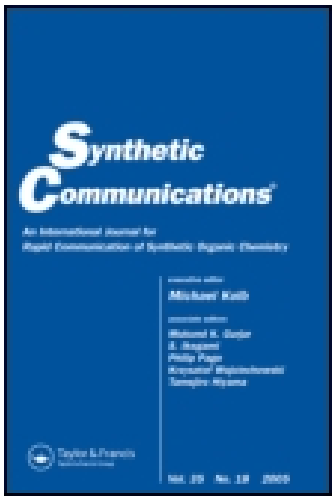

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A Convenient Synthesis of 1-Alkyl-1-phenylhydrazines from *N*-Aminophthalimide

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ABSTRACT

N-Alkylaminophthalimides were synthesized by condensation of *N*-aminophthalimide with aldehydes, and subsequent reduction of the intermediate with pyridine-borane in acetic acid. *N*-Phenylation and removal of the phthalimide group gave 1-alkyl-1-phenylhydrazines in high yield.

Key Words: Phenylhydrazine; Pyridine-borane; N-aminophthalimide; Reductive amination.

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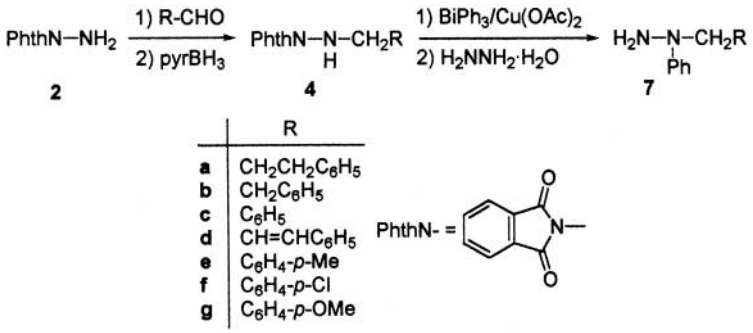
In the course of our investigation of the chemistry of electron-deficient nitrogen, we required 1-substituted 1-phenylhydrazines. For the synthesis of substituted hydrazines, mono-,[1] di-,[2] and tri-[3] protected hydrazines are used for starting compounds. Among the protecting groups, *tert*-butoxycarbonyl (BOC), benzyloxycarbonyl (Z), and tosyl (Ts) groups are commonly used. Very recently, *N*-BOC-aminophthalimide (**1**) was used for the synthesis of 1,1-disubstituted hydrazines.[4] In this case, **1**, which has three electron-withdrawing carbonyl groups in the molecule, is ideally suited for a subsequent Mitsunobu reaction. This is the first example in which a phthalimide group has been used for the protection of hydrazine. However, compound **1** is not accessible by direct benzyloxycarbonylation of *N*-aminophthalimide (**2**).[4]

For the introduction of alkyl groups on hydrazine, reductive and catalytic alkylations of protected hydrazines are often carried out. For example, tosylhydrazones have been reduced by pyridine-borane ($pyrBH_3$),[5] $NaBH_3CN$[6] or $HSiEt_3$[7] to tosylhydrazines, and phenylhydrazones have been catalytically alkylated by alkylating agents in the presence of quaternary ammonium salts.[8]

Previously, $pyrBH_3$ was used for reductive alkylation of amines[9] instead of $NaBH_3CN$.[10] $PyrBH_3$ does not suffer from severe toxicity that is associated with $NaBH_3CN$. In previous work, we investigated $pyrBH_3$ reduction of various functional groups.[11] In an extension of this work, we now have studied the reductive alkylation of **2** with aldehydes as a convenient route to phthalimide-protected hydrazines. For the synthesis of 1-alkyl-1-phenylhydrazines we have designed the route shown in Sch. 1.



Scheme 1.

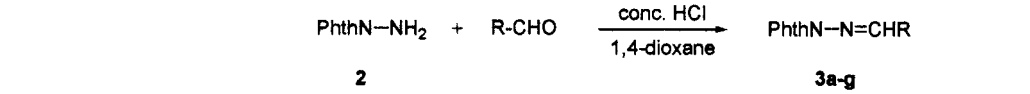
We have performed a 2 step sequence for the synthesis of *N*-(alkylamino)phthalimide (**4**), that involves the initial formation of *N*-(alkylideneamino)phthalimides (**3**) and subsequent reduction with $pyrBH_3$. The condensation reaction was carried out with **2** and aldehydes in 1,4-dioxane by addition of 2-3 drops of conc. HCl to give the corresponding **3** in good yields. The results are presented in Table 1.

