Thermodynamic study of complex formation between substituted heterocyclic drug with Fe(II) between 303-318K at 0.1M ionic strength.

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Abstract:
The determination of stability constant of Acarbose complexes with Fe(II) metal ions in temperature range 303-318 K at constant ionic strength 0.1M.in 20% ethanol-water mixture by adopting pH metric technique been studied. The thermodynamic parameters (ΔG,ΔH and ΔS) were calculated from values of stability constant at different temperatures. The formations of metal complexes were found to be spontaneous and exothermic nature.

Key word: Stability constant, Thermodynamic parameters ,ionic strength, pH-metric.

Introduction

Acarbose is used as antidiabeticdrug [1]. Acarbose is effective, safe and well tolerated in a large cohort of Asian patients with type 2 diabetes[2]. Bansode[3] studied the thermodynamic parameters of trifluoperazine-metal complexes . A. Nezhadali[4] et al did the thermodynamic study of complex formation between 3,5-di iodo-hydroxy quinoline and Zn^{2+}, Ni^{2+} and Co^{2+} cationsin some binary solvents using a conductometric method Parihar et.al. has been studied the stability constant and thermodynamic parameters of Cadmium complexes sulfonamides and Cephapirin at 0.1M ionic strength [5]. The stability constant andthermodynamic parameters such as Gibb's free energy, Enthalpy change and Entropy change forcomplex formation of transition metal complexes derived from 3-methyl-1 phenyl and 1, 3-diphenyl-4-aryllazo-5-pyrazolines were determined by adopting potentiometric technique [6].Vyas et. al. have been studied proton-ligand stability constant and metal-ligand stability constantof rare earths metal complexes of hydroxyl benzoic acid by pH-metric titration technique . Theystudied the stability constant at different temperatures and determined the thermodynamic parameters. The observed value of thermodynamic parameters favours the complex formation [7].Sharma [8] et. al. have been investigated the □ G, □□ H and □ S of complex formation of La(III),Ce(III), Pr(III) and Nd(III) with amino pyridines at different temperature and also different solvent systems. Jain [9] et. al. have been studied the chelates of O-(N-α-oxindolimino)benzoic acid and O-(N-α-oxindolimino) propanoic acid. They studied the stability constant and thermodynamic parameters of complexes of Lanthanum (III).Sarin [10] et. al. have been investigated thermodynamic stability constant and parameters of complexes in the presence of 0.1N NaCl in the temperature range 25- 450C by Irving Rossotti method. Anita Gupta[11] have been studef the thermodynamic parameters of of A Semi-synthetic Derivative with Various Bivalent Metal ions.

After review of literature survey, the detail study of complex under identical set of experimental Condition is still lacking. It was thought of interest to study the effect of temperature on thermodynamic parameters of complexes of Acarbose with Fe(II) in 20% ethanol at constant ionic strength (0.1M) by pH metrically.

Material and method:

The pH measurements were carried out with equip-tronic EQ-610 pH meter (accuracy ± 0.01units) using combine glass electrode at Temperature range from 303 K -318K. Metal ion solution was prepared in triply distill water and concentration was estimated by standard method. The solution of drug was prepared in 20% ethanol.The pH metric reading in 20% ethanol were converted to [H+] value by applying the correction proposed by Van Uitert Haas.The overall ionic strength of solution was constant maintains by adding NaCl. All the solutions were titrated with standard carbonate free NaOH (0.2N) solution at constant ionic strength (0.1M). The titration was carried out in double wall glass jacketed titration cell connect to the constant temperature circulating bath.

The enthalpy change and Entropy change for complex formation were calculated by using Gibb's Helmoltz equations and other standard relations.

$$\Delta G = -2.303\ RT \log_{10} K = \Delta H - T\Delta S \text{ ----------(1)}$$

By rearrangement, we get,

$$\log_{10} K = -\Delta H / (2.303\ RT) + \Delta S / (2.303\ R) \text{ ----------}$$

Where R- universal gas constant, T-absolute temperature and $\log_{10}K$- stability constant of the complex. Enthalpy of complex formation (ΔH) and Entropy of complex formation (ΔS) were calculated by plotting $\log_{10}K$ verses 1/T. We can specify the quantitative dependence of the stability constant on temperature from the relation[12]. An entropy change also plays an important role in complex stability.

