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REACTIVITY OF 6-METHYLCHROMONE-3-CARBONITRILE TOWARDS SOME NITROGEN NUCLEOPHILIC REAGENTS

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Abstract – The chemical reactivity of 6-methylchromone-3-carbonitrile (**1**) was studied towards a variety of nitrogen nucleophiles. A variety of products was obtained from the reaction of carbonitrile **1** with hydrazine hydrate, *S*-benzyl dithiocarbazate, isonicotinic acid hydrazide and cyanoacetohydrazide. A diversity of Schiff bases bearing 2-amino-6-methylchromone linked variable heterocyclic systems was efficiently synthesized. Reaction of carbonitrile **1** with guanidine and cyanoguanidine resulted in ring conversion producing chromeno[4,3-*d*]pyrimidines. Reaction of carbonitrile **1** was also studied towards some 1,4-binucleophiles.

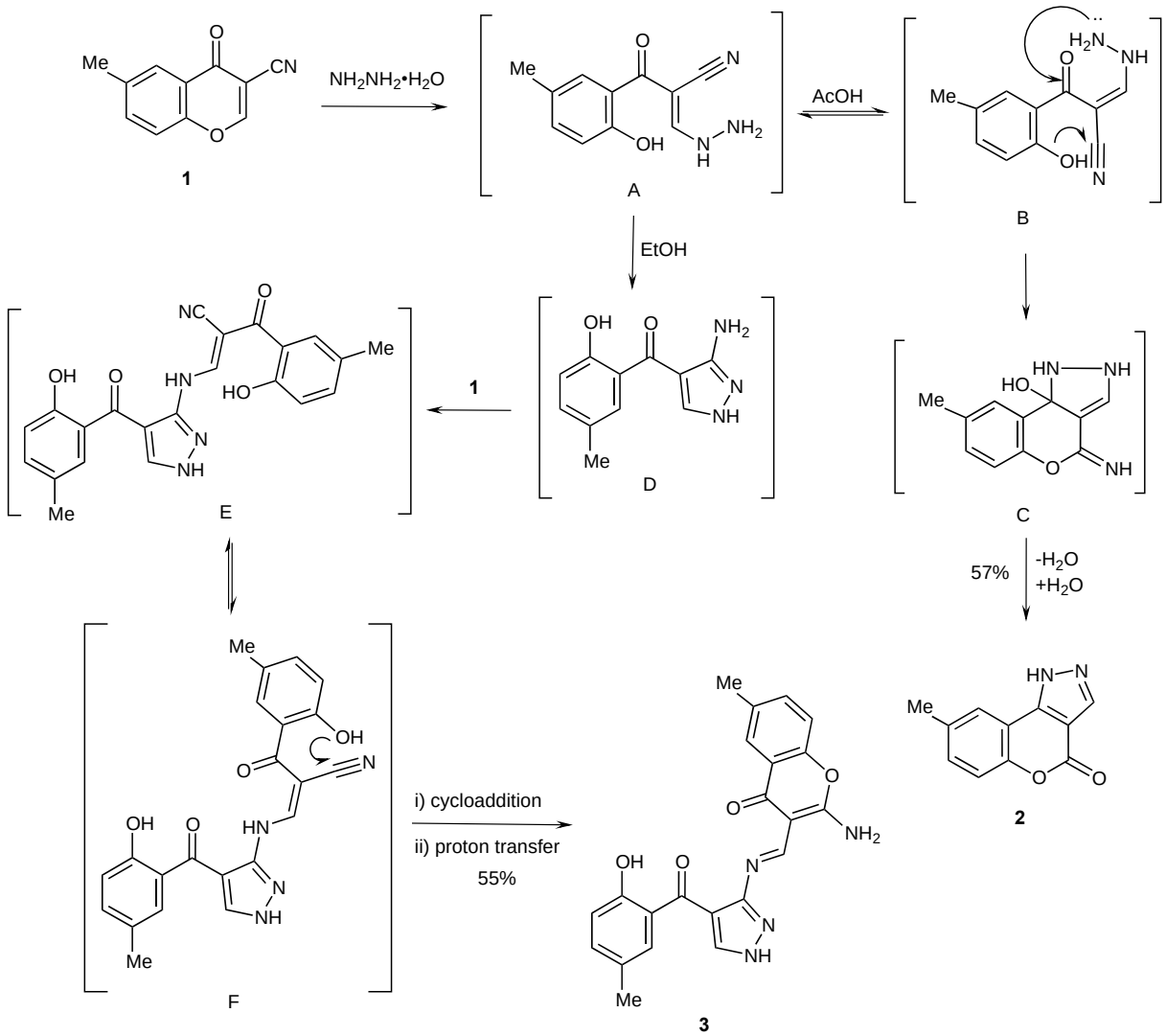
INTRODUCTION

Chromone derivatives represent an important class of oxygen containing heterocyclic compounds, which are widely spread in plants[1-3] and exhibit wide range of biological and pharmacological activities including anti-inflammatory,[4] anti-HIV,[5] anticancer,[6] antibacterial,[7] antimalarial,[8] antitumor,[9] as well as treatment of Alzheimer's disease.[10] The presence of the electron-withdrawing cyano group at the position 3 of the chromone system changes crucially the chemical reactivity of the γ-pyrone ring with respect to nucleophiles, and provides a broad synthetic potential of chromone-3-carbonitriles.[11-14] They have the ability to undergo a nucleophilic 1,4-attack followed by additional transformations related to γ-pyrone ring opening and heterocyclizations at the C-4 atom and/or at the cyano group.[15-19] Herein, we aimed to study the chemical transformations of 6-methylchromone-3-carbonitrile (**1**) towards some nitrogen nucleophiles.

RESULTS AND DISCUSSION

The present work aimed to study the chemical reactivity of 6-methylchromone-3-carbonitrile (**1**) towards

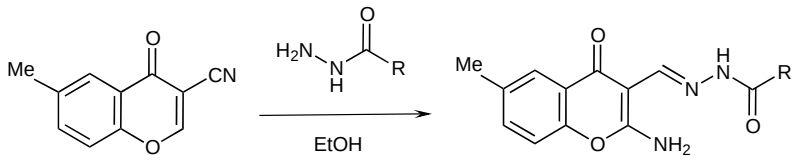
a variety of nitrogen nucleophiles under different reaction conditions. Treatment of carbonitrile **1** with hydrazine hydrate (1:1 molar ratio) in boiling acetic acid afforded 8-methylchromeno[4,3-*c*]pyrazol-4(1*H*)-one (**2**). The proposed mechanism is depicted in Scheme 1, the reaction may proceed through nucleophilic attack at C-2 with ring opening (intermediate **A**). Free rotation around the single bond (intermediate **B**) with concomitant cycloaddition reactions produced intermediate **C** which underwent dehydration followed by hydrolysis to produce the final product **2**. The IR spectrum of compound **2** showed characteristic absorption bands at 3192 (NH), 1706 ($C=O_{\alpha\text{-pyrone}}$) and 1632 cm^{-1} (C=N). Its ^1H NMR spectrum showed two doublets assigned to H-6 and H-7 at δ 7.24 and 7.29, two singlets at δ 7.73 and 8.42 assigned to H-9 and H-3, respectively, in addition to D_2O-exchangeable signal at δ 14.20 attributed to the NH proton. Furthermore, the mass spectrum is a strong evidence for elucidation of structure **2** which revealed the molecular ion peak, as the base peak, at *m/z* 200, which agrees well with the proposed molecular formula ($C_{11}H_8N_2O_2$).



Scheme 1

Interestingly, reaction of carbonitrile **1** with hydrazine hydrate in boiling ethanol showed different behavior producing a yellow crystalline product with high melting point (above 300 ^{o}C). After interpretation of the spectral data, this product was identified as 2-amino-3-[({4-[(2-hydroxy-5-methylphenyl)carbonyl]-1*H*-pyrazol-3-yl}imino)methyl]-6-methylchromone (**3**) (Scheme 1). The reaction may occur through the formation of intermediate **A** followed by the cycloaddition of the NH_2 group onto the nitrile function producing intermediate **D** which reacted with another molecule of carbonitrile **1** producing the target compound **3**, *via* γ-pyrone ring opening (intermediate **E**) with rotation around the single bond (intermediate **F**) followed by cycloaddition of the hydroxyl group on the nitrile group with concomitant proton transfer. The IR spectrum of compound **3** showed characteristic absorption bands at 3390, 3224, 3090 (NH_2, NH, OH), 1652 (C= $O_{\gamma\text{-pyrone}}$) and 1609 cm^{-1} (C=$O_{benzoyl}$ and C=N). The ^{1}H NMR spectrum of compound **3** consists of two upfield signals attributable to 2CH_3 protons at δ 2.08 and 2.39, four doublets assignable to aromatic protons at δ 6.84, 7.10, 7.29 and 7.48, in addition to four singlets at δ 7.05 (Ar-H), 7.78 (H-$5_{pyrazole}$), 8.06 (H-$5_{chromone}$) and 8.76 (CH=N). The spectrum also revealed D_2O-exchangeable signals at δ 7.21 (NH_2) and 9.04 (NH). The OH proton was not observed in the spectrum and this may attributed to the strong hydrogen bonding between the hydroxyl and carbonyl groups. The mass spectrum of compound **3** confirms the suggested structure, which recorded the molecular ion peak at *m/z* 402 and the base peak at *m/z* 135.

