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Synthesis of 3-Aminomethyl-Substituted Pyrazoles and Isoxazoles

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Abstract—A series of new 3-(aminomethyl)pyrazoles and 3-(aminomethyl)isoxazoles was synthesized along a route involving the formation as key intermediates of esters of 5-substituted 1*H*-pyrazole-3-carboxylic and 1*H*-isoxazole-3-carboxylic acids. All compounds obtained were characterized by physicochemical constants, IR, ^{1}H, ^{13}C NMR, and mass spectra.

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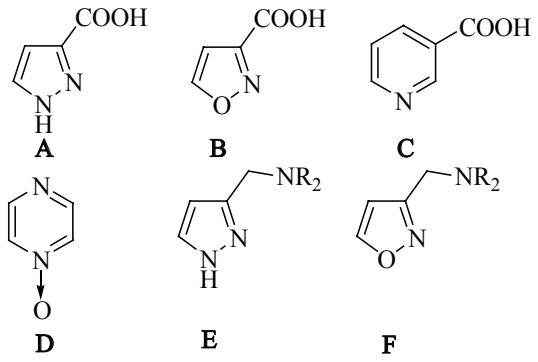
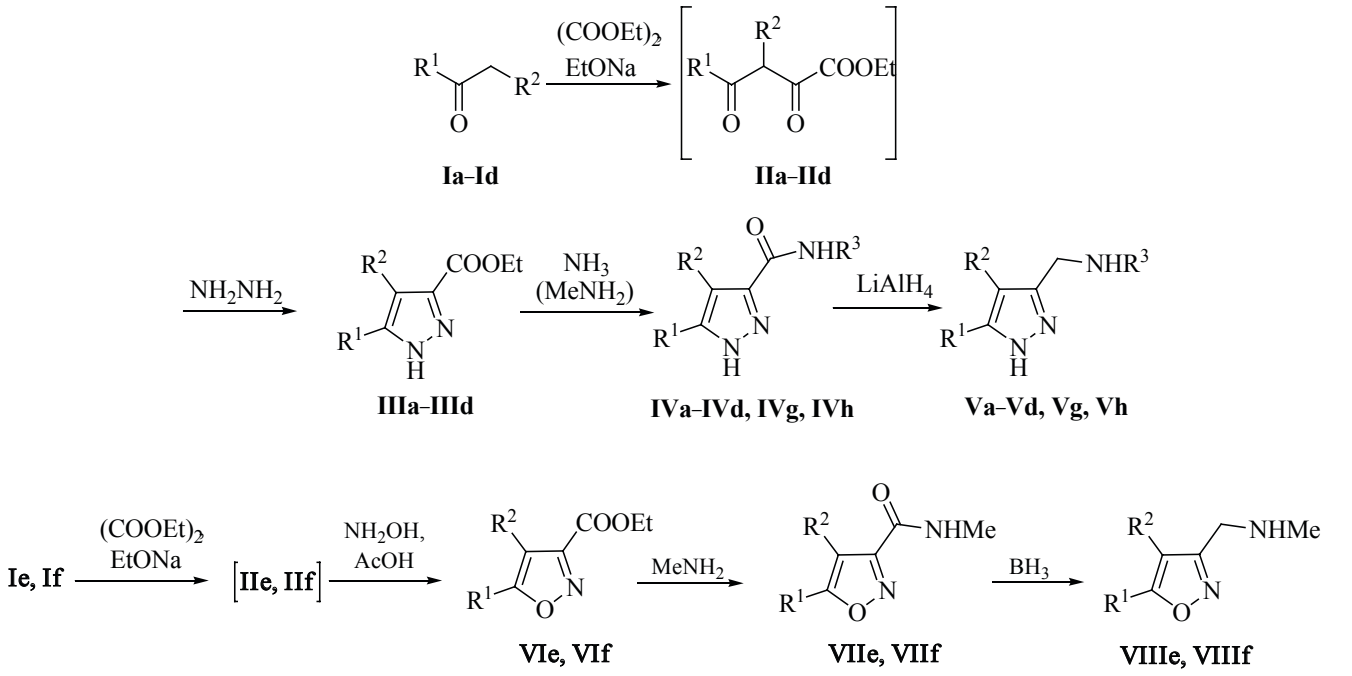
Many functionally substituted pyrazoles and isoxazoles possess a wide range of pharmacologic activity [1–3]. For instance, 3-pyrazole- and 3-isoxazolecarboxylic acids **A** and **B** having alkyl or aryl substituents in the positions *4* and (or) *5* are antagonists of niacinic receptors and analogs of nicotinic acid **C** (niacin) and of acipimox **D** used in the medical praxis in the atherosclerosis treatment [4–6].

