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A facile preparation of methyl indolylacetates *via* Stille carbonylation of *N*-protected bromomethylindoles

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A systematic study on carbonylation of *N*-protected bromomethylindoles using different types of Pd catalyst and bases under Stille condition has been explored. Carbonylation of bromomethylindoles in the presence of methyl/ethyl alcohol led to the formation of the corresponding esters in reasonable yields.

Keywords: Bromomethylindoles, carbonylation, Pd catalyst, indolylmethylesters

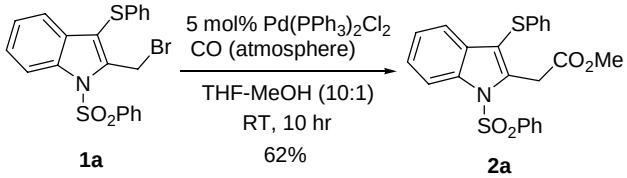
Indole and its myriad derivatives are an important segment of a large number of natural products of both marine and terrestrial origin, and hence continue to capture the attention of synthetic organic chemist. Recently, Gribble has extensively reviewed[1] the various developments involved in the synthesis of indole ring. In general, the most of the substituted indoles are prepared through lithiation protocols[2]. The fact that *N*-protected methylindole can be easily allylic brominated using NBS led to the syntheses of variety of indole derivatives[3-6]. In particular, synthetic elaboration of bromomethylindoles has been thoroughly exploited to the syntheses of different types of indole based natural products[7-9].

Generally, the carbonylation of benzylic bromides/chlorides has been achieved[10] using palladium catalysts under high pressure of carbon monoxide. Relatively, carbonylation of aryl halides is much facile, while a similar reaction with benzylic halides is considered to be tricky due to the high reactivity of benzylic halides. Periyasamy and Narayana have extensively reviewed[11] the carbonylation reactions of organometallic reagents using carbon monoxide. Zucchi *et al*.[12] reported cobalt-catalyzed carbonylation of benzyl chloride involving a biphase system using PEG as PTC catalyst. Jones *et al.*[13] reported Pd-catalyzed carbonylation of arylmethyl halides using organopalladium complexes derived from 2-(bromomethyl)benzenemethanol. Apart from one report[14], which deals with the synthesis of indolylamide involving a Pd-catalyzed carbonylation of *N*-free halo indole, all others are non-carbonylation methods[15] for the preparation of indolylmethyl/ethyl esters involving multi-step procedures and gave only low yields. Since numerous bromomethylindoles were easily available and also encouraged by the fact that these compounds could also be used as crucial intermediates for the synthesis of indole alkaloids, in continuation to the earlier work on *N*-protected bromomethylindoles[16], a systematic study on carbonylation of various bromomethylindoles under Stille condition was undertaken.

Results and Discussion

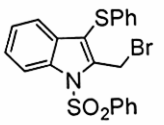
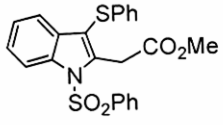
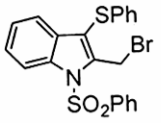
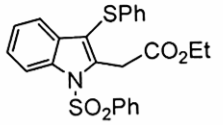
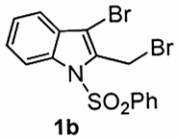
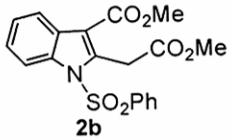
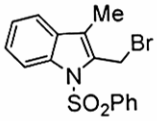
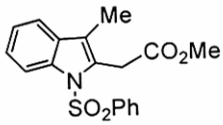
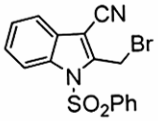
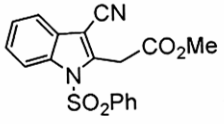
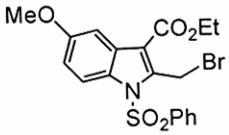
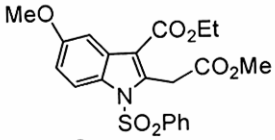
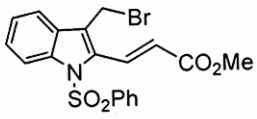
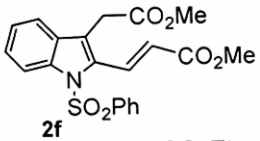
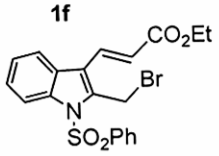
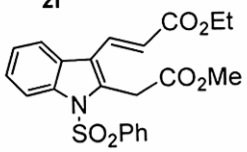
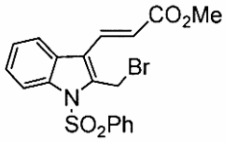
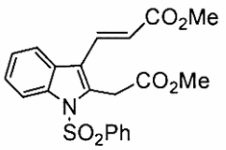
As a model study, bromo compound **1a** was carbonylated using 5% $Pd(PPh_3)_2Cl_2$ catalyst in the CO atmosphere (balloon) using K_2CO_3 as base, in dry THF, in the presence of methanol at RT. The usual work-up followed by column chromatographic purification afforded methyl ester **2a** in 62% yield (**Scheme I**).

