

## Study of Stability Constant of Transition Metal Complexes with 7-Hydroxy Flavones

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### Abstract

*A series of 7-hydroxy flavones are synthesized. Their chelating tendencies towards Cr(II), Cu(II), Ni(II), Co(II) and Zn(II) metal ions are investigated potentiometrically at  $30 \pm 0.1^\circ\text{C}$  in 50 % (V/V) dioxane - water medium and 0.1 M (NaClO<sub>4</sub>) ionic strength. The  $\log K_1$  and  $\log K_2$  values are determined. The stability of chelate found to be following the Mellor and Malley order.*

**Keywords:** Flavone; Chelate; Metal complex; Ionic strength; Stability constant

### Introduction

Flavone is a class of organic compounds widely distributed in plants. The compounds are well known for their physiological activity. They are known to possess the antifungal [1], antimicrobial [2] anti-inflammatory [3] properties. The flavones and chalcones are also showing gastroprotective properties [4]. The flavonoids are found to be potent inhibitors of reverse transcriptases from Rauscher Murine Leukemia Virus (RLV) and Human Immuno Deficiency Virus [5]. The literature survey thus reveals a wealth of data on flavonoids. However, a systematic study of their ligation properties and influence of substituted groups on the complex formation process is lacking. The present investigation is undertaken with a view in mind.

### Experimental Work

All the chemicals used were of AR grade. The 7-hydroxy flavones were synthesized by the procedure reported earlier [6-11], which involved three steps. The product obtained was recrystallized in ethanol and their purities were tested by TLC, elemental analysis and NMR. The metal nitrates were dissolved in doubly distilled water and standardized by known methods. The figure 1 gives scheme for the preparation of ligands.

A digital P<sup>H</sup> meter (Elico, Model L 1-120) in conjugation with a combined electrode was used for P<sup>H</sup> measurements. The Calvin-Bjerrum method [12], modified by Irving and Rossotti [13] was used to obtain P<sup>K</sup> and logK values. The measurements were made at  $30 \pm 0.1^\circ\text{C}$  at  $\mu = 0.1\text{ M}$  (NaClO<sub>4</sub>) in 50 % (V/V) dioxane – water medium. The P<sup>K</sup> and logK values were determined by half integral method, pointwise calculation method and also by method of least square.

