FLUORIDE LEVELS AND PHYSICOCHEMICAL PROPERTIES OF GROUNDWATER IN BUNEFULE AND BUNAGABO PARISHES, BUGOBERO SUBCOUNTY, MANAFWA DISTRICT

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DECLARATION

I, Muwugumya Brenda declare that this research report is my original work and has not been submitted anywhere for the award of the degree expect where other people's has been used it has been cited and acknowledged according to the university policy.

Signed……. Date 29…../11……/2023

APPROVAL

This research report by Muwugumya Brenda has been submitted for examination with my approval as her university supervisor.

Signed…….. date…29…./……11……./……2023……

Dr Egor Moses.

DEDICATION

I dedicate this research report to my beloved father Mr. Nkola Ben and mother Mrs. Naula zeulensi for their continued support throughout my school and university education and bringing me up morally. I owe them a lot and may the almighty God continue protecting them.

ACKNOWLEDGEMENT

I want to take this great opportunity to thank the almighty God for the gift of life and continuous grace that he has given me throughout this course. With great honour and thanks, I do appreciate the entire Department of Chemistry Busitema University for the service provided, more so my supervisor Dr Egor Moses. Thank for the opportunity you gave me to do this project under your tireless efforts of guidance. With great pleasure I thank my beloved parents Mr. Nkola ben and Ms. Naula Zeulensi for their sacrifice to see that I complete this course may the almighty God award you abundantly. I also thank the chemistry class for the support given during that time most especially Namukasa Minawala, Hamba Zaina, Malembo Malia Gorret, Dhikuusoka Hassan and my coordinator, Paskali Mwesigwe John. I cannot fail to appreciate my beloved husband Mr. Monghilo Sam for the financial support and encouragement, for the time I have been at this university. May the almighty God reward you abundantly.

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LIST OF ACRONYMS

APHA: American Public Health Association

AWWA: American Water Works Association

WEF: Water Environment Federation

EC: Electro conductivity

EDTA: Ethylenediaminetetraacetic acid.

TDS: Total Dissolved Solids

WHO: World Health Organization

TISAB: Total Ionic Strength Adjustment Buffer

TH: Total Hardness

ISE: Ion Selective Electrode

ABSTRACT:

This research proposal aims to investigate the presence of fluoride ions and analyze the physicochemical properties of water in Bugobero Subcounty, Manafwa District. The study was focused on various parameters including pH, Total Dissolved Solids (TDS), Turbidity, Total Hardness (TH), and Electrical Conductivity (EC). The presence of fluoride ions in drinking water is of significant concern due to their potential health implications. Elevated fluoride levels can lead to dental and skeletal fluorosis, especially in areas where fluoride concentration exceeds the recommended limits set by regulatory bodies. Therefore, understanding the fluoride levels and associated physicochemical properties of water is crucial for ensuring safe and sustainable water resources. To achieve the objectives of this research, water samples were collected from various sources within Bugobero Subcounty. The physicochemical parameters were measured using standard methods and equipment. pH will be measured to determine the acidity or alkalinity of water, Total Dissolved Solids (TDS) will provide information on the concentration of inorganic and organic substances dissolved in water. Turbidity will be assessed to determine the clarity or cloudiness of the water sample. Total Hardness (TH) was determined to assess the concentration of calcium and magnesium ions, which can affect water quality and household applications. Electrical Conductivity (EC) was measured as an indicator of the water's ability to conduct electrical current, which can be correlated with ion concentration. The collected data was statistically analyzed to identify any correlations between fluoride ions and the physicochemical properties of water. The findings of this research provided valuable insights into the water quality in Bugobero Subcounty and contribute to developing appropriate measures for water treatment and management.

CHAPTER 1 INTRODUCTION

1.1 Background

Fluoride ions (F-) are naturally occurring chemical species found in various minerals and water sources. They play a crucial role in dental health and prevention of tooth decay when present within an optimal concentration range. However, excessive fluoride intake can lead to dental and skeletal fluorosis, a condition characterized by the weakening and disfigurement of teeth and bones (WHO, 2008). The analysis of fluoride ions and the physicochemical properties of water in Bugobero Subcounty, Manafwa District, is essential for evaluating the potential risks associated with fluoride exposure and ensuring the provision of safe drinking water to the local population. Fluoride concentrations in water sources can vary significantly due to geological factors, such as the dissolution of fluoride-rich minerals in the surrounding rocks and soils (Fawell et al., 2006). In certain regions, such as areas with volcanic ash, granite, or fluoride-rich mineral deposits, groundwater may contain high levels of fluoride (WHO, 2008). Manafwa District, located in eastern Uganda, is known to have geological formations that may contribute to fluoride contamination in water sources (Ochola, 2015). The presence of high fluoride concentrations in drinking water is a major concern as it directly affects human health. Chronic exposure to excessive fluoride can lead to dental fluorosis, which manifests as enamel mottling, discoloration, and pitting of teeth (WHO, 2008). Moreover, long-term ingestion of high-fluoride water can result in skeletal fluorosis, where fluoride accumulates in bones, causing pain, stiffness, and skeletal deformities (Aravind et al., 2016). Vulnerable populations, including children and individuals with compromised kidney function, are particularly susceptible to these adverse health effects (WHO, 2008). Assessing the physicochemical properties of water alongside fluoride analysis is crucial for understanding the overall quality and suitability of water sources for various purposes (Silva et al., 2019; Stevenson & Bravo, 2019; T.R. Godebo et al., 2019). Parameters such as pH, electrical conductivity, total dissolved solids, and other chemical constituents provide valuable insights into the composition and potential contamination of water (Ayers & Westcot, 1985). These properties can help identify potential sources of fluoride contamination and enable appropriate remediation strategies to ensure the provision of safe drinking water to the community (Z. Ruan et al., 2017; Zhang et al., 2005). A comprehensive

