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Assessment of heavy metals in some edible fish species of the Komadugu-Yobe River, Gashua, Yobe State, North-East Nigeria: Threat to public health

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Abstract

Contamination of Heavy metals in the aquatic environment has been a major challenge across the globe, due to the persistence of these metals and the tendency to accumulate in living organisms especially, fish species, which are important source of protein for most humans 'consumption. In this study, the bio-accummulation of six metals (As, Cd, Cu, Ni, Pb and Zn) were analysed in three edible fish species (*Oreochromis niloticus*, *Clariasgariepinus* and *Synodontisschall*) sampled from the Komadugu-Yobe Riverusing Atomic Adsorption Spectrophotometry. The potential health threats for consumers were also assessed using standard indicators. Results showed that the mean concentration of heavy metals in the three fish species was in the following rank order: 22.23> 11.23 > 0.45> 2.56 >0.48> 2.33 > 0.05 for Zn >Ni >Cu >Pb >As >Cd, respectively. Zn recorded the highest concentration in both the gills and muscles of all the fishes at 11.28 mg/kg and 15.23 mg/kg, while 4 metals (Zn, Cd, Ni and Cu) out of 6 measured their highest concentrations in *O. niloticus* species. The remaining 2 metals (As and Pb) measured their highest levels in *C. gareipinus.* Furthermore, the highest concentrations of studied metals in the whole fish samples were lower than the maximum acceptable limits compared in this study. The potential human health indices associated with ingesting heavy metal indicated that HI (Hazard intake) and THQ (Target hazard quotient) values were below 1 implying that they pose no health threat, whereas EDI (Estimated Daily Intake) values of each metal were higher than the TDI (Tolerable daily intake) values indicating harmful effect on human health in daily consumption. Thus, constant monitoring and sustainable management of the Komadugu-Yobe River at Gashua is required to reduce the amount of contaminant entering the river which may pose a health threat to the inhabitants that feed on the contaminated fishes.

Keywords: Aquatic pollution; Health risk; Pollution indices; Heavy metals; Bioaccumulation

1. Introduction

Fish is one of the most widely consumed and popular seafood as well as important sources of protein for many communities worldwide [1, 2]. Fish contains unsaturated omega fatty acids and high protein and are known to have significantly impact on the human health status [3, 4]. They occupy a high trophic position in fresh water ecosystems and can easily accumulate heavy metals from the ecosystem they dwell in due to several factors including concentrations of the metal, species characteristics, water parameters and exposure time [5, 6]. Heavy metals (HMs) are one of the most harmful substances for humans and other aquatic life due to their toxicological hazards [7]. HMs pollution can be caused by natural or anthropogenic activities and are easily accumulated in fresh water organisms via trophic level [8, 9]. The consumption of fish polluted with HMs can cause public health challenge [10, 11]. HMs are persistent pollutants and can stay in aquatic habitats for a very long period because of their bio magnification and bioaccumulation properties [12, 13], even at minimal concentrations in water, they can be accumulated by organisms to toxic levels [14]. Accumulation of HMs exceeding maximum permissible limits may cause numerous health

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challenges including impaired or lowered intellectual functions, change in blood makeup, destruction of lungs, liver, kidney, and other visceral organs [15, 16]. Therefore, controlling and monitoring of HMs that have negative impact on the human health through the consumption of metals accumulated in fish is useful and important today [17, 18]. Fish are good bio indicator of pollution and have longed been used to monitor metal concentrations of different aquatic ecosystems [19, 20].

The Komadugu-Yobe River at Gashua is the source of the commercial fishery and has been influenced by human activities involving the use of chemicals and pesticides for farming, domestic sewages discharge and laundry activities [21]. The overloads of contaminants in general and heavy metals into this river ecosystem has been a significant concern over the past few years due to reported cases of high metal accumulation in some cultivated vegetables along the bank of the river [21]. However, there are no previous studies accessing the toxicity and impact of HMs on the river and its edible fish species. Therefore, this present study is aimed at assessing the metal accumulation of some edible fish species of the Komadugu-Yobe river at Gashua, along it 10km flows through Gashua town, to Geidam, Yobe State.

The objectives of this research were (1) to establish the metal loads of As, Cd, Cu Pb, Ni in gills and muscle tissues of commonly consumed fish species in Gashua region. (2) to determine the potential public health threat for consumers. The outcome of this study will recommend an improved identification of environmental risks, and provide important information on the monitoring, control and management of the aquatic environment.

