

Interaction of tryptophane and phenylaline with mercury and tungsten ferrocyanides and its implications in chemical evolution and origins of life

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Abstract

Adsorption of two naturally occurring alpha-amino acids tryptophane and phenylalanine on the surface of mercury and tungsten ferrocyanides was studied at neutral pH (7.0 ± 0.01) and at room temperature $30 \pm 1^\circ \text{C}$. The progress of adsorption was followed spectrophotometrically by measuring the absorbance of tryptophane and phenylalanine at their corresponding λ_{max} . The interaction followed the Langmuir type of adsorption in general. The tryptophane was found to have greater affinity for mercury and tungsten ferrocyanides than the phenylalanine. Present study suggests the significance of metal cyanogens complexes and metal ions in condensation and stabilization of aromatic α -amino acids during process of chemical evolution and origin of life on primitive earth.

1. Introduction

Beck[1] has suggested that CN^- could easily have formed some soluble and insoluble complexes with the transition metal ions which were abundant in the primeval sea. The insoluble cyanogen complexes such as metal hexacyanoferrate(II) complexes could have settled at the bottom of the sea or sea shore and might have catalyzed number of reactions during the course of chemical evolution. Metal ferrocyanides also acted as adsorbents[2] and photosensitizers[3]. A search of literature indicated very few studies on interaction of amino acids[4] with metal ferrocyanides in view of this present work described as the study of Interaction of Tryptophane and Phenylalanine with Mercury and Tungsten Ferrocyanides.

1.1 Experimental Section

All chemicals used were of AnalaR grade. Mercury and tungsten ferrocyanides were prepared according to methods reported by Kourim[5] and Kraus[6] et al. Synthesized metal ferrocyanides were characterized by elemental and spectral studies mercury ferrocyanide percentage ($\text{Hg} = 54.90$; $\text{Fe} = 10.50$; $\text{C} = 14.0$; $\text{H} = 0.60$; $\text{N} = 14.35$) Tungsten ferrocyanide percentage ($\text{W} = 52.71$; $\text{Fe} = 7.27$; $\text{C} = 9.31$; $\text{H} = 1.67$; $\text{N} = 12.07$). The infrared spectral data for mercury and tungsten ferrocyanides are given in the Table. Effects of pH concentration and salts for the adsorption of phenylalanine and tryptophane on mercury and tungsten ferrocyanides were studied.

2. Results and discussions

The maximum uptake of phenylalanine and tryptophane was found at neutral pH. The percentage uptake of tryptophane was found to be higher than phenylalanine for both metal ferrocyanides studied.

difference in absorbance of amino acids
before and after adsorption

$$\% \text{ uptake} = \frac{\text{difference in absorbance of amino acids before and after adsorption}}{\text{Absorbance of amino acid before Adsorption}} \times 100$$

The interaction follows general Langmuir equation given in Equation Section. The maximum uptake of amino acids on metal ferrocyanides follow order: $\text{HgFc} > \text{WFc}$ similar order but higher uptake of amino acids on metal ferrocyanides were observed in the presence of salts.

3. Tables

IR data for Mercury and tungsten ferrocyanides.

MFC	Adsorption frequency (cm ⁻¹)				
	H ₂ O molecules / OH group	HOH bending	C N stretching	Fe-C	Metal -N degree of polymerization
WFC	3510	1600	2000	620	490
HgFc	3600	1620	2000	600	490

MFC = Metal ferrocyanide

WFC = Tungsten ferrocyanide

HgFc = Mercury ferrocyanide

4. Equations

$$1/q_{eq} = (1/Q_0) + (1/C_{eq}) (1/bQ_0) \quad (1)$$

Where Q_0 and b are Langmuir constants. C_{eq} = equilibrium concentration of amino acids; Q_{eq} = amount (mg) of adsorbate adsorbed per gram of adsorbent. .

5. Summary and Conclusions

Interaction of phenylalanine and tryptophane with mercury and tungsten ferrocyanides was studied at room temperature and neutral pH range. The concentration of amino acids was determined spectrophotometrically by measuring their absorbance at their corresponding λ_{max} . The α -amino acids interaction with both metal ferrocyanides follow the order tryptophane > phenylalanine. Salts effect studies suggested that the adsorption occurs due to the interaction of amino acids molecules with metal ions present in the outer layer lattice of metal ferrocyanides. During course of chemical evolution insoluble metal cyanogen complexes are thought to have concentrated biomonomers from dilute prebiotic soup and facilitated a class of prebiotic reactions.

Acknowledgements

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