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# New Synthetic Method for Functionally Substituted Morpholinium 1,4-Dihydropyridine-2-thiolates and Their Derivatives

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**Abstract**—By condensation of aromatic aldehydes with cyanothioacetamide and enamines of 1,3-dicarbonyl compounds functionally substituted morpholinium 1,4-dihydropyridine-2-thiolates were obtained applied to the synthesis of 2-alkylsulfanyl-1,4-dihydropyridines, 1,4-dihydrothieno[2,3-*b*]-pyridines, and 2,3,4,7-tetrahydrothiazolo[3,2-*a*]pyridine.

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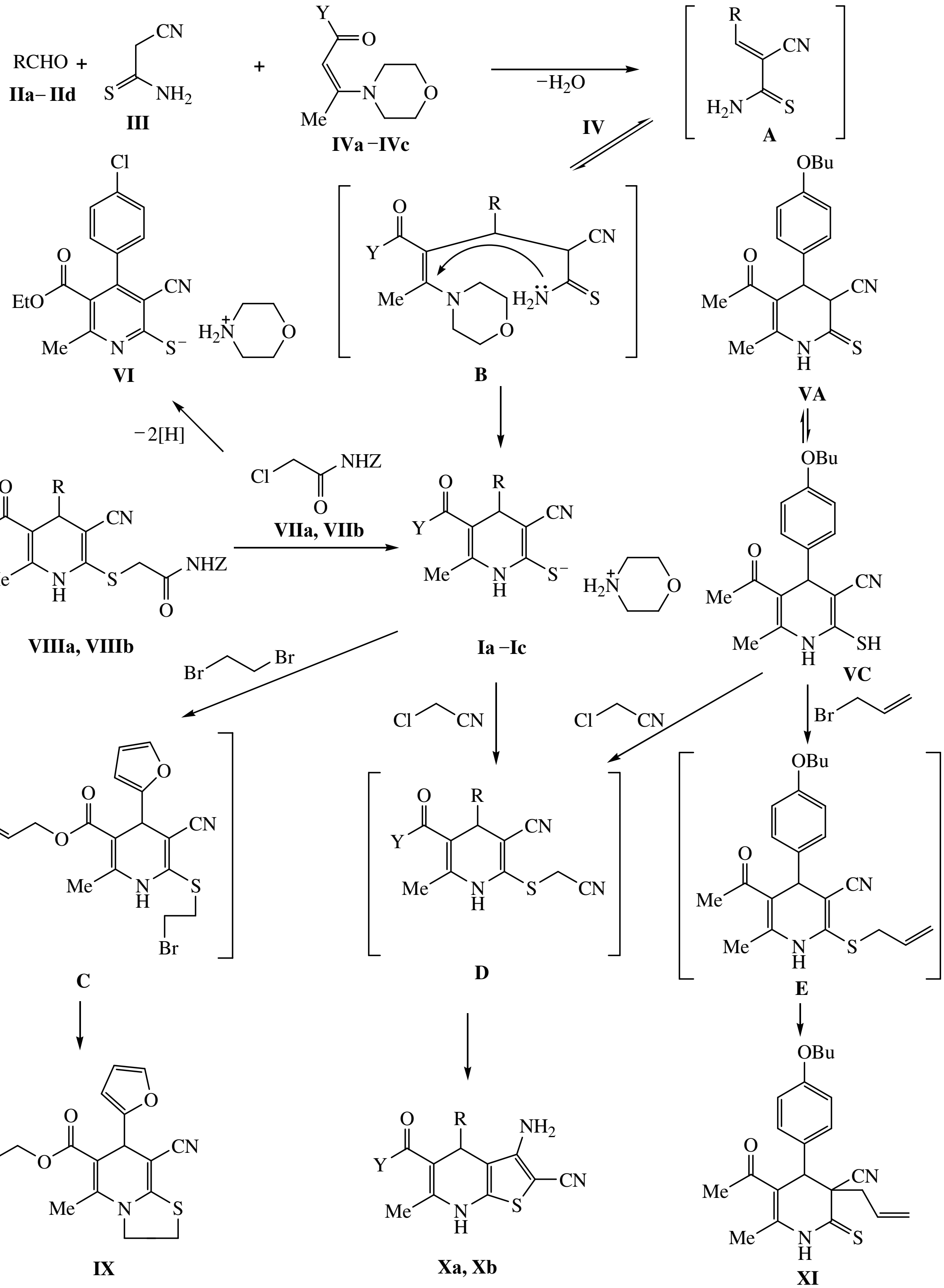
Interest in functionalized ammonium 1,4-dihydropyridine-2-thiolates is due to opportunities of preparing therefrom biologically active compounds with antioxidant [1], hepatoprotector [2], and cardiovascular [3] qualities. The following methods of synthesis for this class compounds were developed: three-component condensation of aldehydes, cyanothioacetamide, and 1,3-dicarbonyl compounds [4], reaction of aryl(heteryl)methylenecyanothioacetamide with 1,3-dicarbonyl compounds [5], and reaction of substituted ethyl acrylates with cyanothioacetamide [6].

