IMPACT OF CATFISH DENSITY ON THE WASTE PRODUCTION, WATER QUALITY AND MORTALITY: COMPARISON BETWEEN RUNNING AND STAGNANT WATER SYSTEM

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ABSTRACT

The objective of this study was to observe the effect of African catfish, Clarias gariepinus density in stagnant and running water systems on the waste production, water quality and mortality. Nine months old male catfish having average weight of 50.00g were placed in running and stagnant water systems with density of 35 and 70, respectively. Water samples were collected twice daily and analyzed for ammonia nitrogen, phosphate and nitrate contents. The samples were analyzed with HACH spectrophotometers DR2800. Water samples temperature, pH and mortality rate were also recorded for each sampling. The results showed significant difference with higher value in stagnant than running water system for ammonia nitrogen (25.95±3.38 mg/L), phosphate (14.14±1.37 mg/L) and nitrate (2.28±0.25 mg/L) with density of 35 catfish. Similar result was obtained for density of 70 catfish which was significantly higher for stagnant than running water system. This study allow to conclude that African catfish were more suitable to be reared in running than stagnant water system. This is due to the ability of the running water system to maintain water quality in terms of waste production which was harmful to the catfish.

Keywords: African catfish, Density, Waste production, Stagnant water, Running Water.

INTRODUCTION

The African catfish or sharptooth catfish, Clarias gariepinus is tolerant to a wide range of temperatures, as well as low oxygen and high salinity levels (Bovendenur et al., 1987). They are valuable species, worldwide due to fast growing rates and tolerates with adverse environmental conditions (Khwuanjai et al., 1997; Raihan, 2007).

Currently, the most popular system used in rearing catfish is re-circulating water system where water running with the aid of water filter. Thurstone (1981) reported that, in re-circulating system at high stocking densities, ammonia, the main end product of nitrogen metabolism in teleost fish, may reach toxic levels (acute or chronic). However, this situation can be prevented if the system is equipped with efficient bio-filters with bacteria that break down ammonia to less toxic nitrite (NO₂) and nitrate (NO₃). The fraction of NH₃ of total ammonia nitrogen (TAN) depends largely on pH and, to a lesser extent, on temperature and salinity (Tomasso, 1994).

In Malaysia, for promoting fish industry recently, under the Rancangan Malaysia Kesepuluh, the Ministry of Agriculture and Agro-Based Industry.
Malaysia had allocated RM82 million to improve the aquaculture industry and executed entrepreneur training scheme and aquaculture rearer. This programme will be focused on fish stocking to ensure enough protein supply within the country (Berita Harian, 2009).

Most of the farmers in Malaysia practice re-circulating water system by using water filter and also pond system in catfish rearing. In Bachok, Kelantan for example, the Kemubu Agricultural Development Authority (KADA) had allocated RM1.2 million to build a factory to process catfish for local consumption and export. The factory needs eight tones of catfish daily to be processed into fish sauce, fish balls and even fish burger (Bernama, 2009).

Many researches on high density of catfish in re-circulating water system have been reported but only few studies about the impact of catfish density in stagnant water system have been attempted. Therefore, this study was conducted to observe the effect of African catfish density in stagnant and running water systems on the waste production, water quality and mortality.

**MATERIAL AND METHODS**

Nine months old male African catfish, *Clarias gariepinus* 50.00g was selected in this experiment. The experiment was carried out for 16 days from 16 - 30 December 2009. The catfish were placed in two different water systems; running and stagnant water systems with catfish density of 35 and 70, respectively. In the running water system, the water was continuously flowing and for the stagnant water system, the water was not flowing. The water volume was constant 0.45m³ for each tank, and aeration was given with the same barometric pressure, 30 Hg. The catfish were fed twice daily with 56.72g (40% of protein) pellet.

The water samples were collected, every morning, 9-10 am and evening, 4-5 pm. The samples were brought to a laboratory for water analysis. The samples were analyzed for the content of the waste production (ammonia nitrogen, phosphate, nitrate), water temperature, pH and mortality rate. The waste production analysis was done using HACH DR 2800 spectrophotometer to obtain accurate results of analysis. The content of ammonia nitrogen, phosphate and nitrate in the water sample was traced using HACH reagents method.

Statistical analysis on data obtained were performed on a microcomputer using Statistical Package for Social Science (SPSS) programme. Data were analyzed through analysis of variance (ANOVA), Karl-Pearsons Correlations Test with significant levels of (P≤0.05).

**RESULTS AND DISCUSSION**

Reducing the outputs of dissolved wastes is considered to be a key element for the long-term sustainability of aquaculture around the world. Ammonia is a primary byproduct of protein metabolism which is excreted directly from the fish gills into the water. Ammonia concentrations are usually at their highest content when the amount of protein fed is greatest. Ammonia is toxic to aquatic life which may cause fish mortalities. Therefore, the ammonia content in rearing water system should be low (Alabaster and Lloyd 1982).

Generally, the present results showed that the waste production in stagnant water system were significantly different with higher value for stagnant as compared to running water system. There were significant differences for ammonia nitrogen (25.95±3.38 mg/L), phosphate (14.14±1.37 mg/L) and nitrate (2.28±0.25 mg/L) with higher value for stagnant than running water system in density of 35 catfish (Table 1) However, for density of 70 catfish, similar result was obtained for ammonia nitrogen (36.97±5.47 mg/L), phosphate (35.44±3.99 mg/L) and nitrate (1.74±0.25 mg/L) which were significantly higher for stagnant than running water system (Table 1) Probably, running water would have flushed out and reduced the concentration of wastes products than the stagnant water system.
In general, the present results observed strong positive correlation for ammonia nitrogen with phosphate ($r=0.832$) and nitrate ($r=0.554$) for both densities of fish in stagnant water system (Table 3). The results showed that an increased production of ammonia nitrogen would increase the concentration of nitrate which will undergo reduction and thermal decomposition to form nitrite. According to Boyd (1982), some of the ammonia may serve as substrate for the production of nitrite which is also highly toxic. If nitrite is absorbed by fish, it reacts with haemoglobin to form methaemoglobin which is not an effective oxygen carrier and under severe conditions, this can be lethal (Boyd, 1982).

