Supporting Information

Kinetic Resolution of Terminal Alkyne Substituted Quaternary Oxindoles via Copper Catalysed Azide-Alkyne Cycloadditions

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General

Reagents were used as purchased from suppliers without further purification; in cases where anhydrous solvents were required they were dried using a solvent purification system (SPS) which is monitored by Karl-Fisher titrations for water levels. $^1$H NMR spectra were recorded at 300 MHz using a Bruker AVIII 300 NMR spectrometer. $^{19}$F NMR spectra were recorded at 282 MHz using a Bruker AVIII 300 NMR spectrometer. $^{13}$C NMR experiments were carried out on a Bruker AVIII400 NMR spectrometer recorded at 101 MHz; in cases where it was required 2D NMR techniques were used to confirm compound identity. $^1$H NMR chemical shifts are reported in ppm relative to TMS ($\delta$ 0.00) and $^{13}$C NMR relative to chloroform ($\delta$ 77.36). Reactions carried out at low temperatures were cooled using a Lab Plant Cryoprobe. Melting points were carried out in triplicate and an average of the values taken and reported as a range using Stuart SMP10 melting point apparatus. IR spectra were recorded on a PerkinElmer 100FT-IR spectrometer at room temperature using ATR. Optical rotations were
recorded on a polar 2001 Automatic Polarimeter. Measurements of each sample were recorded three times and used as an average. HPLC analysis was carried out using a Shimadzu LC2010 and Phenomenex Lux cellulose 3 chiral column, traces were recorded at four UV wavelengths 210, 220, 254 and 280nm, calculations were carried out using the supplied traces recorded at 254 nm. Column chromatography was carried out using a Combiflash Rf 200i, column traces were recorded at two UV wavelengths (254 nm and 280nm).

Synthesis and screening

Synthesis of 3-methyl-3-(prop-2-yn-1-yl)indolin-2-one

\[
\begin{align*}
\text{n-Butyl lithium in hexanes (1.5 M, 8.15 mmol, 5.09 mL, 1.2 equiv.) was transferred into a nitrogen flushed flask, THF (40 mL) was added and the solution cooled to –78 °C. A solution of 3-methyl-2-oxindole (1.00 g, 6.79 mmol, 1 equiv.) dissolved in THF (10 mL) was added dropwise under stirring. The reaction mixture was stirred for 10 minutes before propargyl bromide (7.13 mmol, 0.76 mL, 1.05 equiv.) was added. The solution was allowed to warm to room temperature and stirred for 3 h. Methanol (20 mL) was added to decompose any remaining butyl lithium. The solution was concentrated in vacuo and the residual oil extracted with water (50 mL) and ethyl acetate (3 x 50 mL). The organic phase was dried over MgSO}_4 and concentrated in vacuo. The oil was then purified using automated column chromatography combiflash Rf (0-25% EtOAc : Hexane gradient 20 mins) to yield the product as a cream solid 0.69 g, 55% yield.}
\end{align*}
\]

\[^1\text{H NMR (300 MHz, CDCl}_3\) δ 7.75 (s, 1H), 7.42 (d, J = 7.4 Hz, 1H), 7.29 – 7.21 (m, 2H), 7.07 (td, J = 7.6, 1.0 Hz, 1H), 6.91 (d, J = 7.7 Hz, 1H), 2.63 (ABqd, J = 16.6, 2.7 Hz, 2H),\]
1.98 (t, \(J = 2.7\) Hz, 1H), 1.48 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 182.08, 140.24, 133.47, 128.22, 123.53, 122.54, 109.97, 79.55, 70.85, 47.21, 27.58, 21.93; IR \(\nu_{\text{max}}\) (ATR)/cm\(^{-1}\) 3255, 2981, 2968, 2925, 1705, 1667, 1622, 1471, 1341, 1235, 1191; MS ESI \(m/z\) 186.1 [M+H] HRMS (ESI-TOF) Calculated for C\(_{12}\)H\(_{11}\)NONa = 208.0738 Found = 208.0739; MP 112-114 °C.

**Synthesis of 1-benzyl-3-methyl-3-(prop-2-yn-1-yl)indolin-2-one (1)**

Sodium hydride (2.38 mmol, 0.082 g, 2.2 equiv) was suspended in THF (10 mL). The reaction was cooled to 0 °C using an ice bath, at this temperature a solution of 3-methyl-3-(prop-2-yn-1-yl)indolin-2-one (1.08 mmol, 0.20 g, 1 equiv) dissolved in THF (10 mL) was added dropwise. When the formation of gas had ceased, benzyl bromide (1.08 mmol, 0.185 g, 0.129 mL, 1 equiv) was added to the mixture. The reaction was allowed to warm to room temperature and left to stir for 2 h. Water (5 mL) was added to decompose any remaining sodium hydride and the solution was extracted with water (50 mL) and diethyl ether (3 x 50 mL). The organic phase was dried over magnesium sulphate and concentrated *in vacuo*. To yield the product as a colourless crystalline solid this was then washed with hexane (50 mL) to remove any residual benzyl bromide. Colourless crystalline solid 0.23 g, 77% yield.

\(^{1}\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\) 7.43 (dd, \(J = 7.4, 0.8\) Hz, 1H), 7.36 – 7.28 (m, 5H), 7.18 (td, \(J = 7.7, 1.3\) Hz, 1H), 7.05 (td, \(J = 7.6, 1.0\) Hz, 1H), 6.73 (d, \(J = 7.8\) Hz, 1H), 4.96 (ABq, \(J = 15.7\) Hz, 2H), 2.72 (ABqd, \(J = 16.5, 2.7\) Hz, 2H), 1.92 (t, \(J = 2.6\) Hz, 1H), 1.51 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 179.46, 142.16, 135.84, 132.96, 128.70, 128.14, 127.59, 127.32, 123.21, 122.60, 109.12, 79.76, 70.77, 46.77, 43.76, 27.76, 22.36; IR \(\nu_{\text{max}}\) (ATR)/cm\(^{-1}\) 3285, 2924, 1711, 1608, 1489, 1466, 1426, 1378, 1179; MS ESI \(m/z\) 276.1 [M+H] HRMS (ESI-TOF) Calculated for C\(_{19}\)H\(_{18}\)NO = 276.1388 Found = 276.1378; MP 140-141°C; HPLC
(Cellulose 3) acetonitrile/water 50:50, 1.0 mL/min, \( \lambda = 254 \text{ nm} \), \( t_{\text{major}} = 7.5 \text{ min} \), \( t_{\text{minor}} = 8.5 \text{ min} \); \( \left[ \alpha \right]_{D}^{203} = -41 \text{ (c = 1.0, CHCl}_3) \circ\)

Enantiopure material was recovered by preparative HPLC using cellulose 1 acetonitrile/water 50:50 15.mL/min, \( \lambda = 254 \text{ nm} \). The enantiopure material was subjected to optical rotation analysis and from this it was calculated that the (–) enantiomer was eluting as the \( t_{\text{minor}} \) peak in the cellulose 3 analytical HPLC. Therefore the recovered enantioenriched alkyne from the kinetic resolution should have a positive optical rotation.

