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Reactions of 3-Substituted 3-Azabicyclo[3.3.1]nonan-9-ones with Nitrogen-Containing Nucleophiles

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Abstract—Condensation of 3-substituted 3-azabicyclo[3.3.1]nonan-9-ones with hydroxylamine and hydrazine hydrate gave the corresponding oximes, hydrazones, and azines. Reductive amination of the title compounds in the presence of sodium triacetoxyhydridoborate led to the formation of 3-substituted 3-azabicyclo[3.3.1]nonan-9-amines which were converted into the corresponding dihydrochlorides by treatment with dry hydrogen chloride. Treatment of 3-*tert*-butoxycarbonyl derivatives with HCl under analogous conditions was accompanied by elimination of the *tert*-butoxycarbonyl group to produce 3-azabicyclo[3.3.1]nonan-9-amine dihydrochlorides.

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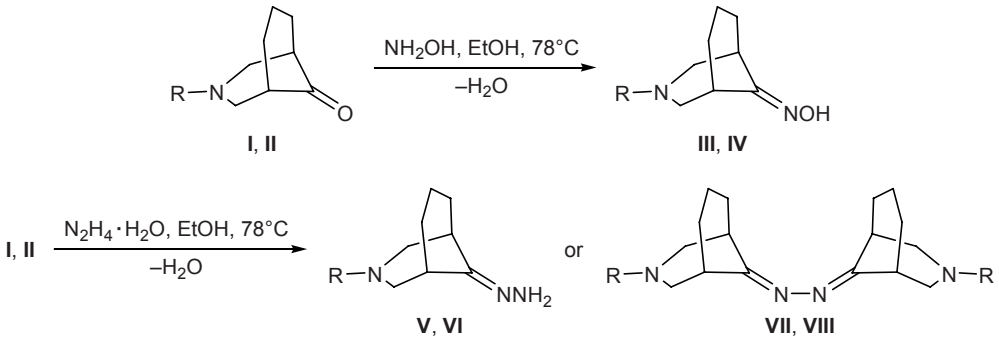
We previously [1] developed a convenient procedure for the synthesis of 3-substituted 3-azabicyclo-[3.3.1]nonan-9-ones whose reactivity was studied very poorly [2]. Molecules of these compounds include a pharmacophoric piperidine fragment, and they attract interest as potential biologically active substances [3].

In the present article we report on new reactions of bicyclic ketones **I** and **II** at the carbonyl group with conventional nitrogen-containing nucleophiles, hydroxylamine and hydrazine. The reactions were carried out by heating the reactants in boiling ethanol. Ketones **I** and **II** reacted with hydroxylamine to produce the corresponding oximes **III** and **IV** (Scheme 1). Depending on the reactant ratio, the reactions of **I** and **II** with hydrazine led to the formation of hydrazones **V** and **VI** (with large excess of hydrazine hydrate) or azines **VII** and **VIII** (Scheme 1). Ketones **I** and **II** smoothly reacted with primary and secondary amines under conditions of reductive amination (in the presence of excess sodium triacetoxyhydridoborate) to give diamines **IX**–**XVIII** (Scheme 2).

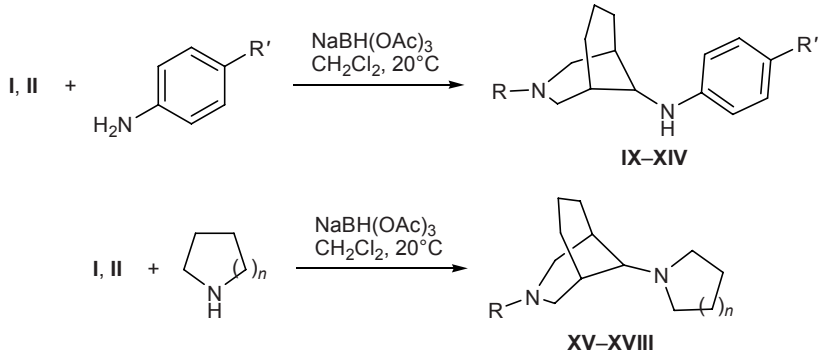
Treatment of compounds **III**, **V**, **IX**–**XI**, **XV**, and **XVI** dissolved in diethyl ether with a saturated solution of dry hydrogen chloride in dioxane resulted in quantitative formation of crystalline dihydrochlorides (azine **VII** gave rise to the corresponding tetrahydrochloride). Under more severe conditions, i.e., on heating solutions of **IV**, **VI**, **VIII**, **XII**–**XIV**, **XVII**, and **XVIII** in ethanol with a saturated solution of hydrogen chloride in dioxane, the salt formation was accompanied by elimination of the *tert*-butoxycarbonyl group, and the products were crystalline secondary bis-

Scheme 1.



