Density is affecting Growth Performance of African catfish (*Clarias garriepinus*) in turbid Water Ponds

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Abstract Our study of density on growth performance of African catfish (*Clarias garriepinus*) grown in turbid water was divided into 2 experiments. Experiment 1, the catfish cultured in turbid earthen ponds of 12 cubic meters with average initial weight 2.91 ± 0.15 gram and average length 8.19 + 0.21 centimeters. The density is at the rate of 20, 40 and 60 fish per cubic meter, respectively. Fish were fed by floating food pellets of 30 percent protein for 90 days. There was no statistical difference (p>0.05) in the average growth rate. Consequently, fish data at the density level of 40 per square meter with average weight, length, feed conversion ratio, and specific growth rates were higher than in other groups. The second experiment was the experiment on rearing African catfish in a cage of 2x2x1.5 cubic meters in turbid water. African catfish with an average initial weight of 2.95 ± 0.19 gram and average length of 8.27 ± 0.01 centimeters were reared in that cage. Densities varied from 20 to 40 and 60 fish per cubic meter according to 3 repeats. Fish were fed with floating food pellets of 30 percent protein for a period of 90 days. The rate of growth was found with no statistical difference (p>0.05). Nevertheless, fish data at the density level of 40 per cubic meter with average weight, length, feed conversion ratio and specific growth rates were higher than the other groups. We conclude that the optimum density for raising African catfish in turbid water both earthen ponds and cages were 40 per square meter.

Keywords: turbid water, African catfish (*Clarias garriepinus*), earthen pond, cages culture

Introduction

High turbidity in fish ponds can affect fish growth substantially (Boyd, 1979). Clay or mud turbidity caused by suspended inorganic substances, such as silt and clay, is the most prevailing problem for fertilization management in freshwater ponds (Lin *et al.*1997). Chaparro-Herrera *et al*. (2019) reported that turbidity decreases the visual ability during the larval development of an endemic predator (*Ambystoma mexicanum*) which in turn influences its capacity to compete against invasive fishes. Ponds with clay bottoms are likely to have high turbidity effects on the respiration of fish. Turbidity caused by clay particles is generally undesirable because it keeps light from penetrating the water, and light is required for algal growth (Hargreaves, 1999). At very high concentrations, clay particles can also clog fish gills or overwhelm fish eggs. Turbidity also may be objectionable to pond owners from an aesthetic point of view. Some sources of clay turbidity are runoffs from clear-cut or overgrazed watersheds, road or building construction or pond bank erosion from wave action. Yi *et al*. (2003) stated that clay turbidity was mainly from the run-off of pond dikes but not from fish disturbance of pond bottoms during the rainy season and indicated that covering pond dikes was effective in mitigating clay turbidity caused by the run-off into fish ponds. Many researchers tried to treat and remove clay particle or water turbidity from fish ponds. The mitigate clay turbidity have been suggested to colloidal particles are negatively charged, the most effective technique is the introduction of inorganic compounds with electrolytes of opposite charge such as alum, agricultural gypsum, slaked lime and quick lime (Boyd, 1990; Vuthana, 1995). The chemical treatments to remove turbidity in pond water are not cost-effective in most cases and can also cause undesirable side effects, such as precipitating nutrients (Lin *et al*., 1999). Some areas of the fish pond in local community of Northeast of Thailand have the turbid water problem. The farmers cannot rear the fish in their after they dig a new pond. Due to many clay particles in the water and they will suspend long time maybe to10 years. In this study, we are not treating or remove clay particle but try to rear the African catfish into the turbid water earthen pond and cages.

Materials and Methods

Two experimental designs by the randomized complete block design dividing the experiment into 3 treatments. Experiment 1, the fish were raised in highly turbid earthen ponds at a size of 3x4x1 m^3 and in experiment 2 they were raised in a cage of a size of 3x4x1 m^3. Each experimental unit had 3 replications. The catfish were treated in groups of 20, 40, and 60 per square meter. The African catfish had an initial weight of 2.91+0.15 grams, a total of 1,500 fish were used for this study. They were obtained from the Panarath Farm. All

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experimental fish were adapted in a fiberglass tank for 2 days before experimentation. Randomly count the total number of larvae and measure the length of the fish in each pond and release the fish into the experimental unit. Using pelleted food with 30 percentages of protein catfish is a food. Experiment feeding at a rate of 10 percentages body weight per day, 2 times a day (08.30 hrs. and 16.30 hrs.) Adjust the amount of food that is given every 15 days according to the growth of the African catfish in each range during 90 days. We measure fish every 15 days by sampling 20 percentages of the number of fish in each pond. At the end of the experiment, the data obtained were analysed for growth results such as average weight and length, specific growth rate, feed conversion ratio and survival rate. Data analysis of variance was analysed by ANOVA analysis method and compares the mean differences with Duncan's new multiple range test at the level of 95 percentages. Fish weight gain, feed conversion ratio, specific growth rate and mortality were determined as follows.
Feed conversion ratio (FCR). This was calculated from the relationship of feed intake and wet weight gain.

$$FCR = \frac{\text{Total feed consumed by fish (g)}}{\text{Weight gain by fish (g)}} \quad (1)$$

Specific growth rate (SGR) was calculated as:

$$SGR\ (\%\ \text{per day}) = \frac{(\text{Loge } W2 - \text{Loge } W1) \times 100}{T2 - T1} \quad (2)$$

Where:
W2 = Weight of fish at time T2 (final)
W1 = Weight of fish at time T1 (initial)

Results

Experiment 1 The result of growth rate and feed conversion ratio were provided in table 1. These results showed that the average data of final weigh, final length, FCR and specific growth rate were not significantly different in all groups. The average final length among all groups was not significantly different. Feed conversion ratio (FCR) was higher in all treatments than those of catfish reared in a low turbidity pond. There was no mortality throughout the experimental period.

