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Determination of selected Heavy metals in Catfish samples collected from Some Dams in Katsina state, Nigeria

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ABSTRACT
This study was conducted to determine the concentrations of the most common pollutants that frequently contaminates the air and water (Cadmium, Cobalt, Copper, Nickel, Lead and Zinc) in the (Gills Muscles) and Tails of Ten African Catfish collected from Gwaigwaye, maska and Zobe dams in Katsina state, Nigeria across the dry and wet seasons. (The collected tissues of African catfish were digested and analyzed for the toxic metals using microwave) plasma atomic emission spectroscopy (MPAES). The levels of the metals obtained were compared with acceptable limits of world health organization (WHO) and Standard organization of Nigeria(SON).The metal levels ranged thus; (0.0132±0.01 to 0.057±0.02mg/kg for Cd, 0.00±0.00 to 0.887±0.01mg/kg for Co, 0.090±0.00 to 0.26±0.00mg/kg for Cu, 0.00±0.00 to 0.138±0.01mg/kg for Ni, 0.00±0.00 to0.003±0.00 mg/kg for Pb and 0.133±0.04 to 0.855±0.01mg/kg) for Zn for catfish gill in dry and wet seasons. Likewise, the concentration levels of the metals in Catfish muscle in the following ranges were as follows (0.01±0.00 to 0.076±0.01mg/kg for Cd, 0.00±0.00 to 0.048±0.01mg/kg for Co, 0.066±0.04 to 0.108±0.03 mg/kg for Cu, 0.01±0.00 to 0.096±0.03mg/kg for Ni, 0.00±0.00 to 0.01±0.00mg/kg for Pb and 0.036±0.05 to 0.411±0.04mg/kg) for Zn . Similarly, (0.019±0.01 to 0.029±0.03mg/kg for Cd, 0.00±0.00 to 0.091±0.01mg/kg for Co, 0.079±0.01 to 0.133±0.03mg/kg for Cu, 0.016±0.03 to 0.116±0.01mg/kg for Ni, 0.00±0.00 to 0.023±0.03 mg/kg for Pb and 0.323±0.03 to1.08±0.01 mg/kg) for Zn in Catfish tail in both dry and wet seasons. The levels of the metals were found to be below the safe limits set by both WHO and SON. African catfish from Gwaigwaye, Maska and Zobe dams are therefore safe for human consumption. The results of statistical analysis and P values<0.05 indicated no significant difference between the tissues of African catfish analyzed across all the dams in both seasons.

Keywords: Heavy metals, Dam, Concentration, Catfish, Gill, Muscle and Tail.

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1 INTRODUCTION
Rapid Growth of Industries and Cities has caused water pollution and quality issues thereby disturbing the delicate balance of water ecosystem (Verma and Boursi,2016). Heavy metal contamination in aquatic environment disturbs the ecological balance due to bioaccumulation and transfer through food chain (Butu *et al*., 2019).

Human activities like domestic waste disposal, industrial operations and other anthropogenic sources can lead to significant contamination of natural aquatic environment with heavy metals (Kamaruzzaman *et al*., 2009). Heavy metals Accumulation in an aquatic environment has become an issue of serious concern globally (Olojo *et al*., 2012). Fish are generally used as biological indicators to determine the level of pollution in fresh water ecosystem (Yousafzai *et al*. 2010) Heavy metals can enter fish bodies via two pathways: external absorption through gills and skin exposed to contaminated water, and internal uptake through ingestion of polluted food sources (Ayyat *et al*., 2020). When fish in an aquatic environment absorbs toxic metals into their bodies, the toxins are transferred to human who consume them, thereby causing metal poisoning through food chain (Amusat, 2020). The amount of pollutants found in a particular tissue of fish depends on how quickly they are absorbed and the rate at which the body processes and remove them (Alkahtani,2009). African catfish is considered for this research because of its pleasant taste, durability, rapid growth rate, reasonable market price and above all being the most farmed fish after tilapia (FAO,2003). Gwaigwaye, maska and zobe dams provides to major towns and the local communities water for consumption, irrigation, farming and other agricultural activities (Suleman and Audu, 2014). The study investigated the levels of Cd, Co, Cu, Ni, Pb and Zn in various tissues (Gills, Muscles and Tails) of African catfish as this information were scarce in the previous literatures. The study aimed to determine the concentrations of these toxic metals in the tissues of African catfish collected from Maska, Gwaigwaye and Zobe dams in dry and wet seasons and to evaluate the potential health hazards that may result from their consumption.

