Synthesis of Some 3-Aryl-1*H*-isochromene-1-thiones

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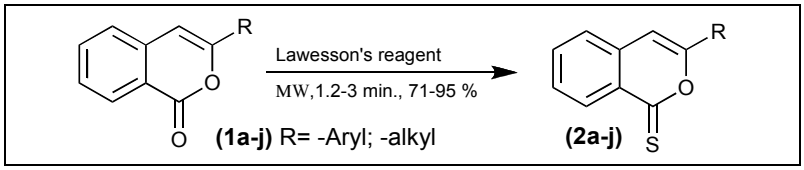

A rapid microwave-accelerated thionation of some 3-substitued isocoumarins to corresponding 1-thio-isocoumarins was achieved employing Lawesson's reagent under solventless conditions.

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INTRODUCTION

Isocoumarins (1*H*-2-benzopyran-1-ones) are the secondary metabolites of an extensive variety of fungi, bacteria, higher plants, marine organisms and are also among insect venoms and pheromones; exhibiting a wide range of structural diversity and biological activities [1-3]. Important examples of natural bioactive isocoumarins include the furoisocoumarin coriandrin phototoxic to RNA-virus Sindbis virus, DNA-virus murine cytomegalo-virus and HIV [4], thunberginol, phyllodulcin and hydrangenol having differentiation inducing, antiallergic, and immunomodulatory effects [5], ochratoxins A & B, nephratoxic, hepatotoxic [6], hiburipyranone, cytotoxic [7], duclauxin, antitumor [8], cytogenin and its synthetic analogues antitumor, antidiabetic anticancer [9] and Sg17-1-4, possessing potent cytotoxic activities [10].

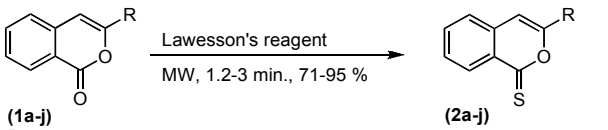
Majority of the natural isocoumarins being of polyketide origin are derived biogenetically from acetate-polymalonate pathway, hence most of them possess a C-3 alkyl/aryl substituent. Although, more than two hundred isocoumarins and dihydroisocoumarins have been isolated and the number is still increasing dramatically, 1-thioisocoumarins are thus far unknown in nature. A review of literature reveals that while, the thio analogues of a number of associated natural products *viz.*, chromones, [11] flavones, [12] isoflavones [13] and coumarins [14] have been prepared; the reports of synthetic 1-thioisocoumarins (1*H*-isochromene-1-thiones) are exceptional [15]. The various reagents and conditions employed for thionation include phosphorus pentasulfide in presence of base [16], hydrogen sulfide in the presence of acid [17], bis-(tricyclohexyltin)sulfide with boron trichloride [18] bis(trimethyl-silyl)sulfide with hydrated cobalt chloride [19] and boron sulfide in refluxing chloroform [20]. Most of these procedures require an excess of reagents, use of anhydrous aromatic hydrocarbon solvents, acidic or basic medium and rigorously dry conditions, affording only modest yields of products. The 2,4-bis(*p*-methoxyphenyl)-1,3-dithiaphos-phetane 2,4-disulfide (Lawesson's reagent), has frequently been used for the conversion of oxygen functionalities into their thio analogues [21]. Conventional conversions require refluxing in dry benzene or toluene for several hours (4-20) under dry inert atmosphere using an excess of the reagent (1-3.0 molar equiv.) and despite these only poor yields (30-50 %) were obtained. It is possibly due to formation of side products and decomposition of the reagent.

The use of microwaves in organic synthesis has now become an area of paramount importance and of considerable interest due to cleaner reactions, shorter reaction times, and the ease of handling [22]. In continuation of our interest towards synthesis of naturally occurring isocoumarins and their synthetic analogues [23] in this article, we wish to describe the microwave accelerated thionation of a number of isocoumarins using Lawesson's reagent (Scheme 1). An easy access to 1-thioanolgues of isocoumarins will be valuable for evaluation of effect of substitution of oxygen by sulfur atom on bioactivity.

