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Synthesis and Some Properties of Heterocyclic Amidine Derivatives of 3-Imidazoline Nitroxides.

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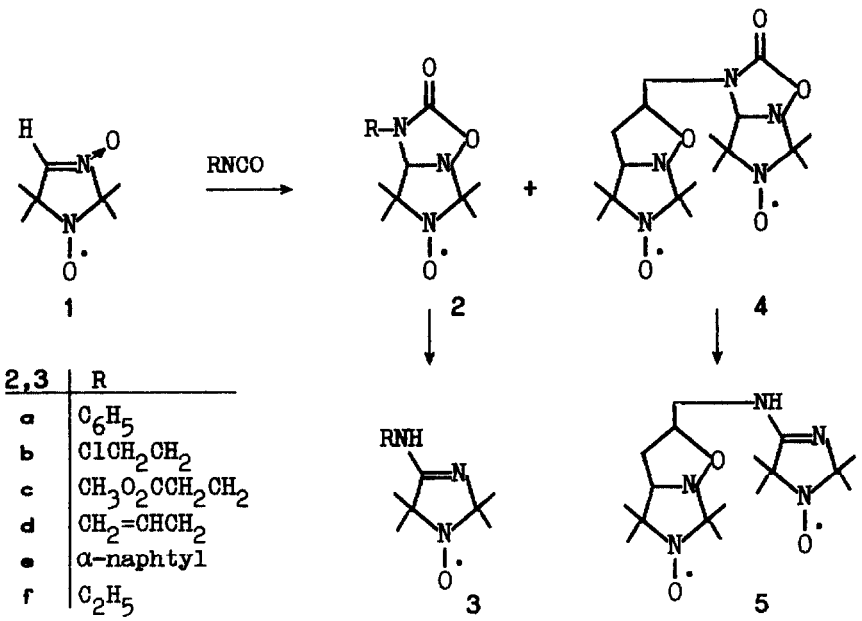
Abstract: The interaction of 2,2,5,5-tetramethyl-3-imidazoline-3-oxide-1-oxyl with isocyanates leads to oxadiazolidine cycloadducts which are smoothly transformed into amidines - 4-R-amino-2,2,5,5-tetramethyl-3-imidazoline-1-oxyles when treated with nucleophilic reagents. This reaction was applied to the synthesis of some paramagnetic amidines containing various functional groups which may be used as spin labels having a pH-sensitive ESR spectrum. The mechanism of transformation of oxadiazolidines into amidines and the tautomeric equilibrium of the amidines synthesized are discussed.

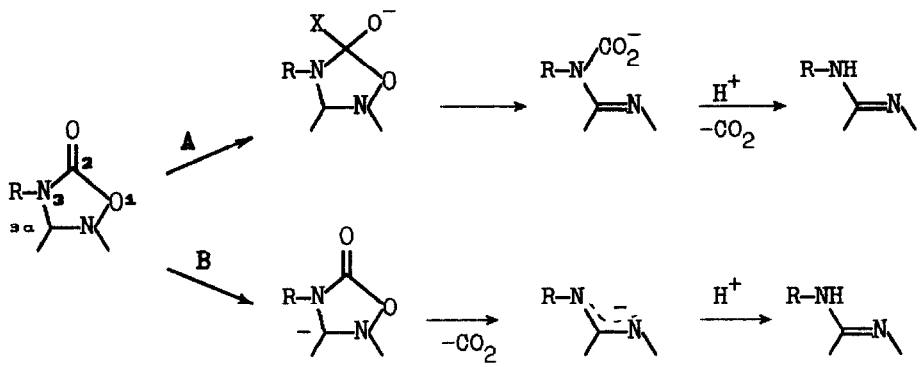
Earlier we have shown (ref.[1]) that the reaction of 1,3-dipolar cycloaddition of paramagnetic heterocyclic aldonitrone, 2,2,5,5-tetramethyl-3-imidazoline-3-oxide-1-oxyl **1**, with isocyanates and subsequent cleavage of oxodiazolidines **2** leads to N-substituted heterocyclic amidines **3**. The reaction may be performed both with aromatic and aliphatic isocyanates. This affords amidines of varying pK values and lipophilicities which may be used as pH-sensitive spin probes. This paper demonstrates the possibilities of this synthetic approach for the synthesis of paramagnetic amidines as new spin labels and probes with a pH-sensitive ESR spectrum and discusses the mechanism of oxadiazolidine ring cleavage by nucleophilic reagents and the structure of the amidines.

