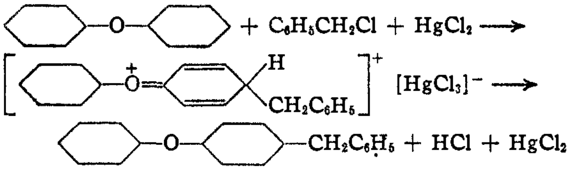

A solution of mercuric chloride in benzyl chloride was found to conduct an electric current but the conductance rapidly decreased upon the addition of diphenyl ether.

Oxidation of Methyl Radicals in Aromatic Ethers.—These experiments were conducted by dissolving 0.02 mole of the aromatic ether in 250 ml. of glacial acetic acid and adding 20 ml. of concentrated sulfuric acid and 50 ml. of a solution of sodium dichromate (20 g. of $Na_2Cr_2O_7{\cdot}2H_2O$ in 100 ml. of water). The flask containing this reaction mixture was placed in a constant temperature bath at 44° and stirred mechanically. The rate of reduction of the chromium was determined by removal of a 5-ml. portion of the solution with a pipet at intervals of fifteen minutes and titration against standardized ferrous ammoniun sulfate solution. At the end of two and one-half hours the reacting solution was poured into 700 ml. of cold water, chilled in ice and the precipitated aromatic acid collected on a filter. For purification the crude acid was dissolved in dilute sodium hydroxide solution, filtered from any material not soluble in alkali and reprecipitated with hydrochloric acid. The acids were identified by their melting points and "mixed melting points" with known samples.[4] The percentage yields of acids obtained by oxidizing different ethers are shown in Table IV.

TABLE IV

Ether	Acid obtained	Yield, %
Phenyl *p*-tolyl	4-Phenoxybenzoic	17
4-Nitrophenyl *p*-tolyl	4-(4-Nitrophenoxy)-benzoic	48
2-Nitrophenyl *p*-tolyl	4-(2-Nitrophenoxy)-benzoic	71
2,4-Dinitrophenyl *p*-tolyl	4-(2,4-Dinitrophenoxy)benzoic	82

According to the procedure used in this experiment *p*-nitrotoluene gave an 82% yield of *p*-nitrobenzoic acid. The volume of sodium dichromate solution reduced cannot be taken as a measure of the extent of oxidation of the methyl group because there is some cleavage of the ether at the oxygen atom and the resulting phenolic compounds consume part of the oxidizing agent. The shift of electrons from the ether oxygen atom to the *p*-tolyl nucleus facilitates oxidative cleavage of the C–O link but this action is hindered by the opposite shift of electrons to the nitro groups of the nitrated ring in those ethers where nitro groups are present. Thus the cleavage of the ether is least and the yield of carboxylic acid is greatest in 2,4-dinitrophenyl *p*-tolyl ether.

Summary

Three sets of experiments have been conducted to study the extent of the resonance effects in one ring of an aromatic ether produced by a substituent in the other ring. It has been shown that the tautomeric or inductive effects are transmitted across the ether oxygen atom from one ring to the other and that a substituent in one ring modifies the reactivity of a substituent in the other almost as much as if the two substituting groups were attached to the same benzene nucleus.

LAWRENCE, KANSAS RECEIVED DECEMBER 14, 1944

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[4] The statements in the literature (Beilstein, "Handbuch der organischen Chemie," Vierte Auflage VI, p. 394) that some of these ethers cannot be oxidized to the corresponding carboxylic acids are in error. We believe the error was caused by too high concentrations of oxidizing agent and sulfuric acid as these conditions result in cleavage of the ether linkage.

