# *n*Bu<sub>4</sub>NI-catalyzed direct synthesis of α-ketoamides from aryl methyl ketones with dialkylformamides in water using TBHP as oxidant

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## **Supporting Information**

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#### I. General Information

All experiments were carried out using common flask in Air. Aryl methyl ketones, dialkylformamides, nBu<sub>4</sub>NI and TBHP (70% in water) were purchased from commercial suppliers and used as received unless otherwise noted. All solvents and other commercially available reagents were purchased from Acros or Adaddin and used directly. Reactions were monitored by thin layer chromatography (TLC) using *Qingdao Haiyang* Chemical Co. Ltd. Silica gel 60 F254. Products were detected using a UV/Vis lamp (254 nm). Column chromatography was performed on *Oingdao Haiyang Chemical Co. Ltd. Gel 60* (200–300 mesh). The <sup>1</sup>H and <sup>13</sup>C NMR spectras were obtained on a Bruker 400 MHz NMR Fourier transform spectrometer. <sup>1</sup>H NMR data was reported as: chemical shift ( $\delta$ ppm), multiplicity, coupling constant (Hz), and integration. <sup>13</sup>C NMR data was reported in terms of chemical shift ( $\delta$  ppm) multiplicity, and coupling constant (Hz). The Spectra are referenced against the internal solvent (CDCl<sub>3</sub>,  $\delta$  1H= 7.26 ppm, <sup>13</sup>C= 77.0 ppm). Data is reported as follows: s = singlet, d = doublet, t = triplet, q = quartet and m = multiplet. ESI-MS spectra were recorded on a Bruker Esquire 3000. High resolution mass spectra (HR MS) were obtained on a Waters Micromass Q-Tof MicroTM instrument using the ESI technique.

## **II. Experimental Section**

#### **Starting Materials**

For this study, aryl methyl ketones were purchased from commercial sources and 1-arylethanol can be synthesized according to the following general procedures:

#### Method:



Aryl methyl ketones (1.0 eq.) and sodium borohydride (6.0 eq.) are dissolved in methanol. The reaction is allowed to stir at 60  $^{\circ}$ C for 6h. The solvent is then evaporated under reduced pressure and the crude reaction mixture is extracted twice with CH<sub>2</sub>Cl<sub>2</sub>. The organic layer is then dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and evaporated under reduced pressure and is purified by column chromatography on silica gel with Petroleum/Ethyl acetate mixtures, 4/1)

#### **General Procedure:**



An 50 mL vial was charged with magnetic stir bar, Aryl methyl ketone (1, 1.0 mmol), dialkylformamide (2, 2.5 mmol), *n*Bu<sub>4</sub>NI (0.2 mmol), TBHP 70% in water (5.0 mmol), followed by H<sub>2</sub>O (2 mL). After stirring at 100°C for 16 h, The reaction mixture was quenched with a saturated solution of Na<sub>2</sub>SO<sub>3</sub> (for removal of excess TBHP) and extracted with ethyl acetate (20mL×3). The combined organic phase was evaporated under reduced pressure and the isolated product was obtained by flash chromatography column on silica gel (gradient eluent of Ethyl acetate in Petroleum: 20 ~ 50%, v/v).



Investigations into the reaction mechanisms.



The reaction did not work maybe the strong conjugation between the nitrogen and phenyl ring retard the radical formation on nitrogen atom.

## NMR Data of Products

## 2-(4-chlorophenyl)-N,N-dimethyl-2-oxoacetamide (3aa)



(pale yellow liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.90$  (d, J = 6.8 Hz, 2H), 7.49 (d, J = 6.8 Hz, 2H), 3.12 (s, 3H), 2.97 (s, 3H). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 190.3$ , 166.5, 141.3, 131.5, 131.0, 129.4, 37.1, 34.1 IR (KBr, cm<sup>-1</sup>): v1684 (C=O), 1646 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>10</sub>H<sub>10</sub>ClNNaO<sub>2</sub><sup>+</sup>: 234.0298, found: 234.0292

## N,N-dimethyl-2-oxo-2-phenylacetamide (3ba)<sup>1</sup>



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta$  = 7.94-7.97 (m, 2H), 7.62-7.67 (m, 1H), 7.49-7.55 (m, 2H), 3.13 (s, 3H), 2.97 (s, 3H). IR (KBr, cm<sup>-1</sup>): v1680 (C=O), 1644 (C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta$  = 191.8, 167.1, 134.7, 133.1, 129.6, 129.0, 37.0, 34.0

