

This article was downloaded by:

On: 29 January 2011

Access details: *Access Details: Free Access*

Publisher *Taylor & Francis*

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Phosphorus, Sulfur, and Silicon and the Related Elements

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t713618290>

CHLOROSULFONATION OF N-BENZYL CARBOXAMIDES

Richard Cremlyn^a, Linda Ellis^a, Anthony Pinney^a

^a Division Of Chemical Sciences, Hatfield Polytechnic, Hertfordshire, England

To cite this Article Cremlyn, Richard , Ellis, Linda and Pinney, Anthony(1989) 'CHLOROSULFONATION OF N-BENZYL CARBOXAMIDES', *Phosphorus, Sulfur, and Silicon and the Related Elements*, 44: 3, 167 — 175

To link to this Article: DOI: 10.1080/10426508908040606

URL: <http://dx.doi.org/10.1080/10426508908040606>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

CHLOROSULFONATION OF *N*-BENZYL CARBOXAMIDES

RICHARD CREMLYN,* LINDA ELLIS and ANTHONY PINNEY
*Division of Chemical Sciences, Hatfield Polytechnic, Hatfield, Hertfordshire,
 AL10 9AB, England*

(Received August 23, 1988)

N-Benzyl *p*-chloro- and 2,4-dichloro-benzamide (3, 4) reacted with chlorosulfonic acid to give the corresponding *p*-sulfonyl chlorides (6, 7). On the other hand, *N*-benzylthiophen-2-carboxamide (5) afforded the 2,4¹-disulfonyl chloride (21). The sulfonyl chlorides (6, 7, 21) were condensed with nucleophiles to give 22 derivatives. The spectral data of the compounds are briefly discussed, together with the results of preliminary biological screening against fungi, insects and weeds.

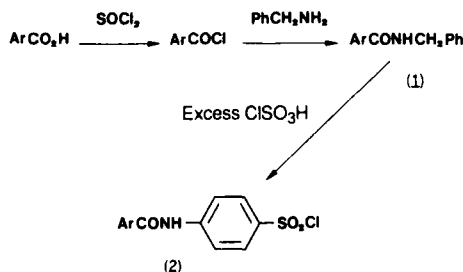
Key words: Chlorosulfonation of; *N*-Benzyl-*p*-chlorobenzamide (3); *N*-Benzyl-2,4-dichlorobenzamide (4); *N*-Benzylthiophen-2-carboxamide (5).

INTRODUCTION

The work forms part of our general programme on the chemistry and biological activity of aryl sulfonyl derivatives.¹⁻³ We have demonstrated that amides⁴⁻⁷ and anilides⁸⁻⁹ reacted smoothly with chlorosulfonic acid to yield the corresponding sulphonyl chlorides.

The chlorosulfonation of anilides is facilitated by the electron-releasing properties of the lone electron pair on the amidic nitrogen atom.

In the current work, we examined the reaction of some benzylbenzamides (1) with chlorosulfonic acid; the chlorosulfonation of this group of compounds has not been reported. The starting materials (1) were prepared by reacting the aromatic carboxylic acid sequentially with thionyl chloride and benzylamine (Scheme 1). (1) with excess of chlorosulfonic acid should yield the *p*-sulfonyl chloride (2). The orientation of sulfonation is governed by the electron-releasing hyperconjugative effect of the methylene group. The other aromatic centre (Ar) is deactivated towards electrophilic substitution by the adjacent electron-withdrawing carbonyl group.

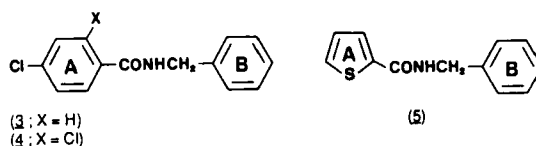


SCHEME 1

The sulfonyl chlorides (2) by condensation with nucleophiles, e.g. amines, hydrazine and azide ion can be converted into novel sulfonyl derivatives for biological evaluation as candidate biocides, especially against bacteria and fungi (cf. Refs, 8, 10).

