International Journal of Contemporary Sciences (IJCS)
Vol. 1, No. 10, 2024: 667-677

Effects of Eichhornia Crassipes Infested Pond on Growth of Clarias Gariepinus (Burchell 1822) in Concrete Ponds

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A R T I C L E I N F O

Keywords: African Catfish, Concrete Ponds, Length, Water Hyacinth, Weight

Received : 07, June
Revised : 15, July
Accepted: 03, August

A B S T R A C T

Concrete tanks measuring 3.0 m x 2.0 m x 1.2 m were stocked with African catfish and infested with water hyacinth at 0%, 10%, 20%, and 30% plant cover to evaluate the effect of water hyacinth on fish growth. The stocking density was 5 fish/m², with an average weight of 10.3 g and an average total length of 10.4 cm. The study lasted 60 days, during which the fish were fed twice daily for six days a week. Weekly, random samples were taken from each tank to measure body weight and length, and water quality parameters were also analyzed. The results indicated that all water quality parameters remained within acceptable limits. However, the final average weight of fish was lower in the control and at 30% plant cover. The study concludes that African catfish grow better in ponds moderately infested with water hyacinth.

E-ISSN: 3047-4078
DOI: https://doi.org/10.55927/ijcs.v1i10.11592
https://journal.formosapublisher.org/index.php/ijcs

INTRODUCTION

Water hyacinth (Eichhornia crassipes) an aquatic macrophyte that originated from South America is known to be notorious and invasive and has spread all over the world. The plant can be found in both tropical and sub-tropical area (Villamagna & Murphy 2010). Water hyacinth grows rapidly and so it is listed as one of the most productive plants. As it spreads, water hyacinth deteriorates quality of the water (Gezie, Assefa, Getnet, Anteneh, Dejen & Mereta, 2018) thereby reducing the biodiversity (Wu & Ding 2020). On the contrary, Brendonck, Maes, Rommens, Dekeza, Nhiwatiwa, Barson, Callebaut, Phiri, Moreau, Gratwicke, Stevens, Alyn, Holsters, Ollevier, & Marshall (2003) reported that water hyacinth increases abundance and diversity as the dense mats and complex root system provides habitat for zooplanktons, small and juvenile fishes.

The rapid growth of water hyacinths in aquatic environments is influenced by its efficient utilization of nutrients in the water (Jafari, 2010) as it removes reasonable quantities of nutrients from the aquatic environment that positively affects its growth (Wanda, Twongo & Denny, 2001). Infestation of water hyacinth of the aquatic ecosystem affects the environment when the mats of weeds consumes major biogenic ions in water (Akinyemiju & Imevbore, 1990) and acidifies the water by reducing euphotic zones (Ndimele & Jimoh, 2011); which affects fish exploitation (Olaleye, Akintunde & Akinyemiju, 1993) and dwindles economic activities.

Rapid wide spread of water hyacinth can affect the physical and chemical properties of the water which could cause instability of the aquatic ecosystem. Reduction in the concentration of dissolved oxygen and disturbance in plant, filter, and fish balance can increase the stress level of the system, which could affect the fish by reducing growth and feeding eventually leading to fish death. The massive population of the weed can also reduce the response of the immune system to viral and bacterial infections and many other physiological dysfunctions (Kjelland, Woodley, Swannack & Smith, 2015). Effects of the presence of the aquatic weed on the ecology of the water body could affect growth rate, feed efficiency, and physiology of the fishes (Hauser, Wernand, Korangteng, & Simpeney, 2014).

African catfish one of the most cultured freshwater fish species in the world grows rapidly that can tolerate harsh conditions. They are carnivores by nature that displays omnivorous characters in their feeding habits. Their food is made up of detritus and phytoplankton, fruits and seeds, birds and fish. Clarias gariepinus possesses dendritic organs, suprabranchial membranes, and gill fans that make it possible for them to breathe air and gills that allow them breathe in water. Their respiratory system allows them to live even in high stocking environment.

Studies on the effect of water hyacinth on ponds stocked with catfish juvenile are scarce. Hence, this research was conducted to investigate the effect of Water hyacinth cover on growth of catfish since macrophytes have been recorded as one of the major food item in the diet of the fish. It is very important to study the effects of water hyacinth on growth of Clarias gariepinus in concrete ponds, as the fish is an omnivore that might survive on water hyacinth to some extent, which could reduce cost of feeding.

