IJABR Vol. 11(1): 35- 43 (2020)

Original article

ANALYSIS OF GUT CONTENT OF RESIDENT FISH SPECIES IN DADIN- KOWA RESERVOIR, GOMBE, NORTH EASTERN, NIGERIA

***Yerima, R.[1]; Usman, L. U. [2]; Bayero, U.[3] and Jibril, J.[4]**

[1]Department of Biological Sciences, Gombe State University, Nigeria
[2]Department of Biology, Umaru Musa Yar'adua University, Katsina State, Nigeria
[3] Department of Biology, Ahmadu Bello University Zaria
[4] Department of Biology, Federal College of Education Zaria

Submitted: March, 2020; Accepted: May, 2020; Published: June, 2020

ABSTRACT

Fish diets represent the integration of many important ecological components, including behavior, condition, habitat use, energy intake, and inter or intra specific interactions among fishes. This study was conducted on the intestinal content of six (6) fish species; *Oreochromis niloticus*, *Clarias gariepinus*, *Bagrus bayad*, *Synodontis clarias*, *Schilbe mystus* and *Mormyrus rume* collected from Dadin-Kowa Reservoir Gombe State between April and June 2018. The techniques used in this study are the Occurrence method for recording the stomach content, gravimetric method to assess the net weight of individual per stomach in each food category, volumetric (displacement) technique used for the estimation of different food items and Index of preponderance used to assess the relative value of various organisms in the fish diet. The preponderance of empty stomachs was also recorded. The results obtained expressed in percentage indicated that out of the One hundred and seventy-three (173) fish species examined, 26.6% fish had an empty stomach content, while 73.4% fishes contained sixteen (16) different food items comprising of Insect larvae, worms, crustaceans, plant detritus, mud/sand, Spirogyra sp, fish part, copepods, green algae, water mite, prawn part, diatoms, bivalves, cyanophyta, small fish, and brown algae. The highest frequency of occurrence of the food item (crustaceans) was observed in *O. niloticus* with 24.4% while volumetric and gravimetric were 32.58% and 29.76 % respectively. For *Clarias gariepinus*, the least frequency occurrence was observed in fish parts (13.38%), while in *Bagrus bayad* highest volumetric was observed in insect larvae (31.37%). In *Synodontis clarias* highest gravimetric was observed in copepods (24.83%) while the least was observed in plant detritus (10.91%). In *Schilbe mystus* highest volumetric was observed in copepods (31.97%) while the least was observed in worms (10.29%). The highest gravimetric in *Mormyrus rume* was recorded in crustaceans (28.97%) while the least was observed in plant detritus (13.49%). The study revealed the relative importance of copepods and insect larvae as the major group of food items for fish diet in the Dadin Kowa reservoir. All the studied fish species were omnivorous and have the same ecological niche.

Keywords: Dadin Kowa Reservoir, Resident fish, Gut contents, Gravimetric, Volumetric

***Corresponding author: ymsultan6@gmail.com [+2348030891930]**

INTRODUCTION

Fish require nutrients for growth, reproduction, and other normal physiological functions. Fish food in a natural aquatic environment includes phytoplankton, zooplankton, plant materials, insect larvae, worms, and small fish [1, 2]. Intestinal content analysis is widely used to determine the food and feed habits of fish species. Fishes are classified into three main groups based on their feeding habit, herbivores; fish that feed only on plants and plant material, carnivores; feed on the flesh-and are further divided into piscivorous- fish that prey on other fish, and omnivorous, fish that feed both on plants and animals [3]. All fish require energy from their food sources for growth, reproduction and migration [4]. Understanding the eating and feeding habits of fish is useful in decision-making process related to natural resources and quantifying the threat of introducing invasive fish species to native fish populations [5, 6]. Also, it provide information for assessing ecosystem integrity and functional redundancy assemblies for understanding subjects such as resource partitioning, habitat preferences, prey selection, and for developing conservation strategies [7, 8]. The intestinal content analysis helps to determine the most frequently consumed prey and the relative importance of different types of food to the fish nutrition and to quantify the rate of consumption of individual prey types. Moreover, the intestinal content of fish helps to understand the inter-specific relationship and productivity of the water bodies [9].

