



Stomach Content, Length-weight Relationship and Condition Factor of *Tilapia* spp. found in the Sombreiro River across Three Communities in Rivers State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author EOH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors GMS and IKEE managed the analyses of the study. Author MM managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2019/v3i430040

Editor(s):

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- Complete Peer review History: <http://www.sdiarticle3.com/review-history/49862>

Original Research Article

Received 07 May 2019
Accepted 17 July 2019
Published 31 July 2019

ABSTRACT

Aim: The present study aims to determine the condition factor incomplete of *Tilapia guineensis* and *Sarotherodon melanotheron* in Sombreiro River across Buguma, Abonnema and Degema communities in Rivers State.

Study Design: This study employs fieldwork, laboratory experimental design, statistical analysis and interpretation of data.

Place and Duration of Study: Live fish samples were caught by fishermen in Buguma, Abonnema and Degema communities in Kalabari kingdom of Rivers State, and were conveyed in a rectangular plastic aquarium containing ice blocks and oxygen bags to the department of Applied and Environmental Biology, Rivers State University. The duration of the study lasted for twelve weeks (65 days).

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Methodology: One hundred and eighty fish samples give their average weights and lengths were identified. The fish samples were weighed using an electronic weighing balance, the total length and length of intestine were measured with a meter rule (cm), color of fish, spines and rays of fish were also observed. Their stomach contents were analyzed viewing under a microscope. The frequency of occurrence method and the numerical method were used for analyzing the food items.

Results: The stomach content analysis indicated that the major food was phytoplankton. The length and weight relationship in the three sampled stations for *T. guineensis* and *Sarotherodon melanotheron* showed negative allometric growth, (<3). The condition factor for all the fish samples was greater than one. The physicochemical parameters showed that there were significant differences in the various physicochemical parameters across the study stations except for turbidity ($P=0.744$) and salinity ($P=0.922$), that showed no significant difference across the study stations.

Conclusion: The length-weight relationship in fishes can be affected by a number of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health and differences in length ranges of the specimen caught. The exact relationship between length and weight differs among species of fish according to their inherited body shape, and within a species according to the condition (robustness) of individual fish.

The stomach content analysis of the sampled fishes provided a baseline study of food and feeding habits of *Tilapia* species in the sampled stations.

Keywords: Tilapia; stomach content; condition factor K; monthly; communities; Sombreiro River.

1. INTRODUCTION

Tilapia is a common name derived from the Latin word *Thiape*, Tswana word for fish [1]. This species of fish are mostly dominant in Middle East and Africa among other regions. *Tilapia* is a fish from the family Cichlidae, one of the famous and common fish found in the marine and fresh water. *Tilapia* is a major source of protein for man [2]. Therefore, it is necessary that absolute attention is given to the feeding habit of *Tilapia*. In Nigeria *Tilapia* is used to complement the protein source in normal diet [2]. According to Pius & Benedicta [3], some *Tilapia* species feed on a wide range of food organism in their aquatic habitat. Fagade & Olaniyan [4] reported that the principal food items of *Tilapia* are diatoms, algal filaments and unidentified organic matter (debris).

Stomach content studies can provide useful information to determine the level of *Tilapia* in the food web and help to formulate strategies to manage multispecies in the fish farming system. Nwafili & Lamai [5] reported that some *Tilapia* are mostly found in the benthopelagic, potamodromous, freshwater and the brackish environment with a depth of five meters and they feed on mostly benthic-algae and phytoplankton. Also, *Tilapia* is omnivorous with a tendency to be herbivorous.

However, the feeding rate and body weight decreases as the fish size increase. Small

Tilapia rendalli consumed significantly more diatom than the larger individual [6]. Saha & Dewan [7] reported that the amount of phytoplankton in the Nile *Tilapia* stomach content is inversely proportional to the body size. However, the stomach content analysis is a search for variation in food consumed by *Tilapia*. But food and feeding habit of *Tilapia* are altered by seasonal change.

2. MATERIALS AND METHODS

The materials used in this study were a rectangular plastic aquarium, dissecting sets, dissecting board, microscope (model), meter rule and a weighing balance (Denver Instrument Germany) TP-512A.

2.1 Study Area

The study was carried out at the middle reach of the Sombreiro River. The Sombreiro River is located east of the Orashi River and originates from swamps in the Oguta-Ebocha zone. It has its source from the Niger River, runs downwards into the Southern tip of the Niger Delta basin and empties into the Atlantic Ocean. The Middle Reach of the Sombreiro River is brackish and appears turbid during the raining season. The wet or rainy season occur between March to October with annual rainfall between 2,000 and 3,000mm per year. The dry season lasts from

October to February with occasional rainfall [8,9].

2.2 Sample Collections

Fish samples of *Tilapia guineensis* and *Sarotherodon melanotheron* were obtained from fishermen across the three sample stations namely Buguma, Abonema and Degema in Nigeria respectively. The fishermen employed cast and gill nets methods and the live fishes were immediately transferred into a 30 litre rectangular plastic aquarium containing brackish water from the same river, the aquariums were fortified with ice blocks to maintain water temperature and oxygen bags for better aeration and were conveyed to the laboratory of Applied and Environmental Biology of the Rivers State University for analysis.