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY OF THE POLYTECHNIC INSTITUTE OF BROOKLYN]

Synthesis of 1-(3',4'-Dimethoxyphenyl)-4-phenyl-butanone-2 and 1-Phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 and Related Compounds

BY E. F. LANDAU, F. LEONARD, R. H. CARROLL[1] AND P. E. SPOERRI

A comparison of the yields of the hydrolytic products obtained from the hydrolysis of 1-cyano-1,4-di-(3',4'-dimethoxyphenyl)-butanone-2[2] (I) with 1-cyano-1,4-diphenylbutanone-2 (II)[3] indicated a marked difference in the ease of hydrolysis of these two substances. The former was hydrolyzed with great difficulty in poor yield to 1-carbamyl-1,4-di-(3',4'-dimethoxyphenyl)-butanone-2 (III) whereas the 1-cyano-1,4-diphenylbutanone-2 was hydrolyzed easily in excellent yield to 1-carbamyl-1,4-diphenylbutanone-2 (IV). It appeared, therefore, to be of interest to attempt the preparation of 1-cyano-1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2 (V), and 1-cyano-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (VI) and compare the ease of hydrolysis of these two cyano ketones with that of the above-mentioned cyano ketones I and II by observing the yields of their respective carbamyl ketones.

Compounds of the following type were prepared:

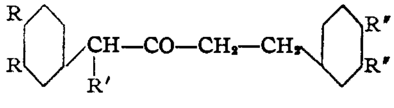

Table I lists the specific compounds discussed.

The preparations of the desired cyano ketones involved the condensation of a substituted propionate with the appropriate nitriles in the presence of a sodium alcoholate. For the synthesis of 1-cyano-1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2 (V), 3,4-dimethoxybenzyl cyanide was condensed with ethyl hydrocinnamate. Similarly by condensing benzyl cyanide with ethyl 3,4-dimethoxyphenyl propionate, the desired 1-cyano-1-phenyl-4-(3',4'-dimethoxyphenyl) butanone-2 (VI) was obtained as a viscous oil

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[1] Present address: Winthrop Chemical Co., Rensselaer, New York.

[2] Carroll and Spoerri, THIS JOURNAL, 60, 2658 (1938).

[3] Haworth, *J. Chem. Soc.*, 1426 (1934).

TABLE I

Compound No.	R	R'	R"
I	CH_3O	CN	CH_3O
II	H	CN	H
III	CH_3O	$CONH_2$	CH_3O
IV	H	$CONH_2$	H
V	CH_3O	CN	H
VI	H	CN	CH_3O
VII	CH_3O	$CONH_2$	H
VIII	H	$CONH_2$	CH_3O
IX	CH_3O	H	H
X	H	H	CH_3O

which could not be crystallized in pure form. However, on subsequent hydrolysis, this oil did yield the expected carbamyl ketone (VIII).

Subsequent hydrolysis of the cyano ketones with a mixture of concentrated hydrochloric and glacial acetic acids resulted in the corresponding carbamyl ketones; 1-cyano-1-(3',4'-dimethoxyphenyl)-4-phenyl-butanone-2 (V) yielding 1-carbamyl-1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2 (VII) and 1-cyano-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (VI) yielding 1-carbamyl-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (VIII). Further hydrolysis of the carbamyl ketones with dilute hydrochloric acid resulted in the formation of 1-(3',4'-dimethoxyphenyl)-4-phenyl-butanone-2 (IX) and 1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (X). A comparison of the yields obtained from the hydrolysis of the various cyanoketones is given in Table II.

TABLE II

Cyano ketone	Carbamyl ketone	Yield, %
1-Cyano-1,4-di-phenylbutanone-2 (II)	1-Carbamyl-1,4-diphenylbutanone-2 (IV)	80[1]
1-Cyano-1,4-di-(3',4'-dimethoxyphenyl)-butanone-2 (I)	1-Carbamyl-1,4-di-(3',4'-dimethoxyphenyl)-butanone-2 (III)	13[1]
1-Cyano-1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2 (V)	1-Carbamyl-1-(3',4'-dimethoxyphenyl)-4-phenyl butanone-2 (VII)	38
1-Cyano-1-phenyl-4-(3'-4'-dimethoxyphenyl)-butanone-2 (VI)	1-Carbamyl-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (VIII)	31

