AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 05 Issue: 03 March 2024 Article No: 17

Role and Importance of Microorganisms in Aquaculture Ponds for Sustainable Productivity and Management- An Overview

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SUMMARY

The primary focus of the article revolves around the impact of microbial actions in aquaculture ponds. In pond culture, microorganisms have a significant role in terms of production, nutrient cycling, animal nutrition, water quality, disease control, and the environmental impact of effluent. Aquaculture microbes are typically found in source water and feeds, which may include supplemented live meals. These microorganisms are present in the muscles, gut, gills, and surface of fish, shrimp, crabs, and other aquatic creatures. Microorganisms are used in aquaculture for a variety of purposes, such as probiotics, live food, pond aeration, and aquarium filtration.

INTRODUCTION

When aquaculture first started many years ago, pure, clear water was preferred in aquaculture facilities and the presence of bacteria and other microbes was considered undesirable. One of the main causes was the overabundance of organic matter in the sediment and water column, which raised the oxygen demand and led to the anoxic zone formation and the biosynthesis of hazardous chemicals. This situation was brought on by inadequate aeration systems and insufficient water circulation in the ponds. However, probiotics containing microorganisms have recently been used in shrimp and fish aquaculture to improve the beneficial microbiota on the water or gut tract. This has improved the nutritional value of feedstuffs because the microorganisms aid in digestion through enzymatic means. Furthermore, because of the infections' displacement and competitive inhibition, they also enhanced the host's health state.

Role of microorganisms in aquaculture:

Microbes comprise viruses, fungus, bacteria, and microalgae. The primary purposes of microalgae photosynthetic activity are to absorb CO2 and provide oxygen to aquatic life. The primary function of fungi and bacteria is to break down organic materials in sediments to maintain clean water. However, anaerobic fermentation or breakdown may occur in sediments as a result of the oxygen shortage, generating toxic gasses such methane and hydrogen sulfide. The concentration of trash lowers the dissolved oxygen in the ponds or tanks and boosts microbial activity. Fish and other aquatic creatures are subjected to high-density stress in intense aquaculture and mariculture, and fishponds containing a lot of humus—remaining feed and excrement—make the fish and shrimp more prone to illness. In order to preserve a healthy aquatic environment, we must add helpful bacteria to water and sediments to hasten the breakdown of organic materials.

Many studies have revealed in recent years that adding organic carbon sources to aquaculture systems can encourage the growth of heterotrophic microorganisms and use nitrogen to produce microbial proteins. An abundance of bacteria, protozoa, and algae will occur in the aquaculture systems with more organic carbon. The resulting highly productive microbial community may remove harmful nitrogen species from the water, such ammonia and nitrite, and the microbial protein it produces can be fed to other organisms. The activities of bacteria and algae control the amount of oxygen in the water in nearly all ponds. The algae produce oxygen during the day. Bacteria are frequently the main reason of respiration. Both aerobic and anaerobic microbial processes have an impact on pH and ammonia levels, among other aspects of water quality.

The food web in all extensive, semi-intensive, and some intense aquaculture systems is also greatly influenced by bacteria. The cultured species (like mullet or tilapia) may consume them directly, or smaller animals that feed the cultured species (like penaeid prawns) may consume them. In order to promote primary production, nitrogen and phosphorus are recycled through the action of the heterotrophic decomposers.Since bacterial cells include necessary amino acids, protein, and polysaccharides, they often have a high nutritional value. Bacteria, which are abundant in exogenous enzymes, aid in the process of digestion and absorption in the stomach of larvae or food creatures by dissolving bigger particles into smaller ones. In addition to bacteria, dietary supplements have also been made from yeasts and microalgae. While many fish larvae may eat yeast directly as their major food source, it is primarily employed as a feed for zooplankton, which is raised for use in larvae culture.

