

SYNTHESIS AND SOME REACTIONS OF PHENYLENE-1, 4DI (1-PHENYL-1-PROPENONE)

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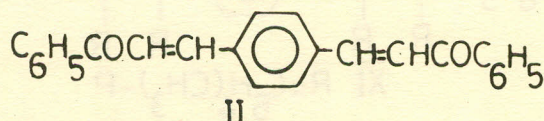
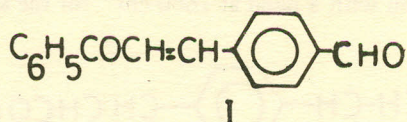
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The condensation of acetophenone with terephthalic aldehyde (molar ratio 2:1) gave mono- and bis-chalcones I and II respectively, but when the molar ratio of ketone to the aldehyde increased (4:1) only II was obtained. The reaction of II with hydrogen peroxide, active methylene (under Michael condensation conditions) aromatic hydrocarbons (under Friedel-Crafts conditions), hydrazines, hydroxylamine hydrochloride and bromine have been studied. Also the reaction of tetrabromide VIII with hydrazines hydroxylamine hydrochloride and aromatic hydrocarbons (under Friedel-Crafts conditions) has been described.

INTRODUCTION

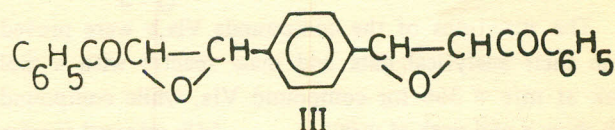
The condensation of acetophenone with terephthalic aldehyde using a molar ratio (2:1) in sodium hydroxide (10%) as a base yielded *p*-phenyl-1-propenone-1-benzaldehyde (I) in 25% yield and phenylene-1,4-di(1-phenyl-1-propenone) (II) in 70% of the total yield. When the condensation was carried out using an excess from the ketone to the aldehyde (4:1) only II was obtained in about 90% yield.



The structure of compounds I and II were proved from their (a) analytical analysis, (b) ir spectra which showed for I an absorption band at 1700 cm^{-1} ($\nu(\text{CO})$) of the aldehydic group and at 1660 cm^{-1} for the aromatic carbonyl while the spectrum of II gave a band at 1550 cm^{-1} for the aromatic carbonyls, (c) $^1\text{H-N.M.R}$ spectra which showed a singlet at $\delta = 10.06\text{ ppm}$ for the aldehydic proton and a multiplet at $\delta = 8.16-7.30\text{ ppm}$ for olefinic and aromatic protons of compound I, while for II it showed two multiplets at $\delta = 8.2-8.0\text{ ppm}$ and at $\delta = 7.93-7.33\text{ ppm}$ for the olefinic and aromatic protons and (d) mass spectra which show a mol peak at $m/e = 236$ for I and for II a mol peak at $m/e = 338$ (fragmentation in the experimental).

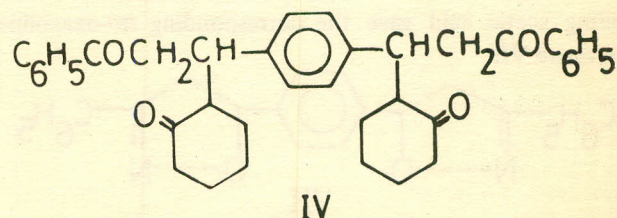
The reaction of hydrogen peroxide with α' β -unsaturated ketones was reported to give the epoxy ketones [1, 2].

In this study, the treatment of II with hydrogen peroxide in the presence of sodium hydroxide gave a bis-epoxide III.