I, **III**, **V**, **VII**, R = $PhCH_2$; **II**, **IV**, **VI**, **VIII**, R = *t*-BuOCO.

Scheme 2.



IX–**XI**, **XV**, **XVI**, R = $PhCH_2$; **XII**–**XIV**, **XVII**, **XVIII**, R = *t*-BuOCO; **IX**, **XII**, R′ = H; **X**, **XIII**, R′ = Cl; **XI**, **XIV**, R′ = Br; **XV**, **XVII**, *n* = 1; **XVI**, **XVIII**, *n* = 2.

amine dihydrochlorides **XIX**, **XX**, and **XXII**–**XXVI** and tetrahydrochloride **XXI** having no substituent on N^3 (Scheme 3).

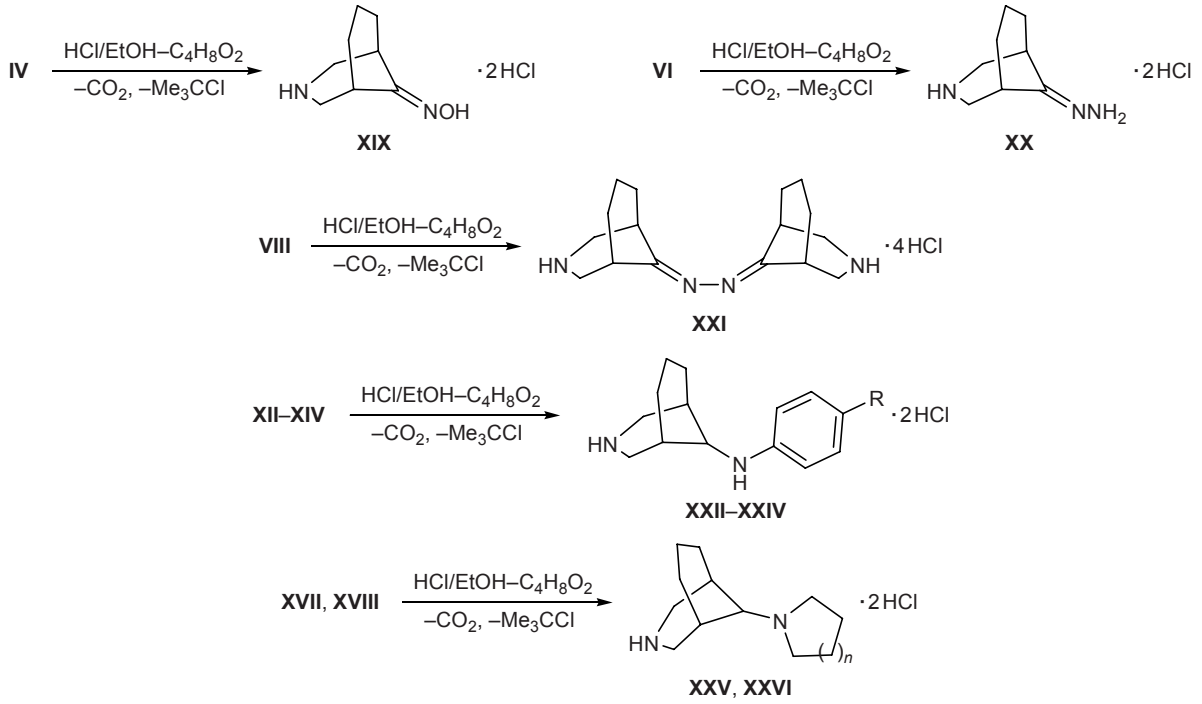
The structure and purity of compounds **III**–**XXVI** were confirmed by elemental analyses, IR, ^{1}H NMR, and mass spectra, and TLC data (see Experimental).

It should be noted that most of the synthesized compounds contain functional amino groups capable of reacting with various electrophiles; therefore, they can be used in fine organic synthesis for the preparation of potential biologically active substances.

