Anal. Calcd. for $C_{18}H_{22}D_6O_2$: 21.43 atom % D. Found: 21.43 atom % D.

Dimerization of 3-Phenylcyclohex-2-en-1-one (XXVIII).—A mixture of 3-phenylcyclohex-2-en-1-one[38] (4.75 g.), sodium amide (1.8 g.) and 30 ml. of ether was refluxed for 19 hr. The reaction mixture was poured into 100 ml. of ice-water and extracted with ether. The solvent was removed *in vacuo* and the product chromatographed on 120 g. of alumina (Alcoa, activity I). From the chromatogram was obtained 3.38 g. (71%) of starting material and 0.10 g. (2.1%) of hydroxy ketone dimer XXXV, which after recrystallization from ethyl acetate melted at 190–192°. Similar results were obtained when the reaction was run in benzene for 36 hr. at 45–60° with high speed stirring; infrared spectrum (in (KBr): 695, 760, 975, 1220, 1320, 1380, 1440, 1475, 1595, 1690, 2610, 2820, and 3400 cm.$^{-1}$. In CS_2: 3450, 1650 (!) cm.$^{-1}$; ultraviolet spectrum: 248 mμ (ε 15,800).

Anal. Calcd. for $C_{24}H_{24}O_2$: C, 83.69; H, 7.02. Found: C, 83.92; H, 7.15.

(38) G. F. Woods and I. W. Tucker, THIS JOURNAL, **70**, 2174 (1948).

CAMBRIDGE, MASS.

[CONTRIBUTION FROM AVERY LABORATORY, UNIVERSITY OF NEBRASKA]

Ethylenimine Ketones. XIII.[1] Derivatives of *p*-Phenylbenzalacetone. *cis*- and *trans*-1-Cyclohexyl-2-(*p*-biphenylyl)-3-acetylethylenimine

BY NORMAN H. CROMWELL AND ROGER P. CAHOY

RECEIVED APRIL 25, 1958

Several phenylhydrazine derivatives of *p*-phenylbenzalacetone, including the phenylhydrazone, a pyrazoline and a pyrazole, have been synthesized. The *cis* and *trans* geometrical isomers of 1-cyclohexyl-2-(*p*-biphenylyl)-3-acetylethylenimine were prepared from the *p*-phenylbenzalacetone dibromide and characterized by their diagnostic behavior with phenylhydrazine and by absorption spectra studies. This is the first pair of arylacetylethylenimines to be reported.

In previous[2] investigations in this Laboratory several pairs of *cis*- and *trans*-arylaroylethylenimines and one pair of *cis*- and *trans*-alkylaroylethylenimines[3] have been prepared by the reaction of primary amines with α,β-dibromoketones. These geometrical isomers (racemates) have been separated by fractional recrystallization or by chromatographic means and characterized by chemical and physical methods.

The present paper includes the first report of a synthesis and characterization of arylacetylethylenimines. To ensure that the products would be solids, *p*-phenylbenzalacetone was selected as a starting point.[4] Several years ago attempts to prepare 1-benzyl-2-phenyl-3-acetylethylenimine from benzalacetone dibromide resulted in a very unstable, oily product which we were unable to purify by distillation. It was of interest to relate this new class of ethylenimine ketones, by their behavior with phenylhydrazine and a study of their ultraviolet and infrared absorption spectra, to the previously studied series.

p-Phenylbenzalacetone (I) was prepared by the base-catalyzed condensation of acetone with *p*-phenylbenzaldehyde, which was prepared by a known method, employing improved techniques of isolation and purification.

The rather unstable bromine addition product of I, 3,4-dibromo-4-(*p*-biphenylyl)-2-butanone (II) reacted rapidly with one mole of cyclohexylamine in dry benzene to give a near quantitative yield of the stable α-bromo-*p*-phenylbenzalacetone (III). Under similar conditions with primary amines, previously studied open chain α-bromo-α,β-unsaturated ketones[2,3] have reacted readily to give directly the α-bromo-β-aminoketones and/or the ring closed product, the ethylenimine ketone. It is probable that the 1,4-addition of amines to III is slow because of the considerable resonance stabilization of this conjugated unsaturated system. The ring closure of the intermediate α-bromo-β-cyclohexylamino ketone (A) should proceed with normal ease.

