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SYNTHESIS OF 2,5-DISUBSTITUTED 1,3,4-OXADIAZOLES FROM TRICHLOROMETHYLARENES AND ACYLHYDRAZINES

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A preparative synthesis of 2,5-disubstituted 1,3,4-oxadiazoles by the reaction of trichloromethylarenes with hydrazides of carboxylic acids of the aliphatic, aromatic and heteroaromatic series in methanol or ethanol in the presence of pyridine was developed.

In the study of the reactions of benzotrichloride with hydroxylamine and hydrazines in pyridine [1-4] in addition to the reductive condensation products – benzaldoxime, benzonitrile, benzaldazine and N-substituted benzalhydrazones – the heterocyclization products – 3,5-diphenyl-1,2,4-oxadiazole and 2,5-diphenyl-1,3,4-oxadiazole – have also been isolated in low yields. Similar results were also obtained by us in the reaction of trichloromethylarenes with semicarbazide and thiosemicarbazide [5, 6]: in addition to the corresponding semicarbazones and thiosemicarbazones, 2-amino-5-aryl-1,3,4-oxadiazoles and 2-amino-5-aryl-1,3,4-thiadiazoles were isolated in up to 30% yields. Furthermore, the ratio of the two competing processes is substantially dependent on the structure of trichloromethylarene and is probably determined by the relative ease of reduction of the latter – for benzotrichloride the yields of oxa- and thiadiazoles were higher than those of the reductive condensation products, in the case of 2,4-dimethylbenzotrichloride, the products of the two reactions were obtained in close to 1:1 ratios, while 2,4,6-trimethylbenzotrichloride gave only the corresponding semicarbazone and thiosemicarbazone.

The aim of the present work was to find such conditions for the reaction of trichloromethylarenes (I) with acylhydrazines (II), which would be optimal for the heterocyclization (Scheme 1, path "*a*"), leading to 2,5-disubstituted 1,3,4-oxadiazoles (III-V), and which would enable the suppression of the reductive condensation (path "b") leading to hydrazones (VI).

In order to find the dependence of the yield of the desired reaction end products on the structure of the starting compounds, we used six trichloromethylarenes (Ia-f) differing in the presence and character of the substituents and 11 hydrazides – derivatives of aliphatic (Ia), aromatic (IIb-g) and heteroaromatic (IIh-k) carboxylic acids.

The simplest method of optimization of the heterocyclization conditions could be by avoiding the use of pyridine as a solvent, since the latter, as we have shown previously [3], itself participates in the reduction process, converting into N-[N'-α-chlorobenzyl-4-pyridyl] pyridinium salt (VII), which gives further reductive condensation products with hydrazines. We made several attempts to exclude pyridine from the reaction studied, which, however, were unsuccessful. In particular, the restricted character was clarified of the range of applicability of the known synthesis of disubstituted 1,3,4-oxadiazoles from benzotrichloride and benzhydrazide or its 4-substituted derivatives in an alcoholic solution in the presence of sodium carbonate [7]: on using methanol (method A) or ethanol (method B) as solvents, with transition from benzotrichloride to its alkyl-substituted derivatives Ib and Ic, the alcoholysis of trichloromethylarenes is sharply accelerated, so that esters of the corresponding substituted benzoic acids became the main products, while the yields of oxadiazoles did not exceed 25% (see Table 1). In the case of mesitotrichloride Id, the esters of 2,4,6-trimethylbenzoic acids were found to be the only reaction products, and the yields reached 80-85%.

The use of triethylamine as solvent and base (method C), although excluding the possibility of alcoholysis, does not lead to increase in the yield of oxadiazoles. In the absence of a base the alcoholysis preferentially takes place in methanol or ethanol.

