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Note

Effect of geometrical configuration of square-planar metal complexes on their R_F values obtained by paper chromatography

T. J. JANJIĆ*, Ž. Lj. TEŠIĆ and M. B. ĆELAP

Institute of Chemistry, Faculty of Science, University of Beograd, P.O. Box 550, 11001 Beograd (Yugoslavia)

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In earlier work, Stefanović and Janjić[1,2] studied the effect of the geometrical configuration of octahedral metal complexes of the cationic type on their R_F values obtained by paper chromatography, and established that the *cis*-isomers exhibit higher R_F values than the corresponding *trans*-isomers. These investigations also included one square-planar complex, $[Ptpy_2(NH_3)_2]Cl_2$, and the results obtained followed the same rule. Exceptions to this rule occurred only when solvent systems containing phenol were used[3]. Later, it was established that this rule is also valid for octahedral complexes of the anionic and non-electrolyte types[4].

Basolo *et al.*[5] determined the R_F values of the geometrical isomers of the square-planar complexes of the type $[PtX_2(NH_3)_2]$ (X = Cl, Br or I), using different

TABLE I

SOLVENT SYSTEMS USED

No.	*Composition*	*Component ratio**	
1	Acetone–water	90:10	(v/v)
2	Acetone–water–conc. HCl	75:20:5	(v/v/v)
3	Acetone–water–conc. HBr	75:20:5	(v/v/v)
4	Acetone–water–KI	75:25:1	(v/v/w)
5	Methanol–conc. HCl	85:15	(v/v)
6	Ethanol–water–conc. HCl	75:20:5	(v/v/v)
7	Ethanol–water–conc. HBr	75:20:5	(v/v/v)
8	Ethanol–water–KI	75:25:1	(v/v/w)
9	Ethyl acetate–ethanol–conc. HCl	60:25:15	(v/v/v)
10	Ethyl methyl ketone–water–conc. HCl	70:10:20	(v/v/v)
11	Acetylacetone–ethanol–conc. HCl	60:25:15	(v/v/v)
12	Diethyl ether–ethanol–conc. HCl	60:25:15	(v/v/v)
13	Tetrahydrofuran–water–conc. HCl	80:10:10	(v/v/v)
14	Dioxan–water–conc. HCl	70:10:20	(v/v/v)
15	Isopropanol–water–conc. HCl	50:40:10	(v/v/v)
16	Ethanol–acetone–water	50:40:10	(v/v/v)
17	Phenol saturated with water	–	
18	Phenol–ethanol–water–LiCl	40:35:10:1	(w/v/v/w)

* v refers to volume in millilitres; w refers to weight in grams.

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TABLE II

EFFECT OF GEOMETRICAL CONFIGURATION ON R_F VALUES

No.	*Isomer*	*Complex**	*Ref.*	$R_F \times 100$**																
				1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
1	*cis-*	$[PtCl_2(NH_3)_2]$	7	73	68	–	–	94	39	–	–	29	64	29	3	72	84	56	46	33	–
	trans-			70	59	–	–	69	29	–	–	0	38	2	0	66	36	47	38	45	–
2	*cis-*	$[PtBr_2(NH_3)_2]$	8	83	–	79	–	–	–	41	–	–	–	–	–	–	–	–	59	38	20
	trans-			78	–	65	–	–	–	31	–	–	–	–	–	–	–	–	56	46	27
3	*cis-*	$[PtI_2(NH_3)_2]$	8	98	–	–	92	–	–	–	94	–	–	–	–	–	–	–	77	42	32
	trans-			96	–	–	80	–	–	–	82	–	–	–	–	–	–	–	75	53	43
4	*cis-*	$[Pt(SCN)_2(NH_3)_2]$	9	90	98	–	–	46	79	–	–	96	98	78	89	98	98	52	90	64	46
	trans-			84	87	–	–	24	44	–	–	76	79	76	33	97	97	46	69	78	53
5	*cis-*	$[Pt(SCN)_2py_2]$	9	84	98	–	–	20	98	–	–	98	98	98	98	98	–	–	98	–	94
	trans-			53	97	–	–	10	96	–	–	97	96	97	97	96	–	–	96	–	98
6	*cis-*	$[PtCl_2py_2]$	10	98	97	–	–	92	96	–	–	98	98	98	–	98	32	–	96	–	–
	trans-			40	0	–	–	0	0	–	–	0	0	0	–	64	3	–	95	–	–
7	*cis-*	$[PtCl_2qu_2]$	11	89	97	–	–	89	90	–	–	–	–	–	–	98	–	–	18	–	–
	trans-			0	0	–	–	0	0	–	–	–	–	–	–	0	–	–	0	–	–
8	*cis-*	$[Ptgly_2]$	12	84	98	–	–	62	69	–	–	76	88	98	95	98	–	66	–	–	–
	trans-			54	96	–	–	0	0	–	–	0	0	0	0	0	–	0	–	–	–
9	*cis-*	$[Pt(NH_3)_2py_2]Cl_2$	13	–	56	–	–	30	50	–	–	17	69	17	16	30	14	75	50	93	93
	trans-			–	0	–	–	0	0	–	–	0	0	0	0	0	0	68	34	98	98
10	*cis-*	$[Pt(NH_3)_2hx_2]Cl_2$	14	5	39	–	–	5	24	–	–	–	22	3	–	–	–	43	12	14	2
	trans-			0	0	–	–	0	0	–	–	–	0	0	–	–	–	42	6	18	3

* py = Pyridine; qu = quinoline; gly = glycine; hx = hydroxylamine.

** The compositions of solvent systems 1–18 are given in Table I.

solvent mixtures consisting of water and acetone or ethanol* [a Whatman No. 3MM filter-paper (26 × 12 cm) was used]. On the basis of the results obtained it was concluded that the investigated *cis*-isomers exhibit higher R_F values than the corresponding *trans*-isomers, except when the solvent mixture contains water and acetone in the volume ratio 1:9.

Continuing these investigations, in this work we studied the chromatographic behaviour of ten pairs of *cis–trans* isomeric platinum(II) complexes by applying eighteen different solvent systems.

EXPERIMENTAL

Preparation of complexes

All of the complexes investigated were synthesized according to known procedures (Table II).

Chromatographic investigations

Chromatographic investigations were carried out by the method of ascending chromatography on Whatman No. 1 paper strips, as described earlier[6]. Platinum(II) complexes were detected by spraying the dried paper strips with a 4 *M* sodium formate solution, followed by heating at 120°C until the appearance of black spots. The compositions of the solvent systems used are given in Table I.

RESULTS AND DISCUSSION

As can be seen from Table II, using the first sixteen solvent systems, the *cis*-isomers exhibited higher R_F values than the corresponding *trans*-isomers, regardless of the composition of the solvent mixture. In addition, the results obtained by Basolo *et al.*[5] are also in accordance with ours, except when the solvent mixture contained acetone and water in the volume ratio 9:1. However, when we applied Whatman No. 1 paper strips (3 × 28 cm) instead of Whatman No. 3MM paper (26 × 12 cm), we obtained higher R_F values for the *cis*-isomers. From Table II it can also be seen that the same complexes, when chromatographed with solvent systems 17 and 18, which contained phenol, deviated from the above rule, which is in accordance with the results obtained earlier for octahedral complexes[3]. Accordingly, the Stefanović and Janjić rule can also be applied to square-planar platinum(II) complexes, thus offering a possibility for the determination of their geometrical configuration.

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* In some instances hydrocloric acid or sodium, potassium or lithium chloride was added.

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