QUANTIFICATION OF LEAD AND ZINC IN GROUND, SURFACE AND TAP DRINKING WATER SOURCES IN KABALE MUNICIPALITY

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DECLARATION

I **Ivan Mongusho** declare that the information in this research report is my original work and it has never been submitted to any university or any other institution for any award

Signature:...... Date: 27/01/2021

Ivan Mongusho

APPROVAL

This is to certify that this research report has been written under my supervision and is ready for submission to Kabale University.

Signature.... Date: 27/01/2021

MRS. TEBETYO ZAKIA

Research Supervisor

DEDICATION

I dedicate this to report to my beloved parents Mr. Limo Fred and Mrs. Catherine Cheptoyek and all my brothers and sisters.

ACKNOWLEDGMENT

First of all, I thank almighty God for the gift of life and for his provision throughout my entire course.

I wish to acknowledge my parents Fred Limo and Mrs. Catherine Cheptoyek for their financial support and parental encouragement they provided to me during the course of my study.

In the same Spirit I thank my friends Robin Cherop, and Joy Cherop for their encouragement in production of this work

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ABSTRACT

Metal contamination in water is the major component in determination of water quality. Water is a dynamic source, essential for all aspects of human and ecosystem for existence and health. Apparently drinking water sources are affected by anthropogenic activities. The objective of this study was to detect zinc and lead concentrations in tap, ground and surface water in Kabale municipality. Two samples were collected from each water source. The samples were analyzed using Atomic Absorption Spectrometry and the results obtained were compared alongside with guidelines for safe drinking water such as world health organization. The results obtained showed the highest concentration of both lead and zinc in surface (river) water and lowest concentrations in spring water. In surface(river)water, the concentrations of lead were(0.0063mg/l)and(0.0073mg/l)and that of zinc were(0.0075mg/l) and (0.0091mg/l). The disposal of municipal wastes, discharge from factories, car washing and use of agrochemicals are the major causes of these metals in such water bodies. Tap water of study area contained concentrations of (0.0037mg/l) and (0.005 lmg/l) zinc while lead had a concentrations of (0.0039mg/l) and (0.0043mg/l). The presence of lead and zinc in tap water is due to corrosion of galvanized and plumbing materials used in water supply. Spring water. recorded the lowest concentration of both lead and zinc compared to other water sources. The concentrations of lead were (0.0012mg/l) and (0.0004mg/l) while zinc concentrations were found to be (0.0022mg/l) to (0.0037mg/l). The accumulation of lead and zinc in spring water is as result of geogenic activities such as weathering actions and influence from anthropogenic activities. In comparison with accepted values for safe drinking water, the outcome of the study indicates that the pollution is minimal since the obtained results are within the accepted limits. However, there is a need for further studies on water treatment, and proper management of environment as well as wastes from different sources to minimize water pollution by these metals.

LIST OF ACRONYMS

ATSDR: Agency for Toxic Substances and disease Registry.

CDC: Centers for Disease Control

CEC: Commission for Environment Corporation.

FAO: Food and Agriculture Organization

JECFA: Joint Expert Committee for Food Additives

KDLGSA: Kabale District Local Government Statistical Abstract

NPIC: National Pesticide Information Center

NTP: National Toxicology Program

TDC: Thanet District Council

UNEP: United Nations Environmental Programme

UN-WW AP: Uganda National World Water Assessment Programme.

WHO: World Health Organization

WRMD: Water Resource Management Department

WRMD: Water Resources Management Department

CHAPTER ONE

INTRODUCTIO

N 1.1 Background of the study

Drinking water is one of the most elementary needs for the survival of the lifespan. Throughout the entire world more than one million people are faced with the deficit of sufficient nontoxic water and among this more than 800 million in village areas are at a threat of obtaining safe drinking water (Kumarpuri, 2012).

According to the world health organization report 2017, safe drinking water is water that does not represent any significant risk to health over a life time of consumption (WHO, 2017). Water is managed poorly in many parts of the world despite its great importance for life (Fakayote, 2005).

The contamination of water in a particular area is always directly related to the degree of contamination of its environment(Peng *at el.*, 2005). While trickling down, rain collects impurities from the atmosphere and, consequently impurities from surface run-off, sewage discharge and industrial effluents are collected by rivers and streams on their course of flow (Skeat, 1969).

Water pollution from anthropogenic activities have been documented in many parts of the world (Lars, 2003). Many rivers, lakes wetlands ground water and oceans suffer a great loss of degradation from various human activities. These activities have effects on water quality, changing both the physiochemical and biological parameters.

The major sources of pollution are from industrial and municipal waste water discharge, inputs from agricultural activities and that includes the use of fertilizers, seepage from waste site, decaying plant life, road, railway and sea accidents involving large oil tankers etc., all leading to environmental degradation and the necessity for environmental protection(Kinchella and Hyland, 1993).

Toxic metals are usually present in industrial, municipal and urban run-off which can be harmful to humans and biotic life. Increased urbanization and industrialization are to be blamed for an increased level of trace metals especially heavy metals in our water ways (Seema Singh *et al*

2011). Many dangerous chemical elements if released into the environment accumulate in the soil and sediments of water bodies (Abida *Begumetal* 2009).

