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COUPLING OF HETEROARYLDIAZONIUM TETRAFLUOROBORATES WITH 1,3-DICARBONYL COMPOUNDS – REGIOSELECTIVE SYNTHESIS OF ALKYL 1-HETEROARYL-4-HYDROXY-1*H*-PYRAZOLE-3-CARBOXYLATES

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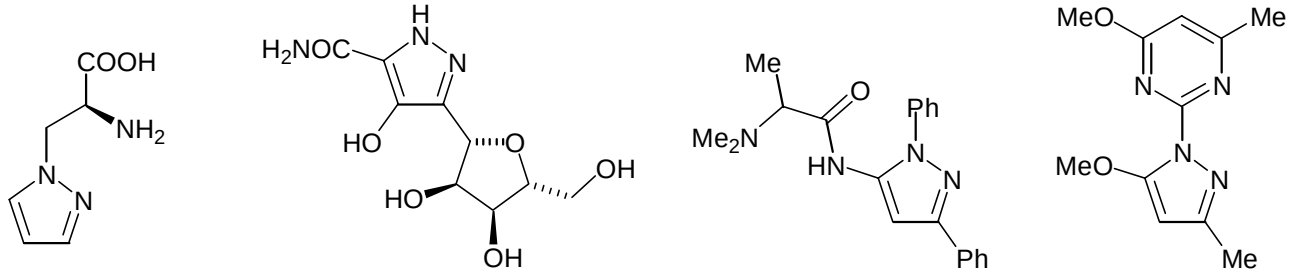
Abstract – Coupling of 1-cyano-4-oxo-4*H*-quinolizine- (**2**), 1-ethoxycarbonyl-4-oxo-4*H*-quinolizine- (**3**), and 4-oxo-4*H*-pyridino[1,2–*b*]pyrimidine-3-diazonium tetrafluoroborates (**4**) with 1,3-dicarbonyl compounds (**1a–i**) afforded the corresponding hydrazones (**5–7**) in 55–96% yields. The orientation around the C=N double bond in unsymmetrically substituted hydrazones (**7a,c**) was determined by NMR (NOESY) spectrometry. Heating of hydrazones (**5a,b–7a,b**), derived from alkyl 4-chloro-3-oxobutanoates (**1a,b**), furnished 1-(1-substituted quinolizin-3-yl)- (**8**, **9**) and 1-(pyridino[1,2–*a*]-pyrimidin-3-yl)-4-hydroxy-1*H*-pyrazole-3-carboxylates (**10**) in 87–96% yields.

Pyrazoles are one of the most important and significant classes of heterocyclic compounds. The pyrazole ring has been found as constituent of natural and synthetic products.[1] Such examples of important pyrazole derivatives are (*S*)-3-pyrazolylalanine,[2] pyrazomycine,[3] deifenamizole,[4] and mepirizole[5] (Figure 1).

Figure 1



(*S*)-3-pyrazolylalanine (*from Citrulus vulgaris*)

Pyrazomycin (*from Streptomyces candidus*)

Difenamizole (*analgesic, antipyretic,antiinflammatory*)

Mepirizole

Usually, pyrazoles are prepared by condensation between a hydrazine derivative and a 1,3-dicarbonyl compound or by 1,3-dipolar cycloaddition of diazoalkanes or nitrile imines to olefins or acetylenes. The major problem, which is usually encountered by synthesis of unsymmetrically substituted pyrazoles, is regioselectivity of cyclization reactions. In many cases, regioselectivity is poor and mixtures of regioisomers are obtained.[1] An example of regioselective synthesis of 1-aryl-4-hydroxy-1*H*-pyrazoles is cyclization of substituted β-halo- and β-tosyloxy-α-oxohydrazones.[6,7] Just recently, synthesis of 1-aryl-4-hydroxy-1*H*-pyrazoles *via* coupling of aryldiazonium salts with 4-chloroacetoacetic acid followed by cyclization of the intermediate hydrazone under basic conditions has been reported.[7f]

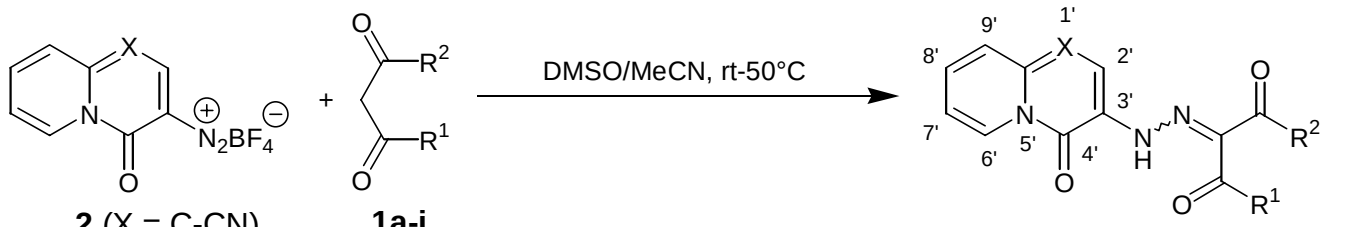
In the last decade, alkyl 2-substituted 3-dimethylaminopropenoates proved to be easily available and efficient reagents for the preparation of various heterocyclic systems.[8] For example, stable 4-oxo-4*H*-quinolizine-3-diazonium tetrafluoroborates (**2**, **3**)[9] and 4-oxo-4*H*-pyridino[1,2–*a*]pyrimidine-3-diazonium tetrafluoroborate (**4**)[10] have been prepared in three steps and in good yields from methyl (*Z*)-2-benzyloxycarbonylamino-3-dimethylaminopropenoate. Just recently, our studies of transformations of heteroaryldiazonium tetrafluoroborates (**2–4**) showed that these compounds could be employed as useful precursors in the preparation of heterocyclic systems. Thus, heating of 4-oxo-4*H*-quinolizine-3-diazonium tetrafluoroborates (**2**, **3**) in primary alcohols resulted in aza-Wolff rearrangement to give the corresponding alkyl indolizine-3-carboxylates,[9] while 4-oxo-4*H*-pyridino[1,2–*a*]pyrimidine-3-diazonium tetrafluoroborates (**4**) underwent, under similar reaction conditions, a 'ring switching' transformation to afford alkyl 1-(4-substituted pyridin-2-yl)-1*H*-1,2,3-triazole-4-carboxylates.[10] In continuation of our research in this field, we report coupling reactions of diazonium salts (**2–4**) with various 1,3-dicarbonyl compounds (**1a**–**i**) and cyclization of hydrazones (**5a,b–7a,b**), derived from alkyl 4-chloro-3-oxobutanoate (**1a,b**), into alkyl 1-heteroaryl-4-hydroxy-1*H*-pyrazole-3-carboxylates (**10a,b**).

The starting compounds, 1-cyano-4-oxo-4*H*-quinolizine-3- (**2**), 1-ethoxycarbonyl-4-oxo-4*H*-quinolizine-3- (**3**), and 4-oxo-4*H*-pyridino[1,2–*a*]pyrimidine-3-diazonium tetrafluoroborate (**4**) were prepared from methyl (*Z*)-2-benzyloxycarbonylamino-3-dimethylaminopropenoate according to the procedures described previously.[9,10] Treatment of diazonium salts (**2–4**) with various 1,3-dicarbonyl compounds (**1a–i**) in DMSO or acetonitrile at 20–50°C afforded the corresponding hydrazones (**5–7**) in 55–96% yield (Scheme 1).