analysis of fluoride ions and physicochemical properties of water is necessary to assess the current state of water sources and providing essential data for policymakers, water resource managers, and public health authorities to develop strategies for mitigating fluoride-related health risks and ensuring the availability of safe drinking water in Bugobero subcounty in Manafwa district.

1.2 Problem statement

Despite the essential role of water in sustaining human health and well-being, there is a lack of comprehensive studies regarding the presence and concentration of fluoride ions, as well as the physicochemical properties of water in Bugobero Sub County, Manafwa District. This knowledge gap hinders the ability to evaluate the potential health risks associated with fluoride exposure and develop appropriate mitigation strategies. Therefore, there is need to conduct an analysis of fluoride ions and various physicochemical parameters of water in this region to provide critical insights for policy-makers, healthcare professionals, and local communities to safeguard water quality and ensure the overall health and well-being of the population.

1.3 Objectives

1.3.1 General Objective

To analyze the fluoride ions and physicochemical properties of water in Bugobero Sub county, Manafwa District.

1.3.2 Specific objectives

1. To determine the concentration of fluoride ions in water samples collected from Bugobero Sub county, Manafwa District.
2. To analyze the physicochemical properties of water such as; pH, temperature, Total Dissolved Solids (TDS), Turbidity, Total Hardness (TH), and Electrical Conductivity (EC).

1.3.3 JUSTIFICATIONS

The justification for this study lies in its significance for public health, water quality assessment, environmental impact evaluation, resource management, establishment of baseline data, policy

and regulation development, and community awareness. By examining parameters such as pH, dissolved oxygen, total acidity and alkalinity, total dissolved solids, turbidity, biochemical and chemical oxygen demand, total hardness, and electrical conductivity, this research will provide crucial insights for addressing public health concerns, ensuring water safety, mitigating environmental risks, guiding resource management practices, informing policy decisions, and empowering local communities with knowledge about water quality issues.

1.3.4 Significance

This proposed research holds significant importance due to several reasons. The fluoride ions have a crucial impact on human health, and excessive fluoride levels can lead to dental and skeletal fluorosis. By studying the fluoride content in the water sources, potential health risks can be identified, and appropriate measures can be taken to ensure the safety of the local community. Investigating the physicochemical properties such as pH, Total Acidity and Total Alkalinity, Total Dissolved Solids (TDS), Turbidity, Total Hardness (TH), and Electro conductivity (EC) will provide valuable information about water quality and its suitability for various purposes like drinking, agriculture, and industrial use.

1.3.5 Scope of the study

The study forcused on a comprehensive analysis of fluoride ions and various physicochemical properties of water in Bugobero Subcounty, Manafwa District. The study involved collecting water samples from different sources such as boreholes, wells, and natural springs within the subcounty and preserved in the frigde under the temperature of 4°c. The collected samples were subjected to laboratory analysis using suitable techniques and instruments to determine the concentration of fluoride ions and assess the physicochemical parameters such as pH, Total Dissolved Solids (TDS), Turbidity, Total Hardness (TH), and Electro conductivity (EC). The research provided a comprehensive overview of the water quality in the study area, identify potential sources of contamination, and propose necessary remedial measures to ensure the provision of safe and potable water to the local population.

CHAPTER 2 LITERATURE REVIEW

Water quality is a critical factor in maintaining human health and well-being. However, the presence of excessive fluoride ions in water sources can have detrimental effects on human health. By examining the extent and causes of fluoride ion contamination and its relationship with physicochemical properties, effective mitigation strategies can be developed to ensure safe drinking water for the local population.

