EAPAS

East African Journal of
Pure and Applied
Science

East African Journal of Pure and Applied Science Vol. 2 (1): 42-49 (2012)

GROWTH PERFORMANCE OF AFRICAN CATFISH *CLARIAS GARIEPINUS* (BURCHELL, 1822) FRY IN A GREEN HOUSE

Matolla G. K and Marigat S.K.

Department of Fisheries and Aquatic Sciences, Chepkoilel University College, Moi University

P.O. Box 1125-30100 Eldoret; Kenya

ABSTRACT

Temperature has pervasive controlling effects on the rates of food consumption and metabolism thus affects growth of fish. Water temperature can be increased by use of green houses to enhance fish growth. A study was conducted at Chepkoilel University College fish farm in Eldoret, Kenya to investigate the effect of greenhouse on growth of catfish (*Clarias gariepinus*) fry.

Four day old fry of an initial average length and weight of 6 mm and 0.02 g respectively were held in black circular plastic tanks of 0.7 meters high inside and outside the greenhouse. The tanks were filled with 1.5 m^3 of water each. Each tank was stocked with 1000 fry.

Dissolved oxygen in tanks that were outside the green house was significantly higher than in those in the green house ($p<0.05$). While all fry had an initial mean length of 6mm. At the end of the study, mean length inside was 12.19 (±2.9) mm and significantly higher than outside the greenhouse at 9.5 (±1.6) mm ($p< 0.05$). Initial mean weight was 0.02g (±0.045) and 0.127g (±0.015) inside and outside the greenhouse respectively at the end of the study. Since fry survival was low (37%), regular grading of fry and provision of adequate live feeds to boost survival of fry is recommended for increased catfish fry production in greenhouses.

[1]Corresponding author E-Mail address: gmatolla@yahoo.com
 ISSN 2070 0903

INTRODUCTION

Fish contributes to national food self-sufficiency through direct consumption and through trade and exports. In general terms, aquaculture can benefit the livelihoods of the poor either through an improved food supply and/or through employment and increased income. FAO estimates that fish provides 22 percent of the protein intake in sub-Saharan Africa. This share, however, can exceed 50 percent in the poorest countries (especially where other sources of animal protein are scarce or expensive). (FAO, 2012).

Catfish is one of the most suitable species for aquaculture in Africa. The African catfish (*Clarias Gariepinus*) has high growth rates and is accepted as food in many African countries. However, its culture has encountered numerous problems, the main one being unreliable fingerling supply to farmers; which a pre-requisite for sustainable aquaculture development. Low survival rates of catfish fingerlings has been the main constraint to fingerling availability survival and growth of fish depends on several factors including food, control of diseases and water quality such as temperature and dissolved oxygen. Water temperature is one of the most important factors influencing fish growth (Corey et. al 1983). In low temperature regions, the metabolic activity of fish is greatly reduced, which affects the growth of fish (Halver, 1972).

African catfish do well at temperatures ranging between 17-30˚C; with an optimum of 30˚C (Swift, 1993). Therefore, in colder climate, additional or supplemental heat to increase the water temperature is necessary. This may be provided through active heating devices, geothermal water sources or use of greenhouses. The later has been investigated by several authors including Frei and Beker (2005); Klemetson and Rodgers (1985); Losordoa and Piedrahitab (1990); Wisely et. al. al (1981); Wood and Ghannudi, (1985); Zhu et. al (1998). The thermal dynamics under greenhouse conditions have been predicted using models such as those developed by Chandra and Albright (1980); Ghosal et. al (2005). Khatry et. al (1978); Santamouris et. al (1994); Tiwari (2003); Tiwari and Dhiman (1986); Rebuck et. al (1997). In the united states, aquaculture is reported to be the largest user of geothermal energy at 35%; with greenhouses amounting to slightly over 13% of the total energy use, if geothermal heat pumps are not considered (Tonya & Lund; 2003). After the decline of the Pajaro Valley flower business on Central California coast, the greenhouses are used in aquaponics; a combination of aquaculture and hydroponics. (Los Angeles Times September, 2010)