RESULTS AND DISCUSSION.

The isocoumarins (**1a-j**) were synthesized according to previously reported method [23]. An intimate mixture of the isocoumarin with Lawesson's reagent (0.5-0.6 equiv) was irradiated in an alumina bath using a domestic microwave oven. The progress of reaction was monitored by analytical TLC every 30 s to establish the minimum time necessary to complete the reaction. The successful thionation was primarily indicated by appearance of a visible yellowish spot on TLC having slightly higher R_f value than the parent isocoumarin. The products were further characterized by mp, IR, ^{1}H and ^{13}C NMR, mass spectral and elemental analysis data. Accordingly, absence of lactonic carbonyl absorption at 1700-1720 cm^{-1} and appearance of absorption at 1070-1250 cm^{-1} in the IR spectra manifested the change from carbonyl to

thiocarbonyl. In general, absorptions of protons H-4 of isocoumarins range from δ 6.77 to 6.96, while the absorption of the same protons in thioisocoumarins range from δ 6.86 to 7.08 in the ^{1}H NMR. A more pronounced downfield shift of ^{13}C absorption of carbons C-1, ranging from 30 to 40 ppm was observed in the ^{13}C NMR (Table 1). The products were obtained in 71-95 % yields in high purity. A variety of substituents on the phenyl ring are well-tolerated, and the reaction leads to completion in all the cases.



(1a-j)
R=
1a=3-FC_6H_4 ; **1b**=4-FC_6H_4
1c=4-ClC_6H_4; **1d**=2-BrC_6H_4
1e=3-IC_6H_4; **1f**=2,4-$DiClC_6H_{312}$
1g=2-F-4-ClC_6H_3; **1h**=4-$MeOC_6H_4$
1i=4-FC_6H_4 CH_2; **1j**=$C_{15}H_{31}$

(2a-j)
R= same as in **1a-j**

Scheme-1 Solvent-Free conversion of Isocoumarin into 1-thioisocoumarins

The generality of the conversion was indicated by substrates bearing an aralkyl group **(2i)** on C-3 or a long aliphatic chain **(2j)**.

In conclusion, an environmentally benign one pot, microwave-accelerated conversion of isocoumarins to their 1-thio analogues is reported. The solvent-free conversion shows several advantages over the conventional method. These include short reaction times, high yields and lack of side-product formation. In addition, it avoids the need for essentially dry conditions, toxic hydrocarbon solvents and acidic or basic media. Furthermore, the work up is not necessary, since the crude mixture can be directly subjected to chromatographic purification.

EXPERIMENTAL

Melting points were recorded using a digital Gallenkamp (SANYO) model MPD BM 3.5 apparatus and are uncorrected. ^{1}H NMR and the ^{13}C NMR spectra were determined as $CDCl_3$ solutions at 300 MHz and 100 MHz respectively, on a Bruker AM-300 machine. FT IR spectra were recorded using an FTS 3000 MX spectrophotometer; Mass Spectra (EI, 70eV) on a GC-MS instrument and elemental analyses with a LECO-183 CHNS analyzer. The reactions were carried out in an unmodified domestic microwave oven (MW 900 W, frequency 2450 MHz, Power level 1, Dawlance, Pakistan). The analytical TLC was carried out using recoated plated from Merck and thick layer chromatography using silica gel from Merck.

General procedure for the conversion of isocoumarins into 1-1*H*-isochromene-1-thiones (2a–j). A homogenized mixture of isocoumarin (**1a-j**) (1 mmol) and Lawesson's reagent (0.5-0.6 mmol) was irradiated for 1.3-2-3 min in an alumina bath inside the microwave oven (Table-1). The progress of the reaction was followed by TLC examination using hexane/ethyl acetate (9:1). On completion the reaction mixture was diluted with ethyl acetate and subjected to thick layer chromatography using same solvent system. Elution using ethyl acetate followed by concentration afforded the products (**2a–j**) which crystallized on standing as yellow needles or plates.

