

The Rapid Synthesis of Schiff-Base without Solvent under Microwave Irradiation

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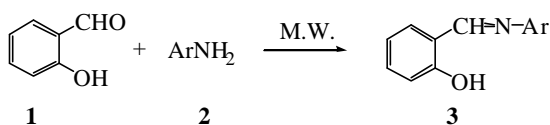
Abstract: A microwave-assisted preparation of a series of Schiff-base *via* efficient condensation of salicylaldehyde and aryl amines without solvent is described in high yield as well as environmental friendship reaction in organic synthesis.

Keywords: Microwave-assisted reaction, Schiff-base, salicylaldehyde, aryl amine.

The chemistry of the carbon-nitrogen double bond plays a vital role in the progresses of chemistry science¹. Schiff-base compounds have been used as fine chemicals and medical substrates. Recently multi-dentate complexes of iron and nickel showed high activities of ethylene oligomerization and polymerization². In our efforts for ligands of polymerization catalysts, synthesis of Schiff-base through classical condensation of aldehydes (or ketones) and amines were pursued, however, the yield of products were low. Driven by industrial application of polymerization catalysts with Schiff-base ligands, the aim of this research project is to screen simple and economic methods for preparation of Schiff-bases. Herein the microwave (M.W.) promoted condensation reaction of salicylaldehyde and aryl amines displayed the convenient practicing way for forming a series of salicylaldimine (**Scheme 1**).

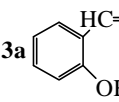
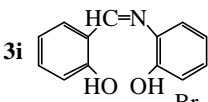
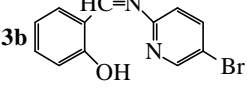
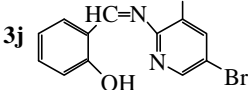
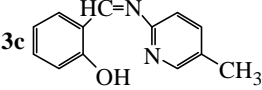
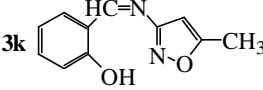
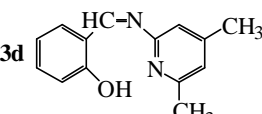
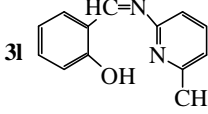
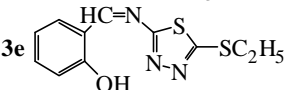
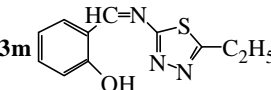
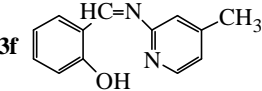
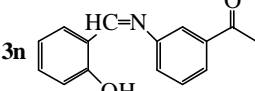
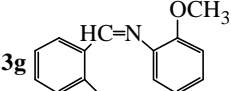
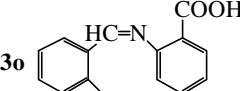
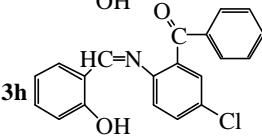
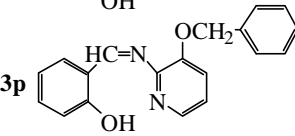
Synthesis of Schiff base is often carried out with acid-catalyzed and generally by refluxing the mixture of aldehyde (or ketone) and amine in organic medium³. However, with the assistance of microwave irradiation, it was found that the condensation reaction of salicylaldehyde and various aryl amines could proceed fast and efficiently without solvent (**Table 1**). The products could be purified simply by re-crystallization in an appropriate solvent or a mixture of solvents. The yields of products were high.

Scheme 1



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Table 1 Preparation of Compounds **3a-3p**

Compounds	Yield (%) Time	Compounds	Yield (%) Time
	93 2 mins		94 4 mins
	92 4 mins		92 3 mins
	94 30 sec		87 30 sec
	98 4 mins		95 2 mins
	84 4 mins		98 3 mins
	95 1 mins		97 3.5 mins
	98 3 mins		77 4 mins
	89 3 mins		88 4 mins

In classical organic synthesis of Schiff bases, it commonly meets the problem of removing solvents from the reaction mixture or liquid extraction especially in the case of aprotic dipolar solvent with high boiling point, or product isolation through liquid-liquid extraction. The absence of solvent reduces the risk of hazardous explosions when the reaction takes place in a closed vessel in a microwave oven⁴. Microwave-assisted reactions have been intensively investigated since the earliest publication of Gedye and Majetich in 1986^{5,6}. Microwave-assisted technique has been popularly used in organic synthesis⁷. The solvent-free organic synthesis mediated by microwave irradiation performs several advantages such as higher atom economy, environmental friendship, reducing the hazard, *etc.*

The method herein showed is the most convenient way to form the salicylaldimines, in which microwave irradiation plays an important role for promoting condensation

reaction of aldehyde and amine. The products **3a** to **3g** and **3i** to **3m** were previously synthesized through traditional Schiff-base formation⁸. With the best of our knowledge, the compounds **3h**, **3n**, **3o**, **3p** were unknown and their structures were confirmed by IR, NMR data and elemental analysis⁹. Further investigation of condensation reaction of ketones and various amines are in progress.

General Procedure

The microwave-assisted condensation of salicylaldehyde and aryl amines were carried out in a domestic oven, Midea PJ21B-A 800W. 3 mmol salicylaldehyde **1** with equal mole aryl amines **2** were mixed together at ambient temperature in an Erlenmeyer flask (25 mL). The mixture was subjected to microwave for an optimized time on the “M-High” setting, except compound **3o** was prepared in “High” setting. The crude products were re-crystallized with ethanol, however, the product **3j** was re-crystallized from the mixture of EtOH-CH₂Cl₂ (2:1).