2 Materials and Method

2.1 Study Areas

Gwaigwaye Dam was built in the year 2003 by the Former Nigerian president Chief Olusegun Obasanjo in Funtua Katsina state purposely to supply water for irrigation to the nearby communities and the neighbouring local government areas namely Funtua Faskari and Bakori Local Government. The reservoir is formed by an embankment over Gwaigwaye River on Latitude (11^{o} 58`N) and longitude (7^{o} 20' E) Funtua, Katsina state. The size of the reservoir is above 450m while the depth is about 130m. It has a storage capacity of 130 million cubic meters. The climate of the area is typical savannah type with wet season (May- October) and dry season (November-April) (Lawal *etal*.,2020).

Maska Dam came into existence in the year 1996 during the regime of Ex Military Head of state Late General Sani Abacha in Funtua Katsina State, with the sole aim of supplying water for irrigation to the surrounding communities and local government areas, namely Funtua, Sabuwa and Dandume Local Government. It is located on Geographical Coordinate of latitude North of the Equator and longitude East of Greenwich Meridian

The Climate of the area is typical savannah type with wet season (May-October and dry season (November-April) (Aminu *et a*l., 2024)

Zobe Dam was initiated in the late 1970s during the Administration of former Military Head of State General Olusegun Obasanjo. It was planned to supply 50% of drinking water for Katsina state while also supporting the dry season farming in Dutsinma Area. The dam was completed and commissioned in 1983 by then President Alhaji Shehu Shagari. It is located on a Geographical coordinate of latitude 12°23'18" North of the equator and longitude 7°28'29"E East of the Greenwich Meridian. It has the height of 19m and a length of 2750m. The Dam has storage capacity of 170 million cubic meters covering 800 Hectares of the Land. The climate of the areas is typical savannah type with wet season (May-October) and dry season (November- April) (Batagarawa and Uli, 2000).

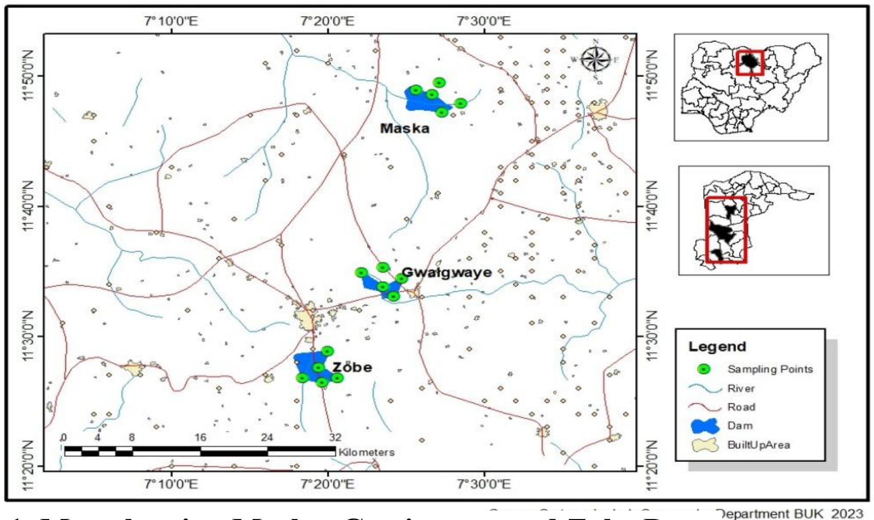

Fig. 2.1. Map showing Maska, Gwaigwaye and Zobe Dams

2.2 Samples Collection

Ten fish species of African Catfish (*Clarias gariepinus*) of different weights and sizes were obtained from Local Fishermen immediately after fishing activities on weekly basis for four weeks from 2nd August to 31St to 2023, the sample were taken to the department of Animal Science, Bayero University, Kano, where identification fish species took place. The tissues (Gills, Muscles, and Tails) were dissected and removed using a stainless knife, stored in an iced polythene bags and transported to the laboratory for preparation (Sani, 2011).

