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Effect of Stocking Densities on Growth and Feed Utilization of Hybrid Catfish (*Clarias gariepinus X Heterobranchus longifilis*) Fed at 1% Body Weight

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Abstract

The stocking density of hybrid catfish (*Clarias gariepinus* X *Heterobranchus longifilis*) fed at 1% body weight was investigated. The fish were reared using tarpaulin tanks measuring $1m^3$ in 250 litres of water and was grouped into five densities-9, 18, 38, 75 and 100 fish/m^3. The experiment had three replicate and lasted for 12 months during wish monthly sampling was done to measure body weight and feed was adjusted accordingly. The highest mean weight gain was at stocking density 75 fish/m^3 (766.60 ± 139.18) while the lowest weight gain was recorded at stocking density 100 fish/m^3 (625.16 ± 68.14) and was not significantly different ($p>0.05$). There was no significant difference in specific growth rate and feed conversion ratio in all the stocking densities ($p>0.05$). Protein efficiency ratio of stocking density 100 fish/m^3 and 75 fish/m^3 were similar ($p>.05$) and significantly different from others ($p<0.05$). The highest percentage survival of 64% was recorded at stocking density 38 fish/m^3 while the least was recorded at stocking density 100 fish/m^3. There was significant difference among the treatments ($p<0.05$). Mean water quality parameters ranged from: temperature 28.3°C-28.7°C, Dissolved oxygen 5.05 mg L – 5.42 mg/L, pH 7.08 -7.69. This was within the range suitable for aquaculture. Stocking density 75 fish/m^3 can be used at 1% body weight feeding to achieve high weight gain.

Keywords

Hybrid Catfish, Stocking Density, Water Quality, Growth, Feed Utilization

1. Introduction

Stocking density is a major factor in determination of successful aquacultural practices. With the high human population and increased demand for fish and fish products, it is necessary to increase stocking density of ponds to enhance productivity. Stocking density is known as the weight of fish per unit volume of water [1] or the number of fish stocked at the beginning of a culture period [2]. Stocking density has direct effect on growth and survival. In spite of the research on stocking density, it is still difficult to obtain information on better densities for each species, because the best densities are affected by different culture systems, fish species and fish age [3]-[5]. Farmers grow fish in high stocking density in order to maximize productivity [6]. For aquaculture to succeed, there is need for proper species selection, adequate feeding, maintenance of water quality and general management. Stocking density may affect fish growth performance, physiology and fish behavior [7], [1], influence feeding activities, metabolism distortion and digestive utility [8], [9] feed utilization [10], hormonal alteration [11] and immunological activities [12], [13].

Growth of fish can be influenced by availability of space, adequate feed and other environmental factors. Fish feed constitute a major limiting factor for large scale aquaculture as the cost of feed is high and this reduces the profitability in the overall production. This study therefore aimed at feeding fish at 1% of its body weight at all the stocking densities to reduce the cost of production and to deduce best growth performances among the stocking densities.

2. Materials and Methods

2.1. Study Area

The study was carried out at the University of Uyo, Uyo, Akwa Ibom State, Nigeria which lies between latitudes 4°52'S and 4°51' N and longitudes 7°54'W and 8°03' E. The area is influenced by the movement of the low pressure system as the Inter tropical Discontinuity (ITD), sometimes referred to as the Inter tropical Convergence Zone (ITCZ). This is a zone separating the humid maritime tropical air mass, with its associated northwesterly winds. The area has two distinct seasons as a result of the ITCZ, a dry season which extends from November to March and a prolonged wet season starting from March to October. A brief lull in the middle of the wet season is another feature of the rainfall pattern and is referred to as the "August break". Mean monthly temperatures are high and change only slightly during the year.

Fig. 1. *Map of the study area (Insert: Map of Nigeria showing the location of Akwa Ibom State) (Google earth, 2014).*

The fingerlings of *Heterobranchus longifilis X Clarias gariepinus* (hybrid catfish) used and was obtained from a breeding exercise using two broodstock females and two broodstock males. The selection of brood fish was based on external morphology and eggs characteristics.

Fifteen tarpaulin tanks measuring $1 \times 1 \times 1m^3$ were used.