Regardless of origin, increase of heavy metal concentration in water is becoming a serious threat to human health and aquatic ecosystems (Humood, 2013, Naveedullaet *al* 2014). The common metals of health concern to humans include lead and zinc among others (WHO, 2008).

When the concentration of this metals exits the environmental tolerance limits, use of such water in agricultural (irrigation and aqua culture) activities could be harmful to aquatic ecosystem and humans via the food chain (Wright and Welboum, 2002).

Zinc is an essential element of great importance for humans, plants and animals. A remarkable mention is made of superoxide dismutase as it has a principal function in protection of the organism against activated oxygen species (TerresMartos, water research, 2002).

Though zinc is an essential requirement it can be harmful since it hinders absorption of iron and copper which are essential elements in human nutrition (WHO, 2008).

Zinc is an element found in all food and portable water inform of organic complexes (Swami Nathans, SechadriMS, Kanagasabapathy, 2011). Taking drinking water having high or low content of zinc than the required has undesirable effects on life.

Increased zinc concentration can lead to eminent health difficulties such as stomach crumps, skin irritation, vomiting, nausea, anemia, protein metabolism and further it can generate arteriolosclerosis. Low concentration of zinc in the diet also leads to poorly developed sex organs (A TSDR, 2005).

Lead is the commonest of heavy metal accounting for 13mg/kg of earth crust(WHO, 2009).Lead is comparatively corrosion resistant, compressible and malleable metal that has been used by humans for at least 50years(Brown MJ, Margolis, 2012). It is well known that the effect of lead(pb)pollution in drinking water causes imbalance in brain function in children, delays physical and mental development, kidney problems like encephalopathy and proximal renal tubular damage in adults (K Steen landet *al* 2000).

Children of 1-6 years are predominantly prone to suffer from extreme lead disclosure as the nervous and circulatory systems in young ones are not completely developed (Nadeen-ul-Hoq et al2009).Lead will tend to be deposited in the brain, bones, kidneys and other fore most organs. Lead service lines (pipes) and lead covering materials are well known basic of drinking water impurities (Badan, *et al.,* 2009).

Concentration of lead in human blood has been connected to lead in drinking water, a public health hazard (Levallois P *et al.*, 2014). Keeping in view of hazardous nature of lead and zinc metals the work was aimed to establish the concentration of lead and zinc metals in surface, ground, and tap water sources in Kabale municipality, Kabale district.

1.2 Statement of the problem

Ground water, tap water and surface water are among the major sources of water for various domestic uses such as drinking. The major sources of lead and zinc in water sources include poor disposal of municipal and house hold wastes, discharge from industries and the use of agrochemicals. However, the local people use this water with limited knowledge about the concentration of lead and zinc in water which causes a number of health problems when they are not present in their permissible concentrations.

1.3 Aim of the study

Due to the threat of lead and zinc metals to human health, the aim of the study was to provide information on the concentration of lead and zinc in tap, surface and ground water sources in Kabale municipality.

1.4 General objective

To quantify the amount of zinc and lead in ground, surface and tap drinking water in Kabale municipality.

1.5 Specific objectives

1. To determine the concentration of lead and zinc in tap, surface and ground water.

2. To compare the concentration of lead and zinc in tap, ground and surface water

1.6 Significance of the study

Drinking water should contain permissible amounts of zinc and lead. The variation in their concentration causes health problems. The research work has provided the essential information about the levels of zinc and lead in drinking water sources.

