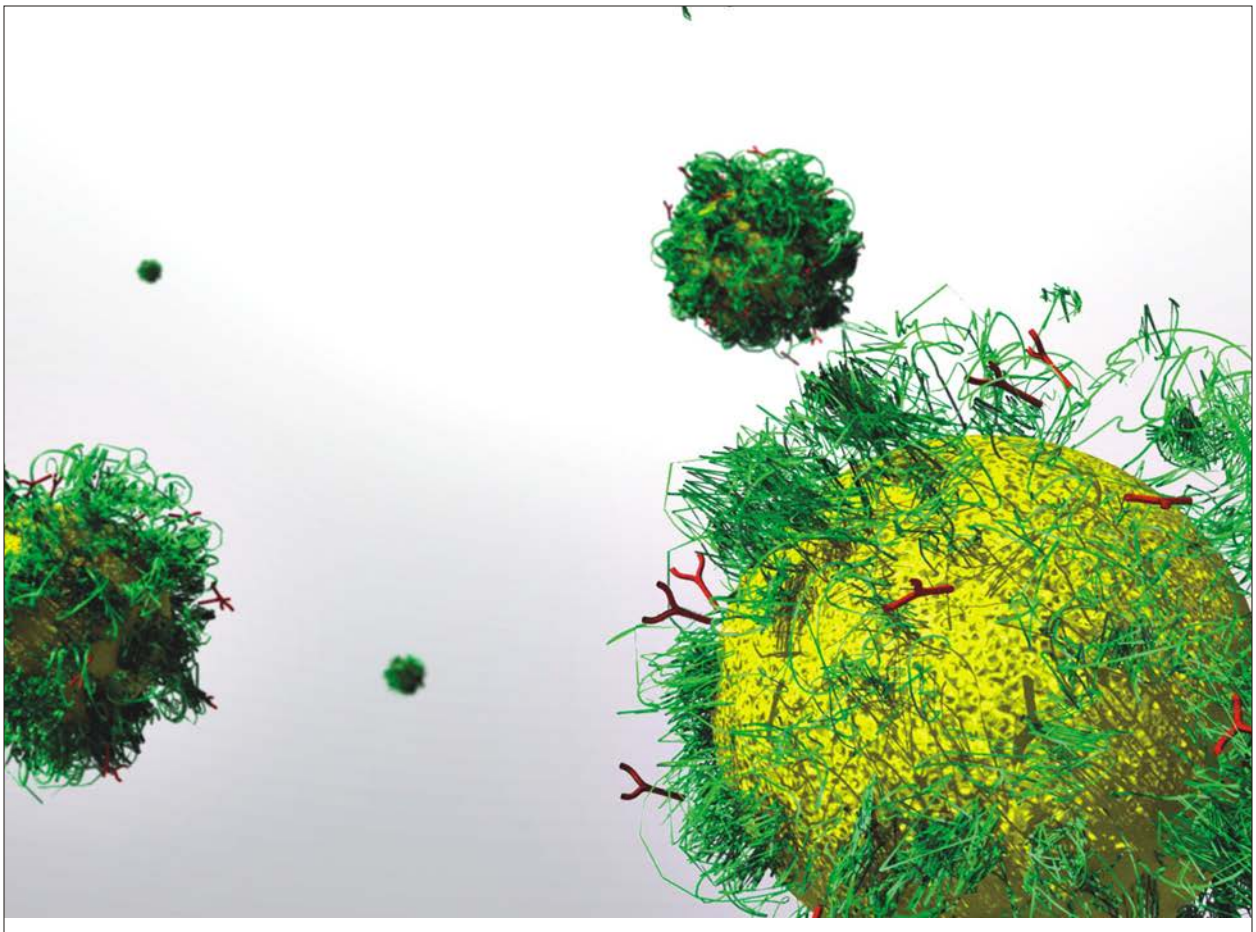

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A Review on Herbal Drugs Against Harmfull Pathogens in Aquaculture

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ABSTRACT

Different herbal plants and herbs or combinations of them known to have properties such as anti-stress, growth promoters, appetisers, tonic and immuno-stimulants. Moreover, these substances also possess other valuable properties; they are non-biodegradable and biocompatible. No herbal-resistance immunity has been found by any pathogen till today. Some of these herbs and herbal plants remedies have potent anti-viral as well as anti bacterial and anti-fungal properties.

