A mild and simple synthesis of *N*-aryl substituted toluenesulfamides under solvent-free conditions

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In this paper, a series of N-aryl substituted toluenesulfamides were synthesised by grinding under solvent-free conditions at room temperature. The yields were excellent (88%–97%), and the process is simple.

Keywords: grinding, solvent-free, N-aryl substituted toluenesulfamides

N- aryl substituted benzenesulfamides are often used as heat-sensitive recording material,[1-2] thermal printing material,[3] sensitisers[4-5] and developers.[6] Moreover, some of the benzenesulfamides have antifungal activities.[7] Many methods have been described for preparation of sulfamides. They are typically carried out in solvents[8] or in solid phase conditions.[9-10] These methods require solvents or solid supports and even require heating or cooling. At the same time, the process of these methods is complex. Now we have developed a new method to prepare *N*-aryl substituted toluenesulfamides under solvent-free conditions.

In recent years, solvent-free technology has gained popularity in organic synthesis. For instance, solid state reactions[11] and microwave reactions[12] have received considerable attention. Solvent-free synthesis of amides has been reported.[13-15] This technology has many advantages such as high efficiency and selectivity, easy separation and environmental acceptability. All these merits are in accord with green chemistry's requirements of energy-saving, high efficiency and environmental benefits.

In our paper, the toluenesulfonyl chloride and *N*-aryl substituted aniline were co-ground in an agate mortar for 3–20min thus affording white powders. The excess of the aniline and the hydrochloric acid created an amine salt, which can be washed out with water. If exceptional amines cannot form amine salt completely, then dilute hydrochloric acid was required to wash the products. Then, the amine salt can be recycled with dilute sodium hydroxide. In all cases, reactions can be monitored by TLC. With this method, we obtained eleven *N*-aryl substituted toluenesulfamides in 88%–97% yield. The amines with strong electron-withdrawing groups cannot react under these conditions. The reactions are shown in the Scheme 1 and the results for the compounds prepared are listed in Table 1.

In conclusion, we have found that *N*-aryl substituted toluenesulfamides can be prepared in high yields under solvent-free conditions which give many environmental benefits.

All reactions were completed at room temperature. In addition, the procedure is very simple. Therefore, this method is mild, facile and environmentally friendly.

Experimental

Melting points were uncorrected. IR spectra were recorded on a FTS-40 spectrophotometer in KBr. ^{1}H NMR were measured on a Bruker DPX-400M spectrometer using TMS as internal standard and $CDCl_3$ as solvent. Elemental analyses were performed on PE-2400 CHN elemental analyzer.

Typical reaction procedure

Toluenesulfonyl chloride (1 mmol) and aniline (2 mmol) were co-ground in an agate mortar for 3 min at room temperature. After the reaction was completed, the white powder was obtained. Then, the reaction mixture was washed with water. The crude product was recrystallised in 65% alcohol.

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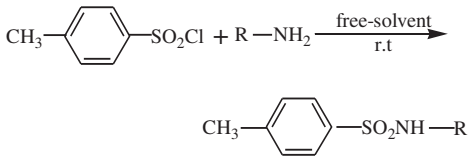

Scheme 1

Table 1 The synthesis of N-aryl substituted toluenesulfamides[a] under solvent-free conditions

Entry	R	Time min	Yield %	M.p. (°C) Lit: (°C)
1	2-$CH_3C_6H_4$	6	96	108–109
2	4-$CH_3C_6H_4$	3	88	116–117 (116–117)[16]
3	2,5-$(CH_3)_2C_6H_3$	4	97	121–123
4	4-$OC_2H_5C_6H_4$	12	91	103.5–104.5
5	4-BrC_6H_4	10	88	157–158.5
6	4-ClC_6H_4	20	92	119–120 (120)[17]
7	C_6H_5	3	95	101.5–103 (101–102)[18]
8	1-Naphthyl	10	94	157–158 (157)[19]
9	2-pyridinyl	6	88	217–218.5 (216–217)[20]
10	4-FC_6H_4	5	94	80–81 (80)[21]
11	2-BrC_6H_4	10	92	94–95 (96–97)[22]
12	4-$NO_2C_6H_4$	40	0	
13	COC_6H_4	40	0	

[a]All the products are known compounds. Some of them were characterised by IR, MASS, elemental analyses and ^{1}H NMR.

