Pergamon

Tetrahedron, Vol. 52, No. 31, pp. 10485-10496, 1996

0040-4020/96 $15.00 + 0.00

PII: S0040-4020(96)00569-8

A Convenient One-Pot Synthesis of 2-Benzimidazolylthioacetophenones and Thiazolo[3,2-a]benzimidazoles

Abd El-Wareth A.O. Sarhan,* Hasan A.H. El-Sherief and Abdalla M. Mahmoud

Chemistry Department, Faculty of Science, Assiut University, Assiut 71516, Egypt.

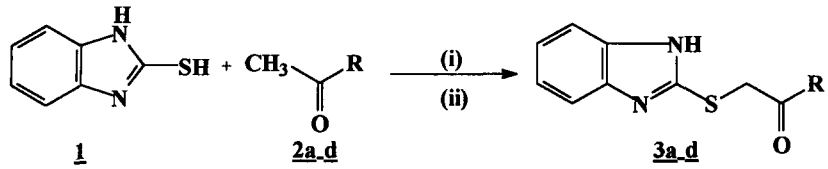
Abstract: 2-Mercaptobenzimidazole (**1**) reacts with aromatic ketones **2a-d** in acidified acetic acid giving 2-benzimidazolylthioacetophenones **3a-d**. which on cyclization yield thiazolo[3.2-a]-benzimidazoles **4a-d**. Acetylation of **3a,d** gave the N-acetyl derivatives **5a,d**. Cyclization of **3a-d** or **5d** in acetic anhydride or acetic anhydride / pyridine mixture afforded **6a-d**. While reaction of **1** with aliphatic or alicyclic ketones gave directly 2,3-disubstituted thiazolo[3.2-a]benzimidazoles **7a-f** and **8a-d** respectively. Copyright © 1996 Elsevier Science Ltd

INTRODUCTION

The chemistry and biological activity of thioacetophenones **3a-d** and thiazolo[3,2-a]benzimidazoles have been studied over several years ago.[1] It is known that aryl / heteroarylthioacetophenones can be prepared from the reaction of phenacyl halide derivatives with thiol compounds[2] in alkaline medium. Other few methods were also reported such as reactions of thiol compounds with ketones or aldehydes using iodine.[3] A novel one pot synthesis, of benzimidazolylthioacetophenones or thiazolo[3,2-a]benzimidazoles, described here has the distinct advantage of dispensing with the use of α-haloketones which are available with difficulty. Also, it is considered not only the simplest, but also the most cheap and efficient method.

RESULTS AND DISCUSSION

Interaction of 2-mercaptobenzimidazole (**1**) with aromatic ketones **2a-d** in boiling acetic acid containing few drops of concentrated H_2SO_4 afforded 2-benzimidazolylthioacetophenone derivatives **3a-d** in very good yields, scheme 1.

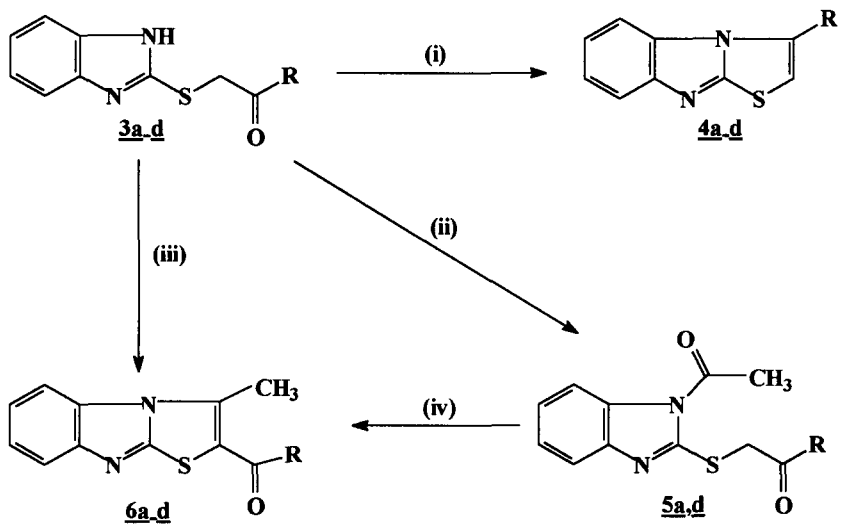


1 **2a-d** **3a-d**

R

a; C_6H_5, b; $C_6H_4CH_3$-p, c; $C_6H_4OCH_3$-p, d; C_6H_4Cl-p.
(i) AcOH / H_2SO_4, reflux, 2 ~ 3h. (ii) NH_4OH solution.
Scheme 1.

Compounds **3a-d** were cyclized to the corresponding thiazolo[3,2-a]benzimidazoles **4a-d** using PPA as reported.[4-7] Reaction of **3a,d** with acetic anhydride at room temperature gave the N-acetyl derivatives **5a,d** quantitatively. Moreover, heating of thioacetophenones **3a-d** in acetic anhydride or in Ac_2O / pyridine mixture afforded the 2-aroyl-3-methylthiazolo[3,2-a]benzimidazoles **6a-d** in good yield. The imidazole **6d** was obtained independently by refluxing of the N-acetyl derivative **5d** in Ac_2O, scheme 2.

