Efficient Microwave-Assisted Solvent-Free Synthesis of N-Substituted Aldimines

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Abstract: Neat non-volatile amines react with various aromatic aldehydes in the absence of any catalyst, solid support, or solvent, to give imines after a reaction time of eight minutes under microwave irradiation by a clean and very efficient process (yields: 75–100%). In the case of volatile amine, methylamine, 1,3-dimethylurea dispersed on montmorillonite K10 is used as an amine precursor to prepare the corresponding imines.

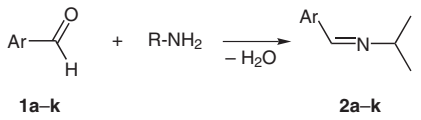
Key words: solvent-free reactions, microwave activation, N-substituted imines, ureas

The development of simple, cheap, and clean processes in the area of 'green chemistry' is of increasing interest.[1–8] Some years ago, we reported an efficient synthesis of electrophilic alkenes under microwave irradiation in a domestic oven by the condensation of carbonyl derivatives with active methylene compounds, without solvent and by the addition of catalytic amounts of piperidine.[9] The polar water molecules eliminated after the reaction are immediately vaporized, avoiding the use of Dean–Stark apparatus. The synthesis of imines, a two step-process (addition of the amine followed by the elimination of water), could be performed in a dry medium coupled with microwave irradiation.

The synthesis of imines has been reviewed many times in recent years.[10–12] Imines are important intermediates in synthetic organic chemistry and pharmaceutical compounds such as β-lactams.[13–19] They have been prepared using mineral supports, such as alumina[20] without solvent, in the presence of organic solvent with azeotropic distillation,[21] or by elimination of water with magnesium sulfate or molecular sieves.[22] However, the reaction times are long (1–7 d), environmentally toxic solvents are required, and additional purification steps are necessary.

We looked at the preparation of imines by microwave irradiation. As a model reaction, an equimolar mixture of neat diisopropylamine and benzaldehyde (Scheme 1) were reacted and the factors, which govern this reaction were carefully investigated.

First, the influence of the reaction time was studied. Therefore, the model reaction was performed in an ice-bath in a quartz reactor, irradiated[23] at 100 °C[24] with a maximum power of 90 W (Figure 1).



Scheme 1

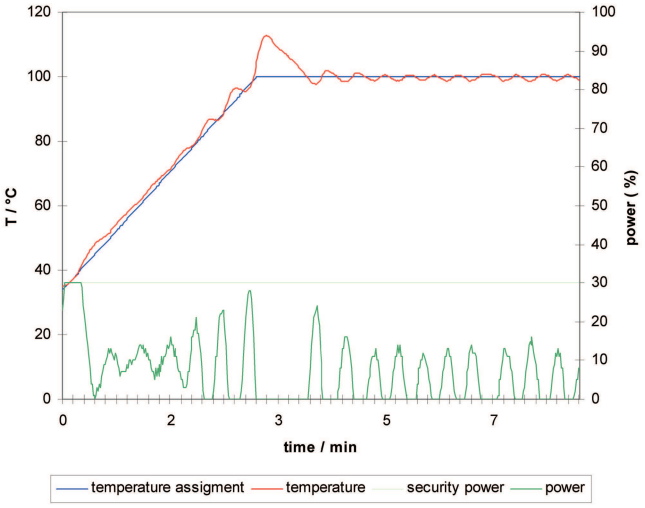


Figure 1

The results reported in Figure 2 and Table 1 show that a quantitative yield was obtained after eight minutes, while degradation of the final imine **2a** was observed with longer reaction times.

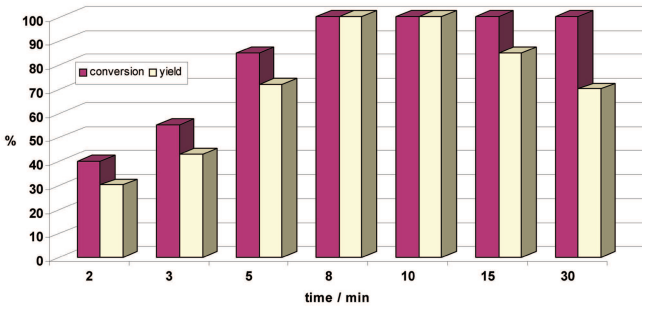


Figure 2 Influence of the reaction time on the conversion of **1a** and the yield of **2a**

In the same way, we studied the influence of the temperature on the reaction by irradiating the reaction vessel for eight minutes at a range of temperatures from –30 °C to 160 °C (Figure 3).

