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Iron-Catalyzed Annulation of 2-Aminobenzaldehydes with Iodonium Ylides: A Mild and General Route for the Synthesis of Acridinone Derivatives

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An inexpensive iron-catalyzed annulation of 2-aminobenzaldehydes with iodonium ylides for the synthesis of acridinone derivatives was reported. A library of biologically relevant 3,4-dihydropyridine-1-one scaffold was synthesized by the reaction of corresponding 2-amino benzaldehyde and iodonium ylides under mild reaction conditions in a green solvent. The reaction tolerates various alkyl, aryl and halogenated substrates and affords the desired product in moderate to good yields. The reported reaction has an inexpensive catalytic system, mild reaction conditions, easily accessible substrates and the use of green solvents.

Keywords: Heterocycles, Acridin-1-one, Iron, Catalysis, Green synthesis.

INTRODUCTION

Nitrogen-containing benzo-fused heterocycles are one of the most important and attractive class of heterocycles, which are comprehensively present as core structural skeletons in various biologically relevant alkaloids and natural products [1-3]. Acridine and acridine-1-one derivatives are nitrogen-containing pivotal heterocyclic scaffolds ubiquitously present in a wide library of life-saving drug molecules such as anti-cancer, anti-Alzheimer, cholinesterase inhibitors, *etc.* [4-7].

Owing to their broad range of potential applications in the medicinal areas, much attention has been devoted to the synthesis of these molecules. In this regard, Friedländer's annulation got much attention and the best-known methods for the synthesis of acridine-1-one derivatives [8]. However, uncatalyzed Friedländer annulation required high reaction temperatures ranging from 150-220 ºC. Owing to the operational simplicity and easily accessible starting materials, this reaction was reported by several research groups in newer versions using acid or base as catalysts [9-11]. Various Lewis acid catalyzed interesting reports including $NaAuCl_4·2H_2O$ [12], $Bi(OTf)_3$ [13], $FeCl_3·6H_2O$ [14], $SnCl_2·2H_2O$ [15], $Y(OTf)_3$ [16], $CeCl_3·7H_2O$ [17], $Ce(NH_4)_2(NO_3)_6$ [3], $Cu(OTf)_2$ [18], $Yb(OTf)_3$ [19], $In(OTf)_3$ [20] are reported for the synthesis of acridine-1-one derivatives. These methods also have certain drawbacks like high catalyst loading, difficulties in workup, low yields and use of precious metals as catalysts. Thus, the development of a cost-effective and environmentally friendly approach is highly desirable.

In the past decade, iodonium ylides have been used as substrates for the construction of carbon-carbon bonds and the cyclization process for synthesizing various complex molecules [21-24]. Iodoniun ylides are inexpensive and readily available stable singlet carbene precursors, which are readily converted into carbenoid species under light, heat, or metal catalysis conditions [25,26]. Beside this, iodonium ylides are also safer and more stable as compared to explosive diazonium and diazo compounds [27,28]. In most cases, iodonium ylides have one or two carbonyl groups at its *ortho*-positions. This carbonyl provides an interaction site to both nucleophiles [29, 30] and electrophiles [31-33] in ketone form and tautomerized enol form, respectively. Thus, iodonium ylides can be used as a two-atom or three-atom surrogate, which makes it an important annulation partner in organic synthesis [29,33,34]. Iodonium ylides are used as annulation partners for the synthesis of various nitrogen-containing heterocycles [35-38]. Herein, an inexpensive and naturally abundant iron-catalyzed synthetic route of acridin-1-one derivatives from the reaction of 2-amino-benzaldehydes and iodonium ylides in moderate to good yields under mild and green reaction conditions is developed.

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EXPERIMENTAL

Majority of the chemicals were procured either from Sigma-Aldrich or TCI chemicals and used as received without further purification. All manipulations were carried out under an atmosphere of nitrogen or in air. NMR spectra were recorded at 298 K on Bruker 500 MHz and JEOL 400 MHz NMR spectrometer. The chemical shifts of proton and carbon were reported in ppm and referenced using residual proton (7.26 ppm) and carbon signals (77.16 ppm) of $CDCl_3$ [39]. Mass data were collected from an Agilent 6545 LC/Q-TOF spectrometer. Solvents were purchased from commercial suppliers and used without further purification.