3-(3-Fluorophenyl)-1*H*-isochromene-1-thione (2a). R_f =0.8 IR (KBr):=1190, 2980, 1615. ^{1}H NMR δ 6.98 (1H, *s*, H-4), 8.34 (1H, *s*, H-2'), 7.66-7.75 (2H, *m*, H-4', H-5'), 7.62 (1H, *d*, *J*=2.1, H-6'), 7.53 (2H, *d*, *J*=7.8, H-5, H-8), 7.44 (1H, *dd*, *J*=1.8, 2.1, H-6), 7.15 (1H, dd, *J*=2.4, 2.4, H-7). ^{13}C NMR δ102 (C-4), 112 (C-4a), 120 (C-6',C-5'), 126 (C-7), 129 (C-8), 130 (C-2',C-4'), 134 (C-5), 135 (C-6), 137 (C-1'), 152 (C-8a), 162 (C-3'), 164 (C-3), 203 (C-1). MS (70eV): *m/z* (%)=256 (M^+,100), 95 (48), 161 (67). *Anal.* Calcd. For $C_{15}H_9OSF$: C, 70.31; H, 3.51; S, 12.50. Found. C, 70.25; H, 3.45; S, 11.45.

3-(4-Fluorophenyl)-1*H*-isochromene-1-thione (2b). R_f=0.6, IR (KBr):=1195, 3020, 1590. ^{1}H NMR δ 7.08 (1H, s, H-4), 8.73 (2H, *d*, *J*=7.8, H-3', H-5'), 7.97 (2H, d, *J*=3, H-2', H-6'), 7.72 (1H, d, *J*=1.2, H-5), 7.51 (3H, *m*, H-6,H-7,H-8), ^{13}C NMR δ104 (C-4), 116 (C-4a), 127 (C-2',C-6'), 129 (C-7), 130 (C-8,C-5), 132 (C-3',C-5'), 135 (C-1'), 155 (C-8a), 162 (C-4'), 165 (C-3), 200 (C-1). MS (70eV): *m*/z (%)=256 (M^+,100), 95 (38), 161 (52). *Anal.* Calcd. For $C_{15}H_9OSF$: C, 70.31; H, 3.51; S, 12.50. Found. C, 70.19; H, 3.41; S, 11.41.

3-(4-Chlorophenyl)-1*H*-isochromene-1-thione (2c). R_f=0.7, IR (KBr) 1171, 3025, 1615. ^{1}H NMR δ 6.96 (1H,*s*, H-4), 7.85 (2H, *d*, *J*=1.8, H-3',H-5'), 7.83 (2H, *d*, *J*=2.1, H-2'-H-6'), 7.75 (1H, *d*, *J*=1.5, H-5), 7.73 (1H, *d*, *J*=1.2, H-8), 7.40 (2H, *m*, H-6, H-7). ^{13}C NMR δ102 (C-4), 120 (C-4a), 126 (C-7), 128 (C-8),

Table 1 Physical and Analytical Data of Compounds **2a-j**

Entry	Compd.	R	Mp (°C)	Reaction time (min.)	Yield (%)	^{1}H NMR δ (ppm) H-4 (s)		^{13}C NMR δ (ppm) C=X	
						1	**2**	**1** X=O	**2** X=S
1	**2a**	3-FC_6H_4	109-113	1.50	78	6.10	6.98	164	203
2	**2b**	4-FC_6H_4	138	2.0	95	6.40	7.08	161	200
3	**2c**	4-ClC_6H_4	128-130	2.2	89	6.01	6.96	161.3	195
4	**2d**	2-BrC_6H_4	Oil	1.20	81	6.2	6.89	163	194
5	**2e**	3-IC_6H_4	116-118	2.30	71	6.34	6.97	163	197
6	**2f**	2,4-$DiClC_6H_3$	123-125	1.50	74	6.21	7.03	162	208
7	**2g**	2-Cl-4-FC_6H_3	129	1.30	81	6.35	6.97	161	200
8	**2h**	4-$MeOC_6H_4$	109-111	2.20	91	5.90	6.86	162.5	203
9	**2i**	4-$FC_6H_4CH_2$	65-67	2.0	93	5.93	7.01	162	176
10	**2j**	$C_{15}H_{31}$	32-33	3.0	87	6.24	6.27	163	201

