SYNTHESIS AND TRANSFORMATIONS OF 2-(2-FURYL)- AND 2-[β-(2-FURYL)VINYL]IMIDAZO[4,5-b]PHENAZINES

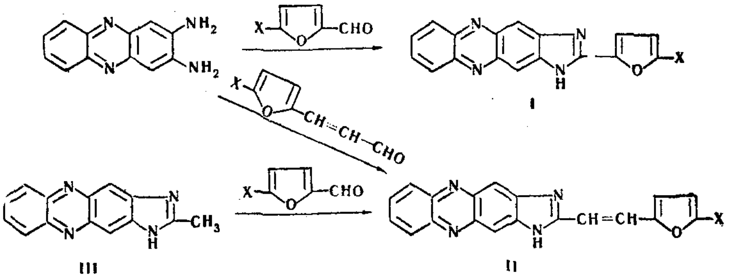
F. T. Pozharskii and L. Ya. Oleinikova

UDC 547.864'781'722.07

The corresponding 2-(2-furyl)- and 2-[β-(2-furyl)vinyl]imidazo[4,5-b]phenazines were obtained by the condensation of 2,3-diaminophenazine with furfural and 2-furylacrolein and with their 5-bromo and 5-nitro derivatives. The phenazines were also synthesized by the reaction of 2-methylimidazo[4,5-b]phenazine with furfural and 5-bromo- and 5-nitrofurfural. The alkylation, acetylation, and nitration of the compounds obtained, as well as replacement of the halogen in the furan ring by a nitro group, were studied.

Continuing our investigation of 2-substituted imidazole systems containing a furan ring [1-4], we set out to synthesize 2-(2-furyl)imidazo[4,5-b]phenazines (I) and 2-[β-(2-furyl)vinyl]imidazo[4,5-b]phenazines (II). It seemed of interest to ascertain the conditions for their formation and to establish the effect of the phenazine system in these compounds on the reactivities of the imidazole and furan rings.

Compounds I and II were obtained by the reaction of 2,3-diaminophenazine with the appropriate aldehydes of the furan series.



Ia X=H; Ib X=Br; Ic X=NO$_2$; IIa X=H; IIb X=Br; IIc X=NO$_2$

The condensation of 2,3-diaminophenazine with furfural, 2-furylacrolein, and their 5-bromo and 5-nitro derivatives was carried out under the conditions of the Weidenhagen reaction [2,5], and also by heating in dimethylformamide in the presence of piperidine. Compounds IIa and IIb were alternatively synthesized by the reaction of 2-methylimidazo[4,5-b]phenazine with furfural and 5-bromofurfural, respectively, by the method described in [2].

The furylimidazophenazines that we obtained are stable, high-melting compounds that have strong luminescence on irradiation with UV light. Some of their transformations occur differently from the transformations of furylbenzimidazoles [1-4]. The methylation of Ia and IIb with methyl iodide in alcoholic alkali proceeds at the imidazole ring and results in the formation of the corresponding 1-methyl-substituted compounds (Id and IId). However, quaternization at the nitrogen atom of the phenazine ring to form methiodides occurs as a result of the action on Ia and IIb of dimethyl sulfate in nitrobenzene or dimethylformamide with subsequent treatment of the reaction mixture with saturated potassium iodide solution. The structures of these methiodides of Ia and IIb were proved by alternative synthesis and were confirmed by comparison of the UV spectra with the UV spectra of the methiodides of Id and IId.

Rostov State University, Rostov-on-Don. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 10, pp. 1425-1428, October, 1971. Original article submitted February 12, 1971.

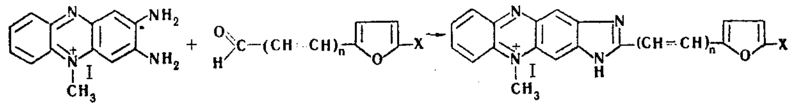
TABLE 1. 2-(2-Furyl)imidazo[4,5-b]phenazines (I) and 2-[β-(2-Furyl)vinyl]imidazo[4,5-b]phenazines (II)

