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## ANTIMICROBIAL RESISTANCE IN FOODBORNE PATHOGENS

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Antimicrobial resistance (AMR) is the ability of the microorganisms (bacteria, fungi, viruses and parasites) resist the action of treatments, it's very difficult to treat the common infections and could cause severe illnesses, chance of spreading of infections and finally lead to death. If we are failure to tackle AMR as a pandemic issue, it could lead to 10 million deaths per year by 2050 and costing $100 trillion lost from global GDP (O'Neill 2014). AMR is a major cause of death globally, with a burden likely to be higher than that of HIV or malaria. A comprehensive systematic study estimated that globally AMR was associated with 4.95 million deaths, including the direct contribution to 1.27 million deaths, in 2019 and India had one of highest burdens of AMR and maximal resistance trends in Asia [Murray et al., 2022]. Moreover, AMR threat has long been signalled from the Recommendation-Commission on antibiotic resistance in 2013 and the O'Neil report, Global Antimicrobial Resistance and Use Surveillance System (GLASS) by WHO in 2015, Fleming Fund, 2015 and G7 Finance Ministers issued statements to support antibiotic development in 2021. But action has been episodic and uneven, resulting in global inequities in AMR. However, surveillance on AMR, diagnostics, treatment, control, vaccines, discovery of new antibiotics are extremely in slow progress. Moreover, the recent SARS-COVID-19 pandemic could have been worsened emergence AMR due to unexpected and unpredicted prescriptions of antibiotics (Hsu, 2020).

**Aquaculture farming and use of antibiotics in aquaculture**

Due to consumer's food habit and awareness on health, fish and fisheries products get more attention across the globe due to nutrient contents viz., essential protein, fatty acids (PUFA), micro, and macro-nutrients. Now the per capita consumption of fish in the world was 9.0 kg in the year 1961, which grew to 20.5 kg in 2017 [FAO, 2018]. Because of its higher demand and exponential population growth, the intensified aquaculture culture farming system is becoming blooming on every years as becomes an intensive and super intensive aquaculture farming system. So the intensive aquaculture often demands the use of formulated feeds, antibiotics, disinfectant's, water, soil treatment compounds, algaecides, pesticides, fertilizers, probiotics and prebiotics etc., (Subasinghe et al., 2000; Bondad- Reantaso et al., 2005 and Rico et al., 2013] which could cause severe stress on fishes that lead to disease outbreak [Rottmann et al., 1992] and with high mortalities. So the fish farmers are often bound use antibiotic to control the diseases. Generally the antibiotics are administered through feed or applied directly into the aquaculture ponds [Heuer et al., 2009, Pham et al., 2015, Okocha et al., 2018]. Moreover, the administered antibiotics are not metabolize completely by the fishes and almost 75% of the consumed antibiotics are excreted in to the pond through faeces and directly applied antibiotics in the ponds will remains for a certain period (varied days of withdrawal period for different antibiotic). As on now, there is no defined antibiotics are produced for the control of fish diseases, often veterinary antibiotics are being used in fish farming [Chi et al., 2017].

**Trends of antibiotic consumption**

Global antimicrobial consumption in aquaculture in 2017 was estimated at 10,259 tons and antimicrobial consumption in aquaculture is expected to increase 33% between 2017 and 2030 and mainly due to its expansion of aquaculture farming. The four countries with the largest share of antimicrobial consumption in 2017 were all in the Asia–Pacific region: China (57.9%), India (11.3%), Indonesia (8.6%), and Vietnam (5%) and they represented the largest share of aquatic animal production output in 2017: China (51.2%); India (9.9%); Indonesia (9.8%); and Vietnam (5.7%) [Schar et al., 2020]. India accounts for about 3% of the global consumption of antimicrobials in food animals [Van Boeckel et al., 2015]. By 2030, global antimicrobial use from human, terrestrial and aquatic food producing animal sectors is projected to reach 236,757 tons annually. On an equivalent biomass basis, estimated antimicrobial consumption in 2017 from aquaculture (164.8 mg kg−1) is 79% higher than human consumption (92.2 mg kg−1) and 18% higher than terrestrial food producing animal consumption (140 mg kg−1), shifting to 80% higher than human (91.7 mg kg−1) consumption and remaining 18% higher than terrestrial food producing animal consumption projected in 2030 [Schar et al., 2020].

