Ponds' Water Quality Analysis and Impact of Heavy Metals on Fishes' Body

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Abstract: The anthropogenic activities have caused increase in the aquatic heavy metals pollution. The higher concentration of heavy metals in fish's body also affects the consumers as it reaches to human body through the food chain. This study was conducted to analyze the ponds' water quality based on physicochemical parameters and nutrients in relation to the dissolved heavy metals accumulated in the fishes' body by using R programing. In this study, the heavy metals bio-accumulated from barrage pond and diversions ponds was analysed. Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds were purposively chosen for the study. The water sample was analysed using HACH DR5000 UV-Vis Spectrophotometer to measure Ammonium-Nitrogen, Nitrate-Nitrogen, Phosphates and Total Phosphorus at Chemistry Department's Laboratory of University of Rwanda. While after filtration of water samples using Whatman filter papers, heavy metals including Fe, Cu, Mn, Zn, Ni, Co, Cd, Cr and Pb were determined using ICP-MS 7900. The analysis of physicochemical parameters showed that the temperature, pH, Conductivity, Turbidity and TDS were within the permissible limit of ponds' water (20-300C, 6.5-9, less than 1000 µs/cm, 30-60 NTU and less than 2000 mg/L respectively) quality for all the sites except Rwasave fishponds, where lower pH was observed. The nutrients level in these ponds were low comparing to the standard limit. The assessed heavy metals were Fe, Cu, Mn, Zn, Cd, Cr and Pb whose concentrations analyzed in water were within permissible limit of 0.3ppm, 1ppm, 0.1ppm, 3ppm, 0.003ppm, 0.5ppm and 0.01ppm respectively while heavy metals bio-accumulated were within the permissible limit of 0.1ppm, 1ppm, 0.05ppm, 5ppm, 0.05ppm, 0.05ppm and 0.05ppm respectively for all the sites except for both dissolved and bio-accumulated Fe and Mn concentration which were high for all sites. The highest level of heavy metals concentration was obtained in particular Fe and Mn. This shows that there is urgent need of continuous water quality analysis within the ponds for maintaining the favorite conditions for fish. The water quality monitoring will help the farmers to create the safe aquatic environment for fishes and improve their production output.

Keywords: *Heavy metals, Nutrients, Physicochemical parameters, Ponds, Rwanda*

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1. Introduction

Nowadays, different anthropogenic activities including agriculture, industries (Joda et al., 2019; Aris et al., 2020) urban run-off (Adeossun et al., 2015; Montazer et al., 2018) mining activities (Shahbaaet al., 2020; Soulivongsa et al., 2020) and geochemical structure (Naggar et al., 2018) increases the aquatic heavy metals pollution (Shahbaaet al., 2020; Ma et al., 2020). The quality of water affects aquatic life (Olanrewaju et al., 2017; Tulsankar et al., 2020) this is why ponds' management is a key during fish farming (Agyakwah et al., 2020) for its importance for aquatic biodiversity (Hornbach et al., 2020) as poor water quality reduce fishes yield (Makori et al., 2017). The existence of trace and accepted heavy metals level are needed by living body (Shahbaaet al., 2020) including fishes to function and survive (Shafiuddin et al., 2019) but its higher concentration contaminates the fishes (mal-growth and reproduction disorder, mainly the skin, gills, liver, spleen, and kidneys alteration) (Arantes et al., 2015), and even the consumers (human health) indirectly through food chain (Kamaruzzaman et al., 2020; Liu et al., 2020). Pb, Cu, Zn are most toxic heavy metals on human body and also affect environment (Zebib and Teame, 2017; Hadeel et al., 2019; Ma et al., 2020). US