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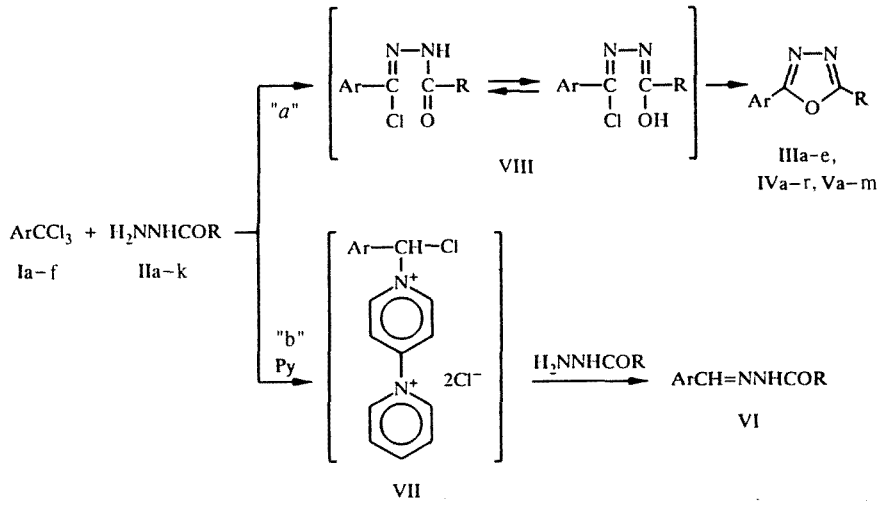
Scheme 1



Ia Ar = Ph, b Ar = 2,4- $Me_2C_6H_3$, c Ar = 2,4,5-$Me_3C_6H_2$, d Ar = 2,4,6-$Me_3C_6H_2$, e Ar = 2,3,4,5-Me_4C_6H, f Ar = 3-Br- C_6H_4; II a R = Me, b R = Ph, c R = HOC_6H_4, d R = 2-$O_2NC_6H_4$, e R = 3-$O_2NC_6H_4$, f R = 4- $O_2NC_6H_4$, g R = 2,4,5-$Me_3C_6H_2$, h R = 4,5-dibromo-2-furyl, i R = 2-thienyl, j R = 3-pyridyl, k R = 4-pyridyl; IIIa-c R = Me; a Ar = Ph, b Ar = 2,4,5-$Me_3C_6H_2$, c Ar = 2,4-$Me_2C_6H_3$; IVa-e Ar = Ph; a R = Ph, b R = 2-HOC_6H_4, c R = 2-$O_2NC_6H_4$, d R = 3-$O_2NC_6H_4$, e R = 4-$O_2NC_6H_4$; f Ar = 3-BrC_6H_4, R = Ph; g-k Ar = 2,4-$Me_2C_6H_3$; g R = Ph, h R = 2-HOC_6H_4, i R = 2-$O_2NC_6H_4$, j R = 3-$O_2NC_6H_4$, k R = 4-$O_2NC_6H_4$; *l*-p Ar = 2,4,5-$Me_3C_6H_2$; *l* R = Ph, m R = 2-HOC_6H_4, n R = 2- $O_2NC_6H_4$, o R = 3- $O_2NC_6H_4$, p R = 4- $O_2NC_6H_4$; q, r Ar = 2,3,4,5-Me_4C_6H, q R = 3-$O_2NC_6H_4$, r = 2- HOC_6H_4; Va-d Ar = Ph; a R = 4,5-dibromo-2-furyl, b R = 2-thienyl, c R = 3-pyridyl, d R = pyridyl, e Ar = 3-BrC_6H_4, R = 4-pyridyl; f-i Ar = 2,4-$Me_2C_6H_3$; f R = 4,5-dibromo-2-furyl, g = R = 2-thienyl, h R = 3-pyridyl, i R = 4-pyridyl; j-m Ar = 2,4,5-$Me_3C_6H_2$; j R = 4,5-dibromo-2-dibromo-2-furyl, k R = 2-thienyl, l R = 3-pyridyl, m R = 4-pyridyl; n Ar = 2,34,5-Me_4C_6H; R = 4-pyridyl.

Better results are obtained by boiling the reagents in a methanol–pyridine (method D) or ethanol-pyridine (method E) solution (ratio of alcohol–pyridine 2:1-5:1) for 6-16 h. Addition of sodium carbonate to the methanol–pyridine mixture (method F) only leads to a decrease in the yield because of a more effective alcoholysis. The yields of oxadiazoles (III-V), the reaction conditions and the characteristics of the compounds obtained are listed in Table 1.

