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RESEARCH ARTICLE

The Length-Weight Relationship and Condition Factor of Nile Tilapia (*Oreochromis niloticus* L.) Broodstock at Kegati Aquaculture Research Station, Kisii, Kenya

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Abstract

The present study describes the Length -Weight Relationship (LWR) and condition factor (K) for 215 *Oreochromis niloticus* broodstock from Kegati Aquaculture Research Station, Kenya. The male broodstock (average length 18.3 ± 0.1 cm and weight 126.69 ± 0.2 g) and female broodstock (average length 15.18 ± 0.1 cm and weight 84.84 ± 0.06 g) were randomly sampled from the stations' production ponds and weighed using digital weighing balance (0.1g) and length measured using measuring board (0.1cm). Length-Weight relationship (LWR) was described by the equation: $W = a L^b$ while the condition factor was determined using the equation: $K = 100W/ L^b$. The value of the regression co-efficient 'b' obtained for the LWR for the male was 2.5 while that for the female was 3.2 suggesting an isometric growth for the brooders. The mean condition factor for the broodstock was 1.02 ± 0.04 and 1.12 ± 0.02 for males and females respectively. There was a significant difference in condition factor between the male and female brooders (ANOVA, $P < 0.05$). The condition factor was within the standard set for healthy fish and this was indicative that indeed, Kegati broodstock were in good condition for larviculture purposes. Further condition factor analysis should be considered for Nile tilapia fingerlings in the station.

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INTRODUCTION

Today, Nile tilapia, which is also popular as 'aquatic chicken' has become the shining star of aquaculture with many farms beginning, others expand as consumption rate increases across the globe (Fitzsimmons, 2005; Ogello et al., 2014). Annual global production of cultured Nile tilapia has continued to increase in recent years in most tropical, subtropical and temperate regions thanks to its favorable culture characteristics (Nandlal and Pickering, 2004; Ashagrie et al., 2008; FAO, 2012). In fact, Nile tilapia is the second most farmed fish in the world after carps (El Sayed, 2002). However, inadequate supply of certified quality feed and seed fish has been a longstanding hurdle to the production of Nile tilapia especially in developing countries (Ogello et al., 2014). Some farmers have given up fish farming because they run into huge losses after stocking their ponds with low-quality fingerlings coming from poorly conditioned broodstocks in many hatcheries (Munguti et al., 2014). Indeed, continued shortage of quality Nile tilapia seed hurts aquaculture activities in tropical countries (El Sayed, 2002). Other challenges in Nile tilapia production include too early maturation and high mortality under crowded conditions (Salama et al., 1996).

Knowledge of quantitative aspects such as length-weight relationship, condition factor, growth, recruitment, and mortality of fishes are important tools for studying fishing biology (Lizama et al., 2002). In fish, the condition factor

(K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare (Ighwela et al., 2011). From a nutritional point of view, there is the accumulation of fat and gonadal development (Le Cren, 1951) while from a reproductive point of view; the highest K values are reached in some species (Ighwela et al., 2011). K also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonadal maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley, 1972; Wootton, 1990; Anyanwu et al., 2007). The study of the condition factor is thus important for understanding the life cycle of fish species and contributes to adequate management of these species and, therefore, to the maintenance of equilibrium in the ecosystem (Lizama et al., 2002). Poorly conditioned fishes are associated with negative allometric growth, which implies that the fish becomes more slender as it increases in weight while fishes with appropriate condition factor have isometric growth, which implies that the fish becomes relatively deeper-bodied as it increases in length. The condition factor of fish can be affected by a number of factors such as stress, sex, season, availability of feeds, and other water quality parameters (Khallaf et al., 2003). Most hatchery managers especially in developing countries do not relate the significance of broodstock condition factor to quality fingerling production. Although, the length-weight relationship and feeding habits of tilapia have been studied (Olurin and Aderibigbe, 2006), this information is largely lacking in many hatcheries and production farms dealing with *O. niloticus* in Kenyan. Thus, the present study aims to provide information regarding the length-weight relationship and the condition factor (K) for Nile tilapia broodstock (*O. niloticus),* with a view to determining whether the brooders are in good condition for larviculture production in Kegati Aquaculture Research Station, Kenya.

MATERIALS AND METHODS

Study area

This study was done at Kegati Aquaculture Station in Kisii County, Kenya (00°42″S; 034°47″E). Kisii County lies on a highland equatorial climate; therefore it receives rain almost throughout the year, although there are two rainy seasons (March to May and October to November).

