Distribution of Stomach Food Content of Fish Species Collected from Industrial Waste Water Effluents a Case Study of Jakara Dam, Kano, Nigeria

I. Badamasi

***Abstract*—Industrially polluted Jakara dam water sample was analyzed; surface water temperature ranges 19.3^{0C}- 27.8^{0C}, pH 6.3-8.4, electrical conductivity 87.5–117.3 us cm^{-1}, chloride concentration was 0.5–1.4 mg L^{-1}, dissolved oxygen 3.7- 5.0 mg L^{-1}, BOD$_5$ 2.1-3.1 mg L^{-1}, Lead 0.02-0.05 mg L^{-1}, Zinc 0.02-0.21 mg L^{-1}, turbidity19.8-90.0 FAU, transparency 100-368mm, and total dissolved solids 43.3-58.6 mg L^{-1}. Lead and Zinc were above the average concentration desirable limit. Species relative abundance recorded using gills and cast net sampling gears; *S. gallilaeus* (32%), *O. niloticus* (32.9%), *T .zilli* (26.3%), and *C. gariepinus* (8.8%). 300 samples of *S. gallilaeus* examined, 214 (71.3%) had food items in their stomach. *T. zilli samples* recorded 246 which includes 190 (77.2%) with food items whereas 56 (22.8%) had empty stomach. 308 *O. niloticus* stomach examined, 240 (79.9%) were identified with food items in stomach. *C. gariepinus* were 82 with 70 (97.2%) consisting of various food items. Plant materials, insects, insect larvae and smaller fishes were the predominant food items identified**

***Index Terms*—Fish species, Industrial effluents, Jakara dam, stomach food.**

I. Introduction

Food and feeding habits of fishes vary from individual fishes, it depend on fish species, food availability, industrial waste discharge, age and spawning seasons [1]. Fish require nutrients for growth, reproduction and other normal body physiological functions; food of fishes in a natural aquatic environment includes phytoplankton, zooplanktons, plant materials, insects, insects' larvae, worms and smaller fishes. Food availability determined the well being of fishes as well as their reproductive potentialities in any aquatic ecological system. Weight and size of fish is a reflection of food availability in the aquatic ecosystem. Aquatic ecosystems are particularly vulnerable to environmental change and many are, at present, severely degraded by industrial waste effluent [2]. The availability of good quality water is an indispensable feature improving quality of life. Physico-chemical properties will also help in the identification of sources of industrial pollution, for conducting further investigations on the ecobiological impacts and for initiating necessary steps for remedial actions in case of industrially polluted water bodies [3], [4]. Therefore, the nature and food availability of any aquatic community are an expression of quality of the water, increase in human population, demand for food, land conversion, and use of fertilizer have led to faster degradation of many freshwater resources.

The discharge of urban, industrial, and agricultural wastes has added the quantum of various harmful chemicals to the water body considerably altering their inherent physico-chemical characteristics [5]. The monitoring of quality of such surface waters by estimating its food productivity is among the major environmental priorities as it permits direct assessment of the status of ecosystems that are exposed to deleterious anthropogenic factors. The alteration in physico-chemical parameters leading to eutrophication has become a widely recognized problem of water quality deterioration [6].

There is the need for frequent, stomach food composition assessment of fishes in Jakara dam because of the frequent discharge of industrial and domestic wastes in to the reservoir that affects food productivity, feeding behavior of fishes and alters the water quality, which is baseline of the work.

II. Materials and Methods

A. The Study Area

Jakara dam was impounded in 1976; the major tributaries of the reservoir are River Jakara and River Getsi which receives most of Kano cities domestic and industrial waste water. The dam lies between longitude 8^0 31^1 to 8^0 45^1 E and latitude 20 ^{0} 13^1 to 12^0 10^1 N in Wasai, a village in Minjibir Local government area of Kano state, about 45km from the state capital .The major fishing sites of Jakara dam includes Bangare, Zango, Madaho, Bela, Kampa Yabawa, Gandu, Kampa, Gandu, Lungun-Tsamia and Lungun- Kore.