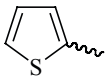


Pyrazoles and isoxazoles with substituent of the basic character of **E** and **F** type are far less understood. They underlie the synthesis of selective inhibitors of enzymes, like factor Xa, and blood anticoagulants [7]. At the same time the known procedures for the preparation of compounds of **E** and **F** type apply difficultly available reagents [3, 8] or unstable compounds like azides [9] or organometallic derivatives [7]. Therefore the search for more convenient synthetic methods for their preparation is urgent.

In this study we performed the synthesis of aminomethyl derivatives of heterocycles of **E** and **F** type along a scheme involving the condensation of various ketons **I** with diethyl oxalate (Claisen reaction) followed by the cyclocondensation of the intermediate α,γ-diketone **II** with hydrazine or hydroxylamine [1–6].

As a result substituted in the ring esters of 3-pyrazole- or 3-isoxazolecarboxylic acids **III** and **IV** were obtained. Therewith the cyclocondensation of diketones **IIe** and **IIf** with the hydroxylamine proceeded regioslectively. In event of diketones **IIa** and **IIb** alongside the 3-ethoxycarbonyl derivatives also 5-ethoxycarbonyl-substituted isoxazoles were obtained in a ratio 9:1. Further compounds **III, VI** were subjected to ammonolysis or aminolysis with methylamine with the subsequent reduction of amides **IV**, **VII** into the corresponding amines **V, VIII**. Amides **IV** of the substituted 3-pyrazolecarboxylic acids were reduced with $LiAlH_4$, and amides **VII** of the substituted 3-isoxazolecarboxylic acid, with the help of BH_3 obtained *in situ* from $NaBH_4$ and $BF_3{\cdot}Et_2O$. The latter procedure was required for the reaction of amides **VII** with $LiAlH_4$ occurred nonselectively with the formation of a large number of side products. In both cases THF was used as solvent.



IV, V, R^1 = *t*-Bu, R^2 = H, R^3 = H (**a**), Me (**g**); R^1 =  , R^2 = H, R^3 = Me (**b**); R^1 =  , R^2 = H, R^3 = H (**c**), Me (**h**); $R^1 + R^2 = (CH_2)_3$, R^3 = Me (**d**); **VI–VIII**, R^1= Ph, R^2 = H (**e**); $R^1 + R^2 = (CH_2)_4$ (**f**).

All the aminomethylpyrazoles and isoxazoles obtained as far as we know have been synthesized for the first time, and they were characterized by IR, ^{1}H,^{13}C NMR, and mass spectra.

EXPERIMENTAL

IR spectra of compounds synthesized were recorded on a spectrometer Specord M82 from pellets with KBr. The melting points were measured on a Boëtius heating block. High-resolution mass spectra were taken on an instrument MicrOTOF II (Bruker Daltonics) with electrospray ionization. ^{1}H and ^{13}C NMR spectra were registered on a spectrometer Bruker AM-300 at operating frequencies 300.13 and 75.47 MHz respectively, solvent DMSO-d_6, internal reference TMS.

Ethyl 5-*tert*-butyl-1*H*-pyrazole-3-carboxylate (IIIa). To a solution of 68.05 g (1 mol) of sodium ethylate in 1 liter of anhydrous ethanol was added gradually 146 g (1 mol) of diethyl oxalate, then 125 ml (1 mol) of ketone **Ia** was poured thereto. The mixture was stirred at room temperature for 20 H, afterwards 57 ml (1 mol) of glacial acetic acid and 57 ml (1 mol) of 55% hydrazine hydrate were added. The reaction mixture was stirred for 20 h, the solvent was distilled off, by portions 500 ml of saturated solution of $NaHCO_3$ was added, and the product was extracted into dichloromethane (3 × 300 ml). The extract was washed with water, dried with $MgSO_4$, and filtered through a bed of silica gel. The solvent was distilled off, the solid residue was crystallized from ethyl acetate and dried in a vacuum. Yield 167 g (85%), colorless crystals, mp 143–144°C. ^{1}H NMR spectrum, δ, ppm: 1.27 m [12H, $C(CH_3)_3$, $CH_2C\underline{H}_3$], 4.25 q (2H, CH_2), 6.48 s (1H, H^4), 13.22 br.s (1H, NH). Found, %: C 61.01; H 8.12; N 14.21. $C_{10}H_{16}N_2O_2$. Calculated, %: C 61.20; H 8.22; N 14.27.

