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DURING THE WINTER, THE PERFORMANCE OF A TEMPERATE-ZONE CHANNEL CATFISH BIOFLOC TECHNOLOGY PRODUCTION SYSTEM

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ABSTRACT

In an outdoor biofloc technology production system, channel catfish (Ictalurus punctuates) have been successfully produced. In the tropics, outdoor biofloc production systems are used all year, while channel catfish research was limited to the growth season and biofloc production tanks. Harvested and put to rest for the winter. If a biofloc production system is to be used outside, Farmers in temperate latitudes, then, throughout the winter, data gaps related to system and fish performance. This issue must be addressed. The purpose of this research was to fill up these data gaps for channel catfish culture. Low (153.3 mg/L) water from a recently finished biofloc production experiment for this research; high total suspended solids (790.0 mg/L) were maintained. Per water source, there are three 15.7-m3 tanks. For a 152-day period, each type was supplied (8 kg/m3) with market-size channel catfish from the same research. From November through April, you will be studying. During the experiment, mean chlorophyll a concentrations were comparable in both treatments. Treatments diverged after 55 days, and chlorophyll a concentration grew linearly. (P 0.001, R2 = 0.721) in the low solids treatment to a mean final concentration of 2251.7 mg/m3.AmmoniaSpikes of ammonium chloride (1.25–1.5 mg TAN) were added three times throughout the experiment. Completely biotransformed, presumably via algal absorption and nitrification. Biotransformation rate of ammonia. In the high solids (P 0.001, R2 = 0.920) and low solids (P 0.001, R2 = 0.920), was directly linked to mean water temperature. Treatments with (P = 0.002, R2 = 0.761). In biofloc tanks, catfish survival was excellent (99.75%) throughout the winter. There were no significant differences between the treatments. There was no significant difference in net fish output between the two groups. Treatments. Net fish yields, on the other hand, were 1–4% lower than starting fish biomasses. In the biofloc, there is water. Regardless of the weather, production tanks seemed to maintain their capacity to biotransform ammonia throughout the winter. Regardless of whether phytoplankton or suspended solids predominate, and despite ongoing ammonia nitrogen addition, having a functioning biofloc in the spring eliminates the need for a lengthy start-up period when establishing a new biofloc. Biofloc is completely functioning, as are the TAN and nitrite spikes.

KEYWORDS: *Biofloc Technology Channel Catfish Low Temperature, Ammonia Biotransformation.*

1. INTRODUCTION

Despite high stocking and feeding rates, two important production limiting factors, dissolved oxygen and total ammonia-nitrogen concentrations, are maintained at near-optimal levels in the biofloc technology (BFT) production system, resulting in high yields of aquatic animals (Avnimelech, 1999; Burford et al., 2004; Hargreaves, 2006). Continuous aeration maintains a high dissolved oxygen content while also keeping the biofloc floating in the water column. The biofloc is a collection of living organisms that are intimately linked to particle organic materials. Phytoplankton and bacteria, which are part of this complex of living creatures, use nitrogenous waste produced by intensively fed culture animals. In an outdoor [1] BFT production system, stocker-size and market-size channel catfish (Ictalurus punctatus) were effectively produced, with a net yield of 9.3 kg/m3 recorded (Green, 2010; Schrader et al., 2011; Green et al., 2014). The channel catfish experiments were performed only during the temperate zone growing season, and BFT [2] production tanks were emptied and idled after harvest, unlike outdoor BFT production systems in the tropics, which are operational all year. Because the BFT method is only used during the growing season, the fish must be marketable or of a size suitable for a later stage of growth when they are harvested. Fish will be relocated needlessly if this is not done. In addition, a fully functioning biofloc takes 4–6 weeks to grow during spring start-up. If farmers in temperate latitudes want to implement an outdoor BFT production system, data gaps related to system and fish performance throughout the winter must be resolved. Channel catfish must be overwintered at least once before being taken as food fish, according to pond production guidelines. The survival rate of fish until harvest is high, usually exceeding 75% [3]. Feeding rates for channel catfish in the winter vary depending on water temperature thresholds (Robinson et al., 2001). Individual fish weight and net output may vary depending on the winter feeding method employed, as well as fish size and survival). The waters for this experiment were kept from a recently completed freshwater BFT experiment that tested various degrees of solids management; the retained waters contained high or low total suspended solids (TSS). High TSS concentrations in BFT may have a detrimental impact on culture animal performance; therefore solids should be reduced to 200–400 mg/L TSS (Ray et al., 2010; Green et al., 2014).

