Determining the Effects of Bioaugmentation in Yield and Feed Consumption in Freshwater Shrimp

Abstract

Based on qualitative studies performed in Taiwan that demonstrated increased yield by weight of Tiger prawns grown in commercial shrimp ponds to which a bioaugmentation product had been added, a quantitative study was undertaken to determine statistically the improved yield, if any, on Macrobrachium rosenbergii. Feed was also monitored to determine biomass conversion efficiencies.

On June 21, 2001 two 1/10 acre ponds were each stocked with 2,150 freshwater shrimp with an average weight of 0.10 gram. Each pond had an estimated volume of 142,718 gallons. The shrimp were fed a manufactured high protein trout diet of 5 lbs. for the first ten (10) days and then switched to a manufactured shrimp diet for the rest of the grow-out season. Pond #4 was fed a total of 244.15 lbs. of feed, while pond #5 was fed a total of 286.55 lbs. of feed. A commercially available bacterial formulation was added only to pond #4 to treat the water and see if it could act as an alternative natural source of food for freshwater shrimp. A total of 5 ¾ gallons of culture were used. (This was the manufacturer recommended rate to inoculate the estimated volume in Pond #4.)

Pond #5 was harvested 125 days after stocking. The shrimp that were harvested were 20 count. The total weight harvested out of the 10' acre pond was 101.07 lbs. (1010.7 lbs. per acre). Survival rate was 94%. Pond #4 was harvested 126 days after stocking. The shrimp from pond #4 were 16 count. Total harvest from pond # 4 was 118.14 lbs. (1.4 lbs. per acre). The survival rate was 91.5%. Pond #4 which was treated with the bacterial formulation had a survival rate of 2.5% less than pond #5, but produced 17.07 lbs. (170.7 lbs. per acre) more than pond #5 on 42.4 lbs. (424 lbs. per acre) less feed. The feed conversion for shrimp in pond #4 was 2.06 to 1 and 2.8 to 1 in pond #5.

These results strongly indicate that bioaugmentation may increase total production and average size of pond raised shrimp while improving food conversion and reducing production costs.

Introduction

With the increased popularity in freshwater shrimp (Macrobrachium rosenbergii) production, researchers are looking for better production methods. The current production methods are good enough to justify the growing of freshwater shrimp, but for farmers the pond is 101.07 lbs. (1010.7 lbs. per acre). To stay competitive in the market place they will have to increase yields and reduce production costs. On average, current niche markets are paying from $5.00 US to as much as $12.00 US per pound for freshwater shrimp. Once the majority of the niche markets are filled the shrimp will need to compete on an open shrimp market where prices average about $2.75 a pound (pond bank). The price at $2.75 a pound may be justified by large production farms but not for the small farmer. The only way for the small farmers to compete will be by improving production methods.

Based on qualitative studies performed in Taiwan that demonstrated increased yield by weight of Tiger prawns grown in commercial shrimp ponds to which a bioaugmentation product had been added, a quantitative study was undertaken to determine statistically the improved yield, if any, on Macrobrachium rosenbergii grown with the same bioaugmentation product. Feed was also monitored to determine biomass conversion efficiencies.
Through an agreement with Global Seafood Technology's Aquaculture Department, the bioaugmentation product producer (Ecological Laboratories, Inc.), and Mississippi Gulf Coast Community College Aquaculture Department a decision was made to evaluate the bioaugmentation product in the production of Macrobrachium rosenbergii.

Materials and Methods

Global Seafood Technology supplied Juvenile shrimp to stock two ponds for the study. Ecological Laboratories supplied the product the Bioaugmentation Product MICROBE-LIFT® to be used in one pond. Mississippi Gulf Coast Community College Aquaculture Department supplied ponds, feed and labor.

The purpose of the study was see if shrimp production could be enhanced using the Bioaugmentation Product MICROBE-LIFT®, to see if further research was warranted, and to provide students with experience in conducting aquaculture research.

Two ponds were used in the study. Both ponds were stocked with juvenile freshwater shrimp. One pond was treated with the bioaugmentation product, according to the manufacturer's recommendations while a second pond was kept as a control. Dissolved oxygen and temperature were measured once per day and pH, alkalinity, and hardness was measured once per week, using industry standard methods. Shrimp were sampled periodically by seine and feed rates were adjusted using sampling results. Both ponds received continuous aeration, using Aerolator brand surface aerators. Aerators were only stopped when students entered the ponds for sampling.

Stocking

Two 1/10 acre ponds (MGJCCC #4 and #5) were stocked with juvenile prawns (Macrobrachium rosenbergii) on June 21, 2001. Prawns with an average weight of .10 grams were stocked at a rate of 2,150 per pond (21.500 per acre). Pond #4 received the Bioaugmentation Product MICROBE-LIFT® treatment, while pond #5 did not; each pond had a volume of 142,718 gallons.

