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N-Hetaryl-2-cyanoacetamides in the Synthesis of Substituted (*E*)-*N*-Hetaryl-2-cyanoacrylamides, (*E*)-*N*-Alkyl-*N*-hetaryl-2-cyanoacrylamides, and 6-Amino-2-oxo-4-phenyl-1-(pyridin-2-yl)-1,2-dihydropyridine-3,5-dicarbonitriles

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Abstract—Knoevenagel condensation of *N*-hetaryl-substituted cyanoacetamides with aldehydes gave the corresponding (*E*)-*N*-hetaryl-2-cyanoacrylamides which were converted into (*E*)-*N*-alkyl-*N*-hetaryl-2-cyanoacrylamides and 6-amino-2-oxo-4-phenyl-1-(pyridin-2-yl)-1,2-dihydropyridine-3,5-dicarbonitriles. The structure of (*E*)-*N*-(pyridin-2-yl)-2-cyano-3-phenylprop-2-enamide was determined by X-ray analysis.

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2-Cyanoacetanilide derivatives are successfully used in the synthesis of 5-arylcarbamoyl-substituted pyridine-2-chalcogenones [1] and their partially hydrogenated analogs [2]. Only a few examples are available from the literature on the chemistry of *N*-hetaryl-2-cyanoacetamides. In particular, these compounds were used as CH acids in the dimerization of nitriles according to Thorpe [3], C-nucleophiles in nucleophilic vinylic substitutions [4], and CH acids in the condensation with acetylacetone, leading to substituted 2-oxopyridine-3-carbonitriles [5]. Dorokhov et al. [6] reported that *N*-(pyridyl)-2-cyanoacetamides under usual conditions exist as cyclic isomers, 4-amino-2*H*-pyrido[1,2-*a*]pyrimidin-2-ones. Comparison of these data with those reported in [3] revealed some discrepancies which stimulated further studies on *N*-hetaryl-substituted cyanoacetamide derivatives.

In the present work we examined acylation of *N*-hetaryl-2-cyanoacetamides **I**, their condensation with aldehydes **II**, and reactions with 2-cyano-3-(2-furyl)prop-2-enethioamide (**III**). The acylation of *N*-(pyridin-2-yl)cyanoacetamide (**Ia**) with butyric anhydride occurred regioselectively at the amide nitrogen atom to give the corresponding *N*-acyl derivative **IV**. The Knoevenagel condensation of CH acids **Ia**–**Id** with aldehydes **IIa**–**IIc** in the presence of piperidine resulted in the formation of (*E*)-*N*-hetaryl-2-cyanoacrylamides **Va**–**Vd** (Scheme 1, method *a*). Compound **Vd** was also synthesized by the Michael reaction following the methylene component exchange pattern [7] (method *b*). Intermediate Michael adduct **A** is unstable, and it decomposes into a new CH acid, cyanothioacetamide (**VI**), and a new alkene, (*E*)-*N*-(5-chloropyridin-2-yl)-2-cyanoacrylamide (**Vd**).

The structure of compounds **Va**–**Vd** was unambiguously determined by X-ray analysis of a single crystal of one of these compounds, *N*-(pyridin-2-yl)-2-cyano-3-phenylprop-2-enamide (**Va**). Like 3-(2-iodophenyl)-2-(4-phenylthiazol-2-yl)acrylonitrile synthesized previously [8] compound **Va** is *E* isomer with respect to the $C^7{=}C^9$ bond. The structure of molecule