**Synthesis of 1-benzyl-3-((1-benzyl-1H-1,2,3-triazol-4-yl)methyl)-3-methylindolin-2-one (2a)**

![Image of the compound 2a](image_url)

To a solution of 1 (0.24 mmol, 0.066 g, 1 equiv) in methanol (10 mL) was added copper (I) iodide (0.0046 g, 0.024 mmol, 10 mol%), sodium ascorbate (0.24 mmol, 0.048 g, 1 equiv) and finally benzyl azide (0.24 mmol, 0.032 g, 1 equiv) this was allowed to stir overnight. The reaction was quenched with aqueous ammonia 5% v/v (10 mL) and extracted with diethyl ether (3 x 25 mL) then washed with water (100 mL). The remaining starting material and the triazolic product were isolated by combiflash chromatography. \( R_f \) petroleum ether: diethyl ether 0-100% gradient followed by EtOAc 100%. To yield the product as brown oil 0.070 g, 71% yield.

\( ^1 \text{H NMR (300 MHz, CDCl}_3 \) \( \delta \) 7.35 – 6.93 (m, 13 H), 6.73 (s, 1 H), 6.57 (d, \( J = 7.6 \text{ Hz} \), 1H), 5.28 (s, 2 H), 4.70 (s, 2 H), 3.81 (ABq \( J = 14.3, 2H \) ) 1.54 (s, 3 H); \( ^{13} \text{C NMR (101 MHz, CDCl}_3 \) \( \delta \) 179.88, 143.35, 142.11, 135.94, 134.87, 132.91, 128.95, 128.71, 128.44, 127.85, 127.69, 127.52, 127.28, 123.25, 122.58, 121.84, 108.82, 53.71, 48.58, 43.48, 34.39, 23.46; IR \( \nu_{\text{max}} \) (ATR)/cm\(^{-1}\) 2924, 1708, 1611, 1489, 1468, 1454, 1355, 1176; MS ESI \( m/z \) 431.3 [M+Na] HRMS (ESI-TOF) Calculated for C\(_{26}\)H\(_{24}\)N\(_4\)O\(_2\)Na = 431.1848 Found = 431.1848;
HPLC (Cellulose 3) acetonitrile/water 40:60, 1.0 mL/min, $\lambda = 254$ nm, $t_{\text{major}} = 11.2$ min, $t_{\text{minor}} = 12.7$ min.

**General procedure for synthesis of racemic oxindole triazoles via in situ azide formation**

![Chemical Structure](image)

The alkyl bromide (0.12 mmol, 1 equiv) was stirred at rt with sodium azide (0.13 mmol, 0.0085 g, 1.1 equiv) in acetone (5 mL). After 10 hours the reaction was diluted with methanol (10 mL) and 1 (0.12 mmol, 0.033 g, 1 equiv) added along with copper (I) iodide (2.3 mg, 0.012 mmol, 0.1 equiv, 10 mol%) and sodium ascorbate (0.12 mmol, 0.024 g, 1 equiv) the reaction was allowed to stir at rt for 24 h. The reaction was quenched with aqueous ammonia 5% v/v (10 mL) and extracted with ether (3 x 25 mL). The triazolic product was isolated by combiflash Rf petroleum ether: diethyl ether 0-100% gradient followed by EtOAc 100%.

(2b) Brown oil 0.030 g, 52% yield $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 7.46 – 6.97 (m, 16H), 6.75 (d, $J = 7.6$ Hz, 1H), 6.64 – 6.53 (m, 2H), 5.22 (s, 2H), 4.68 (q, $J = 15.6$ Hz, 2H), 3.26 (ABq, $J = 14.3$ Hz, 2H), 1.50 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 179.90, 143.04, 142.10, 141.68, 139.74, 135.89, 132.93, 132.27, 130.30, 128.99, 128.66, 128.54, 128.46, 128.30, 128.05, 127.85, 127.67, 127.49, 127.22, 123.31, 122.58, 121.95, 108.83, 51.35, 48.56, 43.48, 34.27, 23.57; IR
ν\text{max} \ (\text{ATR})/\text{cm}^{-1} 2925, 2854, 1707, 1611, 1488, 1467, 1453; \text{MS ESI } m/z \ 507.2 \ [\text{M+Na}]

HRMS (ESI-TOF) Calculated for C_{32}H_{28}N_{4}O_{N}a = 507.2161 Found = 507.2166.

(2c) Brown oil 0.038 g, 75% yield \text{\textsuperscript{1}}H NMR (300 MHz, CDCl\textsubscript{3}) δ 7.28 – 6.93 (m, 10H), 6.85 (d, J = 8.0, 2H), 6.70 (s, 1H), 6.55 (d, J = 7.6, 1H), 5.21 (s, 2H), 4.68 (s, 2H), 3.26 (Abq, J = 14.3, 2H), 2.34 (s, 3H), 1.51 (s, 3H); \text{\textsuperscript{13}}C NMR (101 MHz, CDCl\textsubscript{3}) δ 179.89, 143.23, 142.11, 138.30, 135.95, 132.94, 131.84, 129.60, 128.70, 127.82, 127.77, 127.51, 127.23, 123.26, 122.57, 121.76, 108.83, 53.53, 48.57, 43.48, 34.39, 21.16; IR ν\text{max} (\text{ATR})/\text{cm}^{-1} 2925, 1707, 1611, 1489, 1467, 1453, 1379, 1354, 1175; \text{MS ESI } m/z 445.2 \ [\text{M+Na}]

HRMS (ESI-TOF) Calculated for C_{27}H_{26}N_{4}O_{N}a = 445.2006 Found = 445.2006.

(2d) Brown oil 0.035g, 53% yield \text{\textsuperscript{1}}H NMR (300 MHz, CDCl\textsubscript{3}) δ 7.83 (s, 1H), 7.46 (s, 2H), 7.31 – 6.93 (m, 9H), 6.74 (s, 1H), 6.60 (d, J = 7.5 Hz, 1H), 5.32 (s, 2H), 4.76 (Abq, J = 15.5 Hz, 1H), 3.32 (Abq, J = 14.4 Hz, 2H), 1.52 (s, 3H); \text{\textsuperscript{13}}C NMR (101 MHz, CDCl\textsubscript{3}) δ 179.77, 143.92, 142.06, 137.28, 135.97, 132.81, 132.61, 132.27, 128.68, 128.00, 127.88, 127.53, 127.43, 123.17, 122.66, 122.00, 108.77, 52.51, 48.37, 43.51, 34.22, 23.62; \text{\textsuperscript{19}}F NMR (282 MHz, CDCl\textsubscript{3}) δ -62.83; IR ν\text{max} (\text{ATR})/\text{cm}^{-1} 2928, 1706, 1612, 1489, 1468, 1454, 1382, 1354, 1277, 1173, 1132; \text{MS ESI } m/z 567.2 [\text{M+Na}]

HRMS (ESI-TOF) Calculated for C_{28}H_{22}N_{4}OF_{6}Na = 567.1596 Found = 567.1593.

