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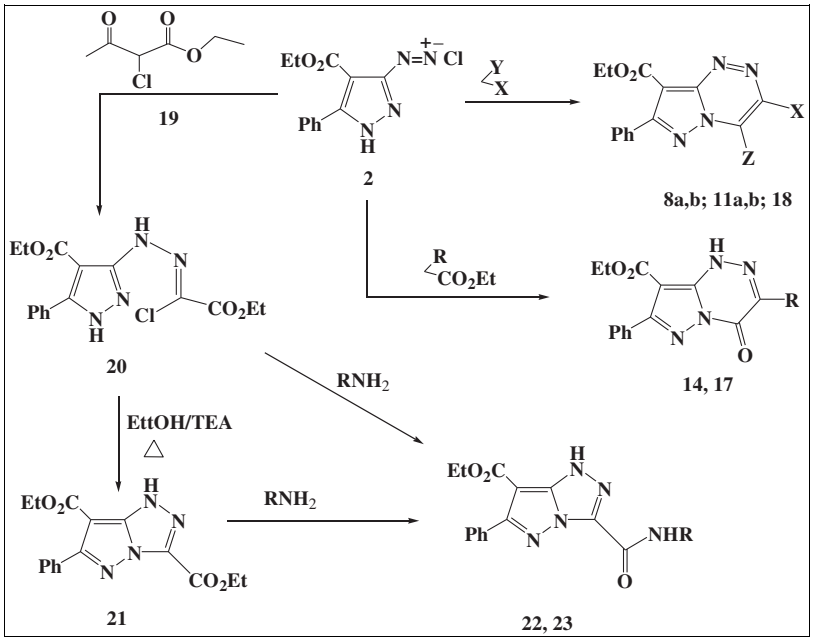

The newly synthesized ethyl 3-amino-5-phenylpyrazole-4-carboxylate **1** was diazotized and coupled with β-naphthol, active methylene reagents **6**, **9**, **12**, **15**, and the active methine **19** to afford the pyrazolo[5,1-*c*] triazines **5**, **8**, **11**, **14**, **17**, **18**, and the pyrazolo[5,1-**c**]-1,2,4-triazoles **21**, **22**, and **23**, respectively. Structures are elucidated and mechanisms are discussed.

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INTRODUCTION

In the past two decades, we have been involved in a program aiming at the synthesis of new heterocyclic compounds that may possess biologically active properties to be used as potential biodegradable agrochemicals [1–5].

Aminopyrazoles are the most extensively utilized heterocyclic amines in heterocyclic synthesis because of their ready availability as well as their stability, which makes them useful precursors in dyes, pharmaceuticals, and agrochemical industries [6–13].

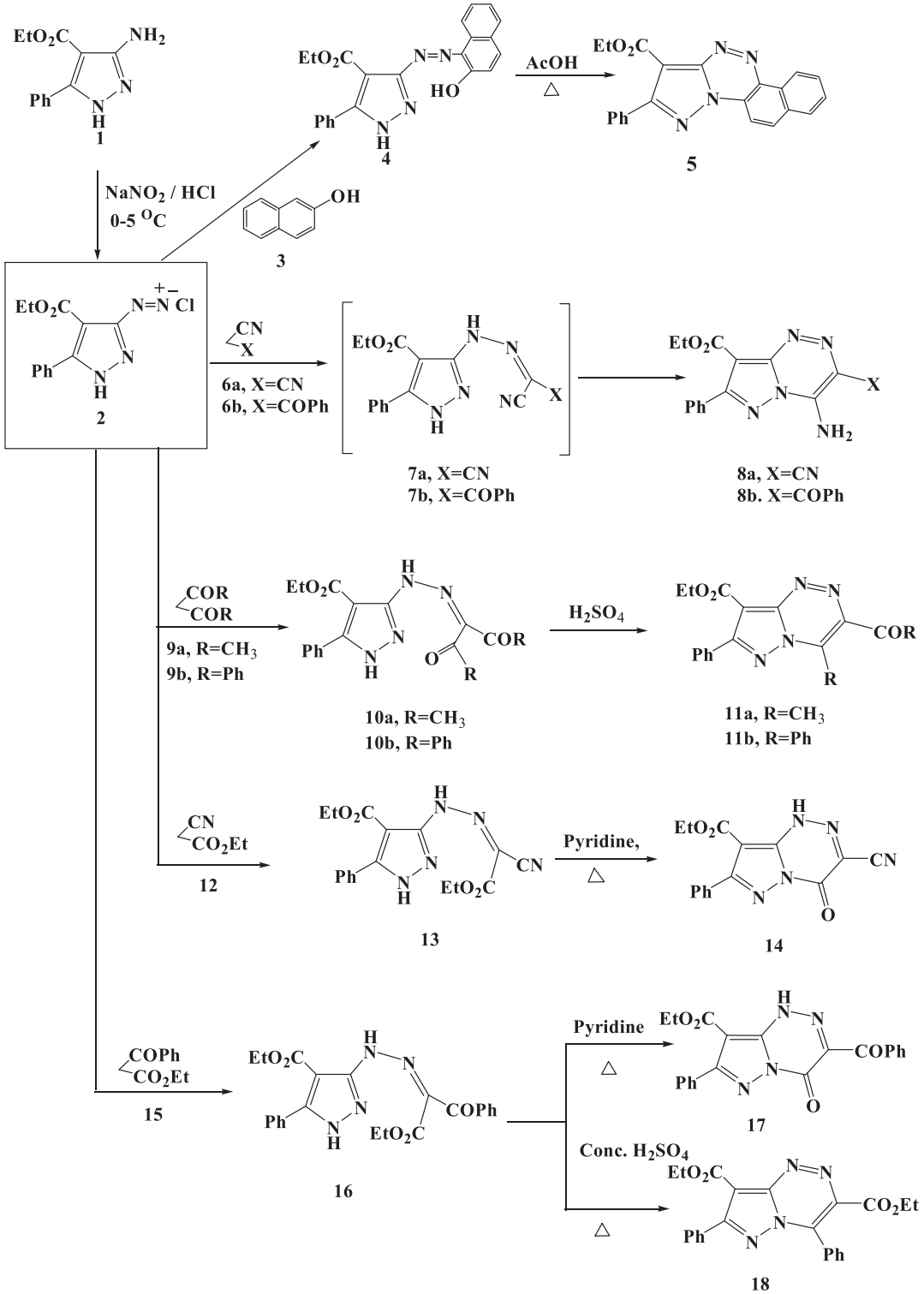
Recently, some newly substituted pyrazolo-fused heterocyclic systems were required for biological activity studies. The pyrazole derivative **1** described earlier by us [1] seemed a good precursor to fulfill this objective. In the present work, we report the results of our studies on the chemistry of the pyrazole **1** [1] and its utility for the synthesis of some novel pyrazolo-[5,l-*c*]-l,2,4-triazines and pyrazolo-[5,1-*c*]-1,2,4-triazole derivatives.

