Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6985

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (5):** 603-610 (2018)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Comparative Study on Growth Performance and Economics between GIFT and Local Varieties of *Oreochromis niloticus* (Linnaeus, 1758) Reared in Pond Culture Systems

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Received: 1.08.2018 | Revised: 29.08.2018 | Accepted: 6.09.2018

ABSTRACT

A comparative study was conducted for the experimental period of 100 days to investigate the suitability of GIFT variety of Oreochromis niloticus (Linnaeus, 1758) over its local variety in pond culture systems. After the conventional method of fertilization in the ponds, experimental fishes were stocked @ 125 nos m^{-3} and fed with locally available commercial floating feed with 30% crude protein. Feeding rate was adjusted @ 5% of the body weight for the initial 30 days and later reduced to 2% for the remaining experimental period. Sampling was done on 25 days interval to measure the length and weight of the experimental fishes. The length-weight relationship (LWR) and condition factor (K) were assessed to determine the growth pattern and general well being of the fishes. The regression coefficient b (2.914 and 2.970) indicates the allometric growth of both the varieties during the experimental period. No significant difference (P>0.05) was found between calculated K values for both the varieties on different sampling days (25, 50, 75 and 100 days). The survival rate did not differ significantly (P>0.05) among the two varieties during the experimental period. But interestingly at the end of the experimental period of 100 days, GIFT variety attained significantly (P<0.05) higher mean body length and weight of 27.341±0.381 cm and 413.636±16.032 gm over the local variety (21.819±0.207 cm and 208.571±6.171 gm respectively). The comparative economic analysis also suggests better profitability of GIFT variety of O. niloticus than the local variety. These results clearly suggest that the culture GIFT variety of O. niloticus will provide economic benefit as well as quality protein to the fish farmers.

Key words: *Oreochromis niloticus, Length-weight relationship, Condition factor, Survival, Growth, economic benefit.*

Cite this article: Das, U.N., Jana, P., Pahari, T., Roy, A. and Dhara, K., Comparative Study on Growth Performance and Economics Between GIFT and Local Varieties of *Oreochromis niloticus* (Linnaeus, 1758) Reared in Pond Culture Systems, *Int. J. Pure App. Biosci.* **6(5):** 603-610 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6985

INTRODUCTION

Selection or suitability of certain fish as a candidate species for farming in a new agro-climatic zone can be known from its growth performance and the state of well-being[1]. Length-weight relationship (LWR) and condition factor (K) are the interrelated measurements which provide basic information to the producer under which organisms are growing[2]. LWR of fish plays a significant role in studying the growth performance and general well-being of the fish population[3,4]. K is a quantitative parameter estimated based on length-weight data which depends upon various ecological and biological factors such as the degree of fitness, adaptability of environmental condition with regards to feeding condition[5]. Even it can be affected by a number of factors such as stress, sex, season, water quality parameters, etc[6]. It indicates the state of well-being of the fish for determining the present and future population success by its influence on the growth, reproduction and survival[7]. In cultured condition, the growth dynamics of a fish species is depended upon its environmental condition of the habitat, management practices and genetic structure of the fish species. Their potential yield in relation to growth in biomass can also be predicted from their length-weight statistics[8]. The isometric fish growth exhibits exponential value exactly at 3.0 which is considered as ideal, but in reality, it is deviated due to various environmental conditions and conditions of fish[3.]

Nile Tilapia (*Oreochromis niloticus* Linnaeus 1758) (Family: Cichlidae) is a most popular and widely distributed tropical fish which is indigenous to Africa[9]. It is a good source of protein to the people of developing countries as it is one of the most easily cultivable and high yielding fish species[1]. To date, several selective breeding programmes have been conducted and maintained in order to make this species more profitable for farmers and diminish the craving for affordable protein in these countries. Genetically Improved Farmed Tilapia (GIFT) is among of them which have been developed during 1988-97 by the World Fish Centre[10]. The GIFT is a tilapia variety with fast growth, high survival rates, high fillet growth, good flesh quality, disease resistance and good adaptation to various farming system[11,12,13]. Currently, it has been disseminated among 16 countries. This study aims in comparative survival, growth and economics analysis between GIFT and local varieties of *O. niloticus* in the agro-climatic condition of the district Murshidabad in West Bengal, India.

MATERIAL AND METHODS

LOCATION

The field experiment was conducted in the nearby farmer's ponds of 0.1 ha water area each for 100 days during March to May 2018 in Sagardighi block (22.2924^{o}N longitude and 88.0852^{o}E latitude) of Murshidabad district, West Bengal. The area is having a tropical wet-and-dry climate (Köppen climate classification) with average temperature 27^{o}C, rainfall 300-350 mm and relative humidity 60-70%. This area comes under Gangetic Alluvial zone with acidic soil and low water retention capacity.

