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Determination and Removal of Hardness of water in Water samples from Bultumari ward in Gashua and Hausari ward in Nguru, Yobe State of Nigeria

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ABSTRACT: *Hard water is the one which does not give immediate lather with soap due to the presence of dissolved salts like $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ which cause temporary hardness while $CaSO_4$ and $MgSO_4$ cause permanent hardness. In this research work, qualitativeanalysis was carried out on the ground water samples collected from Bultumari and Hausari wards in order to determine the hardness. The results disclosed the presence of Ca^{2+}, Mg^{2+}, SO_4^{2-} and HCO_3^-which indicated the presence of both temporary and permanent hardness in the samples. In removing the hardness, 0.1M of soap solution was prepared and titrated against25cm^3 of each water samples before boiling. Water sample from Bultumari consumed 20.00cm^3 of the soap solution while the sample from Hausari consumed 22.00cm^3 of the same soap solution. This indicated the presence of both temporary and permanent hardness of water in the two(2) samples under study. However, after boiling the volume of soap solution consumed dropped to 12.00cm^3 and 14.00cm^3 respectively. This confirmed the removal of temporary hardness of water in both samples. Furthermore, addition of washing soda (Na_2CO_3) to the boiled and cooled 25cm^3 of the water samples resulted in the sudden drop of the volume of soap solution consumed during titration. The samples from Bultumari and Hausari consumed only 4.00cm^{3}and 5.00cm^{3}of the soap solution respectively. This shows the effectiveness of washing soda(Na_2CO_3) in removing permanent hardness of water. In investigating the impact of $CaSO_4$ in causing permanent hardness of water, 25cm^3 of distilled water was titrated with 0.1M soap solution before the addition of calcium sulphate. Lather started appearing when 5.00cm^3 of soap solution was consumed. When 0.2g of calcium sulphate was added to 25cm^3 of distilled water and titrated with soap solution, 7.00cm^3 of soap solution was consumed.Successive additions of 0.4, 0.6, 0.8 and 1.0g of $CaSO_4$ to the distilled water produced a direct relationship between the amount of $CaSO_4$ added and the volume of soap solution consumed. The plot between amount of $CaSO_4$ in grams and the volume of soap solution in cm^3 generated a straight line graph with linear relationship between the two variables.*

KEYWORDS: *Determination, Removal, Hardness of Water.*

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I. INTRODUCTION

Water is a colourless, odourless and tasterless transparent compound of hydrogen and oxygen. It is the most important natural resource in the world without which human, plants and animal survival will be impossible. It is an essential constituents of all living tissues and is present in cells, blood and all body fluids. Similarly, efficient and effective domestic and industrial activities will not be achieved without qualitative water. This is because it is both a reactant and the medium in which all reactions take place (Akinnawonu, 2009). Water plays an important role in the world economy simply because about 70% of the fresh water used by humans goes to agriculture. Fishing in salt and fresh water bodies is a major source of food to some people in different parts of the world. Most of the long distance trade of commodities like manufactured products, oil and gas are transported by boats through seas, rivers, lakes and canals. Water is also central to many sports and other forms of entertainments such as swimming, pleasure boating, boat racing, sports.The three most important sources of contamination are sewage, industrial wastes and wastes from domestic and wild animals fishing and diving (Adelekan and Abegunde, 2011). Its main sources include rivers, lakes, oceans, rain and wells. Water is often contaminated from different sources and therefore need to be treated before consumption. Water is also a natural habitat for a wide variety of microorganisms such as bacteria, algae, protozoa, viruses, fungi and helminthes worms. These microorganisms cause common infectious diseases like typhoid fever, dysentery, cholera, salmonellosis, amoeboid dysentery in man and animals which are transmitted through consumption of untreated surface water (APHA, 1985). Intensive farming activities in the study areas is responsible for the application of variety of fertilizers. Bultumari and Hausari communities are surrounded by River Komadugu Yobe, therefore, farming and fishing are their main economic activities in addition to mining in the surrounding villages. Pollutants from the above mentionedsourcespollute and degrade the quality of drinking water (Navneet and Singh 2010).The extent of the presence of organic and inorganic substances in water is responsible for its acidity, alkalinity, hardness and colour. Today, drinking water supply and its accessibility in developing countries Nigeria inclusive is a problem which requires immediate action. About 884million people most of which are in the developing region still donot have access to drinking water from the approved sources(WHO, 2011). To provide qualitative drinking water, water treatment like boiling and reaction with washing sodaare some of the techniques that could be applied. This will prevent water borne diseases and remove hardness of water. If the above treatments are successfully carried out the health and safety of the people in the communitieswill be improved (Navneet and Singh, 2010). The people from Bultumari and Hausari communities complained of high consumption of soap and stickiness of scum on to their clothes while washings. These are characteristics of hard water which should be identified and removed.

