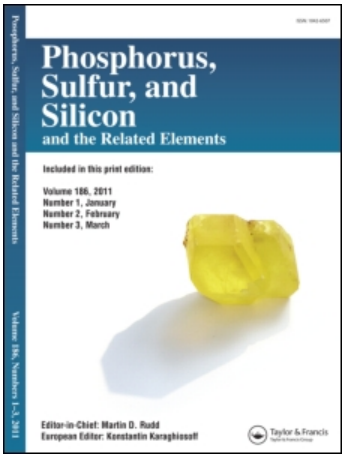

Phosphorus, Sulfur, and Silicon and the Related Elements
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

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To cite this Article Farag, Ahmad M. , Dawood, Kamal M. and Kandeel, Zaghloul E.(1997) 'CONVENIENT SYNTHESIS OF SOME NEW 1,3,4-THIADIAZOLE AND 1,3,4-SELENADIAZOLE DERIVATIVES', Phosphorus, Sulfur, and Silicon and the Related Elements, 130: 1, 43 — 51
To link to this Article: DOI: 10.1080/10426509708033695
URL: http://dx.doi.org/10.1080/10426509708033695

Phosphorus, Sulphur, and Silicon, 1997, Vol. 130, pp. 43–51
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CONVENIENT SYNTHESIS OF SOME NEW 1,3,4-THIADIAZOLE AND 1,3,4-SELENADIAZOLE DERIVATIVES

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(Received 15 January 1997; Revised 12 May 1997; In final form 12 May 1997)

The novel 1-aryl-5-(benzothiazol-2-yl)carbonyl-2-imino-1,3,4-thiadiazoles **7a–c** and their selenium analogues **8a–c** were prepared in high yields by coupling of 2-thiocyanatoacetylbenzothiazole **3** or its selenium analogue **4** with aromatic diazonium salts. The same products were alternatively obtained from the reaction of the hydrazonoyl bromides **2a–c** with potassium thiocyanate and with potassium selenocyanate, respectively. Reactions of **7a–c** and **8a–c** with acetic anhydride and with benzoyl chloride afforded the corresponding *N*-acetyl derivatives **13a–c** and **14a–c** and *N*-benzoyl derivatives **15a–c** and **16a–c**, respectively.

Keywords: 1,3,4-Thiadiazoles; 1,3,4-selenadiazoles; bromoacetylbenzothiazole; benzothiazoles

INTRODUCTION

Recently, we have studied[1] the behavior of α-haloketones **1** and **2a–c** towards different carbon nucleophiles which has proved to be a convenient route to several pyrazolo[3,4-d]pyridazine and pyrazolo[3,4-d]pyrimidine derivatives. As an extension of our study and as part of our program aiming at the synthesis of different heterocyclic systems incorporating benzothiazole moiety,[2–6] we report here the reactivity of **1** and **2** towards some sulfur and selenium nucleophiles.

DISCUSSION

Treatment of 2-bromoacetylbenzothiazole (**1**) with potassium thiocyanate or with potassium selenocyanate in ethanol at room temperature afforded the corresponding 2-thiocyanatoacetylbenzothiazole (**3**) and 2-selenocyanatoacetyl-ben-

