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Polarographic Determination of Stability Constant Values of In(III) Complexes with Amino Acids by DeFord and Hume's and Mihailov's Methods

JYOTI SINGH and O.D. GUPTA*
Department of Chemistry, University of Rajasthan, Jaipur-302 055, India
E-mail: gupta_od@yahoo.com; jyotisingh7july@gmail.com

The reduction of In(III) with amino acids (serine, leucine, isoleueine) has been investigated electrochemically in aqueous medium and the stability constants of complexes formed by In(III) with these amino acids have been evaluated. The complexes of metal with amino acids ratio as 1:1, 1:2, 1:3 have been reported. The values of stability constants of complexes of In(III) with serine are log β_1 = 7.0988, log β_2 = 7.3086, log β_3 = 7.3108 and complexes of In(III) leucine have log β_1 = 5.1363, log β_2 = 6.4771, log β_3 = 7.3247 and complexes of In(III) with isoleucine have log β_1 = 4.3222, log β_2 =4.4051, log β_3 = 4.5051 at 308 K which have been calculated by DeFord and Hume's method. The mathematical Mihailov's method was also used.

Key Words: Indium(III), Leucine, Serine, Isoleucine, Dropping mercury electrode, Polarographic study.

INTRODUCTION

Amino acids are the chemical units or "building block" of the body that make up proteins, which improve the growth and maintenance of all cells are dependent upon them. Leucine, isoleucine and serine are the essential amino acids. Isoleuine, leucine stimulates the brain in order to produce mental alertness. Serine is intimately related to various bodily functions such as fat metabolism, tissues growth, enhancement of immune system.

The reduction of the complexes of Cd(II) and Pb(II), with DL-serine was studied by polarographic method. The stability constants of complexes were calculated by the methods of DeFord and Hume and Mihailov's[1-3]. The formation of complexes of In(III) with ligands 1:1, 1:2, 1:3 is observed.

The Cu(II) complexes of glutamate(I), phenyalaninate(II), threoninate(III), serinate(IV) and some other amino acids were studied polarographically[4]. Polarographic studies of Pb(II) with some amino acids (isoleucine) serine, glycine, alanine and glutamic acid have been carried out. The reduction of all the systems has been found to be reversible and diffusion controlled involving two electrons[5]. Stability constants of mixed-ligand complexe have been evaluated by the Schaap and McMasters method[6]. The formation of binary and ternary complexes of Co(II), Ni(II) and Cu(II) with glycine, L-alanine, leucine, valine and other amino acids was studied potentiometrically[5]. Voltammetric technique was used to study the binary and ternary complexes of Cd(II) with L-amino acids the investigation has been used to determine the thermodynamic parameters such as (ΔH, ΔG and ΔS, respectively[7]. Interaction of Cd(II) wtih L-amino acids has been studied by simple d.c. polarography[8].

Polarographic studies of histidine with *p*-block elements like Ga(III), In(III), Tl(I) have been carried out separately at ionic strength kept constant (μ = 1) by using KCl at 298 and 308 K temepratures[9] Sarkar and Cruck have reported the isolation of complexes of Cu(II) with threonine and theonine from normal human serum and have prepared complexes of Cu(II) with amino acids have been studied polarographically[10-16].

The present paper deals with the determination of stability constants of In(III) complexes of amino acids graphically by the method of DeFord and Hume[2]. The overall formation constants of the complexes have also been calculated using mathematical method of Mihailov.

EXPERIMENTAL

A CL-362 polarographic analyser was used to record polarograms. Using saturated calomel electrode as the refrence electrode and dropping mercury electrode used as microelectrode. Reagent grade chemicals were used. Amino acids were used as complexing agents and all solution were prepared in double distilled water. Potassium nitrate was used as a supporting electrolyte to maintain constant ionic strength.

Triton X-100 in the final solution sufficed to suppress the maxima observed. The DME had the following characteristics, m = 4.62 mg/s, t = 2 s and height of the mercury column h_{eff} = 43 cm. Purified N_2 was used for deaeration.

RESULTS AND DISCUSSION

Current-voltage relationship were obtained. The concentration of amino acids were varied from 0.001-0.008 M. The values of half-wave potentials for metal ions and their complexes shifted to more negative value on increasing the concentration of ligands. The nature of all the waves were quasireversible and diffusion controlled. This system also treated by Gellings method. $E^r_{1/2}$ is obtained by Gellings method, A plot of $E^r_{1/2}$ *versus* current (i) resulted a curves indicating the formation of successive complexes. The method of DeFord and Hume's[2] was applied to determine the value of stability constants of successive complexes. The polarographic measurements have been recorded in Tables 1-4 and Mihailov's Mathematical approach was applied to evaluate stability constants from $F_o(x)$ functions values.

