10. V. P. Kozyukov, V. D. Sheludyakov, and V. F. Mironov, Usp. Khim., 42, No. 8, 1451 (1973).

CYCLIZATION OF α-FURYLMETHYL DERIVATIVES OF LINALOOL BY "ACTIVATED" DMSO

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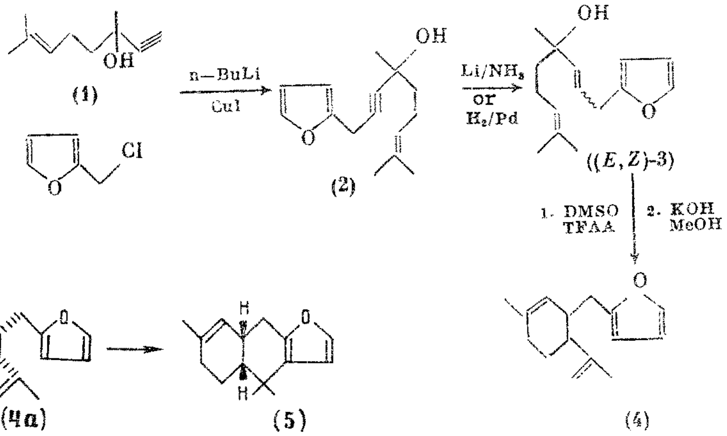
The cyclization of two stereoisomeric α-furylmethyl derivatives of linalool initiated by "activated" DMSO leads to the corresponding substituted limonene in low yield. The stereochemistry of these products was not established.

Keywords: electrophilic cyclization, linalool, limonene, furanosesquiterpenes, furodysinin.

We have recently shown that the solvolytic electrophilic cyclization of simple linear monoterpenols by "activated" DMSO provides a rather efficient approach to p-menthane derivatives [1]. In the present communication, we examine the use of stereoisomeric α-furylmethyl derivatives of (±)-linalool as potential precursors of several natural furanodecalins.

The C-alkylation of the dilithium derivative of dehydralinalool (1) by furfuryl chloride catalyzed by CuI leads to previously unreported, unstable 2 in about 60% yield (taking account of the conversion of starting carbinol 1). The Birch reduction of 2 gives allyl alcohol E-3 in moderate yield. The hydrogenation of disubstituted acetylene 2 over a Lindlar catalyst smoothly gives stereoisomeric olefin Z-3. The structure of the previously unreported and extremely unstable alcohols 3 was established by PMR and IR spectroscopy, mass spectrometry, and elemental analysis.



In accord with the optimal conditions found for the electrophilic cyclization of linalool [1], its derivatives 3 were subjected to treatment with DMSO/$(CF_3CO)_2O$ in CH_2Cl_2 at low temperature. A complex mixture of products was formed. PMR spectral analysis of the fractions chromatographically enriched on silica gel readily showed the unreacted starting alcohol along with the product of its E/Z isomerization. Furthermore, the reaction mixture also contained limonene derivative 4 of unestablished stereochemistry. The yield of this product was about 4% starting from Z-3 and about 7.5% starting from E-3. The structure of 4 was assigned mainly on the basis of its PMR spectrum, which proved very similar to the spectrum of one of its diastereomers 4a [2] used recently in the synthesis of the furanosesquiterpene, furodysinin 5, which is a metabolite of some marine organisms.

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EXPERIMENTAL

The IR spectra were taken neat on a UR-20 spectrometer. The PMR spectra for $CDCl_3$ solutions were taken on a Bruker WM-250 spectrometer. The electron impact mass spectra were taken on a Varian MAT CH-6 mass spectrometer at 70 eV. The R_f values are given for Silufol silica gel plates.