Only after standing at room temperature for 24 hr. did the dibromide II react with three molar equiv. of cyclohexylamine in benzene to give a 92% production of two equiv. of the by-product cyclohexylamine hydrobromide. The *cis–trans* mixture of ethylenimine ketones was separated by fractional crystallization into approximately two parts of the *trans* product Xb to one part of the *cis* isomer Xa. Since only a 68% yield of Xa + Xb was isolated, one cannot decide in what ratio these isomers were actually produced in this reaction.[5]

The assignment of the configurations to Xa and Xb were based initially upon the diagnostic phenylhydrazine reaction which in previous studies has been shown to produce an isolable aminopyrazoline (XI) from a *trans* isomer and only the pyrazole IX from a *cis* form.[6] 1-Phenyl-3-methyl-5-(*p*-biphenylyl)-pyrazole (IX) also was prepared readily

(1) For paper XII in this series see N. H. Cromwell and G. D. Mercer, THIS JOURNAL, **79**, 3815 (1957).

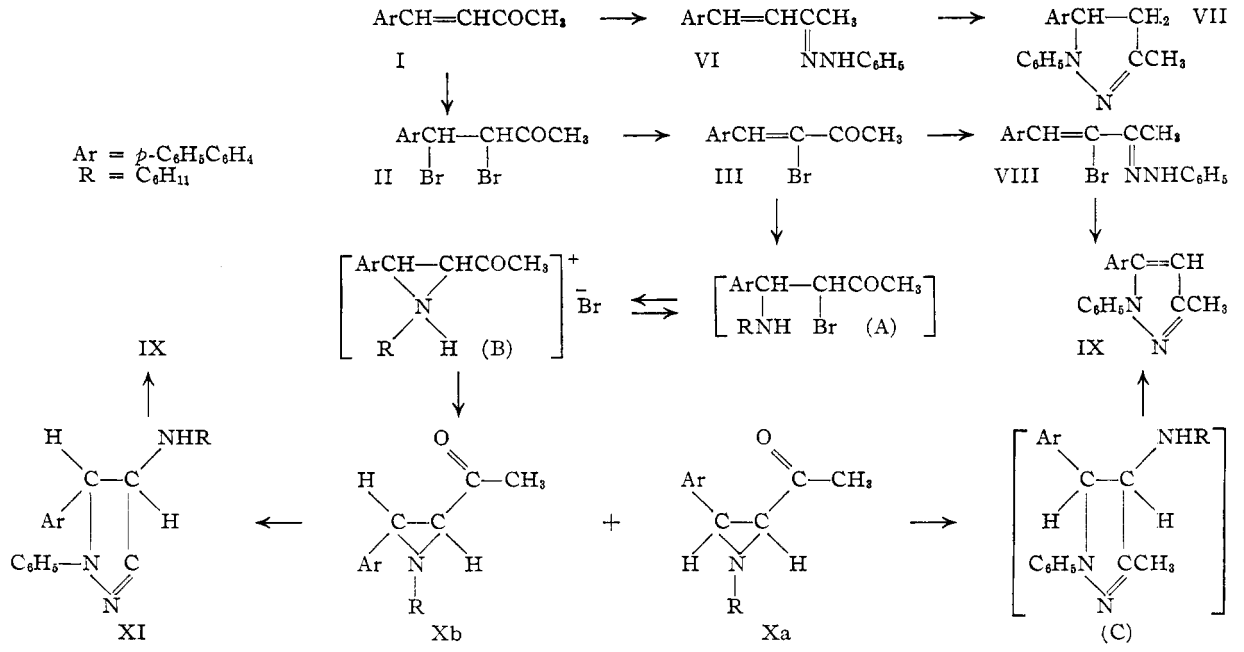
(2) See ref. 1 and preceding papers in the series.