B. Analysis of Water Sample

The water samples were collected fortnightly from four sampling points; JD$_1$, JD$_2$, JD$_3$ and JD$_4$ between 8 and 10 a.m. from January, 2012 to December, 2012. The four sampling points were selected base on morphometric characteristics and average values of samples were taken for each parameter studied. Water samples were collected in cleaned and rinsed plastic containers of two-liter capacity. Physico chemical parameters as pH and temperature were measured on site using a pH meter (Metrohm, 632 models) and mercury bulb thermometer respectively. Conductivity

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I. Badamasi is with the Department of Science Laboratory Technology, Kano State Polytechnic Kano, Nigeria (e-mail: bodmastech1@yahoo.com).

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of water sample was also measured in the field by a conductivity meter. Chloride, lead and zinc were analyzed according to the standard methods described by [7]; biochemical oxygen demand (BOD) and dissolved oxygen (DO) were analyzed using the alkaline-azide modification of Wrinkler's titration method [8].

C. Fish Sampling and Stomach Content Analysis

Fish samples were collected from each of the sampling stations; JD_1, JD_2, JD_3 and JD_4 fortnightly using a number fishing gears such as gill nets, cast nets, traps and hooks with help of fishermen. The study period lasted for twelve months January, 2012 to December, 2012. Fish captured were immediately identified, counted and their total lengths measured to the nearest mm, they were stored under ice and rapidly transported to the laboratory for analysis. Fish lengths were categorized into two size groups of 20-49 mm total length (TL) representing juvenile fish, and 50 mm (TL) and over to represent adult fish.

The method employed for stomach content examination was frequency of occurrence method [9], [10]. Representative samples of juvenile (428) and adult (508) fishes were dissected, guts removed and fixed in a mixture of 10% formaldehyde, glacial acetic acid and 50% ethanol in a ratio of 5:5:90. The fix stomach was preserved in 5% formalin for 3-5 days, after preservation, the stomach contents were identified microspically and macrospically, sorted and enumerated. The number of fishes with each food items occurs was listed as a percentage of the total number of fish examined. The number of occurrence of all food items was often summed and sealed down to a percentage basis; this gave the percentage composition of the food. Stomach fullness was also examined using Points method [10]. Each food item was awarded points in relation to its estimated contribution to stomach volume. Thus points were awarded from 1 to 4 as follows: 1 = ¼ full stomach; 2 = ½ full stomach; 3 = ¾ full stomach; 4 = full stomach. The percentage contribution of each food item to stomach fullness in each size class was then determined on the basis of the awarded points.

III. RESULTS

Result of mean values of the physicochemical parameters of water samples from the four sampling points on Jakara dam were presented in figure 1 to figure11, displaying mean monthly variations as follows: surface water temperature 19.3℃ - 27.8℃, pH 6.3-8.4, electrical conductivity 87.5–117.3 us cm^{-1}, chloride 0.5–1.4 mg L^{-1},dissolved oxygen 3.7- 5.0 mg L^{-1}, BOD_5 2.1-3.1 mg L^{-1}, Lead 0.02-0.05 mg L^{-1}, Zinc 0.02-0.21 mg L^{-1}, turbidity19.8-90.0 FAU, transparency 100-368mm, and total dissolved solids 43.3-58.6 mg L^{-1}.

Table I Represents result of the total number of fish species collected in Jakara dam between January to December, 2012, *Sarotherodon gallilaeus, Tilapia zilli, Oreochromis niloticus* and *Clarias gariepinus* were encountered. Their stomach food contents were analyzed and enumerated.