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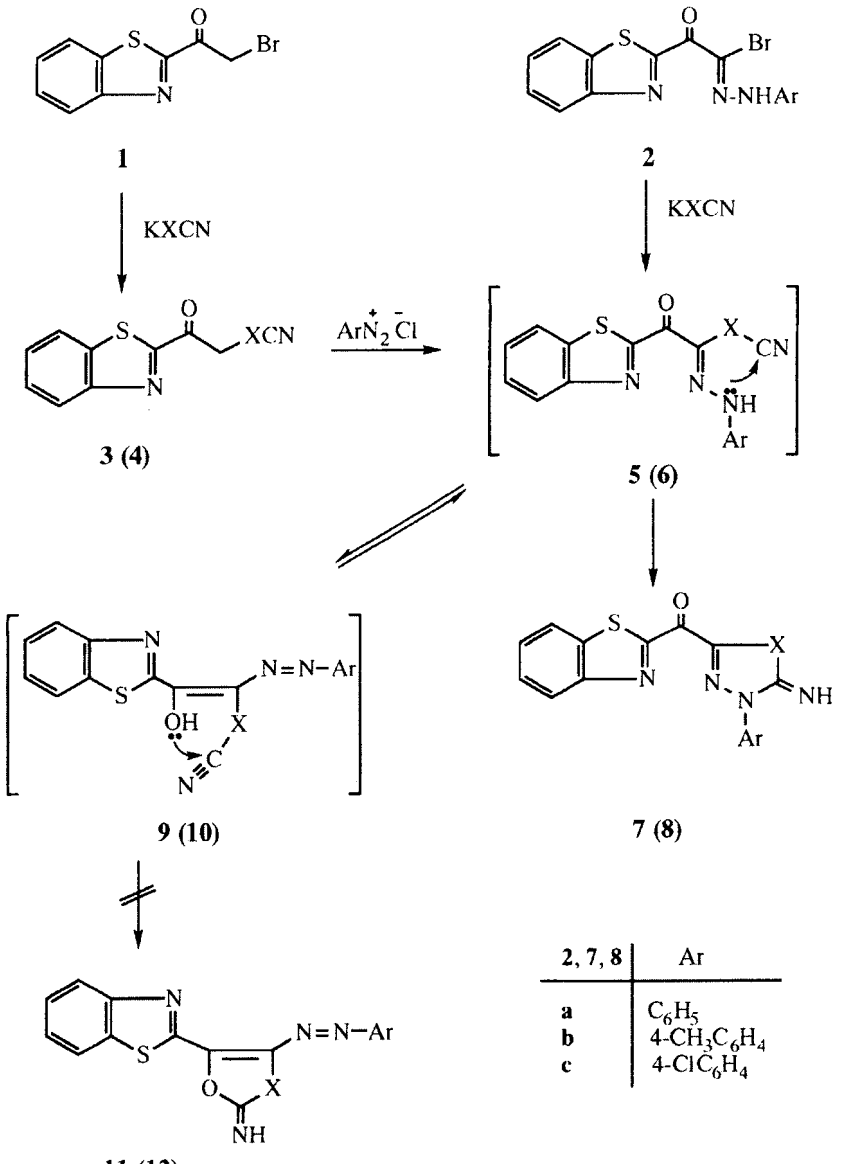
zothiazole (**4**), respectively (Scheme I). The structures of the isolated products were inferred from their elemental analyses and spectral data. Thus, the IR spectra of **3** and **4** revealed bands at 2162 and 2160 cm^{-1} assignable to SCN and SeCN groups, respectively, in addition to a strong carbonyl band near 1680 cm^{-1}. Their ^1H nmr spectra exhibited in each case, a singlet signal near δ 4.8 ppm and a multiplet in the region δ 7.3–8.23 ppm due to methylene and aromatic protons, respectively (Table I).

Compound **3** couples smoothly with diazotized aromatic amines in pyridine to afford compounds identified as 3-aryl-5-(benzothiazol-2-yl)carbonyl-2,3-dihydro-2-imino-1,3,4-thiadiazoles **7a–c** (Scheme I). The structures **7a–c** assigned to the reaction products were amply supported by IR and ^1H nmr spectra (Table I) and confirmed by their alternate syntheses. Thus, treatment of the hydrazonoyl bromides **2a–c** with potassium thiocyanate in ethanol, at room temperature, afforded compounds identical in all respects (m.p., mixed m.p. and spectra) with the products **7a–c**. The IR spectra of **7a–c** showed in each case, the absence of free SCN group[7] in the region 2250–2000 cm^{-1} and revealed the appearance of an imino NH absorption band near 3300 cm^{-1}, in addition to a conjugated carbonyl absorption band near 1650 cm^{-1} (Table I). ^1H nmr spectrum of **7b**, for example, displayed a singlet signal at δ 2.48 ppm and a broad D_2O-exchangeable signal at δ 8.64 ppm due to methyl and imino protons, respectively, in addition to a multiplet at δ 7.44–8.40 ppm due to aromatic protons. These results provide a firm support for structure **7** and exclude the other possible isomeric structures **5**, **9** and **11** for the reaction products as depicted in Scheme I.

