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Assessment of the Proximate, Some Essential and Heavy Metals Composition of Some Fresh Local Varieties of Fish Sold in Sabon Gari Market Kano, Nigeria

B. A. Bello[1], M. M. Sani[1*], A. Gambo[2], F. S. Abdullahi[2], Z. U. Chedi[2] and M. Bashir[3]

[1]Department of Biochemistry, Federal University Dutse, P.M.B.7156, Dutse, Jigawa State, Nigeria.
[2]Department of Food Science and Technology, Kano University of Science and Technology, Wudil, P.M.B. 3244, Kano State, Nigeria.
[3]Department of Biochemistry, Ahmadu Bello University, Zaria, P.M.B.1045, Kaduna State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author MMS designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors FSA and ZUC managed the literature searches, and analyses data from the study. Author MB performed the spectroscopic analysis. Authors BAB and AG managed the experimental process and identified the different fish species used. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Comparisons of the proximate and heavy metal composition were made among some five local varieties of fresh fish sold in Sabon Gari market Kano, Nigeria. This is to ascertain whether such fishes contribute to the nutritional value or heavy metal toxicity of the local populace.
Study Design: Samples were obtained from the market, taken to the laboratory and processed for both proximate and elemental analysis.

**Corresponding author: Email: almusby@yahoo.com;*

Place and Duration of Study: The fishes were obtained from Sabon Gari market, located in Kano State, Northwestern Nigeria.
Methodology: The proximate composition of the fishes used as samples were determined in triplicate using Association of Analytical Chemists methods while elemental analysis was conducted using Atomic Absorption Spectroscopy (Jenway 6405).
Results: The proximate composition analysis revealed that, moisture content range from 57.36% for the flesh of *Oreochromis niloticus* to 71.53% for that from *Alestes baremose;* proteins range from 16.72% to 20.80% for flesh from *Oreochromis niloticus* and *Clarias gariepinus*; fat content of range from 3.09% to 20.94% for flesh from *Alestes baremose* and *Oreochromis niloticus.* The carbohydrate content were found to range from 1.48% for the flesh from *Alestes brevis* to 4.54% for that from *Clarias gariepinus* and ash range from 0.46% to 5.46% for the flesh from *Clarias gariepinus* and *Shilbe isideri* respectively. The elemental analysis revealed a variation in elemental concentration among the fish samples used. All data obtained for heavy metals were significantly lower ($p<0.05\%$) than the corresponding internationally agreed limit. High concentration of zinc (Zn), iron (Fe), manganese (Mn), calcium (Ca) and cobalt (Co) was detected from *Oreochromis niloticus.* The sample from *Clarias gariepinus* was found to contain high amount of both lead and nickel as compared to others. The level of copper and cadmium were detected to be high in sample from *Alestes brevis* while high level of magnesium was detected from *Shilbe isideri* sample as compared to other sources.
Conclusion: The fishes sold in Sabon Gari market are nutritious with low level of heavy metals and thus, may serve as a good source of essential nutrients.

Keywords: Proximate composition; local fish varieties; essential and heavy metals; toxicity.

1. INTRODUCTION

Human beings require food to carryout essential functions. Good health is largely influenced by nutrition. To sustain life and perform various functions, man needs a wide range of nutrients. The food we eat daily which are classified as; cereals, pulses, legumes, nuts, oils, seeds, vegetable, fruits, milk and milk products, consist of these nutrients. A balanced food must provide all nutrients required for energy, body building, maintenance, and regulation of body processes. The nutrients include; carbohydrates, lipids, proteins, minerals, vitamins and water. These primary nutrients are essential for energy provision and development of the body.

Fish is nutritionally composed of protein, carbohydrate, fat and oil, vitamins, minerals and about 75-80% water. The nutritional composition of fish varies greatly from one species to another, depending on age, source, feeding habit, size, age, sex and sexual variations due to spawning, environment and season [1,2,3]. Thus the knowledge of fish composition is essential for its maximum utilization.

Nigeria and other developing countries are subject to poor nutritional status due to low food intake particularly in the area of protein and energy [4]. However, fish stands to be a source of animal proteins and essential nutrients for maintaining a healthy body [5,6], asserts that fish and its products provides about 17-63% of protein requirement of the Nigerian masses.

