THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212

Popular Article

December, 2024 Vol.4(12), 5420−5427

Role of Probiotics Application in Aquaculture

Vedant V. Kharabe[1], Ashish R. Urkude[2], Mitanshu Yadav[3]

[1]M.F.Sc. Division of Aquaculture, Sher-E-Kashmir University of Agricultural Science and Technology of Kashmir (SKUAST-K) Faculty of Fisheries, Rangil, Ganderbal, Jammu and Kashmir, India – 190006

[2]M.F.Sc. Division of Aquatic Animal Health Management, Sher-E-Kashmir University of Agricultural Science and Technology of Kashmir (SKUAST-K) Faculty of Fisheries, Rangil, Ganderbal, Jammu and Kashmir, India – 190006

[3]M.F.Sc. Division of Social Sciences, Sher-E-Kashmir University of Agricultural Science and Technology of Kashmir (SKUAST-K) Faculty of Fisheries, Rangil, Ganderbal, Jammu and Kashmir, India – 190006

https://doi.org/10.5281/zenodo.14561435

Abstract

Aquaculture is the world's fastest growing food-producing sector. However, fish culture is currently suffering from the serious losses due to infectious diseases. As a result, probiotic use in aquaculture is rising in response to the need for environmentally friendly, sustainable aquaculture. Probiotic is a healthy substitute that can be utilized to increase aquaculture productivity in a sustainable manner. Their application has various benefits in aquaculture production as improves growth performance, enhance feed utilization, enhance the immune defense against the pathogens, improves disease resistance, improves water quality, enhance stress tolerance capacity. Probiotic use in aquaculture can therefore be utilized at the farm level to improve the species' economic performance.

INTRODUCTION

Nowadays, Aquaculture is the world's fastest-growing food production sector. World aquaculture production reached 130.9 million tonnes in 2022 of these Asia contributing 91.4 %. World aquaculture has grown tremendously during last 20 years from a production about 43.4 million tonnes in 2002 to 130.9 million tonnes by 2022. The demand for the consumption of fish is increasing day by day. So, with increase in intensification and commercialization of aquaculture production come many challenges such as combating diseases, broodstock improvement, development of appropriate feedstuff, hatchery and grow-out technology as well as water quality management. Of these, disease outbreaks are one of the important problems that affect aquaculture

production, suppressing both economic and social development in many countries. According to a number of earlier studies (Kim and Austin, 2006; Mohideen *et al.*, 2010; Wang and Gu, 2010), probiotic supplementation can lower disease outbreaks by strengthening fish and shrimp's immune systems and can also lower culture expenses by promoting fish growth and feed efficiency. Additionally, probiotics can improve animal physiology, which in turn can improve water quality by reducing waste production from fish that have higher feed efficiency. Probiotics have been widely applied in aquaculture to improve water quality, manage disease, boost immune response, and provide nutritional and enzymatic support for the host's digestion. Additionally, probiotics are thought to be an environmentally friendly form of treatment. The probiotics may be added to feed as live microorganisms to create a balanced indigenous micro floral community in the gastrointestinal tract (Rengpipat, 2005).

Moreover, probiotics are being considered for use as therapeutic agents and some farmers are already using them superiorly over antibiotics. Probiotics are increasingly being considered as an antibiotic substitute due to their ability to inhibit infections via multiple pathways (Verschuere *et al*., 2000). Due to the many threats related to the use of antibiotics in aquaculture, an alternative approach to manage fish health in the aquaculture industry is the use of probiotics, a microbial intervention method, which has been shown to enhance fish development and health in many cases. Probiotics are among the various non-antibiotic agents that aqua culturists have discovered, and they are important for maintaining health in the context of intensive aquaculture.

PROBIOTICS

"A live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance" is the definition of probiotics according to Fuller (1989). A probiotic, according to some definitions used in aquaculture, is a live microbial dietary supplement that gives the host health advantages or disease resistance (Lara-Flores and Aguirre-Guzman, 2009). Aquatic probiotics are a relatively recent notion.

Probiotics are defined by the Food and Agriculture Organization of the United Nations/World Health Organization (FAO/WHO) as live microorganisms that, when given in the right doses, benefit the host's health.