Thorough knowledge of the food and feed habits of fish is key to the selection of cultivable species, and a great deal of information is needed for successful fish farming. The eating habits of different fish vary from month to month. This variation is due to changes in the composition of food organisms occurring in different seasons of the year [10]. Fish diet changes with several factors that are either extrinsic [biotope, region] or inherent [species, size, behavior] and therefore information on fish diets is important for understanding the basic functioning of fish assemblies that are important for the development of Ecosystem-Based Fisheries Management [EBFM] models [11, 12]. Examining the fish feeding habit has incredible significance both in Fisheries and Aquaculture, in fisheries it gives information on the distribution pattern and the feeding ground of both local and regional, furthermore, it has a direct implication for fishing gears, for example, longline and fish trap which use as bait. While in aquaculture the information on food items requires the hatchlings to give distinctive live food at various life stages [13]. The present study aims to generate baseline data for the feeding habits of some resident fish species in the Dadin Kowa reservoir since it plays a major role in fisheries and food web in the aquatic ecosystem.

MATERIALS AND METHODS

Study Area

Dadin-Kowa Reservoir is located 5 km north of Dadin-Kowa village [about 37 km from the town of Gombe, along the Gombe-Biu road] in the Yamaltu Deba local government area of Gombe State. The area lies at lengths 110 30' E and 110 32' E and 100 17' and 100 18° N of the equator. The reservoir is located approximately 35 kilometers from East Gombe, providing drinking water to the city and has a capacity of 800 million cubic meters of water and a surface area

of 30,000 hectares [14]. The majority of Dadin-Kowa's surrounding settlements depend on agriculture as a major source of livelihood. It is essentially an agricultural society that produces agricultural products such as millet, rice, maize and fruit and is engaged in activities that include fishing and hunting, among others [15].

Sampling and Identification of fish

One hundred and seventy-three [173] individual fish species were randomly collected from the local fishers in the Dadin-Kowa reservoir monthly between April to June 2018 and placed in an ice and transported to the laboratory for identification and analysis. Fish samples were identified using descriptive keys, such as Holden and Reed [16] and Babatunde and Raji [17].

Gut Content Analysis

Each fish specimen was placed on a clean, disinfected bench and split open, making a longitudinal incision along the mid-ventral line from the mouth to the anus to expose the visceral organs. The contents were emptied on the Petri-dish and stored immediately in 4 % formalin for subsequent examination of the food items. The weights of each food item were measured with a sensitive digital balance. The stomach content was sorted into a various group of food items. For each stomach, the volume and weight of the preserved individual in each prey taxon were recorded. Prey weights were scaled up to represent digestion by reference to a range of sizes of undigested prey specimens. Identification of prey was done by visual and use of a microscope as adopted from Liao et al. [18], Chipps and Garvey [19], Ahlbeck et al. [20], Baker et al. [21] and Manko, [22]. Stomach content in an advanced condition of processing was not utilized for the examination. For every food item, the following parameters were determined; frequency of occurrence method, the significance is inferred from the proportion of total intestines containing each food item [23, 21]. Quantity of stomach containing at least one individual of every food category was recorded and expressed in percentage of all stomach or each one of those containing food [24, 25, 13]. Frequency of occurrence, $\% Oi = \frac{Ni}{N} X\ 100$ Where: % O is the frequency of occurrence of given food i, Ni is the number of stomachs containing prey i, N is the total number of stomachs with some food. The number method is based on the count of food items in the intestine. The number of individuals in each food category in each stomach was recorded and expressed as a percentage of the total number of food items in all the fish stomachs examined or as a proportion of the food items in each stomach of the fishes examined, which increased to the total percentage [26, 27, 13]. The gravimetric method, the net weight of individuals per stomach in every food category was recorded for all stomachs and the total is expressed as a percentage of the total net weight of all food categories. Displacement [volumetric] technique as proposed by Pillay [28] was adopted for the estimation of different food items, an index of relative importance formed the basis of the evaluation of prey significance. The overall estimation of various organisms in the diet was assessed by the index of preponderance [Ip] as given below: Ip= [ViOi /Σ[ViOi]*100 where Vi and Oi are percentage volume and occurrence of particular food item i percentage preponderance index [% Ip] was arrived as % Ip= [Ip/ΣIp] *100 [29, 30, 13]. Individual stomach fullness degree was examined according to the subjective scale, it ranges from [empty] to ¾ full. Ranking Index [RI] was determined by multiplying the mean volumetric