2.3 Samples Digestion

The fish samples were washed with distilled water to remove impurities then dried in an oven at 105^{OC} for 24 hours to achieve a constant weight. The fish samples were further processed by removing the bones and scales. The remaining tissues (muscle, gill and tail) were grounded into powder using mortar and pestle. Subsequently, 2g of each powdered samples was placed in a beaker followed by the addition of 5ml HNO_3 and 2ml $HClO_4$ The mixture was heated on a hotplate at 85^{OC} for 35 minutes until a clear solution was obtained. It was allowed to cool, then filtered through NO.1 Whatmaan filter paper. The solution was then transferred into a 50 cm^3 volumetric flask and made up to mark (Adebayo, 2017). Triplicate digestion of each sample was carried out.

2.4INSTRUMENTATION

After digesting the sample, the resulting solutions from the digestion were poured into a sample cups. The sample cups were then positioned in the microwave plasma atomic emission spectrometer and were securely sealed. The instrument was switched on and left to stabilize for a short time allowing it to reach its optimal performance temperature. The sample was introduced into the plasma torch, where it underwent atomization and excitation through exposure to microwave energy. The excited atoms released distinctive wavelengths of light, which were subsequently detected and quantified by microwave plasma atomic emission spectrometer. The microwave plasma atomic spectrometer analyzed the wavelength and calculated the corresponding concentrations of Cadmium, Cobalt, Copper, Nickel and Zinc present in the samples. The results were displayed on the computer screen (Mustapha et al., 2024).

2.5 STATISTICAL ANALYSIS

The data collected were expressed as mean ± standard deviations and were subjected to one way analysis of variance in order to Determine whether significant differences existed in metal concentrations between the Gills, Muscles and Tails of Catfish samples collected from Maska, Gwaigwaye and Zobe dams across the dry and wet seasons. The result of the statistical analysis (Anova) indicated no significant differences between the metals in all the catfish species analyzed in both dry and wet seasons.

3 RESULTS AND DISCUSSION

Variation of Metals Concentrations with Season in (*Clarias gariepinus*) Samples

Tables (1 and 4) indicated that levels of Cd in the gills showed slight increment from 0.031±0.01 mg/kg to 0.032±0.01mg/kg in both Maska and Zobe dams samples from dry to wet season while a notable decline was observed from 0.0267±0.03 to 0.025±0.02 mg/kg in catfish gill from dry to wet season in Gwaigwaye dam. Zobe dam's catfish gill had the highest concentration of Cd (0.057±0.002mg/kg) in wet season.. The concentrations of Cadmium in the analyzed catfish gill samples from all the dams were the below the permissible limits of 2.0 and 1.0 mg/kg by (WHO, 2008 and SON, 2007). (Joseph *etal.,*2016) reported 0.065±0.002mg/kg for Cd in catfish gill from river Calabar, Cross river state, and Faithetal (2013) reported 0.03±0.00mg/kg for Cadmium in catfish gill from mersing eastern peninsula Malaysia all of which closely agreed the results of the present work. However, (Iyabo and Immaculate,2015) obtained 0.345mg/kg for catfish gill from Ebonyi River which is slightly higher than the result present research. This could be due to increased industrial waste discharge, Agricultural practice and urbanization.