Initially, the reduction of **3a** to **4a** was examined in EtOH-20%HCl (3:1) or in CF_3CO_2H (TFA), and **4a** was obtained in moderate yields along with **5** (Sch. 2). Formation of **5** can be rationalized by assuming a nucleophilic addition of **4a** to **3a** and subsequent elimination of a *N*-aminophthalimide group (Sch. 3). The $pyrBH_3$ reduction of **3a** in the presence of **4a** was performed as a control experiment and **5** was obtained in increased yield (47%). Carrying out the reduction of **3a**–**g** in acetic acid suppressed the side reaction and compounds **4a**–**g** were obtained in good yields (Table 2).

For the synthesis of 1-alkyl-1-phenylhydrazines (**7a**–**g**), *N*-phenylation of **4a**–**g** was performed with triphenylbismuth and cupric acetate, initially at room temperature and then in refluxing CH_2Cl_2, to give **6a**–**g** in 82–97% yields.[12] Compounds **7a**–**g** were obtained in 90–99% yields by deprotection of the phthalimide group with hydrazine hydrate in ethanol under the usual conditions[12,13] (Sch. 4) (Table 3).

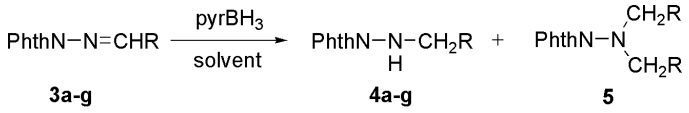
In conclusion *N*-aminophthalimide (**2**) was successfully used for the synthesis of 1-alkyl-1-phenylhydrazines (**7a**–**g**) by reductive alkylation

Table 1. Condensation reaction of **2** with aldehydes in 1,4-dioxane.

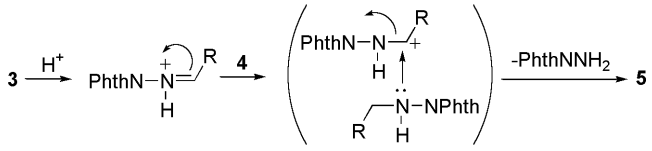


2 **3a-g**

Entry	Molar ratio aldehyde/reagent	Temp. (°C)	Time (min)	Product yield (%)
1	1.05	25	3	**3a** (76)
2	1.05	0	30	**3b** (55)
3	1.05	25	35	**3c** (90)
4	1.05	25	30	**3d** (81)
5	1.05	25	30	**3e** (87)
6	1.05	25	30	**3f** (71)
7	1.05	25	15	**3g** (80)



Scheme 2.



Scheme 3.

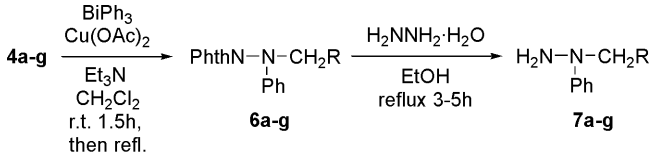
Table 2. Reduction of **3** with $pyrBH_3$.

Entry	Starting material	$PyrBH_3$ (equiv.)	Solvent	Temp. (°C)	Reaction time (h)	Product yield (%)
1	**3a**	3	EtOH–20%HCl (3:1)	0	1	**4a** (76) **5a** (11)
2	**3a**	5	TFA–CH_2Cl_2 (1:2)	0	1	**4a** (45) **5a** (13)
3	**3a**	5	CH_3CO_2H	25	0.25	**4a** (86)
4	**3b**	5	CH_3CO_2H	25	1	**4b** (78)
5	**3c**	5	CH_3CO_2H	25	2.5	**4c** (86)
6	**3d**	5	CH_3CO_2H	25	0.5	**4d** (81)
7	**3e**	5	CH_3CO_2H	25	1	**4e** (82)
8	**3f**	5	CH_3CO_2H	25	1	**4f** (92)
9	**3g**	5	CH_3CO_2H	25	0.25	**4g** (80)

of **2** with carbonyl compounds using $pyrBH_3$ and subsequent *N*-phenylation. Deprotection of phthalimide group was performed as usual in high yield.

EXPERIMENTAL

All melting points were determined with a Yanagimoto hot-stage melting point apparatus and are uncorrected. ^{1}H NMR spectra were measured at 270 MHz on a JEOL JNM-EX270 spectrometer with



Scheme 4.