2.3 Essay Conduct

One hundred and eighty (180) *Tilapia* fishes weighing between the range of 21.98 g-289.45 g with total length ranging between 8cm-28cm for *Tilapia guineensis* and 20.54-250.75 g with total length of 9 cm-27 cm of *Sarotherodon melanotheron* were analyzed. All fishes arrived without mortality to the departmental laboratory where sorting of fish species, as well as measurements, immediately commenced. The fish samples were identified with the aid of keys according to Idodo-Umeh [10] and Nwani [11]. Morphological characteristics such as the total length (TL) of the fish (from the tip of the snout to the tip of the tail fin) was measured with a meter rule. A number of lateral lines, number of rays and spines, mouth part, color of fish and the bands on the fishes were taken. Denver Instrument Germany TP-512A was used to weigh the fishes. Each fish sample was placed in a clear dissecting board and dissected using a dissecting kit. During the dissection, a mild ventral cut was made on each fish from the anal aperture to the base of the operculum, the body wall was cut open at both sides enabling a thorough exposure of alimentary canals. The dissected stomach was slit open and the content was poured into a Petri dish. The stomach content screening was carried out using a dissecting microscope. The frequency of occurrence method and the numerical methods were used in analyzing the food items.

In the frequency of occurrence method, the stomach contents were examined and the individual food items were sorted and identified.

Thereafter, the number of stomachs containing one or more of each food item were recorded and expressed as a percentage of all stomachs containing the food items.

% occurrence of a food item = Total number of stomach with a particular food / Total number of the stomach with food x100

In the numerical method, the number of individual food item in the stomach was sorted and counted. A total of all the food items were recorded and expressed as percentage number of individual food items in the stomach.

% number of a food item = Total number of a particular food item / Total number of all food items x100

The physicochemical parameters were measured both *in-situ* and *ex-situ*. The *in-situ* measurements were done with instruments such as HANNA instrument model HI 8424, and Exttech model DO 700. BOD and COD were done *ex-situ*. Water samples were taken with a clean plastic rubber and were immediately transported to the laboratory for analysis.

The condition factor (K) of the fish was calculated according to Fulton [12].

$$K = W \times 100 / L^3$$

2.4 Statistical Analysis

Data generated were subjected to one-way analysis of variance (ANOVA) with Duncan's Multiple Range Descriptive Test. The results were further analysed using the statistic package for social science (SPSS) VERSION 23. Differences among mean were separated with Turkey HSD at P=0.05.

3. RESULTS AND DISCUSSION

3.1 Stomach Content Analysis

Results on the stomach content (Fig. 1) showed that in the month of August, station 1, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on phytoplankton, than others and then plant materials. In station 2, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on phytoplankton, others and then plant materials. In station 3, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on plant materials, phytoplankton, protozoa and others.

In the month of September, station 1, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on others, phytoplankton and plant materials. In station 2, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on plant

materials, phytoplankton, others and insect parts. In station 3, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on phytoplankton, others, protozoa and plant materials.