EXPERIMENTAL

The IR spectra were recorded on a Specord 75IR spectrometer from samples prepared as thin films or dispersions in mineral oil. The ^{1}H NMR spectra were measured on a Varian Mercury Plus-400 instrument (400 MHz) in $CDCl_3$ or DMSO-d_6 (**XIX**–**XXVI**) using hexamethyldisiloxane as internal reference. The mass spectra (atmospheric pressure chemical ionization) were obtained on a Thermo Finnigan Surveyor MSQ mass spectrometer (USA). The purity of the products was checked by TLC on Silufol UV-254 plates using

Scheme 3.



XXII, R = H; **XXIII**, R = Cl; **XXIV**, R = Br; **XXV**, *n* = 1; **XXVI**, *n* = 2.

hexane–ethyl acetate (1 : 1) as eluent; spots were visualized under UV light.

3-Benzyl-3-azabicyclo[3.3.1]nonan-9-one oxime (III). Ketone **I** [1, 2], 1.15 g (5 mmol), was dissolved in 10 ml of ethanol, 10 ml of an aqueous solution of hydroxylamine [prepared from 0.49 g (7 mmol) of hydroxylamine hydrochloroide and 0.59 g (7 mmol) of sodium hydrogen carbonate] was added, and the mixture was stirred for 3 h on heating under reflux. The mixture was cooled, diluted with 100 ml of water, and extracted with methylene chloride (3×40 ml). The extracts were combined and dried over anhydrous sodium sulfate, the solvent was distilled off, and the residue was subjected to column chromatography on silica gel using hexane–ethyl acetate (1 : 1, by volume) as eluent. Yield 1.00 g (82%), mp 101–102°C. IR spectrum, ν, cm^{-1}: 3350 (OH), 1635 (C=N). ^1H NMR spectrum, δ, ppm: 1.48–2.10 m (6H, CH_2), 2.32–2.37 m (2H, CH), 2.87 d (2H, NCH_2), 2.98 d (2H, NCH_2), 3.46 s (2H, PhC**H**$_2$N), 7.23–7.41 m (5H, C_6H_5), 10.84 s (1H, OH). Mass spectrum: *m*/*z* 245 $[M + H]^+$. Found, %: C 73.65; H 8.23; N 11.54. $C_{15}H_{20}N_2O$. Calculated, %: C 7379; H 8.19; N 11.47.

***tert*-Butyl 9-hydroxyimino-3-azabicyclo[3.3.1]-nonane-3-carboxylate (IV)** was synthesized in a similar way. Yield 87%, mp 143–144°C. IR spectrum, ν, cm^{-1}: 3352 (OH), 1683 (C=O), 1638 (C=N). ^1H NMR spectrum, δ, ppm: 1.32 s (9H, *t*-Bu), 1.46–2.10 m (6H, CH_2), 2.38–2.46 m (2H, CH), 3.44 d (2H, NCH_2), 3.63 d (2H, NCH_2), 10.88 s (1H, OH). Mass spectrum, *m*/*z*: 255 $[M + H]^+$, 198 $[M - 57 + H]^+$, 154 $[M - 101 + H]^+$. Found, %: C 61.42; H 8.57; N 10.98. $C_{13}H_{22}N_2O_3$. Calculated, %: C 61.44; H 8.66; N 11.02.

3-Benzyl-3-azabicyclo[3.3.1]nonan-9-one hydrazone (V). Hydrazine hydrate, 2.5 g (50 mmol), was added to a solution of 1.15 g (5 mmol) of ketone **I** [1, 2] in 15 ml of ethanol, and the mixture was heated for 5 h under reflux on stirring. The mixture was cooled, diluted with 100 ml of water, and extracted with methylene chloride (3×50 ml). The extracts were combined and dried over anhydrous sodium sulfate, the solvent was distilled off, and the residue was subjected to column chromatography on silica gel using hexane–ethyl acetate (1 : 1, by volume) as eluent. Yield 0.78 g (64%), colorless oily substance, R_f 0.38. IR spectrum, ν, cm^{-1}: 3252 (NH_2), 1612 (C=N). ^1H NMR spectrum, δ, ppm: 1.39–2.04 m (6H, CH_2), 2.30–2.35 m (2H, CH), 2.86 d (2H, NCH_2), 2.95 d (2H, NCH_2), 3.44 s (2H, PhC**H**$_2$N), 6.24 br.s (2H, NH_2), 7.21–7.38 m (5H, C_6H_5). Mass spectrum: *m*/*z* 244 $[M + H]^+$. Found, %: C 74.12; H 8.56; N 17.42. $C_{15}H_{21}N_3$. Calculated, %: C 74.09; H 8.64; N 17.27.

