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Medicinal Plants: Source For Sustainable Aquaculture

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ABSTRACT

Aquaculture is an important sector in food producing industry. It contribute nearly half to global fish food consumption. The expansion of aquaculture sector makes culture more intensification. But due to increasing in occurrence of various infectious diseases that leads to loss of partial or entire production. In order to prevent major economic losses, various antibiotics have been uses for prevention and treatment of diseases. Even though, antibiotics were not recommended due to its residual effect and accumulation of various chemical component in fish tissue that threat human health. But traditional medicinal plants are most promising alternative source to control various diseases in aquaculture. Because it contains an active compound such as tannins, alkaloids, terpenoids, saponins, phenolics, steroids and flavonoids that possess various biological activities. These active compounds have various characteristics of antifungal, antiparasitic, antiviral, antibacterial that prevent various fish diseases. Medicinal plants are not only used against diseases but even more including immune stimulation, antistress, growth promotion, and disease resistance.

Addition of this medicinal plant extract in fish diet helps in improvement of fish immunity, reduce stress and prevent diseases. Researchers started to use medicinal plants products as adjuvant to increase the efficacy of fish vaccines. Also there mode of administrations plays important role in enhancing innate and adaptive immune system against fish disesses.

INTRODUCTION

Aquaculture is very highly developing economic sector and main hub of protein sources for human consumption (Hayatgheib et al., 2020). However, diseases cause 50% of loss in production (Gabriel, 2019). Traditional chemical therapeutics and Antibiotics are been administered to minimize the economic impact (Van Doan et al., 2019; Lieke et al., 2020). However, higher use of antibiotics in aquaculture system not only hamper fish metabolism but also environment and public health.

Vaccine is also used to treat the aquaculture diseases; however, it is relatively expensive and not effective for broad-spectrum use (Plant & LaPatra, 2011). As a result, alternative sustainable strategies followed by substitutes for antibiotics, vaccines, or other chemical therapeutics, are highly needed which contribute to fish growth mechanism, and more precisely, cost-effective, eco-compatible best quality products from aquaculture indeed (Gabriel, 2019). Over the past two decades, it has been a common trend of using plant-derived supplements rather than chemical residues in aquaculture because of many factors: low cost, ready availability, fewer side effects in fish health and sustainable practice for aquatic environments (Reverter et al., 2014; Van Hai, 2015; Gabriel, 2019). Plant enriched diets contain bioactive plant components such as phenols, alkaloids, flavonoids, tannins, terpenoids, saponins, glycosides, and essential oils that enhance fish growth, stimulate immune parameters, and increase disease resistance (Ghosh et al., 2018). Medicinal plants can be good alternative means of synthetic drugs in aquaculture (Gabriel, 2019).

MEDICINAL PLANTS ACTING AGAINST FISH DISEASES

Ginger (Zingiber officinale) belong to family of zingiberaceae, it is sweet , aromatic, warming herb was also found by Yin et al., 2008. when administered orally to increase the phagocytic capability of cells in rainbow trout (fish), while the extracts of 4 Chinese herbs (Rheum officinale, Andrographis paniculata, Isatis indigotica and Lonicera ja ponica) increased the phagocytosis of white blood cells of Carp, Cyprinus carpio. The immunostimulant effects of the dietary intake of 3 plants (Viscum album, Urtica dioica and Zingiber officinale) extracts on rainbow trout (Oncorhynchus mykiss) (Dugenci et al. 2003).

Azadirachta indica (Neem) tree which belong to the family of meliaceae has a bitter, tonic herb that acts as antipyretic and anti inflamatory agent (Deni 1996) The leaves of this plant had been shown to contain nimbin, azadirachtin and meliantroil which possess in secticidal and antiviral properties (Chitmanat et al. 2005). The insecticidal and antibacterial effect has been explored in aquaculture (Biswas et al. 2002, Winkaler et al. 2007, Abdul Kader Mydeen and Haniffa 2011) with very little information on the use of its antiviral properties in fish. Ravikumar et al. 2011 studied that among 15 coastal medicinal plants/ parts of plants.

Garlic (Allium sativum) which belong to the family of liliaceae. It is pungent, warming herb has been reported to inhibits bacterial growth, lower fever, reduced blood pressure, blood sugar level, and cholesterol. It has been used as rejuvenatives, detoxicant and aphrodisiac in ayurvedic medicine (Deni 1996). Studies abound on its medicinal and culinary purposes (Rahman et al. 2009). The bulbs which contained an acrid volatile oil (0.25%), propyl disulphide which is a powerful germicide (Anawer 2001). Bacterial infection are also cured by mixing Garlic or onion to shrimp pellet and fed every day (Direkbusarakom 1992). Some investigations revealed the effect of garlic on growth promoting, and enhancement of blood parameters, erythrocytes counts (RBC) and haemoglobin (Hb) content in fish fed on diets containing A. sativum were higher than the control while the total plasma protein content was significantly higher in fish fed on diets containing A. Sativum (Shalaby et al. 2006). The enzymes: Aspartate amino transferase (AST) and alanine amino transferase (ALT) decreased significantly with increasing levels of Garlic.

