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Green Synthesis of Ligand, Volumetric Analysis Using Micellar Medium and Antibacterial Investigations on Cu (II)-thiosemicarbazone Systems

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ABSTRACT

Surfactants containing potential donor ligands can coordinate with metal ions and such compounds can be used for the removal of toxic metals and organometallic compounds from aqueous systems. Micelles have played role as soil and water decontamination agents. Micellar solutions and microemulsions are efficient environmentally-friendly agents for cleaning artworks, especially for the selective removal of aged polymeric coatings from the surface of wall paintings. Thus micelles have great importance in chemistry. Present work explains the synthesis of ligand (4-(Diethylamino) benzaldehyde thiosemicarbazone) by conventional as well as green method, volumetric analysis and antimicrobial investigations on Cu (II)- thiosemicarbazone complexes. Solution studies on the complexes have also been carried out in different micellar (SDS, HTAB,TX-100) systems at 25 °C. Stability constants have been determined in 60% ethanol by pH metric study. Proton ligand stability constant and metal-ligand stability have been determined potentiometrically. Antibacterial investigations have been carried out against, S. *aureus*, B.*substilis* bacterial strain.

Key words*: Cu (II)-Thiosemicarbazone, Antibacterial, Stability constants, SDS, and Triton X-100*

Introduction

Thiosemicarbazones (TSCs) have versatile pharmacological activity including anticancer properties. Thiosemicarbazones usually react as chelating ligands with metal ions by bonding through the thiocarbonyl sulfur and the azomethine nitrogen atoms (Tada *et al.,* 2012). Being a structural and catalytic cofactor in a number of biological pathways, copper accumulates in tumors owing to selective permeability of the cancer cell membranes. Copper(II) ion forms the active centers in a large number of metalloproteins (Singh *et al.,* 2020). Cu metal complexes of di-2-pyridylketone-4, 4-dimethyl-3-thiosemicarbazone have been found redox active and provided appreciable cytotoxicity (Jansson *et al.,* 2010). Interaction of these compounds with target lysosomes and importance in metal metabolism has been studied (Van *et al.,* 2007 and Kurz *et al.,* 2008).

In this paper we are reporting the stability constant and antimicrobial activity of Cu (II) complexes with thiosemicarbazide based ligand : 4-(Diethylamino) benzaldehyde thiosemicarbazone (4-DEABT).

Materials and Methods

All the chemicals used were of AR grade and procured from Himedia. Metal salt were purchased

from E. Merck and were used as received. All solvent used were of standard/spectroscopic grade. Ligand 4-DEABT was synthesized by condensation reaction of thiosemicarbazide with 4-(Diethylamino) benzaldehyde in presence of methanol according to the literature (Lobana *et al.*, 1997). The solid precipitate obtained in both methods, was separated and crystallized. Crystals were purified and recrystalized with ethyl alcohol and dried under vacuum. For green synthesis of ligand microwave has been used. In the microwave synthesis, the reaction mixture was irradiated in a microwave reactor at 600 W for 2-5 minutes. Metal-ligand complexes were formed by potentiometrically. All biological activities have been carried out by disc diffusion method under horizontal laminar. The Digital pH meter 335 is used to observe the pH values of various solutions in present study.

Procedure

Potentiometric Study

Potentiometric study has been conducted in non-micellar (Alcohol, Alcohol and water) and in micellar medium (CTAB, SDS and TX-100). Three sets of titrations were prepared for comparison. Volume of all the system was made up to 25 ml using 60% ethanol. Titration of the three sets of mixtures has been carried out against a standard alkali given by Irving and Rossotti method (Irving, Rosstti, 1954).

Biological Study

Biological investigation has been carried out by disc diffusion method. The agar was prepared in plate and microorganisms were cultivated on to the surface of the agar plate. Broth was applied on agar plate then filter paper discs impregnated with different types of sample, were placed on the agar. After incubation of the plates the diameter of the zone of inhibition (ZI) of microorganism growth around each disc was measured (Mohammadzadeh *et al.*, 2012; Singh *et al.*, 2012).

