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# Synthesis of imidazolidinone containing an ammonium nitrogen atom in the ring

**A. S. Gazizov, M. S. Khakimov, A. R. Burilov, M. A. Pudovik,***
**D. B. Krivolapov, I. A. Litvinov, and A. I. Konovalov**

*A. E. Arbuzov Institute of Organic and Physical Chemistry,*
*Kazan Research Center of the Russian Academy of Sciences,*
*8 ul. Akad. Arbuzova, 420088 Kazan, Russian Federation.*
*Fax: +7 (843 2) 75 2253. E-mail: pudovik@iopc.knc.ru*

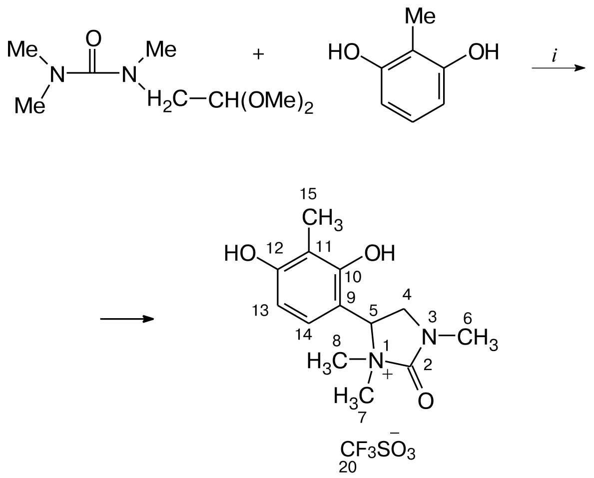
The reaction of 1-(2,2-dimethoxyethyl)-1,3,3-trimethylurea with 2-methylresorcinol in dioxane in the presence of trifluoromethanesulfonic acid affords a new type of imidazolidin-2-ones, *viz.*, 5-(2,4-dihydroxy-3-methylphenyl)-1,1,3-trimethyl-2-oxoimidazolidinium triflate containing an endocyclic ammonium nitrogen atom.

**Key words:** 1-(2,2-dimethoxyethyl)-1,3,3-trimethylurea, 2-methylresorcinol, 5-(2,4-dihydroxy-3-methylphenyl)-1,1,3-trimethyl-2-oxoimidazolidinium triflate.

Imidazol-2-ones and imidazolidin-2-ones are important classes of compounds with a wide spectrum of biological activities. Imidazol-2-ones are antioxidants *in vivo*[1] and can be produced in living organisms.[2] The imidazol-2-one skeleton is involved in the nucleotide antibiotic nikkomycin. Imidazol-2-ones are used also to investigate the mechanism of regulation of intraocular pressure[3] and as protein kinase C modulators;[4] in addition, they have anticonvulsant activity.[5] The most commonly used method for the synthesis of imidazol-2-one derivatives is based on the reaction of functionalized α-aminocarbonyl compounds with isocyanates[6—8] through the intermediate formation of the corresponding ureas, which undergo cyclization predominantly in the presence of acid catalysts. Imidazolidin-2-one derivatives can also be synthesized by the condensation of ethylenediamines with phosgene,[9] bis(trichloromethyl) carbonate,[10] diethyl carbonate,[11] di(*tert*-butyl) dicarbonate,[12] and 1,1′-carbonyldiimidazole.[13]

We performed the reaction of 1-(2,2-dimethoxyethyl)-1,3,3-trimethylurea with 2-methylresorcinol in dioxane in the presence of trifluoromethanesulfonic acid (Scheme 1). The reaction produced 5-(2,4-dihydroxy-3-methylphenyl)-1,1,3-trimethyl-2-oxoimidazolidinium triflate (**1**) bearing a positive charge on the nitrogen atom. Structurally similar charged imidazolidinones have not been reported in the literature so far. We suggest that the first step of the reaction involves the generation of a carbocation from acetal and trifluoromethanesulfonic acid followed by the attack of the carbocation on the C(4) atom activated by two hydroxy groups of the aromatic moiety. The intramolecular attack of the new carbocation on the nitrogen atom of the dimethylamino group affords the five-membered ring with the quaternary nitrogen atom.