Table 3. *N*-Phenylation of **4**.

Entry	Starting material	Reaction time (h)	Product yield (%)
1	**4a**	7	**6a** (97)
2	**4b**	7	**6b** (89)
3	**4c**	8	**6c** (84)
4	**4d**	15	**6d** (86)
5	**4e**	7	**6e** (89)
6	**4f**	7	**6f** (86)
7	**4g**	14	**6g** (82)

tetramethylsilane (Me_4Si) as an internal reference and $CDCl_3$ as the solvent. ^1H NMR spectral data are reported in parts per million (δ) relative to Me_4Si. IR spectra were recorded on a JASCO IR 810 spectrophotometer. Mass spectra were obtained with a JEOL JMS-700 spectrometer with a direct inlet system at 70 eV. Elemental analyses were performed in the Microanalytical Laboratory of this University.

Synthesis of *N*-(Phenylpropylideneamino)phthalimide (3a): Typical Procedure

To a solution of **2** (1.00 g, 6.17 mmol) and phenylpropionaldehyde (867 mg, 6.46 mmol) in 1,4-dioxane (100 mL) was added concentrated hydrochloric acid (2 drops) at room temperature. After the mixture was stirred for 3–5 min, the solvent was evaporated under reduced pressure and the crude product was chromatographed on a column of silica gel with AcOEt–hexane (1:3) as an eluent to give **3a** (1.31 g, 76%). Other *N*-(alkylideneamino)phthalimides (**3b**–**g**) were prepared similarly.

3a: Yield 76%; yellow crystals: m.p. 94–96°C (Et_2O/hexane); IR (KBr) 1795, 1785, 1720; ^{1}H NMR 2.81–2.90 (2H, m, CH_2), 3.00 (2H, t, $J = 7.4$, CH_2), 7.19–7.36 (5H, m, Ar-H), 7.73–7.79 (2H, m, Ar-H), 7.86–7.93 (2H, m, Ar-H), 8.70 (1H, t, $J = 5.1$, CH=N); EIMS m/z (%) 278 (M^+, 12), 130 (100). Anal. Calcd for $C_{17}H_{14}N_2O_2$: C, 73.37; H, 5.07; N, 10.07. Found: C, 73.30; H, 4.88; N, 10.14.

3b: Yield 55%; colorless crystals: m.p. 111–112°C (benzene/hexane); IR (KBr) 1790, 1775, 1720 cm^{-1}; ^{1}H NMR 3.86 (2H, d, $J = 6.0$, CH_2), 7.25–7.39 (5H, m, Ar-H), 7.75–7.80 (2H, m, Ar-H), 7.86–7.91 (2H, m, Ar-H), 8.08 (1H, t, $J = 5.9$, CH=N); EIMS m/z (%) 264 (M^+, 100), 173 (22). Anal. Calcd for $C_{16}H_{12}N_2O_2$: C, 72.72; H, 4.58; N, 10.60. Found: C, 72.71; H, 4.42; N, 10.75.

3c: Yield 90%; light yellow crystals: m.p. 165–166°C (benzene/hexane); IR (KBr) 1785, 1765, 1710 cm^{-1}; ^{1}H NMR 7.41–7.52 (3H, m, Ar-H), 7.74–7.80 (2H, m, Ar-H), 7.87–7.94 (4H, m, Ar-H), 9.39 (1H, s, CH=N); EIMS m/z (%) 250 (M^+, 44), 105 (100). Anal. Calcd for $C_{15}H_{10}N_2O_2$: C, 71.99; H, 4.03; N, 11.19. Found: C, 72.07; H, 4.02; N, 11.13.

3d: Yield 81%; light yellow crystals: m.p. 200°C (AcOEt/hexane); IR (KBr) 1780, 1760, 1725 cm^{-1}; ^{1}H NMR 7.13–7.15 (2H, m, Ar-H), 7.36–7.44 (3H, m, Ar-H), 7.51 (1H, d, $J = 7.7$, CH), 7.54 (1H, dd, $J = 7.7$, 1.8, CH), 7.76–7.79 (2H, m, Ar-H), 7.90–7.93 (2H, m, Ar-H), 9.27 (1H, dd, $J = 7.7$, 2.0, CH=N); EIMS m/z (%) 276 (M^+, 20), 199 (22), 129 (100). Anal. Calcd for $C_{17}H_{12}N_2O_2$: C, 73.90; H, 4.38; N, 10.14. Found: C, 73.83; H, 4.32; N, 9.93.