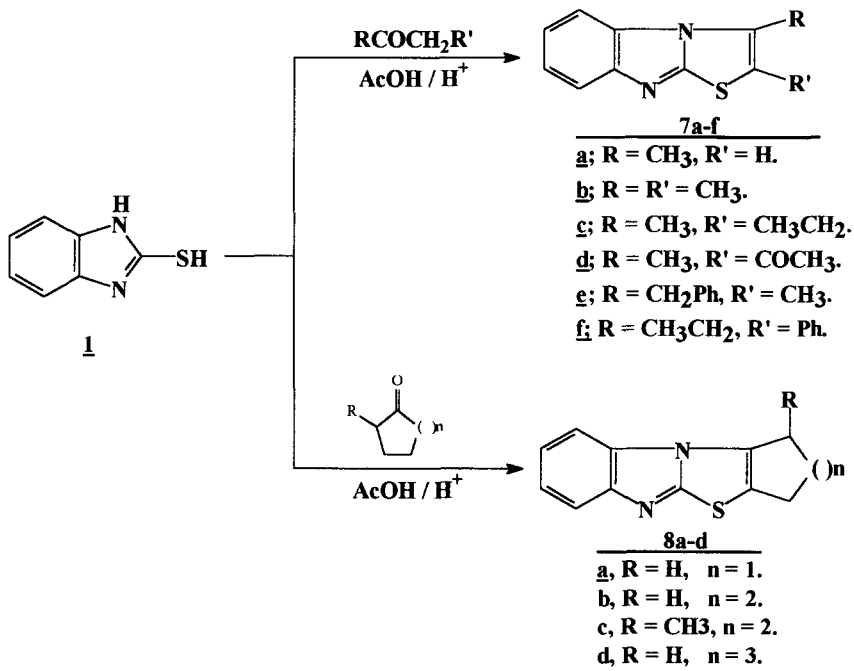


R

a; C_6H_5, b; $C_6H_4CH_3$-p, c; $C_6H_4OCH_3$-p, d; C_6H_4Cl-p
(i) PPA, 100°C, 2h. (ii) Ac_2O, RT, 3h, **5a**, (90%), **5d**, (88%).
(iii) a) Ac_2O, reflux, 3h. b) Ac_2O / pyridine, reflux, 3h. (iv) Ac_2O, reflux, 3h, **6d**, 78%.
Scheme 2.

An attempt to react the 2-mercaptobenzimidazole (**1**) with aromatic ketones in acetic acid only or in acetic acid containing a few drops of phosphoric acid or in trifloroacetic acid instead of AcOH / H_2SO_4 mixture was not successful; this revealed the essential role of H_2SO_4 as a catalyst.

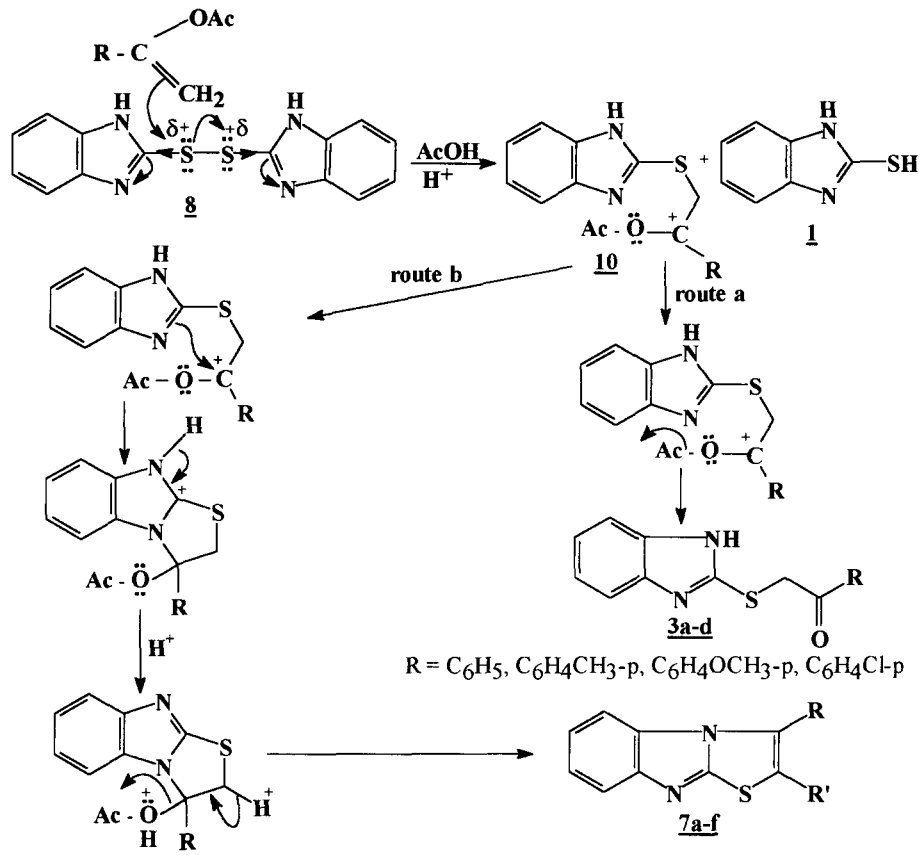
On the other hand, reaction of 2-mercaptobenzimidazole (**1**) with aliphatic ketones such as acetone, acetylacetone, butanone, pentan-2-one and 1-phenylbutan-2-one using the acidified acetic acid method gave the corresponding thiazolo[3,2-a]-benzimidazoles **7a-f** in good yield. Alicyclic ketones like cyclopentanone, cyclohexanone, 2-methylcyclohexanone and cycloheptanone were allowed to react with 2-mercaptobenzimidazole (**1**) in the same reaction conditions (AcOH / H_2SO_4) the tetracyclic compounds **8a-d** were obtained in good yield, scheme 3, table 2. The regioselectivity of the reaction leading to **8c** is attributed to the enolization of the H-C_6 is more favorable than the H-C_2 in 2-methylcyclohexanone due to its more acidic character and the steric hinder of the methyl group.



