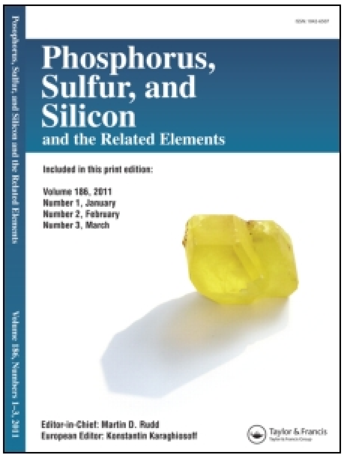

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NEW SYNTHETIC APPROACHES TO CONDENSED AND SPIRO COUMARINS: COUMARIN-3-THIOCARBOXAMIDE AS BUILDING BLOCK FOR THE SYNTHESIS OF CONDENSED AND SPIRO COUMARINS

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NEW SYNTHETIC APPROACHES TO CONDENSED AND SPIRO COUMARINS: COUMARIN-3-THIOCARBOXAMIDE AS BUILDING BLOCK FOR THE SYNTHESIS OF CONDENSED AND SPIRO COUMARINS

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Coumarin-3-thiocarboxamide **1** was reacted with malononitrile, cyanoacetamide or cyanothioacetamide to give the corresponding thiopyrano(3,4-c)coumarin-1-carbonitrile **2**. Also, compound **1** was reacted with a variety of active methylenes having an α-cyano or α-keto group to give thiopyranocoumarin derivatives **3–9**. The reaction of compound **1**with different ketene N,S-acetals, afforded the corresponding thiazino(5,4-c)coumarin derivatives **10,13** and **16**. On reacting compound **10** or **13** with malononitrile, spiro pyran-4,2′-thiazino(5,4-c)coumarin **11** or **14** were obtained, while the reaction of compound **16** with malononitrile gave spiro cyclobutene-1,2′-thiazino(5,4-c)coumarin derivative **17**. Treating of compounds **10, 13** or **16** with cyclohexylidenemalononitrile afforded spiro naphthyl-1,2′-thiazino(5,4-c) coumarin derivatives **12,15** or **18** respectively. Treatment of compound **1** with $CS_2$and malononitrile under PTC condition afforded 1,3-dithiano(5,4-c) coumarin derivative **19**, which in turn reacted with malononitrile or cyclohexylidenemalononitrile to afford spiro cyclobut-2-enyl-1,2′-(1,3)dithiano(5,4-c)coumarin **20** and spiro naphthyl-1,′2-(1,3)dithiano(5,4-c)coumarin **21** derivatives, respectively.

Keywords: Coumarin-3-thiocarboxamide; Thiopyrano-coumarins; Active methylenes; Spiro pyran-thiazino-coumarin Derivatives

INTRODUCTION

Fused coumarins comprise a very interesting class of compounds because of their significant antibacterial[1–5] and novobiocin[6,7] activities. As part of our studies aimed at developing simple and efficient syntheses of poly-

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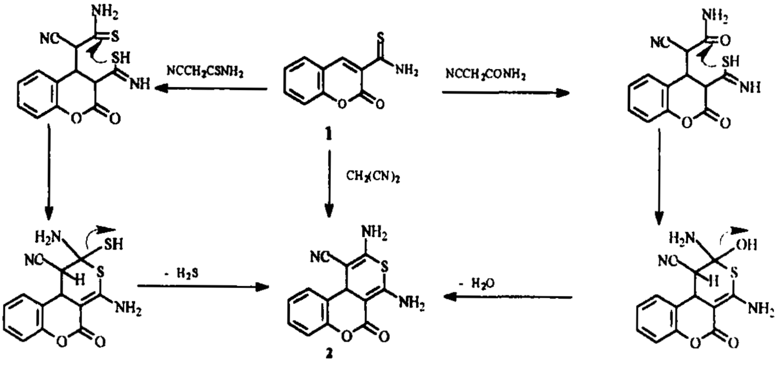
functional heterocycles from readily obtainable starting material[5], we have previously reported the synthesis of [pyrido]-coumarin derivatives via cycloaddition of active methylene compounds with coumarin-3-(4-aminosulfonyl)carbanilide derivatives[8]. This prompted us to use coumarin-3-thiocarboxamide **1** as a precursor for the synthesis of polyfused heterocyclic containing thiopyran, dithiapine, pyrazole, thiazine, and dithiane derivatives.