EXPERIMENTAL PROCEDURE

The water samples collected from a well in Bultumari ward in Gashua Town was labelled "**A**" while the one collected in a well from Hausari ward in Nguru Town was labelled "**B**".

DETERMINATION OF HARDNESS OF WATER

Qualitative analysis was carried out on small portions of sample "**A**" at the end of which the following cations and anions were detected; Ca^{2+}, Mg^{2+}, HCO_3^- and SO_4^{2-}. The same procedure was used on sample "**B**" and similar cations and anions were observed.

REMOVAL OF HARDNESS OF WATER

A soap solution of 0.1M concentration was prepared using the routine laboratory glass wares and standard procedure. Similarly, the same concentrations of sample "**A**" and "**B**" were prepared using the standard method.25cm^3 of 0.1M solution of sample "**A**" before boiling was titrated against 0.1M soap solution from the burette, 20cm^3 of the soap solution was consumed before the appearance of foam or lather. Also, 25cm^3 of the boiled and cooled sample of solution "A" was similarly titrated against 0.1M soap solution. Lather formation started when 12.00cm^3 of soap solution was consumed. Furthermore, 0.6g of sodium carbonate (Na_2CO_3) was added to 25cm^3 of boiled and cooled solution of sample **A** and the content was titrated against the soap solution as explained before. Immediately after the consumption of 4.00cm^3 of soap solution lather started appearing which marked the end of the titration. The above procedure was repeated using sample "**B**" and 22.00, 14.00 and 5.00 cm^3 of soap solution were consumed at end of each of the three titrations.

INVESTIGATION OF THE IMPACT OF CALCIUM SULPHATE ($CaSO_4$) IN CAUSING HARDNESS OF WATER

Sets of 25cm^3 of distilled water in the conical flaskswere titrated with 0.1M soap solution. The initial titration was carried out without addition of calcium sulphate into the conical flask. This was followed by successive additions of 0.2, 0.4, 0.6, 0.8, 1.0 g of calcium sulphate to each set and then titrated against the soap solution from the burette. The amount of calcium sulphate in gramswas plotted against the volume of soap solution in cm^3.

II. RESULTS AND DISCUSSION

TABLE I: Result of qualitative analysis carried out on sample "**A**"

TEST	OBSERVATION	INFERENCE
1.To 2.0cm^3 of sample **A**, HCl (aq)was added and warmed	Effervescence occurred. A colourless and odourless gas which turned wet blue litmus paper red and lime water milky was evolved	The gas given off is acidic and could be CO_2 from CO_3^{2-} or HCO_3^-
2. To solution ofsample **A**,$BaCl_2$ solution was added.	No visible reaction, but on boiling the mixture, a white ppt solublein dilute HCl was formed.	This confirmed the presence of HCO_3^-
3. To a small portion of sample A, $BaCl_2$ solution was added.	A white ppt was formed	SO_4^{2-}, SO_3^{2-}, S^{2-} and CO_3^{2-} could be present
4. A small portion of sample **A** was acidified with dilute HCl followed by the	A white ppt insoluble in dilute HCl was formed	The presence of SO_4^{2-} was confirmed

addition of $BaCl_2$ solution		
5. To 2.0cm^3 of solution **A**, NH_3 solution was added in drops then in excess and shaken	No visible reaction or ppt was formed	Ca^{2+} could be present
6. To 2.0cm^3 of solution **A**, NaOH(aq) was added in drops then in excess and shaken	A white chalky precipitate insoluble in excess NaOH solution was formed	The presence of Ca^{2+} was confirmed
7.To 2.0cm3 of solution **A**, Na_2CO_3 solution was added	A solid white ppt of $MgCO_3$ was formed	Mg^{2+} present
8. To 10 drops of solution **A**, two drops of 4-(p-Nitrophenylazoresorcinol) was added followed by the addition of 6M NaOH dropwise	A "blue lake" ppt of $Mg(OH)_2$ was formed	The presence of Mg^{2+} confirmed

NB: the same result was obtained when sample **B** solution has undergone the same reactions and tests

TABLE II: Result of titration between 0.1M soap solution and 0.1M solutions of samples "**A**" and "**B**"