Key words: Herbal plants, herbs, properties, pathogen control

INTRODUCTION

The total global herbal drug market is estimated as US$62 billion and is expected to grow to US$5 trillion by the year 2050. The global pharmaceutical market was worth US $550 billion in 2004. The world bank reports that trade in medicinal plants, botanical drug products and raw materials is growing at annual rate between 5 and 15%. In India the value of botanical related trade is about US $10 billion per annum with an annual export of US $1.1 billion. In marine fish hatcheries, the indiscriminate use of antibiotics in prophylactic treatment has led to the development of the resistant strains and the need to switch over to other antibiotics. In case of herbal drugs no herbal resistance has been reported till now. The antibiotics also may reduce the larval growth and inhibit defence mechanisms of the fish larvae. Many of the antibiotics and other synthetic drugs have shown sensitisation reaction and other undesirable side effects. At the global level, people have understood the adverse effect of antibiotics and they are now shifting over to natural products. Herbal extracts have important properties like control diseases due to their antioxidant and antimicrobial. Natural plant products have been reported to promote various activities like anti-stress, growth promotion, appetite stimulation, tonic and immune stimulation and to have aphrodisiac and antimicrobial properties in fin fish and shrimps larvae culture (Citrasu, 2010).

When aquaculture production becomes more intensive, the incidence of diseases including infectious diseases has increased and as a result of it, significant economic losses have been incurred. The losses in India alone have been estimated at several million dollars per year (Anonymous, 1996). The use of antibiotics and other chemotherapeutics for controlling diseases has been criticized for their negative impacts. Application of medicinal herbs in disease management is gaining success, because herbal treatment is cost effective, ecofriendly and has minimal side

effects. Traditional herbal medicines seem to have the potential immunostimulation. Pathogens are an integral part of any aquatic environment and can often be found on wild fish. In aquaculture, where usually conditions are sub-optimal, chances of infection are increased through raised stress levels in fish which directly affects their immune response. Poor immune response reduces the ability of fish to fight pathogens. It gives parasites the opportunity to proliferate causing serious health issues and ultimately can prove fatal to the host fish if left untreated. Present paper discussed mainly about advantages of herbs and herbal plants and some of herbal plants commonly used in aquaculture field.

METHODS

Advantages of herbal plants:

- These are available in plenty and cheap
- Their action is effective
- No adverse effect on natural ecosystem
- They act as the substitution for feed, fertilizer in aquaculture
- Herbal drugs act as a growth promoter
- Herbal drugs act as a immune stimulant
- Herbal drugs act as a anti bacterial substrate
- Herbal drugs act as a antimicrobial activity
- Herbal drugs act as a anti fungal agents
- Herbal drugs act as a parasitic agents

According to Citarasu (2010), herbs act as a growth promoter, immune stimulant, antimicrobial activity and anti fungal agents. Use of medicinal plant is an alternative to antibiotics in fish health management (Chakraborty and Chattopadhya, 1998). These herbs are not only safe for consumers but also widely available throughout Asia and they also have a significant role in aquaculture (Direkbusarakom, 2004). Many studies have proved that herbal additives enhanced the growth of fishes and also protected from the diseases (Sasmal *et al*., 2005).

Herbal drugs act as a growth promoter: Herbal products, stressol-I and stressol-II, enriched *Artemia nauplii* fed with *Penaeus indicus* post larvae (PL1020) increased the growth and efficiencies significantly and reduced the osmotic stress. Tefroli enriched with Artimia and fed to Penaeus monodon post larvae (PL20-50) improved the survival, growth and moulting efficiencies. Also trasia, a commercial herbal product, enriched Artemia, fed to *P. monodon* post larvae improve the growth and stress efficiencies significantly. Various herbal products such has *Hygrophila spinosa*, with *Hania somnifera, Zingiber officinalis, Solanum trilobatum, A. paniculata, Psoralea corylifolia, Eclipta erecta, Ocimum sacnctum, Picrorhiza kurooa, P. niruri, Tinospora cordifolia, Purified silajit* and cod liver oil have the characteristics of the growth promotion, anti stress, immunostimulation and anti bacterial. These preparation had a good influence in the *Penaeus larvi* culture (Citarasu *et al*., 2002). Livol (IHF 1000) is a commercial herbal growth promoter which has been found to significantly improve digestion thereby leading to better growth, production and health in cultivable fishes. The herbals/spices in the diets induce the secretion of the digestive enzyme. It will result in stimulating the appetite and increasing food consumption and efficiencies. The growth promoter characteristic herbs induce the transcription and lead to high protein synthesis. Livol (IHF-1000) is a herbal growth promoter

