A. P. MESHCHERYAKOV, I. E. DOLGII

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Abstract

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A. P. MESHCHERYAKOV, I. E. DOLGII

A METHOD FOR OBTAINING UNSATURATED KETONES OF THE CYCLOPROPANE SERIES

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One of the most widespread methods for obtaining α,β-unsaturated ketones is the Kondakov reaction: addition to olefins of acid halides (^{1}) or anhydrides (^{2}) of monobasic carboxylic acids in the presence of zinc chloride. In the first case, β-haloketones are formed, from which hydrogen chloride is readily split off and unsaturated ketones arise; in the second case, keto esters are formed, which then decompose into the corresponding unsaturated ketones and monocarboxylic acids.

Somewhat later (^{3}) this same reaction was carried out by Krapivin in the presence of aluminum chloride, and the corresponding unsaturated ketones were obtained in yields of 15-25%. However, this method of synthesis is not applicable for obtaining unsaturated ketones containing a cyclopropyl group in the molecule, since it is known that a three-membered carbon ring is isomerized in the presence of aluminum and zinc chlorides.

Only a small number of unsaturated ketones of the cyclopropane series have been described in the literature. They are obtained by condensation of methyl cyclopropyl ketone in the presence of alkalis with aromatic (^{4}), cycloaliphatic (^{5}), or higher aliphatic, slightly branched (^{6}) aldehydes; and by condensation of methyl cyclopropyl ketone in the presence of various basic agents (for example KOH), 1,3-dicyclopropylbuten-2-one-1 (^{7}) was obtained—an unsaturated ketone containing two cyclopropyl groups in the molecule.

By decomposition of the Mannich base formed in the reaction of methyl cyclopropyl ketone with CH_2O and dimethylamine, Smith and Shouell (^{8}) obtained vinyl cyclopropyl ketone, which is distinguished by high reactivity and therefore polymerizes readily even at room temperature.

For the synthesis of dialkyl ketones, the reaction of alkyllithium with lithium salts of carboxylic acids has repeatedly been used. This reaction was applied by us (^{9}) for obtaining alkyl cyclopropyl methyl ketones, and in the present work—for obtaining alkyl cyclopropyl alkenyl ketones. Of the alkenyl halides we chose isocrotyl bromide, formed upon dehydrobromination of 1,2-dibromoisobutane. Previously (^{10}), isocrotyl bromide was used for the synthesis of mesityl oxide by the reaction of isocrotyllithium with lithium acetate at the boiling temperature of the reaction mixture. We obtained isocrotyllithium at a temperature of 5–7°; in this case the reaction began very rapidly, and by the end of the addition of isocrotyl bromide all the lithium had dissolved. In contrast to Braude and Coles ([10]), who added isocrotyl bromide to a suspension of lithium acetate and lithium in ether, we introduced the salts of cyclopropanecarboxylic acids into the reaction mixture both before obtaining isocrotyllithium, during it (after the addition of ~ of the isocrotyl bromide), and after completion of its preparation, and found that this has no substantial effect on the yields of the ketones.

Since Braude and Coles used lithium acetate—the salt of a low-molecular-weight carboxylic acid—for the reaction with isocrotyllithium, and the unsaturated ketone (mesityl oxide) was obtained in a yield of 36%, we initially

subsequently carried out the isocrotyllithium reaction under the conditions selected by us with the salt of capric acid and obtained *n*-nonyl isocrotyl ketone in 62% yield.

Carrying out the isocrotyllithium reaction under the same conditions with salts of 2-(*n*-butyl)-, 2-(*n*-amyl)- and 2-(*n*-hexyl)-cyclopropanecarboxylic acids likewise caused no difficulties, and the corresponding unsaturated ketones were obtained in yields of 40–55%.

In a work devoted to the synthesis of alkylcyclopropyl methyl ketones [9], we showed that, in the reaction with methyllithium, lithium as well as sodium and potassium salts of carboxylic acids can be used with equal success. For the synthesis of unsaturated ketones of the cyclopropane series we also used sodium and potassium salts. However, sodium salts of alkylcyclopropanecarboxylic acids are preparatively more convenient, since they are crystalline, whereas the potassium salts of these acids are soap-like, which complicates their drying and introduction into the reaction mixture.

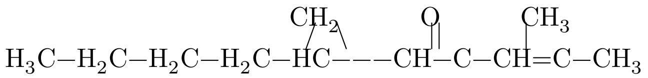
Experimental Part

***n*-Nonyl isocrotyl ketone.** To 2 g of finely divided lithium in 200 ml of absolute ether, at a temperature of 5–7° and with stirring, a solution of 10 g of isocrotyl bromide in an equal volume of ether was added dropwise in an atmosphere of nitrogen; 19 g of dried potassium salt of capric acid was added, and the addition of an ethereal solution of 23 g of isocrotyl bromide was continued. The mixture was then heated for 2 hours on a water bath and decomposed with water. The organic layer was separated, dried with calcium chloride, and distilled. Thirteen grams of a fraction with b.p. 136–142° (4.5 mm) was obtained; on redistillation this gave 12 g of product with b.p. 123–124° (3.5 mm), yield 62%, d_4^{20} 0.8486, n_D^{20} 1.4597.

