

Synthesis of Ethyl dl-Jasmonate and Ethyl dl-2-Epi-jasmonate

Sigeru TORII* and Hideo TANAKA*

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Synopsis

Ethyl dl-jasmonate (1a) and ethyl dl-2-epi-jasmonate (1b), novel constituents in jasmin absolute from Italian Jasminum grandiflorum L, were prepared from 8-endo-(2'-cis-pentenyl)-3-oxo-2-oxa-bicyclo[3.2.1]octane, jasmine acid δ -lactone (2). Improvement of the preparation of the intermediate (9), a key precursor of (2), was made by different route via lactonization of (7) and/or (8). NMR and IR spectra (1a) and (1b) are given.

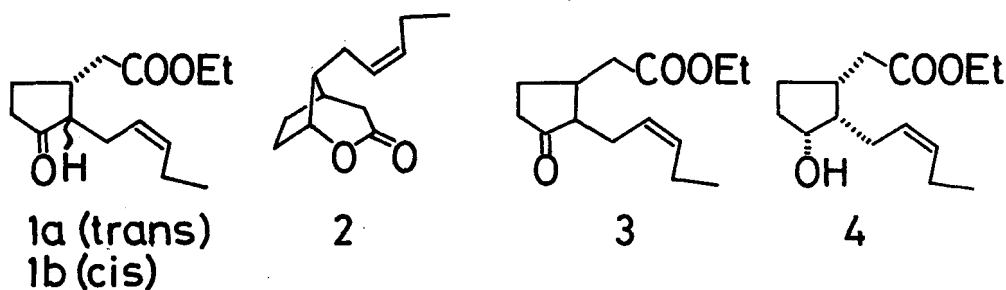
I. Introduction

The occurrence of new cyclopentanoids, ¹⁾ ethyl dl-jasmonate (1a) and ethyl dl-2-epijasmonate (1b), in jasmin absolute obtained from Italian Jasminum gradiflorum L. has aroused our interest in obtaining each epimer synthetically. The related cyclopentanoids, jasmin acid δ -lactone (2) ²⁾ and methyl dehydrojasmonate (3), ³⁾ isolated also from the jasmin absolute, ¹⁾ have recently been synthesized. In the preceeding papers we reported the novel synthetic ways to methyl dl-jasmonate and its related compounds by using 1,7a-cis-3a,7a-cis-1,5,6-tri-hydroxyperhydroindanon and/or exo-2-acetoxy-anti-7-methoxycarbonylnorbornane. ⁴⁾ We have now extended one of the method for the synthesis of ethyl jasmonates. This paper describes an efficient synthesis of ethyl dl-jasmonates (1a) and (1b) and some of their optical properties.

II. Results and Discussion

The syntheses of ethyl dl-jasmonate (1a) and its 2-epimer (1b) were achieved in two steps from 8-endo-(2'-cis-pentenyl)-3-oxo-2-oxa-bicyclo[3.2.1]octane,

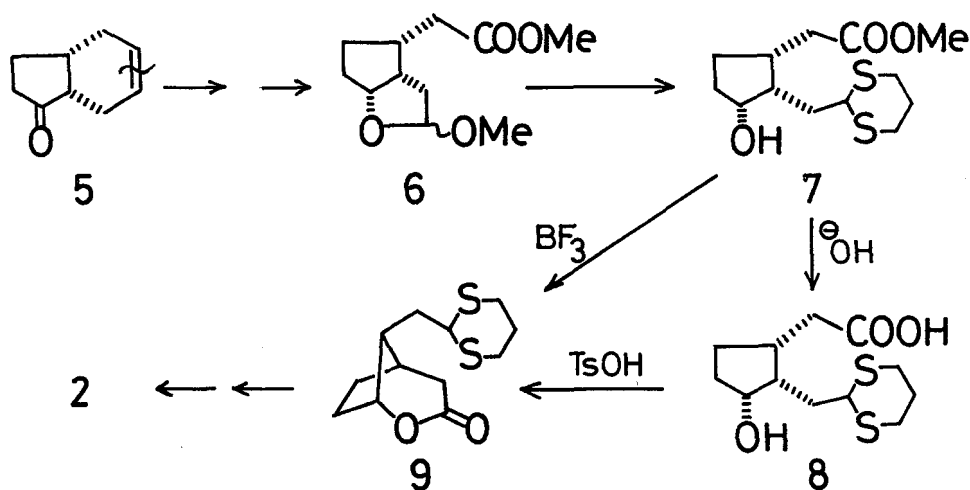
* Department of Industrial Chemistry



jasmin acid δ -lactone (2) which was provided by the method described in the preceeding paper.²⁾ Thus, hydrolysis of the δ -lactone (2) with aqueous methanolic potassium hydroxide and subsequent esterification with diazoethane provided the key intermediate (4) in 86% yield, bp 83.0–85.0 ° C (0.03 mm). Oxidation of the alcohol (4) with aqueous chromic acid in methylene chloride afforded ethyl dl-2-epi-jasmonate (1b) in 97% yield, bp 56.0–57.0 ° (0.03 mm).

