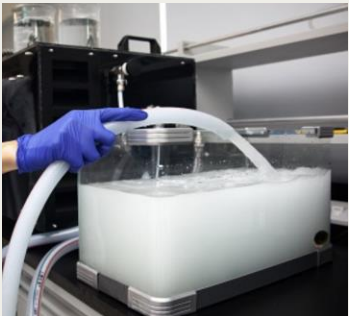


Alternatives to Antimicrobials (ATAs)



Emerging Technologies and Next-generation Therapeutics:

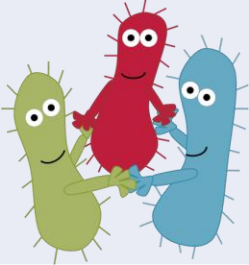
- DNA and RNA particle vaccines
- Quorum quenching
- Antimicrobial peptides and bacteriocins
- Bacteriophages
- Postbiotics and paraprobiotics
- Nanobubble technology
- Genomic selection and selective breeding (SPF, SPR and SPT; genome editing)



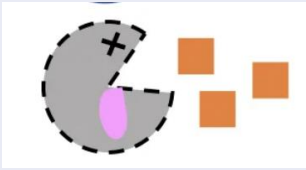
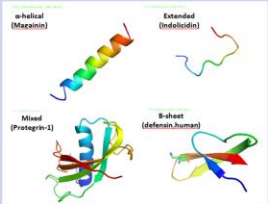


ATA Category	Evidence of Effectiveness	Policy Clarity	Technology Readiness (TRL)
Inactivated Vaccines 	Strong; 99% reduction in AMU in Salmonids.	High	High
DNA Vaccines 	Very Strong; up to 85.9% Relative Percentage Survival (VNN).	Moderate (Complex)	Medium/High
Recombinant Vaccines 	Strong; effective for G protein-based IHNV/SVCV protection.	Moderate	High



ATA Category	Evidence of Effectiveness	Policy Clarity	Technology Readiness (TRL)
Microbiome modulation: Probiotics/prebiotics Synbiotics	Moderate; improves FCR and innate immune response	Low	Medium/High
Bacteriophages 	Specific; effective in controlled trials, requires field validation	Low	Low/Medium
Quorum quenching 	Some can be specific	Low	Low/Medium



ATA Category	Evidence of Effectiveness	Policy Clarity	Technology Readiness (TRL)
Postbiotics and parabiotics 	Moderate	Low	Low/Medium
Microbial peptides 	Moderate	Low	Low/Medium
Nanobubble Technology (vaccine delivery; nanovaccine) 	Strong	Moderate	Medium/High



ATA Category	Evidence of Effectiveness	Policy Clarity	Technology Readiness (TRL)
Seletive breeding, genome editing for disease tolerance and resistance 	Strong	Clear	Medium/Low
Biosecurity 	High	Medium	High



Farm-level Adoption: Interlocking gaps

- 1. Regulatory Barriers:** Unclear or fragmented regulatory frameworks delay the approval and commercialization of ATA products.
- 2. Market and Economic Barriers:** Farmers often face tight margins and limited access to credit, making them risk-averse to new technologies. ATAs may require upfront investment without guaranteed returns, while antimicrobials remain low-cost and readily available.
- 3. Knowledge and Behavioural Barriers:** Limited extension services, weak advisory systems, and low trust in new products hinder adoption.
- 4. Delivery System Constraints:** Input supply chains for ATAs are often underdeveloped, particularly in rural and smallholder contexts.



Conclusions

- ✓ The transition to ATAs in aquaculture is both urgent and achievable.
- ✓ The technologies and approaches required to reduce antimicrobial dependence already exist; the challenge lies in aligning policy, markets, and delivery systems to enable their adoption at scale.
- ✓ A roadmap is needed to provide a structured pathway for moving from fragmented innovation to coordinated, system-wide transformation, positioning aquaculture as part of the solution to AMR rather than a contributor to the problem.



Thank you

For more information, visit us at www.enaca.org



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