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GROWTH PERFORMANCE OF JUVENILES *Oreochromis niloticus* REARED WITH TWO DIFFERENT DIETS IN KUNDUCHI PONDS, DAR ES SALAAM, TANZANIA

Bwathondi, P.O.J. [1] and Abdulkarim, B.[1, 2]
[1] Department of Aquatic Science and Fisheries Technology, University of Dar es salaam, Tanzania,
[2] Department of Biology, Umaru Musa Yar, adua University, Katsina State Nigeria.
Correspondence author**:** bbmohammed911@yahoo.com

ABSTRACT
Comparative study was conducted to observe the growth performance, length-weight relationship and condition factor of Oreochromis niloticus fed with two different diets using standard methods and procedures. The fish were fed with two different formulated diets Agric- Aqua Feed (AAF) and Kunduchi Locally processed Feed (KLF) for a period of six weeks. Maximum weight gain of (10.74 to 12.48 g) was recorded with Kunduchi locally feed (KLF) with specific growth rate of (5.56 to 6.37 % per day), while minimum weight gain of (8.42 to 9.54 g) was recorded with Agric Aqua Feed (AAF) with specific growth rate of (5.14 to 5.73 % per day). No feed-related mortality was observed during the whole experimental period. There were no significant differences (p=0.4618) in the 'b' values among all the experimental ponds and the value of the exponent 'b' ranged from (2.38 to 4.03) indicating both negative and positive allometric growths. The condition factor 'K' of all the experimental fish was above 1.0 (1.53- 1.89) indicating robustness or well being of the fishes from all the experimental ponds. The use of locally processed formulated diet such as KLF is therefore recommended as a step in boosting the aquaculture sector.
Keywords: Condition factor, formulated diets, growth performance, Length- weight, Oreochromis niloticus.

INTRODUCTION

Worldwide, Tilapia is the third most reared fish group after Salmonids and Carps (Yonas, 2006). The genus *Oreochromis* is the most commonly cultured and the species *O. niloticus* was the first species to be cultured in Africa (Thomas and Michael, 2005). *O. niloticus* can survive a wide range of pH, resists low levels of dissolved oxygen (DO) and feeds on a variety of food items (Balirwa, 1998).

Length weight relationships (LWRs) of fish are very important in fishery biology because they allow the estimation of average weight of a given length group by establishing a mathematical relationship between the two (Beyer, 1987). LWRs are useful in fish stock biomass assessment and comparing the ontogeny of fish population from different regions.

The condition factor (K) in fish serves as an indicator of physiological state of the fish in relation to its welfare (Le Cren, 1951). K also provides information when comparing two populations living in certain feeding density, climate and other conditions (Weatherly and Gills, 1987). It is also a useful index for the monitoring of feeding intensity, age and growth rate in fish (Oni *et al.,* 1983). In addition, K may be a useful index to assess the status of the aquatic ecosystem in which fish live.

Good deal of work has been carried out on different aspects of survival and growth, length-weight relationship, condition factor of genus *Oreochromis* in Tanzania and abroad (Al - Hafedh 1999; Tidwell *et al.,* 2000; Bayona *et al.,* 2001; Shoko *et al.,* 2001; El Sayed and Gaber 2005; Mgaya *et al.,* 2005; Abdel-Tawwab *et al*., 2010; Rumisha, 2010; Zaki *et al.,* 2010 and Emanuel, 2013). However, limited studies have been carried out on the effect of locally processed formulated fish meal on the growth performance and survival of *O. niloticus.* Therefore, the present work was aimed to Study Growth Performance of Juveniles *O. niloticus* Reared with Two Different Formulated diets.

This species is preferred for this study due to its rapid growth rates, high tolerance to low or poor water quality, efficient feed conversion, ease of spawning, resistance to diseases and good meat taste (El Sayed and Gaber, 2005). It has high market value because of the flavour and it's availability throughout the year. The fish is suitable for both monoculture and polyculture systems.

MATERIALS AND METHODS

Study Site

The study was conducted at the Kunduchi School of Fisheries Science and Technology, University of Dar es salaam, Tanzania Latitude 6° 40' 0" S and Longitude 39° 13' 0" E.

