THE USE OF PHYTOBIOTICS IN AQUACULTURE

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Abstract

The purpose of this paper was to summarize and evaluate current knowledge of phytobiotics use and action in fish culture, and their potential to be applied further in aquaculture production, because, in recent years, the fish consumption increased and total world production of fish has decreased. The main cause of the decrease fish production is the occurrence of diseases caused by different pathogens. The need for enhanced disease resistance, feed efficiency, and growth performance of cultured organisms is substantial for various sectors of this industry. It is preferable that, in the case of commercial aquaculture, the costs production to be reduced. Because the cost of antibiotics used for prevention and treatment of disease, and hormones used for growth performance is high, and from the desire to search for new options, several studies have been carried out to test new compounds, from which the aquaculture industry has developed the concept of „functional additives". This category includes also phytobiotics. Thus, it was proved that their use in fish diet led to improvement of the innate immune system for infection with various bacteria (Aeromonas hydrophila in particular) in different species of fish. In conclusion are needed further studies to find out the effective use of various phytobiotics with special reference to the timing, dosage, and method of administration.

Key words: phytobiotics, aquaculture, innate immunity, *Aeromonas hydrophila*, growth performance

INTRODUCTION

The aquaculture sector has been expanding at an average compounded rate of 9.2% per year since 1970, compared with only 1.4% for capture fisheries and 2.8% for terrestrial-farmed meat production systems. With the increasing intensification and commercialization of aquaculture production, infectious diseases are a major problem causing heavy loss to the fish farming industry [3]. The recent expansion of intensive aquaculture practices has led to high interest in understanding the various fish diseases, so that they can be treated or prevented. It is widely demonstrated that the occurrence of diseases in fish farm is due to several factors concerned with the rearing methods, environmental conditions and variations. Consequently, cultivated fish can become more susceptible not only to pathogenic but also to opportunistic bacteria [34].

Because, in intensive aquaculture, the use of antibiotics and chemotherapeutics for treatment and prophylaxis has been broadly criticized for its negative impact, and research on interactions between growth, immunity and development of eco-friendly alternatives to antibiotics that may keep fish healthy such as probiotics and plant based immunostimulants has increased, indigenous technological knowledge for treating diseases is enjoying attention in fish health and disease management [27]. In addition, the global demand for safe food has prompted the search for natural alternative growth promoters to be used in aquatic feeds. There has been heightened research in developing new dietary supplementation strategies in which various health and growth promoting compounds as probiotics, prebiotics, synbiotics, phytobiotics and other functional dietary supplements have been assessed [8].

In concerning evaluation of phytobiotics in aquaculture is a relatively new area of research showing promising results.

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This review summarizes and evaluates current knowledge of the use and the action of the phytobiotics in aquaculture and the potential for further application of this in fish production.

DEFINITION OF PHYTOBIOTICS AND THEIR THERAPEUTIC PROPERTIES

Phytobiotics are plant-derived, natural compounds embedded into diets which enhanced animal productivity.

Table 1 Main herbal plant extracts and their multiple therapeutic properties in aquaculture [7]

English name	Scientific name	Useful part	Active substance	Therapeutic properties
Aromatic species				
Nutmeg	*Myristica flagrans*	Seed	Sabinene	Digestion stimulant, antidiarrhoic
Cinnamon	*Cinnamomum zeylanicum*	Bark	Ammameldehyde	Appetite and digestion stimulant, antiseptic
Clove	*Syzygium aromaticum*	Cloves	Eugenol	Appetite and digestion stimulant, antiseptic
Caradamon	*Elettaria caramomum*	Seed	Cinook	Appetite and digestion stimulant
Coriander	*Coriandum sativum L.*	Leaves	Unalol	Digestion stimulant
Cumin	*Cuminum cyminum*	Seed	Cuminaldehyde	Digestive, galactagauge
Anise	*Illicum verum*	Fruit	Anethole	Digestive stimulant, galactagauge
Celery	*Apium graveolens*	Fruit, leaves	Phtalides	Appetite and digestion stimulant
Parsley	*Pelroselinum crispum*	Leaves	Apiol	Appetite and digestion stimulant, antiseptic
Fenugreek	*Trigonella foenum-graecum*	Seed	Trigonelline	Appetite stimulant
Pungent species				
Capsicum	*Capsicum annum longum*	Fruit	Capsaicin	Antidiarrhoic, stimulant tonic, antiinflammatory
Pepper	*Piper nigrum*	Fruit	Piperine	Digestion stimulant
Horseradish	*Cochlearia armoracia*	Root	Allyl isothiocyanate	Appetite stimulant
Mustard	*Brassica spp.*	Seed	Allyl isothiocyanate	Digestion stimulant
Ginger	*Zingiber officinale*	Rhizom	Zingerole	Gastric stimulant
Aromatic herbs and spices				
Garlic	*Allium tuberosum*	Bulb	Allicin	Digestion stimulant, antiseptic
Rosemary	*Aniba rosaeodora*	Leaves	Cineole	Digestion stimulant, antiseptic, antioxidant
Thyme	*Thymus vulgaris*	Whole plant	Thymol	Digestion stimulant, antiseptic, antioxidant
Sage	*Salvia apiana*	Leaves	Cineole	Digestion stimulant, antiseptic, carminative
Bay laurel	*Laurus nobilis*	Leaves	Cineole	Appetite and digestion stimulant, antiseptic
Peppermint	*Mentha piperita*	Leaves	Menthol	Appetite and digestion stimulant, antiseptic
Artemisia	*Artemisia annua*	Leaves	Artemisin	Anticoccidial
Neem	*Azadirachta indica*	Leaves, bark,	Azadirachtin, salanin, numbin	Antiviral, antiseptic, fungicidal