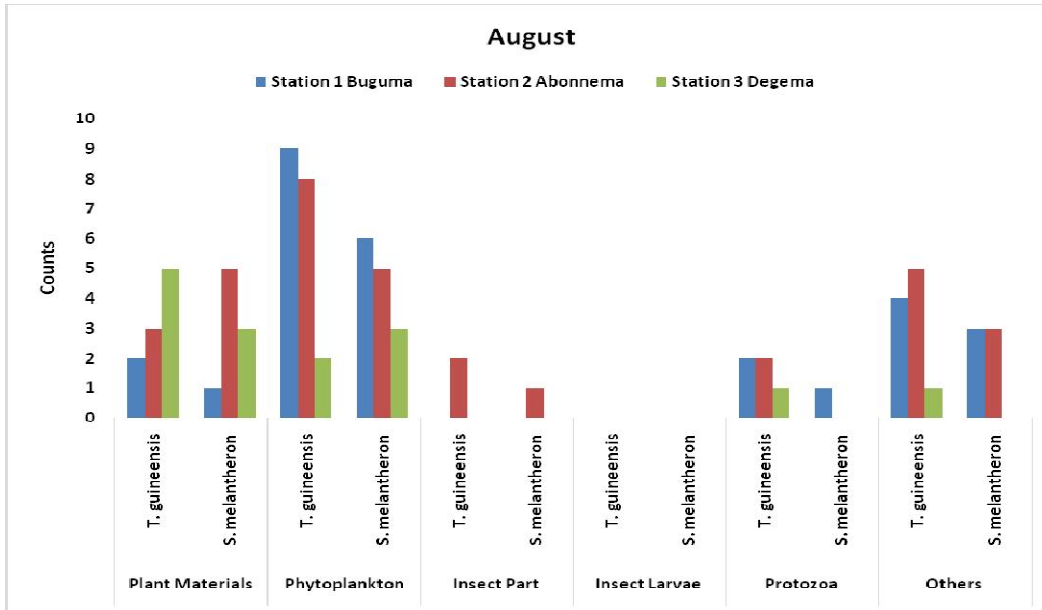


Fig. 1. Stomach content analysis for August 2018

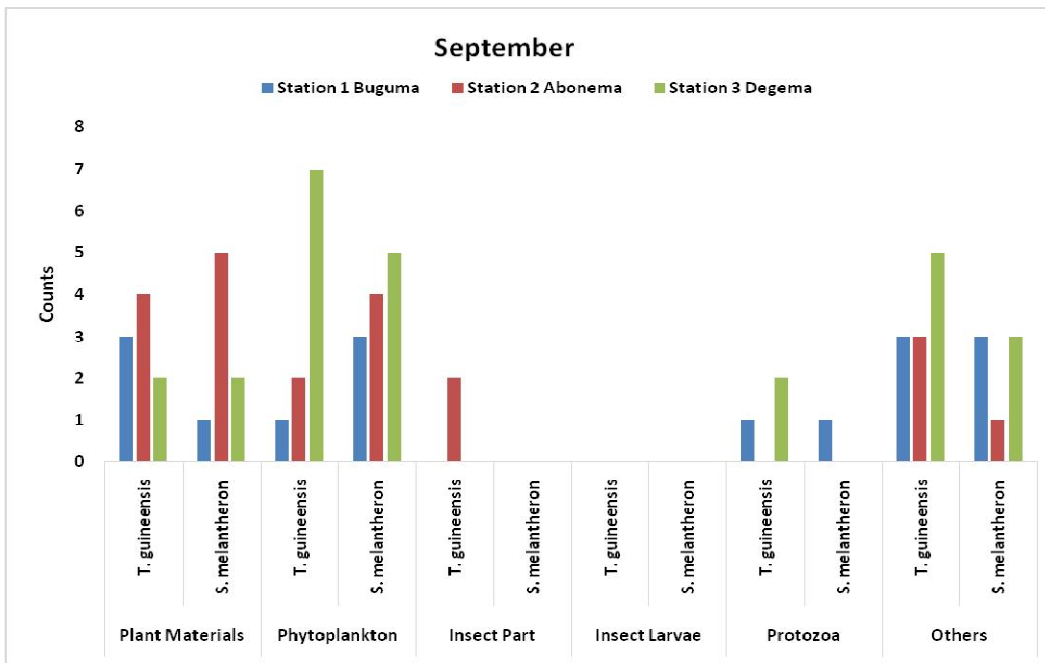


Fig. 2. Stomach content analysis for September 2018

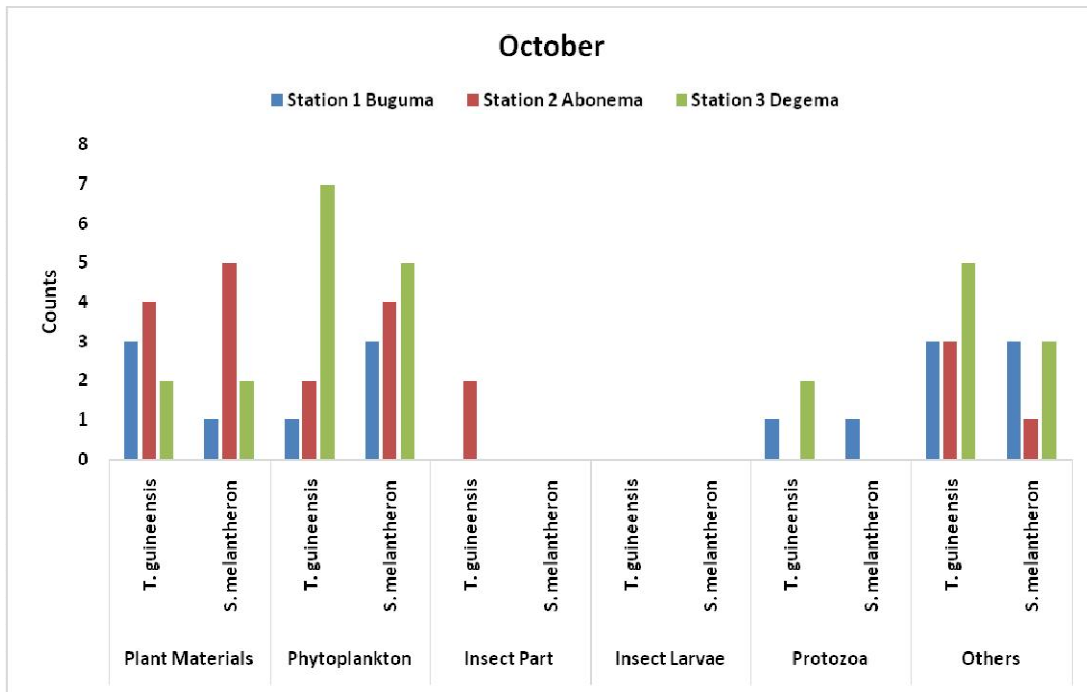


Fig. 3. Stomach content analysis for October 2018

In the month of October, station 1, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on phytoplankton, others and plant materials. In station 2, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on plant materials, phytoplankton and others. In station 3, *Tilapia guineensis* and *Sarotherodon melanotheron* fed more on phytoplankton, others, protozoa and plant materials.

3.2 Physico-chemical Parameters

The values of physico-chemical parameters are presented in Table 1. pH levels showed a narrow range of variation between different stations, with the highest (6.63 ± 0.2) mean p^H and the lowest (5.6 ± 0.2). There were however significant differences in pH between the stations ($P=0.00146$). Temperature levels differed significantly across the stations ($P<0.0001$) which range from $25.33- 26.7^\circ\text{C}$. Conductivity in the three stations vary significantly ($P=<0.0001$) and ranged between $140 \mu\text{S/cm} -416.67 \mu\text{S/cm}$.

3.3 Condition Factor

The condition factor (K) for *Tilapia guineensis* found in Abonema had a mean and standard deviation of 2.17 ± 0.71 , while *Sarotherodon melanotheron* had a mean and standard

deviation of 2.37 ± 0.36 . The results showed that the fishes in Abonema were in a good condition.

The condition factor (K) for *Tilapia guineensis* found in Buguma had a mean and standard deviation of 2.39 ± 0.4 , while *Sarotherodon melanotheron* had a mean and standard deviation of 2.25 ± 0.52 . The results showed that the fishes in Buguma were in a good condition.

The condition factor (K) for *Tilapia guineensis* found in Degema had a mean and standard deviation of 2.35 ± 0.39 , while *Sarotherodon melanotheron* had a mean and standard deviation of 2.27 ± 0.33 . The results showed that the fishes in Degema were in a good condition.

There is no significant difference in the condition factor of the fishes across months and stations as shown in the Table 2.

3.4 Graphical Expression of Weight-length Relationship

Figs. 4-11 is a graphical expression of length – weight relationship. This also showed the allometric growth of all different species of sampled fishes across the sampled stations. The empirical values were plotted their respective weight on an arithmetic scale using the Natural logarithm of the length and weight of the fishes.