## 2-(4-fluorophenyl)-*N*,*N*-dimethyl-2-oxoacetamide (3ca)



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.97-8.02$  (m, 2H), 7.16-7.21 (m, 2H), 3.12 (s, 3H), 2.97 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 190.0$ , 167.9, 166.7, 165.4, 132.4, 129.6, 116.4, 116.2, 37.0, 34.0 IR (KBr, cm<sup>-1</sup>): v1679 (C=O), 1645 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>10</sub>H<sub>10</sub>FNNaO<sub>2</sub><sup>+</sup>: 218.0593, found: 218.0594

## N,N-dimethyl-2-oxo-2-(p-tolyl)acetamide (3da)<sup>3</sup>



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>) δ = 7.85 (d, J = 8.4Hz, 2H), 7.31 (d, J = 8.4Hz, 2H), 3.12 (s, 3H), 2.95 (s, 3H), 2.44 (s, 3H)
IR (KBr, cm<sup>-1</sup>): v1685 (C=O), 1641 (C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>) δ = 191.5, 167.3, 145.9, 130.6, 129.7, 129.1, 37.0, 33.9, 21.9

## 2-(2,4-dimethylphenyl)-*N*,*N*-dimethyl-2-oxoacetamide (3ea)



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.59$  (d, J = 8.4 Hz, 1H), 7.11 (d, J = 7.2 Hz, 2H), 3.1 (s, 3H), 2.96 (s, 3H), 2.64 (s, 3H), 2.38 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 193.4$ , 168.0, 144.8, 141.6, 133.4, 133.0, 128.9, 126.9, 37.1, 33.9, 21.8, 21.6 IR (KBr, cm<sup>-1</sup>): v1673 (C=O), 1631 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>12</sub>H<sub>15</sub>NNaO<sub>2</sub><sup>+</sup>: 228.1000, found: 228.1009

#### N,N-dimethyl-2-(4-nitrophenyl)-2-oxoacetamide (3fa)



(pale yellow solid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 8.34$  (d, J = 8.8Hz, 2H), 8.14 (d, J = 8.8Hz, 2H), 3.16 (s, 3H), 3.01 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 189.3$ , 165.6, 151.1, 137.6, 130.8, 124.1, 37.1, 34.3 IR (KBr, cm<sup>-1</sup>): v1684 (C=O), 1647 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>10</sub>H<sub>10</sub>N<sub>2</sub>NaO<sub>4</sub><sup>+</sup>: 245.0538, found: 245.0534

## N,N-dimethyl-2-oxo-2-(o-tolyl)acetamide (3ga)



(sticky liquid) <sup>1</sup>**H** NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.20$  (d, J = 8.0Hz, 1H), 7.48-7.52 (m, 1H), 7.28-7.34 (m, 2H), 3.13 (s, 3H), 3.0 (s, 3H), 2.68 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 193.7$ , 165.5, 141.5, 133.7, 132.6, 131.6, 126.2, 37.1, 34.1, 21.7 IR (KBr, cm<sup>-1</sup>): v1676 (C=O), 1647 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for  $C_{11}H_{13}NNaO_2^+$ : 214.0844, found: 214.0839

#### N,N-dimethyl-2-oxo-2-(pyridin-2-yl)acetamide (3ha)



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 8.75$  (d, J = 8.4Hz, 1H), 8.12 (d, J = 7.6Hz, 1H), 7.88-7.93 (m, 1H), 7.51-7.54 (m, 1H), 3.14 (s, 3H), 2.96 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 192.0$ , 167.9, 151.3, 149.9, 137.2, 127.9, 123.2, 36.8, 33.9 IR (KBr, cm<sup>-1</sup>): v1697 (C=O), 1647 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>9</sub>H<sub>10</sub>N<sub>2</sub>NaO<sub>2</sub><sup>+</sup>: 201.0640, found: 201.0644

## 2-(furan-2-yl)-N,N-dimethyl-2-oxoacetamide (3ia)



(pale yellow liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.71$  (s, 1H), 7.38 (s, 1H), 6.61 (s, 1H), 3.09 (s, 3H), 3.04 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 178.5$ , 165.4, 150.2, 148.7, 122.4, 112.8, 37.2, 34.5 IR (KBr, cm<sup>-1</sup>): v1694 (C=O), 1650 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>8</sub>H<sub>9</sub>NNaO<sub>3</sub><sup>+</sup>: 190.0480, found: 190.0483

