

SYNTHESIS OF 3-[2-(SUBSTITUTED SULFONYL)-1H-IMIDAZOL-YL]CHROMEN-2-ONE DERIVATIVES

Nalajam.Guravaiah and Vedula.Rajeswar Rao*

Department of Chemistry, National Institute of Technology, Warangal 506 021, AP, India

*Address Corresponding to V.Rajeswar Rao Department of Chemistry, National Institute of Technology, Warangal 506 004, A.P., India.

e-mail: vrajesw@yahoo.com

Abstract: Reaction of 3-(2-Mercapto-1H-imidazol-4-yl)chromen-2-one (1) with various alkyl/aryl/phenacyl halides in a mixture of anhydrous ethanol and dimethyl formamide gave the corresponding 3-(2-substituted sulfanyl-1H-imidazol-4-yl)chromen-2-ones (2). These on further reaction with hydrogen peroxide in acetic acid resulted in the formation of corresponding sulfones (3) in good yields. The structure of the synthesized compounds were established from evidences like IR, NMR and mass spectral data.

Introduction

Substituted imidazoles are a class of pharmaceutically important heterocyclic compounds due to the presence of N-C-N grouping^{1, 2}. They are well known as antiinflammatory agents³, antimicrobials⁴, CNS depressants⁵, fungicides, and herbicides⁷. The sulfonyl moiety has received much attention as a potential pharmacophore in medicinal chemistry due to their antibacterial, antimalarial antifungal and anti tubercular properties⁸⁻¹⁴.

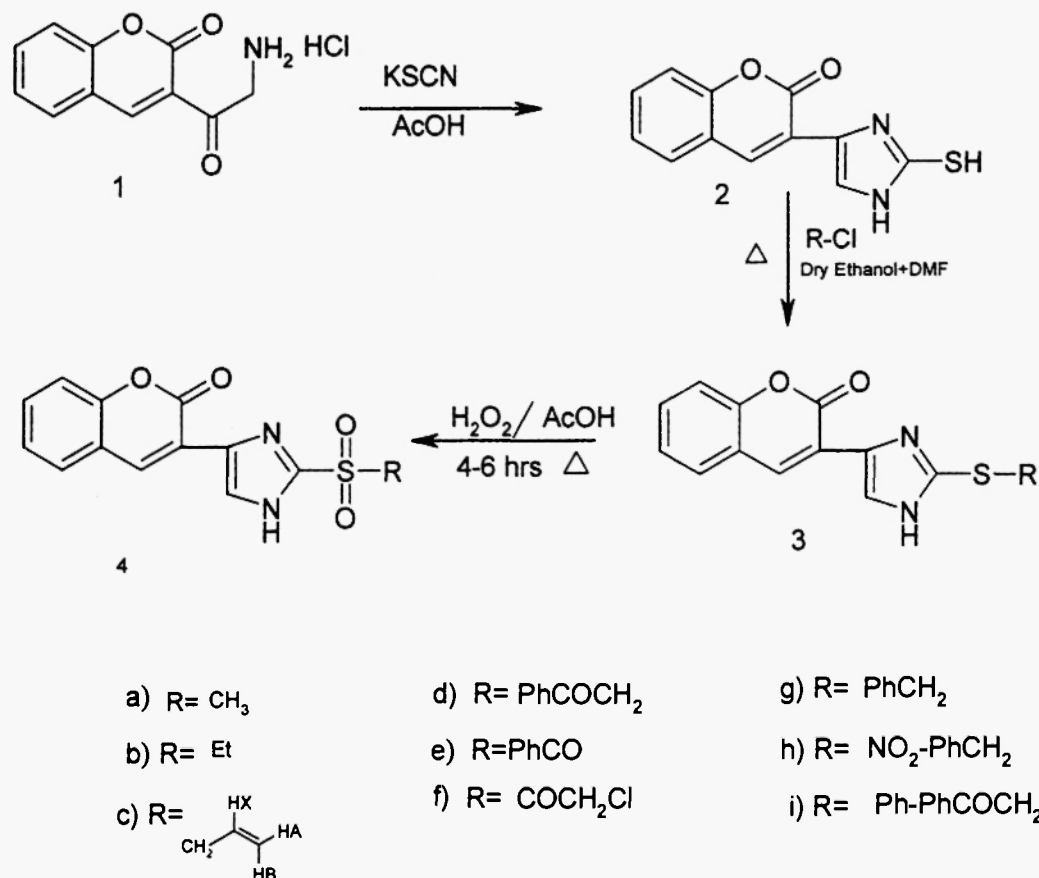
Coumarin derivatives are well known for their anticoagulant, antifungal, diuretic, fibrinolytic and antitubercular activities¹⁵. Among the various heterocyclic system linked to the third position of the coumarin ring, pyridyl-coumarins have been reported as CNS depressants¹⁶ and antimicrobial agents¹⁷. In continuation of our earlier work, on the synthesis of heterocyclic systems derived from coumarin, we report here in a synthesis 3-(2-substituted sulfonyl-1H-imidazol-4-yl) chromen-2-ones.

