taining 2% v/v ethanol). The α anomer is the faster moving spot. ^{1}H NMR (Me_2SO-d_6) δ 8.28 (s, 1, H-6), 5.95 (m, 1, H-1′), 5.05–5.15 (m, 1, H-3′), 4.6 (m, 1, H-4′), 4.1–4.5 (m, 5, H-5′, CH_2-Fmoc, CH-Fmoc), 2.3–2.75 (m, 2 H-2′).

5-Aza-2′-deoxycytidine (6). Triethylamine (5.6 mL, 40 mmol) was added to a solution of **5** (1.8 g, 2.67 mmol) in anhydrous pyridine (25 mL). After 1 h at room temperature, the solvents were removed under reduced pressure, and the residue was dissolved in a small volume of dry methanol. The pure β anomer (**6**β) crystallized from this solution in a 36% yield (215 mg): mp 191 °C dec (lit. mp 191–196 °C);[4] ^{1}H NMR (Me_2SO-d_6) δ 8.45 (s, 1, H-6), 7.5 (d, 2, NH_2), 6.05 (dd, 1, H-1′), 5.2 (d, 1, OH-3′), 5.05 (t, 1, OH-5′), 4.25 (m, 1, H-3′), 3.80 (m, 1, H-4′), 3.6 (m, 2, H-5′), 2.15 (m, 2, H-2′). The filtrate was evaporated to an oil, dissolved in 5 mL of methanol, and the pure α anomer (**6**α) (280 mg, 46%) was obtained by the addition of 50 mL of ether: ^{1}H NMR (Me_2SO-d_6) δ 8.27 (s, 1, H-6), 7.4 (s, 2, NH_2), 5.95 (d, 1, H-1′), 5.2 (d, 1, OH-3′), 4.85 (t, 1, OH-5′), 4.25 (m, 2, H-3′,4′), 3.4 (m, 2, H-5′), 2.3 (m, 2, H-2′); mp (methanol) 181 °C dec (lit. mp 181–182 °C).[7]

Registry No. 1α, 51255-17-5; 1β, 51255-18-6; 2α, 102831-61-8; 2β, 102831-62-9; **4**, 52523-35-0; 5α, 102831-63-0; 5β, 102851-36-5; 6α, 22432-95-7; 6β, 2353-33-5; Fmoc Cl, 28920-43-6.

A Novel Procedure for the Cleavage of Olefin Derivatives to Aldehydes Using Potassium Permanganate

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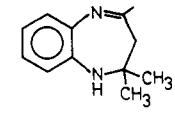
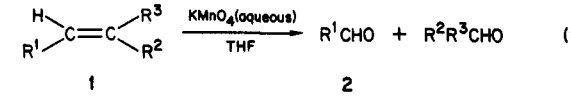
Oxidation of olefin-type substrates with $KMnO_4$ yields mostly dihydroxylated or hydroxy oxo products in alkaline or neutral media, and the double bond is cleaved to the corresponding acids in acidic solutions.[1-9] A series of studies on the mechanism and intermediates of such oxidations in aqueous solution have revealed the transient formation of aldehydes, which, however, undergo further oxidation by manganese(III) and/or manganese(IV) intermediates.[8] No attempt was made at utilizing the cleavage reaction on a preparative scale, although the possibility of quenching the manganese intermediates for saving the aldehydes had been pointed out.[8b-e] Under phase-transfer conditions, isolated examples of olefin to aldehyde conversion have been reported.[2,7] There is, however, no convenient procedure for double bond cleavage to aldehydes in aqueous organic mixtures which would not require special additivies (phase-transfer agent) or techniques (chemical quenching). We now report a simple method in THF/water, in which the solvent plays the role of a quenching reagent, permitting good yields of the aldehydes.