2.1 Fluoride Ion Contamination in Water Sources

Fluoride ions can exist in water due to both natural and anthropogenic sources. Natural geological processes, such as the dissolution of fluoride-bearing minerals such as fluorspar (CaF_2), Apatite ($Ca_2(PO_4)_3F$), and cryolite ($NaAlF_6$) contribute to the presence of fluoride ions in water sources

Additionally, human activities and industrial processes can introduce fluoride into water bodies. A study by (Chakraborty et al., 2017) found elevated fluoride levels in groundwater sources in neighboring districts, suggesting the potential for fluoride ion contamination in Bugobero Subcounty, Manafwa District.

2.2 Determination of fluoride concentration in water

There are several methods that can be used to determine fluoride concentration which include ion selective electrode, ion chromatography and colorimetric method (Abou Neel et al., 2016). However the ion selective electrode method is the most effective, efficient and reliable analytical method for determining fluoride concentration it can measure to about 20mg/l of the concentration of fluoride in water (C.F.Z. Lacson et al., 2020). This method can measure the total amount of free and complex fluoride dissolved in water because the TISAB II solution used can break up the complex to release the fluoride ions so that they can be easily detected by the ISE (Udhayakumari, 2019; W. Yang et al., 2017).

2.3 Health benefits of fluoride

Fluoride helps to prevent tooth decay once it concentration is in the recommended concentration as by the who guidelines. In 1990s, many governments had it introduce artifial fluoride in the

water supplied to the public to reduce the dangers caused by consumption of water with low concentration of fluoride.

2.4 Dangers of high concentration of fluoride.

Excess fluoride above the concentration of 1.5 mg/L when ingested can lead to progressive effects that is to say dental fluorosis and skeletal fluorosis (Ghosh & Norton, 2017). Dental fluorosis is a condition characterized by enamel discoloration and dental pitting while skeletal fluorosis affects the bones and joints leading to joint stiffness, pain and skeletal deformities (Koyaz, 2009). Other related problems due to excess consumption of fluoride include low hemoglobin levels, deformities in red blood cells, gastrointestinal problems, urinary tract malfunctioning among others (Hussain et al., 2004).

2.5 Physicochemical Properties

Physicochemical properties of water are essential for water quality assessment. These parameters provide valuable information about water composition, characteristics, and suitability for various purposes (Koyaz, 2009). Several studies have established guidelines and standards for these parameters, ensuring accurate water quality evaluation.

2.5.1 ph

The pH measures the hydrogen potential of water, which indicates its acidity or alkalinity, is influenced by hydrogen ion concentration (N. Adimalla & H. Qian, 2019; Nabwana, 2022; Ödman et al., 1999). The ph. is expressed on the scale ranging from 0-14, with a ph of 7 being neutral, below 7 is acidic and above 7 is basic. The acceptable pH range for good water for sustainability ranges from 6.5-8.5.

2.5.2 Total Dissolved Solids (TDS)

These measures the amount of mobile charged ions dissolved in water. These are due to inorganic and organic substances dissolved in water (Organization, 2010). High TDS levels can indicate the presence of contaminants and affect water's suitability for drinking or industrial use. TDS is responsible for the turbidity, odour, taste and at times the alkalinity of the water (Rhoades, 1996). The acceptable TDS level for drinking water ranges from 500 to 1,000 mg/L, depending on local regulations (WHO, 2017).

2.5.3 Turbidity

Refers to the cloudiness or haziness of water caused by suspended particles. It affects aesthetic quality and light penetration, thereby impacting aquatic plant growth and photosynthesis (Nabwana, 2022). The acceptable turbidity levels for drinking water generally range from 1 to 5 nephelometric turbidity units (NTU)(EPA, 2012).

2.5.4 Electrical conductivity.

This is the ability of electrical current to pass through the water and it is related to the concentration of ionized substance in water (Saravanan et al., 2021). Electro conductivity is influenced by the presence of dissolved salts such as sodium chloride, and potassium chloride among others which produce ions that migrate in solution and eventually generate electric current. It is also a measure of total dissolved solids and salinity (Stevenson & Bravo, 2019).

2.5.5 Total Hardness (TH) dissolved salts such as sodium chloride and potassium chloride, which

Refers to the concentration of calcium and magnesium ions in water. It affects the operational efficiency of water systems and the effectiveness of soaps and detergents. TH is typically expressed in milligrams of calcium carbonate per liter (mg/L). Hardness can either be permanent hardness or temporary hardness (El Osta et al., 2022). The salts of calcium carbonate and magnesium carbonate cause temporary hardness and can be removed by boiling while calcium sulphate and magnesium sulphate cause permanent hardness which cannot be removed by boiling but rather by chemical methods such as ion exchange method, addition of sodium carbonate (Chen et al., 2011; Choubisa & Choubisa, 2016; Cox & Koenig, 2010). Acceptable drinking water hardness varies, but it is generally considered acceptable up to 200-300 mg/L as calcium carbonate (WHO, 2017). Guidelines and standards for these parameters are established by various organizations and regulatory bodies. The World Health Organization (WHO) provides guidelines for pH, TDS, turbidity, and other parameters to ensure the safety and quality of drinking water (WHO, 2017). By examining the levels of fluoride ions and physicochemical properties of water in different water sources within Bugobero Sub County, Manafwa District, this research aims to provide innovative water strategies for safe drinking water and drawing recommendations for further research to reduce water contamination.