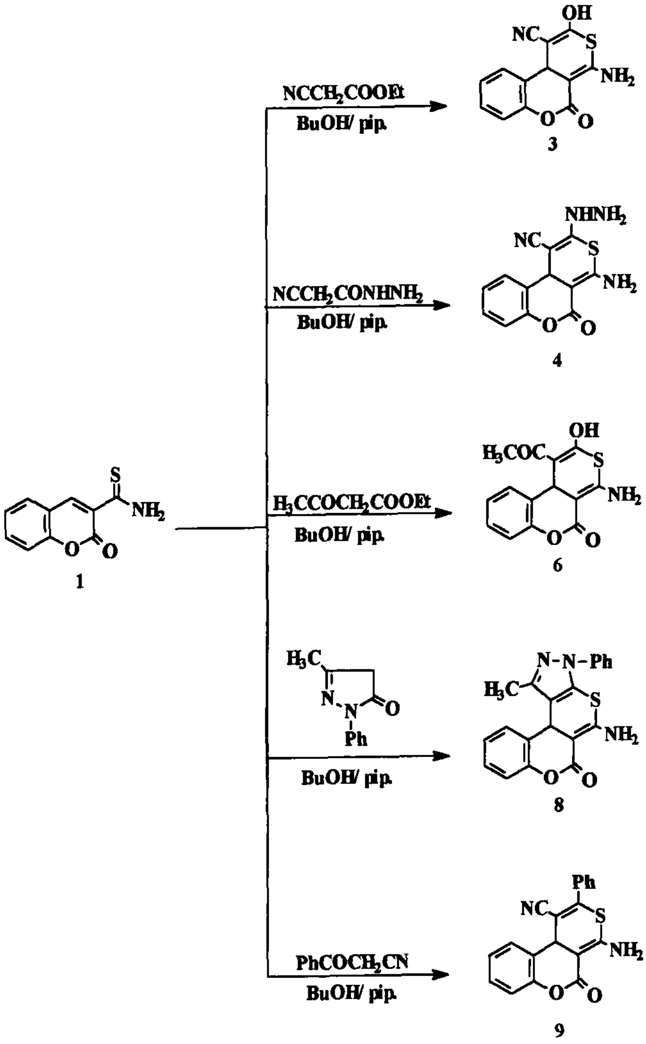
RESULTS AND DISCUSSION

In conjunction with our studies on the addition of active methylenes having α-cyano or α-keto group at the ethylenic double bond in heterocyclic synthesis[9–13], we report here, the synthesis of some new polyfused heterocyclic system containing coumarin derivatives starting with coumarin-3-thiocarboxamide **1**. Compound **1** was prepared by cyclocondesation of cyanothioacetamide with salicylaldehyde[14].

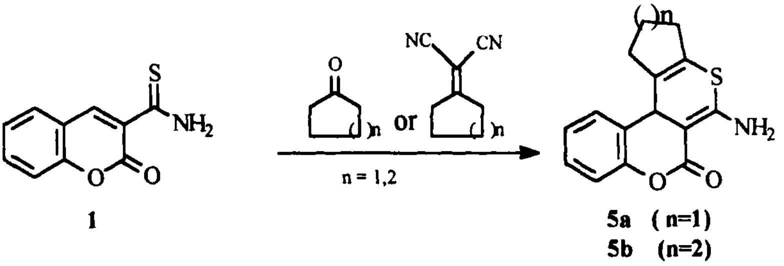
Compound **1** was then reacted with malononitrile, cyanoacetamide, and cyanothioacetamide in refluxing butanol containing a catalytic amount of piperidine, where the same product 2,4-diamino-[10b]-hydrothiopyrano(3,4-c)coumarin-1-carbonitrile **2** was precipitated.



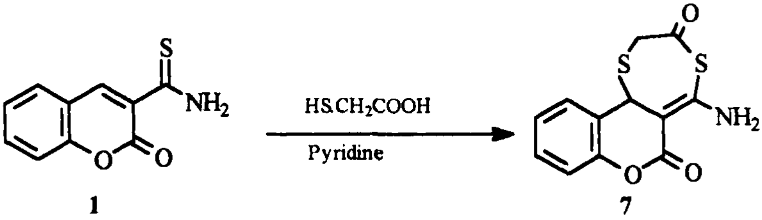
Treatment of compound **1** with a variety of compounds having active methylene groups including, ethyl cyanoacetate, cyanoaceto-hydrazide, ethyl acetoacetate, 1-phenyl-3-methylpyrazol-5-one and benzoyl acetonitrile in refluxing butanol containing piperidine as a base, where, in each reaction a nucleophilic addition of the formed carbanion at the ethylenic bond took place. It was followed by cyclization to afford the desired thiopyranocoumarin heterocycles namely: 4-amino-[10b]-hydro-3-hydroxythiopyrano(3,4-c)-coumarin-1-carbonitrile **3**, 4-amino-2-hydrazino-[10b]-hydrothiopyrano-(3,4-c)coumarin-1-carbonitrile **4**, 1-acetyl-4-amino-[10b]-hydro-2-hydroxythiopyrano(3,4-c)coumarin **6**, 5-amino-[11b]-hydro-1-methyl-3-phenylpyrazolo(3,4-b)thiopyrano(3,4-c)-coumarin **8** and 4-amino-2-phenyl-[10b]-hydrothiopyrano(3,4-c)-coumarin-1-carbonitrile **9**.



