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Some Beneficial Effects of Probiotics in Aquaculture

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ABSTRACT

Probiotics are multifunction and play main role on feed digestibility and water quality in aquaculture. The feeding habits affect on type and concentration of digestive enzymes and short chain fatty acids in fish. In addition, the most important digestive enzymes are different among fish. Probiotics can produce digestive enzymes and increase feed efficiency. They produce supplemental digestive enzymes and also predigesting anti-nutritional factors in feedstuffs. Probiotic bacteria can proliferate in fish intestine and consume nutrients particularly carbohydrates for their growth, and produce digestive enzymes such as amylase, protease and lipase accompanished by short chain fatty acids. Greater diversity of enzymes and short chain fatty acids will be achieved by different types of diet and also functional ingredients like probiotics that could be incorporated in the diet. The volatile fatty acids can play an important role for the growth of gut tissue and microbiota, subsequently more digestion and absorption will happen. Use of probiotics in diets results in more nutrient digestibility for feedstuffs that is attributed to the digestive enzymes activity of bacteria. Therefore, fortified-diet with probiotics will improve the diet digestibility and water quality that results in better performance.

Keywords: Fish, Probiotic, Water quality, Digestive enzyme, Short chain fatty acid

INTRODUCTION

Intensive aquaculture have caused outbreak of viral, bacterial and fungal diseases. This event resulted in economic losses worldwide, as China and India missed more than $750 and $210 million from 1993 to 1996, respectively [1]. Therefore, in recent decades, use of probiotics as a new strategy was suggested by different studies to promote and improve immunity system and feed utilization in fish [1,2]. Based on the type of application, probiotics can be divided into two main groups: (a) Gut probiotics: Which are used as feed additive to improve the gut beneficial microbiota that results in better performance and, (b) water probiotics: which proliferate in water medium and inhabit pathogenic bacteria activity by consuming all available nutrients, resulting in enhancing water quality for desirable growth of fish [3]. Feed additives such as probiotics are using more and more to present better growth and health for fish and other aquatic animals to supply the potential requirements [4]. According to reports, probiotics have different useful effects on fish performance such as digestive enzyme production and short chain fatty acids in fish intestine. The concentration and activity of digestive enzymes vary depending on feedstuffs in fish. In addition, specific fish may exhibit significant differences in type, concentration and enzyme activity, along with different short chain fatty acids in intestine [5]. Enzyme activities and also the most important digestive enzymes are different among fish. Carnivorous fish has higher pepsin activity than herbivorous fish. Moreover, Trypsin is considered a key proteolytic and self-activated enzyme, which may also influence the activity of other pancreatic zymogens, and potentially limit growth rate in some fish [6]. A fish which are fed with different types of diet, can show a greater diversity of enzymes and volatile fatty acids.

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The digestive habits and characteristics of the digestive tract are very important in fish nutrition, because it will help fish nutritionist to formulate diets and choose functional ingredients like probiotics that could be incorporated in the diet [5]. Since *Bacillus* probiotics are spore-forming bacteria, have more shelf life and can improve digestive enzyme activities to increase feed digestion in fish intestine. Therefore, some species of *Bacillus* probiotics are good candidate for commercial production [7]. Nowadays, there are commercial probiotic products prepared from the main important bacteria such as *Bacillus* sp., *Lactobacillus* sp., *Enterococcus* sp., *Carnobacterium* sp., and the yeast *Saccharomyces cerevisiae* that their use depends on careful management recommendations [1].

Although China is the largest aquaculture producer in the world, but use of probiotics in Chinese aquaculture is still at an initial stage. It should be mentioned that there are potential risks for some probiotic applications in aquaculture and further regulation and management are needed [2].

PROBIOTICS AND WATER QUALITY

As probiotics are multifunctional products, they can also improve water quality [3]. A new fruitful product that in recent years was demanded to increase aquaculture performance is "Biofloc or Flocbiotic" and probiotics paly a main role in this product. Biofloc comprises a rich probiotic bacteria, micro and macro minerals which helps and maintains high water quality to create an ideal environment for the better digestion and growth of aquatic animals. Biofloc technology (BFT) is an innovate technique for the management of effluents to solve environmental problems in aquaculture. This compound can oxidize ammonia to form nitrates and enhances natural nitrification cycle to convert nitrates into Nitric oxide, Nitrous oxide and harmless nitrogen. In addition, Biofloc is effective in wide range of salinity, pH and temperature of water. Therefore, higher water quality with Biofloc causes more fish growth through higher digestion [8]. In addition, probiotics are able to transfer the organic matter to CO_2. It is recommended to supply high levels of probiotics in fish ponds to decrease the organic carbon load and to enhance the water quality and fish health [3].