2-(Phenyl-λ^3-iodanylidene)cyclohexane-1,3-dione, 4,4-dimethyl-2-(phenyl-λ^3-iodanylidene)cyclohexane-1,3-dione, 5-methyl-2-(phenyl-λ^3-iodanylidene)cyclohexane-1,3-dione, 5-phenyl-2-(phenyl-λ^3-iodanylidene)cyclohexane-1,3-dione, 5,5-dimethyl-2-(phenyl-λ^3-iodanylidene)cyclohexane-1,3-dione and N-(2-formylphenyl)-4-methylbenzenesulfonamide were synthesized according to reported procedure [35].

General procedure for catalytic reactions: An oven-dried 10 mL glass vial with a magnetic stirring bar was charged with 2-aminobenzaldehydes (1.0 equiv.), iodonium ylides (1.2 equiv.), $Fe(OTf)_3$ (5.0 mol%) and H_2O (1.0 mL). The reaction vial was sealed with a rubber septum and kept for stirring at 60 ºC for 8 h. The progress of the reaction was monitored by TLC analysis and after completion of the reaction, cooled the reaction mixture at room temperature. The reaction mixture was dissolved in chloroform (15 mL) and the organic fraction was separated. The organic fraction was dried over anhydrous $MgSO_4$ and concentrated under reduced pressure. The affording crude product was purified by column chromatography on silica gel eluting with ethyl acetate/petroleum ether (8-28 %) and obtained as a white/off-white solid (**Scheme-I**).

3,4-Dihydroacridin-1(2*H*)-one (3aa) [40]**:** Yield: 0.0571 g, 94%; ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.86 (s, 1H), 8.05 (d, *J* = 8.0 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.85-7.78 (m, 1H), 7.56 (t, *J* = 8.0 Hz, 1H), 3.32 (t, *J* = 6.5 Hz, 2H), 2.80 (t, *J* = 6.5, 2H), 2.28 (quint, *J* = 6.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 198.06, 162.09, 149.80, 137.26, 132.48, 129.87, 128.70, 126.96, 126.83, 126.46, 39.21, 33.57, 21.90.

5-Bromo-3,4-dihydroacridin-1(2*H*)-one (3ba) [4]**:** Yield: 0.044 g, 84%; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.78 (s, 1H), 8.12-8.10 (m, 1H), 7.88-7.86 (m, 1H), 7.38 (t, *J* = 8.0 Hz, 1H), 3.40-3.37 (m, 2H), 2.81-2.78 (m, 2H), 2.29-2.24 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.7, 163.3, 146.51, 137.64, 135.86, 129.69, 128.14, 127.14, 126.99, 124.17, 39.14, 33.67, 21.74.

6-Chloro-3,4-dihydroacridin-1(2*H*)-one (3ca) [41]**:** Yield: 0.0463 g, 83%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.80 (s, 1H), 8.04 (s, 1H), 7.85 (d, *J* = 8.5 Hz, 1H), 7.50-7.48 (m, 1H), 3.30 (t, *J* = 6.0 Hz, 2H), 2.79 (t, *J* = 6.5 Hz, 2H), 2.26 (quint, *J* = 6.5 Hz 2H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.49, 163.23, 149.7, 138.81, 137.16, 130.96, 128.17, 127.66, 126.55, 125.32, 39.07, 33.34, 21.70.

7-Chloro-3,4-dihydroacridin-1(2*H*)-one (3da) [4]**:** Yield: 0.052 g, 75%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.74 (s, 1H), 7.97 (d, *J* = 8.5 Hz, 1H), 7.89 (s, 1H), 7.71 (d, *J* = 8.5 Hz, 1H), 3.29 (t, *J* = 6.0 Hz, 2H), 2.79 (t, *J* = 6.5 Hz, 2H), 2.28-2.25 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.77, 162.36, 148.09, 136.2, 133.28, 132.56, 130.31, 128.14, 127.52, 127.02, 39.14, 33.45, 21.74 ppm.