Next, the chemical transformations of 6-methylchromone-3-carbonitrile (**1**) were studied toward some hydrazides namely; cyanoacetohydrazide, isonicotinic acid hydrazide and *S*-benzyl dithiocarbazate, in different solvents. Therefore, reaction of carbonitrile **1** with cyanoacetohydrazide and isonicotinic acid hydrazide in boiling ethanol afforded the corresponding hydrazones **4** and **5**, respectively (Scheme 2). The ^{1}H NMR spectra of compounds **4** and **5** showed characteristic singlets attributed to CH=N at δ 8.61 and 8.95, respectively.



1

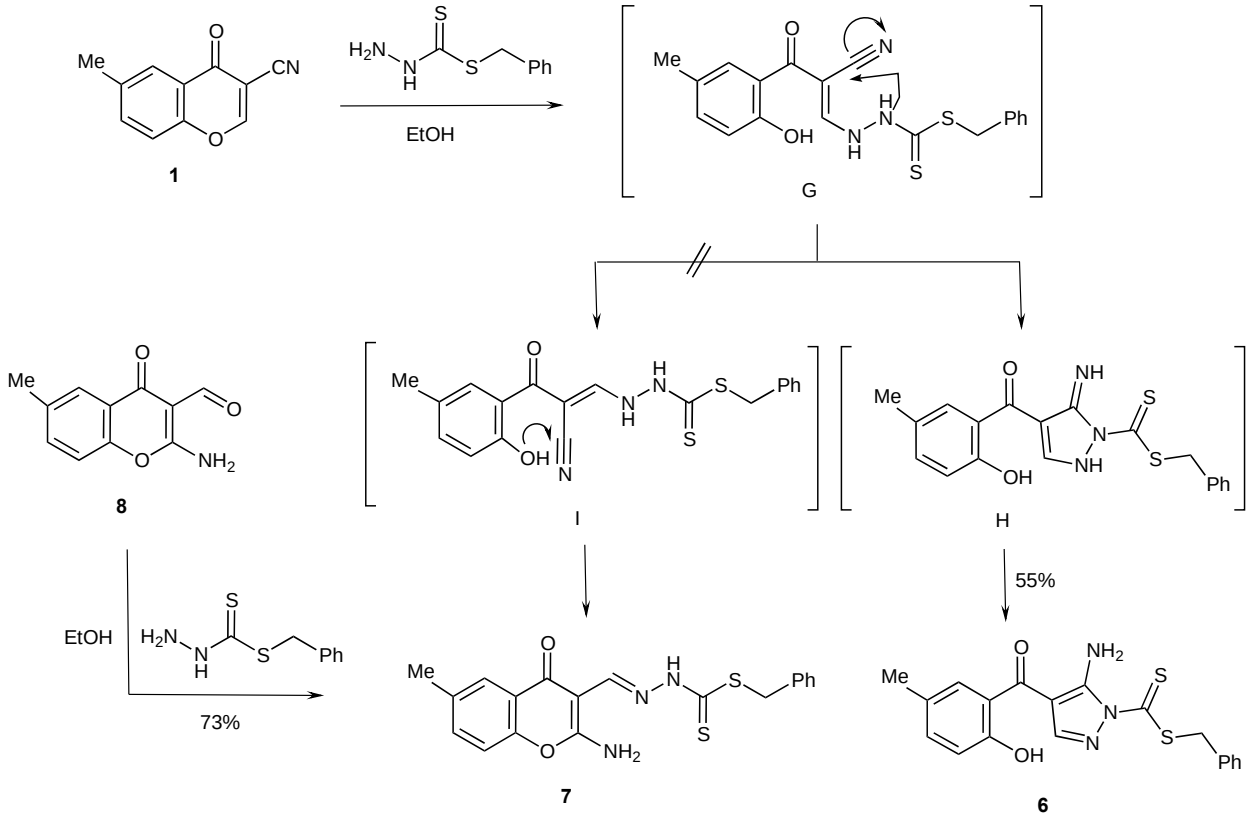
4; R= CH_2CN (61%)

5; R= 4-pyridyl (60%)

Scheme 2

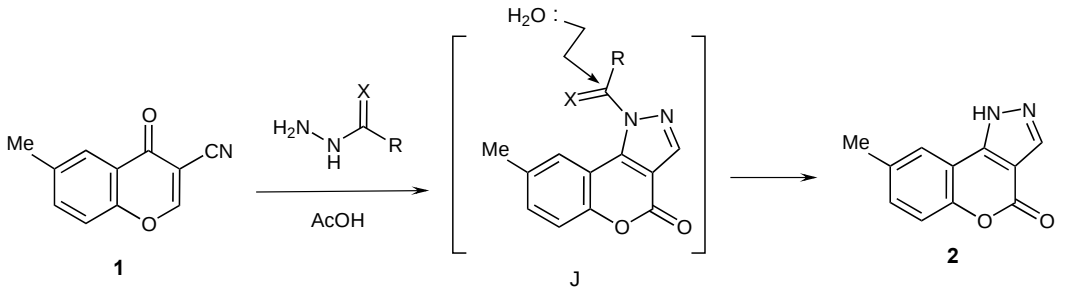
On the other hand, *S*-benzyl dithiocarbazate showed different behavior upon treating with carbonitrile **1** in boiling ethanol producing the unexpected; benzyl 5-amino-4-[(2-hydroxy-5-methylphenyl)carbonyl]-1*H*-pyrazole-1-carbodithioate (**6**), another expected product; benzyl 2-[(2-amino-6-methylchromon-3-yl)methylidene]hydrazine-carbodithioate (**7**) was ruled out based on the spectral data (Scheme 3). Compound **7** was prepared alternatively from the condensation reaction of 2-amino-6-methylchromone-3-

carboxaldehyde (**8**) with *S*-benzyl dithiocarbazate, in boiling ethanol (Scheme 3). Compound **6** gave deep red color with $FeCl_3$ solution, indicating the presence of free phenolic OH group. Formation of compound **6** may occur *via* nucleophilic attack at C-2 position with concomitant γ-pyrone ring opening leading to intermediate **G**, which underwent intramolecular cyclization through addition of NH group onto the nitrile function (intermediate **H**) followed by proton transfer producing the final product **6**. Another reaction pathway leading to hydrazone **7**, *via* intermediate **I**, was excluded.



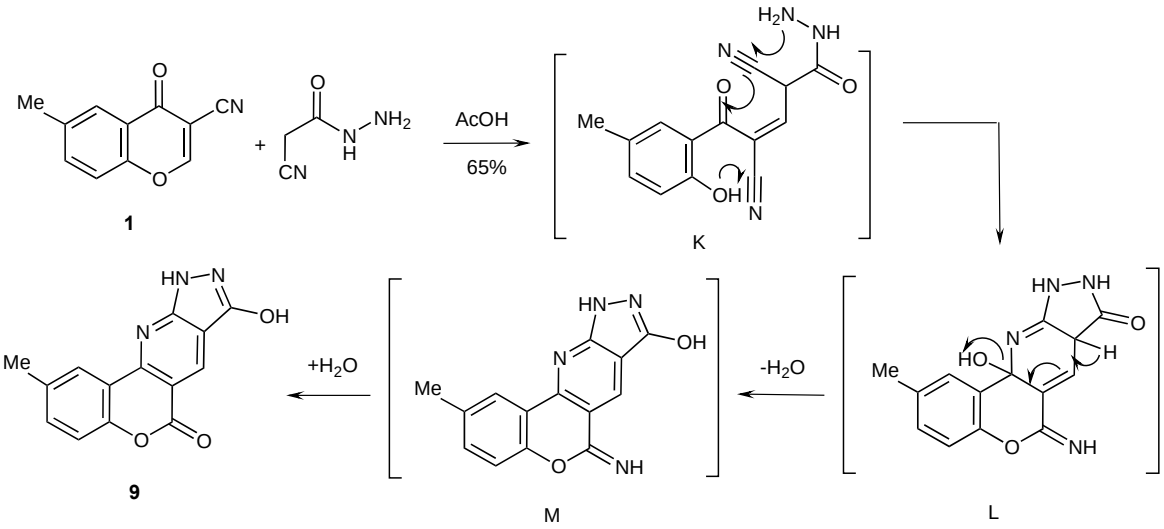
Scheme 3

Next, reactions of carbonitrile **1** with the above hydrazides were repeated in boiling acetic acid. Treatment of carbonitrile **1** with isonicotinic acid hydrazide and *S*-benzyl dithiocarbazate, in boiling acetic acid, gave one product which was found to be identical with 8-methylchromeno[4,3-*c*]pyrazol-4(1*H*)-one (**2**), *via* the nonisolable intermediate **J** (Scheme 4).[20]