Heavy metals are contaminants that cause serious pollution to our natural environment due to their toxicity, persistence and bioaccumulation problems [7]. They are generally considered as those metals and semi metals with potential human or environmental toxicity. Heavy metals make significant contribution to environmental pollution as a result of anthropogenic activities such as mining, energy- and fuel production, power transmission, intensive agricultural practices, sludge and industrial effluent dumping and military operations [8,9].

In natural waters, trace metals and their corresponding sediments have become an important topic of concern for both scientists and engineers in various fields associated with water quality, as well as a concern of the general public health. Their direct toxicity to man and aquatic organisms and the indirect toxicity through their accumulations in the aquatic food chain are the issue of serious concern. Fish have been the most popular choice as test organisms because they are presumably the best-understood organisms in the aquatic environment [10] and also due to their importance to man as a protein source [11].

Even though most fish consumers in Kano obtain their fish from local markets, the main source of

the commercially available fishes in the market vary with some being imported as frozen fish, or captured from local waters within the 44 local governments of Kano state while others were cultured in fish farms in the state. However, irrespective of their source, there is the tendency that the commercially available fishes might have accumulated some heavy to a level that may amount to a potential threat to human health when consumed.

This research aims to assess the proximate and heavy element composition of some fresh local varieties of fish sold in Sabon Gari Market Kano, in order to provide insight on the risks and benefits associated with the indiscriminate consumption of these fish species in Nigeria.

2. METHODOLOGY

2.1 Study Area

Kano State is a State located in North-Western Nigeria (Coordinates: 11º 30'N 8º 30'E) and the most populous State of the Nigerian Federation. Sabon Gari market is in Fagge: one of the Local Government Areas in metropolitan Kano. The Sabon Gari market operates every day from 9:00 am to 6:00 pm and fish sellers usually obtain their supply from local fishermen from different places.

2.2 Sample Acquisition

The fresh *Clarias gariepinus, Oreochromis niloticus, Alestes brevis, Alestes baremose, and Shilbe isideri* samples were purchased from Sabon Gari market in Kano, and labeled accordingly. The samples were placed in polythene bags and were immediately transported in icebox to the laboratory where they were washed with running tap water to remove dirt before the analysis. All the fish samples were then separately stored inside deep freezer at about -10ºC prior to analysis as adopted from [9].

2.2.1 Sample preparation and digestion

The fresh fish samples were placed on an already sterilized chopping board and incised vertically to expose the inner portion (the flesh) of the fish. It was then sliced into pieces with a sterilized knife and was separately dried in a laboratory oven at 65ºC for three days to obtain a constant dry weight of 10 g from each sample. The dried samples were each ground to powder, using laboratory ceramic mortar and pestle, and sieved with 2 mm sieve. The powdered samples were digested using the procedure described by [12].

2.3 Proximate Composition

The proximate composition of the fresh fishes used as samples were determined in triplicate using AOAC methods [13]. Moisture content of the samples were measured by weighing differences before and after oven drying at 100-105ºC for 16 h. The modified Bligh and Dyer [14] procedure was adopted in determining the lipid composition of the samples, the ash content of the fish was determined by igniting the samples at 550ºC for 5-6 hours until the sample was completely free from carbon particles in a carbolite muffle furnace, while the Kjedahl method was used to determine the total nitrogen content of the samples as described by AOAC, [15], and a factor of 6.25 was used for converting the total nitrogen to crude protein of the fish sample.

2.4 Determination of Heavy/Trace Metals

The digested fish samples were then poured into auto analyzer cups and concentration of heavy metals (copper, lead, nickel, Zinc and iron) in each was determined using Atomic Absorption Spectrophotometer (AAS) as adopted from [16].

2.5 Statistical Analysis

Results are presented as means ± Standard deviation. Results from all the species analysed were compared for statistical significance using Analysis of Variance (ANOVA) at $P<0.05\%$.