The carbonylation reaction was tested with a variety of bromomethylindoles **1a**-**m** and the results are presented in **Table I**. The bromo compound **1a**



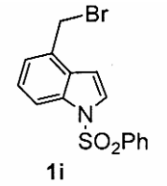
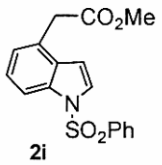
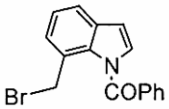
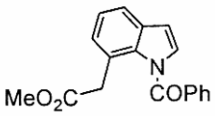
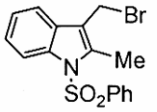
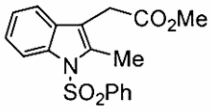
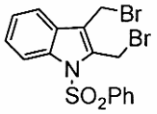
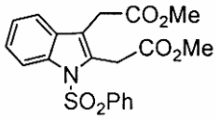
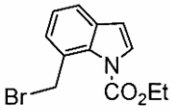
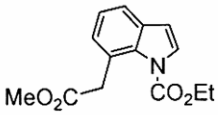
Scheme I

Table I — One-pot procedure for preparation of indolylmethyl esters *via* Stille carbonylation

Bromo compounds[17]	Esters	Yield (%)[a]
 **1a**	 **2a**	62
 **1a**	 **2a'**	61
 **1b**	 **2b**	58
 **1c**	 **2c**	58
 **1d**	 **2d**	47
 **1e**	 **2e**	50
 **1f**	 **2f**	42
 **1g**	 **2g**	45
 **1h**	 **2h**	45

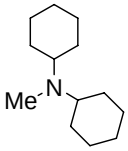
—Contd

Table I — One-pot procedure for preparation of indolylmethyl esters *via* Stille carbonylation — *Contd*

Bromo compounds[17]	Esters	Yield (%)[a]
 **1i**	 **2i**	77
 **1j**	 **2j**	52
 **1k**	 **2k**	58
 **1l**	 **2l**	58
 **1m**	 **2m**	48

[a] Isolated yield after column chromatography

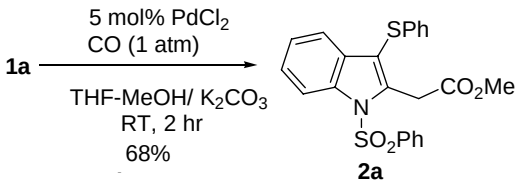
Table II —Yield of **2a** with different bases

Base	Solvent	Yield of **2a** (%)
Li_2CO_3	THF-MeOH	30
K_2CO_3	MeCN-MeOH	mixture of products
K_2CO_3	DMF-MeOH	mixture of products
K_3PO_4	THF-MeOH	45
K_2CO_3	THF-MeOH	62
	THF-MeOH	30

was also converted into the corresponding ethylester **2a′** (entry 2) without any appreciable change in their yield. During the carbonylation of bromomethylindole **1b** (entry 3), indole-3-bromide also underwent simultaneous carbonylation to afford ester **2b**. The bis(bromomethyl)indole **1l** afforded corresponding bisester **2l** (entry 13) in a reasonable yield. The carbonylation of bromomethylindoles **1f-h** containing vinyl ester led to the respective products in slightly diminished yields (entry 7-9). The relatively unexplored bromomethylindoles **1i** and **1j** were also carbonylated to afford the corresponding esters **2i** and **2j** in 77 and 52% yield, respectively.