percentage and rate frequency of occurrence.

RESULTS AND DISCUSSION

The stomach content of 173 individual fishes examined comprising of *Oreochromis niloticus*, *Clarias gariepinus*, *Bagrus bayad*, *Synodontis clarias*, *Shilbe mystus* and *Mormyrus rume* is depicted in Table 1. Forty-six (26.59 %) of 173 fishes examine had an empty stomach. From this investigation, the food item of the fishes was sorted into sixteen (16) different groups. The stomach content was comprised of insect larvae, worms, crustaceans, plant detritus, mud/sand, spirogyra sp., fish part, copepods, green algae, water mite, prawn part, diatoms, bivalves, cyanophyta, small fish, and brown algae. The gut content of individual fish species examined indicated that the fishes fed on a wide variety of food items, for example, *Clarias gariepinus* major food items were insect larvae (29.13%), Copepods (46.11%) and Green algae (17.32%). *Oreochromis niloticus* fed majorly on Crustaceans (24.4%). *Bagrus bayad* highest frequency of food items was water mite (18.62%), prawn part (12.87%), and insect larvae (11.81%). *Synodontis clarias* major feeds were fish part 20.47% and Copepod 30.7%. *Schilbe mystus* highest food items were Copepod 28.02% and part of small fish 19.68%. *Mormyrus rume* major food item was Crustacean 29.13% (Table 2). All the studied fishes were observed to feed both on some plant material as well as animal parts (Omnivores) which are in line with the findings and observations made by Burton [31] who stated that fishes are considered to be omnivorous displaying both scavenging and predatory behavior. The results obtained in this study showed that the most frequent food items are animal materials (copepod and insects larvae).

Table 1: The analysis of the gut content of the resident fish species in Dadin- Kowa Reservoir Gombe State from April to June 2018.

Month	Species	No. of sample	Stomach with food	% of stomach with food	Empty stomach	% of empty stomach
April	*Oreochromis niloticus*	15	11	73.33	4	16
	Clarias gariepinus	9	7	77.77	2	8.33
	Bagrus bayad	12	11	91.66	1	25
	Synodontis clarias	8	8	100	0	0
	Schilbe mystus	6	6	100	0	0
	Mormyrus rume	12	9	95.00	3	25
May	*Oreochromis niloticus*	4	3	75.00	1	25
	Clarias gariepinus	8	6	75.00	2	25
	Bagrus bayard	15	15	10.00	0	0
	Synodontis clarias	7	4	57.14	3	42
	Schilbe mystus	7	3	42.85	4	57.14
	Mormyrus rume	9	6	66.66	3	33.33
June	*Oreochromis niloticus*	8	7	87.50	1	12.5
	Clarias gariepinus	16	10	62.50	6	37.5
	Bagrus bayard	6	4	66.66	2	33.33
	Synodontis clarias	10	3	30.00	7	70
	Schilbe mystus	11	9	81.81	3	27.27
	Mormyrus rume	10	6	60.00	4	40