(2e) Colourless solid 0.035g 64% yield \text{\textsuperscript{1}}H NMR (300 MHz, CDCl\textsubscript{3}) δ 8.15 – 7.96 (m, 2H), 7.26 – 6.88 (m, 2H), 6.90 (d, J = 8.2 Hz, 3H), 5.32 (s, 2H), 4.78 (Abq, J = 15.4 Hz, 1H), 2.02 (s, 3H); \text{\textsuperscript{13}}C NMR (101 MHz, CDCl\textsubscript{3}) δ 179.81, 143.92, 142.06, 137.28, 135.97, 132.81, 132.61, 132.27, 128.68, 128.00, 127.88, 127.53, 127.43, 123.17, 122.66, 122.00, 108.77, 52.51, 48.37, 43.51, 34.22, 23.62; IR ν\text{max} (\text{ATR})/\text{cm}^{-1} 2928, 1706, 1612, 1489, 1468, 1454, 1382, 1354, 1277, 1173, 1132; \text{MS ESI } m/z 567.2 [\text{M+Na}]

HRMS (ESI-TOF) Calculated for C_{28}H_{22}N_{4}OF_{6}Na = 567.1596 Found = 567.1593.
10H), 6.75 (s, 1H), 6.65 (d, J = 7.7, 1H), 5.35 (d, J = 6.3, 2H), 4.79 (Abq, J = 15.5, 2H), 3.36 (Abq, J = 14.4, 2H), 1.55 (3 H, s); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 179.74, 143.90, 142.19, 141.85, 135.94, 132.90, 128.69, 127.96, 127.90, 127.55, 124.06, 123.22, 122.67, 122.15, 108.77, 52.60, 48.56, 43.70, 34.18, 23.81; IR $\nu_{\text{max}}$ (ATR)/cm$^{-1}$ 2925, 1707, 1611, 1521, 1489, 1467, 1453, 1379, 1346, 1176; MS ESI $m/z$ 476.2 [M+Na] HRMS (ESI-TOF) Calculated for C$_{26}$H$_{23}$N$_3$O$_3$Na = 476.1699 Found = 476.1698.

(2f) Brown oil 0.043 g, 82% yield $^1$H NMR (300 MHz, CDCl$_3$) δ 7.27 – 6.94 (m, 10H), 6.78 (t, J = 9.7 Hz, 2H), 6.65 (s, 1H), 6.56 (d, J = 7.7 Hz, 1H), 5.27 – 5.12 (m, 2H), 4.70 (Abq, J = 15.6 Hz, 2H), 3.29 (Abq, J = 14.3 Hz, 2H) 1.52 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 179.80, 143.54, 142.13, 135.92, 134.41, 133.32, 132.89, 129.11, 128.97, 128.71, 127.86, 127.55, 127.37, 123.20, 122.60, 121.79, 108.81, 52.93, 48.57, 43.56, 34.34, 23.57; IR $\nu_{\text{max}}$ (ATR)/cm$^{-1}$ 2925, 1707, 1611, 1490, 1467, 1454, 1380, 1355, 1174; MS ESI $m/z$ 465.2 [M+Na] HRMS (ESI-TOF) Calculated for C$_{27}$H$_{23}$N$_4$OF$_3$Na = 465.1458 Found = 465.1453.

(2g) Brown oil 0.036 g, 63% yield $^1$H NMR (300 MHz, CDCl$_3$) δ 7.49 (d, J = 8.1 Hz, 2H), 7.28 – 6.89 (m, 10H), 6.67 (s, 1H), 6.57 (d, J = 7.6 Hz, 1H), 5.36 – 5.21 (m, 2H), 4.72 (Abq, J = 15.5 Hz, 2H), 3.31 (Abq, J = 14.3 Hz, 2H), 1.53 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 179.77, 143.68, 142.16, 138.75, 135.92, 132.88, 130.47, 128.70, 127.88, 127.73, 127.56, 127.42, 125.88, 125.85, 123.19, 122.60, 121.96, 108.77, 52.97, 48.56, 43.61, 34.28, 23.67; $^{19}$F NMR (282 MHz, CDCl$_3$) δ -62.69; IR $\nu_{\text{max}}$ (ATR)/cm$^{-1}$ 2925, 1709, 1612, 1490, 1468, 1381, 1326, 1169, 1124;
MS ESI m/z 499.2 [M+Na] HRMS [M+Na] Calculated for C_{27}H_{23}N_{4}OF_{3}Na = 499.1722
Found = 499.1721.

General procedure for synthesis and isolation of azides

$$\text{R}^{\text{Br}} \xrightarrow{\text{NaN}_3 (1.1 \text{ equiv})} \text{R}^{\text{N}_3}$$

Acetone : Water 3 : 1
rt, 20 h

Sodium azide (1.20 g, 18.5 mmol, 1.1 equiv) was added to a mixture of acetone : water (3:1), to this benzyl bromide was added (2.88 g, 16.8 mmol, 2 mL, 1 equiv) and the reaction mixture was stirred at rt for 20 h. Water (100 mL) was added and the reaction mixture was extracted with diethyl ether (3 x 25 mL). The combined organic extracts were combined and removed in vacuo to yield benzyl azide 3a as a colourless oil 1.79 g 80% yield

Characterisation was in agreement with the reported literature values.\textsuperscript{1} \textsuperscript{1}H NMR (300 MHz, CDCl\textsubscript{3}) \(\delta\) 7.35 – 7.18 (m, 5H), 4.18 (s, 2H); \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) \(\delta\) 135.65, 128.98, 128.43, 128.38, 54.83; MS EI m/z 133.1 [M], 104 [M-N\textsubscript{2}], 91.1 [M-N\textsubscript{3}], 77.0 [M-CH\textsubscript{2}N\textsubscript{3}].

Prepared from 2-phenylbenzyl bromide (0.50 g, 2.39 mmol, 1 equiv) and sodium azide (0.17 g, 2.63 mmol, 1.1 equiv) according to the general procedure. Isolated as a yellow oil 0.42 g, 85% yield. Characterisation was consistent with the literature.\textsuperscript{2} \textsuperscript{1}H NMR (300 MHz, CDCl\textsubscript{3}) \(\delta\) 7.44 – 7.25 (m, 9H), 4.24 (s, 2H); \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) \(\delta\) 142.33, 140.37, 132.92, 130.56, 129.69, 129.31, 128.45, 127.91, 127.57, 52.68.
Prepared from 4-methylbenzyl bromide (0.5 g, 2.70 mmol, 1 equiv) and sodium azide (0.19 g, 3.00 mmol, 1.1 equiv) according to the general procedure. Isolated as an orange oil 0.40 g, 64% yield. Characterisation was consistent with the literature.\textsuperscript{3} \textsuperscript{1}H NMR (300 MHz, CDCl\textsubscript{3}) \(\delta 7.21 – 7.13 \) (m, 4H), 4.25 (s, 2H), 2.33 (s, 3H); \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) \(\delta 138.18, 132.39, 129.56, 128.33, 54.65, 21.20\). MS EI m/z 147.1 [M], 118.1 [M-N\textsubscript{2}], 105.1 [M-N\textsubscript{3}], 91.1 [M-CH\textsubscript{2}N\textsubscript{3}].

Prepared from 3,5-Bis(trifluoromethyl)benzyl bromide (0.20 g, 0.65 mmol, 1 equiv) and sodium azide (0.05 g, 0.72 mmol, 1.1 equiv) according to the general procedure. Isolated as a yellow oil 0.096 g, 55% yield. Characterisation was consistent with the literature.\textsuperscript{3} \textsuperscript{1}H NMR (300 MHz, CDCl\textsubscript{3}) \(\delta 7.86 \) (s, 1H), 7.79 (s, 2H), 4.56 (s, 2H); \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) \(\delta 138.30, 132.63, 132.29, 131.96, 131.63, 127.86, 127.83, 127.13, 124.42, 122.06, 122.03, 121.99, 121.71, 53.44\).