**Antibiotics used in Aquaculture**

Globally, the most commonly used classes of antimicrobials were quinolones (27%), tetracyclines (20%), amphenicols (18%), and sulfonamides (14%) [Lulijwa Ronald et al., 2020]. Most frequently reported antibiotic compounds in Asian aquaculture production were sulphonamides: sulphadiazine, sulfamethoxine; beta-lactam: amoxicillin and florfenicol[Rico et al., 2012]. Food and Drug Administration (USFDA) has approved oxytetracycline, florfenicol, and Sulfadimethoxine/ormetoprim antibiotics for use in aquaculture [Romero et al., 2012].

**Factors influence of antimicrobial resistance (AMR)**

AMR is poorly understood in this aquaculture sector in the emergence, re-emergence and spread of AMR. Often the water bodies/ aquaculture system may act as the source of AMR pathogen by collecting from all possible settings and potential source for dissemination of AMR across the settings since its well interconnected system in India. The aquaculture system either use the natural water bodies (rivers, lakes, streams, marine backwater and sea cage) and human made aquaculture farming (fin fishes and shell fish farming) are frequently getting a chance of contracting with the AMR pathogen, antibiotic residues and AMR contributing factors such as biocides, chemical residues (cu, selenium, lead etc), heavy metal contaminations, pesticides,, global warming and water quality parameters (pH, salinity, DO, ammonia, nitrate, nitrites, etc) through domestic, industrial and hospital sewage and agricultural runoff. Whereby the existing potential normal microflora of the aquatic system would acquire these ARGs through HGT or vertical and development resistance against these pollutants and influence the transfer of ARGs between them which lead to the accumulation of AMR pathogens and risk to the clinical settings [Michael et al., 2013].Antimicrobial resistant bacteria can be transferred from food animals to humans either through direct contact with animals, contaminated foods, or indirectly through contaminated environments [Sharma et al., 2018, Argudín et al., 2017, Muloi et al., 2018].

The important listed AMR pathogens by FAO/ WHO/ OIE tripartite are ESKAPE whereas, numerous publications are pouring in the recent years with non- pathogenic bacteria species are also harbouring from a few to more than 10 numbers of antimicrobial resistance genes (ARGs) and also harbour virulence and toxigenic genes. So these non-pathogenic antibiotic resistant bacteria species in this aquatic system are either ignored or not monitored properly since these species could act as potential reservoir for the dissemination of AMR. However, a clear cut understanding of the origin and environmental factors that account for the clinical appearance of ARGs is still lacking. Moreover consistent study is warranted to prevent the extent of AMR amplification and its dissemination under the influence of the environmental selection pressure/ factors and to evaluate of its risks (pathogenicity) to human, animal and aquatic animal health. So thereby prevent the spread of AMR infection through proper sanitation, hygiene, use of protective gears, proper disposal of waste and infection prevention measures, proper treatment of effluent from hospitals, manufacturing waste and impact of antibiotic discharges, reducing unnecessary use in aquaculture, promote development of new rapid AMR diagnostics, promote the development of vaccines, immune-modulators, antimicrobial peptides, digestible enzymes in feed, endolysins, hydrolases, and new drugs, enhance the potential of existing antibiotics and finding alternatives to the antibiotics (bacteriophage therapy, pre and probiotics) and CRISPR- cas9 genome editing etc.

**Regulation of antibiotics used in aquaculture**

The use of antibiotics in aquaculture in India is regulated by government agencies: Coastal Aquaculture Authority of India (CAA), Marine Products Export Development Authority (MPEDA), Export Inspection Agency (EIA), Food Safety Standard Authority of India (FSSAI) and State Government have aligned their antibiotics regulations and Maximum Residual Limits (MRLs) with the European Council (EC) and the FDA requirements, to meet export requirements. India, government authorities have listed antibiotic compounds authorized and banned for use in aquaculture (CAA) have adopted EC MRLs to meet export requirements of the importing consuming countries.

**Conclusion**

It is imperative to identify and mitigate the source and spread of AMR as they contributing serious antimicrobial resistance, alterations of microbial community, causes of health hazards to the stakeholders, food safety and quality issues, and economic loss worldwide. It is well known that AMR is a one health approach that includes connections between humans, animals, and the environment as a cause and a solution. Thus for eliminating the contamination of antibiotics and resistance genes in the aquaculture field, it is necessary to implement better management practices, effective biosecurity measures, and employ other disease prevention measures instead of chemotherapy.

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