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Polarographic Study Of Pb(II) - Pyrazinamide Complex.

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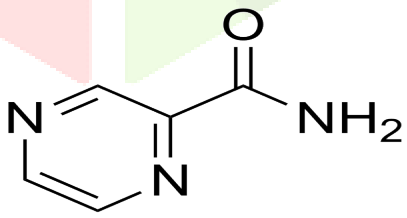
Abstract

The interaction between Pyrazinamide and Pb^{+2} was investigated using direct current polarography. Study of Pb(II) - Pyrazinamide complex carried out with different concentration of drug at two temperatures (20°C and 30°C). Complexes were formed in 1:1 ratio. Pb(II) Pyrazinamide complex shows reversible wave. So thermodynamic parameters (ΔG°, ΔH°, ΔS°) and Stability constants of complexes have been determined by Deford and Hume's method.

Keywords: Pyrazinamide, Direct current polarography, Stability constant, Thermodynamic parameters.

Introduction

Pyrazinamide (PZA) is an antimicrobial agent that is most commonly used for treatment of active tuberculosis (TB) during the initial phase of therapy (generally the first two months of treatment), in combination with other agents. Pyrazinamide is an antituberculosis agent that is structurally related to nicotinamide. The mechanism of action of pyrazinamide is unknown. Active at or below pH 5.6, pyrazinamide may be bacteriostatic or bactericidal, depending on its concentration and the susceptibility of the organism. Pyrazinamide is indicated, in combination with other antimycobacterial drugs, in the treatment of tuberculosis.[1]



Pyrazinamide Chemical Structure

Pyrazinamide is a pyrazine carboxyl amide. Pyrazinecarboxamide with a molecular formula $C_5H_5N_3O$ and molecular weight 123.11 g/mol, Melting point- 69-70 °C, Is a white, crystalline powder, stable at room temperature.

Pyrazinamide is soluble in water, chloroform, slightly soluble in ethanol and very slightly soluble in polar organic solvent.

Complexation of Pyrazinamide with Lead

Although trace metals play a dominant role in biological systems[2-4], little is known about their exact biochemical behavior and every approach may add some knowledge about the composition of the compounds to which trace metals are bound and how they act in the human body. For example, it is well known that some metal complexes of compounds with biological activity may be more reactive than the corresponding free compounds[5], so metal drug complexes are being widely studied by different techniques[6-7].

Analysis of complexes of lead with several drugs have been done such as, Complexes of lead with muscle relaxant drug theophylline have been studied by electrochemical method[8]. Polarographic studies of complexes of lead with antibiotic drug at d.m.e. have been done by Pandey *et al*[9], Pyrazinamide metal complex has been studied earlier by spectrophotometry[10-11]. However, no information is available about the electrochemical behavior of the complexes of lead with pyrazinamide.

Present study includes the complexation behavior of Pyrazinamide with metal present in human body in least amount such as Pb by direct current polarography

EXPERIMENTAL

Apparatus

A digital DC recording Polarography (CL-357) was used to record the current – voltage curves. Measurements were performed with three electrode assemblies, dropping mercury (DME) as working electrode, platinum electrode as counter electrode and a saturated calomel electrode as reference electrode. Capillary of 120 mm length and 0.05mm diameter was used. The dropping mercury electrode had the following characteristics m = 2.422 mg/sec., t = 3.5 sec./drop, h = 60 cm. Elico digital pH meter was employed to measure pH of solution. The current responses and applied potentials were recorded at scan rate100 mv/min.

Materials and Reagents

Analytical grade salts of Lead Nitrate [$PbNO_3$] of strength 2.5×10^{-2} M were used for present study. Aqueous buffers of different pH values were prepared. pH was adjusted by 0.1 M HCl and 0.1 M NaOH, 1.0 M KNO_3 was used as supporting electrolyte for $PbNO_3$. All solutions were prepared in triple distilled water. Triton X-100 (0.001%) was used to suppress polarographic maxima. The depolariser (metal) and ligand (drug) were taken in different ratio.

