α,β-Unsaturated ketones derived from acetylpyridines. IX. Reaction of pyridine analogs of 1,3,5-triphenyl-2-pyrazoline with *N*-bromosuccinimide

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Received 16 April 1975

Dedicated to Professor J. Majer, Corresponding Member of the Slovak Academy of Sciences, on his 50th birthday

Pyridine analogs of 1,3,5-triphenyl-2-pyrazoline reacted with *N*-bromosuccinimide to give, instead of the expected 1,3,5-trisubstituted pyrazoles, 1-*p*-bromophenyl-2-pyrazolines. The same products were obtained in an independent manner from the isomeric azachalcones and *p*-bromophenylhydrazine. The identity of the products was proved by means of their oxidation with lead tetraacetate which afforded 1,3,5-trisubstituted pyrazoles. The confirmation of the structure of the isolated products was based on the u.v., i.r., and p.m.r. spectral data.

Реакцией пиридиновых аналогов 1,3,5-трифенил-2-пиразолина с *N*-бромсукцинимидом, были, вместо ожидаемых 1,3,5-тризамещенных пиразолов, получены производные исходных 2-пиразолинов с *n*-бромфенилом в положении 1. Те же самые соединения были получены независимым синтезом из изомерных азахалконов и *n*-бромфенилгидразина. Этими двумя способами приготовленные пары соединений окислением уксуснокислым четырехвалентным свинцом, привели к 1,3,5-трехзамещенным пиразолом. Структура изолированных соединений была проверена спектральными методами (УФ-, ИК- и ПМР-спектры).

The preparation of 1,3,5-triphenylpyrazole and its pyridine analogs by means of dehydrogenation of the corresponding 1,3,5-trisubstituted 2-pyrazolines has been described previously [1]. Since in certain instances the reaction was unsuccessful and the method applied [2] was time consuming attempts were made to take advantage of the *Ried* and *Lantzsch*'s method [3] for the dehydrogenation of 1,3,5-triphenyl-2-pyrazoline and some derivatives thereof with *N*-bromosuccinimide.

Abbreviations:

TPP	1,3,5-triphenyl-2-pyrazoline.
NBS	*N*-bromosuccinimide.
TMAH	tetramethylammonium hydroxide.

Table 1

Pyrazolines prepared

No.	R¹	R²	Formula	*M*	Calculated/found				Method	Yield %	M.p. °C (Kofler)
					% C	% H	% N	% Br			
I	2-Pyridyl	Phenyl	$C_{20}H_{16}BrN_3$	378.27	63.50	4.26	11.11	21.12			
					63.73	4.47	11.34	20.99	*A*	82	168–170
					63.41	4.50	10.94	21.37	*B*	90	167–168
II	3-Pyridyl	Phenyl	$C_{20}H_{16}BrN_3$	378.27	63.50	4.26	11.11	21.12			
					63.26	4.42	11.32	20.55	*A*	75	156–158
					63.74	4.19	11.40	20.72	*B*	98	155–158
III	4-Pyridyl	Phenyl	$C_{20}H_{16}BrN_3$	378.27	63.50	4.26	11.11	21.12			
					63.64	4.50	11.21	21.36	*A*	84	160–162
					63.30	4.50	11.09	21.47	*B*	87	159–161
IV	Phenyl	2-Pyridyl	$C_{20}H_{16}BrN_3$	378.27	63.50	4.26	11.11	21.12			
					63.72	4.52	11.32	21.16	*A*	74	158–160
					63.27	4.26	11.40	21.33	*B*	95	159–160
V	Phenyl	3-Pyridyl	$C_{20}H_{16}BrN_3$	378.27	63.50	4.26	11.11	21.12	*A*		
					63.78	4.47	11.30	20.76	*B*	64	132–134
VI	Phenyl	4-Pyridyl	$C_{20}H_{16}BrN_3$	378.27	63.50	4.26	11.11	21.12			
					63.73	4.56	10.96	21.04	*A*	84	176–177
					63.77	4.31	11.23	21.39	*B*	65	176–179

Table 2

Spectral characteristics of the synthesized pyrazolines

No.	Ultraviolet spectra						Infrared spectra, cm^{-1}			
	λ_{max} nm	$\cdot 10^{-}$	λ'_{max} nm	$\cdot 10^{-}$	λ''_{max} nm	$\cdot 10^{-}$	ν(C=N) (—C=C—)	ν(Ar—N)	ν(CH—N)	δ(C—H)
I	254	1.30	324	0.73	361	2.39	1594	1328	1128	700
II	260	1.46	323	0.95	368	2.17	1593	1320 1335	1126	701
III	254	1.81	319	0.45	387	2.37	1588	1337	1133	683 700
IV	256	1.68			359	2.08	1591	1327 1338	1130	693
V	253	1.62			361	2.08	1593	1327 1337	1128	694
VI	251	1.63			361	1.95	1590	1323 1334	1128	691

Six isomeric TPP analogs were allowed to react with NBS (Scheme 1) and the results obtained showing that the products were different from those expected, are presented herein.

