

Extraction and Spectrophotometric Determination of Copper with Cetyltrimethylammonium Bromide in Presence of Iodide

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Cetyltrimethylammonium bromide (CTAB), a quaternary ammonium salt, possesses considerable potentiality to find application as a reagent for the determination of a number of metal ions in our laboratory¹. It has been noted that copper(II) forms a complex with CTAB in presence of potassium iodide which is extractable into chloroform. This property of the copper complex suggests that further studies of the system might lead to the development of a simple spectrophotometric method for the determination of copper.

Results and Discussion

Copper(II) forms a yellowish complex with CTAB in presence of potassium iodide. It is extractable into chloroform and shows maximum absorbance at 360 nm. The reagent blank does not absorb in this region.

The extent of extraction of copper as its complex was investigated through absorbance measurements at different pH values in the range 0–10. Maximum absorbance was observed at the pH range 0.5–3.5. In this pH range a single extraction indicated a complete and quantitative recovery of copper.

Apart from chloroform, benzene, carbon tetrachloride and ethyl acetate were tested as extracting solvents. The copper-complex in chloroform showed maximum absorbance and hence this solvent was used for the purpose. In chloroform the colour intensity was found to remain stable for at least 12 h (measured at 360 nm).

It was found that 2 ml of KI along with 2 ml of CTAB was sufficient to extract 52.5 μg of copper in a single operation. Use of excess KI (more than 4 ml) has a tendency to lower the absorbance of the chloroform extract, while higher concentration of CTAB (upto 4 ml) had no adverse effects.

The system obeyed Beer's law over a concentration of 10 ppm of copper. The molar absorptivity of the complex (based on copper content) was evaluated to be $1.064 \times 10^4 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$ and Sandell's sensitivity $0.059 \mu\text{g cm}^{-2}$ at 360 nm.

The reproducibility of the method was examined with four different samples of copper, 13.12, 26.25, 52.5 and 78.74 μg and analysing each six (6) times, and the mean result of each (with corresponding standard deviation) were 13.33 (1.25), 26.66 (1.72), 52.16 (1.32) and 72 μg (1.7).

Using the general procedure at pH 2 the effects of diverse ions, in the binary mixtures with 24 cations and 12 anions, in the estimation of 52.5 μg of copper were examined. Deviation upto $\pm 3\%$ in the recovery of copper was taken as the tolerance limit for the diverse ions tested. The metal could be determined without interference in presence of 3000 μg of SCN^- , F^- , NO_3^- , ascorbate, tartrate, citrate, phthalate, PO_4^{3-} , Br^- ; 2000 μg of Zr^{IV} , Au^{III} , Bi^{III} , Sn^{II} , Ba^{II} , Cd^{II} , Ni^{II} , Pb^{II} , Cr^{III} , Ca^{II} , Co^{II} , Th^{IV} , Sr^{II} , Mo^{VI} , V^{V} , UO_2^{II} , Mg^{II} ; 1000 μg of Rh^{III} , Fe^{III} in presence of fluoride, Zn^{II} ; 500 μg of Hg^{II} , Ag^{I} , Pd^{II} , Pt^{IV} and 60 μg of borate, oxalate and EDTA.

Determination of copper in synthetic mixtures: In absence of real samples the proposed method was extended to some synthetic mixtures to estimate microgram amounts of copper (Table 1).

TABLE 1—DETERMINATION OF COPPER IN SYNTHETIC MIXTURES*

	Composition (μg)	Copper found (μg)
1.	Cu(52.5), Fe(200), Ni(200), F^- (2000)	50.5
2.	Cu(52.5), Pb(200), Bi(200)	52.0
3.	Cu(52.5), Ni(200), Co(200)	52.0
4.	Cu(52.5), Zn(200), Pb(200)	53.0
5.	Cu(52.5), Pd(200), Pt(200)	53.5

*Average of 3 determinations.

The reported method for the spectrophotometric determination of copper is simple and rapid and is well comparable with some other existing methods as shown in Table 2.

Experimental

Absorbance measurements were carried out with a Shimadzu PR-1 spectrophotometer fitted with stoppered quartz cells of 10 mm optical path length.

A stock solution of copper(II) was prepared from $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and standardised. A working solution of copper(II) was prepared by appropriate dilution. Aqueous solutions of CTAB (SISCO) (0.2%) and KI (BDH) (2%) were used. Chloroform and other solvents were distilled before use. Buffer solution of pH 2 (KH-phthalate/HCl)⁸ was used to adjust the acidity of the aqueous phase. Standard solutions of respective diverse ions were prepared from their corresponding salts. All chemicals used were of analytical grade.