REALISTIC INTERPRETATION OF CONDITION FACTOR USING STOMACH CONTENT ANALYSIS OF *Clarias gariepinus* IN GWALLAGA RIVER, BAUCHI – NIGERIA

[1]ABDULKARIM, M., [2]*YUSUF, Z. A., [1]MISAU, A. B., [3]GARBA, A. M. and [1]MAHMOOD, S.
[1]Department of Animal Production, Faculty of Agriculture and Agricultural Technology,
Abubakar Tafawa Balewa University - Bauchi, Bauchi State – Nigeria
[2]Department of Biological Sciences, Faculty of Science,
Abubakar Tafawa Balewa University - Bauchi, Bauchi State – Nigeria
[3]Department of Fisheries, Bauchi State College of Agriculture,
Bauchi, Bauchi State- Nigeria
*Corresponding Author: email: zecology@yahoo.com

ABSTRACT
The predictive power of condition factor (k) as a biomathematical model (BM) was investigated using a case study of stomach content analysis (SCA) of Clarias gariepinus in Gwallaga River, Bauchi, Nigeria. The river was divided into four stations: Headwater (A), Upper middle (B), Lower middle (C) and Tail water (D). Ten fish were caught fortnightly from each station during the dry season. Eighty fish were collected during the period of the research. Lengths and weights of the fish were measured. The fish were dissected, stomach contents were identified. The stomach repletion levels (SRL) were categorized into five (0, 25, 50, 75 and 100%). The SCA of C. gariepinus revealed Phytoplankton had the highest importance index of 489.3273 out of the seven feed items. $X^2 = 26.078$ $(P > 0.05)$ *showed that there is an association between SRL of the fish and their stations. This was supported by the high k-value of fish from station A (k = 1.1889) but fish from other stations had low k-values with observed low SRL. It was concluded that this research has realistically tested the predictive power of k as a BM through SCA because nutrition contributes strongly to the physiological well-being of an organism.*

Keywords: Detritus, Frequency of Occurrence, Stomach Score, Total length, Volumetric Index

INTRODUCTION

Mathematics, though artistic in its mastery and in the employment of its methodology, however, its output is considered to be objective and universal in its generalization. And because of that, mathematics forms the basis of modeling in the sciences.

Freshwater is an important natural resource crucial for the survival of living things. Lima-junior and Goetein (2001) reported that a very common practice in the studies of fish feeding habits is to determine the diet of the species by analysis of the stomach content. Fulton condition factor (k) is widely used in fisheries studies. This factor is estimated from the relationship between the weight of a fish and its length, with the intention of describing the ''Condition'' of that individual fish (Froese and Pauly, 2012). This research aims at investigating the predictive power of condition factor as a biomathematical model by determining the condition factor, identifing the food items consumed and to find out the association between stomach repletion levels of *C. gariepinus* in Gwallaga River

MATERIALS AND METHODS

Study Area

The study was carried and along Gwallaga Rivers Bauchi, Bauchi State the river was divided into four stations: the head (Lushi), the upper middle (Gwallaga), the lower middle (Gadan Bigi) and the tail (Gudum) as Stations A, B, C and D respectively with an approximate distance 50 meters between two stations. Bauchi State occupies a total land area of 49,119 km² and is located between latitudes 9° 3' and 12° 3' North and longitudes 8° 50' and 11^0 East. It is 69020cm above sea level. It covers an estimated area of about 3,354 square kilometres.

Sample Collection

Ten (10) samples of *Clarias gariepinus* were collected from each station in the Gwallaga River, Bauchi, fortnightly taking two stations twice a week with the help of local fishers using different types of fishing gears from November, 2015 to January 2016. A total of eighty *C. gariepinus* were collected. The Total length of Sample fish was measured to the nearest 0.1cm using 100cm Tape rule. Body weight of each fish was measured to the nearest 0.01g using an electronic digital scale with Model No. A – 110 C.