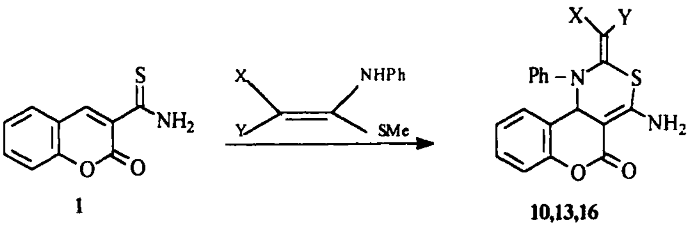
Under the same condition, compound **1** was reacted with cyclopentanone or cyclopentylidenemalononitrile to give 5-amino-2, 3,[11b]-trihydrocyclopenta(1,2-b)thiopyrano(3,4-c)coumarin **5a**, while the reaction of compound **1** with cyclohexanone or cyclohexylidenemalononitrile to afford 6-amino-1,2,3,4,[12b]-tetrahydrobenzo(1,2-b)-thiopyrano-(3,4-c) coumarin **5b**.



On reacting compound **1** with thioglycolic acid in refluxing pyridine for about 4 hrs followed by neutralization with dilute HCl, vielded 5-amino-2,[11b]-dihydro-3H-1,4-dithiabeno(3,4-c)coumarin-3-one **7**.

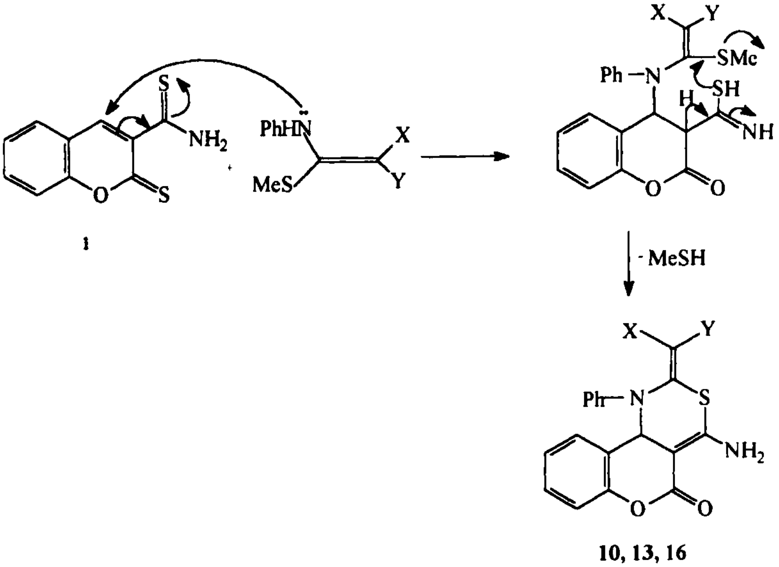


The reaction of compound **1** with ketene N, S-acetal derivatives namely: 3-acetyl-4-methylthio-4-phenylaminobut-3-en-2-one, ethyl 2-acetyl-3-methylthio-3-phenylaminoacrylate and ethyl 2-cyano-3-methyl-thio-3-phenylaminocarboxylate gave the corresponding, 4-amino-2-(3,3-diacetylmethylene)-N-phenyl-[10b]-hydro-2H-thiazino(5,4-c)coumarin **10**, 4-amino-2-(2-acetyl-2-carbethoxymethylene)-N-phenyl-[10b]-hydro-2H-thiazino(5,4-c)coumarin **13** and 4-amino-2-(2-carbethoxy-2-cyano)-N-phenyl-[10b]-hydro-2H-thiazino(5,4-c)coumarin **16**, respectively.

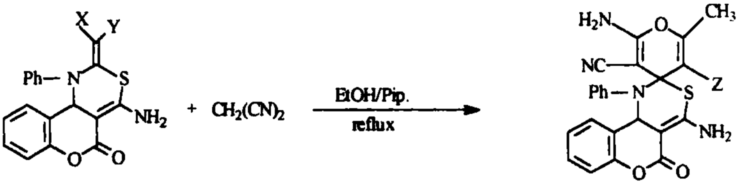


No	X	Y
10	CH_3CO	CH_3CO
13	COOEt	$COCH_3$
16	CN	COOEt

The reaction mechanism was assumed to involve a nucleophilic addition of the imino group of the ketene N,S-acetal at the ethylenic bond of coumarin nuclei followed by intramolecular cyclization via a nucleophilic attack of the SH group at the ethylenic bond of ketene N,S-acetal with elimination of methyl mercaptan to give compounds **10, 13** and **16**, respectively.