LITERATURE REVIEW

Water Hyacinth

Water hyacinth (Eichhornia crassipes) known as one of the most productive plants found in freshwater and belong to the family Pontederiaceae. It grows and reproduces at very high rates, up to 100–400 Mt/ha/year (Hutabarat, Syarani, & Smith, 1986) and can double in 5 days. A medium sized plant mat can contain 2 million plants per hectare weighing between 270 to 400 tons and forms dense mats as reported by Pandey (2020). Plant blocks waterways and affects fishing. Mats of water hyacinth prevent sunlight penetration and aeration of water, causing oxygen deficiency and affecting biological diversity. Water hyacinth is a floating vascular aquatic plant. The plant is one of the most prevalent invasive plants (Gupta, Roy & Mahindrakar, 2012) common in fresh water bodies in areas where there are large quantities of nutrient due to deforestation, agricultural runoff and poor wastewater treatment (Villamagna 2009).

Utilization of Water Hyacinth in Aquaculture

According to Pratiwi and Andhikawati (2012), water hyacinth can be used as an alternative fish food because it contains carbohydrates, proteins, vitamins, minerals and fats. The plant also contains alkaloids, saponins, flavonoids, steriod compounds, glycosides, phenolic compounds and cardiac glycosides, so can be potential antibacterial agent. The use of water hyacinth in fish feed in the culture of African catfish has shown positive results. Konyeme, Sogbesan & Ugwumba (2006) in their study of the nutritive value and utilization of water hyacinth meal as plant protein supplement in the diet of Clarias gariepinus fingerlings recommended a 40% level of water hyacinth as fishmeal supplement to decrease the cost of feed production. Despite the nutritional components, the fibre content of water hyacinth limits its utilization as feed ingredient (Nwanna, Falaye, & Sotolu, 2008).

Fish feeding contributes a very reasonable amount of nutrients in the culture ponds, which can lead to excessive algal growth resulting in oxygen depletion of the water that eventually affects fish growth if not properly managed. The most common method of preventing oxygen depletion is frequently changing the pond water. This method leads to an increase in cost of production (Isyagi, Karen, Veverica, Asiimwe & Daniels, 2009). A cheaper and better management of the pond water is the use of water hyacinth because the plant absorbs nutrients from water bodies (Adeniran, 2011; Ugya and Imam, 2015). According to Echiegu, Ezeugwu, & Ugwu, (2018), the use of water hyacinth in fishponds reduces the rate of water use and contributes to a decrease in the cost of production.

METHODOLOGY

The Experimental Ponds

Concrete ponds of 3.0m x 2.0m x 1.2m were infested with water hyacinth at the rate of 0, 10, 20 and 30% plant cover. The experiment had replicates, kept under the same environmental conditions and filled with water from a borehole.

Experimental Fish

Juvenile Clarias gariepinus were bought from a commercial hatchery and acclimatized for 7 days in experimental ponds before stocking. Each pond was stock at 5/m2 with a mean weight and total length of 10.30g and 10.40cm respectively. 432 fishes were used for the study for 60 days.

Plant Collection

Water hyacinth (Eichhornia crassipes) plants were collected from a nearby freshwater creek at Sagbama in Sagbama Local Government Area of Bayelsa State and identified. The plants were introduced at the rate of 0, 10, 20, 30% plant cover.

Experiment Procedure

Fishes were fed two times a day and 6 days a week for 60 days with a commercial floating feed pellet. Five fish sample were randomly selected from each pond every two weeks to determine their body weights and lengths. Water qualities were taken before stocking the fish to determine the water quality and possible effect of water hyacinth on pond water. During the experimental period, the quality of the water was recorded between 10.30am and 11.00am every day for temperature, dissolved oxygen, pH, and conductivity, using Extech water checker Model DO: 700, while turbidity was measured with the aid of secchi disc.

Fish Growth Performance Evaluation

Growth performance indices were determined from length-weight data described by Sveier, Raae & Lied, (2000) below:

Mean Weight Gained (MWG)

MWG (g) = $W_f - W_i$

Where W_f = Mean Final Weight (g); W_i = Mean Initial Weight (g)

Mean Daily Weight Gained (MDWG)

MDWG (g) = MWG/t

Where MWG = Mean Daily Weight Gained; t = the number of days in the feeding period

Percentages Body Weight Gain (PWG)

PWG (%) = (MDWG/W_i) × 100

Where MDWG = Mean Daily Weight Gained; W_i = Mean Initial Weight (g)

Relative Growth Rate (% Body Weight Per Day)

This was calculated as:

RGR (%) =100[(W_f - W_i)/W_i]/t = Where Wf = mean final weight (g); Wi = mean initial weight (g); t = culture period (in days)

The Specific Growth Rate (SGR)

SGR was estimated from the expression.

