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Current Trends and Future Prospects in Disease Management of Indian Fisheries

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Abstract: India stands as one of the leading countries in aquaculture production, providing crucial economic support to many people in the country. However, the occurrence of diseases has emerged as a primary hindrance to the sustainable production and trade of aquaculture products. Various stress factors, including inadequate physicochemical and microbial quality of culture water, poor nutritional status as well as high stocking density, can lead to infections by opportunistic pathogens. The presence of different opportunistic bacterial pathogens and parasites poses a significant threat, causing substantial losses to the fish industry in terms of heightened morbidity and mortality, diminished growth, and increased expenses on the use of chemicals for preventive and control measures. Therefore, the present paper sheds light on the common freshwater fish diseases in India and their treatment, aiming to promote sustainable aquaculture.
Keywords: Aqua culture, Microbial Diseases, Mortality.

I. INTRODUCTION

India has a long history of seafood exports, with the sector playing a significant role in the country's economy. Fish and fish products have traditionally been an important source of protein for the Indian population, and the country's vast coastline and abundance of water bodies make it well-suited for fishing and aquaculture. Indian fisheries and aquaculture are important sectors of food production, providing nutritional security, contributing to agricultural exports and providing livelihood opportunity for 2.8 crore fishers and fish farmers at primary level and several more along the value chain. The fisheries sector plays an important role in the Indian economy. It contributes to the national income, exports, food and nutritional security as well as employment generation. India has achieved a record fish production of 175.45 lakh tonnes in FY 2022-23, making it the third-largest fish-producing country in the world with around 8% share in global fish production. This accounts for 8 per cent of global production, contributing about 1.09 per cent to the country’s Gross Value Added (GVA) and over 6.724 per cent to the agricultural GVA. The sector has immense growth potential and requires focused attention through policy and financial support to ensure sustainable, responsible, inclusive and equitable development. India’s seafood exports have more than doubled since 2013-14 and increased to Rs. 63,969.14 crore during FY 2022-23

Aquaculture is the fastest growing industry around the world and Nigeria is no exception. Aquaculture production, especially pond aquaculture, is depends upon sources of obtaining increased fish production in order to supply and feed the ever-increasing population of the world (FAO 2010) . New technological advances and increased demands for fish as a source of animal protein are the main reasons for the industry’s growth. Because of expansion of the industry, the culture methods have become more intensive for producing higher yields (Rico et al., 2012. Recently, the sector attracted great attention and it is growing rapidly through the development of aquaculture (Kubecka et al., 2016). The advent and anticipation of aquaculture is to enhance food production; more income generation and good health for the people. However, like other farming sectors, disease is a substantial source of constraint to aquaculture development and sustainability; from both social and economic points of view . Huge loss of production in

Disease outbreaks have long been recognised as a significant constraint to aquaculture production and economic viability (Sarig 1971 and Bondad-Reantaso et al., 2005) . Studies showed that almost fifty percent of production loss is because of diseases which are more severe in developing countries. This is because ninety percent of the aquaculture firm is in the developing world. The annual loss of revenues because of disease reaches up to 6 billion dollars .Disease is a condition in living organisms in which normal physiological functions are being impaired due to alteration in the body systems and typically manifested by distinguishing signs and symptoms (pathological symptoms). Disease is one of the major constraints to aquaculture and limiting factor for economic and social developments in different countries of the world .Production costs are increased through investment lost in dead cultured animals, cost of treatment, and decreased quality and quantity of yields (Francis 2005(9). Disease is considered one of the important factors to decrease in fish production, both in farming system and in wild condition. Large-scale mortality of fish often occurs in ponds due to environmental stress followed by parasitic invasion and bacterial, fungal, protozoan and monogenean infections.

