Limited Methylation of Chlorinated 1,2-Benzenediols to Chlorinated 2-Methoxyphenols

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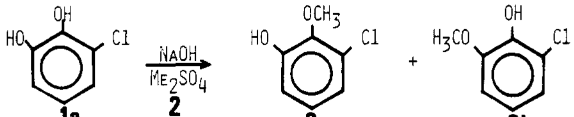
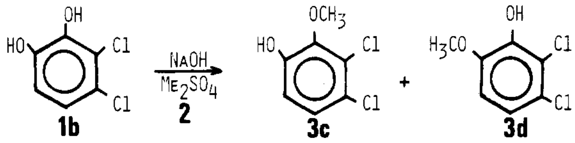
The reaction of chlorinated 1,2-benzenediols with dimethyl sulfate in NaOH solution has been investigated and found to result in chlorinated 2-methoxyphenols including three hitherto unknown compounds. Experimental and spectral data (mass, ^{1}H NMR, and ^{13}C NMR) for all compounds are reported.

As a part of our general research program in the synthesis of new chlorinated phenolic compounds which have been shown to be present in pulp bleachery effluents (*1-3*), we report here a convenient method for the preparation of chlorinated 2-methoxyphenols **3** (eq 1-3). Compounds **3** constitute three products (**3c-e**) which have not hitherto been described in the literature. However, the related synthesis has previously been employed for the preparation of methyl- and isopropyl-substituted 2-methoxyphenols (*4*). We have now found that chlorinated 1,2-benzenediols **1a-c**, which were synthesized from the corresponding chlorinated 2-hydroxybenzaldehydes by using the method of Dakin (*5*), react with dimethyl sulfate, **2** (highly poisonous, see ref *6*), to produce chlorinated 2-methoxyphenols (**3a-e**) in 10-20% yields (eq 1-3). The products were separated and purified by silica gel column chromatography and further structurally verified by means of their ^{1}H NMR, ^{13}C NMR, and mass spectra.



(1)



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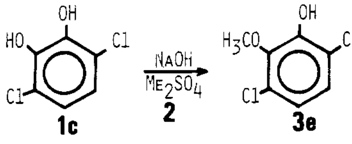

(3)

Experimental Section

All melting points were uncorrected. NMR spectra were obtained on a JEOL FX-60 spectrometer from ~10% acetone-d_6 solutions; the chemical shifts are described as parts per million (ppm) from tetramethylsilane. Mass-spectral data were obtained on a JEOL JMS D300 mass spectrometer operating at 70 eV using the direct inlet.

General Procedure for the Preparation of 3a-e. Chlorinated 1,2-benzenediols **1** (0.01 mol) were stirred at room temperature (20 °C) with 7 mL of 8% NaOH solution for 15 min. Dimethyl sulfate (**2**) (0.01 mol) was added, and the stirring was continued for 15 min. The dark brown reaction mixture was acidified with 2 N H_2SO_4 solution (pH to ~2) and then extracted with diethyl ether. The ether layer was washed twice with 2 N H_2SO_4 solution and dried over $MgSO_4$, and then the ether was removed by a nitrogen gas stream. The crude product was fractionated by column chromatography on Kieselgel 60 (230-400 mesh, Merck). The column used was 2 × 40 cm, and the solvent CH_2Cl_2 (Merck). The purity of the fractions was checked by ^{1}H NMR spectroscopy and by TLC on silica gel 60 (precoated TLC plates with a silica gel 60 and a concentrating zone, 10 × 20 cm, layer thickness 0.25 mm; Merck, Darmstadt, West Germany) with CH_2Cl_2. A 2% solution of 3,5-dichloro-*p*-benzoquinonechlorimine in toluene was used for spot detection (*7*).

