

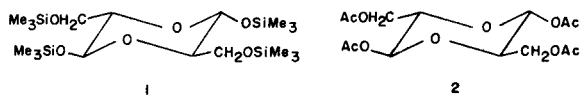
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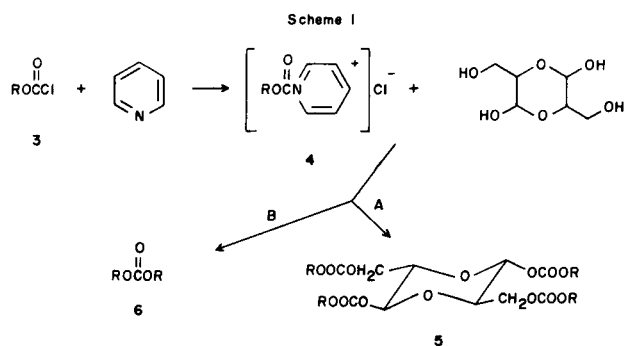
A number of 2,5-bis(aryl- and alkyloxycarbonyloxymethylene)-3,6-bis(aryl- and alkyloxycarbonyloxy)-1,4-dioxanes **5a-d** have been prepared by the reaction of glyceraldehyde with aryl and alkyl chloroformates. Bis aryl carbonates were also formed under certain conditions in this reaction. Nuclear magnetic resonance analysis of **5c** indicated that it existed in a chair conformation with all the substituents in an equatorial position.

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Glyceraldehyde can exist in different structural forms in solution [1] depending on the solvent. It exists in a monomeric form in aqueous solution and in a dimeric form in organic solvents. Gardiner [2] and Hall [3] have shown that the reaction of glyceraldehyde with chlorotrimethylsilane or with acetic anhydride and pyridine yields 1,4-dioxane derivatives **1** and **2** respectively; *i.e.*, the products originate from the dimeric form. We were interested in investigating the reaction of glyceraldehyde with aryl and alkyl chloroformates. Since the reaction of glyceraldehyde with chloroformates can only be conveniently carried out in aprotic organic solvents, we anticipated obtaining the 1,4-dioxane derivatives as products.



Matzner *et al.* [4] reported that chloroformates react with tertiary amines, such as pyridine, yielding unstable quaternary ammonium compounds. The latter react with alcohols and phenols to give the expected carbonates in good yield. It was also reported [5] that aryl chloroformates give bis-aryl carbonates directly when treated with pyridine at elevated temperatures. A later report [6] indicated that the presence of water was the reason for the formation of the bis aryl carbonate **6**.



- a, R = *cis*-3-hexenyl
 b, R = 2-isopropyl-5-methylcyclohexyl
 c, R = phenyl
 d, R = 2-methoxy-4-methylphenyl
 e, R = 2-methoxy-4-formylphenyl

Generally, in our hands, when the reaction of glyceraldehyde with aryl chloroformates was conducted at room temperature, a heterogeneous mixture was observed and maintained throughout the course of the reaction, with the isolation of **6** as the major product (Scheme 1, path B). When the reaction was carried out at an elevated temperature (40-60°) a homogeneous solution was observed with **5** as the major product obtained (Scheme 1, path A). However, in the case of alkyl chloroformates, the only product obtained was **5**, regardless of the temperature (see Table I).

Table I

Reaction of Glyceraldehyde with Aryl and Alkyl Chloroformates

Compound	Temperature (°C)	Yield (%) [a]	
		6	5
3a	40-60	- [b]	65
3b	25	- [b]	55
3b	40-60	- [b]	80
3c	40-60	- [c]	65
3d	25	53	35
3d	40-60	18	70
3e	25	20	- [b]
3e	40-60	20	- [b]

[a] Isolated yields. [b] These compounds were not detected in the reaction. [c] Compound **6c** was not detected.

It may be assumed that at room temperature, the pyridine-chloroformate complex **4** would preferably react with the primary hydroxyl groups in the glyceraldehyde dimer, resulting in **7** (Scheme 2). Once the primary hydroxyl groups were substituted the vicinal secondary hydroxyl groups had two possible sites of nucleophilic attack. One would be an intermolecular nucleophilic attack on the pyridine-chloroformate complex **4** which would result in **5** being formed. The other alternative would be an intramolecular nucleophilic attack of the hydroxyl group on the carbonate. This would result in the formation of a cyclic carbonate **8** with the elimination of an alkoxy or aryloxy anion. The anion, in turn, could then attack the pyridine-chloroformate complex, **4**, which would result in the formation of the bis carbonate, **6**.

2-propanol to yield 4.0 g (80%) of the pure product, mp 139-140°; ir (nujol mull): 1748 cm^{-1} (carbonate); nmr (deuteriochloroform): δ 5.7 (2H, d, J = 7.0 Hz, C₃), 4.75-4.25 (8H, m, CO₂CH₂, and OCH₂CH), 3.9 (2H, m, C₂), 2.25-0.65 (72H, m, menthyl protons).

Anal. Calcd. for C₅₀H₈₄O₁₄: C, 66.05; H, 9.31. Found: C, 65.85; H, 9.46.

Method B.

The synthesis of **5b** was conducted on a 11.1 mmole scale using the conditions described in Method B. The product was recrystallized from isopropanol and yielded 2.7 g (55%) of the pure product, mp 139-140°. Its spectral data were identical to that obtained by Method A.

