Studies with Enaminones: The reaction of enaminones with Aminoheterocycles. A route to Azolopyrimidines, Azolopyridines and Quinolines

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Received December 18, 2002
Received Revised October 18, 2003

The enaminones **1b,d,f** react with 4-phenyl-3-methyl-5-pyrazoleamine **3a** to yield the pyrazole derivatives **4a-c** that cyclised readily on reflux in pyridine solution in presence of hydrochloric acid to yield the pyrazolo[1,5-*a*]pyrimidines **5a-c**. Similarly 3(5)-amino-1*H*-triazole (**3b**) reacted with **1b,d,f** to yield the triazolo[1,5-*a*]pyrimidines **5d-f**. In contrast attempted condensation of the 5-tetrazoloamine (**3c**) with **1a,d,e** resulted in its trimerisation and only triaroylbenzene **8a,d,e** was isolated. The reaction of **1a,b,d** with anthranilonitrile **9a** and the reaction of **1a-c** with the 2-aminocyclohexene thiophene-3-nitrile **10a** afforded the *cis* enaminones **11a-c** and **12a-c**. Similarly, reaction of **1a-c** with the methylanthranilate **9b** and reaction of **1b,e** with ethyl 2-aminocyclohexene thiophene-3-carboxylate **10b** afforded the *cis* enaminones **11d-f** and **12d,e** respectively. Attempted cyclization of **11a-c** into quinoline failed. Successful cyclization of **11d** into the quinolinone **13** could be affected, on heating for five minutes in a domestic microwave oven at full power. The reaction of **1a-c,f** with piperidine afforded the *trans* enaminones **14a-d**. Similarly, *trans* **14e** was formed from the reaction of **1b** with morpholine. The coupling reaction of **1b** with excess of benzene diazonium chloride afforded the formazane **16**. The enaminone **2** reacted with heterocyclic amines to yield the pyridones **17,18**.

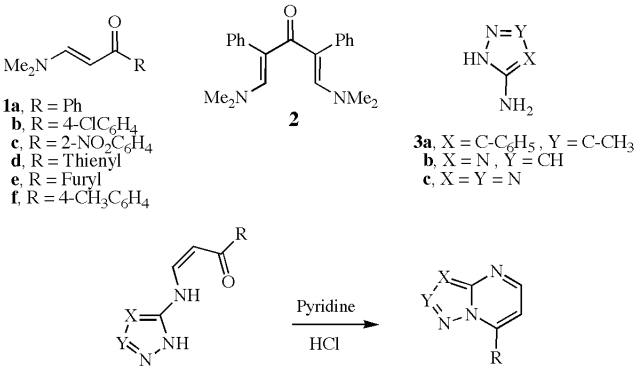
J. Heterocyclic Chem., **41**, 267 (2004).

In conjunction to our interest in the chemistry of enaminones [1-3], we report here our results aiming to further explore synthetic potential of this class of compounds. The newly required enaminones **1a-f** and **2** were prepared *via* refluxing methyl ketones and dibenzylketone with excess of dimethylformamide dimethylacetal (DMFDMA). Attempted preparation of **1b,c** by refluxing the respective methyl ketones with DMFDMA in refluxing acetic acid [4] or in toluene solution [5] utilizing reported procedure for synthesis of enaminones from reaction of arylmethyl ketones with DMFDMA resulted in less than 25% yield even after prolonged reflux. The enaminones **1b,d,f** reacted with the aminopyrazole derivative **3a** to yield the enaminone **4a-c**. The structures of which proved to exist in the *cis* form as ^{1}H NMR revealed the presence of olifinic protons at δ 5.95 and 6.85 ppm with $J = 9$ Hz typical for *cis* olefinic protons.

We believe that domination the *cis* form is a result of hydrogen bonding of the NH and aroylcarbonyl which "fixes" this form. Compounds **4a-c** readily cyclized into the pyrazolo[1,5-*a*]pyrimidines **5a-c** on reflux in pyridine solution in the presence of concentrated hydrochloric acid (*cf.* Scheme 1).

The reaction of pyrazole amines with enaminones has been reported earlier, however to our knowledge this is the first reported isolation of **4** thus confirming structure of the formed pyrazolo[1,5-*a*]pyrimidines. Similar to the reported behavior of 1,2,4-1*H*-triazolo-5-amine (**3b**) toward enaminones, **3b** reacted with **1b,d,f** to yield the 1,2,4-triazolo[1,5-*a*]pyrimidines **5d-f**, respectively.

Scheme 1

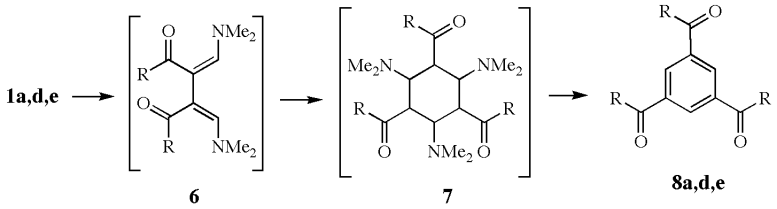


4,5	X	Y	R	4,5	X	Y	R
a	C-Ph	C-Me	4-ClC_6H_4	**d**	N	CH	4-ClC_6H_4
b	C-Ph	C-Me	Thienyl	**e**	N	CH	Thienyl
c	C-Ph	C-Me	4-$CH_3C_6H_4$	**f**	N	CH	4-$CH_3C_6H_4$

In contrast to this attempted consideration of 5-tetrazole amine **3c** with **1a,d,f** failed, only the triaroyl benzenes **8a,d,f** were isolated. We believe that acidity of the reaction mixture has prompted such trimerization which has very recently been reported to occur on refluxing enaminones in acetic acid solution. Formation of intermediates **6** and **7** is suggested although direct concerted 2+2+2 cycloaddition leading directly to **7** cannot be overlooked (*cf.* Scheme 2).

