

Role of Medicinal Plants in Aquaculture

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Aquaculture is the fastest growing animal food producing sector. Global aquaculture production in 2020 reached a record 122.6 million tonnes of which around 54.4 million tonnes were farmed in inland waters and 68.1 million tonnes came from marine and coastal aquaculture (FAO,2022). However, aquaculture growth is often linked to culture intensification facilitating the spread of pathogens and increasing disease outbreaks and mortality.

Intensive use of antibiotics has resulted in accumulation in muscle of commercialized animals and the development of resistant bacteria strains. Thus, alternative solutions should maximize fish immunity and fitness as a strategy to face pathogen infections. Medicinal plants can therefore provide a cheaper and more sustainable alternative to chemotherapy in aquaculture, since they have been reported to display numerous bioactivity such as anti-stress, immunostimulant and antiparasitic (bacterial, fungus, virus and ectoparasites) effects.

Medicinal Herbs

The medicinal plants are gaining success in aquaculture because they are cheaper, eco-friendly and have minimal side effect that proved to be most promising alternative for antibiotics in the treatment of various infectious diseases.

More than 60 different medicinal herb species have been applied to treat aquatic diseases in aquaculture. Several parts of medicinal plants including seeds, leaves, roots and flowers or sometimes extracted compounds from the medicinal plant parts have been studied in fish culture to ascertain their health benefits.

In aquaculture medicinal plants are administered through injection, bathing/immersion or oral through feed. Medicinal plants have been applied as immunostimulants as mono species, multispecies and in combination with other feed additives such as probiotics.

Different plants contain considerable bioactive compounds including steroids, proteins, tannins, saponins, terpenoids and alkaloids. Medicinal plants have numerous biological functions such as antimicrobial activities, ameliorating stress, promoting growth, orexigenic and immune booster in fish.

The medicinal plant species that most widely used in aquaculture are Ginger (*Zingiber officinale*), Onion (*Allium cepa*), Tulsi (*Ocimum sanctum*), Garlic (*Allium sativum*), Bermuda grass (*Cynodon dactylon*), Pomegranate (*Punica granatum*), Indian ginseng (*Whitania somnifera*), Neem (*Azadirachta indica*), Kalmegh (*Andrographis paniculata*), Bhringaraj (*Eclipta allea*) and Thyme (*Origanum heracleoticum* L).

Use of Medicinal Plants as Growth Promoter

One of the modulatory actions of herbal plants is to promote growth. Growth promoters are proven to enhance the secretion of digestive enzymes leading to increased survival and growth rates of aquatic organisms particularly for fish. In contrast to the antibiotic herbal medicines have outstanding features such as rich in protein, amino acids, lipids, vitamins and some unknown components that could promote growth and strengthen the metabolism of aquatic animals. Numerous plant extracts are confirmed to have induced appetite and increase weight gain administered to cultured fish.

Dietary ginger and aloe vera extract improved growth performance, antioxidant capacity and gene expression in *Cyprinus carpio*. An extract of the herbal plant such as emodin has been proven to improve the growth rate of freshwater prawns (*Macrobrachium rosenbergii*).

Use of Medicinal Plants as Anti-Stress and Immunostimulants

In intensive aquaculture aquatic animals are vulnerable to adverse stresses from their living surroundings such as poor water quality, high environmental temperature, overcrowding and pathogen infection. These adverse stressors reduced the immune capacity which could further inhibit the growth performance disturb the metabolic and antioxidant balance and even induce disease outbreaks and massive mortalities.

Medical plants or herbal medicines are natural resources that are reserved abundantly in nature. In contrast to the antibiotic herbal medicines have outstanding features such as highly effective, low toxicity and side effects in medicinal treatment when used properly. Rosemary leaf mitigated the adverse effects of crowding stress in *C. carpio* and turmeric

improved the anti-stress ability of *common carp* during copper exposure.

Herbal medicines were well studied to improve the immunity of aquatic animals. Immunostimulants are naturally occurring or synthetic compounds aimed at stimulating the immune system through specific (vaccine or antigen) and non-specific actions (without antigen specificity). Various research demonstrated that intraperitoneal injection or oral administration of plant extracts enhanced phagocytic and lysosomal function, respiratory burst and complement activity and serum protein level in some distinct fish species.

The supplementation of olive leaf extract at a level of 0.1% enhanced the immune-related genes expression, serum biochemistry parameters and survival rate in rainbow trout.

Enhanced Antimicrobial Activity

The herb extract has excellent antibacterial activity against Gram-positive and Gram-negative bacteria. They can even be used to treat certain diseases caused by viruses, parasites and fungi.

Aeromonas hydrophila, an opportunistic aquatic pathogen causes several major diseases including skin ulcers and haemorrhagic septicaemia. feeding 15 g/kg tamarind pulp extract promoted growth, nutrient digestibility of Nile tilapia and protection against *A. hydrophila* infection. Plant species that have antiviral activity against aquatic primary pathogenic viruses as follows: white spot syndrome virus (WSSV), grouper iridovirus (GIV), grass carp reovirus (GCRV), spring viraemia of carp virus (SVCV) and cyprinid herpesvirus 2 or 3 (CyHV).