Table 1. African catfish growth in high turbidity earthen ponds.

Parameter	Density [a] (fish/m^3)		
	20	40	60
Initial weight	2.91±0.25	2.95±0.15	2.87±0.16
Final weight	102.68±21.96	103.60±3.57	98.28±0.64
Initial length	8.19±0.21	8.02±0.08	8.36±0.16
Final length	23.72±1.58	24.93±0.8	23.89±0.2
Feed conversion ratio	2.24±1.17	2.16±1.68	2.25±0.66
Specific growth rate	1.12±1.58	1.16±0.57	1.09±0.18

[a] mean values in the superscript indicate no significant differences (P>0.05)

Table 2. Water quality fluctuations in experimental turbidity earthen ponds.

Treatments	Temperature (° C)	D O (mg/l)	pH (range)	Turbidity (NTU)	Conductivity (mg/l)	TDS (mg/l)
20 (fish/m^3)	31.31±0.39	1.43±0.60	8.14±0.23	539.61±304.18	675.69±173.10	401.14±12.07
40 (fish/m^3)	31.46±0.46	1.46±0.47	8.07±0.17	549.58±470.54	690.52±151.25	442.41±101.25
60 (fish/m^3)	31.67±0.61	1.41±0.00	8.04±0.11	636.31±39.82	858.55±126.15	502.92±151.58

Experiment 2 The final weight of the catfish 40 fish/m^3 was higher than in the other groups. Final length and feed conversion ratio was not significantly different (P>0.05) among all groups. Specific growth rate of 40 and 60 fish/m^3 were similar but higher than 20 fish/m^3 (P< 0.05). The experimental fish showed no mortality throughout the experimental period.

Table 3. African catfish growth in experimental cages in the high turbidity water.

Parameter	Density (fish/m^3)		
	20	40	60
Initial weight	3.00±018^a	3.10±0.15^a	3.25±0.05^a
Final weight	112.90±1.72^b	122.18±0.77^a	114.29±1.72^b
Initial length	8.30±0.20^a	8.31±0.22^a	8.27±0.01^a
Final length	22.11±0.26^a	25.55±0.06^a	24.77±0.26^a
Feed conversion ratio	2.47±0.02^a	2.22±0.00^a	2.76±0.02^a
Specific growth rate	1.11±0.12^b	1.79±0.18^a	1.74±0.32^a

$^{a, b, c, d}$ mean values in the same row with different superscript are significantly different (P< 0.05)

Table 4. Water quality fluctuations in experimental cages.

Treatments	Temperature (ºC)	D O (mg/l)	pH (range)	Turbidity (NTU)	Conductivity (mg/l)	TDS (mg/l)
20 (fish/m^3)	31.02±0.11	1.65±0.15	8.02±0.44	568.33±4.19	698.23±54.30	467.45±12.07
40 (fish/m^3)	30.46±0.24	1.51±0.21	7.98±0.15	599.34±6.12	712.34±67.51	486.22±19.25
60 (fish/m^3)	30.27±0.91	1.38±0.18	8.01±0.22	603.27±9.17	798.55±29.34	498.97±51.58

Discussion

Several species of catfish, including the African sharp tooth catfish (*Clarias gariepinus*), have both gills that take in oxygen from water and an organ called the "labyrinth" or dendritic organ that allows the fish to breathe air. These catfish evolved to survive in subtropical/ tropical rivers–where oxygen levels in the water can drop dramatically at night. So, while they breathe through their gills most of the time, the fish also have the option of swimming to the surface and taking a big gulp of air (Killen *et al*., 2017). Although, the African catfish has a dendrite it is difficult for it to breathe when they swim in highly turbid waters. In experiment 1, the fish had no significantly different growth parameters. However, they all survived in high turbidity water. The feed conversion ratio in the 40 fish/m^3 group is lower than in the other group, but it is higher than rate of the commercial catfish farm by Betagro Company Limited. In Thailand, FCR of hybrid catfish should be 1.1-1.6 (Department of Animal Feed Service, 2014). In experimental 2, the final weight of individual fish in the 40 fish/m^3 group is higher than in the other group. Although the FCR were not significantly different, fish with 40/m^3 seem to have high FCR similar to the specific growth rate. In case of channel catfish *Ictalurus punctatus,* fish growth and feed efficiency significantly decreased with increasing stocking density. Serum concentrations of glucose, triglyceride, and total cholesterol, as well as the activities of both aspartate aminotransferase and alanine aminotransferase, were significantly elevated with increased stocking density (Refaey *et al*. 2018). In juvenile sparid fish (*Pagrus auratus*), turbidity had a highly significant effect on fish SGR over 30 days of NTU exposure. The control <10 NTU group maintained its weight, but there was a significant loss of weight observed at 80, 60 and 40 NTU with respect to the control group (Cumming and Herbert, 2016). Ardjosoediro and Ramnarine (2002) reported that the Jamaica red tilapia strain showed significant decreases (P<0.05) in weight gain and length increases as turbidity increased. SGR decreased and FCR increased with increasing turbidity but the differences were not significant. Survivorship was negatively correlated with turbidity and the differences were significant (P <0.05) at lower turbidity. We suggest that clay turbidity levels in earthen ponds should be kept below 100 mg/L. Water quality of both experiments has similar values. DO concentration was rather low during the experiment. Due to the dendritic organ that allows the fish to breathe air, these catfish evolved to survive in turbid waters. In conclusion the African sharp tooth catfish (*C. gariepinus*) can be reared in highly turbid waters. From this study, we suggest that an optimum density can be 40 fish/m^3 or even higher since higher densities were not tested.

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