Results and discussion

Condensation of 3-(2-bromo acetyl) coumarin with hexamethylenetetraamine resulted in the formation of 3-(2-amino acetyl) coumarin¹⁸. This on further reaction with potassium thiocyanate in acetic acid gave 3-(2-mercapto-1H-imidazol-4-yl) chromen-2-one (1). Condensation of 3-(2-mercapto-1H-imidazol-4-yl) chromen-2-one (1) with various alkyl/aryl/phenacyl halides in a mixture of anhydrous ethanol and dimethyl formamide provides 3-(2-Substituted sulfanyl-1H-imidazol-4-yl)chromen-2-ones (2). These on oxidation with hydrogen peroxide in acetic acid afforded the 3[2-(substituted sulfonyl)-1H-imidazol-yl]chromen-2-one derivatives (4). The newly synthesized compounds have been characterized from their analytical and spectral data.

The compounds (2) displayed characteristic absorption bands in IR spectrum due to 2560 cm⁻¹ (SH), 1726 cm⁻¹ (lactone -C=O), and 3407 cm⁻¹ (NH) groups. The ¹H NMR spectrum of (2) exhibited characteristic peaks for -SH, -NH and imidazole and C₄

proton of coumarin, at δ 12.6, δ 12.3, δ 7.3 and δ 8.3 respectively. The remaining protons of coumarin were observed in the usual regions. In mass spectrum of (2) the molecular ion was recorded at m/z 244. Reaction of (2) with various alkyl / aryl / phenacyl halides in a mixture of anhydrous ethanol and dimethyl formamide (equal volumes) afforded a series of 3-(2-substituted sulfanyl-1H-imidazol-4-yl) chromen-2-ones (3). In the alkylation process the more nucleophilic sulphur of thiol group displaces the halogen atom of alkylhalide to yield thioether (3). The alkylation is regioselective and no mixture of product is formed. This is evidenced from TLC and spectra. These compounds (3) displayed characteristic absorption bands in the IR spectrum at 1228 cm^{-1} are due to C-N-C linkage. The lactone carbonyl absorption were found in the region of 1720 cm^{-1} and $3200\text{--}3230\text{ cm}^{-1}$ (-NH). In the ^1H NMR spectra (3) exhibited a characteristic peaks for NH and C_4 proton of coumarin at δ 9.5 and δ 8.2 respectively. In the IR spectrum the compound 4 showed two characteristic peaks at $1301\text{--}1328$ and $1148\text{--}180\text{ cm}^{-1}$ SO asymmetric stretching and SO asymmetric stretching. The lactone -C=O $1729\text{--}1744\text{ cm}^{-1}$ while NH stretching vibration are observed at $3350\text{--}3438\text{ cm}^{-1}$.



Scheme-1

EXPERIMENTAL

All melting points were determined in open capillaries with a "cintex" melting point apparatus Mumbai, India and were uncorrected. CHNS analysis was done by Carlo Erba EA 1108 automatic elemental analyzer. The purity of the compounds was checked by TLC plates (E.Merek, Mumbai, India) IR spectra (KBr) were recorded on a Bruker WM-4(X) spectrometer (577 model). ¹H NMR spectra were recorded on a Bruker WM-300 spectrometer in δ ppm using TMS as internal standard. Mass spectra (EI-MS) were determined on Perkin Elmer (SCIEX API-2000, ESI) at 12.5 eV. The 3-(2-amino acetyl) coumarin ¹⁸, 3-(2-bromo acetyl) coumarin ^{19,20} were prepared according to the literature procedure.

3-(2-Mercapto-1H-imidazol-4-yl) chromen-2-one (1)

A mixture of 3-(2-amino acetyl) coumarin (0.01 mole) and potassiumthiocyanate (0.01 mole) in acetic acid was refluxed for four hours. The reaction mixture was cooled to room temperature, the solid separated was filtered, washed with water and recrystallised from methanol.