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Table 1 Determination of the Optimal Reaction Time for the Preparation of **2a**[a]

Entry	Time (min)	Completion (%)[b]	Yield (%)[c]
1	2	40	30
2	3	55	43
3	5	85	72
4	8	100	100
5	10	100	100
6	15	100	85
7	30	100	70

[a] Reactions were run at 100 °C (monitored temperature) under microwave irradiation.
[b] Estimated by ^{1}H NMR spectroscopy of the crude reaction mixture.
[c] Isolated pure product.

The reaction was run in a liquid nitrogen bath in a modified monomode Prolabo MX 350 to achieve a temperature of –30 °C, both with and without irradiation. After a reaction time of eight minutes, under microwave irradiation the reaction was 60% complete (58% yield of isolated pure imine after drying over $MgSO_4$); in the absence of irradiation the reaction went to only 15% completion (12% yield of isolated pure imine).

The results show that the reaction reached 100% completion after eight minutes at 100 °C. At this temperature the water molecules formed are vaporized and eliminated from the reaction mixture and the equilibrium is displaced, favoring imine formation. At higher temperatures, we observed a physical and chemical runaway of the reaction. The thermal stability of pure imine was analyzed by microwave irradiation of the imine at 150 °C (reached after 10 min) for 15 minutes and no degradation was observed.

The reaction was extended to various aldehydes **1a–k** (Scheme 1) and the results are reported in Table 2.

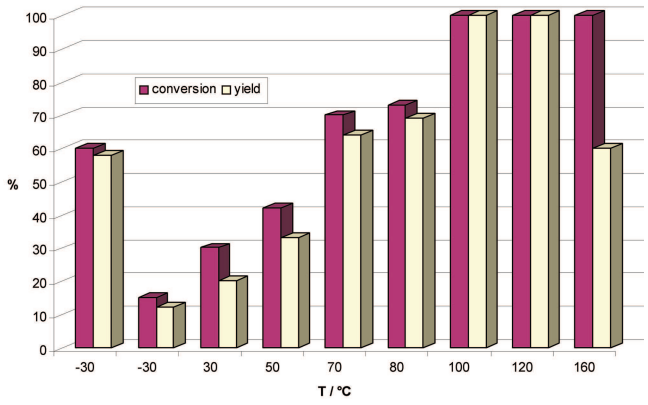


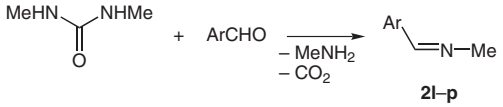
Figure 3 Influence of reaction temperature on the conversion of **1a** and the yield of **2a**

Table 2 Preparation of N-Substituted Imines **2a–k** under Microwave Irradiation

Ar	Amine (R)	2	Yield (%)[a]	Mp (°C) or bp/Torr
Ph	*i*-$PrNH_2$	**a**	100	34
4-$MeOC_6H_4$	*i*-$PrNH_2$	**b**	85[b]	$55/8 \times 10^{-2}$
4-ClC_6H_4	*i*-$PrNH_2$	**c**	99	$45/8 \times 10^{-2}$
4-$NO_2C_6H_4$	*i*-$PrNH_2$	**d**	97	62
3,4,5-$MeOC_6H_2$	*i*-$PrNH_2$	**e**	98	54
piperonyl	*i*-$PrNH_2$	**f**	95	$43/8 \times 10^{-2}$
piperonyl	$PrNH_2$	**g**	99	$68/8 \times 10^{-2}$
piperonyl	H_2NCH_2Ph	**h**	96	89
3,4-$MeOC_6H_3$	$PrNH_2$	**i**	95	$62/8 \times 10^{-2}$
3,5-$MeOC_6H_3$	$PrNH_2$	**j**	96	49
4-OHC_6H_4	$PrNH_2$	**k**	96	120

[a] Yield of isolated pure product.
[b] Yield of isolated pure product after removal of unreacted amine.