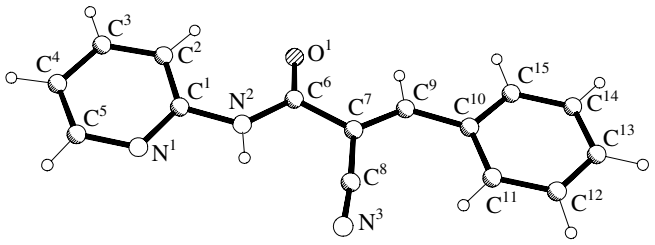
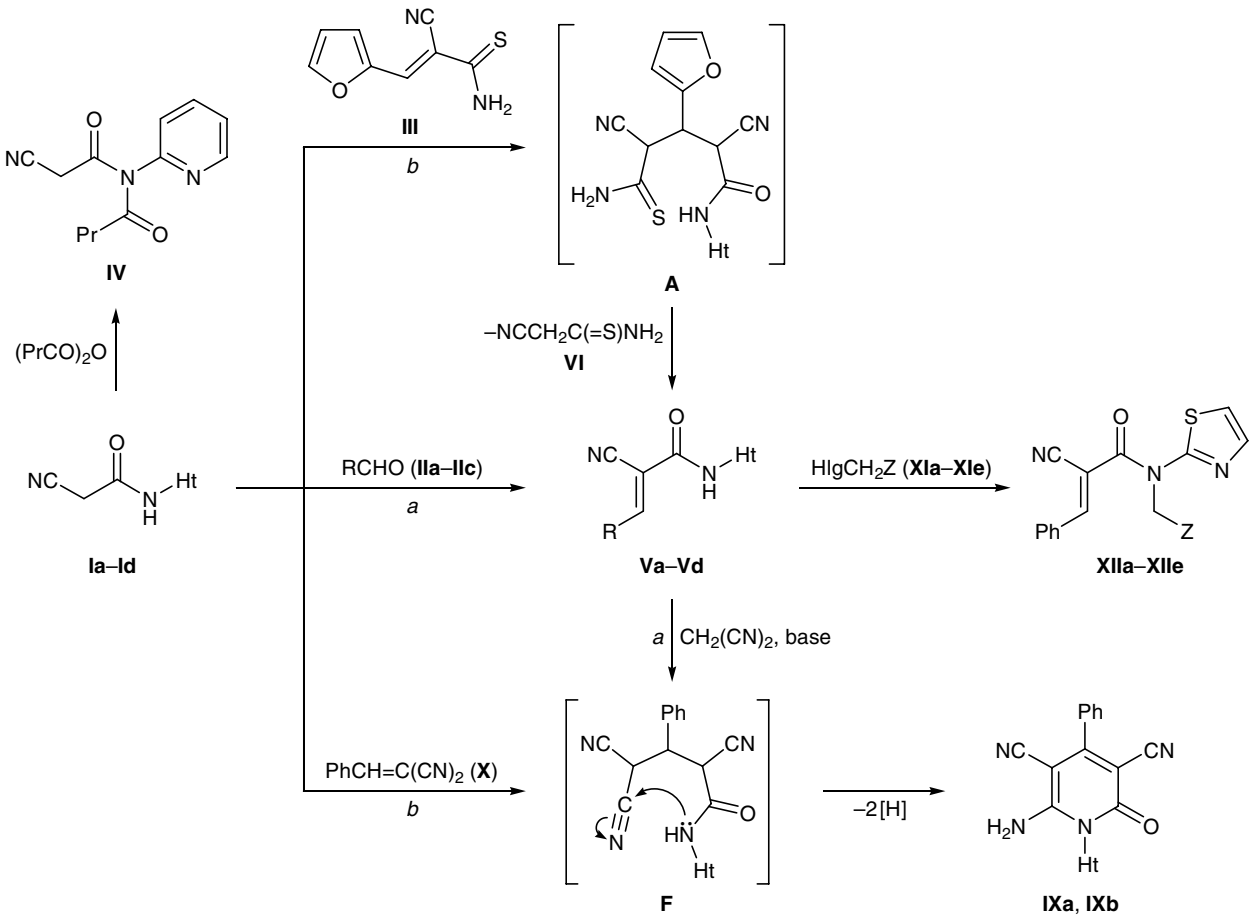


Fig. 1. Structure of the molecule of (2*E*)-2-cyano-3-phenyl-*N*-(pyridin-2-yl)prop-2-enamide (**Va**) according to the X-ray diffraction data with atom numbering.

Scheme 1.



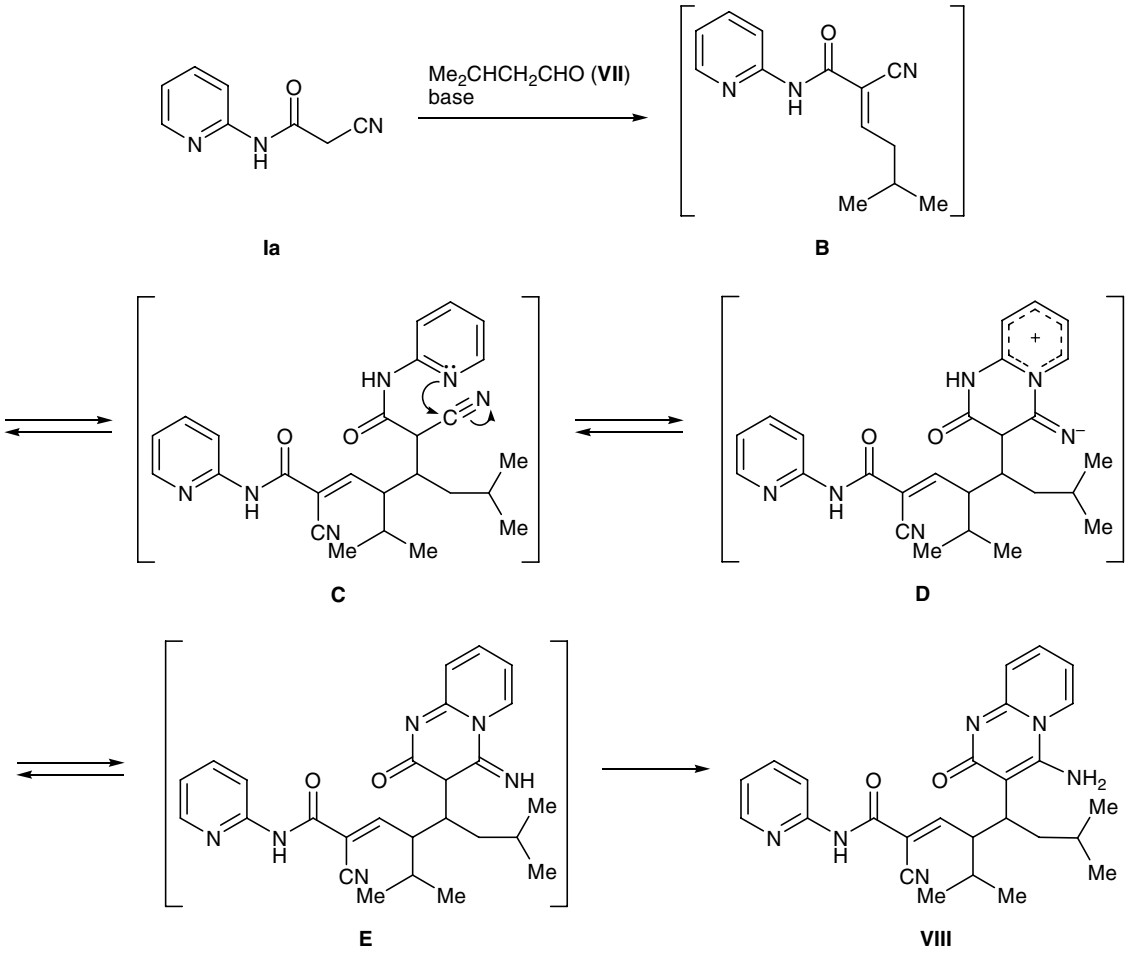
Base is piperidine; **I**, Ht = pyridin-2-yl (**a**), 4-methylpyridin-2-yl (**b**), 1,3-thiazol-2-yl (**c**), 5-chloropyridin-2-yl (**d**); **II**, R = Ph (**a**), cyclohex-3-en-1-yl (**b**), 2-furyl (**c**); **V**, Ht = pyridin-2-yl, R = Ph (**a**), Ht = 4-methylpyridin-2-yl, R = cyclohex-3-en-1-yl (**b**), Ht = 1,3-thiazol-2-yl, R = Ph (**c**), Ht = 5-chloropyridin-2-yl, R = 2-furyl (**d**); **IX**, Ht = pyridin-2-yl (**a**), 4-methylpyridin-2-yl (**b**); **XI**, Hlg = I (**a**, **b**), Cl (**c**, **d**), Br (**e**); **XI**, **XII**, Z = Me (**a**), H (**b**), PhNHCO (**c**), Ph (**d**), CH_2=CH (**e**).