Epimerization of (1b) was performed by heating in triethylamine in a sealed tube at 130–140 ° C for 3 hr, giving (1a) in quantitative yield, bp 55.0–57.0 ° C (0.03 mm). Infrared and NMR spectral charts of (1a) and (1b) are shown in Figures 1 and 2.

Our continued interest in the improvement of the preparation of the δ -lactone (2) has caused us to investigate a product-selective, alternative route from



Scheme 1

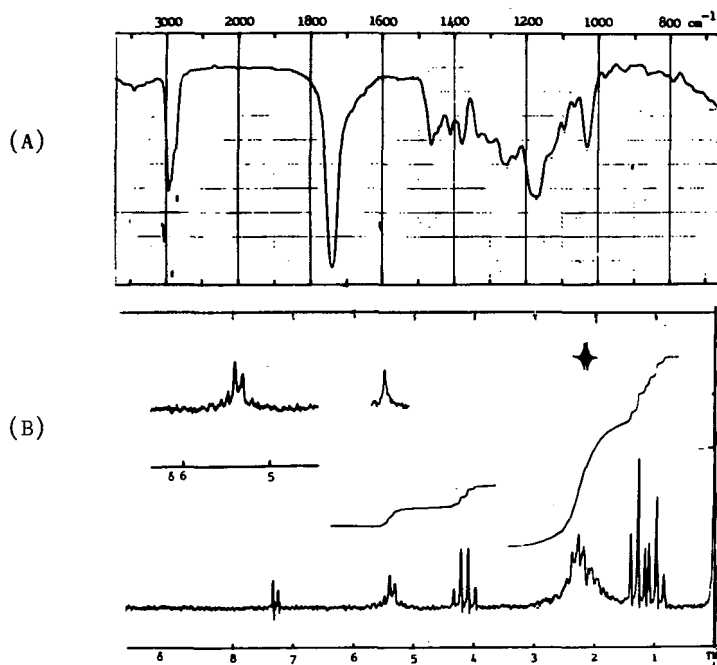


Figure 1. IR (A) and NMR (B) spectra of ethyl dl-jasmonate (1a)

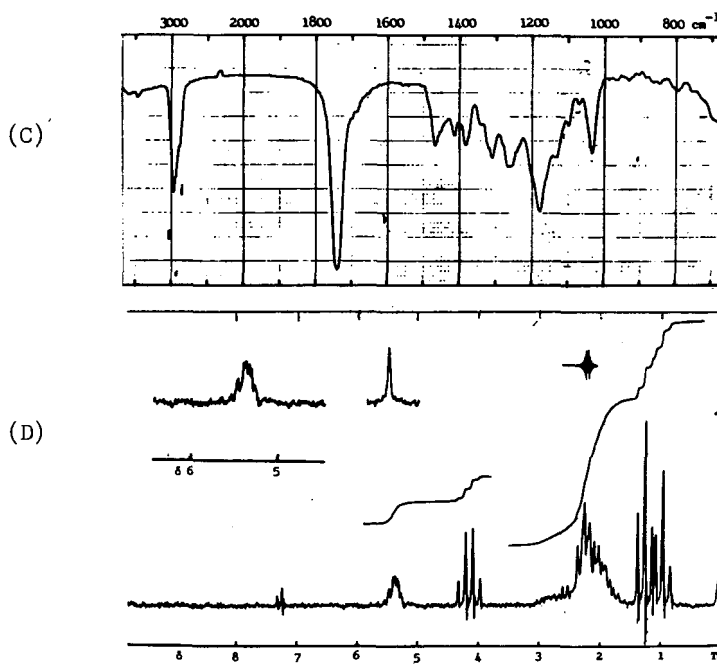


Figure 2. IR (C) and NMR (D) spectra of ethyl dl-2-epi-jasmonate (1b)

the intermediates (6) and (7). The outline of the novel synthetic ways of (9) from the alcohol (7) are shown in Scheme 1. In an earlier study involving the conversion of (6) into the intermediate (9), we showed that the thioacetalization of (6) using an excess amount of boron trifluoride etherate in the presence of a catalytic amount of water afforded (9) as a major product along with a small amount of (7).

Lactonization of (7) with boron trifluoride in chloroform gave (9) in 43% yield together with the starting material (7) (43%). However, hydrolysis of (7) with aqueous methanolic potassium hydroxide and subsequent acid-catalyzed dehydration afforded smoothly (9) in 93% yield. Similarly, the crude product from the thioacetalization of (6) could be converted into (9) in 85% yield.

III. Experimental Section

Melting points and boiling points are uncorrected. NMR spectra were determined with a Hitachi R-24 instrument. IR spectra were recorded on a Hitachi EPI-S2. Mass spectral data were obtained on a Hitachi RMS-4 spectrometer at 30 eV. Wako gel C-200 was used for elution chromatography. Elemental analysis was performed in our laboratory.