containing different plant ingredientssuch as *Bohaevia diffusa*, *Solanum nigrum*, *Terminaelia arjuna*, Colosynth and black saltand has been found to significantly improve digestion, thereby leading to better growth, production and health in cultivable fishes. Papaya leaf meal contain an enzyme namely papain which increases the protein digestion, food conversion ratio, specific growth rate and weight gain in the 16% unsoaked papaya meal diet fed to *P. monodon* postlarvae. Herbal growth promoters help to induce the transcription rate. This process leads to increase RNA, total amino acid, finally increases production of proteins in the cells.

Herbal drugs act as immunostimulants: Natural plant product promote various activities such as Antistress, Growth promotion, Appetite stimulation, Immunostimulation, Aphrodisiac and Antimicrobial properties. Due to the active principles such as alkaloids, flavanoids pigments, phenolics, terpenoids, steroids and essential oils. Immuno stimulants are substances, which enhance the non specific defense mechanism and provide resistance against pathogenic organisms (Citarasu *et al.*, 2002, 2006). Many plant-derived compounds have been found to have non specific immuno-stimulating effects in animals, of which more than a dozen have been evaluated in fish and shrimp (Citarasu *et al.*, 2006; Sakai, 1999). The betterperformance of haematological, biochemical and immunological parameters were found immunostimulant incorporated diet fed to shrimps (Citarasu *et al.*, 2006). The best example is the herb Picrorhiza kurroa used as an antistress compound for shrimps.

Some of the following plants act as growth promoters: Leaves of *Ocimum sanctum* contain water-soluble phenolic compounds and various other constituents, such as eugenol, methyl eugenol and caryophylllene that may act as an immunostimulant. In tilapia (*Oreochromis mossambicus*), the acetone extract of *O. sanctum* was found to enhance the anti-sheep red blood cell (SRBC; sheep erythrocytes) antibody response. Leaves extract of *Ocimum sanctum* affected both specific and non-specific immune responses and disease resistance against *Aeromonas hydrophila*. It stimulated both antibody response and neutrophil activity (Jayathirtha and Mishra, 2004).

Phyllanthus emblica has antioxidant activity, anti-fungal activity, antimicrobial activity and anti-inflammatory activity. Amla fruit pulp contains large proportion of vitamin C, which has also been identified as an immunostimulant. An acetone extract of *P. emblica* enhanced the anti-SRBC antibody response in tilapia (Jayathirtha and Mishra, 2004), while both crude extract and a water-soluble fraction of *P. emblica* fruit had a stimulatory effect on the immune response of tilapia.

Azadirachta indica is a highly esteemed "wonder" tree of India that is widely dispersed throughout the country. Biomedical research has revealed that neem possesses anti-human immunodeficiency virus, anti-tumor and antimicrobial activities. Azadirachtin, a triterpenoid derived from *A. indica*, enhanced respiratory burst activities, the leukocyte count and the primary and secondary antibody response against SRBC in tilapia (Logambal and Michael, 2001; Rao and Chakrabarti, 2005).

The herbal extract of *Solanum trilobatum* contains compound like Sobatum, b-solamarine, solaine, solasodine, glycoalkaloid, diosogenin and tomatidine (Abdel-Tawwab *et al.*, 2010). *Solanum trilobatum* possesses a broad spectrum of antibiotic, antibacterial and anticancer activity. A study aimed at assessing the effects of the water-and hexane-soluble fractions of *S. trilobatum* on the nonspecific immune mechanisms and disease resistance of tilapia found that all doses of the water soluble fraction significantly enhanced the production of reactive oxygen and decreased the % age mortality following a challenge with *Aeromonas hydrophila* (Nya and Austin, 2009).

Eclipta alba a herb belonging to Asteraceae, is widely available and distributed throughout India. This plant has been reported to possess several medicinal properties. The methanol extracts of the whole plant of *Eclipta alba* significantly increased the phagocytic index, antibody titer and WBC count in mice (Kirubakaran *et al*., 2010). Oral administration of *Eclipta alba* leaf aqueous extract to *Oreochromis mossambicus* indicate that dietary intake of *E. alba* aqueous leaf extract enhances the non-specific immune responses and disease resistance of *O. mossambicus* against *A. hydrophila* (Christybapita *et al*., 2007).