(3) N. H. Cromwell and R. J. Mohrbacher, THIS JOURNAL, **75**, 6252 (1953).

(4) After this investigation was substantially completed a prior synthesis of *p*-phenylbenzalacetone came to our attention; see R. Trave and G. Bianchetti, *Atti accad. nazl. Lincei, Rend., Classe sci. fis., mat. e nat.*, **11**, 211 (1951); *C. A.*, **49**, 2381 (1955).

(5) In a recent publication (N. H. Cromwell, R. P. Cahoy, W. E. Franklin and G. D. Mercer, THIS JOURNAL, **79**, 922 (1957)) a rationale was developed to explain the ethylenimine ketone *cis/trans* product ratio based on relative group sizes in the intermediate α-bromo-β-aminoketones and favored conformations in transition states. It now appears to the present authors that such a rationale is tenuous, in that it is based upon the probably unwarranted assumption that one can readily assign relative effective size to various chemical groupings in complex systems such as these. Moreover, the application of the rationale led to the unusual, and probably theoretically unsound, conclusion that the protonation step of the 1,4-addition of amines to the α-bromo-α,β-unsaturated ketones involves a pyramidal carbanion (the α-carbon); see J. Hine, "Physical Organic Chemistry," McGraw-Hill Book Co., Inc., New York, N. Y., 1956, p. 225. It is hoped that definitive experiments now being carried out in this Laboratory will clarify the stereochemistry of these conjugate addition reactions.

(6) See N. H. Cromwell, *et al.*, THIS JOURNAL, **73**, 1044 (1951), for a theoretical discussion of the method.



from α-bromo-*p*-phenylbenzalacetone (III) *via* the phenylhydrazone VIII which was isolable. 1-Phenyl-3-methyl-5-(*p*-biphenylyl)-pyrazoline (VII) was synthesized from *p*-phenylbenzalacetone phenylhydrazone (VI). 4-(*p*-Biphenylyl)-2-butanone (IV) was obtained by catalytic hydrogenation of the unsaturated ketone I and its phenylhydrazone V prepared for spectra study.

The dibromoketone II reacted with morpholine to give a 62% yield of 3,4-dimorpholino-4-(*p*-biphenylyl)-2-butanone (XII).

Absorption Spectra.—The results of the ultraviolet absorption spectra studies of compounds in the *p*-phenylbenzalacetone series are not as informative as might be desired. The biphenyl ultraviolet absorption (λ_{max} 248 mμ, ε 16,600)[7] frequently obscured less powerful resonating systems absorbing light from 230–280 mμ. Because of this factor, corresponding compounds in the benzalacetone series can be expected to show few comparable spectral similarities. The functional groups of the compounds in the *p*-phenylbenzalacetone series had a bathochromic as well as a hyperchromic effect upon the dominant biphenyl band.

The isomeric ethylenimine ketones Xa and Xb showed maxima at slightly greater wave lengths with increased extinction coefficients (Xa, λ 257 mμ, ε 21,500; Xb, λ 263 mμ, ε 25,000) than the parent saturated ketone IV (λ 252 mμ, ε 19,800), indicating some three-ring biphenyl (and possibly three-ring carbonyl) hyperconjugation. The fact that Xb absorbs at somewhat longer wave lengths with greater intensity than Xa is taken as further evidence for the assignment of the *trans* configuration to isomer Xb. Some steric inhibition[6] of the biphenyl and carbonyl three-ring hyperconjugation might be expected with the *cis* structure Xa. Although the Nujol mull infrared spectra data indicated three-ring carbonyl hyperconjugation to be more pronounced with Xb ($\gamma_{C=O}$ 1682 cm.$^{-1}$) than with Xa ($\gamma_{C=O}$ 1690 cm.$^{-1}$) as expected, the carbon tetrachloride solution studies indicated Xa ($\gamma_{C=O}$ 1715 (Sh.), 1698 cm.$^{-1}$) and Xb ($\gamma_{C=O}$ 1700 cm.$^{-1}$) to have carbonyl groups of nearly the same polarity, but both are more polarized in the ground state than the carbonyl group of the parent saturated ketone IV ($\gamma_{C=O}$ 1710 cm.$^{-1}$ (CCl_4), 1697 cm.$^{-1}$ (Nujol)).

