

Research Note

REGIOSPECIFIC SYNTHESIS OF 1,6-DIMETHYL-9,10-ANTHRACENEDIONE

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Abstract

Treatment of acetyl-1,4-benzoquinone with isoprene gave the corresponding regioselective adduct (1). Rearrangement of the adduct (1) in pyridine and methanol gave 2-acetyl-5, 8-dihydro-6-methyl-1,4-dihydroxynaphthalene (2). Silver oxide oxidation of the rearranged product (2) gave 2-acetyl-5,8-dihydro-6-methyl-1,4-naphthalenedione (3). Regioselective addition of *trans*-piperylene to this compound (3) gave the corresponding adduct (4). Treatment of the resulting cycloadduct (4) with manganese dioxide gave the regioselective 1,6-dimethyl-9, 10-anthracenedione (5). Each of the foregoing reactions proceeds in high yield.

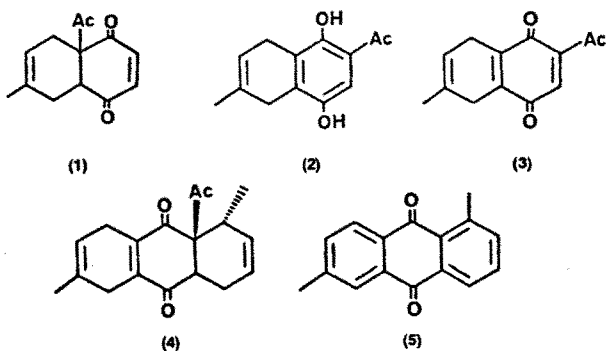
Diels-Alder reactions of 1,3-butadienes with 1,4-benzoquinones containing electron-donating substituents should occur at the unsubstituted ethene linkage, and those of 1,3-butadienes with 1,4-benzoquinones containing electron-withdrawing substituents should occur at the substituted ethene linkage. Use of dimethylantracenes for preparation of 2,6- and 2,7-dimethyl-9, 10-anthracenediones has been reported [1]. 1,8-Dimethyl-9, 10-anthracenedione has been pre-

pared [2], but as a mixture with its 1,5-dimethyl isomer, which was then separated by recrystallisation from ethanol and chromatography on alumina.

Diels-Alder reaction of isoprene with 1,4-benzoquinone to give a mixture of the corresponding bis-adducts has been reported [3]. Activated manganese dioxide has been used as a selective dehydrogenating agent in a series of chemical reactions [4,5].

We have reported the regioselectivity of the acyl migrations in Diels-Alder adducts and the regioselectivity of the Diels-Alder additions to acyl-1,4-benzoquinones previously [6-8]. We now report on the synthesis of new 1,6-dimethyl-9, 10-anthracenedione and a convenient method for the synthesis of other dimethyl-9, 10-anthracenediones in good yield.

Addition of freshly distilled isoprene to acetyl-1,4-benzoquinone in dry dichloromethane containing trifluoroacetic acid at -76°C gave 4a-acetyl-4a, 5, 8, 8a-tetrahydro-7-methyl-1,4-naphthalenedione (1) in 90% yield. Rearrangement of the adduct (1) in 1:1 mixture of pyridine and methanol at room temperature gave 2-acetyl-5, 8-dihydro-6-methyl-1,4-dihydroxynaphthalene (2) in 84% yield. Treatment of the rearranged product (2) with silver oxide in dry



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diethyl ether gave 2-acetyl-5,8-dihydro-6-methyl-1,4-naphthalenedione (3) in 96% yield. Reaction of this compound (3) with *trans*-piperylene in dry dichloromethane containing trifluoroacetic acid at -15°C gave 4a-acetyl-1, 4, 4a, 5, 8, 9a-hexahydro-4, 7-dimethyl-9, 10-anthracenedione (4) in 94% yield. Refluxing a mixture of the resulting cycloadduct (4) and manganese dioxide in dry benzene gave 1,6-dimethyl-9, 10-anthracenedione (5) in 78% yield.

Using analogous procedures, 1,8-dimethyl- and 2,7-dimethyl-9, 10-anthracenediones were also prepared in excellent overall yield. Their mixed m.p. and ^1H NMR spectra were identical with those of authentic samples.

Experimental Section

Infrared spectra were recorded on a Perkin-Elmer 257 instrument. ^1H NMR spectra, referenced to tetramethylsilane, were recorded using Perkin-Elmer R12A and R12B (60 MHz), and Perkin-Elmer R32 (90 MHz) instruments. Mass spectra were determined with AEI MS 12 and MS 30 instruments.

