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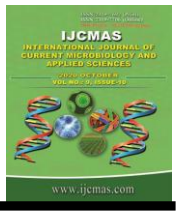

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Role of Probiotics in Aquaculture

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A B S T R A C T

Aquaculture plays a vital role in providing sustainable livelihood and food security for the ever increasing population. Accordingly there is expansion, intensification and diversification of aquaculture practices to obtain enhanced production. This has resulted in increased environmental and aquatic animal stress, finally to disease out bursts, reduction in production and threat to sustainability of aquaculture. To control the diseases, an excess of chemical compounds and antibiotics has been applied indiscriminately. The application of these compounds caused many complications and their danger could affect human's health indirectly. This has led to the development of natural microbiological / acceptable substitutes and growth promoters which are very important and urgent for healthier aquatic animals and sustainability of aqua production and productivity.

Introduction

Aquaculture is emerging as one of the fastest growing and most promising industry for providing animal protein and food security to the growing population. Due to its lucarativeness it is surpassing the agriculture sector also. The expansion of culture area and intensification of culture practices are leading to high stocking densities. The intensification of aquaculture practices has given rise to stressful conditions for both the aquatic animals and the environment (Dawood *et al.*, 2016 a, b, Hossain *et al.*, 2016). As a result, disease outbreaks are being progressively documented as one the most important threats to the aquaculture industry. The diseases and deterioration of environmental conditions often occur and result in serious situation.

During the last decades, antibiotics used as traditional strategy for fish diseases management and also for the improvement of growth and efficiency of feed conversion. An alternative approach to manage fish and shrimp health, that is fast gaining attention in aquaculture industry is, "probiotics", a microbial intervention approach for disease

prevention and control, high survival and growth by enhancing the feed conversion efficiency.

Probiotics introduced for aquaculture have several forms including bacterial cells. Commonly used probiotic micro-organisms are *Bacillus* sps: *Lactobacilus* sp, *Enterococcus* sp, *Carnobacterium* sps, and the yeast, *Saccharomyces cerevisiae*, etc. Application of antimicrobial agents in aquaculture practices can be reduced by encouraging the usage of immune–stimulants, non-specific immune enhancers, probiotics and vaccines. Further, these are considered as major thrust areas of potential research for disease control in aquaculture.

Generally, probiotics refers bacteria belonging to gram positive especially *Lactobacillus* sps, *Bifidobacterium* sps and *Streptococcus*, *Bacillus* sps, *Lactococcus* sps., *Micrococcus* sps., *Carnobacterium* sps., *Enterococcus* sps., *Lactobacillus* sps., *Streptococcus* sps. and *Weissella* sps. Microalgae (Tetraselmis) and Yeasts (Debaryomyces), Phaffia and Saccharomyces (Gatesoupe, 1999). There are many types of probiotics. There include lactobacilli, bifidobacteria and some yeast. Different probiotics have diverse effects. The present paper summarizes the current knowledge of the use of probiotics in aquaculture.

Definition of probiotics

The world "probiotics was coined by Parker (1974), and defined as "Organisms and substances that give to intestinal microbial balance. Fuller (1989) revised the definition as "live microbial feed supplement which beneficially affects host animal by improving its intestinal microbial balance". Probiotics are often termed as "friendly", "beneficial", "good" or "helpful" bacteria, because they help keep the gut healthy. More recently, the probiotics are defined as "live microorganisms" that when administered in adequate amounts confer a health benefit on the host (FAO / WHO, 2001).

Types of probiotics

They are three types of probiotics, as mentioned below:

Water probiotics: these are marked in 2 forms i) dry forms ii) liquid forms. Liquid forms give positive results in lesser time, when compared to the dry and spore form bacteria, through they are lower in density (Nageswara and Babu 2006). These play major role in improving the water quality of culture pond.

Soil probiotics: Bacteria like Nitrobacter, Nitrosomonas and sulphur reducing bacteria clean the bottom of aqua ponds.

Feed / gut probiotics: Lactic acid bacteria.

Probiotics act as a microbial dietary medicine that benefits the host health condition by reducing mucosal and systemic immunity and improving the physiological and nutritional actions. These enhance the fish and shrimp feed efficiency by stimulating digestive enzyme and maintain the balance of intestinal microbes, resulting in improved nutrient absorption, utilization and ultimately the survival, growth of fish and shrimp.

