added. The reaction mixture was extracted with ether. The ether layer was dried and all the ether was removed under reduced pressure. To the residue was added a solution of 2.4 g. (0.06 mole) of sodium hydroxide in 25 ml. of water. The reaction mixture was heated under reflux for approximately 20 hr., cooled, and made acid to Congo Red indicator paper by the addition of dilute hydrochloric acid. The acidic solution was extracted with benzene. The benzene layer was dried, concentrated, and petroleum hexane added to precipitate an oil that crystallized upon scratching, 1.42 g., m.p. 83.5–85°, 17.7% yield. Hoch[16] reported, m.p. 83–84°.

4-Chloro-2,2-dimethylbutanenitrile.[18] Phenyllithium was prepared in 2.3 molar quantity according to the directions of Gilman.[24] A solution of 168 g. (2.3 moles) of calcium hydride-dried diethylamine in 200 ml. of anhydrous ether was added to the solution of phenyllithium. After the reaction mixture cooled to room temperature, a solution of 159 g. (2.3 moles) of isobutyronitrile in 200 ml. of anhydrous ether was added. After cooling, the reaction mixture was added dropwise, over a period of 7.5 hr., under nitrogen, to a refluxing solution of 286.8 g. (2.0 moles) of 1-chloro-2-bromoethane in 1 l. of anhydrous ether. After the addition, the reaction mixture was heated under reflux overnight, then cooled to 5° in an ice bath, and 1 l. of water was added. The layers were separated and the ether layer was washed with water, 10% hydrochloric acid, and water. After drying, distillation gave 97.5 g. of product, b.p. 86–88°/18 mm., 37% yield. A sample was redistilled by Mr. D. W. Karle for analysis, b.p. 83.0–83.5°/16 mm.

Anal. Calcd. for $C_6H_{10}NCl$: C, 54.76; H, 7.66; N, 10.64. Found: C, 54.51; H, 7.75; N, 10.44.

2,2-Dimethylglutaronitrile.[18] A solution of 78.2 g. (1.50 moles) of 95% sodium cyanide in 150 ml. of water was added to 175.5 g. (1.33 moles) of 4-chloro-2,2-dimethylbutanenitrile in 500 ml. of 95% ethanol. More 95% ethanol was added until a homogeneous solution resulted. A few crystals of potassium iodide were added as a catalyst. The reaction mixture was heated under reflux for 5.5 days. The ethanol was removed by distillation which resulted in the formation of two layers. After cooling, the layers were separated. The water layer was extracted several times with ether. The combined organic layer was dried and distilled. After a forerun of starting material, 27.0 g., b.p. 80–85°/16 mm., and a middle fraction, 19.5 g., b.p. 85–130°/16 mm., the product was collected, 72.5 g., b.p. 130–137°/16 mm., 52.6% yield.

Anal. Calcd. for $C_7H_{10}N_2$: C, 68.76; H, 8.24. Found: C, 68.62; H, 8.31.

The water layer was made acidic by the addition of hydrochloric acid and heated under the hood to remove all hydrogen cyanide, and then evaporated to dryness under reduced pressure. The solid was extracted with chloroform. After drying and concentrating, addition of petroleum hexane caused crystallization of 10.0 g. of 2,2-dimethylglutaric acid, which upon mixing with authentic 2,2-dimethylglutaric acid, gave m.p. 71–73°. Hoch[16] reported m.p. 83–84° for 2,2-dimethylglutaric acid.

2,2-Dimethylglutaric acid. A mixture of 97.5 g. (0.80 mole) of 2,2-dimethylglutaronitrile, 400 g. (4.05 moles) of concd. hydrochloric acid, and 100 ml. of water was heated under reflux for 21 hr. The mixture was cooled and allowed to stand until the mixture solidified. The solid was collected and most of the hydrochloric acid was removed by suction. The still moist crystals were dissolved in chloroform. The chloroform layer was separated from the aqueous layer, dried, and concentrated. Addition of petroleum hexane caused crystallization. The solid was collected and dried in the air to give 119.0 g. of acid, m.p. 82–84°, 93% yield. Hoch[16] reported m.p. 83–84°.