The reaction of nitrone **1** with isocyanates led to formation of cycloadducts **2a-f** which were transformed into amidines **3** (cf.[1]). The reaction with allyl isocyanate gave not only the cycloadduct **2d** but also the biradical **4** which is a product of cycloaddition both at the isocyanate group and the C=C bond (cf.[2]). Biradical **4** was also converted to corresponding amidine **5**.



2,3	R
a	C_6H_5
b	$ClCH_2CH_2$
c	$CH_3O_2CCH_2CH_2$
d	$CH_2=CHCH_2$
e	α-naphtyl
f	C_2H_5

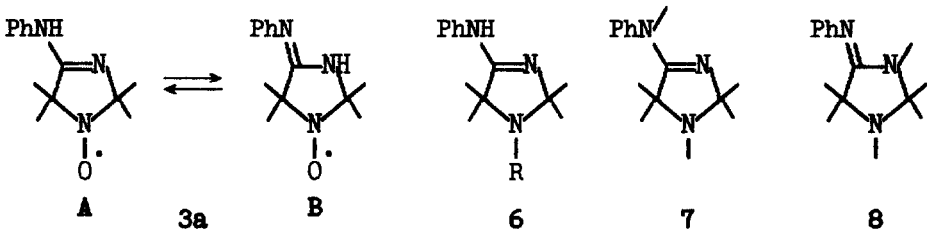
Amidines may be formed from the corresponding oxadiazolines under thermolysis conditions.[3] For the compounds 2, no such reaction has been observed. Cleavage of the oxodiazolidine cycle in a molecule of cycloadducts 2 can occur either as a result of the nucleophilic attack at the carbonyl carbon atom (route **A**) or by the initial elimination of acid proton from the carbon atom in the 3α-position (route **B**). This suggests that strong nucleophiles will accelerate the cleavage reaction of the oxodiazolidine ring when it occurs by route **A**, and, vice versa, strong bases will promote the reaction if it proceeds by route **B**.



It has been shown in studies on the reactions of cycloadducts 2 with different nucleophiles and bases that their activity in this reaction qualitatively varies in the series CH_3O^- > OH^-, RNH_2 > SH^- > CN^- >> NaH.

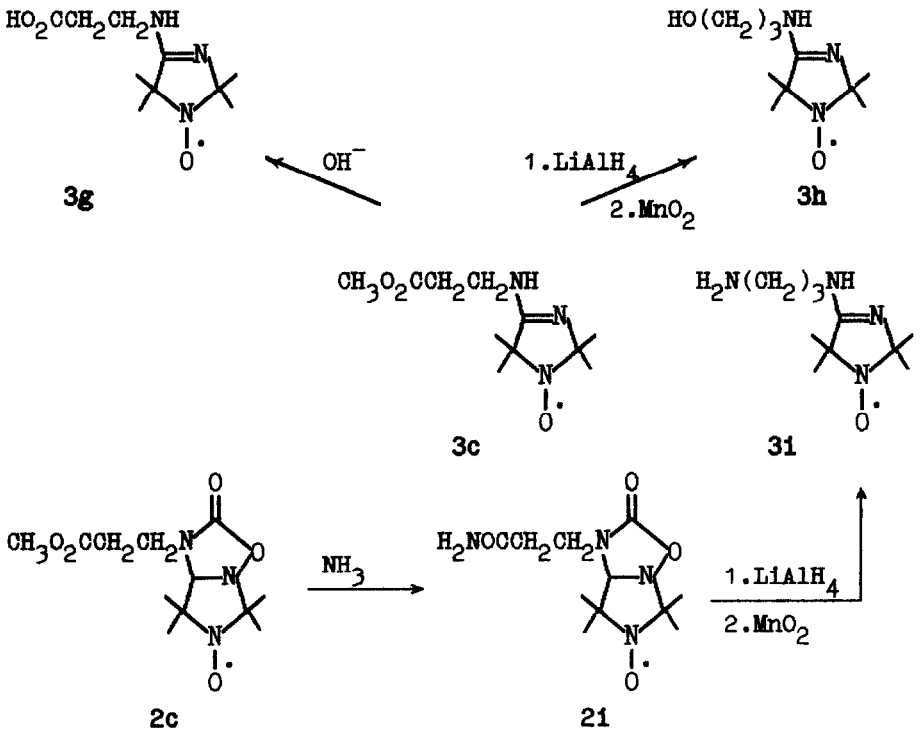
There was no reaction with triethylamine and pyridine, while the reaction with $NaBH_4$ only led to slow reduction of the nitroxyl group to the hydroxylamino group. These data have led us to suggest route **A** to be the most probable route of cleavage of the oxadiazolidine cycle. It should be noted that using sodium methoxide in the methanol solution not only leads to the high-rate cleavage of cycloadducts **2** but also affords various amidines **3** with yields as high as 90%.