Cobalt level showed a declining trend from 0.076±0.03 and 0.887±0.01mg/kg to 0.074±0.03 and 0.108±0.03mg/kg from dry to wet season in both maska and gwaigwaye dam. Whereas, zobe dam exhibited an increase in cobalt concentration from 0.00±0.00 to 0.019±0.01 mg/kg during the same period. The highest Cobalt level(0.887±0.01mg/kg) was found in maska dam's catfish in dry season (tables 1 and 4). The concentrations of Cobalt in the analyzed catfish head samples from all the dams were lower than the permissible limits of 0.05 – 0.28 and 1.33mg/kg by (WHO, 2008 and SON, 2007). A similar study by (Narejo *etal.,*2018), 0.012±0.00 mg/kg for Cobalt in catfish gill from Indus River was obtained. and 0.05±0.01mg/kg for Cobalt in Catfish gill obtained by (Solgi *etal*.,2018), when they analyzed Catfish gill samples from Caspian Sea which closely agreed with the values obtained in the present research. However, (Ezekiel *etal.*,2012) reported that Nickel was not found in the Catfish gill from cross river, Nigeria, which is not in the agreement with the result of the present study.

The levels of Copper in the gills of Catfish from Maska and Zobe dams slightly dropped from 0.133±0.01 and 0.26±0.00mg/kg to 0.098±0.04 and 0.25±0.01mg/kg as the season transitioned from dry to wet, whereas the concentration remained steady with no significant change between the two seasons(0.090 ± 0.04mg/kg) in Gwaigwaye dam. The concentrations of Copper in the analyzed catfish gill samples from all the dams were the below the permissible limits of 3.0 and

1.0 mg/kg by (WHO, 2008 and SON, 2007) as shown in (tables 1and4). (Sani, 2011) reported 0.456±0.07mg/kg for Cu in Catfish gill from Tiga dam Kano state. 1.10±0.12mg/kg of Cu obtained by ((Olawusi peters etal.,2014) from Ondo state was slightly above the results of the present work. This could be due to accumulation of metal in river Ogbesi as a result of agricultural and or anthropogenic activities.

Table1: Concentrations of some Heavy metals (mg/kg) in Gill of Catfish samples collected from Gwaigwaye, Maska and Zobe dams in dry season. ND=Not Detected.

Metals	Gwaigwaye dam	Maska dam	Zobe dam
Cd	0.0267±0.03	0.031±0.01	0.013±0.01
Co	0.076±0.03	0.887±0.01	ND
Cu	0.09±0.00	0.133±0.01	0.26±0.00
Ni	0.013±0.03	0.138±0.1	ND
Pb	0.0266±0.03	ND	0.003±0.00
Zn	0.53±0.00	0.855±0.01	0.413±0.03

Table2: Concentrations of some heavy metals (mg/kg) in the Muscle of Catfish samples collected from Gwaigwaye, Maska and Zobe dams in dry season. ND=Not Detected.

Metals	Gwaigwaye Dam	Maska dam	Zobe dam
Cd	0.076±0.01	0.021±0.02	0.01±0.00
Co	0.046±0.03	0.033±0.01	ND
Cu	0.08±0.00	0.066±0.04	0.11±0.00
Ni	0.096±0.03	0.085±0.01	ND
Pb	0.001±0.00	ND	0.01±0.00
Zn	0.396±0.03	0.41±0.02	0.036±0.05

Table3: Concentration of some heavy metals (mg/kg) in the Tail of Catfish sample collected from Gwaigwaye, Maska and Zobe dams in dry season. ND=Not Detected.

Metals	Gwaigwaye Dam	Maska dam	Zobe dam
Cd	0.023±0.05	0.029±0.03	0.0196±0.03
Co	0.07±0.00	0.091±0.01	ND
Cu	0.079±0.03	0.090±0.01	0.116±0.03
Ni	0.08±0.00	0.116±0.01	0.016±0.03
Pb	0.023±0.03	ND	ND
Zn	0.41±0.02	1.01±0.01	0.323±0.03

Table4: Concentrations of some heavy metals (mg/kg) in the Gill of Catfish samples collected from Gwaigwaye, Maska and Zobe dams in wet season. ND=Not Detected.

