Indian Journal of Chemistry
Vol. 46B, June 2007, pp.980-984

# Microwave-assisted synthesis and biological activity of 3-alkyl /aryl-6-(1-chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-s-triazolo [3,4-*b*] [1,3,4] thiadiazoles

Poonam Kamotra, Avinash K Gupta & Rajive Gupta*

Department of Chemistry, University of Jammu, Jammu 180 006, India

and

P Somal[a] & S Singh[b]

[a]Department of Microbiology and [b]Department of Pharmacology, Regional Research Laboratory, Jammu 180 001, India

E-mail : rajgupta@sancharnet.in

*Received 12 September 2006; accepted (revised) 16 October 2006*

3-Alkyl/aryl-6-(1-chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-s-triazolo[3,4-*b*][1,3,4]thiadiazoles **3** have been synthesised by the condensation of 5-alkyl/aryl-4-amino-3-mercapto-1,2,4-triazoles **2** with 1-chloro-2-formyl-3,4-dihydronaphthalene **1** in presence of catalytic quantity of *p*-TsOH under microwave irradiation. Rate enhancement and improvement in yields, characteristics of synthesis under microwave irradiation, have been observed. The compounds synthesised have been characterised and screened for their antibacterial, antifungal, antiinflammatory and antioxidant activity.

**Keywords**: 3-Alkyl/aryl-6-(1-chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-s-triazolo[3,4-*b*][1,3,4]thiadiazoles, *p*-TsOH, microwave irradiation, rate enhancement, specific microwave effect, biological activity

Among a wide variety of nitrogen heterocycles that have been explored for developing pharmaceutically important molecules, substituted 1,2,4- or s-triazoles and N-bridged heterocycles derived from them have received considerable attention during the last two decades as potential bioactive agents[1-6]. A triazolo-thiadiazole system may be viewed as a cyclic analogue of two very important components - thiosemicarbazide[7,8] and biguanide[9] which often display diverse biological activity.

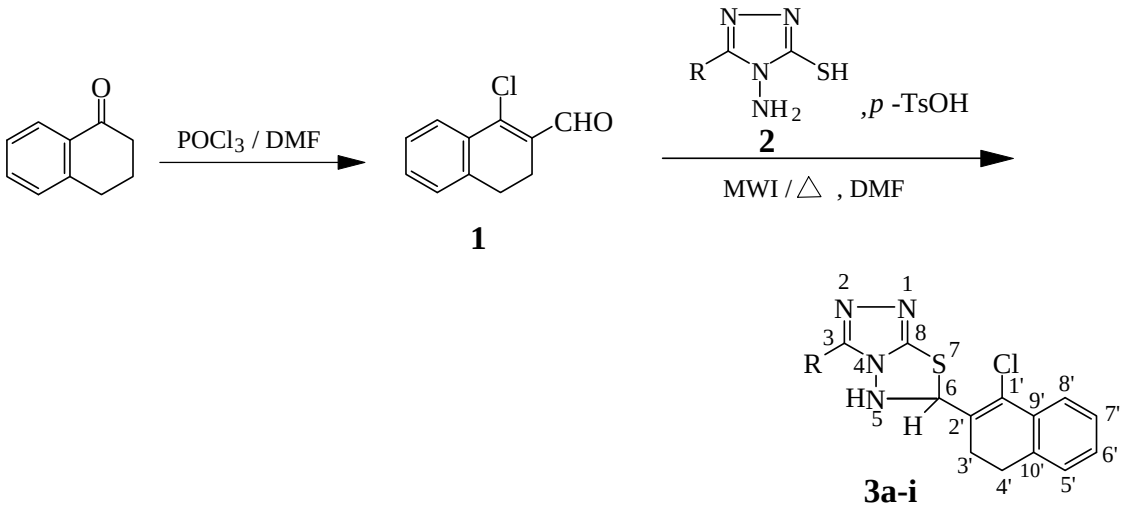
Application of microwaves to organic synthesis is well established[10]. The reactions are carried out in open vessels using polar solvents as energy transfer media or under solvent free conditions using neat reactants or solid supports. It has earlier been demonstrated[11] that on addition of a small amount of a polar solvent like DMF, the reaction rate is appreciably enhanced as compared to the rate in dry media conditions.