Trimerization of enaminones into triazoylbenezenes has recently been reported from our laboratories [6,7].

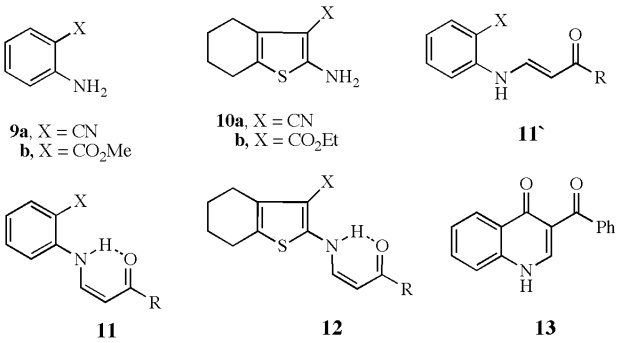
Scheme 2



Compound **1a-d** reacted with anthranilonitrile **9a** and methylanthranilate **9b** to yield the *cis* enaminones **11a-f**. The ^{1}H NMR showed the presence of a mixture of the *cis* form **11** and *trans* form **11'**. ^{1}H NMR indicated the predominance of the *cis* form (*cf.* Table 1 for relative concentration of *cis* and *trans* forms in the mixture as indicated from ^{1}H NMR). Predominance of *cis* form is a result of hydrogen bonding. Although the *trans* form can also be stabilized through hydrogen bonding with ester group, it seems that this effect does not give as much stability to the *trans* form.

Similarly, the reaction of **1a-c** with 2-aminocyclohexene thiophene-3-nitrile **10a** and the reaction of **1b,e** with ethyl 2-aminocyclohexene thiophene-3-carboxylate **10b** afforded the corresponding enaminones **12a-e** (*cf.* Scheme 3).

Scheme 3



11	X	R
a	CN	Ph
b	CN	4-ClC_6H_4
c	CN	thienyl
d	CO_2Me	Ph
e	CO_2Me	4-ClC_6H_4
f	CO_2Me	2-$NO_2C_6H_4$

12	X	R
a	CN	Ph
b	CN	4-ClC_6H_4
c	CN	2-$NO_2C_6H_4$
d	CO_2Et	4-ClC_6H_4
e	CO_2Et	furyl

Attempted cyclization of **11a-c** into quinoline failed. Successful cyclisation of **11d** into the quinolinone **13** could be affected, on heating for five minutes in domestic microwave oven at full power. The reaction of **1a,c,f** with piperidine afforded the *trans* enaminones **14a,c,f**.

Table 1

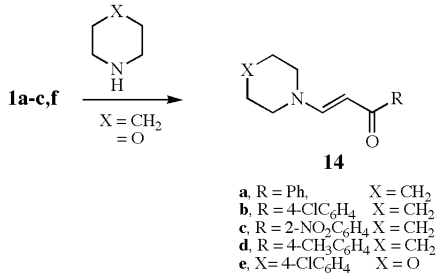
Relative concentration of *cis* and *trans* form of enaminones **11, 12** as indicated from ^{1}H NMR

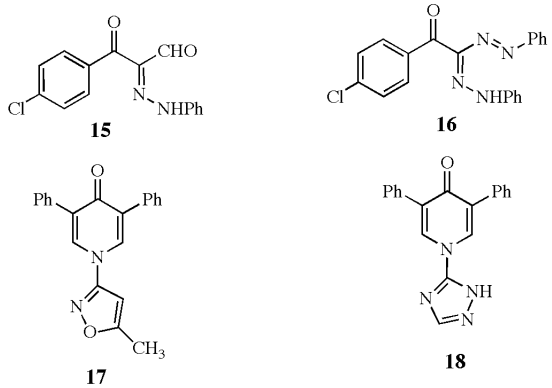
Compounds	*Cis* form	*Trans* form
11b	7	1
11e	4	1
11f	4.2	1
12a	6.5	1
12c	6	1
12e	4	1

Similarly, *trans* **14b** was formed from the reaction of **1b** with morpholine.

Similar to established behavior of enaminones toward aromatic diazonium salts [8,9] **1b** couples with benzene diazonium chloride to yield the arylhydrazone **15** as major

Scheme 4





reaction product [10,11]. However GCMS indicated always the presence of the formazane **16**. Pure **16** could be prepared on coupling **1ab** with excess benzene diazonium chloride in DMF solution at 0 °C. The reaction of **2** with aminoazoles afforded the azolylpyridones **17** and **18** (Scheme 4).

EXPERIMENTAL

All melting points were measured on Gallenkamp electrothermal melting point apparatus and are uncorrected. IR spectra were recorded as KBr pellets on a Pye Unicam SP 3-300 Spectrophotometer. ^{1}H NMR spectra were recorded in deuterated dimethylsulfoxide (d_6-DMSO): or deutrated chloroform ($CDCl_3$) at 200 MHz on a Varian Gemini NMR spectrometer using tetramethylsilane (TMS) as an internal reference and results are expressed as δ values. Mass spectra were performed on a Shimadzu GCMS-QP 1000 Ex mass spectrometer at 70 eV. Microwave experiments were conducted in a microwave oven DAEWOO, edition II (KOR-8667). Elemental analyses were carried out at the Microanalytical center of Cairo University.