***tert*-Butyl 9-hydrazono-3-azabicyclo[3.3.1]nonane-3-carboxylate (VI)** was synthesized in a similar way. Yield 71%, mp 61–62°C, R_f 0.21. IR spectrum, ν, cm^{-1}: 3250 (NH_2), 1681 (C=O), 1614 (C=N). ^1H NMR spectrum, δ, ppm: 1.32 s (9H, *t*-Bu), 1.45–2.12 m (6H, CH_2), 2.38–2.44 m (2H, CH), 3.45 d (2H, NCH_2), 3.64 d (2H, NCH_2), 5.98 br.s (2H, NH_2). Mass spectrum, *m*/*z*: 254 $[M + H]^+$, 197 $[M - 57 + H]^+$, 153 $[M - 101 + H]^+$. Found, %: C 61.57; H 9.03; N 16.52. $C_{13}H_{23}N_3O_2$. Calculated, %: C 61.68; H 9.09; N 16.59.

3-Benzyl-3-azabicyclo[3.3.1]nonan-9-one azine (VII). Hydrazine hydrate, 0.125 g (2.5 mmol), was added to a solution of 1.15 g (5 mmol) of ketone **I** in 5 ml of ethanol, and the mixture was heated for 10 h under reflux on stirring. The mixture was cooled, diluted with 20 ml of water, and left to stand overnight in a refrigerator at 5–6°C. The precipitate was filtered off, dried, and recrystallized from hexane–ethyl acetate (1 : 1, by volume). Yield 0.54 g (48%), colorless crystalline substance, mp 164–165°C. IR spectrum: ν 1610 cm^{-1} (C=N). ^1H NMR spectrum, δ, ppm: 1.41–2.11 m (12H, CH_2), 2.32–2.41 m (4H, CH), 2.82–2.92 m (4H, NCH_2), 2.99–3.08 m (4H, NCH_2), 3.42–3.53 m (4H, PhC**H**$_2$N), 7.22–7.41 m (10H, C_6H_5). Mass spectrum: *m*/*z* 455 $[M + H]^+$. Found, %: C 79.28; H 8.44; N 12.38. $C_{30}H_{38}N_4$. Calculated, %: C 79.31; H 8.36; N 12.33.

Di-*tert*-butyl 9,9′-hydrazine-1,2-diylidenebis(3-azabicyclo-[3.3.1]nonane-3-carboxylate) (VIII) was synthesized in a similar way. Yield 62%, mp 182–183°C. IR spectrum, ν, cm^{-1}: 1683 (C=O), 1610 (C=N). ^1H NMR spectrum, δ, ppm: 1.31 s (18H, *t*-Bu), 1.44–2.13 m (12H, CH_2), 2.36–2.45 m (4H, CH), 3.48–3.52 m (4H, NCH_2), 3.68–3.77 m (4H, NCH_2). Mass spectrum, *m*/*z*: 475 $[M + H]^+$, 418 $[M - 57 + H]^+$, 374 $[M - 101 + H]^+$, 361 $[M - 114 + H]^+$, 273 $[M - 202 + H]^+$. Found, %: C 65.75; H 8.82; N 11.63. $C_{26}H_{42}N_4O_4$. Calculated, %: C 65.84; H 8.86; N 11.81.

3-Benzyl-*N*-phenyl-3-azabicyclo[3.3.1]nonan-9-amine (IX). Ketone **I**, 1.15 (5 mmol), was dissolved in 20 ml of anhydrous methylene chloride, 0.47 g (5 mmol) of freshly distilled aniline and 0.2 ml of glacial acetic acid were added, and the mixture was heated for 1 h under reflux on stirring. The mixture was cooled to room temperature, 3.37 g (16 mmol) of sodium triacetoxyhydridoborate was added, the mixture was stirred for 24 h, 20 ml of 20% aqueous potassium carbonate was added, the mixture was stirred for 0.5 h, 30 ml of water was added, and the organic phase

