Unexpected Behavior of Enaminones: Interesting New Routes to 1,6-Naphthyridines, 2-Oxopyrrolidines and Pyrano[4,3,2-de][1,6]naphthyridines

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Abstract: Reaction of enaminones 1a–d with 2-aminoprop-1-ene-1,1,3-tricarbonitrile (2) in the presence of AcOH/NH₄OAc afforded 7-amino-5-oxo-5,6-dihydro-1,6-naphthyridine-8-carbonitrile derivatives 9a–d. On the other hand, 2-aminopyrano[4,3,2-de] [1,6]naphthyridine-3-carbonitriles 20a–c,e were the only obtained products from the reactions of 1a–d with 2 in the presence of AcOH/NaOAc, while 1d afforded [3,5-bis-(4-chloro-benzoyl)-phenyl]-(4-chloro-phenyl)-methanone 21 under the same condition. The reaction of 2 with diethyl acetylenedicarboxylate in the presence of AcOH/NH₄OAc afforded (4-cyano-5-dicyanomethylene-2-oxo-2,5-dihydrot-1H-pyrrol-3-yl)-acetic acid ethyl ester 15B.

Keywords: enaminones; 3-amino-2-cyanopent-2-enedinitrile; 7-amino-5-oxo-5,6-dihydro-1,6-naphthyridine-8-carbonitrile; 2-aminoprop-1-ene-1,1,3-tricarbonitrile
1. Introduction

During the last decade we have been involved in a program aimed at exploring the synthetic potentials of enaminones [1] as building blocks for polyfunctionally substituted aromatics and heteroaromatics [1–3]. We have in the past successfully developed syntheses of polysubstituted benzenes [4,5] and polysubstituted pyridines [6,7] utilizing enaminones 1a–d as starting materials. In the present article we report our further results in this area where a novel one pot synthesis of 7-amino-5-oxo-5,6-dihydro-1,6-naphthyridine-8-carbonitriles 9a–d, 2-aminopyrano[4,3,2-de][1,6]naphthyridine-3-carbonitrile derivatives 20a–c,e and (4-cyano-5-dicyanomethylene-2-oxo-2,5-dihydro-1H-pyrrol-3-yl)-acetic acid ethyl ester 15B could be achieved. To our knowledge only one derivative of the 2-aminopyrano[4,3,2-de][1,6]naphthyridine-3-carbonitrile system has been reported, prepared via a multistep route [8]. The newly synthesized 2-aminopyrano[4,3,2-de][1,6]naphthyridine-3-carbonitrile derivatives 20a–c,e seem interesting for biological activity investigations as investigations on such polynuclear aromatics are rare [8].

2. Results and Discussion

Although the reaction of enaminone 1c and 3-amino-2-cyanopent-2-enedinitrile (2) in refluxing acetic acid in presence of ammonium acetate (NH4OAc) has been reported earlier [1,9] to afford 2,4-diamino-5-benzoylisophthalonitrile, with molecular formula C15H10N4O and molecular mass M+ = 262, we found, however, that enaminone 1c and compound 2 react in acetic acid in the presence of NH4OAc to yield a completely different product with the same molecular formula and molecular mass. Both starting compounds the enaminone 1 and 3-amino-2-cyanopent-2-enedinitrile (2) are bifunctional reactants. The carbonyl group of 1 can form an imine (1 + 2 → 3) or participate in a Knoevenagel reaction with the methylene group of 2 (1 + 2 → 6). Michael-type additions 1+2 → 4 or 1 + 2 → 5 are other alternatives. The subsequent ring closure reactions can lead to the pyridine derivatives 7 or 8. Finally, the 1,6-naphthyridine systems 9–12 can also be generated. The yields obtained from 1a–d are between 75 and 90%. We have depicted all possible end products that could be obtained from reacting 1a–d and 2 in Scheme 1 as secondary carbamides, but their tautomers having a hydrogen atom bound to N-1 or to the oxygen atom have to be considered as well. The structure determination of the reaction products of 1a–d and 3-amino-2-cyanopent-2-enedinitrile (2) proved to be very difficult, because all twelve possible 1,6-naphthyridine derivatives should have similar 1H- and 13C-NMR spectra. Therefore, we performed a series of 2D NMR measurements: (1H,1H)COSY, (1H,13C)HSQC, (1H,13C)HMBC, (1H,15N)HSQC, (1H,15N)HMBC, and INADEQUATE. The final decision was made in favor of the structures 9a–d. Figures 1 and 2 showed the 1H, 13C and 15N chemical shifts and the results of the 2D-INADEQUATE and the two HMBC measurements which represent the basis for the assignment of the chemical shifts (Scheme 1).
Scheme 1. Formation of compounds 9a–d.