The phytobiotics have a wide variety of properties such as: antioxidant, antimicrobial, anticarcinogenic, analgesic, insecticidal, antiparasitic, anticoccidial, growth promoters, appetite enhancement, stimulant of secretion of bile and digestive enzyme activity, laxatives and antidiarrhea, hepatoprotection (Table 1).

CURRENT STATE OF PHYTOBIOTICS USE IN AQUACULTURE

Immunity stimulation. The immune systems of fish and higher vertebrates are similar and both have two integral components. First component is the innate, natural or nonspecific defense system formed by a series of cellular and humoral components, and second is the adaptive, acquired or specific immune system characterized by the humoral immune response through the production of antibodies and by the cellular immune response which is mediated by T-lymphocytes, capable of reacting specifically with antigens [20].

The first line of defense against invading pathogens in fish [21] is constitute by the major components of the innate immune system. They are macrophages, monocytes, granulocytes, and humoral elements, like lysozyme or complement system [19].

In aquaculture one of the most promising methods strengthening of the defense mechanism disease management is through prophylactic administration of immunostimulants [25]. In fish, the immunostimulants are known to increase certain aspects of innate immunity [11].

Recent advancement in immuno-nutrition studies revealed that some nutrients are linked to the immunological status of fish [17]. This has drawn the attention of fish nutritionists to the immunoprotection of fish besides the growth. Sustainable aquaculture depends on perfectly balance between health and growth condition of fish. The use of chemotherapeutics and antibiotics to combat fish diseases has the risk of generating resistant pathogens, bioaccumulation and environmental pollution. The commercial vaccines are expensive for fish farming practices and are specific against particular pathogens [17].

It has been shown that herbal based immunostimulants are capable of enhancing nonspecific and specific defence mechanisms and/or reducing losses from viruses, bacteria and/or parasitic infections in carp [28, 29, 26]. Several plant materials/products such as *Eclipta alba* [6], *Aloe vera* [15], *Ocimum sanctum* [18], *Viscum album*, *Urtica dioica* and *Zingiber officinale* [10], *Solanum trilobatum* [9], *Astragalus radix* and *Scutellaria radix* [36], and *Achyranthes aspera* [33] have been reported to enhance the immunity of fish.

The prophylactic effect of dietary garlic aplication to rainbow trout, infected with *Aeromonas hydrophila*, was confirmed by Nya and Austin (2011) [22]. Thanikachalam et. al., in 2010, showed that the embedding of garlic peel in feed enhances the hematological parameters even at a low level (0.5%) incorporation and makes *Clarias gariepinus*, fingerlings, highly immunopotent and more resistant to infection by *A. hydrophila* [32].

In the speciality literature has shown that decaffeinated green tea in lower doses (20mg /kg feed) of administration could be optimum to enhance the immunity of rainbow trout [31], but in some species of fish, several studies have also been reported on the reduction of growth and body lipid accumulation in yellowtail (*Seriola quinqueradiata*) and ayu (*Plecoglossus altivelis*) by green tea extracts and ground green tea [16].

Bilen et. al. (2011) showed the highest values of the non-specific immune parameters (respiratory burst activity, phagocytic activity, lysozyme activity, total protein levels). These values were observed in the group of rainbow trout fed with 1% tetra (*Cotinus coggyria*). Tetra groups did not show any significant difference ($P > 0.05$) in terms of specific growth rate and average weight of the fish [2].

The ethanolic extract of plant *Cynodon dactylon* is very effective immunostimulant in *Catla catla* against *A. hydrophila* infection. This plant extract could develop or induce the specific antibody in fish against the antigen, especially at the higher (5%) concentration [14]. Chakrabarti and Vasudeva (2006) also stated that prophylactic treatment of *Achyranthes aspera* significantly enhanced the specific antibody response and antigen clearance against BSA in *C. catla* [5]. Similarly, Spirulina significantly enhanced the antibody titers to keyhole limpet haemocyanin (KLH) in channel

catfish *I. punctatus*. In addition, Hemapriya et al. (1997) reported that the intraperitoneal administration of leaf extract of *Acalypha indica*, *Phyllanthus niruri* and seed kernel of *A. indica* enhanced the antibody response in tilapia against sheep red blood cells [13].

