Indian Journal of Chemistry
Vol. 47B, February 2008, pp. 319-324

Note

p-TsOH Catalyzed regioselective synthesis of 8,8'-methylene-bis-4-oxo-dihydro-chromeno[4,3-*c*]pyrazoles

Ch Sanjeeva Reddy* & A Nagaraj

Department of Chemistry, Kakatiya University, Warangal 506 009, India

E-mail: chsrkuc@yahoo.co.in

Received 7 June 2007; accepted (revised) 30 November 2007

The ethyl-5-[3-(ethoxycarbonyl)-4-hydroxybenzyl]-2-hydroxybenzoate **3** is prepared by the usual esterification of 5-(3-carboxy-4-hydroxybenzyl)-2-hydroxy benzoic acid **2**. Compound **3** on reacting with ethyl acetoacetate yields 3-acetyl-6-[(3-acetyl-4-hydroxy-2-oxo-2*H*-6-chromenyl)methyl]-4-hydroxy-2*H*-2-chromenone **4**. The regioselective conversion, by cyclizing the hydrazone **5** of compound **4** to either 8,8'-methylene-bis-4-oxo-1,4-dihydrochromeno[4,3-*c*]pyrazoles **6** with *p*-toluene sulfonic acid in refluxing xylene or 8,8'-methylene-bis-4-oxo-2,4-dihydro chromeno[4,3-*c*]pyrazoles **7** with corresponding hydrazine hydrochloride in refluxing acetic acid is described.

Keywords: *p*-TsOH, regioselective synthesis, 8,8'-methylene-bis-4-oxo-1,4-dihydrochromeno[4,3-*c*]pyrazoles, 8,8′-methylene-bis-2,4-dihydrochromeno[4,3-*c*]pyrazoles

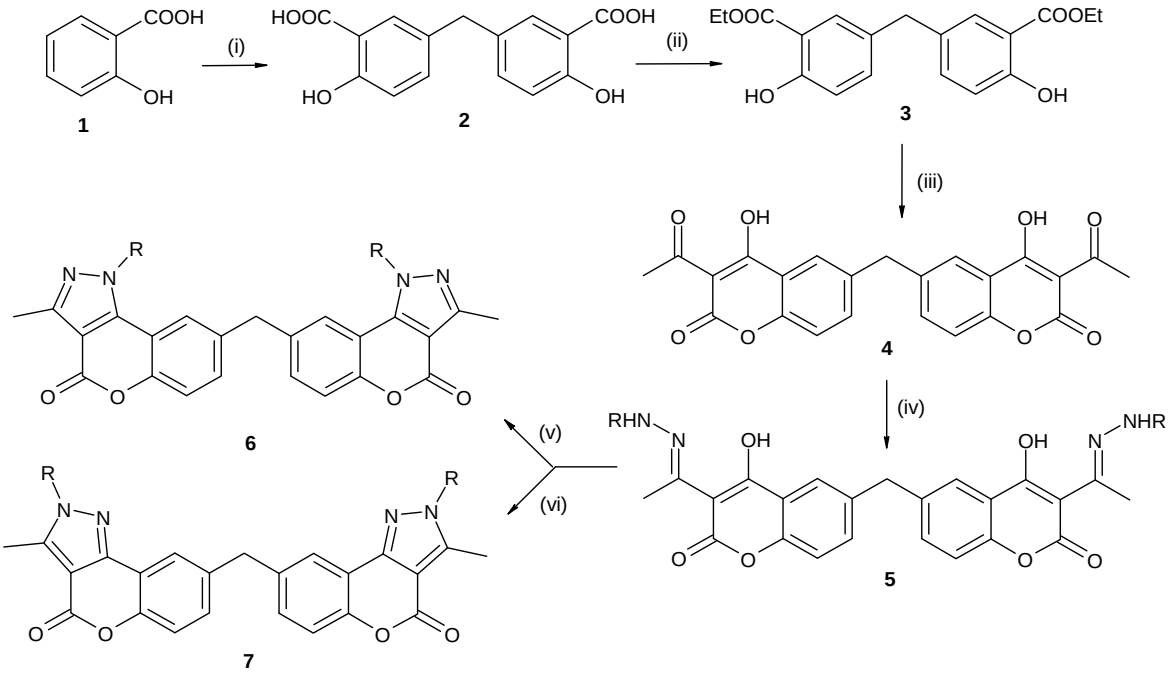
Heterocyclic compounds have attracted considerable attention in the design of biologically active molecules[1,2]. Coumarins are a class of compounds with biological activity[3], such as analgesics[4], anti-coagulants[5], specific inhibitors of α-chymotripsin[6], human leukocyte elastase[7], diuretics[8]. On the other hand, the classes of pyrazoles possess a broad spectrum of biological effectiveness such as antiviral[9], antibacterial[10], antidepressents[11], inhibitors of protein kinases[12], antiagregating[13], antiarthritic[14] and cere-broprotectors[15]. Recently some aryl pyrazoles[16] were reported to have non-nucleoside HIV-1 reverse trans-criptase inhibitory activity[17], COX-2 inhibitors[18], potent activator of the nitric oxide receptor and soluble guanylate cyclase[19]. Besides, great interest in the pyrazole molecule has been stimulated by some promising pharmacological, agrochemical and analytical applications of its derivatives.