Considering the influence of the structure of the starting compounds on the ease of formation of oxadiazoles III-V, it should be emphasized that the effect of the structure of the hydrazide is manifested fairly weakly. Thus, in the reaction of trichloromethylarenes Ia-c with nitrobenzhydrazides IId-f some decrease in the yields of oxadiazoles IV is observed on transition from meta- and para-nitrobenzhydrazides to the ortho-isomer, which can be explained by steric hindrances to the heterocyclization produced by the ortho-nitro group. At the same time, the OH group at the ortho-position – a less bulky substituent, having in addition an opposite polar character, cannot possibly exhibit any substantial influence on the yield of the oxadiazoles. For the reactions of trichloromethylarenes with hydrazides of the heteroaromatic series some decrease is observed in the yields of the desired end products V in comparison with the yields of oxadiazoles IV in reactions with the hydrazides of aromatic acids, which decrease is especially evident for hydrazides IIh, i – derivatives of 4,5-dibromo-2-furancarboxylic and 2-thiophenecarboxylic acids.

On transition from unsubstituted benzotrichloride Ia to alkyl-substituted Ib, c, e, the yields of oxadiazoles decrease, which is attributable to the acceleration in the same sequence of the parallel proceeding alcoholysis. In the case of 2,4,6-trimethylbenzotrichloride Id, even under the optimal conditions for of heterocyclization, i.e., on heating of the trichloromethylarene and hydrazide in an alcohol-pyridine solution (methods D and E), the desired oxadiazoles cannot be obtained: only the reductive condensation products are formed – the substituted hydrazones of 2,4,6-trimethylbenzaldehyde VI and esters of 2,4,6-trimethylbenzoic acid, formed as the result of the alcoholysis of trichloride Id. This result may be con-

TABLE 1. Preparation Conditions, Yields and Characteristics of Oxadiazoles III-V

Compound	Empirical formula [Ref]	mp, °C	M+·	Yield, % (method, durationn of reaction, h)
IIIa	[7]	63...65	160	38 (A, 8); 52 (D, 8)
IIIb	$C_{12}H_{14}N_2O$	89...91	202	46 (D, 8)
IIIc	$C_{11}H_{12}N_2O$	71...73	188	31 (D, 8)
IVa	[7—9]	139...140	222	77 (A, 11); 23 (C 15); 85 (D, 8)
IVb	[10]	163...165	238	24 (A, 6); 19 (B, 6); 80 (D, 7); 52 (F, 14)
IVc	[8, 11]	119...120	267	52 (A, 6)
IVd	[8, 11]	154...155	267	39 (A, 9); 81 (D, 14)
IVe	[7, 8]	206...208	267	30 (A, 14); 79 (D, 14); 35 (F, 14)
IVf	$C_{14}H_9BrN_2O$	125...126	300	12 (A, 14); 22 (D, 30); 25 (D, 25)
IVg	$C_{16}H_{14}N_2O$	98...99	250	79 (D, 7)
IVh	$C_{16}H_{14}N_2O_2$	129...131	266	70 (D, 9)
IVi	$C_{16}H_{13}N_3O_3$	117...118	295	62 (D, 8)
IVj	$C_{16}H_{13}N_3O_3$	150...152	295	80 (D, 9)
IVk	$C_{16}H_{13}N_3O_3$	192...193	295	85 (D, 7)
IVl	$C_{17}H_{16}N_2O$	134...135	264	72 (D, 9)*2; 79 (D, 9)*3
IVm	$C_{17}H_{16}N_2O_2$	166...167	280	65 (D, 8)
IVn	$C_{17}H_{15}N_3O_3$	145...146	309	64 (D, 9)
IVo	$C_{17}H_{15}N_3O_3$	169...171	309	20 (A, 6); 75 (D, 6)
IVp	$C_{17}H_{15}N_3O_3$	224...226	309	73 (D, 9)
IVq	$C_{18}H_{17}N_3O_3$	193...194	323	64 (D, 7)
IVr	$C_{18}H_{18}N_2O_2$	162...163	294	56 (D, 9)
Va	$C_{12}H_6Br_2N_2O_2$	164...165	368	62 (D, 9)
Vb	[8]	118...119	228	69 (D, 8)
Vc	[8]	124...126	223	76 (D, 8)
Vd	[8, 10, 12]	144...145	223	50 (A, 4); 97 (D, 15)
Ve	$C_{13}H_8BrN_3O$	153...155	301	21 (A, 25); 35 (D, 25); 25 (E, 24)
Vf	$C_{14}H_{10}Br_2N_2O_2$	142...143	396	52 (D, 9)
Vg	$C_{14}H_{12}N_2OS$	95...96	256	65 (D, 9)
Vh	$C_{15}H_{13}N_3O$	139...141	251	66 (D, 8)
Vi	$C_{15}H_{13}N_3O$	138...140	251	30 (A, 8); 62 (D, 8)
Vj	$C_{15}H_{12}Br_2N_2O_2$	184...185	410	50 (D, 8)
Vk	$C_{15}H_{14}N_2OS$	160...161	270	54 (D, 9)
Vl	$C_{16}H_{15}N_3O$	138...140	265	54 (D, 7)
Vm	$C_{16}H_{15}N_3O$	180...181	265	23 (A, 3); 65 (D, 7)
Vn	$C_{17}H_{17}N_3O$	189...191	279	58 (D, 9)