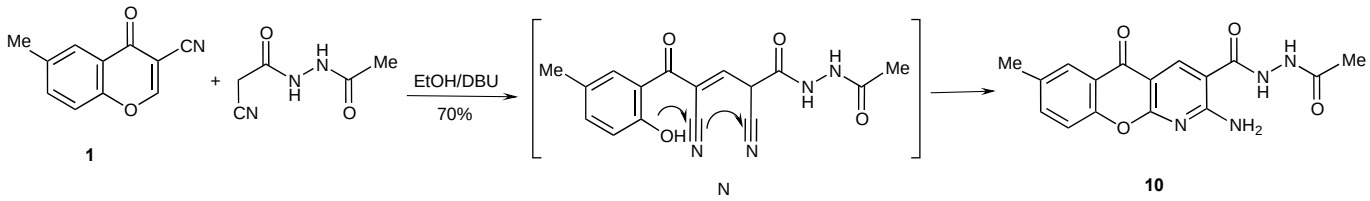
Scheme 4

Interestingly, reaction of carbonitrile **1** with cyanoacetohydrazide in boiling acetic acid proceeds in a different mechanism leading to unexpectedly, 3-hydroxy-9-methylchromeno[4,3-*b*]pyrazolo[4,3-*e*]-pyridin-5(1*H*)-one (**9**) (Scheme 5). Under these reaction conditions cyanoacetohydrazide acted as carbon nucleophile, and the ring transformation of carbonitrile **1** into the annulated system **9** may initially proceeds *via* nucleophilic attack at C-2 position with γ-pyrone ring opening to produce intermediate **K**, which underwent cycloaddition reactions including addition of phenolic OH into the C≡N group, two consecutive cycloaddition reactions through addition of NH_2 into the C≡N group followed by addition to the C=O group, generating intermediate **L**. Dehydration of the latter intermediate gave intermediate **M** which hydrolyzed under the reaction conditions producing the final product **9** as depicted in Scheme 5. The IR spectrum of compound **9** showed characteristic absorption bands at 3196 (OH and NH), 1694 ($C=O_{\alpha\text{-pyrone}}$) and 1608 cm^{-1} (C=N). The mass spectrum is a strong evidence for elucidation of structure **9** which revealed the molecular ion peak at *m/z* 267, as the base peak, which agrees well with the proposed molecular formula ($C_{14}H_9N_3O_3$).



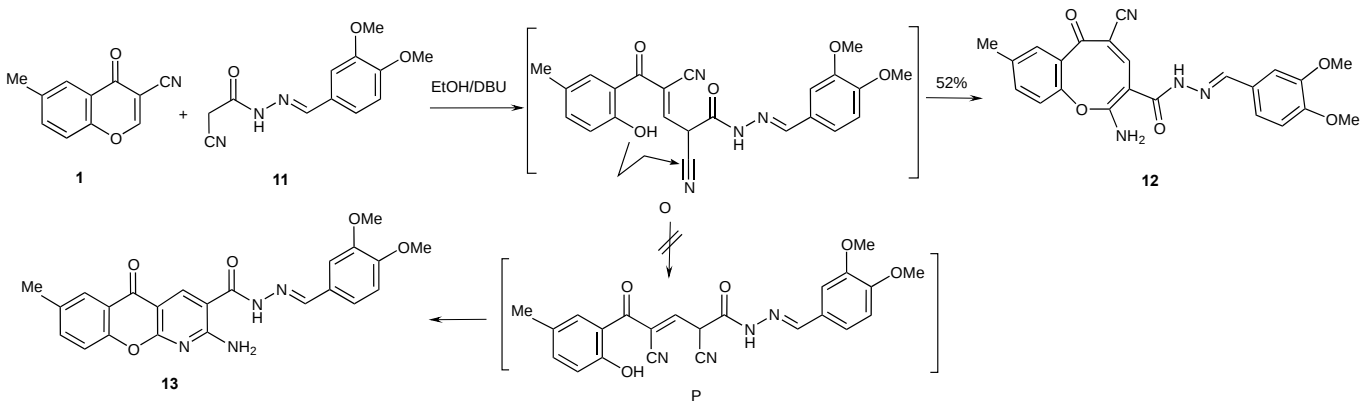
Scheme 5

Due to the interesting behavior of cyanoacetohydrazide, the reaction of carbonitrile **1** was studied towards *N*`-acetyl-2-cyanoacetohydrazide and 2-cyano-*N*'-[(3,4-dimethoxyphenyl)methylidene]acetohydrazide. Thus, reaction of carbonitrile **1** with *N*'-acetyl-2-cyanoacetohydrazide afforded *N*'-acetyl-2-amino-7-methyl-5-oxo-5*H*-chromeno[2,3-*b*]pyridine-3-carbohydrazide (**10**), *via* the nonisolable intermediate **N** (Scheme 6).[17] The ^{1}H NMR spectrum of compound **10** revealed four singlet signals at δ 1.89 (CH_3), 2.37 (CH_3), 7.77 (H-6), 8.56 (H-4$_{pyridine}$), two doublets at δ 7.31 (H-9), 7.47 (H-8), in addition to D_2O-exchangeable signals at δ 9.02, 9.49 (NH_2), 10.95 (NH) and 11.28 (NH). The mass spectrum of compound **10** revealed the molecular ion peak at *m/z* 326 and confirms the suggested structure.



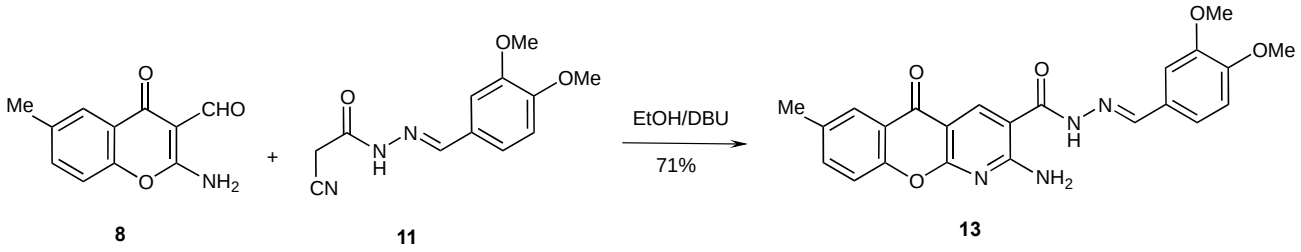
Scheme 6

On the other hand, reaction of carbonitrile **1** with 2-cyano-*N*'-[(3,4-dimethoxyphenyl)methylidene]-acetohydrazide (**11**) in boiling ethanol containing 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) yielded 2-amino-5-cyano-*N*'-[(3,4-dimethoxyphenyl)methylidene]-8-methyl-6-oxo-1-benzoxocine-3-carbohydrazide (**12**).[17,18] The expected product from the latter reaction, 2-amino-*N*'-[(3,4-dimethoxyphenyl)-methylidene]-7-methyl-5-oxo-5*H*-chromeno[2,3-*b*]pyridine-3-carbohydrazide (**13**), was excluded based on the spectral data (Scheme 7). The expansion of carbonitrile **1** into benzoxocine derivative **12** may occur *via* the formation of intermediate **O** followed by an intramolecular nucleophilic addition of the hydroxyl group onto the nitrile function leading to the final product **12** as shown in Scheme 7. Another reaction pathway leading to compound **13**, *via* intermediate **P**, was ruled out. The IR spectrum of compound **12** showed characteristic absorption bands at 3384 (br, NH_2, NH), 2231 (C≡N), 1669 (C=O$_{amide}$ and C=O$_{oxocine}$) and 1615 cm^{-1} (C=N).



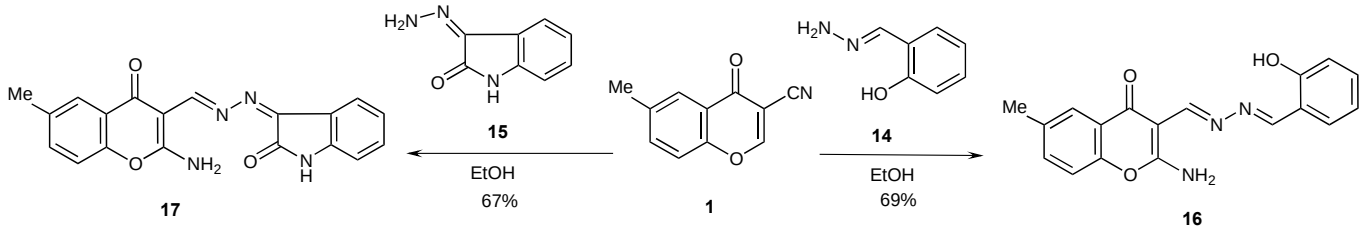
Scheme 7

An alternative route was utilized to synthesize chromeno[2,3-*b*]pyridine derivative **13** from condensation reaction of 2-amino-6-methylchromone-3-carboxaldehyde (**8**) with cyanoacetohydrazide derivative **11** (Scheme 8). The IR spectrum of compound **13** showed characteristic absorption bands at 3399, 3289, 3154 (NH_2, NH), 1671 ($C=O_{amide}$ and $C=O_{\gamma\text{-pyrone}}$) and 1608 cm^{-1} (C=N). Its ^1H NMR spectrum showed characteristic singlets at δ 8.50s and 8.61 attributed CH=N and H-$4_{pyridine}$, respectively. The spectrum also revealed broad D_2O-exchangeable signals at δ 9.32 (NH_2) and 11.44 (NH). Furthermore, the mass spectrum of compound **13** is a strong evidence for elucidation of structure **13** which revealed the molecular ion peak at *m/z* 432, which agrees well with the proposed formula weight (432.43).