# <u>N,N-dimethyl-2-oxo-2-(3-(trifluoromethyl)phenyl)acetamide</u> (3ja)



<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 8.23$  (s, 1H), 8.15 (d, J = 7.6Hz, 1H), 7.90 (d, J = 8.0Hz, 1H), 7.64-7.68 (m, 1H), 3.14 (s, 3H), 2.99 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 189.9$ , 166.0, 133.7, 132.9, 131.8, 131.5, 130.9, 129.6, 126.3, 124.8, 122.1, 37.1, 34.2 IR (KBr, cm<sup>-1</sup>): v1687 (C=O), 1651 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>11</sub>H<sub>10</sub>F<sub>3</sub>NNaO<sub>2</sub><sup>+</sup>: 268.0561, found: 268.0557

## 4-(2-(dimethylamino)-2-oxoacetyl)phenyl

## 4-methylbenzenesulfonate (3ka)



(pale yellow liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.88-7.92$  (m, 2H), 7.71-7.73 (m, 2H), 7.34 (d, J = 8.4Hz, 2H), 7.12-7.16 (m, 2H), 3.1 (s, 3H), 2.96 (s, 3H), 2.46 (s, 3H) <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta$ = 190.0, 166.4, 154.1, 146.0, 131.9, 131.6, 131.5, 130.0, 128.4, 122.9, 37.1, 34.1, 21.7 IR (KBr, cm<sup>-1</sup>): v1684 (C=O), 1647 (C=O). ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>17</sub>H<sub>17</sub>NNaO<sub>5</sub>S<sup>+</sup>: 370.0725,

found: 370.0722

## *N*,*N*-dimethyl-2-(naphthalen-1-yl)-2-oxoacetamide (3la)



(colorless liquid) <sup>1</sup>**H** NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 9.26$  (d, J = 8.4Hz, 1H), 8.12 (d, J = 8.0Hz, 1H), 8.18 (d, J = 6.8Hz, 1H), 7.95 (d, J = 8.0Hz, 1H), 7.72 (t, J = 7.6Hz, 1H), 7.45-7.64 (m, 2H), 3.18 (s, 3H), 3.04 (s, 3H) **IR** (**KBr, cm<sup>-1</sup>**): v1668 (C=O), 1647 (C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 194.3$ , 167.7, 134.4, 134.1, 130.9,

129.3, 128.7, 128.4, 126.9, 125.8, 124.6, 37.2, 34.1

**ESI-HRMS**:  $[M+Na]^+$  m/z calcd for  $C_{14}H_{13}NNaO_2^+$ : 250.0844, found: 250.0843

N,N-diethyl-2-oxo-2-phenylacetamide (3bb)<sup>2</sup>



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta$  = 7.93-7.95 (m, 2H), 7.61-7.65 (m, 1H), 7.49-7.53 (m, 2H), 3.56 (q, *J* = 7.2Hz, 2H), 3.26 (q, *J* = 7.2Hz, 2H), 1.29 (t, *J* = 7.2Hz, 3H), 1.16 (t, *J* = 7.2Hz, 3H) IR (KBr, cm<sup>-1</sup>): v1680 (C=O), 1639 (C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta$  = 191.6, 166.7, 134.5, 133.3, 129.6, 128.9, 42.1, 38.8, 14.1, 12.8

## 2-(4-chlorophenyl)-N,N-diethyl-2-oxoacetamide (3ab)



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>) δ = 7.89 (d, *J* = 8.8Hz 2H), 7.49 (d, *J* = 8.8Hz, 2H), 3.55 (q, *J* = 7.2Hz, 2H), 3.24 (q, *J* = 7.2Hz, 2H), 1.28 (t, *J* = 7.2Hz, 3H), 1.16 (t, *J* = 7.2Hz, 3H) IR (KBr, cm<sup>-1</sup>): v1680 (C=O), 1639 (C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 190.2, 166.2, 141.2, 131.7, 130.9, 129.4, 42.2, 38.9, 14.2, 12.8$ **ESI-HRMS**:  $[M+Na]^+$  m/z calcd for  $C_{12}H_{14}CINNaO_2^+$ : 262.0611, found: 262.0611

*N*,*N*-diethyl-2-(4-fluorophenyl)-2-oxoacetamide (3cb)



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.96$  (m, 2H), 7.16-7.20 (m, 2H), 3.55 (q, J = 7.2Hz, 2H), 3.26 (q, J = 7.2Hz, 2H), 1.27 (t, J = 7.2Hz, 3H), 1.16 (t, J = 7.2Hz, 3H) IR (KBr, cm<sup>-1</sup>): v1679 (C=O), 1640 (C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 189.8$ , 167.8, 166.4, 165.3, 132.4, 129.8, 116.4, 116.2, 42.2, 38.9, 14.2, 12.8 ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>12</sub>H<sub>14</sub>FNNaO<sub>2</sub><sup>+</sup>: 246.0906, found: 246.0901