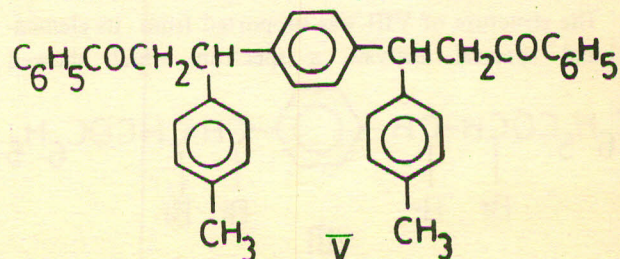
The proposed structure ir for III was supported from (a) its analytical data and (b) ir spectrum which showed strong absorption bands at 1660 cm^{-1} ($\nu(\text{CO})$) ir and at 1240 cm^{-1} (epoxide linkage).

Michael condensation of the chalcone, II with active methylene such as cyclohexanone in the presence of sodium methoxide yielded IV [3, 4].



The structure of the compound IV was proved from (a) its analytical data and (b) ir spectrum which showed strong types of carbonyl frequencies at 1700 cm^{-1} and at 1675 cm^{-1} for cyclic and aromatic ketones respectively.

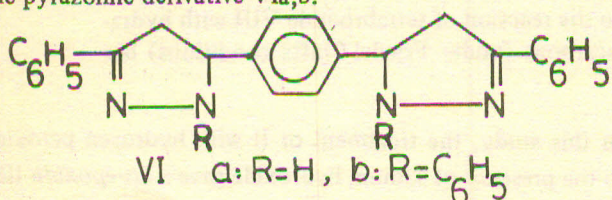
The Friedel-Crafts reaction can be also carried out with α' β -unsaturated ketones [1]. This reaction can be



extended to the chalcone II which on treatment with aromatic hydrocarbons such as toluene in the presence of anhydrous aluminium chloride gave an arylated derivative V.

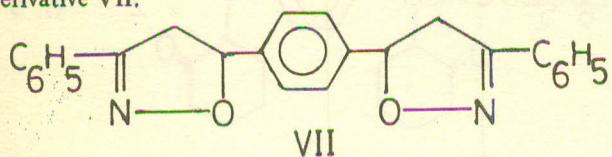
The structure of V was established from it, (a) analytical data and (b) ir spectrum which showed an absorption band at 1665 cm^{-1} for the aromatic ketone.

Hydrazines and hydroxylamine hydrochloride react easily with α, β -unsaturated ketones producing pyrazolines and *iso*-oxazolines respectively [5]. This reaction has now been extended to II which on treatment with hydrazine hydrate and/or phenylhydrazine in acetic acid gave the corresponding hydrazone which rearranged to the pyrazoline derivative VIa,b.



The structures of the compounds VIa,b were proved from their analytical data and mass spectra with a mol peak at $m/e = 366$ for compound VIa, while compound VIb show a mol peak at $m/e = 518$; infrared spectra which showed for VIa a band at 3350 cm^{-1} ($\nu(\text{NH})$) and at 1580 cm^{-1} ($\nu(\text{C}=\text{N})$), while for VIb it showed a band at 1595 cm^{-1} ($\nu(\text{C}=\text{N})$); $^1\text{H.n.m.r.}$ (cf. Experimental); and the colour test [6]. A drop of ferric chloride solution added to a concentrated sulphuric acid solution of the compounds VIa,b, gave a violet blue colour.

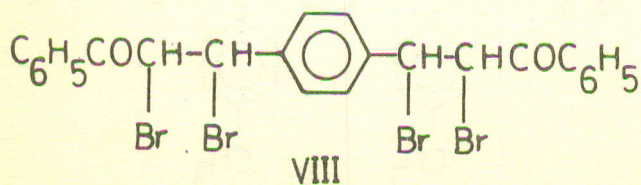
Treatment of II with hydroxylamine hydrochloride in boiling acetic acid gave the corresponding *iso*-oxazoline derivative VII.



The structure of VII was proved through, (a) analytical data, ir spectrum with an absorption band at 1615 cm^{-1} ($\nu(\text{C}=\text{N})$) and (c) mass spectrum with a mol peak at $m/e = 386$ (fragmentation, cf. Experimental).