Scheme 8

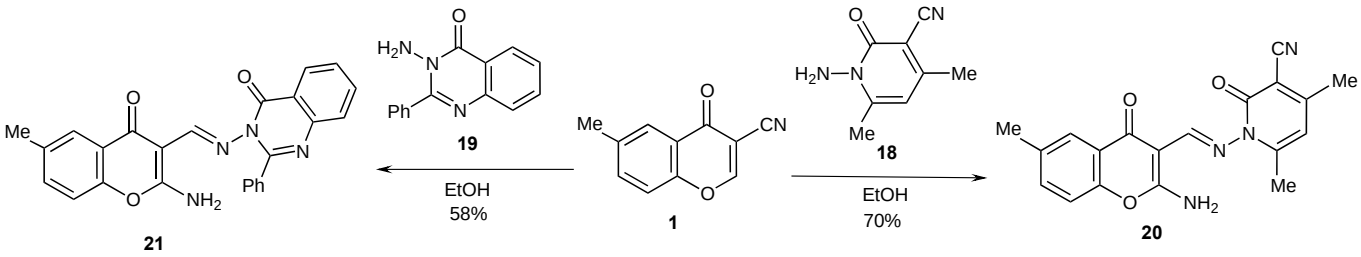
Then, the chemical reactivity of carbonitrile **1** was studied towards some hydrazones. Therefore, treatment of carbonitrile **1** with salicylaldehyde hydrazone **14** and isatin hydrazone **15** in boiling ethanol furnished the corresponding unsymmetrical Schiff bases **16** and **17**, respectively (Scheme 9). The IR spectra of compounds **16** and **17** showed characteristic absorption bands at 1651/1652 ($C=O_{\gamma\text{-pyrone}}$), 1625/1609 cm^{-1} (C=N). The ^1H NMR spectrum of compound **16** showed two singlet signals attributed to two CH=N protons at δ 8.98 and 9.02, while the ^1H NMR spectrum of compound **17** showed singlet signal corresponding to CH=N at δ 8.99.



Scheme 9

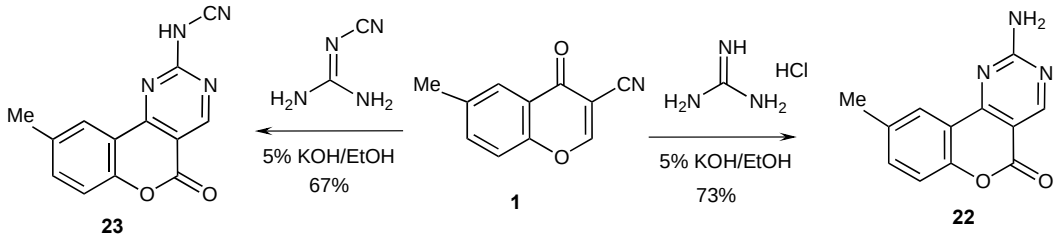
In the same manner, reaction of carbonitrile **1** with 1-amino-4,6-dimethyl-2-oxo-1,2-dihydropyridine-3-carbonitrile (**18**),[20] and 3-amino-2-phenylquinazolin-4(3*H*)-one (**19**),[21] afforded Schiff bases **20** and **21**, respectively, in which 2-amino-6-methylchromone linked pyridine and quinazoline moities in one molecular frame (Scheme 10). The IR spectra of compounds **20** and **21** showed characteristic absorption

bands at 3250, 3130/3293, 3219 (NH_2), 1655/1652 ($C=O_{\gamma\text{-pyrone}}$), 1614/1607 cm^{-1} (C=N), respectively, in addition the spectrum of compound **20** showed absorption band assigned to C≡N at 2213 cm^{-1}, while the spectrum of compound **21** showed absorption band attributed to $C=O_{quinazoline}$ at 1669 cm^{-1}. The ^1H NMR spectra of compounds **20** and **21** showed characteristic singlet signals attributed to H-5 and CH=N at δ 7.80/8.06 and 8.84/8.97, respectively. The spectrum of compound **20** showed distinctive singlet at δ 6.03 assigned to $H\text{-}5_{pyridone}$.



Scheme 10

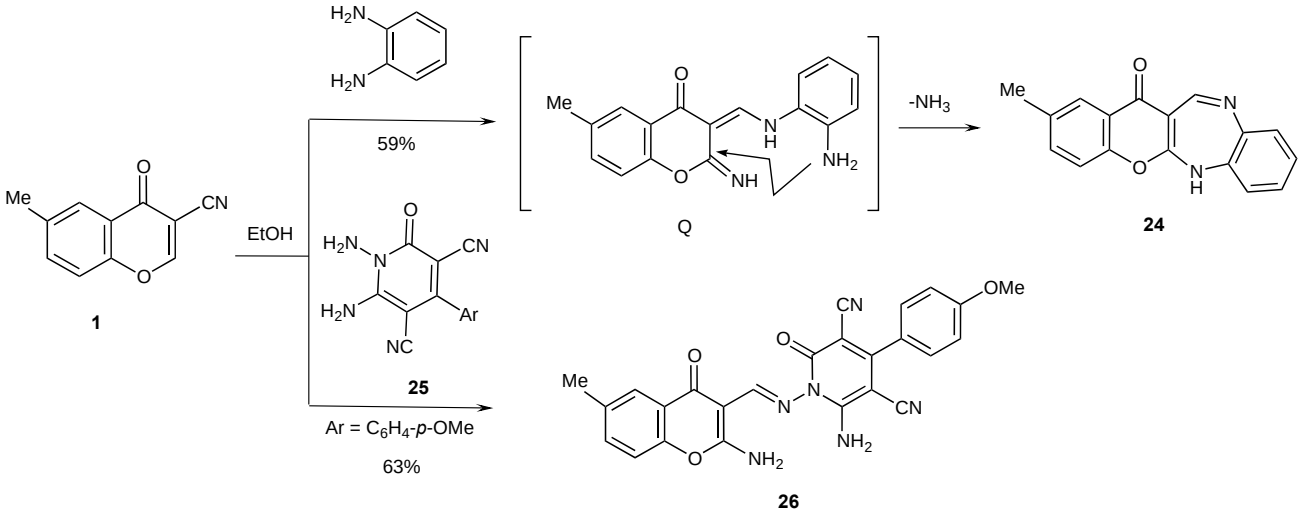
Next, the conversion of carbonitrile **1** into chromeno[4,3-*d*]pyrimidines **22** and **23**, was achieved through the ring opening/ring closure (RORC) reactions of carbonitrile **1** with guanidine hydrochloride and cyanoguanidine in ethanolic potassium hydroxide solution (Scheme 11). The IR spectra of compounds **22** and **23** revealed characteristic absorption bands attributed to $C=O_{\alpha\text{-pyrone}}$ at 1720 and 1695 cm^{-1}, respectively. Their ^1H NMR spectra showed characteristic singlet attributed to $H\text{-}4_{pyrimidine}$ at δ 8.94. Structures of compounds **22** and **23** were deduced from their mass spectrum which revealed their molecular ion peaks at *m/z* 227 (base peak) and 252 (92%), respectively.



Scheme 11

After that, carbonitrile **1** was allowed to react with some 1,4-binucleophiles. Reaction of carbonitrile **1** with *o*-phenylenediamine in boiling ethanol afforded chromeno[2,3-*b*][1,5]benzodiazepine **24** as shown in Scheme 12. The reaction may proceed *via* intermediate **Q** followed by an intamolecular cyclization with loss of ammonia molecule. The IR spectrum of compound **24** showed characteristic absorption bands assigned to NH, $C=O_{\gamma\text{-pyrone}}$ and C=N at 3303, 1642 and 1614 cm^{-1}, respectively. Its ^1H NMR spectrum showed characteristic singlet attributed to CH=N at δ 9.35, in addition to an exchangeable signal

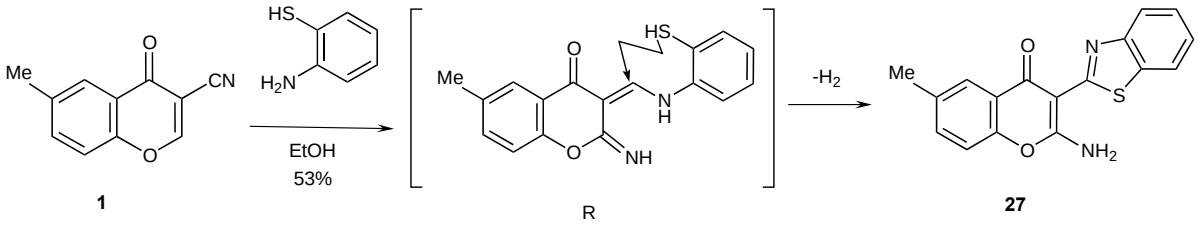
attributed to NH proton at δ 12.62. Structure of compound **24** was further deduced from its mass spectrum which revealed the molecular ion peak, as the base peak, at *m/z* 276 and confirms the suggested structure.