In a mechanistic study on 1,5-benzodiazepines, we needed compound R^4CHO for identifying a reaction intermediate. Attempts at converting the 4-methyl of R^4CH_3 to a formyl group via oxidation or dihalogenation/hydrolysis were unsuccessful. We have found however that



(R^4)

treatment of a dilute THF solution of 1 (with $R^1 = R^4$, $R^2 = H$, and $R^3 = Ph$) by a concentrated aqueous solution of $KMnO_4$ afforded the desired aldehyde R^4CHO and benzaldehyde in 80% yield. The lack of extensive overoxidation is surprising since in the overwhelming majority of reported cases cleavage leads to the corresponding acids.



1 2 (1)

The testing of this procedure on some other olefinic compounds indicates that it may be useful in the synthesis of a variety of aldehydes. Examples are listed in Table I. Apparently, activation of the double bond by conjugation increases, whereas adjacent bulky groups decrease the yield.

Table I. Yield of Aldehyde R^1CHO in Reaction 1

R^1	R^2	R^3	yield, %
R^4	H	Ph	78.7
Ph	CO_2Et	CO_2Et	37.5
Ph	H	Ph	70.5
i-Pr	CO_2Et	CO_2Et	14.2
CO_2Et	H	CO_2Et	50.5
CO_2Et	CO_2Et	H	47.9
1,4-butylene		H	10.2[a]

[a] Product: 1,6-Hexadial.

Experimental Section

4-Formyl-2,2-dimethyl-1*H*-1,5-benzodiazepine (2, $R^1 = R^4$). To a solution of 10 g (0.036 mol) of 1 in 300 cm^3 of THF was added 10 g (0.063 mol) of $KMnO_4$ dissolved in 100 cm^3 of water, over a period of 3.5 h in small portions. The reaction mixture was allowed to warm up to 40 °C. After the addition was finished, the brown precipitate was filtered, and the filtrate was concentrated and extracted with diethyl ether. After drying, the organic phase was concentrated and the resulting oil crystallized from diisopropyl ether: 7 g (78.7%); mp 102–104 °C; ^{1}H NMR δ 1.30 (s, 6 H), 2.70 (s, 2 H), 4.15 (s, 1 H, NH), 6.5–7.7 (m, 4 H), 9.60 (s, 1 H); IR (KBr) ν_{NH} 3325; $\nu_{as\ gem\ CH_3}$ and $\nu_{s\ gem\ CH_3}$ 2960, 2870, ν_{CH_2} 2930, $\nu_{aldehyde\ CH}$ 2838, 2705, ν_{CO} 1692, γ_{C_ArH} 768 cm^{-1}; mass spectrum, M$^+$ for $C_{12}H_{14}N_2O$ 202.1102.

The above procedure can be used to synthesize all of the other aldehydes listed in Table I. Solubility of the starting material determines the THF/H_2O ratio. In case of low solubility, a few preliminary tests should be made to determine the minimum amount of THF. *Attention*: Usage of neat THF or addition of solid $KMnO_4$ may lead to an explosion and therefore must be avoided. Yields were determined by GC analysis (5% QF-1 column) of the Et_2O phase after suitable dilution.

4-(2-Phenylvinyl)-2,2-dimethyl-1*H*-1,5-benzodiazepine (1, $R^1 = R^4$, $R^2 = H$, $R^3 = Ph$). A solution of 10 g (0.053 mol) of 2,2,4-trimethyl-1*H*-1,5-benzodiazepine, 5.63 g (0.053 mol) of benzaldehyde, and 0.5 g of ammonium acetate in 100 cm^3 benzene was refluxed for 4 h and then concentrated. The resulting oil is crystallized from diisopropyl ether: 12.1 g (82.4%); mp 134–136 °C; ^{1}H NMR δ 1.35 (s, 6 H), 2.53 (s, 2 H), 2.90 (s, 1 H, NH), 6.6–7.6

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(m, 11 H); IR (KBr) ν_{NH} 3250, $\nu_{C_Ar H}$ 3100–3000, $\nu_{as\ gem\ CH_3}$ and $\nu_{s\ gem\ CH_3}$ 2962, 2860, $\nu_{as\ CH_2}$ 2930; $\nu_{C_Ar C_Ar}$, $\nu_{C=C}$, $\nu_{C=N}$ 1630–1450, $\gamma_{C_Ar H\ monosubst}$ 750, $\gamma_{C_Ar C_Ar\ monosubst}$ 690; $\gamma_{C_Ar H}$ 770 cm^{-1}; mass spectrum *m/e* 276 (M^+).