Each was designed with an outlet for easy drainage. Complete Randomized design was used for this study. The experiment was designed to have five stocking densities and each was fed at 1% body weight. Each treatment was replicated three times. The initial weight of the fingerlings was taken before stocking them in the various tanks which were randomly positioned.

The fish was fed three times a day using commercial feed. The feed was adjusted monthly with increase in body weight.

To calculate and monitor growth parameters, fish were randomly weighed from each tank and measurements taken before the start of the experiment and same was done every month.

The biological parameters that were computed include:

2.2. Mean Weight Gain (MWG)

This was computed as the difference between initial and final weight values of fish in each pond.

$$\text{Mean Weight Gain (MWG) (\%)} = \frac{(W_t - W_0)}{W_0} \times 100$$

Where W_t is weight of fish at time t, W_0 is weight of fish at time O, and t is the culture period in days

2.3. Specific Growth Rate (SGR)

This was calculated as:

Specific Growth Rate (SGR); $\text{SGR} = \frac{log_e W_1 - log_e W_0}{T} \times \frac{100}{1}$

Where; Log_e =Natural log, W_1 = Final Mean Weight, W_0 = initial Mean Weight and T = Trial duration.

Nutrient utilization indices were expressed as follows;

2.4. Food Conversion Ratio (FCR)

This was computed as: $\text{FCR} = \frac{\text{Weight of feed}}{\text{Initial stocking}}$

2.5. Protein Efficiency Ratio (PER)

$$\text{PER} = \frac{\text{Mean Weight Gain of Fish}}{\text{Protein intake}}$$

$$\text{Where protein intake} = \frac{\text{total feed intake}}{\text{Protein content of feed}}$$

2.6. Survival Rate (SR)

$$\text{SR (\%)} = \frac{\text{Number of survival}}{\text{Initial stocking}} \times 100$$

2.7. Water Quality Parameters

2.7.1. Temperature

This was measured monthly using a mercury in glass thermometer calibrated 0°-50°C which was dipped in the various tanks and read off after two minutes.

2.7.2. Hydrogen Ion Concentration (pH)

This was measured monthly using an electronic pH meter.

2.7.3. Dissolved Oxygen

This was measured monthly using dissolved oxygen meter (HI 9146).

2.8. Statistical Analyses

Scientific Package for Social Sciences (SPSS version 19) was used to determine the means, one way Analysis of Variance (ANOVA), New Duncan Multiple Range Test was used to separate the means. Microsoft Excel 2010 was used for graphical illustrations of monthly growth parameters.

3. Results

Table 1 shows summarized growth and feed utilization parameters of the cultured hybrid catfish. Mean Weight Gain (MWG) was best at stocking density 75 fish/m^3 (766.60 ± 139.18) and the poorest was at stocking density 100 fish /m3 (625.17 ± 68.14). There was no significant difference ($p>0.05$) in the different stocking densities. The Specific Growth Rate (SGR) showed no significant difference ($p>0.05$) for the hybrid catfish grown in the different stocking densities. The best mean Feed Conversion Ratio (FCR) was at stocking density 100 fish/m^3 while the worst was at stocking density 9 fish/m^3 although, the means were not significantly different ($p>0.05$) among the treatment tanks. Protein Efficiency Ratio (PER) was best at stocking density 75 fish/m^3 (1.897 ± 0.19) and second to that was at stocking density 100 fish /m^3 (1.881 ± 0.19). The least in PER was at stocking density 9 fish /m3 (1.275 ± 0.19) and was significantly different from all others. Percentage survival was highest at stocking density 38 fish/m^3 (64.0% ± 5.51), followed by stocking density 9 fish /m^3. Survival at stocking density 100 fish/m^3 was significantly different ($p>0.05$) from all others (37.0% ± 7.06).