CHAPTER 3 METHODS AND MATERIAL

3.1 Study Area

Bugobero Subcounty is located in Manafwa District, which is situated in the Eastern Region of Uganda and its approximately 42 KM from Mbale city. The Subcounty is characterized by its rural setting, with a mix of agricultural and residential areas. Its geographical coordinates are approximately Latitude 0.9265°N and Longitude 34.2893° E. The population of Bugobero Subcounty is estimated to be 357,000. Water sources in Bugobero Subcounty include wells, boreholes, rivers, and other natural water bodies. These sources are commonly used for domestic purposes such as drinking, cooking, and bathing.

Table 1: The latitude, longitude and altitude of the sampled areas

SAMPLE	PLACE	LATITUDE	LONGITUDE	ALTITUDE
BI	BUNEFULE	0.8741	34.1246	3864
B2	NAKHUPA	0.6156	34.1454	3921
B3	BUKHONZO	0.8039	43.1512	3885
B4	BUMULULU	0.8366	4.2437	3985
B5	BUMULULU	0.8375	34.2418	3840
B6	BUWAFUTU	0.8238	34.2412	3937
W1	BUNEFULE	0.8696	34.1242	3816
W2	BWAKORO	0.8401	34.2433	3879
W3	BUMULULU 1	0.8366	34.2513	3813
W4	BUSIMALI	0.8357	34.2481	3870

3.2 Sample collection

The samples were collected from the villages of Bugobero Subcounty in Manafwa district by use of 500 ml empty plastic bottles. The bottles were washed thoroughly with soap, distilled water and dried. While in the field the bottles were rinsed three times using the water from which the sample is to be taken labeled properly according to the site from which the water will be taken. The samples were immediately covered after collection and stored in the laboratory in the fresh refrigerate set at a temperature of 4° C in cooler ice packed blocks to avoid microbial action and change in concentration, contamination and gas dissolution since all the analyses were not performed on the same day.

Figure 1: water sampling.

3.3 Experimental procedures

3.3.1 Preparation of reagents

(a) Preparation of TISAB II

500 ml of distilled Water was placed in 1 L beaker. 57 ml of glacial acetic acid and 58 g of reagent grand sodium chloride was added to the beaker. 4g of 1,2-cyclohexanedinitrilotetraacetic acid (CDTA) was dissolved by stirring and the beaker was placed in a water bath at 25ºC for 30 minutes. The calibrated ph. meter was immersed in the solution and added about 150 ml of

5Msodium hydroxide solution until the ph. is between 5.0 and 5.5. The solution was transferred to 1 L volumetric flask and topped up to the mark with distilled water.

(b) Preparation of calibration stock

0.2210 g of dried sodium fluoride was weighed and transferred into 100 ml polyethylene volumetric flask and dissolved using distilled water. 10 ml of the solution was measured and diluted to 100 ml with distilled water and this made 100ppm of the fluoride solution. Then 0.5 of this solution was pipetted and topped up with distilled water to 100 ml to obtain 1 ppm, then 1.5 ml and 5ml to obtain 3 ppm and 10ppm respectively.

3.3.2 Measurement of Turbidity

Turbidity was measured using a turbidity meter. A standard solution of known turbidity was prepared in order to be used for calibration of the turbidity meter that is to say 5 ml of hydrazine Sulphate and 5 ml of hexamethylenetetramine. After calibration of the turbidity meter this substance whose turbidity is to be measured will be placed in the meter and its turbidity is read. The acceptable value according to the world health organization ranges from 5ppm to 10ppm.

3.3.3 Measurement of pH

The pH. was measured using ph. meter. The electrode tip of the ph. meter was placed in distilled water to clean off the impurities. The tip was then dipped in the sample whose ph. is to be determined and automatically the meter displayed the results.

3.3.4 Measurement of Electrical Conductivity

The electro conductivity of water was measured by use of a conductance meter. The electrode tip of the conductivity meter was carefully rinsed with distilled water and carefully wiped with a tissue paper. 100 mL of water sample was measured into a beaker and the electrode tip was then dipped in the sample and a steady reading was taken as the conductivity of that water sample.

3.3.5 Measurement of temperature

The temperature was measured by use of the thermometer from the water source from where the samples were got. 100 mL of water were put in the beaker. The thermometer was rinsed with the

water whose temperature is to be determined. The thermometer was then dipped into the water and the temperature was recorded.

3.3.6 Measurement of Total Hardness (TH):

50 ml of the water sample was placed in a flask. Eriochrome Black T, to the flask containing the sample as the indicator. The sample was titrated against a standardized ethylenediaminetetraacetic acid (EDTA) solution until the color of the indicator changes from pink to blue. The volume of EDTA solution used was recorded.