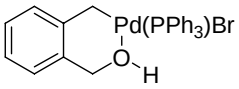
Different types of bases, solvents employed and the respective yields obtained for carbonylation of bromomethylindole **1a** using 5 mol% of $Pd(PPh_3)_2Cl_2$ are presented in **Table II**. It is clear that other than K_2CO_3/THF-MeOH condition, in most other cases, either yield of **2a** was poor or carbonylation led to the mixture of products. Carbonylation of **1a** using solvent systems such as MeCN-MeOH or DMF-MeOH was found to be sluggish. Other base such as Li_2CO_3 or K_3PO_4 also didn't enhance the yield of the product.

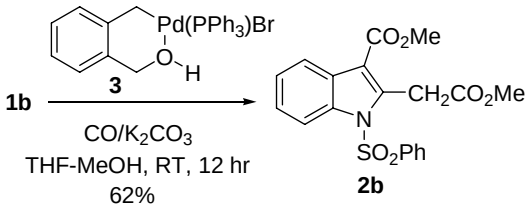
The carbonylation of **1a** using 5 mol% of $PdCl_2$ under carbon monoxide atmosphere in THF-MeOH



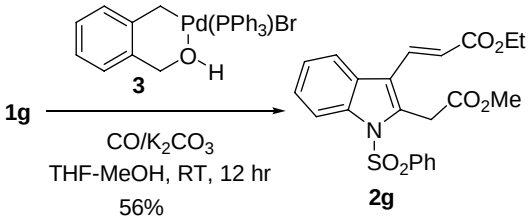
Scheme II

Table III —Yield of **2a** with different catalysts

Pd catalyst	Yield of Product **2a** (%)
$PdCl_2(PPh_3)_2$	62
$PdCl_2$(dppf)	50
$Pd(PPh_3)_4$	45
$Pd(OAc)_2.2PPh_3$	42
$PdCl_2$(dpephos)	53
$PdCl_2$	68
	57



Scheme III

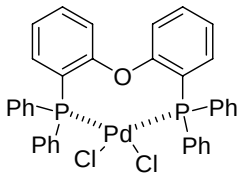
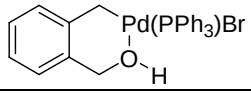


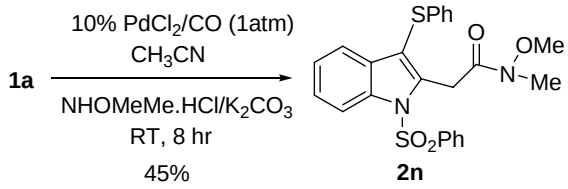
Scheme IV

led to the isolation of expected product **2a** in 68% yield (**Scheme II**).

The yield of the ester **2a** obtained using various types of 5 mol% Pd catalysts for carbonylation of **1a** in the presence of K_2CO_3 in dry THF-MeOH condition is outlined in **Table III**.

Table IV —Yield of **2e** with different catalysts

Pd catalyst	Yield of **2e** (%)
$PdCl_2$(dppf)	48
	52
	56



Scheme V

1-Phenylsulfonyl-3-bromo-2-bromomethylindole **1b** in the presence of 5 mol% of Pd complex **3** (Ref 13) underwent simultaneous carbonylation of indole-3-position and indolyl-2-methyl position to afford the expected product **2b** in 62% yield (**Scheme III**).