Preparation of Pyrazole Derivatives **4a-c** and Triazole Derivatives **4d-f**.

General Procedure.

To a solution of each of enaminone **1b,d,f** (10 mmole) in ethanol (20 ml), 4-phenyl-3-methyl-5-pyrazoleamine **3a** or 3(5)-amino1H-triazole **3b** (10 mmole) was added. The reaction mixture was refluxed for 6 h. The solid product formed on evaporation the excess solvent was collected by filtration and crystallized from ethanol to give **4a-f** respectively.

1-(4-Chloro phenyl)-3-(5-methyl-4-phenyl-2*H*-pyrazo-3-ylamino)-propenone (**4a**).

This compound was obtained in 76 % yield, mp 91-92 °C; IR (KBr): ν 3350-3240 (NH), 3024 (CH, olefinic), 2916 (CH, aliphatic), 1650 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 2.85 (s, 3H, CH_3), 5.95 (d, *J* = 9Hz, olefinic H), 7.14-8.18 (m, 9H, H-Ar), 7.50 (d, *J* = 9Hz, olefinic H), 8.10 (s, 1H, NH), 12.02 (d, 1H, NH); MS (EI, 70 eV): m/z (%)= 337 [M$^+$, (37)].

Anal. Calcd. for $C_{19}H_{16}N_3Ocl$: C, 67.56; H, 4.77; N, 12.44; Cl, 10.49 %. Found: C, 67.70; H, 4.60; N, 12.50; Cl, 10.60.

3-(5-Methyl-4-phenyl-2*H*pyrazo-3-ylamino)-1-thiophen-2-yl-propenone (**4b**).

This compound was obtained in 71% yield, mp 96-97 °C; IR (KBr): ν 3350-3244 (NH), 3020 (CH, olefinic), 2918 (CH, aliphatic), 1660 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 2.80 (s, 3H, CH_3), 5.90 (d, *J* = 9Hz, olefinic H), 7.10-7.85 (m, 8H, H-Ar), 7.42 (d, *J* = 9Hz, olefinic H), 8.35 (s, 1H, NH), 12.22 (d, 1H, NH).

Anal. Calcd. for $C_{17}H_{15}N_3OS$: C, 66.00; H, 4.89; N, 13.58; S, 10.36 %. Found: C, 65.90; H, 4.90; N, 13.50; S, 10.30.

3-(5-Methyl-4-phenyl-2*H*-pyrazo-3-ylamino)-1-p-tolyl-propenone (**4c**).

This compound was obtained in 65 % yield mp 110-111 °C; IR (KBr): ν 3360-3254 (NH), 3015 (CH, olefinic), 2921 (CH, aliphatic), 1645 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 2.39 (s, 3H, CH_3), 2.75 (s, 3H, CH_3), 5.98 (d, *J* = 9Hz, olefinic H), 7.05-7.89 (m, 9H, H-Ar), 7.62 (d, *J* = 9Hz, olefinic H), 8.25 (s, 1H, NH), 12.42 (d, 1H, NH).

Anal. Calcd. for $C_{20}H_{19}N_3O$: C, 75.69; H, 6.03; N, 13.24 %. Found: C, 75.60; H, 6.00; N, 13.20.

1-(4-Chlorophenyl)-3-(2*H*-[1,2,4]triazol-3-ylamino)-propenone (**4d**).

This compound was obtained in 66 % yield, mp 136-38 °C; IR (KBr): ν 3355-3230 (NH), 3022 (CH, olefinic), 2912 (CH, aliphatic), 1652 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 6.54 (d, *J* = 9Hz, olefinic H), 6.95-7.85 (m, 4H, H-Ar), 7.45 (d, *J* = 9Hz, olefinic H), 8.25 (s, 1H triazoleH-5), 8.65 (s, 1H, NH), 12.42 (d, 1H, NH).

Anal. Calcd. for $C_{11}H_9N_4OCl$. C, 53.13; H, 3.65; N, 22.53; Cl, 14.26 %. Found: C, 53.20; H, 3.70; N, 22.50; Cl, 14.30.

1-Thiophen-2-yl-3-(2*H*[1,2,4]triazol-3-ylamino)-propenone (**4e**).

This compound was obtained in 61% yield, mp 96-98 °C; IR (KBr): ν 3345-3240 (NH), 3030 (CH, olefinic), 2922 (CH, aliphatic), 1646 cm-1 (CO); 1H NMR (d6-DMSO): δ = 6.35 (d, J = 9Hz, olefinic H), 7.05-7.70 (m, 3H, thiophene H), 7.35 (d, J = 9Hz, olefinic H), 8.14 (s, 1H triazoleH-5), 8.45 (s, 1H, NH), 12.52 (d, 1H, NH).

Anal. Calcd. for $C_9H_8N_4OS$: C, 49.08; H, 3.66; N, 25.44; S, 14.56 %. Found: C, 49.0; H, 3.70; N, 25.50; S, 14.60.

1-*p*-Tolyl-3-(2*H*-[1,2,4]triazol-3-ylamino)-propenone (**4f**).