Temperature has pervasive controlling effects on the rates of both food consumption and metabolism and so has effects on growth (Wooton R. J 1994). The observation that growth rates of fishes living in moderate or high altitude are usually reduced during winter is circumstantial evidence for an effect of temperature. A fish's immune response or its ability to ward off disease is best near the optimum growth temperature. The probability of culture success is also enhanced at or near the temperature for optimum growth. (Meade, W. J. 1989)

Water temperature can be increased by use of green houses to enhance fish growth. The greenhouse effect is based on the principle that during sunshine hours, the solar radiation is incident on the covering of green house. A fraction of solar radiation is reflected back from the covering of the green house. A part of the remaining radiation is transmitted inside green house. After reflection from the surface, part of the radiation, is absorbed by the wall and remaining part is lost to the ambient through conduction. There is a convective and radiative heat loss from the wall to the room air. Further, the rest of solar radiation falls on the tanks or ponds. Some parts come to the floor of the greenhouse and the rest is conducted inside the ground. After absorption by the floor there are convective and radiative heat losses from the floor to the room air. The convected and radiated energy from the floor and wall raises the temperature of air inside the greenhouse. There are also convective, radiative and evaporative heat losses from the water tanks or ponds to enclosed room air hence increased temperature in the greenhouse promoting growth of fish (Gupta, 2004).

Depending largely on the management practices, green house or plastic shelter ponds could achieve a 2.8-4.4 ˚C increase in water temperature for each month of the year when compared with an open-air pond (Klemetson and Roggers, 1985; Losordoa and Piedrahitab, 1990; Wisely et. al; 1981; Wood and Ghannudi, 1985). Temperature increases of up to 9˚C by Brooks and Kimball, (1987) have been also been reported in greenhouses.

To improve temperature and growth of catfish fry, a simple greenhouse structure measuring 6m long by 3 m wide was constructed using standard greenhouse sheeting and wooden poles. Growth, survival and water temperature were monitored to assess its effect on *Clarias gariepinus* fry.

METHODS

Study area

A preliminary study to investigate the performance of catfish fry was conducted at Chepkoilel campus of Moi University. The area is at an altitude of 2180 meters above sea level with an annual mean temperature of 17.6^{o}C. Chepkoilel campus is about 11km North East of Eldoret town in Uasin Gishu district of Kenya. Uasin Gishu extends between longitudes 34^{o}50' East and 0^{o}03' and 0^{o}55'North. The study was conducted between March and April, 2007.

Experimental design

As this was a preliminary study to investigate performance of catfish fry, a simple green house structure measuring six meters long and three meters wide was constructed using standard green house sheeting and wooden poles. A green house paper lining (green tinted) was used to cover the structure. A door was made on the southern side. Ventilation was provided through the door and openings between the roof and walls of the structure.

Since the structure was small, only two tanks of 0.7m high and a capacity of 2000l could fit inside the structure. In total, four black circular tanks were used in the study; two placed inside and the other two outside the green house in open air as controls. Each tank was filled with 1500l of water and stocked with 1000 fry. Initial mean weight and length of the fry weighed 0.02g and

6mm respectively. The fry were four days old at time of stocking in the tanks.

Fish

Catfish brood fish were obtained from Chepkoilel campus fish farm for artificial propagations as described by Swift (1993) to obtain fry. On hatching, fry were fed on zooplankton for four days. From the fourth day onward, the fry were transferred to experimental units and fed interchangeably using live food and formulated feed of 43% crude protein. Formulated feed was given to fish at 8.00am and at 6.00pm while live food was given to fish at noon.

Sampling of fry

As this was a preliminary study, fry were sampled every five days for 20 days for length (mm) and weight (g) to obtain initial growth of fry. Sampling was done randomly using a scoop net to remove fry from the tanks. A sample of 30 fry was removed from each tank on each sampling day.

Water quality analysis

Temperature and dissolved oxygen were monitored daily. Temperature was measured three times daily at 8.00 am, 12.00 pm and 6.00 pm using a probe thermometer.