4,8-Dimethyl-1-(2′-furyl)non-7-one-2-yn-4-ol (2). A sample of 38 ml 1.88 M n-BuLi in hexane (72 mmoles) was added with stirring to a solution of 5.32 g (35 mmoles) 1 in 50 ml THF over 20 min in an argon atmosphere at -20°C. After 30 min, 1 g CuI was added in a single batch and after an additional 20 min, the mixture was treated at -20°C for 5 min with a solution of 3.92 g (35 mmoles) furfuryl chloride [3] in 7 ml THF at -20°C. The reaction mixture was warmed over 20 min to ~25°C, maintained at this temperature for 20 h, diluted with 200 ml ether, and decomposed with 50 ml saturated aqueous NH_4Cl. The organic layer was separated, washed with water, dried over Na_2SO_4, and evaporated in vacuum. The residue (7.3 g) was subjected to chromatography on 150 g silica gel with 4:1 hexane—ether as the eluent to give 5.2 g of a product, which was distilled in vacuum. The yield of 1 was 0.98 g, bp 35-40°C ($4\cdot10^{-2}$ mm). The yield of 2 was 3.85 g (47%) as a light yellow oil, bp 97-110°C ($4\cdot10^{-2}$ mm), n_D^{20} 1.4988. IR spectrum (ν, cm^{-1}): 730, 810, 885, 940, 1010, 1065, 1130, 1180, 1320, 1380, 1445, 1510, 1600, 1675, 2870, 2935, 2980, 3420. PMR spectrum (δ, ppm, J, Hz): 1.44 s, 1.58 and 1.66 br.s (9H, CH_3), 1.6 and 2.2 m (4H, CH_2), 3.56 br.s (2H, HC^1), 5.13 br.t (1H, HC^7, J 6.7), 6.15 and 6.26 m (2H, $HC^{3'}$, $HC^{4'}$), 7.28 m (1H, $HC^{5'}$). Mass spectrum, m/z: 232 $[M]^+$. Found: C, 77.12; H, 8.95%. Calculated for $C_{15}H_{20}O_2$: C 77.55; H, 8.68%.

4,8-Dimethyl-1-(2′-furyl)nona-2E,7-dien-4-ol (E-3). A sample of 0.18 g (25 mg-atom) Li was added with stirring over 5 min to a solution of 2.32 g (10 mmoles) 2 in 180 ml ammonia and 20 ml THF at -70°C in an argon atmosphere. The reaction mixture was decomposed with excess NH_4Cl for 2 h and ammonia was evaporated off. The residue was dissolved in water and extracted with ether. Ordinary work-up of the extract gave 2.35 g of a product which was subjected to chromatography on 300 g silica gel with 4:1 hexane—ether as the eluent to give 0.75 g (32%) E-3 as a light yellow oil, bp 89-90°C ($5\cdot10^{-2}$ mm), n_D^{20} 1.4975. IR spectrum (ν, cm^{-1}): 735, 800, 890, 930, 975, 1010, 1075, 1120, 1165, 1265, 1330, 1380, 1455, 1505, 1600, 1630, 1675, 2735, 2860, 2965, 3180-3640. PMR spectrum (δ, ppm, J, Hz): 1.28 s, 1.59 and 1.68 br.s (9H, CH_3), 1.6 and 2.0 m (4H, CH_2), 3.38 d (2H, HC^1, J 6), 5.13 br.t (1H, HC^7, J 7), 5.64 d.d (1H, HC^3, J 1.2 and 16), 5.75 d.t (1H, HC^2, J 16 and 6), 6.02 and 6.29 m (2H, $HC^{3'}$, $HC^{4'}$), 7.31 m (1H, $HC^{5'}$). Mass spectrum, m/z: 234 $[M]^+$. Found: C, 76.79; H, 9.43%. Calculated for $C_{15}H_{22}O_2$: C, 76.88; H, 9.46%.