Stomach Content Analysis

Stomach repletion was indicated as 0 for empty 1, 2, 3 and 4 for 25%, 50%, 75% and 100% of the observed depletion of the stomach respectively as modified from the work of Koubi *et al*. (1990). Volumetric Index (VI) was determined according to the method described by Lima-Junior and Goitein (2001), slightly modified such that the stomach score is shared equally among observed content of each stomach analysed.

$$\text{Mi} = \sum [\text{Stomach Score x } (1/\text{number of feed item in the stomach})] / (\text{total number of Analyzed Stomach}) \quad \ldots 1$$

Where M_i is an average point of each feed item identified

$$\text{VI} = 25 \text{ x Mi} \quad \ldots 2$$

Feed Items in the Stomach, Frequency of Occurrence (*F*) and Importance Index (AI) of Feed Items

Each fish was dissected and gut removed. The stomach was removed and dissected and its content was observed with hand magnifying lens to identify the feed items consumed by the *C. gariepinus.* Frequency of occurrence (*F*) was estimated using the formula below:

$$F = \frac{100\text{ni}}{\text{n}} \ldots. \quad 3,$$

where n_i is the total number of stomachs with feed item i and n is the total number of stomachs with feed item. Importance Index was done as described by Hyslop (1980) for the analysis of stomach content of the fish

$$AI = Fi \text{ x } VIi \quad \ldots 4,$$

where AI_i is Importance Index of the identified feed item in the sample, F_i is the Frequency of Occurrence of the item and VI_i is the Volumetric Analysis Index of the item.

Condition Factor (K)

The condition factor was estimated using the formula:

$$\text{K} = \frac{100\text{W}}{\text{L\^{}3}} \quad \ldots 5,$$

where: W = Body weight of fish (g) and L = Total body length of fish (cm).

Statistical Analysis

Correlation and regression analysis, Condition Factor and Chi–square were carried out using Microsoft Excel 2007.

RESULTS

Table 1 shows Stomach Content Analysis of *Clarias gariepinus* in Gwallaga River, Bauchi Phytoplankton has the highest F = 36.84 while the least was sandy soil and water where both had F = 1.75. However, some feed items might have relatively high F but the quantity might be relatively low. This is why it is very important to consider the Volumetric or gravimetric index of the feed combined with the F as to determine the importance index (AI) from which the feed items can be ranked.

It was observed that zooplankton and maize bran had same F = 14.04 but with varying volumetric indices of 5.5625 and 3.0625 respectively led to varying AI as 78.0975 and 42.9975 which led to different ranking as 4 and 5 for zooplankton and Maize bran respectively. Similarly, sandy soil and water which both had same F = 1.75 were ranked differently as 6 and 7 due to varying volumetric indices values of 0.6250 and 0.3125 giving AI values of 1.0938 and 0.5469 respectively.

Table 2 shows the condition factors of *C. gariepinus* from Gwallaga River, Bauchi. **S**tations A had an average k value of 1.1889 which means that the fish in the station were faring well while stations B, C and D were, 0.8186, 0.7169 and 0.6376 respectively, which all indicated that the fish were in poor conditions However, the overall average k value was 0.8405 for the *C. gariepinus* from the river.

Chi–square (X^2) of association between Stomach Repletion Levels (SRL) of *C. gariepinus* and the sampling stations from which the fish were caught (Table 3) indicated an association with X^2 calculated = 26.078 compared to the critical value of X^2 = 19.675 at degree of freedom, df = 12 ($P > 0.05$). Station A had 0 (empty stomach), the highest number of 50% SRL (12) and highest number of 100% SRL (4) compared to other stations with relatively high numbers of empty SRL of 8, 6 and 9 for stations B, C and D respectively. Also, the other three stations B, C and D had 5, 3 and 4 respectively, which were less than half of 12 to 50% SRL which station A had.