The parent unsaturated ketone I in the series shows a strong cinnamoyl ultraviolet band (λ 305 mμ, ε 23,500) and the effect of the *p*-phenyl group is observed.[8] The infrared spectrum of I in carbon tetrachloride shows two distinct carbonyl bands ($\gamma_{C=O}$ 1687 cm.$^{-1}$ (62%) and 1667 cm.$^{-1}$ (77%)). By analogy with the previously made benzalacetone assignments, we suggest that the higher frequency, less intense band be assigned to a labile S-*cis*-*trans* and the lower frequency more intense band to a labile S-*trans*-*trans* conformation of *p*-phenylbenzalacetone.[9]

The ultraviolet spectra of the α,β-unsaturated ketone phenylhydrazones VI and VIII were similar showing two strong bands in the ranges of 360–367 and 293–294 mμ. Ring closure of VI to the pyrazoline VII changed the ultraviolet absorption to a one-maximum curve (λ 258 mμ). Conversion of VIII to the pyrazole IX also caused a change in ultraviolet absorption to a single-maximum curve (λ 277 mμ). As might be expected, the ultraviolet absorption spectrum of the parent saturated ketone phenylhydrazone V was found to be very similar to those of the related pyrazoline VII and of the amino pyrazoline XI, all having maxima near 258 mμ (ε 25,800–31,400). The absorption maximum of the pyrazoline in the benzalacetone series (1,5-diphenyl-3-methylpyrazoline, 279 mμ, ε 10,200)[10] indicates that the bands of the corresponding

(7) L. Freedman, THIS JOURNAL, **77**, 6223 (1955).

(8) See N. H. Cromwell and W. R. Watson, *J. Org. Chem.*, **14**, 411 (1949), for the data and discussion of the spectrum of benzalacetone.

(9) See footnote 28, R. D. Campbell and N. H. Cromwell, THIS JOURNAL, **79**, 3456 (1957), for a discussion of conformation and the infrared spectrum of *trans*-benzalacetone.

(10) Prof. H. E. Baumgarten, unpublished work, University of Nebraska.

chromophores in VII and XI are probably obscured by the biphenylyl group absorption.

Acknowledgment.—This investigation was supported in part by a grant from the National Science Foundation, NSF-G1091.

Experimental

***p*-Phenylbenzaldehyde.**—A modification of the method of Gattermann[11] and Hey[12] was employed. A 120-g. (0.78 mole) amount of biphenyl, 180 g. (1.36 moles) of anhyd. aluminum chloride and 24 g. (0.12 mole) of freshly fused cuprous chloride were dissolved in 480 ml. of dry benzene and treated with a mixture of carbon monoxide and hydrogen chloride gases generated by the method of Bert[13] from chlorosulfonic acid and 95% formic acid. The mixed gases were passed into the well-stirred reaction mixture for 8 hr. which was then poured over ice. The suspended solids were filtered from the benzene layer through a Celite bed and the filtrate then stirred with a high speed stirrer while 1 liter of saturated sodium bisulfite solution was slowly added. Small amounts of solid sodium bisulfite were added from time to time to maintain saturation of the aqueous layer. The benzene layer containing the suspended bisulfite addition product was filtered and the addition product well washed with benzene.

The bisulfite addition product was mixed with 800 ml. of fresh benzene and 1 liter of saturated sodium carbonate solution and warmed under reflux with rapid stirring. Additional solid sodium carbonate was added from time to time to keep the aqueous layer basic to litmus. After two hours the conversion to the aldehyde was complete. The benzene layer was separated, dried over magnesium sulfate and reduced in volume to 200 ml. by vacuum distillation. Addition of low-boiling petroleum ether precipitated the colorless *p*-phenylbenzaldehyde which was recrystallized from methanol, wt. 89 g. (63% yield), m.p. 58–59°.

