Archives of Animal and Poultry Sciences

Juniper Publishers key to the Researchers

Review Article
Volume 2 Issue 3- September 2023
DOI: 10.19080/AAPS.2023.02.555590

Arch Anim Poult Sci

Application of Predatory Bacteria in the Prevention and Control of Aquaculture Diseases

Xiaoli Chen[1], Shuangping Liu[2], Jian Mao[1,2*]

[1]*Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou), Guangzhou, Guangdong, 511458, China*

[2]*National Engineering Research Center of Cereal Fermentation and Food Biomanufacturing, State Key Laboratory of Food Science and Technology, School of Food Science and Technology, Jiangnan University, Wuxi, Jiangsu, 214122, China*

Submission: September 13, 2023; **Published:** September 22, 2023

***Corresponding author:** Jian Mao, Southern Marine Science and Engineering Guangdong Laboratory, Guangzhou, Guangdong, China.

Abstract

The green and healthy development of aquaculture is an important guarantee for food security. Pathogenic bacteria are a major factor constraining the development of aquaculture. Predatory bacteria are a class of potentially beneficial bacteria that can be used as an alternative to antibiotics for the prevention and control of aquatic animal diseases. This article reviews the application of predatory bacteria in the prevention and control of aquaculture diseases, discusses their potential as probiotics, and also points out some unresolved issues, including limited bacterial resources, insufficient studies on biological and ecological properties, lack of systematic safety and

Keywords: Predatory bacteria; Aquaculture; Antibiotic substitution; Probiotics; Disease control

Introduction

Aquaculture meets nearly half of the world's demand for fish and shellfish consumption [1]. The sustainable development of aquaculture is a crucial guarantee for food security and is closely related to human health. In recent years, global aquaculture has rapidly developed towards large-scale and intensive production, making outstanding contributions to ensuring the supply of high-quality protein, reducing the intensity of utilizing natural aquatic resources, promoting the prosperity of the fishery industry, and improving the livelihoods of fishermen [2]. However, disease outbreaks are an important factor that hampers the sustainable development of aquaculture. Antibiotics have been widely used to prevent and control diseases in aquatic animals [3]. However, the excessive use of antibiotics can lead to the emergence of bacterial resistance, inhibit the host's immune system, and disrupt the balance of environmental microorganisms [4,5].

In addition, the presence of antibiotic residues in aquatic products can indirectly harm human health [6,7]. Therefore, many countries have implemented strict regulations on antibiotic use in aquaculture. Although many countries have gradually entered the era of antibiotic-free aquaculture, there are still issues such as the occurrence of diseases in cultured animals and reduced yields in practical production. It is urgent to develop strategies for the prevention and control of aquatic animal diseases without using antibiotics to achieve truly antibiotic-free aquaculture and ensure the sustainable development of aquaculture [8,9].

Predatory bacteria possess both probiotic and antibiotic properties and are a promising alternative to antibiotics for the prevention and control of aquatic animal diseases [10,11]. Predatory bacteria utilize the biopolymers of their prey as a source of nutrients for growth and reproduction. Depending on the predatory method, predatory bacteria can be classified into endocytic, ectocytic, and transcytotic groups. Endocytic bacteria invade and reproduce within their prey, ectocytic bacteria attach to and kill their prey from the outside, and transcytotic bacteria secrete lytic proteins and feed on the cellular contents released by the prey [12].

Representative predatory bacteria include Myxobacteria, Bdellovibrio bacteriovorus, and Bradymonadales, all of which belong to the phylum Proteobacteria. Their host range includes both Gram-positive and Gram-negative bacteria and they are distributed in phyla such as Proteobacteria, Bacteroidetes, Firmicutes, and Actinobacteria, including aquatic animal pathogens such as Vibrio, Aeromonas, Plesiomonas, as well as human pathogens such as Acinetobacter baumannii, Escherichia coli bacteria, Streptococcus pneumoniae, and Pseudomonas adaceae. Predatory bacteria are widely distributed in various

environments. For example, B. bacteriovorus can be found in saltwater, freshwater, sewage, soil, and sediments, as well as in the viscera and gills of animals [13]. Bradymonadales is a core group in bacterial communities in many marine environments and has also been found in inland salt lakes and the intestines of mammals [14].