Recrystallization solvent: Ethyl acetate.

129 (C-1'), 130 (C-2',C-6'), 135 (C-3',C-5'), 136 (C-5), 137 (C-6), 152 (C-8a,), 152 (C-4'), 162 (C-3), 195 (C-1). MS (70eV): *m*/z (%)=272.5 (M^+,100), 111.5 (48), 161 (67). *Anal*. Calcd. For $C_{15}H_9OSCl$: C, 66.05; H, 3.30; S, 11.74. Found. C, 65.76; H, 3.22; S, 11.66.

3-(2-Bromophenyl)-1*H*-isochromene-1-thione (2d). R_f=0.6, IR (KBr):=1079, 3025, 1590; ^{1}H NMR δ 6.89 (1H, *s*, H-4), 8.03 (1H, *d*, *J*= 2.4, H-3'), 7.61-7.69 (3H, *m*, H-4',5',6'), 7.30-7.40 (4H, *m*, H-5,6,7,8), ^{13}C NMR δ107 (C-4), 113 (C-4a), 127 (C-7), 129 (C-8), 131 (C-5'), 132 (C-4',C-6'), 133 (C-3'), 133.8 (C-1'), 134 (C-5), 136 (C-6), 141 (C-2'), 152 (C-8a), 164 (C-3), 194 (C-1). MS (70eV): m/z (%)=316 (M^+,100), 155 (52), 161 (68). *Anal*. Calcd. For $C_{15}H_9OSBr$: C, 56.96; H, 2.84; S, 10.12. Found. C, 56.87; H, 2.78; S, 10.05.

3-(3-Iodophenyl)-1*H*-isochromene-1-thione (2e). R_f=0.65, IR (KBr):=1085, 3010, 1580; ^{1}H NMR δ 6.97 (1H, *s*, H-4), 8.25 (1H, *s*, H-2'), 8.06 (1H, *d*, *J*=9, H-4'), 7.77 (1H, *d*, *J*=8.1, H-6'), 7.73 (1H, *dd*, *J*=4.8, 3.3, H-5'), 7.52-7.57 (4H, *m*, H-5-H-8). ^{13}C NMR δ 109 (C-4), 109 (C-4a), 112 (C-6') 113 (C-5'), 125 (C-1'), 128 (C-2',C-4'), 130 (C-7), 132 (C-8), 135 (C-5), 137 (C-6), 152 (C-3'), 155 (C-8a), 158 (C-3), 197 (C-1); MS (70eV): *m*/z (%)=364 (M^+,100), 203 (48), 161 (67). *Anal*. Calcd. For $C_{15}H_9OSI$: C, 49.45; H, 2.47; S, 8.79. Found. C, 49.37; H, 2.39; S, 8.71.

3-(2,4-Dichorophenyl)-1*H*-isochromene-1-thione (2f). R_f = 0.7 IR (KBr):=1128, 2970, 1620. ^{1}H NMR δ 7.03 (1H, *s*, H-4), 7.80 (1H, *d*, *J*=0.9, H-3'), 7.74 (1H, *d*, *J*=13.2, H-5'), 7.71 (1H, *d*, *J*=8.5,H-6'), 7.51-7.61 (4H, *m*, H-5-H-8). ^{13}C NMR δ106 (C-4), 108 (C-4a), 126 (C-6'), 127 (C-7), 128 (C-8), 129 (C-5), 130 (C-6), 131 (C-5'), 133 (C-1'), 135 (C-3'), 136 (C-8a), 137 (C-2',C-4') 150 (C-3), 208 (C-1). MS (70eV): *m*/z (%)=307 (M^+,100), 146 (52), 161 (62). *Anal*. Calcd. For $C_{15}H_9OSCl_2$: C, 58.63; H, 2.60; S, 10.42. Found. C, 58.55; H, 2.52; S, 10.37.