Another very important plant of interest is Aloe vera which belong to the family of Liliaceae/ Aloeaceae.it is bitter ,pungative herb that have shown as antifungal, anti- inflammatory, healing promoting agent. The growth promoting effect and disease resistant property was proven in gold fish Carassius auratus by A. hydrophila (Ahilan et al. 2010). Harikrishnan et al. 2010 reported that mixed herbal extracts supplementation diets restored the altered haematological parameters and triggered the innate immune system of goldfish (C. auratus) against A. hydrophila infection. A. vera has also been used found to a disease suppressing agent and showed antibacterial effect in juvenile rock fish. The growth increase in Labeo rohita fish fed with herbal supplemented diet was due to improved food utilization and high protein synthesis. The benefit of herbal growth promoters as an additive in the carp feed has also been the focus of many researchers.

Tulsi (Ocimum sanctum) contains some chemicals that play a major role in phagocytic activity in fishes. Mainly leaves, stem, flower, seed, roots are used for aquaculture purpose. Especially it helps to control fungal and bacterial diseases in fishes. Its main function is to secrete antibody for improving defense mechanisms in fishes.

Garlic (Allium sativum) has been widely used for medicinal purposes. Garlic mixed feed resulted in specific growth rate and protein efficiency ratio in tilapia (Oreochromis niloticus). Several studies shows immunostimulant capacity and effectiveness against pathogenic bacteria, which include Aeromonas hydrophila and pathogenic protozoa such as Spironucleus vortens, Ichthyophthirius multifiliis (Nya et al, 2010; Millet et al, 2011; Tanekhy and Fall, 2015).

However, some of the medicinal plants were found to be harmful and are also toxic to fishes. El-Galil and Aboelhadid (2012) determined LC50 of garlic oil and was seen it was toxic for tilapia at 61.86 ppt.

Zhou et al (2017) determined LC50 of methanolic extract of *Macleaya cordata* was toxic for Gold fish (*Carassius auratus*) at 81.4 mg/l.

EVALUATION OF PLANT PARTS USED IN AQUACULTURE

Majority of studies based on the usage of herbal medicine utilized 37% plant leaves, 22% whole plant (powder, oil or extract), 18% roots, 8% seeds, 6% barks, 6% fruits and 4% flowers in aquaculture as shown in Fig 1.

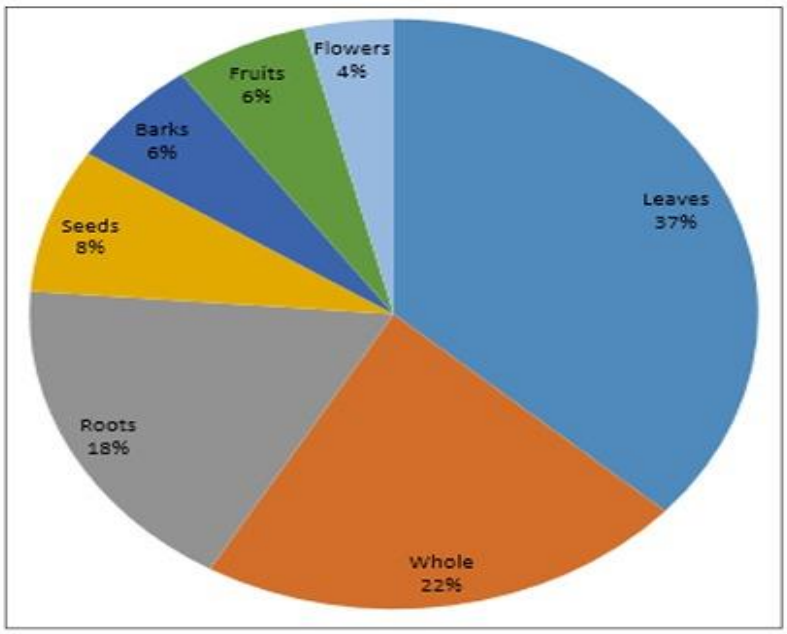

Fig. 1 :Plants parts used in aquaculture. Source: Reverter et al (2017)

Table 1. Antibacterial effect of medicinal plants.