RESULTS AND DISCUSSION

Thus, the pyrazole **1** was diazotized with sodium nitrite/HCl to afford the corresponding diazonium salt **2** that was coupled with a variety of active methine and active methylene reagents to afford the corresponding azo/hydrazo derivatives. For example, the diazonium salt **2** couples with β-naphthol **3** to afford the pyrazolylazo-β-naphthol derivative **4**, which was cyclized on reflux in glacial acetic acid into the corresponding pyrazolo-[5,1-c]-triazine derivative **5**. Structures **4** and **5** were established on the basis of analytical and spectral data. The ^{1}H NMR spectrum of **4** revealed a singlet at $\delta = 15.9$ ppm for the hydroxyl group proton beside the expected signals. This singlet disappeared in the ^{1}H NMR spectrum of **5**. Also, the mass spectrum of **5** showed a base peak at $m/z = 368$ (50.2%), which is in complete agreement with the formula $C_{22}H_{16}N_4O_2$, Scheme 1.

When the diazonium salt **2** was coupled with malononitrile **6a** and benzoylacetonitrile **6b**, the pyrazolo-[5,1-c]-

Scheme 1. Synthesis of the pyrazolo[5,1-c] triazines **5, 8, 11, 14, 17, 18**.



1,2,4-triazine derivatives **8a**,**b** have been obtained. It is apparent that **2** couples with the active methylenes **6a**,**b** to afford the non-isolable azo/hydrazo intermediates **7a**,**b** that undergoes *in situ* cyclization to afford **8a**,**b**. Structures **8a**,**b** were suggested for these products based on analytical and spectral evidences. The ^{1}H NMR of **8a** revealed a triplet at $\delta = 1.20$ ppm ($J = 7.2$ Hz) for methyl group, a quartet at $\delta = 4.25$ ppm ($J = 7.2$ Hz) for CH_2 group, a multiplet at

$\delta = 7.52–7.79$ ppm because of the 5 phenyl protons, and a singlet at $\delta = 9.55$ ppm for NH_2 protons. Moreover, the mass spectrum of structure **8a** showed a base peak at $m/z = 308$ (75%), which is in agreement with the molecular mass of the molecular formula $C_{15}H_{12}N_6O_2$. The IR spectrum of **8a** revealed two absorption bands $\upsilon = 3433$ and $3325\ cm^{-1}$ for the amino group and one band at $\upsilon = 2229\ cm^{-1}$ for a cyano group. The IR spectrum of **8b** showed absorption bands at $\upsilon = 3248$ and $3175\ cm^{-1}$ assignable to the NH_2 group, and two bands at $\upsilon = 1695$ and $1639\ cm^{-1}$ assignable for two carbonyl groups (ester and benzoyl groups). The hypsochromic shift of the benzoyl carbonyl may be attributed to the formation of hydrogen bonding with the amino group. The direct formation of cyclic products **8a**,**b** from the reaction of the diazonium salt **2** with both malononitrile **6a** and benzoylacetonitrile **6b** is in accordance with the previously reported direct formation of pyrazolo-[5,1-c]-1,2,4-triazines on treatment of diazotized 5-aminopyrazoles with both reagents [14,15], Scheme 1.