A detailed literature survey indicates that, synthesis of some thiochromeno[4,3-*c*] and [3,4-*c*]pyrazoles[20], pyrazolo-pyrazoles, isoxazolo-pyrazoles, pyrazolo-pyrimidines, pyrazolo-thiazines, pyrazolo-pyridines[21], pyrazolo[4,3-*c*]diazepines, pyrazolo[3,4-*d*]triazines, benzoxaphosphino[4,3-*c*]pyrazoles[22], monomaric benzopyrano[4,3-*c*]pyrazoles[23] have been reported.

In view of these observations it was considered of interest to synthesize some new dimeric chemical entities incorporating the two active pharmacophores namely coumarin and pyrazole in a single molecular frame work. In this regard, 3-acetyl-6-[(3-acetyl-4-hydroxy-2-oxo - 2*H*-6-chromenyl)methyl]-4-hydroxy-2*H*-2-chromenone **4** would be suitable for preparing either 8,8'-methylene-bis-4-oxo-1,4-dihydrochromeno-[4,3-*c*] pyrazoles **6** or 8,8'-methylene-bis-4-oxo-2,4-dihydrochromeno[4,3-c]pyrazoles **7** (**Scheme I**).

The esterification of 5-(3-carboxy-4-hydroxy-benzyl)-2-hydroxybenzoic acid **2** with absolute ethyl alcohol in the presence of an acid catalyst afforded ethyl-5-[3-(ethoxycarbonyl)-4-hydroxybenzyl]-2-hydro-xybenzoate **3** in 82% yield. Subsequently compound **3** reacted with ethyl acetoacetate in the presence of sodium ethoxide afforded 3-acetyl-6-[(3-acetyl-4-hydroxy-2-oxo - 2*H*-6-chromenyl)methyl]-4-hydroxy-2*H*-2-chromenone **4**. In the first instance the compo-und **4** reacted with phenyl hydrazine hydrochloride afforded hydrazones **5** in excellent yields.

Compound **5** was regioselectively converted into the new 3-methyl-8-[(3-methyl-4-oxo-1-phenyl-1,4-dihydrochromeno[4,3-*c*]pyrazole-8-yl)methyl]-1-phe-nyl-1,4-dihydro-chromeno[4,3-*c*]pyrazol-4-one **6a** with *p*-toluene sulfonic acid in refluxing xylene in 69% yield or 3-methyl-8-[(3-methyl-4-oxo-2-phenyl-2, 4-dihydrochromeno[4, 3-c]pyrazol-8-yl)methyl]-2-phenyl-2,4-dihy drochromeno[4,3-*c*]pyrazol-4-one **7a** with phenylhydrazinium chloride in refluxing acetic acid in 64% yield. The molar ratio of the isomeric products **6** and **7** depends on the amount of nucleo-phillic reagent used, thus in the presence of one equivalent of hydrazine, compound **6** and two equivalents of hydrazine, compound **7** were formed[23a]. While formation of **6** from **5** under PTSA catalysis is straight forward, that of **7** requires initial attack of the hydrazine reagent at C-4 of the coumarin system and subsequent ring closure with elimination of the original phenyl/alkyl hydrazine moiety. Further when compound **5** alone refluxed in acetic acid, the methylene-bis-(hydroxybenzoylpyrazoles)[24] was formed instead of compound **7**. It is interesting to note that in