Sample size and data collection

A total of 215 *O. niloticus* broodstock were obtained from production ponds between January and April 2014. The fish were harvested by 50 m long seining net with 0.1cm mesh size and placed in buckets before transporting to the stations' laboratory. The fish were blot-dried to remove the excess water from the body before measuring. This also helped avoid errors during weighing exercise. The male broodstock (average length 18.3 ± 0.1 cm and weight 126.69 ± 0.2 g) and female broodstock (average length 15.18 ± 0.1 cm and weight 84.84 ± 0.06 g) were randomly sampled from the stations' production ponds and weighed using digital weighing balance (0.1g) and length measured using measuring board (0.1cm) as described by Lagler (1970).

Sex determination

Sexing of the fish was manually done. The sex of male fish was determined by the presence of two openings situated just in front of the anal fin, of which one is the anus. The other is the opening of the urethra, at the end of the genital papilla (an oval-shaped lobe just rearward of the anus), from which milt and urine are discharged. The female possess three body openings, of which one is the anus, the urethra and the opening of the oviduct (a crescent-shaped slit), from which eggs are released (Nandlal and Pickering, 2004).

Water quality parameters

Some selected water quality parameters such as pH, DO, temperature, electrical conductivity and total ammonia were measured weekly using surveyor II model hydrolab.

Data analysis

Length-weight relationship

Linear transformation of length and weight of the fish was made using natural logarithm at the observed lengths and weights. The length-weight relationship (LWR) was calculated following Pauly (1983). The LWR was used to calculate the regression coefficient (slope of regression line of weight and length). The parameter "b" of the length-weight relationship were estimated using the formula $W= aL^b$.
Where: W = the weight of the fish in grams,
L = the total length of the fish in centimeters
a = exponent describing the rate of change of weight with length
b = weight at unit length
The expression of the relationship was represented by the following formula:
Log W = b log L + log a

Condition factor

The value of **b** from the weight-length relation (Lizama et al., 1999) was used to compute the condition factor. Individual values of the condition factor were obtained through the formula $K = 100W/L^b$ (Gomiero and Braga, 2005). The mean condition factor was obtained differently for both males and females.

Where:

K = condition factor

W = the weight of the fish in gram (g)

L = the total length of the fish in centimeters (cm)

b = the value obtained from the length-weight equation.

Results

Water quality analyses

There were no significant differences between water quality parameters within and among the production ponds in the station (ANOVA, P > 0.05). Values of the selected water quality parameters are presented in table 1.

Table 1: Water quality parameters recorded during the period of study including ± Standard Error (SE)

Parameter	Mean (± SE)
D.O	8.21 ± 0.28
PH	6.96 ± 0.11
Temperature	23.95 ± 0.22
Conductivity	88.76 ± 1.55
Total ammonia	1.05 ± 0.01

Length-Weight relationship

At the end of experiment, the results of the length-weight analysis are presented in Table 2. The mean length for the male broodstock was 18.3 ± 0.1 cm while the mean weight was 126.69 ± 0.2 g. The mean length and weight for the female fish were 15.18 ± 0.1 cm and 84.84 ± 0.06 g respectively. The length-weight relationship among pairs of plotted data, values of determination coefficients and corresponding equation are demonstrated in Figure 2 and Figure 3 for males and females respectively. The values of the regression coefficient obtained from the LWR for males and female brooders and condition factor are presented in table 2. There was significant correlation between length and weight for both male and female broodstock ($P < 0.05$). There was also a significant difference in condition factor between the males and females of O. niloticus ($p < 0.05$).

Table 2: Length-weight relationship, regression coefficient and condition factor parameters of *O. niloticus* in Kegati Aquaculture Station

Sex	N	Mean Length (SE)	Mean Weight (SE)	a	b	Condition Factor Range (SE)	Condition Factor Mean(SE)
Male	123	18.3 ±0.1	126.69 ±0.2	-1.09	2.5	0.5 - 1.5	1.02 ±0.04
Female	92	15.18 ±0.1	84.84 ±0.06	-2.17	3.3	0.5 - 3.1	1.12 ±0.02

