ISSN 1070-3632, Russian Journal of General Chemistry, 2014, Vol. 84, No. 9, pp. 1689–1693. © Pleiades Publishing, Ltd., 2014.
Original Russian Text © V.L. Gein, L.F. Gein, V.S. Platonov, O.V. Bobrovskaya, 2014, published in Zhurnal Obshchei Khimii, 2014, Vol. 84, No. 9, pp. 1449–1453.

Reactions of 1,5-Diaryl-4-heteroyl-3-hydroxy-3-pyrrolin-2-ones with Arylamines and Butylamine

V. L. Gein[a], L. F. Gein[b], V. S. Platonov[a], and O. V. Bobrovskaya[a]

[a] *Perm State Pharmaceutical Academy, Perm, Russia*
[b] *Perm State Medical Academy, ul. Polevaya 2, Perm, 614990 Russia*
e-mail: geinvl48@mail.ru

Received May 8, 2014

Abstract—1,5-Diaryl-4-[2-thienoyl(furanoyl)]-3-hydroxy-3-pyrrolin-2-ones reacted with aromatic amines to form arylamino-3-pyrrolin-2-ones. Reactions with butylamine occurred via intermediate salt formation followed by their transformation into 3-butylamino-3-pyrrolin-2-ones at heating.

Keywords: 1,5-diaryl-4-heteroyl-3-hydroxy-3-pyrrolin-2-ones, arylamines, butylamine
DOI: 10.1134/S1070363214090072

Heteroyl-substituted 1,5-diaryl-4-acyl-3-hydroxy-3-pyrrolin-2-ones have been known to possess high antimicrobial activity against both *Staphylococcus aureus* and *Escherichia coli* [1, 2]. 3-Amino-derived 1,5-diaryl-3-hydroxy-3-pirrolin-2-ones show antiphlogistic activity [1].

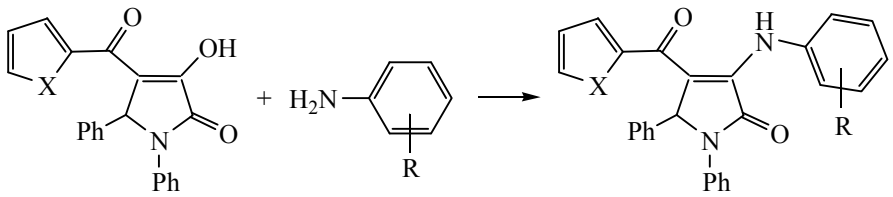
Aiming to obtain potentially biologically active compounds, we studied reactions of the previously obtained [1] 1,5-diphenyl-4-[2-furanoyl(thienoyl)]-3-hydroxy-3-pyrrolin-2-ones with aromatic and aliphatic amines.

Depending on the nature of the substituent in the position *4* of the heterocycle, 1,4-disubstituted 5-aryl-3-hydroxy-3-pyrrolin-2-ones reacted with nucleophilic reagent involving the carbonyl group in the position *3* of the heterocycle [3–6] or the carbonyl in the side chain [3, 4, 7–9]. We found that prolonged reflux of a mixture of 1,5-diphenyl-4-(2-furanoyl)-3-hydroxy-3-pyrrolin-2-one **Ia** or 1,5-diphenyl-4-(2-thienoyl)-3-hydroxy-3-pyrrolin-2-one **Ih** with aromatic amines in glacial acetic acid afforded 1,5-diphenyl-3-arylamino-4-furanoyl-3-pyrrolin-2-ones **IIa**–**IIg** and 1,5-diphenyl-3-arylamino-4-thienoyl-3-pyrrolin-2-ones **IIh**–**IIo** (Scheme 1).

The obtained compounds **IIa**–**IIo** were colorless or yellow crystalline substances soluble in common organic solvents.