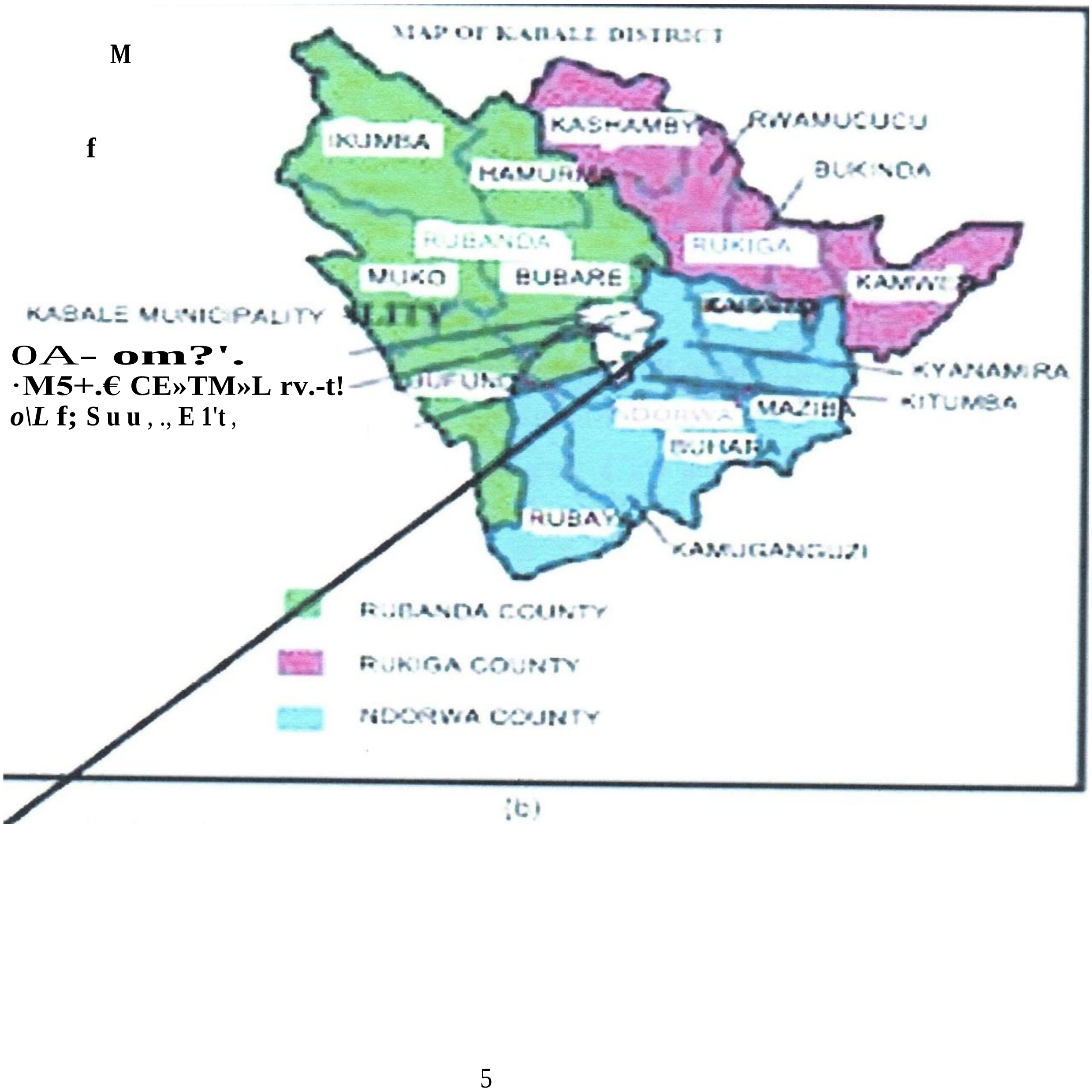
1. 7 Justification of the study

Human based activities carried out in Kabale municipality such as disposal of municipal, consumer, sewage sludge's, demolition and construction wastes, use of agricultural chemicals have resulted into accumulation of zinc and lead containing pollutants on land. Subsequently after heavy rains, the runoff water carries these pollutants into water sources. The use of pipes for water supply for a long period of time without replacing has resulted into accumulation of these metals in water through corrosion. The above activities cause a variation in concentration of zinc and lead in water thus polluting such water of which local people and their livestock consume. High concentration of zinc causes health difficulties such as stomach crump's while its low concentration results into poorly developed sex organs. Biologically lead is considered to be of no value to human health but only harm at any concentration as it results into health risks. The research work provided information to the people about the effect of lead and zinc in drinking water on their health so as to be conscious about the quality of water before drinking.

1.8 Scope of the study

Kabale municipality located in Kabale District, Southwestern Uganda, 406.78Km from Uganda's Capital City, Kampala. Geographically, Kabale Municipality lies between longitudes 29"45'o" E and 30"150'0" E and Latitudes 0"l '0" S and l "29"0" s. It covers a total area of 33Km2(HGSA, 2009). It boarders within the sub counties of Kitumba in the south, Bubare to the north and Kyanamira to the east (KDLGSA, 2012). The fairly densely populated Kabale municipality of about 149,667 people is divided into Kabale North, Kabale South, Kabale center divisions and 82% of households are said to have access to improved drinking water sources (NWSCSDR, 2010). The source of drinking water includes water pipe-borne water, open tube wells, river water and spring water. In spite of relatively high accessibility to improved water resources, a reasonable proportion of people rely on unimproved domestic water sources in Kabale municipality and therefore a need to determine lead and zinc metals in surface, tap and ground water distributed within municipality.

Figure 1: A map of Kabale district showing location of Kabale municipality



CHAPTER TWO

LITRA TURE REVIEW

2.0 Introduction

Drinking water comes from ground sources such as groundwater and aquifers it can also be obtained from surface water such as rivers, Streams and glaciers. Drinking water is exposed to different contaminants. depending on its sources.

Surface water contaminations occur when water travels over a surface of a land or through ground. As it travels it dissolves naturally occurring substances and pick up minerals resulting from presence of animal or human activities. While for ground water the contaminants come from land fill, and septic system, haphazard disposal from agricultural chemicals. The contaminants in ground water take time to be cleaned because it moves slowly and is not exposed to natural cleansing benefits of air, sunlight and micro-organisms (Nriagu&Pacyna, 1988).

2.1 Ground water occurrence

The primary source of fresh water for drinking in the world is ground water. Ground water supplies 75% of all state sources of drinking water in Africa (MicehamL;2009). In Uganda for instance 6l % of the country's water is from ground water source, accessed from springs and boreholes around Lake Victoria and South-western Uganda (Tindimugayac, 2006).

2.2. Ground water potential

The potential of ground water in various areas of the state is exhibited by presence of deep boreholes, Shallow wells, and springs.