Table 1. Results of physiochemical parameters of the three sampled stations

Parameters	Temperature (°C)	pH	Conductivity (µS/cm ³)	Turbidity (NTU)	Salinity	Chemical oxygen demand (mg/L)	Biological oxygen demand (mg/L)
Station 1	26.7±0.31 ^b	5.6±0.2 ^c	416.67±10 ^a	7.4±2.13 ^a	8.7±5.12 ^a	16.53±0.1 ^a	3.95±0.1 ^a
Station 2	25.33±0.1 ^c	6.2±0.15 ^b	140±7.64 ^c	8.8±1.82 ^a	8.93±3.46 ^a	42.6±0.01 ^c	1.3±0.01 ^b
Station 3	27.3±0.2 ^a	6.63±0.2 ^a	208.33±15.28 ^b	9.5±5.03 ^a	10.07±4.5 ^a	20.57±0.06 ^b	3.94±0.01 ^a
P	< 0.0001	0.00146	< 0.0001	0.744	0.922	< 0.0001	< 0.0001
Significant Difference	Yes	Yes	Yes	No	No	Yes	Yes

Key: (^{abcd}) Superscript of different alphabets along columns shows Mean comparisons that are significantly different

Table 2. Anova (Turkey test) comparisons across months and stations

	Weight	Length	Condition factor K
August	127.49±37.08 ^a	17.11±1.7 ^a	2.58±0.98 ^a
September	80.066±30.34 ^b	14.72±2.37 ^b	2.48±0.73 ^a
October	63.27±27.74 ^c	13.18±2.12 ^c	2.65±0.55 ^a
Pr> F(Model)	< 0.0001	< 0.0001	0.48
Significant Difference	Yes	Yes	No
	Weight	Length	Condition factor K
Station 1	92.61±44.41 ^a	15.33±2.72 ^a	2.41±0.49 ^a
Station 2	90.81±41.89 ^a	14.86±2.59 ^a	2.73±1.01 ^a
Station 3	87.41±39.75 ^a	14.82±2.57 ^a	2.59±0.71 ^a
Pr> F(Model)	0.79	0.492	0.072
Significant Difference	No	No	No

For the Abonnema as shown in Figs. 4 & 5, *Tilapia guineensis* had R² Value of 0.912 which showed a strong relationship between the weight and length of the fishes. It also had a b=2.26 (b<3), which showed negative allometry indicating that the *Tilapia guineensis* in Abonnema grew faster in length than in weight.

Sarotherodon melanotheron had R² Value of 0.952 which showed a strong relationship between the weight and length of the fishes. It also had a b=2.91 (b<3), which showed negative allometry indicating that the *Sarotherodon melanotheron* in Abonnema grew faster in length than in weight.

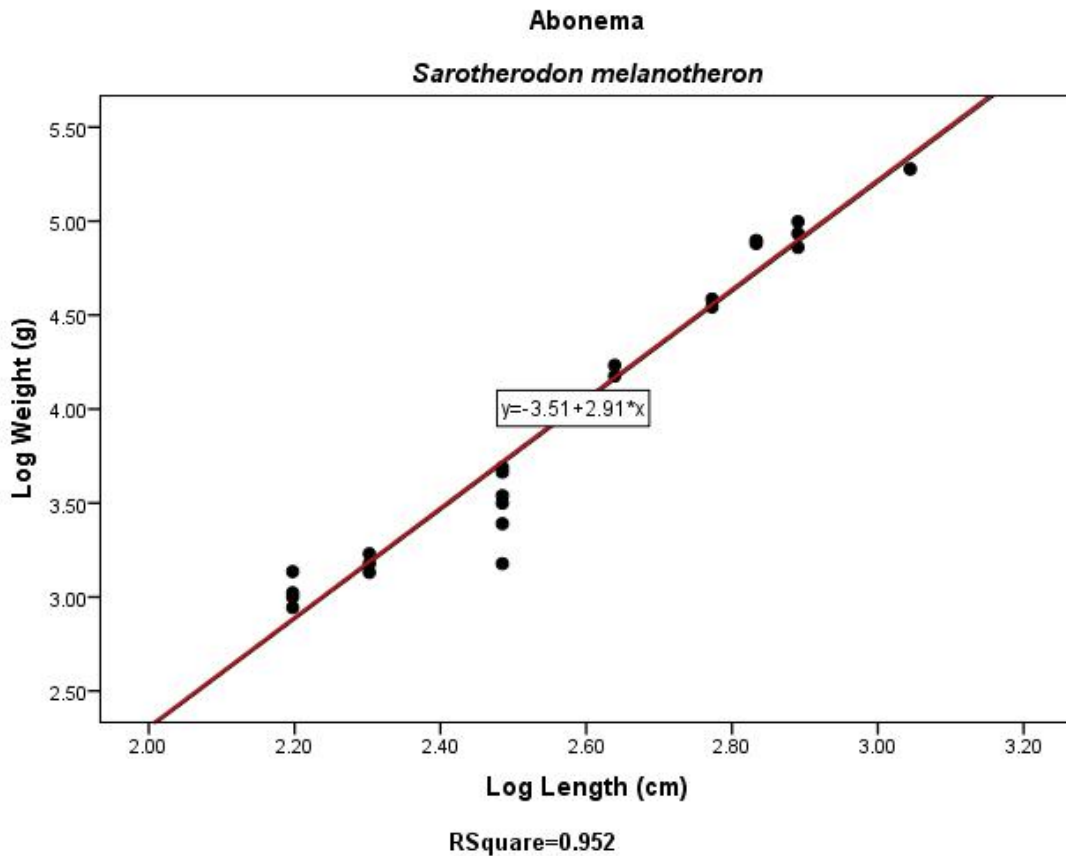


Fig. 4. Log length and log weight relationship (Bivariate Fit) of *Sarotherodon melanotheron* in Abonnema