was separated. The aqueous phase was extracted with methylene chloride (2×30 ml), the extracts were combined with the organic phase and dried over anhydrous sodium sulfate, the solvent was distilled off, and the residue was subjected to column chromatography on silica gel using hexane–ethyl acetate (1:1, by volume) as eluent. Yield 1.42 g (93%), colorless oily substance, R_f 0.58. IR spectrum: ν 3325 cm^{-1} (NH). ^1H NMR spectrum, δ, ppm: 1.45–2.09 m (6H, CH_2), 2.28–2.36 m (2H, CH), 2.82 d (2H, NCH_2), 2.93 d (2H, NCH_2), 3.45 s (2H, PhC**H**$_2$N), 3.96 m (1H, NCH), 6.98–7.08 m (5H, NC_6H_5), 7.21–7.43 m (5H, C_6**H**$_5CH_2$). Mass spectrum: *m*/*z* 306 $[M + H]^+$. Found, %: C 82.51; H 8.23; N 9.06. $C_{21}H_{25}N_2$. Calculated, %: C 82.63; H 8.19; N 9.17.

Compounds **X**–**XVIII** were synthesized in a similar way.

3-Benzyl-*N*-(4-chlorophenyl)-3-azabicyclo[3.3.1]-nonan-9-amine (X). Yield 91%, colorless oily substance, R_f 0.52. IR spectrum: ν 3328 cm^{-1} (NH). ^1H NMR spectrum, δ, ppm: 1.47–2.12 m (6H, CH_2), 2.31–2.38 m (2H, CH), 2.88 d (2H, NCH_2), 3.02 d (2H, NCH_2), 3.59 s (2H, PhC**H**$_2$N), 3.97 m (1H, NCH), 7.04 d (2H, NC_6H_4), 7.18–7.63 m (7H, NC_6H_4, C_6H_5). Mass spectrum: *m*/*z* 340 $[M + H]^+$. Found, %: C 74.18; H 7.13; N 8.15. $C_{21}H_{24}ClN_2$. Calculated, %: C 74.24; H 7.06; N 8.24.

3-Benzyl-*N*-(4-bromophenyl)-3-azabicyclo[3.3.1]-nonan-9-amine (XI). Yield 88%, light yellow oily substance, R_f 0.61. IR spectrum: ν 3324 cm^{-1} (NH). ^1H NMR spectrum, δ, ppm: 1.46–2.08 m (6H, CH_2), 2.32–2.37 m (2H, CH), 2.87 d (2H, NCH_2), 3.01–3.06 m (3H, NCH_2, NH), 3.61 s (2H, PhC**H**$_2$N), 3.98 m (1H, NCH), 7.05 d (2H, NC_6H_4), 7.20–7.59 m (7H, NC_6H_4, C_6H_5). Mass spectrum: *m*/*z* 385 $[M + H]^+$. Found, %: C 65.48; H 6.22; N 7.21. $C_{21}H_{24}BrN_2$. Calculated, %: C 65.64; H 6.28; N 7.29.

***tert*-Butyl 9-phenylamino-3-azabicyclo[3.3.1]-nonane-3-carboxylate (XII).** Yield 95%, colorless oily substance, R_f 0.43. IR spectrum, ν, cm^{-1}: 3328 (NH), 1683 (C=O). ^1H NMR spectrum, δ, ppm: 1.30 s (9H, *t*-Bu), 1.44–2.09 m (6H, CH_2), 2.38–2.45 m (2H, CH), 3.04 br.s (1H, NH), 3.46 d (2H, NCH_2), 3.66 d (2H, NCH_2), 4.01 m (1H, NCH), 7.01–7.12 m (5H, C_6H_5). Mass spectrum, *m*/*z*: 316 $[M + H]^+$, 259 $[M - 57 + H]^+$, 215 $[M - 101 + H]^+$. Found, %: C 72.27; H 8.63; N 8.91. $C_{19}H_{27}N_2O_2$. Calculated, %: C 72.40; H 8.57; N 8.88.