The reaction of **1a** with **2** gave two chlorinated 2-methoxyphenols: **3a** (3-chloro-2-methoxyphenol), mp 32 °C, in 13% yield; and **3b** (6-chloro-2-methoxyphenol), mp 54 °C, in 18% yield. R_f values of **1a**, **3a**, and **3b** were 0.10, 0.23, and 0.35, respectively. Spectra of **3a**: ^{1}H NMR δ 3.88 (MeO), 6.9-7.1 (aryl multiplet), 8.35 (broad singlet, OH); ^{13}C NMR δ 60.8, 116.2, 121.4, 125.7, 128.3, 144.9, 152.4; mass spectrum (relative intensities in parentheses): $M^{+\cdot}$ 158, 160 (87, 32), 143, 145 (100, 38), 115, 117 (54, 21), 107 (15). Spectra of **3b**: ^{1}H NMR δ 3.88 (MeO), 6.85-7.15 (aryl multiplet), 8.1 (singlet, OH); ^{13}C NMR δ 56.6, 110.8, 120.3, 120.3, 122.5, 143.9, 149.3; mass spectrum $M^{+\cdot}$ 158, 160 (100, 33), 143, 145 (94, 31), 115, 117 (26, 8), 107, (8).

Analytical data were satisfactory.

The reaction of **1b** with **2** gave viscous liquids of **3c** (3,4-dichloro-2-methoxyphenol) and **3d** (5,6-dichloro-2-methoxyphenol), in yields of 10% and 15%, respectively. R_f values of **1b**, **3c**, and **3d** were 0.08, 0.25, and 0.37, respectively. Spectra of **3c**: ^{1}H NMR δ 3.89 (MeO), 6.85-7.35 (quartet), 8.7 (broad singlet, OH); ^{13}C NMR δ 60.9, 116.5, 123.3, 126.0, 127.3, 146.2, 151.0; mass spectrum $M^{+\cdot}$ 192, 194, 196 (83, 55, 9), 177, 179, 181 (100, 64, 11), 149, 151, 153 (43, 28, 5), 113, 115 (48, 17). Spectra of **3d**: ^{1}H NMR δ 3.92 (MeO), 6.8-7.1 (quartet), 8.6 (broad singlet, OH); ^{13}C NMR δ 56.8, 111.2, 119.4, 120.4, 124.9, 145.5, 148.0; mass spectrum $M^{+\cdot}$ 192, 194, 196 (80, 50, 9), 177, 179, 181 (100, 64, 11), 149, 151, 153 (37, 25, 4), 113, 115 (43, 14).

Analytical data were satisfactory.

The reaction of **1c** with **2** gave **3e** (3,6-dichloro-2-methoxyphenol), mp 70 °C, in 20% yield. R_f values of **1c** and **3e** were 0.12 and 0.29, respectively. Spectra of **3e**: ^{1}H NMR δ 3.92 (MeO), 6.9-7.4 (quartet), 8.9 (singlet, OH); ^{13}C NMR δ 61.1 120.6, 121.2, 126.1, 126.9, 145.9, 148.9; mass spectrum $M^{+\cdot}$ 192, 194, 196 (97, 62, 10), 177, 179, 181 (100, 64, 9), 149, 151, 153 (26, 14, 2), 113, 115 (13, 4).

Analytical data were satisfactory.

Literature Cited

(1) Lindström, K.; Nordin, J. *J. Chromatogr.* **1976**, *128*, 13.
(2) Voss, R. H.; Wearing, J. T.; Wong, A. *CPAR PROJECT No. 828*, Pulp and Paper Research Institute of Canada, 1979.
(3) Holmbom, B. *Pap. Puu* **1980**, *No. 9*, 523.
(4) Vickery, E. H.; Pahler, L. F.; Eisenbraun, E. J. *J. Org. Chem.* **1979**, *44*, 4444.
(5) Dakin, H. D. *Am. Chem. J.* **1909**, *42*, 477.
(6) Vogel, A. I. "Elementary Practical Organic Chemistry"; Longmans, Green and Co.: London, 1966; Part 1, p 311.
(7) Knuutinen, J.; Paasivirta, J. *J. Chromatogr.* **1980**, *194*, 55.

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