Anal. Calcd.: Neut. equiv., 80.1. Found: Neut. equiv., 82.1.

LOS ANGELES 7, CALIF.

[CONTRIBUTION FROM THE WESTERN REGIONAL RESEARCH LABORATORY, AGRICULTURAL RESEARCH SERVICE, U. S. DEPARTMENT OF AGRICULTURE]

The Selective Alkylation of Polyphenols. II. Methylation of 7-, 4′-, and 3′-Hydroxyl Groups in Flavonols

LEONARD JURD

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The methylation, benzylation, or allylation of quercetin pentacetate in anhydrous acetone results in the replacement of acetyl groups by alkyl in the 7- and, to a lesser extent, 4′- positions only. Methylation of a fully acetylated flavonol in acetone containing methanol, however, preferentially methylates hydroxyls in the 7-, 4′- and 3′- positions. A wide variety of partial methyl ethers have been prepared by these reactions.

The methylation of quercetin pentacetate in *anhydrous* acetone yields 7-*O*-methylquercetin. Under similar conditions benzylation and subsequent alkaline hydrolysis gives 7-*O*-benzylquercetin[1] and, in addition, smaller quantities of 4′,7-di-*O*-benzylquercetin. These benzyl ethers differ markedly in their solubilities in benzene. They are therefore separated easily and are useful intermediates in the conversion of quercetin into a variety of its partial methyl ethers. Partial allyl ethers of quercetin, however, do not appear to be useful for these purposes. Thus, quercetin pentacetate reacts particularly readily with excess of allyl bromide in dry acetone to form chiefly 4′,7-di-*O*-allylquercetin triacetate from which 4′,7-di-*O*-allylquercetin is readily obtained. Unexpectedly, however, the allyloxy linkages in this comcompound proved remarkably stable to acid hydrolysis, all attempts to de-allylate its and its trimethyl ether having so far been unsuccessful.

The alkylations in dry acetone discussed above result in the replacement of acetyl groups in the 7- and, to a lesser extent, 4′- positions only. All acetoxy groups are hydrolyzed, however, when fully acetylated flavonols are methylated in a mixture of

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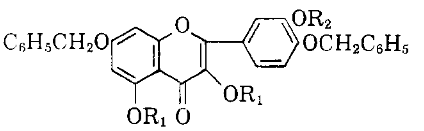
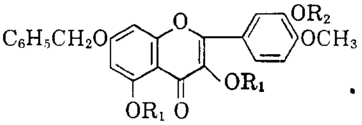
(1) L. Jurd, *J. Am. Chem. Soc.*, 80, 5531 (1958).

acetone and methanol, and hydroxyls in the 7-, 4′-, and 3′- positions are preferentially methylated in the process. With limited amounts of dimethyl sulfate, hydroxyls in the 3- and 5- positions are not methylated.

Many naturally occurring ethers may be conveniently prepared by this methylation reaction. Thus, with a slight excess of one equivalent of dimethyl sulfate 4′,7-di-*O*-benzylquercetin triacetate (I) gives 3′-*O*-methyl-4′,7-di-*O*-benzylquercetin (II) which may be debenzylated to yield isorhamnetin. 7-*O*-Benzlquercetin tetraacetate under similar conditions gives a mixture of the 4′-*O*-methyl and 3-′,4′-di-*O*-methyl derivatives, (III) and (IV). These may be separated readily and debenzylated to give tamaraxetin and 3′,4′-di-*O*-methylquercetin, respectively. With two equivalents of dimethyl sulfate quercetin pentacetate similarly yields ombuin (4′,7-di-*O*-methylquercetin) and 3′,4′,7-tri-*O*-methylquercetin while 3,7-di-*O*-methylquercetin triacetate and one equivalent of dimethyl sulfate react to give ayanin (3,4′,7-tri-*O*-methylquercetin) and 3,7,3′,4′-tetra-*O*-methylquercetin.