DISCUSSION

p-Chloro-, 2,4-dichloro-benzoic acid and thiophen-2-carboxylic acid were treated with thionyl chloride and benzylamine to give excellent yields of the corresponding benzyl carboxamides (3, 4, 5).



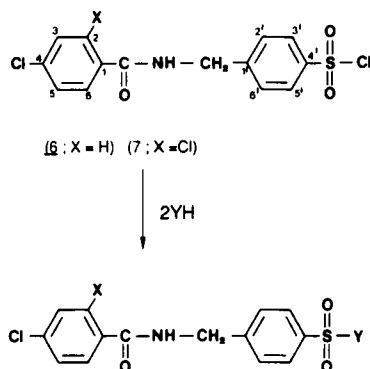
The mass spectra of the benzyl carboxamides (3, 4, 5) showed the molecular ions (M^+ , 243, 277 and 217 respectively); the fragmentation pattern was consistent with successive loss of the PhCH_2 , NH and CO moieties.

The high resolution NMR spectrum of 3 showed the resonance of the 4 protons of the phenyl ring (A) as the AA' BB' pattern (δ 7.7) at lower field than the multiplet due to the 5 protons of ring B (δ 7.35). The difference arises from the deshielding effects of the chlorine and carbonyl groups on the ring A protons. The methylene protons appeared as a doublet (δ 4.6) which was in excellent agreement with the calculated value (δ 4.5) based on the application of Schoolery's Rule. *N*-Benzylthiophen-2-carboxamide (5) showed the thiophene and phenyl ring protons as multiplets (δ 7.8, 7.3 respectively) with the methylene protons as a doublet (δ 4.5).

N-Benzyl *p*-chlorobenzamide (3) reacted with chlorosulfonic acid (6 equivalents) at room temperature (1 week) to give water-soluble products, probably the sulfonic acid. The amount of reagent was increased (12 equivalents), but only very low yields of product (<5%) were realised. However, repetition of the reaction in boiling chloroform (3 h) afforded an excellent yield (84%) of the *p*-sulfonyl chloride (6). *N*-Benzyl 2,4-dichlorobenzamide (4) was similarly converted into 7 (74%).

The sulfonyl chlorides (6, 7) were condensed with amines and hydrazine to give the sulfonyl derivatives (8–20) (Chart 1 and Table I).

The reaction of *N*-benzylthiophen-2-carboxamide (5) with chlorosulfonic acid was initially examined using 6 equivalents of the reagent at 40°C for $\frac{3}{4}$ hour, conditions successfully used for the chlorosulfonation of thiophen-2-carboxanilide.¹¹ However, this procedure only afforded water-soluble products, and the reaction was then studied using varying amounts of chlorosulfonic acid (3, 6, 9, 12 and 18 equivalents) at room temperature. With 3 equivalents of the reagent, starting material remained and with <12 equivalents a plastic mass was obtained on addition of water. The optimum conditions were found to involve a



	X	Y
8	H	NH ₂
9	H	morpholino
10	H	PhCH ₂ NH
11	H	NHNH ₂
12	H	NHN = CMe ₂
13	H	NHN = CHPh
14	H	NHN = CHC ₆ H ₄ -NO ₂ -p
15	H	NHN = CHC ₆ H ₄ -OMe-p
16	Cl	NMe ₂
17	Cl	NEt ₂
18	Cl	morpholino
19	Cl	2, 6 - dimethylmorpholino
20	Cl	NHN = CMe ₂

CHART 1

large excess of the reagent (16.5 equivalents) at room temperature (31 days) which afforded an excellent yield (90%) of the disulfonyl dichloride (**21**) (Chart 2).

The chlorosulfonation was examined at different temperatures (40°, 65°, 80°, 90° and 140°) for a period of 4 hours. At 40°C, reaction was incomplete, while at higher temperatures increasing amounts of decomposition occurred (TLC showed up to 8 spots). However, it was discovered that the reaction could be carried out in boiling chloroform (4 hours) to give a lower yield (54%) of **21**.

