

Supporting Information

Direct Organocatalytic Asymmetric Vinylogous Michael Reaction of α , β -Unsaturated Ketones with 2(5*H*)-furanone

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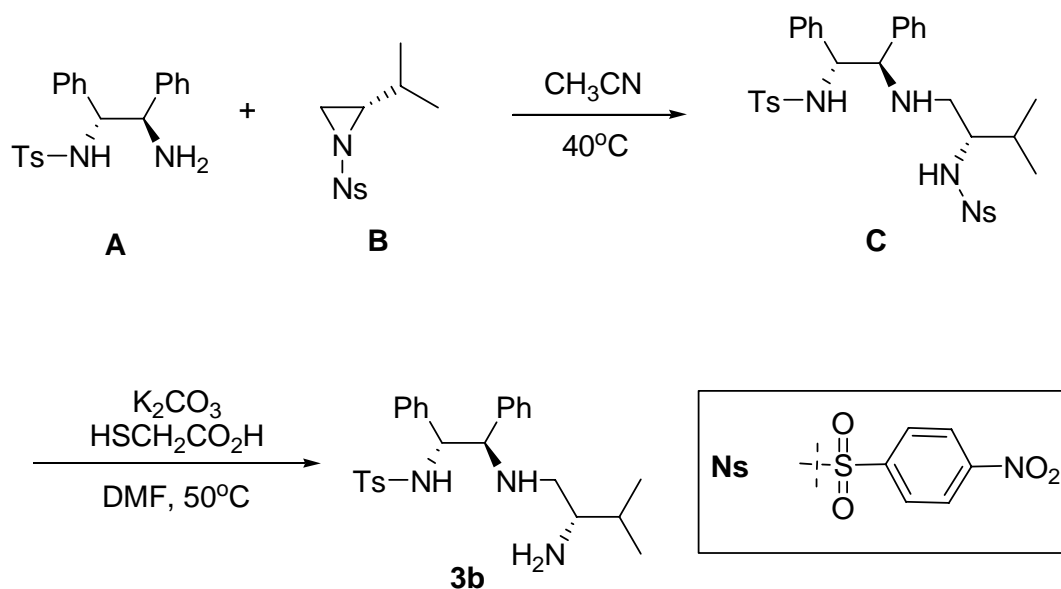
A: General Information and Starting Materials

General Information. Proton nuclear magnetic resonance (^1H NMR) spectra and carbon nuclear magnetic resonance (^{13}C NMR) spectra were recorded on a Bruker AV-400 spectrometer (400 MHz and 100 MHz). Chemical shifts for protons are reported in parts per million downfield from tetramethylsilane and are referenced to residual protium in the NMR solvent (CDCl_3 : δ 7.26). Chemical shifts for carbon are reported in parts per million downfield from tetramethylsilane and are referenced to the carbon resonances of the solvent (CDCl_3 : δ 77.16). Data are represented as follows: chemical shift, integration, multiplicity (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants in Hertz (Hz). Mass spectra (EI) were measured on a Waters Micromass GCT spectrometer. Optical rotations were measured on an Autopol III automatic polarimeter (Rudolph Research analytical). Melting points were measured on a XT3A apparatus. High performance liquid chromatography (HPLC) was performed on an Agilent 1200 Series chromatographs using a chiral columns (AS-H, AY-H, IA, IC) as noted.

Starting Materials. All solvents and inorganic reagents were from commercial sources and used without purification unless otherwise noted.

B: Experimental Procedure and Characterization of Catalysts

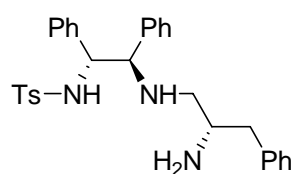
General procedure for the synthesis of new chiral catalysts¹.



To a solution of N-Ts DPEN **A** (2.93g, 8.0mmol) in CH₃CN (80.0 mL) was added **B** (2.16g, 8.0mmol). The reaction mixture was stirred at 40°C for 12h. TLC indicated the reaction was completed. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography to afford the pure product as a white solid **C** in 92% yield. ¹H NMR (400 MHz, CDCl₃): δ (ppm) 8.18 (d, *J* = 8.8 Hz, 2H), 7.90 (d, *J* = 8.4 Hz, 2H), 7.49 (d, *J* = 8.0 Hz, 2H), 7.14-6.99 (m, 8H), 6.88-6.87 (m, 4H), 4.24 (d, *J* = 8.0 Hz, 1H), 3.58 (d, *J* = 8.0 Hz, 1H), 2.99-2.98 (m, 1H), 2.43-2.39 (m, 1H), 2.36 (s, 3H), 2.17-2.12 (m, 1H), 1.78-1.69 (m, 1H), 0.75 (d, *J* = 6.8 Hz, 3H), 0.70 (d, *J* = 6.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 149.6, 147.0, 143.1, 139.0, 138.2, 136.7, 129.3, 128.3, 128.2, 128.0, 127.6, 127.2, 127.1, 124.2, 68.1, 63.6, 59.7, 47.6, 29.8, 21.5, 18.8, 18.7.

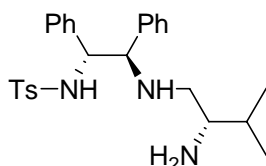
To a stirred solution of **C** (3.18 g, 5.0 mmol) in DMF (30.0 mL) was added K₂CO₃ (2.07 g, 15.0 mmol), HSCH₂CO₂H (0.92 g, 10.0 mmol). The mixture was stirred at 50°C until TLC indicated that the reaction was completed. The mixture was then diluted with EtOAc (50 mL), and washed with 5M NaOH (3 × 100 mL). The aqueous layer was extracted with EtOAc (3 × 30 mL) and the combined organic layers were dried over MgSO₄ and concentrated. The residue was purified by silica gel chromatography to afford the pure product **3b** as a white solid in 80% yield.

3a: N-((1R,2R)-2-((S)-2-amino-3-phenylpropylamino)-1,2-diphenylethyl)-4-methylbenzenesulfonamide



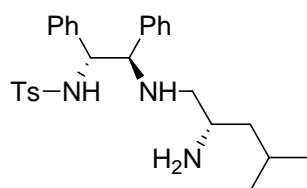
White solid. Mp 164-165°C; [α]_D²⁰ - 20.3 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.40-7.38 (m, 2H), 7.32-7.29 (m, 2H), 7.25-7.21 (m, 1H), 7.16-7.11 (m, 5H), 7.07-7.01 (m, 5H), 6.96-6.93 (m, 4H), 4.32 (d, *J* = 8.0 Hz, 1H), 3.64 (d, *J* = 8.0 Hz, 1H), 3.03-2.98 (m, 1H), 2.72 (dd, *J* = 4.4, 13.2 Hz, 1H), 2.50 (dd, *J* = 4.0, 11.6 Hz, 1H), 2.44-2.39 (m, 1H), 2.34 (s, 3H), 2.26-2.21 (m, 1H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 142.5, 139.6, 138.9, 138.6, 137.6, 129.2, 129.1, 128.5, 128.3, 127.8, 127.6, 127.5, 127.4, 127.1, 127.0, 126.3, 68.6, 63.4, 53.5, 52.8, 42.3, 21.4; HRMS (EI): exact mass calculated for [(M+H)⁺] (C₃₀H₃₄N₃O₂S) requires *m/z* 500.2372, found *m/z* 500.2374.

3b: N-((1R,2R)-2-((S)-2-amino-3-methylbutylamino)-1,2-diphenylethyl)-4-methylbenzenesulfonamide



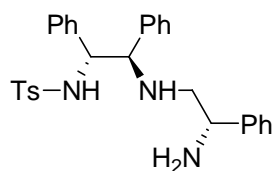
White solid. Mp 112-113°C; [α]_D²⁰ - 34.1 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.40-7.39 (m, 2H), 7.15-7.13 (m, 3H), 7.07-7.02 (m, 5H), 6.96-6.95 (m, 4H), 4.34 (d, *J* = 8.0 Hz, 1H), 3.65 (d, *J* = 8.0 Hz, 1H), 2.50-2.44 (m, 2H), 2.34 (s, 3H), 2.18-2.13 (m, 1H), 1.55-1.51 (m, 1H), 0.83 (d, *J* = 6.8 Hz, 3H), 0.79 (d, *J* = 6.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 142.6, 139.6, 138.5, 137.2, 129.1, 128.3, 127.9, 127.6, 127.4, 127.2, 127.1, 68.6, 63.3, 57.0, 51.8, 31.7, 21.4, 19.5, 17.4; HRMS (EI): exact mass calculated for [(M+H)⁺] (C₂₆H₃₄N₃O₂S) requires *m/z* 452.2372, found *m/z* 452.2373.

3c: *N*-((1*R*,2*R*)-2-((*S*)-2-amino-4-methylpentylamino)-1,2-diphenylethyl)-4-methylbenzenesulfonamide



White solid. Mp 120-121°C; $[\alpha]_D^{20}$ - 39.3 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.41-7.39 (m, 2H), 7.16-7.15 (m, 3H), 7.06-7.03 (m, 5H), 6.96-6.94 (m, 4H), 4.33 (d, *J* = 8.0 Hz, 1H), 3.64 (d, *J* = 8.8 Hz, 1H), 2.80-2.74 (m, 1H), 2.45-2.41 (m, 1H), 2.35 (s, 3H), 2.15-2.10 (m, 1H), 1.66-1.60 (m, 1H), 1.13-1.09 (m, 1H), 0.88 (d, *J* = 6.8 Hz, 3H), 0.86 (d, *J* = 6.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 142.7, 139.6, 138.4, 137.3, 129.1, 128.3, 127.9, 127.6, 127.5, 127.4, 127.2, 127.1, 68.5, 63.3, 54.5, 49.1, 45.1, 24.6, 23.4, 22.0, 21.4; HRMS (EI): exact mass calculated for [(M+H)⁺] (C₂₇H₃₆N₃O₂S) requires *m/z* 466.2528, found *m/z* 466.2530.

3d: *N*-((1*R*,2*R*)-2-((*S*)-2-amino-2-phenylethylamino)-1,2-diphenylethyl)-4-methylbenzenesulfonamide



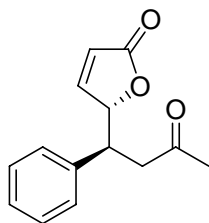
White crystals. Mp 79-80°C; $[\alpha]_D^{20}$ - 153.7 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.40-7.38 (m, 2H), 7.32-7.28 (m, 3H), 7.16-7.14 (m, 3H), 7.06-7.01 (m, 5H), 6.97-6.94 (m, 2H), 6.90-6.87 (m, 2H), 6.79-6.77 (m, 2H), 4.30 (d, *J* = 8.4 Hz, 1H), 3.42 (d, *J* = 8.4 Hz, 1H), 3.28-3.25 (m, 1H), 2.83 (dd, *J* = 4.4, 12.4 Hz, 1H), 2.71 (dd, *J* = 4.4, 12.4 Hz, 1H), 2.35 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 142.7, 141.2, 139.1, 138.2, 137.1, 129.1, 128.7, 128.3, 127.8, 127.7, 127.6, 127.5, 127.4, 127.3, 127.1, 64.3, 63.5, 61.7, 48.9, 21.4; HRMS (EI): exact mass calculated for [(M+H)⁺] (C₂₉H₃₂N₃O₂S) requires *m/z* 486.2215, found *m/z* 486.2216.

C: General Procedure for Asymmetric Michael Addition

To a solution of α , β -unsaturated ketones **5** (1.0 mmol, 2.0 equiv.) in CHCl₃ (1.0 mL) was added catalyst **3b** (0.05 mmol, 0.1 equiv.) and *N*-Boc-L-Phe (0.05 mmol, 0.1 equiv.) then followed by 2(*5H*)-furanone (35 μ L, 0.5 mmol, 1.0 equiv.). The reaction mixture was stirred at 50°C for 3 days and then the solvent was removed under vacuum. The residue was purified by silica gel chromatography to yield the desired addition product.

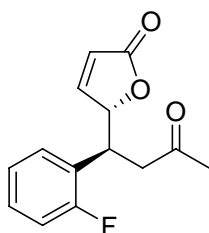
D: Characterization of Michael Addition Products

6a: 5-(3-oxo-1-phenylbutyl)furan-2(5H)-one



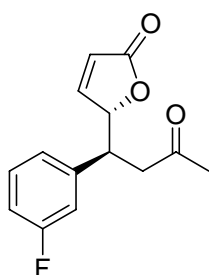
The product was obtained in 84% yield, white solid. Mp 77-78°C; $[\alpha]_D^{20}$ - 59.5 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.38-7.34 (m, 2H), 7.31-7.28 (m, 3H), 7.24-7.23 (m, 1H), 6.10 (dd, *J* = 1.2, 5.6 Hz, 1H), 5.18-5.16 (m, 1H), 3.49-3.44(m, 1H), 3.05 (dd, *J* = 5.2, 17.6 Hz, 1H), 2.93 (dd, *J* = 8.0, 17.6 Hz, 1H), 2.08 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.9, 172.6, 155.5, 139.3, 129.0, 128.0, 127.7, 121.9, 85.7, 45.0, 44.2, 30.5; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₄O₃) requires *m/z* 230.0943, found *m/z* 230.0944; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: EtOH = 1:1, 0.60 mL/min]: 17.9 min (minor), 29.7 min (major), ee 98%.

6b: 5-(1-(2-fluorophenyl)-3-oxobutyl)furan-2(5H)-one



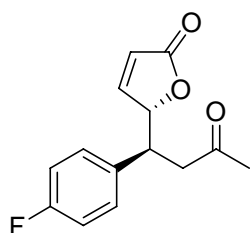
The product was obtained in 80% yield, white solid. Mp 89-91°C; $[\alpha]_D^{20}$ - 64.2 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.34-7.26 (m, 3H), 7.17-7.13 (m, 1H), 7.11-7.06 (m, 1H), 6.12 (dd, *J* = 1.2, 5.6 Hz, 1H), 5.27-5.25 (m, 1H), 3.78-3.72(m, 1H), 3.10 (dd, *J* = 5.2, 17.6 Hz, 1H), 3.00 (dd, *J* = 7.6, 18.0 Hz, 1H), 2.11 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.6, 172.5, 161.8, 159.3, 155.4, 130.2, 130.2, 129.5, 129.4, 126.0, 125.9, 124.7, 124.7, 122.0, 116.0, 115.9, 84.4, 43.7, 38.5, 30.3; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₃FO₃) requires *m/z* 248.0849, found *m/z* 248.0850; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: EtOH = 7:3, 0.80 mL/min]: 24.2 min (minor), 42.9 min (major), ee 97%.

6c: 5-(1-(3-fluorophenyl)-3-oxobutyl)furan-2(5H)-one



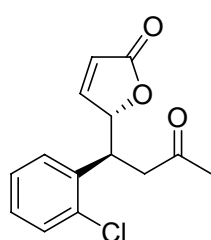
The product was obtained in 75% yield, white solid. Mp 80-82°C; $[\alpha]_D^{20}$ - 53.1 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.36-7.31 (m, 1H), 7.27 (d, *J* = 5.6 Hz, 1H), 7.11-7.09 (m, 1H), 7.04-6.09 (m, 2H), 6.14 (dd, *J* = 1.6, 5.6 Hz, 1H), 5.18-5.16 (m, 1H), 3.54-3.49(m, 1H), 3.02 (dd, *J* = 5.2, 18.0 Hz, 1H), 2.89 (dd, *J* = 8.0, 18.0 Hz, 1H), 2.11 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.5, 172.4, 164.2, 161.7, 155.1, 142.1, 142.0, 130.6, 130.5, 123.9, 123.8, 122.2, 115.2, 115.2, 115.0, 114.8, 114.6, 85.2, 50.8, 44.5, 43.6, 30.5; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₃FO₃) requires *m/z* 248.0849, found *m/z* 248.0852; The enantiomeric excess was determined by HPLC. [IA column, 220nm, n-Hexane: EtOH = 4:1, 1.0 L/min]: 12.3 min (major), 14.2 min (minor), ee 96%.

6d: 5-(1-(4-fluorophenyl)-3-oxobutyl)furan-2(5H)-one



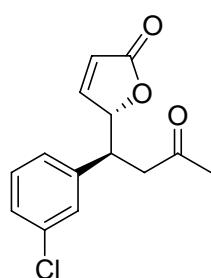
The product was obtained in 79% yield, colorless oil. $[\alpha]_D^{20}$ - 41.8 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.29-7.24 (m, 3H), 7.05-7.01 (m, 2H), 6.11 (dd, *J* = 1.6, 5.6 Hz, 1H), 5.15-5.13 (m, 1H), 3.52-3.47(m, 1H), 2.99 (dd, *J* = 5.2, 17.6 Hz, 1H), 2.87 (dd, *J* = 8.0, 18.0 Hz, 1H), 2.07 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.7, 172.5, 163.3, 160.9, 155.2, 135.2, 135.2, 129.8, 129.7, 122.1, 115.9, 115.7, 85.5, 44.7, 43.2, 30.5; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₃FO₃) requires *m/z* 248.0849, found *m/z* 248.0847; The enantiomeric excess was determined by HPLC. [AS-H column, 220nm, n-Hexane: *i*-PrOH = 1:1, 0.50 mL/min]: 37.3 min (major), 47.7 min (minor), ee 98%.

6e: 5-(1-(2-chlorophenyl)-3-oxobutyl)furan-2(5H)-one



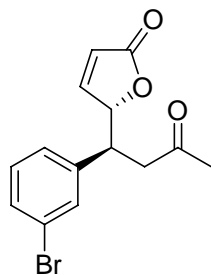
The product was obtained in 78% yield, brown oil. $[\alpha]_D^{20}$ - 3.5 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.42-7.36 (m, 2H), 7.33-7.31 (m, 1H), 7.28-7.21 (m, 2H), 6.11 (dd, *J* = 1.2, 6.0 Hz, 1H), 5.24-5.23 (m, 1H), 4.16-4.11(m, 1H), 2.98 (dd, *J* = 6.4, 17.6 Hz, 1H), 2.88 (dd, *J* = 6.8, 18.0 Hz, 1H), 2.08 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.5, 172.6, 155.7, 137.1, 133.8, 130.1, 129.1, 128.8, 127.4, 121.8, 84.6, 43.1, 39.5, 30.2; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₃ClO₃) requires *m/z* 264.0553, found *m/z* 264.0547; The enantiomeric excess was determined by HPLC. [AS-H column, 220nm, n-Hexane: *i*-PrOH = 1:1, 0.50 mL/min]: 32.2 min (minor), 57.6 min (major), ee 95%.

6f: 5-(1-(3-chlorophenyl)-3-oxobutyl)furan-2(5H)-one



The product was obtained in 81% yield, yellow oil. $[\alpha]_D^{20}$ - 28.4 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.30-7.28 (m, 3H), 7.27-7.26 (m, 1H), 7.22-7.19 (m, 1H), 6.14 (dd, *J* = 2.0, 5.6 Hz, 1H), 5.17-5.15 (m, 1H), 3.52-3.47(m, 1H), 3.00 (dd, *J* = 5.2, 18.0 Hz, 1H), 2.89 (dd, *J* = 8.0, 18.0 Hz, 1H), 2.10 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.4, 172.4, 155.2, 141.6, 134.7, 130.2, 128.2, 127.9, 126.5, 122.2, 85.2, 44.3, 43.5, 30.4; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₃ClO₃) requires *m/z* 264.0553, found *m/z* 264.0558; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: *i*-PrOH = 1:1, 0.50 mL/min]: 36.9 min (minor), 62.8 min (major), ee 97%.

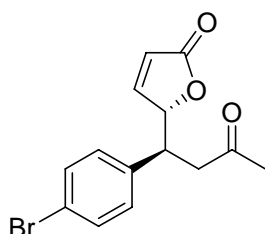
6g: 5-(1-(3-bromophenyl)-3-oxobutyl)furan-2(5H)-one



The product was obtained in 75% yield, yellow oil. $[\alpha]_D^{20}$ - 31.2 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.46-7.43 (m, 2H), 7.27-7.21 (m, 3H), 6.14 (dd, *J* = 2.0, 6.0 Hz, 1H), 5.17-5.15 (m, 1H), 3.51-3.46(m, 1H), 3.00 (dd, *J* = 5.2, 18.0 Hz, 1H), 2.88 (dd, *J* = 7.6, 18.0 Hz, 1H), 2.10 (s, 3H). ¹³C NMR (100 MHz,

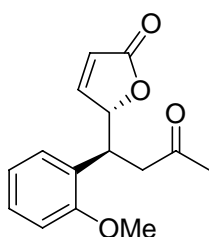
CDCl₃): δ (ppm) 205.4, 172.4, 155.1, 142.0, 131.0, 130.9, 130.5, 127.0, 122.9, 122.2, 85.2, 44.4, 43.5, 30.5; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₃BrO₃) requires m/z 308.0048, found m/z 308.0054; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: EtOH = 1:1, 0.60 mL/min]: 14.0 min (minor), 17.3 min (major), ee 97%.

6h: 5-(1-(4-bromophenyl)-3-oxobutyl)furan-2(5H)-one



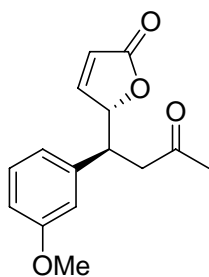
The product was obtained in 78% yield, white solid. Mp 91-92°C; $[\alpha]_D^{20}$ - 47.5 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.44 (d, *J* = 8.4 Hz, 2H), 7.24 (d, *J* = 5.6 Hz, 1H), 7.16 (d, *J* = 8.0 Hz, 2H), 6.08 (dd, *J* = 2.0, 5.6 Hz, 1H), 5.13-5.11 (m, 1H), 3.48-3.43(m, 1H), 2.96 (dd, *J* = 5.2, 17.6 Hz, 1H), 2.85 (dd, *J* = 8.0, 18.0 Hz, 1H), 2.05 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.5, 172.4, 155.2, 138.5, 132.0, 129.9, 122.2, 121.6, 85.2, 44.391, 43.3, 30.5; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₃BrO₃) requires m/z 308.0048, found m/z 308.0055; The enantiomeric excess was determined by HPLC. [IC column, 220nm, n-Hexane: EtOH = 4:1, 1.0 mL/min]: 18.0 min (minor), 19.8 min (major), ee 95%.

6i: 5-(1-(2-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one



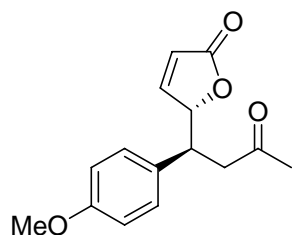
The product was obtained in 85% yield, colorless oil. $[\alpha]_D^{20}$ - 44.9 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.28-7.24 (m, 1H), 7.22-7.21 (m, 2H), 6.95-6.89 (m, 2H), 6.05 (dd, *J* = 1.6, 5.6 Hz, 1H), 5.33-5.31 (m, 1H), 3.86(s, 3H), 3.80-3.75 (m, *J* = 5.2, 1H), 3.06-2.94 (m, 2H), 2.06 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 206.4, 172.9, 156.9, 156.4, 129.4, 128.8, 127.0, 121.2, 121.0, 111.0, 84.9, 55.4, 43.9, 39.2, 30.3; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₆O₄) requires m/z 260.1049, found m/z 260.1051; The enantiomeric excess was determined by HPLC. [AS-H column, 220nm, n-Hexane: EtOH = 4:1, 0.80 mL/min]: 26.5 min (minor), 38.7 min (major), ee 98%.

6j: 5-(1-(3-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one



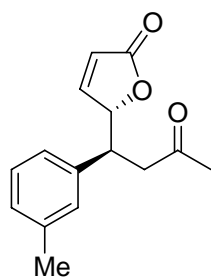
The product was obtained in 73% yield, colorless crystals. Mp 68-69°C; $[\alpha]_D^{20}$ - 47.9 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.27-7.22 (m, 2H), 6.84 (d, *J* = 7.6 Hz 1H), 6.81-6.80 (m, 2H), 6.07 (dd, *J* = 1.2, 6.0 Hz, 1H), 5.14-5.12 (m, 1H), 3.79 (s, 3H), 3.42-3.37 (m, 1H), 3.02 (dd, *J* = 5.2, 17.6 Hz, 1H), 2.91 (dd, *J* = 8.0, 18.0 Hz, 1H), 2.06 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.9, 172.6, 159.8, 155.6, 140.8, 130.0, 121.8, 120.2, 114.1, 112.7, 85.6, 55.2, 45.0, 44.268, 30.5; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₆O₄) requires m/z 260.1049, found m/z 260.1046; The enantiomeric excess was determined by HPLC. [AS-H column, 220nm, n-Hexane: EtOH = 7:3, 0.80 mL/min]: 19.2 min (minor), 33.4 min (major), ee 97%.

6k: 5-(1-(4-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one



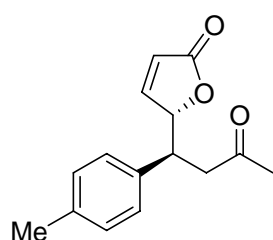
The product was obtained in 84% yield, colorless crystals. Mp 87-89°C; $[\alpha]_D^{20}$ - 53.4 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.22 (d, *J* = 5.6 Hz, 1H), 7.17 (d, *J* = 8.8 Hz 2H), 6.84 (d, *J* = 8.8 Hz 2H), 6.05 (dd, *J* = 1.6, 5.6 Hz, 1H), 5.11-5.09 (m, 1H), 3.76 (s, 3H), 3.40-3.35 (m, 1H), 2.98 (dd, *J* = 5.2, 17.2 Hz, 1H), 2.87 (dd, *J* = 8.4, 17.2 Hz, 1H), 2.03 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 206.1, 172.7, 158.9, 155.6, 131.1, 129.1, 121.8, 114.2, 85.9, 55.2, 45.2, 43.5, 30.5; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₁₆O₄) requires *m/z* 260.1049, found *m/z* 260.1052; The enantiomeric excess was determined by HPLC. [IC column, 220nm, n-Hexane: EtOH = 4:1, 1.0 mL/min]: 33.8 min (minor), 37.9 min (major), ee 96%.

6l: 5-(3-oxo-1-*m*-tolylbutyl)furan-2(5H)-one



The product was obtained in 83% yield, yellow oil. $[\alpha]_D^{20}$ - 26.2 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.23-7.20 (m, 2H), 7.09-7.05 (m, 3H), 6.07 (dd, *J* = 1.6, 5.6 Hz, 1H), 5.14-5.13 (m, 1H), 3.42-3.37 (m, 1H), 3.02 (dd, *J* = 5.2, 17.6 Hz, 1H), 2.91 (dd, *J* = 8.4, 17.6 Hz, 1H), 2.34 (s, 3H), 2.06 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 205.9, 172.6, 155.7, 139.2, 138.5, 128.8, 128.4, 125.0, 121.7, 85.8, 45.0, 44.2, 30.5, 21.4; HRMS (EI): exact mass calculated for M⁺ (C₁₅H₁₆O₃) requires *m/z* 244.1099, found *m/z* 244.1100; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: EtOH = 1:1, 0.60 mL/min]: 19.7 min (minor), 23.7 min (major), ee 97%.

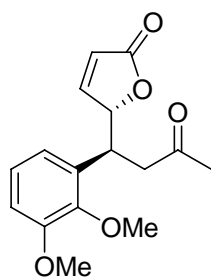
6m: 5-(3-oxo-1-*p*-tolylbutyl)furan-2(5H)-one



The product was obtained in 85% yield, yellow oil. $[\alpha]_D^{20}$ - 48.1 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.23 (d, *J* = 5.6 Hz, 1H), 7.16-7.15 (m, 4H), 6.09 (dd, *J* = 1.2, 5.6 Hz, 1H), 5.14-5.12 (m, 1H), 3.43-3.38 (m, 1H), 3.03 (dd, *J* = 5.2, 17.6 Hz, 1H), 2.91 (dd, *J* = 8.0, 17.6 Hz, 1H), 2.34 (s, 3H), 2.07 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 206.0, 172.7, 155.6, 137.4, 136.1, 129.6, 127.9, 121.8, 85.8, 45.2, 44.0, 30.5, 21.0; HRMS (EI): exact mass calculated for M⁺ (C₁₅H₁₆O₃) requires *m/z* 244.1099, found *m/z* 244.1098; The enantiomeric excess was determined by HPLC. [IC column, 220nm, n-Hexane: EtOH = 4:1, 1.0 mL/min]: 24.2 min (minor), 27.6 min (major), ee 96%.

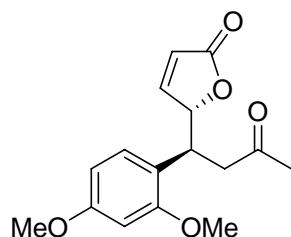
6n: 5-(1-(2,3-dimethoxyphenyl)-3-oxobutyl)furan-2(5H)-one

The product was obtained in 86% yield, yellow oil. $[\alpha]_D^{20}$ - 49.9 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.23 (d, *J* = 5.6 Hz, 1H) 7.07-7.03 (m, 1H),



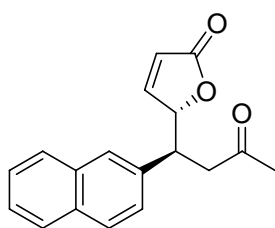
6.88-6.83 (m, 2H), 6.07 (dd, $J = 1.6, 5.6$ Hz, 1H), 5.14-5.12 (m, 1H), 3.92 (s, 3H), 3.88 (s, 3H), 3.86-3.82 (m, 1H), 3.07 (dd, $J = 5.2, 17.6$ Hz, 1H), 2.99 (dd, $J = 8.4, 17.6$ Hz, 1H), 2.10 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ (ppm) 206.1, 172.8, 156.1, 153.0, 146.8, 132.6, 124.3, 121.4, 119.8, 111.7, 85.4, 60.7, 55.7, 44.4, 38.0, 30.4; HRMS (EI): exact mass calculated for M^+ ($\text{C}_{16}\text{H}_{18}\text{O}_5$) requires m/z 290.1154, found m/z 290.1153; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: EtOH = 1:1, 0.60 mL/min]: 38.2 min (major), 56.1 min (minor), ee 97%.

6o: 5-(1-(2,4-dimethoxyphenyl)-3-oxobutyl)furan-2(5H)-one



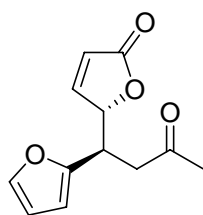
The product was obtained in 85% yield, yellow oil. $[\alpha]_{\text{D}}^{20} - 48.0$ (c 1.0, CH_2Cl_2); ^1H NMR (400 MHz, CDCl_3): δ (ppm) 7.22 (d, $J = 6.0$ Hz, 1H), 7.12-7.10 (m, 1H), 6.47-6.45 (m, 2H), 6.04 (dd, $J = 1.2, 5.6$ Hz, 1H), 5.29-5.27 (m, 1H), 3.83 (s, 3H), 3.79 (s, 3H), 3.69-3.64 (m, 1H), 3.04-2.92 (m, 2H), 2.06 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ (ppm) 206.6, 172.9, 160.2, 157.9, 156.5, 130.0, 121.0, 119.1, 104.6, 98.8, 85.1, 55.4, 55.2, 44.2, 39.0, 30.2; HRMS (EI): exact mass calculated for M^+ ($\text{C}_{16}\text{H}_{18}\text{O}_5$) requires m/z 290.1154, found m/z 290.1157; The enantiomeric excess was determined by HPLC. [IA column, 220nm, n-Hexane: EtOH = 8:1, 1.0 mL/min]: 17.5 min (minor), 18.6 min (major), ee 98%.

6p: 5-(1-(naphthalen-2-yl)-3-oxobutyl)furan-2(5H)-one



The product was obtained in 86% yield, white solid. Mp 123-124°C; $[\alpha]_{\text{D}}^{20} - 59.8$ (c 1.0, CH_2Cl_2); ^1H NMR (400 MHz, CDCl_3): δ (ppm) 7.87-7.83 (m, 3H), 7.77-7.76 (m, 1H), 7.54-7.48 (m, 2H), 7.44-7.41 (m, 1H), 7.25-7.24 (m, 1H), 6.11 (dd, $J = 1.6, 6.0$ Hz, 1H), 5.28-5.26 (m, 1H), 3.67-3.61 (m, 1H), 3.13 (dd, $J = 5.2, 17.6$ Hz, 1H), 3.04 (dd, $J = 8.0, 17.6$ Hz, 1H), 2.09 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ (ppm) 205.9, 172.6, 155.5, 136.9, 133.4, 132.8, 128.8, 127.8, 127.7, 127.0, 126.5, 126.2, 126.0, 122.0, 85.7, 45.1, 44.3, 30.5; HRMS (EI): exact mass calculated for M^+ ($\text{C}_{18}\text{H}_{16}\text{O}_3$) requires m/z 280.1099, found m/z 280.1096; The enantiomeric excess was determined by HPLC. [IA column, 220nm, n-Hexane: EtOH = 4:1, 1.0 mL/min]: 15.5 min (maior), 20.1 min (minor), ee 98%.

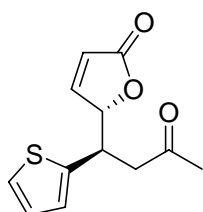
6q: 5-(1-(furan-2-yl)-3-oxobutyl)furan-2(5H)-one



The product was obtained in 79% yield, colorless oil. $[\alpha]_{\text{D}}^{20} - 105.8$ (c 1.0, CH_2Cl_2); ^1H NMR (400 MHz, CDCl_3): δ (ppm) 7.36-7.34 (m, 2H), 6.32-6.31 (m, 1H), 6.19-6.18 (m, 1H), 6.10 (dd, $J = 1.6, 5.6$ Hz, 1H), 5.23-5.22 (m, 1H), 3.66-3.61 (m, 1H), 3.02-2.89 (m, 2H), 2.13 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ (ppm) 205.4, 172.4, 155.1, 152.0, 142.0, 121.9, 110.5, 107.5, 83.7, 42.5, 37.7,

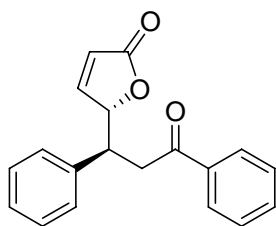
30.2; HRMS (EI): exact mass calculated for M^+ ($C_{12}H_{12}O_4$) requires m/z 220.0736, found m/z 220.0737; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: EtOH = 1:1, 0.60 mL/min]: 23.4 min (minor), 27.4 min (major), ee 97%.

6r: 5-(3-oxo-1-(thiophen-2-yl)butyl)furan-2(5H)-one



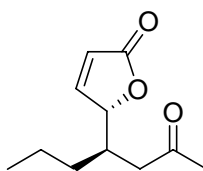
The product was obtained in 83% yield, brown solid. Mp 60-61°C; $[\alpha]_D^{20}$ - 73.6 (*c* 1.0, CH_2Cl_2); 1H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.32 (dd, J = 0.8, 6.0 Hz, 1H), 7.22-7.21 (m, 1H), 6.97-6.96 (m, 2H), 6.11 (dd, J = 1.6, 5.6 Hz, 1H), 5.20-5.18 (m, 1H), 3.84-3.79 (m, 1H), 3.05-2.90 (m, 2H), 2.11 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) 205.4, 172.3, 155.0, 141.6, 127.1, 126.0, 124.7, 122.2, 85.2, 45.9, 39.4, 30.5; HRMS (EI): exact mass calculated for M^+ ($C_{12}H_{12}O_3S$) requires m/z 236.0507, found m/z 236.0506; The enantiomeric excess was determined by HPLC. [IA column, 220nm, n-Hexane: EtOH = 4:1, 1.0 mL/min]: 15.1 min (major), 45.3 min (minor), ee 98%.

6s: 5-(3-oxo-1,3-diphenylpropyl)furan-2(5H)-one



The product was obtained in 79% yield, white solid. Mp 83-85°C; $[\alpha]_D^{20}$ - 52.4 (*c* 1.0, CH_2Cl_2); 1H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.91-7.89 (m, 2H), 7.58-7.54 (m, 1H), 7.46-7.43 (m, 2H), 7.36-7.33 (m, 4H), 7.30-7.24 (m, 2H), 6.10-6.09 (m, 1H), 5.30-5.28 (m, 1H), 3.75-3.8270 (m, 1H), 3.59 (dd, J = 5.2, 17.6 Hz, 1H), 3.50 (dd, J = 7.6, 17.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) 197.4, 172.7, 155.7, 139.6, 136.6, 133.4, 128.9, 128.7, 128.7, 128.4, 128.2, 128.1, 128.0, 127.7, 122.0, 85.8, 44.4, 40.1; HRMS (EI): exact mass calculated for M^+ ($C_{19}H_{16}O_3$) requires m/z 292.1099, found m/z 292.1101; The enantiomeric excess was determined by HPLC. [IC column, 220nm, n-Hexane: EtOH = 4:1, 1.0 mL/min]: 16.8 min (minor), 19.2 min (major), ee 97%.

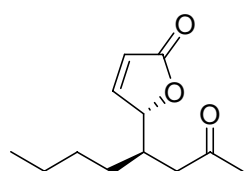
6t: 5-(2-oxoheptan-4-yl)furan-2(5H)-one



The product was obtained in 75% yield, yellow oil. $[\alpha]_D^{20}$ - 119.1 (*c* 1.0, CH_2Cl_2); 1H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.42 (dd, J = 1.6, 5.6 Hz, 1H), 6.10 (dd, J = 2.0, 5.6 Hz, 1H), 5.16-5.15 (m, 1H), 2.51-2.47 (m, 1H), 2.35-2.33 (m, 2H), 2.11 (s, 3H), 1.58-1.53 (m, 1H), 1.43-1.38 (m, 3H), 0.97-0.93 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) 207.2, 173.0, 156.2, 121.5, 84.7, 41.9, 35.7, 34.0, 30.4, 20.2, 14.0; HRMS (EI): exact mass calculated for M^+ ($C_{11}H_{16}O_3$) requires m/z 196.1099, found m/z 196.1100; The enantiomeric excess was determined by HPLC. [AS-H column, 205nm, n-Hexane: EtOH = 8:1, 1.0 mL/min]: 15.0 min (minor), 32.2 min (major), ee 98%.

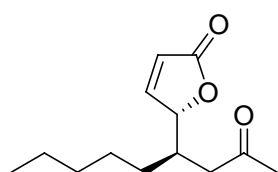
6u: 5-(2-oxooctan-4-yl)furan-2(5H)-one

The product was obtained in 74% yield, yellow oil. $[\alpha]_D^{20}$ - 128.0 (*c* 1.0, CH_2Cl_2); 1H



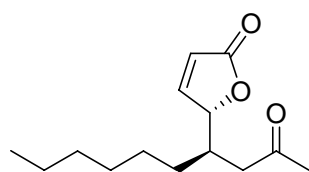
NMR (400 MHz, CDCl₃): δ (ppm) 7.42 (dd, $J = 1.2, 5.6$ Hz, 1H), 6.10 (dd, $J = 1.6, 5.6$ Hz, 1H), 5.16-5.15 (m, 1H), 2.51-2.43 (m, 1H), 2.35-2.34 (m, 2H), 2.11 (s, 3H), 1.60-1.56 (m, 1H) 1.44-1.31 (m, 5H), 0.94-0.91 (m, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 207.2, 173.1, 156.2, 121.6, 84.8, 42.0, 35.9, 31.6, 30.5, 29.2, 22.6, 14.0; HRMS (EI): exact mass calculated for M⁺ (C₁₂H₁₈O₃) requires m/z 210.1056, found m/z 210.1259; The enantiomeric excess was determined by HPLC. [AS-H column, 205nm, n-Hexane: EtOH = 8:1, 1.0 mL/min]: 12.6min (minor), 18.8 min (major), ee 96%.

6v: 5-(2-oxononan-4-yl)furan-2(5H)-one



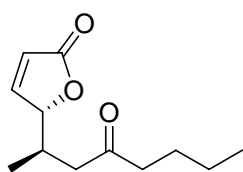
The product was obtained in 82% yield, yellow oil. $[\alpha]_D^{20} - 82.4$ (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.41 (dd, $J = 1.6, 5.6$ Hz, 1H), 6.09 (dd, $J = 2.0, 5.6$ Hz, 1H), 5.16-5.15 (m, 1H), 2.50-2.43 (m, 1H), 2.34-2.33 (m, 2H), 2.11 (s, 3H), 1.60-1.52 (m, 1H) 1.43-1.31 (m, 7H), 0.92-0.88 (m, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 207.1, 173.0, 156.2, 121.5, 84.7, 41.9, 35.9, 31.7, 31.7, 30.4, 26.7, 22.4, 13.9; HRMS (EI): exact mass calculated for M⁺ (C₁₃H₂₀O₃) requires m/z 224.1412, found m/z 224.1415; The enantiomeric excess was determined by HPLC. [AS-H column, 205nm, n-Hexane: EtOH = 8:1, 1.0mL/min]: 11.6min (minor), 15.7 min (major), ee 97%.

6w: 5-(2-oxodecan-4-yl)furan-2(5H)-one



The product was obtained in 78% yield, yellow oil. $[\alpha]_D^{20} - 81.0$ (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.41 (dd, $J = 1.6, 5.6$ Hz, 1H), 6.09 (dd, $J = 2.0, 5.6$ Hz, 1H), 5.16-5.15 (m, 1H), 2.48-2.43 (m, 1H), 2.34-2.33 (m, 2H), 2.11 (s, 3H), 1.61-1.52 (m, 1H) 1.42-1.3129 (m, 9H), 0.91-0.88 (m, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 207.2, 173.0, 156.2, 121.5, 84.7, 41.9, 35.9, 31.8, 31.6, 30.4, 29.2, 27.0, 22.5, 14.0; HRMS (EI): exact mass calculated for M⁺ (C₁₄H₂₂O₃) requires m/z 238.1569, found m/z 238.1572; The enantiomeric excess was determined by HPLC. [AS-H column, 205nm, n-Hexane: EtOH = 8:1, 1.0 mL/min]: 10.1min (minor), 13.8 min (major), ee 97%.

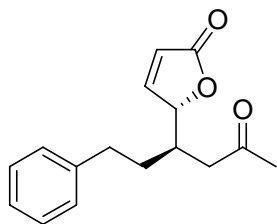
6x: 5-(4-oxooctan-2-yl)furan-2(5H)-one



The product was obtained in 65% yield, yellow oil. $[\alpha]_D^{20} - 85.6$ (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.45 (dd, $J = 1.6, 5.6$ Hz, 1H), 6.12 (dd, $J = 2.0, 5.6$ Hz, 1H), 4.99-4.98 (m, 1H), 2.53-2.47 (m, 2H) 2.39-2.30 (m, 3H) 1.58-1.50 (m, 2H), 1.33-1.26 (m, 2H), 1.11-1.10 (m, 3H), 0.93-0.89 (t, 3H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 209.3, 172.8, 155.4, 121.9, 86.5, 43.6, 43.1, 31.9, 25.8, 22.2, 16.8, 13.8; HRMS(EI): exact mass calculated for M⁺ (C₁₂H₁₈O₃) requires m/z 210.1256, found m/z 210.1257; The enantiomeric excess was determined by HPLC. [IC column, 205nm, n-Hexane: EtOH = 4:1, 1.0 mL/min]:

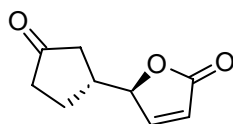
14.5 min (major), 15.7 min (minor), ee 99%.

6y: 5-(5-oxo-1-phenylhexan-3-yl)furan-2(5H)-one



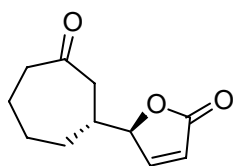
The product was obtained in 76% yield, yellow oil. $[\alpha]_D^{20}$ - 57.8 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.39 (dd, *J* = 1.2, 5.6 Hz, 1H), 7.33-7.30 (m, 2H), 7.24-7.19 (m, 3H), 6.10 (dd, *J* = 2.0, 6.0 Hz, 1H), 5.20-5.19 (m, 1H), 2.79-2.66 (m, 2H), 2.59-2.52 (m, 1H), 2.38-2.37 (m, 2H), 2.10 (s, 3H), 1.97-1.87 (m, 1H), 1.82-1.73 (m, 1H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 206.9, 173.0, 156.1, 141.1, 128.6, 128.3, 126.2, 121.7, 84.6, 41.8, 35.5, 33.5, 33.4, 30.4; HRMS (EI): exact mass calculated for M⁺ (C₁₆H₁₈O₃) requires *m/z* 258.1256, found *m/z* 258.1255; The enantiomeric excess was determined by HPLC. [AY-H column, 220nm, n-Hexane: EtOH = 1:1, 0.60 mL/min]: 14.2min (minor), 15.4 min (major), ee 97%.