Furthermore, the retained fluids utilized in this experiment will be kept for a follow-up research to see whether BFT water may be reused during a second growth season. The goal of this study was to track changes in water quality, ammonia biotransformation capability, and channel catfish performance throughout the course of the winter. The USDA Agricultural Research Service (ARS), Harry K. Dupree Stuttgart National Aquaculture Research Center (HKDSNARC), Stuttgart, AR, USA, used six wood-framed rectangular tanks with a slightly sloped bottom (18.6 m2, mean 15.7 m3 of water, mean depth of 0.81 m) lined with high density polyethylene (HDPE) located outdoors for this study. A diffuser grid (six 5.95 m 2.5 cm polyvinyl chloride pipes with 1.9-mm diameter holes inserted at 15-cm intervals) on the bottom of each tank supplied air (ca. 295 m3/h) constantly via a 2.6-kW blower per three tanks. Waters from a BFT production trial evaluating various degrees of solids removal that ended on the 14th and 15th of November 2013 and had low (153.3 39.5 mg/L, mean SE) or high (790.0 48.4 mg/L, mean SE) TSS were used in this research. To fill each tank, approximately 10% of the water had to come from the well. The low and high TSS concentrations were allocated to each of the three triplicate tanks at random. During this research, no solids were removed from the tanks.

Water samples were collected and analyzed for this research six days after stocking. At about 0830 h, water samples were taken from each tank on average every two weeks. In a flow injection system, total ammonia-nitrogen (TAN) was fluorometrically measured using the o-phthaldialdehyde technique (Genfa and Dasgupta, 1989). Flow injection analysis was used to determine nitrite-nitrogen[4] (NO2-N, diazotization), nitrate-nitrogen (NO3-N, cadmium reduction), and soluble reactive phosphorus (ascorbic acid technique) following manufacturer directions (FIAlab 2500; FIAlab Instruments, Bellevue, Washington). Eaton et a technique's were used to determine total alkalinity and total suspended solids (2005). Chlorophyll a was extracted from phytoplankton (which includes plank tonic algae and cyan bacteria as well as those attached to bioflocs) previously filtered from water samples using a 0.45-m pore size glass fiber filter, and the chlorophyll a concentration in the extract was determined by spectroscopy (Lloyd and Tucker, 1988). The pH of the sample was determined electrometrically.

A galvanic oxygen sensor and a thermostat (Model 109, Campbell Scientific, Logan, Utah) connected to a data logger (Model CR206 or CR10X, Campbell Scientific, Logan, Utah) continuously monitored dissolved oxygen (DO) concentration and water temperature in each tank. The weather station at USDA ARS Dale Bumpers National Rice Research Center, Stuttgart, Arkansas, was used to collect air temperature data. To guarantee that the chloride content in each tank surpassed 100 mg/L, stock salt (144 g/m3) was supplied to each tank. Only one time (day 123) was sodium bicarbonate (72 g/m3) supplied to high solids treatment tanks to maintain pH values between 7.0 and 7.8 and total alkalinity of approximately 100 mg/L as CaCO3.Three times, untreated technical grade ammonium chloride (99.9%, The Dallas Group of America, Whitehouse, New Jersey) was injected to each tank to track TAN biotransformation. Ammonium chloride has a dry matter content of 99.6%. On a dry matter basis, each tank was doused with ammonium chloride to add 1.5 mg/L TAN (16 December 2013) and 1.25 mg/L TAN (27 January 2014; 10 March 2014). The amount of TAN injected was sufficient to be noticeable, but unlikely to harm the catfish (Hargreaves and Kucuk, 2001). Water samples were taken from each tank at 0 minutes, 15–60 minutes, 4 hours (10 March only), 7–8 hours, 24 hours, 48 hours, 72 hours, 96 hours, and 173 hours (27 January 2014 only) after TAN addition and analyzed for TAN and NO2-N; samples were also analyzed for NO3-N at the beginning and end of each spike event.