(i) HCHO, H_2SO_4 (ii) C_2H_5OH, H_2SO_4 (iii) EAA, C_2H_5ONa (iv) $RNHNH_2.HCl$, C_2H_5OH (v) p-TsOH / Xylene (vi) $RNHNH_2.HCl$, CH_3COOH

Scheme I

case of unsubstituted hydrazine, cyclization by either method resulted only one isomer **6h**, and when substituted hydrazines were used either **6** or **7** were obtained depending on experimental conditions.

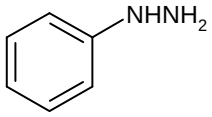
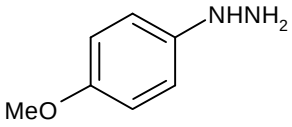
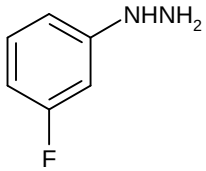
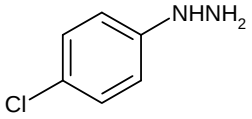
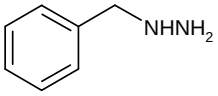
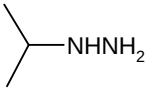
The scope and generality of the present method was further demonstrated by converting compound **4** with different hydrazines followed by regioselective conversion by cyclization under different experimental conditions. The versatility of the reaction is well demonstrated with the fact that both aromatic (entries a-d, **Table I**) and aliphatic (entries e-g, **Table I**) hydrazines afforded their corresponding pyrazoles **6** or **7** in good yields. The structures of all the new compounds were confirmed by IR, NMR and mass spectral studies. The ^{13}C NMR spectra of **6a**, **d** and **7a**, **d** clearly demonstrated their structures, by comparison of the C-3, C-3a, C-9b, and CH_3 signals (**Figure 1**, **Table II**). It is known that a carbon adjacent to substituted nitrogen resonates up field of the signal of the same carbon in the other isomer (unsubstituted nitrogen). Further the structure of the product **6a** and **7a** was assigned by using Noesy experiment. The appearance of NOE cross peaks between H2/H9 indicates the compound **6a,** and between H2/H1 indicates the compound **7a** (**Figure 1**). Additional support for the assignments was provided by the ^1H NMR spectra of each isomer.

In conclusion, an efficient protocol for the synthesis of regioselectively pure 8,8'-methylene-bis-4-oxo-1,4 **6** and 2,4-dihydrochromeno[4,3-*c*]pyrazoles **7** by the reaction of 3-acetyl-6-[(3-acetyl-4-hydroxy-2-oxo - 2*H*-6-chromenyl)methyl]-4-hydroxy-2*H*-2-chromenone **4** and a variety of hydrazines under different experimental conditions has been described.

Experimental Section

General. Melting points were determined on a Gallenkamp capillary melting point apparatus and are uncorrected. ^1H NMR and ^{13}C NMR spectra were obtained on a Varian- Gemini spectrometer at 400 and 100 MHz respectively. Chemical shifts are reported in δ (ppm) with respect to internal TMS, and *J* values are quoted in Hz. IR spectra were recorded on a Perkin-Elmer BX series spectrometer in KBr and only the most significant absorptions in cm^{-1} are indicated. Mass spectra were recorded on a VG-micromass 7070H spectrometer and the molecular ion and/or base peaks are given. 5,5'-Methylene-bis-salicylic acid **2**, was prepared according to literature[25]. All other reagents were purchased from Aldrich chemicals and were used without further purification. Crude products were purified by column chromatography on silica gel of 60-120 mesh.