In contrast to the original 3-pyrrolin-2-ones, ^{1}H NMR spectra of arylamino derivatives **IIa**–**IIo** contained the signal of the secondary amino group at 8.33–9.55 ppm that indicates the reaction involving the carbonyl group in the position *3* of the heterocycle [3, 4]. When the carbonyl group of the side chain takes part in the reaction, in the spectra of the reaction products the

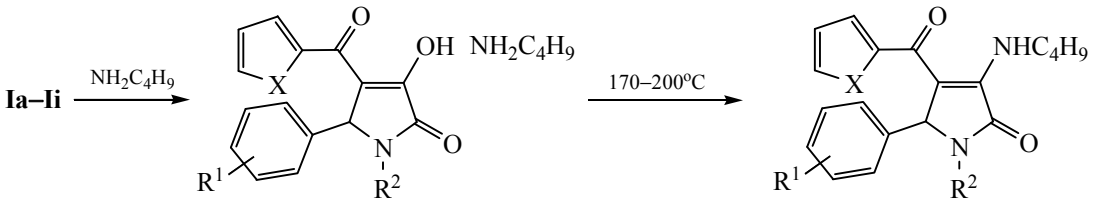
Scheme 1.



Ia, Ih **IIa–IIn**

I, X = O (**a**), X = S (**h**); **II**, R = H (**a, h**), 4-CH_3 (**b, n**), 4-CH_3O (**c, m**), 2-CH_3O (**d, i**), 4-Br (**e**), 2-CH_3 (**f**, **j**), 3-CH_3 (**g**, **k**), 4-Cl (**l**); X=O (**a–g**), S (**h–n**).

Scheme 2.



R^1 = 4-$(CH_3)_2CH$ (**a**), H (**b**, **c**, **f**, **g**), 4-Cl (**d**), 3-NO_2 (**e**), 4-F (**h**), 4-Br (**i**); R^2 = C_6H_5 (**a**, **d**, **e**, **h**, **i**), 4-$CH_3C_6H_4$ (**b**), 2-thiazolyl (**c**, **f**), 3-$CH_3C_6H_4$ (**g**); X = O (**a**–**e**), S (**f**–**i**).

signal of the NH group was shifted downfield (12.45–12.58 ppm) [6].

In the mass spectra of **IIb**, **IIe**, **IIj** the molecular ion peak and peaks of the fragment ions were observed supporting the structure of the compounds obtained.

Note that electron-withdrawing substituents in the arylamine likes chloro, bromo, and nitro hampers the reaction course. However the nature of the heterocycle in the position *4* almost does not affect the reaction course.

Reactions of 1,5-diaryl-4-heteroyl-3-hydroxy-3-pyrrolin-2-ones with butylamine proceeded in dioxane at room temperature to afford the corresponding butylammonium 3-pyrrolin-3-olates **IIIa**–**IIIi** (Scheme 2).

The obtained compounds **IIIa**–**IIIi** were colorless or pale yellow crystalline substances soluble in dimethylformamide or dimethylsulfoxide and insoluble in water.

The IR spectra of **IIIa**–**IIIi** contained absorption bands of the exocyclic carbonyl group (1612–1635 cm^{-1}), the lactam carbonyl group (1675–1683 cm^{-1}), the OH and NH_2 groups (3050–3110 cm^{-1}).

In the ^1H NMR spectra of **IIIa**–**IIIi** there were the signals of *t*-butyl fragment (0.88–0.89 ppm), the methylene (1.33–1.35, 1.52–1.55 ppm), CH_2N (2.80–2.83 ppm), OH and NH_2 groups (7.78–8.05 ppm) along with the signals characteristic of the starting materials **I**.

All compounds obtained showed a characteristic cherry coloring when reacting with an alcohol solution of iron(III) chloride, which confirmed the structure formation by the interaction of the enol hydroxy group and the amine.

Heating the obtained salts **IIId**–**IIIf**, and **IIIh** at 170–200°C until gas evolution ceased resulted in 1,5-diaryl-3-butylamino-4-3-heteroyl-3-pyrrolin-2-ones **IVd**–**IVf**, and **IVh**.

The obtained compounds **IVd**–**IVf**, and **IVh** were colorless or pale yellow crystalline substances soluble in dimethylformamide or dimethylsulfoxide, and insoluble in water.

The IR spectra of **IVd**–**IVf** and **IVh** contained the absorption bands of the exocyclic carbonyl group (1635–1650 cm^{-1}), the lactam carbonyl group (1700–1710 cm^{-1}), and the NH group (3080–3100 cm^{-1}).