Environmental Protection Agency and even International Agency for research on cancer classify As, Pb, Cr and Hg as carcinogens (Shahbaaet al., 2020). In general, heavy metals are higher density (great than 5gmL-1) (Mamboya, 2007) metallic element, very toxic at even lower concentration (Joda et al., 2019). Though it is less than 1% mass of living organisms, (Khayatzadeh and Abbasi, 2010) but are not bio-degradable (Abalaka et al., 2020). In this study the heavy metals bio-accumulated from barrage pond and diversions ponds was analysed. The dissolved heavy metals reach directly to the fish tissues (Khayatzadeh and Abbasi, 2010; Adebayo, 2017; Rajeshkumar and Li, 2018; Liu et al., 2020) by gills, body surface and also digestive track (Afshan et al., 2014), which is excreted via the feces, urine, and respiratory membranes (Joda et al., 2019). The concentration of heavy metals is not balanced in all organs of the fishes (Jia et al., 2017; Rajeshkumar and Li, 2018; Tulsankar et al., 2020). According to Amal and Nahed (2012), the higher concentration was observed in intestine than muscle. The highest concentration was observed in the liver tissues of fish, while the least concentration was observed in bone tissues (Uwem et al., 2013). The fish's composition varies due to different factors even on the same species, with major factors including seasonal variation, environment, sexual cycle, maturity stage, feed, organs and also muscle location (Talab et al., 2016). The aquatic heavy metals concentration affects the fish size, with the linkage to the ecological needs, swimming behaviours and also metabolic activity (Yia and Zhang, 2012; Zebib and Teame, 2017), growth and increase fishes' developmental anomalies (Khayatzadeh and Abbasi, 2010). Even Jia et al., (2017) found that it is at low probability $p<0.01$. Physio-chemicals parameters (physical, chemical and biological characteristics) (Zebib and Teame, 2017) indicate the nature and quality of water contained in the ponds (Mohamed, 2005; Ma et al., 2020) as the basic factor to control the dynamics and even structure of aquatic life (Makori et al., 2017; Ndayisenga and Habimana, 2020) and affect type and amount of nutrients (Chen et al., 2018). The presence of mineral concentrations in fish muscle affect different biological factors (Talab et al., 2016) while the presence of higher nutrients level causes the eutrophication of water (Chen et al., 2018) and becomes threat to the fish life (Kane et al., 2015). A study has shown that the nutrient level and organic matter is high in the ponds than in the rivers (Dróżdż et al., 2019). The water temperature, dissolved oxygen and saturated dissolved oxygen are the major parameters affecting fish distribution (Yağcı et al., 2015; Ndayisenga and Habimana, 2020).

2. Materials and methods

2.1. Sampling location

The three spatial distributed sampling sites were chosen, based on its highest production compared to the other ponds and the long period of serving the community. Since 1954, Kigembe pond was established between Gisagara and Nyaruguru Districts in south of Rwanda for small scale fish farming. The inlet water in this ponds is from the Migina River. Nyamagana fish pond is located in Nyanza district, Southern province of Rwanda about 2 km from Nyanza town. Rwasave fish farming is in Huye district (the study consider fertilized and non-fertilized ponds) and the inlet water comes from Rwabuye River. The types of fish produced at the stations are *Tilapia nilotica* and *Clarias gariepinus.*

2.2. Sample preparation and analysis

Some parameters including pH, TDS, conductivity and temperature were measured at the field using multiparameter and followed by taking the water samples using a well rinsed and acid-cleaned polyethylene bottles for heavy metals and nutrients analysis. The samples were transported to the University of Rwanda, Chemistry Department's Laboratory for analysis. Using HACH DR5000 UV-Vis Spectrophotometer, nutrients including Ammonium-Nitrogen (NH_4-N), Nitrate-Nitrogen (NO_3-N), Phosphates (PO_4^{3-}) and Total Phosphorus (TP) were measured. While after filtration of water samples using whatman filter papers (Cat No.1001 150), heavy metals including Fe, Cu, ¬Mn, Zn, Ni, Co, Cd, Cr and Pb were determined using ICP-MS 7900. For heavy metals analysis in fish samples, the fishes' intestine was removed first and the remaining part were dried in oven at 700C for 48 hours, followed by crushing together with pestle and mortar into fine powder. 1.250g of this powder was put in 125mL digestion flasks and digested in concentrated nitric acid (69% HNO_3, ANALAR Grade) and 30% H_2O_2 by heating and cooling processes from 100^0C to 200^0C. The solutions were evaporated to 5 ml until no brown fumes evolved for about 3 hours. After cooling, the solutions were kept into volumetric flasks of 250 ml and filled up to the mark using distilled water. The sample solutions were transferred in Teflon bottles and settled over 15 hours. The digested sample solutions were filtered through Whatman filter papers (Cat No.1001 150) into volumetric flasks and heavy metals were measured as done on water sample.

3. Results and discussion

3.1. Physicochemical parameters

The aquatic temperature influence generally aquatic life and in particular the metabolism rate (Ndayisenga and Habimana, 2020). Temperature is proportional to the solubility of solute contained in water, the rate of reaction, rate of bio-chemical activity of the micro biota, plant respiratory rate, evaporation, and vaporization of the water content. For all the sampled ponds, based on guideline for aquatic life (Bhavimani and Puttaiah et al., 2014), the temperature was in acceptable range for fish life (Figure 1 and Table 3), thus the fishes are not stressed by temperature in the ponds. Some factors including season, diurnal sampling time, depth, cloud cover, air circulation and flow affect the magnitude of the water's temperature. Generally, there is negative correlation of physicochemical parameters along the ponds as mentioned on corplot (Figure 3).

