

Enantioselective Conjugate Hydrosilylation of α,β -Unsaturated Ketones

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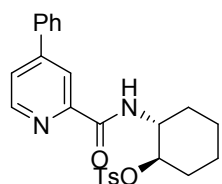
1. General remarks

Chemicals were purchased from commercial suppliers and used without further purification unless otherwise stated. Solvents were dried and purified according to the standard procedures before use. Reactions were monitored by TLC. Racemic products were obtained from corresponding substrates catalyzed by dry DMF at room temperature. Flash column chromatography was performed on silica gels (200-300 mesh). ¹H NMR and ¹³C NMR (300 or 400 and 75 or 100 MHz, respectively) spectra were recorded on a Bruker 300 MHz or 400 MHz NMR spectrometer in CDCl₃ or DMSO. ¹H NMR chemical shifts are reported in ppm (δ) relative to tetramethylsilane (TMS) with the solvent resonance employed as the internal standard (CDCl₃, δ 7.26 ppm, DMSO-d₆ at 2.50 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, brs = broad singlet, d = doublet, t = triplet, td = triplet of doublets, q = quartet, m = multiplet), coupling constants (Hz) and integration. ¹³C NMR chemical shifts are reported in ppm from tetramethylsilane (TMS) with the solvent resonance as the internal standard (CDCl₃, δ 77.0 ppm, DMSO-d₆ at 39.51 ppm). All enantiomeric ratios have been controlled by co-injections of the pure sample with the racemates. HRMS data were obtained on a Bruker Daltonics. Inc mass instrument (ESI). Chiralpak AD-H column, Chiralcel OD column and Chiralpak IC column were purchased from Daicel Chemical Industries (Hong Kong, China). Optical rotations were measured on a Perkin-Elmer 241 Polarimeter. Melting points were recorded on a Buchi Melting Point B-545.

2. Procedures and characterizations data of compounds.

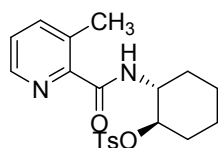
2.1 Synthesis of novel lewis base catalysts: catalysts 2a,^[1] 2b,^[2] 2c,^[3] 2d-2i,^[4] were synthesized according to the literature procedures and the analytical data were identical

to those of literatures. Catalysts 2j-2m were synthesized according to the literature procedure.^[4]



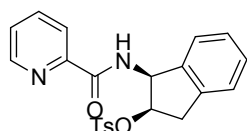
(1R,2R)-2-(4-phenylpicolinamido)cyclohexyl 4-methylbenzene-

sulfonate (2j): white solid, m.p: 124-125°C, 32% yield. ¹H NMR (300 MHz, CDCl₃) δ 8.54 (d, *J* = 5.1 Hz, 1H), 8.34 (d, *J* = 1.5 Hz, 1H), 8.04 (d, *J* = 7.9 Hz, 1H), 7.74-7.64 (m, 5H), 7.55 - 7.48 (m, 3H), 7.03 (d, *J* = 8.3 Hz, 2H), 4.62 - 4.53 (m, 1H), 4.14 - 4.04 (m, 1H), 2.21 (s, 3H), 2.16 - 2.13 (m, 2H), 1.83 - 1.67 (m, 3H), 1.48 - 1.32 (m, 3H). ¹³C NMR (100 MHz, DMSO) δ 163.3, 150.8, 149.2, 148.9, 144.2, 137.1, 134.3, 131.3, 130.1, 129.9, 128.5, 127.4, 125.9, 124.0, 119.4, 84.5, 51.3, 33.1, 31.3, 24.3, 24.0, 21.4. [α]^{20.0}_D = -27.6 (c = 0.5, CH₂Cl₂); HRMS (ESI): Calcd. for [C₂₅H₂₆N₂O₄S+H]⁺ 451.1613, found 451.1686.



(1R,2R)-2-(3-methylpicolinamido)cyclohexyl 4-methylbenzene-

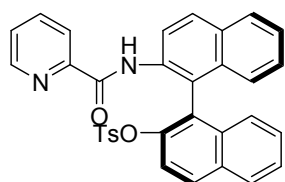
sulfonate (2k): white solid, m.p: 75-76°C, 45% yield. ¹H NMR (300 MHz, CDCl₃) δ 8.35-8.33 (m, 1H), 8.09 (d, *J* = 9.5 Hz, 1H), 7.66 (d, *J* = 8.3 Hz, 2H), 7.58 - 7.55 (m, 1H), 7.30 (dd, *J* = 4.6 Hz, 1H), 7.01 (d, *J* = 8.0 Hz, 2H), 4.57-4.49 (m, 1H), 4.07-3.96 (m, 1H), 2.66 (s, 3H), 2.26 (s, 3H), 2.19- 2.04 (m, 2H), 1.80-1.69 (m, 3H), 1.45-1.26 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 165.3, 146.8, 145.2, 144.0, 140.7, 135.5, 134.3, 129.4, 127.5, 125.6, 83.1, 51.6, 32.4, 31.7, 24.0, 24.0, 21.6, 20.6. [α]^{20.0}_D = -53.6 (c= 0.5, CH₂Cl₂); HRMS (ESI): Calcd for [C₂₀H₂₄N₂O₄S+H]⁺ 389.1457, found 389.1530.



(1S,2R)-1-(picolinamido)-2,3-dihydro-1H-inden-2-yl 4-methyl-

benzenesulfonate (2l): white solid, m.p: 123-124°C, 57% yield. ¹H NMR (300 MHz, DMSO) δ 8.68 (d, *J* = 4.1 Hz, 1H), 8.38 (d, *J* = 9.6 Hz, 1H), 8.09-8.04 (m, 1H), 8.02-7.94 (m, 1H), 7.83-7.52 (m, 3H), 7.50-7.14 (m, 4H), 7.10 (d, *J* = 8.0 Hz, 2H), 5.72-5.67 (m, 1H), 5.33-5.30 (m, 1H), 3.40 (d, *J* = 4.6 Hz, 1H), 3.10 (d, *J* = 17.2 Hz, 1H), 2.22 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 164.2, 149.2, 148.2, 144.5, 139.5, 138.5, 137.2, 133.3, 129.5, 128.6, 127.9, 127.5, 126.4, 125.3, 123.6, 122.3, 83.6, 55.9, 38.5, 21.6.

$[\alpha]^{20.0}_D = -4.8$ ($c = 0.5$, CH_2Cl_2); HRMS (ESI): Calcd. for $[\text{C}_{22}\text{H}_{20}\text{N}_2\text{O}_4\text{S}+\text{H}]^+$ 409.1144, found 409.1217.

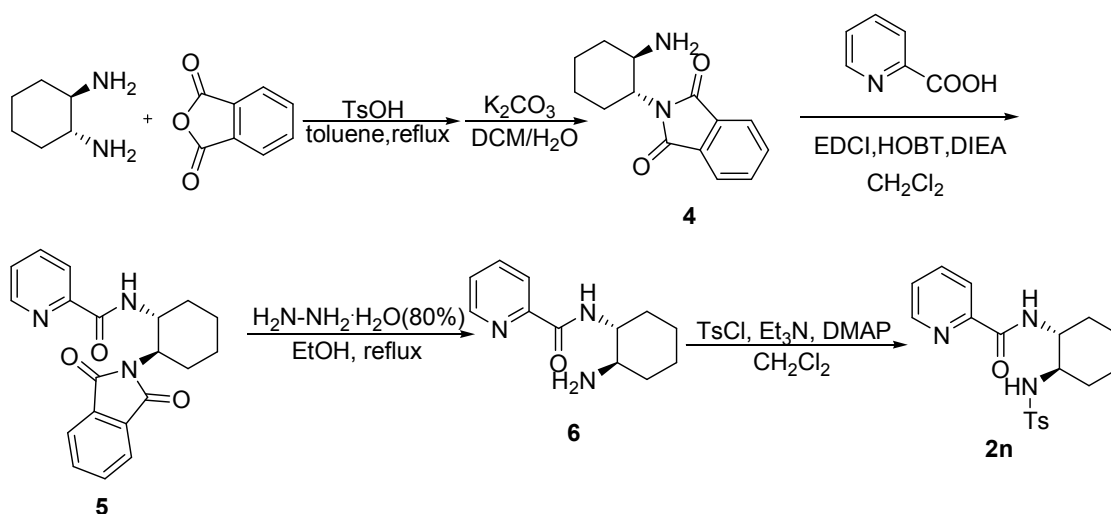


(R)-1-(2-(picolinamido)naphthalen-1-yl)naphthalen-2-yl 4-methyl-

benzenesulfonate (2m): white solid, m.p: 211 - 212°C, 40% yield. ^1H

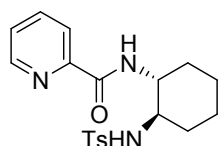
NMR (300 MHz, d -DMSO) δ 9.64 (s, 1H), 8.61 (d, $J = 9.1$ Hz, 1H), 8.29 (d, $J = 9.0$ Hz, 1H), 8.17-8.11 (m, 3H), 8.07 - 7.93 (m, 3H), 7.66 (d, $J = 9.1$ Hz, 1H), 7.55 - 7.43 (m, 3H), 7.36 - 7.24 (m, 2H), 7.13 (d, $J = 8.3$ Hz, 2H), 7.01 (t, $J = 9.8$ Hz, 3H), 6.84 (d, $J = 8.7$ Hz, 1H), 2.21 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 161.9, 149.5, 147.8, 146.1, 144.6, 137.3, 134.8, 133.1, 132.7, 132.6, 132.4, 130.8, 130.6, 129.4, 129.2, 128.2, 127.8, 127.5, 127.4, 126.6, 126.5, 126.3, 126.1, 125.8, 124.7, 124.5, 12.0, 121.9, 120.1, 119.7, 21.6. $[\alpha]^{20.0}_D = -87.6$ ($c = 0.5$, CH_2Cl_2); HRMS (ESI): Calcd for $[\text{C}_{33}\text{H}_{24}\text{N}_2\text{O}_4\text{S}+\text{H}]^+$ 545.1547, found 545.1530.

Synthesis of catalyst 2n:



To a solution of (1R,2R)-cyclohexane-1,2-diamine (10.0 mmol) in 35 mL of toluene was added tosyl acid (11.0 mmol) and phthalic anhydride (10.0 mmol). The mixture was heated under reflux for 8 hours. Then the mixture was cooled to room temperature and the precipitate was separated by filtration. To the solid was added 35 mL of CH_2Cl_2 and 25 mL of water. Then K_2CO_3 was added to the mixture until $\text{pH} = 9$. The mixture was stirred at room temperature overnight and the phases were separated. The aqueous phase was extracted with CH_2Cl_2 (3×30 mL). The combined organic layer was dried over anhydrous Na_2SO_4 . The solvents were

removed under reduced pressure. The crude product (**4**) was used in the next step without further purification. To a solution of pyridine-2-carboxylic acid (2.2 mmol) in 15 mL of CH₂Cl₂ was added EDCI (2.4 mmol), HOBT (2.4 mmol) and DIEA (4.0 mmol) successively. The mixture was cooled with an ice-water bath and stirred for 20 minutes. Then compound **4** (2.0 mmol) was added in the solution. The solution was stirred overnight, during which time the reaction temperature naturally rose to room temperature. The solvent was removed under reduced pressure. Then saturated aqueous NaHCO₃ (20 mL) was added to the residue and the aqueous layer was extracted with EtOAc (3×15 mL). The combined organic layer was dried over anhydrous Na₂SO₄. The solvents were removed under reduced pressure. The residue was purified by silica-gel chromatography with ethyl acetate/petroleum ether to give the pure product **5** (555.0 mg, 1.6 mmol). Then compound **5** (555.0 mg, 1.6 mmol) was dissolved in 4 mL of EtOH and hydrazine hydrate (80%, 300 μL, 3.0 eq.) was added in the solution. The mixture was heated under reflux for 0.5 hour. Then the mixture was cooled to room temperature and the precipitate was separated by filtration. The solid was dissolved in 10 mL of CH₂Cl₂. Then Et₃N (4.8 mmol) and DMAP (0.16 mmol) were added in the solution. The mixture was stirred at 0 °C for 0.5 hour. Then tosyl chloride (1.6 mmol) was added in the solution and the solution was stirred overnight, during which time the reaction temperature naturally rose to room temperature. The solvents were removed under reduced pressure. The residue was purified by silica-gel chromatography with ethyl acetate/petroleum ether to give the pure product **2n**.

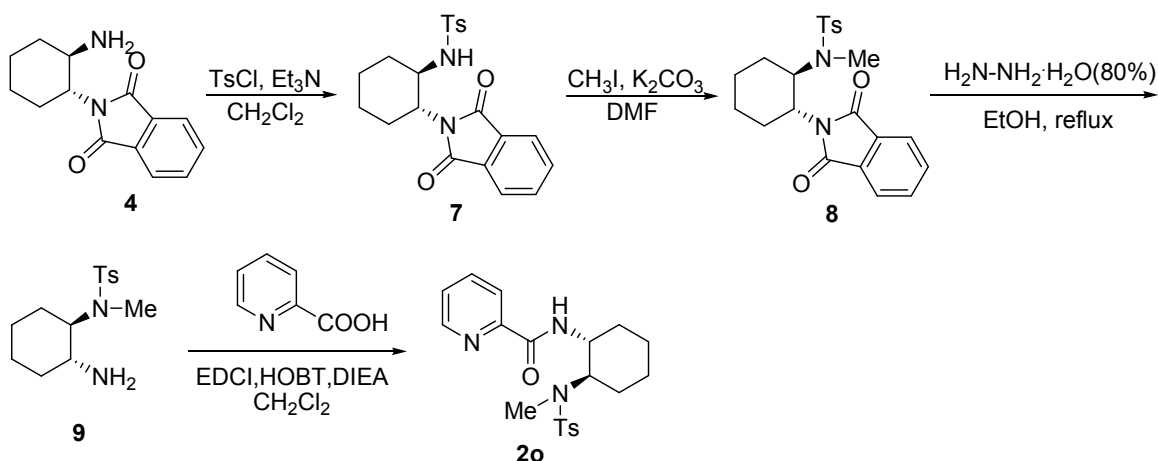


N-((1R,2R)-2-(4-methylphenylsulfonamido)cyclohexyl)picolinamide

(2n): white solid, m.p: 173-174°C, 60 % yield. ¹H NMR (300 MHz, CDCl₃):

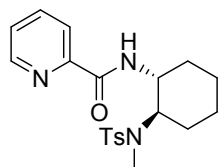
δ 8.41 (d, *J* = 4.5 Hz, 1H), 8.11 (d, *J* = 7.8 Hz, 1H), 7.91 - 7.85(m, 1H), 7.63 (d, *J* = 8.0 Hz, 1H), 7.53 (d, *J* = 8.2 Hz, 2H), 7.47 - 7.43(m, 1H), 6.75 (d, *J* = 9.0 Hz, 2H), 5.97 (d, *J* = 5.3 Hz, 1H), 3.85 - 3.74(m, 1H), 3.04 - 2.94(m, 1H), 2.25 (d, *J* = 13.9 Hz, 1H), 2.12(s, 3H), 1.99 - 1.95(m, 1H), 1.77-1.72(m, 2H), 1.52 - 1.39(m, 1H), 1.37 - 1.25(m, 3H). [α]^{20.0}_D = -8.6 (c = 0.5, CH₂Cl₂); HRMS (ESI): Calcd for [C₁₉H₂₃N₃O₃S+H]⁺ 374.1460, found 374.1533.

Synthesis of catalyst **2o**:



To a solution of compound **4** (2.5 mmol) in 25 mL of CH_2Cl_2 was added Et_3N (13.0 mmol) and tosyl chloride (2.5 mmol) were added in the solution and the solution was stirred overnight at room temperature. The solvents were removed under reduced pressure. The residue was purified by silica-gel chromatography with ethyl acetate/petroleum ether to give the pure product **7** (800 mg). Then compound **7** (800 mg) was dissolved in 4 mL of DMF and K_2CO_3 (2.2 mmol) and CH_3I (2.2 mmol) were added to the solution. The mixture was stirred overnight at room temperature. Then water was added in the solution. The aqueous phase was extracted with EtOAc (3×15 mL). The combined organic layer was dried over anhydrous Na_2SO_4 . The solvents were removed under reduced pressure. The residue was purified by silica-gel chromatography with ethyl acetate/petroleum ether to give the pure product **8**. Then the same procedures of deprotection and condensation with pyridine-2-carboxylic acid as above afforded the catalyst **2o**.

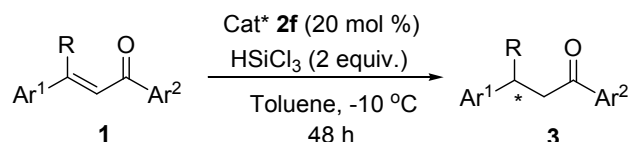
N-((1R,2R)-2-(N,4-dimethylphenylsulfonamido)cyclohexyl)picolinamide (2o): white solid,



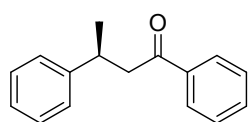
m.p: 108-109°C, 43 % yield. ^1H NMR (300 MHz, CDCl_3): δ 8.59 (d, $J = 4.6$ Hz, 1H), 8.12 (t, $J = 9.3$ Hz, 2H), 7.86 - 7.80 (m, 1H), 7.62 (d, $J = 8.2$ Hz, 2H), 7.44-7.40 (m, 1H), 7.06 (d, $J = 8.1$ Hz, 2H), 4.13 - 3.99 (m, 1H), 3.89 - 3.80 (m, 1H), 2.77 (s, 3H), 2.30 (s, 3H), 2.22-2.18 (m, 1H), 1.86 - 1.69 (m, 2H), 1.53-1.50 (m, 1H), 1.46 - 1.23 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ 164.0, 149.8, 148.2, 142.8, 137.4,

137.1, 129.4, 127.0, 126.0, 122.1, 60.0, 49.0, 33.4, 29.3, 28.6, 25.2, 24.7, 21.5. $[\alpha]^{20.0}_D = -12.4$ ($c = 0.5$, CH_2Cl_2); HRMS (ESI): Calcd. for $[\text{C}_{20}\text{H}_{25}\text{N}_3\text{O}_3\text{S}+\text{H}]^+$ 388.1617, found 388.1689.

2.2 Enantioselective conjugate hydrosilylation of α,β -unsaturated ketones **1**



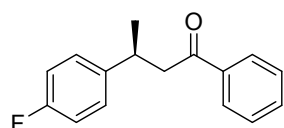
A solution of trichlorosilane (21 μL , 0.2 mmol, 2.0 equiv) in 0.5 mL of toluene was added to a stirred solution of the corresponding α,β -unsaturated ketones (0.1 mmol) and the catalyst **2f** (0.02 mmol) in toluene (2.0 mL) at -10°C . The mixture was stirred at the same temperature for 48 hours. The reaction mixture was then treated with saturated aqueous solution of NaHCO_3 at room temperature for 20 minutes. Then the mixture was extracted with EtOAc. The combined extracts were washed with brine and dried over anhydrous Na_2SO_4 . The solvents were removed under reduced pressure. The residue was purified by silica-gel chromatography with ethyl acetate/petroleum ether to give the pure product. The *ee* values were determined using established HPLC techniques with chiral stationary phases.



(S)-1,3-diphenylbutan-1-one (3a): white solid, 97% yield, 65% *ee*.

