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Assessment of the Suitability of Surface and Ground-Water Quality for Aquaculture in River Yadzaram, Mubi, Adamawa State, Nigeria

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Abstract
Assessment of the suitability of surface and ground-water quality for aquaculture was conducted in River Yadzaram, Mubi. Surface water samples were collected from river Yazaram and Ground-water samples were collected from randomly selected wells around river Yadzaram. Sampling was done bi-monthly for the period four months (May-August, 2020). The sample were analysed with reference to water quality testing guide for aquaculture system. Data obtained were analyzed using Analysis of Variance (ANOVA), followed by Duncan Multiple Range Test (DMRT) to separate the means. Assessment of surface and ground-water quality analysed with reference to water quality testing guide for aquaculture showed some marked variation in physiochemical parameters in this study and that not all the parameters determined were within the limits specified by the relevant regulations in all the sites. The results of the study revealed that some physicochemical parameters and Heavy metals values obtained were slightly above the recommended safety limits for aquaculture. The water temperature fluctuation was observed throughout the study in all the sites and was within the normal range of 8-30^{0}C that fish adaptation in tropics. The pH values recorded in this research fall within the EU recommended range of 6-9 for aquatic life. Conductivity values also fluctuate between sites and sources but were within the recommended range for aquaculture. The mean TDS obtained in this study was below the WHO maximum contaminant level of 1000mg/l. The heavy metals revealed that the levels of Cupper were within the permissible limit of 0.05mg/l set by WHO for the survival and physiological function of aquatic organisms from both the surface and ground-water from the various sites. The level of Zinc in surface and ground-water from the sites fluctuated but was found to be within the recommended range of 0.3 mg/l for aquaculture as recommended by water quality testing guide for aquaculture system. The lead fluctuated and slightly exceeded the permissible level of 0.01 mg/l set by WHO for aquatic life in both surface and ground-water from the various sites.The study, therefore, recommends that both surface and ground-water can be used for aquaculture but suggested a routine check-up for water quality in order to avoid increase in level recommended by water quality testing guide for aquaculture system.

Keywords: Surface water; Ground-water; Water quality; physicochemical parameters; Heavy metals.

Introduction
Water quality assessment is usually aimed at pollution control as well as for the planning of water resources management, to provide data that may be useful in the development of fishery resources. Water quality is defined in terms of the chemical, physical and biological contents of water. The water quality of the river and lakes changes with seasons and geographical areas even when there is no pollution present. Human activities interfere in many ways with natural water cycle and constantly increase human population and its expectation regarding the standard living increase demand on exploitation of existing resources including water (Chowndhury, 2013). Different uses of water affect both quality and quantity of the water available and management of water pollution both national and international. An understanding of the discharge regime of a river is extremely important to the interpretation of water quality measurements. The discharge of a river is related to the nature of its catchment particularly the geological, geographical, and climatological influences. Artificial pollution of surface and groundwater may arise from either point or diffuse sources. Some of the more common sources include domestic sewage and latrines, municipal solid waste, agricultural wastes and manure, and industrial wastes (including tipping, direct injection, spillage, and leakage) (Sasakova *et al*., 2013) and (Fridrich *et al*., 2014). Surface and

ground-water quality is influenced by the effects of human activities which cause pollution at the land surface because most groundwater originates by recharge of rainwater infiltrating from the surface (Alexander, 2010) and (Ikusemoran and Ibrahim, 2011). Some contaminants enter ground waters directly from abandoned wells, mines, and quarries which by-pass the unsaturated zone (and, therefore, the possibility of some natural decontamination processes). Water quality is defined in terms of the chemical, physical and biological contents of water. The water quality of the river and lakes changes with seasons and geographical areas even when there is no pollution present. Water quality guidelines provide basic scientific information about water quality parameters and ecological relevant toxicological threshold values to protect specific water uses (Lawson, 2011). Hydrobiology is necessary to understand the level of pollution in the environment to understand eutrophication growth of water bodies and to understand the varieties of organisms and substances bounded in aquatic systems that are directly or indirectly useful to humans (Amina *et al*, 2020). The aquatic environment provides food shelter for fishes, crustaceans, molluscas, sea turtles, crocodiles and nutrients supplies for economically important fish species (Ekubo and Abowei, 2011). Human and industrial activities results in the discharge of various pollutants in-to the aquatic environment threatening the health of the population and damaging the quality of the environment by rendering water bodies unsuitable (Amina *et al*,2020). It has been generally accepted that surface water contains more contaminants compared to other sources of water including groundwater and rainfall (Akoteyon and Omotayo, 2015). Some research have been conducted on the surface and ground water from Mubi (Alexander, 2010) and (Ikusemoran, and Ibrahim, 2011). Most of the work was on suitability of the water for domestic use (Ibrahim *et al*, 2020). According to Alexander (2010) Boreholes and dug wells in Mubi is suitable for drinking and domestic use, but suggested a routine check-up for water quality. So far little or no work has been done with regards the suitability of surface and ground- water quality for Aquaculture in river Yadzaram. The aim of this research therefore is to assess the suitability of surface and ground-water quality of River Yadzaram, Mubi for aquaculture.