A total of 300 samples of *S. gallilaeus* examined, 214 samples (71.3%) had food items in their stomach while 86 samples (28.7%) had an empty stomach. Out of 214 samples of *S. gallilaeus* that had food items in their stomach, 42.0% consists of unidentified food materials, 58.0% had being identified with food items in their stomach. The identified foods item includes; insect parts and plant materials 17.3% and 40.7% respectively.

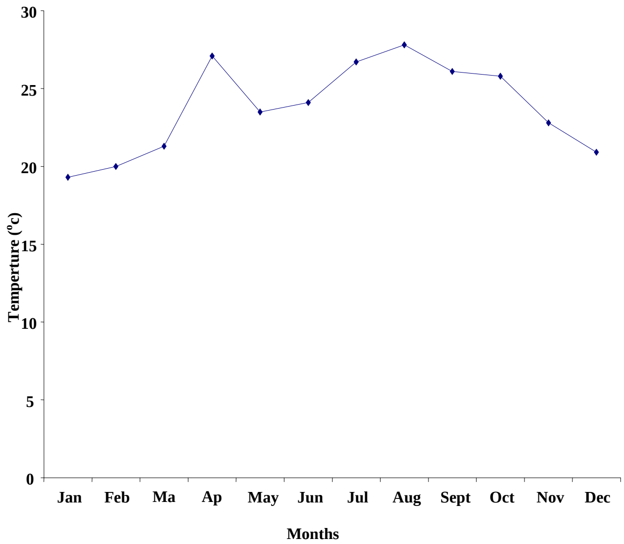

Fig. 1. Monthly temperature variations in Jakara lake.

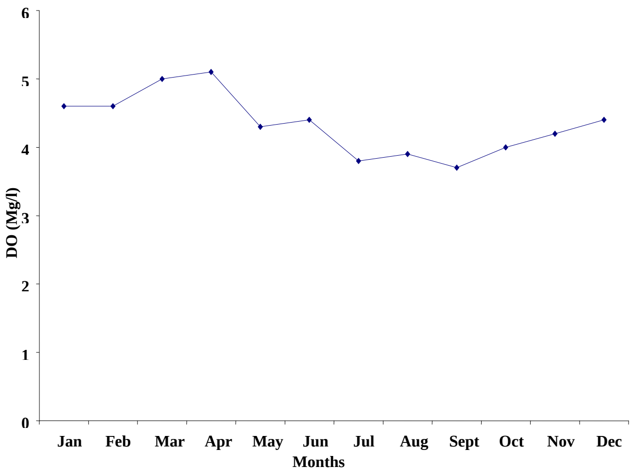

Fig. 2. Monthly DO variations in Jakara lake.

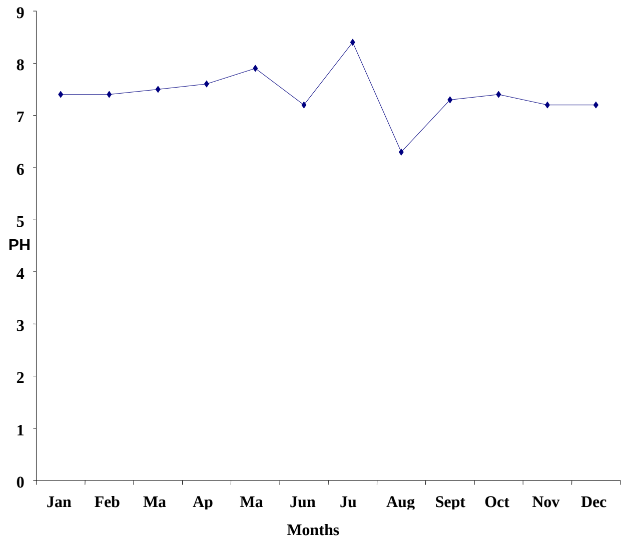

Fig. 3. Monthly PH values in Jakara lake.