Source of Experimental Fishes

Two hundred and Fifty (250) fingerlings of *O. niloticus* were used in this study. They were obtained from Eden Agri-aqua limited Company, Dar es Salaam, Tanzania. The collection and transportation of the fishes was done as recommended by Mgaya and Tamatamah (1996). Upon reaching Kunduchi the fishes were released into storage tanks to acclimatize for 2 days before the beginning of the experiment.

Experimental Materials and Layout

The study was done in 10 concrete ponds (labelled P1- P10) with sizes of 50 x 100 x 100 cm (H x L x B). Initial body weight of the fish was 0.90 ± 0.02 g and initial length was 3.81 ±0.07 cm. Water level was maintained nearly full throughout the study and replaced at 40% every 2 weeks to ensure adequacy of oxygen. Each pond was stocked with 25 fingerlings. The growths of the fishes were assessed with agric-aqua feed (AAF) and Kunduchi locally feed (KLF) fed over a period of 6 weeks.

Feed Formulation

Thirty (30 %) crude protein of Kunduchi Locally Feed (KLF) was formulated using Pearson Square Method. Ingredients that were used in the formulations were maize bran, fish meal (dagaa), cotton seed cake, vitamin premix and mineral premix. Eden Agric-Aqua Feed (AAF) proximate contents were 30% crude protein, 25% carbohydrate, 7% lipid and 8% fibre. Ingredients used in its preparations were fishmeal, Soybean, rice bran, cassava, lipids, vitamin premix and mineral premix. Proximate compositions of the two diets were determined according to the standard methods of AOAC (2000).

Water Analysis

Throughout the study period physico–chemical parameters of water samples including water temperature, pH and dissolved oxygen were measured following standard methods (APHA, 2005). Temperature (°C) of the water was measured by dipping a glass mercury thermometer in to the water for about 1-2minutes then the readings were recorded (APHA, 2005). pH was measured with Hanna 420 pH meter; it was calibrated according to instructional manual provided by the manufacturer. The electrode of the pH meter was dipped into the water sample for 2-3minutes and readings were recorded. Hanna Dissolved Oxygen microprocessor HI 98186 was used to determine the dissolved oxygen; the readings were recorded in mgL^{-1}.

Feeding of Fish

The fishes were fed at 10% of their body weight per day throughout the experiment. Feeding was done at 08.00 hrs and 16.00 hrs daily (twice a day). Fingerlings in pond 1 to pond 5 were fed with AAF, while fingerlings in pond 6 to pond 10 were fed with KLF.

Length -weight Relationship Assessment (LWRA)

In order to assess the growth performance and length- weight relationship of the fishes, lengths and weights were taken in each pond. A sensitive electronic balance (Model number YP 500 IN) was used to measure the weights. The Total Length (TL) of the fish was measured from the tip of the anterior part of the mouth to the caudal fin using meter rule calibrated in centimetres. Samples of the stocked fingerlings were taken randomly from each pond by using a scoop net. The fish weight and length measurements were taken and returned into their respective ponds. Sampling was done after every 14 days.The statistical relationships between these two parameters were established by using the parabolic equation by Froese (2006):

$W = aL^b$

Where, W = Weight of fish (g)

L = length of fish in cm

a = constant, b = (slope) exponential expressing the relationship between length and weight.

The relationship ($W = aL^b$) when converted into the logarithmic form gives a straight line relationship graphically as: LogW= Log a+ b Log L

Where, b= slope, Log a= constant.

Fulton's condition factor (k)-The coefficient of condition (K) was calculated using Fulton's (1904) formula as follow:

$$K = \frac{Wx100}{L^3}$$

Where, W= weight of the fish in gram, L = length of the fish in cm, 100 = is a factor to bring the value of K near unity.