Due to the high temperatures required this method is not applicable to volatile amines such as methylamine. In the case of methylamine, 1,3-dimethylurea[24] was used as a synthetic equivalent and the reaction was carried out in the presence of solid clay-montmorillonite K10 (Scheme 2).



Scheme 2

Equimolar amounts of benzaldehyde with 1,3-dimethylurea were dispersed on 3 g of clay and irradiated at 80 °C (maximum power 120 W, reached after 3 min). The optimal reaction time is ten minutes giving a 40% isolated yield of imine **2l** (Table 3, entry 4).

Table 3 Influence of the Reaction Time on the Preparation of Imine **2l**

Entry	Time (min)	Completion (%)[a]	Yield (%)[b]
1	2	15	8
2	3	20	17
3	5	30	26
4	10	45	40
5	15	60	30
6	20	100	0

[a] Estimated by ^{1}H NMR spectroscopy of the crude reaction mixture.
[b] Isolated pure product.

In order to optimize the yield of **2l** we studied the influence of the reaction temperature (in the range 40–140 °C) on the reaction. The results show the optimal temperature is 120 °C (Table 3, entry 5); above this temperature we observed a degradation of the final products and below this temperature water elimination is disfavored and the yield decreases.

Table 4 Influence of the Temperature on the Preparation of Imine **2l**

Entry	Temperature (°C)	Completion (%)[b]	Yield (%)[c]
1	50	14	8
2	70	25	20
3	80	45	37
4	100	53	43
5	120	75	73
6	140	75	48

[a] Reaction time: 10 min.
[b] Estimated by ^{1}H NMR spectroscopy of the crude reaction mixture.
[c] Isolated pure product.

Finally, we prepared *N*-methylimines **2l–p** by adsorption onto an excess of montmorillonite K10, without solvent under microwave irradiation for ten minutes at 120 °C (Table 5).

Table 5 Preparation of *N*-Methylimines **2l–p**

Ar	**2**	Yield (%)[a]	Bp (°C)/Torr
Ph	**l**	73	72/0.024
4-MeOC$_6$H$_4$	**m**	60[b]	65/0.035
4-ClC$_6$H$_4$	**n**	65	50/0.04
4-NO$_2$C$_6$H$_4$	**o**	48	48[b]
4-Me	**p**	55	25/0.034

[a] Yield of isolated pure product after short-path distillation.
[b] After crystallization (MeOH).

In conclusion, we report a useful, expeditious, and eco-friendly method for the synthesis of N-substituted imines, which is simpler than methods previously reported.

Melting points were determined on a Kofler melting point apparatus and are uncorrected. IR spectra were taken with a Perkin-Elmer 1420 spectrometer. ^{1}H NMR spectra were recorded on Bruker ARX 200 (200 MHz), Bruker AC 300 P (300 MHz) spectrometers and ^{13}C NMR spectra on Bruker AC 300 P (75 MHz) spectrometer. Chemical shifts are expressed in parts per million downfield from tetramethylsilane as an internal standard. Mass spectra (MS) were taken on a Varian MAT 311 at 70 eV at the Centre de Mesures Physiques de l'Ouest (CRMPO, Rennes). Elemental analyses were performed at the Laboratoire Central de Microanalyses-CNRS (Lyon) and Centre de Mesures Physiques de l'Ouest (CRMPO, Rennes). Reactions under microwave irradiation were performed in a Prolabo Synthewave 402® (2.45 GHz) microwave reactor[23] with a single focused system. All solvents and reagents were purchased from Acros Organics and Aldrich Chimie and used without further purification unless otherwise stated.

For compounds **2c**, **2e**, **2i**, and **2j** although NMR spectra and HMR were acceptable, elemental analyses were not satisfactory due to the instability of these compounds during purification.

N-Substituted Aldimines 2a–k; General Procedure

An equimolar mixture of neat aldehyde (10 mmol) and amine (10 mmol) at 0 °C was placed in a quartz reactor and irradiated in a Synthewave 402® oven[23] at 100 °C (monitored temperature,[24] reached after 3 min) for 5 min. Imine **2** is generally obtained pure. In a few cases, a small excess of amine is present, which was removed by short-path distillation. This procedure was scaled up to 1 mol and a Synthewave 1000®.