3e: Yield 87%; colorless crystals: m.p. 165–167°C (hexane); IR (KBr) 1800, 1770, 1720 cm^{-1}; ^{1}H NMR 2.41 (3H, s, CH_3), 7.75–7.80 (6H, m, Ar-H), 7.89–7.93 (2H, m, Ar-H), 9.32 (1H, s, CH=N); EIMS m/z (%) 264 (M^+, 30), 117(100). Anal. Calcd for $C_{16}H_{12}N_2O_2$: C, 72.72; H, 4.58; N, 10.60. Found: C, 73.01; H, 4.68; N, 10.63.

3f: Yield 71%; colorless crystals: m.p. 206°C (AcOEt); IR (KBr) 1800, 1780, 1730 cm^{-1}; ^{1}H NMR 7.44 (2H, d, $J = 8.5$, Ar-H), 7.78–7.81 (2H, m, Ar-H), 7.84 (2H, d, $J = 8.5$, Ar-H), 7.92–7.94 (2H, m, Ar-H), 9.43 (1H, s, CH=N); EIMS m/z (%) 286 ($M^+ + 2$, 10), 284 (M^+, 30), 105 (100). Anal. Calcd for $C_{15}H_9ClN_2O_2$: C, 63.28; H, 3.10; N, 9.84. Found: C, 63.40; H, 2.92; N, 9.84.

3g: Yield 80%; yellow crystals: m.p. 193–195°C (AcOEt); IR (KBr) 1790, 1765, 1720 cm^{-1}; ^{1}H NMR 3.88 (3H, s, CH_3O), 6.97 (2H, d, $J = 8.8$, Ar-H), 7.76–7.79 (2H, m, Ar-H), 7.85 (2H, d, $J = 8.8$, Ar-H), 7.90–7.93 (2H, m, Ar-H), 9.25 (1H, s, CH=N); EIMS m/z (%) 280 (M^+, 31), 133 (100). Anal. Calcd for $C_{16}H_{12}N_2O_3$: C, 68.56; H, 4.32; N, 9.99. Found: C, 68.43; H, 4.21; N, 9.96.

Synthesis of *N*-(3-Phenylpropylamino)phthalimide (4a): Typical Procedure

To a solution of **3a** (200 mg, 0.719 mmol) in CH_3CO_2H (5 mL) was added $pyrBH_3$ (334 mg, 3.60 mmol) at room temperature. After the reaction mixture was stirred for 15 min, the solvent was evaporated under reduced pressure and 10% HCl (2 mL) was added with ice cooling. After the solution was stirred for 30 min, 5% Na_2CO_3 (20 mL) was added to the mixture. The mixture was extracted with AcOEt (20 mL × 2) and the combined organic layer was washed with brine, dried (Na_2SO_4), and concentrated. After removal of solvent under reduced pressure, the residue was chromatographed on a column of silica gel with AcOEt–hexane (1:3) as an eluent to give **4a** (174 mg, 86%). Other *N*-(alkylamino) phthalimides (**4b–g**) were prepared similarly.

4a: Yield 86%; light yellow crystals: m.p. 55–57°C (Et_2O/hexane); IR (KBr) 3300, 1785, 1770, 1720 cm^{-1}; ^1H NMR 1.85–1.94 (2H, m, CH_2), 2.75 (2H, t, $J = 8.0$, CH_2), 3.08 (2H, m, CH_2), 4.59 (1H, br s, NH), 7.17–7.30 (5H, m, Ar-H), 7.71–7.76 (2H, m, Ar-H), 7.81–7.86 (2H, m, Ar-H); EIMS *m*/*z* (%) 280 (M^+, 47), 175 (100). Anal. Calcd for $C_{17}H_{16}N_2O_2$: C, 72.84; H, 5.75; N, 9.99. Found: C, 72.67; H, 5.83; N, 9.95.

4b: Yield 78%; light yellow crystals: m.p. 79–80°C (benzene/hexane); IR (KBr) 3250, 1780, 1765, 1715 cm^{-1}; ^1H NMR 2.93 (2H, t, $J = 7.5$, CH_2), 3.36 (2H, dd, $J = 7.5$, 6.0, CH_2), 4.62 (1H, t, $J = 6.0$, NH), 7.16–7.36 (5H, m, Ar-H), 7.71–7.75 (2H, m, Ar-H), 7.80–7.85 (2H, m, Ar-H); EIMS *m*/*z* (%) 266 (M^+, 3), 175 (100). Anal. Calcd for $C_{16}H_{14}N_2O_2$: C, 72.16; H, 5.30; N, 10.52. Found: C, 72.06; H, 5.27; N, 10.45.

