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Analysis of Heavy Metals Concentration in Culture Water and *Clarias gariepinus* from Various Culture Facilities under Selected Local Government Area of Edo State

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ABSTRACT

This study analysed the heavy metal concentrations in culture water and *Clarias gariepinus* collected from different fish farms in Ikpoba Okha and Oredo local government areas of Edo State in different culture facilities. Lead (Pb), Zinc (Zn), Manganese (Mn) and Copper (Cu) were analysed as well as some physico – chemical parameters. The water pH (6.5-8.5) and water temperature (25-30^{o}C) was within acceptable limit of WHO standard. However, mean temperature varied with the culture facility in the two LGA. Highest DO was recorded in plastic tank while the least was in concrete tank . TDS was highest in Earthen pond and least in plastic tank. The study revealed that heavy metal concentrations in water varies among the culture facilities as well as heavy metals in the *Clarias gariepinus*.

Keywords:
Heavy metals, culture facilities

Introduction

In Africa, aquaculture has contributed immensely to the total amount of fish produced over the past decade, supporting rising fish demand and improving incomes, food and nutrition security of the growing population in the region (Mwima *et al*. 2012). The fresh water catfish can be raised in any facility that can retain fresh water. There are various fish culture facilities in aquaculture practices. All these culture facilities are likely to receive heavy metals from different sources such as underground water, soil with oil spillage, river/stream as sources of pond water, artificial feed among others. The main aim of this study is to investigate the presence of heavy metal concentrations in fish culture water and *Clarias gariepinus* from various fish culture facilities in Edo State.

Materials and Methods

Collection of Samples: Samples were collected from fish farms in Edo State using earthen pond, concrete tank, plastic tank, tarpaulin as culture facility ies. Two farms using each culture facilities was sampled, giving a total of eight (8) farms with a total of 48 fish samples and 48 water samples.

Laboratory Analysis Procedure for Heavy metal analyses

The digestion procedures was modified from Manutsewee *et al.*, (2007). The fish sample was dried to a constant weight in an oven and allowed to cool, then crushed into fine powder with a mortal and pestle. 10g of the sample was weighted and digested with nitric acid and H_2SO_4 at the ratio of 1:1. The digested samples was diluted with 20ml distilled water and then it was filtered with a Whatman filter paper into 100ml volumetric flask and made up to mark with distilled water for analysis of Cu, Pb, Zn, Mn by means of AAS (Atomic absorption spectrometer).

Determination of physico–chemical parameters

The temperature of the water samples was determined using mercury–in-glass thermometer, pH was measured using a pH meter, dissolved oxygen was determine using winkler's solution and the total dissolved solids was determine using a conductivity meter.

Experimental design and Statistical Analysis

The study was laid out as factorial experiment in complete randomized design (CRD). Data obtained was subjected to analysis using GENSTAT computer software (version 15). Analysis of variance (ANOVA) was used to test for significant difference while least significant difference (LSD) and Duncan multiple range test was used to separate the means.

Results

Comparative Analysis of Heavy Metals in Fish from Various Culture Facilities

Cu analysis: The result of Copper analysis in fish is shown in table 1.It was observed that there was no significant difference in copper level found in fish at Ikpoba Okha and Oredo LGA ($P>0.05$). However , there was significant difference in the Cu level found in fish cultured with various culture facility($P <0.05$).

Table 1: Cu content of *Clarias gariepinus*

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	tarpauin	Vertical mean(*)
CU	Ikpoba okha	0.02	0.02	0.01	0.04	0.02a
	Oredo	0.02	0.03	0.01	0.03	0.02a
Horizontal mean**		0.02c	0.03b	0.01d	0.04a	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05) *Vertical mean only, **Horizontal mean only

Pb analysis in *Clarias gariepinus*: The result of analysis of lead content is fish is shown in table 2. It was observed that there was significant difference in Pb level found in fish at ikpoba okha and oredo LGA ($P<0.05$). There was also a significant difference in the Pb level found in fish cultured with various culture facility($P<0.05$).

Table 2: Pb content of *Clarias gariepinus*

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	tarpaulin	Vertical mean
PB	Ikpoba okha	0.004	0.0004	0.01	0.0004	0.0037a
	Oredo	0.01	0.01	0.03	0.01	0.015b
Horizontal mean		0.007b	0.52a	0.02c	0.0052a	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean onl.***

Zinc (Zn) analysis in *Clarias gariepinus*: The result of the zinc content of the *Clarias gariepius* is shown table 3, it was observed that there was significant difference in Zn level found in fish at ikpoba okha and oredo LGA (P< 0.05).There was also significant difference in the Zn level found in fish cultured with various culture facilities(P<0.05).