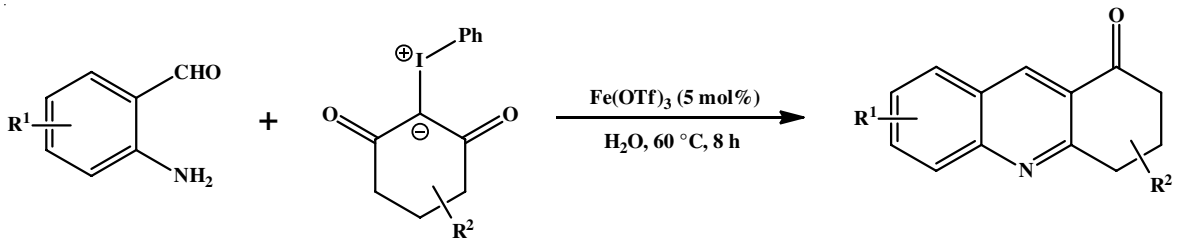
3-Methyl-3,4-dihydroacridin-1(2*H*)-one (3ab) [42]**:** Yield: 0.0743 g, 91%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.85 (s, 1H), 8.10 (d, *J* = 8.5 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.82 (t, *J* = 7.5 Hz, 1H), 7.56 (t, *J* = 7.5 Hz, 1H), 3.45-3.42 (m, 1H), 3.01-2.98 (m, 1H), 2.90-2.84 (m, 1H), 2.50-2.44 (m, 2H), 1.22-1.21 (m, 3H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.67, 161.35, 149.25, 137.5, 132.78, 129.90, 128.25, 126.93, 127.08, 125.89, 47.11, 41.31, 29.11, 21.39.

3-Phenyl-3,4-dihydroacridin-1(2*H*)-one (3ac) [43]**:** Yield: 0.098 g, 92%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.89 (s, 1H), 8.11 (d, *J* = 8.5 Hz, 1H), 7.95 (d, *J* = 8.0 Hz, 1H), 7.83 (t, *J* = 7.5 Hz, 1H), 7.58 (t, *J* = 7.5 Hz, 1H), 7.39-7.32 (m, 4H), 7.29-7.26 (m, 1H), 3.68-3.58 (m, 2H), 3.54-3.49 (m, 1H), 3.13-3.12 (m, 1H), 3.01-2.96 (m, 1H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.12, 160.91, 149.81, 142.72, 137.28, 132.63, 129.87, 128.99, 128.59, 127.19, 126.99, 126.91, 126.77, 125.72, 46.11, 40.91, 39.40.

3,3-Dimethyl-3,4-dihydroacridin-1(2*H*)-one (3ad) [4]**:** Yield: 0.062 g, 89%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.83 (s, 1H), 8.05 (d, *J* = 8.5 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.81-7.78 (m, 1H), 7.56-7.53 (m, 1H), 3.19 (s, 2H), 2.65 (s, 2H), 1.14 (s, 6H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.86, 160.82, 149.88, 136.63, 132.3, 129.79, 128.52, 126.78, 126.77, 125.33, 52.50, 47.12, 32.79, 28.42.

4,4-Dimethyl-3,4-dihydroacridin-1(2*H*)-one (3ae) [42]**:** Yield: 0.0544 g, 78%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.87 (s, 1H), 8.07 (d, *J* = 8.5 Hz, 1H), 7.93 (d, *J* = 8.0 Hz, 1H), 7.81-7.78 (m, 1H), 7.53 (t, *J* = 7.5 Hz, 1H), 3.35 (t, *J* = 6.5 Hz, 2H), 2.10 (t, *J* = 6.5 Hz, 2H), 1.28 (s, 5H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 202.19, 161.25, 149.27, 138.43, 132.51, 129.74, 128.28, 127.0, 126.82, 125.38, 42.02, 35.23, 29.36, 24.37.

