Biomanufacturing of Aquaculture Enzymes

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Introduction

Aquaculture has always contributed a lot in meeting our needs and demands. These demands include various purposes starting from the basic needs of human beings to the needs of the environment. As the population keeps increasing rapidly, the mouths to be fed also keeps increasing simultaneously and seafood plays a major role in contributing to our daily meals. Fish and seafood are generally healthier than red meats. It acts as a major source of protein necessary for our body's wellbeing especially in Asia and coastal regions. The amount of fishes found generally in nature are depleting because of overfishing. Hence, aquaculture comes into the picture to assist the problem by replacing the wild-caught fishes and easing pressure on oceans. This aquaculture seafood is found to be completely environmental friendly than other land-based farming. Also, introduction of this method of development has paved way in creating a new field of study and has opened our minds to think out of the box. They have also promised in eradicating the problems of unemployment and have given a lot of job opportunities to many.

Aquaculture Enzymes

A study has been carried out for many years based on replacing different seafood items with different plant protein components. Plant proteins generally possess various anti-nutritional substances and this becomes one of the negative points when we study relating this with fish feed. Hence, it is clearly understood that, for using plant protein components as a replacement in fish feed, it is essential to remove or at least reduce their anti-nutritional quality.

Enzymes are generally protein structures that assist the biochemical processes such as breaking down food, building of new molecules, or any other essential life process. They are also sometimes referred to as biological catalysts. Likewise, enzymes that assist the biochemical processes in fishes and other marine organisms are termed as aquaculture enzymes. Figure 1 shows the types of aquaculture enzymes used in aquaculture sector. Recent researches on exoenzymes that act as feed additives are attracting researcher's interests into this aquaculture industry. This aims in increasing the nutrient quality of plant protein components and creates a new way of providing nutrient enriched seafood or fish feed, increasing the profits for the aquaculture industries.

Assisting in better food digestion in fish, making more quantity of nutrients available, increasing the feed efficiency, and strengthening of immune system are some of the important roles of aquaculture enzymes. All these enzymes must be manufactured, altered and inserted in the fish feed production units appropriately for their assistance in improving the yield. These aquaculture enzymes can be extracted from plant based protein components. As already mentioned, plant based protein components have to be processed by feed processing to reduce its anti-nutritional factors (ANFs). Introduction of these processed exoenzymes into aquaculture fields has created a lot of developments like reduction in the impacts of anti-nutritional factors (ANFs), improvement in the health and immune response of the fish, increase in the availability of nutrients, increase in the quality of water, thereby increasing the possibilities of incorporating high levels of plant proteins to enhance the fish productivity and economy.

Major Aquaculture Enzymes

Proteases:

These enzymes are generally called the proteolytic enzymes, required to breakdown proteins into amino acids. Recently, these enzymes have claimed to be one of the common and important enzymes in aquaculture. Their roles in the development of fish feed have been enormous. Plant derived proteases, animal derived proteases, and microorganisms derived proteases are the three different sources of the enzyme protease. In these sources, microorganisms contribute the most in providing with the protease enzymes for fish feed. Hence, pH and temperature are the most influencing factors of the enzyme activity. The protease enzymes help in modifying the plant proteins that assists fish feed by interrupting the cell content, develops the contact between protease enzyme and the cell content, thereby decreasing the anti-nutritional factors (ANFs) and increases the quality of the protein in all aspects. Endogenous protease activity is stimulated by the incorporation of these protease enzymes that lead to the utilization of amino acids. Recent researches also state that protease enzymes have the capability in assisting the immune response and growth of the organisms. Hence, this simultaneously increases the aquaculture population.