Esters **IIIb–IIId** were similarly prepared.

Ethyl-5-cyclopropyl-1*H*-pyrazole-3-carboxylate (IIIb) [5]. Yield 146 g (81%), mp 90–92°C. ^{1}H NMR spectrum, δ, ppm: 0.71 m, 0.92 m (4H, $2CH_2$ cyclopropyl), 1.25 t (3H, CH_3), 1.90 m (1H, CH cyclopropyl), 4.22 q (2H, $C\underline{H}_2CH_3$), 6.39 s (1H, H^4), 13.17 br.s (1H, NH). Found, %: C 59.76; H 6.59; N 15.60. $C_9H_{12}N_2O_2$. Calculated, %: C 59.99; H 6.71; N 15.55.

Ethyl-5-(2-thienyl)-1*H*-pyrazole-3-carboxylate (IIIc. Yield 200 g (90%), mp 136–137°C. ^{1}H NMR spec-

trum, δ, ppm: 1.31 t (3H, CH_3), 4.32 q (2H, $C\underline{H}_2CH_3$), 7.11 m (2H, H^4, $C\underline{H}CHS$), 7.52 m (2H, CHCS, CHS), 13.98 br.s (1H, NH). Found, %: C 53.91; H 4.47; N 12.57. $C_{10}H_{10}N_2O_2S$. Calculated, %: C 54.04; H 4.53; N 12.60.

Ethyl-1,4,5,6-tetrahydrocyclopentapyrazole-3-carboxylate (IIId [2]. Yield 142 g (79%), mp 103–105°C (mp 124–125°C [10]). ^{1}H NMR spectrum, δ, ppm: 1.27 t (3H, CH_3), 2.41 m (2H, $CH_2C\underline{H}_2CH_2$), 2.64 m (4H, $C\underline{H}_2CH_2C\underline{H}_2$), 4.23 q (2H, $C\underline{H}_2CH_3$), 13.14 br.s (1H, NH). Found, %: C 59.83; H 6.69; N 15.49. $C_9H_{12}N_2O_2$. Calculated, %: C 59.99; H 6.71; N 15.55.

5-*tert*-Butyl-1*H*-pyrazole-3-carboxamide (IVa). The ammonolysis of 167 g (0.85 mol) of ester **IIIa** was carried out in 1 liter of a mixture of ethanol with 25% aqueous ammonia, 1:1, at room temperature over 7 days. Then the reaction mixture was boiled for 5 h, ethanol and excess ammonia were removed, 0.5 liter of petroleum ether was added, the white precipitate was filtered off and dried in a vacuum. Yield 129 g (91%), mp 237°C (sublimation). ^{1}H NMR spectrum, δ, ppm: 1.27 s [9H, $C(CH_3)_3$], 6.38 s (1H, H^4), 7.11 br.s (1H, NH amide), 7.37 br.s (1H, NH amide), 12.89 br.s (1H, NH). Found, %: C 57.25; H 7.75; N 25.19. $C_8H_{13}N_3O$. Calculated, %: C 57.46; H 7.84; N 25.13.

Compound **IVc** was prepared analogously, and by replacement of ammonia by 30% aqueous methylamine compounds **IVb, IVd, IVg, IVh** were obtained.

5-Cyclopropyl-1*H*-pyrazole-3-(*N*-methyl)-carboxamide (IVb) was obtained from 146 g (0.81 mol) of ester **IIIb**. Yield 120 g (90%), mp 176–178°C. ^{1}H NMR spectrum, δ, ppm: 0.68 m, 0.92 m (4H, $2CH_2$ cyclopropyl), 1.89 m (1H, CH cyclopropyl), 2.71 s (3H, CH_3), 6.28 s (1H, CH=), 7.89 br.s (1H, NH amide), 12.87 br.s (1H, NH). Found, %: C 57.97; H 6.60; N 25.50. $C_8H_{11}N_3O$. Calculated, %: C 58.17; H 6.71; N 25.44.