COLLECTION OF SEED AND FARMING

Prior to start of the experiment, two selected ponds were completely dewatered and sundried. Quick lime (CaO) was broadcasted in powder form on the bottom of dried pond @ 300 kg ha^{-1} maintaining the water level at 30 cm. The ponds were then fertilized with an application of raw cow dung (@ 7.5 tonne ha^{-1}) followed by urea (@ 30 kg ha^{-1}) and single super phosphate (SSP) (@ 45 kg ha^{-1}) during pond preparation. After completion of liming and fertilization, the pond water level was increased to about 100 cm. Then the GIFT tilapia fish seeds (average length and weight of 2.68±0.32 cm and 2.36±0.18 gm) were collected from the State Government Farm (Freshwater Fisheries Research & Training Centre, Kulia, Kalyani, West Bengal) and were acclimatized and stocked in the ponds @ 125 nos m^{-3} [21]. Another two nearby ponds were also selected and prepared in the same manner for farming of local variety of tilapia.

The seeds of the local variety of tilapia (average length and weight of 2.45±0.87 cm and 1.98±0.55 gm) were collected from the local hatchery. After stocking both types of the experimental pond were managed monthly in the same manner with lime (@ 37.5-75 kg ha^{-1} depending on water pH), raw cow dung (@ 750 kg ha^{-1}), urea (@ 30 kg ha^{-1}) and SSP (@ 45 kg ha^{-1}). Experimental fishes were fed twice a day daily at 9:00 hr and 16:00 hr with locally available commercial feed[14].

Samples were collected randomly irrespective of sex and in equal number in between 08.00 to 09.00 hr at 25 days interval during the experimental period of 100 days for statistical analysis. Fishes were measured in terms of weight gain of wet body (BW) with analytical balance and increase in total length (TL) with a normal scale of 30 cm.

LENGTH WEIGHT RELATIONSHIP

The length-weight relationship of fish under study was calculated using the expression: $W= aL^b$ where W = body weight (gm), L= total length (cm); and 'a' and 'b' is the intercept and regression coefficients respectively[3]. The statistical analysis, linear regression was done using MS Excel software to estimate the value of the coefficients 'a' and 'b,' and coefficient of determination, i.e., R^2. In computing linear regression between the length and weight of the collected fish samples, the confidence limit was set to be 95 %.

CONDITION FACTOR (K)

The condition factor was determined by Fulton's formulae (Chow and Sandifer, 1991) as follows: $k = 100* W/L^3$, where W = weight (gm), L = length (cm) and 100 is a factor to bring the value of K near unity.

WATER QUALITY ANALYSIS

The water samples were collected between 08:00 and 9:00 hours at a periodical interval for analysis of various water quality parameters viz. temperature, pH, dissolved oxygen (DO), free carbon dioxide (CO_2), total alkalinity, total hardness of the pond water following standard methods[14].

STATISTICAL ANALYSIS

The statistical analysis was carried out by using statistical software package SPSS (16.0 for Windows). One way ANOVA and Duncan's multiple range tests[16] were used to determine the significant differences between the means. Comparisons were made at the 5% probability level.

RESULTS

The experiment was conducted from late spring to summer months. The water quality parameters of the experimental ponds farming with the GIFT and local varieties of *O. niloticus* are presented in Table 1 and 2. There was no significant difference ($P>0.05$) found in water quality parameters throughout the total culture period as well as between the two types of experimental ponds farming with two different types of tilapia varieties.

Growth performance of the GIFT and local varieties of Nile tilapia (*O. niloticus)* in terms of final length (cm) and weight (gm) during the study period is presented in Figure 1 (A & B). Throughout the rearing period of 100 days, GIFT variety of tilapia showed significant higher ($P<0.05$) growth performance than the local variety shown in Figure 2. GIFT tilapias were grown from 2.36±0.18 gm to 15.541±1.993, 95.818±8.650, 201.136±11.856 and 413.636±16.032 gm at the end of 25, 50, 75 and 100 days respectively. Similarly the variety also succeeded in length from 2.68±0.32 cm to 8.841±0.394, 16.136±0.484, 21.045±0.333 and 27.341±0.381 cm at the same interval. On the other hand, the local variety shown very less growth up to the end of 25th days from 1.98±0.55 gm; 2.45±0.87 cm to 5.205±0.372gm; 5.368±0.206 cm and finally attained to 208.571±6.171 gm and 21.819±0.207 cm at the end of 100 days of rearing period. After the experiment survival rate was 87.356±0.3% for GIFT variety and 88.55±0.4% for the local variety of *O. niloticus.*