3-(2-Chloro-4-fluorophenyl)-1*H*-isochromene-1-thione (2g). R_f=0.6 IR (KBr):=1275, 2990, 1595. ^{1}HNMR δ 6.97 (1H, *s*, H-4), 7.83 (1H, *s*, H-3'), 7.81 (1H, *d*, *J*=2.7 H-5'), 7.29 (1H, *d*, *J*=2.4, H-6'), 7.28 (4H, *m*, H-5,6,7,8). ^{13}C NMR δ 107 (C-4), 114 (C-4a), 127 (C-7), 129 (C-8), 130 (C-6'), 131 (C-1'), 132 (C-5'), 133 (C-3'), 134 (C-5), 135 (C-6), 153 (C-8a), 153 (C-2') 161 (C-4'), 164 (C-3), 200 (C-1). MS (70eV): *m*/z (%)=290.5 (M^+,100), 129.5 (34), 161 (75). *Anal*. Calcd. For $C_{15}H_9OSClF$: C, 61.96; H, 2.75; S, 11.01. Found. C, 61.85; H, 2.68; S, 10.96.

3-(4-Methoxyphenyl)-1*H*-isochromene-1-thione (2h). R_f= 0.6 IR (KBr):=1205, 3015, 1575. ^{1}H NMR δ 6.86 (1H, *s*, H-4), 7.85 (2H, *d*, *J*=2.1, H-3',H-5'), 7.83 (2H, *d*, *J*=2.1, H-2'-H-6'), 7.74 (1H, *d*, *J*=1.5, H-5), 7.69 (1H, *d*, *J*=1.5, H-8), 7.40-7.50 (2H, *m*, H-6, H-7), 3.88 (3H, *s*, OCH_3). ^{13}C NMR δ 55.0 (CH_3), 100 (C-4), 114 (C-4a), 126 (C-2',C-6'), 127 (C-7), 128 (C-8), 129 (C-1'), 130 (C-3',C-5'), 134 (C-5), 137 (C-6), 153 (C-8a), 161 (C-4'), 162 (C-3), 203 (C-1). MS (70eV): *m*/z (%)=268 (M^+,100), 107 (72), 161 (63). *Anal*. Calcd. For $C_{16}H_{12}O_2S$: C, 71.64; H, 4.47; S, 11.94. Found. C, 71.57; H, 4.39; S, 11.87.

3-(4-Fluorobenzyl)-1*H*-isochromene-1-thione (2i). R_f=0.6 IR (KBr):=1194, 2960, 1610. ^{1}H NMR δ 7.01 (1H, *s*, H-4), 7.73 (2H, *d*, *J* = 3.1, H-3',5'), 7.71 (2H, *d*, *J*=3.3 H-2',H-6'), 7.30 (4H, *m*, H-5,6,7,8), 3.64 (2H, *s*, CH_2). ^{13}C NMR δ 68 (CH_2), 107 (C-4), 114 (C-4a), 127 (C-7), 129 (C-8), 130 (C-1'), 131 (C-2',6'), 134 (C-3',5'), 135 (C-5), 136 (C-6), 153 (C-8a), 164 (C-4'), 167 (C-3), 176 (C-1). MS (70eV): *m*/z (%)=270 (M^+, 100), 109 (37), 161 (62). *Anal*. Calcd. For $C_{16}H_{11}OSF$: C, 71.11; H, 4.07; S, 11.85. Found. C, 71.05; H, 4.01; S, 11.78.