7a: 5-(3-oxocyclopentyl)furan-2(5H)-one



The product was obtained in 51% yield, yellow oil. $[\alpha]_D^{20}$ - 75.3 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.50-7.46 (m, 1H), 6.18-6.16 (m, 1H), 5.08-5.07 (m, 1H), 2.55-2.49 (m, 1H), 2.38-2.29 (m, 2H), 2.22-2.15 (m, 2H), 1.98-1.91 (m, 2H), 1.76-1.66 (m, 1H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 216.4, 172.5, 154.7, 122.6, 122.4, 84.9, 84.6, 40.4, 39.4, 39.2, 37.8, 37.7, 25.4, 24.1; HRMS (EI): exact mass calculated for M⁺ (C₉H₁₀O₃) requires *m/z* 166.0630, found *m/z* 166.0632; The enantiomeric excess was determined by HPLC. [IC column, 205nm, n-Hexane: EtOH = 1:1, 1.0 mL/min]: 19.2min (major), 21.2 min (minor), ee 97%.

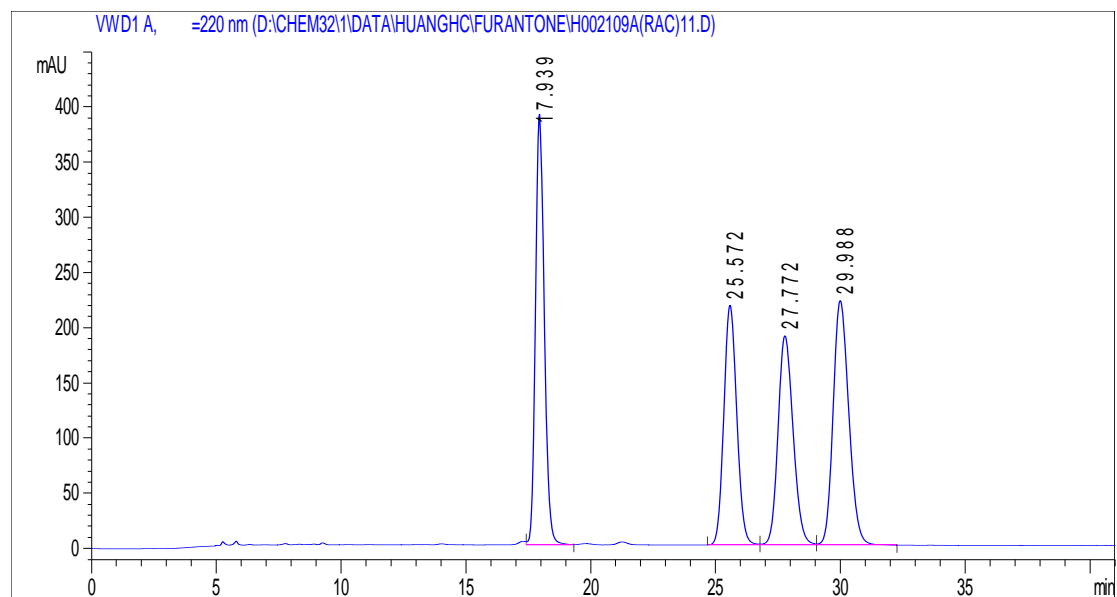
7b: 5-(3-oxocycloheptyl)furan-2(5H)-one



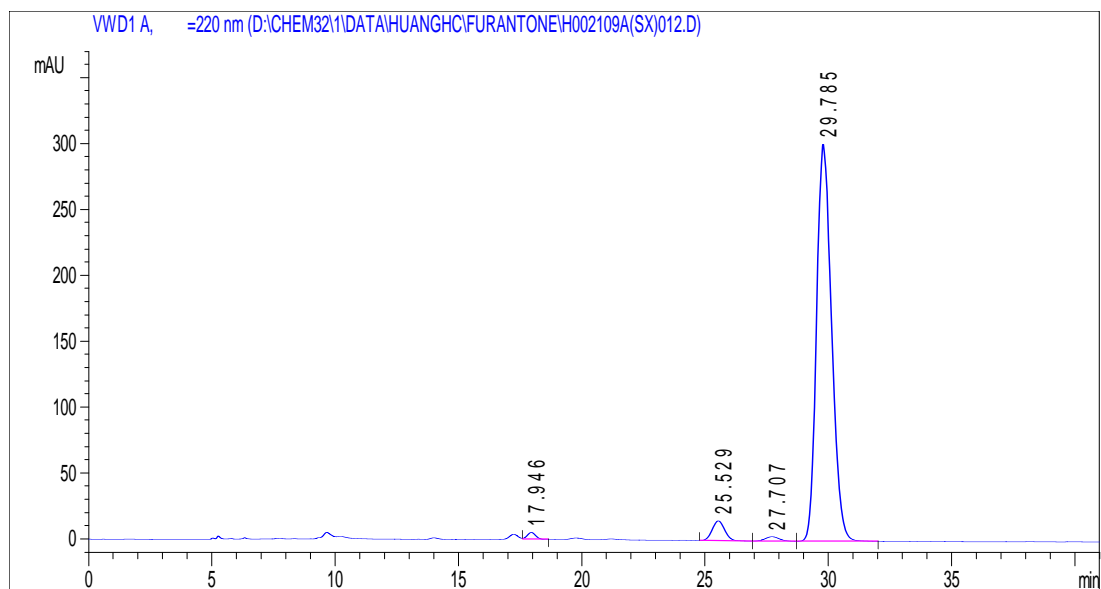
The product was obtained in 67% yield, yellow oil. $[\alpha]_D^{20}$ - 69.9 (*c* 1.0, CH₂Cl₂); ¹H NMR (400 MHz, CDCl₃): δ (ppm) 7.48-7.45 (m, 1H), 6.148-6.16 (m, 1H), 5.06-5.07 (m, 1H), 2.51-2.49 (m, 1H), 2.40-2.26 (m, 3H), 2.22-2.10 (m, 4H), 1.95-1.88 (m, 2H), 1.70-1.65 (m, 1H). ¹³C NMR (100 MHz, CDCl₃): δ (ppm) 216.5, 216.4, 172.6, 154.7, 122.5, 122.4, 84.9, 84.7, 40.4, 39.3, 39.2, 37.8, 37.7, 25.4, 24.1; HRMS (EI): exact mass calculated for M⁺ (C₁₁H₁₄O₃) requires *m/z* 194.0943, found *m/z* 194.0946; The enantiomeric excess was determined by HPLC. [IC column, 205nm, n-Hexane: EtOH = 1:1, 1.0 mL/min]: 22.7min (major), 25.6 min (minor), ee 97%.

E: HPLC Charts of Michael Addition Products

6a: 5-(3-oxo-1-phenylbutyl)furan-2(5H)-one

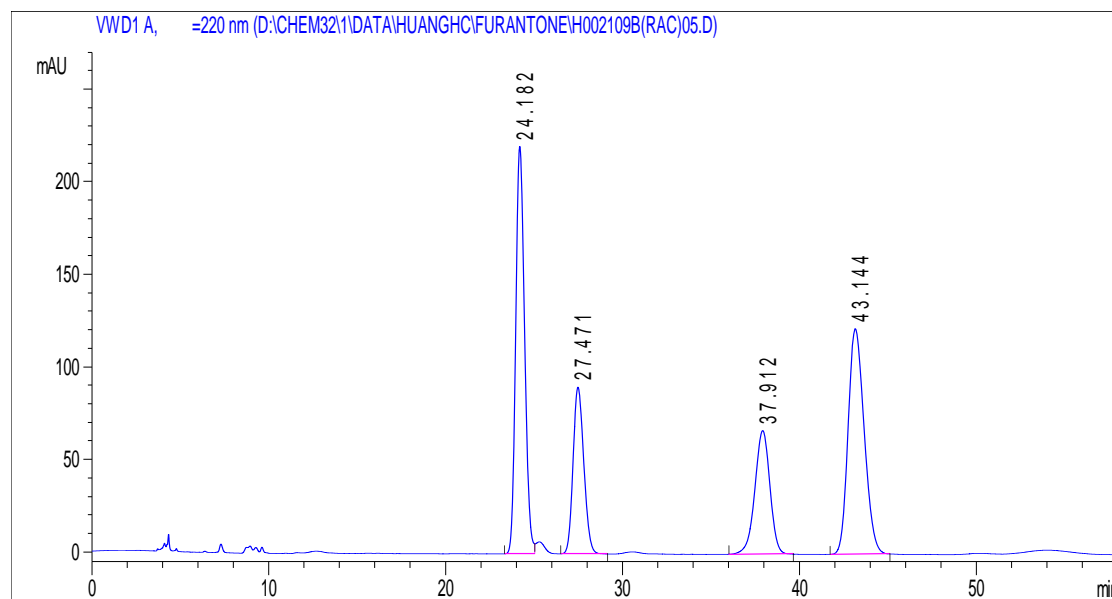


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 17.939 | 9578.3 | 390.1 | 0.3796 | 0.787 | 27.323 |
| 2 | 25.572 | 7837.6 | 217.3 | 0.5607 | 0.874 | 22.358 |
| 3 | 27.772 | 7977.3 | 189.6 | 0.6539 | 0.805 | 22.756 |
| 4 | 29.988 | 9662.2 | 221.6 | 0.6805 | 0.787 | 27.563 |

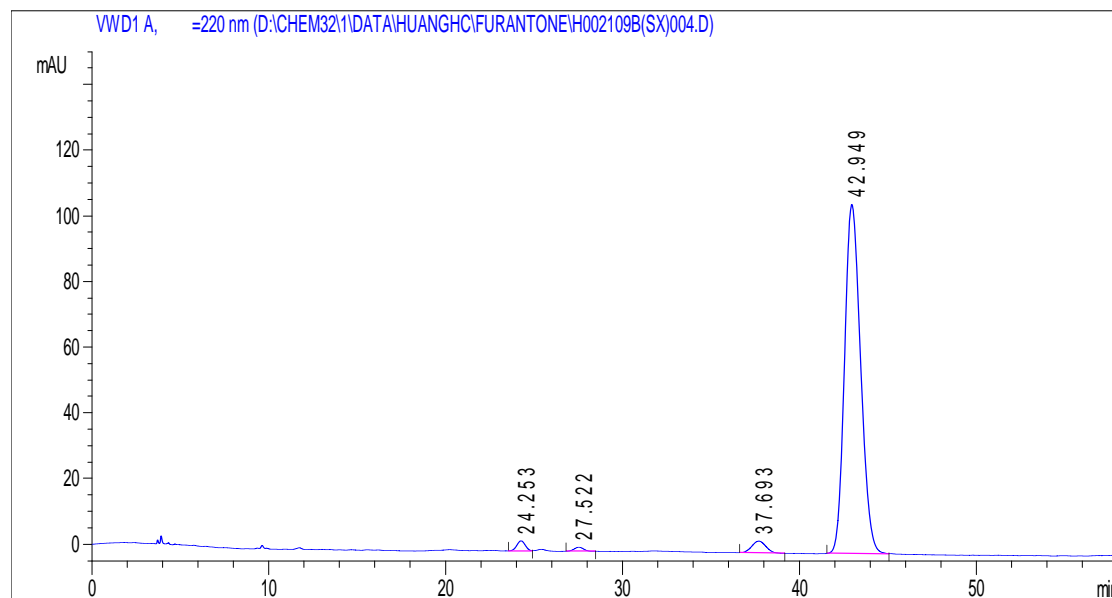


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|-------|--------|--------|----------|--------|
| 1 | 17.946 | 131.3 | 5.3 | 0.3802 | 0.917 | 0.966 |
| 2 | 25.529 | 535.3 | 15.1 | 0.5499 | 0.916 | 3.937 |
| 3 | 27.707 | 133.3 | 3.4 | 0.6251 | 0.894 | 0.980 |
| 4 | 29.785 | 12796 | 301.3 | 0.6586 | 0.759 | 94.117 |

6b: 5-(1-(2-fluorophenyl)-3-oxobutyl)furan-2(5H)-one

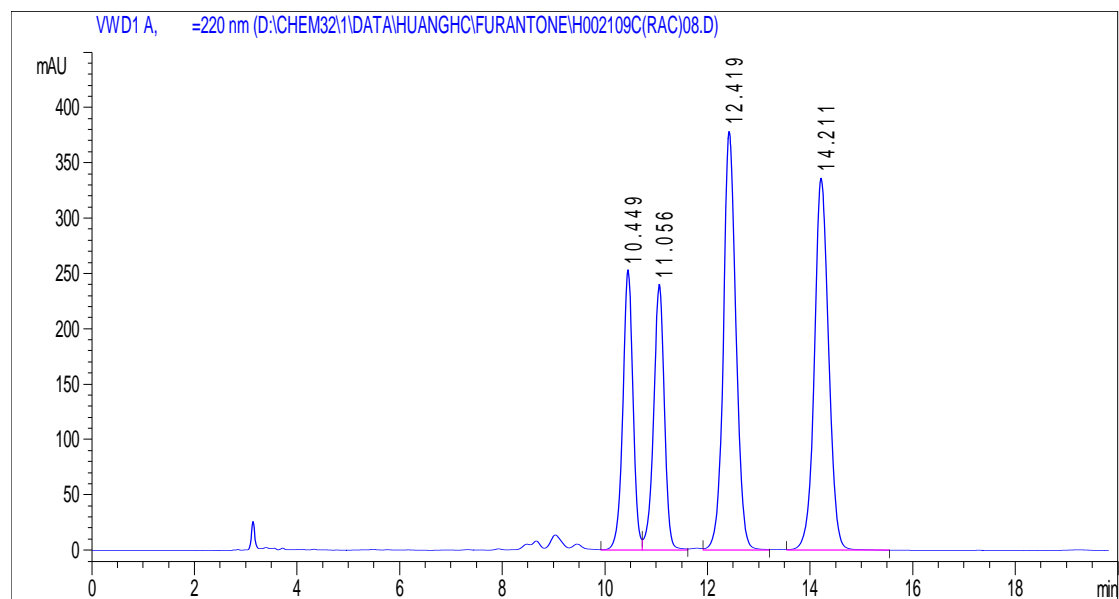


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 24.182 | 7669.4 | 220.2 | 0.5404 | 0.807 | 33.165 |
| 2 | 27.471 | 3803.1 | 90.1 | 0.6583 | 0.804 | 16.446 |
| 3 | 37.912 | 3957.5 | 66.8 | 0.915 | 1.067 | 17.114 |
| 4 | 43.144 | 7695 | 121.9 | 0.9871 | 0.768 | 33.276 |

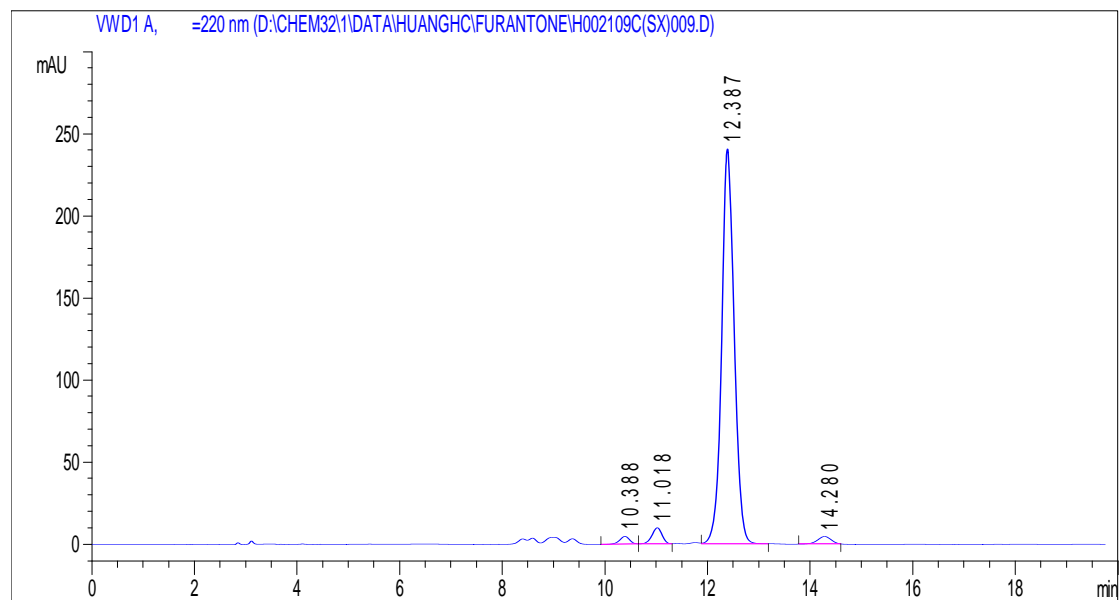


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 24.253 | 105.4 | 3.1 | 0.5317 | 0.96 | 1.491 |
| 2 | 27.522 | 48.5 | 1.3 | 0.5631 | 0.939 | 0.686 |
| 3 | 37.693 | 200.3 | 3.6 | 0.8183 | 0.958 | 2.833 |
| 4 | 42.949 | 6716.2 | 106.3 | 0.9843 | 0.788 | 94.990 |

6c: 5-(1-(3-fluorophenyl)-3-oxobutyl)furan-2(5H)-one

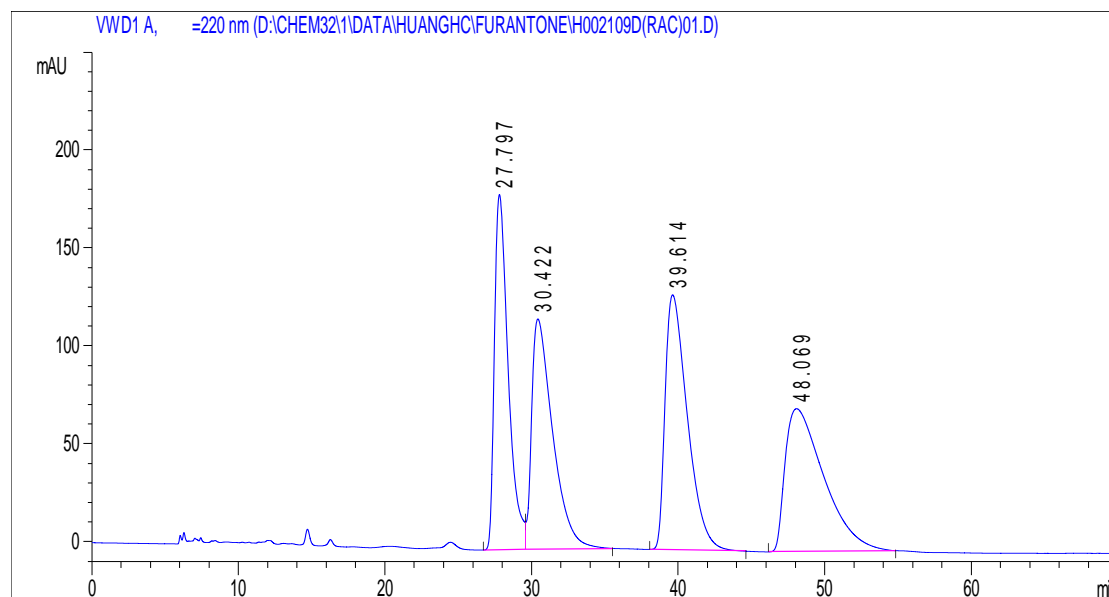


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 10.449 | 3502.8 | 253.4 | 0.2137 | 1.038 | 17.523 |
| 2 | 11.056 | 3505.4 | 240.4 | 0.2226 | 1.058 | 17.536 |
| 3 | 12.419 | 6481.1 | 378.4 | 0.261 | 0.833 | 32.422 |
| 4 | 14.211 | 6500.7 | 336.2 | 0.2955 | 0.87 | 32.520 |

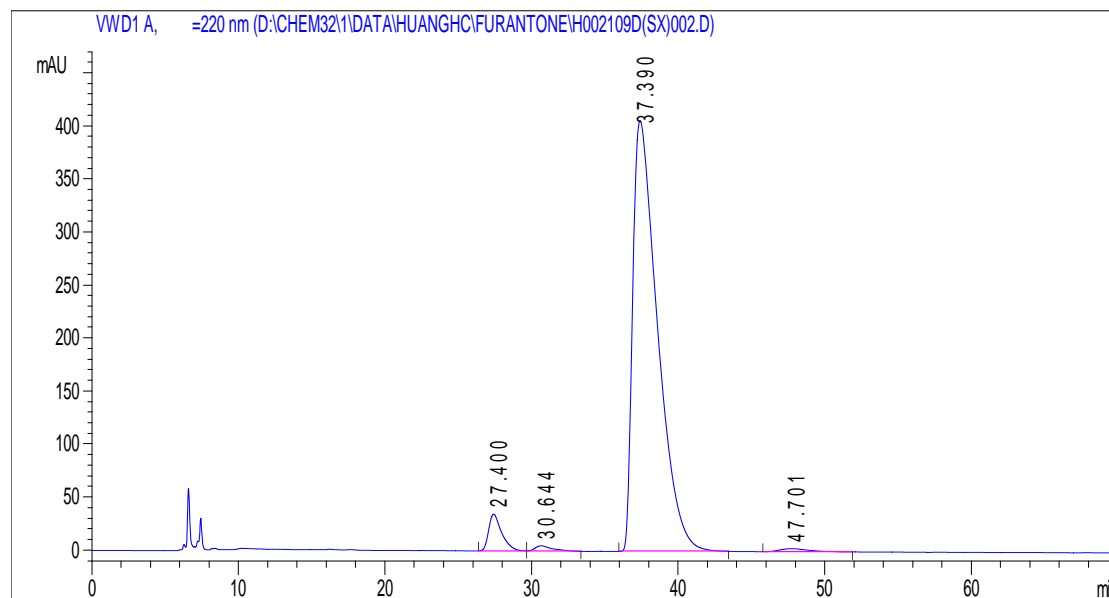


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 10.388 | 68.6 | 4.9 | 0.2141 | 1.082 | 1.559 |
| 2 | 11.018 | 144.8 | 10.1 | 0.2201 | 1.103 | 3.291 |
| 3 | 12.387 | 4102.2 | 240.6 | 0.2571 | 0.848 | 93.206 |
| 4 | 14.28 | 85.6 | 4.6 | 0.309 | 1.097 | 1.944 |

6d: 5-(1-(4-fluorophenyl)-3-oxobutyl)furan-2(5H)-one

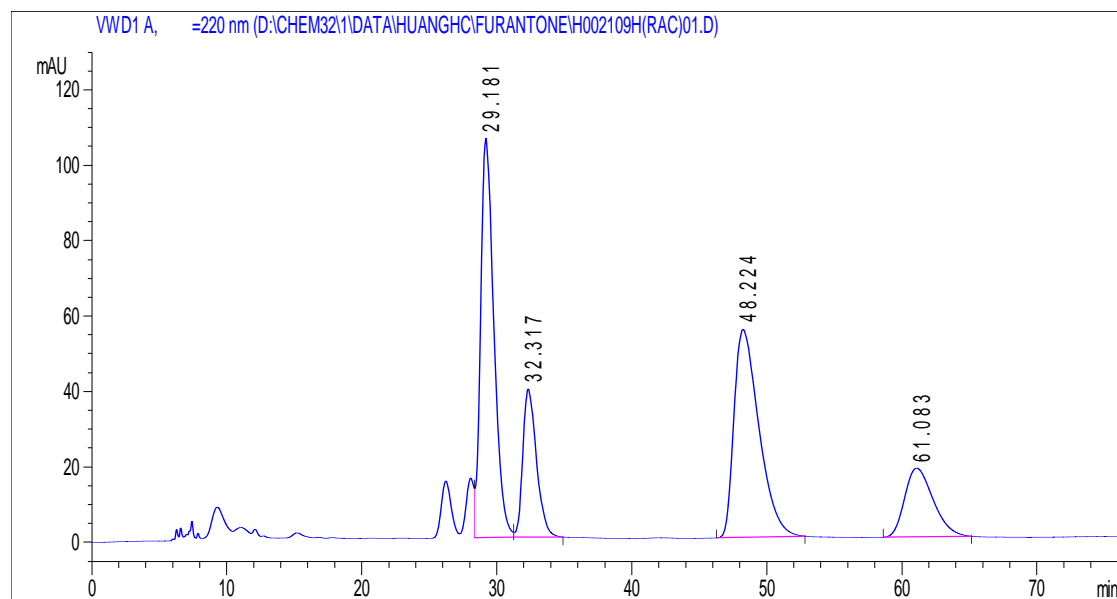


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 27.797 | 11874.1 | 181.5 | 0.9992 | 0.522 | 23.353 |
| 2 | 30.422 | 11781 | 117.7 | 1.4936 | 0.391 | 23.170 |
| 3 | 39.614 | 13761.8 | 130.3 | 1.6225 | 0.473 | 27.066 |
| 4 | 48.069 | 13428.6 | 73 | 2.7156 | 0.391 | 26.411 |

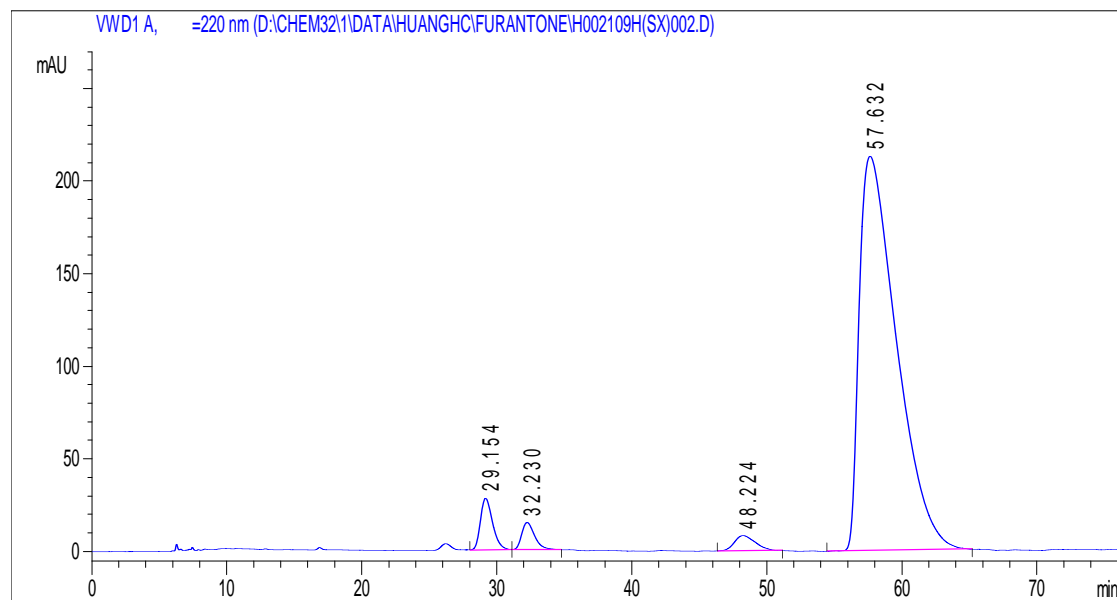


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 27.4 | 2162.5 | 34.8 | 0.9203 | 0.566 | 4.265 |
| 2 | 30.644 | 437 | 5.1 | 1.2081 | 0.484 | 0.862 |
| 3 | 37.39 | 47698.7 | 406.2 | 1.7601 | 0.388 | 94.067 |
| 4 | 47.701 | 408.7 | 3 | 1.6095 | 0.629 | 0.806 |

6e: 5-(1-(2-chlorophenyl)-3-oxobutyl)furan-2(5H)-one

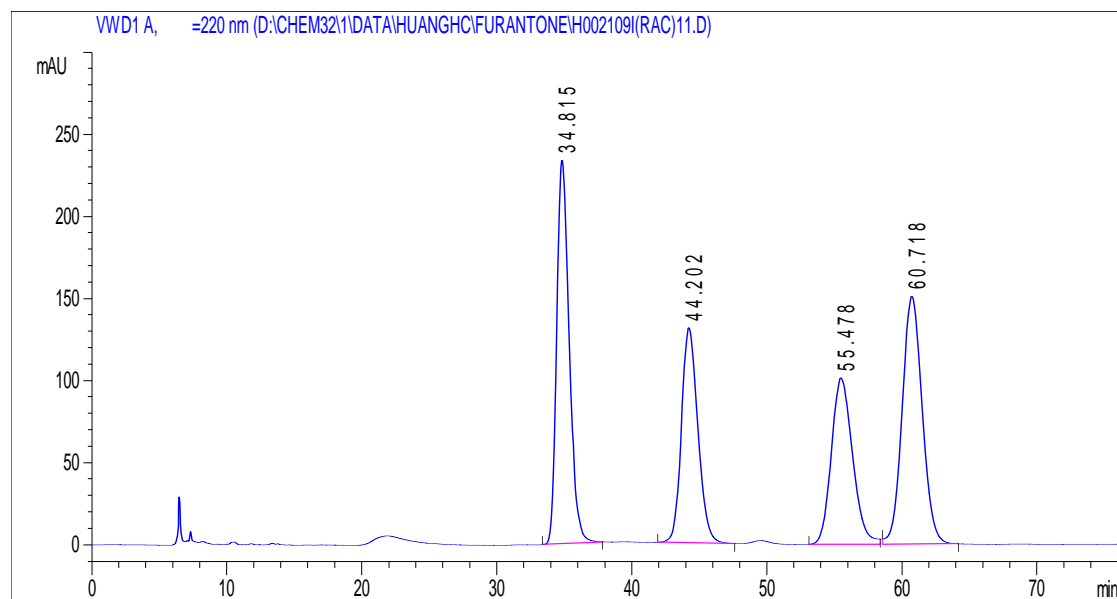


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 29.181 | 7264.1 | 106 | 1.0589 | 0.63 | 36.553 |
| 2 | 32.317 | 2787.8 | 39.4 | 1.0879 | 0.641 | 14.028 |
| 3 | 48.224 | 7113.1 | 55.2 | 1.9381 | 0.537 | 35.793 |
| 4 | 61.083 | 2708 | 18.3 | 2.1311 | 0.696 | 13.626 |

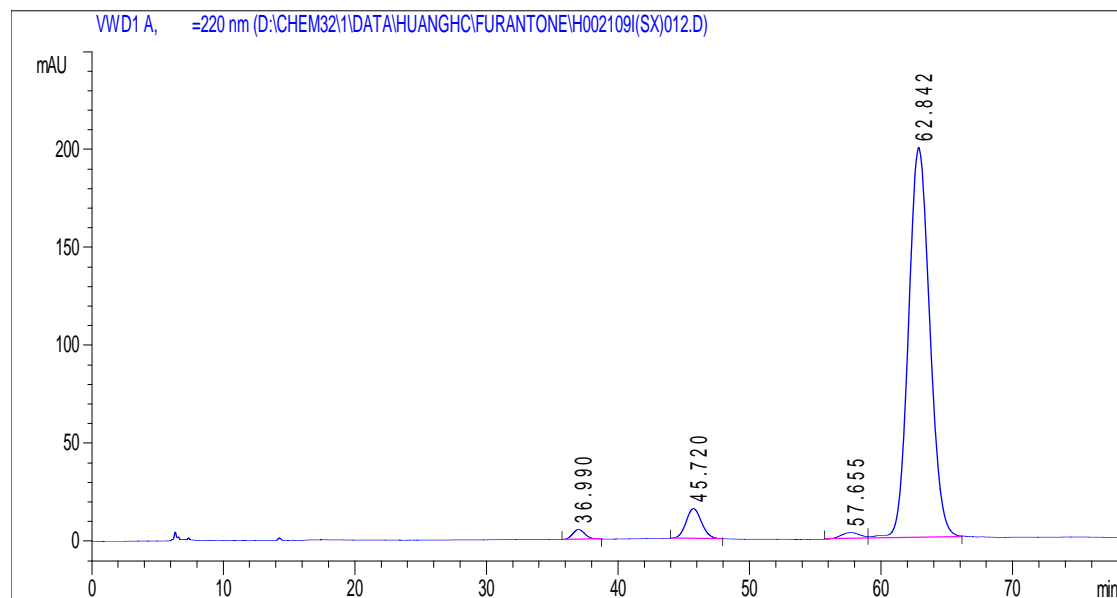


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 29.154 | 1777.8 | 28 | 0.9784 | 0.694 | 3.986 |
| 2 | 32.23 | 1012.4 | 14.9 | 1.015 | 0.677 | 2.270 |
| 3 | 48.224 | 914.7 | 8.3 | 1.5672 | 0.675 | 2.051 |
| 4 | 57.632 | 40893.7 | 213.2 | 2.8553 | 0.381 | 91.693 |

6f: 5-(1-(3-chlorophenyl)-3-oxobutyl)furan-2(5H)-one

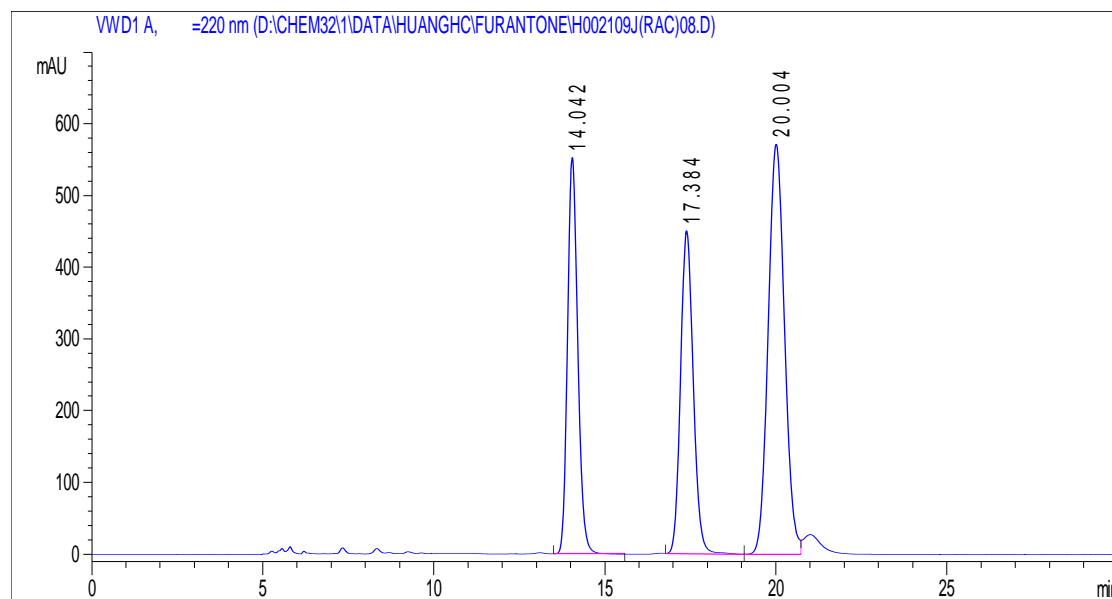


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 34.815 | 15033.7 | 233.6 | 0.9897 | 0.705 | 28.472 |
| 2 | 44.202 | 11099.4 | 131.1 | 1.3077 | 0.779 | 21.021 |
| 3 | 55.478 | 11089.7 | 101.4 | 1.5585 | 0.797 | 21.03 |
| 4 | 60.718 | 15578.6 | 150.9 | 1.5916 | 0.894 | 29.504 |

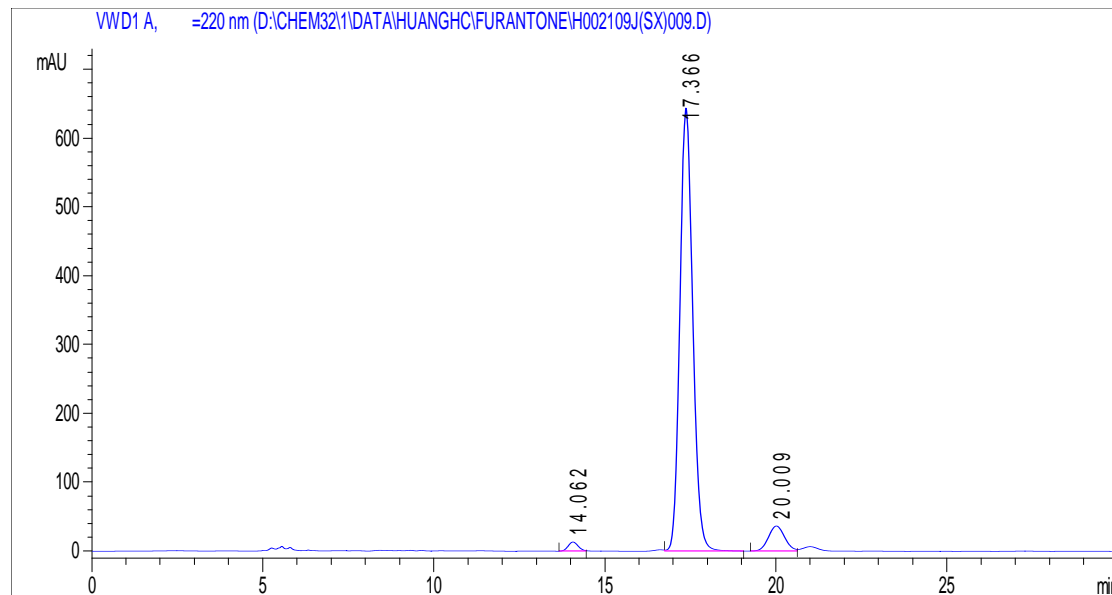


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 36.99 | 329 | 5 | 0.9838 | 0.875 | 1.355 |
| 2 | 45.72 | 1270.7 | 15.4 | 1.242 | 0.887 | 5.234 |
| 3 | 57.655 | 325.9 | 3.2 | 1.2231 | 0.958 | 1.342 |
| 4 | 62.842 | 22351.6 | 199.1 | 1.7405 | 0.894 | 92.068 |

6g: 5-(1-(3-bromophenyl)-3-oxobutyl)furan-2(5H)-one

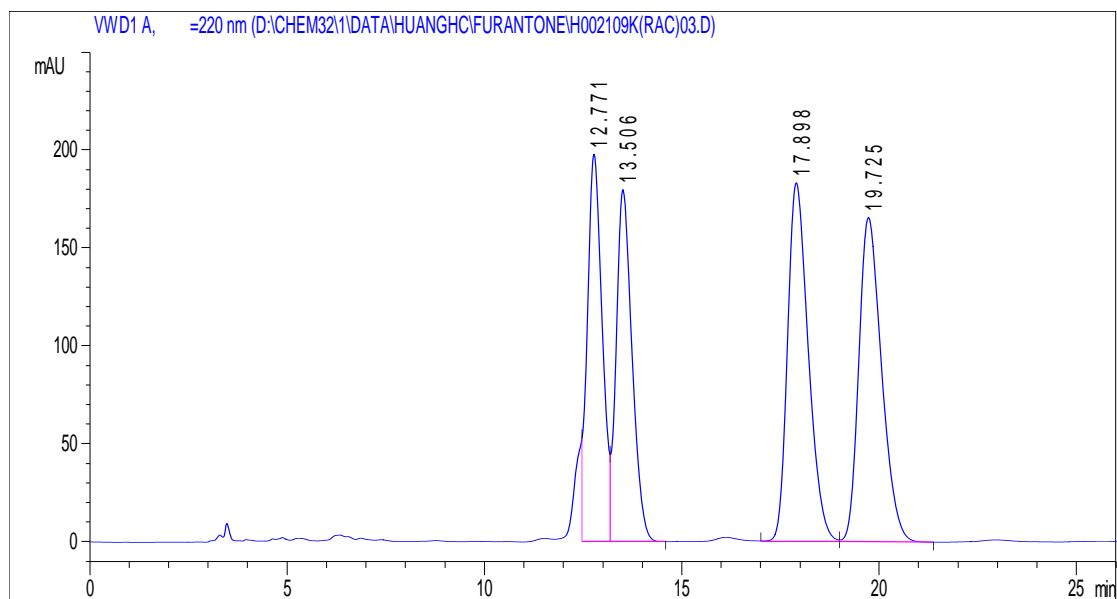


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 14.042 | 11548.2 | 553.1 | 0.3222 | 0.809 | 27.313 |
| 2 | 17.384 | 11722.4 | 451.3 | 0.402 | 0.848 | 27.725 |
| 3 | 20.004 | 19010.5 | 571.8 | 0.516 | 0.912 | 44.962 |

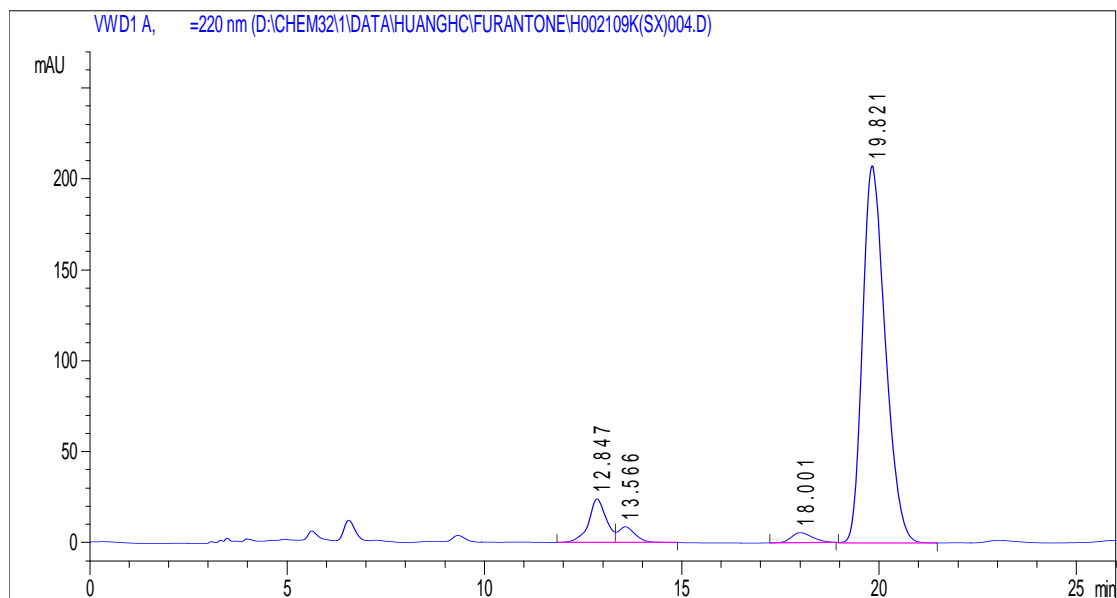


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 14.062 | 265.8 | 13.2 | 0.3363 | 0.927 | 1.453 |
| 2 | 17.366 | 16806.9 | 644.1 | 0.4063 | 0.843 | 91.873 |
| 3 | 20.009 | 1221 | 36.6 | 0.52 | 0.924 | 6.674 |

6h: 5-(1-(4-bromophenyl)-3-oxobutyl)furan-2(5H)-one

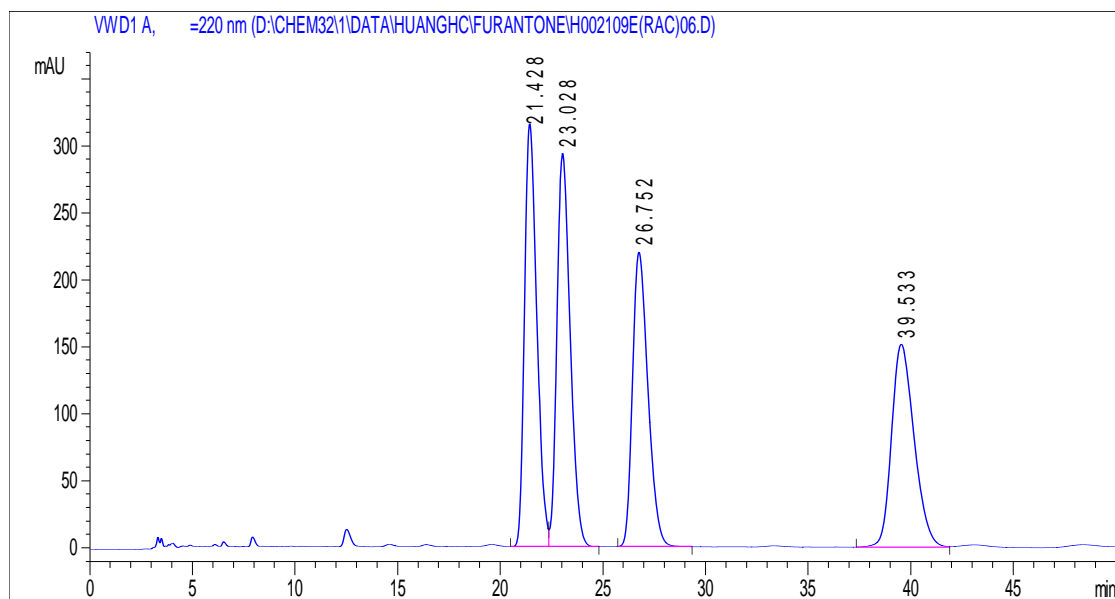


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 12.771 | 5173.9 | 198 | 0.4355 | 0.775 | 21.970 |
| 2 | 13.506 | 5027.4 | 179.8 | 0.4223 | 0.71 | 21.348 |
| 3 | 17.898 | 6708.9 | 183.4 | 0.5579 | 0.693 | 28.489 |
| 4 | 19.725 | 6639.3 | 165.8 | 0.6158 | 0.696 | 28.193 |