Roots and the obtained extracts of *Zingiber oficinale* contain polyphenol compounds (6-gingerol and its derivatives), which have a high antioxidant activity. The use of Ginger @0.5/1 10 g of feed reduced mortalities to 0% compared with the controls (64%). Moreover, there was a significant increase in growth, feed conversion and protein efficiency. There was proliferation in the number of neutrophils, macrophages and lymphocytes and enhanced phagocytic, respiratory burst, lysozyme, bactericidal and anti-protease activities compared with the controls (Hemapriya, 1997).

Echinacea and *Allium sativum* improve the gain in body weight, survival rate and resistance against challenge infection of *Aeromonas hydrophila*. Both compounds showed extended effects after withdrawal and improved resistance to cold stress during the winter season (Aly and Mohamed, 2010).

Green tea (GT) extracts contain a unique set of catechins that possess biologic activity in antioxidant, antiangiogenesis and antiproliferative assays that are potentially relevant to the prevention and treatment of various forms of cancer. The inclusion of green tea in fish diet up to 0.5 g kg^{-1} diet enhanced the protein contents in fish body, while the lowest lipid contents were obtained at 0.0-0.5 g GT kg^{-1} diet. Hematological and biochemical parameters were improved in fish fed 0.2 5-2.0 g GT kg^{-1} diet, while the lowest values were obtained in the control. The survival of fish challenged with *A. hydrophila* increased with increasing GT level in fish diets. These results indicate that GT supplement is promising immunostimulant, which could improve fish performance, health (Yoshida *et al*., 1993).

Oral administration of aloe vera in common carp can enhance some of specific and non specific immune responses. This appears to be achieved primarily by increasing lysozyme activity, serum bactericidal power and the total protein and IgM levels. *Aloe vera* supplementation (0.5%) per feed can increases the resistance to *Aeromonas hydrophila* and *A. septicemia*. The Relative% Survival (RPS) was found to be increased in the fish fed with *Aloe vera* (Alishahi *et al*., 2010).

The antiviral activity of a large scale produced plant extract of *Cynodon dactylon* was examined on white spot syndrome virus (WSSV) in black tiger shrimp *Penaeus monodon* by *in vivo* testing after administration through oral route. The results of the study showed that the plant extract of *C. dactylon* was found to be highly effective in preventing WSSV infection with no mortality and no signs of WSD (White spot disease) at 2 and 40% mortality at 1% *in P. monodo,* respectively (Balasubramanian *et al*., 2008).

When *Catla catla* was fed with *Achyranthes aspera* (0.5%), both specific and non-specific immunity were enhanced compared with the control fish fed with the normal diet (Sahoo and Mukherjee, 1999). This was revealed by higher serum antibody levels and higher serum anti-proteases in the test group fish than control groups. Serum globulin level and RNA/DNA ratio of the spleen were also significantly enhanced in the fish fed with the *A. aspera* containing diet.

Nyctanthes arbortristis (L) is widely used plant in the traditional medicinal systems of India. It possesses hepatoprotective, antileishmanial, antiviral and antifungal activities. Feeding tilapia for 2 weeks with selected doses of chloroform extract of *Nyctanthes arbortristis* seeds significantly

enhanced serum lysozyme, alternate complement activities and cellular ROS (cellular reactive oxygen species), RNI (reactive nitrogen intermediate) and MPO production. It was evident from the disease resistance test that feed supplemented with *Nyctanthes arbortristis* seed extract at 0.1% or 1% level significantly reduced the mortality of *O. mossambicus* and a 3-week feeding with 0.1% extract-supplemented diet appears to be the optimal regimen for maximal disease resistance (Logambal and Michael, 2000).

The phagocytic activities and superoxide generation of peritoneal induced leukocytes were significantly higher in fish Japanese flounder (*Paralichthys olivaceus*) fed the FVP supplemented diet than fish fed the control diet. FVP feeding in fish had a significantly higher ($p<0.05$) activity of lysozyme than in the control fish (Ashida and Okimasu, 2005).