In continuation of the ongoing work for the synthesis of heterocycles[12] of biological interest and the application of microwaves to organic synthesis[13], herein is reported the synthesis of 3-alkyl/aryl-6-(1-chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-s-triazolo-[3,4-*b*][1,3,4]thiadiazoles **3** by the condensation of 5-alkyl/aryl-4-amino-3-mercapto-1,2,4-triazoles **2** with 1-chloro-2-formyl-3, 4-dihydronaphthalene **1** in presence of catalytic amount of *p*-TsOH under microwave irradiation using 1.0 mL of DMF as energy transfer medium as well as homogeniser or by stirring at 70-80°C using DMF as solvent (**Scheme I**).

The reaction times and yields of **3a-i** obtained under microwave irradiation and under classical conditions have been compared in **Table I**.

In order to study the possible existence of specific microwave effect, all the reactions were repeated using the conventional mode of heating (a preheated oil-bath) at the same final temperatures and reaction times as in the case of microwave irradiation experiments. In all cases using the conventional mode, no reaction or trace of the product was detected as determined by TLC.

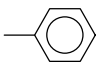
The required 1-chloro-2-formyl-3,4-dihydronaph-thalene **1** (m.p. 36-37°C, Lit.[14] m.p. 37°C, b.p. 145-53°C) was prepared by the Vilsmeier-Haack reaction[15] of α-tetralone. 5-Alkyl-4-amino-3-mercapto-1,2,4-triazoles **2a-c** were prepared from thiocarbo-hydrazide by cyclisation in appropriate aliphatic



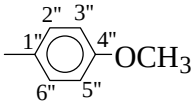

**3a** : R = $CH_3$

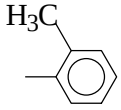
**3b** : R = $C_2H_5$

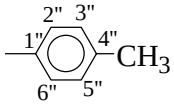
**3c** : R = $CH_2CH_2CH_3$

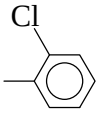
**3d** : R = 

**3e** : R = 

**3f** : R = 

**3g** : R = 

**3h** : R = 

**3i** : R = 

**Scheme I**

**Table I —** Comparison of reaction times and yields of **3a-i** under microwave irradiation and classical conditions

| Compd | Reaction Time | | Yield (%) | |
|---|---|---|---|---|
| | MWI (min) | Classical (h) | MWI | Classical |
| **3a** | 3 | 15 | 81 | 63 |
| **3b** | 3.5 | 15 | 79 | 57 |
| **3c** | 3.5 | 17 | 78 | 51 |
| **3d** | 2 | 16 | 71 | 55 |
| **3e** | 1.5 | 10 | 75 | 58 |
| **3f** | 3.5 | 14 | 81 | 61 |
| **3g** | 2.5 | 17 | 76 | 58 |
| **3h** | 2 | 14 | 71 | 63 |
| **3i** | 2 | 13 | 74 | 60 |

acids[16,17] and 4-amino-5-aryl-3-mercapto-1,2,4-triazoles **2d-i** were prepared following the method of Reid and Heindel[18].

## Antioxidant activity

The compounds **3a-i** were evaluated for antioxidant activity against sodium nitroprusside induced nitric oxide (NO) production, measured by Griess reaction[19,20]. Out of the compounds tested, **3c**, **3d** and **3h** showed significant antioxidant effect against sodium nitroprusside induced NO production (**Table II**).