Specific Growth Rate (%SGR)

Specific Growth Rate was calculated using formula adopted from Hopkins (1992):

$$SGR = \frac{\text{In Final weight} - \text{In Initial weight}}{\text{Number of rearing days}} \times 100$$

Survival Rate

Percent Survival Rate was calculated using a formula:

$$\% \text{ survival rate} = \frac{\text{Number of fish harvested}}{\text{Total number of juvenile stocked}} \times 100$$

Statistical Analysis

One Way Analysis of variance (ANOVA) was performed to determine variations in 'b' values, while t- test was performed to determine differences in weight of the species fed with the two different diets. Significant difference was set at $p \leq 0.05$. All the statistical tests were performed using a Graph Pad Statistical Software Version 6.04.

RESULTS AND DISCUSSION

Table 1 shows the water quality parameters of the experimental ponds. Temperature ranged from 26.25±0.44 - 27.13±0.48 °C and dissolved oxygen ranged from 6.82±1.5 mg/L - 9.52±0.3 mg/L. All the average values of the water quality parameters were within the suitable range for normal growth and survival of *O. niloticus* and other tropical fishes as suggested by Boyd and Pillai (1984); Rowland (1986) and Madalla (2008).

Table 1: Water Quality Parameters of the Experimental Ponds at Kunduchi, Dar es salaam.

Parameter	Time of measurement	Minimum and Maximum ranges
Temperature	08:00 - 09: 00 hrs	26.25± 0.44 - 27.13±0.48 °C
pH	08:00 - 09:00 hrs	7.87± 0.18 - 7.99±0.19
Dissolved oxygen	08:00 - 09:00 and 16:00 hours	6.82± 1.5 mg/L - 9.52±0.3 mg/L

Hundred (100 %) survival of fish was observed in all the ponds. Specific growth rate higher in P7 followed by P9, P6, P8, P2, P3, P10, P1, P5, P4 respectively (Table 2). There was a significant difference in specific growth rates between the fish reared under the two different diets (t test, t = 4.372 d.f.= 4, p= 0.0119). Fish yields were higher in KLF than AAF. This finding agreed with the study of Shoko *et al.,* (2001) who reported high specific growth rate in *O. variabilis*. However, the finding was not in agreement with the finding of Datta *et al.,* (2013) who reported lower values in *Channa punctata.*

Table 2: Specific Growth Rates of *O. niloticus* Fed with two Different diets from Kunduchi Experimental Ponds.

Pond	Init. Av.Wt. (g)	Final Av.Wt.(g)	Logn init wt.	Lognfin. wt.	SGR%/day
P1	0.84	8.62	-0.17	2.15	5.54
P2	0.86	9.54	-0.15	2.26	5.73
P3	0.78	8.42	-0.25	2.13	5.67
P4	1.02	8.82	0.02	2.18	5.14
P5	0.98	8.64	-0.02	2.16	5.18
P6	0.88	10.74	-0.13	2.37	5.96
P7	0.86	12.48	-0.15	2.52	6.37
P8	0.96	11.20	-0.04	2.42	5.85
P9	0.90	11.04	-0.11	2.40	5.97
P10	1.08	11.14	0.08	2.41	5.56

The initial weight and length relationship of *O. niloticus* in both ponds are shown in Table 3 and 4. The b value ranged from b = -1.312 to 6.98 in pond 1 to pond 5. However, most of the LWR are non-significant. The 'b' values of pond 6-10 ranged from 0.03 to 3.48 respectively.

Table 3: Initial Length Weight Relationship and Condition Factors of *O. niloticus* Fed with (AAF) Agric -Aqua Feed.

Pond	Mean length (cm)	Mean weight (g)	N	b	A	R	R^2	K
P1	3.74	0.84	5	-1.31	0.65	0.14	0.02	1.61
P2	3.74	0.86	5	6.98	-4.07	0.67	0.45	1.64
P3	3.68	0.78	5	6.41	-3.76	0.60	0.36	1.57
P4	3.88	1.02	5	6.02	-3.46	0.95	0.91	1.75
P5	3.98	0.98	5	4.10	-2.56	0.86	0.74	1.55
Average	3.81	0.90	5	4.44	-2.64	0.64	0.50	1.62

Table 4: Initial Length Weight Relationship and Condition Factors of *O. niloticus* Fed with (KLF) Kunduchi Locally feed.

