PREPARATION OF 1-CYCLOPROPYL-2-(4'-HYDROXY-1'-

OXOBUTYL)-CYCLOPROPANE

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The N. D. Zelinskii Institute of Organic Chemistry of the Academy of Sciences of the USSR Translated from Izvestiya Akademii Nauk SSSR, Otdelenie Khimicheskikh Nauk No. 12, pp. 2248-2250, December, 1961 Criginal article submitted June 28, 1961

We have shown [1] that in the hydrogenation of 1-cyclopropyl-2- α -tetrahydrofurylcyclopropane is formed with a yield of 39% In the present work it was found that at normal pressure and room temperature the process takes place extremely slowly and the sole product of the reaction is 1-cyclopropyl-2-(4'-hydroxy-1'-oxobutyl)-cyclopropane, formed through the addition of molecules of hydrogen and water. In addition, it was found that, when water was added, hydrogenation under the conditions described in [1] go considerably faster and more completely. Under these conditions, in addition of 1-cyclopropyl-2- α -tetrahydrofurylcyclopropane, 1-cyclopropyl-2-(4'-hydroxy-1'-oxobutyl)-cyclopropyl- $2-\alpha$ -furylcyclopropane proceeds parently, according to the following scheme:



We have fundamentally simplified the previous conditions for the preparation of acetopropyl chloride and methyl cyclopropyl ketone—the starting materials for the synthesis of 1-cyclopropyl-2- α -furylcyclopropane. It has been established that the conditions found for closing the cyclopropyl ring by the action of dry caustic potash on a γ -chloride are general for the p-sparation of a dicyclopropyl ketone.

As a result of the reduction by Kizhner's method of the keto group in 1-cyclopropyl-2-(4'-hydroxy-1'-oxobutyl)-cyclopropane, an alcohol was obtained containing two cyclopropyl rings in the molecule. Since the replacement of the hydroxyl group by chlorine in cyclopropane compounds is generally accompanied by isomerization of the cyclopropyl ring [2], conditions were worked out, using methyl cyclopropyl carbinol as an example, which avoid the opening of the cyclopropyl ring. Under these conditions, a primary chloride with two cyclopropyl rings in the molecule was successfully obtained. The reaction of this chloride with sodium in ether led to the production of 1cyclopropyl-2-butylcyclopropane.

EXPERIMENTAL PART

<u>Acetopropyl chloride</u>. Hydrochloric acid (440 ml) was saturated with hydrogen chloride (from 270 ml of HCl and 300 ml of H₂SO₄) during 1 hour, with stirring and cooling to -10° . Then 213 g of acetopropyl alcohol with b.p. 87-38° (6 mm) and n_D^{20} 1.4415, cooled to -5° , was added over 45 minutes to the cooled flask. After stirring the reaction mixture for an hour, cooling was discontinued. After 2 hours, 400 ml of water was added to the flask and the acetopropyl chloride was obtained, with b.p. 69° (19 mm); n_D^{17} 1.4390; yield 75.5%

<u>Methyl cyclopropyl ketone</u> was obtained from acetopropyl chloride by the method described earlier [3], but without the use of ether for its extraction. Salting-out instead of extraction scarcely diminished the yield of methyl cyclopropyl ketone. <u>Dicyclopropyl ketone.</u> 1,7-Dichloroheptan-4-one [4] with b.p. $104-110^{\circ}$ (4 mm) (85 g) was added with shaking to 160 g of granulated KOH. Then the mixture was heated for 2 hours on the boiling water bath, after which 250 ml of water was added to the flask. After cooling, the upper layer was separated off and dried with KOH, and the lower layer was extracted three times with 40-ml portions of ether. After distilling off the ether, the residue, together with the upper layer, was distilled in vacuum. A yield of 43.5 g of dicyclopropyl ketone was obtained, with b.p. 67° (26 mm); n_{20}^{20} 1.4682; d_{20}^{20} 0.9646; found; MR 31.75; calculated: MR 31.61.