Figure 1. Upper part: \((^{13}\text{C}, ^1\text{H})\)- and \((^{15}\text{N}, ^1\text{H})\) couplings \(nJ (n = 2–4)\) according to the crosspeaks observed in the HMBC measurements of 9c. Lower part: Assignment of all \(^1\text{H}, ^{13}\text{C}\) and \(^{15}\text{N}\) signals of 9c. The δ values obtained in \(\text{CD}_3\text{SOCD}_3\) at room temperature are related to TMS and \(\text{NH}_3\) (liquid). The measurements were performed at 14.1 T (600 MHz for \(^1\text{H}\)).
Figure 2. Upper part: $(^{13}C, ^1H)$- and $(^{15}N, ^1H)$ couplings $nJ$ ($n = 2–4$) according to the crosspeaks observed in the HMBC measurements of $9d$. Lower part: Assignment of all $^1H$, $^{13}C$ and $^{15}N$ signals of $9d$. The $\delta$ values obtained in CD$_3$SOCD$_3$ at room temperature are related to TMS and NH$_3$ (liquid). The measurements were performed at 14.1 T (600 MHz for $^1H$).

In order to extend this finding further we reacted 3-amino-2-cyanopent-2-enedinitrile (2) with diethyl acetylenedicarboxylate (13) in the presence of AcOH/NH$_4$OAc. In this case, however, ethyl (4-cyano-5-dicyanomethylene-2-oxo-pyrrolidin-3-ylidene) acetate $15B$ was obtained as indicated by an X-ray crystal structure determination (Figure 3) [10]. It is believed that compound 2 reacts with 13 to initially afford adduct 14 that cyclizes preferably to the pyrrolidine 15 rather than the alternative pyridine derivative 16 (Scheme 2). Although 15 has been shown to exist as a solid, in DMSO solution only form $15B$ exists, as indicated by the $^1H$-NMR data that showed a singlet at $\delta = 5.50$ ppm for the methylene proton and a broad signal at $\delta = 2.48$ ppm for proton of the dicyanomethyl moiety.

Figure 3. X-ray crystal structure of compound $15A$.

We conducted the same reactions of enaminones 1a–c,e with 3-amino-2-cyanopent-2-enedinitrile (2) in the presence of AcOH/NaOAc. This reaction afforded in this case a different product with molecular formula C$_{20}$H$_{10}$N$_4$O$_2$S$_2$ and molecular mass $M^+ = 402$. It is believed that compound 1a reacted with 3-amino-2-cyanopent-2-enedinitrile (2) to form the highly unsaturated intermediates $17a–c,e$ and their anions $18a–c,e$, respectively (Scheme 3).
Scheme 2. Formation of compound 15B.

The intermediate 18 can undergo a cyclic \( \pi \)-electron shift (\( 6\pi \rightarrow 3\sigma + 3\pi \), valence isomerization) to 19a–c,e. Protonation of 19a–c,e, followed by 1,5-H-shift and dehydrogenation lead finally to the 2-aminopyrano[4,3,2-de][1,6]naphthyridine-3-carbonitrile 20a–c,e. Yields of 20a–c,e amounted to 85–92% when 2:1-mixtures of 1 and 2 were refluxed in AcOH/NaOAc. The reaction of 1d with 2 under the same conditions afforded [3,5-bis-(4-chloro-benzoyl)-phenyl]-(4-chloro-phenyl)-methanone 21 previously obtain by upon refluxing 1d in AcOH. It has been previously observed that 1d readily trimerise on attempted condensation with nucleophils [12].

Scheme 3. Formation of compounds 20a–c,e.
The structure determination of 20 was based on 2D NMR measurements (COSY, HSQC, HMBC and (1H, 15N) HMBC) of 20a and on a crystal structure analysis of 20c (Figures 4 and 5) [11].