Table 1. *Growth and feed utilization parameters during the experiment.*

	9 fish/m^3	18 fish /m^3	38 fish /m^3	75 fish /m^3	100 fish /m^3
Initial weight	2.07 ± 0.33^{a}	2.03 ± 0.88^{a}	2.17 ± 0.33^{a}	2.03 ± 0.88^{a}	2.00 ± 0.00^{a}
Final weight	740.10 ± 71.20^{a}	658.73 ± 82.12^{a}	674.10 ± 83.52^{a}	768.63 ± 139.15^{a}	627.17 ± 68.1^{a}
MWG	737.97 ± 71.29^{a}	656.70 ± 82.07^{a}	671.93 ± 83.51^{a}	766.60 ± 139.18^{a}	625.17 ± 68.14^{a}
FCR	1.60 ± 0.20^{a}	1.46 ± 0.05^{a}	1.30 ± 0.11^{a}	1.31 ± 0.16^{a}	1.28 ± 0.14^{a}
PER	1.27 ± 0.19^{a}	1.66 ± 0.06^{ab}	1.63 ± 0.08^{ab}	1.90 ± 0.26^{b}	1.88 ± 0.19^{a}
SGR	0.60 ± 0.10^{a}	0.61 ± 0.03^{a}	0.67 ± 0.02^{a}	0.71 ± 0.24^{a}	0.73 ± 0.02^{a}
% Survival	59 ± 10.27^{b}	48 ± 2.00^{ab}	64 ± 5.51^{b}	48 ± 3.93^{ab}	37 ± 7.05^{a}

Means with different superscripts along the same row are significantly different $p<0.05$.

Figure 2 show the monthly FCR at the different stocking densities for feeding level 1%. In January, stocking density 100 fish/m^2 and stocking density 38 fish/m^2 had the highest value (0.49) while stocking density 9 fish/m^2 had the least value (0.32). There was a decline in FCR values for February, March and April. May, experienced increase in the values which was thereafter maintained throughout the experimental period.

Figure 3 show monthly SGR for the different stocking densities at feeding level 1%. The bar chart showed an irregular trend. There was a sharp increase in month May and a gradual decline through to the end.

Figure 4 show the monthly Mean Weight Gain values for the different stocking densities at feeding level 1%, feeding level 1.5% and feeding level 2%. Stocking density 100 fish/m^2 showed the highest monthly MWG while stocking density 18 fish/m^2 showed the least MWG for feeding level 1%.

Figure 5 represent the percentage survival. This showed low survival percentages generally. Stocking density 100 fish/m^2, stocking density 75 fish/m^2, stocking density 38 fish/m^2, stocking density 18 fish/m^2 and stocking density 9 fish/m^2 had values of 37%, 48%, 64%, 48% and 59% respectively. Stocking density 9 fish/m^2 had the highest survival rate.