2. Material and methods

2.1. Study area

Kamodugu Yobe-River is one of the most significant rivers in Yobe State, located in (longitud12º52´N and latitude 10º58´E) Gashua area of Bade LGA. The river was formed from the tributaries of Hadejia and Jama' are rivers that meet at the Hadejia Nguru Wetlands, flows through Gashua and drains to Lake Chad [22]. The river covers a total area size of 772 sq km is studied at a full length of about 10km in Gashua, with a population size of about 139,804 [23]. The average annual temperature of the town ranges from 38^{O}C to 40^{O}C with a mean maximum temperature of 39.8°C between March to April and mean minimum temperatures of 28.1°C between June to September. Gashua falls within the vegetation zone of Sudan Savannah usually dominated by shrubs and short tress with a yearly rainfall of 500 to 1000mm that lasts for about 120 days [24]. The river serves as a valuable source of untreated water for consumption and other home activities for communities who live along the course. Also, irrigational farm practices are a dominant form of the agricultural system around the research area. Therefore, agrochemicals easily enter the river ecosystem and become primary contaminant of the river at Gashua.

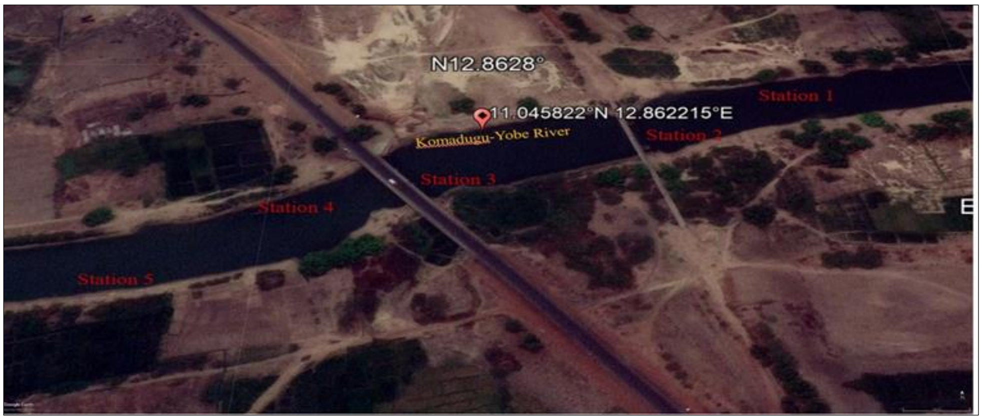

Figure 1 Map of Komadugu-Yobe River at Gashua showing five sample locations, Source: (Google Earth, 2022)

