A New Method for Transcarbamation and Amidation from Benzyl Carbamate

Gondi Sudershan Reddy[1]*

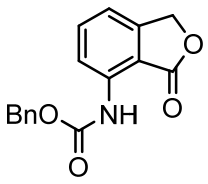
Affiliations:

[1] Departments of Chemistry, National Taiwan Normal University, Taipei, Taiwan, 116 (ROC).

Correspondence email: gondisr@gmail.com

General Information: All reagents unless otherwise noted were obtained from commercial sources and used without further purification. The reactions were carried out under an argon atmosphere, and the products were isolated by column chromatography on silica gel (200–300 mesh) by using petroleum ether (60–90°C) and ethyl acetate as eluents. Compounds described in the literature was characterized by comparing their ^{1}H and ^{13}C NMR spectra and MS data to the reported data. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ and chemical shifts are reported in ppm, individual peaks are reported as: multiplicity, integration, coupling constant in Hz. Low resolution (LR) and High-resolution (HR) mass spectrometry data were acquired on a Bruker Daltonics MicroTOF-Q-II Mass Spectrometer using CH_3CN/H_2O as solvent.

N-(3-Oxo-1,3-dihydro-isobenzofuran-4-yl)-carbamic acid benzyl ester (1a): To a suspension of zinc dust (750 mg, 11.0 mmol, 1.0 eq) and benzyl chloroformate (1.75 mL, 2.1 g, 12.2 mmol, 1.1 eq,) in ethyl acetate (100 ml), a solution of 7-Amino phthalide (2.0 g, 11.0 mmol, 1.0 eq) solution was added, and stirred the reaction mixture at room temperature for one hour. TLC showed completion of reaction. Filtered the zinc suspension and wash with water. Separate the layers. Dried the organic layer over $MgSO_4$ and filtered, concentrated under reduced pressure



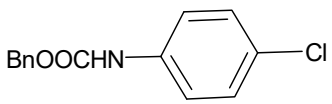
on rota evaporator to get the residue. Column chromatography purification gives pure product **1a** in 80% yield. MP 154°C. ^{1}H-NMR (500 MHz, $CDCl_3$): δ 9.08 (s, 1H, NH), 8.28-8.26 (d, 1H, *J* = 8.2 Hz), 7.63-7.60 (t, 1H, *J* = 8.0 & 16.0 Hz), 7.42-7.34 (m, 5H), 7.06-7.04 (d, 1H, *J* = 8.2 Hz), 5.28 (s, 2H), 5.23 (2H). ^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.8, 152.9, 146.8, 138.9, 136.2, 135.62, 128.6, 128.4, 128.3, 116.8, 115.1, 111.3, 69. 8, 67.3. Mass m/z: 282 (M-1). HRMS *m/z*: 283.0841, (calculated for $C_{16}H_{13}NO_4$: 283.0845).

N-(3-Oxo-1,3-dihydro-isobenzofuran-7-yl)-carbamic acid benzyl ester (1b): To a suspension of zinc dust (110 mg, 1.67 mmol, 1.0 eq) and benzyl chloroformate (315 mg, 1.84 mmol, 1.1 eq,) in toluene (15 ml), and 4-Amino phthalide (0.25 g, 1.67 mmol, 1.0 eq) was added, and stirred the reaction mixture at room temperature for one hour. TLC showed completion of reaction. Filtered the zinc suspension and wash with water. Separate the layers. Dried the organic layer over $MgSO_4$, filtered, concentrated under reduced pressure on rota evaporator to get the residue. Which on column chromatography purification gives 430 mg of product **1b** in 91% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.76-7.72 (d, 1H, *J* = 8.0 Hz), 7.67-7.63 (d, 1H, *J* = 7.2 Hz), 7.50-7.42 (t, 1H, *J* = 8.0 Hz), 7.39-7.31 (m, 5H), 7.20 (br-s, 1H, NH), 5.31 (s, 2H), 5.19 (s, 2H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 171.1, 153.3, 137.4, 135.5, 132.6, 130.1, 128.7, 128.6, 128.4, 127.1, 125.8, 121.6, 69.1, 67.6. Mass m/z: 283 (M+). HRMS *m/z*: 283.0840, (calculated for $C_{16}H_{13}NO_4$: 283.0845).