***p*-Phenylbenzalacetone (I).**—A 52-g. (0.285 mole) sample of *p*-phenylbenzaldehyde was mixed with 250 ml. of acetone and treated with 10 ml. of 2% aqueous potassium hydroxide. The mixture was stirred for 30 minutes and the solid product collected by filtration of the cooled solution. Recrystallization from methanol readily separated the less soluble yellow colored bis-(*p*-phenylbenzal)-acetone, 4.0 g. (7% yield), m.p. 254–255°, from the colorless *p*-phenylbenzalacetone, 55 g. (87% yield), m.p. 135°[4]; ultraviolet (isoöctane) λ_{max} 226 and 305 mμ (ε 10, 600 and 23,500); infrared bands, γ cm.$^{-1}$, in CCl_4, 1687 (62%) (sh.), 1667 (77%); in Nujol, 1660 (45%), 1640 (27%), 1625 (16%), 1605 (6%).

Anal. Calcd. for $C_{29}H_{22}O$: C, 90.12; H, 5.74. Found for bis cpd.: C, 89.90; H, 5.82. Calcd. for $C_{16}H_{14}O$: C, 86.45; H, 6.35. Found for I: C, 86.61; H, 6.40.

3,4-Dibromo-4-(*p*-biphenylyl-2-butanone (II).—This bromine addition product was prepared by slowly adding 8.4 g. (0.053 mole) of bromine to a well-stirred solution of 11.7 g. (0.053 mole) of *p*-phenylbenzalacetone in 400 ml. of dry carbon tetrachloride at 0°. The solvent was removed by vacuum distillation and the oily residue crystallized from methanol to give 16 g. (79% yield) of a mixed product, m.p. 112–138°, which when recrystallized from the same solvent gave 11.3 g. of colorless product, m.p. 145–147°. This compound was stable in the ice-chest for relatively short periods of time.

Anal. Calcd. for $C_{16}H_{14}OBr_2$: C, 50.29; H, 3.69. Found: C, 50.01; H, 3.67.

α-Bromo-*p*-phenylbenzalacetone (III).—A 5.0-g. (0.013 mole) sample of crude dibromide II (m.p. 112–138°) was stirred with 1.3 g. (0.013 mole) of cyclohexylamine in 30 ml. of dry benzene for one hour at 0°. The precipitated cyclohexylamine hydrobromide (2.2 g. 92% yield) was removed by filtration, the filtrate washed with water, dried and treated with petroleum ether to crystallize the product, 3.8 g. (96% yield), m.p. 96–102°; recrystallized from ether, m.p. 108–109°. This product was purified easily and could be stored for long periods of time; ultraviolet (isoöctane) λ_{max} 300 mμ (ε 18,200).

Anal. Calcd. for $C_{16}H_{13}OBr$: C, 63.80; H, 4.35. Found: C, 63.99; H, 4.57.

4-(*p*-Biphenylyl)-2-butanone (IV).—A 2.0-g. sample of the unsaturated ketone I was dissolved in 250 ml. of abs. ethanol and shaken under 45 lb./in.^{2} of hydrogen in the presence of platinum oxide for 10 minutes. Evaporation of the solvent produced 1.95 g. (98% yield) of product, m.p. 75–77°, recrystallized from abs. ethanol; ultraviolet (isooctane) λ_{max} 252 mμ (ε 19,800); infrared bands, γ cm.$^{-1}$, (in CCl_4) 1710 (80%), 1600 (30%); (in Nujol), 1697 (70%), 1600 (25%).

Anal. Calcd. for $C_{16}H_{16}O$: C, 85.68; H, 7.19. Found: C, 86.05; H, 7.38.

4-(*p*-Biphenylyl)-2-butanone phenylhydrazone (V), m.p. 110–115°, recrystallized from glacial acetic acid, was prepared in glacial acetic acid solution. This compound showed signs of decomposition when held at room temperature for six hours; ultraviolet (95% ethanol) λ_{max} 258 mμ (ε 25,800); infrared bands, γ cm.$^{-1}$, (Nujol) 1620 (14%) (sh), 1602 (55%), 1572 (17%).