The disulfonyl dichloride (**21**) was reacted with amines and hydrazine to give the sulfonyl derivatives (**22-30**) (Chart 2 and Table II).

The microanalytical data for **21** and its derivatives and the FAB MS of **21** which showed the $M^+ + 1$ ion (415) clearly indicated that the product was the disulfonyl dichloride. Disulfonation would not occur in the same ring due to the deactivating effect of the sulfonyl group.

The NMR spectrum of **21** showed the resonances due to the 4 protons of the phenyl ring as a multiplet (δ 8.4–8.0) with the AA' BB' pattern, indicative of *p*-sulfonation. In the case of a thiophene containing an electron-withdrawing substituent in the 2-position, further electrophilic substitution would occur preferentially in the 4-rather than the 5-position of the thiophene ring.¹¹⁻¹² Thus

TABLE I

Physical data for the *N*-(*p*-sulfonylbenzyl)-4-chloro- and 2,4-dichlorobenzamides

Compd. no.	Yield (%)	m.p. (°C)	Molecular formula	Microanalysis found (calc.) %			MS (M ⁺)
				C	H	N	
6	84	150–151	C ₁₄ H ₁₁ Cl ₂ NO ₃ S	49.2 (48.9)	3.3 (3.2)	4.0 (4.0)	347*
7	74	96–98	C ₁₄ H ₁₀ Cl ₃ NO ₃ S	44.2 (44.4)	2.8 (2.6)	3.9 (3.7)	383*
8	87	208–210	C ₁₄ H ₁₃ ClN ₂ O ₃ S	51.9 (51.8)	4.0 (4.0)	8.6 (8.6)	326*
9	92	121–123	C ₁₈ H ₁₉ ClN ₂ O ₄ S	54.9 (54.8)	4.8 (4.9)	7.1 (7.1)	394*
10	95	201	C ₂₁ H ₁₉ ClN ₂ O ₃ S	60.6 (60.8)	4.6 (4.6)	6.7 (6.8)	414*
11	88	143	C ₁₄ H ₁₄ ClN ₂ O ₃ S	50.0 (49.5)	4.2 (4.2)	12.2 (12.2)	340*†
12	38	153–155	C ₁₇ H ₁₈ ClN ₃ O ₃ S	54.0 (53.8)	4.8 (4.8)	10.9 (11.1)	380†
13	33	201–202	C ₂₁ H ₁₈ ClN ₃ O ₃ S	59.0 (58.9)	4.2 (4.2)	9.7 (9.8)	429*†
14	50	182	C ₂₁ H ₁₈ ClN ₄ O ₅ S	53.0 (53.2)	4.0 (3.8)	12.1 (11.8)	474*†
15	70	192–193	C ₂₁ H ₂₀ ClN ₃ O ₄ S	56.2 (56.5)	4.4 (4.5)	9.8 (9.5)	459*†
16	65	130–131	C ₁₆ H ₁₆ Cl ₂ N ₂ O ₃ S	49.9 (49.6)	4.2 (4.1)	7.1 (7.2)	386*
17	72	166–168	C ₁₈ H ₂₀ Cl ₂ N ₂ O ₃ S	51.7 (52.0)	4.7 (4.8)	6.6 (6.75)	416*
18	75	169	C ₁₈ H ₁₈ Cl ₂ N ₂ O ₄ S	50.5 (50.3)	4.4 (4.2)	6.2 (6.5)	430*
19	74	187–188	C ₂₀ H ₂₂ Cl ₂ N ₂ O ₄ S	52.3 (52.5)	4.7 (4.8)	6.2 (6.1)	458*
20	55	153	C ₁₇ H ₁₇ Cl ₂ N ₃ O ₃ S	49.0 (49.3)	3.9 (4.1)	9.8 (10.1)	—

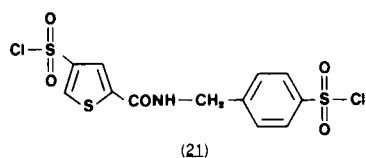
* Molecular ion cluster, highest ion quoted.

† FAB MS showing M⁺ + 1 ion.