Va is shown in Fig. 1, and the bond lengths and bond angles are given in table. The geometric parameters of the pyridine ring in molecule **Va** do not differ from the corresponding standard values [9]. The length of the formally single C^1–N^2 bond, 1.413(2) Å, approaches that of standard single C–N bond, while the C^6–N^2 bond is strongly shortened [1.351(2) Å against the standard value 1.45 Å], indicating *n*–π conjugation between the lone electron pair on N^2 and π electrons of the carbonyl group. The sum of the bond angles at the N^2 atom is 359.9(15)°. The C^7–C^9 bond length, 1.337(3) Å, is typical of a double C=C bond [9]. On the whole, the molecule is almost planar, the maximal deviation of atoms from the mean-square plane is 0.135 Å, and the average deviation is as small as 0.061 Å. Molecules **Va** in crystal are held together through van der Waals forces, and no shortened intermolecular contacts were detected. Figure 2 shows packing of molecules **Va** in crystal.

By condensation of *N*-(pyridin-2-yl)-2-cyanoacetamide (**Ia**) with 3-methylbutanal (**VII**) in ethanol at 20°C in the presence of piperidine we obtained 5-(4-amino-2-oxo-2*H*-pyrido[1,2-*a*]pyrimidin-3-yl)-2-cyano-4-isopropyl-7-methyl-*N*-(pyridin-2-yl)oct-2-enamide (**VIII**). The process is likely to include a set of consecutive reactions (Knoevenagel condensation, Michael addition, and intramolecular heterocyclization), whose preparative advantages are obvious from the viewpoint of modern organic synthesis [10].

Intermediate Knoevenagel condensation product, alkene **B**, undergoes dimerization according to Michael to form adduct **C**. Intramolecular heterocyclization of that adduct gives zwitterionic system **D** which is transformed into imine **E**, and the latter is

Scheme 2.



stabilized as enamine tautomer **VIII** (Scheme 2). We previously reported on the reaction of 3-methylbutanal with cyanothioacetamide, which also involved successive Knoevenagel condensation, Michael addition, intramolecular heterocyclization, and Thorpe–Ziegler reaction ("domino" process) and led to the formation of 5-amino-8-isopropyl-6-thiocarbamoyl-3-thioxo-2-azabicyclo[2.2.2]oct-5-ene-4-carbaldehyde [11].

The reaction of substituted acrylamide **Va** as Michael acceptor with malononitrile afforded 6-amino-2-oxo-4-phenyl-1-(2-pyridyl)-1,2-dihydropyridine-3,5-dicarbonitrile (**IXa**) (Scheme 1) which is a potential insecticide [12]. Presumably, the reaction path includes formation of primary adduct **F** which undergoes chemoselective heterocyclization with elimination of hydrogen to give substituted pyridin-2(1*H*)-one **IXa**. Compounds **IXa** and **IXb** were also obtained by the reaction of CH acids **Ia** and **Ib** with benzylidenemalononitrile according to Michael (method *b*). Probably, intermediate **F** is common for pathways *a* and *b*.

The alkylation of acrylamide **Vc** with alkyl halides **XIa**–**XIe** in DMF at 20°C in the presence of KOH was regioselective, and the products were the corresponding *N*-alkyl derivatives **XIIa**–**XIIe** whose structure was confirmed by spectral data.

