437. *Derivatives of* 1 : 2 : 3 : 4-*Tetrahydroxybenzene. Part II.*

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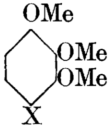
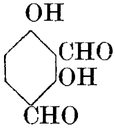
Two further methods for the preparation of 1 : 2 : 3 : 4-tetrahydroxybenzene derivatives (see Baker and Smith, J., 1931, 2542) are now recorded.

(1) The hydrolysis of 4-iodo- or 4-bromo-pyrogallol trimethyl ether (I; X = I or Br). The former compound is conveniently prepared by iodination of pyrogallol trimethyl ether in presence of mercuric oxide, and the authors are grateful to Dr. H. Erdtman for permission to record this method.


(I.)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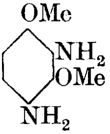
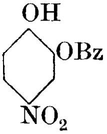

(III.)


(IV.)

The iodo-compound was hydrolysed by aqueous alkali, with or without copper powder, best at 210°; below 200° there was hardly any action, and above 250° much tar was produced. Replacement of the halogen atom by hydrogen and demethylation always occurred to some extent. From the product a high-boiling fraction was obtained which gave 1 : 2 : 3 : 4-tetramethoxybenzene on methylation. Less dehalogenation of the bromo-compound (I; X = Br) occurred, the best yield (about 35%) being obtained by using aqueous potassium hydroxide without addition of copper powder. 4-Iodopyrogallol trimethyl ether, when heated with water and silver oxide at 245°, yielded pyrogallol.

(2) When resorcyldialdehyde (Tiemann and Lewy, *Ber.*, 1877, **10**, 2211) was oxidised in alkaline solution with hydrogen peroxide (Dakin, *Amer. Chem. J.*, 1909, **42**, 477) and then methylated, 1 : 2 : 3 : 4-tetramethoxybenzene was obtained. The dialdehyde is therefore resorcinol-2 : 4-dialdehyde (II); it has not previously been oriented. Although freely soluble in alkaline solutions, it is resistant to methylation by methyl sulphate in aqueous alkali.

2 : 4-*Diaminoresorcinol dimethyl ether* (III) could not be hydrolysed in aqueous solution to give 1 : 2 : 3 : 4-tetrahydroxybenzene 1 : 3-dimethyl ether (compare hydrolysis of 3 : 5 diaminoveratrole; Chapman, Perkin, and Robinson, J., 1927, 3015; Baker and Robinson, J., 1929, 156). Catechol dibenzyl ether on nitration gave 4-*nitrocatechol dibenzyl ether*, which could not be hydrolysed to 4-nitrocatechol 2-benzyl ether, nor could the corresponding 4-*aminocatechol dibenzyl ether* be oxidised to benzyloxy-*p*-benzoquinone (compare oxidation of 4-aminopyrogallol trimethyl ether; Baker and Smith, *loc. cit.*), and this quinone was not obtained by the oxidation of *o*-aminophenyl benzyl ether. 4-Nitro-2-benzyl-oxyanisole was hydrolysed at 150—200° by aqueous alkali, giving 4-*nitrocatechol 2-benzyl ether* (IV) in poor yield.

EXPERIMENTAL.

4-*Iodopyrogallol Trimethyl Ether* (I; X = I).—Into fused pyrogallol trimethyl ether (33·6 g.) at 80°, I (52 g.) and HgO (26 g.) were stirred alternately in small portions so that the temp. remained at 80° without external heating. After ½ hr., the product was treated with C_6H_6, shaken with 20% KI aq. to remove traces of HgI_2, dried, and distilled, finally under diminished press. 4-Iodopyrogallol trimethyl ether (51 g.) distilled at 165°/19 mm.; it formed highly refracting prisms, m. p. 41—42°, from light petroleum (b. p. 40—60°) (Graebe and Suter, *Annalen*, 1905, **340**, 230, record m. p. 40—41°).

Hydrolysis. The ether (20 g.) was heated with alkali (NaOH, 24 g., in H_2O, 275 c.c.) and Cu bronze (6 g.) at 210° for 3 hr. The solution was at once acidified, and Et_2O then extracted an oil which, distilled at 13 mm., gave fractions, b. p. 125—140° (A), 140—145° (B), and 145—155° (C). Fraction (A) (7 g.) on methylation with Me_2SO_4 and NaOH aq. yielded pyrogallol trimethyl ether, m. p. 45—47° after crystn. from ligroin, and by prolonged distillation in steam and extraction of both distillate and residue with Et_2O, it was separated into two almost equal fractions. That from the distillate consisted largely of pyrogallol 1 : 3-dimethyl ether, since by oxidation in EtOH with HNO_3 (*d* 1·2) (cf. Will, *Ber.*, 1888, **21**, 608) it gave a quinone reducible in aq. suspension by SO_2 to 2 : 6-dimethoxyquinol, m. p. and mixed m. p. 159°. The non-volatile product contained much pyrogallol 1-methyl ether, since after treatment with methylene sulphate and alkali (see Baker, Montgomery, and Smith, this vol., p. 1282) in dilute acetone, steam-distillation yielded