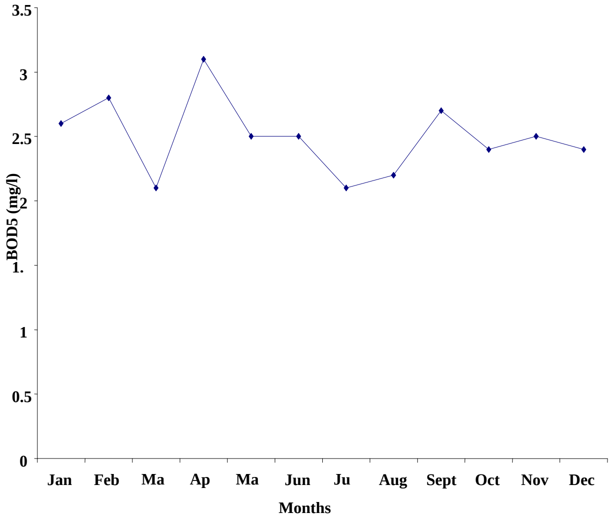

Fig. 4. Monthly BOD5 (mg/l) in Jakara lake.

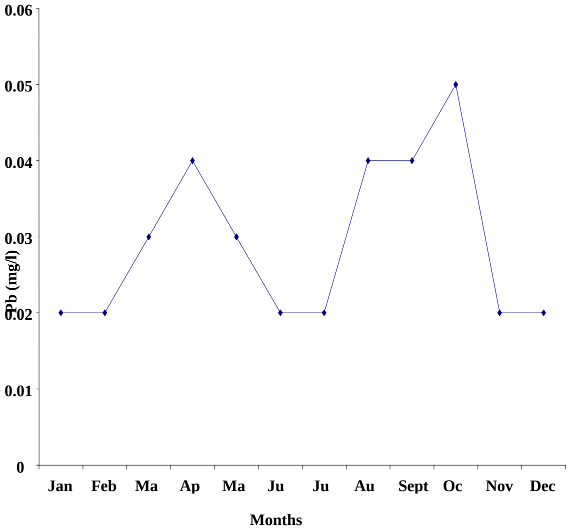

Fig. 5. Monthly Lead concentration in Jakara lake.

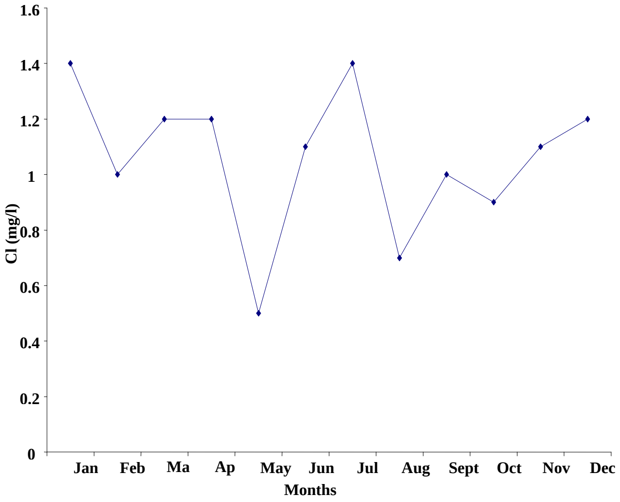

Fig. 6. Monthly chloride concentration in Jakara lake.

A total of 246 *T. zilli* samples examined, 190 samples (77.2%) have been identified with food items in their stomach, 56 samples (22.8%) with empty stomach and 67 samples (35.2%) contained unidentified food items while 123 samples (64.8%) includes, 10 samples (5.3%) insect parts, 21 samples (11.1%) insect larvae and 99 samples (48.4%) were plant materials. 308 samples of *O. niloticus* stomach examined, 240 samples (79.9%) were found with food items in their stomach and 68 samples (22.1%) had empty stomach, 59 samples (24.6%) stomach food items were unable to be identified. Moreover, 181 samples (75.4%) contained food items which include; 39 samples (16.2%) insect part, 36 samples (15.0%) insect larvae and 106 samples (44.2%) plant materials.

