



# Investigation on Some Biological Aspects of Nile Tilapia, *Oreochromis niloticus* (L. 1758) from Khashm El-Girba Fish Market, Sudan: Length Weight Relationship, Condition Factor and Sex Ratio

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## Authors' contributions

This work was carried out in collaboration among all authors. Author MYM designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analysis of the study. Authors AAZA and MME managed the literature search. All authors read and approved the final manuscript.

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## ABSTRACT

The present study was carried out to investigate some aspects of the biology of *Oreochromis niloticus*, it has ecological and economic importance, found in Khashm El-Girba market; here, we describe the length-weight relationships, condition factors and sex ratio of *O. niloticus*. A total of 525 specimens were collected from August to November 2016. This study indicated that; the regression of length against weight was computed from the relationship  $W = aL^b$ ; growth coefficient (b) value  $2.880 \pm 0.430$  less than 3, which indicate have negative allometric growth. The condition factors (K) is  $3.866 \pm 0.027$ ; While the sex ratio was (M: F) 1:0.98.

Keywords: Allometric growth; fulton factor; Nile tilapia; the regression coefficient.

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## 1. INTRODUCTION

FAO estimated that, in 2012, the fish production reaches 158.0 million tons, 11.6 million tons of total production produced for inland captures, marine capture constituted by 79.7 million tons, while 41.9 million tons come for inland aquaculture and 24.7 million tons for marine culture, when the world population reached 7.1 billion, and human consumption was 136.2 million tons fish and fish product and 21.7 of non-food uses. (<http://fao.org>, 2014)

Inland fisheries are important in Africa, where  $\frac{1}{3}$  of total capture fisheries production comes from inland waters about 2.7 million tonnes. The "Value of African Fisheries" study highlights the importance of inland fisheries in terms of value and employment (<http://fao.org>, 2014).

Sudan is one of the largest countries in Africa with area of 1861500 km<sup>2</sup>. The main fresh water fisheries located in the lake with major reservoirs, in Sudan man-made lake covers about 3075 km<sup>2</sup> total sustainable yield of fisheries capture production was estimated about 34000 tonnes in 2012, 29000 tonnes from inland water catches and 5000 tonnes from marine catches, aquaculture was estimated at 2000 tonnes (<http://fao.org>, 2014).

The lake Khashm El-Girba support a seasonal fishery (October – July) for a group of fishermen who combine fishing with other economic activities, (mainly rain-fed agriculture) [2].

This lake flushed annually since 1970, the flushing is done during the flood season prior to storage (usually August), which completely drains the reservoir. Fisheries conservation in this dam reservoir has special problem, because each year it is flushed to remove silt and debris, as result of which the fish population suffers great losses every years, this is through mass mortality due to the high speed current and the blockage of gills by silt in addition to carrying over part of the population downstream [2]. In Khashm El-Girba and Atbara River 19 fish species belonging to 10 families, the most abundance of which are cyprinids, cichlids, mochokids and schilbeids is indicated that *Labeo niloticus* is most dominant fish species, and next in order of dominance are *Oreochromis niloticus*[3].

Fish researches often require the use of biometric relationship to transform data collection in the field into appropriate indices, quantitative aspect of fish such as length-weight relationships, condition factor and sex ratio are important tools for studies fish [4].

Data on the length and weight of fish have commonly been analyzed to yield biological information, which is very important for proper exploitation and management of the population of fish species, length and weight data are useful fish sampling programs, standing crops biomass can be estimated [5]. The relationship of length and weight, estimated condition factor (K) of the fish species. Length–weight relationship provides information on growth patterns of animal, fish are known to pass through stages in their life history which are defined by different length-weight relation [6]. Biometric data such as length-weight relationship is veritable tool in fisheries management, according to [7].

This study aimed to measure the weight- length relationship, condition factor and sex ratio of *O. niloticus* to investigate the biological aspects of those parameters in Khashm El-Girba fish market to fill information gap due to few studies was done in this area.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

This study was carried out in Khashm El-Girba area; it's the arid desert landscape of eastern Sudan. It's about 526 km away from the capital of Sudan (Khartoum) about 526 km, Coordinate determined using GPS (Garmin 62sc) 14°85'23.03'' N - 35°45'48.86'' E and elevation was 1440 ft as shown in Plate 1.

### 2.2 Sampling Method

Fish samples were collected from Khashm El-Girba market, located in the arid desert landscape of eastern, Kassala state, Sudan. The fishermen gear used to collect fish in Khashm El-Girba reservoir are seine beach nets, cast net, long line and trap.

A total of 265 males and 260 females were collected from between August–November 2016 identified using key provided by [8] and [9].

#### 2.2.1 Length-weight measurement

Total length (TL) and standard length (SL) of the collected specimens were measured by measuring board to the nearest 0.1 cm.



**Plate 1. A map of Khashm El-Girba reservoir, Atbara River and the sampling sites (source Google earth programme, 2016)**

Body weight (BW) was measured by digital balance (Electronic Scale, Sensor Disc, SF-400), to the nearest 0.0 g.

