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Potentiometric Study of Nicotinic acid (VitB_3) Complexes with Transition Metal ions.

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ABSTRACT

The stability constants of Nicotinic acid (vitamin B_3) complexes with transition metal ions V(II), Cr(II), Fe(III), Co(II), Ni(II), Cu(II) & Zn(II) were determined pH metrically for various ionic strengths 0.1M, 0.3M & 0.6M $NaClO_4$. The temperature of 298K maintained as constant. The stability constants of Nicotinic acid (vitamin B_3) and transition metals i. e. pK_1 and $logK_1$ have been calculated and studied.

KEYWORDS

Nicotinic acid, stability constants, binary complexes, transition metals.

1. INTRODUCTION

Nicotinic Acid is a water-soluble vitamin. It exists in two forms as nicotinic acid and nicotinamide. It does not have pharmacolic action of the acid that is administered at high doses to lower blood lipids, but it exists within the redox-active coenzymes nicotinamide adenine dinucleotide (NAD) and its phosphate (NADP) which function dehydrogenase-reductase system requiring the transfer of hydride ion [1-2]. NAD is also required for non-redox adenosin diphophate - ribose transfer reactions involved in DNA repair and calcium mobilization [3]. NADP functions in reductive biosynthesis such as fatty acid, steroid synthesis, and in the oxidation of glucose 6 phosphate to ribose-5 phosphate. Source of vitamin B_3 is liver, fish, yeast and cereal grains. Its dietary deficiency causes chronic wasting disease pellagra [4]. Its chemical formula is $C_6 H_5 N0_2$. Its Mol. wt. is 123.11.

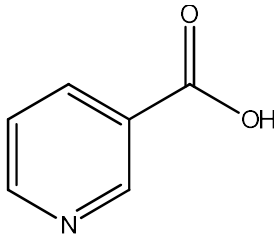

Fig. 1. Structure of Nicotinic acid.

Complexes of transition metals, the formation of a coordination bond can be considered as a transfer of a lone electron pair from the coordinated group or ligand to the metal ion[**5]**. The Literature survey reveals that no work has been reported on the complex formation of vitamin B_3 with transition metal ions in an aqueous medium. Therefore to understand the complex formation behavior of vitamin B_3 at different ionic strength i.e. 0.1M, 0.3M and 0.6M $NaClO_4$ at constant temperature i.e. 298K (25^0C) is studied.

2. MATERIALS AND METHODS

All chemicals used were of A. R. grade. Ligand sample of nicotinic acid was obtained in pure form. $NaClO_4$ solution was prepared in carbon dioxide-free double distilled water. Metal ions were used in the nitrate form (S.D.fine chem.) The sodium hydroxide 0.1M was standardized against oxalic acid. The ionic strength was maintained at 0.1M, 0.3M and 0.6M by using $NaClO_4$ (B.D.H.).

The ligand solution and acid solution were transferred into 100 ml beaker and titrated against NaOH solution. The titration was performed first without the addition of metal and then in its presence.

The potentiometric titrations are performed by using an Elico model LI-120 digital pH meter in conjuction with an Elico combined glass electrode consisting of glass and reference electrode. The combined glass electrode was activated by immersing 24 hours in 0.1 N hydrochloric acid and then 12 hours immersed in glass distilled water. The precautions suggested by Bates [6],

Albert and Sergent[**7]** were adopted for smooth handling of the electrode. The combined glass electrode was connected to the pH meter. By adopting the standard procedure, all titrations were carried out under inert atmosphere by bubbling oxygen-free nitrogen gas through an assembly. The buffer solution having the pH ranges 4.00 and 9.18 were used for the standardization of pH meter before and after each titration. The ligand solution of ascorbic acid was prepared in aqueous medium which was used for further titrations i.e. without and with the transition metals V(II), Cr(II), Fe(III), Co(II), Ni(II), Cu(II), and Zn(II) maintaining ionic strength 0.1M, 0.3M and 0.6M $NaClO_4$ at constant temperature.

Table 1. Proton ligand stability constants of Nicotinic acid (vitamin B_3) at different ionic strengths.

Medium -Water	Temperature- 298K		
Proton Ligand stability constants	**Ionic Strengths**		
	0.1	**0.3**	**0.6**
pK_1	4.65	4.41	3.17

Table 2. Metal ligand stability constants of Nicotinic acid (vitamin B_3) different ionic strengths.

	Metal Ligand stability constants	**Ionic strengths**		
Transition Metals		**0.1**	**0.3**	**0.6**
V(II)	$logK_1$	4.80	4.79	3.17
Cr(II)	$logK_1$	4.44	4.33	3.17
Fe(III)	$logK_1$	4.55	4.53	4.13
Co(II)	$logK_1$	4.86	4.62	4.43
Ni(II)	$logK_1$	3.67	3.53	3.48
Cu(II)	$logK_1$	3.74	3.21	3.01
Zn(II)	$logK_1$	3.72	2.83	2.69

3. RESULTS AND DISCUSSION

The proton ligand and metal-ligand stability constant of Nicotinic acid with transition metal ions V^{++}, Cr^{++}, Fe^{+++}, Co^{++}, Ni^{++}, Cu^{++}, Zn^{++} at ionic strengths 0.1M, 0.3M and 0.6M $NaClO_4$ in aqueous medium is given in table 1 and 2 .The temperature was maintained by constant i. e. 298K. In Nicotinic acid one pK value is obtained. This is attributed to the dissociation of one enolic-OH group. The first pK values are 4.65 which is decreases as ionic strength increase from 0.1M, 0.3M to 0.6 M

This decrease in pK values is according to Debye-Huckel theory the –COOH and –OH group decreases the pK value by increasing the ionic strength.

In the case of metal-ligand stability constants as ionic strength increases metal-ligand stability constant decreases.

The order of stability constant of Nicotinic acid for 0.1M $NaClO_4$ is

Co>V>Fe>Cr > Cu > Zn > Ni
For 0.3M $NaClO_4$ is
V>Co>Fe> Cr>Ni > Cu > Zn
For 0.6M $NaClO_4$ is
Co > Fe >Ni > V, Cr >Cu > Zn
All the above order of stabilities of the metal complexes with all the ligands show good agreement with the stability order shown by workers [8-9] and others [10-11].

4. CONCLUSION

In the present work pH metric study was performed to determine stability constants and to asses binary species for nicotinic acid with transition metals in aqueous medium pH range 2.00 to 6.45. The following conclusions have been drawn.

- **a)** Nicotinic acid forms complexes with transition metal ions in the pH range 2.00 to 6.45
- **b)** The one pK values of nicotinic acid are due to the presence of the enolic group in it. The order of pK values in varying ionic strength is 0.1M > 0.3M > 0.6M.
- **c)** The order for logK values for transition metals are 0.1M > 0.3M > 0.6M.

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