Materials and Methods

Area of study

The study was carried out in river Yadzaram, Mubi North in Mubi town of Adamawa State, Nigeria. Mubi is located between latitude 10^{0}12N and longitude 13^{0}10E. It is characterized by two seasons. The wet season begins in April and ends in October and the dry season begins in November and end in March (Adebayo, 2004). A lot of anthropogenic activities take place around this river such as wet and dry season farming, dumping of domestic waste, washing of cars and clothes, building block industries are also located around this area. Since this river passes through the metropolis, if properly controlled can be used for aquaculture.

Sample Collection

Surface water samples were collected from river and Ground-water samples were collected from randomly selected wells around river Yadzaram. River Yadzaram for this study was divided into three (3) sites. Site A Lokuwa behind Emirate palace, Site B Garden City, Site C Wuro Gude. Water was sampled twice a month for four months (May-August). Physicochemical parameters such as temperature, pH, transparency, and electrical conductivity were determined at the sampling site while those that cannot be determined at the sampling site like TDS were brought to the laboratory for analysis. All water samples collected in1-littre capacity bottle with strict adherence to sampling protocols described by standard method (APHA *et al*, 2017). Water sample for heavy metal determination was preserved before being transported to the laboratory for processing.

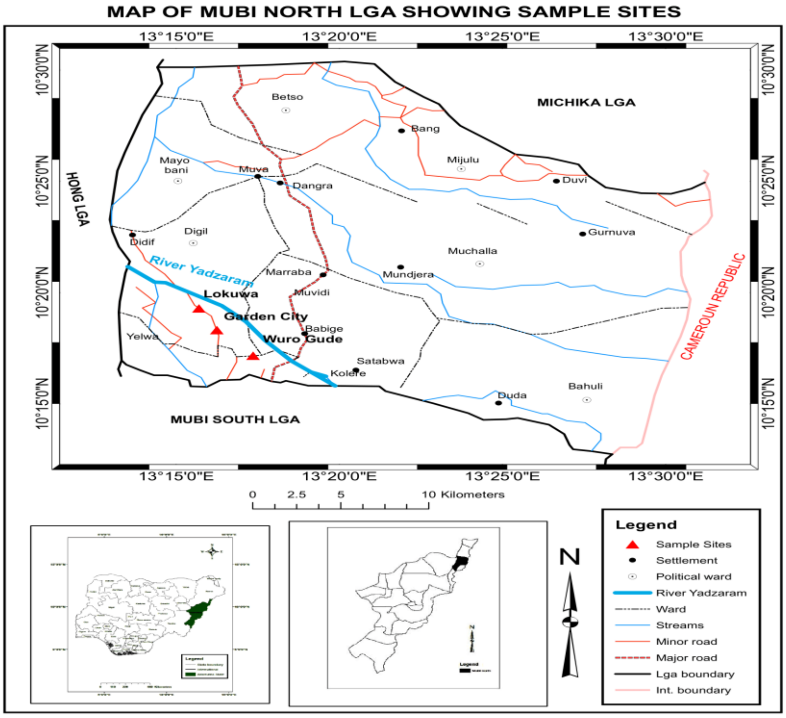

Figure 1: The study area

Physicochemical Parameters

Temperature, pH, Electrical conductivity, and Transparency were measured directly on water samples at the sampling stations using mercury bulb thermometer, pH meter, conductivity meter as recommended by ((APHA *et al*, 2017)). The total dissolved solid was determined as described by (WHO, 2011).

Determination of Heavy Metal

Heavy metal in the water sample was determined as described by the American public health association (APHA 1998). Water samples were digested and determination of copper, zinc lead, Cadmium and iron was made directly on each final solution using Atomic Absorption Spectroscopy (AAS) (VGP 210).