Harikrishnan et. al. (2010), suggested that intraperitoneal administration of the leaf extracts of *P. granatum* at 50 or 100 mg/kg dose clearly enhance the innate immune responses and disease resistance after 8 weeks in *P. olivaceus* against natural LDV (lymphocystis disease virus) infection [11]. In 2010, also, reported that the mixed herbal (*Azadirachta indica*, *Ocimum sanctum* and *Curcuma longa*) supplementation feeds responsible for returning haematological and biochemical parameters to near normal values and triggering the immune system of the specific and innate immunity of goldfish against *A. hydrophila* when treated with 400 mg/kg or 800 mg/kg of mixed herbal supplementation feeds undoubtedly, and, indicated that the ethanol of triherbal solvent extracts seems to be a better immunostimulant, which can have a promising role in aquaculture to prevent diseases and infectious outbreaks [12].

Sahu et. al. (2007) reported that long term dietary administration of mango kernel led to considerably increases immunity and survival of fingerlings of rohu. The group fed with 5 g kernel/kg dry diet showed highest percentage survival (98%). Results indicated that mango kernel stimulates the immunity and makes *Labeo rohita* more resistant to *A. hydrophila* infection [27].

Have achieved high values of hemoglobin, hematocrit, lysozyme and myeloperoxidase activity, the addition of thyme, rosemary and fenugreek in fish feed. Thus these herbal plants could be considered as feed additives for improving haematological and immune status and so the fish welfare in aquaculture [35].

Antioxidant effect of phytobiotics on stress. Fishes from the intensive culture systems are continuously exposed to a form of stress, so it can lead in organism significant changes of biochemical and physiological level. Fishes from the intensive culture systems are continuously exposed to a form of stress, so it can lead in organism significant changes of biochemical and physiological level. Stress factors include: repeated handling, high density, therapeutic treatments, improper water chemistry, temperature changes etc. Onceanu Mariana demonstrated that the use of plant extracts of *Allium ursinum* and *Alliaria petiolata*, in fish feed, can determine, in certain concentrations (2% and 5%), reduction of stress induced by intoxication with sodium nitrite or due to high density on *Oncorhynchus mykiss* species [23].

Growth performance. Various types of feed additives enhance the digestibility and/or utilization efficiency of nutrients, including exogenous enzymes, stimulators of enzyme secretion, compounds that aid in the digestive process by improving absorption, mobilization and transport of nutrients, feeding stimulants that reduce feed/nutrient waste, prebiotics, probiotics, and botanical extracts that modulate gut microflora. Nile tilapia that received diets supplemented with a mixture of digestive herbal extracts, natural emulsifying agents and co-factors of digestion had better feed conversion and protein efficiency than fish whose diets did not contain the mixture [4].

Seung-Cheol et al. [30] showed that the addition of different single herbal extracts (*Massa medicata*, *Crataegi fructus*, *Artemisia capillaries*, *Cnidium officinale*) or a mixture of all the herbs promoted growth and enhanced some non-specific immunity indicators of red sea bream *Pagrus major*. Among a wide variety of herbs tested against *A. hydrophila* infection in tilapia (*Oreochromis niloticus*), the ethanol extract of *Psidium guajava* was found to have the highest antimicrobial activity [24].

Abd-El-Rhman (2009) evaluated the increased *Oreochromis niloticus* resistance to *A. hydrophila* by using crude propolis and its ethanolic extract as non-specific immunostimulant and to study their effect on growth performance. He found that the propolis-ethanolic-extract enhanced the growth, immunity and resistance of Nile tilapia against *A. hydrophila* more than the crude propolis [1].

CONCLUSIONS

Certainly, the use of immunostimulants as functional additives is acknowledged to improve the non-specific defence mechanism in fish, so giving resistance to infections. Exciting would be to argue that the fish innate immune system not dispose of memory, and as such the duration of beneficial immunostimulant induced responses will inevitably be shorter than the specific or adaptive immune response. Also, consider that the fish exposure on a long period to immunostimulants can lead to the elimination of immune function, natural immune system thereby losing sensitivity. After consulting the literature it can be said that the ethanolic extract of various phytobiotics would be more effective than raw phytobiotics, aqueous or methanolic extract of phytobiotics.

In conclusion the studies by various authors have been proved efficient of phytobiotics in innate immune system in fish, but also on growth performance. Further studies are needed to find out the effective use of various phytobiotics with special reference to the timing, dosage, and method of administration.

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