In contrast to the observed direct formation of pyrazolo-[5,1-c]-1,2,4-triazines **8a**,**b** on treating **2** with the active methylene reagents **6a**,**b**, the diazonium salt **2** coupled with acetylacetone **9a** and dibenzoylmethane **9b** to yield isolable coupling products that were formulated as **10a**,**b**. These latter compounds could be readily cyclized into pyrazolo-[5,1-c]-1,2,4-triazines **11a**,**b**, respectively on treatment with concentrated sulfuric acid at room temperature for 24 h presumably via water elimination.

Structures **10a**,**b** and **11a**,**b** were confirmed on the basis of analytical and spectral analyses

Thus, the mass spectrum of **10a** revealed a base peak at $m/z = 342$ (6.3%), which is consistent with the molecular mass for the molecular formula $C_{17}H_{18}N_4O_4$. The ^{1}H NMR spectrum of **10a** revealed a tripled at $\delta = 0.99$ ppm and a quartet at $\delta = 4.04$ ppm ($J = 7.2$ Hz) for ethyl ester group, two singlet at $\delta = 1.75$ and 2.17 ppm for two methyl groups, a multiplet at $\delta = 6.70–7.50$ ppm integrated for six protons that can be attributed to phenyl and NH, and a broad singlet at $\delta = 10.13$ ppm for pyrazole-NH. Thus, the ^{1}H NMR indicated the absence of any signal for methine proton, which means that the hydrazo form **10a** predominates.

The ^{1}H NMR spectrum of **10b** revealed a singlet at $\delta = 5.85$ ppm that is attributed to the presence of NH proton beside the other expected signals. Also, the mass spectrum of **10b** revealed a base peak at $m/z = 466$ (25.3%) that is consistent with the molecular mass for the molecular formula $C_{27}H_{22}N_4O_4$. On the other hand, structures **11a**,**b** were confirmed also on the basis of analytical and spectral evidences where their mass spectra revealed peaks for the molecular ions at $m/z = 324$ (55.5%) and $m/z = 448$ (56.9%) consistent with the molecular masses of both **11a** and **11b**, respectively, Scheme 1.

On the other hand, compound **2** coupled with ethyl cyanoacetate **12** and ethyl benzoylacetate **15** to afford the acyclic coupling products **13** and **16**, respectively. Structures **13** and **16** were assigned for these coupling products on the basis of elemental analysis and spectral data. The acyclic hydrazone product **13** could be cyclized upon reflux in pyridine to afford the pyrazolotriazine **14**. The mass spectrum of this reaction product showed a high intensity signal at $m/z = 309$ (84.8%), which is in agreement with the molecular formula $C_{15}H_{11}N_5O_3$.

Refluxing **16** in pyridine for 3 h afforded a product for which structure **17** was suggested and seemed to be formed via ethanol elimination. Attempts to effect cyclization of **16** by action of concentrated sulfuric acid at room temperature for 24 h afforded however, another product for which the pyrazolo[5,1-c]1,2,4-triazine **18** was suggested and its formation presumably takes place via water elimination. Structures **17** and **18** were assigned based on the elemental analysis and spectral data. Thus, the mass spectra revealed signals at $m/z = 388$ (20.3%) and $m/z = 416$ (19.28%), corresponding to the molecular ions [M^+] of each of **17** ($C_{21}H_{16}N_4O_4$) and **18** ($C_{23}H_{20}N_4O_4$), respectively, Scheme 1.

The ^{1}HNMR spectrum of **17** indicated only one triplet at $\delta = 1.25$ ppm ($J = 7.2$ Hz) and one quartet at $\delta = 4.31$ ppm ($J = 7.2$ Hz) and a singlet at $\delta = 8.06$ ppm for the triazine-NH proton, whereas the ^{1}HNMR spectrum of **18** revealed two triplets at $\delta = 1.03$ ppm ($J = 7.2$ Hz) and at $\delta = 1.20$ ppm ($J = 7.2$ Hz) and two quartet at $\delta = 4.02$ ppm ($J = 7.2$ Hz) and $\delta = 4.20$ ppm ($J = 7.2$ Hz) for two ethyl ester groups and a multiplet at $\delta = 7.28–7.75$ ppm integratable for 10 protons (2Ph-protons) (Scheme 1 and Experimental).