Pond	Mean length(cm)	Mean weight (g)	N	b	a	R	R^2	K
P6	3.82	0.88	5	0.03	0.58	0.44	0.19	1.58
P7	3.82	0.86	5	0.07	0.59	0.56	0.31	1.54
P8	3.70	0.96	5	1.16	-0.68	0.41	0.17	1.89
P9	3.82	0.90	5	3.48	-2.08	0.92	0.85	1.61
P10	4.30	1.08	5	1.17	-0.75	0.62	0.39	1.36
Average	3.89	0.94	5	1.18	-0.47	0.59	0.38	1.60

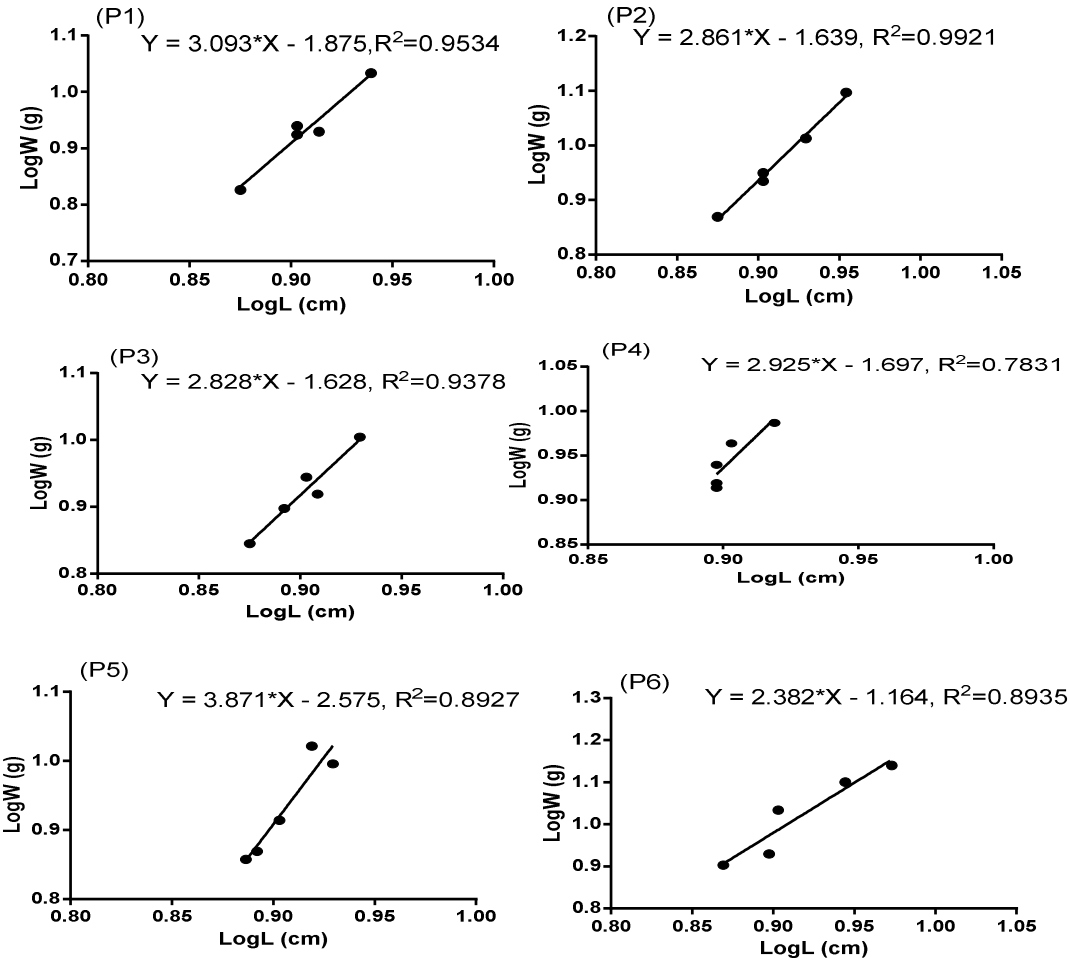
The final length weight relationships of *O. niloticus* are shown in Table 5 and Fig. 1. The established power curve equations indicated that the parameter b ranged from b=2.83 to b=3.87 in P1 to P5, while the b values ranged from b=2.38 to b=4.03 in P6 to P10. There were no significant differences in b values among the ponds (Kruskal- Wallis test, p=0.4618).