In DMSO–d_6 solution, unsymmetrically substituted hydrazones (**5a–d**, **6a,b**, and **7a–c**) exist as mixtures of the (*E*)-isomers and the (*Z*)-isomers. Comparison of chemical shifts for NH protons revealed two general patterns. In the case of hydrazones derived from alkyl 4-chloro-3-oxobutanoates (**1a,b**), the signals for the NH protons appear at lower field (~12.8 ppm) for the major isomers and at higher field (~14.5 ppm) for the minor isomers. In the case of other unsymmetrically substituted hydrazones (**5c,d** and **7c**), just the opposite situation was observed. In order to establish, whether this is, either due to different

substitution pattern, or due to different configuration around the C=N double bond, the NOESY spectra of hydrazones (**7a,c**) were taken. In the case of the major isomer of the hydrazone (**7a**), NOE between the MeO group and the NH proton and NOE between the MeO group and the 2'–H proton support the (*Z*)-configuration around the C=N double bond. Similarly, the (*E*)-configuration around the C=N double bond in the major isomer of hydrazone (**7c**) was established on the basis of NOE between the CH_3 group and the NH proton. From this spectroscopic evidence it might be presumed that the hydrazones (**5a,b**–**7a,b**), derived from γ-chloro-β-keto esters (**1a,b**) exist in solution predominantly in the (*Z*)-form, while hydrazones (**5c** and **7c**), derived from benzoylacetone (**1c**), exist predominantly in the (*E*)-form. Thus, the configuration around the C=N double bond of the prepared hydrazones (**5a–c**, **6a,b**, and **7a–c**) can be correlated with typical chemical shifts for NH protons. An exception is the hydrazone (**5d**), which exists in solution as approximately 1:1 mixture of isomers, with both signals for NH protons appearing at ~14.5 ppm (Scheme 2).

Scheme 1



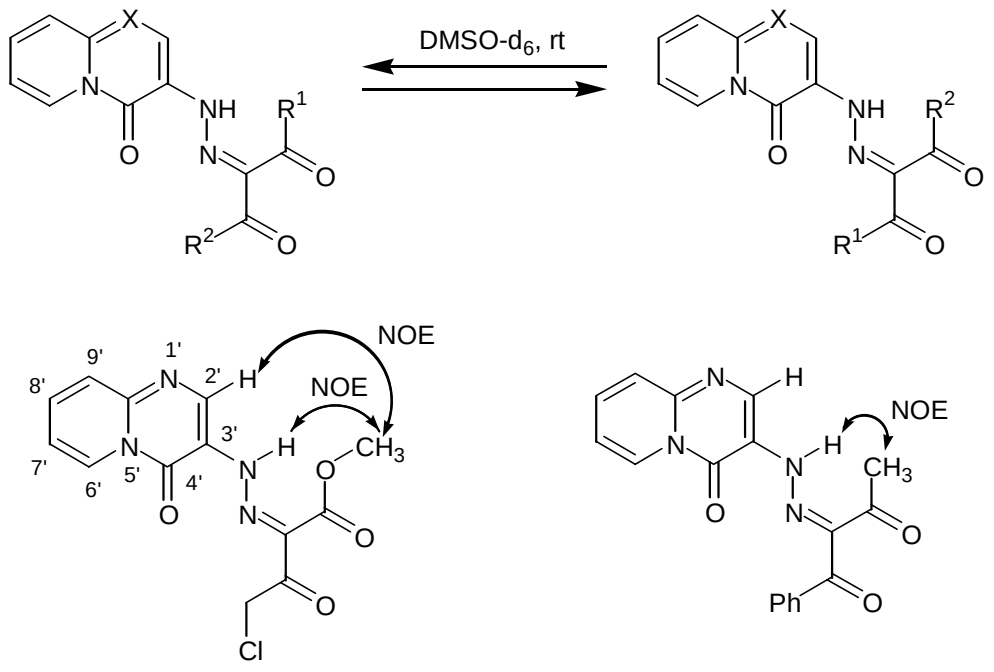
2 (X = C-CN)
3 (X = C-COOEt)
4 (X = N)

1a-i

5 (X = C-CN)
6 (X = C-COOEt)
7 (X = N)

Compound	1,3-Dicarbonyl Residue		Yield [%]		
	R^1	R^2	**5**	**6**	**7**
1a, **5a**–**7a**	CH_2Cl	OMe	72	64	61
1b, **5b**–**7b**	CH_2Cl	OEt	60	55	60
1c, **5c**, **7c**	Me	Ph	66		72
1d, **5d**	Me	COOEt	61		
1e, **5e**, **7e**	Me	Me	89		78
1f, **5f**, **7f**	Ph	Ph	91		62
1g, **5g**, **7g**	1,3-cyclohexanedione		96		96
1h, **5h**, **7h**	5,5-dimethylcyclohexane-1,3-dione		90		62
1i, **5i**, **7i**	*N*,*N*-dimethylbarbituric acid		90		79

Scheme 2



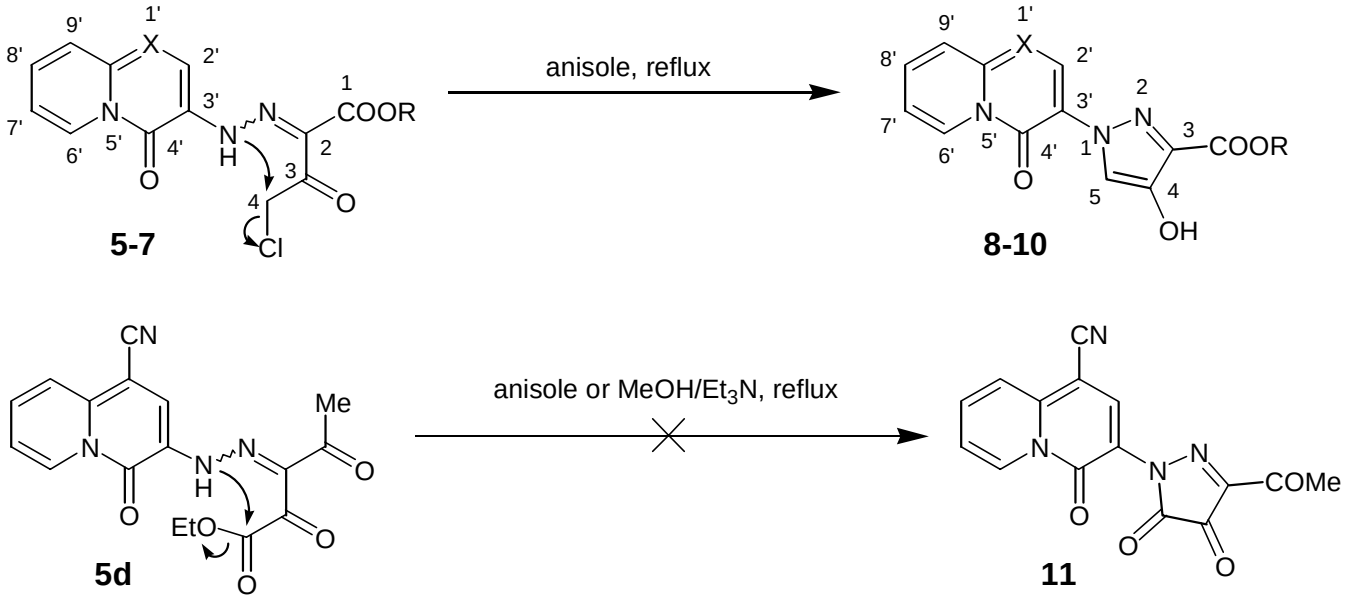
Compound	X	R^1	R^2	*E*:*Z*	NH, δ [ppm]	
					major isomer	*minor isomer*
5a	C–CN	CH_2Cl	OMe	14:86	12.91	14.46
5b	C–CN	CH_2Cl	OEt	14:86	12.87	14.45
6a	C–COOEt	CH_2Cl	OMe	40:60	12.99	14.59
6b	C–COOEt	CH_2Cl	OEt	44:56	12.95	14.53
7a	N	CH_2Cl	OMe	20:80	12.79	14.43
7b	N	CH_2Cl	OEt	11:89	12.74	14.38
5c	C–CN	Me	Ph	64:36	14.34	12.11
7c	N	Me	Ph	71:29	14.29	12.04
5d	C–CN	Me	COOEt	53:47	14.88	14.30

Heating of hydrazones (**5a,b–7a,b**) in anisole under reflux afforded the corresponding alkyl 1-heteroaryl-4-hydroxy-1*H*-pyrazole-3-carboxylates (**8a,b–10a,b**) in 87–96% yields. On the other hand, cyclization of the hydrazone (**5d**) into the pyrazolone derivative (**11**), either upon heating in anisole, or upon heating in the presence of a base, did not take place (Scheme 3).