Procedure

Electrochemical measurement were performed in the solution (10ml) containing Pyrazinamide, Pb(II), Triton X-100(maximum suppress maxima), 1.0 M KNO_3. The solution (10ml) were purged with nitrogen for at least 15 minutes. Prior to each experiment. The polarograms were recorded in following order-pure supporting electrolyte, after Pb (II) addition and addtion of each aliquot of Pyrazinamide.

Results and Discussion

A well–defined two-electron reversible reduction and diffusion controlled wave observed in 1.0 M KNO_3. The value of $E^{1/2}$ reversible for Pb^{2+} was – 0.470 V vs. SCE. Single and well defined polarograms were obtained for complexes of Pb(II) with Pyrazinamide in the concentration range 2.5×10^{-3} to 7.6×10^{-3} at 20° C and 30° C. With successive addition of Pyrazinamide Half wave potential of Pb(II) shifts towards more negative side and diffusion current of metal (i_d) decreases, which suggests complex formation (table-1,2). The plots of log $[i/(i_d-i)]$ vs $E_{d.e.}$ were linear with lower slope values suggesting electrode reactions to be reversible.

Overall formation constant logβ of the complexes have been determined by Deford and Hume's method using polarographic measurements.

The plots of Fj (x) vs. X (where X is the concentration of Pyrazinamide are represented in Fig. (1,2). By seeing them we can say that at 20° C and 30° C the complexes of Pb(II)- Pyrazinamide are in 1:1 ratio. Value of intercept gives the value of β, where as the value of (log β) represents the stability constant. The values of Fj (x) with respect to Pyrazinamide concentration are summarized in table (1,2). From the plots of Fj (x) vs. X values of stability constants $\log\beta_1$ have been evaluated. More will be the value of stability constant more will be stability of complex. From the values of stability constants, thermodynamic parameters have also been evaluated.

Table (1)
Pb(II) - Pyrazinamide system at 20°C
$PbNO_3$ = 2.5 × 10^{-2} M,
Temp = 20°±1°C, $E_{1/2}$ (M) = -0.475 volts vs S.C.E.

$C_x \times 10^{-3}$	I_d (µA)	$\Delta E_{1/2}$ (Volt)	log(Im/Ic)	$F_0(x)$	$F_1(x) \times 10^2$
2.0	5.2	0.481	0.0398	2.8659	9.3297
2.8	4.9	0.484	0.0656	3.5679	9.1712
3.6	4.7	0.486	0.0837	4.3027	9.1742
4.4	4.5	0.489	0.1026	5.1500	9.4318
5.2	4.3	0.491	0.1224	6.0918	9.7919
6.0	4.2	0.493	0.1326	7.0639	10.1065
6.8	4.1	0.495	0.1430	8.2531	10.6663
7.6	3.9	0.497	0.1648	9.8450	11.6381

$\beta_1 = 2.996 \times 10^4$

Here
$E_{1/2}$ (M) = Half wave potential of Lead
β_1 = Overall formation constant or Overall stability constant for 1:1
Pb (II) = Pyrazinamide complexes at 20°C

Table (2)
Pb(II) - Pyrazinamide system at 30°C
$PbNO_3$ = 2.5 × 10^{-2} M,
Temp = 30°±1°C, $E_{1/2}$ (M) = -0.480 volts vs S.C.E.

$C_x \times 10^{-3}$	I_d (µA)	$\Delta E_{1/2}$ (Volt)	log(Im/Ic)	$F_0(x)$	$F_1(x) \times 10^2$
2.0	6.3	0.4827	0.0395	1.4729	2.3648
2.8	5.9	0.4846	0.0679	1.7260	2.5931
3.6	5.7	0.4864	0.0829	1.9862	2.7394
4.4	5.6	0.488	0.0906	2.2421	2.8229
5.2	5.5	0.4893	0.0984	2.4752	2.8370
6.0	5.2	0.4905	0.1228	2.7284	2.8808
6.8	5.0	0.4916	0.1398	2.9746	2.9038
7.6	4.8	0.4927	0.1576	3.2416	2.9494

Here $\beta_1 = 2.441 \times 10^4$

$E_{1/2}$ (M) = Half wave potential of Lead
β_1 = Overall formation constant or Overall stability constant for 1:1
Pb (II) = Pyrazinamide complexes at 30°C.

