Palladium-Catalyzed Internal Nucleophile–Assisted Hydration–Olefin Insertion Cascade: Diastereoselective Synthesis of 2,3-Dihydro-1H-inden-1-ones

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1. General Information

Commercially available reagents were used without further purification and the reaction solvents (THF, MeCN, DCM etc) were purified using standard procedures. All the reactions were performed in oven-dried glassware under N₂ atmosphere. The reactions were monitored by TLC using Merck silica gel 60 F254 and visualized by UV detection or using β-anisaldehyde stain or molecular iodine. Flash column chromatography was performed using 230-400 mesh silica. The melting points were recorded in capillaries and are uncorrected. ¹H and ¹³C NMR spectra were recorded in CDCl₃ at room temperature on a Brucker Avance 300 Spectrometer at 300 MHz for ¹H and 75 MHz for ¹³C. Chemical shifts (δ) are quoted in ppm using TMS as internal standard and coupling constants (J) are given in Hz. Infrared (IR) spectra were obtained in an Agilent Cary630 FTIR spectrometer with a diamond ATR accessory for solid and liquid samples, requiring no sample preparation and the major frequencies were reported in cm⁻¹. Elemental analyses were determined at the CAI de Microanálisis Elemental, Universidad Complutense, by using a Leco 932 CHNS combustion microanalyzer.

2. General procedure for the synthesis of compounds S3

2.1. Synthesis of compound S3a-h

To a solution of methyl ketone (5 mmol) in EtOH (18 mL) was added NaOH (7.5 mmol, in 1 mL H₂O) at 0 °C. The mixture was stirred at 0 °C for 5 min then aldehyde (5.5 mmol) was added and stirring was continued at 10 °C for 4-5 h. After completion of the reaction, as indicated by TLC, the reaction mixture was poured into ice water and then acidified with 1.5 N HCl. The aqueous suspension was extracted with CH₂Cl₂ (2 x 30 mL), washed with water and brine solution. The organic layer was dried over anhyd. Na₂SO₄ and concentrated under reduced pressure. The crude product was purified by flash column chromatography using petroleum ether and ethyl acetate mixture as eluent (98:2, v/v).

(E)-3-(2-Iodophenyl)-1-phenylprop-2-en-1-one (S3a):

Pale yellow viscous liquid; yield: 1.525 g, 95%; IR (neat) 3056, 3013, 1660, 1601, 1458, 1309, 1263, 1210, 1010 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ 7.11 (td, J = 7.8, 1.5 Hz, 1H), 7.36 (d, J = 15.6 Hz, 1H), 7.42 (t, J = 7.8 Hz, 1H), 7.51-7.56 (m, 2H), 7.60-7.65 (m, 1H), 7.71 (dd, J = 7.8, 1.5 Hz, 1H), 7.94-8.06 (m, 4H); ¹³C NMR (75 MHz, CDCl₃)*: δ 101.9, 125.2, 127.5, 128.6, 128.7, 131.4, 133.0, 137.8, 138.3, 140.1, 147.9, 190.3; Anal Caled for C₁₅H₁₁IO: C, 53.92; H, 3.32. Found: C, 54.21; H, 3.58.*One aromatic carbon is merged with others.

(E)-3-(2-Iodophenyl)-1-(4-methoxyphenyl)prop-2-en-1-one (S3b):

White solid; mp 96-97 °C; yield: 1.729 g, 95%; IR (neat) 3056, 2932, 2840, 1651, 1590, 1506, 1454, 1310, 1256, 1175, 1007 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ 3.90 (s, 3H), 6.94-7.56 (m, 5H), 7.94-8.06 (m, 4H); ¹³C NMR (75 MHz, CDCl₃)*: δ 100.4, 125.2, 127.5, 128.6, 128.7, 131.4, 133.0, 137.8, 138.3, 140.1, 147.9, 190.3; Anal Caled for C₁₅H₁₁IO: C, 53.92; H, 3.32. Found: C, 54.21; H, 3.58.*One aromatic carbon is merged with others.

S2
(d, J = 8.7 Hz, 2H), 7.08 (t, J = 7.5 Hz, 1H), 7.35 (d, J = 15.3 Hz, 1H), 7.41 (d, J = 7.8 Hz, 1H), 7.69 (d, J = 7.8 Hz, 1H) 7.93 (d, J = 7.5 Hz, 1H), 7.96 (d, J = 15.3 Hz, 1H), 8.05 (d, J = 8.7 Hz, 2H); 13C NMR (75 MHz, CDCl3): δ 55.5, 101.7, 113.9, 125.2, 127.5, 128.6, 130.7, 131.0, 131.2, 138.6, 140.1, 147.1, 163.6, 188.6; Anal Calcd for C16H13IO2: C, 52.77; H, 3.60. Found: C, 52.97; H, 3.75.

(E)-1-(3,4-Dimethoxyphenyl)-3-(2-iodo-5-methoxyphenyl)prop-2-en-1-one (S3c):

Yellow solid; mp 59-60 °C; yield: 1.76 g, 83%; IR (neat) 3004, 2933, 2835, 1654, 1580, 1512, 1460, 1416, 1262, 1162, 1022 cm⁻¹; 1H NMR (300 MHz, CDCl3) δ 3.86 (s, 3H), 3.98 (s, 6H), 6.71 (dd, J = 8.7, 3.0 Hz, 1H), 6.94 (d, J = 8.4 Hz, 1H), 7.22 (d, J = 3.0 Hz, 1H), 7.31 (d, J = 15.3 Hz, 1H), 7.62 (d, J = 1.8 Hz, 1H) 7.68 (dd, J = 8.1, 1.8 Hz, 1H), 7.79 (d, J = 8.7 Hz, 1H), 8.00 (d, J = 15.3 Hz, 1H); 13C NMR (75 MHz, CDCl3): δ 55.5, 56.0, 56.1, 90.4, 110.0, 110.8, 113.2, 117.5, 123.4, 125.1, 130.8, 139.2, 140.4, 146.9, 149.2, 153.4, 160.0, 188.5; Anal Calcd for C18H17O4: C, 50.96; H, 4.04. Found: C, 50.66; H, 3.99.

(E)-3-(2-Iodo-5-methoxyphenyl)-1-phenylprop-2-en-1-one (S3d):

White solid; mp 71-72 °C; yield: 1.639 g, 90%; IR (neat) 3078, 2930, 1660, 1593, 1554, 1460, 1409, 1312, 1285, 1226, 1050, 1016 cm⁻¹; 1H NMR (300 MHz, CDCl3) δ 3.85 (s, 3H), 6.72 (dd, J = 8.7, 3.0 Hz, 1H), 7.22 (d, J = 3.0 Hz, 1H), 7.31 (d, J = 15.6 Hz, 1H), 7.49-7.54 (m, 2H), 7.58-7.63 (m, 1H) 7.78 (d, J = 8.7 Hz, 1H), 7.92 (d, J = 15.6 Hz, 1H), 8.01-8.04 (m, 2H); 13C NMR (75 MHz, CDCl3): δ 55.6, 90.5, 113.1, 117.8, 125.5, 128.6, 128.7, 133.0, 137.8, 139.1, 140.5, 147.9, 160.0, 190.6; Anal Calcd for C16H13IO2: C, 52.77; H, 3.60. Found: C, 52.41; H, 3.71.

(E)-1-(2,4-Dichlorophenyl)-3-(2-iodo-5-methoxyphenyl)prop-2-en-1-one (S3e):

White solid; mp 89-90 °C; yield: 1.776 g, 82%; IR (neat) 3065, 2880, 1655, 1587, 1446, 1332, 1277, 1046, 1018 cm⁻¹; 1H NMR (300 MHz, CDCl3) δ 3.83 (s, 3H), 6.72 (dd, J = 8.7, 3.0 Hz, 1H), 6.93 (d, J = 15.9 Hz, 1H), 7.17 (d, J = 3.0 Hz, 1H), 7.37 (dd, J = 8.1, 2.1 Hz, 1H), 7.47 (d, J = 8.4 Hz, 1H), 7.51 (d, J = 2.1 Hz, 1H), 7.63 (d, J = 15.9 Hz, 1H), 7.76 (d, J = 8.7 Hz, 1H); 13C NMR (75 MHz, CDCl3): δ 55.6, 90.8, 112.9, 118.5, 127.3, 128.5, 130.3, 130.6, 132.5, 137.0, 137.1, 138.2, 140.6, 149.9, 160.1, 192.4; Anal Calcd for C16H13Cl2IO4: C, 44.38; H, 2.56. Found: C, 44.02; H, 2.47.