In the ^1H NMR spectra of compounds **IV** there were the signals of butyl residue [0.75–0.91 ppm (CH_3), 1.26–1.36 ppm (C^2H_2), 1.47–1.58 ppm (C^3H_2)], the enantiotopic protons of $C^1H_AH_B$ moiety (3.23–3.80, 3.32–3.93 ppm), and the NH group (8.60–9.08 ppm). Location of the signal of NH group in this region confirms the formation of 3-amino derivatives.

In contrast to the initial salts, compounds **IV** did not gave a cherry coloring when reacting with an alcohol solution of iron(III) chloride. It confirmed the formation of 3-alkylamino derivatives **IV**, whose enamine structure is apparently stabilized by an intramolecular hydrogen bonding (according to NMR).

EXPERIMENTAL

IR spectra were obtained on a Specord UR-20 instrument (mineral oil). ^1H NMR spectra of the solutions in DMSO-d_6 were registered on a Bruker DRX 500 spectrometer (500.13 MHz), internal reference TMS. Mass spectra (EI) were recorded on a Finnigan MAT INCOS 50 spectrometer (70 eV). Elemental analysis was performed on a Perkin Elmer 2400 instrument. Melting points were determined on a Melting Point M-565 apparatus.

4-(2-Furanoyl)-1,5-diphenyl-3-phenylamino-3-pyrrolin-2-one (IIa). A mixture of 3.60 g (0.01 mol) of 1,5-diphenyl-4-furanoyl-3-hydroxy-3-pyrrolin-2-one and 0.93 g (0.01 mol) of aniline in 10 ml of glacial

acetic acid was refluxed for 1 h. After cooling the formed precipitate was filtered off and recrystallized. Yield 1.60 g (38%), mp 215–217°C (toluene). ^{1}H NMR spectrum, δ, ppm: 6.32 s (1H, C^{5}H), 6.99 m (18H, H_{Ar}), 9.37 s (1H, NH). Found, %: C 77.27, 77.19; H 4.86, 4.73; N 6.79, 6.72. $C_{27}H_{20}N_2O_3$. Calculated, %: C 77.13; H 4.79; N 6.66.

Compounds **IIb**–**IIn** were obtained similarly.

4-(2-Furanoyl)-1,5-diphenyl-3-(4-tolylamino)-3-pyrrolin-2-one (IIb). Yield 3.12 g (72%), mp 238–240°C (toluene). IR spectrum, ν, cm^{-1}: 1650 (C=O), 1700 (CON), 3290 (NH). ^{1}H NMR spectrum, δ, ppm: 2.17 s (3H, CH_3), 6.54 s (1H, C^{5}H), 7.09 m (17H, H_{Ar}), 9.20 s (1H, NH). Mass spectrum (EI, 70 eV), *m*/*z*: 434 $[M]^+$, 339 [*M* – furanoyl]$^+$, 95 [furanoyl]$^+$, 92 $[CH_3C_6H_4]^+$, 77 [Ph]$^+$. Found, %: C 77.58, 77.51; H 5.26. 5.17; N 6.61. 6.65. $C_{28}H_{22}N_2O_3$. Calculated, %: C 77.40; H 5.10; N 6.45.

4-(2-Furanoyl)-3-(4-methoxyphenylamino)-1,5-diphenyl-3-pyrrolin-2-one (IIc). Yield 3.65 g (81%), mp 229–231°C (EtOH). IR spectrum, ν, cm^{-1}: 1640 (C=O), 1695 (CON), 3280 (NH). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 3.74 s (3H, CH_3O), 6.36 s (1H, C^{5}H), 7.01 d (4H, H_{Ar}, *J* 7.4 Hz), 7.08 m (13H, H_{Ar}), 9.55 s (1H, NH). Found, %: C 74.59, 74.70; H 5.20, 5.11; N 6.31, 6.28. $C_{28}H_{22}N_2O_4$. Calculated, %: C 74.65; H 4.92; N 6.22.

4-(2-Furanoyl)-3-(2-methoxyphenylamino)-1,5-diphenyl-3-pyrrolin-2-one (IId). Yield 2.16 g (48%), mp 148–150°C (EtOH). ^{1}H NMR spectrum, δ, ppm: 3.70 s (3H, CH_3O), 6.59 s (1H, C^{5}H), 7.08 m (17H, H_{Ar}), 9.17 s (1H, NH). Found, %: C 77.63, 77.17; H 5.29, 5.22; N 6.55, 6.59. $C_{28}H_{22}N_2O_4$. Calculated, %: C 77.40; H 5.10; N 6.45.

