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Electrochemical study of mixed-ligands complexes of In(III) with Succinic acid and Asparagine

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Abstract: The composition and stability constants of complexes formed by In(III) with Succinic acid and amino acid (Asparagine) have been investigated in aqueous media. The simple complex of In (III) with L-Asparagine was first investigated and formation constants evaluated by DeFord and Hume's method and verified by Mihailov's method. The values of formation constants of mixed-ligands complexes were found to be log β_{11} = 4.07, log β_{12}=4.678, log β_{21}=5.41 at 298K, calculated by Schaap and McMaster method.
Keywords: In(III), DME, L-Asparagine, Succinic acid.

Introduction

Mixed-ligand complexes are formed in solutions containing metal with two or more different ligands. The investigations on mixed-ligands complexes have been stimulated due to their analytical applications. Their formation as intermediate in ligand displacement reaction as well as in metal ion and enzyme catalyzed reactions and their possible significance for biological process. It is well known that mixed-ligands complexes of some metal play an important role in the activation of enzyme and mixed-ligands complexes are biologically[1-3] active against pathogenic micro organism mixed-ligands complexes of different metals have been reported with amino acid[4-9], mixed-ligands complexes of Zn(II)and Cd(II) reported with antibiotics[10] and mixed-ligands complexes of Indium(III)[11-17] have been reported. Schaap and McMaster's method has been used by many other workers[18-20] to calculate the formation constants of mixed-ligands complexes

O.D.Gupta et al.[21] studied the complexes of Cd(II) with itaconic acid and some amino acids. The present paper deals with the mixed-ligand complexes of In(III) with Succinic acid and L-Asparagine and their determination of stability constants by Schaap and McMaster's method.

Experimental

The test solution was prepared in measuring flasks of pyrex-glass using conductivity water. The solution contains 0.1mM of In (III) with varying concentration of strong ligand (Asparagine) and fixed concentration of weak ligand (Succinic acid). KCl solution of concentration 1M was used as supporting electrolyte to maintain the ionic strength of the solution at 0.1M and 0.002 TritonX-100 was used as maxima supressor. The current-voltage measurements were performed with three electrode assembly, a dropping mercury electrode as working electrode and calomel as reference electrode and platinum as counter electrode. A

C.L. 362 polarographic analyzer was used to record the CV data. The capillary had the following characteristics m = 4.62 mg/sec, t = 2 sec was used.

Results And Discussion

The weaker ligand in this system is succinic acid and two concentrations of the weaker ligand were kept fixed so as to get the values of mixed stability constants β_{11}, β_{12} and β_{21} by using the following relations.

$$\beta = \beta_{10} + \beta_{11} (Y) + \beta_{12} (Y)_2 \quad (1)$$

$$C = \beta_{20} + \beta_{21}(Y) \quad (2)$$

Two equations with two unknown were simultaneously solved to give log β_{11} and logβ_{12} for 1:1:1 and 1:1:2 mixed-ligands complexes respectively. The formation constant for the 1:2:1 mixed-ligands complexes was computed from equation (2) and both the experimental values of 'C' gives the same value for β_{21}. These β_{11}, β_{12} and β_{21} vvalues are recorded in table 3.

The numerical values in each step are log K values where K is the equilibrium constant for each step indicated in the Scheme-1. The equilibria between various formed complex species in the ternary system have been shown in Scheme-1.

It can be seen from Scheme-1 that [In (SA)]$^{+1}$ can add to (Asp) more easily than [In(Asp)]$^{+2}$ to add (SA) and also that tendency of [In(SA)$_2$]$^{-1}$ to add (Asp) is more than to add (SA). In the same way [In(Asp)$_2$]$^{+1}$ has greater tendency to add (SA) than to add (Asp). Like wise [In(Asp)(SA)] can add (Asp) more easily than (SA) as indicated by the values of equilibrium constant. From these results it can be concluded that In(III) forms stable mixed-ligands complexes as compared to single ligand in binary system.

The values of stability constants for mixed-ligands complexes are greater than the stability constants for the simple metal-ligand system.

Table-1-Formation constants values of In (III) simple complexes

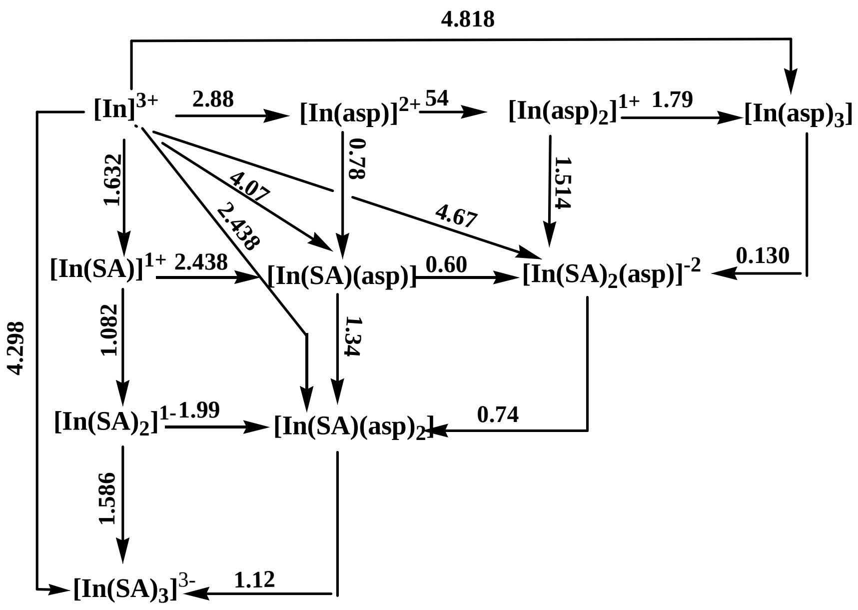
Complex species	**Composition**	**Stability Constants log β_j**
[In(Succinate)]$^{+1}$	1:1	1.632
[In(Succinate)$_2$]$^{-1}$	1:2	2.712
[In(Succinate)$_3$]$^{-3}$	1:3	4.298
[In(Asparagine)]$^{+2}$	1:1	2.88
[In(Asparagine)$_2$]$^{+1}$	1:2	3.428
[In(Asparagine)$_3$]	1:3	4.818

Table 2- Values of stability constants of the ternary In (III) complex of L-Asparagine- Succinic acid at 298K

Succinic acid (fixed)	log A	log B	log C	log D
0.25M	0.072	2.903	3.540	5.164
0.5M	0.540	3.832	3.965	5.169

Table 3-The overall formation constants of mixed-ligands In(III)-L-Asparagine- Succinic acid complexes at 298K

Mixed-ligands Metal complexes	**Formation constants**
[In(Asparagine)(SA)]	log β_{11} = 4.07
[In(Asparagine)(SA)$_2$]$^{-2}$	log β_{12} = 4.678
[In(Asparagine)$_2$(SA)]$^{-1}$	log β_{21} = 5.41



Scheme-1 In(III)-succinate-asparginate complex

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