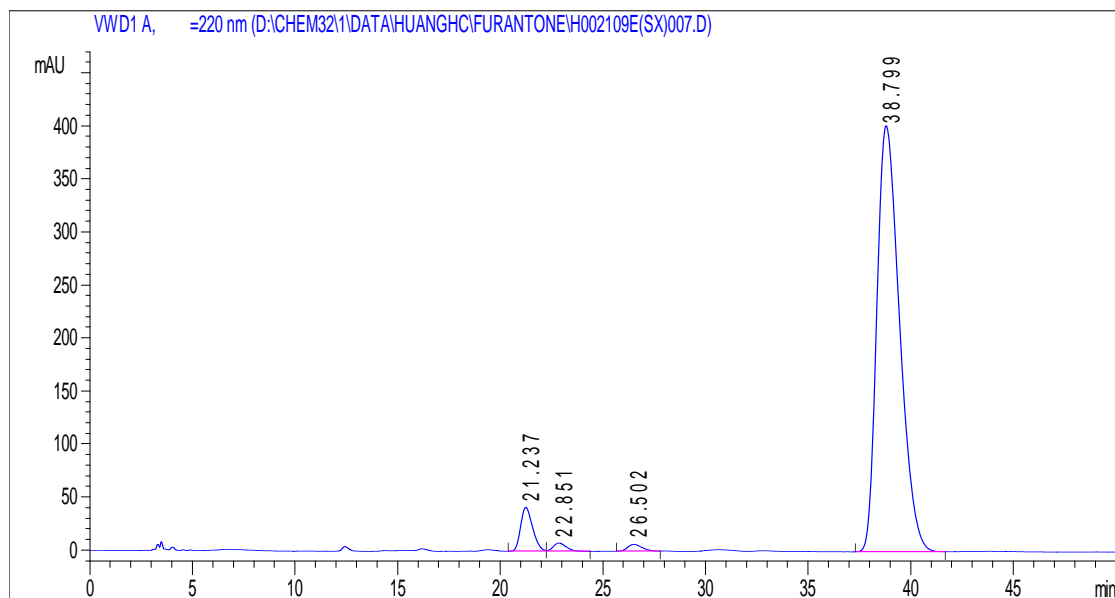


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 12.847 | 753.8 | 24 | 0.4619 | 0.915 | 7.888 |
| 2 | 13.566 | 265.8 | 8.7 | 0.4449 | 0.612 | 2.781 |
| 3 | 18.001 | 210.3 | 5.6 | 0.6294 | 0.741 | 2.201 |
| 4 | 19.821 | 8327.2 | 207.5 | 0.6168 | 0.701 | 87.131 |

6i: 5-(1-(2-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one

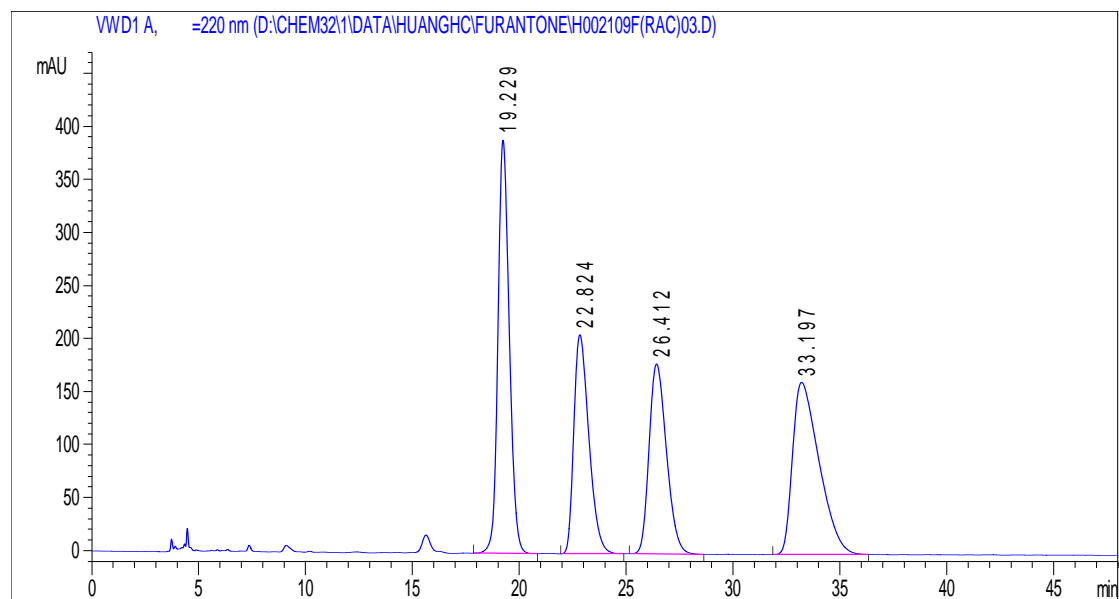


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 21.428 | 13098.7 | 315.7 | 0.6443 | 0.696 | 26.523 |
| 2 | 23.028 | 13199.3 | 293.6 | 0.6963 | 0.701 | 26.727 |
| 3 | 26.752 | 11477.4 | 219.7 | 0.8074 | 0.68 | 23.240 |
| 4 | 39.533 | 11610.7 | 151.5 | 1.1793 | 0.725 | 23.510 |

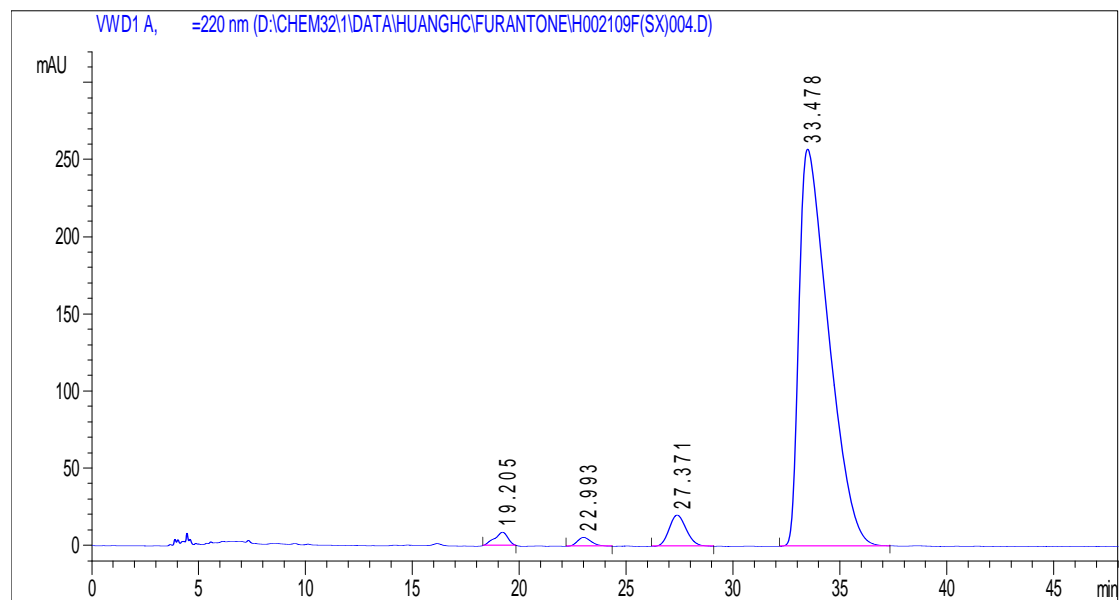


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 21.237 | 1699.7 | 41.4 | 0.6329 | 0.72 | 5.126 |
| 2 | 22.851 | 351.1 | 7.9 | 0.669 | 0.731 | 1.059 |
| 3 | 26.502 | 307.3 | 6.4 | 0.733 | 0.73 | 0.927 |
| 4 | 38.799 | 30800.7 | 401.8 | 1.1914 | 0.658 | 92.888 |

6j: 5-(1-(3-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one

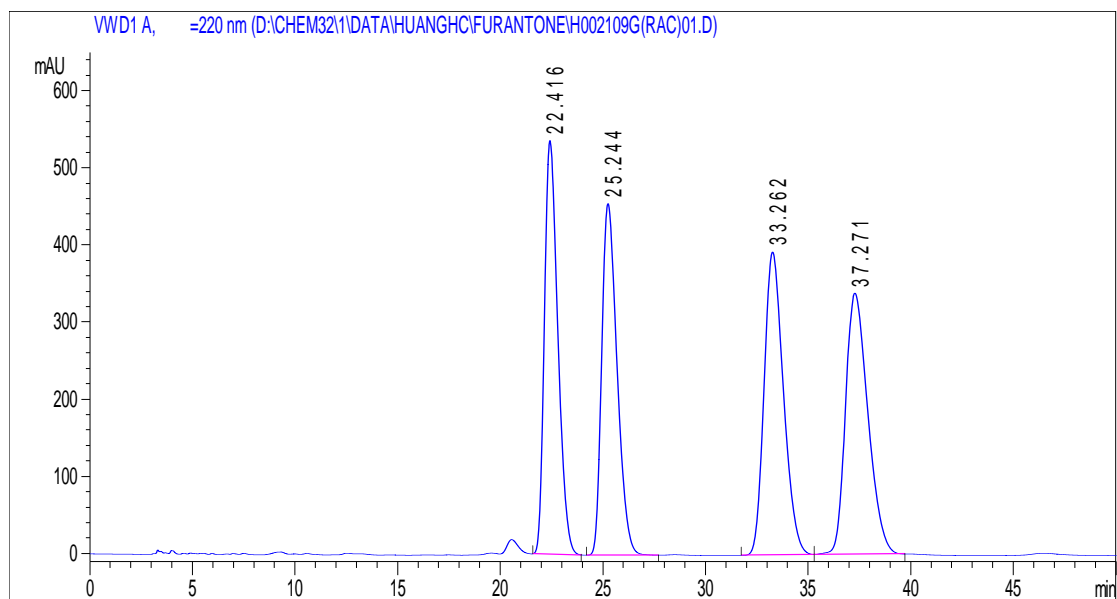


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 19.229 | 14344 | 389.7 | 0.5692 | 0.786 | 29.499 |
| 2 | 22.824 | 10132.5 | 206.7 | 0.7584 | 0.629 | 20.838 |
| 3 | 26.412 | 10157.2 | 179.4 | 0.8788 | 0.723 | 20.889 |
| 4 | 33.197 | 13991.5 | 162.4 | 1.3283 | 0.49 | 28.774 |

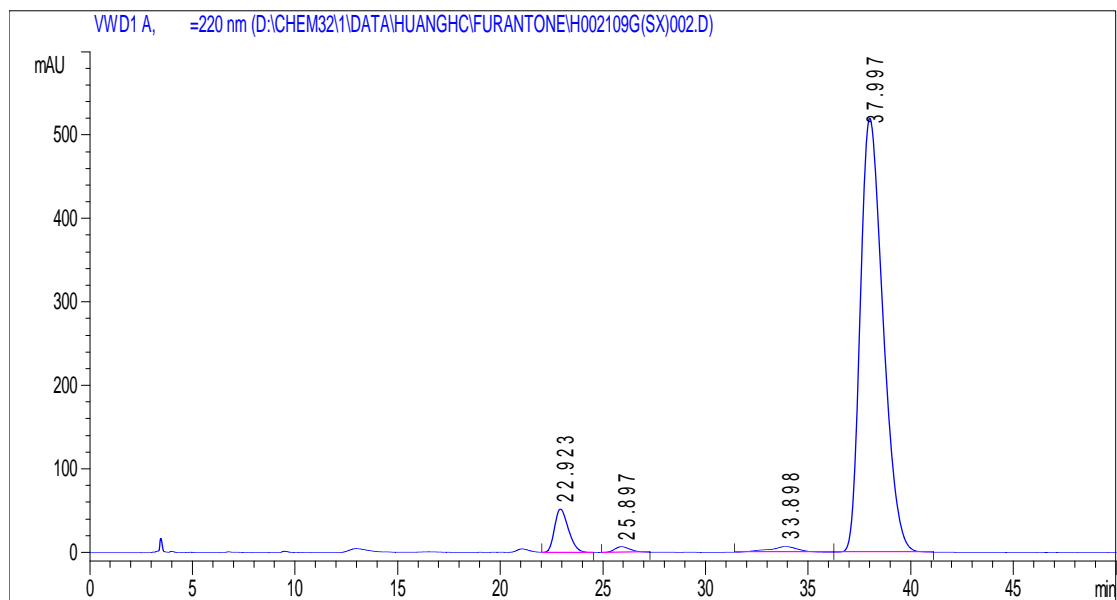


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 19.205 | 381.5 | 8.7 | 0.7319 | 1.427 | 1.438 |
| 2 | 22.993 | 263.5 | 5.8 | 0.697 | 0.747 | 0.993 |
| 3 | 27.371 | 1147.6 | 20.4 | 0.864 | 0.825 | 4.327 |
| 4 | 33.478 | 24731.2 | 257.4 | 1.45 | 0.385 | 93.242 |

6k: 5-(1-(4-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one

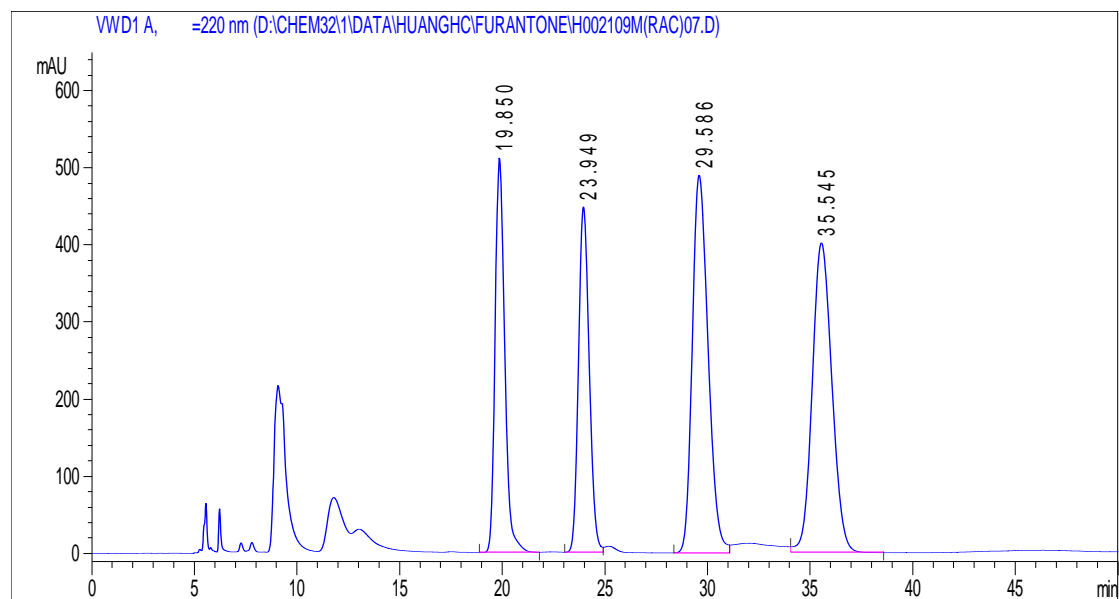


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 22.416 | 24359.9 | 536.7 | 0.7565 | 0 | 24.464 |
| 2 | 25.244 | 23713.6 | 456 | 0.8047 | 0.656 | 23.815 |
| 3 | 33.262 | 25786.9 | 393 | 1.043 | 0.742 | 25.897 |
| 4 | 37.271 | 25715.9 | 338.8 | 1.1739 | 0.691 | 25.825 |

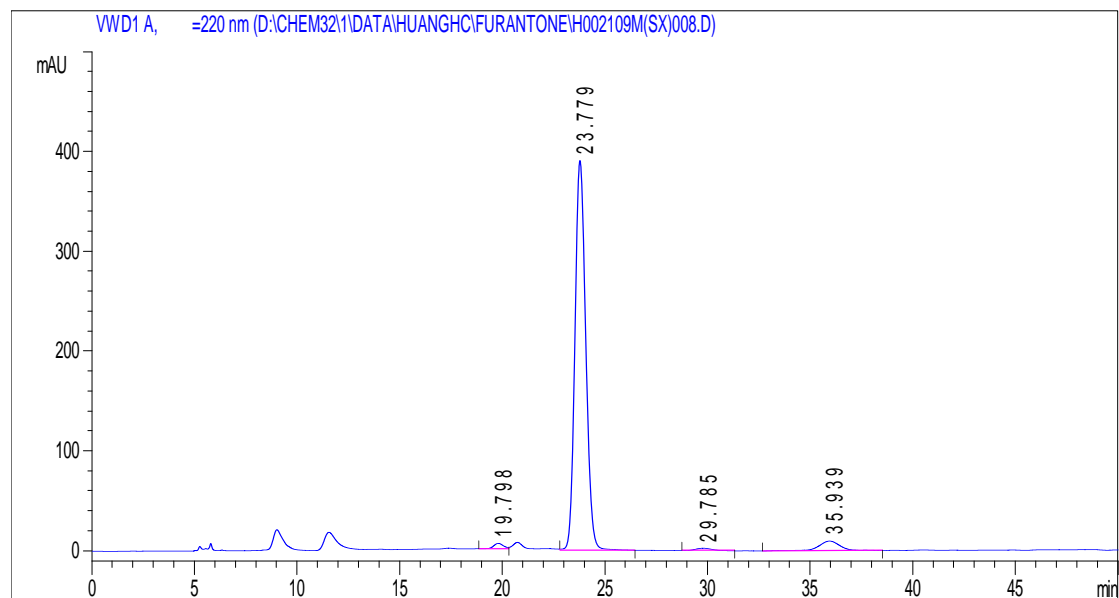


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 22.923 | 2431.6 | 52 | 0.7232 | 0.698 | 5.607 |
| 2 | 25.897 | 348.7 | 6.7 | 0.7836 | 0.738 | 0.804 |
| 3 | 33.898 | 701 | 6.9 | 1.4175 | 1.398 | 1.617 |
| 4 | 37.997 | 39886.1 | 520.1 | 1.1888 | 0.674 | 91.972 |

6l: 5-(3-oxo-1-*m*-tolylbutyl)furan-2(5*H*)-one

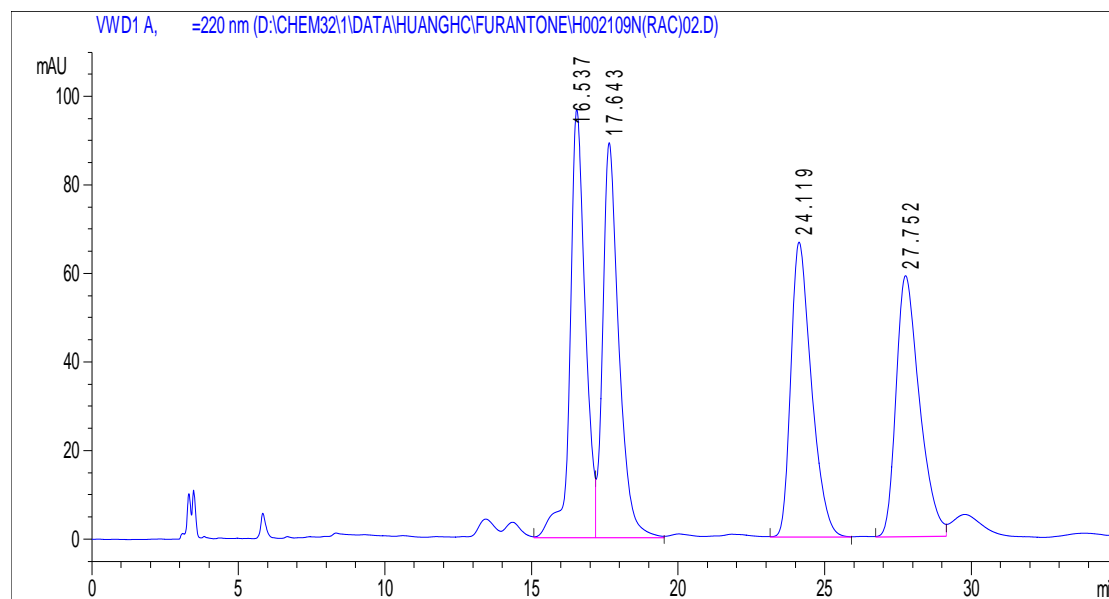


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 19.85 | 16788 | 511.5 | 0.5052 | 0.741 | 19.473 |
| 2 | 23.949 | 16384 | 448.5 | 0.5718 | 0.819 | 19.005 |
| 3 | 29.586 | 26245.7 | 489.6 | 0.8351 | 0.725 | 30.444 |
| 4 | 35.545 | 26792.3 | 401.7 | 1.0373 | 0.85 | 31.078 |

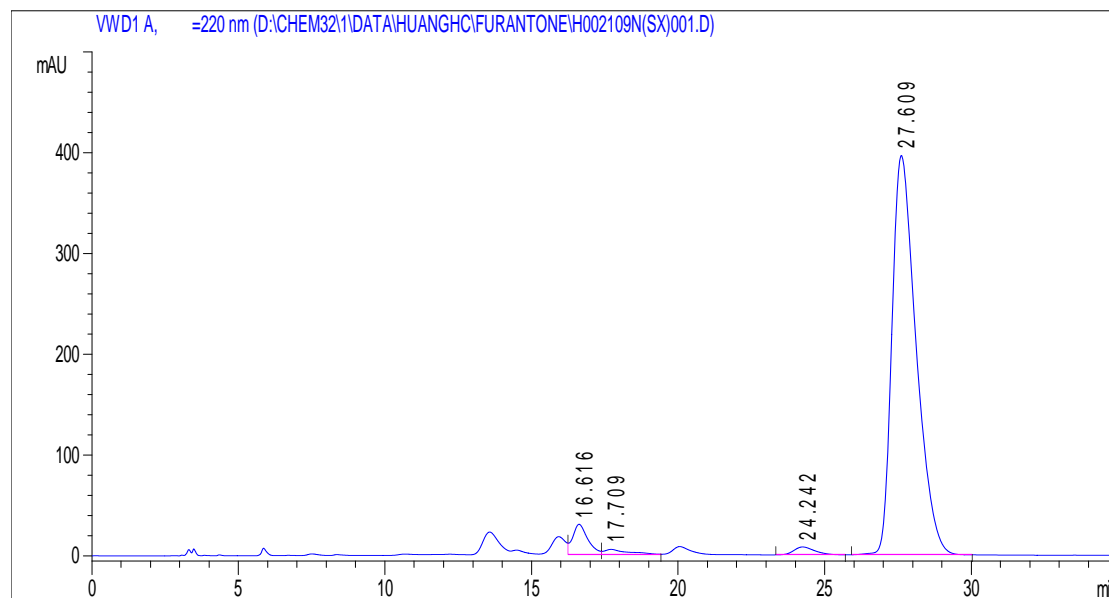


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 19.798 | 184.1 | 5.5 | 0.5617 | 0 | 1.196 |
| 2 | 23.779 | 14318.8 | 390.5 | 0.5705 | 0.826 | 93.064 |
| 3 | 29.785 | 139.3 | 2.5 | 0.7514 | 0.818 | 0.906 |
| 4 | 35.939 | 743.8 | 9.7 | 1.1239 | 1.021 | 4.834 |

6m: 5-(3-oxo-1-*p*-tolylbutyl)furan-2(5*H*)-one

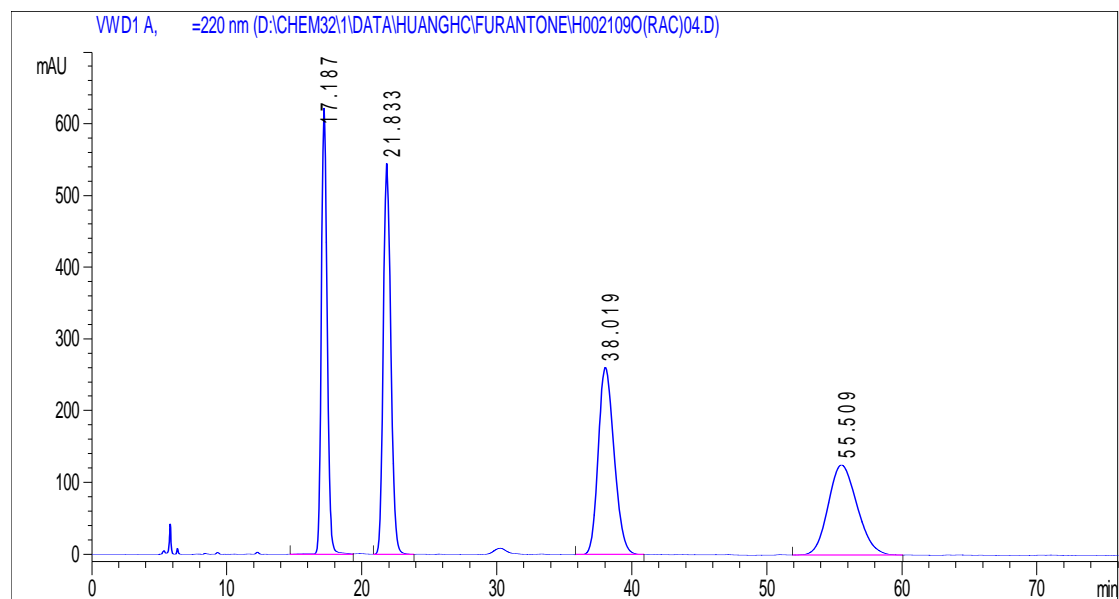


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 16.537 | 3510.6 | 96.9 | 0.5362 | 0.813 | 26.074 |
| 2 | 17.643 | 3397.9 | 89.3 | 0.5633 | 0.613 | 25.237 |
| 3 | 24.119 | 3265 | 66.7 | 0.7369 | 0.63 | 24.250 |
| 4 | 27.752 | 3290.7 | 59.1 | 0.8365 | 0.639 | 24.440 |

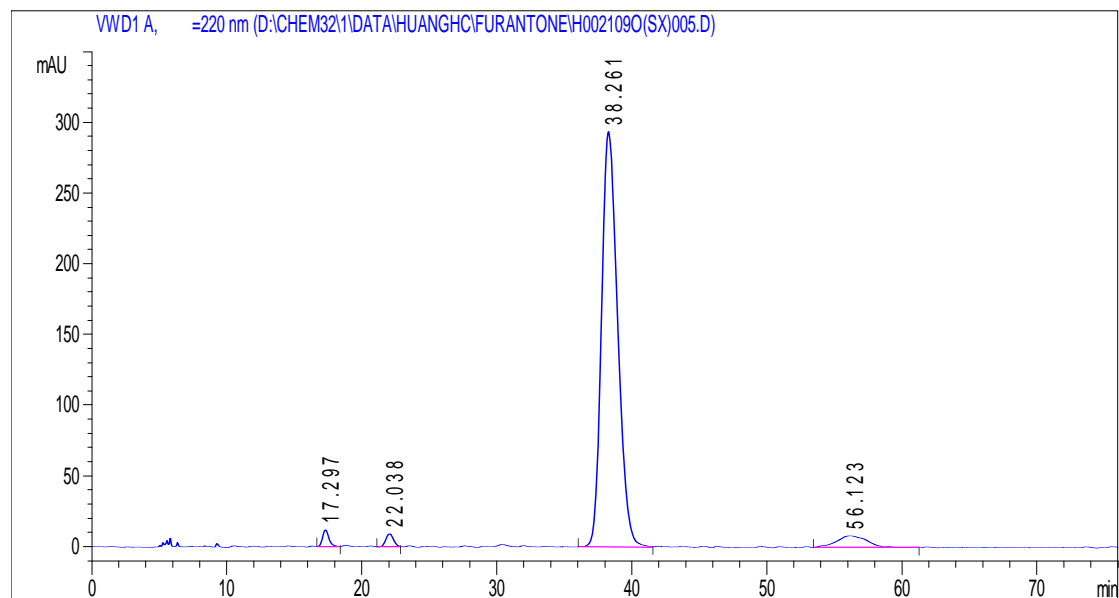


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 16.616 | 1110.9 | 30.5 | 0.5302 | 0.684 | 4.529 |
| 2 | 17.709 | 336 | 5.5 | 0.81 | 0.312 | 1.370 |
| 3 | 24.242 | 393.8 | 7.9 | 0.7484 | 0.683 | 1.605 |
| 4 | 27.609 | 22688.1 | 396.2 | 0.8662 | 0.6 | 92.496 |

6n: 5-(1-(2,3-dimethoxyphenyl)-3-oxobutyl)furan-2(5H)-one

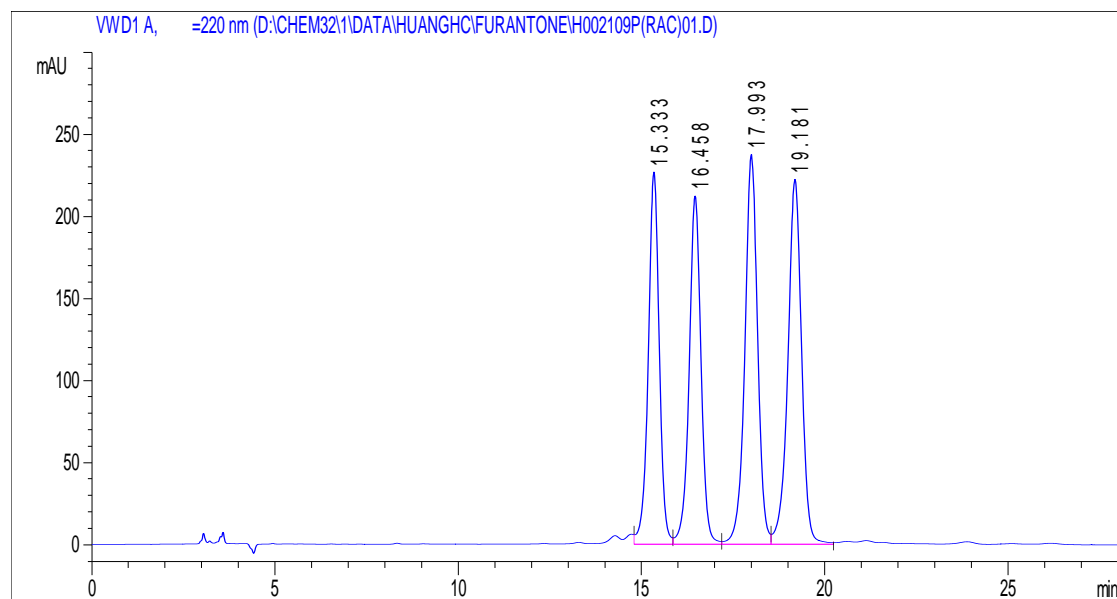


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 17.187 | 18712.3 | 622.3 | 0.4673 | 0.811 | 23.326 |
| 2 | 21.833 | 21308.3 | 545.2 | 0.6074 | 0.809 | 26.562 |
| 3 | 38.019 | 21353.7 | 261.5 | 1.2671 | 0.759 | 26.618 |
| 4 | 55.509 | 18847.7 | 126 | 2.2896 | 0.818 | 23.494 |

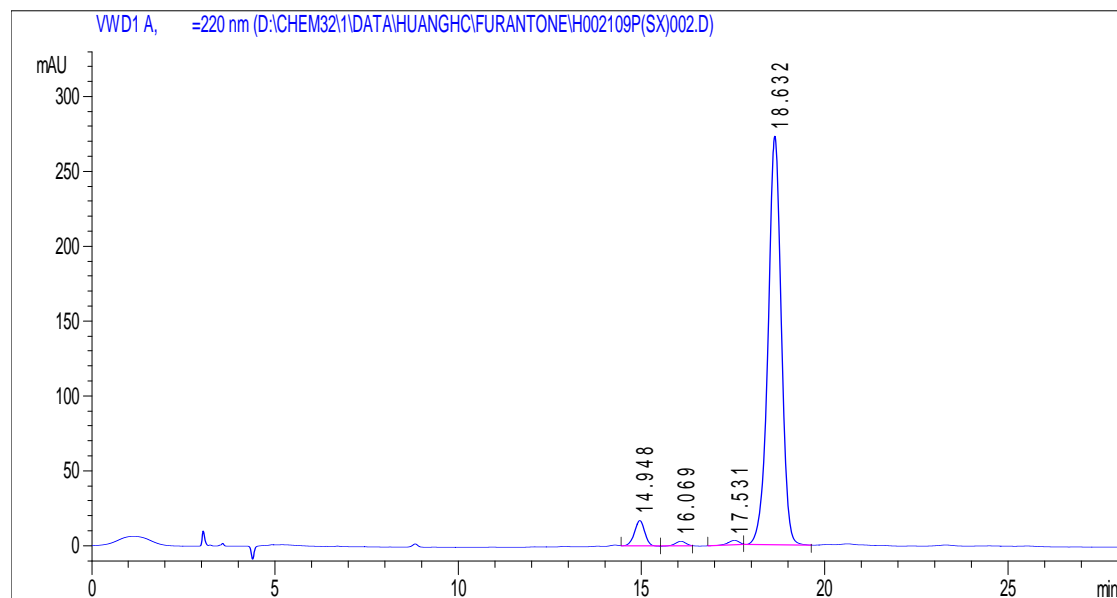


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 17.297 | 419.6 | 12.2 | 0.5216 | 0.756 | 1.581 |
| 2 | 22.038 | 364.7 | 9.2 | 0.6604 | 0.893 | 1.374 |
| 3 | 38.261 | 24404.8 | 293.8 | 1.2835 | 0.736 | 91.945 |
| 4 | 56.123 | 1353.7 | 8.3 | 2.2202 | 0.749 | 5.100 |

6o: 5-(1-(2,4-dimethoxyphenyl)-3-oxobutyl)furan-2(5H)-one

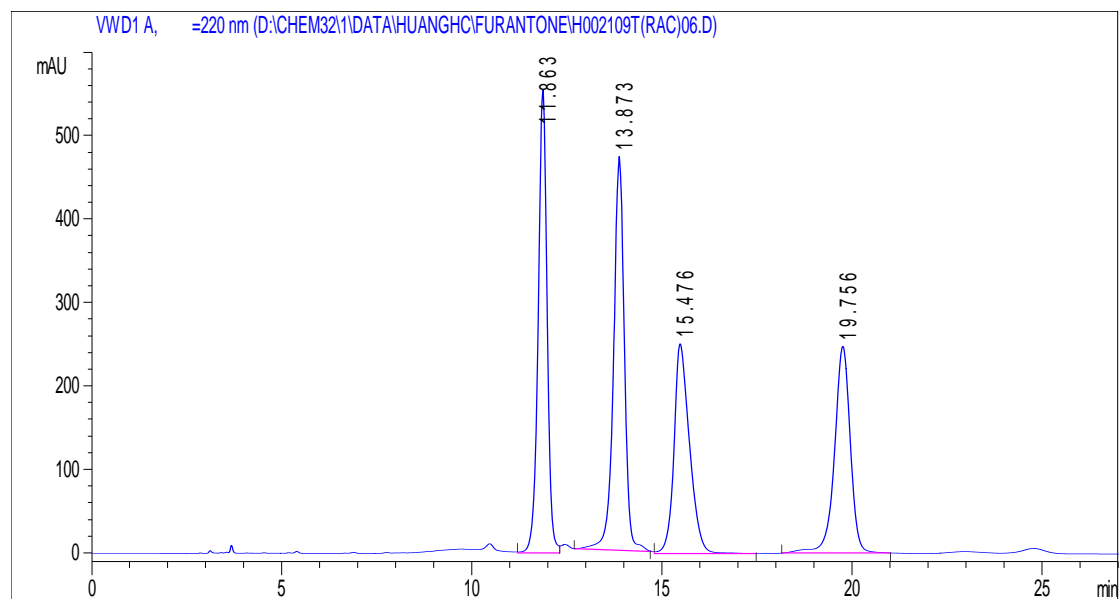


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 15.333 | 4719.3 | 226.7 | 0.3157 | 1.021 | 22.462 |
| 2 | 16.458 | 4758.8 | 212.1 | 0.3404 | 0.984 | 22.650 |
| 3 | 17.993 | 5743 | 237.4 | 0.3666 | 1.027 | 27.335 |
| 4 | 19.181 | 5788.7 | 222.3 | 0.3941 | 1.036 | 27.552 |

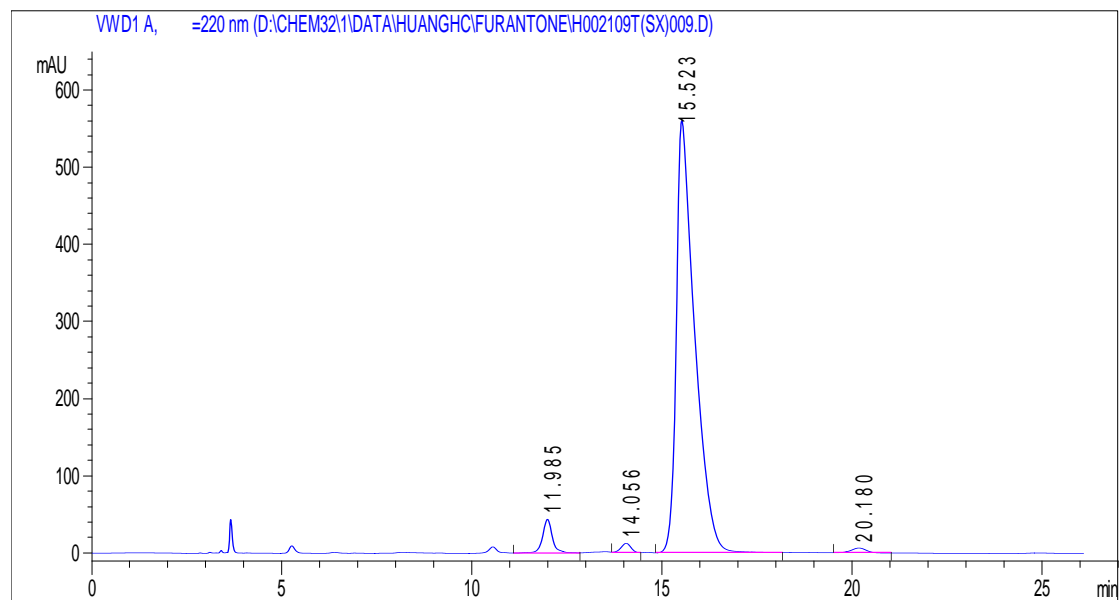


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|-------|--------|--------|----------|--------|
| 1 | 14.948 | 342.5 | 17.2 | 0.3324 | 1.027 | 4.668 |
| 2 | 16.069 | 76.7 | 3.4 | 0.373 | 1.067 | 1.045 |
| 3 | 17.531 | 72.1 | 3.2 | 0.3773 | 1.438 | 0.982 |
| 4 | 18.632 | 6847 | 273 | 0.418 | 0 | 93.305 |

6p: 5-(1-(naphthalen-2-yl)-3-oxobutyl)furan-2(5H)-one

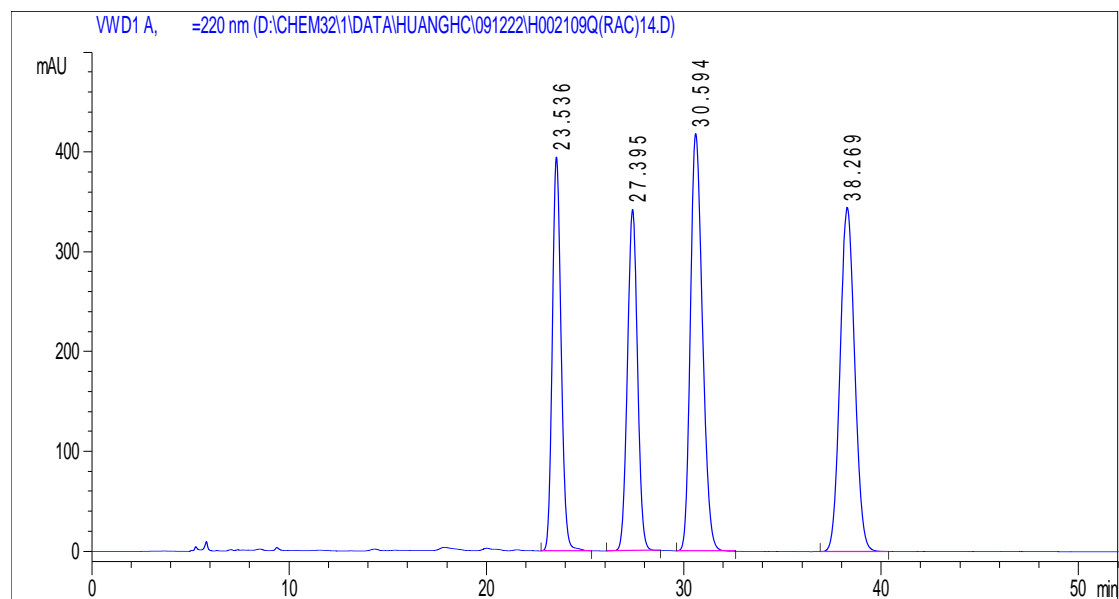


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 11.863 | 9083.3 | 555.3 | 0.2462 | 1.053 | 27.717 |
| 2 | 13.873 | 9387.4 | 472.4 | 0.3312 | 1.067 | 28.645 |
| 3 | 15.476 | 7135.8 | 251.4 | 0.4214 | 0.632 | 21.774 |
| 4 | 19.756 | 7165.3 | 247.7 | 0.4822 | 1.109 | 21.864 |

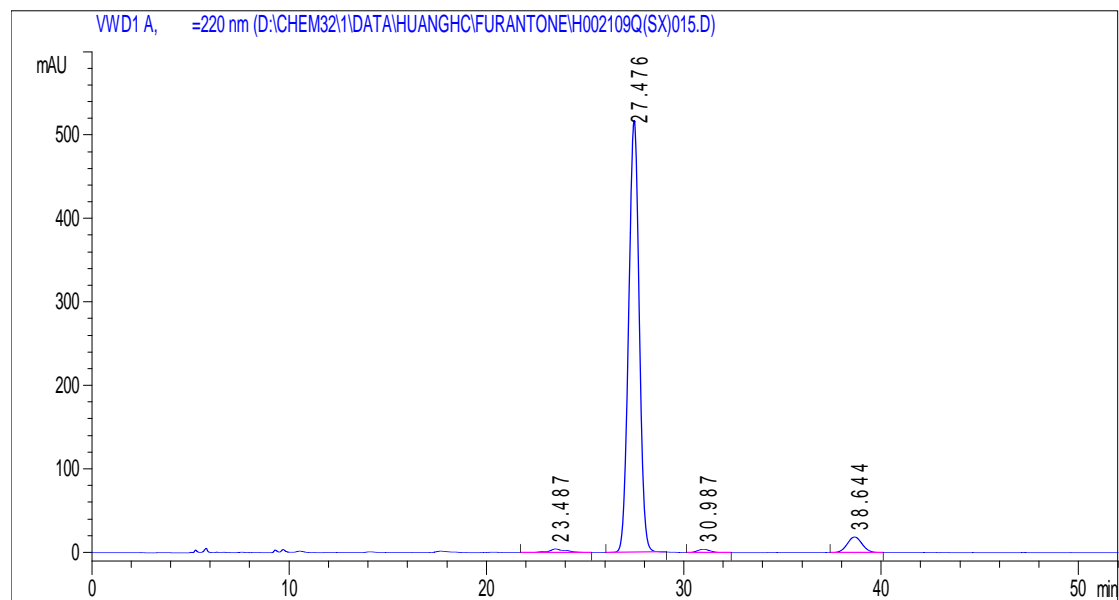


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 11.985 | 809.3 | 44 | 0.2729 | 0.967 | 4.047 |
| 2 | 14.056 | 236.9 | 12.4 | 0.2919 | 1.097 | 1.184 |
| 3 | 15.523 | 18783.3 | 560.3 | 0.4756 | 0.411 | 93.930 |
| 4 | 20.18 | 167.6 | 6.2 | 0.4155 | 1.077 | 0.838 |

