

SHORT
COMMUNICATIONSCondensation of 1,1,1-Trifluoropentane-2,4-dione
with BenzaldehydeZ. G. Aliev^a, V. L. Gein^b, N. V. Nosova^b, K. D. Potemkin^b, and A. P. Kriven'ko^c^a Institute of Chemical Physics Problems, Russian Academy of Sciences, Chernogolovka, Moscow oblast, Russia^b Perm State Pharmaceutical Academy, ul. Lenina 48, Perm, 614990 Russia
e-mail: perm@pfa.ru^c Saratov State University, Saratov, Russia

Received February 28, 2006

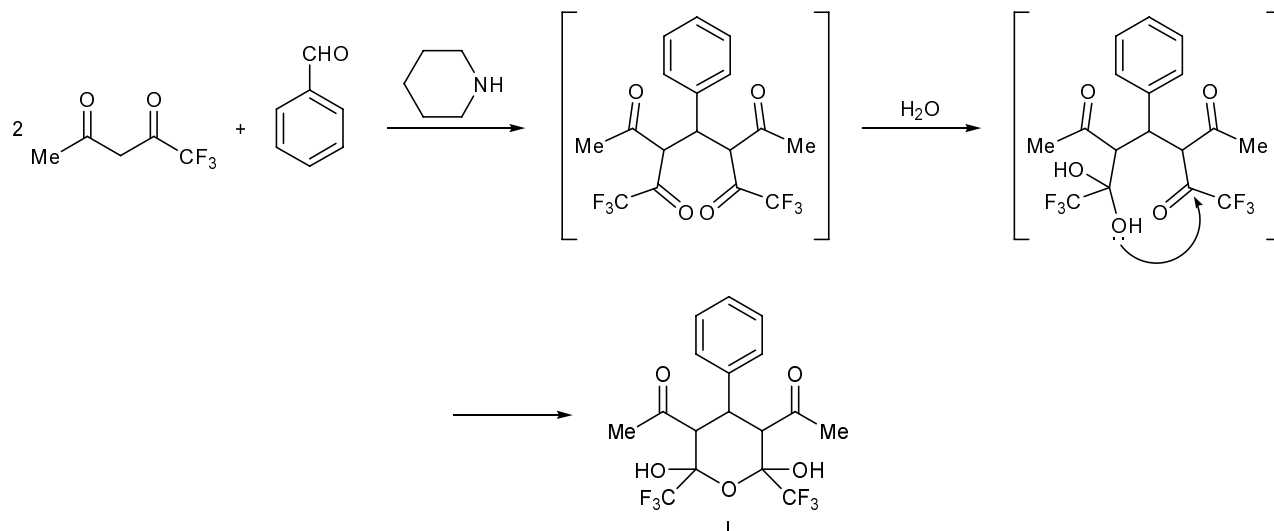
DOI: 10.1134/S1070428006090296

Acetylacetone and acetoacetic acid esters are known to react with aromatic aldehydes under conditions of base catalysis to give cyclic β -hydroxy ketones [1–4]. We examined the reaction of 1,1,1-trifluoropentane-2,4-dione with benzaldehyde in the presence of a base with a view to elucidate how the nature of the methylene-active component affects the condensation direction. The reaction was carried out in ethanol using excess β -diketone in the presence of piperidine at room temperature according to the procedure described in [1]. Under these conditions, the condensation occurred in an unusual way and led to the formation of 3,5-diacyl-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-phenyltetrahydropyran (**I**).

Presumably, the process involves hydration of one carbonyl group in the α -position with respect to the

electron-acceptor trifluoromethyl group, followed by closure of pyran ring. The structure of the product was proved by X-ray analysis of a single crystal obtained by slow crystallization from a solution in ethanol (Fig. 1). The pyran ring has a *chair* conformation. All bulky substituents at the pyran ring (except for the hydroxy groups) occupy equatorial positions. The acetyl groups are turned apart with respect to each other through an angle of $\sim 180^\circ$ so that the O⁴ and O⁵ atoms and the corresponding methyl groups are arranged *trans* relative to the pyran ring. All bond lengths and bond angles approach standard values.