5-(2-Thienyl)-1*H*-pyrazole-3-carboxamide (IVc) was obtained from 200 g (0.90 mol) of ester **IIIc**. Yield 151g (87%), mp 262–263°C. ^{1}H NMR spectrum, δ, ppm: 7.02 s (1H, H^4), 7.11 s (1H, $C\underline{H}CHS$), 7.39 s (1H, CHCS), 7.46 m (2H, CHS, NH amide), 7.83 br.s (1H, NH amide), 13.51 br.s (1H, NH). Found, %: C 49.49; H 3.58; N 21.70. $C_8H_7N_3OS$. Calculated, %: C 49.73; H 3.65; N 21.75.

1,4,5,6-Tetrahydrocyclopentapyrazole-3-(*N*-methyl)carboxamide (IVd) was obtained from 142 g (0.79 mol) of ester **IIId**. Yield 112 g (86%), mp 218–219°C. ^{1}H NMR spectrum, δ, ppm: 2.42 m (2H, $CH_2C\underline{H}_2CH_2$), 2.60–2.81 m (7H, CH_3, $C\underline{H}_2CH_2C\underline{H}_2$), 7.78 br.s (1H, NH amide), 12.48 br.s (1H, NH). Found, %: C 57.98; H 6.69; N 25.40. $C_8H_{11}N_3O$. Calculated, %: C 58.17; H 6.71; N 25.44.

5-*tert*-Butyl-1*H*-pyrazole-3-(N-methyl) carboxamide (IVg) was obtained from 167 g (0.85 mol) of ester **IIIa**. Yield 137 g (89%), mp 193–194°C. ^{1}H NMR spectrum, δ, ppm: 1.27 s [9H, $C(CH_3)_3$], 2.75 m (3H, $NHC\underline{H}_3$), 6.38 s (1H, H^4), 8.03 br.s (1H, NH amide), 12.89 br.s (1H, NH). Found, %: C 59.60; H 8.29; N 23.22. $C_9H_{15}N_3O$. Calculated, %: C 59.64; H 8.34; N 23.19.

5-(2-Thienyl)-1*H*-pyrazole-3-(N-methyl) carboxamide (IVh) was obtained from 200 g (0.90 mol) of ester **IIIc**. Yield 167 g (90%), mp 199–201°C. ^{1}H NMR spectrum, δ, ppm: 2.77 s (3H, CH_3), 6.96 m (1H, H^4), 7.12 m (1H, $C\underline{H}CHS$), 7.38 m (1H, CHCS), 7.50 m (1H, CHS), 8.31 br.s (1H, NH amide), 13.54 br.s (1H, NH). Found, %: C 51.94; H 4.31; N 20.31. $C_9H_9N_3OS$. Calculated, %: C 52.16; H 4.38; N 20.27.

3-Aminomethyl-5-*tert*-butyl-1*H*-pyrazole dihydrochloride (Va). To a dispersion of 44 g (1.16 mol) of $LiAlH_4$ in 1 liter of anhydrous THF at 35–40°C was cautiously added by portions 129 g (0.77 mol) of amide **IVa**. The reaction mixture was boiled for 8 h, cooled, the excess of $LiAlH_4$ was quenched with 100 ml of 40% KOH, then the mixture was boiled for 2 h more. Salts were filtered off, the solution was passed through a bed of celite, the solvent was distilled off. The residue was dissolved in 1 liter of a mixture ethyl acetate–ethanol, 2 : 1, ~100 ml of 6 M HCl solution in dioxane was added, the mixture was boiled for 3 h and cooled. The separated crystals of the dihydrochloride were filtered off, washed with ether, and dried in a vacuum. Yield 143 g (82%), mp 188–190°C. IR spectrum, ν, cm^{-1}: 3124, 2196, 1608, 1600, 1492, 1484. ^{1}H NMR spectrum, δ, ppm: 1.27 s [9H, $C(CH_3)_3$], 3.95 m (2H, CH_2), 6.31 m (1H, CH), 6.80–7.90 br.s (2H, NH·HCl), 8.60 br.s (3H, NH_2·HCl). ^{13}C NMR spectrum, δ, ppm: 29.94 [$C(\underline{C}H_3)_3$], 30.83 [$\underline{C}(CH_3)_3$], 35.65 (CH_2), 101.18 (CH), 142.90 (CNH), 155.09 (C=N). Mass spectrum: *m/z* 154.1338 $[M + H]^+$. $C_8H_{15}N_3$·2HCl. *M* 153.2249.