Structures of compounds (**5–10**) were determined by spectroscopic methods (NMR, IR, MS) and by analyses for C, H, and N. Unfortunately, we were not able to obtain the pyrazole (**8a**) in analytically pure

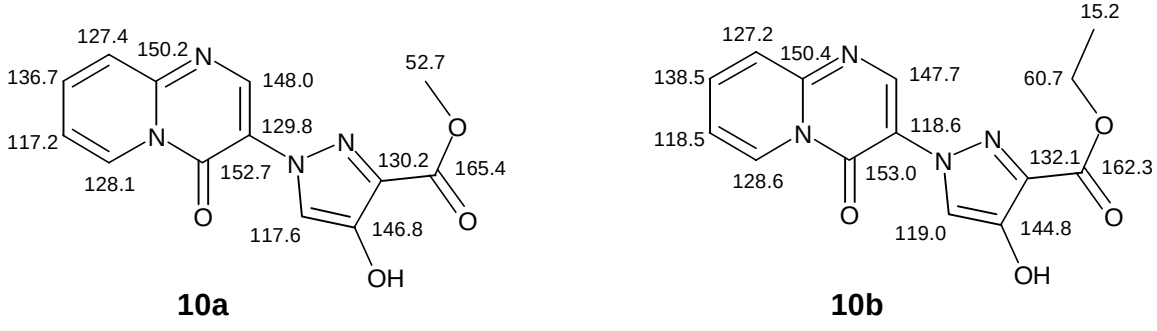
form, however, the identity of **8a** was confirmed by HRMS, ^{1}H NMR and ^{13}C NMR spectra. Spectral data for compounds (**5–10**) were in agreement with the literature data, reported previously for related compounds. Total assignment of ^{1}H and ^{13}C signals for the pyrazole derivatives (**10a,b**) was performed by 2D NMR using HMQC and HMBC techniques. Due to very low solubility of hydrazones (**5–7**) in DMSO-d_6, satisfactory ^{13}C NMR spectra of hydrazones (**5–7**) could not be obtained. (Figure 2).

Scheme 3



Compound	X	R	Yield (%)
8a	C–CN	Me	89
8b	C–CN	Et	87
9a	C–COOEt	Me	96
9b	C–COOEt	Et	88
10a	N	Me	88
10b	N	Et	90

Figure 2



In conclusion, coupling of 1,3-diacarbonyl compounds (**1a–i**) with heteroaryldiazonium salts (**2–4**) affords the corresponding hydrazones (**5–7**) in good yields. Hydrazones (**5a,b–7a,b**), derived from alkyl 4-chloro-3-oxobutanoates (**1a,b**), undergo thermal cyclization to give the corresponding 4-hydroxy-1-(4-oxo-4*H*-quinolizinyl- (**8**, **9**) and 4-hydroxy-1-(4-oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)-1*H*-pyrazole-3-carboxylates (**10**) regioselectively in high yields. These transformations represent a convenient and regioselective synthetic route to 1-(quinolizin-3-yl) and 1-(pyridino[1,2–*a*]pyrimidin-3-yl) substituted 1*H*-pyrazole derivatives.

EXPERIMENTAL

General procedures. Melting points were taken with a Kofler micro hot stage. The ^{1}H NMR, ^{13}C NMR, and 2D NOESY, HMQC, HMBC spectra were obtained with a Bruker Avance DPX 300 spectrometer with DMSO–d_6 and $CDCl_3$ as solvents and Me_4Si as internal standard. IR spectra were recorded with a Perkin-Elmer Spectrum BX FTIR and a Perkin-Elmer 1310 spectrophotometers (KBr discs). The MS spectra were recorded with an Autospeck Q (VG-Analytical) spectrometer in Laboratory for Mass Spectroscopy (Josef Stefan Institute, Ljubljana). The microanalyses for C, H, and N were obtained with a Perkin-Elmer CHN Analyser 2400. TLC: Merck, Alufolien Kieselgel 60 F 254, 0.2 mm. Column chromatography was performed on silica gel (Fluka, Kieselgel 60, 0.04–0.063 mm).

Materials. All starting materials were commercially available (in most cases from Fluka) and purified following the standard techniques. The following compounds were prepared according to the procedures described in the literature: 1-cyano-4-oxo-4*H*-quinolizine-3-diazonium tetrafluoroborate (**2**), 1-cyano-4-oxo-4*H*-quinolizine-3-diazonium tetrafluoroborate (**3**),[9] and 4-oxo-4*H*-pyridino[1,2–*a*]pyrimidine-3-diazonium tetrafluoroborate (**4**).[10]

General procedure for the preparation of *N*-heteroarylhydrazones (5–7).

Heteroaryldiazonium tetrafluoroborate (**2–4**) (0.5 mmol) was dissolved in minimum amount of acetonitrile or dimethyl sulfoxide (2–7 mL), 1,3-dicarbonyl compound (**1**) (0.5 mmol) was added, and the mixture was stirred at rt–50°C for 1–7 h. Then equal volume of water and/or ethanol (2–7 mL) was added, the precipitate was collected by filtration, and washed with ethanol and ether to give hydrazones (**5–7**).

The following compounds were prepared in this manner:

Methyl 4-Chloro-2,3-dioxobutanoate 2-[*N*-(1-Cyano-4-oxo-4*H*-quinolizin-3-yl)]hydrazone (5a). This compound was prepared from methyl 4-chloro-3-oxobutanoate (**1a**) and diazonium salt (**2**) in dimethyl sulfoxide (2 mL); stirring at rt for 2 h, followed by addition of ethanol. Yield: 0.181 g (72%), mp

242–245°C (decomp), yellow-orange solid, *E/Z* = 86:14. IR (cm^{-1}): 3109 (NH), 2220 (CN), 1707, 1672 (C=O), 1531, 1235, 1142. MS (EI): *m/z* = 346 (M^+), (FAB): *m/z* = 347 (MH^+). ^1H NMR (DMSO-d_6) δ major isomer 3.86 (s, 3H, OMe), 5.15 (s, 2H, CH_2), 7.51 (ddd, 1H, *J* = 1.5, 6.8, 7.2, 7'–H), 7.90 (ddd, 1H, *J* = 1.1, 6.8, 8.7, 8'–H), 8.00 (dd, 1H, *J* = 1.5, 8.7, 9'–H), 8.61 (s, 1H, 2'–H), 9.13 (dd, 1H, *J* = 1.1, 7.2, 6'–H), 12.91 (br s, 1H, NH), minor isomer 3.83 (s, 3H, OMe), 5.00 (s, 2H, CH_2), 8.20 (s, 1H, 2'–H), 9.19 (dd, 1H, *J* = 1.1, 7.2, 6'–H), 14.46 (br s, 1H, NH). Anal. Calcd for $C_{15}H_{11}N_4O_4Cl$: C, 51.96; H, 3.20; N, 16.16. Found: C, 52.05; H, 3.26; N, 16.11.