Raman spectrum ($\Delta \nu$ cm⁻¹): 202 (1); 246(1); 365(2 broad); 474 (2); 534 (1); 633 (very broad); 728 (2 broad); 753 (5); 814 (10); 842 (1 broad); 923 (10); 1037 (5); 1060 (1); 1096 (2 broad); 1105 (3 broad); 1142 (2 sharp); 1178 (3); 1200 (10); 1247 (0); 1295 (0); 1348 (8); 1382 (10); 1417 (2); 1450 (7); 1682 (6); 2872 (0); 2913 (1); 2950 (2); 3010 (10); 3075 (6 broad).

<u>Methylcyclopropylcarbinol</u>[5] was obtained by hydrogenating methyl cyclopropyl ketone over Raney nickel at 40° and -120 atmospheres of H₂ with a yield of 85%; b.p. 122-122.5°, n_D^{20} 1.4318.

Methyl cyclopropyl carbinyl chloride. A mixture of 23 g of PCl₃, 1 g of dimethylaniline, and 50 ml of absolute ether was added to a mixture of 43 g of methyl cyclopropyl carbinol, 20 g of dimethylaniline, and 100 ml of absolute ether during 1 hour, with stirring and cooling to -10°. Then the ethereal solution was poured off the precipitate and the residue was washed with ether. After distilling off the ether, the residue was distilled in vacuum. A yield of 26.1 g of methyl cyclopropyl carbinyl chloride was obtained, with b.p. 50° (136 mm); 101° (760 mm); n_D^{20} 1.4320; d_4^{20} 0.9419; yield 50%. Found: C 57.42; H 8.67; Cl 33.9%. MR 28.68.

Raman Spectrum ($\Delta \nu$ cm⁻¹): 282 (2 broad); 312 (2); 336 (1); 393 (10); 498 (0); 592 (very broad); 643, 659 (5 broad, 10 broad); 710 (0); 768 (3 broad); 824 (3 broad); 908 (7 broad); 1007, 1037 (2 broad, 3 broad); 1093 (1 broad); 1187, 1198 (4, 10); 1218 (2); 1238 (2 broad); 1298 (2); 1394 (4); 1432, 1447 (3 broad, 3 broad); 1465 (3 broad); 2873 (3 broad); 2930 (8 broad); 3010 (10); 3078 (4 broad).

<u>1-Cyclopropyl-2- α -tetrahydrofurylcyclopropane</u>. A mixture of 144 g of 1-cyclopropyl-2-furylcyclopropane, 200 ml of C₂H₅OH, 30 ml of H₂O, and 10 g of Raney nickel was heated to 70° with hydrogen (120 atm.) in a liter autoclave with stirring until 52 atmosphers of hydrogen had been adsorbed. After the usual working up [1], 103 g (69%) of 1-cyclopropyl-2- α -tetrahydrofurylcyclopropane was obtained, together with 20 g of 1-cyclopropyl-2-(4'-hydroxy-1'oxobutyl)-cyclopropane, with b.p. 130° (3 mm); n²⁰_D 1.4845; d³⁰₄ 1.0212; yield 12.3% Found: C 71.75; 71.65; H 9.80; 9.67% MR 47.16. C₁₀H₁₆O₂. Calculated: C 71.39; H 9.58% MR 47.00. Number of atoms of active hydrogen found: 1.2; 1.1; 1.1.

Raman spectrum ($\Delta v \text{ cm}^{-1}$): 263 (1 broad); 400 (3 broad); 735 (5 broad); 792 (4 broad); 812 (4 broad); 842 (3 broad); 885 (3 broad); 932 (5 broad); 966 (4 broad); 1040 (4 broad); 1102 (1 broad); 1036 (3 broad); 1195 (6); 1240 (6); 1295 (1 broad); 1410 (3 broad); 1435 (4 broad); 1457 (3 broad); 1685 (2 broad); 3046 (3 broad).

<u>1-Cyclopropyl-2-(4'-hydroxybutyl)-cyclopropane</u>. A mixture of 25 g of 1-cyclopropyl-2-(4'-hydroxy-1'-oxobutyl)-cyclopropane, 15 g of hydrazine hydrate, and 20 ml of C_2H_5OH was boiled for 10 hours under reflux. After distilling off the alcohol and the hydrazine hydrate, the residue was distilled in vacuum. A yield of 26.8 g of the alkylidenehydrazine was obtained, with b.p. 158-165° (5 mm); n_D^{20} 1.5210; d_4^{20} 1.045; yield 99%. The alkylidenehydrazine (23 g) was slowly distilled over 3 g of KOH. A yield of 15 g of 1-cyclopropyl-2-(4'-hydroxybutyl)-cyclopropane was obtained, with b.p. 102° (5 mm); n_D^{20} 1.4650; d_4^{20} 0.9120. Found: C 77.32; 77.15; H 11.52; 11.59% MR 46.73. $C_{10}H_{18}O$. Calculated: C 77.86; H 11.76% MR 47.03.