Growth is said to be positive allometric when the weight of an organism increases more than length (b>3) and negative allometric when length increases more than weight (b<3) (Wootton, 1992). When Total lengths were regressed with body weights, the slopes values were significantly lower than critical isometric value i.e. 3, in P2, P3, P4, P6 and P8 indicating negative allometric growth; thus species become slender as it increases in length, whereas b values were higher than 3 in P1, P5, P7, P9 and P10, indicating the species becomes heavier for its weight, as it grows longer (positive allometric growth). The results of the present study is in conformity with the views of Le Cren (1951) and Chauhan (1987) that a fish normally does not retain the same shape or body outline throughout their lifespan and specific gravity

of tissue may not remain constant, the actual relationship may depart significantly from the cube law. Negative allometric growth pattern have been reported in *O. niloticus* by King (1991) and Zenebe (1997). Negative allometric growth has also been reported by Ayoade and Ikulala (2007), who reported negative allometric growth in *Chromidotilapia guntheri.* Positive allometric growth was similarly reported by Gayanilo and Pauly, (1997) who reported a b value up to 3.5 in tropical fish species and Abdulkarim and Jabir (2013) who reported a positive allometric growth in *T. zilli.* The higher slopes of *O. niloticus* in P10, P5, P7, P1 and P5 reflect faster growth compared to P2, P3, P4, P6 and P8.

Table 5: Final Length Weight Relationships and Condition Factors of *O. Niloticus* Fed with 2 different Diets in Kunduchi Experimental Ponds.

Pond	Mean length(cm)	Mean weight (g)	N	b	A	R	R^2	K
P1	8.08	8.62	5	3.09	-1.88	0.97	0.95	1.63
P2	8.20	9.54	5	2.83	-1.63	0.97	0.94	1.73
P3	7.98	8.42	5	2.83	-1.63	0.97	0.94	1.66
P4	8.00	8.82	5	2.93	-1.70	0.88	0.78	1.72
P5	8.06	8.64	5	3.87	-2.58	0.94	0.89	1.65
P6	8.30	10.74	5	2.38	-1.16	0.94	0.89	1.89
P7	9.22	12.48	5	3.01	-1.80	0.87	0.76	1.59
P8	8.84	11.20	5	2.92	-1.72	0.97	0.95	1.62
P9	8.78	11.04	5	3.12	-1.90	0.96	0.93	1.63
P10	9.00	11.14	5	4.03	-2.81	0.84	0.71	1.53



