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Mechanism of Oxidation of N-Aryl-N'-acylthioureas

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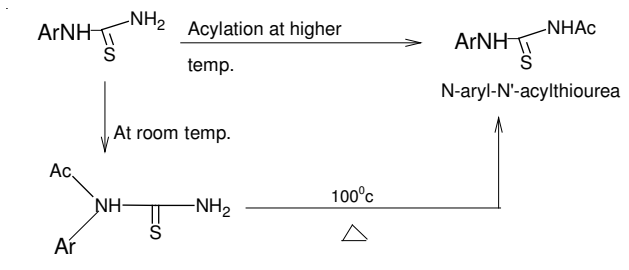
The synthesis of N-2-(6-methoxy/6-nitrobenzothiazolyl)-N,N'-diacyl-N''-(4-methoxy/4-nitrophenyl)-guanidine (**4**) and 2-acetylamino-6-acetylamino-6-(methoxy/nitro)-benzothiazoles (**5**) from N-aryl-N'-acetylthioureas by oxidation under various conditions is described. The structure of products was confirmed by IR and NMR spectral evidence.

Key Words: Thiourea, Disulfide, Sulfide, Amidinothiourea, Benzothiazole.

INTRODUCTION

Extensive oxidation work has been carried out in case of aryl substituted thioureas, diaryl, N-alkyl-N-arylthioureas and also mixture of thioureas[1-4]. Less attention has been paid in case of N-aryl-N'-acetylthioureas. So, it is worthwhile to investigate into the oxidation of this class of thiourea. N-Aryl-N'-acetylthioureas and N-aryl-N'-benzoylthioureas were chosen to study the oxidation[5], when an acetyl and a benzoyl group which were strongly electronegative and labile group were loaded on one of the nitrogen's atom.

N-Arylthioureas on acylation is known[6] to form two acyl derivatives: (i) when the acylation is carried out at room temperature, N-aryl-N-arylthiourea is the sole product of the reaction, whereas (ii) if the acylation was carried out at boiling water bath temperature N-aryl-N'-acylthiourea was formed. The former can be changed into the later if it was heated at about 100 ºC for few minutes.



Ar=4-$CH_3OC_6H_4$, 4-$NO_2C_6H_4$

Ac=CH_3CO,C_6H_5CO

Thus, it may be inferred that N-aryl-N'-acylthiourea derivative is more stable in comparison to N-aryl-N-acylthiourea derivative because during the course of oxidation reaction N-aryl-N-acyl derivative could be changed into N-acyl-N'-acyl derivative leading to the formation of mixture of products, whose separation and identification might pose a serious problem.

