Alliance
(https://www.aquaculturealliance.org)

Global Aquaculture Advocate

Health & Welfare

Added carbohydrates aid production in extensive culture

Tuesday, 1 February 2005

By M.C.J. Verdegem , J.W. Schrama , B. Hari , M.B. Kurup and J.T. Varghese

Carbohydrate reduces TAN and nitrite-N levels in experimental tanks

Small dams were built in water channels to make the 250-square-meter test ponds.

Adding a carbon source to intensive shrimp production systems can control total ammonia nitrogen (TAN) levels and improve feed conversion. Studies have shown that immobilization of inorganic nitrogen only occurs when the carbon:nitrogen (C:N) ratio of the organic matter is higher than 10.

Immobilization of TAN results in the production of bacterial cells rich in single-cell protein that can be utilized as food by carp, tilapia and shrimp. As a result, the feed-conversion ratio of the supplemental feed applied to ponds decreases, making it possible to use lower-cost, lower-protein feeds.

Although commonly applied in intensive aquaculture, the technique of C:N ratio control is not used in extensively managed ponds, even though these systems support much of the farmed shrimp production worldwide. The authors recently evaluated the effects on water quality and production of adding organic carbon to extensive stagnant shrimp ponds in India.

Continuous mixing to keep dissolved and particulate matter dissolved in the water column is a key factor in the success of C:N ratio manipulation in intensive systems. The challenge, therefore, was to determine if the added carbohydrates would positively impact water quality before precipitating to the bottom.

Dual trials

The goals of the study were to evaluate the combined effects of reducing the protein content in supplemental feeds and carbohydrate addition in extensively managed ponds containing black tiger shrimp (*Penaeus monodon)*. To reduce costs, an indoor trial in small replicate tanks was conducted to develop the technique before applying it to farmers' ponds.

In both experiments, 20 grams of tapioca flour was added for each gram of NH_4^+ (ammonia-nitrogen) released. The amount of ammonia-nitrogen released was estimated assuming that 50 percent of the dietary protein input was converted to ammonia.

In consequence, 0.39 kg of tapioca flour was added for each kg of the 25 percent-protein feed used in the trials. For one kg of the 40 percent-protein diet used, 0.62 kg tapioca flour was added. In the indoor experiment, the photoperiod was maintained at 12 hours dark and 12 hours light.

Indoor experiment

The indoor experiment was carried out in triplicate 1,200-liter tanks for each of four diet treatments. Twenty-five and 40 percent crude protein diets were applied, with or without carbohydrate addition, resulting in treatments referred to as P25, P40, P25+CH, and P40+CH. Shrimp were fed initially at 15 percent body weight, which was gradually reduced to 6 percent toward the end of the culture. The sinking feed pellets were distributed evenly over the tank surfaces twice daily.

All tanks were filled with 26-ppt saline water and provided a uniform 4-cm sediment layer taken from an extensive shrimp culture pond. The water level in the tanks was maintained at 50 cm. Uniformly sized 0.36-gram shrimp juveniles were stocked at a density of 6 animals per square meter. The tanks were fertilized with urea and super phosphate at rates of 4 and 1 grams per square meter per week, respectively, during the first three weeks of the experiment.

Indoor results

The addition of carbohydrate reduced the TAN and nitrite-N levels in the experimental tanks. The high-protein diet resulted in higher levels of TAN, nitrite-N, and total nitrogen concentrations. There was no effect on the organic carbon content of the sediment, but the addition of carbohydrate caused a significant reduction of sediment TAN. The total heterotrophic bacteria count in the water column and sediment were higher in treatments with added carbohydrate.

Table 1 shows the effects of carbohydrate addition and protein levels on various yield parameters. The specific growth rate and feed conversion ratio were similar in the P40 and P25+CH treatments. The protein efficiency ratio was highest in treatment P25+CH. The survival was 80 to 88 percent and did not vary between treatments.

The addition of carbohydrate reduced the TAN and nitrite-N levels in the test tanks.

Verdegem, Effects of carbohydrate, Table 1

	Treatment Means P25	Treatment Means P25+CH	Treatment Means P40	Treatment Means P40+CH
Indoor Trial				
Specific growth rate (% bw/day)	2.6^{c}	3.4^{b}	3.4^{b}	3.8^{a}
Feed-conversion ratio	6.4^{a}	3.0^{b}	3.0^{b}	2.4^{b}
Nitrogen retention (%)	16.3^{c}	28.9^{a}	17.1^{c}	22.4^{b}
Protein efficiency ratio	0.6^{c}	1.3^{a}	0.9^{c}	1.1^{b}
Survival rate (%)	81	89	89	89
Farm Trial				
Specific growth rate (% bw/day)		7.9^{a}	7.7^{b}	
Feed-conversion ratio		1.6^{b}	2.2^{a}	
Nitrogen retention (%)		45.3^{a}	19.8^{b}	
Protein efficiency ratio		2.5^{a}	1.2^{b}	
Survival rate (%)		42	36	

Table 1. Effects of carbohydrate addition and protein levels on P. monodon performance in indoor and farm experiments.