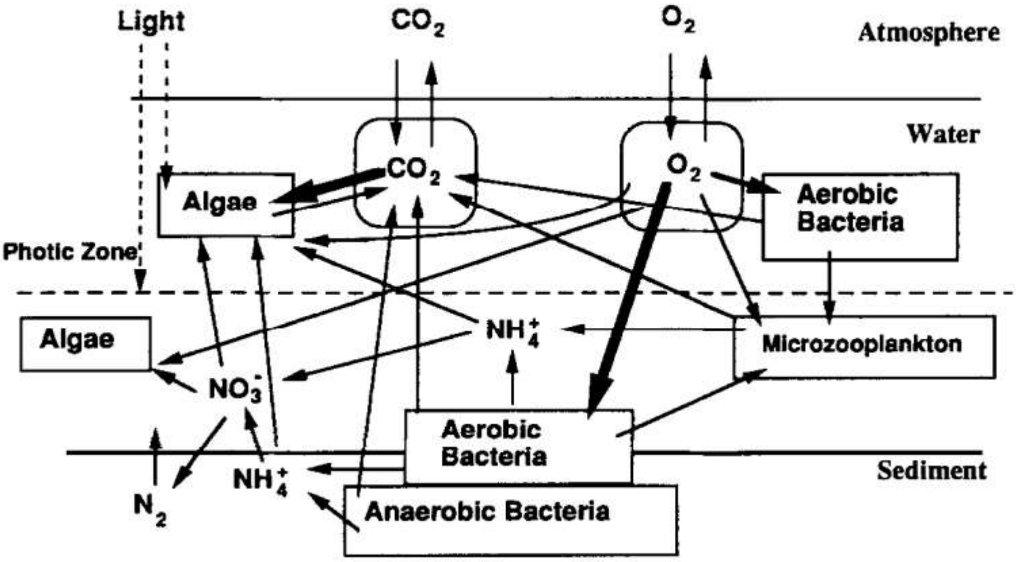

Fig. 1. Flows of oxygen, carbon dioxide and some nutrients between the principal microorganisms in a pond. In the photic zone, which is generally where the light intensity is more than 1% of the surface intensity, oxygen is produced by phytoplankton at a greater rate than it is consumed by respiration. Net mineralisation of nitrogen as ammonium by bacteria is only greater than uptake if the C:N ratio of detritus is less than 10:1. Where the C:N ratio is greater, bacteria will be net immobilisers of nitrogen and compete with the algae for it; microzooplankton mineralise the nitrogen when they feed on bacteria.

Microbes as wastewater purifiers in Fish Farm:

These bacteria remove nitrogenous compounds from water, so acting as a water conditioner. These microorganisms' generated enzymes break down organic material that has accumulated from shrimp and fish cultures, causing ponds to undergo bioremediation and preventing bacterial and viral illnesses as a result. The recirculating aquaculture system (RAS) is powered by a biological filter, or biofilter, which is a live filter that typically grows a bacterial film on a medium. By eliminating impurities, the bacteria treat the waste. Unused fish feed particles and fish waste, which includes harmful ammonia compounds, are the two main water contaminants that must be eliminated. Ammonia and other fish excretory wastes are removed (detoxified) by helpful microorganisms in the biofilter.

Aeration by green algae:

Fish respiration is impacted by rising carbon dioxide levels and falling water pH. For optimal fish growth, carbon dioxide levels should be kept below 30 mg/l. Since carbon dioxide reduces pH and decreases ammonia toxicity, some of it is favorable. Aquatic green algae may remove carbon dioxide through their photosynthetic processes. By using carbon dioxide to synthesize plant carbohydrates, these algae allow oxygen to be released into the surrounding water. The oxygen release keeps the pond's aerobic condition intact and the fish in the aquarium in good health.

Negative effects:

The most significant adverse effects are as follows: potential illnesses, excretion of poisons and nitrogenous metabolites, and increased oxygen consumption in specific situations. For example, many cyanobacteria have the ability to release toxins such geosmin and 2-methylisoborneol, which cause shrimp and fish flavor "off."

Microbial diversity:

The water quality of a fish farm has a significant impact on its microbial diversity. Fish farms' water quality is determined by its biological and physical characteristics. Freshwater fish guts have been used to isolate bacteria belonging to the following genera: *Aeromonas, Vibrio, Staphylococcus, Corynobacteria, Pseudomonas, Acinetobacter, Enterobacter, Escherichia, Klebsiella, Proteus, Serratia, and Bacillus*. Fish ponds contain yeast genera (*Candida albicans, Cryptococcus neoformans, Saccharomyces*, etc.) and diatoms (*Chlorella, Chaetoceros, and Skeletonema*). Fish in farm ponds are in continual contact with the microorganisms found in the pond substrate, fish food, and water. These organisms will affect the fish's exterior surface microflora, which includes the gills. The food and water that enter the digestive tract will also include bacteria.

Inhibition of pathogenic microorganisms:

There is a lot of promise for using probiotics to control infections in fish culture (Westerdahl et al., 1991). Bacteria that suppress infections can probably take the role of antibiotics in hatcheries and ponds. Antibiotics frequently have no impact because the infections are either in a non-growing phase when they are immune to the antibiotics or resistant bacteria emerge. A different method of biological control is to stop bacterial development by using phytoplankton. Antibiotics produced by some algae, such as Tetraselmis, have been shown to have the ability to inhibit bacterial development in tanks and so avert illness (Austin and Day, 1990).

CONCLUSION

Maintaining high water quality and the health of farmed creatures depends critically on the control of both autotrophic and heterotrophic bacteria. An effective control of the organic load lowers the likelihood of solids building up in the system, minimizes the risk of ammonia and nitrite accumulation, and lessens the growth of opportunistic pathogens and microorganisms that cause off-flavors. In order to advance microorganism-based technologies, a number of areas still need to be researched. These include: water movement and aeration devices; nutritional key points implementing natural productivity into account (lower protein diets, increased use of vitamins and minerals, etc.); microorganism selection; genetics applied to high densities (in the case of biofloc systems); stable isotope tracing, and others. These enhancements will help aquaculture become more sustainable.

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