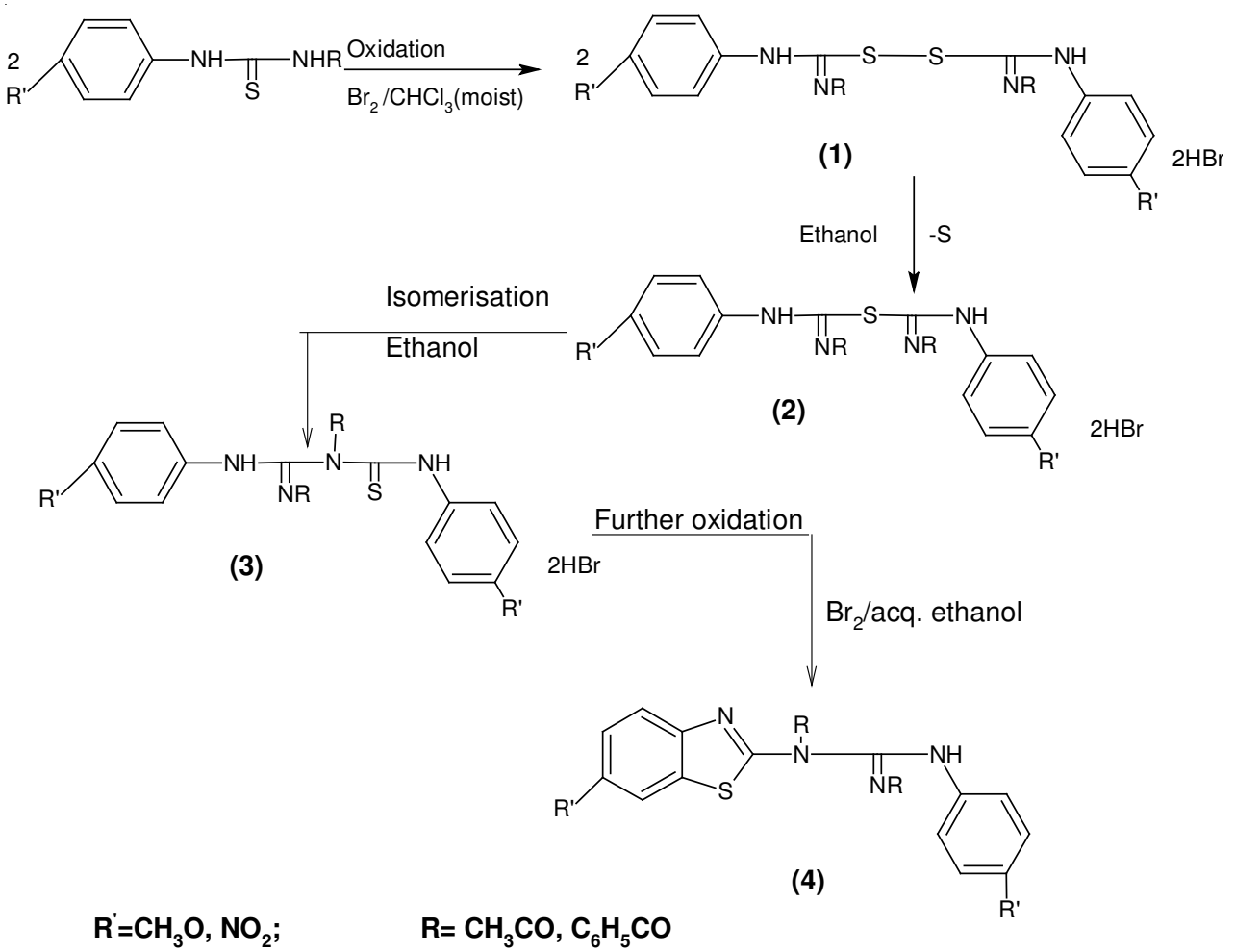
From the above observations we have used N-aryl-N'-acyl thiourea for oxidation purpose.

EXPERIMENTAL

Oxidation of N-aryl-N'-acetylthiourea: The required thioureas *i.e.*, N-(4-methoxyphenyl) -N'-acetylthiourea (m.p. 198 ºC) and N-(4-nitro phenyl)-N'-acetylthiourea (m.p. 199 ºC) were prepared by acetylating of 4-anisylthiourea and 4-nitro phenylthiourea at higher temperature (steam bath).

Oxidation of N-(4-methoxyphenyl)-N'-acetylthiourea and N-(nitrophenyl)-N'-acetylthiourea with bromine in chloroform (moist) medium (1, Scheme-I).

***Bis*-[N-(4-methoxyphenyl)-N'-acetyl formamidine]-disulfide dihydrobromide:** N-(4-Methoxyphenyl)-'acetylthiourea (11.2 g, 0.05 mol) was suspended in moist chloroform (100 mL) and a solution of bromine in the same solvent (1.25 mL, 0.025 mol in 20 mL) was added gradually with cooling and stirring. On standing for 3 h, a colourless granular product was separated, which was filtered and washed thoroughly with acetone and chloroform to remove the unchanged thiourea. Yield: 14 g (50 %); m.p. 210-212 ºC, IR (KBr, ν_{max}, cm^{-1}): 3402 (NH), 1703(C=O), 1624 (C=N), 480 (-S-S-). NMR ($CDCl_3$): δ 2.5 (s, 6H, $COCH_3$), 3.8 (s6H, CH_3O), 5.46 (s, 2H,



Scheme-I

NH), 7.6-8.1 (m, 8H, ArH). Elemental analyses: calcd. (%) for $C_{20}H_{22}N_4O_4S_2 \cdot 2HBr$, C, 39. 47; H, 3.61; N, 9.21; S, 10.52. Found (%) C, 39.07; H, 3.37; N, 9.25; S, 10.50. On addition of picric acid to its alcoholic solution, a picrate (m.p. 226 ºC) was obtained.