In extension of our studies on the chemistry of partially hydrogenated pyridine-2-chalcogenones [7] we developed a new synthetic procedure for morpholinium 4-aryl-(heteryl)-6-methyl-3-cyano-1,4-dihydropyridine-2-thiolates **Ia–Ic** involving a three-component condensation of aromatic aldehydes **IIa–IId**, cyanothioacetamide (**III**), and enamines of 1,3-dicarbonyl compounds **IVa–IVc** in ethanol at 20°C in the presence of morpholine. The reaction pathway is likely to start with the formation of aryl(heteryl)methylenecyanothioacetamides **A** resulting from condensation of aldehydes **IIa–IId** with cyanothioacetamide (**III**) by Knoevenagel reaction. Then follows the alkylation of alkenes **A** with enamines of 1,3-dicarbonyl compounds **IVa–IVc** by Stork reaction type [8]. Adducts **B** thus formed undergo an intramolecular transamination that finishes in heterocyclization into substituted morpholinium 4-aryl-(heteryl)-6-methyl-3-cyano-1,4-dihydropyridine-2-thiolates **Ia–Ic**.

The structure of salts **Ia–Ic** was confirmed by spectral findings. In the IR spectra characteristic absorption bands were observed of the stretching vibrations of a conjugated cyano group and a carbonyl group at 2180–2194 and 1684–1695 cm$^{-1}$ respectively. $^1$H NMR spectra of compounds **Ia–Ic** alongside the characteristic signals of the substituents and of the morpholinium cation contained proton signals from the 1,4-dihydropyridine ring as singlets at δ 4.21–4.42 ($C^4H$) and 8.01–8.31 ($N^1H$) ppm in agreement with the data of [7, 9].

Involving in this condensation 4-butoxybenzaldehyde (**IId**) resulted in the formation of 5-acetyl-4-(4-butoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyridine-3-carbonitrile (**V**) existing in DMSO solution as a mixture of nearly equal amounts of thionethiol prototropic tautomers **VA** and **VB** as showed $^1$H NMR spectra. The direction of the chemical transformation of salts **Ia–Ic** and thione **V** also confirms their structure. In particular, the boiling in ethanol of compound **Ia** results in the aromatization of the 1,4-dihydropyridine ring, apparently by air oxygen, and in the formation of morpholinium 6-methyl-4-(4-chlorophenyl)-3-cyano-5-ethoxycarbonylpyridine-2-thiolate (**VI**). Alkylation of salts **Ib** and **Ic** in DMF with compounds **VIIa** and **VIIb** gives the corresponding thioethers **VIIIa** and **VIIIb**. At the same time the alkylation of salt **Ic** with 1,2-dibromoethane did not stop at the formation of the corresponding thioether **C**, but an intramolecular alkylation of a nitrogen from the dihydropyridine ring with the bromoethyl moiety occurred providing allyl-5-methyl-



