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SHORT COMMUNICATION **KISA MAKALE**

PRODUCTION RATE OF NITROGEN COMPOUNDS AND OTHER WATER QUALITY VARIABLES IN *Macrobrachium vollenhovenii* CULTURED IN TANKS

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Abstract:

Juvenile-size of African River prawns (*Macrobrachium vollenhovenii*) of an average length of 46.34 ±0.23mm were collected from Epe Lagoon and cultured in concrete tanks for 56 days. The production of Nitrogenous compounds was monitored and the analyses of the water quality variables were carried out weekly. The range of the water quality variables were 6.74-7.90 (pH), 25.7-30.3°C (Temperature), 6.71-8.01mg/L (Dissolved Oxygen), 0.00-0.03% (Salinity), 0.199 and 0.725 mS/cm (Conductivity), 24-48 NTU (Turbidity). The result showed that Nitrite (NO_2^-) ranged between 0.07-0.50mg/L, Nitrate (NO_3^-) was between the range of 1.32-6.63mg/L and Ammonia (NH_3^-) was between 0.32-1.65mg/L.

Keywords: Prawns, Water quality, Nitrite, Nitrate, Ammonia

Introduction

Water quality and quantity are critical to the success of prawn culture which is an important factor to consider in prawn culture medium. Freshwater is normally used for rearing freshwater prawns from post-larvae to market size. Water of 3-4 ppt salinity may be acceptable for the culture of prawns (FAO, 1982). The African River prawn, *M. vollenhovenii* belonging to the family Palaemonidae is the largest prawn species among the available prawns across the West-Africa water bodies and a good candidate for aquaculture and its omnivore. The African River prawn, *M. vollenhovenii* has good potentials for aquaculture (Bello-Olusoji *et. al.,* 2004, Bello-Olusoji *et. al.,* 1997). The species can be reared extensively in captivity like other *Macrobrachium* species such as *M. rosenbergii* in Asia, *M. idea* in India, *M. amanzonii* in America and *M. brazilensis* in Brazil, thus contributing to their economies. The oxygen requirement for prawn culture is not known in details as well as most of the water quality factors requirements for prawn culture are unknown. According to Bielsa *et. al*., 1983; oxygen decreases with an increase in temperature. Prawns grow faster in warm water between 26-30^{0}C and water salinity of 6-33ppt (Motoh, 1981). pH also affect prawn's growth, pH of over 9 and pH lower than 5 are lethal for post-larvae. Poor water quality parameters make shrimps susceptible to diseases, a situation that caused an average reduction of 64% in prawn production and an estimated total loss of US$ 4.44 million due to the disease outbreak (Jayasinghe, 1995). Oxidation of accumulated organic wastes compounds in shrimp pond water depletes the dissolved oxygen, a reaction producing other water quality variables such as ammonia and nitrite, thus contributing greatly to shrimp mortality. High ammonia concentration causes prawn mortality. Ammonia or ammonium (NH_3 and NH_4^+) is converted into nitrite (NO_3), which, is quickly converted to non-toxic nitrate (NO_3, plant food), (Robert *et al* 1997b). Nitrites cause reddening of the fins and irritation of the gills, gasping plus excess mucus. Nitrites also bind the fish Red Blood Cells resulting in suffocation and "Brown Blood Disease". This study however, focused on the determination on the rate of production of some water quality variables in tank rearing of African river prawn (*M. vollenhovenii*).

Materials and Methods

The juvenile sizes of African river prawn *Macrobrachium vollenhovenii* were collected from Epe lagoon in Lagos State and they were transported to the Fish Farm in the Department of Fisheries and Wildlife, Federal University of Technology Akure in 4 (four) 50Litres ice-chest (in order to keep the water temperature constant during transportation), ¾ filled with oxygenated water. They were acclimatised for 7 days, after which sixty (60) healthy prawns were randomly selected between 42.24-51.03 mm and an average length value of 46.34 ±0.23mm, grouped into two concrete tanks (1.5mx1.5mx0.8m) (in order to allow a better distribution during rearing and reduction in cannibalism associated with overcrowding) with a stocking density of 30 prawns per tank and they were fed with a local formulated diet of 35% crude protein. Tanks were filled with filtered pond water and water was replaced weekly. The experiment was conducted for 56 days (8weeks). The water temperature was measured by using a standard mercury thermometer to the nearest 0.1^{o}C. The water was analyzed at the beginning and at the end of each week and throughout the period of the experiment. Weekly measurements of concentration levels of the most important water quality parameters such as nitrate, nitrite and ammonia (NO_3^-, NO_2^-, NH_3^+) were determined using a colorimetric method for NO_3^- and NO_2, while titration method was used to determine the ammonia (NH_3^+). The tests were in triplicates. The pH was monitored daily in each tank with pH meter to the nearest 0.1 pH unit (Fisher Accumet pH meter), to obtain the mean pH value on daily basis. The dissolved oxygen "DO" concentrations was measured daily throughout the period using a portable oxygen meter (Model no: HI 9146) to the nearest 0.1mg/l. When measuring the ammonia, the pH was measured simultaneously in order to determine the relative dissociation of ammonium ions into free ammonia. The physico-chemical parameters – temperature, salinity, turbidity and conductivity were measured with Palintest comparator and Horiba U-10 water checker respectively.