Scheme 12

On the other hand, reaction of carbonitrile **1** with 1,6-diamino-4-(4-methoxyphenyl)-2-oxo-1,2-dihydropyridine-3,5-dicarbonitrile (**25**)[22] in boiling ethanol afforded the Schiff base **26** (Scheme 12). The IR spectrum of compound **26** showed absorption bands at 3458, 3396, 3305, 3150 ($2NH_2$), 2218 (2C≡N), 1671 ($C=O_{\gamma\text{-pyrone}}$ and $C=O_{pyridone}$) and 1612 cm^{-1} (C=N). Its ^1H NMR spectrum showed characteristic singlet attributed to H-5 and CH=N at δ 7.79 and 10.05, respectively, in addition to an exchangeable signal attributed to NH_2 and 2NH protons at δ 8.39, 9.49 and 9.55.

Finally, reaction of carbonitrile **1** with *o*-aminothiophenol in boiling ethanol gave 2-amino-3-(1,3-benzothiazol-2-yl)-6-methylchromone (**27**), *via* the nonisolable intermediate **R** followed by cycloaddition of SH group onto the azomethine function with concomitant dehydrogenation, under the reaction conditions (Scheme 13). The IR spectrum of compound **27** showed characteristic absorption bands at 3447, 3290 (NH_2), 1654 ($C=O_{\gamma\text{-pyrone}}$) and 1613 cm^{-1} (C=N). The mass spectrum of compound **27** did not record the molecular ion peak, but the molecule splits into two parts corresponding to benzothiazole fragment, as the base peak at *m/z* 135, and 2-amino-6-methylchromone fragment at *m/z* 175, with high relative intensity (91%).



Scheme 13

EXPERIMENTAL

General: Melting points were determined on a digital Stuart SMP3 apparatus. Infrared spectra were measured on FTIR Nicolet IS10 spectrophotometer (cm^{-1}), using KBr disks. ^{1}H NMR (300 MHz) and ^{13}C NMR (75 MHz) spectra were measured on Mercury-300BB (300 MHz), using DMSO-d_6 as a solvent and TMS (δ) as the internal standard. Mass spectra were obtained using GC-2010 Shimadzu Gas chromatography instrument mass spectrometer (70 eV). Elemental microanalyses were performed on a Perkin–Elmer CHN-2400 analyzer. 6-Methylchromone-3-carbonitrile (**1**) and 2-amino-6-methyl-chromone-3-carboxaldehyde (**8**) were prepared according to the published methods.[23]

8-Methylchromeno[4,3-*c*]pyrazol-4(1*H*)-one (2). ***Method A:*** A mixture of carbonitrile **1** (0.55 g, 3 mmol) and hydrazine hydrate (0.15 g, 3 mmol) in acetic acid (10 mL) was heated under reflux for 2 h. After cooling, the reaction mixture was poured onto crushed ice. The solid so formed was filtered and crystallized from EtOH/H_2O to give compound **2** as white crystals. mp 186-187 ºC, yield (0.34 g, 57%).
Method B: A mixture of carbonitrile **1** (0.55 g, 3 mmol) and isonicotinic acid hydrazide or *S*-benzyl dithiocarbazate (3 mmol) in acetic acid (10 mL) was heated under reflux for 4 h. After cooling, the reaction mixture was poured onto crushed ice (~20 g). The solid so formed was filtered and crystallized from EtOH/H_2O to give compound **2** as white crystals, mp 186-187 ºC, yield (45-48%). IR (KBr, cm^{-1}): 3192 (NH), 3034 ($CH_{arom.}$), 2919 ($CH_{aliph.}$), 1706 ($C=O_{\alpha\text{-pyrone}}$), 1632 (C=N), 1583 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.32 (s, 3H, CH_3), 7.24 (d, 1H, J = 7.8 Hz, H-6), 7.29 (d, 1H, J = 7.8 Hz, H-7), 7.73 (s, 1H, H-9), 8.42 (s, 1H, H-3), 14.20 (bs, 1H, NH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 20.9, 114.6, 118.9, 122.4, 123.6, 124.9, 136.3, 145.7, 154.3, 158.4, 175.1. Mass spectrum (*m/z*, *I*%): 200 (100), 171 (17), 144 (15), 115 (16), 89 (10), 77 (6), 63 (7). Anal. Calcd for $C_{11}H_8N_2O_2$ (200.19): C, 66.00; H, 4.03; N, 13.99%. Found: C, 65.91; H, 4.01; N, 13.79%.

2-Amino-3-[({4-[(2-hydroxy-5-methylphenyl)carbonyl]-1*H*-pyrazol-3-yl}imino)methyl]-6-methyl-chromone (3). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and hydrazine hydrate (0.15 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 2 h. The yellow crystals obtained during heating were filtered and crystallized from DMF/EtOH to give compound **3** as yellow crystals. mp >300 ºC, yield (0.33 g, 55%). IR (KBr, cm^{-1}): 3390, 3224, 3090 (NH_2, NH, OH), 1652 ($C=O_{\gamma\text{-pyrone}}$), 1609 ($C=O_{benzoyl}$ and C=N), 1559 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.08 (s, 3H, CH_3), 2.39 (s, 3H, CH_3), 6.84 (d, 1H, J = 7.5 Hz, Ar-H), 7.05 (s, 1H, Ar-H), 7.10 (d, 1H, J = 8.7 Hz, Ar-H), 7.21 (bs, 2H, NH_2 exchangeable with D_2O), 7.29 (d, 1H, J = 8.1 Hz, H-$8_{chromone}$), 7.48 (d, 1H, J = 8.4 Hz, H-$7_{chromone}$), 7.78 (s, 1H, H-$5_{pyrazole}$), 8.06 (s, 1H, H-$5_{chromone}$), 8.76 (s, 1H, CH=N), 9.04 (bs, 1H, NH exchangeable with D_2O). Mass spectrum (*m/z*, *I*%): 402 (16), 386 (13), 367 (6), 217 (19), 201 (72), 185 (20), 170 (18), 135 (100), 115 (15), 106 (28), 91 (16), 77 (39), 65 (11). Anal. Calcd for $C_{22}H_{18}N_4O_4$ (402.40): C, 65.66; H, 4.51; N, 13.92%.

Found: C, 65.26; H, 4.31; N, 13.77%.

***N*'-[(2-Amino-6-methylchromon-3-yl)methylidene]-2-cyanoacetohydrazide (4).** A mixture of carbonitrile **1** (0.55 g, 3 mmol) and cyanoacetohydrazide (0.30 g, 3 mmol) in EtOH (15 mL) was heated under reflux for 2 h. The pale yellow crystals obtained during heating were filtered and crystallized from DMF/EtOH to give compound **4** as yellow crystals, mp >300 ºC, yield (0.52 g, 61%). IR (KBr, cm^{-1}): 3284, 3196, 3113 (NH_2, NH), 3063 ($CH_{arom.}$), 2958, 2921 ($CH_{aliph.}$), 2254 (C≡N), 1680 ($C=O_{amide}$), 1636 ($C=O_{\gamma\text{-pyrone}}$), 1616 (C=N), 1571 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.38 (s, 3H, CH_3), 4.22 (s, 2H, CH_2), 7.30 (d, 1H, *J* = 8.7 Hz, H-8), 7.47 (d, 1H, *J* = 8.7 Hz, H-7), 7.78 (s, 1H, H-5), 8.61 (s, 1H, CH=N), 9.22 (bs, 1H, NH exchangeable with D_2O), 9.32 (bs, 1H, NH exchangeable with D_2O), 11.69 (bs, 1H, NH exchangeable with D_2O). Anal. Calcd for $C_{14}H_{12}N_4O_3$ (284.27): C, 59.15; H, 4.25; N, 19.71%. Found: C, 59.01; H, 4.13; N, 19.55%.

***N*'-[(2-Amino-6-methylchromon-3-yl)methylidene]pyridine-4-carbohydrazide (5).** A mixture of carbonitrile **1** (0.55 g, 3 mmol) and isonicotinic acid hydrazide (0.41 g, 3 mmol) in EtOH (15 mL) was heated under reflux for 2 h. The yellow crystals obtained during heating were filtered and crystallized from DMF/H_2O to give compound **5** as yellow crystals, mp 304-305 ºC, yield (0.58 g, 60%). IR (KBr, cm^{-1}): 3395, 3295, 3137 (NH_2, NH), 1652 ($C=O_{amide}$ and $C=O_{\gamma\text{-pyrone}}$), 1604 (C=N), 1588 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.41 (s, 3H, CH_3), 7.35 (d, 1H, *J* = 8.4 Hz, H-8), 7.51 (d, 1H, *J* = 8.7 Hz, H-7), 7.85 (d, 2H, *J* = 5.7 Hz, H-$3_{pyridine}$ and H-$5_{pyridine}$), 8.78 (d, 2H, *J* = 6.3 Hz, H-$2_{pyridine}$ and H-$6_{pyridine}$), 8.95 (s, 1H, CH=N), 9.22 (bs, 1H, NH exchangeable with D_2O), 9.60 (bs, 1H, NH exchangeable with D_2O), 12.03 (bs, 1H, NH exchangeable with D_2O). Mass spectrum (*m/z*, *I*%): 322 (9), 218 (10), 201 (100), 188 (20), 135 (53), 123 (15), 106 (24), 91 (9), 78 (40), 64 (7). Anal. Calcd for $C_{17}H_{14}N_4O_3$ (322.32): C, 63.35; H, 4.38; N, 17.38%. Found: C, 63.14; H, 4.25; N, 17.09%.