Equation (2) is linear equation of the form Y= mX + C,

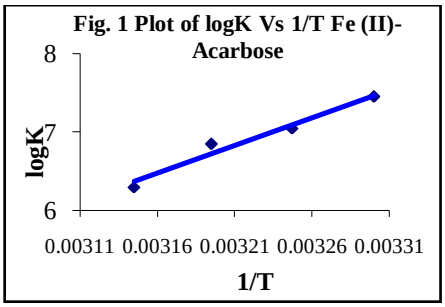
Where $Y= \log_{10}K$, m = Slope = $-\Delta H / (2.303\ R)$, X = 1/T

C = intercept = $\Delta S / (2.303\ R)$.

RESULTS AND DISCUSSION:

Table-1 Thermodynamic parameters and stability constant of Fe (II)-Acarbose complexes at 0.1M ionic strength in 20% ethanol at different temperature.

Temp.(K)	pK	$logK_1$	$logK_2$	$-\Delta G$ (J/Mol.)	$-\Delta H$ (J/Mol.)	ΔS (J/Mol.)
303	7.2735	7.45	4.65	43221.80	134949.06	302.33
308	7.0679	7.05	4.50	41576.10		
313	6.8561	6.85	4.29	41052.43		
318	6.6383	6.30	3.70	38359.38		



The proton-ligand stability constants values decreases with increase in temperature for all systems. This suggested that liberation of protons becomes easier at higher temperature .The liberation of proton is easier due to the presence of –OH group at metal and para position. The values of metal-ligand stability constant decreases with increase in temperature. This suggests that the complex formation is exothermic and favorable at lower temperature. The negative values of ΔH and –ΔG of complex formation indicates the complex formation process is spontaneous [13].The all values of entropy change are positive indicating that the disorder of system increases more rapidly than the increase in the order taking place in complexation[13]. The values of ΔH and ΔS are very large and are mainly responsible for complex formation.

Conclusion:

The complexation of substituted heterocyclic drug with Fe (II) is thermodynamically spontaneous and exothermic process. Because ΔG and ΔH is negative and ΔS is positive which indicates the spontaneity of reaction according to thermodynamic.

References

1. *Naomi Kresge (21 November 2011). "China's Thirst for New Diabetes Drugs Threatens Bayer's Lead". Bloomberg Business Week. Archived from the original on 21 November 2011*. Retrieved *15 April* 2016.
2. A Multinational, Observational Study to Investigate the Efficacy, Safety and Tolerability of Acarbose as Add-On or Monotherapy in a Range of Patients: The GlucoVIP Study.
3. Tanaji N. Bansode, *Der Pharma Chemica*, 2015, 7(6):59-63.
4. A. Nezhadali , Gh. Taslimi ., Alexandria Engineering Journal (2013) 52, 797–800
5. M.S. Parihar and F. Khan, *Eclet Quim*, 2008, Vol.33 (1), 1-9.
6. Samir A. Abdel-Latif, Saber E. Mansour and Abdulrahman A. Fatouh,*Natural Sci*., 2010,2(8) ,793-802.
7. Alok Vyas and R.P. Mathur, *J. Rare Earths*, 2009, 27(3), 457-460.
8. Sangeeta Sharma, M.C. Shah, Dipika Dalwadi, Falguni Thakkar and J.J. Vora, *Res. J. Chem . Env.* , 2008, 12(4), 29-34.
9. Lata Jain, Suresh Jangid, Hanwant singh and R.K. Mehta, *J. Ind.Inst. Sci*., 1992, 72, 495-499.
10. R. Sarin and K.N. Munshi, *J. Inorg. Nuc. Chem*., 1972, Vol.34 (2), 581-590.
11. Anita Gupta1, *International Research Journal of Pure & Applied Chemistry* , 2013, 3(4): 441-448.
12. S. A. Abdel-Latif, S. E. Mansour, A. Rahman and A. Fatouh, *Nat. Sci.* , Vol.**2(8)** :793 (2010).
13. Ramandeep Kaur and B.S. Sekhon, *J. Ind. Chem.Soc*., **2006,** 83,645