It liberated iodine from an ethanolic solution of potassium iodide. On treatment with cold water it went into solution immediately and turbidity was observed to develop due to separation of sulfur. A deep yellow product was found to separate which was filtered and washed, first with carbon disulfide to remove the elemental sulfur and then with dry chloroform. Thus a pale yellow crystalline product m.p. 200 ºC was obtained.

On evaporation of chloroform washings, a mixture of N-(4-methoxypheyl)-N'-acetyl-thiourea (m.p. 198 ºC) and 4-methoxypheylthiourea (m.p. 171 ºC) was obtained. The fractionation was effected with warm water.

***Bis*-[N-(4-nitrophenyl)-N'-acetylformamidine]-diulfide dihydrobromide:** This was obtained by adopting similar procedure as in the previous experiment using N-(4-nitrophenyl)-N'-acetylthiourea. Yield: 15 g (47 %); m.p. 193-196 ºC, IR (KBr, ν_{max}, cm^{-1}): 3310 (NH), 1685 (C=0), 1624 (C=N), 470 (S-S-). NMR ($CDCl_3$): δ 2.54 (s, 6H, $COCH_3$), 6.9-7.9 (m, 8H, ArH), 8.4 (s, 2H, NH). Elemental analyses (%): C, 33.85; H, 2.50; N, 13.16; S, 10.03. Found (%) C, 33.75; H, 2.52; N, 13.06; S, 9.97. On addition of alcoholic solution of picric acid to its alcoholic solution, a picrate m.p. (221 ºC) was obtained.

***Bis*-[N-(4-methoxyphenyl)-N'-acetylformamidine]-monosulfide dihydrobromide (2, Scheme-I):** *Bis*-[N-(4-methoxyphenyl)-N'-acetylformamidine]-disulfide dihydrobromide (6.08 g, 0.01 mol), was dissolved in ethanol (50 mL) and was allowed to stand for 3 h. Elemental sulfur separated out gradually and was filtered and was filtered off. The pale yellow coloured filtrate on keeping overnight afforded a pale yellow product, which was filtered, washed with carbon disulfide and acetone. Yield: 3.5 g (60 %); m.p. 205-207 ºC, IR (KBr, ν_{max}, cm^{-1}): 3402 (NH),1703 (C=O), 1624 (C=N), 685 (C-S-C). NMR ($CDCl_3$): δ 3.7(s, 6H, CH_3O), 5.5 (s, 2H, NH), 2.45 (s,6H, $COCH_3$), 7.2-8.2 (m, 8H, ArH). Elemental analyses: Calcd. (%) for $C_{20}H_{22}N_4O_4S \cdot 2HBr$, C, 41.66; H, 3.81; N, 9.72; S, 5.55. Found (%) C, 41.56; H, 3.78; N, 9.65; S, 5.50. On addition of alcoholic solution of picric acid to its alcoholic solution, a picrate m.p. (220 ºC) was obtained.

***Bis*-[N-(4-nitrophenyl)-N'-acetylformamidine]-monosulfide dihydrobromide:** This was obtained by following similar procedure as in the previous experience using *bis*-[N-(4-nitrophenyl)-N'-acetylformamidine]-disulfide dihydrobromide. Yield: 3.3 g (54 %); m.p. 200-203 ºC, IR (KBr, ν_{max}, cm^{-1}): 3340 (NH), 1690 (C=O), 1624 (C=N), 660

(C-S-C). NMR ($CDCl_3$): δ 2.5 (s, 6H, $COCH_3$), 7.2-8.2 (m, 8H, ArH), 9.5 (s, 2H, NH). Elemental analyses: calcd. (%) for $C_{18}H_{16}N_6O_6S·2HBr$, C, 35.64; H, 2.64; N, 13.86; S, 5.28. Found (%) C, 35.60; H, 2.54; N, 13.93; S, 5.37. On addition of alcoholic solution of picric acid to its alcoholic solution, a picrate m.p. (220 ºC) was obtained.