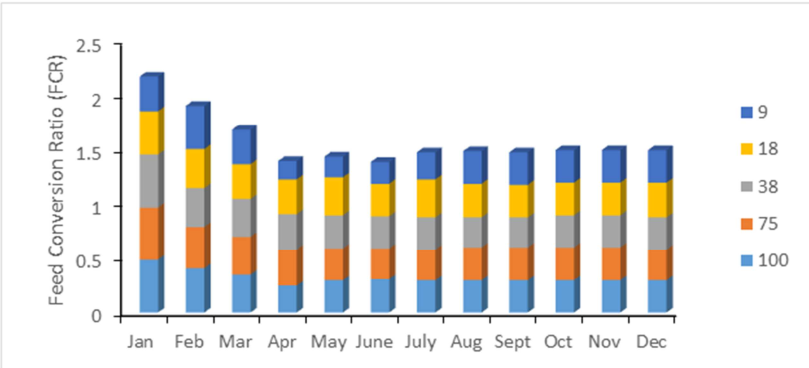

Fig. 2. *Monthly variations in feed conversion ratio.*

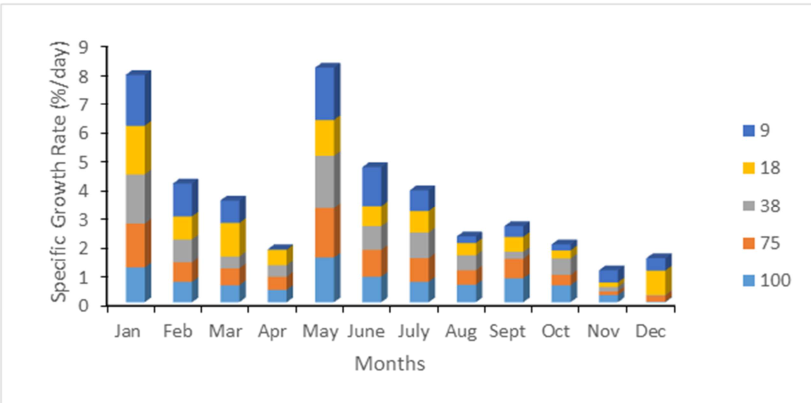

Fig. 3. *Monthly variations in specific growth rate.*

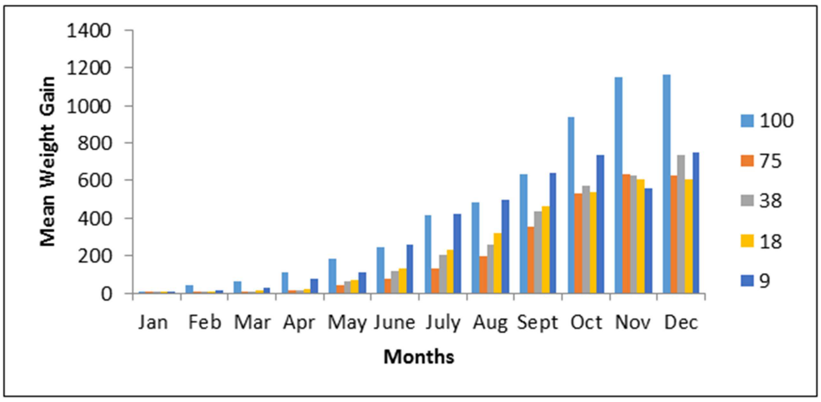

Fig. 4. *Monthly variations in mean weight gain.*

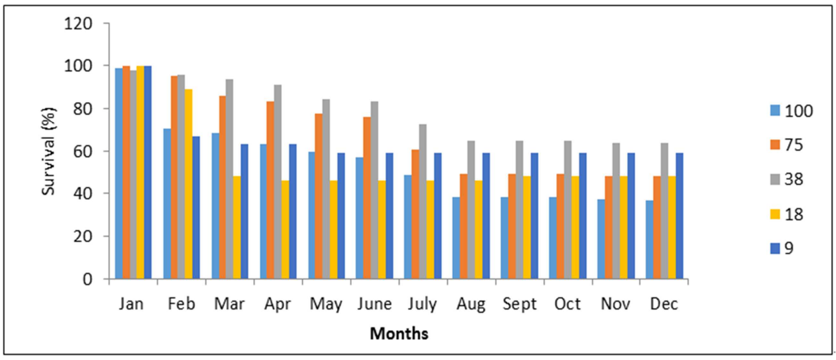

Fig. 5. *Monthly variations in percentage survival.*

Table 2. *Water quality parameters monitored during the experiment.*

	9 fish /m^3	18 fish /m^3	38 fish /m^3	75 fish /m^3	100 fish /m^3
Temperature (°C)	28.4 ± 0.19^a	28.7 ± 0.20^a	2.85 ± 0.15^a	28.3 ± 0.10^a	28.5 ± 0.20^a
Do (mg/L)	5.05 ± 0.05^a	5.13 ± 0.06^a	5.20 ± 0.05^a	5.21 ± 0.09^a	5.42 ± 0.09^b
PH	7.08 ± 0.15^a	7.48 ± 0.14^{ab}	7.69 ± 0.15^b	7.62 ± 0.15^b	7.59 ± 0.15^b

Means with different superscripts along the same row are significantly different p<0.05.

Temperature values recorded ranged from 28.4°C - 28.7°C, there was no significant difference (p>0.05) among the stocking densities.

Dissolved oxygen values showed significant difference (p>0.05) among the treatments. Stocking densities 75 fish/m^3, 38 fish/m^3, 18 fish/m^3, and 9 fish/m^3 were similar (5.21, 5.20, 5.13 and 5.03 respectively but differed significantly (p<0.05) from stocking density 100 fish/m^3 (5.42).

pH of stocking densities 100 fish/m^3, 75 fish/m^3 and 38 fish/m^3 were not significantly different at (p>0.05) but significantly different from stocking density 100 fish/m^3.