Data Analysis

Data collected from this research was analysed using Analysis of Variance (ANOVA) followed by Duncan Multiple Range Test (DMRT) to separate the means.

Results

Physicochemical parameters

The result for physicochemical parameters from sampling sites is presented in table 1. The highest pH was reported in surface water from Wuro Gude (6.23 ± 0.02^a) which was significantly higher ($P > 0.05$) than the-lowest (5.60 ± 0.01^b) which was reported in ground-water from Lokuwa behind Emirate Palace. pH values recorded in this study fall within the EU recommended range of 6-9 for aquatic life. The highest TDS was reported in ground-water (822.01 ± 0.02^a) from Wuro Gude ground-water was significantly higher ($P > 0.05$) than the lowest (106.00 ± 0.01^c) which was reported in surface water from Lokuwa behind Emires palace. TDS obtained in this study was below the WHO maximum contaminant level of 1000mg/l. The highest transparency was reported in surface water from Wuro Gude (62.50 ± 0.00^a) which was significantly higher ($P > 0.05$) than the lowest (1.00 ± 0.00^c) which was reported in ground-water from Lokuwa behind Emirate Palace. The highest temperature value was reported in surface water Lokuwa behind Emirate Palace (27.05 ± 0.00^a) which was significantly higher ($P > 0.05$) than the lowest temperature (22.51 ± 0.08^b) was reported in surface water from Garden City. Conductivity values also fluctuate between sites and sources but were within the recommended range for aquaculture. The highest value (231.00 ± 0.00^a) was reported in surface water from Wuro Gude while the lowest value (107.73 ± 0.03^b) was reported in ground-water from lokuwa behind Emirs palace which was significantly higher ($P > 0.05$).A

Heavy Metals

The result for heavy metals from the sampling site is presented in table 2. Cadmium and Iron were not detected in both the surface and ground-water in all sites. Copper, Zinc and Lead were recorded in both surface and ground-water in all the sites. The highest Copper level (0.047±0.03^{a}) was reported in ground-water from Lokuwa behind Emirate Palace (0.067+0.00a) which was significantly higher (P > 0.05) than the lowest (0.021+0.01^{c}) reported in surface water also from Lokuwa behind Emirate Palace. The highest Zinc was reported in surface water from Garden city (0.038+0.00a) which was significantly higher (P < 0.05) than the lowest (0.00+0.00a) in ground-water from Garden City. The highest lead (0.120+0.01^{a}) was reported in ground-water from Lokuwa behind Emirs palace which was significantly (P > 0.05) higher than the lowest (0.002+0.00^{a}) in ground-water and surface water from Garden-city.

Table 1: Some physic-chemical parameters of River Yadzaram

		Physiochemical parameters				
Sample Station	**Sampling site**	**pH**	**TDS (mg/l)**	**Transparency (cm)**	**Temperature (°C)**	**Conductivity (µs)**
Lokuwa behind	Surface water	5.81±0.02^{b}	106.0±0.03^{c}	47.00±0.00^{b}	27.05±0.00^{a}	156.66±0.07^{a}
Emirs Palace	Ground water	5.60±0.01^{b}	553.0±0.05^{a}	1.00±0.00^{c}	25.25±0.01^{b}	107.73±0.03^{b}
Garden city	Surface water	5.91±0.03^{b}	109.0±0.00^{c}	50.1±0.01^{a}	22.51±0.08^{b}	224.00±0.01^{a}
	Ground water	6.11±0.01^{a}	623.0±0.00^{a}	2.50±0.03^{c}	23.10±0.01^{b}	131.0±0.02^{b}
Wuro Gude	Surface water	6.23±0.02^{a}	97.00±0.01^{c}	62.50±0.00^{a}	27.01±0.01^{a}	231.00±0.00^{b}
	Ground water	5.71±0.03^{b}	822.01±0.02^{a}	1.00±0.02^{c}	23.10±0.02^{b}	158.7±0.00^{a}

Mean in the same column with superscript do not differ significantly (P> 0.05)

