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Spectrophotometric Determination of Cobalt in Water and Agricultural Samples

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ABSTRACT

A simple, specific and rapid Spectrophotometric method is developed for the determination of Cobalt as Co-(M.D.T.C) complex in the presence of sodium acetate-acetic acid medium at pH = 7.0 and 0.2M $MgSO_4$ as salting out agent. This complex shows absorption in visible region at 640nm. The method is sensitive up to 0.59ppm and it is free from interference of many metal ions like Cd^{+2}, Cu^{+2}, Zn^{+2}, Ni^{+2}, Fe^{+2}. The developed method is applied for the determination of Co (II) in various water and agricultural samples.

Keywords: Spectrophotometry, cobalt (II), water and agricultural samples.

INTRODUCTION

Cobalt is one of the most essential trace metals. It is an integral part of vitamin B_{12} which is needed by humans. Deficiency of vitamin B_{12} affects the normal blood cell formation. The nervous system is seriously affected with, sometimes, degeneration of nerve fibers in the spinal cord and peripheral - nerves. The deficiency is clearly seen where cells are undergoing rapid division, such as in blood-forming tissues of bone marrow. Toxic effects of cobalt have not been reported much and are possible only when cobalt compounds have been deliberately added during food processing or used in high doses therapeutically for the treatment of anemia. Goiter is the side-effect of cobalt therapy[1,2].In view of the importance of cobalt in diverse fields and particularly for its active role in various metabolic activities of living systems including man, the metal is selected for its trace level determination using morpholine dithiocarbamate(MDTC) as complexing agent .The Spectrophotometric method developed for traces of cobalt (II) determination is applied to the analysis of water samples and agricultural materials.

MATERIALS AND METHODS

Bio Spectrophotometer with TE controller- Model No .BL 198-Elico Make was used for absorbance measurements. A digital pH meter (model No. 335), of Systronic make is employed for pH measurements. All other chemicals were

of A.R grade. A stock solution of cobalt (II) was prepared by dissolving 0.25 g of cobalt acetate in distilled water. Sodium morpholine dithiocarbamate solution was prepared in double distilled water.

RESULTS AND DISCUSSION

For developing the quantitative experimental conditions various factors effecting the extraction are studied.

Effect of pH : The study of effect of pH (from 6.0 to 10.0) has been tried. In sodium acetate-acetic acid medium from 6.0 to 7.0 and sodium acetate- sodium hydroxide buffer from 8.0 to 10.0, the studies are carried out taking 0.5 ml of cobalt solution (10^{-4} M), 10.0 ml of sodium acetate buffer of 0.4M, 2.0 ml of Na (MDTC) solution (10^{-4}M), 2.0 ml salting out agent, $MgSO_4$ (2M) and 5.5 ml of water into a separating funnel and extracted in to 10.0 ml of chloroform in three installments (5+3+2). The chloroform layers are separated collected and the absorbance is measured at 640 nm and the results are presented in Table 1.

Table 1. Effect of pH

p^H	Absorbance
6.0	0.385
7.0	0.400
8.0	0.389
9.0	0.386
10.0	0.379

The pH for the quantitative studies in the present work is maintained at pH 7.0.

Solvent Effect: Various solvents like n-butanol, isoamyl alcohol, MIBK, chloroform, 1,4-dioxan, carbon tetra chloride, nitrobenzene, benzene, hexane and methyl ethyl ketone are tried to extract Co-MDTC complex at pH 7.0. Among the solvents used chloroform is found to be effective in extracting the complex quantitatively. The absorbance values of Co- (MDTC) complex are noted at different intervals of time at 640 nm and found that the complex is stable for 24 hours.

Effect of Sodium acetate concentration: The concentration of sodium acetate is varied form 0.2 M to 1.0 M and extraction is repeated keeping the amounts of cobalt (II) and Na (MDTC) constant. The absorbance results are shown in Table 2.

Table 2 : Effect of sodium acetate

Concentration of Sodium acetate, M	Absorbance
0.2	0.385
0.4	0.405
0.6	0.380
0.8	0.370
1.0	0.370

Co (II)- 0.5 ml of 10^{-4} M, Na (MDTC)- 2.0 ml of 10^{-4} M, pH -7.0, Magnesium sulphate -0.2M

As seen from the table, it is clear that 0.4 M sodium acetate concentration gives maximum absorbance value for the Co (II) – MDTC complex and therefore the buffer of 0.4 M concentration is used throughout the quantitative studies.