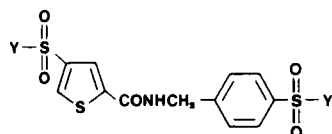
previous studies¹² demonstrated that thiophen-2-carboxamide reacted with chlorosulfonic acid to give the 4-sulfonyl chloride. In the current work, the NMR spectra of **21** and its derivatives showed the thiophen-3,5 proton resonances as two singlets: δ 8.36, 8.1 with the coupling constant ($J_{3,5}$) of ca. 1.0 Hz. If sulfonation had occurred in the 5-position, the coupling constant ($J_{3,4}$) would have been appreciably larger (4 Hz).

We have found previously¹¹ that thiophen-2-carboxanilide reacted with chlorosulfonic acid (6 equivalents) with selective sulfonation in the *p*-position of the aniline ring. There was no sulfonation of the thiophene nucleus, presumably a reflection of the strong electron-releasing property of the amino group.

In contrast, with *N*-benzylthiophen-2-carboxamide (**6**) monosulfonation was not observed and only the disulfonyl dichloride (**21**) was isolated. The two aromatic rings A and B apparently have comparable reactivity towards sulfonation, probably because the hyperconjugative electron-releasing effect of the



4YH



Y

- 22 NMe₂
- 23 morpholino
- 24 2, 6 - dimethylmorpholino
- 25 PhCH₂NH
- 26 pyrrolidino
- 27 piperidino
- 28 3, 4(MeO)₂C₆H₃CH₂CH₂NH
- 29 NHHN₂
- 30 NHN = CMe₂

CHART 2

TABLE II
Physical data for the *N*-(*p*-sulfonylbenzyl)-4-sulfonyl thiophen-2-carboxamides

Compd. no.	Yield (%)	m.p. (°C)	Molecular formula	Microanalysis found (calc.) %				MS (FAB) (M ⁺ + 1)
				C	H	N	S	
21	90	161–162	C ₁₂ H ₉ Cl ₂ NO ₅ S ₃	35.1 (34.8)	2.2 (2.2)	3.2 (3.4)		414*
22	36	153–154	C ₁₆ H ₂₁ N ₃ O ₅ S ₃	44.7 (44.5)	4.9 (4.9)	9.4 (9.7)	22.0 (22.3)	432
23	25	233–235	C ₂₀ H ₂₅ N ₃ O ₇ S ₃	46.4 (46.6)	4.9 (4.9)	8.0 (8.1)	18.6 (18.9)	516
24	57	180	C ₂₄ H ₃₃ N ₃ O ₇ S ₃	50.1 (50.4)	5.7 (5.8)	7.0 (7.3)		572
25	50	161–162	C ₂₁ H ₂₅ N ₃ O ₅ S ₃	50.7 (50.9)	5.1 (5.1)	8.3 (8.5)		554
26	3	169–171	C ₂₀ H ₂₅ N ₃ O ₅ S ₃	49.5 (49.7)	5.1 (5.2)	8.5 (8.7)	19.6 (19.9)	484
27	28	159–161	C ₂₂ H ₂₉ N ₃ O ₅ S ₃	51.4 (51.7)	5.9 (5.7)	8.1 (8.2)	18.6 (18.8)	512
28	13	145	C ₃₂ H ₃₇ N ₃ O ₉ S ₃	55.0 (54.6)	5.2 (5.3)	6.2 (6.0)		703
29	62	127–129	C ₁₂ H ₁₅ N ₅ O ₅ S ₃	35.9 (35.6)	4.0 (3.7)	17.0 (17.3)		406
30	49	169–171	C ₁₈ H ₂₃ N ₅ O ₅ S ₃	44.6 (44.5)	4.8 (4.8)	14.1 (14.4)	19.6 (19.8)	486

methylene group on the phenyl ring (B) would be relatively weak as cf. the amino group in thiophen-2-carboxanilide.