(E)-3-(2-Iodo-5-methoxyphenyl)-1-(naphthalen-2-yl)prop-2-en-1-one (S3f):

White solid; mp 101-102 °C; yield: 1.719 g, 83%; IR (neat) 3053, 2930, 2827, 1610, 1457, 1293, 1225, 1188, 1127, 1042 cm⁻¹; 1H NMR (300 MHz, CDCl3) δ 3.88 (s, 3H), 6.73 (dd, J = 8.7, 3.0 Hz, 1H), 7.28 (d, J = 2.7 Hz, 1H), 7.44 (d, J = 15.6 Hz, 1H), 7.58-7.65 (m, 2H), 7.80 (d, J = 8.7 Hz, 1H) 7.90-8.02 (m, 4H), 8.10 (dd, J = 8.7, 1.5 Hz, 1H), 8.56 (s, 1H); 13C NMR (75 MHz, CDCl3): δ 55.6, 90.5, 113.2, 117.7, 124.6, 125.6, 126.9, 127.9, 128.5, 128.7, 129.6, 130.4, 132.5, 135.1, 135.6, 139.2, 140.5, 147.8, 160.1, 190.3; Anal Calcd for C20H15IO2: C, 57.99; H, 3.65. Found: C, 57.68; H, 3.70.
(E)-1-(Furan-2-yl)-3-(2-iodo-5-methoxyphenyl)prop-2-en-1-one (S3g):
White solid; mp 133-134 °C; yield: 1.753 g, 99%; IR (neat) 3108, 2151, 1656, 1596, 1564, 1461, 1289, 1244, 1225, 1050 cm⁻¹; H NMR (300 MHz, CDCl₃) δ 3.86 (s, 3H), 6.61 (dd, J = 3.6, 15 Hz, 1H), 6.71 (dd, J = 8.7, 3.0 Hz, 1H), 7.23 (d, J = 3.6 Hz, 1H), 7.26 (d, J = 15.6 Hz, 1H), 7.36 (d, J = 3.6 Hz, 1H) 7.66-7.69 (m, 1H), 7.79 (d, J = 8.7 Hz, 1H), 8.02 (d, J = 15.6 Hz, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 55.6, 90.6, 112.7, 113.1, 117.8, 118.0, 124.4, 138.9, 140.6, 146.7, 146.9, 153.4, 160.0, 177.6; Anal Calcd for C₁₄H₁₁IO₃: C, 47.48; H, 3.13. Found: C, 47.22; H, 3.24.

(E)-1-(2-Iodo-5-methoxyphenyl)hex-1-en-3-one (S3h):
Colourless liquid; yield: 0.99 g, 60%; IR (neat) 3145, 1662, 1448, 1332, 1281, 1218 cm⁻¹; H NMR (300 MHz, CDCl₃) δ 1.00 (t, J = 7.2 Hz, 3H), 1.74 (sextet, J = 7.2 Hz, 2H), 2.71 (t, J = 7.2 Hz, 2H), 3.82 (s, 3H), 6.54 (d, J = 16.2 Hz, 1H), 6.70 (dd, J = 8.7, 3.0 Hz, 1H), 7.11 (d, J = 3.0 Hz, 1H), 7.71 (d, J = 16.2 Hz, 1H) 7.75 (d, J = 8.7 Hz, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 13.9, 17.8, 42.1, 55.5, 90.4, 112.6, 118.1, 129.4, 138.5, 140.4, 145.7, 160.1, 200.5; Anal Calcd for C₁₃H₁₅IO₂: C, 47.29; H, 4.58. Found: C, 46.95; H, 4.32.

2.2. Synthesis of compound S3i

A mixture of 2-iodobenzaldehyde (2.2 mmol) and Wittig ylide (2.8 mmol) in toluene (10 mL) was heated at 90 °C for 3 h. After cooling, the solvent was evaporated to dryness and the residue was treated with diethyl ether (20 mL). Solidified OPPh₃ was removed by filtration and the filtrate was concentrated. The crude was purified by flash column chromatography eluting with petroleum ether and ethyl acetate mixture to obtain compound S3i (95:5, v/v).

(E)-4-(2-Iodophenyl)but-3-en-2-one (S3i):
White colour solid; mp 55-56 °C; yield: 0.514 g, 86%; IR (neat) 3110, 1656, 1636, 1459, 1432, 1359, 1258, 1203 cm⁻¹; H NMR (300 MHz, CDCl₃) δ 2.44 (s, 3H), 6.55 (d, J = 16.2 Hz, 1H), 7.08 (td, J = 7.5, 1.5 Hz, 1H), 7.38 (t, J = 7.5 Hz, 1H), 7.58 (dd, J = 7.8, 1.5 Hz, 1H), 7.74 (d, J = 16.2 Hz, 1H), 7.92 (dd, J = 7.8, 1.2 Hz, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 27.2, 101.7, 127.4, 128.7, 130.0, 131.5, 137.6, 140.0, 146.8, 198.2; Anal Calcd for C₁₀H₇IO: C, 44.14; H, 3.33. Found: C, 44.46; H, 3.44.

3. General procedure for the synthesis of compounds 5a-i

S4
To a solution of aryl iodide $S_{3a-1}$ (2 mmol) in acetonitrile (5 mL) were added PdCl$_2$ (0.05 mmol), PPh$_3$ (0.1 mmol) and CuI (0.072 mmol) under N$_2$ atmosphere. The mixture was stirred and then $N$-(but-3-yn-1-yl)-4-methylbenzenesulfonamide $S_4$ (3 mmol) followed by Et$_3$N (6 mmol) were added and stirring was continued for 12 h at room temperature. After completion of the reaction, the reaction mixture was filtered through celite, washed with CH$_2$Cl$_2$ (2x20 mL) and concentrated under reduced pressure. The resulting crude was chromatographed using petroleum ether and ethyl acetate eluting mixture (60:40, v/v).

**(E)-4-Methyl-N-(4-(2-(3-oxo-3-phenylprop-1-ynyl)phenyl)but-3-yn-1-yl)benzenesulfonamide (5a):**

Brown solid; mp 109-110 °C, yield: 0.764 g, 89%; IR (neat) 3194, 3115, 2890, 1652, 1589, 1570, 1440, 1320, 1219, 1154, 1080 cm$^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$) δ: 2.39 (s, 3H), 2.68 (t, $J = 6.3$ Hz, 2H), 3.26 (q, $J = 6.3$ Hz, 2H), 5.52 (t, $J = 6.3$ Hz, 1H), 7.28 (d, $J = 8.7$ Hz, 2H), 7.33-7.37 (m, 2H), 7.42-7.45 (m, 1H), 7.49-7.54 (m, 4H), 7.74-7.77 (m, 1H), 7.82 (d, $J = 8.7$ Hz, 2H), 8.02-8.05 (m, 2H), 8.28 (d, $J = 15.9$ Hz, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): δ: 21.5, 42.0, 80.3, 93.3, 123.1, 124.8, 126.1, 127.1, 128.3, 128.6, 128.7, 129.7, 130.1, 132.8, 133.0, 136.2, 137.4, 138.0, 143.1, 143.4, 190.8; Anal Calcd for C$_{26}$H$_{23}$NO$_3$: C, 72.70; H, 5.40; N, 3.26. Found: C, 72.58; H, 5.25; N, 3.30.*Two aliphatic carbons are merged together.

**(E)-N-(4-(2-(3-(4-Methoxyphenyl))-3-oxoprop-1-ynyl)phenyl)but-3-yn-1-yl)-4-methylbenzenesulfonamide (5b):**

Pale red colour solid; mp 124-125 °C, yield: 0.772 g, 84%; IR (neat) 3180, 3086, 2882, 1646, 1603, 1589, 1561, 1330, 1261, 1228, 1181, 1152, 1084 cm$^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$): δ 2.39 (s, 3H), 2.68 (t, $J = 6.3$ Hz, 2H), 3.27 (q, $J = 6.3$ Hz, 2H), 3.90 (s, 3H), 5.70 (t, $J = 6.3$ Hz, 1H), 7.00 (d, $J = 8.7$ Hz, 2H), 7.26-7.36 (m, 4H), 7.41-7.44 (m, 1H), 7.58 (d, $J = 15.6$ Hz, 1H), 7.74-7.77 (m, 1H), 7.83 (d, $J = 8.1$ Hz, 2H), 8.06 (d, $J = 8.7$ Hz, 2H), 8.27 (d, $J = 15.6$ Hz, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): δ: 21.5, 21.6, 42.1, 55.6, 80.3, 93.3, 113.9, 122.8, 124.7, 126.0, 127.1, 128.3, 129.7, 129.8, 130.9, 131.0, 132.6, 136.4, 137.5, 142.3, 143.3, 163.6, 188.9; Anal Calcd for C$_{27}$H$_{23}$NO$_3$: C, 70.57; H, 5.48, N, 3.05. Found: C, 70.25; H, 5.41; N, 3.18.

