



International Journal of Fauna and Biological Studies

Available online at www.faujournal.com

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International
Journal of
Fauna And
Biological
Studies

ISSN 2347-2677

IJFBS 2019; 6(1): 10-14

Received: 16-11-2018

Accepted: 19-12-2018

Anita

Department of Aquaculture,
College of Fisheries, Junagadh
Agricultural University, Veraval,
Gujarat, India

Akansha Khati

Department of Aquaculture,
College of Fisheries, GBPUAT,
Pantnagar, Uttarakhand, India

Biomedicines and their role in fish health management

Anita and Akansha Khati

Abstract

The present study reviews the role of plant and animal originated biomedicines and probiotics in the field of aquaculture. Many herbal and animal originated extracts prove their potential as anti stress, antioxidant, antibacterial, anti fungal and viral, appetite stimulator, potent immunomodulator and growth promoter. These herbal extracts and animal originated extracts stimulate the growth and immunity of fishes and they reduce the cost of feed as they are easily available and cheap feed ingredients. They reduce the chances of emergence of pathogens which may cause serious threat to fish health and environment. Yet the diseases, pathogens and pest can be treated with chemicals and antibiotics but due to their residual side effect and bio magnification in the body of fish forces the researchers to search suitable alternatives for healthy fish, environment and sustainable fish production.

Keywords: Antioxidant, biomedicine, immunomodulators, probiotics

Introduction

Aquaculture sector is substantially growing food producing sector for future generation. India is the 2nd largest fish producer country in the world and contributes 6.29% of world's fish production (FAO, 2012). Besides providing food security the sector also provides livelihood security to 14.49 million peoples in India (DAHDF, 2013) [3]. This sector is facing serious threats due to the intensification of aquaculture production, the emergence of various infectious pathogens and pest causing savior disease outbreaks, resulting in high economic losses. Although, various antibiotics, hormones, vitamins are commonly used as medicines by the Farmers which generally cause various side effects and many farmers are not aware of proper method of application, amount of dose and their negative impact on fish health and environment. Intensified use of drugs and antibiotics are causing the problem of drug resistant, antibiotic resistant bacteria and degradation of environment. Jayaprakas and Sambhu, in the year 1996 studied this problem and they suggested that these chemicals should not be recommended in commercial fish production because they found the residual accumulation of antibiotics in the edible tissues of fishes and prawns. The intensive use of antibiotics in fish and shrimp hatcheries has resulted in bioaccumulation and tissue bio magnifications which is the main reason of rejection of consignment during export in international market. Recently concept of biomedicines is providing an alternative for enhancing the health of fish and fish products produced in aquacultural operations. They possess the potential of promoting growth of fishes and also improving their immune system and appetite stimulators. Now, globally, people are aware of the negative impact of antibiotics and are shifting over to natural products (Fauci 1993) [19]. Citarasu. (2010) [13] studied herbal biomedicines: a new opportunity for aquaculture industry. Hormones, antibiotics, vitamins and several other chemicals have been tested in aquaculture operations for various remedies. The alternative herbal bio-medicinal products used in the aquacultural operations have growth promoting ability, work as tonic to improve the immune system and act as appetite stimulators. Herbal compounds such as phenolics, polyphenols, alkaloids, quinones, terpenoids, lectins and polypeptides have been shown to be very effective alternatives to antibiotics and other synthetic compounds.

Biomedicines Commonly Used In Aquaculture

In aquaculture generally three kinds of biomedicines are mostly used *viz.* plant originated, animal originated and probiotics. Various researchers investigated the potential of all these biomedicines for healthy fish production and environment safety. Chanu *et al.*, in 2012 reviewed the Herbal Biomedicine as an Alternative to Synthetic Chemicals in Aquaculture Feed in Asia and concluded that the use of herbal biomedicines in aquaculture will reduce the

Correspondence

Anita

Department of Aquaculture,
College of Fisheries, Junagadh
Agricultural University, Veraval,
Gujarat, India

emergence of pathogenic bacteria, viruses, fungus, protozoa and parasitic infections. While Bairwa *et al.* in the year (2012) [8] reviewed the herbal extracts and animal originated products that have been shown to modulate the immune system of fish.

