Determination of the Concentration of K^{+1} , Na^{+1} and Fe^{+2} in Achane and Shay River a Case of Tepi Town

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Abstract Physical environments such as rivers can be affected by the massive movement of chemicals from different human activities through run off system. Therefore the metals concentration can be fluctuated and can exceed level of tolerance and even become toxic. The objective of the work is to determine the concentration of metal ions. Water samples were obtained from two sites located around Tepi town namely Achane River and Shay River. From each river six replicate samples were obtained. The acidified plastic bottles were used for sample collection to avoid fluctuation in acidity because of different environmental factors. The standard solution used for calibration purpose is prepared by mixing the standard solution of Na^{+1} and K^{+1} metal ion. After standards are aspirated the concentration of potassium and sodium metal ions has been determined in unknown using flame photometry and Fe^{+2} determined by using Uv-visible spectroscopy. The concentration determined is in the range of 0ppm-10ppm. Hence the mean concentration of potassium is 2ppm and 1.33ppm in Achane and Shay River respectively. Concentration of sodium is 2.895ppm and 6.9ppm in Achane and Shay River respectively. Iron is determined to be 1.1ppm and 1.6ppm in Achane and Shay River respectively. The concentration of sodium and iron in Achane River is less than that of Shay River and potassium is higher slightly in Achane than Shay and finally the concentration of sodium in both rivers is greater than that of potassium and iron ion. No significant influence can be stated on health because of such detection; since it can be tolerated and of course improvement is needed.

Keywords Concentration, Emission, Flame Photometry, River

1. Introduction

Flame photometry is a branch of atomic spectroscopy in which the species examined in the spectrometer are in the form of atoms. Flame photometry is suitable for qualitative and quantitative determination of several cations, especially

for metals that are easily excited to higher energy levels at a relatively low flame temperature (mainly Na, K, Rb, Cs, Ca, Ba, Cu). This technique uses a flame that evaporates the solvent and also sublimates and atomizes the metal and then excites a valence electron to an upper energy state. Light is emitted at characteristic wavelengths for each metal as the electron returns to the ground state that makes qualitative determination possible. Flame photometers use optical filters to monitor for the selected emission wavelength produced by the analyte species (Amrutkar R. 2013). Iron is transition metal requires measurement of absorbance vs concentration using uv-visible spectrophotometer.

The wavelengths of the color tell us what the element is and the color intensity tells us how much element is present

Comparison of emission intensities of unknowns to either that of standard solutions (plotting calibration curve), allows quantitative analysis of the analyst metal in the sample solution. Flame photometry is based on measurement of intensity of light emitted when metal is introduced into a flame.

The work is interested in detection of the concentration of metal ions in surface water. The concentration of such important minerals can even cause adverse conditions when in lower or higher level than permissible level. Therefore this study is the part of investigation and controlling of environmental problems. The variation in concentration of such metal is caused by additives from artificial activities such as use of fertilizer into the soil and water softening purposes. Therefore detection of such metal ion is used to know the level and compare with the safe and tolerable amounts. In this specific work addition of chemicals to soften water is not the cause of fluctuation of the concentration.

The objectives of the study is assessment of the level of alkali metals in surface water located around Tepi town and compare the results obtained with previously studied and permissible levels.

Sodium and potassium are required in macro level to human and therefore their concentration in diets as well as drinks contributes the tolerable amount in the cell. The minimum concentrations established by WHO for this element is 30-60mg/L of sodium.

2. Materials and Methods

2.1. Instrumentation and reagents

2.1.1. Instrumentation and apparatuses

The important apparatuses used in the work are plastic bottles, beakers, volumetric flasks, hot plate, dropper, pipettes and filter papers. Flame photometry is used for emission determination in the sample.

2.1.2. Reagents

Reagents are compounds or solvents used to calibrate, dissolve and overcome the problem of sample degradation during collection from the site. Therefore 0.02M HNO_3 , 1M HCl and standard solution of analytes used in the current study (M.S.Subramanian, 2008).

2.2. Sampling and Sample Collection

The plastic bottles are rinsed with 0.02M HNO_3 before the sample has been collected to maintain the constant pH and minimize loss of sample because of variation in pH, evaporation, precipitation and other relevant physical and chemical properties (Cailly Howell Frontiers Abroad, 2011).

Samples are obtained from Achane and Shay River located around Tepi Town in the rural site. The area of sample collection is at about 611km from Addis Ababa. The reason why the sample collection limited to these rivers is they are largest and longest of the rivers found in the area; hence covering long distance and erode large mass of the soil as well as minerals in the soil. The samples are collected randomly using acidified plastic bottles and mixed. The bottles were filled then sealed tightly to avoid head space that cause loss of samples because of oxidation. The total number of samples obtained from the rivers is twelve where six 0.5L plastic bottles sample are collected from each river.

Figure 1. Achane River from where sample collected

2.3. Sample preparation

Samples obtained from the rivers taken to the laboratory and analysis started. 50ml of the samples has been filtered

and transferred in to the beaker and 5drops of 1MHCl was added. The acidified sample is heated gently (not to evaporation) on hot plate for 7 minutes at 35°C then cooled for 5 minutes and 3drops of hydrochloric acid added to dissolve deposited carbonates of metals and heated again for another 5minutes to confirm the loss of organic constituents in the form of carbon dioxide and cooled for few minutes and ready for analysis. Since organic impurities are almost removed from the sample by heating; no more organic interferences are suspected significantly (Department of Chemistry, University of Kentucky, 2007).

