Unusual result of the reaction of 4-(1-methyl-1*H*-imidazol-2-yl)methylene-substituted 2-alkylthioimidazol-5(4*H*)-one with copper(II) chloride

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A reaction of potassium ({(4*Z*)-4-[(1-methyl-1*H*-imidazol-2-yl)methylene]-5-oxo-1-phenyl-4,5-dihydro-1*H*-imidazol-2-yl}thio)acetate with copper(II) chloride in methanol leads to bis(5-anilino-7-methoxycarbonyl-1-methyl-1*H*-imidazo[1,2-*c*]pyrimidin-4-ium) tetrachlorocuprate(II), whose structure was confirmed by the X-ray diffraction studies.

Key words: 2-alkylthioimidazol-5(4*H*)-one, 1-methyl-1*H*-imidazole, imidazopyrimidines.

In continuation of our studies of 5-hetarylmethylene-substituted 2-thioxoimidazol-4-ones, their S-alkylated derivatives, and the Cu^{II} complexes with these organic compounds,[1—4] we used a two-step sequence of reactions of 3-phenyl-2-thiohydantoin **1** and 1-methyl-2-imidazolecarbaldehyde with the intermediate formation of a potassium salt of (4*Z*)-2-mercapto-4-[(1-methyl-1*H*-imidazol-2-yl)methylene]-1-phenylimidazol-5(4*H*)-one (**2**) to synthesize a new ligand from the series of 5-substituted 2-alkylthio-3,5-dihydro-4*H*-imidazolones, *viz.*, potassium ({(4*Z*)-4-[(1-methyl-1*H*-imidazol-2-yl)methylene]-5-oxo-1-phenyl-4,5-dihydro-1*H*-imidazol-2-yl}thio)-acetate (**3**), (Scheme 1).

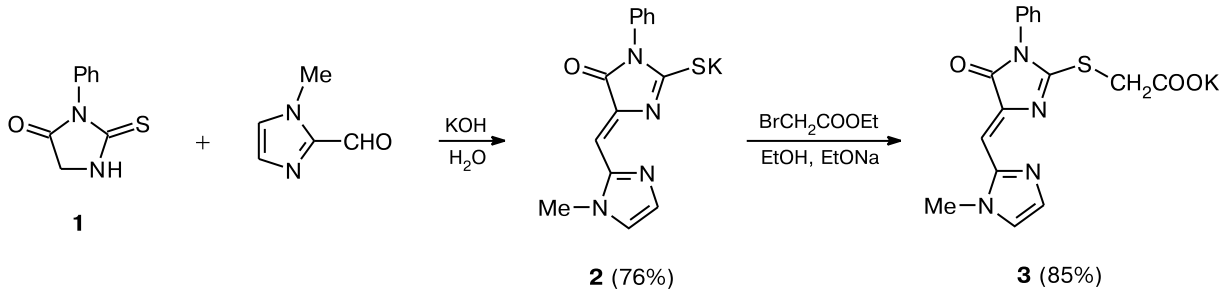
Note that the attempt to synthesize 2-acetoxythio-substituted 1-phenylimidazol-5(4*H*)-one **3** by the reaction of sodium bromoacetate with the potassium salt **2** did not lead to the target product: the starting reactants were isolated from the reaction mixture. Apparently, the lower electrophilicity of the anion of bromoacetic acid as compared to the corresponding ester interferes with the proceeding the nucleophilic substitution reaction for the bromine atom. If ethyl bromoacetate was used in the reaction, ethyl ({4-[(1-methyl-1*H*-imidazol-2-yl)methylene]-5-oxo-1-phenyl-4,5-dihydro-1*H*-imidazol-2-yl}thio)-acetate **A** is apparently formed initially, which undergoes E2-elimination in the presence of sodium ethoxide, yielding ethylene and the target salt **3** (Scheme 2).

When we studied a reaction of compound **3** with copper(II) chloride, an unusual result was obtained (Scheme 2): the imidazopyrimidinium salt **4** was isolated from the reaction mixture in 22% yield instead of the expected coordination compound **4´**.

The structure of compound **4** was confirmed by the data of X-ray diffraction analysis (Fig. 1). The crystallographic data, details of the experiment, and parameters of refinement for the structure **4** are given in Table 1. All the atoms of the heterobicyclic fragment are placed in one plane; the exocyclic nitrogen atom and atoms of the benzene ring are in this plane, as well. In the crystal, the molecules are arranged in stacks with the parallel orientation of the aromatic fragments.