Compound **I** crystallizes together with piperidine and trifluoroacetic acid molecules; the latter is likely to be formed by hydrolysis of trifluoroacetylacetone with water in the presence of base catalyst. The trifluoro-



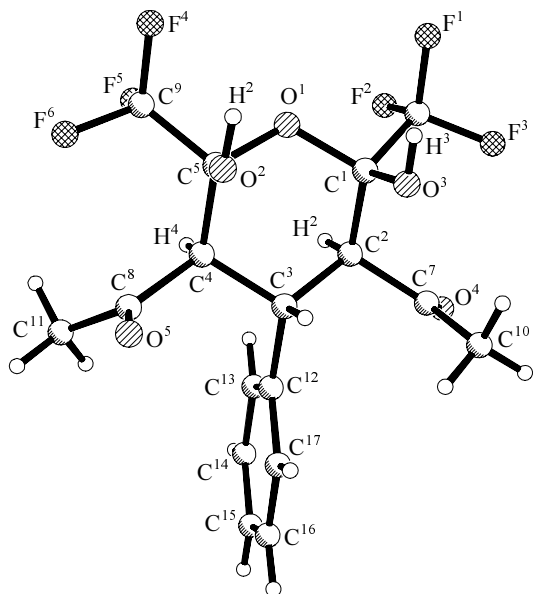


Fig. 1. Structure of the molecule of 3,5-diacetyl-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-phenyltetrahydropyran (**I**) according to the X-ray diffraction data.

acetic acid molecule is statistically disordered by two positions via rotation by 180° with respect to the C–CF₃ bond. The hydroxy groups in the pyran ring are linked to the trifluoroacetic acid oxygen atoms through very strong hydrogen bonds (Fig. 2): O²...O²⁵ 2.635(3), O³...O²⁴ 2.661(3) Å; the angles at the hydrogen atoms,

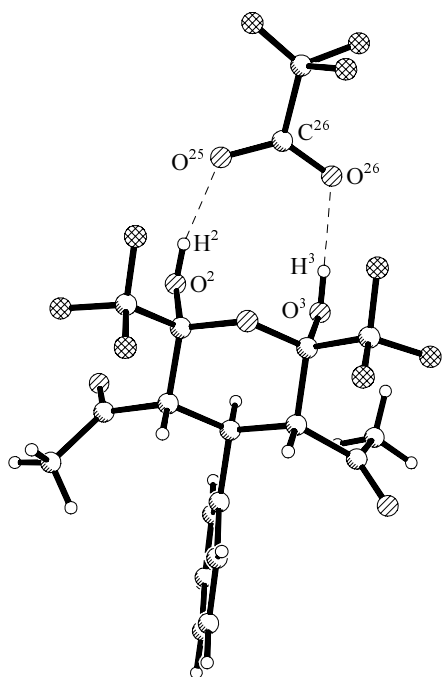


Fig. 2. Hydrogen bonds between the molecules of 3,5-diacetyl-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-phenyltetrahydropyran (**I**) and trifluoroacetic acid in crystal.

$\angle \text{O}^2\text{H}^2\text{O}^{25}$ and $\angle \text{O}^3\text{H}^3\text{O}^{24}$, are 179(3) and 170(4) $^\circ$, respectively. We failed to localize hydrogen atom in the carboxy group of trifluoroacetic acid; however, the C²⁶–O²⁴ and C²⁶–O²⁵ bond lengths [1.250(4) and 1.220(4) Å, respectively] unambiguously indicate that the hydrogen atom resides on O²⁴. The piperidine molecule in crystal gives rise to neither shortened intermolecular contacts nor hydrogen bonds.

The ¹H NMR spectrum of compound **I** contained signals from protons in the benzene ring, a singlet at δ 1.90 ppm from the two methyl groups, a doublet at δ 3.30 ppm from the CH protons in positions 3 and 5 of the pyran ring, a triplet at δ 4.23 ppm from the 4-H proton, and a broadened signal in the region δ 8.0–9.0 ppm (3H) from the hydroxy protons and NH proton in piperidine.