Length-weight relationship calculated using following equation [10].

$$w = a L^b$$

Where: W = weight of fish in grams, L = standard length of fish in centimeter, a = constant, and b = an exponent.

The above equation, data were transformed in to logarithms before the calculations were made.

Therefore equation becomes:

$$\text{Log } W = \text{log } a + b \text{ log } L$$

Where: log w: weight (g), log SL: length (cm), a and b are intercept and slope of regression line, respectively. The line fitted to the data was described by the regression equation for *O. niloticus*.

### 2.2.2 Fulton condition factor

Condition Factor (K) the well-being of each *O. niloticus* species of the Khashm El-Girba market was studied by using Fulton's condition factor according to [10] and [11]; Fulton's condition factor (%) was calculated as:

$$\text{FCF} = \frac{w}{L^3} \times 100$$

Where: w= weight (g) and L= standard length (cm).

Sex ratio is the proportion of females to males, was determined using this formula; Sex determine by examination of genetic papilla.

$$\text{sex ratio} = \frac{\text{number of females}}{\text{number of males}}$$

### 2.3 Data Analysis

Variations in the Length-weight relationship (represented by b) were carried out using the regression analysis and condition factor (represented by K) of the individual fish in Khashm El-Girba market, averages were expressed with standard deviations ( $\pm$  SD).

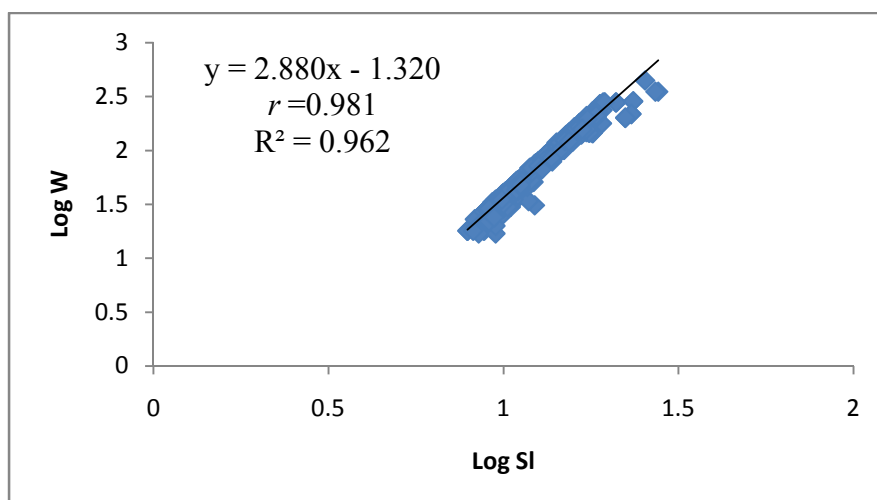
## 3. RESULTS

525 specimens of *O. niloticus* was collected from Khashm El-Girba market; standard length ranged between 7.9 - 27.7 cm with average 12.8 cm and weight ranged from 20 to 445g and average 90.8 g as showed in Table 1.

Length-weight relationship were analyzed in this study presented in Fig. 1 and Table 1, the slope of length-weight relationship (b) with (S.E)

**Table 1. Showed standard length, body weight, condition factor and (b) value with indicated growth pattern for *O. niloticus* during study period**

Month	Standard length			Body weight			Condition factor			Growth pattern	
	min	max	aver	min	max	aver	min	max	aver	b value	Growth pattern
August	9.3	17.6	13.42	32	204	92.923	2.858	3.999	3.506 ± 0.286	2.886	N.P
September	10	27.7	16.23	33	351	161.705	1.651	4.00	3.582 ± 0.675	2.657	N.P
October	2.8	27.2	13.38	32	445	102.211	1.744	4.010	3.873 ± 0.524	2.799	N.P
November	7.8	18.4	10.59	20	215	51.304	3.011	3.980	4.000 ± 0.424	2.685	N.P
General			12.8			90.8	1.651	3.997	3.866 ± 0.027	2.880 ± 0.430	N.P



**Fig. 1. Length-weight relationship of *O. niloticus***

=2.880±0.430, with high correlation ( $r = 0.981$ ); condition factor ( $K$ ) fluctuated between 1.651 to 3.997 with average (S.D)  $3.866 \pm 0.027$ ; While the sex ratio was 1:0.98 (M: F) present in Table 2 respectively.

**Table 2. Showed sex ratio of *O. niloticus* during study period**

Month	M:F
August	1:09
September	1:1
October	1:1
November	1:08
General	1:0.98

## 4. DISCUSSION

### 4.1 Length-weight Relationship

The slopes ( $b$ ) of the Length – Weight relationship, when the ( $b$ ) value less than 3.0 indicated a negative allometric growth as grown for *Oreochromis niloticus* [12] and that shown in this study when the slopes ( $b$ ) of the Length-weight in Khashm El-Girba market fell within 2.657 and 2.886 with average  $2.880 \pm 0.430$ . This study also agrees with [12], their recorded ( $b$ ) value ranged from 2.299 to 3.648 for *O. niloticus*. When  $b = 3$ , the fish grows isometrically resulting in ideal shape of fish. Such value was not observed for all fish collecting from the market in this study and [13], studied *O. niloticus* from Khashm El-Girba reservoir and Atbara River; he reported that, growth of *O. niloticus* was allometric growth pattern.