Experimental

Pyridine TPP analogs were prepared from the six isomeric azachalcones [5] and phenylhydrazine as described [6]. 1-(*p*-Bromophenyl)-5-phenyl-3-(2-, 3-, and 4-pyridyl) and 1-(*p*-bromophenyl)-3-phenyl-5-(2-, 3-, and 4-pyridyl)-2-pyrazolines were made similarly (method *B*) from *p*-bromophenylhydrazine and the isomeric azachalcones.

The reaction of pyridine TPP analogs with NBS was carried out as described by *Ried* and *Lantzsch* [3] (method *A*). NBS was prepared by the known procedure [7].

Oxidation of 2-pyrazolines with lead tetraacetate was performed according to the directions given in [2].

The u.v. absorption spectra were measured using Specord UV-VIS (Zeiss, Jena) instrument in 1-cm cells using solutions (2.6×10^{-5} M) in spectral grade ethanol.

The i.r. spectra in the range of 1800—670 cm^{-1} were measured using a double-beam instrument UR-10 (Zeiss, Jena) applying the KBr technique (1/800 mg KBr). The instrument was calibrated against a polystyrene foil (25 μm thickness).

The p.m.r. spectra for the solutions in deuteriochloroform were obtained using a Tesla BS 487 A instrument and hexamethyldisiloxane as the internal standard. The results obtained were recalculated for tetramethylsilane.

Discussion

As mentioned above, the application of the *Ried* and *Lantzsch*'s method [3] to TPP pyridine analogs gave unexpected results. Instead of the expected 1,3,5-trisubstituted pyrazoles products were obtained which both in solid state and in organic solvents exhibited intense fluorescence characteristic of the starting 2-pyrazolines. Elemental analysis, however, showed the presence of one atom of bromine in the molecules of the isolated substances (Table 1). Based on the results of other workers [3] it was first assumed that the atom of bromine was present on the 2-pyrazoline ring. This was later disproved by p.m.r. spectroscopy which showed that the *ABX* system characteristic of the starting pyrazolines [4, 8, 9, 12] remained unaltered (Table 3). It was concluded by the analysis of the p.m.r. spectra of the isolated sub-

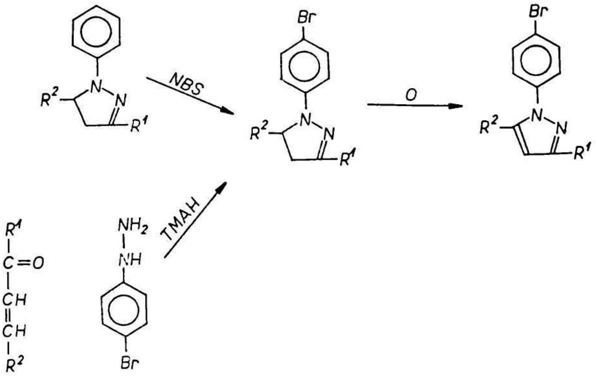
Table 3

P.m.r. spectral data of the synthesized pyrazolines

No.	Coupling constants, cps			Chemical shift, p.p.m.		
	J_{AX}	J_{BX}	J_{AB}	δH_A	δH_B	δH_X
I	7.0	12.25	17.8	3.25	3.92	5.22
II	7.25	12.5	17.5	3.06	3.77	5.22
III	7.25	12.5	17.25	3.04	3.76	5.26
IV	7.0	12.15	17.40	3.18	3.88	5.37
V	6.8	12.5	17.1	3.1	3.8	5.2
VI	7.2	12.15	17.2	3.1	3.8	5.2

stances that the bromine atom was located in the *p*-position of the phenyl ring located in the position 1 of the pyrazoline ring (Scheme 1).