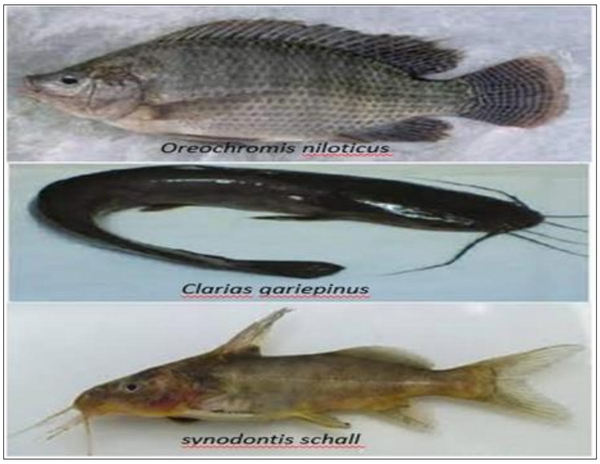

Figure 2 Studied fish species

2.2. Sample collection and digestion

Sixty (60) samples of fish consisting of three different species namely Catfish Fishes (*Clarias gariepinus*, *Synodontis schall*) and tilapia (*Oreochromis niloticus*) were collected from fishing nets that were casted and left overnight with assistance from fisher men in the area. The samples were removed from nets, kept inside icebox, and taken to the laboratory for analysis. In the laboratory, the fishes were washed, dissected, and organs (gills and muscles) removed, and oven dried separately for 24 hours at a steady temperature of 105^{o}C. Dried samples of each fish species were grounded using mortar and pestle then placed in moisture free synthetic bag and kept in a desiccator for further analysis. Method described by [25], was employed in the digestion of fish samples. Acid mixture (HNO_3+ $HClO_4$) in the ratio of 4:1) was poured in to a 250 ml beaker containing 1g of dried fish samples and boiled on hot plate until close to dryness. The resulting mixture was cooled then filtered through Whatman filter paper no. 1 and poured in to 100 ml volumetric flask. The digested samples were made up to 50ml using deionized water and kept in pre-acid washed polythene bottles. The heavy metal concentration (As, Cd, Cr, Pb and Zn) were analysed using atomic absorption spectrophotometer (Unicam 969, Analytical Technology Inc., Cambridge, United Kingdom). The equipment was standardized using certified buck atomic absorption standards for individual metals to obtain calibration curves. Reagent banks were run after every ten samples analysed to overcome equipment drift. Triplicate samples were run for each metal and measured concentrations of heavy metals in the samples were computed and expressed as mg/kg.

2.3. Metal pollution index (MPI) of heavy metals concentrations in fish species

The metal pollution index is an accurate and credible index used in monitoring HMs pollution in aquatic habitats and food. MPI is a mathematical model that combines impacts of metals in a single form. In this study, MPI of HMs in fish gills and muscles was computed using a geometric equation by [26].

$$\mathrm{MPI\ (mg/kg)} = (\mathrm{Cf_1} \times \mathrm{Cf_2} \mathrm{X} \ldots \ldots \mathrm{X\ Cf_n})^{\frac{1}{n}} \quad (1)$$

Where Cf represents mean concentrations of HMs in fish organs

2.4. The Public health risk assessment of HMs related with fish consumption

2.4.1. Estimation of daily intake (EDI)

The daily intake was estimated by multiplying the mean HMs content of individual fish by the expected intake proportion of the fish. One-third of adults is regarded as the intake amount for children and was computed using the equation according to [27, 14].

$$\mathrm{EDI} = \frac{(Cn\ X\ IGr)}{Bwt} \quad (2)$$

Where Cn represents metal concentrations in the studied fish species (mg/kg dry-wt), IGr represents the recommended intake rate, which is about 55.5 g per day for adults, while Bwt stands for body weight estimated to be 70 kg for adults [27].

2.4.2. Target hazard quotient (THQ)

The target hazard quotient (THQ) was determined by the proportion of EDI and oral reference dose (RfD). RfDs values of metals in this study are,0.0003, 0.003, 0.001, 0.004 and 0.0005 mg/kg per day for As, Cr, Zn ,Cd, Ni, Pb and Zn respectively [28, 29]. If value ratio < 1 indicates a non-significant hazard effect [30]. THQ is expressed using the formular:

$$\text{THQs} = \frac{Ed\ x\ Ep\ x\ EDI}{At\ x\ RfD} X\ 0.001 \qquad (3)$$

Where Ed represents the time of exposure, which is 65 years, Ep is the frequency of exposure at 365 days per year, while At is the mean time period for non-carcinogenic element (Ed x Ep) [30].

2.4.3. Hazard index (HI)

The hazard index (HI) was established for different elements (Cd, Cr, As, Ni, Pb and Zn) observed in the sampled fish species using the equation:

$$\text{HI} = \sum_{i=K}^{n} THQs \qquad (4)$$

Where THQs represent the probable risk value for HM [31]. If HI > 1 is hazardous, HI< 1 is safe and HI< 1 indicates safety, whereas HI > 1 indicates public health risk.

2.5. Data analysis

One-way analysis of variance (ANOVA) was used to access if there were significant differences statistically between the HMs values in the fish samples ($p < 0.05$). SPSS version 16 was used for all data analysis.

3. Results and discussion

3.1. Metal concentrations of samples

Metal pollution levels were established by employing different pollution indicators in the sampled fish species of *Oreochromis niloticus*, *Clariase gariepinus* and *synodontis schall* caught from Komadugu-Yobe River at Gashua. Descriptive statistics of HMs from three analysed species were shown in Table 1. An overall total of 60 fish species were sampled, the highest metal concentrations were observed in Zn and Ni, and the lowest concentrations were seen in As and Cd. Comparative effects from studies of different species of fish have been reported by many researchers [32, 33, 34]. The metal concentrations in the gills of all the studied fish samples were generally higher compared to the concentrations recorded in the fish muscles (Table 1).