Feeding

Feeding began in both ponds on June 24, 2001, three days after stocking. Both ponds were fed ~2 Rangen trout starter at a rate of 1 lb. per pond every other day. This feed rate was chosen not only to feed the shrimp but to also build up a food base for the microbes that were to be introduced into pond #4. Both ponds were to be treated as close to the same as possible. On July 4, 2001 feed type was changed to Burns Shrimp Crumbles and feed rate was changed to 1 lb. per day. Feed rate was changed again on August 20, 2001, based on shrimp samples. Pond #4 was fed 2.7 lbs. of Burns Shrimp Crumbles per day. Pond #5 was fed 3.1 lbs. of Burns Shrimp Crumbles per day. Feed rates were determined by utilizing "Freshwater Prawns Pond Production & Grow Out", from Mississippi State University. Feeding was done daily, except in a few instances where weather made feeding dangerous. Half feed rates were fed on 8/23/01, 9/4/01 and 9/17/0l due to heavy rains and thunderstorms. Neither pond

was fed on 9/1/01 nor 9/2/01 due to loss of electrical power to the aerators. Dissolved oxygen did not fall to a dangerous level, and no shrimp losses were observed. On August 24, 2001 feed type was changed to Burris Shrimp grow-out pellets, but feeding continued at the same rates as before. Feed rate was changed to 4.5 lbs. per day (Pond #5) and 3.6 lbs. per day (Pond #4) on September 13, 2001 and continued at this rate until harvest. Feeding was discontinued two days prior to harvest.

Water Quality

Aerators were operated continuously to prevent dissolved oxygen problems. The aeration also helped to distribute and suspend microbes and organic material. The aerators were turned off briefly for shrimp sampling and other work details around ponds. As noted above, aerators were off for two days 9/01/01 and 9/02/01, due to electrical problems. Aerators were off briefly in Pond #4 on 9/27/02 and 9/30/01 due to electrical problems but these were quickly remedied.

Dissolved oxygen and temperature were taken every day in both ponds. Pond #4 had average dissolved oxygen of 8.53 for the growing season. The lowest dissolved oxygen was 5.41 ppm and the highest dissolved oxygen of the growing season in was 13.59. The average temperature for the growing season in pond #4 was 28.10 Celsius. The lowest temperature was 20.6 Celsius and the highest was 32.9 Celsius. Pond #5 had average dissolved oxygen of 7.94 ppm for the growing season. The lowest dissolved oxygen was 3.96 and the highest was 13.60. The average temperature for the growing season in pond #5 was 27.55 Celsius. The lowest temperature recorded was 20.4 Celsius and the highest was 32.4. The growing season for the shrimp was from 6/21/01 to 10/23/01 a total of 125 days.

Alkalinity, pH, and hardness were measured once per week. The pH was low during most of the growing season, a common problem for aquaculture ponds in South Mississippi. An attempt was made to correct the low pH problem with the addition of 50 lbs. of agricultural lime to both Pond #4 and #5. This was done at the beginning of the shrimp-growing season on 7/2/01. It was found later at the end of the growing season that the bench pH meter that was being used to measure the pH would not calibrate correctly although it was very consistent in its readings.

The pH meter readings were compared to chemical pH tests several times and the differences were very consistent, averaging 1.3 higher on the chemical tests. The average pH reading for pond #4 with the bench meter was 6.54, which meant that the actual pH was 7.84. Pond #5 had an average pH reading of 6.59, with the actual pH being 7.89.

There was a problem with alkalinity or hardness in both ponds. The average alkalinity for pond #4 was 91.28 and 74.14 for pond #5. Pond #4 had an average hardness of 9.57 with an average of 10.07 for pond #5. The water quality parameters that were observed during this grow-out period are typical for south Mississippi. The first cold front of the fall season came through on September 24, 2001. After this, both ponds were flushed with warm (33 Celsius) well water whenever pond temperature reached 20 degree Celsius or lower. This was done to both to extend the growing season and to pick a scheduled time for the shrimp harvest.