3. RESULTS AND DISCUSSION

The proximate and some metal analysis of some fresh local varieties of fish sold in Kano market was carried out. The result of this analysis is depicted on Table 1. The moisture, proteins and fat contents of the samples used were found to range between 57.36% for the flesh from *O. niloticus* (B) to 71.53% for that from *A. baremose* (D), 16.72% for the flesh from *O. niloticus* (B) to 20.81 for that from *A. brevis* (C) and 3.24 % for the flesh from *C. gariepinus* (A) to 20.94% for that from *O. niloticus* (B). The percentage carbohydrates and ash content of the flesh from the fish samples used range from 1.48% for the flesh from *A. brevis* (C) to 4.53% for that from *C. gariepinus* (A) and 0.43% for the flesh from *C. gariepinus* (A) to 5.46% for that from *S. isideri* (E) respectively.

The heavy/ trace elemental composition of the flesh of the local varieties of fish used as samples in this work were found to vary. Copper (Cu) was found to range from 0.0080 ppm in *S. isideri* (E) to 0.0162 ppm in *A. brevis* (C). Lead (Pb) and Nickel (Ni) were found to range from 0.0012 ppm and 0.0001 ppm in *O. niloticus* (B) and *S. isideri* (E) to 0.0031 ppm and 0.0040 ppm both in *C. gariepinus* (A). Zinc was found to range from 0.1395 ppm in *O. niloticus* (B) and *A. brevis* (C) to 0.1530 ppm in *S. isideri* (E). Cadmium (Cd) was found to range from 0.0002 ppm in *O. niloticus* (B), *A. baremose* (D) and E to 0.0008 ppm in *A. brevis* (C). Cobalt (Co) ranged from 0.0002 ppm in C to 0.0013 ppm in *O. niloticus* (B). Calcium (Ca) and Magnesium (Mg) were found to range from 32.5802 ppm and 1.1643 ppm both in *A. baremose* (D) to 99.5791ppm and 3.8468 ppm in *O. niloticus* (B) and *S. isideri* (E). Iron (Fe) and Manganese (Mn) were found to range from 0.0945 ppm and 0.01530 ppm both in *A. baremose* (D) to 0.3481 ppm and 0.1496 ppm both in *O. niloticus* (B).

The proximate composition of the flesh from fresh *Clarias gariepinus, Oreochromis niloticus, Alestes brevis, Alestes baremose, and Shilbe isideri* samples were determined using AOAC methods [13]. The moisture content of the flesh from the local varieties of fishes used were found to range between 57.36 % for *Oreochromis niloticus* to 70.98% for that from *Clarias gariepinus*. Least moisture was detected in the flesh from *Oreochromis niloticus* and *Shilbe isideri* indicating that, this samples may have longer shelf life than that from others because the less the moisture the less the susceptibility to microbial contamination. The moisture content for the flesh of the samples used were much lower than that reported by Olakunle [2] that, cat fish, croaker fish and mackerel fish obtain in South West markets of Nigeria range between 72.73% and 80.70% respectively.

The ash content of the flesh from the fishes used was found to range between 0.46% for the flesh from *C. gariepinus* (A) to 5.46% for that from *S. isideri* (E). This result was found to indicate much ash content as compared to that reported by Olakunle [2] that, the ash content of cat fish, croaker fish and mackerel fish was 1.54%, 1.71% and 2.79%. Therefore flesh from the samples used particularly the *S. isideri* (E) contains much mineral element as compare to that reported by Olakunle [2].

The percentage protein composition in the flesh of the fresh local varieties of fishes sold in Sabon Gari Market Kano were found to range between 16.72% for the flesh from *O. niloticus* (B) and 20.81% for that from *A. brevis* (C). Therefore, since percentage proteins of a food determines it quality, the most nutritious among this fish sample is *O. niloticus* (B) followed by *C. gariepinus* (A) and *A. baremose* (D). This result is similar to that reported by Olakunle [2] that, the protein composition of Cat fish, Croaker fish and Mackerel fish were 14.60%, 15.22% and 18.25% respectively.