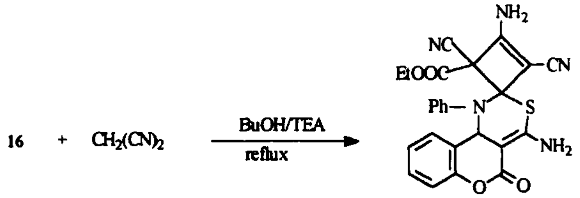


When compounds **10, 13** or **16** were reacted with malononitrile in refluxing ethanol or butanol in the presence of a basic catalyst, the products precipitated to afford, spiro (3-acetyl-6-amino-5-cyano-2-methylpyrane)-4,2′-(4′-amino-10′b(H)-N-phenyl-1′,3′-thiazino-(5,4-c)coumarin **11**, spiro (6-amino-5-cyano-3-ethoxycarbonyl-2-methyl-pyrane)-4,2′-(4′-amino-10′b (H)-N-phenyl-1′,3′-thiazino(5,4-c)coumarin **14** or spiro (3-amino-2,4-dicyano-2-ethoxycarbonyl-2-cyclobutene)-1,2′-(4′-amino-10′b(H)-N-phenyl-1′,3′-thiazino(5,4-c)coumarin **17**[15]. While, treating of compounds **10, 13** or **16** with cyclohexylidenemalononitrile in refluxing ethanol in the presence of triethylamine as a base gave, spiro (4-amino-2,2-diacetyl-3-cyano-5,6,7,8-tetrahydronaphthyl)-1,2′-(4′-amino-10′b(H)-N-phenyl-1′,3′-thiazino(5,4-c) coumarin **12**, spiro(2-acetyl- 4-amino-3-cyano-2-ethoxycarbonyl-5,6,7,8-tetrahydronaphthyl)-1,2′-(4′-amino-10′b(H)-1′,3′-thiazino(5,4-c)coumarin **15** or spiro (4-amino-2,3-dicyano-2-ethoxycarbonyl-5,6,7,8-tetrahydronaphthyl)- 1,2′-(4′-amino-10′(H)-N-phenyl-1′,3′-thiazino(5,4-c)coumarin **18**, respectively[11,15].

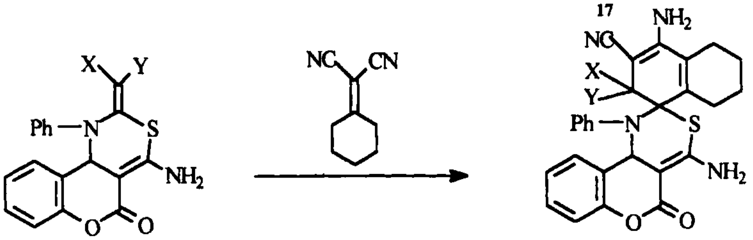


10, 13

11, Z=H
14, Z=COOEt



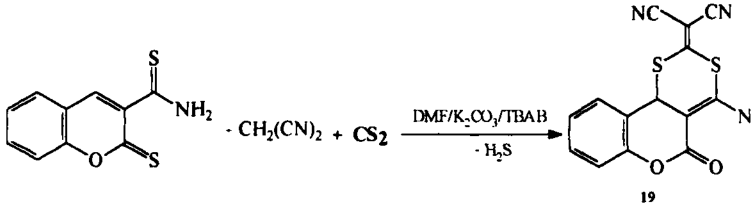
17



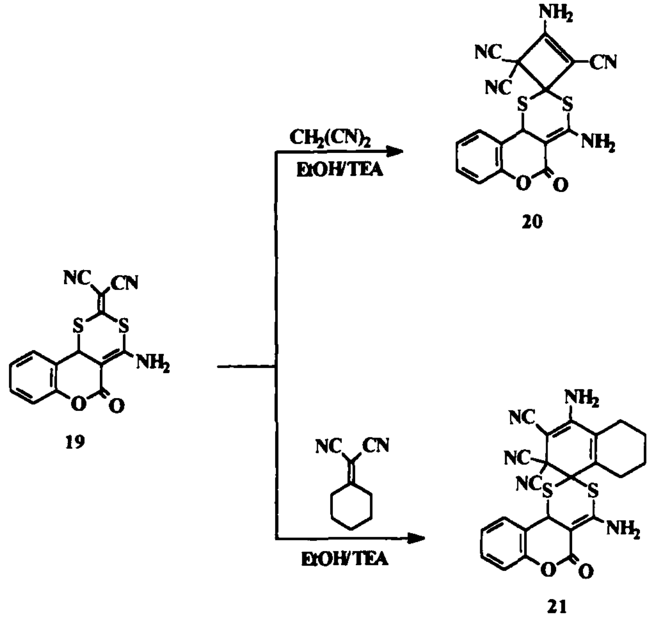
10,13,16

12, 15, 18

4-Amino-2-(2,2-dicyanomethylene)-[10b]-hydro-2H-1,3-dithiano-(5,4-c)coumarin **19** was prepared by reaction of compound **1** with malononitrile and carbon disulfide in 1:1:1 molar ratio under solid-liquid phase transfer catalysis in (DMF/K_2CO_3) at 60 °C in the presence of tetrabutylammonium bromide (TBAB) as a catalyst.



