

## Short Communication

# Interaction of metal ions with pyrimidines

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### Abstract

The stability constants of pyrimidine bases, viz., cytosine, thymine and uracil with Co(II) and Cd(II) have been determined by paper electrophoresis. Log K values have been found respectively to be 4.95, 3.20 and 3.72, 2.10 for Co(II) and Cd(II)-Cytosine systems; 4.52, 3.33 and 3.41, 2.12 for Co(II), Cd(II)-Thymine systems and 4.22, 3.10 and 3.21, 2.00 for Co(II), Cd(II)-Uracil system at  $\mu = 0.1$  and temp.  $35 \pm 0.1^\circ\text{C}$ .

**Key words:** Paper electrophoresis, stability constants, cytosine, thymine, uracil, cobalt (II), cadmium (II).

### 1. Introduction

Metal-complexes of pyrimidine bases play a dominant role in many biological systems<sup>1</sup>. As the part of our programme to investigate the interaction of purines and pyrimidines with metal ions, it was considered worthwhile to study the metal chelates of cytosine, thymine and uracil to gain an insight into the nature and type of metal complexes that these bases form. This study was undertaken employing 'Paper Electrophoretic (PE) technique' developed in this laboratory<sup>2-4</sup>. The electrophoretic technique usually suffers from a number of defects<sup>5-6</sup> as a result affecting parameters like temperature during electrophoresis, capillary flow on the paper, electroosmosis adsorption and molecular sieving affect the mobility of charged moieties. The technique developed in our laboratory is, however, almost free from these vitiating factors.

### 2. Experimental

**Apparatus:** Electrophoresis equipment (Systronics model, 604, India) has been used. The details of the PE units and pH meter have already been reported<sup>2-4</sup>.

**Chemicals:** Suitable concentrations of stock solutions of Co(II) and Cd(II) perchlorates were prepared so as to keep the concentration at  $5.0 \times 10^{-3}$  M in the system<sup>7</sup>. The background electrolyte in the study of binary complexes consists of 0.1M perchloric acid and  $1.0 \times 10^{-2}$ M cytosine/thymine/uracil. Rest of the details are as reported in our earlier publication<sup>7</sup>.

### 3. Procedure

The details of procedure employed have already been reported<sup>7</sup>.

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#### 4. Result and discussion

The plot of overall electrophoretic mobility of metal spot against pH gives a curve with a number of plateaus as shown in fig. 1 where a plateau is an indication of a pH range having speed practically constant. This is possible only when a particular complex is overwhelmingly formed. Thus every plateau indicates formation of a certain complex species. The first one in the beginning and lying in the low pH region where concentration of protonated species of cytosine and neutral species of thymine and uracil is maximum, hence corresponds to the non-complexing nature of ligand in these species. Beyond this range, the figure reveals that a second plateau in each case with positive mobility indicates the formation of a 1:1 complex of cationic nature. Further increase of pH gives rise to a third plateau with zero mobility in each case which indicates formation of electrically-neutral metal complex. This is possible only when two anionic species of pyrimidines  $L^-$  combines with one bivalent metal ion and, in fact, is in agreement with the reported findings<sup>8-10</sup>. The equation<sup>2-4</sup>

$$U = \frac{u_0 + u_1 K_1 [L^-] + u_2 K_1 K_2 [L^-]^2}{1 + K_1 [L^-] + K_1 K_2 [L^-]^2}$$

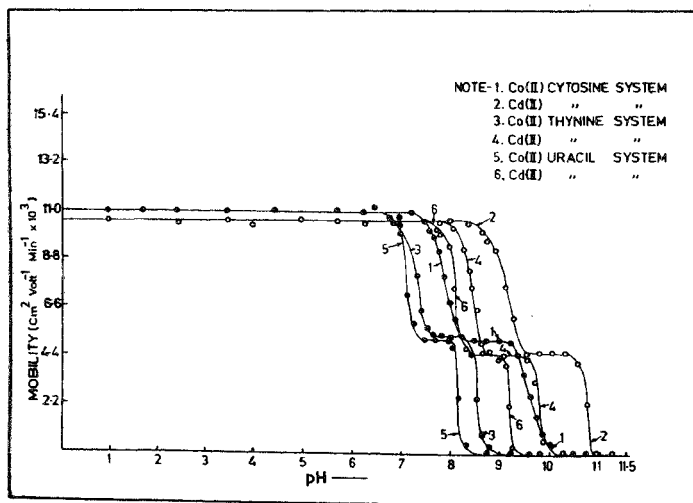


FIG. 1. Mobility curve M(II) pyrimidine system (Temp. 35°C; Ionic strength: 0.1).

has been used for calculating stability constants of the complexes of metal ions with ligand anions. With the help of dissociation constants of these ligands<sup>11</sup>, the concentration of complexing anion  $L^-$  is determined (Table I).

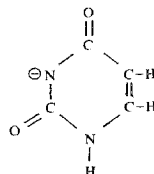
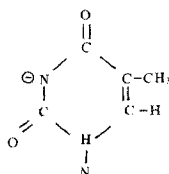
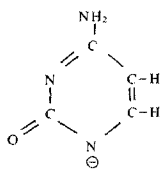
**Table I**  
**Stability constants of binary complexes of Cd(II) and Co(II)**

Ionic strength = 0.1  
Temperature =  $35 \pm 0.1^\circ\text{C}$

Cytosine anion  $L^-$

Thymine anion  $L^-$

Uracil anion  $L^-$



Metal ion	M(II) Cytosine		M(II) Thymine		M(II) Uracil	
	$\log K_{1M1_2}^M$	$\log K_{2M1_2}^{ML}$	$\log K_{1M1_1}^M$	$\log K_{2M1_2}^{ML}$	$\log K_{1M1}^M$	$\log K_{2M1_2}^{ML}$
<i>Experimental values of stability constants</i>						
Co(II)	4.95	3.20	4.52	3.33	4.22	3.10
Cd(II)	3.72	2.10	3.41	3.12	3.21	2.00
<i>Literature values of stability constants*</i>						
Co(II)	2.8 <sup>10</sup>	-	3.7 <sup>10</sup>	---	3.2 <sup>10</sup>	---
	2.4 <sup>18</sup>	3.11 <sup>18</sup>	4.17 <sup>19</sup>	3.70 <sup>19</sup>	---	---

\* No literature is available for Cd(II) complexes with these ligands. The table depicts different complexing species of the bases whose structures are well substantiated in literature<sup>12-16</sup>

A comparison of stability constants of Co(II) and Cd(II) with these pyrimidine bases shows that Co(II) form stronger complexes than that of Cd(II). This gradation in stabilities of the complexes of Co(II) and Cd(II) are self-explanatory in view of Irving-William Rule<sup>17</sup>. Further, from the point of view of stability constants, pyrimidine bases show following order: Cytosine > Thymine > Uracil. This order of complexing capacities is according to the order of their basicity.

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