Benzyl 5-amino-4-[(2-hydroxy-5-methylphenyl)carbonyl]-1*H*-pyrazole-1-carbodithioate (6). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and *S*-benzyl dithiocarbazate (0.59 g, 3 mmol) in EtOH (20 mL) was heated under reflux for 30 min. The white crystals obtained during heating were filtered and crystallized from EtOH to give compound **6** as white crystals, mp 172 ºC, yield (0.63 g, 55%). IR (KBr, cm^{-1}): 3405, 3282 (OH, NH_2), 3022 ($CH_{arom.}$), 2920, 2870 ($CH_{aliph.}$), 1634 ($C=O_{benzoyl}$), 1615 (C=N), 1577 (C=C), 1282 (C=S). ^{1}H NMR (DMSO-d_6, δ): 2.25 (s, 3H, CH_3), 4.48 (s, 2H, CH_2), 6.86 (d, 1H, Ar-H), 7.17-7.22 (m, 2H, Ar-H), 7.28-7.31 (m, 2H, Ar-H), 7.44 (s, 1H, H-$3_{pyrazole}$), 7.46-7.48 (m, 2H, Ar-H), 8.90 (bs, 2H, NH_2 exchangeable with D_2O), 10.13 (bs, 1H, OH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 20.7, 44.2, 113.7, 118.8, 121.1, 125.6, 130.5, 135.2, 137.6, 138.7, 145.7, 149.2, 153.6, 159.7, 164.5, 168.9, 176.6, 199.1. Mass spectrum (*m/z*, *I*%): 383 (26), 307 (6), 244 (13), 203 (13), 135 (27), 107 (6), 105 (3), 91 (100), 77 (17). Anal. Calcd for $C_{19}H_{17}N_3O_2S_2$ (383.49): C, 59.51; H, 4.47; N, 10.96; S, 16.72%. Found: C, 59.45; H, 4.36; N, 10.71; S, 16.39%.

Benzyl 2-[(2-amino-6-methylchromon-3-yl)methylidene]hydrazine-carbodithioate (7). A mixture of 2-amino-6-methylchromone-3-carboxaldehyde (**8**) (0.41 g, 2 mmol) and *S*-benzyl dithiocarbazate (0.40 g, 2 mmol) in EtOH (10 mL) was heated under reflux for 1 h. The yellow crystals obtained during heating were filtered and crystallized from DMF/EtOH to give compound **7** as yellow crystals, mp 299-300 ºC, yield (0.56 g, 73%). IR (KBr, cm^{-1}): 3442, 3270, 3126 (NH_2, NH), 2963, 2925 ($CH_{aliph.}$), 1641 ($C=O_{\gamma\text{-pyrone}}$), 1607 (C=N), 1573 (C=C), 1287 (C=S). ^{1}H NMR (DMSO-d_6, δ): 2.39 (s, 3H, CH_3), 4.55 (s, 2H, CH_2), 7.21-7.48 (m, 6H, Ar-H), 7.51 (d, 1H, *J* = 8.4 Hz, Ar-H), 7.79 (s, 1H, H-5), 8.69 (bs, 1H, NH exchangeable with D_2O), 8.77 (s, 1H, CH=N), 9.42 (bs, 1H, NH exchangeable with D_2O), 13.35 (bs, 1H, NH exchangeable with D_2O). Mass spectrum (*m/z*, *I*%): 383 (40), 343 (7), 307 (7), 244 (9), 217 (3), 203 (8), 173 (11), 135 (20), 91 (100), 77 (11), 65 (12). Anal. Calcd for $C_{19}H_{17}N_3O_2S_2$ (383.49): C, 59.51; H, 4.47; N, 10.96; S, 16.72%. Found: C, 59.25; H, 4.21; N, 10.68; S, 16.47%.

3-Hydroxy-9-methylchromeno[4,3-*b*]pyrazolo[4,3-*e*]pyridin-5(1*H*)-one (9). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and cyanoacetohydrazide (0.30 g, 3 mmol) in AcOH (10 mL) was heated under reflux for 2 h. The solid obtained after cooling was filtered and crystallized from AcOH/H_2O to give compound **9** as pale yellow crystals, mp >300 ºC, yield (0.52 g, 65%). IR (KBr, cm^{-1}): 3196 (OH and NH), 2920 ($CH_{aliph.}$), 1694 ($C=O_{\alpha\text{-pyrone}}$), 1608 (C=N), 1588 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.38 (s, 3H, CH_3), 7.23 (d, 1H, *J* = 7.5 Hz, H-7), 7.38 (d, 1H, *J* = 8.1 Hz, H-8), 8.12 (s, 1H, H-10), 8.85 (s, 1H, $H\text{-}4_{pyridine}$), 11.59 (bs, 1H, NH exchangeable with D_2O), 12.79 (bs, 1H, OH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 20.3, 104.6, 117.2, 125.9, 128.0, 128.7, 129.0, 129.8, 133.5, 135.0, 145.4, 154.0, 188.9, 200.9. Mass spectrum (*m/z*, *I*%): 267 (100), 239 (18), 210 (10), 195 (3), 154 (6), 127 (9), 105 (5), 91 (4), 77 (13), 64 (8). Anal. Calcd for $C_{14}H_9N_3O_3$ (267.25): C, 62.92; H, 3.39; N, 15.72%. Found: C, 62.85; H, 3.28; N, 15.60%.

***N*'-Acetyl-2-amino-7-methyl-5-oxo-5*H*-chromeno[2,3-*b*]pyridine-3-carbohydrazide (10).** A mixture of carbonitrile **1** (0.55 g, 3 mmol) and *N*'-acetyl-2-cyanoacetohydrazide (0.43 g, 3 mmol) in absolute EtOH (20 mL) containing piperidine (0.2 mL) was heated under reflux for 30 min. The yellow crystals obtained during heating were filtered and crystallized from DMF/H_2O to give compound **10** as white crystals, mp >300 ºC, yield (0.69 g, 70%). IR (KBr, cm^{-1}): 3226 (br, NH_2, 2NH), 1652, 1625 ($C=O_{acetyl}$ and $2C=O_{amide}$), 1610 (C=N), 1567 (C=C). ^{1}H NMR (DMSO-d_6, δ): 1.89 (s, 3H, CH_3), 2.37 (s, 3H, CH_3), 7.31 (d, 1H, *J* = 8.0 Hz, H-9), 7.47 (d, 1H, *J* = 8.4 Hz, H-8), 7.77 (s, 1H, H-6), 8.56 (s, 1H, H-4), 9.02 (bs, 1H, NH exchangeable with D_2O), 9.49 (bs, 1H, NH exchangeable with D_2O), 10.95 (bs, 1H, NH exchangeable with D_2O), 11.28 (bs, 1H, NH exchangeable with D_2O). Mass spectrum (*m/z*, *I*%): 326 (2), 313 (2), 259 (14), 218 (6), 201 (100), 188 (14), 135 (40), 107 (10), 91 (6), 77 (13). Anal. Calcd for $C_{16}H_{14}N_4O_4$ (326.31): C, 58.89; H, 4.32; N, 17.17%. Found: C, 58.64; H, 4.30; N, 17.00%.

2-Amino-5-cyano-*N*'-[(3,4-dimethoxyphenyl)methylidene]-8-methyl-6-oxo-6*H*-1-benzoxocine-3-

carbohydrazide (12). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and *N*`-[(3,4-dimethoxyphenyl)-methylidene]-2-cyanoacetohydrazide (**11**) (0.62 g, 3 mmol) in absolute EtOH (20 mL) containing DBU (0.1 mL) was heated under reflux for 45 min. The yellow crystals obtained during heating were filtered and crystallized from DMF/EtOH to give compound **12** as yellow crystals, mp >300 ºC, yield (0.68 g, 52%). IR (KBr, cm^{-1}): 3384 (br, NH_2, NH), 2930, 2863 ($CH_{aliph.}$), 2231 (C≡N), 1669 ($C=O_{amide}$ and $C=O_{oxocine}$), 1615 (C=N), 1590 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.25 (s, 3H, CH_3), 3.82 (s, 3H, OCH_3), 3.86 (s, 3H, OCH_3), 7.18 (d, 1H, *J* = 8.7, Ar-H), 7.23 (d, 1H, *J* = 8.7, Ar-H), 7.43 (d, 1H, *J* = 8.4, Ar-H), 7.58 (d, 1H, *J* = 7.4, Ar-H), 7.69 (s, 1H, H-7), 8.59 (bs, 2H, NH_2 exchangeable with D_2O), 8.66 (s, 1H, Ar-H), 8.77 (s, 1H, CH=N), 9.84 (bs, 1H, NH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 21.4, 50.6 (C-5), 61.6, 62.2, 105.3, 106.2, 110.9, 114.7, 117.8, 119.8, 121.8, 129.9, 144.5, 146.4, 147.0, 147.6, 148.3, 149.0, 154.6, 165.1, 172.4, 175.4, 196.8. Anal. Calcd for $C_{23}H_{20}N_4O_5$ (432.43): C, 63.88; H, 4.66; N, 12.96%. Found: C, 63.78; H, 4.50; N, 12.80%.