2.2.1 Deep Boreholes

Deep boreholes potential can be accessed by a means of a number of borehole parameters such as regolith, thickness, aquifer yields and rest water levels. Uganda is characterized with clayey regolith especially in upper Layers where relatively low permeability dominates. The regolith thickness across country can be described as low to medium varying between 20-45m. This leads to medium to high ground water potential through provisional storage. Aquifer yields on the other hand vary from one part of the country to another according to the information in which they are drilled and their degree of weathering for example, potential yield from deep aquifers were estimated during A QUAST AT Survey to be above 3 m3/hr in Southwest, South east, North West and along the eastern boarder of country. In large central parts of the country potential yield between 2 and 3 m3/hr, while in some areas it is below lm3/hr (FAQ; 2005).

2.2.2 Springs

Springs occur either where the flow of unconfined ground water is interrupted by an impermeable formation or where the head of confined ground water is released by flow of the surface (F AO; 2005).

2.3 Surface water resources

Uganda is a landlocked Country that occupied 241550.7km' of land open water and Swamps constitute 41743.2 km^2 of area (UN-WWAP:2006), with about 16% of total land area wetland and open water, plus the annual water supply of $66km^3$. in form of rain and inflows. The department of Water Resources Management of Uganda categorized the surface water resources into eight main drainage sub-basins, and these include Lake Victoria, Lake Kyoga, River Kafu, Lake Eduard, Lake Albert, River Aswa, Albert Nile and Kidepo Valley (WRMD; 2004)

2.4 Heavy metal and water contamination

The environmental potential Agency and World Health Organization set a maxmrnm contaminant level in drinking water supplied to municipal or population (review of the EPA water Security Research and Technical Support Action Community Water system, plan part **1$** part 11, 2003).

When a standard is exceeded in a municipal or community water system, the states are required to take proper actions to improve on water quality level including treating the water through filtration or aeration, blending water from several sources to reduce contaminants such as metals, salts and minerals. These substances occur naturally in geological structures or sometimes caused by mining, industrial, and agricultural activities.

These chemicals can badly affect human health when they are consumed in large amount (WHO, 2006). The natural concentration of metals in raw water when has not been treated varies from state to state, country to country. It depends on many factors such as geological structures, the soil, the acidity of water and the particulate matter concentration (Berman, 1980)

2.5 Potential sources of lead into water sources

2.5.1. Lead service line

Lead service line(LSL) also known as lead service pipe, and lead connection pipe (Hayes, Colin.R, Hydess Owen D. 2012) is a pipe made of lead which is used in potable water distribution to connect water to a user's premise.

According to world Health organization the presence of lead service lines is the most significant contributor of lead contamination in drinking water in many countries (WHO, 2014).

Lead is unlikely to be present in source water unless a specific source of contamination exists. However, lead has long been used in the plumbing materials and solder that are in contact with water as it is transported from its source into homes. Lead leaches into tap water through corrosion of plumbing materials that contain lead (Chin.D, Koralekas pej, 1984).

2.5.2 Recycling used Lead-Acid batteries

The average amount of lead in automotive batteries can range from 2 to 13 kg depending on size of vehicle (CEC, 2016). Almost all parts of a lead-acid battery can be recycled. At collection and transportation stage, sulphuric acid electrolyte solution is sometimes drained out to reduce weight of the batteries or because a high price is offered for drained batteries (Manhart Schleicher, 2015) The electrolyte contains dissolved lead, and if poured into the ponds or streams will contaminate water that may be used for drinking, fishing and cooking (UNEP, 2003).

2.6 Potential sources of zinc into water

Anthropogenic activities including municipal wastewater discharge, coal-burning power plants, manufacturing processes involving metals, and atmospheric fallout are the major sources of zinc pollution (Pertsemli.E and Vousa D;2007). Zinc has low solubility in aqueous solution; it is easily adsorbed on water-borne suspended particles. After a series of natural processes, the water-borne zinc finally accumulates in the sediment, and the quantity of zinc contained in the sediment reflect the degree of pollution for water body (Chen.C. *wet al*, 2007)

2.6.1 Motor oil and Hydraulic fluids

Zinc is an additive used in many motor oil and Lubricants. One estimate 50% of lubricants eventually make their way into the water environment through total loss application, volatility, Spills, or accidents(Madanhires& Mbohwa, 2016).

2.6.2 Tire wear

Zinc oxide (Zno) is a typical additive for rubber products, including vehicle tires (council, Duckenfield, Landa and Callender, 2004) Tires are worn down by road surfaces, generating rubber particles and dust that are then distributed along the road corridor. As storm water flows over the pavement and collects in ditches and drains, these particles are transported and zinc is introduced into nearby water bodies (TDC, 2015)

2.6.3 Corrosion of Galvanized materials

Usually zinc is introduced in tap water through galvanized plumbing materials. Many galvanized pipes in old buildings were manufactured using zinc that probably contained high levels of lead which is a common impurity in the zinc galvanized pipes and still common in older homes and commercial buildings; Galvanized pipes will corrode over time and results into high level of zinc in tap water (Hut zinger, 1995).