Fungal diseases are the fourth most infectious disease that damage tissue on the exterior of the fish. The extraction of medicinal plants may lyse fungal cell wall, altering its permeability, affecting metabolism and RNA and protein synthesis which ultimately causes death of the fungal pathogen. The extract of Indian almond leaves (*T. catappa*) has potentiality to reduce the fungal infection of tilapia eggs.

The most important parasitic diseases that pose significant treat to fish population are *Ichthyophonus*, *Nanophyetus salmincola*, *Ichthyophthirius multifiliis*, *Dactylogyrus*, *Gyrodactylus* and Whirling diseases. medicinal plants have antiparasitic effect against fish ectoparasites. Herbal plants such as *Galla chinensis*, *Carica papaya* and *Macleaya cordata* exhibit good therapeutic efficacy and preventive effect against *Ichthyophthirius multifiliis*.

Role of Medicinal Plants as Adjuvant Effect for Fish Vaccines

For more effective working of vaccines addition of potent adjuvant is the important consideration. Generally, adjuvant is a substance that is distinct from antigen. Adjuvant primarily plays major role in enhancing B and T cell activation by promoting the accumulation and activation of antigen presenting cells (APC) at the site of antigen exposure. Adjuvant also prolongs the expression of peptide MHC complexes on the surface of APCs. Herbal plants should be used in combination with vaccination program to improve fish health.

Prunella vulgaris extract resulted in significant higher level of antibody production when used as adjuvant for a tilapia vaccine. dietary supplementation containing garlic (*Allium sativum*), eastern purple coneflower (*Echinacea purpurea*), Organic Green and Vet-Yeast before vaccination with *Aeromonas hydrophila* increases antibody titre and survival as compared with fish treated with only vaccine.

Mode of Administration and Dosage of Medicinal Plants in Aquaculture

Administration of medicinal plants include either whole plant or its part (leaf, seed, root, fruit) which can be used as fresh or prepared extracts with different solvents (water, chloroform, methanol, ethyl acetate). Also, appropriate dosing plays an important role to obtain desirable effects because inappropriate dose exhibits toxic effects in fishes. Supplemented diet containing 1% ethanol katuk leaf extract (*Sauropus androgynous*) showed enhanced growth and improved food utilization as compared to 2.5% and 5% which resulted in lower growth levels in grouper (*Epinephelus coioides*).

Treatment length is second most important requirement in medicinal plants because it directly influences treatment effectiveness. Farmed barramundi (*Lates calcarifer*) fed with enriched diet of garlic (*Allium sativum*) for 30 days resulted in 70% decreased of *Neobenedenia* sp infection compared to control and short-term treatment of 10 days.

Administration of medicinal plants in aquaculture includes oral administration, immersion or baths as well as intraperitoneal or intramuscular injection and these three methods are not creating any kind of threat to people health, fishes and environments because medicinal plants are of natural origin. Intraperitoneal injection of herbal extract has proved to be most rapid and efficient method of

administration but cannot be operating on large production. This method disadvantage is that it creates stressful condition for fishes especially for young ones and also this technique is expensive and laborious.

Bath techniques also exhibit positive results. Immersing the fishes into different medicinal plant extracts can treat various bacterial and fungal pathogens (Hu *et al*, 2014). They are enormously used for the treatment of ectoparasites. Treatment or dose should be determined per used of medicinal plants and the quantity of fish. Fish have to be taken out of the water for treatment which leads to the stress and also this technique is expensive and laborious.

Oral administration seems to be most suitable method for aquaculture. they also added into the fish feed for stimulating growth and prophylaxis purpose. This method disadvantage is that their absorption within gastrointestinal tract can vary in different fish species and also some of the bioactive compounds considered antinutritional or toxic for fishes.

Medicinal plants also co-administrated with probiotics and trace elements for treatment of various infectious diseases in fish. In vitro test should be carried out to determine the plant bioactivity and to test its cytotoxicity on fish cells. After then in vivo test is performed on model species to understand its effect on fish physiology. However, some of the medicinal plants were found to be harmful and they also create toxic effect in fishes. The LC₅₀ of methanolic extract of

Macleaya cordata was toxic for Gold fish (*Carassius auratus*) at 81.4 mg/l.

Conclusion

Medicinal plants present promising potential for use in aquaculture as a substitute for chemotherapy in the treatment of disease outbreaks. Ethnobotanical studies have been highly useful in the discovery of bioactive plants and natural products with interesting applications in aquaculture. However, there is still little knowledge on the mode of action of most bioactive plants as well as the most suitable form for effective and safe administration. more research is needed to elucidate plant products and their modes of action to establish the bioactive parts of the plant and the most suitable preparations and to test plant effects on the organism's physiology in order to establish an appropriate treatment strategy (route of administration, dose and length). In addition, research in this field could also benefit greatly from the traditional knowledge of fish farmers who regularly use plants.

References

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