Chemical transformation of 1,8-cineole: synthesis of seudenone, an insect pheromone

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Abstract

A simple method to transform the easily available 1,8-cineole (1) into the more valuable compound seudenone, 3-methyl-2-cyclohexenone (4), a sex pheromone of Dendroctonus pseudotsugae Hopkins, is described. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Eucalyptus globulus Labill. occupies 18.3% of the Portuguese forest area; it is a very important source of raw materials for the pulp industries, which have a relevant impact in the economies of several countries, Portugal being one of them (CELPA, 1996). However, the economical value of the E. globulus trees can be increased if new applications are found for the essential oil-rich parts of the plant (essentially leaves and small branches), which are normally left behind on the fields by the pulp producers.

E. globulus essential oil is mainly composed of 1,8-cineole (1) (Silvestre et al., 1994, 1997a) but, despite its natural abundance, no major or signifi-

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and Evans, 1985), from δ-ketocarboxylic acids and derivatives through Wittig reactions (Bestmann et al., 1985, 1993), and also from copper-catalysed addition of methyl manganese chloride to cyclohexanone (Cahiez and Alami, 1989). The method now reported uses a natural and abundant monoterpen, and it is highly efficient in its overall yield.

2. Materials and methods

3-Keto-1,8-cineole (2) can be obtained by oxidation of 1 with hydrogen peroxide (Cavaleiro et al., 1996) or with chromyl acetate (Boggiato et al., 1987). In the present work, we prepared compound 2 according to Boggiato et al. with 65% yield.

Seudenone 4 was obtained according to the following procedure. 3-Keto-1,8-cineole (1.0 g) was added to a stirred solution of KOH (1.5 g) in ethanol (100 ml) under a nitrogen atmosphere, at room temperature. After 80 min, the mixture was poured into water, extracted with dichloromethane and dried over anhydrous sodium sulphate; after concentration on the rotary evaporator, the compound was further purified by thin-layer chromatography on silica gel, eluting with chloroform. After removing the solvent, seudone ) was obtained as a light-sensitive dark-yellow liquid (637 mg, 97% yield): boiling point, 199–200°C. Mass spectrometry (MS) of compound 4 was obtained as the only reaction product in very high yields (97%). This transformation occurs through the formation under basic conditions of an anion in the position 2 of ketone 2; this anion can rearrange to form the alcoxide 3 which, under basic conditions, can easily undergo a retro-Aldol condensation reaction to form the ketone 4 in a selective way (Fig. 1).

Seudenone 4 was identified by GC-MS, comparing its mass spectrum with literature data (Kinzer et al., 1971) and with the equipment mass spectral library. The structure of 4 was also confirmed, after treatment with 2,4-dinitrophenylhydrazine, through the spectroscopic characterisation of the corresponding 2,4-dinitrophenylhydrazine (5) by NMR and MS. The multiplet at δ 1.93–1.99 ppm was attributed to H-5 overlapped with 3-CH₃; the triplets at δ 2.23 and 2.53 ppm were attributed to H-4 and H-6. H-2 resonance appears at δ 6.15 ppm as a quartet (J = 1.31 Hz) by coupling with 3-CH₃. Aromatic proton resonances were assigned based on their characteristic coupling constants. ¹³C assignments were based on HETCOR (¹H/¹³C) experiments, and also on liter-
nature data (Torri and Azzaro, 1974; Breitmeier and Voelter, 1990).

4. Conclusions

This transformation can be considered as an alternative way to prepare the expensive seudone 4, since 1,8-cineole (1) is an easily available and low-cost raw material, and, at the same time, this might represent an important contribution to the valorisation of essential oil-rich parts of E. globulus trees. This alternative can be even more promising considering that scaling up the process would not result in a yield loss (assays up to 5 g scale have been shown to be as successful as that described in Section 2); in addition, taking into account the high yield obtained and the boiling point of seudenone 4 (199–200°C), purification of the reaction mixture will be successfully attained by distillation.

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