## Antibacterial and antifungal activities

The antibacterial activity of **3a-i** was determined *in vitro* using paper disc method against two pathogenic microorganisms *viz.*, *Escherichia coli* (Gram-negative) and *Staphylococcus aureus* (Gram-positive) at 10 mg/mL concentration in the nutrient agar media. The compounds were not significantly active towards these bacteria. Similarly, the antifungal screening of the compounds, **3a-i** was carried out *in vitro* by paper

Table II — Antioxidant effect of compounds 3a–i against sodium nitroprusside induced NO production

| Compd | Optical density (OD) at 546 nm | % Protection |
|---|---|---|
| Control | 0.302 | — |
| **3a** | 0.331 | nil |
| **3b** | 0.287 | 4.96 |
| **3c** | 0.270 | 10.59 |
| **3d** | 0.226 | 25.16 |
| **3e** | 0.302 | nil |
| **3f** | 0.295 | 2.31 |
| **3g** | 0.352 | nil |
| **3h** | 0.276 | 8.60 |
| **3i** | 0.359 | nil |

(i) compounds were incubated for 150 min at 20°C

(ii) each compound was tested at 50 μg /mL

(iii) sodium nitroprusside used = 5 μM

(iv) optical density (OD) was taken after 30 min of Griess reaction

disc method against *Aspergillus niger* at 10mg/mL concentration. The compounds **3a**, **3b**, **3e**, **3f** and **3g** showed significant antifungal activity.

### Antiinflammatory activity

The synthesised compounds **3a-i** were also assessed for their antiinflammatory activity by acute carrageenan-induced oedema in rat paw following the technique of Winter *et. al*[21]. The test compounds showed mild antiinflammatory activity of about 3.0 to 12.0% taking phenylbutazone as standard which showed 58% inhibition.

### Experimental Section

Melting points were determined in open capillaries on Toshniwal melting point apparatus and are uncorrected. The reactions under microwave irradiation were carried out in a BPL BMO 800T domestic microwave oven operating at 2450 MHz with maximum power output of 800 W. IR spectra were recorded on Shimazu IR-435 spectrometer using KBr disc or Nujol. $^1$H NMR spectra were recorded in $CDCl_3$/$CDCl_3$ + DMSO-$d_6$/DMSO-$d_6$ on Bruker DPX -200 (200MHz) or Bruker AM-250 (250 MHz) spectrometers and $^{13}$C NMR spectra were recorded in DMSO-$d_6$ on Bruker DPX-200 (200 MHz) spectrometer using TMS as an internal standard. Mass spectra were recorded on Jeol JMS D-300 mass spectrometer at 70 eV. The products were analyzed for C, H and N and the values were found within ± 0.5% of the theoretical values.

### General procedure for the synthesis of 3-alkyl/aryl-6-(1-chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-s-triazolo[3,4-*b*][1,3,4] thiadiazoles, 3a-i

**Microwave method**. A mixture of 5-alkyl/aryl-4-amino-3-mercapto-1,2,4-triazole **2a-i** (0.005 mole), 1-chloro-2-formyl-3,4-dihydronaphthalene **1** (0.960 g, 0.005 mole), *p*-TsOH (50 mg) and DMF (1.0 mL) taken in a borosil beaker (100 mL) was mixed properly with the help of a glass rod. The paste thus obtained was irradiated in a domestic microwave oven at 300 W for an appropriate time (**Table I**, monitored on TLC after every 30 s). After cooling to RT, crushed ice was added into the beaker and the reaction mixture was stirred thoroughly. The solid separated was filtered, washed with water, dried and purified by recrystallization from a suitable solvent to give **3a-i** in 71-81% yield.

**Conventional method**. An equimolar mixture of 5-alkyl/aryl-4-amino-3-mercapto-1,2,4-triazole **2a-i** (0.005 mole), 1-chloro-2-formyl-3,4-dihydronaphthalene **1** (0.960 g, 0.005 mole) and *p*-TsOH (50 mg) in DMF (25 mL) was stirred at 70-80°C for an appropriate time (**Table I**, monitored on TLC). The reaction mixture was cooled and poured over crushed ice. The solid separated was filtered, washed with water, dried and purified by recrystallization from a suitable solvent to give **3a-i** in 51-63% yield.

