

THE REACTIVITY OF α -CYANOCHALCONES AS MICHAEL ACCEPTORS

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ABSTRACT

Substituted ω -cyanoacetophenone reacts with aromatic aldehydes to give the corresponding chalcones I *a-d*. Compounds I *a-d* reacted with each of malononitrile, ethyl cyanoacetate, ω -cyanoacetophenone and ethyl acetoacetate to give the corresponding cyclic Michael adducts IV *a, b*, V *a, b*, VII and VI respectively. Similarly substituted ω -cyanoacetophenones were readily coupled with a variety of aromatic diazonium chlorides to give the corresponding arylazo derivatives IX *a-d*.

IN spite of enormous literature concerning the reactivity of chalcones¹⁻⁵ as Michael acceptors, little attention has been paid towards the reactivity of the double bond in α -cyanochalcones as acceptor in the Michael reaction. In continuation of our work on the chemical behaviour of α, β -unsaturated cyano compounds⁶⁻⁸, it has been found that the arylidene derivatives I *a-e*, prepared via condensation of β -ketonitrile derivatives II *a, b* with aromatic aldehydes, react with malononitrile to yield addition products which may be formulated as III or as the enaminopyran IV. Structure IV could be established for the reaction product based on spectral data. Thus, the IR spectra of the reaction products revealed absorption of νNH_2 , δNH_2 and two cyano bands for enaminonitrile CN and for conjugated CN. Also the ^1H NMR revealed in addition to aromatic protons a singlet at $\delta 4$ for pyran H-4.

Compound I *a, e* reacted with ethyl cyanoacetate to yield the addition products for which structure V was suggested. Similarly I *d* reacted with ethyl acetoacetate to give the cyclic adducts VI. Compound VI was readily acetylated with acetic anhydride to yield the acetyl derivative VII.

Successful attempts have been made to generalize Michael reaction using ω -cyanoketone with α -cyanochalcones. Thus II *a* reacted with *p*-methyl- ω -cyanoacetophenone to give the cyclic Michael adduct VIII.

In continuation of our previous studies in the chemistry of arylazo- β -oxonitriles⁹⁻¹², a variety of aryl diazonium salts were coupled with substituted ω -cyanoacetophenone (II) to give the α -arylhydrazon- β -oxo- β -phenylpropionitrile derivatives IX *a-d*. The IR spectra of the coupled products IX *a-d* indicate that they have the hydrazone structure.

EXPERIMENTAL

 α -Cyanochalcones :

To a solution of II (0.1 mole) in ethanol (100 ml) was added the appropriate aromatic aldehyde (0.1 mole) and piperidine (few drops). The reaction mixture was heated under reflux for two hours and the solvent was

removed under vacuo. The residue was triturated with ethanol, filtered and crystallized from ethanol.

2-Amino-3,5-dicyano-4,6-diaryl-4H-pyran (IV) :

To a solution of I *a* and I *d* (0.1 mole) in ethanol (100 ml) was added malononitrile (0.1 mole) and the reaction mixture was treated with piperidine (2 drops). The reaction mixture was boiled under reflux for eight hours, the solvent was removed in vacuo and the solid product that separated out was filtered and crystallized from ethanol.

2-Amino-5-cyano-3-ethoxycarbonyl-4,6-diaryl-4H-pyran (V *a, b*) :

Compounds I *a, d* reacted with ethyl cyanoacetate using the same procedure for the preparation of IV and the products were crystallized from ethanol.

2-Amino-5-acetyl-3-ethoxycarbonyl-4-*p*-methoxyphenyl-6-*p*-chlorophenyl-4H-pyran (VI) :

Compound I *d* was treated with ethyl acetoacetate as above for preparing compound IV and the product was crystallized from ethanol.

2-Acetylamino-5-acetyl-3-ethoxycarbonyl-4-*p*-methoxyphenyl-6-*p*-chlorophenyl-4H-pyran (VII) :

A solution of VI (0.1 mole) in acetic anhydride (10 ml) was heated under reflux for five hours. The reaction mixture was then poured onto water (50 ml) and the solid product so formed was collected by filtration and crystallized from acetic acid.

2-Amino-3-*p*-tolylketon-4-phenyl-6-*p*-tolyl-5-cyano-4H-pyran (VIII) :

Compound I *a* was treated with II *b* as previously described for preparing compound V. The product obtained was collected by filtration and crystallized from ethanol.

 α -Arylhydrazon- β -oxo- β -phenylpropionitrile (IX *a-d*) :

To a solution of each of II *a* and II *b* (0.1 mole) in alcohol (100 ml) was added a solution of sodium acetate (5.0 g) in 35 ml of water and then the appropriate

TABLE I

Compound	m.p. °C	Yield %	Molecular formula	IR
Ia	93	60	C ₁₇ H ₁₃ NO	2200 cm ⁻¹ (CN), 1650 cm ⁻¹ (CO).
Ib	128	63	C ₁₇ H ₁₂ NOC1	
Ic	86	65	C ₁₈ H ₁₅ NO	
Id	140	78	C ₁₇ H ₁₃ NO ₂ Cl	
IVa	135	40	C ₂₀ H ₁₅ N ₃ O	3400 cm ⁻¹ , 3350 cm ⁻¹ (NH ₂), 2230 cm ⁻¹ and 2220 (two cyano).
IVb	145	75	C ₂₀ H ₁₄ N ₃ O ₂ Cl	
Va	152	45	C ₂₂ H ₂₀ N ₂ O ₃	3400 cm ⁻¹ , 3300 cm ⁻¹ (NH ₂); 2200 cm ⁻¹ (conj. CN); 1675 cm ⁻¹ (ester CO); 1630 cm ⁻¹ (C = C).
Vb	150	60	C ₂₂ H ₁₉ N ₂ O ₄ Cl	
VI	210	70	C ₂₃ H ₂₂ NO ₅ Cl	3300, 3400 cm ⁻¹ (NH ₂); 1675 cm ⁻¹ (ester CO); 1740 cm ⁻¹ (acetyl CO) and 1630 cm ⁻¹ (C=C).
VII	168	70	C ₂₅ H ₂₄ NO ₆ Cl	3200, 3010 cm ⁻¹ (NH); 1750 cm ⁻¹ (acetyl CO); 1740 cm ⁻¹ (amide CO).
VIII	90	43	C ₂₇ H ₂₂ N ₂ O ₂	3300, 3400 cm ⁻¹ (NH ₂); 1740 cm ⁻¹ (benzyl CO); 2220 cm ⁻¹ (CN); 1630 cm ⁻¹ (C=C).
IXa	177	80	C ₁₆ H ₁₂ N ₃ OCl	2210 cm ⁻¹ (CN); 1735 cm ⁻¹ (CO).
IXb	153	75	C ₁₇ H ₁₅ N ₃ O	
IXc	143	80	C ₁₇ H ₁₅ N ₃ O ₂	
IXd	221	75	C ₁₅ H ₉ N ₃ OCl ₂	

N.B.: (1) All melting points are uncorrected.

(2) Analytical data agreed with theoretical values within the limits of experimental errors.

(3) IR spectra were measured in KBr on a Pye Unicam SP 1000.

aryldiazonium salt (prepared from 0.1 mole of the amine and the corresponding quantity of sodium nitrite) was added. The reaction mixture was left at room temperature for one hour and the solid product, so formed, was collected by filtration.

Compound IXa was crystallized from benzene and IXb-d were crystallized from ethanol.

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