**Scheme 1**



**1**

*i.* $CF_3SO_3H$/dioxane, 8 h, reflux.

The structure of compound **1** was determined by $^1H$ NMR and IR spectroscopy and X-ray diffraction. The molecular structure and the atomic numbering scheme for **1**, which exists in the crystalline state as a salt, are presented in Fig. 1.

The five-membered heterocycle of molecule **1** adopts an envelope conformation. The N(1)C(2)N(3)C(4) fragment is planar within 0.008(5) Å. The C(5) atom deviates

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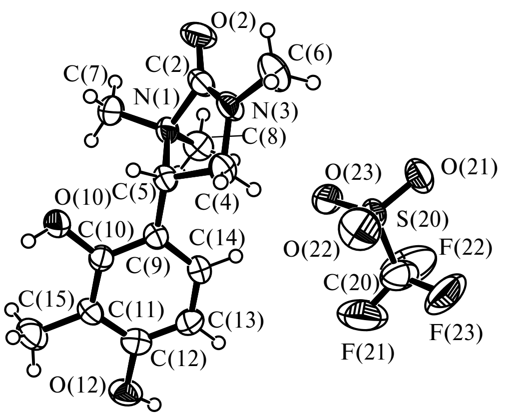

**Fig. 1.** Molecular structure of compound **1** with displacement ellipsoids drawn at the 50% probability level.

from this plane by 0.513(4) Å. The resorcinol substituent at the C(5) atom is in the equatorial position and is unsymmetrically twisted around the C(5)—C(9) bond. The plane of the resorcinol substituent does not coincide with the bisecting plane of the C(4)—C(5)—N(1) angle and is almost orthogonal to the N(1)—C(5) bond (N(1)—C(5)—C(9)—C(10), −96.4(4)°; C(4)—C(5)—C(9)—C(14), −29.5(5)°; H(5)—C(5)—C(9)—C(14), 24°). The N(3) atom has a trigonal-planar coordination. The C(2)—N(3) bond (1.303(6) Å) is strongly shortened, which is indicative of the conjugation between the lone pair and the C=O bond. A slight elongation of the C=O bond to 1.197(5) Å is also consistent with this fact. The geometric parameters of the resorcinol substituent and the anion have standard values.

In the crystal structure of compound **1**, the cations and anions form infinite zigzag chains along the diagonal *a*0*c* through hydrogen bonds between the hydrogen atoms of the hydroxy groups of the cations and the oxygen atoms of the anions (Fig. 2). The hydrogen bond parameters are as follows: for O(10)—H(10)...O(22′) (−3/2 − *x*, 1 − *y*, −1/2 + *z*), O(10)—H(10), 0.85(3) Å; H(10)...O(22′), 1.98(4) Å; O(10)...O(22′), 2.803(5) Å; O(10)—H(10)...O(22′), 162(5)°; for O(12)—H(12)...O(23″) (−7/4 − *x*, 1/4 + *y*, 1/4 + *z*), O(12)—H(12), 0.84(4) Å; H(12)...O(23″), 1.97(4) Å; O(12)...O(23″), 2.800(5) Å; O(12)—H(12)...O(23″), 172(5)°.

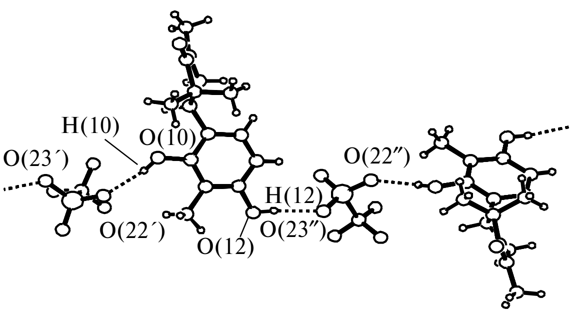

**Fig. 2.** Hydrogen bonds in the crystal structure of compound **1**.

The molecular packing in the crystal structure of compound **1** can be described as a system of corrugated layers consisting of parallel hydrogen-bonded chains, which are in the perpendicular arrangement in the adjacent layers.

## Experimental

The $^1$H NMR spectrum was recorded on a Bruker MSL-400 instrument operating at 250 MHz with respect to the signals for the residual protons of the deuterated solvent (DMSO-d$_6$) at 20 °C. The IR spectrum of a crystalline sample was measured in an KBr pellet on an UR-20 spectrophotometer in the 400—3600 cm$^{-1}$ region.