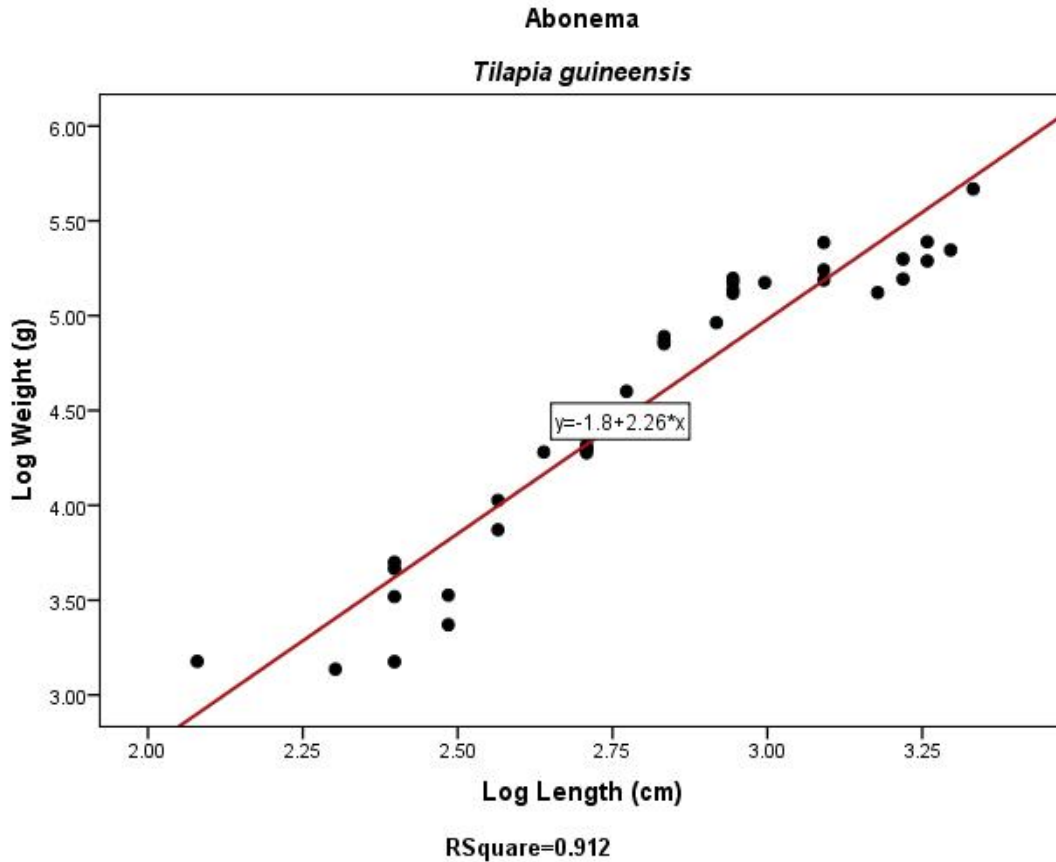


Fig. 5. Log length and log weight relationship (Bivariate Fit) of *Tilapia guineensis* in Abonema

For the Buguma as shown in Figs. 6 & 7, *Tilapia guineensis* had R^2 Value of 0.943 which showed a strong relationship between the weight and length of the fishes. It also had a $b=2.82$ ($b<3$), which showed negative allometry indicating that the *Tilapia guineensis* in Buguma grew faster in length than in weight. *Sarotherodon melanotheron* had R^2 Value of 0.774 which showed a strong relationship between the weight and length of the fishes. It also had a $b=2.58$ ($b<3$), which showed negative allometry indicating that the *Sarotherodon melanotheron* in Buguma grew faster in length than in weight.

For the Degema as shown in Figs. 8 & 9, *Tilapia guineensis* had R^2 Value of 0.952 which showed a strong relationship between the weight and length of the fishes. It also had a $b=2.62$ ($b<3$), which showed negative allometry indicating that the *Tilapia guineensis* in Degema grew faster in length than in weight. *Sarotherodon melanotheron* had R^2 Value of 0.948 which showed a strong relationship between the weight

and length of the fishes. It also had a $b=2.88$ ($b<3$), which showed negative allometry indicating that the *Sarotherodon melanotheron* in Degema grew faster in length than in weight.

The total *Tilapia guineensis* found in all 3 stations as shown in Fig. 10 had R^2 Value of 0.927 which showed a strong relationship between the weight and length of the fishes. It also had a $b=2.48$ ($b<3$), which showed a negative allometry indicating that the *Tilapia guineensis* in all sampled stations grew faster in length than in weight.

The total *Sarotherodon melanotheron* found in all 3 stations as shown in Fig. 11 had R^2 Value of 0.891 which showed a strong relationship between the weight and length of the fishes. It also had a $b=2.75$ ($b<3$), which showed a negative allometry indicating that the *Sarotherodon melanotheron* in all sampled stations grew faster in length than in weight.