5-Bromo-3-methyl-3,4-dihydroacridin-1(2*H*)-one (3bb): Yield: 0.0405 g, 73%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.79 (s, 1H), 8.12 (d, *J* = 7.5 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H),



Scheme-I: Synthesis of 3,4-dihydroacridin-1(2*H*)-ones from 2-aminobenzaldehydes and iodonium ylides

7.39 (t, *J* = 7.7 Hz, 1H), 3.52-3.49 (m, 1H), 3.07-3.01 (m, 1H), 2.88 (q, *J* = 10.5 Hz, 1H), 2.48 (d, *J* = 10.5 Hz, 2H), 1.23-1.22 (m, 3H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.81, 162.75, 146.78, 137.41, 135.83, 129.74, 128.16, 127.16, 126.46, 124.3, 47.21, 41.92, 29.17, 21.4. HRMS (ESI) calcd. for $C_{14}H_{12}BrNO$ $[M+H]^+$ *m/z* 290.0180; Found 290.0167.

5-Bromo-3-phenyl-3,4-dihydroacridin-1(2*H*)-one (3bc): Yield: 0.0573 g, 86%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.86 (s, 1H), 8.15 (d, *J* = 7.5 Hz, 1H), 7.93 (d, *J* = 8.0 Hz, 1H), 7.43-7.33 (m, 5H), 7.30-7.26 (m, 1H), 3.77 (d, *J* = 15.5 Hz, 1H), 3.64-3.52 (m, 2H), 3.13 (d, *J* = 8.0 Hz, 1H), 3.03-2.97 (m, 1H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.1, 162.23, 146.95, 142.65, 137.67, 136.02, 129.78, 129.06, 128.27, 127.34, 127.31, 126.83, 126.41, 124.43, 46.28, 41.31, 39.52. HRMS (ESI) calcd. for $C_{19}H_{14}BrNO$ $[M+H]^+$ *m/z* 352.0337; Found 352.0315.

5-Bromo-3,3-dimethyl-3,4-dihydroacridin-1(2*H*)-one (3bd): Yield: 0.0434 g, 75%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.81 (s, 1H), 8.14 (d, *J* = 7.5 Hz, 1H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.41 (t, *J* = 8.0 Hz, 1H), 3.33 (s, 2H), 2.67 (s, 2H), 1.16 (s, 6H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.85, 162.21, 146.9, 137.23, 135.91, 129.79, 128.2, 127.24, 126.1, 124.15, 52.66, 47.25, 32.93, 28.51. HRMS (ESI) calcd. for $C_{15}H_{14}BrNO$ $[M+H]^+$ *m/z* 304.0337; Found 304.0322.

5-Bromo-4,4-dimethyl-3,4-dihydroacridin-1(2*H*)-one (3be): Yield: 0.041 g, 71%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.86 (s, 1H), 8.13 (d, *J* = 7.0 Hz, 1H), 7.91 (d, *J* = 7.5 Hz, 1H), 7.40 (t, *J* = 7.5 Hz, 1H), 3.45 (s, 2H), 2.13 (s, 2H), 1.30 (s, 6H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 202.18, 162.66, 146.63, 138.54, 135.69, 129.62, 128.26, 127.01, 126.06, 124.24, 42.10, 35.24, 29.78, 24.35. HRMS (ESI) calcd. for $C_{15}H_{14}BrNO$ $[M+H]^+$ *m/z* 304.0337; Found 304.0314.

6-Chloro-3-methyl-3,4-dihydroacridin-1(2*H*)-one (3cb): Yield: 0.037 g, 61%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.79 (s, 1H), 8.05 (s, 1H), 7.87 (d, *J* = 9.0 Hz, 1H), 7.50 (d, *J* = 8.0 Hz, 1H), 3.39-3.35 (m, 1H), 3.00-2.95 (m, 1H), 2.90-2.86 (m, 1H), 2.48-2.46 (m, 2H), 1.23-1.22 (m, 3H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.62, 162.7, 150.14, 138.63, 136.74, 130.98, 128.1, 127.89, 126.01, 125.32, 47.10, 41.67, 29.07, 21.40. HRMS (ESI) calcd. for $C_{14}H_{12}ClNO$ $[M+H]$ + *m/z* 246.0685; Found 246.0680.