3.1.1. Cadmium

Cadmium (Cd) levels in the fish gills were observed to be highest in *O. niloticus* (0.05 mg/kg), and lowest in S. schall (0.031 mg/kg). The lowest and highest values of Cd concentrations in the muscle were established in *S. schall* (0.002 mg/kg) and *O. niloticus* (0.06 mg/kg)(Table 1). The average Cd concentrations vary significantly among the fish species in both gills and muscles ($p < 0.05$). Compared to this study, [33] reported a higher mean value of Cd concentration in tilapia fish species. The mean Cd level observed in all the fish species were lower compared to other studies (Table 3).

3.1.2. Nickel

The maximum levels of Nickel in fish gills were detected in *O. niloticus* at 4.19 mg/kg and the lowest in *C. gariepinus* at 2. 65 mg/kg. Ni levels in the gill of *C. gariepinus* were generally low in this study compared to *O. niloticus* and *S.schall*. Conversely, the maximum and minimum values of Ni concentrations in muscles were recorded in *C. pariepinus* with 2.56 mg/kg and in *S. schall* with 0.17 mg/kg, respectively. The average value of Ni recorded in the muscle tissue of C. *soborna* caught from Bangshi River, Dhaka was 3.76 mg/kg [35]. Ni concentrations were found in a comparable range of 2.06 - 4 .08 in this study. The average Ni concentrations recorded in this study was similar to the level of concentration reported for three fish species from Lake George, Uganda [36]. A higher concentration of Ni was detected in this research when compared to the level in the fish muscles from freshwater lake of Bhopa, [37].

3.1.3. Copper

The highest concentration of Cu in gill was observed in *O.niloticus* (3.42 mg/kg), while *C. gariepinus* and *S. schall* recorded concentrations of 2.52 mg/kg and 1.29 mg/kg as shown in Table 1. Variations in the Cu content in the three fish species indicated that *O. niloticus* had higher Cu level than the other two species at ($P < 0.05$). The maximum Cu level in muscles of the fish was 1.89 mg/kg and 1.63 mg /kg in *S. schall* and *C. gariepinus*, respectively. The Cu levels recorded in the muscles of commercial fish in River Benue were reported as 9.99 mg/kg [33]. A similar average concentration of 5.13 Mg/Kg was observed in *S. membranaceus* sampled from Anambra River, Nigeria [38]. Generally, the mean Cu concentration in this present study was below maximum acceptable concentrations of 30 Mg/Kg set by the World Health Organization [39]. (Table 2).

3.1.4. Zinc

Zinc concentrations in fish tissues have been recognized as the second most accumulated metals after iron [32]. Zn concentrations in muscles were observed at the average highest level of 11.09 mg/kg in *C. gariepinus* and lowest concentration of 8.22 mg/kg in *O. niloticus*. The average maximum and minimum zinc concentrations in the gills were recorded in *O. noliticus* in the level of 14.46 mg/kg and in *S. schall* in the level of 11.40 mg/kg (Table 1). It was also observed that there was no significant difference in Zn level of the three species when the Zn levels were examined at ($P < 0.05$). [33] reported average Zn concentrations of 7.15 mg/kg in the fish gills and 5.66 mg/kg in the fish muscles from River Benue. Lower mean levels of Zn have been recorded in common carp (0.48 Mg/Kg) from freshwater lake of Bhopal [38]. Similar mean Zn concentrations (3.85 mg/kg) was measured in the muscles of *Mugil species* from Lake Qarun, Egypt [40], and lower average Zn concentrations in *M. cephalus* muscle (5.82 Mg/Kg) has been reported from India [41]. (Table 3). In general, the average Zn concentrations in the three fish species were found below the permissible range of 30 mg/kg.

3.1.5. Lead

Maximum Pb levels in gill were measured in *O. noliticus* (0.48 mg/kg), and minimum concentrations in *C. gariepinus* (0.03 Mg/Kg). Maximum level of Pb concentrations in fish muscles were observed in C. gariepinus (0.42 Mg/kg) and minimum concentrations were recorded in *O. niloticus* (0.38 Mg/Kg). similarly, there was significant difference in Pb concentrations among the three fish species at ($p < 0.05$). [42], stated that the mean Pb concentration from *C. nigrodigitatus*, *E. fimbriata and P. elongatus* in the Cross-river system, Nigeria was 3.0mg/kg, 3.8 mg/kg and 10.0 mg/kg respectively. The mean Pb levels in fish muscles in this study, (0.14 - 0.48 Mg/g) were observed to be greater than those in the studies conducted by [43, 44]. The average Pb levels in the fish muscles in this present study is lower compared to other studies as shown in Table 3. And were also lesser than maximum permissible limits set by [45] (1.0 mg/mg), [46] (0.5 mg/kg), [47] (0.5 mg/ kg) and [48] (2.0 mg/kg).