This compound was obtained in 65 % yield, mp 103-105 °C; IR (KBr): ν 3365-3250 (NH), 3020 (CH, olefinic), 2918 (CH, aliphatic), 1655 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 2.38 (s, 3H, CH_3), 6.70(d, *J* = 9 Hz, olefinic H), 7.25-7.85 (m, 4H, H-Ar), 7.65 (d, *J* = 9 Hz, olefinic H), 8.28 (s, 1H triazole H-5), 8.55 (s, 1H, NH), 12.62 (d, 1H, NH).

Anal. Calcd. for $C_{12}H_{12}N_4O$: C, 63.15; H, 5.30; N, 24.55 %. Found: C, 63.20; H, 5.20; N, 24.50.

Cyclization of **4a-c** into Pyrazolo[1,5-*a*]pyrimidine Derivatives **5a-c** and **4d-f** into Triazolo[1,5-*a*]pyrimidine Derivatives **5d-f**.

General Procedure.

A solution of each of **4a-f** (10 mmole) was refluxed in pyridine (20 ml) for 2h, then 1ml of concentrated hydrochloric acid was added and the reflux continued for further one hour. After cooling, the reaction mixture was poured into ice-cold water, the solid precipitate so formed was filtered off and recrystalized from ethanol to afford **5a-f** respectively.

7-(4-Chlorophenyl)-2-methyl-3-phenylpyrazolo[1,5-*a*]pyrimidine (**5a**).

This compound was obtained in 77% yield mp 196-198 °C; ^{1}H NMR (d_6-DMSO): δ = 2.84 (s, 3H, CH_3), 7.14-8.28 (m, 11H, H-Ar), ^{13}C NMR (d_6-DMSO): δ = 18.65, 122.20, 124.90, 127.40, 128.10, 128.62, 129.05, 129.87, 132.60, 133.90, 135.10, 136.70, 142.20, 158.20, 165.10.*Anal*. Calcd. for $C_{19}H_{14}N_3Cl$. C, 71.36; H, 4.41; N, 13.14, Cl, 11.09 %. Found: C, 71.30; H, 4.40; N, 13.20, Cl, 11.10.

2-Methyl-3-phenyl-7-thiophen-2-yl-pyrazolo[1,5-*a*]pyrimidine (**5b**).

This compound was obtained in 73% yield mp 158-160 °C; IR (KBr): ν 2925 (CH, aliphatic), cm^{-1}; ^{1}H NMR (d_6-DMSO): δ = 2.82 (s, 3H, CH_3), 7.10-7.65 (m, 10H, H-Ar).

Anal. Calcd. for $C_{17}H_{13}N_3S$: C, 70.08; H, 4.50; N, 14.42; S, 11.00 %. Found: C, 70.10; H, 4.60; N, 14.50, S, 10.90.

2-Methyl-3-phenyl-7-*p*-tolyl-pyrazolo[1,5-*a*]pyrimidine (**5c**).

This compound was obtained in 65% yield mp 178-180 °C; IR (KBr): ν 2918 (CH, aliphatic), cm^{-1}; ^1H NMR (d_6-DMSO): δ = 2.35 (s, 3H, CH_3), 2.85 (s, 3H, CH_3), 7.05-7.78 (m, 11H, H-Ar).

Anal. Calcd. for $C_{20}H_{17}N_3$: C, 80.24; H, 5.72; N, 14.04 %. Found: C, 80.30; H, 5.70; N, 14.0.

7-(4-Chlorophenyl)-[1,2,4]triazolo[1,5-*a*]pyrimidine (**5d**).

This compound was obtained in 72% yield mp 226-228 °C; ^1H NMR (d_6-DMSO): δ = 7.14-8.25 (m, 6H, H-Ar), 8.50 (s, 1H, triazole H-5).

Anal. Calcd. for $C_{11}H_7N_4Cl$: C, 57.28; H, 3.06; N, 24.29; Cl, 15.37 %. Found: C, 57.30; H, 3.10; N, 24.20; Cl, 15.40.

7-(Thiophen-2-yl-[1,2,4]triazolo[1,5-*a*]pyrimidine (**5e**).

This compound was obtained in 72% yield mp 180-182 °C; ^1H NMR (d_6-DMSO): δ = 7.0-7.30 (m, 3H, H, thiphene), 7.55 (d, 1H, pyrimidine H), 8.40 (s, 1H, triazole H-5) 8.88 (d, 1H, pyrimidine H).

Anal. Calcd. for $C_9H_6N_4S$: C, 53.45; H, 2.99; N, 27.70; S, 15.85 %. Found: C, 53.50; H, 3.10; N, 27.60; S, 15.90.

7-*p*-Tolyl-[1,2,4]triazolo[1,5-*a*]pyrimidine (**5f**).

This compound was obtained in 75% yield mp 188-190 °C; IR (KBr): ν 2914 (CH, aliphatic), cm^{-1}; ^1H NMR (d_6-DMSO): δ = 2.37 (s, 3H, CH_3), 7.15-7.78 (m, 5H, H-Ar), 8.30 (s, 1H, triazole H-5), 8.55 (sd, 1H, pyrimidine H).

Anal. Calcd. for $C_{12}H_{10}N_4$: C, 68.56; H, 4.79; N, 26.65 %. Found: C, 68.60; H, 4.70; N, 26.70.

General Procedure for the Preparation of **8a,d,e**.