3-(N-Methylaminomethyl)-5-cyclopropyl-1*H*-pyrazole (Vb) was obtained from 120 g (0.73 mol) of compound **IVb**. Yield 86 g (78%), bp 155°C (1 mm Hg). IR spectrum, ν, cm^{-1}: 3584, 3188, 1584, 1448. ^{1}H NMR spectrum, δ, ppm: 0.60 m, 0.83 m (4H, $2CH_2$ cyclopropyl), 1.82 m (1H, CH cyclopropyl), 2.23 s (3H, CH_3), 3.01 br.s (1H, NH), 3.51 s (2H, $C\underline{H}_2NH$), 5.78 s (1H, CH=), 11.50–12.30 br.s (1H, NH). ^{13}C NMR

spectrum, δ, ppm: 7.58 ($2CH_2$ cyclopropyl), 29.15 (CH cyclopropyl), 35.60 (CH_3), 47.23 (CH_2), 99.41 (C=CNH), 157.74 (CNH), 162.50 (C=N). Mass spectrum: *m/z* 152.1181 $[M + H]^+$. $C_8H_{13}N_3$. *M* 151.2090.

3-Aminomethyl-5-(2-thienyl)-1*H*-pyrazole dihydrochloride (Vc) was obtained from 151 g (0.78 mol) of compound **IVc**. Yield 131g (66%), mp 204–206°C. IR spectrum, ν, cm^{-1}: 3196, 2608, 1672, 1608, 1524. ^1H NMR spectrum, δ, ppm: 4.03 m (2H, CH_2NH_2), 6.15 br.s (2H, NH·HCl), 6.66 s (1H, CHCNH), 7.11 m (1H, CHCHS), 7.42 d (1H, CHCS, *J* 3.2 Hz), 7.51 d (1H, CHS, *J* 5.0 Hz), 8.63 br.s (3H, NH_2·HCl). ^{13}C NMR spectrum, δ, ppm: 34.82 (CH_2), 102.23 (CHCNH), 124.18 (CHCHS), 125.47 (CNH), 127.86 (CHCS), 133.54 (CHS), 141.39 (CS), 142.07 (C=N). Mass spectrum: *m/z* 180.0590 $[M + H]^+$. $C_8H_9N_3S2$·HCl. *M* 179.2433.

3-(N-Methylaminomethyl)-1,4,5,6-tetrahydrocyclopentapyrazole dihydrochloride (Vd) was obtained from 112 g (0.68 mol) of compound **IVd**. Yield 117 g (77%), mp 159–162°C. IR spectrum, ν, cm^{-1}: 3000–2400, 2344, 1644, 1600, 1560, 1448. ^1H NMR spectrum, δ, ppm: 2.42 m (2H, $CH_2CH_2CH_2$), 2.50 s (3H, CH_3), 2.69 m (4H, $CH_2CH_2CH_2$), 4.08 s (2H, CH_2NH), 9.68 br.s (2H, NH·HCl), 10.80–11.50 br.s (2H, NH·HCl). ^{13}C NMR spectrum, δ, ppm: 22.35 (CH_2C=C), 23.50 (CH_2C=N), 30.05 ($CH_2CH_2CH_2$), 31.84 (CH_3), 41.93 (CH_2NH), 126.05 (C=CNH), 131.99 (C=CNH), 155.18 (C=N). Mass spectrum: *m/z* 152.1183 $[M + H]^+$. $C_8H_{13}N_3$·2HCl. *M* 151.2090.

3-(*N*-Methylaminomethyl)-5-*tert*-butyl-1*H*-pyrazole dihydrochloride (Vg) was obtained from 137 g (0.76 mol) of compound **IVg**. Yield 139 g (77%), mp 141–144°C. IR spectrum, ν, cm^{-1}: 3128, 2464, 1592, 1468. ^1H NMR spectrum, δ, ppm: 1.27 s [9H, $C(CH_3)_3$], 2.50 m (3H, $NHCH_3$), 4.03 m (2H, CH_2), 6.34 s (1H, CH), 9.54 br.s (2H, NH·HCl), 10.20–10.60 br.s (2H, NH·HCl). ^{13}C NMR spectrum, δ, ppm: 29.87 [$C(CH_3)_3$], 30.72 [$C(CH_3)_3$], 31.82 ($NHCH_3$), 44.24 (CH_2), 101.69 (CH), 141.35 (CNH), 154.79 (C=N). Mass spectrum: *m/z* 168.1490 $[M + H]^+$. $C_9H_{17}N_3$·2HCl. *M* 167.2515.

