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Study of (Pb" - amino acids-imidazole) system as a tool in removal of excess lead from human blood: A polarographic approach

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ABSTRACT

The excess of Lead in the human blood is extremely dangerous for their health specially for their nervous system. We have been studied mixed ligand complexes of imidazole (Im), glycine (gly^{1-}) and alanine (ala^{1-}) with Pb (II) with make Pb soluble and exrete it thrugh urine. The stability constants of these soluble complees $[Pb(gly)(Im)]^{1+}$, and $[Pb(ala(Im)]^{1+}$ are log β_{11}=7.26, log β_{11}=7.56, respectively at pH 7.3 and 25±0.1°C. The value of stability constant is determined by polarographic method.

Key words: Polarography, mixed ligand complexes, stability constants.

INTRODUCTION

Heavy metals like Pb^{2+}, Cd^{2+}, Cu^{2+} are entering our body in several ways. If they exceed a proper limit, they prove to be harmful to the body. In the present study the object of researchers is to fidn out the possibility of excreting the redundacies of these metals by the proper use of amino acids and imidazole by means of the formation of simple and mixed soluble Pb complexes.

From the survey of literature[1-12] it appears that polarographic studies of mixed complexes of Pb (II) with Imidazole and glycine and alanine are still lacking. Keeping in view the above mentioned toxic nature of lead and its harmul effect of the health of human beings the present study has been under taking.

EXPERIMENTAL

All reagents were analytical grade and their solutions were prepared in conductivity water. The ionic strength was maintained constant at μ=1.5 M using $NaNO_3$ as supporting electrolyte. The concentration of Pb (II) was maintained at 1×10^{-3}M. $NaNO_3$ was used as supporting electrolyte and also to maintain a constant ionic strength (μ=1.5M). Triton X - 100 (2×10^{-3}%) was used as a maximum suppressor. Polarogram were obtained by means of a manual polarography (Toshniwal CL 02) in conjunction with Toshniwal polyflex galvanometer (PL 50)[13-14]. All the measurements were made at 25±0.1°C and pH 7.3. A saturated calomel electrode (S.C.E) was used as reference electrode. The d.m.e had the following characteristics (in 0.1M $NaNO_3$, open circuit): m=2.229 mg/sec, t=3.5 sec, $m^{2/3}$ $t^{1/6}$ = 2.10 $mg^{2/3}$ $sec^{-1/2}$, h_{corr}= 40cm.

The simple system of Pb (II) with imidazole (0.01-0.10 M), glycine (1.7×10^{-5}- 8.3×10^{-5} M) and alanine (1.3×10^{-5} - 6.7×10^{-5} M) were studied at different concentraions separately prior to study of mixed system. In case of mixed systems glycine and alanine concentrations was varied from 0.10M to 0.50M and that of Im was kept constant at 0.04M. The system was repeated at another concentration of Im (0.08M).

RESULTS AND DISCUSSION

The reduction of Pb (II) in imidazole, glycine and alanine was found to be reversible and diffusion controlled. The same was true for the mixed system. The slops of linear plots of log i/id-i vs $E_{d.m.e}$ were in the range 30-33 mv and the plots of id vs $h^{½}_{corr}$ were linear and passed through the origin with the addion of increasing amounts of glycine and alanine it is seen that $E_{½}$ of Pb (II) is shifted, in each case, to more negative values there was showing the formation of complexes. The plots of $E_{½}$ Vs log [gly] and log [ala] are smooth curves thereby indicating the formation of successive complexes. The composition and stability of the simple complexes have been determined by DeFord and Hume's method[15]. The results are detailed below.

System	Complexes species	Stability constants
Pb (I) - Im	$[Pb\ (Im)]^{2+}$	$\log \beta_1$=2.845
	$[Pb\ (Im)]^{2+}$	$\log \beta_2$=4.397
Pb(II) - gly^{1-}	$[Pb\ (gly)]^{1+}$	$\log \beta_1$=5.300
	$[Pb\ (gly)_2]$	$\log \beta_2$=9.748
Pb (II) - ala^{1-}	$[Pb\ (ala)]^{1+}$	$\log \beta_1$=5.180
	$[Pb\ (ala)_2]$	$\log \beta_2$=9.360

The method of Schaap and McMaster[16] was used to determine the values of the stability constants of mixed complexes. The polarographic charactertistics and $F_{ij}[XY]$ functions of mixed complexes of Pb(II) with imidazole, glycine and alanine at fixed [Im] (0.01 M and 0.08M) are presented in table 1 and 2.

Three mixed complexes in Pb(II)-glycine-imidazole system and one mixed complex in Pb(II)-alanine-imidazole system are formed. The results are detailed below.

Pb(II)-Glycine-imidazole system

[Pb(gly) (Im)]; $\log \beta_{11} = 7.26$

Pb(II)-Alanine-imidazole system

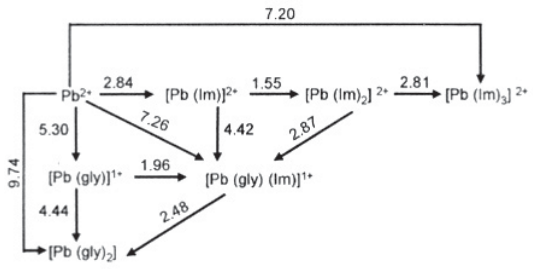
[Pb(ala) (Im)]; $\log \beta_{11} = 7.56$

The overall results of the present are summerised in the following diagrams (Scheme 1 and 2), where the numerical values shown are teh logaithms of the equilibrium constants for the reactions indicated.