In a similar manner, compound **4** coupled with diazotized aromatic amines in cold ethanolic sodium acetate solution and gave compounds identified as 3-aryl-5-(benzothiazol-2-yl)carbonyl-2,3-dihydro-2-imino-1,3,4-selenadiazoles **8a–c**. The latter products were alternatively synthesized by the reaction of the hydrazonoyl bromides **2a–c** with potassium selenocyanate in ethanol at room temperature (Scheme I). The products obtained by these two independent methods are identical in all respects (m.p., mixed m.p. and spectra). The spectral data of the reaction products were in complete agreement with structure **8** and ruled out all the other possible isomeric structures **6**, **10** and **12** (Scheme I).

Acetylation of **7a–c** and **8a–c** with acetic anhydride afforded the corresponding *N*-acetylimino derivatives **13a–c** and **14a–c**, respectively, in high yields (Scheme II). The structures of the latter products were confirmed by the disappearance of the imino **NH** absorption band in the region 3400–3200 cm^{-1} and the appearance of two carbonyl bands around 1665 and 1630 cm^{-1} in their IR spectra. The band at *ca.* 1630 cm^{-1} is assigned to *N*-acetyl carbonyl group. The ^1H nmr spectrum of **13b**, for example, exhibited singlet signals at δ 2.43

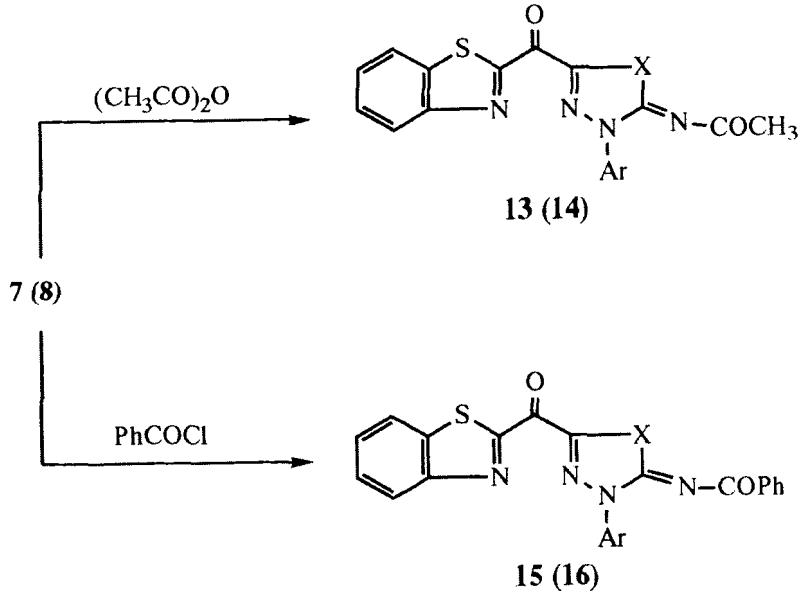


SCHEME I

TABLE I IR and ^{1}H nmr data of compounds **3**, **4**, **7**, **8**, and **13–16**.