***tert*-Butyl 9-(4-chlorophenylamino)-3-azabicyclo-[3.3.1]nonane-3-carboxylate (XIII).** Yield 92%, mp 72–75°C, R_f 0.41. IR spectrum, ν, cm^{-1}: 3325 (NH), 1683 (C=O). ^1H NMR spectrum, δ, ppm: 1.31 s (9H, *t*-Bu), 1.46–2.11 m (6H, CH_2), 2.39–2.47 m (2H, CH), 3.11 br.s (1H, NH), 3.48 d (2H, NCH_2), 3.72 d (2H, NCH_2), 4.05 m (1H, NCH), 7.08 d and 7.64 d (2H each, C_6H_4, J = 7.5 Hz). Mass spectrum, *m*/*z*: 350 $[M + H]^+$, 293 $[M - 57 + H]^+$, 249 $[M - 101 + H]^+$. Found, %: C 65.18; H 7.36; N 7.94. $C_{19}H_{26}ClN_2O_2$. Calculated, %: C 65.25; H 7.44; N 8.01.

***tert*-Butyl 9-(4-bromophenylamino)-3-azabicyclo-[3.3.1]nonane-3-carboxylate (XIV).** Yield 87%, mp 75–76°C, R_f 0.45. IR spectrum, ν, cm^{-1}: 3327 (NH), 1682 (C=O). ^1H NMR spectrum, δ, ppm: 1.31 s (9H, *t*-Bu), 1.45–2.10 m (6H, CH_2), 2.37–2.45 m (2H, CH), 3.12 br.s (1H, NH), 3.47 d (2H, NCH_2), 3.81 d (2H, NCH_2), 4.03 m (1H, NCH), 7.06 d and 7.59 d (2H each, C_6H_4, J = 7.8 Hz). Mass spectrum, *m*/*z*: 395 $[M + H]^+$, 338 $[M - 57 + H]^+$, 294 $[M - 101 + H]^+$. Found, %: C 58.03; H 6.71; N 7.04. $C_{19}H_{26}BrN_2O_2$. Calculated, %: C 57.89; H 6.60; N 7.10.

3-Benzyl-9-(pyrrolidin-1-yl)-3-azabicyclo[3.3.1]-nonane (XV). Yield 90%, colorless oily substance, R_f 0.72. ^1H NMR spectrum, δ, ppm: 1.42–2.15 m (10H, CH_2), 2.29–2.38 m (2H, CH), 2.81–3.12 m (8H, NCH_2), 3.46 s (2H, PhC**H**$_2$N), 3.98 m (1H, NCH), 7.19–7.45 m (5H, C_6H_5). Mass spectrum: *m*/*z* 284 $[M + H]^+$. Found, %: C 80.47; H 9.51; N 9.73. $C_{19}H_{27}N_2$. Calculated, %: C 80.58; H 9.53; N 9.89.

3-Benzyl-9-piperidino-3-azabicyclo[3.3.1]nonane (XVI). Yield 91%, colorless oily substance, R_f 0.74. ^1H NMR spectrum, δ, ppm: 1.40–2.18 m (12H, CH_2), 2.30–2.41 m (2H, CH), 2.79–3.15 m (8H, NCH_2), 3.48 s (2H, PhC**H**$_2$N), 3.99 m (1H, NCH), 7.20–7.48 m (5H, C_6H_5). Mass spectrum: *m*/*z* 298 $[M + H]^+$. Found, %: C 80.78; H 9.64; N 9.41. $C_{20}H_{29}N_2$. Calculated, %: C 80.82; H 9.76; N 9.42.

***tert*-Butyl 9-(pyrrolidin-1-yl)-3-azabicyclo[3.3.1]-nonane-3-carboxylate (XVII).** Yield 88%, colorless oily substance, R_f 0.64. IR spectrum: ν 1682 cm^{-1} (C=O). ^1H NMR spectrum, δ, ppm: 1.29 s (9H, *t*-Bu), 1.40–2.18 m (10H, CH_2), 2.30–2.41 m (2H, CH), 2.83–3.15 m (8H, NCH_2), 3.88 m (1H, NCH). Mass spectrum, *m*/*z*: 294 $[M + H]^+$, 237 $[M - 57 + H]^+$, 193 $[M - 101 + H]^+$. Found, %: C 69.57; H 9.83; N 9.48. $C_{17}H_{29}N_2O_2$. Calculated, %: C 69.64; H 9.89; N 9.55.