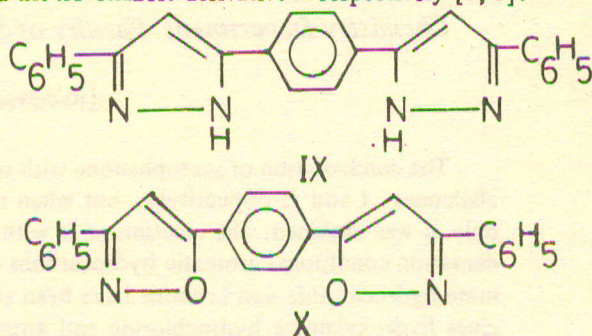
The bromination of II in acetic acid yielded the corresponding tetrabromide VIII.

The structure of VIII was supported from its elemental and spectral analysis, ir spectrum which showed



an absorption band at 1680 cm^{-1} ($\nu(\text{CO})$) and (c) mass spectrum gave a mol peak at $m/e = 685$ (cf. Experimental).

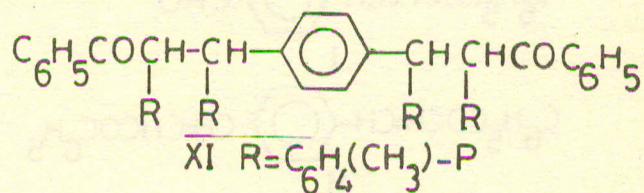
Treatment of the tetrabromide VIII with hydrazine hydrate and/or hydroxylamine hydrochloride in acetic acid yielded the corresponding pyrazole derivative IX, and the *iso*-oxazole derivative X respectively [7, 8].



The proposed structures IX and X were confirmed from their spectral and elemental analysis i.e. spectra which showed a band at 1590 cm^{-1} [$\nu(\text{C}=\text{N})$] for compound IX and at 1585 cm^{-1} for compound X and mass spectra which gave a mol peak ion at $m/e = 362$ and for X a mol peak ion at $m/e = 366$.

Friedel-Crafts reaction of VIII with an aromatic hydrocarbon such as toluene in the presence of anhydrous aluminium chloride gave the arylated compound XI.

The structure of XI was established from its analysis and ir spectrum with a band at 1660 cm^{-1} for the aromatic ketone.



EXPERIMENTAL

Melting points are not corrected $^1\text{H.n.m.r.}$ were measured on Bruker HFX 90 (90 MHz) using tetramethylsilane as the internal reference. Infrared spectra were determined with a Perkin-Elmer model 157G spectrophotometer in KBr discs and mass spectra were carried out on MS 9 and MS 30 (AEJ Manchester).

Condensation of acetophenone with terephthalic aldehyde: formation of I, II. A mixture of 2.25 g sodium hydroxide in 20 ml water and 15 ml ethanol was cooled in an ice bath. 5.1 g (0.04 mol) acetophenone was added in one portion with stirring followed by 2.61 g (0.02 mol) terephthalic aldehyde dissolved in 15 ml ethanol; the solution became clear and after about 5 min. a yellow substance was precipitated. The stirring was continued for

another half hr; the solution was filtered off, washed with water followed by washing with ethanol. The solid product obtained was recrystallized from glacial acetic to give 4.2 g (68%) II as yellow crystals, mp 204 °C (lit. [a] mp 200°). The mother liquor was concentrated and the solid product obtained was recrystallized from ethanol to afford 1.16 g (24%) I, mp 130-1° (lit. [9] mp 125).

When this experiment was repeated using an excess from acetophenone 6 g (0.05 mol) and terephthalic aldehyde, 1.67 g (0.012 mol) and the stirring time was increased to 2 hr. at room temperature, it gave 3.7 g (90%) II. Compound I: $C_{16}H_{12}O_2$ (236.27), Calcd. C: 81.33%, H: 5.12%.

Found C: 81.12%, H: 5.24%

MS (rel. int. %), m/e = 236 (M^+ , 100), 207(78), 179(61), 159(34), 131(50), 104(66), 77(84) and 51(57).