The nonsymmetrically substituted amidines usually exist in solution as a mixture of two tautomeric forms.[4] The ^{13}C NMR spectrum (CD_2Cl_2) of diamagnetic amidine **6a** synthesized by the reduction of paramagnetic amidine **3a** with hydrazine shows a signal of the C=N carbon atom at 160.88 ppm whose position is close to that of the signal of C-4 of the 3-imidazoline heterocycle.[5] It seems that for the tautomeric form of N-phenyl-substituted amidines, where the C=N bond is conjugated with the phenyl group, the signal of the *ipso*-carbon of the phenyl group lies at 151-152 ppm. When there is no conjugation, the signal should lie at 144 ppm (cf. [6]). In the spectrum of compound **6a**, the signal of this carbon atom is at 141.97 ppm, indicating the existence of this compound in the tautomeric form **A** with an endocyclic multiple bond. In the ^{13}C NMR spectra ($CDCl_3$) of model amidines **7** and **8** with fixed position of the C=N bond, the *ipso*-carbon signals lie at 145.72 and 150.31 ppm respectively, which confirms the existence of compound **6a** predominantly in the tautomeric form with an endocyclic C=N bond. Broadening of the C-4 and C-2 signals may indicate the existence in solution of an equilibrium mixture of two tautomeric forms. The lowered temperature of recording of the ^{13}C NMR spectrum to 193 K did not bring about any signals of another tautomeric form. This may be attributed to the fact that the tautomeric equlibrium, if any, is fast in the NMR time scale, even at that temperature. It should be noted that in the ^{13}C NMR spectra (DMSO-d_6) of diamagnetic amidines **6b,c**, the signals of phenyl *ipso*-carbons are respectively at 141.58 and 140.36 ppm, indicating their preference for the same tautomeric form. Taking into account this fact, as well as the similarity of the IR and UV spectra of compounds **3a** and **6a**, one can suggest that the paramagnetic amidine **3a** also exists in the tautomeric form **A**. Thus, using the chemical shift value of the *ipso*-carbon atom for N-phenyl-substituted amidines proved to be a useful criterion for evaluating the position of the tautomeric equilibrium for the nonsymmetrically substituted amidines.

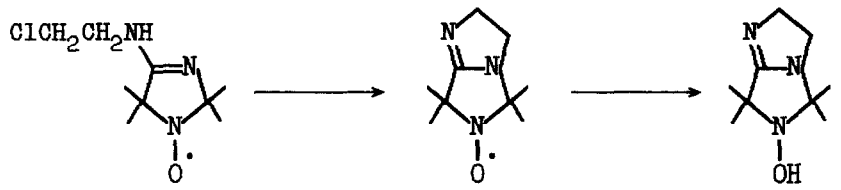


6	a	b	c
R	OH	CH_3	NO_2

Some amidines, useful as spin labels with a pH-sensitive ESR spectrum, have been obtained by modification of an ester group in the molecule of **2c**, **3c**. Thus, hydrolysis of **3c** leads to the acid **3g**, and the reduction of **3b** with lithium aluminum hydride and subsequent oxidation with MnO_2 gives alcohol **3h**. The interaction of cycloadduct **2c** with ammonia leads to amide **2i** whose reduction with lithium aluminum hydride and subsequent oxidation with MnO_2 leads to aminoamidine **3i**. It should be noted that this reaction proceeds not only with reduction of the amide and nitroxyl groups but also with cleavage of the isoxazolidine ring.

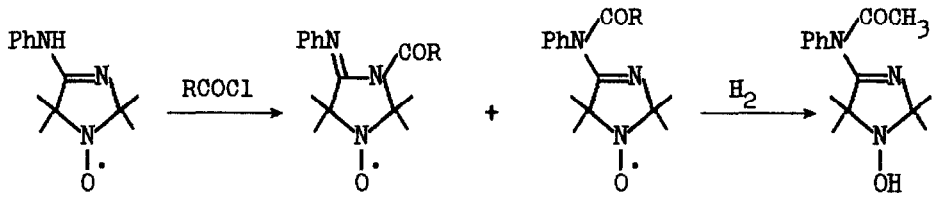


The amidine **3b** containing the chloroethyl group in a molecule may be regarded as an alkylating spin label with a pH-sensitive ESR spectrum (cf.[1,7]) or its precursor with the chlorine atom substituted by another, easier leaving group. However, when compound **3b** reacts with various nucleophilic reagents: NaI, NaN_3, NH_4, sodium acetate or hydride, or potassium phthalimide, no nucleophilic substitution of the chlorine atom occurs, but, rather, the intramolecular alkylation takes place to form the bicyclic amidine **9**. The structure of compound **9** has been confirmed by the PMR spectrum of its diamagnetic analogue **10** obtained by the reduction of compound **9** with hydrazine.



