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SYNTHESIS OF QUEEN BEE PHROMONE

R. N. MAJEE, R. RAMANI AND S. N. MUKHERJEE*
Indian Lac Research Institute, Namkum, Ranchi 834 010, India.
*Department of Chemistry, St. Xavier's College, Ranchi 834 001, India.

THE mandibular glands of the queen honey-bee, *Apis mellifera*, secrete the queen substance which principally contains 9-oxo-Δ^2-decenoic acid. The queen substance inhibits the development of ovaries and prevents queen rearing in workers. It also acts as sex attractant in mating[1].

9-oxo-Δ^2-decenoic acid (VI) has been synthesised from a number of starting materials[2-10]. We report here its synthesis from 7-hydroxyheptanal, one of the periodate oxidation products of aleuritic acid, the major constituent acid of shellac.

7-Hydroxyheptanal (II), on condensation with malonic acid in the presence of pyridine gave an α, β-unsaturated hydroxy acid (III), which on oxidation with pyridiniumchlorochromate resulted in an unsaturated aldehydic acid (IV).

The carbinol (V) obtained by the condensation of IV with CH_3MgI on further oxidation with aluminium tert. butoxide yielded 9-oxo-Δ^2-decenoic acid (VI).

$HOH_2C.(CH_2)_5.CH(OH).CH(OH).(CH_2)_7.CO_2H$ (I)

$HOH_2C.(CH_2)_5.CHO$ (II)

$HOH_2C.(CH_2)_5.CH=CH.CO_2H$ (III)

$OHC.(CH_2)_5.CH=CH.CO_2H$ (IV)

$H_3C.CHOH.(CH_2)_5.CH=CH.CO_2H$ (V)

$H_3C.C.(CH_2)_5.CH=CH.CO_2H$ (VI)

7-Hydroxyheptanal (II)

Threo-aleuritic acid (I, m.p. 99-100°, 8 g) in methanol-water (400 ml, 1:1) at 40° C on sodium periodate oxidation[11] for 10 min and on usual workup afforded 7-hydroxyheptanal as liquid (3.2 g). It was purified through a column of neutral alumina by eluting with ether. I.R.(Neat):3250, 1720 cm^{-1} (Found:C, 64.80; H, 10.72.Calcd. for:$C_7H_{14}O_2$:C, 64.70; H, 10.80%).

9-*Hydroxy*-Δ^2-*nonenoic acid* (III)

The above hydroxyaldehyde (II, 3 g) was heated on a steam bath for 4 hr with malonic acid (3 g) in dry pyridine (5 ml). Extraction with ether yielded the unsaturated hydroxy acid as thick liquid (2.8 g), which was purified over a column of neutral alumina in ether. I.R.(Neat):3250, 1700, 970 cm^{-1} (Found:C, 62.72; H, 9.24. Calcd. for $C_9H_{16}O_3$:C, 62.80; H, 9.30%).

Δ^2-*Noneldehydic acid* (IV)

A solution of III (2 g) in dry methylene chloride (10 ml) was added with stirring to a suspension of pyridinium chlorochromate (3.28 g) and anhy. sodium acetate (0.25 g) in dry methylene chloride. After 2 hr, dry ether was added and the supernatant decanted from the black gummy mass. The ethereal extract was then passed through a column of neutral alumina to remove the impurities and the solvent was evaporated off to obtain IV (1.4 g) as thick oil. I.R.(Neat): 1725, 1700, 970 cm^{-1} (Found: C, 63.50; H, 8.20. $C_9H_{14}O_3$ requires C, 63.52; H, 8.23%).

9-*Hydroxy*-Δ^2-*decenoic acid* (V)[12]

The above compound (IV, 2.5 g) in dry ether (10 ml) was condensed with CH_3MgI. The resultant product (V) obtained as liquid (2 g) was purified through a column of neutral alumina in ether. I.R.(Neat): 3250, 1700, 970 cm^{-1}. (Found: C, 64.42; H, 9.63. $C_{10}H_{18}O_3$ requires C, 64.51; H, 9.70%).

9-*oxo*-Δ^2-*decenoic acid* (IV)

The above carbinol (2 g) in a mixture of dry acetone (15 ml) and benzene (20 ml) was heated at 80° for 8 hr with a solution of aluminium tert. butoxide (3.4 g in dry benzene). It was then cooled and treated with 10% H_2SO_4 (10 ml). On workup with benzene, VI was obtained as solid (1.2 g) and was cyrstallised from methanol m.p. 53-55° (lit[7]. 53-54°). The purity of the compound was tested by TLC. I.R.(KBr): 1725, 1700, 970 cm^{-1}. Its 2,4 DNP derivative has m.p. 126-128° (lit[7]. 127-128°) (Found: N, 15.34. Calcd. for $C_{16}H_{20}N_4O_6$: N, 15.40%).

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