Since no single technique for stomach content examination is satisfactory for defining the significance of any one food item, a multi-technique methodology was adopted in the study, to limit possible bias of every methodology. From the whole food item devoured by the resident fish's copepod and insect larvae made the major component of the entire content of the fish stomach by volume and by weight. The highest percentage frequency of occurrence (PFO) of copepods and insect larvae in the fish stomach content was found to be 46.11% and 29.13% in *C. gariepinus* respectively while the least of PFO was 7.08% observed in Plant detritus. The findings from the present study show in *O. niloticus* highest frequency of occurrence was observed in crustaceans 24.4% while it's volumetric and gravimetric were 32.58% and 29.76% respectively. *Clarias gariepinus* least frequency occurrence was observed in fish part (13.38%), while In *Bagrus bayad* highest volumetric was observed in insect larvae (31.37%). In *Synodontis clarias* highest gravimetric was observed in copepods (24.83%) while the least was observed in plant detritus (10.91%). In *Schilbe mystus* highest volumetric was also observed in copepods (31.97%) while the least was observed in worms (10.29%). The highest gravimetric in *Mormyrus rume* was recorded in crustaceans (28.97%) while the least was observed in plant detritus (13.49%) (Table 2). An index of the relative importance of prey or index of preponderance indicates copepod ranked first which is 91% (Figure 1). The intensity of feeding was evaluated based on the distension of the stomachs and was categorized as empty, ¼ full, ½ full, ¾ full, and full. The empty and ¼ full stomachs were considered as inadequately fed and others as effectively fed.

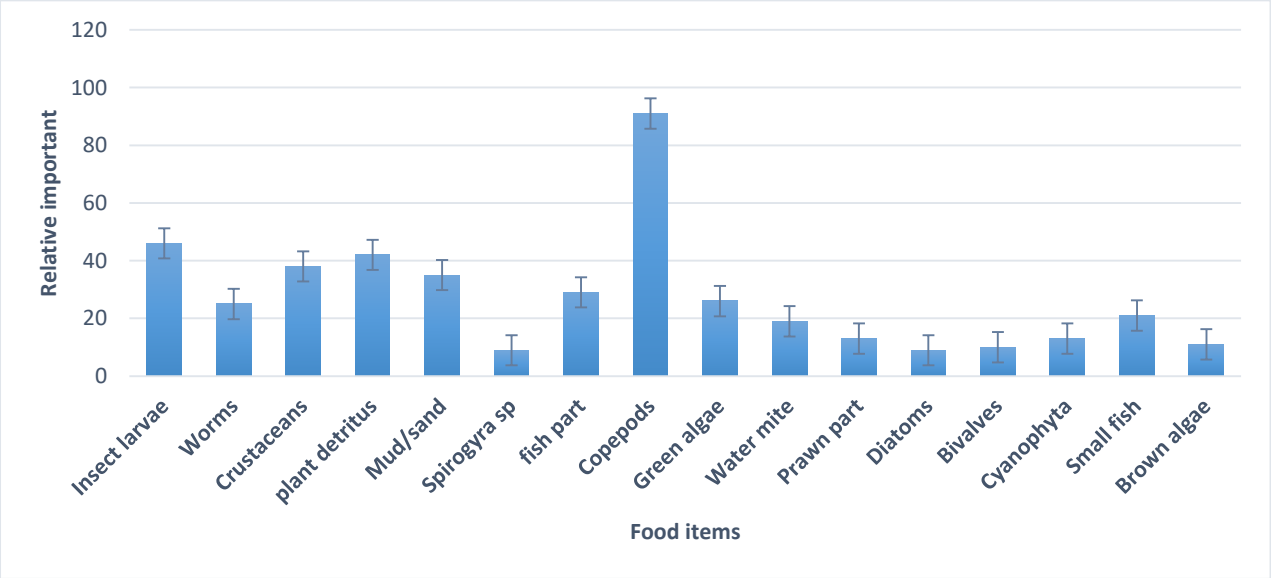

Figure 1: Mean index of relative importance of prey or index of preponderance in the fishes of Dadin kowa reservoir