Mean values in same row with different superscripts differ significantly ($P < 0.05$).

Pond experiment

In the farm trial, eight 250-square-meter earthen ponds were stocked at 6 PL_{20} per square meter. Treatments P40 and P25+CH were applied to four replicate ponds each. Initially, lime was applied at 2,000 kilograms per hectare and cow dung at 1,000 kilograms per hectare. Urea and single super phosphate were added biweekly to the water column at 80 and 20 kilograms per hectare, respectively, during the first two months of culture to initiate algal blooms in the ponds. Lime was added to the ponds at 5 kilograms per pond biweekly.

Pond results

TAN concentrations in the water column and sediment were lower in treatment P25+CH than P40. The addition of carbohydrate had a profound effect on the heterotrophic bacteria count (Fig. 1). Shrimp yield and individual shrimp weight at harvest were higher in treatment P25+CH than P40. Growth rates, feed conversion, and protein efficiency were also better for P25+CH. Survival was 36 to 42 percent and not different between treatments (Table 1).

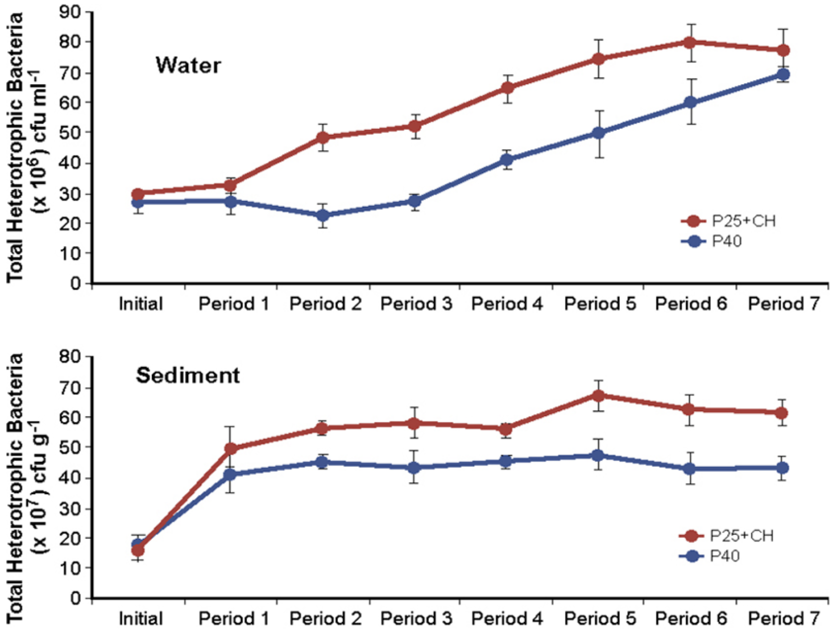

Fig. 1: Total heterotrophic bacteria count in pond water and sediment of the farm trial. Number of replicates = 4. Each period represents biweekly sampling.

Cost computations

The combined cost of feed and carbohydrate for treatment P25+CH was lower than for P40 due to the higher cost of high-protein shrimp feed – Rs. 46 (U.S. $1.03) against Rs. 26 ($.58) per kilogram. The harvested shrimp from P25+CH came under count 40 compared to count 50 for treatment P40.

The revenue per hectare from the harvested shrimp was 54 percent higher in P25+CH than P40 due to the combined effect of better yield and higher prices for bigger shrimp (Table 2). A 35 percent reduction in feed cost was recorded in the P25+CH treatment when compared to treatment P40. The benefit:cost ratio was significantly higher in treatment P25+CH than P40.

Verdegem, Economic analysis of farm equipment, Table 2

	Treatment P25+CH	Treatment P40
Variable costs	$1,729	$2,182
Fixed costs	$134	$134
Production costs	$1,863	$2,316
Shrimp yield (kg)	644.3	447.9
Shrimp price	$7	$6
Gross return	$4,329	$2,809
Net profit	$2,465	$492
Benefit:cost ratio	1.3	0.2

Table 2. Economic analysis of farm experiment (U.S. $/ha – rounded).

(Editor's Note: This article was originally published in the February 2005 print edition of the Global Aquaculture Advocate.*)*

Authors

M.C.J. VERDEGEM

Fish Culture and Fisheries Group
Wageningen Institute of Animal Sciences
Wageningen University
P.O. Box 338
6700 AH Wageningen
The Netherlands

J.W. SCHRAMA

Fish Culture and Fisheries Group
Wageningen Institute of Animal Sciences
Wageningen University
P.O. Box 338
6700 AH Wageningen
The Netherlands

B. HARI

School of Industrial Fisheries
Cochin University of Science and Technology
Cochin, India

M.B. KURUP

School of Industrial Fisheries
Cochin University of Science and Technology
Cochin, India

J.T. VARGHESE

School of Industrial Fisheries
Cochin University of Science and Technology
Cochin, India