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Global Aquaculture Advocate ™

Responsibility

Protein content of fish feed affects water quality

Sunday, 1 February 2004

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Maintaining aerobic conditions provides better conditions for organic matter decomposition

The test setup used eight units with controlled gas flow.

In intensive and semi-intensive pond culture, the application of formulated feed constitutes the main nutrient input. Species like shrimp, salmon, and cod are fed with very high protein content of 30 to 60 percent. The use of high-protein feeds is based on assuring proper nutrition, preventing diseases, and maximizing animal growth.

Water quality is also a very important factor that influences the health and growth performance of cultured animals. It directly relates to the amount and quality of organic input that enters a pond.

A significant amount of the feed provided is typically not consumed by the targeted species and increases the organic load of the culture environment. The combination of high-protein feeds and high-intensity production, if not properly managed, can cause water quality problems.

Organic matter decomposition

The accumulation of organic matter increases as the production cycle progresses because considerable amounts of uneaten feed and excreted metabolic products and feces accumulate with dead plankton in bottom sediments. The decomposition of this organic matter consumes oxygen and can deplete the levels of dissolved oxygen in the water.

Under these conditions, anaerobic decomposition takes over. Moreover, even if there is enough dissolved oxygen in the water column above the sediment, this oxygen only penetrates a few millimeters into the very thin upper layer, while deeper stratums remain under anaerobic conditions. Therefore, the decomposition of the accumulated organic matter in aquaculture ponds occurs both in aerobic and anaerobic environments, and switches from one to the other depending on oxygen availability.

Lab study

The authors recently carried out a study to evaluate the decomposition process of fish feed with different protein content under aerobic and anaerobic conditions in an intensive fish culture setup simulated under laboratory conditions. The experiment was carried out in 2,000-ml glass flasks filled with filtered fresh water and inoculated with bacteria communities collected from a tilapia recirculation system.

The microcosm received pure oxygen or pure nitrogen. The mixture was stirred continuously and incubated in a 21 degrees-C water bath. The daily feed rate was 40 milligrams per using the two diets. Water quality parameters and organic matter decomposition indicators were routinely monitored during the 49-day experiment.

Results

Anaerobic conditions were achieved after five days, when the oxygen in the water was depleted and the average Redox potential was –399.15 ± 78.74 mV. In the aerobic flasks, the average Redox potential was 213.29 ± 39.97 mV.

The differences in the 23 and 49 percent protein input contents corresponded to 19.9 and 4.2 C:N ratio, respectively, with higher ammonia concentration in the high-protein treatment. No differences were found in oxygen presence, showing that a similar amount of nitrogen was ammonified under aerobic and anaerobic conditions (Fig. 1).

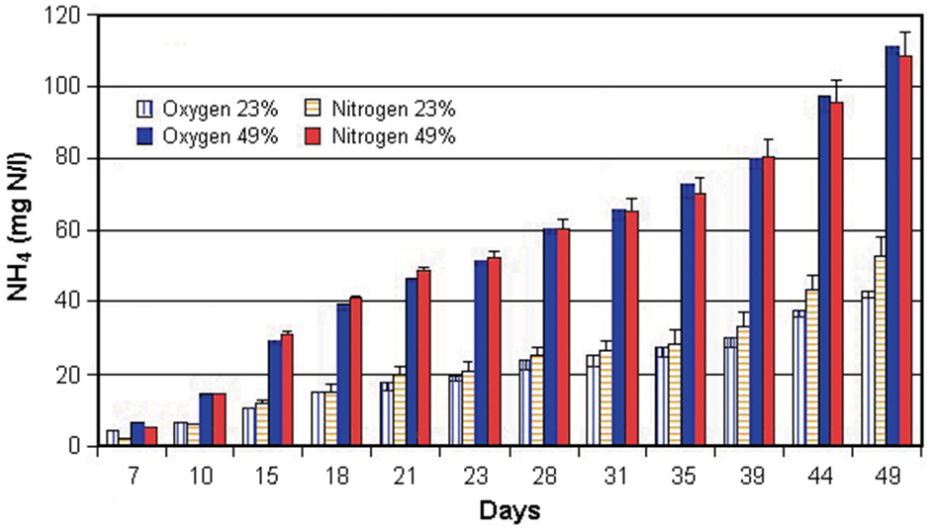

Fig. 1: Ammonia concentration. Percentage of protein content is shown next to the gas treatment.

Nitrate concentrations in the anaerobic treatments were insignificant. In aerobic treatments, the average NO_{3-} concentration was 0.87 ± 0.23 and 2.54 ± 0.33 mgN · l^{-1} for the 23 percent and 49 percent protein diets, respectively.

The organic matter that remained in the system was expressed through chemical oxygen demand (COD) values. The COD content increased in all treatments as the experimental period progressed (Fig. 2). The highest content of COD remaining in the anaerobic system showed that in aerobic systems, the durability of organic matter such as fish feed is short and rapidly oxidized, and leaves the system as carbon dioxide. Hydrogen sulfide, which is toxic in higher concentrations, was produced in the anaerobic treatments.

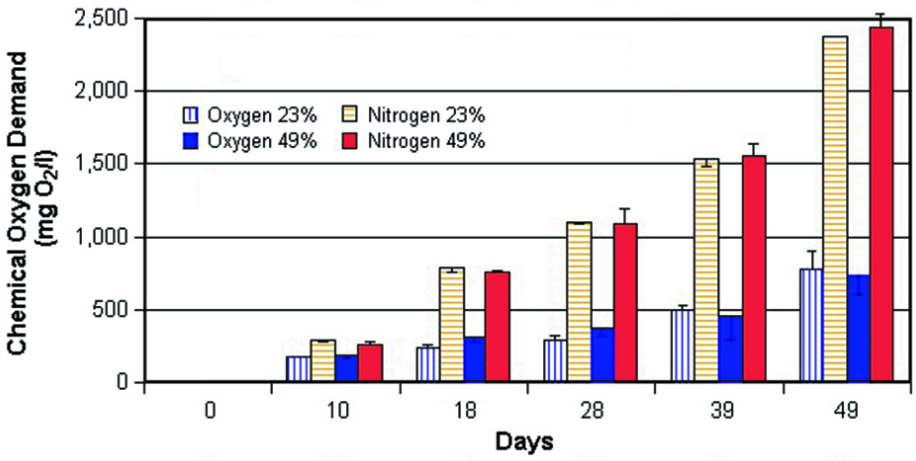

Fig. 2: Chemical oxygen demand concentration.

Conclusion

In this study, faster and more complete decomposition of fish feed was observed in aerobic treatments. The protein content in the fish feed influenced aerobic decomposition and nitrogen transformation pathways. A higher accumulation of nutrients in anaerobic systems was observed, compared with aerobic flasks. The ammonia nitrogen concentration in the high-protein treatment reached much higher values than in the low-protein treatment.

Maintaining aerobic conditions in an aquaculture system through mechanical aeration or water exchange provides better conditions for organic matter decomposition and complete nitrogen oxidation. Preventing anaerobic conditions is more important in intensive systems, where high organic carbon and nitrogen loads are applied. Efficient and sensible feeding regimes should be implemented for optimal aquaculture production.

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

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