3-(4-Bromophenylamino)-4-(2-furanoyl)-1,5-diphenyl-3-pyrrolin-2-one (IIe). Yield 4.29 g (86%), mp 240–242°C (EtOH). ^{1}H NMR spectrum, δ, ppm: 6.43 s (1H, C^{5}H), 6.95 m (17H, H_{Ar}), 9.42 s (1H, NH). Mass spectrum (EI, 70 eV), *m*/*z*: 449 $[M]^+$, 403 [*M* – furanoyl]$^+$, 157 $[BrC_6H_4]^+$, 95 [furanoyl]$^+$, 77 [Ph]$^+$. Found, %: C 64.73, 64.81; H 3.96, 3.90; N 5.79, 5.72. $C_{27}H_{19}BrN_2O_3$. Calculated, %: C 64.94; H 3.83; N 5.61.

4-(2-Furanoyl)-1,5-diphenyl-3-(2-tolylamino)-3-pyrrolin-2-one (IIf). Yield 2.26 g (52%), mp 171–172°C (EtOH). ^{1}H NMR spectrum, δ, ppm: 2.26 s (3H, CH_3), 6.52 s (1H, C^{5}H), 7.06 m (17H, H_{Ar}), 8.91 s (1H, NH). Found, %: C 77.28, 77.21; H 5.37, 5.29; N 6.23, 6.30. $C_{28}H_{22}N_2O_3$. Calculated, %: C 77.40; H 5.10; N 6.45.

4-(2-Furanoyl)-1,5-diphenyl-3-(3-tolylamino)-3-pyrrolin-2-one (IIg). Yield 3.56 g (82%), mp 218–219°C (2-propanol). IR spectrum, ν, cm^{-1}: 1641 (C=O), 1690 (CON), 3272 (NH). ^{1}H NMR spectrum, δ, ppm: 2.11 s (3H, CH_3), 6.53 s (1H, C^{5}H), 7.07 m (17H, H_{Ar}), 9.09 s (1H, NH). Found, %: C 77.19, 77.31; H 5.33, 5.27; N 6.31, 6.24. $C_{28}H_{22}N_2O_3$. Calculated, %: C 77.40; H 5.10; N 6.45.

1,5-Diphenyl-3-phenylamino-4-(2-thienoyl)-3-pyrrolin-2-one (IIh). Yield 3.88 g (89%), mp 228–229°C (EtOH). ^{1}H NMR spectrum, δ, ppm: 6.48 s (1H, C^{5}H), 7.23 m (18H, H_{Ar}), 8.90 s (1H, NH). Found, %: C 74.37, 74.41; H 4.80. 4.76; N 6.61, 6.57; S 7.56, 7.49. $C_{27}H_{20}N_2O_2S$. Calculated, %: C 74.29; H 4.62; N 6.42; S 7.34.

1,5-Diphenyl-3-(2-methoxyphenylamino)-4-(2-thienoyl)-3-pyrrolin-2-one (IIi). Yield 3.08 g (66%), mp 194–196°C (2-propanol). IR spectrum, ν, cm^{-1}: 1660 (C=O), 1704 (CON), 3362 (NH). ^{1}H NMR spectrum, δ, ppm: 3.66 s (3H, CH_3O), 6.51 s (1H, C^{5}H), 7.20 m (17H, H_{Ar}), 8.64 s (1H, NH). Found, %: C 72.23, 72.17; H 4.69, 4.77; N 6.15, 6.23; S 6.65, 6.73. $C_{28}H_{22}N_2O_3S$. Calculated, %: C 72.08; H 4.75; N 6.00; S 6.87.

1,5-Diphenyl-4-(2-thienoyl)-3-(2-tolylamino)-3-pyrrollin-2-one (IIj). Yield 4.06 g (90%), mp 194–196°C (toluene). ^{1}H NMR spectrum, δ, ppm: 2.16 s (3H, CH_3), 6.44 s (1H, C^{5}H), 7.23 m (17H, H_{Ar}), 8.33 s (1H, NH). Mass spectrum (EI, 70 eV), *m*/*z* : 450 $[M]^+$, 339 [*M* – thienoyl]$^+$, 111 [thienoyl]$^+$, 92 $[CH_3C_6H_4]^+$, 77 [Ph]$^+$. Found, %: C 74.53, 74. 47; H 5.07, 5.01; N 6.35, 6.29; S 7.33, 7.28. $C_{28}H_{22}N_2O_2S$. Calculated, %: C 74.64; H 4.92; N 6.22; S 7.12.