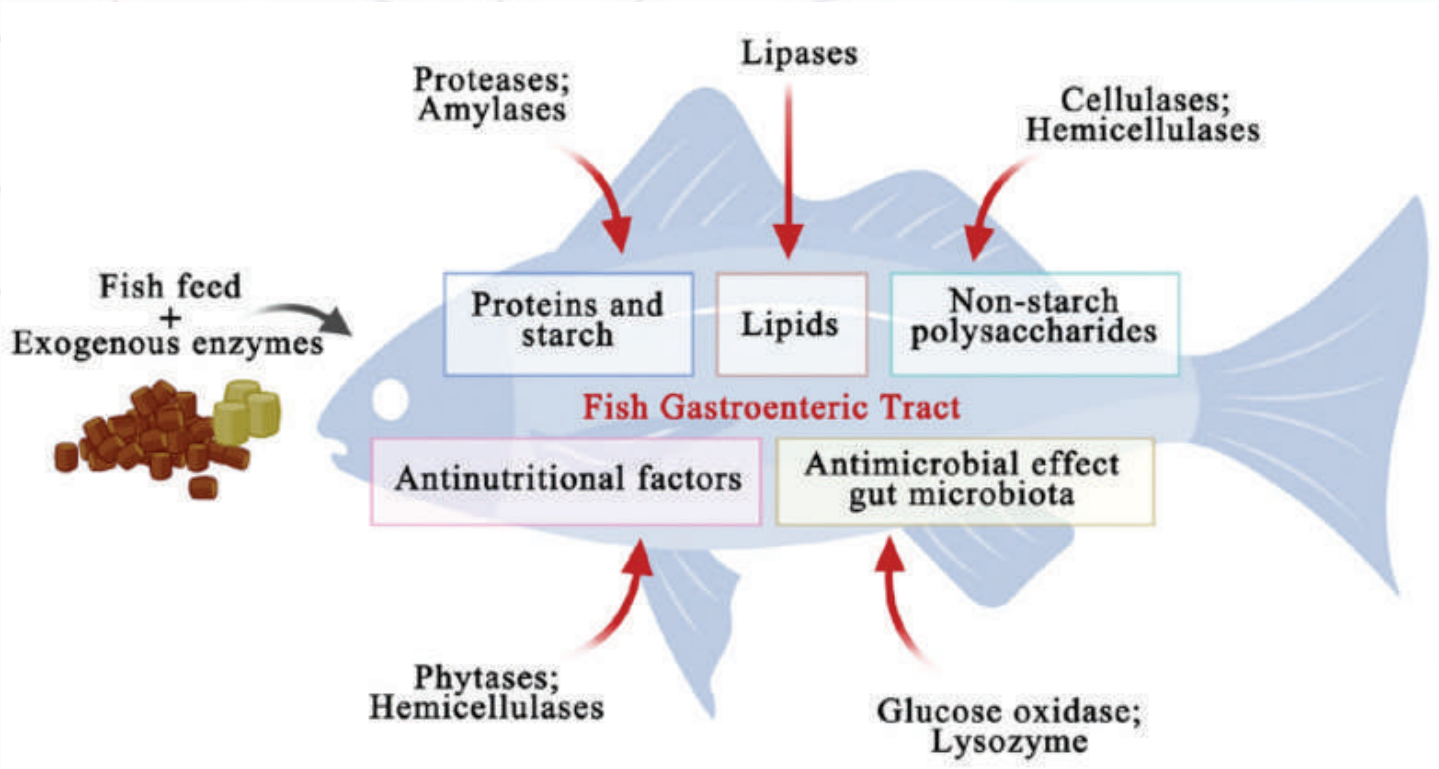

Figure 1: Types of Aquaculture enzymes used in aquaculture sector

Carbohydrase:

The main cause for the importance of utilization of this enzyme in fish feed is to reduce the non-starch polysaccharides (NSPs). This is because they play a vital role in reducing the availability of nutrients for fish feed. They are one of the most common anti-nutritional factors. Generally, fishes lack the capacity to produce the necessary enzymes to reduce these non-starch polysaccharides and thereby, carbohydrases become needy as NSPs causes viscidness in the digestive tract of fishes leading to negative growth rates. This helps in a developed gut health. CHO digestion enzymes increase nutrient digestibility and availability. Implementation of these enzymes in fish feed increases its growth, health, feed conversion ratio, and its gut microbiome. Factors influencing the incorporation of these enzymes are the amount of plant protein in the diet of the fish, size and age of the species, and type and quantity of the enzymes according to the species.

Phytase:

Phytate is a naturally occurring substance in the plants especially in grains, beans, and oilseeds. It is the main storage form of phosphorous in plants. Fishes and animals lack the phytase enzyme that degrades the phytate. Therefore, all the phosphorous stored in the phytate molecule gets trapped and the fishes find it harder to utilize the particular nutrient. These phytate molecules also bind to certain micronutrients and macronutrients like calcium, iron, and zinc leading to unavailability of these nutrients too. Hence, incorporation of the phytase enzymes in the food source of fish feed leads to more utilization of phosphorous, nitrogen, and unbind phosphorous from phytate acid which can be used by the fishes for their development. They also contribute to reduction in the environmental impact by releasing a lot of phosphorous unutilized. This methodology has lead to improved growth, weight gain and feed efficiency of the fish feed. The factors influencing the use of this methodology are fish physiology, nutrition and environmental conditions.

Other Aquaculture enzymes:

Other aquaculture enzymes include lipases for breaking down fats, cellulase for breaking down plant fibers like cellulose, xylanase for decomposing hemicelluloses fibers, glucanase for degrading beta-glucans, chitinase for breaking down chitin from crustaceans, pectinase for degrading pectin cell walls and many more.

Conclusion and future perspectives:

Aquaculture exogenous enzymes have successfully proved to contribute to the development of aquaculture feeds. They have increased the growth rate, health, immune responses, gut microbiome, production of antioxidants, feed utilization etc. Their strategic use not only boosts the overall efficiency and sustainability of aquaculture production but also supports healthier and faster-growing aquatic species. Future researches can be based on improving the causes of influential factors that have been mentioned above for each enzyme. Providing optimum growth conditions like temperature, pH and other required factors for the growth of organisms from which these enzymes are extracted can contribute a lot to the development of aquaculture industry. Further researches can be done on creating more stable enzymes for better efficiency. They can be tested to work under different environmental conditions. Also production of genetically modified microorganisms to produce even more efficient species specific and condition specific enzymes can lead to even more advancements.

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