The physical and spectral data of **3a-i** are as follows:

### 6-(1-Chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-3-methyl-s-triazolo[3,4-*b*][1,3,4] thiadiazole, 3a

Shining yellow needles (ethyl acetate); m.p. 203-204°C; IR (Nujol): 3290, 3060, 1590, 1545, 1480, 820, 725 cm$^{-1}$; MS: *m/z* (%) 305 ($M^+$ +1, 15.98), 304 ($M^+$ 29.59), 189 (91.12), 154 (100), 127 (72.78), 115 (96.45), 56(45.56), 43 (46.15); $^1$H NMR (DMSO-$d_6$): δ 2.3 (s, 3H, -C*H*$_3$), 2.7-2.9 (m, 4H, Ar – C*H*$_2$ - C*H*$_2$ -), 5.7 (bs, 1H, -N*H* -), 6.6 (s,1H, -NH-C*H* -), 7.3-7.5 (m, 3H, Ar- *H*), 7.7 (d, 1H, Ar – *H*); $^{13}$C NMR (DMSO-$d_6$): δ 10.98 ($CH_3$), 22.5 ($C'_3$), 26.5 ($C'_4$), 125.6 ($C'_7$), 127.4 ($C'_8$), 128.04 ($C'_6$), 130.8 ($C'_5$), 131.8 ($C'_9$), 138.4 ($C'_{10}$), 138.6 ($C'_2$), 142.9 ($C'_1$), 149.2 ($C_8$), 157.4 ($C_6$), 161.3 ($C_3$). Anal. Found: C, 55.14; H, 4.30; N, 18.37. $C_{14}H_{13}ClN_4S$ requires C, 55.17; H, 4.27; N, 18.39%.

### 6-(1-Chloro-3,4-dihydronaphth-2-yl)-3-ethyl-5,6-dihydro-s-triazolo[3,4-*b*][1,3,4] thiadiazole, 3b

Shining light brown crystals (ethyl acetate); m.p. 192-93°C; IR (KBr): 3315, 3040, 1610, 1570, 1470,

810, 705 $cm^{-1}$; $^1H$ NMR ($CDCl_3$ + DMSO-$d_6$): δ 1.3 (t, 3H, – $CH_2$- C*H* $_3$), 2.6 – 3.0 (m, 4H, Ar – C*H* $_2$ – C*H* $_2$ –and q buried, 2H, - C*H* $_2$ – $CH_3$), 5.5 (bs, 1H, -N*H* -), 6.48 (s, 1H, -NH – C*H* -), 7.1 – 7.4 (m, 3H, Ar – *H*), 7.8 (d, 1H, Ar – *H*). Anal. Found: C, 56.55; H, 4.73; N, 17.56. $C_{15}H_{15}ClN_4S$ requires C, 56.51; H, 4.71; N, 17.58%.

**6-(1-Chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-3-propyl-s-triazolo[3,4-][1,3,4]thiadiazole, 3c**

Shining light brown crystals (ethyl acetate); m.p. 187–88°C; IR (KBr): 3310, 3055, 1625, 1570, 1475, 810, 685 $cm^{-1}$; $^1H$ NMR ($CDCl_3$ + DMSO-$d_6$): δ 1.1 (t, 3H, -$CH_2$-$CH_2$- C*H* $_3$), 1.8 (m, 2H, - $CH_2$- C*H* $_2$- $CH_3$), 2.6 – 3.0 (m, 4H, Ar- C*H* $_2$- C*H* $_2$- and t buried, 2H, - C*H* $_2$- $CH_2$- $CH_3$), 6.65 (s, 1H,-NH-C*H* -), 7.1-7.3 (m, 3H, Ar- *H*), 7.7 (d, 1H, Ar- *H*). Anal. Found: C, 57.72; H, 5.15; N, 16.87. $C_{16}H_{17}ClN_4S$ requires C, 57.74; H, 5.11; N, 16.84%.

**6-(1-Chloro-3, 4-dihydronaphth-2-yl)-5, 6-dihydro-3-phenyl-s-triazolo[3,4-*b*][1,3,4]thiadiazole, 3d**

Light brown solid(ethyl acetate); m.p. 196-97°C; IR (KBr): 3280, 3020, 1600, 1540, 1460, 795, 690 $cm^{-1}$; $^1H$ NMR ($CDCl_3$ + DMSO-$d_6$): δ 2.7-3.0 (m, 4H, Ar -C*H* $_2$ -C*H* $_2$), 5.1 (bs, 1H, -N*H* -), 6.8 (s, 1H, -NH-C*H* -), 7.1-8.0 (m, 9H, Ar-*H*). Anal. Found: C, 62. 24; H, 4.12; N, 15.25. $C_{19}H_{15}ClN_4S$ requires C, 62.21; H, 4.09; N, 15.28%.