Found, %:	C 78.98, 79.24;	H 12.30, 12.50
$C_{14}H_{26}O$. Calculated, %:	C 79.93;	H 12.45

MR_D found 67.49, calculated 66.62.

(2-*n*-Butylcyclopropyl) isocrotyl ketone.



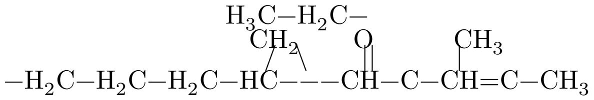
$$H_3C-H_2C-H_2C-H_2C-\overset{CH_2}{HC}---CH-\overset{O}{\overset{\|}{C}}-CH=\overset{CH_3}{\overset{|}{C}}-CH_3$$

To a suspension of 22 g of the potassium salt of 2-butylcyclopropanecarboxylic acid and 2.5 g of finely divided lithium in 250 ml of absolute ether, at 5-7° and with stirring, a solution of 35 g of isocrotyl bromide in absolute ether was added dropwise. The reaction mixture was heated for 1.5 hours on a water bath and decomposed with water. From the organic layer, after drying it with calcium chloride, 10 g of ketone with b.p. 122-127° (9 mm) was isolated, yield 45%, d_4^{20} 0.8789, n_D^{20} 1.4740.

Found, %:	C 79.91, 80.12;	H 11.24, 11.37
$C_{12}H_{20}O$. Calculated, %:	C 79.94;	H 11.18

MR_D found 57.58, calculated 55.85.

(2-*n*-Amylcyclopropyl) isocrotyl ketone.



$$\overset{H_3C-H_2C-}{-H_2C-H_2C-H_2C-\overset{CH_2}{HC}---CH-\overset{O}{\overset{\|}{C}}-CH=\overset{CH_3}{\overset{|}{C}}-CH_3}$$

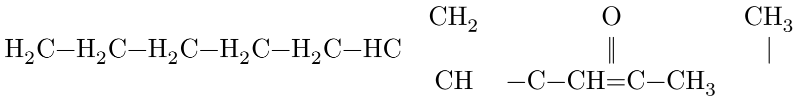
To 4.5 g of metallic lithium in 200 ml of absolute ether, at 5-7°, a solution of 78 g of isocrotyl bromide in ether was added dropwise, and 39 g of the sodium salt of 2-amylcyclopropanecarboxylic acid was added. The mixture was stirred for 2 hours at 20° and decomposed with water. The organic layer was separated, dried with calcium chloride, and distilled in vacuum. Eighteen grams of ketone was obtained.

b.p. 124-142° (8-9 mm), yield 43%, d_4^{20} 0.8813, n_D^{20} 1.4742.

Found, %:	C 80.36; 80.31;	H 11.47, 11.49
$C_{13}H_{22}O$. Calculated, %:	C 80.35;	H 11.41

MR_D found 61.98, calculated 60.49.

(2-*n*-Hexylcyclopropyl)isocrotyl ketone.



$$H_2C-H_2C-H_2C-H_2C-H_2C-HC \quad \overset{CH_2}{CH} \quad -\overset{O}{\overset{\|}{C}}-CH=\overset{CH_3}{\overset{|}{C}}-CH_3$$

To 3.5 g of metallic lithium in ether at 5-7°, a solution of 52 g of isocrotyl bromide in ether was added dropwise. After about 1/3 of the isocrotyl bromide had been added, 39.5 g of the potassium salt of 2-*n*-hexylcyclopropanecarboxylic acid, dried in a vacuum desiccator, was introduced into the reaction mixture, and the addition of isocrotyl bromide was continued at the same temperature, 5-7°. After the addition was complete, the mixture was stirred for 2 hours at 20° and decomposed with water. The organic layer was separated, dried over calcium chloride, and distilled. This gave 22 g of ketone with b.p. 158-164° (9 mm), yield 55%, d_4^{20} 0.8769, n_D^{20} 1.4470.

Found, %: C 80.62, 80.74; H 11.52, 11.48
$C_{14}H_{24}O$. Calculated, %: C 80.70; H 11.61

MR_D found 66.76, calculated 65.14.

Zelinsky Institute of Organic Chemistry
Academy of Sciences of the USSR

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Note: Figure translations are in progress. See original paper for figures.