HPLC conditions: IC column, hexane/*i*PrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{\text{major}} = 6.43$ min, $t_{\text{minor}} = 6.82$ min; ^1H

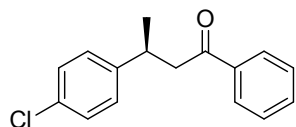
NMR (300 MHz, CDCl_3) δ 7.95-7.92 (m, 2H), 7.58 - 7.52 (m, 1H), 7.47 - 7.42 (m, 2H), 7.34 - 7.29 (m, 4H), 7.23 - 7.17 (m, 1H), 3.57 - 3.45 (m, 1H), 3.35 - 3.15 (m, 2H), 1.34 (d, $J = 6.9$ Hz, 3H).



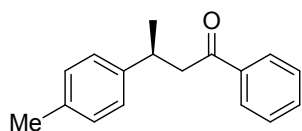
(S)-3-(4-fluorophenyl)-1-phenylbutan-1-one (3b): colorless oil, 98% yield, 50% *ee*. HPLC conditions: AD-H column, hexane/*i*PrOH = 95/5,

flow rate 1.0 mL/min, UV detection at 254 nm, $t_{\text{minor}} = 6.96$ min, $t_{\text{major}} = 8.26$ min; ^1H NMR (300 MHz, *d*-DMSO) δ 7.93-7.90 (m, 2H), 7.58 - 7.53 (m, 1H), 7.47 -

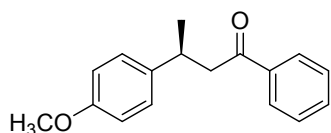
7.42 (m, 2H), 7.26 - 7.20 (m, 2H), 7.01 - 6.93 (m, 2H), 3.56 - 3.44 (m, 1H), 3.31 - 3.13 (m, 2H), 1.32 (d, $J = 6.9$ Hz, 3H).



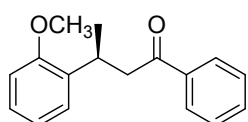
(S)-3-(4-chlorophenyl)-1-phenylbutan-1-one (3c): colorless oil, 94% yield, 48% ee. HPLC conditions: AD-H column, hexane/iPrOH = 95/5, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 7.01$ min, $t_{r_{major}} = 8.80$ min; $^1\text{H NMR}$ (300 MHz, *d*-DMSO) δ 7.93-7.90 (m, 2H), 7.58-7.53 (m, 1H), 7.47-7.42 (m, 2H), 7.28-7.27 (m, 1H), 7.25-7.19 (m, 3H), 3.55-3.44 (m, 1H), 3.31-3.13 (m, 2H), 1.32 (d, $J = 6.9$ Hz, 3H).



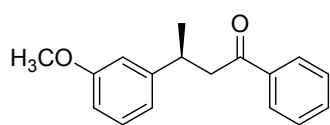
(S)-1-phenyl-3-(p-tolyl)butan-1-one (3d): white solid, 97% yield, 53% ee. HPLC conditions: AD-H column, hexane/iPrOH = 95/5, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 5.88$ min, $t_{r_{major}} = 7.24$ min; $^1\text{H NMR}$ (300 MHz, *d*-DMSO) δ 7.93 (d, $J = 7.5$ Hz, 2H), 7.55 (t, $J = 7.3$ Hz, 1H), 7.44 (t, $J = 7.6$ Hz, 2H), 7.16-7.10 (m, 4H), 3.53 - 3.41 (m, 1H), 3.32 - 3.13 (m, 2H), 2.32 (s, 3H), 1.32 (d, $J = 6.9$ Hz, 3H).



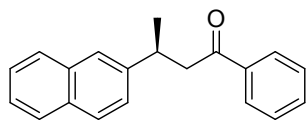
(S)-3-(4-methoxyphenyl)-1-phenylbutan-1-one (3e): colorless oil, 91% yield, 62% ee. HPLC conditions: AD-H column, hexane/iPrOH = 95/5, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 8.92$ min, $t_{r_{major}} = 11.47$ min; $^1\text{H NMR}$ (300 MHz, *d*-DMSO) δ 7.94 - 7.91 (m, 2H), 7.58 - 7.52 (m, 1H), 7.47 - 7.42 (m, 2H), 7.21 - 7.17 (m, 2H), 6.87 - 6.82 (m, 2H), 3.78 (s, 3H), 3.54 - 3.41 (m, 1H), 3.31 - 3.11 (m, 2H), 1.31 (d, $J = 6.9$ Hz, 3H).



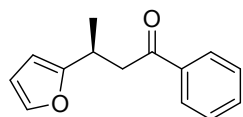
(S)-3-(2-methoxyphenyl)-1-phenylbutan-1-one (3g): colorless oil, 92% yield, 20% ee. HPLC conditions: IC column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{major}} = 9.91$ min, $t_{r_{minor}} = 10.69$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 8.00 (d, $J = 7.3$ Hz, 2H), 7.56 (t, $J = 7.3$ Hz, 1H), 7.45 (t, $J = 7.5$ Hz, 2H), 7.26 - 7.18 (m, 2H), 6.94 (t, $J = 7.4$ Hz, 1H), 6.87 (d, $J = 8.1$ Hz, 1H), 3.91 - 3.79 (m, 4H), 3.41 - 3.01 (m, 2H), 1.31 (d, $J = 6.9$ Hz, 3H).



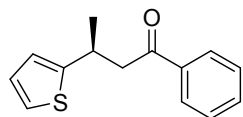
(S)-3-(3-methoxyphenyl)-1-phenylbutan-1-one (3h): colorless oil, 91% yield, 58% ee. HPLC conditions: IC column, hexane/iPrOH = 95/5, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{major}} = 7.54$ min, $t_{r_{minor}} = 9.19$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.95 - 7.92 (m, 2H), 7.58 - 7.53 (m, 1H), 7.47 - 7.42 (m, 2H), 7.22 (d, $J = 7.9$ Hz, 1H), 6.88 (d, $J = 7.7$ Hz, 1H), 6.83 (t, $J = 2.1$ Hz, 1H), 6.77 - 6.73 (m, 1H), 3.80 (s, 3H), 3.56 - 3.43 (m, 1H), 3.34 - 3.14 (m, 2H), 1.33 (d, $J = 6.9$ Hz, 3H).



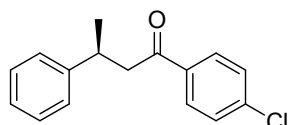
(S)-3-(naphthalen-2-yl)-1-phenylbutan-1-one (3i): white solid, 97% yield, 65% ee. HPLC conditions: AD-H column, hexane/iPrOH = 95/5, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 8.00$ min, $t_{r_{major}} = 9.24$ min; $^1\text{H NMR}$ (300 MHz, d -DMSO) δ 7.99 - 7.96 (m, 2H), 7.86 - 7.78 (m, 4H), 7.65 - 7.60 (m, 1H), 7.55 - 7.40 (m, 5H), 3.57 - 3.40 (m, 3H), 1.33 (d, $J = 6.5$ Hz, 3H).



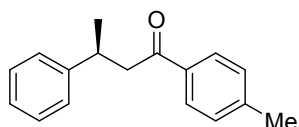
(S)-3-(furan-2-yl)-1-phenylbutan-1-one (3k): white solid, 90% yield, 57% ee. HPLC conditions: AD-H column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 6.97$ min, $t_{r_{major}} = 8.03$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.90 - 7.87 (m, 2H), 7.52 - 7.46 (m, 1H), 7.41 - 7.36 (m, 2H), 7.23 - 7.22 (m, 1H), 6.21 - 6.19 (m, 1H), 6.02 (d, $J = 3.2$ Hz, 1H), 3.65 - 3.5 (m, 1H), 3.39 - 2.97 (m, 2H), 1.26 (d, $J = 6.9$ Hz, 3H).



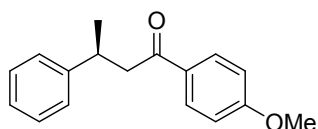
(S)-1-phenyl-3-(thiophen-2-yl)butan-1-one (3l): white solid, 96% yield, 59% ee. HPLC conditions: AD-H column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 8.23$ min, $t_{r_{major}} = 9.34$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.96 - 7.94 (m, 2H), 7.57 (t, $J = 7.3$ Hz, 1H), 7.46 (t, $J = 7.5$ Hz, 2H), 7.14 - 7.12 (m, 1H), 6.94 - 6.87 (m, 2H), 3.92 - 3.80 (m, 1H), 3.42 - 3.17 (m, 2H), 1.43 (d, $J = 6.9$ Hz, 3H).



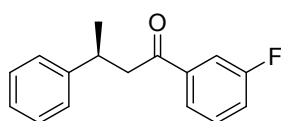
(S)-1-(4-chlorophenyl)-3-phenylbutan-1-one (3n): colorless oil, 95% yield, 64% ee. HPLC conditions: AD-H column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{minor}}} = 9.05$ min, $t_{r_{\text{major}}} = 10.71$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.88 - 7.84 (m, 2H), 7.43 - 7.39 (m, 2H), 7.34 - 7.27 (m, 3H), 7.25 - 7.17 (m, 1H), 3.55 - 3.43 (m, 1H), 3.31 - 3.11 (m, 2H), 1.34 (d, $J = 6.9$ Hz, 3H).



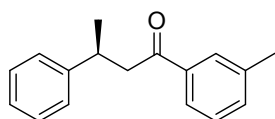
(S)-3-phenyl-1-(p-tolyl)butan-1-one (3o): white solid, 94% yield, 58% ee. HPLC conditions: AD-H column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{minor}}} = 10.13$ min, $t_{r_{\text{major}}} = 13.40$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.84 (d, $J = 8.2$ Hz, 2H), 7.33 - 7.28 (m, 4H), 7.25 - 7.17 (m, 3H), 3.56 - 3.44 (m, 1H), 3.31 - 3.12 (m, 2H), 2.40 (s, 3H), 1.33 (d, $J = 6.9$ Hz, 3H).



(S)-1-(4-methoxyphenyl)-3-phenylbutan-1-one (3p): white solid, 94% yield, 59% ee. HPLC conditions: AD-H column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{minor}}} = 20.17$ min, $t_{r_{\text{major}}} = 27.94$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.93 - 7.90 (m, 2H), 7.33 - 7.28 (m, 4H), 7.22 - 7.16 (m, 1H), 6.91 (d, $J = 8.9$ Hz, 2H), 3.86 (s, 3H), 3.56 - 3.43 (m, 1H), 3.28 - 3.09 (m, 2H), 1.33 (d, $J = 6.9$ Hz, 3H).

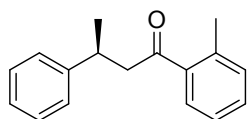


(S)-1-(3-fluorophenyl)-3-phenylbutan-1-one (3q): white solid, 91% yield, 54% ee. HPLC conditions: IC column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{major}}} = 6.18$ min, $t_{r_{\text{minor}}} = 6.56$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.74 - 7.65 (m, 1H), 7.62 - 7.57 (m, 1H), 7.45 - 7.38 (m, 1H), 7.33 - 7.27 (m, 4H), 7.25 - 7.17 (m, 2H), 3.55 - 3.44 (m, 1H), 3.32 - 3.11 (m, 2H), 1.34 (d, $J = 6.9$ Hz, 3H).

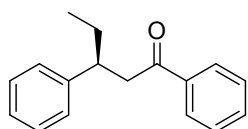


(S)-3-phenyl-1-(m-tolyl)butan-1-one (3r): white solid, 95% yield, 52% ee. HPLC conditions: IC column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{major}}} = 7.23$ min, $t_{r_{\text{minor}}} = 7.89$ min.

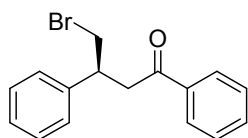
min; ^1H NMR (300 MHz, CDCl_3) δ 7.72 (d, $J = 6.8$ Hz, 2H), 7.35 - 7.28 (m, 6H), 7.22 - 7.14 (m, 1H), 3.36 - 3.44 (m, 1H), 3.32 - 3.13 (m, 2H), 2.40 (s, 3H), 1.34 (d, $J = 6.9$ Hz, 3H).



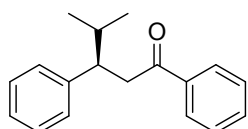
(S)-3-phenyl-1-(o-tolyl)butan-1-one (3s): colorless oil, 90% yield, 28% ee. HPLC conditions: AD-H column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{minor}}} = 6.15$ min, $t_{r_{\text{major}}} = 6.90$ min; ^1H NMR (300 MHz, CDCl_3) δ 7.46 (d, $J = 7.8$ Hz, 1H), 7.39 - 7.28 (m, 2H), 7.25 - 7.15 (m, 6H), 3.51 - 3.40 (m, 1H), 3.25 - 3.07 (m, 2H), 2.35 (s, 3H), 1.32 (d, $J = 6.9$ Hz, 3H).



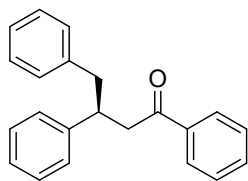
(S)-1,3-diphenylpentan-1-one (3t): white solid, 94% yield, 65% ee. HPLC conditions: AD-H column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{minor}}} = 7.95$ min, $t_{r_{\text{major}}} = 10.16$ min; ^1H NMR (300 MHz, CDCl_3) δ 7.91 - 7.89 (m, 2H), 7.56 - 7.41 (m, 1H), 7.45 - 7.40 (m, 2H), 7.31 - 7.27 (m, 2H), 7.26 - 7.15 (m, 3H), 3.34 - 3.19 (m, 3H), 1.86 - 1.57 (m, 2H), 0.80 (t, $J = 7.3$ Hz, 3H).



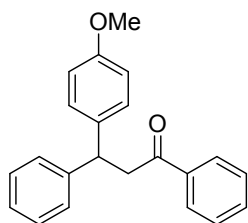
(S)-4-bromo-1,3-diphenylbutan-1-one (3u): colorless oil, 76% yield, 67% ee. HPLC conditions: IC column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{major}}} = 13.06$ min, $t_{r_{\text{minor}}} = 13.84$ min; ^1H NMR (300 MHz, CDCl_3) δ 8.03 - 7.93 (m, 2H), 7.66 - 7.43 (m, 4H), 7.36 - 7.27 (m, 3H), 7.25 - 7.23 (m, 1H), 3.84 - 3.78 (m, 1H), 3.76 - 3.66 (m, 2H), 3.62 (d, $J = 6.1$ Hz, 1H), 3.47 - 3.39 (m, 1H).



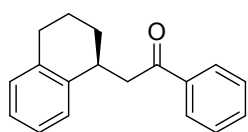
(R)-4-methyl-1,3-diphenylpentan-1-one (3v): white solid, 88% yield, 65% ee. HPLC conditions: IC column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{\text{major}}} = 8.68$ min, $t_{r_{\text{minor}}} = 10.42$ min; ^1H NMR (300 MHz, CDCl_3) δ 7.90 - 7.87 (m, 2H), 7.56 - 7.50 (m, 1H), 7.45 - 7.39 (m, 2H), 7.28 - 7.27 (m, 2H), 7.25 - 7.12 (m, 3H), 3.37 (d, $J = 7.0$ Hz, 2H), 3.20 - 3.13 (m, 1H), 2.00 - 1.89 (m, 1H), 0.99 (d, $J = 6.7$ Hz, 3H), 0.79 (d, $J = 6.7$ Hz, 3H).



(S)-1,3,4-triphenylbutan-1-one (3x): white solid, 91% yield, 59% ee. HPLC conditions: IC column, hexane/iPrOH = 98/2, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{major}} = 11.40$ min, $t_{r_{minor}} = 11.99$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.96 - 7.83 (m, 2H), 7.58 - 7.49 (m, 1H), 7.44 - 7.33 (m, 2H), 7.31 - 7.14 (m, 8H), 7.10 - 7.07 (m, 2H), 3.72 - 3.62 (m, 1H), 3.40 - 3.24 (m, 2H), 3.05 - 2.86 (m, 2H).



3-(4-methoxyphenyl)-1,3-diphenylpropan-1-one (3y): white solid, 70% yield, 11% ee. HPLC conditions: OD-H column, hexane/iPrOH = 90/10, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 7.17$ min, $t_{r_{major}} = 7.99$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 7.96 - 7.93 (m, 2H), 7.59 - 7.531 (m, 1H), 7.47 - 7.42 (m, 2H), 7.32 - 7.25 (m, 4H), 7.21 - 7.15 (m, 3H), 6.83 - 6.81 (m, 2H), 4.79 (t, $J = 7.3$ Hz, 1H), 3.76 (s, 3H), 3.72 (d, $J = 7.3$ Hz, 2H).

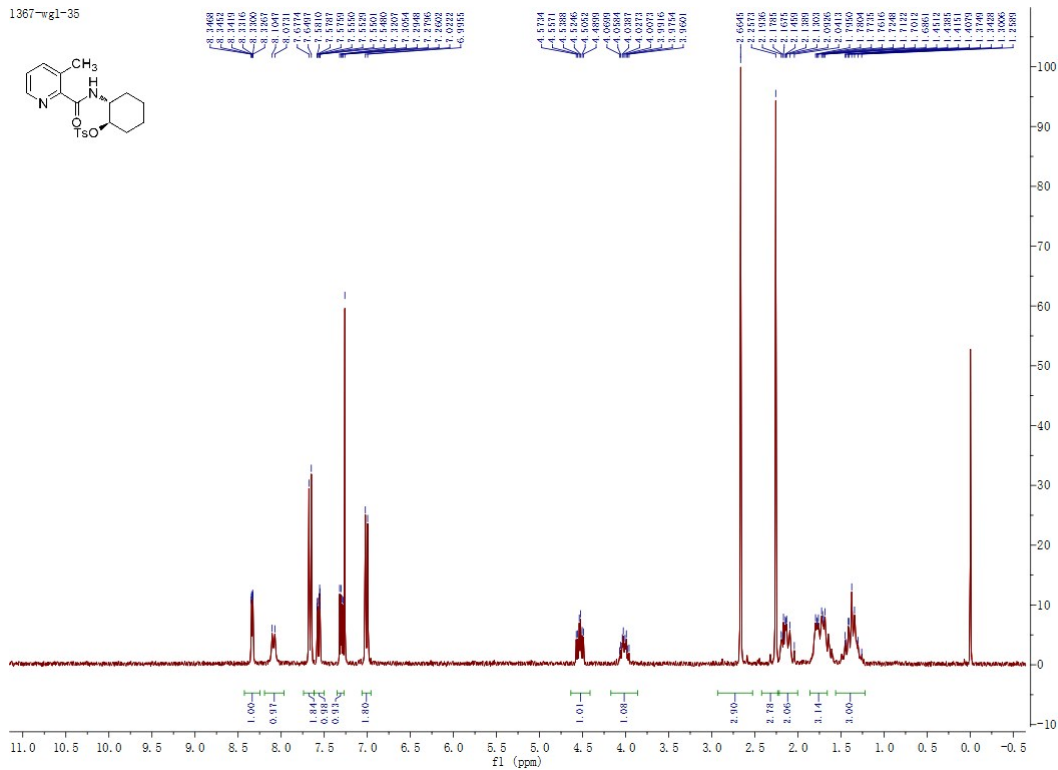
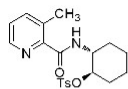


1-phenyl-2-(1,2,3,4-tetrahydronaphthalen-1-yl)ethan-1-one (3z): white solid, 98% yield, 22% ee. HPLC conditions: OD-H column, hexane/iPrOH = 95/5, flow rate 1.0 mL/min, UV detection at 254 nm, $t_{r_{minor}} = 6.22$ min, $t_{r_{major}} = 6.61$ min; $^1\text{H NMR}$ (300 MHz, CDCl_3) δ 8.00 - 7.98 (m, 2H), 7.61 - 7.55 (m, 1H), 7.50 - 7.47 (m, 2H), 7.20 - 7.08 (m, 4H), 3.68 - 3.60 (m, 1H), 3.39 - 3.23 (m, 2H), 2.86 - 2.71 (m, 2H), 1.99 - 1.90 (m, 1H), 1.86 - 1.66 (m, 3H).