The IR spectra of the sulfonyl chlorides (**6**, **7**, **21**) showed the normal stretching absorptions associated with the C=O, NH and ArC=C groups and additionally two bands at 1380–1330 and 1180–1130 indicative of the SO₂ group.¹³

In agreement with previous observations,^{8,11} electron impact mass spectroscopy (EI MS) of the hydrazides and hydrazones (**11–15**, **29–30**) did not show the molecular ions (M⁺). However, when these compounds were examined by fast atom bombardment mass spectroscopy (FAB MS) the M⁺ + 1 ions were observed (Tables 1 and 2). The technique allows formation of the M⁺ + 1 ions with less energy input as cf. EI MS, consequently there is less fragmentation of sensitive molecules and an enhancement of the molecular ion signal.

The compounds described have been examined for biocidal properties against fungi, insects and weeds. In the preliminary antifungal screen at 100 ppm against vine downy mildew, potato blight, wheat rust, apple and barley mildew and rice blast, compounds **11**, **12**, **16**, **19**, **20**, **24**, **29** and **30** were all active against wheat rust and **20** was also active against downy mildew. All the compounds were inactive against the range of insect and weed species.

EXPERIMENTAL

Melting points were determined with a Mettler FP5 automatic apparatus set at 2°C per minute, and are uncorrected. NMR spectra were recorded on a Bruker WP80 spectrometer on a Bruker WH 300 spectrometer (high resolution) using tetramethylsilane as internal standard and DMSO-d₆ as solvent unless otherwise stated, an asterisk indicates resonances that were removed by D₂O treatment. MS were recorded with a VG 7070F high resolution mass spectrometer. TLC was carried out Merck silica gel plates sensitized to UV 254 nm and ethyl acetate-hexane (1:1) as eluant unless otherwise indicated.

N-Benzyl *p*-chlorobenzamide (**3**)

p-Chlorobenzoic acid (29 g, 0.13 mol) was dissolved in thionyl chloride (121.6 g, 1.0 mol) containing DMF (2 drops). The solution was refluxed for 3 hours. Excess thionyl chloride was removed, the residual liquid diluted with ether (50 ml).

A solution of triethylamine (38.9 g, 0.39 g mol) and benzylamine (41.4 g, 0.39 mol) in ether (80 ml) was added dropwise with stirring.

The mixture was heated on the steam-bath for 1 hour and poured onto crushed ice (200 g). The precipitate was filtered off, washed with water (3 × 50 ml) and air-dried. The solid was shaken with ether (60 ml) for 15 minutes, and filtered to give **3** (27.1 g, 99%), m.p. 166°C (lit.¹⁴ 167–168°C). TLC showed 1 spot *R_F* 0.50 (Found: C, 68.0; H, 4.8; N, 5.8. C₁₄H₁₂ClNO requires C, 68.4; H, 4.9; N, 5.7%). IR ν_{\max} 3350 (NH), 1660 (C=O), 1610 (ArC=C) cm⁻¹. MS: 245 (M⁺), 139 (M–NHCH₂Ph), 106, 91, 75. NMR: δ 9.2* (s, 1H, NH), 7.5 (m, 9H, ArH), 4.5 (d, 2H, CH₂).

High resolution NMR: δ 9.2* (s, 1H, NH), 7.7 (m, 4H, Ar–H(A)), 7.35 (m, 5H, ArH(B)), 4.6 (d, 2H, CH₂).

N-Benzyl 2,4-dichlorobenzamide (**4**)

2,4-Dichlorobenzoic acid (24 g, 0.13 mol) was similarly converted into **4** (32.9 g, 73%), m.p. 125°C. TLC (cyclohexane: EtoAc 1:1) showed 1 spot *R_F* 0.91. (Found: C, 60.1; H, 4.0; N, 5.0. C₁₄H₁₁Cl₂NO requires C, 60.0; H, 3.9; N, 5.0%). IR ν_{\max} 3255 (NH), 1640 (C=O), 1590 (ArC=C) cm⁻¹.

