**Synbiotics in Aquaculture**

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**Introduction**

Aquaculture has grown tremendously over the past decades and has become an economically important industry. It is the fastest-growing food producing sector globally with the greatest potential to meet the increasing demand for aquatic food. The intensive culture of aquatic organisms to fulfill the demands of a ever-increasing human population has come with a number of difficulties. Aquaculture can have a negative impact on the environment by spreading illnesses, destroying wetlands and mangroves, reducing the richness of wild fish populations by allowing non-native fish to escape, and polluting surface and groundwater through effluent discharge.

The modernization of aquaculture, which includes extensive stocking, feeding and manuring for high fish production has resulted in a number of issues including drop in water quality, decline in fish health and resulting in occurrence of a range of diseases, which is the significant issue that makes aquaculture systems non-viable leading to economic losses. Several workers have identified a large number of disease causing organisms including bacteria, viruses and parasites which have been studied in greater detail. As a result, fish health management has become one of the most important factors in achieving safe and well-grown fish from aquaculture. In recent years, almost 20% of production was lost due to diseases that brought economic losses. For several decades, it has been common practice to use chemotherapeutic/antimicrobial agents to prevent and control infectious diseases, but with little success in preventing or treating disease in aquatic animals. However, the routine use of these substances has several adverse consequences, such as environmental degradation, food safety problems, which have also led to the development of resistant bacterial strains. To address these issues, immunostimulants such as probiotics, prebiotics and their synergistics have been proposed as an alternative method for disease outbreak prevention and control.

**Immunostimulants**

Immunostimulants are substances that enhance nonspecific defense mechanisms by increasing phagocytosis, leukocyte activity, macrophage and neutrophil migration, or a specific immune response. In addition, they also reduce the immunosuppressive effect of stress. Immunostimulants have been derived from diverse natural sources and a large number were later synthesized chemically with the natural products as structural models. They show varying degrees of effectiveness in preventing disease caused by microbial pathogens. Various compounds such as selected proteins, lipids, carbohydrate-based cell wall extracts and synthetic compounds have been used as immunostimulants in farmed fish and crustaceans. Immunostimulants are classified by origin as bacteria and bacterial products, complex carbohydrates, drugs that enhance the immune response, nutritional factors, animal extracts, cytokines and lectins and plant extracts. The most common of these are glycans, yeasts, yeast glycans, abalone extracts, crude mutants, levamisole, Ferund’s adjuvant and other naturally or synthetically produced substances.

**Probiotics**

The term probiotic was originated from the Greek words “pro” and “bios” which mean “for life” and are often called as promoter of life that help in a natural way to improve the overall health status of the host organism and is currently used to name bacteria associated with beneficial effects on human and animals. According to WHO/FAO (2002), the probiotics are defined as live microorganism which when administered in adequate amount confers a health benefit on the host. Probiotic bacteria were first studied by Elie Metchnikoff, a Nobel laureate of 1908 in the field of medicine. The term probiotic was first mentioned by Kollath (1953), defined as organic and inorganic food additives necessary to restore health in malnourished patients. In the 1960s, interest in the concept of probiotics also extended to animal husbandry. Feed additives became available to farm animals when LAB were included as health agents. The use of probiotics in aquaculture has been associated with several beneficial effects, namely modulation of the gut microbiota and immune system, and improvement of survival, development, and nutritional and disease resistance. However, further research is needed to determine their exact operation.

Probiotics can play an important role as immunostimulants and antimicrobial agents. Merrifield et al. (2010) proposed a more comprehensive and broad definition of probiotic for use in aquatic animals: "all microbial cells obtained through food or rearing water that provide benefits to the host fish, fish farmer or fish consumer, achieved at least in part by improving the microbial balance of the fish.Use, improved carcass and meat quality and reduction of deformities Often, lactic acid bacteria (LAB) have been widely used and studied in humans and animals and are known to be present in the gut of healthy fish. The increasing interest in the possible use of probiotics in aquaculture and thus, the research into the use of probiotics for aquatic animals is necessary owing to the demand for environment-friendly sustainable aquaculture. The probiotic improves water quality and the host's immune response by balancing the microbial load. Some of the beneficial effects of probiotics appear in the improvement of nutritional utilization of cultured aquatic animals through the addition of digestive enzymes, improvement of nutritional efficiency and growth, prevention of intestinal disorders and pre-digestion of the nutritional factor in the mixture. Most probiotics colonize the host and affect the digestive processes by increasing the quantity and production of microbial enzymes, improving the microbial balance of the gut and thus promoting digestibility and assimilation and nutrient utilization.

Probiotics are marketed in two forms a) Dry forms: Dry probiotics, which are packaged, can be given with feed or applied in water and must be incubated on the farm before use. Each packet of dry probiotics contains a packet of dry powder and a packet of enzyme catalyst. After emptying the packages and mixing them, they should be done in clean, disinfected water. It is usually done at 27-32°C for 16-18 hours with continuous aeration. Finished products must be used within 72 hours. In semi-intensive culture ponds, maximum aeration is necessary. If aeration is low, probiotics should be administered on two consecutive days at 50% of the dose each time.

b) Liquid forms: hatcheries usually use liquid forms that are live and usable. These liquid forms are added directly to hatcheries or mixed with farm feed. In indoor containers, liquid forms can be applied at any time of the day, but in outdoor containers in the morning or evening. Liquid forms give positive results in a shorter time compared to dry and spore forms of bacteria, although their density is lower. Adverse effects of probiotics have not been reported, but it has been observed that biological oxygen consumption levels may temporarily increase with its use; therefore, underground aeration is recommended to accelerate the formation of probiotic organisms. A minimum dissolved oxygen level of 3 mg/l is recommended during probiotic treatment.