Scheme 3.

The mechanism of the reaction is still under investigation. It may be proceed via formation of dimeric disulfide (**9**) followed by nucleophilic attack by α-aryl/alkyl-α-hydroxymethylene carboxylate (**10**) [formed by esterification of the enol form] as shown in scheme 4.

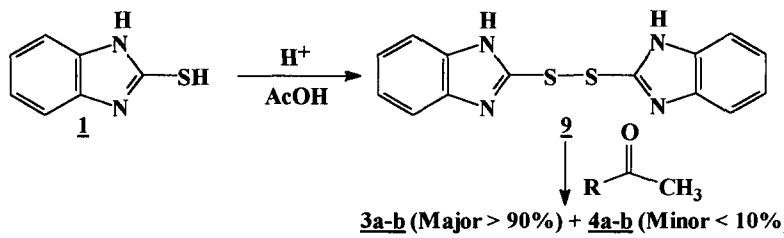
The carbonium ion **10** in case of aromatic ketones (route a) stabilized by resonance with aryl moiety and finally led to the formation of 2-benzimidazolylthioacetophenones (**3a-d**) via oxygen acetyl bond fission. While with aliphatic ketones (route b) the less stable intermediate **10** cyclized directly to thiazolo[3,2-a]benzimidazoles **7a-f** and **8a-d**.



a; R = CH_3, R' = H, b; R = R' = CH_3, c; R = CH_3, R' = CH_3CH_2,
d; R = CH_3, R' = $COCH_3$, e; R = CH_2Ph, R' = CH_3, f; R = CH_3CH_2, R' = Ph.

Scheme 4.

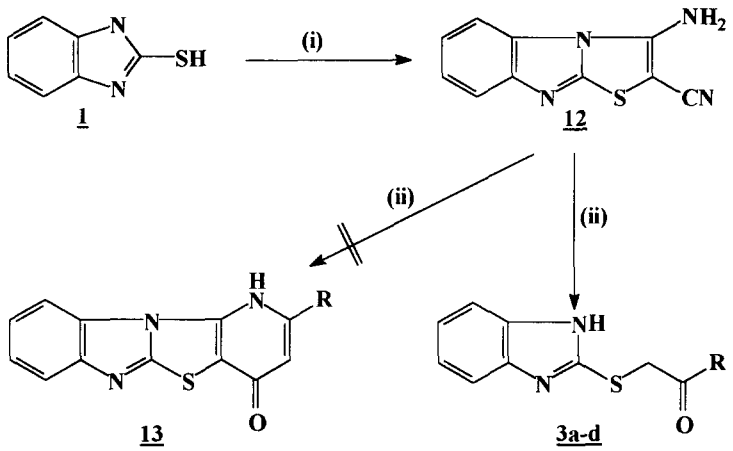
The mechanism is proposed on the basis of the experimental observations. When refluxing of 2-mercaptobenzimidazole (**1**) in AcOH / H_2SO_4 gave the dimeric products **9**. The reaction of benzimidazolyl-disulfide **9** with acetophenone **2a-b** in AcOH / H_2SO_4 yielded a mixture of the corresponding **3a-b** and **4a-b**, the major products being **3a-b**, scheme 5.



3a-b (Major > 90%) + 4a-b (Minor < 10%)

Scheme 5.

Moreover, 2-benzimidazolylthioacetophenones **3a-d** were obtained also when 3-aminothiazolo[3,2-a]-benzimidazole-2-carbonitrile (**12**)[1f-h] was allowed to react with aromatic ketones **2a-d** using acidified acetic acid. While the expected compound **13** was not obtained.

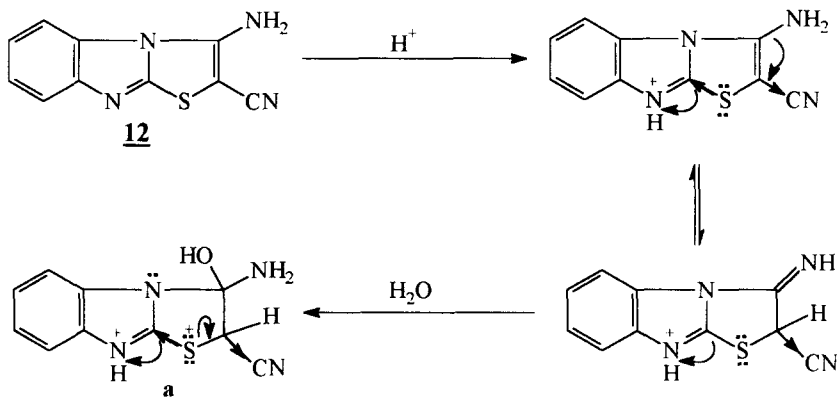


(i) a) $BrCH(CN)_2$ / KOH / aq. EtOH, RT, 3h. b) AcONa / EtOH, 80 ~ 90°C, 4h, 12, 55%.
(ii) Aromatic ketones 2a-d / AcOH / H^+, reflux, 4h.