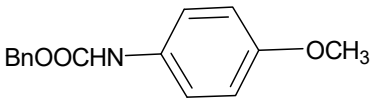
Cyclohexyl-carbamic acid benzyl ester[1] (1c): To a suspension of zinc dust (660mg, 10.0mmole) and benzyl chloroformate (1.45 mL, 1.72 g, 10.0 mmol) in toluene (20 mL), cyclohexylamine (1.0 g, 10.0 mmol, 1.0 eq) is added, and stirred the reaction mixture at room temperature for 2 h. TLC showed completion of reaction. Filtered the zinc suspension and wash with water. Separate the layers. Dried the

organic layer over $MgSO_4$, filtered, concentrated under reduced pressure on rota evaporator to get the residue. Which on column chromatography purification gives 2.1g of pure product in 90% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.35 (m, 5H), 5.07 (s, 2H), 4.7 (br-s, 1H, NH), 3.47-3.44 (m, 1H), 1.94-1.88 (d, 2H, *J* = 11.6Hz), 1.73-1.41 (m, 3H), 1.35-1.01 (m, 5H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 155.6, 136.7, 128.4, 128.0, 127.9, 66.3, 49.7, 33.2, 25.3, 24.6.

(4-Chloro-phenyl)-carbamic acid benzyl ester[2] (1d): To a suspension of zinc dust (512 mg, 7.8 mmol) and benzyl chloroformate (1.1 mL, 1.3 g, 7.8 mmol) in toluene (20 mL), 4-chloro aniline (1.0 g, 7.8 mmol, 1.0 eq) is added, and stirred the reaction mixture at room temperature for 2 h. TLC showed completion of reaction. Filtered the zinc suspension and wash with water. Separate the layers. Dried the organic layer over $MgSO_4$, filtered, concentrated under reduced pressure on rota evaporator to get the residue. Which on column chromatography purification gives 1.95 g of product **1d** in 96% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.41-7.22 (m, 9H), 6.73 (br-s, 1H, NH), 5.19 (s, 2H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 153.3, 136.4, 135.9, 129.1, 128.7, 128.6, 128.5, 128.4, 120.0, 67.2.

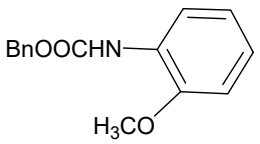


(4-Methoxy-phenyl)-carbamic acid benzyl ester[3] (1e): To a suspension of zinc dust (530 mg, 8.1 mmol) and benzyl chloroformate 1.1 mL, 1.4 g, 8.1 mmol) in toluene (20 mL), 4-methoxy aniline (1.0 g, 8.1 mmol, 1.0 eq) is added, and stirred the reaction mixture at room temperature for 2 h. TLC showed completion of reaction. Filtered the zinc suspension and wash with water. Separate the layers. Dried the organic layer over $MgSO_4$, filtered, concentrated under reduced pressure on rota evaporator to get the residue. Column chromatography purification gives 1.95 g of pure product **1e** in 93% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.32-7.22 (m, 7H), 7.08 (br-s, 1H, NH),

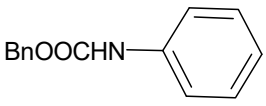


6.78-6.74 (d, 2H, 4.8 Hz), 5.11 (s, 2H), 3.68 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 155.8, 153.9, 136.1, 130.9, 128.4, 128.0, 120.7, 114.0, 66.6, 55.1.

(2-Methoxy-phenyl)-carbamic acid benzyl ester[3] (1f): To a suspension of zinc dust (530 mg, 8.13 mmol) and benzyl chloroformate (1.1 mL, 1.4 g, 8.13 mmol) in toluene (20 mL), 2-methoxy aniline (1.0 g, 8.13 mmol, 1.0 eq) is added, and stirred the reaction mixture at room temperature for 2 h. TLC showed completion of reaction. Filtered the zinc suspension and wash with water. Separate the layers. Dried the organic layer over $MgSO_4$, filtered, concentrated under reduced pressure on rota evaporator to get the residue. Which on column chromatography purification gives 2.0 g of product **1f** in 94.5% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 8.12-8.08 (d, 1H, NH), 7.43-7.29 (m, 6H), 7.00-6.91 (m, 2H), 6.86-6.81 (m, 1H), 5.20 (s, 2H), 3.82 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 153.2, 147.6, 136.1, 128.6, 128.3, 127.5, 122.8, 121.0, 118.1, 109.9, 66.8, 55.4. Mass m/z: 258 (M+1). HRMS *m/z*: 257.1054, (calculated for $C_{15}H_{15}NO_3$: 257.1052).