*The data for molecular ions of bromine-containing compounds are given according to peaks containing ^{79}Br.

*2Yield of the product obtained from Ic and IIa.

*3Yield of the product obtained from Ia and IIg.

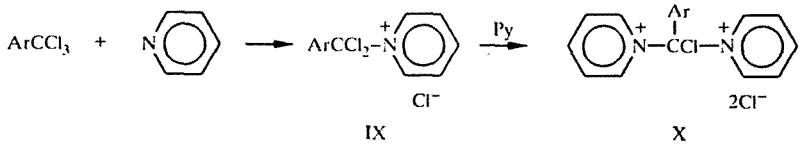
sidered to be the result of steric hindrances to heterocyclization, produced by two orthomethyl substituents, but this effect, if it takes place, plays only a minor role, since even dimesityl-1,3,4-oxadiazole has been described [13].

It is possible that a coordinated polar effect of three methyl groups, strongly facilitating the nucleophilic substitution of chlorine atoms in the trichloromethylarene molecule by the action of an alcohol is of a decisive importance, the contribution of pyridine to which cannot be ignored. In this connection we should note the exceptional ease of hydrolysis and alcoholysis of 3,5-ditert-butyl-2-trichloromethylthiophene, caused by the coordinated action of two tert-butyl groups, recently described by us in [14].

In Scheme 1 (path "*a*") an assumed sequence of stages during heterocyclization is given, which includes the intermediate formation of hydrazonoyl chlorides (VIII). The formation of these compounds is indubitable when the reaction is carried out in triethylamine, but under different conditions it is not at all obvious. To clarify the mechanism of the reaction of benzotrichlorides with hydrazides in an alcohol—pyridine solution, and, in particular, the role of pyridine, we investigated

thepossibility of the participation in the heterocyclization of mono- (IX) or bispyridinium (X) salts forming in the reaction of trichloromethylarenes with pyridine according to Scheme 2.