Stille carbonylation of bromo compound **1g** using Pd-complex **3** led to the isolation of product **2g** in 56% yield (**Scheme IV**).

Similarly, Stille carbonylation of bromo compound **1e** was studied using three different types of Pd catalysts in THF-MeOH to afford the methyl ester **2e**, **Table IV**.

Finally, the indolylmethyl Weinreb amide **2n** was also prepared using Stille carbonylation reaction of 1-phenylsulfonyl-3-phenylthio-2-bromomethylindole **1a** in the presence of HN(OMe)Me using 10 mol% palladium catalyst (**Scheme V**).

Experimental Section

All melting points are uncorrected. IR spectra were recorded on a Shimadzu 8300 FT-IR spectrometer. ^1H and ^{13}C NMR spectra were recorded in $CDCl_3$ using TMS as an internal standard on a Jeol 400 spectrometer and Bruker 300 spectrometer. Mass spectra were recorded on a Jeol DX 303 HF spectrometer. Elemental analysis was performed on a Perkin-Elmer 240 B instrument.

Representative procedure for carbonylation

A two necked flask containing bromo compound **1a** (0.5 g, 1.09 mmole), $PdCl_2(PPh_3)_2$ (40 mg, 0.06 mmole) and K_2CO_3 (0.16 g, 1.16 mmole) was evacuated. To this dry THF (30 mL) and MeOH (5 mL) were added *via* syringe. The reaction-mixture was then purged with dry carbon monoxide gas for 5 min, and then stirred under a carbon monoxide atmosphere (balloon) at RT for 10 hr. After completion of the reaction (monitored by TLC), it was diluted with water (50 mL) and extracted with ethyl acetate (2 × 20 mL). The combined extract was washed with water (10 mL) and dried (anhyd. Na_2SO_4). Removal of solvent followed by column chromatographic purification (silica gel, EtOAc-hexane 1:5) afforded **2a** as a colourless solid.

1-Phenylsulfonyl methyl 2-(3-phenylthio)-1*H*-indol-2-yl)acetate, 2a

Yield: (0.42 g, 62%); colourless solid; m.p. 114-16ºC; IR (KBr): 1740, 1365, 1172 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 3.58 (s, 3 H), 4.30 (s, 2 H), 6.98-7.03 (m, 3 H), 7.06-7.15 (m, 3 H), 7.24 (t, *J* = 7.36 Hz, 1 H), 7.37-7.40 (m, 3 H), 7.50 (t, *J* = 6.3 Hz, 1H), 7.80 (t, *J* = 8.3 Hz, 2 H), 7.98 (d, *J* = 8.3 Hz, 1 H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 33.0, 52.3, 114.5, 120.2, 124.2, 125.6, 125.7, 126.8, 126.9, 128.9, 129.4, 130.1, 134.1, 135.8, 136.3, 138.2, 138.7, 169.7; MS (EI): *m/z* (%) 437 (M^+, 28), 378 (42), 237 (100). Anal. Calcd for $C_{23}H_{19}NO_4S_2$: C, 63.14; H, 4.38; N, 3.20; S, 14.66. Found: C, 63.08; H, 4.52; N, 3.17; S, 14.53%.

1-Phenylsulfonyl ethyl 2-(3-phenylthio)-1*H*-indol-2-yl)acetate, 2a'

Yield: (0.29 g, 61%); colourless solid; m.p. 90ºC; IR (KBr): 1740, 1365, 1172 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$): δ 1.22 (t, *J* = 6.9 Hz, 3H), 4.14 (q, *J* = 6.9 Hz, 2H), 4.36 (s, 2H), 7.05-7.09 (m, 3H), 7.15 (t, *J* = 7.5 Hz, 2H), 7.19 (t, *J* = 6.9 Hz, 1H), 7.29-7.32 (m, 1H), 7.43-7.47 (m, 3H), 7.57 (t, *J* = 7.5 Hz, 1H), 7.88 (d, *J* = 7.5 Hz, 2H), 8.02 (d, *J* = 8.0 Hz, 1H); ^{13}C NMR (125.8 MHz, $CDCl_3$): δ 14.2, 33.4, 61.4, 105.4, 113.6, 114.5, 126.9, 127.0, 127.1, 129.0, 129.2 129.5, 130.2, 130.3, 138.5, 138.6, 138.8, 169.5. Anal. Calcd for $C_{24}H_{21}NO_4S_2$: C, 63.84; H, 4.69; N, 3.10; S, 14.20. Found: C, 63.68; H, 4.86; N, 3.24; S, 14.03%.