The diazonium salt **2** couples with ethyl 2-chloroacetoacetate **19** to afford the hydrazonyl halide derivative **20** with loss of acetyl group via the *Japp–Klingmann* reaction. The reaction product **20** could be cyclized into the pyrazolo [5,1-c]triazole derivative **21** by refluxing in ethanol and in the presence of catalytic amount of triethylamine. The cyclization process takes place with hydrogen chloride elimination. Structure **21** was assigned on the basis of ^{1}H NMR that revealed two of the triplets at $\delta = 1.24$ ppm ($J = 7.2$ Hz) and $\delta = 1.35$ ppm ($J = 7.2$ Hz) for two methyl groups; two quartets at $\delta = 4.22$ ppm ($J = 7.2$ Hz) and $\delta = 4.45$ ppm ($J = 7.2$ Hz) for two CH_2 groups, a multiplet at $\delta = 7.45–7.84$ ppm integratable for five phenyl protons and a singlet at $\delta = 14.60$ ppm for the triazole-NH. The ^{13}C NMR of **21** revealed the signals shown in Figure 1.

On the other hand, it has been found that when the cyclization process was carried out by boiling in ethanol and in the presence of equivalent amount of 2-aminopyridine, a reaction product was obtained for which structure **22** was assigned on the basis of analytical and spectral analyses where the mass spectrum of the reaction product revealed a high intensity base peak at $m/z = 376$ (100%, base peak), which is in agreement with molecular weight of the molecular formula $C_{19}H_{16}N_6O_3$. The ^{1}H NMR spectrum of this product

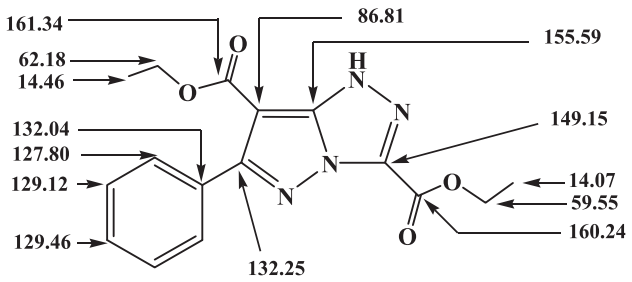


Figure 1. ^{13}C NMR values of compound 21

showed only one triplet at $\delta = 1.26$ ppm ($J = 7.5$ Hz) and only one quartet at $\delta = 4.24$ ppm ($J = 7.5$ Hz) for one ethyl ester group beside the expected peaks, Scheme 2.

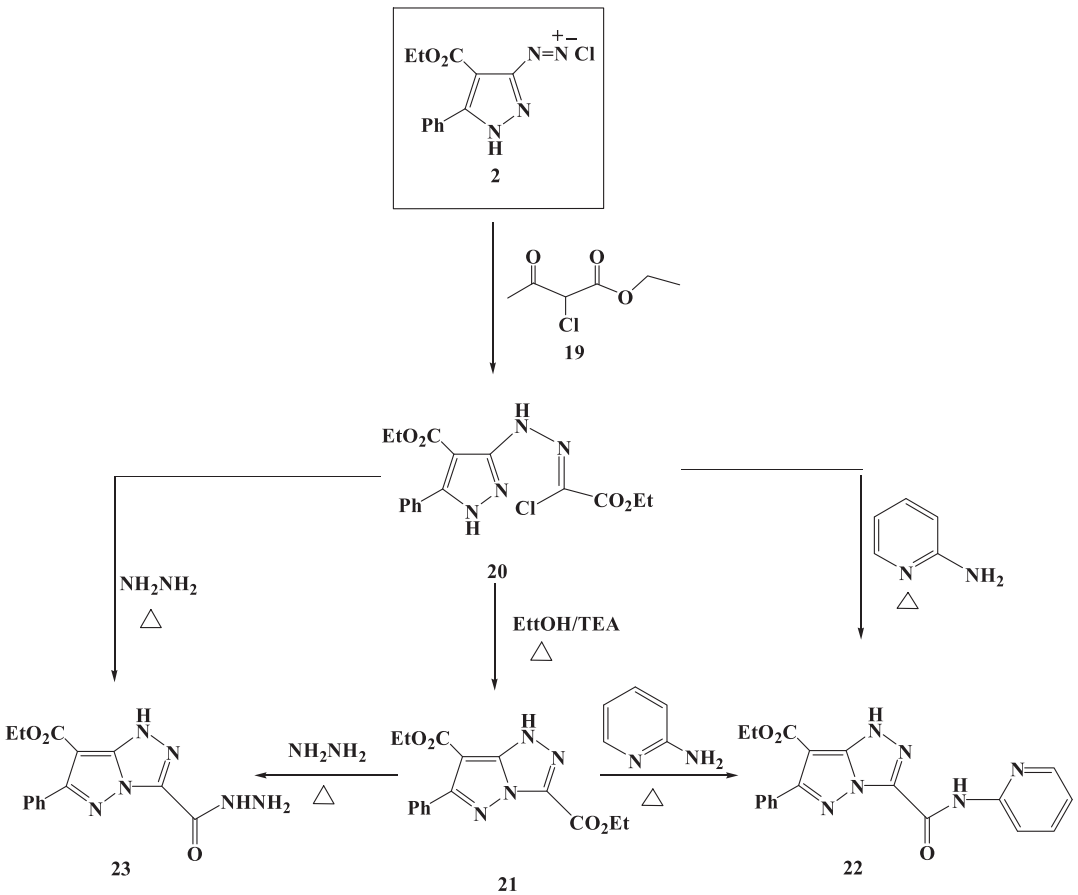
Moreover, an authentic sample of **22** could be synthesized via the reaction of **21** with 2-aminopyridine in boiling ethanol for 3 h (melting point and mixed melting point). Refluxing **20** with hydrazine hydrate in ethanol afforded the pyrazolo[5,1-c]triazole-6-hydrazide derivative for which structure **23** was assigned on the basis of analytical and spectral data. The same product **23** was obtained via treatment of **21** with hydrazine hydrate in ethanol solution (melting point and mixed melting point) (Scheme 2 and Experimental).