**(E)-N-(4-(2-(3-(3,4-Dimethoxyphenyl))-3-oxoprop-1-ynyl)-4-methoxyphenyl)but-3-yn-1-yl)-4-methylbenzenesulfonamide (5c):**

White solid; mp 149-150 °C, yield: 0.634 g, 61%; IR (neat) 3170, 3055, 2850, 1650, 1599, 1572, 1490, 1419, 1329, 1256, 1152, 1081 cm$^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$): δ 2.59 (t, $J = 6.3$ Hz, 2H), 3.18 (q, $J = 6.3$ Hz, 2H), 3.81 (s, 3H), 3.90 (s, 3H), 3.91 (s, 3H), 5.45 (t, $J = 6.3$ Hz, 1H), 6.83 (dd, $J = 8.7$, 2.7 Hz, 1H), 6.89 (d, $J = 8.4$ Hz, 2H), 7.16 (d, $J = 2.7$ Hz, 1H), 7.19 (d, $J = 8.4$ Hz, 2H), 7.29 (d, $J = 8.7$ Hz, 1H), 7.48 (d, $J = 15.6$ Hz, 1H) 7.57 (d, $J = 1.8$ Hz, 1H), 7.63 (dd, $J = 8.4$, 2.1 Hz, 1H), 7.75 (d, $J = 8.4$, 2Hz), 8.14 (d, $J = 15.6$ Hz, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): δ: 21.5, 42.1, 55.5, 56.0, 56.1, 80.2, 91.4, 110.1, 110.8, 111.1, 115.9, 117.1, 122.9, 123.4, 127.1, 129.7, 130.1, 133.9, 137.5, 137.8, 142.2, 143.3, 149.2, 153.5, 159.3, 188.8; Anal Calcd for C$_{29}$H$_{29}$NO$_6$: C, 67.03; H, 5.63, N, 2.70. Found: C, 66.71; H, 5.53; N, 2.87.*Two aliphatic carbons are merged together.
(E)-N-(4-(4-Methoxy-2-(3-oxo-3-phenylprop-1-en-1-yl)phenyl)but-3-yn-1-yl)-4-methylbenzenesulfonylamide (5d):

Brown colour solid; mp 94-95 °C, yield: 0.625 g, 68%; IR (neat) 3181, 3065, 2875, 1651, 1598, 1568, 1490, 1319, 1287, 1153, 1082 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 2.39 (s, 3H), 2.65 (t, J = 6.3 Hz, 2H), 3.23 (q, J = 6.3 Hz, 2H), 3.88 (s, 3H), 5.42 (t, J = 6.3 Hz, 1H), 6.91 (dd, J = 8.4, 2.4 Hz, 1H), 7.22 (d, J = 2.4 Hz, 1H), 7.27 (d, J = 8.7 Hz, 2H), 7.37 (d, J = 8.7 Hz, 1H), 7.50-7.63 (m, 4H), 7.82 (d, J = 8.7 Hz, 2H), 8.02 (d, J = 7.5 Hz, 2H), 8.21 (d, J = 15.9 Hz, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 21.4, 21.5, 42.1, 55.5, 80.2, 91.4, 111.0, 116.3, 117.2, 123.3, 127.1, 128.6, 129.7, 132.0, 133.0, 134.1, 137.4, 137.6, 138.0, 143.1, 143.4, 159.4, 190.9; Anal Calcd for C₂₇H₂₅NO₄S: C, 70.57; H, 5.48; N, 3.05. Found: C, 70.18; H, 5.44; N, 3.27.

(E)-N-(4-(2-(3-(2,4-Dichlorophenyl)-3-oxoprop-1-en-1-yl)-4-methoxyphenyl)but-3-yn-1-yl)-4-methylbenzenesulfonyamide (5e):

Red viscous liquid; yield: 0.803 g, 76%; IR (neat) 3266, 3040, 2920, 1651, 1583, 1489, 1323, 1288, 1222, 1099, 1091 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 2.42 (s, 3H), 2.57 (t, J = 6.3 Hz, 2H), 3.15 (q, J = 6.3 Hz, 2H), 3.85 (s, 3H), 5.07 (t, J = 6.3 Hz, 1H), 6.91 (dd, J = 8.7, 2.7 Hz, 1H), 7.12 (d, J = 16.2 Hz, 1H), 7.15 (d, J = 2.1 Hz, 1H), 7.29-7.37 (m, 4H), 7.44-7.47 (m, 2H), 7.80 (d, J = 8.1 Hz, 2H) 7.89 (d, J = 16.2 Hz, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 21.2, 21.5, 41.9, 55.5, 79.8, 91.3, 110.9, 117.0, 117.3, 126.9, 127.1, 127.3, 129.8, 130.1, 130.6, 132.4, 134.2, 136.9, 137.0, 137.2, 137.4, 143.5, 144.7, 159.5, 192.7; Anal Calcd for C₂₇H₂₃Cl₂NO₄S: C, 61.37; H, 4.39; N, 2.65. Found: C, 59.95; H, 4.37; N, 2.67.

(E)-N-(4-(4-Methoxy-2-(3-(naphthalen-2-yl)-3-oxoprop-1-en-1-yl)phenyl)but-3-yn-1-yl)-4-methylbenzenesulfonyamide (5f):

Off white solid; mp 135-136 °C, yield: 0.744 g, 73%; IR (neat) 3264, 1652, 1600, 1491, 1454, 1325, 1227, 1158 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 2.33 (s, 3H), 2.56 (t, J = 6.3 Hz, 2H), 3.14 (q, J = 6.3 Hz, 2H), 3.83 (s, 3H), 5.37 (t, J = 6.3 Hz, 1H), 6.85 (dd, J = 8.7, 2.7 Hz, 1H), 7.18-7.22 (m, 3H), 7.30 (d, J = 8.4 Hz, 1H), 7.48-7.56 (m, 2H), 7.60 (d, J = 15.9 Hz, 1H), 7.74 (d, J = 8.1 Hz, 2H) 7.82-7.94 (m, 3H), 8.03 (dd, J = 8.7, 1.8 Hz, 1H), 8.19 (d, J = 15.9 Hz, 1H), 8.47 (s, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 21.4, 21.5, 42.1, 55.6, 80.2, 91.5, 111.1, 116.2, 117.3, 123.3, 124.5, 126.9, 127.1, 127.9, 128.5, 128.6, 129.6, 129.7, 130.2, 132.5, 134.0, 135.3, 135.5, 137.4, 137.6, 143.1, 143.3, 159.4, 190.5; Anal Calcd for C₃₁H₂₃NO₄S: C, 73.06; H, 5.34; N, 2.75. Found: C, 72.68; H, 5.31; N, 2.92.

(E)-N-(4-(2-(3-(Furan-2-yl)-3-oxoprop-1-en-1-yl)-4-methoxyphenyl)but-3-yn-1-yl)-4-methylbenzenesulfonyamide (5g):

Red gummy solid; yield: 0.629 g, 70%; IR (neat) 3228, 2918, 1672, 1582, 1432, 1355, 1288, 1043 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 2.40 (s, 3H), 2.67 (t, J = 6.6 Hz, 2H), 3.26 (q, J = 6.3 Hz, 2H), 3.88 (s, 3H), 5.48 (t, J = 6.0 Hz, 1H), 6.62 (dd, J = 3.6, 1.8 Hz, 1H), 6.90 (dd, J = 8.4, 2.4 Hz, 1H), 7.22 (d, J = 2.4 Hz, 1H), 7.28 (d, J = 8.7 Hz, 2H), 7.35-7.37 (m, 2H), 7.46 (d, J = 15.9 Hz, 1H), 7.67-7.68 (m, 1H), 7.81 (d, J = 8.4 Hz, 2H), 8.25 (d, J =
15.9 Hz, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): $\delta$ 21.4, 21.5, 42.1, 55.5, 80.1, 91.5, 111.1, 112.8, 116.4, 117.3, 118.0, 122.5, 127.1, 129.7, 134.1, 137.3, 142.2, 143.4, 146.8, 153.6, 159.3, 178.2; Anal Calcd for C$_{23}$H$_{23}$O$_5$N$_3$: C, 66.80; H, 5.16; N, 3.12. Found: C, 66.35; H, 5.07; N, 3.01. One aromatic carbon is merged with others.

$^{(E)}$-N-(4-(4-Methoxy-2-(3-oxohex-1-en-1-yl)phenyl)but-3-yn-1-yl)-4-methylbenzenesulfonyamide (5h):

Red viscous liquid; yield: 0.655 g, 77%; IR (neat) 3265, 2959, 2890, 1653, 1598, 1490, 1323, 1154, 1090 cm$^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ 0.91 (t, $J = 7.5$ Hz, 3H), 1.64 (sextet, $J = 7.5$ Hz, 2H), 2.34 (s, 3H), 3.16 (q, $J = 6.3$ Hz, 2H), 3.88 (s, 3H), 5.24 (t, $J = 6.3$ Hz, 1H), 6.67 (d, $J = 16.2$ Hz, 1H), 6.80 (dd, $J = 8.4$, 2.4 Hz, 1H), 7.03 (d, $J = 2.4$ Hz, 1H), 7.22 (d, $J = 8.4$ Hz, 2H), 7.27 (d, $J = 8.4$ Hz, 1H), 7.73 (d, $J = 8.4$ Hz, 2H) 7.89 (d, $J = 16.2$ Hz, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): $\delta$ 13.7, 17.6, 21.1, 21.3, 41.9, 42.6, 55.2, 79.8, 91.0, 110.2, 116.3, 116.7, 126.8, 127.2, 129.5, 133.9, 136.9, 137.0, 140.3, 143.2, 159.2, 200.9; Anal Calcd for C$_{23}$H$_{27}$NO$_4$: C, 67.74; H, 6.40; N, 3.29. Found: C, 67.41; H, 6.28; N, 3.33.