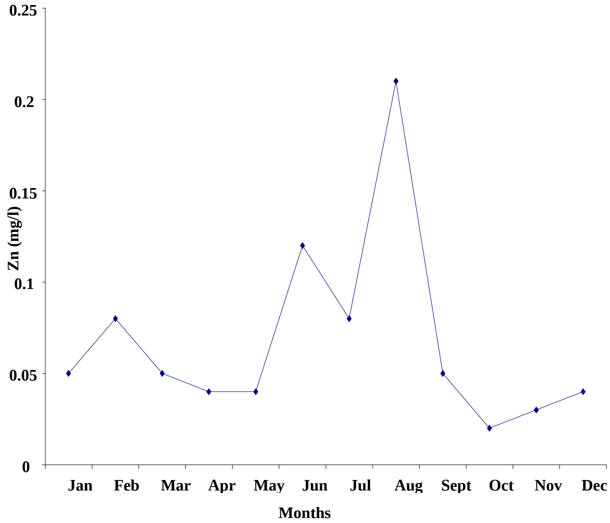

Fig. 7. Monthly zinc concentration in Jakara lake.

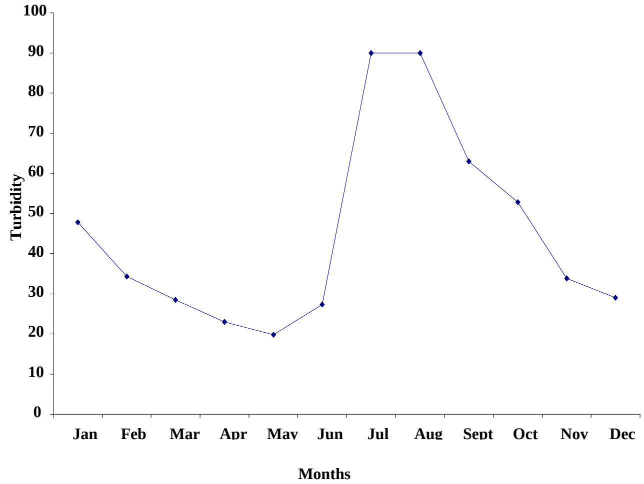

Fig. 8. Mean monthly turbidity in Jakara lake.

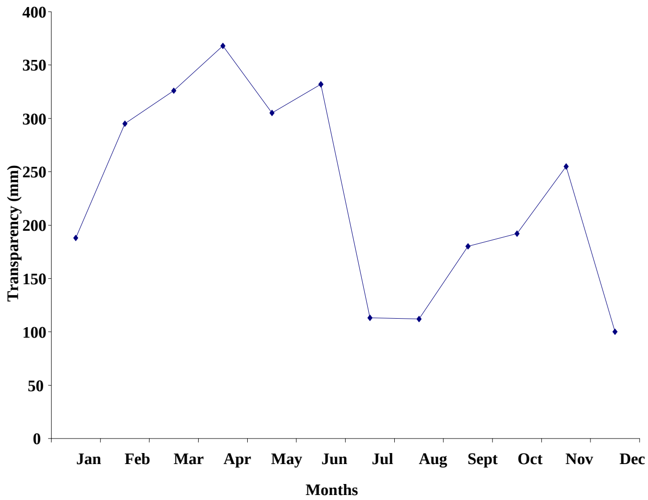

Fig. 9. Mean monthly transparency in Jakara Lake.

