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Research Article

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Dissociation constants of some pyrazole schiff bases in Dimethylformamide and Tetrahydrofuran

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ABSTRACT

The proton ligand dissociation constants of some Schiff bases of pyrazole aldehyde and the stability constants have been determined in DMF/THF-water (60:40 v/v) medium at 308.15 K. using Bjerrum-Calvin pH titration as extended by Irving and Rossotti. The stability constants are related to dissociation constants of these ligands, which depends on the substituents attached to the organic moiety.

Key words: Dissociation constant, Schiff bases, DMF, THF.

INTRODUCTION

Literature survey shows that much research has been carried out with the aim to find the therapeutic values of pyrazole moiety, since their discovery [1-3]. Various pyrazole and its derivatives have been used in many drugs [4-6]. Various workers studied the dissociation constant of many substances [7-12] using different methods. Mahajan and co-workers [13] studied dissociation of some Schiff bases. The spectrophotometric determination of dissociation constants of crown ethers have been reported by Kadar et al.[14]. Sharma and co-workers studied dissociation constants of some protonated cysteine species in seawater media [15]. Liskova and Slampova also reported pK_a values of some synthesized heteroarylaminoethanols [16]. The present paper reports the dissociation constants of some pyrazole Schiff bases in DMF/THF-water (60:40 v/v) medium at 308.15 K.

EXPERIMENTAL SECTION

The Schiff bases have been synthesized and their structures are given in Figure 1. The synthesized compounds were recrystallized and purity of compounds was checked by thin layer chromatography. Further, the characterization was done by IR, NMR and mass spectral analysis. The physical constants of Schiff bases are given in Table 1.

The proton ligand dissociation constants of these Schiff bases have been studied by pH titration technique [17]. For this, the following sets of mixtures were prepared for titration:

(I) 0.8 ml HNO_3 (0.1M) + 11.2 ml water + 24.0 ml (DMF/ THF) + 4.0 ml $NaNO_3$ (1.0 M).
(ii) 0.8 ml HNO_3 (0.1M) + 11.2 ml water + 22.0 ml (DMF/ THF) + 2.0 ml ligand solution (0.1M) + 4.0 ml $NaNO_3$ (1.0 M).

Thus, total volumes (V^0) in each set = 40.0 ml and (DMF /THF): water ratio 60:40 (v/v).

A systronic pH meter (Model No. EQ 664) was used for the pH determination. The systronic glass electrode and a saturated calomel electrode were used as indicator and reference electrodes respectively. Before measurement, the pH meter was calibrated with buffer solution of known pH.

The above mentioned solutions were allowed to attain a constant temperature (308.15 K) and then titrated against standard NaOH solution (0.5 M) under an inert atmosphere of nitrogen. The change in the pH of solution with each addition of alkali was recorded.

RESULTS AND DISCUSSION

From the acid titration curve and ligand titration curve, the average number of protons associated with ligand ($\overline{n_H}$) can be calculated by Irring and Rossotti equation.

$$\overline{n_H} = Y - \left\{ \left(V'' - V' \right) \left(N^0 + E^0 \right) \right\} \Big/ \left\{ \left(V^0 + V' \right) T_L^0 \right\}$$

where Y is the number of displaceable protons per ligand molecule. For all the Schiff bases, Y is taken as one. V' and V" are the volume of alkali required at the same pH for both acid and ligand titration curves respectively. V^0 is the initial volume of the test solution. N^0, E^0 and T^0_L are the initial concentration of the alkali, acid and ligand respectively. The proton-ligand dissociation constants were evaluated by using Bjerrum's half integral method and average method and are given in Table 2. It is evident from Table 2 that there is good agreement between the values evaluated by these methods.

Table 1: Physical constants of Schiff bases

Sr. No.	Code	R	M.F.	M. Wt. g	R_f* Value	M.P. °C	Yield %
1.	**JPA-1**	-NH -C_6H_5	$C_{22}H_{17}N_5O_2$	383	0.67	266	65
2.	**JPA-2**	4-CH_3-C_6H_4	$C_{23}H_{18}N_4O_2$	382	0.54	218	69
3.	**JPA-3**	4-NO_2-C_6H_4	$C_{22}H_{15}N_4O_4$	413	0.62	246	65
4.	**JPA-4**	4-OCH_3-C_6H_4	$C_{23}H_{18}N_4O_3$	398	0.54	258	78
5.	**JPA-5**	4-F,3-Cl -C_6H_3	$C_{22}H_{14}ClFN_4O_2$	421	0.47	243	65
6.	**JPA-6**	4-Cl-C_6H_4	$C_{22}H_{15}ClN_4O_2$	403	0.55	198	70
7.	**JPA-7**	4-F-C_6H_4	$C_{22}H_{15}FN_4O_2$	387	0.60	268	72
8.	**JPA-8**	2-Cl,5-Cl -C_6H_3	$C_{15}H_{10}ClNO_4$	436	0.46	283	68
9.	**JPA-9**	2-OH-C_6H_4	$C_{22}H_{14}Cl_2N_4O_2$	382	0.47	256	76

**TLC Solvent system- Hexane: Ethyl acetate - 7.0:3.0*

Table 2. The dissociation constants values for all the Schiff bases calculated by Half-integral method and Average method.

Compound	DMF		THF	
	Half-integral method	Average log pK_1^H	Half-integral method	Average log pK_1^H
JPA-1	11.20	11.21	11.36	11.34
JPA-2	11.44	11.42	10.09	10.07
JPA-3	10.12	10.11	10.93	10.95
JPA-4	11.16	11.14	11.28	11.25
JPA-5	10.60	10.59	10.47	10.50
JPA-6	11.39	11.35	11.58	11.53
JPA-7	9.98	10.03	10.04	10.08
JPA-8	10.48	10.63	10.55	10.60
JPA-9	9.78	9.81	9.51	9.56

For Schiff bases, in DMF-water system, JPA-9 is more acidic and JPA-2 is least acidic whereas in THF-water system, JPA-9 is more acidic but JPA-6 is least acidic. JPA-9 contains $-CH_3$ group at ortho position whereas JPA-2 contain $-CH_3$ group at para position. Thus, presence of $-CH_3$ at ortho position increases the acidity whereas at para position, it decrease the acidity. In THF-water system, again the presence of $-CH_3$ group at ortho position increases

the acidic character i.e., JPA-9 is more acidic. But, the presence of chloro group at para position decreases the acidity. In this solvent, the $-CH_3$ group at ortho position causes more acidity than in DMF-water system. This proves that solvent plays an important role in dissociation constant.

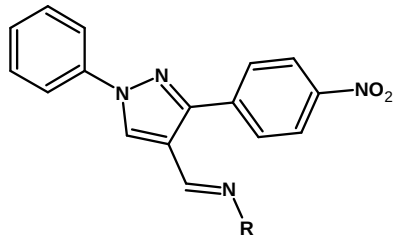

Figure 1:General structure for synthesized Schiff bases.

1 JPA-1 : 3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazole-4-carbaldehyde phenylhydrazone
2 JPA-2 : 4-methyl-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline
3 JPA-3 : 4-nitro-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline
4 JPA-4 : 4-methoxy-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline
5 JPA-5 : 3-chloro-4-fluoro-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline
6 JPA-6 : 4-chloro-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline
7 JPA-7 : 4-fluoro-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline
8 JPA-8 : 2,5-dichloro-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline
9 JPA-9 : 2-methyl-*N*-{(1*E*)-[3-(4-nitrophenyl)-5-phenyl-4*H*-pyrazol-4-yl]methylene}aniline

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