Table 3: Zinc content in *Clarias gariepius*

Heavy metal	LGA	Concrete tank	Plastic tank	Earthen pond	tarpaulin	Vertical mean*
Zn	Ikpoba okha	0.01	0.03	0.02	0.04	0.025b
	Oredo	0.02	0.04	0.03	0.05	0.035a
Horizontal mean**		0.015d	0.035b	0.025c	0.045a	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean only***

Manganese content of *Clarias gariepinus:* The result of the manganese content of fish is shown in table 4, it was observed that there was significant difference in Mn level found in fish at Ikpoba Okha and Oredo LGA (P< 0.05). There was also significant difference in the Mn level found in fish cultured with various culture facilities (P<0.05).

Table 4: Manganese content in fish

Heavy metal	**LGA**	**Concrete tank**	**Plastic tank**	**Earthen pond**	**tarpaulin**	**Vertical mean***
Mn	Ikpoba okha	0.02	0.04	0.02	0.01	0.023b
	Oredo	0.03	0.02	0.03	0.02	0.025a
Horizontal mean**		0.04a	0.03b	0.04a	0.02c	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean only***

Mn: Earthen pond and plastic tank > Tarpaulin >Concrete tank

Comparative Analysis of Heavy Metals In Fish Culture Water.

Analysis of Copper in culture water: The result of Cu in culture water is shown in table 5, it was observed that there was no significant difference in Cu level found in fish culture water at ikpoba okha

and oredo LGA (P> 0.05). There was also significant difference in the Cu level found in fish culture water with various culture facilities(P<0.05).

Table 5: Copper content in culture water

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	Tarpaulin	Vertical mean*
Cu	Ikpoba okha	0.17	0.19	0.05	0.26	0.17a
	Oredo	0.18	0.16	0.08	0.25	0.17a
Horizontal mean**		0.18b	0.18b	0.07c	0.26a	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
Vertical mean only, **Horizontal mean only

Manganese in fish culture water: The result of Mn found in the culture water is shown in table 6, it was observed that there was significant difference in Mn level found in fish culture water at ikpoba okha and oredo LGA (P< 0.05). There was also significant difference in the Mn level found in fish culture water with various culture (P<0.05).

Table 6: Manganese in culture water

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	Tarpaulin	Vertical mean
Mn	Ikpoba okha	0.18	0.33	0.14	0.41	0.27b
	Oredo	0.22	0.41	0.17	0.54	0.34a
Horizontal mean		0.2d	0.37b	0.15c	0.47a	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
Vertical mean only, **Horizontal mean only

Lead content of fish culture water: The result of lead analysis of culture water is shown in table 7, it was observed that there was significant difference in Pb level found in fish culture water at ikpoba okha and oredo LGA (P< 0.05). There was also significant difference in the Pb level found in fish culture water with various culture facilities(P<0.05)

Table 7: Pb analysis of culture water

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	Tarpaulin	Vertical mean*
Pb	Ikpoba okha	0.018	0.014	0.073	0.005	0.028b
	Oredo	0.08	0.076	0.206	0.056	0.105a
Horizontal mean**		0.049b	0.045d	0.140a	0.031c	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
Vertical mean only, **Horizontal mean only

Zinc content of fish culture water: The result of the analysis of Zinc content of the culture water is shown table 8, it was observed that there was significant difference in Zn level found in fish culture

water at ikpoba okha and oredo LGA (P<0.05). There was significant difference in the Zn level found in fish culture water with various culture.

Table 8: Zn content of culture water

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	tarpaulin	Vertical mean*
Zn	Ikpoba okha	0.07	0.21	0.17	0.36	0.20b
	Oredo	0.16	0.34	0.32	0.16	0.25a
Horizontal mean**		0.12d	0.28a	0.25c	0.26b	

Note mean with difference alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean only***

Mean Physico Chemical Parameters of Water Samples in Fish Culture Water

Dissolve oxygen in fish culture water: The result of the analysis of DO in culture water is shown in table 9, it was observed that there was no significant difference in DO level found in fish culture water at ikpoba okha and oredo LGA (P<0.05). There was also significant difference in the DO level found in fish culture water with various culture facilities (P< 0.05)