1,5-Diphenyl-4-(2-thienoyl)-3-(3-tolylamino)-3-pyrrollin-2-one (IIk). Yield 4.01 g (89%), mp 123–125°C (EtOH). ^{1}H NMR spectrum, δ, ppm: 2.14 s (3H, CH_3), 6.30 s (1H, C^{5}H), 7.08 m (17H, H_{Ar}), 8.55 s (1H, NH). Found, %: C 74.53, 74.59; H 5.10, 5.13; N 6.42, 6.37; S 7.23, 7.27. $C_{28}H_{22}N_2O_2S$. Calculated, %: C 74.64; H 4.92; N 6.22; S 7.12.

3-(4-Chlorophenylamino)-1,5-diphenyl-4-(2-thienoyl)-3-pyrrolin-2-one (IIl). Yield 4.00 g (85%), mp 251–253°C (toluene). ^{1}H NMR spectrum, δ, ppm: 6.48 s (1H, C^{5}H), 7.36 m (17H, H_{Ar}), 9.04 s (1H, NH). Found, %: C 68.73, 68.77; H 4.28, 4.24; N 5.81, 5.78; S 6.85, 6.73. $C_{27}H_{19}ClN_2O_2S$. Calculated, %: C 68.86; H 4.07; N 5.95; S 6.81.

3-(4-Methoxyphenylamino)-1,5-diphenyl-4-(2-thienoyl)-3-pyrrolin-2-one (IIm). Yield 4.33 g (93%),

mp 227–229°C (EtOH). IR spectrum, ν, cm^{-1}: 1655 (C=O), 1700 (CON), 3320 (NH). ^1H NMR spectrum, δ, ppm: 3.63 s (3H, CH_3O), 6.47 s (1H, C^5H), 7.16 m (17H, H_{Ar}), 8.86 s (1H, NH). Found, %: C 72.32, 72.26; H 4.59, 4.68; N 6.19, 6.08; S 6.76, 6.80. $C_{28}H_{22}N_2O_3S$. Calculated, %: C 72.08; H 4.75; N 6.00; S 6.87.

1,5-Diphenyl-4-(2-thienoyl)-3-(4-tolylamino)-3-pyrrolin-2-one (IIn). Yield 3.20 g (71%), mp 243–244°C (toluene). ^1H NMR spectrum, δ, ppm: 2.17 s (3H, CH_3), 6.32 s (1H, C^5H), 7.20 m (17H, H_{Ar}), 8.68 s (1H, NH). Found, %: C 74.53. 74.60; H 5.05, 5.11; N 6.40, 6.34; S 7.22, 7.27. $C_{28}H_{22}N_2O_2S$. Calculated, %: C 74.64; H 4.92; N 6.22; S 7.12.

Butylammonium 4-(2-furanoyl)-5-(4-isopropylphenyl)-2-oxo-1-phenyl-3-pyrrolin-3-olate (IIIa). To a solution of 3.87 g (0.01 mol) of **Ia** in 10 mL of dioxane was added 0.73 g (0.01 mol) of *n*-butylamine. The reaction mixture was stirred at room temperature for 1 day. The precipitate was filtered off and recrystallized. Yield 4.55 g (99.0%), mp 190–192°C (toluene). IR spectrum, ν, cm^{-1}: 1612 (C=O), 1675 (CON), 3110 (OH, NH_2). ^1H NMR spectrum, δ, ppm: 0.88 t (3H, C^4H_3), 1.08 d [6H, $(CH_3)_2$], 1.35 m (2H, C^3H_2), 1.53 m (2H, C^2H_2), 2.72 q [1H, $CH(CH_3)_2$], 2.82 m (2H, C^1H_2), 5.92 s (1H, C^5H), 7.56 m (12H, H_{Ar}), 8.03 s (1H, OH, NH_2). Found, %: C 72.87, 72.95; H 6.86, 6.92; N 5.79, 5.86. $C_{28}H_{32}N_2O_4$. Calculated, %: C 73.02; H 7.00; N 6.01.