Scheme 3 shows a possible mechanism for the formation of imidazopyrimidinium cation. In the first step of the reaction, a Lewis acid ($CuCl_2$) catalyzed imidazolone

Scheme 1



1 **2** (76%) **3** (85%)

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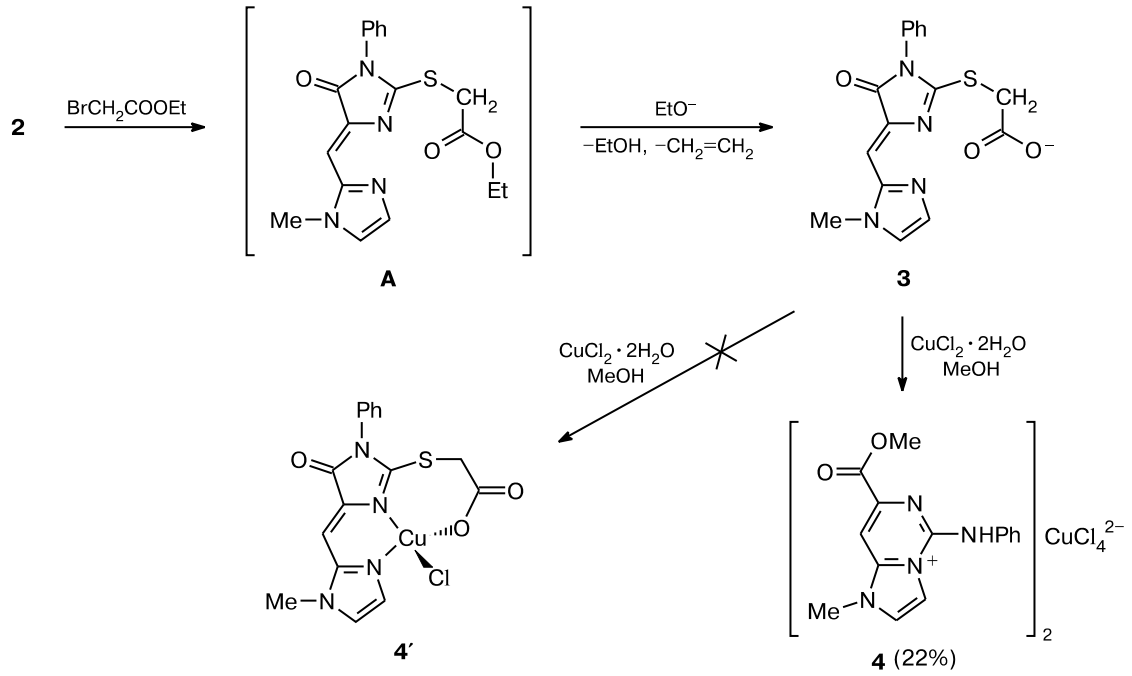
Scheme 2



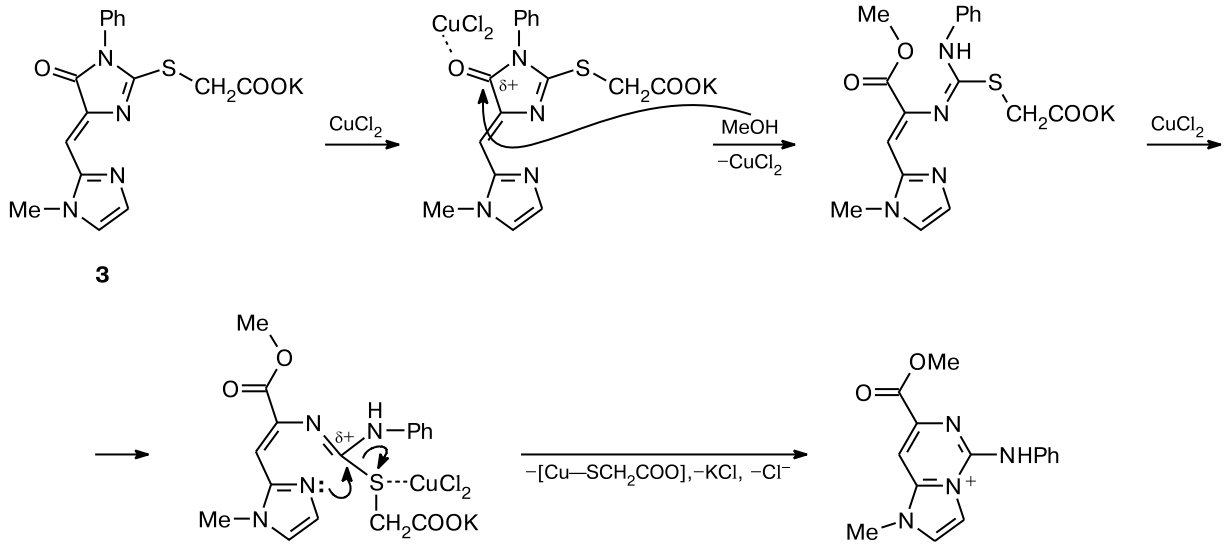
ring opening in compound **3** occurs with a solvent (methanol) molecule. Further, recyclization takes place, also catalyzed with $CuCl_2$, with the formation of the cation of compound **4** and elimination of the sulfur-containing fragment.