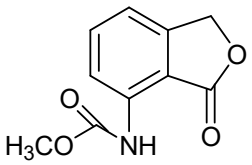
Phenyl-carbamic acid benzyl ester[4] (1g): To a suspension of zinc dust (705 mg, 10.2 mmol) and benzyl chloroformate 1.52 mL, 1.83 g, 10.2 mmol) in toluene (20 mL), aniline (1.0 g, 10.2 mmol, 1.0 eq) was added, and stirred the reaction mixture at room temperature for 2 h. TLC showed completion of reaction. Filtered the zinc suspension and wash with water. Separate the layers. Dried the organic layer over $MgSO_4$, filtered, concentrated under reduced pressure on rota evaporator to get the residue. Column chromatography purification gives 2.30 g of product **1g** in 94% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.37-7.28 (m, 8H), 7.23-7.03 (m, 2H), 5.12 (s, 2H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 153.5, 137.8, 136.0, 128.9, 128.5, 128.2, 128.2, 123.4, 118.8, 66.8.



General Procedure for Transcarbamation: to a 0.5 mmol of benzyl carbamates in methyl alcohol **(Method-A)** or ethyl alcohol **(Method-B)** in a round bottom flask was added 2.5 mmol

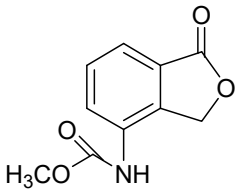
of potassium carbonate and heated at reflux under nitrogen atmosphere and the reaction monitored by tlc. After the reaction was complete (16 h - 24 h), the reaction mixture was cooled to room temperature. Concentrated gives the residue and dissolved in water. After neutralization, extracted with ethyl acetate (15 ml X 2) and washed with water, brine solution, dried over $MgSO_4$ and filtered. The filtrate upon concentrated and column chromatography purification gives methyl carbamates in 75-88% yield.

N-(3-Oxo-1,3-dihydro-isobenzofuran-4-yl)-carbamic acid methyl ester (2a): followed



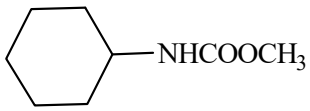
Method-A by using **1a** and obtained 81 mg in 78% yield. ^{1}H-NMR (200MHz, $CDCl_3$) : δ 9.04 (s, 1H, NH), 8.28-8.25 (d, 1H, *J* = 8.2 Hz), 7.67-7.59 (t, 1H, *J* = 7.6 Hz), 7.08-7.05 (d, 1H, *J* =7.4 Hz), 5.30 (s, 2H), 3.82 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 172.0, 153.7, 146.9, 139.1, 136.3, 116.8, 115.1, 111.3, 69.8, 52.6. Mass m/z: 207 (M+). HRMS *m/z*: 207.0533, (calculated for $C_{10}H_9NO_4$: 207.0532).

N-(3-Oxo-1,3-dihydro-isobenzofuran-7-yl)-carbamic acid methyl ester (2b): followed



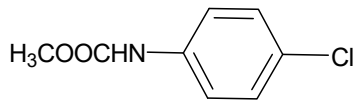
Method-A by using **1b** and obtained 77 mg in 75% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.72-7.67 (dd, 2H, *J* = 3.4, 2.6, 4.4 & 7.0 Hz), 7.53-7.45 (t, 1H, *J* = 7.8 Hz), 7.19 (br-s, 1H, NH), 5.39 (s, 2H), 3.79 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 171.2, 154.0, 137.6, 132.6, 130.1, 127.1, 126.0, 121.7, 69.2, 52.8. Mass m/z: 207 (M+). HRMS *m/z*: 207.0525, (calculated for $C_{10}H_9NO_4$: 207.0532)

Cyclohexyl-carbamic acid methyl ester[5] (2c): followed Method-A by using 1c and obtained



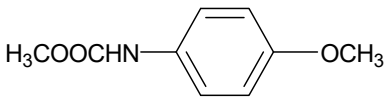
63 mg in 80% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 4.74 (br-s, 1H, NH), 3.65 (s, 3H), 3.45-3.45 (m, 1H), 1.94-1.88 (d, 2H, *J* = 11.8Hz), 1.75-1.43 (m, 3H), 1.39-1.03 (m, 5H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 156.2, 51.4, 49.6, 33.0, 25.1, 24.5.

