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Health & Welfare

Prebiotics, probiotics provide alternatives to antibiotics

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Some prebiotics show protection when injected but not when fed

Oligosaccharides fed to European sea bass and other species have shown varying degrees of success in improving growth efficiency and resistance to disease.

As aquaculture continues to expand, pressures to find alternatives to medicinal disease treatments are also rising. Concerns over antibiotic use in aquaculture include the development and transfer of antibiotic resistance to fish and human pathogens, as well as the potential for accumulation of residual antibiotics in aquaculture products.

As the demand for aquaculture products increases, so does the search for environmentally friendly alternatives to antibiotics. Alternatives to antibiotics include dietary prebiotics, probiotics and synbiotics.

Prebiotics and probiotics have been shown to enhance both growth efficiency and disease resistance in a variety of aquatic species, while synbiotics (mixtures of pre- and probiotics) have yet to be extensively evaluated. Research using prebiotics and probiotics in aquaculture is growing, but the results are often inconsistent, and the mechanisms through which they function are poorly understood.

Prebiotics

A prebiotic is a non-digestible substance that is thought to provide a beneficial effect on the host by stimulating growth or activity of naturally occurring bacteria in the gastrointestinal tract. Typically, prebiotics are non-digestible carbohydrates (fructo-oligosaccharides, galacto-oligosaccharides, mannan-oligosaccharides), but can also include indigestible dietary fibers (dextrins, inulin, lignin, waxes, beta glucans).

Many forms of prebiotics have been fed to a wide variety of fish species with varying responses. For example, inulin has recently been shown to alter the intestinal microbial communities of turbot, Arctic char, Atlantic salmon and hybrid striped bass, but did not yield any benefits toward improving growth or feed efficiency.

Prebiotics like glucans have shown protection against enteric septicemia of catfish in channel catfish when the products are injected but not when fed. Furthermore, a prebiotic composed of brewer's yeast, dairy components and dried fermentation products was found to significantly increase feed efficiency and reduce the mortality of hybrid striped bass challenged with bacterial pathogens.

Non-digestible oligosaccharides fed to rainbow trout, European sea bass, channel catfish and hybrid striped bass have shown varying degrees of success in improving growth efficiency and resistance to disease. The results of these studies suggested that prebiotics have a role in aquaculture as a feed additive for improving growth and resistance to disease.

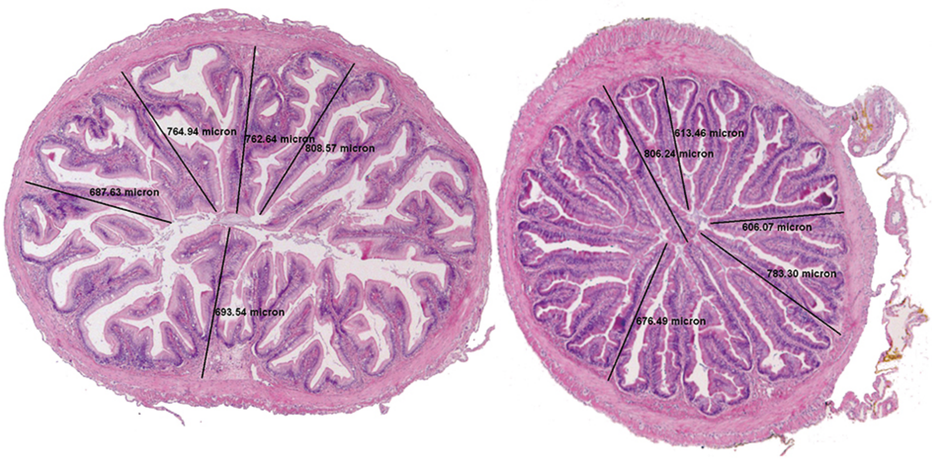

Fig. 1: The lower intestine of catfish fed a control diet showed microvilli lengths similar to those in the intestine of fish that received feed supplemented with the prebiotic mannanoligosaccharide.

Probiotics

Probiotics are live microorganisms thought to have a beneficial health effect on the host by adding "good" bacteria to the gut. *Lactobacillus, Bacillus, Enterococcus, Carnobacterium, Saccharomyces* and *Candida* are probiotic organisms widely investigated in aquaculture. These organisms are added directly to the water environment of the fish or administered orally in feed.

Probiotics have been shown to protect against bacterial infections by *Vibrio, Aeromonas, Yersinia* and *Ichthyophthirius* in rainbow trout. In African catfish, *Lactobacillus* enhanced fish health, survival and growth performance. In channel catfish, *Pediococcus* and *Entebacteria* had no growth-promoting or immune-stimulating effect, while *Bacillus* bacteria were shown to increase the survival of pond-raised catfish.

Synbiotics

Another class of compounds called synbiotics includes mixtures of prebiotics and probiotics. Synbiotics may work by stimulating the growth of beneficial bacteria within the gastrointestinal tract of the host. The authors are not aware of any studies in aquatic animals that have evaluated the efficacy of these products, but synbiotics have potential for manipulating the microflora of the gut and improving growth and disease resistance.

MOS research

At the Thad Cochran National Warmwater Aquaculture Center in Stoneville, Miss., USA, the authors examined a commercial mannan-oligosaccharide (MOS) available from Alltech, Inc. derived from the cell wall of yeast as a potential feed additive in channel catfish.

In one study, the catfish were fed the prebiotic at 2 grams per kg diet for six weeks, then challenged with *Edwardsiella ictaluri*, the bacterium that causes enteric septicemia of catfish. All fish were bled before the challenge as well as on day 14 of the challenge. In a second study, catfish received the prebiotic at 4 grams per kg diet for nine weeks, followed by challenge with *E. ictaluri*. Mortalities were collected for 21 days.

Gut morphology was examined in fish fed diets with mannan-oligosaccharide, as well as controls prior to challenge. Sections of the upper, middle and lower parts of the intestine were taken for analysis.

Results

Feeding MOS at 2 or 4 grams per kg diet for six or nine weeks did not improve weight gain, specific growth rate or feed conversion in the fish (Table 1). However, survival was significantly increased after challenge with *E. ictaluri* in both studies.

Peterson, Culture performance of channel catfish, Table 1

Treatment	Weight Gain (g)*	Specific Growth Rate	Feed-Conversion Ratio	Survival (%)
Study I				
Control	59.5	2.00	1.40	52.5^{y}
MOS	54.9	1.90	1.49	90.0^{z}
Standard error	4.0	0.10	0.10	5.8
Study II				
Control	40.6	2.60	1.32	45.0^{y}
MOS	44.4	2.90	1.33	70.0^{z}
Standard error	1.4	0.01	0.10	1.7

Table 1. Culture performance of channel catfish fed an MOS -supplemented diet or control diet. Values with different letters within columns are significantly different ($P < 0.05$).

Plasma levels of lysozyme, an indicator of a non-specific immune response, were similar in fish fed MOS feed before and after challenge. Fig. 1 shows representative lower intestine sections of fish fed MOS compared to controls. Microvilli lengths in the lower, middle and proximal intestine were similar after nine weeks of feeding.

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