2-Acetyl-5,8-dihydro-6-methyl-1,4-naphthalenedione (3)

2-Acetyl-5,8-dihydro-6-methyl-1,4-dihydroxynaphthalene [6] (100 mg), anhydrous sodium sulphate (0.5 g) and silver oxide (0.5 g) were shaken in dry diethyl ether (10 ml) for 8h at room temperature. Filtration through celite and removal of the solvent gave a yellow solid (96 mg, 96%) which was recrystallised from cyclohexane to give yellow needles, m.p. $69-71^{\circ}\text{C}$. (Found C, 72.2; H, 5.7%; M, 216.0786. $\text{C}_{13}\text{H}_{12}\text{O}_3$ requires C, 72.2; H, 5.6%; M, 216.0786). ^1H NMR $\delta(\text{CDCl}_3)$ 6.91(s, 1H), 5.52(m, 1H), 3.01(bs, 4H), 2.53(s, 3H), 1.78 (bs, 3H); ν max (Nujol) 1690s, 1653vs, 1244m Cm^{-1} ; and m/z 218 $[(\text{M} + 2)^+$, 26], 217 $[(\text{M} + 1)^+$, 17], 216(M^+ , 67), 214(22), 119(37), 91(19), 43(100), 28(21).

4a-Acetyl-1, 4, 4a, 5, 8, 9a-hexahydro-4, 7-dimethyl-9,10-anthracenedione (4)

2-Acetyl-5, 8-dihydro-6-methyl-1, 4-naphthalenedione (162 mg) was dissolved in a solution of trifluoroacetic acid (95 mg) in dry dichloromethane (15 ml). The reaction mixture was cooled and stirred at -20°C (dry ice-acetone) and then *trans*-piperylene (56 mg) in dry dichloromethane (3 ml) was added. After stirring at -20°C to -15°C for 1.5h the colour of the solution had faded to pale yellow. It was stirred for a further hour, and then left to warm up to room temperature. Removal of the solvent gave a yellow oil, which was distilled at $140-146^{\circ}\text{C}$ / 0.1 mm Hg to give a sticky pale yellow oil (201 mg,

94%). (Found C, 76.4; H, 7.2%; M, 284.1410. $\text{C}_{18}\text{H}_{20}\text{O}_3$ requires C, 76.1; H, 7.0%; M, 284.1412). ^1H NMR $\delta(\text{CDCl}_3)$ 5.74(bd, J12Hz, with fine structure on each line, 1H), 5.61(bd, J12Hz, with fine structure on each line, 1H), 5.48(bs, 1H), 3.79(dd, J₁8Hz, J₂3Hz, 1H), 3.00(bs, 5H), 2.86(bd, J18Hz, each line showing fine structure, 1H, H-1 α), 2.36(s, 3H), 1.98(dd, J₁18Hz, J₂8Hz, with fine structure on each line, 1H, H-1 β), 1.77(bs, 3H), 0.87(d, J7.5Hz, 3H); ν max (film) 1712s, 1690vs, 1668vs, 1238m Cm^{-1} ; and m/z 284 (M^+ , 3), 242(31), 241(100), 239(26), 227(23), 225(21), 213(32), 199(24), 119(63), 105(31), 93(23), 91(89), 77(72), 43(97), 28(27).

1,6-Dimethyl-9, 10-anthracenedione (5)

4a-Acetyl-1, 4, 4a, 5, 8, 9a-hexahydro-4, 7-dimethyl-9, 10-anthracenedione (120 mg) in dry benzene (30 ml) was treated with freshly prepared [9] manganese dioxide (1.1 g), and the mixture was refluxed for 12h. Filtration through celite and removal of the solvent gave a yellow solid, which was sublimed at $140-145^{\circ}\text{C}$ /0.1 mm Hg to give yellow needles (78 mg, 78%), m.p. $138-139^{\circ}\text{C}$. (Found C, 81.7; H, 5.2%; M, 236.0836. $\text{C}_{16}\text{H}_{12}\text{O}_2$ requires C, 81.7; H, 5.1%; M, 236.0837). ^1H NMR $\delta(\text{CDCl}_3)$ 8.30-7.86(mm, 3H), 7.66-7.30(mm, 3H), 2.80(s, 3H), 2.47(s, 3H); ν max (Nujol) 1672vs, 1660s, 1328s, 1273s Cm^{-1} ; and m/z 237 $[(\text{M} + 1)^+$, 24], 236(M^+ , 100), 221(39), 208(18), 178(16), 165(27), 89(19), 28(16).

Conclusion

These methods therefore appear to be generally applicable to the synthesis of 9, 10-anthracenediones in good yield, and they provide predictable control of the relative orientations of the substituents in the two outer rings.

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