N-Benzylthiophen-2-carboxamide (**5**)

This was similarly obtained from thiophen-2-carboxylic acid (50 g, 0.39 mol). Yield: 82.4 g (97%), m.p. 118°C (lit.¹⁵ 119.5–120°C). TLC showed 1 spot *R_F* 0.76 (Found: C, 65.9; H, 5.1; N, 6.2. C₁₂H₁₁NOS requires C, 66.3; H, 5.1; N, 6.5%). IR ν_{\max} 3350 (NH), 1630 (C=O), 1580

($\text{ArC}=\text{C}$) cm^{-1} . MS: 217 (M^+), 111 ($\text{M}-\text{NHCH}_2\text{Ph}$), 106, 91, 83, 65, 39. NMR: δ 9.1* (s, 1H, NH), 7.8 (m, 3H, thiophene-H), 7.3 (m, 5H, Ph), 4.5 (d, 2H, CH_2).

N-(4'-Chlorosulfonylbenzyl)-4-chlorobenzamide (**6**)

Method 1

N-Benzyl *p*-chlorobenzamide (**3**) (10 g, 0.04 mol) was added to chlorosulfonic acid (59.3 g, 0.51 mol) at 0°C. The black solution was stirred at room temperature for 2 hours, poured onto ice (100 g); the plastic solid was collected, dissolved in acetone (40 ml) and diluted with ice-water (250 ml). After 20 minutes, the white precipitate was filtered off, washed with water and dried *in vacuo* to give **6** (11.7 g, 84%), m.p. 149–153°C. TLC showed one spot R_F 0.35.

Method 2

N-benzyl *p*-chlorobenzamide (**3**) (5 g, 0.02 mol) was dissolved in chloroform (20 ml) and cooled (0°C). Chlorosulfonic acid (29.6 g, 0.25 mol) was added and the dark brown solution refluxed for 3 hours. The solution was cooled, diluted with chloroform (100 ml) and added to ice-water (25 ml). The brown solid was filtered off under suction, dissolved in acetone (25 ml) and poured onto ice-water (70 ml). The white precipitate was collected and dried *in vacuo* to give **6** (5.9 g, 84%) (Table I). TLC showed one spot R_F 0.33. IR ν_{max} 3275 (NH), 1650 (C=O), 1600 ($\text{ArC}=\text{C}$), 1380, 1180 (SO_2) cm^{-1} . MS: M^+ (347, 345, 343), 139 ($\text{M}-\text{NHCH}_2\text{C}_6\text{H}_4\text{SO}_2\text{Cl}$), 111, 102, 75. NMR: δ 9.2* (s, 1H, NH), 7.6 (m, 8H, ArH), 4.5 (d, 2H, CH_2).

N-(4'-Chlorosulfonylbenzyl)-2,4-dichlorobenzamide (**7**)

N-Benzyl 2,4-dichlorobenzamide (**4**) (5 g) was similarly reacted with chlorosulfonic acid (12.5 mol) to give **7** (5.0 g) (Table 1). IR ν_{max} 3270 (NH), 1640 (C=O), 1590 ($\text{ArC}=\text{C}$), 1350, 1150 (SO_2) cm^{-1} .

N-(4'-Chlorosulfonylbenzyl)-4-Chlorosulfonylthiophen-2-carboxamide (**21**)

First Method

N-Benzylthiophen-2-carboxamide (**5**) (10 g, 0.046 mol) was reacted with chlorosulfonic acid (87.7 g, 0.75 mol) at room temperature for 31 days. The solution was added to ice (200 g), the solid was dissolved in acetone and extracted with chloroform (150 ml). The extract was washed with water, 10% aqueous sodium hydrogen carbonate, water, dried (Na_2SO_4) and evaporated to give **21** (17.2 g), m.p. 159–160°C (Table II).