**Prebiotics**

A prebiotic, unlike a probiotic, is not an organism and has less impact on the natural environment. Based on the definition of Gibson and Roberfroid (1995), a prebiotic is an indigestible food ingredient that has a beneficial effect on the host by selectively stimulating the growth and activity of one or a limited number of bacteria in the colon, thus improving colonic health. . a host Some non-digestible carbohydrates considered prebiotics include resistant inulin and oligofructose, trans-galacto-oligosaccharides (TOS), lactulose, isomalto-oligosaccharides (IMO), lactose, xylo-oligosaccharides (XOS), soybean oligosaccharides and glyco-oligosaccharides. Bongers and Van Den Heuvel (2003), demonstrated that increasing effect of prebiotics on mineral absorption, the osmotic effect of the exchange of protons and possible decrease in proteins such as calcium-binding protein which may increase the availability of trace elements in the small intestine, acidification of the colonic content due to fermentation and production of short-chain fatty acids (SCFA), formation of calcium and magnesium salts of these acids and hypertrophy of the colon wall. Prebiotics can alter the microbial community in the gastrointestinal tract to enhance nonspecific immune responses. Mannan-oligosaccharide (MOS) extracted from the outer wall of yeast (*Saccharomyces* spp.) maintains intestinal health by adsorbing pathogenic bacteria containing type I fimbriae or by agglutination of different bacterial strains. Lowering colonic pH due to SCFA production resulted in the inhibition of the growth of certain harmful pathogens by increasing the growth of bifidobacteria and other lactic acid species. Soleimani *et al*. (2012) reported improved growth (final weight, SGR and FCR) in fish fed 2% and 3% FOS. So that FOS can be considered as a beneficial dietary supplement for improving the immune response, stress resistance, digestive enzyme activities and growth performance of Caspian roach fry. The fish blood profile and growth performance could be affected by probiotic (Gro-Biotic A, 1-3%). Prebiotic supplementation and lipid concentration significantly affected several aspects of fish performance and body composition some of the differences were numerically small. Most of the information regarding the role of prebiotics in the gut physiology includes the study of the microbiota. These microbial communities in the gut varied with the prebiotic used (nature, concentration, duration, etc.) and the fish species. In general, the dietary intake of prebiotics provokes the microbiota with a higher number of “good” bacteria (namely *Lactobacillus* and *Bifidobacterium* species) and lower of “bad” bacteria (potential pathogenic bacteria such as *Aeromonas* sp. or *Vibrio* spp).

**Synbiotics**

Synbiotic means a dietary supplement that combines a mixture of probiotics and prebiotics in a synergistic form. The concept of sybiotics was proposed to characterize some colonic foods with interesting nutritional properties that make these compounds suitable for classification as health-promoting functional ingredients. A mixture of prebiotics and probiotics can have beneficial effects on the host by improving the survival and engraftment of live microbial supplements in the gastrointestinal tract, selectively stimulating the growth of one or a limited number of health-promoting bacteria, and activating metabolism, improving health, welfare of the host. Effective binding would allow the intestinal environment to be altered by a prebiotic that selects favorable growth conditions for known beneficial probiotics. The advantage of this approach is that fish farmers are able to control and create favorable conditions for the colon and ensure that sufficient amounts of beneficial probiotics are present. Artichoke and L. plantarum combination diet showed significantly improved SGR, FCR, serum lysozyme activity, phagocytic activity, respiratory burst activity compared to control and individual applications. Dietary *Jerusalem artichoke* and *L. plantarum* significantly stimulated growth, immunity and disease resistance of *P. bocourti* was reported by many authors. The juvenile angelfish fed with *Artemia* enriched with synbiotic (*Pediococcus acidilactici* and fructooligosaccharide) improved growth performance, mucosal immune response, stress resistance as well as modulation of intestinal microbiota toward potentially beneficial bacteria such as Lactic acid bacteria and the diet supplementation with synbiotic (*Enterococcus faecium* and FOS) significantly increased blood factors at all treatments and the synbiotic fed groups showed significantly higher survival rate after challenges with *Saprolegnia parasitica*. Sybiotic supplementation in the host has beneficial effects by improving survival and engraftment of live microbial supplements in the gastrointestinal tract by selectively stimulating the growth and metabolism of a limited number of health-promoting bacteria studied in rainbow trout (*Oncorhynchus mykiss*). Partida-Arangure *et al*. (2013) found that insulin and bacteria improved immunity in cultured *Litopenaeus vannamei*. Sybiotics in combination with plant products or yeast have recently been used in aquaculture with promising results on gut microbiota, gut morphology and mucosal immune responses. Sybiotics promote immunity by allowing beneficial bacteria to colonize the mucosa and preventing harmful bacteria from colonizing by competing for substrates and attachment sites. Sybiotics have been shown to improve growth performance by promoting fat breakdown.

Synbiotics are now becoming an important aspect of aquaculture procedures in order to achieve high yield. Despite the promising potential benefits of these feed supplements as demonstrated in the current literature, the use of synbiotics in fish farms has been poorly investigated to date and the above account clearly summarizes a limited amount of work on the effect of synbiotics on carps as well as the influence of synbiotics on histo-pathological changes including the gut and other associated body organs.

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