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pH-METRIC STUDY OF TERNARY COMPLEXES OF Co (II) WITH AMINO ACIDS IN AQUA-ORGANIC SOLVENTS

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ABSTRACT

pH-metric determination has been used for the simultaneous equilibrium of cobalt (II) with picolinic acid, L-serine and L-threonine. Picolinic acid has been used as a primary ligand where as L-serine and L-threonine as secondary ligands in ternary complexes. Ionic strength was maintained i. e. 1.0 m $NaClO_4$ and complex formation was seen on the basis of the equilibrium curve in aqua–organic media. pH-metry is most widely used method for calculation of stability constants. The results are computed using software program SCOGS.

Key words : pH-Metric studies, Stability constants, Amino acids, Chelation.

INTRODUCTION

The present work provides a systematic solution study of the complex formation of cobalt with amino acid.

Metals form complexes with different ligands. There are a large number of chelating agents, but the donor atom, which coordinate with the metal ions is very few. Common donor atoms are nitrogen, oxygen and sulphur.

Present trend of studying solution equilibria gives information about the metal ligand bond. Stability constants of various binary and ternary complexes of amino acids with metals in aqua-organic medium are known. Metal ions play an important role in the formation of stable complexes and it is of interest to the analytical chemists.

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Amino acid provides –COOH and $–NH_2$ Coordination site and shows the formation of binary and ternary complexes depending upon the basicity of ligands. Substitution may prevent purely due to the steric effect [1-3].

Calvin and Wilson[4] observed that resonance affects the formation and stability of a chelate. Khobragade and Narwade[5] have investigated the metal ligand stability constants of UO_2(II) and Cu(II) complexes with some substituted sulphonic acids. The chelating properties of some substituted isoxazoline with Co (II) ions were reported by Pradip et al.[6] Reddy et al.[7] observed the formation of Co (II) and Ni (II) chelates with amino acids and substituted pyrimidines.

pH-metric studies of mixed-ligand complexes of sulphur containing ligand and amino acids with transition elements were reported by Zine[8]. The stability constants of metal complexes were determined pH-metrically in aqua–organic medium at 1.0M $NaClO_4$ by the technique as reported by Irving-Rossotti[9]. The mixed ligand titration curve MXY involved simultaneous equilibrium.

Present study deals with pH-metric study of Co (II) complex with picolinic acid, L-serine and L-threonine in aqua-organic medium.

EXPERIMENTAL

The ligands i.e. picolinic acid, L-serine, L-threonine and metal Co (II), were of analytical grade and obtained from SD fine Chemicals. Sodium hydroxide, sodium perchlorate and perchloric acid of Anala R-grade. All the solutions were prepared in glass. Distilled water and the alcohol was also distilled again. The pH-measurements were carried out by LI-612 ELICO INDIA pH-meter (accuracy 0.01 unit).

All the titrations in present work were carried out in an inert atmosphere, which was obtained by bubbling oxygen free nitrogen gas. It also worked for proper stirring of solutions.

RESULTS AND DISCUSSION

Cobalt corrinoid appeared to have been functionally important even before DNA and therefore, it can be said that cobalt had played key role in the process evolution[10]. The present study has great importance as the formation constants of amino acid complexes are

important in many biological processes[11]. Amino acids are the organic compounds in which $–NH_2$ and –COOH groups are present, which played key role in the stability of complexes.

The pH-metric tritration were carried out keeping 1 : 5 metal to ligand ratio. The protonation constants and metal ligand stability constants are given in Tables. In the case of threonine - $Co^{+2.}$ system, the stability constant of metal ion with amino acid obey lrving-William[12, 13] order. The stability constants of various complexes are given here –

Table 1 : Protonation constants of ligands

Ligands	Aqua-organic medium	
	log K_1^H	**log K_2^H**
Picolinic acid	4.8950	----
L-Serine	7.1685	8.1863
L-threonine	----	7.977

Table 2: Metal-ligand stability constants

Metal ion	Picolinic acid	L-serine	L. threonine
Co(II)	3.966	6.721	4.719

The metal ligand stability constants of various ligands with metal ions were obtained by taking 1 : 5 : 5 ratio at (25 ± 0.5ºC) and ionic strength maintained at 1M $NaClO_4$ in aqua-organic media.

The ligand complexation of Co (II) with picolinic acid as primary ligand and other amino acid as a secondary ligand was also studied. The results are shown in Table 3.

Table 3 : Stability constant of mixed-ligand complexes

Metal ions	Mixed-ligand system	log K_{MXY}	Δ log k
Co (II)	PA+L-Serine	6.0316	2.1651
	P. A+L-Threonine	7.1266	0.9166

Zine[14] reported that ternary complexes of Co (II) with amino acids show positive

log K values, which gives them extra stability.

The present work show stability constants for mixed ligand complexes are in the range of 6.00 to 8.00 (positive) and confirmed the complexation between the metal and amino acids.

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