1-Acetyl-1-[N'-(4-methoxyphenyl)-formamidino]-3-(4-methoxyphenyl)-thiocarbamide hydrobromide (3, Scheme-I): *Bis*-[N-(4-methoxyphenyl)-N'-acetyl formamidine]-monosulfide dihydrobromide (2.8 g, 0.005 mol) was refluxed in an ethanolic medium for about 0.5 h. On evaporation of alcohol from the resulting solution, semisolid was obtained which on treatment with a small quantity of acetone afforded a solid. Yield: 1.8 g (82 %); m.p. 152-153 ºC, IR (KBr, ν_{max}, cm^{-1}): 34.2, 3159 (NH), 1700 (C=O), 1624 (C=N), 1109 (C=S), 796 (sub-phenyl ring). NMR ($CDCl_3$): δ 2.5 (s, 6H, $COCH_3$), 3.6 (s, 6H, CH_3O), 5.56 (s, 2H, NH), 7.1-8.8 (m, 8H, ArH). Elemental analyses: Calcd. (%) for $C_{20}H_{22}N_4O_4S·2HBr$, C, 48.48; H, 4.44; N, 11.31; S, 6.46. Found (%) C, 48.40; H, 4.37; N, 11.39; S, 6.39.

1-Acetyl-1-[N'-(4-methoxyphenyl)-formamidino]-3-(4-methoxyphenyl)-thiocarbamide hydrobromide: By adopting similar procedure as in the previous experiment this was prepared using *bis*-[N-(4-nitrophenyl)-N'-acetyl formamidine]-monosulfide dihydrobromide. Yield: 2 g (77 %); m.p. 208-210 ºC. IR (KBr, ν_{max}, cm^{-1}): 3340 (NH), 1680 (C=O), 1635 (C=N), 1090. NMR ($CDCl_3$): δ 2.45 (s, 6H, $COCH_3$), 7.1-8.1 (m, 8H, ArH), 9.2 (s, 2H, NH). Elemental analyses: Calcd. (%) For $C_{18}H_{16}N_6O_6S·2HBr$, C, 41.14; H, 3.04; N, 16.00; S, 6.09. Found (%) C, 41.04; H, 2.96; N, 15.91; S, 5.89.

Final oxidation product

N-2-(6-Methyoxybezothiazolyl)-N,N'-diacetyl-N''-(4-methoxyphenyl)-guanidine (4 Scheme-I): To a cold aqueous ethanolic solution (25 mL) of the hydrobromide of l-acetyl-l-(N-acetyl-N'-(4-methoxyphenyl) formamidino]-3-(4-methoxyphenyl)-thiocarbamide (2.5 g, 0.0005 mol) was added gradually with vigorous stirring an ice cold, aqueous ethanolic solution of bromine (0.13 mL, 0.0025 mol) and the reaction mixture was basified after standing for 0.5 h. A soft base was obtained. Yield: 1.3 g (65 %); m.p. 206 ºC. IR (KBr, ν_{max}, cm^{-1}): 3402 (NH), 1703 (C=O), 1624 (C=N), 760 (subs. phenyl ring). NMR ($CDCl_3$): δ 2.56 (s, 6H, $COCH_3$), 3.5 (s, 6H, CH_3O) 5.46 (s, 1H, NH), 7.2-8.4 (m, 7H, ArH). Elemental analyses: Calcd. (%) for $C_{20}H_{20}N_4O_4S$, C, 58.25; H, 4.85; N, 13.59; S, 7.76. Found (%) C, 58.27; H, 4.80; N, 13.62; S, 7.79.

Ethanolic solution of picric acid and the crude product were mixed when a picrate was immediately precipitated. It was filtered and recrystallised from ethanol, m.p. 173 ºC.

N-2-(6-Nitrobenothiazolyl)-N, N'-diacetyl-N''-(4-nitrophenyl)-guanidine (4, Scheme-I): This was obtained as in the previous experiment from hydrobromide of 1-acetyl-1-[N-acetyl-N'-(4-nitrophenyl) formamidino]-3-(4-nitrophenyl)-thiocarbamide. Yield: 1 g (55 %); m.p. 202 ºC. IR (KBr, ν_{max}, cm^{-1}): 3402 (NH), 1743 (C=O), 1624 (C=N). NMR ($CDCl_3$): δ 2.54 (s, 6H, $COCH_3$), 7.15-7.95 (m, 7H, ArH) 8.6 (s, 1H, NH). Elemental analyses: Calcd. (%) for $C_{18}H_{14}N_6O_6S$, C, 48.86; H, 3.16; N, 19.00; S, 7.23. Found (%) C, 48.92; H, 3.11; N, 18.95; S, 7.25.

Ethanolic solution of picric acid and the crude product were mixed when a picrate was immediately precipitated. It was filtered and recrystallised from ethanol, m.p. 176 ºC.

