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Spectrophotometric Determination Of Fe, Ni, Cu, Zn, Cd, Hg With 1-(Benzimidazol-2-yl) Ethanone Thiosemicarbazone



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ABSTRACT

A simple and sensitive method for the spectrophotometric determination of Fe, Ni, Cu, Zn, Cd and Hg in trace amounts by using 1-(benzimidazol-2-yl) ethanone thiosemicarbazone (BET) as complexing agent. Metal, ligand ratios are computed as 1:2 in the metal complexes at pH 9.0. This ligand is forming stable colour with metals. The molar absorptivity, applicability of Beer's law, stability constants and the effect of foreign ions also studied for different metal complexes.

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KEYWORDS

Estimation of metal ions;
1-(Benzimidazole-2-yl)
ethanone thiosemicarbazone.

INTRODUCTION

The metal chelates of thiosemicarbazones find wide range of applications in medicine^[1-3]. The use of thiosemicarbazones in inorganic analytical work has been revised by Singh et al^[4]. Due to the good ability of thiosemicarbazones in forming coloured complexes with different metal ions, they are widely employed^[5-7] in spectrophotometric and extractive spectrophotometric analysis of various cations and anions. But the survey of literature reveals that only a few of benzimidazole thiosemicarbazones are employed for the spectrophotometric determination of

divalent metal ions. Here the authors introduced a new complexing agent 1-(benzimidazole-2-yl) ethanone thiosemicarbazone (BET) for the determination of metal ions.

EXPERIMENTAL

All the solvents used were AR grade. The solvents used for the synthesis of ligands were distilled before use. All other chemicals were of reagent grade quality. The pH measurements were made by using digital pH meter Model DPH-500. The absorbance measurements were made by using U.V. visible re-

TABLE 1

Metal	Reagent	λ_{\max} (nm)	Molar absorptivity Lit mol ⁻¹ cm ⁻¹	Applicability of Beer's law	P ^H	Colour of the complex	Colour stability	Composition of the complex	Interfering ions
Fe	BET	327	----	----	----	Reddish	----	----	----
	BET	380	4.78 x 10 ³	0.25-6.1	9.0	Brown	80	1:2	Ag (I), Ce (IV) Co (II), Cd (II) Cu(II), Pd (I), V(V), Zn(II) & EDTA
Ni	-do-	375	5.147 x 10 ³	0.3-5.0	9.0	Brown	48	1:2	Ag (I), Co (II) Cd (II), Cu (II) Pd (II), V (V) DMG & EDTA
Cu	-do-	390	7.55 x 10 ³	0.25-6.0	9.0	Green	80	1:2	Ag (I), Cd(II), V (V), DMG & EDTA
Zn	-do-	380	6.14 x 10 ³	0.4-5.1	9.0	Light yellow	48	1:2	Ag (I), Co (II) Cu (II), V(V) DMG& EDTA
Cd	-do-	390	1.12 x 10 ⁴	0.2-8.2	9.0	Yellow	72	1:2	Ag (I), V (V), DMG & EDTA
Hg	-do-	380	4.385 x 10 ³	0.5-16.1	9.0	Yellow	60	1:2	Ag (I), Cu (II), Co (II), V(v), DMG&EDTA

cording spectrophotometer Model U-3210, Hitachi Corporation, Tokyo, Japan.

Metal solutions

All the metal solutions are prepared by using standard procedures^[8]. The stock solution is standardized volumetrically. Lower concentrations of metal solutions are prepared by diluting the stock solution with double distilled water. The metal ion concentration is 5 x 10⁻⁴ M.

Reagent solution

The reagent solution was prepared^[9] by refluxing methanolic 1-(benzimidazole-2-yl) ethanone and aqueous thiosemicarbazide in acediacid medium. 1x10⁻² M solution is used in the studies.

Buffer solutions

Buffer solutions were prepared by adopting the standard procedures^[10]. Here 2 M NH₄Cl and 2 M NH₄OH (pH 8-12) is used for the studies.

RESULTS AND DISCUSSION

The absorption spectra of the BET and its metal complexes were recorded in the wavelength range 300 to 500 nm individually against buffer and reagent blank respectively^[11]. The reagent showed the negligible absorbance and metal complex showed absorbance at 375-390 nm. Job's and mole ratio methods are applied for the determination of composition of the complex.

All the metals are formed complexes with BET in 1:2 ratio (M: L) under the experimental conditions. The complex colour stability for 72 h, and absorbance remains constant in the pH range 8.0 to 9.5. The studies are carried out at pH 9.0 using ammonical buffer. A ten fold molar excess of the reagent is used to obtain maximum colour intensity. Applicability of Beer's law, λ_{\max} , molar absorptivity, pH, colour of the complex, stability of the colour, composition of the complexes and interfering ions of the metal complexes data are presented in the TABLE 1. The amount of iron is 5.586 $\mu\text{g/ml}$, nickel is 5.87 $\mu\text{g/ml}$, copper is 6.35 $\mu\text{g/ml}$, zinc is 6.538 $\mu\text{g/ml}$, cadmium is 11.24 $\mu\text{g/ml}$ and mercury is 20.06 $\mu\text{g/ml}$ is used in the determination.

Effect of foreign ions^[12]

The effect of various cations like Ag (I), Ce (IV), Cd (II), Co(II), Cu(II),Pb(II), V(V) and Zn (II) are studied in the determination of different metal ions. Similarly the effect of different anions like DMG and EDTA are also studied. The interfering radicals are presented in the TABLE 1.

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