SELECTION OF PROBIOTICS

The proper selection of probiotics is very important because inappropriate strains can lead to undesirable effects in the host. bsMaking sure probiotics are safe and provide the desired effects is the main goal when choosing them. Furthermore, before they are delivered to the customer, they must maintain their quality throughout the manufacturing, distribution, and storage processes (Shewale e*t al*., 2014).

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 25/12/2024

Characteristics of good probiotics (Fuller, 1989):

1) It should be non- pathogenic and non-toxic.
2) Effectiveness in application.
3) It must exist as live cells, ideally in a significant quantity.
4) It should be resistant to low pH and organic acids, as well as able to survive and metabolize in the gut environment.
5) It needs to be stable and able to endure prolonged durations of viability in both field and storage settings.

METHODS OF APPLICATION

In aquaculture, probiotics can be given by a variety of methods, including feeding, injecting, or submerging directly in the water. The most commonly used methods for administrating probiotic mixture is incorporation into the feed (92.8%), followed by direct incorporation into the water (4.8%) and in live food (1.6%) (Melo *et al*., 2020). Some beneficial bacterial, fungal strains can be mixed with feeding pellets or by encapsulating into live feed stock or administered orally to feed for rearing animals.

1. ORAL METHOD BY SUPPLEMENTING FEED WITH PROBIOTICS

Probiotic feed supplementation is a popular practice in aquaculture. The goal of this approach is to deliver live probiotic cells into the gut of the host animal in order to build a balanced gastrointestinal microbial flora, enhance immune system responses, and improve digestive performance. Bacterial species like *Lactobacillus spp., Enterococcus faecium, Bifidobacterium thermophilum, Streptomyces spp., Micrococcus spp.,* and *Pseudomonas fluorescens*, as well as yeasts like *Saccharomyces cerevisiae*, herbs, and extracted substrates like azadirachtin, are some examples of probiotics that have been added to animal feed.

2. DIRECT INCORPORATION IN WATER

Direct application of probiotics into the culture ponds to improve water quality and the survival of cultured animals. The effectiveness of probiotics application by this method can be explained by bioaugmentation or biocontrol mechanisms by which the microbial ecology of the water and sediment is improved.

3. INJECTION METHOD

In addition, fish immune responses against bacterial infections have been boosted by injecting probiotic supplements into aquatic animals. Probiotic injection into cultured fish is a challenging procedure, particularly when dealing with small animals or a high number of fish. The right dosage needs to be given in order for the probiotic to work as effectively as possible for that

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 25/12/2024

specific species. The type of probiotic, the physiological state of the fish, the rearing environment, and the intended use of the probiotic all influence the right amount of probiotics.

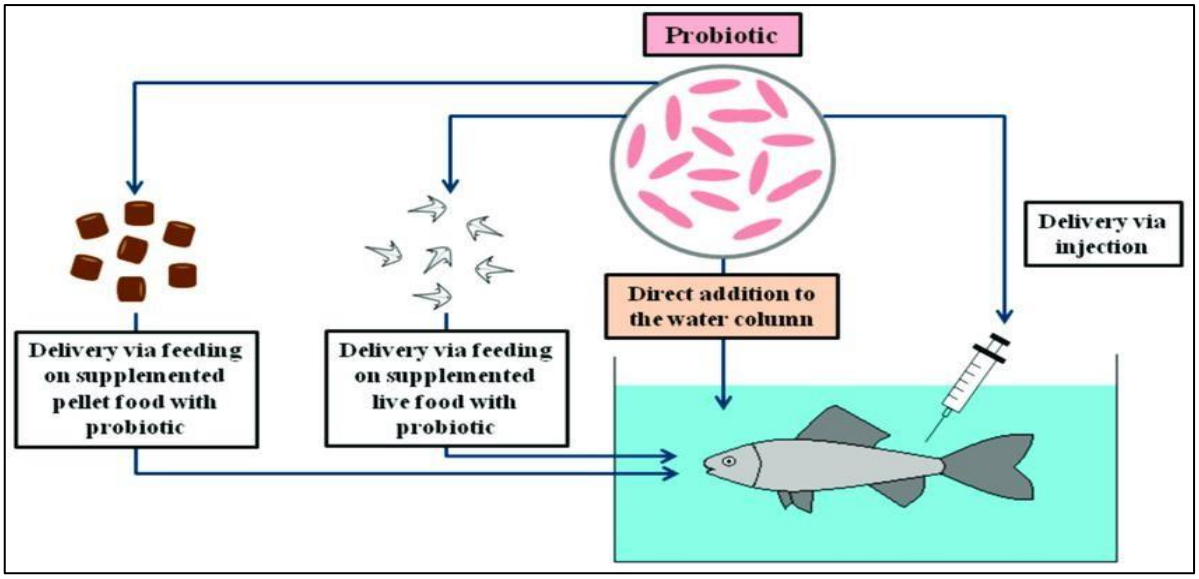

Fig.1: Different routes for administration of probiotic *(Source: Jahangiri and Esteban, 2018)*