Table I — Synthesis of 8,8'-methylene-bis-4-oxo-1,4 and 2,4-dihydrochromeno[4,3-*c*]pyrazoles

Entry	Hydrazine	Product R=	Product[a] **6** Yield (%)[b]	Product[a] **7** Yield (%)[b]
a		C_6H_5-	69	64
b		4-(MeO)-C_6H_4-	75	65
c		3-F-C_6H_5-	73	66
d		4-Cl-C_6H_5-	78	68
e		C_6H_5-CH_2-	76	70
f		Isopropyl	74	72
g	CH_3-$NHNH_2$	CH_3-	70	67
h	NH_2-NH_2	H	79	—

[a] Products were characterized by IR, NMR and mass spectroscopy.
[b] Yields refer to pure products after chromatography.

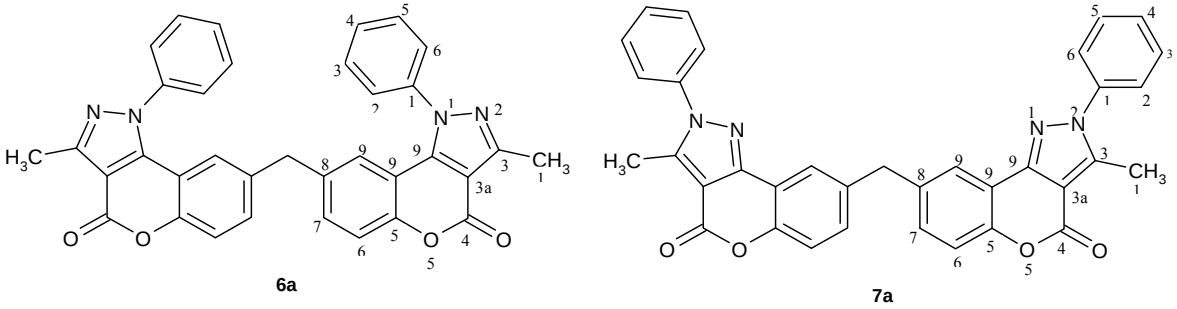


Figure 1 — Chemical structure and numbering used in ^{13}C NMR & NOE assignments

Ethyl-5-[3-(ethoxycarbonyl) - 4-hydroxybenzyl]-2-hydroxybenzoate 3. To the solution of **2** (1 mmole) in absolute ethyl alcohol (20 mL), concentrate sulphuric acid (1.5 mL) was added. The mixture was refluxed for 3 hr. After completion of the reaction, the mixture was poured into the ice water. Crude solid **3** was filtered off, washed with 10% $NaHCO_3$ solution, dried and recrystallized from ethyl alcohol to collect **3** as pink solid, yield: 82%, m.p. 220-22°C; ^1H NMR (DMSO-d_6): δ 10.2 (s, 2H), 7.7-7.1 (m, 6H), 4.3 (q, 4H),

Table II — Selected ^{13}C NMR spectral data (δ, ppm)

Compound	C-3	C-3a	C-4	C-9b	CH_3
6a	149.1	107.1	156.4	137.6	14.1
6d	149.3	107.4	156.6	137.4	14.1
7a	144.4	106.1	157.1	152.0	12.0
7d	144.7	105.9	158.2	151.2	12.1

4.0 (s, 2H), 1.41 (t, 6H); ^{13}C NMR: δ 170.2, 154.1, 131.9, 130.1, 128.3, 119.7, 113.4, 60.3, 43.8, 16.0; IR (KBr): 3367, 1718, 1220 cm^{-1}; MS: *m*/*z* 344 (M^+).