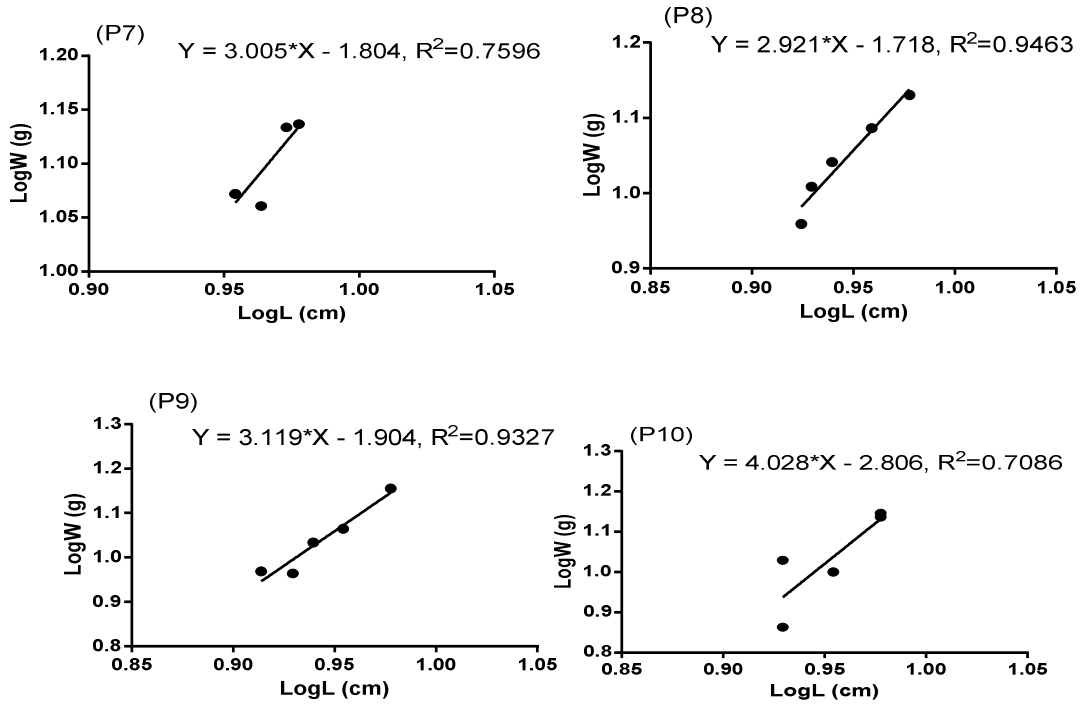


Figure 1: Final Logarithmic Relationship between Length and Weight of *O. niloticus* in Kunduchi Experimental Ponds.

The Fulton's condition factor (K) of a fish reflects physical and biological circumstances and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951). This also indicates the changes in food reserves and therefore an indicator of the general fish condition. Moreover, condition factor provides an alternative to the expensive *in vitro* proximate analyses of tissues (Sutton *et al.,* 2000). The values of condition factor 'K' recorded in the present study ranged from 1.63 to 1.73 in P1- P5 and ranged from 1.53 to 1.89 in P6 to P10 respectively (Table 5). Condition factor of greater than one showed the well being of fishes. Consequently, all the fishes of this study from all the ten experimental ponds were in good condition. The results of this finding was in line with the findings of Abowei (2010) who reported K= 0.4 to 1.61 in *Ilisha Africana,* Olurin and Aderibigbe, (2006) who reported K values of 1.08 to 114 in *O. niloticus*. The result finding was lower than those earlier reported by Anene (2005) and Imam *et al*. (2010).

The co-efficient of determination (R^2) values in Table 5 explained the proper fit of the model for growth. In the present study, lowest value of R^2 of *O. niloticus* were recorded as 0.71 (71% variability) in P10 and highest recorded as 0.95 (95% variability) in Pond 1 and Pond 8 indicating 95% variability by the model and good fitness.

The t-test showed that final average weights differed significantly between fish reared with AAF and KLF (t=test, t=15.98 d.f. =4, $p < 0.0001$) (Table 5). Fish fed with KLF have higher average weights than those fed with AAF. The reason for this difference was due to the higher specific growth rate (% body gain per day) of O. *niloticus* fed with KLF.

CONCLUSION AND RECOMMENDATION(S)

In present study, growth rate, condition factor and coefficient of determination value recorded on *O. niloticus* reared under KLF diet indicated a favourable response of the fish to the diet and the experimental environments. The appreciable growth rate exhibited by the fish during rearing period indicated that the prevailing environmental conditions were within the tolerance range for the species. The finding of the present study supports that the species can be reared with the locally processed feed in large scale to meet the nutritional demand.

It is recommended that further studies should be conducted to evaluate other locally processed feeds on the growth performance of *O. niloticus* so as to come up with feed that can make the species grow well in areas where it is difficult to get a fish feed from industry.

Lastly, the local feed manufacturing industries should finance studies on the best, but cost effective feeds that support high fish growth. The situation at the moment is that most feed manufacturers obtain formulae from books or abroad and adopt them as 'their original' feed. Some of such feeds do not support good fish growth as a result farmers do complain of the expensive, but poor quality feeds produced by the local manufacturers.

Contribution of Authors: Prof. Bwathondi collected the field data, read and edited the manuscript, while Dr. Abdulkarim carried out statistical analysis of the data and wrote the manuscript.

Conflict of Interest: There is no conflict of interest whatsoever between the authors.

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