Strong positive correlation was also observed for ammonia nitrogen and pH ($r=0.695$) in the stagnant water system with density of 35 catfish (Table 3). This result is in agreement with those obtained for silver catfish (Denise dos et al., 2008), rainbow trout and fathead minnows (Thurston et al., 1981). However, for density of 70 catfish in similar water system strong negative correlation was observed between ammonia nitrogen and pH ($r=-0.826$) (Table 3). Probably, in higher density, the catfish would produce more ammonia nitrogen and at the same time excreted more acidic wastes which reduced the pH of the water in the stagnant water system.

There was no correlation between mortality and other parameters measured for both types of water systems in the density of 70 catfish (Table 2 and 3). Hecth and Uys (1997) found that the level of aggression decreased dramatically with increasing density. This is in accordance with Kaiser et al. (1995) reporting that agonistic behavior in African catfish was highest in low stocking densities.

### Table 1: Water parameter measurements for both densities of 35 and 70 catfish in running and stagnant water systems

<table>
<thead>
<tr>
<th>Water Parameter</th>
<th>Density of catfish (n = 35)</th>
<th>Water System</th>
<th>Density of catfish (n = 70)</th>
<th>Water System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Running (Mean ± SEM)</td>
<td>Stagnant (Mean ± SEM)</td>
<td>Running (Mean ± SEM)</td>
<td>Stagnant (Mean ± SEM)</td>
</tr>
<tr>
<td>Ammonia Nitrogen</td>
<td>0.23 ± 0.02$^a$</td>
<td>25.95 ± 3.38$^b$</td>
<td>0.69 ± 0.12$^a$</td>
<td>36.97 ± 5.47$^b$</td>
</tr>
<tr>
<td>Nitrogen (mg/L)</td>
<td>0.36 ± 0.03$^a$</td>
<td>14.14 ± 1.37$^b$</td>
<td>0.59 ± 0.09$^a$</td>
<td>35.44 ± 3.99$^b$</td>
</tr>
<tr>
<td>Phosphate (mg/L)</td>
<td>1.11 ± 0.07$^a$</td>
<td>2.28 ± 0.25$^b$</td>
<td>0.96 ± 0.07$^a$</td>
<td>1.74 ± 0.25$^b$</td>
</tr>
<tr>
<td>Nitrate (mg/L)</td>
<td>27.95 ± 0.14$^a$</td>
<td>27.44 ± 0.12$^b$</td>
<td>27.75 ± 0.20$^a$</td>
<td>26.41 ± 0.09$^b$</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>6.98 ± 0.06$^a$</td>
<td>7.03 ± 0.05$^a$</td>
<td>6.87 ± 0.05$^a$</td>
<td>5.94 ± 0.06$^a$</td>
</tr>
<tr>
<td>pH</td>
<td>0.03 ± 0.03$^a$</td>
<td>0.13 ± 0.10$^a$</td>
<td>0.00 ± 0.00$^a$</td>
<td>0.28 ± 0.18$^b$</td>
</tr>
</tbody>
</table>

$^a,b$ superscript in the same row within a column between running and stagnant show significant difference (Pd" 0.05)

### Table 2: Correlation of water parameter measurements for density of 35 and 70 catfish in running water system

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Density of catfish (n = 35)</th>
<th>Density of catfish (n = 70)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia Nitrogen</td>
<td>35 70</td>
<td>35 70</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>70</td>
<td>70</td>
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<tr>
<td>Phosphate</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>Nitrate</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>Temperature</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>pH</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>Mortality</td>
<td>35</td>
<td>70</td>
</tr>
</tbody>
</table>

$^*$ Indicates significant at Pd" 0.01

$^a,b$ Indicates highly significant at Pd" 0.05

n.s - not significant
The present results also showed no significant differences in the mortality for running and stagnant water system in both densities of catfish. Probably, the catfish are able to survive because this species was strong enough to live in both water systems and well adapted in dense population. The catfish should be highly disease-resistant due to high stocking density. Hecht et al. (1997) reported that, African catfish can be grown at very high densities because they are air-breathers, have relatively high tolerance to poor water quality conditions and display unusual behavioral responses under high density conditions. According to Khwuanjai et al. (1997), the reason for the ability of African catfish to maintain high production levels when cultured at high densities, but provided with sufficient food, may be their adaptation as air breather which was observed to increase at the higher stocking densities.

Additional experiment could be conducted to determine the optimal stocking density which would produce the maximum biomass of catfish in desired numbers in the running and stagnant water systems. The study on breakdown of metabolic wastes could be yet another aspect of study for understanding the environment of fish under various densities.

**CONCLUSION**

This study had shown that running water system is more appropriate for rearing catfish than stagnant water system. This was due to the ability of maintaining water quality in terms of waste production (ammonia nitrogen, nitrate and phosphate) which was harmful to the fish. The results obtained in this study further proved the hardy nature of the African catfish in terms of the ability to withstand water quality stress and survival at high stocking densities when reared in stagnant water system.

**REFERENCES**