3-Acetyl-6-[(3-acetyl-4-hydroxy-2-oxo-2*H*-6-chromenyl)methyl]4-hydroxy-2*H*-2-chrome none 4. To a stirred solution of **3** (1 mmole) in absolute ethyl alcohol (10 mL) and ethylacetoacetate (2.5 mmole) was added sodium ethoxide (1.5 mmole). The mixture was refluxed at 110°C with stirring for 3 hr. After completion of the reaction, monitored by TLC (EtOAc: hexane, 1:3), the mixture was acidified with dilute HCl (10 mL). Crude solid **4** was filtered off, washed with water, dried and recrystallized from ethanol to collect **4** as white solid, yield: 86%, m.p. 118-20°C; ^1H NMR (DMSO-d_6): δ 13.8 (s, 2H), 7.22-7.70 (m, 6H), 4.0 (s, 2H), 2.32 (s, 6H); ^{13}C NMR: δ 184.2, 178.3, 159.7, 149.8, 136.2, 130.7, 121.9, 119.1, 117.3, 101.2, 43.6, 20.9; IR (KBr): 3440, 1728, 1680, 1560, 1180 cm^{-1}; MS: *m*/*z* 420 (M^+).

General procedure for the preparation of hydrazones 5. To a stirred solution of compound **4** (5 mmole) in ethyl alcohol (25 mL) was added the corresponding hydrazine hydrochloride (11 mmole) and the reaction-mixture was refluxed for 1.5 hr. After completion of the reaction (TLC), the mixture was cooled. The precipitated hydrazones **5** was filtered off, washed with water, dried and recrystallized from ethyl alcohol.

8,8'-Methylene-bis-4-oxo-1,4-dihydrochromeno-[4,3-*c*]pyrazoles 6. To a stirred solution of compound **5** (1 mmol) in xylene (10 mL) was added catalytic amount of *p*-toluene sulfonic acid and the reaction-mixture refluxed for 6 hr. After completion of the reaction TLC (EtOAc: hexane, 3:1), the mixture was diluted with water and extracted with EtOAc. The combined organic layers were dried over Na_2SO_4, evaporated and the crude product purified by column chromatography on silica gel to give the corresponding **6** in excellent yields.

3-Methyl-8-[(3-methyl-4-oxo-1phenyl-1,4-dihydrochromeno[4,3-*c*]pyrazol-8-yl)methyl]-1-phenyl-1,4-dihydrochromeno[4,3-*c*]pyrazol-4-one 6a: Brown solid, m.p. 202-03°C; ^1H NMR (DMSO-d_6); δ 7.72-7.16 (m, 16H), 4.0 (s, 2H), 2.47 (s, 6H); ^{13}C NMR: δ 156.4, 149.1, 147.2, 138.8, 138.3, 137.6, 131.4, 129.4, 128.4, 124.4, 119.9, 118.0, 112.4, 107.1, 47.1, 14.1; IR (KBr): 3028, 1724, 1567, 1562 cm^{-1}; MS: *m*/*z* 564 (M^+).

1-(4-Methoxyphenyl) - 8-{[1-(4-methoxyphenyl)-3-methyl-4-oxo-1,4-dihydrochromeno[4, 3-*c*]pyrazol-8-yl]methyl}-3-methyl-1, 4-dihydrochromeno-[4,3-*c*]pyrazol-4-one 6b: Gray solid, m.p. 216-18°C; ^1H NMR (DMSO-d_6): δ 7.72-7.36 (m, 6H), 7.42 (d, *J* = 8.7 Hz, 4H), 7.10 (d, *J* = 8.7 Hz, 4H), 4.0 (s, 2H), 3.90 (s, 6H), 2.47 (s, 6H); ^{13}C NMR: δ 158.5, 157.7, 149.2, 147.0, 138.4, 137.9, 131.4, 130.9, 124.3, 119.1, 118.0, 115.3, 112.2, 107.2, 54.3, 43.9, 14.2; IR (KBr): 3090, 1710, 1585, 1569, 1245 cm^{-1}; MS: *m*/*z* 624 (M^+).

1-(3-Fluorophenyl)-8-{[1-(3-fluorophenyl)-3-methyl-4-oxo-1, 4-dihydrochromeno[4, 3-*c*]pyrazol-8-yl]methyl}-3-methyl-1, 4-dihydrochromeno[4, 3-*c*]-pyrazol-4-one 6c. Pink solid, m.p. 233-34°C; ^1H NMR (DMSO-d_6): δ 7.8-6.63 (m, 12H), 7.68 (d, *J* = 6.2 Hz, 2H), 7.27 (d, *J* = 6.2 Hz, 2H), 4.0 (s, 2H), 2.47 (s, 6H); ^{13}C NMR: δ 166.2, 154.5, 150.9, 147.2, 139.5, 138.2, 136.1, 132.1, 130.4, 120.9, 119.1, 118.0, 112.1, 111.3, 106.2, 105.0, 44.5, 14.3; IR (KBr): 3080, 1715, 1569, 1584 cm^{-1}; MS: *m*/*z* 600 (M^+).