Metals	Gwaigwaye Dam	Maska dam	Zobe dam
Cd	0.025±0.02	0.032±0.01	0.057±0.02
Co	0.074±0.03	0.108±0.03	0.019±0.01
Cu	0.090±0.04	0.098±0.04	0.25±0.01
Ni	0.011±0.01	0.137±0.01	0.019±0.01
Pb	ND	0.008±0.01	ND
Zn	0.418±0.02	0.212±0.01	0.133±0.04

The concentrations of Nickel have increased from 0.130 ± 0.06 and 0.013 ± 0.003mg/kg in catfish gill of Maska and Gwaigwaye dams in dry season to 0.138±0.001mg/kg and 0.106±0.00mg/kg in wet season. However, Nickel was not found in the gill from Zobe dam in dry season but 0.019±0.009mg/kg was obtained in wet season. The concentrations of Nickel in the analyzed catfish head samples from all the dams were the below the permissible limit of 0.5 - 0.6mg/kg by (WHO, 2008 and SON, 2007). Shonovon *etal*.(2017) reported 6.63±1.00mg/kg for Nickel in catfish gill from Bangladesh River and (Faye- ofore *etal*.,2015) also obtained 1.243±0.128 mg/kg for Nickel in catfish gill from Okilo Creek river state. This higher concentration of Nickel was above the results of the present work. This could be as a result of accumulation of the metal in water bodies due to Agricultural and or Anthropogenic activities taking place (Musa,2022).

Table5: Concentrations of some heavy metals (mg/kg) in Muscle of Catfish samples collected from Gwaigwaye, Maska and Zobe dams in wet season. ND=Not Detected.

Metals	Gwaigwaye Dam	Maska dam	Zobe dam
Cd	0.023±0.01	0.021±0.02	0.019±0.01
Co	0.048±0.01	0.033±0.01	ND
Cu	0.079±0.01	0.066±0.04	0.108±0.03
Ni	0.096±0.01	0.085±0.01	0.019±0.01
Pb	ND	ND	ND
Zn	0.336±0.01	0.411±0.04	0.057±0.02

Table6: Concentrations of some heavy metals (mg/kg) in the Tail of Catfish samples collected from Gwaigwaye, Maska and Zobe dams in wet season. ND=Not Detected.

Metals	Gwaigwaye Dam	Maska dam	Zobe dam
Cd	0.024±0.03	0.029±0.03	0.019±0.01
Co	0.067±0.01	0.091±0.01	ND
Cu	0.079±0.01	0.090±0.01	0.133±0.03
Ni	0.080±0.01	0.116±0.01	0.019±0.01
Pb	ND	ND	ND
Zn	0.183±0.04	1.08±0.01	0.336±0.01

The levels of lead in the Catfish gills varied seasonally, with concentrations of 0.01±0.00, 0.027±0.003 and 0.003±0.00mg/kg detected in dry season, whereas no lead was found in all the gill samples in the wet season. The concentrations of Lead in the analyzed catfish head samples from all the dams were the below the permissible limits of 0.2 and 0.3 mg/kg by (WHO, 2008 and SON, 2007). In another relevant study, 0.12 mg/kg for lead in Catfish gill from coastal water of Ondo state obtained by (Olusa and Festus,2015) and 0.27mg/kg for lead in the Catfish gill from Anyigba major market Kogi state reported by (Egbeja *etal*.,2017) closely agreed with the results of the current research. However, in another relevant research by Saiyaidi *etal*.(2022), a concentration higher than the permissible limit (0.91±0.06mg/kg)of lead was obtained in Catfish gill of warwade reservoir, jigawa state, Nigeria. The concentration of zinc in Catfish gill showed reduction slightly from 0.856± 0.006, 0.530±0.00 and 0.143± 0.00mg/kg in dry to 0.855±0.001, 0.418±0.002 and 0.133±0.035mg/kg in wet season in the gills from Maska, Gwaigwaye and Zobe dams respectively.