3-(2-Substituted sulfanyl-1H-imidazol-4-yl) chromen-2-ones (2): General procedure

A mixture of **1** (0.001 mole) and appropriate alkyl/aryl/ phenacyl halide (0.001 mole) was refluxed in a mixture of equal volumes of anhydrous ethanol and dimethyl formamide for 6-8 hours. The reaction mixture was cooled to room temperature, the solid separated was filtered, washed with water and recrystallised (**Table-I**) from suitable solvents.

3[2-(Substitute sulfonyl)-1H-imidazol-yl] chromen-2-one derivatives (3): - General procedure

Compound **2** (0.01 mole) was suspended in 15 ml glacial acetic acid. To above suspension 5 ml of 30% hydrogen peroxide was added and heated on a water bath for 2-3 hours. The contents were cooled and poured on to crushed ice and the solid separated was collected dried and recrystallised from ethyl acetate.

Conclusions :

In summary, we have prepared 3-(2-mercapto-1H-imidazol-4-yl) chromen-2-one (**2**) in single step starting from 3-(2-amino acetyl) coumarin (**1**) in high yield. This compound was subsequently converted into their basic ethers (**3**). The compounds (**3**) were oxidized into corresponding sulfones with hydrogen peroxide in acetic acid. The compounds prepared have been subjected for their anticancer activity. None of the compounds have shown anticancer activity.

Table 1: Analytical data of compounds 2, 3a-i and 4a-i

Comp*	R	Yield (%)	m p (°C)	Mol. formula (Mol. wt)	Found (calcd) %			
					C	H	N	S
2	-	90	>300	C ₁₂ H ₁₁ N ₂ O ₂ S (244)	58.95 (59.00)	3.26 (3.30)	11.43 (11.47)	13.10 (13.13)
3a	CH ₃ -	93	130-132	C ₁₃ H ₁₀ N ₂ O ₂ S (258)	60.41 (60.45)	3.87 (3.90)	10.81 (10.85)	12.36 (12.40)
3b	Et-	95	140-142	C ₁₄ H ₁₂ N ₂ O ₂ S (272)	61.78 (61.75)	4.40 (4.44)	10.25 (10.29)	11.67 (11.7)
3c	CH ₂ =CH-CH ₂ -	82	200-202	C ₁₅ H ₁₂ N ₂ O ₂ S (284)	66.24 (63.36)	4.21 (4.25)	9.88 (9.85)	11.21 (11.20)
3d	PhCOCH ₂ -	85	226-228	C ₂₀ H ₁₄ N ₂ O ₃ S (362)	66.24 (66.28)	3.85 (3.89)	7.70 (7.73)	8.81 (8.85)
3e	PhCO-	68	140-144	C ₁₉ H ₁₂ N ₂ O ₃ S (348)	65.50 (65.51)	3.43 (3.47)	8.00 (8.04)	9.17 (9.20)
3f	COCH ₂ Cl-	90	212-214	C ₁₄ H ₁₁ C N ₂ O ₃ S (320)	52.42 (52.45)	2.83 (2.81)	8.73 (8.70)	10.00 (10.05)
3g	PhCH ₂ -	83	260-262	C ₁₉ H ₁₄ N ₂ O ₂ S (334)	68.21 (68.25)	4.20 (4.22)	8.38 (8.38)	9.52 (9.59)
3h	O ₂ N-PhCH ₂ -	88	212-213	C ₁₉ H ₁₁ N ₂ O ₂ S (379)	60.10 (60.15)	3.41 (3.45)	11.00 (11.08)	8.1 (8.4)
3i	Ph-PhCOCH ₂ -	87	230-232	C ₂₆ H ₁₈ N ₂ O ₃ S (438)	71.20 (71.22)	4.10 (4.14)	6.34 (6.39)	7.28 (7.31)
4a	CH ₃ -	60	80-82	C ₁₃ H ₁₀ N ₂ O ₃ S (290)	53.91 (53.97)	3.41 (3.47)	9.60 (9.65)	11.00 (11.05)
4b	Et-	55	88-90	C ₁₄ H ₁₂ N ₂ O ₃ S (304)	55.20 (55.26)	3.90 (3.97)	9.18 (9.21)	10.44 (10.50)
Comp*	R	Yield (%)	m p (°C)	Mol. formula (M	Found (ca'cd) %			

