JAFE/MS/Vol. 2 (3)/2015/06

LENGTH-WEIGHT RELATIONSHIP OF MALE *Oreochromis niloticus* FED VARIOUS CRUDE PROTEIN RATIONS AT DIFFERENT STOCKING DENSITIES

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Abstract

Length-weight relationship of fish is very important, because it helps to predict weight from length measurement. Two hundred and forty fish samples of O. niloticus, having body weight value between 10.01-12.11 g and total length size ranging from 8.0 - 9.7 cm were hand-sexed with Methylene blue solution. Fish samples were randomly selected and introduced into twelve (12) 100 liters plastic bowls measuring 76 cm in diameter and fed on formulated diet, twice daily for 90 days with plankton inclusion at 5 % body weight. The experiment which was bi-factorial, was conducted in triplicates (at stocking densities of 10, 20, and 30) using four crude protein rations thus: (20, 25, 30, and 35 % and labeled A-D). Each crude protein ration at different stocking densities had influence on the growth of fish samples, resulting in negative allometric growth as observed from the regression coefficient "b = 0.68" which was less than the value of 3. This type of growth pattern implied that fish grew more in length than in weight, thus making them more slender as they increased in length. Data realized from the interaction between crude protein rations at different stocking densities revealed that a diet of 30 % crude protein at a stocking density of 20 gave rise to the highest body weight value (16.72 ± 6.52^{a}) at a total length of (11.69 ± 2.93^{a}). Alternatively, a protein ration of 20 % at a stocking density of 10 fish samples resulted in the second best result with a body weight of (12.86 ± 1.67^{a}) having a total length of (10.27 ± 1.24^{a}) as recommended.

Keywords: *Length weight relationship, Oreochromis niloticus, monosex, fish samples*

Introduction

One of the most commonly used parameter in the analysis of fisheries data is length-weight relationship (Mendes, Fonseca, Campos, 2004). This parameter was used to predict weight from length measurements. It was also used to analyze growth patterns as isometric, negative or positive allometric growth. Isometric growth was associated with no change of body shape as the fish grows. Negative allometric growth implies that fish become slenderer as it increases in length with a regression coefficient of ($b<3$) while positive allometric growth implied that fish become relatively stouter or more rounded as they increased in length, resulting in a regression coefficient of ($b>3$) (Riedel, Caskey and Hurlbert, 2007).

The level of dietary protein producing maximum growth in tilapia depends on the protein quality, energy content of the diet, the physiological state of the fish, size, their production state and the condition of the environment (Yassir, Mohsen, and Mohamed, 2010). In aquaculture, fish quantity in regards to size and weight are important to meet market demands which determine the price the fish may be sold. Increasing stocking density eliminates issues of land shortage. This species is notable for its ability to become sexually matured at a size of 8-10cm after three months. (Kamal, Kurt and Michael, 2010).

Studies concerning the relationship between stocking density and growth of tilapia have shown that optimal stocking density for obtaining the highest possible fish yields depended upon the amount and quality of food available. It was therefore important to consider various protein rations and how they may influence tilapia growth. This study assessed the length-weight relationship of *Oreochromis niloticus* at various protein rations and stocking densities.

Materials and Methods

Harvesting, sexing and acclimation of experimental fish

Oreochromis niloticus samples were harvested from the Departmental Research Fish Farm at Musa Camp, in Asaba Campus, Asaba, Nigeria. Two hundred and forty hand-sexed fish samples whose body weight ranged from 10.01 – 12.11g and total length of 8.0 – 9.7cm were used for this study. Sexing of fish samples was done twice to ensure that all fish samples to be used for the study were males. A solution of 1g Methylene blue mixed in 0.5g of Sodium Chloride (NaCl) was used to sex fish samples. The samples were transported to the project site located at the Fisheries Department of Delta State University, Asaba Campus.

They were acclimated for 7 days in twelve 100 L rearing bowls measuring 76 cm diameter at the start of the study. Compounded fishmeal was used to feed the fish samples morning and evening to satiation with plankton inclusion generated from poultry droppings. It was necessary to introduce plankton because the fish samples used for the study are herbivorous and grows better when sustained on plankton. Poultry droppings were bagged in 25 kg sack and introduced into 1000 liters water tank to produce plankton for the experimental fish samples. Seventy (70) liters bowl of water collected from the surface of the 1000 liters water tank (containing cultured plankton) was introduced into each treatment bowl. The fish samples were distributed randomly in triplicates (10, 20, and 30) within the four crude protein rations (20 %, 26 %, 30 %, and 35 %) labeled A-D.

Feed treatments and meristic measurements

The fish samples were fed at different fish meal rations, at 5% body weight with plankton inclusion. Body weight (g) and total length (cm) measurement were done bi weekly for 3 months, with the aid of an analytical weighing balance (Model- MT 200) and a calibrated meter rule respectively. Both measurements were recorded before, during and after the study.

