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Influences of dietary factors on fish health

1 February 2004

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The role of vitamins, immunostimulants, probiotics and more



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enhancing immune responses and disease resistance when administered in the diet.

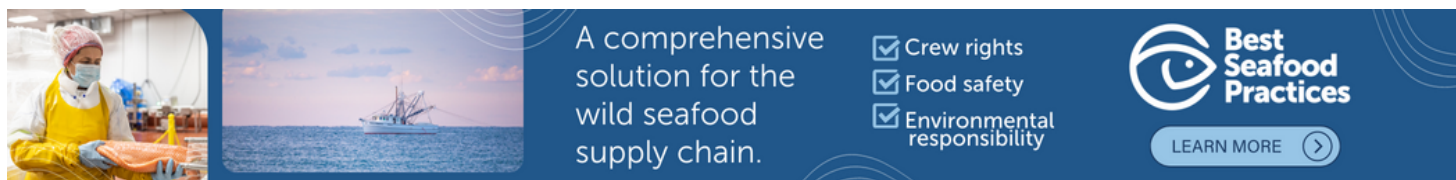
Proper nutrition plays a critical role in maintaining the normal growth and health of aquacultured fish. Based on current knowledge, a variety of dietary factors and nutritional strategies can influence fish health.

Nutrients

Research with several fish species has established that immunocompetence and disease resistance can be compromised by deficiencies of nutrients, especially amino acids/proteins, certain vitamins and minerals. Sufficient input of high-quality protein with balanced amino acid composition is essential for optimal growth and health because various immunological factors are specific proteins or protein-catalyzed products. In addition, adequate levels of micronutrients such as vitamins and minerals should be supplied in prepared diets to support optimal growth and production efficiency in aquaculture.

Nutrients involved in antioxidative defense mechanisms, including vitamins C and E, as well as the mineral selenium, are important for maintenance of the immune functions of aquacultured fish because immunological cells such as macrophages and lymphocytes are sensitive to oxidative stress. Based on recent studies with terrestrial animals, other micronutrients such as vitamin A, copper, and zinc are required for gene expression of immunological cells, although research in this area with fish is in its infancy.

Sufficient supply of all required nutrients and effective monitoring of the levels and availability of these nutrients after processing are basic considerations to provide nutritionally complete and balanced aquafeeds.



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Nonnutritive immunostimulants

In recent years, interest has heightened in the potential use of natural or synthetic compounds which may activate immune responses and thus enhance the disease resistance of aquacultured fish. Most of the immunostimulatory compounds examined in fish have shown immunoenhancing potential by improving the nonspecific immune responses considered the first line of defense against invading organisms.

The responses of macrophages – cell migration, phagocytosis, and bactericidal activity – as well as changes in leukocyte numbers and the activation potential of cells as measured by tissue levels of oxidative radicals and enzymes, are often used to assess nonspecific immunity.

Brewer's yeast

Brewer's yeast is a natural feedstuff that contains beta-glucans, chitin, mannoproteins, and nucleic acids, all of which have been found immunostimulatory in fish. Because yeast byproducts are completely natural, they hold great promise for use in aquafeed. The beneficial influences of dietary brewer's yeast on resistance in fish species from rainbow trout to *Aeromonas salmonicida* have already been demonstrated.

Although commercial preparations of beta-glucans have received considerable attention as immunostimulants for fish culture, recent data on rainbow trout and hybrid striped bass indicates dietary brewer's yeast may be even more effective than beta-glucans in enhancing immune responses and disease resistance when administered in diets.

Nucleotides and oligonucleotides

Nucleotides and oligonucleotides hydrolyzed from yeast have also shown noticeable positive effects on both the specific and nonspecific immune responses of some fish species and resistance to pathogenic viral, bacterial, and parasitic organisms. Results with rainbow trout, Atlantic salmon, common carp, hybrid striped bass, and tilapia consistently show positive responses in terms of immunostimulation and enhanced disease resistance when nucleotides are supplemented in diets.

Dietary immunostimulants

Levamisole is a broad-spectrum antihelminthic drug widely used to control internal parasites in terrestrial animals. It also has been used in studies on fish with the aim of enhancing nonspecific immune responses or serving as an adjuvant with vaccines.

Due to its low cost and low residue in fish, levamisole holds promise as an immunostimulant. Relatively low doses of 100 mg levamisole per kilogram diet enhanced the growth of hybrid striped bass and gilthead sea bream, and improved immune responses including respiratory burst, phagocytosis, and lymphokine production. The enhancement induced by dietary levamisole in resistance to infectious diseases has not been consistent, which may depend on the specific mechanism of infection.

Other dietary immunostimulants, including chitin, lactoferrin, peptidoglycan, liposaccharides, sulfated polysaccharides, beta-hydroxy-beta-methylbutyrate, and certain bacterins and fungal products, have been reported to experimentally enhance fish health, but additional supporting research is warranted.

Prebiotics and probiotics

Dietary supplementation with probiotics or live microorganisms such as bacteria or yeast to alter the environment of the gastrointestinal (GI) tracts of fish enhances growth as well as reduces disease risk in some fish species. Supplementation of prebiotics or dietary ingredients which favor the growth of certain beneficial bacteria in the GI tract also has been investigated.

The authors' laboratory recently evaluated graded levels of a commercial prebiotic mixture of partial autolyzed brewer's yeast, dairy ingredient components, and dried fermentation products, in fishmeal-based diets with hybrid striped bass. The prebiotic was added to the control diet at 1 and 2 percent levels, with each diet fed to juvenile bass for four or seven weeks.