1.1. Stocking, Feeding, And Harvesting Of Catfish

The BFT production experiment's channel catfish (I. punctatus) were re-stocked into tanks. The mean biomass at stocking for the low and high solids treatments was 7.8 0.2 and 8.2 0.5 kg/m3, respectively, and did not vary significantly across treatments (P = 0.490). The mean starting weight did not vary substantially across treatments, averaging 560.8 5.8 g/fish for the low solids treatment and 611.3 22.9 g/fish for the high solids treatment, respectively. Once the afternoon water temperature surpassed 16°C for two consecutive days, fish in each tank were given as much 32 percent protein feed (Delta Western Feed Mill, Indianola, Mississippi) as they could eat in 10 minutes, and the amount was recorded. On April 16, 2014, 152 days following stocking, fish were collected from all tanks. At harvest, 25% of the fish in each tank were individually weighed, while the rest were counted and weighed in bulk. The HKDSNARC Institutional Animal Care and Use Committee authorized the animal care and experimental procedures, which followed ARS Policies and Procedures 130.4 and 635.1 [5].

1.2. Analyzing Data

Mixed models analysis of variance (MIXED) and linear regression (REG) methods in SAS v. 9 were used to examine the data. The repeated measures mixed models procedure (MIXED) was used to compare slopes of ammonia-nitrogen transformation over time between treatments for each spike event; first-order ante dependence covariance structure was used for the first two spike events, and spatial power covariance structure was used for the third spike event.

2. DISCUSSION

2.1. Application:

The high solids treatment (790.0 48.4 mg/L) was significantly higher than the low solids treatment (153.3 39.5 mg/L) (P = 0.002). For mean TAN, NO2-N, and total alkalinity concentrations, no significant differences were found between solids levels (Table 1). Although the high solids treatment had a 43 percent higher mean NO3-N concentration than the low solids treatment, the difference was not statistically significant at the 0.05 level ($P = 0.062$). The high solids treatment had significantly higher PO4-P and TSS concentrations, while the low solids treatment had significantly higher chlorophyll a concentration and pH. Because the same small amount of feed was added to each treatment, the water quality treatment means were most likely unaffected by feed addition. During the experiment, changes in water quality variable concentrations were different for each treatment. In the high solids treatment, mean TAN was significantly lower, and total alkalinity and pH were significantly higher in final samples compared to initial samples (Table 2). However, mean final NO2-N, TSS, and chlorophyll a concentrations in the low solids treatment were significantly higher than mean initial concentrations, while mean final NO3-N, soluble reactive phosphorus, total alkalinity, and pH concentrations were significantly lower than initial concentrations Total alkalinity decreased linearly in the low solids treatment throughout the Throughout the study, the mean TSS concentration in the high solids treatment remained above 300 mg/L, and the water remained brown in color . The mean TSS concentration in the low solids treatment remained around 200 mg/L until day 123, after which it gradually increased to 403.3 mg/L by day 151. TSS levels in channel catfish should be between 282 and 427 mg/L.During the first 55 days, mean chlorophyll a concentrations were similar in both treatments, but after that, treatments diverged and chlorophyll a concentrations increased linearly (P 0.001, $R2 = 0.721$) in the low solids treatment to a mean final concentration of 2251.7 mg/m3 (Fig. 2). Because of the low solids content, sunlight was able to penetrate deeper into the water column, promoting algae development. Similarly high chlorophyll a concentrations were observed in a channel catfish BFT production system throughout the summer and autumn [6].