4. Discussion

Stocking density is one of the main factors determining fish growth [14], [15] and the final biomass harvested [16]. The mean weight gain varied among the treatments. Stocking density 75 fish/m^3, obtained highest weight gain among the treatments. Socking density 100 fish/m^3 could have had the reduced weight gain due to social interactions through competition for space; this could have led to increase in stress that resulted in increase in energy requirements causing a reduction in weight gain. Similar observations were made by [17]-[21]. At stocking density 75 fish/m^3 which showed higher weight gain above all others, it can be assumed that at this density there was metabolic savings and low energy expenditure. This findings is similar to that reported by [22]-[24] who achieved best weight gain at lower stocking densities. The lower densities provide more space, food and less competition, which is reported by [25]. The greatest improvements in SGR were found in the highest stocking although they were not significantly different. References [26], [27] reported similar findings which described an increment on growth rate with the increasing of stocking density. It is assumed that The FCR range of 1.28-1.59 was not affected by the stocking density of fish as there was no significant difference among the treatments. The feed conversion ratio recorded the best values at stocking density 100 fish/m^3. This indicates that stocking density did not affect feed consumed as fish in all the treatments were fed according to their body weight. This was not similar to the finding of [28] Chang 1988 who stated that as the number of fish stocked in an aquarium increases, the amount of feed available to each fish decreases. Reference [29] stated that the food conversion ratio ranges from 0.9 to 1.9 for turbot fed on dry pellets. High FCR values can be attributed to various factors like feed quality and feeding, temperature variations, rearing units and size of fish.

The Percentage survival was least at the highest stocking density (100 fish/m^3). This could be attributed to overcrowding which led to competition for space hence the weaker ones were eliminated through cannibalism. Reference [30] reported that the lower density gave larger size and higher survival rate in *Clarias macrocephalus*. Reference [31] obtained similar findings where lower stocking density showed higher survival of *Clarias angullaris*. The relations between stocking density and PER obtained in the study were in agreement with many reports on other catfish species.

Survival rates were inversely related to stocking density. Reference [32] reported that the survival rate of African catfish in ponds was not clearly influenced by stocking density. Similarly, [33] reported that mortality of Nile tilapia raised in cages was not dependent on stocking density. Reference [34] reported that it is assumed that catfish, being air-breathing species, are highly likely to be tolerant of higher densities, therefore they are less likely to be subject to density-dependent mortality and can easily survival if the nutritional and environmental conditions are met. They stated that the density-dependent mortalities may be expected during early life stages if stocked at high densities. The mean weight and survival rate decreased with increasing stocking density, feed conversion ratio and specific growth rate were not affected by stocking density.

Water quality recorded in this study agrees with the recommendation by [35]. The parameters measured were within the optimal range as reported by [36]-[38]

5. Conclusion

The results presented here indicate that hybrid catfish (*Clarias gariepinus* X *Heterobranchus longifilis*) reared at stocking density of 75 fish /m^3 produced the best weight gain and PER. The percentage survival rate was related to stocking density as the lower stocking density showed significantly higher rate of survival.

References

[1] Ellis T. What is Stocking density. Trout News. CEFAS 2011; 32:35-37.

[2] Ruane, N.M., Carballo, E.C., Komen, J. Increasing stocking densityiInfluences the acute physiological stress response of Common carp *Cyprinus carpio* (L). *Aquatic Resources* 2002; 33:777-784.

[3] Ellis, T., North, B., Scott, A.P., Bromage, N.R., Porter, M., Gadd, D. The relationship between stocking density and welfare in farmed Rainbow trout. *Journal of Fisheries Biology* 2002; 61:493 531.

[4] Jorgensen, E.H., Christiansen, J.S., Jobling, M. Effects of stocking density on food intake, growth performance and oxygen consumption in Arctic charr (*Salvelinus alpines*). *Aquaculture* 1993; 110:191-204.

[5] Greaves, K. and Tuene, S. The form and context of aggressive behavior in farmed Atlantic halibut (*Hippoglossus hippoglossus* L). *Aquaculture* 2001; 193:139-147.

[6] Iguchi, K., Ogawa, K., Nagae, M., Ito, F. The influence of rearing density on the stress response and diseases susceptibility of ayu (*Plecoglossus altivelis*). *Aquaculture* 2003; 220:515-523.