Total hardness = volume of EDTA used×1000/volume of water used

3.3.7 Fluoride determination:

Fluoride concentration was determined by the ion selective electrode. The electrode was calibrated using calibration standards of 1 mg/L, 3 mg/L and 10 mg/L which were prepared using the total ionic strength adjustment buffer (TISAB). 5 mL of the water sample (B1) was measured into a plastic container and added 5 mL of the TISAB solution. The mixture was shaken well while stirring and the ISE was dipped into the solution to read the concentration of the fluoride in the water sample. This was repeated for all samples (B2, B3, B4, B5, B6, W1, W2, W3, and W4).

Figure 2: Determination of fluoride

CHAPTER 4 RESULTS AND DISCUSSIONS

Table 2: The table shows the concentration of fluoride and other physicochemical properties of water in the Bugobero sub-county.

SAMPLE	PH	EC (μS/cm)	TURBIDITY (NTU)	TH (mg/l)	TDS (mg/l)	FLUORIDE CONC (mg/l)	TEMPERATURE (ºC)
B1	7.2	300.3	0.6	50	164.4	2.25	27.0
B2	7.3	432.3	0.49	47	217.8	3.30	27.0
B3	6.7	313.6	0.52	59	157.8	3.15	26.5
B4	6.9	487.6	0.68	67	242.2	1.35	27.0
B5	6.7	502	0.72	70	252.7	1.80	26.0
B6	6.2	307.8	3.77	85	155.4	1.10	27.0
W1	7.7	263.8	34.60	28	131.2	1.180	27.0
W2	7.4	381.8	18.30	35	189.6	1.40	26.0
W3	7.2	370	21.90	36	184.7	1.55	27.0
W4	6.2	160.8	27.53	21	80.53	0.83	26.0

4.1 pH

The pH of the water samples was recorded to be in the normal ranges as shown in the table of results it ranged from 6.2-7.7 indicating that high fluoride in water is associated with neutral ph. Most of the water sources their pH ranges within the acceptable pH limit (6.5-8.5) according to WHO for drinking water except for water sample W4. The pH of water has no immediate and direct effect on human health but brings changes in the water quality parameters such as

solubility of metals and survival of pathogens. Therefore the pH nearer the neutral point favours the presence of fluoride in the water.

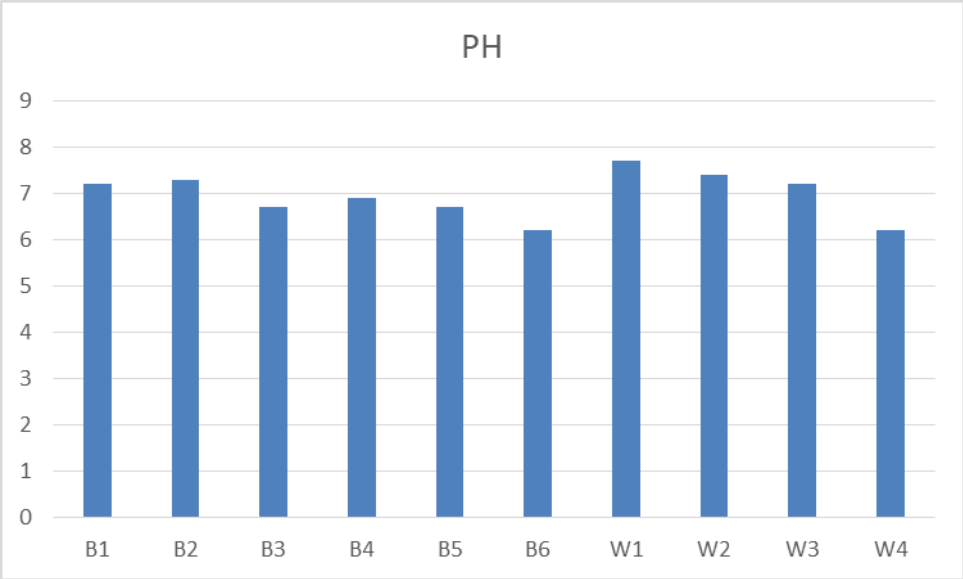


Figure 3: The variation of ph

4.2 Electrical conductivity

The electro conductivity of water from bugobero Sub County was found to range from 160.8 to 502 µS/cm. The highest was recorded from Bumululu borehole water and the lowest from Busimali wall water. According to the WHO all the water samples were within the acceptable limits therefore the water was safe for drinking. However the higher the concentration of EC the high the levels of fluoride in the water sample due to the presence of ions dissolved in water.