EXPERIMENTAL

The melting points were determined on a Stuart melting point apparatus and are uncorrected. The IR spectra were recorded as KBr pellets using an FTIR unit Bruker-Vector 22 spectrophotometer (Chem Analytical Lab, NIU, USA). The ^{1}H and ^{13}C NMR spectra were recorded in DMSO-d_6 as solvent at 300 and 75 MHz, respectively on Varian Gemini NMR spectrometer (Varian, Oxford, UK) using TMS as internal standard. Chemical shifts are reported in δ units (ppm). Mass spectra were measured on a Shimadzu GCMS-QP-1000 EX mass spectrometer (Shimadzu, Kyoto, Japan) at 70 eV. The elemental analyses were performed at the Micro analytical Center, Cairo University.

General procedures for preparation of compounds (4), (8a,b), (10a,b), (13), (16) and (20). The diazonium chloride **2** [prepared by diazotization of the amino pyrazole **1** (10 mmol) in the appropriate amount of mixture of hydrochloric acid and glacial acetic acid with cold sodium nitrite solution] was added dropwise while stirring and keeping the temperature below 5°C to a cold solution of β-naphthol **3** or the active methylenes **6a**, **b**, **9a**,**b**, ethyl cyanoacetate **12**, ethyl benzoylacetate **15**, or ethyl 2-chloroacetoacetate **19** (10 mmol) in ethanol (50 ml) containing sodium acetate (10 mmol). After complete addition, the reaction mixture was left for further 2 h. The formed precipitated solid products were filtered off and crystallized from the proper solvents.

Scheme 2. Synthesis of the pyrazolo[5,1-c]-1,2,4-triazoles 21, 22, 23.



5-(2-Hydroxynaphthalen-1-yl-azo)-3-phenyl-1H-pyrazole-4-carboxylic acid ethyl ester (4). Red crystals (70%), mp 145°C (EtOH). υ_{max}/cm^{-1} 3430 (br, OH), 3225 (NH), 1700 (CO). MS: *m/z* 386 [M^+]. $\delta_H = 1.27$ (t, 3H, $J = 7.2$ Hz, CH_3), 4.27 (q, 2H, $J = 7.2$ Hz,CH_2), 6.72 (d, 1H, $J = 9.6$ Hz, Naphthyl-H_4), 7.45–7.72 (m, 10H, Ar–H and NH), 7.90 (d, 1H, $J = 9.6$ Hz, naphthyl-H_3), 15.90 (s, 1H, OH). *Anal*. calcd for $C_{22}H_{18}N_4O_3$ (386.41): C, 68.38; H, 4.69; N, 14.49. Found C, 68–31; H, 4.63; N, 14.40.

4-Amino-3-cyano-7-phenyl-pyrazolo[5,1-c]l,2,4-triazine-8-carboxylic acid ethyl ester (8a).. Pale brown crystal (70%), mp 234°C. $\upsilon_{max}/cm^{-1} = 3433$, 3325 ($NH_2$), 2229 (CN), 1689 (CO). MS: *m/z* = 308 [M^+]. $\delta_H = 1.20$ (t, 3H, $J = 7.2$ Hz, CH_3), 4.25 (q, 2H, $J = 7.2$ Hz, CH_2), 7.52–7.79 (m, 5H, Ar–H), 9.55 (s, 2H, NH_2). *Anal*. calcd for $C_{I5}H_{12}N_6O_2$ (308.30): C, 58.43; H, 3.92; N, 27.75. Found: C, 58.38., H, 3.86; N, 27.65.

4-Amino-3-benzoyl-7-phenyl-pyrazolol[5,l-c]l,2,4-triazine-8-carboxylic acid ethyl ester (8b). Green crystal (65%), mp 186°C. $\upsilon_{max}/cm^{-1} = 3348$, 3293 ($NH_2$) 1693, 1639 (2CO). MS: *m/z* 387 [M^+]. *Anal*. calcd for $C_{21}H_{17}N_5O_3$ (387.40): C, 65.10; H, 4.42; N, 18.07. Found: C, 64.95; H, 4.39; N, 17.96.