To prove the above-mentioned conclusion the compounds in question were synthesized from the isomeric azachalcones and *p*-bromophenylhydrazine (method *B*; see Scheme 1 and Table 1) applying the method previously elaborated in our laboratory [6].



R^1 = 2,3,4-pyridyl, R^2 = phenyl;
R^1 = phenyl, R^2 = 2,3,4-pyridyl.

Scheme 1

The structures of the substances were further verified by spectral methods. In the u.v. spectra absorption maxima characteristic of the compounds of this class [8, 13—21] were found (Table 2). The i.r. spectra showed bands corresponding to the C=N, Ar—N, CH—N, and C—H vibrations which, according to numerous authors [8, 13, 15—17, 22], prove the pyrazoline arrangement. In the range of 1390 cm^{-1} the usual medium intensity bands characteristic of the CH_2 deforming vibrations of the 2-pyrazoline ring [8, 14—17] were present.

The most conclusive evidence as to the presence of this group was provided by p.m.r. spectroscopy which showed the identity of the pair of substances prepared by the two independent manner (method *A* and *B*). Other spectral data for these pairs were also identical and, therefore, Tables 2—4 show for each compound only one set of results.

Lead tetraacetate oxidation (Scheme 1) gave from each pair of substances identical pyrazole derivatives (Table 4) which again substantiated the identity of the parent compounds. The structures of the isolated pyrazoles follow from the interpretation of their p.m.r. spectra which was based on the chemical shift observed for the sole proton present in the heterocycle of 1,3,5-trisubstituted pyrazoles. This proton appears as a singlet at ~7 p.p.m. and is separated from other protons of the molecule [1, 10]. In agreement with this it was possible to identify singlets at δ 6.7—7.1 in the spectra of all synthesized compounds (Table 4) and confirm their pyrazole structure.

Table 4

Pyrazoles prepared

No.	R^1	R^2	Formula	*M*	Calculated/found % C	 % H	 % N	 % Br	Yield %	M.p. °C (Kofler)	Chemical shift δ
VII	2-Pyridyl	Phenyl	$C_{20}H_{14}BrN_3$	376.26	63.85 64.20	3.75 3.69	11.17 11.39	21.24 21.52	70	121—123	7.11
VIII	3-Pyridyl	Phenyl	$C_{20}H_{14}BrN_3$	376.26	63.85 64.15	3.75 3.98	11.17 11.23	21.24 21.49	88	128—129.5	6.75
IX	4-Pyridyl	Phenyl	$C_{20}H_{14}BrN_3$	376.26	63.85 63.99	3.75 4.04	11.17 11.36	21.24 21.10	76	150—150.5	6.80
X	Phenyl	2-Pyridyl	$C_{20}H_{14}BrN_3$	376.26	63.85 64.12	3.75 3.95	11.17 11.31	21.24 21.38	94	122—124	7.00
XI	Phenyl	3-Pyridyl	$C_{20}H_{14}BrN_3$	376.26	63.85 64.04	3.75 4.00	11.17 11.30	21.24 21.64	64	115—117	6.80
XII	Phenyl	4-Pyridyl	$C_{20}H_{14}BrN_3$	376.26	63.85 63.77	3.75 3.82	11.17 11.10	21.24 21.23	70	152—153	6.84

The pyrazoline synthesis itself, regardless of the method applied, proceeded smoothly with no complications encountered. One exception was the preparation of 1-(*p*-bromophenyl)-3-phenyl-5-(3-pyridyl)-2-pyrazoline (*V*) which, when prepared by method *A*, could not be obtained pure even after purification by chromatography. Oxidation of the isolated crude product with lead tetraacetate gave, however, the corresponding pyrazole derivative *XI* (Table 4) identical with the pyrazole derivative prepared by lead tetraacetate oxidation of the pyrazoline derivative obtained by method *B*.

Oxidation of all other pyrazolines to give pyrazoles proceeded also without difficulties.

Taking into account the results of *Ried* and *Lantzsch* [3] it can be concluded that the reaction of TPP pyridine analogs with NBS gives unexpected products. Therefore, the reaction of NBS with TPP was also repeated and the directions given by the authors [3] were strictly followed. In agreement with the above-mentioned results the 2-pyrazoline derivative substituted with the *p*-bromophenyl residue in the position 1 was obtained [11].

Acknowledgements. The authors thank V Hartelová (Department of Inorganic and Organic Chemistry, Faculty of Pharmacy, Komenský University, Bratislava) for the microanalyses and m.p.s. determination.

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Translated by P. Kováč