	Volume of soap solution needed to form leather	
	Sample **A** (cm^3)	Sample **B** (cm^3)
Before Boiling	20.00	22.00
After Boiling	12.00	14.00
After treatment with Na_2CO_3	4.00	5.00

Table III: Result of addition of $CaSO_4$ to distilled water during its titration with 0.1M soap solution

$CaSO_4$ added to distilled water in grams	Volume of soap needed to form lather in cm^3
0	5.00
0.2	7.00
0.4	10.00
0.6	12.00
0.8	14.00
1.0	16.00

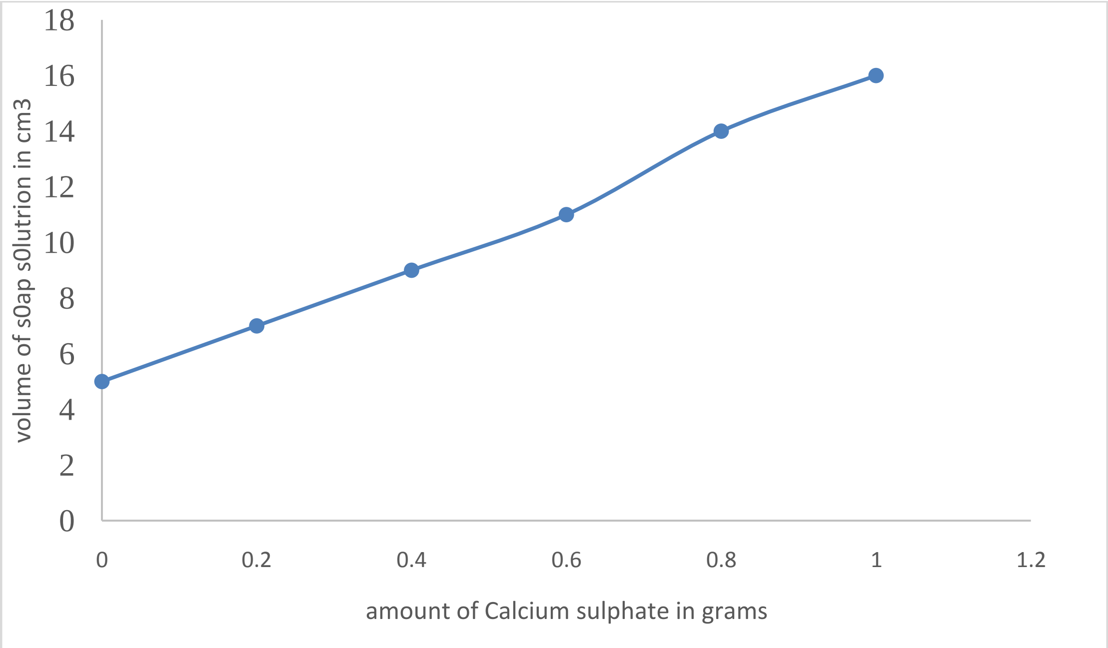

Figure 1: The impact of $CaSO_4$ on the consumption of soap solution

III. DISCUSSION

The qualitative analysis carried out on water samples from the two locations i.e Bultimari ward(sample **A**) and Hausari ward (sample **B**) in Gashua and Nguru Towns indicated the presence of the following cations and anions (Ca^{2+}, Mg^{2+}, HCO_3^- and SO_4^{2-}). It is therefore in order to say that both water samples contained both temporary and permanent hardness of water, table 1 confirmed this statement. This is due to the fact that temporary hardness of water is caused by the presence of hydrogen trioxocarbonate iv (HCO_3^-)ion of either calcium or magnesium. Whilepermanent hardness of water is brought about by the presence of sulphate (SO_4^{2-}) ion of calcium and magnesium.

Rain water which is formed from condensation of water vapourin the atmosphere does not contain calcium and magnesium salts which cause hardness of water. Hard water does not readily form lather with soap as found in the two (2) water samples studied due to the presence of the dissolved salts of Calcium and magnesium like $Ca(HCO_3)_2$, $Mg(HCO_3)_2$, $CaSO_4$ and $MgSO_4$. This is uneconomical especially to the people with limited income. For the water to be soft, free and suitable for industrial and domestic applications, the hardness must to be removed through scientific methods such as boiling, additions of calculated amount of slaked lime($Ca(OH)_2$), washing soda(Na_2CO_3), caustic soda(NaOH),permutit or zeolite processes, ion exchange resin and distillation.

