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Antibacterial Potential of Microalga Against Fish and Shrimps Bacterial Pathogens

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ABSTRACT

Bacteria are one of pathogens which caused fish and shrimps diseases. Some of them are Vibrio, Streptococcus, and Aeromonas. Some diseases can cause mortality and decrease the aquaculture production. Because of that, control of bacterial disease need to be done. Microalga has a lot of bio-active compound such as proteins, flavonoids, carotenoids, polyphenols, terpenoid, polysaccharides, polyunsaturated fatty acids and others. These bioactive compounds has been proved that can inhibit bacteria growth. The aim of this review paper are to describe kind of bioactive compound in microalga and its potential as antibacterial agent against fish and shrimps pathogens.

Keywords: *Antibacterial, microalga, bacterial pathogens, disease, bioactive compounds*

I. INTRODUCTION

Fisheries is a sector that contributes to meeting the food and nutritional needs of humans around the world. Bene et.al (2015) [1} stated that fishery products fulfill at least 15% of the average intake of animal protein per capita. Based on Fao (2020) [2], world consumption of fishery products reaches 19.4 kg per capita with an increased rate per year reaching 1.3%. This increasing level of consumption is proportional to the amount of world fishery production which has also increased from year to year. In 2018, fishery production in the capture fisheries sector reached 96.4 million tons and fisheries production from aquaculture reached 114.5 million tons [2].

The fisheries sector also contributes to the economy. Based on data from the World Bank [3], the share value of trade in world GDP (Gross Domestic Product) from the fisheries sector reaches 46.1%. The price of the world's fishery products from aquaculture is up to $ 250 billion. The fisheries sector is also able to absorb a fairly high number of workers, reaching around 59.51 million people in 2018 [2].

One of the challenges in the world of fisheries is fish and shrimp disease. This disease can cause death in fish, thereby reducing production. The decline in fishery production will have an impact on the global economy. Bacteria are one of the pathogens that attack fish and shrimp. *Vibrio parahaemolyticus* is known to cause acute hepatopancreatic necrosis disease syndrome. This disease causes mass mortality in shrimp (*Penaeus monodon* and *Penaeus vannamei*) to reach 100% in the first 20-20 days of culture [4]. Another bacteria, Streptococcus spp, Aeromonas, Pseudomonas, Lactococcus can causes mortality in fish [5]. A*. hydrophila* is an opportunistic bacteria, Gram negative, that can cause fish mortality in a very short time up to 80-100% [6]. Therefore, control of bacterial disease needs to be done.

Microalgae are organisms that are abundant in nature, easy to cultivate and contain various bioactive compounds. A lot of microalgae have been used as natural food and medicine. Some researchers have also proven that microalgae shown have antibacterial potential. This article aims to describe the antibacterial potential of microalgae against fish and shrimps pathogens.

II. ANTIBACTERIAL POTENTIAL OF MICROALGA

2.1 General Review of Microalga

Microalgae are single-cell photosynthetic organisms that are abundant in nature. They contain a lot of nutrients such as protein, polysaccharides, lipids, amino acids, various kinds of pigments, and others. So that microalgae have been used for various applications [7]. The use of microalgae includes a role for bioremediation [8], aquatic feed additives [9], human cosmetic, human food supplement, the drug industry [7] etc. In the aquaculture industry, microalgae can also improve the aquatic animals' immune system so useful for disease control. Microalgae can provide the nutritional requirements of aquatic animals such as fish and shrimp at different growth stages [10]. In this article, the overview of *Spirulina platensis*, *Chlorella vulgaris*, and *Dunaliella salina*.

S. platensis, filamentous blue-green algae that can live in freshwater, brackish water, or seawater. The growth of Spirulina will be optimal if it grows in an environment with a temperature of 25–30 °C, light intensities of 1500–3500 lux, and pH levels between 8.5 to 10.5. Spirulina can be cultivated outside or inside [11].

Dunaliella salina is a unicellular halophilic green alga that can change the cell color in response to environmental changes. *D. salina* will turn green if it is in a non-stressed culture environment, turning orange if it is under stress, and orange Orange cells from a culture exposed to nutrient stress due to β-carotene accumulation (ramos). The growth of *D. salina* will be optimal if growing in an environment with a temperature of 20 ° C, light intensities of 18x103 lux, and pH levels 8, and high salinities (45 PSU) [12].

Chlorella vulgaris is unicelullar green algae that can live in fresh water (algabase). The cell diameters range between 2-10 µm in diameter [13]. The growth of *C. vulgaris* will be optimal if growing in alkaline conditions (pH 9 to 10), 200 ml/min [14] for aeration, and light intensities of 2920 Lux [15]. This alga can be used for wastewater treatment and suitable pioneer organism for soil restoration [16].