Compounds **IIIb**–**IIIi** were prepared similarly.

Butylammonium 4-(2-furanoyl)-2-oxo-5-phenyl-1-(4-tolyl)-3-pyrrolin-3-olate (IIIb). Yield 4.14 g (96.0%), mp 179–181°C (toluene). ^1H NMR spectrum, δ, ppm: 0.89 t (3H, C^4H_3), 1.34 m (2H, C^3H_2), 1.53 m (2H, C^2H_2), 2.18 s (3H, CH_3), 2.80 m (2H, C^1H_2), 5.89 s (1H, C^5H), 7.55 m (12H, H_{Ar}), 8.03 s (1H, OH, NH_2). Found, %: C 72.37, 72.17; H 6.61, 6.70; N 6.59, 6.51. $C_{26}H_{28}N_2O_4$. Calculated, %: C 72.20; H 6.52; N 6.47.

Butylammonium 4-(2-furanoyl)-2-oxo-5-phenyl-1-(2-thiazolyl)-3-pyrrolin-3-olate (IIIc). Yield 4.04 g (95.0%), mp 182–183°C (toluene). IR spectrum, ν, cm^{-1}: 1620 (C=O), 1670 (CON), 3070 (OH, NH_2). ^1H NMR spectrum, δ, ppm: 0.88 t (3H, C^4H_3), 1.35 m (2H, C^3H_2), 1.52 m (2H, C^2H_2), 2.80 m (2H, C^1H_2), 5.99 s (1H, C^5H), 7.58 m (10H, H_{Ar}), 7.82 s (1H, OH, NH_2). Found, %: C 62.31, 62.26; H 5.31, 5.39; N 9.69, 9.75; S 7.57, 7.48. $C_{22}H_{23}N_3O_4S$. Calculated, %: C 62.10; H 5.45; N 9.87; S 7.53.

Butylammonium 5-(4-chlorophenyl)-4-(2-furanoyl)-2-oxo-1-phenyl-3-pyrrolin-3-olate (IIId). Yield 3.40 g (75.0%), mp 188–190°C (toluene). ^1H NMR spectrum, δ, ppm: 0.88 t (3H, C^4H_3), 1.34 m (2H, C^3H_2), 1.52 m (2H, C^2H_2), 2.81 m (2H, C^1H_2), 5.94 s (1H, C^5H), 7.58 m (12H, H_{Ar}), 7.91 s (1H, OH, NH_2). Found, %: C 66.51, 66.47; H 5.67, 5.61; N 6.09, 6.23. $C_{25}H_{25}ClN_2O_4$. Calculated, %: C 66.30; H 5.56; N 6.18.

Butylammonium 4-(2-furanoyl)-5-(3-nitrophenyl)-2-oxo-1-phenyl-3-pyrrolin-3-olate (IIIe). Yield 4.58 g (98.0%), mp 182–184°C (toluene). IR spectrum, ν, cm^{-1}: 1610 (C=O), 1675 (CON), 3050 (OH, NH_2). ^1H NMR spectrum, δ, ppm: 0.88 t (3H, C^4H_3), 1.33 m (2H, C^3H_2), 1.54 m (2H, C^2H_2), 2.82 m (2H, C^1H_2), 6.13 s (1H, C^5H), 7.61 m (12H, H_{Ar}), 7.92 s (1H, OH, NH_2). Found, %: C 64.61, 64.72; H 5.53, 5.59; N 8.89, 9.02. $C_{25}H_{25}N_3O_6$. Calculated, %: C 64.78; H 5.44; N 9.10.

Butylammonium 2-oxo-5-phenyl-1-(2-thiazolyl)-4-(2-thienoyl)-3-pyrrolin-3-olate (IIIf). Yield 4.23 g (96.0%), mp 123–125°C (toluene). ^1H NMR spectrum, δ, ppm: 0.89 t (3H, C^4H_3), 1.33 m (2H, C^3H_2), 1.52 m (2H, C^2H_2), 2.80 m (2H, C^1H_2), 5.99 s (1H, C^5H), 8.16 m (10H, H_{Ar}), 7.78 s (1H, OH, NH_2). Found, %: C 59.61,59.66; H 5.01, 5.18; N 9.69, 9.61; S 14.62, 14.68. $C_{22}H_{23}N_3O_3S_2$. Calculated, %: C 59.83; H 5.25; N 9.52; S 14.52.