5-[N′-(l-Acetyl-2-oxopropylidene)-hydrazino]-3-phenyl-lH-pyrazole-4-carboxylic acid ethyl ester (10a).. Yellow crystal (70%), mp 160°C. $\upsilon_{max}/cm^{-1} = 3410$, 3298 (NH), 1724, 1678 (CO). MS: *m/z* = 342 [M^+]. $\delta_H = 0.99$ (t, 3H, $J = 7.2$ Hz, CH_3), 1.75 (s, 3H, CH_3), 2.17 (s, 3H, acetyl CH_3), 4.04 (q, 2H, $J = 7.2$ Hz, CH_2), 6.70–7.50 (m, 6H, Ar.H + hydazino-NH), 10.13 (s, 1H, pyrazole NH). $\delta_C = 12.01$ (CH_3, ester), 14.30 (CH_3, acetyl), 24.92 (CH_3, acetyl), 57.31(CH_2, ester), 57.76 (CH-viny1), 59.54 (C-4 pyrazole), 113.66 (CN), 125.28, 126.76, 127.51, 128.12 and 129.04 (aromatic C), 138.71 (CO, ester), 161.45 (CO, acetyl). *Anal*. calcd for $C_{17}H_{18}N_4O_4$ (342.36): C, 59.64; H, 5.30; N, 16.37. Found: C, 59.44; H, 5.1; N, 16.29.

Ethyl 5-[N′-(l-benzoyl-2-oxo-2-phenylethylidene)-hydrazino]-3-phenyl-lH-pyrazole-4-carboxylate (10b). Pale yellow crystal (75%), mp 183 °C. $\upsilon_{max}/cm^{-1} = 3344$, 3278 (NH), 1662, 1631 (2CO). MS: *m/z* 466 [M^+]. $\delta_H = 1.25$ (t, 3H, $J = 7.2$ Hz, CH_3), 4.28 (q, 2H, $J = 7.2$ Hz, CH_2), 5.85 (s, 1H, NH), 7.33–7.92 (m, 15H, 3Ph-H), 10.18 (s, 1H, pyrazole NH). *Anal*. calcd for $C_{27}H_{22}N_4O_4$ (466.50): C, 69.52; H, 4.75; N, 12.01. Found: C, 69.39; H, 4.60; N, 11.90.

Ethyl 5-[N′-(cyano-ethoxycarbonyl-methylene)-hydrazino]-3-phenyl-lH-pyrazole-4-carboxylate 13. Pale brown crystal (70%), mp 165°C. $\upsilon_{max}/cm^{-1} = 3395$, 3215 (NH), 2206 (CN), 1720, 1674 (2CO). MS: *m/z* = 355 [M^+]. $\delta_H = 1.16$ (t, 3H, $J = 7.2$ Hz, CH_3), 1.33 (t, 3H, $J = 7.2$ Hz, CH_3), 4.17 (q, 2H, $J = 7.2$ Hz, CH_2), 4.3 1 (q, 2H, $J = 7.2$ Hz, CH_2), 7.50–7.65 (m, 5H, Ph-H), 13.67 (s, 2H, 2NH), *Anal*. calcd for $C_{17}H_{17}N_5O_4$ (355.36): C, 57.45; H, 4.82; N, 19.70. Found: C, 57.41; H, 4.78; N, 19.65.

Ethyl 5-[N′-(l-ethoxycarbonyl-2-oxo-2-phenyl-ethylidene)-hydrazino]-3-phenyl-lH-pyrazole-4-carboxylate 16. White crystal (70%), mp 191°C. $\upsilon_{max}/cm^{-1} = 3363$ (NH), 1724 (CO). MS: *m/z* = 434 [M^+]. *Anal*. calcd for $C_{23}H_{22}N_4O_5$ (434.46): C, 63.58; H, 5.10; N, 12,89. Found: C, 63.52; H, 4.95; N, 12.81.

Phenyl-11,12,14,15-tetraazacyclopenta[a]phenanthrene-17-carboxylic acid ethyl ester (5) (Cyclization of 4). Compound **4** (3.86 g, 10 mmol) was refluxed in glacial acetic acid (25 mL) for 2 h, then allowed to cool at room temperature. The formed solid product was crystallized from ethanol.

Yellow crystal (80%), mp 224°C. $\upsilon_{max}/cm^{-1} = 1695$ (CO). MS: *m/z* 368 [M^+]. *Anal*. calcd for $C_{22}H_{I6}N_4O_2$ (368.40): C, 71.72; H, 4.37; N, 15.20. Found: C, 71.67; H, 4.31; N, 15.14.

General procedure for preparation of compounds 11a,b (Cyclization of 10a,b). To each of compounds **10a** and **10b** (10 mmol) was added 10 mL of concentrated sulfuric, and the mixture was warmed to 40°C for 2 h and left overnight. The reaction mixture was then neutralized using sodium carbonate and the precipitated solid products were collected by filtration and recrystallized from ethanol.