Experimental

1-Cyano-1-(3',4'-dimethoxyphenyl)-4-phenyl-butanone-2 (V).—To a supension of sodium methylate (3.9 g.) in 60 ml. of benzene, heated to 70°, was added a mixture of 3,4-dimethoxybenzyl cyanide (8.8 g.) and ethylhydrocinnamate (8.8 g.). The resulting mixture was refluxed for five hours, care being taken to exclude moisture. During the course of the reflux, the solution turned brown and crystals appeared. At the end of the reflux period, the solution was cooled and filtered. After washing the precipitate of the crude sodium salt (12 g.) with benzene and ether, it was dissolved in 150 ml. of water. After two ether extractions this aqueous solution was acidified with hydrochloric acid. Subsequently, after standing overnight in a refrigerator, the crystals which formed were filtered and recrystallized from a methanol-water mixture; yield, 10 g.; m. p. 88–89°. *Anal.* Calcd. for $C_{19}H_{19}O_3H$: C, 73.78; H, 6.15; N, 4.53. Found: C, 73.70, 73.60; H, 6.48, 6.32; N, 4.59, 4.60.

1-Cyano-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (VI).—Benzyl cyanide (6 g.) and ethyl 3,4-dimethoxyphenyl propionate (12 g.) were condensed in the same manner as described above. The final product, a light yellow viscous oil (6 g.) could not be crystallized; b. p. 223–228° (2 mm.).

1-Carbamyl-1-(3',4'-dimethoxyphenyl)-4-phenyl-butanone-2 (VII).—A mixture of 1-cyano-1-(3',4'-dimethoxyphenyl)-4-phenyl-butanone-2 (6 g.) in 75 ml. of glacial acetic acid and 75 ml. of concd. hydrochloric acid was allowed to stand six days in a water-bath at 15–20°. At the end of this time, the resultant dark red solution was poured into 1500 ml. of water and cooled. The crystals which formed were filtered and recrystallized from 95% ethanol; yield, 2.5 g. (38%); m. p. 129–130°. *Anal.* Calcd. for $C_{19}H_{21}O_4N$: C, 69.72; H, 6.42; N, 4.28. Found: C, 69.65; H, 6.55; N, 4.35, 4.37.

1-Carbamyl-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (VIII).—The 6 g. of oil obtained from the preparation of 1-cyano-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 was treated in the same manner as was 1-cyano-1-(3',4'-dimethoxyphenyl)-4-phenyl-butanone-2. A white crystalline hydrolytic product was obtained: yield, 2.0 g. (31%) m. p. 119–120°. *Anal.* Calcd. for $C_{19}H_{21}O_4N$: C, 69.72; H, 6.42; N, 4.28. Found: C, 69.63; H, 6.50; N, 4.32, 4.31.

1-(3',4'-Dimethoxyphenyl)-4-phenyl-butanone-2 (IX).—1-Carbamyl-1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2 (2 g.) was refluxed for two hours in 120 ml. of 3.5% hydrochloric acid. After cooling the reaction mixture, the gum which appeared was separated and crystallized from 95% ethanol; yield, 0.6 g., m. p. 44–45°. *Anal.* Calcd. for $C_{18}H_{20}O_3$: C, 76.05; H, 7.01. Found: C, 76.11; H, 6.91.

1-Phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 (X).—Hydrolysis of 1-carbamyl-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2 with dilute hydrochloric acid, as described above, yielded 0.3 g. of material of m. p. 49–50°. *Anal.* Calcd. for $C_{18}H_{20}O_3$: C, 76.05; H, 7.01. Found: C, 76.12; H, 6.93.

Summary

1. The following new compounds were prepared: 1-cyano-1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2, 1-cyano-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2, 1-carbamyl-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2, 1-carbamyl-1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2, 1-(3',4'-dimethoxyphenyl)-4-phenylbutanone-2, 1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2.

2. A comparison of the yields of carbamyl ketones obtained by the hydrolysis of: 1-cyano-1-(3',4'-dimethoxyphenyl)-4-phenyl-butanone-2, 1-cyano-1-phenyl-4-(3',4'-dimethoxyphenyl)-butanone-2, 1-cyano-1,4-diphenyl-butanone-2 and 1-cyano-1-4-di-(3',4'-dimethoxyphenyl)-butanone-2 was made.

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