Each of compound **1a,d,e** (10 mmol) was refluxed in acetic acid (20 ml) for 4 h after which it was cooled to room temperature. The precipitate, which formed, was collected by filtertration and successively crystallized from ethanol/dioxane (3:1 v/v).

1,3,5-Tri-benzoylbenzene (**8a**).

Yield (71%) mp 242-244 °C; -IR (KBr) ν_{max} = 1666 (CO), cm^{-1} -^1H NMR (d_6-DMSO): δ_H = 6.95-7.75 (m, 18H, Ar-H) ^{13}C NMR (d_6-DMSO): δ_C = 127.90, 129.85, 131.96, 135.20, 136.80, 137.86, 188.50 (CO). -MS (EI, 70 EV): *m/z* (%) = 390(100) [M^+].

Anal. Calcd. for $C_{27}H_{18}O_3$: C, 83.06; H, 4.65 %. Found: C, 83.10; H, 4.70.

1,3,5-Tri-thiopheno–2-ylbenzene (**8d**).

Yield (78%) mp 262-264 °C; -IR (KBr) ν_{max} = 1660 (CO), cm^{-1} -^1H NMR (d_6-DMSO): δ_H = 7.3-8.35 (m, 12H, Ar-H). -MS (EI, 70 EV): *m/z* (%) = 408(8.0) [M^+].

Anal. Calcd. for $C_{21}H_{12}O_3S_3$: C, 61.74; H, 2.96; S, 23.55 %. Found: C, 61.70; H, 3.00; S, 23.50.

1,3,5-Tri-furano-2-ylbenzene (**8e**).

yield (70%) mp 238-240 °C; -IR (KBr) ν_{max} = 1654 (CO), cm^{-1} -^1H NMR (d_6-DMSO): δ_H = 6.85-8.10 (m, 12H, Ar-H).

Anal. Calcd. for $C_{21}H_{12}O_6$: C, 70.00; H, 3.36 %. Found: C, 70.10; H, 3.40.

Preparation of enaminones **11a-f** and **12a-e**.

General procedure.

To a solution of each of compounds **1a-d** (10 mmole) in dioxane (20 ml), was added (10 mmole) of each of anthranilonitrile **9a**, methylanthranilate **9b**, 2-amino-cyclohexene thiophene-3-nitrile **10a**, ethyl 2-aminocyclohexene thiophene-3-carboxylate **10b**. The reaction mixture was refluxed for 8 h in each case and left to cool over night. The precipitated solid in each case was separated by filtration and recystallized from the proper solvent.

2-(3-Oxo-3-phenylpropenylamino)benzonitrile (**11a**).

This compound was obtained in 75% yield mp 123-125 °C (EtOH); IR (KBr): ν 3350-3244 (NH), 3018 (CH, olefinic), 2925 (CH, aliphatic), 2218 (CN), 1635 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 6.45 (d, *J* = 9Hz, olefinic H), 7.05-7.90 (m, 9H, H-Ar), 7.78 (d, *J* = 9Hz, olefinic H), 12.20 (d, 1H, NH), -MS (EI, 70 EV): *m/z* (%) = 248(36) [M^+].

Anal. Calcd. for $C_{16}H_{12}N_2O$: C, 77.40; H, 4.87; N, 11.28 %. Found: C, 77.30; H, 4.90; N, 11.30.

2-[3-(4-Chlorophenyl)-3-oxo-propenylamino)benzonitrile (**11b**).

This compound was obtained in 71% yield mp 133-135 °C (EtOH); IR (KBr): ν 3341-3238 (NH), 3019 (CH, olefinic), 2920 (CH, aliphatic), 2221 (CN), 1639 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 6.55 (d, *J* = 9Hz, olefinic H), 7.0-7.95 (m, 8H, H-Ar), 7.71 (d, *J* = 9Hz, olefinic H), 12.40 (d, 1H, NH), -MS (EI, 70 EV): *m/z* (%) = 282 (40) [M^+].

Anal. Calcd. for $C_{16}H_{11}N_2OCl$: C, 67.97; H, 3.92; N, 9.91; Cl, 12.54 %. Found: C, 68.00; H, 4.00; N, 9.90; Cl, 12.50.

2-(3-Oxo-3-thiophen-2-yl-propenylamino)benzonitrile (**11c**).

This compound was obtained in 75% yield mp 114-116 °C (EtOH); IR (KBr): ν 3350-3304 (NH), 3025 (CH, olefinic), 2920 (CH, aliphatic), 2214 (CN), 1630 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 6.61 (d, *J* = 9Hz, olefinic H), 7.15-7.99 (m, 7H, H-Ar), 7.66 (d, *J* = 9Hz, olefinic H), 12.30 (d, 1H, NH), -MS (EI, 70 EV): *m/z* (%) = 254 (46) [M^+].

Anal. Calcd. for $C_{14}H_{10}N_2OS$: C, 66.12; H, 3.96; N, 11.02; S, 12.61 %. Found: C, 66.10; H, 4.00; N, 11.10; S, 12.70.

Methyl 2-(3-oxo-3-phenylpropenylamino)benzoate (**11d**).

This compound was obtained in 65% yield mp 108-110 °C (EtOH); IR (KBr): ν 3310-3250 (NH), 3025 (CH, olefinic), 2920 (CH, aliphatic), 1710, 1640 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 3.85 (s, 3H, CH_3), 6.41 (d, *J* = 9Hz, olefinic H), 7.05-7.90 (m, 9H, H-Ar), 7.70 (d, *J* = 9Hz, olefinic H), 12.29 (d, 1H, NH).