6-Chloro-4,4-dimethyl-3,4-dihydroacridin-1(2*H*)-one (3cc): Yield: 0.0405 g, 64%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.83 (s, 1H), 8.04 (s, 1H), 7.86 (d, *J* = 8.5 Hz, 1H), 7.49-7.47 (m, 1H), 3.31 (t, *J* = 6.5 Hz, 2H), 2.11 (t, *J* = 6.5 Hz, 2H), 1.29 (s, 6H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 202.05, 162.59, 150.01, 138.43, 137.79, 130.84, 127.91, 127.82, 125.53, 125.40, 42.04, 35.22, 29.62, 24.39 ppm. HRMS (ESI) calcd. for $C_{15}H_{14}ClNO$ $[M+H]$ + *m/z* 260.0842; Found 260.0845.

7-Chloro-3-methyl-3,4-dihydroacridin-1(2*H*)-one (3db): Yield: 0.051 g, 68%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.72 (s, 1H), 8.00 (d, *J* = 9.0 Hz, 1H), 7.89 (s, 1H), 7.72 (d, *J* = 9.0 Hz, 1H), 3.40-3.37 (m, 1H), 3.00-2.95 (m, 1H), 2.90-2.84 (m, 1H), 2.50-2.43 (m, 2H), 1.23-1.21 (m, 3H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.47, 161.69, 147.93, 136.16, 133.37, 132.69, 130.12, 128.16, 127.49, 126.46, 47.07, 41.43, 29.03, 21.38. HRMS (ESI) calcd. for $C_{14}H_{12}ClNO$ $[M+H]^+$ *m/z* 246.0685; Found 246.0666.

7-Chloro-3-phenyl-3,4-dihydroacridin-1(2*H*)-one (3dc) [6]**:** Yield: 0.069 g, 73%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.77 (s, 1H), 8.00 (d, *J* = 9.0 Hz, 1H), 7.91 (s, 1H), 7.74 (d, *J* = 8.5 Hz, 1H), 7.39-7.36 (m, 2H), 7.33-7.27 (m, 3H), 3.63-3.60 (m, 2H), 3.52-3.46 (m, 1H), 3.13-3.10 (m, 1H), 3.02-2.96 (m, 1H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 196.93, 161.26, 148.35, 142.6, 136.17, 133.4, 132.76, 130.4, 129.08, 128.19, 127.55, 127.32, 126.79, 126.37, 46.14, 41.03, 39.37.

7-Chloro-3,3-dimethyl-3,4-dihydroacridin-1(2*H*)-one (3dd) [44]**:** Yield: 0.0655 g, 83%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.70 (s, 1H), 7.97 (d, *J* = 9.0 Hz, 1H), 7.88-7.87 (m, 1H), 7.71-7.69 (m, 1H), 3.17 (s, 2H), 2.64 (s, 2H), 1.13 (s, 6H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 197.61, 161.18, 148.25, 135.72, 133.19, 132.62, 130.2, 128.17, 127.48, 126.0, 52.53, 47.1, 32.86, 28.47.

7-Chloro-4,4-dimethyl-3,4-dihydroacridin-1(2*H*)-one (3de): Yield: 0.045 g, 79%, ^{1}H NMR (500 MHz, $CDCl_3$, δ ppm): 8.78 (s, 1H), 8.01 (d, *J* = 9.0 Hz, 1H), 7.90 (s, 1H), 7.72-7.70 (m, 1H), 3.33 (t, *J* = 6.2 Hz, 2H), 2.11 (t, *J* = 6.2 Hz, 2H), 1.28 (s, 6H). ^{13}C NMR (125 MHz, $CDCl_3$, δ ppm): 201.83, 161.54, 147.57, 137.4, 133.33, 132.59, 129.9, 128.05, 127.58, 126.01, 42.07, 35.07, 29.28, 24.31. HRMS (ESI) calcd. for $C_{15}H_{14}ClNO$ $[M+H]^+$ *m/z* 260.0842; Found 260.0818.