The concentrations of Zinc in the analyzed Catfish gill samples from all the dams were the below the permissible limit of 10 mg/kg by (WHO, 2008 and SON, 2007) Higher values above the result of the present work were previously reported which include, 5.23 ± 0.46mg/kg for Zn in catfish gill from Saki Dam Oyo state by Lawal *etal*.(2019) and 55.83± 2.93mg/kg for Zinc from Ajiwa dam in Katsina state reported by (Musa, 2021). These higher concentrations of zinc could be as a result of run-off around the sampling areas where zinc rich fertilizer and other chemicals are applied during Agricultural activities.

From Tables (2 and 5), it is clearly shown that the concentration of cadmium in the Catfish muscle was found to have slightly increased from 0.0296±0.002 and 0.010± 0.00mg/kg in dry season to 0.031±0.002 and 0.090± 0.009mg/kg in wet season for the catfish muscles from Maska and Zobe dams respectively. The concentrations of Cadmium in the analyzed samples from all the dams were the below the permissible limits of 2.0 and 1.0mg/kg by (WHO, 2008 and SON 2007). Ibrahim *etal*.(2018) reported 0.06±0.04mg/kg for Cd in Catfish muscles from Lake Njuwa. Onyidoh *etal*.(2017) also reported 0.04±0.01mg/kg for Cadmium in catfish muscle sampled from river Kaduna, 0.00-0.298mg/kg of Cadmium in the Muscle of Catfish in farm cluster from Niger delter region, Nigeria by Ehiemere *etal*.(2022) and 0.04±0.02mg/kg of Cd in the catfish muscle from Koramar wanke, zamfara state, Nigeria by (Muazu *etal*.,2023) closely agreed the result of the present work. However, 1.19±0.2mg/kg obtained for Cadmium in Catfish muscle from Manzallah lake Egypt by Abdelkhader etal.(2022) was above the result of the current research. Concentration decreased from 0.076±0.011 to 0.023±0.006mg/kg for the Muscle from Gwaigwaye dam. A Significant increase in concentration of cobalt was observed from 0.034±0.005 and 0.046±0.003mg/kg in the muscles from Maska and Gwaigwaye dam in dry season to 0.087±0.005 and 0.048±0.001mg/kg in wet season, however Cobalt was not detected in Zobe dam fish muscles for both seasons.

The concentrations of Cobalt in the analyzed samples from all the dams were the below the permissible limits of 0.05 – 0.28 and 1.33mg/kg by (WHO, 2008 and SON 2007). 0.07mg/kg was reported for Cobalt in catfish muscle from Vardar River of north Macedonia by (Shaqiri and Mavromati,2019) which is in agreement with present work. Likewise, Andreji etal.(2006) reported 0.06±0.28mg/kg for Cobalt in the muscle of Catfish species sampled from Nitra River Slovakia which also agreed with the present work. Concentration of Copper decreased from 0.170±0.004, 0.080±0.00 0.11 ± 0.00 mg/kg in the muscles in dry season to 0.133±0.01, 0.079±0.00 and 0.108±0.00 mg/kg in wet season for Maska, Gwaigwaye and zobe dams. The concentrations of Copper in the analyzed samples from all the dams were the below the permissible limits of 3.0 and 1.0mg/kg by (WHO, 2008 and SON 2007). (Abubakar and Adeshina, 2019) reported 0.14±0.01 mg/kg for Cu in the Catfish muscle from university of Ilorin dam agreed with the present work. But 0.58±0.2 mg/kg Obtained for Copper in the muscle of Catfish sampled from Lake Ngami by (Mazui *etal*.,2018) was slightly above the rSesult of the present research.