The reaction discovered is the first example of the formation of imidazopyrimidine ring in the reactions of imidazolylmethylene-substituted dihydroimidazolones.

Experimental

The reaction progress was monitored by thin-layer chromatography (TLC) on silica gel precoated plates (Silufol plates). ^{1}H NMR spectra were recorded on a Bruker Avance 400 spectrometer in $CDCl_3$ and DMSO-d_6 at 25 °C. IR spectra were recorded on a UR-20 spectrometer in Nujol. Mass spectra were recorded on a Shimadzu LCMS 2010A instrument in the chemical ionization version at the atmospheric pressure in the positive

Scheme 3



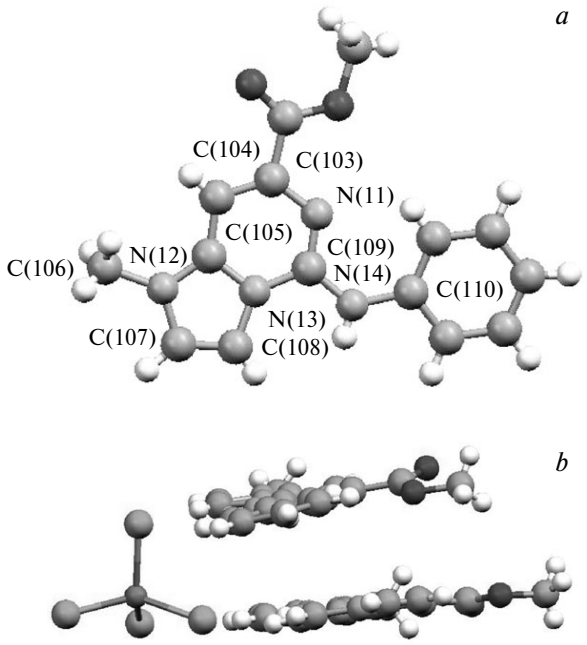


Fig. 1. The structure of the cation $C_{15}H_{15}N_4O_2^+$ (*a*) and the molecule (*b*) in compound **4**. Selected bond distances/Å: N(11)—C(109) 1.299(2), C(105)—N(12) 1.339(2), C(105)—N(13) 1.369(3), N(12)—C(106) 1.460(3), N(12)—C(107) 1.373(3), N(13)—C(109) 1.394(2), C(109)—N(14) 1.348(3), N(14)—C(110) 1.420(2); selected bond angles/deg: N(11)—C(103)—C(104) 124.48(18), C(103)—N(11)—C(109) 119.51(15), N(12)—C(105)—N(13) 107.08(17), N(12)—C(107)—C(108) 108.95(19), N(11)—C(109)—N(13) 120.44(17).

ions mode. X-ray diffraction studies were performed on a CAD-4 monocrystal automatic diffractometer (graphite monochromator, λ(Mo-Kα) = 0.71069 Å, ω-scanning) at 293 K.