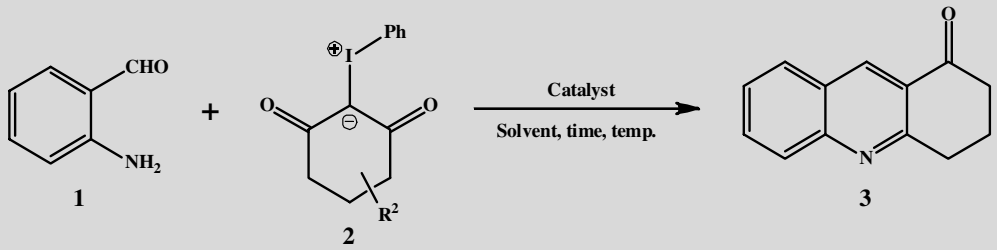
RESULTS AND DISCUSSION

For the optimization study of annulation reactions, the investigation was started by using 2-aminobenzaldehyde (**1**) and 2-(phenyl-λ^3-iodanylidene)cyclohexane-1,3-dione (**2**, so-called iodonium ylide) as model substrates (Table-1). Present study commenced from the reaction of 2-aminobenzaldehyde (1.0 equiv.), 2-(phenyl-λ^3-iodanylidene)cyclohexane-1,3-dione (1.2 equiv.), $Fe(OTf)_3$ (5.0 mol%) in HFIP at 60 ºC for 8 h. The desired product **3** could be obtained in a 56% yield (entry 1, Table-1). Later on, a variety of solvents such as DCE, toluene, CH_3CN, MeOH and H_2O were screened for this reaction (entries 1-6, Table-1) and found that the polar protic solvent MeOH and H_2O afforded good yield of product, H_2O to be the optimal solvent (entry 6, Table-1). Various catalysts such as $FeCl_3$, $Fe(OAc)_2$, $Cu(OTf)_2$ and TFA were also screened (entries 7-10, Table-1) and concluded that $Fe(OTf)_3$ is the best catalyst for the reaction (entry 6, Table-1). Not surprisingly, decreasing the catalyst loading led to a decrease in product yield to 63% (entry 11, Table-1). Reducing the reaction temperature (entry 12, Table-1) and reaction time (entry 13, Table-1) significantly reduces the yield to 68% and 73%, respectively. In the absence of catalyst, a 37% yield was achieved (entry 14, Table-1).

After optimization conditions in hand, the reaction was examined generality and scope with respect to both easily accessible 2-aminobenzaldehydes and iodonium ylides (**Schemes II** and **III**). In **Scheme-II**, a variety of 2-aminobenzaldehydes reacts with iodonium ylides, lead the formation of corresponding products in moderate to good yields. In case of 2-aminonicotinaldehyde, the desired product 3ea was not obtained

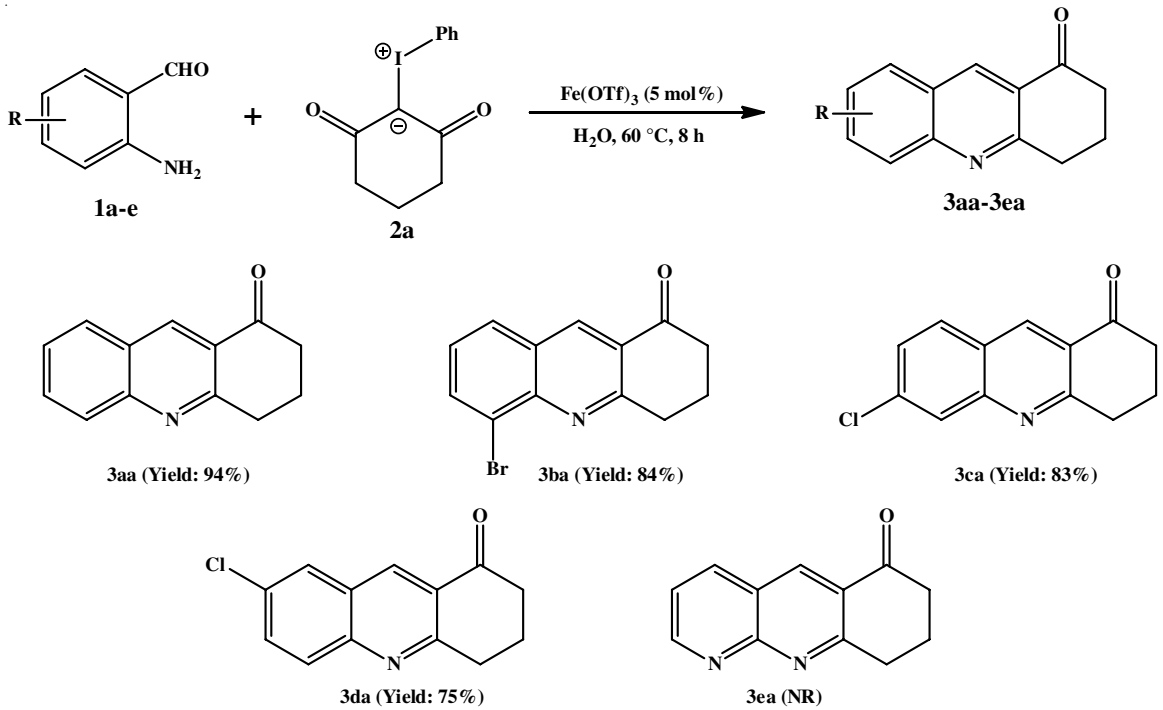
In the next step, the substrate scope was investigated with respect to iodonium ylides. For that, a variety of methyl, dimethyl and phenyl-substituted iodonium ylide at C4 and C5 positions