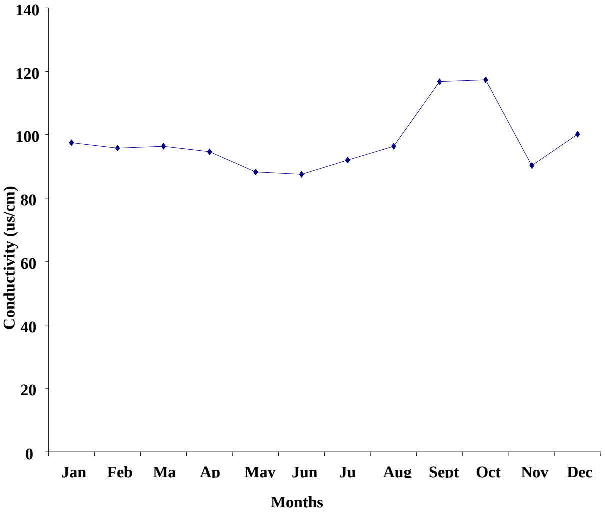

Fig. 10. Mean monthly conductivity values in Jakara Lake.

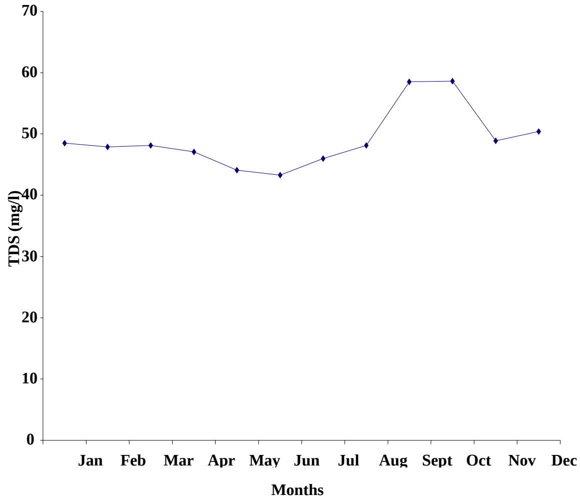

Fig. 11. Monthly Total Dissolved Solids in Jakara Lake.

TABLE I: THE STOMACH CONTENTS OF FISHES OF JAKARA DAM

	Species:	*S. g*	%	*T. z*	%	*O. n*	%	*C. g*	%
	Stomach examined.	300	-	246	-	308	-	82	-
	Stomach with food item.	214	71.3	190	77.2	240	77.9	72	87.8
	Stomach empty.	86	28.7	56	22.8	68	22.1	10	12.2
	Stomach with unidentified Food items.	90	42	67	35.2	59	24.6	2	2.8
	Stomach with identified	124	58	123	64.8	181	75.4	70	97.2
Food items	Insect parts	37	17.3	10	5.3	39	16.2	16	22.2
	Smaller fishes	0	0	0	0	0	0	29	40.3
	Insect larvae	0	0	21	11.1	36	15	25	34.7
	Plant materials	87	40.7	92	48.4	106	44.2	0	0

S.g= S. gallilaeus, T.z= T. zilli, O.n= O.niloticus, C.g=C.gariepinus

The total number of *C. gariepinus* samples examined was 82, including 70 samples (97.2%) with identified food items consisting of 16 samples (22.2%) containing insect part, 29 samples (40.3%) smaller fishes and 25 samples (34.7%) insect larvae. The remaining samples were found with an empty stomach. A total of 2 samples (2.8%) had food content that cannot be identified.

IV. DISCUSSION

Water temperature plays an important role in the solubility of salts; gases and it accelerate food productivity in aquatic ecosystem. It is one of the most significant parameters which control inborn physical qualities of water. The water temperature of the Jakara dam fluctuated between 19.3 ℃ in the month of January, a period characterized by a cold dry and dusty harmattan wind with less solar radiation heating the water body, to 27.8 ℃ in August, a period of hot humid air. The temperature tends to decrease progressively from September to January; this had shown that the prevailing winds exert a tremendous effect on the temperature of the tropical lentic water bodies. Surface water temperature fluctuates seasonally with minimum occurring during the winter and maximum in the dry season [11].