***tert*-Butyl 9-piperidino-3-azabicyclo[3.3.1]nonane-3-carboxylate (XVIII).** Yield 92%, colorless oily substance, R_f 0.65. IR spectrum: ν 1682 cm^{-1} (C=O). ^1H NMR spectrum, δ, ppm: 1.30 s (9H, *t*-Bu), 1.42–2.24 m (12H, CH_2), 2.32–2.45 m (2H, CH), 2.84–

3.17 m (8H, NCH_2), 3.91 m (1H, NCH). Mass spectrum, *m*/*z*: 308 $[M + H]^+$, 251 $[M - 57 + H]^+$, 207 $[M - 101 + H]^+$. Found, %: C 70.26; H 10.03; N 9.14. $C_{18}H_{31}N_2O_2$. Calculated, %: C 70.38; H 10.09; N 9.12.

3-Azabicyclo[3.3.1]nonan-9-one oxime dihydrochloride (XIX). Oxime **IV**, 1.27 g (5 mmol), was dissolved in 5 ml of anhydrous ethanol, 10 ml of a ~15–16% solution of hydrogen chloride in dioxane was added, and the mixture was left to stand for 12 h and was then heated for 10 min under reflux. The solvent was distilled off, and 30 ml of anhydrous diethyl ether was added to the residue. After 20–30 h, the precipitate was filtered off, washed with 20 ml of diethyl ether, and dried in a vacuum desiccator over anhydrous calcium chloride until constant weight. Yield 1.05 g (93%), mp 185–186°C. IR spectrum, ν, cm^{-1}: 3364 ($^+NH_2$), 1648 (C=N). ^1H NMR spectrum, δ, ppm: 1.52–2.31 m (6H, CH_2), 2.58–2.67 m (2H, CH), 4.12 d (2H, NCH_2), 4.21 d (2H, NCH_2), 9.81 br.s (2H, H_2N^+), 11.93 s (1H, OH). Mass spectrum: *m*/*z* 154 $[M + H]^+$. Found, %: C 42.51; H 6.18; N 12.56. $C_8H_{14}Cl_2N_2O$. Calculated, %: C 42.69; H 6.22; N 12.44.

Compounds **XX–XXVI** were synthesized in a similar way.

3-Azabicyclo[3.3.1]nonan-9-one hydrazone dihydrochloride (XX). Yield 87%, mp 167–168°C. IR spectrum, ν, cm^{-1}: 3371–3386 ($^+NH_2$), 1622 (C=N). ^1H NMR spectrum, δ, ppm: 1.56–2.34 m (6H, CH_2), 2.56–2.64 m (2H, CH), 4.15 d (2H, NCH_2), 4.20 d (2H, NCH_2), 8.74 br.s (3H, H_3N^+), 9.84 br.s (2H, H_2N^+). Mass spectrum: *m*/*z* 153 $[M + H]^+$. Found, %: C 42.76; H 6.57; N 18.63. $C_8H_{15}Cl_2N_3$. Calculated, %: C 42.88; H 6.69; N 18.74.

3-Azabicyclo[3.3.1]nonan-9-one azine tetrahydrochloride (XXI). Yield 95%, mp 211–212°C. IR spectrum, ν, cm^{-1}: 3372–3386 ($^+NH_2$), 1620 (C=N). ^1H NMR spectrum, δ, ppm: 1.55–2.36 m (12H, CH_2), 2.58–2.66 m (4H, CH), 4.12–4.23 m (4H, NCH_2), 4.31–4.42 m (4H, NCH_2), 9.24 br.s (2H, NH^+), 9.82 br.s (2H, H_2N^+). Mass spectrum: *m*/*z* 273 $[M + H]^+$. Found, %: C 45.64; H 7.47; N 13.12. $C_{16}H_{30}Cl_4N_4$. Calculated, %: C 45.73; H 7.14; N 13.33.

***N*-Phenyl-3-azabicyclo[3.3.1]nonan-9-amine dihydrochloride (XXII).** Yield 96%, mp 204–205°C. IR spectrum: ν 3375–3388 cm^{-1} ($^+NH_2$). ^1H NMR spectrum, δ, ppm: 1.51–2.36 m (6H, CH_2), 2.31–2.48 m (2H, CH), 4.12 d (2H, NCH_2), 4.23 d (2H, NCH_2), 5.08 m (1H, NCH), 7.84–8.05 m (5H, C_6H_5), 9.45 br.s (2H, $\mathbf{H}_2N^+Ph$), 9.88 br.s (2H, H_2N^+). Mass spectrum: *m*/*z* 215 $[M + H]^+$. Found, %: C 58.07; H 7.53; N 9.74. $C_{14}H_{22}Cl_2N_2$. Calculated, %: C 58.15; H 7.61; N 9.68.