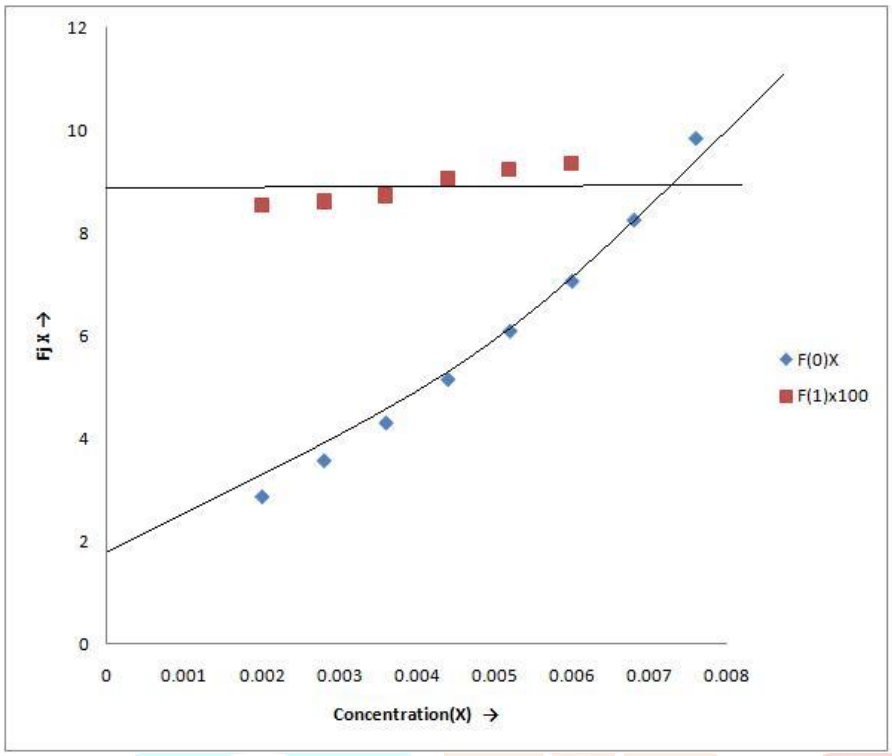


Fig. 1 - $F_j(X)$ vs. (X) for Pb^{+2}- Pyrazinamide system at $T=20^O$

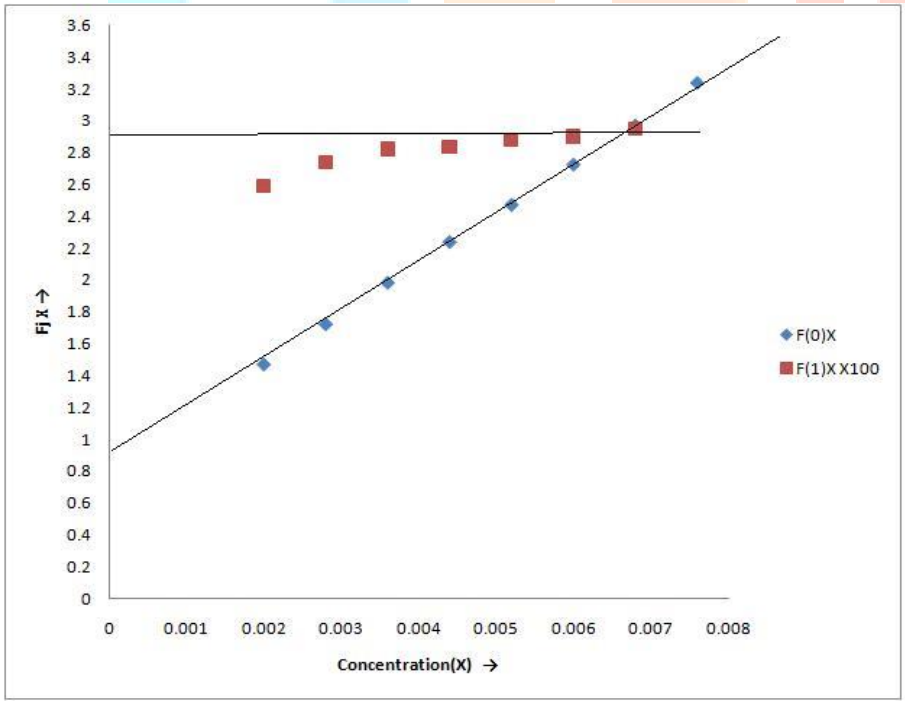


Fig. 2 - $F_j(X)$ vs. (X) for Pb^{+2}- Pyrazinamide system at $T=30^OC$

Values of stability [12]constants for 1:1 complexes are 2.9962 and 2.4411 at 20° C and 30° C respectively. This shows that stability of complexes decrease with increase in temperature table-(3)