2.6.4 Fertilizers, pesticides and Fungicides

Zinc sulphate used as an additive of many lawn car and agriculture products, including fertilizers, pesticides, and fungicides (NPIC, 2012) and these products are major source of zinc on agriculture and commercial landscaping

2. 7 Toxic effects of lead

Lead has no apparent physiological function. It has an affinity for sulfuydryl groups and other organic ligands in proteins and can mimic other biologically essential metals such as zinc, Iron and in particular, calcium (Health Canada, 2013). This enables lead to disrupt enzyme systems accounting for many of its toxic effects (lidsky&Schreider 2003, Garza *et al;* 2006)

2.7.1 Neurological effects

Lead exerts toxic effects in all parts of the nervous system; lead poisoning can cause life-threatening encephalopathy (disruption of brain function). Lead encephalopathy is a life-threatening condition and children can be left with mental retardation, seizure disorders, blindness arid hemiparesis (chisolm and Barltrop, 1979; Al Khayat *et al* 1997). Such severe impacts are now relatively uncommon in developed countries but can still be seen in places where the high level of exposure and limited or no access to diagnosis and treatment (Haefliger *et al*, 2009, Grieget *al.*, 2014).

2. 7.2 Gastrointestinal effects

Gastrointestinal effects are common in lead toxicity. The effects include loss of appetite with weight loss, constipation, abdominal pain or discomfort, nausea vomiting and a metallic taste in the mouth. Diarrhea occurs occasionally (Winship, 1989). Gastrointestinal bleeding has occasionally been reported (MeNutt *et al;* 2001; Frith *et al;* 2005).

2. 7.3 Cardiovascular effects

Lead exposure is associated with an increased risk of hypertension in adults and pregnant women, even at levels of exposure below l0ug/dl (NTP;2012). Significantly, though modest associations have been found between lead concentrations in blood and blood pressure (Cherg; 2001; Nawrot *et al* 2002; A, 2007). The association is strong with bone lead, suggesting that the increase in blood pressure is related to the long-term effects of lead exposure earlier in life (Cheng 200 l *,Gerret al2002).*

2.7.4 Reproductive system and pregnancy.

Impotence and decreased libido are occasionally reported in lead-poisoned patients (Cullen *et al* 1983). Reduced fertility has been found in couples during periods when the blood lead concentration in male is elevated (JECF A, 2011). Possible causes include reduced sperm motility, decreased Sperm count and reduced semen volume (NTP, 2012).

Maternal lead exposure, even at low levels may be associated with reduced fetal growth, low birth weight, and spontaneous abortion (NTP, 2012, Health Canada, 2013).

Lead exposure is a risk factor for hypertension in pregnancy (gestational hypertension) and high levels of exposure may be a risk factor for pre-eclampsia, which can be life threatening for both mother and baby (Tribesmen, 2006.CDC, 2010).

2.7.5 Endocrine

Environmental Lead exposure has been associated with delay in sexual maturity in girls (Selevanet *al* 2003, Wu *et al* 2003; NTP, 2012) lead exposure has also been associated with delays in growth and reduced growth (e.g. Small stature, Small head Circumference) in children (NTP, 2012).

2.8. Effects of zinc

Zinc is an essential element in human diet, zinc in low concentration and also high concentration can cause health problems. Too little zinc can cause slow wound healing and Skin sores, decreased sense of taste and smell, loss of appetite and damage in immune system. In August 2005, Agency for toxic substances and disease registry reported that by putting low levels of zinc acetate and zinc chloride on the skins of rabbits, guinea pigs and mice caused skin irritation. They concluded that skin irritation will probably occur in people (A TSDR, 2005). While in large amount for a short period of exposure time it can cause stomach cramps, nausea anemia, pancreas damage and low level of high density lipoprotein cholesterol.

2.9 Importance of access to safe drinking water

Access to safe drinking water contributes directly to good health, food security, economic development, poverty eradication and the long term socio-economic development of a country (Opio, 2012).

2.9.1 Atomic absorption spectroscopy (AAS)

AAS is a spectroanalytical procedure for the quantitative determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state. ASS is based on absorption of light by free metallic ions.

In analytical chemistry the technique is used for determining the concentration of a particular element(the analyte) in the sample to be analyzed.

Atomic emission spectroscopy was first used as analytical technique, and the underlying principles were established in the second half of the 19th century by Robert Wihlem Bunsen and Gostav Robert Kirchhoff both professors at the University of Heidelberg, Germany

The modem form of AAS was largely developed by during 1950s by a team of Australian Chemists. They were led by sir Alan Walsh at Commonwealth scientific and industrial Research organization

CHAPTER THREE:
METHODS AND MATERIALS

3.0 Preparation of standard

solutions Lead stock (standard)

solution The standard solution was prepared by weighing accurately (2.832g) of lead nitrate and transferred into a 250ml volumetric flask and deionized water (250cm3) was added to the mark followed by addition of 2ml of nitric acid to complete dissolution of the salt.

Zinc stock (standard solution).

The stock solution was prepared by weighing accurately (2.7256g) of zinc chloride and transferred into a 250ml volumetric flask followed by addition of deionized water (250cm3) up to the mark, and 2ml of hydrochloric acid was added to complete dissolution.

3.1 Sampling

The samples were collected from river, tap and spring water sources.