6q: 5-(1-(furan-2-yl)-3-oxobutyl)furan-2(5H)-one

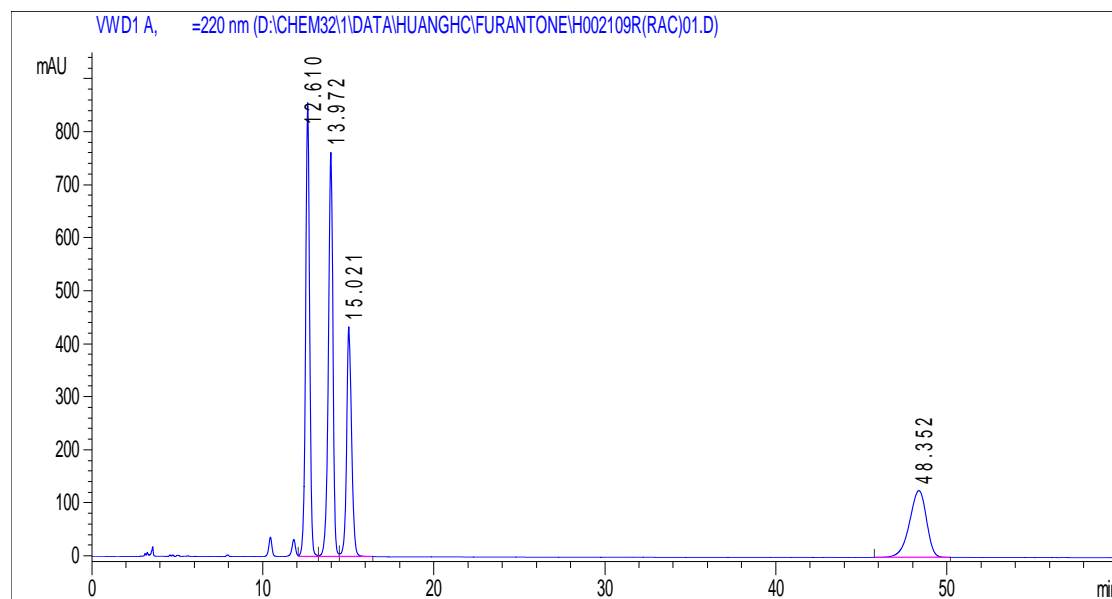


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 23.536 | 12151 | 394.7 | 0.4786 | 0.828 | 20.330 |
| 2 | 27.395 | 12104.6 | 342.1 | 0.5526 | 0.988 | 20.253 |
| 3 | 30.594 | 17736.7 | 418.2 | 0.6608 | 0.741 | 29.676 |
| 4 | 38.269 | 17775.2 | 345 | 0.8049 | 0.905 | 29.741 |

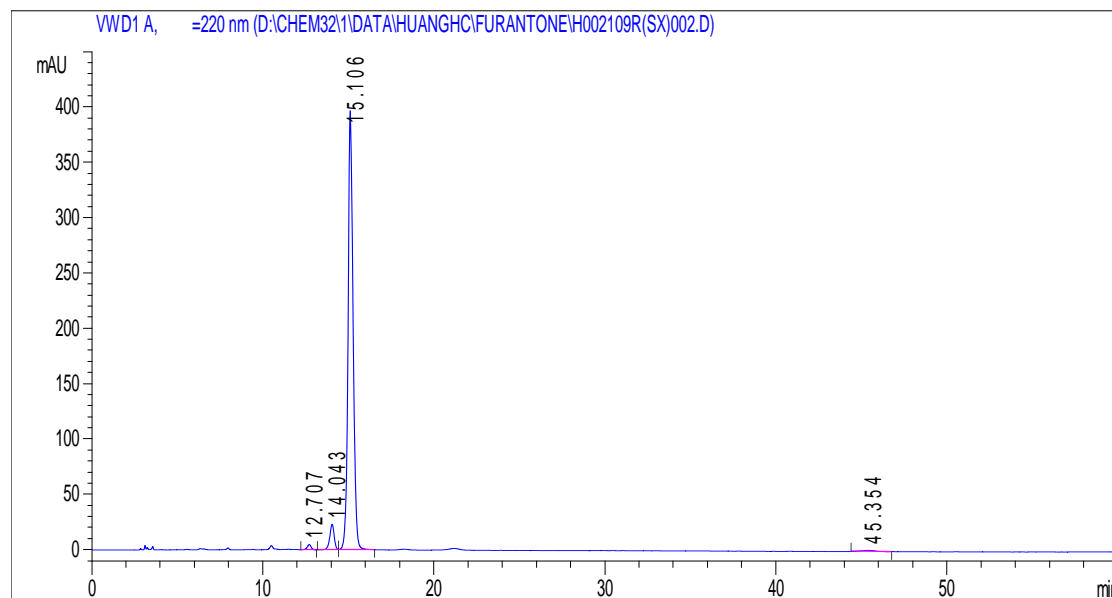


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 23.487 | 270.1 | 4.3 | 0.8347 | 0.749 | 1.310 |
| 2 | 27.476 | 19196.3 | 517.5 | 0.5783 | 1.039 | 93.099 |
| 3 | 30.987 | 174.8 | 3.9 | 0.6743 | 0.858 | 0.848 |
| 4 | 38.644 | 978 | 18.7 | 0.8148 | 0.938 | 4.743 |

6r: 5-(3-oxo-1-(thiophen-2-yl)butyl)furan-2(5H)-one

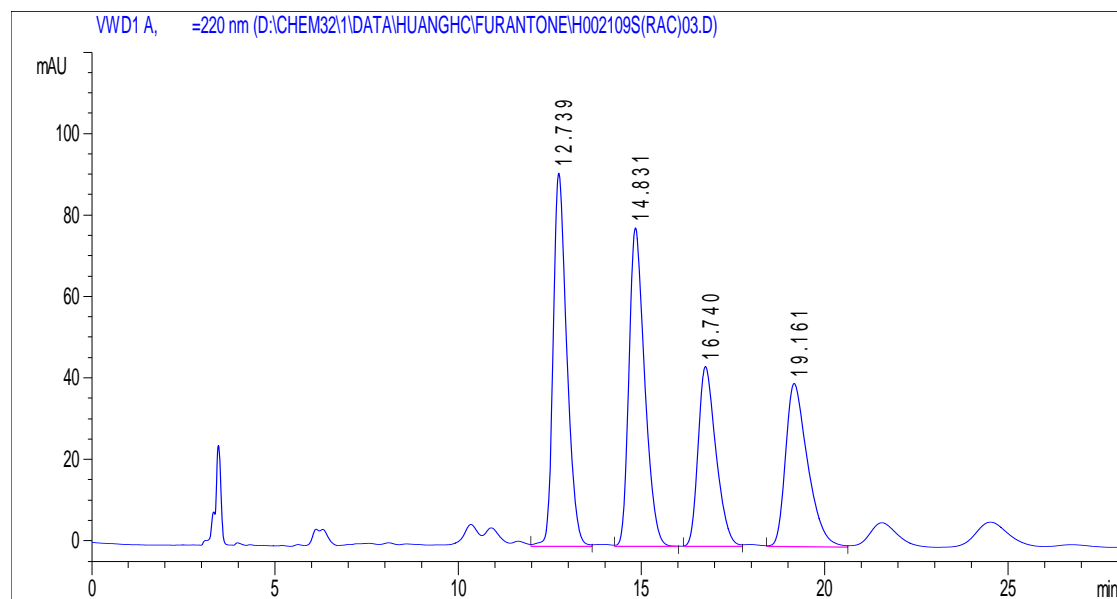


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 12.61 | 14104.5 | 856.1 | 0.2505 | 0.96 | 30.864 |
| 2 | 13.972 | 14143.5 | 762.3 | 0.2834 | 1.185 | 30.949 |
| 3 | 15.021 | 8771.4 | 433.5 | 0.303 | 0.775 | 19.194 |
| 4 | 48.352 | 8680.2 | 126 | 1.0746 | 1.23 | 18.994 |

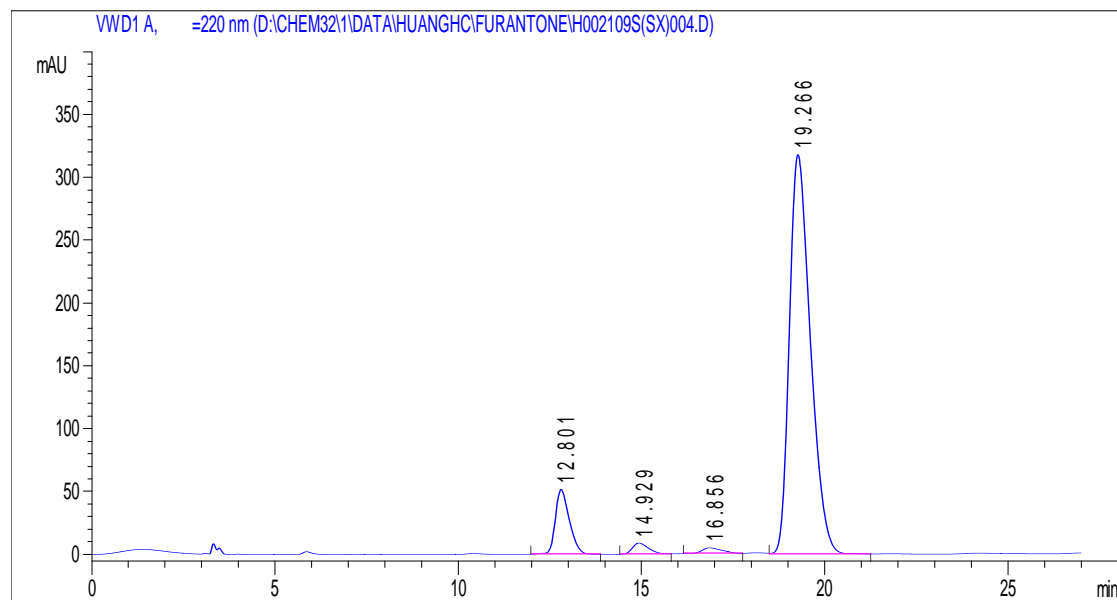


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 12.707 | 79.1 | 4.8 | 0.2531 | 1.169 | 0.917 |
| 2 | 14.043 | 419.9 | 23.1 | 0.2765 | 1.129 | 4.870 |
| 3 | 15.106 | 8063.9 | 396.7 | 0.307 | 0.786 | 93.522 |
| 4 | 45.354 | 59.6 | 1.1 | 0.7834 | 0.984 | 0.691 |

6s: 5-(3-oxo-1,3-diphenylpropyl)furan-2(5H)-one

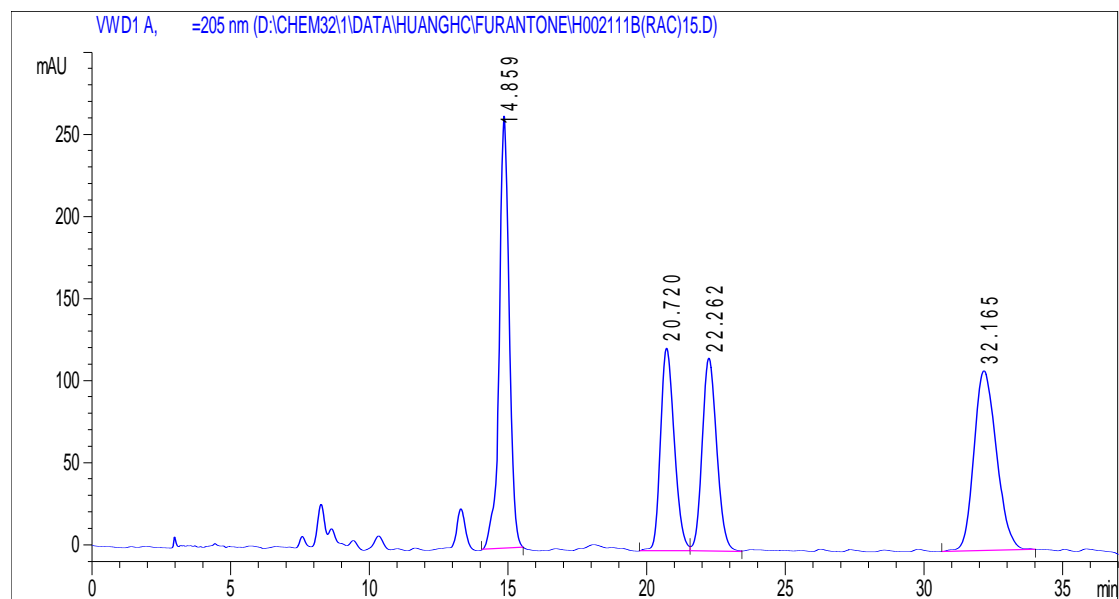


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 12.739 | 2378.4 | 91.7 | 0.3928 | 0.678 | 30.062 |
| 2 | 14.831 | 2335.8 | 78.3 | 0.4527 | 0.666 | 29.524 |
| 3 | 16.74 | 1505.4 | 44.3 | 0.5158 | 0.66 | 19.028 |
| 4 | 19.161 | 1692 | 40.2 | 0.6282 | 0.604 | 21.386 |

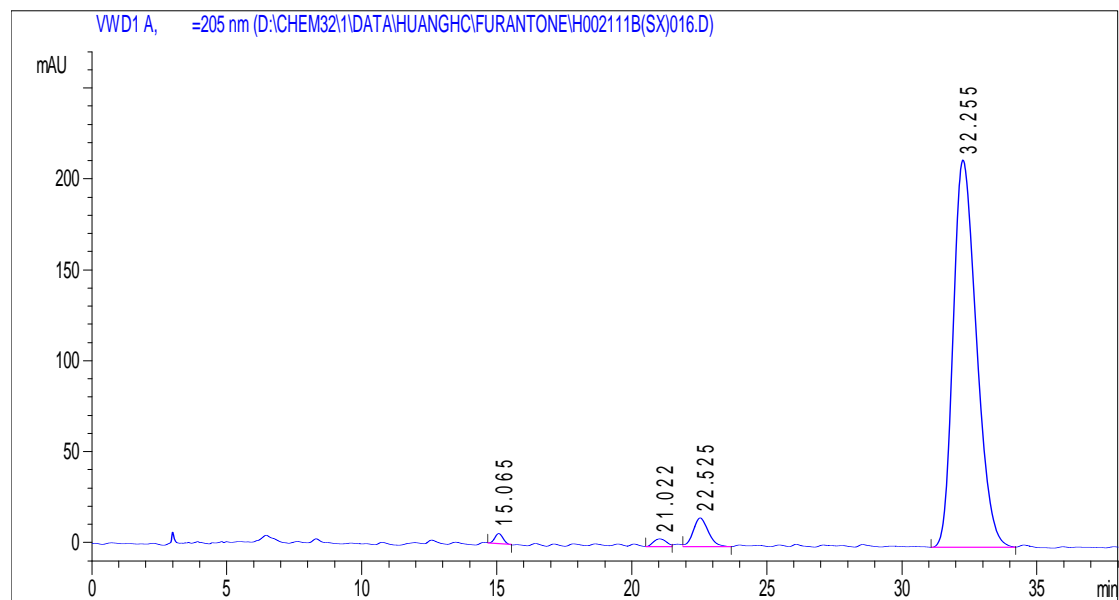


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 12.801 | 1373.7 | 51.7 | 0.4032 | 0.676 | 9.472 |
| 2 | 14.929 | 279 | 8.9 | 0.4723 | 0.64 | 1.924 |
| 3 | 16.856 | 166.1 | 4.5 | 0.6127 | 0.608 | 1.145 |
| 4 | 19.266 | 12684 | 317.9 | 0.6112 | 0.655 | 87.459 |

6t: 5-(2-oxoheptan-4-yl)furan-2(5H)-one

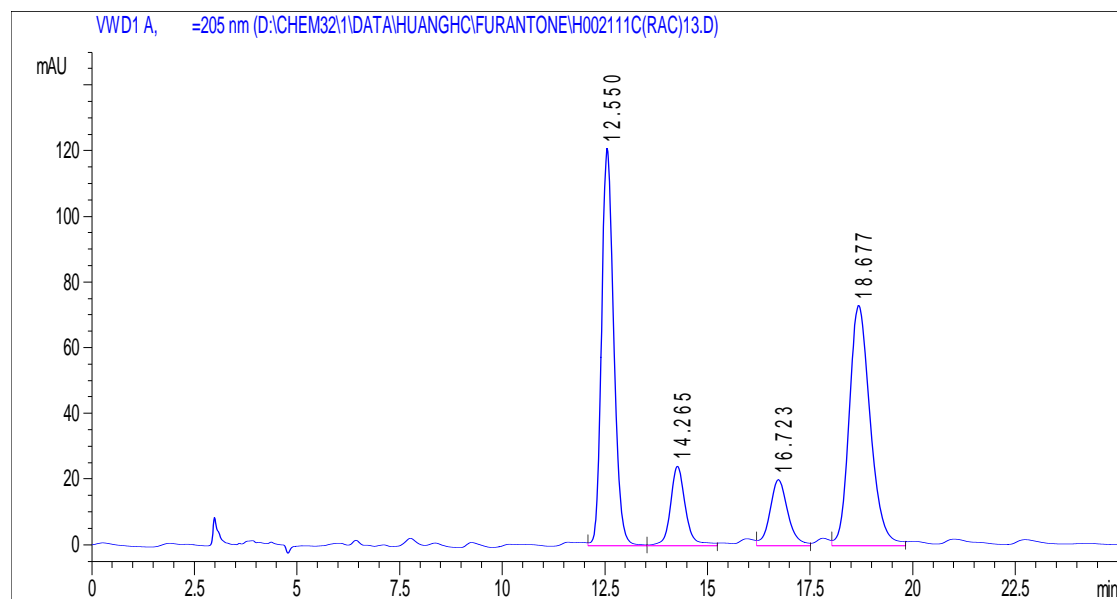


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 14.859 | 6595 | 263.3 | 0.4174 | 0.927 | 30.803 |
| 2 | 20.72 | 4294 | 123.6 | 0.579 | 0.765 | 20.056 |
| 3 | 22.262 | 4305.6 | 47.1 | 1.4594 | 0 | 20.110 |
| 4 | 32.165 | 6215.6 | 109.6 | 0.9451 | 0.789 | 29.031 |

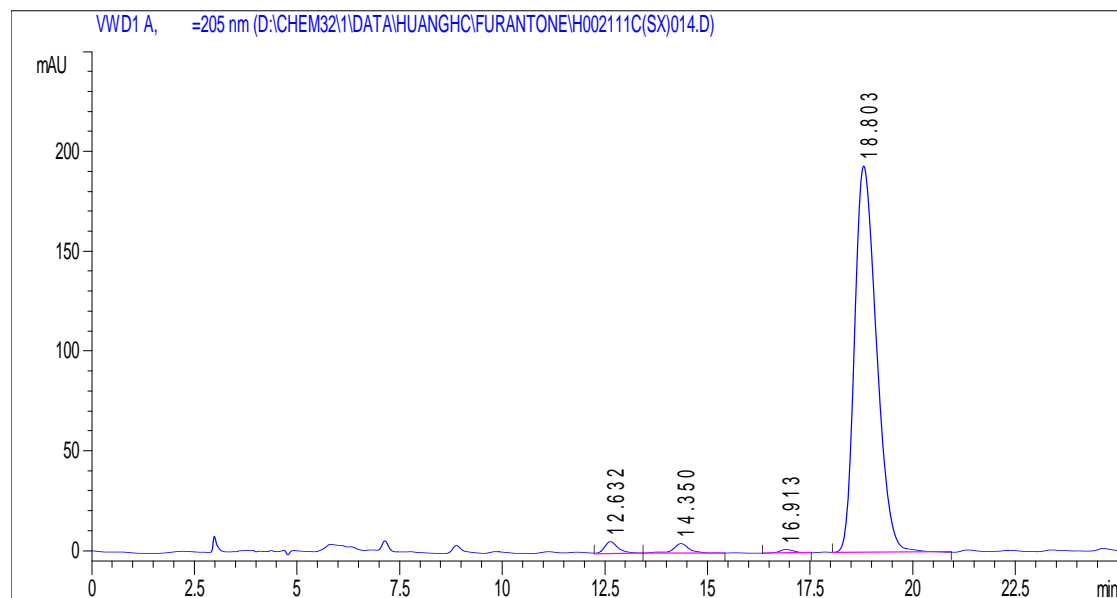


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 15.065 | 116.4 | 5.6 | 0.348 | 0.916 | 0.851 |
| 2 | 21.022 | 148.9 | 4.4 | 0.5653 | 0.888 | 1.088 |
| 3 | 22.525 | 632.5 | 16 | 0.6011 | 0.817 | 4.624 |
| 4 | 32.255 | 12781.1 | 213.3 | 0.9319 | 0.691 | 93.436 |

6u: 5-(2-oxooctan-4-yl)furan-2(5H)-one

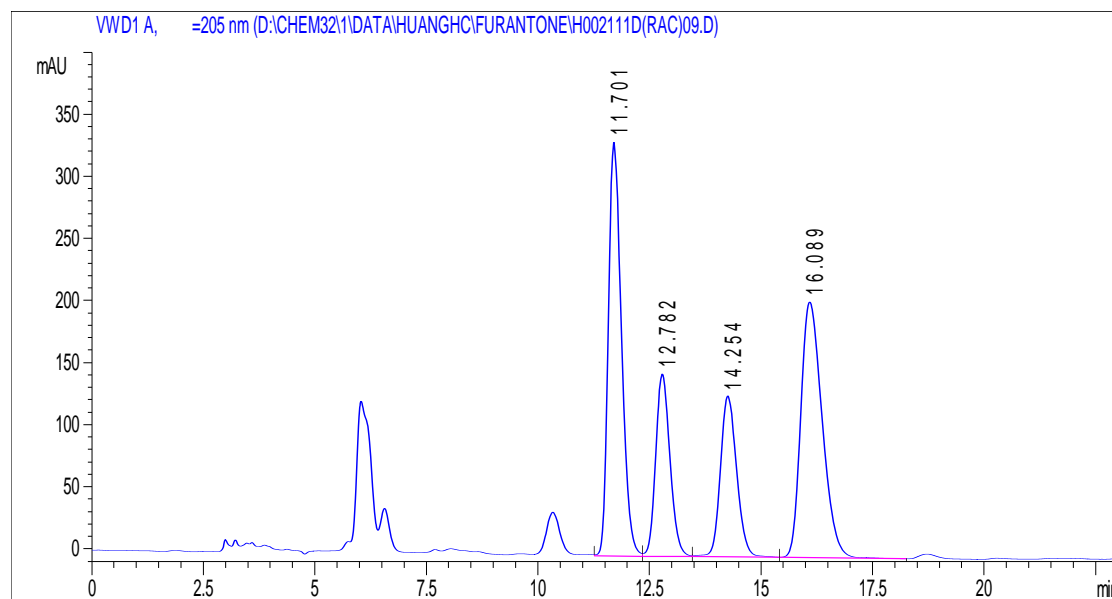


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 12.55 | 2505.8 | 121.1 | 0.32 | 0.781 | 39.436 |
| 2 | 14.265 | 624.5 | 24.3 | 0.3871 | 0.815 | 9.828 |
| 3 | 16.723 | 612.1 | 20.2 | 0.4589 | 0.848 | 9.634 |
| 4 | 18.677 | 2611.6 | 73.2 | 0.55 | 0.756 | 41.102 |

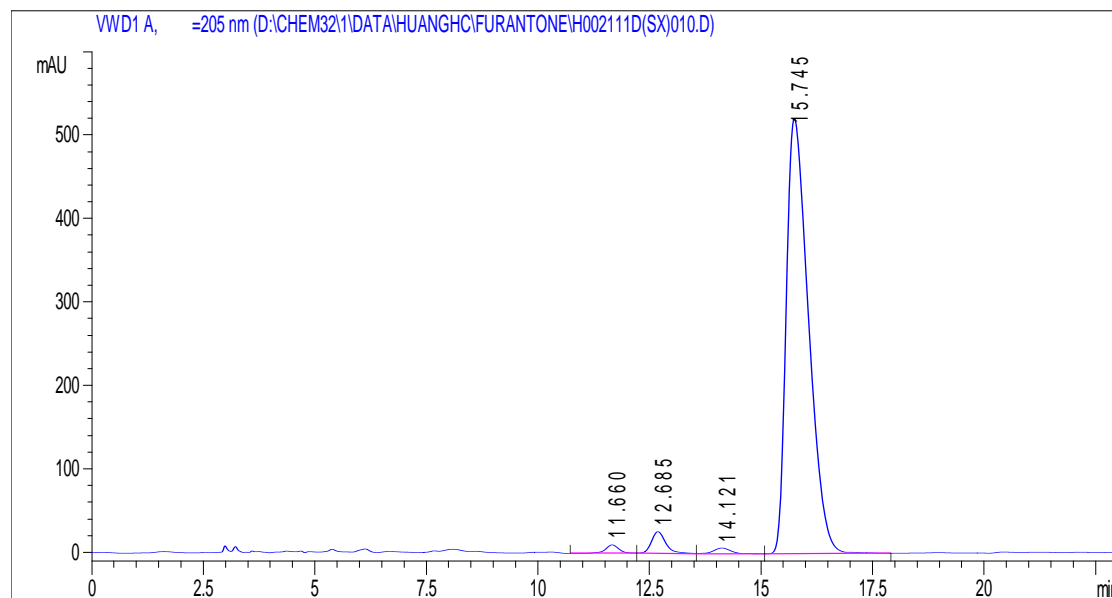


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 12.632 | 149 | 6.1 | 0.3576 | 0.659 | 1.974 |
| 2 | 14.35 | 157.6 | 5 | 0.4592 | 0.995 | 2.089 |
| 3 | 16.913 | 48.5 | 1.8 | 0.401 | 0.754 | 0.643 |
| 4 | 18.803 | 7191.9 | 193.7 | 0.5758 | 0.673 | 95.295 |

6v: 5-(2-oxononan-4-yl)furan-2(5H)-one

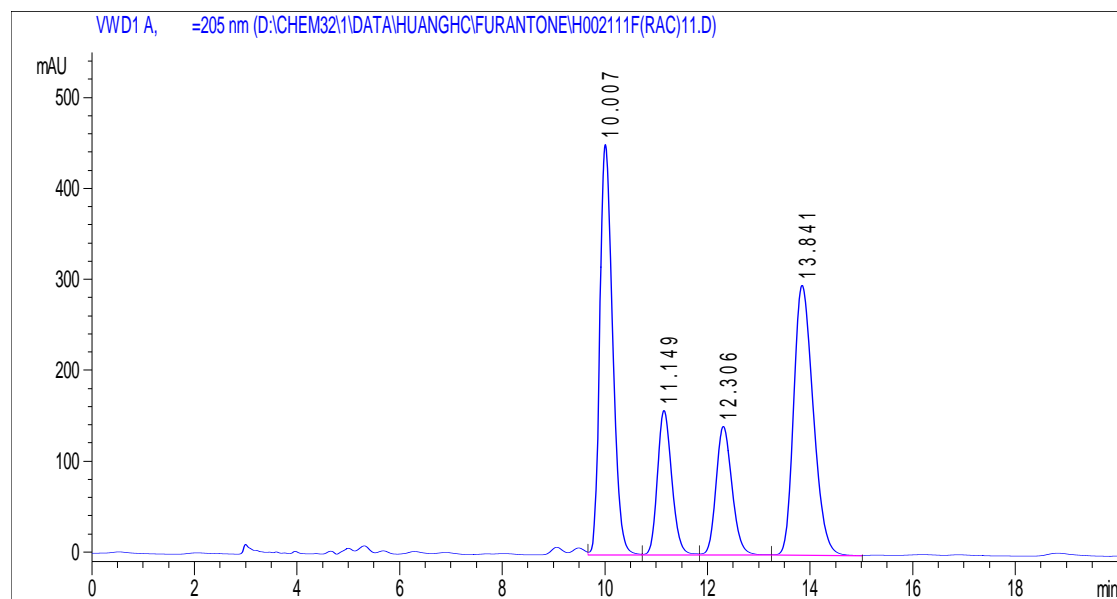


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 11.701 | 6858.3 | 333.6 | 0.3214 | 0.711 | 33.659 |
| 2 | 12.782 | 3295.6 | 147.3 | 0.3454 | 0.803 | 16.174 |
| 3 | 14.254 | 3339.9 | 130.1 | 0.3985 | 0.814 | 16.391 |
| 4 | 16.089 | 6882.2 | 206.2 | 0.5176 | 0.675 | 33.776 |

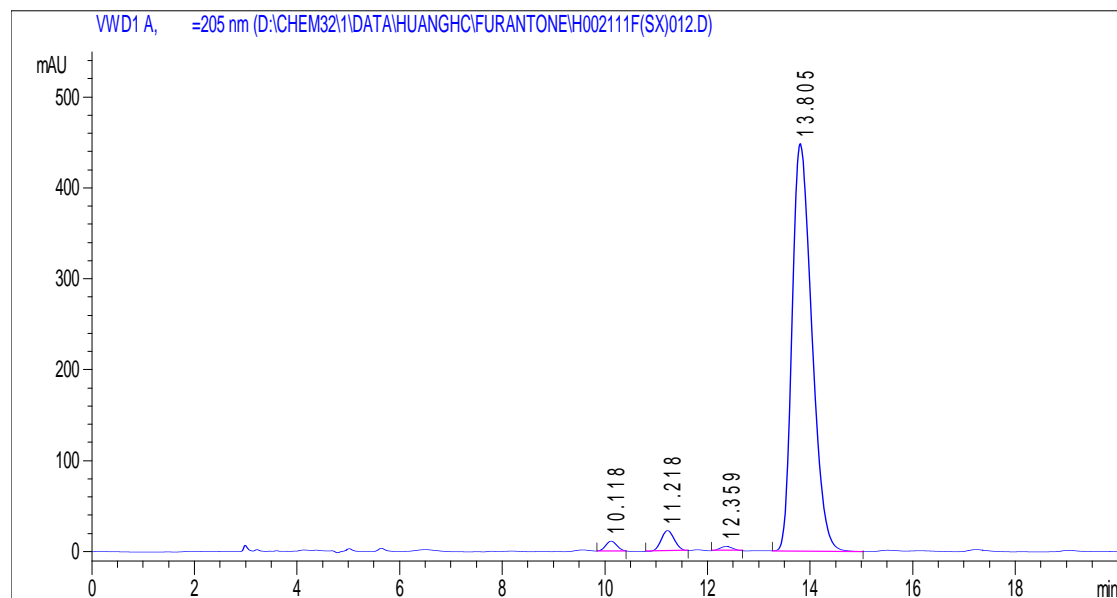


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 11.66 | 254.4 | 10.6 | 0.3492 | 1.053 | 1.331 |
| 2 | 12.685 | 615 | 26.5 | 0.3524 | 0.768 | 3.217 |
| 3 | 14.121 | 193 | 7 | 0.4237 | 0.96 | 1.09 |
| 4 | 15.745 | 18055.9 | 521.7 | 0.5377 | 0.539 | 94.443 |

6w: 5-(2-oxodecan-4-yl)furan-2(5H)-one

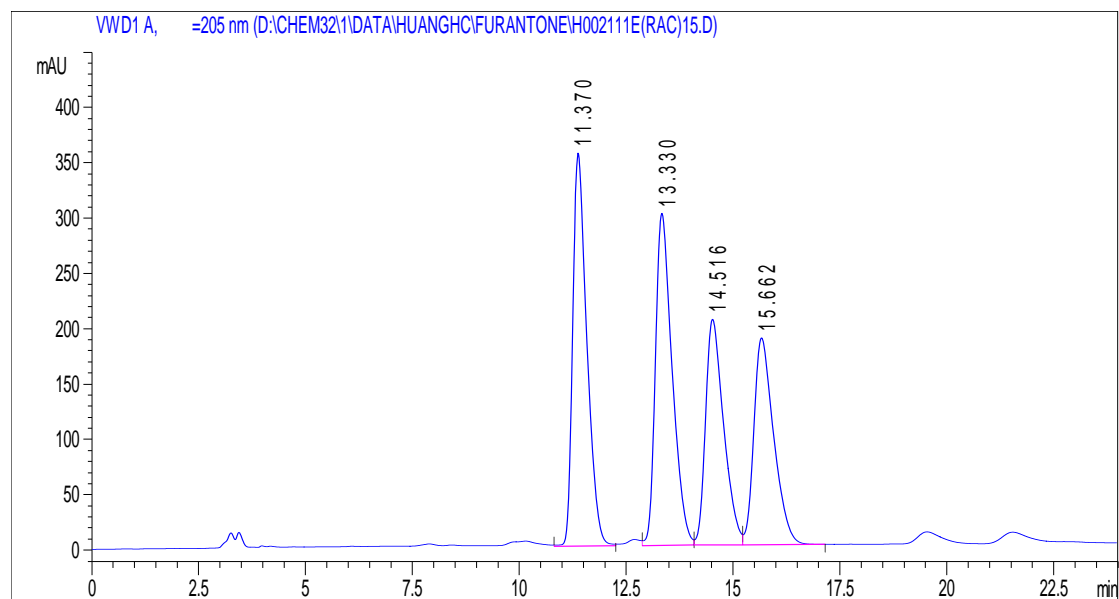


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 10.007 | 7838 | 451.5 | 0.2695 | 0.721 | 35.736 |
| 2 | 11.149 | 3109.4 | 159.3 | 0.3034 | 0.794 | 14.177 |
| 3 | 12.306 | 3103.7 | 142 | 0.3365 | 0.793 | 14.151 |
| 4 | 13.841 | 7882 | 297.4 | 0.4141 | 0.716 | 35.937 |

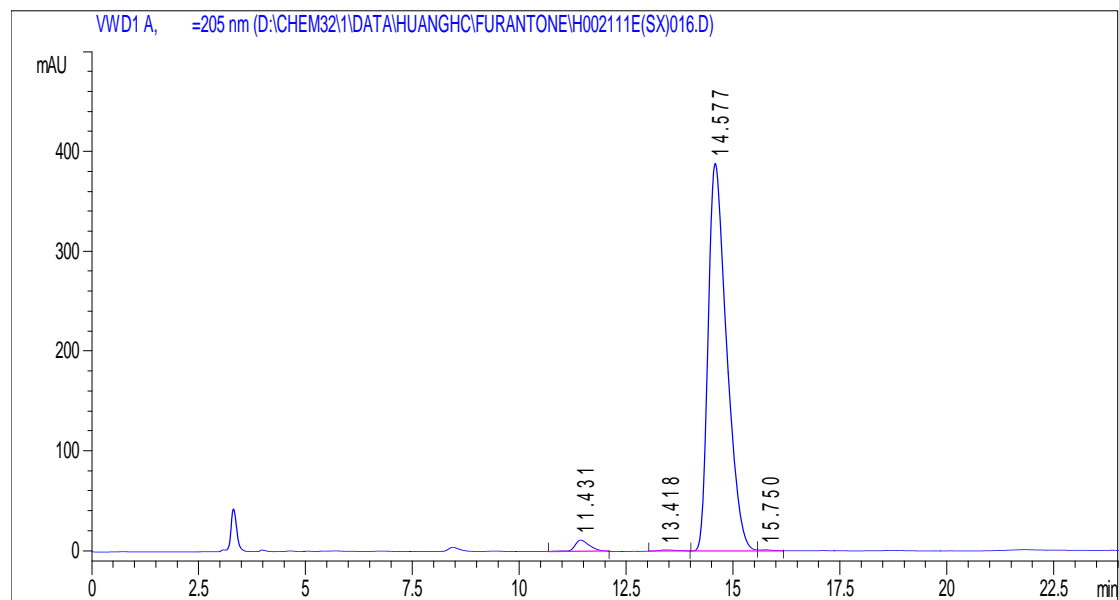


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 10.118 | 164.1 | 10.9 | 0.2502 | 0.875 | 1.300 |
| 2 | 11.218 | 406.8 | 22.6 | 0.2995 | 0.925 | 3.222 |
| 3 | 12.359 | 86.6 | 4.8 | 0.3006 | 0.922 | 0.686 |
| 4 | 13.805 | 11967.4 | 448.6 | 0.4149 | 0 | 94.792 |

6x: 5-(4-oxooctan-2-yl)furan-2(5H)-one

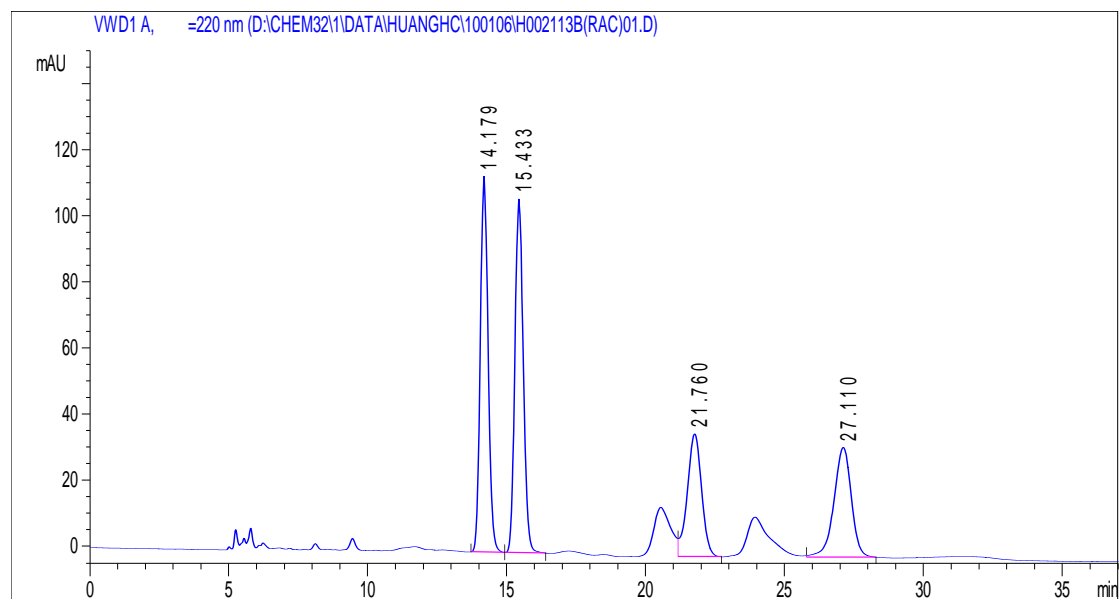


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 11.37 | 8177.1 | 355.3 | 0.3413 | 0.577 | 28.736 |
| 2 | 13.33 | 8174.5 | 300.4 | 0.4048 | 0.593 | 28.727 |
| 3 | 14.516 | 6027.6 | 204.3 | 0.4402 | 0.602 | 21.183 |
| 4 | 15.662 | 6076.4 | 187.3 | 0.4862 | 0.599 | 21.354 |

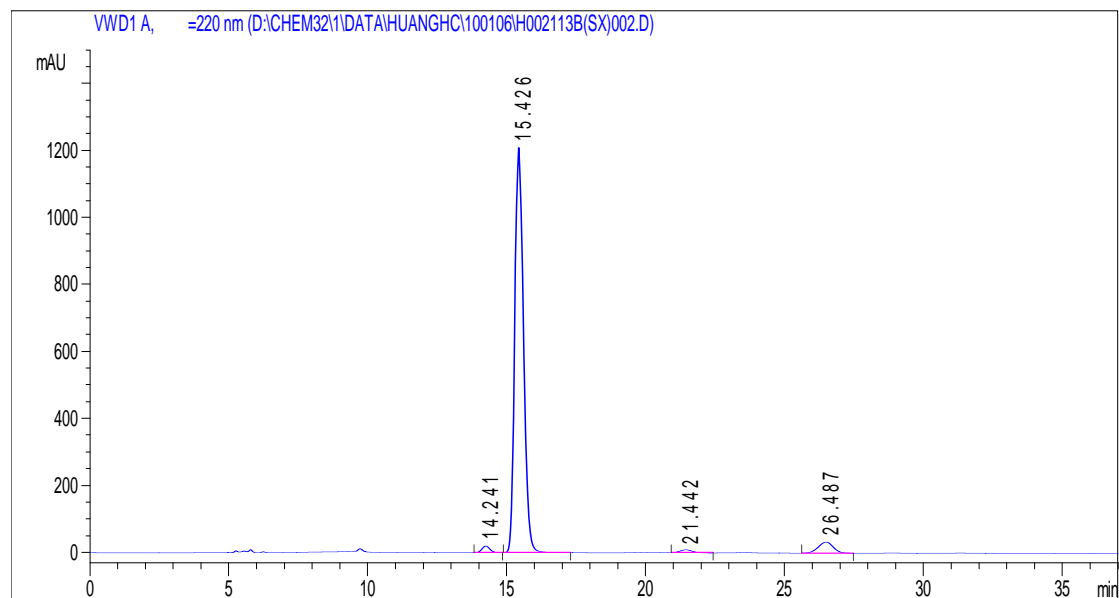


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 11.431 | 288.5 | 11.5 | 0.4174 | 0.716 | 2.400 |
| 2 | 13.418 | 39.6 | 1.3 | 0.5203 | 0.592 | 0.329 |
| 3 | 14.577 | 11662.1 | 388.5 | 0.4657 | 0 | 97.031 |
| 4 | 15.75 | 28.8 | 1.2 | 0.3976 | 0.657 | 0.240 |

6y: 5-(5-oxo-1-phenylhexan-3-yl)furan-2(5H)-one

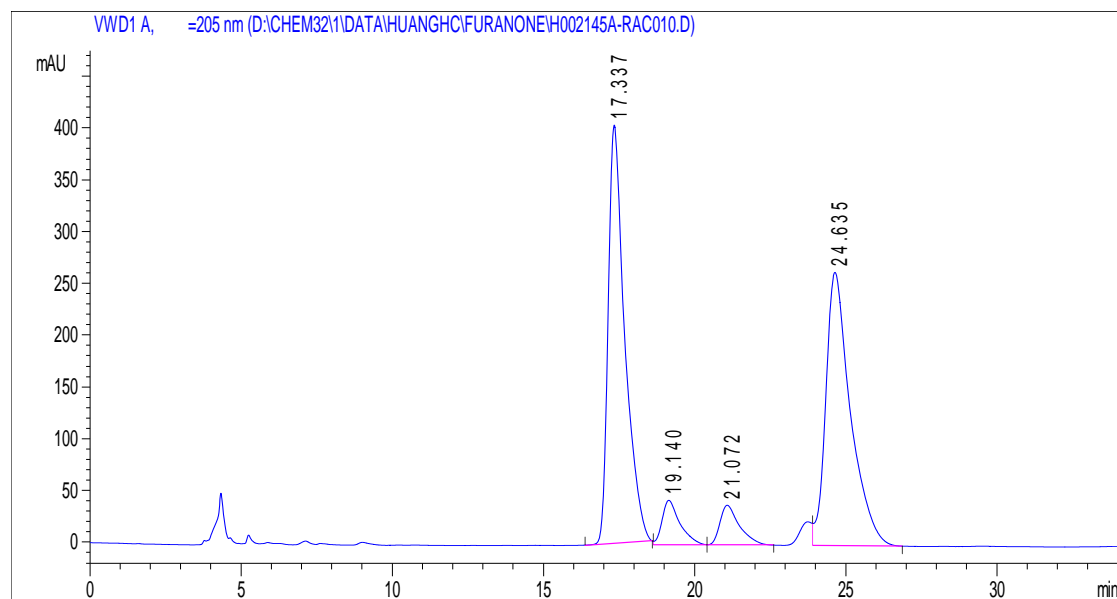


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 14.179 | 2234.1 | 113.7 | 0.305 | 0.876 | 30.748 |
| 2 | 15.433 | 2253.9 | 107 | 0.3288 | 0.867 | 31.020 |
| 3 | 21.76 | 1325 | 37.2 | 0.5469 | 1.032 | 18.235 |
| 4 | 27.11 | 1453 | 33.3 | 0.6712 | 1.149 | 19.997 |

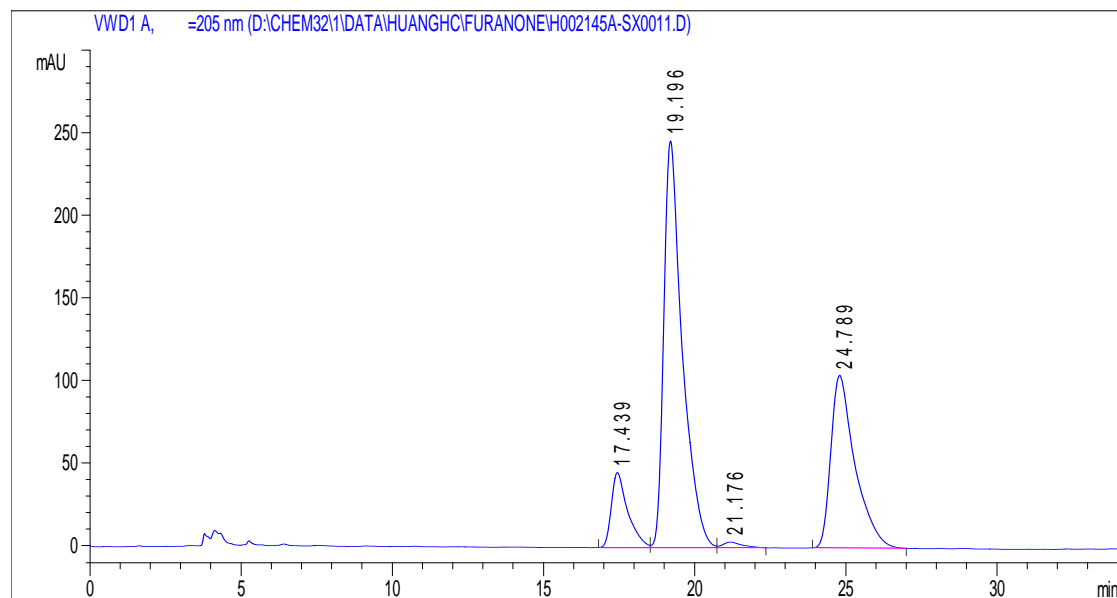


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|--------|--------|--------|----------|--------|
| 1 | 14.241 | 388.7 | 19.7 | 0.3054 | 0.878 | 1.364 |
| 2 | 15.426 | 26570 | 1209.1 | 0.3437 | 0.773 | 93.238 |
| 3 | 21.442 | 304.4 | 9.3 | 0.4984 | 0.937 | 1.068 |
| 4 | 26.487 | 1233.9 | 33 | 0.582 | 1.062 | 4.330 |

