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Phytobiotics in Aquaculture

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Abstract

This paper aims to assess the existing knowledge on the use and effects of phytobiotics in fish farming and their potential for broader application in aquaculture. With the rising demand for fish, there has been a noticeable decline in fish production in recent years, which could be a driving factor behind the increasing interest in using phytobiotics in this field. The main factor contributing to the decrease in fish production is the widespread occurrence of diseases caused by various pathogens. Enhancing disease resistance, feed efficiency, and growth performance in farmed fish is crucial for the different sectors within this industry. In commercial aquaculture, reducing production costs is a priority, especially given the high expenses associated with antibiotics for disease prevention and treatment, as well as hormones for growth enhancement. This has driven research into new alternatives, leading to the development of the concept of functional additives in aquaculture, which includes "phytobiotics." Studies have demonstrated that incorporating phytobiotics into fish diets can improve the innate immune response against bacterial infections, particularly Aeromonas hydrophila, across various fish species. These compounds primarily boost the activity of phagocytic cells, enhance their bactericidal properties, stimulate natural killer cells, complement activity, lymphocyte proliferation, lysozyme production, and antibody responses in fish. In conclusion, further research is required to determine the optimal use of different phytobiotics, with a focus on timing, dosage, and methods of administration. This paper aims to assess the existing knowledge on the use and effects of phytobiotics in fish farming and their potential for broader application in aquaculture. With the rising demand for fish, there has been a noticeable decline in fish production in recent years, which could be a driving factor behind the increasing interest in using phytobiotics in this field. The main cause of the drop in fish production is the widespread presence of diseases brought on by various pathogens. Enhancing disease resistance, feed efficiency, and growth performance in farmed fish is crucial for the different sectors within this industry. In commercial aquaculture, reducing production costs is a priority, especially given the high expenses associated with antibiotics for disease prevention and treatment, as well as hormones for growth enhancement. This has driven research into new alternatives, leading to the development of the concept of functional additives in aquaculture, which includes "phytobiotics." Studies have demonstrated that incorporating phytobiotics into fish diets can improve the innate immune response against bacterial infections, particularly Aeromonas hydrophila, across various fish species.

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INTRODUCTION

Fish are an affordable and easily digestible source of animal protein, making it a vital component of the global diet. With the current global population nearing eight billion and projections indicating that it will reach nine billion by 2050, fish play a crucial role in meeting the nutritional needs of people worldwide. Consequently, the demand for animal protein is anticipated to double by that time, with a

significant increase in the consumption of farmed fish and chicken. The global fish production industry is currently under pressure to increase output to address the growing demand for protein and to secure livelihoods and nutritional security in the future. However, the use of chemical drugs is associated with several negative effects on both the environment and human health. Antibiotics and their residues harm aquatic ecosystems as numerous bacterial strains in the environment are becoming resistant to these drugs. Therefore, in recent years, there has been a shift in focus toward eco-friendly and sustainable approaches for managing diseases in aquaculture [1]. To address this issue, enhancing the non-specific immune system has emerged as the preferred method for boosting the immunity and growth performance of farmed organisms. Phytobiotics, which are rich in bioactive compounds, have the potential to act as effective immunostimulants [2].

HERBS AS THERAPEUTICS IN AQUACULTURE

The use of plant-based products to manage aquaculture diseases is emerging as a promising alternative to chemical drugs. Numerous plant-derived products have been shown to stimulate appetite, enhance growth performance, serve as immunostimulants, and exhibit antibacterial, antiviral, and antiparasitic properties (against protozoans and monogeneans) in aquaculture [3]. The positive effects are linked to bioactive compounds, such as phenols, sulfur compounds, terpenoids, alkaloids, flavonoids, and saponins. Multiple studies have shown that these phytobiotics or herbal extracts have dose-dependent stimulatory effects on the fish's immune system. However, there remains a knowledge gap regarding the preparation methods, administration techniques, and long-term effects of various herbal extracts on fish physiology. The growing consumer preference for organic food products in recent years has further enhanced the potential use of phytobiotics in aquaculture. Table 1 lists the herbs used in the aquaculture.