***N*-Methylaldimines 2l–p; General Procedure**

An equimolar mixture of neat aldehyde and 1,3-dimethylurea (10 mmol) was dispersed on montmorillonite K10 clay (3 g), the resulting mixture was placed in a quartz reactor (diameter 3 cm), and irradiated in a Synthewave 402® oven[23] at 120 °C (monitored temperature, reached after 3 min) for 7 min. The mixture was cooled and extracted with CH_2Cl_2 (2 × 15 mL). The clay was removed by filtration through celite, the solvent was removed under vacuum, and the residual oil is purified by short-path distillation or crystallization from MeOH.

***N*-(2-Propyl)benzylideneamine (2a)[25]**

White solid; mp 34 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.32 [d, ^3J = 6.3 Hz, 6 H, $(CH_3)_2CH$], 3.56 (hept, J = 6.29 Hz, 1 H, CHN=C), 7.34–7.79 (m, 5 H, Ph), 8.27 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.2 [q, J = 121 Hz, $NCH(CH_3)_2$], 61.7 [d, J = 140 Hz, $NCH(CH_3)_2$], 128.0 [d, J = 118 Hz, Ph(C-3), Ph(C-5)], 128.5 [d, J = 160 Hz, Ph(C-2), Ph(C-6)], 130.4 [d, J = 143 Hz, Ph(C-4)], 136.5 [s, Ph(C-1)], 158.4 (d, J = 155 Hz, C=N).

HMRS: *m/z* calcd for $C_{10}H_{13}N$: 147.10480; found: 147.1045.

***N*-(2-Propyl)-4-methoxybenzylideneamine (2b)**

Yellow liquid; bp 55 °C (8 × 10^{-2} Torr).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.21 [d, ^3J = 6.34 Hz, 6 H, $(CH_3)_2CH$], 3.53 (hept, ^3J = 6.30 Hz, 1 H, CHN=C), 3.73 (s, 3 H, OCH_3), 6.75–7.25 (m, 4 H, Ph), 8.18 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.2 [q, J = 121.1 Hz, $CH_2(CH_3)_2$], 55.5 (q, J = 144.1 Hz, OCH_3), 61.5 [d, J = 115.9 Hz, $CH(CH_3)_2$], 114.0 [d, J = 164.7 Hz, Ph(C-3), Ph(C-5)], 129.6 [d, J = 148.7 Hz, Ph(C-2), Ph(C-6)], 131.9 [s, Ph(C-1)], 157.7 (d, J = 154.7 Hz, C=N), 161.4 [s, Ph(C-4)].

HMRS: *m/z* calcd for $C_{11}H_{15}NO$: 177.11536; found: 177.1153.

Anal. Calcd for $C_{11}H_{15}NO$: C, 74.54; H, 8.53; N, 7.90. Found: C, 74.68; H, 8.55; N, 7.90.

***N*-(2-Propyl)-4-chlorobenzylideneamine (2c)**

Colorless liquid; bp 45 °C (8 × 10^{-2} Torr).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.22 [d, ^3J = 6.3 Hz, 6 H, $(CH_3)_2CH$], 3.48 (hept, ^3J = 6.3 Hz, 1 H, CHN=C), 7.28–7.63 (m, 4 H, Ph), 8.16 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.1 [q, J = 120.6 Hz, $CH_2(CH_3)_2$], 61.7 [d, J = 132.4 Hz, $CH(CH_3)_2$], 128.8 [d, J = 164.9 Hz, Ph(C-3), Ph(C-5),], 129.3 [d, J = 164.9 Hz, Ph(C-2), Ph(C-6)], 134.9 [s, Ph(C-1)], 136.3 [s, Ph(C-4)], 156.9 (d, J = 161 Hz, C=N).

HMRS: *m/z* calcd for $C_{10}H_{12}{}^{35}ClN$: 181.06583; found: 181.0648.

