Tetrahedron Letters No. 46, pp 4125 - 4128, 1976. Pergamon Press. Printed in Great Britain.

SUBSTITUTED SPIRO[4,5]DECA-3,6,9-TRIENE-2,8-DIONES FROM ELECTROPHILIC REACTIONS OF NITRILIUM IONS

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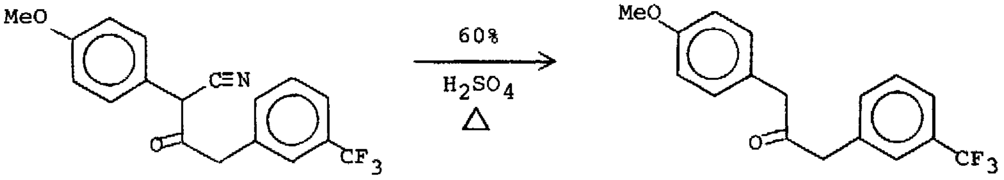
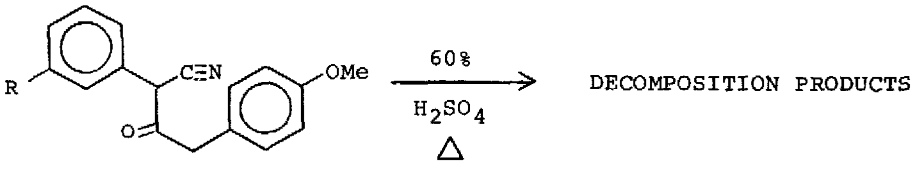
(Received in USA 9 August 1976; received in UK for publication 1 October 1976)

Unsymmetrically substituted 1,3-diphenyl-2-propanones are useful intermediates to 3,5-diaryl-4(1H)-pyridinones (1). They are generally prepared by the hydrolysis of the Claisen condensation product of an arylacetonitrile and an arylacetic acid ester (2). For example, 60% sulfuric acid hydrolyzed α-(4-methoxyphenyl)-γ-(α,α,α-trifluoro-m-tolyl)acetoacetonitrile (I) to 1-(4-methoxyphenyl)-3-(α,α,α-trifluoro-m-tolyl)-2-propanone (II) in 61% (distilled) yield, but the same procedure failed for γ-(4-methoxyphenyl)-α-(α,α,α-trifluoro-m-tolyl)acetoacetonitrile (IIIa). Similar results were reported by Coan and Becker (2) for IIIb.



(I) (II)

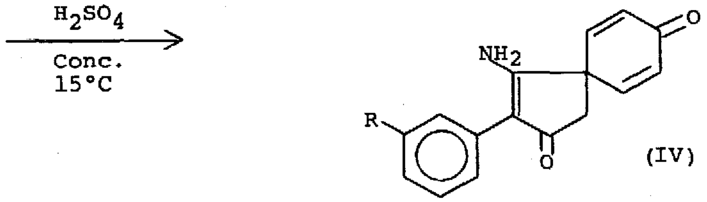


(III)

(a) R = CF_3; (b) R = H

However, when IIIa was merely dissolved in cold concentrated sulfuric acid and immediately poured over ice, a single product precipitated. The ir spectrum (mull) showed absorptions at 3360 cm^{-1} and 3180 cm^{-1}, which are characteristic of the asymmetric and symmetric vibrations of an $-NH_2$ group. Further, the ir showed a carbonyl absorption at 1665 cm^{-1} and the absence of nitrile absorption. The nmr spectrum exhibited a four-proton AB quartet (J = 10 Hz) centered at 6.65 δ and the absence of a methoxyl group. The mass spectrum indicated a molecular ion of 319. Ultraviolet absorption maxima in ethanol were 227 nm (ε=18,400) and 258 nm (ε=25,100). The microanalysis was consistent with $C_{17}H_{12}F_3NO_2$. Anal. Calcd.: C, 53.95; H, 3.79; N, 4.39. Found: C, 53.73; H, 3.85; N, 4.55. On the basis of the above data, the structure was assigned as 4-amino-3-(α,α,α-trifluoro-m-tolyl)-spiro[4,5]deca-3,6,9-triene-2,8-dione (IVa). IVb and IVc were similarly prepared and gave satisfactory spectral and microanalytical data (Table I).