2.2 Bioactive Compound in Microalga

Microalga have a lot of bioactive compound. Pradhan et.al (2014) [17] have reviewed the bioactive compounds in *Chlorella vulgaris* and *Spirulina platensis*. *Chlorella vulgaris* contains chlorophyll-a and -b, beta carotene, 50-70% protein, lipid, vitamins (provitamin A, vitamins C, B1, B2, B5, B12, E and K, inositol, folic acid), 18 amino acids, and mineral (iron, calcium, potassium, magnesium, phosphorous), flavonoid, and phenolic compounds. Whereas *Spirulina platensis* contains carotenoid, chlorophyll, and major phycocyanin pigment. *Spirulina platensis* is also rich in nutrient such as proteins (60-70%), vitamins (vitamins A, B, E, and K), minerals, carbohydrates, fatty acids, flavonoid, and phenolic compounds. *Dunaliella salina* contains carbohydrates (25.31%), proteins (10.03%), and total dietary fiber (TDFs) (8.97%) on dry basis, lipids (3.49% w/w on dry basis) [18] *Dunaliella salina* also has pigment such as chlorophyll a dan b, b carotene, lutein, neoxanthin, violaxanthin, zeaxanthin [19]. Table 1 show pigment and phenolic compounds in *Spirulina platensis, Chlorella vulgaris, Dunaliella salina*.

Table 1: Pigments and phenolic compounds in *Spirulina platensis, Chlorella vulgaris, Dunaliella salina*.

Microalga	Phytopigments		Phenolic compounds	
	Chlorophyll (mg/g DW)	Carotenoids (mg/g DW)	Total phenolic (mg/g)	Total flavonoid (mg/g)
Spirulina platensis	25.59 [20]	4.69 [20]	50.2 [23]	11.5 [23]
Chlorella vulgaris	35.76 [21]	32.14 [21]	39.4 [23]	24.8 [23]
Dunaliella salina	14.255 [19]	4.83 [22]	4.52 [22]	4.03 [22]

2.3 Antibacterial Activity of Microalga

Bioactive compounds present in the three algae *S. platensis, C. vulgaris*, and *D. salina* have been shown to inhibit the growth of various bacteria that attack fish and shrimps and human pathogens. The mechanisms of antibacterial action of phenolic compounds are unclear. But there are some proposal theories of the mechanism. Phenolic compounds are thought to inhibit bacterial activity by damaging cell membranes, disrupting membrane integrity [24], and inhibiting nucleic acid synthesis. The antibacterial activity of flavonoids is increased due to the presence of hydroxyls at special sites on the aromatic rings [25]. Table 2, Table 3, and Table 4 show the inhibition of *S. platensis, C. vulgaris,* and *D. salina* against bacteria, respectively.

Table 1. Inhibition zone in mm of *Spirulina platensis*

Bacteria Pathogens	Inhibition Zone (mm)	Reference
Pseudomonas putida	14.3± 0.3	[26]
Pseudomonas aeruginosa	13.3± 0.3	[26]
Pseudomonas fluorescens	13.3± 0.3	[26]
Aeromonas hydrophila	15.3± 0.3	[26]
Vibrio alginolyticus	13.3± 0.3	[26]
Vibrio parahaemolyticus	13.3± 0.3	[26]
Vibrio harveyi	11.6± 0.3	[26]
Vibrio fluvialis	11.6± 0.3	[26]
Vibrio fisheri	15.3± 0.3	[26]
Vibrio anguillarum	15.3± 0.3	[26]
Escherischia coli	15.6± 0.3	[26]
Edwardsiella tarda	12.3± 0.3	[26]
Bacillus cereus	40.33±0.3	[26]
Bacillus subtilis	34.33±0.3	[27]
Micrococcus luteus	39.00±1.0	[27]
Klebsiella pneumoniae	15±0.5	[28]
Shigella flexneri	15±0.6	[28]

Table 2. Inhibition zone in mm of *Chlorella vulgaris*

Bacteria Pathogens	Inhibition Zone (mm)	Reference
Pseudomonas putida	10.6± 0.3	[26]
Pseudomonas aeruginosa	09.6± 0.3	[26]
Pseudomonas fluorescens	12.3± 0.3	[26]
Aeromonas hydrophila	16.3± 0.3	[26]
Vibrio alginolyticus	14.3± 0.3	[26]
Vibrio parahaemolyticus	12.0± 1.0	[26]
Vibrio harveyi	13.0± 1.1	[26]
Vibrio fluvialis	14.3± 0.3	[26]
Vibrio fisheri	11.3± 0.6	[26]
Vibrio anguillarum	15.3± 0.3	[26]
Escherischia coli	15.3± 0.3	[26]
Edwardsiella tarda	11.3± 0.3	[26]

Table 3. Inhibition zone in mm of *Dunaliella salina*

Bacteria Pathogens	Inhibition Zone (mm)	Reference
Edwardsiella tarda	20.07±0.19	[29]
Lactococcus garviae	18.21±0.09	[30]
Yersinia ruckeri	15.64±0.13	[30]
Vibrio anguillarum	15.44±0.25	[30]
Vibrio alginolyticus	7.39±0.15	[30]
Pseudomonas aeruginosa ATCC 27853	17.06±0.09	[30]
Staphylococcus aureus ATCC 25923	16.42±0.11	[30]
Escherichia coli ATCC 35218	16.14±0.12	[30]
Streptococcus mutans PTCC 168	18.5±0.97	[31]

III. CONCLUSION

In conclusion, Spirulina platensis, Chlorella vulgaris, and Dunaliella salina have pigments, phenolic, and flavonoids. They have antibacterial activity against fish, shrimps, and also human bacterial pathogens. The mechanisms of antibacterial activity of bioactive compounds in algae are thought by damaging cell membranes, disrupting membrane integrity, and inhibiting nucleic acid synthesis.

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