***N*-(2-Propyl)-4-nitrobenzylideneamine (2d)**
Brown solid; mp 62 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.24 [d, ^3J = 6.3 Hz, 6 H, $(CH_3)_2CH$], 3.57 (hept, ^3J = 6.3 Hz, 1 H, CHN=C), 6.76–8.22 (m, 4 H, Ph), 8.36 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 23.9 [q, J = 125 Hz, $CH_2(CH_3)_2$], 61.9 [d, J = 133.1 Hz, $CH(CH_3)_2$], 123.7 [d, J = 168 Hz, Ph(C-3), Ph(C-5)], 128.7 [d, J = 157 Hz, Ph(C-2), Ph(C-6)], 142.1 [s, Ph(C-1)], 149.0 [s, Ph(C-4)], 156.0 (d, J = 158 Hz, C=N).

HMRS: *m*/*z* calcd for $C_{10}H_{12}N_2O_2$: 192.08988; found: 192.0890.

Anal. Calcd for $C_{10}H_{12}N_2O_2$: C, 62.49; H, 6.29; N, 14.57. Found: C, 62.57; H, 6.38; N, 14.45.

***N*-(2-Propyl)-3,4,5-trimethoxybenzylideneamine (2e)**
Light-brown solid; mp 54 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.22 [d, ^3J = 6.3 Hz, 6 H, $(CH_3)_2CH$], 3.52 (hept, ^3J = 6.3 Hz, 1 H, CHN=C), 3.88 (s, 9 H, OCH_3), 6.99 (s, 2 H, Ph), 8.18 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.1 [q, J = 121.1 Hz, $CH_2(CH_3)_2$], 56.2 (q, J = 144.4 Hz, OCH_3), 61.5 [d, J = 144.5 Hz, $CH(CH_3)_2$], 105.0 [d, J = 160.4 Hz, Ph(C-2), Ph(C-6)], 161.6 [d, J = 163.1 Hz, Ph(C-3), Ph(C-5)], 139.9 [s, Ph(C-4)], 143.5 [s, Ph(C-1)], 157.8 (d, J = 156.1 Hz, C=N).

HMRS: *m*/*z* calcd for $C_{13}H_{19}NO_3$: 237.13649; found: 237.1378.

***N*-(2-Propyl)piperonylideneamine (2f)**
Yellow liquid; bp 43 °C (8×10^{-2} Torr).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.12 [d, ^3J = 6.3 Hz, 6 H, $(CH_3)_2CH$], 3.42 (hept, ^3J = 6.3 Hz, 1 H, CHN=C), 5.94 (s, 2 H, OCH_2O), 7.34 [s, 1 H, Ar(H-6)], 6.76 [dd, J = 47.8, 7.9 Hz, 1 H, Ar(H-2)], 7.00 [dd, J = 47.8, 7.9 Hz, 1 H, Ar(H-5)], 8.14 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.2 [q, J = 126.1 Hz, $CH_2(CH_3)_2$], 61.3 [d, J = 130.2 Hz, $CH(CH_3)_2$], 101.3 [d, J = 175 Hz, OCH_2O], 124.1 [d, J = 155.2 Hz, Ar(C-2)], 128.6 [d, J = 161.8 Hz, Ar(C-6)], 131.2 [d, J = 163 Hz, Ar(C-5)], 148.6 [s, Ar(C-4)], 149.6 [s, Ar(C-3)], 153.1 [s, Ar(C-1)], 157.5 (d, J = 151.8 Hz, C=N).

HMRS: *m*/*z* calcd for $C_{11}H_{13}NO_2$: 191.09463; found: 191.0951.

Anal. Calcd for $C_{11}H_{13}NO_2$: C, 69.09; H, 6.85; N, 7.32. Found: C, 69.23; H, 6.84; N, 7.32.