Table 2: Volumetrically and gravimetrically indices of the food item group in resident fishes of Dadin kowa reservoir

Fish species	Food items	Food composition	Frequency occurrence %	volumetric %	Gravimetric %
O. niloticus	Insect larvae	12	9.45	17.63	15.34
	Worms	8	6.29	4.96	10.02
	Crustaceans	31	24.4	32.58	29.76
	plant detritus	10	7.87	15.47	13.85
	Mud/sand	25	19.68	22.56	21.75
	Spirogyra sp	9	7.08	6.48	9.11
C. gariepinus	Insect larvae	37	29.13	20.06	17.94
	fish part	17	13.38	18.42	12.05
	plant detritus	19	14.96	16.51	22.46
	Copepods	86	46.11	33.74	27.92
	Green algae	22	17.32	11.08	19.38
B. bayad	Insect larvae	15	11.81	31.37	26.83
	Plant detritus	7	5.51	13.04	18.91
	Water mite	24	18.62	22.56	25.44
	Prawn part	16	12.87	20.07	16.07
	Diatoms	11	8.66	12.94	12.73
S. clarias	Fish part	26	20.47	22.57	18.66
	Plant detritus	9	7.08	9.42	10.91
	Bivalves	10	7.87	11.95	15.44
	Copepod	57	30.7	28.63	24.83
	Cyanophyta	25	18.83	11.79	11.04
	Mud/sand	21	14.4	15.63	19.11
S. mystus	Small fish	25	19.68	23.76	28.04
	Worms	17	13.38	10.29	13.66
	Insects larvae	22	17.32	22.01	18.32
	Copepod	43	28.02	31.97	25.16
	Brown algae	25	17.55	11.95	14.81
M rume	Crustacean	37	29.13	33.52	28.97
	Small fish	19	14.96	19.11	21.06
	Plant detritus	17	13.38	15.21	13.49
	Copepod	23	18.11	21.76	19.83
	Green algae	10	7.87	10.23	16.49

The current study also indicated that copepod was the major food item in most of the fishes. Insect larvae, mud/sand, and fish part were seen in the fish guts, this can be attributed to their feeding at the bottom or feeding on dead fish as observed by Larris et al. [32] on fishes inhabiting Lake Victoria, in South Africa, which indicated that fish species did not rely solely on offshore and benthic invertebrates at high lake level, but that they readily switched their feeding to coastal zones and invertebrates when they became abundant. In addition to the

substantial amount of animal material found in the stomach of resident fish species, a high proportion of zooplankton (copepod) was consumed by these fish. The use of zooplankton as food by this species in the reservoir is likely to be because their large sub-terminal mouth enables them to suck in large amounts of water that washed through the gill for filter feeding. Also, mud /sand grains were observed in the stomachs of *O. niloticus* and *S. clarias*. Moreover, the stomach contents were dark greenish in color when sand grain was present. Spirogyra and plant detritus was also found as a constituent of the gut content, these suggest that the entry of mud/sand into the stomach was not accidental but could be due to the bottom-feeding habit of the fish occasionally. Shalloof and Khalifa, [33] reported *O. niloticus* are herbivores with the highest percentage of the occurrence of higher plant residues at 49.2% and 60.3 %, respectively. This is not in line with the findings of this study, as a result of different sampling approaches may cause different values of stomach loss through regurgitation. David et al. [34] also observed that the presence of tiny unicuspid teeth in the mouth of fish indicates that fish species feed on water lilies plants, leaves, buds, and seeds and are therefore herbivorous feeders.