(4-Chloro-phenyl)-carbamic acid methyl ester[6] (2d): followed Method-A by using **1d** and



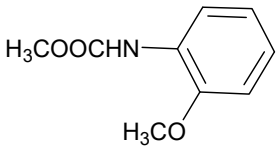
obtained 79 mg in 85% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.35-7.21 (m, 4H), 6.91 (br-s, 1H, NH), 3.76 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 154.1, 136.5, 129.0, 128.4, 120.0, 52.3.

(4-Methoxy-phenyl)-carbamic acid methyl ester[7] (2e): followed Method-A by using **1e** and



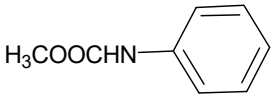
obtained 72 mg in 80% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.29-7.25 (d, 2H, *J* = 8.6 Hz), 6.97 (br-s, 1H, NH), 6.83-6.79 (d, 2H, *J* = 7.8 Hz), 3.75 (s, 3H), 3.73 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 155.9, 154.7, 131.0, 121.0, 114.1, 55.3, 52.1.

(2-Methoxy-phenyl)-carbamic acid methyl ester[7] (2f): followed Method-A by using **1f** and



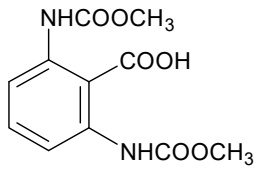
obtained 75 mg in 83% yield. ^{1}H-NMR (200MHz, $CDCl_3$) : δ 8.09-8.05 (d, 1H, *J* = 8.6 Hz), 7.27 (br-s, 1H, NH), 7.00-6.92 (m, 2H), 6.91-6.78 (m, 1H), 3.78 (s, 3H), 3.74 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 153.8, 147.5, 127.4, 122.6, 120.8, 118.0, 109.8, 55.3, 51.9.

Phenyl-carbamic acid methyl ester[8] (2g): followed Method-A by using **1g** and obtained 62



mg in 84% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.41-7.37 (d, 2H, *J* = 8.0 Hz), 7.27-7.19 (t, 2H, *J* = 7.4 Hz), 7.04-6.97 (t, 1H, *J* = 7.2 Hz), 3.70 (s, 3H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 154.4, 137.9, 128.7, 123.2, 118.8, 51.9.

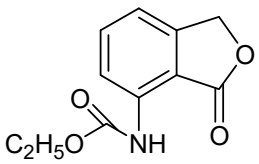
2,6-Bis-methoxycarbonylamino-benzoic acid (2i): To 2,6-DICBZ-benzoic acid methyl



ester[9]. (200mg, 0.46 mmol) in methanol, add potassium carbonate (318mg, 2.3 mmol, 5 eq) and heat at reflux for 24 h. Remove the solvent and dissolve the residual oil in water and adjust the pH=6, with HCl, then extracted with diethyl ether (25 mL x 2), washed the organic layer with water, brine solution, dried over $MgSO_4$, concentrated essentially get 81 mg of product in 66% yield. ^{1}H-NMR

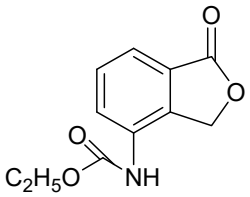
(200MHz, $CDCl_3$): δ 9.78 (s, 2H, NH), 7.99-7.95 (d, 1H, *J* = 8.4 Hz), 7.46-7.38 (t, 1H, *J* = 8.6 Hz), 3.74 (s, 6H). Mass m/z: 268 (M+). HRMS *m/z*: 268.0758, (calculated for $C_{11}H_{12}N_2O_6$: 268.0695).

N-(3-Oxo-1,3-dihydro-isobenzofuran-4-yl)-carbamic acid ethyl ester (3a): followed



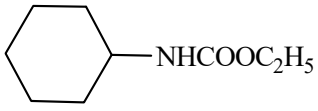
Method-B by using **1a** and obtained 84 mg in 76% yield. ^{1}H-NMR (200MHz, $CDCl_3$) : δ 8.97 (s, 1H, NH), 8.26-8.22 (d, 1H, *J* = 8.24 Hz), 7.65-7.57 (t, 1H, *J* = 8.2 Hz), 7.08-7.04 (d, 1H, *J* = 7.46 Hz), 5.29 (s, 2H), 4.31-4.20 (q, 2H, *J* = 7.2 Hz), 1.37-1.30 (t, 3H, *J* = 7.0 Hz). ^{13}C-NMR (50MHz, $CDCl_3$): δ 171.9, 153.2, 146.8, 139.1, 136.6, 116.6, 114.9, 111.1, 69.7, 61.6, 14.2. Mass m/z: 222 (M+1). HRMS *m/z*: 221.0687, (calculated for $C_{11}H_{11}NO_4$: 221.0688).