***N*-Propylpiperonylideneamine (2g)**
Yellow liquid; bp 68 °C (8×10^{-2} Torr).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.95 (t, J = 7.4 Hz, 3 H, CH_2CH_3), 1.72 (sext, J = 7.2 Hz, 2 H, CH_2CH_3), 3.57 (td, J = 7.0, 1.2 Hz, 2 H, CH_2CH_2), 6.03 (s, 2 H, OCH_2O), 6.85 (d, J = 8.0 Hz, 1 H, Ar), 7.12 (dd, J = 8.0, 1.5 Hz, 1 H, Ar), 7.35 (d, J = 1.5 Hz, 1 H, Ar), 8.17 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 11.8 ($NCH_2CH_2CH_3$), 24.0 ($NCH_2CH_2CH_3$), 63.3 ($NCH_2CH_2CH_3$), 102.8 (d, J = 174.5 Hz, OCH_2O), 123.8 [d, J = 154.5 Hz, Ar(C-2)], 127.9 [d, J = 162.1 Hz, Ar(C-6)], 132.8 [d, J = 163.3 Hz, Ar(C-5)], 148.4 [s, Ar(C-4)], 149.3 [s, Ar(C-3)], 152.8 [s, Ar(C-1)], 156.6 (d, J = 152.2 Hz, C=N).

HMRS: *m*/*z* calcd for $C_{11}H_{13}NO_2$: 191.09463; found: 191.0944.

Anal. Calcd for $C_{11}H_{13}NO_2$: C, 69.09; H, 6.85; N, 7.32. Found: C, 69.23; H, 6.84; N, 7.32.

***N*-Benzylpiperonylideneamine (2h)**
Yellow solid; mp 89 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 4.83 (d, J = 1.0 Hz, 2 H, CH_2Ph), 6.04 (s, 2 H, OCH_2O), 6.88 (d, J = 8.0 Hz, 1 H), 7.17–7.47 (m, 8 H, Ar), 8.32 (s, 1 H, =CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 65.2 (tm, J = 156 Hz, CH_2), 101.9 (t, J = 175 Hz, OCH_2O), 107.1 (d, J = 165 Hz, Ph), 108.5 (d, J = 175 Hz, Ph), 125.0 [d, J = 155.1 Hz, Ar(C-2)], 127.4 (m, Ph), 128.4 [d, J = 161.3 Hz, Ar(C-6)], 131.5 [d, J = 162.4 Hz, Ar(C-5)], 139.9 [s, Ar(C-4)], 148.7 [s, Ar(C-1)], 150.3 [s, Ar(C-3)], 161.5 (d, J = 151.8 Hz, C=N).

HMRS: *m*/*z* calcd for $C_{15}H_{13}NO_2$: 239.0946; found: 239.0932.

Anal. Calcd for $C_{15}H_{13}NO_2$: C, 75.30; H, 5.48; N, 5.85. Found: C, 75.08; H, 5.57; N, 5.67.

***N*-Propyl-3,4-dimethoxybenzylideneamine (2i)**
Yellow liquid; bp 62 °C (8×10^{-2} Torr).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.61 (t, J = 7.3 Hz, 3 H, $NCH_2CH_2CH_3$), 1.36 (sext, J = 7.2 Hz, 2 H, $NCH_2CH_2CH_3$), 3.18 (t, J = 6.9 Hz, 2 H, $NCH_2CH_2CH_3$), 3.49 (s, 3 H, OCH_3), 3.55 (s, 3 H, OCH_3), 6.47 [d, J = 8.2 Hz, 1 H, Ph(H-5)], 6.78 [dd, J = 8.2, 1.4 Hz, 1 H, Ph(H-6)], 7.13 [d, J = 1.7 Hz, 1 H, Ph(H-2)], 7.78 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 11.5 ($NCH_2CH_2CH_3$), 23.9 ($NCH_2CH_2CH_3$), 55.4 (q, J = 144.4 Hz, OCH_3), 55.4 (q, J = 144.4 Hz, OCH_3), 62.9 ($NCH_2CH_2CH_3$), 108.6 [d, J = 163.1 Hz, Ph(C-5)], 110.2 [d, J = 160.4 Hz, Ph(C-2)], 122.6 [d, J = 160.4 Hz, Ph(C-6)], 129.25 [s, Ph(C-1)], 149.0 [d, J = 163.1, Hz, Ph(C-3)], 149.9 [d, J = 163.4 Hz, Ph(C-4)], 160.0 (N=CH).

HMRS: *m*/*z* calcd for $C_{12}H_{17}NO_2$: 207.1259; found: 207.1256.