1-(4-Chlorophenyl)-8-{[1 - (4-chlorophenyl)-3-methyl-4-oxo-1, 4-dihydrochromeno[4,3-*c*]pyrazol-8-yl]methyl}-3-methyl-1, 4-dihydrochromeno[4, 3-*c*]pyrazol-4-one 6d: Yellow solid, m.p. 209-11°C; ^1H NMR (DMSO-d_6): δ 7.70-7.10 (m, 6H), 7.62 (d, *J* = 8.3 Hz, 4H), 7.54 (d, *J* = 8.3 Hz, 4H), 4.0 (s, 2H), 2.47 (s, 6H); ^{13}C NMR: δ 156.6, 149.3, 147.2, 138.8, 137.4, 135.7, 132.7, 131.2, 130.3, 125.7, 119.9, 117.9, 112.3, 107.4, 44.1, 14.1; IR (KBr): 3080, 1721, 1570, 1557, 1187 cm^{-1}; MS: *m*/*z* 634 (M^+).

1-Benzyl-8-[(1-benzyl - 3-methyl-4-oxo-1,4-dihydrochromeno[4,3-*c*]pyrazol-8-yl)methyl]-3-methyl-1,4-dihydrochromeno[4,3-*c*]pyrazol-4-one 6e: Pink solid, m.p. 217-18°C; ^1H NMR (DMSO-d_6): δ 7.75-7.10 (m, 6H), 7.52-7.15 (m, 10H), 5.13 (s, 4H), 4.0 (s, 2H), 2.39 (s, 6H); ^{13}C NMR: δ 158.7, 152.1, 150.3, 140.1, 138.8, 135.0, 131.2, 128.3, 127.8, 126.4, 121.3, 119.8, 112.6, 102.1, 56.1, 43.1, 15.2; IR (KBr): 3080, 1714, 1585, 1560, 1180 cm^{-1}; MS: *m*/*z* 592 (M^+).

1-Isopropyl-8-[(1-isopropyl-3-methyl-4-oxo-1,4-dihydrochromeno[4, 3-*c*]pyrazol-8 - yl]methyl]-3-methyl-1, 4-dihydrochromeno[4, 3-*c*]pyrazol-4-one 6f: Yellow solid, m.p. 221-23°C; ^1H NMR (DMSO-d_6): δ 7.42 (m, 2H), 7.39 (d, *J* = 6.8 Hz, 2H), 7.12 (d, *J* = 6.8 Hz, 2H) 5.77 (m, 2H), 4.0 (s, 2H), 2.37 (s,

6H), 1.52 (d, *J* = 6.7 Hz, 12H); ^{13}C NMR: δ 159.1, 149.3, 148.6, 138.3, 137.6, 131.4, 119.3, 117.8, 112.4, 101.9, 59.1, 44.3, 23.2, 15.7; IR (KBr): 1585, 1567, 1720, 1600, 1183 cm^{-1}; MS: *m*/*z* 496 (M^+).

1-Methyl-8-[(1-methyl-3-methyl-4-oxo-1,4-dihydrochromeno[4,3-*c*]pyrazol-8-yl]methyl]-3-methyl-1, 4-dihydrochromeno[4, 3-*c*]pyrazol-4-one 6g: Yellow solid, m.p. 198-99°C; ^{1}H NMR (DMSO-d_6): δ 7.33 (m, 2H), 7.69 (d, *J* = 6.8 Hz, 2H), 7.12 (d, *J* = 6.8 Hz, 2H), 4.0 (s, 2H), 3.90 (s, 6H), 2.41 (s, 6H); ^{13}C NMR: δ 158.3, 149.7, 148.4, 139.3, 137.7, 131.7, 119.7, 118.2, 112.2, 102.6, 43.7, 37.1, 14.1; IR (KBr): 3078, 2985, 1710, 1595, 1180 cm^{-1}; MS: *m*/*z* 440 (M^+).