***N*-(4-Chlorophenyl)-3-azabicyclo[3.3.1]nonan-9-amine dihydrochloride (XXIII).** Yield 94%, mp 208–209°C. IR spectrum, ν, cm^{-1}: 3378–3391 ($^+NH_2$). ^1H NMR spectrum, δ, ppm: 1.53–2.41 m (6H, CH_2), 2.34–2.50 m (2H, CH), 4.15 d (2H, NCH_2), 4.24 d (2H, NCH_2), 5.11 m (1H, NCH), 7.43 d and 8.09 d (2H each, C_6H_4, J = 8.0 Hz), 9.48 br.s (2H, $\mathbf{H}_2N^+C_6H_4$), 9.91 br.s (2H, $\mathbf{H}_2N^+$). Mass spectrum: *m*/*z* 250 $[M + H]^+$. Found, %: C 51.93; H 6.38; N 8.57. $C_{14}H_{21}Cl_3N_2$. Calculated, %: C 51.95; H 6.49; N 8.65.

***N*-(4-Bromophenyl)-3-azabicyclo[3.3.1]nonan-9-amine (XXIV).** Yield 91%, mp 218–219°C. IR spectrum: ν 3374–3389 cm^{-1} ($^+NH_2$). ^1H NMR spectrum, δ, ppm: 1.52–2.43 m (6H, CH_2), 2.36–2.52 m (2H, CH), 4.18 d (2H, NCH_2), 4.26 d (2H, NCH_2), 5.09 m (1H, NCH), 7.39 d and 8.06 d (2H each, C_6H_4, J = 7.5 Hz), 9.46 br.s (2H, $\mathbf{H}_2N^+C_6H_4$), 9.90 br.s (2H, H_2N^+). Mass spectrum: *m*/*z* 295 $[M + H]^+$. Found, %: C 45.61; H 5.48; N 7.59. $C_{14}H_{21}BrCl_2N_2$. Calculated, %: C 45.67; H 5.70; N 7.61.

9-(Pyrrolidin-1-yl)-3-azabicyclo[3.3.1]nonane dihydrochloride (XXV). Yield 89%, mp 174–175°C. IR spectrum: ν 3369 cm^{-1} ($^+NH_2$). ^1H NMR spectrum, δ, ppm: 1.48–2.64 m (10H, CH_2), 2.72–2.86 m (2H, CH), 4.23–4.42 m (8H, NCH_2), 5.12 m (1H, NCH), 8.83 s (1H, HN^+), 9.89 br.s (2H, H_2N^+). Mass spectrum: *m*/*z* 194 $[M + H]^+$. Found, %: C 54.04; H 8.89; N 10.63. $C_{12}H_{24}Cl_2N_2$. Calculated, %: C 53.95; H 8.98; N 10.48.

9-Piperidino-3-azabicyclo[3.3.1]nonane dihydrochloride (XXVI). Yield 90%, mp 188–189°C. IR spectrum: ν 3372 cm^{-1} ($^+NH_2$). ^1H NMR spectrum, δ, ppm: 1.51–2.68 m (12H, CH_2), 2.71–2.86 m (2H, CH), 4.22–4.46 m (8H, NCH_2), 5.08 m (1H, NCH), 8.85 s (1H, HN^+), 9.90 br.s (2H, H_2N^+). Mass spectrum: *m*/*z* 208 $[M + H]^+$. Found, %: C 55.43; H 9.18; N 9.85. $C_{13}H_{26}Cl_2N_2$. Calculated, %: C 55.54; H 9.25; N 9.96.

REFERENCES

1. Moskalenko, A.I. and Boev, V.I., *Russ. J. Org. Chem*., 2009, vol. 45, p. 472.
2. Lowe, J.A., Drozda, S.E., McLean, S., Bryce, D.K., Crawford, R.T., Snider, M.R., Longo, K.P., Nagahisa, A., and Tsuchiya, M., *J. Med. Chem*., 1994, vol. 37, p. 2831.
3. Yakhontov, L.N. and Glushkov, R.G., *Sinteticheskie lekarstvennye sredstva* (Synthetic Medicines), Moscow: Meditsina, 1983.