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The impact of solvents on the stability of complexes of Cd(II) with L-tyrosine in aqueous-organic solvent mixtures

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ABSTRACT

The polarographic study of Cd(II) with L-Tyrosine has been investigated in aqueous organic solvent mixtures at 300K. The Dimethyl sulphoxide and Dimethyl formamide solvents have been used with water to study the effect of solvents on the stability of complexes. Cadmium(II) formed 1:1, 1:2 and 1:3 complexes with L-Tyrosine in the aqueous-organic solvent mixture i.e. DMSO and DMF. The stability constants of the water DMSO solvent mixtures are higher than water-DMF solvent mixtures due to the higher dielectric constant of DMSO than DMF. DeFord and Hume's method has been applied for the determination of stability constants of complex species. The values of overall formation constants were also determined by the mathematical method (Mihailov method) in order to compare the values.

Key words: Cadmium (II), L-Tyrosine, Polarography dropping mercury electrode, Effect of solvents, Mihailov's method.

INTRODUCTION

The polarographic behaviour of simple[1-4] and mixed[5-8] complexes of various metal ions have been studied. The behaviour of various metal ion complexes with different ligands, has also been studied on a function of solvent mixture concentration with different Polarographic Technique[9-11]. During the study of Cd(II)-L-Tyrosine complex mixture, it was found that metal reduced reversibly in DMSO-water and DMF-water mixtures and reduction was found to be diffusion controlled.

EXPERIMENTAL

A.R. grade chemical were used. The solution of Cd(II) was prepared from its nitrate. The DME had the following characteristic m = 1.75 mg/rec and t = 3.8 sec. (In open circuit). A constant Temp. (300K) was maintained using a Haake-type ultra thermostat. All the half wave potential refers to saturated calomel electrode. Solutions containing 0.1mm Cd(II) and various concentration of L-Tyrosine in different percentage of the aqueous-organic solvent mixtures were prepared. All the polarograms were recorded after de-aeration of test solutions with purified nitrogen gas.

Theoretical Consideration

The overall formation of the complexes in solution has been calculated using DeFord and Hume's method. Mihailov's mathematical method was also used to compare the values of overall formation constant. The values obtained by both the methods are in good agreements.

RESULTS AND DISCUSSION

In each case, a single well defined reduction wave appeared. The diffusion current was found to decrease with the increase of ligand concentration as a result of the complex formation. The complex ion formed is of much large size on compared to the aqua-metal ion, hence, there is a low value of diffusion current with the increase of ligand concentration.

The plots of log i / i_d-i vs $E_{1/2}$ were found to be linear with a slope of the order of 41±2 mV in all the cases. The value of n is 2 in Cadmium(II) ions reduction and it can therefore be concluded that the reaction is reversible process.

The change of medium, affects directly or indirectly the diffusion coefficient of the depolarizer, solvation capacity, viscosity and surface tension of the solution. The diffusion coefficient in not directly affected by the change in medium but with a function of the viscosity of the medium and size of the depolarizer.

Table 1: Stability constants of Cd(II)-L-Tyrosinate system in aqueous-aqueous-nonaqueous medium

Solvent mixture	DeFord's and Humemethod			Mihailov's method		
	log β_1	log β_2	log β_3	log β_1	log β_2	log β_3
DMSO (20%)	3.47	5.23	9.54	2.68	6.18	9.49
DMSO (40%)	3.66	5.54	9.85	2.84	6.43	9.84
DMSO (60%)	3.91	5.81	9.95	3.19	6.65	9.94
DMF (20%)	3.22	4.98	7.81	3.13	5.46	7.61
DMF (40%)	3.45	5.26	7.96	3.38	5.65	7.75
DMF (60%)	3.82	5.64	8.61	3.69	6.16	8.46

Among the physical properties of the solvent, i.e. dielectric constant has been regarded to be the most important. DMSO (E = 46.7) DMF (E = 36.7) have less dielectric constant as compared to water (E = 78.3) so these solvents affect the complex formation in the same direction.

CONCLUSION

In the present research it was found that in the presence of DMSO-water and DMF-water as a solvent mixture, the stoichiometry of the complex formed between Cadmium(II) and L-Tyrosine is 1:1, 1:2 and 1:3 similar to the simple aqueous medium but the increase in percentage of non-aqueous solvents (viz. DMSO, DMF) leads to increase in the value of stability constants of a complex, which may be attributed to less solvation of metal ion.

The effect of the solvent in the formation of complexes can satisfactory be explained in terms of solvent concept because it preferentially displaces water molecules from the solvent sheath of the ions, which explain the complex formation in aqueous-DMF and Aqueous-DMSO.

The decrease in diffusion current with the increase in the percentage of non-aqueous solvent may well be explained with the decreasing value of the diffusion coefficient.

In aqueous-non-aqueous mixture, its obvious, that in addition to water molecules some molecules of the non-aqueous solvent occupy a place in the solvation sphere of the depolarizer. The size of these molecules being greater than the size of the depolarizer. The size of these molecules, which decreases the value of diffusion coefficient which in turn is responsible for the decrease is diffusion current as the amount of non-aqueous solvent is increased. Many factors viz. dielectric constant, density, surface tension also affect the stability of complex.

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