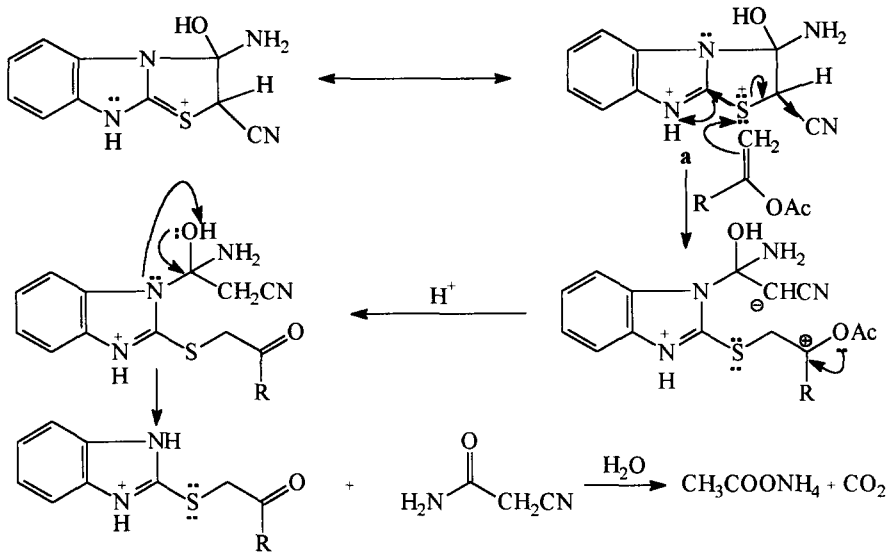
Scheme 6.

The structure of new compounds is confirmed by elemental analyses and spectral data (IR, ^{1}H-NMR, ^{13}C-NMR and MS).

The reaction mechanism of the 3-aminothiazolo[3,2-a]benzimidazol-2-carbonitrile (**12**) with aromatic ketones **2a-d**, was suggested to be as in scheme 7.



Scheme 7.



Scheme 7 continued.

Furthermore we study now the behavior of similar heterocyclic systems with ketones under the same reaction conditions.

EXPERIMENTAL

General. Melting points were uncorrected. IR Spectra were measured on a Perkin-Elmer spectrometer. ^{1}H-NMR (90 MHz and 200 MHz) and ^{13}C-NMR (50 MHz) spectra were recorded on a WP 200 SY, Brucker Company spectrometer. TMS was used as internal standard, δ ppm. Mass Spectra were recorded on MAT 312 spectrometer (Organic Chemistry Department, Hannover University, Germany). Elemental analyses were performed in the microanalytical unit (Chemistry Department, Faculty of Science, Assiut University, Assiut 71516, Egypt).

General Proceedures for Synthesis of 2-Benzimidazolylthioacetophenone Derivatives (3a-d).

A mixture of 2-mercaptobenzimidazole (**1**, 1.5 g, 10 mmol) and p-subistituted acetophenones (15 mmol) was refluxed in acetic acid (15 ml) containing a few drops of concentrated H_2SO_4 for 2 ~ 3h. The reaction mixture was cooled and neutrallized with NH_4OH solution. The resulting precipitate was collected by filtration, washed several times with water, dried well and crystallized from ethanol or methanol to give the corresponding **3a-d** as colourless crystals in 85-90% yield.[8]

1-Acetyl-2-aroylmethylthiobenzimidazole derivatives 5a,d.

A mixture of **3a,d** (2.8 g, 10 mmol) and Ac_2O (10 ml) was stirred at room temperature for 1h. The resulting precipitate was collected by filtration and crystallized from ethanol to give **5a,d** as colourless crystals in 90% and 88% yield respectively.

5a; *R = C_6H_5.* IR (KBr) ν 3040w, 2900m, 1700s, 1693s, 1595s, 1440s, 1340s, 1320s, 1245s, 1190s, 760s, 740s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 90 MHz) δ 2.75 (s, 3H, CH_3), 4.75 (s, 2H, CH_2), 7.1-7.7 (m, 7H, arom-H), 8.2 (m, 2H, arom-H).

5d; *R = C_6H_4Cl-p.* IR (KBr) ν 3058w, 2914w, 1714s, 1694s, 1589s, 1572m, 1478m, 1456s, 1262m, 1092m, 1038w, 761s, 743s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 200 MHz) δ 2.82 (s, 3H, CH_3), 4.8 (s, 2H, SCH_2CO), 7.2-7.655 (m, 6H, arom-H), 8.05 (m, 2H, arom-H); ^{13}C-NMR ($CDCl_3$, 50 MHz) δ 26.11 (- , CH_3), 40.05 (+ , CH_2), 113.12, 119.05, 123.16, 124.64, 129.02, 130.02 (- , arom-CH), 133.19, 134.51, 140.00, 143.94 (+ , arom-C), 154.05 (+ , C-2), 168.70 (+ , NCO), 192.89 (+ , CO); MS m/e (%) 344 [M^+] (17), 325 (5), 301 (10), 285 (10), 276 (5), 269 (16), 260 (11), 239 (4), 219 (4), 205 (7), 178 (6), 163 (89), 149 (16), 139 (100), 122 (11), 111 (27), 90 (10), 75 (9), 51 (55).