4,8-Dimethyl-1-(2′-furyl)nona-2Z,7-dien-4-ol (Z-3). A stirred suspension of 2.32 g 2 and 0.4 g Lindlar catalyst in 23 ml ethanol was maintained under normal conditions in a hydrogen atmosphere for about 4 h and then subjected to normal work-up to give 2.3 g of a product subjected to chromatography on 100 g silica gel with 4:1 hexane—ether as the eluent, which yielded 1.54 g (66%) Z-3 as a light yellow oil, bp 89-91°C ($5\cdot10^{-2}$ mm), n_D^{20} 1.4965. IR spectrum (ν, cm^{-1}): 730, 790, 835, 910, 940, 1010, 1075, 1120, 1170, 1300, 1375, 1450, 1505, 1595, 1650, 2730, 2860, 2970, 3120, 3220-3640. PMR spectrum (δ, ppm, J, Hz): 1.28 s, 1.63 and 1.70 br. s (9H, CH_3), 1.6 and 2.1 m (4H, CH_2), 3.77 d (2H, HC^1, J 6), 5.15 br.t (1H, HC^7, J 7), 5.52 br.d (1H, HC^3, J 10), 5.60 d.d (1H, HC^2, J 6 and 10), 6.02 and 6.29 m (2H, $HC^{3'}$, $HC^{4'}$), 7.32 m (2H, $HC^{5'}$). Mass spectrum, m/z: 234 $[M]^+$. Found: C, 76.81; H, 9.40%. Calculated for $C_{15}H_{22}O_2$: C, 76.88; H, 9.46%.

Cyclization of Alcohols 3. A sample of 0.78 g (3.7 mmoles) $(CF_3CO)_2O$ was added with stirring to a solution of 0.58 g (2.5 mmoles) Z-3 and 0.25 g (3.3 mmoles) DMSO in 4 ml CH_2Cl_2 over 1 min at -70°C in an argon atmosphere. After 30 min, the reaction mixture was wash diluted three-fold with ether. The solution was washed with water, dried over Na_2SO_4, and evaporated in vacuum. The residue (0.66 g) was dissolved in 10 ml 5% methanolic KOH. The reaction mixture was maintained for 30 min at ~25°C and then neutralized by the addition of 5% sulfuric acid. The solvent was evaporated in vacuum and the residue (0.53 g) was subjected to chromatography on 50 g silica gel with gradient elution from 3:2 pentane—ether to give, in order of elution, 20 mg (3.7%) 4 as a colorless liquid, R_f 0.55 (hexane), 110 mg Z-3, R_f 0.48 (1:1 hexane—ether), and 40 mg E-3, R_f 0.40 (1:1 hexane—ether).

For 4: IR spectrum (ν, cm^{-1}): 730, 810, 850, 900, 970, 1020, 1090, 1150, 1250, 1380, 1450, 1510, 1600, 1650, 2940. PMR spectrum (δ, ppm, J, Hz): 1.67 s and 1.80 s (6H, CH_3), 1.7 and 2.0 m (4H, CH_2), 2.3 m (2H, CH_2), 2.65 m (2H, CH), 4.73 and 4.90 br.s (2H, $H_2C{=}C$), 5.37 m (1H, $HC{=}C$), 5.97 d (1H, $HC^{3'}$, J 3), 6.29 d.d (1H, $HC^{4'}$, J 3 and 2), 7.32 d (1H, $HC^{5'}$, J 2). Mass spectrum, m/z: 216 $[M]^+$, 148, 135, 122, 107, 93, 77, 69.

Analogously, 0.58 g E-3 gave 40 mg (7.4%) 4 and 100 mg unreacted alcohol E-3 was recovered.

LITERATURE CITED

1. A. A. Surkova, A. V. Lozanova, V. A. Dragan, B. A. Gur'yan, and A. M. Moiseenkov, Izv. Akad. Nauk, Ser. Khim., No. 4, 862 (1991).
2. V. Vaillancourt, M. R. Agharahimi, U. N. Sundram, O. Richou, D. J. Faulkner, and K. F. Albizati, J. Org. Chem., 56, No. 1, 378 (1991).
3. A. L. Mndzhoyan (editor), Syntheses of Heterocyclic Compounds [in Russian], first edn., Izd. Akad. Nauk Armyansk, Yerevan (1956), p. 70.