The levels of nickel in catfish muscle showed a significant rise from 0.090±0.05 and 0.010±0.00mg/kg in dry season to 0.183±0.00 and 0.020±0.001mg/kg for muscles from Maska and Zobe Dams but the levels of nickel remained constant in Gwaigwaye dam across both seasons. The concentrations of Nickel in the analyzed samples from all the dams were the below the permissible limit of 0.5 – 0.6 mg/kg by (WHO, 2008 and SON 2007). Gholizadeh *etal*.(2021) obtained 0.39±0.13mg/kg for Nickel in Catfish samples from Terapon which is slightly higher than the result of the present study. A higher value of 2.327±0.201mg/kg for Nickel in the Catfish muscle from Okilo creek river state obtained by (Faye-ofore *etal*.,2015). This value is above the result of the present work. This might be as a result of contamination of body due to agricultural and or anthropogenic activities like washing and cleaning around the dams, indiscriminate discharge of untreated effluent from industrial sources and runoff from agricultural farmlands around the dams.

Lead concentration was found to be 0.007±0.00, 0.010±0.003 and 0.010±0.00mg/kg in dry season but lead was not found in all the samples in wet season. The concentrations of Lead in the analyzed samples from all the dams were the below the permissible limits of 0.2 and 0.3 mg/kg by (WHO, 2008 and SON 2007). Statistical analysis of variance (ANOVA) showed no significant difference at P (> 0.05) between the lead Concentrations in analyzed Catfish muscles samples. (Uba and shago,2017) reported 0.265mg/kg for lead in catfish muscle from Yobe river and 1.29±0.17mg/kg obtained for lead in Catfish Muscle from river Nile Egypt by (Abdallah and Ismail,2017) are above the results of the current work. This high concentration might come from contamination due to anthropogenic activities like washing and cleaning around the dams. The concentration of Zinc increased from 0.044±0.00 to 0.855±0.004mg/kg from dry to wet season in Maska dam fish muscles, metal concentration decreased from 0.396±0.003 and 0.063±0.005mg/kg to 0.336±0.001 and 0.060±0.001mg/kg in Gwaigwaye and Zobe dams' muscles. The concentrations of Zinc in the analyzed samples from all the dams were the below the permissible limit of 10 mg/kg by (WHO, 2008 and SON 2007). In comparison with previously reported works in the literature, 0.048 ± 0.019mg/kg for zinc in catfish muscle from Al ahsa Saudi Arabia reported by (Abdelghany,2015) 0.80±0.05mg/kg for Zinc in catfish muscle from Eko-Ende dam in Osun state obtained by (Adeyeye and Ayoola,2013) and0.41±0.02mg/kg of Zn in catfish muscle reported by (Olayinka-olajungu, 2022) from Ose river agreed with the results of the present study.

Tables (3 and 6) revealed, a decrease in concentrations of cadmium from 0.0296±0.003 and 0.0196±0.001mg/kg for the catfish tail from Maska and Zobe dams from dry to wet season. However, the concentration slightly increased from 0.023±0.05 to 0.024±0.003mg/kg in Gwaigwaye dam. The concentrations of Cadmium in the analyzed samples from all the dams were the below the permissible limits of 2.0 and 1.0mg/kg by (WHO, 2008 and SON 2007). Ejike *et al.* (2015) reported 1.10mg/kg for Cd in Catfish tail from Kwalkwalawa River Dundaye Sokoto State. However, 0.04±0.03mg/kg was obtained for Cadmium in catfish tail from Ozoro dam Delta State by (Ojebah and Emumejaye,2015)

The concentration of cobalt decreased from 0.096 ± 0.01 and 0.070±0.03mg/kg in the tail from Maska and Gwaigwaye dams from dry to wet season and Cobalt was not detected in Zobe dam in both seasons. The concentrations of Cobalt in the analyzed samples from all the dams were the below the permissible limits of 0.05 – 0.2 and 1.33mg/kg by (WHO, 2008 and SON 2007). No previous reported works on Cobalt concentrations in the tail of catfish was found when writing this research.