Bioaugmentation Product

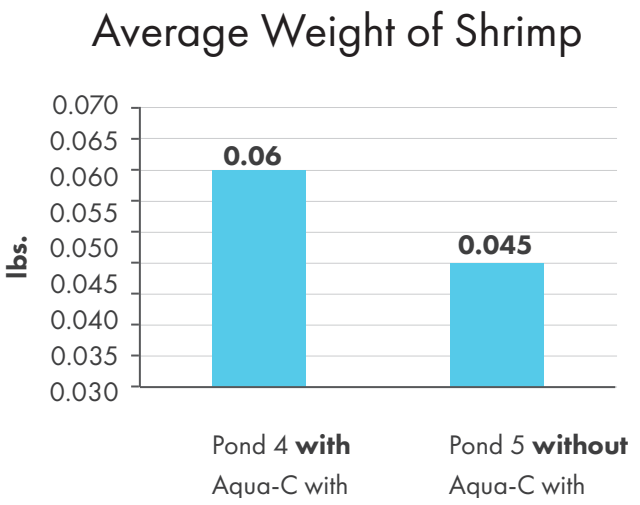
The bioaugmentation product is a liquid product that is produced by Ecological Laboratories of Lynbrook, NY in their manufacturing facility in Cape Coral, FL. The product is used to help with water quality problems. This research was designed to determine if this product would improve water quality and produce an alternative food source for pond raised freshwater shrimp.

Pond #4 was treated with the bioaugmentation product at the manufacturer's recommended rates. Treatment took place 26 days after stocking and 22 days after first feeding. The bioaugmentation product was applied to the pond by spreading it over as much of the surface as possible. On June 16, 2001 three gallons of the bioaugmentation product was added to pond #4. On the following dates 1/2 gallon of the bioaugmentation product was applied to pond #4: 6/24/01, 6/31/01, 7/8/01, and 7/15/01. On 9/14/01 the dosage amount was reduced to 1 quart.

Results

Both ponds were first seined for a partial harvest and then were pumped down and hand harvested to completion.

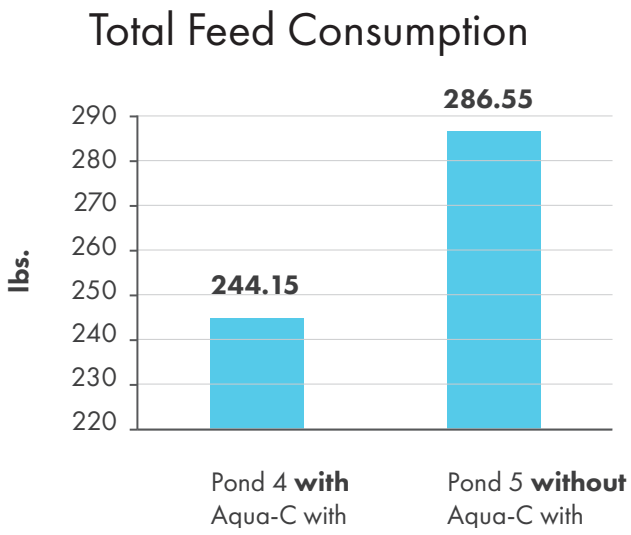
Pond #5 was pumped down half way and then seined during the day. That evening the pond was pumped down the rest of the way and hand harvested. A representative sample of shrimp was counted (389) and weighed (19.3 lbs.) to determine the average individual shrimp weight of .049 lbs. It was determined that the shrimp harvested were 20 count (20 shrimp to the pound). The total pounds of shrimp that were harvested from pond #5 were 101.07 lbs. The survival rate was determined to be 94%.



Conclusions

Earlier qualitative studies had assumed that the increase in shrimp yield, mostly due to increased size, was based mostly on improving the water quality of the shrimp ponds. The quantitative study suggests that there may also be other factors associated with the bioaugmentation product since the increased yield was realized with a reduction in feed use. There are two potential explanations for this. First, the bacteria may be acting as a probiotic and helping the shrimp to digest the food more efficiently thus extracting more nutrients from the feed.

Second, the bioaugmentation product contains photosynthesis bacteria and heterotrophs that can use solar energy as a driving force for growth and the shrimp waste as a source of carbon and other macronutrients. These photosynthetic bacteria, along with other heterotrophic organisms in the bioaugmentation product, may be providing a beneficial feed supplement for the shrimp providing a dual benefit – purifying the water and at the same time providing a food source to supplement the added feed. Increasing the yield while reducing feed costs may significantly enhance the economics of growing shrimp for lower price markets.



Future Studies

A follow-up study was conducted to determine the impact of putting a solid growth substrate to provide a surface to which the bacteria in the bioaugmentation product could attach. The study, recently conducted, showed an additional 66.67% improvement over the results achieved with bioaugmentation alone demonstrating that this could enhance the benefits of the bioaugmentation product. This further improves the potential of using this technology to make freshwater shrimp farming profitable in lower cost markets.

Acknowledgements

The authors wish to acknowledge the contributions of high school and post secondary aquaculture students who performed much of the routine care, water quality lab work, harvesting and processing of shrimp from this study.

Mark J. Krupka
Ecological Laboratories, Inc. 215 N. Main Street Freeport, NY

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
P12301