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Review Article



Probiotics in Aquaculture

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Abstract

The probiotics can be applied through external bathing or dietary supplementation. In aquaculture, the usage of probiotics is mainly confined to hatcheries of shrimps, bivalves and fishes. However, scientific studies are scanty on the use of probiotics in grow out systems of fish/shrimps and even its benefits are debated. Use of various brands of commercial probiotics has become a regular farming practice in shrimp culture in India. A strain of *Vibrio alginolyticus* is used for larval rearing of *Penaeid* prawn. *Lactobacillus spp.* against pathogenic *vibrios* and white spot disease was reported in *Penaeid* prawn. Use of probiotics in aquaculture has been increasing rapidly due to its environment friendly nature contrary to the traditional use of probiotics as feed additives. It is used in aquaculture and production systems to modify the microbial population of the environment ultimately leading to better growth and survival of the targeted species.

Keywords: probiotics, Aquaculture, Use of probiotics.

Introduction

Aquaculture is one of the fastest growing food producing sectors in the world at an average rate of 8.9% per year since 1970, compared with only 1.2% for capture fisheries and 2.8% for terrestrial farmed meat production systems over the same period (Subasinghe, 2005). It has emerged as an industry to supply protein rich food throughout the world. Disease outbreaks are a significant constraint on aquaculture. The use of disinfectants and antimicrobials have had limited success. Use of antibiotics encourages the emergence of bacterial resistance. Intensive rearing of marine fish larvae suffers from heavy mortalities which may be attributed to bacteria introduced in the rearing system with live food. The search for safe and permanent solution has led aqua scientists to the use of beneficial microorganisms or 'Probiotics' for environmental cleanup and maintenance of water quality. Probiotics considered to be one of the most significant technologies to have evolved in response to disease control. In the last decade, the scientific

community carefully examined roles and effects of probiotics in aquaculture as an alternative to antimicrobial drugs. The probiotics can be applied through external bathing or dietary supplementation. In aquaculture, the usage of probiotics is mainly confined to hatcheries of shrimps, bivalves and fishes. However, scientific studies are scanty on the use of probiotics in grow out systems of fish/shrimps and even its benefits are debated. Use of various brands of commercial probiotics has become a regular farming practice in shrimp culture in India.

What are probiotics?

The word probiotic is constructed from the Latin word pro (for) and the Greek word bios (life). "Probiotic is a live microbial feed supplement which beneficially affects the host animal by improving microbial balance". In aquaculture, probiotics can be defined as 'microbial cells that are administered in such a way as

to enter the gastrointestinal tract and to be kept alive, with the aim of improving health'. Most studies on the effects of probiotics on cultured aquatic animals have emphasized a reduction in mortality or the improved resistance against putative pathogens. FAO has now designated the use of probiotics as a major means for the improvement of aquatic environmental quality. Main probiotics are the bacteria belonging to the genera *Lactobacillus*, *Enterococcus*, *Pediococcus*, *Bacillus*, microscopic fungi and *Saccharomyces* yeast.

Probiotics in live feed and Aquaculture

Probiotics enriched live feed culture of rotifer, *Artemia* and copepods used as feed for larval fish in many hatcheries. A strain of *Vibrio alginolyticus* is used for larval rearing of *Penaeid* prawn. *Lactobacillus* spp. against pathogenic vibrios and white spot disease was reported in *Penaeid* prawn. Probiotic bacteria are being used in molluscan hatcheries also for competitive exclusion of pathogens and as food supplement. Recently, the use of probiotics to improve and maintain healthy environment for prawn culture has become popular. Probiotics was used to supply beneficial bacterial strains to rearing water that will help to increase microbial species composition in the environment and to improve water quality. It is considered to be able to make cultured animals more healthy by inhibiting the growth of pathogenic bacteria in the same habitat. This has led to new strategy for prevention of disease outbreak and improvement of seed quality. However, effectiveness of probiotics in aquaculture is still a debate due to different observations in different areas and cultured species.