II. CHALLENGES IN AQUACULTURE

Aquaculture industry plays a vital role in many countries in the world especially developing countries. Fish disease is a substantial source of monetary loss to aqua culturists. Production costs are increased by fish disease outbreaks because of the investment lost in dead fish, cost of treatment, and decreased growth during convalescence. Fish disease impedes both economic and social development in many ways: directly, through production losses and increased operational costs and indirectly, through cost to society (social, welfare and environmental), adjustment in market shares and increase in price due to lower supply. Fish diseases affect fish survival and growth rates resulting to poor yield (both in quality and quantity), the livelihood of people involved in the Aquaculture. The surging demand for fish, coupled with a decline in marine catches, has exerted significant pressure on the aquaculture industry, driving the need for intensified operations. Various organisms suitable for cultivation are reared in different types of culture systems. There are three main types of cultures: open, semi-closed, and closed cultures. Open culture systems include cage culture, pen culture, rack culture and raft culture. Semi closed culture system includes pond and raceway culture and closed culture system include Bio floc system and Recirculating aquaculture system (RAS). Fish are highly susceptible to various pathogens, especially when they are cultivated under controlled culture production and the community in which they occur through reduced food availability, loss of earnings/employments and recreation, apprehension of healthy environment, consumption and handling of sick fish. Invariably, fish culturists and consumers suffer hefty socio-economic losses conditions. Disease outbreaks occur due to inadequate cultural conditions, stress, the suppression of the host's immune system, high stocking densities with improper management, and the virulence of pathogens

Types of diseases in aquaculture Occurrence of diseases in aquaculture is a result of complex interaction of host, pathogen and environment. There are three types of diseases Infectious diseases which include bacterial, viral, fungal and parasitic.

A. *Bacterial Diseases*

Fish diseases caused by bacteria are widespread and present a formidable challenge in terms of health management. These bacteria are generally saprophytic in nature and turning pathogenic only under conditions where the fish's physiological equilibrium is disrupted, nutritional deficiencies occur, or when various stressors like poor water quality and overstocking create opportunities for opportunistic bacterial infections to take hold (Sandeep et al., 2016). Bacterial infections have commonly been observed in fish eggs, fry, and fingerlings, leading to significant mortality rates. These microorganisms primarily act as opportunistic pathogens, invade the tissues of fish hosts that have become vulnerable to infection due to the presence of stress-inducing factors. Several significant bacterial diseases, such as motile aeromonad septicaemia, edwardsiellosis, Pseudomonas septicaemia, flexibacteriosis, Vibriosis, bacterial gill disease, mycobacteriosis, and enteric septicaemia, have been frequently reported in carp culture in India (Mukherjee, 2002; Mohanty and Sahoo, 2007) .

B. *Fungal Diseases*

Only a few numbers of fungal species are recognized as fish pathogens. These organisms are primarily found in water, and they tend to exploit unfavourable circumstances to target fish, resulting in skin lesions. Most fungal infections recorded in carp culture are those caused by species belonging to the oomycete fungi, Saprolegnia, Achlya and Aphanomyces. Diseases caused by these fungi are collectively called “saprolegniasis” (Das and Mishra, 2014) (14). The oomycete fungi, which are frequently found in aquatic environment, are considered as primary pathogens. They are more commonly acknowledged as saprophytic entities, opportunistic secondary pathogens that readily colonise the damaged tissues infected by bacteria or parasites (Mukherjee, 2002). Alongside Saprolegnia, diseases in pond aquaculture can also arise from Branciomyces and Aphanomyces fungi. Another crucial fungal-induced disease with substantial economic implications in fish culture is Epizootic Ulcerative Syndrome (EUS).

C. *Parasitic Diseases*

The productivity of aquaculture systems is hindered by the presence of diverse fish parasites. Among various diseases, parasitic diseases have emerged as a prominent and concerning issue, leading to substantial setbacks for freshwater aquaculture in India (Sahoo et al., 2013) . Fish parasites proliferate swiftly under favourable circumstances, consequently impacting the well-being of fish and frequently resulting in elevated mortality rates. These parasites intrude upon the hosts nutrition, disturb metabolic processes, affect the secretory functions of the alimentary canal, and inflict damage on the nervous system (Sandeep et al., 2016) . Primarily, protozoan ciliates such as Ichthyophthirius sp. and Trichodina sp., along with monogenetic trematodes like Dactylogyrus spp. and Gyrodactylus sp., as well as larger crustacean ectoparasites including Lernae spp., Argulus spp. and Ergasilus, contribute significantly to the economic losses within fish