Compound II: $C_{24}H_{18}O_2$ (338.41); Calcd. C: 85.18%, H: 5.36%.

Found C: 84.98%, H: 5.45%.

MS (rel.int.%), m/e = 338(M^+ , 100), 310(11), 261(9) 233(99), 207(8), 178(7), 155(8), 127(21), 105(94), 77(89), 51(42) and 43(6).

Epoxidation of II: formation of oxirane derivative III. A solution of 0.4 g (1.2 mmol) of II in acetone (10 ml) and methanol (10 ml) was treated with 10% aqueous sodium hydroxide (10 ml) followed by hydrogen peroxide (30%, 5 ml). The solution was stirred and heated to boiling point during one hr. On cooling a crystalline substance separated out and was crystallized from acetone/ water to give 0.32 g (73%) III, mp 226-7°.

Compound III: $C_{24}H_{18}O_4$ (370.41); Calcd. C: 77.82%, H: 4.89%.

Found C: 77.58%, H: 5.02%

Michael reaction of II with cyclohexanone: formation of IV. 2 g sodium methoxide in 30 ml absolute methanol was added to a solution of 0.5 g (1.5 mmol) II and 0.3 g (3 mmol) cyclohexanone in 15 ml methanol. The reaction mixture was refluxed for 16 hr. After cooling it was poured into ice/water. The solid product was filtered off and recrystallized from ethanol to give 0.67 g (86%) of IV as colourless crystals, mp 258-60 °C.

Compound IV: $C_{36}H_{34}O_4$ (534.70); Calcd. C: 80.87%, H: 7.16%.

Found C: 80.73%, H: 7.02%.

Reaction of II with toluene (under Friedel Crafts conditions): formation of V. To a cooled stirred mixture of anhydrous aluminium chloride 2.66 g (20 mmol) in 20 ml dry toluene, a solution of 0.5 g (1.5 mmol) of II in 15 ml toluene was added. The stirring was continued for 3 hr. at room temperature and for 4 hr. under reflux. The reaction mixture was poured into cooled dilute hydrochloric acid and the excess of toluene was evaporated by steam distillation after which the obtained solid product was chromatographed by column chromatography on silica gel using carbon tetrachloride/methylene chloride (2:1, v/v) as an eluant. It gave 0.32 g (42%) of V after recrystallization from ethanol as scarlet red crystals, mp 192-5°.

Compound V: $C_{38}H_{28}O_2$ (516.64); Calcd. C: 88.34%, H: 5.46%.

Found C: 88.19%, H: 5.41%.

Reaction of II with hydrazines: formation of VIa, b. A mixture of 0.3 g (0.9 mmol) of II in 30 ml glacial acetic acid (2 mmol) hydrazine hydrate and/or phenylhydrazine was heated under reflux for 3 hr. The solid products obtained were crystallized from acetic acid (cf. Table 1).

Reaction of II with hydroxylamine hydrochloride: formation of VII. A mixture of 0.2 g (0.6 mmol) of II and

Table 1

Comp.	mp °C (yield)	Mol. formula (mol. wt.)	1H -n.m.r. (δ) ppm	Analysis %	
				Calcd.	Found
VIa	206-8 (75%)	$C_{24}H_{22}N_4$ (366.47)	3.66-2.50(m, 6H, CH ₂ , CH-H) 4.8(t, 2H, NH), 7.76-7.23 (m, 14H, Ar-H)	C: 78.66 H: 6.05 N: 15.29	78.13 6.24 15.41
VIb	238-9 (67%)	$C_{36}H_{30}N_4$ (518.66)	7.96-7.07(m, 14H, Ar-H), 3.2-2.91(m, 6H, CH ₂ , CH-N)	C: 83.37 H: 5.83 N: 10.80	82.81 5.89 11.02

0.2 g (2.85 mmol) hydroxylamine hydrochloride in glacial acetic acid (20 ml) with some drops of pyridine was refluxed for 5 hr. After cooling the reaction mixture was poured into ice/water where the obtained solid product was recrystallized from ethanol to give 0.181 g (83%) of VII as colourless crystals, mp 269-71°.