Comp. no.	*IR (KBr), cm^{-1}*	*^{1}H nmr, δ (ppm)*
3	2162 (SCN), 1695 (C=O)	4.79 (s, 2H, CH_2), 7.56–8.23 (m, 4H, ArH)[a]
4	2160 (SeCN), 1675 (C=O)	4.85 (s, 2H, CH_2), 7.32–8.2 (m, 4H, ArH)[a]
7a	3300 (NH), 1650 (C=O), 1620 (C=N)	7.4–8.32 (m, 9H, ArH), 8.62 (br. s, 1H, NH)[a]
7b	3248 (NH), 1649 (C=O), 1600 (C=N)	2.48 (s, 3H, CH_3), 7.44–8.4 (m, 8H, ArH) 8.64 (br. s, 1H, NH)[a]
7c	3297 (NH), 1655 (C=O), 1615 (C=N)	7.45–8.4 (m, 8H, ArH), 8.60 (br.s, 1H, NH)[a]
8a	3300 (NH), 1640 (C=O), 1605 (C=N)	7.36–8.31 (m, 9H, ArH), 8.63 (br.s, 1H, NH)[a]
8b	3292 (NH), 1639 (C=O), 1598 (C=N)	2.40 (s, 3H, CH_3), 7.35–8.38 (m, 8H, ArH), 8.79 (br.s, 1H, NH)[b]
8c	3280 (NH), 1650 (C=O), 1600 (C=N)	7.36–8.4 (m, 8H, ArH), 8.77 (br.s, 1H, NH)[a]
13a	1663, 1630 (2 C=O), 1605 (C=N)	2.47 (s, 3H, $COCH_3$), 7.25–8.3 (m, 9H, ArH)[a]
13b	1667, 1630 (2 C=O), 1599 (C=N)	2.43 (s, 3H, CH_3), 2.48, (s, 3H, $COCH_3$), 7.36–8.4 (m, 8H, ArH)[a]
13c	1675, 1635 (2 C=O), 1600 (C=N)	2.48 (s, 3H, $COCH_3$), 7.3–8.4 (m, 8H, ArH)[b]
14a	1660, 1630 (2 C=O), 1610 (C=N)	2.47 (s, 3H, $COCH_3$), 7.21–8.32 (m, 9H, ArH)[a]
14b	1665, 1631 (2 C=O), 1611 (C=N)	2.43 (s, 3H, CH_3), 2.47 (s, 3H, $COCH_3$), 7.26–8.36 (m, 8H, ArH)[a]
14c	1663, 1635 (2 C=O), 1600 (C=N)	2.45 (s, 3H, $COCH_3$), 7.51–8.37 (m, 8H, ArH)[b]
15a	1668, 1630 (2 C=O), 1605 (C=N)	7.27–8.22 (m, ArH)[b]
15b	1675, 1634 (2 C=O), 1603 (C=N)	2.43 (s, 3H, CH_3), 7.3–8.26 (s, 13H, ArH)[b]
15c	1670, 1635 (2 C=O), 1605 (C=N)	7.23–8.20 (m, ArH)[b]
16a	1660, 1635 (2 C=O), 1607 (C=N)	7.3–8.32 (m, ArH)[b]
16b	1671, 1636 (2 C=O), 1600 (C=N)	2.45 (s, 3H, CH_3), 7.4–8.34 (m, 13H, ArH)[b]
16c	1670, 1632 (2 C=O), 1610 (C=N)	7.33–8.32 (m, ArH)[b]

[a]In $CDCl_3$
[b]In DMSO-d_6



13, 15 X = S
14, 16 X = Se

13-16	Ar
a	C_6H_5
b	4-$CH_3C_6H_4$
c	4-ClC_6H_4

SCHEME II

and 2.48 ppm assignable to methyl and *N*-acetyl protons, respectively. The ^1H nmr spectrum of **14b** revealed singlet signals at δ 2.42 and 2.46 ppm corresponding to methyl and CH_3CO protons, respectively (Table I).

Treatment of **7a–c** and **8a–c** with benzoyl chloride in refluxing pyridine afforded the corresponding *N*-benzoyl derivatives **15a–c** and **16a–c**, respectively (Scheme II). The structures **15** and **16** were established on the basis of their elemental analyses and supported by spectral data (Table I). For example, the IR spectra of **15a–c** and **16a–c** revealed in each case, two carbonyl absorption bands around 1665 and 1635 cm^{-1}. The latter band is assigned to the *N*-benzoyl carbonyl group.

EXPERIMENTAL

Melting points were recorded on a Gallenkampmelting point apparatus. IR spectra were measured as KBr pellets on a Pye-Unicam SP 3–300 spectrophotometer. ^1H nmr spectra were recorded on deuterated dimethylsulfoxide at 200 MHz on

TABLE II Physical data of compounds **3**, **4**, **7** and **8**.

Comp. no.	*M.p., °C*	*Yield, %*	*Formula (M.W.)*	*Analysis, Calcd/(Found)*			
				C	*H*	*N*	*S*
3	108–9[a]	95	$C_{10}H_6N_2OS_2$ (234.28)	51.26 (51.15)	2.56 (2.72)	11.93 (11.81)	27.36 (27.44)
4	113–4[a]	90	$C_{10}H_6N_2OSSe$ (281.18)	42.71 (42.43)	2.15 (2.12)	9.96 (9.64)	11.40 (11.36)
7a	152–4[a]	87	$C_{16}H_{10}N_4OS_2$ (338.39)	56.78 (56.73)	2.97 (2.89)	16.55 (16.34)	18.94 (19.02)
7b	143–5[b]	75	$C_{17}H_{12}N_4OS_2$ (352.42)	57.93 (58.10)	3.43 (3.47)	15.89 (15.57)	18.19 (18.31)
7c	189–91[b]	85	$C_{16}H_9ClN_4OS_2$ (372.83)	51.54 (51.46)	2.43 (2.45)	15.03 (15.23)	17.19 (17.10)
8a	140–2[b]	82	$C_{16}H_{10}N_4OSSe$ (385.28)	49.87 (49.95)	2.61 (2.53)	14.54 (14.25)	8.32 (8.27)
8b	158–60[b]	80	$C_{17}H_{12}N_4OSSe$ (399.31)	51.13 (51.26)	3.03 (3.10)	14.03 (13.77)	8.02 (7.85)
8c	210–12[b]	86	$C_{16}H_9ClN_4OSSe$ (419.73)	45.78 (45.65)	2.16 (2.05)	13.35 (13.13)	7.63 (7.70)