Statistical Analysis and Experimental Design

The experiment was bi-factorial, at stocking densities of 10, 20, and 30 in four crude protein rations (20, 25, 30, 35 % (labelled A-D). Length-weight relationship was calculated from the formula $Log_{10}W = a + b \log_{10} L$ (Moutopoulos and Stergiou 2002). The growth pattern of the fish sample was derived from the regression coefficient "*b*".

Results

Effect of dietary protein levels and stocking densities on body weight and total length of male *Oreochromis niloticus*

A high significant (P<0.01) difference between dietary protein and stocking density is shown in Table 1. The table revealed that treatment T_C^2 at a stocking density of 20 resulted in the highest body weight gain (16.72±6.52) and highest total length size (11.69±2.93). Both values were significantly different from the values at stocking densities of 10 and 30 fish samples (in treatment 'C'). Also in treatment 'A' at a stocking density of 10 fish samples, a significant difference was observed for body weight having a value of (12.86±1.67). This value was higher than the body weight realized at stocking densities of 20 (10.82±1.76) and 30 (10.16±1.81).

Table 1: Effect of Dietary Protein and Stocking Density on Body Weight and Total Length of Male *Oreochromis niloticus* Fish.

Dietary protein rations (%)	Stocking density	Body weight (g)	Total length (cm)
20	T_A^1 10	12.86±1.67[a]	10.27±1.24[a]
	T_A^2 20	10.82±1.76[b]	10.14±1.06[a]
	T_A^3 30	10.16±1.81[c]	10.26±0.90[a]
25	T_B^1 10	12.29±1.33[a]	10.29±0.91[a]
	T_B^2 20	11.18±1.35[b]	10.24±0.80[a]
	T_B^3 30	11.14±1.26[b]	10.38±0.85[a]
30	T_C^1 10	12.32±1.64[b]	10.79±1.37[b]
	T_C^2 20	16.72±6.52[a]	11.69±2.93[a]
	T_C^3 30	11.70±1.70[c]	10.54±0.98[b]
35	T_D^1 10	11.51±1.57[b]	10.49±1.63[a]
	T_D^2 20	12.16±1.73[a]	10.62±0.67[a]
	T_D^3 30	12.01±1.60[a]	10.55±0.77[b]

Means in the same column with similar superscripts do not differ significantly (P<0.01).

KEY:

T_{A}^{1}-$_{A}^{3}$= Treatment A at different stocking densities;

T_{B}^{1}-$_{B}^{3}$= Treatment B at different stocking densities

T_{C}^{1}-$_{C}^{3}$= Treatment C at different stocking densities;

T_{D}^{1}-$_{D}^{3}$= Treatment D at different stocking densities

Again, in treatment D, a significant difference was observed when the total length was 10.62±0.67 and the stocking density was 20 fish samples. The value of the result was higher than that at a stocking density of 30 fish samples (10.55±0.77) at the same D treatment.

The length-weight relationship of all fish samples showed negative allometric growth with a regression coefficient “b” value of 0.688 (Fig 1). This showed that fish became more slender as they increased in length.

