Review Article

Development of Bioprocess Technology For Parasite Control In Aquaculture Commodities

ABSTRACT

Controlling parasites in cultivated commodities is a crucial challenge in the fisheries industry that can impact fish health and production quality. The use of conventional methods such as chemical drugs often results in negative side effects on the environment and human health. Therefore, the development of bioprocess technology offers a more environmentally friendly and sustainable solution for parasite management. In bioprocess technology, probiotic microorganisms are used to enhance fish immune responses, enzymes such as proteases or lipases are used to lower the number of parasites. Additionally, research also focuses on the development of vaccines to target specific parasites, providing a more permanent control alternative. By reducing reliance on synthetic chemicals and minimizing parasite resistance, these technologies enhance the sustainability of aquaculture. The development and application of this bioprocess technology have the potential to enhance the efficiency and sustainability of aquaculture production. Future research could explore the integration of advanced genetic engineering and microbiome manipulation to enhance the precision and efficacy of bioprocess technologies for parasite control in aquaculture.

Keywords: Aquaculture Commodities, Bioprocess, Parasites, Probiotics, Sustainable Aquaculture

1. INTRODUCTION

Aquaculture remains a primary method for supporting economic development and meeting global food demands. The high interest in aquaculture shows that the sector has bright prospects and continues to grow, both on a small and large scale (Little et al. 2016). However, in practice, there are various obstacles that are often faced, such as low production efficiency, fluctuations in crop quality, and environmental impacts that are not well managed. To overcome these various obstacles, innovations and technologies that are able to increase productivity and sustainability of aquaculture are needed (Mustafa et al. 2021). With the application of bioprocessing, it is hoped that aquaculture can become more efficient, produce high-quality products, and remain environmentally friendly (Skilton et al. 2020).

The development of bioprocess technology for parasite control in farmed fish is very important to increase productivity and sustainability of aquaculture (Kassim et al. 2014). The application of this bioprocess technology can produce healthier fish populations, reduce dependence on chemical processing and encourage more environmentally friendly aquaculture practices. By integrating natural biocontrol agents and optimizing growth conditions, aquaculture can achieve a balance that improves fish health while minimizing ecological impacts (Assefa & Abunna, 2018). Innovative approaches such as the use of microbes can further enhance efforts to create ecosystems that support sustainable farming practices. Additionally, it can increase resistance to disease and improve overall fish health.

Microbes used in bioprocessing can come from a variety of sources, including fish bodies. As is known, the body of fish, especially the intestines, is a habitat for various types of bacteria. Aisyah et al. (2019) reported that the bacteria with the highest abundance in the intestines of fish include *Cetobacterium, Clostridium sensu stricto 1, Bacteroides, Enterovibrio, Plesiomonas, Lactococcus, Romboutsia, Stenotrophomonas, Turicibacter*, and *Edwardsiella,* among other types. These various bacteria have important roles in the metabolic process of fish, including digestion, vitamin synthesis, and protection against pathogens. In addition, these bacteria also have the potential to be utilized in bioprocesses, such as enzyme production, probiotics, and waste treatment, making them an important component in the development of sustainable fisheries biotechnology.

The many potentials possessed by these different types of bacteria show great opportunities in the development of bioprocess techniques. With the right application, this bacterium can be used to support various innovations in the fisheries sector. In order to maximize these benefits, it is important to pay attention to the characteristics of fish parasites, as the interaction between microbes, fish, and parasites can affect the effectiveness of bioprocesses as well as the overall health of the fish. These parasites can be categorized into different types, each affecting fish differently based on their habitat and environmental conditions (Bui et al., 2019). Understanding the nature of these parasites is essential for effective management and control strategies, such as incorporating host behavior into management strategies.

2. PARASITIC PROBLEMS IN CULTIVATED FISH

Parasitic infections in aquaculture are caused by protozoans (e.g., Microsporidia) and metazoans (e.g., Cestoda), which are often found in both freshwater and marine fish. These parasitic infections not only impact fish growth and reproduction, but can also cause mass deaths, especially in intensive aquaculture systems (Kanwal et al., 2023; Scholz et al., 2021).