2-Aroyl-3-methylthiazolo[3,2-a]benzimidazoles (6a-d).

A mixture of **3a-d** (5 mmol) and Ac_2O (10 ml) or Ac_2O / pyridine mixture was stirred at 100 ~ 120°C for 3h. The resulting precipitate after cooling was collected by filtration and recrystallized from ethanol to give **6a-d** as colourless crystals in high yield (physical constants and yields are listed in table 1).

Similarly, **6d** was also obtained from **5d** under the same reaction condition in 78% yield.

6a; *R = C_6H_5.* IR (Kbr) ν 3056w, 1640s, 1596s, 1540s, 1488s, 1452s, 1396m, 1300s, 1280s, 1248s, 1048s, 740s, 700m cm^{-1}; ^{1}H-NMR ($CDCl_3$, 90 MHz) δ 2.95 (s, 3H, CH_3), 7.35, (m, 5H, arom-H), 7.8 (m, 4H, arom-H); MS m/e (%) 292 [M^+] (25), 291 [M^{-1}](100), 277 (16), 263 (3), 250 (80), 230 (44), 215 (31), 205 (7), 192 (9), 187 (8), 163 (3), 150 (33), 143 (37), 129 (4), 105 (26), 102 (24), 91 (7), 77 (47), 57 (14).

6b; *R = $C_6H_4CH_3$-p.* IR (KBr) ν 3031m, 2922m, 1639s, 1606s, 1581s, 1552s, 1486s, 1457s, 1424s, 1310s, 1282s, 1249s, 1041m, 739s, 723m cm^{-1}; ^{1}H-NMR ($CDCl_3$, 200 Mhz) δ = 2.45 (s, 3H, CH_3), 2.85 (s, 3H, CH_3), 7.3 (m, 4H, arom-H), 7.75 (m, 4H, arom-H); ^{13}C-NMR ($CDCl_3$, 50 MHz) δ 14.86 (- , CH_3), 21.71 (- , CH_3), 111.56, 119.47, 121.41, 124.54, 129.07, 129.37 (- , arom-CH), 121.15, 129.37, 135.8, 137.43, 143.94, 148.90, 155.40 (+ , arom-C and C-2, 3, 9a), 188.38 (+ , C = O); MS m/e (%) 306 [M^+] (100), 305 [M^{-1}] (52), 291 (37), 277 (2), 248 (2), 231 (11), 215 (9), 198 (7), 187 (2), 170 (2), 143 (9), 119 (17), 102 (5), 91 922), 77 (2), 65 (5), 57 (3).

6c; *R = $C_6H_4OCH_3$-p.* IR (KBr) ν 3056m, 2964m, 2936w, 1647s, 1596s, 1560s, 1508s, 1488s, 1456s, 1432s, 1308s, 1258s, 1224s, 1032s, 792s, 758s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 90 MHz) δ 2.88 (s, 3H, CH_3), 3.9 (s, 3H, OCH_3), 6.95-7.50 (m, 4H, arom-H), 7.70-7.95 (m, 4H, arom-H).

6d; *R = C_6H_4Cl-p.* IR (KBr) ν 3050w, 2960w, 2932w, 1640s, 1608s, 1584s, 1548s, 14.84s, 1456s, 1312s, 1248s, 1224s, 1056m, 740s, 708m cm^{-1}; ^{1}H-NMR ($CDCl_3$, 90 MHz) δ 2.9 (s, 3H, CH_3), 7.2 (m, 4H, arom-H), 7.6 (m, 4H, arom-H); MS m/e (%) 328 [M^{+2}] (45), 327 [M^+] (24), 326 [M^{-1}] (100), 291 (24), 290 (28), 274 (6), 263 (2), 233 (4), 215 (10), 187 (2), 163 (2), 149 (3), 143 (21), 139 (29), 113 (11), 111 (31), 102 (12), 90 (4), 75 (10), 63 (2), 51 (3).

Table 1. Physical Data and Elemental Analyses of Compounds **5a,d** and **6a-d**.

No. R	Yield (%)	m.p. oC	M. Wt.	Elemental Analysis Calcd:/ Found C	H	N	S
5a; C_6H_5	90	171	$C_{17}H_{14}N_2O_2S$ (310.36)	65.79	4.54	9.02	10.33
				65.68	4.41	9.12	10.16
5d*; C_6H_4Cl-p	88	143	$C_{17}H_{13}N_2ClO_2S$ (344.82)	59.21	3.79	8.12	9.29
				59.11	3.68	8.20	9.10
6a; C_6H_5	85	125	$C_{17}H_{12}N_2OS$ (292.36)	69.84	4.13	9.58	10.96
				69.63	4.24	9.41	10.80
6b; C_6H_4Me-p	79	100	$C_{18}H_{14}N_2OS$ (306.38)	70.56	4.60	9.14	10.46
				70.53	4.62	9.14	10.31
6c; C_6H_4OMe-p	82	170	$C_{18}H_{14}N_2O2S$ (322.38)	67.06	4.37	8.68	9.94
				67.17	4.52	8.91	9.82
6d**; C_6H_4Cl-p	84	204	$C_{17}H_{11}N_2ClOS$ (326.80)	62.47	3.39	8.57	9.81
				62.60	3.50	8.45	9.70

d*: Cl, 10.29 ; Cl, 10.09. 6d**: Cl, 10.86 ; Cl, 10.72.