3b **9** **10**

It is interesting to note that, by contrast with this reaction, the alkylations of amidines **3** by dimethylsulphate and CH_3I have failed. But the acylations proceeded rather easily. In the reaction of amidine **3a** with acetyl chloride, two isomeric acyl derivatives **11a** and **12a** were formed. For the acylated amidines, the acylotropy effect has been observed (cf.[8]). However, when compounds **11a** and **12a** were allowed to stay in solution or were heated, they were not transformed into each other. This may be explained by the reduced nucleophilicity of amidine nitrogens caused by the electron accepting effect of the nitroxyl group (cf.[9]).



3a **11a,b** **12a-c** **13**

	a	b	c
R	CH_3	C_6H_5	C_2H_5O

An attempt to reduce compounds **11a** and **12a** with zinc or hydroxylamine to prepare the corresponding diamagnetic analogues has resulted in the deacylation to form the diamagnetic amidine **6a**. But under conditions of catalytic hydrogenation, one of the products (**11a**) also formed the amidine **6a**, while another product (**12a**) gave the diamagnetic derivative **13**. The latter was assigned the structure of the product of acylation at the exocyclic nitrogen atom on the basis of comparison of its ^{13}C NMR spectrum with that of amidines **6-8**. In particular, the ^{13}C NMR spectrum ($CDCl_3$) contains the signal of the C-4 atom at 158.56 ppm and of the phenyl ipso-carbon atom at 135.62 ppm.

The reactions of amidine **3a** with benzoyl chloride and ethylchloroformiate gave compounds **11b**, **12b** and **12c** respectively, whose structure has been identified from comparison of their IR spectra with those of compounds **11a** and **12a**.

For some amidines the pK value have been measured which has been shown to be within the physiological range (5.0-7.2), which makes it possible to use these compounds as spin labels and probes for pH measurements in biological microobjects (cf.[10]).

Experimental section

The IR spectra were recorded on a Specord M-80 instrument in KBr pellets (C = 0.25%) and in CCl_4 solutions (C = 5%). The UV spectra were measured on a Specord UV-VIS instrument in ethanol. The ^1H and ^{13}C NMR spectra were recorded on a "Bruker AC-200" (200 MHz) and "Bruker WP-200-SY" (200 MHz) instruments for 10% solutions, the chemical shift values were determined relative to the signal of the solvent. The pK values of amidines were measured by titration in a flat tube of the ESR spectrometer Bruker ER-200 SRC as in ref.[9], the error of constant determination ± 0.05 units. The elemental analysis of the products was carried out in the Microanalysis Laboratory of the Novosibirsk Institute of Organic Chemistry. The course of reactions was controlled using thin-layer chromatography (TLC) on Silufol UV-254 plates, chloroform-methanol=9:1 as eluent. For the reaction with isocyanates, $CHCl_3$ was dried over anhydrous $CaCl_2$. Aldonitrone **1** was prepared according to ref.[2], the cycloadducts **2a,b**, and amidine **3b** according to ref.[1,11], and amidines **6b,7,8** according to ref.[12]

3-Substituted-4,4,6,6-tetramethyl-5-oxyl-2-oxoperhydroimidazo[1,5-b]-oxadiazoles-1,2,4 (2c-f, 4). A solution of 0.01 mol of nitrone **1** and