1-Phenylsulfonyl methyl 2-((methoxycarbonyl)-methyl)-1*H*-indole-3-caboxylate, 2b

Yield: (0.28 g, 58%); colourless solid; m.p. 122-24ºC; IR (KBr): 1739, 1712, 1384, 1195 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 3.71 (s, 3H), 3.93 (s, 3 H), 4.74 (s, 2 H), 7.30-7.33 (m, 2 H), 7.45 (t, *J* = 7.9 Hz, 2 H), 7.53-7.55 (t, *J* = 7.3 Hz, 1 H), 7.89 (d, *J* = 7.4 Hz, 2 H), 8.02-8.09 (m, 2 H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 32.87, 51.62, 52.29, 113.42, 114.05, 122.15, 124.42, 125.35, 126.83, 129.37, 134.06, 138.43, 140.49, 164.84, 169.77; MS (EI): *m/z* (%) 388 (M^++1, 40), 329 (23). Anal. Calcd for $C_{19}H_{17}NO_6S$: C, 58.91; H, 4.42; N, 3.62; S, 8.28. Found: C, 59.11; H, 4.57; N, 3.58; S, 8.32%.

1-Phenylsulfonyl methyl 2-(3-methyl-1*H*-indol-2-yl)acetate, 2c

Yield: (0.31 g, 58%); colourless solid; m.p. 120-22ºC; IR (KBr): 1739, 1365, 1173 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 2.11 (s, 3H), 3.63 (s, 3H), 4.00 (s, 2H), 7.15-7.23 (m, 3H), 7.30-7.37 (m, 2H), 7.42 (t, *J* = 7.4 Hz, 1H), 7.70 (d, *J* = 7.3 Hz, 2H), 7.95 (d, *J* = 7.3 Hz, 1H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 9.2, 33.8, 52.4, 114.3, 120.6, 122.4, 124.6, 125.1, 126.4, 128.2, 129.1, 129.6, 133.4, 139.0, 140.1, 170.1. Anal. Calcd for $C_{18}H_{17}NO_4S$: C, 62.96; H, 4.99; N, 4.08; S, 9.34. Found: C, 62.79; H, 4.81; N, 4.24; S, 9.19%.

1-Phenylsulfonyl methyl 2-(3-cyano-1*H*-indol-2-yl)acetate, 2d

Yield: (0.22 g, 47%); colourless solid; m.p. 96ºC; IR (KBr): 2214, 1740, 1361, 1184 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 3.49 (s, 3H), 4.75 (s, 2H), 7.23-7.41 (m, 7H), 7.70 (d, *J* = 8.1 Hz, 2H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 30.8, 58.8, 65.9, 96.1, 111.7, 112.3, 112.8, 113.6, 117.5, 119.5, 122.2, 124.1, 170.2; MS (EI): *m/z* (%) 355 [M^++1]. Anal. Calcd for $C_{18}H_{14}N_2O_4S$: C, 61.01; H, 3.98; N, 7.90; S, 9.05. Found: C, 60.83; H, 3.79; N, 7.63; S, 9.26%.