References and Notes

1. S. Patai, *The Chemistry of the carbon-nitrogen double bond*, John Wiley & Sons Ltd., London, **1970**.
2. S. D. Ittel, L. K. Johnson, M. Brookhart, *Chem. Rev.*, **2000**, *100*, 1169.
3. M. M. Sprung, *Chem. Rev.*, **1940**, *26*, 297
4. S. A.-E. Ayoubi, F. Texier-Boulet, J. Hamelin., *Synthesis*, **1994**, *3*, 258.
5. R. Gedye, F. Smith, K. Westaway, H. Ali, L. Baldisera, L. Laberge, J. Roussel, *Tetrahedron Lett.*, **1986**, *27*, 1729.
6. R. J. Giguere, T. L. Bray, S. M. Duncan, G. Majetich, *Tetrahedron Lett.*, **1986**, *27*, 4945.
7. Y. W. Sha, Y. Wang, J. Ge, X. Wang, *Chin. J. Org. Chem.*, **2001**, *21*, 102.
8. a) H. Ranganathan, T. Ramasami, D. Ramaswamy, M. Santappa, *Indian J. Chem., Sect A*, **1986**, *25*, 127; b) C. Escobar, M. T. Garland, E. Spodine, *J. Appl. Crystallogr.*, **1983**, *16*, 276; c) F. G. Singleton, C. B. Pollard, *J. Am. Chem. Soc.*, **1947**, *62*, 2288; d) H. B. Amin, *J. King Sand Univ., Sci.*, **1997**, *9*, 65; e) S. Sailaja, E. Rajanarendar, C. J. Rao, A. Krishnamurthy, *Sulfur Lett.*, **1987**, *6*, 81; f) H. M. A. El-Nader, A. M. Shalaby, M. N. H. Moussa, E. M. Fakhry, *Indian J. Chem. Technol.*, **1995**, *2*, 337; g) J. Csaszar, N. M. Bizony, *Acta Phys. Chem.*, **1987**, *33*, 37.
9. Selected data for **3h**: mp 141-143°C; FT-IR (KBr pellet, cm⁻¹) 3439.5, 1666.4, 1614.1, 1579.4, 1472.5, 1453.2, 1284.0, 1184.4, 756.4; ¹H NMR (CDCl₃, δ ppm) 6.81 - 7.82 (m, 12 H), 8.49 (s, 1H), 11.61 (s, 1 H); ¹³C NMR (CDCl₃, δ ppm) 117.1, 118.6, 119.0, 120.0, 128.2, 128.6, 128.7, 129.8, 131.3, 132.2, 132.5, 133.7, 135.7, 136.4, 145.5, 160.6, 164.0, 195.3.; Anal Calcd. for C₂₀H₁₄ClNO₂: C, 71.54%; H, 4.20%; N, 4.17%; Found: C, 71.56%; H, 4.15%; N, 4.10%. For **3n**: mp 90-92°C; FT-IR (KBr pellet, cm⁻¹) 3436.4, 1676.4, 1618.0, 1572.4, 1498.9, 1436.0, 1271.0, 1222.0, 756.2; ¹H NMR (CDCl₃, δ ppm) 2.65 (s, 3H), 6.90 - 7.85 (m, 8H), 8.66 (s, 1H), 13.01 (s, 1H); ¹³C NMR (CDCl₃, δ ppm) 26.6, 117.1, 118.8, 119.1, 120.2, 126.0, 126.5, 129.5, 132.4, 133.4, 138.1, 148.7, 160.9, 163.6, 197.5; Anal Calcd. for C₁₅H₁₃NO₂: C, 75.30%; H, 5.48%; N, 5.85%; Found: C, 75.31%; H, 5.42%; N, 5.83%. For **3o**: mp 199.5-201.5°C; FT-IR (KBr pellet, cm⁻¹) 3439.7, 3070.6, 1683.3, 1620.0, 1488.6, 1457.5, 1366.8, 1244.8, 757.0; ¹H NMR (DMSO-d₆, δ ppm) 6.41 - 7.68 (m,

8H), 8.84 (s, 1H), 10.25 (s, 1H), 10.70 (s, 1H); ^{13}C NMR (DMSO- d_6 , δ ppm) 109.7, 114.8, 116.5, 117.5, 119.3, 119.7, 122.5, 129.5, 131.4, 134.0, 136.7, 151.7, 169.8, 192.0; Anal Calcd. for $\text{C}_{14}\text{H}_{11}\text{NO}_3$: C, 69.70%; H, 4.60%; N, 5.81%; Found: C, 69.62%; H, 4.67%; N, 5.80%. For **3p**: mp 106-107°C; FT-IR (KBr pellet, cm^{-1}) 3436.8, 1605.3, 1580.3, 1555.6, 1453.9, 1434.8, 1382.4, 1287.8, 1212.8, 1119.5, 1021.1, 762.3; ^1H NMR (CDCl_3 , δ ppm) 5.21 (s, 2H), 6.79 - 7.48 (m, 11H), 8.10 (d, 1H), 9.44 (s, 1H), 14.17 (s, 1H); ^{13}C NMR (CDCl_3 , δ ppm) 70.3, 117.4, 118.3, 118.7, 119.1, 121.1, 126.7, 127.9, 128.5, 133.0, 133.6, 135.9, 139.9, 147.4, 148.5, 162.4, 162.9; Anal Calcd. for $\text{C}_{19}\text{H}_{16}\text{N}_2\text{O}_2$: C, 74.98%; H, 5.30%; N, 9.20%; Found: C, 74.97%; H, 5.33%; N, 9.17%.

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