I. $R_1 = R_2 = COCH_3$
II. $R_1 = H, R_2 = CH_3$



III. $R_1 = R_2 = H$
IV. $R_1 = H, R_2 = CH_3$

In these methylation reactions it will be noted that mixtures of the 4′,7-di- and 3′,4′,7-trialkyl ethers are usually obtained. The separation of these ethers, however, is not difficult since the potassium salts of the dialkyl ethers crystallize from the reaction mixtures while the potassium salts of the trialkyl ethers remain in the acetone–methanol solution.

Structures were assigned to the various ethers discussed above on the basis of (a) their elemental analyses (b) comparison of their melting points and the melting points of derived products with the literature values for known compounds and (c) their ultraviolet spectra (Table I) in the presence of basic and chelating reagents.[2,3] In the latter procedure, the spectrum of the flavonol was determined successively in ethanol, ethanolic sodium acetate, ethanolic boric acid–sodium acetate, 0.002 *M* sodium ethylate, and aluminum chloride. 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[3] while a bathochromic shift of about 60 mμ of the long wave length band in aluminum chloride shows a free 3-hydroxyl. In sodium ethylate decomposition with disappearance of the long wave length band establishes the presence of a free 3,4′-dihydroxyl group.[2] Stability in sodium ethylate shows that either the 3- or 4′- (or both) hydroxyl group is alkylated. By these spectral methods, the structures assigned to most of the products obtained in the alkylation reactions were unequivocally confirmed. Thus, for example, the quercetin monomethyl ethers, isorhamnetin and tamaraxetin (Table I), gave shifts with sodium acetate and with aluminum chloride (free 7- and 3-hydroxyl groups) but did not shift with boric acid–sodium acetate (no free *o*-dihydroxyl group). With sodium ethylate isorhamnetin decomposed thereby locating the methoxyl at position 3′. Tamaraxetin, on the other hand, gave a stable intense peak with sodium ethylate. The methoxyl was therefore located at position 4′.

The 3′,4′-di-*O*-methylquercetin obtained by methylation and subsequent debenzylation of 7-*O*-benzylquercetin tetraacetate does not appear to have been described previously. The spectra of this compound (Table I) establish the location of the two methoxyl groups in either the 3′,4′- or the 4′,5- positions. The former location, however, seems certain since (a) 7,3′,4′-tri-*O*-methylquercetin and the 7-*O*-benzyl-di-*O*-methylquercetin from which the quercetin dimethyl ether is derived have almost identical spectra in the various media and (b) a methoxyl is introduced into the 3′-position in analogous reactions, *viz.*, in the methylation of 4′,7-di-*O*-benzylquercetin triacetate and in the methylation of quercetin pentaacetate.

EXPERIMENTAL

7-O-Benzyl- and 4′,7-di-O-benzylquercetin. A mixture of quercetin pentaacetate (10.0 g.), potassium iodide (1.0 g.), benzyl chloride (10.0 ml.), anhydrous potassium carbonate (25 g.) and dry acetone (150 ml.) was heated under reflux for 20 hr. The filtered solution was concentrated to an oil which crystallized from benzene–hexane. The colorless crystals (9.2 g.) were suspended in methanol (100 ml.) and 10% aqueous sodium hydroxide (35.0 ml.) and heated on a steam bath for 5 min. Water (300 ml.) and concd. hydrochloric acid (20 ml.) were added. The yellow granular product was collected (6.0 g.), dried, finely powdered, and extracted with boiling benzene (2 × 100 ml.). The undissolved yellow solid (3.0 g., m.p. 241–242°) was purified by recrystallization from ethyl acetate and from acetone–methanol. Pure 7-O-benzylquercetin was thus obtained as yellow needles, m.p. 253°.