0.015 mol of isocyanate in 10 ml of $CHCl_3$ was kept for 10-30 h at 20°C (TLC control). The chloroform was evaporated, the residue was washed with hexane, and the compounds **2c-f** and **4** were isolated chromatographically on a silica gel column, eluent $CHCl_3$. **2c**, yield 80%, oil, IR, ν, cm^{-1}: 1730, 1765 (C=O). Found,%: C, 50.5; H, 7.0; N, 14.8. $C_{12}H_{20}N_3O_5$. Calculated, %: C, 50.4; H, 7.0; N, 14.7. **2d**, yield 60%, m.p. 68-70° (from hexane), IR, ν, cm^{-1}: 1780 (C=O). Found,%: C, 55.1; H, 7.5; N, 17.3. $C_{11}H_{18}N_3O_3$. Calculated, %: C, 55.0; H, 7.5; N, 17.5. **2e**, yield 85%, m.p. 72-75° (from hexane), IR, ν, cm^{-1}: 1775 (C=O). UV, λ_{max} nm (lg ε): 286 (3.91). Found,%: C, 66.2; H, 6.1; N, 12.8. $C_{18}H_{20}N_3O_3$. Calculated,%: C, 66.3; H, 6.1; N, 12.9. **2f**, yield 60%, m.p. 39-40° (from hexane), IR, ν, cm^{-1}: 1770 (C=O). Found,%: C, 52.6; H, 8.2; N, 18.4. $C_{10}H_{18}N_3O_3$. Calculated,%: C, 52.6; H, 7.9; N, 18.4. **4**, yield 1%, m.p. 58-59° (from hexane), IR, ν, cm^{-1}: 1770 (C=O). Found,%: C, 54.3; H, 7.7; N, 17.5. $C_{18}H_{31}N_5O_5$. Calculated,%: C, 54.4; H, 7.8; N, 17.6.

3-(2-Carbamoylethyl)-4,4,6,6-tetramethyl-5-oxyl-2-oxo-perhydroimidazo[1,5-b]oxadiazole-1,2,4 (2i). A solution of 2.9 g (0.01 mol) of ether **2c** in 10 ml of methanol and 3 ml of aqueous 20% ammonia were kept for 15 h at 20°C, then evaporated, and compound **2i** was isolated chromatographically on a silica gel column, eluent chloroform, yield 70%, oil, IR, ν, cm^{-1} :1730, 1750 (C=O). Found, %: C, 48.0; H, 7.0; N, 20.5. $C_{11}H_{19}N_4O_4$. Calculated, %: C, 48.7; H, 7.0; N, 20.7.

4-R-Amino-2,2,5,5-tetramethyl-3-imidazoline-1-oxyls (3a,c-f,5). A solution of 0.01 mol of compound **2a,c-f,4** and CH_3ONa prepared from 0.02 mol of Na in 10 ml of abs. CH_3OH was kept for 1 h at 20°C, then evaporated, 15 ml of water was added and the solution was extracted with chloroform. Then organic solution was extracted with 1% solution of H_2SO_4. The aqueous solution was neutralized with Na_2CO_3 and extracted with $CHCl_3$, the extract was dried over $MgSO_4$, the solution was evaporated, and the amidines **3a,c-f,5** were isolated chromatographically on a silica gel column, eluent $CHCl_3$. **3a**, yield 90%, m.p. 213-214°C (from hexane-ethyl acetate mixture), IR, ν, cm^{-1}: 1610, 1640 (C=C, C=N), 3350 (NH). UV, λ_{max} nm (lg ε): 256 (4.17), pK = 5.0. Found, %: C, 67.5; H, 8.1, N, 18.0. $C_{13}H_{18}N_3O$. Calculated, %: C, 67.2; H, 7.8; N, 18.1. **3c**, yield 95%, oil, IR, ν, cm^{-1}: 1730 (C=O), 3460 (NH). Found, %: C, 54.5; H, 8.2; N, 17.4. $C_{11}H_{20}N_3O_3$. Calculated, %: C, 54.6; H, 8.3; N, 17.4. **3d**, yield 90%, m.p. 141-142° (from hexane - ethyl acetate mixture). IR, ν, cm^{-1}: 1620 (C=N), 3310 (NH). pK = 5.7. Found, %: C, 61.2; H, 9.3; N, 21.5. $C_{10}H_{18}N_3O$. Calculated, %: C, 61.2; H, 9.2; N, 21.4. **3e**, yield 40%, m.p. 130-131° (from

hexane - ethyl acetate mixture). IR, ν, cm^{-1}: 1640, 1680 (C=N), 3400 (NH). UV, λ_{max} nm (lg ε): 223 (4.63), 294 (3.83). pK = 5.0. Found, %: C, 72.4; H, 7.3; N, 15.0. $C_{17}H_{20}N_3O$. Calculated, %: C, 72.3; H, 7.1; N, 14.9. **3f**, yield 45%, m.p. 154-155° (from ether). IR, ν, cm^{-1}: 1580, 1640 (C=N), 3400 (NH). UV, λ_{max} nm (lg ε): 241 (3.22). pK = 6.4. Found, %: C, 58.3; H, 9.8; N, 22.5. $C_9H_{18}N_3O$. Calculated, %: C, 58.7; H, 9.8; N, 22.8. **5**, yield 80%, m.p. 91-93° (from hexane). IR, ν, cm^{-1}: 1620 (C=N), 3370 (NH). Found, %: C, 57.6; H, 8.7; N, 19.8. $C_{17}H_{31}N_5O_3$. Calculated, %: C, 57.8; H, 8.8; N, 19.8.