SGR (%) = 100(log W_f – log W_i) / t

Where W_f = mean final weight (g); W_i= mean initial weight (g) t = time (days) between weighing

Percentage (%) Survival

% Survival = Nf / Ni where: Nf = final fish population at the end of the experiment

Ni = initial fish population at the beginning of the experiment

Statistical Analysis

Data collected were analyzed using SPSS software version 12.0 and presented as means and standard error.

RESEARCH RESULT

Water Quality Parameters

Physio -chemical properties of the water are shown in Table 1. Water hyacinth free pond WHIP 0% had higher ($p< 0.05$) mean temperature than the water hyacinth infested ponds. The mean pH was lowest in WHIP10% and increases as the plant cover increases with highest in WHIP0%. Turbidity was lowest in WHIP0%. Dissolved oxygen DO was higher in the WHIP0% pond compared to the water hyacinth-infested treatment. Higher mean conductivity values were recorded in the WHIPs.

Table 1. Some Physico-Chemical Parameters of Water Hyacinth Infested Ponds and Water Hyacinth Free Ponds

Parameters	**WHIP (0%)**	**WHIP (10%)**	**WHIP (20%)**	**WHIP (30%)**
Temperature °C	27.00–29.40 28.50± 0.34	26.00-28.20 26.12±0.11	25.70 – 26.01 25.84±0.22	25.81-26.00 25.80±0.41
pH	7.12 – 8.40 7.44 ±1.58[a]	7.12 – 7.94 7.28±0.07[a]	7.12-7.91 7.30±0.30	7.12-7.93 7.31±0.22
Turbidity(cm)	35.40-37.00 32±3.88	35.20-39.10 37±2.23	33.40 -39.50 37.28±1.42	33.70-39.80 37.27±0.44
DO (mg/l)	5.00– 7.00 5.31 ± 0.26	5.20– 6.40 5.22 ± 0.55	5.2-6.10 5.16± 0.45	4.8-5.6 4.96± 0.25
Conductivity (µS/cm)	152.0–290.00 218.53±1.19	249.00-326.00 300.11 ± 1.14	236-348 298.15±1.11	285-332 311.11 ±1.24

Fish Growth

Juvenile Clarias gariepinus grown in the water hyacinth-infested tanks growth rate was significantly better than the fishes cultured in water hyacinth-free tanks (Table 2). The final mean weight gained was higher in the water hyacinth infested pond WHIP 20% and lowest at WHIP 0%. Other growth performance indices such as Percentages body weight gain (PWG), Relative growth rate (% body weight per day) and Specific growth rate (SGR) were all higher in WHIP (20%).

Table 2. Growth Performance of Clarias Gariepinus Grown in Eichhornia Crassipes Infested Ponds

Parameters	**WHIP (10%)**	**WHIP (20%)**	**WHIP (30%)**	**WHIP (0%)**
Initial mean weight (g)	10.30 ± 1.02	10.30 ± 1.02	10.30± 1.02	10.30± 1.02
Final mean weight (g)	227.03 ±3.62	234.64± 2.60	186.61±0.4	173.30±0.2
Mean Weight Gained (MWG)	216.73±3.42	224.34±2.32	176.31±1.1	163.00±0.6
Mean Daily Weight Gained (MDWG) g/d	3.60±2.1	3.73 ±3.0	2.83± 13.0	2.72±0.4
Percentages Body Weight Gain (PWG)	34.94±0.7	36.11 ±2.2	28.47±3.0	26.42±0.2
Relative Growth Rate (RGR) %/d	35.20±3.4	36.061±2.5	28.53±0.52	26.12±0.71
Specific Growth Rate (SGR) %/d	2.21±0.31	2.23±0.23	2.10±0.22	2.05±0.20
Percentage survival (PS)	93.66±0.21	94.42±0.32	90.35±0.33	91.45±0.22

DISCUSSION

From the results in table 1, water quality parameters were within the acceptable limits in the study. Each species of fish has minimum and maximum temperature range for growth and survival. Mayer (2012) recorded temperature of between 25 to 37°C as generally tolerable to fish. Temperature range of 25.70 – 29.40 °C recorded in this study falls within the limits of 22.0 – 35.0°C recorded by Howerton (2001) for Clarias gariepinus as any increase in temperature above 27.0°C might cause decline in growth (Ibrahim, Umar & Burak, 2023). The fish Clarias gariepinus can survive at temperatures below this range, but will experience a decrease in rate of growth. According to Kasihmuddin, Ghaffar & Das, (2021) water temperature of between 26-32°C does not have any significant difference in growth performance of Clarias gariepinus. Hence, optimal temperature of 26°C is recommended for yolk sac absorption as well as maximum growth rate (Ogunji & Awoke, 2017) since high temperatures can encourages growth of toxic bacteria and fungi.