(III)

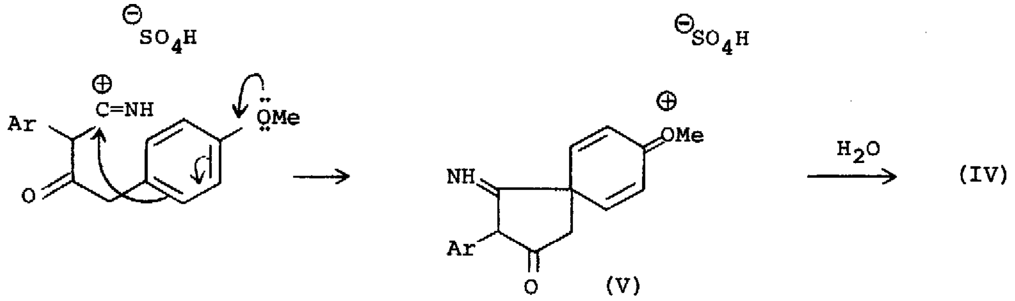


(a) R = CF_3; (b) R = H; (c) R = Cl

TABLE I

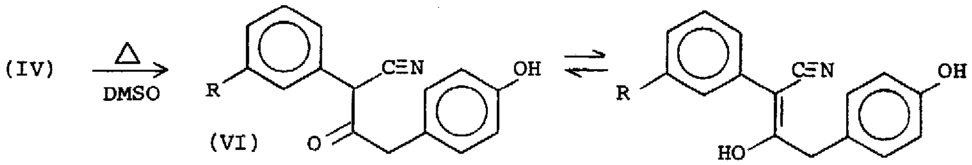
	MP °C	% Yield	NMR (δ) DMSO-d_6			
(IVa)	152-5d	99	2.6 (s, 2);	6.35 (d, 2);	7.0 (d, 2);	7.35 (m, 6)
(IVb)	117-19d	74	2.55 (s, 2);	6.2 (d, 2);	6.9 (d, 2);	7.2 (m, 7)
(IVc)	127-30d	98	2.6 (s, 2);	6.3 (d, 2);	7.0 (d, 2);	7.6 (m, 6)

The formation of IV is similar to the formation of spiro-cationic intermediates in the solvolysis of 4-aryl-1-butyl-arenesulfonates via Ar_1-5 participation (3). However, the reaction is unique in that spiro-annelation arises from an electrophilic attack of a nitrilium ion at the 1-position of the 4-methoxyphenyl ring (4). Furthermore, in the former case, the spiro-cations rearranged to tetralins; whereas, under the reaction conditions of the present case, no rearrangement to aminomethoxynaphthols occurred. These results contrast with those reported for α,γ-bis-arylacetoacetic esters; where treatment with concentrated H_2SO_4 or anhydrous HF produced naphthols (5). The carbonyl group of the cyclohexadiene moiety presumably results either by hydrolysis of V with water or by loss of methylsulfate.



Several workers have applied spiro-annelation reactions via $\overset{\ominus}{\mathrm{Ar}_1}$-5 participation of alkylphenols to the synthesis of terpene compounds (6,7). Further synthesis which retains the spiroskeleton of the present work is under current investigation. However, these endeavors are complicated by the thermal lability of the spirocycles (IV).

Heating IVb in DMSO on a steam bath for 1 hr afforded a single isomeric rearrangement product, which exhibited two nitrile absorptions at 2218 cm^{-1} and 2260 cm^{-1} in the ir spectrum. These were assigned to γ-(4-hydroxyphenyl)-α-phenylacetoacetonitrile (VIb) and its enol tautomer. Anal. Calcd. for $C_{16}H_{13}NO_2$: C, 76.48; H, 5.21; N, 5.57. Found: C, 76.74; H, 5.36; N, 5.47. Data for VIa and VIc are listed in Table II.



(a) R = CF_3; (b) R = H; (c) R = Cl

TABLE II

	MP °C	% Yield	NMR (δ) $CDCl_3$			
(VIa)	121-3	69[a]	3.8 (s);	4.95 (s);	7.2 (m);	4.0 (s)[b]
(VIb)	oil	92	3.7 (s);	4.8 (s);	7.0 (m);	3.85 (s)[b]
(VIc)	85-6	70[a]	3.7 (s);	4.8 (s);	7.1 (m);	3.9 (s)[b]

[a] Recrystallized from $MeOH/H_2O$; 48 hrs heating was required.

[b] Due to significant amounts of enol tautomer.

Acknowledgments. I wish to thank Dr. James R. Beck for many stimulating discussions and Mr. Paul L. Unger for spectral data and analysis.

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