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Bioremediation in Aquaculture

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Abstract

Aquaculture is a needed industry in the Indian agricultural sector to boost the Indian economy. Aquaculture is now considered as a potential polluter of the aquatic environment and a cause of degradation of wetland areas due to higher usage of inputs. The bacteria are applied for the purpose of enhancing the microbial communities in pond waters and soils. The bioremediation technology can be used to cure the contaminated water and increase the fish production in the pond. Bioremediation consists of using living organisms such as bacteria, fungi, actinomycetes, cyanobacteria and to a lesser extent, plants. The current approach to improving water quality in aquaculture is the application of microbes/ enzymes to the ponds known as 'bioremediation'.

Introduction

Aquaculture production has increased steadily in recent years and is the fastest growing food production sector in the world. Increased fish production is being achieved by the expansion of land and water under culture and the use of more intensive and modern farming technologies that involve higher usage of inputs such as water, feed, fertilizer and chemicals. As a result, aquaculture is now considered as a potential polluter of the aquatic environment and a cause of degradation of wetland areas. Accumulation of unconsumed high protein feed, shrimp/ fish excretion and microbial degradation processes of organic matter result in increase of ammonia level. The bacteria are applied for the purpose of enhancing the microbial communities in pond waters and soils by adding bacteria capable of degrading cellulose, nitrifying bacteria, sulphide oxidizing bacteria, and other specific types of bacteria. The net effect of organic enrichment in sediments is to move the ecosystem to the one dominated by bacteria, ciliates and meiofauna, where the trophic links to the next level of the food web are broken (Wildish *et al*., 2004; Vezzulli *et al*., 2002; Weston, 1990). Under these conditions, the predominant bacteria are anaerobes, mainly sulfate reducers and methanogens. Sediments close to aquaculture facilities can become enriched reservoirs of viruses associated with organic detritus (McAllister and Bebak, 1997). Pohle *et al*. (2001) reported one study of benthic-pelagic coupling for salmon aquaculture. The bioremediation technology can be used to treat waters that are contaminated with heavy metals, excess feed, fish waste, *etc*.

What is Bioremediation?

Bioremediation consists of using living organisms (bacteria, fungi, actinomycetes, cyanobacteria and to a lesser extent, plants) to reduce or eliminate toxic pollutants. The wastes in aquaculture farms can be categorized as residual food and faecal matter, metabolic

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by-product, residues of biocides and bio stats, fertilizer derived wastes and wastes produced during moulting and collapsing algal blooms. The current approach to improving water quality in aquaculture is the application of microbes/ enzymes to the ponds known as 'bioremediation'. When macro- and micro-organisms and/or their products are used as additives to improve water quality, they are referred to as bioremediators or bioremediating agents. The newest attempt being made to improve water quality in aquaculture is the application of probiotics and enzymes to the ponds is known as bioremediation, which involves manipulation of microorganisms in ponds to enhance mineralization of organic matter and get rid of undesirable waste compounds.

Microbes Involved in Bioremediation

Bacterial species belonging to genera Bacillus, Pseudomonas, Acinetobacter, Cellulomonas, Rhodoseudomonas, Nitrosomonas and Nitrobacter are known to help in mineralization of organic wastes. Lots of new microbes are being identified as having bioremediation potential in different ecosystem and the list is ever increasing. The microbial product applied in the ponds containing *Bacillus* spp., nitrite oxidizing bacteria and low numbers of ammonia oxidizing bacteria, sulphur oxidizing bacteria, sulphur reducing bacteria and a yeast, *Saccharomyces* sp. with a total plate count of 3-10 cfu rn^{-1} (colony-forming units) is reported to give better result.

Probiotics

A bacterial supplement of a single or mixed culture of selected non pathogenic bacterial strains was termed probiotics. 'Probiotics' the term was originated from two Greek words 'pro' and 'bios' which mean 'for life'. Human, cattle, chicken, fish, prawn or shrimp require good bacteria to break down nutrients for digestion. Living systems require bacteria to decompose waste. In literature, probiotic bacteria are generally called the bacteria, which can improve the water quality of aquaculture, and (or) inhibit the pathogens in water thereby increasing production. "Probiotics", "Probiont", "Probiotic bacteria", "Beneficial bacteria", or "Friendly bacteria" are the terms synonymously used for probiotic bacteria. The theory of ecological prevention and cure in controlling the insect pest of terrestrial higher grade animals and plants has been in practice for long time, and has achieved remarkable success. The bio controlling theory has been applied to aquaculture and many researchers attempt to use some kind of probiotics in aquaculture water to regulate the micro flora of aquaculture water, control pathogenic microorganisms, to enhance decomposition of the undesirable organic substances in aquaculture water, and improve ecological environment of aquaculture. In addition, the use of probiotics can increase the population of food organisms, improve the nutrition level of aquacultural animals and improve immunity of cultured animals to pathogenic microorganisms.

According to some recent publications, in the aquaculture the mechanism of action of the probiotic bacteria have several aspects.

- Probiotic bacteria competitively exclude the pathogenic bacteria or produce substances that inhibit the growth of the pathogenic bacteria (*e.g.*, Bacitracin and polymyxin produced by *Bacillus* sp.).
- Provide essential nutrients to enhance the nutrition of the cultured animals.
- Provide digestive enzymes to enhance the digestion of the cultured animals.
- Probiotic bacteria directly uptake or decompose the organic matter or toxic material in the water improving the quality of the water.

Table 1: Role of different Probiotics

Probiotics	Role
Bacillus sp.	Mineralization and Breakage of proteins
Nitrosomonas sp.	Oxidation of ammonia
Nitrobacter sp	Oxidation of nitrites
Aerobacter sp.	Reduction of organic matter
Cellulomonas sp.	Breakage of plant material

Application of Probiotics in Aquaculture

- To regulate the microflora of aquaculture water.
- To control pathogenic microorganisms.
- To enhance decomposition of the undesirable organic substances in aquaculture water and improve ecological environment of aquaculture by minimizing the toxic gases like ammonia, nitrite, hydrogen sulphide, methane etc.
- To increase the population of food organisms.
- Improves the nutrition level of aquaculture animals and improve immunity of cultured animals to pathogenic microorganisms.
- The frequent outbreaks of diseases can be prevented.

Conclusion

Constant efforts are being made to address the negative impacts food production systems including aquaculture have on the environment. The role of beneficial bacteria to control pathogens will become important in aquaculture, especially in the light of the increasing number of antibiotic resistant strains of bacteria. The management of pond microbial ecology is an area where applied research can lead to important findings for improving the productivity and

environmental friendliness of the shrimp farming industry worldwide. The use of bioremediators will gradually increase and the success of aquaculture in future may be synonymous with the success of bioremediators that, if validated through rigorous scientific investigation and used wisely, may prove to be a boon for the aquaculture industry.

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