

# Rapid synthesis of 1,4-diaryl thiosemicarbazides using microwave technology<sup>†</sup>

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A new and rapid method for the preparation of 1,4-diaryl thiosemicarbazides is reported. Ten 1,4-diaryl thiosemicarbazides have been synthesised in excellent yields (89.8–96.3%). The reaction proves to be extremely simple and highly efficient (in 1.5–5 min).

**Keywords:** 1,4-diaryl thiosemicarbazides

1,4-Diaryl thiosemicarbazides and their derivatives exhibit excellent biological activities.<sup>1</sup> Some of them can be used as insecticides, herbicides and plant-growth regulators.<sup>2</sup> In recent years, particularly intense interest has been directed towards the synthesis of these compounds. Generally, these synthetic routes were carried out in solution.<sup>3</sup> These methods have their merits, but all have drawbacks such as using large amounts of volatile and poisonous solvent that will pollute the environment inevitably, in addition to expensive phase transfer catalysts.<sup>4</sup> Moreover, the reaction times are long (most of them more than one hour) and the reaction yields are not high.

In previous work, we reported a solvent-free route for the synthesis of these compounds. These reactions were processed at room temperature. This procedure is benign towards the environment and could increase the yields in some degree, but the reaction times are still rather long. In order to synthesise 1,4-diaryl thiosemicarbazides rapidly and efficiently, we coupled the solvent-free reaction with microwave technology.

As we know, the application of microwave techniques for chemical synthesis has attracted considerable interest in the last decade.<sup>5–7</sup> The reason is that technology can enhance the selectivity and reactivity,<sup>8,9</sup> increase the chemical yields and shorten the reaction time.<sup>10,11</sup> Today, it has been widely used in a variety of organic reactions.<sup>12–14</sup> Recently, we have studied the reaction of aryl isothiocyanate and aryl hydrazine assisted by microwave and found it has not been reported so far.

By this new method, in short time (1.5–5 min), without any solvent, catalyst and complicated instruments, we have synthesised 10 1, 4-diaryl thiosemicarbazides in excellent yields. The structures of the products were confirmed by IR, <sup>1</sup>H NMR, MS and elemental analysis.

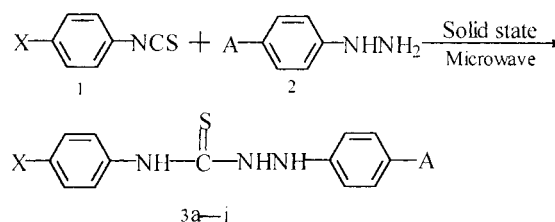
In conclusion, from our experimental practice, we can say that solvent-free reaction using microwave proceeds with significant decreases in reaction time, and comparable high chemical yields. It is a rapid and convenient method for the preparation of 1, 4-diaryl thiosemicarbazides.

## Experimental

Melting points were determined with a Kofler micro melting point apparatus and were uncorrected. IR spectra were recorded on a SP3-300 spectrophotometer in KBr. <sup>1</sup>H NMR spectra were measured on a FT-80A spectrometer using TMS as internal standard and (CD<sub>3</sub>)<sub>2</sub>CO as solvent. Elemental analyses were performed on PE-2400 CHN elemental analyser. Microwave oven (750W).

General procedure for the preparation of 1, 4-diaryl thiosemicarbazides (**3a–j**): A mixture of aryl isothiocyanate (1 mmol) and aryl

hydrazine (1 mmol) was mixed thoroughly in an agate mortar. The mixture was then placed into a household microwave oven and the adjustor of the microwave oven set to a temperature of about 50°C. The reaction mixture was then irradiated for the specified time under solvent-free conditions. The end of the reaction was monitored by TLC. After the reaction was completed (1.5–5min), the crude products were recrystallised from chloroform and petroleum ether (1:3), and dried in vacuum to yield the pure products.



a: X=Cl	A=CH <sub>3</sub>	b: X=Cl	A=Cl
c: X=Cl	A=Br	d: X=Cl	A=I
e: X=Br	A=CH <sub>3</sub>	f: X=Br	A=Cl
g: X=Br	A=Br	h: X=Br	A=I
i: X=EtO	A=CH <sub>3</sub>	j: X=EtO	A=Cl

The physical and spectra data of compounds **3a–j**:

**3a**: White-needle; Yield: 93.7%; m.p. 136–137.5°C; IR (KBr)v: 3260, 3163, 3030, 2970, 2850, 1590, 1506, 1335, 1250, 825cm<sup>-1</sup>; <sup>1</sup>H NMR δ: 2.34 (s, 3H, CH<sub>3</sub>), 6.72–7.86 (m, 9H, ArH, NH), 8.80 (s, 1H, NH), 9.71 (s, 1H, NH); Anal. calcd. for C<sub>14</sub>H<sub>14</sub>ClN<sub>3</sub>S: C, 57.63; H, 4.80; N, 14.41. Found: C, 57.50; H, 4.91; N, 14.35.

**3b**: White-powder; Yield: 95.5%; m.p. 150–152°C; IR (KBr) v: 3250, 3215, 3160, 3050, 1595, 1550, 1250, 820 cm<sup>-1</sup>; <sup>1</sup>H NMR δ: 6.65–7.80 (m, 9H, ArH, NH), 8.89 (s, 1H, NH), 9.73 (s, 1H, NH); Anal. calcd. for C<sub>13</sub>H<sub>11</sub>Cl<sub>2</sub>N<sub>3</sub>S: C, 50.00; H, 3.53; N, 13.46. Found: C, 50.11; H, 3.42; N, 13.53.