The percentage fat and carbohydrate content of fresh flesh from the fishes used were found to range between 3.09 % for the flesh from *A. baremose* (D) to 20.94% for that from *O. niloticus* (B) and 1.48 % for the flesh from *A. brevis* (C) to 4.54 % for that from *C. gariepinus* (A) . Highest fat content was detected in the flesh from *O. niloticus* (B) and *S. isideri* (E) while highest carbohydrate was detected in the flesh from *C. gariepinus* (A) and *O. niloticus* (B). This result is in line with that reported by Olakunle [2] that, the fat and carbohydrate content of Cat fish, Croaker fish and Mackerel fish were 1.38%, 1.40% and 3.03% and 1.85, 0.97 and 3.20 %. This result is not in line with that reported by Olayemi et al., [17] that, fat and carbohydrate content of fresh Cat fish were 0.50 and 0.90 respectively.

Table 1. Proximate composition of some local varieties of fresh fish sold in Sabon-Gari market Kano

Sample	Moisture (g/100 g)	Proteins (g/100 g)	Fat (g/100 g)	Carbohydrate (g/100 g)	Ash (g/100 g)
C. gariepinus (A)	70.98±0.33	20.80±0.01	3.24±0.01	4.54±0.33	0.46±0.01
O. niloticus (B)	57.36±0.00	16.72±0.01	20.94±0.09	4.01±0.10	0.98±0.0 1
A. brevis (C)	71.16±1.25	20.81±0.01	5.42±0.02	1.48±1.27	1.13±0.01
A. baremose (D)	71.53±1.06	20.73±0.01	3.09±0.02	3.59±1.02	1.07±0.01
S. isideri (E)	59.12±0.00	19.97±0.01	19.19±0.01	1.63±0.01	5.46±0.0 1

Values are mean and ± standard deviation of two determinations

Table 2. Elemental composition of some local varieties of fresh fish sold in Sabon-Gari market Kano

	Concentrations (ppm)									
Sammple	**Cu**	**Pb**	**Ni**	**Zn**	**Fe**	**Cd**	**Mn**	**Ca**	**Co**	**Mg**
A	0.0130±0.0003	0.0031±0.0002	0.0040±0.0004	ND	0.2428±0.0018	0.0005±0.0003	0.0254±0.0005	50.4407±0.0005	0.0004±0.0005	3.6566±0.0019
B	0.0146±0.0001	0.0012±0.0003	0.0016±0.0003	0.1395±0.0006	0.3481±0.0011	0.0002±0.0003	0.1496±0.0006	99.5791±0.0022	0.0013±0.0003	3.7831±0.0000
C	0.0162±0.0009	0.0018±0.0006	0.0023±0.0008	0.1395±0.0009	0.3104±0.0006	0.0008±0.0001	0.0853±0.0014	88.8438±0.0038	0.0002±0.0002	3.6908±0.0000
D	0.0019±0.0003	ND	ND	ND	0.0945±0.0003	0.0002±0.0005	0.0125±0.0003	32.5802±0.0006	0.0004±0.0002	1.1643±0.0035
E	0.0080±0.0001	0.0021±0.0004	0.0001±0.0002	0.1530±0.0009	0.2631±0.0012	0.0002±0.0001	0.0342±0.0005	66.4420±0.0013	0.0003±0.0002	3.8468±0.0000

Values are mean and ± standard deviation of two determinations. ND: Not detected

The bioaccumulation of toxic elements such as heavy metals in the analyzed species was studied. These contaminants originating from contaminated water or diet accumulate in the fishes and with time may ultimately reach hundreds or even thousands folds above concentrations detectable in the water, sediments and foods [18,19].