2,5-bis(Phenoxy-carbonyloxymethylene)-3,6-bis(phenoxy-carbonyloxy)-1,4-dioxane (**5c**).

The synthesis of **5c** was conducted on a 11.1 mmole scale using the conditions described in Method A. The product was recrystallized from ethanol to yield 2.4 g (65%) of the pure product, mp 155°; ir (nujol mull): 1768 cm^{-1} (carbonate); nmr (deuteriochloroform): δ 7.55-7.05 (20H, m, aromatic protons), 5.95 (2H, d, J = 7.5 Hz, C₃), 4.6 (4H, m, CO₂CH₂), 4.23 (2H, m, C₂).

Anal. Calcd. for C₃₄H₂₈O₁₄: C, 61.82; H, 4.27. Found: C, 61.64; H, 4.49.

2,5-bis(2-Methoxy-4-methylphenoxy-carbonyloxymethylene)-3,6-bis(2-methoxy-4-methylphenoxy-carbonyloxy)-1,4-dioxane (**5d**).

Method A.

The synthesis of **5d** was conducted on a 11.1 mmole scale using the condition described in Method A. The product was recrystallized from chloroform:isooctane and yielded 3.2 g (70%) of the pure product, mp 191-192°; ir (nujol mull): 1766 cm^{-1} (carbonate); nmr (deuteriochloroform): δ 7.1-6.6 (12H, m, aromatic protons), 5.9 (2H, d, J = 6.0 Hz, C₃), 5.05 (4H, m, CO₂CH₂), 4.28 (2H, m, C₂), 3.8 (12H, s, OCH₃), 2.3 (12H, s, CH₃).

Anal. Calcd. for C₄₂H₄₄O₁₆: C, 60.28; H, 5.30. Found: C, 60.13; H, 5.37.

The mother liquor was evaporated under reduced pressure to yield a solid which was recrystallized from chloroform:hexane to yield 0.6 g (18%) of **6d**. Its spectral data was identical to that obtained for an authentic sample of **6d**.

Method B.

The synthesis of **5d** was conducted on a 11.1 mmole scale using the conditions described in Method B. The product was recrystallized from chloroform:isooctane to yield 1.6 g (35%) of the pure product, mp 191-192°. Its spectral data was identical to that obtained by Method A.

The mother liquor was evaporated under reduced pressure to yield a solid which was recrystallized from chloroform:hexane to yield 1.8 g (53%) of **6d**. Its spectral data were identical to the authentic sample of **6d**.

Reaction of Glyceraldehyde With 2-Methoxy-4-formylphenyl Chloroformate (**3e**).

Method A.

The reaction was conducted on a 11.1 mmole scale using the conditions described in Method A. The product was washed with ethanol yielding 0.7 g (20%) of bis(2-methoxy-4-formylphenyl)carbonate (**6e**). Its spectral data were identical to the authentic sample of **6e**.

Method B.

The reaction was conducted on a 11.1 mmole scale using the conditions described in Method B. The product was washed with ethanol which yielded 0.7 g (20%) of bis(2-methoxy-4-formylphenyl) carbonate (**6e**). Its spectral data was identical to the authentic sample of **6e**.

bis(2-Methoxy-4-formylphenyl) Carbonate (**6e**).

To a solution of 4 ml of pyridine in 50 ml of methylene chloride was added 0.7 g (4.7 mmoles) of 2-methoxy-4-formylphenol. The solution was chilled in an ice bath. A solution of 1.0 g (4.7 mmoles) of 2-methoxy-4-formylphenyl chloroformate in 10 ml of methylene chloride was added dropwise. Stirring was continued for approximately 15 minutes, while maintaining the temperature at 0°, then 18-24 hours at room temperature. Ether was added and the reaction mixture was washed with water, followed by aqueous saturated sodium bicarbonate. The organic layer was dried over anhydrous sodium sulfate. Evaporation of the solvent under reduced pressure yielded a solid. It was washed with ethanol to remove any 2-methoxy-4-formylphenol yielding 1.3 g (85%) of **6e**, mp 149-150°; ir (nujol mull): 1700 cm^{-1} (aldehyde), 1770 cm^{-1} (carbonate); nmr (deuteriochloroform): δ 9.97 (2H, s, CHO), 7.63-7.25 (6H, m, aromatic protons), 4.0 (6H, s, OCH₃).

Anal. Calcd. for C₁₇H₁₄O₇: C, 61.82; H, 4.27. Found: C, 62.01; H, 4.47.

bis(2-Methoxy-4-methylphenyl) Carbonate (**6d**).

The synthesis of **6d** was conducted on a 5 mmole scale by using the conditions described for **6e**. The product was recrystallized from chloroform:hexane to yield 1.2 g (87%) of the pure product, mp 145-147°; ir (nujol mull): 1780 cm^{-1} (carbonate), nmr (deuteriochloroform): δ 7.3-6.63 (6H, m, aromatic protons), 3.88 (6H, s, OCH₃), 2.35 (6H, s, OCH₃).

Anal. Calcd. for C₁₇H₁₈O₇: C, 67.54; H, 6.00. Found: C, 67.30; H, 5.91.

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