2,3-Disubstituted thiazolo[3,2-a]benzimidazoles (7a-d).

According to the general procedures, **7a-d** were obtained as colourless crystals in very good yield.[1c,d,2g6-7]

7c; R = CH_3, R' = CH_2CH_3, Ref.[1c], m.p. 107- 8°C. IR (KBr) ν 3061w, 2970s, 7628m, 1474s, 1455s, 1379m, 1328w, 1264s, 1220s, 1137m, 1011w, 758s, 741s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 200 MHz) δ 1.25, t, J = 8 Hz, 3H, CH_3), 2.46 (s, 3H, CH_3), 2.75 (q, J = 8 Hz, 2H, CH_2), 7.05-7.30 (m, 2H, arom-H), 7.6 (dd, J = 8 Hz, J = 8 Hz, 1H, arom-H), 7.72 (d, J = 8 Hz, 1H, arom-H); ^{13}C-NMR ($CDCl_3$, 50 MHz) δ 11.71 (- , CH_3-2), 15.34 (- , CH_3-3), 20.56 (+ , CH_2-2), 110.33, 118.77, 120.31, 122.74 (- , arom-CH), 123.61, 123.70 (+ , C-3, C-2), 130.25, 147.74 (+ , C-4a, C-8a), 155.14 (+, C-9a); MS m/e (%) 216 [M^+] (56), 201 (100), 189 (4), 175 (4), 169 (9), 161 (5), 156 (7), 149 (6), 143 (26), 135 (17), 129 (6), 118 (5), 115 (9), 107 (14), 102 (15), 90 (14), 77 (13), 71 (11), 63 (15).

3-Benzyl-2-methylthiazolo[3,2-a]benzimidazole (7e) and 3-Ethyl-2-Phenylthiazolo[3,2-a]benzimidazole (7f).

A mixture of 2-mercaptobenzimidazole (**1**; 1,5 g, 10 mmol) and 1-phenylbutan-2-one (1.5 g, 10 mmol) was refluxed in acetic acid (20 ml) containing a few drops of concentrated H_2SO_4 as a catalyst for 4h. The reaction mixture was left with stirring at room temperature over night. The reaction mixture was diluted with NH_4OH, washed with water, extracted with dichloromethane and the combined extract was dried ($MgSO_4$). The dichloromethane was removed from the filtrate and the resulting solid mass product was crystallized from dilute ethanol to give the corresponding **7e** in 17%yield. The undissolved material in the dichloromethane was collected and crystallized from absolute ethanol to give the isomer **7f** in 33% yield.

7e: R = CH_2CH_3, R' = CH_3. IR (KBr) ν 3050w, 2970m, 2930m, 2870m, 1620s, 1575s, 1465s, 1385s, 1250s, 1220s, 1070s, 765s cm^{-1}; ^{1}H-NMR (CDC_3, 90 MHz) δ 2.38 (s, 3H, CH_3), 4.25 (s, 2H, CH2Ph), 6.95 - 7.50 (m, 7H, arom-H), 7.85 (m, 2H, arom-H).

7f: R = CH_2CH_3, R' = Ph. IR (KBr) ν 3056w, 2964m, 2932m, 2876m, 1616s, 1572m, 1464s, 1380m, 1252s, 1224s, 1072m, 760s, 732s cm^{-1}; ^{1}H-NMR (CD_2Cl_2, 200 MHz) δ 1.5 (t, J = 8 Hz, 3h, CH_3), 3.05 (q, J = 8 Hz, 2H, CH_2), 7.25-7.60 (m, 7H, arom-H), 7.76 (m, 2H, arom-H); ^{13}C-NMR (CD_2Cl_2, 50 MHz) δ 13.517 (-, CH_3), 20.015 (+ , CH_2), 111.519, 119.362, 121.098, 123.452, 128.977, 129.382, 129.710 (-, arom-CH), 121.464, 130.429, 131.607, 132.157, 148.548 (+ , C-2, C-3, C-4a, C-8a, arom-C), 155.836 (+ , C-9a); Ms m/e (%) 278 [M^+] (100), 263 (54), 244 (2), 230 (4), 219 (7), 204 (18), 187 (1), 178 (2), 160 (3), 149 (3), 139 (8), 130 (9), 121 (6), 119 (4), 103 (18), 91 (8), 77 (22), 65 (7).

Synthesis of the Tetracyclic Compounds 8a-d.

According to the general method **8a-d** were obtained in good yields. The data for derivative **8b** was agreed with that reported[2d].

8a; R = H , n = 1. IR (KBr) ν 3058m, 2965m, 2861w, 1629s, 1471s, 1451s, 1411s, 1329m, 1236m 1215m, 1082w, 742s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 200 MHz) δ 2.55 (m, 2H, CH_2), 2.95 (m, 2H, CH_2), 3.0 (m, 2H, CH_2), 7.15-7.35 (m, 2H, arom-H), 7.45 (m, 1H, arom-H), 7.72 (m, 1H, arom-H); ^{13}C-NMR ($CDCl_3$, 50 MHz) δ 25.60, 26.50, 27.76 (+ , 3 CH_2), 110.23, 117.60, 121.81, 123.92, (- , arom-CH), 125.82, 128.11, 133.75, 143.40 (- , C-2, C-3, C-4a, C-8a), 160.24 (- , C-9a); MS m/e (%) 214 [M^+] (100), 213 [M^{-1}] (76), 203 (2), 199 (3), 187 (4), 181 (12), 169 (13), 154 (10), 149 (8), 145 (9), 139 (2), 129 (9), 119 (4), 111 (5), 102 (15), 91 (10), 83 (12), 77 (12), 69 (14), 57 (24), 51 915), 47 (2).