3-Methyl-8-[(3-methyl-4-oxo-1,4-dihydrochromeno[4, 3-*c*]pyrazol-8-yl)methyl]-1, 4-dihydrochromeno[4,3-*c*]pyrazol-4-one 6h: Yellow solid, m.p. 241-43°C; ^{1}H NMR (DMSO-d_6): δ 7.70-7.17 (m, 6H), 4.77 (s, 2H), 4.0 (s, 2H), 2.41 (s, 6H); ^{13}C NMR: δ 154.9, 150.3, 146.3, 142.1, 139.8, 131.3, 119.7, 117.2, 114.2, 104.1, 47.1, 12.7; IR (KBr): 3410, 2973, 1720, 1600, 1585 cm^{-1}; MS: *m*/*z* 412 (M^+).

8,8'-Methylene-bis-4-oxo-2,4-dihydrochromeno-[4,3-*c*]pyrazoles 7. To a solution of compound **5** (1 mmole) in acetic acid (10 mL) was added the corresponding hydrazine hydrochloride (2 mmole) in acetic acid (20 mL) and the reaction-mixture refluxed for 4 hr. After completion of the reaction, monitored by TLC (EtOAc: benzene, 3:1), the mixture was diluted with water and extracted with dichloromethane, washed with 10% K_2CO_3 solution, brine, dried over Na_2SO_4, evaporated and the crude product chromatographed on silica gel resulted **7** in excellent yields.

3-Methyl-8-[(3-methyl-4-oxo-2-phenyl-2,4-dihydrochromeno[4,3-*c*]pyrazol-8-yl)methyl]-2-phenyl-2,4dihydrochromeno[4,3-c]pyrazol-4-one 7a: Brown solid, mp 211-12°C; ^{1}H NMR (DMSO-d_6): δ 7.8-6.9 (m, 6H), 7.26-7.52 (s, 10H), 4.0 (s, 2H), 2.69 (s, 6H); ^{13}C NMR: δ 157.1, 152.0, 149.1, 144.4, 136.2, 134.8, 134.1, 131.2, 129.2, 127.2, 125.1, 121.1, 119.7, 106.1, 40.8, 12.0; IR (KBr): 1732, 1590, 1600 cm^{-1}; MS: *m*/*z* 564 (M^+).

2-(4-Methoxyphenyl)-8-{[2-[4-methoxyphenyl)-3-methyl-4-oxo-2,4-dihydrochromeno[4,3-*c*]pyrazol-8-yl]methyl}-3-methyl-2, 4-dihydrochromeno-[4,3-*c*]pyrazol-4-one 7b: Brown solid, m.p. 221-23°C; ^{1}H NMR (DMSO-d_6): δ 7.72-7.36 (m, 6H), 7.42 (d, *J* = 8.3 Hz, 4H), 7.10 (d, *J* = 8.3 Hz, 4H), 4.0 (s, 2H), 3.9 (s, 6H), 2.67 (s, 6H); ^{13}C NMR: δ 159.1, 157.8, 151.2, 150.1, 144.3, 134.9, 133.0, 131.4, 130.7, 127.1, 120.9, 119.1, 117.6, 106.2, 55.3, 40.7, 12.1; IR (KBr): 1730, 1587, 1610 cm^{-1}; MS: *m*/*z* 624 (M^+).

2-(3-Fluorophenyl)-8-{[2-(3-fluorophenyl)-3-methyl-4-oxo-2, 4-dihydrochromeno[4, 3-*c*]pyrazol-8-yl]methyl}-3-methyl-2, 4-dihydrochromeno[4, 3-*c*]-pyrazol-4-one 7c: Brown solid, m.p. 202-04°C; ^{1}H NMR (DMSO-d_6): δ 7.7-6.20 (m, 10H), 7.67 (d, *J* = 6.2 Hz, 2H), 7.12 (d, *J* = 6.2 Hz, 2H), 4.0 (s, 2H), 2.68 (s, 6H); ^{13}C NMR: δ 168.1, 167.0, 157.2, 152.7, 150.3, 143.4, 139.2, 134.1, 133.7, 131.0, 122.7, 119.7, 118.4, 112.1, 107.6, 106.9, 40.7, 12.1; IR (KBr): 1728, 1591, 1602 cm^{-1}; MS: *m*/*z* 600 (M^+).