3.1.6. Arsenic

The maximum and minimum levels of As content in the gills of the fish was detected in *O. niliticus* (0.24 mg / kg) and *S. schall* (0.03). Correspondingly, As accumulations in the muscles recorded the highest and lowest concentrations of 0.38 Mg/kg in *S. schall* and 0.20 in *O. noliticus* (Table 1). [35], reported an average As level of 0.88 mg/kg from a variety of fish species caught from the River Bangshi , Bangladesh . In the research conducted in the Cika-Koshi reservoir, Katsina North-western Nigeria, an average of 3.15 mg/kg of As was found in the muscles of *B. bayad* [34]. The maximum permissible concentrations for As in fish by the New Zealand and Australian food specifications [47] were 0.10 mg/kg and 2.2 mg/kg. As level measured in *O. noliticus* of this study were above the maximum permissible level set by [46]. Whereas As level in *C. gariepinus* and *S. shchall* were below the maximum permissible limit set by [46]. Generally, the As concentrations in the muscle of the three fish species were higher compared to the values reported by [43], but lower than values reported in other literatures (Table 3).

Table 1 Mean concentrations of HMs in gills and muscles of fish (Mg/Kg)

	Tissue (n= 12)	***O. niloticus***	***C. gariepinus***	***S. schall***
As	G	0.24 ± 0.14^{a}	0.19 ± 0.09^{ab}	0.03 ± 0.012^{c}
	M	0.20 ± 0.08^{ab}	0.24 ± 0.08^{b}	0.38 ± 0.002^{c}
Cd	G	0.05 ± 0.01^{a}	0.046 ± 0.01^{b}	0.031 ± 0.02^{bc}
	M	0.06 ± 0.00^{a}	0.05 ± 0.01^{ab}	0.002 ± 0.004^{c}

Cu	G	3.42 ± 1.47^{ac}	2.52± 4.67^{b}	1.29 ±0.24b^{c}
	M	1.63 ± 2.31^{ab}	1.87 ± 1.65^{c}	1.08 ±0.10^{c}
Pb	G	0.48 ± 0.26^{a}	0.03 ± 0.09^{ab}	0.38 ± 0.01^{b}
	M	0.38 ± 0.20^{a}	0.45 ± 0.07^{b}	0.41 ± 0.02^{b}
Ni	G	4.19 ± 3.89^{ab}	2.65 ± 3.26^{b}	2.85 ±0.47^{b}
	M	2.13 ± 1.89^{a}	2.56 ± 0.98^{a}	1.42 ±0.04^{b}
Zn	G	14.46 ± 3.99^{ab}	13.45 ± 3.32^{c}	11.48 ± 10.98^{c}
	M	8.22 ± 2.86^{b}	11. 09 ± 3.12^{b}	8.34 ± 8.98^{b}

Different letters (a, b, c) in similar rows indicates statistical difference among fish species for similar HM content ($p<0.05$)

Table 2 Maximum values of heavy metals in this study compared to upper limit standards for fish muscles tissues

	As	**Cd**	**Cu**	**Pb**	**Ni**	**Zn**	
Detected maximum values	0.23	0.05	2.56	0.35	11.69	20.22	This study
NAFDAC, Nigeria		0.1		1.0		50	[45]
Food Standards Australia New Zealand	2			0.5			[47]
European Commission		0.05		0.3			[49]
Chinese Health Ministry	0.1	0.1		0.5			[46]
World Health Organization		1.00	30	2.0	0.5-1	100	[39]
Codex Alimentarius Commission				0.3			[48]

(Modified from [50])

Table 3 Mean HMs levels in fish muscle in this study compared with other regional studies

