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Battling the invisible enemy

Antibiotic resistance in aquaculture

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AQUACULTURE, often known as aquafarming, is the breeding, rearing, growing, and harvesting activity of aquatic organisms in either saltwater or freshwater, with the goal of primarily feeding humans.

The aquaculture sector is rapidly expanding in tandem with the growing population, as it is a critical industry for meeting the global demand for food supply needed to feed a population in the foreseeable future.

According to the Food and Agriculture Organisation of the United Nations (FAO), the global apparent consumption of aquatic food per capita continues to rise from 9.1 kg in 1961 to 20.6 kg per capita in 2021, bringing the total global apparent consumption of aquatic animal foods in 2021 to 162.5 million tonnes (FAO, 2024).

The increase in aquaculture production, however, presents significant challenges. Antibiotics have become increasingly important in maintaining high yields and protection against disease outbreaks, particularly in intensive farming systems.

While the use of antibiotics has undeniably led to increased aquaculture production and a consistent supply of seafood, it has also introduced a series of potentially harmful repercussions and risks to farmed animals, humans and the environment at large.

Overuse and improper application of antibiotics in aquaculture can contribute to the growth and spread of antibiotic resistance (AR), in which bacteria evolve to withstand the effects of these drugs.

RISE OF ANTIBIOTIC RESISTANCE

Antibiotics are commonly used in aquaculture for various purposes, including prophylactic measures to prevent infections, therapeutic treatment for sick animals, metaphylactic use to prevent anticipated diseases, and as growth promoters in which medications like oxytetracycline and florfenicol are given to animals to enhance the growth and feed conversion of aquatic organisms (Alotaibi, 2023).

The global aquaculture industry is a significant consumer of antibiotics, with the Asia-Pacific region accounting for the majority (93.8 per cent) of this consumption. In 2017, the estimated global antimicrobial use in aquaculture was 10,259 tonnes, projected to increase by 33 per cent to 13,600 tonnes by 2030.

The four leading countries in antibiotic consumption are China, India, Indonesia, and Vietnam, reflecting their dominance in global aquaculture production. Antibiotics like quinolones, tetracyclines, amphenicols, and sulfonamides are the most used antimicrobials in aquaculture (Schar et al., 2020).

However, the widespread use of antibiotics creates selective pressure on the ecosystem, favouring the survival and proliferation of resistant bacteria. These resistant bacteria can be pathogenic or can transfer their resistance genes to other bacteria, leading to the spread of antibiotic resistance genes (ARGs) within microbial communities of the aquaculture.

In many producing countries, the misuse and overuse of antibiotics were reported and have led to significant concerns, including the exclusion of fishery products from countries like China, India, Malaysia, Bangladesh, and Vietnam by the EU and the USA due to the presence of banned antibiotics such as chloramphenicol and nitrofuran (Alotaibi, 2023).

Antibiotic resistance happens when bacteria or microorganisms retrieve the ability to endure the effects of antibiotics, or in other words, they no longer respond to these antimicrobial medicines, leading to their ineffectiveness in treating the disease.

This can occur via various mechanisms, including mutation and horizontal gene transfer (HGT). Random mutations in bacterial DNA, for instance, are making them susceptible to antibiotic resistance.

When a single bacterium mutates to become antibiotic-resistant, it can transmit that resistance to other bacteria within its surroundings through the transfer of genes (HGT).

Plasmids, or little circular bits of DNA, are one of the most common mediums for gene transfer among bacteria, with resistance genes being exchanged within and across farmed animals and humans by direct physical contact with the bacteria (Darphorn et al., 2021).

In this case, the conjugation process (a process where bacteria connect and share a small piece of DNA that helps them pass on traits, like antibiotic resistance, making them stronger and better able to survive) permits bacteria to share or exchange their antibiotic resistance genes with other genes present in their surroundings.

SILENT EPIDEMIC

Both ARGs (Antibiotic Resistance Genes) and ARB (Antibiotic Resistance Bacteria) are responsible for the silent epidemic that could impact a nation's public health.

Residual antibiotics (small amounts of antibiotics that remain in animals, like fish, after they have been treated with medication) and resistant bacteria can enter surrounding aquatic environments through effluent discharge, water exchange, and the release of untreated wastewater.

This can lead to environmental contamination, allowing antibiotics in water bodies to persist, resulting in the selection of resistant bacteria. Aside from that, ARGs can move amongst bacteria in the environment, including those that are pathogenic (harmful) to humans and animals, adding to the global pool of antibiotic resistance.

Hence, when seafood is traded locally or internationally, these resistant bacteria and their associated resistance genes can be transferred to different regions, impacting local ecosystems and human health. The movement or transportation of seafood products can facilitate the dissemination of ARB through various pathways, including contaminated water, processing facilities, and distribution networks.

Furthermore, the use of antibiotics in aquaculture might result in residues entering the environment, promoting the selection and spread of resistant strains.