Compound VII: $C_{24}H_{20}N_2O_2$ (368.44); Calcd. C: 78.24%, H: 5.47%, N: 7.60%

Found C: 78.11% H: 5.49%, N: 7.71%

MS (rel. int. %), $m/e = 368(M^+, 74), 351(12), 321(4), 265(31), 248(84), 233(21), 219(45), 193(37), 178(24), 146(75), 131(100), 117(87), 103(100), 91(74)$ and $63(51)$.

$^1H_{n.m.r.}$ (DMSO- d_6), $\delta = 7.9-6.8$ ppm(m, 14H-Ar-H), 3.55-2.82 ppm(m, 6H, 2CH₂, 2CH-O).

Bromination of II: Formation of tetrabromide VIII. To 0.68 g (2.01 mmol) of II in 30 ml glacial acetic acid, 0.5 ml of bromine was added and the reaction mixture was refluxed for 1.5 hr. After cooling the solid product was filtered off and recrystallized from acetic acid to give 1.12 g (85%) of the corresponding tetrabromide VIII, mp more than 300°.

Compound VIII: $C_{24}H_{18}O_2Br_4$ (658.04); Calcd. C: 43.81%, H: 2.76%.

Found C: 43.98%, H: 2.89%.

MS (rel.int.,%), $m/e = 658(M^+, 3), 474(17), 417(77), 338(100), 309(19), 259(16), 233(86), 202(34), 189(7), 178(10), 127(25), 105(75)$ and $77(72)$.

Treatment of VIII with hydrazine hydrate: formation of IX. A mixture of 0.5 g (0.76 mmol) of VIII in ethyl alcohol (30 ml) and 0.3 g (3 mmol) hydrazine hydrate was heated under reflux for 5 hr. The reaction mixture was cooled, the solid product filtered off and recrystallized from ethanol to give 0.204 g (74%) of IX as colourless crystals with mp of over 310°.

Compound IX: $C_{24}H_{18}N_4$ (362.44); Calcd. C: 79.54%, H: 5.01%, N: 15.46%.

Found C: 79.41%, H: 4.93%, N: 15.32%.

MS (rel.int. %), $m/e = 362(M^+, 100), 336(10), 304(6), 230(11), 184(16), 181(52), 167(42), 152(46), 139(34), 105(52), 104(92)$ and $77(86)$.

Reaction of VIII with hydroxylamine hydrochloride: formation of X. A mixture of 0.5 g (0.76 mmol) VIII and 0.21 g (3 mmol) hydroxylamine hydrochloride in 30 ml

ethanol and a few drops of pyridine was refluxed for 6 hr. After cooling the reaction mixture was poured into ice/water, filtered off, recrystallized from acetic acid to give 0.196 g (72%) of X as colourless crystals mp 258°.

Compound X: $C_{24}H_{16}N_2O_2$ (364.41); Calcd. C: 79.11%, H: 4.43%, N: 7.69%.

Found C: 78.92%, H: 4.63%, N: 7.52%.

Reaction of VIII with toluene (under Friedel-Crafts reaction conditions). formation of XI. To 0.5 g (0.76 mmol) VIII in dry toluene (30 ml), 2.6 g of anhydrous aluminium chloride were added and the temperature was not allowed to rise above 40°. The reaction mixture was heated as 80° for 6 hr., then cooled and poured into ice/hydrochloric acid and the excess of toluene was evaporated by steam distillation. The solid product was filtered through column chromatography over silica gel using carbon tetrachloride/chloroform (2:1) as eluant. The solvent was evaporated and the solid product crystallized from ethanol to give 0.254 g (54%) of XI as red crystals, mp 244-6°.

Compound XI: $C_{52}H_{42}O_2$ (698.91); Calcd. C: 89.36%, H: 6.06%.

Found C: 88.82%, H: 6.17%.

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