8b; R = H, n = 2. IR (KBr) ν = 3057w, 2939s, 2866m, 1637w, 1483s, 1472s, 1223m, 1133m, 757s, 745s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 200 MHz) δ 1.85-2.05 (m, 4H, -CH_2CH_2-), 2.63 (m, 2H, CH_2), 2.95 (m, 2H, CH_2), 7.10-7.35 (m, 2H, arom-H), 7.6 (d, J = 8 Hz, 1H, arom-H), 7.75 (d, J = 8 Hz, 1H, arom-H); ^{13}C-NMR ($CDCl_3$, 50 MHz); δ 21.74, 22.65, 23.20, 24.29 (+ , 4 CH_2 of C-1, C-2, C-3, C-4), 110.40, 118.89, 120.41, 122.69 (- , arom-CH), 119.15, 127.21, 130.00, 147.73 (+ , C-4a, C-11a, C-5a, C-9a), 155.62 (+ , C-10a); MS m/e (%)

228 [M^+] (100), 214 (2), 208 (3), 200 (36), 191 (4), 187 (3), 178 (17), 167 (6), 157 (4), 149 (6), 143 (3), 134 (5), 128 (2), 118 (5), 109 (3), 102 (6), 91 (5), 77 (6), 69 (8), 63 (5), 57 (8), 551 (5), 45 (4).

8c; *R = CH_3, n = 2.* IR (KBr) ν = 3054m, 2937s, 2865m, 1630m, 1611m, 1480s, 1471s, 1309m, 1270m, 1013w, 757s, 741s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 200 MHz) δ 1.45 (d, J = 7 Hz, 3H, CH_3), 1.8-2.05 (m, 2H, CH_2), 2.15-2.40 (m, 2H, CH_2), 2.7 (m, 2H, CH2), 3.4 (m, 1H, CH), 7.1-7.4 (m, 2H, arom-H), 7.6-7.8 (m, 2H, arom-H); MS m/e (%) 242 [M^+] (5), 227 (3), 204 (2), 189 (1), 178 (2), 164 (1), 161 (1), 151 (1), 149 (2), 135 (1), 123 (2), 119 (4), 112 (2), 105 91), 97 (2), 88 (10), 86 (65), 84 (100), 77 (2), 69 (4), 65 (2), 57 (4), 49 (19), 45 (20).

8d; *R = H, n = 3.* IR (KBr): ν = 3045w, 2925s, 2852m, 1622w, 1479s, 1448s, 1359w, 1314m, 1274s, 1129m, 1015w, 755s, 742s cm^{-1}; ^{1}H-NMR ($CDCl_3$, 200 MHz) δ 1.75-1.95 (m, 6H, 3 CH2 of - $(CH_2)3$ -), 2.65 (bt, 2H, CH_2), 3.15 (bt, 2H, CH_2), 7.1 (m, 1H, arom-H), 7.25 (m, 1H, arom-H), 7.65 (d, 1H, J = 8 Hz, arom-H), 7.72 (dd, J = 8 Hz, J = 1 Hz, 1H, arom-H); ^{13}C-NMR ($CDCl_3$, 50 MHz) δ 25.42, 27.37, 27.77, 29.15 (+ , 5 CH2), 110.59, 118.89, 120.08, 122.59 (- , C-7, C-8, C-9, C-10), 121.91, 130.37, 130.94, 147.86 (+ , C-5a, C-12a, C-6a, C-10a), 155.28 (+ , C-11a); MS m/e (%) 243 [M^{+1}] (100), 242 [M^+] (20), 228 (12), 214 (38), 210 (21), 201 (27), 195 (7), 189 (37), 187 (5), 182 (8), 169 (8), 161 (8), 155 (9), 149 (12), 143 98), 134 (9), 129 98), 119 (5), 102 (8), 97 (8), 91 (9), 83 (8), 77 (8), 69 (8), 63 (7).

Table 2. Physical Data and Elemental Analyses of Compounds **7c,e** and **8a-d**.

No. R R'	Yield (%)	m.p. oC	M. Wt.	Elemental Analysis Calcd:/ Found C	H	N	S
7c; Et Me	67	105	$C_{12}H_{12}N_2S$ (216.3)	66.63 66.52	5.59 5.51	12.95 12.90	14.82 14.68
7e; $PhCH_2$ Me		----	$C_{17}H_{14}N_2S$ (278.37)	73.35 73.30	5.07 5.10	10.06 10.15	11.52 11.25
7f; Et Ph	33	154	$C17H_{14}N_2S$ (278.37)	73.35 73.25	5.07 5.01	10.06 10.12	11.52 11.32
8a; H, n = 0	65	174	$C_{12}H_{10}N_2S$ (214.28)	67.26 67.33	4.70 4.72	13.07 12.90	14.96 14.86
8b; H, n = 1	60	149	$C_{13}H_{12}N_2S$ (228.31)	68.39 68.30	5.29 5.18	12.27 12.18	14.04 14.20
8c; H, n = 2	52	104	$C_{14}H_{14}N2S$ (242.34)	69.38 69.30	5.82 5.71	11.55 11.45	13.23 13.03
8d; H, n = 3	74	138	$C_{14}H_{14}N_2S$ (242.34)	69.38 69.29	5.82 5.70	11.55 11.42	13.23 13.10

Synthesis of Benzimidazolyldisulfide (9).