[7] Holm, J.C., Refstie, T., B, O. S. The effects of fish density on feeding regime on individual growth rate and mortality in rainbow trout (*Oncorhynchus mykiss*). *Aquaculture* 1990; 89:225-232.

[8] Vijayan, M.M., Ballantyne, J.S., Leatherland, J.S. High stocking density alters the energy metabolism of brook charr, *Salvelinus fontinali. Aquaculture* 1990; 88:371-381.

[9] Dibattista, J., Levesque, H. Moon, T., Gilmour, K. An investigation on factors that contribute of the low growth rate of subordinate Rainbow trout (*Oncorhynchus mykiss*). In: Proceedings of the 44 Annual Meeting of the Canadian Society of Zoologist 2005.

[10] Alanara, N., Brannas, E. Dominance-feeding behavior in Arctic charr and Rainbow trout: the effect of stocking density. *Journal of Fisheries Biology* 1996; 48:242-254.

[11] Kebus, M.J., Collins, M.T., Brownfield, M.S., Amundson, C.H., Kayes, T.B., Malison, J.A. Effects of rearing density on stress response and growth of rainbow trout. *Journal of Aquatic Animal Health* 1992; 4:1-6.

[12] Yin, Z., Lam, T.J., Sin, Y.M. The effects of crowding stress on the non-specific immune response in Fancy carp (*Cyprinus carpio* L). *Fish and Shellfish Immunology* 1995. 5:519-529.

[13] Tort, L., Sunyer, J.O., Gomez, E., Molinero, A. Crowding stress induced changes in serum haemolitic and agglutinating activity in the Gilthead sea bream *Sparus auratus*. *Veternary Immunol. Immunop*.1996; 51:179-188.

[14] Engle, C.R. and Valderrama, D. (2001). Effect of stocking density on production characteristics, coasts, and risk of producing fingerlings channel catfish. *North American Journal of Aquaculture* 2001; 63:201-207.

[15] Rahman, M. A,. Mazid, M. A., Rahman, M., Khan, M. N., Hossain, M. A., Hussain, M. G. Effect of stocking density on survival and growth of critically endangered masher, *Tor putitora* (Hamilton), in nursery ponds. *Aquaculture* 2005; 249:275-284.

[16] Boujard, T., Labbe, L., Auperin, B. Feeding behavior, energy expenditure and growth of rainbow trout in relation to stocking density and food accessibility. *Aquaculture Research*, 2002; 33(15):1233-1242.

[17] Yousif, O. M. The effect of stocking density, water exchange rate, feeding frequency and grading on size hierarchy development in juvenile Nile tilapia, *Oreochromis niloticus* L. *Emirate journal of Agriculture* 2002; 14:45-53.

[18] Breine, J.J., Nguenga, D., Tuegels,G.G., Ollevier, F. A. comperative study on the effect of stocking density and feeding egime on the growth rate of *Tilapia cameronensis* and *Oreochrois niloticus* (Cichlidae) in fish culture in Cameroun. *Aquatic Living Resources*, 2013; 9:51-56.

[19] Aksungur, N., Aksungur, M., Akbulut, B. Kutlu, I. Effects of stocking density on growth performance, survival and food conversion ratio of Turbot (*Psett maxima)* in the net cages on the southeastern coast of the Black Sea. Turkish Journal of Fisheries and Aquatic Sciences, 2007; 147-152.

[20] Mensah, E.T., Attipoe, F.K., Ashun-Johnson, M. Effect of different stocking densities on growth performance and profitability of *Oreochromis niloticus* fry reared in hapa-in-pond system. International Journal of Fisheries and aquaculture 2013; 5(8):204-209.

[21] Dasuki, A., Auta, J., Oniye, S. J. Effect of stocking density on clarias gariepinus (Tuegel) in the foating bamboo cages at Kubanni Reservoir, Zaria, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 2013 6(1):113-117.

[22] Samad, A. P. A., Hua, N. F., Chou, L. M. Effect of stocking density on growth and feed utilization of grouper (Ephinephelus coioides) reared in recirculation and flow-through water system. *African Journal of Agriculture Research* 2014; 9(9): 812-822.

[23] Iqbal, R., Narejo, N. T., Umer, K., Rasul, S. Manzoor, H. Ali, M. Effect of stocking density on growth and survival rate of Cirrhinus mirgala reared in cemented cisterns. *Standard Scientific Research and Essays* 2014. 2(12):632-635.