1-methoxy-2 : 3-methylenedioxybenzene, m. p. 41°. Fraction (B) (1·4 g.) when methylated yielded a mixture, m. p. 35—75°, of pyrogallol trimethyl ether and 1 : 2 : 3 : 4-tetramethoxybenzene. Fraction (C) (3·3 g.), which was very viscous and cloudy, similarly gave almost homogeneous 1 : 2 : 3 : 4-tetramethoxybenzene, m. p. 88—89° after crystn. from ligroin (Found : C, 60·6; H, 7·0. Calc. for $C_{10}H_{14}O_4$: C, 60·6; H, 7·1%). This fraction contained, in addition to partly methylated tetrahydroxybenzenes, a trace of pyrogallol 1-methyl ether, since on methylenation, followed by steam-distillation, it gave a small yield of 1-methoxy-2 : 3-methylenedioxybenzene.

By heating 4-iodopyrogallol trimethyl ether (20 g.) with freshly pptd. Ag_2O (17 g.) and H_2O (500 c.c.) for 3 hr. at 245° and proceeding as above, the only product obtained was pyrogallol (7·5 g.; b. p. 165—172°/13 mm.), m. p. 132° after crystn. from $CHCl_3$.

Hydrolysis of 4-*Bromopyrogallol Trimethyl Ether*.—The ether (70 g.; b. p. 260—265°; Kohn and Grün, *Monatsh.*, 1925, **46**, 85; yield 68%) was heated with KOH (140 g.) in H_2O (560 c.c.) for 1½ hr. at 210—215°. The product, isolated as previously described, yielded fractions (A) and (B) (8 g.), and a fraction (C) (19 g.) which gave 1 : 2 : 3 : 4-tetramethoxybenzene on methylation.

Resorcinol-2 : 4-*dialdehyde* (II).—The method described by Tiemann and Lewy (*loc. cit.*; yield not recorded) could not be successfully repeated. The following method gives consistent but poor yields. Resorcinol (15 g.) in 20% NaOH aq. (1200 c.c.) was gently warmed and treated during 8 hr. with $CHCl_3$ (240 g.), the mixture refluxed for 26 hr., dil. H_2SO_4 added, and the dialdehyde distilled in steam; it separated from the distillate as a voluminous mass of white needles (0·85 g.), m. p. 127°.

1 : 2 : 3 : 4-*Tetramethoxybenzene*.—Resorcinoldialdehyde (1 g.) in *N*-NaOH (12·5 c.c.) was treated with 3% H_2O_2 (17·1 c.c.) in coal gas. Rise of temp. occurred and after ½ hr. 2*N*-NaOH (30 c.c.) and Me_2SO_4 (3·5 g.) were added and the mixture was warmed at 60° for 5 min. The crystals deposited on cooling separated from ligroin (b. p. 40—60°) in colourless prisms, m. p. 86—87° (mixed m. p. with 1 : 2 : 3 : 4-tetramethoxybenzene, 87—88°).

2-*Nitroresorcinol Dimethyl Ether*.—Me_2SO_4 (122 g.) was added during 4 hr. to a stirred solution of 2-nitroresorcinol (50 g.) (Kauffmann and de Pay, *Ber.*, 1904, **37**, 725) in 10% NaOH aq. (1100 c.c.) at 60—70°, the almost pure substance separating in 80% yield. It formed pale yellow needles, m. p. 130°, from EtOH (see Baeyer, *Annalen*, 1909, **372**, 125).

2 : 4-*Dinitroresorcinol Dimethyl Ether*.—2-Nitroresorcinol dimethyl ether (40 g.) was slowly added to a mixture of HNO_3 (20 c.c.; *d* 1·42) and HNO_3 (30 c.c.; *d* 1·5) kept at − 5°, and the product poured on ice. The solid separated from CCl_4 in pale yellow crystals (30 g.), m. p. 71—72° (cf. Kauffmann and Franck, *Ber.*, 1907, **40**, 4003).

2 : 4-*Diaminoresorcinol Dimethyl Ether*.—The dinitro-ether (10 g.) was warmed for ½ hr. with conc. HCl (100 c.c.), H_2O (40 c.c.), and Sn (60 g.), the solution evaporated to dryness in CO_2 under diminished press., the Sn pptd. as sulphide, and the *dihydrochloride* obtained by evapn. as before. It formed an almost colourless cryst. crust (7·2 g.), m. p. about 210° (decomp.) (Found : N, 11·2; Cl, 28·2. $C_8H_{12}O_2N_2,2HCl$ requires N, 11·6; Cl, 29·4%), rapidly darkened in aq. solution, and could not be converted into a cryst. base.