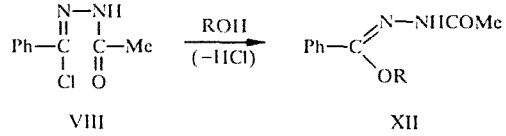
Scheme 2



IX X

We showed that a salt of type X (Ar = 2,4,5-$Me_3C_6H_2$), which is capable of reacting with benzhydrazide in methanol, converts into oxadiazole IV*l* (yield 14%), but we were unable to detect the formation of salts of type X under the heterocyclization conditions. On the other hand, N,N′-diaroylhydrazines or N-aroyl-N′-heteroaroylhydrazines may form under the heterocyclization conditions, for example due to condensation with hydrazides of esters formed as a result of the alcoholysis of benzotrichlorides. In particular, in the reaction of 2,4,5-trimethylbenzotrichloride with salicylhydrazide by method D, in addition to oxadiazole IVm, a small amount of N-benzoyl-N′-(2-hydroxybenzoyl)-hydrazine (XIa) was isolated. On the basis of the specially prepared N-benzoyl-N′-(3-nitrobenzoyl)hydrazine (XIb), it was shown that these N,N′-diacylhydrazines do not cyclize on boiling in methanol–pyridine solution. The most probable mechanism appears to be the participation in the heterocyclization of esters of N′-acylbenzhydrazonic acids of type XII, which may form, for example, during the alcoholysis of hydrazonoyl chlorides of type VIII. The practicability of this path of heterocyclization is confirmed by the separation from the reaction mixture of a small amount of ester XII, the occurrence of which is illustrated

Scheme 3



VIII XII

VIII, XII Ar = Ph, R = Me

by scheme 3. When methanol was used, the corresponding ester could not be isolated, which agrees with the data in [7] on the substantially greater ease of cyclization of methyl esters of type XII into oxadiazoles in comparison with ethyl esters (in [7] the cyclization was carried out in alcoholic solutions in the presence of sodium carbonate).

The structure of the newly synthesized products was confirmed by the data of the elemental analysis, mass spectrometry, IR and NMR spectroscopy. In the IR spectra of all the oxadiazoles there are absorption bands in the 1620-1600 ($\nu_{C=N}$) and 1190-1100 cm^{-1} (ν_{N-C-C}) regions, which are characteristic for the oxadiazole ring and agree with the data published in the literature [8-10, 12]. A separate article [15] will be devoted to a detailed description of the ^1H and ^{13}C NMR spectra of oxadiazoles III-V.

We have thus developed a simple one step synthesis of 2,5-disubstituted 1,3,4-oxadiazoles from trichloromethylarenes and acylhydrazines, clarified the range of applicability of this method, including the possibility of using the hydrazides of heteroaromatic acids, studied the dependence of the yield of the oxadiazoles on the structure of the starting compounds and obtained some data on the heterocyclization mechanism.

EXPERIMENTAL

The ^1H NMR spectra were recorded on a Bruker WM 250 radiospectrometer (250 MHz) in $CDCl_3$ and DMSO-d_6. The IR spectra were run on Perkin–Elmer 577 and Specord-80 spectrophotometers in KBr tablets. The mass spectra were obtained on Varian MAT CH-6 and Kratos MS-30 mass spectrometers with direct introduction of the sample into the ionic

source, using an ionizing voltage of 70 eV and an emission current of 0.1 mA. The melting points were measured on a Boetius microscope stage and were not corrected. The elemental analysis results of the synthesized compounds for C, H, S (Br) corresponded to the calculated data. Commercial samples of benzotrichloride Ia and hydrazides IIa-f were used. Trichloromethylarenes Ib-e were obtained by electrophilic trichloromethylation, as described in [16] (Ib, c), [17] (Id) and [17, 18] (Ie), while 3-bromobenzotrichloride If — by the action of $AlCl_3$ and AcCl on 3-bromobenzotrifluoride according to the method described in [19]. Hydrazides IIg-k were synthesized by a known method [20] — boiling of methyl or ethyl esters of the acids with hydrazine hydrate in an alcoholic solution. Hydrazides (IIg) and (IIh) were synthesized for the first time.

Hydrazide of 2,4,5-trimethylbenzoic acid (IIg, $C_{10}H_{14}N_2O$), mp 168-170°C (from alcohol), M^+ = 178. PMR spectrum (DMSO-d_6): 2.18 and 2.21 (6H, s, 4- and 5-Me), 2.27 (3H, s, 2-Me), 6.98 and 7.07 (2H, s, s, 3- and 6-H), 9.27 (1H, s, NH), 4.40 (2H, br., NH_2). Yield 72%.