Butylammonium 2-oxo-5-phenyl-4-(2-thienoyl)-1-(4-tolyl)-3-pyrrolin-3-olate (IIIg). Yield 4.39 g (98.0%), mp 176–178°C (toluene). IR spectrum, ν, cm^{-1}: 1635 (C=O), 1683 (CON), 3050 (OH, NH_2). ^1H NMR spectrum, δ, ppm: 0.88 t (3H, C^4H_3), 1.34 m (2H, C^3H_2), 1.55 m (2H, C^2H_2), 2.21 s (3H, CH_3), 2.83 m (2H, C^1H_2), 5.91 s (1H, C^5H), 8.05 m (12H, H_{Ar}), 8.05 s (1H, OH, NH_2). Found, %: C 69.47, 69.45; H 6.41, 6.36; N 6.39, 6.16; S 7.33, 7.24. $C_{26}H_{28}N_2O_3S$. Calculated, %: C 69.62; H 6.29; N 6.24; S 7.15.

Butylammonium 5-(4-fluorophenyl)-2-oxo-1-phenyl-4-(2-thienoyl)-3-pyrrolin-3-olate (IIIh). Yield 3.23 g (69%), mp 173–175°C (toluene). ^1H NMR spectrum, δ, ppm: 0.88 t (3H, C^4H_3), 1.33 m (2H, C_3H_2), 1.53 m (2H, C^2H_2), 2.81 m (2H, C^1H_2), 5.93 s (1H, C^5H), 8.11 m (12H, H_{Ar}), 7.88 s (1H, OH, NH_2). Found, %: C 64.31; H 5.27; N 6.09; S 6.75. $C_{25}H_{25}FN_2O_3S$. Calculated, %: C 64.09; H 5.38; N 5.98; S 6.84.

Butylammonium 5-(4-bromophenyl)-2-oxo-1-phenyl-4-(2-thienoyl)-3-pyrrolin-3-olate (IIIi). Yield 4.82 g (94%), mp 162–164°C (toluene). ^1H NMR spectrum, δ, ppm: 0.88 t (3H, C^4H_3), 1.34 m (2H,

C^3H_2), 1.52 m (2H, C^2H_2), 2.81 m (2H, C_1H_2), 5.94 s (1H, C_5H), 7.58 m (12H, H_{Ar}), 7.91 s (1H, OH, NH_2). Found, %: C 58.61, 58.56; H 4.67, 4.75; N 5.60, 5.52; S 6.41, 6.31. $C_{25}H_{25}BrN_2O_3S$. Calculated, %: C 58.48; H 4.91; N 5.46; S 6.24.

3-Butylamino-5-(4-chlorophenyl)-4-(2-furanoyl)-1-phenyl-3-pyrrolin-2-one (IVd). 4.52 g (0.01 mol) of **IIId** were heated on a metal bath at 170–200°C until gas evolution ceased. The residue was treated with ethanol, filtered off, and recrystallized. Yield 1.30 g (30%), mp 129–131°C (EtOH). IR spectrum, ν, cm^{-1}: 1650 (C=O), 1700 (CON), 3100 (NH). ^1H NMR spectrum, δ, ppm: 0.90 t (3H, C^4H_3), 1.35 m (2H, C^3H_2), 1.57 m (2H, C^2H_2), 3.78 m (1H, $C^1\underline{H}_AH_B$), 3.90 m (1H, $C^1H_A\underline{H}_B$), 6.58 s (1H, C^5H), 7.22 m (12H, H_{Ar}), 9.08 s (1H, NH). Found, %: C 69.21, 69.16; H 5.07, 5.14; N 6.49, 6.38. $C_{25}H_{23}ClN_2O_3$. Calculated, %: C 69.04; H 5.33; N 6.44.

Compounds **IVe**, **IVf**, **IVh** were prepared similarly.