EXPERIMENTAL

The IR spectra were recorded on an IKS-40 spectrometer from samples dispersed in mineral oil. The ^{1}H NMR spectra were measured on Varian Gemini-200 (199.975 MHz; compounds **Va** and **IXa**) and Varian Mercury-400 instruments (400.397 MHz; **IV**, **Vb**–**Vd**, **VIII**, **IXb**, **XIIa**–**XIIe**) from solutions in DMSO-d_6 using tetramethylsilane as internal reference. The mass spectra were obtained on a Hewlett–Packard Chrommas GC–MS system (HP 5890/5972; electron impact, 70 eV; HP-5MS column; samples were injected as solutions in methylene chloride). The melting points were determined on a Kofler melting point apparatus. The progress of reactions and the purity of products

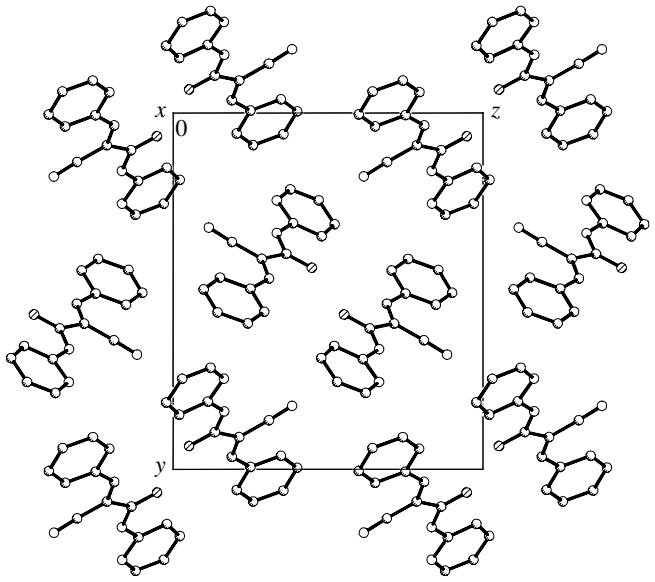


Fig. 2. Packing of molecules of (2*E*)-2-cyano-3-phenyl-*N*-(pyridin-2-yl)prop-2-enamide (**Va**) in crystal (*bc* projection).

were monitored by TLC on Silufol UV-254 plates using acetone–hexane (3:5) as eluent; development with iodine vapor or under UV light.

X-Ray analysis of compound Va. The X-ray diffraction data were obtained on an Enraf–Nonius CAD-4 automatic four-circle diffractometer ($\lambda Cu K_\alpha$ irradiation, graphite monochromator, $\omega/2\theta$ scanning, θ_{max} = 61.94°, spherical segment $0 \le h \le 7$, $0 \le k \le 16$, $-15 \le l \le 14$) at room temperature from a 0.12×0.16×0.50-mm single crystal. The unit cell parameters and crystal orientation matrix were determined from 22 reflections with $25.18 < \theta < 28.07°$. Total of 2167 reflections were measured, 1982 of which were symmetry-independent (R_{int} = 0.0258). Monoclinic crystals; a = 6.671(2), b = 14.814(3), c = 13.163(2) Å; β = 102.13(2)°; V = 1271.8(5) Å^3; Z = 4; d_{calc} = 1.302 g/cm^3; μ = 0.685 mm^{-1}; $F(000)$ = 520; space group $P2_1/c$ (no. 14). The structure was solved by the direct method and was refined by the least-squares procedure in full-matrix anisotropic approximation using SHELXS97 and SHELXL97 software [13, 14]. The refinement was performed using 1529 reflections with $I > 2\sigma(I)$ {217 refined parameters, 7.05 reflections per parameter; weight scheme $\omega = 1/[\sigma^2(Fo^2) + (0.0506R)^2 + 0.2245R]$, where $R = (Fo^2 + 2Fc^2)/3$; ratio of the maximal (mid) shift to the error in the last cycle 0.002

Bond lengths d and bond angles ω in the molecule of (2*E*)-2-cyano-3-phenyl-*N*-(pyridin-2-yl)prop-2-enamide (**Va**)