The concentration of copper decreased from 0.240±0.006 and 0.080±0.003mg/kg in dry season to 0.090±0.006 and 0.079±0.009mg/kg in wet season. The concentration of the Copper increased from 0.116 ±0.03mg/kg in dry season to 0.133±0.003 mg/kg from Zobe dam in wet season. The concentrations of Copper in the analyzed samples from all the dams were the below the permissible limits of 3.0 and 1.0mg/kg by (WHO, 2008 and SON 2007) 0.37±0.5mg/kg of copper was reported to have been found in the tail of Catfish from Bariga section of Lagos lagoon (Yahaya *etal*.,2021) 1.60 ± 0.10mg/kg was also obtained for copper in the tail of Catfish sampled from Ozoro dam in Delta state by (Ojebah andEmumejaye,2015) were above the values obtained in the present study.

Concentration of Nickel decreased from 0.133±0.00 in dry season to 0.116 ± 0.005mg/kg in wet season for Maska Dam while it increased from 0.016±0.003 in dry season to 0.0190± 0.01 mg/kg in wet season for Zobe dam samples. However, the concentration of the metal remains unchanged in Gwaigwaye dam tail sample. The concentrations of Nickel in the analyzed samples from all the dams were the below the permissible limit of 0.5 – 0.6mg/kg by (WHO, 2008 and SON 2007) Olubunm *et al.* (2019) reported 0.27±0.01mg/kg for Nickel in Catfish tail from Badagry Creek Lagos which is not in agreement with the result of the present study. The present study also disagreed with the report of (Onyema *etal*.,2014) in which Nickel was completely not found in catfish tail from Eke Awka market Anambra state, Nigeria (Mustapha etal.,2024) also reported 0.08±0.00mg/kg for Nickel in catfish tail from Gwaigwaye dam, Katsina state, Nigeria.

Lead was only detected in the catfish tail from Gwaigwaye dam in wet season, with no presence in other dams in dry season. The concentrations of Lead in the analyzed samples from all the dams were the below the permissible limits of 0.2 and 0.3mg/kg by (WHO, 2008 and SON 2007). Jegede *et al*. (2018) reported 0.01±0.01mg/kg for lead when they analyzed catfish tail from Igbona market Osogbo which agreed with present study. A value of 0.09±0.04mg/kg was obtained for lead in the tail of catfish from Owah-Abbi (Ethiope) River Delta State by Omuku et al. (2008).

The concentration of zinc moderately decreased from 1.096±0.006 and 0.41±0.0015 in dry season to 1.088 ± 0.006 and 0.183±0.004mg/kg in wet season for Maska and Gwaigwaye catfish tail respectively, while the concentration in the tail increased from 0.323±0.003 in dry to 0.336± 0.001mg/kg for Zobe dam in wet season. The concentrations of Zinc in the analyzed samples from all the dams were the below the permissible limit of 10mg/kg by (WHO, 2008 and SON 2007). Almost similar value (0.406mg/kg) was obtained for zinc by Oluwa *et al*. (2019) when they analyzed catfish tail sampled from Epe lagoon Lagos State. However, in a research conducted by (Iromini and Abiola,2021) a higher value of 5.88± 0.02mg/kg was found in the tail of juvenile catfish exposed to detergent. The value is above the result of the present work. This higher concentration of zinc might come from the zinc rich detergent the fish is exposed to.

CONCLUSION

In the present study, the concentrations of Cadmium, Cobalt, Copper, Nickel Lead and Zinc were investigated in gill, muscle and tails of African catfish collected from Gwaigwaye, Maska and Zobe dams in dry and wet seasons. From the results of the analysis,

The levels of Cd, Co, Cu, Ni, Pb and Zn in Afican catfish tissues analyzed were within the safe levels established by regulatory agencies. This indicated that the fish do not poses health hazard due to these heavy metals. The fish are therefore safe for human consumption. However, to ensure the absolute safety of the consumers, other tissues of the fish not included in this research should be analyzed. Likewise, other toxic metals like Arsenic and Chromium not considered in the present study should also be investigated.

CONFLICT OF INTEREST

The Authors wish to declare that no conflict of interest exist between them.

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