Proc. of M.A.A.S (Feb. 2001)

Spectrophotometric Determination of Boron in Environmental Water Samples

San San, Khin Win Kyi and Kyaw Naing

Abstract

The present paper deals with the study on the methods for the determination of boron in the environmental water samples. The standard methods which are useful for this determination are discussed thoroughly in this work. Among the standard methods approved by American Public Health Association, the carmine method was selected for this study. Prior to the determination of boron in the water samples, the precision and accuracy of the methods of choice were examined by using standard boron solutions. The determination of Boron was carried out by using water samples, waste water from Aquaculture Research Centre, University of Yangon, the Ayeyarwady River water near Magway Myathalon Pagoda in Magway Division, ground water from Sanchaung Township, and tap water from Universities' Research Centre, University of Yangon.

Analyses of these water samples were done and statistical treatment of the results was carried out.

1. Introduction

Boron is a natural component of fresh water, arising from weathering of rocks, soil leaching, volcanic action and other natural processes. In Natural water, boron concentration is more than 0.1 ppm. Drinking water rarely contains no more than 1 ppm and generally contains less than 0.15 ppm concentration of boron and is considered innocuous for human consumption. Boron is an element essential for plant growth, but more than 2 ppm is deleterious for irrigation water. Sea water contains

Department of Chemistry, University of Yangon.

nearly 5 ppm. The ingestion of large amount of boron can affect the central nervous system. Protracted ingestion may result in clinical syndrome known as "Borism". The high concentration of boron in water could be due to industrial and marine intrusion from ceramic sector and waste water. Water and soil contamination by boron can occur from application of excessive fertilizer and pesticide. Analysis of boron in environmental water samples can be very helpful from environmental point of view. *(Taras, Lopez) (1989, 1993)*

2. Experimental

All experiments were carried out at the Universities' Research Centre, University of Yangon. The chemicals used in this research were obtained from British Drug House Chemicals Ltd., Poole, England. All chemicals were of analytical grade.

The apparatus used was a Shimadzu UV-240 uv-visible spectrophotometer at the Universities' Research Centre of the University of Yangon.

Carmine method for spectroscopic determination of boron was employed and statistically the results were examined Boron contents in the environmental water samples were determined by using this method.

3. Results and Discussion

3.1. Carmine method

Carmine is an anthraquinone dye derived from co-chineal and it occures in several different forms. Carmine No. 40 N.F from Gerrad Co. Ltd., U.S.A was used in the research work. *(Hatcher, 1950)* For quantitative analysis of a compound by visible spectroscopy, first it is

necessary to know the wavelength of maximum absorption.*(Variey, Grant) (1980, 1964)*

Figure 3.1 indicates the absorption spectrum of carmine solution showing λ_{max} at 540 nm. On the otherhand, the absorption spectrum of boron-carmine complex solution shows λ_{max} at 610 nm.

Figure 3.2 shows the absorption spectra of different boron concentrations (57, 43, 28, 14 and 7 ppm) complexing with carmine solutions. In this case, λ_{max} was also found at 610 nm.

Table 3.1 shows the concentration of boron in the water sample from Aquaculture Research Centre. From this table it was observed that concentration of Boron is in the range of 1.84 ppm to 2.43 ppm for five different samples from five different locations. This value is a somewhat higher than the allowable value (0.2 ppm) so that water from Aquaculture Research Centre is considered not to be suitable for drinking purpose.

Table 3.2 indicates the concentration of boron in the Ayeyarwaddy River water samples. The observed limit is lower than allowable limit so that the Ayeyarwaddy River water can be used as drinking water from the environmental point of view.

Table 3.3 and 3.4 show the concentration of boron in the ground water sample from Sanchaung Township and the tap water from Universities' Research Centre respectively.

From these tables it was observed that boron contents in water samples were in the ranges of 0.07 to 0.11 ppm (Sanchaung Sample) and 0.12 to 0.15 ppm (tap water sample from Universities' Research Centre) respectively.

These two limits are allowable limit and it can be concluded that water from these two areas are innocuous for human being and water from Sanchaung Township is considered to be the most suitable for drinking purpose.

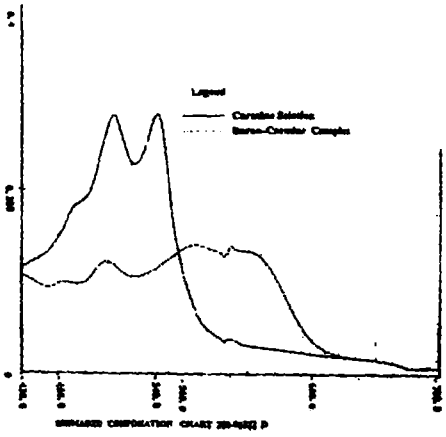

Figure 3.1- UV spectra of carmine-solution and boron-carmine complex solution

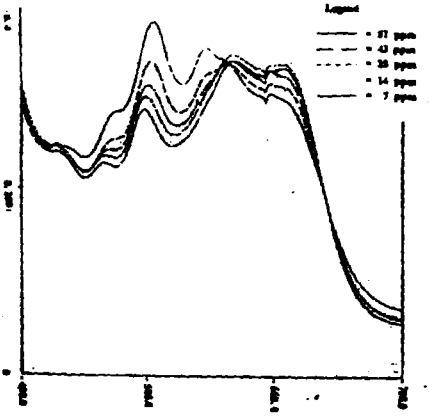

Figure 3.2- UV spectra of boron-carmine complex solutions and standard boron solutions.