Table 1: Water quality parameters of the experimental ponds reared with GIFT varieties of *O. niloticus*

Parameters	**0th day**	**25th day**	**50th day**	**75th day**	**100th day**
Temperature (°C)	25.25±0.26	26.65±0.25	28.65±0.86	31.26±0.32	34.56±0.45
pH	8.07±0.40	8.32±0.62	7.95±0.42	8.18±0.42	7.88±0.53
Dissolved Oxygen (DO) (mg/L)	5.35±1.32	4.20±1.36	5.05±1.40	5.21±0.15	5.02±0.36
Free Carbon dioxide CO_2 (mg/L)	1.25±0.19	1.17±0.10	1.29±0.16	1.07±0.14	1.13±0.12
Total alkalinity (mg/L)	311.09±43.99	324.59±23.65	354.89±29.36	389.65±22.44	345.35±12.56
Total hardness (mg/L)	278.67±23.63	240.08±11.12	273.33±26.59	262.35±12.65	265.28±14.58

Mean values are represented as Mean±standard error obtained from three replicates. [abcde]Mean values having different superscripts in a row differ significantly (P <0.05).

Table 2: Water quality parameters of the experimental ponds reared with local varieties of *O. niloticus*

Parameters	**0th day**	**25th day**	**50th day**	**75th day**	**100th day**
Temperature (°C)	25.68±0.85	26.15±0.57	27.19±0.18	31.82±0.32	34.66±0.89
pH	8.11±0.48	8.48±0.054	7.98±0.66	7.82±0.69	7.93±0.09
Dissolved Oxygen (DO) (mg/L)	5.26±0.58	5.12±0.66	5.29±0.32	5.30±0.22	5.38±0.22
Free Carbon dioxide CO_2 (mg/L)	1.02±0.09	1.09±0.08	0.99±0.15	1.01±0.05	1.07±0.12
Total alkalinity (mg/L)	355.68±18.65	346.25±29.48	388.75±33.65	375.95±21.85	385.75±18.62
Total hardness (mg/L)	257.34±14.75	276.98±18.35	269.34±13.69	271.75±16.37	278.54±23.87

Mean values are represented as Mean±standard error obtained from three replicates. [abcde]Mean values having different superscripts in a row differ significantly (P<0.05).

Figure 1 (A & B): Length and weight comparison of GIFT and local varieties of tilapia (*O. niloticus)* at the end of experimental period of 100 days in pond culture system