D. Viral Diseases

Over 125 distinct viruses have been recognized in fish worldwide, and fresh discoveries continue to emerge. However, only a limited number of accounts exist regarding viral diseases impacting finfish in India. Viral diseases such as Cyprinid Herpesvirus-2 (CyHV-2), Koi Rana Virus (KIRV), Carp Edema Virus (CEV), Megalo cytiviris, and Goldfish hematopoietic virus necrosis herpes have been reported in ornamental fish culture (Sahoo et al., 2017) . There are some reports of occurrence of Tilapia Lake Virus (TILV) in some region of India (Suresh et al., 2023)

III. CURRENT SOLUTIONS

A. Antibiotic Administration

Antibiotic treatments have been widely used against bacterial illnesses in aquaculture for several years. The World Health Organization (WHO) has declared that a number of antibiotics used in agriculture and aquaculture, including the antibiotic families tetracyclines, quinolones, and penicillin, are essential for human. Many different bacteria, including those dangerous to humans, have been found to exhibit resistance to all antibiotic classes (Marijani 2022) . Antibiotics in the aquatic environment may cause human pathogens that from the microbiota to develop resistance. The high level of contamination of seawater and freshwater with untreated sewage and agricultural and industrial wastewater containing normal intestinal flora and pathogens of animals and humans typically resistant to antibiotics in many aquaculture settings in developing countries has increased the possibilities of these exchanges. If the usage of antibiotics is inevitable due to rapidly spreading critical illness, it should have effective control and monitoring protocols to minimize the concerns outlined above. Alternative and more sustainable ways can be applied through various farming practices, such as optimizing water quality (*RAS Roundtable: Feeding Strategies to Maintain Optimal Water Quality and Fish Performance*) and reducing stocking densities to reduce stress and disease risk (Mohanty et al. 2018) .

B. Phage Treatment

A bacteriophage is a virus that grows and divides inside a bacterium, destroying it.. It consists of proteins that encase a DNA or RNA genome and replicate inside the bacterium after the genome is injected into the cytoplasm (McGrath et al. 2004) . Seawater is one of the most abundant natural sources of bacteriophages and other viruses (Keen 2012) . Unlike terrestrial animals, pisciculture species and their surrounding environment can be subjected to bacteriophages to simultaneously remove diseases in the organism and its immediate habitat. Phage therapy may be a good substitute for antibiotics in the treatment of fish pathogenic bacteria, but it must be used with knowledge of kinetics phenomena.

C. Vaccine administration

There are several different vaccinations that have previously been created, including bacterin, toxoid, DNA, subunit, live attenuated, whole-cell, and anti -idiotypic vaccines. Currently, killed whole-cell vaccines are the most widely utilized commercially available and approved vaccinations in the aquaculture sector.

D. Biosurfactants

Microorganisms naturally create surface-active chemicals known as microbial surfactants or biosurfactants (BS). They include both hydrophilic and hydrophobic components, such as acids, peptides, mono-, di-, and polysaccharides, and saturated and unsaturated hydrocarbon chains and fatty acids (Rodríguez-López et al. 2019) . The amphipathic character of BS causes them to cluster at surfaces and lower interfacial tension, enhancing the solubility of hydrophobic chemicals in the water. Currently, BS are an essential component in various industrial applications (Giri et al. 2020) . BS have been investigated to strengthen marine fish defence systems against different infections and have been employed as immunostimulants in marine fish production

E. Current antimicrobials and other alternative solutions

With the issues associated with antibiotics as the existing prophylactic or therapeutic agents and vaccines, being available only for a limited number of species of fish, there is an increasing shift towards the use of antimicrobial peptides (AMPs) due to their antimicrobial and immunomodulatory properties.

The mechanism of these antimicrobial peptides depends on several things, including but not limited to the sequence of the amino acids, their charge, amphipathic property, the secondary structure (Kumar et al. 2018) . The mechanism of AMPs from various sources has been extensively studied.