$^{(E)}$-N-(4-(4-Methoxy-2-(3-oxobut-1-en-1-yl)phenyl)but-3-yn-1-yl)-4-methylbenzenesulfonyamide (5i):

Off-White solid; mp 122-123 °C, yield: 0.691 g, 94%; IR (neat) 3378, 3085, 2884, 1662, 1631, 1591, 1471, 1366, 1322, 1260, 1053 cm$^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ 2.38 (s, 3H), 2.41 (s, 3H), 2.70 (t, $J = 6.3$ Hz, 2H), 3.24 (q, $J = 6.3$ Hz, 2H), 5.21 (t, $J = 6.3$ Hz, 1H), 6.77 (d, $J = 16.5$ Hz, 1H), 7.26-7.34 (m, 4H), 7.41-7.44 (m, 1H), 7.61-7.64 (m, 1H), 7.79 (d, $J = 8.4$ Hz, 2H), 7.96 (d, $J = 16.5$ Hz, 1H); $^{13}$C NMR (75 MHz, CDCl$_3$): $\delta$ 21.3, 21.5, 27.7, 42.0, 80.2, 92.8, 124.4, 126.0, 127.1, 128.2, 128.5, 129.8, 130.0, 133.0, 135.7, 137.1, 141.4, 143.5, 198.9; Anal Calcd for C$_{21}$H$_{21}$NO$_3$: C, 68.64; H, 5.77; N, 5.81. Found: C, 68.28; H, 5.66; N, 3.70.

4. General procedure for the palladium-catalyzed NHTs-assisted cascade: Synthesis of compounds 6a-i

To a stirred solution of alkyne 5 (0.5 mmol) in MeCN (6 mL) and water (2 mmol) was added PdCl$_2$(MeCN)$_2$ (0.05 mmol) under nitrogen atmosphere and stirring was continued for 2 h at 25 °C. After completion of the reaction, as indicated by TLC, the mixture was filtered through a short pad of silica and washed with ethyl acetate. The combined organic layer was dried over anhyd. Na$_2$SO$_4$ and evaporated. The crude mixture was purified through flash column chromatography using petroleum ether-ethyl acetate mixture as eluent (70:30, v/v) to afford 2,3-dihydro-1H-inden-1-ones 6.
(±)-4-Methyl-N-(2-((1-oxo-3-(2-oxo-2-phenylethyl)-2,3-dihydro-1H-inden-2-yl)ethyl)benzenesulfonamide (6a):

Yellow viscous liquid; yield: 0.204 g, 91%; IR (neat) 3267, 2922, 1681, 1597, 1446, 1323, 1214, 1152, 1090 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.87-2.03 (m, 2H), 2.38 (s, 3H), 2.43 (td, J = 6.9, 3.3 Hz, 1H), 3.15-3.23 (m, 2H), 3.29 (dd, J = 18.0, 8.1 Hz, 1H), 3.52 (dd, J = 18.0, 5.4 Hz, 1H), 3.70-3.75 (m, 1H), 5.48 (t, J = 6.3 Hz, 1H), 7.25-7.27 (m, 2H), 7.39-7.52 (m, 4H), 7.58-7.65 (m, 2H), 7.73-7.77 (m, 3H), 7.95-7.98 (m, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 21.5, 31.3, 40.3, 41.7, 44.9, 52.2, 124.0, 125.8, 127.1, 128.1, 128.2, 128.8, 129.7, 133.6, 135.4, 135.7, 136.5, 137.0, 143.2, 156.6, 198.8, 208.0; Anal Calcd for C₂₆H₂₃NO₄S: C, 69.78; H, 5.63; N, 3.13. Found: C, 69.45; H, 5.57; N, 3.06.

(±)-N-(2-((1-(2-(4-Methoxyphenyl)-2-oxoethyl)-3-oxo-2,3-dihydro-1H-inden-2-yl)ethyl)-4-methylbenzenesulfonamide (6b):

Pale brown viscous liquid; yield: 0.225 g, 94%; IR (neat) 3260, 2902, 1688, 1670, 1551, 1438, 1240, 1165, 1078 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.88-1.97 (m, 2H), 2.39 (s, 3H), 2.43 (td, J = 6.9, 3.0 Hz, 1H), 3.17-3.26 (m, 3H), 3.46 (dd, J = 17.7, 5.1 Hz, 1H), 3.68-3.74 (m, 1H), 3.89 (s, 3H), 5.57 (t, J = 6.3 Hz, 1H), 6.95 (d, J = 9.0 Hz, 2H), 7.26 (d, J = 8.1 Hz, 2H), 7.39-7.47 (m, 2H), 7.61 (td, J = 7.5, 1.2 Hz, 1H), 7.73-7.77 (m, 3H), 7.94 (d, J = 9.0 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 21.5, 31.3, 40.4, 41.7, 44.7, 52.5, 55.6, 114.0, 124.1, 125.8, 127.1, 128.1, 129.5, 129.7, 130.5, 135.4, 135.6, 137.1, 143.2, 156.7, 163.9, 197.2, 208.1; Anal Calcd for C₂₇H₂₅NO₅S: C, 67.90; H, 5.70; N, 2.93. Found: C, 67.61; H, 5.53; N, 2.88.

(±)-N-(2-((2-(3,4-Dimethoxyphenyl)-2-oxoethyl)-5-methoxy-1-oxo-2,3-dihydro-1H-inden-2-yl)ethyl)-4-methylbenzenesulfonamide (6c):

Pale brown solid; mp 138-140 °C, yield: 0.261 g, 97%; IR (neat) 3267, 2933, 1692, 1663, 1593, 1512, 1419, 1321, 1258, 1157, 1089 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.77-1.94 (m, 2H), 2.31 (s, 3H), 2.31-2.34 (m 1H), 3.08-3.23 (m, 3H), 3.36 (dd, J = 17.7, 5.4 Hz, 1H), 3.55-3.61 (m, 1H), 3.79 (s, 3H), 3.89 (s, 6H), 5.57 (t, J = 6.3 Hz, 1H), 6.81-6.83 (m, 2H), 6.7 (dd, J = 8.4, 2.1 Hz, 1H), 7.19 (d, J = 8.1 Hz, 2H), 7.47-7.52 (m, 2H), 7.61 (d, J = 8.4 Hz, 1H), 7.68 (d, J = 8.1 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 21.5, 31.5, 35.1, 40.6, 41.8, 44.5, 52.8, 55.7, 56.0, 56.1, 109.3, 110.1, 110.2, 115.8, 123.0, 125.8, 127.1, 128.8, 129.6, 129.7, 131.7, 143.1, 149.1, 153.7, 159.7, 165.8, 197.3, 206.1; Anal Calcd for C₂₉H₃₁NO₅S: C, 64.79; H, 5.81; N, 2.93. Found: C, 64.58; H, 5.89; N, 2.63.

(±)-N-(2-((5-Methoxy-1-oxo-2-phenylethyl)-2,3-dihydro-1H-inden-2-yl)ethyl)-4-methylbenzenesulfonamide (6d):

Pale brown viscous liquid; yield: 0.196 g, 82%; IR (neat) 3258, 2901, 1679, 1579,1442, 1258, 1166, 1081 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.90-1.97 (m, 2H), 2.38 (s, 3H), 2.37-2.39 (m, 1H), 3.15-3.24 (m, 2H), 3.29 (dd, J = 18.0, 3.9 Hz, 1H), 3.48 (dd, J = 18.0, 5.4 Hz, 1H), 3.63-3.68 (m, 1H), 3.86 (s, 3H), 5.63 (t, J = 6.3 Hz, 1H), 6.87 (d, J = 1.8 Hz,
1H), 6.94 (dd, J = 8.7, 2.1 Hz, 1H), 7.25 (d, J = 8.1 Hz, 2H), 7.47-7.52 (m, 2H), 7.61 (tt, J = 6.6, 1.2 Hz, 1H), 7.68 (d, J = 8.4 Hz, 1H), 7.76 (d, J = 8.1 Hz, 2H), 7.95-7.97 (m, 2H); 13C NMR (75 MHz, CDCl3): δ 21.5, 31.5, 40.4, 41.8, 45.1, 52.7, 55.7, 109.2, 116.0, 125.9, 127.1, 128.1, 128.7, 128.8, 129.6, 133.7, 136.5, 137.1, 143.1, 159.6, 165.9, 198.8, 206.1; Anal Calcd for C_{27}H_{27}NO_{5}S: C, 67.90; H, 5.70; N, 2.93. Found: C, 67.59; H, 5.62; N, 2.85.