To a 1.0 g sample of 2-mercaptobenzimidazole (**1**) in acetic acid (10 ml), few drops of concentrated H_2SO_4 was added at once. A yellow solid, deposited after stirring for 3 min., was refluxed for 3h. The reaction mixture was cooled and neutrallized with NH_4OH solution. The resulting precipitate was extracted with chloroform, dried ($CaCl_2$) and the chloroform was removed under reduced pressure. The separated compound was crystallized from ethanol to give the disulfides **9** in 67% yield.[9]

Reaction of 3-Aminothiazolo[3,2-a]benzimidazole-2-carbonitrile (12) with Aromatic Ketones Using Acidified Acetic Acid Method.

A mixture of 3-amino-thiazolo[3,2-a]benzimidazole-2-carbonitrile (**12**; 2.14 g, 10 mmol) and aromatic ketones **2a-d** (10 mmol) was refluxed in acetic acid containing few drops of H_2SO_4 for 4h. The reaction mixture was cooled and neutralized with NH_4OH solution. The resulting precipitate was collected by filtration, dried well and crystallized from ethanol to give **3a-d** in good yields. Compound **12** was prepared by us and the data was published recently.[1f,g,h]

Acknowledgement: We thank the *DAAD foundation (Germany)* for support of this work. Thanks also to *Prof. Dr. H.M.R. Hoffmann, Ph.D, D.Sc. (Institute fur Organishe Chemie, Universitat Hannover, Schneiderberg 1B, D-30167 Hannover, Germany)* for his kind help.

REFERENCES AND NOTES

1. a) Ogura, H.; Itoh, T. and Tajika, T., J. Heterocyclic Chem., **1968**, 5, 319. b) Ogura, H.; Itoh, T. and Shimada, Y., Chem. Pharm. Bull., **1968**, 16, 2167. c) Preston, P.N.; Stevens, M. F. G. and Tennant, G., Heterocyclic Compounds, **1981**, part 2, vol 40, 84-219. d) Chimirri, A.; Grasso, S.; Romeo, G. and Zappala, M. Heterocycles, **1988**, 27 (8), 1975-2003. e) Krasovskii, A. N. and Kochergin, P.M., Chem. Heterocycl. Compds., **1969**, 243 , Chem. Abstr., **1969**, 71, 22067. f) Sarhan, A.A.O.; Hozien, Z.A.; El-Sherief, H.A.H.; and Mahmoud, A.M., Pol. J. Chem., **1995**, 69, 1479-83. g) Sarhan, A.A.O.; El-Sherief, H.A.H.; and Mahmoud, A.M., J. Chem. Research (S), **1996**, 1, 4-5., ibid, J. Chem Research (M), **1996**,115-136. h) Sarhan, A.A.O., AFINIDAD, **1995**, 57-60.

2. a) Alper, H.; Keung, E.C.H and Parts, R.A., J. Org. Chem., **1971**, 36 (10), 1352. b) Alper, H.; Alper, A.E. and Taurins, A., J. Chem. Education, **1970**, 47, 227. c) Singh, H. and Singh, S., Indian J. Chem., **1971**, 9, 918. d) Singh, H. and Singh, S, Indian J. Chem., **1973**, 11, 311. e) Chadha,V.K.; Sharma, K.S. and Pujari, H.K., Indian J. Chem., **1971**, 9, 913. f) Singh, S.; Singh, H.; Singh, M. and Narang, K.S., Indian J. Chem., **1970**, 8, 230. g) Krasovskii, A.N.;Kochergin, P.M. and Kozlovskaya, T.E., Chem.

Heterocycl. Compds., **1971**, 7, 363 , Khim. Geterotsikl. Soedin., **1971**, 7, 393 , Chem. Abstr., **1972**, 76, 14433.

3. Chadha, V.K.; Chaudhary, H.S. and Pujari, H.K. , Ind. J. Chem., **1969**, 7, 769.
4. Mohan, J.; Chadha. V.K. and Pujari, H.K., Indian J. CHem., **1973**, 11, 1119.
5. Burgi, H.B.; Lehn, J.M. and Wipff, G., J. Amer. Chem. Soc., **1974**,1957
6. D'Amico, J.J.; Compbell, R.H. and Gunn, E.C, J.Org. Chem.,**1964**, 29, 865.
7. Alper, A.E. and Taurins, A., Can. J. Chem., **1967**, 45, 2903.
8. Physical and analytical data of compounds **3a-d** were in satisfactory agreement with the reported results.
9. Data of **9** was agreed with that reported in literature, S.W. Park, W. Ried and W. Schuckmann; Liebigs Ann. Chem., **1977**, 106.

(*Received in UK* 12 *April* 1996; *revised* 14 *June* 1996; *accepted* 18 *June* 1996)