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Bioenrichment of Artemia and Rotifers: A Key to Successful Fish and Shrimp Larviculture

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Bioenrichment of live feed organisms such as Artemia (brine shrimp) and Rotifers (*Brachionus spp.*) plays a crucial role in modern aquaculture, particularly during the larval rearing stage. Although these organisms are widely used due to their suitable size, ease of culture, and high digestibility, they are naturally deficient in essential nutrients such as highly unsaturated fatty acids (HUFAs), particularly DHA and EPA. These nutrients are vital for the growth, survival, and proper development of fish and shrimp larvae. Bioenrichment, also known as bioencapsulation, is a technique used to enhance the nutritional quality of live feeds by feeding them nutrient-rich substances such as oil emulsions, microalgae, yeast, probiotics, phospholipids, and biofloc. This process transforms live feed into nutrient carriers, improving larval performance, immunity, and stress resistance. Despite certain challenges such as nutrient loss and microbial contamination, bioenrichment remains an essential practice for successful larviculture and sustainable aquaculture production.

Keywords: Bioenrichment, Artemia, Rotifers, Larviculture

Introduction

Aquaculture is one of the fastest-growing food production sectors in the world, contributing significantly to global food security. Among all stages of fish and shrimp culture, the larval stage is the most delicate and critical, where even slight nutritional deficiencies can lead to high mortality. At this stage, larvae depend entirely on externally supplied feed after yolk absorption, making the quality of feed extremely important. Live feeds such as Artemia (brine shrimp) and rotifers (*Brachionus* spp.) are widely used in hatcheries because of their small size, soft body, high digestibility, and swimming behaviour that stimulates feeding in larvae. However, these organisms are naturally deficient in essential nutrients, particularly highly unsaturated fatty acids (HUFAs) such as DHA, EPA, and ARA, which are vital for brain development, vision, cellular structure, and immunity. Since fish and shrimp larvae have a limited ability to synthesize these fatty acids, their deficiency often results in poor growth, deformities, weak immunity, and low survival rates. This nutritional limitation led to the development of the concept of bioenrichment, where live feed organisms are enriched with essential nutrients before being offered to larvae. In this process, Artemia and rotifers act as tiny carriers or "living nutrient capsules," delivering a nutrient-rich meal to larvae in a natural and easily digestible form. By improving the nutritional profile of live feeds, bioenrichment enhances larval growth, increases survival rates, strengthens resistance to stress and diseases, and supports proper pigmentation and metamorphosis, making it an indispensable technique in modern aquaculture.

Methods of Bioenrichment

Bioenrichment can be carried out using different techniques depending on availability, cost, and hatchery requirements. Each method has its own advantages and limitations.

1. Oil Emulsion Enrichment

Oil emulsion enrichment is the most widely practised method in commercial hatcheries. In this technique, Artemia nauplii or rotifers are fed with emulsified oils rich in HUFAs such as DHA and EPA. These emulsions are finely dispersed in water, allowing easy ingestion by live feed organisms. Within 6–24 hours, the organisms accumulate these nutrients in their bodies. This method is highly efficient and provides rapid enrichment, making it suitable for large-scale operations. However, excessive use can lead to water quality deterioration and increased bacterial load, requiring careful monitoring of dosage and aeration.

2. Microalgal Enrichment

Microalgal enrichment uses live microalgae such as Isochrysis, Nannochloropsis, and Aurantiochytrium to naturally enhance the nutritional quality of live feed. These microalgae are rich in essential fatty acids, vitamins, pigments, and antioxidants. When Artemia and rotifers consume these algae, they incorporate these nutrients into their tissues. This method is environmentally friendly and provides a balanced nutrient profile while also improving water quality. However, large-scale cultivation of microalgae requires technical expertise and controlled environmental conditions.

3. Yeast-Based Enrichment

Yeast-based enrichment is a simple and low-cost method commonly used in small-scale hatcheries. Baker's yeast provides proteins, carbohydrates, and B vitamins, thereby improving the overall nutritional condition of live feeds. It is easy to handle and readily available. However, yeast lacks essential fatty acids such as DHA and EPA, making it insufficient when used alone. Therefore, it is often combined with other enrichment methods to achieve a balanced nutritional profile.

4. Probiotic Enrichment

Probiotic enrichment involves introducing beneficial bacteria into live feed organisms. These probiotics are either ingested or attached to the surface of Artemia and rotifers. When larvae consume these enriched feeds, the probiotics improve gut health, digestion, and immunity. This method also helps in controlling pathogenic bacteria in hatchery systems. It is gaining popularity as an eco-friendly alternative to antibiotics in aquaculture.

5. Phospholipid Enrichment

Phospholipid enrichment is an advanced technique where essential fatty acids are provided in the form of phospholipids rather than neutral lipids. This form is more easily absorbed and utilized by fish larvae, especially during early developmental stages. It improves cell membrane formation, growth rate, and survival. However, the cost of phospholipid-based enrichment products is relatively high, limiting their widespread use.

6. Biofloc-based Enrichment

Biofloc-based enrichment is a sustainable approach that utilizes microbial aggregates consisting of bacteria, algae, and organic matter. These bioflocs are rich in proteins, lipids, vitamins, and minerals. Artemia and rotifers feeding on bioflocs become nutritionally enriched. This method also helps in recycling nutrients and maintaining water quality, making it an eco-friendly option for modern aquaculture systems.

Bioenrichment Process

The bioenrichment process generally involves culturing live feed organisms, harvesting them, and transferring them into enrichment tanks where nutrient-rich diets are provided under controlled conditions. Adequate aeration is maintained to ensure proper mixing and oxygen supply. The organisms are allowed to feed on the enrichment medium for a specific duration (usually 6–24 hours), after which they are harvested, washed, and immediately fed to larvae to prevent nutrient loss.

Factors Affecting Enrichment

The success of bioenrichment depends on several environmental and biological factors. The duration of enrichment plays a key role, as insufficient time leads to poor nutrient uptake, while excessive time may cause nutrient loss. The type and quality of enrichment feed

determine the final nutritional profile of Artemia and rotifers. Temperature and salinity influence metabolic activity and nutrient retention, while adequate aeration ensures proper oxygen supply and uniform distribution of feed particles. Stocking density is another important factor, as overcrowding reduces feeding efficiency and enrichment effectiveness. Proper control of these factors is essential for achieving consistent and high-quality enrichment.

Challenges

Despite its advantages, bioenrichment faces several practical challenges in hatchery operations. One major issue is the rapid loss of nutrients from enriched organisms if they are not fed immediately to larvae. Another concern is bacterial contamination, as live feeds can act as carriers of harmful microorganisms. The high cost of commercial enrichment products also limits their use, especially in small-scale farms. Additionally, variations in enrichment efficiency due to environmental conditions and feed quality can affect the consistency of results. Addressing these challenges requires proper management practices, quality control, and the adoption of improved technologies.

Conclusion

Bioenrichment is a powerful and essential tool in modern aquaculture that enhances the nutritional quality of live feed organisms. By enriching Artemia and rotifers with essential nutrients, it ensures better growth, survival, and health of fish and shrimp larvae. Bioenrichment acts as a nutritional bridge between microscopic feed and growing aquatic life, ensuring that every bite consumed by larvae is packed with essential nutrients. As aquaculture continues to expand, bioenrichment will remain a cornerstone technique for achieving sustainable and high-quality production.

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