CONCLUSION

The present study indicates that the food consumed by the fish living in different waters varies to a certain degree depending upon the requirements of the environment. From the 173 studied fishes, 26.6% was observed to have empty gut content (or more digested food items that cannot be identified). However, the most common food items found in most of the fish's stomach were copepod, insect larvae, and plant material. The study reveals the relative importance of copepods and insect larvae as the major group of food items for fish diet in the Dadin Kowa reservoir. All the studied fish species were omnivorous and have the same ecological niche. The availability of food supplies in the environment is very important for fish, as is the case for any organism, and fish require adequate nutrition to grow and survive.

REFERENCES

1. Bagenal, T. B. (2002). "*Aspects of fish fecundity" in Ecology of freshwater fish production*. 9th ed., D. Shelb, Oxford: Blackwell scientific publication 2002, pp, 166-177.

2. Omondi, R., Yasindi, A. W. & Magana, A. M. (2011). "Spatial and temporal variations of zooplankton in relation to some environmental factors in lake Baringo, Kenya". Eger. *J. Sci. Technol.,* 11:29- 50.

3. Ogueri, C. (2001). *Fish Biology simplified*. Nimsay printing and publishing Co. Nig. Ltd. 90pp.

4. Gwana, A. M., Mshelia, N. H., Abdullahi, M.M., Auwal, M. S., Bagudu, B. Y., Mala, B. M., Abdullahi, H. M. & Sadiq, A. B. (2014). Effects of Domestic Wastes on Water from Shallow – Wells in Moduganari, Nigeria." *International Journal of Environmental Monitoring and Analysis*. 2(4): 185-190. doi: 10.11648/ijema. 20140204.11

5. Fritts, A. L. & Pearsons, T. N. (2004). Smallmouth bass predation on hatchery and wild salmonids in the Yakima River, Washington. *Transactions of the American Fisheries Society*, 133(4): 880-895.

6. Kido, M. H. (2014). Morphological variation in feeding traits of native

Hawaiian stream fishes. *Pacific Science*, 50 (2): 184-193.

7. Matthews, W. J., Bek, J. R. & Surat, E. (19842). Comparative ecology of the darters Etheostoma podostemone, E. flabellare and Percina roanoka in the upper Roanoke River drainage, Virginia. *Copeia*, 805-814.

8. Usman, L. U. & Adakole, J. A. (2017) Biodiversity Assessment of Some Benthic Macro Invertebrates in Ajiwa Reservoir, Katsina State, Nigeria. *UMYU Journal of Microbiology Research*, 2(1): 107-113.

9. Mi, K., Khin, Y. M. K. & Nyunt, L. (2019). Food and feeding habit of some freshwater fishes from Ayeyawady River, Myitkyina Township Kachin State, Myanmar. *International Journal of Entomology Research*, 4(4):96-100.

10. Oronsaye, C.G. & Nakpodia, F.A. (2005). A comparative study of the food and feeding habits of *Chrysichthy nigrodigitatus* and *Brycinus* nurse in a tropical river. *Pakistan journal of scientific and industrial research,* 48(2):118-121

11. Hanson, J. M. & Chouinard, G. A. (2002). Diet of Atlantic cod in the southern Gulf of St. Lawrence as an index of ecosystem change, 1959 -2000. *J. Fish Biol*., 60(4): 902-922.

12. Kulbicki, M., Bozec, Y. M., Labrosse, P., Letourneur, Y. & Mou-Tham G. (2005). Diet composition of carnivorous fishes from coral reef lagoons of New Caledonia. *Aquat Living Resour*, 18(3): 231-250.

13. Nath, S. R., Beraki, T., Abraha, A., Abraham, K., Berhane, Y. (2015). Gut Content Analysis of Indian Mackerel (Rastrelliger kanagurta). *J Aquac Mar Biol* 3(10): 00052. DOI: 10.15406/jamb.2015.03.00052

14. Upper Benue River Basin Development Authority (UBRBDA) 1980). Dadin-Kowa Resettlement Project, Draft final report. Vol. 2. Pp 16-27

15. Ahmed, F. F. & Philip, U. J. (2012). The impact of the second national Fadama development Program on the standard of living of Dadin-Kowa community of Yamaltu-Deba Local Government of Gombe State (2004-2010). *Academic Research International*, 2(2): 549- 554.