Compound	Mp, °C, crystal color	λ_{max}, nm	lg ε	Empirical formula	Found, %			Calc., %			Yield, %
					C	H	N	C	H	N	
Ia	> 400[a], Yellow	258; 284; 409	4,78; 4,37; 4,60	$C_{17}H_{10}N_4O$	71,0	3,6	19,8	71,3	3,5	19,5	59,7
Ib	> 400[a], Light-brown	258; 292; 409	4,86; 4,46; 4,96	$C_{17}H_9N_4OBr$	56,2	3,0	15,4	55,9	2,5	15,3	58,0
Ic	> 400[b], Dark-red	258; 324; 412	4,57; 3,87; 4,48	$C_{17}H_9N_5O_3$	59,9	3,1	21,1	60,2	2,7	21,1	30,5
Id	> 300[a], Yellow-brown	258; 286; 409	4,84; 4,44; 4,63	$C_{18}H_{12}N_4O$	71,9	3,5	18,8	72,0	3,4	18,9	47,0
Methiodide of Id	> 400[b], Dark-brown	258; 286; 410	4,86; 4,70; 4,67	$C_{19}H_{15}IN_4O$	—	—	12,9	—	—	12,7	31,0
Methiodide of Ia	> 400[b], Black	258; 405	5,48; 5,21	$C_{18}H_{13}IN_4O$	—	—	12,9	—	—	13,1	61,0
IIa	> 400[a], Orange	258; 408	4,81; 4,52	$C_{19}H_{12}N_4O$	72,9	4,0	17,7	73,1	3,9	17,9	56,3
IIb	> 400[a], Orange	258; 410	4,04; 4,71	$C_{19}H_{11}BrN_4O$	58,0	3,1	14,2	58,3	2,9	14,4	55,4
IIc	> 400[b], Dark-red	258; 314; 412	4,74; 4,08, 4,60	$C_{19}H_{11}N_5O_3$	63,5	3,4	20,6	63,9	3,1	20,6	30,0
IId	> 300[a], Light-brown	258; 410	4,81; 4,59	$C_{20}H_{13}BrN_4O$	59,5	3,7	13,9	59,8	3,2	13,8	48,0
Methiodide of IId	> 400[b], Brown-violet	258; 410	4,99; 4,77	$C_{21}H_{16}BrIN_4O$	—	—	9,9	—	—	10,0	30,0
Methiodide of IIb	> 400[b], Black-brown	258; 410	5,88; 5,60	$C_{20}H_{14}BrIN_4O$	—	—	10,3	—	—	10,6	49,0
IIe	> 400[a], Brown	258; 405	4,73; 4,51	$C_{19}H_{11}N_5O_3$	63,8	3,3	20,4	63,9	3,1	20,6	70,0
IIf	> 400[a], Dark-brown	276; 412	4,13; 4,13	$C_{21}H_{15}N_5O_7$	56,2	3,1	15,7	56,1	3,4	15,6	74,0

---

[a] From ethanol.

[b] From dimethylformamide.

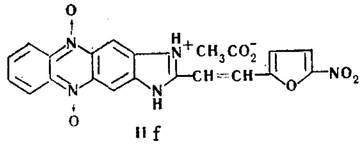


IV

methiodides: Ia n=0, X=H; IIb n=1, X=Br

It is known that compounds that contain a furan ring directly bonded to a vinyl grouping readily undergo electrophilic substitution at the free α position of the furan ring [3,4,6-8]. Compound IIa proved to be an exception to this principle. It is not acetylated by acetic anhydride and is not nitrated by a mixture of nitric acid and acetic anhydride in the α position of the furan ring. In the latter case, a mononitro product containing a nitro group in the phenazine ring (IIe) is formed when the nitration is carried out by the method in [3].

In [3,9], it was found that a halogen atom in the furan ring of 2-(5-halo-2-furyl)benzimidazoles is readily replaced by a nitro group by the action of metal nitrites in glacial acetic acid. Under these conditions, IIb also smoothly exchanges a bromine atom for a nitro group to form IIf, which is the acetate of the N,N'-dioxide of IIc:



IIf

The properties of the compounds obtained are presented in Table 1.

EXPERIMENTAL

2-Methylimidazo[4,5-b]phenazine (III). A mixture of 10.5 g (0.05 mole) of 2,3-diaminophenazine and 300 ml of glacial acetic acid was refluxed for 12 h and cooled. The dark-red solution was neutralized with 10% sodium hydroxide solution to pH 7. The precipitate was removed by filtration and crystallized from methanol or ethanol to give 4.8 g (41%) of golden-brown crystals with mp greater than 400°. Found: C 71.9; H 4.4; N 23.7%. $C_{14}H_{10}N_4$. Calculated: C 71.8; H 4.6; N 23.9%.

