Chemistry of Natural Compounds, Vol. 30, No. 4, 1994

SYNTHESIS OF RACEMIC 10-METHYLTRIDECAN-2-ONE, THE SEX PHEROMONE OF *Diabrotica undecimpunctata*

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UDC 547.594:632.936.2

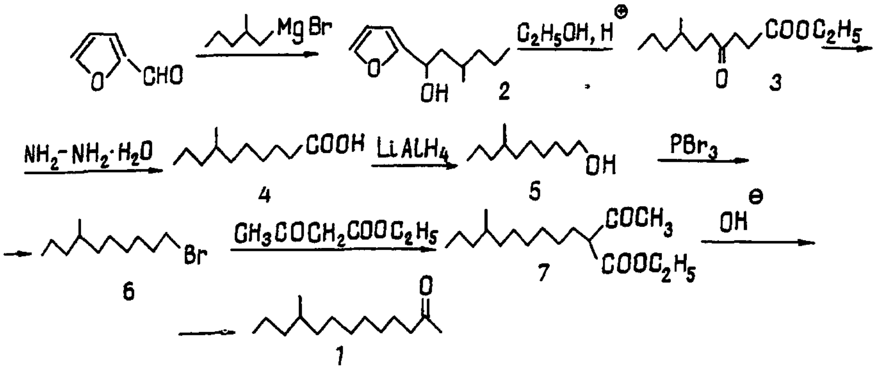
A new synthesis of racemic 10-methyltridecan-2-one, the sex pheromone of Diabrotica undecimpunctata *Howardi has been effected.*

The sex pheromone of the southern corn rootworm *Diabrotica undecimpunctata* Howardi Barber (Coleoptera: Chrysomelidae), a pest of maize, peanuts and legumes widespread on the North American continent, has been identified as 10-methyltridecan-2-one [1].

It has been established that of the enantiomers the activity of the R-form considerably exceeds that of the S-form [2], although the latter does not inhibit the activity of the R-enantiomer. The racemic ketone (I) can therefore be widely used for the fight against this pest.

The synthesis of the racemic ketone (1) has been achieved by coupling the cuprate derivative of 1-bromo-4-methylheptane with 6-iodohept-2-yl propionate, followed by saponification and oxidation of the resulting secondary alcohol to the ketone (1) [1]. The R- and S-enatiomers have been obtained from the acid methyl ester of R-3-methylglutaric acid [2] and also from undec-10-enoic acid via its α-alkylation followed by the separation of the diastereomeric α-methylbenzylamides [3].

We have carried out a new synthesis of the racemic ketone (1) by the scheme given below.



The hydrolytic cleavage of the carbinol (2) gave ethyl 7-methyl-4-oxodecanoate (3) in satisfactory yield, and this was converted by the action of hydrazine hydrate into 7-methyldecanoic acid (4). The acid (4) was reduced with lithium tetrahydroaluminate to 7-methyldecan-1-ol (5) which was then converted by the action of phosphorus tribromide into 1-bromo-7-methyldecane (6). Alkylatuion of the bromide (6) with acetoacetic ester and ketonic cleavage of the ketoester (7) formed finally led to 10-methyltridecan-2-one (1).

EXPERIMENTAL

IR spectra of the substances in CCl_4 were taken on a IR-75 instrument with a NaCl cell and diffraction gratings at a layer thickness of 0.125 μm [sic]. PMR spectra were obtained on a Bruker AC-80 spectrometer with a working frequency of

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"InterBAV" Scientific Production Company RM, Kishinev. Translated from Khimiya Prirodnykh Soedinenii, No. 4, pp. 558-560, July-August, 1994. Original article submitted December 30, 1993.

80 MHz using tetramethylsilane as internal standard. The purity of the compounds obtained was checked by GLC on a Chrom-5 instrument with a glass column (2.5 × 4 mm [sic]) containing 5% of SE-30 on Chromaton, 90-120 mesh. The analyses of the compounds (2)-(7) obtained corresponded to the calculated values.

1-Furyl-3-methylhexan-1-ol (2). Over 2 h, with vigorous stirring and cooling (temperature of the reaction mixture not above 10°C) a solution of 96.0 g of furfural in 100 ml of absolute diethyl ether was add dropwise to the Grignard reagent obtained from 24.3 g of magnesium and 165.1 g of 1-bromo-2-methylpentane in 450 ml of absolute diethyl ether. The mixture was heated to the boil for 4 h and it was then cooled and poured onto 300 g of ice. The ethereal layer was separated off, and the aqueous layer was extracted with ether (3 × 40 ml). The ethereal extracts were combined, washed with 10% potash solution and 10% sodium bisulfate solution, dried with Na_2SO_4 and evaporated, and the residue was distilled. This gave 90.0 g (49.4%) of the carbinol (2), bp 95-97°C (1 mm), n_D^{20} 1.4765. IR spectrum, ν, cm^{-1}) 3100-3600, 3620.