Table 9: Mean of dissolve oxygen levels in culture water

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	tarpaulin	Vertical mean*
DO	Ikpoba okha	9.63	14.1	10.1	12.2	11.51a
	Oredo	10.0	11.7	9.83	12.3	10.95b
Horizontal mean**		9.81d	12.9a	9.96c	12.3b	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean only***

pH of culture water: The result of the analysis of pH level in culture water is shown in table 10, it was observed that there was significant difference in pH level found in fish culture water at Ikpoba Okha and oredo LGA (P<0.05). There was also significant difference in the pH level found in fish culture water with various culture facilities (P< 0.05)

Table 10: Mean pH of culture water

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	tarpaulin	Vertical mean*
PH	Ikpoba okha	6.73	6.73	6.56	6.46	6.62b
	Oredo	6.43	6.93	7.3	6.4	6.76a
Horizontal mean**		6.58c	6.83 b	6.93a	6.43d	

Note mean with difference alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean only***

Total dissolved oxygen in fish culture water: The result of the total dissolve solid in culture is shown in table 11, it was observed that there was significant difference in TDS level found in fish culture water at ikpoba okha and oredo LGA (P<0.05).There was also significant difference in the TDS level found in fish culture water with various culture facilities (P< 0.05)

Table 11: Total dissolve solid in culture water

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	tarpaulin	Vertical mean
TDS	Ikpoba okha	2.0	0.7	1.47	1.1	1.32b
	Oredo	1.93	0.93	5.07	1.03	2.24a
Horizontal mean		1.96b	0.81d	3.27a	1.06c	

Note: mean with difference alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean only***
TDS in water: Earthen pond > Concrete tank> Tarpaulin > plastic tank.
The TDS was highest in earthen pond and least in the plastic tank.

Temperature of fish culture water: The result of the mean temperature in culture is shown in table 12, it was observed that there was no significant difference in Temperature level found in fish culture water at ikpoba okha and oredo LGA (P<0.05). There was significant difference in the temperature level found in fish culture water with various culture facilities (P< 0.05).

Table12: Mean Temperature of culture water.

Heavy metals	LGA	Concrete tank	Plastic tank	Earthen pond	tarpaulin	Vertical mean
Temperature	Ikpoba okha	29.5	29.4	29.5	29.3	29.4a
	Oredo	29.3	29.4	29.5	29.5	29.4a
Horizontal mean		29.4a	29.4a	29.5b	29.4a	

Note: mean with difference in alphabetical remarks are significantly different (p<0.05)
****Vertical mean only, **Horizontal mean only***

Discussion

The contamination of fish and water from various culture facilities by heavy metals is of important concern especially in our country Nigeria and the world at large because of their toxicity, persistence and bioaccumulation nature (Ikem *et al*.;2003). It is clear from the result of this study that the distribution of heavy metals in fish farms showed varied values among the different culture facilities from the two local government area (Ikpoba okha and Oredo) where difference were as a result of industrial pollution, runoff, atmospheric deposition, nature of material the culture facility is made of among other.

Heavy Metals in Fish (*Clarias gariepius)*
In this study, it was osbserved in the experiment that concentration of Copper (Cu) has been shown to be highest in tarpaulin and lowest in earthen pond. The trend in the copper concentration analysis in

Clarias gariepinus is tarpaulin> plastic tank> concrete tank >earthen pond. The source of high Cu observered in tarpaulin can be as a result of contamination of water with industrial effluents or from copper pipes and fittings. It agrees with (Boyd, 2015) who stated that water used in tarpaulin tanks can contain copper especially if the water source is contaminated with industrial effluents or from copper pipes and fittings. It can also be as a result of increase in atmospheric deposition, use of copper based chemicals to control algae and fungal infections in aquaculture system, rapid development of industrialization and anthropogenic activities around these bodies (Aladesanmi *et al*.,2014).

The concentration of lead was shown to be highest in plastic tank and lowest in concrete tank. The trend in the Pb concentration in *Clarias gariepinus* are plastic tank> earthen pond > tarpaulin> concrete tank. The source of higher concentration of lead observed in plastic tank may be as a result of contamination from runoffs as major source of water is river and also leaching from plastic tanks. Teuten *et al*., 2009 stated that leaching may occur when plastic tanks not specifically designed for aquaculture are used as they may contain lead stabilizers or additives that may leach into the water. Also the concentration of heavy metals (lead) observed may be as result of increase atmospheric deposition, industrial waste, fumes from car exhaust around these water bodies.