Bond	d, Å	Bond	d, Å	Bond	d, Å	Bond	d, Å
C^1–N^1	1.326(2)	C^4–H^4	1.00(2)	C^8–N^3	1.146(3)	C^{12}–H^{12}	1.01(3)
C^1–C^2	1.378(3)	C^5–N^1	1.343(3)	C^9–C^{10}	1.459(3)	C^{13}–C^{14}	1.365(3)
C^1–N^2	1.413(2)	C^5–H^5	0.96(2)	C^9–H^9	0.962(18)	C^{13}–H^{13}	1.00(2)
C^2–C^3	1.386(3)	C^6–O^1	1.214(2)	C^{10}–C^{11}	1.385(3)	C^{14}–C^{15}	1.384(3)
C^2–H^2	0.97(2)	C^6–N^2	1.351(2)	C^{10}–C^{15}	1.391(3)	C^{14}–H^{14}	0.97(2)
C^3–C^4	1.372(3)	C^6–C^7	1.509(3)	C^{11}–C^{12}	1.383(3)	C^{15}–H^{15}	1.00(2)
C^3–H^3	0.97(3)	C^7–C^9	1.337(3)	C^{11}–H^{11}	0.95(3)	N^2–H^{N2}	0.86(2)
C^4–C^5	1.364(3)	C^7–C^8	1.425(3)	C^{12}–C^{13}	1.367(3)		
Angle	ω, deg	Angle	ω, deg	Angle	ω, deg	Angle	ω, deg
$N^1C^1C^2$	124.34(18)	$N^1C^5C^4$	124.1(2)	$C^{10}C^9H^9$	114.0(11)	$C^{12}C^{13}H^{13}$	120.2(14)
$N^1C^1N^2$	111.67(17)	$N^1C^5H^5$	111.2(15)	$C^{11}C^{10}C^{15}$	117.72(18)	$C^{13}C^{14}C^{15}$	120.1(2)
$C^2C^1N^2$	123.96(18)	$C^4C^5H^5$	124.5(15)	$C^{11}C^{10}C^9$	124.88(19)	$C^{13}C^{14}H^{14}$	120.1(13)
$C^1C^2C^3$	117.2(2)	$O^1C^6N^2$	124.56(17)	$C^{15}C^{10}C^9$	117.40(18)	$C^{15}C^{14}H^{14}$	119.8(13)
$C^1C^2H^2$	120.1(12)	$O^1C^6C^7$	121.00(17)	$C^{12}C^{11}C^{10}$	120.8(2)	$C^{14}C^{15}C^{10}$	121.0(2)
$C^3C^2H^2$	122.7(12)	$N^2C^6C^7$	114.44(16)	$C^{12}C^{11}H^{11}$	119.0(15)	$C^{14}C^{15}H^{15}$	118.9(12)
$C^4C^3C^2$	119.8(2)	$C^9C^7C^8$	123.97(17)	$C^{10}C^{11}H^{11}$	120.1(15)	$C^{10}C^{15}H^{15}$	120.1(12)
$C^4C^3H^3$	120.4(15)	$C^9C^7C^6$	118.87(17)	$C^{13}C^{12}C^{11}$	120.4(2)	$C^1N^1C^5$	116.4(2)
$C^2C^3H^3$	119.7(15)	$C^8C^7C^6$	117.17(17)	$C^{13}C^{12}H^{12}$	123.8(15)	$C^6N^2C^1$	129.64(18)
$C^5C^4C^3$	118.0(2)	$N^3C^8C^7$	175.0(2)	$C^{11}C^{12}H^{12}$	115.5(16)	$C^6N^2H^{N2}$	119.3(15)
$C^5C^4H^4$	119.4(13)	$C^7C^9C^{10}$	131.30(19)	$C^{14}C^{13}C^{12}$	119.9(2)	$C^1N^2H^{N2}$	111.0(15)
$C^3C^4H^4$	122.6(13)	$C^7C^9H^9$	114.7(11)	$C^{14}C^{13}H^{13}$	119.8(14)		

(0.000)}. A correction for anomalous scattering was applied. In order to obtain more valid data, a semiempirical correction was applied via PSI scanning (T_{min} = 0.8122, T_{max} = 0.8837). All hydrogen atoms were visualized objectively, and their positions were refined in isotropic approximation. A correction for isotropic extinction was introduced in the final calculation step. The final divergence factors were $R_1(F)$ = 0.0417, $R_W(F^2)$ = 0.1006; GOF 1.029. The residual electron density from the Fourier difference series after the last iteration was 0.14 and –0.12 *e*/Å^3.

***N*-Butanoyl-*N*-(pyridin-2-yl)-2-cyanoacetamide (IV).** A suspension of 1.61 g (10 mmol) of compound **Ia** in 15 ml of butyric anhydride was heated for 4 h under reflux. The mixture was cooled, and the precipitate was filtered off and washed with diethyl ether. Yield 1.08 g (47%), red powder, mp 238–240°C (decomp.). IR spectrum, ν, cm^{-1}: 2248 (C≡N), 1696 (C=O). ^{1}H NMR spectrum, δ, ppm: 0.89 t (3H, Me, *J* = 6.11 Hz), 1.52 m (2H, CH_2), 2.33 t (2H, CH_2, *J* = 6.25 Hz), 3.88 s (2H, CH_2CN), 7.03 m (1H, 4-H), 7.78 m (1H, 5-H), 8.13 d (1H, 3-H, *J* = 3.12 Hz), 8.24 d (1H, 6-H, *J* = 0.92 Hz). Mass spectrum, *m*/*z* (I_{rel}, %): 232 (10) $[M + 1]^+$, 165 (100), 166 (29), 147 (15), 95 (91), 99 (16). Found, %: C 62.19; H 5.48; N 17.96. $C_{12}H_{13}N_3O_2$. Calculated, %: C 62.33; H 5.67; N 18.17. *M* 231.26.

Compounds Va–Vd (*general procedure*). *a*. Piperidine, 0.10 ml (1 mmol), was added at 20°C to a mixture of 10 mmol of CH acid **Ia**–**Id** and 10 mmol of aldehyde **IIa**–**IIc** in 25 ml of ethanol. The mixture was stirred for 10 min and was left to stand for 24 h. The precipitate was filtered off, washed with ethanol and hexane, and recrystallized from glacial acetic acid.