3,5-Diacetyl-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-phenyltetrahydropyran (I). Piperidine, 1 ml, was added to a solution of 0.05 mol of 1,1,1-trifluoropentane-2,4-dione and 0.025 mol of benzaldehyde in 6 ml of ethanol, and the mixture was kept for 7 days at room temperature. The precipitate was filtered off and recrystallized from ethanol. Yield 26%, mp 108–110 $^\circ\text{C}$. IR spectrum, ν , cm⁻¹: 3260 (OH), 3200 (NH), 1720 (C=O). ¹H NMR spectrum (DMSO-*d*₆), δ , ppm: 8.0–9.0 br.s (3H, OH, NH), 7.35 m (5H, H_{arom}), 4.23 t (1H, 4-H), 3.30 d (2H, 3-H, 5-H), 3.00 m (4H, CH₂NHCH₂), 1.90 s (6H, COCH₃), 1.65 m (4H, CH₂CH₂NHCH₂CH₂), 1.55 m (2H, CH₂). Found, %: C 52.83; H 5.58; N 2.70 C₂₂H₂₇F₆NO₅. Calculated, %: C 52.91; H 5.45; N 2.80.

The IR spectrum of compound **I** in mineral oil was recorded on a Specord M-80 spectrophotometer, and the ¹H NMR spectrum was measured on a Bruker DRX-400 instrument (400 MHz) using HMDS as internal reference.

Crystallographic data for compound **I**: C₂₄H₂₈F₉NO₇; unit cell parameters: $a = 15.282(3)$, $b = 10.349(2)$, $c = 18.685(4)$ Å; $\alpha = 90$, $\beta = 110.21(3)$, $\gamma = 90^\circ$; $V = 2773.2(10)$ Å³; M 613.47; $d_{\text{calc}} = 1.469$ g/cm³; $Z = 4$; space group *P*-1. A set of experimental reflections was measured on a KM-4 automatic four-circle diffractometer (χ -geometry, monochromatized MoK α irradiation, $\omega/2\theta$ scanning, $2\theta \leq 52.1^\circ$). Total of 4036 independent reflections were measured with no correction for absorption ($\mu = 0.145$ mm⁻¹). The structure was solved by the direct method using SIR92 program [5], followed by a series of calculations of electron density maps. The positions of hydrogen atoms in the

methyl groups and benzene ring were set on the basis of geometry considerations, and the other were visualized by the difference synthesis of electron density. The structure was refined by the full-matrix least-squares procedure in anisotropic approximation (for non-hydrogen atoms) using SHELXL-97 software [6] to $R_1 = 0.0418$, $wR_2 = 0.1069$ [from 3900 reflections with $I \geq 2\sigma(I)$] and $R_1 = 0.1098$, $wR_2 = 0.1200$ (from all 4036 reflections); GooF = 1.000.

This study was performed under financial support by the Russian Foundation for Basic Research (project no. 04-03-96042).

REFERENCES

1. Finar, I.L., *J. Chem. Soc.*, 1961, p. 674.
2. Kriven'ko, A.P. and Sorokin, V.V., *Russ. J. Org. Chem.*, 1999, vol. 35, p. 1097.
3. Gein, V.L., Gein, N.V., Voronina, E.V., and Kriven'ko, A.P., *Khim.-Farm. Zh.*, 2002, vol. 36, no. 3, p. 23.
4. Gein, V.L., Gein, N.V., and Kriven'ko, A.P., *Russ. J. Gen. Chem.*, 2003, vol. 73, p. 490.
5. Altomare, A., Cascarano, G., Giacovazzo, C., and Guarlardi, A.J., *J. Appl. Crystallogr.*, 1993, vol. 26, p. 343.
6. Sheldrick, G.M., *SHELX97. Programs for Crystal Structure Analysis*, Göttingen: Univ. of Göttingen, 1998, 2332.