Ethyl 3-aceyl-4-methyl-7-phenyl-pyrazolo[5,1-c]-1,2,4-triazine-8-carboxylate (11a). Yellow crystal (65%), mp 212°C. $\upsilon_{max}/cm^{-1} = 1710$, 1675 (2CO). MS: *m/z* 324 [M^+]. *Anal*. calcd for $C_{17}H_{16}N_4O_3$ (324.34): C, 62.95; H, 4.97; N, 17.27. Found: C, 62.88; H, 4.82; N, 17.18.

Ethyl 3-benzoyl-4,7-diphenylpyrazolo[5,1-c]-1,2,4-triazine-8-carboxylate (11b). White crystal (70%), mp 217°C. $\upsilon_{max}/cm^{-1} = 1722$, 1680 (2CO). MS: *m/z* 448 [M^+]. *Anal*. calcd for $C_{27}H_{20}N_4O_3$ (448.49): C, 73.30; H, 4.49; N, 12.49. Found: C, 73.21; H, 4.38; N, 12.34.

Ethyl 3-cyano-4-oxo-7-phenyl-l,4-dihydro-pyrazolo[5,1-c]-1,2,4-triazine-8-carboxylate 14. (Cyclization of 13). Compound **13** (3.55 g, 10 mmol) was refluxed in pyridine (25 mL) for 3 h and allowed to cool to room temperature then poured into cold water and neutralized with dilute HCl. The resulting product was collected by filtration and crystallized from ethanol.

Pale brown crystal (65%), mp 258°C. $\upsilon_{max}/cm^{-1} = 3444$ (NH), 2218 (CN), 1735, 1666(2CO). MS: *m/z* = 309 [M^+]. *Anal*. calcd for $C_{15}H_{11}N_5O_3$ (309.29): C, 58.25; H, 3.58; N, 22.64. Found: C, 58.16; H, 3.42; N, 22.58.

Ethyl 3-benzoyl-4-oxo-7-phenyl-1,4-dihydro-pyrazolo[5,l-c]-l,2,4-triazine-8-caboxylate (17). A solution of compound **16** (4.34 g, 10 mmol) in pyridine (25 mL) was refluxed for 3 h and then left to cool to room temperature. The reaction mixture was then poured into cold water and neutralized with dilute HCl. The resulting precipitate was collected by filtration and crystallized from ethanol.

White crystal (55%), mp 220°C. $\upsilon_{max}/cm^{-1} = 3223$ (MH), 1732, 1663 (2CO). MS: *m/z* 388 [M^+]. $\delta_H = 1.25$ (t, 3H, $J = 7.2$ Hz, CH_3), 4.31 (q, 2H, $J = 7.2$ Hz, CH_2), 7.50–7.82 (m, 10H, 2Ph-H), 8.04 (s, IH, triazine NH). *Anal*. calcd for $C_{21}H_{16}N_4O_4$ (388.39): C, 64.944; H, 4.15; N, 14.42. Found: C, 64.82; H, 4.04; N, 14.33.

4,7-diphenyl-pyrazolo[5,l-c]-l,2,4-triazine-3,8-dicarboxylic acid diethyl ester (18). A mixture of compound **16** (4.34 g, 10 mmol) and (10 mL) concentrated sulfuric acid was warmed at 40°C for 2 h and left overnight. The reaction mixture was neutralized cautiously with sodium carbonate solution and the resulting product was collected by filtration and crystallized from ethanol.

Yellow crystal (65%), mp 129 C. $\upsilon_{max}/cm^{-1} = 1727$, 1659 (2CO). MS: *m/z* = 416 [M^+]. $\delta_H = 1.03$ (t, 3H, $J = 7.2$ Hz, CH_3), 1 .20 (t, 3H, $J = 7.2$ Hz, CH_3), 4.02 (q, 2H, $J = 7.2$ Hz, CH_2), 4.20 (q, 2H, $J = 7.2$ Hz, CH_2), 7.28–7.75 (m, 10H, 2Ph-H). *Anal*. calcd for $C_{23}H_{20}N_4O_4$ (416.44): C, 66.33; H, 4.84; N, 13.45. Found: C, 66.25; H, 4.73; N, 13.31.

Ethyl 5-[N′-(chloro-ethoxycarbonyl-methylene)-hydrazine]-3-phenyl-1H-pyrazole-4-carboxylate (20). Pale brown crystals (65%), mp 116°C. $\upsilon_{max}/cm^{-1} = 3328$, 3232 (NH), 1705 (CO). MS: *m/z* = 364 and 366 [$M^{\pm}$]. $\delta_H = 1.13$ (t, 3H, $J = 7.2$ Hz, CH_3), 1.26 (t, 3H, $J = 7.2$ Hz, CH_3), 4.17 (q, 2H, $J = 7.2$ Hz, CH_2), 4.32 (q, 2H, $J = 7.2$ Hz, CH_2), 7.33–7.65 (m, 6H, Ph-H + pyrazole NH), 10.04 (s, 1H, hydrazone NH). *Anal*. calcd for $C_{16}H_{17}Cl\ N_4O_4$

(364.79): C, 52.68; H, 4.69; N, 15.35; Cl, 9.71. Found: C, 52.61; H, 4.63; N, 15.28; Cl, 9.65.