2-Amino-*N*'-[(3,4-dimethoxyphenyl)methylidene]-7-methyl-5-oxo-5*H*-chromeno[2,3-*b*]pyridine-3-carbohydrazide (13). A mixture of 2-amino-6-methylchromone-3-carboxaldehyde (**8**) (0.41 g, 2 mmol) and *N*'-[(3,4-dimethoxyphenyl)methylidene]-2-cyanoacetohydrazide (**11**) (0.42 g, 2 mmol) in absolute EtOH (20 mL) containing piperidine (0.2 mL) was heated under reflux for 30 min. The solid obtained during heating was filtered and crystallized from DMF/H_2O to give compound **13** as yellow crystals, mp >300 ºC, yield (0.61 g, 71%). IR (KBr, cm^{-1}): 3399, 3289, 3154 (NH_2, NH), 2914, 2858 ($CH_{aliph.}$), 1671 ($C=O_{amide}$ and $C=O_{\gamma\text{-pyrone}}$) and 1608 (C=N), 1582 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.39 (s, 3H, CH_3), 3.75 (s, 3H, OCH_3), 4.23 (s, 3H, OCH_3), 7.30-7.35 (m, 3H, Ar-H), 7.48-7.51 (m, 2H, Ar-H), 7.78 (s, 1H, H-6), 8.50 (s, 1H, CH=N), 8.61 (s, 1H, $H\text{-}4_{pyridine}$), 9.32 (bs, 2H, NH_2 exchangeable with D_2O), 11.44 (bs, 1H, NH exchangeable with D_2O). Mass spectrum (*m/z*, *I*%): 432 (29), 416 (20), 401 (16), 385 (22), 370 (45), 341 (17), 328 (31), 313 (17), 286 (15), 253 (95), 225 (15), 201 (35), 185 (22), 175 (18), 151 (55), 135 (100), 105 (31), 91 (30), 77 (84), 65 (32). Anal. Calcd for $C_{23}H_{20}N_4O_5$ (432.43): C, 63.88; H, 4.66; N, 12.96%. Found: C, 63.50; H, 4.30; N, 12.70%.

2-Amino-3-{(2-hydroxybenzylidene)hydrazinylidene}methyl}-6-methylchromone (16). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and salicylaldehyde hydrazone (**14**) (0.41 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 2 h. The solid obtained after cooling was filtered and crystallized from AcOH/H_2O to give compound **16** as white crystals, mp >300 ºC, yield (0.66 g, 69%). IR (KBr, cm^{-1}): 3222 (br, NH_2 and NH), 3079 ($CH_{arom.}$), 2914 ($CH_{aliph.}$), 1651 ($C=O_{\gamma\text{-pyrone}}$), 1625 (C=N), 1566 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.39 (s, 3H, CH_3), 6.94-6.97 (m, 3H, Ar-H), 7.33-7.41 (m, 2H, Ar-H), 7.66 (d, 1H, *J* = 8.4 Hz, H-7), 7.81 (s, 1H, H-5), 8.98 (s, 1H, CH=N), 9.02 (s, 1H, CH=N), 9.30 (bs, 1H, NH exchangeable with D_2O), 9.45 (bs, 1H, NH exchangeable with D_2O), 11.08 (bs, 1H, NH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 20.8, 92.7 (C-3), 116.9, 118.6, 118.8, 120.0, 121.5,

125.3, 131.2, 132.9, 133.6, 134.8, 135.0, 151.4, 158.5, 158.8, 161.4, 163.2. Mass spectrum (*m/z*, *I*%): 321 (36), 285 (7), 236 (6), 201 (100), 185 (5), 175 (6), 147 (9), 135 (41), 121 (20), 91 (20), 77 (29), 65 (23). Anal. Calcd for $C_{18}H_{15}N_3O_3$ (321.33): C, 67.28; H, 4.71; N, 13.08%. Found: C, 66.80; H, 4.55; N, 12.75%.

3-{[(2-Amino-6-methylchromon-3-yl)methylidene]hydrazinylidene}-1,3-dihydro-2*H*-indol-2-one (17). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and isatin hydrazone (**15**) (0.45 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 2 h. The yellow crystals obtained during heating were filtered and crystallized from DMF to give compound **17** as yellow crystals, mp >300 ºC, yield (0.70 g, 67%). IR (KBr, cm^{-1}): 3227 (br, NH_2 and NH), 3070 ($CH_{arom.}$), 1716 ($C{=}O_{isatine}$), 1652 ($C{=}O_{\gamma\text{-pyrone}}$), 1609 (C=N), 1566 (C=C). ^{1}H NMR (DMSO, δ): 2.36 (s, 3H, CH_3), 7.03 (d, 1H, *J* = 8.4 Hz, Ar-H), 7.21-7.30 (m, 4H, Ar-H), 7.47 (t, 1H, *J* = 6.4 Hz, Ar-H), 7.70 (s, 1H, H-5), 8.85 (bs, 2H, NH_2 exchangeable with D_2O), 8.99 (s, 1H, CH=N), 10.42 (bs, 1H, NH exchangeable with D_2O). Anal. Calcd for $C_{19}H_{14}N_4O_3$ (346.34): C, 65.89; H, 4.07; N, 16.18%. Found: C, 65.66; H, 4.04; N, 15.90%.

1-{[(2-Amino-6-methylchromon-3-yl)methylidene]amino}-4,6-dimethyl-2-oxo-1,2-dihydropyridine-3-carbonitrile (20). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and 1-amino-4,6-dimethyl-2-oxo-1,2-dihydropyridine-3-carbonitrile (**18**) (0.49 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 2 h. The yellow crystals obtained after cooling were filtered and crystallized from DMF/EtOH to give compound **20** as yellow crystals, mp >300 ºC, yield (0.73 g, 70%). IR (KBr, cm^{-1}): 3250, 3130 (NH_2), 3011 ($CH_{arom.}$), 2928 ($CH_{aliph.}$), 2213 (C≡N), 1655 ($C{=}O_{\gamma\text{-pyrone}}$), 1614 (C=N), 1578 (C=C). ^{1}H NMR (DMSO, δ): 2.29 (s, 3H, CH_3), 2.33 (s, 3H, CH_3), 2.42 (s, 3H, CH_3), 6.03 (s, 1H, $H\text{-}4_{pyridine}$), 7.33 (d, 1H, *J* = 8.4 Hz, H-8), 7.53 (d, 1H, *J* = 8.4 Hz, H-7), 7.80 (s, 1H, H-5), 8.84 (s, 1H, CH=N), 9.03 (bs, 1H, NH exchangeable with D_2O), 9.12 (bs, 1H, NH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 19.0, 19.6, 20.6, 92.7 (C-3), 108.2, 110.0, 113.2, 115.5, 117.1, 118.9, 121.8, 125.2, 128.4, 135.3, 144.6, 158.4, 162.2, 171.1, 188.4. Anal. Calcd for $C_{19}H_{16}N_4O_3$ (348.35): C, 65.51; H, 4.63; N, 16.08%. Found: C, 65.29; H, 4.41; N, 15.87%.

3-{[(2-Amino-6-methylchromon-3-yl)methylidene]amino}-2-phenylquinazolin-4(3*H*)-one (21). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and 3-amino-2-phenylquinazolin-4(3*H*)-one (**19**) (0.71 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 2 h. The yellow crystals obtained during heating were filtered and crystallized from MeOH to give compound **21** as yellow crystals, mp >300 ºC, yield (0.74 g, 58%). IR (KBr, cm^{-1}): 3293, 3219 (NH_2), 1669 ($C{=}O_{quinazoline}$), 1652 ($C{=}O_{\gamma\text{-pyrone}}$), 1607 (C=N), 1559 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.39 (s, 3H, CH_3), 7.12-7.27 (m, 2H, Ar-H), 7.34 (d, 1H, Ar-H), 7.40-7.45 (m, 3H, Ar-H), 7.58-7.61 (m, 4H, Ar-H), 7.83 (d, 1H, *J* = 8.4 Hz, Ar-H), 7.89 (bs, 2H, NH_2 exchangeable with D_2O), 8.06 (s, 1H, H-5), 8.97 (s, 1H, CH=N). ^{13}C NMR (DMSO-d_6, δ): 20.7, 91.3 (C-3), 105.4, 115.8, 116.5, 116.9, 117.0, 117.6, 118.3, 122.2, 123.1, 124.5, 125.6, 129.1, 129.2, 133.9,

134.8, 136.5, 152.8, 153.2, 161.0, 162.4, 165.6, 166.0, 174.4. Anal. Calcd for $C_{25}H_{18}N_4O_3$ (422.44): C, 71.08; H, 4.29; N, 13.26%. Found: C, 70.70; H, 4.10; N, 13.00%.