The type of parasitic infection is often specific depending on the habitat of the fish. In freshwater fish, infections such as Renal Sphaerosporosis caused by protozoa of the genus Sphaerospora can impair kidney function, disrupt metabolism, and cause high mortality rates. In contrast, marine fish are more susceptible to diseases such as Cryptocaryonosis (sea white spot disease) caused by Cryptocaryon irritans and Brooklynelliosis which attacks the skin and gills of marine fish, often causing severe tissue damage (Kanwal et al., 2023).

Some fish parasites not only cause health problems in their hosts but also act as vectors for other pathogens. An example is the copepod *Lernanthropus kroyeri*, which is known to carry and transmit pathogenic bacteria such as *Vibrio anguillarum*. This facilitates the spread of disease in fish populations, especially in high-density environments such as aquaculture (Yildiz & Otgucuoğlu, 2021).

3. FISH PARASITE CONTROL AND MANAGEMENT

Fish parasite control and management is an important aspect in ensuring the health of farmed fish and the quality of the products produced. Parasitic infections can reduce fish growth, increase mortality rates, and reduce the quality of fish meat which can have an impact on the profits of fish farmers. Therefore, an effective parasite control approach is indispensable to prevent greater losses.

1. Effective environmental management is a fundamental approach to parasite control. Optimal environmental conditions, such as the right temperature, salinity, and pH, can help reduce the conditions that favor the parasite's life. In addition, maintaining pond cleanliness and using a good water circulation system can reduce the accumulation of parasites in the aquaculture environment. These measures can help reduce stress in fish, which is often a trigger factor for the high prevalence of parasites. Effective control strategies include improving fish farming practices and monitoring environmental conditions to reduce the prevalence of parasites (Kanwal et al., 2023).

2. In addition to environmental management, the use of biotechnology methods can help in the control of parasites in fish farming. One approach is the use of probiotics, such as good bacteria and microalgae, which can increase the fish's immune system to parasitic infections. Probiotics work by improving the balance of the fish's gut microflora, thus inhibiting the growth of parasites naturally.

3. Bioprocess technologies, such as the use of enzymes produced by microorganisms, also have great potential in reducing the number of parasites in aquaculture systems. For example, praziquantel has been shown to be effective against adult tapeworms, although the management of the parasitic larval stage is still a challenge (Scholz et al., 2021).

4. In addition, biological control by utilizing predators or natural competitors to manage parasite populations is an alternative that can reduce dependence on chemicals (Buchmann, 2022). Another promising approach is immunological methods, such as the development of vaccines that target specific parasites, including protozoa and metazoa (Buchmann, 2015).

5. The use of antimicrobial drugs, such as praziquantel, is one option in parasite control in fish. However, its use must be done with caution and in accordance with the right dosage to prevent parasite resistance to the drug. Therefore, a combination of environmental management, the application of biotechnology, and measurable treatment becomes an effective strategy in parasite management in farmed fish. Although dependence on drugs such as praziquantel is still common, the emergence of drug resistance is an increasingly worrying issue and requires more attention (Widdicombe et al., 2024).

4. CONCEPT OF BIOPROCESS TECHNOLOGY IN PARASITE CONTROL

Bioprocess technology plays an important role in developing sustainable methods for controlling parasites, utilizing biological systems and processes to produce effective biopesticides and other control agents. This innovative approach not only minimizes dependence on chemical pesticides but also improves ecological balance, encouraging healthier agricultural practices. and reducing environmental impacts (Vurro & Gressel 2007).

By utilizing natural microorganisms and compounds, bioprocess technology offers a promising alternative that can target specific parasites while preserving beneficial organisms in the ecosystem. This targeted strategy not only increases crop yields but also contributes to overall crop resilience. agricultural system, encouraging a more sustainable and environmentally friendly pest management approach (Kamal et al. 2015). There are several applications of bioprocess technology in disease control, which can be seen in the following table.