Compound **19** was reacted with malononitrile or cyclohexylidene-malononitrile to afford spiro(3-amino-2,2,4-tricyano-cyclobut-2-enyl)-1,2′-(4′-amino-10′b(H)-1′,3′-dithiano(5,4-c)coumarin[15] **20** or spiro-(4-amino2,2,3-tricyano-5,6,7,8-tetrahydro)naphthyl-1,2′-(3′amino-10′b(H) 1′,3′-dithiano(5,4-c)coumarin **21**, respectively.



EXPEREMENTALS

All melting points were determined on a Kofler melting points apparatus and were uncorrected. IR spectra were obtained on a Nicolet 710 FT-IR spectrometer. ^{1}H-NMR spectra were recorded on a Varian EM 360 A at 60 MHz using TMS as an internal reference. Elemental analyses were carried out with an elemental analyzer model 240 C.

Reaction of coumarin-3-thiocarboxamide 1 with active methylene compounds

General procedure

A mixture of compound **1** (0.01 mol) was added to a stirred suspension of (0.01 mol) of the appropriate active methylene reagent including malononitrile, cyanoacetamide, cyanothioacetamide, ethylcyanoacetate, cyanoacetohydrazide, ethyl acetoacetate, 3-methyl-1-phenylpyrazol-5-one, cyclopentanone, cyclohexylidenemalononitrile, cyclohexanone or cyclohexylidenemalononitrile in 10 ml n-BuOH containing catalytic amounts of piperidine. The reaction mixture was refluxed over different periods of time, concentrated to its half-volume, left to cool and poured into ice-cold water. The obtained solid was collected by filtration and recrystallized from the appropriate solvent.

Compound 2

Method A: A mixture of compound **1** and malononitrile was refluxed for 1 hr, the solid product was filtered off and recrystallized from dioxane to yield yellow crystals.

Method B: A mixture of compound **1** and cyanoacetamide was refluxed for 3 hrs, the solid product was filtered off and recrystallized from dioxane to yield yellow crystals.

Method C: A mixture of compound **1** and cyanothioacetamide was refluxed for 4 hrs, the solid product was filtered off and recrystallized from dioxane to yield yellow crystals.

Compound 3

The reaction mixture was refluxed for 3 hrs. The solid product was filtered off and recrystallized from DMF to yield red crystals.

Compound 4

The reaction mixture was refluxed for 5 hrs. The solid product was filtered off and recrystallized from acetic acid to yield brown powder.

Compound 5a

A mixture of compound 1 and cyclopentanone or cyclopentylidenemalononitrile was refluxed for 4 hrs. The solid product was filtered off and recrystallized from DMF to yield pale brown crystals.

Compound 5b

A mixture of compound 1 and cyclohexanone or cyclohexylidenemalononitrile was refluxed for 4 hrs. The solid product was filtered off and recrystallized from acetic acid to yield reddish brown crystals.

Compound 6

The reaction mixture was refluxed for 4 hrs. The solid product was filtered off and recrystallized from DMF to yield deep brown crystals.

Compound 8

The reaction mixture was refluxed for 3 hrs. The solid product was filtered off and recrystallized from dioxane to yield brown crystals.

Compound 9

The reaction mixture was refluxed for 3 hrs. The solid product was filtered off and recrystallized from benzene to yield gray powder.

Reaction of compound 1 with thioglycolic acid (compound 7)

A mixture of compound **1** (0.01 mol) was added to a stirred suspension of (0.01 mol) of thioglycolic in 10 ml pyridine. The reaction mixture was refluxed for 4 hrs, and neutralized with dil. HCl. The obtained solid was collected by filteration, and recrystallized from ethanol to yield deep brown crystals.