Table 1: Heavy metals concentration levels in water sample

Heavy metals	Kigembe pond	Nyamagana pond	Rwasave fertilized	Rwasave non fertilized
Chromium	0.00094	0.00005	0.00049	0.00031
Manganese	0.145	0.144	0.17	0.18
Iron	1.849	0.235	0.779	1.87
Cobalt	0.00098	0.0009	0.00096	0.00086
Nickel	0.00347	0.003	0.0023	0.0032
Copper	0.0045	0.002	0.0025	0.0038
Zinc	0.078	0.025	0.0097	0.027
Cadmium	0.00063	0.00019	0.00092	0.00039
Lead	0.0026	0.00145	0.0093	0.0016

Table 2: Heavy metals concentration levels in sampled fishes

Heavy metals	Kigembe pond	Nyamagana pond	Rwasave fertilized	Rwasave non fertilized
Chromium	0.025	0.032	0.026	0.028
Manganese	0.174	0.186	0.069	0.19
Iron	0.96	1.3	0.61	1.39
Cobalt	0.00083	0.0015	0.001	0.011
Nickel	0.014	0.019	0.013	0.025
Copper	0.022	0.025	0.014	0.023
Zinc	0.18	0.39	0.27	0.6
Cadmium	0.011	0.0011	0.006	0.00063
Lead	0.0065	0.0069	0.17	0.014

Table 3: Physico-chemical and nutrients concentrations levels in the water body

Parameters	Kigembe pond	Nyamagana pond	Rwasave fertilized	Rwasave non fertilized
Temperature (ºC)	23.9	27.1	24.8	26.3
PH	8.72	8.01	6.32	5.84
E.C (µS/cm)	96.1	113.5	112.2	86.8
Turbidity (NTU)	53.7	56	50	48
TDS (mg/L)	54.2	53.8	53.2	40.7
Ammonia-Nitrogen (mg/L)	0.2	0.22	0.1	0.1
Nitrate-Nitrogen (mg/L)	0.1	0.3	0.2	0.1
Total Nitrogen (mg/L)	0.333	0.57	0.33	0.29
Phosphate (mg/L)	0.18	0.05	0.15	0.13
Total Phosphorus (mg/L)	0.33	0.33	0.42	0.17

pH

The acidity and basicity of the ponds' water influences biological and chemical processes within a water body (Mohamed, 2005). The high pH present in Kigembe fishpond was attributed to the type of soil containing Ca_2CO_3 and $MgCO_3$ in its structure therefore playing a key role in this high pH values recorded. The low pH present in Rwasave ponds (Figure 1 and Table 3) are also attributed to the rabbit farming above the pond and pigs, chickens surrounding those ponds. The CO_2 dissolved in water form H_2CO_3 which decrease the pH value and becomes harmful to the aquatic life (Hemalatha and Puttaiah, 2014) by increasing stress levels and causing slow growth, this is why there is a need to regularize the ponds' pH.

Electrical Conductivity

The electrical conductivity values in water samples were below the permitted value (<1000 µS/cm) recommended by Rwanda Standard Board guideline

(Figure 1 and Table 3). This is the ability of water to conduct current and it is the results of presence of charged particles (Ndayisenga and Habimana, 2020). The water conductivity is proportional to the dissolved salts and also increases with temperature.

Total dissolved solids (TDS)

The ponds' water body dissolved solids include inorganic salts like calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulphates and even few organic materials originating from leaves, silt, plankton and sometimes industrial waste and sewage. This parameter indicates hardness of the water. For all sampled ponds TDS were below the standard value of surface water (Figure 1 and Table 3).

Turbidity

The ponds' suspended matters including grains, grey, planktons and organic matters are the major cause of highest light scattering than the reference (Hemalatha and Puttaiah, 2014). This parameter varies seasonally as aquatic biological activities and surface run-off varies. Diurnal turbidity variation may take place depending mostly on rainfall (Ndayisenga and Habimana, 2020). In case of brownish ponds' water, it indicates the presence of clay while greenish indicate presence of plankton. Even the sample was taken during rainy season it didn't cause to exceed maximum permissible limit (Figure 1 and Table 3).

3.2. Nutrients

Total nitrogen

This is determined by the nitrogen in its different forms including NH3, NO3-, NO2- and organic nitrogen. The main total Nitrogen concentration comes from the decomposition of human wastes, plant decomposition, livestock wastes and runoff from fertilizers for agricultural purpose and the discharge of municipal wastes into ponds. The amount of municipal waste is in increasing trend due to increase in population (Giri, 2021; Khanal, Sondhi and Giri, 2021) causing threat to the aquatic ecosystem. The fishponds feeding with organic manure increase the nutrients in fishponds for maximizing production and this must be controlled to limit excess nutrient feed. The lower concentration of TN was observed at Rwasave non fertilized pond (Figure 1 and Table 3), this means that the practice of fertilizing fishponds is needed.

Ammonium ions

NH_4+ is a nitrogen source and used by algae and plants. Than nitrate, the NH_3 is toxic while NH_4+ is not but the two forms are grouped together as total ammonia. The values of ammonium ion concentrations were 0.2, 0.22, 0.1 and 0.1 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Figure 1 and Table 3). Thus, ammonium ion levels are normally stabilized in the 0-2 mg/l as desirable range.