1-Phenylsulfonyl ethyl 2-((methoxycarbonyl)methyl)-5-methoxy-1*H*-indole-3-carboxylate, 2e

Yield**:** (0.24 g, 50%); colourless solid; m.p. 118ºC; IR (KBr): 1740, 1707, 1375, 1175 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 1.43 (t, *J* = 13.6 Hz, 3H), 3.71 (s, 3H), 3.85 (s, 3H), 4.39 (q, *J* = 7.1 Hz, 2H), 4.69 (s, 2H), 6.92-6.95 (m, 1H), 7.45 (t, *J* = 8.0 Hz, 2H), 7.55-7.59 (m, 2H), 7.87 (d, *J* = 5.5 Hz, 2H), 7.93 (d, *J* = 6.9 Hz, 1H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 14.3, 33.1, 52.3, 55.6, 60.7, 104.4, 114.5, 115.1, 119.4, 121.6, 123.5, 126.8, 129.4, 134.2, 138.7, 141.0, 165.1, 169.6; MS (EI): *m/z* (%) 432 [M^++1, 45]. Anal. Calcd for $C_{21}H_{21}NO_7S$: C, 58.46; H, 4.91; N, 3.25; S, 7.43. Found: C, 58.61; H, 4.79; N, 3.07; S, 7.16%.

1-Phenylsulfonyl methyl 3-(3-((methoxycarbonyl)-methyl)-1*H*-indol-2-yl)acrylate, 2f

Yield: (0.20 g, 42%); colourless solid; m.p. 150ºC; ^{1}H NMR (300 MHz, $CDCl_3$): δ 3.65 (s, 3H), 3.72 (s, 2H), 3.87 (s, 3H), 6.38 (d, *J* = 15.6 Hz, 1H), 7.29 (t, *J* = 7.3 Hz, 2H), 7.38 (q, *J* = 7.8 Hz, 3H), 7.50 (t, *J* = 8.3 Hz, 1H), 7.70 (d, *J* = 7.3 Hz, 2H), 8.15-8.21 (m, 2H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 32.2, 51.4, 52.7, 114.3, 118.7, 120.7, 121.1, 124.4, 125.7, 126.3, 127.1, 129.7, 134.5, 134.8, 136.3, 138.3, 167.9, 169.3. Anal. Calcd for $C_{21}H_{19}NO_6S$: C, 61.01; H, 4.63; N, 3.39; S, 7.76. Found: C, 61.20; H, 4.48; N, 3.52; S, 7.97%.

1-Phenylsulfonyl ethyl 3-(2-((methoxycarbonyl)-methyl)-1*H*-indol-3-yl)acrylate, 2g

Yield: (0.21 g, 45%); colourless solid; m.p. 142ºC; IR (KBr): 1743, 1712, 1369, 1172 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 1.32 (t, *J* = 7.36 Hz, 3 H), 3.72 (s, 3 H), 4.23-4.28 (m, 4 H), 6.52 (d, *J* = 16.1 Hz, 1 H), 7.29-7.33 (m, 3 H), 7.41-7.44 (m, 2 H), 7.53 (t, *J* = 7.8 Hz, 1H), 7.74 (d, *J* = 16.1 Hz, 1 H), 7.77-7.79 (m, 1 H), 7.83 (d, *J* = 7.3 Hz, 1 H), 8.02 (d, *J* = 6.8 Hz, 1 H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 14.3, 32.4, 52.5, 60.7, 114.6, 118.6, 120.3, 120.6, 124.3, 125.5, 126.8, 127.2, 129.3, 134.1, 134.5, 134.7, 136.4, 138.7, 166.9, 169.5; MS (EI): *m/z* (%) 427 (M^+, 13), 286 (77), 182 (36), 154 (95). Anal. Calcd for $C_{22}H_{21}NO_6S$: C, 61.81; H, 4.95; N, 3.28; S, 7.50. Found: C, 61.73; H, 5.02; N, 3.22; S, 7.58%.