TABLE-1
OPTIMIZATION OF REACTION CONDITIONS FOR ANNULATION REACTION[a]



Entry	Catalyst (mol %)	Solvent	Temperature (°C)	Time (h)	Isolated yield (%)
1	$Fe(OTf)_3$ (5 mol%)	HFIP	60	8	56
2	$Fe(OTf)_3$ (5 mol%)	DCE	60	8	63
3	$Fe(OTf)_3$ (5 mol%)	Toluene	60	8	45
4	$Fe(OTf)_3$ (5 mol%)	CH_3CN	60	8	74
5	$Fe(OTf)_3$ (5 mol%)	MeOH	60	8	83
6	$Fe(OTf)_3$ (5 mol%)	H_2O	60	8	94
7	$FeCl_3$ (5 mol%)	H_2O	60	8	86
8	$Fe(OAc)_2$ (5 mol%)	H_2O	60	8	82
9	$Cu(OTf)_2$ (5 mol%)	H_2O	60	8	75
10	TFA (5 mol%)	H_2O	60	8	72
11	$Fe(OTf)_3$ (3 mol%)	H_2O	60	8	63
12	$Fe(OTf)_3$ (5 mol%)	H_2O	rt	8	68
13	$Fe(OTf)_3$ (5 mol%)	H_2O	60	4	73
14	–	H_2O	60	8	42

[a]Reaction conditions: 2-Aminobenzaldehyde (1.0 equiv.), iodonium ylide (1.2 equiv.), $Fe(OTf)_3$ (5 mol%), solvent (1.0 mL) at 60 °C in 8 h.