3-Phenyl-2-thiohydantoin (**1**) was obtained according to the published procedure.[5]

(4*Z*)-2-Mercapto-4-[(1-methyl-1*H*-imidazol-2-yl)methylene]-1-phenylimidazol-5(4*H*)-one potassium salt (2). 1-Methyl-2-imidazolecarbaldehyde (0.29 g, 2.6 mmol) was added to a solution of thiohydantoin **1** (0.5 g, 2.6 mmol) in the minimum amount of 2% aqueous KOH and this was stirred at room temperature for 3 h. A precipitate that formed was filtered off and dried in air to obtain compound **2** (0.64 g, 76%) as an orange powder. M.p. 310 °C. ^{1}H NMR (DMSO-d_6), δ: 3.75 (s, 3 H, CH_3); 6.00 (s, 1 H, =CH); 7.26 (dd, 2 H, Ph, J_1 = 8.2 Hz, J_2 = 1.1 Hz); 7.31 (m, 3 H, Ph and CH_{imid}); 7.41 (m, 2 H, Ph and CH_{imid}). IR, ν/cm^{-1}: 2950, 1680. MS, *m/z*: 285 [M — K + 2 H]$^+$ (100). Found (%): C, 52.36; H, 3.87; N, 16.94. $C_{14}H_{11}KN_4OS$. Calculated (%): C, 52.15; H, 3.44; N, 17.38.

({(4Z)-4-[(1-Methyl-1*H*-imidazol-2-yl)methylene]-5-oxo-1-phenyl-4,5-dihydro-1*H*-imidazol-2-yl}thio)potassium acetate (3). Metallic sodium (0.02 g) and compound **2** (0.2 g, 0.62 mmol) were sequentially dissolved in EtOH (5 mL), followed by addition of ethyl bromoacetate (0.12 g, 0.7 mmol) to the reaction mixture, which was stirred for 4 h. A precipitate that formed was filtered off, washed with water, and dried in air to obtain compound **3** (0.115 g, 85%) as a yellow powder. M.p. 340 °C. ^{1}H NMR ($CDCl_3$), δ: 3.50 (s, 2 H, CH_2); 3.82 (s, 3 H, CH_3); 6.68 (s, 1 H, =CH); 7.37—7.43 (m, 3 H, Ph and CH_{imid}); 7.48—7.61 (m, 4 H, Ph and CH_{imid}). ^{13}C NMR ($CDCl_3$), δ: 34.6, 38.0, 108.8, 125.5, 128.2 (2 C); 129.6, 129.9 (2 C); 131.3, 133.1, 137.6, 144.7, 164.0, 166.2, 167.4. IR, ν/cm^{-1}: 3380 (br), 3120, 3135, 1750, 1600. Found (%): C, 46.09; H, 4.07; N, 12.79; S, 7.60. $C_{16}H_{13}KN_4O_3S \cdot 2H_2O$. Calculated (%): C, 46.14; H, 4.11; K, 9.39; N, 13.45; O, 19.21; S, 7.70.

Table 1. Crystallographic data, details of experiment, and refinement parameters for the structure of compound **4**

Parameter	Value
Molecular formula	$C_{30}H_{30}Cl_4CuN_8O_4$
Molecular weight	772
Crystal form	Black prisms
Crystal size/mm	0.36×0.34×0.085
Crystal system	Triclinic
Space group	$\bar{P}1$
a/Å	10.6220(12)
b/Å	12.105(3)
c/Å	13.8875(17)
α/deg	96.482(14)
β/deg	111.191(10)
γ/deg	91.612(13)
V/Å^3	1649.7(5)
Z	2
d_{calc}/g cm^{-3}	1.5536
μ/mm^{-1}	1.036
F(000)	790
Region of scanning, θ/deg	2.00—29.99
Region of *h*, *k*, *l*	$0 \le h \le 14$
	$-17 \le k \le 17$
	$-19 \le l \le 19$
Number of measured reflections	9592
Number of independent reflections	6665
Number of refined parameters	544
Q-factor on F^2	1.18
R-factors on reflections with $I > 2\sigma(I)$	
R_1	0.0348
wR_2	0.0490
R-factors (on all the data)	
R_1	0.0348
wR_2	0.0490

Bis(5-anilino-7-methoxycarbonyl-1-methyl-1*H*-imidazo-[1,2-*c*]pyrimidin-4-ium) tetrachlorocuprate(II) (4). A solution of $CuCl_2 \cdot 2H_2O$ (0.03 g, 1.4 mmol) in MeOH (2 mL) was added to a solution of compound **3** (0.05 g, 1.4 mmol) in MeOH (2 mL), the reaction mixture was tightly capped and kept for two days at room temperature. The crystals that formed were filtered off, washed with diethyl ether and dried in air to obtain compound **4** (0.22 g, 22%) as black crystals. M.p. 245—247 °C. Found (%): C, 45.99; H, 3.77; N, 14.58. $C_{30}H_{30}Cl_4CuN_8O_4$. Calculated (%): C, 46.68; H, 3.92; N, 14.52.

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