Regression analysis of total weight, standard length of *O. niloticus* species form Jebel Aulia revealed that, the growth is allometric for both

males and females with  $b$ -value ranging from 1.969 to 2.366 [14] and that was in agreement with the obtained results. This study also agree with [15] when the slope of relationship between length and weight ( $b = 2.69$ ).

*Oreochromis niloticus* from Khashm El-Girba market respectively suffered from this pattern of growth. When the value of  $b$  is more than 3.0, the fish grow following the positive allometric pattern value was not observed for all fish collecting from the market, as the values of  $b$  increases, the size of the fish also increases because the fish usually grows proportionately in all directions. However, the changes in fish weight in general are actually greater than the changes in its length. However, the body shape of fish tends to change as the length increases. The 95% confidence interval of  $b$  for *O. niloticus* 2.649 similar results were recorded by [12] their studied the length weight relationships of 6 freshwater fish species in Khashm El-Girba reservoir and Atbara River, reported 95% CI of  $b$  values that ranged from 2.446 to 3.885, the correlation coefficient  $r = 0.973$  for length weight relationships for *O. niloticus* high which indicates that the length increases with increase in weight of the fish; this is an agreement with previous studies. The length-weight distributions of fishes collected from Khashm El-Girba market showed considerably large variations in fish sizes contributed to the minimum-maximum length of fish collected 7.9 to 27.7cm (S.l) hence the weight which ranged from 20 to 445g.

### 4.2 Condition Factor

In the fisheries science, the condition factor is used to compare the “condition”, “fitness” or

wellbeing of fish, it is based on the hypothesis that heavier fish of a particular length are in a better physiological condition [11]. According to [12], condition factor (K) of *Oreochromis niloticus* ranged between  $2.441 \pm 0.948$  to  $3.415 \pm 0.707$ . Fulton condition factor of *O. niloticus* ranged from 1.47 to 2.29 for females and 1.44 to 2.37 for males, the values were relatively lower between May and August which seem to coincide with peak breeding season [16]; While [13] recorded that, condition factor of *O. niloticus* vary monthly and fluctuated between 2.574 to 3.560 in Khashm El-Girba and Atbara river.

The condition factors (K) of the *O. niloticus* ranged between 1.651 and 3.866 this agree to [12], their recorded (k) value ranged from  $2.441 \pm 0.948$  to  $3.415 \pm 0.707$  and [16] who recorded Fulton condition factor of *O. niloticus* ranged between 1.47 to 2.29 for females and 1.44 to 2.37 for males

### 4.3 Sex Ratio

The biology of reproduction account for the interaction of the individuals and their surrounding, the identification of the breeding season, the onset of the maturity and spawning times and frequency, the behavior attached to breeding, the fecundity, the parental care recruitment and replacement [17].

The sex ratio (M: F) is 1:0.98 a closer examination of the sex ratio 1:0.97 recorded by [18] and 1:1 showed by [19] and 1:1 showed by [13].

According to [20], the sex ratio of *O. niloticus* was approximately 1:1; while [14], recorded that, sex ratio of *O. niloticus* was approximately 1:0.97. The sex ratio varied with season and zone, According to [19], the sex ratio of *O. niloticus* population 1:1. Sex ratio (M: F) was 1:1.37 [21].

The 319 of *O. niloticus* fishes ranged from 117 to 206 mm in total length, and 31.2 to 167.0 g in body weight with 161 females (50.4 %) and 158 males (49.6 %), the sex ratio was 1:1.02 (males: females), and did not differ significantly of the sex ratio 1:1 [22].

This caused oppositely environmental factors. Khashm El-Girba reservoir has been flushed annually, because it faces serious siltation problem, which is very critical in the sense that the reservoir is losing storage capacity at an average rate of 40 million m<sup>3</sup>/year, in this

process complete drainage of the reservoir occurs within approximately nine hours when the dam gates are fully opened during the flushing process massive mortality of fish occurs, the process is a detrimental factor which affects various fish populations as considerable amount of fish was lost in the reservoir [2].

## 5. CONCLUSION

In conclusion, the present study found that *O. niloticus* in Khashm El-Girba had different length and weight relationship and condition factor due to factors such as differences in length and body weight, differences in food availability, other environmental conditions, affected of flushing operation and reproduction period, all of the *O. niloticus* had negative allometric growth, sex ratio closely equal. An important contribution of this study is the provision of base line data on the length-weight relationship, condition factor and sex ratio in the Khashm El-Girba.

Thus, we have needed more studies on the relationships, condition factors and sex ratio of some fish species in the Khashm El-Girba reservoir.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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