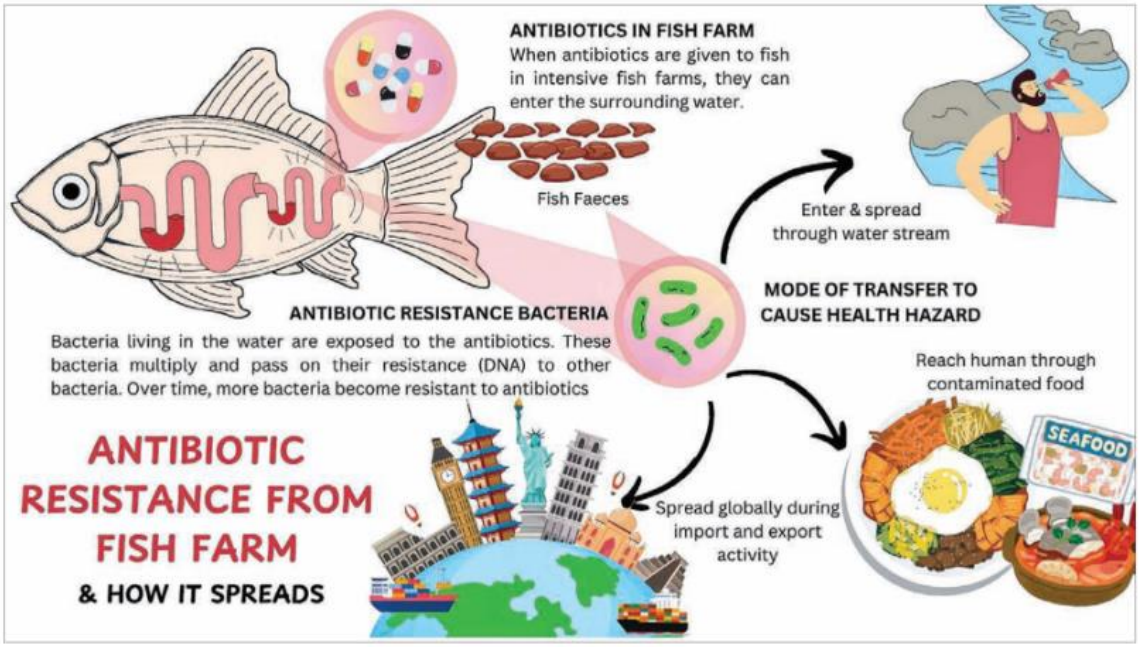
The impact of antibiotic use in aquaculture extends beyond the farming area, potentially posing a global public health challenge. As seafood is consumed worldwide, ARB from aquaculture can quickly spread across borders. Contributing factors include poor sanitation, misuse of antibiotics in fish feeds and treatments, lack of awareness, and environmental pressures that allow resistant strains to persist (Alotaibi, 2023).

ARB from aquaculture can reach people via a variety of routes, including eating infected fish, cross-contamination during food processing, and direct contact with contaminated water. This can lead to infections that are difficult to treat, resulting in higher medical costs, more extended hospital stays, and increased mortality. People in direct contact with contaminated water, like fishermen and recreational users, are especially at risk.

The spread of ARGs from aquaculture to human pathogens makes illnesses more challenging to treat and manage, further straining public health systems.

STRATEGIES FOR MITIGATION

Many studies highlight the urgent need to scale up antibiotic resistance surveillance in aquaculture, particularly in Asia, where the



industry is rapidly expanding. To effectively mitigate antibiotic resistance in aquaculture, a comprehensive and integrated approach is essential.

Strategies must prioritise reducing antibiotic usage, enforcing stringent biosecurity measures, and promoting alternative disease control methods such as vaccines and probiotics. A successful example is Norway's salmon farming industry, where antibiotic use was significantly reduced through vaccination and improved management practices (Bailey and Eggereide, 2020).

In Malaysia, national strategies like the Malaysian Action Plan on Antimicrobial Resistance (MyAP-AMR) 2017-2021 and 2022-2026, alongside the Malaysian Good Agricultural Practices (MyGAP) certification, emphasise the need for stringent regulations, awareness campaigns, and the promotion of sustainable aquaculture practices and halalan toyyiban (HT) compliance in producing fishery products.

These initiatives are designed to ensure safe and responsible farming practices that minimise antibiotic misuse and environmental impact.

University-led research, funded by agencies such as the Kurita Water and Environment Foundation (KWEF), also plays a critical role in developing innovative solutions to address these challenges

Collaborative efforts among policymakers, researchers, and industry stakeholders are crucial. Implementing measures such as prohibiting the sale of antibiotics without prescriptions, addressing financial barriers for farmers, and providing comprehensive training for veterinarians are necessary to control antibiotic use and prevent the spread of resistance.

STEWARDSHIP OF THE SEA

Ultimately, sustainable aquaculture practices must balance food security with public health, ensuring the industry's long-term viability without compromising human health. It is essential to recognise our responsibility to manage the resources provided by the sea.

"And He is the One Who has subjected the sea, so from it, you may eat tender seafood and extract ornaments to wear. And you see the ships ploughing their way through it, so you may seek His bounty and give thanks to Him."
(Quran, Al-Nahl, 16:14)

The verse reminds us that the sea (or any aquatic ecosystem) is a blessing, providing both sustenance and opportunity. By implementing sustainable aquaculture practices, guided by strategies like MyAP-AMR, and adhering to initiatives like MyGAP, we honour this gift. In doing so, we are following the principles of Maqasid al-Shari'ah, which emphasise the protection of life (Hifz al-Nafs).

As Islam teaches the importance of taking care of the environment, this action is also seen as a form of protection of the religion (Hifz ad-Deen). All in all, efforts to combat antibiotic resistance in aquaculture not only protect public health but also ensure that future generations continue to reap the benefits of the sea. This allows us to complete our duty to be stewards of the earth and express our gratitude for the blessings we have been given. - **@AGROBiz**

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