Ethyl 4-Chloro-2,3-dioxobutanoate 2-[*N*-(1-Cyano-4-oxo-4 *H*-quinolizin-3-yl)]hydrazone (5b). This compound was prepared from ethyl 4-chloro-3-oxobutanoate (**1b**) and diazonium salt (**2**) in dimethyl sulfoxide (2 mL); stirring at rt for 2 h, followed by addition of ethanol. Yield: 0.107 g (60%), mp 230–234°C, yellow-orange solid, *E/Z* = 86:14. IR (cm^{-1}): 3097 (NH), 2230 (CN), 1698, 1679 (C=O), 1490, 1211, 1144. MS (EI): *m/z* = 360 (M^+). ^1H NMR (DMSO-d_6) δ major isomer 1.32 (t, 3H, *J* = 7.0, CH_2CH_3), 4.34 (q, 2H, *J* = 7.0, CH_2CH_3), 5.15 (s, 2H, CH_2Cl), 7.50 (ddd, 1H, *J* = 1.5, 6.8, 7.2, 7'–H), 7.90 (ddd, 1H, *J* = 1.1, 6.8, 8.7, 8'–H), 8.00 (dd, 1H, *J* = 1.5, 8.7, 9'–H), 8.60 (s, 1H, 2'–H), 9.13 (dd, 1H, *J* = 1.1, 7.2, 6'–H), 12.87 (br s, 1H, NH), minor isomer 1.34 (t, 3H, *J* = 7.0, CH_2CH_3), 4.30 (q, 2H, *J* = 7.0, CH_2CH_3), 5.00 (s, 2H, CH_2Cl), 8.18 (s, 1H, 2'–H), 9.19 (dd, 1H, *J* = 1.1, 7.2, 6'–H), 14.45 (br s, 1H, NH). Anal. Calcd for $C_{16}H_{13}N_4O_4Cl$: C, 53.27; H, 3.63; N, 15.53. Found: C, 53.41; H, 3.58; N, 15.31. HRMS Calcd for $C_{16}H_{13}N_4O_4Cl$ (M^+): 360.062533. Found: 360.063800.

1-Phenylbutane-1,2,3-trione 2-[*N*-(1-Cyano-4-oxo-4*H*-quinolizine-3-yl)]hydrazone (5c). This compound was prepared from 1-phenylbutane-1,3-dione (**1c**) and diazonium salt (**2**) in dimethyl sulfoxide (2.7 mL); stirring at rt for 2 h, then at 50°C for 4 h, followed by addition of ethanol. Yield: 0.118 g (66%), mp 186–188°C, dark red solid, *E/Z* = 64:36. IR (cm^{-1}): 3105 (NH), 2216 (CN), 1660, 1625 (C=O), 1483, 1129, 871. MS (EI): *m/z* = 358 (M^+). ^1H NMR (DMSO-d_6) δ major isomer 2.54 (s, 3H, COMe), 7.46–7.71 (m, 5H, 4H of Ph, 7'–H), 7.61 (s, 1H, 2'–H), 7.86–7.92 (m, 2H, 1H of Ph, 9'–H), 7.96 (dd, 1H, *J* = 1.1, 8.9, 9'–H), 9.15 (dd, 1H, *J* = 1.2, 7.3 Hz, 6'–H), 14.34 (br s, 1H, NH), minor isomer 2.60 (s, 3H, COMe), 8.43 (s, 1H, 2'–H), 9.09 (dd, 1H, *J* = 1.2, 7.3, 6'–H), 12.11 (br s, 1H, NH). Anal. Calcd for $C_{20}H_{14}N_4O_3$: C, 67.03; H, 3.94; N, 15.63. Found: C, 67.04; H, 3.60; N, 15.74. HRMS Calcd for $C_{20}H_{14}N_4O_3$ (M^+): 358.106591. Found: 358.107400.

Ethyl 2,3,4-Trioxopentanoate 3-[*N*-(1-Cyano-4-oxo-4*H*-quinolizin-3-yl)]hydrazone (5d). This compound was prepared from ethyl 2,4-dioxopentanoate (**1d**) and diazonium salt (**2**) in dimethyl sulfoxide (2.7 mL); stirring at rt for 3 h, followed by addition of ethanol. Yield: 0.108 g (61%), mp

176–179°C, orange solid, *E/Z* = 53:47. IR (cm^{-1}): 3443, 3117 (NH), 2218 (CN), 1740, 1674 (C=O), 1486, 1234, 1085. MS (EI): *m*/*z* = 354 (M^+). ^1H NMR (DMSO-d_6) δ major isomer 1.30 (t, 3H, *J* = 7.1, CH_2CH_3), 2.58 (s, 3H, COMe), 4.32 (q, 2H, *J* = 7.1, CH_2CH_3), 7.61 (ddd, 1H, *J* = 1.4, 6.8, 7.1, 7'–H), 7.94 (s, 1H, 2'–H), 8.00–8.07 (m, 2H, 8'–H and 9'–H), 9.23 (dd, 1H, *J* = 1.1, 7.1, 6'–H), 14.88 (br s, 1H, NH), minor isomer 1.38 (t, 3H, *J* = 7.1, CH_3CH_2), 3.29 (s, 3H, COMe), 4.42 (q, 2H, *J* = 7.1, CH_2CH_3), 8.70 (s, 1H, 2'–H), 14.30 (br s, 1H, NH). Anal. Calcd for $C_{17}H_{14}N_4O_5$: C, 57.63; H, 3.98; N, 15.81. Found: C, 57.97; H, 3.97; N, 15.78. HRMS Calcd for $C_{17}H_{14}N_4O_5$ (M^+): 354.096420. Found: 354.097700.

Pentane-2,3,4-trione 3-[*N*-(1-Cyano-4-oxo-4*H*-quinolizine-3-yl)]hydrazone (5e). This compound was prepared from pentane-2,4-dione (**1e**) and diazonium salt (**2**) in dimethyl sulfoxide (2.7 mL); stirring at rt for 2 h, followed by addition of ethanol. Yield: 0.132 g (89%), mp 272–274°C, orange solid. IR (cm^{-1}): 3130 (NH), 2222 (CN), 1664, 1630 (C=O), 1489, 1145, 774. MS (EI): *m*/*z* = 296 (M^+). ^1H NMR ($CDCl_3$) δ 2.56 (s, 3H, COMe), 2.65 (s, 3H, COMe), 7.30 (ddd, 1H, *J* = 1.5, 6.8, 7.5, 7'–H), 7.30 (ddd, 1H, *J* = 1.1, 6.8, 9.0, 8'–H), 8.06 (dd, 1H, *J* = 1.5, 9.0, 9'–H), 8.23 (s, 1H, 2'–H), 9.23 (dd, 1H, *J* = 1.1, 7.5, 6'–H), 14.69 (br s, 1H, NH). Anal. Calcd for $C_{15}H_{12}N_4O_3$: C, 60.81; H, 4.08; N, 18.91. Found: C, 60.96; H, 3.88; N, 18.73. HRMS Calcd for $C_{15}H_{12}N_4O_3$ (M^+): 296.090940. Found: 296.091500.

1,3-Diphenylpropane-1,2,3-trione 2-[*N*-(1-Cyano-4-oxo-4*H*-quinolizin-3-yl)]hydrazone (5f). This compound was prepared from dibenzoylmethane (**1f**) and diazonium salt (**2**) in dimethyl sulfoxide (4 mL); stirring at rt for 3 h, then at 50°C for 4 h, followed by addition of ethanol. Yield: 0.192 g (91%), mp 274–277°C, dark red solid. IR (cm^{-1}): 3098 (NH), 2213 (CN), 1657, 1623 (C=O), 1496, 1220, 990. MS (EI): *m*/*z* = 420 (M^+). ^1H NMR (DMSO-d_6) δ 7.47–7.51 (m, 3H, 2H of Ph, 7'–H), 7.58–7.77 (m, 6H, 6H of Ph), 7.75 (s, 1H, 2'–H), 7.87 (ddd, 1H, *J* = 1.3, 6.6, 8.9, 8'–H), 7.97 (dd, 1H, *J* = 1.2, 8.9, 9'–H), 8.10–8.12 (m, 2H, 2H of Ph), 9.14 (dd, 1H, *J* = 1.3, 7.4, 6'–H), 13.03 (br s, 1H, NH). Anal. Calcd for $C_{25}H_{16}N_4O_3$: C, 71.42; H, 3.84; N, 13.33. Found: C, 71.69; H, 3.64; N, 13.00. HRMS Calcd for $C_{25}H_{16}N_4O_3$ (M^+): 420.122241. Found: 420.119050.