***N*-Propyl-3,5-dimethoxybenzylideneamine (2j)**
Brown solid; mp 49 °C.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.90 (t, J = 7.4 Hz, 3 H, $NCH_2CH_2CH_3$), 1.67 (sext, J = 7.2 Hz, 2 H, $NCH_2CH_2CH_3$), 3.50 (td, J = 6.9, 1.1 Hz, 2 H, $NCH_2CH_2CH_3$), 3.73 (s, 3 H, OCH_3), 3.85 (s, 3 H, OCH_3), 6.45 [d, J = 8.2 Hz, 1 H, Ph(H-4)], 6.84 [d, J = 1.4 Hz, 2 H, Ph(H-6), Ph(H-2)], 8.09 (s, 1 H, N=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 11.8 ($NCH_2CH_2CH_3$), 24.0 ($NCH_2CH_2CH_3$), 55.2 (q, J = 144.4 Hz, OCH_3), 63.3 ($NCH_2CH_2CH_3$), 103.1 [(m, Ph(C-4)], 105.6 [d, J = 160.4 Hz, Ph(C-2), Ph(C-6)], 138.4 [s, Ph(C-1)], 160.8 [d, J = 163.1 Hz, Ph(C-3), Ph(C-5)], 160.9 (d, J = 155.5 Hz, C=N).

HMRS: *m*/*z* calcd for $C_{12}H_{17}NO_2$: 207.1259; found: 207.1258.

***N*-Propyl-4-hydroxybenzylideneamine (2k)**
Brown solid; mp 120 °C.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 0.88 (t, J = 7.4 Hz, 3 H, $NCH_2CH_2CH_3$), 1.59 (sext, J = 7.1 Hz, 2 H, $NCH_2CH_2CH_3$), 3.45 (td, J = 6.8, 1.0 Hz, 2 H, $NCH_2CH_2CH_3$), 6.80 (dt, J = 8.6, 1.8 Hz, 2 H, Ph), 7.55 (dt, J = 8.6, 1.9 Hz, 2 H, Ph), 8.17 (s, 1 H, N=CH), 9.86 (s, 1 H, OH).

^{13}C NMR (75 MHz, DMSO-d_6): δ = 12.2 ($NCH_2CH_2CH_3$), 24.3 ($NCH_2CH_2CH_3$), 62.7 ($NCH_2CH_2CH_3$), 115.8 [d, J = 164.7 Hz, Ph(C-3), Ph(C-5)], 128.0 [s, Ph(C-1)], 130.0 [d, J = 148.7 Hz, Ph(C-2), Ph(C-6)], 160.1 [s, Ph(C-4)], 160.3 (d, J = 156.6 Hz, C=N).

HMRS: *m*/*z* calcd for $C_{10}H_{13}NO$: 163.0997; found: 163.0993.

Anal. Calcd for $C_{10}H_{13}NO$: C, 73.59; H, 8.03; N, 8.58. Found: C, 73.89; H, 8.13; N, 8.55.

***N*-Methylbenzylideneamine (2l)[25]**
Yellow liquid; bp 72 °C (0.024 Torr).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.35 (d, ^4J = 2 Hz, 3 H, NCH_3), 7.15–7.80 (m, 5 H, Ph), 8.05 (q, ^4J = 2 Hz, 1 H, CH=).

***N*-Methyl-4-methoxybenzylideneamine (2m)[26]**
Yellow liquid; bp 65 °C (0.035 Torr).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.37 (d, ^4J = 2 Hz, 3 H, NCH_3), 3.73 (s, 3 H, 4-CH_3OPh), 6.78 – 7.67 (m, 4 H, Ph), 7.86 (q, ^4J = 2 Hz, 1 H, CH=).

***N*-Methyl-4-Chlorobenzylideneamine (2n)[26]**
Pale yellow liquid; bp 50 °C (0.04 Torr).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.48 (d, ^4J = 2 Hz, 3 H, NCH_3), 7.20–7.69 (m, 4 H, Ph), 8.20 (q, ^4J = 2 Hz, 1 H, CH=).

***N*-Methyl-4-nitrobenzylideneamine (2o)[27]**
Yellow/brown solid; mp 48 °C.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.55 (d, ^4J = 2 Hz, 3 H, NCH_3), 7.70–8.30 (m, 4 H, Ph), 8.33 (q, ^4J = 2 Hz, 1 H, CH=).