3-(N-Methylaminomethyl)-5-(2-thienyl)-1*H*-pyrazole (Vh) was obtained from 167 g (0.81 mol) of compound **IVh**. Yield 137 g (88%), mp 114–116°C. IR spectrum, ν, cm^{-1}: 3756, 3268, 1580, 1476, 1448. ^1H NMR spectrum, δ, ppm: 2.28 s (3H, CH_3), 3.05 br.s (1H, NH), 3.66 s (2H, CH_2NH), 6.43 s (1H, CHCNH), 7.06 m (1H, CHCHS), 7.33 d (1H, CHCS, *J* 3.0 Hz), 7.41 d (1H, CHS, *J* 4.8 Hz), 12.10–12.80 br.s (1H, NH). ^{13}C NMR spectrum, δ, ppm: 35.42 (CH_3), 45.98 (CH_2), 100.68 (CHCNH), 123.20 (CHCHS), 124.33 (CNH), 127.49 (CHCS), 134.37 (CHS), 141.69 (CS), 144.26 (C=N). Mass spectrum: *m/z* 194.0748 $[M + H]^+$. $C_9H_{11}N_3S$. *M* 193.2699.

Ethyl-5-phenylisoxazole-3-carboxylate (VIe) [11]. To a solution of 68 g (1 mol) of sodium ethylate in 1 liter of anhydrous ethanol was added by portions 146 g (1 mol) of diethyl oxalate and afterwards 117 ml (1 mol) of acetophenone **Ie**. The mixture was stirred at room temperature for 20 h, 57 ml (1 mol) of glacial acetic acid and a solution of 64.5 g (1mol) of NH_2OH·HCl in 300 ml of water were added. After 20 h of stirring the reaction mixture was extracted with dichloromethane (3 × 300 ml). The extract was washed with water, dried with $MgSO_4$, the solvent was distilled off. The residue was dissolved in 1 liter of anhydrous ethanol, catalytic quantity of TsOH was added, and the solution was boiled for 2 h. Then the solvent was distilled off, the residue was dissolved in dichloromethane, the solution was washed with water, dried with $MgSO_4$, the solvent was distilled off. The reaction product was crystallized from ethyl acetate. Yield 161 g (74%), mp 50–51°C (mp 49°C [11]). ^1H NMR spectrum, δ, ppm: 1.35 t (3H, CH_3), 4.49 q (2H, CH_2CH_3), 7.47 s (1H, H^4), 7.54 m (3H, H_{Ar}), 7.94 m (2H, H_{Ar}). Found, %: C 66.11; H 5.08; N 6.47. $C_{12}H_{11}NO_3$. Calculated, %: C 66.35; H 5.10; N 6.45.

Ethyl-4,5,6,7-tetrahydrobenzo[*d*]isoxazole-3-carboxylate (VIf) was obtained similarly from 104 ml (1 mol) of cyclohexanone **If**. Yield 137 g (70%), bp 120–122°C (5 mm Hg). ^1H NMR spectrum, δ, ppm: 1.31 t (3H, CH_3), 1.72 m [4H, $CH_2(CH_2)_2CH_2$], 2.72 m [4H, $CH_2(CH_2)_2CH_2$], 4.49 q (2H, CH_2CH_3). Found, %: C 61.41; H 6.65; N 7.12. $C_{10}H_{13}NO_3$. Calculated, %: C 61.53; H 6.71; N 7.18.

5-Phenylisoxazole-3-(*N*-methyl)carboxamide (VIId) was obtained by aminolysis of 161 g (0.74 mol) of ester **VIe** with 30% aqueous methylamine. Yield 132 g (88%), mp 190–192°C (198–199°C [11]). ^1H NMR spectrum, δ, ppm: 2.80 s (3H, CH_3), 7.33 s (1H, H^4), 7.54 m (3H, H_{Ar}), 7.92 m (2H, H_{Ar}), 8.72 br.s (1H, NH). Found, %: C 65.02; H 4.92; N 13.88. $C_{11}H_{10}N_2O_2$. Calculated, %: C 65.34; H 4.98; N 13.85.