3-(Pentadecyl)-1*H*-isochromene-1-thione (2j). R_f=0.6 IR (KBr):=1272, 3010, 1605. ^{1}H NMR δ 6.27 (1H, *s*, H-4), 8.26 (1H, *d*, *J*=8.1, H-8), 7.66-7.68 (2H, *m*, H-6-H-7), 7.36 (1H, *d*, *J*=7.8,H-5), 2.50 (2H, *t*, *J*=7.5,H-1'), 1.73 (2H, *p*, *J*=6.6,H-2'), 1.27-1.38 (24H, *m*, H-3'-H-14'), 0.89 (3H, *t*, *J*=5.4, H-15'). ^{13}C NMR δ10 (C-15'), 14 (C-14'), 22 (C-13'), 23 (C-12'), 26 (C-11'), 28 (C-10'), 29 (C-9'), 29 (C-8'), 29 (C-7'), 30 (C-6'), 31 (C-5'), 33 (C-4'), 38 (C-3'), 55 (C-2'), 68 (C-1'), 112 (C-4), 125 (C-4a), 128 (C-5), 129 (C-7), 132 (C-8), 137 (C-6), 158 (C-8a), 167 (C-3), 201 (C-1). MS (70eV): *m*/z (%)=372 (M^+,100), 211 (27), 161 (55), 43 (66). *Anal*. Calcd. For $C_{24}H_{36}OS$: C, 77.42; H, 9.67; S, 8.60. Found. C, 77.36; H, 9.59; S, 8.52.

REFERENCES

[1] Yoshikawa, M.; Harada, E.; Naitoh, Y.; Inoue, K.; Matsuda, H.; Shimoda, H.; Yamahara, J. Murakami N *Chem. & Pharm. Bull.* **1994**, *42*, 2225; Matsuda, H.; Shimoda, H.; Yamahara, H.; Yoshikawa, M. *Bioorg. Med. Chem. Lett.* **1998**, *8*, 215.

[2] Whyte, A. C.; Gloer, J. B.; Scott, J. A.; Malloch, D. *J. Nat. Prod.* **1996**, *59*, 765; Handa, M.; Sunazuka, T.; Nagai, K.; Kimura, R.; Otoguro, K.; Harigaya, Y.; Ōmura, S. *J. Antibiot.* **2001**, *54*, 386.

[3] Oikawa, T.; Sasaki, M.; Inose, M.; Shimamura, M.; Kuboki, H.; Hirano, S.; Kumagai, H.; Ishizuka, M.; Takeuchi, T. *Anticancer Res.* **1997**, *17* (3C), 1881.

[4] Hudson, J. B.; Graham, E. A.; Harris, L.; Ashwood-Smith, M. J. *Photochem. & photobio.* **1993**, *57* (3), 491.

[5] Günes, M.; Speicher, A. *Tetrahedron* **2003**, *59*, 8799.

[6] Knasmüller, S.; Cavin, C.; Chakraborty, A.; Darroudi, F.; Majer, B. J.; Huber, W. W.; Ehrlich, V. A. *Nutrition and Cancer* **2004**, *50*, 190.

[7] Uchida, K.; Watanabe, H.; Kitahara, T. *Tetrahedron* **1998**, *54*, 8975.

[8] Kawai, K.; Shiojiri, H.; Nakamaru, T.; Nozawa, Y.; Sugie, S.; Mori, H.; Kato, T.; Ogihara, Y. *Cell Biol Toxicol.* **1985**, *1*, 1.

