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Seaweed Extracts to Mitigate Aquatic Diseases

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Abstract

Aquaculture is one of the world's fastest-growing ways of producing food. To mitigate the outbreak of disease, which is the key issue in aquaculture, chemotherapeutic approaches are highly used. Prolonged and improper use of chemicals (antibiotics) leads to resistance as well as a major environmental hazard. For disease control in aquaculture, compounds or metabolites from natural biosystems are being studied. The use of seaweeds and their metabolites is important to aquaculture health and disease management to monitor pathogens. Crude or purified compounds are used in the context of water therapy or as feeding additives.

Introduction

Fisheries and aquaculture play a vital role in feeding healthy and low-carbon-footprint foods to an increasing world population. The industry is also a source of alternative foods such as edible marine algae. Moreover, the sector is vital to the livelihoods of nearly 60 million people worldwide (FAO, 2018). Global fish production is estimated to have reached approximately 179 million tonnes in 2018, with a total first-selling value estimated at USD 401 billion, of which USD 250 billion was derived from aquaculture (Table 1). Of the total, 156 million tonnes were used for human consumption, equivalent to an average 20.5 kg per capita annual supply. The remaining 22 million tonnes, primarily for the processing of fish meal and fish oil, is intended for non-food uses. Aquaculture accounted for 46% of total production, and 52% of human consumption of fish (FAO, 2020).

Overview about the Cultivation of Seaweeds

In 2018, out of the total of 32.4 million tonnes of wild-collected and cultivated aquatic algae combined, farmed seaweed accounted for 97.1 percent by volume. Seaweed farming is practised in a relatively smaller numbers of countries, dominated by countries in East and South-east Asia. Global production of marine macroalgae or seaweed has more than tripled, growing from 10.6 million tons in 2000 to 32.4 million tons in 2018 (Table 1) (FAO, 2020).

Importance of Seaweed Extracts in Aquaculture

Aquaculture is highly susceptible to micro-organism-causing diseases that have a serious effect on aquaculture production. In aquatic animals, increases in temperature, insufficient water treatment and lower nutritional levels contribute to stress and immune suppression. To prevent economic losses, there are many ancient control

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Table 1: World Aquaculture Production and Aquatic Algae

Production	2016	2017	2018
Aquaculture	(million tonnes, live weight)		
Inland	48.0	49.6	51.3
Marine	28.5	30.0	30.8
Total aquaculture	76.5	79.5	82.1
Aquatic Algae	(thousand tonnes, live weight)		
Laminaria japonica	10 662.6	11 174.5	11 448.3
Eucheuma spp.	9 775.9	9 578.0	9 237.5
Gracilaria spp.	4 248.9	4 174.2	3 454.8
Undaria pinnatifida	2 063.5	2 341.7	2 320.4
Porphyra spp.	1 312.9	1 733.1	2 017.8
Kappaphycus alvarezii	1 524.5	1 545.2	1 597.3
Brown seaweeds *(Phaeophyceae)*	805.0	666.6	891.5
Laver *(Porphyratenera)*	713.4	831.2	855.0
Sargassum fusiforme	216.4	254.6	268.7
Eucheuma denticulatum	214.0	193.8	174.9
Spirulina spp.	73.4	72.0	69.6
Seaweeds nei (algae)	15.8	20.0	22.5
Other algae	24.2	28.1	27.8
Total	31 650.5	32 612.9	32 386.2

measures that have been adopted. A few veterinary drugs have been used in aquaculture to control disease outbreaks. More focus has been drawn to the use of a bio-based, eco-friendly approach to infection control and thus growth promotion, as the use of synthetic and industrial antibiotics induces antibiotic resistance have confirmed that the presence of residual antibiotics has a major effect on humans.

Potential Uses of Marine Algae in Aquaculture

Seaweed extracts have shown a broad variety of beneficial properties, including antioxidants, growth rate promotion, anti-stress, stimulation of appetite, immune stimulation and physiological benefits. In addition, compared to synthetic particles, the use of such secondary metabolites is cost-effective and also readily biodegradable. Several seaweeds have been checked for antimicrobial properties by extracting their active compounds (carotenoids, free phenolics, saturated and unsaturated fatty acids) with different solvents and are also responsible for antioxidant activity. It has been documented that the antibacterial properties of marine algae (*J. Corniculate* & *L. papillosa*) are due to the presence of fatty acids. The WHO (2002) advocated the use of preventive, natural plant-based approaches to disease control, particularly in agriculture and aquaculture, for the use of immune stimulants in medicinal plants as an alternative to antibiotics, immune prophylactics. Seaweeds and their extracts and different formulated combinations of extracts are currently increasingly involved in promoting activities such as growth, immunity, antibacterial and antiviral properties against host pathogens.

Beneficial Properties of Seaweed Extracts

Because of its amino acid structure, the availability of high levels of food proteins, the Rhodophyta tends to be an enticing and potentially useful source of food. The biotechnological applications of the essential protein Phycoerythrin (PE) derived from Rhodophyceae (dye in immune fluorescence reaction). These bioactive diets also proven to increase the host organisms' body weight and improves consumer triglyceride levels and muscle protein deposition. Additional benefits have been identified from the use of seaweed extracts as fish feed containing various formulations. Such algal diets have improved the resistance of fishes to diseases. Thus, the algal diversity seen in different seaweeds can be used as a complementary and beneficial alternative source of protein for mammalian nutrition. *Delisea pulchra*, which has an antiviral property due to the presence of sulphated polysaccharides, halogenated furanones and antifouling compounds, are algae that are currently receiving maximum attention. For the production of natural antifouling agents, antimicrobials, and novel UV-sunscreens, chemical compounds found in algae are potentially useful. Seaweed-isolated active compounds have a wide variety of biological activities and some have a high production potential for environmentally friendly pesticides, agrochemical compounds and biochemical, pharmaceutical and medical research products (Smit, 2004).

Seaweed Extracts as an Alternative Source to Control Pathogens in Aquaculture

In microbial populations, antibiotics only generate transient and local problems, while genes of antibiotic resistance present in gene transfer units can spread in nature that can influence human health and the evolution of environmental microbiota. In general, most of the fish's bacterial infections were susceptible to various seaweed extracts. Seaweeds demonstrate strong antimicrobial activity, but the degree of efficacy varies from the species to species. Extracts of different

species showed antibacterial properties against various fish and shrimp virulence factors. Nevertheless, a wider spectrum of antibacterial properties is demonstrated by *A. sparagopsi sp.* (red seaweed) and *Sargassum sp.* (brown algae). In fish, almost all of the bacterial virulence knowledge reported focused only on *in vitro* screening. The use of extract-based treatment by immersion and intramuscular methods against *P. aeruginosa* and *A. solmonicida* infection in Tilapia has been recorded (Thanigaivel *et al.,* 2016).

Conclusion

Seaweeds are readily available and inexpensive because they are not only beneficial but also harmless to bacteria such as probiotics. Instead of synthetic antibiotics that induce resistance to organisms, seaweed extracts activate immune stimulants and can be used to demonstrate anti-pathogenic activity. However, in large-scale cultivation, its bioavailability has yet to be investigated. There is a lack of full awareness of quantitative nutrient requirements and natural products (bioactive compounds) for the prevention of diseases in most fish. This is the hot spot, therefore, where it is appropriate to conduct future research.

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