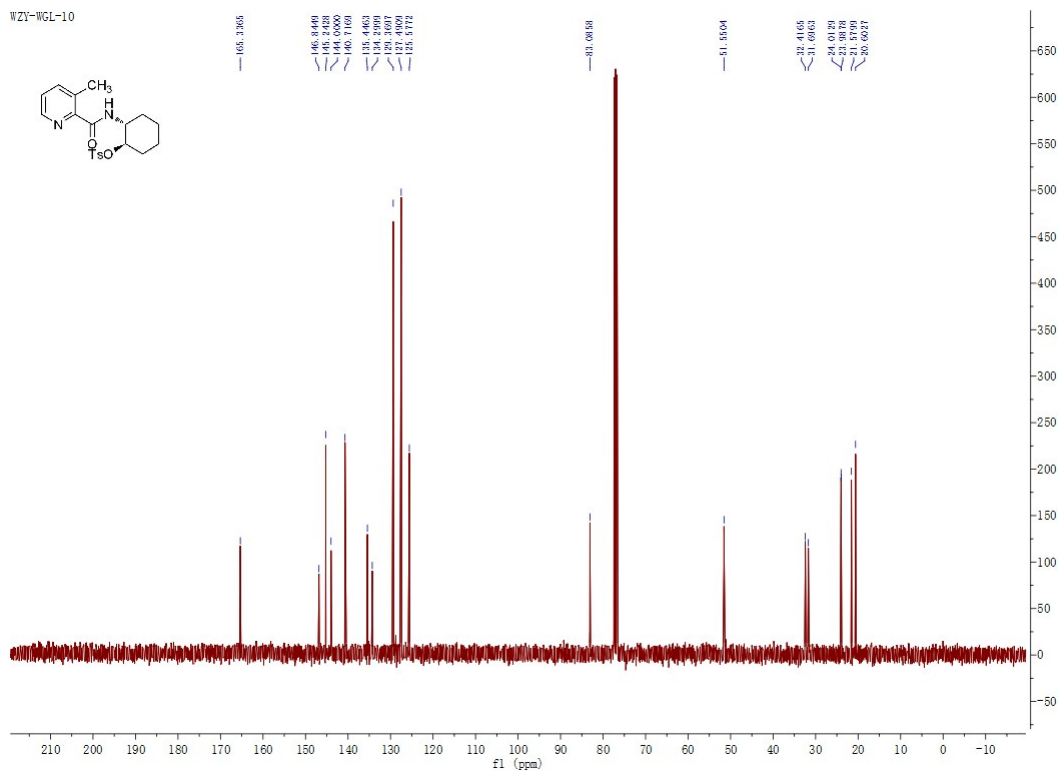
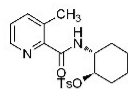
References:

1. Z. Wang, M. Cheng, P. Wu, S. Wei, J. Sun, *Org. Lett.* **2006**, 8, 3045-3048.
2. D. Pei, Y. Zhang, S. Wei, M. Wang, J. Sun, *Adv. Synth. Catal.* **2008**, 350, 619-623.
3. Z. Xue, Y. Jiang, W. Yuan, X. Zhang, *Eur. J. Org. Chem.* **2010**, 616-619.
4. X. J. Dai, G. L. Weng, S. W. Yu, H. Chen, J. Y. Zhang, S. B. Cheng, X. Y. Xu, W. C. Yuan, Z. Y. Wang, X. M. Zhang, *Org. Chem. Front.* **2018**, 5, 2787-2793.

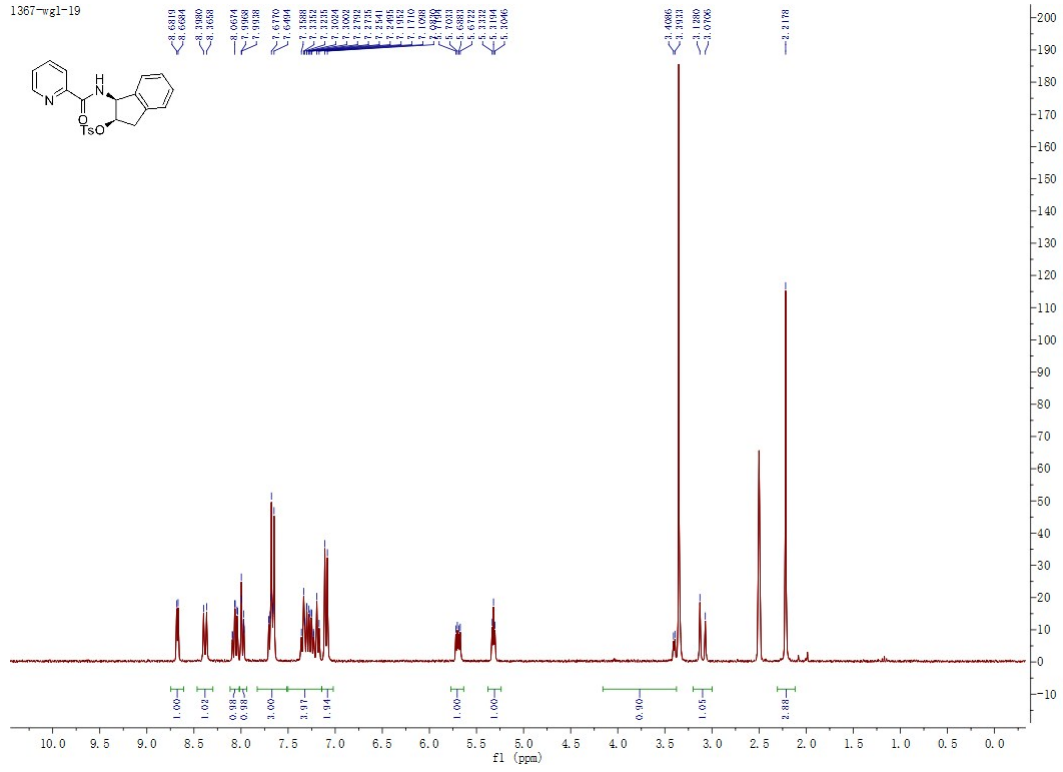
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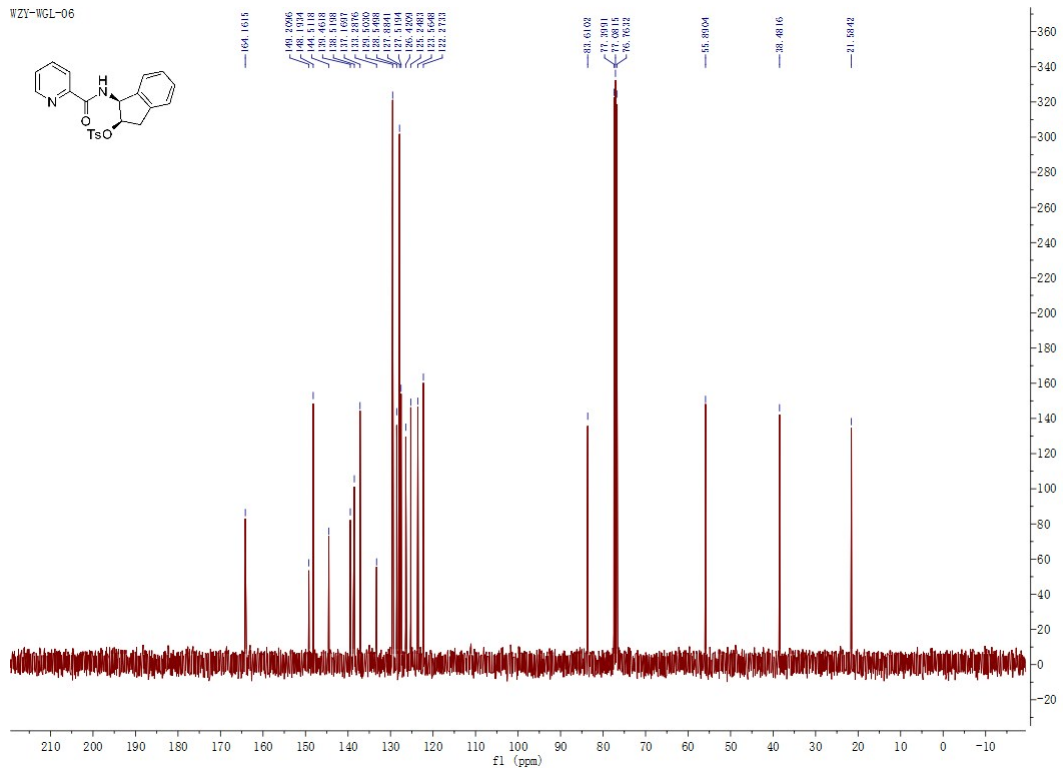
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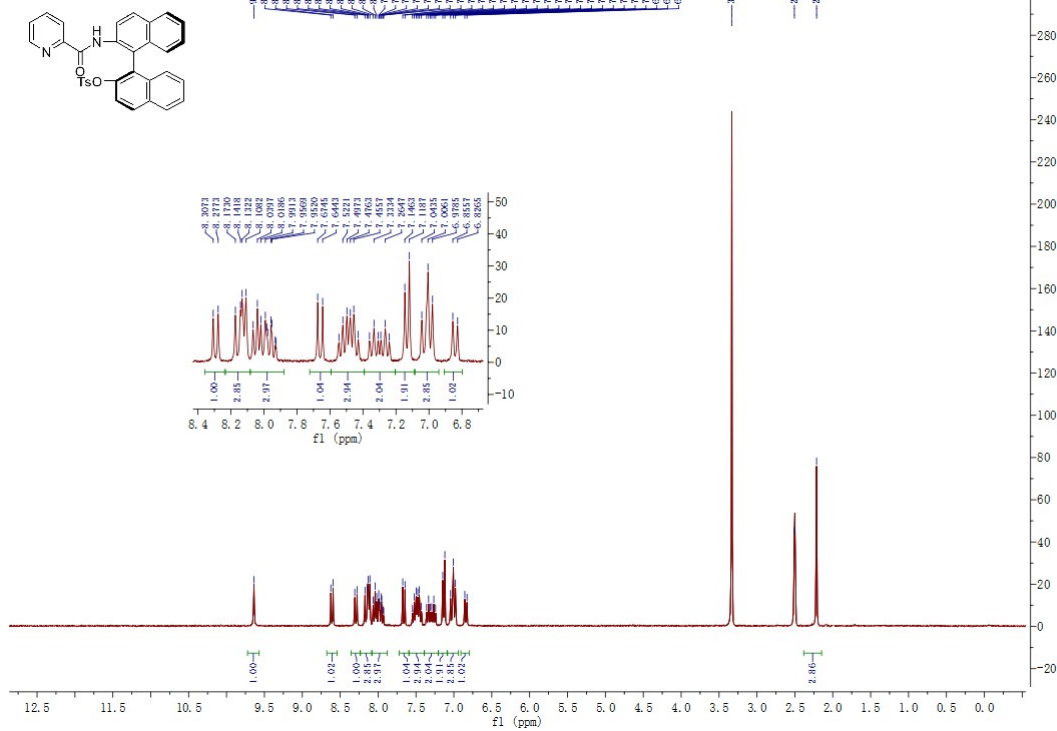
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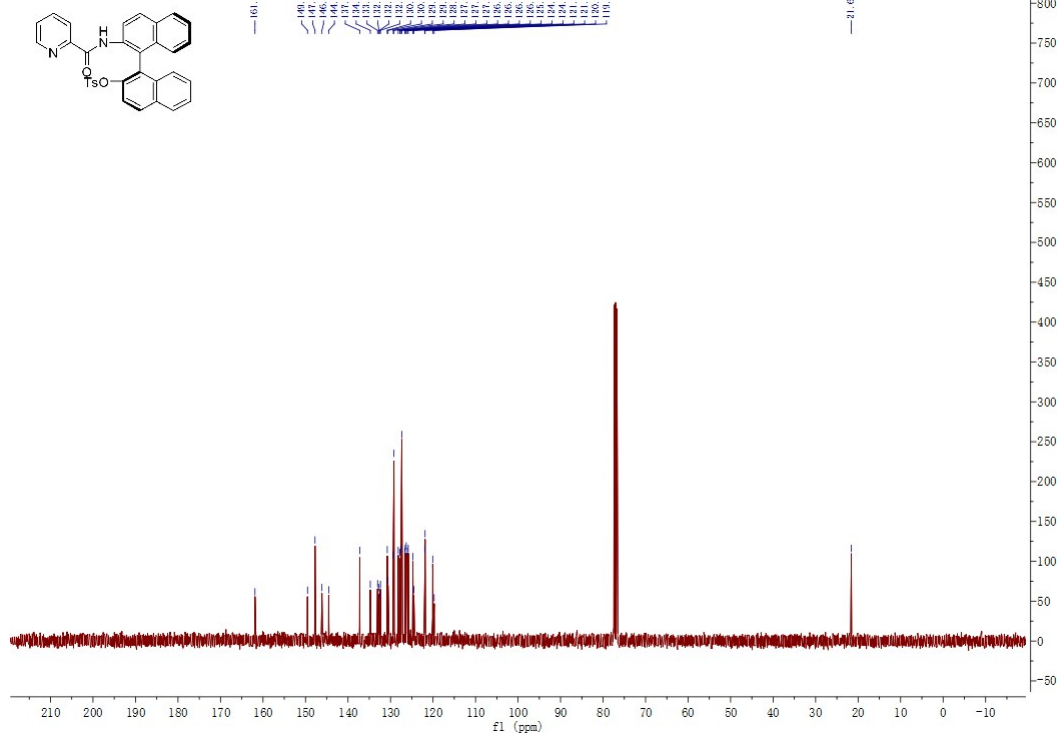
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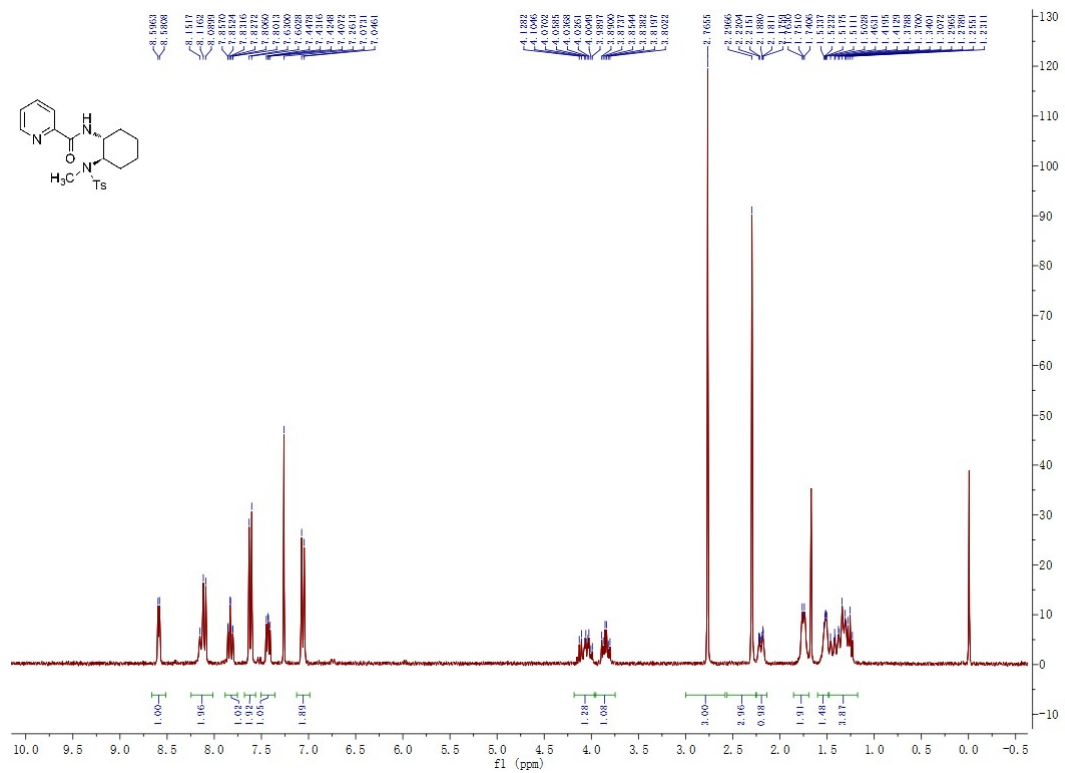
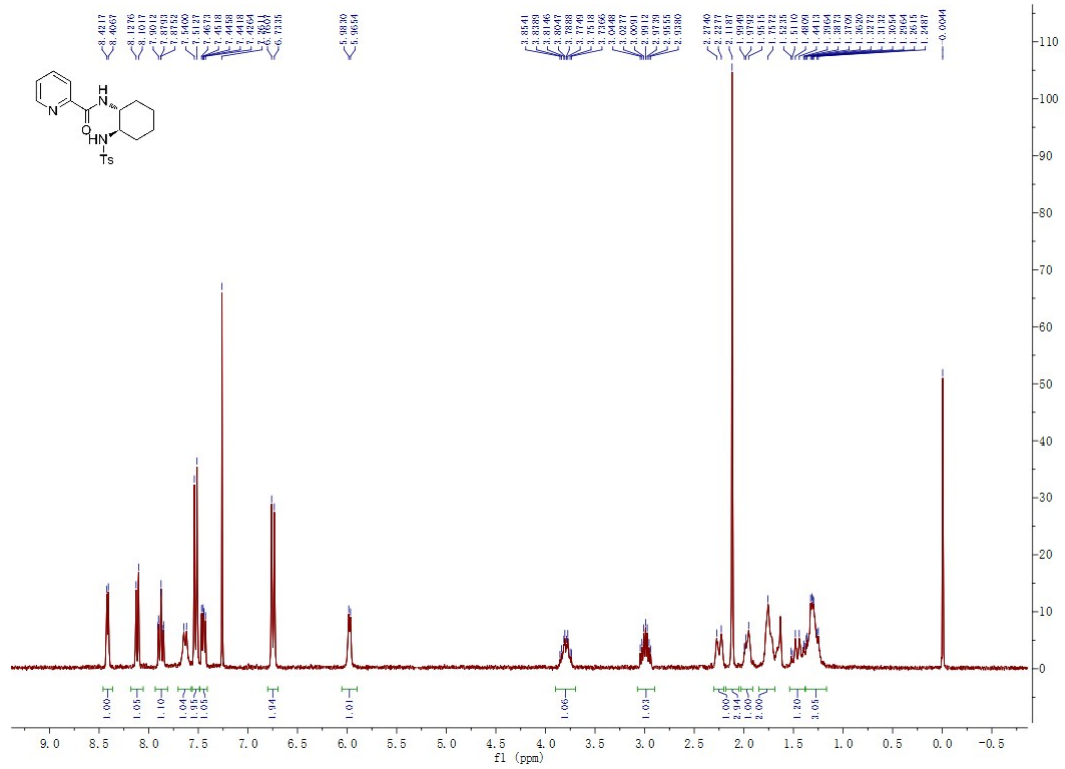