Role of probiotics

The three types of probiotic bacteria can be directly applied to soil, water of the farming pond and also as an additive to feed. Various commercial probiotics are available in the market in different combinations and bacterial counts. Reports inform that use of probiotic bacteria reduces mortality rate. However, the quantity of cells present in the probiotic,

given with feed plays a major role in the survival of animals. The bacterial count of 10^9 g-l is ideal than 10^{12} g-l and it indicates that the increasing of bacterial count does not offer protection to the animals. Mixed culture of probiotic bacteria yields better result by enhancing lysozyme activity, migration of neutrophils, and plasma bactericidal activity, than probiotic with single species. Now a days, probiotics like yucca, gluceans etc are also included in the probiotic preparation which are non digestible ingredients and help in stimulating the growth of probiotic bacteria especially in colon region of fish. Probiotic bacteria are isolated from the pond, sediment, soil, water and animal. The potential effect of probiotic relies on the source from which the bacteria are isolated and the way of application. So, it cannot be considered that all the commercial probiotics available in the market are potential one and they many vary based on the source and type.

The effect of probiotic is arbitrated by various factors like mainly the type of probiotic, the dosage, method of application, duration of application, frequency of application. Probiotic delivers its effect by secreting antibacterial substance like bacteriocin and other peptides such as difensins, chemokines etc. which inhibit microbes and fight against the diseases. In some other cases probiotic is arresting bacterial movement bacteria crossing the GIT wall and improving the mucosal secretion by producing immune molecules. The commercial probiotics available in market are either in liquid or powder form. Instead of applying these products directly in the pond water or soil, it may be allowed for further fermentation mixing with jaggery for a period of 4-6 hrs which would improve the viability and functionality of microbes for better performances. The probiotics are also prepared in encapsulated form through various processes like emulsification, extrusion, spray drying and adhesion to starch etc. This encapsulation aids to preclude the damage of probiotic bacteria from low pH and other digestive enzymes of GIT. If the probiotic bacteria survive well in the intestine, then the performance of bacteria will be effective against the infectious. The viability of probiotic depends on the method of production, storage temperature, survival and stability in the intestinal tract (Fig. 1–3).

Fig.1 Probiotics

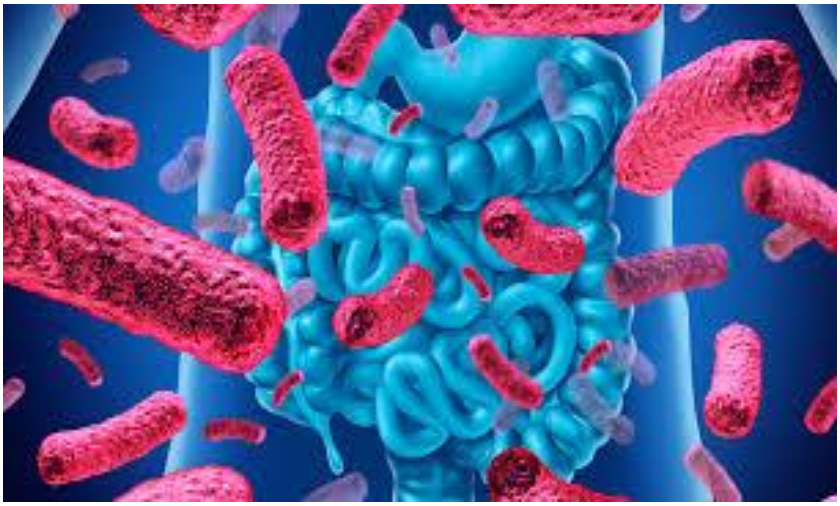

Fig.2 Fish harvest

Fig.3 Vannaemi harvest

Use of probiotics for sustainable aquaculture

Now a days there is rising interest in the use of beneficial bacteria, probiotics, as an alternative approach to antimicrobial compounds for disease prevention and control. These naturally occurring bacteria utilize their beneficial effects on the host by revising the microbial community associated with host, by guaranteeing improved use of the feed or enhancing its nutritional value, or by enhancing the host response towards diseases. The probiotic increase the growth and survival of fish and shrimp by modifying the host – associated or ambient microbial community.

Role of probiotic in improvement of feed utilization

The probiotic used in aquaculture is a live microbial addition, supplied through feed which yields beneficial effect by modifying the gut microflora by enhancing feed absorption, nutrition and immunity against the pathogenic bacteria in the gut. The probiotic bacteria normally produce anti – microbial

agents like bacteriocins and organic acids which complete with pathogens and cease the adhesion of pathogens in the Gastro Intestinal Tract (GIT) of aquatic animals. Hence, the probiotics bacteria is called as friendly or health bacteria. GIT harbours various potentially pathogenic bacteria like *Escherichia coli, Listeria* and *Salmonella* along with other probiotic bacteria. The other probiotic bacteria which are commonly found in GIT are gram positive *Bacillus, Canbobacterium, Enterococcus, Lactobacillus* and gram negative facultative anaerobic such as vibrio and pseudomonas and yeasts, fungi and algae.