TABLE I Analytical and spectral Data of the New Compounds

. P C)^a	*Yield (%)*	*Mole. Form. (Mol.wt.)*	*IR (Cm^{-1})^b*	*^{1}H-NMR ∂ (ppm)^c*
0	70	$C_{13}H_9N_3O_2S$ (271.28)	3433,3341,3175 (2NH_2), 2201 (CN), 1690 (CO).	8.30–7.80(m,4H, arom.), 4.90(s,1H,CH γ-thiopyr 4.50–4.10(br, 3H, 2NH_2).
–8	65	$C_{13}H_8N_2O_3S$ (272 27)	3423(OH),3281,3140(NH_2), 2190(CN), 1694 (CO).	8.10–7.60(m,4H,arom.),4.80(s,1H,CH γ-thiopyra 4.50 –4.10(br, 2H, NH_2),2.50(s, 1H, OH).
3	49	$C_{13}H_{10}N_4O_2S$ (286.31)	3424,3310,3221(NH,NH_2), 2203(CN), 1697 (CO).	8.40–7.80(m,4H,arom.),5.50–4.70(m,4H,NHNH CH γ- thiopyran), 4.10–3.80(br, 2H, NH_2).
121	56	$C_{15}H_{13}NO_2S$ (271.38)	3424,3310(NH_2), 2970($CH_{aliph.}$), 1687 (CO).	8.30–7.80(m,4H,arom.),4.80(s, 1H,CH γ-thiopyra 4.40–4.10(br,2H,NH_2), 2.50–2.10(m,4H,2CH_2), 1.90–1.50
	70	$C_{16}H_{15}NO_2S$ (285.37)	3344,3230(NH_2), 2960($CH_{aliph.}$), 1692 (CO).	(m,2H,CH_2). 7.8–7.3(m,6H,arom.), 4.70(s,1H, CH γ-thiopyran), 4.40- 4.00(br,2H,NH_2),2.50– 2.10(m,4H,2CH_2),1.90–1.50
	80	$C_{14}H_{11}NO_4S$ (289.29)	3441(OH),3340,3311(NH_2), 2960($CH_{aliph.}$), 1689(CO), 1608(CO_{acetyl}).	(m,4H,2CH_2). 8.10–7.70(m,4H, arom.), 4.70(s,1 γ-thiopyran), 4.60–4.20(br,2H,NH_2), 2.30(s,3H, 2.10 (s, 1H,
	69	$C_{12}H_9NO_3S_2$ (279.32)	3376,3223(NH_2), 2860($CH_{aliph.}$), 1712(CO), 1688($CO_{coumarin}$).	OH). 8.70–8.10(m,4H, arom.), 4.80(s,1H,CH γ-th opyran) 4.60–4.30(br,2H,NH_2),4. 1 (s,2H,CH_2).
–5	73	$C_{20}H_{15}N_3O_2S$ (361.40)	3344,3250(NH_2), 2922($CH_{aliph.}$), 1697 (CO).	8.40–7.90 (m,9H,arom.), 5.10(s,1H,CH γ-thiopyr 4.40–4.10 (br, 2H, NH_2), 2.40(s,3H,CH_3).
–5	80	$C_{19}H_{12}N_2O_2S$ (332.38)	3314,3200(NH_2), 2206(CN), 1700 (CO).	8.60–8.00(m,9H,arom.), 4.80(s,1H,CH γ-thiopyra 4.50–4.00(br,2H,NH_2).

. P C)^a	Yield (%)	Mole. Form. (Mol.wt.)	IR (Cm^{-1})^b	^{1}H-NMR ∂ (ppm)^c
0	70	$C_{22}H_{18}N_2O_4S$ (406.51)	3335,3287(NH_2),2970(CH_{aliph}.), 2210(CN), 1689(CO), 1608(CO_{acetyl}).	8.20–7.70(m,9H, arom.), 4.50(s,1H,CH γ-thiopyr 4.40–4.00(br,2H,NH_2), 2.30 (s,6H,2CH_3).
0	65	$C_{23}H_{18}N_4O_3S$ (430.49)	3328,3211,3194(2NH_2), 2922(CH_{aliph}.), 2200(CN), 1690(CO).	8.40–7.90(m,9H, arom.), 5.20(s, 1H, =CH), 4.90(s,1H,CH γ-thiopyran) 4.70–4.40(br,4H,2NH 2.50 (s,3H,CH_3).
	46	$C_{31}H_{28}N_4O_4S$ (552.66)	3329,3201,3120(2NH_2), 2922(CH_{aliph}.), 2201(CN), 1680(CO), 1609(CO_{acetyl}).	8.40–7.90(m,9H,arom.), 4.90(s,1H,CH γ-thiopyra 4.30–3.90(br,4H,2NH_2),2.70(s,6H,2CH_3), 2.50–2
–	50	$C_{23}H_{20}N_2O_5S$ (436.46)	3329,3201,3120(2NH_2), 2922 (CH_{aliph}.), 1720(CO_{ester}), 1685(CO), 1609(CO_{acetyl}).	4H, 2CH_2),1.90–1.50 (m,4H,2CH_2). 8.70– 8.10(m,9H,arom.), 5.00(s,1H,CH γ-thiopyran), 4. 4.40(br.4H,NH_2 + $CH_{2\ ester}$), 2.50(s,3H,CH_3CO), 1.10 (t,3H, CH_3)
	65	$C_{26}H_{22}N_4O_5S$ (502.26)	3342,3280,3196(2NH_2), 2932(CH_{aliph}.), 2206(CN),1736(CO_{ester}), 1685(CO).	8.60–8.00(m,9H,arom.), 4.90(s,1H,CH γ-thiopyra 4.60–4.10(br,6H,2NH_2 + CH_2 ester), 2.40(s,3H, 1.30–1.10(t,3H, CH_3).
	65	$C_{26}H_{22}N_4O_5S$ (502.26)	3342,3280,3196(2NH_2), 2932(CH_{aliph}.), 2206(CN),1736(CO_{ester}), 1685(CO).	8.60–8.00(m,9H,arom.), 4.90(s,1H,CH γ-thiopyra 4.60–4.10(br,6H,2NH_2 + CH_2 ester), 2.40(s,3H, 1.30–1.10 (t, 3H, CH_3).
-3	45	$C_{32}H_{30}N_4O_5S$ (582.65)	3319,32071,3130(2NH_2), 2932(CH_{aliph}.), 2206(CN), 1738(CO_{ester}), 1685(CO), 1602(CO_{acetyl})	8.40–7.90(m,9H,arom.), 5.30(s,1H,CH γ-thiopyri 4.90–4.40(br,6H,2NH_2 + $CH_{2\ ester}$), 2.70(s,3H,C 2.40- 2.10(m, 4H, 2CH_2),1.80–1.50 (m,4H,2CH_2 1.10(t,3H,CH_3)
-3	70	$C_{22}H_{17}N_3O_4S$ (419.44)	3310,3210,3110(2NH_2), 2932(CH_{aliph}.), 2212,2203(2CN), 1730 (CO_{ester}), 1690 (CO).	8.50–7.80(m,9H,arom.), 5.40(s,1H,CH γ-thiopyri 4.30–3.90(br,4H,NH_2+$CH_{2\ ester}$), 1.30–1.10(t,3H