N-(3-Oxo-1,3-dihydro-isobenzofuran-7-yl)-carbamic acid ethyl ester (3b): followed



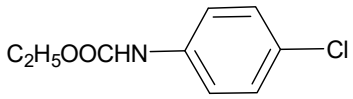
Method-B by using **1b** and obtained 90 mg in 81% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.73-7.67 (t, 2H, *J* = 7.0 Hz), 7.53-7.45 (t, 1H, *J* = 8.0 Hz), 7.13 (br-s, 1H, NH), 5.39 (s, 2H), 4.29-4.19 (q, 2H, *J* = 7.2 Hz), 1.36-1.26 (t, 3H, *J* = 7.4 Hz). ^{13}C-NMR (50MHz, $CDCl_3$): δ 171.2, 153.6, 137.6, 132.8, 130.1, 127.2, 125.9, 121.5, 69.2, 62.0, 14.3. Mass m/z: 221(M+). HRMS *m/z*: 221.0687, (calculated for $C_{11}H_{11}NO_4$: 221.0688).

Cyclohexyl-carbamic acid ethyl ester[6] (3c): followed Method-B by using **1c** and obtained



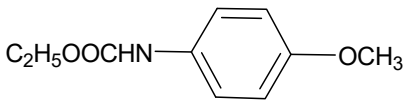
70 mg in 82% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 4.88 (br-s, 1H, NH), 4.00-3.90 (q, 2H, *J* = 6.8 Hz), 3.31-3.24 (m, 1H), 1.80-1.74 (d, 2H, *J* = 11.8 Hz), 1.61-1.43 (m, 3H), 1.29-0.90 (m, 8H). ^{13}C-NMR (50MHz, $CDCl_3$): δ 155.7, 60.0, 49.4, 33.0, 25.1, 24.5, 14.2.

(4-Chloro-phenyl)-carbamic acid ethyl ester[10] (3d): followed Method-B by using **1d** and



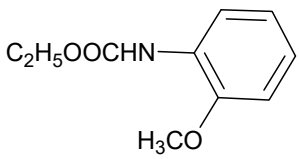
obtained 88 mg in 88% yield. ^{1}H-NMR (200MHz, $CDCl_3$) : δ 7.36-7.31 (d, 2H, *J* = 9.0 Hz), 7.24-7.20 (d, 2H, *J* = 9.0 Hz), 7.01 (br-s, 1H, NH), 4.26-4.15 (q, 2H, *J* = 7.0 Hz), 1.31-1.24 (t, 3H, *J* = 7.0 Hz). ^{13}C-NMR (50MHz, $CDCl_3$): δ 153.8, 136.7, 128.8, 128.2, 120.0, 61.2, 14.3.

(4-Methoxy-phenyl)-carbamic acid ethyl ester[11] (3e): followed Method-B by using **1e** and



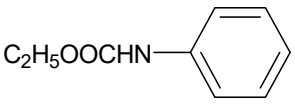
obtained 81 mg in 83% yield. ^{1}HNMR (200MHz, $CDCl_3$) : δ 7.30-7.26 (d, 2H, *J* = 8.8 Hz), 7.09 (br-s, 1H, NH), 6.82-6.77 (dd, 2H, *J* = 7.2 & 1.6 Hz), 4.23-4.12 (q, 2H, *J* = 7.2 Hz), 3.74 (s, 3H), 1.29-1.21 (t, 3H, *J* = 7.0 Hz). ^{13}C-NMR (50MHz, $CDCl_3$): δ 155.7, 154.2, 131.1, 120.8, 114.03, 60.8, 55.2, 14.3.

(2-Methoxy-phenyl)-carbamic acid ethyl ester[12] (3f): followed Method-B by using **1f** and



obtained 79 mg in 81% yield. ^{1}H-NMR (200MHz, $CDCl_3$) : δ 8.10-8.06 (d, 1H, *J* = 9.0 Hz), 7.23 (br-s, 1H, NH), 6.97-6.92 (m, 2H), 6.89-6.78 (m, 1H), 4.25-4.21 (q, 2H, *J* = 6.2 Hz), 3.79 (s, 3H), 1.32-1.25 (t, 3H, *J* = 6.2 Hz). ^{13}C-NMR (50MHz, $CDCl_3$): δ 153.5, 147.5, 127.6, 122.6, 120.9, 118.0, 109.8, 60.8, 55.4, 14.3.