Total phosphorus and phosphates

This is a key nutrient for stimulating aquatic plants and algae growth, resulting in the eutrophication of water bodies. The phosphate levels are normally stabilized in the range of 0.01-3 mg/l. This study showed that phosphate concentrations (in mg/l) were 0.18, 0.05, 0.15 and 0.13 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively while the total phosphorus (TP) were 0.33, 0.33, and 0.42, 0.17 mg/l respectively (Table 3). Rwanda standard board guideline for TP levels are normally stabilized in the < 3 mg l^{-1} as desirable range for surface water. The high phosphate and TP observed at Kigembe and Rwasave fertilized ponds were attributed to rabbits, pigs and chickens manure droppings in the ponds. Thus, fertilizers from marshland of Rwabuye in the rice plantation increase the level of TP and Phosphate concentration of Rwasave ponds.

3.3. Heavy metals

The finding of this research on heavy metals are summarized in Figure 2 and Figure 3. Figure 3 relate the concentration in fishes' tissues versus that of water, and these figures shows that heavy metals are concentrated in fishes' body than in water. But some heavy metals concentration is high in water than in fishes for very few sampling station like Mn at Rwasave fertilized, Fe at Kigembe, Rwasave fertilized and Rwasave non fertilized, Co at Kigembe pond (Table 1 and Table 2).

Manganese (Mn)

Mn is among the most abundant metals element in Earth's crust. It supports animals functioning through its cellular enzymes including manganese superoxide dismutase. For water samples, the Mn concentrations (in ppm) were 0.145, 0.144, 0.17 and 0.18 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Table 1) while for Mn accumulated by fishes (in ppm) were 0.174, 0.186, 0.069 and 0.19 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Table 2). These results are above the recommended values of 0.1ppm for ponds water and 0.05 ppm for fishes. Therefore, this indicates that water and fishes from the studied ponds are polluted with Mn. This pollution was attributed to weathering of soils and rocks that are habitually discharged in Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds.

Chromium (Cr)

Cr is naturally found in rocks and soil and is very persistent in water sediments. The metal is used in metal alloys and pigments for paints, cement, paper, rubber and other materials. Its chronic exposure to human cause kidney, liver damage, circulatory and nerve tissues. For water samples, the Cr concentrations (in ppm) were 0.000094, 0.00005, 0.00049 and 0.00031 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Table 1 and Figure 2) while for fishes, its concentrations in ppm were 0.025, 0.032, 0.026 and 0.028 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Table 2).