Anal. Calcd. for $C_{17}H_{15}NO_3$: C, 72.58; H, 5.37; N, 4.98 %. Found: C, 72.60; H, 5.40; N, 4.90.

Methyl 2-[3-(4-chlorophenyl)-3-oxo-propenylamino)benzoate (**11e**).

This compound was obtained in 68% yield mp 114-115 °C (EtOH); IR (KBr): ν 3315-3250 (NH), 3023 (CH, olefinic), 2924 (CH, aliphatic), 1708, 1642 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 3.89 (s, 3H, CH_3), 6.42 (d, *J* = 9Hz, olefinic H), 7.05-8.10 (m, 8H, H-Ar), 7.60 (d, *J* = 9Hz, olefinic H), 13.10 (d, 1H, NH).

Anal. Calcd. for $C_{17}H_{14}NO_3Cl$: C, 64.67; H, 4.47; N, 4.44; Cl, 11.23 %. Found: C, 64.70; H, 4.40; N, 4.50; Cl, 11.30.

Methyl 2-[(3-(2-nitrophenyl)-3-oxo-propenylamino)benzoate (**11f**).

This compound was obtained in 69% yield mp 120-122 °C (EtOH); IR (KBr): ν 3320-3240 (NH), 3021 (CH, olefinic), 2922

(CH, aliphatic), 1715, 1640 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 3.85 (s, 3H, CH_3), 6.25 (d, *J* = 9Hz, olefinic H), 7.14-7.98 (m, 8H, H-Ar), 7.72 (d, *J* = 9Hz, olefinic H), 12.82 (d, 1H, NH).

Anal. Calcd. for $C_{17}H_{14}N_2O_5$: C, 62.58; H, 4.32; N, 8.58 %. Found: C, 62.60; H, 4.40; N, 8.60.

2-(3-Oxo-3-phenylpropenylamino)-4,5,6,7-tetrahydrobenzo-[*b*]thiophene-3-carbo-nitrile (**12a**).

This compound was obtained in 79% yield mp 168-170 °C (AcOH); IR (KBr): ν 3350-3154 (NH), 3018 (CH, olefinic), 2925 (CH, aliphatic), 2210 (CN), 1640 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.82 (m, 4H), 2.75 (m, 4H), 6.65 (d, *J* = 9Hz, olefinic H), 7.10-7.89 (m, 5H, H-Ar), 7.62 (d, *J* = 9Hz, olefinic H), 10.99 (d, 1H, NH).

Anal. Calcd. for $C_{18}H_{16}N_2OS$: C, 70.10; H, 5.23; N, 9.08; S, 10.40 %. Found: C, 70.10; H, 5.30; N, 9.10; S, 10.50.

2-[3-(4-Chlorophenyl)-3-oxo-propenylamino]-4,5,6,7-tetrahydrobenzo[*b*]thiophene-3-carbonitrile (**12b**).

This compound was obtained in 79% yield mp 178-180 °C; IR (KBr): ν 3355-3159 (NH), 3018 (CH, olefinic), 2922 (CH, aliphatic), 2222 (CN), 1645 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.80 (m, 4H), 2.79 (m, 4H), 6.60 (d, *J* = 9Hz, olefinic H), 7.15-7.95 (m, 4H, H-Ar), 7.69 (d, *J* = 9Hz, olefinic H), 11.90 (d, 1H, NH); MS (EI, 70 EV): *m/z* (%) = 342 (43) [M^+].

Anal. Calcd. for $C_{18}H_{15}N_2OSCl$: C, 63.06; H, 4.41; N, 8.17; S, 9.35 %. Found: C, 63.10; H, 4.30; N, 8.10; S, 9.50.

2-[3-(2-Nitrophenyl)-3-oxo-propenylamino]-4,5,6,7-tetrahydrobenzo[*b*]thiophene-3-carbonitrile (**12c**).

This compound was obtained in 74% yield mp 138-140 °C (EtOH); IR (KBr): ν 3335-3169 (NH), 3012 (CH, olefinic), 2920 (CH, aliphatic), 2220 (CN), 1640 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.82 (m, 4H), 2.76 (m, 4H), 6.61 (d, *J* = 9Hz, olefinic H), 7.65-8.10 (m, 4H, H-Ar), 7.68 (d, *J* = 9Hz, olefinic H), 11.90 (d, 1H, NH).

Anal. Calcd. for $C_{18}H_{15}N_3O_3S$: C, 61.18; H, 4.28; N, 11.89; S, 9.07 %. Found: C, 61.20; H, 4.30; N, 11.90; S, 9.10.

Ethyl 2-[3-(4-Chlorophenyl)-3-oxo-propenylamino]-4,5,6,7-tetrahydrobenzo[*b*]thiophene-3-carboxylate (**12d**).

This compound was obtained in 74% yield mp 128-130 °C (EtOH); IR (KBr): ν 3350-3175 (NH), 3018 (CH, olefinic), 2922 (CH, aliphatic), 1695, 1645 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.23 (t, 3H, CH_3), 1.60 (m, 4H), 2.70 (m, 4H), 4.15 (q, 2H, CH_2), 5.92 (d, 1H, *J* = 9Hz, olefinic H), 7.15-7.98 (m, 4H, H-Ar), 7.50 (d, 1H, *J* = 9Hz, olefinic H), 11.99 (d, 1H, NH).