#### *N*,*N*-diethyl-2-(4-nitrophenyl)-2-oxoacetamide (3fb)



(colorless liquid) <sup>1</sup>**H NMR (400MHz, CDCl<sub>3</sub>)** δ = 8.34 (d, *J* = 7.2Hz 2H), 8.14 (d, *J* = 7.2Hz, 2H), 3.56 (q, *J* = 7.2Hz, 2H), 3.28 (q, *J* = 7.2Hz, 2H), 1.31 (t, J = 7.2Hz, 3H), 1.19 (t, J = 7.2Hz, 3H) **IR** (**KBr**, **cm**<sup>-1</sup>): **v**1690 (C=O), 1643 (C=O). <sup>13</sup>**C NMR** (100MHz, CDCl<sub>3</sub>)  $\delta =$  189.1, 165.4, 151.0, 137.7, 130.7, 124.1, 42.3, 39.3, 14.3, 12.8 **ESI-HRMS**: [M+Na]<sup>+</sup> m/z calcd for C<sub>12</sub>H<sub>14</sub>N<sub>2</sub>NaO<sub>4</sub><sup>+</sup>: 273.0851, found: 273.0855

## **<u>1-phenyl-2-(piperidin-1-yl)ethane-1,2-dione (3bc)**<sup>1-5</sup></u>



(colorless liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>)  $\delta = 7.96$  (d, J = 7.6Hz 2H), 7.19 (t, J = 7.6Hz, 1H), 7.51 (t, J = 7.6Hz, 2H), 3.71 (s, 2H), 3.29 (t, J = 6.4Hz, 2H), 1.70 (s, 4H), 155 (s, 2H) IR (KBr, cm<sup>-1</sup>): v1678 (C=O), 1640 (C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>)  $\delta = 191.9$ , 165.5, 134.6, 133.3, 129.6, 129.0, 47.0, 42.2, 26.2, 25.5, 24.4

## 1-(4-chlorophenyl)-2-(piperidin-1-yl)ethane-1,2-dione (3ac)<sup>5</sup>



(pale yellow liquid) <sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>) δ = 7.89 (d, J = 8.8Hz 2H), 7.48 (t, J = 8.4Hz, 2H), 3.70 (s, 2H), 3.28 (t, J = 6.4Hz, 2H), 1.70 (s, 4H), 156 (s, 2H) IR (KBr, cm<sup>-1</sup>): v1680 (C=O), 1640

(C=O). <sup>13</sup>C NMR (100MHz, CDCl<sub>3</sub>) δ = 190.5, 164.9, 141.2, 131.7, 130.9, 129.4, 47.1, 42.2, 26.2, 25.4, 24.3

1-morpholino-2-(p-tolyl)ethane-1,2-dione (3dd)<sup>1-4</sup>



(white solid) <sup>1</sup>**H NMR** (400MHz, CDCl<sub>3</sub>)  $\delta = 7.86$  (d, J = 8.4Hz 2H), 7.33 (t, J = 8.4Hz, 2H), 3.78 (s, 4H), 3.65 (t, J = 4.8Hz, 2H), 3.37 (t, J = 4.8Hz, 2H), 2.44(s, 3H). <sup>13</sup>C **NMR** (100MHz, CDCl<sub>3</sub>)  $\delta$ = 190.9, 165.7, 146.3, 130.6, 129.8, 129.7, 66.7, 66.6, 46.3, 41.5, 21.9

#### 1-(4-methylpiperazin-1-yl)-2-phenylethane-1,2-dione (3be)



<sup>1</sup>**H NMR** (400MHz, CDCl<sub>3</sub>)  $\delta = 7.94-7.96$  (m, 2H), 7.63-7.67 (m, 1H), 7.50-7.54 (m, 2H), 3.80 (t, J = 4.4Hz, 2H), 3.38 (t, J = 4.4Hz, 2H), 2.52 (t, J = 4.4Hz, 2H), 2.39 (t, J = 4.4Hz, 2H), 2.33(s, 3H). <sup>13</sup>**C NMR** (100MHz, CDCl<sub>3</sub>)  $\delta = 191.5$ , 165.4, 134.8, 133.1, 129.6, 129.1, 54.9, 54.5, 46.0, 45.8, 41.2 ESI-HRMS: [M+Na]<sup>+</sup> m/z calcd for C<sub>13</sub>H<sub>16</sub>N<sub>2</sub>NaO<sub>2</sub><sup>+</sup>: 255.1109, found: 255.1103

## **III. References and Notes**

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## IV. NMR Spectrum Copies





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