MECHANISM OF ACTION

Probiotics have only recently been used in aquaculture, which is a novel idea in comparison to its usage in mammals and other terrestrial livestock including cattle, pigs, and poultry. Probiotics have been shown in numerous studies to improve feed efficiency, regulate microbiota, and confer resistance to diseases through a variety of mechanisms, such as: (1) competitive exclusion of pathogenic bacteria through habitat competition, nutrient competition, and alteration of pathogen enzymatic activities; (2) enzymatic contribution to improve feed digestibility and feed utilization; (3)Direct absorption of dissolved organic material by microorganisms; (4)Strengthening the immune system's defenses against infectious agents; (5) Antiviral properties.

BENEFITS OF PROBIOTICS IN AQUACULTURE:

Probiotics application in aquaculture has various benefits including:

1.GROWTH AND DIGESTIVE PROCESS PROMOTER

Probiotics are now frequently added to fish meals on aquaculture farms as a result. By increasing the quantity and generation of microbial enzymes, the majority of probiotics colonize the host and influence the digestive processes. This improves the intestinal microbial balance, which in turn improves feed utilization and digestibility. According to Sakata (1990), the microbiota can provide additional nutrition and microbial activity in the digestive tract. It can also provide fatty acids, vitamins, and essential amino acids (Balcazar *et al*., 2006). Different probiotics have different functions in promoting growth and nutrient utilization in different fish species

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 25/12/2024

(Mohapatra *et al*., 2012). Thus, the effectiveness of probiotics in the culturing of aquatic animals depends on factors such as body temperature, enzyme level, and genetic resistance of the host, and water quality.

2. ENHANCE IMMUNE SYSTEM

In the aquaculture, the use of beneficial bacteria to drive out infections through competition is a more effective approach than using antibiotics, and it is also becoming more widely accepted for the management of pathogens in aquaculture. Shrimps, fish, and other invertebrates have less developed immune systems as larvae than they are in adult stage. As such, the resistance of larvae to infection usually depends more on nonspecific immune responses. The non-specific immune responses of the species can be stimulated by the supplementation of probiotics to the diet or to the culture water. Nevertheless, the efficiency of different probiotics against pathogens differs depending on the defense mechanism of the fish species to different pathogens and the pathogenic mechanisms of the pathogen.

3.WATER QUALITY IMPROVEMENT

The sensitivity of aquaculture aquatic species to elevated levels of nitrogenous compounds, like ammonia, nitrite, and nitrate, varies depending on the species, elevated concentrations of these compounds have an impact on the animals and probably result in significant animal death. Gram-positive *Bacillus* species are often more effective in converting organic matter back to CO2 than are gram-negative bacterium species, leading to a higher percentage of organic carbon being converted to bacterial biomass.

Other beneficial bacterial species in the genera *Nitrobacter*, *Pseudomonas*, *Enterobacter*, *Cellulomonas* and *Rhodopseudomonas*, and probiotics derived from plant sources, including yucca extract, tannic acid and citrus seed extract also been used in culture systems to improve the water quality. Improved algal growth, increased availability of dissolved oxygen, suppressed cyanobacteria blooms, controlled ammonia, nitrite, and hydrogen sulfide concentrations, decreased disease incidence, increased survival, and improved production are requirements for the use of candidate probiotics in aquaculture ponds.