**5-(2,4-Dihydroxy-3-methylphenyl)-1,1,3-trimethyl-2-oxoimidazolidinium triflate (1).** A solution of 1-(2,2-dimethoxyethyl)-1,3,3-trimethylurea (1.53 g, 8.06 mmol), 2-methylresorcinol (1.0 g, 8.06 mmol), and trifluoromethanesulfonic acid (2.41 g, 16.13 mmol) in dioxane (10 mL) was kept at 110 °C for 8 h. Then the solvent was removed, ethanol (3 mL) was added to the residue, and the reaction mixture was kept for 4 h. The precipitate that formed was filtered off, washed with diethyl ether, and dried *in vacuo*. The yield was 1.61 g (44.5%), m.p. 154 °C. Found (%): C, 41.98; H, 4.68; N, 7.10. $C_{14}H_{19}F_3N_2O_6S$. Calculated (%): C, 42.00; H, 4.78; N, 7.00. $^1$H NMR, δ: 2.05 (s, 3 H, C(15)H$_3$); 2.72 (s, 3 H, C(6)H$_3$); 3.04 (s, 3 H, C(7)H$_3$); 3.11 (s, 3 H, C(8)H$_3$); 3.77 (dd, 1 H, C(4)H, $^1J_{\mathrm{H,H}}$ = 8.05 Hz, $^2J_{\mathrm{H,H}}$ = 10.73 Hz); 4.16 (t, 1 H, C(5)H, $^1J_{\mathrm{H,H}}$ = 10.73 Hz); 5.66 (dd, 1 H, C(4)H, $^1J_{\mathrm{H,H}}$ = 8.05 Hz, $^2J_{\mathrm{H,H}}$ = 10.73 Hz); 6.50 (d, 1 H, C(13)H, $^1J_{\mathrm{H,H}}$ = 8.71 Hz); 7.22 (d, 1 H, C(14)H, $^1J_{\mathrm{H,H}}$ = 8.71 Hz). IR, ν/cm$^{-1}$: 1610 (arom.), 1819 (C=O), 3334 (OH).

**X-ray diffraction study of compound 1.** Crystals are orthorhombic, $C_{13}H_{19}N_2O_3 \cdot CF_3SO_3$, M = 400.38, $a$ = 28.584(4) Å, $b$ = 23.566(5) Å, $c$ = 10.518(3) Å, $V$ = 7085(3) Å$^3$, $Z$ = 16, $d_{\mathrm{calc}}$ = 1.501 g cm$^{-3}$, space group *Fdd*2. The intensities of 3150 independent reflections (2012 reflections were with $I \geq 2\sigma$) were measured on an Enraf-Nonius CAD-4 diffractometer (ω/2θ-scanning technique, θ ≤ 26.29°, λ(Mo-Kα), graphite monochromator, $R_{\mathrm{int}}$ = 0.0515) at 20 °C. The intensities of three check reflections showed no decrease in the course of X-ray data collection. The absorption correction was not applied because the absorption coefficient was small (μ(Mo) = 2.47 cm$^{-1}$). The stability of the crystals was monitored at 2 h intervals by measuring three check reflections. The orientation was monitored at 200 reflection intervals by centering two check reflections. The structure was solved by direct methods using the SIR program[14] and refined first isotropically and then anisotropically with the use of the SHELX-97 program package.[15] The hydrogen atoms at the O(10) and O(12) atoms were located in difference electron density maps and refined isotropically. The coordinates of the other hydrogen atoms were calculated based on the stereochemical criteria and refined using a riding model. All calculations were carried out with the use of the MolEN[16] and WinGX[17] programs. The final $R$ factors were $R_{ob}$ = 0.0508 and $R_{wob}$ = 0.1124 (GOOF = 0.978) based on 2012 independent reflections with $F^2 \geq 2\sigma^2$. The intermolecular interactions were analyzed and the figures were drawn with the use of the PLATON program.[18]

Complete tables of atomic coordinates, thermal parameters, bond lengths, and bond angles were deposited with the Cambridge Structural Database.

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