The diversity of predatory bacterial communities plays an important role in the microbial diversity of marine environments. Previous studies have shown that the use of B. bacteriovorus can improve the survival and growth parameters of fish species such as Siniperca chuatsi, Litopenaeus vannamei, Penaeus monodon, Haliotis discus hannai, and Scophthalmus maximus. It can also reduce the mortality rate of L. vannamei after infection with pathogenic bacteria such as Vibrio anguillarum, and inhibit the formation of biofilms by pathogens [15,16]. Furthermore, B. bacteriovorus are natural residents of the human gut microbiota. In vitro studies using various mammalian cell lines have shown that B. bacteriovorus cannot grow in eukaryotic cells, do not induce strong inflammatory responses, do not significantly affect cytokine levels, and do not impact cell viability. In vivo experiments using several animal models have demonstrated that B. bacteriovorus have no toxic effects on hosts, indicating their safety for human use [6]. Predatory bacteria play a crucial role in regulating the gut microbiota of hosts, helping to prevent dysbiosis caused by susceptible conditions in aquatic animals, such as environmental stress and excessive antibiotic use [16]. Therefore, several studies have suggested the potential use of predatory bacteria, such as B. bacterivorous, as probiotics in aquaculture.

Although predatory bacteria have shown great potential in aquaculture, there are still many issues that need further research. Firstly, single strains of predatory bacteria are often unable to completely eradicate the entire pathogenic population, and resources of predatory bacteria with different biological characteristics need to be explored. Secondly, the ecological characteristics of different strains of predatory bacteria need to be clarified. Most published studies have used pure cultures to elucidate the interactions between predators. However, existing research has shown that the predation efficiency of predatory bacteria is influenced by environmental factors such as optimal growth conditions, pollutants, or microbial interactions. The predatory activities of predatory bacteria in complex natural habitats still need to be studied [17].

For example, as probiotics, the vitality and predation activity of bacterial strains should be considered, taking into account the effects of gastric acidity levels, exposure levels, bile salt concentrations, as well as the presence of pancreatic fluids and antimicrobial peptides after passing through the gastrointestinal tract [16, 18]. Thirdly, before potential probiotic strains of predatory bacteria enter the market for further use, it is necessary to follow clinically relevant steps to evaluate the safety and effectiveness of different strains, including evaluations in farmed animals and humans, assessments of preventive or therapeutic effects in specific situations or diseases, and clarifying the mechanisms of action of probiotics in the body [19].

Lastly, the associated biological resources of predatory bacterial strains need to be explored, such as the hydrolytic enzymes they produce, which may serve as a source for exploring new biotechnological enzymes. Existing research has shown that the genome of B. bacteriovorus HD100 is predicted to encode a large number of different cytoplasmic and outer membrane protein transport systems. From the perspective of the types of hydrolytic enzymes, Bacillus subtilis should be considered an interesting biotic source for identifying new bacterial proteins, which have application value in basic research and the life science industry [17]. Despite the need for further research, predatory bacteria remain promising candidates for intestinal therapeutics or probiotics in aquaculture animals.

Conclusion

With the destruction of the aquatic environment caused by industrial wastewater, domestic wastewater, atmospheric pollutants, and other pollutants, the quality of the aquaculture water environment has been deteriorating, resulting in an increased burden on disease prevention and control in aquaculture. It is particularly important to clarify the current situation of disease prevention and control in aquaculture and develop diverse strategies for disease prevention and control. Predatory bacteria are one of the potential alternatives to antibiotics for the prevention and control of aquatic animal diseases. Although predatory bacteria show promising prospects in the field of disease prevention and control, there are still multiple constraints that need to be overcome, including the exploration of bacterial strains, safety and efficacy evaluation.