4. INCREASE DISEASE RESISTANCE

Probiotic microbes can increase a host's resistance to disease by releasing chemicals that have bactericidal or bacteriostatic effects on pathogenic bacteria living in the intestines of the host, such as Bacitracin and polymyxin, which are generated by *Bacillus sp.* and supplementation of probiotic *Enterobacter sp.* boost rainbow trout's (*Oncorhynchus mykiss*) disease resistance against *Flavobacterium psychrophilum* (Laptra *et al*., 2014). The disease resistance of Common carp

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 25/12/2024

against *Aeromonas hydrophila* was increased by two isolated intestinal autochthonous probiotic bacteria, *Aeromonas veronii* and *Flavobacterium sasangense.*

Pediococcus pentosaceus has demonstrated remarkable antibacterial action against various significant fish diseases, such as *Plesiomonas shigelloide, Aeromonas hydrophila, Aeromonas veroni, Aeromonas sobria, Eelwardsiella tarda,* and *Lactococcus garviae.*

5. STRESS TOLERANCE

The stress tolerance of aquaculture species is greatly enhanced by probiotic supplementation. *Aspergillus oryzae* probiotics dramatically strengthen nile tilapia's resistance to hypoxic stress (Dawood *et al*., 2019). Due to the fact that cortisol is a stress hormone, fish fed probiotics *Lactobacillus plantarum* showed a reduced increase in cortisol concentration as compared to those fed a control diet when it came to stress tolerance to ammonia.

CONCLUSION

Aquaculture has become the fastest-growing business because it provides high-quality animal protein that contributes to food security and nutrition. Many obstacles, such as an increase in disease, extreme stress levels, a lack of fish meal for protein sources, etc., are limiting this increasingly intense aquaculture production. These issues are typically resolved by utilizing chemical disinfectants and antibiotics, which have caused concerns about the safety of food for aquatic animals and humans as a result of their aftereffects and ultimately contaminated the environment. When considered as a feasible substitute for sustainable aquaculture, probiotics herald a new era in contemporary aquaculture. In order to create the ideal environment for aquaculture species to grow and, consequently, improve their health, probiotics can be employed. The most crucial step before applying probiotics is choosing the right strain to increase their efficacy. Although application as water additives is the most practically relevant way, supplementing as feed additives is the most often employed route of probiotic delivery in aquaculture. Due to the fish's undeveloped digestive tracts during the early stages of development, administration by feeding presents challenges, and injection causes significant stress in the fish larvae. Therefore, it is realistically appropriate at all phases to administer probiotics straight to the raising water. We know that 60–80% of operating expenses in intensive aquaculture operations are related to feeding along. Probiotic use improves feed consumption and growth performance, which in turn lowers feeding costs. Applying probiotics can improve aquaculture's health. From this we can conclude that probiotics can be used in the aquaculture widely to enhance the aquaculture production in sustainable way.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 25/12/2024

REFERENCES

Aquaculture/FAO/ Food and Agriculture Organization of the United Nations, 2022. http://www.fao.org/aquaculture/en/

Balcazar, Jose & de Blas, Ignacio & Ruiz-Zarzuela, Imanol & Vendrell, Daniel & Gironés, Olivia & Muzquiz, José. (2007). Enhancement of the immune response and protection induced by probiotic lactic acid bacteria against furunculosis in rainbow trout *Oncorhynchus mykiss*.

Balcazar, J.L., I. de Blas, I. Ruiz-Zarzuela, D. Cunningham, D. Vendrell and J.L. Muzquiz, 2006. The role of probiotics in aquaculture. Review. *Veterinary Microbiology*, 114:173-186.

Bandyopadhyay P, Das Mohapatra PK. Effect of a probiotic bacterium Bacillus circulans PB7 in the formulated diets: on growth, nutritional quality and immunity of *Catla catla* (Ham.). *Fish Physiol Biochem*. 2009;35(3):467-478. doi:10.1007/s10695-008-9272-8

mohapatraDawood, Mahmoud & Magouz, Fawzy & Salem, Mahmoud & Abdel-Daim, Hanaa. (2019). Modulation of digestive enzyme activity, blood health, oxidative responses and growth-related gene expression in GIFT by heat-killed Lactobacillus plantarum (L-137). Aquaculture. 505. 10.1016/j.aquaculture.2019.02.053.

F.J. Gatesoupe, "The use of probiotics in aquaculture," *Aquaculture*, vol. 180, no. 1-2, pp. 147–165, 1999.

FAO. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome.

Fuller R (1989) A review: probiotics in man and animals. Journal of Applied Bacteriology 66: 365–378.

Hai, N. (2015), The use of probiotics in aquaculture. J Appl Microbiol, 119: 917-935. doi:10.1111/jam.12886 .