Anal. Calcd. for $C_{22}H_{16}O_7$: C, 67.3; H, 4.11. Found: C, 67.4; H, 4.13.

Acetylation of this product (20.0 g.) with acetic anhydride (60 ml.) and sodium acetate (20 g.) in the usual way gave 7-

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

[3] L. Jurd, *Arch. Biochem. Biophys.*, **63**, 376 (1956).

TABLE I
ULTRAVIOLET SPECTRA OF QUERCETIN ETHERS

	λ_{max} (mμ)				
	C_2H_5OH	NaOAc	H_3BO_3–NaOAc	$AlCl_3$	0.002 *M* $NaOC_2H_5$
7-*O*-Benzylquercetin	373		389		
	258	259			
7-*O*-Benzylquercetin tetraacetate	307				
	257				
4′,7-Di-*O*-methylquercetin	369		369	427	419
	256	256			
4′,7-Di-*O*-benzylquercetin	370		370		
	259	259			
4′,7-Di-*O*-allylquercetin	370		370	427	416
	257	257			
4′,7-Di-*O*-methylquercetin triacetate	314				
	256				
4′,7-Di-*O*-benzylquercetin triacetate	315				
	259				
4′,7-Di-*O*-allylquercetin triacetate	315				
	257				
4′,7-Di-*O*-allylquercetin trimethyl ether	340				
	265				
	250				
7,3′,4-Tri-*O*-methylquercetin′	367		368	427	417
	255	255			
7-*O*-Benzyl-3′,4′-di-*O*-methylquercetin	368		368	427	416
	255	255			
7,3′,4′-Tri-*O*-methylquercetin diacetate	328				
	237				
4′-*O*-Methylquercetin (tamaraxetin)	369		369	429	420
	257	272			
3′-*O*-Methylquercetin (isorhamnetin)	371		371	430	dec.
	256	271			
3′,4′-Di-*O*-methylquercetin	367		369	428	
	256	277			
3,7,4′-Tri-*O*-methylquercetin	354			397	380
	257				
3,7,3′,4′-Tetra-*O*-methylquercetin	351			399	378
	256				284

O-benzylquercetin tetraacetate which separated from acetone–methanol as colorless needles, m.p. 170° (24.5 g.).

Anal. Calcd. for $C_{30}H_{24}O_{11}$: C, 64.2; H, 4.32; 4 CH_3CO, 30.7. Found: C, 64.4; H, 4.33; CH_3CO, 30.4.

The benzene extract was concentrated, diluted with hexane, and filtered. The yellow needles (1.8 g., m.p. 177°) were recrystallized from acetone–methanol. 4′,7-Di-*O*-benzylquercetin separated as brightly yellow needles, m.p. 181°.

Anal. Calcd. for $C_{29}H_{22}O_7$: C, 72.2; H, 4.60. Found: C, 72.3; H, 4.60.

4′,7-Di-*O*-benzylquercetin triacetate crystallized from acetone–methanol or benzene–hexane as colorless needles, m.p. 156°.

Anal. Calcd. for $C_{35}H_{28}O_{10}$: C, 69.1; H, 4.64; 3 CH_3CO, 21.2. Found: C, 69.2; H, 4.63; CH_3CO, 21.0.

4′,7-Di-O-allylquercetin. A mixture of quercetin pentaacetate (20.0 g.), allyl bromide (50 ml.), potassium carbonate (40 g.), and dry acetone (250 ml.) was refluxed for 24 hr. The product crystallized from benzene–hexane as colorless needles, m.p. 120–122° (16.0 g.).

The crude product (5.0 g.) was heated under reflux with ethanol (25.0 ml.) and cond. hydrochloric acid (3.0 ml.) for 2 hr. Water (20 ml.) was added. The yellow crystals were collected and recrystallized from acetone–methanol. 4′,7-Di-*O*-allylquercetin separated as yellow needles, m.p. 159–160° (2.8 g.).