There appear to be two major mechanisms causing the antimicrobial activity—direct killing and immune modulation. The direct killing mechanism of action can be divided further into membrane targeting and non-membrane targeting. The membrane-targeted approach could either be receptor-mediated or non-receptor mediated (Kumar et al. 2018) .Most AMPs derived from vertebrates and invertebrates have non-receptor-mediated mechanisms of action. For the cationic ones, the difference in their charge and that of the negatively charged membrane of Gram-negative bacteria helps initiate the interaction. The mammalian cells do not contain anionic molecules oriented pointing outwards of the cell, making the peptides selective.Other mechanisms that may be involved in inducing antimicrobial activity interfere with metabolic processes—inhibition of cell walls, and proteins, nucleic acid, or enzyme synthesis, consequently making it difficult for the bacteria to develop resistance against them

F. Antimicobial Peptides

Antimicrobial peptides form a part of the innate host defence system in various organisms, including fish. As discussed above, they have a broad-spectrum activity against variety of pathogens, remain potent under various conditions, including extremities of temperature, saliva, marine environments, and possess a low capacity to develop resistance against bacteria (Cole et al. 1997a. This creates a plethora of opportunities to develop naturally produced peptides into therapeutic agents. Thus, a detailed analysis of the structure, function, and activity of various kinds of pathogens is necessary There are five major known classes of peptides—Piscidins, Defensins, Hepcidines, Cathelicidins, and Histone-derived peptides.

G. Synthetic Peptides

several studies have been performed using natural AMPs using their antibacterial, antifungal, and antiparasitic properties , there continue to exist inherent disadvantages associated with natural AMPs such as instability due to presence of proteolytic sites and high manufacturing cost .

Thus, there has been a shift towards designing and manufacturing more stable, shorter peptides with higher efficiency. RY12WY is a novel peptide designed based on a knowledge-based approach and considering the various physiochemical properties. Unlike natural amino acids, it is shorter and contains only hydrophobic, positively charged amino acids. It has shown antimicrobial activity against *S. aureus, A. hydrophila,* and *A. salmonicida,* known antibiotic-resistant fish pathogens. It also showed activity against *E.coli and S.parasitica* .Recently, the 2022 iGEM Team of MIT_MAHE (AMPIFIN | MIT_MAHE-IGEM designed an antimicrobial peptide—AMPifin—against *V. parahaemolyticus.*

H. Probiotics

The idea of using probiotics or other beneficial microorganisms as a disease bio-control strategy in aquaculture is based on their advantageous roles in improving water quality, regulating fish health, altering the microbial community in the aquatic environment and within the GI tract, and promoting non-specific immune response and resistance against pathogens (Li et al. 2019) , which have positive effects on growth performance and nutrient utilisation (Martínez Cruz et al. 2012) .Probiotic, prebiotic, and synbiotic therapeutics' mechanisms for conferring pathogen resistance and enhanced immunity in fish. (Talukder Shefat 2018; Wee et al. 2022).

It has been reported that multi-strain probiotics are more effective than single-strain probiotics at preventing illness and they have been suggested for use in aquaculture. sometimes improve the feed digestibility and total intestinal enzyme activity which enhances the growth performance of the host (Rohani et al. 2022) .

I. Medicinal Plants

Medicinal plants were introduced as a viable and alternative strategy for treating fish sickness due to the negative effects of veterinary pharmaceuticals used in aquaculture, either on fish or the environment and human health. Indeed, due to their abundance of minerals and chemical components, medicinal plants are utilised in aquaculture not only as chemotherapeutics but also as feed additives Medicinal plants can modulate the innate immune system by enhancing the protease inhibitors and lytic enzymes of immune cells and molecules to react against the invading pathogen Traditional medicinal plant items also provide immunomodulation, defence against bacterial infections, and suppression of infections. With the use of *Solanum nigrum*, it was discovered that spotted snakeheads' resistance to *Aeromonas hydrophila* infections was boosted, and their death rate was decreased

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(Rajendiran et al. 2008) . Moreover, extracts of mango, peppermint, turmeric, jasmine, neem, and other plants are among the other effective treatments for bacterial infections in aquatic species brought on by *Aeromonads* and *Vibrios*

J. Essential Oils

Iin recent years, scientists and researchers around the world have been experimenting with their antimicrobial properties. The antibacterial properties of essential oils are now well recognised to be correlated with their chemical makeup, particularly the phenolic components. By interfering with and impairing the phospholipid bilayer of bacterial cell membranes, enzyme systems, and genetic material, essential oils also exhibit an antibacterial effect. These essential oils inhibit the production of toxic bacterial metabolites and sometimes even their growth. This usually occurs due to the interaction between the essential oils and the cytoplasm and/or the bacterial membrane which in turn affects their quorum sensing systems, i.e., bacterial pheromones (Anastasiou et al. 2019) . Essential oils can be obtained from various parts of a plant such as twigs, bark, wood, roots, fruits, flowers, herbs, leaves, buds, and buds. Some examples of essential oils are fennel (*Foeniculum vulgare* Miller), cypress (*Cupressus sempervirens* L.), thyme (*Thymus vulgaris* L.), herb-of-the-cross (*Verbena officinalis* L.) and pine (*Pinus sylvestris*) .