7a:5-(3-oxocyclopentyl)furan-2(5H)-one

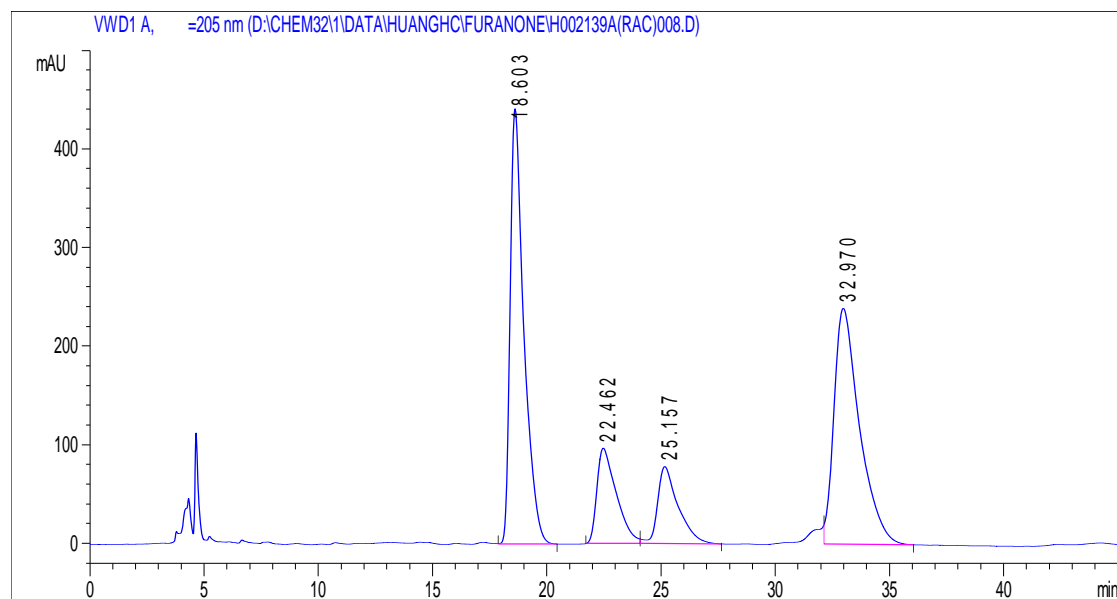


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 17.337 | 15372.1 | 403.8 | 0.6345 | 0.56 | 45.372 |
| 2 | 19.14 | 1802.7 | 43.4 | 0.6064 | 0.566 | 5.321 |
| 3 | 21.072 | 1743.1 | 38.6 | 0.6604 | 0.558 | 5.145 |
| 4 | 24.635 | 14962.5 | 264 | 0.8273 | 0.554 | 44.163 |

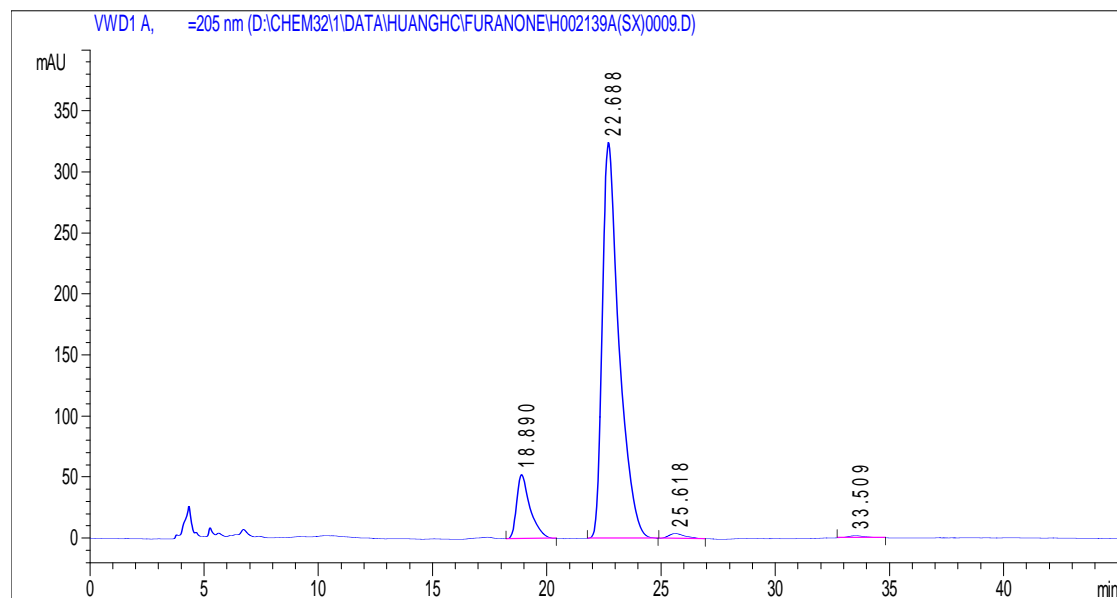


| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 17.439 | 1717.1 | 45.4 | 0.55 | 0.538 | 9.460 |
| 2 | 19.196 | 10477.3 | 246.1 | 0.622 | 0.523 | 57.720 |
| 3 | 21.176 | 155.1 | 3.5 | 0.6428 | 0.573 | 0.854 |
| 4 | 24.789 | 5802.3 | 104.3 | 0.8133 | 0.53 | 31.966 |

7b:5-(3-oxocycloheptyl)furan-2(5H)-one



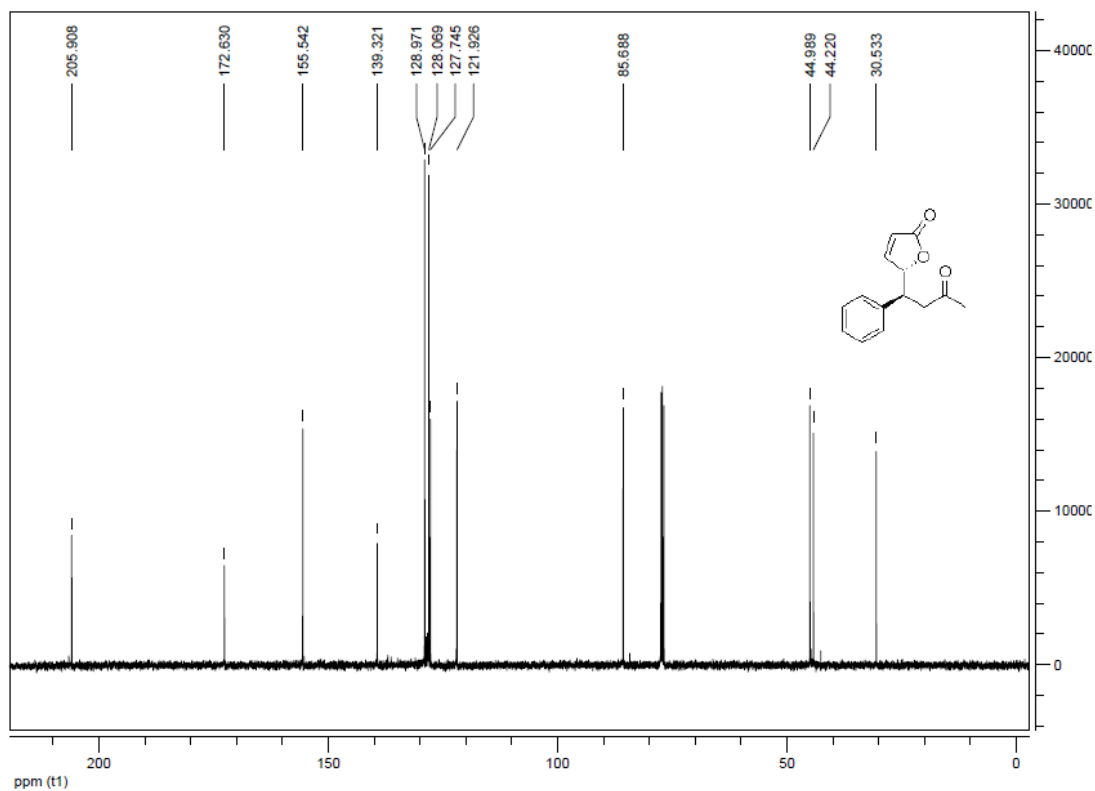
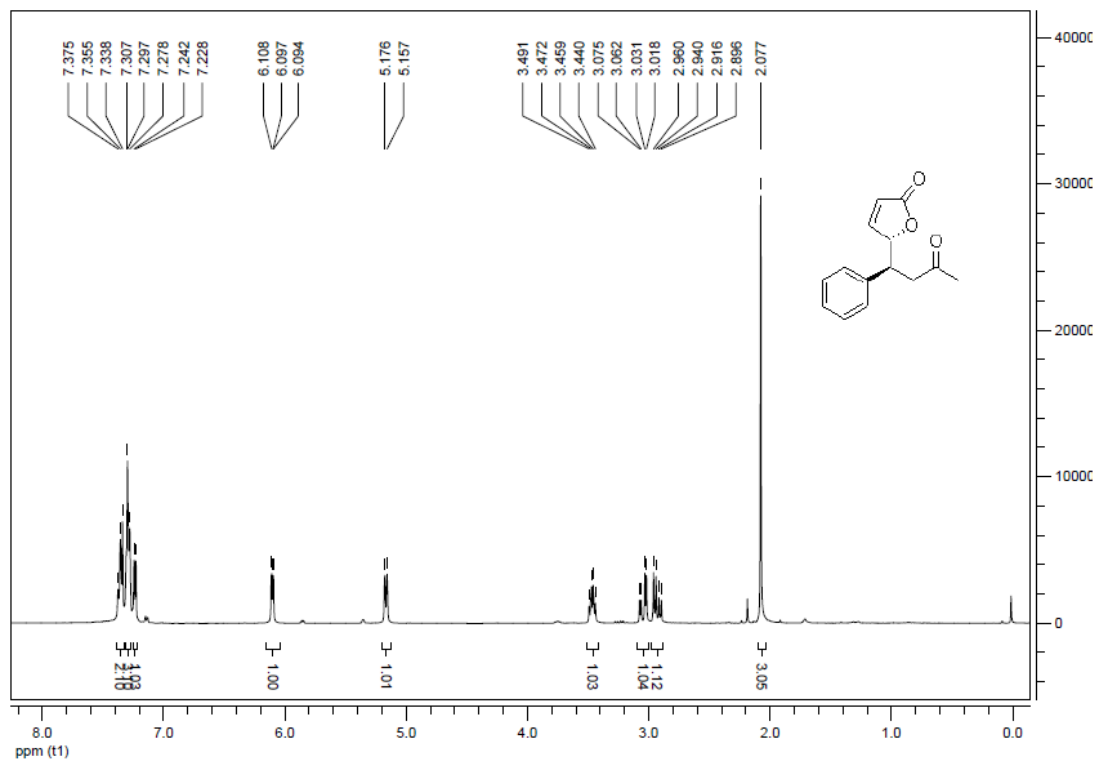
| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 18.603 | 18412.2 | 441.6 | 0.6131 | 0.513 | 38.621 |
| 2 | 22.462 | 5710 | 96.7 | 0.9845 | 0.471 | 11.977 |
| 3 | 25.157 | 4929.9 | 78.3 | 1.0495 | 0.528 | 10.341 |
| 4 | 32.97 | 18621.7 | 239.7 | 1.2948 | 0.551 | 39.061 |



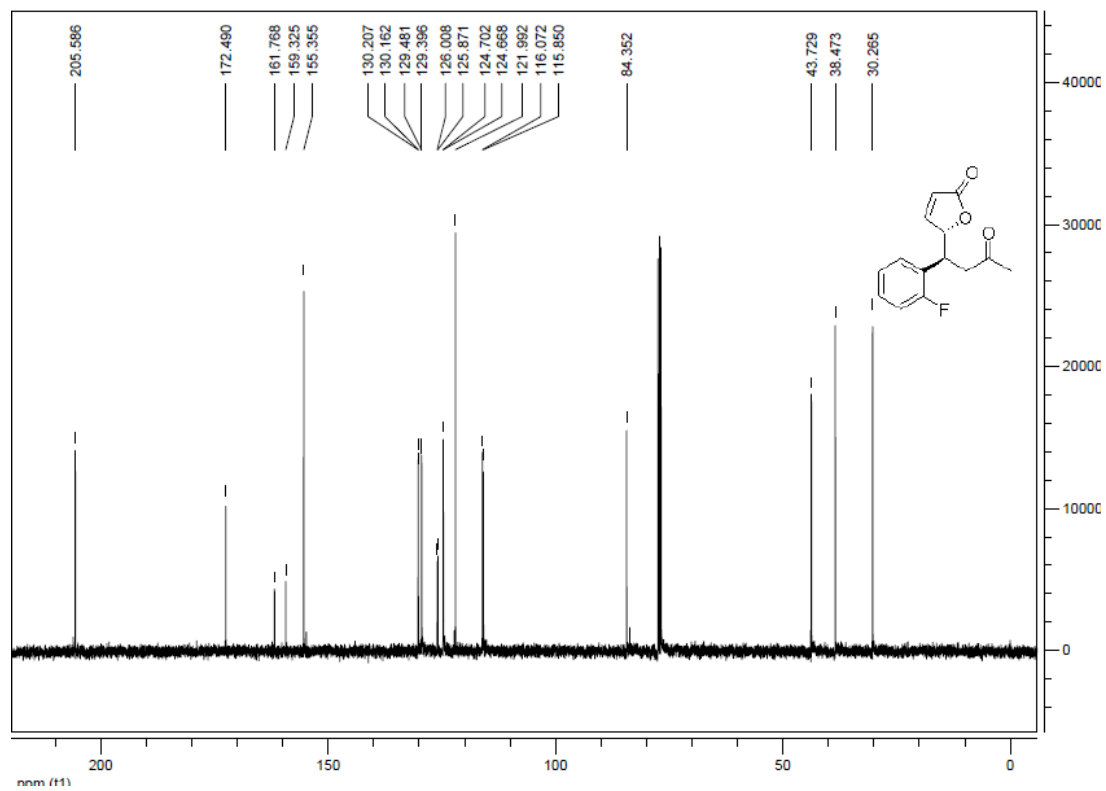
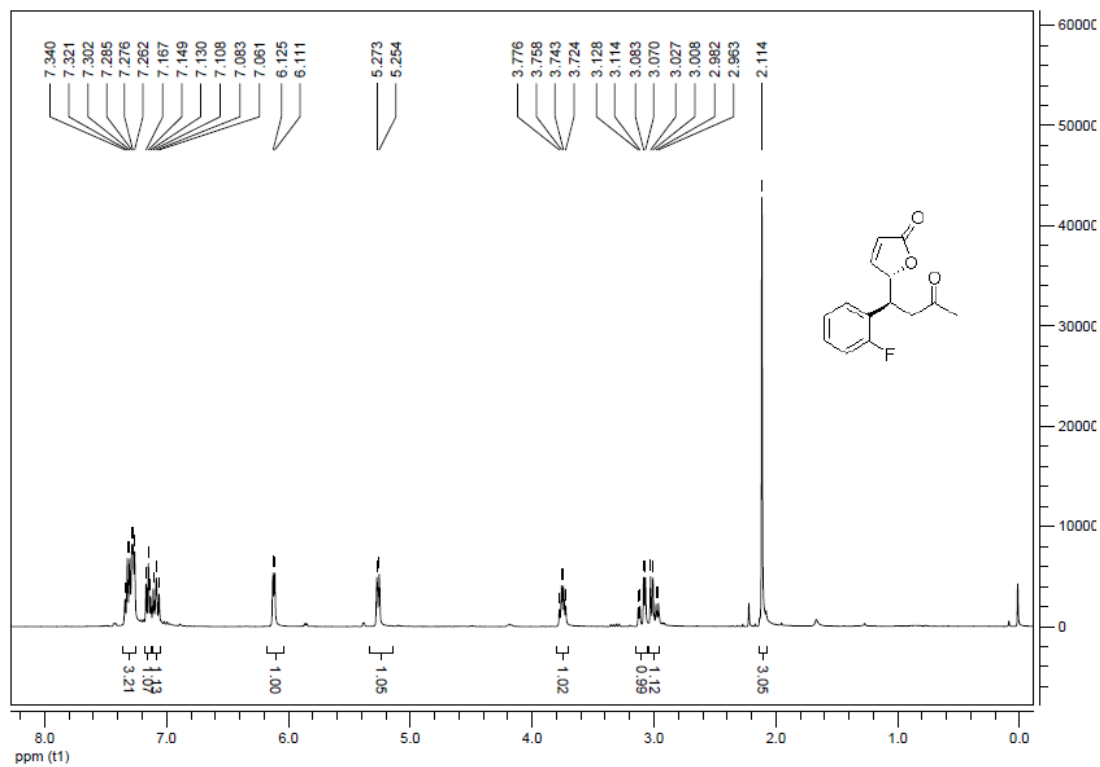
| # | Time | Area | Height | Width | Symmetry | Area % |
|---|--------|---------|--------|--------|----------|--------|
| 1 | 18.89 | 2155.3 | 52.6 | 0.597 | 0.545 | 11.343 |
| 2 | 22.688 | 16525.9 | 324.5 | 0.7471 | 0.527 | 86.974 |
| 3 | 25.618 | 218.5 | 4.2 | 0.7348 | 0.649 | 1.150 |
| 4 | 33.509 | 101.3 | 1.8 | 0.6664 | 0.687 | 0.533 |

F: NMR Spectra of Michael Addition Products

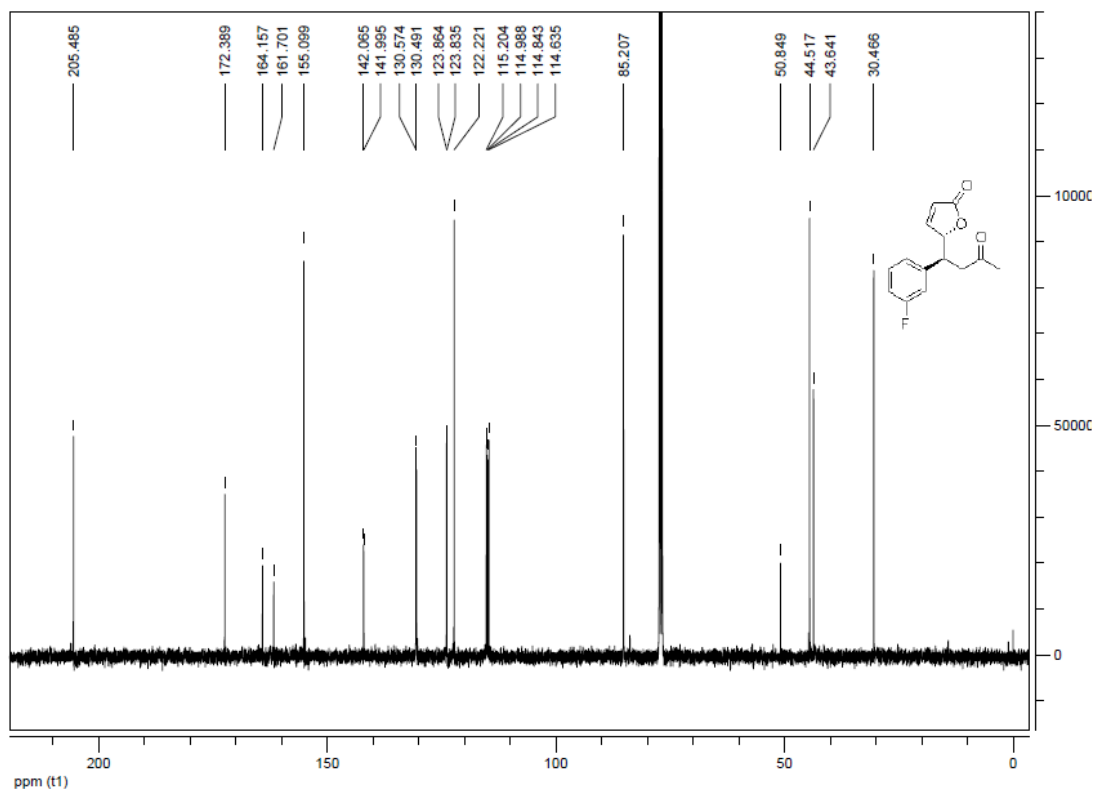
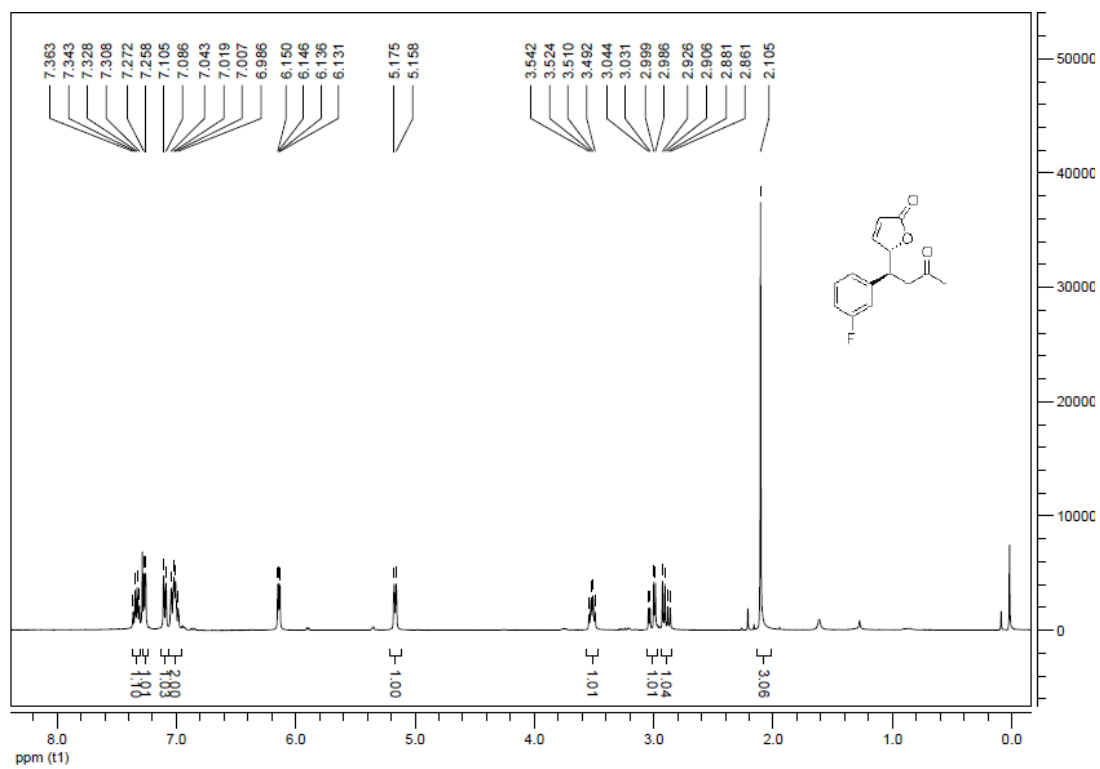
6a: 5-(3-oxo-1-phenylbutyl)furan-2(5H)-one



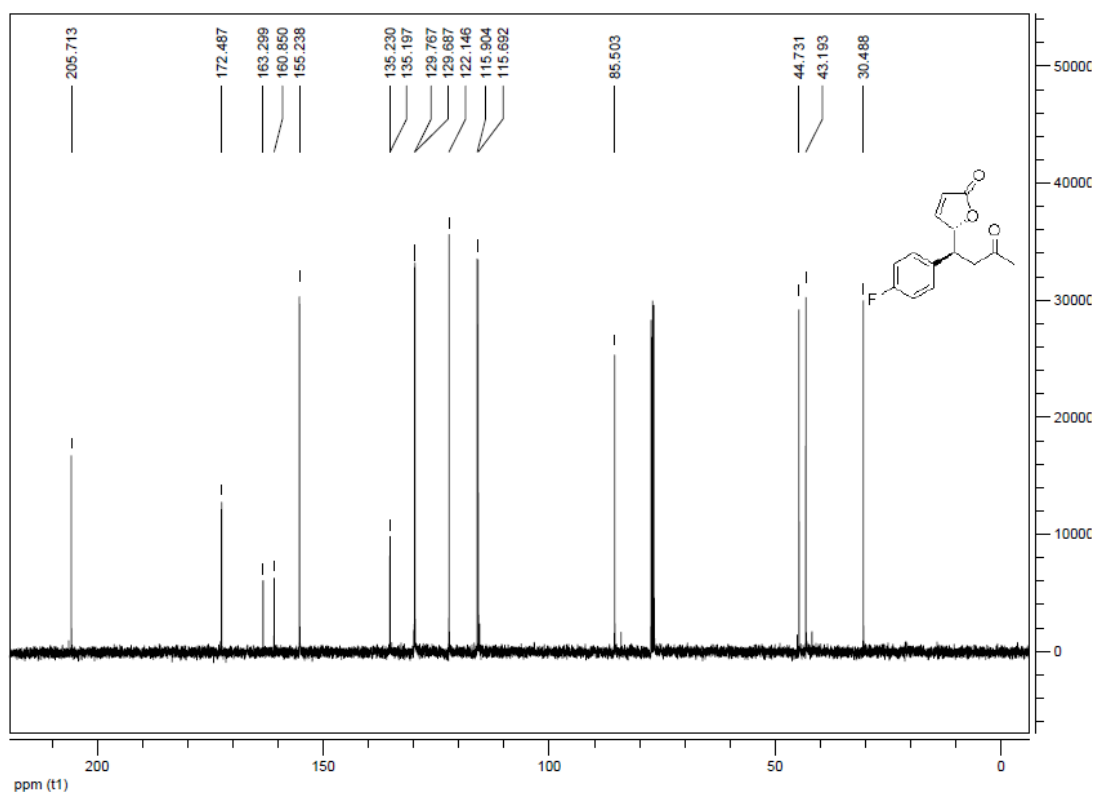
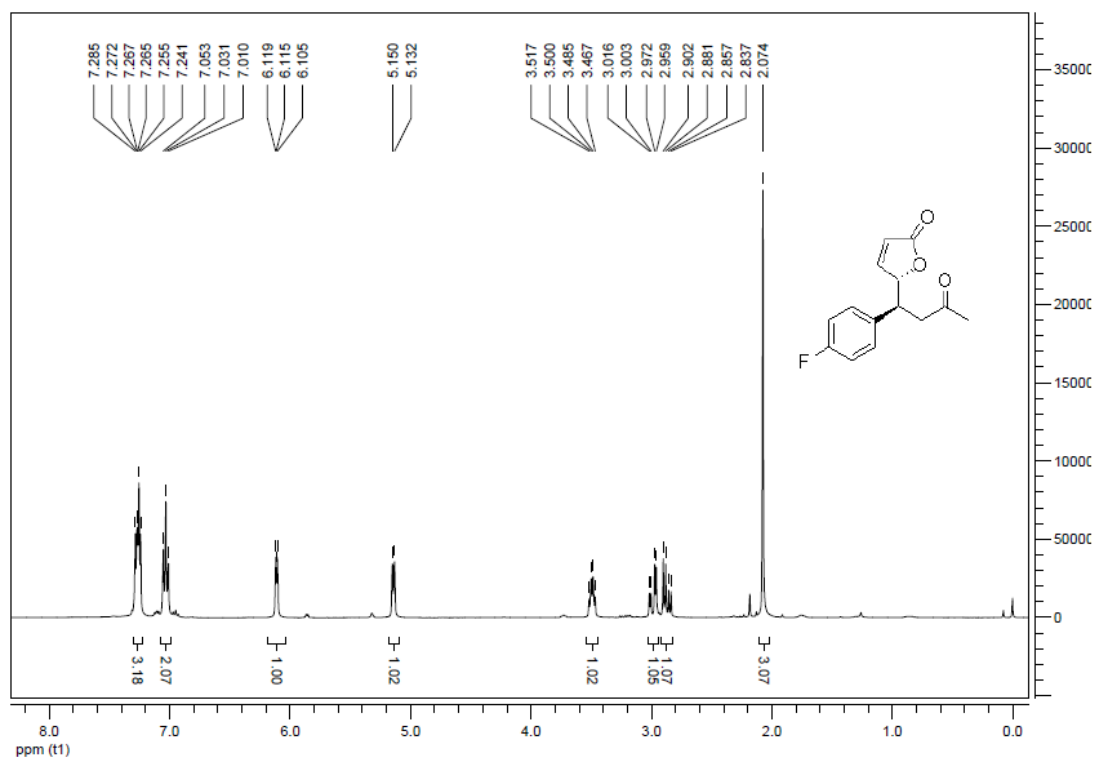
6b: 5-(3-oxo-1-phenylbutyl)furan-2(5H)-one



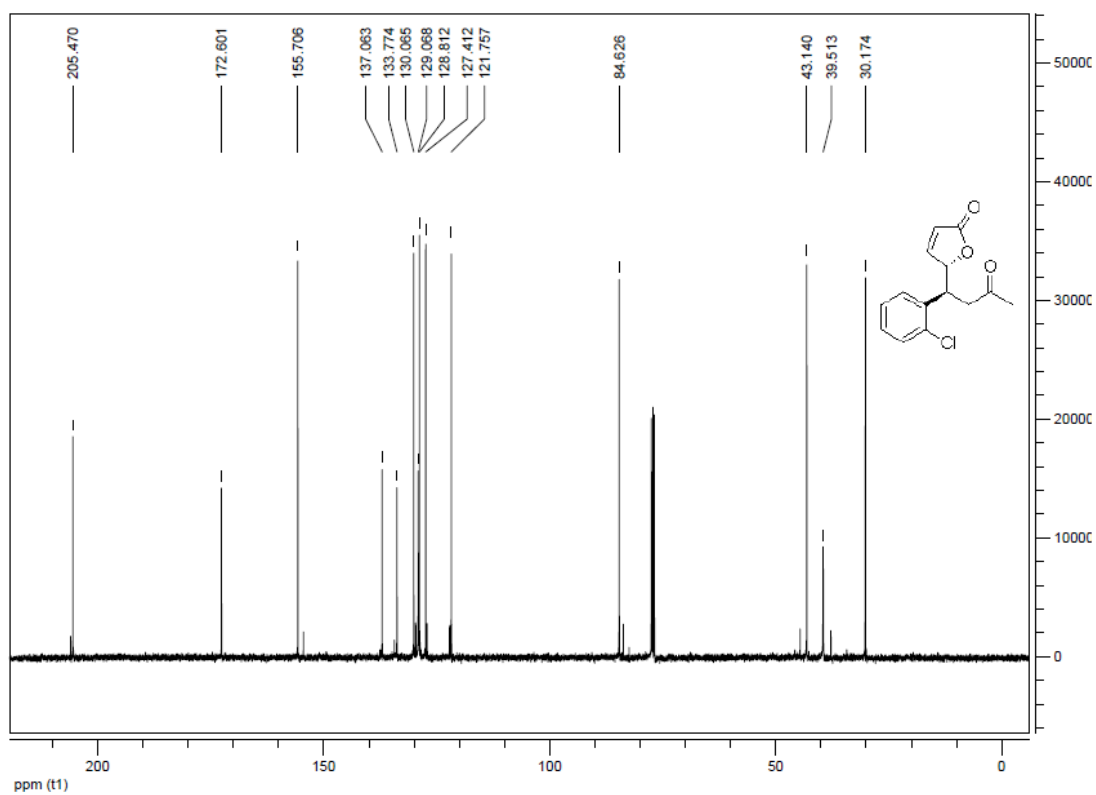
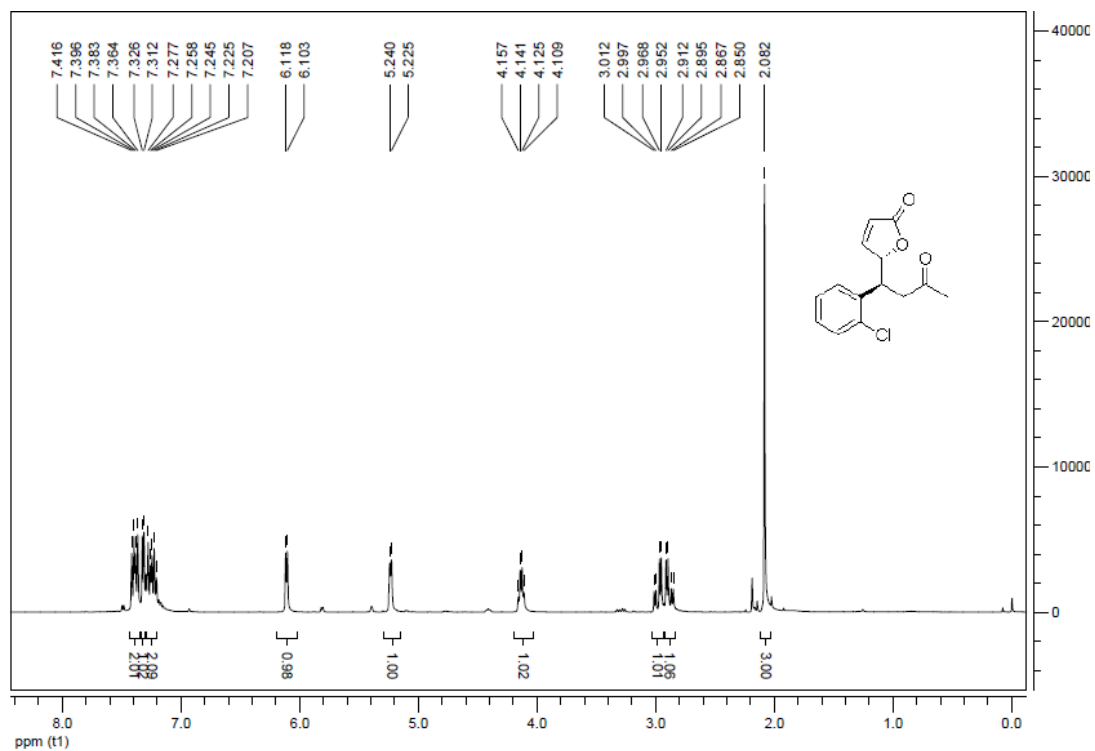
6c: 5-(3-oxo-1-phenylbutyl)furan-2(5H)-one



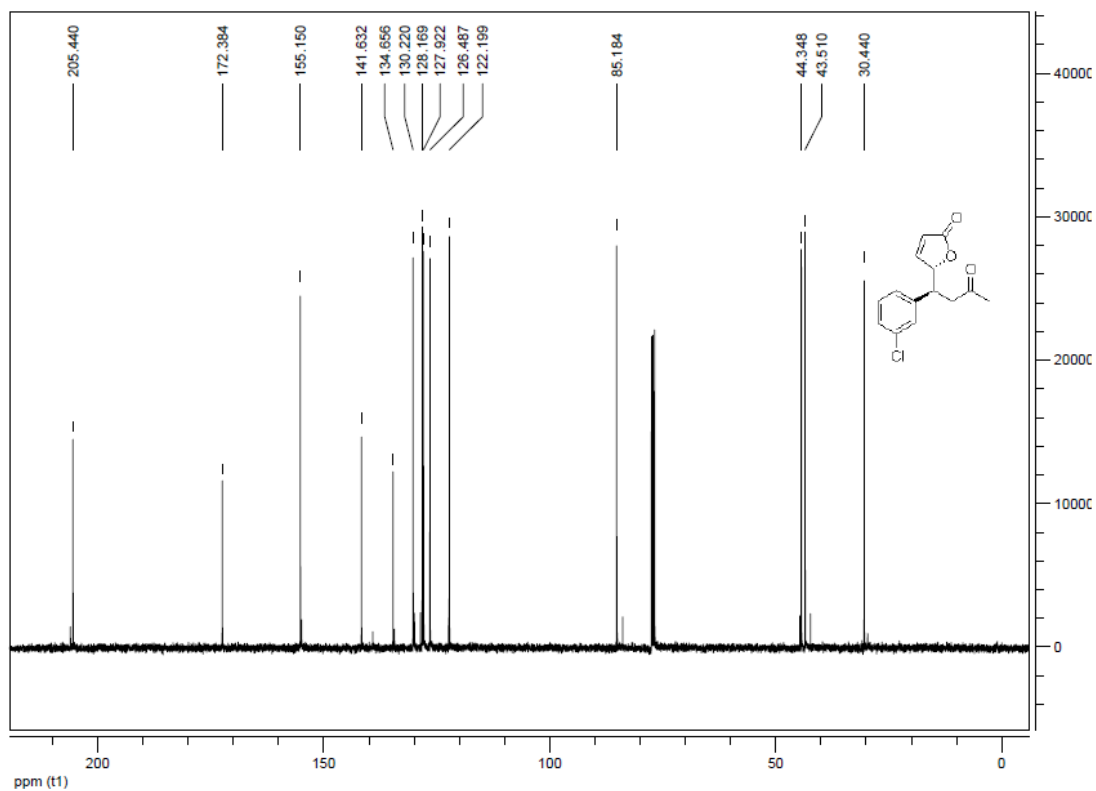
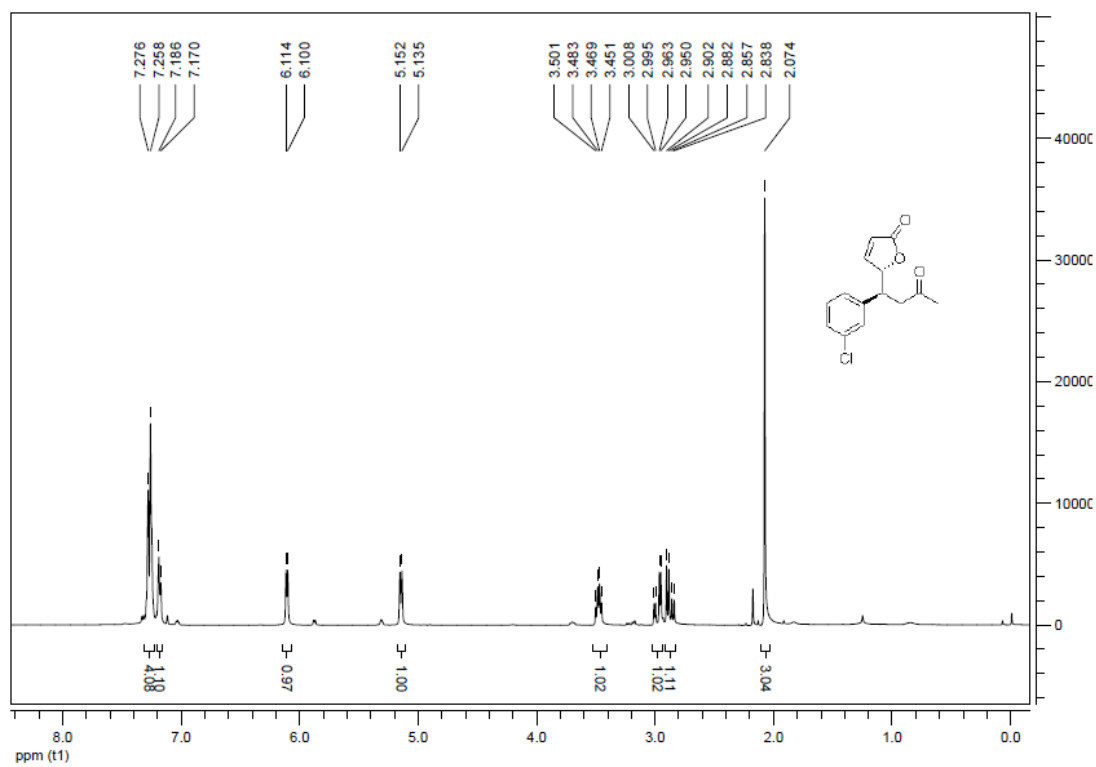
6d: 5-(1-(4-fluorophenyl)-3-oxobutyl)furan-2(5H)-one



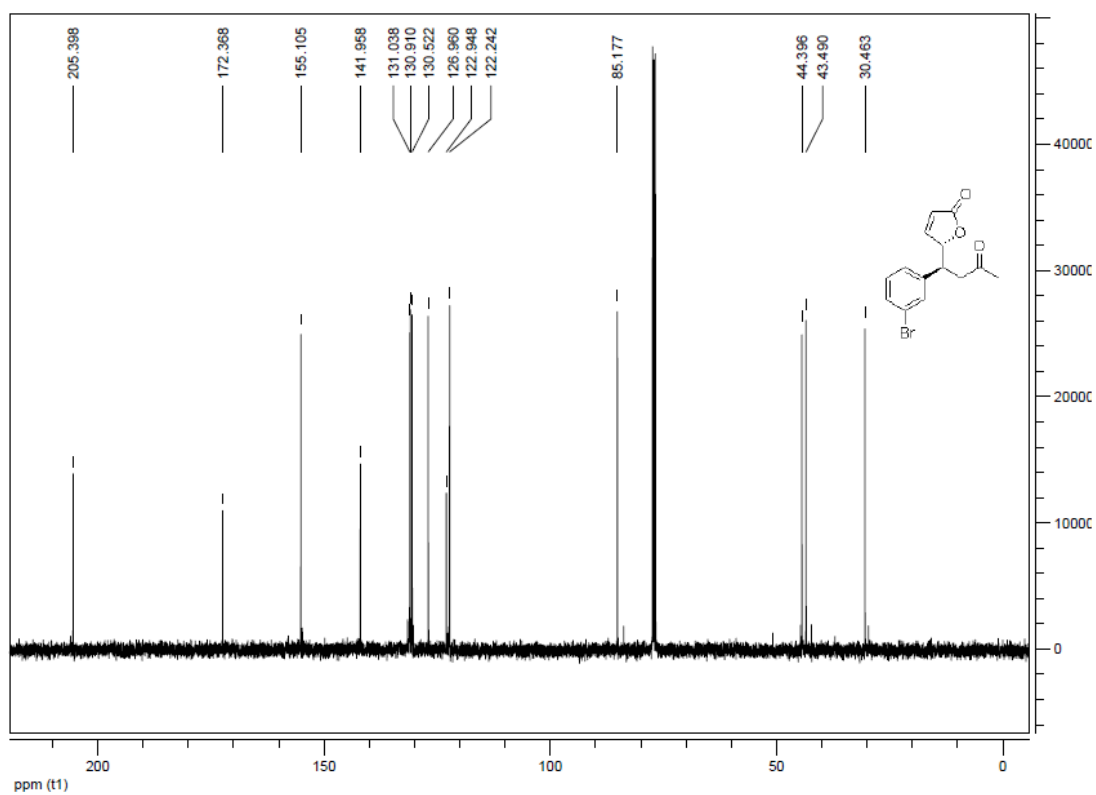
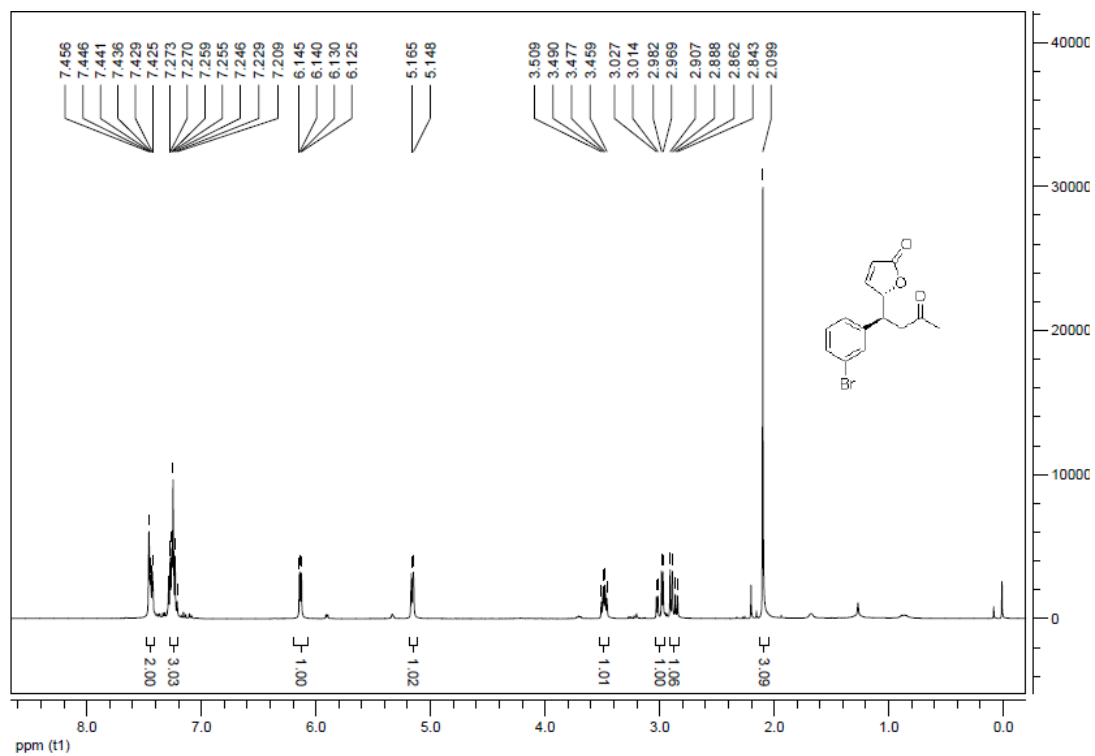
6e: 5-(1-(2-chlorophenyl)-3-oxobutyl)furan-2(5H)-one