Anal. Calcd. for $C_{21}H_{18}O_7$: C, 66.0; H, 4.75. Found: C, 5.9; H, 4.79.

It formed a *triacetate* which crystallized from methanol as colorless needles, m.p. 133°.

Anal. Calcd. for $C_{27}H_{24}O_{10}$: C, 63.8; H, 4.76; 3 CH_3CO, 25.4. Found: C, 63.6; H, 4.89; CH_3CO, 25.0.

Methylation of the diallylquercetin with methyl iodide and potassium carbonate formed the *trimethyl ether* which separated from methanol or benzene–hexane in large, flat needles, m.p. 124°.

Anal. Calcd. for $C_{24}H_{24}O_7$: C, 67.9; H, 5.70. Found: C, 68.0; H, 5.80.

Benzylation of the diallylquercetin in acetone in the usual way gave 4′,7-di-*O*-allylquercetin tribenzyl ether. This crystallized from acetone–methanol as cream colored needles, m.p. 135°.

Anal. Cald. for $C_{42}H_{36}O_7$: C, 77.3; H, 5.56. Found: C, 77.2; H, 5.62.

4′,7-Di-*O*-allylquercetin and its trimethyl ether were recovered unchanged when heated with 50% acetic acid and concd. hydrochloric acid or with acetic acid containing a little concd. sulfuric acid.

3′-O-Methyl-4′,7-di-O-benzylquercetin. 4′,7-Di-*O*-benzylquercetin triacetate (4.2 g.) was heated under reflux with dimethyl sulfate (1.04 g., 1.2 mol. equiv.), anhydrous potassium carbonate (5.0 g.), acetone (60 ml.), and methanol (20 ml.) for 2 hr. The yellow undissolved potassium salts were collected and suspended in dilute aqueous hydrochloric acid. The yellow solid thus obtained, 4′,7-di-*O*-benzylquercetin, crystallized from acetone–methanol as yellow needles, m.p. 175° (0.4 g.).

The acetone–methanol filtrate from the potassium salts was treated with 10% aqueous hydrochloric acid (20 ml.), concentrated, and diluted with water. The yellow needles (2.0 g., m.p. 182°) were recrystallized from benzene-hexane and from acetone-methanol. 3'-*O*-Methyl-4',7-di-*O*-benzylquercetin thereby separated in yellow needles, m.p. 187°, which gave an olive green-brown color with alcoholic ferric chloride.

Anal. Calcd. for $C_{30}H_{24}O_7$: C, 72.6; H, 4.87; 1 MeO, 6.25. Found: C, 72.7; H, 4.94; MeO, 6.27.

The *diacetate* of this product crystallized from acetone-methanol as colorless needles, m.p. 155°.

Anal. Calcd. for $C_{34}H_{28}O_9$: C, 70.3; H, 4.86; 1 MeO, 5.35; 2 CH_3CO, 14.8. Found: C, 70.3; H, 4.94; MeO, 5.54; CH_3CO, 14.0.

Isorhamnetin. 3'-*O*-Methyl-4',7-di-*O*-benzylquercetin (1.5 g.) was heated on a steam bath with glacial acetic acid (75 ml.) and concd. hydrochloric acid (40 ml.) for 1 hr. The product, isorhamnetin, separated from acetone-methanol as yellow needles, m.p. 305-306° (lit.,[4] m.p. 305°) (1.0 g.).

Anal. Calculated for $C_{16}H_{12}O_7$: C, 60.8; H, 3.82; 1 MeO, 9.9. Found: C, 61.0; H, 4.01; MeO, 10.5.

Isorhamnetin tetraacetate separated from acetone-methanol as colorless needles, m.p. 205° (lit.,[4] m.p. 205-207°).