**3-Benzyl-6-(1-chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-s-triazolo[3,4-*b*][1,3,4] thiadiazole, 3e**

Shining pale yellow solid (ethyl acetate-petroleum ether); m.p. 204-05°C; IR (KBr): 3330, 3020, 1625, 1565, 1490, 825, 690 $cm^{-1}$; MS: *m/z*(%), 382 ($M^+$ + 2, 4.4), 380 ($M^+$,10.4), 343 (21.3), 191 (100), 190 (55.8), 154 (49.2), 128 (30.5), 78 (33.2); $^1H$ NMR (DMSO-$d_6$): δ 2.5 – 2.9 (m, 4H, Ar – C*H* $_2$ – C*H* $_2$ -), 4.1 (s, 2H, Ar – C*H* $_2$ -), 6.0 (bs, 1H, -N*H* -), 6.65 (s, 1H, -NH- C*H* -), 7.0-7.7 (m, 9H, Ar- *H*). Anal. Found: C, 63.03; H, 4.45; N, 14.75. $C_{20}H_{17}ClN_4S$ requires C, 63.07; H, 4.47; N, 14.72%.

**6-(1-Chloro-3,4-dihydronaphth-2-yl)-5,6-dihydro-3-(4-methoxyphenyl)-s-triazolo[3,4-b][1,3,4]thiadiazole, 3f**

Shining light brown needles (ethyl acetate); m.p. 211-12°C; IR (Nujol): 3315, 3030, 1610, 1575, 1500, 1270, 1025, 825, 670 $cm^{-1}$; MS: *m/z*(%), 397 ($M^+$ +1, 11.46), 396 ($M^+$, 18.75), 361 (26.04), 327 (12.50), 207 (100), 187 (11.46), 162 (19.79), 154 (72.92), 127 (65.63), 77 (48.96), 63 (51.04), 51 (39.58); $^1H$ NMR (DMSO-$d_6$): δ 2.7-2.9 (m, 4H, Ar- C*H* $_2$ – C*H* $_2$-), 3.8 (s, 3H, -OC*H* $_3$), 5.8 (bs, 1H-N*H* -), 6.55 (s, 1H, -NH-C*H* -), 7.0-7.9 (m, 8H, Ar-*H*); $^{13}C$ NMR (DMSO-$d_6$): δ 21.1 ($C'_3$), 24.9 ($C'_4$), 54.0 ($CH_3O$), 112.7 ($C''_3$ and $C''_5$), 124.1 ($C'_7$), 125.8 ($C'_8$), 126.4 ($C'_6$), 128.4 ($C'_5$). 128.9 ($C''_2$ and $C''_6$), 129.3 ($C''_1$), 130.1 ($C'_9$), 136.8 ($C'_{10}$), 137.5 ($C'_2$), 147.6 ($C'_1$), 159.3 ($C_6$), 159.6 ($C_3$ and $C_8$), 160.4 ($C''_4$). Anal. Found: C, 60.57; H, 4.32; N, 14.09. $C_{20}H_{17}ClN_4OS$ requires C, 60.53; H, 4.29; N, 14.12%.

**6-(1-Chloro-3, 4-dihydronaphth-2-yl)-5,6-dihydro-3-(2-methylphenyl)-s-triazolo[3,4-*b*][1,3,4]thiadiazole, 3g**

Shining pale yellow solid (benzene-petroleum ether); m.p. 185–86°C; IR (KBr): 3350, 3040, 1595, 1570, 1480, 775, 680 $cm^{-1}$; MS: *m/z*(%), 380 ($M^+$, 7.4), 347 (14.9), 190 (100), 153 (73.8), 127 (41.8),116 (51.2), 77(70.3), 53 (54.6); $^1H$ NMR ($CDCl_3$): δ 2.3 (s, 3H, Ar-C*H* $_3$), 2.5-2.9 (m, 4H, Ar- C*H* $_2$- C*H* $_2$-), 5.1 (bs, 1H, -N*H* -), 6.6 (s, 1H, -NH-C*H* -), 7.2-7.9 (m, 8H, Ar- *H*). Anal. Found: C, 63.10; H, 4.44; N, 14.76. $C_{20}H_{17}ClN_4S$ requires C, 63.07; H, 4.47; N, 14.72%.