Anal. Calcd. for $C_{20}H_{20}NO_3SCl$: C, 61.61; H, 5.17; N, 3.59; S, 8.22 %. Found: C, 61.60; H, 5.20; N, 3.60; S, 8.20.

Ethyl 2-(3-furan-2-yl-3-oxo-propenylamino)-4,5,6,7-tetrahydrobenzo[*b*]thiophene-3-carboxylate (**12e**).

This compound was obtained in 71% yield mp 148-150 °C (EtOH); IR (KBr): ν 3355-3165 (NH), 3018 (CH, olefinic), 2922 (CH, aliphatic), 1700, 1645 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.12 (t, 3H, CH_3), 1.60 (m, 4H), 2.65 (m, 4H), 4.11 (q, 2H, CH_2), 5.96 (d, 1H, *J* = 9Hz, olefinic H), 6.6 (m, 1H, furan H-4), 7.23 (d, 1H, furan H-3), 7.30 (d, 1H, *J* = 9Hz, olefinic H), 7.91 (d, 1H, furan H-5), 11.84 (d, 1H, NH).

Anal. Calcd. for $C_{18}H_{19}NO_4S$: C, 62.59; H, 5.54; N, 4.05; S, 9.28 %. Found: C, 62.50; H, 5.60; N, 4.00; S, 9.30.

3-Benzoyl-1*H*-quinolin-4-one (**13**).

Compound **11a** (10 mmol) was heated for 3 minutes in domestic microwave oven at full power. The residue cooled to deposit a solid, which was crystallized from DMF/EtOH (1:2) to afford **13**; yield (70%) mp 230-232 °C; IR (KBr): ν 3340-3280 (NH), 1670, 1650 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 685-7.95 (m, 9H, H-Ar) 8.31 (s, 1H), 8.95 (s, 1H, NH), 12.12 (d, 1H, NH) ^{13}C NMR (d_6-DMSO): δ = 115.90, 116.30, 118.20, 122.80, 128.60, 129.20, 131.10, 133.95, 135.10, 137.25, 148.15, 155.30, 184.40 (CO), 188.20 (CO).

Anal. Calcd. for $C_{16}H_{11}NO_2$: C, 77.10; H, 4.45; N, 5.62 %. Found: C, 76.90; H, 4.60; N, 5.70.

Preparation of piperidine-1-yl propenone **14a-d** and 3-morpholin-4-yl-1-(4-chloro-phenyl)propenone **14e**.

General procedure.

Each of compounds **1a-c,f** (10 mmol) was boiled in excess of piperidine, **1b** was boiled with morpholine, for 3 minutes then left to cool to room temperature. The solid so formed in each case was collected by filtertration and recystallized from ethanol to afford **14a-e** respectively.

1-Phenyl-3-piperidin-1-yl-propenone (**14a**).

This compound was obtained in 79% yield mp 96-98 °C; IR (KBr): ν 3012 (CH, olefinic), 2939 (CH, aliphatic), 1635 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.50 (m, 6H, $3CH_2$), 3.40 (m, 4H, $[CH_2]_2N$), 5.96 (d, 1H, *J* = 13Hz, olefinic H), 7.30 (d, 1H, *J* = 13Hz, olefinic H), 7.40-7.85 (m, 5H, Ar-H); -MS (EI, 70 EV): *m/z* (%) = 215 (87) [M^+].

Anal. Calcd. for $C_{14}H_{17}NO$: C, 78.10; H, 7.96; N, 6.51 %. Found: C, 78.20; H, 8.00; N, 6.50.

1-(4-Chlorophenyl)-3-piperidin-1-yl-propenone (**14b**).

This compound was obtained in 72% yield mp 132-134 °C; IR (KBr): ν 3019 (CH, olefinic), 2935 (CH, aliphatic), 1631 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.56 (m, 6H, $3CH_2$), 3.44 (m, 4H, $[CH_2]_2N$), 5.95 (d, 1H, *J* = 14Hz, olefinic H), 7.44 (d, 2H Ar-H), 7.65 (d, 1H, *J* = 14Hz, olefinic H), 7.88 (d, 2H Ar-H).

Anal. Calcd. for $C_{14}H_{16}NOCl$: C, 67.33; H, 6.46; N, 5.61; Cl, 14.20 %. Found: C, 67.30; H, 6.50; N, 5.60; Cl, 14.10.

1-(2-Nitrophenyl)-3-piperidin-1-yl-propenone (**14c**).

This compound was obtained in 75% yield mp 136-137 °C; IR (KBr): ν 3010 (CH, olefinic), 2936 (CH, aliphatic), 1645 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.54 (m, 6H, $3CH_2$), 3.36 (m, 4H, $[CH_2]_2N$), 5.96 (d, 1H, *J* = 13Hz, olefinic H), 7.60 (d, 1H, *J* = 13Hz, olefinic H), 7.68-8.14 (m, 4H, Ar-H).

Anal. Calcd. for $C_{14}H_{16}N_2O_3$: C, 64.60; H, 6.20; N, 10.76 %. Found: C, 64.50; H, 6.30; N, 10.70.

3-Piperidin-1-yl-1-*p*-tolyl-propenone (**14d**).