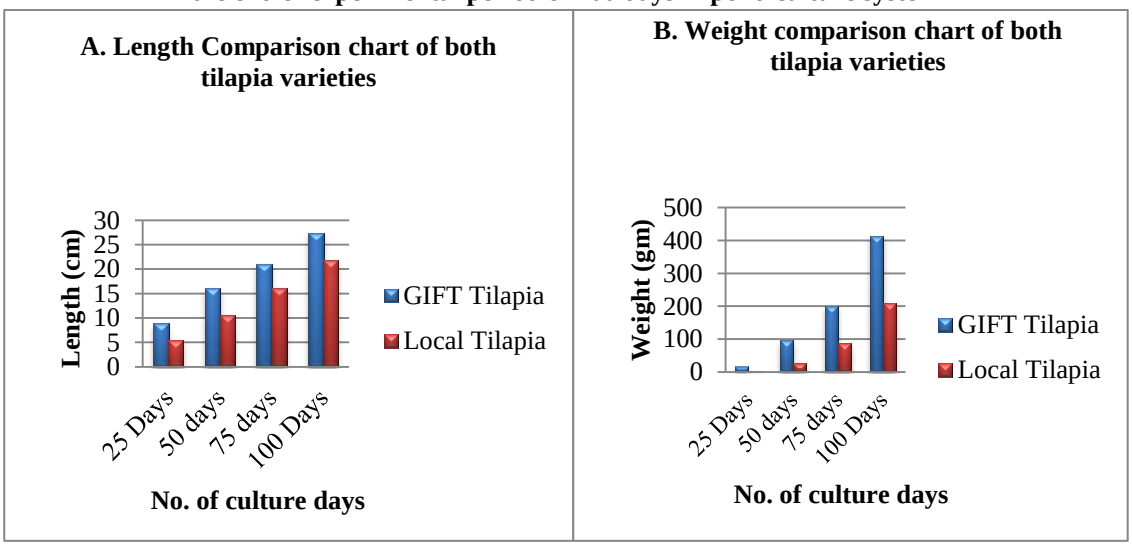
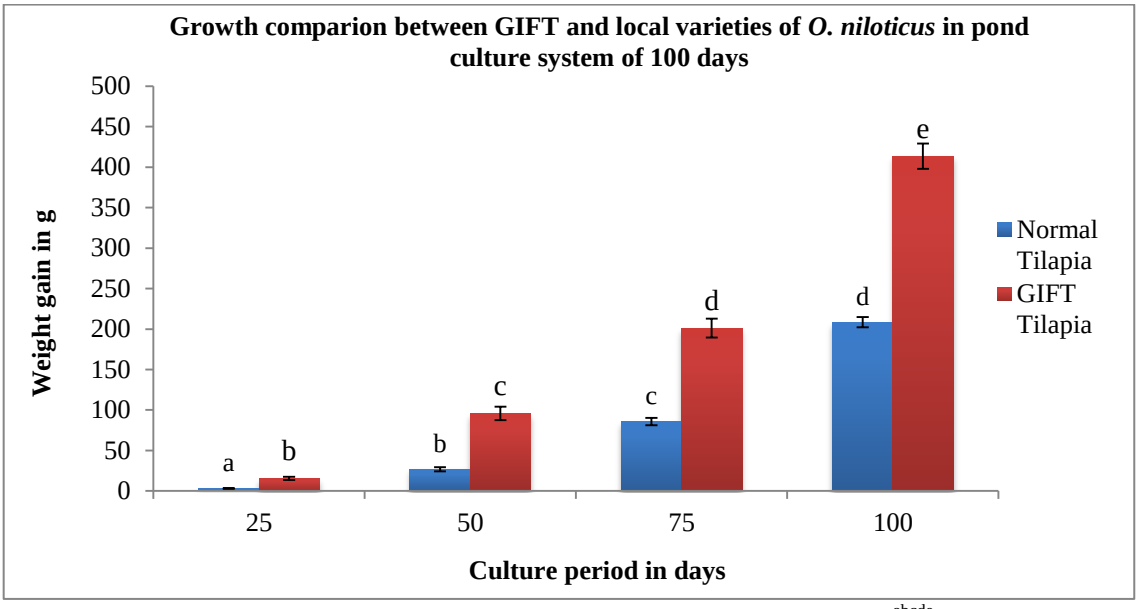


Figure 2: Growth performance of GIFT and local varieties of tilapia (*O. niloticus)* at the end of experimental period of 100 days in pond culture system



Mean values are represented as Mean±standard error obtained from three replicates. [abcde]Mean values having different superscripts in a row differ significantly (P<0.05).

Length-weight relationship (LWR) showed linear growth pattern for both the varieties presented in Figure 3 (A & B). The exponential values (b) of LWR for GIFT and local varieties of tilapia were recorded as 2.914 and 2.970 respectively in the present study indicating allometric growth of fish in both cases during the experimental period of 100 days.

The Fulton's condition factor (K) of GIFT and local varieties of *O. niloticus* was ranged between 2.019±0.061 to 2.178±0.053 while the value of K for the local variety was ranged between 2.002±0.034 to 2.119±0.091 (Table 3). There were no significant differences found among the calculated condition factors for both the varieties. The higher values were observed between 25th to 50th days of interval for both cases.

Figure 3 (A & B): Length-weight relationship (LWR) of GIFT and local varieties of tilapia (*O. niloticus)* at the end of experimental period of 100 days in pond culture system