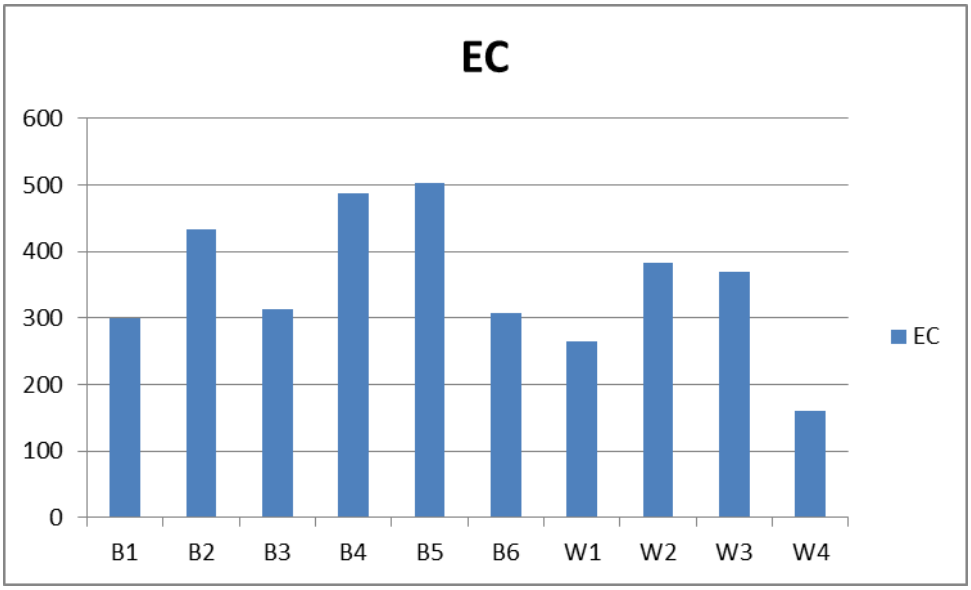


Figure 4: the variation of electroconductivity

4.3 Total hardness

The total hardness of the water shows the concentration of calcium ions ranged from (21-85) mg/L with the lowest being 21 mg/L from the water of Busimali and the highest being 85 mg/L from the Water of Buwafutu. This shows that the water contained calcium ions which favour the presence of fluoride hence increase in the level of fluoride ions in solution. However high levels of hardness in water result into hardness which eventually affect the rate of lathering with soap, cause stain in clothes and even corrosion in sauce pans.

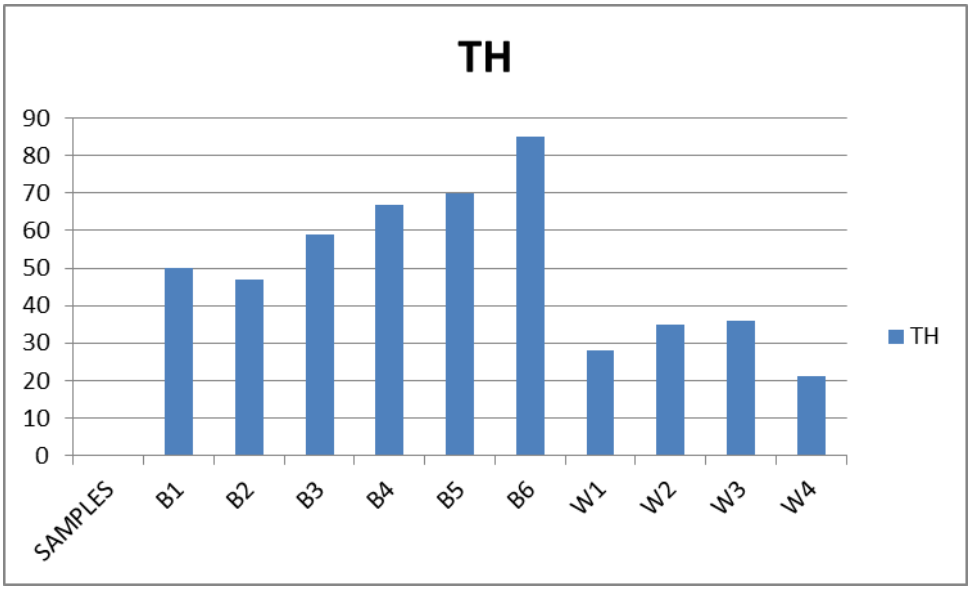


Figure 5: variation total hardness

4.4 Total Dissolved Solids

The TDS are important indicators of drinking water quality because they can affect other drinking water characteristics such as taste, hardness, and turbidity. It is observed that the TDS of the samples was below 500mg/l which is within the acceptable limits according to the WHO. In this study, the values of TDS ranged from 80.53-252.7 mg/l with the lowest from the well water of Busimali and the highest from the borehole water of Bumululu. Therefore all the water samples were within the acceptable limits indicating that the water was safe for drinking. However, the high levels of TDS show the presence of ions in the water which include fluoride ions.