The stability constants obtained by the two methods have been tabulated in Table-1.

Complexes of In(III) with isoleucine are less stable than that of serine and leucine due to steric hindrances and hence weaker complexation reduced in In(III) complex with isoleucine compare to serine and leucine.

TABLE-1
SUCCESSIVE STABILITY CONSTANTS FOR ML AND ML_2 AND ML_3 COMPLEXES OF In(III)-AMINO ACIDS DETERMINED BY TWO METHODS AT 308 K

System	Methods	Stability constants		
		log β_1	log β_2	log β_3
In(III)-Serine	DeFord and Hume	7.2988	7.3086	7.3108
	Mihailov	7.3496	7.3094	7.3426
In(III)-Leucine	DeFord and Hume	5.1363	6.4771	7.3247
	Mihailov	5.2086	6.3564	7.4072
In(III)-Isoleucine	DeFord and Hume	4.3222	4.4051	4.5051
	Mihailov	4.4062	4.4051	4.6486

TABLE-2
POLAROGRAPHIC MEASUREMENTS AND $F_j(x)$ VALUES FOR THE In(III)-SERINE SYSTEM
In(III) = 0.1 mM, μ = 1 M (KNO_3), Temperature = 308 K

Cx (Serine) (mol L^{-1})	$\Delta E^r_{1/2}$	$F_o[(x)]$	$F_1[x] \times 10^6$	$F_2[x] \times 10^7$	$F_3(x) \times 10^7$
0.001	0.0479	2.06949	20.6548	2.03560	0.18320
0.002	0.0690	2.98108	14.9053	3.29498	0.36516
0.003	0.0822	3.55144	11.83810	2.17205	0.58000
0.004	0.0832	3.59948	8.98700	7.64507	0.05430
0.005	0.0998	4.31240	8.52260	8.11820	0.14883
0.006	0.1400	6.04896	10.0815	9.49280	0.13191
0.007	0.1845	7.97140	11.3878	10.04269	0.12737

Cx = Serine concentration mol L^{-1} ; β_1 = 7.2988, β_2 = 7.3086, β_3 = 7.3108.

TABLE-3
POLAROGRAPHIC MEASUREMENT AND $F_j(x)$ VALUES FOR THE In(III)-LEUCINE
In(III) = 0.1 mM, μ = 1.9 M (KNO_3), Temperature = 308 K

Cx (Serine) (mol L^{-1})	$\Delta E^r_{1/2}$	$F_o[(x)]$	$F_1[x] \times 10^6$	$F_2[x] \times 10^7$	$F_3(x) \times 10^7$
0.001	0.0340	14.6889	13.68830	1.1129	2.8242
0.002	0.0422	18.2319	8.61550	3.6235	2.1125
0.003	0.0605	26.1379	8.37930	2.3368	2.2104
0.004	0.0642	27.7371	6.68425	13.2884	2.1182
0.005	0.0735	31.7558	8.55110	14.3645	2.1727
0.006	0.0798	34.4781	5.57968	13.0179	2.2624
0.007	0.0848	36.6386	7.09120	15.7475	2.6992

Cx = Leucine concentration mol L^{-1} ; β_1 = 5.1363, β_2 = 6.4771, β_3 = 7.3247.

TABLE-4
POLAROGRAPHIC MEASUREMENT AND $F_j(x)$ VALUES FOR THE In(III)-ISOLEUEINE SYSTEM
In(III) = 0.1 mM, μ = 1 M (KNO_3), Temperature = 308 K

Cx (Serine) (mol L^{-1})	$\Delta E^r_{1/2}$	$F_o[(x)]$	$F_1[x] \times 10^4$	$F_2[x] \times 10^5$	$F_3(x) \times 10^8$
0.001	0.0188	3.1334	2.1334	2.13800	2.1329
0.002	0.0353	6.3551	2.6775	1.33853	2.6924
0.003	0.0426	9.4257	2.8085	9.34725	2.1157
0.004	0.0707	15.5680	3.6420	9.09419	2.2735
0.005	0.0769	30.2500	5.8500	11.69170	2.3382
0.006	0.0829	33.8454	5.4742	9.11646	2.1519
0.007	0.0869	35.5806	4.9400	7.05096	1.0072

Cx = Isoleucine concentration mol L^{-1}; β_1 = 4.3222, β_2 = 4.4051, β_3 = 4.5051.

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