(2*E*)-2-Cyano-3-phenyl-*N*-(pyridin-2-yl)prop-2-enamide (Va). Yield 3.39 g (90%), yellow crystals, mp 139–140°C; fluoresces upon UV irradiation. IR spectrum, ν, cm^{-1}: 2206 (C≡N), 1697 (CO). ^{1}H NMR spectrum, δ, ppm: 7.10 d.d (1H, pyridine, *J* = 6.18 Hz), 7.41–7.62 m (3H, Ph), 7.76 t (1H, pyridine, *J* = 8.10 Hz), 7.98 m (2H, Ph), 8.13 d (1H, pyridine, *J* = 8.46 Hz), 8.33 m (2H, CH=, pyridine), 10.58 br.s (1H, NH). Found, %: C 72.02; H 4.21; N 16.68. $C_{15}H_{11}N_3O$. Calculated, %: C 72.28; H 4.45; N 16.86. *M* 249.27.

(2*E*)-2-Cyano-3-(cyclohex-3-en-1-yl)-*N*-(4-methylpyridin-2-yl)prop-2-enamide (Vb). Yield 2.35 g (88%), yellow powder, mp 153–155°C. IR spectrum, ν, cm^{-1}: 2162 (C≡N), 1698 (CO). ^{1}H NMR spectrum, δ, ppm: 1.61 m (1H, cyclohexene), 1.82 m (1H, cyclohexene), 2.03–2.24 m (4H, $2CH_2$), 2.39 s (3H, Me), 2.88 m (1H, 1-H, cyclohexene), 5.71 m (2H, CH=CH), 6.89 d (1H, 5-H, pyridine, *J* = 1.12 Hz), 7.53 d (1H, CH=, *J* = 4.25 Hz), 7.91 s (1H, 3-H, pyridine), 8.14 d (1H, 6-H, pyridine, *J* = 1.10 Hz), 10.29 br.s (1H, NH). Found, %: C 71.70; H 6.28; N 15.60. $C_{16}H_{17}N_3O$. Calculated, %: C 71.89; H 6.41; N 15.72. *M* 267.33.

(2*E*)-2-Cyano-3-phenyl-*N*-(1,3-thiazol-2-yl)prop-2-enamide (Vc). Yield 1.84 g (72%), yellow powder, mp 189–190°C. IR spectrum, ν, cm^{-1}: 2218 (C≡N), 1672 (CO). ^{1}H NMR spectrum, δ, ppm: 6.99 d (1H, 4-H, *J* = 2.84 Hz), 7.38 d (1H, 5-H), 7.46–7.58 m (3H, Ph), 7.92–8.04 m (2H, Ph), 8.36 s (1H, CH=), 12.98 br.s (1H, NH). Mass spectrum, *m*/*z* (I_{rel}, %): 257 (8) $[M + 2]^+$, 256 (19) $[M + 1]^+$, 255 (46) $[M]^+$, 226 (13), 178 (10), 156 (100), 128 (96), 101 (52), 77 (97) $[Ph]^+$, 55 (49), 39 (16). Found, %: C 61.02; H 3.22; N 16.30. $C_{13}H_9N_3OS$. Calculated, %: C 61.16; H 3.55; N 16.46. *M* 255.30.

(2*E*)-*N*-(5-Chloropyridin-2-yl)-2-cyano-3-(2-furyl)prop-2-enamide (Vd). Yield 1.75 g (64%), white "wool," mp 173–174°C. IR spectrum, ν, cm^{-1}: 2210 (C≡N), 1698 (CO). ^{1}H NMR spectrum, δ, ppm: 6.85 d.d (1H, 4-H, furan, *J* = 2.18 Hz), 7.41 d (1H, 3-H, furan, *J* = 2.95 Hz), 7.96 m (1H, 4-H, pyridine), 8.08 d (1H, 3-H, pyridine, *J* = 4.12 Hz), 8.18 s (1H, 6-H, pyridine), 8.23 s (1H, CH=), 8.44 d (1H, 5-H, furan, *J* = 1.13 Hz), 10.89 br.s (1H, NH). Mass spectrum, *m*/*z* (I_{rel}, %): 274 (100) $[M + 1]^+$. Found, %: C 56.89; H 2.87; N 15.20. $C_{13}H_8ClN_3O_2$. Calculated, %: C 57.05; H 2.95; N 15.35. *M* 273.68.

b. *N*-Methylmorpholine, 1.10 ml (10 mmol), was added under stirring at 20°C to a suspension of 1.96 g (10 mmol) of compound **Id** and 1.78 g (10 mmol) of 2-cyano-3-(2-furyl)prop-2-enethioamide (**III**) in 20 ml of ethanol, the mixture was stirred for 10 min and left to stand for 24 h, and the precipitate was filtered off and washed with ethanol and hexane. Yield 1.94 g (71%). The product was identical in the melting point, chromatographic data, and IR spectrum to a sample prepared as described above in *a*.