IV. CONCLUSION AND FUTURE PROSPECTS

Disease outbreaks in aquaculture pose tremendous pressure on aqua farmers. It may hamper the growth of aquaculture in India. With the galloping growth of aquaculture, diseases continue to emerge. Therefore, rapid detection and preventive measures are a must. Needless to say, that epidemiological study of risk factors for diseases in aquaculture will go a long way to plan measures for prevention and control of major diseases successfully and in an environmental-friendly manner. Disease reporting and information sharing will aid in minimizing the impact of serious aquatic animal health issues if pragmatic plans are implemented in a coordinated approach with all stakeholders. Apart from this, aqua farmers need to be continuously provided with quality service and sound advice to overcome the disease problems. Effective health management strategies are the need of the hour. Planning, funding, implementing these strategies are arduous and if not done in a meticulous way will remain infeasible. The present aquatic animal disease surveillance programme in our country need to be strengthened and institutes like NFDB, NBFGR, MPEDA, CIBA, CIFA, CIFE and the like need to work out simple, implementable strategies that will address the disease mitigation.

Certain actions need to be taken by the Government of India to further refine the disease surveillance programme in a fool proof manner by identify gaps in the existing disease surveillance programme, sanction proper funds for thorough implementation of disease surveillance, provide necessary infrastructure support to nodal centres liberally, arrange focused and need based training to field level officers, establish more surveillance labs, To analyse the trends in diseases and provide the database to all aqua labs by networking them, review the work done on disease surveillance quarterly in respective states through online and suggest the ways and means for further follow up studies, encourage corporate sector/ Multi-national Companies into the disease surveillance programme as part of Corporate Social Responsibility (CSR), increase the number of surveillance teams depending on the aquaculture area, identify and rope in reliable private labs/ institutes having adequate facilities towards Disease Surveillance Programme, develop Standard Operating Procedures (SOPs) for proper implementation. To properly harmonise testing protocols/ methods, constitute task force team for disease surveillance in respective states by inclusion of stakeholders, develop advisories to all aqua farmers on the disease outbreaks and how to prevent or control them (in vernacular language),organize farmer-scientist meets in all nodal centres and create heightened awareness, strengthen research-extension linkage on disease surveillance and to disseminate the information to the end users.

REFERENCES

[1] FAO, 2010. State of World Aquaculture- Fisheries Department. FAO Fisheries Technical Paper 500,21-26
[2] Rico, K. Satapornvanit, M. M. Haque et al., "Use of chemicals and biological products in Asian aquaculture and their potential environmental risks: A critical review," Reviews in Aquaculture, vol. 4, no. 2, pp. 75–93, 2012.
[3] Kubecka J., Boukal D. S., Cech M. et al., "Ecology and ecological quality of fish in lakes and reservoirs," Fisheries Research, vol.173, pp. 1–3, 2016
[4] Sarig, S. (1971). Diseases of Fishes. Book 3: The Prevention and Treatment of Diseases of Warmwater Fishes under Subtropical Conditions, with Special Emphasis on Intensive Fish Farming. TFH Publications, Inc. Ltd., London
[5] Sandeep P, Chamundeswari Devi B, Kumar KP. Present status of parasitic and bacterial diseases in fresh water fish seed farms in East Godavari District, Andhra Pradesh. International Journal of Applied and Pure Science and Agriculture; c2016. p. 117-121
[6] Mukherjee SC. Fish diseases in India, their causes and control measures-Winter school on recent advances in diagnosis and management of diseases in mariculture, 7th to 27th November 2002, Course Manual.
[7] Mohanty BR, Sahoo PK. Edwardsiellosis in fish: a brief review. Journal of biosciences. 2007 Dec; 32:1331- 1344.