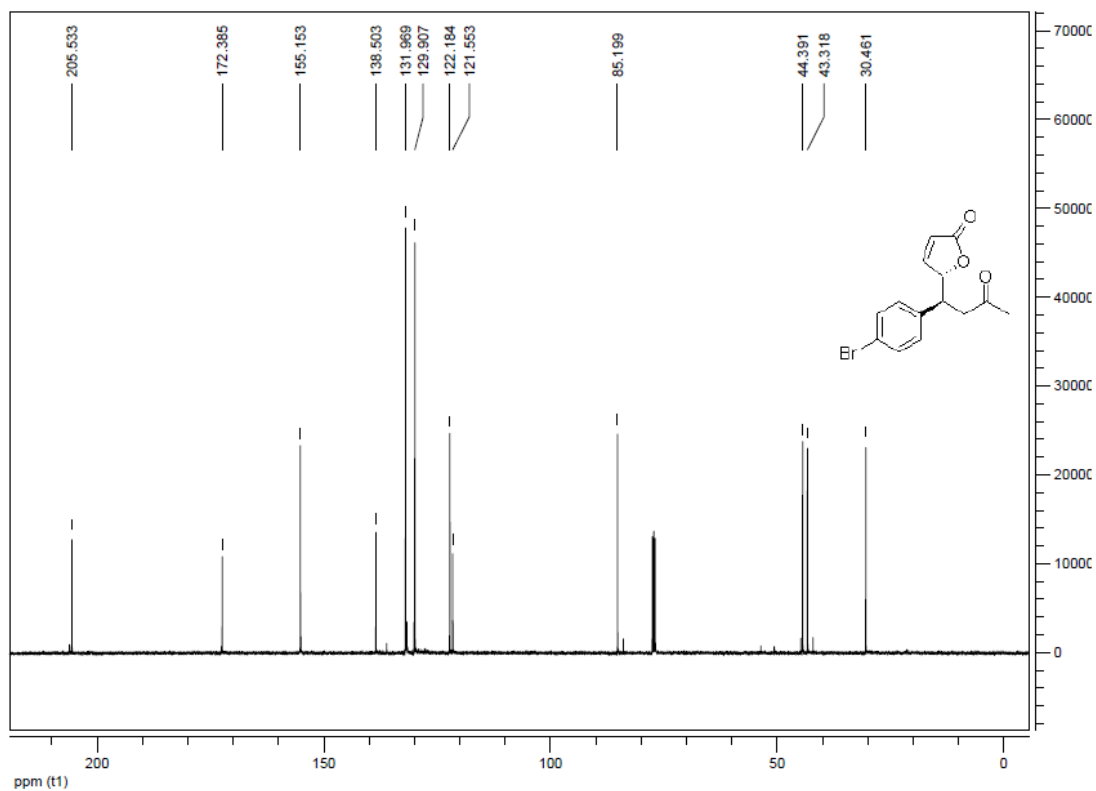
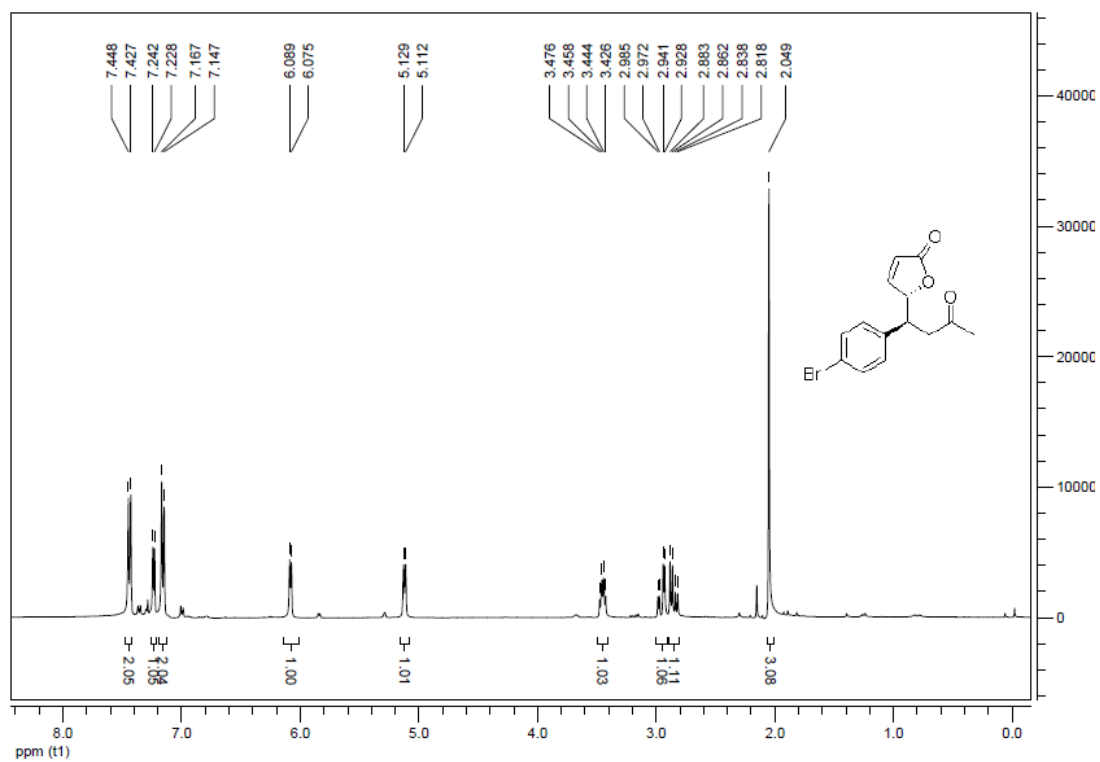
6f: 5-(1-(3-chlorophenyl)-3-oxobutyl)furan-2(5H)-one



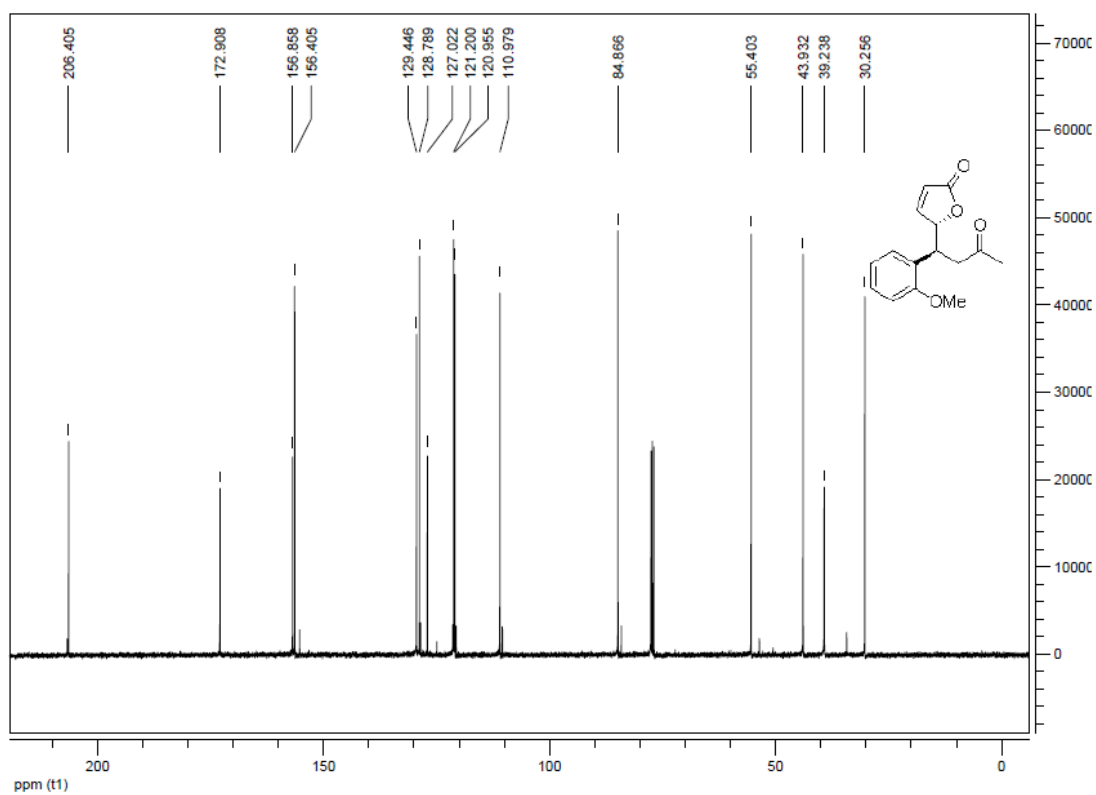
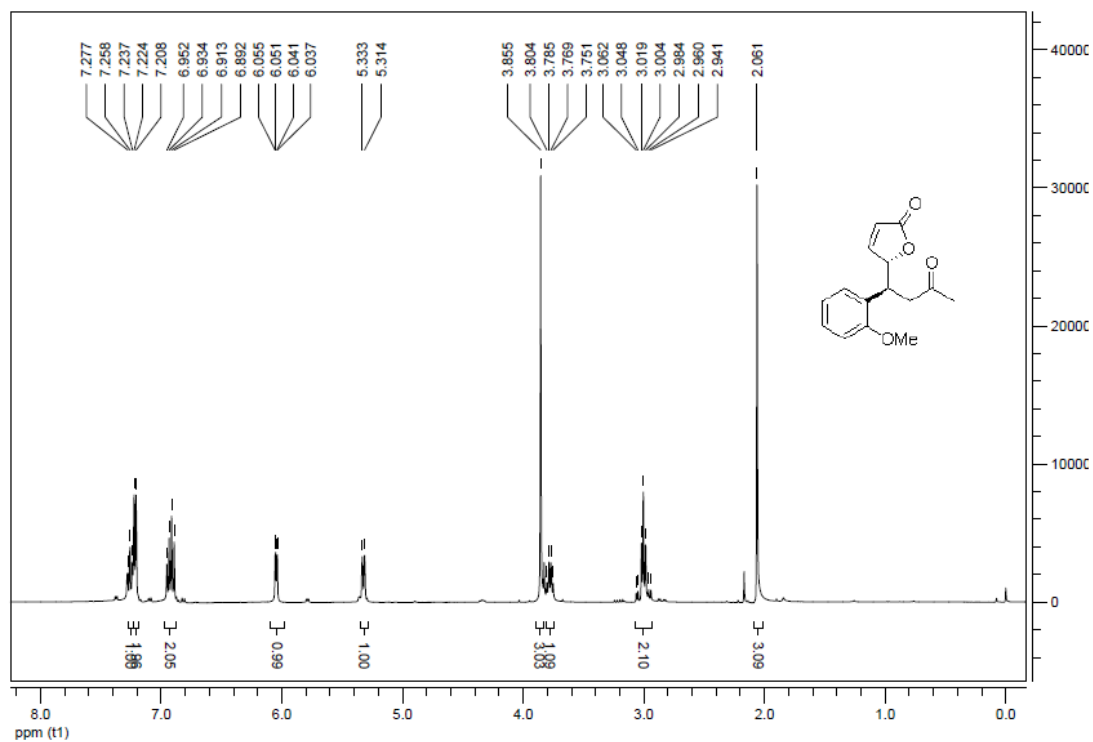
6g: 5-(1-(3-bromophenyl)-3-oxobutyl)furan-2(5H)-one



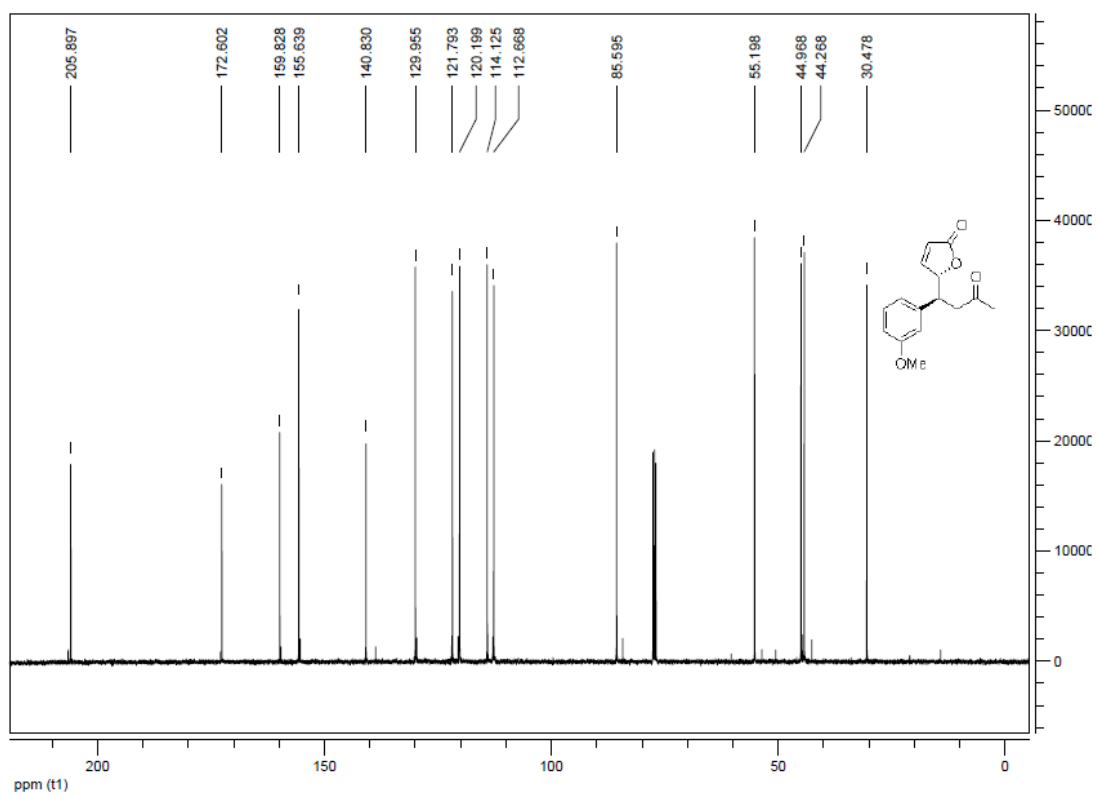
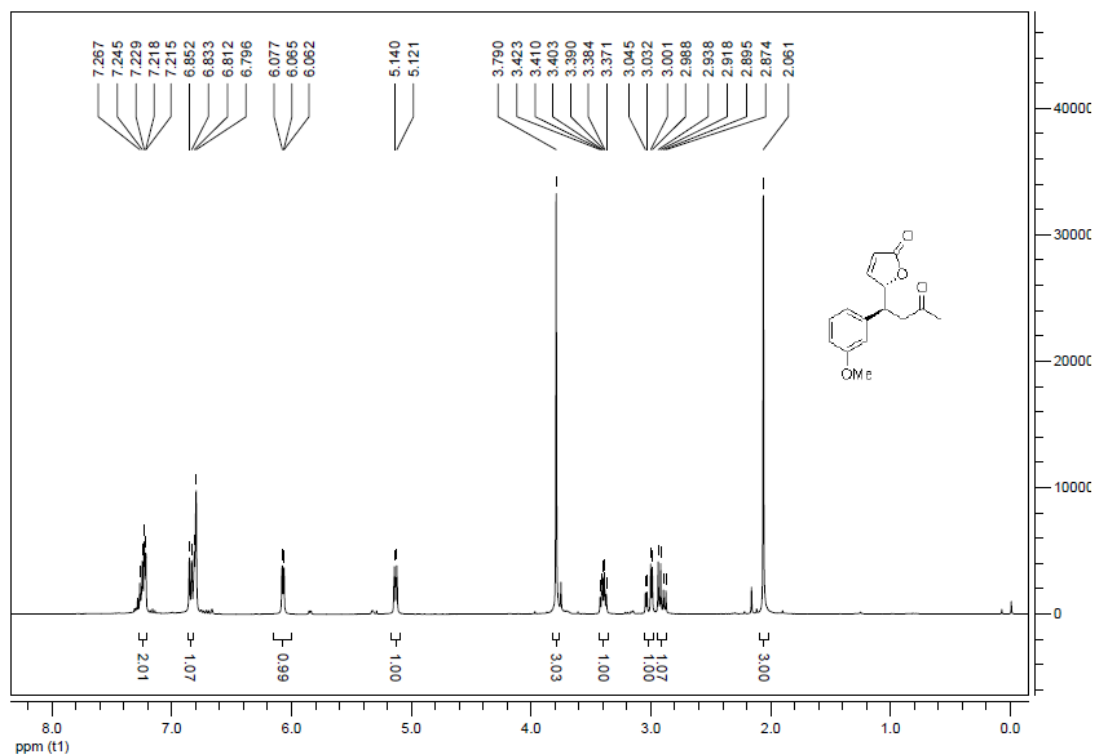
6h: 5-(1-(4-bromophenyl)-3-oxobutyl)furan-2(5H)-one



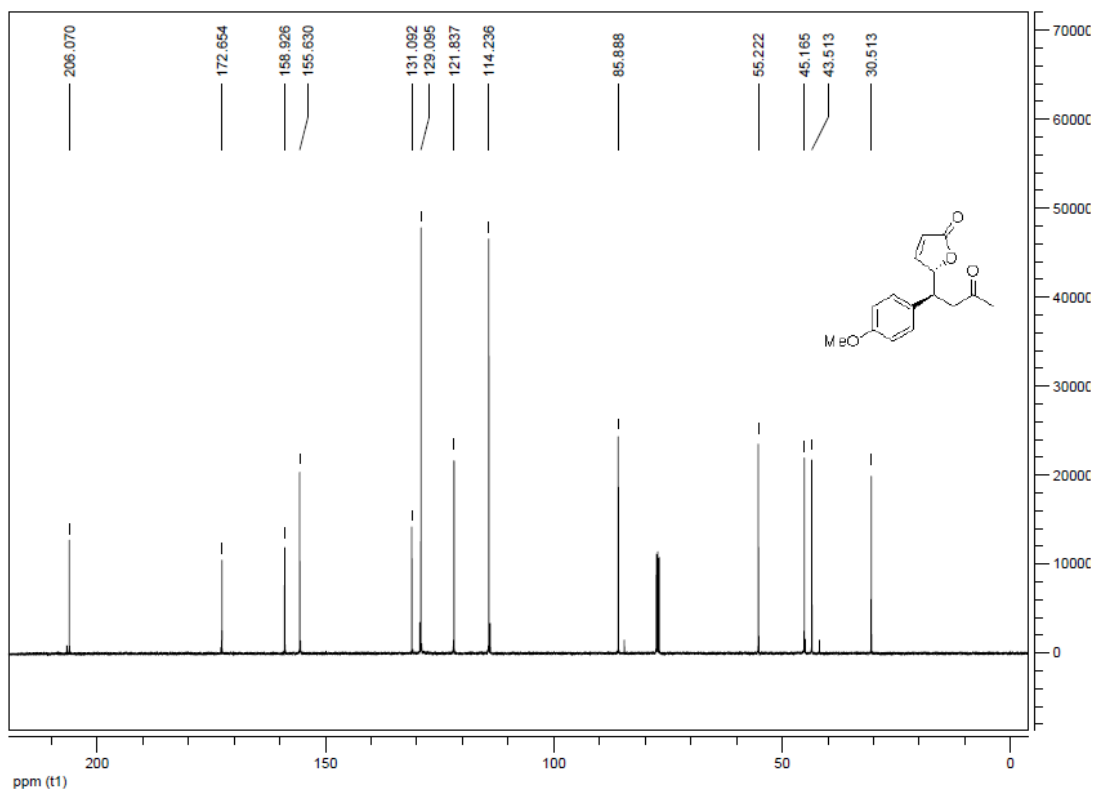
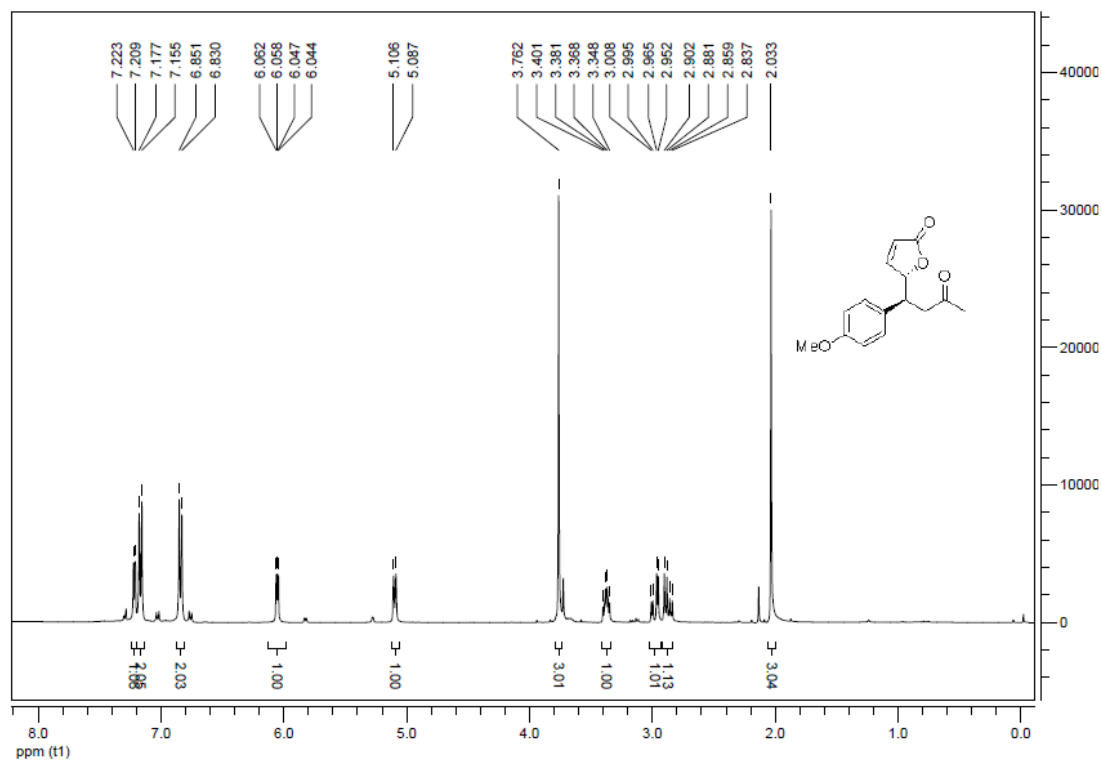
6i: 5-(1-(2-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one



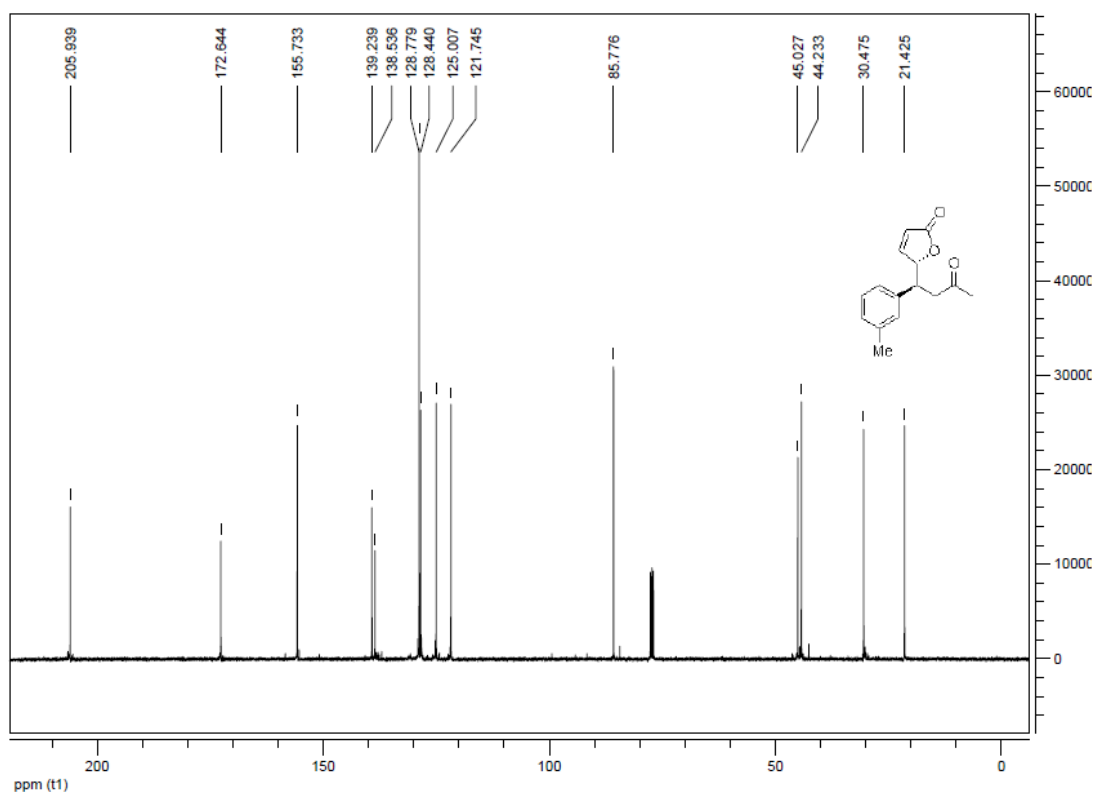
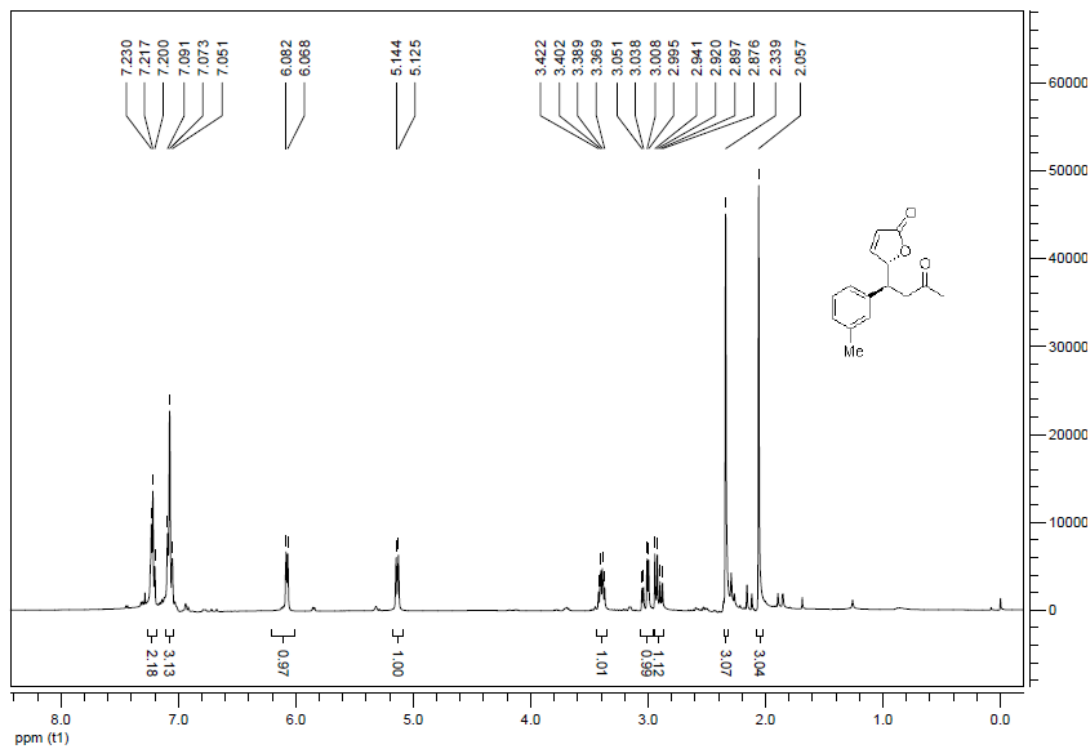
6j: 5-(1-(2-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one



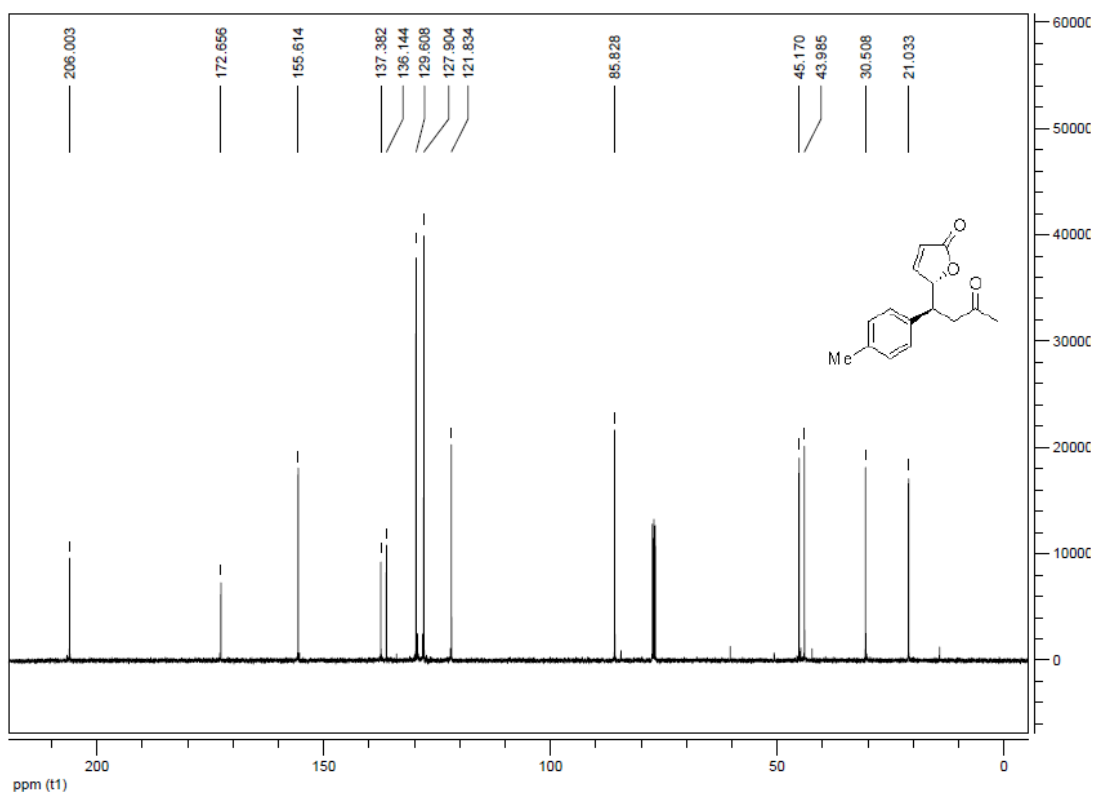
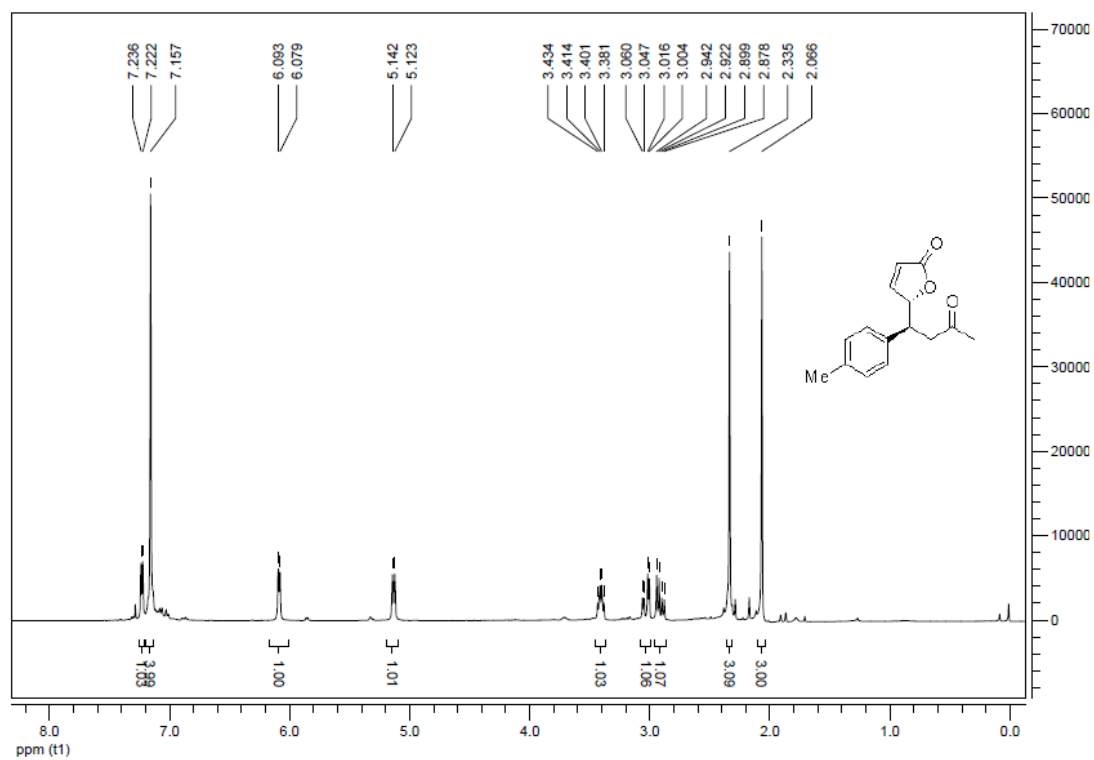
6k: 5-(1-(4-methoxyphenyl)-3-oxobutyl)furan-2(5H)-one



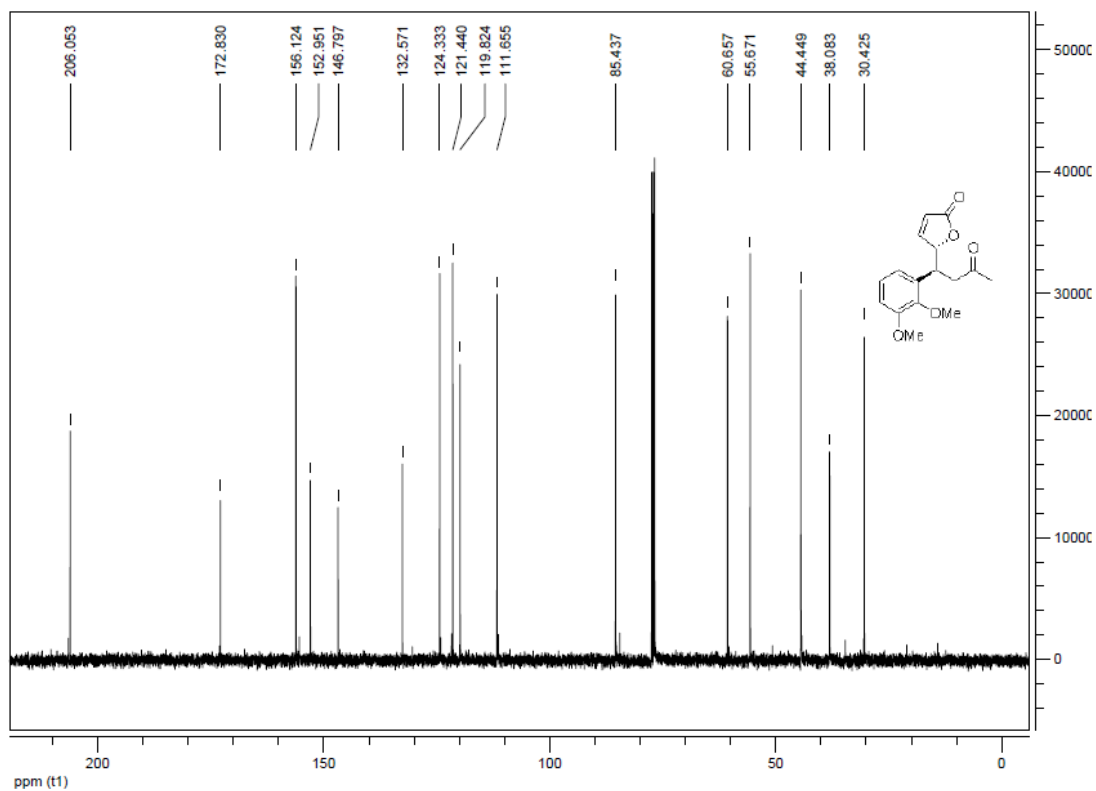
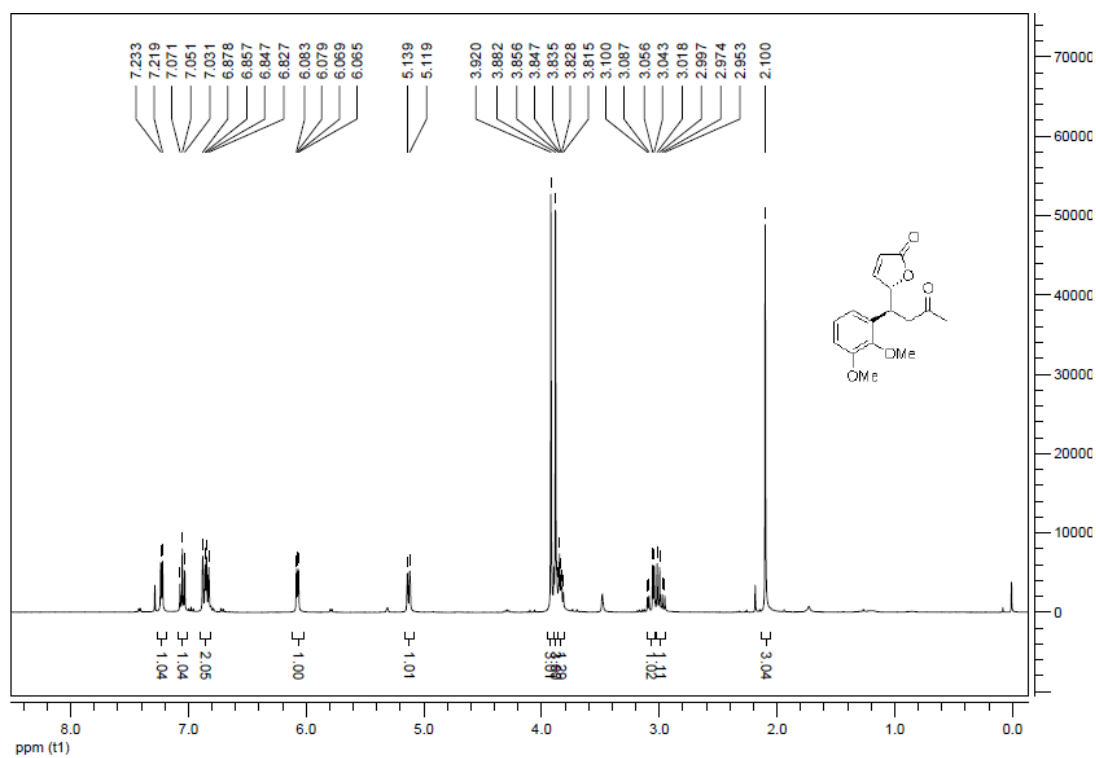
6l: 5-(3-oxo-1-*m*-tolylbutyl)furan-2(5*H*)-one



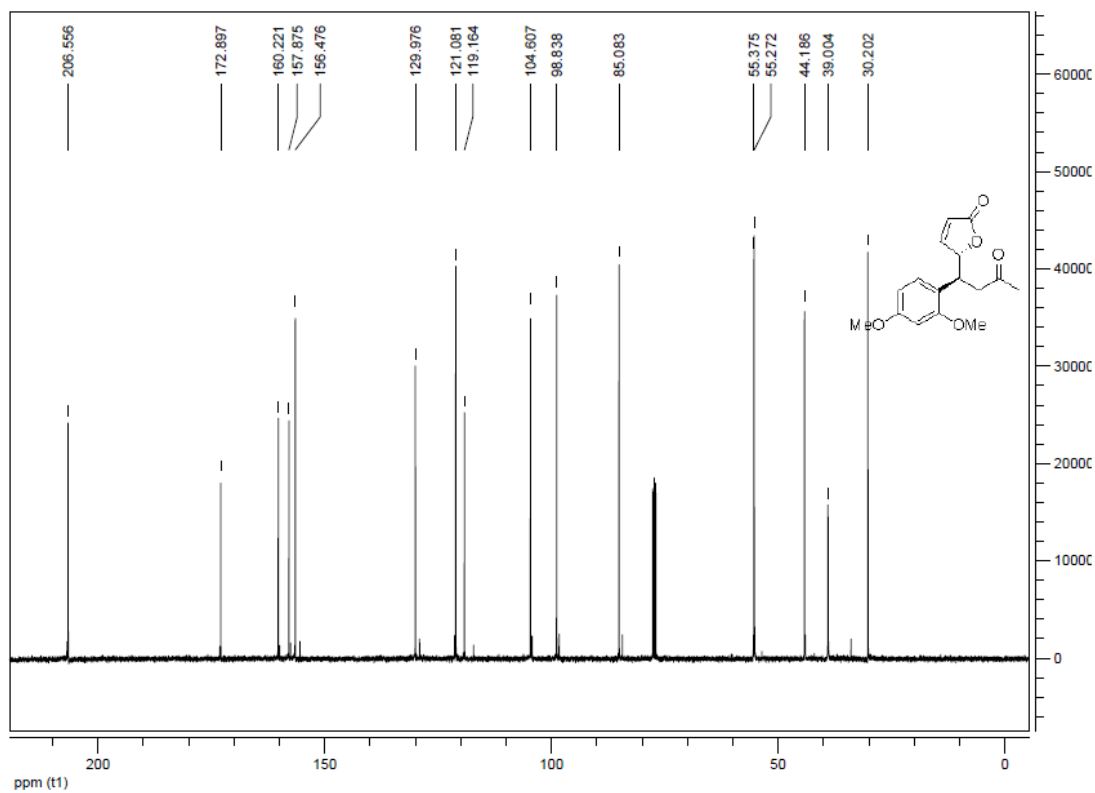
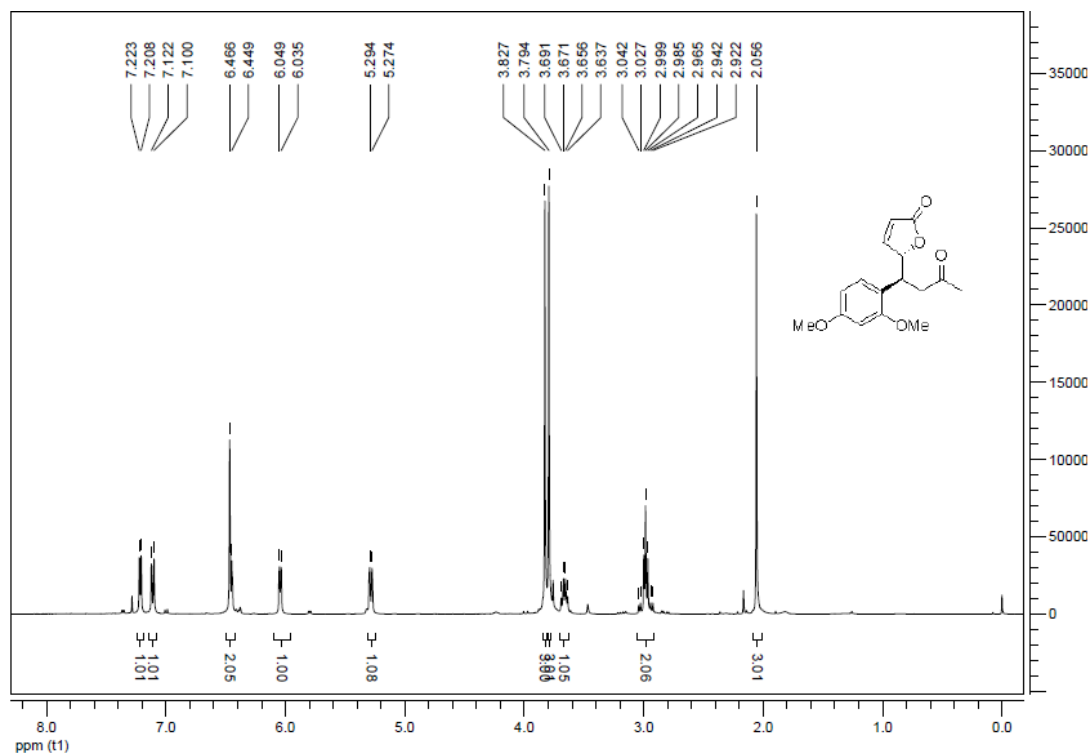
6m: 5-(3-oxo-1-*p*-tolylbutyl)furan-2(5*H*)-one



