Medicinal herbs: The missing link to sustainable aquaculture

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Abstract

Aquaculture, given its direct role in the human diet, mandates strict quality assurance and health protocols. Healthy fish require a strong immune system to defend themselves from a broad spectrum of pathogens such as bacteria, viruses, and parasites. Stimulating the immune system is a prevalent measure taken to ensure satisfactory immune response and disease control. Measures against disease outbreaks are available, such as chemoprophylaxis with vaccines, chemical therapeutics, and antibiotics. All of which, alongside their benefits, pose certain risks to the fish's habitat and itself. Natural substances extracted from herbs or their parts (roots, leaves, etc) tend to be the most effective therapeutics with the least adverse effects. In this study, natural remedies have been discussed as a potent method of preventive care in aquaculture.

Introduction

Disease outbreaks can be considered a major risk factor towards sustainable production. Along with the development of aquaculture, an increasing number of fish farms tend to use a broad spectrum of antibiotics, vaccines, and therapeutic agents. To prevent parasitic, bacterial and fungal diseases, a variety of chemicals and disinfectants are used in fish farms. However, it seems that we need new approaches regarding disease prevention. Excessive use of antibiotics has led to a generation of bacteria that are resistant to drugs.[1] At the same time, the accumulation of antimicrobials and chemicals in edible fish tissues has endangered the lives of many and is a cause for concern in public health.

Various herbal components have been studied for their variety of effects including antimicrobial activity, growth promotion, and immunostimulation.[2-6] Thus, incorporating such substances into the diet of fish can lead to promising results. These herbs tend to have properties such as growth promotion, immune system strengthening, antimicrobial capability, stimulatory effects on appetite, and anti-stress effects.[7]

The immunomodulatory properties of the plant can be allocated to several parts of the plant. Some of these ingredients include phenolic, alkaloid, quinone, lectine, terpenoid, and polypeptide compounds, most of which can replace antibiotics.[8] Medicinal plants are used in aquaculture as dietary modifications and feed additives. Moreover, these plants consist of several beneficial nutrients vital to fish life.[9] Several derivatives of the plant can be used for numerous purposes. Leafs, roots, extract, and essential oil are examples that have been seen to act beneficially when used as a feed supplement.

In this paper, the role of plants and their derivate on disease prevention in fish culture will be addressed. Such information also has the potential to be implemented in innovative research regarding disease prevention in the human species and thus is of high importance.[10]

Immunomodulation

Many natural products can be used as an immunomodulator. Substances such as levamisole, glucan, glucan plus, yeast RNA, growth hormone, vitamin C, lipopolysaccharides, zeranol and chitosan are mere examples. However, many immunostimulants, despite being effective, are not practical due to several disadvantages, including expensive cost, excessive labour, limited effectiveness upon parenteral administration, etc.[11-15]

A variety of herbs are used in aquaculture, including aloe (*Aloe vera*),[16] cinnamon (*Cinnamomum zeylanicum*),[17] garlic (*Allium sativum*),[18-20] ginger (*Zingiber officinale*),[21-24] and peppermint (*Mentha piperita*).[25] Some studies have also mentioned that combiminig the medicinal plants and adding them to the fish's diet promote the immune system and antioxidant defence of the cultured fish.[26]

These substances can augment the immune system of fish through different pathways. Typically, they activate respiratory burst activity, phagocytosis, immunoglobulin and plasma lysozyme activity.[27,28] They also are able to increase serum and mucus antioxidant compounds.[26] Similarly, they have the ability to increase antibody production in fish. Such a benefit can be employed when the plant is used as an adjuvant. Certain studies have reported the adjuvant effect of plant oils when injected intraperitoneally with vaccines in trout.[28]

Specific and non-specific mechanisms are used by fish to

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Key words: Herbs; disease prevention; immunity; aquaculture; natural prophylaxis.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Ethics approval and consent to participate: Not applicable.

Informed consent: Not applicable.

Received for publication: 4 November 2021.
Revision received: 21 November 2021.
Accepted for publication: 21 November 2021.