(±)-N-(2-(3-(2-(2,4-Dichlorophenyl)-2-oxoethyl)-5-methoxy-1-oxo-2,3-dihydro-1H-inden-2-yl)ethyl)-4-methylbenzenesulfonamide (6e):

![Image of 6e](image)

Off-white gummy solid; yield: 0.265 g, 97%; IR (neat) 3275, 2922, 1684, 1595, 1436, 1315, 1249, 1152, 1088 cm⁻¹; 1H NMR (300 MHz, CDCl3) δ: 1.82-1.91 (m, 2H), 2.33 (s, 3H), 2.40 (td, J = 6.9, 3.3 Hz, 1H), 3.08-3.16 (m, 2H), 3.30-3.33 (m, 2H), 3.57-3.62 (m, 1H), 3.79 (s, 3H), 5.33 (t, J = 6.3 Hz, 1H), 6.82 (d J = 2.1 Hz, 1H), 6.86 (dd, J = 8.4, 2.1 Hz, 1H), 7.21 (d, J = 8.7 Hz, 2H), 7.27 (dd, J = 8.4, 2.1 Hz, 1H), 7.39 (d, J = 2.1 Hz, 1H), 7.47 (d, J = 8.4 Hz, 1H), 7.59 (d, J = 8.4 Hz, 1H), 7.68 (d, J = 8.4 Hz, 2H); 13C NMR (75 MHz, CDCl3): δ 21.5, 31.4, 40.3, 41.7, 48.8, 52.1, 55.8, 109.0, 116.2, 125.8, 127.1, 126.7, 128.8, 129.7, 130.4, 130.6, 132.0, 136.7, 136.9, 137.8, 143.2, 159.1, 165.9, 200.5, 205.8; Anal Calcd for C_{27}H_{25}Cl_{2}NO_{5}S: C, 59.35; H, 4.61; N, 2.56. Found: C, 59.19; H, 4.77; N, 2.71.

(±)-N-(2-(5-Methoxy-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1-oxo-2,3-dihydro-1H-inden-2-yl)ethyl)-4-methylbenzenesulfonamide (6f):

![Image of 6f](image)

Off-white solid; mp 175-177 °C, yield: 0.251 g, 95%; IR (neat) 3261, 2919, 1675, 1593, 1438, 1319, 1251, 1152, 1088 cm⁻¹; 1H NMR (300 MHz, CDCl3) δ: 1.80-2.00 (m, 2H), 2.29 (s, 3H), 2.37 (td, J = 6.9, 3.0 Hz, 1H), 3.08-3.21 (m, 2H), 3.36 (dd, J = 18.0, 8.1 Hz, 1H), 3.54 (dd, J = 18.0, 5.4 Hz, 1H), 3.63-3.68 (m, 1H), 3.79 (s, 3H), 5.60 (t, J = 6.3 Hz, 1H), 6.84 (d, J = 1.8 Hz, 1H), 6.87 (dd, J = 8.4, 2.1 Hz, 1H), 7.17 (d, J = 8.4 Hz, 2H), 7.47-7.59 (m, 2H), 7.62 (d, J = 8.4 Hz, 1H), 7.63 (d, J = 8.1 Hz, 2H), 7.81-7.90 (m, 3H), 7.96 (dd, J = 8.7, 1.8 Hz, 1H), 8.39 (s, 1H); 13C NMR (75 MHz, CDCl3) *: δ 21.5, 31.5, 40.5, 41.8, 45.2, 52.9, 55.7, 109.3, 116.0, 123.6, 125.9, 127.0, 127.1, 127.8, 128.7, 128.9, 130.1, 132.5, 133.8, 135.8, 137.1, 143.1, 159.7, 165.9, 198.7, 206.1; Anal Calcd for C_{31}H_{29}NO_{5}: C, 70.57; H, 5.54; N, 2.65. Found: C, 70.24; H, 5.58; N, 2.84. *Two aromatic carbons are merged with others.

(±)-N-(2-(3-(2-(Furan-2-yl)-2-oxoethyl)-5-methoxy-1-oxo-2,3-dihydro-1H-inden-2-yl)ethyl)-4-methylbenzenesulfonamide (6g):

![Image of 6g](image)

Brown gummy solid; yield: 0.224 g, 96%; IR (neat) 3254, 2922, 1669, 1593, 1464, 1323, 1254, 1153, 1087 cm⁻¹; 1H NMR (300 MHz, CDCl3) δ: 1.74-1.90 (m, 2H), 2.32 (s, 3H), 2.31-2.34 (m, 1H), 3.02-3.16 (m, 3H), 3.24 (dd, J = 17.4, 5.7 Hz, 1H), 3.51-3.56 (m, 1H), 3.79 (s, 3H), 5.50 (t, J = 6.3 Hz, 1H), 6.51 (dd, J = 3.6, 1.8 Hz, 1H), 6.81 (d, J = 2.1 Hz, 1H), 6.86 (dd, J = 8.4, 2.1 Hz, 1H), 7.17-7.21 (m, 3H), 7.54-7.55 (m, 1H), 7.60 (d, J = 8.7 Hz, 1H), 7.67 (d, J = 8.4 Hz, 2H); 13C NMR (75 MHz, CDCl3): δ 21.4, 31.1, 40.1, 41.6, 44.2, 52.4, 55.6, 109.0, 112.5, 115.9, 117.9, 125.7, 126.9, 128.6, 129.5, 136.9, 143.0, 146.8, 152.3, 159.1, 165.8, 187.6, 205.8; Anal Calcd for C_{28}H_{23}NO_{6}S: C, 64.23; H, 5.39; N, 3.00. Found: C, 64.45; H, 5.32; N, 3.04.
(±)-N-(2-(5-Methoxy-1-oxo-3-(2-oxopentyl)-2,3-dihydro-1H-inden-2-yl)ethyl)-4-methylbenzenesulfonylamide (6h):

Brown viscous liquid; yield: 0.205 g, 99%; IR (neat) 3255, 2903, 1702, 1584, 1438, 1322, 1178, 1085 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 0.75 (t, J = 7.5 Hz, 3H), 1.41-1.48 (m, 2H), 1.65-1.72 (m, 2H), 2.12 (td, J = 6.9, 3.0 Hz, 1H), 2.22 (s, 3H), 2.24 (t, J = 7.2 Hz, 2H), 2.58 (dd, J = 18.3, 7.8 Hz, 1H), 2.72 (dd, J = 18.3, 6.0 Hz, 1H), 2.92-3.00 (m, 2H), 3.26-3.31 (m, 1H), 3.68 (s, 3H), 5.36 (t, J = 6.3 Hz, 1H), 6.61 (d, J = 2.1 Hz, 1H), 6.73 (dd, J = 8.4, 2.1 Hz, 1H), 7.10 (d, J = 8.1 Hz, 2H), 7.46 (d, J = 8.4 Hz, 1H), 7.57 (d, J = 8.4 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 13.7, 17.2, 21.5, 31.7, 39.9, 41.7, 45.0, 48.8, 52.5, 55.7, 109.0, 115.9, 125.7, 127.1, 128.7, 129.7, 137.0, 143.1, 159.6, 165.9, 206.1, 210.1; Anal Calcd for C₂₄H₂₉NO₅S: C, 64.99; H, 6.59; N, 3.16. Found: C, 64.81; H, 6.40; N, 3.11.

(±)-4-Methyl-N-(2-(1-oxo-3-(2-oxopropyl)-2,3-dihydro-1H-inden-2-yl)ethyl)benzenesulfonylamide (6i):

White solid; mp 105-107 °C, yield: 0.150 g, 78%; IR (neat) 3255, 2924, 1707, 1599, 1460, 1433, 1317, 1284, 1158, 1090, 1063 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 1.8-1.93 (m, 2H), 2.22 (s, 3H), 2.37 (td, J = 6.6, 3.0 Hz, 1H), 2.41 (s, 3H), 2.84 (dd, J = 18.3, 7.5 Hz, 1H), 2.98 (dd, J = 18.3, 5.7 Hz, 1H), 3.15-3.20 (m, 2H), 3.30-3.35 (m, 1H), 5.37 (t, J = 6.0 Hz, 1H), 7.27-7.31 (m, 2H), 7.39-7.41 (m, 2H), 7.61 (t, J = 7.5 Hz, 1H), 7.70-7.77 (m, 3H); ¹³C NMR (75 MHz, CDCl₃): δ 21.5, 30.4, 31.2, 39.9, 41.6, 49.6, 52.0, 124.0, 125.6, 127.1, 128.0, 129.7, 135.4, 135.6, 137.0, 143.2, 156.4, 207.6, 207.9; Anal Calcd for C₂₁H₂₃NO₄S: C, 65.43; H, 6.01; N, 3.63. Found: C, 65.08; H, 5.89; N, 3.72.

5. General procedure for the synthesis of compounds 7a-j

Compounds 7 were synthesized using literature procedure involving Sonagashira coupling of 2-bromoarylaldehydes and 3-butyn-1-ol followed by aldol condensation.

6. General procedure for the palladium-catalyzed OH-assisted cascade: Synthesis of compounds 8a-i

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To a stirred solution of alkyne 7 (0.5 mmol) in THF (6 mL) and water (2 mmol) was added PdCl₂ (0.05 mmol) under nitrogen atmosphere and stirring was continued for 2-4 h at 25 °C. After completion of the reaction, as indicated by TLC, the mixture was filtered through a short pad of silica and washed with ethyl acetate. The combined organic layer was dried over anhyd. Na₂SO₄ and evaporated. The crude mixture was purified through flash column chromatography using petroleum ether-ethyl acetate mixture as eluent (70:30, v/v) to afford 2,3-dihydro-1H-inden-1-ones 8.