Plant originated/ Herbal Biomedicine/Phytobiotics

Phytobiotics are plant-derived biomedicines, natural compounds embedded into diets which enhance the growth and immunity of the cultivated fishes. In Indian Ayurveda herbal plants are known for medicinal value such as antistress, promotion of growth, immunostimulation, antivirals, antibacterial, antifungal, appetite stimulators and aphrodisiac activities. The use of herbal plants/ plant extracts/ herbs are safe and highly economic. The plant extracts contain active ingredients like alkaloids, polyphenols phenolics, lectines, quinones, terpenoids, flavonoids, pigments, polysaccharides, essential oils and polypeptides with antioxidant, antimicrobial, antistress, growth promotion, appetite stimulation, tonic and immunostimulation, and aphrodisiac properties. Some examples of phytobiomedicines are *Tinospora cordifolia*, *Glycyrrhiza glabra*, *Ocimum sanctum* (Tulsi), *Phyllanthus emblica* (Amla), *Azadirachta indica* (Neem), *Solanum trilobatum* (Purple Fruited Pea Eggplant), *Eclipta alba* (Bhringraj), *Zingiber officinale* (Ginger), *Sida cordifolia* (Bala), *Si Echinacea* (Purple coneflowers), *Allium sativum* (Garlic), *Camellia sinensis* (Green tea), *Aloe vera*, *Cynodon dactylon* (Bermuda Grass), walnut (*Tetracarpidium conophorum*), *Achyranthes aspera* (Prickly Chaff Flower), *Nyctanthes arbortristis* (Night-flowering Jasmine), and *Picrorhiza kurooa* (Kutki), Watercress (*Nasturtium nasturtium*), *Coriandrum sativum*, *Plumbago rosea* etc.

Properties of Phyto Biomedicines

- 1. Antioxidant Properties:** Herbal plant extracts are rich in antioxidants. The antioxidants present inside them help to deal with oxidative stress caused by free radical damage (Chanu *et al.*, 2012). Certain compounds present in basil (*Ocimum*) possess strong antioxidant activity (Middleton and Kandaswami 1993) [34]. *Tinospora cordifolia* (Gulvel, Guduchi) is very potent antioxidant, radio protective, anti hyper glycemc, anti-inflammatory herb (Mutalik and Mutalik, 2011) [36].
- 2. Antimicrobial Activity:** The herbal extracts are source of many phenolic compounds, polysaccharides, proteoglycans and flavonoids which plays very important role in preventing or controlling infectious pathogens and microbes. Punitha *et al.* (2008) [37] observed that herbals such as *Cynodon dactylon*, *Piper longum*, *Phyllanthus niruri*, *Tridax procumbens*, and *Zingiber officinalis* extracts with acetone, benzene, butanol, and petroleum ether and screened against the pathogen *Vibrio harveyi* isolated from the infected Grouper *Epinephalus tauvina*. Incorporated diets significantly increased the survival, growth and immune responses compared to the control group. Sakkaravarthi *et al.* (2010) [39] observed antibacterial activity of herbal extract on pathogens isolated from the swollen hind gut of *Penaes Monodon* he suggested that the methanol extract of *Ricinus communis* played a vital role in the disease resistance of black tiger shrimp *Penaes monodon*. Hari Krishnan *et al.* (2010) [24] studied identification and antimicrobial activity of combined extract from *Azadirachta indica* and *Ocimum sanctum*. The antimicrobial activity of

methanolic and ethanolic extracts of walnut (*Tetracarpidium conophorum*) leaves and onion bulbs (*Allium cepa*) were evaluated against six pathogenic bacteria (*Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas fluorescens*, *Escherichia coli*, *Salmonella typhi*) using the cup – plate method by Bello *et al.* (2013) [10].

- 3. Antistress Activity:** Ayurvedic herbs possess the potential of reducing stress in human. The herb *Picrorhiza kurroa*, was used as an anti stress compound for shrimp (Citarasu *et al.* 1998) [11]. *Tinospora cordifolia* (Guduchi) is well known anti stress herb in ayurveda (Mittal *et al.* in 2014) [35]. Safer and cheaper herbal medicines are useful as antistress agents because animals can withstand stress without altering physiological functions. Various herbs, *Withania somnifera*, *Emblca officinalis*, *Asparagus racemosus*, *Ocimum sanctum*, *Tribulus terrestris* and *Piper longum*, are claimed to have adaptogenic, anabolic effects and the ability to improve vital energy. Liu *et al.* (2012) [31] evaluated the effects of anthraquinone extract and emodin from *Rheum officinale* on the physiological response, disease resistance of *Megalobrama amblycephala* under high temperature stress.
- 4. Antiviral Activity:** Several plant products have potent antiviral activity against fish and shrimp viruses. Methanol extracts of five different herbal medicinal plants, such as *Cynodon dactylon*, *Aegle marmelos*, *Tinospora cordifolia*, *Picrorhiza kurroa* and *Eclipta alba*, were incorporated into a diet for WSSV-infected shrimp. Better values of haematological, biochemical and immunological parameters were found in shrimp fed a diet that incorporated immunostimulants (Citarasu *et al.* 2006).
- 5. Immunostimulant Activity:** An immunostimulant is a chemical, drug, stressor or action that enhances defense mechanisms or immune response. When an immunostimulants is given as dietary supplements it can improve the innate defense of animals which will provide them resistance against pathogen infection. The use of medicinal herbs as immunostimulants in aquaculture is increasing day by day which includes the use of herbal extracts *viz.* glycyrrhizin, *T. cordifolia*, *Emblca officinalis*, *Cynodon dactylon*, *Adathoda vasica*, *O. sanctum*, *Myristica fragrans*, *E. alba*, and *Aegle marmelos*, *P. kurooa* and *W. somnifera* against various disease causing pathogens in fishes. Sudhakaran *et al.* (2006) [40] studied immunostimulatory effect of leaf extract of *Tinospora cordifolia* on specific immunity and disease resistance against *Aeromonas hydrophila* on *Oreochromis mossambicus*. Asadi *et al.* (2012) observed the immunomodulatory effects of watercress extract on immunological and hematological parameters of rainbow trout (*Oncorhynchus mykiss*). The results indicated that the oral administration of 1 % watercress extract in fish may enhance some hematological and immunological parameters including Hb and MCHC, lysozyme and complement activities, total protein and globulin levels, compared to the controls after 21 days of experimental period. Alambra *et al.* in 2012 studied the immunomodulatory potential of Turmeric (*Curcuma longa*) on *Macrobrachium rosenbergii* against *Vibrio alginolyticus*. Arulvasu *et al.* (2013) [5] observed efficacy