**Figure 4.** Crystal structure of 20c.

**Figure 5.** Left part: (13C, 1H) couplings $^nJ$ (n = 2–4) according to the crosspeaks observed in HMBC measurement of 20a. Right part: Assignment of all 1H and 13C signals and one 15N signal of 20a. The δ values obtained in CD$_3$SOCD$_3$ at room temperature are related to TMS and NH$_3$ (liquid). The measurements were performed at 14.1 T (600 MHz for $^1$H).
3. Experimental

3.1. General

Melting points are reported uncorrected and were determined with a Sanyo (Gallaenkamp) instrument. Infrared spectra were recorded using KBr pellets and a Perkin-Elmer 2000 FT–IR instrument. $^1$H- and $^{13}$C-NMR spectra were determined by using a Bruker DPX instrument at 600 MHz for $^1$H-NMR and 150 MHz for $^{13}$C-NMR and either CDCl$_3$ or DMSO-d$_6$ solutions with TMS as internal standards. Chemical shifts are reported in $\delta$ (ppm). Mass spectra were measured using VG Autospec Q MS 30 and MS 9 (AEI) spectrometer, with the EI (70 EV) mode. Elemental analyses were carried out by using a LEOCHNS-932 Elemental Analyzer. X-ray crystal structure determined by using a Single Crystal X-ray Crystallography-Rigaku Rapid II & Bruker X8 Prospector system.

3.2. General Procedure for the Synthesis of 9a–d

A mixture of enammine 1a–d (0.01 mol) and 3-amino-2-cyanopent-2-enedinitrile (2, 1.32 g, 0.01 mol) in AcOH (25 mL)/NH$_4$OAc (1 g) was heated under reflux for 2 h (followed until completion by TLC using 1:1 ethyl acetate–petroleum ether as eluent). The mixture was then cooled and poured onto ice-water. The solid, so formed, was collected by filtration and recrystallized from AcOH to give yellow crystals.

7-Amino-5-oxo-2-(thienyl)-5,6-dihydro-1,6-naphthyridine-8-carbonitrile (9a). Yield 75%; mp. 291–292 °C. Anal. Calcd. for C$_{13}$H$_8$N$_4$OS (268.29): C, 58.20; H, 3.01; N, 20.88; S, 11.95%. Found: C, 58.17; H, 3.13; N, 20.65; S, 11.92%; IR (KBr, cm$^{-1}$): 3471 (NH), 3363, 3295 (NH$_2$), 2252 (CN), 1652 (CO); $^1$H-NMR (DMSO-d$_6$): $\delta$ = 7.05 (br, 2H, NH$_2$), 7.21 (t, 1H, $J$ = 4.0, thienyle-H), 7.69 (d, 1H, $J$ = 8.0, CH), 7.77 (d, 1H, $J$ = 4.0, thienyl-H), 7.94 (d, 1H, $J$ = 4.0, thienyl-H), 8.22 (d, 1H, $J$ = 8.0, CH), 11.22 (br, 1H, NH, D$_2$O exchangeable); $^{13}$C-NMR (DMSO-d$_6$): $\delta$ = 160.6, 156.1, 155.2, 154.4, 143.6, 136.2, 130.9, 128.6, 127.7, 116.2, 113.5, 112.56, 67.4. MS: m/z (%): 268 (M$^+$, 40), 256 (35), 241 (15), 213 (25), 185 (25), 169 (20), 129 (55), 97 (40), 73 (100).

7-Amino-2-(furyl)-5-oxo-5,6-dihydro-1,6-naphthyridine-8-carbonitrile (9b). Yield 80%; mp. 287–289 °C. Anal. Calcd. for C$_{13}$H$_8$N$_4$O$_2$ (252.23): C, 61.90; H, 3.20; N, 22.21%. Found: C, 61.84; H, 3.31; N, 22.32%; IR (KBr, cm$^{-1}$): 3424 (NH), 3343, 3240 (NH$_2$), 2214 (CN), 1662 (CO); $^1$H-NMR (DMSO-d$_6$): $\delta$ = 6.72 (t, 1H, $J$ = 4.0, furyl-H), 7.05 (br, 2H, NH$_2$), 7.25 (d, 1H, $J$ = 4.0, furyl-H), 7.51 (d, 1H, $J$ = 8.0, CH), 7.94 (d, 1H, $J$ = 4.0, furyl-H), 8.25 (d, 1H, $J$ = 8.0, CH), 11.24 (br, 1H, NH, D$_2$O exchangeable); $^{13}$C-NMR (DMSO-d$_6$): $\delta$ = 160.1, 155.3, 154.5, 152.4, 152.3, 145.7, 136.3, 116.4, 113.3, 112.7, 112.6, 111.9, 67.5. MS: m/z (%): 252 (M$^+$, 100), 224 (20), 195 (10), 73 (90).