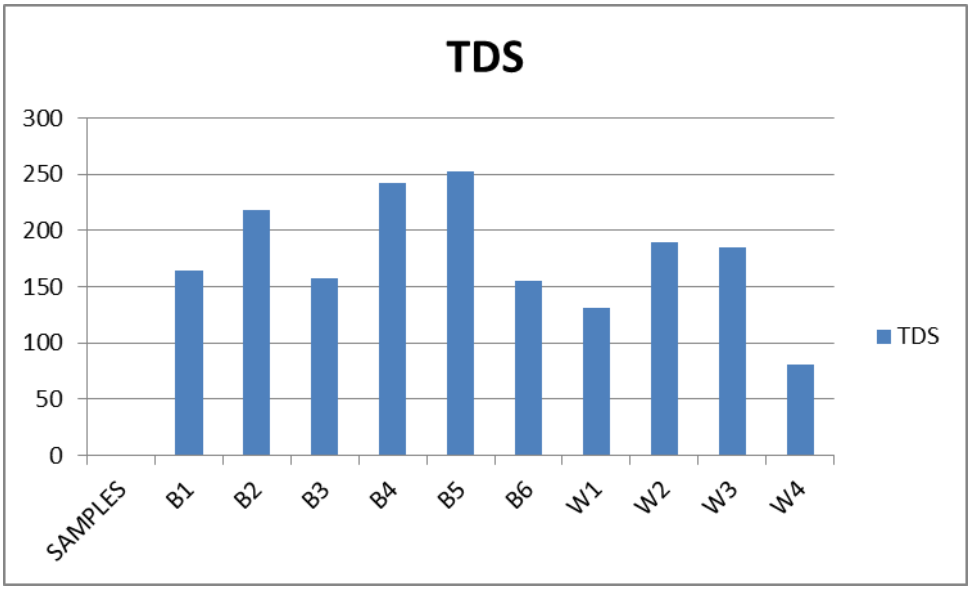
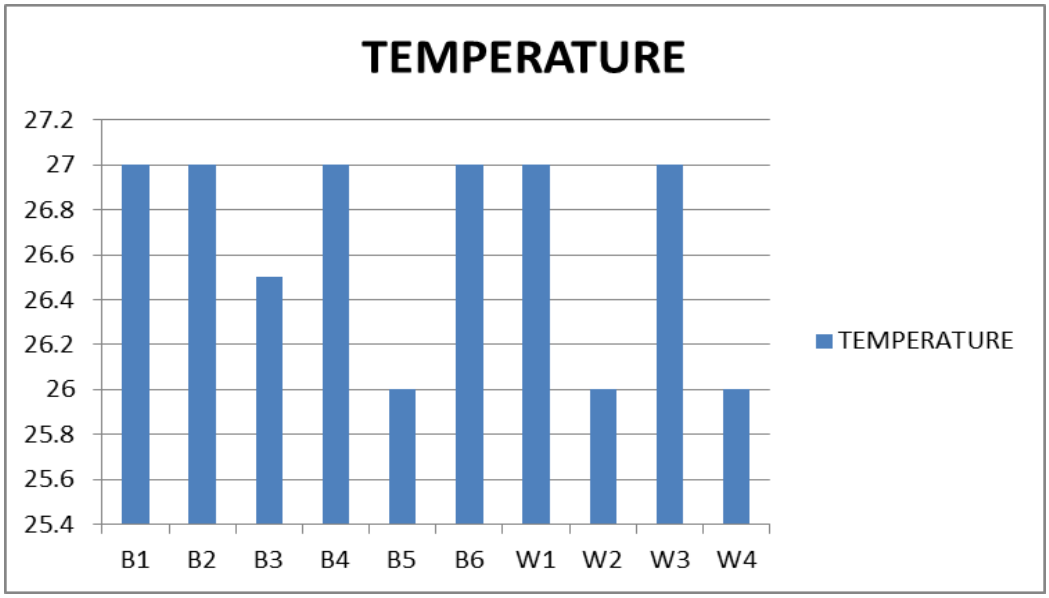


Figure 6: variation of total dissolved solids

4.5 Temperature

The temperature of the water samples ranged from (26.0-28.0) ºC with the highest being 28 from the borehole water of Bukhonzo and the lowest being 26.0 ºC from the well water of Bumululu and Busimali. High temperatures make water not safe for drinking because they enhance the growth of microorganisms, and increase the taste, odor, color, and corrosion of the water



4.6 Turbidity

The turbidity of the water ranged from (0.60-27.53) NTU with that of Busimali well water being the highest and that of Bunefule borehole water being the lowest. The turbidity of water varies from one place to another due to human activities, rise in water levels, and presence of particulate matter. In this study some of the water samples were high which indicate the presence of hazardous chemicals in the water and microbial contaminants which are associated with disease causing bacteria.