4c: Yield 86%; light yellow crystals: m.p. 114°C (AcOEt/hexane); IR (KBr) 3300, 1780, 1760, 1720 cm^{-1}; ^1H NMR 4.21 (2H, d, $J = 5.5$, CH_2), 4.79 (1H, t, $J = 5.5$, NH), 7.26–7.37 (3H, m, Ar-H), 7.44–7.47 (2H, m, Ar-H), 7.70–7.75 (2H, m, Ar-H), 7.79–7.84 (2H, m, Ar-H); EIMS *m*/*z* (%) 252 (M^+, 12), 91 (100). Anal. Calcd for $C_{15}H_{12}N_2O_2$: C, 71.42; H, 4.79; N, 11.10. Found: C, 71.38; H, 4.51; N, 11.13.

4d: Yield 81%; colorless crystals: m.p. 138–139°C (benzene/hexane); IR (KBr) 3300, 1780, 1760, 1720 cm^{-1}; ^1H NMR 3.86 (2H, t, $J = 5.5$, CH_2), 4.73 (1H, br s, NH), 6.33 (1H, dt, $J = 16.1$, 6.6, CH), 6.55 (1H, d, $J = 16.1$, CH), 7.21–7.35 (5H, m, Ar-H), 7.69–7.73 (2H, m, Ar-H), 7.82–7.85 (2H, m, Ar-H); EIMS *m*/*z* (%) 278 (M^+, 10), 117 (100). Anal. Calcd for $C_{17}H_{14}N_2O_2$: C, 73.37; H, 5.07; N, 10.07. Found: 73.36; H, 4.96; N, 9.91.

4e: Yield 82%; yellow crystals: m.p. 104°C (hexane); IR (KBr) 3300, 1770, 1760, 1710 cm^{-1}; ^1H NMR 2.32 (3H, s, CH_3), 4.17 (2H, d,

$J = 5.9$, CH_2), 4.76 (1H, t, $J = 5.9$, NH), 7.13 (2H, d, $J = 8.1$, Ar-H), 7.33 (2H, d, $J = 8.1$, Ar-H), 7.70–7.75 (2H, m, Ar-H), 7.79–7.84 (2H, m, Ar-H); EIMS m/z (%) 266 (M^+, 4), 105 (100). Anal. Calcd for: $C_{16}H_{14}N_2O_2$: C, 72.17; H, 5.30; N, 10.52. Found: C, 72.27; H, 5.42; H, 10.53.

4f: Yield 92%; colorless crystals: m.p. 140°C (benzene/hexane); IR (KBr), 3300, 1780, 1760, 1720 cm^{-1}; ^1H NMR 4.20 (2H, d, $J = 5.1$, CH_2), 4.31 (1H, t, $J = 5.1$, NH), 7.30 (2H, d, $J = 8.4$, Ar-H), 7.40 (2H, d, $J = 8.4$, Ar-H), 7.71–7.73 (2H, m, Ar-H), 7.83–7.85 (2H, m, Ar-H); EIMS m/z (%) 288 ($M^+ + 2$, 2), 286 (M^+, 6), 125 (100). Anal. Calcd for $C_{15}H_{11}ClN_2O_2$: C, 62.84; H, 3.87; N, 9.77. Found: C, 62.62; H, 4.09; N, 9.71.

4g: Yield 80%; yellow crystals: m.p. 132°C (benzene/hexane); IR (KBr) 3280, 1780, 1760, 1720 cm^{-1}; ^1H NMR 3.79 (3H, s, CH_3O), 4.15 (2H, d, $J = 5.1$, CH_2), 4.74 (1H, t, $J = 5.1$, NH), 6.87 (2H, d, $J = 8.5$, Ar-H), 7.36 (2H, d, $J = 8.5$, Ar-H), 7.70–7.73 (2H, m, Ar-H), 7.80–7.84 (2H, m, Ar-H); EIMS m/z (%) 282 (M^+, 2), 121 (100). Anal. Calcd for $C_{16}H_{14}N_2O_3$: C, 68.07; H, 5.00; N, 9.92. Found: C, 68.34; H, 4.86; N, 9.83.