This compound was obtained in 75% yield mp 125-127 °C; IR (KBr): ν 3018 (CH, olefinic), 2930 (CH, aliphatic), 1640 cm^{-1} (CO); ^1H NMR (d_6-DMSO): δ = 1.52 (m, 6H, $3CH_2$), 2.35 (s, 3H, CH_3), 3.39 (m, 4H, $[CH_2]_2N$), 5.99 (d, 1H, *J* = 14Hz, olefinic H), 7.40 (d, 1H, *J* = 14Hz, olefinic H), 7.10-7.85 (m, 4H, Ar-H).

Anal. Calcd. for $C_{15}H_{19}NO$: C, 78.56; H, 8.35; N, 6.11 %. Found: C, 78.50; H, 8.30; N, 6.10.

1-(4-Chlorophenyl)-3-morpholin-4-yl-propenone (**14e**).

This compound was obtained in 74% yield mp 114-116 °C; IR (KBr): ν 3025 (CH, olefinic), 2955 (CH, aliphatic), 1635 cm^{-1}

(CO); ^{1}H NMR (d_6-DMSO): δ = 3.45 (m, 4H, $2CH_2$), 3.64 (m, 4H, $[CH_2]_2N$), 6.02 (d, 1H, *J* = 14Hz, olefinic H), 7.40 (d, 2H Ar-H), 7.60 (d, 1H, *J* = 14Hz, olefinic H), 7.90 (d, 2H Ar-H).

Anal. Calcd. for $C_{13}H_{14}NO_2Cl$: C, 62.03; H, 5.61; N, 5.56; Cl, 14.08 %. Found: C, 62.10; H, 5.60; N, 5.60; Cl, 14.10.

3-(4-Chlorophenyl)-3-oxo-2-(phenylhydrazono)-proionaldehyde (**15**).

A cold solution of benzene diazonium salt (10 mmol) was prepared by a solution of sodium nitrite (10 mmol in H_2O) to a cold solution of the aniline with stirring. The resulting solution of the benzene diazonium salt was added to a cold solution of **1b** (10 mmol) in ethanol (50 ml) containing sodium acetate. The reaction mixture was stirred at room temperature for 30 min. The solid product, so formed, was washed with water and crystallized from the ethanol; yield (74%) mp 151-153 °C; IR (KBr): ν 3350-3240 (NH), 1695 (CHO), 1650 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 6.85-7.75 (m, 9H, H-Ar), 9.3 (s, 1H, CHO), 11.5 (s, 1H, NH); MS (EI, 70 eV): m/z (%)= 286[M$^+$, (34)].

Anal. Calcd. for $C_{15}H_{11}N_2O_2Cl$: C, 62.84; H, 3.87; N, 9.77, Cl, 12.37 %. Found: C, 62.80; H, 3.80; N, 9.70, Cl, 12.40.

3-Aza-1-(4-chlorophenyl)-3-(phenylamino)-2-(phenyldiazenyl)-prop-2-en-1-one (**16**).

A cold solution of benzene diazonium salt (20 mmol) was prepared as described above. The resulting solution of the benzene diazonium salt was added to a cold solution of **1b** (10 mmol) in DMF (50 ml). The reaction mixture was stirred at room temperature for 30 min. The solid product, so formed, was washed with water and crystallized from the DMF/ethanol (1:2); yield (64%) mp 270-272 °C; IR (KBr): ν 3350-3240 (NH), 1660 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 6.85-7.75 (m, 14H, H-Ar), 12.45 (s, 1H, NH); MS (EI, 70 eV): m/z (%)= 362[M$^+$, (24)].

Anal. Calcd. for $C_{20}H_{15}N_4OCl$: C, 66.21; H, 4.17; N, 15.44, Cl, 9.77 %. Found: C, 66.10; H, 4.20; N, 15.60, Cl, 9.80.

Preparation of azolylpyridone **17** and **18**.

General Procedure.

To a solution of 2 (10 mmole) in ethanol (20 ml), was added (10 mmole) of each of 3-amino-5-methyl isoxazole or 3-amino-1,2,4-triazole. The reaction mixture was refluxed for 6 h. The solid product, so formed, on evaporation of the excess solvent was collected by filtration and crystallized from ethanol to give **17** and **18** respectively.

1-(5-Methyl isoxazol-3-yl)-3,5-diphenyl-1*H*-pyridin-4-one (**17**).

This compound was obtained in 66% yield mp 182-184 °C; IR (KBr): ν 1655 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 2.35 (s, 3H, CH_3), 7.14-7.85 (m, 12H, H-Ar), 8.1 (s, 1H, isoxazol H-4), ^{13}C NMR (d_6-DMSO): δ = 17.35 (CH_3), 102.50, 122.70, 125.90, 127.70, 128.90, 135.10, 138.20, 148.70, 159.90, 185.70 (CO).

Anal. Calcd. for $C_{21}H_{16}N_2O_2$: C, 76.81; H, 4.91; N, 8.53 %. Found: C, 76.90; H, 4.80; N, 8.50.

3,5-Diphenyl-1-(2*H*-[1,2,4]triazol-3-yl-1*H*-pyridin-4-one (**18**)

This compound was obtained in 69% yield mp 197-198 °C; IR (KBr): ν 1665 cm^{-1} (CO); ^{1}H NMR (d_6-DMSO): δ = 7.14-7.85 (m, 12H, H-Ar), 8.5 (s, 1H, triazole H-5).

Anal. Calcd. for $C_{19}H_{14}N_4O$: C, 72.60; H, 4.49; N, 17.82 %. Found: C, 72.60; H, 4.40; N, 17.90.

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