1-Phenylsulfonyl methyl 3-(2-((methoxycarbonyl)-methyl)-1*H*-indol-3-yl)acrylate, 2h

Yield: (0.21 g, 45%); colourless solid; m.p. 150ºC; ^{1}H NMR (300 MHz, $CDCl_3$): δ 3.67 (s, 3H), 3.76 (s, 3H), 4.19 (s, 2H), 6.47 (d, *J* = 15.9 Hz, 1H), 7.26 (t, *J* = 3.9 Hz, 2H), 7.38 (t, *J* = 7.8 Hz, 2H), 7.49 (t, *J* = 7.2 Hz, 1H), 7.68-7.73 (m, 2H), 7.79 (d, *J* = 7.5 Hz, 2H), 7.98 (d, *J* = 9.0 Hz, 1H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 32.4, 51.8, 52.5, 114.6, 118.5, 120.1, 120.3, 124.4, 125.5, 126.8, 127.1, 129.4, 134.2, 134.8, 136.4, 138.7, 167.4, 169.5. Anal. Calcd for $C_{21}H_{19}NO_6S$: C, 61.01; H, 4.63; N, 3.39; S, 7.76. Found: C, 61.18; H, 4.42; N, 3.56; S, 7.60%.

1-Phenylsulfonyl methyl 2-(1*H*-indol-4-yl)acetate, 2i

Yield: (0.36 g, 77%); colourless solid; m.p. 88ºC; IR (KBr): 1724, 1361, 1184 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.63 (s, 3H), 3.83 (s, 2H), 6.74 (d, *J* = 2.9 Hz, 1H), 7.12 (d, *J* = 7.3 Hz, 1H), 7.24 (t, *J* = 7.3 Hz, 1H), 7.42 (t, *J* = 8.3 Hz, 2H), 7.54 (t, *J* = 7.3 Hz, 1H), 7.60 (d, *J* = 3.9 Hz, 1H), 7.82 (d, *J* = 8.3 Hz, 2H), 7.93 (d, *J* = 8.3 Hz, 1H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 38.7, 52.1, 107.3, 112.6, 124.4, 124.8, 126.3, 126.8, 126.9, 129.3, 130.4, 133.9, 134.8, 138.2, 171.5. Anal. Calcd for $C_{17}H_{15}NO_4S$: C, 61.99; H, 4.59; N, 4.25; S, 9.74. Found: C, 62.15; H, 4.33; N, 4.49; S, 9.97%.

1-Benzoyl methyl 2-(1*H*-indol-7-yl)acetate, 2j

Yield: (0.24 g, 52%); colourless solid; m.p. 88-90ºC; IR (KBr): 1739, 1698 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.68 (s, 3H), 4.31 (s, 2H), 6.62 (d, *J* = 6.8 Hz, 1H), 7.12 (d, *J* = 7.2 Hz, 1H), 7.16-7.24 (m, 3H), 7.26 (d, *J* = 7.3 Hz, 1H), 7.30-7.41 (m, 2H), 7.48 (d, *J* = 7.7 Hz, 1H), 7.52-7.56 (m, 1H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 32.5, 53.1, 114.3, 119.0, 123.3, 124.2, 128.6, 128.8, 128.9, 129.8, 129.9, 133.4, 134.9, 169.1, 169.9. Anal. Calcd for $C_{18}H_{15}NO_3$: C, 73.71; H, 5.15; N, 4.78. Found: C, 73.58; H, 5.32; N, 4.59%.

1-Phenylsulfonyl methyl 2-(2-methyl-1*H*-indol-3-yl)acetate, 2k

Yield: (0.31 g, 58%); colourless solid; m.p. 70ºC; IR (KBr): 1739, 1365, 1173 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.14 (s, 3H), 3.67 (s, 3H), 4.12 (s, 2H), 7.25-7.29 (m, 2H), 7.41(d, *J* = 7.6 Hz, 2H), 7.52 (t, *J* = 7.1 Hz, 2H), 7.75-7.78 (m, 2H), 8.19 (d, *J* = 7.6 Hz, 1H). Anal. Calcd for $C_{18}H_{17}NO_4S$: C, 62.96; H, 4.99; N, 4.08; S, 9.34. Found: C, 62.72; H, 4.84; N, 4.21; S, 9.18%.