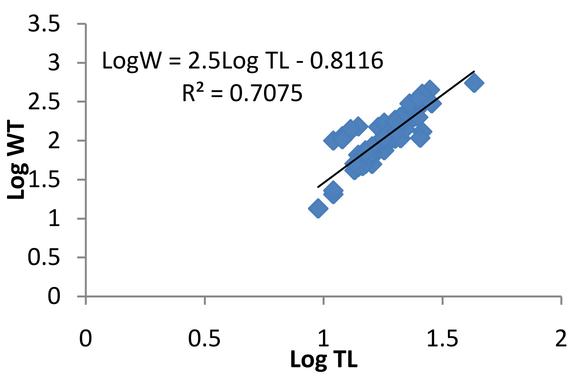

Figure 2: Length-Weight Relationship of *O. niloticus* males

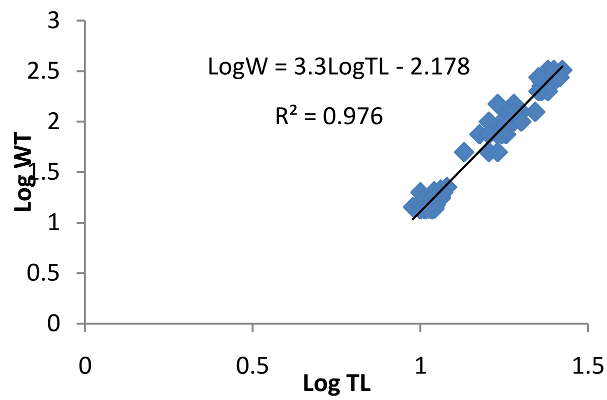

Figure 3: Length-Weight Relationship of *O. niloticus* females

Discussion

The length-weight relationship (LWR) is an important tool that provides information on growth patterns and growth of animals (Ighwela et al., 2011). Fish generally passes through different stages of development which can be defined by different LWR. Statistical analysis of the LWR of the current study showed that the regression coefficients are indicative of isometric growths in males and female brooders. This result was similar to Moradinasab et al. (2012) who concluded that the increase in weight is significant with every unit increase in length for isometric growths. The values of ‘b’ in this study were 3.3 for the females and 2.5 for the males. These values were within the range of 2 - 4 recommended by (Bagenal and Tesch, 1978; Hile, 1936; Martin, 1949) as ideal for fresh water fishes. Values of ‘b’ above 3 are possible in some conditions such as stress free environments **(**Prasad and Anvar, 2007). The significant difference in regression coefficient of individual fishes agrees with the findings of Stewart (1998) who observed that other factors including environmental and management could also cause variations in b. Even though there was no significant difference in water quality parameters among the production ponds and the values were all within the recommended ranges, it is possible that food availability and feeding characteristics could cause differences in b in Kegati station.

Condition coefficient is one of the standard practices in fisheries used as an indicator of the variability attributable to growth coefficient (b). Here, the individual fish condition is determined based on the analysis of length-weight data reflecting that the heavier fish at a given length is in better condition, hence indicating favorable condition (Bolger and Connolly (1989). The mean condition coefficient (K) for the *O. niloticus* was 1.02 ± 0.04 and 1.12 ± 0.02 for males and females respectively. This finding is coherent with Ighwela et al., (2011) thus indicating that the fish were above average in terms of condition. The condition factors were close to those reported by Olurin and Aderibigbe (2006) in juvenile *O.niloticus* where the condition factor was 1.14 in males and 1.08 in females. The condition factor higher than one suggests good fish health condition and indicates an isometric growth, which is the desirable in a fish farm (Ayode, 2011). There may be differences in the condition factor due to sex, environmental conditions such as pollution (Olurin and Aderibigbe, 2006). In this study the LWR was found to be in a linear form conforming to the general formula expressing the relationship between the length and weight of fishes. This perhaps suggests that best farm management practices applied in the station contributes to the steady increase in their weight and length. In this study, females of *O. niloticus* were heavier than males. This may be attributed to the higher fat accumulation and higher gonadal weight (Le Cren, 1951; Shafi and Quddus, 1974; Maguire and Mace, 1993 and Ahmad Dar et al., 2012).

Conclusion and recommendations

The authors conclude that Nile tilapia *O. niloticus* examined at Kegati aquaculture Research Station were in good condition and healthy and thus are suitable for larviculture purposes. Therefore, the LWR is an important indicator of their physiological status. A further study should be conducted to investigate the condition factor of Nile tilapia fingerlings obtained by the broodstock.

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