Specific Growth Rate (SGR)

Specific growth rate (S.G.R) was determined in the following manner according to Swift (1993): $(L_2-L_1)/(T_1-T_2) \times 100$ Where L_1 is the length of fish at time T_1 expressed in natural logarithm L_2 is the length of fish in natural logarithm at time T_2.

Data analysis

Two sample t- tests were used to compare growth, water temperature, dissolved oxygen, and survival of catfish fry inside and outside the green house. MINITAB statistical software was used to analyze data.

RESULTS

Throughout the study, the dissolved oxygen levels outside the greenhouse was significantly higher than inside at 5.3 ± 0.31mg/l and 4.3 ± 0.09 mg/l respectively ($p<0.05$) (Figure1). Dissolved oxygen was measured and calculated using the Winkler method.

Survival

The number of fry surviving at the end of the experiment was determined for both inside and outside the green house and used to calculate percent (%) survival of fry inside and outside the greenhouse.

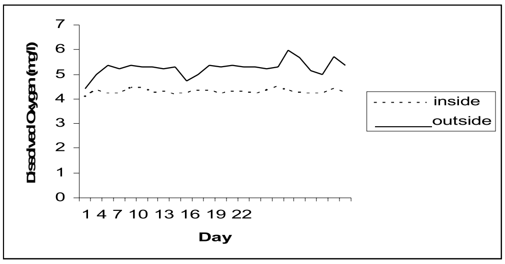

Figure 1: Dissolved oxygen inside and outside greenhouse.

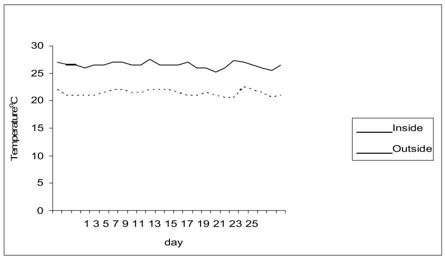

Figure 2: Water temperature inside and and outside greenhouse.

Mean water temperature inside the greenhouse was significantly higher inside than outside the greenhouse (26.5 ^{o} C ± 0.56 and 21.4 ^{o}C ± 0.55 respectively; $p < 0.05$) throughout the study. Water temperature variations were higher outside the greenhouse (Figure 2).

Both length and weight of fry reared inside the greenhouse increased steadily during the study period. Fry weight increased from a mean weight of 0.02 ± 0.001g to 0.13 ± 0.02g and 0.05 ± 0.007g inside and outside the greenhouse respectively (Figure 3 and 4).

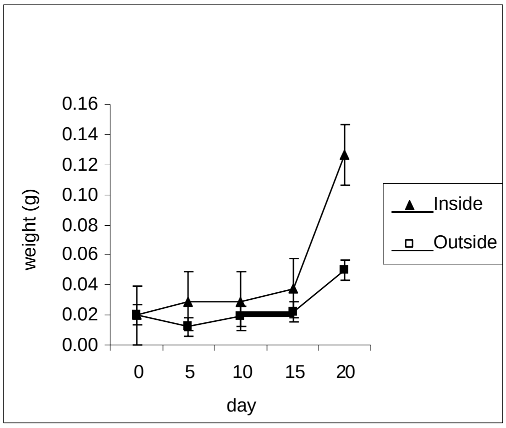

Figure 3: Mean weight (g) of catfish fry reared inside and outside greenhouse.

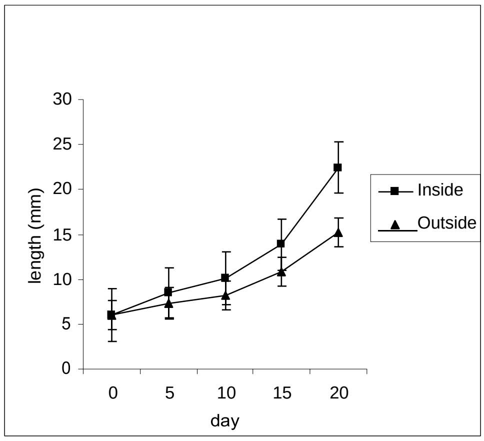

Figure 4: Mean length of catfish fry reared inside and outside greenhouse.