Herbal products act as anti-bacterial: The ability of some herbs and seaweeds to inhibit activity of bacteria having potential interest as fish pathogens has been documented (Direkbusarakom, 2004; Muniruzzaman and Chowdhury, 2004; Abutbul *et al.*, 2005; Borisutpeth *et al.*, 2005; Bansemir *et al.*, 2006; Duber and Harder, 2008), some of the local herbs and desert plants were reported to inhibit the pathogenic bacteria in aquaculture and referred to limited number of plant species (Direkbusarakom, 2004; Muniruzzaman and Chowdhury, 2004; Abutbul *et al.*, 2005; Borisutpeth *et al.*, 2005). *A. hydrophila*, the most common bacterial pathogen in freshwater fish, has been recognized to be the aetiological agent of several distinct pathological conditions including tail/fin rot and haemorrhagic septicemia especially in freshwater and ornamental fish (Austin and Austin, 2007) (Table 1).

Anti microbial activity: Some of scientist reported the anti microbial activity of five Chinese herbal extracts, *Stellaria aquatic*, *Impatiens biflora*, *Oenothera bennis*, *Artemisia vulgari* and *Lonicera japonica* against 13 bacterial fish pathogens. *Stellaria aquatic* was the most effective both in terms of the number of pathogens inhibited as well as the degree of inhibition. Ethonol methanol and hexane extracts from *Ocimum bacilicum* were investigated for their *in vitro* anti microbial properties against 146 microbial organisms including aquaculture pathogens. The hexans extracts showed astronger and broder spectrum of anti bacterial activity (Adigozel *et al.*, 2005) (Table 2-7).

Herbal drugs act as antiviral agents: Many herbs have been used for millennia as home remedies and some of these have potentantiviral properties. Several plant products found to have

Table 1: Herbal medicines and their activities shown in the following

Herbal medicines	Activity
Rheum palmatum (Chinese rhubarb) (and other species in same genus), *Isatis indigotica* (woad), *Houttuynia cordata* (lizard tail), *Stemona japonica* (stemona), *Pulsatilla chinensis* (bai tou weng) and others	Anti-bacterial and anti-fungal
Isatis indigotica (Chinese woad), *Polygonum cuspidatum* (Japanese knotweed), *Belamcanda chinensis* (blackberry lily), *Chrysanthemum indicum* (mums) and *Corydalis bungeana* (yan hu so, a native Chinese herd)	Anti-viral
Amomum tsao-ko (type of ginger), *Dichroa febrifuga (*blue evergreen hydrangea), *Areca catechu* (betel nut palm)	Insecticide
Allium sativum (garlic), *Rosa lavigata* (Cherokee rose), *Cyanotis arachnoidea* (a perennial herb) and *Gentiana flavomaculata* (a perennial herb)	Stimulates growth and regulation of the ecdysis rhythm in crustaceans

Alessandro Lovatelli[1] and Jiaxin Chen, Use of environmental friendly feed additives and probiotics in Chinese aquaculture, Aquaculture Management and Conservation Service, FAO Department of Fisheries and Aquaculture, Rome, Italy, Alessandro

Table 2: Following herbal or spice plants showing their various properties

Spice/Herb	Activity	Microorganisms
Garlic	Anti bacterial	*Salmonella typhymurium, Escherichia coli, Staphylococcus aureus, Bacillus cereus, Bacillus subtilis, Mycotoxigenic aspergillus, Candida albicans*
Onion	Anti fungal	*Aspergillus flavis, Aspergillus parasiticus*
Cinnamon	Anti fungal	*Mycotoxigenic aspergillus, Aspergillus parasiticus*
Cloves	Anti fungal	*Mycotoxigenic aspergillus*
Mustard	Anti fungal	*Mycotoxigenic aspergillus*
Allspice	Anti fungal	*Mycotoxigenic aspergillus*
Oregano	Anti fungal, anti bacterial	*Mycotoxigenic aspergillus, Salmonella* spp., *Vibrio parahaemolyticus*
Rosemary	Anti bacterial	*Bacillus cereus, Staphylococcus aureus, Vibrio parahaemolyticus*
Bay leaf	Anti bacterial	*Clostridium botulinum*
Sage	Anti bacterial	*Bacillus cereus, Staphylococcus aureus, Vibrio parahaemolyticus*
Thyme	Anti bacterial	*Vibrio parahaemolyticus*

Table 3: Dosage, application, directipon of neem in aquaculture shown in the following