5-(4-Amino-2-oxo-2*H*-pyrido[1,2-*a*]pyrimidin-3-yl)-2-cyano-4-isopropyl-7-methyl-*N*-(pyridin-2-yl)-oct-2-enamide (VIII) was synthesized as described above for compounds **V** (method *a*) from 1.61 g (10 mmol) of acrylamide **Ia** and 1.08 ml (10 mmol) of 3-methylbutanal (**VII**). Yield 1.92 g (48%), colorless plates, mp 224–226°C (from EtOH). IR spectrum, ν, cm^{-1}: 3345, 3266, 3162 (NH_2); 2212 (C≡N); 1696 (C=O); 1648 (δNH_2). ^{1}H NMR spectrum, δ, ppm:

0.71 d (3H, Me, J = 5.01 Hz), 0.92–1.01 m (9H, 3Me), 1.26 m (1H, 7-H), 1.46–1.58 m (4H, CH_2, 4-H, 5-H), 1.95 m (1H, C**H**Me_2), 6.02 d (1H, CH=, J = 0.85 Hz), 7.06 d.d (1H, 4'-H, J = 4.11 Hz), 7.32 d.d (1H, 5'-H, J = 3.08 Hz), 7.51 br.s (2H, NH_2), 7.76 t (1H, pyridopyrimidine), 7.88 d (1H, 6'-H), 7.96 d (1H, 3'-H, J = 3.98 Hz), 8.04 d (1H, pyridopyrimidine, J = 4.04 Hz), 8.34 d (1H, pyridopyrimidine, J = 2.14 Hz), 8.57 d (1H, pyridopyrimidine, J = 1.99 Hz), 9.92 br.s (1H, NH). Mass spectrum, m/z (I_{rel}, %): 459 (100) $[M + 1]^+$, 338 (28), 262 (10), 95 (11). Found, %: C 67.95; H 6.42; N 18.14. $C_{26}H_{30}N_6O_2$. Calculated, %: C 68.10; H 6.59; N 18.33. M 458.57.

6-Amino-2-oxo-4-phenyl-1-(pyridin-2-yl)-1,2-dihydropyridine-3,5-dicarbonitrile (IXa). *a*. Piperidine, 0.10 ml (10 mmol), was added under stirring at 20°C to a mixture of 1.61 g (10 mmol) of compound **Ia** and 0.66 g (10 mmol) of malononitrile in 20 ml of ethanol, and the mixture was stirred for 30 min and was left to stand for 24 h. The precipitate was filtered off, washed with ethanol and hexane, and recrystallized from glacial acetic acid. Yield 2.13 g (68%), pink needles, mp 300°C (decomp.; sublimes at 250°C). IR spectrum, ν, cm^{-1}: 3354, 3294, 3186 (NH_2); 2218 (C≡N); 1682 (C=O); 1634 (δNH_2). ^{1}H NMR spectrum, δ, ppm: 7.28–7.72 m (7H, H_{arom}, NH_2); 7.85–8.16 m (3H, H_{arom}), 8.63 d (1H, H_{arom}, J = 1.14 Hz). Mass spectrum, m/z (I_{rel}, %): 314 (100) $[M + 1]^+$. Found, %: C 68.84; H 3.42; N 22.19. $C_{18}H_{11}N_5O$. Calculated, %: C 69.00; H 3.54; N 22.35. M 313.32.

b. Piperidine, 0.10 ml (10 mmol), was added at 20°C to a mixture of 1.61 g (10 mmol) of compound **Ia** and 1.54 g (10 mmol) of benzylidenemalononitrile (**X**) in 20 ml of ethanol, and the mixture was stirred for 1 h and left to stand for 24 h. The precipitate was filtered off and washed with ethanol and hexane. Yield 2.25 g (72%). The product was identical in the melting point, chromatographic data, and IR spectrum to a sample prepared as described above in *a*.

6-Amino-1-(4-methylpyridin-2-yl)-2-oxo-4-phenyl-1,2-dihydropyridine-3,5-dicarbonitrile (IXb) was synthesized as described above for compound **IXa** (method *b*) from 1.75 g (10 mmol) of *N*-(4-methylpyridin-2-yl)cyanoacetamide (**Ib**). Yield 2.19 g (67%), colorless plates, mp 310–314°C (from AcOH). IR spectrum, ν, cm^{-1}: 3444, 3295, 3156 (NH_2); 2212 (C≡N); 1696 (C=O); 1650 (δNH_2). ^{1}H NMR spectrum, δ, ppm: 2.44 s (3H, Me), 7.31 d (1H, 5-H, J = 2.02 Hz), 7.54–7.61 m (5H, Ph), 7.82 d (1H, 6-H, J = 1.19 Hz), 7.64 br.s (2H, NH_2), 8.46 s (1H, 3-H). Mass spectrum, m/z (I_{rel}, %): 328 (95) $[M + 1]^+$, 265 (14), 264 (100), 109 (11). Found, %: C 69.58; H 3.82; N 21.14. $C_{19}H_{13}N_5O$. Calculated, %: C 69.72; H 4.00; N 21.39. M 327.35.

Compounds XIIa–XIIe (*general procedure*). Acrylamide **Vc**, 10 mmol, was dissolved in 15 ml of DMF, 5.6 ml (10 mmol) of 10% aqueous potassium hydroxide and 10 mmol of alkyl halide **XIa**–**XIe** were added in succession under stirring at 20°C, and the mixture was stirred for 2 h, left to stand for 24 h, and diluted with an equal volume of water. The precipitate was filtered off, washed in succession with water, ethanol, and hexane, and recrystallized from butyl alcohol.