**General procedure for oxindole kinetic resolution screening**

To an oven dried Radleys multi reactor tube, under an atmosphere of nitrogen, were added \textbf{L1} (0.0067 g, 0.018 mmol, 15.0 mol%) and CuCl (0.0015 g, 0.015 mmol, 12.5 mol%) followed by 2,5-hexanediol (1 mL). After the solution was stirred at rt for 1 h, compound \textbf{1} (0.033 g, 0.12 mmol, 1 equiv) dissolved in 2,5-hexanediol (1 mL) was added. The reaction mixture was stirred for a further 15 mins at rt then cooled to 0°C for another 15 mins, benzyl azide (0.0095 g, 0.07 mmol, 0.6 equiv) was then added. The resulting mixture was maintained at 0 °C for 96 h with stirring. The reaction was quenched with aqueous ammonia 5% v/v (10 mL) and extracted with diethyl ether (2 x 25mL) dried over MgSO\textsubscript{4} and
concentrated in vacuo. A crude $^1$H NMR spectrum was taken to determine conversion. The remaining starting material and the triazolic product were then isolated by automated column chromatography combiflash Rf petroleum ether: diethyl ether 0-100% gradient followed by EtOAc 100%. Conversion was measured by $^1$H NMR and enantiomeric excess via chiral HPLC.

**Representative procedure for oxindole kinetic resolution screening using in situ azide formation**

\[
\begin{align*}
\text{R-Br} & \xrightarrow{\text{NaN}_3, \text{Aceton, rt, 24h}} [\text{R-N}_3] & \xrightarrow{1} \text{CuCl} & \text{(12.5 mol%), L1} & \text{(15.0 mol%), 96h, 0°C, Acetone} \\
\text{Me} & \text{N} & \text{N} & \text{N} & \text{R}
\end{align*}
\]

4-Nitrobenzyl bromide (0.015 g, 0.07 mmol, 0.6 equiv) was stirred at rt with sodium azide (0.0052 g, 0.08 mmol, 1.1 equiv) in acetone (5 mL) for 10 h. In a separate reaction vessel a solution of L1 (0.0067 g, 0.018 mmol, 15.0 mol%) and CuCl (0.0015 g, 0.015 mmol, 12.5 mol%) in acetone (1 mL) was stirred for 1 h at rt. To this 1 (0.033 g, 0.12 mmol, 1 equiv) in acetone (1 mL) was added. The reaction was then cooled to 0°C and stirred for 30 minutes the azide formation solution was then transferred by syringe this was then maintained at 0°C for 96 h. The reaction was quenched with aqueous ammonia 5% v/v (10 mL) and extracted with diethyl ether (2 x 25 mL). The remaining starting material and the triazolic product were isolated by combiflash Rf petroleum ether: diethyl ether 0-100% gradient followed by EtOAc 100% and enantiomeric excess determined by chiral HPLC.

**In situ azide screening table**

<table>
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<th>Entry</th>
<th>R</th>
<th>Conv (%)</th>
<th>ee SM (%)</th>
<th>Selectivity Factor (S)</th>
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<td>1</td>
<td>2b 2-PhC₆H₄</td>
<td>13</td>
<td>14</td>
<td>35.2</td>
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</table>
Representative determination of conversion via 1H NMR Spectroscopy

Conversion of alkyne 1 to triazole 2a was determined by direct comparison of the integrations of a series of peaks in the crude 1H NMR spectra of the resolution reaction mixture. Due to the high boiling point of 2,5-hexanedione it was only possible to remove this via column chromatography therefore HPLC was not an appropriate manner for conversion analysis. The signals in the benzylic region were used as this was a clear area away from any interference from remaining solvent. The ABq centred at 4.96 of compound 1 was directly compared with the two singlets at 5.28 and 4.70 of compound 2a. A representative example is shown in Figure 1. When the azide was varied the analogous signals in the triazolic product were used.

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<tr>
<td>6</td>
<td>2g 4-CF₃C₆H₄</td>
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<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

* Conversion determined by inspection of 1H NMR spectra (see ESI); † E.e. of recovered starting material (HPLC); ‡ \( S = \ln[(1-c)(1-\text{e.e})]/\ln[(1-c)(1+\text{e.e})] \).
Figure 1 Crude 1H NMR showing direct comparison of signals related to product and starting material for calculation of conversion

Integration per proton in 1 = $\frac{1.00+0.95}{2} = 0.98$
Integration per proton in 2a = $\frac{1.90+1.84}{4} = 0.94$

% Conversion = $\frac{0.94}{0.94+0.98} \times 100 = 49\%$
## Screening Tables

### Solvents

<table>
<thead>
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<sup>a</sup> Conversion determined by inspection of 1H NMR spectra (see ESI).  
<sup>b</sup> E.e. of recovered starting material (HPLC).  
<sup>c</sup> \( S = \frac{\ln((1-c)(1-\text{ee}))}{\ln((1-c)(1+\text{ee}))} \).  
<sup>d</sup> Average of three \( S = 22.1 \pm 0.5 \), best unique case \( S = 23.2 \).
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<sup>a</sup> Conversion determined by inspection of ¹H NMR spectra (see ESI).<br>
<sup>b</sup> E.e. of recovered starting material (HPLC).<br>
<sup>c</sup> $S = \frac{\ln[(1-c)(1-ee)]}{\ln[(1-c)(1+ee)]}$. 
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\(^a\) Conversion determined by inspection of $^1$H NMR spectra (see ESI); \(^b\) E.e. of recovered starting material (HPLC); \(^c\) $S = \ln[(1-c)(1-ee)]/\ln[(1-c)(1+ee)]$. 
Ligands

![Chemical structures of ligands L1-L12](Image)

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<sup>a</sup> Conversion determined by inspection of 1H NMR spectra (see ESI).<sup>b</sup> E.e. of recovered starting material (HPLC);<sup>c</sup> $S = \frac{\ln[(1-c)(1-e)]}{\ln[(1-c)(1+e)]}$.  

NMR Data
$^{1}H$ NMR 3-methyl-3-(prop-2-yn-1-yl)indolin-2-one
$^{13}$C NMR 3-methyl-3-(prop-2-yn-1-yl)indolin-2-one

WBNH

Current Data Parameters
NAME  05-06-Paszey-14
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20150506
Time  23.11
INSTRUM spect
PROBNO 5 mm PADUL 13C
PULPROG udef_t
TD  16178
SOLVENT CDCl3
NS  380
DS  0
SNR  252.525 Hz
FIDRES  1.399181 Hz
AQ  0.3599244 sec
RG  2050
DW  19.800 use
DE  8.200 use
TE  293.1 K
DI  3.00000000 sec
D11  0.03000000 sec
D12  0.00002000 sec
D20  200.00000000 sec
TD0  380

------- CHANNEL F1 -------
SFCl 105.6243690 MHz
NQC1 13C
P1  8.80 use
P13 2000.00 use
P26  500.00 use
PLM1  58.6399994 W
SPRAM[5] Crp60comp.4
GPOXL5 0.500
SPOFF5 0 Hz
SPE5 6.93809986 W
SPRAM[8] Crp69.0.5,20.1
GPOXL8 0.500
SPOFF8 0 Hz
SPE8 6.93809986 W