1-Phenylsulfonyl dimethyl 2,2′-(1*H*-indole-2,3-diyl)diacetate, 2l

Yield: (0.26 g, 58%); colourless solid; m.p. 138ºC; IR (KBr): 1726, 1707, 1365, 1170 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$): δ 3.82 (s, 3H), 3.95 (s, 3H), 4.21 (s, 2H), 4.46 (s, 2H), 7.46-7.54 (m, 5H), 7.57-7.63 (m, 2H), 7.79 (d, *J* = 6.2 Hz, 2H). Anal. Calcd for $C_{20}H_{19}NO_6S$: C, 59.84; H, 4.77; N, 3.49; S, 7.99. Found: C, 59.68; H, 4.94; N, 3.31; S, 7.76%.

Ethyl 7-[(methoxycarbonyl)methyl]-1*H*-indole-1-carboxylate, 2m

Yield: (0.22 g, 48%); thick liquid; IR (KBr): 1736, 1718 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 1.42 (t, *J* = 6.8 Hz, 3H), 3.73 (s, 3H), 4.29 (s, 2H), 4.44 (q, *J* = 7.3 Hz, 2H), 6.62 (d, *J* = 3.9 Hz, 1H), 7.13 (d, *J* = 7.3 Hz, 1H), 7.26 (t, *J* = 7.3 Hz, 1H), 7.54 (d, *J* = 7.8 Hz, 1H), 7.63 (d, *J* = 3.9 Hz, 1H); MS (EI): *m/z* (%) 262 (M^++1, 26).

3-Phenylthio-2-[(*N*-methoxy-*N*-methylcarbamoyl)-methyl]-1-(phenylsulfonyl)-1*H*-indole, 2n

CO gas was bubbled through the stirred solution of 1-phenylsulfonyl-3-phenylthio-2-bromomethylindole **1a** (0.3 g, 0.67 mmole) in CH_3CN (10 mL). To this $PdCl_2$ (20 mg, 0.11 mmole) and an *in situ* prepared HN(OMe)Me solution in CH_3CN [Prepared using HCl.HN(OMe)Me (80 mg, 0.82 mmole), K_2CO_3 (0.23 g, 1.65 mmole) in CH_3CN (10 mL) and H_2O (2 drops)] was added. The reaction-mixture was then stirred under CO atmosphere (balloon) for 8 hr. Removal of solvent followed by column chromatographic purification (silica gel; hexane-EA; 7:3) afforded **2n** as a thick pale yellow liquid. Yield: 0.24 g (45%); IR (KBr): 1182, 1375, 1668 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 3.14 (s, 3H), 3.74 (s, 3H), 4.48 (s, 2H), 6.97-7.17 (m, 7H), 7.28-7.47 (m, 4H), 7.76 (d, *J* = 8.1 Hz, 1H), 7.91 (d, *J* = 7.2 Hz, 2H); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ 14.1, 31.6, 61.2, 113.6, 114.2, 120.1, 123.9, 125.1, 125.5, 126.9, 127.3, 128.9, 129.2, 130.1, 133.9, 136.1, 138.7, 139.8, 170.2. Anal. Calcd for $C_{24}H_{22}N_2O_4S_2$: C, 61.78; H, 4.75; N, 6.00. Found: C, 61.41; H, 4.92; N, 6.28%.

Conclusion

In conclusion, the carbonylation of *N*-protected bromomethylindoles are studied in detailed manner using Pd(0) and Pd(II) catalysts. The carbonylation reaction has also been explored using different types of bases and solvents. Among the various conditions employed, carbonylation of bromomethylindoles using an organopalladium complex **3** derived from 2-(bromomethyl)benzenemethanol led to the isolation of the carbonylation products in better yields. The resulting carbonylation products, indolylmethyl acetates **2a-m** and **2n** may find use as bidentate intermediates for the synthesis of substituted carbazole alkaloids.

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17 The required bromo indoles **1a-m** are prepared *via* the allylic bromination of the corresponding methylindoles using NBS in the presence of catalytic amount of benzoyl peroxide in dry CCl_4 under refluxing condition[9].