Oxidation of N-aryl-N'-benzoylthiourea: The required thiourea *i.e.*, N-(4-methoxyphenyl)-N'-benzoylthiourea (m.p. 140 ºC) and N-(4-nitrophenyl)-N'-benzoylthiourea (m.p. 130 ºC) was prepared by benzoylation of 4-methoxyphenylthiourea and 4-nitrophenylthiourea were carried out at higher temperature (steam bath).

Oxidation of N-(4-methoxyphenyl)-N'-benzoylthiourea and N-(4-nitrophenyl)-N'-benzoylthiourea with bromine in chloroform (moist) medium

***Bis*-[N-4-methoxyphenyl)-N'-benzoylformamidine]-disulfide dihydrobromide (1, Scheme-I):** N-(4-Methoxyphenyl)-N'-benzoylthiourea (14.3 g, 0.05 mol) was suspended in mosit chloroform (100 mL) and a solution of bromine in the same solvent (1.25 mL, 0.025 mol in 20 mL) was added gradually with cooling and stirring. On standing for 3 h, a colourless granular product was separated, which was filtered and washed thoroughly with acetone and chloroform to remove the unchanged thiourea. Yield: 15 g (41 %); m.p. 208-210 ºC. IR (KBr, ν_{max}, cm^{-1}): 3410 (NH), 1710 (C=O), 1624 (C=N), 460 (S-S-). NMR ($CDCl_3$): δ 3.89 (s, 6H, CH_3O), 7.1-8.45 (m, 18H, ArH) 9.2 (s, 2H, NH). Elemental analyses: Calcd. (%) for $C_{30}H_{26}N_4O_4S_2·2HBr$, C, 49.18; H, 3.55; N, 7.65; S, 8.74. Found (%) C, 49.9; H, 3.59; N, 7.58; S, 8.80. On addition of alcoholic solution of picric acid to its alcoholic solution, picrate (m.p. 215 ºC) was obtained.

It liberated iodine from an alcoholic solution of potassium iodide. On treatment with cold water it went into solution immediately and turbidity was observed due to separation of sulfur. A deep yellow product was separated and washed, first with carbon disulfide to remove the elemental sulfur and then with chloroform. Thus, a pale yellow crystalline product was obtained (m.p. 220 ºC).

On evaporation of chloroform washings, a mixture of N-(4-methoxyphenyl)-N'-benzoylthiorea (m.p. 14 ºC) and 4-methoxypheny thiourea was obtained. The fractionation was effected with warm water.

***Bis*-[N-(4-nitrophenyl)-N'-benzoylformamidine]-disulfide dihydrobromide (1, Scheme-I):** Following the similar procedure as in the previous experiment using N-(4-nitropheyl)-N'-benzoylthiourea. Yield: 14 g (36 %); m.p. 200-204 ºC. IR (KBr): 3310 (NH), 1710 (C=O), 1624 (C=N), 470 (S-S-). NMR ($CDCl_3$): δ 6.9-8.2 (m, 18H, ArH) 9.0 (s, 2H, NH). Elemental analyses: Calcd. (%) for $C_{28}H_{20}N_6O_6S_2·2HBr$, C, 44.09; H, 2.62; N, 11.02; S, 8.39. Found (%) C, 43.98; H, 2.57; N, 10.97; S, 8.45. On addition of alcoholic solution of picric acid to its alcoholic solution, a picrate (m.p. 178 ºC) was obtained.

***Bis*-[N-(4-methoxyphenyl)-N'-benzoylformamidine]-monosulfide dihydrobromide (1, Scheme-I):** *Bis*-[N-(4-methoxyphenyl)-N'-benzoylformamidine]-disulfide dihydrobromide (7.3 g, 0.01 mol) was dissolved in ethanol (50 mL) and was allowed to stand for some time. Elemental sulfur separated for gradually and was filtered off. The pale yellow coloured filtrate on keeping overnight afforded a pale yellow product, which was filtered, washed with carbon disulfide and

acetone. Yield: 4.5 g (46 %); m.p. 189-191 ºC. IR (KBr, ν_{max}, cm^{-1}): 3425 (NH),1670 (C=O), 1597 (C=N), 706 (C-S-C-). NMR ($CDCl_3$): δ 3.89 (s, 6H, CH_3O) 6.8-8.1 (m, 18H, ArH), 9.2 (s, 2H, NH). Elemental analyses: Calcd. (%) for $C_{30}H_{26}N_4O_4S_2 \cdot 2HBr$, C, 51.42; H, 3.71; N, 8.00; S, 4.57. Found (%) C, 51.39; H, 3.68; N, 7.97; S, 4.65. On addition of alcoholic solution of picric acid to its alcoholic solution, a picrate (m.p. 202 ºC) was obtained.