Phenyl-carbamic acid ethyl ester[13] (3g): followed Method-B by using **1g** and obtained 66

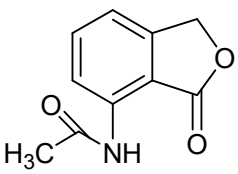


mg in 82% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.43-7.39 (d, 2H, *J* = 8.2Hz), 7.33 (br-s, 1H, NH), 7.27-7.19 (t, 2H, *J* = 7.2 Hz), 7.03-6.96 (t, 1H, *J* = 7.2 Hz), 4.22-4.13 (q, 2H, *J* = 7.2 Hz), 1.27- 1.20 (t, 3H, *J* = 7.2 Hz). ^{13}C-NMR (50MHz, $CDCl_3$): δ 153.9, 138.0, 128.7, 123.0, 118.7, 60.8, 14.2.

Method-C, General Procedure for Amidation: to a 0.1 mmol of benzyl carbamates in isopropyl alcohol in a round bottom flask was added 0.25 mmol of potassium carbonate and heated at reflux under nitrogen atmosphere and the reaction monitored by tlc. After the

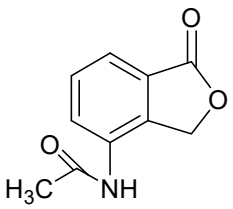
reaction was complete (16 h - 24 h), the reaction mixture was cooled to room temperature. Concentrated to gives the residue, which was dissolved in DMF, cool to 0°C, and added 1.2 eq of acid chloride. Stir at 0°C-rt under nitrogen atmosphere and the reaction monitored by tlc. After completion of reaction (30-60 minutes), quenched by addition of water. Extracted with ethyl acetate (15 ml X 2) and washed with 10% $NaHCO_3$ solution, brine solution, dried over $MgSO_4$ and filtered. The filtrate upon concentrated and column chromatography purification gives amide in 65-81% yield.

N-(3-oxo-1,3-dihydro-isobenzofuran-4-yl)-acetamide[14] (4a): followed Method-C by using



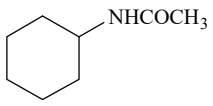
1a and obtained 77 mg in 81% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 9.60 (br-s, 1H, NH), 8.56-8.52 (d, 1H, *J* = 8.2 Hz), 7.68-7.60 (t, 1H, *J* = 8.0 Hz), 7.14-7.10 (d, 1H, *J* = 7.8 Hz), 5.32 (s, 2H), 2.27 (s, 3H). ^{13}C-NMR (125MHz, $CDCl_3$): δ 172.2, 169.2, 146.6, 138.8, 136.4, 118.3, 115.9, 111.4, 69.9, 24.9. Mass m/z: 191(M+) HRMS *m/z*: 191.0583, (calculated for $C_{10}H_9NO_3$: 191.0582).

N-(3-oxo-1,3-dihydro-isobenzofuran-7-yl)-acetamide[15] (4b): followed Method-C by using



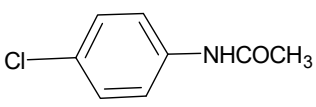
1b and obtained 68 mg in 71% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.87 (br-s, 1H, NH), 7.75-7.72 (d, 1H, *J* = 7.4 Hz), 7.65-7.61 (d, 1H, *J* = 8.0 Hz), 7.53-7.45 (t, 1H, *J* = 7.8 Hz), 5.36 (s, 2H), 2.24 (s, 3H).

N-cyclohexyl-acetamide[16] (4c): followed Method-C by using **1c** and obtained 63 mg in 73%



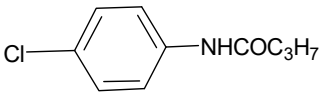
Yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 5.36 (br-s, 1H, NH), 3.78-3.68 (m, 1H), 2.09 (s, 1H), 1.95 (s, 3H), 1.78-1.50 (m, 3H), 1.49-1.01 (m, 6H).