16. Holden, M. & Reed, W. (1992). *West Africa Freshwater Fishes*. Longman Limited, London pp: 33.

17. Babatunde, D.O. & Raji, A. (2004). *Field guide to Nigeria freshwater Fisheries*", Newbusa (Nigeria) Federal college of Freshwater Fisheries Technology, second edition; 47-49.

18. Liao, H., Pierce, C. L & Larscheid, J. G. (2001). Empirical assessment of indices of prey importance in the diets of predacious fish. *Trans. Am. Fish. Soc.,* 130 (4): 583-591.

19. Chipps, S. R. & Garvey, J. E. (2007). Assessment of food habits and feeding patterns, In: Guy, C. S & Brown, M. L. (eds). Analysis and interpretation of freshwater fisheries data. *American Fisheries Society, Bethesda*. MD. 961.

20. Ahlbeck, I., Hansson, S. & Hjerne, O. (2012). Evaluating fish diet analysis methods by individual-based modeling. *Can. J. Fish. Aquat. Sci.*, 69 (7): 1184-1201.

21. Baker, R., Buckland, A. & Sheaves, M. (2014). Fish gut content analysis: robust

measures of diet composition. *Fish,* 15 (1): 170-177.

22. Manko, P. (2016). *Stomach content analysis in freshwater fish feeding ecology*. University of Presov, ISBN 9788055516134. p.114.

23. Hyslop, E. J. (1980). Stomach contents analysis. A review of methods and their application. *Journal of Fish Biology*, 17: 411-429.

24. Frost, W. E. (1946). On the food relationships of fish in Windermere. *Biol. Jaarb.*, 13, 216–231.

25. de Crespin, B. V, Dolédec, S. & Chessel, D. (2000). Biplot presentation of diet composition data: an alternative for fish stomach content analysis. *Journal of Fish Biology*, 56, 961-973.

26. Hynes, H.B. N. (1950). The food of the freshwater sticklebacks (*Gastrosteus aculeatus*) and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes. *Journal of Animal Ecology*, 19, 36-58.

27. Lima-Junior, S. E. & Goitein, R. (2001). A new method for the analysis of fish stomach contents. *Acta Scientiarum*, 23, 421-424.

28. Pillay, T.V.R. (1952). A critique of the methods of study of fishes. *J. Zool Soc* 4(2): 185-200.

29. Natarajan A.V. & Jhingran, A. G. (1961). Index of Preponderance - a method of grading the food elements in the stomach analysis of fishes. *Indian J Fish,* 8(1): 54-59.

30. Marshall, S. & Elliott, M. (1997). A comparison of univariate and multivariate numerical and raphical techniques for determining inter- and intraspecific feeding relationships in stuarine fish. *J. Fish Biol.* 51, 526–45.

31. Burton, M.N. (1994). The Biology of *Clarias gariepinus* in Lake, Sibaya, kwazulu with emphasis on the role as the predator. Unpublished, Department of Zoology Institution for Freshwater Studies, Rhodes University.

32. Larris, M., Okeyo-Owuor, J.B., Muchiri, M. & Cowx, I.G. (2004). "Shift in the food of Nile Tilapia, *Oreochromis niloticus* (L.) In Lake Victoria, kenya," *African Journal of Ecology,* 42, 163-170.

33. Shalloof, K.A.S. & Khalifa, N. (2009). "Stomach contents and feeding habit of *Oreochromis niloticus* (L.) from Abu-Zabal lakes, Egypt. *World Applied Science Journal*, 6(1):1-5.

34. David, N. D., Johnson, T. B., Heath, D. D. & Ludsin, S. A. (2010). Water temperature and prey size effects on the rate of digestion of larval and early juvenile fish. *Transactions of the American Fisheries Society*, 139(3), 868-87.