[a]Crystallization solvent is benzene/pet.ether
[b]Crystallization solvent is dioxane.

a Varian Gemini NMR spectrometer using tetramethylsilane as an internal reference. Mass spectra were performed on Shimadzu GCMS-QP 1000 EX mass spectrometer at 70 eV. Elemental analyses were carried out at the Microanalytical Center of Cairo University. 2-Bromoacetylbenzothiazole[8] (**1**), *N*-aryl-α-oxo-2-benzo-thiazoleethanethydrazonoyl bromides[1] **2a–c** and arene diazonium salts[9] were prepared according to literature procedures.

2-Thiocyanatoacetylbenzothiazole (3) and 2-Selenocyanatoacetylbenzo-Thiazole (4)

General procedure:

To a solution of 2-bromoacetylbenzothiazole (**1**) (2.56 g, 10 mmol) in ethanol (20 mL) was added potassium thiocyanate (0.97 g, 10 mmol) or potassium selenocyanate (1.46 g, 10 mmol). The mixture was stirred for 3 hours during which the reactants went into the solution and the products separated out as a solid, which was collected by filtration, washed with water and dried. Recrystallization from benzene/petroleum ether (60/80°C) afforded the corresponding products **3** and **4** in 95 and 90% yield, respectively. The compounds synthesized together with their physical data are listed in Table II.

3-Aryl-5-(Benzothiazol-2-yl)Carbonyl-2,3-Dihydro-2-Imino-1,3,4-Thiadiazoles 7a–c and their Selenium Analogues 8a–c

Method A: General procedure:

A solution of the appropriate arene diazonium chloride (5 mmol) was added portionwise to a cold solution of 2-thiocyanato-acetylbenzothiazole (**3**) or 2-selenocyanatoacetylbenzothiazole (**4**) (5 mmol) in ethanol (50 mL), in the presence of sodium acetate trihydrate (5 g), with stirring. After the addition was complete, the mixture was stirred at 0–5°C for further 3 hours. The solid product that formed was collected, washed with water and dried. Recrystallization from dioxane gave the corresponding 1,3,4-thiadiazole derivatives **7a–c** and 1,3,4-selenadiazole derivatives **8a–c** in 75–85% and 80–86% yields, respectively. The compounds synthesized together with their physical data are listed in Table II

Method B: General procedure:

To a solution of the appropriate hydrazonoyl bromide **2a–c** (5 mmol) in ethanol (30 mL) was added potassium thiocyanate or potassium selenocyanate (5 mmol) in water (5 mL). The reaction mixture was stirred for 6 hours at room temperature and the solid that formed was collected by filtration, washed with water and dried. Recrystallization from dioxane afforded 55–73% yields of compounds identical in all respects (m.p., mixed m.p. and spectra) with those obtained by method A above.

Acetylation of 7 and 8

General procedure:

A solution of the appropriate iminothiadiazole **7a–c** or iminoselenadiazole **8a–c** (2 mmol) in acetic anhydride (10 mL) was refluxed for one hour, then cooled and poured onto crushed ice. The precipitated solid was filtered off, washed with water, dried and then recrystallized from dimethylformamide to afford *N*-acetyl-iminothiadiazole derivatives **13a–c** and *N*-acetyliminoselenadiazole derivatives **14**a–c in 77–85% and 78–83% yields, respectively. The compounds synthesized together with their physical data are listed in Table III.

TABLE III Physical data of compounds **13–16**.

