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SYNTHESIS OF (±)-PENTALENENE USING ELECTROCHEMICAL METHOD AS A KEY STEP

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Summary (±)-Pentalenene has been synthesized from 6-acetoxymethyl-2-methyl-9-methoxytricyclo[5.3.1.$0^{1,5}$]-undec-9-en-8,11-dione which has been produced efficiently by means of electrochemical method.

Pentalenene belongs to a group of triquinane sesquiterpenes[1] and is attractive to synthetic chemists.[2,3] We describe herein a synthesis of (±)-pentalenene using electrochemical method as a key step. The known phenol (1) (418 mg)[4] was subjected to anodic oxidation [CCE: 71.8 mA (+540 - 1500 mV *vs.* SCE; ca. 2 F/mol] using MeOH (30 ml) - AcOH (20 ml) containing $LiClO_4$ (400 mg) under argon, diluted with large amounts of toluene (1000 ml), and then concentrated under reduced pressure at 50 °C to afford the desired tricyclic compound (2) and its epimer at C_2-position in 64 and 16% yields, respectively.[4] The former was reduced with DIBAL-H and then acetylated to give a triacetate (3)[5] in 94% overall yield. The compound (3) was hydrolyzed with oxalic acid and treated again with Ac_2O - pyridine to afford a ketone (4),[5] which was further subjected to Grignard reaction followed by selective benzylation to give rise to a monobenzyl ether (5)[5] in 77% overall yield in 4 steps.

In the next step, 5 was oxidized with PCC and then with $Pb(OAc)_4$ in MeOH to afford a bicyclic compound (6),[5] which was further hydrolyzed to yield a diketone (7),[5] as seen in Scheme 1. On intramolecular aldol condensation followed by catalytic hydrogenation, 7 was readily converted into a tricyclic compound (8),[5] in high yield. Dehydration of 8 followed by acid-catalyzed isomerization gave rise to the known ketone (9),[3,6] which had been already transformed to (±)-pentalenene (10).[3]

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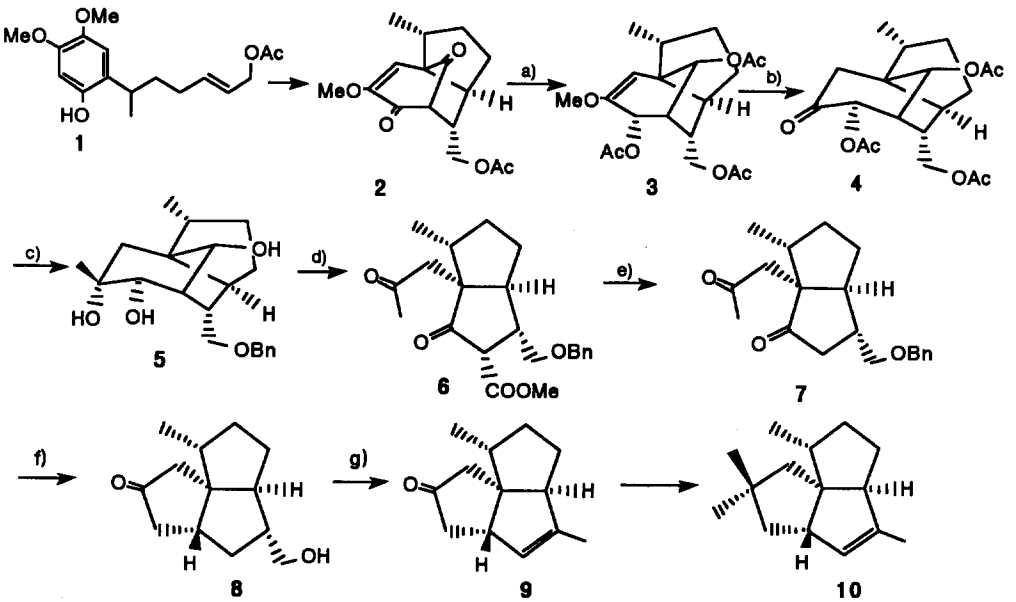
REFERENCES

1. H. Seto and H. Yonehara, J. Antibiot., **33**, 92 (1980); D. E. Cane, T. Rossi, and J. P. Pachlatko, Tetrahedron Lett., **1979**, 3639.
2. S. Misumi, T. Ohtsuka, Y. Ohfune, K. Sugita, H. Shirahama, and T. Matsumoto, Tetrahedron Lett., **1979**, 31; G. D. Annis and L. A. Paquette, J. Am. Chem. Soc., **104**, 4504 (1982); L. A. Paquette and G. D. Annis, *ibid.*, **105**, 7358 (1983); E. Piers and V. J. Karunaratne, J. Chem. Soc., Chem. Commun., **1984**, 959; M. T. Crimmins and J. A. DeLoach, J. Am. Chem. Soc., **108**, 800 (1986); D. H. Hua, *ibid.*, **108**, 3835 (1986); T. Imanishi, F. Ninbari, M. Yamashita, and C. Iwata, Chem. Pharm. Bull., **34**, 2268 (1986); G. Pattenden and S. J. Teaque, Tetrahedron Lett., **1984**, 3021 and Tetrahedron, **43**, 5637 (1987); T. Hudlicky, M. G. Natchus, and G. Sinai-Zingde, J. Org. Chem., **52**, 4641 (1987); T. Imanishi, M. Yamashita, F. Ninbari, T. Tanaka, and C. Iwata, Chem. Pharm. Bull., **36**, 1371 (1988); M. Ihara, M.

