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A NEW SYNTHESIS OF 1,4-DIKETONES : APPLICATION TO A SYNTHESIS OF DIHYDROJASMONE AND *CIS*-JASMONE

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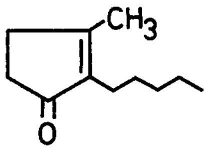
cis-Jasmone (1b), the odoriferous constituent of the jasminum family, is of value in the reproduction of jasmine fragrance and accordingly it is still an attractive synthetic objective even though the pioneering work of Treff and Werner was achieved nearly forty years ago.[1]

1,4-Diketones are in general valuable intermediates for further conversions into either furan or cyclopentenone systems. Although several ingenious new methods for synthesis of jasmones have been published, the numerous approaches involving cyclization of 1,4-diketones to jasmones have been reported in the recent years.[4∿17]

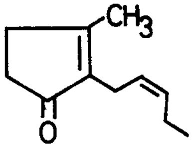
In the preceding paper,[19] we have described a convenient synthetic procedure of the ketone starting from an aliphatic ester. As an extention of a synthetic utility of this method, this paper describes a ready six-step synthesis of 1,4-diketones which have been easily converted into dihydrojasmone (1a) and *cis*-jasmone (1b) on base treatment.[18]

Enediol-bis-trimethylsilyl ether (3), [b.p. 148∿149° (0.03mm), IR (neat) μ 5.97, NMR (CDCl$_3$) δ 0.15 (s. 18H), 1.32 (s. 6H), 1.55∿2.35 (m. 8H), 3.94 (s. 8H)], readily obtained in 65% yield by the acyloin condensation of methyl levulinate ethylene ketal (2) in the presence of trimethylchlorosilane,[2] was converted by addition of 2 equiv. of methyllithium in monoglyme (rt, 30min.) into its enediolate (3')[3] which was immediately subjected to alkylation with n-hexyl iodide (rt, 16hrs), after replacement of the solvent by either tetrahydrofuran or hexamethylphosphoramide to afford exclusively the α-hydroxy ketone (4a)** in 80% yield [IR (neat) μ 2.87, 5.87, NMR (CCl$_4$) δ 1.22, 1.27 (6H), 3.64 (s. 1H), 3.85, 3.89 (8H)].

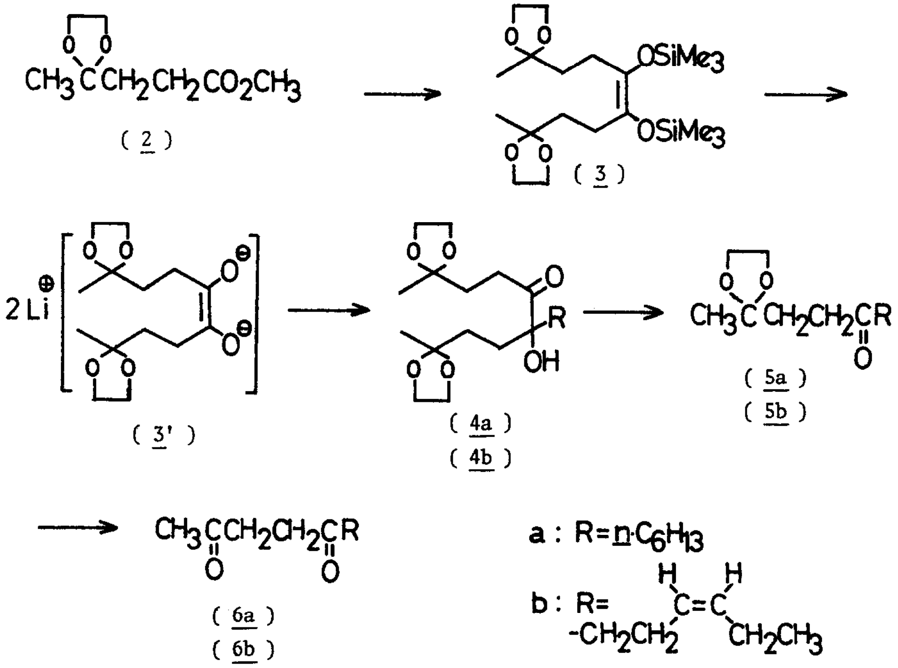
Reduction of (4a) with sodium borohydride in methanol (rt, 2hrs), followed by oxidation with 1.5 equiv. of lead tetraacetate in benzene (rt, 2hrs) gave the ketal ketone (5a)** [b.p. 94∿97° (2mm), IR (neat) μ 5.85, NMR (CCl_4) δ 1.23 (s. 3H), 3.84 (s. 4H)], which upon acid hydrolysis with 10% HCl/THF led to the known diketone, 2,5-undecanedione (6a)[18] in quantitative yield from (4a) [IR (melt) μ 5.85, NMR ($CDCl_3$) δ 2.18 (s. 3H), 2.42 (t. 2H), 2.69 (s. 4H)].