Anal. Calcd. for $C_{22}H_{22}N_2$: C, 84.03; H, 7.05. Found: C, 84.03; H, 7.28.

***p*-Phenylbenzalacetone phenylhydrazone (VI)** was formed in glacial acetic acid and collected immediately and washed with petroleum ether to give yellow crystals, m.p. 217° (instantaneous), yield 94%. Recrystallization attempts decomposed the product; λ_{max} 293 and 367 mμ (ε 17,600 and 43,000); infrared bands (Nujol) γ cm.$^{-1}$, 3360 (25%), 1603 (35%), 1554 (15%).

Anal. Calcd. for $C_{22}H_{20}N_2$: C, 84.58; H, 6.45; N, 8.97. Found: C, 84.67; H, 6.61; N, 8.86.

1-Phenyl-3-methyl-5-(*p*-biphenylyl)-pyrazoline (VII).—A 2.7-g. (0.012 mole) sample of I in 30 ml. of warm glacial acetic acid was treated with one equiv. of phenylhydrazine. The yellow hydrazone precipitated immediately. An additional 30 ml. of glacial acetic acid was added and the reaction mixture heated on the steam-bath for one hour. Cooling the solution produced 3.5 g. (96% yield) of bright yellow-green crystals, m.p. 165–167°, recrystallized from methanol and chloroform; ultraviolet (95% ethanol) λ_{max} 258 mμ (ε 31,400).

Anal. Calcd. for $C_{22}H_{20}N_2$: C, 84.58; H, 6.45; N, 8.97. Found: C, 84.72; H, 6.56; N, 9.05.

α-Bromo-*p*-phenylbenzalacetone phenylhydrazone (VIII), m.p. 136°, was prepared in glacial acetic acid and recrystallized from methanol; ultraviolet (95% ethanol) λ_{max} 211, 294, 360 mμ (ε, 20,800, 19,200, 28,000).

Anal. Calcd. for $C_{22}H_{19}N_2Br$: C, 67.52; H, 4.89; N, 7.16. Found: C, 67.68; H, 4.86; N, 7.04.

1-Phenyl-3-methyl-5-(*p*-biphenylyl)-pyrazole (IX).—A 2.0-g. sample of VIII was warmed on the steam-bath for 15 min. in 20 ml. of glacial acetic acid. The reaction mixture was cooled and water added to precipitate a crude product which after purification by charcoal treatment and recrystallization from methanol had m.p. 120°, wt. 1.2 g. (79% yield); ultraviolet (95% ethanol) λ_{max} 277 mμ (ε 27,400); infrared bands (Nujol) γ cm.$^{-1}$, 1660 (25%), 1568 (15%).

Anal. Calcd. for $C_{22}H_{18}N_2$: C, 85.12; H, 5.85; N, 9.03. Found: C, 85.25; H, 5.94; N, 9.06.

***cis*- and *trans*-1-Cyclohexyl-2-(*p*-biphenylyl)-3-acetylethylenimines (Xa) and (Xb).**—A 24.0-g. (0.065 mole) amount of dibromide II was stirred with 19.2 g. (0.195 mole) of cyclohexylamine in 100 ml. of a 50–50 mixture of ether and benzene for 24 hr. at room temperature (after 18 hr. only 78% reaction had occurred.) Filtration gave a 92% yield of cyclohexylamine hydrobromide. The filtrate was washed with water, dried and the solvent evaporated. Fractional recrystallization of the residue from dry ether produced a total yield of 68% of mixed ethylenimine ketones which consisted of a 22% yield of a low melting product Xa, m.p. 82–83° (recrystallized from petroleum ether), and a 46% yield of the high melting isomer Xb, m.p. 102–103° (recrystallized from methanol). Isomers Xa and Xb were isolated in about the same yields when the monobromide III was used in place of the dibromide II; for Xa, ultraviolet (isoöctane) λ_{max} 213 and 257 mμ (ε 23,000 and 21,500); infrared bands, γ cm.$^{-1}$ (in CCl_4 (1715 (65%) (sh), 1698 (83%), 1600 (21%); (in Nujol), 1690 (70%). For Xb, ultraviolet (isoöctane) λ_{max} 213 and 263 mμ (ε 23,000 and 25,000); infrared bands, γ cm.$^{-1}$ (in CCl_4), 1700 (83%), 1597 (23%); (in Nujol), 1682 (67%), 1595 (16%).