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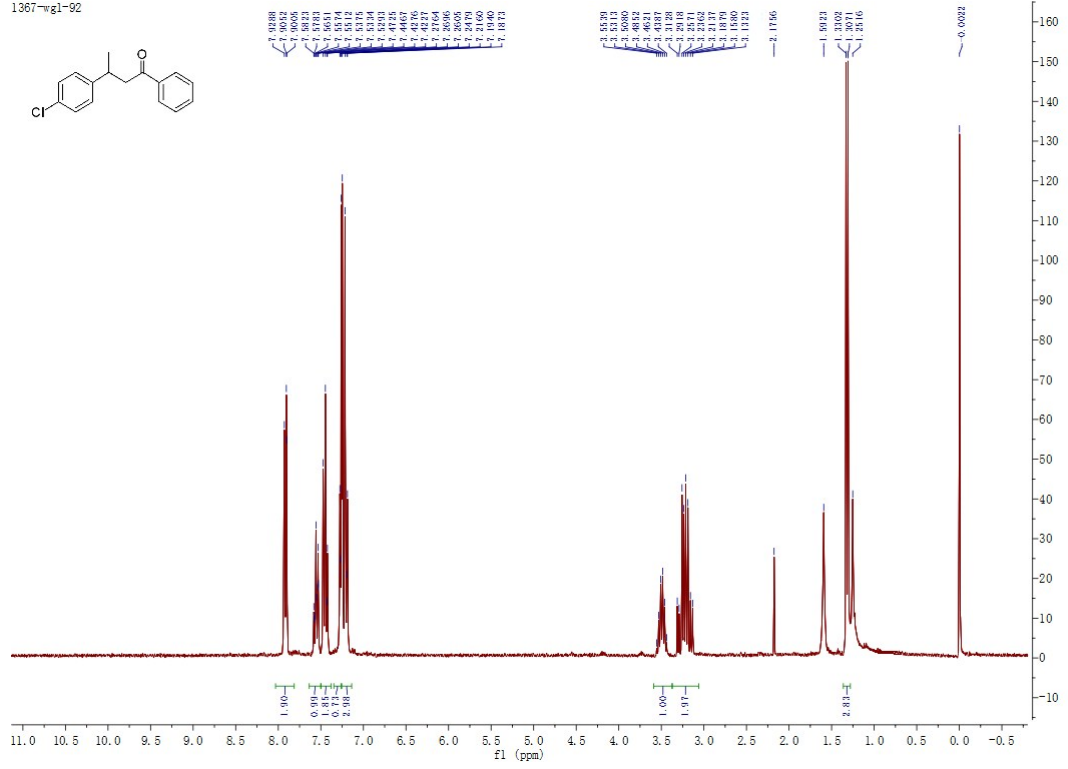
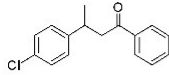


WZY-WGL-01

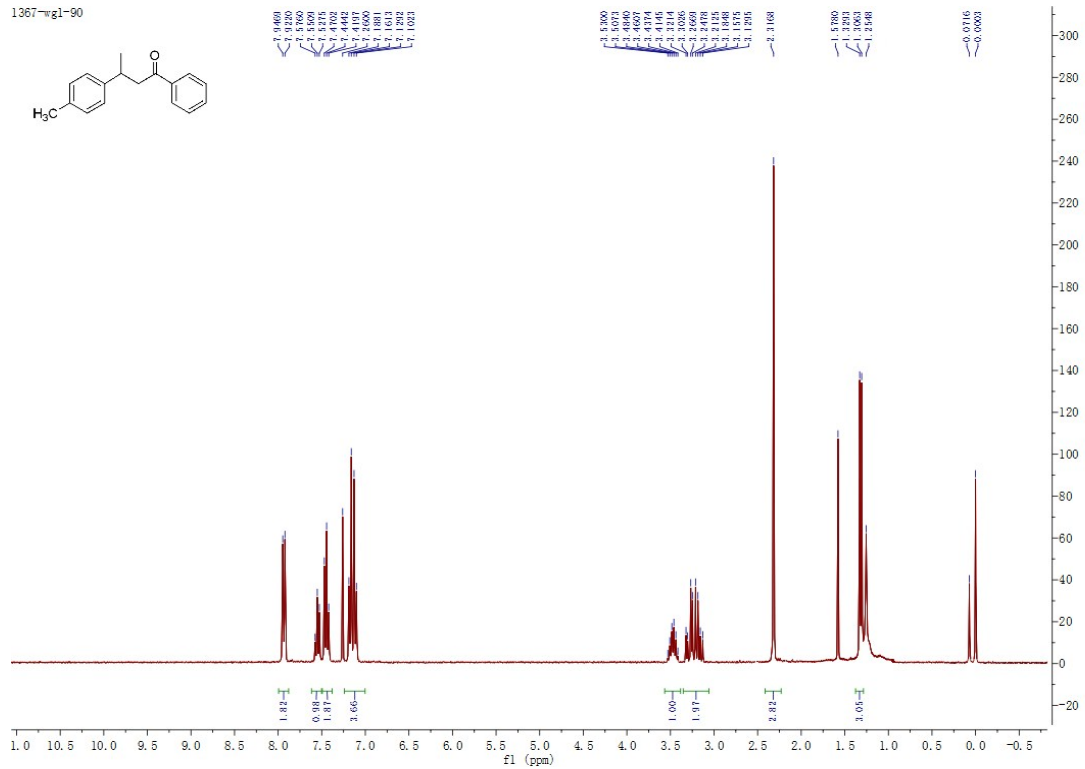
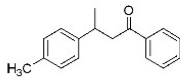