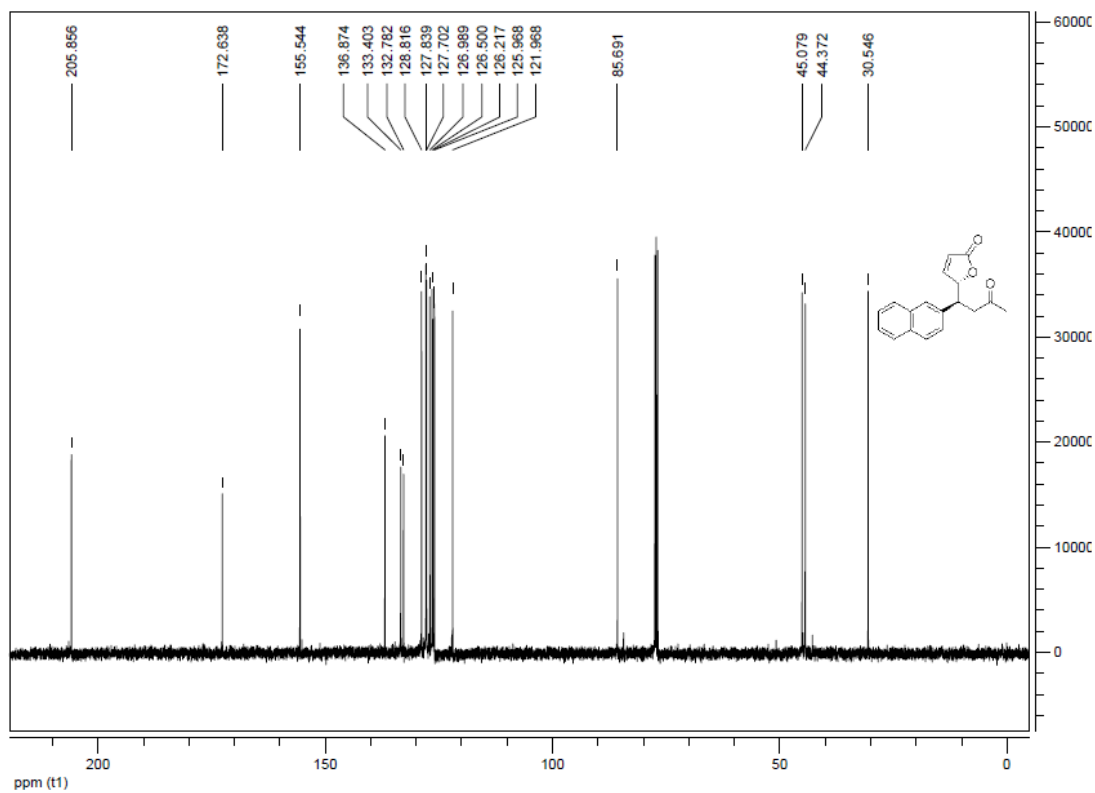
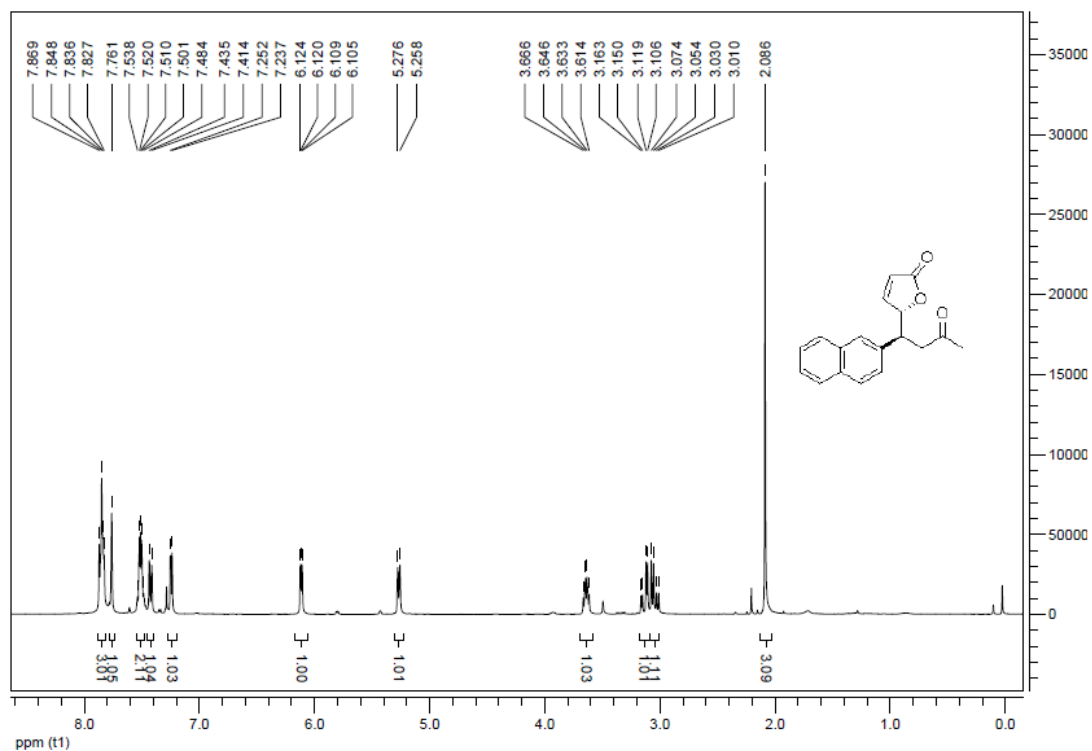
6n: 5-(1-(2,3-dimethoxyphenyl)-3-oxobutyl)furan-2(5H)-one



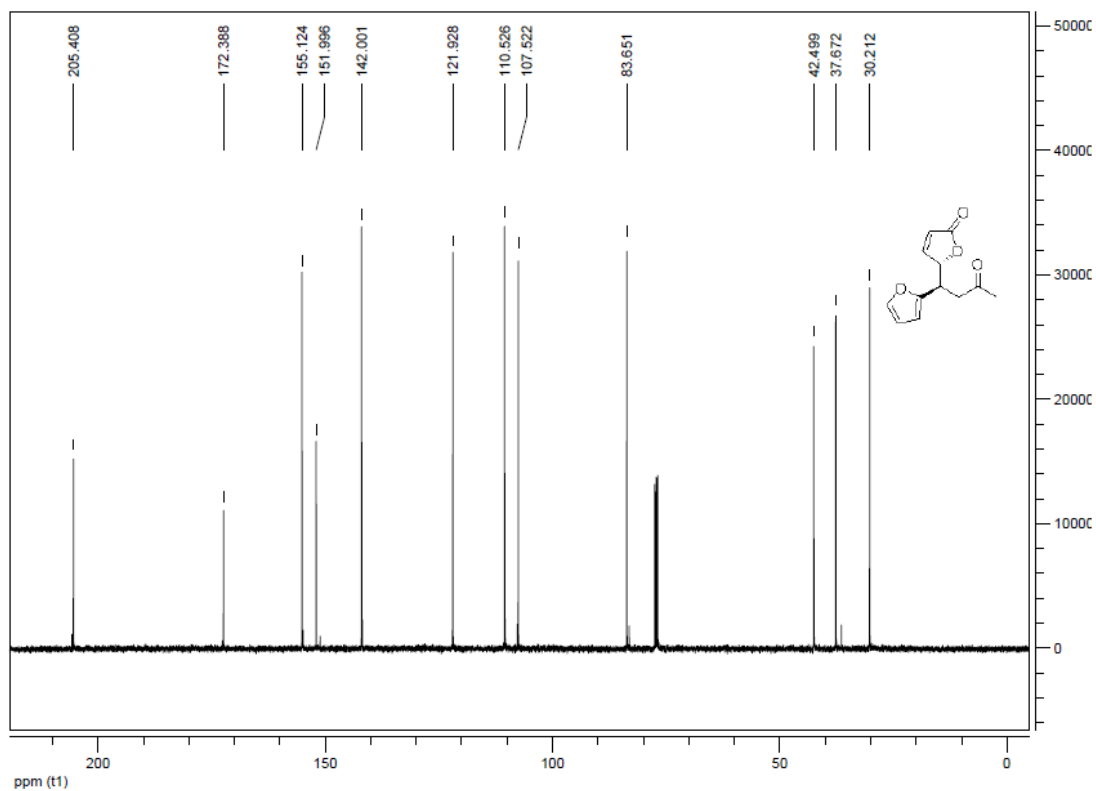
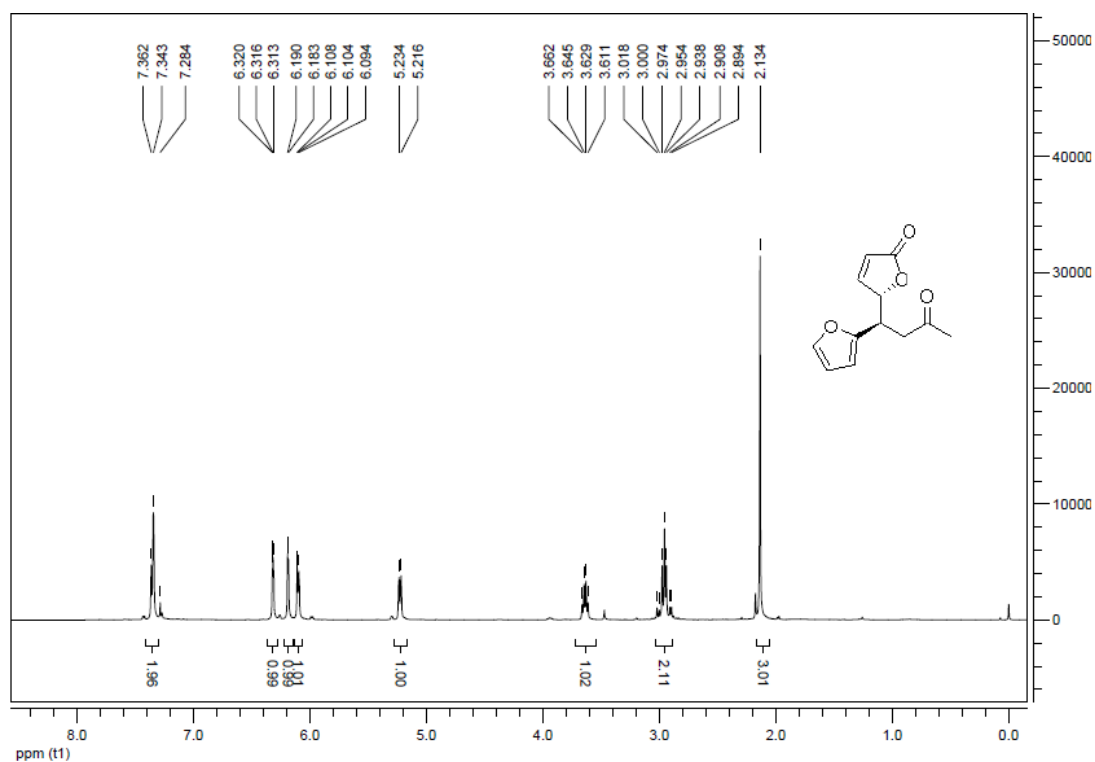
6o: 5-(1-(2,4-dimethoxyphenyl)-3-oxobutyl)furan-2(5H)-one



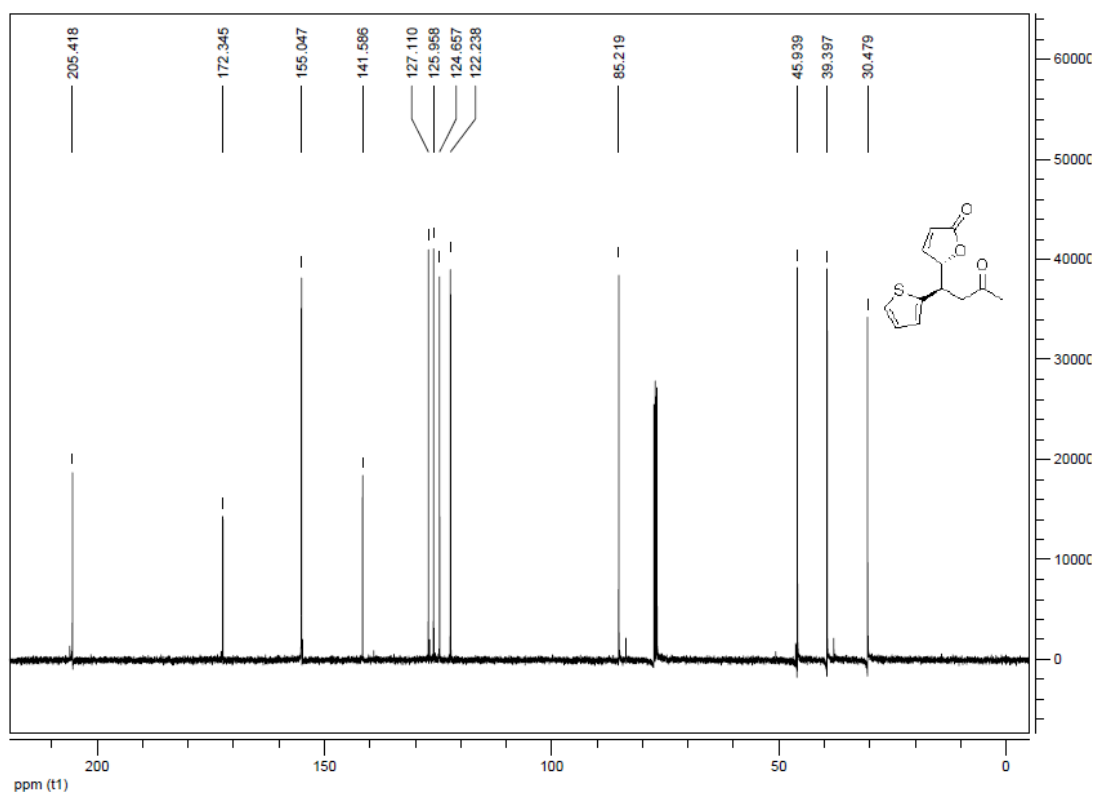
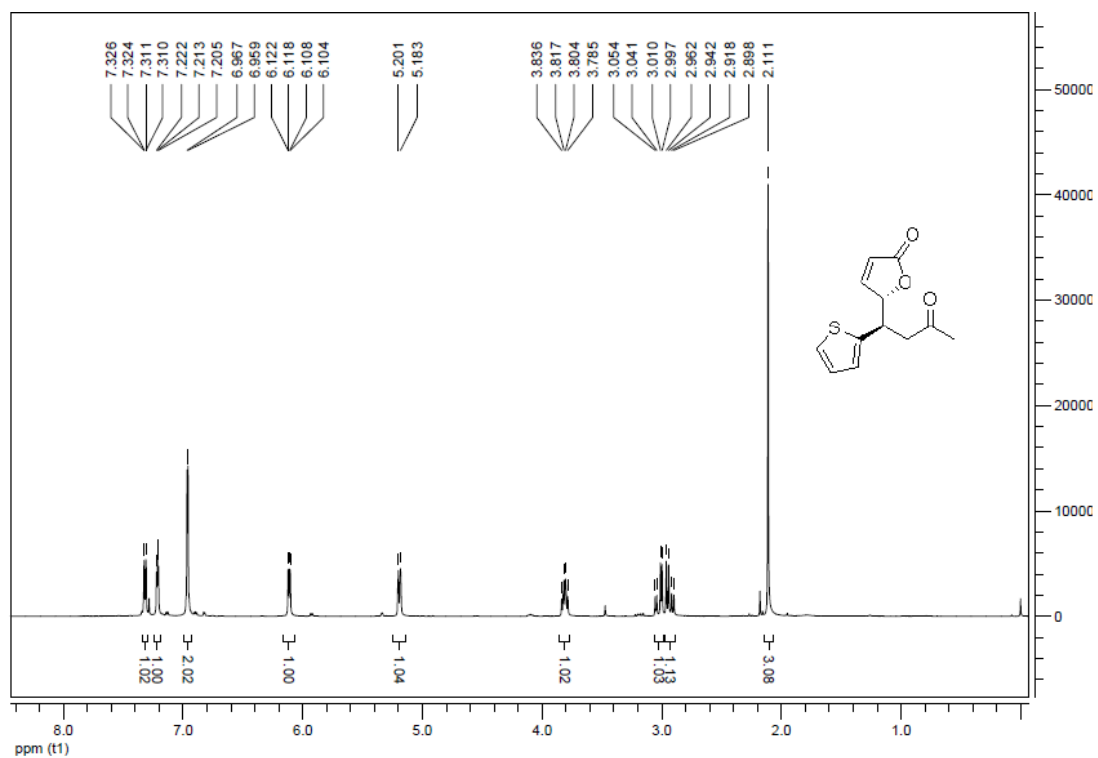
6p: 5-(1-(naphthalen-2-yl)-3-oxobutyl)furan-2(5H)-one



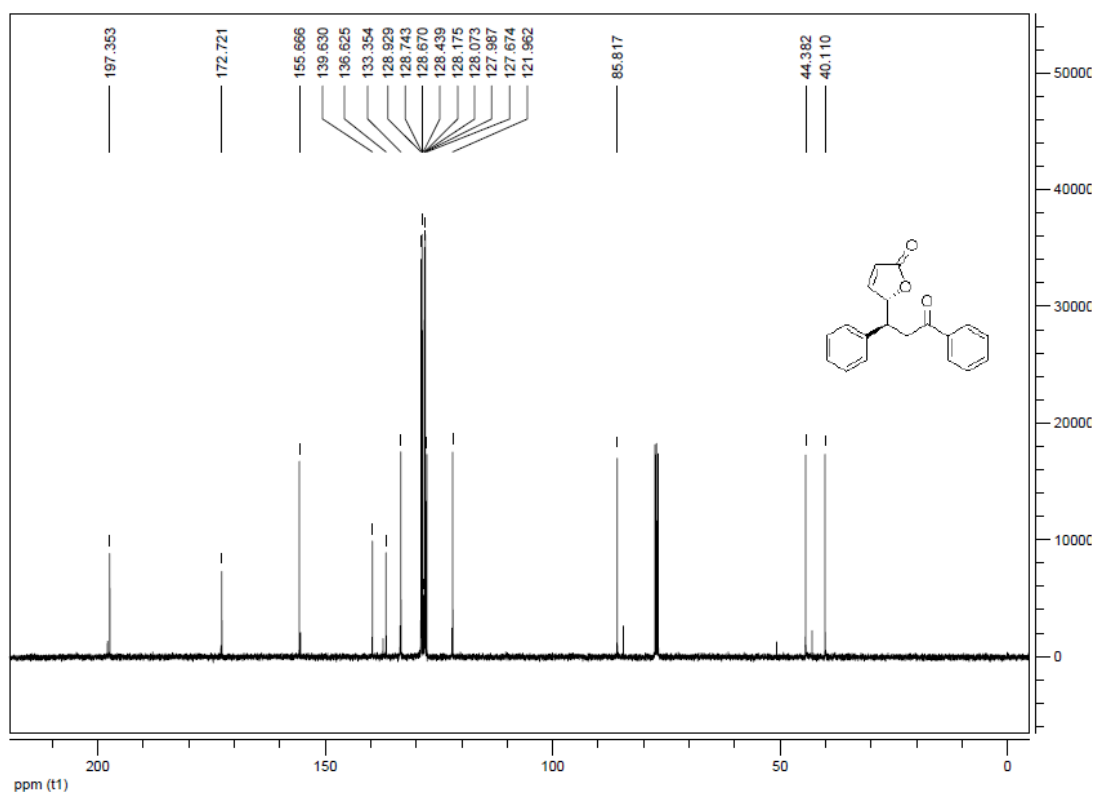
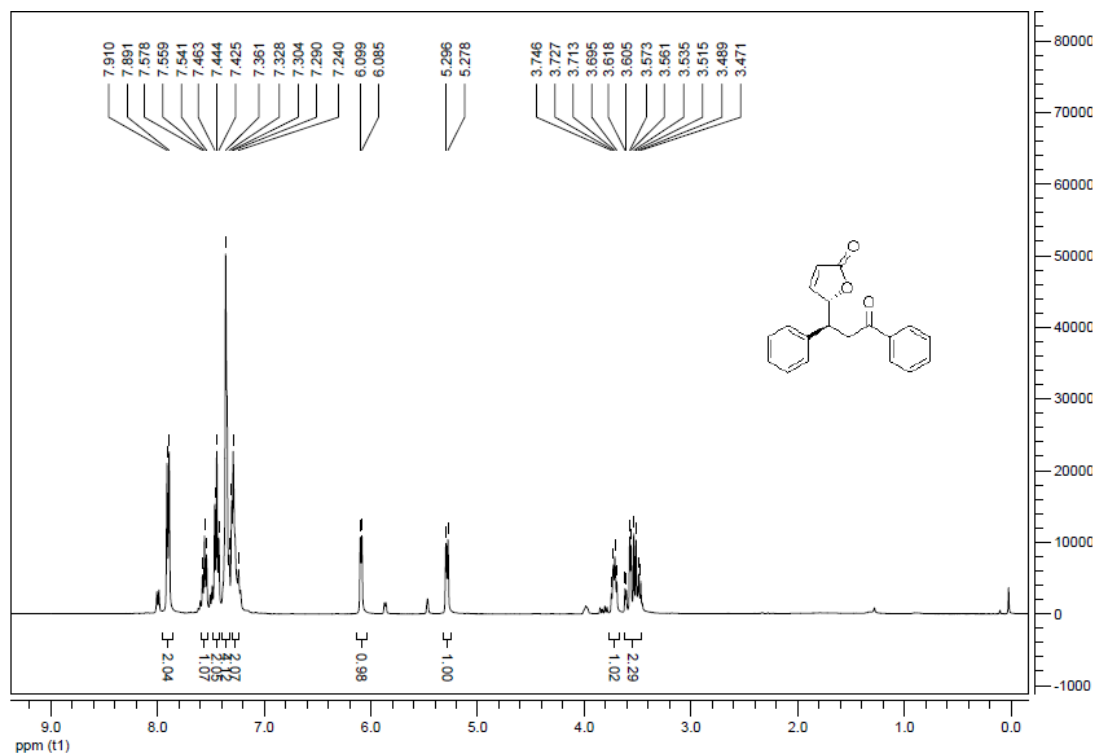
6q: 5-(1-(furan-2-yl)-3-oxobutyl)furan-2(5H)-one



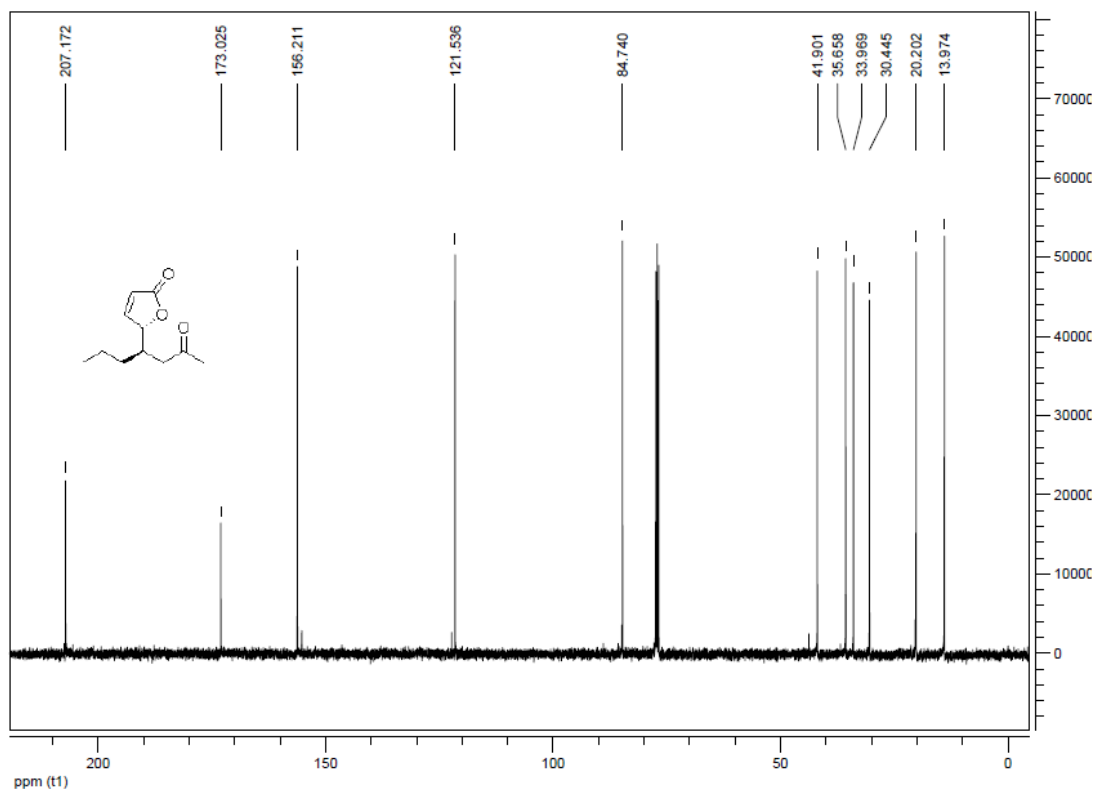
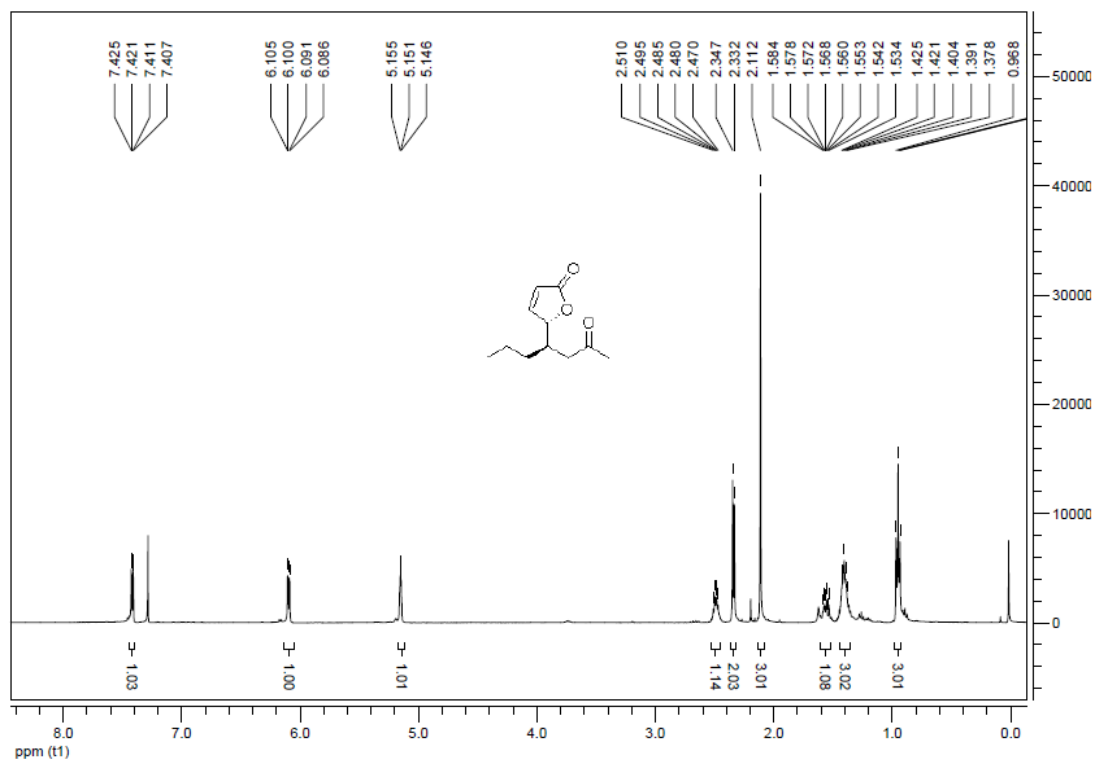
6r: 5-(3-oxo-1-(thiophen-2-yl)butyl)furan-2(5H)-one



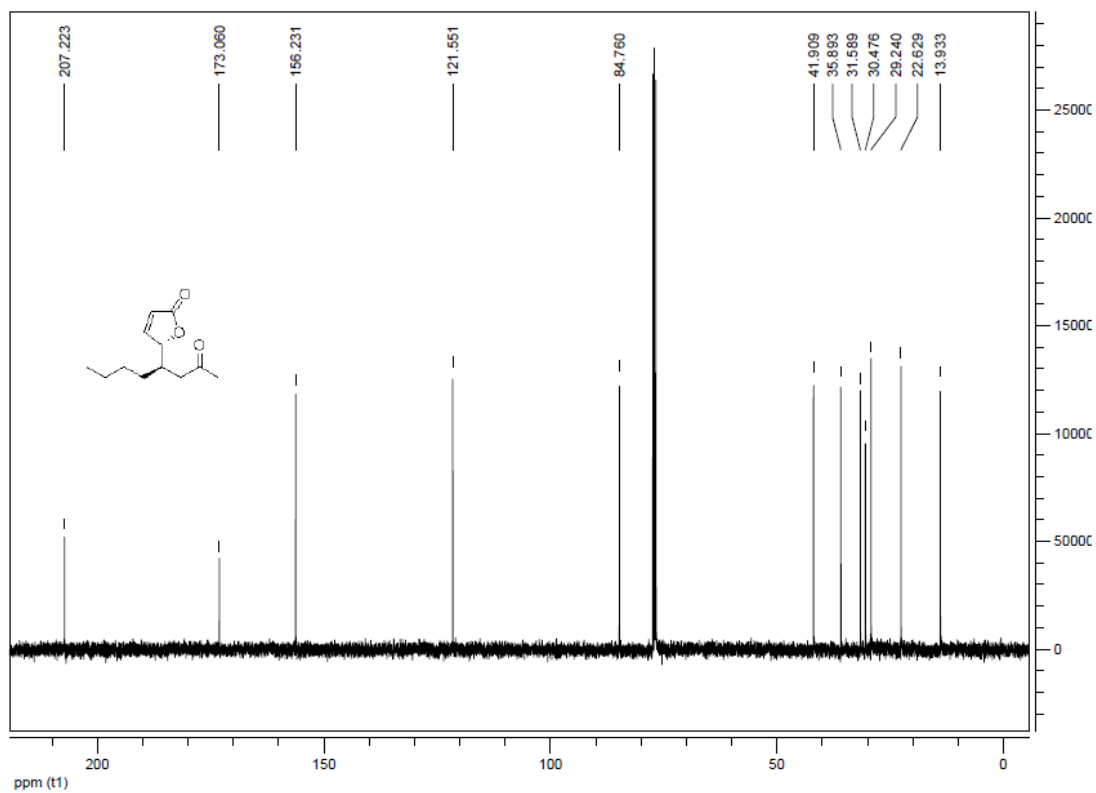
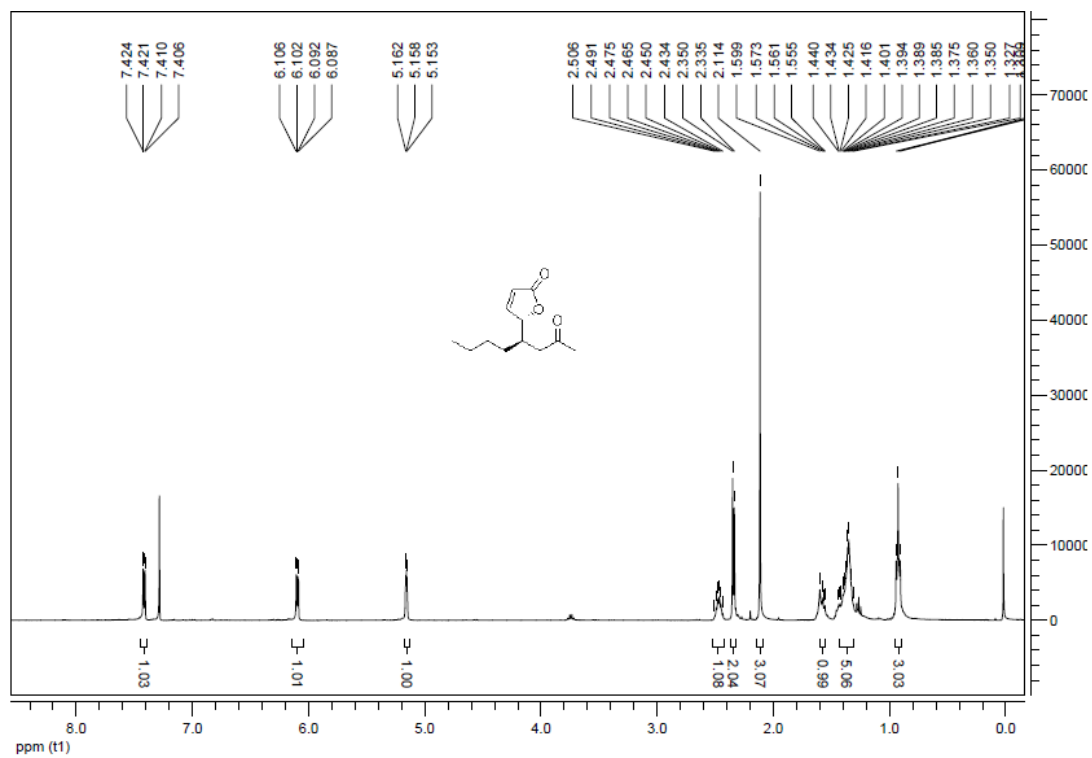
6s: 5-(3-oxo-1,3-diphenylpropyl)furan-2(5H)-one



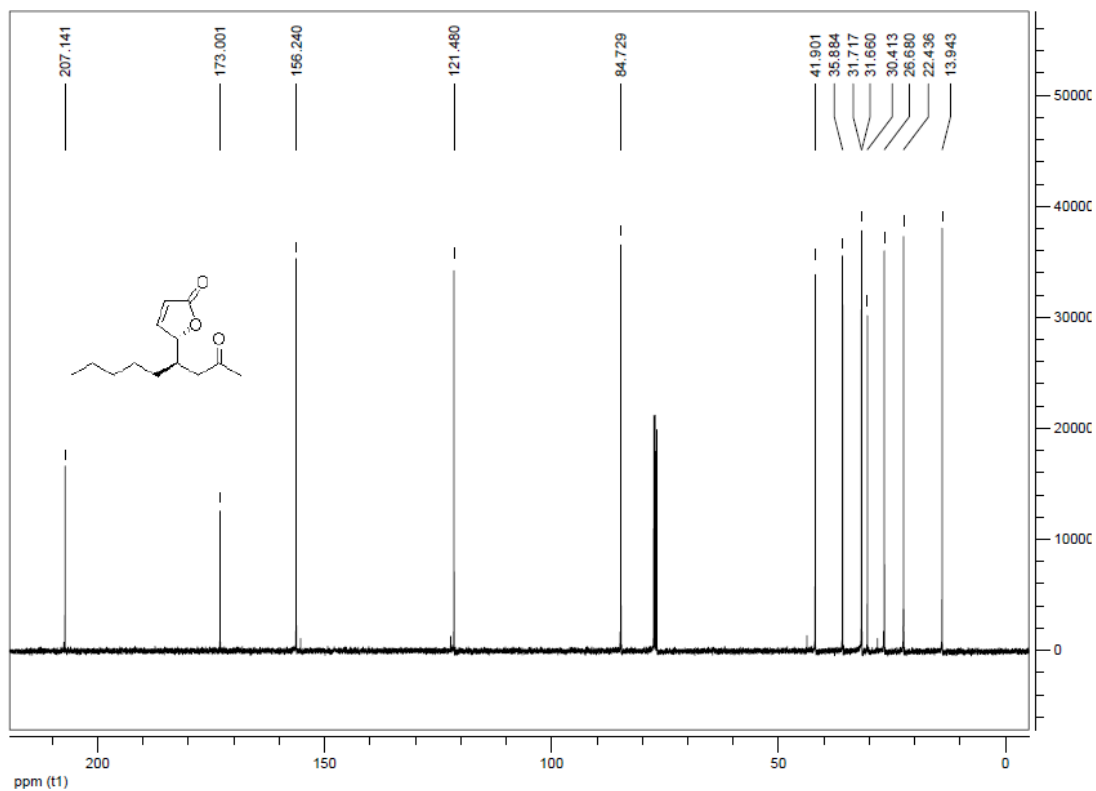
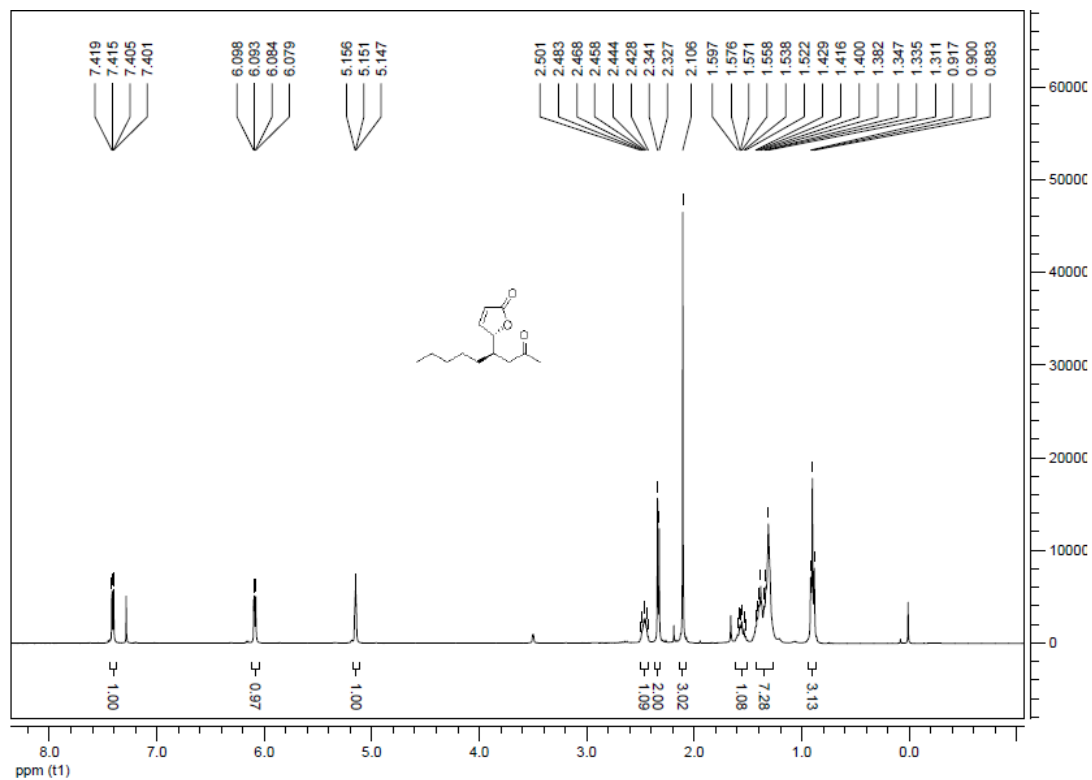
6t: 5-(2-oxoheptan-4-yl)furan-2(5H)-one



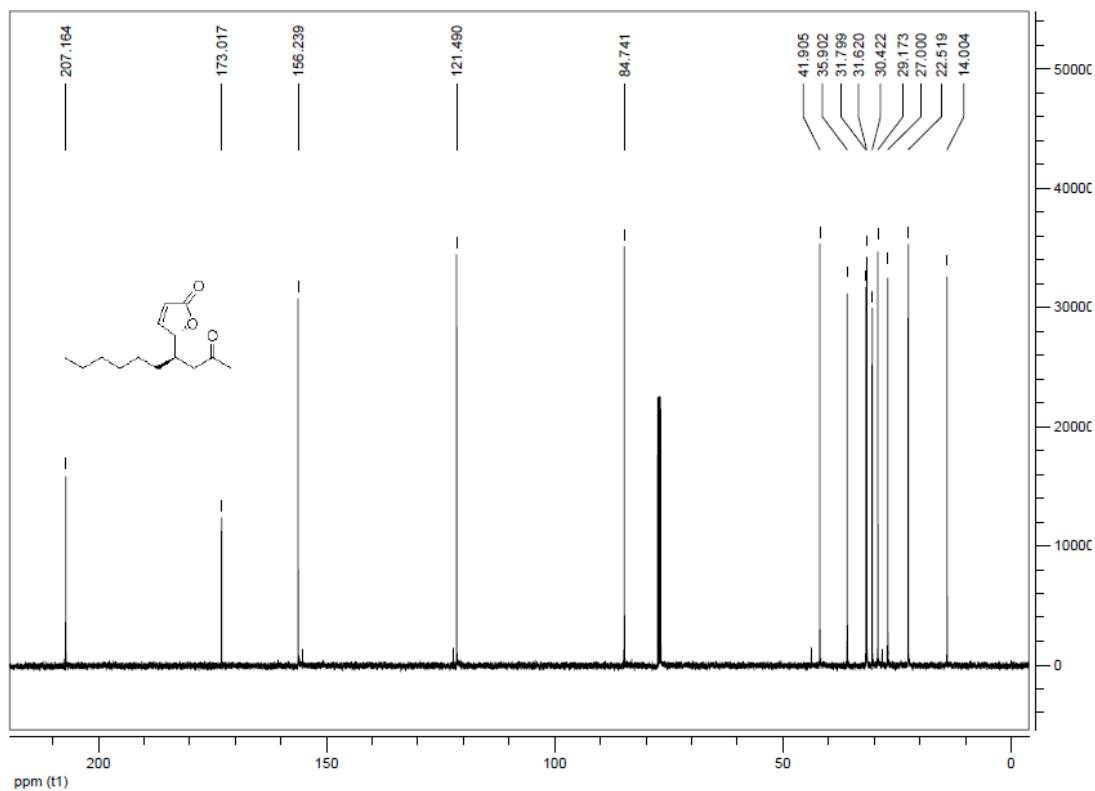
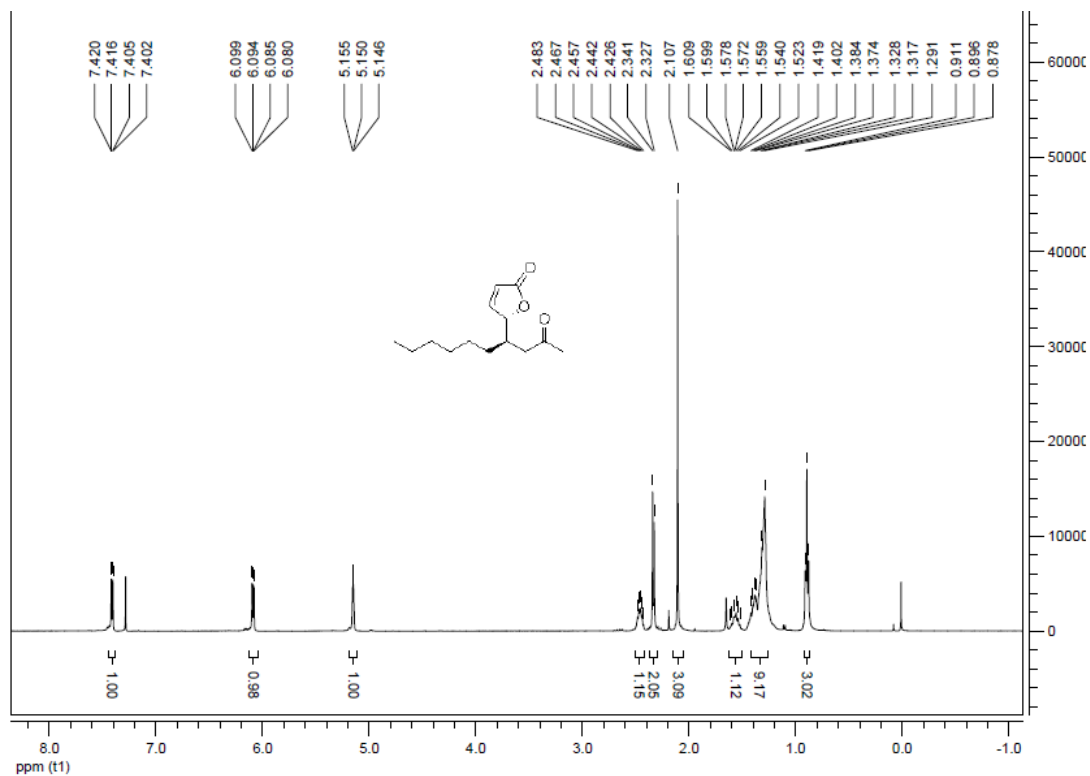
6u: 5-(2-oxooctan-4-yl)furan-2(5H)-one