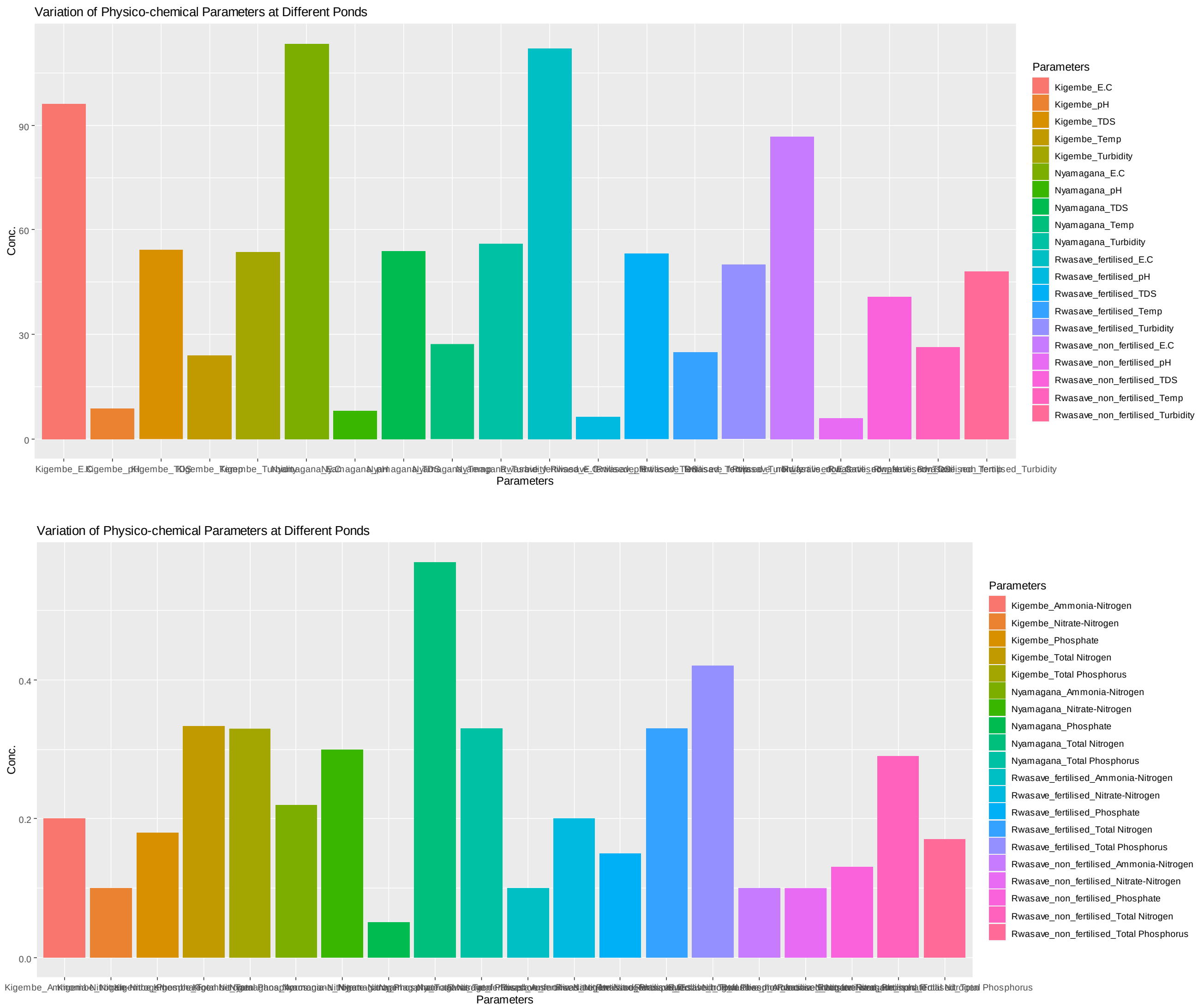
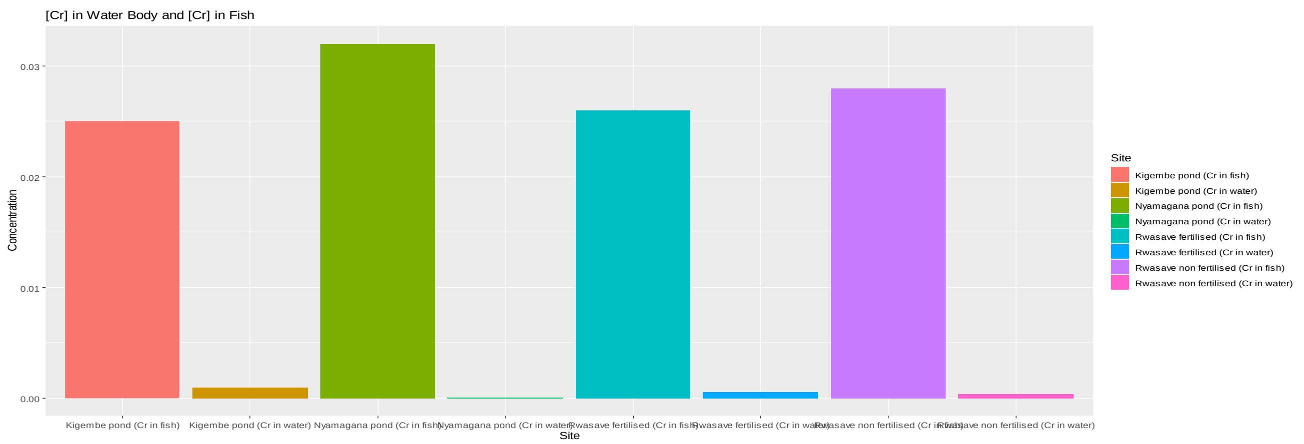
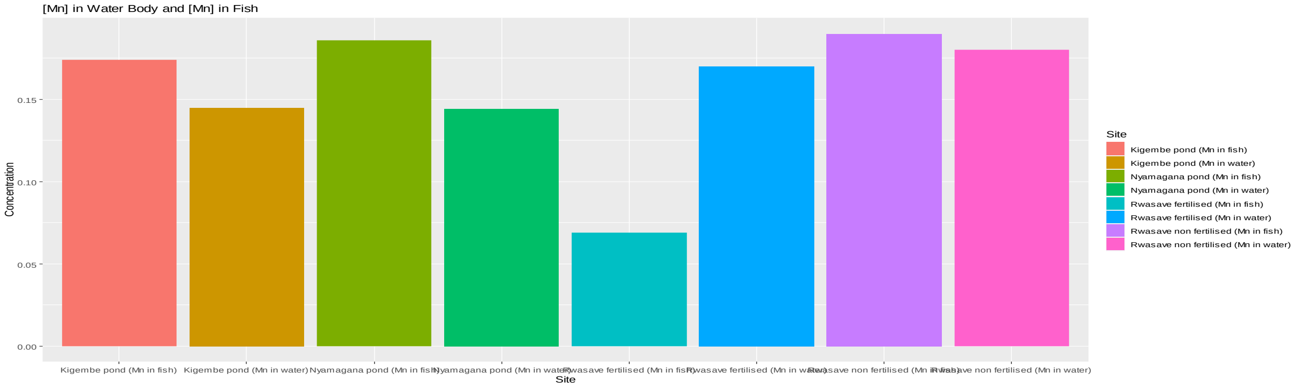