Medicinal plants	Dose	Mode of Administration	Fish	Antibacterial effect against	Reference
Toona sinensis	4 or 8 mg/g	Intraperitoneally	*Oreochromis mossambicus*	*Aeromonas hydrophila*	Wu et al (2010)
Scutellaria baicalensis	1% for 6 weeks	Feed additive	*Oplegnathus fasciatus*	*Edwardsiella tarda*	Harikrishnan et al (2011c)
Urtica dioica	0.1 and 0.5 g/kg for 30 days	Feed additive	*Oncorhynchus mykiss*	*Aeromonas hydrophila*	Bilen et al (2016)

Tinospora cordifolia	100 mg/kg, single or double	Intraperitoneally	*Oreochromis mossambicus*	*Aeromonas hydrophila*	Alexander et al (2010)
Padina gymnospora	100-150 mg/l for 15 days	Bath	*Oreochromis mossambicus*	*Pseudomonas aeruginosa*	Thanigaivel et al (2015)

Table 2.Antiparasitic effect of medicinal plants.

Medicinal plants	Dose	Mode of Administration	Fish	Antibacterial effect against	Reference
Allium sativum	1, 2 & 10 ml/l for 1 hour	Bath	*Lates calcarifer*	*Neobenedenia sp.*	Militz et al (2014)
Cinnamomum cassia	200mg/l for 48 hour	Bath	*Carassius auratus*	*Dactylogyrus intermedius*	Ji et al (2012)
Lindera aggregata	40mg/l for 48 hour	Bath	*Carassius auratus*	*Dactylogyrus intermedius*	Ji et al (2012)
Camellia sinensis	0.3-0.9% for 1-5 min	Bath	*Oncorhynchus keta*	*Ichtyobodo necator*	Suzuki et al (2006)

MODE OF ADMINISTRATION 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, choloroform, methanol, ethyl acetate) (Van Hai, 2015). Also, appropriate dosing plays an important role to obtain desirable effects because inappropriate dose exhibit toxic effects in fishes (Kavitha et al, 2012; Ekanem et al, 2007). Putra et al (2013) revealed that 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 effectiveness is depend on treatment length and is second most important thing in treatment of diseases. Militz et al (2013) showed that farmed barramundi, Lates calcarifer fed with enriched diet of garlic (A. sativum) for 30 days result decreased of Neobenedenia sp. Infection by 70% as 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 (Putra et al, 2013; Wu et al, 2010; Ji et al, 2012). (Gabor et al;2010) determined that these three methods are not creating any kind of threat to people's health, fishes, and environments because medicinal plants are of natural origin. The most rapid and efficient method of administration is intraperitoneal injection of herbal extract . Injection rapidly causes high blood levels and tissue levels of the antibacterial substance (Sekkin and Kum, 2011). The method's disadvantage is that it creates stressful condition for fishes, especially for young ones (Yoshida et al, 1995; Anderson, 1992) and also this technique is expensive and laborious.

Bath techniques also exhibit positive results (Wu et al, 2011). Various pathogens, bacterial infection, fungal infection can be treated by immersing fishes into different medicinal plant extract.(Hu et al, 2014). They are enormously used for the treatment of ectoparasities (Whittington, 2012; Forwood et al, 2013). Treatment or dose should be determined per used of medicinal plants and the quantity of fish (Reverter et al, 2014). The method's disadvantage includes the releases of exogenous molecules into marine environments (Umeda et al, 2006), 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. Supplementation of medicinal plants into fish diet can treat various bacterial diseases (Reverter et al, 2014). They also added into the fish feed for stimulating growth and prophylaxis purpose (Rico et al, 2013). Gabor et al (2010) suggested that treatment or preventive dose should be determined per used of medicinal plant. The method's 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.

CONCLUSION

The expansion of aquaculture sector is directly linked with culture intensification. But infectious diseases are major problems for semi-intensive and intensive culture that diminish entire production of aquaculture. Antibiotics has used to control various infectious diseases but it led to adverse effects. 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. Medicinal plants are rich in active compounds such as tannins, alkaloids, terpenoids, saponins, phenolics, steroids and flavonoids that possess various biological activity. This biological activity stimulates growth promotion, immune stimulation, antibacterial, antiviral, antiparasitic, antifungal and antistress activities in aquaculture.

The feed supplementation of medicinal plants promotes growth, improves immunity, minimize stress and prevent various infectious diseases in aquaculture. Medicinal plants also evaluate their adjuvant effects for increases potentiality of vaccine efficacy in aquaculture. Mode of administration through oral, or

injection, or immersion methods enhances innate and adaptive immune system against various infectious diseases in fish. Therefore based on present review, it can be concluded that medicinal plants creates a prominent source for sustainable aquaculture.

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