Raman spectrum ($\Delta \nu \text{ cm}^{-1}$): 198 (0); 365 (0); 455 (0); 712 (2 broad); 730, 743 (2 broad, 2 broad); 775 (3 broad); 810 (1 broad); 815 (3 broad); 832 (1 broad); 865 (3), 895, 910 (2 broad, 2 broad); 952 (3); 975 (1 broad); 1020 (2 broad); 1073 (2 broad); 1127 (2 broad); 1170 (3); 1188 (4); 1225 (6); 1296 (3); 1322 (1); 1372 (2); 1405 (5); 1435 (5); 1460 (6); 2855 (5 broad); 2903 (6); 2938 (3); 3002 (10); 3070 (5).

<u>1-Cyclopropyl-2-(4'-chlorobutyl)-cyclopropane</u>. A mixture of 5.5 g of PCl₃, 1 g of pyridine, and 50 ml of ether was added to a mixture of 18 g of 1-cyclopropyl-2-(4'hydroxybutyl)-cyclopropane, 5 g of pyridine, and 50 ml of ether with stirring and cooling to -10°. After 2 hours' stirring, the liquid was poured off from the precipitate and the residue was washed with ether. After the ether had been distilled off, the residue was distilled in vacuum. A yield of 4 g (20%) of 1-cyclopropyl-2-(4'-chlorobutyl)cyclopropane was obtained, with b.p. 85° (6 mm); n_D^{20} 1.4649; d_A^{20} 0.953. Found: C 69.64; 69.68; H 9.93; 10.03; Cl 20.54; 20.44% MR 50.08. C₁₀H₁₇Cl. Calculated: C 69.54; H 9.91; Cl 20.53% MR 50.42.

<u>1-Cyclopropyl-2-butylcyclopropane</u>. A mixture of 2.5 g of 1-cyclopropyl-2-(4[•]-chlorobutyl)-cyclopropane and 3 g of sodium in 15 ml of ether was boiled for 10 hours under reflux. After distilling off the ether, the residue was distilled in vacuum. A yield of 1 g of 1-cyclopropyl-2-butylcyclopropane was obtained, with b.p. 55[•] (10 mm); n^{20}_{D} 1.4376; d^{20}_{4} 0.8017; yield 50% Found: C 87.23; 86.95; H 12.90; 13.10% MR 45.22. C₁₀H₁₈. Calculated: C 86.87; H 13.12% MR 45.58.

SUMMARY

1. Over Raney nickel in the presence of water, the hydrogenation of the furyl ring in 1-cyclopropyl-2- α -furylcyclopropane is accompanied by its hydration without rupture of the cyclopropyl rings.

2. 1-Cyclopropyl-2-(4'-hydroxy-1'-oxobutyl)-cyclopropane, 1-cyclopropyl-2-(4'hydroxybutyl)-cyclopropane, 1.-cyclopropyl-2-(4'-chlorobutyl)-cyclopropane, and 1-cyclopropyl-2-butylcyclopropane have been obtained for the first time.

LITERATURE CITED

- 1. A. P. Meshceryakov, V. G. Glukhovtsev, and N. N. Lemin, Izv. AN SSSR, Otd. khim. n., 1901(1961).
- 2. Ya. M. Slobodin and I. N. Shokhor, Zh. obshch. khimii., 22, 208 (1952).
- 3. A. P. Meshcheryakov and V. G. Glukhovtsev, Izv. AN SSSR, Otd. khim. n., 1490(1959).
- 4. O. E. Curtic, I. M. Sandri, R. E. Crocker, and H. Hart, Organic Syntheses 38, 19 (1958).
- 5. L. Kh. Freidlin, A. P. Meshcheryakov, V. I. Gorshkov, and V. G. Glukhovtsev, Izv. AN SSSR, Otd. khim. n., 2237(1959).

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