In river Muz_ihogo the samples were collected from Kirigime Bridge while in river Rwabakazi the samples were collected from Butobere Bridge.

Tap water samples were collected from kigongi B and Nyakirima located in Bugongi lower.

Spring water samples were collected from kyamishana in Nyakambo and Green hill located in kirigime. The sampling was carried out in three divisions (Central, Southern and Northern) in Kabale municipality. Two samples from each water source were collected into 500ml bottles. Prior to sampling, the bottles were rinsed three times using water to be sampled and then filled. The sample bottles were labeled indicating the type of water sample and the sampling site.

3.2 sample treatment and storage.

The collected samples were transported to the laboratory of national water and sewerage corporation Kabale. The samples were filtered through a filter paper to remove suspended solids; 2ml of concentrated nitric acid was added to each 500ml of water samples to reduce PH<2.Below PH2, precipitation, adsorption of metal ions onto the wall of plastic bottles and microbial degradation are minimized. Before analysis the samples were kept refrigerated at temperature of +4°c to prevent break down of contaminants present in the analyte (water samples)

3.3 Calibration of Atomic Absorption Spectrometry

The characteristic concentration of check value is the concentration of the metal (mg/l) that will produce a signal of approximately 0.2 absorbance units under optimum conditions at the wavelength of the metal. By using a characteristic concentration check, the operator can determine whether the instrumental parameters are optimized and whether the instrument is performing up to specifications. Calibration of AAS was carried out by using external

concentrations of the sample metal which was also known as stock solution. High purity metal salts dissolved in high purity acids were used to make the stock solutions. Working standards were diluted from the stock solutions.

3.4 Quantification of lead and zinc in the water samples

Quantification of lead and zinc was carried out using atomic absorption Spectrometry. The standard solution of each analyte was diluted to obtain the standard working solutions of different concentrations and each passed through the calibrated machine from which the absorbance of each concentration of the analytes were measured and calibration curve obtained (A curve of absorbance against concentration).

After the calibration curve established, the samples of unknown concentration of the analytes were passed through the machine and their absorbance measured after which their concentrations were determined using the calibration curve.

CHAPTER FOUR

Results and discussion

The analysis was carried out on river, tap and spring water at different locations in Kabale municipality to quantify the concentration of lead and zinc. The concentration of each metal was detected and tabulated as shown in the table 1 below.

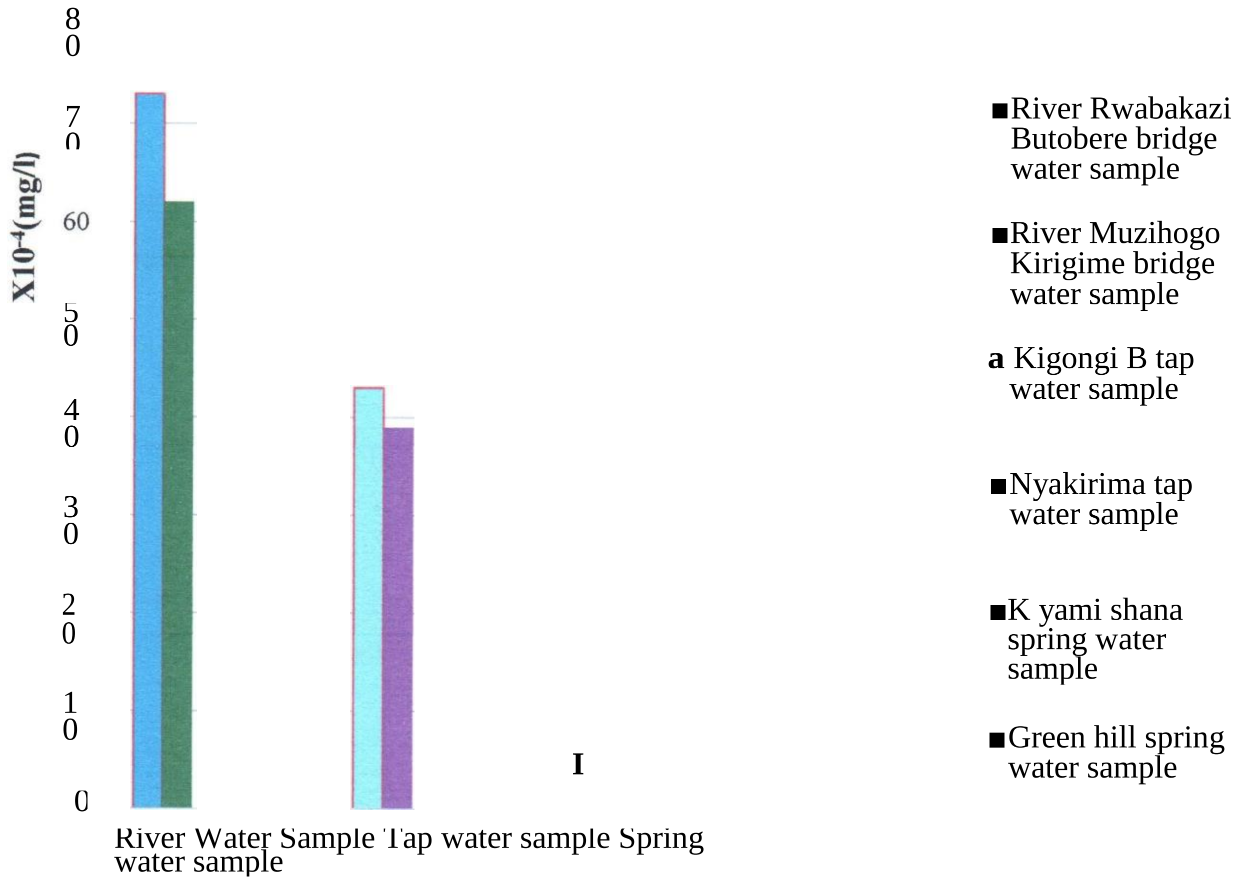
Table 1: The concentration of each metal