Cyclohexane-1,2,3-trione 2-[*N*-(1-Cyano-4-oxo-4*H*-quinolizin-3-yl)]hydrazone (5g). This compound was prepared from cyclohexane-1,3-dione (**1g**) and diazonium salt (**2**) in acetonitrile (5.5 mL); stirring at rt for 2 h, followed by addition of water. Yield: 0.150 g (96%), mp 262–265°C, dark red solid. IR (cm^{-1}): 3118 (NH), 2223 (CN), 1662, 1624 (C=O), 1469, 1227, 905. MS (EI): *m*/*z* = 308 (M^+). ^1H NMR ($CDCl_3$) δ 2.10 (deg tt, 2H, *J* = 6.8, 6.8, 5–CH_2), 2.73–2.80 (m, 4H, 4,6–CH_2), 7.32 (ddd, 1H, *J* = 1.2, 6.8, 7.8, 7'–H), 7.72 (ddd, 1H, *J* = 1.2, 6.8, 9.0, 8'–H), 8.07 (ddd, 1H, *J* = 0.9, 1.2, 9.0, 9'–H), 8.54 (s, 1H, 2'–H), 9.25 (ddd, 1H, *J* = 0.9, 1.2, 7.8, 6'–H), 15.38 (br s, 1H, NH). Anal. Calcd for $C_{16}H_{12}N_4O_3$: C, 62.33; H, 3.92; N,

18.17. Found: C, 62.59; H, 4.20; N, 18.40. HRMS Calcd for $C_{16}H_{12}N_4O_3$ (M^+): 308.090940. Found: 308.091200.

5,5-Dimethylcyclohexane-1,2,3-trione 2-[*N*-(1-Cyano-4-oxo-4*H*-quinolizin-3-yl)]hydrazone (5h). This compound was prepared from 5,5-dimethylcyclohexane-1,3-dione (**1h**) and diazonium salt (**2**) in acetonitrile (5.5 mL); stirring at rt for 1 h. Volatile components were evaporated *in vacuo*, the solid residue was tirturated with water (2 mL), the precipitate was collected by filtration, and washed with water and ether to give **5h**. Yield: 0.151 g (90%), mp 263–266°C, dark red solid. IR (cm^{-1}): 3121 (NH), 2219 (CN), 1660, 1624 (C=O), 1474, 1224, 1139. MS (EI): *m*/*z* = 336 (M^+). ^{1}H NMR ($CDCl_3$) δ 1.15 (s, 6H, 2Me), 2.65 (s, 2H, CH_2), 2.66 (s, 2H, CH_2), 7.32 (ddd, 1H, *J* = 1.1, 6.8, 7.5, 7'–H), 7.72 (ddd, 1H, *J* = 1.1, 6.8, 8.7, 8'–H), 8.07 (ddd, 1H, *J* = 1.0, 1.1, 8.7, 9'–H), 8.54 (s, 1H, 2'–H), 9.25 (ddd, 1H, *J* = 1.0, 1.1, 7.5, 6'–H), 15.35 (br s, 1H, NH). Anal. Calcd for $C_{18}H_{16}N_4O_3$: C, 64.28; H, 4.79; N, 16.66. Found: C, 64.09; H, 4.86; N, 16.33. HRMS Calcd for $C_{18}H_{16}N_4O_3$ (M^+): 336.122241. Found: 336.123050.

1,3-Dimethylperhydropyrimidine-2,4,5,6-tetraone 5-[*N*-(1-Cyano-4-oxo-4*H*-quinolizine-3-yl)]hydrazone (5i). This compound was prepared from 1,3-dimethylbarbituric acid (**1i**) and diazonium salt (**2**) in acetonitrile (5.5 mL); stirring at rt for 1 h, followed by addition of water. Yield: 0.158 g (90%), mp 340–343°C, orange solid. IR (cm^{-1}): 3120 (NH), 2217 (CN), 1726, 1660, 1624 (C=O), 1479, 1363, 1092. MS (EI): *m*/*z* = 352 (M^+). ^{1}H NMR ($CDCl_3$) δ 3.43 (s, 3H, Me), 3.45 (s, 3H, Me), 7.34 (ddd, 1H, *J* = 1.1, 6.9, 7.4, 7'–H), 7.74 (ddd, 1H, *J* = 1.2, 6.9, 8.8, 8'–H), 8.10 (ddd, 1H, *J* = 0.9, 1.1, 8.8, 9'–H), 8.53 (s, 1H, 2'–H), 9.26 (ddd, 1H, *J* = 0.9, 1.2, 7.4, 6'–H), 14.82 (br s, 1H, NH). Anal. Calcd for $C_{16}H_{12}N_6O_4$: C, 54.55; H, 3.43; N, 23.85. Found: C, 54.74; H, 3.30; N, 23.83. HRMS Calcd for $C_{16}H_{12}N_6O_4$ (M^+): 352.092003. Found: 352.092500.

Methyl 4-Chloro-3-oxobutanoate 2-[*N*-(1-Ethoxycarbonyl-4-oxo-4*H*-quinolizin-3-yl)]hydrazone (6a). This compound was prepared from methyl 4-chloro-3-oxobutanoate (**1a**) and diazonium salt (**3**) in dimethyl sulfoxide (2.5 mL); stirring at rt for 2 h, followed by addition of ethanol. Yield: 0.126 g (64%), mp 202–205°C, orange solid, *E*/*Z* = 60:40. IR (cm^{-1}): 3446 (NH), 1702, 1662 (C=O), 1624, 1480, 1215. MS (EI): *m*/*z* = 393 (M^+), (FAB): *m*/*z* = 394 (MH^+). ^{1}H NMR (DMSO-d_6) δ major isomer 1.38 (t, 3H, *J* = 7.1, CH_2CH_3), 3.87 (s, 3H, OMe), 4.38 (q, 2H, *J* = 7.1, CH_2CH_3), 4.94 (s, 2H, CH_2Cl), 7.51 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 7.89 (ddd, 1H, *J* = 1.1, 6.8, 9.0, 8'–H), 8.63 (s, 1H, 2'–H), 9.11 (dd, 1H, *J* = 1.5, 9.0, 9'–H), 9.22 (dd, 1H, *J* = 1.1, 7.1, 6'–H), 12.99 (br s, 1H, NH), minor isomer 1.39 (t, 3H, *J* = 7.1, CH_2CH_3), 3.83 (s, 3H, OMe), 5.00 (s, 2H, CH_2Cl), 7.53 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 7.92 (ddd, 1H, *J* = 1.1, 6.8, 9.0, 8'–H), 8.66 (s, 1H, 2'–H), 9.14 (dd, 1H, *J* = 1.5, 9.0, 9'–H), 9.25 (dd, 1H, *J* = 1.1, 7.1, 6'–

H), 14.59 (br s, 1H, NH). Anal. Calcd for $C_{17}H_{16}N_3O_6Cl$: C, 51.85; H, 4.10; N 10.67. Found: C, 51.64; H, 3.92; N, 10.48.