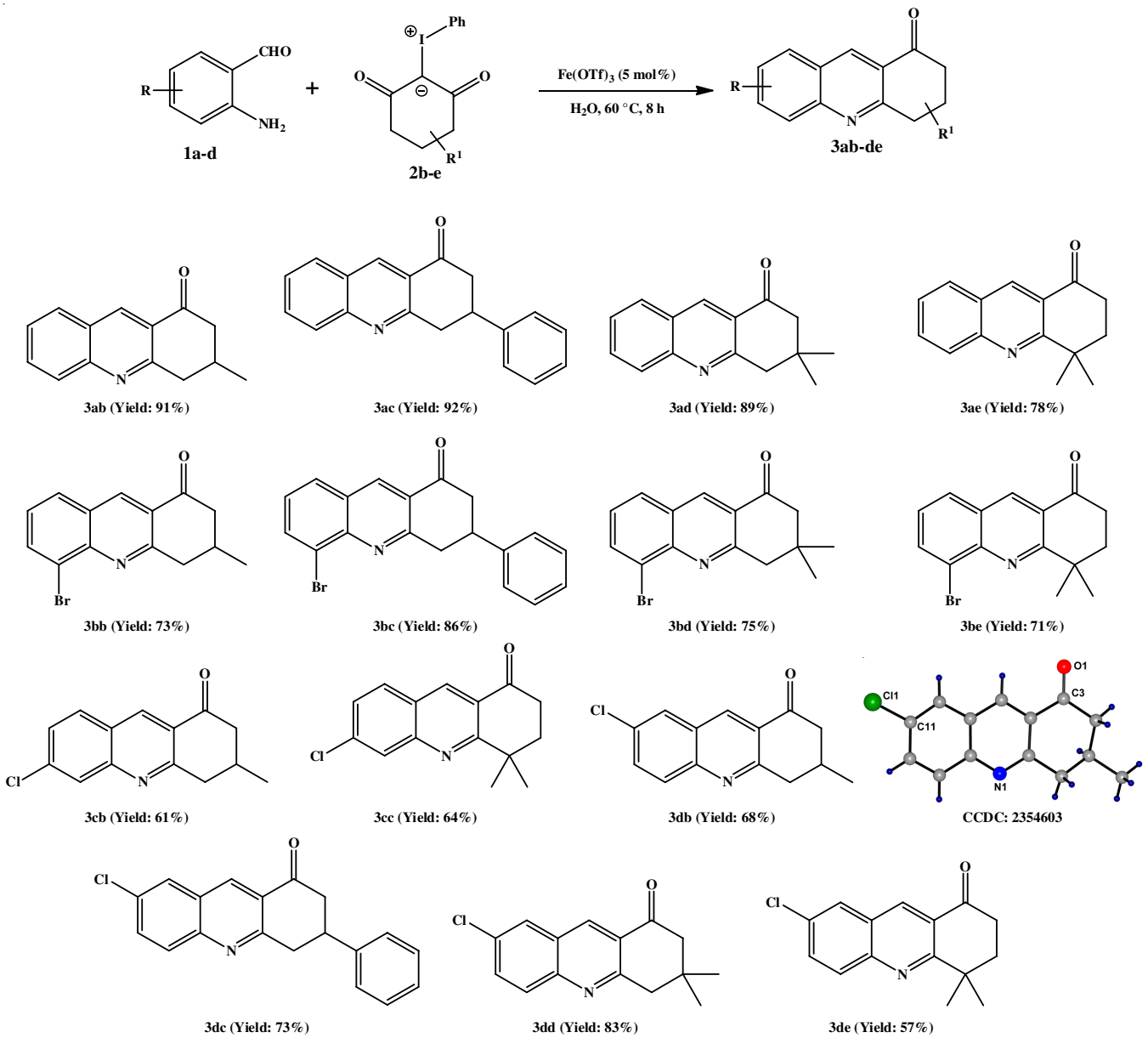


Scheme-II: Substrate scope of 2-aminobenzaldehyde [Reaction conditions: 2-aminobenzaldehyde (1.0 equiv.), iodonium ylide (1.2 equiv.), $Fe(OTf)_3$ (5.0 mol%), H_2O (1.0 mL) at 60 °C in 8 h]

were used (**Scheme-III**). Reaction of 2-aminobenzaldehydes with various iodonium ylides yielding the corresponding NH-free carbazolones in moderate to good yields (57-92%). It was found that substituents have little effect on yield, but C4 substituents gave a lower yield than C5 substituents, this may be due to steric hindrance.

Conclusion

A variety of biologically relevant 3,4-dihydropyridine-1-one scaffolds were synthesized by annulations of corresponding 2-aminobenzaldehyde and iodonium ylides using iron as a catalyst. Desired 3,4-dihydropyridine-1-one derivatives were obtained in moderate to good yields, showing tolerance with



Scheme-III: Scope of annulation of 2-aminobenzaldehydes with iodonium ylides [Reaction conditions: 2-aminobenzaldehyde (1.0 equiv.), iodonium ylide (1.2 equiv.), $Fe(OTf)_3$ (5.0 mol%), H_2O (1.0 mL) at 60 °C in 8 h]

alkyl, aryl and halo functional groups under mild reaction conditions. Some interesting features such as an inexpensive catalytic system, mild reaction condition, easily accessible substrates and use of green solvents are attractive features of this reaction.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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