Water sources	**Sampling site**	**Lead mg/I**	**Zinc mg/I**
River water Samples	Butobere bridge	0.0073	0.0091
	Kirigime bridge	0.0062	0.0075
Tap water Samples	Kigongi B	0.0043	0.0051
	Nyakirima	0.0039	0.0037
Spring water Samples	Kyamishana	0.0004	0.0022
	Green hill	0.0012	0.0034

Table 2: Acceptable values for lead and zinc according to world health organization 2011

Contaminant and unit of measurement	**Acceptable value**	**Source of reference**
Zinc(mg/1)	3.00	WHO
Lead (mg/1)	0.01	WHO

Figure 2: Concentration of lead of lead in river, tap and ground water sources



The highest concentration of lead was recorded in surface water of river Rwabakazi at Butobere bridge (0.0073mg/l) followed by river Muzihogo at Kirigime bridge (0.0062mgI). This is due to disposal of municipal wastes composed of wastes generated by households and wastes of similar character from markets, shops including consumer wastes into the land which contain toxic metals like lead. These wastes are carried by runoff water into the rivers and thus increasing concentration of lead.

Wastes arising from the demolition and rehabilitation of existing buildings are more profound in the central division of the study area.

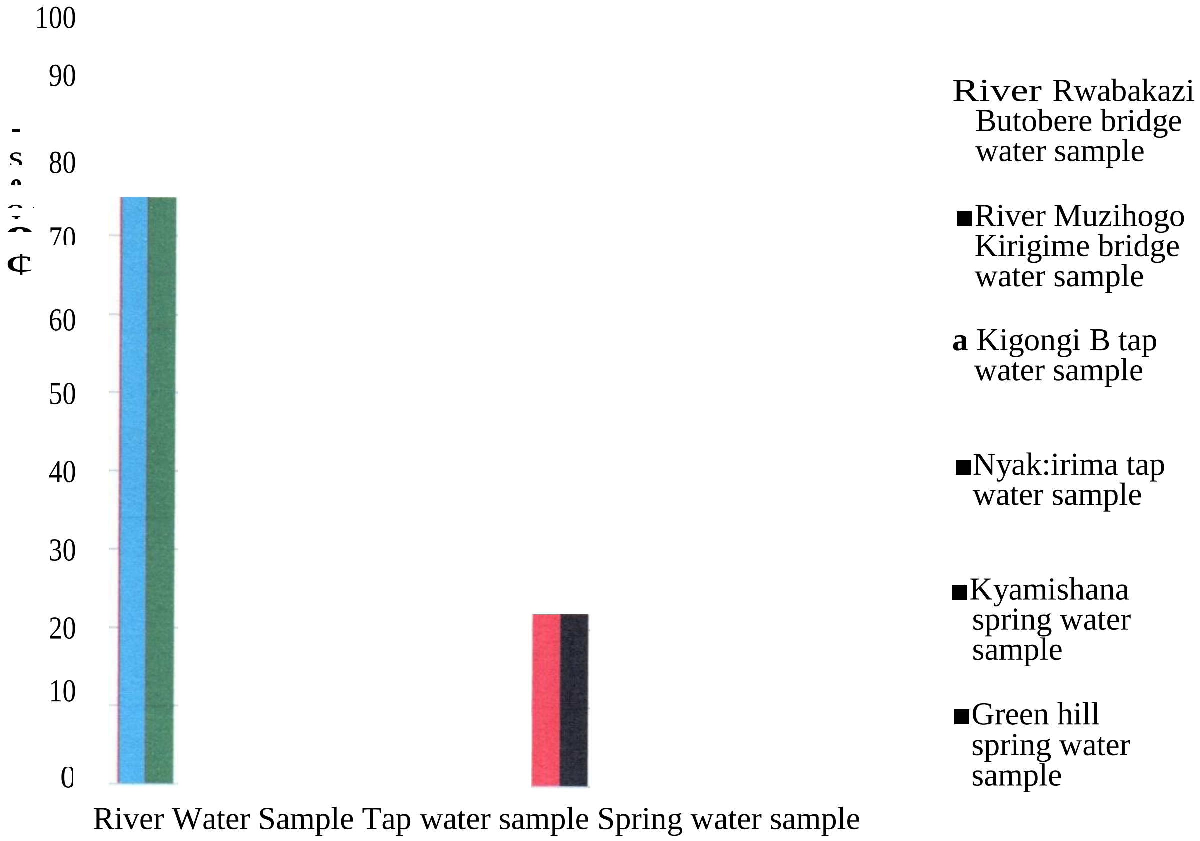
These wastes contain lead-based paints disposed onto land during process and find their way into surface water (river) by water runoff. However, its concentration in river Rwabakazi was higher compared to its concentration in river Muzihogo, this can be attributed to other activities along river Rwabakazi banks such as car and motor cycle washing which adds petrol and engine oil containing dissolved lead into the water body and discharge from factories which contributes to undesirable increase in the concentration. When compared to accepted levels in table 2 it shows that lead concentration in surface water are within the permissible levels according to world health organization.