2-Amino-9-methyl-5*H*-chromeno[4,3-*d*]pyrimidin-5-one (22). To a solution of carbonitrile **1** (0.55 g, 3 mmol) in absolute EtOH (15 mL), guanidine hydrochloride (0.29 g, 3 mmol) in aqueous potassium hydroxide (5%, 15 mL) was added. The reaction mixture was heated under reflux for 2 h. After cooling, the reaction mixture was poured onto crushed ice (~ 20 g) and neutralized with conc. HCl. The solid so formed was filtered and crystallized from AcOH/H_2O to give compound **22** as yellow crystals, mp >300 ºC, yield (0.49 g, 73%). IR (KBr, cm^{-1}): 3381, 3329 (NH_2), 2920 ($CH_{aliph.}$), 1720 ($C{=}O_{\alpha\text{-pyrone}}$), 1659 (C=N), 1610 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.39 (s, 3H, CH_3), 7.26 (d, 1H, *J* = 8.4 Hz, H-7), 7.48 (d, 1H, *J* = 8.8 Hz, H-8), 7.90 (bs, 2H, NH_2 exchangeable with D_2O), 8.05 (s, 1H, H-10), 8.94 (s, 1H, H-4). Mass spectrum (*m/z*, *I*%): 227 (100), 199 (25), 185 (10), 170 (6), 157 (8), 129 (7), 111 (6), 97 (9), 77 (7). Anal. Calcd for $C_{12}H_9N_3O_2$ (227.22): C, 63.43; H, 3.99; N, 18.49%. Found: C, 63.20; H, 3.70; N, 18.40%.

(9-Methyl-5-oxo-5*H*-chromeno[4,3-*d*]pyrimidin-2-yl)cyanamide (23). To a solution of carbonitrile **1** (0.55 g, 3 mmol) in absolute EtOH (15 mL), cyanoguanidine (0.26 g, 3 mmol) in aqueous potassium hydroxide (5%, 15 mL) was added. The reaction mixture was heated under reflux for 2 h. After cooling, the reaction mixture was poured onto crushed ice and neutralized with conc. HCl. The solid so formed was filtered and crystallized from AcOH/H_2O to give compound **23** as yellow crystals, mp >300 ºC, yield (0.52 g, 67%). IR (KBr, cm^{-1}): 3307 (NH), 2926 ($CH_{aliph.}$), 2201 (C≡N), 1695 ($C{=}O_{\alpha\text{-pyrone}}$), 1652 (C=N), 1610 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.37 (s, 3H, CH_3), 7.28 (d, 1H, *J* = 8.0 Hz, H-7), 7.50 (d, 1H, *J* = 8.0 Hz, H-8), 7.97 (s, 1H, H-10), 8.94 (s, 1H, H-4), 10.05 (bs, H, NH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 20.4, 106.5, 117.4, 121.7, 122.6, 128.2, 130.8, 131.8, 134.2, 135.4, 150.6, 157.3, 172.4. Mass spectrum (*m/z*, *I*%): 252 (92), 227 (40), 224 (23), 211 (6), 199 (15), 182 (13), 171 (6), 157 (11), 134 (100), 117 (10), 106 (41), 91 (11), 77 (33), 63 (13). Anal. Calcd for $C_{13}H_8N_4O_2$ (252.23): C, 61.90; H, 3.20; N, 22.21%. Found: C, 61.80; H, 3.15; N, 22.01%.

9-Methyl-7-oxo-7,13-dihydrochromeno[2,3-*b*][1,5]benzodiazepine (24). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and *o*-phenylenediamine (0.32 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 30 min. The solid obtained during heating was filtered and crystallized from DMF/EtOH to give compound **24** as yellow crystals, mp 256-257 ºC, yield (0.49 g, 59%). IR (KBr, cm^{-1}): 3303 (NH), 3048 ($CH_{arom.}$), 2915, 2880 ($CH_{aliph.}$), 1642 ($C{=}O_{\gamma\text{-pyrone}}$), 1614 (C=N), 1575 (C=C). ^{1}H NMR (DMSO-d_6, δ): 2.45 (s, 3H, CH_3), 7.18-7.24 (m, 2H, Ar-H), 7.63-7.72 (m, 4H, Ar-H), 8.05 (s, 1H, H-8), 9.35 (s, 1H, CH=N), 12.62 (bs, 1H, NH exchangeable with D_2O). ^{13}C NMR (DMSO-d_6, δ): 20.7, 113.7, 117.0, 118.7, 121.1, 122.2, 125.2, 125.6, 130.5, 135.2, 137.6, 138.7, 151.6, 153.6, 159.7, 164.5, 165.8. Mass spectrum (*m/z*, *I*%): 276 (100), 248 (5), 220 (15), 134 (4), 119 (17), 105 (8), 91 (15), 77 (11), 64 (10). Anal. Calcd for $C_{17}H_{12}N_2O_2$ (276.29): C, 73.90; H, 4.38; N, 10.14%. Found: C, 73.73; H, 4.21; N, 10.11%.

6-Amino-1-{[(2-amino-6-methylchromon-3-yl)methylidene]amino}-2-oxo-4-(4-methoxyphenyl)-1,2-dihydropyridine-3,5-dicarbonitrile (26). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and 1,6-diamino-4-(4-methoxyphenyl)-2-oxo-1,2-dihydropyridine-3,5-dicarbonitrile (**25**) (0.84 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 4 h. The yellow crystals obtained after cooling were filtered and crystallized from AcOH to give compound **26** as yellow crystals, mp 297-298 ºC, yield (0.88 g, 63%). IR (KBr, cm^{-1}): 3458, 3396, 3305, 3150 ($2NH_2$), 2218 (2C≡N), 1671 ($C=O_{\gamma\text{-pyrone}}$ and $C=O_{pyridone}$), 1612 (C=N), 1577 (C=C). ^{1}H NMR (DMSO, δ): 2.38 (s, 3H, CH_3), 3.82 (s, 3H, OCH_3), 7.07 (d, 2H, *J* = 8.8 Hz, Ar-H), 7.28 (d, 1H, *J* = 8.4 Hz, H-8), 7.43 (d, 2H, *J* = 8.8 Hz, Ar-H), 7.52 (d, 1H, *J* = 8.4 Hz, H-7), 7.79 (s, 1H, H-5), 8.39 (bs, 2H, NH_2 exchangeable with D_2O), 9.49 (bs, 1H, NH exchangeable with D_2O), 9.55 (bs, 1H, NH exchangeable with D_2O). 10.05 (s, 1H, CH=N). Mass spectrum (*m/z*, *I*%): 466 (2), 451 (3), 437 (3), 423 (4), 409 (3), 367 (6), 313 (12), 299 (6), 285 (6), 236 (7), 203 (21), 187 (12), 160 (34), 134 (22), 91 (9), 77 (29), 64 (9). Anal. Calcd for $C_{25}H_{18}N_6O_4$ (466.45): C, 64.37; H, 3.89; N, 18.02%. Found: C, 64.20; H, 3.65; N, 18.04%.

2-Amino-3-(1,3-benzothiazol-2-yl)-6-methylchromone (27). A mixture of carbonitrile **1** (0.55 g, 3 mmol) and *o*-aminothiophenol (0.38 g, 3 mmol) in absolute EtOH (20 mL) was heated under reflux for 30 min. The solid obtained during heating was filtered and crystallized from DMF/MeOH to give compound **27** as yellow crystals, mp 291-292 ºC, yield (0.49 g, 53%). IR (KBr, cm^{-1}): 3447, 3290 (NH_2), 3058 ($CH_{arom.}$), 2917 ($CH_{aliph.}$), 1654 ($C=O_{\gamma\text{-pyrone}}$), 1613 (C=N), 1557 (C=C). ^{1}H NMR (DMSO, δ): 2.37 (s, 3H, CH_3), 5.44 (bs, 2H, NH_2 exchangeable with D_2O), 6.44 (t, 1H, *J* = 7.2 Hz, Ar-H), 6.74 (d, 1H, *J* = 7.8 Hz, Ar-H), 7.01-7.12 (m, 2H, Ar-H), 7.26 (d, 1H, *J* = 8.4 Hz, Ar-H), 7.40 (d, 1H, *J* = 8.4 Hz, Ar-H), 7.77 (s, 1H, H-5). ^{13}C NMR (DMSO-d_6, δ): 20.8, 93.5 (C-3), 111.7, 113.6, 116.8, 118.5, 121.9, 125.0, 129.4, 129.6, 133.9, 134.5, 136.0, 145.8, 151.1, 162.0, 173.1. Mass spectrum (*m/z*, *I*%): 308 (M^+, not recorded), 175 (91), 135 (100), 106 (28), 91 (10), 77 (28), 63 (10). Anal. Calcd for $C_{17}H_{12}N_2O_2S$ (308.35): C, 66.22; H, 3.92; N, 9.08%. Found: C, 66.05; H, 3.78; N, 8.90%.

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