Second Method

N-Benzylthiophen-2-carboxamide (**4**) (10 g, 0.046 mol) was added to chlorosulfonic acid (87.7 g, 0.75 mol) and diluted with chloroform (40 ml). The solution was refluxed for 4 hours and allowed to cool. The mixture was poured onto ice (200 g) and worked up as previously detailed (Method 1) to give **21** (10.3 g, 54%), m.p. 161–162°C. TLC showed one spot R_F 0.96. IR ν_{max} 3300 (NH), 1640 (C=O), 1600, 1590 ($\text{ArC}=\text{C}$), 1390, 1180 (SO_2) cm^{-1} . High resolution NMR: δ 9.24* (s, 1H, NH), 8.38 (m, 2H, thiophen-3, 5H, $J_{3,5}$ 1.2 Hz), 8.05 (d, 2H, Ar-3', 5'-H), 7.62 (d, 2H, Ar-2', 6'-H), 4.69 (d, 2H, CH_2).

The Preparation of Derivatives

(a) *Sulfonamides (8–10, 16–19)*

The sulfonyl chloride (**6** or **7**) (0.01 mol) was reacted with the appropriate amine (0.02 mol) in acetone (30 ml). The mixture was stirred at room temperature for 3 hours, added to ice-water (100 ml) and the solid product filtered off and recrystallized from ethanol.

For the preparation of the bis-sulfonamides (**22, 28**), the disulfonyl dichloride (**21**) (0.01 mol) was reacted with the amine (0.04 mol) in acetone (30 ml) for 4 days at room temperature.

Compound (9)

IR ν_{max} 3350 (NH), 1660 (CO), 1600, 1580 ($\text{ArC}=\text{C}$), 1360, 1130 (SO_2), 760 (C—Cl) cm^{-1} , MS: 394 (M^+), 245 ($\text{M}-\text{SO}_2\text{C}_6\text{H}_4\text{NO}$), 139 ($\text{ClC}_6\text{H}_4\text{CO}$), 111, 104, 86, 75, 56.

High resolution NMR: δ 7.7 (m, 4H, ClC_6H_4), 7.45 (m, 4H, ArH), 6.5* (t, 1H, NH), 4.52 (d, 2H, ArCH_2), 3.75–2.95 (m, 8H, morpholino H).

Compound (16)

MS: 386, 278 ($\text{M}-\text{SO}_2\text{NMe}_2$), 173 ($\text{Cl}_2\text{C}_6\text{H}_3\text{CO}$). NMR (CDCl_3): δ 8.2–7.5 (m, 7H, ArH), 6.4* (s, 1H; NH), 4.8 (d, 2H, ArCH_2), 2.9 (s, 6H, NMe_2).

Compound (22)

IR ν_{max} 3350 (NH), 1640 ($\text{C}=\text{O}$), 1600, 1560 ($\text{ArC}=\text{C}$), 1340, 1160 (SO_2) cm^{-1} . High resolution NMR δ : 9.45* (t, 1H, NH), 8.45 (d, 1H, thiophen-3H), 8.0 (d, 1H, thiophen-5H, $J_{3,5}$ 1.2 Hz), 7.75–7.6 (m, 4H, ArH), 4.56 (d, 2H, ArCH_2), 2.62 (d, 12H, NMe_2).

(b) Sulfonohydrazides and hydrazones (11–15, 20, 29, 30)

The sulfonyl chloride (6 or 7, 0.02 mol) was condensed with 98% hydrazine hydrate (0.04 mol) in THF (30 ml). The reaction was initially kept at 0°C and then left at room temperature for 3 hours. The mixture was poured onto crushed ice, the precipitate collected, washed with water and dried to give the hydrazides. The chloride (21) (0.22 mol) was similarly reacted with hydrazine (0.08 mol for 12 hours) to give the bis-hydrazide (29).

The acetone hydrazones (12, 30) were obtained by dissolving the hydrazide (0.006 mol) in acetone (30 ml). After remaining at room temperature (3 hours) the solution was diluted with water to give the products.

For the aromatic hydrazones, the hydrazide (0.006 mol) was reacted with the aromatic aldehyde (0.01 mol) in THF (30 ml) for 6 hours. The products (13–15) were filtered off and purified by recrystallization from methanol.

Compound (12)

IR ν_{max} 3340, 3250 (NH), 1640 ($\text{C}=\text{O}$), 1600, 1550 ($\text{ArC}=\text{C}$), 1340, 1180 (SO_2), 690 ($\text{C}-\text{Cl}$) cm^{-1} .