**I**, R = 4-$ClC_6H_4$, Y = EtO (**a**), R = 4-$HOC_6H_4$, Y = Me (**b**), R = 2-furyl, Y = $CH_2$=$CHCH_2O$ (c); **II**, R = 4-$ClC_6H_4$ (**a**), 4-$HOC_6H_4$ (**b**), 2-furyl (**c**), 4-$BuOC_6H_4$ (**d**); **IV**, Y = EtO (**a**), Me (**b**), $CH_2$=$CHCH_2O$ (**c**); **VII**, Z = H (**a**), 2-thiazolyl (**b**); **VIII**, R = 4-$HOC_6H_4$, Y = Me, Z = H (**a**), R = 2-furyl, Y = $CH_2$=$CHCH_2O$, Z = 2-thiazolyl (**b**); X, R = 2-furyl, Y = $CH_2$=$CHCH_2O$ (**a**), R = 4-$BuOC_6H_4$, Y = Me (**b**).

7-(2-furyl)-8-cyano-2,3,4,7-tetrahydrothiazolo[3,2-*a*]pyridine-6-carboxylate (**IX**). A reaction of salt **Ic** and thione **V** with α-chloroacetonitrile in DMF led to the formation of substituted 4,7-dihydrothieno[2,3-*b*]pyridines **Xa** and **Xb** resulting from the intramolecular dimerization of **D** by Thorpe–Ziegler reaction [10]. Alkylation of mercaptan **V** with allyl bromide in DMF did not finish at the formation of the corresponding thioether **E** due to the ready trans-formation of the latter under the reaction conditions into 3-allyl-5-acetyl-4-(4-butoxyphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyridine-3-carbonitrile (**XI**) originating from the regioselective [3,3]-sigmatropic rearrangement characteristic of the substituted 2-allylsulfanyl-1,4-di-hydropyridine systems [11].

The spectral characteristics of compounds **V, VI, VIIIa, VIIIb**, and **IX–XI** confirm their structure. The special feature of the $^1$H NMR spectra of thioethers **VIIIa** and **VIIIb** consists in the nonequivalence of the protons in the SCH$_2$ group giving rise to appearance of the signals as two doublets with a coupling constant $^2J$. This fact may be understood assuming the lack of free rotation of the alkylsulfanyl moiety around the ordinary bonds originating likely from the existence of a an intramolecular hydrogen bond between the H$^1$ atom of the dihydropyridine ring and the oxygen of the amide fragment. The presence of such a bond in the molecules of the 1,4-dihydropyridine systems can increase their stability against aromatization [12].

## EXPERIMENTAL

IR spectra were recorded on a spectrophotometer IKS-40 from mulls in mineral oil. $^1$H NMR spectra were registered on spectrometers Bruker WP-100SY (100 MHz) (compounds **Ib, Ic, VIIIa, Xb**) Gemini-200 (199.975 MHz) (compound **Ia**), Bruker AM-300 (300.13 MHz) (compound **VI**), Varian Mercury-400 (400.397 MHz) (compounds **VIIIb, XI**), and Bruker DRX 500 (500.13 MHz) (compounds **IX, Xa**) from solutions in DMSO-$d_6$ with TMS as an internal reference. Mass spectrum of compound **VIIIb** was measured on Chrommas GC/MS-Hewlett-Packard 5890/5972 instrument, column HP-5MS (70 eV) in CH$_2$Cl$_2$ solution. Melting points were determined on a Koeffler heating block. The reactions progress was monitored and the purity of compounds obtained was checked by TLC on Silufol UV-254 plates, eluent acetone–hexane, 3:5, development in iodine vapor or under UV irradiation.