***Bis*-[N-(4-nitrophenyl)-N'-benzoylformamidine]-monosulfide dihydrobromide:** This is obtained by adopting similar procedure as in the previous experiment using *bis*-[N-(4-nitrophenyl)-N'-benzoylformamidine]-disulfide dihydrobromide. Yield: 5 g (68 %); m.p. 168-170 ºC. IR (KBr, ν_{max}, cm^{-1}): 3429 (NH), 1718 (C=O), 1624 (C=N), 700 (C-S-C-). NMR ($CDCl_3$): δ 7.1-8.5 (m, 18H, ArH) 9.2 (s, 2H, NH). Elemental analyses: Calcd. (%) for $C_{28}H_{20}N_6O_6S \cdot 2HBr$, C, 46.02; H, 2.73; N, 11.50; S, 4.38. Found (%) C, 45.97; H, 2.85; N, 11.43; S, 4.47. On addition of alcoholic solution of picric acid to its alcoholic solution, a picrate (m.p. 175 ºC) was obtained.

Amidino thiourea salts (3, Scheme-I)

1-Benzoyl-1-[N-benzoyl-N'-(4-methoxyphenyl)-formamidino]-3-(4-methoxyphenyl)-thiocarbamide hydrobromide: *Bis*-[N-(4-methoxyphenyl)-N'-benzoyl formamidine]-monosulfide dihydrobromide (3.5 g, 0.005 mol) was refluxed in an ethanolic medium for about 0.5 h. On evaporation of alcohol from the resulting solution, a semisolid was obtained which on treatment with a small quantity of acetone afforded as solid. Yield: 2 g (66 %); m.p. 135-138 ºC, IR (KBr, ν_{max}, cm^{-1}): 3447 (NH), 1670 (C=O), 1597 (C=N), 1155 (C=S). NMR ($CDCl_3$): δ 3.82 (s, 6H, CH_3O) 6.8-7.9 (m, 18H, ArH) 9.1 (s, 2H, NH). Elemental analyses: Calcd. (%) for $C_{30}H_{26}N_4O_4S \cdot HBr$, C, 58.15; H, 4.20; N, 9.04; S, 5.16. Found (%) C, 58.09; H, 4.23; N, 8.93; S, 5.19.

1-Benzoyl-1-[N-benzoyl-N'-(4-nitrophenyl)-formamidino]-3-(4-methoxyphenyl)-thio-carbamide hydrobromide: By following similar procedure as in previous experiment this product was prepared using *bis*-[N-(4-nitrophenyl)-N'-benzoylformamidine]-monosulfide dihydro-bromide. Yield: 2.2 g (68 %); m.p. 164-166 ºC. IR (KBr, ν_{max}, cm^{-1}): 3430 (NH), 1710 (C=O), 1624 (C=N), 1150 (C=S). NMR ($CDCl_3$): δ 6.9-8.2(m, 18H, ArH) 9.4 (s, 2H, NH). Elemental analyses: Calcd. (%) for $C_{28}H_8N_6O_6S \cdot HBr$, C, 51.93; H, 2.78; N, 12.98; S, 4.94. Found (%) C, 52.03; H, 2.85; N, 13.01; S, 5.05.

Final oxidation product

N-2-(6-Methoxybenzothiazoyl)-N,N'-dibenzoyl-N''-(4-methoxyphenyl)-guanidine (4, Scheme-I): To a cold aqueous ethanolic solution (25 mL) of the hydrobromide of l-benzoyl-l-[N-benzolyl)-N'-(4-methoxyphenyl)-formamidino]-3-(4-methoxyphenyl)-thiocarbamide (3 g, 0.005 mol) was added gradually with vigorous stirring an ice cold, aqueous ethanolic solution of bromine (0.13 mL, 0.0025 mol) and the reaction mixture was basified after standing for 0.5 h. A soft base was obtained. Yield: 1.8 g (72 %); m.p. 185 ºC. IR (KBr, ν_{max}, cm^{-1}): 3449 (NH), 1699 (C=O), 1599 (C=N), 827-706 (subs. phenyl ring). NMR ($CDCl_3$): δ 3.78 (s, 6H, CH_3O) 6.9-8.0 (m, 17H, ArH) 9.1-9.2 (s, 1H, NH). Elemental analyses: Calcd. (%) for $C_{30}H_{24}N_4O_4S \cdot HBr$, C, 67.16; H, 4.47; N, 10.14; S, 5.97. Found (%) C, 67.06; H, 4.40; N, 10.48; S, 6.03.