The lake pH was slightly alkaline throughout the year except in the month of August when it turns to be acidic. Therefore, this pH lowering during the rainy month could be as a result of the dilution effect of the acidic rain water. Change in water pH indicates the presence of certain industrial and domestic effluent [11], [12]. Decaying and decomposition of aquatic weeds can cause accumulation of acidic gasses at the lake; these may consequently change the water pH [13]. The lowering of pH during the rainy season could also be due to the derived materials and decomposed organic matter within the lakes and hence temper with food productivity. The pH range of 6.3 to 8.4 recorded in this study is favorable for fishery and fish productions. The best pH for fish growth ranges 6 to 8.5 [12]. Ph values of 6.8 to 8.5 are moderate for fish growth and reproduction [14]. Water sediment pH range of 6.6 to 9.3 is conducive for all aquatic life including fish [12]. Prolonged exposure on fish to acidic pH could result in low egg hatchability, poor egg laying and general poor feeding and also fishes die at acidic ph of 5.5 [15]-[17]. The value of dissolved oxygen concentration ranged from 3.7mg/l in September to 5.1mg/l in the month of April. The dissolved oxygen concentration within Jakara reservoir is satisfactory for most fish species. Dissolved oxygen concentration of fresh water fishes, below 5mg/L impairs the growth, reproduction and fishes become more susceptible to diseases and parasite attack [18]. Dissolved oxygen concentration < 2mg/L is deleterious [12]. The mean DO value of 4.3mg/l recorded in Jakara dam is below the maximum permissible limit of 5–7 Mg /L O_2 [19].

The concentration of lead and zinc shows less seasonal variation. This is an indication that the level of chemical pollution in Lake Jakara is throughout the year, also indicates that the heavy chemical concentration in lake water was due to the discharge waste from industrial, municipal and domestic activities in the neighborhoods. The lakes have complex and fragile ecosystem, as they do not have self cleaning ability and therefore readily accumulate pollutants. Sewage effluent of municipal origin contain appreciable amount of heavy metal (Pb, Ni, Cd, Cu, Hg, Zn, and Cr^2) which have potential to contaminate fishes [20]. It was also observed that; the average values of heavy metals concentrations in Jakara lake is above the average concentration desirable limit fixed by central pollution control board, government of India (0.54ug/l) of lead and zinc, while Ontario water quality standard [21].

Lowest value of transparency recorded in August was due to water turbulence, erosion and deposition of waste. Transparency in lakes tends to be lower during the rainy season than but never as clear as rivers and streams. In Jakara dam, transparency reading was lowest during the rainy season but the reading increases in the dry season [22].

High concentration of chloride is considered to be the indicators of pollution due to organic wastes of animal or industrial origin. High chloride content of water indicates organic pollution of animal origin. In this study, the chloride concentration oscillated between 0.5 and 1.4 mg·L−1. Chloride can be considered as one of the basic parameters of classifying lakes polluted by sewage and industrial effluents into different categories. The high chloride content might be attributed to the presence of large amount of organic matter of both allochthonous and autochthonous origin [23].

Conductivity value of 91.7μs cm^- was lower than the specified limit of 100μs/cm [24]. Conductivity and mean depth of a reservoir can be used to predict the potential fish yield of a lake. Highest value was recorded at the peak of the rainy season and value reduces drastically in the dry season and was as a result of flow of inorganic materials during the rainy season [25]. Total dissolved solid follows the same trend as with conductivity. This had indicated that during the rainy season when TDS was highest fishes obtained potentially limiting nutrients such as Na, K, Ca and phosphate.