6-Phenyl-lH-pyrazolo[5,1-c]-1,2,4-triazole-3,7-dicarboxylic acid diethyl ester (21). To a suspension of **20** (3.64 g, 10 mmol) in ethanol (25 mL) was added 0.5 mL of triethylamine. The reaction mixture was refluxed for 3 h and allowed to cool to room temperature, then poured into ice-cold water and neutralized with dilute HCl. The resulting product was collected by filtration and crystallized from ethanol.

Pale brown crystal (60%), mp 204°C. $\upsilon_{max}/cm^{-1} = 3110$ (NH), 1736, 1649 (2CO). MS: $m/z = 328$ [M^+]. $\delta_H = 1.24$ (t, 3H, $J = 7.2$ Hz, CH_3), 1.35 (t, 3H, $J = 7.2$ Hz ,CH_3), 4.22 (q. 2H, $J = 7.2$ Hz, CH_2), 4.45 (q. 2H, $J = 7.2$ Hz, CH_2), 7.45–7.84 (m, 5H, Ph-H), 14.6 (s, 1H, triazole NH). $\delta_C = 14.07$, 14.46 (2$\underline{C}H_3$), 59.55, 62.18 (2$\underline{C}H_2$), 86.81 (C-7), 127.80, 129.12, 129.46, 132.04 (Ph C), 132.25 (C-6), 149.15 (C-3), 155.59 (C-8), 160.24, 161.34 (2$\underline{C}O$). *Anal*. calcd for $C_{16}H_{16}N_4O_4$ (328.33): C, 58.53; H, 4.87; N, 17.06. Found: C, 58.42; H, 4.80; N, 16.92.

Ethyl 6-phenyl-3-(N′-pyridine-2-yl-hydrazinocarbonyl)-1*H*-pyrazolo [5,1-*c*]-1,2,4-triazole-7-carboxylate (22). ***Method (1).*** 2-Aminopyridine (0.94 g, 10 mmol) was added to a solution of **20** (3.64 g, 10 mmol) in ethanol. The reaction mixture was refluxed for 3 h, left to cool and then poured into cold water. The resulting solid product was collected by filtration and crystallized from ethanol/dioxane.

Method (2). 2-Aminopyridine (0.94 g, 10 mmol) was added to a solution of **21** (3.28 g, 10 mmol) in ethanol. The reaction mixture was refluxed for 3 h, left to cool and then poured into cold water. The resulting solid product was collected by filtration and crystallized from ethanol/dioxane.

Red crystal (70%), mp > 300°C. $\upsilon_{max}/cm^{-1} = 3402$, 3 175 (NH), 1678, 1650 (2CO). MS: $m/z = 376$ [M^+]. $\delta_H = 1.26$ (t, 3H, $J = 7.5$ Hz, CH_3), 4.24 (q, 2H, $J = 7.5$ Hz, CH_2), 7.17–7.20 (m, 4H, pyrid-H), 7.47–7.65 (m, 5H, Ph-H), 7.83 (s, 1H, amide NH), 8.35 (s, 1H, triazole NH). *Anal*. calcd for $C_{19}H_{16}N_6O_3$ (376.38): C, 60.63; H, 4.28; N, 22.32. Found: C, 60.57; H, 4.22; N, 22.27.

Ethyl 3-hydrazinocarbonyl-6-phenyl-1*H*-pyrazolo[5,1-*c*]-1,2,4-triazole-7-carboxylate (23). ***Method (1).*** Compound **20** (3.64 g, 10 mmol) was refluxed with hydrazine hydrate (0.50 mL, 10 mmol.) in ethanol (20 mL) for 3 h, allowed to cool and then poured into cold water. The resulting solid product was collected by filtration and crystallized from ethanol.

Method (2). A solution of **21** (3.28 g, 10 mmol) and hydrazine hydrate were refluxed in ethanol (25 mL) for 3 h, left to cool and then poured into cold water. The resulting solid product was collected by filtration and crystallized from ethanol.

Yellow crystal (75%), mp 195°C. $\upsilon_{max}/cm^{-1} = 3356$, 3331, 3286 (NH and NH_2), 1648, 1592 (2CO). MS: $m/z = 312$ ($M^+ - 2$). *Anal*. calcd for $C_{14}H_{14}N_6O_3$ (314.31): C, 53.49; H, 4.48; N, 26.73. Found: C, 53.40; H, 4.39; N, 26.64.

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