After seven weeks, enhanced growth performance and feed efficiency were generally observed in fish fed the supplemented diets compared to the control animals. After four weeks of feeding in trial 2, growth and feed efficiency were not significantly affected by the various dietary treatments, although some immunological responses such as neutrophil oxidative radical anion production and extracellular

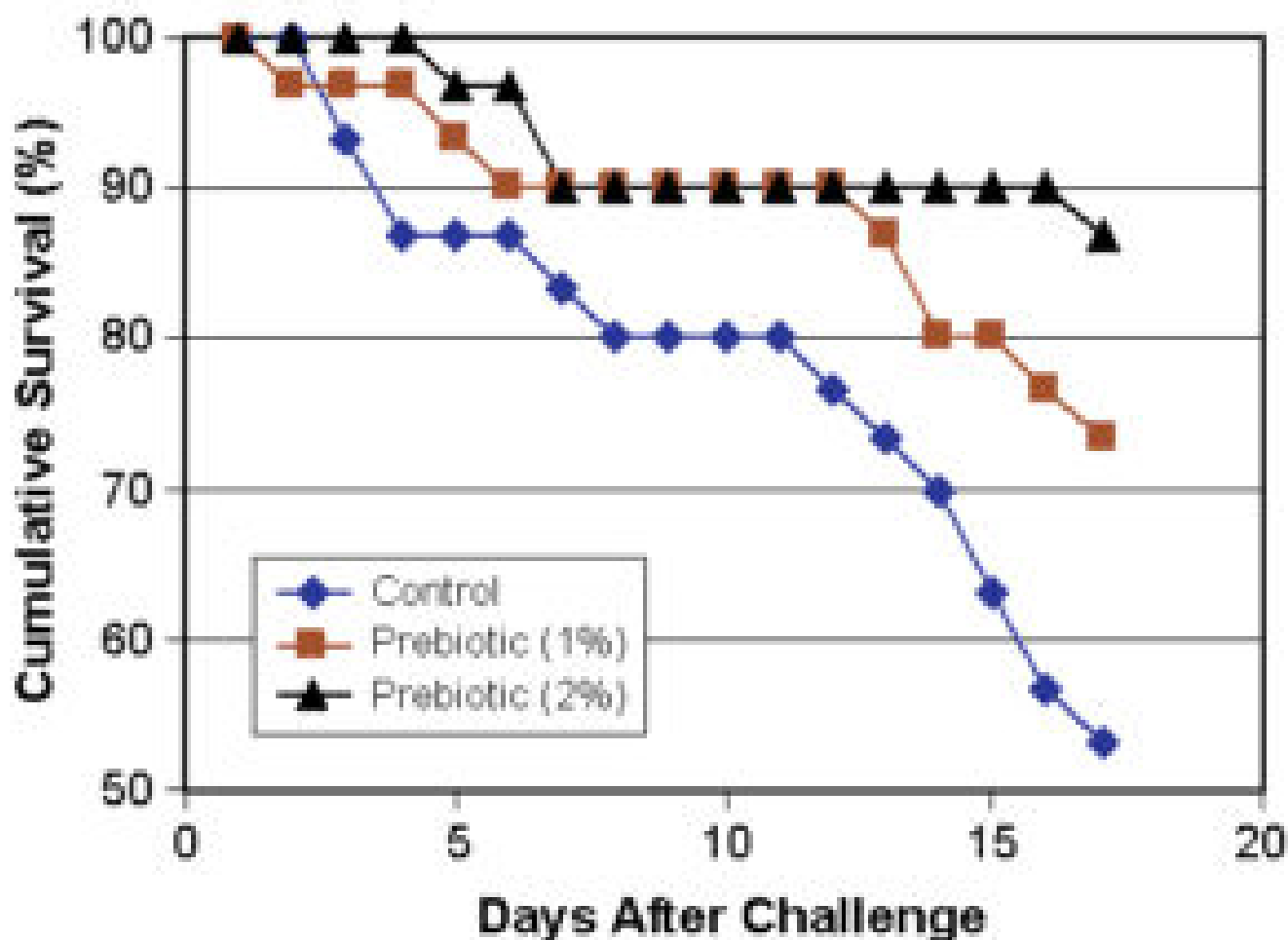


Fig. 1: Survival of hybrid bass fed low levels of a prebiotic four weeks and then exposed to *Streptococcus iniae* ($P < 0.018$). Symbols represent means of 3 replicate tanks/treatment.

superoxide anion production of head kidney macrophages were enhanced in fish fed diets supplemented with the prebiotic.

All groups of hybrid striped bass fed the supplemented diets showed enhanced survival of 73.3 to 90 percent 17 days after bath exposure to *Streptococcus iniae* as compared to 53.3 percent survival in fish fed the control diet (Fig. 1).

Administration protocols

Although various dietary compounds have shown potential to enhance fish health, it should be considered that some nutrients and nonnutritive immunostimulants have potentially negative side effects and even toxicity when administered at improper levels or for a prolonged time. This phenomenon is particularly noticeable with certain trace minerals and synthetic immunostimulants such as levamisole.

It is generally suggested that dietary administration of immunostimulants such as beta-glucans should be alternated with a nonsupplemented diet at approximately four-week intervals. Long-term administration may attenuate previously enhanced immune responses.

Further research into optimizing the dosage and length of exposure to various immunostimulants may allow dietary modulation of the immune response to be used as an effective and relatively inexpensive alternative chemical therapy in combating diseases in aquacultured fish.

(Editor's Note: This article was originally published in the February 2004 print edition of the Global Aquaculture Advocate.)

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