Table 2: Some Healy Metals of water River Yadzaram

				Heavy Metals		
Sample Station	**Sampling site**	**Cu (mg/l)**	**Zn (mg/l)**	**Pb (mg/l)**	**Cd (mg/l)**	**Fe (mg/l)**
Lokuwa behind	Surface water	0.02±0.01^{c}	0.016±0.01^{b}	0.110±0.00^{b}	0.00±0.00^{a}	0.00±0.00^{a}
Emirate Palace	Ground water	0.047±0.00^{a}	0.007±0.05^{c}	0.120±0.01^{a}	0.00±0.00^{a}	0.00±0.00^{a}
Garden city	Surface water	0.043±0.06^{b}	0.038±0.00^{a}	0.002±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	Ground water	0.045±0.06^{b}	0.002±0.00^{e}	0.002±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
Wuro Gude	Surface water	0.044±0.01^{a}	0.004±0.06^{d}	0.115±0.00^{b}	0.00±0.00^{a}	0.00±0.00^{a}
	Ground water	0.025±0.05^{c}	0.005±0.05^{d}	0.115±0.03^{b}	0.00±0.00^{a}	0.00±0.00^{a}

Mean in the same column with superscript do not differ significantly (P> 0.05)

Discussion

Protection of water sources from pollution that can ensure availability of water of good quality for aquaculture is an essential requirement for sustainable development. Assessment of surface and ground-water quality analysed with reference to water quality testing guide for aquaculture showed some marked variation in physiochemical parameters in this study and that not all the parameters determined were within the limits specified by the relevant regulations in all the sites. The result of the study revealed that water temperature fluctuates in the surface and ground-water between the sampling sites. The water temperature fluctuation observed throughout the study in all the sites were within the normal range of 8-30^{0}C that fish adaptation to in tropics (Abubakar *et al*., 2015). The range of temperature recorded during the period of the research is nearly in line with the range of values obtained by (Alexander, 2010) and (Ikusemoran and Ibrahim 2011) in Mubi, Adamawa State. The pH values recorded in this study fall within the EU recommended range of 6-9 for aquatic life (Akindelel *et al*; 2013). Conductivity values also fluctuate between sites and sources but were within the recommended range for aquaculture. Amina *et al.,* (2020) recorded the same value for conductivity in Mubi. The highest transparency was recorded in surface water from Wuro Gude while the lowest was recorded in ground-water from Lokuwa behind the emirate palace. Total dissolved solids (TDS) also fluctuated in this study. The fluctuation could be attributed due to the diverse anthropogenic activities around the study sites. High TDS reduced water clarity which could contribute to decreasing photosynthetic activities and might lead to an increase in temperature as observed in this study. The mean TDS obtained in this study was below the WHO maximum contaminant level of 1000mg/l. It is relatively low when compared to the values obtained by Lawson (2011).

The result of the analysis of Heavy metal in water showed some variations between stations and source except Cadmium and Iron which were below detection level in both surface and groundwater from all the stations. The copper concentration in groundwater from Lokuwa behind emirate palace was found to be slightly higher than the permissible limit of 0.05mg/l set by WHO (2004) for the survival and physiological function of aquatic organisms and within the permissible limit of 1mg/l set NIS (2007) for domestic used. The level of Zinc in the water sample was higher in surface water from Garden city and lowest in ground-water from Garden city. The concentration of Zinc in the river Yadzaram was above the permissible limit of 0.3mg/l and 3mg/l water set by WHO (2004) and NIS (2007) respectively. The level of Zinc in surface and groundwater fluctuated but was found to be within the recommended range of 0.3 mg/l set by WHO (2004). Zinc is an element commonly found in the earth's crust. It is released to the environment through natural and anthropogenic sources such as discharge of smelter slag and waste, mine tilling, and use of commercial products such as fertilizers and wood preservatives that contain zinc. Zinc plays a biochemical role in the life processes of all aquatic plants and animals. Zinc is an essential growth element for plants and animals but an elevated level is toxic to fish species. The lead fluctuated and slightly exceeded the permissible level of 0.01 mg/l set by WHO (2004). The concentration of lead in water samples from Wuro Gude exceeds the permissible limit of 0.01 mg/L set by NIS (2007) for aquaculture. The higher level of lead observed in the water samples from River Yadzaram might be attributed to run-off from agricultural land which contains agrochemicals (pesticides, fertilizer, etc.) (Sasakova *et al*., 2013)

Conclusion

The assessment showed a relatively good water quality of both surface and ground-water for aquaculture potential with respect to physicochemical and heavy metal parameters even at sampling sites where some pollution from point source was expected. However, not all parameters reflecting quality of surface and ground-water were determined. Also more frequent sampling is required to support fully such conclusion managed.

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