Table 1: Stomach Content Analysis of *Clarias gariepinus* in Gwallaga River, Bauchi

Feed Items	Occurrence Frequency (F)	Volumetric Index (V)	Importance Index (AI) [AI = FV]	Ranking
Phytoplankton	36.84	13.2825	489.3273	1
Detritus	28.07	10.3125	289.1719	2
Insects and Insect Parts	22.81	6.8750	156.8188	3
Zooplankton	14.04	5.5625	78.0975	4
Maize Bran	14.04	3.0625	42.9975	5
Sandy Soil	1.75	0.6250	1.0938	6
Water	1.75	0.3125	0.5469	7

Table 2: Condition factors of *C. gariepinus* from Gwallaga River, Bauchi

Sampling Station	Condition Factor (k) Values			
	Minimum	Maximum	Average	Remark
Head water (A)	0.6662	1.9263	1.1889	Good condition
Upper middle water (B)	0.3986	1.5683	0.8186	Poor condition
Lower middle water (C)	0.5674	1.1814	0.7169	Poor condition
Tail water (D)	0.4113	0.7778	0.6376	Poor condition
All Stations	0.3986	1.9263	0.8405	Poor condition

Table 3: Chi – square (X^2) of Association between Stomach Repletion levels of *C. gariepinus* and the Sampling Stations from which they were caught

Stomach Repletion Level (%)	Sampling Stations				
	A Observed (Expected)	B Observed (Expected)	C Observed (Expected)	D Observed (Expected)	Total Observed
0	0 (5.75)	8 (5.75)	6 (5.75)	9 (5.75)	23
25	4 (4)	4 (4)	4 (4)	4 (4)	16
50	12 (6)	5 (6)	3 (6)	4 (6)	24
75	0 (1.25)	1 (1.25)	4 (1.25)	0 (1.25)	5
100	4 (3)	2 (3)	3 (3)	3 (3)	12
Total Observed	20	20	20	20	80

X^2 calculated = 26.078; critical value of X^2 = 19.675 at degree of freedom, df = 12 ($P > 0.05$)

DISCUSSION

The major feed items consumed by *C. gariepinus* in Gwallaga River as identified in the stomach include; phytoplankton, detritus, insect/insect parts, zooplankton, maize bran, sandy soil and water. The feeding habits were similar to those reported by Fagade and Olanigan (1972) in Lagos lagoon. This ability to exploit the different variety of food makes them omnivorous. Several other workers have also reported on the high degree of overlap in the diet of fishes from the same community (Akinwumi, 2003).

The greater average k value of sample fish from station A (k = 1.1889) recorded in this study agrees with the suggestion of Nehemia *et al*. (2012) that k value of any fish which is equal to or greater than 1 is an indication that such fish is in a good condition. However, fish samples from other stations are lower than 1 indicating that the fish are not in good condition. The main water entrance might be richer in nutrients. As the water flows down through the middle to the tail end of the water, the nutrients dispersed and mix up or consumed by organisms, and became less available to fish. The Condition factor (k) gives information on the physiological condition of fish in relation to its wellbeing (Abdullahi *et al*., 2014). This study revealed that from Table 2, out of the four stations from which the fish samples were collected, 75% of the samples had their k values less than one. This may be most likely due to insufficient feed in the stations B, C and D probably because of onset of the dry season at the time of conducting this research.

X^2 calculated = 26.078 compared to the critical value of X^2 = 19.675 at degree of freedom, DF = 12 ($P > 0.05$) showed that there is an association between stomach repletion levels of *C. gariepinus* and the sampling station from which they were caught. The results of this table 3 agrees with the observations of results obtained from Table 2 such that the average condition factor of samples of fish from station A (k = 1.18889) indicates that they are in good condition and from Table 3, there is no empty stomach (0) among observed samples of station A and the same station has the highest observed sample of 12 of 50% stomach repletion levels. This can be said that there is a varying availability of feed in the microhabitats of the stations with station D having least availability as indicated by its highest observed samples of an empty stomach (9).

CONCLUSION

Fulton condition factor is a common biomathematical model used in predicting the physiological condition of fishes. This study has tested its predictive power by analyzing the stomach content of the fish as the productivity of a water body contributes strongly to the physiological well-being of an organism. This indicates that the fish are not physiologically normal, possibly due to malnutrition as what they feed on from the environment is not sufficient. The overall average condition factor (k = 0.8405) for all the samples of *C. gariepinus* is less than one indicating that the fish species in Gwallaga river are not in good condition. Gwallaga river requires proper management to improve its productivity for the wellbeing of its fish biota.

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