An Electrochemical Study of L-3,4-dihydroxyphenylalanine (L-dopa)

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**An Electrochemical Study of L-3,4-dihydroxyphenylalanine (L-DOPA)**

Rachel Van Atta

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**Objective:** Understand electrochemistry of L-DOPA to have insight into electrochemistry of proteins isolated from blue mussel (*Mytilus edulis*).

**Introduction**

**Blue Mussels**
- Secrete adhesive structures composed of proteins containing L-DOPA
- Adhesive structures contain metal ions
- Ability to complex metal ions allows for attachment to substrates
- L-DOPA is a novel amino acid having a catecholic functional group

**Catechols**
- Catechol is 1,2-dihydroxybenzene
- Metal-ligand coordination plays a critical role in adhesive structure formation and adhesion
- Coordination between Iron (Fe) and catechol ligands is correlated to high extensibility of mussel byssal threads
- When a catechol coordinates with Iron, it forms a metal-catechol complex
- The stoichiometry of Fe³⁺-catechol complexes (mono-, bis-, or tris-) is controlled by pH
- A mono- complex is formed at an acidic pH, a bis- complex at a neutral pH, and a tris- complex at an alkaline pH

**Methodology**

**CV Scans**
- 10mL cell with platinum working electrode
- Silver silver chloride reference electrode

**Spectroscopy**
- Measured absorbances
  - pH=4.5 λmax 650 nm
  - pH=7.2 λmax 545 nm
  - pH=10.2 λmax 503 nm

**Results**

**Cyclic Voltammetry**
- 99ppm L-DOPA / 30ppm Fe = 3.3
  - 3.3/197.2 g/mol L-DOPA * 55.85 g/mol Fe = 0.9:1
  - 0.9:1 is ~ 1 L-DOPA to 1 Iron
- pH= 7.2
  - 198ppm L-DOPA/ 30ppm Fe = 6.6
  - 6.6/197.2 g/mol L-DOPA * 55.85 g/mol Fe = 1.9:1
  - 1.9:1 is ~ 2 L-DOPA to 1 Iron

**Spectroscopy**
- pH=4.5
  - 137.9 ppm L-DOPA / 30 ppm Fe= 4.6
  - 4.6/ 197.2 g/mol L-DOPA * 55.85 g/mol Fe=1.3:1
  - 1.3 L-DOPA to 1 Iron
- pH=7.2
  - 238.59 ppm L-DOPA / 30 ppm Fe= 8.0
  - 8.0/ 197.2 g/mol L-DOPA * 55.85 g/mol Fe= 2.3:1
  - 2.3 L-DOPA to 1 Iron

**Conclusions**

- Fe³⁺/L-DOPA complex stoichiometric at pH= 4.5 and 7.2
- Fe³⁺ is more strongly complexed in L-DOPA at pH=7.2
- Absorbance plot shape implies a larger Kₐ at pH=7.2

**References:**