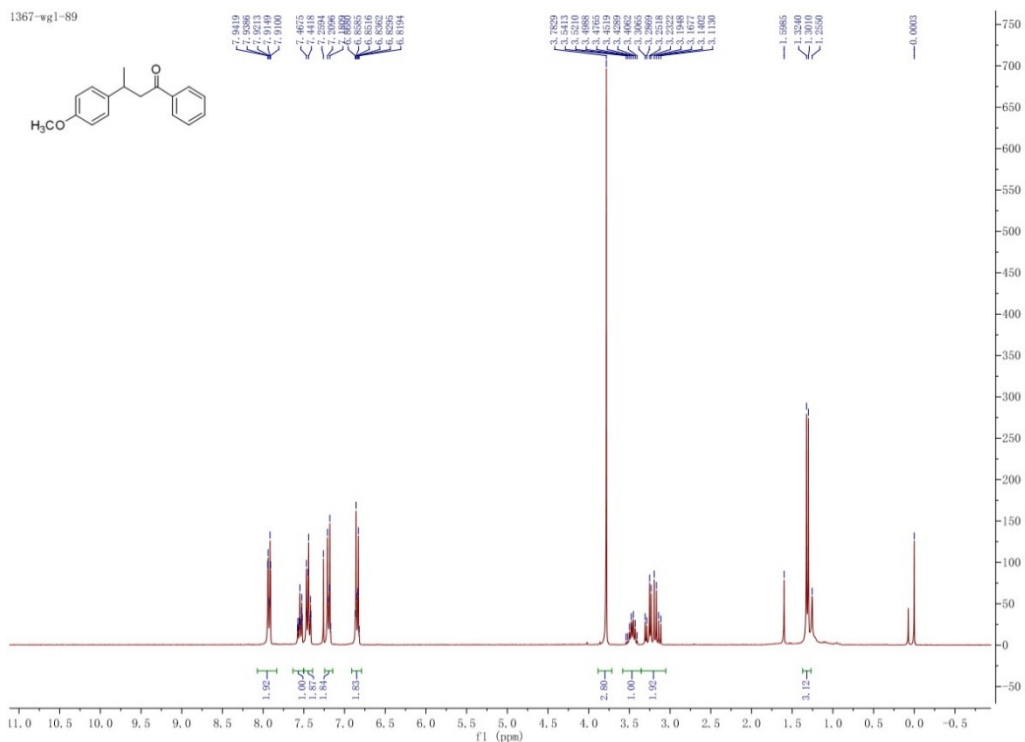
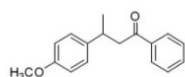
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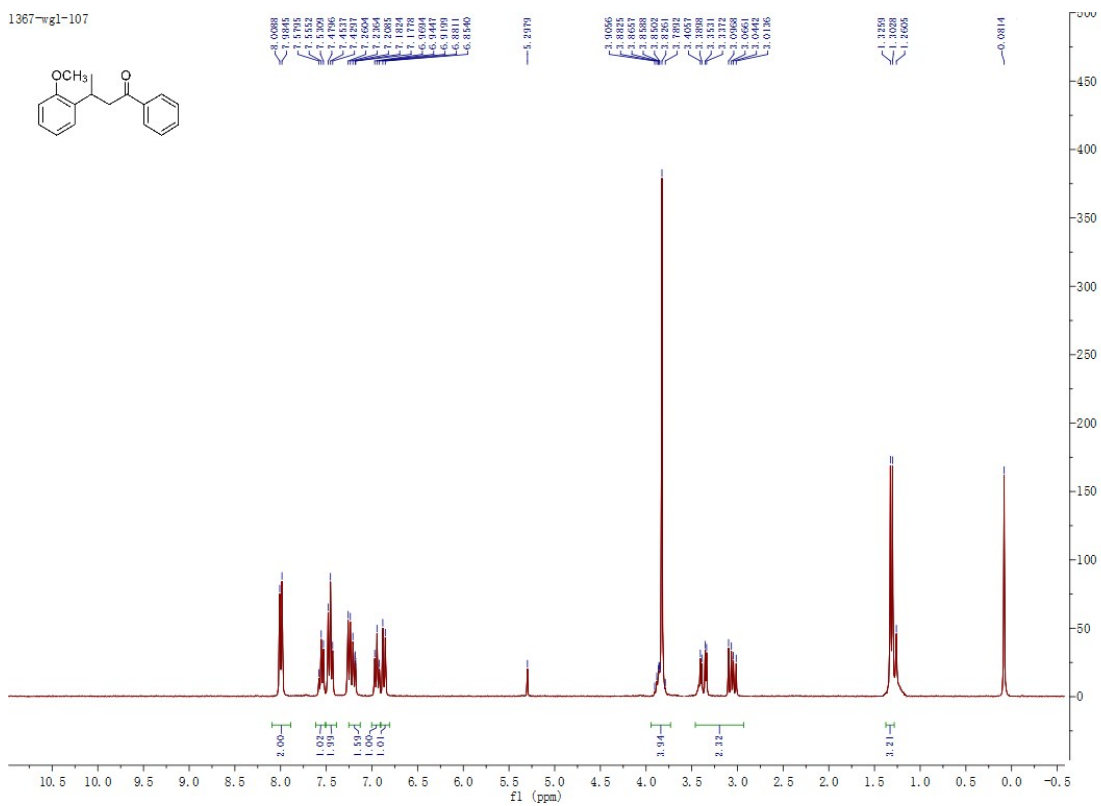
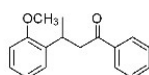
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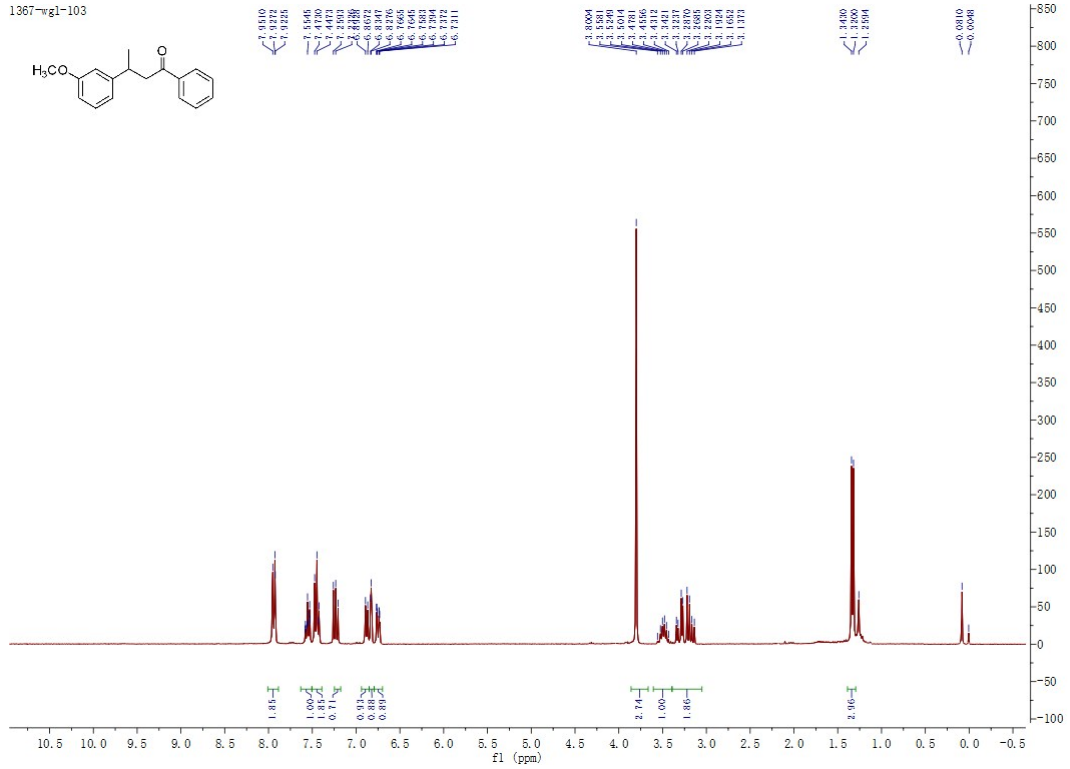
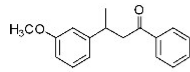
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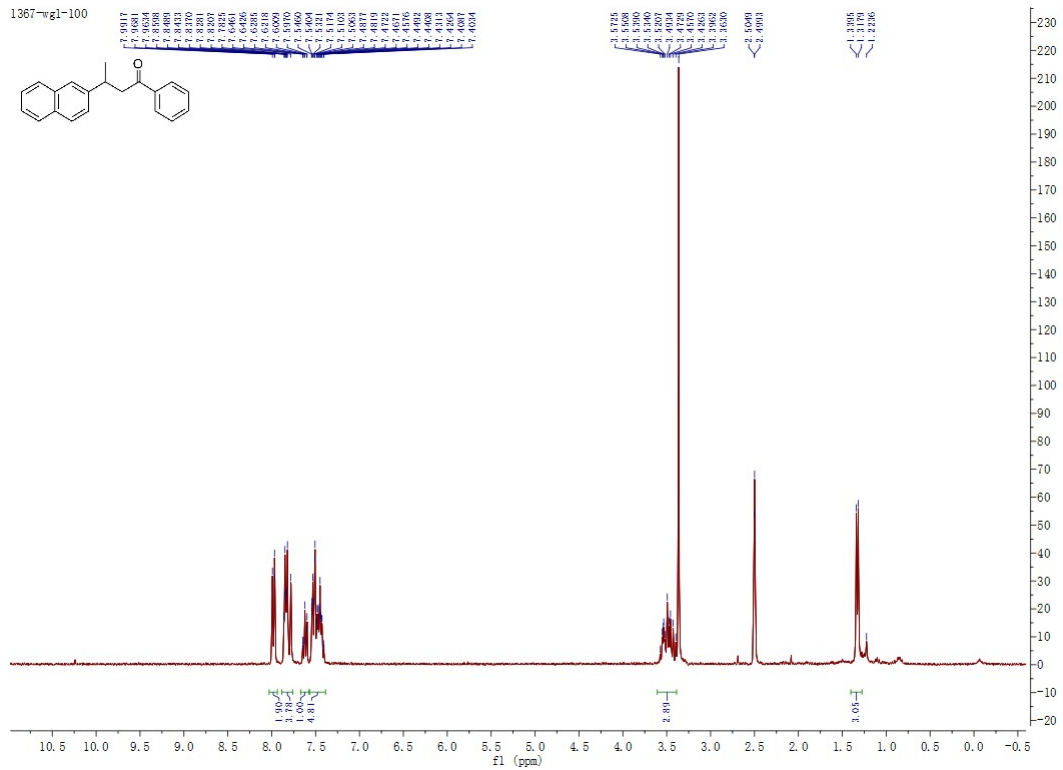
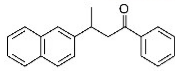
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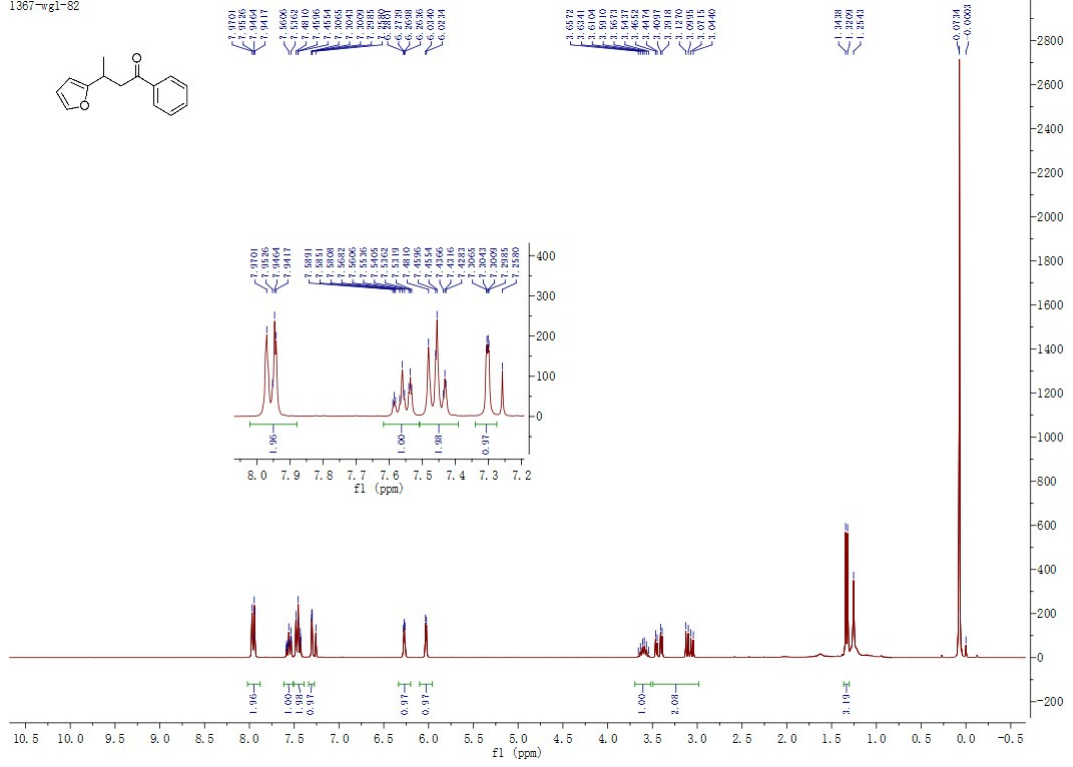
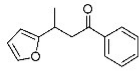
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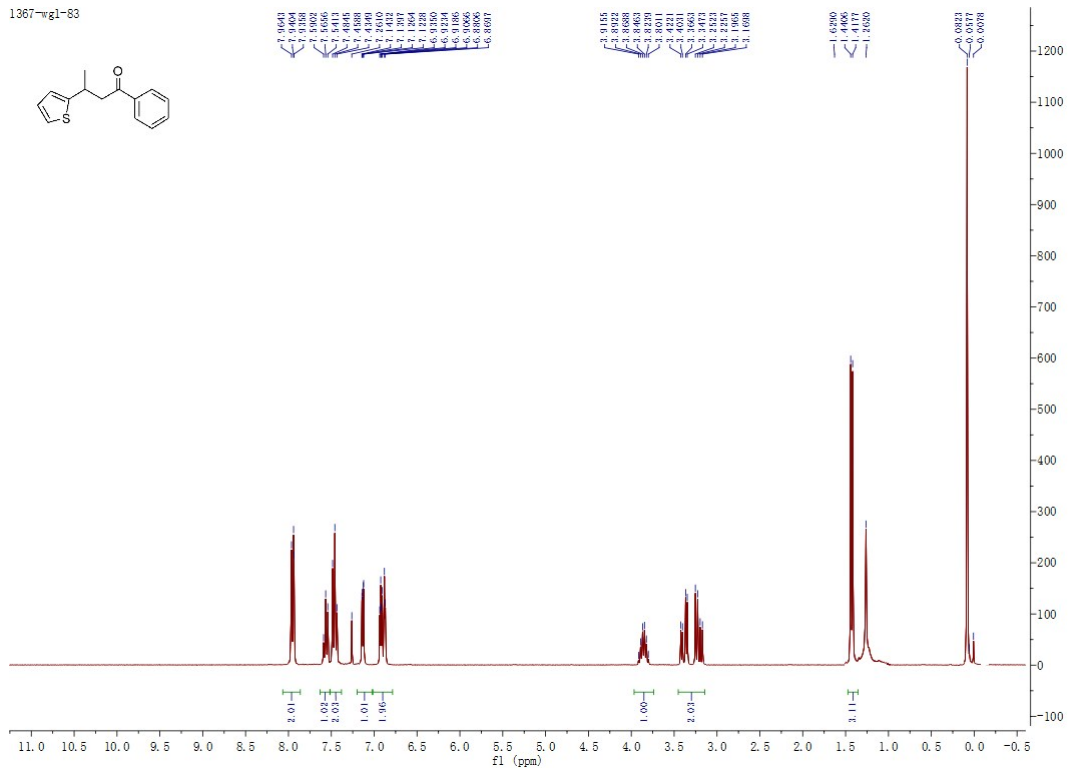
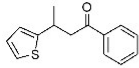
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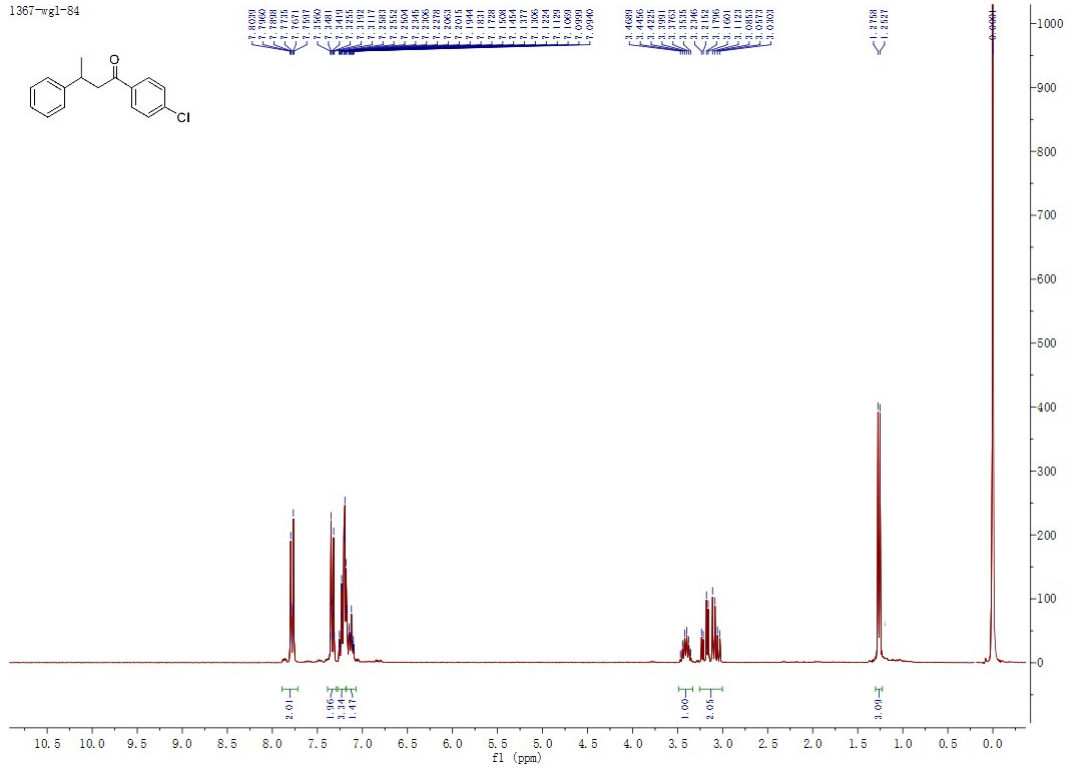
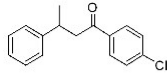
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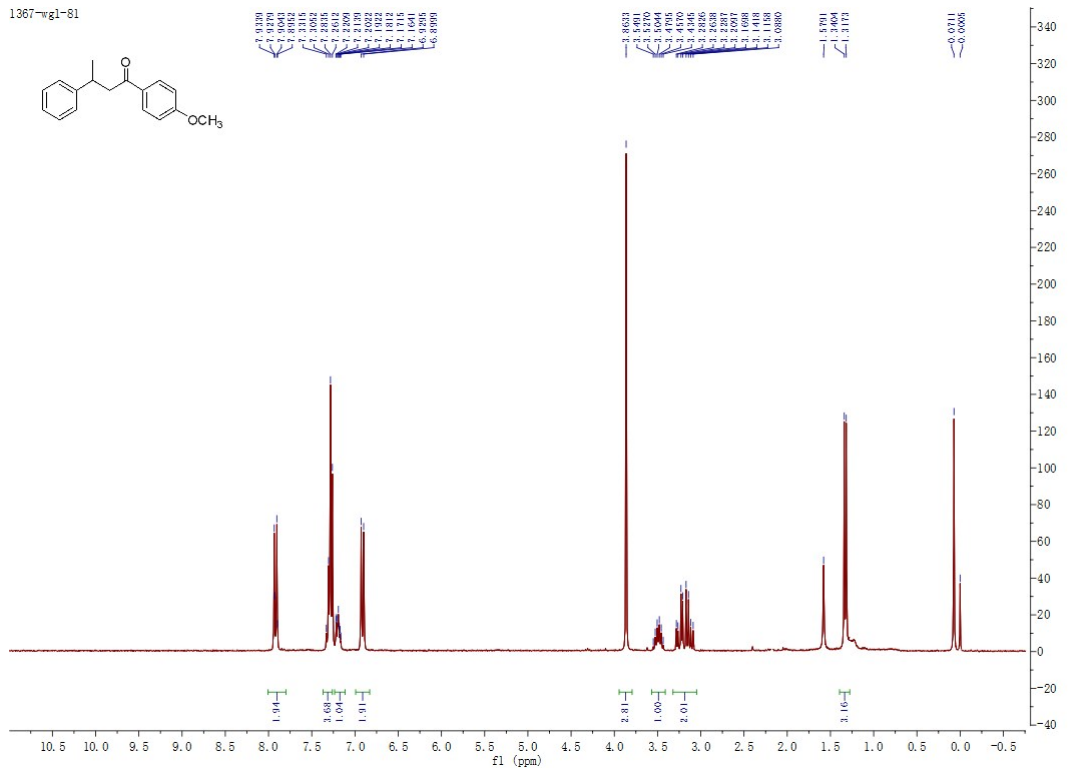
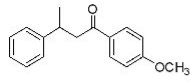
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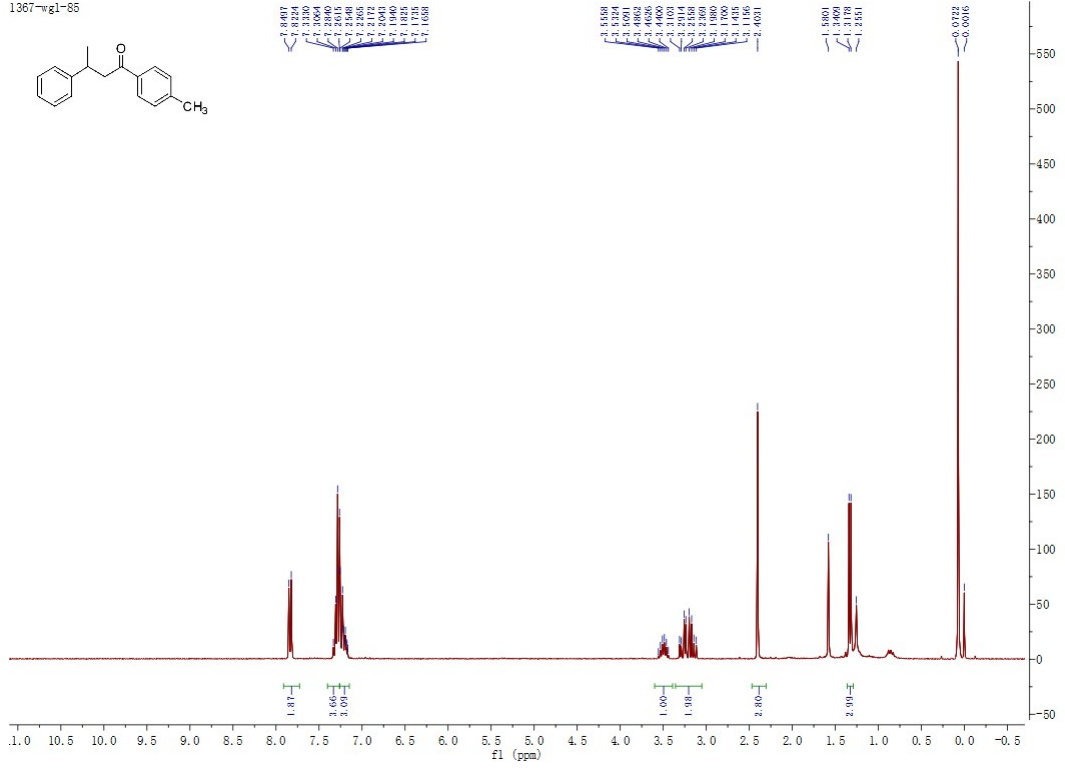
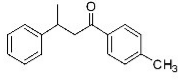
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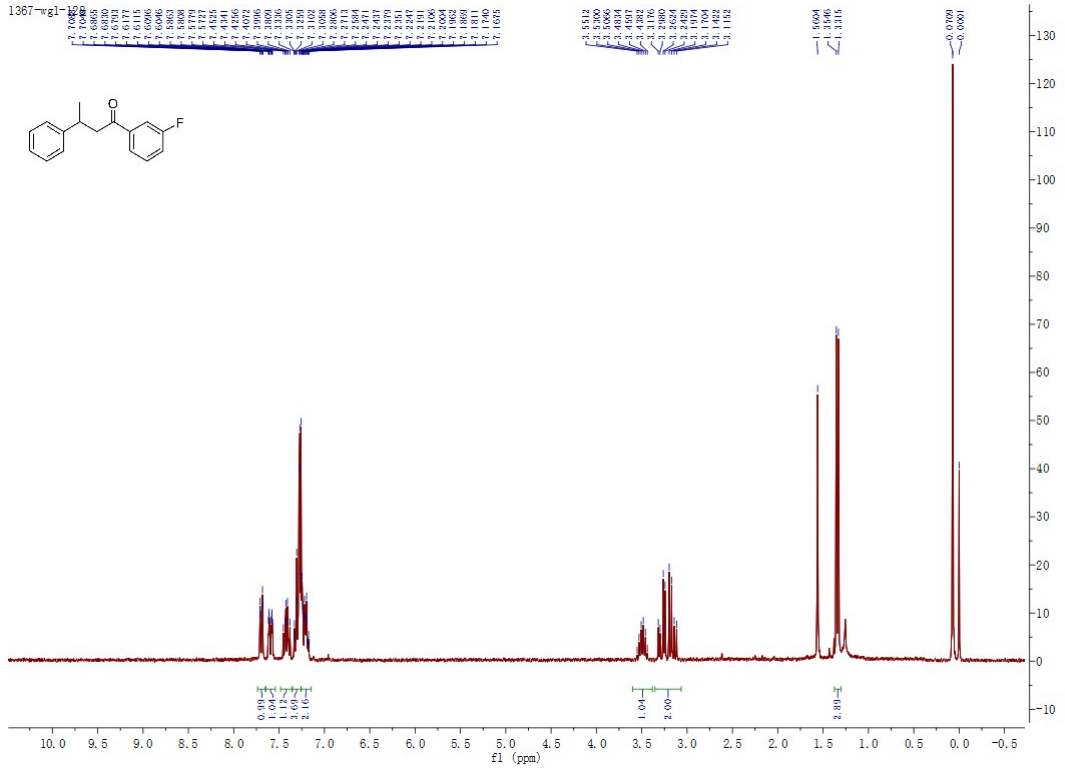
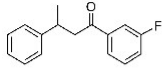
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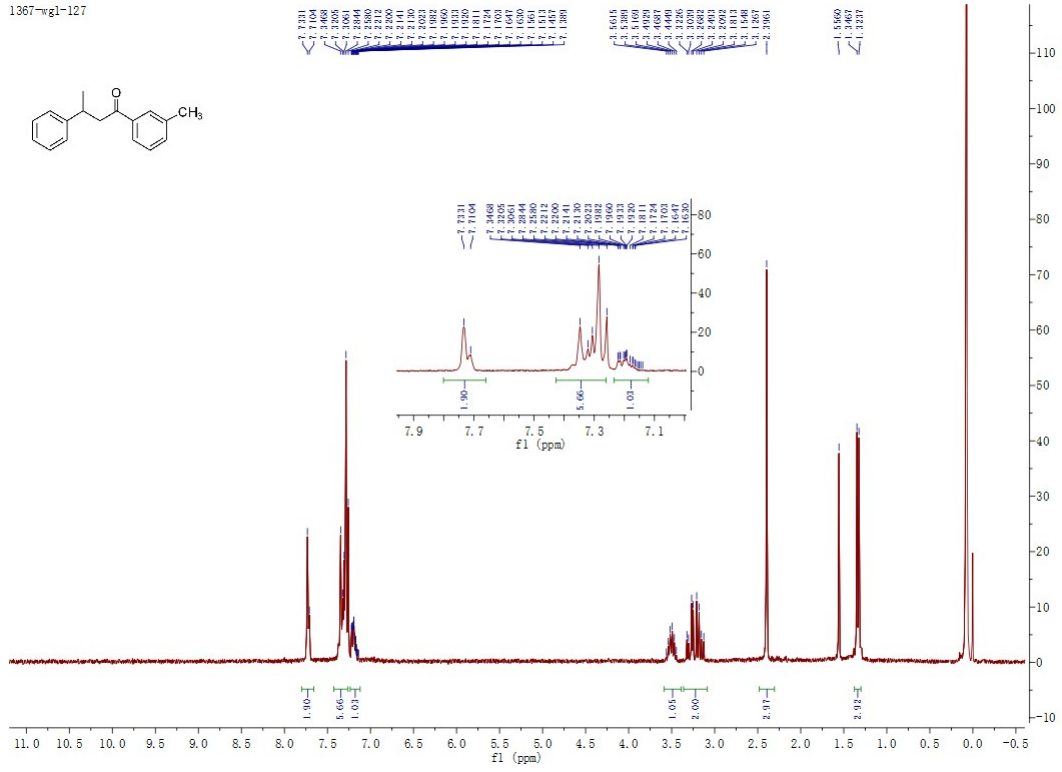
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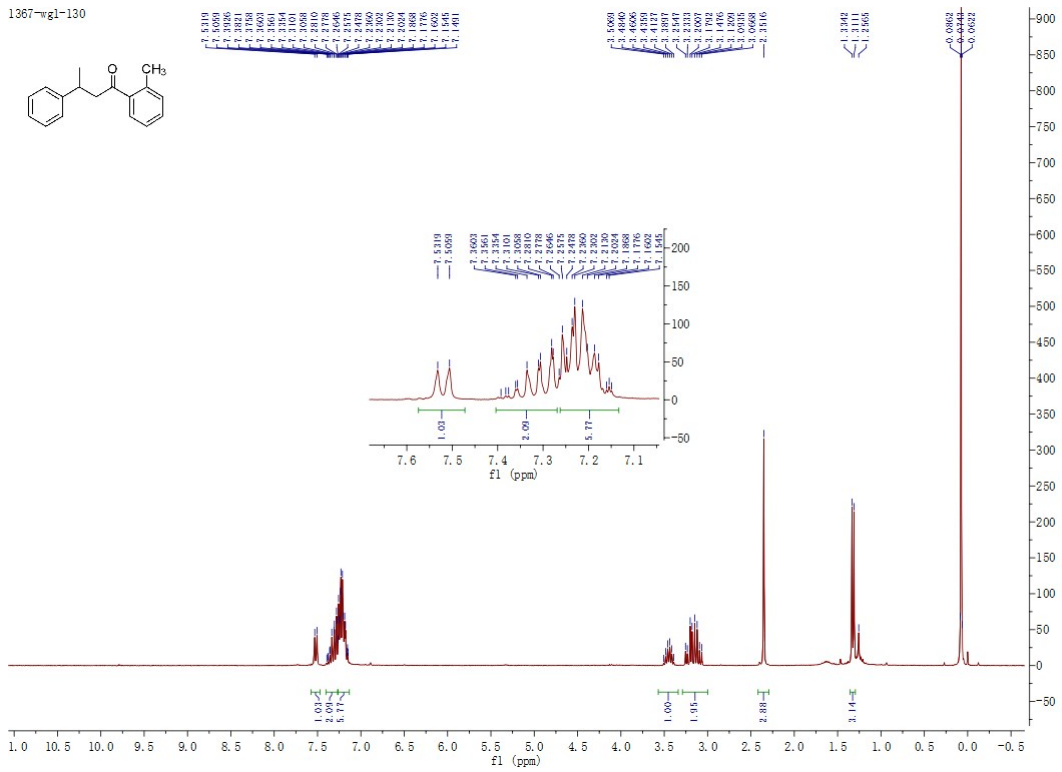
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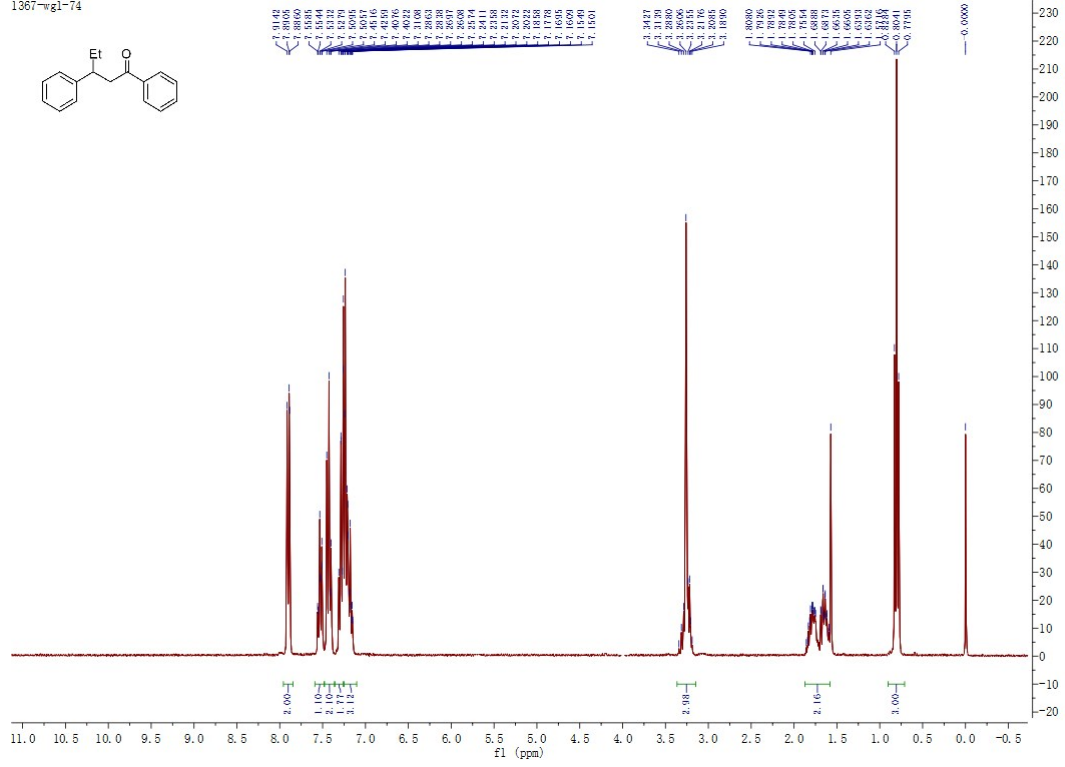
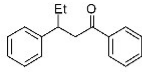
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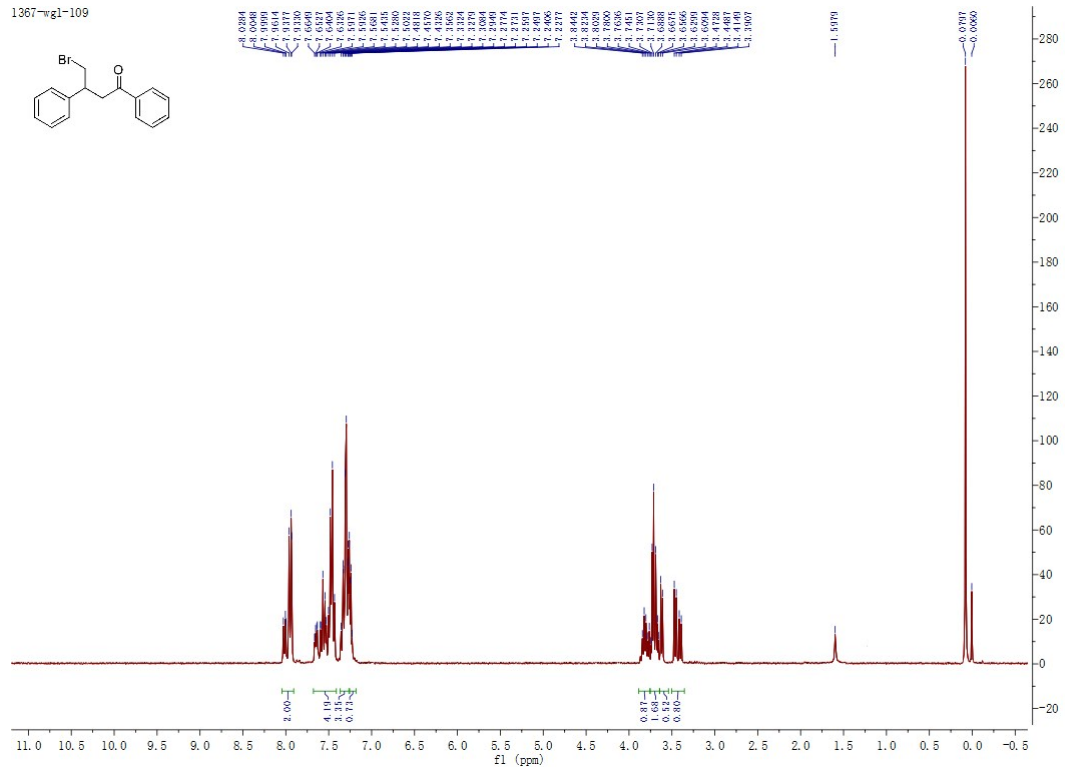
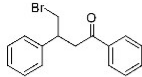
1367-wg1-130