**Morpholinium 6-methyl-4-(4-chlorophenyl)-3-cyano-5-ethoxycarbonyl-1,4-dihydropyridine-2-thiolate (Ia).** To a mixture of 1.4 g (10 mmol) of 4-chlorobenzaldehyde (**IIa**) and 1.0 g (10 mmol) of cyanothioacetamide (**III**) in 15 ml of ethanol was added at 20°C 2 drops of morpholine, and the mixture was stirred for 10 min. Therewith the initial compounds dissolved,and alkene **A** formed. Then 1.99 g (10 mmol) of ethyl acetoacetate enamine (**IVa**) was added, and the reaction mixture was stirred for 1h and left standing for 24 h. Then the precipitate formed was filtered off, washed with ethanol and hexane. Yield 2.70 g (64%), yellow powder, mp 147–149°C. IR spectrum, cm$^{-1}$: 2194 (C≡N), 1692 (C=O). $^1$H NMR spectrum, δ, ppm: 1.10 t (3H, $\underline{\mathrm{Me}}\mathrm{CH}_2$, *J* 7.04 Hz), 2.55 s (3H, Me), 3.07 t (4H, CH$_2$NCH$_2$, *J* 4.78 Hz), 3.75 t (4H, CH$_2$OCH$_2$), 3.93 q (2H, CH$_2$), 4.32 s (1H, C$^4$H), 7.10 d and 7.16 d (2H each, C$_6$H$_4$, *J* 8.42 Hz), 8.01 br.s (1H, NH). Found, %: C 56.80; H 5.61; N 9.79. C$_{20}$H$_{24}$ClN$_3$O$_3$S. Calculated, %: C 56.93; H 5.73; N 9.96.

**Morpholinium 5-acetyl-4-(4-hydroxyphenyl)-6-methyl-3-cyano-1,4-dihydropyridine-2-thiolate (Ib)** was obtained similarly from 4-hydroxybenzaldehyde (**IIb**) and acetylacetone enamine (**IVb**). Yield 2.65 g (71%), colorless powder, mp 144–146°C. IR spectrum, cm$^{-1}$: 3595 (OH), 2188 (C≡N), 1684 (C=O). $^1$H NMR spectrum, δ, ppm: 1.92 C (3H, MeCO), 2.23 C (3H, Me), 3.06 t (4H, CH$_2$NCH$_2$, *J*4.73 Hz), 3.74 t (4H, CH$_2$OCH$_2$), 4.21 s (1H, C$^4$H), 6.63 d and 6.90 d (2H each, C$_6$H$_4$, *J* 8.53 Hz), 8.18 br.s (1H, NH), 10.11 br.s (1H, OH). Found, %: C 60.89; H 6.02; N 11.04. C$_{19}$H$_{23}$N$_3$O$_3$S. Calculated, %: C 61.10; H.21; N 11.25.

**Morpholinium 5-allyloxycarbonyl-6-methyl-4-(2-furyl)-3-cyano-1,4-dihydropyridine-2-thiolate (Ic)** was obtained similarly to salt **Ia** from furfural and enamine **IVc**. Yield 3.46 g (89%), red powder, mp 178–180°C (sublim. at 150°C). IR spectrum, cm$^{-1}$: 2180 (C≡N), 1695 (C=O). $^1$H NMR spectrum, δ, ppm: 2.20 C (3H, Me), 3.08 t (4H, CH$_2$NCH$_2$, *J*4.69 Hz), 3.74 t (4H, CH$_2$OCH$_2$), 4.42 s (1H, C$^4$H), 4.48 d (2H, CH$_2$O, *J* 6.41 Hz), 5.03 d (1H, CH$_2$=, $J_{trans}$ 9.44 Hz), 5.17 d (1H, CH$_2$=, $J_{cis}$ 9.45 Hz), 5.78 d (1H, C$^3$H of furan, *J* 2.99 Hz), 5.81 m (1H, =CH), 6.23 d.d (1H, C$^4$H of furan, *J* 2.38 Hz), 7.40 d (1H, C$^5$H of furan, *J* 1.20 Hz), 8.31 br.s (1H, NH). Found, %: C 58.40; H.78; N 10.66. C$_{19}$H$_{23}$N$_3$O$_4$S. Calculated, %: C 58.59; H.95; N 10.79.