pH of the water in both the water hyacinth infested ponds and the water hyacinth free ponds were within the alkaline range of between 7.12 to 8.40 and generally acceptedpH value of 6.5 to 9.0 for aquaculture ponds (Wurts & Durborow, 1992). Fishes could die if the pH is less than 4.0 or more than 11.0. In addition, there could be negative effect on the fish when the pH of the culture water ranges from 4.0 to 6.5 and from 9.0 to 11.0 (Bhatnagar and Devi, 2019). According to Giraldo and Garzon (2002), water hyacinth was found to stabilize temperature and pH in experimental lagoons by forestalling stratification in the water as observed in the study. The lower pH values recorded in the water hyacinth infested pond agrees with the findings of Ugya and Imam (2015) who reported that water hyacinth can neutralize water level from acidity or alkalinity.

Average DO in all the ponds were within survival limits of 5mg/l for catfish and so did not affect growth performance of the fish. Though DO was within the survival range it was lowest in 30% WHIP. Dissolved oxygen is reduced when there are other materials and organisms that require oxygen to survive and so compete with the fish for the available oxygen. This phenomenon explains the lower DO recorded in WHIPs which is connected to increase in bacteria respiration of decomposing dead plants (Saeed and Al-nagaawy, 2013)

Turbidity readings fall within the range of 30-60cm good for fish health. Lower turbidity <30cm prevents plankton bloom, between 30-60cm is good for fish growth, while turbidity>60cm is detrimental to fish (Bhatnagar and Devi, 2019).

Conductivity range of 152-332 µS/cm falls within the range of 30-5,000µS/cm recommended by Stone and Thommforde (2004) for pond fish culture. Mean Conductivity was highest in the water hyacinth infested ponds. The high conductivity recorded in water hyacinth infested ponds could be attributed to the release of carbonate and bicarbonate ions from decomposing organic matter leading to increase in electrical conductivity (Akan, Abdulrahman, Dimari & Ogugbuaja, 2008). Results of the water quality parameters measured clearly shows that there was no effect on growth performance of the fish because all parameters measured were within acceptable limits.

All estimated growth performance indices showed that growth was better in water hyacinth infested treatments. The finding corroborates those of Adeyeni, Adewole, Lawal, Ogundepo, Obuotor, Olaleye, Adeoye &Odufuwa, (2022) but disagrees with Echiegu, Ezeugwu & Ugwu (2018). In their study of effects of water hyacinth (Eichhornia crassipes) on the physicochemical properties of fishpond water and growth of African catfish, they concluded that the use of water hyacinth does not indicate any significant advantage in African catfish culture. But Adeyeni et al (2022) gave a contrary view which agrees with this study, that at a moderate stocking rate of not more than 12 plants/m2, Clarias gariepinus grown in WHIP perform better, could be connected to the ability of the aquatic weed to mop up pollutants from the water thereby purifying and stabilizing the system to promote fish growth.

The shade provided by the water hyacinth reduces the intensity of sun penetration allowing the fish to feed all the time because C. gariepinus is most active at dawn and dusk utilizing darkness provided by the water hyacinth to feed almost all the time (Hossain, Batty, Haylor, & Beveridge, 1999).

Plant covering reduces movement of fish, increase energy conservation, which would have been used for metabolic activities are converted to growth. High density of aquatic plants contributes to low growth performance as reported by Ndimele and Jimoh (2011) that fishes do better in moderate plant cover as absence or excess aquatic vegetation can be detrimental as observed in this study.

CONCLUSIONS AND RECOMMENDATIONS

Water hyacinth, a fast-growing aquatic plant rich in nutrients, can play a beneficial role in aquaculture. Growth performance indices of *Clarias gariepinus* juveniles, observed under varying levels of water hyacinth coverage, revealed that fish in ponds with moderate plant cover exhibited better growth than those in ponds without any hyacinth. A 20% plant cover is recommended for aquaculture as it can lower feeding costs and water usage, ultimately reducing overall production expenses while maintaining optimal fish growth.

ADVANCED RESEARCH

Building upon the conclusion that moderate coverage of *Eichhornia crassipes* (water hyacinth) positively influences the growth of *Clarias gariepinus* in concrete ponds, future research could explore optimal management strategies for controlling the plant's growth and nutrient release. Investigating the biochemical interactions between water hyacinth and pond water quality, such as dissolved oxygen levels, nutrient cycling, and their effects on fish metabolism, can provide deeper insights. Additionally, research could focus on determining the long-term impacts of different hyacinth coverage levels on fish health, feed efficiency, and water reuse in aquaculture systems, as well as exploring its potential for sustainable waste management and environmental remediation in larger-scale operations.

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