5a: A pale yellow oil: IR (Neat) 1785, 1720 cm^{-1}; ^1H NMR 1.74 (4H, quint, $J = 7.7$, CH_2), 2.72 (4H, t, $J = 7.7$, CH_2), 3.26 (4H, t, $J = 7.7$, CH_2), 7.12–7.26 (10H, m, Ar-H), 7.71–7.74 (2H, m, Ar-H), 7.80–7.83 (2H, m, Ar-H); EIMS m/z (%) 398 (M^+, 39), 189 (100). HRMS calcd for $C_{26}H_{26}N_2O_2$ 398.1994, found 398.1994.

Synthesis of *N*-Phenyl-*N*-(3-phenylpropyl)aminophthalimide (6a): Typical Procedure

A mixture of **4a** (100 mg, 0.359 mmol), triphenylbismuth (316 mg, 0.718 mmol), cupric acetate (98 mg, 0.539 mmol), and triethylamine (54 mg, 0.539 mmol) was stirred for 1.5 h at room temperature under Ar and then refluxed for 15 h. After completion of the reaction, the solution was diluted with AcOEt (30 mL) and filtered through celite. The filtrate was evaporated under reduced pressure. The crude product was chromatographed on a column of silica gel with AcOEt–hexane (4:1) to give **6a** (110 mg, 86%). Other *N*-alkyl-*N*-phenylaminophthalimides (**6b**–**g**) were prepared similarly.

6a: Yield 97%; yellow crystals: m.p. 124.5–125°C (Et_2O/hexane); IR (KBr) 1790, 1730 cm^{-1}; ^1H NMR 1.94–2.00 (2H, m, CH_2), 2.79 (2H, t, $J = 7.3$, CH_2), 3.76 (2H, t, $J = 7.3$, CH_2), 6.76 (2H, d, $J = 7.8$, Ar-H), 6.88 (1H, t, $J = 7.3$, Ar-H), 7.17–7.29 (7H, m, Ar-H), 7.79–7.82 (2H, m, Ar-H),

7.89–7.93 (2H, m, Ar-H); EIMS *m/z* (%) 356 (M^+, 91), 251 (100). Anal. Calcd for $C_{23}H_{20}N_2O_2$: C, 77.51; H, 5.66; N, 7.86. Found: C, 77.32; H, 5.67; N, 7.59.

6b: Yield 89%; yellow crystals: m.p. 124–124.5°C (benzene/hexane); IR (KBr) 1790, 1735 cm^{-1}; ^1H NMR 3.01 (2H, t, $J = 8.1$, CH_2), 3.99 (2H, t, $J = 8.1$, CH_2), 6.81 (2H, d, $J = 7.7$, Ar-H), 6.89 (1H, t, $J = 7.3$, Ar-H), 7.10–7.27 (7H, m, Ar-H), 7.79–7.84 (2H, m, Ar-H), 7.86–7.91 (2H, m, Ar-H); EIMS *m/z* (%) 342 (M^+, 15), 251 (100). Anal. Calcd for $C_{22}H_{18}N_2O_2$: C, 77.17; H, 5.30; N, 8.18. Found: C, 77.07; H, 5.19; N, 8.02.

6c: Yield 84%; yellow crystals: m.p. 134–136°C (benzene/hexane); IR (KBr) 1790, 1725 cm^{-1}; ^1H NMR 4.93 (2H, s, CH_2), 6.83–6.94 (3H, m, Ar-H), 7.20–7.31 (5H, m, Ar-H), 7.50–7.53 (2H, m, Ar-H), 7.70–7.76 (2H, m, Ar-H), 7.78–7.84 (2H, m, Ar-H); EIMS *m/z* (%) 328 (M^+, 25), 181 (100). Anal. Calcd for $C_{21}H_{16}N_2O_2$: C, 76.81; H, 4.91; N, 8.53. Found: C, 76.88; H, 4.81; N, 8.25.

6d: Yield 86%; yellow crystals: m.p. 137–138°C (benzene/hexane); IR (KBr) 1780, 1730 cm^{-1}; ^1H NMR 4.54 (2H, d, $J = 8.0$, CH_2), 6.87 (1H, dt, $J = 16.1$, 8.0, CH), 6.55 (1H, d, $J = 16.1$, CH), 7.19–7.30 (10H, m, Ar-H), 7.74–7.77 (2H, m, Ar-H), 7.85–7.88 (2H, m, Ar-H); EIMS *m/z* (%) 354 (M^+, 20), 117 (100). Anal. Calcd for $C_{23}H_{18}N_2O_2$: C, 77.95; H, 5.12; N, 7.90. Found: C, 77.95; H, 5.25; N, 7.90.