To estimate reactivities of cycloadducts **2** with different bases and nucleophiles the reactions with the same cycloadduct **2** and sodium hydroxide, butylamine, propylamine, pyridine, triethylamine, sodium hydrosulfide, sodium cyanide and sodium borohydride were carried out in methanol in the reagent-substrate ratio 5:1. Reaction with sodium hydride was carried out in tetrahydrofurane or dimethylformamide with the same reagent-substrate ratio. The completing of reaction was controled by TLC. During interaction of cycloadduct **2a** with NaSH together with oxadiazolidine heterocycle cleavage, partial reduction of nitroxyl group to hydroxylamino group occurs.

The amidine **6c** was prepared by the reaction of 2,2,5,5-tetramethyl-1-nitro-3-imidazoline-3-oxide (ref.[13]) with phenylisocyanate and subsequent treatment with sodium methoxide in methanol under the above-described conditions, yield 67%, m.p. 192-193° (from hexane), IR, ν, cm^{-1}: 1325, 1540 (NO_2), 1600, 1655 (C=N, C=C), 3405 (NH). UV, λ_{max} nm (lg ε): 255 (4.38). NMR ^{13}C (DMSO-d_6, δ ppm): 21.78, 26.21 (2,5-$(CH_3)_2$), 67.83 (C-5), 89.87 (C-2), 118.68, 121.84, 128.36 (*o,m,p*-C_6H_5), 140.36 (C_t), 157.99 (C-4). Found, %: C, 59.6; H, 6.8; N, 21,3. $C_{13}H_{18}N_4O_2$. Calculated, %: C, 59.5; H, 6.9; N, 21.4. **6b**, NMR ^{13}C (DMSO-d_6, δ ppm): 23.44, 27.37 (2,5-$(CH_3)_2$), 27.02 (N-CH_3), 65.83 (C-5), 85.01 (C-2), 117.94, 120.39, 128.05 (*o,m,p*-C_6H_5), 141.88 (C_t), 162.64 (C-4). **7**, NMR ^1H ($CDCl_3$, δ ppm): 0.84s (6H), 1.29s (6H, 2,5-$(CH_3)_2$), 2.20s (3H, N-CH_3), 3.21s (3H, N-CH_3), 7.3m (5H, C_6H_5). NMR ^{13}C ($CDCl_3$, δ ppm): 24.79, 27.28 (2,5-$(CH_3)_2$), 27.07, 42.72 (N-CH_3), 66.39 (C-5), 82.98 (C-2), 127.07, 128.88, 129.31 (*o,m,p*-C_6H_5), 145.72 (C_t), 167.48 (C-4). **8**, NMR ^1H ($CDCl_3$, δ ppm): 1.13s (6H), 1.24s (6H, 2,5-$(CH_3)_2$), 2.25s (3H), 2.73s (3H, N-CH_3), 6.8m (3H), 7.1m (2H, C_6H_5). NMR ^{13}C ($CDCl_3$, δ ppm): 23.87, 24.42 (2,5-$(CH_3)_2$), 26.15, 27.35 (N-CH_3), 62.44 (C-5), 77.85 (C-2), 120.62, 122.70, 127.87 (*o,m,p*-C_6H_5), 150.31 (C_t), 159.40 (C-4).

4-(2-Carboxyethyl)amino-2,2,5,5-tetramethyl-3-imidazoline-1-oxyl (3g). A solution of 0.24 g (0.001 mol) of ether **3c** in 5 ml of CH_3OH and 1 ml of

10% NaOH was kept for 0.5 h, then neutralized with 1% H_2SO_4 and evaporated. The residue was washed with ether, the inorganic precipitate was filtered off, and the solution was evaporated. Compound **3g** was purified by recrystallization from ethyl acetate - methanol (8:3) mixture, yield 70%, m.p. 212-214°. IR, ν, cm^{-1}: 1695 (C=O), 3400 (NH). pK = 6.6. Found, %: C, 52.4; H, 7.8; N, 18.6. $C_{10}H_{18}N_3O_3$. Calculated, %: C, 52.6; H, 7.9; N, 18.4.