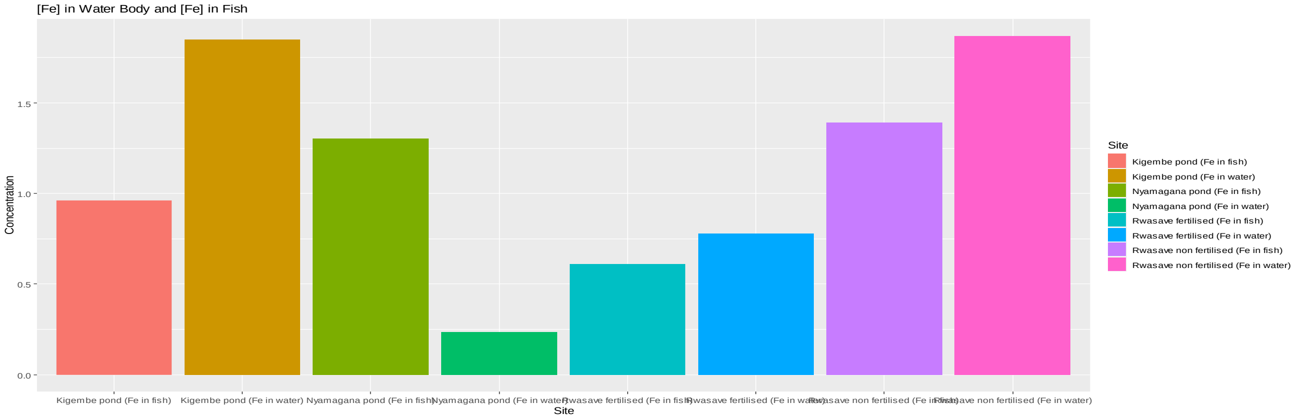
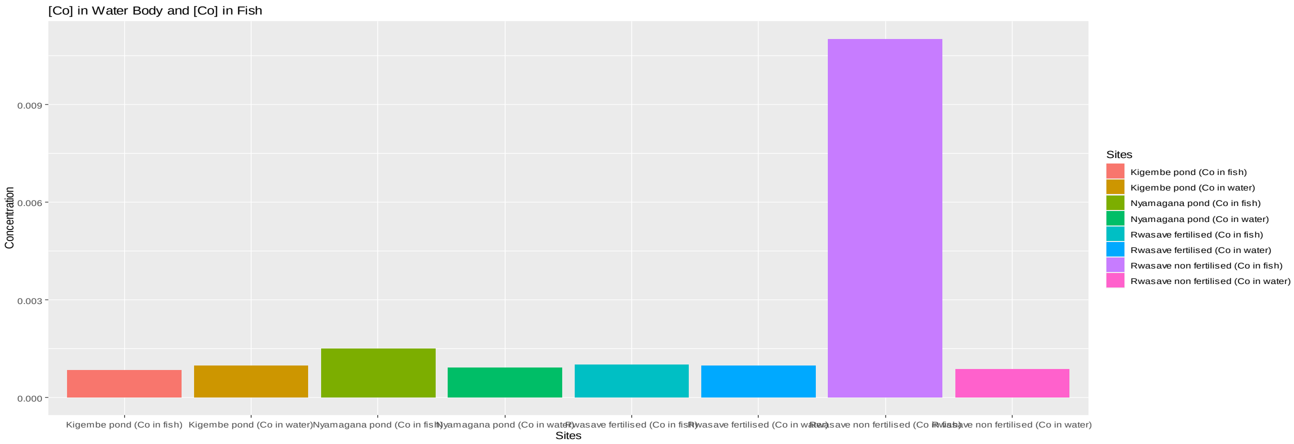