of different dietary doses of *Zingiber officinale* powder for the immune response and the disease resistance of the Indian major carp (*Catla catla*) infected by *Aeromonas hydrophila*. The total erythrocyte, leukocyte count, haemoglobin content and total serum protein were significantly ($P < 0.05$) enhanced in *Z. officinale* supplemented groups.

6. **Antifungal Activity:** Many herbal extracts/ plants affect lysis of fungal cell walls they also alter the permeability of membrane, affect metabolism and protein synthesis and finally death of fungal cell. Many plants have antifungal properties like *Tinospora cordifolia*, *W. somnifera*, *Ocimum sanctum*, *Azadirachta indica*. A DMSO extract of *Tamarix dioica* has significant activity against *A. flavus* and moderate activity against *F. solani* (Khan *et al.* (2004) [27]). Ali, Enas M. in the year 2013 studied the phytochemical composition, antifungal, anti aflatoxicogenic, antioxidant, and anticancer activities of *Glycyrrhiza glabra* L. and *Matricaria chamomilla* L. essential oils.
7. **Appetite Stimulants:** In Ayurveda it is found that various plant extracts from herbs and spices helps in improving the performance of animal either by stimulating gut secretions or by a direct bactericidal effect on gut microflora. The active components present in the herbs/ plant extracts when incorporated in diets they induces the secretion of digestive enzymes and stimulates amylase production. They have potential to stimulate appetite thereby increasing food consumption and improving feed conversion efficiencies.
8. **Aphrodisiac Activity:** Medicinal plants/ herbs are well known for the potential of hormonal boosting. Babu 1999 in his study concluded that the black tiger shrimp fed a maturation diet containing *W. somnifera*, *Mucuna pruita*, *Ferula asafoetida* and *Piper longum* extracts had increased fecundity and gonadal weight and reduced intermolt periods compared to controls.
9. **Growth Promoting Activity:** Herbs are well known for better health and growth promotion since ancient times. Kaur *et al.* (2004) studied use of herb Bala (*Sida cordifolia* Linn.) as growth promoter in the supplementary feed of *Cirrhinus mrigala* (Ham.). Kumar *et al.* (2007) [30] found the growth per day in per cent body weight, average weight gain, food conversion ratio (FCR), gross conversion efficiency (GCE) and specific growth rate (SGR) were significantly higher ($P < 0.05$) in all the three treatments (root powder of mulethi (*Glycyrrhiza glabra* in feed of *Cirrhinus mrigala*) as compared to control. DADA (2012) studied effects of herbal growth promoter feed additive in fish meal on the performance of Nile Tilapia (*Oreochromis niloticus*). Results revealed that the medicinal herbs in diets enhance growth, feed utilisation and survival of *O. niloticus* fingerlings. Heidarieh *et al.* (2013) [25] studied the effects of dietary Aloe Vera on growth performance, skin and gastrointestinal morphology in Rainbow trout (*Oncorhynchus mykiss*). Results showed that Aloe vera at 0.1% and 1% administration resulted in improved specific growth rate (SGR) and feed conversion ratio (FCR). All the findings suggested that herbal extracts are environment friendly growth promoters for fishes.