(11) L. Gattermann, *Ann.*, **347**, 381 (1906).

(12) D. Hey, *J. Chem. Soc.*, 2476 (1931).

(13) L. Bert, *Compt. rend.*, **221**, 77 (1945).

Anal. Calcd. for $C_{22}H_{25}NO$: C, 82.72; H, 7.89: N, 4.39. Found: for Xa, C, 82.63; H, 7.91; N, 4.48; for Xb: C, 82.39; H, 7.45; N, 4.43.

Reaction of *cis*- and *trans*-Ethylenimine Ketones Xa and Xb with Phenylhydrazine.—A 1.4-g. (0.004 mole) amount of Xb was dissolved in 30 ml. of abs. ether and 0.49 g. (0.004 mole) of pure phenylhydrazine added. After standing in the dark at room temperature the solid crystalline precipitate was removed by filtration and washed with cold ether, m.p. 154° (instantaneous), colorless crystals, wt. 0.83 g. Attempts to recrystallize this amino pyrazoline XI from warm benzene quantitatively converted it to the pyrazole IX, m.p. 120°. Carbon–hydrogen analysis of the pyrazoline XI required the precaution of mixing the sample with copper oxide in the combustion boat to prevent the rapid escape of cyclohexylamine. The amino pyrazoline XI gave a positive Knorr and Raiford pyrazoline test[14]; ultraviolet (95% ethanol) λ_{max} 259 mμ (ε 27,200).

(14) L. Raiford and W. Peterson, *J. Org. Chem.*, **1**, 544 (1937).

Anal. Calcd. for $C_{28}H_{31}N_3$: C, 82.11; H, 7.63; N, 10.26. Found for XI: C, 81.71; H, 7.94; N, 10.02.

A similar experiment with the low-melting ethylenimine ketone XA produced only the pyrazole IX, m.p. 120°. In the presence of acetic acid both Xa and Xb decomposed rapidly to red oils.

3,4-Dimorpholine-4-(*p*-biphenylyl)-2-butanone (XII).—A 7.6-g. (0.020 mole) sample of the dibromide II was mixed with 40 ml. of abs. ethanol and 7.1 g. (0.082 mole) of morpholine and held in a water-bath at 20° for 30 minutes. The morpholine hydrobromide was removed by filtration and the filtrate concentrated to produce a residue which was recrystallized from abs. ethanol and then abs. ether to give 4.9 g. (62% yield) of a colorless crystalline product, m.p. 155–157°.

Anal. Calcd. for $C_{24}H_{30}N_2O_3$: C, 73.06; H, 7.67; N, 7.10. Found: C, 73.19; H, 7.72; N, 7.08.

LINCOLN, NEBR.

[CONTRIBUTION FROM THE FRUIT AND VEGETABLE CHEMISTRY LABORATORY, WESTERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION, AGRICULTURAL RESEARCH SERVICE, U. S. DEPARTMENT OF AGRICULTURE]

Plant Polyphenols. IV. Migration of Acetyl Groups during Alkylation of the Partial Acetates of Flavonoid Compounds

BY LEONARD JURD[1] AND L. A. ROLLE

RECEIVED MARCH 14, 1958

Quercetin 3,3′,4′,7-tetraacetate (II, R = H) and rhamnetin 3,3′,4′-triacetate react with methyl iodide and potassium carbonate in acetone to give 5-O-methylquercetin tetraacetate and 5,7-di-O-methylquercetin triacetate. The benzylation of these compounds does not, however, give the corresponding 5-O-benzyl compounds. Acetyl migration occurs during the benzylation reaction. Quercetin 3,3′,4′,7-tetraacetate and 4-acetylresacetophenone (VI) give 7-O-benzylquercetin tetraacetate and 4-O-benzyl-2-acetylresacetophenone (VII), respectively.