7-Amino-5-oxo-2-phenyl-5,6-dihydro-1,6-naphthyridine-8-carbonitrile (9c). Yield 90%; mp. 253–255 °C. Anal. Calcd. for C$_{15}$H$_{10}$N$_4$O (262.27): C, 68.69; H, 3.84; N, 21.36%. Found: C, 68.65; H, 3.75; N, 21.40%; IR (KBr, cm$^{-1}$): 3325 (NH), 3251, 3209 (NH$_2$), 2209 (CN), 1673 (CO); $^1$H-NMR (DMSO-d$_6$): $\delta$ = 7.07 (br, 2H, NH$_2$), 7.52–7.53 (m, 3H, Ph-H), 7.75 (d, 1H, $J$ = 8.0, CH), 8.20–8.21 (m, 2H, Ph-H), 8.28 (d, 1H, $J$ = 8.0, CH), 11.27 (br, 1H, NH, D$_2$O exchangeable); $^{13}$C-NMR (DMSO-d$_6$): $\delta$ = 160.8, 160.2, 155.2, 154.3, 137.5, 136.4, 130.3, 128.8 (2C), 127.2 (2C),
116.5, 114.8, 113.1, 67.8. MS: m/z (%) 262 (M+, 100), 234 (15), 217 (10), 192 (5), 164 (10), 129 (10), 83 (10), 73 (25).

7-Amino-2-(4-chlorophenyl)-5-oxo-5,6-dihydro-1,6-naphthyridine-8-carbonitrile (9d). Yield 90%; mp. 275–276 °C. Anal. Calcd. for C_{15}H_{9}ClN_{4}O (296.72): C, 60.72; H, 3.06; N, 18.88%. Found: C, 60.70; H, 3.11; N, 18.87%; IR (KBr, cm\(^{-1}\)): 3436 (NH), 3324, 3216 (NH\(_2\)), 2211 (CN), 1678 (CO); \(^1\)H-NMR (DMSO-d\(_6\)): \(\delta = 7.06\) (s, 2H, NH\(_2\), D\(_2\)O exchangeable), 7.54 (d, 2H, Ph-H), 7.69 (d, 1H, \(J = 8.0\), CH), 8.17 (d, 2H, Ph-H), 8.23 (d, 1H, \(J = 8.0\), CH), 11.25 (br, 1H, NH, D\(_2\)O exchangeable); \(^{13}\)C-NMR (DMSO-d\(_6\)): \(\delta = 160.7, 158.8, 155.2, 154.2, 136.4, 136.2, 135.2, 129.0\) (2C), 128.8 (2C), 116.4, 114.6, 113.2, 67.8. MS: m/z (%) 296 (M\(^+\), 100), 268 (20), 216 (15), 189 (15), 164 (10), 130 (10), 88 (15), 73 (20).

Synthesis of (4-cyano-5-dicyanomethylene-2-oxo-2,5-dihydro-1H-pyrrol-3-yl)-acetic acid ethyl ester (15B). A mixture of 3-amino-2-cyanopent-2-enenitrile (2, 1.32 g, 0.01 mol) and diethyl acetylenedicarboxylate (13, 1.70 g, 0.01 mol) in AcOH (25 mL)/NH\(_4\)OAc (1 g) was refluxed for 2 h (followed until completion by TLC using 1:1 ethyl acetate–petroleum ether as eluent). The mixture was cooled and then was poured onto ice-water. The solid, so formed, was collected by filtration and recrystallized from EtOH to give orange crystals, yield 70%; mp. 200–202 °C. Anal. Calcd. for C\(_{12}\)H\(_8\)N\(_4\)O\(_3\) (256.22): C, 56.25; H, 3.15; N, 21.87%. Found: C, 56.22; H, 3.27; N, 22.00%; IR (KBr, cm\(^{-1}\)): 3363 (NH), 2223 (CN), 2211 (2CN), 1695 (CO), 1653 (CO); \(^1\)H-NMR (DMSO-d\(_6\)): \(\delta = 1.22\) (t, 3H, \(J = 8.0\), CH\(_3\)), 2.48 (br, 1H, , \(J = 8.0\), CH), 4.10 (q, 2H, CH\(_2\)), 5.50 (s, 1H, CH), 10.84 (br, 1H, NH, D\(_2\)O exchangeable); \(^{13}\)C-NMR (DMSO-d\(_6\)): \(\delta = 169.0, 165.8, 161.3, 138.5, 117.2, 116.0, 115.6, 100.1\) (2C), 68.2, 59.0, 14.2. MS: m/z (%) 256 (M\(^+\), 50), 211 (15), 184 (75), 156 (10), 112 (100), 97 (10), 84 (25), 70 (25), 55 (90).