**5-Acetyl-4-(4-butoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyridine-3-carbonitrile (V)** was obtained similarly from 4-butoxybenzaldehyde and enamine **IVb**. Yield 2.33 g (68%), yellow powder, mp 172–174°C (EtOH). IR spectrum, cm$^{-1}$: 2248 (C≡N), 1684 (C=O). $^1$H NMR spectrum, δ, ppm: 0.92 t (3H, MeCH$_2$, *J* 6.11 Hz), 1.14–1.79 m (4H, 2CH$_2$), 2.03 s (3H, MeCO), 2.33 s (3H, Me), 3.93 t (2H, OCH$_2$, *J* 5.99Hz), 4.31 d (0.5H, C$^3$H, *J*4.13 Hz), 4.46 s and 4.95 d (1H, C$^4$H), 6.86 d and 7.07 d (2H each, C$_6$H$_4$, *J* 8.51 Hz), 11.99 br.s and 12.19 br.s (1H, NH). Found, %: C 66.49; H.32; N 8.14. $C_{19}H_{22}N_2O_2S$. Calculated, %: C 66.64; H.48; N 8.18.

**Morpholinium 6-methyl-4-(4-chlorophenyl)-3-cyano-5-ethoxycarbonylpyridine-2-thiolate (VI).** A suspension of 4.22 g (10 mmol) of salt **Ia** in 15 ml of ethanol was boiled for 2 h, on cooling the precipitate was filtered off and washed with acetone. Yield 3.44 g (82%), yellow crystals, mp 210–212°C (sublim. at 150°C). IR spectrum, cm$^{-1}$: 2212 (C≡N), 1726 (C=O). $^1$H NMR spectrum, δ, ppm: 0.80 t (3H, MeCH$_2$, *J* 6.90 Hz), 2.35 s (3H, Me), 3.11 t (4H, CH$_2$NCH$_2$, *J*4.80 Hz), 3.76 t (4H, CH$_2$OCH$_2$), 3.86 q (2H, MeCH$_2$), 7.27 d and 7.53 d (2H each, C$_6$H$_4$, *J* 8.70 Hz). Found, %: C 57.02; H.12; N 9.85. $C_{20}H_{22}ClN_3O_3S$. Calculated, %: C 57.21; H.28; N 10.00.

**5-Acetyl-4-(4-hydroxyphenyl)-2-carbamoylethylsulfanyl-1,4-dihydropyridine-3-carbonitrile (VIIIa).** To a suspension of 3.73 g (10 mmol) of salt **Ib** in 15 ml of DMF was added 0.94 g (10 mmol) of α-chloroacetamide, the mixture was stirred for 3 h and diluted with an equal volume of water. After 24 h the precipitate was filtered off and washed with water, ethanol, and hexane. Yield 2.44 g (71%), yellow powder, mp 189–191°C (PrOH). IR spectrum, cm$^{-1}$: 3300 (NH), 2192 (C≡N), 1690 (C=O). $^1$H NMR spectrum, δ, ppm: 2.03 s (3H, MeCO), 2.28 s (3H, Me), 3.55 d and 3.81 d (1H, SCH$_2$, $^2$*J* 14.13 Hz), 4.51 s (1H, C$^4$H), 6.70 d and 6.99 d (2H each, C$_6$H$_4$, *J* 7.99 Hz), 7.50 br.s and 7.88 br.s (1H each, NH$_2$), 9.30 br.C (1H, NH), 10.25br.s (1H, OH). Found, %: C 59.33; H.78; N 12.07. $C_{17}H_{17}N_3O_3S$. Calculated, %: C.46; H.99; N 12.24.