Length increased from mean weight of 6.0 ± 0.15g to 22.4 ± 2.5g and 15.2 ± 1.4 g inside and outside the greenhouse respectively. There were significant differences in length of fry inside and outside the greenhouse from the fifth day onwards ($p < 0.05$). Fry in the greenhouse also appear to exhibit greater variation in weight than their counterparts outside the greenhouse (Figure 3) which encourages cannibalism of smaller fry by larger ones and therefore explains lower survival in the greenhouse at 37% compared to 55% outside Table 1). This is supported by presence of small body parts of fry in the greenhouse tanks. Specific growth rate in the greenhouse fry was higher than inside (0.57 and 0.39 respectively) (Table 1)

Table 1: Specific growth rate and survival (%) of Catfish (*C. gariepinus*) reared inside and outside greenhouse.

	Tank no.	No. of fry at stocking	No. of fry at harvest	Initial length of fry (mm)	Final length of fry (mm)	Specific growth rate	Survival (%)
Inside greenhouse	1	1000	344	6	25 ± 1.8	0.50	34
	2	1000	402	6	19.8 ± 2.0	0.64	40
Outside greenhouse	3	1000	503	6	15.8 ± 1.2	0.37	56
	4	1000	593	6	14.6 ± 1.6	0.41	54

DISCUSSION AND CONCLUSION

While catfish fry inside the greenhouse had higher growth specific growth rates, survival was lower inside the greenhouse. The higher growth is attributed to increased water temperature coupled with lower temperature fluctuations in the greenhouse. A temperature difference of 5.1^{o} C was recorded between the water inside and outside the greenhouse. Similar observations were by Zhu et. al (1998) where a water temperature increase of 5.2^{o} C in greenhouse ponds increased fish growth. Brooks and Kimball (1987) reported that a 9^{0} C rise in water temperature can be achieved in Phoenix, USA in a solar heated aquaculture pond. An increase in water temperature of 2.8 to 4.4^{o} C in greenhouses was achieved for each month of the year when compared to open air ponds (Klemetson and Rogers, 1985). Temperature fluctuations outside green houses may have adverse effects on fish growth. In open air ponds, temperature variations of only a few degrees represent a proportionally large change for fish growth and survival (Tiwari, 2003). Green house fish pond systems maintain higher temperatures and reduce temperature variations associated with open air ponds (Klemetson and Rogers, (1985); Zhu et. al, (1988). However, super optimal temperatures may have a negative effect on growth (Jobling, 1993). Higher feed efficiencies and consequently higher production can be achieved by using green houses. This was evident as specific growth rate was higher in the fry cultured in the greenhouse.

Although fry survival in the green house was lower than in the open air tanks it is not attributed to low dissolved oxygen levels in the greenhouse but to cannibalism. This is because catfish are considered to be tolerant to low dissolved oxygen levels than many fish species. Furthermore, it was observed hat dead fry in this study had body parts such as the head missing; suggesting that cannibalism, a common phenomena among carnivorous fish such as catfish, may have been the cause of mortality. Catfish fry production is generally associated with high mortality in the early stages of the life cycle

Greenhouse had greater variation in weight than their counterparts outside the greenhouse, a factor that enhances cannibalism of small fry by the bigger ones and thus resulting in lower survival in the greenhouse. Frequent grading of fry may also ensure uniformity in size of fry; thus lowering mortality through predation.

This study has demonstrated the potential for increased catfish production in greenhouses. For maximum yields, regular grading of fry is recommended to maintain uniform sizes and minimize cannibalism.

Acknowledgements

The greenhouse lining material for this study was kindly provided for by Maji Mazuri Flower Company to whom we are most grateful.

REFERENCES

Brooks, Jr., G. B., and B.A. Kimball. 1983. Simulation of a low cost method for solar heating and aquaculture pond, *Energy in Agriculture.*1: 281-285.