#### Scheme of preparation of ligands

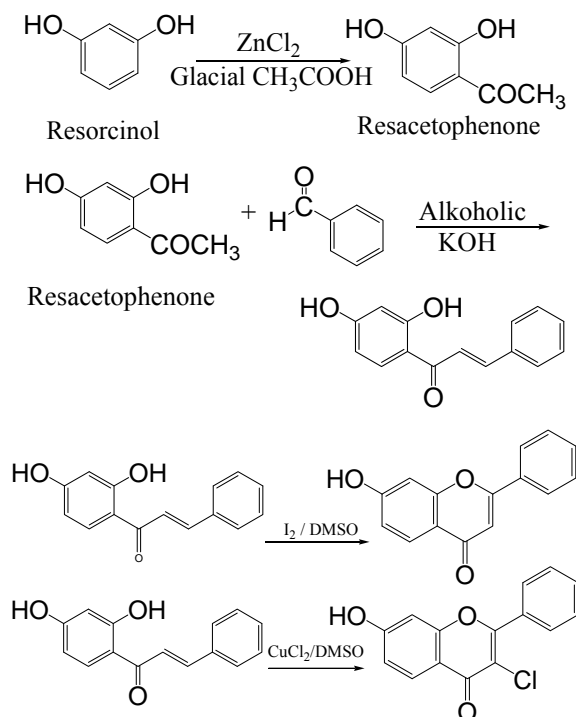


Figure 1. Scheme of preparation of ligands

#### Results and Discussions

Unsubstituted phenol with thermodynamic  $\text{P}^{\text{K}}$  value of 10.5 in 50 % dioxane - water medium could be compared with substituted 7-hydroxyl flavones compounds, since both the compounds have -OH group. The dissociation in these compounds therefore to the release of proton from the same. However, an examination of the  $\text{P}^{\text{K}}$  values of both the compounds show that  $\text{P}^{\text{K}}$  value of 7- hydroxyl flavones is lower than that of phenol. The other substituent group present in the flavones must be responsible for increased acidic strength of the compounds. The donor group like  $-\text{CH}_3$ ,  $-\text{C}_2\text{H}_5$ ,  $-\text{OCH}_3$ ,  $-\text{C}_3\text{H}_7$  and other similar alkyl groups destabilize the conjugate base. The acidity therefore decreases thereby increasing the  $\text{P}^{\text{K}}$  value. Similarly, electron withdrawing groups like  $-\text{NO}_2$ ,  $-\text{CN}$ ,  $-\text{C}=\text{O}$ ,  $-\text{C}-$ ,  $\text{C}-\text{X}$  ( $\text{X} = \text{Cl}$ ,  $\text{Br}$ ,  $\text{I}$ ) stabilize the conjugate base (+M effect) result in increase in acidity and decrease in  $\text{P}^{\text{K}}$  value. Figure 2 shows the structure for ligands 1, 2, 3 and 4. The ligand numbers 1 and 4 have  $-\text{OCH}_3$  and  $-\text{CH}_3$  groups respectively at 4' position. Both these group are known for their electron donating behavior. The  $\text{P}^{\text{K}}$  values of these ligands are therefore expected to be higher than that of other ligands. Since methoxy group is stronger electron donor than that of methyl group the  $\text{P}^{\text{K}}$  value of the ligand number 1 is higher than that of ligand 4. The ligand numbers 2 and 3 have electron withdrawing chloride group at 4' and 2' positions respectively. The  $\text{P}^{\text{K}}$  values of these ligands are therefore lower due to +M effect. When the substituting group is para position, the structure is expected to get stabilized as compared to when the substituent

group is at ortho or meta positions. The extra stability of the structure when the group is at para position arises due to the resonance effect. This is reflected in the ligand number 2 having lower  $P^K$  value lower than that of ligand number 3 (Table 1).