**Allyl 6-methyl-2-(thiazol-2-ylcarbamoylmethylsulfanyl)-4-(2-furyl)-3-cyano-1,4-dihydropyridine-5-carboxylate (VIIIb)** was obtained in the same way as thioether VIIIa from salt **Ic** and compound **VIIb**. Yield 3.49 g (79%), colorless powder, mp 209–210°C (1-BuOH). IR spectrum, cm$^{-1}$: 3312 (NH), 2198 (C≡N), 1693 (C=O). $^1$H NMR spectrum, δ, ppm: 2.38 s (3H, Me), 3.84 d and 3.96 d (ïO 1H, SCH$_2$, $^2$*J* 13.98 Hz), 4.52 m (2H, CH$_2$O), 4.71 s (1H, C$^4$H), 5.10 d (1H, CH$_2$=, $J_{cis}$ 9.49 Hz), 5.18 d (1H, CH$_2$=, $J_{trans}$ 17.33 Hz), 5.84 m (1H, =CH), 6.00 d (1H, C$^3$H of furan, *J*2.88 Hz), 6.21 d.d (1H, C$^4$H of furan, *J*2.41 Hz), 7.05 d (1H, C$^5$H of thiazole, *J*3.01Hz), 7.32 d (1H, C$^5$H of furan, *J*1.21 Hz), 7.44 d (1H, C$^4$H of thiazole), 9.72 br.s (1H, NH), 12.43 br.s (1H, CONH). Mass spectrum, *m/z* ($I_{rel}$, %): 443 (100)[$M + 1$]$^+$, 440 (39)[$M - 2$]$^+$, 375 (28), 343 (15), 275 (22), 101 (14). Found, %: C 54.10; H.95; N 12.48. $C_{20}H_{18}N_4O_4S_2$. Calculated, %: C.28; H.10; N 12.66. *M* 442.51.

**Allyl 5-methyl-7-(2-furyl)-8-cyano-2,3,4,7-tetrahydrothiazolo[3,2-*a*]pyridine-6-carboxylate (IX)** was obtained similarly from salt **Ic** and 1,2-dibromoethane. Yield 2.75 g (84%), dark red crystals, mp 105°C (MeOH). IR spectrum, cm$^{-1}$: 2200 (C≡N), 1688 (C=O). $^1$H NMR spectrum, δ, ppm: 2.45 s (3H, Me), 3.41 m (2H, NCH$_2$), 4.19m (2H, SCH$_2$), 4.54 m (2H, OCH$_2$), 4.76 s (1H, C$^7$H), 5.15 d (1H, CH$_2$=, $J_{cis}$ 9.31 Hz), 5.24 d (1H, CH$_2$=, $J_{trans}$ 17.48 Hz), 5.86 m (1H, =CH), 6.06 d (1H, C$^3$H of furan, *J*2.81 Hz), 6.37 d.d (1H, C$^4$H of furan, *J*2.35 Hz), 7.51 d (1H, C$^5$H of furan, *J*1.18 Hz). Found, %: C 61.98; H.78; N.42. $C_{17}H_{16}N_2O_3S$. Calculated, %: C.18; H.91; N 8.53. *M* 328.39.

**Allyl 3-amino-6-methyl-4-(2-furyl)-2-cyano-4,7-dihydrothieno[2,3-*b*]pyridine-5-carboxylate (Xa)** was obtained similarly from salt **Ic** and α-chloroacetonitrile. Yield 2.35 g (69%), yellow powder, mp 204–207°C (1-BuOH), fluorescent under UV irradiation. IR spectrum, cm$^{-1}$: 3295–3442 (NH$_2$), 2194 (C≡N), 1688 (C=O), 1647 [δ(NH$_2$)]. $^1$H NMR spectrum, δ, ppm: 2.29 s (3H, Me), 4.51 m (2H, OCH$_2$), 5.11 d (1H, CH$_2$=, $J_{cis}$ 9.37 Hz), 5.20 d.d (1H, C$^4$H), 5.25 d (1H, CH$_2$=, $J_{trans}$ 17.42 Hz), 5.79 m (1H, =CH), 6.03 br.s (2H, NH$_2$), 6.09 d (1H, C$^3$H of furan, *J*2.81 Hz), 6.22 d.d (1H, C$^4$H of furan, *J* 2.38 Hz), 7.34 d (1H, C$^5$H of furan, *J*1.24 Hz), 9.86 br.s (1H, NH). Found, %: C 59.70; H.35; N.18. $C_{17}H_{15}N_3O_3S$. Calculated, %: C.81; H.43; N 12.31.