Results and Discussion

The results for the water test analysed for the eight weeks are shown in Table 1 and 2. The water quality parameters were observed to

change on a weekly basis, though very close to each other in comparison to the prawns' growth (Plate 1). Temperature affects the growth and survival of shrimps. Thus, the rate of growth increases with temperature. Though, higher temperature causes mortality.

Other water variables are shown in table 2. The pH ranged from 6.74-7.90, DO ranged between 6.71-8.01 mg/L, Salinity between 0.00-0.03 %, Turbidity ranged between 24-48 NTU, Conductivity between 0.199 and 0.725 mS/cm, Nitrite (NO_2) was between 0.07-0.50 mg/L, Nitrate (NO_3) ranged between 1.32-6.63 mg/L and Ammonia (NH_3) was between the range of 0.32-1.65 mg/L.

Figures 2a, b and c showed that the nitrite, nitrate and the ammonia level fluctuates respectively as the weeks increases. But the resulting mean values (Table 2) were 0.285, 3.975 and 0.985 respectively.

The growth rate of *M.vollenhovenii* is water quality variable dependent, it increases as temperature increases. Water temperature throughout the experiment ranged between 25.7-30.3°C (Table 2). Temperatures between 26-30°C are considered best in terms of maximum production. Temperature above 32°C is deleterious. Motoh (1981) reported that there exist a relationship between temperature and DO. Thus, as temperature increases, DO reduces and vice versa. These were similar to the observed result in Table 1, while figure 1 shows the temperature and DO recorded during the culture period.

However, the pH result of 6.74-7.90 supports the work of Bielsa *et. al.* (1983), which states that optimum pH for prawn, is between 7.0 and 8.5. The result was also similar to what was observed by Okoye *et. al.* (2006), he recorded a temperature range of 27.0-29.5, pH values of 6.9-7.1 and DO_2 of 6.95-7.45 in the water quality parameters during an experimental period. Wickins (1976) found that even though *Penaeus monodon* grow without suffering mortalities with water pH of 6.4 in the presence of inorganic carbon, growth was reduced to 60%. In water pH of 6.4 and less than 10-20 mg/l of inorganic carbon, *P. merguiensis* and *P. aztecus* exhibited greatly reduced growth and lower survival. When pH fell below 5.0, heavy mortalities occurred. A fall in pH have indirect effect for instance, resistance of the shrimp to pathogens might be reduced.

Its survival, growth and development in water with salinity range (0.00-0.03%) show that *M. vollenhovenii* can be cultured in any freshwater habitat. Though, it can tolerate 0-20 ppt salinity (Anetekhai, 1986). Thus *M. vollenhovenii* is a good candidate for freshwater culture (Bello-Olusoji, 2004).

Bello-Olusoji (2007) reported that the ammonia values obtained from the water samples of *M. vollenhovenii* ranged between 0.24-1.50mg/L and as the pH increases, the more ammonia is excreted by the prawns. He also reported that the species can do well at a temperature ranging between 23 and 29 °C, DO_2 ranging between 5.11 and 7.1 mg/L. These results were similar to the ones recorded in Table 2. Shrimps are quite sensitive to low oxygen levels. Growth is best at dissolved oxygen level above 3ppm. Shigueno (1975) recorded a die-off in a pond when oxygen level reached 2.7ppm during the night. The observed DO range in this study was thus safe for the prawns.

Wickins (1976) discussed the three forms of nitrogen compounds and the effects of sublethal levels on shrimp growth. Two tests with nitrate showed that the growth of *P. monodon* was not affected by a concentration of 200mg/L after five weeks of exposure. In a test with *P.indicus*, growth was reduced by nearly 50% over a period of 34 days where nitrate concentration was 6.4mg/L. For ammonia, chronic toxicity test with five species of penaeid shrimps, *P. japonicus*, *P. occidentalis*, *P. schmitti*, *P. semisulcatus* and *P. setiferus*, showed that a mean concentration of 0.45mg/L reduced growth by 50% of the control. Wickins estimated that a "maximum acceptable level" at which growth would be reduced by only 1-2% is 0.10mg/L. The concentration range of these nitrogen compounds which can be tolerated by *P. monodon* are: Un-ionized ammonia (NH_3): 0.0-1.0 mg/L,

Ionized ammonia (NH_3^+): 0.0-0.5 mg/L, Nitrite (NO_2): 0.0-0.6 mg/L and Nitrate (NO_3): 0.0-2.00 mg/L (Shigueno, 1975). The pH of the water should be in the range of 7.0-8.5. Ammonia concentration in the water should not exceed 11.5 ppm of ammonia ion (NH_4^+) and 0.1 ppm of un-ionized ammonia (NH_3).