Hydrazide of 4,5-dibromo-2-furancarboxylic acid (IIh, $C_5H_4Be_2N_2O_2$), mp 195-197°C, M^+ 282, 284, 286 (2 Br atoms). IR spectrum: 3315, 3240 (ν_{NH}, ν_{NH2}), 1655 ($\nu_{C=O}$), 1630, 1590, 1515, 1480 cm^{-1} (δ_{NH}, δ_{NH2}). Yield 83%.

Reaction of Trichloromethylarenes with Acid Hydrazides. A. A 0.005 mole portion of trichloromethylarene I was added dropwise to a mixture of 0.005-0.01 mole of anhydrous Na_2CO_3 and a solution of 0.005 mole of hydrazide II in 5-10 ml of methanol. The mixture obtained was boiled (duration is indicated in Table 1), the hot solution was filtered, the filtrate was partially evaporated, and the precipitate of the product that separated out on cooling was filtered off, washed with aqueous alcohol and recrystallized from methanol or ethanol. An additional amount of oxadiazole and (or) the methyl ester of the corresponding acid was obtained from the mother liquor after the evaporation of the alcohol, treatment with water and extraction with ether. The yields of oxadiazoles are given in Table 1. Methyl ester of 2,4-dimethylbenzoic acid n_D^{20} 1.5032, Lit. n_D^{20} 1.5015 [21]. Yield 60%. Methyl ester of 2,4,5-trimethylbenzoic acid n_D^{22} 1.5050, Lit. n_D^{20} 1.5050 [22]. Yield 71%. Methyl ester of 2,4,6-trimethylbenzoic acid n_D^{22} 1.5090, Lit. n_D^{20} 1.5083 [23]. Yield 88%.

B. The reaction was carried out in a similar way, but in ethanol.

C. A 0.0035 mole portion of benzotrichloride Ia was added to a suspension of 0.0035 mole of benzhydrazide IIb in 10 ml of triethylamine and the mixture was boiled for 15 h. The cooled solution was poured into water (40 ml) and extracted with ether. The extract was washed with water, dried over $MgSO_4$ and evaporated. Crystallization of the residue from methanol gave 0.18 g (23%) of 2,5-diphenyl-1,3,4-oxadiazole IVa. After evaporation of the mother liquor 0.40 g (58%) of unreacted benzotrichloride remained (TLC on Silufol, eluent—ethyl acetate—hexane, 2:1).

D. A 0.005 mole portion of trichloromethylarene I was added to a solution of 0.005 mole of hydrazide II in 4-10 ml of methanol and 1-2.5 ml of dry pyridine. The mixture was boiled for 6-25 h (Table 1) and further treated as described in method A. Oxadiazoles IIIa-c were isolated after the evaporation of the ethereal extract and recrystallized from hexane or aqueous ethanol. From the mixture obtained as a result of the reaction of mesitotrichloride Id with benzhydrazide IIb (boiling for 9 h), crystals of benzoylhydrazone of 2,4,6-trimethylbenzaldehyde (VI, $C_{16}H_{18}N_2O$) separated out after cooling and were filtered off and washed with aqueous ethanol. After the evaporation of the filtrate an additional amount of the above benzoylhydrazone was obtained. The overall yield was 0.67 g (46%), mp 199-200°C, M^+ = 266; IR spectrum: 3196 (ν_{NH}), 2968, 2916 (ν_{CH3}), 1652 ($\nu_{C=O}$), 1600 ($\nu_{C=N}$) cm^{-1}; PMR spectrum (DMSO-d_6): 2.23 (3H, s, 4-Me), 2.41 (6H, s, 2- and 6-Me), 6.90 (2H, s, 3-H and 5-H), 7.53 (3H, m, m- and p-H_{Ph}), 7.93 (2H, m, o-H_{Ph}), 8.77 (1H, s, CH=N), 11.72 (1H, s, NH). The compound was identical with an authentic sample obtained from 2,4,6-trimethylbenzaldehyde and benzhydrazide in ethanol (absence of a depression of the melting point in a mixed sample). Treatment of the mother liquor remaining after the separation of hydrazide VI with water and further extraction with ether gave 0.34 g (35%) of an oily methyl ester of 2,4,6-trimethylbenzoic acid (TLC data), n_D^{22} 1.5097. Lit. n_D^{20} 1.5083 [23]. In the reaction of mesitotrichloride Id with benzhydrazide IId, in addition to 2-(2-hydroxyphenyl)-5-2,4,5-trimethylphenyl)-1,3,4-oxadiazole IVm, N-2,4,5-trimethylbenzoyl-N′-2-hydroxybenzoylhydrazine (XIa, $C_{17}H_{18}N_2O_3$), was also isolated from the mother liquor, mp 227-229°C, M^+ 298. PMR spectrum (in DMSO-d_6): 2.22 (6H, br. s, 4-CH_3, 5-CH_3), 2.36 (3H, s, 2′-CH_3), 6.97 (2H, m, 3′-H, 5′-H), 7.07 (1H, s, 3-H), 7.27 (1H, s, 6-H), 7.45 (1H, t, 4′-H), 7.93 (1H, d, 6′-H), 10.27 (1H, s, NH), 10.67 (1H, s, NH), 12.04 (1H, s, OH), $J_{3',4'} = J_{4',5'} = 7.5$, $J_{5',6'} = 7.8$ Hz. Yield, 6%.