------- CHANNEL F2 -------
SFCl 405.1320000 MHz
NQC2 1H
CPPO[2] waltz216
PCPD2 90.00 use
PLM2 24.29199982 W
PLM12 0.28218801 W
F2 - Processing parameters
G1  65536
GT  100.6127690 MHz
MDW EM
DSB 0
LB  2.00 Hz
GR  0
PC  1.00
WB2-86 0mol%

$^1$H NMR (1)

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Current Data Parameters
NAME  09-02-Power-57
EXPNO  10
PROCNO  1

F1 - Acquisition Parameters
Date_  20140902
Time  17:57
INSTRUM  spect
PROBHD  5 mm PASSBO BB-
PD1PFGO  ep30
TD  32768
SOLVENT  CDCl3
NS  32
DS  2
SWH  6009.615 Hz
PIDSRES  0.183399 Hz
AQ  2.7262976 sec
RG  228
DW  83.200 ues
DE  12.89 ues
TE  284.2 K
DI  1.000000000 sec
TD0  1

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SP01  300.1318534 MHz
NUC1  1H
P1  12.80 ues
PLW1  9.577300007 W

F2 - Processing parameters
SI  32768
SF  300.1300101 MHz
MOW  EM
ZE  0
LB  0.30 Hz
GB  0
PC  1.00
$^1$H NMR (2a)
$^{13}$C NMR (2a)
$^1$H NMR (2b)
$^{13}$C NMR (2b)

**Current Data Parameters**

- **NAME**: 02-10-Ponsey-22
- **EXPNO**: 10
- **PROCNO**: 1

**Acquisition Parameters**

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- Time: 2.20
- **B1**: Spect
- **reso**: 5 mm PULD: 13C
- **PULPROG**: udef7
- **TD**: 18178
- **SOLVENT**: CDCl3
- **NS**: 380
- **DS**: 0
- **ZHN**: 25255.525 Hz
- **FIDRES**: 1.3891 Hz
- **AQ**: 0.3599244 sec
- **BG**: 2050
- **DW**: 19.800 usec
- **DE**: 8.000 usec
- **TE**: 293.1 K
- **D1**: 3.000000000 sec
- **D11**: 0.030000000 sec
- **D12**: 0.000000000 sec
- **D20**: 200.000000000 sec
- **TD0**: 380

**Channel 1**

- **F1**: 100.624600 MHz
- **NUCL**: 13C
- **F1**: 8.400 usec
- **P1**: 2000.000 usec
- **P13**: 500.000 usec
- **PL1**: 58.6389994 W
- **SPM1**: 5 Crp60comp.4
- **SPORL5**: 0 Hz
- **SPORL5**: 6.93809986 W
- **SPORL5**: 0 Hz
- **SPORL5**: 5.500
- **SPORL5**: 0 Hz
- **SPORL5**: 6.93809986 W

**Channel 2**

- **F2**: 480.152000 MHz
- **NUCL**: 1H
- **CPD**: walt216
- **BCPD**: 90.000 usec
- **PLM**: 24.29199982 W
- **PLM**: 0.28218001 W

**Processing Parameters**

- **SI**: 55536
- **ZF**: 100.612766 MHz
- **WDW**: EM
- **SUB**: 0
- **LB**: 2.00 Hz
- **SH**: 0
- **PC**: 1.00
$^1$H NMR (2c)
$^{13}$C NMR (2c)

Current Data Parameters
NMR 02-09-Fazey-2
EXPND 10
PROCNO 1

F2 - Acquisition Parameters
Date_ 2010/209
Time 11:03
INSTRUM spect
PULPROG 5 mm PABOL 13C
SOVLD
TU 18178
SOLVENT CDCl3
NS 360
DG 0
SNR 25252.525 Hz
P1 1.388181 Hz
AQ 0.3599244 sec
DG 2050
DW 19.800 usec
DM 8.20 usec
TE 29.0 K
D1 3.00000000 sec
D11 0.03000000 sec
D12 0.00020000 sec
D20 200.00000000 sec
TD 380

--- CHANNEL F1 ---
SF01 100.6242660 MHz
NUC1 13C
P1 1.80 usec
P13 2000.00 usec
P16 500.00 usec
PLM1 58.6389999 W
SFNAM[5] Crp600 comp. 4
SFOAL2 0.500
SFOFF2 0 Hz
SFW5 6.93809986 W
SFW8[8] Crp60, 0.5, 20.1
SFOAL8 0.500
SFOFF2 0 Hz
SFW5 6.93809986 W

--- CHANNEL F2 ---
SF02 480.1320000 MHz
NUC2 1H
CPDPO2(w) 216
CPDPS 90.00 usec
PLM1 24.3919999 W
PLM2 0.28218001 W

F2 - Processing parameters
ST 65534
SF 100.6242660 MHz
WDM EM
SBB 0
LH 2.00 Hz
GB 0
PC 1.00
$^1$H NMR (2d)
$^{13}$C NMR (2d)
$^1$H NMR (2e)
$^{13}$C NMR (2e)

Current Data Parameters
NAME  02-04-Foxxy-10
EXPNO 10
PROCNO 1

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Date_ 20150224
Time 20:59
INSTEIN spect
PRESYS 5 mm PAGD, 13C
POLARZG adf
TD 18178
SOLVENT CDCl3
MS 380
DS 0
SNR 25252.52 Hz
FTDR33 1.389181 Hz
AQ 0.3599246 sec
MG 2050
DW 19.850 usec
DE 8.20 usec
TE 253.3 K
D1 3.60000000 sec
D11 0.03000000 sec
D12 0.00000000 sec
D20 200.0000000 sec
TD0 380

---------- CHANNEL f1 ----------
SF01 100.6242690 MHz
MOC1 13C
P1 8.80 usec
P13 2050.00 usec
P26 500.00 usec
PJWI 58.63999984 W
SPRAM[5] Crp60comp.4
SPDS[5] 0 Hz

---------- CHANNEL f2 ----------
SF02 400.1320000 MHz
MOC2 1H
GDFS[2] waltz16
PCDF2 90.00 usec
PJWI 24.29199982 W
PJWI 0.28218001 W

P2 - Processing parameters
SI 65516
SF 100.6127690 MHz
SM 0
SB 0
LB 2.00 Hz
PB 1.00
$^{1}H$ NMR (2f)
$^1$H NMR (2g)

[Chemical structure image]

Current Data Parameters
NAME 02-08-Fossey-3-1H
EXPNO 10
PROCNO 1

P2 - Acquisition Parameters
Date 20150209
Time 19.14
INSTRUM spect
PROBNO 5 mm PA90O BB-900
PULPROG zg30
TD 32768
SOLVENT CDCl3
HZ 32
DS
SW 6009.615 Hz
FDRES 0.183399 Hz
AQ 2.7262976 sec
BG 161
DW 83.200 use
DE 12.89 use
TE 294.2 K
DI 1.0050000000 sec
TD0 1

---------- CHANNEL f1 ----------
SFO1 300.1316534 MHz
NMX1 1H
P1 12.80 use
PLN1 9.577360007 W

P2 - Processing parameters
SI 32768
SF 300.1300064 MHz
MDX EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
$^{13}$C NMR (2g)
$^{19}$F NMR (2g)