[9] K. Ichinose, Y.; Maeshima, Y.; Yamamoto, M.; Kinomura, K.; Hirokoshi, H.; Kitayama, Y.; Takazawa, H.; Sugiyama, Y.; Yamasaki, N.; Agata, *et al. Diabetes*, **2006**; *55*, 1232.; Reimer, C.L.; Agata, N.; Tammam, J.G.; Bamberg, M.; Dickerson, W.M.; Kamphaus, G.D.; Rook, S.L.; Milhollen, M.; Fram, R.; Kalluri, R.; Kufe D.; and Kharbanda S. *Cancer Research* **2002**, *62*, 789.; Song, M.-Q.; Zhu, J.-S.; Chen, J.-L.; Wang, L.; Da, W.; Zhu, L.; Zhang, W.-P. *World J. Gastroenterol.*, **2007**, *13*, 1788.

[10] Huang, Y.-F.; Li, L.-H.;Tian, L.; Qiao, L.; Hua, H-M.; Pei, Y.H. *J. Antibiot.* **2006**, *59*, 355.

[11] Levai, A. *J. Chem. Res. (S).* **1992,** *163*; Levai, A.; Szabo, Z. *J.Chem. Res. (S).* **1992,** *380*.

[12] Dudley, K. H.; Miller, H. W.; Corley, R. C.; Wall, M. E. *J. Med. Chem.* **1967**, *10*, 985.

[13] Baker, W.; Harborne, J. B.; Ollis, W. D. *J. Chem. Soc.* **1952**, 1303; Baruah, A. K.; Prajapati, D.; Sandhu, J. S. *Tetrahedron* **1988**, *44*, 6137.

[14] Kumar, S.; Singh, B. K.; Kalra, N.; Kumar, V.; Kumar, A.; Prasad, A. K.; Raj, H. G.; Parmar, V. S.; Ghosh, B. *Bioorg. Med. Chem.* **2005**, *13*, 1605; Levai, A.; Jeko, J. *J. Heterocyclic Chem.* **2005**, *42*, 739; Levai, A. *Heterocyclic Commun.* **1999**, *5*, 419.

[15] Duddeck, H.; Kaiser, M. *Spectrochimica Acta* **1985**, *41A*, 913. Letcher, N.-C.; Kwok, W.-H. Lo.; K.-W. Ng, *J. Chem.Soc., Perkin Trans. 1* **1998**, 1715.

[16] Scheeren, J. W.; Ooms, P. H. J.; Nivard, R. J. F. *Synthesis* **1973**, 149, Dash, B.; Dora, E. K.; Panda, C. S. *Heterocycles* **1982**, *19*, 2093.

[17] Staudinger, H.; Freundenberger, H. *Chem. Ber.* **1928**, *61*, 1576.

[18] Steliou, K.; Mrani, M. *J. Am. Chem. Soc.* **1982**, *104*, 3104.

[19] Capperucci, A.; Degl'Innocenti, A.; Ricci, A.; Mordini, A.; Reginato, G. *J. Org. Chem.* **1991**, *56*, 7323.

[20] Dean, F. M.; Goodchild, J.; Hill, A.W. *J. Chem. Soc. C* **1969**, 2192.

[21] Perregaard, J.; Scheibye, S.; Meyer, H. J.; Thomsen, I.; Lawesson, S. O. *Bull. Soc. Chim. Belg.* **1977**, *86*, 679; Levinson, M. I.; Cava, M. P. *Tetrahedron* **1985**, *41*, 5061; Jesberger, M.; Davis, T. P.; Barner, L. *Synthesis* **2003**, 1929.

[22] Varma R.S.; Kumar, D. *Org. Lett.***1999,** *1*, 697.

[23] Saeed, A. *Helv. Chim. Acta* **2003**, *86*, 377-383.; Saeed, A. *Z. Naturforsch.* C **2003,** *58*, 691; Saeed, A. *Natural Prod. Res.* **2004**, *18*, 373; Saeed, A. *J. Heterocycl. Chem.* **2004**, *41*, 975; Saeed, A.; Ehsan, S. *J. Braz. Chem. Soc.* **2005**, *16*, 739.; Saeed, A. *J. Asian Nat. Prod. Res.* **2006**, *8*, 417; Saeed, A. *Syn. Commun.* **2007**, *37*, 1485.