E. The reaction was carried out by method D, but in an ethanol—pyridine solution. Together with IIIa, the ethyl ester of N′-acetylbenzhydrazonic acid (XII) was obtained as a by-product (yield 12%), M^+ 206, mp 100-101°C; mp 102°C [7].

F. A 0.005 mole portion of trichloromethylarene I was added to a mixture of 0.005-0.01 mole of anhydrous sodium carbonate and a solution of 0.005 mole of hydrazide II in 4-10 ml of methanol and 1-2.5 ml of dry pyridine. The mixture was boiled for 5-15 h. The product was isolated as described in method A.

Synthesis of N,N′-2,4,5-Trimethyl-α-chlorobenzylbispyridinium Dichloride (X) and Its Reaction with Benzhydrazide. A 0.88 ml portion (0.0108 mole) of dry pyridine was added to a solution of 1.29 g (0.0054 mole) of 2,4,5-trimethylbenzotrichloride Ic in 5 ml of dry methylene chloride. The mixture was stirred and was held at room temperature for a further 30 days. The solvent was evaporated, the residue was treated with dry ether, the dark-brown precipitate was filtered rapidly, washed with ether and hexane, dried and stored in a vacuum desiccator over P_2O_5 or $MgSO_4$. The yield was 2.01 g (93%) of bispyridinium salt X. The melting point was not established because of the high hygroscopicity. PMR spectrum (in $CDCl_3$)): 2.19, 2.22 (6H, s, 4- and 5-Me), 2.62 (3H, s, 2-Me), 6.99 (1H, s, 3-H), 7.73 (1H, s, 6-H), 7.96 (4H, d.d, β-H), 8.42 (2H, m, δ-H), 8.85 (4H, m, α-H).

Salt X (0.003 mole) was introduced into a mixture of 0.003 mole of anhydrous Na_2CO_3 and a solution of 0.003 mole of benzhydrazide in 9 ml of methanol. The mixture was boiled for 5 h, cooled, poured into water and extracted with ether. From the residue, after the evaporation of the ether, 0.11 g (14%) of oxadiazole IV*l* was obtained by recrystallization from methanol, mp 134-135°C, M^+ 264, which was identical with samples obtained by method D (see Table 1).

Synthesis of N-Benzoyl-N′-3-nitrobenzoylhydrazine (XIb) and an Attempt of Its Cyclization into Oxadiazole. A 0.5 ml portion (4.27 mmoles) of benzoyl chloride was added to a solution of 4.27 mmoles of 3-nitrobenzhydrazide in 5 ml of methanol and 2.1 ml of dry pyridine, and the mixture was boiled for 8 h. After cooling and evaporation of the solution, 1.03 g (84%) of diacylhydrazine XIb was obtained, mp 222-224°C. M^+ 285. Lit. mp 220-222°C [24]. Oxadiazole IVd was not detected.

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