[8] Das BK, Mishra SS. Diseases in Freshwater aquaculture. Training Manual on Model training course on Preventive health management practices in freshwater aquaculture. ICAR-Central Institute of Freshwater aquaculture, Bhubaneswar, Odisha, India; c2014.

[9] Mukherjee SC. Fish diseases in India, their causes and control measures-Winter school on recent advances in diagnosis and management of diseases in mariculture, 7th to 27th November 2002, Course Manual.

[10] Sahoo PK, Mohanty J, Garnayak SK, Mohanty BR, Banya K, Hema P, et al. Estimation of loss due to argulosis in carp culture ponds in India. Indian Journal of Fisheries. 2013;60(2):99-102.

[11] Suresh T, Nithin MS, Kushala KB, Girisha SK, Shivakumar VB, Dheeraj SB, et al. Largescale mortality of Oreochromis mossambicus in lakes and reservoirs of Karnataka due to coinfection of Tilapia Lake virus (TiLV) and multidrug-resistant Aeromonas veronii: An emerging fish disease in India. Aquaculture. 2023 Feb 25; 565:739077.

[12] Marijani E (2022) Prevalence and antimicrobial resistance of bacteria isolated from marine and freshwater fish in Tanzania. Int J Microbiol 2022:1–8. https://doi.org/10.1155/2022/4652326

[13] Mohanty RK, Ambast SK, Panigrahi P, Mandal KG (2018) Water quality suitability and water use indices: useful management tools in coastal aquaculture of Litopenaeus vannamei. Aquaculture 485:210–219. https://doi.org/10.1016/j.aquaculture.2017.11.048

[14] McGrath S, Fitzgerald GF, Van Sinderen D (2004) The impact of bacteriophage genomics. Curr Opin Biotechnol 15(2):94–99. https://doi.org/10.1016/J.COPBIO.2004.01.007 30.Keen EC (2012) Phage therapy: concept to cure. Front Microbiol 3(JUL):238. https://doi.org/10.3389/FMICB.2012.00238/BIBTEX

[15] Rodríguez-López L, Rincón-Fontán M, Vecino X, Cruz JM, Moldes AB (2019) Preservative and irritant capacity of biosurfactants from different sources: a comparative study. J Pharm Sci 108(7):2296–2304. https://doi.org/10.1016/j.xphs.2019.02.010

[16] Giri SS, Kim HJ, Kim SG, Kim SW, Kwon J, Bin LS, Park SC (2020) Immunomodulatory role of microbial surfactants, with special emphasis on Fish. Int J Mol Sci 21:7004. https://doi.org/10.3390/IJMS21197004

[17] Kumar P, Kizhakkedathu JN, Straus SK (2018) Antimicrobial peptides: diversity, mechanism of action and strategies to improve the activity and biocompatibility in vivo. Biomolecules 8(1):4. https://doi.org/10.3390/BIOM8010004

[18] Cole AM, Weis P, Diamond G (1997a) Isolation and characterization of pleurocidin, an antimicrobial peptide in the skin secretions of winter flounder. J Biol Chem 272(18):12008–12013. https://doi.org/10.1074/jbc.272.18.12008

