Syntheses of 2-Cycloalken-1-ones

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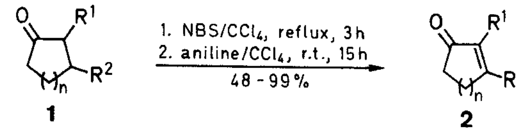
The bromination of 2-alkyl- and 2-phenyl-1-cycloalkanones with *N*-bromosuccinimide and subsequent dehydrobromination with aniline gave the corresponding 2-cycloalken-1-ones.

Conjugated cycloalkenones are very important Michael acceptors in organic syntheses and many papers describing their preparation have been published.[1] In 1984, Sahni and Gupta reported the preparation of 5-hexyl-2-cyclopenten-1-one, 6-alkyl-2-cyclohexen-1-ones and 7-alkyl-2-cyclohepten-1-ones by the bromination of the corresponding 2-alkyl-1-cycloalkanones with *N*-bromosuccinimide followed by dehydrobromination with aniline.[2] As we required 5-pentyl-2-cyclopenten-1-one we repeated this procedure starting from 2-pentylcyclopentan-1-one[3] (**1b**), however, the main product was not the target compound but rather 2-pentyl-2-cyclopenten-1-one (**2b**) as shown by the ^{1}H-NMR spectrum. The introduction of a double bond into various 2-alkyl- and 2-phenyl-1-cycloalkanones **1** by this method was carried out, yielding 2-alkyl- and 2-phenyl-2-cycloalken-1-ones **3** (Scheme **A**, Table).



1, 2	n	R^1	R^2	1, 2	n	R^1	R^2
a	1	Me	H	**e**	2	Me	H
b	1	n-C_5H_{11}	H	**f**	2	Ph	H
c	1	n-C_6H_{13}	H	**g**	1	n-C_5H_{11}	Me
d	1	Ph	H				

Scheme **A**

Table. 2-Cycloalken-1-ones **2** Prepared

Products	Yield[a] (%)	mp (°C) or bp (°C)/Torr	Lit. mp (°C) bp (°C)/Torr
2a	48	58–63/30	45–46/10[9]
2b	55	85–90/5	52–53/0.1[9]
2c	56	90–94/3	79–80/0.1[9]
2d	85	69–72	72[10]
2e	99	65–70/16	98–101/77[11]
2f	79	98–100	95–96[12]
2g	63	125–130/5	79–81/0.2[5]

[a] Yields refer to pure isolated compounds. All products are known compounds and characterized by IR and ^{1}H-NMR data, typically:
2b:
IR (film): $\nu = 1630$ (C=C), 1710 cm^{-1} (C=O).
^{1}H-NMR (CDCl$_3$): $\delta = 0.87$ (t, 3H), 1.25–1.33 (m, 4H), 1.43–1.50 (m, 2H), 2.15 (t, 2H), 2.37–2.39 (m, 2H), 2.54–2.56 (m, 2H), 7.29 (t, 1H)

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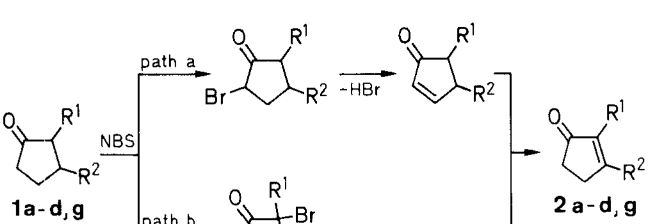
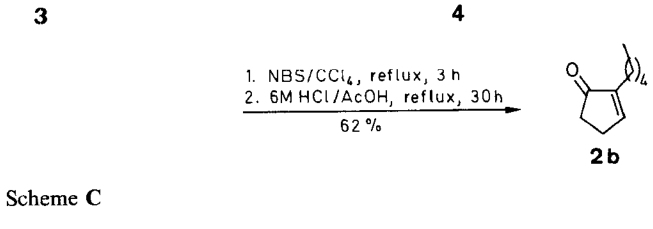
Compound **2g**, dihydrojasmone, one of the flavors of jasmin oil, was prepared from **1g** which was itself prepared from **2b** by with methylmagnesium iodide in the presence of copper(I) chloride according to the reported procedure.[5]

The two routes shown in Scheme **B** were considered as possible reaction pathways to cyclopentenones **2a–d,g**: path a, by initial bromination at the α-unsubstituted carbon of **1**, followed by dehydrobromination and rearrangement to give **2**; path b, by bromination of **1** at the α-substituted carbon and subsequent dehydrobromination to give **2**. The ^{1}H-NMR spectra of the reaction mixture prepared from **1b** and *N*-bromosuccinimide suggested the presence of 5-pentyl-2-cyclopenten-1-one, 2-pentyl-2-cyclopenten-1-one (**2b**) and 2-bromo-5-pentylcyclopentanone. However, the bromide could not be isolated from the mixture as a pure compound. The reaction of **1f** with *N*-bromosuccinimide gave 2-bromo-6-phenyl-1-cyclohexanone in 88% yield, with spectroscopic data in agreement with reported values.[4] It is thus evident that the reaction proceeds via path a in Scheme **B**.