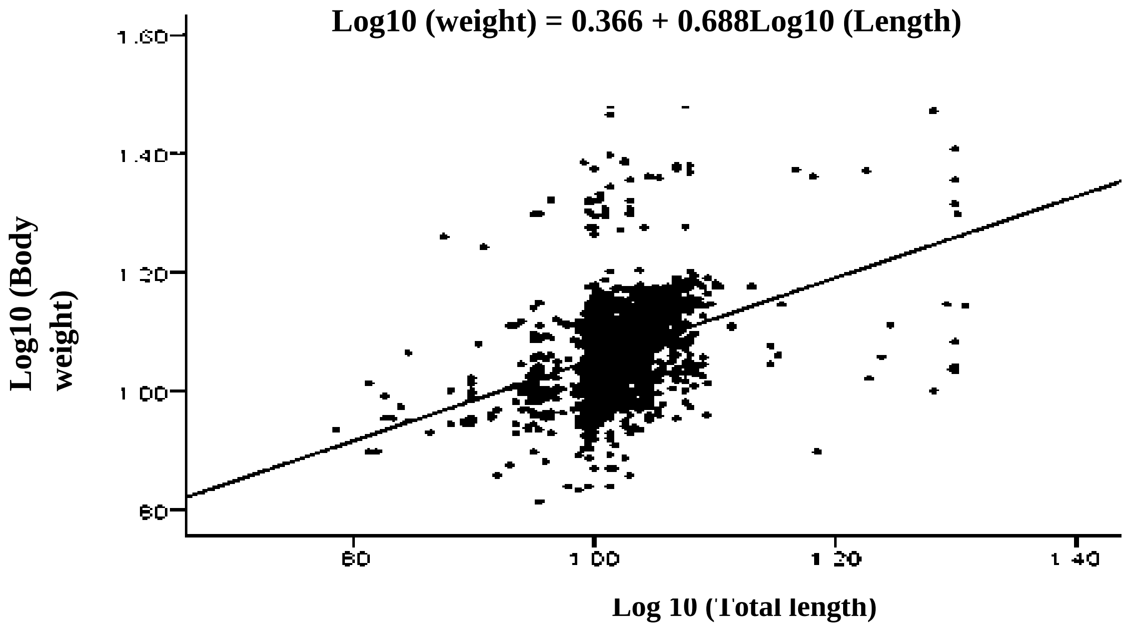

Fig 1: Length-weight relationship of *Oreochromis niloticus*

Water qualities monitored

Water quality parameters were monitored throughout the study to ensure that the water was not polluted during the cause of the study and to react promptly when pollution does occur. The monthly mean result for water quality parameters is presented in Tables 2, 3, and 4. Dissolved Oxygen values varied between 5.9-6.9 mg/l, temperature records varied between 25.6 ^{o}C -27.7^{o}C, while Hydrogen-ion-concentration (pH) value varied between 6.1-6.9 units. All the parameters were at their optimal levels for adequate fish culture.

Table 2: Dissolved Oxygen Measurements (mg/l) Under Varying Crude Protein and Stocking Density Regimens as Affected by Months

Crude protein level	Treatments											
	20% (A)			25% (B)			30% (C.)			35% (D)		
Stocking Density in months	(10)	(20)	(30)	(10)	(20)	(30)	(10)	(20)	(30)	(10)	(20)	(30)
	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
1	6.7	6.5	6.3	6.1	5.9	6.2	6.2	6.2	6.1	6.3	6.8	6.2
2	6.6	6.3	6.4	6.2	6.3	6.3	6.0	5.9	6.1	6.4	6.3	6.2
3	6.8	6.9	6.9	6.6	6.6	6.5	6.3	6.1	6.1	5.8	6.5	6.2

Table 3: Mean Monthly Temperature Scores (^{o}C) Under Different Levels of Crude protein and Fish Stocking Density

Crude protein level	Treatments											
	20% (A)			25% (B)			30% (C)			35% (D)		
Stocking Density in months	(10)	(20)	(30)	(10)	(20)	(30)	(10)	(20)	(30)	(10)	(20)	(30)
	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
1	25.9	26.7	26.9	26.3	26.8	26.1	27.6	26.9	26.9	26.4	26.1	26.5
2	27.7	26.3	26.8	27.7	26.3	26.8	28.2	25.6	25.9	26.9	27.1	27.2
3	27.4	27.7	27.1	26.9	26.6	26.7	27.1	26.5	26.8	26.8	27.1	25.8

Table 4: Mean Monthly Hydrogen-ion-concentration (pH) values as Affected by Different Levels of Crude Protein and Fish Stocking Density

	Treatments											
Crude protein level	20% (A)			25% (B)			30% (C.)			35% (D)		
Stocking Density in months	(10) A1	(20) A2	(30) A3	(10) B1	(20) B2	(30) B3	(10) C1	(20) C2	(30) C3	(10) D1	(20) D2	(30) D3
1	6.3	6.8	6.5	6.4	6.9	6.7	6.6	6.6	6.6	6.3	6.3	6.2
2	6.5	6.5	6.3	6.3	6.2	6.1	6.7	6.1	6.4	6.5	6.3	6.3
3	6.6	6.7	6.6	6.9	6.3	6.7	6.6	6.2	6.8	6.5	6.6	6.4

Discussion

Length-weight relationship

Result of the length-weight relationship in this study revealed that a significant relationship exists between body weight and total length of male Nile tilapia. The result also revealed negative allometric growth because the regression coefficient ''b'' value was less than 3 (0.68). The regression coefficient value (0.68) was far below that reported by (Alex *et al*., 2012) in *Tilapia zilli* **(**2.94) and *Oreochromis urolepis urolepis* (2.07) reared in fresh water ponds. Since both results were less than 3, they revealed negative allometric growth, which implied that the fish became more slender as they increased in length. Other researchers who reported negative allometric growth includes Dan-Kishiya (2013) for *Tilapia mariae* whose range was between (1.4 and 2.3); Haruna (2006) reported a value of (2.7) for *Tilapia zilli* in fresh water body; Bala *et al*., (2009) reported a value of (2.91) for *Tilapia zilli*. The low value obtained in the present study may be due to differences in location, type of water bodies used, and or difference in species of fish.

Conclusion and Recommendation

The result of this study indicates that the fish samples used for this study exhibited negative allometric growth pattern because its regression coefficient (b= 0.68) was less than 3. This meant that fish samples grew better in length than in weight, thus becoming more slender as they increased in length. A positive allometric growth would have been the outcome if the regression coefficient was greater than 3. It is therefore recommended that fisher-folks be advised to use a diet of 30 % crude protein at a stocking density of 20 fish samples in aqua-culture, because this improved fish body weight and total length resulting in the best yield.

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