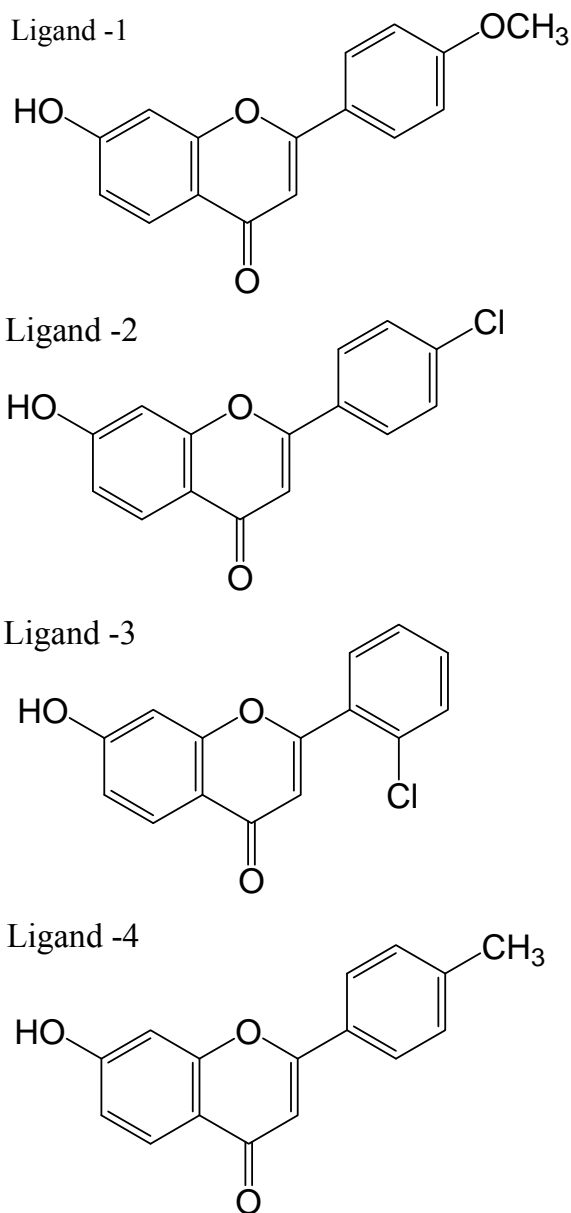


Figure 2. Structure of ligands prepared

The metal ligand titration curve deviates from the acid dissociation curve in the  $P^H$  range 3.0 to 8.0 indicating that complexation takes place in this  $P^H$  range [Figures 3 and 4]. The values of  $\log K_1$  and  $\log K_2$  were determined by half integral method, pointwise calculation method and least square method. The stability constant of 7-hydroxy flavones with their metal complexes. The stability constant of Cr(II),

Cu (II), Ni(II), Co(II) and Zn(II) complexes with 7-hydroxy flavones follows the order  $\text{Co(II)} < \text{Ni(II)} < \text{Cr(II)} < \text{Cu(II)} > \text{Zn(II)}$  [Table 4]. These stabilities are similar to the observations made by number of workers [14 - 18] and accordance with Mellor and Malley order [19].

Table 1 Proton ligand stability constants of 7- hydroxyl flavones (L = ligand)

L	Ligand	$p^K$
1	-2-(4' methoxy phenyl)-7hydroxy flavone	8.87
2	-2-(4'chlorophenyl )-7hydroxy flavones	5.78
3	-2-(2'chlorophenyl )-7hydroxy flavones	8.13
4	-2-(4' methyl phenyl )-7hydroxy flavone	8.60

Table 2. Stability constant (L = ligand)

L	Stab. Const.	Cr(II)	Co(II)	Ni(II)	Cu(II)	Zn(II)
1	$\log K_1$	5.25	3.57	5.46	5.63	4.90
	$\log K_2$	3.87	3.39	3.41	5.21	4.35
	$\log \beta$	9.12	7.96	8.87	10.08	9.25
2	$\log K_1$	4.54	2.71	3.30	4.97	3.31
	$\log K_2$	3.87	2.69	2.20	3.41	3.21
	$\log \beta$	8.01	5.40	5.50	8.38	6.52
3	$\log K_1$	4.69	3.21	3.48	5.89	3.94
	$\log K_2$	3.52	2.91	3.02	4.74	3.87
	$\log \beta$	8.21	6.12	6.50	10.6	7.81
4	$\log K_1$	4.59	3.05	3.75	4.83	4.23
	$\log K_2$	3.71	2.83	3.54	4.15	3.73
	$\log \beta$	8.30	5.88	7.29	8.98	7.96

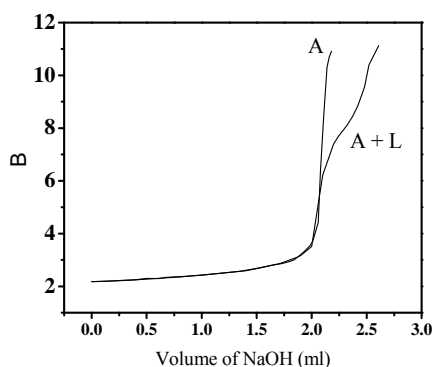


Figure 3. Proton ligand stability constant 2 - (4' methoxy phenyl)-7 hydroxy Flavone [ligand 1]

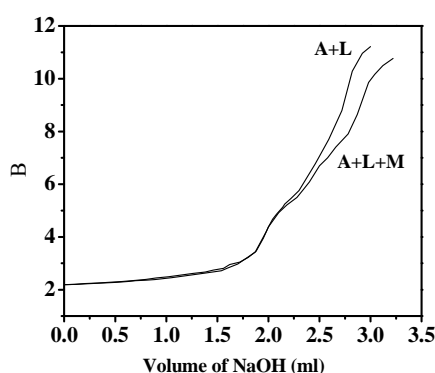


Figure 4. Metal- ligand stability constant Cr (II)- (4' methoxy phenyl)-7 hydroxy Flavone [ligand-1]



## Conclusions

The linear relationship between  $\log \beta$  and  $P^K$  values is found to hold. The binding sites are expected to be the same in all these compounds.

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