Table 1. List of herbs used in aquaculture.

S.N.	Herbs (scientific name)	Common name	Properties
1.	*Eclipta erecta*	Bhringraj	Antibacterial
2.	*Ricinus communis*	Castor oil plant	Antibacterial
3.	*Inonotus obliquus*	Chaga mushroom	Antibacterial
4.	*Allium sativum*	Garlic	Antibacterial, antiparasitic
5.	*Cinnamomum verum*	Ceylon cinnamon tree	Antibacterial
6.	*Aloe vera*	Aloe	Antibacterial
7.	*Azadirachta indica*	Neem	Antibacterial, antifungal, antiparasitic
8.	*Lactuca indica*	Indian lettuce	Antibacterial
9.	*Datura metel*	Thorn apple	Antibacterial, antifungal
10.	*Curcuma longa*	Haldi	Antibacterial
11.	*Withania somnifera*	Ashwagandha, Indian ginseng	Antibacterial, growth promoter, antistress
12.	*Ocimum sanctum*	Tulsi	Appetite stimulation, growth promoter, antibacterial
13.	*Zingiber officinale*	Ginger	Antistress, growth promoter, antibacterial
14.	*Cynodon dactylon*	Bermuda grass	Antiviral, growth promoter
15.	*Cnidium monnieri*	Conidium fruit	Antifungal
16.	*Terminalia catappa*	Indian almond	Antifungal, antibacterial
17.	*Leucaena glauca*	Sababul, River tamarind	Antiparasitic
18.	*Lindera aggregata*	Chinese spice bush	Antiparasitic
19.	*Areca catechu*	Indian nut	Antiparasitic
20.	*Santalum album*	Indian sandalwood	Antiparasitic
21.	*Melia azedarach*	China berry	Antiparasitic
22.	*Mentha piperita*	Peppermint	Antiseptic
23.	*Syzygium aromaticum*	*Clove*	Antiseptic

POTENTIAL OF PHYTOBIOTICS IN AQUACULTURE

Phytobiotics and plant extracts have been recognized for their diverse properties in aquaculture, including antistress effects, growth promotion, appetite stimulation, immune system enhancement, broodstock maturation, aphrodisiac effects, and anti-pathogenic actions. These advantages stem from several bioactive compounds, including alkaloids, terpenoids, tannins, saponins, glycosides, flavonoids, phenolics, steroids, and essential oils. Phytotherapies are cost-effective, environmentally friendly, and offer sustainable alternatives to synthetic chemicals [4, 5].

Phytobiotics as Antibacterial Agent

Bioactive compounds present in plant extracts, including polysaccharides, phenolics, proteoglycans, and flavonoids, play key roles in preventing or managing infectious microbes. Phytobiotics demonstrate antibacterial properties through various mechanisms, including disruption of bacterial cell walls, enhancement of lysozyme and complement activity, and inhibition of nucleic acid translation and transcription [6].

Plant-derived products with antibacterial properties have been widely investigated for potential use in aquaculture systems. Research indicates that hexane extracts of oarweed (*Laminaria digitata*) (31 mg dry weight/mL) and methanolic extracts of red horn weed (*Ceramium rubrum*) (10 mg dry weight/mL) demonstrate significant antibacterial activity against 16 different marine bacteria and fish pathogens. The findings revealed that gram-positive marine Bacillaceae were more susceptible, whereas gram-negative marine Vibrionaceae were less susceptible. Additionally, studies have shown that an ethanolic extract of chaga mushroom (Inonotus obliquus) notably reduced cumulative mortality in kelp groupers (*Epinephelus bruneus*) infected with *Vibrio harveyi* when included in the diet at 20% and 15% for 1% and 2%, respectively, in contrast to the control group, which had a 90% mortality rate [7].