Anal. Calculated for $C_{24}H_{20}O_{11}$: C, 59.5; H, 4.16; 1 MeO, 6.44; 4 CH_3CO, 35.5. Found: C, 59.4; H, 4.19; MeO, 6.32, CH_3CO, 35.5.

4'-O-Methyl- and 3',4'-di-O-methyl-7-O-benzylquercetin. Potassium carbonate (15.0 g.) and methanol (30 ml.) were added to a solution of 7-*O*-benzylquercetin tetraacetate (8.4 g.) and dimethyl sulfate (2.28 g., 1.2 mol. equiv.) in dry acetone (90 ml.). The mixture was heated under reflux for 1.5 hr. and filtered. The yellow potassium salts were suspended in dilute acid, and the yellow solid was collected and recrystallized from acetone-methanol. 4'-*O*-methyl-7-*O*-benzylquercetin separated as yellow needles, m.p. 200° (1.5 g.).

Anal. Calcd. for $C_{23}H_{18}O_7$: C, 68.0; H, 4.46; 1 MeO, 7.64. Found: C, 68.1; H, 4.43; MeO, 7.64.

It formed a *triacetate* which crystallized from acetone-methanol as colorless needles, m.p. 176° (sintering at 152°).

Anal. Calcd. for $C_{29}H_{24}O_{10}$: C, 65.4; H, 4.54. Found: C, 65.3; H, 4.45.

Acidification and concentration of the acetone-methanol filtrate from the yellow potassium salts gave yellow needles (3.0 g.). Recrystallized from benzene-hexane and from acetone-methanol 3',4'-di-*O*-methyl-7-*O*-benzylquercetin was obtained as yellow needles, m.p. 183° (2.0 g.).

Anal. Calcd. for $C_{24}H_{20}O_7$: C, 68.6; H, 4.80; 2 MeO, 14.8. Found: C, 68.6; H, 4.78; MeO, 14.7.

Tamaraxetin. Debenzylation of 4'-*O*-methyl-7-*O*-benzylquercetin (2.7 g.) in hot acetic acid (160 ml.) and concd. hydrochloric acid (160 ml.) for 2 hr. gave tamaraxetin (4'-*O*-methylquercetin). It separated from acetone as bronze-yellow prisms, m.p. 256-257° (lit.,[5] m.p. 256-258°) (1.8 g.).

Anal. Calcd. for $C_{16}H_{12}O_7$: C, 60.8; H, 3.82; 1 MeO, 9.87. Found: C, 60.9; H, 3.86; MeO, 9.71.

The tetraacetate of the product separated from acetone-methanol as colorless needles, m.p. 202-203° (lit.,[5] m.p. for tamaraxetin tetracetate, 202°).

Anal. Calcd. for $C_{24}H_{20}O_{11}$: C, 59.5; H, 4.16; 1 MeO, 6.44; 4 CH_3CO, 35.5. Found: C, 59.6; H, 4.26; MeO, 6.38; CH_3CO, 34.7.

3',4'-Di-O-methylquercetin. 3',4'-Di-*O*-methyl-7-*O*-benzylquercetin (2.0 g.) was debenzylated in the usual way to give 3',4'-di-*O*-methylquercetin (1.2 g.). It crystallized from acetone as lemon yellow needles, m.p. 293°.

Anal. Calcd. for $C_{17}H_{14}O_7$: C, 61.8; H, 4.27; 2 MeO, 18.8. Found: C, 62.4; H, 4.38; MeO, 18.1.

3',4'-Di-*O*-methylquercetin triacetate separated from acetone-methanol as colorless needles, m.p. 203°.

Anal. Calcd. for $C_{23}H_{20}O_{10}$: C, 60.5; H, 4.42; 2 MeO, 13.6. Found: C, 60.4; H, 4.44; MeO, 13.4.