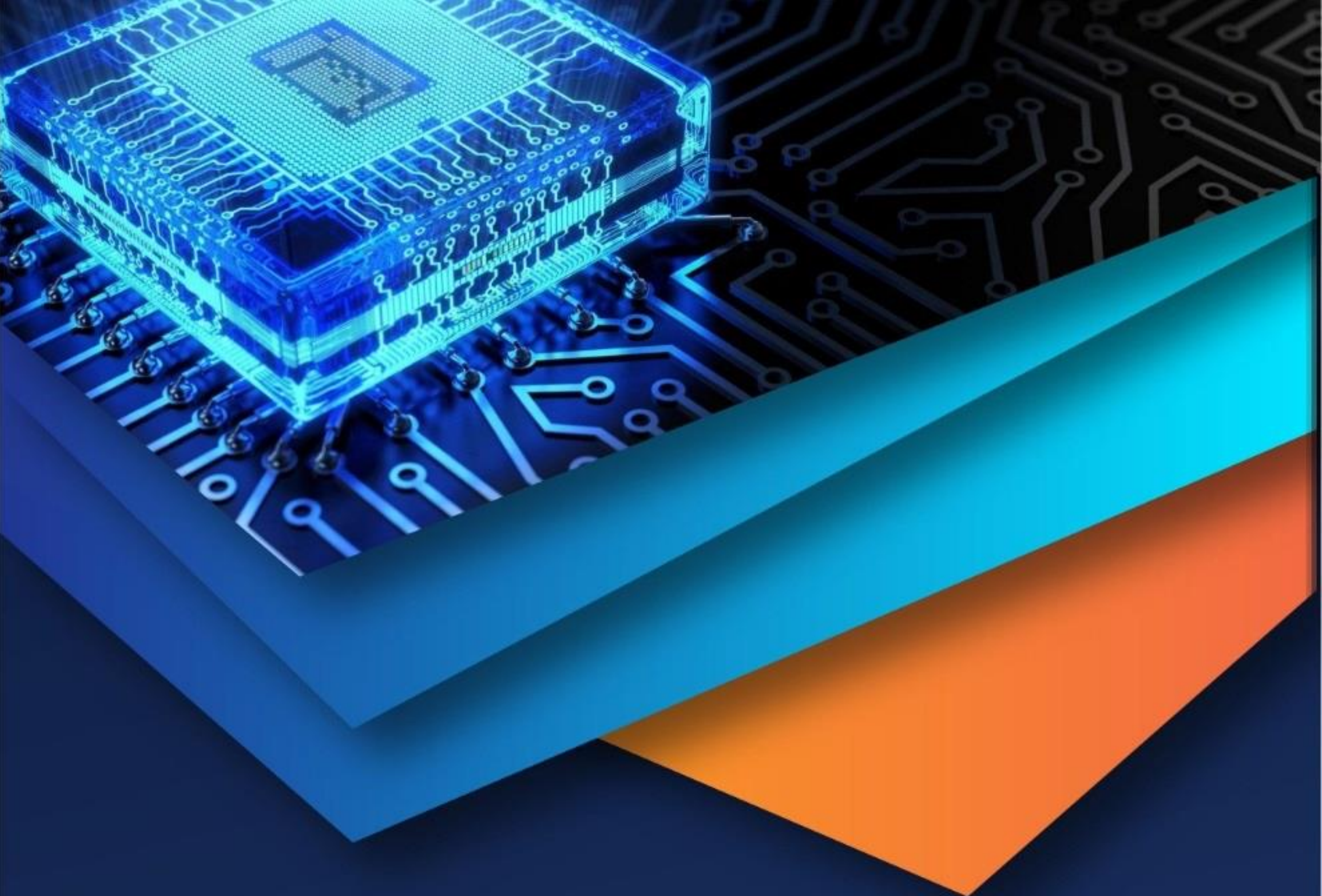
[19] Martínez Cruz P, Ibáñez AL, Monroy Hermosillo OA, Ramírez Saad HC (2012) Use of probiotics in aquaculture. ISRN Microbiol 2012:1–13. https://doi.org/10.5402/2012/916845

[20] Talukder Shefat SH (2018) Probiotic strains used in aquaculture. Int Res J Microbiol. https://doi.org/10.14303/irjm.2018.023

[21] Rohani MF, Islam SM, Hossain MK, Ferdous Z, Siddik MAB, Nuruzzaman M, Padeniya U, Brown C, Shahjahan M (2022) Probiotics, prebiotics and synbiotics improved the functionality of aquafeed: Upgrading growth, reproduction, immunity and disease resistance in fish. Fish Shellfish Immunol 120:569–589. https://doi.org/10.1016/j.fsi.2021.12.037

[22] Rajendiran A, Natarajan E, Subramanian P (2008) Control of aeromonas hydrophila infection in spotted snakehead, Channa punctatus, by Solanum nigrum L., a medicinal plant. J World Aquac Soc 39(3):375–383. https://doi.org/10.1111/j.1749-7345.2008.00163.x

[23] Anastasiou TI, Mandalakis M, Krigas N, Vézignol T, Lazari D, Katharios P, Dailianis T, Antonopoulou E (2019) Comparative evaluation of essential oils from medicinal-aromatic plants of greece: chemical composition, antioxidant capacity and antimicrobial activity against bacterial fish pathogens. Molecules 25(1):148. https://doi.org/10.3390/molecules25010148



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