**3-Amino-5-acetyl-4-(4-butoxyphenyl)-6-methyl-4,7-dihydrothieno[2,3-*b*]pyridine-2-carbonitrile (Xb)**. To a stirred solution of 3.42 g (10 mmol) of pyridinethiol **V** in 15 ml of DMF was added in succession 5.6 ml (10 mmol) of 10% water solution of KOH and 0.63 ml (10 mmol)of α-chloroacetonitrile, the mixture was stirred for 3 h, diluted with equal volume of water, and left standing for 24 h. The precipitate was filtered off, washed with water, ethanol, and hexane. Yield 2.74 g (72%), yellow crystals, mp 205–207°C (AcOH–EtOH, 1:1). IR spectrum, cm$^{-1}$: 3285–3449 (NH$_2$), 2204 (C≡N), 1687 (C=O), 1649 [δ(NH$_2$)]. $^1$H NMR spectrum, δ, ppm: 0.89 t (3H, MeCH$_2$, *J* 7.12 Hz), 1.15–1.87 m (4H, 2CH$_2$), 2.08 s (3H, MeCO), 2.28 s (3H, Me), 3.86 t (2H, OCH$_2$, *J*7.08 Hz), 5.07 s (1H, C$^4$H), 6.28 br.s (2H, NH$_2$), 6.77 d and 7.22 d (2H each, C$_6$H$_4$, *J* 8.55 Hz), 9.88 br.s (1H, NH). Found, %: C 65.91; H.89; N.84. $C_{21}H_{23}N_3O_2S$. Calculated, %: C.12; H.08; N 11.01.

**3-Allyl-5-acetyl-4-(4-butoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyridine-3-carbonitrile (XI)** was obtained similarly from allyl bromide. Yield 2.60 g (68%), yellow powder, mp 151–153°C (EtOH). IR spectrum, cm$^{-1}$: 2255 (C≡N), 1679 (C=O). $^1$H NMR spectrum, δ, ppm: 0.98 t (3H, $\underline{\text{Me}}$CH$_2$, *J* 7.09 Hz), 1.48 m (2H, CH$_2$), 1.73 m (2H, CH$_2$), 2.00 s (3H, MeCO), 2.36 s (3H, Me), 2.61 m (2H, $\underline{\text{CH}_2}$CH=), 3.91 m (3H, C$^4$H and SCH$_2$), 5.19 d (1H, CH$_2$=, $J_{trans}$ 17.45 Hz), 5.36 d (1H, CH$_2$=, $J_{cis}$ 9.16 Hz), 5.97 m (1H, =CH), 6.79 d and 7.08 d (2H each, $C_6H_4$, *J* 8.49 Hz), 11.94 br.C (1H, NH). Found, %: C 68.92; H.74; N.19. $C_{22}H_{26}N_2O_2S$. Calculated, %: C.08; H.85; N 7.32.