**6-(1-Chloro-3, 4-dihydronaphth-2-yl)-5,6-dihydro-3-(4-methlphenyl)-s-triazolo [3,4-*b*][1,3,4]thiadiazole, 3h**

Shining light yellow crystals (ethyl acetate): m.p. 221-22°C; IR (KBr): 3320, 3050, 1600, 1560, 1485, 820, 675 $cm^{-1}$; MS: *m/z*(%), 382 ($M^+$ + 2, 2.8), 380 ($M^+$, 6.0), 342 (16.4), 193 (39.2), 191 (100), 154 (28.9), 132 (29.5), 127 (30.4), 118 (44.4), 91 (20.1), 77 (11.9); $^1H$ NMR (DMSO-$d_6$): δ 2.3 (s, 3H, Ar - C*H* $_3$), 2.6-3.0 (m, 4H, Ar - C*H* $_2$- C*H* $_2$-), 5.8 (bs, 1H, -N*H* -), 6.7(s, 1H,-NH-C*H*-), 7.2 - 7.8 (m, 8H, Ar- *H*); $^{13}C$ NMR (DMSO-$d_6$): δ 20.4 ($CH_3$), 21.8 ($C'_3$), 25.5 ($C'_4$), 124.8 ($C'_7$), 126.5 ($C'_8$), 127.1 ($C'_6$), 127.8 ($C''_2$ and $C''_6$), 128.5 ($C''_3$ and $C''_5$), 129.0 ($C''_1$), 130.0 ($C'_5$), 130.8 ($C'_9$), 137.5 ($C''_4$), 138.2 ($C'_{10}$), 139.9 ($C'_2$), 148.5 ($C'_1$), 153.9 ($C_8$), 159.9 ($C_6$), 161.3 ($C_3$). Anal. Found: C, 63.11; H, 4.44; N, 14.68. $C_{20}H_{17}ClN_4S$ requires C, 63.07; H, 4.47; N, 14.72%.

**6-(1-Chloro-3,4-dihydronaphth-2-yl)-3-(2-chlorophenyl)-5,6-dihydro-s-triazolo[3,4-*b*][1,3,4] thiadiazole, 3i**

Shining light brown crystals (benzene): m.p. 175-76°C; IR (KBr): 3310, 3045, 1590, 1560, 1480, 825, 715 $cm^{-1}$; MS: m/z(%), 402 ($M^+$ +1, 1.6), 400 ($M^+$ -1,

4.4), 227 (41.7), 225 (51.9), 212 (49.7), 190 (100), 188 (52.8), 153 (79.0), 149 (70.3), 126 (65.5), 115 (26.8), 75 (63.2), 63 (37.1); $^1$H NMR (DMSO-$d_6$): δ 2.5 - 2.8 (m, 4H, Ar - C*H*$_2$ -C*H*$_2$ -), 5.3 (bs, 1H, - N*H* -), 6.74 (s, 1H, -NH-C*H* -), 7.1 – 7.8 (m, 8H, Ar-*H*). Anal. Found: C, 56.88; H, 3.45; N, 13.95. $C_{19}H_{14}Cl_2N_4S$ requires C, 56.86; H, 3.49; N, 13.97%.