N-(4-chloro-phenyl)-acetamide[17] (4d) followed Method-C a by using **1d** and obtained 60



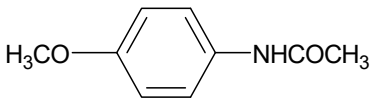
mg in 71% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.49-7.25 (m, 4H), 7.13-7.09 (br-s, 1H, NH), 2.17 (s, 3H).

N-(4-chloro-phenyl)-propionamide[18] (5d): followed Method-C by using **1d** and obtained 75



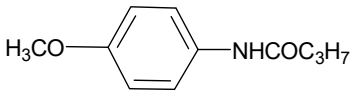
mg in 75% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.48-7.45 (m, 2H), 7.28-7.24 (m, 2H), 7.10-7.08 (br-s, 1H, NH), 2.40-2.33 (q, 2H, *J* = 7.6 Hz), 1.27-1.20 (t, 3H, *J* = 7.6 Hz).

N-(4-methoxy-phenyl)-acetamide[19] (4e): followed Method-C by using **1e** and obtained 54



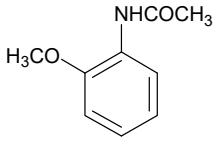
mg in 65% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.41-7.37 (d, 2H, *J* = 8.2 Hz), 7.26 (br-s, 1H, NH), 6.87-6.83 (d, 2H, *J* = 7.8 Hz), 3.78 (s, 3H), 2.15 (s, 3H).

N-(4-methoxy-phenyl)-propionamide[20] (5e): followed Method-C by using **1e** and obtained



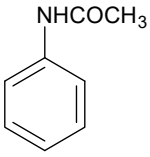
71 mg in 73% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.43-7.39 (d, 2H, *J* = 8.2 Hz), 7.26 (br-s, 1H, NH), 6.88-6.83 (d, 2H, *J* = 8.2 Hz), 3.78 (s, 3H), 2.42-2.30 (q, 2H, *J* = 7.8 Hz), 1.27-1.19 (t, 3H, *J* = 7.8 Hz).

N-(2-methoxy-phenyl)-acetamide[21] (4f): followed Method-C by using **1f** and obtained 55 mg



in 66% yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 8.37-8.36 (dd, 1H, *J* = 6.0 & 1.8 Hz), 7.75 (br-s, 1H, NH), 7.07-6.99 (m, 3H), 3.87 (s, 3H), 2.19 (s, 3H).

N-phenyl-acetamide[22] (4g): followed Method-C by using **1g** and obtained 53 mg in 76%



yield. ^{1}H-NMR (200MHz, $CDCl_3$): δ 7.51-7479 (d, 2H, *J* = 8.0 Hz), 7.35-7.31 (m, 2H), 7.13-7.05 (t, 1H, *J* = 7.8 Hz), 2.17 (s, 3H).

Reference:

1 Yoganathan, S. & Miller, S. J. N-Methylimidazole-catalyzed Synthesis of Carbamates from Hydroxamic Acids via the Lossen Rearrangement. *Org. Lett.* **15**, 602-605, doi:10.1021/ol303424b (2013).

2 Wipf, P. & Maciejewski, J. P. Titanocene(III)-Catalyzed Formation of Indolines and Azaindolines. *Org. Lett.* **10**, 4383-4386, doi:10.1021/ol801860s (2008).

3 Moon, S.-Y., Kim, U. B., Sung, D.-B. & Kim, W.-S. A Synthetic Approach to N-Aryl Carbamates via Copper-Catalyzed Chan-Lam Coupling at Room Temperature. *J. Org. Chem.* **80**, 1856-1865, doi:10.1021/jo502828r (2015).