6e: Yield 89%; yellow crystals: m.p. 150–151°C (benzene/hexane); IR (KBr) 1780, 1730 cm^{-1}; ^1H NMR 2.26 (3H, s, CH_3), 4.89 (2H, s, CH_2), 6.84–6.94 (3H, m, Ar-H), 7.07 (2H, d, $J = 8.0$, Ar-H), 7.20–7.26 (2H, m, Ar-H), 7.36–7.40 (2H, m, Ar-H), 7.72–7.75 (2H, m, Ar-H), 7.80–7.83 (2H, m, Ar-H); EIMS *m/z* (%) 342 (M^+, 27), 105 (100). Anal. Calcd for $C_{22}H_{18}N_2O_2$: C, 77.17; H, 5.30; N, 8.18. Found: C, 77.31; H, 5.53; N, 7.90.

6f: Yield 86%; yellow crystals: m.p. 145°C (benzene/hexane); IR (KBr) 1790, 1730 cm^{-1}; ^1H NMR 4.90 (2H, s, CH_2), 6.03 (2H, d, $J = 7.7$, Ar-H), 6.93 (1H, t, $J = 7.7$, Ar-H), 7.21–7.27 (4H, m, Ar-H), 7.47 (2H, d, $J = 8.4$, Ar-H), 7.74–7.77 (2H, m, Ar-H), 7.82–7.85 (2H, m, Ar-H); EIMS *m*/z (%) 364 ($M^+ + 2$, 8), 362 (M^+, 23), 215 (100). Anal. Calcd for $C_{21}H_{15}ClN_2O_2$: C, 69.52; H, 4.17; N, 7.72. Found: C, 69.48; H, 4.22; N, 7.73.

6g: Yield 82%; colorless crystals: m.p. 157°C (benzene/hexane); IR (KBr) 1780, 1730; ^1H NMR 3.73 (3H, s, CH_3O), 4.86 (2H, s, CH_2), 6.79 (2H, d, $J = 8.7$, Ar-H), 6.86 (2H, d, $J = 9.0$, Ar-H), 6.92 (1H, t, $J = 7.5$, Ar-H), 7.24 (2H, dd, $J = 9.0$, 7.5, Ar-H), 7.40 (2H, d, $J = 8.7$, Ar-H), 7.70–7.81 (4H, m, Ar-H); EIMS *m/z* (%) 358 (M^+, 10), 121 (100). Anal. Calcd for $C_{22}H_{18}N_2O_3$: C, 73.73; H, 5.06; N, 7.82. Found: C, 73.77; H, 5.12; N, 7.81.

Synthesis of 1-Phenyl-1-(3-phenylpropyl)hydrazine (7a): Typical Procedure

To **7a** (400 mg, 1.12 mmol) in EtOH (10 mL) was added $NH_2NH_2 \cdot H_2O$ (80%) (0.16 mL, 2.81 mmol) at room temperature. After refluxing the reaction mixture for 4 h, EtOH was evaporated under reduced pressure. To the residue benzene (5 mL) was added and insoluble material was removed by filtration. After evaporation of the filtrate, the crude product was chromatographed on a column of silica gel with benzene as an eluent to give **7a** (231 mg, 91%). Other 1-alkyl-1-phenylhydrazines (**7b–g**) were prepared similarly.

7a: Yield 91%; a pale yellow oil: IR (Neat) 3340, 1600; ^{1}H NMR (DMSO-d_6) 1.88 (2H, quint, $J = 7.7$, CH_2), 2.62 (2H, t, $J = 7.7$, CH_2), 3.31–3.37 (2H, m, CH_2), 4.20 (2H, br s, NH_2), 6.59 (1H, t, $J = 7.3$, Ar-H), 6.91 (2H, d, $J = 7.6$, Ar-H), 7.08–7.32 (7H, m, Ar-H); EIMS m/z (%) 226 (M^+, 55), 121 (100). HRMS calcd for $C_{15}H_{18}N_2$ 226.1470, found 226.1472.