Comp. no.	*M.p.*, °C*	*Yield, %*	*Formula (M.W.)*	*Analysis, Calcd/(Found)*			
				C	*H*	*N*	*S*
13a	208–10	82	$C_{18}H_{12}N_4O_2S_2$ (380.44)	56.82 (56.87)	3.18 (3.20)	14.72 (14.56)	16.85 (16.93)
13b	219–21	77	$C_{19}H_{14}N_4O_2S_2$ (394.47)	57.85 (57.80)	3.57 (3.62)	14.20 (14.11)	16.25 (16.13)
13c	198–200	85	$C_{18}H_{11}ClN_4O_2S_2$ (414.88)	52.10 (52.33)	2.67 (2.70)	13.50 (13.43)	7.72 (7.81)
14a	243–5	78	$C_{18}H_{12}N_4O_2SSe$ (427.34)	50.58 (50.43)	2.83 (2.75)	13.11 (13.02)	7.50 (7.46)
14b	233–5	82	$C_{19}H_{14}N_4O_2SSe$ (441.37)	51.70 (51.63)	3.19 (3.24)	12.69 (12.38)	7.26 (7.30)
14c	230–2	83	$C_{18}H_{11}ClN_4O_2SSe$ (461.78)	46.81 (46.59)	2.40 (2.52)	12.13 (12.20)	6.94 (6.75)
15a	257–9	98	$C_{23}H_{14}N_4O_2S_2$ (442.51)	62.42 (62.26)	3.18 (3.21)	12.66 (12.27)	14.49 (14.38)
15b	230–2	96	$C_{24}H_{16}N_4O_2S_2$ (456.54)	63.14 (63.35)	3.53 (3.62)	12.33 (12.20)	14.04 (13.87)
15c	250–2	98	$C_{23}H_{13}ClN_4O_2S_2$ (476.96)	57.91 (57.86)	2.74 (2.63)	11.74 (11.95)	13.44 (13.61)
16a	255–7	95	$C_{23}H_{14}N_4O_2SSe$ (489.3)	56.44 (56.25)	2.88 (3.05)	11.44 (11.23)	6.55 (6.45)
16b	229–31	95	$C_{24}H_{16}N_4O_2SSe$ (503.44)	57.25 (57.30)	3.20 (3.30)	11.13 (10.85)	6.36 (6.41)
16c	253–5	96	$C_{23}H_{13}ClN_4O_2SSe$ (523.86)	52.73 (52.61)	2.50 (2.57)	10.69 (10.51)	6.12 (6.03)

(*) All compounds were crystallized from dimethylformamide

Benzoylation of 7 and 8

General procedure:

To a solution of **7a–c** or **8a–c** (2 mmol) in pyridine (10 mL) was added benzoyl chloride (0.5 mL). The mixture was refluxed for 1/2 hour, then cooled and poured onto crushed ice containing concentrated hydrochloric acid (10 mL). The solid that formed was filtered off, washed with water and dried. Recrystallization from dimethylformamide afforded the corresponding *N*-benzoyl derivatives **15a–c** and **16a–c** in 96–98% and 95–96% yields, respectively. The compounds synthesized together with their physical data are listed in Table III

References

[1] A. M. Farag and K. M. Dawood, *Heteroatom Chem.*, **8**, 45 (1997).
[2] A. M. Farag, K. M. Dawood and Z. E. Kandeel, *Tetrahedron*, **53**, 161 (1997).
[3] A. M. Farag, K. M. Dawood and Z. E. Kandeel, *J. Chem. Research (S)*, 416 (1996).
[4] A. M. Farag, K. M. Dawood and Z. E. Kandeel, *Tetrahedron*, **52**, 7893 (1996).

[5] A. M. Farag, K. M. Dawood, Z. E. Kandeel and M. S. Algharib, *J. Chem. Research (S)*, 530 (1996).
[6] A. M. Farag, *J. Chem. Research (S)*, 96 (1995).
[7] Y. Y. Kharitonov, V. V. Skopenko, *Zh. Neorg. Khim.* **10**, 1803 (1965); *Chem. Abstr*, **64**, 168 (1966).
[8] S. N. Sawhney and J. Singh, *Indian J. Chem.*, **8**, 882 (1970).
[9] H. Zollinger, "Azo and Diazo Chemistry, Aliphatic and Aromatic Compounds", Interscience, New York, N. Y., 1961 (1961).