1,2-cis-2,3-cis-3-Methoxycarbonyl-2-(cis-2'-pentenyl)cyclopentanol (4).

A solution of (2) (15 mg, 0.077 mmol) and KOH (100 mg, 1.8 mmol) in MeOH (2 ml) containing few drops of water was stirred for 17 hr at room temperature. The reaction mixture was diluted with 3 ml of water and evaporated to remove volatile solvent. The residual aqueous solution was washed with CHCl_3 , acidified to pH 4-3 with diluted H_2SO_4 , extracted with CHCl_3 , washed with water, and dried (Na_2SO_4). After evaporation of the solvent the residue was treated with an excess amount of diazoethane and worked up in the usual manner to give 18 mg of an oil, which was purified by column chromatography on silica gel with benzene-AcOEt (20/1), giving 16 mg (86%) of (4), bp 83-85 °C (0.03 mm); IR (Neat) 3550 (OH), 1733, 1718 (C=O), 1651 cm^{-1} (C=C); NMR (CDCl_3) δ 0.97 (t, J = 7.1 Hz, 3H, CH_3), 1.24 (t, J = 7.2 Hz, 3H, CH_3 -C-O), 1.48-2.40 (10H), 2.46 (br, 2H, CH_2 -C=O), 4.11 (q, J = 7.2 Hz, CH_2 -O), 5.38 (m, 2H, HC=CH); mass spectrum m/e (rel.

intensity, %) 222 ($M^+ - H_2O$), 211 (6), 198 (6), 197 (6), 196 (5), 183 (4), 179 (6), 176 (4), 167 (26), 166 (18), 153 (27), 148 (18), 134 (85), 107 (35), 93 (43), 79 (65), 55 (55), 41 (100).

Anal. Calcd for $C_{14}H_{24}O_3$: C, 69.96; H, 10.07. Found: C, 69.71; H, 9.73.

Ethyl dl-2-Epi-jasmonate (1b). To a stirred CH_2Cl_2 solution (2 ml) of (4) (12 mg, 0.05 mmol) Jones Reagent (0.3 ml) prepared from $Na_2Cr_2O_7$ (60 mg) and concentrated H_2SO_4 (75 mg) was added with cooling on an ice-bath. After stirring for 10 min the ice-bath was removed and the mixture was stirred for additional 3 hr at room temperature. The organic phase was separated, washed with aqueous $NaHCO_3$, and water, dried (Na_2SO_4), and concentrated. The residue was chromatographed over silica gel with benzene-AcOEt (20/1) to give 11.5 mg (97%) of (1b), bp 56-57 °C (0.03 mm). IR and NMR spectra of (1b) are shown in Figure 2.

Anal. Calcd for $C_{14}H_{22}O_3$: C, 70.56; H, 9.30. Found: C, 70.43; H, 9.24.

Epimerization of (1b). A solution of (1b) (7 mg, 0.092 mmol) in 0.3 ml of triethylamine was heated in a sealed tube for 4 hr at 140 °C. Evaporation of the solvent followed by a short-path distillation gave 7 mg (100%) of (1a), bp 55-57 °C (0.03 mm). IR and NMR spectra of (1a) are shown in Figure 1.

Anal. Calcd for $C_{14}H_{22}O_3$: C, 70, 56; H, 9.30. Found: C, 70.73; H, 9.59.

Conversion of (7) to δ -lactone (9). Procedure A. A solution of (7) (44 mg, 0.15 mmol) and KOH (100 mg) in MeOH (2 ml) containing few drops of water was stirred for 12 hr at room temperature. The mixture was diluted with water (3 ml), acidified with diluted HCl, and extracted with $CHCl_3$. The extracts were washed with water and dried (Na_2SO_4). Removal of the solvents gave 41 mg of (8), whose IR and NMR spectra were identical with authentic sample.²⁾ Without further purification, (8) was dissolved in benzene (5 ml) and refluxed for 12 hr in order to remove water azeotropically. The mixture was diluted with ether, washed with aqueous $NaHCO_3$ and water, and dried (Na_2SO_4). Evaporation of the solvents gave 40 mg of an oil, which was chromatographed over silica gel with benzene-AcOEt (20/1) to afford 38 mg (97%) of (9) as a white crystal, mp 105-106 °C (lit.²⁾ mp 105.0-105.5 °C).

Procedure B. To a stirred CHCl_3 solution (1 ml) of (7) (42 mg, 0.14 mmol) a CHCl_3 solution (1 ml) of boron trifluoride-etherate (21 mg, 0.15 mmol) was added under cooling with an ice-bath. After stirring for 10 min the ice-bath was removed and the mixture was stirred for 10 hr at room temperature. After work-up as an usual manner, the residual product was chromatographed on silica gel with benzene-AcOEt (20/1) to give 18 mg (48%) of (9) and 20 mg (48%) of (7) (recovered). IR and NMR spectra of (9) were identical with authentic sample. 2)

References

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