(2*E*)-2-Cyano-*N*-ethyl-3-phenyl-*N*-(1,3-thiazol-2-yl)prop-2-enamide (XIIa). Yield 2.26 g (80%), yellow powder, mp 95–97°C. IR spectrum, ν, cm^{-1}: 2214 (C≡N), 1682 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.37 t (3H, Me, J = 6.14 Hz), 4.31 q (2H, CH_2), 7.20 d (1H, 4-H, J = 2.22 Hz), 7.54–7.61 m (3H, Ph), 7.71 d (1H, 5-H), 8.02–8.09 m (2H, Ph), 8.38 s (1H, CH=). Mass spectrum, m/z (I_{rel}, %): 284 (100) $[M + 1]^+$. Found, %: C 63.40; H 4.38; N 14.69. $C_{15}H_{13}N_3OS$. Calculated, %: C 63.58; H 4.62; N 14.83. M 283.35.

(2*E*)-2-Cyano-*N*-methyl-3-phenyl-*N*-(1,3-thiazol-2-yl)prop-2-enamide (XIIb). Yield 2.15 g (80%), yellow crystals, mp 142–143°C. IR spectrum, ν, cm^{-1}: 2214 (C≡N), 1680 (C=O). ^{1}H NMR spectrum, δ, ppm: 3.55 s (3H, Me), 7.18 d (1H, 4-H, J = 2.25 Hz), 7.54–7.61 m (3H, Ph), 7.68 d (1H, 5-H), 8.02–8.06 m (2H, Ph), 8.41 s (1H, CH=). Mass spectrum, m/z (I_{rel}, %): 270 (100) $[M + 1]^+$. Found, %: C 62.25; H 4.00; N 15.42. $C_{14}H_{11}N_3OS$. Calculated, %: C 62.44; H 4.12; N 15.60. M 269.33.

(2*E*)-2-Cyano-3-phenyl-*N*-(phenylcarbamoylmethyl)-*N*-(1,3-thiazol-2-yl)prop-2-enamide (XIIc). Yield 3.18 g (80%), yellow powder, mp 276–278°C (sublimes at 205°C). IR spectrum, ν, cm^{-1}: 3302 (NH), 2218 (C≡N), 1678 (C=O). ^{1}H NMR spectrum, δ, ppm: 5.18 s (2H, CH_2), 7.07 t (1H, Ph, J = 6.96 Hz), 7.19 d (1H, 4-H, J = 1.94 Hz), 7.32 t (2H, Ph, J = 6.95 Hz), 7.51–7.59 m (5H, Ph), 7.62 d (1H, Ph, J = 7.12 Hz), 7.68 d (1H, 5-H), 7.89 d (1H, Ph, J = 7.09 Hz), 8.39 s (1H, CH=), 10.52 br.s (1H, NH). Mass spectrum, m/z (I_{rel}, %): 389 (100) $[M + 1]^+$. Found, %: C 64.80; H 4.01; N 14.35. $C_{21}H_{16}N_4O_2S$. Calculated, %: C 64.93; H 4.15; N 14.42. M 388.45.

(2*E*)-*N*-Benzyl-2-cyano-3-phenyl-*N*-(1,3-thiazol-2-yl)prop-2-enamide (XIId). Yield 3.00 g (87%), yellow powder, mp 103–104°C. IR spectrum, ν, cm^{-1}:

2212 (C≡N), 1698 (C=O). ^{1}H NMR spectrum, δ, ppm: 5.48 s (2H, CH_2), 7.21 d (1H, 4-H, J = 1.99 Hz), 7.28–7.42 m (3H, Ph), 7.53–7.62 m (5H, Ph), 7.83 d (1H, 5-H), 8.04 m (2H, Ph), 8.39 s (1H, CH=). Mass spectrum, m/z (I_{rel}, %): 346 (100) $[M + 1]^+$, 91 (12) $[PhCH_2]^+$. Found, %: C 69.42; H 4.28; N 11.99. $C_{20}H_{15}N_3OS$. Calculated, %: C 69.54; H 4.38; N 12.16. M 345.43.

(2*E*)-*N*-Allyl-2-cyano-3-phenyl-*N*-(1,3-thiazol-2-yl)prop-2-enamide (XIIe). Yield 2.32 g (78%), yellow powder, mp 107–108°C. IR spectrum, ν, cm^{-1}: 2222 (C≡N), 1682 (C=O). ^{1}H NMR spectrum, δ, ppm: 4.91 d (2H, NCH_2, J = 6.65 Hz), 5.24 d (1H, CH_2=, J_{trans} = 17.11 Hz), 5.30 d (1H, CH_2=, J_{cis} = 8.99 Hz), 6.00–6.14 m (1H, CH_2=C**H**), 7.22 d (1H, 4-H, J = 1.98 Hz), 7.55 m (3H, Ph), 7.69 d (1H, 5-H), 8.09 m (2H, Ph), 8.40 s (1H, C**H**=CC≡N). Mass spectrum, m/z (I_{rel}, %): 296 (100) $[M + 1]^+$. Found, %: C 64.88; H 4.21; N 14.05. $C_{16}H_{13}N_3OS$. Calculated, %: C 65.06; H 4.44; N 14.23. M 295.36.

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