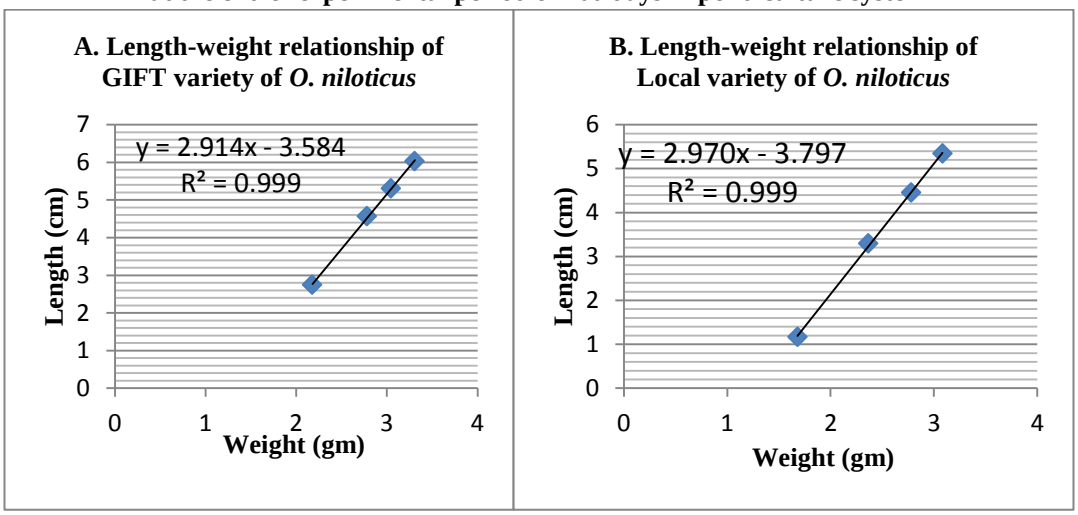


Table 3: Condition factors (K) for GIFT and local varieties of *O. niloticus* during the experimental period of 100 days in pond culture system

Rearing period (day)	Condition Factor (K)	
	GIFT variety of tilapia	Local variety of tilapia
25	2.019±0.061	2.071±0.091
50	2.178±0.053	2.119±0.091
75	2.111±0.051	2.004±0.041
100	2.019±0.052	2.002±0.034

Mean values are represented as Mean±standard error obtained from three replicates. [abcde]Mean values having different superscripts in a row differ significantly (P<0.05).

Economic analysis for the both GIFT and local varieties of *O. niloticus* along with cost benefit ratio is presented in Table 4. As revealed from the study it was recorded that the culture of GIFT tilapia is much profitable than local variety of the species in pond based culture system.

Table 4: Comparative economic analysis of GIFT and local varieties of *O. niloticus* in pond culture system for 100 days

Items	GIFT variety of tilapia	Local variety of tilapia
Gross Cost	1,28,563.00	86,405.00
Gross return	1,76,332.00	1,05,440.00
Net return	47,769.00	19035.00
Cost benefit ratio	0.371	0.22

Currency is given in Indian rupee (₹)

DISCUSSION

In this present study, trial experiment was conducted in farmer's ponds to access the suitability of GIFT variety of *O. niloticus* over the local variety in the agro climatic zone of Murshidabad district, West Bengal. Both the varieties of tilapia species were stocked in the similar environment in respect of pre-stocking and post-stocking management, stocking density and feeding schedule. From the point of physic-chemical parameters of the water body viz. temperature, pH, DO, free CO_2, total alkalinity, total hardness etc. play a significant role in the growth of fish[17]. The optimum temperature for tilapia culture is reported to be 20-30°C or above and DO level is 4-5 mg/^{l} [17]. The optimum pH of for tilapia culture is reported to be 7.91-8.03[18]. In the present study recorded water quality parameters were within optimum ranges for aquaculture[18,20] and both type of ponds provided good environment for tilapia culture. Under such ambient condition, survival rates were recorded as 87.356±0.30% and 88.55±0.40% for the GIFT and local varieties of *O. niloticus* respectively which do not have any significant difference. Similar findings also reported by several authors[14,21]. Besides, Author[22] found 57% survival rate in a periphyton based earthen pond culture system. Such variations are probably due to the variation in culture condition and pre stocking history of the fish. In this study GIFT variety of *O. niloticus* has shown 98.31% higher growth as compared to the local variety within 100 days of rearing period. Length and weight based growth performance for the both varieties of the fish species were noted periodically from where condition factor has been calculated. The condition factor of a fish reflects physical and biological circumstances and fluctuations by interaction among various physiological and other exogenous factors and also indicates the general state of fish condition[23]. There were no significant differences found among the calculated condition factors for both the varieties of tilapia on different sampling days which suggests general well being of the both varieties throughout the culture period. But interestingly growth of GIFT variety was

much higher than the local variety of tilapia. As the total body weight and total length value's regression co-efficient is little lower than the critical isometric value *i.e.* 3, the growth is a negative allometric[24]. This is in conformity with the findings of some author[25] for the same species. The cost benefit analysis revealed that culture of GIFT variety of tilapia is much profitable as compared to the local variety suggesting economic viability of the species which is also supported by the higher growth performance of the GIFT variety in the agro-climatic condition of Murshidabad district.

CONCLUSION

In this present study survivality, growth performance, length-weight relationship and condition factor of the GIFT and local varieties of *O. niloticus* and cost benefit ratio of their farming system were analysed from a field trial. The results clearly suggest the adoption of GIFT variety of tilapia over the local one in the agro-climatic situation of Murshidabad, West Bengal. The economic analysis also proved its techno-economic viability.

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