Chandra, P., and L. D. Albright.1980. Analytical determination of the effect on greenhouse heating requirements of using

(Pouomogne, 2008). To achieve high survival rates, relatively intense management with regards to reducing predation and cannibalism and ensuring the availability of adequate live feed during the larval phase is required. In this study it was evident that fry in the in the greenhouse had greater variation in weight than their counterparts outside the greenhouse, a factor that enhances cannibalism of small fry by the bigger ones and thus resulting in lower survival in the greenhouse. Frequent grading of fry may also ensure uniformity in size of fry; thus lowering mortality through predation.

night curtains. *Transactions of the ASA*E. 994-1000.

Corey, P.D., D.A. Leith, and M.J. English. 1983. A growth model for Coho salmon including effects of varying ration allotments and temperature. *Aquacultur*e. 30:

Edwards, P., Little D. C. and Demaine, H. 2002. Proceedings of the fifth Asian Fisheries Forum, international conference on fisheries and food security beyond the year 2000. November 1998.Thailand. In: Rural Aquaculture. UK: CABI Publishing. 385p 125-143.

FAO 2012. Contribution of aquaculture to food security. Food and Agricultural Organization of the United Nations (FAO). Fisheries and Aquaculture Department. http://www.fao.org/fishery/topic/14886/en. Accessed on 20th 2011.

Frei, M., and K. Becker. 2005. A greenhouse experiment on growth and yield effects in integrated rice-fish culture. *Aquacultur*e. 244: 119-128.

Ghosal, M.K., Tiwari G. N., D.K. Das, K. P. Pandey. 2005. Modeling and comparative thermal performance of greenhouse air collector and earth air heat exchanger for heating of greenhouse. *Energy and Buildings*. 37: 613-621.

Gupta, Ravi. 2004. Thermal modeling of a greenhouse using the concept of solar fraction. Ph.D. Thesis, IIT Delhi, India.

Khatry, A.K., Sodha M.S., and Malik. M.A.S. 1978. Periodic variations of ground temperature with depth and time. *Solar Energy*. 20: 425-427.

Klemetson, S.L., and Rogers. 1985. Aquaculture pond temperature modeling. *Aquaculture Engineering*. 4: 91-208.

Losordoa, T.M and R.H. Piedrahitab. 1990. Modeling temperature variation and thermal Stratification in shallow aquaculture ponds. *Ecol. Model*. 54: 189-226

Los Angeles Times. 2010. Fish Farming could soon revive empty greenhouse on CentralCoast. http://articles.latimes.com/2010/sep/11/business/la-fi-fish-farm-20100911. Accessed on 20th December 2011.

Rebuck, S.M., R.A. Awrich, and J.W. White. 1997. Internal pattern for energy conservation in greenhouse. *Transactions of the ASAE*. 20 (4):714-719

Santamouris, M., C.A. Balaras, E. Daskalaki, and M. Vallindras. 1994b. Passive solar Agricultural greenhouse: a worldwide classification evaluation of technologies and systems used for heating purpose. *Solar Energy*. 53 (5): 411-426

Swift, D. R, 1993. Aquaculture Training Manual. Second Edition. Fishing News Book.

Tiwari, G.N., 2003. Greenhouse Technology for Controlled Environment: Narosa Publishing.

Tonya L.B. and J.W. Lund. 2011. Geothermal heating of greenhouses and aquaculture facilities. International Geothermal Conference, Reykjavík, Sept. 2003 Session #14.

Wisely, B.,J.E. Holiday, and R.E. Macdonald. 1981. Heating an aquaculture pond with a solar pool blanket. *Aquaculture*. 26 (3-4): 385-387.

Wood, C.S., and S.A.Ghannudi[2]. 1985. Study of a shallow carp (*Cyprinus carpio*) pond and its relevance to inland fish farming in Libyan Jamahiriya. *Aquaculture.* 44 (2): 125-131.

Zhu, S., J. Deltour., and S.Wang. 1998. Modeling the thermal characteristics of greenhouse pond systems. *Aquacultural Engineering* 18: 201-217.