The ground water of the studied area showed varied concentrations for lead. The concentration of lead was higher in spring water (0.0004mg/l) collected from Kyamishana sampling area than its concentration in spring water (0.0012mg/l) from Green hill.

The presence of lead in ground water is as a result of weathering actions on rocks which primarily introduces lead into ground water. Acid rain water also contains lead which seeps through the soil and end up dissolved in ground (spring) water.

However, the highest lead concentration of (0.0004mg/l) can be due to the farming activities such as vegetable growing around the water source in which chemicals like fertilizers are applied, such chemicals mix up with soil and when it rains they seep through the porous of the soil and eventually come in to contact with ground water and thus causing a water pollution.

Figure 3: Concentration of zinc in river, tap and ground water sources



The highest concentration of zinc was recorded in surface water of river R wabakazi at Butobere bridge (0.0091mg/l) followed by river Muzihogo at Kirigime Bridge (0.0075mg/l,).

This is attributed to corrosive action on galvanized roof top structure materials(iron sheets) which contain zinc, with rainfall the scrapped off metallic particles can be easily removed from faded surfaces and washed in to the ground and carried by surface water runoff into the nver which results in to increasing levels of zinc .

The use of agro chemicals such as pesticides, fertilizers by farrners have resulted into undesirable accumulation of zinc in River R wabakazi with its highest level of

(0.0091mg/l)compared to its concentration in river Muzihogo since much of agricultural activities such as animal rearing, and cultivation of crops are carried out along River Rwabakazi.

Zinc concentration of (0.0034mg/I) was recorded in spring water in Green **hill** sampling site and (0.0022mg/I) in spring water in Kyamishana sampling site. Zinc has limited mobility in soil and the anthropogenic activities have less impact on ground water.

Zinc 'can be introduced into ground(spring)water through the weathering action on rocks under oxidizing conditions, easy solubility of zinc sulphate facilitates an intensive migration of this metal which becomes one of the most mobile water migrant (Ajea and Tabatabai 1997).

The use of chemicals such as insecticides, pesticides and fertilizers in farming activities near the Water sources have resulted into an increase in zinc concentration in ground (spring) water.

However, it's higher concentration of (0.0034mg/l) compared to (0.0022mg/l) can be attributed to other activities that take place within the water source from which the later concentration was recorded such as car and motor cycle washing, burning of house hold wastes which introduces zinc metal containing wastes on ground which seep through the soil and find their way down into ground water.

The analysis indicates a highest level of both lead and zinc in the tap water samples obtained from Kigongi B and lowest concentrations in tap water samples from Nyakirima sampling site as shown in figures 2 and3 above.

Lead concentrations were (0.0043mg/l) and (0.0039mg/l) and they are within acceptable value of (0.01 mg/I) according to world health organization. Lead in tap water mostly comes from lead lined pipes, lead folder arid brass plumbing fixtures.

Zinc concentrations were (0.0037 mg/I) and (0.005 lmg/l). Zinc is introduced in tap water through corrosion of galvanized plumbing materials. Galvanized pipes are manufactured using zinc that probably contains high levels of lead a common impurity in zinc.

The difference in concentrations of both lead and zinc in tap water samples is basically due the time that water spend on the pipes. The highest concentrations in tap water of Kigongi B showed that water remains in the pipes for long period of time which allows intense corrosion to take place and thus resulting into rapid dissolution and accumulation of both lead and zinc in tap water

CHAPTER FIVE

5.0 Conclusion

The present study was performed to evaluate the quality of drinking water (tap, surface and ground water). According to obtained results all the water samples contains zinc and lead concentrations within the world health organization requirements. However, the concerned authorities for water supply in the municipality should ensure adequate treatment of water most especially tap water to ensure considerable amount of zinc since it's important to human health, and again carry out water refining to minimize neurotoxic lead which is taken to have no biological function. Also it is necessary to make people conscious about quality of water before drinking and furthermore the government could also provide free testing services to ensure the close monitoring of quality of water for drinking as well as preventing public health hazard.

5.1 Recommendations

There should. be Proper disposal and treatment of municipal and industrial wastes to reduce on the potential impact of these metals on surface, ground water quality. Farmers should use organic manure and also practice better farming methods that have little or no impact on the environment for instance tree planting that helps to reduce water surface runoff. The authorities of Kabale national water and Sewage Corporation should ensure time replacement of water pipes to avoid over corrosion that would result in to high levels of zinc and lead in water. The authorities of factories in Kitumba along river Rwabakazi should ensure that all waste materials are properly managed before disposal to avoid water pollution.

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