

Nitration of cubane-1,4-dicarboxylic acid dimethyl ester by dinitrogen tetroxide

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A first direct nitration of C—H bond of cubane-1,4-dicarboxylic acid dimethyl ester by dinitrogen tetroxide at -20°C has been carried out. During the nitration no rearrangement of cubane skeleton has been observed.

Key words: CH-nitration, cubane-1,4-dicarboxylic acid dimethyl ester, dinitrogen tetroxide, homolytic nitration, NMR spectroscopy.

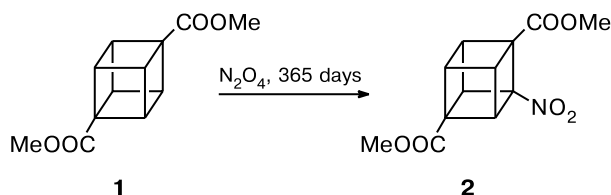
The known methods for homolytic nitration of alkanes include nitration by nitric acid (Konovalov reaction),^{1,2} nitrogen oxides, or nitric acid in the presence of *N*-hydroxyphthalimide,^{3–5} nitrogen trioxide, generated upon the reaction of nitrogen dioxide with ozone^{6–9} (so-called Kyodai-nitration), or by nitrogen dioxide.¹⁰ As a model CH-component adamantane was used in all above methods. It is possible to introduce several nitro groups (up to five) in adamantane cage simultaneously (*i.e.*, in one chemical step) only by the latter method.¹⁰

According to the literature, cubane has not been subjected to the direct nitration. Development of methods for the direct nitration of cubane skeleton is perspective for obtaining new potentially pharmacologically active compounds of cubane series and for simplifying methods for the synthesis of polynitrocubanes as well.

In this study a first direct homolytic substitution of nitrogroup for hydrogen in cubane-1,4-dicarboxylic acid dimethyl ester (**1**) has been carried out.

Reaction was carried out in the dinitrogen tetroxide solution at the day light for 365 days at -20°C . As a result, a mixture of starting compound **1** and nitrocubane **2** was obtained, which according to ^1H NMR spectra contained 14% of nitrocompound (Scheme 1).

Scheme 1



Experimental

The IR spectra were recorded on a Specord M82 spectrometer. The ^1H , ^{13}C , and ^{14}N NMR spectra were registered on Bruker DXP-200, Bruker AM-300, and Bruker DRX-500 spectrometers with Me_4Si as the internal standard. Chromato-mass spectra were recorded on a Finnigan MAT ITD-700 spectrometer (EI, 70 eV, column Ultra-1, 25 m \times 0.2 mm). Dinitrogen tetroxide was prepared and purified according to the known procedure.¹¹

Nitration of cubane-1,4-dicarboxylic acid dimethyl ester (1). A solution of ester **1** (**12**) (100 mg, 0.45 mmol) in N_2O_4 (10 mL) was sealed in a 20 mL glass ampoule and allowed to stand at the day light for 365 days at -20°C . Dinitrogen tetroxide was distilled off at reduced pressure, the residue was dissolved in CH_2Cl_2 (100 mL), washed with water (3×100 mL), saturated NaHCO_3 solution, and dried over Na_2SO_4 . The solution was filtered through a short silica gel layer, concentrated on the rotary evaporator. The residue was purified on a short column (5 cm) with silica gel L 5/40 μm (eluent — hexane— CH_2Cl_2 , 3 : 1) and 100 mg of crystalline material was obtained, m.p. $145\text{--}147^{\circ}\text{C}$, which was a mixture of cubane-1,4-dicarboxylic acid dimethyl ester (**1**) and 2-nitrocubane-1,4-dicarboxylic acid dimethyl ester (**2**) in the $\sim 86 : 14$ ratio (according to the ^1H NMR data). IR (KBr), ν/cm^{-1} : 3001, 2954, 2855, 1720, 1536 (NO_2), 1440, 1324, 1219, 1196, 1092, 1032, 913. ^1H NMR* (CDCl_3), δ : 3.74 (s, 3 H, OMe); 3.75 (s, 3 H, OMe); 4.19 (m, 1 H, CH); 4.29 (m, 2 H, CH); 4.85 (m, 2 H, CH). ^{13}C NMR* (CDCl_3), δ : 171.89 (COO); 83.70 (CNO_2); 62.20 (C(1) or C(4)); 53.98 (C(6), C(8)); 52.42 (OMe); 52.21 (OMe); 51.50 (C(4) or C(1)); 48.10 (C(7)); 43.55 (C(3), C(5)). ^{14}N NMR (CDCl_3), δ : -0.99 (NO_2). MS, m/z (I_{rel} (%)): 265 [$\text{M}]^+$ (7), 233 (8), 219 [$\text{M} - \text{NO}_2$] $^+$ (48), 206 (8), 191 (100), 177 (12), 160 (23), 145 (23), 129 (47), 117 (32), 101 (47), 89 (18), 75 (67), 59 (48), 51 (38).

* Received by subtraction of signals of ester **1**.

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