Ethyl 4-Chloro-3-oxobutanoate 2-[*N*-(1-Ethoxycarbonyl-4-oxo-4*H*-quinolizin-3-yl)]hydrazone (6b). This compound was prepared from ethyl 4-chloro-3-oxobutanoate (**1a**) and diazonium salt (**3**) in dimethyl sulfoxide (2.5 mL); stirring at rt for 2 h, followed by addition of ethanol. Yield: 0.111 g (55%), mp 205–208°C, orange solid, *E*/*Z* = 56:44. IR (cm^{-1}): 3429 (NH), 2984 (CH), 1694, 1665 (C=O), 1493, 1215. MS (EI): *m*/*z* = 407 (M^+), (FAB): *m*/*z* = 408 (MH^+). ^1H NMR (DMSO-d_6) δ major isomer 1.31–1.41 (m, 6H, $2CH_2CH_3$), 4.32–4.41 (m, 4H, $2CH_2CH_3$), 4.95 (s, 2H, CH_2Cl), 7.51 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 7.88 (ddd, 1H, *J* = 1.2, 6.8, 9.0, 8'–H), 8.63 (s, 1H, 2'–H), 9.11 (dd, 1H, *J* = 1.5, 9.0, 9'–H), 9.22 (dd, 1H, *J* = 1.1, 7.1, 6'–H), 12.95 (br s, 1H, NH), minor isomer 5.00 (s, 2H, CH_2Cl), 7.53 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 7.92 (ddd, 1H, *J* = 1.2, 6.8, 9.0, 8'–H), 8.71 (s, 1H, 2'–H), 9.15 (dd, 1H, *J* = 1.5, 9.0, 9'–H), 9.26 (dd, 1H, *J* = 1.2, 7.1, 6'–H), 14.53 (br s, 1H, NH). Anal. Calcd for $C_{18}H_{18}N_3O_6Cl$: C, 53.01; H, 4.45; N, 10.30. Found: C, 53.23; H, 4.38; N, 10.27.

Methyl 4-Chloro-2,3-dioxobutanoate 2-[*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]hydrazone (7a). This compound was prepared from methyl 4-chloro-3-oxobutanoate (**1a**) and diazonium salt (**4**) in dimethyl sulfoxide (2 mL); stirring at rt for 3 h, followed by addition of ethanol–water (1:1). Yield: 0.099 g (61%), mp 170–173°C, orange solid, *E*/*Z* = 80:20. IR (cm^{-1}): 3105 (NH), 1702, 1677 (C=O), 1533, 1247. MS (EI): *m*/*z* = 322 (M^+). ^1H NMR (DMSO-d_6) δ major isomer 3.85 (s, 3H, OMe), 5.04 (s, 2H, CH_2), 7.44 (ddd, 1H, *J* = 1.5, 6.8, 7.2, 7'–H), 7.80 (ddd, 1H, *J* = 0.8, 1.5, 9.1, 9'–H), 7.92 (ddd, 1H, *J* = 1.5, 6.8, 9.1, 8'–H), 8.88 (s, 1H, 2'–H), 8.99 (ddd, 1H, *J* = 0.8, 1.5, 7.2, 6'–H), 12.79 (br s, 1H, NH), minor isomer 3.82 (s, 3H, OMe), 4.99 (s, 2H, CH_2), 8.71 (s, 1H, 2'–H), 14.43 (br s, 1H, NH). Anal. Calcd for $C_{13}H_{11}N_4O_4Cl$: C, 48.38; H, 3.44; N, 17.36. Found: C, 48.27; H, 3.17; N, 17.39. HRMS Calcd for $C_{13}H_{11}N_4O_4Cl$ (M^+): 322.046883. Found: 322.047020.

Ethyl 4-Chloro-2,3-dioxobutanoate 2-[*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]hydrazone (7b). This compound was prepared fron methyl 4-chloro-3-oxobutanoate (**1b**) and diazonium salt (**4**) in dimethyl sulfoxide (2 mL); stirring at rt for 3 h, followed by addition of ethanol–water (1:1). Yield: 0.101 g (60%), mp 193–195°C, red solid, *E*/*Z* = 89:11. IR (cm^{-1}): 3090 (NH), 1697, 1637 (C=O), 1485, 1195. MS (FAB): *m*/*z* = 337 (MH^+). ^1H NMR (DMSO-d_6) δ major isomer 1.32 (t, 3H, *J* = 7.2, CH_2CH_3), 4.34 (q, 2H, *J* = 7.2, CH_2CH_3), 5.05 (s, 2H, CH_2Cl), 7.43 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 7.80 (dd, 1H, *J* = 1.5, 9.0, 9'–H), 7.91 (ddd, 1H, *J* = 1.4, 6.8, 9.0, 8'–H), 8.88 (s, 1H, 2'–H), 8.99 (dd, 1H, *J* = 1.4, 7.1, 6'–H), 12.74 (br s, 1H, NH), minor isomer 1.33 (t, 3H, *J* = 7.2, CH_2CH_3), 4.28 (q, 2H, *J* = 7.2, CH_2CH_3), 4.99 (s,

2H, CH_2Cl), 8.71 (s, 1H, 2'–H), 14.38 (br s, 1H, NH). Anal. Calcd for $C_{14}H_{13}N_4O_3Cl$: C, 49.94; H, 3.89; N, 16.64. Found: C, 49.70; H, 4.05; N, 16.35.

1-Phenylbutane-1,2,3-trione 2-[(*E*)-*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]hydrazone (7c). This compound was prepared from 1-phenylbutane-1,3-dione (**1c**) and diazonium salt (**4**) in dimethyl sulfoxide (4 mL); stirring at rt for 3 h, followed by addition of ethanol. Yield: 0.119 g (72%), mp 175–176°C, orange solid, *E/Z* = 71:29. IR (cm^{-1}): 3131, 1678, 1633 (C=O), 1476, 1127. MS (EI): *m*/*z* = 334 (M^+). ^1H NMR (DMSO-d_6) δ major isomer 2.55 (s, 3H, COMe), 7.43 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 7.50–7.94 (m, 7H, 5H–Ph, 8'–H), 7.73 (dd, 1H, *J* = 1.5, 8.6, 9'–H), 8.21 (s, 1H, 2'–H), 8.99 (dd, 1H, *J* = 1.5, 7.1, 6'–H), 14.29 (br s, 1H, NH), minor isomer 8.81 (s, 1H, 2'–H), 12.04 (br s, 1H, NH). Anal. Calcd for $C_{18}H_{14}N_4O_3$: C, 64.66; H, 4.22; N, 16.76. Found: C, 64.77; H, 3.91; N, 16.62. HRMS Calcd for $C_{18}H_{14}N_4O_3$ (M^+): 334.106591. Found: 334.107400.

Pentane-2,3,4-trione 3-[*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]hydrazone (7e). This compound was prepared from pentane-2,4-dione (**1e**) and diazonium salt (**4**) in acetonitrile (6.5 mL); stirring at rt for 1 h, followed by addition of water. Yield: 0.108g (78%), mp 209–211°C, orange solid. IR (cm^{-1}): 3130, 1670 (C=O), 1486, 1100, 776. MS (EI): *m*/*z* = 272 (M^+), (FAB): *m*/*z* = 273 MH^+). ^1H NMR ($CDCl_3$) δ 2.53 (s, 3H, COMe), 2.64 (s, 3H, COMe), 7.23 (ddd, 1H, *J* = 2.3, 5.6, 7.2, 7'–H), 7.68–7.77 (m, 2H, 8'–H and 9'–H), 8.87 (s, 1H, 2'–H), 9.09 (dd, 1H, *J* = 1.1, 7.2, 6'–H), 14.60 (br s, 1H, NH). Anal. Calcd for $C_{13}H_{12}N_4O_3$: C, 57.35; H, 4.44; N, 20.58. Found: C, 57.19; H, 4.30; N, 20.27.