4,5,6,7-Tetrahydrobenzo[*d*]isoxazole-3-(*N*-methyl) carboxamide (VIIf) was obtained by aminolysis of 137 g (0.70 mol) of ester **VIf** with 30% aqueous methylamine. Yield 111 g (89%), mp 135–137°C. ^1H NMR spectrum,

δ, ppm: 1.70 m (4H, $2CH_2$), 2.72 m (7H, $2CH_2$, CH_3), 8.63 br.s (1H, NH). Found, %: C 59.77; H 6.65; N 15.48. $C_9H_{12}N_2O_2$. Calculated, %: C 59.99; H 6.71; N 15.55.

3-(*N*-Methylaminomethyl)-5-phenylisoxazole hydrochloride (VIIIe). To a dispersion of 30 g (0.8 mol) of $NaBH_4$ in 1 liter of anhydrous THF under argon was added dropwise 70 ml (0.26 mol) of 48% $BF_3 \cdot Et_2O$ solution in anhydrous ether, and the mixture was stirred for 0.5 h at room temperature. To the prepared BH_3 solution was gradually added 61 g (0.3 mol) of amide **VIIe**, the mixture was boiled for 4 h, then it was cooled and treated with ~100 ml of saturated $NaHCO_3$ solution adding it by small portions, and the resulting mixture was stirred for 1 h. After adding 0.5 l of water and 0.5 l of ethyl acetate the organic layer was separated, and the water layer was additionally extracted with ethyl acetate (2 × 200 ml). The combined extracts were dried with $MgSO_4$ and filtered through a celite bed. After the neutralization of the alkaline solution with 6 N HCl solution in dioxane till weak acidic reaction (~100 ml) the solvents were distilled off, the residue was crystallized from a mixture ethyl ether–ethanol, 2:1. Yield 37 g (54%), mp 229–232°C. IR spectrum, ν, cm^{-1}: 2368, 1596, 1452. ^1H NMR spectrum, δ, ppm: 2.63 s (3H, CH_3), 4.32 s (2H, $C\underline{H}_2NH$), 7.26 s (1H, CH), 7.56 m (3H, H_{Ar}), 7.85 m (2H, H_{Ar}), 9.86 br.s (2H, NH·HCl). ^{13}C NMR spectrum, δ, ppm: 32.31 (CH_3), 42.51 (CH_2), 100.57 (CH), 125.57, 126.28, 129.36, 130.77 (C_{Ar}), 157.57 (C=N), 169.74 (CO). Mass spectrum: *m/z* 189.1025 $[M + H]^+$. $C_{11}H_{12}N_2O \cdot HCl$. *M* 188.2259.

3-(N-Methylaminomethyl)-4,5,6,7-tetrahydrobenzo[*d*]isoxazole hydrochloride (VIIIf) was similarly obtained from 66.2 g (0.4mol) of amide **VIIf** by the action of BH_3 formed from 39.6 g (1.05 mol) of $NaBH_4$ and 93 ml (0.35mol) 48% $BF_3 \cdot Et_2O$ in 1 liter of solution anhydrous THF. Yield 46 g (57%), mp 147–149°C. IR spectrum, ν, cm^{-1}: 2952, 2712, 1644, 1580, 1452, 1412. ^1H NMR spectrum, δ, ppm: 1.68 m [4H, $CH_2(C\underline{H}_2)_2CH_2$], 2.52 s (3H, CH_3), 2.60 t (2H, CH_2CO, *J* 5.9 Hz), 2.67 t (2H, CH_2CCN, *J* 5.6 Hz), 4.24 s (2H, $C\underline{H}_2NH$), 9.78 br.s (2H, NH·HCl). ^{13}C NMR spectrum, δ, ppm: 18.12 ($\underline{C}H_2CO$), 20.83 ($\underline{C}H_2CH_2CO$), 21.52 ($\underline{C}H_2CH_2CCN$), 21.60 ($\underline{C}H_2CCN$), 32.13 (CH_3), 40.31 (CH_2NH), 115.59 ($\underline{C}CO$), 156.73 (C=N), 160.81 (CO). Mass spectrum: *m/z* 167.1178 $[M + H]^+$. $C_9H_{14}N_2O \cdot HCl$. *M* 166.2203.

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