Scheme **B**

The rearrangement of 5-pentyl-2-cyclopenten-1-one to 2-pentyl-2-cyclopenten-1-one (**2b**) under alkaline conditions has been reported by Tsuji and co-workers.[6] We also obtained **2b** in 62% yield by refluxing the mixture, derived from the reaction of 2-ethoxycarbonyl-2-pentyl-1-cyclopentanone (**4**)[7] with *N*-bromosuccinimide, in a mixture of 6 M hydrochloric acid and glacial acetic acid as shown in Scheme **C**. This confirms that the rearrangement also proceeds under acid conditions. It is known that 2-ethoxycarbonyl-2-alkyl-1-cyclopentanones are easily prepared from commercial 2-ethoxycarbonyl-1-cyclopentanone (**3**) and alkyl halides;[7] therefore this procedure should prove convenient for the synthesis of various 2-alkyl-2-cyclopenten-1-ones. An attempt was made to prepare 2-ethoxycarbonyl-2-pentyl-1-cyclohexanone, possibly the starting material of 2-pentyl-2-cyclohexen-1-one. However, the reaction of 2-ethoxycarbonyl-1-cyclohexanone, a commercially available compound, with 1-bromopentane failed to proceed under the same conditions as those for the synthesis of **4**.



Scheme **C**

All reagents were of commercial quality. 2-Methyl-1-cyclopentanone, 2-methyl-1-cyclohexanone and 2-phenyl-1-cyclohexanone were purchased from Aldrich Chemical Co. 2-Hexyl-1-cyclopentanone, 2-ethoxycarbonyl-1-cyclopentanone, 1-bromopentane, *N*-bromosuccinimide and aniline were purchased from Tokyo Kasei Kogyo Co., Ltd., aniline was distilled before use. 2-Pentyl-1-cyclopentanone[3] and 2-phenyl-1-cyclopentanone[8] were synthesized by literature procedures. Reagent quality solvents were used without further purification. Melting points were taken using Yanagimoto micro melting point apparatus and are uncorrected. Mass spectra were obtained using Hitachi M-80B spectrometer. IR spectra were obtained using Japan Spectroscopic Co. A-100 spectrometer. ^{1}H-NMR spectra were obtained using Brucker AM-400 spectrometer and the chemical shift values were measured by setting the value of the proton of $CHCl_3$ in the solvent ($CDCl_3$) to $\delta = 7.26$.

2-Pentyl-2-cyclopenten-1-one (2b); Typical Procedure from 2-Pentylcyclopentan-1-one (1b):

To a solution of 2-pentylcyclopentan-1-one[3] (**1b**, 1.54 g, 10 mmol) dissolved in CCl_4 (50 mL) is added *N*-bromosuccinimide (1.78 g, 10 mmol) and the resulting suspension is heated in a water bath at 90 °C for 3 h. The suspension is then cooled to r.t., the precipitates filtered off and aniline (0.93 g, 10 mmol), is added to the filtrate with cooling (ice-water). The solution is stirred at r.t. for 15 h, washed with 5% HCl (3 × 30 mL) and then with 5% $NaHCO_3$ (2 × 30 mL). After drying (Na_2SO_4), the solvent is evaporated *in vacuo* to give a brownish oil, which is purified by distillation under reduced pressure; yield: 0.84 g (55%), (Table).

2-Pentyl-2-cyclopenten-1-one (2b) from 2-Ethoxycarbonyl-1-cyclopentanone (3):

A mixture of 2-ethoxycarbonyl-2-pentyl-1-cyclopentanone (**4**, 2.26 g, 10 mmol), [obtained by the reaction of 2-ethoxycarbonyl-1-cyclopentanone (**4**) and 1-pentyl bromide in the presence of K_2CO_3 by literature procedures,[7]] and *N*-bromosuccinimide (1.78 g, 10 mmol) is refluxed for 3 h in CCl_4 (50 mL). After cooling, the precipitates are filtered off and the filtrate is concentrated *in vacuo*. To the residual oil is added a mixture of 6 M HCl (20 mL) and glacial AcOH (80 mL) and the resulting system is refluxed for 30 h and poured into ice-water. It is then neutralized with K_2CO_3 powder and extracted with Et_2O (3 × 50 mL). The extract is dried (Na_2SO_4) and evaporated to give a brownish oil, which was purified by distillation under reduced pressure; yield: 0.94 g (62%).

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