[24] Haque, M.M., Islam, M.A., Ahmed, G.U., Haq, M.S. Intensive culture of Java tilapia *(Oreochromis mossambica)* in floating pond at different stocking density. Bangladesh Journal of Fisheries, 1984; 7:55-59.

[25] Narejo, N. T., salam, M. A., Sabur. M. A., Rahmatullah, S. M. Effect of stocking density on growth and survival of indigenous catfish, Heteropneustes fossils (BLOCH) reared in cemented cistern fed on formulated feed. *Pakistan Journal of Zoology* 2005; 37(1):49–52.

[26] North, B.P., Turnbull, J.F., Ellis, T., Porter, M.J., Migaud, H., Bron, J., Bromage, N.R. The effects of stocking density on the welfare of Rainbow trout (*Oncorhynchus mykiss*). *Aquaculture* 2006; 255:466-479.

[27] Paputsoglou, S.E., Tziha,G., Vrettos, X., Athanasiou, A. Effects of stocking density on bahaviour and growth rate of European sea bass (*Dicentrarchus labrax)* juveniles reared in a closed circulated system. *Aquacultural Engineering*; 1998; 18:135-144.

[28] Chang, W. Y. B. Fish production: data synthesis and model development. In: Pond dynamics / aquaculture collaborative Research support program (CRSP), 6th annual administrative report. Oregon State University, Oregon, pp 41-49, 1988.

[29] Devesa, S. Nutrition and feeding of cultured turbot (*Scophthalmus maximus* L.) In: P. Lavens and R. A. M. Remmerswaal (Eds.), Turbot culture problems and prospects. Spec. Publication 22, *European Aquaculture Society, Gent*: 1994; 81-92.

[30] Mollah, M.F.A. Effects of stocking density and water depth on the growth and survival of freshwater catfish, (*Clarias macrocephalus* Gunther*)* larvae. *Indian Journal of Fisheries* 1985; 32:1-17.

[31] Ita, E.O., Madu, C.T., Omorinkoba, W.S., P and ogari, A. Preliminary estimator of the survival rate of *Clarias angullaris* fry under outdoor hatchery management system. Annual Report, National Institute of Fisheries Resources (Nigeria). 1989; 88-94.

[32] Hogendoorn, H; J. Jansen, W. Koops, M. Machiels, P. Van Ewijk, P. H, J. Van Hees "Growth and production of the African catfish, *Clarias gariepinus* (C and V.) II. Effects of body weight, temperature and feeding level in intensive tank culture," *Aquaculture* 1983; 265-285.

[33] Daungsawasdi, S., Chomchei, C., Yamorbsin, R., Kertkomut, B. Net cage culture and Puntius in klong Praew irrigation Tank. Technical paper NIFI No. 64, Bangkhen, Bangkok, Thailand; 1986, 10p.

[34] Islam, M. S., Rahman, M.M., Tanaka, M. Stocking density positively influences the yield and farm profitability in cage aquaculture of sutchi catfish, *Pangasius sutchi. Journal of Applied Ichthyology*, 2006, 22:441-445.

[35] Viveen, W.J.A.R., Ritcher, C.J.J., Van Oordti, P.G.W.J., Janssen, J.A.L., Huisman, E.A. Practical manual for culture of African catfish *Clarias gariepinus.* Joint–Publication Directorate International Cooperation for foreign Affairs. The Hugue Department of fish Culture, 1985, Netherlands pp13.

[36] Rahman, M.S. Water quality management of aquaculture. BRAC, Prokashana, Mohakhali, Dhaka, 1992.

[37] Islam, M.A., Rahmatatullah, S.M and Salam, M.A. Effect of food and stocking density on the rearing of shgnigi *Heteropneustes fossilis* (Bloch) fry. *Bangladesh Journal of Science*, 1996; 25:73-78.

[38] Kohinoor, A. H.M., Islam,M.L., Wahab, M.A. and Thilsted, S.H. Effect of mola (*Amblypharyngodon mola* Ham.) on the growth and production of carps in polyculture. *Bangladesh Journal of Fisheries Resources*, 1998; 2:119-126.