(±)-2-(2-Hydroxyethyl)-3-(2-oxo-2-phenylethyl)-2,3-dihydro-1H-inden-1-one (8a):

![Chemical structure of 8a](image)

Colourless viscous liquid; yield: 0.127 g, 86%; IR (neat) 3416, 3014, 1684, 1599, 1464, 1359, 1214 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.92-2.11 (m, 2H), 2.38 (td, J = 6.9, 3.0 Hz, 1H), 3.09 (brs, 1H), 3.34 (dd, J = 18.0, 8.1 Hz, 1H), 3.55 (dd, J = 18.0, 5.4 Hz, 1H), 3.87-3.90 (m, 3H), 7.41-7.51 (m, 4H), 7.58-7.66 (m, 2H), 7.79 (d, J = 7.5 Hz, 1H), 7.98 (d, J = 7.5 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 34.4, 40.3, 45.2, 53.1, 61.3, 124.1, 125.7, 128.0, 128.1, 128.8, 133.6, 135.3, 135.7, 136.4, 156.7, 198.9, 208.8; Anal Calcd for C₁₉H₁₈O₃: C, 77.53; H, 6.1. Found: C, 77.31; H, 6.32.

(±)-2-(2-Hydroxyethyl)-3-(2-oxo-2-(p-tolyl)ethyl)-2,3-dihydro-1H-inden-1-one (8b):

![Chemical structure of 8b](image)

Colourless viscous liquid; yield: 0.116 g, 75%; IR (neat) 3409, 2921, 1703, 1676, 1603, 1462, 1405, 1287, 1179 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.90-2.10 (m, 2H), 2.42 (s, 3H), 2.59 (td, J = 6.9, 3.0 Hz, 1H), 3.20 (brs, 1H), 3.30 (dd, J = 18.0, 8.4 Hz, 1H), 3.52 (dd, J = 18.0, 5.1 Hz, 1H), 3.83-3.89 (m, 3H), 7.28 (d, J = 6.9 Hz, 2H), 7.42 (t, J = 7.5 Hz, 1H), 7.48 (dd, J = 7.8, 0.6 Hz, 1H), 7.62 (td, J = 7.5, 1.2 Hz, 1H), 7.78 (d, J = 7.8 Hz, 1H), 7.88 (d, J = 8.1 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 21.7, 34.5, 40.4, 45.2, 53.2, 61.4, 124.1, 125.8, 128.1, 128.3, 129.5, 134.0, 135.4, 135.7, 144.7, 156.9, 198.6, 208.9; Anal Calcd for C₂₀H₂₁O₃: C, 77.90; H, 6.54. Found: C, 77.55; H, 6.71.

(±)-3-(2-(4-Chlorophenyl)-2-oxoethy l)-2-(2-hydroxyethyl)-2,3-dihydro-1H-inden-1-one (8c):

![Chemical structure of 8c](image)

Pale yellow viscous liquid; yield: 0.125 g, 73%; IR (neat) 3394, 2921, 1701, 1682, 1587, 1464, 1399, 1213, 1090, 1045 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.87-2.02 (m, 2H), 2.52 (td, J = 6.9, 3.0 Hz, 1H), 2.93 (brs, 1H), 3.25 (dd, J = 18.0, 7.6 Hz, 1H), 3.44 (dd, J = 18.0, 5.4 Hz, 1H), 3.75-3.84 (m, 3H), 7.34-7.41 (m, 4H), 7.56 (td, J = 7.5, 1.2 Hz, 1H), 7.71 (d, J = 7.8 Hz, 1H), 7.85 (d, J = 8.7 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 34.4, 40.3, 45.2, 52.9, 61.2, 124.2, 125.7, 128.2, 129.1, 129.6, 134.8, 135.4, 135.8, 140.2, 156.5, 197.7, 208.7; Anal Calcd for C₁₉H₁₇ClO₃: C, 69.41; H, 5.2. Found: C, 69.73; H, 5.50.
(±)-3-(2-(2,4-Dichlorophenyl)-2-oxoethyl)-2-(2-hydroxyethyl)-2,3-dihydro-1H-inden-1-one (8d):

Pale yellow viscous liquid; yield: 0.127 g, 70%; IR (neat) 3334, 3109, 2977, 1700, 1628, 1498, 1200, 1104 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 1.93-2.00 (m, 2H), 2.54 (td, \(J = 7.2, 3.3\) Hz, 1H), 2.72 (brs, 1H), 3.28 (dd, \(J = 18.0, 7.5\) Hz, 1H), 3.43 (dd, \(J = 18.3, 5.7\) Hz, 1H), 3.72-3.78 (m, 1H), 3.80-3.84 (m, 2H), 7.26 (dd, \(J = 8.4, 2.1\) Hz, 1H), 7.33-7.44 (m, 4H), 7.56 (td, \(J = 7.5, 1.2\) Hz, 1H), 7.70 (d, \(J = 7.5\) Hz, 1H); \(^13\)C NMR (75 MHz, CDCl\(_3\)): \(\delta\) 34.2, 40.6, 49.0, 52.7, 61.2, 124.2, 125.6, 127.6, 128.2, 130.3, 130.7, 132.2, 135.4, 135.8, 136.8, 138.0, 156.1, 200.5, 208.5; Anal Caled for C\(_{19}\)H\(_{16}\)Cl\(_2\)O\(_3\): C, 62.83; H, 4.44. Found: C, 62.48; H, 4.32.

(±)-2-(2-Hydroxyethyl)-3-(2-(naphthalen-2-yl)-2-oxoethyl)-2,3-dihydro-1H-inden-1-one (8e):

Pale yellow viscous liquid; yield: 0.134 g, 78%; IR (neat) 3394, 2920, 1701, 1673, 1600, 1464, 1361, 1276, 1122, 1034 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 1.87-2.05 (m, 2H), 2.57 (td, \(J = 6.9, 3.0\) Hz, 1H), 3.12 (brs, 1H), 3.41 (dd, \(J = 18.0, 8.1\) Hz, 1H), 3.60 (dd, \(J = 18.0, 5.4\) Hz, 1H), 3.82-3.86 (m, 3H), 7.36 (t, \(J = 7.5\) Hz, 1H), 7.44-7.59 (m, 4H), 7.72 (d, \(J = 7.8\) Hz, 1H), 7.80-7.88 (m, 3H), 7.98 (dd, \(J = 8.7, 1.5\) Hz, 1H), 8.41 (s, 1H); \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta\): 34.5, 40.5, 45.3, 53.2, 61.4, 123.6, 124.1, 125.8, 127.0, 127.8, 128.1, 128.7, 128.8, 129.6, 130.1, 132.5, 133.8, 135.4, 135.8, 156.8, 198.9, 208.9; Anal Caled for C\(_{23}\)H\(_{20}\)O\(_5\): C, 80.21; H, 5.85. Found: C, 79.92; H, 5.66.*One aromatic carbon is merged with others.

(±)-2-(2-Hydroxyethyl)-3-(2-oxopropyl)-2,3-dihydro-1H-inden-1-one (8f):

Colourless viscous liquid; yield: 0.094 g, 81%; IR (neat) 3235, 3105, 2920, 1665, 1599, 1368, 1227, 1164, 1088 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 1.93-2.05 (m, 2H), 2.23 (s, 3H), 2.49 (td, \(J = 6.9, 3.0\) Hz, 1H), 2.83 (dd, \(J = 18.3, 7.8\) Hz, 1H), 3.01 (dd, \(J = 18.3, 5.7\) Hz, 1H), 3.05 (brs, 1H), 3.62-3.67 (m, 1H), 3.85-3.88 (m, 2H), 7.38-7.44 (m, 2H), 7.62 (td, \(J = 8.1, 1.5\) Hz, 1H), 7.75 (d, \(J = 7.5\) Hz, 1H); \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta\): 30.5, 34.3, 40.0, 49.9, 52.6, 61.1, 124.0, 125.6, 128.0, 135.4, 135.7, 156.6, 207.8, 208.8; Anal Caled for C\(_{14}\)H\(_{16}\)O\(_3\): C, 72.39; H, 6.94. Found: C, 72.02; H, 6.86.