4-(3-Hydroxypropyl)amino-2,2,5,5-tetramethyl-3-imidazoline-1-oxyl (3h). A solution of 0.06 g (0.0015 mol) of $LiAlH_4$ in 5 ml of THF was added dropwise with stirring to a solution of 0.24 g (0.001 mol) of ether **3c** in 5 ml of THF. Stirring was continued for 15 min., then 5 ml of ethyl acetate and 0.5 ml of H_2O were added. The reaction mixture was evaporated to dryness, the residue was washed with $CHCl_3$, and the inorganic precipitate was filtered off. The filtrate was dried over $MgSO_4$, the drying agent was filtered off, 1 g of MnO_2 was added to the solution and the solution was stirred for 30 min. An excess of the oxidant was filtered off, the solution was evaporated, and compound **3h** was isolated by thin-layer chromatography (SiO_2, $CHCl_3$-methanol=10:1 mixture as eluent). Yield 60%, m.p. 128-129° (from hexane-ethyl acetate mixture). IR, ν, cm^{-1}: 1620 (C=N), 3310 (NH). pK = 6.0. Found, %: C, 56.0; H, 9.2; N, 19.6. $C_{10}H_{20}N_3O_2$. Calculated, %: 56.1; H, 9.4; N, 19.6.

4-(3-Aminopropyl)amino-2,2,5,5-tetramethyl-3-imidazoline-1-oxyl (3i) was prepared under the same conditions as described for the alcohol **3h** by the reduction of 0.271 g (0.001 mol) of amide **2i** in 15 ml of THF with 0.057 g (0.0015 mol) of $LiAlH_4$ and subsequent oxidation. The amine **3i** was purified chromatographically on a silica gel column, eluent $CHCl_3$, yield 30%, m.p. 90-91° (from hexane-ethyl acetate mixture). IR, ν, cm^{-1}: 1595 (C=N), 3340 (NH). Found, %: C, 56.0; H, 9.7; N, 26.1. $C_{10}H_{21}N_4O$. Calculated, %: C, 56.3; H, 9.9; N, 26.3.

1-Hydroxy-4-phenylamino-2,2,5,5-tetramethyl-3-imidazoline (6). A solution of 2.32 g (0.01 mol) of amidine **3a** and 2 ml of hydrazine hydrate in 50 ml of CH_3OH were kept for 15 h at 20°, then evaporated, the residue was washed with water, the precipitate of compound **6** was filtered off and dried. Compound **9** was reduced under similar conditions to give the hydroxy derivative **10**. The yield of amidine **6** 95%, m.p. 149-150° (from hexane-ethyl acetate mixture). IR, ν, cm^{-1}: 1630 (C=N), 3350 (NH). UV (heptane), λ_{max} nm (lg ε): 253 (4.3). NMR ^{13}C (CD_2Cl_2 δ ppm): 23.65 (5-$(CH_3)_2$); 26.65 (2-$(CH_3)_2$; 67.25 (C-5), 85.23 (C-2), 119.14, 121.64,

128.42, 141.97 (C_6H_5); 160.88 (C-4). Found, %: C, 67.0; H, 8.2; 18.0. $C_{13}H_{19}N_3O$. Calculated, %: C, 66.9; H, 8.1; N, 18.0. **10**, yield 90%, m.p. 139-140° (from hexane-ethyl acetate mixture). IR, ν, cm^{-1}: 1665 (C=N). NMR ^1H ($CDCl_3$, δ, ppm): 1.40s (6H, 5-$(CH_3)_2$), 1.49s(6H, 7-$(CH_3)_2$), 3.0-4.2 m (4H ,-CH_2-CH_2-). Found, %: C, 59.2; H, 9.2; N, 23.0. $C_9H_{17}N_3O$. Calculated, %: C, 59.0; H, 9.3; N, 23.0.

2,3,4,5,6,7-Hexahydro-6-oxyl-5,5,7,7-tetramethyl-7H-imidazo[1,5-a]-imidazole 9. A solution of 2.19 g (0.01 mol) of amidine **3b** in acetonitrile was stirred with 0.02 mol of potassium phthalimide, NaI, NaN_3, or sodium acetate for 30-60 h (TLC control) at 20°. The reactions were carried out in the presence of the catalytic amounts of dicyclohexyl-18-crown-6-ether. The inorganic precipitate was filtered off, the solution was evaporated, and compound **9** was isolated chromatographically on a silica gel column, eluent $CHCl_3$. The reaction with NaH was carried out in THF with subsequent decomposition of the reaction mixture with water and isolation of compound **9** in a similar way. The reaction of amidine **3b** with ammonia was carried out in water-ethanol mixture.Yield of compound **9** 85%, m.p. 70-71° (from hexane). IR, ν, cm^{-1}: 1680 (C=N). pK = 7.2. Found, %: C, 59.2; H, 8.9; N, 23.1. $C_9H_{16}N_3O$. Calculated, %: C, 59.3; H, 8.8; N, 23.1.