**3c**: White-needle; Yield: 89.8%; m.p. 163–165°C; IR v: 3290, 3205, 3150, 3030, 1594, 1505, 1490, 1245, 825cm<sup>-1</sup>; <sup>1</sup>H NMR δ: 6.73–7.62 (m, 9H, ArH, NH), 8.89 (s, 1H, NH), 9.79 (s, 1H, NH); Anal. calcd. for C<sub>13</sub>H<sub>11</sub>BrClN<sub>3</sub>S: C, 43.76; H, 3.09; N, 11.78. Found: C, 43.60; H, 3.01; N, 11.54.

**3d**: White-needle; Yield: 92.7%; m.p. 167–169°C; IR (KBr) v: 3290, 3200, 3160, 3030, 1595, 1550, 1470, 1240, 826 cm<sup>-1</sup>; <sup>1</sup>H NMR δ: 6.64–7.85 (m, 9H, ArH, NH), 8.89 ((s, 1H, NH), 9.60 (s, 1H, NH); Anal. calcd. for C<sub>13</sub>H<sub>11</sub>ClIN<sub>3</sub>S: C, 38.66; H, 2.73; N, 10.41. Found: C, 38.45; H, 2.52; N, 10.32.

**3e**: White-powder; Yield: 90.7%; m.p. 167–169°C; IR (KBr) v: 3305, 3215, 3030, 2985, 2850, 1605, 1495, 1350, 1240, 830 cm<sup>-1</sup>; <sup>1</sup>H NMR δ: 2.24 (s, 3H, CH<sub>3</sub>), 6.72–7.63 (m, 9H, ArH, NH), 8.78 (s, 1H, NH), 9.78 (s, 1H, NH); Anal. calcd. for C<sub>14</sub>H<sub>14</sub>BrN<sub>3</sub>S: C, 50.00; H, 4.17; N, 12.50. Found: C, 50.10; H, 4.30; N, 12.41.

**3f**: white-powder; Yield: 91.8%; m.p. 174–176°C; IR (KBr) v: 3340, 3245, 3150, 3030, 1595, 1550, 1481, 1270, 1240, 823 cm<sup>-1</sup>; <sup>1</sup>H NMR δ: 6.15 (s, 1H, NH) 6.73–7.68 (m, 9H, ArH, NH), 8.90 (s, 1H, NH); Anal. calcd. for C<sub>13</sub>H<sub>11</sub>BrClN<sub>3</sub>S: C, 43.76; H, 3.09; N, 11.78. Found: C, 43.51; H, 2.93; N, 11.63.

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<sup>†</sup> This is a Short Paper, there is therefore no corresponding material in *J. Chem. Research (M)*.

**3g:** White-powder; Yield: 94.1%; m.p. 167–169°C; IR (KBr)  $\nu$ : 3325, 3220, 3170, 3035, 1600, 1505, 1485, 1255, 826  $\text{cm}^{-1}$ ;  $^1\text{H NMR}$   $\delta$ : 6.77–7.79(m, 9H, ArH, NH), 8.91 (s, 1H, NH), 9.76(s, 1H, NH); Anal. calcd. for  $\text{C}_{13}\text{H}_{11}\text{Br}_2\text{N}_3\text{S}$ : C, 38.90; H, 2.74; N, 10.47. Found: C, 38.75; H, 2.45; N, 10.56.

**3h:** White-needle; Yield: 96.3%; m.p. 170–172°C; IR (KBr)  $\nu$ : 3305, 3259, 3150, 1590, 1540, 1485, 1245, 830  $\text{cm}^{-1}$ ;  $^1\text{H NMR}$   $\delta$ : 6.62–7.75(m, 9H, ArH, NH), 8.93(s, 1H, NH), 9.75 (s, 1H, NH); Anal. calcd. for  $\text{C}_{13}\text{H}_{11}\text{BrIN}_3\text{S}$ : C, 34.82; H, 2.46; N, 9.38. Found: C, 34.89; H, 2.38; N, 9.41.

**3i:** White-needle; Yield: 91.5%; m.p. 172–173°C; IR  $\nu$ : 3305, 3200, 3175, 3073, 2995, 2853, 1600, 1556, 1494, 1240, 825  $\text{cm}^{-1}$ ;  $^1\text{H NMR}$   $\delta$ : 1.37 (t, 3H,  $\text{CH}_3$ ), 4.01 (q, 2H,  $\text{CH}_2$ ), 6.81–7.69 (m, 9H, ArH, NH), 8.62 (s, 1H, NH), 9.52 (s, 1H, NH); Anal. calcd. for  $\text{C}_{16}\text{H}_{19}\text{N}_3\text{OS}$ : C, 63.79; H, 6.31; N, 13.95. Found: C, 63.50; H, 6.22; N, 13.75.

**3j:** White-powder; Yield: 95.2%; m.p. 179–181°C; IR (KBr)  $\nu$ : 3307, 3205, 2990, 2850, 1592, 1480, 1385, 1250, 825  $\text{cm}^{-1}$ ;  $^1\text{H NMR}$   $\delta$ : 1.34(t, 3H,  $\text{CH}_3$ ), 4.02 (q, 2H,  $\text{CH}_2$ ), 6.75–7.55 (m, 9H, ArH, NH), 8.76(s, 1H, NH), 9.51 (s, 1H, NH); Anal. calcd. for  $\text{C}_{15}\text{H}_{16}\text{ClN}_3\text{OS}$ : C, 55.99; H, 4.98; N, 13.06. Found: C, 55.82; H, 4.73; N, 12.93.

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