Disease	Dosage	Application	Direction
Parasite control (Anchor worm, *Trichodina*, *Triprtiella* and *Trichodinella*)	150-200 twigs for a 1000 sq. m pond. Or regularly by each 15 days at a dose of 100 twigs 1000 m^{-2}	Immersion	Neem leaves tied up in bundles are dipped in the fish ponds infected. They will work best when placed at the access of the water flow or at the 4 corners of the pond

Ricinus communis: This mainly used for controlling of Epizootic Ulcerative Syndrome (Red-spot Disease)

Table 4: Usage of *Ricinus communis* in aquaculturebshown in the following

Disease	Dosage	Application	Direction
Contaminating bitterness, *Ricinus communis* L. leaves are used for Epizootic Ulcerative Syndrome (Red-spot Disease)	25-30 kg for a 1000 sq. m in width and 1, 5-2 m in depth pond. Acting as a Prophylaxis 15 kg *Ricinus communis* L. leaves are regularly put into the water in every 15 days	Immersion	*Ricinus communis* L. leaves are tied up in bundles are dipped in the fish ponds infected

Portulaca oleracea: This is used in aquaculture for bacterial *Enteritis* infecting *Ctenopharyngodon idella*

Table 5: Dosage, application, direction shown in the following

Disease	Dosage	Application	Direction
For bacterial *Enteritis* in fecting *Ctenopharyngodon idella*	1, 5-3 kg 100 kg^{-1} of fishes	Feeding	Wash the leaves with fresh water and then with salt water 3% Feed the fish once/day during 5-7 days Especially to the breed fishes, the leaves should be shreded and scattered all over the pond Note: it will work best when the fishes are in deep hunger. For prevention purpose: feed the fish every 10 days with the dose of 100 kg of leaves 100 kg^{-1} fishes

Eclipta alba: This is used for parasites control

potent antiviral activity against fish and shrimp viruses. For example, shrimp fed ethanol extract of *Clinacanthus nutans* had 95% survival rates when exposed to Yellow Head Virus (YHV) compared to only 25% survival in control group of black tiger shrimp. The extract of *Clinacanthus nutans* has been tested against Yellow Head Virus (YHV) of shrimp and the results

Table 6: Dosage, application, direction shown in the following

Disease	Dosage	Application	Direction
Parasites	10 g of *Eclipta alba* (L.) leaves, 1-3 timesn day^{-1}	Feeding	10 g of *Eclipta alba* (L.) leaves, combined with 10 g of Betel leaves, mixed with 3 g of squid liver oil to create a mixture. Put this mixture into 1 kg^{-1} fish-feed, then feed the fish 1-3 times day^{-1}

Water-pepper: This is used for controle of epizootic ulcerative syndrome control

Table 7: Dosage, application, direction shown in the following

Disease	Dosage	Application	Direction
Endoparasites and epizootic ulcerative syndrome	3 kg Water-pepper leaves 100 kg^{-1} fishes, or 1-2 kg^{-1} water pepper powder 100 kg^{-1} fishes	Feeding	Water pepper trunk and leaf boiled, mixed with fish-feed, feed the fish continuously 3-6 days

indicating that this plant could effectively control YHV infection in shrimp (Direkbusarakom *et al*., 1998). Many species of Phyllanthus have been widely used as herbal medicines (Unander *et al*., 1990). We found that *P. amarus* had only partial activity against WSSV while Direkbusarakom (2004) found that it was very effective against the fish viruses such as INHV and OMV and shrimp virus YHV. The aqueous extract of *C. dactylon* showed the strongest antiviral activity against WSSV (no mortality and no signs of WSD at 100 mg kg^{-1} of animal body weight) while the methanol extract of *M. chariantia* showed significant antiviral activity (no mortality and no signs of WSD at 150 mg kg^{-1} of animal body weight). Rohani *et al*. (2006) announced that *Zataria Multiflora* is an appropriate alternative of Malachite green. This plant is very effective on 25, 50, 100 ppm days.

The herbal active compounds may inhibit or block the transcription of the virus to reduce the replication in the host cells and enhance thenon-specific immunity. They act as immunostimulants to the host immune system.

Herbal drugs act as antifungal agents: Like herbal antibacterial and antiviral agents to aquaculture, there has been limited work performed against the fungal pathogens related to fish/shrimp diseases to stop zoospore germination, the MIC should be 42/5 mg L^{-1}; therefore, mustard extract is the effective antifungal factor against Saprolegniosis. Adigozel *et al*. (2005) controlled infection of *Aspergillus flavus* and *Fusarium oxyspoum* with extract of *O. basilicum*.