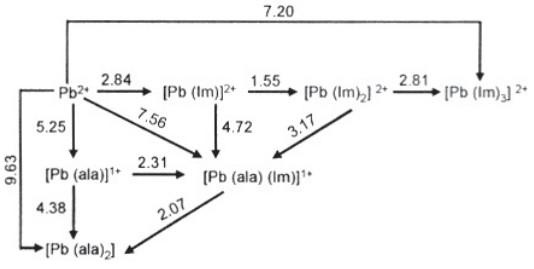
The mixing constant KM (equilibrium constant) for the reactions:

$$½[Pb(gly)_2]+½[Pb(lm)2] \rightleftharpoons [Pb(gly)\ (lm)]^{1+} \quad ..(1)$$

$$½[Pb(ala)_2]+½[Pb(lm)2] \rightleftharpoons [Pb(ala)\ (lm)]^{1+} \quad ..(2)$$



Scheme 1: Pb (II)-Glycine-imidazole system



Scheme 2: Pb (II)-Alanine-imidazole system

Table 1: Pb(II)-glycine-imidazole system $[Pb^{2+}] = 1\times10^{-3}$M, μ = 1.5M ($NaNO_3$), pH = 7.3, Temp = 25±.1°C $(E_{½})_s$ = - 0.584 Volts (S.C.E)

$[gly]_f \times10^5$ M	$-E_{½}$ V (S.C.E)	log I_m/I_c	Slope mv	F_{00} [X,Y]	F_{10}[X,Y] $\times10^{-4}$	F_{30} [X,Y] $\times10^{-9}$
			Series - I $[Im]_t$ = 0.1 M (Fixed)			
1.7	0.429	0.004879	30	8.28	-	-
3.3	0.438	0.009318	30	16.87	17.78	-
4.9	0.448	0.019340	31	37.62	54.32	5.77
6.6	0.452	0.019340	32	51.38	61.18	5.33
8.3	0.456	0.022400	32	70.66	71.87	5.52
			Series - II $[Tr]_t$ = 0.2 M (Fixed)			
1.7	0.431	0.006847	31	9.72	-	-
3.3	0.440	0.016819	30	20.06	24.42	-
4.9	0.450	0.016819	32	43.71	64.71	6.47
6.6	0.455	0.016819	33	64.53	79.59	7.05
8.3	0.459	0.198500	33	88.74	92.45	7.16
Series I:	log A = 1.04	log B = 5.41	log C = 9.74			
Series II :	log A = 1.079	log B = 5.518	log C = 9.869			

Table 2: Pb(II)-alanine-imidazole system $[Pb^{2+}] = 1\times10^{-3}$M, μ = 1.5M ($NaNO_3$), pH = 7.3, Temp = 25±.1°C $(E_{½})_s$ = - 0.584 Volts (S.C.E)

$[ala]_f \times10^5$ M	$-E_{½}$ V (S.C.E)	log I_m/I_c	Slope mv	F_{00} [X,Y]	F_{10}[X,Y] $\times10^{-4}$	F_{30} [X,Y] $\times10^{-9}$
			Series - I $[Im]_t$ = 0.1 M (Fixed)			
1.3	0.427	0.004879	30	7.08	-	-
2.7	0.437	0.011300	31	16.65	29.44	-
4.0	0.445	0.011300	31	29.24	50.60	5.15
5.4	0.449	0.022400	33	40.96	59.18	5.40
6.7	0.453	0.022400	33	55.94	70.05	5.97
			Series - II $[Tr]_t$ = 0.2 M (Fixed)			
1.3	0.429	0.005862	30	8.30	-	-
2.7	0.439	0.013300	30	18.40	31.11	-
4.0	0.448	0.013300	32	35.98	64.95	5.23
5.4	0.452	0.014800	33	50.85	75.64	5.85
6.7	0.455	0.020870	33	65.14	82.29	5.71
Series I:	log A = 0.95	log B = 5.477	log C = 9.73			
Series II :	log A = 1.00	log B = 5.64	log C = 9.76			

is given by the relation.

$\log K_M = \log \beta_{11} - ½ (\log \beta_{20} + \log \beta_{02})$

These works out to be +0.20 and 0.55 for the reactions 1 and 2 respectively. The positive values shows that the mixed complexes are more stable than simple complexes.

The equilibrium constant (log values) for the following disproportion reactions.

$2[Pb(gly)(lm)]^{1+} \rightleftharpoons [Pb(gly)_2] + [Pb(lm)_2]^{2+}$ ...(3)

$2[Pb(ala)(lm)]^{1+} \rightleftharpoons [Pb(ala)_2] + [Pb(lm)_2]^{2+}$ ...(4)

Works our to be -0.39 and -1.093 for the disproportion reactions 3 and 4 respectively. The negative log values for the equilibrium constants in show that the formation of mixed complexes is favoured over simple ones.

CONCLUSIONS

The values of stability constant shows that the soluble mixed ligand complexes of Pb (II) with triazole, glycine and alanine are stable. So triazole, glycine and alanine can from the soluble complexes with the lead present in the human blood and they can excrete it through urine.

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