4-(N-Phenylacetamido-2,2,5,5-tetramethyl-3-imidazoline-1-oxyl (12a) and 4-phenylimino-2,2,5,5-tetramethyl-3-acetylimidazolidine-1-oxyl (11a). Acetyl chloride 2.1 ml (0.02 mol) was added dropwise with stirring to a solution of 2.3 g (0.01 mol) of amidine **3a** and 4.2 ml (0.03 mol) of triethylamine in 15 ml of $CHCl_3$. The reaction mixture was allowed to stay for 15 min. at 20°, then evaporated, and compounds **11a** and **12a** were separated chromatographically on a silica gel column, eluent $CHCl_3$. Compound **11a**, yield 35%, m.p. 76-77° (from hexane). IR, ν, cm^{-1}: 1600 (C=N), 1695 (C=O). UV, λ_{max} nm (lg ε): 235 (4.35). Found, %: C, 65.6; N, 7.3; N, 15.1. $C_{15}H_{20}N_3O_2$. Calculated, %: C, 65.7; H, 7.3; N, 15.3. **12a**, yield 60%, m.p. 148-149°(from hexane-ethyl acetate mixture). IR, ν, cm^{-1}: 1630 (C=N), 1710 (C=O). UV λ_{max} nm (lg ε): 227 (4.11). Found, %: C, 65.8; H, 7.3; N, 15.2. $C_{15}H_{20}N_3O_2$. Calculated, %: C, 65.7; H, 7.3; N, 15.3.

The reaction of amidine **3a** with benzoyl chloride and chloroethylformiate under similar conditions afforded **4-(N-phenylbenzamido)-12b**, **4-(N-ethoxycarbonylamino)-2,2,5,5-tetramethyl-3-imidazoline-1-oxyl 12c** and **4-phenylimino-2,2,5,5-tetramethyl-3-benzoyl-3-imidazoline-1-oxyl 11b**. Compound **11b**, yield 15%, m.p. 85-86° (from hexane). IR, ν, cm^{-1}: 1615 (C=N),

1685 (C=O). UV, λ_{max} nm (lg ε): 239 (4.27). Found, %: C, 71.4; H, 6.5; N, 12.4. $C_{20}H_{22}N_3O_2$. Calculated, %: C, 71.4; H, 6.5; N, 12.5. **12b**, yield 75%, m.p. 103-104° (from hexane). IR, ν, cm^{-1}: 1620 (C=N), 1690 (C=O). UV λ_{max} nm (lg ε): 231 (4.23). Found, %: C, 71.3; H, 6.5; N, 12.3. $C_{20}H_{22}N_3O_2$. Calculated, %: C, 71.4; H, 6.5; N, 12.5. **12c**, yield 60%, m.p. 79- 80° (from hexane). IR, ν, cm^{-1}: 1720 (C=O). UV, λ_{max} nm (lg ε): 228 (4.0). Found, %: C, 63.1; H, 7.2; N, 13.7. $C_{16}H_{22}N_3O_3$. Calculated, %: C, 63.2; H, 7.2; N, 13.8.

1-Hydroxy-4-(N-phenylacetamido)-2,2,5,5-tetramethyl-3-imidazoline 13 was prepared by hydrogenation of 0.55 g (0.02 mol) of compound **12a** in 10 ml of CH_3OH in the presence of 200 mg of a catalyst (5% Pd/C) at atmospheric pressure and 20° during 5 h. Compound **13** was purified chromatographically on a silica gel column, eluent $CHCl_3$. Yield 30%, m.p. 143-145° (from hexane-ethyl acetate mixture). IR, ν, cm^{-1}: 1630 (C=N), 1700 (C=O). UV, λ_{max} nm (lg ε): 253 (3.9). NMR ^{13}C ($CDCl_3$ δ, ppm): 180.85 (C=O); 158.56 (C-4); 135.62, 128.79, 128.31, 125.57 (C_6H_5); 25.63 ($\underline{C}H_3CO$); 24.70 (2-$(CH_3)_2$); 23.16 (5-$(CH_3)_2$). NMR ^1H ($CDCl_3$, δ, ppm): 1.42s (6H, 5-$(CH_3)_2$); 1.54s (6H, 2-$(CH_3)_2$); 1.84s (3H, CH_3CO); 7.2m (2H), 7.4m (3H, C_6H_5). Found, %: C, 65.4; H, 7.4; N, 15.2. $C_{15}H_{21}N_3O_2$. Calculated, %: C, 65.5; H, 7.6. N, 15.3.

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