7b: Yield 91%; colorless crystals: m.p. 48–50°C (hexane); IR (Neat) 3330, 1600 cm^{-1}; ^{1}H NMR 2.92 (2H, t, $J = 7.7$, CH_2), 3.55 (2H, br s, NH_2), 3.66 (2H, t, $J = 7.7$, CH_2), 6.78 (1H, t, $J = 8.1$, Ar-H), 6.95 (2H, d, $J = 7.9$, Ar-H), 7.17–7.33 (7H, m, Ar-H); EIMS m/z (%) 212 (M^+, 16), 121 (100). Anal. Calcd for $C_{14}H_{16}N_2$: C, 79.21; H, 7.60; N, 13.20. Found: C, 79.16; H, 7.68; N, 13.18.

7c: Yield 96%; a pale yellow oil: IR (Neat) 3340, 1600 cm^{-1}; ^{1}H NMR 3.56 (2H, s, CH_2), 4.60 (2H, s, NH_2), 6.81 (1H, t, $J = 7.3$, Ar-H), 7.10 (2H, d, $J = 7.8$, Ar-H), 7.23–7.38 (7H, m, Ar-H); EIMS m/z (%) 198 (M^+, 27), 107 (100). HRMS calcd for $C_{13}H_{14}N_2$ 198.1157, found, 198.1143.

7d: Yield 99%; yellow crystals: m.p. 53–54°C (pet. ether); IR (KBr) 3320, 1620 cm^{-1}; ^{1}H NMR 3.06 (2H, br s, NH_2), 4.19 (2H, dd, $J = 6.2$, 1.3, CH_2), 6.27 (1H, dt, $J = 15.8$, 6.2, CH), 6.63 (1H, d, $J = 15.8$, CH), 6.82 (1H, t, $J = 7.3$, Ar-H), 7.14 (2H, d, $J = 7.9$, Ar-H), 7.20–7.39 (7H, m, Ar-H); EIMS m/z (%) 224 (M^+, 21), 107 (100). Anal. Calcd for $C_{15}H_{16}N_2$: C, 80.32; H, 7.19; N, 12.49. Found: C, 80.13; H, 7.16; N, 12.37.

7e: Yield 98%; colorless crystals: m.p. 39–40°C (pet. ether); IR (KBr) 3290, 1590 cm^{-1}; ^{1}H NMR 2.34 (3H, s, CH_3), 3.52 (2H, br s, NH_2), 4.54 (2H, s, CH_2), 6.78 (1H, t, $J = 7.3$, Ar-H), 7.01–7.30 (8H, m, Ar-H); EIMS m/z (%) 212 (M^+, 48), 107 (100). Anal. Calcd for $C_{14}H_{16}N_2$: C, 79.21; H, 7.60; N, 13.20. Found: C, 78.99; H, 7.61; N, 13.20.

7f: Yield 93%; yellow crystals: m.p. 40°C (pet. ether); IR (KBr) 3360, 1600 cm^{-1}; ^{1}H NMR 3.58 (2H, br s, NH_2), 4.56 (2H, s, CH_2), 6.83 (1H, t,

$J = 7.3$, Ar-H), 7.05 (2H, d, $J = 7.9$, Ar-H), 7.22–7.32 (6H, m, Ar-H); EIMS m/z (%) 234 ($M^+ + 2$, 6), 232 (M^+, 17), 107 (100). Anal. Calcd for $C_{13}H_{13}N_2Cl$: C, 67.10; H, 5.63; N, 12.04. Found: C, 66.97; H, 5.56; N, 12.06.

7g: Yield 94%; light yellow crystals: m.p. 71–72°C (Et_2O/hexane); IR (KBr) 3350, 1600 cm^{-1}; ^1H NMR (DMSO-d_6) 3.72 (3H, s, CH_3O), 4.23 (2H, br s, NH_2), 4.52 (2H, s, CH_2), 6.61 (1H, t, $J = 7.2$, Ar-H), 6.87 (2H, d, $J = 8.6$, Ar-H), 6.98 (2H, d, $J = 9.2$, Ar-H), 7.12 (2H, dd, $J = 9.2$, 7.2, Ar-H), 7.20 (2H, d, $J = 8.6$, Ar-H); EIMS m/z (%) 228 (M^+, 10), 121 (100). Anal. Calcd for $C_{14}H_{16}N_2O$: C, 73.66; H, 7.06; N, 12.27. Found: C, 73.66; H, 6.89; N, 12.23.

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