

BROMINATION OF 3-DIALKYLAMINO- AND 3-ARYLAMINO-2-ARYLPROPENENITRILES

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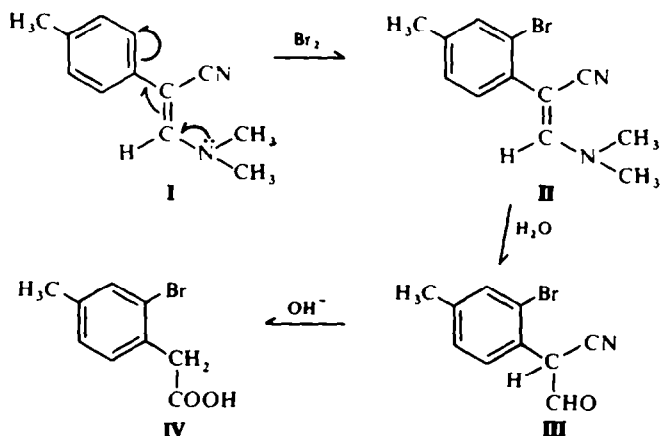
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Abstract—3-Dialkylamino- and 3-arylamino-2-arylpropenenitriles were brominated, and bromination occurred on the most reactive aromatic ring. The enamine function in the studied compounds would not participate in the reaction.

THE halogenation of enamines may follow several pathways, but the double bond generally participates in the reaction.^{1, 2}

In a previous report³ we have shown that 3-dialkylamino-2-phenylpropenenitriles⁴ were easily brominated and the 3-dialkylamino-2-(*p*-bromophenyl)propenenitriles had been the isolated products.

We now report a study of this new reaction. If the *para* position of the enamionitrile to be brominated was blocked, as in 3-dimethylamino-2-(*p*-tolyl)propenenitrile (I) [$\lambda_{\text{max}}^{\text{HCCl}_3}$ 317m μ (ϵ , 8,410), 298 (9,030) and 260 (3,790)]. The attack of bromine occurred at a free *ortho* position and the unstable 3-dimethyl-amino-2-(*o*-bromo-*p*-tolyl)propenenitrile (II) was produced.



II decomposed on exposure to moisture into III, whose elemental analysis indicated the empirical formula C₈H₈NBrO. The IR spectrum presented bands at 2232 (nitrile), 1639 (C=O) and 826 cm⁻¹ (1,2,4-trisubstituted benzene). By alkaline hydrolysis III afforded 2-bromo-4-tolylacetic acid (IV) whose IR spectrum showed strong absorption

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bands at 1701, 1232 (carboxyl), 833 and 797 cm^{-1} (1,2,4-trisubstituted benzene). The position of the bromine in IV was established through comparison of the NMR spectrum of the product and that of *p*-tolylacetic acid. IV presented resonances at 7.22 and 7.52 (3H, aromatic); 3.83 (2H, methylene) and 2.32 ppm (3H, Me). Chauffe *et al.*⁵ assigned to *p*-tolylacetic acid peaks at 7.18 (4H, aromatic); 3.59 (2H, methylene) and 2.28 ppm (3H, Me). The chemical shift of the methylene in IV to lower fields could be due to the deshielding effect of the bromine.

The results obtained in the reaction of I and bromine encouraged us to try the syntheses and bromination of other related enamionitriles. The reaction took a different direction when 3-dialkylamino was replaced by 3-aryl amino groups. In Table 1 are summarized the 3-aryl amino-2-arylpropenenitriles brominated and the course of the reaction.

TABLE I

V, R = R ₁ = R ₂ = H	VI, R = R ₂ = H; R ₁ = Br
λ_{max} 338 m μ (ϵ 30,700), 295 (14,600) and 244 (22,400)	λ_{max} 339 m μ (ϵ 31,200), 298 sh (15,700) and 241 (13,600)
VI	VII, R = R ₁ = Br; R ₂ = H
VII	λ_{max} 346 m μ (ϵ 40,600), 305 (20,400) and 240 (26,700)
VIII, R = CH ₃ ; R ₁ = R ₂ = H	NO BROMINATION
λ_{max} 338 m μ (ϵ 26,100), 294 (13,500) and 243 (18,800)	IX, R = CH ₃ ; R ₁ = Br; R ₂ = H
X, R = R ₂ = H; R ₁ = CH ₃	λ_{max} 345 m μ (ϵ 33,000), 304 (17,600) and 243 (23,300)
λ_{max} 336 m μ (ϵ 24,000), 298 (14,200) and 240 (19,500)	XI, R = Br; R ₁ = CH ₃ ; R ₂ = H
XI	λ_{max} 339 m μ (ϵ 21,000), 300 sh (11,400) and 243 (10,300)
XIII, R = R ₁ = CH ₃ ; R ₂ = H	XII, R = R ₂ = Br; R ₁ = CH ₃
λ_{max} 339 m μ (ϵ 22,700), 301 (14,000) and 242 (14,200)	λ_{max} 336 m μ (ϵ 22,900), 305 sh (12,900) and 240 (14,000)
UV spectra: solvent CHCl ₃	XIV, R = R ₁ = CH ₃ ; R ₂ = Br
	λ_{max} 345 m μ (ϵ 27,400), 306 (15,800) and 245 (24,000)

A consistent interpretation of the experimental data is that the enamine function in the studied compounds did not react with bromine, and the bromination occurred by electrophilic attack on the most reactive aromatic ring.

The participation of enamionitrile double bond in the reaction was discarded because UV spectra have not shown appreciable changes, but a bathochromic shift for

most of the bands, during the bromination. Besides, VII, with both *para* positions blocked by bromine, had no reaction after being in contact with the halogen for 24 hr.