(±)-2-(2-Hydroxyethyl)-6-methyl-3-(2-oxo-2-phenylethyl)-2,3-dihydro-1H-inden-1-one (8g):

Colourless viscous liquid; yield: 0.125 g, 81%; IR (neat) 3420, 2932, 1699, 1652, 1458, 1290, 1172, cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 1.89-1.97 (m, 2H), 2.35 (s, 3H), 2.51 (td, \(J = 6.9, 3.0\) Hz, 1H), 3.07 (brs, 1H), 3.24 (dd, \(J = 18.0, 8.1\) Hz, 1H), 3.45 (dd, \(J = 18.0, 5.4\) Hz, 1H), 3.70-3.79 (m, 1H), 3.80-3.88 (m, 2H), 7.30 (d, \(J = 7.8\) Hz, 1H), 7.37-7.44 (m, 3H), 7.51-7.56 (m, 2H), 7.91 (d, \(J = 8.1\) Hz, 2H); \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta\): 21.1, 34.5, 40.1, 45.4, 53.6, 61.5, 124.1, 125.5, 128.2, 128.8, 133.7, 135.9, 136.5, 136.6, 138.2, 154.1, 199.0, 208.9; Anal Caled for C\(_{26}\)H\(_{20}\)O\(_5\): C, 77.90; H, 6.54. Found: C, 77.62; H, 6.50.
(±)-2-(2-Hydroxyethyl)-6-methyl-3-(2-oxo-2-thiophen-2-yl)ethyl)-2,3-dihydro-1H-inden-1-one (8h):

Pale yellow viscous liquid; yield: 0.132 g, 84%; IR (neat) 3412, 3021, 2923, 1701, 1659, 1414, 1283, 1232, 1051, 1050 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.86-1.98 (m, 2H), 2.35 (s, 3H), 2.53 (td, J = 7.2, 3.3 Hz, 1H), 3.00 (brs, 1H), 3.17 (dd, J = 17.1, 8.4 Hz, 1H), 3.37 (dd, J = 17.1, 5.4 Hz, 1H), 3.69-3.85 (m, 3H), 7.08 (dd, J = 4.8, 3.9 Hz, 1H), 7.31 (d, J = 7.8 Hz, 1H), 7.38 (dd, J = 8.1, 1.5 Hz, 1H), 7.50 (s, 1H), 7.62 (dd, J = 5.1, 1.2 Hz, 1H), 7.65 (dd, J = 3.9, 1.2 Hz, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 21.1, 34.3, 40.3, 45.6, 53.3, 61.3, 124.0, 125.5, 128.4, 132.5, 134.5, 135.9, 136.6, 138.2, 143.8, 153.8, 191.8, 208.7; Anal Calcd for C₁₈H₁₈O₃S: C, 68.77; H, 5.77. Found: C, 68.53; H, 5.71.

(±)-2-(2-Hydroxyethyl)-5-methoxy-3-(2-oxo-2-phenylethyl)-2,3-dihydro-1H-inden-1-one (8i):

Colourless viscous liquid; yield: 0.101 g, 62%; IR (neat) 3430, 3072, 1688, 1601, 1371, 1251, 1151 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.89-1.96 (m, 2H), 2.49 (td, J = 6.9, 2.7 Hz, 1H), 3.27 (dd, J = 18.0, 7.8 Hz, 1H), 3.44 (dd, J = 18.0, 5.7 Hz, 1H), 3.70-3.85 (m, 3H), 3.79 (s, 3H), 6.83 (d, J = 2.1 Hz, 1H), 6.88 (dd, J = 8.7, 2.1 Hz, 1H), 7.41 (t, J = 7.5 Hz, 2H), 7.54 (tt, J = 7.5, 1.2 Hz, 1H), 7.64 (d, J = 8.7 Hz, 1H), 7.90 (d, J = 7.2 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 34.5, 40.4, 45.3, 53.7, 55.7, 61.5, 109.2, 115.9, 125.9, 128.1, 128.8, 128.9, 133.7, 136.5, 159.8, 165.9, 199.0, 207.0; Anal Calcd for C₂₀H₂₀O₄: C, 74.06; H, 6.22. Found: C, 73.74; H, 6.11.

(±)-6-(2-Hydroxyethyl)-7-(2-oxo-2-(thiophen-2-yl)ethyl)-6,7-dihydro-5H-indeno[5,6-d][1,3]dioxol-5-one (8j):

Off-white solid; mp 136-137 °C, yield: 0.112 g, 65%; IR (neat) 3435, 3078, 2924, 1677, 1593, 1468, 1265, 1155, 1029 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 1.80-1.95 (m, 2H), 2.48-2.55 (m, 1H), 3.06 (brs, 1H), 3.17 (dd, J = 17.4, 7.8 Hz, 1H), 3.32 (dd, J = 17.4, 5.7 Hz, 1H), 3.60-3.68 (m, 1H), 3.73-3.88 (m, 2H), 6.01 (s, 2H), 6.79 (s, 1H), 7.04 (s, 1H), 7.08 (t, J = 3.9 Hz, 1H), 7.62-7.66 (m, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 34.5, 40.5, 45.6, 53.6, 61.5, 102.4, 102.5, 105.1, 128.4, 130.4, 132.5, 134.5, 143.7, 148.8, 154.0, 154.8, 191.6, 206.4; Anal Calcd for C₁₈H₁₆O₆S: C, 62.78; H, 4.68. Found: C, 62.51; H, 4.57.

2-(4,5-dihydro-3H,3′H-spiro[furan-2,1′-isobenzofuran]-3′-yl)-1-phenylethanol-one (9):

Colourless liquid; yield: 0.014 g, 19% (Obtained during optimization from 0.25 mmol of compound 7a); IR (neat) 3054, 2957, 1682, 1599, 1454, 1357, 1788, 1208, 1042 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ: 2.12-2.31 (m, 4H), 3.24 (dd, J = 16.5, 5.4 Hz, 1H), 3.69 (dd, J = 16.5, 7.5 Hz, 1H), 4.02-4.11 (m, 2H), 5.77 (t, J = 7.2 Hz, 1H), 7.26-7.35 (m, 4H), 7.46 (t, J = 7.2 Hz, 2H), 7.57 (t, J = 7.2 Hz, 1H), 8.03 (d, J = 7.5 Hz, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 25.1, 37.1, 47.0, 68.4, 78.3, 116.3, 121.7, 122.0, 128.3, 128.5, 128.6, 129.1,
133.2, 137.1, 139.5, 143.1, 198.4; Anal Calcd for C_{19}H_{18}O_3: C, 77.53; H, 6.16. Found: C, 77.31; H, 6.32.

7. Preparation of compounds 11, 13 and 21.
The general procedure used for the preparation of compounds 7 was employed for the synthesis of compounds 11, 13 and 21 (4 mmol scale; two step overall yields are given).

8. Preparation of compounds 17, 19 and 23.
The general procedure used for the preparation of compounds 5 was employed for the synthesis of compounds 17, 19 and 23.

*(E)-1-(3,4-Dimethoxyphenyl)-3-(2-(hex-1-yn-1-yl)phenyl)prop-2-en-1-one (11):

Yellow viscous liquid; yield: 1.101 g, 79%; IR (neat) 3356, 3097, 2945, 2360, 1695, 1592, 1494, 1208, 1125 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 0.941 (t, \(J = 7.2\) Hz, 3H), 1.45-1.55 (m, 2H), 1.59-1.67 (m, 2H), 2.49 (t, \(J = 7.2\) Hz, 2H), 3.98 (s, 6H), 6.93 (d, \(J = 8.4\) Hz, 1H), 7.29-7.35 (m, 2H), 7.46-7.49 (m, 1H), 7.60 (d, \(J = 15.9\) Hz, 1H), 7.67-7.74 (m, 3H), 8.27 (d, \(J = 15.9\) Hz, 1H); \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta\): 13.6, 19.4, 22.1, 30.8, 56.0, 56.1, 78.5, 97.2, 109.9, 110.9, 123.1, 123.2, 125.4, 126.3, 127.8, 129.7, 131.4, 133.1, 136.3, 142.4, 149.2, 153.2, 189.1; Anal Calcd for C_{23}H_{24}O_3: C, 79.28; H, 6.94. Found: C, 79.66; H, 6.80.

*(E)-1-(4-Methoxyphenyl)-3-(2-(phenylethynyl)phenyl)prop-2-en-1-one (13):

White solid; mp 96-97 °C; yield: 1.083 g, 80%; IR (neat) 2927, 2846, 1648, 1338, 1600, 1261, 1180, 1021 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 3.87 (s, 3H), 6.95 (d, \(J = 9.0\) Hz, 2H), 7.35-7.60 (m, 5H), 7.54-7.63 (m, 3H), 7.67 (d, \(J = 15.9\) Hz, 1H), 7.76-7.79 (m, 1H), 8.04 (d, \(J = 9.0\) Hz, 2H), 8.33 (d, \(J = 15.9\) Hz, 1H); \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta\): 55.5, 87.4, 95.7, 113.9, 122.9, 124.0, 126.8, 128.5, 128.7, 129.8, 131.0, 131.1, 131.7, 133.0, 136.4, 142.1, 163.4, 189.4; Anal Calcd for C_{24}H_{25}O_2: C, 85.18; H, 5.36. Found: C, 84.92; H, 5.30.

4-Methyl-N-(4-phenylbut-3-yn-1-yl)benzenesulfonamide (17):

Off-white solid; mp 91-92 °C; yield: 0.575 g, 96%; IR (neat) 3289, 3027, 2915, 2231, 1654, 1593, 1424, 1309, 1154, 1084 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 2.42 (s, 3H), 2.58 (t, \(J = 6.3\) Hz, 2H), 3.19 (q, \(J = 6.3\) Hz, 2H), 4.83 (t, \(J = 6.3\) Hz, 1H), 7.25-7.37 (m, 7H), 7.78 (d, \(J = 8.4\) Hz, 2H); \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta\): 20.7, 21.5, 42.0, 82.7, 85.8, 123.0, 127.1, 128.1, 128.3, 129.8, 131.7, 137.0, 143.6; Anal Calcd for C_{17}H_{17}NO_2S: C, 68.20; H, 5.72. Found: C, 67.93; H, 5.63.