The percentage of fish samples examined with empty stomach was low in the month of July, August and September while highest percentage of fish samples examined with food items in their stomach was in the month of July, August and September. Moreover, all the fish samples examined for food stomach content had predominant food item which consists of insect, plant materials or smaller fishes. The stomach content analysis revealed that; insect parts, smaller fishes, insect larvae and plant materials are the main diet of Jakara lake fishes. *S. gallilaeus, T. zilli and O. niloticus* feeds predominantly on plants parts but few stomach of the cichlid contains insects, insect parts, and insect larvae. This had indicated the omnivorous feeding behavior of *S. gallilaeus, T. zilli and O. niloticus*, [26], [27] this work agreed with several workers [28], [29].

The omnivorous feeding behavior was identified among *C.gariepinus* species which predominantly feed on insect parts, smaller fishes and insect larvae, this may be attributed to bottom dwelling nature of this specie and *Clarias species* as piscivorous, insectivorous and bottom feeders' species respectively [30], [31]. The high percentage of stomach with food items in all the fish samples examined was an indication of food availability within Jakara reservoir. Food availability also determined the maximum size a fish can be attained in its environment [32]. The fish sample examined with empty stomach could be due to the long hours the fish spent in gill nets and on hooks before being removed for examination [33].Virtually, all the food items assessed had the highest percentage of occurrence during the rainy season than in the dry season. The percentages of fish samples examined with empty stomach were lowest in July, August and September. These are the months characterized by rainfall, dense growth of vegetative plants and breeding season of numerous insects and spontaneous inflow of nutrients and detritus from River Jakara and River Getsi, this may contribute to the proliferation of food abundance.

V. Conclusion

Generally poor feeding with scarce food items was observed among fishes of Jakara dam and only tolerance fish species were encountered, it was believed wastewater produces pollutants that are biologically and chemically harmful with high potential to cause disease and detrimental environmental effects. The pH of the Jakara dam affects the quality of the water by increasing the toxicity of the metal as the pH decreases. The discharge of industrial effluent to Jakara dam cause thermal pollution, however the impact of this phenomena to the aquatic organism is minimal to be measured but have a direct impact of their feeding behavior as such they defend on bottom feed. High temperature rise due to the effluent discharged caused decrease in the amount of oxygen that can be dissolved in the water consequently leading to oxygen stress of the water. The electrical conductivity of the wastewater estimates the amount of total dissolved solids (TDS) of the total amount of dissolved ions present in the water. On the other hand, the turbidity measures the total suspended solids present in the waste water. High amount of suspended solids observed in this study area resulted in high turbidity which means the wastewater is murkier in appearance; hence less light will be able to pass through the water. These will consequently lead to the disruption of the aquatic living organism which will be unable to synthesize food and poor visibility to catch feeds. Industrial waste discharge should be discouraging through compatible policies and programmes for improvement in the industrial waste water treatment methods, it also suggests the need of consistent internationally recognized data driven strategy to assess the water quality of Jakara dam so as to save the life of Jakara lake fishes.

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I. Badamasi was born in K. Jaba, Nassarawa local government in Kano state Nigeria, on 12th December, 1968. He obtained his first degree in applied biology from Bayero University Kano, Masters Degree in Zoology (Fisheries) in 2008, and the same Bayero University.

He is working with Kano State Polytechnic as a senior lecturer, department of science laboratory technology, school of technology Kano. His published articles include. (1). Inuwa, B. (2013): Fecundity and Length Relationship of Fish Species Collected from Jakara Dam, Kano, Nigeria, *Journal of Biological Sciences and Bioconservation, 5(1)*: 143 – 153. (2). Inuwa, B. and Othman S. A. (2013) Comparative efficacy of Some Plant Extracts and Praziquantel on Rats Infected with *Schistosoma mansoni*, *Journal of Medical and Applied Biosciences*, 5 (1): 107- 115. (3). Inuwa B (2013): Fecundity and Length Relationship of Fish Species Collected from Jakara Dam, Kano, Nigeria, *Journal of Biological Sciences and Bioconservation, 5(1)*: 143 - 153. My area of research interest is Fish endocrinology.

Mr. Inuwa is a member Zoological Association of Nigeria (ZSN).