Ethanolic solution of pirric acid and the crude product were mixed when a picrate was immediately precipitated. It was filtered and recrystallized from ethanol, m.p. 172 ºC.

N-2-(6-Nitrobenzothiazolly-,N'-dibenzoyl-N''-(4-nitrophenyl)]-guanidine (4, Scheme-I): This was obtained by adopting similar procedure as in the previous experiment using 1-benzoyl-1-[N-benzoyl-N'-4-nitrophenyl-formamidino]-3(-4-nitrophenyl) thiocarbamide hydro-bromide. Yield: 2 g (72 %); m.p. 240 ºC, IR (KBr, ν_{max}, cm^{-1}): 1618 (C=N), 3425 (N=H), 1726 (C=O), 748 (subs. phenyl ring). NMR ($CDCI_3$): δ 7.1-8.4 (m, 18H, ArH), 9.1 (s, 2H, NH). Elemental analysis: Calcd. (%) for $C_{28}H_{18}N_6O_6S$, C, 59.36; H, 3.18; N, 14.84; S, 5.65. Found (%) C, 59.42; H, 3.22; N, 14.89; S, 5.71.

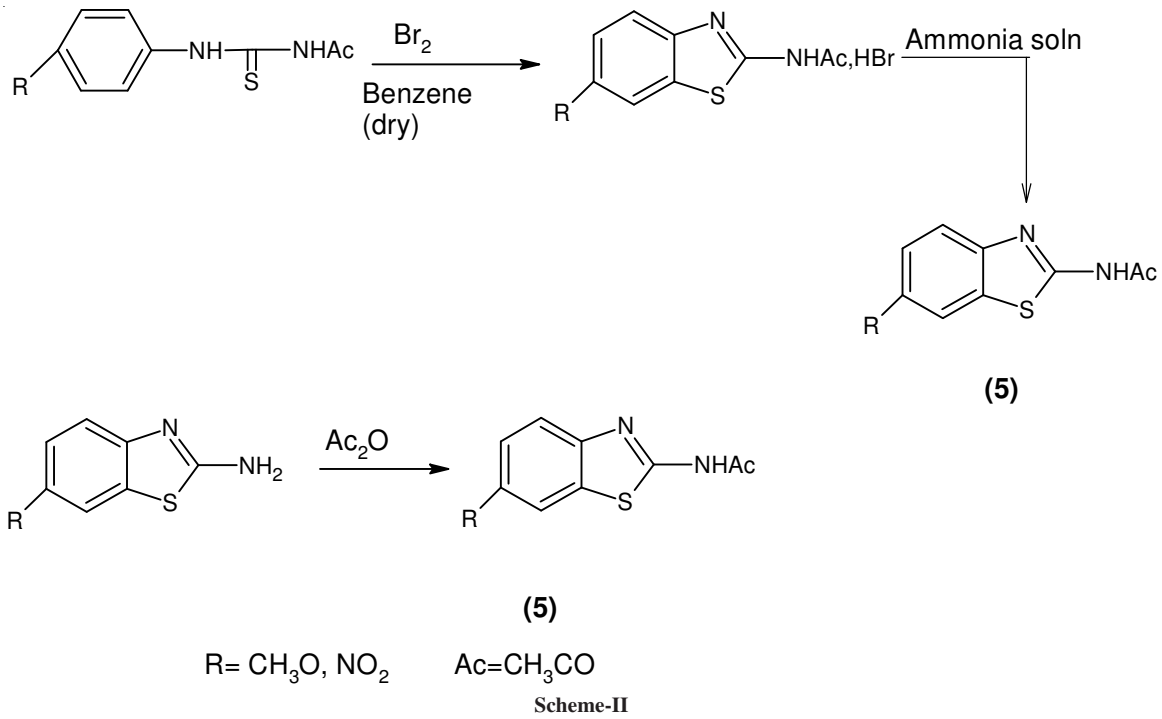
Ethanolic solution of picric acid and the crude product were mixed, a picrate was immediately precipitated. It was filtered and recrystallized from ethanol m.p. 165 ºC.