Figure 1: Physicochemical parameters and nutrients concentrations measured in the ponds' station




[Mn] in Water Body and [Mn] in Fish
Concentration
0.15
0.10
0.05
0.00
Site
Kigembe pond (Mn in fish)
Kigembe pond (Mn in water)
Nyamagana pond (Mn in fish)
Nyamagana pond (Mn in water)
Rwasave fertilised (Mn in fish)
Rwasave fertilised (Mn in water)
Rwasave non fertilised (Mn in fish)
Rwasave non fertilised (Mn in water)


[Fe] in Water Body and [Fe] in Fish
Concentration
1.5
1.0
0.5
0.0
Site
Kigembe pond (Fe in fish)
Kigembe pond (Fe in water)
Nyamagana pond (Fe in fish)
Nyamagana pond (Fe in water)
Rwasave fertilised (Fe in fish)
Rwasave fertilised (Fe in water)
Rwasave non fertilised (Fe in fish)
Rwasave non fertilised (Fe in water)


[Co] in Water Body and [Co] in Fish
Concentration
0.009
0.006
0.003
0.000
Sites
Kigembe pond (Co in fish)
Kigembe pond (Co in water)
Nyamagana pond (Co in fish)
Nyamagana pond (Co in water)
Rwasave fertilised (Co in fish)
Rwasave fertilised (Co in water)
Rwasave non fertilised (Co in fish)
Rwasave non fertilised (Co in water)

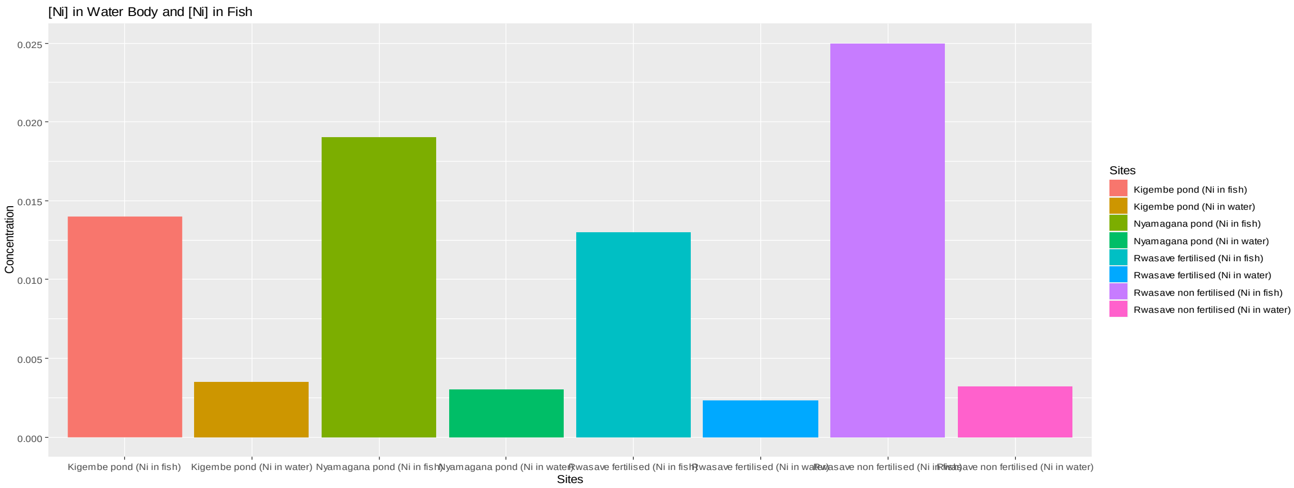

[Ni] in Water Body and [Ni] in Fish
Concentration
0.025
0.020
0.015
0.010
0.005
0.000
Sites
Kigembe pond (Ni in fish)
Kigembe pond (Ni in water)
Nyamagana pond (Ni in fish)
Nyamagana pond (Ni in water)
Rwasave fertilised (Ni in fish)
Rwasave fertilised (Ni in water)
Rwasave non fertilised (Ni in fish)
Rwasave non fertilised (Ni in water)

Figure 2: The comparison plot of measured heavy metals concentration in ponds' water versus that in fishes' tissues

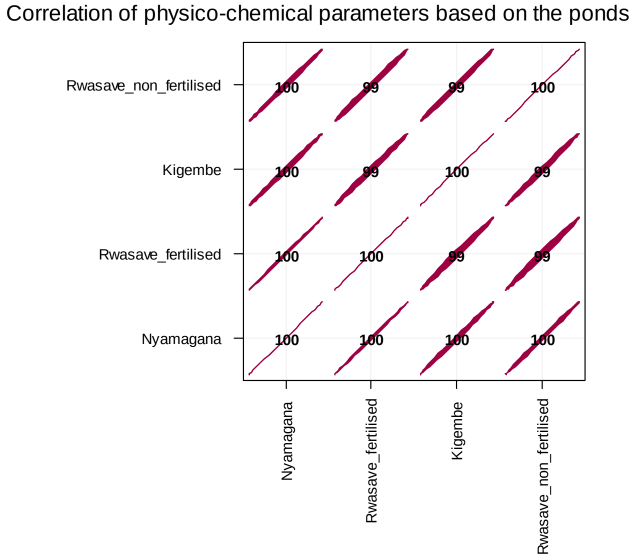


Figure 3: The comparison plot of measured heavy metals concentration in ponds' water versus that in fishes' tissue

These results are below the recommended values of 0.50ppm for ponds water and 0.05 ppm for bio accumulated concentration. These low concentrations of Cr were due to less agro-chemical usage around the study areas and less industrial activities which are the major sources of Cr aquatic pollution.