Licensee PAGEPress, Italy
Infectious Diseases and Herbal Medicine 2021; 2:171
doi:10.4081/idhm.2021.171

defend themselves from a variety of pathogens. In fish, non-specific defense measures can be considered the skin and mucus. After pathogen entry to the body, activation of humoral and cellular non-specific defenses are visible. The main mediator for non-specific immunity against pathogens such as viruses, bacteria, and parasites in fish is considered phagocytosis. The humoral immune system is another pathway that is activated when fish are challenged with a pathogenic agent. Medicinal plants in different forms, including extract and essential oils, can trigger fish immune systems resulting in disease resistance. Medicinal plants are also amongst the natural products that stimulate the immune system of bony fish. According to Bulfon,[29] Several studies on medicinal plant species exist exceeding 60 in count, all of which signify improving fish health and disease management in aquaculture.

Germicidal activity

Many studies have reported herbal and seaweed prevention against bacteria that have an interest in fish.[5,30-35] Bacteria prevention using local herbs and desert plants is common in aquaculture.[30-33] They have proved their efficacy against pathogenic bacteria in fish such as *Aeromonas hydrophila*, *Yersinia ruckeri*, *Lactococcus garvieae*, *Streptococcus agalactiae* and *Enterococcus faecalis*.[36] Tilapia fed with *Citrus limon* and *C. sinensis* EOs resisted *Streptococcus iniae* and *Edwardsiella tarda*, have fought pathogens more efficiently. Also, findings in tilapia that signified similar immunomodulation and protection were reported after *C. limon* peel Eos dietary modification at (1, 2, 5, and 8%) in *Labeo victorianus* for 28 days.[37] Antibacterial mechanisms of medicinal plants on an identical bacterium, *L. garvieae*, have also been proven. *Zataria multifora*, *Thymbra spicata*, *Bunium persicum*, *Satureja bachtiarica*, and *Thymus daenensis* EOs signified therapeutic, and preventive effects with MIC and MBC values ranging from 4 µL/mL to 16 µL/mL against *L. garvieae*.[38] Potent inhibition is observed in *Zatarua multiflora*, *Cinnamomum zeylanicum*, and *Allium sativum* EOs on *L. garviesae* (MIC: 0.12 to 0.5 µL/mL and MBC: 0.12 to 1 µL/mL).[39] *Argania spinosa* is observed to have MIC values of 125 µL/mL and a zone diameter of ~11 mm on *L. garvieae*.[40]

Antimicrobial functions of certain herbal essential oils on prevalent fish pathogens have been investigated in a variety of studies.[41,42] Hayatgheib *et al*.[41] identified that MIC and MBC values of various essential oils from herbs on different *A. salmonicida* subsp. *salmonicida* isolates ranged from 113 to ≥3628µg/mL, (MIC and MBC: ≤520 µg/mL) The most effective herb species included *Cinnamomum zeylanicum/verum, Origanum vulgare, O. compactum, Origanum heracleoticum, Eugenia caryophyllata, and Thymol rich Thyme vulgaris.*

The effects of *Varronia curassavica* oil, on *Ichthyophthirius multifiliis trophont* and *tomont* were reported by Nizio *et al*.[43] to signify 100 percent efficacy once applied in doses of 10 mg/L and 50 mg/L for one hour, respectively. However, in case of large invase parasites that leave extensive lesions[44] the sitiation will be different as they should be treated with chemicals. Similarly, *Hyptis mutab Silis* (10 mg/L for 30 min)[45] and *Melaleuca alternifolia*, *Lavandula angustifolia*, and *Mentha piperita* (455 µL/L for 1 h)[46] were also very effective. Antiprotozoal effects of garlic and lemon balm have also been proved in other studies.[20,47]

Conclusions

Herb extracts have the potential to be used as immunostimulants in fish cultures, mainly because they are accessible, relatively cheap and defend against a broad spectrum of pathogens. Many herbs and their extracts are administered orally due to ease and convenience. However, the dangers of overdosing and toxicity always exist as the effects are dose-dependent; consequently, dosage optimization is strongly recommended. The results of this study signify the effective approach of immunostimulation via natural herbs and their extracts. Healthy fish, as a part of the human diet, have a direct effect on human lives. Thus, having the potential to be studied and researched in regards to public health and disease prevalence on the social and human level.

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