Data on products: 2′-methyl-p-toluenesulfonanilide: White needles; IR (KBr) ν: 3279,3057,2976,1600, 1332, 1160; MASS: 261 (M^+), 106 (100), 91, 77; ^{1}H NMR ($CDCl_3$) δ 7.61 (d, *J* = 8 Hz, 2H), 7.31 (d, *J* = 7.6 Hz, 1H), 7.21 (d, *J* = 8 Hz, 2H), 7.04–7.16 (m, 3H), 6.34 (brs, 1H), 2.39 (s, 3H), 1.99 (s, 3H); Anal. Calcd. for $C_{14}H_{15}NO_2S$: C, 64.37; H, 5.75; N, 5.36. Found: C, 64.21; H, 5.59; N, 5.19.

4′-methyl-p-toluenesulfonanilide: White crystals; IR (KBr) ν: 3235, 3029, 2923, 1598, 1335, 1162; MASS: 261 (M^+), 106 (100), 91, 65; ^{1}H NMR ($CDCl_3$) δ: 7.64 (d, *J* = 8.4 Hz, 2H), 7.21 (d, *J* = 8 Hz, 2H), 7.02 (d, *J* = 8 Hz, 2H), 6.95 (d, *J* = 8.4 Hz, 2H), 6.79 (s, 1H), 2.37 (s, 3H), 2.26 (s, 3H). Anal. Calcd. for $C_{14}H_{15}NO_2S$: C, 64.37; H, 5.75; N, 5.36. Found: C, 64.23; H, 5.53; N, 5.15.

2′,5′-dimethyl-p-toluenesulfonanilide: White needles; IR (KBr) ν: 3266, 3046, 2922, 1598, 1332, 1171; MASS: 275 (M^+), 120 (100), 91, 77; ^{1}H NMR ($CDCl_3$) δ: 7.60 (d, *J* = 8 Hz, 2H), 7.21 (d, *J* = 8 Hz, 2H), 7.17 (s, 1H), 6.94 (d, *J* = 7.6 Hz, 1H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.38 (s, 1H), 2.39 (s, 3H), 1.91 (s, 3H). Anal. Calcd. for $C_{15}H_{17}NO_2S$: C, 65.45; H, 6.18; N, 5.09. Found: C, 65.21; H, 6.03; N, 4.96.

4′-ethoxy-p-toluenesulfonanilide: White needles; IR (KBr) ν: 3273, 3060, 2981, 1599, 1331, 1159; MASS: 291 (M^+), 136, 108 (100), 91, 65; ^{1}H NMR ($CDCl_3$) δ: 7.57 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 8.4 Hz, 2H), 6.95 (d, *J* = 6.8 Hz, 2H), 6.74 (d, *J* = 6.8 Hz, 2H),6.42 (s, 1H), 3.96 (q, *J* = 7.2 Hz, 2H),2.38 (s, 3H), 1.38 (t, *J* = 7.2

Hz, 3H). Anal. Calcd. for $C_{15}H_{17}NO_3S$: C, 61.86; H, 5.84; N, 4.81. Found: C, 61.63; H, 5.69; N, 4.64.

4′-bromo- p-toluenesulfonanilide: White needles; IR (KBr) ν: 3230, 3051, 2916, 1597, 1326, 1163; MASS: 327 (M^+), 170, 155, 91 (100), 65; ^{1}H NMR ($CDCl_3$) δ: 7.68 (d, *J* = 8 Hz, 2H), 7.37 (s, 1H), 7.32 (d, *J* = 8.4 Hz, 2H), 7.23 (d, *J* = 8 Hz, 2H), 6.98 (d, *J* = 8.4 Hz, 2H), 2.37 (s, 3H). Anal. Calcd. for $C_{13}H_{12}BrNO_2S$: C, 47.85; H, 3.68; N, 4.29. Found: C, 47.79; H, 3.41; N, 4.03.

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