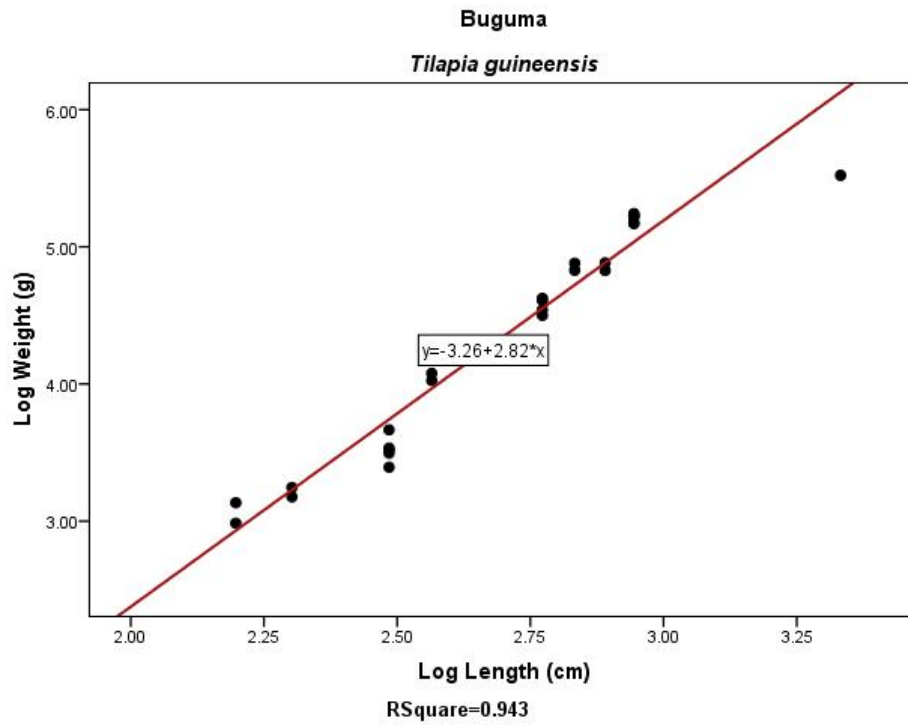


Fig. 6. Log length and log weight relationship (Bivariate Fit) of *Tilapia guineensis* in Buguma

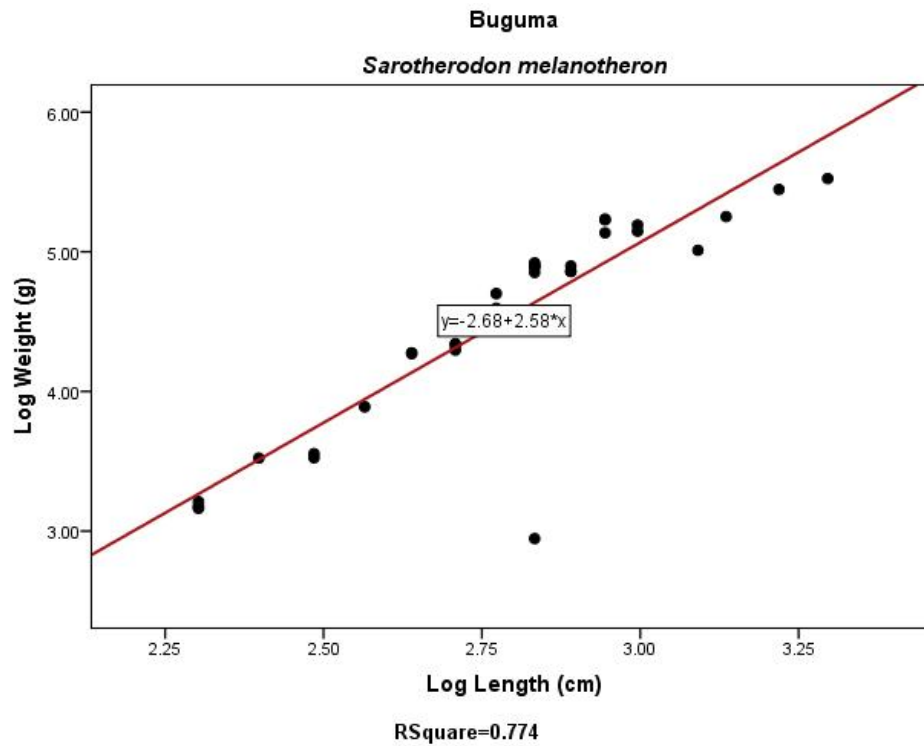


Fig. 7. Log length and log weight relationship (Bivariate Fit) of *Sarotherodon melanotheron* in Buguma

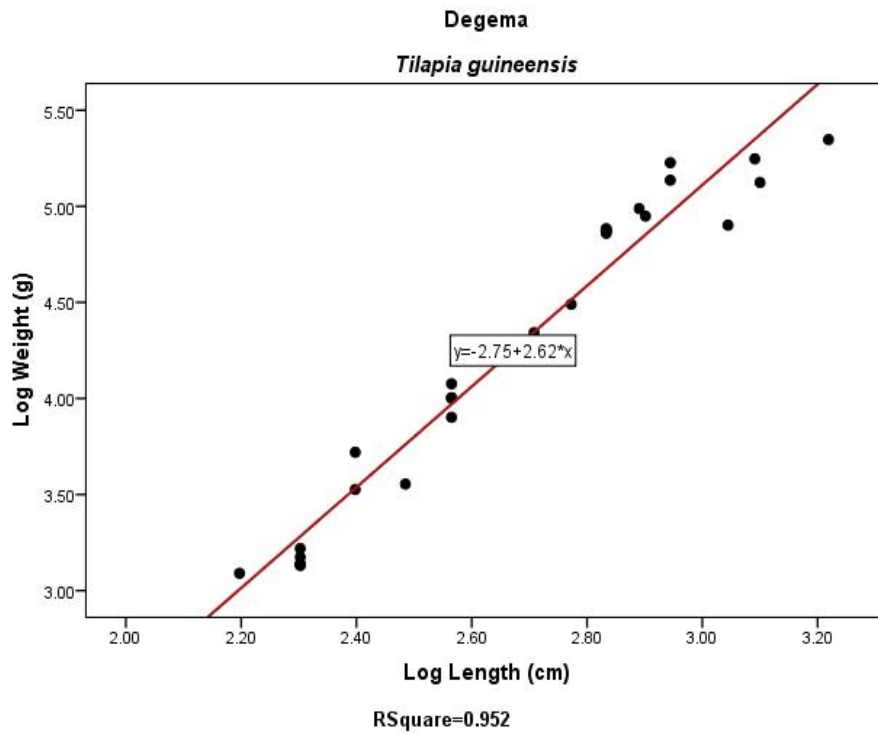


Fig. 8. Log length and log weight relationship (Bivariate Fit) of *Tilapia guineensis* in Degema