Action of probiotics

Several studies on probiotics have been published during the last decade. However, the methodological and ethical limitations of animal studies make it difficult to understand the mechanisms of action of probiotics, and only partial explanations are available. Nevertheless, some possible benefits linked to the administering of probiotics have already been suggested as: 1) Competitive exclusion of pathogenic bacteria. 2) Enhancement of digestion through production of exoenzymes by moderating and promoting direct uptake of dissolved organic materials. 3) By inhibiting growth of pathogenic bacteria through production of antibiotics. 4)

Controlling phytoplankton and blue-green algal bloom. 5) Reducing toxic metabolites like nitrate, nitrites and ammonia and phosphates. 6) Increasing dissolved oxygen concentration by efficient removal of detritus and thereby heterotrophs. 7) Maximizing carbon mineralization as CO₂ to minimize sludge accumulation and maximizing primary productivity. 8) Maintaining diverse and stable pond community and eliminating cost of cleaning ponds after harvest and 9) Reducing cost of disease treatment and crop management.

Effects of Probiotics

Adhesion to enteric mucus is necessary for bacteria to become established in fish intestines this is probably the first probiotic effect. Adhesion can be specific (based on adhesin and receptor molecules) or non-specific (based on physiochemical factors). Lactic acid bacteria administered orally may induce increased resistance to enteric infections, production of inhibitory substances against pathogens and competition for essential nutrients and adhesion sites. The supply of essential nutrients and enzymes results in enhanced nutrition in the host as well as the modulation of interactions with the environment and the development of beneficial immune responses. Total probiotic effect is probably a mixture of site competition, production of inhibitory compounds and nutrient/energy competition. Probiotics microorganisms reduce the proliferation of pathogens by competing for attachment sites. Probiotics were found to inhibit the growth of Gram negative gut microflora, which were dominant in the gut of the postlarvae of *Macrobrachium rosenbergii*. The inhibitory effect may be due to lowering of pH, due to the production of organic acids normally produced by the lactic acid bacteria or due to the competition for the nutrients or by bacteriocin production. Some probiotics strains including *Lactobacillus* and *Lactococcus* have been reported to inhibit the adhesion of pathogenic bacteria to intestinal cells.

Evaluation of pathogenicity

Probiotics must not be pathogenic to the host organism -- this must be confirmed prior to acceptance. The host must be challenged under stressed and non-stressed conditions usually accomplished by adding probiotic to the culture water. Proper way to do this under monoxenic conditions (only the probiont present) also look at interaction with other food organisms found simultaneously in culture.

Applications of Probiotics

Use of probiotics in aquaculture has been increasing rapidly due to its environment friendly nature contrary to the traditional use of probiotics as feed additives. It is used in aquaculture and production systems to modify the microbial population of the environment ultimately leading to better growth and survival of the targeted species. Generally, probiotic administration during early developmental stages is most effective. Probiotics are well known to positively impact fish welfare by reducing the general stress response and promoting growth, as well as increasing survivorship overall. Since, the microorganisms or probiotics are found to have the capability of improving the water quality, their application in aquaculture has gained momentum. Use of various brands of commercial probiotics have become a regular farming practice in shrimp culture in India, particularly after the viral disease outbreak in 1995.

Future of probiotics in aquaculture

The important role of the gut flora in the maintenance of health and in the prevention of disease is well recognized (Holzapfel and Schillinger, 2002). Use of probiotics is likely to be the most natural and safe means for improving gut flora balance to prevent bacterial pathogens by competing for essential nutrients or attachment sites (Chukeatirote, 2003). As for aquatic animals gut flora, the continuous interaction with the environment, the body system and intrinsic microorganisms is very complex. Although the explosion in recent years of publications dealing with probiotic organisms has been increased, central and vital information is still needed and therefore more advanced methods should be developed to assess the changes in the composition of the gut flora and their mutual interaction with the metabolism of aquatic animals. It has been projected as promising practice to improve the efficiency of aquaculture systems in general and this technology tends to have the potential to be a significant factor in sustainable shrimp culture. Many vendors of commercial probiotics are not aware of the physiological and ecological requirements of their bacterial products and do not pass the information to the clients. Utmost care should be taken in selection of appropriate probiotic combinations and all necessary environmental safeguards should be provided to get optimum benefits from its use.

Exaggerated claims of probiotic combinations are to be scientifically evaluated in different culture conditions. It is desirable to discourage use of imported probiotics, till its beneficiary effects in local conditions are properly evaluated. Another potential social problem in countries like India will be the handling of probiotics at farmsite. The farm hands, mostly, unskilled, should be properly trained in handling microbial preparation while brewing at farm site to avoid accidental infections to them.

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