Further, the addition of probiotics was examined in phytoplankton, which forms the basis of aquatic food chains because of their nutrient – producing photosynthetic mechanisms (Bonnet *et al.,* 2010; Paiva Maia et al, 2013). Studies on diets containing probiotics revealed the possible involvement of these probiotics on the improvement of intestinal microflora balance and the production of extracellular enzymes to elevate the feed efficiency and growth of cultured species as growth promoters (Kar and Ghoh 2008). A deep rooted intestinal microflora is crucial for the growth and health of the fish and shrimp, since the microflora has effects on nutrition, the avoidance of pathogenic infections, the integrity and function of digestive organs and the development of the immune system.

Probiotic bacteria are capable of synthesizing the enzymes like analyses, lipases and preleased and vitamins, fatty acids and amino acids which facilitate nutrition absorption in the aquatic animals. Similarly feed given to fish supplemented with yeast, *Saccharomyces curevisiae* enhances their growth and produces the anti oxidative enzymes like catalyse, glutathione, peroxidase etc. In vannamei, the inclusion of Bacillus with its feed, augments the digestibility of dry matter, protein and fat.

Feed supplemented with probiotics are digested and absorbed more efficiently due to the aptitude of probiotics to produce the digestive enzymes like amylases, proteases and lipases etc. and provide nutrients like vitamins, fatty acid and amino acids. The supplementation of these play vital role on the digestive process, feed utilization and as well as assimilation of the diet components. This results in good health and better growth performance of fish and shrimp.

Role of probiotics in improving water quality

Water quality can be maintained in the culture ponds by addition of gram positive bacillus strains than gram negative as they convert organic matter into carbondioxide efficiently. Hence, it is essential to maintain higher level of gram positive probiotic bacteria in the production ponds by repeated addition which reduces the accumulation of dissolved and particulate organic carbon in the ecosystem. Further they improve the primary productivity of the ponds. Other bacterial like *Nitrobacter, Pseudomonas, Enterobacter, Cellulomonas* and *Rhodopseudomonas* are effective in maintaining the water quality especially for removal of organic wastes in the pond bottom. In fish ponds, ammonia production and nitrite toxicity are major problem which is highly toxic and it can be removed by application of above probiotic bacteria thorough nitrification process. Many of probiotic bacteria serve as algaicide which inhibits the growth of certain unicellular algae like *Pavlova lutheri*. The relationship between the algae and the probiotic should also be considered during selection of any probiotic. High stocking densities and intensive culture practices cause stress in the fish and shrimp which is indicated by presence of hormone

cortisol and glucose levels of lactate and plasma in the tissues of the animals. It leads to poor synthesis of body muscle protein and thereby poor growth. It can be eliminated by application of probiotic bacteria. Probiotics trigger the gonadal somatic index in many fishes. Application of probiotics in the larval rearing tanks of shrimp encourages good survival of past larvae and shorter development period. The live feed like rotifer act as vector for bacterial infection which can be controlled by application of microbial culture. In the shrimp hatchery, the survival and growth rate of live feed, *Artemia nauplii* depends on inclusion of microbial complex (probiotics bacteria). The application of probiotics in aquaculture exhibit promising enhancement in aqua production.

In conclusion the aquaculture sector occupies very important role in the socio-economic development of the country besides providing proteinacens food globally. Intensification has come up as a boon to meet the increasing food demand of the growing population. The aquatic animal (fish and shrimp) health is regulated by application of several antibiotics, pesticides and disinfectants indiscriminately for control of diseases. This application caused the evolution and spread of drug resistant strains of pathogenic bacteria which result negative impact on the environment and risk for aquatic animal health. The approach of bioremediation in improving the water quality of the culture pond, involves manipulation of microorganisms in ponds to enhance mineralization of organic matter and get rid off undesirable waste compounds. The application of probiotics in culture ponds benefitted the improvement of intestinal microbial balance, enhancement of the disease resistance by suppressing the pathogens and also the enhancement in the immunity or improvement of water quality by the decomposition of organic matter, reduction in nitrogen and phosphorus concentrations for controlling of ammonia, nitrite and hydrogen sulphide level, production of inhibitory compounds (Biomui, 2009) and enhancement of immune response against pathogenic bacteria. The other benefits include improvement of feed conversion ratio (FCR), specific growth rate and protein efficiency ratio (Marrifield *et al.*, 2010). Lower incidence of disease, greater survival and increase in both shrimp and fish production were observed in the ponds (Boyd and Massaaut, 1999; Verschurera *et al.*, 2000). In recent years, this biological control of disease affecting aqua sps. especially bacteriological disorders including environmentally friendly methods has developed and got rich importance in reducing the stress and diseases, healthy gut environment, health of aquatic animals, improved water quality parameters and in achieving higher survival, growth production, productivity. Use of probiotics for the bacterial infection is well reported whereas for viral infection is under research. Application of probiotics from the beginning of the culture to the end yields good production than during the disease outbreak. As probiotics play a key role in aquaculture, there application in the pond soil, water and as feed supplement is strongly recommended. Nevertheless, the success of probiotics supplementation depends on strains, concentrations, management followed and time of application.

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