WBC1-4

**Current Data Parameters**

**NMR** 05-05-Fossey-7

**EXPNO** 10

**PROCNO** 1

**F2 - Acquisition Parameters**

**Date** 20150505

**Time** 11:17

**INSTRUM** spect

**PROBNO** 5 mm PABBO BH-

**PULPROG** zpgi

**TD** 133072

**SOLVENT** CDCl3

**DS** 32

**D2** 0

**GWM** 66964,281 Hz

**FIDRES** 0.510897 Hz

**AQ** 0.9786710 sec

**RG** 456

**DW** 7.467 use

**DR** 7.27 use

**TE** 294.2 K

**DI** 3.00000000 sec

**D11** 0.00000000 sec

**TD0** 1

**----- CHANNEL F1 -----**

**SFO1** 282.3823550 MHz

**NUC1** 19F

**P1** 8.70 use

**PLM1** 30.5820073 W

**----- CHANNEL F2 -----**

**SFO2** 360.1312005 MHz

**NUC2** 1H

**CFQD[2]** waltz16

**PQD0** 90.00 use

**PLM2** 9.57730007 W

**PLM12** 0.18723000 W

**F2 - Processing parameters**

**SI** 133072

**RF** 282.4043550 MHz

**MDW** EM

**SBB** 0

**LR** 0.50 Hz

**GRR** 1.00
HPLC Traces

**34 WB Bn SM**

Cell-3 50% MeCN 50% water, 1ml/min

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<td>Sample Weight</td>
<td>1.0000</td>
</tr>
<tr>
<td>Run Time (min)</td>
<td>20.01</td>
<td>Sample Amount</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Racemic starting material

Column = Phenomenex Lux Cellulose 3

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time</th>
<th>Peak Name</th>
<th>Height mAU</th>
<th>Area mAU</th>
<th>Rel.Area %</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.53</td>
<td>n.a.</td>
<td>1311.427</td>
<td>259.060</td>
<td>49.82</td>
<td>n.a.</td>
<td>BM</td>
</tr>
<tr>
<td>2</td>
<td>8.53</td>
<td>n.a.</td>
<td>1189.898</td>
<td>260.893</td>
<td>50.18</td>
<td>n.a.</td>
<td>MB</td>
</tr>
<tr>
<td>Total</td>
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<td></td>
<td>2501.325</td>
<td>519.952</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>
Catalyst = L1
Solvent = 2,5-Hexandione
Reaction Time = 96 h
Reaction Temperature = 0°C
Catalyst = L1
Solvent = Acetone
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.55</td>
<td>n.a.</td>
<td>1201.675</td>
<td>237.272</td>
<td>66.78</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>2</td>
<td>8.57</td>
<td>n.a.</td>
<td>552.682</td>
<td>118.011</td>
<td>33.22</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1754.357</td>
<td>355.283</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>
Catalyst = L1
Solvent = MeCN
Reaction Time = 96 h
Reaction Temperature = 0°C
Catalyst = L1
Solvent = DMSO
Reaction Time = 96 h
Reaction Temperature = 0°C
**43 WB2-42 SM**

**Cell-3 50% MeCN 50% water, 1ml/min**

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Injection Volume</th>
<th>Vial Number</th>
<th>Channel</th>
<th>Sample Type</th>
<th>Wavelength</th>
<th>Control Program</th>
<th>Bandwidth</th>
<th>Quantif. Method</th>
<th>Dilution Factor</th>
<th>Recording Time</th>
<th>Sample Weight</th>
<th>Run Time (min)</th>
<th>Sample Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB2-42 SM</td>
<td>10.0</td>
<td>1_10</td>
<td>UV_VIS_3</td>
<td>unknown</td>
<td>n.a.</td>
<td>50% MeCN v 1</td>
<td>n.a.</td>
<td>50% MeCN v 1</td>
<td>1.0000</td>
<td>28/8/2014 18:13</td>
<td>1.0000</td>
<td>15.01</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Catalyst = **L1**

Solvent = 1,4 Dioxane

Reaction Time = 96 h

Reaction Temperature = 0°C

![Graph](image-url)

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time</th>
<th>Peak Name</th>
<th>Height</th>
<th>Area</th>
<th>Rel.Area</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.54</td>
<td>n.a.</td>
<td>1402.586</td>
<td>279.975</td>
<td>52.77</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>2</td>
<td>8.55</td>
<td>n.a.</td>
<td>1143.103</td>
<td>250.542</td>
<td>47.23</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
</tbody>
</table>

Total: 2545.689 530.518 100.00 0.000
Catalyst = L1
Solvent = tBuOH
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area %</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.51</td>
<td>n.a.</td>
<td>1909.535</td>
<td>410.489</td>
<td>49.99</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>2</td>
<td>8.50</td>
<td>n.a.</td>
<td>1743.787</td>
<td>410.719</td>
<td>50.01</td>
<td>n.a.</td>
<td>BMB</td>
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<tr>
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<td></td>
</tr>
</tbody>
</table>
36  WB2-44 SM

Cell-3 50% MeCN 50% water, 1ml/min

<table>
<thead>
<tr>
<th>Sample Name:</th>
<th>WB2-44 SM</th>
<th>Injection Volume:</th>
<th>10.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vial Number:</td>
<td>1_3</td>
<td>Channel:</td>
<td>UV_VIS_3</td>
</tr>
<tr>
<td>Sample Type:</td>
<td>unknown</td>
<td>Wavelength:</td>
<td>n.a.</td>
</tr>
<tr>
<td>Control Program:</td>
<td>50% MeCN v 1</td>
<td>Bandwidth:</td>
<td>n.a.</td>
</tr>
<tr>
<td>Quantif. Method:</td>
<td>50% MeCN v 1</td>
<td>Dilution Factor:</td>
<td>1.0000</td>
</tr>
<tr>
<td>Recording Time:</td>
<td>28/8/2014 16:25</td>
<td>Sample Weight:</td>
<td>1.0000</td>
</tr>
<tr>
<td>Run Time (min):</td>
<td>15.01</td>
<td>Sample Amount:</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Catalyst = L1
Solvent = tBuOH : H2O 1:1
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time</th>
<th>Peak Name</th>
<th>Height</th>
<th>Area</th>
<th>Rel.Area</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.54</td>
<td>n.a.</td>
<td>789.986</td>
<td>153.679</td>
<td>49.93</td>
<td>n.a.</td>
<td>BM</td>
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<tr>
<td>2</td>
<td>8.55</td>
<td>n.a.</td>
<td>714.878</td>
<td>154.083</td>
<td>50.07</td>
<td>n.a.</td>
<td>MB</td>
</tr>
<tr>
<td>Total</td>
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<td></td>
<td>1504.774</td>
<td>307.762</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

USB: USB2-44 SM
50% MeCN v 1 #36 [modified by Shimadzu]
### 42 WB2-48 SM

**Cell-3 50% MeCN 50% water, 1ml/min**

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Injection Volume</th>
<th>Vial Number</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB2-48 SM</td>
<td>10.0</td>
<td>1_9</td>
<td>UV_VIS_3</td>
</tr>
<tr>
<td>Sample Type</td>
<td>Wavelength:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unknown</td>
<td>n.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Program</td>
<td>Bandwidth:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% MeCN v 1</td>
<td>n.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantif. Method</td>
<td>Dilution Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% MeCN v 1</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recording Time</td>
<td>Sample Weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28/8/2014 17:58</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run Time (min)</td>
<td>Sample Amount</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.01</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph of 50% MeCN v 1 #42](modified by Shimadzu)