PROBIOTICS AND DIGESTIVE ENZYMES

The gastrointestinal tract is a main organ, where probiotics can establish and profilate and exert their effects. Gut and probiotics have direct relationship together [9]. There are many documents that probiotics can improve the digestibility of nutrients in feedstuffs [1]. The relationships between probiotics and digestive enzymes activity were not investigated in most cultured fishes [10]. Fewer experiments have been conducted to incorporate probiotics into freshwater fish species based on growth performances and digestive enzymes activity [3,10,11]. Probiotics can increase feed efficiency in fish by production of digestive enzymes. One of the main beneficial effects of probiotics in aquaculture is the increase in nutrition of the host by the production of supplemental digestive enzymes and also predigesting anti-nutritional factors in feedstuffs. Probiotic bacteria after passing from the stomach proliferate in the intestine and consume nutrients particularly carbohydrates for their growth, and produce digestive enzymes such as amylase, protease and lipase [10]. Amylase is the primary glucosidase found in fish. Amylase hydrolyses amylose, glycogen, or linear fragments of amylopectin secreted by pancreatic cells. Amylase activity been observed in several teleosts (including herbivorous to strictly carnivorous fish). In addition, this enzyme has activity at different portions of the digestive tract, although mainly in the pyloric cecum, liver and pancreas [6].

In aquaculture, probiotics can be administered either by adding in feed or water [10,12,13]. As illustrated by some authors, all the probiotics that were administered through feed have caused an increase in growth performance, specific growth rate and survival in freshwater and marine fishes and also shrimp [10,14]. In addition, digestive enzyme investigation can also be used as a marker or indicator and to some extent as an indicator for the digestive capacity in relation to the type of feed offered. In addition, the evaluation of the presence and level of digestive enzyme activity may be applied for determination of the rate of development of fish larvae, feed intake, digestive capacity, as well as their further survival rate [10]. Most carnivorous fish show low or moderate activity of α-amylase in the intestine and pancreas which is related to the low-carbohydrate diet of these fish in the natural environment [6]. Furthermore, enzymatic activities could not be recognized due to the enzyme being synthesized by the host or bacteria [10,12]. However, lactic acid bacteria (LAB) have high ability to produce digestive enzymes such as amylase, protease and lipase [15]. It is supposed that probiotics affect the digestive processes through increasing the beneficial population of microorganisms, microbial enzyme activity that improved the intestinal microbial balance, consequently improving the digestibility and absorption of feed [10,12,16].

PROBIOTICS AND SHORT CHAIN FATTY ACIDS

Probiotics are able to enhance the concentration of the volatile fatty acids (VFAs) or short chain fatty acids (SCFAs) comprising acetate, propionate and butyrate in the fish intestine [16]. The short chain fatty acids can play an important role for the growth of gut tissue and microbiota [17]. Furthermore, it is well known that dietary fibers are fermented by the anaerobic intestinal microbiota, particularly those colonizing the large intestine [18]. This leads to the production of lactic acid and short chain fatty acids particularly acetate, propionate and butyrate that are utilized by the host as a source of energy and also the production of gases such as H_2, CO_2 and CH_4. These short

chain fatty acids help the gut to grow and develop, subsequently more digestion and absorption will happen. Moreover, the reduction of luminal colonic pH results in increase of calcium solubility and absorption [3,18].

PROBIOTIC AND DIGESTIBILITY

In general, the application of probiotics in diets results in more nutrient digestibility for feedstuffs [3,19]. This suggests that the addition of probiotics will improve the diet and protein digestibility, which may in turn explain the better performance [20]. The positive effects of probiotics in fish diets on feed nutrients digestion were reported attributable to the digestive enzyme activity of bacteria [15,21] evaluated the effect of chitin on the adherent aerobic intestinal microbiota of Atlantic salmon (*Salmo salar* L.) and further tested for protease, amylase, cellulose, phytase and chitinase activities particularly for LAB. They reported that the LABs have the ability to produce digestive enzymes such as amylase, lipase and protease. The positive effects on nutrient digestibility in Rohu fish (*Labeo rohita*) were observed when the diets supplemented with different microbial probiotics [19]. Similar effects have been reported for terrestrial animals (such as poultry) in which digestibility is shown to increase considerably with the use of probiotics in diet [22-24] recorded an increase in the digestive enzyme activities of amylase, trypsin and lipase in sea bass (*Dicentrachus labrax*) using live yeast. Wang's [25] investigated the effect of *Bacillus* sp. probiotics on protease, amylase and lipase specific activities in the common carp and a significant increase in digestive enzyme activities in the all-probiotics treatment groups were observed. Also, a significant effect of the probiotic treatment on amylase and trypsin activities in the shrimp was reported by [26]. Therefore, as Suzer et al. [10] demonstrated, probiotics affect the digestive process by enhancing the population of beneficial microorganisms and then microbial enzyme activity, consequently improving the digestibility and absorption of feed and feed utilization. They also illustrated that the high growth performance can enhance specific activities of digestive enzymes as well. Therefore, according to all studies and reports, probiotics can seriously affect on fish performance and feed digestibility through enhancing the water quality, digestive enzyme activity and short chain fatty acids production.

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