Effect of Magnesium Sulphate: 0.5 ml of cobalt solution (10^{-4}M), 10.0 ml of sodium acetate, 2.0ml of Na (MDTC) solution (10^{-4} M), 2.0 ml of magnesium sulphates, 5.5 ml of water are taken in a separating funnel and the extraction with chloroform is carried out as usual. Keeping Co(II), MDTA and buffer volumes constant as above the concentration of magnesium sulphate is varied from 0.2 M to 0.8 M and the extracted into chloroform with each volume of magnesium sulphate. The absorbance results are shown in Table 3.

The salting out agent, ($MgSO_4$) of 0.2 M concentration, is enough for quantitative extraction.

Table 3. Effect of salting out agent

Concentration of $MgSO_4$, M	Absorbance
0.2	0.440
0.4	0.412
0.6	0.397
0.8	0.389

Co (II) - 0.5 ml of 10^{-4} M, Na (MDTC) -2.0 ml of 10^{-4} M, Sodium Acetate-0.4 M, pH-7.0

Effect of reagent, Na (MDTC) concentration: Different concentrations of reagent, Na (MDTC) solution are taken into a separating funnel Co(II), sodium acetate buffer and salting out agent are added and after extraction with chloroform, absorbance values are recorded in Table 4.

Table 4. Effect of Na (MDTC)

Reagent Na (MDTC), ml	Absorbance
1.0	0.234
1.5	0.323
2.0	0.417
2.5	0.395
3.0	0.392

Co (II) - 0.5 ml of 10^{-4} M, Na (MDTC) -10^{-4} M, Sodium acetate -0.4 M, Magnesium sulphate - 0.2 M, pH -7.0

Applicability of Beer's law: A set of separating funnels are taken and into each funnel 10.0 ml of sodium acetate (pH 7.0), 2.0 ml of Na (MDTC) solution (10^{-4}M), 2.0 ml of magnesium sulphate and different known concentrations of Co (II) solutions are added and extracted into 10.0 ml of chloroform in three installments (5+3+2), the organic layers are separated, collected and absorbance of total volume is measured at 640 nm. Cobalt (II) in ppm is plotted against the absorbance. The data is given in Table 5.

Table 5. Applicability of Beer's law

Amount of Co (II), ppm	Absorbance
0.59	0.090
1.18	0.189
1.77	0.295
2.36	0.399
2.95	0.500
3.54	0.619
4.13	0.700
4.72	0.810
5.31	1.160
5.90	1.308

Na (MDTC) -10^{-4} M, Sodium acetate -0.4 M, Magnesium sulphate - 0.2 M, pH -7.0

APPLICATIONS

Estimation of Cobalt in Water and Agriculture materials: The Spectrophotometric method developed for traces of cobalt (II) determination is applied to the analysis of water samples and agricultural materials.One liter of the water samples collected from municipal supply of Vijayawada town are pre concentrated by evaporation and analyzed.

Agricultural Materials: 1 g of daucus carota (carrot root), sample.1 and solamum tuberosum (potato) sample.2 are cut into small pieces and dried in oven for 30 minutes, digested by dry ash method[3] and brought into solution by dissolving in 25 ml and 10 ml distilled water, respectively.

Table .6. Determination of cobalt (II) in water samples of Vijayawada Town

S. No	Na (MDTC)		
	Co (II) added, ppm	Co (II) Found ppm	% Recovery
1	0.5	0.50	100.00
2	1.0	0.98	98.00
3	1.5	1.50	100.00

4	2.0	1.98	99.00
5	2.5	2.50	100.40
		Average	99.40

MDTC - 10^{-4} M, Sodium acetate - 0.4 M, Magnesium sulphate - 0.2 M, pH- 7.0, 5 ml of the concentrated sample is used.

Table.7. Determination of Cobalt (II) in Agricultural Materials.

Sample	**Co (II), ppm**		
	Added	**Total Found**	**Co (II) in the sample ppm g^{-1}**
I	0.5	0.70	0.500
	0.5	0.68	0.450
	0.5	0.69	0.475
II	0.5	1.50	1.000
	0.5	1.48	0.980
	0.5	1.47	0.970

MDTC-10^{-4} M, Sodium acetate - 0.4 M ,Magnesium sulphate - 0.2 M, pH- 7.0 .1 ml of the sample solution is used**.**

CONCLUSIONS

The results in the Table .6 indicate that the water samples do not contain cobalt where as the agricultural material (Table .7) have microgram quantities of cobalt. These values are in good agreement with the standard – values reported in the literature.

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