3.2. Calibration Curve for Standard Boron Solution

Standard boron solutions (10, 20, 30, 40, 50 ppm) were made to react with carmine reagent and the absorbances were measured at 610 nm. *(Vogel, 1964)*

The nature of the curve was a straight line passing through the origin showing that Beer's law was obeyed. *(Neillands, 1955)*

3.3. Precision and Accuracy of Carmine Method

Before doing the determination of boron in environmental water samples, the precision and accuracy of the carmine method was studied

statistically using the standard boron solutions. Determinations were carried out in five replicates per day for five days. *(Ckchanger, 1969)*

The precisions (relative standard deviation %) were found to be 1.38, 1.68, 3.79, 0.98 and 3.48 %. The accuracy (relative error %) were found to be 5.3, 1.77, 4.9, 3.12 and 1.32 %.

Therefore, the allowable limits of precision and accuracy for carmine method are found to be 5% and 10% respectively. *(Taras, 1989)*

3.4. Determination of Boron in Environmental Water Samples

The water samples were: waste water from Aquaculture Research Centre, University of Yangon. Ayeyarwady River water near Magway Myathalon pagoda, ground water from Sanchaung Township and tap water from (URC) Universities' Research Centre. Determinations of boron were carried out by the carmine method and data were shown in Table 3.1, 3.2, 3.3 and 3.4 respectively.

Table 3.1. Concentration of boron in waste water sample from Aquaculture Research Centre

No.	Water samples	Concentration of Boron (ppm)
1	S_1	1.84 ± 0.05
2	S_2	1.70 ± 0.05
3	S_3	2.84 ± 0.09
4	S_4	2.72 ± 0.07
5	S_5	2.43 ± 0.07

Table 3.2. Concentration of boron in Ayeyarwady River water samples

No.	Water samples	Concentration of Boron (ppm)
1	S_1	0.20 ± 0.005
2	S_2	0.08 ± 0.003
3	S_3	0.15 ± 0.006

Table 3.3. Concentration of boron in ground water samples

No.	Water samples	Concentration of Boron (ppm)
1	S_1	0.07 ± 0.014
2	S_2	0.07 ± 0.015
3	S_3	0.11 ± 0.040
4	S_4	0.07 ± 0.015
5	S_5	0.09 ± 0.021

Table 3.4. Concentration of boron in tap water samples from Universities' Research Centre

No.	Water samples	Concentration of Boron (ppm)
1	S_1	0.12 ± 0.03
2	S_2	0.15 ± 0.05
3	S_3	0.15 ± 0.06
4	S_4	0.13 ± 0.05
5	S_5	0.15 ± 0.04

4. Conclusion

In this research, different methods for the determination of boron in environmental water samples were discussed thoroughly. Among these methods, the carmine method, due to its good precision and accuracy, was chosen for the determination of boron. From the research data, it was found that the ground water from Sanchaung Township was suitable for drinking and other purposes. This research should be further extended for other water samples in the environment.

Acknowledgements

The author would like to express their deep gratitude to the Department of Higher Education, Ministry of Education, Yangon, Myanmar, for allowing to carry out this research programme and to Dr. Soe Yin, Rector and Head of the Department, Universities' Research Centre, University of Yangon, for granting permission to use the necessary equipment at the URC. We would also like to express our sincere gratitude to Professor Dr. Maung Maung Htay, Department of Chemistry, University of Yangon, for his kind provision of the research facilities.

References

Ckchanger, K.E., Errors, Measurements and Results in Chemical Analysis, Von Nastrand Reinhold Co., Ltd., London, 9 (1969).

Grant (Editor), J., Clowes and Coleman's, Quantitative Chemical Analysis, Longmans, Green and Co., London, 259 (1964).

Hatcher, J.T., and Wilcox, L.V., Colorimetric Determination of Boron Using Carmine, Anal. Chem., **22**: 567 (1950).

Lopez, F.J., Fresenius .J. Anal. Chem., **346**: 984 (1993).

Neillands, J.B., stumpf, P.K., and Stainer, R.Y, Outline of Enzyme Chemistry, John-Wiley and Sons, Inc., New York, 35 (1955).

Taras, M.J., and Greenberg, A.E., Standard Method for the Examination of Water and Waste Water, American Public Health Association. New York, 4.7 (1989).

Variey, H., Gowenlock, A.H., Bell, M., Practical Clinical Biochemistry. William Heineman Medical Books Ltd., London, 1,162 (1980).

Vogel, A.I., A Textbook of Quantitative Inorganic Analysis, Longmans. Green and Co., London, 259 (1964).