Oxidation of N-(4-methoxyphenyl/4-nitrophenyl)-N'-acetylthiourea with bromine in dry benzene medium (5, Scheme-II): N-(4-Methoxyphenyl)-N'-acetylthiourea (4.9 g, 0.02 mol) was dissolved in dry benzene (100 mL) and a solution of bromine (1.0 mL, 0.02 mol) in the same solvent (20 mL) was added gradually with cooling and stirring. On standing for 3 h, a colourless granular product comes out, which was filtered and washed thoroughly with acetone. The hydrobrmide was basifie with ammonia solution. The free base of 2-acetylamino-6-methoxbenzothiazole (**5**) was obtained (m.p. 180-82 ºC). This was found identical with 2-acetyamino-5-methylbenzothiazole. (**5**), m.p. 180-82 ºC prepared by the acetylation of 2-amino-6-methylbenzothiazole. Yield: 2g (45 %); m.p. 180 ºC. IR (KBr, ν_{max}, cm^{-1}): 3440 (NH), 1722 (C=O), 1625 (C=N), 770 (subs. phenyl ring). NMR ($CDCI_3$): δ 2.4 (s, 3H, $COCH_3$), 3.75 (s, 3H, CH_3O) 7.1-7.5 (m, 3H, ArH), 9.92 (s, 1H, NH). Elemental analysis: Calcd. (%) for $C_{10}H_{10}N_2O_2S$, C, 54.05; H, 4.50; N, 12.61; S, 14.41. Found (%) C, 53.96; H, 4.53; N, 12.57; S, 14.37.

Similarly 2-acetylamino-6-nitrobenzothiazole (m.p. 190 ºC) (**5**, **Scheme-II**) was obtained by using N-(4-nitrophenyl)-N'-acetylthiourea, which was identical with the 2-acetylamino-6-nitrobenzothiazole (**5**), m.p. 188 ºC prepared by the acetylation of 2-amino-6-nitrobenzothiazole. Yield: 2.2 g (45 %); m.p. 188-90 ºC. IR (KBr, ν_{max}, cm^{-1}): 3440 (NH), 1690 (C=O), 1624 (C=N), 770 (subs. phenyl ring). NMR ($CDCI_3$): δ 2.5 (s, 3H, $COCH_3$), 7.7-8.4 (m, 3H, ArH), 10.45 (s, 1H, NH. Elemental analysis: Calcd. (%) for $C_9H_7N_3O_3S$, C, 45.56; H, 2.95; N, 17.72; S, 13.50. Found (%) C, 45.50; H, 3.05; N, 17.37; S, 13.51.

RESULTS AND DISCUSSION

N-(4-Anisyl/4-nitrophenyl)-N'-acylthiourea has been found to give on oxidation N-2-(6-methoxy/6-nitrobenzothiazolyl)-N,N'-diacyl-N''-(4-methoxy/4-nitrophenyl)-guanidine (**4**) as the final oxidation product, the structure of which has been confirmed by synthesis. In the mechanism proposed for the oxidation, related substituted formamidine disulfide, formamidine monosulfide salts and amidino thiocarbamide are formed as intermediate stages as shown in **Scheme-I**.



Scheme-II

Oxidation of N-aryl-N'-acetylthiourea with bromine in dry benzene: When N-(4-methoxy/4-nitrophenyl)-N'-acetylthioureas were oxidized with bromine in dry benzene medium, 2-acetylamino-6-acetylamino-6-(methoxy/nitro)-benzothiazoles (**5**) were formed, which were identical with 2-acetylamino-6-(methoxy/nitro)-benzothiazole (**5**) prepared by acetylation of corresponding 2-amino-6-(methoxy/nitro)-benzothiazole. The similarity between two structures was proved by undepressed meting points, elemental analyses IR and NMR spectra. The sequence of changes are shown in **Scheme-II**.

Conclusion

These studies have confirmed the intermediate of disulfides, monosulfides, amidino thioureas, in the final oxidation product of acylthioureas to 1, 2, 4, thiadiazoles in polar media.

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