3.3. General Procedure to Syntheses of 20a–c,e

A mixture of enaminone 1a–e (0.01 mol) and 2-aminoprop-1-ene-1,1,3-tricarbonitrile (2, 1.32 g, 0.01 mol) in AcOH/NaOAc (1 g) was refluxed for 2 h (followed until completion by TLC using 1:1 ethyl acetate–petroleum ether as eluent). The mixture was cooled and then was poured onto ice-water. The solid, so formed, was collected by filtration and recrystallized from AcOH to give yellow crystals.

2-Amino-8-(thiophen-2-yl)-6-(thiophene-2-carbonyl)pyrano-[4,3,2-de][1,6]naphthyridine-3-carbonitrile (20a). Yield 92%; mp. 369–370 °C. Anal. Calcd. for C\(_{20}\)H\(_{10}\)N\(_4\)O\(_2\)S\(_2\) (402.45): C, 59.69; H, 2.50; N, 13.92; S, 15.93%. Found: C, 59.72; H, 2.33; N, 13.97; S, 15.86%; IR (KBr, cm\(^{-1}\)): 3363, 3295 (NH\(_2\)), 2213 (CN), 1642 (CO); \(^1\)H-NMR (DMSO-d\(_6\)): \(\delta = 7.27\) (t, 1H, \(J = 4.0\), thienyl-H), 7.31 (t, 1H, \(J = 4.0\), thienyl-H), 7.47 (s, 1H, CH), 7.78 (d, 1H, \(J = 4.0\), thienyl-H), 7.86 (br, 3H, thienyl-H, NH\(_2\), D\(_2\)O exchangeable), 7.94 (d, 1H, \(J = 4.0\), thienyl-H), 8.16 (d, 1H, \(J = 4.0\), thienyl-CH), 8.98 (s, 1H, CH); \(^{13}\)C-NMR (DMSO-d\(_6\)): \(\delta = 184.8, 162.1, 160.4, 157.2, 156.2, 154.0, 143.7, 136.1, 135.8, 134.1\) (2C), 131.6, 129.3, 129.00, 128.9, 118.1, 115.9, 104.0, 98.3, 77.1 . MS: m/z (%) 402 (M\(^+\), 100), 373 (15), 319 (25), 263 (5), 236 (5), 187 (10), 111 (30), 83 (5).
2-Amino-6-(furan-2-carbonyl)-8-(furan-2-yl)pyrano[4,3,2-de]-[1,6]naphthyridine-3-carbonitrile (20b). Yield 90%; mp. 375–77 °C. Anal. Calcd. for C_{20}H_{10}N_{4}O_{4} (370.32): C, 64.87; H, 2.72; N, 15.13%. Found: C, 64.88; H, 2.68; N, 15.22%. IR (KBr, cm^{-1}): 3471, 3373 (NH2), 2210 (CN), 1653 (CO); 1H-NMR (DMSO-d6): δ = 6.78 (t, 1H, J = 4.0, furyl-H), 6.82 (t, 1H, J = 4.0, furyl-H), 7.19 (d, 1H, J = 4.0, furyl-H), 7.44 (s, 1H, CH), 7.46 (d, 1H, J = 4.0, furyl-H), 7.83 (br, 2H, NH2, D2O exchangeable), 8.04 (d, 1H, J = 4.0, furyl-H), 8.24 (d, 1H, J = 4.0, furyl-H), 8.98 (s, 1H, CH); 13C-NMR (DMSO-d6): δ = 179.20, 162.29, 161.98, 160.13, 157.31, 156.08, 151.64, 150.06, 148.72, 147.23, 145.30, 140.47, 121.34, 117.48, 115.76, 113.36, 112.97, 103.98, 97.56, 77.23. MS: m/z (%) 370 (M^+, 90), 264 (15), 224 (25), 195 (15), 169 (10), 129 (10), 83 (30), 73 (35).