References

1. Ushakova NA, Pravdin VG, Kravtsova LZ, Ponomarev SV, Gridina TS, et al. (2021) Complex Bioactive Supplements for Aquaculture—Evolutionary Development of Probiotic Concepts. Probiotics and Antimicrobial Proteins 13(6): 1696-1708.
2. Tal Y, Schreier H, Sowers K, Stubblefield J, Place A, et al. (2009) Environmentally sustainable land-based marine aquaculture. Aquaculture 286: 28-35.
3. Serrano P (2005) Responsible Use of Antibiotics in Aquaculture.
4. Capkin E, Altinok I (2009) Effects of dietary probiotic supplementations on prevention/treatment of yersiniosis disease. Journal of applied microbiology 106(4): 1147-1153.
5. Dawood M, Koshio S (2015) Recent advances in the role of probiotics and prebiotics in carp aquaculture: A review. Aquaculture 454.
6. Langdon A, Crook N, Dantas G (2016) The effects of antibiotics on the microbiome throughout development and alternative approaches for therapeutic modulation. Genome Med 8(1): 39-39.
7. Hoseinifar SH, Sun YZ, Wang A, Zhou Z (2018) Probiotics as Means of Diseases Control in Aquaculture, a Review of Current Knowledge and Future Perspectives. Frontiers in microbiology 12(9): 2429.

How to cite this article: Xiaoli C, Shuangping L, Jian M. Application of Predatory Bacteria in the Prevention and Control of Aquaculture Diseases. Arch Anim Poult Sci. 2023; 2(3): 555590. DOI: 10.19080/AAPS.2023.02.555590

8. Abdelkhalek NKM, Eissa IAM, Ahmed E, Kilany OE, El Adl M, et al. (2017) Protective role of dietary Spirulina platensis against diazinon-induced Oxidative damage in Nile tilapia; Oreochromis niloticus. Environmental toxicology and pharmacology 54: 99-104.
9. Altinok I, Capkin E, Karsi A (2015) Succinate dehydrogenase mutant of Listonella anguillarum protects rainbow trout against vibriosis. Vaccine 33(42): 5572-5577.
10. Waso M, Reyneke B, Havenga B, Khan S, Khan W (2021) Insights into Bdellovibrio spp. mechanisms of action and potential applications. World journal of microbiology & biotechnology 37(5): 85.
11. Dwidar M, Monnappa AK, Mitchell RJ (2012) The dual probiotic and antibiotic nature of Bdellovibrio bacteriovorus. BMB reports 45(2): 71-78.
12. Novick RP (2021) Antibacterial particles and predatory bacteria as alternatives to antibacterial chemicals in the era of antibiotic resistance. Current Opinion in Microbiology 64: 109-116.
13. Cavallo FM, Jordana L, Friedrich AW, Glasner C, Van Dijl JM (2021) Bdellovibrio bacteriovorus: a potential 'living antibiotic' to control bacterial pathogens. Critical Reviews in Microbiology 47(5): 630-646.
14. Wang S, Mu D, Du ZJ (2020) Persicimonas caeni gen. nov., sp. nov., the Representative of a Novel Wide-Ranging Predatory Taxon in Bradymonadales. Frontiers in microbiology 11: 698.
15. Chen X, Yi H, Liu S, Zhang Y, Su Y, et al. (2021) Promotion of pellet-feed feeding in mandarin fish (Siniperca chuatsi) by Bdellovibrio bacteriovorus is influenced by immune and intestinal flora. Aquaculture 542: 736864.
16. Bonfiglio G, Neroni B, Radocchia G, Marazzato M, Pantanella F, et al. (2020) Insight into the Possible Use of the Predator Bdellovibrio bacteriovorus as a Probiotic. Nutrients 12(8): 2252.
17. Bratanis E, Andersson T, Lood R, Bukowska Faniband E (2020) Biotechnological Potential of Bdellovibrio and Like Organisms and Their Secreted Enzymes. Frontiers in microbiology 11: 662.
18. Mitchell RJ, Mun W, Mabekou SS, Jang H, Choi SY (2020) Compounds affecting predation by and viability of predatory bacteria. Applied Microbiology and Biotechnology 104(9): 3705-3713.
19. Kim SK, Bhatnagar I, Kang KH (2012) Development of marine probiotics: prospects and approach. Advances in food and nutrition research 65: 353-362.

DOI: 10.19080/AAPS.2023.02.555590

How to cite this article: Xiaoli C, Shuangping L, Jian M. Application of Predatory Bacteria in the Prevention and Control of Aquaculture Diseases. Arch Anim Poult Sci. 2023; 2(3): 555590. DOI: 10.19080/AAPS.2023.02.555590