The mean concentration of copper(Cu), lead (Pb), nickel (Ni), zinc (Zn), iron (Fe), cadmium (Cd), manganese(Mn), Calcium (Ca), Cobalt (Co) and Magnesium (Mg) from the flesh of the fishes used in this work was found to vary with variety as depicted on Table 2. The concentrations of the elements from the flesh of fresh *Clarias gariepinus, Oreochromis niloticus, Alestes brevis, Alestes baremose, and Shilbe isideri* samples purchased from Sabon Gari market in Kano were shown to be below the tolerable values in fish as reported by Wyse et al. [20] that, the tolerable values of the metals in fish were 0.18, 0.73, 3.28, 146, 0.60, and 0.12 mg/kg for Cd, Cr, Cu, Fe, Ni, and Pb. This result for Cu and Cd was found to be lower than that reported by Nord et al. [21] that, the concentration range for Cu and Cd in fishes to be 0.22 to 1.62 ppm and 0.006 to 1.00ppm. The result for Fe, Pb and Cd were also found to be lower than that reported by Amani and Lamia [22] that, their concentration in sardine and black spot emperor to be 250.23 and 85.91 ppm, 9.17 and 28.59 ppm and 2.55 and 1.17 ppm respectively. The concentration of lead and cadmium were below the permissible ranges of 0.4 to 0.5 ppm for lead (Pb) and less than 0.1 ppm for Cadmium (Cd) [23,24].

The result revealed, that, among the local varieties of fish used, highest concentration of Cu was found in the flesh from *A. brevis* (C) (0.0162 ppm) and least concentration was detected in the flesh from *A. baremose* (D) (0.0019 ppm). Furthermore, it was found that, the flesh from *O. niloticus* (B) has the highest concentration of Fe (0.3481 ppm), Cd (0.0008 ppm), Mn (0.1496 ppm) and Ca (99.5791 ppm) when compared with that from other varieties analyzed. Meanwhile, least concentrations of the, aforementioned elements (0.0945, 0.0005, 0.0125 and 32.5802 ppm) was detected in the flesh from *A. baremose* (D). These values were found to be below the lowest effect level, [25] and the heavy metals tolerable values in fish, [18] respectively. The values obtained in this work for Fe, Zn, Mn, Mg and Cu were found to be much greater than that reported by Olakunle [2] that, the concentration range of Fe, Zn, Mn, Mg and Cu in the flesh from fresh Cat fish, Croaker fish and Mackerel fish were 0.0053 to 0.0074 ppm, 0.0092 to 0.0098 ppm, 0.0005 to 0.002 ppm, 0.0020 to 0.0035 ppm and 0.0010 to 0.0018 ppm respectively.

The concentration of Pb and Ni detected from the local varieties of fishes used was found to be more in the flesh from *C. gariepinus* (A) (0.0031 and 0.0040 ppm) while least amount of Pb (0.0012ppm) and Ni (0.0001 ppm) was detected in the flesh from *O. niloticus* (B) and *S. isideri* (E) respectively. These were found to be lower than both the lowest effect level [25] and the heavy metals tolerable values in fish as reported by Wyse [20].

Zinc and magnesium being among the essential elements, serves as cofactors to some important enzymes in the body, however, at higher concentration they tend to be toxic. The concentration of these element detected in this work was found to be high in the flesh from *S. isideri* (E) (0.1530 and 3.8468 ppm) but flesh from *O. niloticus* (B) and *A. baremose* (D) were found to contain least amount of Zn (0.1395 ppm) and Mg (1.1643 ppm) in comparison to the flesh from other sources used. The result for Zn does not tally with that reported by Nord [21] and Amani & Lamia [22] that, the concentration of Zn in flesh from Sun fish range from 23.6 ton173 ppm and that from Sardines and Black spot emperors were 49.43 and 28.59 ppm. However, the values obtained in this work are below the permissible limit of Zn reported by [26].

The concentration of Cobalt (Co) from the flesh of the fresh fish samples used was found to be highest in that from *O. niloticus* (B) (0.0013 ppm) and least concentration was found in the flesh from *A. brevis* (C) (0.0002 ppm). This result was found to be much lower than that reported by Babatunde et al., [9] that, the concentration of Co in the muscle from *H. forskahlii, H. bebe accidentalis* and *C. garienpium* obtained from downstream Ogun Coastal Waters Nigeria, were 0.42, 0.37 and 0.00 ppm respectively.

4. CONCLUSION

The result of this work clearly confirms that, the fresh varieties of local fishes sold in Sabon Gari market Kano may not have accumulated the elements to a toxic level and thus may be used as a good source of both essential and non-essential nutrients. Hence it is therefore recommended that other foods sources

commonly consumed should be checked for these contaminants in order to identify the source from which this toxic chemical reach humans.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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