The nature of the blocking substituents in the *para* positions is very important. Blocking substituents with +I, as a methyl group, produced an additional activation of the aryl groups and the halogenation could take place. For example, in XI and XIII the *ortho* position of the *N*-tolyl moiety could be brominated.

That the enamine double bond did not participate in the bromination is in accordance with the behaviour of these compounds in other typical reactions. The enamionitriles have failed to react with iodine, cyanogen bromide, diazomethane, acrylonitrile, methyl

TABLE 2

Compd	Formula	Mp., °C ^c	Yield	Analyses	
				Requires	Found
I	C ₁₂ H ₁₄ N ₂	85-86	84	C, 77.41 H, 7.57 N, 15.05	C, 77.20 H, 7.30 N, 15.41
II	C ₁₂ H ₁₃ BrN ₂	decomposed			
V	C ₁₄ H ₁₂ N ₂	157-158 ^b	85	C, 81.81 H, 5.45 N, 12.72	C, 82.00 H, 5.70 N, 12.60
VI	C ₁₄ H ₁₁ BrN ₂	178-179 ^c	81	C, 60.22 H, 3.70 N, 9.36	C, 60.34 H, 3.95 N, 9.10
VII	C ₁₅ H ₁₀ Br ₂ N ₂	213-214	70	C, 47.61 H, 2.64 N, 7.40	C, 48.00 H, 3.00 N, 7.53
VIII	C ₁₆ H ₁₄ N ₂	142-144	73	C, 82.05 H, 7.29 N, 14.58	C, 82.40 H, 7.10 N, 14.40
IX	C ₁₆ H ₁₃ BrN ₂	187-188	64	C, 61.34 H, 4.15 N, 8.94	C, 61.70 H, 4.40 N, 9.25
X	C ₁₆ H ₁₄ N ₂	129-130 ^d	80	C, 82.05 H, 7.29 N, 14.58	C, 82.40 H, 7.50 N, 14.60
XI	C ₁₆ H ₁₃ BrN ₂	183-185	68	C, 61.34 H, 4.15 N, 8.94	C, 61.40 H, 4.32 N, 9.10
XII	C ₁₆ H ₁₂ Br ₂ N ₂	147-148	60	C, 48.97 H, 3.06 N, 7.14	C, 48.70 H, 2.80 N, 6.93
XIII	C ₁₇ H ₁₆ N ₂	143-145	66	C, 82.25 H, 6.45 N, 11.29	C, 82.00 H, 6.59 N, 11.40
XIV	C ₁₇ H ₁₅ BrN ₂	175-177	55	C, 62.38 H, 4.58 N, 8.56	C, 62.60 H, 4.70 N, 9.05

^a The compounds were recrystallized from xylene, except IX from C₆H₆-petroleum ether. ^b Lit.⁷ m.p. 157-158°. ^c See ref 6. ^d Lit.⁷ m.p. 128°.

acrylate,⁶ sodium borohydride or lithium aluminium hydride and in every instance the unchanged enamine was recovered. This showed that these enamionitriles have a very low double bond contribution to the resonance hybrids.

EXPERIMENTAL

The analytical values of the compounds, unless otherwise stated, are recorded in Table 2.

M.ps are uncorrected and were taken on a Fischer-Johns hot stage. IR spectra were measured as Nujol mulls between NaCl plates on a Perkin-Elmer Model 137E Infracord. Satisfactory IR spectra were recorded for all compounds listed in Tables. UV absorption spectra were recorded on a Beckman DB-G spectrophotometer. NMR spectra were determined with a Varian A-60 instrument, using CDCl_3 as solvent. Chemical shifts are reported as parts per million downfield from TMS as internal reference. Microanalyses were performed at this laboratory.

3-Dimethylamino-2-(p-tolyl)propenenitrile (I). A mixture of 10 g of α -formil- α -(p-tolyl)acetone nitrile in 40 ml DMF was heated at 180° for 5 hr. After cooling, the mixture was diluted with water. The deposited material was filtered, washed with water, dried and recrystallized (light petroleum) to give 9.8 g (84%) of I.

3-Arylamino-2-arylpropenenitriles—general procedure. 0.01 Mole of the α -formil- α -arylacetone nitrile and 0.01 mole of the aniline were cautiously mixed. When spontaneous reaction ceased, the mixture was heated at 140 – 150° for 1 hr. Upon cooling, the residue was recrystallized.

Bromination of enamionitriles—general procedure. To a cold soln of 0.01 mole of the enamine in 10 ml CHCl_3 , were added dropwise 12.8 ml of the soln containing 12.5 g Br_2 per 100 CHCl_3 , while the flask was shaken. The reaction was quite rapid; the Br colour quickly disappeared. The soln was concentrated under reduced pressure, cooled and the residue recrystallized. II decomposed by exposure to moisture to III, yield: 71% (C_6H_6 -light petroleum), m.p. 148 – 149° . Found: C, 50.6; H, 3.70; N, 5.63. $\text{C}_{10}\text{H}_8\text{BrNO}$ requires: C, 50.42; H, 3.36; N, 5.88).

Alkaline hydrolysis of the bromoenamines. 1 g of the bromoenamine was dissolved in 5 ml EtOH diluted with 5 ml 10% NaOH aq and boiled under reflux from 5 to 20 hr. Most of the solvent was eliminated and the water insoluble residue extracted twice with CHCl_3 , dried (MgSO_4), the solvent evaporated and the amine identified.

The alkaline water soln was made acid by addition of 10% HCl aq. After standing, the ppt was filtered off, washed, dried and the acid identified as IV, yield: 72% ($\text{EtOH}-\text{H}_2\text{O}$), m.p. 144 – 145° . (Found: C, 47.4; H, 4.20. $\text{C}_9\text{H}_8\text{BrO}_2$ requires: C, 47.16; H, 3.93).

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