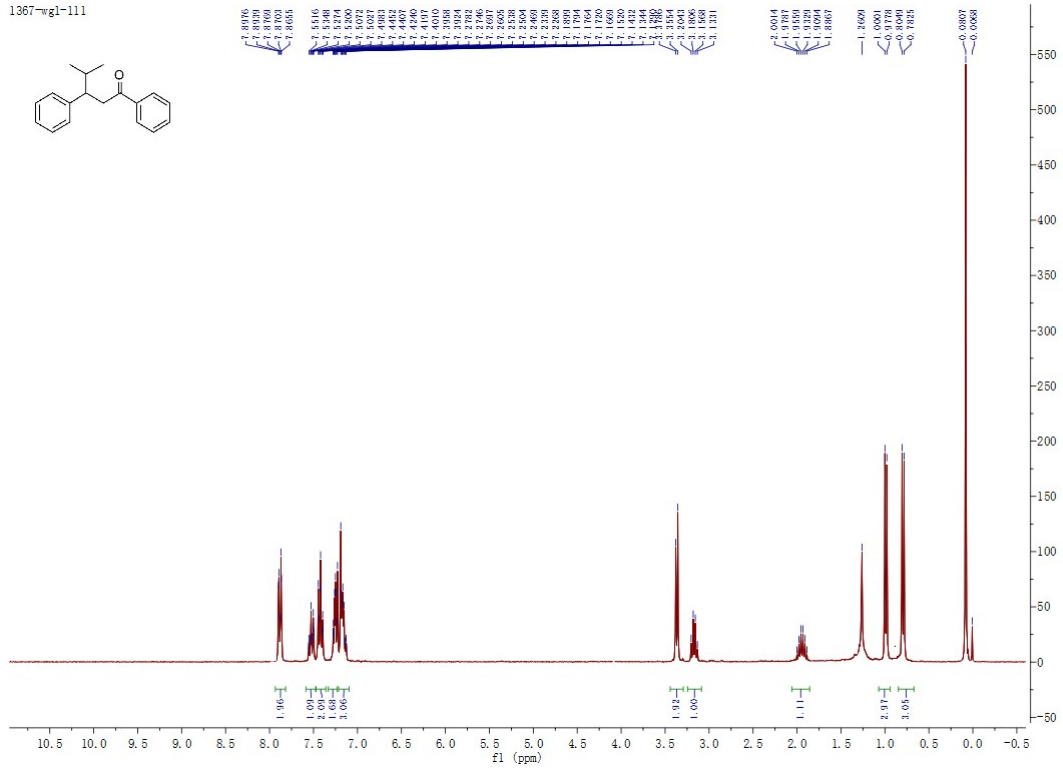
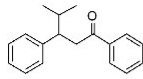
1367-wg1-74



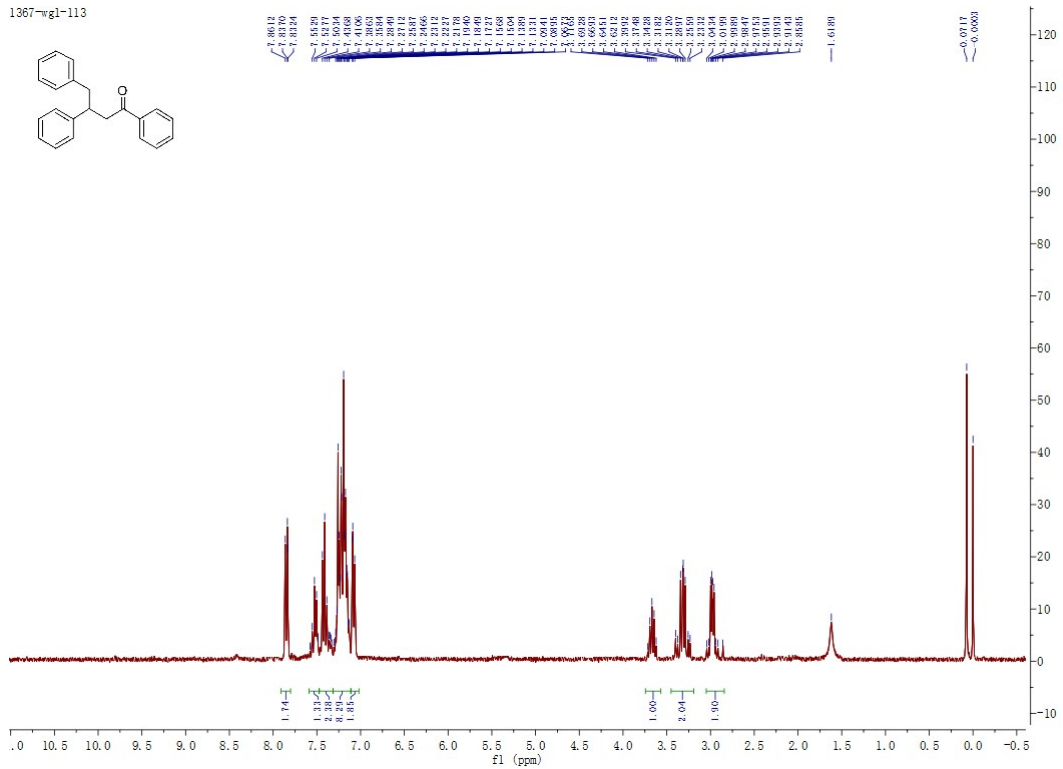
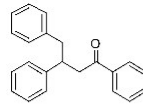
1367-wg1-109



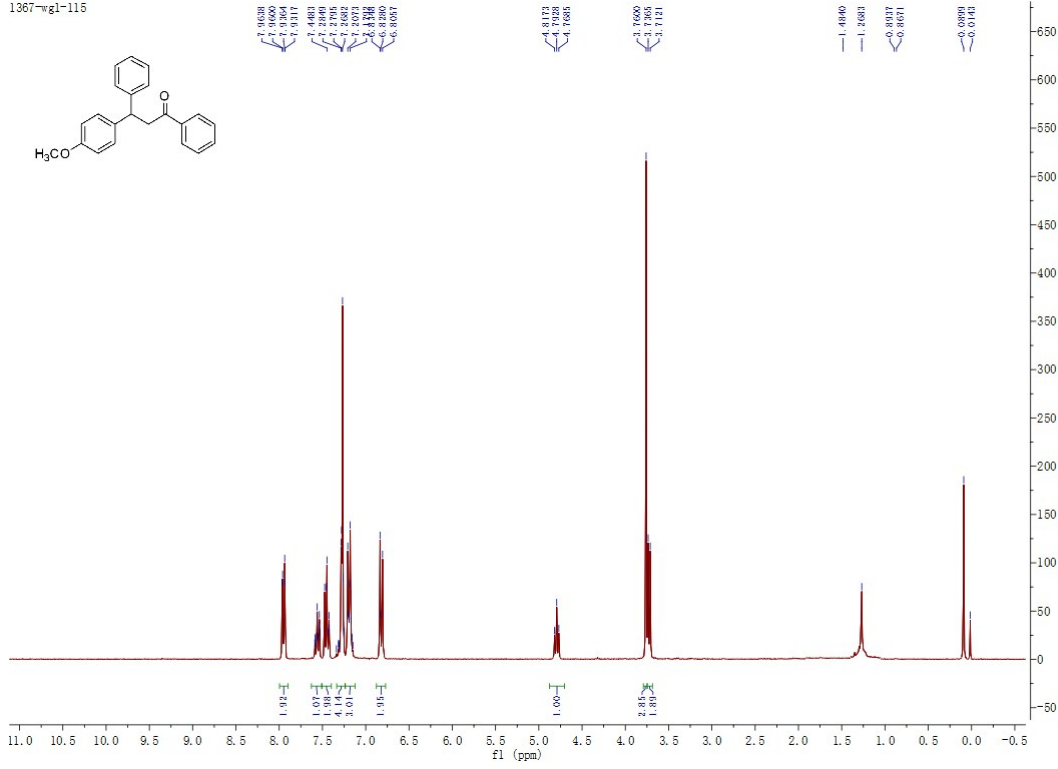
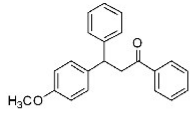
1367-wg1-111



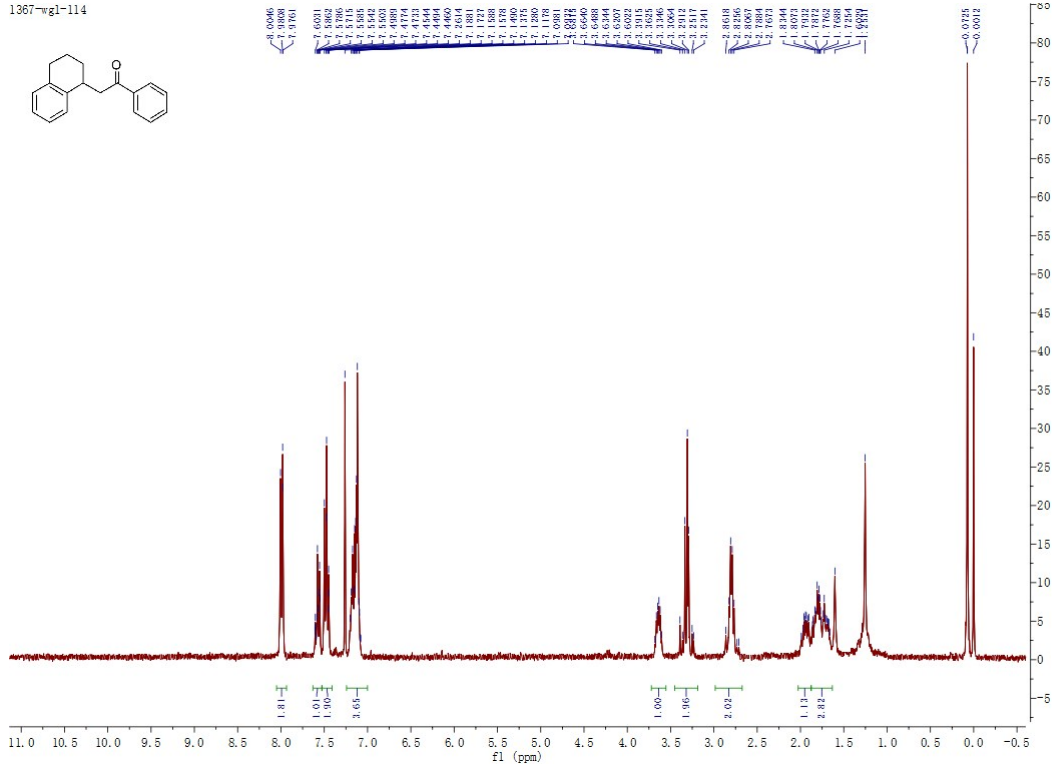
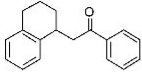
1367-wg1-113



1367-wg1-115

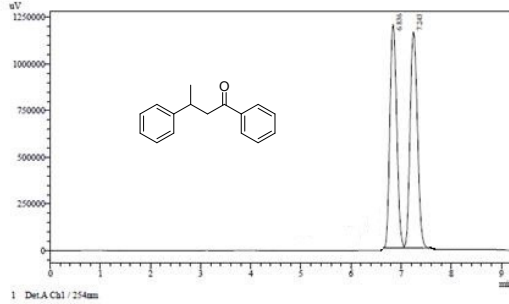


1367-wg1-114



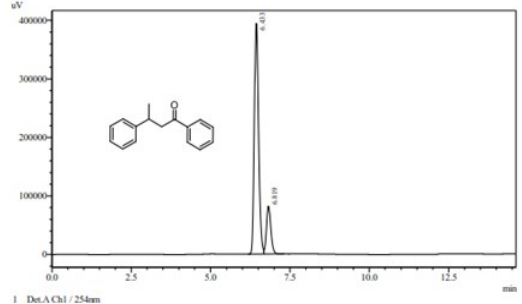
4. HPLC Charts of Products

Acquired by : clf
 Sample Name : ogl-0
 Injection Volume : 10 uL
 Data Filename : ogl-0.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2016-12-29 12:50:53
 Data Processed : 2017-2-27 17:16:19



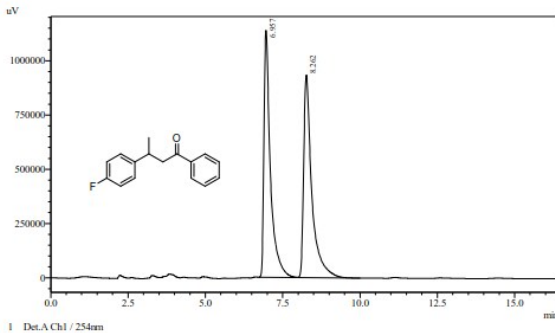
Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.816	11357661	1196812	49.151	50.844
2	7.243	11750232	1157093	50.849	49.152
Total		23107894	2353905	100.000	100.000

Acquired by : clf
 Sample Name : wgl-109
 Injection Volume : 10 uL
 Data Filename : wgl-109.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2017-9-20 9:29:49
 Data Processed : 2017-9-20 9:47:10



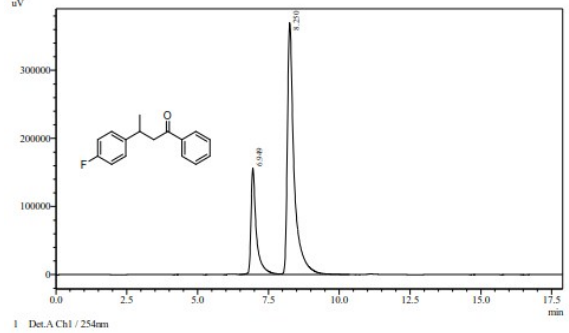
Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.433	3643210	393950	82.539	82.796
2	6.819	770710	81858	17.461	17.204
Total		4413920	475808	100.000	100.000

Acquired by : clf
 Sample Name : wgl-163
 Injection Volume : 10 uL
 Data Filename : wgl-163.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2018-1-5 11:40:39
 Data Processed : 2018-1-5 12:03:22



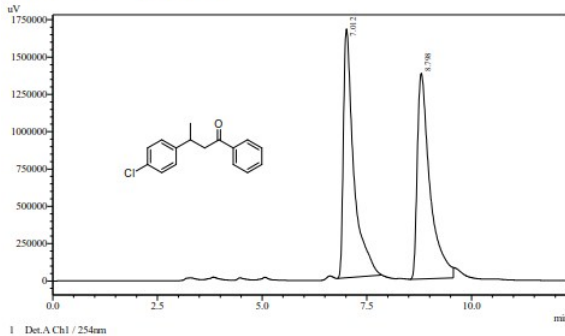
Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.957	16591017	1137831	49.070	54.915
2	8.262	17219795	934150	50.930	45.085
Total		33810812	2071981	100.000	100.000

Acquired by : clf
 Sample Name : wgl-164
 Injection Volume : 10 uL
 Data Filename : wgl-164.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2018-1-5 11:20:58
 Data Processed : 2018-1-5 12:02:42



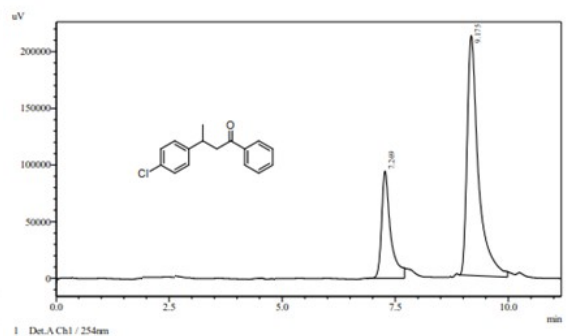
Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.949	2061050	156171	25.020	29.705
2	8.250	6176599	369571	74.980	70.295
Total		8237649	525743	100.000	100.000