Jahangiri, Ladan & Esteban, Maria. (2018). Administration of Probiotics in the Water in Finfish Aquaculture Systems: A Review

Jha, Dilip & Bhujel, Ram & Anal, Anil. (2014). Dietary supplementation of probiotics improves survival and growth of Rohu (*Labeo rohita* Ham.) hatchlings and fry in outdoor tanks. Aquaculture. 435.10.1016/j.aquaculture.2014.10.026.

Kim, D.H. and B. Austin, 2006. Innate immune responses in rainbow trout (*Oncorhynchus mykiss*, Walbaum) induced by probiotics. *Fish & Shellfish Immunology*, 21:513-524.

LaPatra, Scott & Fehringer, Tyson & Cain, Kenneth. (2014). A probiotic *Enterobacter sp.* provides significant protection against *Flavobacterium psychrophilum* in rainbow trout (*Oncorhynchus mykiss*) after injection by two different routes. Aquaculture. 433. 361–366. 10.1016/j.aquaculture.2014.06.022.

Lara-Flores, M. and G. Aguirre-Guzman, 2009. The use of probiotic in fish and shrimp aquaculture. A review. *In:* N.P. Guerra and L.P. Castro (Eds.) Probiotics: Production, evaluation and uses in animal feed. Research Signpost 37/661 (2), Fort P.O., Trivandrum-695 023, Kerala, India.

Lara-Flores, M., 2011. The use of probiotic in aquaculture: an overview. *Int. Res. J. Microbiol.*, 2(12):471-478.

Lilly DM, Stillwell RH.,1965. Probiotics: Growth Promoting Factors produced by microorganisms. Science, 147(3659): 747-748.

Merrifield, D.L., A. Dimitroglou, G. Bradley, R.T.M. Baker and S.J. Davies, 2010a. Probiotic applications for rainbow trout (*Oncorhynchus mykiss* Walbaum) I. Effects on growth performance, feed utilization, intestinal microbiota and related health criteria. *Aquaculture Nutrition Journal* , 16:504-510.

Michael ET, Amos SO, Hussaini LT (2014) A Review on Probiotics Application in Aquaculture. Fish Aquac J 5: 111.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 25/12/2024

Mohapatra, S., T. Chakraborty, A.K. Prusty, P. Das, K. Paniprasad and K.N. Mohanta, 2012. Use of probiotics in the diet of rohu, *Labeo rohita* fingerlings: effects on growth nutrient digestibility, retention digestive enzyme activities and intestinal microflra. *Aquaculture Nutrition*, 18:1-11.

Mohideen, M.M., A. Kader, T.S. Mohan, S.P. Mohamed and M.I.Z. Hussain, 2010. Effect of Probiotic Bacteria on the Growth rate of Fresh Water Fish, *Catla catla*. *International Journal of Biological Technology*, 1(2):113-117.

Rengpipat, S., S. Rukpratanporn, S. Piyatiratitivorakul and P. Menasaveta, 2000. Immunity enhancement in black tiger shrimp (*Penaeus monodon*) by a probiont bacterium (*Bacillus* S11). *Aquaculture*, 191:271-288.

Sakai, M., T. Yoshida, S. Atsuta and M. Kobayashi, 1995. Enhancement of resistance to vibriosis in rainbow trout, *Oncorhynchus mykiss* (Walbaum), by oral administration of *Clostridium butyricum* bacterin. *Journal of Fish Diseases*, 18:187-190.

Shewale, R.N. & Sawale, Pravin & Khedkar, Chandraprakash & Singh, Ajay. (2014). Selection criteria for probiotics: A review. International Journal of Probiotics and Prebiotics. 9. 17-22.

Subasinghe, Rohana P., et al. "Recent technological innovations in aquaculture." *FAO Fisheries Circular* 886 (2003): 85.

Verschuere, L., G. Rombaut, P. Sorgeloos and W. Verstraete, 2000. Probiotic bacteria as biological control agents in aquaculture. *Microbiology and Molecular Biology Reviews*, 64(4):655-671.

Wang, Y.B. and Q. Gu, 2010. Effect of probiotics on white shrimp (*Penaeus vannamei)* growth performance and immune response. *Marine Biology Research*, 6:327-332.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 25/12/2024