Flavones which contain an hydroxyl group in position 3 and *o*- or *p*-dihydroxyl groupings in the B ring (I) inhibit the aerobic oxidation of unsaturated fats. A free *m*-dihydroxyl grouping in the 5,7-position of the A ring, however, has a pro-oxidant effect.[2–5] As part of an investigation on the development of potential anti-oxidants from phenolic natural products methods are being studied for the selective alkylation of those hydroxyl groups (5- and 7-) of flavones which exert undesirable oxidant effects.

The purpose of this communication is to describe the results of experiments which originally were undertaken to prepare a series of 5-alkyl ethers of quercetin. In each case the constitution of the product first was established spectrophotometrically and then confirmed analytically and by comparison of the melting points of derivatives with literature values for known compounds. The spectrophotometric method designed to locate hydroxyl functions in flavonols was reported recently.[6,7] In this procedure the spectrum of the flavonol is determined successively in ethanol, ethanolic sodium acetate, ethanolic boric acid–sodium acetate and in sodium ethylate. A bathochromic shift (8–20 mμ) of the low wave length band in sodium acetate indicates a free 7-hydroxyl group. A bathochromic shift (15–30 mμ) of the long wave length band in boric acid–sodium acetate shows the presence of a free *o*-dihydroxyl group. Decomposition with disappearance of the long wave length band in sodium ethylate establishes the presence of a free 3,4′-dihydroxyl group. Stability in sodium ethylate shows that either the 3- or 4′- (or both) hydroxyl group is alkylated.

Kubota and Perkin[8] have reported that quercetin 3,3′,4′,7-tetraacetate (II, R = H) slowly reacts with diazomethane to give the tetraacetate II (R = Me) of 5-O-methylquercetin. It now has been found that quercetin 3,3′,4′,7-tetraacetate also reacts with methyl iodide and potassium carbonate in anhydrous acetone[9] to yield a monomethylquercetin tetraacetate whose properties closely agree with those of Perkin's product. On alkaline hydrolysis the tetraacetate gives a monomethylquercetin whose spectra (Fig. 1) confirm the location of the methoxyl group at position 5. The low wave length band in alcohol (253 mμ) shifts 20 mμ on the addition of sodium acetate thus showing the presence of a free 7-hydroxyl.[6] A free *o*-dihydroxyl group (3′,4′-) is indicated by the 17 mμ shift of the long wave length band in boric acid–sodium acetate[7] while the disappearance of the long wave length band in sodium ethylate shows that the hydroxyls at both the 3 and 4′-positions are free.[6] Therefore, since the hydroxyls at positions 3,3′,4′,7 are unprotected, the methoxyl group is located at position 5.

(1) Financial support for this work was provided by the Diamond Walnut Growers, Inc.

(2) T. H. Simpson and N. Uri, *Chemistry and Industry*, 956 (1956).

(3) C. H. Lea and P. A. T. Swoboda, *ibid.*, 1426 (1956).

(4) W. Heimann, A. Heimann and H. Holland, *Fette u. Seifen*, **55**, 394 (1953).

(5) W. Heimann and F. Reiff, *ibid.*, **55**, 451 (1953).

(6) L. Jurd and R. M. Horowitz, *J. Org. Chem.*, **22**, 1618 (1957).

(7) L. Jurd, *Arch. Biochem. and Biophys.*, **63**, 376 (1956).

(8) O. Kubota and A. G. Perkin, *J. Chem. Soc.*, **127**, 1889 (1925).

(9) *Cf.* V. B. Mahesh, S. Neelakanton and T. R. Seshadri, *J. Sci. Ind. Research (India)*, **15B**, 287 (1956).