1. P 'C)^a	Yield (%)	Mole. Form. (Mol.wt.)	IR (Cm^{-1})^b	^{1}H-NMR ∂ (ppm)^c
5	40	$C_{25}H_{19}N_5O_4S$ (485.50)	3374,3270,3190(2NH$_2$), 2922(CH$_{aliph}$.), 2203,2199(2CN), 1732 (CO$_{ester}$), 1690 (CO).	8.00–7.20(m,9H,arom.), 5.40(s,1H,CH γ-thiopyr 4.40–4.00(br,6H,2NH$_2$+CH$_{2\ ester}$),1.30–1. 10(t,3H,CH$_3$).
)	70	$C_{31}H_{27}N_5O_4S$ (565.62)	335,3220,3170(2NH$_2$), 2932(CH$_{aliph}$), 2207(CN), 1740 (CO$_{ester}$), 1690 CO).	8.30–7.80(m,9H,arom.), 5.00(s,1H,CH γ-thiopyr 4.50–4.00(m,6H,2NH$_2$ + CH$_{2\ ester}$), 2.50–2 20(m 2CH$_2$),1.80–1.50 (m,4H,2CH$_2$), 1.30–1.10(t,3H,
)	77	$C_{14}H_7N_3O_2S_2$ (313.33)	3320,3208 (NH$_2$),2207(CN), 1680 (CO).	8.60–8.00(m,4H,arom.), 4.80(s,1H,CH γ-thiopyr 4.40–4.10(br,2H,NH$_2$).
40	61	$C_{23}H_{17}N_5O_2S_2$ (459.52)	3424,3330,3161 (2NH$_2$), 2922(CH $_{aliph}$.), 2215 2207, 2198(3CN), 1679 (CO).	8.20–7.70(m,4H,arom.),4.70(s,1H,CH γ-thiopyri 4.40–4. 10(br,4H,2NH$_2$),2.60–2 20(m,4H,2CH$_2$) 1.50 (m,4H,2CH$_2$).
40	65	$C_{17}H_9N_5O_2S_2$ (379.39)	3324,3240,3156 (2NH$_2$), 2225,2200,2218 (3CN), 1679 (CO).	8.60–8.00(m,4H,arom.), 4.90(s,1H,CH γ-thiopyr 4.50–4.00(br,4H,2NH$_2$).

cted.

ed by Nicolet FT-IR 710 Spectrophotometer.

ed by a varian EM 360 L spectrometer at 60 MHZ using TMS as internal standard and DMSO as a solvent.

tory microanalysis obtained C; ± 0.35, H; ± 0.4, N; ± 0.2, S; ± 0.32

Reaction of compound 1 with ketene N,S-acetal derivatives

General procedure

An equimolar mixture (0.01 mol) of compound **1** and ketene N, S-acetal derivatives was dissolved in 5 ml DMF and 10 ml EtOH in the presence of catalytic amounts of piperidine. The reaction mixture was refluxed for about 12 hrs (until the odour of MeSH disappeared), left to cool and poured into ice cold water and acidified with dil. HCl.

Compound 10

The solid product was filtered off and recrystallized from dioxane to yield reddish brown crystals.

Compound 13

The solid product was filtered off and recrystallized from ethanol to yield brown crystals.

Compound 16

The solid product was filtered off and recrystallized from acetic acid to yield pale red crystals.

Reaction of 10 or 13 with malononitrile

A mixture of compound **10** or **13** (0.01 mol) and malononitrile (0.01 mol) in 10 ml abs. EtOH was refluxed for about 2 hrs where compound **11** or **14** were precipitate respectively. Compound **11** was filtered off and recrystallized from methanol to give yellow crystals. Compound **14** was filtered off and recrystallized from dioxane to give red crystals.