				ol.wt)	C	H	N	S
4c	$\text{CH}_2=\text{CH}\cdot\text{CH}_2^-$	50	92-94	$\text{C}_{13}\text{H}_{12}\text{N}_2\text{O}_5\text{S}$ (316)	56.91 (56.95)	3.80 (3.82)	8.83 (8.86)	10.17 (10.23)
4d	PhCOCH_2^-	80	120-124	$\text{C}_{10}\text{H}_{10}\text{N}_2\text{O}_5\text{S}$ (394)	60.88 (60.91)	3.50 (3.53)	7.08 (7.10)	8.10 (8.13)
4e	$\text{PhCO}-$	77	110-112	$\text{C}_9\text{H}_{10}\text{N}_2\text{O}_5\text{S}$ (380)	59.97 (60.00)	3.14 (3.18)	7.32 (7.36)	8.40 (8.43)
4f	$\text{COCH}_2\text{Cl}-$	90	96-98	$\text{C}_{14}\text{H}_{13}\text{N}_2\text{O}_5\text{S}$ (352)	59.49 (59.59)	4.61 (4.67)	9.21 (9.27)	10.54 (10.60)
4g	PhCH_2^-	85	118-120	$\text{C}_{10}\text{H}_{10}\text{N}_2\text{O}_5\text{S}$ (366)	62.24 (62.29)	3.81 (3.85)	7.61 (7.65)	8.70 (8.79)
4h	$\text{O}-\text{N}-\text{PhCH}_2^-$	88	155-156	$\text{C}_{10}\text{H}_{10}\text{N}_2\text{O}_5\text{S}$ (411)	55.44 (55.47)	3.15 (3.19)	10.2 (10.21)	7.65 (7.73)
4i	Ph-PhCOCH_2^-	85	160-162	$\text{C}_{16}\text{H}_{16}\text{N}_2\text{O}_5\text{S}$ (470)	66.31 (66.37)	3.80 (3.85)	5.91 (5.97)	6.75 (6.81)

Compound 2 was recrystallised from methanol. Compounds 3a,c,d,f were recrystallised from methanol. 3d,e,g,h,i were recrystallised aqueous acetone. 4(a-i) was recrystallised from ethyl acetate.

Table : 2 Spectroscopic data of compounds 2,3(a-i) and 4(a-i)

compd	IR ($\nu_{\max}$ cm ⁻¹)				¹ H NMR (δ ppm)		Mass spectra (m/z) 100%
	-C=N-	>C=O(lactone)	NH	-C=O	SO ₂ (sym.)	SO ₂ (asym.)	
2	1609	1726	3407	---	---	---	244
3a	1611	1709	3436	---	---	---	258
3b	1606	1706	3621	---	---	---	212
3c	1636	1706	3420	---	---	---	284
3d	1607	1715	3399	1690	---	---	362
3e	1610	1720	3437	1750	---	---	---
3f	1615	1730	3420	---	---	---	---
3g	1606	1720	3060	---	---	---	---
3h	1602	1719	3436	---	---	---	379
3i	1600	1721	3621	1662	---	---	437

compd	IR ($\nu_{\max}$ cm ⁻¹)					¹ H NMR (δ ppm)		Mass spectra (m/z, 100%)
	-C=N-	>C=O(lactone)	NH	C=O	SO ₂ (sym.)	SO ₂ (asym)		
4a	1605	1742	3390	---	1170	1303	3.1 (s, 3H, -CH ₃), 7.30-7.60 (m, 4H, Ar-H), 8.10 (s, 1H, imidazole), 8.6 (s, 1H, C4 of coumarin) and 9.3 (b NH)	244
4b	1628	1729	3438	---	1179	1303	1.75 (t, 3H, -CH ₃), 3.4 (q, 2H, -CH ₂), 7.30-7.72 (m, 4H, Ar-H), 8.0 (1H, imidazole), 8.6 (s, 1H, C4 of coumarin) 9.3 (b, NH)	290
4c	1607	1735	3395	---	1176	1322	4.15 (d, 2H, J=5 Hz SO ₂ -CH ₂), 5.3 (d, 1H, H _A , J=8 Hz), 5.4 (d, H _B , H _B , J=18 Hz), 6.12-6.30 (m, 1H, H _C), 7.30-7.70 (4H, Ar-H), 8.3 (s, 1H, imidazole), 8.7 (s, 1H, C4 of coumarin), 9.35 (s, 1H, NH)	304
4d	1607	1731	3441	1689	1180	1314	5.3 (s, 2H, SO ₂ -CH ₂), 7.5-7.70 (m, 9H, Ar-H), 7.95 (s, 1H, NH), 8.20 (s, 1H, imidazole), 8.6 (s, 1H, C4 of coumarin),	317
4e	1622	1744	3400	1686	1148	1302	-----	---
4f	1619	1744	3469	1685	1150	1301	-----	---
4g	1614	1718	3365	1697	1165	1315	4.75 (s, 2H, -CH ₂), 7.3-7.5 (m, 7H, Ar-H), 7.62-7.70 (m, 3H, 2Ar-H and 1H imidazole), 8.0 (C4 of Coumarin), 8.70 (s, 1H, NH)	---
4h	1629	1725	3390	1680	1174	1305	-----	---
4i	1602	1729	3350	1690	1176	1328	5.6 (s, 2H, -SO ₂ -CH ₂), 7.30-7.80 (m, 15H, Ar-H and NH of imidazole), and 8.0 (s, 1H, C4 of Coumarin)	470