High resolution NMR: δ 9.1* (s, 1H, SO_2NH), 8.1* (t, 1H, NHCH_2), 7.9 (m, 4H, ClC_6H_4), 7.45 (m, 4H, ArH), 4.7* (d, 2H, NH_2), 4.56 (d, 2H, ArCH_2), 1.85 (d, 6H, $\text{N}=\text{CMe}_2$).

Compound (20)

IR ν_{max} 3320, 3280 (NH), 1650 ($\text{C}=\text{O}$), 1590 ($\text{ArC}=\text{C}$), 1355, 1170 (SO_2) cm^{-1} . NMR (CDCl_3) δ : 8.2–7.5 (m, 7H, ArH), 6.8* (s, 2H, NH), 4.7 (d, 2H, ArCH_2), 1.86 (d, 6H, NMe_2).

Compound (30)

IR ν_{max} 3370, 3280 (NH), ($\text{C}=\text{O}$), 1600, 1550 ($\text{ArC}=\text{C}$), 1340, 1170 (SO_2) cm^{-1} .

High resolution NMR: δ 10.08* (s, 1H, thiophen SO_2NH), 10.04* (s, 1H, benzyl SO_2NH), 9.45* (t, 1H, CONH), 8.36 (d, 1H, thiophen 3-H), 8.1 (d, 1H, thiophen 5-H), 7.8–7.5 (m, 4H, ArH), 4.54 (d, 2H, ArCH_2), 1.8 (d, 12H, NMe_2).

ACKNOWLEDGEMENT

We thank Dr N. F. Elmore of ICI (Pharmaceuticals Division) Macclesfield, Cheshire, England, for the microanalyses and Mr A New of Smith, Kline and French Ltd., Welwyn Garden City, Hertfordshire, England, for the FAB mass spectra.

REFERENCES

1. R. J. Cremllyn and R. Nunes, *Gazz. Chim. Ital.*, **117**, 183 (1987).
2. R. J. Cremllyn, S. Jethwa, G. Joiner and D. White, *Phosphorus and Sulfur*, **36**, 99 (1988).
3. R. J. Cremllyn and S. Clowes, *J. Chem. Soc. Pakistan*, **10**, 97 (1988).
4. R. J. Cremllyn, *J. Chem. Soc.*, 1329 (1963).
5. R. J. Cremllyn, F. J. Swinbourne and R. Mguni, *Phosphorus and Sulfur*, **8**, 321 (1980).
6. R. J. Cremllyn, K. Thandi and R. Wilson, *Indian J. Chem.* **23B**, 94 (1984).
7. R. J. Cremllyn, O. Obiorah and G. Singh, *Indian J. Chem.*, **25B**, 559 (1986).
8. R. J. Cremllyn, F. J. Swinbourne, J. G. Bloy, K. Pathak and O. O. Shode, *J. Chem. Soc. Pakistan*, **7**, 111 (1985).
9. R. J. Cremllyn, S. D. Lewis and R. J. Nunes, *J. Chem. Soc. Pakistan*, **8**, 491 (1986).
10. R. J. Cremllyn, *Internat. J. Sulfur Chem.*, **8**, 133 (1973).

11. R. J. Cremlyn, F. J. Swinbourne and O. O. Shode, *J. Chem. Soc. Pakistan*, **8**, 323 (1986).
12. R. J. Cremlyn, K. H. Goulding, F. J. Swinbourne and K. Yung, *Phosphorus and Sulfur*, **10**, 111 (1981).
13. L. J. Bellamy, *The Infra-red Spectra of Complex Molecules*, (Methuen, London, 1966) 2nd Ed.
14. K. Ishimara and S. Nakao, *Seikei Daigaku Kogakubu Kogaku Hukoku*, **8**, 689 (1969); *Chem. Abst.*, **73**, 14017e (1970).
15. K. Tetsuji *et al.*, *Yakugaku Zasshi*, **86**(9), 823 (1966); *Chem. Abst.*, **65**, 20093 g (1966).