Registry No. 1 (R^1 = R^4, R^2 = H, R^3 = Ph), 102651-36-5; 1 (R^1 = Ph, R^2 = R^3 = CO_2Et), 5292-53-5; 1 (R^1 = R^3 = Ph, R^2 = H), 588-59-0; 1 (R^1 = *i*-Pr, R^2 = R^3 = CO_2Et), 5652-68-6; 1 (R^1 = R^3 = CO_2Et, R^2 = H), 623-91-6; 1 (R^1 = R^2 = CO_2Et, R^3 = H), 141-05-9; 1 (R^1 = R^2 = 1,4-butylene, R^3 = H), 110-83-8; 2 (R^1 = R^4), 102651-37-6; 2 (R^1 = Ph), 100-52-7; 2 (R^1 = *i*-Pr), 78-84-2; 2 (R^1 = CO_2Et), 924-44-7; 1,6-hexadial, 1072-21-5; 2,2,4-trimethyl-1*H*-1,5-benzodiazepine, 24107-34-4.

Fragmentation of 2-Benzyl-3-(tosylazo)cyclohex-2-en-1-one to Methyl 7-Phenyl-5-heptynoate

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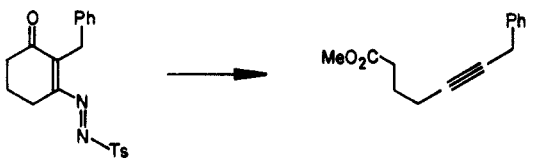
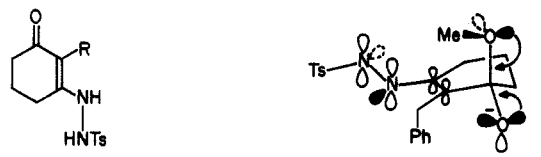
To test a hypothesis that 7-aryl-5-heptynoic acids might inhibit biosynthesis of peptidoleukotrienes, we needed a source of the acids which are not commercially available. Save for one bond, their carbon–carbon connectivity corresponds to that of enolized 2-(arylmethyl)-1,3-cyclohexanediones. The common connectivity suggested that an invented cleavage of the uncommon bond should transform the diones into the acids. Here we report that compound 1 fragmented to **2**, breaking the C_1–C_2 bond of 1.



1 **2**

Known reactions changed 2-benzyl-1,3-cyclohexanedione[1] to 1. (Toluenesulfonyl)hydrazine condensed with the dione forming **3** (16%),[2] and HIO_4 oxidized **3** to the unstable 1 (92%).[4] The geometry of azo group substituents of 1 is presumably trans.[4] Such an arrangement would facilitate concerted Grob fragmentation of presumptive intermediate **4** (vide infra).[6,7]



3, R=CH_2Ph
7, R=H

4

Treatment of 1 with NaOMe in hot MeOH yielded 52% of **2** after distillation. Assignment of structure followed from IR, ^1H NMR, and mass spectra. Identity of spectra of **2** with those of a sample that was synthesized independently from **5** confirmed our assignment. Separate saponifications of both ester samples and spectral and chromatographic comparisons of the resulting acid samples also supported assignments of structures. Contrasting spectra of both samples of 7-phenyl-5-heptynoic acid to those of 2-benzyl-1,3-cyclohexanedione established that the latter had *not* been obtained unwittingly.[8]

$$(MeO)_3C(CH_2)_3C{\equiv}CH \rightarrow \underset{5}{}$$

$$(MeO)_3C(CH_2)_3C{\equiv}CCH_2Ph \rightarrow \mathbf{2}$$

In hot, (initially) neutral EtOH solution, the 2-unsubstituted compound **6** underwent low-yielding (4%) addition–elimination to 3-ethoxycyclohex-2-en-1-one. Neither IR nor ^1H NMR spectra of the black, complex (TLC) product mixture detected ethyl 5-hexynoate. Treatments of **6** with NaOMe in MeOH as well as with $(MeO)_3CH$ in MeOH also gave complex mixtures. Clean, high-yielding fragmentation of **6** was elusive.