1,3-Diphenylpropane-1,2,3-trione 2-[*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]hydrazone (7f). This compound was prepared from dibenzoylmethane (**1f**) and diazonium salt (**4**) in dimethyl sulfoxide (4 mL); first stirring at rt for 3 h then stirring at 50°C for 3 h, followed by addition of ethanol. Yield: 0.122 g (62%), mp 197–198°C, orange solid. IR (cm^{-1}): 3132, 1677, 1638 (C=O), 1482, 992. MS (EI): *m*/*z* = 396 (M^+). ^1H NMR (DMSO–d_6) δ 7.42 (ddd, 1H, *J* = 1.5, 6.7, 7.2, 7'–H), 7.46–7.75 (m, 9H, 8H–Ph, 9'–H), 7.89 (ddd, 1H, *J* = 1.5, 6.7, 9.1, 8'–H), 8.08–8.10 (m, 2H, 2H–Ph), 8.35 (s, 1H, 2'–H), 8.99 (dd, 1H, *J* = 1.5, 7.2, 6'–H), 12.90 (br s, 1H, NH). Anal. Calcd for $C_{23}H_{16}N_4O_3$: C, 69.69; H, 4.07; N, 14.13. Found: C, 69.88; H, 3.79; N, 13.90. HRMS Calcd for $C_{23}H_{16}N_4O_3$ (M^+): 396.122241. Found: 396.119100.

Cyclohexane-1,2,3-trione 2-[*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]hydrazone (7g). This compound was prepared from cyclohexane-1,3-dione (**1g**) and diazonium salt (**4**) in acetonitrile (6.5 mL); stirring at rt for 1 h, followed by addition of water. Yield: 0.130 g (96%), mp 265–266°C, orange solid. IR (cm^{-1}): 3080 (NH), 2953 (CH), 1667, 1619 (C=O), 1466, 1235, 790. MS (EI): *m*/*z* = 284 (M^+). ^1H

NMR ($CDCl_3$) δ 2.12 (deg tt, 2H, *J* = 6.4, 6.4, 5–CH_2), 2.73–2.80 (m, 4H, 4,6–CH_2), 7.27 (ddd, 1H, *J* = 2.6, 6.0, 7.5, 7'–H), 7.74–7.82 (m, 2H, 8'–H and 9'–H), 9.09 (s, 1H, 2'–H), 9.11 (dd, 1H, *J* = 1.1, 7.5, 6'–H), 15.42 (br s, 1H, NH). Anal. Calcd for $C_{14}H_{12}N_4O_3$: C, 59.15; H, 4.25; N, 19.71. Found: C, 59.25; H, 4.23; N, 19.60. HRMS Calcd for $C_{14}H_{12}N_4O_3$ (M^+): 284.090940. Found: 284.091550.

5,5-Dimethylcyclohexane-1,2,3-trione 2-[*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]hydrazone (7h). This compound was prepared from 5,5-dimethylcyclohexane-1,3-dione (**1h**) and diazonium salt (**4**) in acetonitrile (5 mL), stirring at rt for 1 h. The volatile components were then evaporated *in vacuo*, the solid residue was tirturated with water (2.5 mL), the precipitate was collected by filtration, and washed with water and ether to give **7h**. Yield: 0.097 g (62%), mp 250–251°C, orange solid. IR (cm^{-1}): 2954 (CH), 1674, 1615 (C=O), 1475, 1235, 773. MS (EI): *m*/*z* = 312 (M^+). ^{1}H NMR ($CDCl_3$) δ 1.16 (s, 6H, 2Me), 2.65 (s, 2H, CH_2), 2.67 (s, 2H, CH_2), 7.27 (ddd, 1H, *J* = 2.5, 5.6, 7.2, 7'–H), 7.74–7.82 (m, 2H, 8'–H and 9'–H), 9.10 (s, 1H, 2'–H), 9.11 (dd, 1H, *J* = 1.1, 7.2, 6'–H), 15.40 (br s, 1H, NH). Anal. Calcd for $C_{16}H_{16}N_4O_3$: C, 61.53; H, 5.16; N, 17.94. Found: C, 61.77; H, 5.35; N, 17.81. HRMS Calcd for $C_{16}H_{16}N_4O_3$ (M^+): 312.122241. Found: 312.122532.

1,3-Dimethylperhydropyrimidine-2,4,5,6-tetraone 5-[*N*-(4-Oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)]-hydrazone (7i). This compound was prepared from 1,3-dimethylbarbituric acid (**1i**) and diazonium salt (**4**) in acetonitrile (5 mL); stirring at rt for 2 h, followed by addition of ethanol–water (1:1). Yield: 0.129 g (79%), mp 300°C, orange solid. IR (cm^{-1}): 3074 (NH), 1717, 1682, 1636 (C=O), 1484, 1085, 752. MS (EI): *m*/*z* = 328 (M^+). ^{1}H NMR ($CDCl_3$) δ 3.44 (s, 3H, Me), 3.46 (s, 3H, Me), 7.29 (ddd, 1H, *J* = 2.6, 5.7, 7.2, 7'–H), 7.76–7.84 (m, 2H, 8'–H and 9'–H), 9.09 (s, 1H, 2'–H), 9.12 (dd, 1H, *J* = 1.1, 7.2, 6'–H), 14.80 (br s, 1H, NH). Anal. Calcd for $C_{14}H_{12}N_6O_4$: C, 51.22; H, 3.68; N, 25.60. Found: C, 51.38; H, 3.77; N, 25.31. HRMS Calcd for $C_{14}H_{12}N_6O_4$ (M^+): 328.092003. Found: 328.093000.

General Procedure for the Preparation of Alkyl 1-Heteroaryl-4-hydroxy-1*H*-pyrazole-3-carboxylates (8–10).

A mixture of alkyl 4-chloro-2,3-dioxobutanoate 2-(*N*-heteroaryl)hydrazone (**5–7**) (0.3 mmol) and anisole (10 mL) was heated under reflux for 14–20 h. The hot reaction mixture was filtered and the filtrate was evaporated *in vacuo*. The solid residue was triturated with ether (5 mL), the precipitate was collected by filtration, and washed with ethanol and ether to give alkyl 1-heteroaryl-4-hydroxy-1*H*-pyrazole-3-carboxylate (**8–10**).

The following compounds were prepared in this manner:

Methyl 1-(1-Cyano-4-oxo-4*H*-quinolizin-3-yl)-4-hydroxy-1*H*-pyrazole-3-carboxylate (8a). This compound was prepared from hydrazone (**5a**); reflux for 20 h. Yield: 0.083 g (89%), mp 262–265°C (from ethanol–water), orange crystals. IR (cm^{-1}): 3403 (OH), 2224 (CN), 1702, 1674 (C=O), 1331, 1145, 757. MS (EI): *m*/*z* = 310 (M^+), (FAB): 311 (MH^+). ^1H NMR (DMSO-d_6) δ 3.82 (s, 3H, OMe), 7.61 (ddd, 1H, *J* = 1.4, 6.9, 7.1, 7'–H), 8.06–8.08 (m, 2H, 8'–H and 9'–H), 8.22 (s, 1H, 5–H), 8.59 (s, 1H, 2'–H), 9.32 (dd, 1H, *J* = 1.1, 7.1 Hz, 6'–H), 9.33 (br s, 1H, OH). ^{13}C NMR ($CDCl_3$) δ 52.1, 84.6, 117.4, 118.8, 119.6, 119.9, 123.9, 130.2, 132.1, 132.7, 137.2, 144.7, 144.7, 152.9, 162.6. Anal. Calcd for $C_{15}H_{10}N_4O_4$: C, 58.07; H, 3.25; N, 18.06. Found: C, 58.28; H, 3.40; N, 16.74. HRMS Calcd for $C_{15}H_{10}N_4O_4$ (M^+): 310.070205. Found: 310.071500.