Acquired by : clf
 Sample Name : wgl-166
 Injection Volume : 10 uL
 Data Filename : wgl-166.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2018-1-5 12:11:21
 Data Processed : 2018-1-5 16:54:26



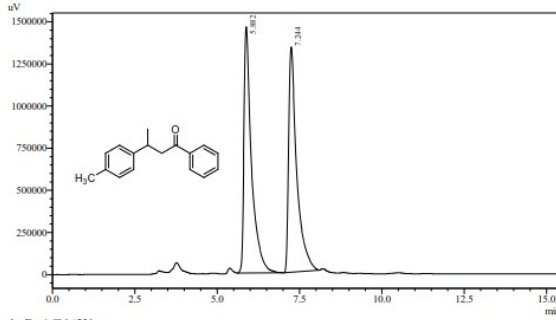
Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.012	28892782	1668521	49.941	54.775
2	8.798	28960757	1377620	50.059	45.225
Total		57853539	3046141	100.000	100.000

Acquired by : clf
 Sample Name : wgl-165
 Injection Volume : 10 uL
 Data Filename : wgl-165.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2018-1-5 11:59:33
 Data Processed : 2018-1-5 12:23:34



Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.175	3684909	211424	73.755	69.123
2	9.717	1311206	94444	26.245	30.877
Total		4996115	305868	100.000	100.000

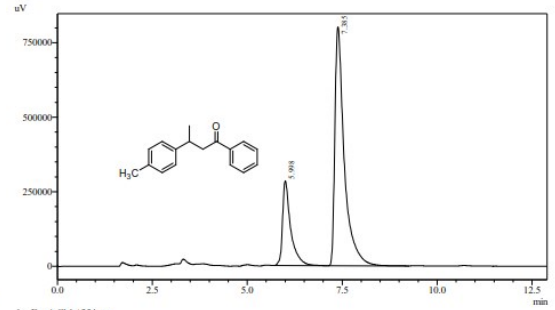
Acquired by : clf
 Sample Name : wgl-160
 Injection Volume : 10 uL
 Data Filename : wgl-160.lcd
 Method Filename : fuff.lcm
 Date Acquired : 2018-1-5 10:08:59
 Data Processed : 2018-1-5 12:00:26



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	5.882	23370185	1460645	50.519	52.219
2	7.244	22890148	1336500	49.481	47.781
Total		46260333	2797145	100.000	100.000

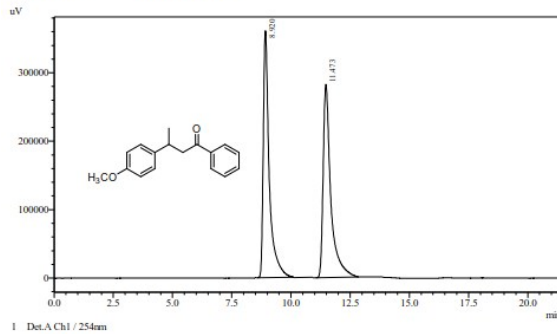
Acquired by : clf
 Sample Name : wgl-159
 Injection Volume : 10 uL
 Data Filename : wgl-159.lcd
 Method Filename : fuff.lcm
 Date Acquired : 2018-1-5 10:25:57
 Data Processed : 2018-1-5 12:01:01



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	5.998	4269813	284523	23.538	26.223
2	7.385	13870089	800473	76.462	73.777
Total		18139903	1084996	100.000	100.000

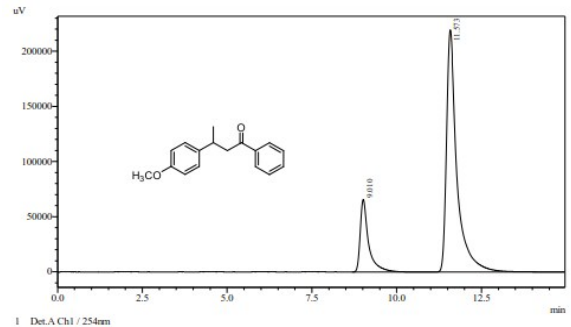
Acquired by : clf
 Sample Name : wgl-162
 Injection Volume : 10 uL
 Data Filename : wgl-162.lcd
 Method Filename : fuff.lcm
 Date Acquired : 2018-1-5 10:41:53
 Data Processed : 2018-1-5 12:01:37



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.920	6321722	360679	49.788	56.067
2	11.473	6375451	282617	50.212	43.933
Total		12697173	643296	100.000	100.000

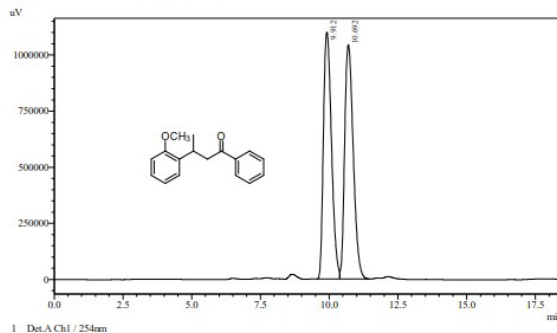
Acquired by : clf
 Sample Name : wgl-161
 Injection Volume : 10 uL
 Data Filename : wgl-161.lcd
 Method Filename : fuff.lcm
 Date Acquired : 2018-1-5 11:04:30
 Data Processed : 2018-1-5 12:02:13



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.010	1128599	65813	19.157	23.066
2	11.573	4762706	219515	80.843	76.934
Total		5891305	285328	100.000	100.000

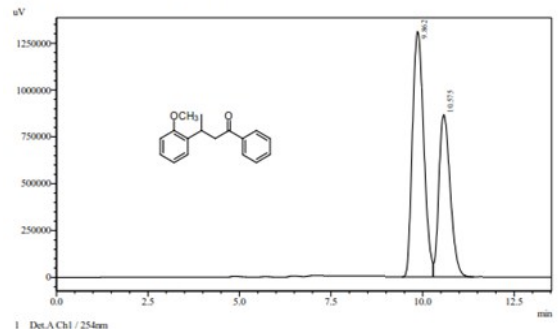
Acquired by : clf
 Sample Name : wgl-175**
 Injection Volume : 10 uL
 Data Filename : wgl-175**.lcd
 Method Filename : fuff.lcm
 Date Acquired : 2018-1-26 16:08:29
 Data Processed : 2018-1-26 16:30:38



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.912	22510573	1099730	49.793	51.314
2	10.692	22697859	1043397	50.207	48.686
Total		45208432	2143126	100.000	100.000

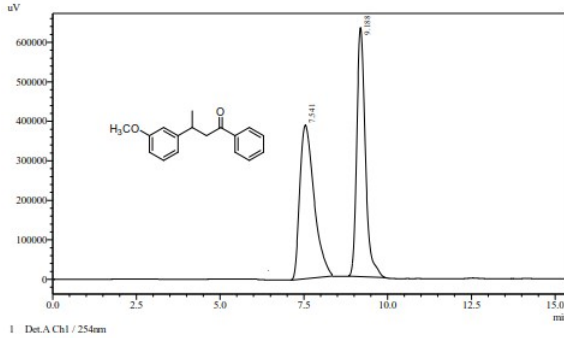
Acquired by : clf
 Sample Name : wgl-176
 Injection Volume : 10 uL
 Data Filename : wgl-176.lcd
 Method Filename : fuff.lcm
 Date Acquired : 2018-1-26 16:29:20
 Data Processed : 2018-1-26 16:45:26



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.862	28166453	1309619	60.144	60.237
2	10.575	18665173	864500	39.856	39.763
Total		46831626	2174119	100.000	100.000

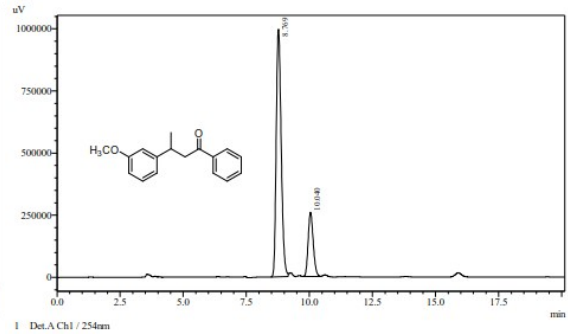
Acquired by : clf
 Sample Name : wgl-167
 Injection Volume : 10 uL
 Data Filename : wgl-167.lcd
 Method Filename : fdf.lcm
 Date Acquired : 2018-1-17 16:40:40
 Data Processed : 2018-1-18 11:01:16



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.541	11546327	389136	50.634	38.169
2	9.188	11257103	630382	49.366	61.831
Total		22803430	1019518	100.000	100.000

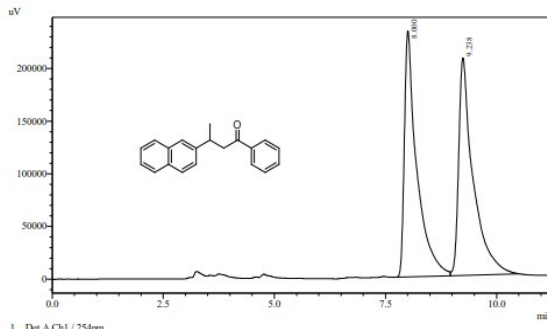
Acquired by : clf
 Sample Name : wgl-168
 Injection Volume : 10 uL
 Data Filename : wgl-168.lcd
 Method Filename : fdf.lcm
 Date Acquired : 2018-1-18 9:29:01
 Data Processed : 2018-1-18 11:02:22



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.769	13645281	995822	79.159	79.425
2	10.040	3592563	257975	20.841	20.575
Total		17237844	1253797	100.000	100.000

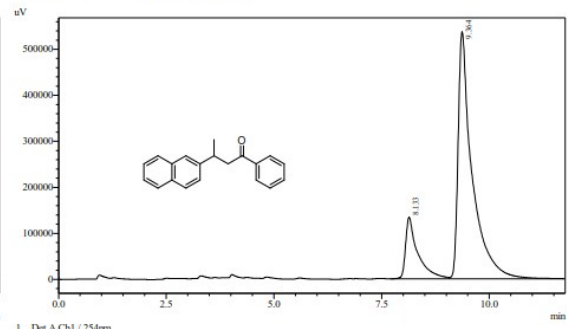
Acquired by : clf
 Sample Name : wgl-169
 Injection Volume : 10 uL
 Data Filename : wgl-169.lcd
 Method Filename : fdf.lcm
 Date Acquired : 2018-1-16 16:40:38
 Data Processed : 2018-1-16 16:54:37



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.000	4539029	233185	49.302	53.048
2	9.238	4667507	206388	50.698	46.952
Total		9206536	439573	100.000	100.000

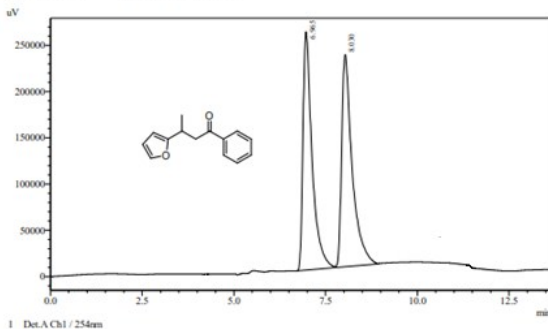
Acquired by : clf
 Sample Name : wgl-170
 Injection Volume : 10 uL
 Data Filename : wgl-170.lcd
 Method Filename : fdf.lcm
 Date Acquired : 2018-1-16 16:52:36
 Data Processed : 2018-1-16 17:04:52



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.133	2638358	133950	17.768	19.968
2	9.364	12163911	536891	82.232	80.032
Total		14792269	670842	100.000	100.000

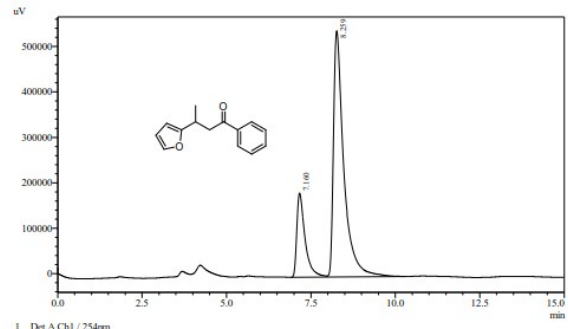
Acquired by : clf
 Sample Name : wgl-146'
 Injection Volume : 10 uL
 Data Filename : wgl-146'.lcd
 Method Filename : fdf.lcm
 Date Acquired : 2017-12-13 15:10:51
 Data Processed : 2017-12-13 16:30:30



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.965	4450786	257903	49.263	52.851
2	8.030	4583949	230076	50.737	47.149
Total		9034735	487979	100.000	100.000

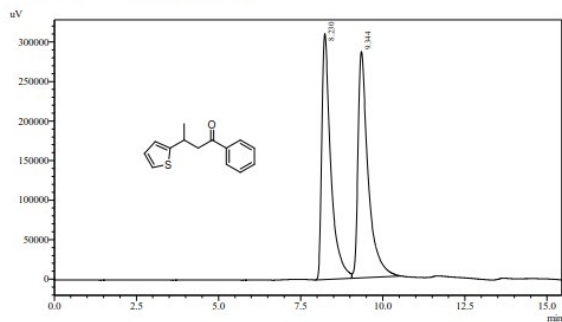
Acquired by : clf
 Sample Name : wgl-147
 Injection Volume : 10 uL
 Data Filename : wgl-147.lcd
 Method Filename : fdf.lcm
 Date Acquired : 2017-12-13 15:25:44
 Data Processed : 2017-12-13 16:31:38



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.160	3133399	185392	21.390	25.492
2	8.259	11515456	541857	78.610	74.508
Total		14648855	727249	100.000	100.000

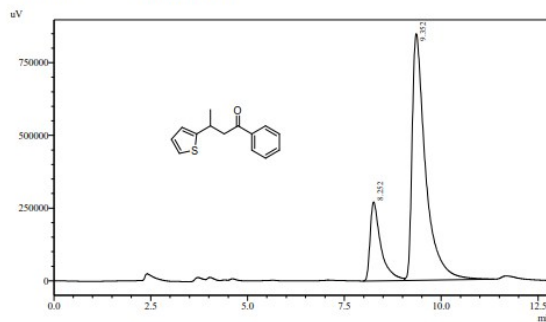
Acquired by : clf
 Sample Name : wgl-148
 Injection Volume : 10 uL
 Data Filename : wgl-148.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2017-12-13 16:11:31
 Data Processed : 2017-12-13 16:32:34



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.230	5930095	310779	49.116	52.064
2	9.344	6143661	286143	50.884	47.936
Total		12073757	596922	100.000	100.000

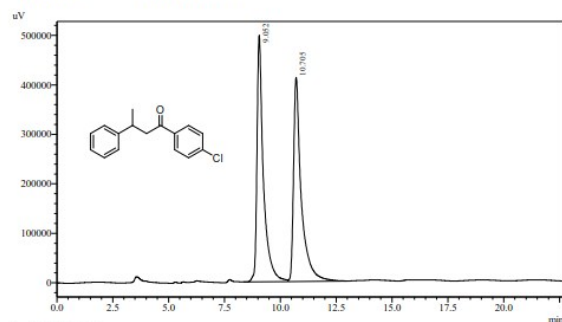
Acquired by : clf
 Sample Name : wgl-149
 Injection Volume : 10 uL
 Data Filename : wgl-149.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2017-12-13 16:28:58
 Data Processed : 2017-12-13 16:42:33



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.252	5225560	270868	20.341	24.212
2	9.352	20463700	847872	79.659	75.788
Total		25689260	1118740	100.000	100.000

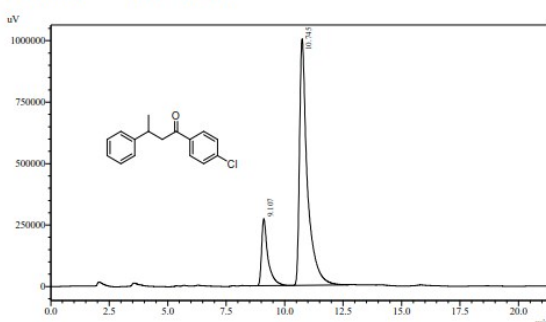
Acquired by : clf
 Sample Name : wgl-150
 Injection Volume : 10 uL
 Data Filename : wgl-150.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2017-12-19 14:52:52
 Data Processed : 2017-12-19 15:54:55



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.052	9984819	498064	50.210	54.708
2	10.705	9901460	412344	49.790	45.292
Total		19886279	910407	100.000	100.000

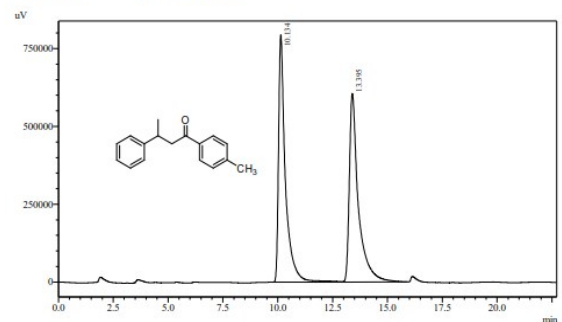
Acquired by : clf
 Sample Name : wgl-151
 Injection Volume : 10 uL
 Data Filename : wgl-151.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2017-12-19 15:17:55
 Data Processed : 2017-12-19 16:14:59



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.107	5118068	272735	17.891	21.384
2	10.745	23489405	1002699	82.109	78.616
Total		28607473	1275434	100.000	100.000

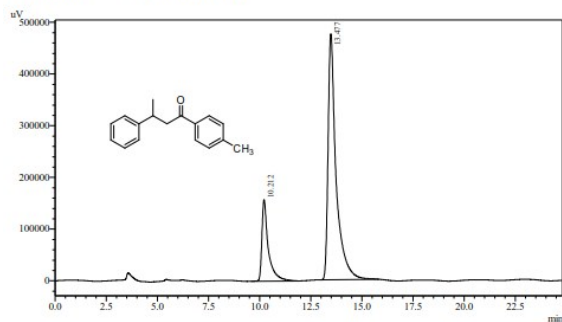
Acquired by : clf
 Sample Name : wgl-152
 Injection Volume : 10 uL
 Data Filename : wgl-152.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2017-12-19 15:41:34
 Data Processed : 2017-12-19 16:15:47



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.134	17412961	794442	50.089	56.748
2	13.395	17351190	605515	49.911	43.252
Total		34764151	1399956	100.000	100.000

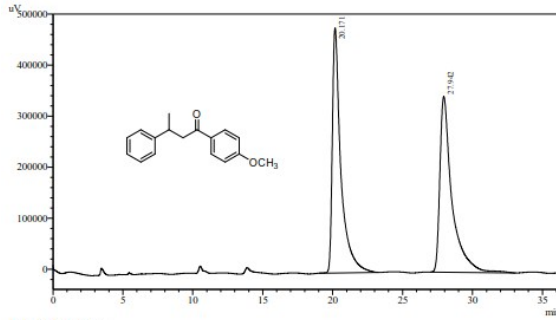
Acquired by : clf
 Sample Name : wgl-153
 Injection Volume : 10 uL
 Data Filename : wgl-153.lcd
 Method Filename : fxfp.lcm
 Date Acquired : 2017-12-19 16:05:14
 Data Processed : 2017-12-19 16:32:49