Lead (Pb)

Pb is among the heavy metals with specific toxicity and cumulative effects. The main aquatic sources are lead processing industries (Ndayisenga and Habimana, 2020). Some of its health effects include liver damage, kidney and reduction in haemoglobin formation, mental retardation, infertility and abnormalities in case of pregnancy, and at strong contaminated it cause gastrointestinal disorders, constipation, abdominal pain, neuromuscular effects weakness, nervous system effects or syndrome that may result to coma or death. For water samples, the Pb in ppm were 0.0026, 0.00145, 0.00093 and 0.0016 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Table 1 and Table 2) while for fishes were 0.0065, 0.0069, 0.17 and 0.014 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Table 2). These results are below the recommended values of 0.01 ppm for ponds water and 0.05 ppm for bio accumulated in fishes. Thus, the water from the studied ponds are not polluted with Pb, due to less anthropogenic sources like industrial and municipal wastewater discharges, mining around study areas which are the among the major sources of aquatic Pb concentration.

Iron (Fe)

Fe is involved in the haemoglobin synthesis in the red blood and is a necessary element in human diet and has a significant role in metabolic processes, in case of too little Fe in the body; the iron deficiency (anemia) was developed (Arantes et al., 2015). For water samples, the Fe concentrations (in ppm) were 1.849, 0.235, 0.779 and 1.87 (Table 1 and Figure 2) while for fishes were 0.96, 1.30, 0.61 and 1.39 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (see table 2 and figure 2). Simply, the results are above the recommended values of 0.3ppm for ponds water except at Nyamagana and 0.1ppm for fishes. Therefore, the ponds' water and fishes are polluted with Fe. This high concentration of Fe should be raised by run-off rusting materials and sewage effluents containing iron into these ponds. Naturally, rocks and soil weathering should increase the level of iron concentration at studied ponds.

Cupper (Cu)

Cu is a low-toxicity, corrosion-resistant metal widely used because of its ductility and malleability, electrical conductivity, and ability to conduct heat. Cu is also used in tubing and piping. For water samples, Cu concentrations (in ppm) were 0.0045, 0.002, 0.0025 and 0.0038 (Table 1 and Figure 2) while for fishes were 0.022, 0.025, 0.014 and 0.023 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Figure 2 and Table 2). These results are below the recommended values of 1.0ppm for ponds water and 1.0 ppm for fishes. This indicates that water and fishes from the studied ponds are not polluted by Cu.

Zinc (Zn)

Earth's crust is one of the main sources of Zn. This is an enzyme co-factor in several enzyme systems including carbonic anhydrase found in red blood cells. Like other metals it is emitted from its natural and anthropogenic sources (Arantes et al., 2015). For water samples, the Zn concentrations (in ppm) were 0.078, 0.025, 0.0097 and 0.027 (see table 1 and figure 2) while for fishes were 0.18, 0.39, 0.27 and 0.60 at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (Figure 2 and Table 2) which are under the recommended values of 3.0ppm for ponds water and 5.0 ppm for fishes. This indicates that water and fishes are not polluted by Zn. Thus, Zn concentrations in fishes were greater than in water; this confirms that sediments are repository of metals and indicated a certain degree of bio-accumulation.

Cadmium (Cd)

During metals plating Cd is used and is toxic at even low concentrations, non-biodegradable, non-essential heavy metals and have no role in biological processes in living tissues. Thus, even in low concentration, it could be harmful to fish. For water samples, the Cd (in ppm) were 0.00063, 0.00019, 0.00092 and 0.00039 (Table 1 and Figure 2) while for fishes were 0.011, 0.0011, 0.006 and 0.00063 ppm at Kigembe, Nyamagana, Rwasave fertilized and Rwasave non-fertilized ponds respectively (see table 2 and figure 2). These results are below the recommended values of 0.003ppm for ponds water and 0.05 ppm for fishes. Cd concentrations in fishes were also greater than in water, this difference in the pattern of heavy metals in these fish samples might be a result of their difference in many factors such as feeding habits, habitats, ecological needs, metabolism and biology.

4. Conclusion

Based on the study finding, the water quality based on physicochemical parameters, nutrients analysis and even heavy metals concentration have great health effect to the fishes' community. The physicochemical and nutrients parameters for water body mainly influence the abundance and fertility of fishes, and are tolerant at a certain level. The heavy metals are bio accumulated in fishes, which means the more heavy metals content in water body means more bio accumulation. Therefore, during implementation of fishes farming projects, the ponds' water quality must be assessed periodically. The water quality monitoring will help the farmers to create the safe aquatic environment for fishes and improve their production output. This will reduce the health effects related to the consumption of contaminated fishes as the contamination level depends on species and different aquatic environment. Food chain becomes the main route of accumulating toxic contained in fishes by human body.

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