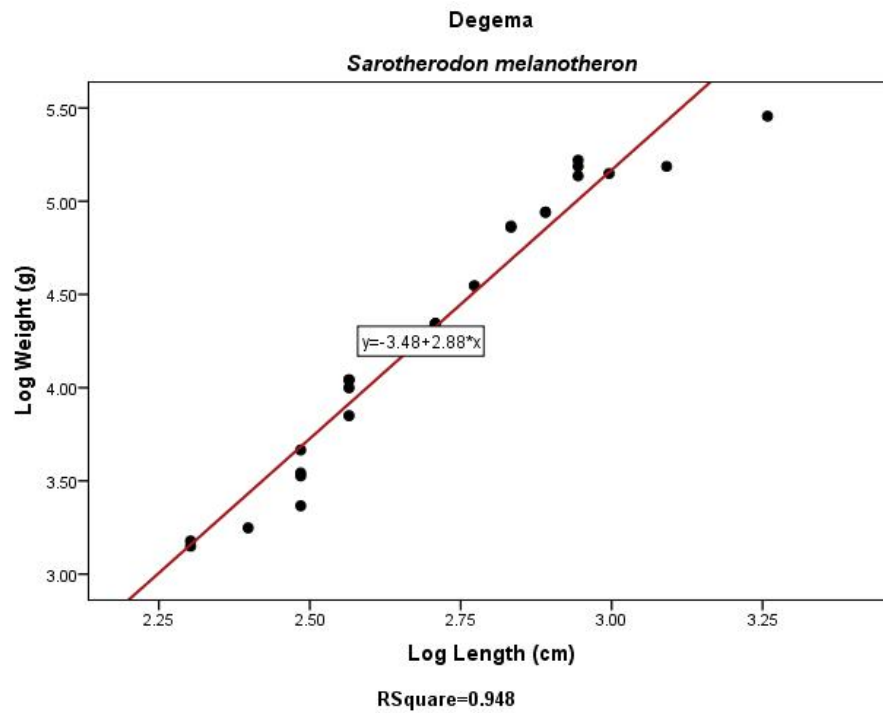


Fig. 9. Log length and log weight relationship (Bivariate Fit) of *Sarotherodon melanotheron* in Degema

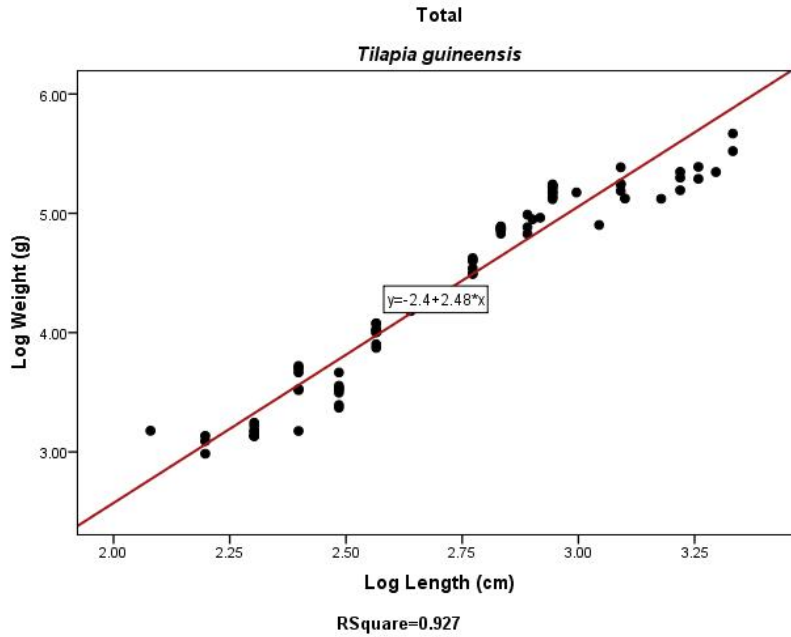


Fig. 10. Log length and log weight relationship (Bivariate Fit) of *Tilapia guineensis* sampled in all stations

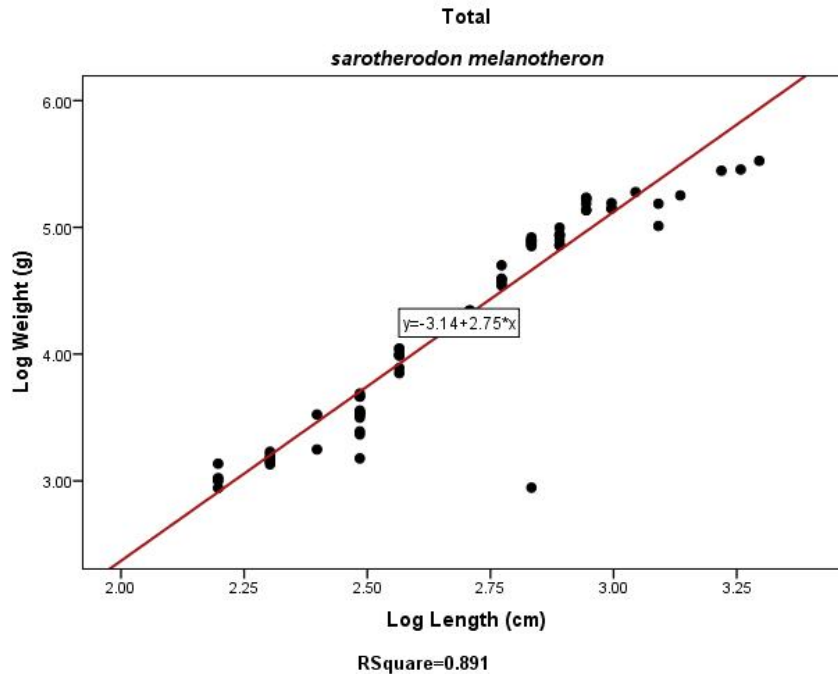


Fig. 11. Log length and log weight relationship (Bivariate Fit) of *Sarotherodon melanotheron* sampled in all stations

4. DISCUSSION

Two Species of Tilapia were identified in this study. They Include *Tilapia guineensis* and *Sarotherodon melanotheron*.