4-Methyl-N-(4-oxo-4-phenylbutyl)benzenesulfonamide (18):

Off-white solid; mp 101-102 °C; yield: 0.135 g, 85%; IR (neat) 3252, 3058, 2917, 1678, 1593, 1325, 1155, 1093 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\): 1.92 (quin, \(J = 6.6\) Hz, 2H), 2.39 (s, 3H), 3.01-3.09 (m, 4H), 4.79 (t, \(J = 6.3\) Hz, 1H), 7.26 (d, \(J = 8.4\) Hz, 2H), 7.42-7.48 (m, 2H), 7.57 (tt, \(J = 8.7, 1.5\) Hz, 1H), 7.73 (d, \(J = 8.4\) Hz, 2H), 7.89-7.93 (m, 2H); \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta\): 21.5, 23.6, 35.4, 42.7, 127.1, 128.0, 128.6,
(E)-4-Methyl-N-(3-(2-(3-oxo-3-phenylprop-1-en-1-yl)phenyl)prop-2-yn-1-yl)benzenesulfonamide (19): White solid; mp 164-165 °C; yield: 0.781 g, 94%; IR (neat) 3279, 3061, 2922, 1661, 1601, 1433, 1326, 1155, 1054 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ: 2.23 (s, 3H), 4.14 (d, J = 6.3 Hz, 2H), 5.24 (brs, 1H), 7.16-7.22 (m, 2H), 7.30-7.40 (m, 3H), 7.49-7.56 (m, 3H), 7.63 (t, J = 7.2 Hz, 1H), 7.72 (d, J = 7.2, 1H), 7.79 (d, J = 8.4 Hz, 2H), 7.96 (d, J = 15.9 Hz, 1H); 13C NMR (75 MHz, CDCl₃): δ: 20.4, 32.8, 81.2, 88.8, 122.3, 122.6, 125.0, 126.4, 127.6, 127.7, 127.8, 128.6, 128.8, 132.1, 135.0, 135.9, 136.9, 141.5, 142.5, 189.7; Anal Calcd for C₂₅H₂₅NO₃S: C, 72.27; H, 5.09. Found: C, 71.96; H, 5.17.*One aromatic carbon is merged with others.

(E)-1-(Furan-2-yl)-3-(2-(3-hydroxyprop-1-en-1-yl)-5-methoxyphenyl)prop-2-en-1-one (21): Yellow gummy solid; yield: 0.994 g, 88%; IR (neat) 3450, 3290, 2920, 1646, 1595, 1458, 1228, 1028 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ: 3.88 (s, 3H), 4.34 (s, 1H), 4.57 (s, 2H), 6.60-6.61 (m, 1H), 6.91 (dd, J = 8.7, 1.8 Hz, 1H), 7.21 (d, J = 1.8 Hz, 1H), 7.37 (d, J = 3.6 Hz, 1H), 7.43 (d, J = 8.4 Hz, 1H), 7.50 (d, J = 15.9 Hz, 1H), 7.67 (s, 1H), 8.27 (d, J = 15.9 Hz, 1H); 13C NMR (75 MHz, CDCl₃): δ: 51.4, 55.5, 82.8, 92.8, 111.3, 112.8, 116.4, 116.8, 118.4, 122.6, 134.4, 137.3, 142.1, 147.0, 153.5, 159.5, 178.3; Anal Calcd for C₁₇H₁₄O₄: C, 72.33; H, 5.00. Found: C, 72.66; H, 5.04.

4-Methyl-N-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (23): Off-white solid; mp 119-120 °C; yield: 0.491 g, 86%; IR (neat) 3264, 3057, 2925, 2339, 1596, 1423, 1325, 1156, 1048 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ: 2.35 (s, 3H), 4.08 (d, J = 6.0 Hz, 2H), 4.70 (t, J = 6.0 Hz, 2H), 7.13 (dd, J = 8.1, 1.8 Hz, 2H), 7.25-7.30 (m, 5H), 7.81 (d, J = 8.4 Hz, 2H); 13C NMR (75 MHz, CDCl₃): δ: 21.5, 33.8, 83.3, 84.7, 122.1, 127.5, 128.2, 128.5, 129.7, 131.6, 136.9, 143.7; Anal Calcd for C₁₆H₁₄NO₂S: C, 67.34; H, 5.30. Found: C, 67.03; H, 5.22.

9. Alternative mechanism initiated by intramolecular nucleopalladation

The assistance of the internal nucleophile in the domino sequence can be explained through the intramolecular nucleopalladation-initiated mechanism shown below. Initial coordination of the palladium(II) species with the alkyne moiety of compound 5/7 triggers the nucleopalladation to generate intermediate B. Subsequent protonation followed by palladium-catalyzed Michael addition affords iminium cation E through the intermediacy of dihydropyrrrole/dihydrofuran C. Addition of water to intermediate E and the successive ring-opening provides 2,3-dihydro-1H-inden-1-ones 6/8. Cossy and co-workers have also proposed an intermediate related to F in a recent report. Other possible products I/J,

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expected to form from intermediate B via olefin insertion-protonation/β-hydride elimination steps were not obtained.¹

10. Proposed mechanism for the formation of spiroketal 9
The formation of spiroketal 9 could be visualized through the proposed mechanism shown below. Initial palladium-catalyzed nucleopalladation followed by protonation steps afford the dihydrofuran intermediate B. The Michael addition-hydration-ring opening cascade would afford 2,3-dihydro-1H-inden-1-ones 8. On the other hand, intermediate B generates oxonium ion C upon protonation under certain experimental conditions, which could undergo nucleophilic water addition followed by oxa-Michael reaction to furnish the diastereomeric spiroketals 9 through intermediate D. Although one of the diastereomeric spiroketal 9a was isolated and characterized, the second diastereomer was inseparable in pure form.
11. Optimization of reaction conditions for the NHTs-assisted cascade reaction

Table 1

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<th>Solvent</th>
<th>Reaction time (h)</th>
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<td>18</td>
<td>PdCl$_2$(MeCN)$_2$</td>
<td>MeCN</td>
<td>5</td>
<td>94$^d$</td>
</tr>
</tbody>
</table>

$^a$All reactions were carried out with 5a (0.25 mmol), water (4 equiv) and catalyst (10 mol%) in 3 mL solvent at 25 °C. $^b$Isolated yield. $^c$Optimized reaction condition. $^d$5 mol% of catalyst was used.
12. Optimization of reaction conditions for the hydroxyl-assisted cascade reaction

Table 2

<table>
<thead>
<tr>
<th>Entry</th>
<th>Catalyst (10 mol%)</th>
<th>Solvent</th>
<th>Reaction time (h)</th>
<th>8a:9a:9b ratio(^b)</th>
<th>Yield of 8a (%)(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PdCl(_2)(MeCN)(_2)</td>
<td>MeCN</td>
<td>2</td>
<td>26:44:30</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>PdCl(_2)(MeCN)(_2)</td>
<td>THF</td>
<td>2</td>
<td>83:7:10</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>PdCl(_2)(MeCN)(_2)</td>
<td>DCM</td>
<td>2</td>
<td>68:17:15</td>
<td>61</td>
</tr>
<tr>
<td>4</td>
<td>PdCl(_2)(MeCN)(_2)</td>
<td>Toluene</td>
<td>2</td>
<td>25:33:42</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>PdCl(_2)(MeCN)(_2)</td>
<td>Dioxane</td>
<td>2</td>
<td>28:41:31</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>PdCl(_2)(MeCN)(_2)</td>
<td>THF(^d)</td>
<td>10</td>
<td>100:0:0</td>
<td>83</td>
</tr>
<tr>
<td>7(^e)</td>
<td>PdCl(_2)</td>
<td>THF</td>
<td>2</td>
<td>100:0:0</td>
<td>86</td>
</tr>
<tr>
<td>8</td>
<td>PdCl(_2)</td>
<td>DCM</td>
<td>3</td>
<td>80:12:8</td>
<td>62</td>
</tr>
<tr>
<td>9</td>
<td>PdCl(_2)</td>
<td>Dioxane</td>
<td>2</td>
<td>76:15:9</td>
<td>61</td>
</tr>
</tbody>
</table>

\(^a\)Unless otherwise noted, all reactions were carried out with 7a (0.25 mmol), water (4 equiv) and catalyst (10 mol%) in 3 mL solvent at 25 °C. \(^b\)Product ratio was obtained from the crude \(^1\)H NMR spectra. \(^c\)Isolated yield. \(^d\)1:1 THF/H\(_2\)O was used as solvent. \(^e\)Optimized reaction condition.
13. $^1$H and $^{13}$C NMR Spectra
S3i

S3i