Table 1. Application of Bioprocess in Parasite Control

No.	Bioprocess Technology	Description	Advantage	Reference
1	Probiotics	Induction of Bacillus CgM22 Probiotic in Feed	Increases the resistance of fish	Haetami *et al.* 2022
2	Vaccine Manufacturing	Control of Anti-helminthic vaccines in fish	Effective treatment strategies to prevent getting worms/helmintes	Widdicombe et al., 2024
3	Probiotics	Induction of *Staphylococcus* sp. JC20 from Octopus Digestive Tract (*Octopus* sp.)	Increases the immune system of fish	Istiqomah et al. 2019
4	Probiotics	Induction of bacteria from the intestines of fish to fight *Aeromonas*.	Increases the resistance of fish from parasite attacks	Mulyani et al. 2018
5	Vaccination creation	Vaccination of Tiger Grouper Fish (*Epinephelus fuscoguttatus*) With Three pathogenic bacteria that have been inactivated	Increases the resistance of fish to parasitic attacks	Zafran, 2015
6	Addition of organic matter	Addition of miana leaf extract (*Coleus scutellarioides*) to feed given to tiger shrimp (*Penaeus monodon*)	Increases tiger shrimp's immunity	Febriani et al 2023
7	Enzyme Inhibitors Cause Parasite Development	Control of protease inhibitors to inhibit the development of parasites, virulence and pathogenesis. Mechanism of protease are host tissue degradation, immune evasion, and nutrient acquisition, with	This can increase the effectiveness of treatment against various parasitic infections, potentially leading to a more efficient and targeted therapeutic approach.	Rascon and McKerrow, 2013

No.	Bioprocess Technology	Description	Advantage	Reference
		different classes of proteases enabling processes such as host hemoglobin digestion, cell invasion, and immune system evasion.		
8	Probiotics	*Acetobacter* sp., *Lactobacillus* sp., and *Saccharomyces cerevisiae* (yeast)	Using natural ingredients that are easy to obtain, safe, and have the potential as an alternative to chemicals to increase fish's immunity	Safir *et al.* 2023
9	Biofiltration	Control of 3 probiotics in the fish filtration system. Novozymes pond plus (Novozymes Biological, Boston), Zhongshui BIO-AQUA (Zhongshui Fish Medicine,Wuxi, China) and Effective Microorganisms (Jiangsu Suwei Microbiology Research, Wuxi, China) at Fengqiao farm (Zhuji, China)	A water filtration system that incorporates decomposing microorganisms to reduce contaminants, including parasites, in the aquaculture water.	2016 Donation

The development of bioprocess technology for parasite control in fish farming is increasingly important to support the sustainability of the fisheries sector. One promising approach is the use of microorganisms or natural compounds that can inhibit or kill parasites without damaging the balance of the ecosystem. For example, the use of probiotics or decomposing bacteria that can reduce the number of parasites in fish by affecting the microflora in the fish's body or in their surrounding environment. Application of probiotic bacteria in fish (Aisyah et al. 2022)

In addition, enzyme-based technologies are also being developed to break down the body walls of parasites or disrupt their life cycles (Rascon and McKerrow, 2013). Enzymes extracted from certain microorganisms or plants can be used as an environmentally friendly alternative to parasite control. The application of this technology can also reduce dependence on synthetic chemicals that have the potential to cause adverse effects on the health of fish and the surrounding environment.

On the other hand, the application of biotechnology to improve water quality in aquaculture systems also has the potential to reduce the prevalence of parasites. One example is the development of a biofiltration system that incorporates decomposing microorganisms to clean water from feed residues and feces that can be a source of parasite development (ranjan and bavitha 2014). With the combination of these various bioprocess technologies, parasite control in fish farming can be carried out more efficiently and environmentally friendly.

5. CONCLUSION

The development of bioprocess technology for parasite control in aquaculture commodities offers an environmentally friendly and sustainable solution through the use of probiotics, microbial enzymes, and biological control. The application of this technology can reduce dependence on chemicals, enhance fish resilience, and support the sustainability of the aquaculture industry.

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