4.1 Stomach Content Analysis

The stomach contents of Tilapia species found in this study across stations were mainly planted compositions ranging from phytoplankton, plants

parts, etc. indicate that they were herbivorous. They feed mainly on plant food substances such as phytoplankton, plant parts, leaf parts and some percentages of animal food include insect pupae, insect larva and protozoa. Previous findings reported that *Oreochromis niloticus* are obligate herbivores that feed on algal filaments, diatoms and unidentified organic matter [4,13, 14]. Similarly Akintunde & Imevbore [15] reported that the main stomach content of *Synodontis niloticus* is phytoplankton.

Job & Udo [16] and Northcott et al. [17] reported that insects and crustaceans comprise a large portion of the diet of *Oreochromis niloticus* and also reported that *O. niloticus* have the ability to feed on either small or bulky particles and can efficiently filter, and utilize a broad range of particle size [18]. Pauly [19] reported that Blackchin Tilapia feeds primarily on phytoplankton and filamentous algae. The stomach contents of these fish also include granules of mud and sand implying that they suction feed on the bottom of their aquatic habitat.

Tilapia guineensis sampled in all three stations had a mean and standard deviation of 2.29 ± 0.54 implying that the fishes sampled during the study were in good condition. While *Sarotherodon melanotheron* sampled in all the three stations had a mean and standard deviation of 2.29 ± 0.42 implying that the fishes sampled during this study were in a good condition.

4.2 Physico-chemical Parameters

pH levels showed a narrow range of variation between different stations, with the highest (6.63 ± 0.2) mean p^H and the lowest (5.6 ± 0.2). There was significant difference in pH between the stations ($P = 0.00146$).

Temperature levels differed significantly across the stations ($p = < 0.0001$), with range from 25.33 to 26.7°C.

Conductivity in three stations vary significantly (P value = < 0.0001) and ranged between 140 $\mu\text{S/cm}$ to 416.67 $\mu\text{S/cm}$. Crane [20] noted that conductivity values greater than 100 $\mu\text{S/cm}$ were indicative of human activity. According to Russell et al. [21], water conductivity of between 150 and 500 $\mu\text{S/cm}$ is ideal for fish culture. Stone et al [22], however, put the desirable range of conductivity for fishponds at between 100 and 2000 $\mu\text{S/cm}$.

4.3 Length / Weight Relationship

The length-weight relationship in fishes can be affected by a number of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health and preservation techniques, and differences in the length ranges of the specimen caught. The exact relationship between length and weight differs among species of fish according to their inherited body shape, and within a species according to the condition (robustness) of individual fish. The logarithmic values of length were plotted against their logarithmic respective weight on an arithmetic scale, the smooth curve was obtained. Statistical analysis of LWR showed that the regression coefficients obtained from length-weight relationships (LWR) as presented here was a significant correlation between length and weight.

The results from the study showed a strong relationship between the length and weight of the two Tilapia species sampled across stations as shown in Fig. 4 to Fig. 11. The average b values were less than 3 for both species which shows that most of the fishes had a negative allometric growth i.e. most of the Tilapia grows faster in length than in weight. It also indicates when $b < 3$, either that the large specimens have changed body shape, i.e., become more elongated, or the small specimens were in better nutritional condition at the time of sampling. These results agree with the studies of Froese [23] and other fisheries studies (.....) that postulated that there is a strong relationship between the length and the weight of Tilapia species and that generally exhibit a negative allometric growth pattern.

4.4 Condition Factor

The individual fish species condition is determined based on the analysis of length weight data reflecting that the heavier fish at a given length is in better condition [24], hence indicating favourable condition. The Tilapia species found across stations had an average condition factor above two [15]. This shows that the fishes are in a favourable condition and agrees with the studies of *Puntius chola*, [25], *Ailia coilia* [26] and *Botia lohachata* [27].

Condition sometimes reflects food availability and growth within the weeks prior to sampling. However, the condition is variable and dynamic. Individual fish within the same sample vary considerably, and the average condition of each population varies seasonally and yearly.

The differences were attributed to the effect of eutrophication and pollution on growth and other biological aspects of *Oreochromis niloticus* as suggested by Khallaf et al. [28] and Santic et al [29], also observed similar results. The study presented the basic information on length-weight relationships and condition factor of *T. mossambica* of study area which would be useful for fishery managers as well as the sustainable management.

5. CONCLUSION

The stomach contents analysis indicated diverse food sources. The major food source was phytoplankton. Other food samples from plant sources found in the stomach analysis were; leaf plants, plant tissue, etc. The animal sources were insect parts, insect larva, protozoa and others. The stomach content analysis of the sampled fishes provided a baseline study of food and feeding habits of Tilapia species in the sampled stations.

The condition factor for all the fish samples was greater than one. This result is an indication that all the fishes were in a good condition. The condition factor for the sampled fishes in the three sampled stations agreed with the length and weight relationship.

The length and weight relationship in the three sampled stations for the *Tilapia guineensis* and *Sarotherodon melanotheron* showed negative allometric growth, i.e. they were all < 3. This is an indication that fishes grow longer in length than in weight. The length-weight relationship in fishes can be affected by a number of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health and preservation techniques, and differences in the length ranges of the specimen caught. The exact relationship between length and weight differs among species of fish according to their inherited body shape, and within a species according to the condition (robustness) of individual fish.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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