Reaction of compound 1 with carbon disulfide and malononitrile

An equimolar mixture (0.05 mol) of malononitrile and CS_2 in 30 ml DMF was treated with 7g of anhydrous. K_2CO_3. The formed dianionic ambident compound was treated with (0.05 mol) of compound **1** dissolved in 10 ml DMF and a catalytic amount of tetrabutylammonium bromide (TBAB, 3 mmol). The reaction mixture was stirred for about 3 hrs, at 60°C and the DMF layer was then separated by filtration and evaporated in vacuo. The solid product was washed with light petroleum ether (40–60°C) and collected by filtration to yield deep red crystals.

Reactions of 10, 13, 16 or 19 with cyclohexylidene malononitrile

General Procedure

An equimolar mixture (0.01 mol) of cyclohexylidenemalononitrile and arylidene derivatives **10, 13, 16** or **18** was dissolved in 30 ml EtOH containing (0.01 mol) of TEA. The reaction mixture was refluxed over different periods of time and concentrated to half its volume.

Compound 12

The reaction mixture was refluxed for 4 hrs, left to cool and poured into ice-cold water. The solid product was filtered off and recrystallized from ethanol to give deep brown crystals.

Compound 15

The reaction mixture was refluxed for 5 hrs and left to cool. The solid product was filtered off and recrystallized from acetic acid to give deep brown crystals.

Compound 18

The reaction mixture was refluxed for 4 hrs and left to cool. The solid product was filtered off and recrystallized from dioxane to give brown crystals.

Compound 21

The reaction mixture was refluxed for 5 hrs and left to cool. The solid product was filtered off and recrystallized from DMF to give yellowish brown crystals.

Synthesis of compound 17

A mixture of compound **1** (0.01 mol) was added to a stirred suspension of (0.01 mol) of malononitrile in 20 ml n-BuOH containing (0.01 mol) of TEA. The reaction mixture was refluxed for about 3 hrs and left to cool.

The obtained solid was collected by filtration, and recrystallized from n-butanol to give deep brown powder.

Synthesis of compound 20

A mixture of compound **1** (0.01 mol) was added to a stirred suspension of (0.01 mol) of malononitrile in 30 ml EtOH containing (0.01 mol) of TEA. The reaction mixture was refluxed for about 3 hrs, concentrated to half its volume and left to cool. The obtained solid was collected by filtration, and recrystallized from n-butanol to yield deep red crystals.

References

[1] K. Okumura, K. Ashino and T. Okuda; *Yakugaku Zasshi* **81**, 1482 (1961), C.A. **56**, 7938(1962).
[2] G.M. Gingolani, F. Gaultrieri and M. Pigini; *J. Med. Chem.* **12**, 531(1969).
[3] B. Rao, C. Mouli and Y.D. Reddy; *Ind. J. Chem.* **22B**, 176(1983).
[4] A.M. El-Naggar, F.S. Ahmed, A.M. Abd El-Salam, M.A. Rady and M.S.A. Latif; *J. Heterocycl. Chem.* **18**, 1203(1981).
[5] M.A.A. Moustafa; *Scientica Pharmaceutica (Sci. Pharm.)*, **59**, 213(1991).
[6] E.A. Kacska, F.J. Wolf, F.P. Rathe and K.J. Folkers; *J. Am. Chem. Soc.* **73**, 6404(1955).
[7] E.E. Smissman, in C.O. Wilson, O. Gisvold and R.F. Doerge; *Textbook of Organic Medicinal and Pharmaceutical Chemistry*, 8th ed., P. 291–292, Lippincott Co. Philadelphia, Toronto 1982.
[8] A.M.M. El-Saghier and El-Jazi I. Al-Afaleq; *Phosphorus, Sulfur and Silicon*, **139**, 67–75(1998).
[9] A.M.M. El-Saghier; *Bull. Chem. Soc. Jpn.*, **66**, 2011–2015(1993).
[10] A.K. El-Shafei, H.A. Abdel-Ghany, A. Sultan and A.M.M. El-Saghier; *Phosphorus, Sulfur and Silicon*, **73**, 15(1992).
[11] A.K. El-Shafei, A.M.M. El-Saghier and E.A. Ahmed; *Synthesis*, 152(1994).
[12] A.K. El-Shafei, A.M. El-Sayed and A.M.M. El-Saghier; *Phosphorus, Sulfur and Silicon*, **90**, 213(1994).
[13] H. Abdel-Ghany, H.M. Moustafa and A. Khodairy, *Synth. Commun*, **8**, 533(1978).
[14] J.S.A. Brunskill, A.D.Z. Elagbar, D.F. Ewing and H. Jeffrey, *Synth. Commun*, **8**, 533(1978).
[15] S.A.M. Metwally, G.M. El-Naggar and T.I. El-Emary, Liebigs Ann. Chem. 961–962(1991).