Catechol Dibenzyl Ether.—Catechol (60 g.), anhydrous K_2CO_3 (220 g.), and dry acetone (240 c.c.) were refluxed for 2½ hr. while $Ph{\cdot}CH_2Cl$ (190 g.) was slowly added, and then for a further 70 hr. and poured into H_2O. The oily product was taken up in Et_2O and steam-distilled till no more $Ph{\cdot}CH_2{\cdot}OH$ came over; the residual catechol dibenzyl ether solidified on cooling and crystallised from EtOH in pale yellow prisms (50 g.), m. p. 63—64° (cf. Schiff and Pellizzari, *Annalen*, 1883, **221**, 378).

4-*Nitrocatechol Dibenzyl Ether.*—Schiff and Pellizzari (*loc. cit.*) observed that catechol dibenzyl ether and HNO_3 gave a solid, m. p. 98°, but it was not investigated. To the ether (5 g.) in AcOH (25 c.c.) was gradually added HNO_3 (5 c.c.; *d* 1·42) in AcOH (25 c.c.). After 1 hr. the product was pptd. by H_2O and crystallised from EtOH, forming fine, very pale yellow needles (4·8 g.), m. p. 98° (Found : N, 4·2. Calc. for $C_{20}H_{17}O_4N$: N, 4·2%).

Hydrolysis for 1½ hr. with conc. HCl in AcOH (1 : 2) and isolation of the phenolic product yielded 4-nitrocatechol as yellow needles (from C_6H_6), m. p. 174°, which was converted by Me_2SO_4 into 4-nitroveratrole, m. p. and mixed m. p. 95—96°.

4-*Aminocatechol Dibenzyl Ether.*—4-Nitrocatechol dibenzyl ether (5 g.) in EtOH (150 c.c.) and $Na_2S_2O_4$ (20 g.) in H_2O (100 c.c.) were heated on the water-bath for 1½ hr., the EtOH was distilled, and the *amino*-compound (4·2 g.) pptd. by H_2O (200 c.c.). Cryst. from EtOH aq. and then ligroin (b. p. 60—80°), it formed colourless leaflets, m. p. 112° (Found : N, 4·5. $C_{20}H_{19}O_2N$ requires N, 4·6%). The *acetyl* derivative separated from much hot H_2O in flaky crystals, m. p. 228° (decomp.) (Found : N, 3·8. $C_{22}H_{21}O_3N$ requires N, 4·0%).

o-*Nitrophenyl Benzyl Ether.*—*o*-Nitrophenol (50 g.) in EtOH (200 c.c.) was added to Na (16·5 g.) dissolved in EtOH (250 c.c.), and $Ph{\cdot}CH_2Cl$ (90 g.) was gradually added to the stirred mixture, which was heated on the water-bath for 12 hr. Excess of dil. HCl was added, *o*-nitrophenol distilled in steam, and the product extracted with Et_2O; the extracts after shaking with NaOH aq. yielded a residue, m. p. 24—28°, which, recryst. from ligroin, gave pure *o*-nitrophenyl benzyl ether, m. p. 29° (cf. Kumpf, *Annalen*, 1884, **224**, 121; Sieglitz and Koch, *Ber.*, 1925, **58**, 78).

o-*Aminophenyl Benzyl Ether.*—The reduction of *o*-nitrophenyl benzyl ether by means of ammonium sulphide (Sieglitz and Koch, *loc. cit.*) is tedious and the yields are very poor. To *o*-nitrophenyl benzyl ether (10 g.) in EtOH (200 c.c.) was added $Na_2S_2O_4$ (35 g.) in water (150 c.c.) with shaking and warming, and the mixture heated gently for 1½ hr. The EtOH was distilled off, the solution made alkaline and cooled to 0°, and the amino-compound collected and recrystallised from ligroin (b. p. 60—80°), forming colourless flakes (5 g.), m. p. 38—39°.

4-*Nitrocatechol* 2-*Benzyl Ether* (IV).—4-Nitro-2-benzyloxyanisole (1 g.) (Allan and Robinson, J., 1926, 382) and 10% KOH aq. (20 c.c.) were heated for 12 hr. first at 150°, then at 200°. H_2O was now added, the filtered solution acidified at 0°, and the solid crystallised from ligroin (b. p. 60—80°), forming very pale yellow prisms, m. p. 83—85° (Found : N, 5·7. $C_{13}H_{11}O_4N$ requires N, 5·7%).

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[*Received, October 18th,* 1932.]