Phytobiotics as Antiviral Agent

Various ethanolic and methanolic herbal extracts, rich in bioactive compounds, can inhibit or block viral mRNA synthesis, thereby reducing viral replication in host cells and boosting non-specific immunity. Researchers have discovered that 18 traditional Thai herbs demonstrate antiviral activity against the Oncorhynchus masou virus (OMV) and Infectious Hematopoietic Necrosis Virus (IHNV). In addition, star gooseberry (*Phyllanthus acidus*) and *Ochrocarpus siamensis* were found to inhibit the replication of OMV and Infectious Pancreatic Necrosis Virus (IPNV) in traditional Indian medicinal plants such as *A. marmelos, C. dactylon, L. camara, M. charantia,* and *P. amarus,* and have shown significant antiviral effects against White Spot Syndrome Virus (WSSV) in *P. monodon*. Herbal extracts or phytobiotics can affect fungal cells by disrupting their cell walls, changing their permeability, and interfering with their metabolism and protein synthesis. A compound called 2-(3, 4-dimethyl-2,5-dihydro-1H-pyrrol-2-yl)-1-methyl ethyl pentanoate (DHP), extracted from *Datura metel*, showed antifungal activity against 19 *Aspergillus* species and 10 *Candida* species. Neem (*Azadirachta siamensis*) at a concentration of 5 ppm and tea tree oil (*Melaleuca alterniflora*) at 20 ppm have been found to have potent antifungal effects against *Aphanomyces invadans*. Additionally, ethanol extracts of common rue (*Ruta graveolens*) have demonstrated antifungal properties by inhibiting Saprolegnia sp. growth, whereas red algae, *Asparagopsis taxiformis,* have shown antifungal activity against *Aspergillus* species [8, 9].

Phytobiotics as Antiparasitic Agent

Monogenean parasites are flatworms that infect the skin, gills, and eyes of fishes. Species of the genera *Dactylogyrus*, *Gyrodactylus*, and *Neobenedenia* are common parasites that affect a wide range of cultured fish, leading to significant economic losses globally. Currently, there are no reliable methods for preventing monogenean infections in open aquaculture systems. The only option is to eliminate the attached parasite stages by using different bath treatments. Additionally, researchers have discovered that garlic extract is effective in killing the theront and tomocyst stages of the ciliate *Ichthyophthirius multifiliis*, which causes freshwater white spot disease, at concentrations of 62.5 mg/L and 570 mg/L, respectively [10].

Phytobiotics as Appetite Stimulators and Growth Promoters

Phytobiotics typically enhance the secretion of digestive enzymes and directly influence gut microflora. Plant extracts have been shown to improve nutrient digestibility and bioavailability, leading to improved feed conversion, increased protein synthesis, and enhanced fish growth. Hot spices, such as capsaicin from peppers and piperine from black pepper, along with cinnamaldehyde from cinnamon, are known to stimulate salivation. Studies have shown that feeding Nile tilapia (*Oreochromis niloticus*) a diet with garlic increases food intake, specific growth rate, and final weight. Moreover, papaya leaf meal has been shown to enhance protein digestion, improve the food conversion ratio (FCR), increase the specific growth rate (SGR), and promote weight gain in P. monodon post-larvae. Various plant extracts are also known to stimulate appetite and promote weight gain when administered to cultured species [11, 12].

CONCLUSION AND PERSPECTIVES

The health, growth, and reproductive success of cultured species are greatly affected by the parts of the herbs used, the extraction techniques applied, and the concentration of the extracts. Preparing, concentrating, and administering herbal extracts poses some challenges. Numerous studies have highlighted diverse activities and potential applications of herbal extracts in aquaculture. However, these extracts can be costly and may induce stress responses in fish. Therefore, oral administration is the most suitable method for aquaculture. The impact of herbal products on fish health is dose-dependent, making it crucial to determine the appropriate extract concentration before application. It is essential to identify, quantify, and characterize the bioactive molecules in various herbal extracts to develop a standardized protocol that includes optimal extraction methods and effective doses while excluding less effective administration methods.