4 Hatano, M., Kamiya, S., Moriyama, K. & Ishihara, K. Lanthanum(III) isopropoxide catalyzed chemoselective transesterification of dimethyl carbonate and methyl carbamates. *Org. Lett.* **13**, 430-433, doi:10.1021/ol102754y (2011).
5 Yoshimura, A., Middleton, K. R., Luedtke, M. W., Zhu, C. & Zhdankin, V. V. Hypervalent Iodine Catalyzed Hofmann Rearrangement of Carboxamides Using Oxone as Terminal Oxidant. *J. Org. Chem.* **77**, 11399-11404, doi:10.1021/jo302375m (2012).
6 Guo, X. *et al.* Green and practical synthesis of carbamates from ureas and organic carbonates. *Synth. Commun.* **41**, 1102-1111, doi:10.1080/00397911003707055 (2011).
7 Reixach, E., Haak, R. M., Wershofen, S. & Vidal-Ferran, A. Alkoxycarbonylation of Industrially Relevant Anilines Using Zn4O(O2CCH3)6 as Catalyst. *Ind. Eng. Chem. Res.* **51**, 16165-16170, doi:10.1021/ie301315k (2012).
8 Jevtic, I. I., Dosen-Micovic, L., Ivanovic, E. R. & Ivanovic, M. D. Hofmann Rearrangement of Carboxamides Mediated by N-Bromoacetamide. *Synthesis* **48**, 1550-1560, doi:10.1055/s-0035-1561405 (2016).
9 Reddy, G. S., Chen, H.-Y. & Chang, I. J. Cysteine-Specific Blue Fluorescence Probe. *Journal of the Chinese Chemical Society* **53**, 1303-1308, doi:10.1002/jccs.200600174 (2006).
10 Leardini, R. & Zanardi, G. A new and facile synthesis of alkyl N-arylcarbamates. *Synthesis*, 225-227, doi:10.1055/s-1982-29757 (1982).
11 Magnus, P., Garizi, N., Seibert, K. A. & Ornholt, A. Synthesis of carbamates from diethoxycarbonyl hydrazine derivatives by E1cB eliminative cleavage of the N-N'-bond rather than reduction. *Org. Lett.* **11**, 5646-5648, doi:10.1021/ol902313v (2009).
12 Elghamry, I. Unexpected reaction of oximinoacetoacetate with amines. A novel synthesis of carbamates. *Synth. Commun.* **39**, 3010-3015, doi:10.1080/00397910802564741 (2009).
13 Feng, P. *et al.* Ceric Ammonium Nitrate (CAN) Catalyzed Modification of Ketones via Two C-C Bond Cleavages with the Retention of the Oxo-Group. *Org. Lett.* **16**, 3388-3391, doi:10.1021/ol5014476 (2014).
14 Wamser, C. C. & Phillips, R. B. Chemiluminescent oxidations of 4- and 7-aminophthalide. *J. Org. Chem.* **41**, 2929-2931, doi:10.1021/jo00879a031 (1976).
15 Kumar, V., Kumar, M., Sharma, S. & Kumar, N. Highly selective direct reductive amidation of nitroarenes with carboxylic acids using cobalt(II) phthalocyanine/PMHS. *RSC Adv.* **4**, 11826-11830, doi:10.1039/c3ra46619a (2014).
16 Alalla, A., Merabet-Khelassi, M., Aribi-Zouioueche, L. & Riant, O. Green Synthesis of Benzamides in Solvent- and Activation-Free Conditions. *Synth. Commun.* **44**, 2364-2376, doi:10.1080/00397911.2014.898072 (2014).
17 Liu, Z., Liao, P. & Bi, X. General Silver-Catalyzed Hydroazidation of Terminal Alkynes by Combining TMS-N3 and H2O: Synthesis of Vinyl Azides. *Org. Lett.* **16**, 3668-3671, doi:10.1021/ol501661k (2014).
18 Du, X., Zheng, M., Chen, S. & Xu, Z. A novel synthesis of N-arylamides from nitroarenes via reductive N-acylation with red phosphorus and iodine. *Synlett*, 1953-1955, doi:10.1055/s-2006-947334 (2006).
19 Mali, S. M., Bhaisare, R. D. & Gopi, H. N. Thioacids Mediated Selective and Mild N-Acylation of Amines. *J. Org. Chem.* **78**, 5550-5555, doi:10.1021/jo400701v (2013).
20 Goodman, C. A., Eagles, J. B., Rudahindwa, L., Hamaker, C. G. & Hitchcock, S. R. Synthesis, X-Ray Crystallography, and Reactions of N-Acyl and N-Carbamoyl Succinimides. *Synth. Commun.* **43**, 2155-2164, doi:10.1080/00397911.2012.690061 (2013).
21 Dooleweerdt, K., Fors, B. P. & Buchwald, S. L. Pd-Catalyzed Cross-Coupling Reactions of Amides and Aryl Mesylates. *Org. Lett.* **12**, 2350-2353, doi:10.1021/ol100720x (2010).

22 Becerra-Figueroa, L., Ojeda-Porras, A. & Gamba-Sánchez, D. Transamidation of Carboxamides Catalyzed by Fe(III) and Water. *The Journal of Organic Chemistry* **79**, 4544-4552, doi:10.1021/jo500562w (2014).