2.4. Sample Analysis

2.4.1. Standard stock solution preparation

Stock solution is prepared from analytical reagent grade NaCl and KCl dried in oven at 105°C for 1hour. Part of the dried standard chemicals weighed; i.e. 0.2543g of NaCl, 0.1910g of KCl and 1.4g of $[(NH_4) SO_4.FeSO_4]$. The amount of potassium and sodium mixed together and dissolved in deionized water. The dissolved salts transferred into 1000ml volumetric flask and diluted to the mark to prepare 100ppm of each metals ions (Department of Chemistry University of Kentucky). Iron standard is dissolved separately in another 1000ml volumetric flask.

2.4.2. Preparation of working standards

A linear concentration range of the metal is 1 to 10 mg/L and calibration within the range expected for environmental water samples. The method is simple and sample has been prepared and care has been taken that the calibration of the instrument and analytical measurements are performed quickly after each other.

Five 100ml volumetric flasks are prepared and labeled as 2ppm, 4ppm, 6ppm, 8ppm and 10ppm. The assigned concentrations are prepared by adding 2ml, 4ml, 6ml, 8ml and 10ml of 100ppm stock solution in to 2ppm, 4ppm, 6ppm, 8ppm and 10ppm flasks respectively and filled to the mark. The blank solution is prepared from 2ml of 1MHCl and deionized water. The instrument is then calibrated by aspirating the working solution in the order of blank then standard analyte solution. After the calibration curve is established the samples are aspirated into the flame photometry through nebulizer from sample1 to sample 6. For iron 1ppm, 2ppm, 3ppm, 4ppm and 5ppm standard solution was used to calibrate the instrument. In between each measurement there was aspiration of blank solution to avoid the effect of contamination or error in concentration reading. The concentration of each metal ion is determined selectively at specific wavelength. The maximum wavelength at which Na^{+1} determined is 589nm and K^{+1} is at 766nm (Department of Chemistry, University of Kentucky, 2007).

Figure 2. Calibration curve established for the study

Figure 3. concentration of potassium and sodium obtained from Achane River

Figure 4. Concentration of potassium and sodium from Shay River

3. Results and Discussion

The standard solution prepared aspirated to the flame photometry to calibrate and establish consistence reading during measurement of the sample. Hence the calibration

graph indicated that it is safe method to proceed with the determination of samples under study since the deviation of the curve from straight line is only about 0.02%.

The calibration curve is constructed using concentration range of 2ppm-10ppm; and the blank solution is used as the

method detection limit for potassium and sodium.

The total replicate sample is twelve; where six sample is collected and mixed to obtain representative from each sites of the river water. The six replicate samples are assigned to be 1,2,3,4,5 and 6 indicated horizontally in figure 3 and 4.

According to the results shown in figure 3 the concentration of sodium ion is determined to be in range of 2.5ppm-3.2ppm and the mean concentration is 2.895ppm in Achane River (table1). These results are compared with sodium concentration obtained from shay river range from 6ppm to 7.5ppm and the mean value become 6.9ppm(table1). From this observation the concentration of sodium in Achane River is smaller than that of Shay River. It is because the location of Achane River is far from the town and no significant exposure to the activity of human being. Another important point to be considered is the results obtained compared with the works conducted before in other areas. According to the comparison the concentration of the current work is almost less than for example in drinking water between 30 and 60 mg/L and also by far it is less than that of EPA 20 mg/L in Mississippi River (EPA, 2003). Metal ions can be added to the water body by runoff system and from exposure of environmental effluents released from industries, factories and different human activities. The nature of the sample analyzed was not exposed to such an environmental effects contributing to the increase in concentration of the metals since no industry or factory releasing sewage.

Table 1. the mean concentration of potassium and sodium ions from six replicate samples ($p=0.05$)

Sample	Potassium ion(ppm)	Sodium ion(ppm)	Iron ion(ppm)
Achane River	2 ± 0.18	2.895 ± 0.27	1.1 ± 0.089
Shay River	1.33 ± 0.15	6.9 ± 0.53	1.6 ± 0.14

The concentration of potassium is determined to be 1.8ppm-2.2ppm and mean concentration of 2ppm (table1) in Achane River. In case of Shay River the concentration of potassium is in the range of 1.2ppm-1.6ppm and the mean concentration of 1.33ppm (table1). The mean concentration of potassium obtained from Achane River is slightly greater than that obtained from Shay River which can be explained in terms of the effect of fertilizers used for fertility of the soil and hence there may be run off mixing with the river. Further the concentration stated in relative to previously conducted work in other areas and it is found to be less than in almost referred materials i.e. 8.0-8.31ppm in ground water body (ANNEX 3, 2006) .

The concentration of potassium and sodium was determined within the same concentration range in mixed standard solution and the concentration of sodium is greater than that of potassium in both Achane and Shay river which may be explained with respect to the fact that potassium is the mineral that is demanded by the plant than sodium by far and hence there is higher consumption of potassium than sodium by plants (BWB Technologies, 2012)

Iron is determined by using Uv- visible spectroscopy at

510nm and its concentration in Achane River fall in the range of 1-1.2ppm whose average is 1.1ppm. In Shay River it is determined to be 1.4ppm-1.8ppm. From the result the concentration in Achane River is less than Shay River since Shay River is near the town and slightly contaminated with small scale manmade activities releasing to the river from metal corrosion. The concentration of iron in both Achane and Shay River is greater than permissible level established by WHO for drinking water which is 0.3ppm is. It is because of less iron consuming phenomenon in the environment.

5. Conclusions

Metal ions such as potassium, sodium and iron have been detected in sample using flame emission photometry and Uv-visible spectroscopy. Samples were obtained from Achane and Shay River. The concentration of metal ions was determined using emission and absorbance. The concentration of sodium and iron in Achane River is less than that of Shay River and potassium is slightly higher in Achane than Shay River. The concentration of sodium in both rivers is greater than that of potassium and iron ion.

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