Ombuin and 3',4',7-tri-O-methylquercetin. A mixture of quercetin pentaacetate (8.0 g.), dimethyl sulfate (4.0 g., 2 mol. equiv.), acetone (120 ml.), methanol (30 ml.), and potassium carbonate (12.0 g.) was allowed to react for 1.5 hr. as described above. The undissolved potassium salts on acidification gave a yellow solid which was recrystallized from acetone-methanol. Ombuin (4',7-di-*O*-methylquercetin) separated as bronze-yellow needles, m.p. 232° (lit.,[6] m.p. 229-230°) (1.5 g.).

Anal. Calcd. for $C_{17}H_{14}O_7$: C, 61.8; H, 4.27; 2 MeO, 18.8. Found: C, 62.1; H, 4.31; MeO, 18.7.

Ombuin triacetate crystallized from acetone-methanol as colorless, glistening prisms, m.p. 209° (lit.,[6] m.p. 211-212°).

Anal. Calcd. for $C_{23}H_{20}O_{10}$: C, 60.5; H, 4.42; 2 MeO, 13.6. Found: C, 60.6; H, 4.40; MeO, 13.5.

Acidification of the acetone-methanol filtrate from the potassium salts and concentration gave yellow needles (1.8 g.). Recrystallized from acetone-methanol 3',4',7-tri-*O*-methylquercetin separated as lemon yellow needles, m.p. 183-184° (lit.,[7] m.p. 183-184°).

Anal. Calcd. for $C_{18}H_{16}O_7$: C, 62.8; H, 4.68; 3 MeO, 27.05. Found: C, 62.9; H, 4.70; MeO, 26.5.

The product formed a diacetate which crystallized from acetone-methanol as glistening, slightly yellow prisms, m.p. 188° (lit.,[7] m.p. for 7,3',4'-tri-*O*-methylquercetin diacetate is 187-188°).

Anal. Calcd. for $C_{22}H_{20}O_9$: C, 61.7; H, 4.71. Found: C, 61.6; H, 4.73.

Ayanin and 3,7,3',4'-tetra-O-methylquercetin. 3,7-Di-*O*-methylquercetin triacetate (1.5 g.) and dimethyl sulfate (0.50 g., 1.2 mol. equiv.) were allowed to react as described above. Acidification of the yellow potassium salts gave ayanin (3,4',7-tri-*O*-methylquercetin) which separated from acetone-methanol and from acetone alone as yellow needles, m.p. 169° (lit.,[9] m.p. 172-173°). The melting point of this product could not be raised by repeated recrystallization. Chromatographed on silicic acid chromatostrips it migrated as a single species.

Anal. Calculated for $C_{18}H_{16}O_7$: C, 62.8; H, 4.68; 3 MeO, 27.05. Found: C, 62.8; H, 4.69; MeO, 27.4.

The above product formed a *diacetate* which crystallized from acetone-methanol as colorless needles, m.p. 171° (lit.,[9] m.p. for ayanin diacetate is 176°).

Anal. Calcd. for $C_{22}H_{20}O_9$: C, 61.7; H, 4.71; 3 MeO, 21.7. Found: C, 61.7; H, 4.62; MeO, 22.0.

Acidification of the acetone-methanol filtrate from the potassium salts gave 3,7,3',4'-tetra-*O*-methylquercetin. It crystallized from acetone-methanol as yellow needles, m.p. 158-159° (lit.,[9] m.p. 158-159°).

Anal. Cald. for $C_{19}H_{18}O_7$: C, 63.7; H, 5.06; 4 MeO, 34.6. Found: C, 63.6; H, 4.95; MeO, 33.9.

The 3,7,3',4'-tetra-*O*-methylquercetin formed a monoacetate which separated from methanol as colorless felted needles, m.p. 169° (lit.,[9] m.p. 168-169°).

Anal. Calcd. for $C_{21}H_{20}O_8$: C, 63.0; H, 5.04. Found: C, 63.0; H, 4.94.

Acknowledgment. The author is indebted to L. M. White and Miss G. Secor for the elemental analyses.

ALBANY, CALIF.

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