**Catalyst = L1**

**Solvent = THF**

**Reaction Time = 96 h**

**Reaction Temperature = 0°C**

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height mAU</th>
<th>Area mAU'min</th>
<th>Rel.Area %</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.54</td>
<td>n.a.</td>
<td>1683.354</td>
<td>347.246</td>
<td>69.75</td>
<td>n.a.</td>
<td>BM</td>
</tr>
<tr>
<td>2</td>
<td>8.55</td>
<td>n.a.</td>
<td>699.790</td>
<td>150.579</td>
<td>30.25</td>
<td>n.a.</td>
<td>MB</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td>2383.144</td>
<td>497.824</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

---

**DEFAULT/Integration**

Chromelone (c) Dionex 1996-2006
Version 6.80 SR9 Build 2673 (161349)
Catalyst = L1
Solvent = 2,5-Hexanedione : acetone 1:10
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.54</td>
<td>n.a.</td>
<td>1677.147</td>
<td>346.774</td>
<td>76.67</td>
<td>n.a.</td>
<td>BM</td>
</tr>
<tr>
<td>2</td>
<td>8.57</td>
<td>n.a.</td>
<td>494.037</td>
<td>105.495</td>
<td>23.33</td>
<td>n.a.</td>
<td>MB</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>2171.184</td>
<td>452.270</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>
Catalyst = L1
Solvent = 2,3-butanedione
Reaction Time = 96 h
Reaction Temperature = 0°C
**57 WB2-69 SM**

Cell-3 50% MeCN 50% water, 1ml/min

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Injection Volume</th>
<th>Vial Number</th>
<th>Channel</th>
<th>Sample Type</th>
<th>Wavelength</th>
<th>Control Program</th>
<th>Bandwidth</th>
<th>Quantif. Method</th>
<th>Dilution Factor</th>
<th>Recording Time</th>
<th>Run Time (min)</th>
<th>Sample Weight</th>
<th>Sample Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB2-69 SM</td>
<td></td>
<td>1_24</td>
<td></td>
<td>unknown</td>
<td>n.a.</td>
<td>50% MeCN v 1</td>
<td>n.a.</td>
<td>50% MeCN v 1</td>
<td>1.0000</td>
<td>28/8/2014 21:49</td>
<td>15.01</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Catalyst = L1

Solvent = THF : 2,5-Hexanedione 100:1

Reaction Time = 96 h

Reaction Temperature = 0°C

![Graph with peaks](chart.png)

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.51</td>
<td>n.a.</td>
<td>1421.375</td>
<td>283.815</td>
<td>55.45</td>
<td>n.a.</td>
<td>BM</td>
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<tr>
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<td>8.51</td>
<td>n.a.</td>
<td>1049.278</td>
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<td>MB</td>
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<tr>
<td>Total</td>
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<td>511.838</td>
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<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

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Operator: Shimadzu  Timebase: LC_System1  Sequence: 50% MeCN v 1  Page 1-1  18/2/2015 3:59 PM

Chromeleon (c) Dionex 1996-2006  Version 6.80 SR9 Build 2673 (161349)
55  WB2-71 SM

Cell-3 50% MeCN 50% water, 1ml/min

Catalyst = L1
Solvent = THF : 2,5-hexanedione 1:1
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.50</td>
<td>n.a.</td>
<td>1227.367</td>
<td>241.604</td>
<td>56.90</td>
<td>n.a.</td>
<td>BM</td>
</tr>
<tr>
<td>2</td>
<td>8.50</td>
<td>n.a.</td>
<td>850.574</td>
<td>182.997</td>
<td>43.10</td>
<td>n.a.</td>
<td>MB</td>
</tr>
</tbody>
</table>

Total: 2077.941 424.601 100.00 0.000
Catalyst = L1
Solvent = Acetone
Copper Source = CuBr
Reaction Time = 96 h
Reaction Temperature = 0°C

No. | Ret.Time (min) | Peak Name | Height (mAU) | Area (mAU*min) | Rel.Area (%) | Amount | Type
---|---------------|-----------|--------------|----------------|--------------|--------|---
1   | 7.56          | n.a.      | 944.956      | 184.013        | 53.77        | n.a.   | BMB
2   | 8.59          | n.a.      | 736.171      | 158.200        | 46.23        | n.a.   | BMB

Total: 1681.127 342.213 100.00 0.000
Catalyst = L1
Solvent = Acetone
Copper Source = Cu(OTf)$_2$
Reaction Time = 96 h
Reaction Temperature = 0°C
Catalyst = \text{L1}

Solvent = Acetone

Copper Source = CuI

Reaction Time = 96 h

Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret. Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel. Area (%)</th>
<th>Amount (n.a.)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.54</td>
<td>n.a.</td>
<td>954.444</td>
<td>185.554</td>
<td>64.23</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>2</td>
<td>8.57</td>
<td>n.a.</td>
<td>508,033</td>
<td>103,341</td>
<td>35.77</td>
<td>n.a.</td>
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<td>288.895</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>
54  WB2-82 SM

Cell-3 50% MeCN 50% water, 1ml/min

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Injection Volume</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB2-82 SM</td>
<td>10.0</td>
<td>UV_VIS_3</td>
</tr>
<tr>
<td>Vial Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1_21</td>
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</tr>
<tr>
<td>Sample Type</td>
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</tr>
<tr>
<td>Control Program</td>
<td>50% MeCN v 1</td>
<td></td>
</tr>
<tr>
<td>Quantif. Method</td>
<td>50% MeCN v 1</td>
<td></td>
</tr>
<tr>
<td>Recording Time</td>
<td>28/8/2014 21:03</td>
<td></td>
</tr>
<tr>
<td>Run Time (min)</td>
<td>15.01</td>
<td></td>
</tr>
</tbody>
</table>

Catalyst = L1
Solvent = Acetone
Copper Source = Cu(OAc)
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.50</td>
<td>n.a.</td>
<td>1231.918</td>
<td>242.361</td>
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<td>n.a.</td>
<td>BM</td>
</tr>
<tr>
<td>2</td>
<td>8.50</td>
<td>n.a.</td>
<td>1116.686</td>
<td>243.884</td>
<td>50.16</td>
<td>n.a.</td>
<td>MB</td>
</tr>
</tbody>
</table>

Total: 2348.604 486.245 100.00 0.000
Catalyst = L1
Solvent = Acetone
Copper Source = Cu metal
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.54</td>
<td>n.a.</td>
<td>1251.774</td>
<td>247.277</td>
<td>49.94</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
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<td>n.a.</td>
<td>1131.994</td>
<td>247.847</td>
<td>50.06</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>Total</td>
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<td>2383.768</td>
<td>495.125</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>
### 45 WB2-84 SM

**Cell-3 50% MeCN 50% water, 1ml/min**

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Injection Volume</th>
<th>Vial Number</th>
<th>Channel</th>
<th>Sample Type</th>
<th>Wavelength</th>
<th>Quantif. Method</th>
<th>Dilution Factor</th>
<th>Recording Time</th>
<th>Run Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB-24 SM</td>
<td>10.0</td>
<td>1_12</td>
<td>UV_VIS_3</td>
<td>unknown</td>
<td>n.a.</td>
<td>50% MeCN v 1</td>
<td>1.0000</td>
<td>28/8/2014 18:44</td>
<td>15.01</td>
</tr>
</tbody>
</table>