2-Amino-6-benzoyl-8-phenylpyrano[4,3,2-de][1,6]naphthyridine-3-carbonitrile (20c). Yield 88%; mp. 318–319 °C. Anal. Calcd. for C_{24}H_{14}N_{4}O_{2} (390.11): C, 73.84; H, 3.61; N, 14.35%. Found: C, 73.92; H, 3.6; N, 14.28%. IR (KBr, cm^{-1}): 3445, 3341 (NH2), 2216 (CN), 1646 (CO); 1H-NMR (DMSO-d6): δ = 7.56–7.61 (m, 5H, Ph-H), 7.65 (s, 1H, CH), 7.69–7.86 (m, 7H, Ph-H, NH2, D2O exchangeable), 8.72 (s, 1H, CH); 13C-NMR (DMSO-d6): δ = 193.50, 162.10, 160.86, 158.22, 158.31, 156.20, 141.80, 141.10, 137.70, 135.20, 132.90, 131.60, 130.70, 129.60 (2C), 129.30, 128.80 (2C), 125.70, 117.75, 115.77, 104.21, 100.10, 77.10. MS: m/z (%) 390 (M^+, 100), 373 (15), 313 (65), 257 (10), 230 (10), 188 (5), 181 (5), 105 (20), 77 (25).

2-Amino-6-(4-methoxybenzoyl)-8-(4-methoxyphenyl)pyrano[4,3,2-de][1,6]naphthyridine-3-carbonitrile (20e). Yield 85%; mp. 325–327 °C. Anal. Calcd. for C_{26}H_{18}N_{4}O_{4} (450.45): C, 69.33; H, 4.03; N, 12.44%. Found: C, 69.40; H, 4.12; N, 12.42%. IR (KBr, cm^{-1}): 3424, 3343 (NH2), 2216 (CN), 1644 (CO); 1H-NMR (DMSO-d6): δ = 7.56–7.61 (m, 5H, Ph-H), 7.65 (s, 1H, CH), 7.69–7.86 (m, 7H, Ph-H, NH2, D2O exchangeable), 8.72 (s, 1H, CH); 13C-NMR (DMSO-d6): δ = 191.90, 163.30, 162.90, 160.82, 158.21, 157.65, 157.50, 156.20, 141.80, 141.10, 137.70, 135.20, 132.90, 131.60, 130.70, 129.60 (2C), 129.30, 128.80 (2C), 125.70, 117.75, 115.77, 104.21, 100.10, 77.10. MS: m/z (%) 450 (M^+, 100), 419 (20), 407 (5), 343 (30), 300 (10), 211 (15), 135 (25), 107 (5), 77 (20).

3.4. Synthesis of [3,5-bis-(4-chlorobenzoyl)phenyl]-(4-chlorophenyl)methanone (21)

A mixture of enaminone 1d (2.09 g, 0.01 mol) and 2-aminoprop-1-ene-1,1,3-tricarbonitrile (2, 1.32 g, 0.01 mol) in AcOH/NaOAc (1 gm) was refluxed for 2 h (followed until completion by TLC using 1:1 ethyl acetate–petroleum ether as eluent). The mixture was cooled and then was poured onto ice-water. The solid, so formed, was collected by filtration and recrystallized from AcOH to give faint yellow crystals, yield 80%. This product was also prepared via refluxing 1d in AcOH as described earlier by Elnagdi et al. [12].

4. Conclusions

New simple and efficient routes for the synthesis of 7-amino-5-oxo-5,6-dihydro-1,6-naphthyridine-8-carbonitrile derivatives 9a–d, (4-cyano-5-dicyanomethylene-2-oxo-pyrrolidin-3-ylidene)-acetic acid ethyl ester 15B and 2-aminopyrano[4,3,2-de][1,6]naphthyridine-3-carbonitrile derivatives 20a–e from the reaction of enaminones with 2-aminoprop-1-ene-1,1,3-tricarbonitrile (2) have been described.
These products look interesting for potential biological evaluation. Moreover, all the products have latent functional moieties that seem interesting precursors to other derivatives of the described ring systems.

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References and Notes


10. CCDC 861196 contains the supplementary crystallographic data for compound 15A. These data can be obtained free of charge from the Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk.
11. CCDC 838314 contains the supplementary crystallographic data for compound 20c. These data can be obtained free of charge from the Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk.


*Sample Availability:* Samples of the all compounds are available from the authors.

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