Methiodide of 2,3-Diaminophenazine (IV). A mixture of 1 g (0.005 mole) of 2,3-diaminophenazine, 4.24 ml of dimethyl sulfate, and 20 ml of dimethylformamide was heated at 100° for 10 min. The mixture was cooled, and 15 ml of water was added. The precipitate was removed by filtration and treated with 10 ml of saturated potassium iodide solution. Crystallization from dimethylformamide gave dark-violet crystals with mp greater than 400°. Found: N 12.9%. $C_{18}H_{13}IN_4O$. Calculated: N 13.1%.

2-(2-Furyl)imidazo[4,5-b]phenazine (Ia). A) A mixture of 2.10 g (0.01 mole) of 2,3-diaminophenazine, 1.15 g (0.012 mole) of furfural, 40 ml of dimethylformamide, and 2 to 3 drops of piperidine was refluxed for 1 h and allowed to stand overnight. The precipitate was removed by filtration, washed with dimethylformamide, and recrystallized from ethanol.

Compounds Ic and IIa,c,d were similarly obtained, and the methiodides of Ia and IIb were obtained by alternative synthesis.

B) A solution of 4 g (0.02 mole) of cupric acetate in 50 ml of water was added to a solution of 2.1 g (0.01 mole) of 2,3-diaminophenazine in 400 ml of ethanol, 1.44 g (0.015 mole) of furfural in 15 ml of ethanol was added, and the mixture was refluxed for 2 h and allowed to stand overnight. The precipitate of the copper salt of the reaction product was removed by filtration and suspended in 50 ml of 60% ethanol. A strong jet of hydrogen sulfide was bubbled into the suspension for 2 h. The excess hydrogen sulfide was removed by heating, the precipitate of cupric sulfide was removed by filtration, and the filtrate was evaporated to half its volume and diluted with water. The crystals of Ia were removed by filtration.

Compounds Ib and IIb were similarly obtained.

1-Methyl-2-(2-furyl)-imidazo[4,5-b]phenazine (Id). A 0.28 g (0.001 mole) sample of Ia was dissolved in 50 ml of ethanol, and a solution of 0.11 g (0.001 mole) of potassium hydroxide in 5 ml of ethanol and 0.28 g (0.002 mole) of methyl iodide were added. The mixture was refluxed for 3 h, and the potassium iodide was removed by filtration. The filtrate was cooled to 10°, the precipitate was separated, and Id was crystallized from alcohol.

Compound IId was similarly obtained by methylation of IIa.

The methiodides of Id and IId were obtained by refluxing benzene solutions of these compounds with a twofold excess of methyl iodide.

The UV spectra of methanol solutions were recorded with an SF-4a spectrophotometer.

LITERATURE CITED

1. F. T. Pozharskii, V. Ts. Bukhaeva, and A. M. Simonov, Khim. Geterotsikl. Soedin., 910 (1967).
2. F. T. Pozharskii, V. Ts. Bukhaeva, A. M. Simonov, L. Ya. Bakhmet, and O. M. Aleksan'yan, Khim. Geterotsikl. Soedin., 325 (1969).
3. L. Ya. Bakhmet and F. T. Pozharskii, Khim. Geterotsikl. Soedin., 832 (1970).
4. F. T. Pozharskii, L. Ya. Oleinikova, and L. G. Pupkova, Khim. Geterotsikl. Soedin., 1014 (1971).
5. R. Weidenhagen, Ber., 69, 2203 (1936).
6. H. Gilman and G. Wright, J. Am. Chem. Soc., 52, 2550, 4105 (1930).
7. T. Sasaki, Bull. Chem. Soc. Japan, 27, 389 (1954); Chem. Abstr., 15, 10,261 (1955).
8. G. N. Dorofeenko and G. A. Korol'chenko, Izv. Vuzov, Ser. Khim., 5, 932 (1962).
9. F. T. Pozharskii, V. Ts. Bukhaeva, A. M. Simonov, and R. A. Savel'eva, Khim. Geterotsikl. Soedin., 183 (1969).