## REFERENCES

1. Krauze, A., Verhe, R., and DubURS, G., *Latv. Kim. Z.,* 1996, p. 94; Kirule, I.E., Krauze, A.A., Velena, A.Kh., Antipova, D.Yu., Arnitsane, G.Ya., Vutsina, I.A., and Dubur, G.Ya., *Khim.-Farm. Zh.,* 1992, p. 59.
2. Krauze, A.A., Odynets, A.G., Verreva, A.A., Germane, S.K., Kozhukhov, A.N., and Dubur, G.Ya., *Khim.-Farm. Zh.,* 1991, vol. 25, p. 40.
3. Krauze, A.A., Vitolinya, R.O., Romanova, M.R., and Dubur, G.Ya., *Khim.-Farm. Zh.,* 1988, vol. 22, p. 548; Krauze, A.A., Vitolinya, R.O., Romanova, M.R., and Dubur, G.Ya., *Khim.-Farm. Zh.,* 1988, vol. 22, p. 955; Krauze, A., Baumane, L., Sile, L., Chernova, L., Vilyums, M., Vitolinya, R., Duburs, G., and Stradyn', Ya*., Khim. Geterotsikl. Soedin.,* 2004, p. 1022.
4. Tirzite, D., Krauze, A., Zubareva, A., Tirzitis, G., and Dubur, G*., Khim. Geterotsikl. Soedin.,* 2002, p. 902; Dyachenko, V.D., Krivokolysko, S.G., Nesterov, V.N., and Litvinov, V.P*., Khim. Geterotsikl. Soedin.,* 1996, p. 1243; Krauze, A. and Duburs, G., *Heterocyclic Commun.,* 2000, vol. 6, p. 239.
5. Sharanin, Yu.A., Shestopalov, A.M., Rodinovskaya, L.A., Nesterov, V.N., Shklover, V.E., Struchkov, Yu.T., Promonenkov, V.K., and Litvinov, V.P*., Zh. Org. Khim.,* 1986, vol. 22, p. 2600; Krauze, A. and Duburs, G., *Latv. Kim. Z.,* 1994, p. 928; Dyachenko, V.D., Krivokolysko, S.G., and Litvinov, V.P*., Zh. Org. Khim.,* 1998, vol. 34, p. 927.
6. Rubio, M.J., Seoane, C., Soto, J.L., and Susaeta, A. *Lieb. Ann.,* 1986, 210; Krauze, A.A., Liepin'sh, E.E., Pelcher, Yu.E., Kalme, Z.A., Dipan, I.V., and Dubur, G.Ya*., Khim. Geterotsikl. Soedin.,* 1985, p. 95.
7. Dyachenko, V.D., Krivokolysko, S.G., and Litvinov, V.P., *Khim. Geterotsikl. Soedin.,* 1997, p. 666; Dyachenko, V.D., Nikishin, A.A., and Litvinov, V.P*., Khim. Geterotsikl. Soedin.,* 1997, p. 996; Dyachenko, V.D., Krivokolysko, S.G., and Litvinov, V.P., *Izv. Akad. Nauk, Ser. Khim.,* 1997, p. 2016; Dyachenko, V.D., Litvinov, V.P*., Zh. Org. Khim.,* 1998, vol. 34, p. 589.
8. Stork, G., Brizzolara, A., Landesman, H., Szmuszkovicz, J., and Terrell, R., *J. Am. Chem. Soc.,* 1963, vol. 85, p. 207; Stork, G. and Landesman, H.K., *J. Am. Chem. Soc.,* 1956, vol. 78, p. 5128.
9. Sharanin, Yu.A., Krivokolysko, S.G., and Dyachenko, V.D*., Zh. Org. Khim.,* 1994, vol. 30, p. 581.
10. Babichev, F.S., Sharanin, Yu.A., Litvinov, V.P., Promonenkov, V.K., and Volovenko, Yu.M., *Vnutrimolekulyarnoe vzaimodeistvie nitril'noi i C–H-, O–H-, i S–H-grupp* (Intramolecular Interaction of Nitril and *C–H-, O–H-, and S–H-groups*), Kiev: Naukova Dumka, 1985, p. 33.
11. Nesterov, V.N., Shklover, V.E., Struchkov, Yu.T., Sharanin, Yu.A., Goncharenko, M.P., and Dyachenko, V.D*., Izv. Akad. Nauk SSSR. Ser. Khim*., 1991, p. 521; Litvinov, V.P., Sharanin, Yu.A., Goncharenko, M.P., Dyachenko, V.D., and Shestopalov, A.M*., Izv. Akad. Nauk SSSR. Ser. Khim.,* 1991, p. 1888.
12. Dyachenko, V.D. and Chernega, A.N*., Zh. Org. Khim.,* 2005, p. 1007; Baumane, L., Krauze, A., Belyakov, S., Sile, L., Chernova, L., Griga, M., Duburs, G., and Stradyn', Ya*., Khim. Geterotsikl. Soedin.,* 2005, p. 416.