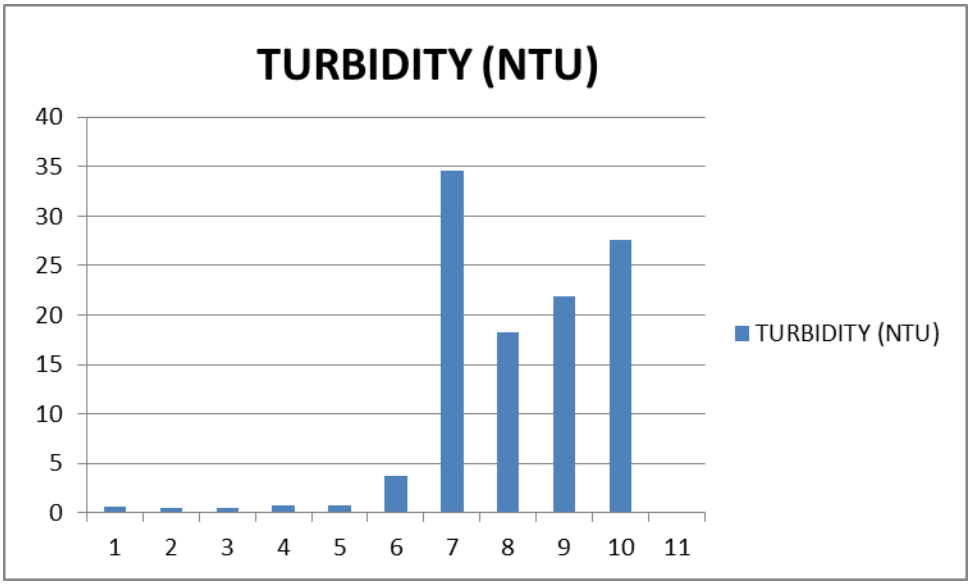


Figure 8: variation of turbidity

4.7 Fluoride concentration

The concentration of fluoride in the water of Bugobero Sub County is higher according to the WHO ranging from (0.83-3.15) mg/L with the lowest from Busimali water and the highest from Bukhonzo water indicating that the water from Bugobero contained high levels of fluoride. High levels of fluoride in drinking water result in dental fluorosis which is associated with the brown teeth which is common among the residents of Bugobero, skeletal fluorosis. Therefore dental fluorosis is a result of high levels of fluoride in drinking water above 1.5 mg/l as recommended by the WHO.

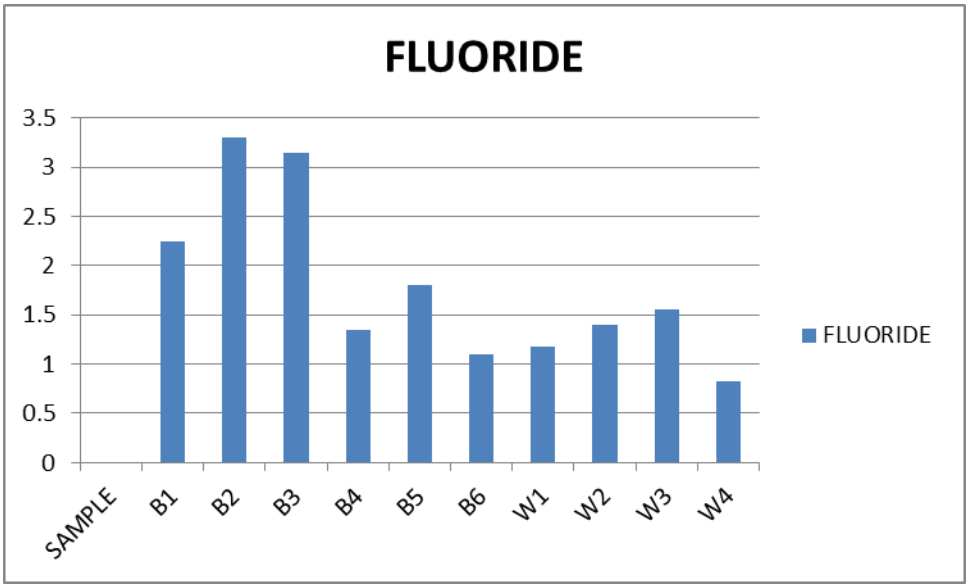


Figure 9: variation of fluoride concentration

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 Recommendations

I therefore recommend the responsible authorities to sensitize the public about the dangers of consuming high concentration of fluoride in drinking water.

More studies should be carried out considering all seasons the dry season and wet season.

The residents should adopt other sources of drinking water and some measures on how to reduce the concentration of fluoride before drinking.

5.2 Conclusion

From the above results and discussion, Bugobero water is not save for drinking since some water sources do not meet the acceptable values for the physicochemical properties of water and the concentration of fluoride is very high compared to the acceptable levels according to the WHO and UNBS. This implies that the residents of Bugobero are exposed to health risks such as dental fluorosis, skeletal fluorosis as a result of consuming water with high levels of fluoride.

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