Results and Discussion

Potentiometric Study

Proton-ligand Stability Constants (pK)

The proton–ligand formation curves were estimated by plotting graphs between the values ($\bar{n}_A$) Vs pH readings. This curve indicates average number of hydrozen ions ($_A$) attached to a ligand. The value of pH where $\bar{n}_A = 1.5$ and $\bar{n}_A = 0.5$ corresponds to the values of pK_1 and pK_2, respectively. The proton-ligand formation numbers ($_A$) were calculated by Irving and Rossotti method (Irving, Rosstti, 1954).

$$\bar{n}_A = Y - \frac{(V_1 - V_2)(N^o + E^o)}{(V^o + V_1)T_{CL^o}} \quad .. (1)$$

Where, V^0 = Initial volume of solution (25 ml), E^0 = Initial concentration of free acid (HNO_3), Y= Number of dissociable protons from ligand, $T_{CL}{}^0$ is concentration of ligand in solution, (V_1–V_2) = Volume of alkali (KOH) consumed by acid and ligand on the same pH (Pund *et al.*, 2010).

pK_1 values for alcohol, alcohol + water, CTAB, SDS, TX-100 have been obtained 11.4, 11.9, 11.9, 11.65, 10.60 respectively.

Metal ligand Stability Constant (logK)

Metal ligand stability constant (log K) were determined by metal complex formation curve and this curve indicated average number of ligand () attached to metal ion. Metal ligand stability constant (logK) were determine by the half integral method by plotting vs. pL.

$$\bar{n} = \frac{(V_3 - V_2)(N^o + E^o)}{(V^o + V_1)(\bar{n}_A)T_{CM^o}} \qquad pL = \log_{10} \frac{\sum_{n=0}^{n} \beta_n^H \cdot \frac{1}{(anti\log pH)^n}}{T_{CL^o} - \bar{n}T_{CM^o}} \times \frac{V^o + V_3}{V^o}$$

V_3 is the volume of KOH added in the metal ions titration to attain the given pH reading and $T_{CM}{}^0$ total concentration of metal present in solution. log K_1 and $logK_2$ were calculated from the formation curve by the known value of pL at which ($\bar{n}$) = 0.5 and ($\bar{n}$) = 1.5 corresponding to the values of $logK_1$ and $logK_2$, respectively (Janrao *et al.*, 2014).

$logK_1$ values for alcohol, alcohol + water, CTAB, SDS, TX-100 have been obtained 0.44,0.56, 0.608, 2.05, 0.263 respectively. These values are found

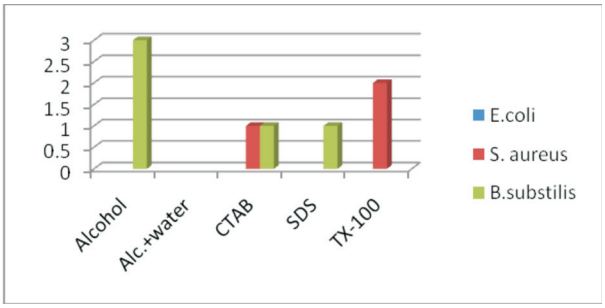

Fig. 1. Biological activity of thiosemicarbazone ligand and metal complexes

greater than zero which indicate formation of complexes.

Biological Investigations

E.coli, S. aureus, B.substilis bacterial strain have been used for Study of ligand and metal complexes. By applying disc diffusion method following results have been found (Gakkhar *et al.,* 2015).

Conclusion

Ligand synthesized using microwave takes very less time as compared to conventional method. The values of log K are found greater than zero which indicates the formation of complex between metal ion and ligand potentiometrically. Highest antibacterial activity has been screened by ligand in alcoholic medium against *B.substilis*. Almost equal zone of inhibition has been shown by *S. aureus* and *B.substilis* in CTAB. Moderate biological activity has been exhibited against *S. aureus* in TX-100.

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