In this research work, boiling and addition of washing soda were the suitable methods used in removing the hardness. This is because boiling is a very simple process while washing soda is cheap and available. When 0.1M of soap solution was titrated against 0.1M solution of sample **A** before boiling, lather formation started when 20cm^3 of the soap solution was consumed indicating the presence of both temporary and permanent hardness in the sample. 500cm^3 of 0.1M solution of sample **A** was boiled, cooled and divided into two portions. 25cm^3 of the first portion was titrated against the soap solution from the burette. Appearance of lather was observed when 12.00cm^3 of the soap solution was consumed. This showed that temporary hardness was successfully removed by boiling. This result is in agreement with the principle of removal of temporary hardness of water as described by Akinnawonu, (2016). Furthermore, this was generally supported byionic equation below;

$$2HCO_3^- \xrightarrow{boiling} CO_3^{2-} + H_2O + CO_2$$

To 25cm^3 of the second portion, 0.2g of sodium carbonate crystals were added and shaken vigorously to ensure proper mixing. The content was titrated against the soap solution and the emergence of lather when 4.00cm^{3}of soap solution was consumed confirmed the removal of permanent hardness of water as explained by Akinnawonu, (2016). When sample **B** has undergone the same procedure and the reaction, similarresults were obtained with slight changes as presented in table 2.

Gashua and its environment have more deposit of calcium sulphate than magnesium sulphate(Egwu, *et al.*, 2018). In view of this therefore, calcium sulphate was used in investigating hardness of water by its addition to distilled water. Before the addition of calcium sulphate, the appearance of lather was observed when 5.00cm^3 of 0.1M soap solution was consumed during its titration with distilled water. This revealed that the water does not contain either temporary or permanent hardness.However, on the addition of 0.2g of calcium sulphate to 25cm^3 of distilled water and the content titrated against the soap solution, lather started appearingwhen 7.00cm^3 of the soap solution was consumed. Furthermore, successive additions i.e 0.4, 0.6, 0.8 and 1.00g of calcium sulphate to distilled water revealed that 10.00, 12.00, 14.00 and 16.00cm^3 of soap solution were respectively consumed as presented in figure 1. This result is in agreement with the work of Ojokuku, 2012.

In conclusion, the water samples from the study areas contained both temporary and permanent hardness. There is a linear relationship between the quantity of calcium sulphate present in water and the volume of soap solution consumed. Therefore, the presence of hardness of water in the study areas is responsible for high consumption of soap in their domestic activities.For health and safety improvement as well as soap economy water in the study areas should be softened before embarking on cooking andwashings undertaking.

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REFERENCES

[1]. Adelekan, B. A. and Abegunde K.D. (2011). Heavy metals contamination of soil and ground water at automobile mechanic villages in Ibadan, Nigeria. *Nature environment and pollution technology*, 4(4): 633-636.

[2]. Agostinho, L. C., Nascinomento, L., Cavalcanti, B. F. (2012). Water hardness removal for industrial use. Application of the electrolysis process. *Open Access Sci. Rep.* 1:460-465.

[3]. Akinnawonu, O.T. (2016). Distinction approach to calculation in chemistry. Kaysho Educational, 8 Olupitan Close Ikolaba Estate, Bodija Ibadan. Rev. edn Pp 240-245.

[4]. APHA (1985). Standard methods for examination of water and waste water, 20th edn, America public health association, Washington, dc 7(3): 32-41

[5]. Egwu, G. N., Okunola, O. J and Ugwoke, K. C (2018). Evaluation of some heavy metals in wetland soils of Uguru, Yobe State, Nigeria. *J. Appl. Sc. Env. Managem.* 22(6):987-992.

[6]. Naveen k. S. (2007). Chemical analysis of ground water collected from different areas of Antiri and some nearby villages, *current world environment*. 2(1): 73-75

[7]. Navneet, K.and Singh, D.K. (2010). Drinking water quality management through correlation studies among various physicochemical parameters: A case study. *International journal of environmental Sciences*, 1(2): 253-259.
[8]. Ojokoku, O. G. (2012). Text book of Practical chemistry. 4th edn Press on chemresources. Pp. 151-154
[9]. Omenesa H. Z., Udoh, A. P. and Singh, R. L. (2006). Determination of some quality assessing parameter for drinking water. *Nigeria journal of scientific research* 1(1): 53-56.
[10]. WHO (2011). Guidelines for drinking water quality. 4th edn.WHO press, Switzerland, 5(2):75-78

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