Species	**Locations**	**As**	**Cd**	**Cu**	**Pb**	**Ni**	**Zn**	**References**
Tilapia zilli	River Benue, Nigeria		0.99	9.99	3.58		18,1	[33]
Alestes nurse	Oguke lake, Nigeria		1.50	12.4	10.9		119.6	[51]
Clarias gariepinus	Warri River, Nigeria		0.19		0.21			[52]
Bagrusbayad	Cika-Koshi reservoir, Nig.	3.15	0.79		1.01			[34]
Synodontis membranaceus	Anambra River, Nigeria			5.13	61.3		71.17	[38]
Chrysicthys nigrodigitatus	Okumeshi River, Nigeria		0.03		0.01	0.13		[53]
L. rohita	Fresh water Lake of Bhopal, Indian		0.42	0.39	0.39	0.20	0.48	[37]
Labeo senegalensis	Red volta river, Ghana		0.024					[54]
Clarias gariepinus	Lake Tshangalele, Congo	0.41	0.66	88.10		0.3		[55]
Protopterusaethiopicus	Lake George, Uganda			1.5		2.0	64.4	[36]
C. soborna	Bangshi River Dhaka, Bangladash.	4.27	0.87	27.36	10.27	3.76	371.04	[35]
M. cephalus	Chilika lagoon, India			3.76			5.82	[41]

3.2. Classification of studied fish species based on heavy metal concentrations

In this study, the three fish species were categorized based on the average levels of metal content (As Cd, Cu, Ni, Pb and Zn) (Fig. 3). The highest metal concentration was observed in *O. niloticus*, while lowest level was found in *S. schall*. In fact, the rank order of metal concentrations in the studies species is as follows: ON>CG> SS. Difference in metal accumulated by these species may be due to habitat type, physiology, environmental sources level and feeding behavior of the fish species [41].

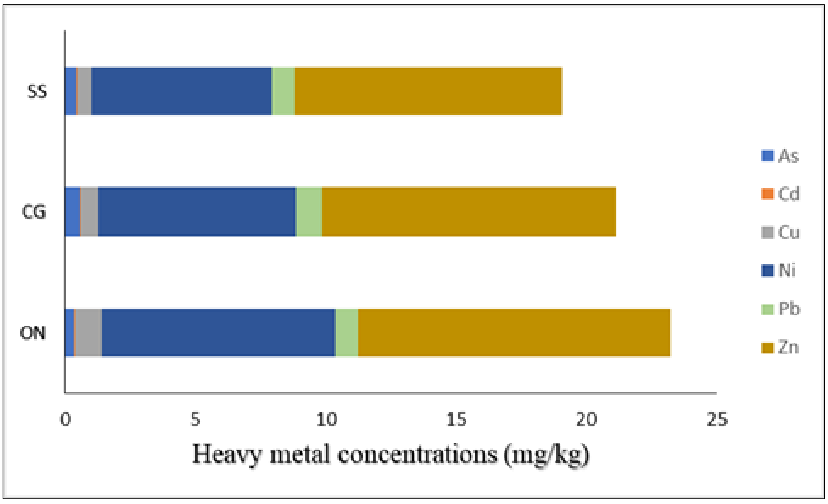

Figure 3 Heavy metal concentrations (mg/kg)

3.3. Evaluation of probable public health threat related to the intake of fish

The metal pollution index (MPI) was computed for the muscles and the gills of every fish species. The computed MPI values were higher in the gills compared to the muscles, The calculated MPI values for the gills were 2.21 in *O. niloticus*, 1.16 in *C. gariepinus* and 1.79 in *S. schall*. Meanwhile, 1.06*1.31*and1.26 MPI values were recorded in the muscles of *O. niloticus*, *C. gariepinus* and *S. schal* respectively.The Estimated Daily Intakes (EDI) values were computed for the six metals studied in the three fish species as presented in Table 5. Generally, most of the EDI values for individual metal were greater than the TDI values for metals recorded for the three different fish species. The EDI values of Pb and Zn were greater than all the TDI values recorded in all the fish species. Also, the EDI values for Ni are greater in *C. gariepinus* and *S. schall* than the TDI values. Whereas, the TDI values for Cd and Zn were higher in *S. schall* and *C. gariepinus* respectively. Thus, daily consumption of these fish laden metals may pose a health risk challenge. The public health risk indicator indices (HI, MPI and THQ) for adults in the studied fish species were computed as shown in Table 5. All the metals recorded a THQ value of less than 1, indicating that the metals may cause any health issue. As well, the HI values of individual fish species were below 1 and are considered to pose no potential health hazards (Fig. 4, Table 5).