(1a)



(1b)



Finally, the base-catalyzed cyclization of the resulting 1,4-diketone (6a) (0.5N-NaOH/ EtOH, reflux, 6hrs)[18] yielded dihydrojasmone (1a) in 90% yield, semicarbazone m.p. 177° and this was identified by comparison of ir and nmr spectra with those of a sample kindly provided by Professor T. Mukaiyama. The overall yield of dihydrojasmone was 49.5% starting from (2).

Through a similar series of transformations, starting from *cis*-1-bromo-hex-3-ene[4] in place of n-hexyl iodide, the compound (4b)** [IR (neat) μ 2.89, 5.87, NMR (CCl_4) δ 0.97 (t. J = 7.5 Hz. 3H), 1.20, 1.25 (6H), 3.69 (s. 1H), 3.81, 3.84 (8H), 5.23 (m. 2H)] was obtained in 73% yield. Reduction of (4b), followed by oxidation in a similar manner gave the corresponding ketal ketone (5b)** [b.p. 109∿112° (2mm), IR (neat) μ 5.85, NMR (CCl_4) δ 0.96 (t. J = 7.5 Hz. 3H), 1.22 (s. 3H), 3.82 (s. 4H), 5.27 (m. 2H)], which was deketalized to afford (6b) in 76% yield from (4b) [IR (neat) μ 5.86, NMR ($CDCl_3$) δ 0.94 (t. J = 7.5 Hz. 3 H), 2.16 (s. 3H), 2.68 (s. 4H), 5.35 (m. 2H)].

The product (6b) gave *cis*-jasmone in 90% yield on a similar base treatment (23% overall yield), 2,4-dinitrophenylhydrazone m.p. 115∿116°, and the spectra of its ir and nmr were also identical with those of *cis*-jasmone kindly provided by Professor H. Nozaki.

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References and Notes

1. W. Treff and H. Werner, *Ber.*, **66**, 1521 (1933) ; **68**, 640 (1935).
2. For a good review, see K. Rühlmann, *Synthesis*, **209**, 236 (1971).
3. G. Stork and P. E. Hudrlik, *J. Amer. Chem. Soc.*, **90**, 4462, 4464 (1968).
4. G. Stork and R. Borch, *J. Amer. Chem. Soc.*, **86**, 936 (1964).
5. G. Büchi and H. Wüest, *J. Org. Chem.*, **31**, 977 (1966).
6. L. Crombie, P. Hemesley, and G. Pattenden, *J. Chem. Soc.* (C), 1024 (1969).
7. E. Wenkert, R. A. Mueller, E. J. Reardon Jr., S. S. Sathe, D. J. Scharf, and G. Tosi, *J. Amer. Chem. Soc.*, **92**, 7428 (1970).
8. J. E. McMurry and T. E. Glass, *Tetrahedron Letters*, 2575 (1971).
9. J. E. McMurry and J. Melton, *J. Amer. Chem. Soc.*, **93**, 5309 (1971).
10. R. A. Ellison and W. D. Woessner, *Chem. Commun.*, 529 (1972).
11. S. M. Weinreb and R. J. Cvetovich, *Tetrahedron Letters*, 1233 (1972).

12. H. C. Ho, T. Ho, and C. M. Wong, *Can. J. Chem.*, **50**, 2718 (1972).

13. T. Mukaiyama, K. Narasaka, and M. Furusato, *J. Amer. Chem. Soc.*, **94**, 8641 (1972).

14. T. Ho, H. C. Ho, and C. M. Wong, *Can. J. Chem.*, **51**, 153 (1973).

15. T. Sakan, Y. Mori, and T. Yamazaki, *Chem. Lett.*, 713 (1973).

16. J. E. Richman, J. L. Herrmann, and R. H. Schlessinger, *Tetrahedron Letters*, 3267, 3271, 3275 (1973).

17. T. Mukaiyama, M. Araki, and H. Takei, *J. Amer. Chem. Soc.*, **95**, 4763 (1973).

18. H. Hunsdiecker, *Ber.*, **75**, 447, 460 (1942).

19. Tetrahedron Letters, preceding paper (1974).

** Satisfactory elemental analysis was obtained for these compounds.