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.212	3450372	157777	20.992	24.909
2	13.477	12986363	475634	79.008	75.091
Total		16436735	633411	100.000	100.000

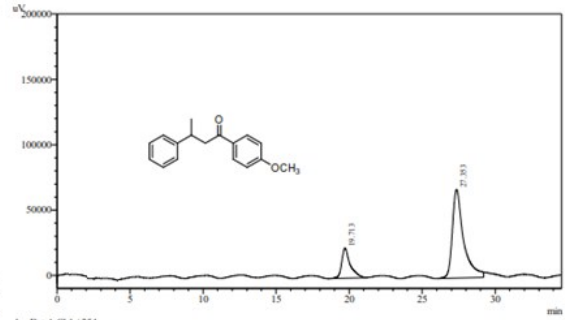
Acquired by : clf
 Sample Name : wgl-154
 Injection Volume : 10 uL
 Data Filename : wgl-154.lcd
 Method Filename : fidd.lcm
 Date Acquired : 2017-12-20 9:18:11
 Data Processed : 2017-12-20 10:36:56



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.171	20519506	479842	49.815	58.219
2	27.942	20671516	344359	50.185	41.781
Total		41191022	824201	100.000	100.000

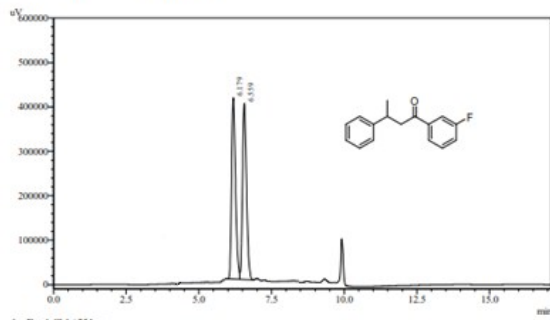
Acquired by : clf
 Sample Name : wgl-155
 Injection Volume : 10 uL
 Data Filename : wgl-155.lcd
 Method Filename : fidd.lcm
 Date Acquired : 2017-12-20 9:57:19
 Data Processed : 2017-12-21 10:17:45



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.713	932407	22919	20.394	25.254
2	27.353	3639542	67836	79.606	74.746
Total		4571949	90756	100.000	100.000

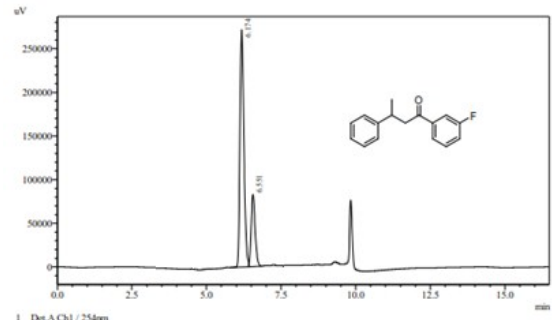
Acquired by : clf
 Sample Name : wgl-252
 Injection Volume : 20 uL
 Data Filename : wgl-252.lcd
 Method Filename : 001.lcm
 Date Acquired : 2006-1-4 6:58:59
 Data Processed : 2006-1-4 7:19:29



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.179	3836456	408210	50.307	50.738
2	6.559	3789642	396334	49.693	49.262
Total		7626098	804544	100.000	100.000

Acquired by : clf
 Sample Name : wgl-253
 Injection Volume : 20 uL
 Data Filename : wgl-253.lcd
 Method Filename : 001.lcm
 Date Acquired : 2006-1-4 7:17:42
 Data Processed : 2006-1-4 7:35:17



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.174	2512091	271388	76.806	76.707
2	6.551	758626	82410	23.194	23.293
Total		3270717	353798	100.000	100.000

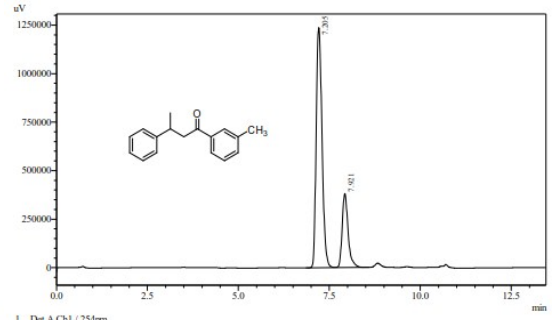
Acquired by : clf
 Sample Name : wgl-250
 Injection Volume : 20 uL
 Data Filename : wgl-250.lcd
 Method Filename : 001.lcm
 Date Acquired : 2006-1-4 6:30:17
 Data Processed : 2006-1-4 6:47:10



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.227	10750402	1005001	49.111	50.646
2	7.893	11139549	979377	50.889	49.354
Total		21889951	1984378	100.000	100.000

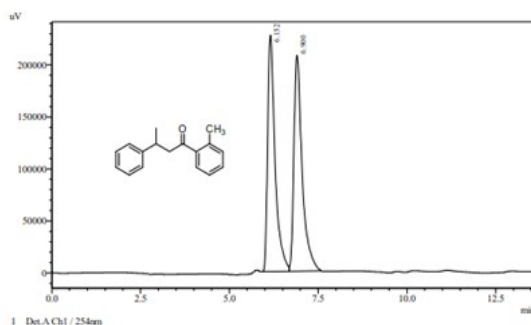
Acquired by : clf
 Sample Name : wgl-254
 Injection Volume : 20 uL
 Data Filename : wgl-254.lcd
 Method Filename : 001.lcm
 Date Acquired : 2006-1-5 0:14:40
 Data Processed : 2006-1-5 0:31:56



1 Det.A Ch1 / 254nm

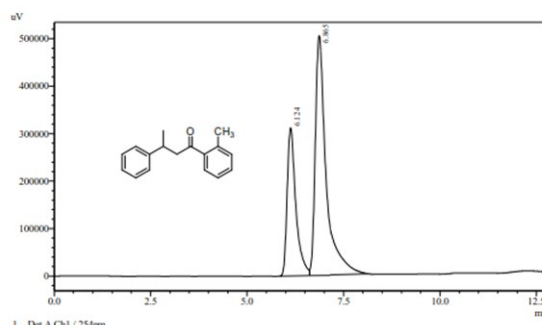
Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.205	13864773	1237154	76.194	76.421
2	7.921	4331903	381710	23.806	23.579
Total		18196676	1618864	100.000	100.000

Acquired by : clf
 Sample Name : wgl-258'
 Injection Volume : 20 uL
 Data Filename : wgl-258'.lcd
 Method Filename : 001.lcm
 Date Acquired : 2006-1-5 7:16:44
 Data Processed : 2006-1-5 7:32:42



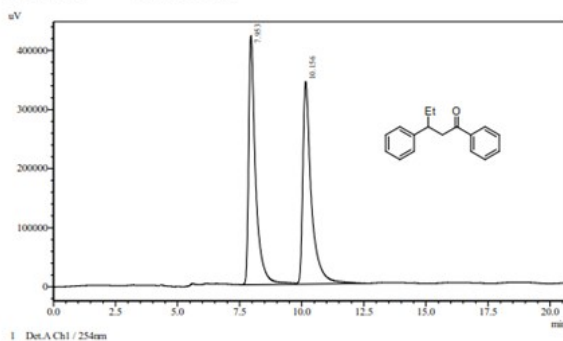
Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.152	3311597	227354	49.608	52.238
2	6.900	3363887	207872	50.392	47.762
Total		6675484	435225	100.000	100.000

Acquired by : clf
 Sample Name : wgl-259
 Injection Volume : 20 uL
 Data Filename : wgl-259.lcd
 Method Filename : 001.lcm
 Date Acquired : 2006-1-5 7:31:45
 Data Processed : 2006-1-5 7:46:24



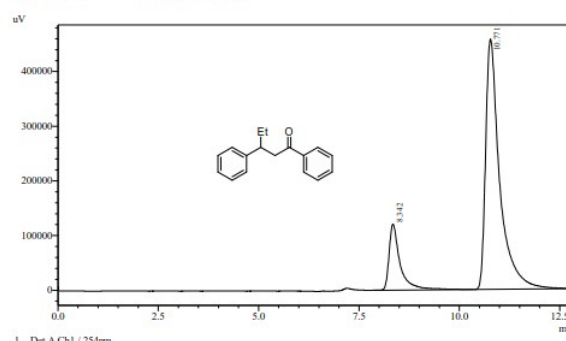
Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.124	4906555	311359	35.708	38.153
2	6.865	8834111	504713	64.292	61.847
Total		13740666	816072	100.000	100.000

Acquired by : clf
 Sample Name : wgl-144
 Injection Volume : 10 uL
 Data Filename : wgl-144.lcd
 Method Filename : fxff.lcm
 Date Acquired : 2017-12-5 16:30:15
 Data Processed : 2017-12-5 16:54:22



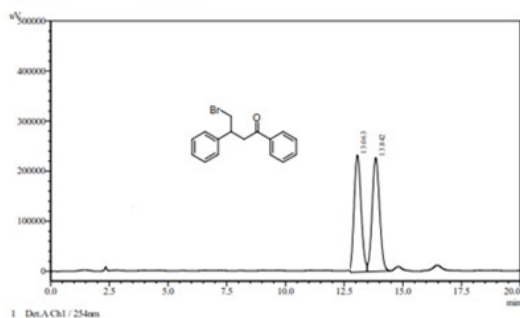
Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.953	8194222	421030	50.160	55.139
2	10.156	8141924	342551	49.840	44.861
Total		16336146	763581	100.000	100.000

Acquired by : clf
 Sample Name : wgl-145
 Injection Volume : 10 uL
 Data Filename : wgl-145.lcd
 Method Filename : fxff.lcm
 Date Acquired : 2017-12-5 16:52:23
 Data Processed : 2017-12-5 17:05:46



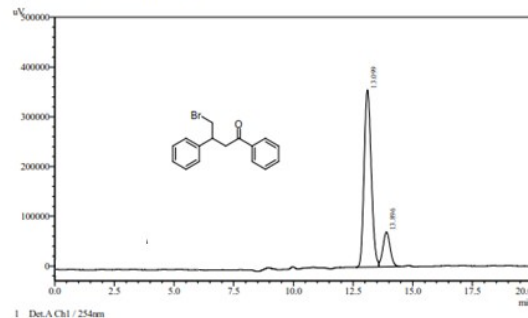
Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.342	2333900	120531	17.282	20.838
2	10.771	11170903	457893	82.718	79.162
Total		13504803	578424	100.000	100.000

Acquired by : clf
 Sample Name : wgl-195
 Injection Volume : 10 uL
 Data Filename : wgl-195.lcd
 Method Filename : fxff.lcm
 Date Acquired : 2018-2-6 16:05:48
 Data Processed : 2018-3-8 11:24:19



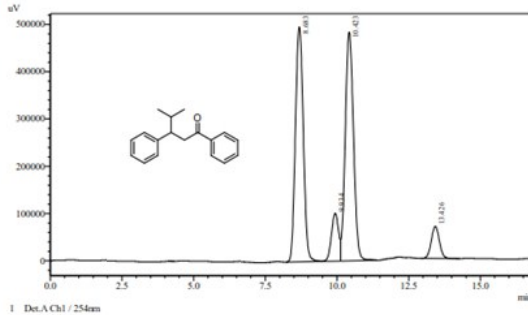
Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.063	4902297	233733	49.535	50.686
2	13.842	4994275	227402	50.465	49.314
Total		9896572	461135	100.000	100.000

Acquired by : clf
 Sample Name : wgl-196
 Injection Volume : 10 uL
 Data Filename : wgl-196.lcd
 Method Filename : fxff.lcm
 Date Acquired : 2018-2-6 16:29:33
 Data Processed : 2018-3-8 11:24:50



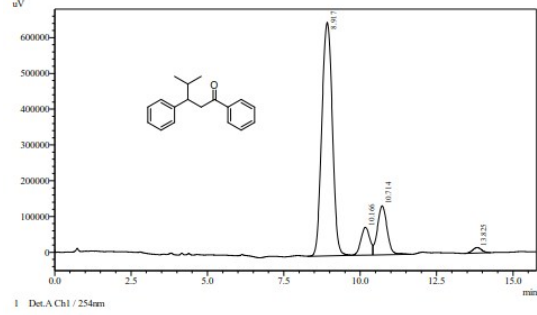
Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.099	7476591	356212	83.503	83.595
2	13.896	1477126	69906	16.497	16.405
Total		8953717	426119	100.000	100.000

Acquired by : clf
 Sample Name : wgl-186*
 Injection Volume : 10 uL
 Data Filename : wgl-186*.lod
 Method Filename : fxf.lcm
 Date Acquired : 2018-2-7 9:23:44
 Data Processed : 2018-2-7 9:59:34



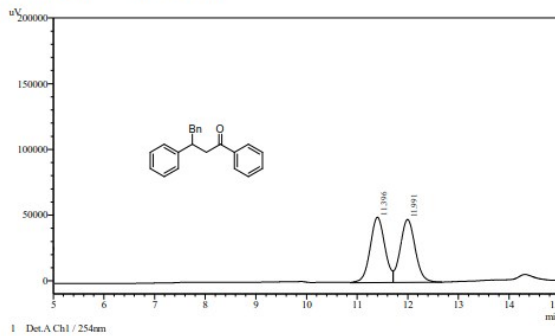
Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.683	9509885	497151	42.720	43.200
2	9.934	1753958	101388	7.879	8.810
3	10.423	9654497	484130	43.370	42.069
4	13.426	1342368	68136	6.030	5.921
Total		22260708	1150804	100.000	100.000

Acquired by : clf
 Sample Name : wgl-187
 Injection Volume : 10 uL
 Data Filename : wgl-187.lod
 Method Filename : fxf.lcm
 Date Acquired : 2018-2-7 9:43:54
 Data Processed : 2018-2-7 10:00:37



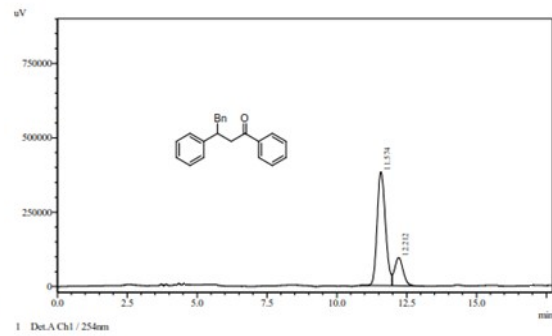
Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.917	15683364	652787	76.187	73.967
2	10.166	1579548	77580	7.673	8.791
3	10.714	3016075	136951	14.652	15.518
4	13.825	306402	15220	1.488	1.725
Total		20585389	882539	100.000	100.000

Acquired by : clf
 Sample Name : wgl-184
 Injection Volume : 10 uL
 Data Filename : wgl-184.lod
 Method Filename : fxf.lcm
 Date Acquired : 2018-2-2 10:07:06
 Data Processed : 2018-2-2 10:52:10



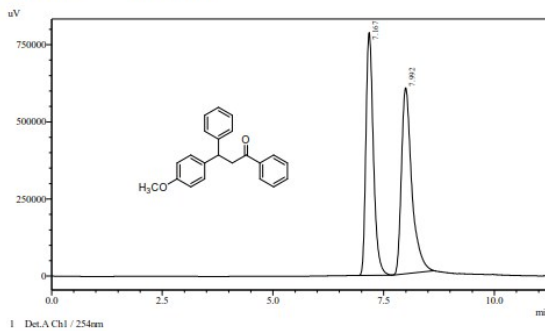
Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.396	1007227	49754	50.688	50.974
2	11.991	979886	47853	49.312	49.026
Total		1987112	97607	100.000	100.000

Acquired by : clf
 Sample Name : wgl-185
 Injection Volume : 10 uL
 Data Filename : wgl-185.lod
 Method Filename : fxf.lcm
 Date Acquired : 2018-2-2 10:32:49
 Data Processed : 2018-2-2 10:53:54



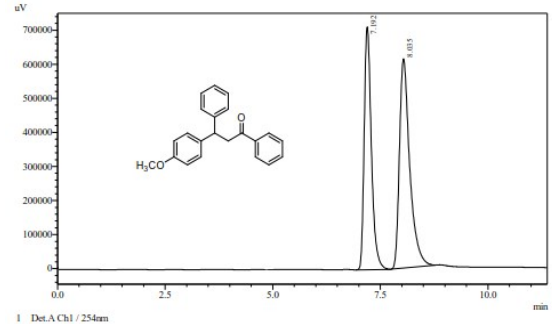
Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.574	7954658	382269	79.673	80.129
2	12.212	2029526	94800	20.327	19.871
Total		9984184	477069	100.000	100.000

Acquired by : clf
 Sample Name : wgl-190
 Injection Volume : 20 uL
 Data Filename : wgl-190.lod
 Method Filename : 001.lcm
 Date Acquired : 2006-1-1 7:06:26
 Data Processed : 2006-1-1 7:18:44



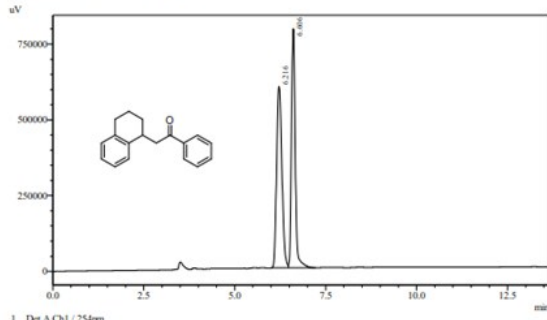
Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.167	9261960	786590	48.550	56.652
2	7.992	9815132	601863	51.450	43.348
Total		19077092	1388453	100.000	100.000

Acquired by : clf
 Sample Name : wgl-191
 Injection Volume : 20 uL
 Data Filename : wgl-191.lod
 Method Filename : 001.lcm
 Date Acquired : 2006-1-1 7:21:20
 Data Processed : 2006-1-1 7:35:13



Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.192	8286943	712215	44.792	53.691
2	8.035	10214026	614288	55.208	46.309
Total		18500969	1326503	100.000	100.000

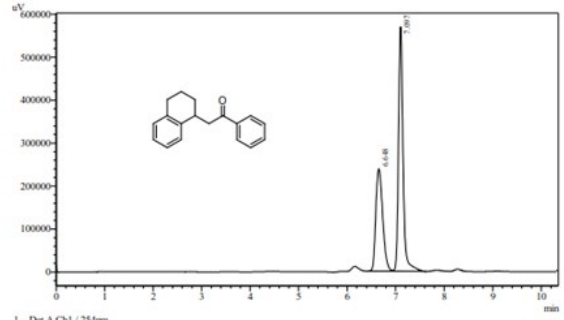
Acquired by : clf
 Sample Name : wgl-188*
 Injection Volume : 10 uL
 Data Filename : wgl-188*.lcd
 Method Filename : fdfp.lcm
 Date Acquired : 2018-2-1 10:48:03
 Data Processed : 2018-2-1 11:05:49



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.216	6067065	598045	51.323	43.138
2	6.606	5754335	788294	48.677	56.862
Total		11821400	1386339	100.000	100.000

Acquired by : clf
 Sample Name : wgl-189
 Injection Volume : 10 uL
 Data Filename : wgl-189.lcd
 Method Filename : fdfp.lcm
 Date Acquired : 2018-2-1 11:04:02
 Data Processed : 2018-2-1 14:41:16



1 Det.A Ch1 / 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.648	2341390	238302	38.815	29.524
2	7.097	3690813	568835	61.185	70.476
Total		6032204	807138	100.000	100.000