2.2.Working:

Except after ammonium chloride was added to tanks, the mean TAN concentration was less than 0.4 mg/L TAN. Following the addition of ammonium chloride, the total ammonia-nitrogen concentration peaked, and then fell as ammonia-nitrogen was converted. During the first spike event, there was no significant treatment difference ($P = 0.240$) in slope for ammonia transformation. For the low and high solids treatments, the regression equations were $y = 1.719$ $0.016x$ ($R2 = 0.944$) and $y = 2.208$ $0.018x$ ($R2 = 0.893$), respectively, where y = mg/L TAN and x = h. The ammonia transformation slope was considerably higher ($P = 0.048$) in the high solids treatment during the second spike occurrence. For the low and high solids treatments, regression equations $y = 1.204$ $0.003x$ ($R2 = 0.560$) and $y = 1.500$ $0.005x$ ($R2 = 0.749$) were used to explain the ammonia transformation. During the third spike event, the slope of ammonia transformation did not vary substantially ($P = 0.096$) across treatments. Solids in low and high concentrations Soluble reactive phosphorus (mg/L) 93.44 65.32 7.75 0.062 Nitrate-nitrogen (mg/L) 17.52 1.44 0.004 29.80 17.52 1.44 0.004 Initial and end water quality variable concentrations for outdoor biofloc technology tanks stocked with channel catfish for a 152-day trial starting November 15, 2013. Low and high starting concentrations of total suspended solids were examined [7]. NH4-Na NO2-Na NO3-Na PO4-Pa Chl aa TSSa T Alka pH Low solids Treatment NH4-Na NO2-Na NO3-Na PO4-Pa Total nitrogen (mg/L NH4-N), nitrite (mg/L NO2-N), nitrate (mg/L NO3-N), soluble reactive phosphorus (mg/L PO4-P), chlorophyll a (mg/m3 Chl a), total suspended solids (mg/L TSS), total alkalinity (mg/L as CaCO3 T Alk), total suspended solids (mg/L T) [8]

$y = 1.129$ $0.016x$ ($R2 = 0.934$) and $y = 1.111$ $0.025x$ ($R2 = 0.890$) were the treatment regression equations, respectively.

The mean water temperature for each ammonium chloride spike incident seemed to influence the ammonia transformation rate (slope absolute value) during treatment for both treatments, the rise in ammonia transformation rate as mean water temperature rose from spike event 1 to 2 was comparable. Daya lot of solids content is low. a straight line (High solids) a straight line (Low solids)

The ammonia transformation rate increased linearly with increasing water temperature in the low solids treatment as mean water temperature rose between spike events 2 and 3, while the ammonia transformation rate increased linearly with increased water temperature in the high solids treatment [9]. The linear relationship in the high solids treatment explained more of the variance in ammonia transformation rate. It should be emphasized, however, that if the connection between ammonia transformation rate and water temperature is to be completely characterized, more data points at higher temperatures, which were outside the scope of the current research, are required.

Following the addition of ammonium chloride, the mean NO2-N concentration rose in both treatments. NO2-N concentrations started to rise 24–48 hours after ammonium chloride was added during spike event 1. During the Christmas vacation, sampling was halted, and at the first sample in January, the mean NO2-N content in both treatments was analytically undetectable. Following the second spike event, increases in NO2-N concentrations were sluggish in both treatments, and peak concentrations trailed peak TAN concentrations by 3 weeks in the high solids treatment and 5 weeks in the low solids treatment, due to limited water availability. Please use the following citation when citing this work in print: Green, B.W., Performance of a Temperate-Zone Channel.