Animal originated

1. **Chitin and chitosan:** Chitin and chitosan are non-

specific immunostimulators which are effective on a short term basis. Chitosan is a deacetylation product of chitin. Both chitin and chitosan are isolated from shrimp shell waste and they play very important role in aquaculture as growth promoters and immunostimulators. Maqsood *et al.*, in the year 2010 worked on effect of dietary chitosan on non-specific immune response and growth of *Cyprinus carpio* challenged with *Aeromonas hydrophila*. Common carp with an average weight of 45 ± 2 g and total length of 31 ± 2 cm were fed diets containing 0 (control), 1%, 2% and 5% chitosan for a period of 70 days. Phagocytic index, phagocytic ratio and serum bactericidal activity were increased in the chitosan fed (2 and 5%) groups, compared to the control group ($P < 0.05$). After the fish in all treatments were challenged intra-peritoneally with *Aeromonas hydrophila*, the relative percentage survival (82.78 %) was higher in chitosan (2%) group ($P < 0.05$) when compared to other treatments. Feed conversion ratio (1.81) and specific growth rate (2.67) were higher in chitosan fed (2%) group, when compared to other treatments. The findings revealed that dietary supplementation of Chitin and chitosan improved the survival, specific growth rate, phagocytic index, phagocytic ratio and serum bactericidal activity in the fishes.

Fermented products of chicken egg (EF203)

Other animal originated biomedicine is fermented products of chicken egg (EF203) which is rich in immunologically active peptides. The peptides showed Immunostimulatory effects on oral administration to rainbow trout, *Oncorhynchus mykiss*. The kidney shows chemiluminescent responses to phagocytes after treatment with EF203 were significantly increased. Fish administered EF203 showed high phagocytic activities as compared to controls, and immunomodulatory effects were found to be dose dependent (Bairwa *et al* 2012) [8].

2. **Probiotics:** Probiotics are defined as "A live microbial feed supplement which beneficially affects host animal by improving its intestinal microbial balance" (Fuller, 1989). Based on the previous research results on use of probiotics in farm animals, it has been suggested their use in aquaculture has tremendous scope and the study of the application of probiotics in aquaculture has a glorious future. Probiotics principally inhibit the growth and decrease the pathogenicity of the pathogenic bacteria, enhance the nutrition of the aqua-animals, improve the quality of the aquaculture water and decrease the use of antibiotics and other chemicals; thus decreasing environmental contamination by the residual antibiotics and chemicals. The first application of probiotics in aquaculture seems relatively recent (Kozasa, 1986) [29], but the interest in such environment friendly treatment is increasing rapidly Gibson and Roberfroid (1995) [23] introduced the concept of 'probiotics'. It is defined as non digestible food ingredients that beneficially affect the host by selectively stimulating the growth and the activity of one or a limited number of bacteria in the colon, and thus improves the health. Douillet and Langdon (1994) [17] have reported use of probiotics for the culture of larvae of the Pacific oyster (*Crassostrea gigas* Thunberg). They added probiotic bacteria as a food supplement to xenic larval cultures of the oyster *Crassostrea gigas* which consistently enhanced growth of

larvae during different seasons of the year. Rengpipat *et al.*, (2000) [38] mentioned that the use of *Bacillus* species (strain S11) provided disease protection by activating both cellular and humoral immune defenses in tiger shrimp (*P. monodon*). It has been reported that the use of *Bacillus* species improved water quality, survival and growth rates and increased the health status of *P. monodon* and reduced the pathogenic vibriosis (Dalmin *et al.*, 2001) [15]. Ghosh *et al.*, (2003) [22] reported that addition of probiotics reduced culture costs of Indian major carps. Ajitha *et al.*, (2004) [2] demonstrated that LAB was able to protect *Penaeus indicus* against disease caused by *Vibrio alginolyticus*. Balcazar *et al.*, (2006) [9] have suggested that microorganisms have a beneficial effect in the digestive processes of aquatic animals, especially by supplying fatty acids and vitamins. In addition, some bacteria may participate in the digestion processes of bivalves by producing extracellular enzymes, such as proteases, lipases, as well as providing necessary growth factors. Gatesoupe (2008) [21] reported that feeding with Gram-positive as well as Gram negative selected probiotics caused and increases cellular parameters such as the number of erythrocytes, lymphocytes and macrophages and enhanced lysozyme activity. Influence of probiotic bacteria, *Lactobacillus rhamnosus* on blood profile of rainbow trout *Onchorhynchus mykiss* (Walbaum) was observed by Panigrahi *et al.*, (2009) [1].

Conclusion

The irrational use of antibiotics, chemotherapeutic agents and antimicrobial growth promoters is causing emergence of various pathogens in aquatic ecosystem. Herbal biomedicines are potent alternate to synthetic drugs and antibiotics in aquaculture. The responsible authorities should sincerely review the current legislation and form a strong framework regarding the use of herbal biomedicines and probiotics in aquaculture and become more flexible in their application. Most of the herbs, animal extract and probiotics are administered orally being the most convenient method of immunostimulation and growth promotion. However, the effect is dose-dependent; therefore dose standardization is must. Use of biomedicines as immunostimulants in fish culture systems is ecofriendly approach for a better tomorrow.

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