Katogi, K. Fukumoto, and T. Kametani, J. Chem. Soc., Perkin Trans. 1, **1988**, 2963; E. Piers and V. J. Karanaratne, Can J. Chem., **67**, 160 (1989).

3. G. Mehta and K. S. Rao, J. Am. Chem. Soc., **108**, 8015 (1986).
4. The yield of **2** has been improved enough to be used for further synthesis of the target sesquiterpene (see the previous paper: Y. Shizuri, M. Ohkubo, and S. Yamamura, Chem. Lett., **1989**, 113).
5. The spectral data for the new compounds are in accord with the structures assigned, and only selected data are cited: **3**: $C_{20}H_{28}O_7$ [m/z 380.1854 (M^+)]; IR (film) 1740 and 1650 cm^{-1}; δ ($CDCl_3$) 0.96 (3H, d, J = 7 Hz), 2.01 (3H, s), 2.09 (6H, s), 3.52 (3H, s), 4.27 (2H, d, J = 8 Hz), 4.95 (1H, s), and 5.84 (1H, d, J = 5 Hz). **4**: $C_{19}H_{26}O_7$ [m/z 366.1650 (M^+)]; IR (film) 1740 cm^{-1}. **5**: $C_{21}H_{30}O_4$ [m/z 364.2146 (M^+)]; IR (film) 3400 cm^{-1}; δ ($CDCl_3$) 1.18 (3H, s), 4.42 (2H, s), and 7.27 (5H, complex). **6**: $C_{21}H_{24}O_4$ [m/z 340.1658 (M^+ - MeOH)]; IR (film) 1750, 1720, and 1715 cm^{-1}; δ ($CDCl_3$) 2.10 (3H, s) and 3.71 (3H, s). **7**: $C_{20}H_{26}O_3$ [m/z 314.1876 (M^+)]; IR (film) 1735 and 1720 cm^{-1}. **8**: $C_{13}H_{20}O_2$ [m/z 208.1465 (M^+)]; IR (film) 3450 and 1730 cm^{-1}; δ ($CDCl_3$) 3.57 (1H, dd, J = 6, 17 Hz) and 3.67 (1H, dd, J = 5, 17 Hz).
6. The synthetic sample (**9**) as racemic form: $C_{13}H_{18}O$ [m/z 190.1347 (M^+)]; IR (film) 1740 cm^{-1}; δ ($CDCl_3$) 0.96 (3H, d, J = 6.8 Hz), 1.35 (2H, m), 1.65 (3H, d, J = 1.0 Hz), 1.80 - 2.58 (7H, complex), 2.63 (1H, m), 2.92 (1H, m), and 5.11 (1H, q, J = 1.0 Hz). The ^1H NMR spectral data of **9** are compatible with the data cited in ref. 3.



a) 1. DIBAL-H (1.1 equiv.) / THF (-70 °C, 45 min, and then room temp., 45 min) 2. Ac_2O/pyr. (room temp., 14.5 h) (94% in 2 steps); b) 1. sat. aq. $(COOH)_2$ / MeOH (40 - 45 °C, 5 h) 2. Ac_2O / pyr. (room temp., 18 h) (88%, in 2 steps); c) 1. MeMgBr (15 equiv.) / THF under Ar (room temp., 1.5 h) 2. BnCl (1.1 equiv.) / NaH (1.5 equiv.) / DMF under Ar (room temp., 35 h) (88% in 2 steps); d) 1. PCC (4.8 equiv.) / CH_2Cl_2 under Ar (room temp., 3.5 h) (40%) 2. $Pb(OAc)_4$ (7.8 equiv.) / MeOH under Ar (room temp., 50 min) (40%); e) 12N HCl / dioxane - H_2O (10:1) (refluxing temp., 3 h) (94%); f) 1. NaOEt / EtOH (refluxing temp., 1 h) 2. H_2 / Pd-C (room temp., 13.5 h) (83% in 2 steps); g) 1. o-$O_2NC_6H_4SeCN$ (6 equiv.) / nBu_3P (6 equiv.) / THF under Ar (room temp., 18 h) 2. 35% H_2O_2 / THF (0 °C, 1 h and then room temp., 17 h) (82% in 2 steps) 3. p-TsOH / CH_2Cl_2 (room temp., 5.5 h) (96%).

Scheme 1. Synthesis of (±)-pentalenene.

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