REFERENCES

1. Harikrishnan R, Balasundaram C, Heo MS. Herbal supplementation diets on hematology and innate immunity in goldfish against Aeromonas hydrophila. Fish Shellfish Immunol. 2010;28(2):354–61. DOI: 10.1016/j.fsi.2009.11.013, PubMed: 19941960.
2. Christybapita D, Divyagnaneswari M, Michael RD. Oral administration of Eclipta alba leaf aqueous extract enhances the non-specific immune responses and disease resistance of Oreochromis mossambicus. Fish Shellfish Immunol. 2007;23(4):840–52. DOI: 10.1016/j.fsi.2007.03.010, PubMed: 17499515.
3. Thanikachalam K, Kasi M, Rathinam X. Effect of garlic peel on growth, hematological parameters and disease resistance against Aeromonas hydrophila in African catfish Clarias gariepinus (Bloch) fingerlings. Asian Pac J Trop Med. 2010;3(8):614–8. DOI: 10.1016/S1995-7645(10)60149-6.
4. Vasudeva Rao Y, Das BK, Jyotyrmayee P, Chakrabarti R. Effect of Achyranthes aspera on the immunity and survival of Labeo rohita infected with Aeromonas hydrophila. Fish Shellfish Immunol. 2006;20(3):263–73. DOI: 10.1016/j.fsi.2005.04.006. PubMed: 15961319.
5. Kumar A, Raman RP, Kumar K, Pandey PK, Kumar V, Mohanty S, et al. Antiparasitic efficacy of piperine against Argulus spp. on Carassius auratus (Linn. 1758): In vitro and in vivo study. Parasitol Res. 2012;111(5):2071–6. DOI: 10.1007/s00436-012-3054-z, PubMed: 22864920.
6. Harikrishnan R, Balasundaram C, Heo MS. Effect of chemotherapy, vaccines and immunostimulants on innate immunity of goldfish infected with Aeromonas hydrophila. Dis Aquat Organ. 2009;88(1):45–54. DOI: 10.3354/dao02143, PubMed: 20183964.
7. Divyagnaneswari M, Christybapita D, Michael RD. Enhancement of nonspecific immunity and disease resistance in Oreochromis mossambicus by Solanum trilobatum leaf fractions. Fish Shellfish Immunol. 2007;23(2):249–59. DOI: 10.1016/j.fsi.2006.09.015, PubMed: 17448687.
8. Eirna-Liza N, Hassim HA, Min CC, Syukri F, Karim M. The duration of protection conferred by garlic on African catfish (Clarias gariepinus) against Aeromonas hydrophila. J Aquac Res Dev. 2018;9(2):2.
9. Das R, Raman RP, Saha H, Singh R. Effect of Ocimum sanctum Linn. (Tulsi) extract on the immunity and survival of Labeo rohita (Hamilton) infected with Aeromonas hydrophila. Aquac Res. 2015;46(5):1111–21.

10. Kumar S, Raman RP, Kumar K, Pandey PK, Kumar N, Mohanty S, et al. In vitro and in vivo antiparasitic activity of azadirachtin against Argulus spp. in Carassius auratus (Linn. 1758). Parasitol Res. 2012;110(5):1795–800. DOI: 10.1007/s00436-011-2701-0, PubMed: 22042504.
11. Banerjee A, Manna S, Saha SK. Effect of aqueous extract of Azadirachta indica A. Juss (neem) leaf on oocyte maturation, oviposition, reproductive potentials and embryonic development of a freshwater fish ectoparasite Argulus bengalensis Ramakrishna, 1951 (Crustacea: Branchiura). Parasitol Res. 2014;113(12):4641–50. DOI: 10.1007/s00436-014-4155-7, PubMed: 25270235.
12. Kumar S, Raman RP, Kumar K, Pandey PK, Kumar N, Mallesh B, Mohanty S, Kumar A. Effect of azadirachtin on haematological and biochemical parameters of argulus-infested goldfish Carassius auratus (Linn. 1758). Fish Physiol Biochem. 2013;39:733–747. DOI: 10.1007/s10695-012-9736-8. PubMed: 23090629.