2-(4-Chlorophenyl)-8-{[2 - (4-chlorophenyl)-3-methyl-4-oxo-2, 4-dihydrochromeno[4,3-*c*]pyrazol-8-yl]methyl}-3-methyl-2,4-dihydrochromeno[4,3-*c*]pyrazol-4-one 7d: Yellow solid, m.p. 227-28°C; ^{1}H NMR (DMSO-d_6): δ 7.70-7.10 (m, 6H), 7.52 (d, *J* = 8.3, 4H), 7.60 (d, *J* = 8.3, 4H), 4.0 (s, 2H), 2.68 (s, 6H); ^{13}C NMR: δ 158.2, 151.2, 150.3, 144.7, 135.9, 134.7, 133.6, 132.3, 131.0, 130.3, 126.7, 120.0, 118.1, 105.9, 42.3, 12.1; IR (KBr): 1727, 1586, 1601 cm^{-1}; MS: *m*/*z* 634 (M^+).

2-Benzyl-8-[(2-benzyl - 3-methyl-4-oxo-2,4-dihydrochromeno[4,3-*c*]pyrazol-8-yl)methyl]-3-methyl-2,4-dihydrochromeno[4,3-c]pyrazol-4-one 7e: Brown solid, m.p. 197-200°C; ^{1}H NMR (DMSO-d_6): δ 7.75-7.0 (m, 16H), 5.31 (s, 2H), 4.0 (s, 2H), 2.57 (s, 6H); ^{13}C NMR: δ 158.0, 152.0, 150.9, 144.7, 134.8, 133.1, 131.2, 129.0, 128.7, 127.9, 126.1, 120.3, 118.1, 102.4, 55.1, 42.0, 12.1; IR (KBr): 1728, 1587, 1602 cm^{-1}; MS: *m*/*z* 592 (M^+).

2-Isopropyl-8-[(2-isopropyl-3-methyl-4-oxo-2,4-dihydrochromeno[4, 3 - *c*]pyrazol-8-yl)methyl]-3-methyl-2, 4-dihydrochromeno[4, 3-*c*]pyrazol-4-one 7f: Yellow solid, m.p. 212-13°C; ^{1}H NMR (DMSO-d_6): δ 7.7-6.9 (m, 6H), 5.70 (m, 2H), 4.0 (s, 2H), 2.52 (s, 6H), 1.35 (d, *J* = 6.7 Hz, 12H); ^{13}C NMR: δ 159.1, 150.7, 149.8, 140.3, 133.2, 131.7, 130.3, 119.8, 117.3, 101.7, 54.1, 41.9, 22.3, 12.1; IR (KBr): 1729, 1587, 1601 cm^{-1}; MS: *m*/*z* 496 (M^+).

2-Methyl-8-[(2-methyl-3-methyl-4-oxo-2,4-dihydrochromeno[4,3-*c*]pyrazol-8-yl)methyl]-3-methyl-2,4-dihydrochromeno[4,3-c]pyrazol-4-one 7g: Yellow solid, m.p. 186-87°C; ^{1}H NMR (DMSO-d_6): δ 7.76-6.9 (m, 6H), 4.0 (s, 2H), 3.71 (s, 6H), 2.52 (s, 6H); ^{13}C NMR: δ 158.2, 150.6, 149.3, 142.1, 133.6, 132.3, 131.2, 119.4, 118.1, 101.8, 41.9, 32.5, 11.2; IR (KBr): υ 3050, 2985, 1710, 1590, 1600 cm^{-1}; MS: *m*/*z* 440 (M^+).

Acknowledgements

The authors thank the Director, Indian Institute of Chemical Technology, Hyderabad, India for providing facilities for spectral analysis.

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