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DIETARY OF *GANODERMA LUCIDUM* TO ENHANCE THE GROWTH AND IMMUNE RESPONSE IN AQUACULTURE: REVIEW IN FISH NUTRITION

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ABSTRACT

The utilities of natural sources of anti pathogenic bacterial to increase growth and immune response in aquaculture have been studied a long time ago. The immunostimulants from natural sources became highlight because its function to increase the immune system and to control pathogenic diseases in aquatic animals. Varieties of immunostimulants have been applied in aquaculture, which contain polysaccharides, such as k-carrageenan, laminaran, β-glucan, chitosan, chitin, fucoidan, predicted to control the development and immune response in aquatic animals. One source of potential immunostimulans is *Ganoderma lucidum,* known as traditional Chinese mushroom (Lingzhi). It is used to treat various human diseases because it contain high concentration (25.1%) of polysaccharides (β-D-glucans, heteropolysaccharides and glycoproteins), antioxidants, flavonoids, alkaloids, and proteins. This review aim to discuss the potentiality of *Ganoderma lucidum* as immunostimulants in aquaculture, through by diets.

INTRODUCTION

The expansion of anti-microbials and vaccines have been utilized to control the bacterial infections in aquaculture industries, nevertheless, these utilities can increase the pathogenic bacterial resistance, hence, other source of novel techniques should be found to control the pathogenic microbes. On the other hand, immunostimulants became the most suitable preference to control the pathogenic disease of aquatic animals [1]. In regard to this, varieties of immunostimulants have been applied in aquaculture [2]. Polysaccharides, such as k-carrageenan, laminaran, β-glucan, chitosan, chitin, fucoidan, predicted to control the development and immune response in aquatic animals [3,4]. One of pontential sources is traditional Chinese mushroom, *Ganoderma lucidum*.

This medicinal mushroom has a long history of being used to improve health and longevity in China, Japan, and other Asian countries. This mushroom is large shape and dark in color with a shiny exterior. In Indonesia, China and Korea, this mushroom is known as “lingzhi” and in Japan this mushroom is called “reishi” or “mannentake” [5]. *Ganoderma lucidum* is used to treat various human diseases, such as bronchitis, allergies, hepatitis, hypertension, immunological disorders, and cancer [6,7]. This mushroom is

composed of a high concentration (25.1%) of polysaccharides (β-D-glucans, heteropolysaccharides and glycoproteins), antioxidants, flavonoids, alkaloids, and proteins [8].

These polysaccharides have been identified as a major bioactive component with multiple pharmacological properties including antioxidants, immunomodulation, hepatoprotection, anti-proliferation, and anti-angiogenesis without any adverse effects to organisms [9]. This review discussed about the dietary effect of *Ganoderma lucidum* in order to enhance the growth performance and immune response of aquatic animals in aquaculture.

PHYSIOLOGY AND MORPHOLOGY OF *Ganoderma lucidum*

Generally, the morphology of the genus *Ganoderma* has a glossy surface. *Ganoderma* is widespread throughout the world, from the Amazon through the southern regions of North America and in most of Asia. It has various characteristics, such as the shape and color (red, black, blue / green, white, yellow, and purple) of the fruiting body, the specificity of the host, and geographic origin. It can be easily growing in some woods, usually in dead trees or agony/dying, mainly in deciduous forest, especially oak, maple, elm, willow, sweetgum, magnolia and at plum trees. It also found at the stump, especially at surface of soil and sometimes in soil, which is buried from the roots. In the Southeast and Southwest of United States, *Ganoderma* often to find at an ek's forest. In the Northeast, this species most widely find at maple grove. This mushroom often growth at the tree's roots which old or have the disease. In addition, It could grow at temperature 21-27^{o} C with moisturize 90-95% [5].

BIOACTIVE COMPOUNDS IN *Ganoderma lucidum*

Ganoderma lucidum or Lingzhi mushroom contains some element of bioactive like terpenoid (ganoderic acid), polysaccharides, steroids, phenol and glycoproteins, and some researcher has reported that triterpenes and polysaccharides is main components which has acted in physiological. Antibacteria compounds in this mushroom is triterpenoid. Formation of clear zone in a around paper on disk was affected because of triterpenoid compounds has a mechanism of action against bacteria.

Triterpenoid compounds reacted with Porin (protein transmembrane) in outside of the membrane cell of bacteria wall, forming strong polymer bonds resulting in the destruction of Porin. Destruction of Porin which is a door to exit or enter the compound going to decrease permeabilities, the cell wall of bacteria, and resulted in bacteria cells will get deficiency nutrition, so growth of bacteria will hamper or die.

Ganoderma lucidum contains 43.1% compound β-D- glucan that the function is an effect of immunologies, anti-inflammation, and anti-cancer. Lingzhi mushroom contains a vitamin B1 3.5 mg, B2 17 mg, B6 0.7 mg, Choline 1150 mg, Niacin 62 mg and Inositol 307 mg [10]. increase immunity by stimulating the proliferation of the Lymphosite-T, indicate that linghzi mushroom can be an additional of promising to against the effect of immunosuppressive which is will not wanted but general from more medicine of chemotherapy [11]. This mushroom contains ontituent anti-bacteria, which could obstruct of positive gram bacteria or negative gram bacteria. It seems some elements of ganosimin triterpenoid and extracts from species *Ganoderma* have an activities spectrum anti-bacteria in vitro which area against positive gram bacteria and negative gram [5].

IMMUNOSTIMULANTS IN AQUACULTURE

Several studies have been examined the uses of certain polysaccharides to increase immune response against pathogenic [9]. The immunostimulants from nature become new development, which is biocompatible, biodegradable, cost effective, and safe for the environment to prevent disease in aquaculture [12]. The application of polysaccharides were mostly due to their immunostimulating impact such as fighting autoimmune disease and increase the function of immune system [13,14]. Dietary polysaccharides are digested in the body and used as potential energy sources, which can decrease the utilization of nutrients as an energy source. In aquaculture industry, dietary supplementation polysaccharides can stimulate the immune response, reduced pathogens it leads to improved survival and growth performance of fish and crustaceans [15]. Polysaccharides as immunostimulants have been appeared to diminish mortality against pathogens in aquatic animals [16]. Several studies about the application of dietary *Ganoderma lucidum* are shown in Table 1.

Table 1. Dietary *Ganoderma lucidum* in Fish Culture

Animals test	*Treatments*	*Results*
Grass carp, *Ctenopharyngodon idella*[17]	0.1, 0.5 and 1.0 g/kg of *Ganoderma lucidum* pollysacharides supplemented diets	1.0 g/kg *Ganoderma lucidum* pollysacharides can be taken as a dietary supplement for regulating better production
Prawn, *Macrobrachium rosenbergii* [14]	1.0-2.5 g/Kg of *Ganoderma lucidum* pollysacharides supplemented diets	2.5 g/kg *Ganoderma lucidum* pollysacharides gave the highest survival rate and growth
Red hybrid tilapia, *Oreochromis,* sp. [18]	mycelial biomass and exopolysaccharide *Ganoderma lucidum*	Biomass extract (MB) 2000 μ g/mL. and Exopolysaccharide 3000 μ g/mL of *Ganoderma lucidum* extracts were considered as non-toxic for vertebrates.

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