The concentration of Zn were shown to be highest in tarpaulin. The trend zinc concentration were shown to be highest in tarpaulin. The trend in zinc concentration of the clarias gariepinus are Tarpaulin> Plastic tank> Earthen pond> Concrete tank. The source of high concentration in tarpaulin may be as a result of material used for tarpaulin makeup which may be due to the presence of PVC being part of the constituent of tarpaulin. PVC contain dangerous chemical additives such as Zinc which leach out from the surface of the tarpaulin into water in which the fish live can lead to bioaccumulation which can be toxic to the fish (Schlenk *et al.,* 1998).

Heavy Metals in Water Sample

From the analysis of the culture water, it was observed in this experiment that high concentration of Cu were found in the culture water particularly in Tarpaulin where it is highest and lowest in earthen pond. The trend in the Cu concentration culture water is as follow; tarpaulin>plastic tank and concrete tank> earthen pond. This may be as a result of agric run offs, domestic waste water that gets into the river and the use of copper based pesticides and fertilizers. This agrees with the findings of (Iwebgue *et al.*, 2006) who stated that Agric run offs domestic sewage and waste water can contain copper from household plumbing sytem and consumer products which finds its way into the water source used for culture. The concentration of heavy metals Mn observed in the culture water were shown to be highest in Tarpaulin> Plastic tank > Earthen pond > Concrete tank. This variation may as a result of fish feed, where unconsumed feed may pollute the water . there by increasing Mn in the water.

The concentration (Pb) observed in the culture water were shown to be highest in earthen pond and lowest in tarpaulin. The trend in the lead concentration is as follow; Earthen pond> Concrete tank> Plastic tank> Tarpaulin. The cause of high lead in earthen pond may be as result of industrial activities in and around the study area which could have discharged lead into the nearby water body. Car tyres were used to construct some ponds and the car tyres are very high in lead concentration which can leach into the water. This agrees with the findngs of Kibria *et al*., (2016) who stated that leaching may occur if earthen pond is lined or reinforced with materials that contain lead.

This agrees with Ogbeibu and Ezeunara (2002) who stated that industrial activities such battery manufacturing, paint and metal processing are significant sources of lead contaminant. The concentration Zn observed in the culture water were shown to be highest in plastic tank and lowest in concrete tank. The trend in the zinc concentration is as follow Plastic tank > Tarpaulin > Earthen pond > Concrete tank. The cause of high zinc in plastic tank can be as a result of anhropogenic activities around the area, agricultural runoffs from zinc based fertilizers and pesticides. This agrees with the studies of Adebayo *et al*., (2015) who stated that industrial effluents, agric runoffs are major sources of zinc in water bodies.

Physico – Chemical Parameter of water samples

The pH content of the culture water were within the range of 6.5-8.5 given by
WHO (2009) . The pH concentration was highest in earthen pond and lowest in tarpaulin. The trend is as follow; Earthen pond > Plastic tank > Concrete tank > Tarpaulin. The high pH level may be as a result of the high pH level may be as a result of the application of lime in the pond which can increase the pH level of the pond. Also earthen pond are susceptible to high pH due to the activities of run off that may occur in an Earthen pond as a result of rainfall, flooding and leaching.

The value of dissolve oxygen were within the acceptale limit for aquaculture production. The DO concentration were highest in plastic tank and least in concrete tank. The high DO value in plastic tank may be as a result of good management practices by the fish culturist.

The total dissolve solid TDS, of the culture water were highest in earthen pond and least in the plastic tank. The trend is as follow Earthen pond > Concrete tank > Tarpaulin > Plastic tank. The high TDS may be as a result of the use of artificial fish feed and the presence of macroplankton presence in the pond. The water temperature of the culture water were highest in tarpaulin and lowest in plastic and concrete tank.The trend is as follow tarpaulin > Earthen pond > Plastic tank> Concrete tank. The highest temperature value in tarpaulin may be as a result of direct sunlight into the culture facilities where without shade there by increasing the heat of the water body.

Conclusion

This study showed that the heavy metals of interest are still within the safe limit for consumption. Effort should however be concentrated on ensuring that these concentration are not exceeded. It is necessary that biological monitoring of water and fish meat for consumption should be done regularly to ensure continuous safety of food. Safe disposal of domestic sewage and industrial effluent should be practiced and where possible recycled to avoid these metals and other contaminant from going into the environment.

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