Antifungalbioassay were made by using agar tube dilution method against the sixfungal species including *Fusarium solani* and *A. fiavus* with the DMSO extract of Tamarixdioica. Rutin is a biofiavonoid extracted from Toonasinensis with strong antioxidant and antistress activity in crustaceans.

Rutin has improvedthe biochemical, immunological and haematological parameters in *Litopenaeus vannamei* during the stress conditions by *Vibrio alginolyticus*. The herbal extracts, *Astragalus membranaceus*, *Portulaca oleracea*, *Flavescent sophora* and *A. paniculata*, actas an antistress and induce the immunological parameters such as serum lysozyme activity, SOD, NOS and levels of total serum protein, globulin and albumin in *Cyprinus carpio*.

Herbal plants act as anti parasitic agents: Other herbal extracts are very effective against gills and skin flukes such as *Benedenia seriolae* (Kolkovski, personal comment, Nutrakol Pty Ltd).

Herbal compounds have the ability to inhibit the generation of oxygen anions and scavenge free radical, hence reducing stress effects. Herbal antioxident effect was demonstrated by Citarasu *et al*. (2006) when *P. kurroa* (picrorhiza) was used as anti-stress compound for black tiger shrimp.

Some of herbal plants application, dosage and direction for various diseases

Neem tree: Neem tree commonly called as herbal Indian doctor. The neem tree produces a compound called azadirachtin, which protects it from damaging insects. There are several products registered in Alaska containing azadirachtin, including Azatin XL®, Bioneem® and Ornazin®. An active compound extracted from the neem tree (*Azadirachta indica*), whose antiviral, antibacterial and antifungal properties have been known for several years (Isman *et al*., 1990). All the parts of the neem plant is usefull.

GARLIC

Application of garlic: Garlic (2 kg)+Salt (2 kg)+$CuSO_4$ (20 g)+KM_nO_4 (20 g) mixed of these used as disease treatment or disease control. Ingredients made into paste, is mixed in 30-50l L of water and sprayed over pond water of 0.133 ha pond.

Purpose: This is use for control of EUS disease and it contains antimicrobial compound. A wide range of microorganisms including bacteria and protozoa have been shown to be sensitive to crushed garlic preparations and can help in the control of pathogens, especially bacteria and increase the welfare of fish (Corzo-Martinez *et al*., 2007). Madsen *et al*. (2000) reported that raw and squeezed garlic (*Allium sativum*) at 200 mg L^{-1} treat Trichodinaiasis in eel.

Effect of garlic: Garlic is considered as effective herbal drugs as it contains antimicrobial compound called allicin (Saleem and Al Delaimy, 1982). *Pseudomonas* sp. *Vibrio cholera, V. fluvialis, V. gazogenes, V. mimicus* are the most sensitive against garlic and inhibit completely at 10% concentration, 65% of *Aeromonas* sp. can be inhibited at 10% garlic level. Other bacterial flora exhibit varying level of resistance to garlic. The Gram-positive bacteria are generally more sensitive to allicin (Garlic contain 30-0.50% allicin) than Gram-negative bacteria (Table 2-7).

CONCLUSION

Herbal compounds have the ability to inhibit the generation of oxygen anions and scavenge free radical, hence reducing stress effects. It will be best if we use herbal plant extract instead of chemicals. Using of chemicals to control diseases leads to effluent remittance in the fish muscle which may cause side effects to the consumer. As this biological and eco-friendly approach is known to many of the farmers, awareness programmers should be done to popularize these herbal medicines. It is better to conduct result demonstration to disseminate this herbal approach rapidly among the farmers to control the diseases. Chemicals such as hydrogen peroxides, formalin, malachite green and others may offer a short term solution against parasitic problems. In sea cages, bathing fish is a labour intensive and costly operation. Although it usually brings temporary relief from parasites, the treatment also causes stress to the fish and increases the chances of future infections. Many of these chemicals are not environmentally sustainable and most of them are prohibited for use in aquaculture systems and banned in many countries. Authorities should review

the current legislation regarding the use of herbal and natural remedies in aquaculture taking the above issues into consideration and allowing more flexibility in the use of herbal medicine in aquaculture.

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