Table (3)

Stability constant for Pb (II) - Pyrazinamide

System	Composition of complex	Stability constants	
		20°C	30°C
$[Pb(Pyrazinamide)]^{2+}$	1:1	2.9962	2.4411

Thermodynamic parameters

The kind of complex species that reduces on a mecury electrode depends on thermodynamic parameters[13] such as free energy change (ΔG), enthalpy change (ΔH) and entropy change (ΔS) have been calculated using the following equations and listed in table (4).

$$\Delta G = -\ 2.303RT \log \beta \qquad (1)$$

$$\Delta H = -\frac{2.303RT_1T_2\left[\log\frac{\beta_{T_1}}{\beta_{T_2}}\right]}{T_2 - T_1} \qquad (2)$$

$$\Delta G = \Delta H - T\Delta S \qquad (3)$$

Positive value of (ΔG), suggests non spontaneous nature of electrode process and negative value of (ΔG), suggests spontaneous nature of electrode process. Similarly positive value of (ΔS) suggests that formation of activated state is accompanied by increase of entropy. The (ΔH) values are negative, meaning that these processes are exothermic.

Table (4)

Thermodynamic parameters for Pb (II) - Pyrazinamide at 20°C

System	Composition of complex	Thermodynamic parameters		
		ΔG° Kcal/mole	ΔH° Kcal/mole	ΔS° Cal/degree/mole
$[Pb(Pyrazinamide)]^{2+}$	1:1	-16.8092	15.1242	5.7508

Reference

1. Y. Zhang , W. Shi ,W.Zhang , D. Mitchison, Mechanisms of Pyrazinamide Action and Resistance, *Microbiol Spectr*., 2(4), 1-12 , **2013**.
2. M.J. Kendrik, M.T.Ay, M.J. Olishka, K.D. Robinson, Metals in Biological Systems, *Ellis Horwood Chichester, **1992***.
3. J.J.R. Frausto da Silva, R.J.P. Williams, The Biological Chemistry of the Elements, *The Inorganic Chemistry of Life, Claredon, Oxonia*, **1991**.
4. R. Cornelis, F. Borguet, J. De Kimpe, *Anal. Chimica Acta*, 283(1), 183-189,**1993**.
5. A. J. Thomson, R.P.J. Williams, S.Reslova, *Structure and Bonding*, 11, 1-46,**1972**.
6. X. Chu , G. Shen , J. Jiang , R.Yu , *Anal. Lett.*, 32, **1999.**
7. S.C.Wallis , B.G.Charles , L.R. Gahan,L.J. Fillipich , M.G. Bredhauer , P.A. Duck Worth , *J. Pharm. Sci*., 85(8), 803-809, **1996.**
8. Y. Kumar, O.P. Meena, M.Singh , R.S.Pandey, *Int. Chem Tech Res*., 2(4), 1907-1917, **2010.**
9. Sharda, R.S. Pandey, *Int. Chem Tech Res*., 3(4), 2033-2039, **2011.**
10. P.Budhani, S.A.Iqbal, S.Malik, M. Bhattacharya, L.Mitu, *J. Saudi Chemical Soc*., 14(3), 281-285, **2010**.
11. S. Akyuz , *J. Mol.Struct*., 651–653, 541–545, **2003.**
12. J. Francis, C. *Rossotti*, H. *Rossotti*, The Determination of Stability Constants., *Mcgraw-hill*, ***1961.***
13. B.L. Lewis, G.W. Luther, H. Lane, T.M. Church, *J. Electroana*., 7(2), 166-177, **1995**.