**Catalyst = L1**

**Solvent = Acetone**

**Copper Source = Cu(OAc)$_2$**

**Reaction Time = 96 h**

**Reaction Temperature = 0°C**

---

<table>
<thead>
<tr>
<th>No.</th>
<th>Rel.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount (n.a.)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.53</td>
<td>n.a.</td>
<td>1511.468</td>
<td>303.294</td>
<td>51.37</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>2</td>
<td>8.53</td>
<td>n.a.</td>
<td>1293.097</td>
<td>287.101</td>
<td>48.63</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>Total</td>
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<td>2804.565</td>
<td>590.395</td>
<td>100.00</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

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Chromeleon (c) Dionex 1996-2006
Version 6.80 SR9 Build 2673 (161349)
Catalyst = L2
Solvent = Acetone
Copper Source = CuSO₄
Additive = NaAsc
Reaction Time = 96 h

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area %</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.51</td>
<td>n.a.</td>
<td>1324.159</td>
<td>262.107</td>
<td>50.03</td>
<td>n.a.</td>
<td>BM</td>
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<tr>
<td>2</td>
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<td>n.a.</td>
<td>1192.548</td>
<td>261.744</td>
<td>49.97</td>
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<td>MB</td>
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<td>2516.707</td>
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<td>0.000</td>
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</tr>
</tbody>
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## 52 WB2-81SM

**Cell-3 50% MeCN 50% water, 1ml/min**

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>1_19</th>
<th>Injection Volume</th>
<th>10.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vial Number</td>
<td></td>
<td>Channel</td>
<td>UV_VIS_3</td>
</tr>
<tr>
<td>Sample Type</td>
<td>unknown</td>
<td>Wavelength</td>
<td>n.a.</td>
</tr>
<tr>
<td>Control Program</td>
<td>50% MeCN v 1</td>
<td>Bandwidth</td>
<td>n.a.</td>
</tr>
<tr>
<td>Quantif. Method</td>
<td>50% MeCN v 1</td>
<td>Dilution Factor</td>
<td>1.0000</td>
</tr>
<tr>
<td>Recording Time</td>
<td>28/8/2014 20:32</td>
<td>Sample Weight</td>
<td>1.0000</td>
</tr>
<tr>
<td>Run Time (min)</td>
<td>15.01</td>
<td>Sample Amount</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

**Catalyst = L2**

**Solvent = Acetone**

**Copper Source = Cu(OTf)0.5Toluene**

**Reaction Time = 96 h**

**Reaction Temperature = 0°C**

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time min</th>
<th>Peak Name</th>
<th>Height mAU</th>
<th>Area mAU*min</th>
<th>Rel.Area %</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.51</td>
<td>n.a.</td>
<td>1208.048</td>
<td>237.848</td>
<td>49.91</td>
<td>n.a.</td>
<td>BMB</td>
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<tr>
<td>2</td>
<td>8.52</td>
<td>n.a.</td>
<td>1093.990</td>
<td>238.717</td>
<td>50.09</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
</tbody>
</table>

**Total:**

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2302.038</td>
<td>476.565</td>
<td>100.00</td>
<td>0.000</td>
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Catalyst = L1
Solvent = 2,5-Hexanedione
Additive = NaAsc
Reaction Time = 96 h
Reaction Temperature = 0°C

Sample Name: WB2-105-SM
Vial Number: 1_6
Sample Type: unknown
Control Program: 50% MeCN v 1
Quantif. Method: 50% MeCN v 1
Recording Time: 25/9/2014 13:11
Run Time (min): 15.01

Injection Volume: 10.0
Channel: UV_VIS_3
Wavelength: n.a.
Bandwidth: n.a.
Dilution Factor: 1.0000
Sample Weight: 1.0000
Sample Amount: 1.0000

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.37</td>
<td>n.a.</td>
<td>1645.146</td>
<td>319.812</td>
<td>60.38</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>2</td>
<td>8.30</td>
<td>n.a.</td>
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<td>209.880</td>
<td>39.62</td>
<td>n.a.</td>
<td>BMB</td>
</tr>
<tr>
<td>Total</td>
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<td>2669.738</td>
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<td>0.000</td>
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</tr>
</tbody>
</table>
Catalyst = L1
Solvent = THF
Additive = NaAsc
Reaction Time = 96 h
Reaction Temperature = 0°C

Sample Name: WB2-106-SM
Vial Number: 1_9
Sample Type: unknown
Control Program: 50% MeCN v 1
Quantif. Method: 50% MeCN v 1
Recording Time: 25/9/2014 13:57
Run Time (min): 15.01
Injection Volume: 10.0
Channel: UV_VIS_3
Wavelength: n.a.
Bandwidth: n.a.
Dilution Factor: 1.0000
Sample Weight: 1.0000
Sample Amount: 1.0000

Me
N
O
Bn
Catalyst = L1
Solvent = THF
Additive = NaAsc
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount (n.a.)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.38</td>
<td>n.a.</td>
<td>1440.567</td>
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<td>50.34</td>
<td>n.a.</td>
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<tr>
<td>2</td>
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<td>1296.554</td>
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<td>538.581</td>
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Catalyst = L1
Solvent = THF
Reaction Time = 24 h
Reaction Temperature = 50°C
Catalyst = L1
Solvent = THF
Additive = DIPEA
Reaction Time = 96 h
Reaction Temperature = 0°C

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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</tbody>
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Catalyst = L1
Solvent = Acetone
Additive = DIPEA
Reaction Time = 96 h
Reaction Temperature = 0°C
27 WB3-178 SM

Cell 3, 50% MeCN 50% Water

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Injection Volume</th>
<th>Vial Number</th>
<th>Channel</th>
<th>Sample Type</th>
<th>Wavelength</th>
<th>Control Program</th>
<th>Bandwidth</th>
<th>Quantif. Method</th>
<th>Dilution Factor</th>
<th>Recording Time</th>
<th>Sample Weight</th>
<th>Run Time (min)</th>
<th>Sample Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB3-178 SM</td>
<td>10.0</td>
<td>1_6</td>
<td>UV_VIS_1</td>
<td>unknown</td>
<td>254</td>
<td>Isocratic 50 50 water MeCN</td>
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</table>

Catalyst = L1
Solvent = 2,5-Hexanediode
Reaction Time = 96 h
Reaction Temperature = 0°C
Azide = 3b

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount (ng)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
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<td>226.589</td>
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<td>16.57</td>
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</tbody>
</table>
Catalyst = L1
Solvent = 2,5-Hexanedione
Reaction Time = 96 h
Reaction Temperature = 0°C
Azide = 3d

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height mAU</th>
<th>Area mAU*min</th>
<th>Rel.Area</th>
<th>Amount</th>
<th>Type</th>
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<tr>
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</tbody>
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Catalyst = L1
Solvent = 2,5-Hexanedione
Reaction Time = 96 h
Reaction Temperature = 0°C
Azide = 3d
Racemic product

Column = Phenomenex Lux Cellulose 3

<table>
<thead>
<tr>
<th>No</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (mAU)</th>
<th>Area (mAU*min)</th>
<th>Rel.Area (%)</th>
<th>Amount</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
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Catalyst = L1

Solvent = 2,5-Hexanedione

Reaction Time = 96 h

Reaction Temperature = 0°C
References