***N*-Methyl-4-methylbenzylideneamine (2p)[28]**
Yellow liquid; bp: 25 °C (0.034 Torr).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 2.32 (s, 3 H, 4-CH_3Ph), 3.46 (d, ^4J = 2 Hz, 3 H, NCH_3), 7.10–7.69 (m, 4 H, Ph), 8.22 (q, ^4J = 2 Hz, 1 H, CH=).

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References

(1) Loupy, A.; Petit, A.; Hamelin, J.; Texier-Boullet, F.; Jacquault, P.; Mathé, D. *Synthesis* **1998**, 1213; and references cited therein.
(2) Lidström, P.; Tierney, J.; Wathey, B.; Westman, J. *Tetrahedron* **2001**, 9225; and references cited therein.
(3) Varma, R. S. *Green Chem.* **1999**, *1*, 43.
(4) Varma, R. S. *Clean Prod. Processes* **1999**, *1*, 132.
(5) Bose, A. K.; Manhas, M. S.; Ganguly, S. N.; Sharma, A. H.; Banik, B. K. *Synthesis* **2002**, 1578.
(6) *Microwaves in Organic Synthesis*; Loupy, A., Ed.; Wiley-VCH: Weinheim, **2002**.
(7) (a) Loupy, A. *Top. Curr. Chem.* **1999**, *206*, 199. (b) Tanaka, K.; Toda, F. *Chem. Rev.* **2000**, *100*, 2025. (c) Sridharan, V.; Perumal, S.; Avendano, C.; Menendez, J. C. *Synthesis* **2006**, 91.
(8) Jeselnik, M.; Varma, R. S.; Polanc, S.; Kocevar, M. *Chem. Commun.* **2001**, 1716.
(9) Abdallah-El Ayoubi, S.; Texier-Boullet, F.; Hamelin, J. *Synthesis* **1994**, 258.
(10) Spring, M. M. *Chem. Rev.* **1940**, *26*, 297.
(11) Wagner, E. C. *J. Org. Chem.* **1954**, *19*, 1862.
(12) Layer, R. W. *Chem. Rev.* **1963**, *63*, 489.
(13) Staudinger, H.; Liebigs, H. *Liebigs Ann. Chem.* **1907**, *51*, 356.
(14) Ojima, I.; Inaba, S.; Oshida, K. *Tetrahedron Lett.* **1977**, 3643.
(15) Ojima, I.; Inaba, S. *Tetrahedron Lett.* **1980**, *21*, 2077.
(16) Taggi, A. E.; Hafez, A. M.; Wack, H.; Young, B.; Ferraris, D.; Lectka, T. *J. Am. Chem. Soc.* **2002**, *124*, 6626.
(17) Mukaiyama, T.; Akamatsu, H.; Han, J. S. *Chem. Lett.* **1990**, 889.
(18) Schunk, S.; Enders, D. *Org. Lett.* **2000**, *2*, 907.
(19) Texier-Boullet, F.; Latouche, R.; Hamelin, J. *Tetrahedron Lett.* **1993**, *34*, 2123.
(20) Texier-Boullet, F. *Synthesis* **1985**, 679.
(21) Leardini, R.; Nanni, D.; Tundo, A.; Zanardi, G.; Ruggieri, F. *J. Org. Chem.* **1992**, *57*, 1842.
(22) Midland, M.; Koops, R. *J. Org. Chem.* **1992**, *57*, 1158.
(23) Commarmot, R.; Didenot, R.; Gardais, J. F. Prolabo Rhône-Poulenc/Prolabo Patent number 84/03496, **1986**; *Chem. Abstr.* **1986**, *105*, 17442.
(24) Rault, P.; Pilard, J. F.; Touaux, B.; Texier-Boullet, F.; Hamelin, J. *Synlett* **1994**, 93.
(25) Compare to a commercial product: CAS number 6852-56-8.
(26) *Beilsteins Handbuch der Organischen Chemie;* E IV, Vol. 7: 518; compare to a commercial product, CAS number 622-29-7.
(27) Jang, J.; Sin, K. S.; Park, H. *Arch. Pharm. Res.* **2001**, *24*, 503.
(28) Kaupp, G.; Schmeyers, J.; Boy, J. *Tetrahedron* **2000**, *56*, 6899.