## References


1 Ewiss N F, Bahajaj A A & Elsherbini, *J Heterocycl Chem*, 23, **1986**, 1451.

2 Walser A, Flynn T & Mason C, *J Heterocycl Chem*, 28, **1991**, 1121.

3 Bradbury R H & Rivett J E, *J Med Chem*, 34, **1991,** 151.

4 Kane J M, Baron B M, Dudley M W, Sorensen S M & Stager M A, *J Med Chem*, 33, **1990**, 2772.

5 Dawood K M, Raslan M A & Farag A M, *Synth Commun*, 33, **2003**, 4079.

6 Bhat K S & Holla B S, *Phosphorus, Sulphur and Silicon*, 179, **2004**, 1019.

7 Joshi K C & Giri S, *J Indian Chem Soc*, 40, **1963**, 42.

8 Tiwari N, Chaturvedi B & Nizamuddin, *Indian J Chem*, 28B, **1989**, 200.

9 Haglind J, *Intern Congr Chemotherapy Proc*, 3rd, Stuttgart, 1, **1963**, 887; *Chem Abstr*, 64, **1966**, 16509e.

10 a) Abramovitch R A, *Org Prep Proced Int*, 23, **1991**, 685;
b) Caddick S, *Tetrahedron*, 51, **1995**, 10403;
c) Majetich G & Hicks R, *Radiat Phys Chem*, 45, **1995**, 567;
d) Bose A K, Banik B K, Lavlinskaia N, Jayaraman M & Manhas M S, *Chemtech*, 27, **1997**, 18;
e) Loupy A, Petit A, Hamelin J, Texier-Boullet F, Jacquault P & Mathe D, *Synthesis*, **1998**, 1213;
f) Varma R S, *Green Chemistry*, 1, **1999**, 43;
g) Deshayes S, Liagre M, Loupy A, Luche J-L & Petit A, *Tetrahedron*, 55, **1999**, 10851;
h) Elander N, Jones J R, Lu S –Y & Stone – Elander S, *Chem Soc Rev*, 29, **2000**, 239.
i)Lidstorm P, Tierney J, Wathey B & Westman J, *Tetrahedron*, 57, **2001**, 9225.

11 a)Paul S, Gupta R & Loupy A, *J Chem Research (S)*, **1998**, 330.
b) Gupta R, Gupta A K, Paul S & Somal P, *Indian J Chem*, 39B, **2000**, 847.

12 a) Gupta R, Sudan S, Kachroo P L & Jain S M, *Indian J Chem*, 35B, **1996**, 718;
b) Gupta R, Paul S, Gupta A K, Kachroo P L & Bani S, *Indian J Chem*, 36B, **1997**, 707;
c) Gupta R, Paul S, Gupta A K, Kachroo P L & Bani S, *Indian J Chem*, 37B, **1998**, 498;
d) Gupta R, Gupta A K, Paul S & Kachroo P L *Indian J Chem*, 37B, **1997**, 1211.

13 a) Gupta R, Paul S, Gupta A K & Kachroo P L, *Indian J Chem*, 33B, **1994**, 888;
b) Gupta R, Gupta A K, Paul S & Kachroo P L, *Indian J Chem*, 34B, **1995**, 61, 151;
c) Gupta R, Paul S, Gupta A K & Kachroo P L, *Indian J Chem*, 36B, **1997**, 281;
d) Paul S & Gupta R, *Indian J Chem*, 37B, **1998**, 1279;
e) Paul S, Gupta M, Gupta R & Loupy A, *Tetrahedron Lett*, 42, **2001**, 3827;
f) Paul S, Gupta M, Gupta R & Loupy A, *Synthesis*, **2002**, 75.

14 Zeigenbein W & Lang W, *Chem Ber*, 93, **1960**, 2743; *Chem Abstr*, 55, **1961**, 5378d.

15 Chakrabotry A & Ray J K, *Synth Commun*, 25, **1995**, 1869.

16 Dhaka K S, Jagmohan, Chadha V K & Pujari H K, *Indian J Chem*, 12, **1974**, 287.

17 Gakhar H K, Jain A & Gupta S B, *J Indian Chem Soc*, 59, **1982**, 900.

18 Reid J R & Heindel N D, *J Heterocycl Chem*, 13, **1976**, 925.

19 Green L C, Wagner D A, Glogwoski J, Skipper P L, Wishnok J & Tannenbaum S R, *Anal Biochem*, 126, **1982**, 131.

20 Marcocci L, Maguire, J J, Droy –Lefaiz M T & Packer L, *Biochem Biophys Res Commun*, 201, **1994**, 748.

21 Winter C A, Risley E A & Nuss G W, *Proc Soc Biol Med*, 11, **1962**, 544.