Stereoelectronic control explained fragmentation of 1 to **2** via **4**, according to a Deslongchampsien conformational analysis. Neither formation nor fragmentation of **4** required any conformational or rotational changes for **4** to attain needed antiperiplanar orbital alignment. In contrast, at least one such change would have been needed for any intermediate to convert 1 to 3-methoxycyclohex-2-en-1-one in an addition–elimination reaction.

Experimental Section[11]

2-Benzyl-3-[[(4-methylphenyl)sulfonyl]azo]cyclohex-2-en-1-one (1). Prepared from **3** according to ref 3, compound 1 was obtained as a bright orange solid, mp 89–91 °C, in a yield of 92%. Rapid decomposition ensued when 1 was allowed to dry in air on a filter; unrecrystallized but pure 1 was used directly in the next step: IR 1680 s (CO), 1600 m (vinyl), 1494 m (N=N), 1455 br (N=N), 1345 s (SO_2), 1160 s (SO_2); ^1H NMR 7.78 (d, *J* = 9, 2 H, Ar), 7.30 (d, *J* = 9, 2 H, Ar), 7.10 (m, 3 H, Ar), 6.75 (m, 2 H, Ar), 3.77 (s, 2 H, -$CH_2C_6H_5$), 2.54 (m, 4 H, -CH_2CO- and -CH_2CN_2-), 2.40 (s, 3 H, CH_3), 2.00 (m, -CH_2)-); MS, 368 (4, M^+), 213 (44, M – $O_2SC_6H_4CH_3$), 185 (29, M – $N_2SO_2C_6H_4CH_3$), 91 (100, $C_7H_7^+$).

Anal. Calcd for $C_{20}H_{20}N_2O_3S$: C, 65.19; H, 5.47; N, 7.60; S, 8.70. Found: C, 64.97; H, 5.10; N, 7.72; S, 8.48.

Methyl 7-Phenyl-5-heptynoate (2). A. From Fragmentation of 1. NaOMe (0.460 g, 8.5 mmol) was added to a solution of 1 (3.00 g, 8.15 mmol) in MeOH (50 mL), and the resulting orange mixture was heated over 30 min to reflux. MeOH was evaporated from the cooled orange solution and the residue was

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(2) The illustrated vinylogous tosylhydrazide structure (**3**) is that expected.[3,4] Misinterpretation of ^1H NMR data accounted for misassignment of an unconjugated tosylhydrazone structure in a closely related case.[5]
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(8) Failure to increase yields of **3** despoiled hopes to exploit fragmentation of 1 to **2**. Several attempts to apply published conditions[3-5,9,10] to preparation of vinylogous arylsulfonylhydrazides from 2-(arylmethyl)-1,3-cyclohexanediones were unsuccessful.
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(11) Uncorrected melting points were taken on a Fisher Digital Melting Analyser (Model 355) or on a Kofler block (Thomas Model 40). Boiling points are also uncorrected. IR spectra (in CH_2Cl_2 solution or in other media as noted) were obtained on Perkin-Elmer 727B or 1320 spectrophotometers; ν values are in cm^{-1}. ^1H NMR spectra (in $CDCl_3$ or other solvents as noted) were recorded on a Varian EM-390 instrument; δ values are in ppm downfield from internal Me_4Si. *J* values of coupling constants are in hertz. High-resolution MS were determined on a MAT-312, double-focusing instrument operating at 70 sV. Medium-resolution MS were measured on a Varian CH5 spectrometer. Parenthesized numbers following *m/z* values are relative ion intensities. E. Merck (Darmstadt) supplied F-254 silica gel plates for TLC, as did Analtech. Developed plates were visualized in UV light, in I_2 vapor, or (Analtech plates) by spraying with phosphomolybdic acid followed by heating. E. Merck as well as Baker provided 60–200-mesh silica gel for column chromatography.

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