Table 1. Water parameters tested on a weekly basis (Mean ±S.D)

Week	pH	Temp. (°C)	DO (mg/L)	Salinity (%)	Conduct. (mS/cm)	Turbidity (NTU)	Nitrite (mg/L)	Nitrate (mg/L)	Ammonia (mg/L)
1	7.90±3.02	26.0±5.32	6.84±2.40	0.00±0.01	0.235±1.20	24±4.90	ND	ND	ND
2	7.25±1.12	30.3±1.03	6.71±1.08	0.01±0.01	0.257±1.08	31±3.07	0.01±1.10	1.77±1.03	0.43±0.05
3	7.16±2.23	28.0±2.65	7.37±2.43	0.00±0.01	0.212±0.12	48±4.66	0.30±1.02	1.33±2.01	0.39±1.02
4	7.07±2.12	27.7±2.22	7.37±2.21	0.00±0.01	0.199±1.09	41±6.07	0.25±0.22	3.52±1.20	0.88±1.54
5	7.02±3.24	26.2±3.30	7.93±1.09	0.00±0.01	0.234±2.01	37±6.77	0.07±0.03	1.32±1.20	0.32±0.56
6	6.74±3.01	25.8±3.01	7.90±2.01	0.03±0.10	0.725±2.03	29±6.06	0.50±1.23	6.63±1.50	1.65±0.70
7	6.98±2.05	25.7±3.22	8.01±1.22	0.01±0.01	0.305±0.07	27±6.06	0.33±2.00	4.40±1.09	1.10±1.25
8	7.26±2.60	25.7±1.22	7.99±0.90	0.00±0.01	0.244±1.02	30±4.16	0.36±1.20	3.98±2.30	1.01±1.22

Table 2. Mean water quality parameters measured during the experimental period

Measured Parameters	**Range**	**Mean values**
pH	6.74-7.90	7.32
Temperature (°C)	25.7-30.3	28
Dissolved Oxygen DO (mg/L)	6.71-8.01	7.36
Salinity (%)	0.00-0.03	0.015
Conductivity (mS/cm)	0.199-0.725	0.462
Turbidity (NTU)	24-48	36
Nitrite NO_2 (mg/L)	0.07-0.50	0.285
Nitrate NO_3 (mg/L)	1.32-6.63	3.975
Ammonia NH_3 (mg/L)	0.32-1.65	0.985

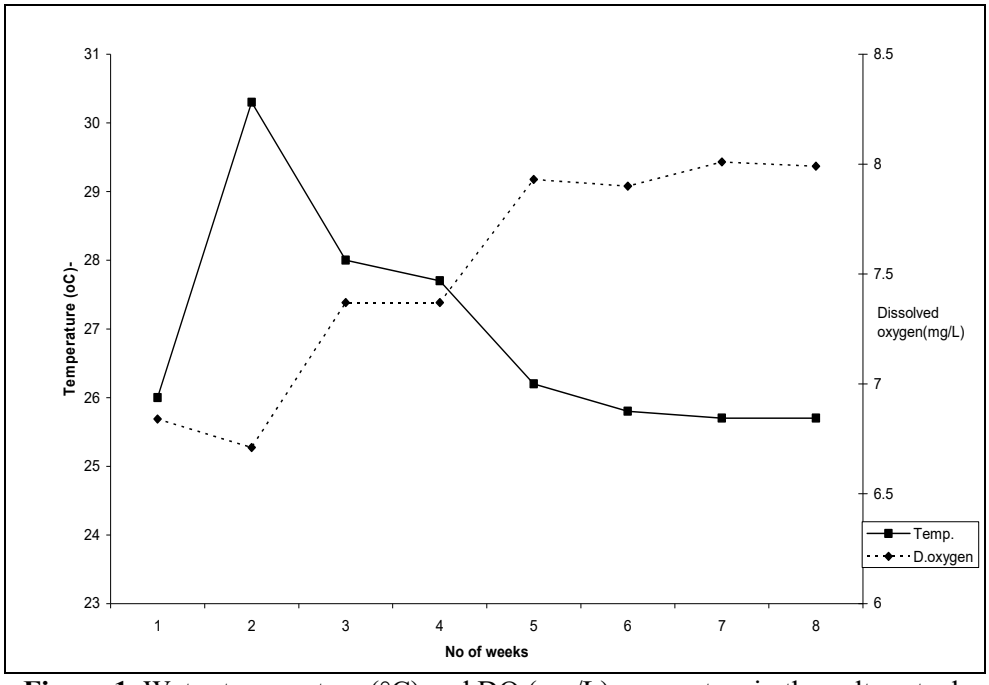

Figure 1. Water temperature (°C) and DO (mg/L) parameters in the culture tanks during the 8 weeks.

Conclusions

However, for successive prawn production in tanks, each water variables must be monitored carefully at regular intervals. Measurements must be taken at the same time in the same place using identical devices and lots of helping hands. Thus, this work seeks to address the ranges of various physico-chemical water quality for prawn culture which can as well be used as a baseline for future researchers.

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