Table 4 RfD, EDI and TDI metals values in the muscle of sampled from the Komadugu-Yobe river, Gashua

	EDI (Mg/Kg/day)			**RfD***	**TDI****
	O. niloticus	*C. gariepinus*	*S. schall*	(Mg/Kg/day)	Mg/Kg/day
As	3.35E-02	2.93-02	2.46E-02	3.00E-01	2.16E-03
Cd	4.20E-03	3.82E-02	2.26E-03	1.00E-03	3.00E-03
Cu	I.91E-01	1.62E-01	1.07E-02	3.00E-02	2.00E-01
Ni	3.89E-02	3.46E-02	2.38E-01	2.00E-02	1.30E-02
Pb	5.46E-02	3.42E-02	2.32E-03	2.80E-03	1.60E-03
Zn	2.56E+00	2.18E+00	3.76E+00	300E-01	2.20E-03

Table 5 Hazard index (HI), Target hazard quotient (THQ) and Metal pollution index (MPI) values through fish consumption

		O. niloticus	*C. gariepinus*	*S. schall*
HI		3.83E-01	2.50E-01	1.67E-01
THQ	As	1.45E-01	1.76E-01	1.52E-01
	Cd	4.26E-04	3.92E-05	2.93E-05
	Cu	1.52E-02	2.52E-04	1.43E-02
	Ni	2.35E-03	2.93E-04	1.90E-03
	Pb	1.64E-04	1.14E-04	1.81E-04
	Zn	4.45E-03	5.71E-05	3.89E-03
MPI	Gill	2.34E+ 00	1.18E+00	1.81E+ 00
	Muscles	1.08E+00	1.33E+00	1.93+00

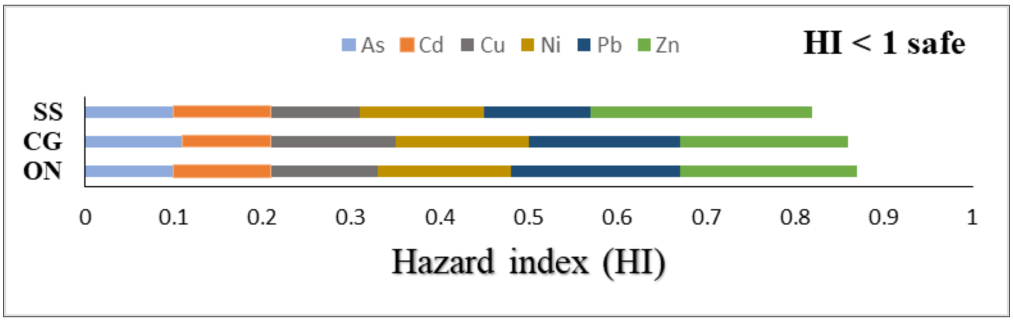

Figure 4 Different fish species with their Hazard Index (HI)

3.4. Credit authorship contribution statement

Akogwu Simeon:Conceptualization, writing-review and editing. Lami Jafiya: Data curation, methodology, Validation and conceptualization Jibrin Sabo Suleiman: Supervision, investigation, and data curation. Osunlaja A.A: Methodology, data curation and editing.

4. Conclusion

This study revealed that the fish species, captured and ingested from the Komadugu-Yobe river at Gashua, contain different metal levels of accumulation which differ amongst the different species. Among all metals investigated (As Cd, Cu,Ni, Pb and Zn), Zn was the most accumulated element in the gills of *O.niliticus* and the muscles of *C.gareipinus*, whereas As and Cd were the least accumulate in the gills and tissue muscles. There was statistical difference between the levels of metals determined in all the species in the study site. The rank order of metal accumulation in the muscles of the fish is as follows; Zn> Ni > Cu > Pb >As>Cd. The highest concentrations of metals were measured in *O. niloticus*, while the lowest concentrations of metals were established in *S. schall*. The average level of As, Cd, Cr, Ni, Pb and Zn in all the fish species were below the maximum acceptable limits. The hazard intake (HI) and total health quotient (THQ) values were less than 1 implying that it poses no health threat, whereas estimated daily intake (EDI) values of individual metal were higher than the tolerable daily intake (TDI) values indicating harmful effect on human health in daily consumption. Thus, constant monitoring and sustainable management of the Komadugu-Yobe River at Gashua is required to reduce the amount of contaminant entering the water which may pose health risk to human and fish in the area.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declare that they are no competing personal or financial interest that could have influenced the output of this work reported in this paper.

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