Ethyl 1-(1-Cyano-4-oxo-4*H*-quinolizin-3-yl)-4-hydroxy-1*H*-pyrazole-3-carboxylate (8b). This compound was prepared from hydrazone (**5b**); reflux for 20 h. Yield: 0.084 g (87%), mp 242–245°C (from ethanol–water), yellow crystals. IR (cm^{-1}): 3391 (OH), 2226 (CN), 1705, 1676 (C=O), 1321. MS (EI): *m*/*z* = 324 (M^+), (FAB): *m*/*z* = 325 (MH^+). ^1H NMR (DMSO-d_6) δ 1.31 (t, 3H, *J* = 7.1, CH_2CH_3), 4.30 (q, 2H, *J* = 7.1, CH_2CH_3), 7.61 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 8.07–8.09 (m, 2H, 8'–H and 9'–H), 8.21 (s, 1H, 5–H), 8.59 (s, 1H, 2'–H), 9.26 (dd, 1H, *J* = 1.1, 7.1, 6'–H), 9.32 (br s, 1H, OH). ^{13}C NMR ($CDCl_3$) δ 14.8, 62.1, 85.8, 116.3, 117.5, 118.1, 120.7, 124.0, 129.6, 130.7, 132.4, 134.9, 144.2, 146.8, 152.3, 165.0. Anal. Calcd for $C_{16}H_{12}N_4O_4$: C, 59.26; H, 3.73; N, 17.28. Found: C, 59.41; H, 3.65; N, 16.94. HRMS Calcd for $C_{16}H_{12}N_4O_4$ (M^+): 324.085855. Found: 324.086750.

Methyl 1-(1-Ethoxycarbonyl-4-oxo-4*H*-quinolizin-3-yl)-4-hydroxy-1*H*-pyrazole-3-carboxylate (9a). This compound was prepared from hydrazone (**6a**); reflux for 20 h. Yield: 0.103 g (96%), mp 195–198°C (from ethanol–water), orange crystals. IR (cm^{-1}): 3413 (OH), 1667 (C=O), 1211, 785. MS (EI): *m*/*z* = 357 (M^+). ^1H NMR (DMSO-d_6) δ 1.37 (t, 3H, *J* = 7.1 Hz, CH_2CH_3), 3.83 (s, 3H, OMe), 4.40 (q, 2H, *J* = 7.1, CH_2CH_3), 7.58 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 8.02 (ddd, 1H, *J* = 1.5, 6.8, 9.1, 8'–H), 8.31 (s, 1H, 5–H), 8.88 (s, 1H, 2'–H), 9.20 (dd, 1H, *J* = 1.5, 9.1, 9'–H), 9.30 (br s, 1H, OH), 9.37 (dd, 1H, *J* = 1.5, 7.1, 6'–H). ^{13}C NMR ($CDCl_3$) δ 14.5, 52.2, 61.3, 102.5, 117.3, 117.5, 118.8, 124.4, 128.9, 129.5, 133.0, 133.9, 143.4, 146.3, 152.8, 164.7, 165.0. Anal. Calcd for $C_{17}H_{15}N_3O_6$: C, 57.14; H, 4.23; N, 11.76. Found: C, 56.95; H, 4.28; N, 11.75. HRMS Calcd for $C_{17}H_{15}N_3O_6$ (M^+): 357.096085. Found: 357.097550.

Ethyl 1-(1-Ethoxycarbonyl-4-oxo-4*H*-quinolizin-3-yl)-4-hydroxy-1*H*-pyrazole-3-carboxylate (9b). This compound was prepared from hydrazone (**6b**); reflux for 14 h. Yield: 0.098 g (88%), mp 197–200°C (from ethanol–water), orange crystals. IR (cm^{-1}): 3354 (OH), 1702, 1667 (C=O), 1335, 785. MS (EI): *m*/*z* = 371 (M^+). ^1H NMR (DMSO-d_6) δ 1.30–1.40 (m, 6H, $2CH_2CH_3$), 4.28–4.43 (m, 4H, $2CH_2CH_3$), 7.58

(ddd, 1H, *J* = 1.5, 6.8, 7.2, 7'–H), 8.03 (ddd, 1H, *J* = 1.5, 6.8, 8.9, 8'–H), 8.30 (s, 1H, 5–H), 8.89 (s, 1H, 2'–H), 9.20 (dd, 1H, *J* = 1.5, 8.9, 9'–H), 9.24 (br s, 1H, OH), 9.38 (dd, 1H, *J* = 1.5, 7.2, 6'–H). ^{13}C NMR ($CDCl_3$) δ 14.78, 14.82, 61.6, 61.9, 102.8, 117.6, 117.8, 119.2, 124.8, 129.3, 130.2, 133.5, 134.2, 143.8, 146.7, 153.2, 165.1, 165.1. Anal. Calcd for $C_{18}H_{17}N_3O_6$: C, 58.22; H, 4.61; N, 11.32. Found: C, 58.36; H, 4.57; N, 11.39. HRMS Calcd for $C_{18}H_{17}N_3O_6$ (M^+): 371.111736. Found: 371.112900.

Methyl 4-Hydroxy-1-(4-oxo-4*H*-pyridino[1,2-*a*]pyrimidin-3-yl)-1*H*-pyrazole-3-carboxylate (10a). This compound was prepared from hydrazone (**7a**) reflux for 14 h. Yield: 0.075 g (88%), mp 202–207°C (from ethanol–water), orange crystals. IR (cm^{-1}): 3400 (OH), 1700 (C=O), 1323, 1124, 768. MS (EI): *m*/*z* = 286 (M^+), (FAB): *m*/*z* = 287 (MH^+). ^{1}H NMR (DMSO-d_6) δ 3.82 (s, 3H, OMe), 7.52 (ddd, 1H, *J* = 1.5, 6.8, 7.1, 7'–H), 7.87 (ddd, 1H, *J* = 0.7, 1.5, 9.1, 9'–H), 8.10 (ddd, 1H, *J* = 1.5, 6.8, 9.1, 8'–H), 8.13 (s, 1H, 5–H), 8.87 (s, 1H, 2'–H), 9.14 (ddd, 1H, *J* = 0.7, 1.5, 7.1, 6'–H), 9.30 (br s, 1H, OH). ^{13}C NMR ($CDCl_3$) δ 52.7, 117.2, 117.6, 119.2, 127.4, 128.1, 130.2, 136.7, 146.8, 148.0, 150.2, 152.7, 165.4. Anal. Calcd for $C_{13}H_{10}N_4O_4$: C, 54.55; H, 3.52; N, 19.57. Found: C, 54.56; H, 3.55; N, 19.32. HRMS Calcd for $C_{13}H_{10}N_4O_4$ (M^+): 286.070205. Found: 286.071050.

Ethyl 4-Hydroxy-1-(4-oxo-4*H*-pyridino[1,2–*a*]pyrimidin-3-yl)-1*H*-pyrazole-3-carboxylate (10b). This compound was prepared from hydrazone (**7b**) reflux for 20 h. Yield: 0.080 g (90%), mp 165–168°C (from ethanol–water), orange crystals. IR (cm^{-1}): 3403 (OH), 1700, 1676 (C=O), 1319, 1130, 774. MS (EI): 300 (M^+). ^{1}H NMR (DMSO-d_6) δ 1.31 (t, 3H, *J* = 7.1, CH_2CH_3), 4.30 (q, 2H, *J* = 7.1, CH_2CH_3), 7.52 (ddd, 1H, *J* = 1.5, 6.8, 7.0, 7'–H), 7.87 (dd, 1H, *J* = 1.5, 9.0, 9'–H), 8.07 (ddd, 1H, *J* = 1.5, 6.8, 9.0, 8'–H), 8.12 (s, 1H, 5–H), 8.87 (s, 1H, 2'–H), 9.14 (dd, 1H, *J* = 1.5, 7.0 6'–H), 9.23 (br s, 1H, OH). ^{13}C NMR (DMSO-d_6) δ 15.2, 60.7, 118.5, 118.6, 119.0, 127.2, 128.6, 132.1, 138.5, 144.8, 147.7, 150.4, 153.0, 162.3. Anal. Calcd for $C_{14}H_{12}N_4O_4$: C, 56.00; H, 4.03; N, 18.66. Found: C, 56.11; H, 3.82; N, 18.60. HRMS Calcd for $C_{14}H_{12}N_4O_4$ (M^+): 300.085855. Found: 300.086950.

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