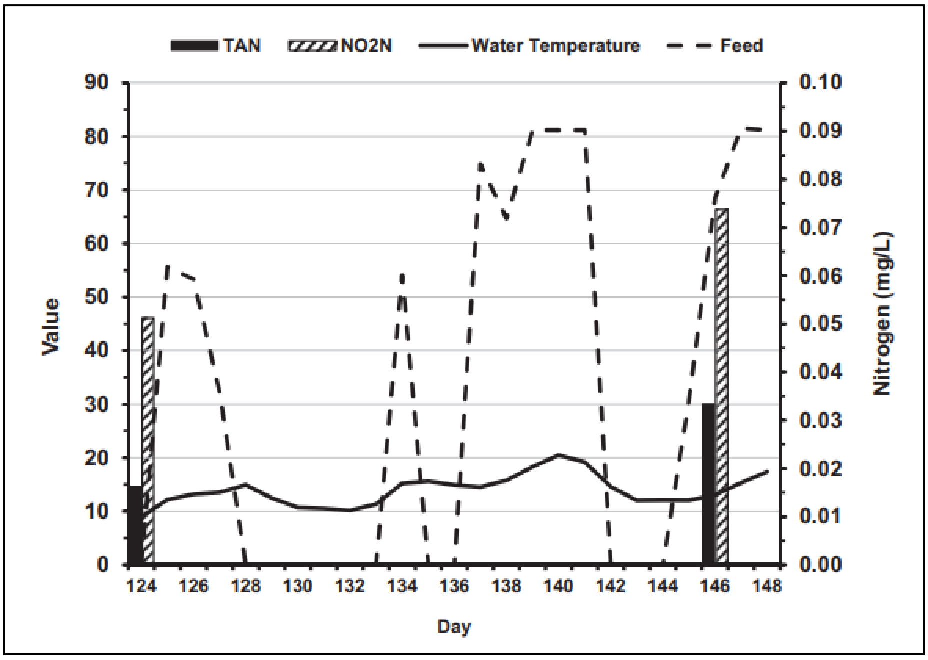

Figure 1: Mean water temperature (◦C), daily feed ration (g/m3), total ammonia-nitrogen, and nitrite-nitrogen from days 124 to 148 in the high solids treatment. Water temperature and daily feed correspond to the left-hand vertical axis, and TAN and nitrite correspond to the right-hand vertical axis.

3. CONCLUSION

In conclusion, BFT water with a low starting TSS concentration migrated to a phytoplankton-dominated system, while water with a high initial TSS concentration evolved to a phytoplankton-dominated system. Despite a high initial TSS concentration, the system remained bacterially dominated. The quality of the water changed as a consequence of this divergence. factors that varied from one another throughout the duration of the experiment treatments. The biofloc system's capacity to biotransformation low winter water temperatures, ammonia-nitrogen was maintained. In both treatments, in the absence of persistent TAN input, although, since fish do not consume feed and do not excrete ammonia, this is of little significance. What matters, though, is that is that after feeding restarts, the capacity to biotransform ammonia without a significant lag is maintained. a lot of biomass Throughout the winter, market-size channel catfish were kept. In both therapies, the patients had a high rate of survival and were in excellent health. NetIn all treatments, yield was negative, although it might have been positive if feeding had started at a temperature of 10°C instead. a temperature of 16°C In the spring, having an active biofloc eliminates the need for a start-up. The time it takes to set up a new, fully functioning biofloc, as well as the cost TAN and nitrite increases are also seen. Of course, a financial analysis is required. Costs and economic feasibility would have to be determined. of keeping the biofloc going during the winter. Figure 1 discloses the Mean water temperature (◦C), daily feed ration (g/m3), total ammonia-nitrogen, and nitrite-nitrogen from days 124 to 148 in the high solids treatment. Water temperature and daily feed correspond to the left-hand vertical axis, and TAN and nitrite correspond to the right-hand vertical axis [10].

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