¹H NMR of the compounds 2, 3 (a, b, c, f, g, h, i) and 4 a-d i were run in CDCl₃ while the compounds 3d, 3e were run in CDCl₃+ DMSO-d₆

Acknowledgement:

The authors are thankful to Head analytical division, IICT Hyderabad for analytical and spectral data. Further the authors are very thankful to CSIR, New Delhi for the sanction of the project (No.01 (2062) 06 / EMR-II).

References

- 1 S.Kano, D. Takiguchi & T. Nagouchi , Japan 6824,187;Chem Abstr, 70, 57839 (1969).
- 2 N. H. Lin, L. Wang , X.Wang ,G.T. Wang , J. Cohen, W.Z .Cu,H. Zhang, S.H.Rosen berg and H.L.Sham, Bioorg & Med Chem Lett, 14 (20), 5057 (2004).
- 3 R.Singh, V.K.Pandey, & R.C.Srimal , Indian J Pharm Sci,54, 4 (1992).
- 4 M.M.Girges , M.M.A.Zahab & M.A.Hanna ,collect Czech Chem Coumum, 54,109 (1989);Chem Abstr 112, 55699 (1990).
- 5 M.Kidwai , P.Sapra , K.R,Bhushan and P. Misra , Synthesis,10,1509 (2001).
- 6 A.F.Pozhershii, A.T.Soldatenkov and A. Katritzky, Hetero cycles in life and society, Wiley:New York, 179 (1997).
- 7 R.Liebl , R. Randle , H.Mildenberger , K.Bauer and H.Bieringer , Ger offen DE 3,604,042; Chem Abstr 108(1), 6018 (1988).
- 8 E.D.Bergmann and D. Lavie , J Am Chem Soc,74.4948 (1952).
- 9 I.C.Popoff, A.R.Engle, R.L.Whitaker and G.H. Singhal, J Med Chem, 14, 1166 (1971).
- 10 R.E.Boundy, Burger's Medicinal Chemistry, Part-II, edited by M.E Wolf(John Wiley, New York).
- 11 V.E.Bhingolikar, S.R.Mahalle, S.P.Bondge and R.A. Mane, Ind.J.Chem, 44B, 2589 (2005).
- 12 S.N.Pandeya, T.J.Ojha and V. Srivastava, J Scient Ind Res, 44, 150 (1985).
- 13 M.R.Christopher, Contemporary Organic Synthesis,2, 409 (1995).
- 14 N.S.Simpkins ,Sulfones in organic synthesis in Tetrahedron organic chemistry series, Vol.10,edited by J.E.Baldwin and P.D.Mangus.(pergamon press,Oxford),(1993).
- 15 G.Feuer, In progress in Medicinal Chemistry edited by G.P.Ellis andG.B.West (North Holland publiseing Comp), New York, p.85 (1974).
- 16 R.S.Moffet, J.Med.Chem, 7, 446 (1964).
- 17 B. Sreenivasulu, V. Sundara Murthy, and N. V. Subba Rao, Proc,Ind.Acad.sci.,79A, 41 (1974).
- 18 R.V.Jhoshi and V.V.Badiger,Current Science,56, 811 (1987)
- 19 C.F.Koelsch, J.Am.Chem.Soc, 72, 2993 (1950).
- 20 V.Rajeswar Rao and T.V.Padmanabha Rao, Ind J Chem, 25B, 413 (1986).

Received on 10 June, 2008