3-Butylamino-4-(2-furanoyl)-5-(3-nitrophenyl)-1-phenyl-3-pyrrolin-2-one (IVe). Yield 2.09 g (47%), mp 119–121°C (EtOH). IR spectrum, ν, cm^{-1}: 1635 (C=O), 1710 (CON), 3080 (NH). ^1H NMR spectrum, δ, ppm: 0.76 t (3H, C^4H_3), 1.27 m (2H, C^3H_2), 1.51 m (2H, C^2H_2), 3.35 m (1H, $C^1\underline{H}_AH_B$), 3.66 m (1H, $C^1H_A\underline{H}_B$), 6.06 s (1H, C^5H), 7.22 m (12H, H_{Ar}), 8.80 s (1H, NH). Found, %: C 67.28, 67,33; H 5.19, 5.12; N 9.63, 9.52. $C_{25}H_{23}N_3O_5$. Calculated, %: C 67.41; H 5.20; N 9.43.

3-Butylamino-5-phenyl-1-(2-thiazolyl)-4-(2-thienoyl)-3-pyrrolin-2-one (IVf). Yield 3.14 g (74%), mp 136–139°C (EtOH). IR spectrum, ν, cm^{-1}: 1635 (C=O), 1710 (CON), 3080 (NH). ^1H NMR spectrum, δ, ppm: 0.76 t (3H, C^4H_3), 1.27 m (2H, C^3H_2), 1.51 m (2H, C^2H_2), 3.35 m (1H, $C^1\underline{H}_AH_B$), 3.66 m (1H, $C^1H_A\underline{H}_B$), 6.06 s (1H, C^5H), 7.22 m (10H, H_{Ar}), 8.80 s (1H, NH). Found, %: C 62.19, 62.26; H 5.11, 5.06; N 10.13, 9.98; S 15.33, 15.27. $C_{22}H_{21}N_3O_2S_2$. Calculated, %: C 62.39; H 5.00; N 9.92; S 15.14.

3-Butylamino-5-(4-fluorophenyl)-1-phenyl-4-(2-thienoyl)-3-pyrrolin-2-one (IVh). Yield 2.82 g (65%), mp 157–160°C (toluene). ^1H NMR spectrum, δ, ppm: 0.85 t (3H, C^4H_3), 1.30 m (2H, C^3H_2), 1.54 m (2H, C^2H_2), 3.59 m (1H, $C^1\underline{H}_AH_B$), 3.69 m (1H, $C^1H_A\underline{H}_B$), 6.60 s (1H, C^5H), 7.25 m (12H, H_{Ar}), 8.60 s (1H, NH). Found, %: C 69.27, 69.21; H 5.52, 5.45; N 6.39, 6.47; S 7.29, 7.25. $C_{25}H_{23}FN_2O_2S$. Calculated, %: C 69.10; H 5.34; N 6.45; S 7.38.

REFERENCES

1. Platonov, V.S., *Cand. Sci. (Pharm.) Dissertation*, Perm, 2004.
2. RF Patent no. 2259369, 2005; *Bull. Izobret.*, 2005, no. 24.
3. Gein, V.L., Fedorova, N.L., Levandovskaya, E.B., and Vakhrin, M.I., *Russ. J. Org. Chem.*, 2011, vol. 47, no. 1, p. 95. DOI: 10.1134/S1070428011010118.
4. Armisheva, M.N., Kornienko, N.A., Gein, V.L., and Vakhrin, M.I., *Russ. J. Gen. Chem.*, 2011, vol. 81, no. 9, p. 1893. DOI: 10.1134/S107036321109026X.
5. Andreichikov, Yu.S., Gein, V.L., and Anikina, I.N., *Zh. Org. Khim*., 1986, vol. 22, no. 8, p. 1749.
6. Gein, V.L., Shumilovskikh, E.V., Voronina, E.V., and Andreichikov, Yu.S., *Chem. Heterocycl. Comp*., 1992, no. 1, p. 27.
7. Gein, V.L., Voronina, E.V., and Andreichikov, Yu.S., *Zh. Org. Khim*., 1991, vol. 27, p. 1951.
8. Gein, L.F., Gein, V.L., Kylosova, I.A., and Aliev, Z.G., *Russ. J. Org. Chem.*, 2010, vol. 46, no. 2, p. 252. DOI: 10.1134/S1070428009020181.
9. Gein, V.L., Shumilovskikh, E.V., Voronina, E.V., Andreichikov, Yu.S., and Gein, L.F., *Zh. Obshch. Khim.*, 1994, vol. 64, p. 1203.