Ethyl 7-Methyl-4-oxodecanoate (3). A solution of 88.0 g of the carbinol (2) in 260 ml of absolute ethyl alcohol was treated with 5.05 ml of absolute ethyl ether containing 0.4 g of hydrogen chloride, and the mixture was boiled for 2.5 h. The alcoholic solution was 2/3 evaporated, the residue was poured into a saturated solution of potash, the reaction product was extracted with ether, the extract was dried with potash and was evaporated, and the residue was distilled. This gave 63.0 g (57.5%) of the ketoester (3), bp 110-113°C (1 mm), $n_D{}^{20}$ 1.4418. IR spectrum (ν, cm^{-1}): 1720, 1740. PMR spectrum (ppm): 0.86 (3H, CH_3, t), 0.87 (3H, CH_3, t), 1.20-1.58 (7H, CH_2, H, m), 1.23 (3H, OCH_2CH_3, t), 2.34-2.55 (4H, CH_2COCH_2, m), 2.66 (2H, $C\underline{H}_2COOC_2H_5$, t), 4.11 (2H, $-OCH_2CH_3$, q).

7-Methyldecanoic Acid (4). A mixture of 9.8 g of the ketoester (3), 46 ml of diethyleneglycol, and 8.9 g of 85% hydrazine hydrate was heated at the boil with stirring for 1 h and it was then cooled and a solution 9.8 g of caustic soda in 7 ml of water was added and the resulting mixture was again heated to the boil with stirring, for 2 h. The reflux condenser was replaced with one for distillation, and the excess of hydrazine hydrate was distilled off until the temperature of the mixture had reached 195°C, after which it was kept at 195-200°C for 2 h; it was then cooled, and, after the addition of 10 ml of water and 20% aqueous hydrochloric acid to an acid reaction, the reaction product was extracted with ether (4 × 30 ml), and the ethereal solution was washed twice with saturated NaCl solution, dried with Na_2SO_4, and evaporated, and the residue was distilled. This gave 6.3 g (79.1%) of the acid (4), bp 122-125°C (2 mm), $n_D{}^{20}$ 1.4427. IR spectrum (ν, cm^{-1}): 1730, 2500-3000. PMR spectrum (ppm): 086 (6H, CH_3, t) 1.25 (6H, CH_2, s), 1.52 (2H, $C\underline{H}_2COOH$, m), 2.35 (1H, CH, t), 11.38 (1H, COOH, s).

7-Methyldecan-1-ol (5). With cold-water cooling, a solution of 24.2 g of the acid (4) in 50 ml of absolute diethyl ether was added dropwise to a suspension of 4.94 g of lithium tetrahydroaluminate in 100 ml of absolute diethyl ether. The mixture was stirred at 20-25°C for 5 h and was heated at the boil for 3 h. The excess of lithium tetrahydroaluminate was decomposed with ethyl acetate and water, the ether layer was separated off, dried with Na_2SO_4, and evaporated, and the residue was distilled. In this way we obtained 20.5 g (91.7%) of the alcohol (5), bp 126-130°C (13 mm), $n_D{}^{20}$ 1.4378. IR spectrum (ν, cm^{-1}): 3100-3600, 3620, PMR spectrum (ppm): 0.79 (3H, CH_3, t), 0.84 (3H, CH_3, t), 1.22 (14H, CH_2, br.s), 1.45-1.52 (1H, CH, m), 2.51 (1H, OH, s), 3.57 (2H, $C\underline{H}_2OH$, t).

1-Bromo-7-methyldecane (6). Dropwise, at such a rate that the temperature did not rise above 55°C, 14.9 gm of phosphorus tribromide was added to 19.0 g of the alcohol (5). After the whole of the phosphorus tribromide had been added, the mixture was stirred at 60°C for 4 h. Then it was cooled and was treated with water and extracted with ether (3 × 50 ml); the ethereal extract was washed with saturated aqueous $NaHCO_3$, dried with Na_2SO_4, and evaporated, and the residue was distilled. The yield of the bromide (6) was 20.0 g (77.3%), 103-105°C (3 mm), $n_D{}^{20}$ 1.4731. PMR spectrum (ppm): 0.90 (6H, CH_3, m), 1.27 (8H, CH_2, m), 1.57 (1H, CH, m), 3.41 (2H, CH_2CH_2Br, t).

3-Ethoxycarbonyl-10-methyltridecan-2-one (7). To a hot solution of sodium ethanolate obtained from 3.0 g of sodium and 68 ml of absolute ethyl alcohol was added 17.0 g of acetoacetic ester and then, dropwise, 26.0 g of the bromide (6), and the resulting mixture was boiled for 8 h, after which the bulk of the alcohol was evaporated off in vacuum, and the residue was treated with water. The reaction product was extracted with ether (3 × 30 ml), the extract was dried with Na_2SO_4, and evaporated, and the residue was distilled. This gave 22.9 g (73.2%) of the ketoester (7), bp 105-107°C (3 mm), n_D^{20} 1.4401, IR spectrum (ν, cm^{-1}): 1720, 1740.

10-Methyltridecan-2-one. A solution consisting of 1.0 g of the ketoester (7) and 60 ml of an 8.5% aqueous solution of caustic soda in 66 ml of ethyl alcohol was heated at the boil for 45 min. Then it was cooled and was neutralized with 25% aqueous hydrochloric acid. The reaction product was extracted with ether (3 × 30 ml), dried with Na_2SO_4, and evaporated, and the residue was distilled, to give 0.5 g (80.5%) of the ketone (1), 110-112°C (3 mm, $n_D{}^{20}$ 1.4366. IR spectrum (ν, cm^{-1}: 1720. PMR spectrum (ppm): 0.87 (6H, CH_3, t), 1.25 (19H, CH_2, CH, s), 2.13 (3H, $COCH_3$, s), 2.4 (2H, $C\underline{H}_2COCH_3$, m).

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