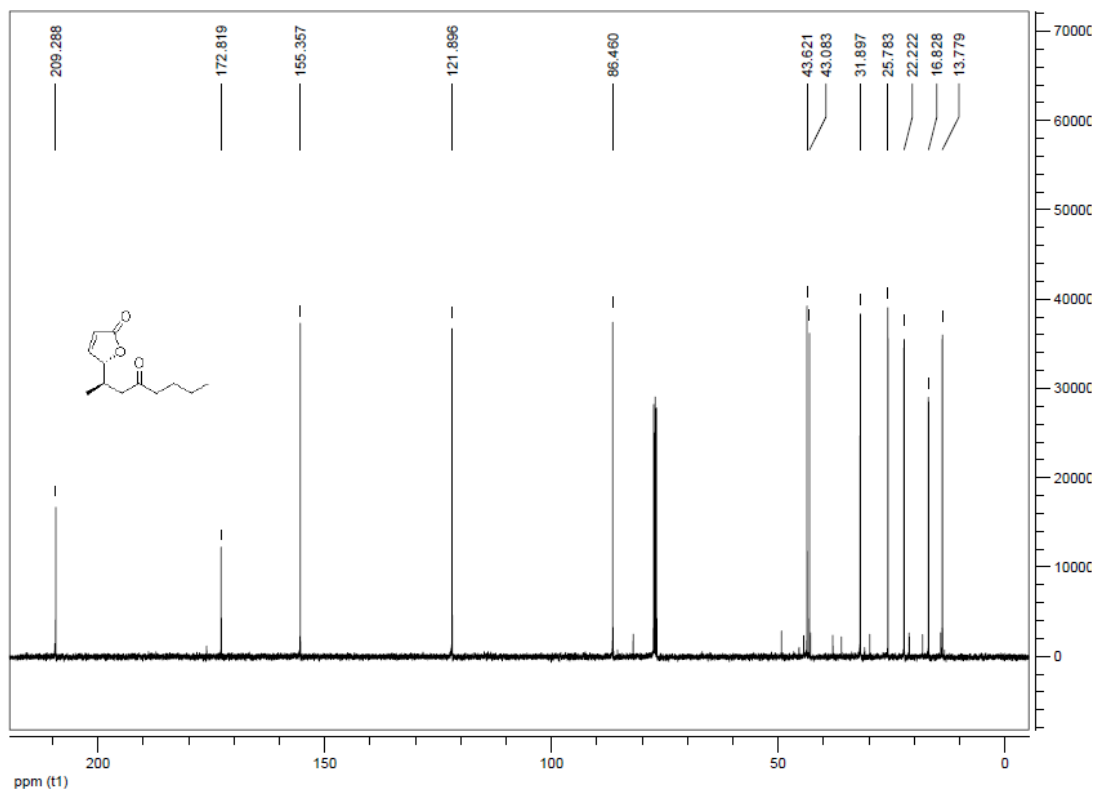
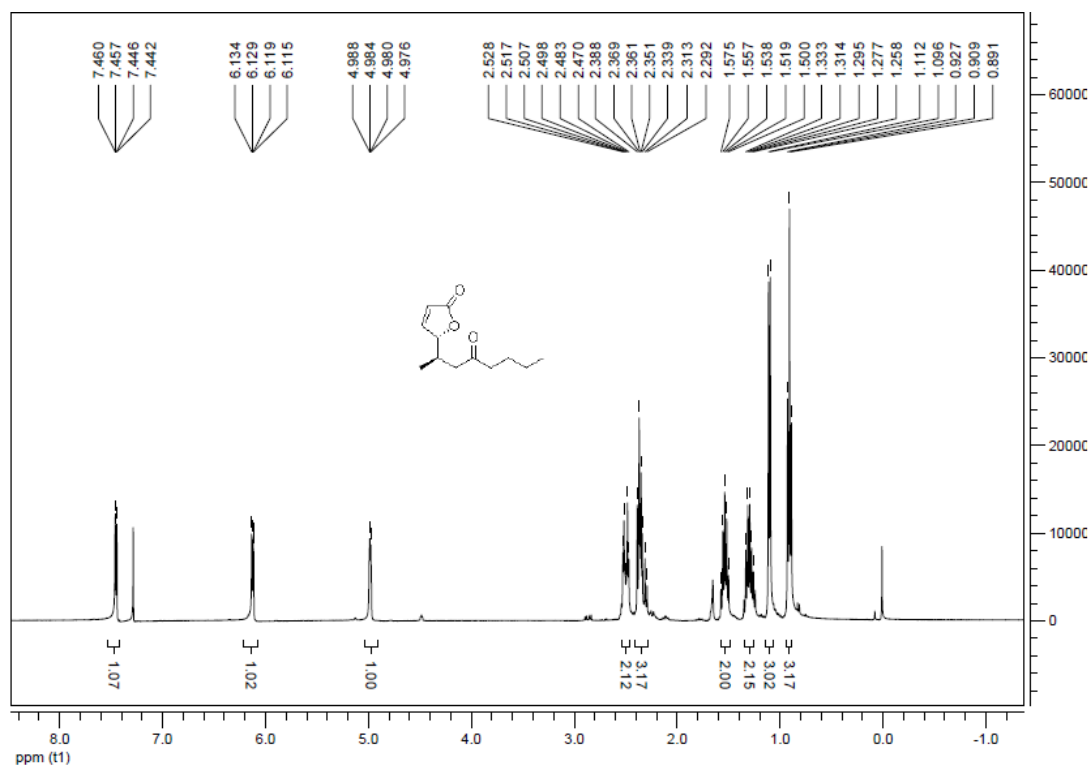
6v: 5-(2-oxononan-4-yl)furan-2(5H)-one



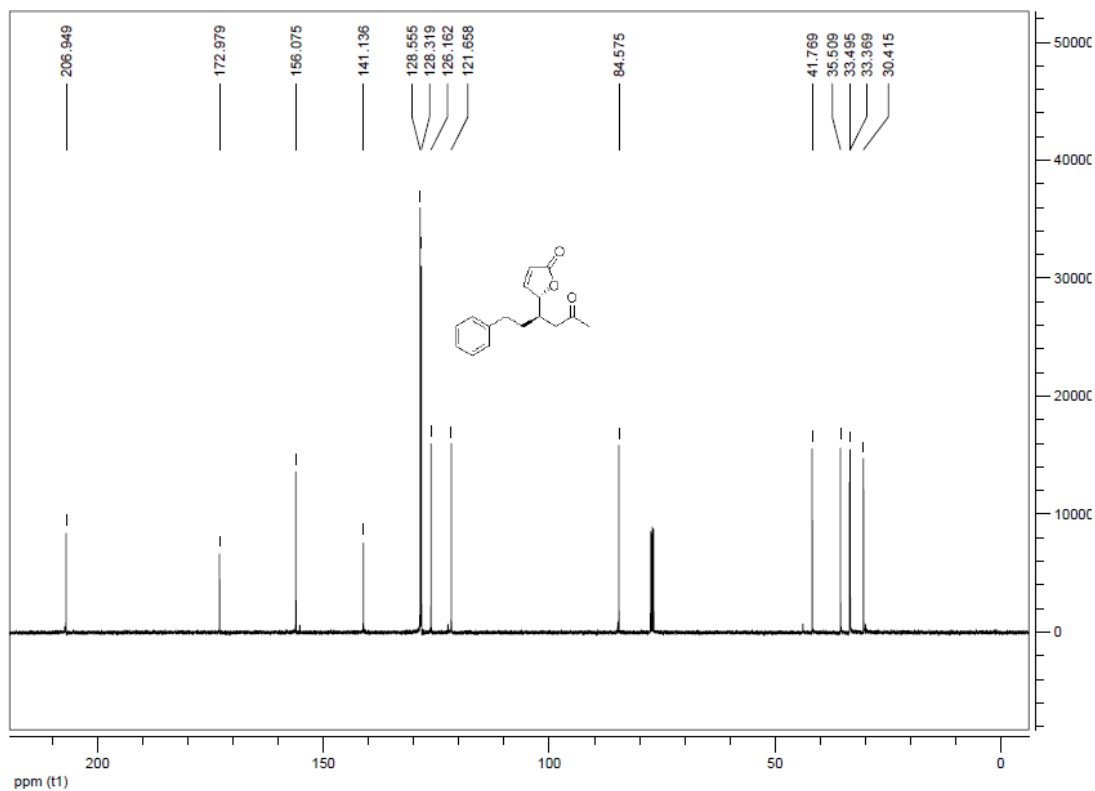
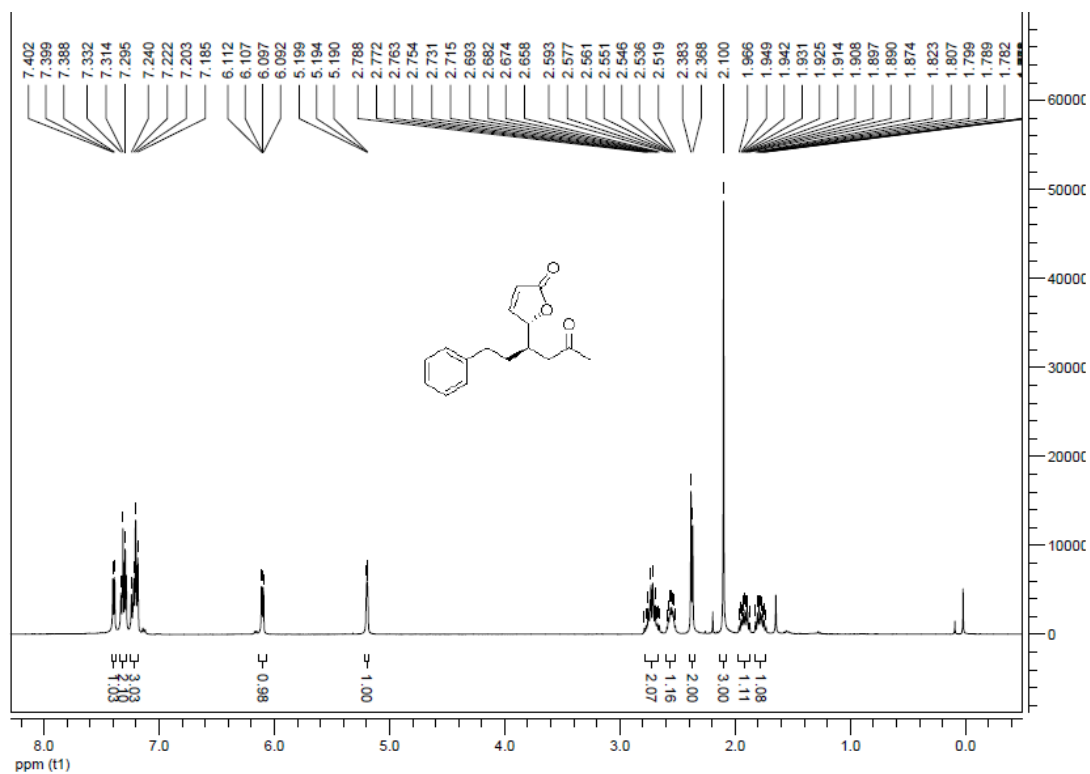
6w: 5-(2-oxodecan-4-yl)furan-2(5H)-one



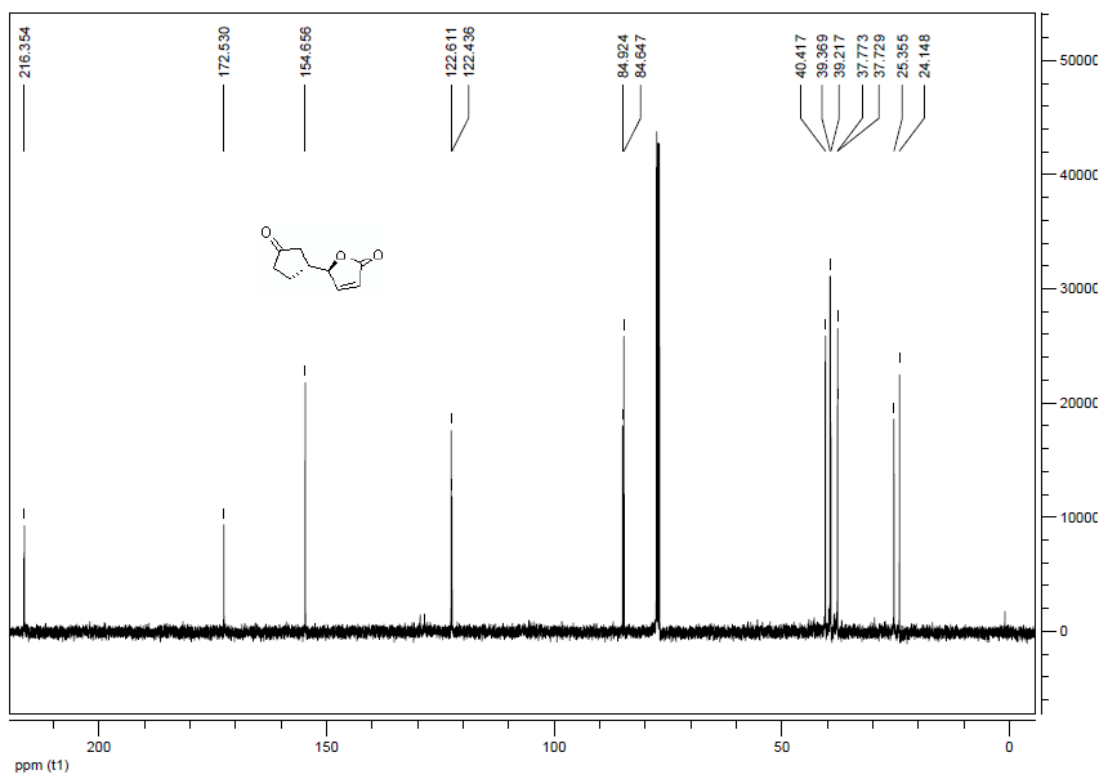
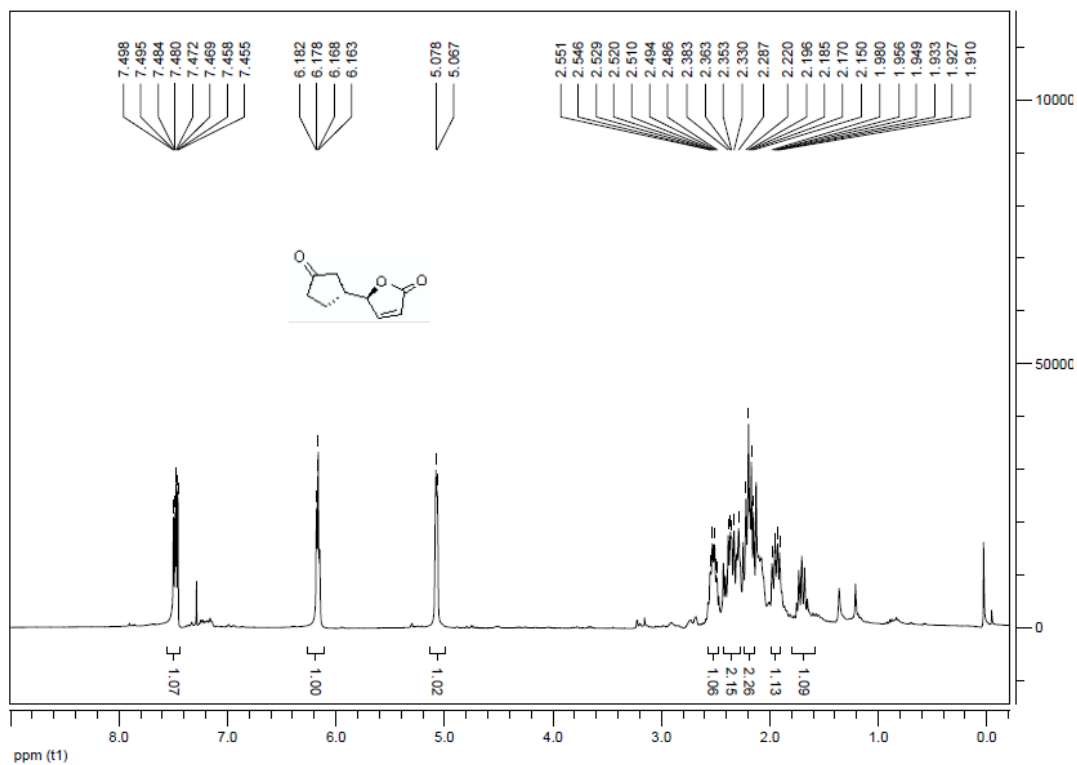
6x: 5-(4-oxooctan-2-yl)furan-2(5H)-one



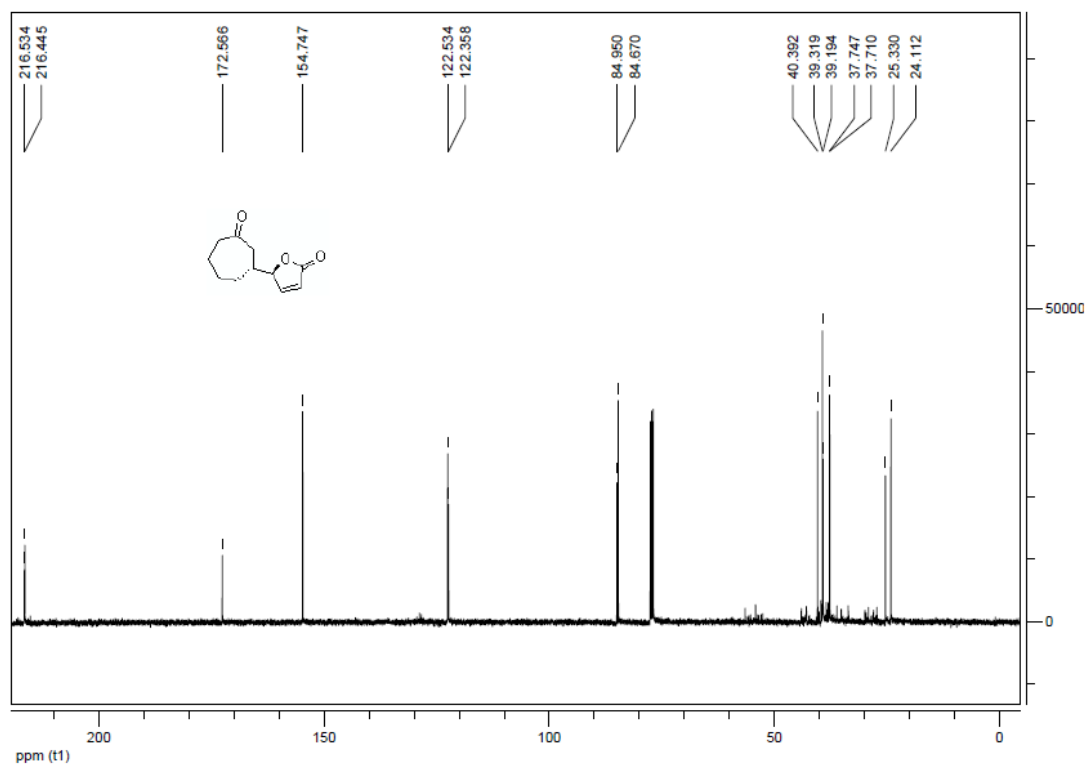
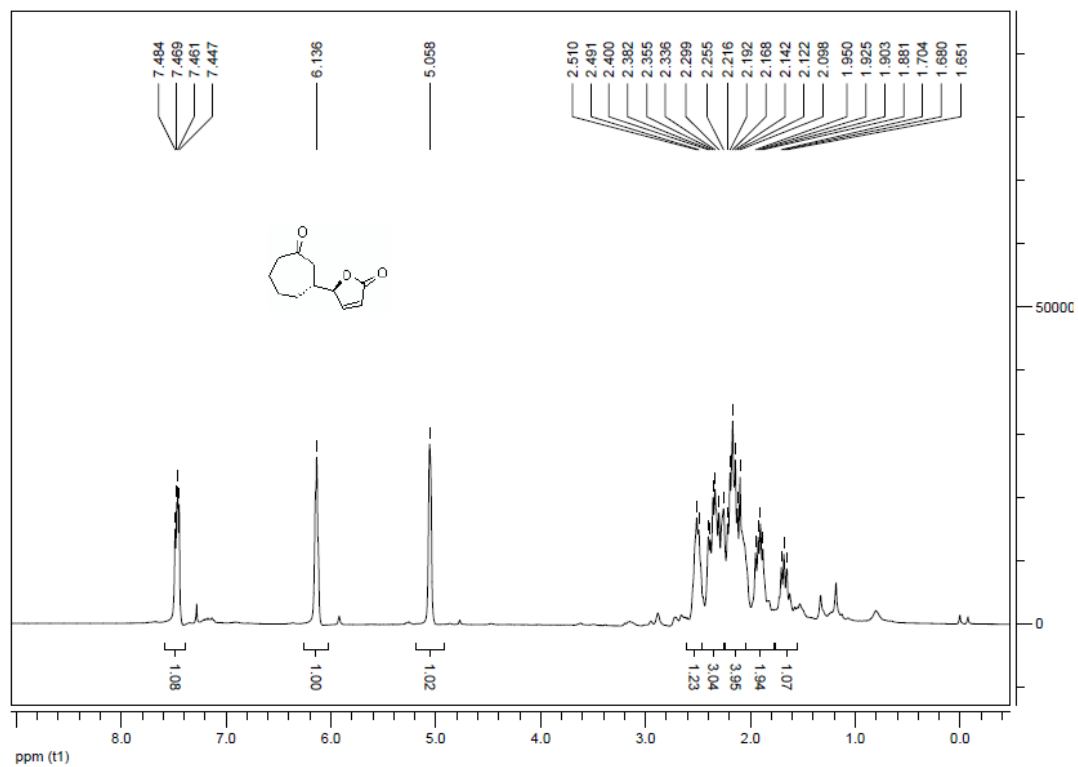
6y: 5-(5-oxo-1-phenylhexan-3-yl)furan-2(5H)-one



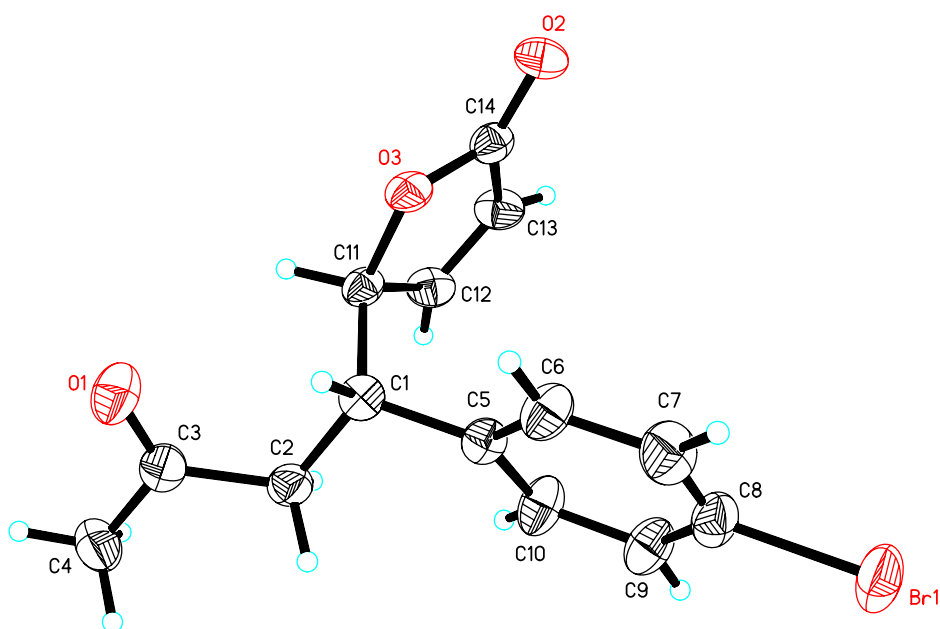
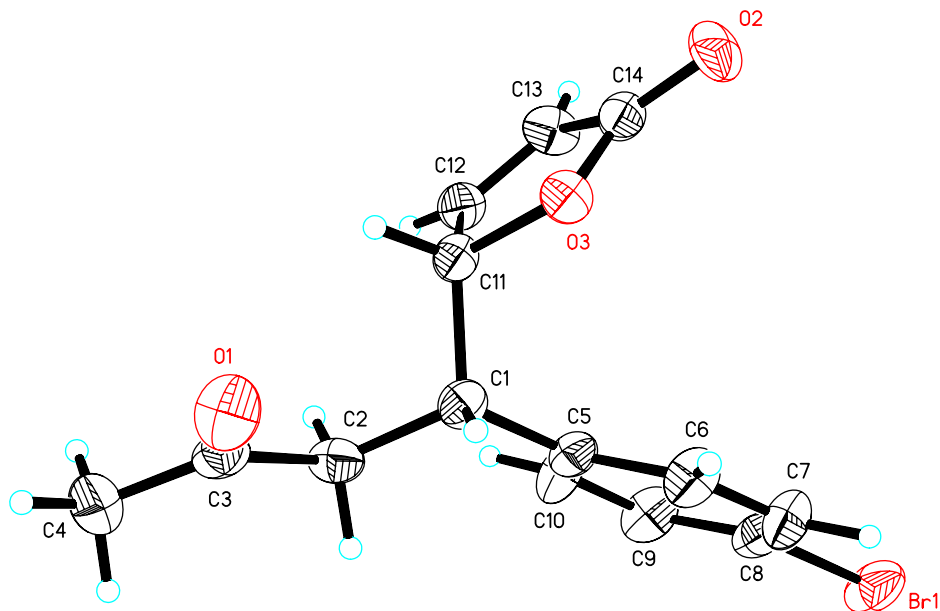
7a: 5-(3-oxocyclopentyl)furan-2(5H)-one

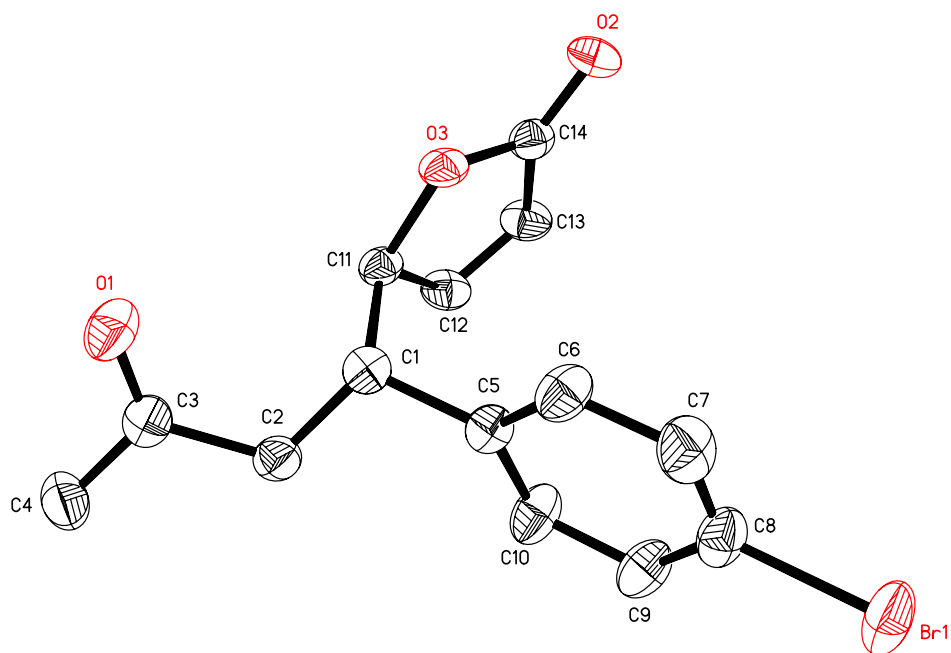
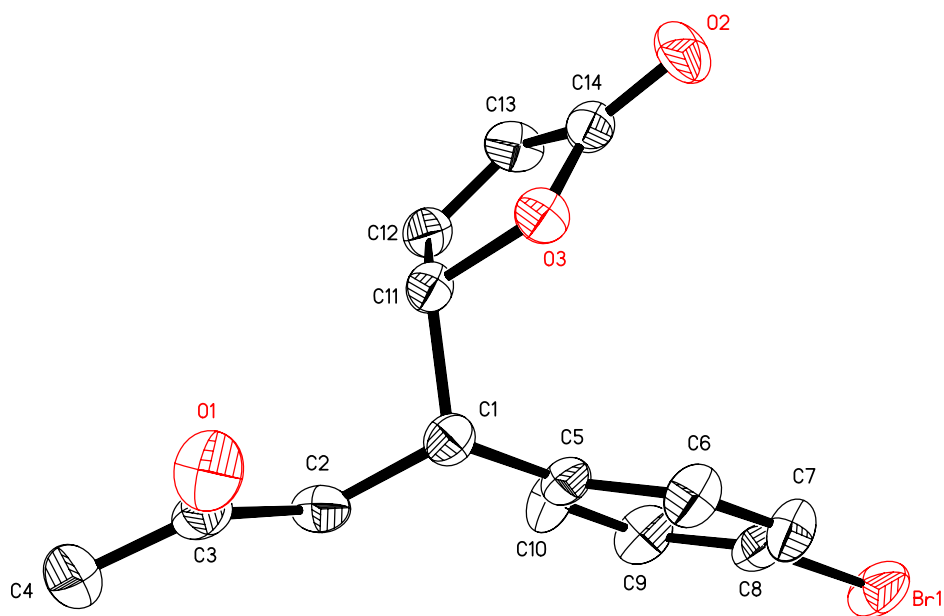


7b: 5-(3-oxocycloheptyl)furan-2(5H)-one



G: Absolute Configuration and X-Ray Analysis Data





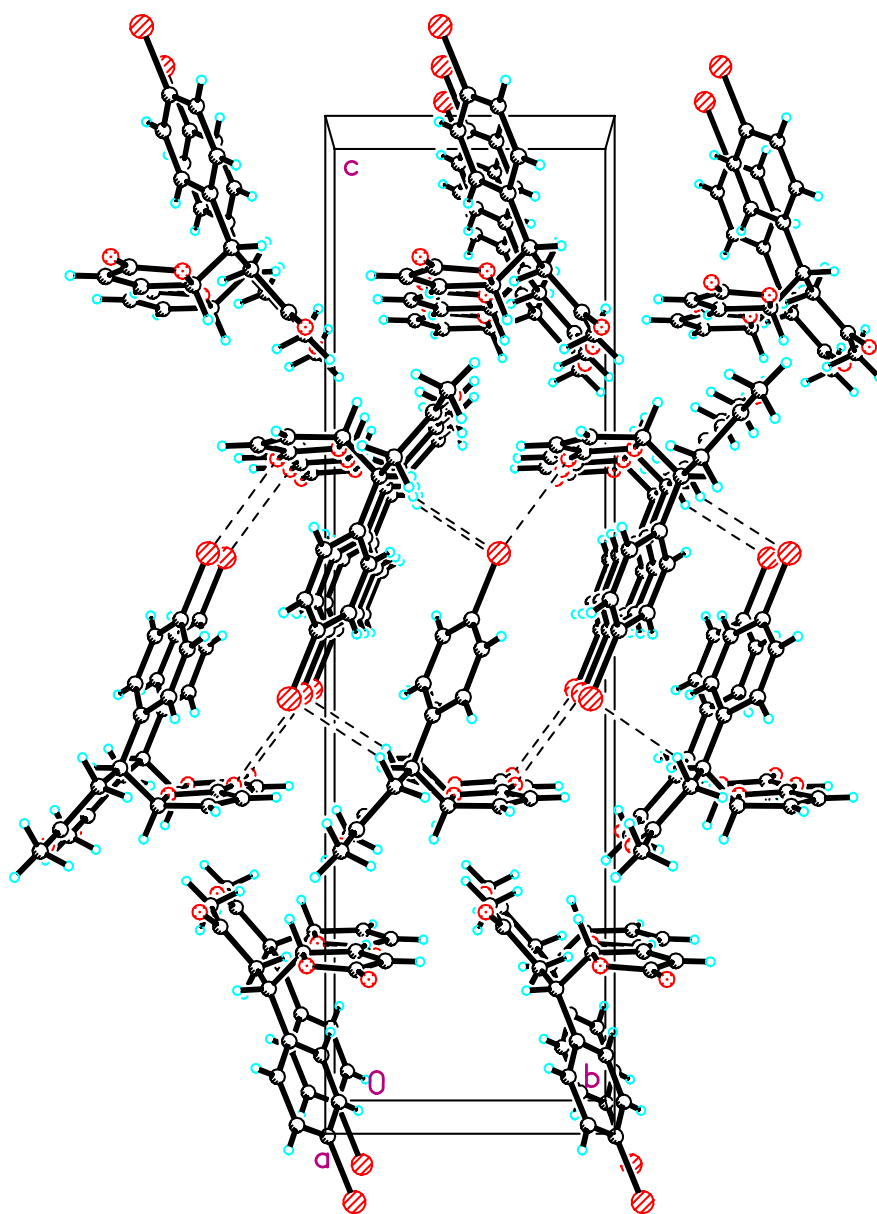


Table 1. Crystal data and structure refinement for cd20181.

| | |
|-----------------------------|---|
| Identification code | cd20181 |
| Empirical formula | C ₁₄ H ₁₃ Br O ₃ |
| Formula weight | 309.15 |
| Temperature | 293(2) K |
| Wavelength | 0.71073 Å |
| Crystal system, space group | Orthorhombic, P2(1)2(1)2(1) |
| Unit cell dimensions | a = 6.5631(11) Å alpha = 90 deg. b = 7.7659(12) Å beta = 90 deg. c = 27.286(4) Å gamma = 90 deg. |
| Volume | 1390.7(4) Å ³ |
| Z, Calculated density | 4, 1.477 Mg/m ³ |

| | |
|---------------------------------|---|
| Absorption coefficient | 2.953 mm ⁻¹ |
| F(000) | 624 |
| Crystal size | 0.425 x 0.340 x 0.308 mm |
| Theta range for data collection | 2.73 to 27.50 deg. |
| Limiting indices | -8<=h<=8, -9<=k<=10, -19<=l<=35 |
| Reflections collected / unique | 8391 / 3168 [R(int) = 0.0517] |
| Completeness to theta = 27.50 | 99.5 % |
| Absorption correction | Empirical |
| Max. and min. transmission | 1.0000 and 0.4111 |
| Refinement method | Full-matrix least-squares on F ² |
| Data / restraints / parameters | 3168 / 0 / 165 |

| | |
|--------------------------------------|---------------------------------------|
| Goodness-of-fit on F^2 | 0.847 |
| Final R indices [$I > 2\sigma(I)$] | R1 = 0.0414, wR2 = 0.0838 |
| R indices (all data) | R1 = 0.0765, wR2 = 0.0910 |
| Absolute structure parameter | 0.036(12) |
| Extinction coefficient | 0.0309(15) |
| Largest diff. peak and hole | 0.615 and -0.574 e. \AA^{-3} |

Table 2. Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{Å}^2 \times 10^3$) for cd20181.

U(eq) is defined as one third of the trace of the orthogonalized

U_{ij} tensor.

| | x | y | z | U(eq) |
|-------|----------|----------|---------|-------|
| Br(1) | 9345(1) | 10993(1) | -699(1) | 83(1) |
| O(1) | 8262(5) | 5554(4) | 2143(1) | 73(1) |
| O(2) | 14229(4) | 11606(3) | 1619(1) | 62(1) |
| O(3) | 12042(3) | 9439(3) | 1696(1) | 45(1) |
| C(1) | 8985(5) | 7999(5) | 1398(1) | 45(1) |
| C(2) | 6833(6) | 7466(5) | 1552(1) | 50(1) |
| C(3) | 6748(7) | 6181(5) | 1966(1) | 52(1) |
| C(4) | 4654(6) | 5714(6) | 2141(2) | 75(1) |
| C(5) | 9068(6) | 8721(4) | 882(1) | 45(1) |
| C(6) | 10710(6) | 8385(5) | 582(1) | 58(1) |
| C(7) | 10802(7) | 9061(6) | 111(2) | 70(1) |

| | | | | |
|-------|----------|----------|---------|-------|
| C(8) | 9260(8) | 10062(5) | -51(1) | 61(1) |
| C(9) | 7600(7) | 10403(5) | 234(2) | 64(1) |
| C(10) | 7536(6) | 9778(5) | 699(2) | 61(1) |
| C(11) | 9883(4) | 9238(5) | 1774(1) | 41(1) |
| C(12) | 9101(5) | 11036(5) | 1771(1) | 49(1) |
| C(13) | 10608(6) | 12092(5) | 1713(1) | 52(1) |
| C(14) | 12505(6) | 11150(5) | 1669(1) | 45(1) |

Table 3. Bond lengths [Å] and angles [deg] for cd20181.

| | |
|------------|----------|
| Br(1)-C(8) | 1.911(4) |
| O(1)-C(3) | 1.207(5) |
| O(2)-C(14) | 1.194(4) |
| O(3)-C(14) | 1.365(4) |
| O(3)-C(11) | 1.441(4) |
| C(1)-C(5) | 1.516(5) |
| C(1)-C(11) | 1.526(5) |
| C(1)-C(2) | 1.531(5) |
| C(1)-H(1) | 0.9800 |
| C(2)-C(3) | 1.509(5) |
| C(2)-H(2A) | 0.9700 |
| C(2)-H(2B) | 0.9700 |
| C(3)-C(4) | 1.498(5) |
| C(4)-H(4A) | 0.9600 |
| C(4)-H(4B) | 0.9600 |
| C(4)-H(4C) | 0.9600 |
| C(5)-C(6) | 1.379(5) |
| C(5)-C(10) | 1.391(5) |

| | |
|------------------|----------|
| C(6)-C(7) | 1.390(5) |
| C(6)-H(6) | 0.9300 |
| C(7)-C(8) | 1.350(6) |
| C(7)-H(7) | 0.9300 |
| C(8)-C(9) | 1.364(6) |
| C(9)-C(10) | 1.359(5) |
| C(9)-H(9) | 0.9300 |
| C(10)-H(10) | 0.9300 |
| C(11)-C(12) | 1.487(5) |
| C(11)-H(11) | 0.9800 |
| C(12)-C(13) | 1.295(5) |
| C(12)-H(12) | 0.9300 |
| C(13)-C(14) | 1.448(5) |
| C(13)-H(13) | 0.9300 |
| C(14)-O(3)-C(11) | 109.4(3) |
| C(5)-C(1)-C(11) | 112.2(3) |
| C(5)-C(1)-C(2) | 112.8(3) |
| C(11)-C(1)-C(2) | 110.0(3) |
| C(5)-C(1)-H(1) | 107.2 |
| C(11)-C(1)-H(1) | 107.2 |
| C(2)-C(1)-H(1) | 107.2 |

| | |
|------------------|----------|
| C(3)-C(2)-C(1) | 114.7(3) |
| C(3)-C(2)-H(2A) | 108.6 |
| C(1)-C(2)-H(2A) | 108.6 |
| C(3)-C(2)-H(2B) | 108.6 |
| C(1)-C(2)-H(2B) | 108.6 |
| H(2A)-C(2)-H(2B) | 107.6 |
| O(1)-C(3)-C(4) | 122.1(4) |
| O(1)-C(3)-C(2) | 122.3(4) |
| C(4)-C(3)-C(2) | 115.6(4) |
| C(3)-C(4)-H(4A) | 109.5 |
| C(3)-C(4)-H(4B) | 109.5 |
| H(4A)-C(4)-H(4B) | 109.5 |
| C(3)-C(4)-H(4C) | 109.5 |
| H(4A)-C(4)-H(4C) | 109.5 |
| H(4B)-C(4)-H(4C) | 109.5 |
| C(6)-C(5)-C(10) | 117.6(3) |
| C(6)-C(5)-C(1) | 120.6(3) |
| C(10)-C(5)-C(1) | 121.7(3) |
| C(5)-C(6)-C(7) | 120.8(4) |
| C(5)-C(6)-H(6) | 119.6 |
| C(7)-C(6)-H(6) | 119.6 |
| C(8)-C(7)-C(6) | 119.2(4) |

| | |
|-------------------|----------|
| C(8)-C(7)-H(7) | 120.4 |
| C(6)-C(7)-H(7) | 120.4 |
| C(7)-C(8)-C(9) | 121.6(4) |
| C(7)-C(8)-Br(1) | 119.9(3) |
| C(9)-C(8)-Br(1) | 118.5(3) |
| C(10)-C(9)-C(8) | 119.1(4) |
| C(10)-C(9)-H(9) | 120.4 |
| C(8)-C(9)-H(9) | 120.4 |
| C(9)-C(10)-C(5) | 121.6(4) |
| C(9)-C(10)-H(10) | 119.2 |
| C(5)-C(10)-H(10) | 119.2 |
| O(3)-C(11)-C(12) | 103.7(3) |
| O(3)-C(11)-C(1) | 110.4(3) |
| C(12)-C(11)-C(1) | 117.0(3) |
| O(3)-C(11)-H(11) | 108.5 |
| C(12)-C(11)-H(11) | 108.5 |
| C(1)-C(11)-H(11) | 108.5 |
| C(13)-C(12)-C(11) | 109.4(3) |
| C(13)-C(12)-H(12) | 125.3 |
| C(11)-C(12)-H(12) | 125.3 |
| C(12)-C(13)-C(14) | 110.3(3) |
| C(12)-C(13)-H(13) | 124.9 |

| | |
|-------------------|----------|
| C(14)-C(13)-H(13) | 124.9 |
| O(2)-C(14)-O(3) | 120.4(3) |
| O(2)-C(14)-C(13) | 132.4(4) |
| O(3)-C(14)-C(13) | 107.2(3) |

Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($\text{Å}^2 \times 10^3$) for cd20181.

The anisotropic displacement factor exponent takes the form:

$$-2 \pi^2 [h^2 a^2 U_{11} + \dots + 2 h k a^* b^* U_{12}]$$

| | U11 | U22 | U33 | U23 | U13 | U12 |
|-------|--------|-------|-------|--------|--------|--------|
| Br(1) | 141(1) | 65(1) | 42(1) | 2(1) | 7(1) | -12(1) |
| O(1) | 78(2) | 70(2) | 70(2) | 17(2) | -1(2) | 18(2) |
| O(2) | 29(1) | 80(2) | 76(2) | 7(1) | -2(1) | 0(2) |
| O(3) | 31(1) | 51(2) | 52(2) | 2(1) | -5(1) | 11(1) |
| C(1) | 45(2) | 44(2) | 46(2) | -4(2) | 3(2) | 6(2) |
| C(2) | 58(2) | 41(2) | 51(2) | -3(2) | -10(2) | -2(2) |
| C(3) | 72(3) | 40(2) | 45(2) | -10(2) | -2(2) | 2(2) |
| C(4) | 83(3) | 71(3) | 70(3) | 9(3) | 5(2) | -22(3) |
| C(5) | 52(2) | 42(2) | 40(2) | -6(2) | 2(2) | 4(2) |
| C(6) | 61(3) | 63(3) | 50(3) | 2(2) | 0(2) | 18(2) |
| C(7) | 74(3) | 81(3) | 56(3) | -11(3) | 21(2) | 2(3) |
| C(8) | 92(3) | 51(2) | 41(2) | -5(2) | 3(3) | -7(3) |

| | | | | | | |
|-------|-------|-------|-------|--------|-------|-------|
| C(9) | 80(3) | 59(3) | 53(3) | 5(2) | -6(2) | 21(2) |
| C(10) | 71(3) | 70(3) | 43(2) | 4(2) | 12(2) | 25(2) |
| C(11) | 33(2) | 51(2) | 38(2) | 1(2) | -1(1) | 7(2) |
| C(12) | 34(2) | 61(2) | 50(2) | -11(2) | 3(2) | 7(2) |
| C(13) | 43(2) | 44(2) | 69(3) | -5(2) | -8(2) | 9(2) |
| C(14) | 39(2) | 56(3) | 39(2) | 0(2) | -1(2) | 6(2) |

Table 5. Hydrogen coordinates ($\times 10^4$) and isotropic displacement parameters ($\text{Å}^2 \times 10^3$) for cd20181.

| | x | y | z | U(eq) |
|-------|-------|-------|------|-------|
| H(1) | 9828 | 6957 | 1402 | 54 |
| H(2A) | 6088 | 8490 | 1649 | 60 |
| H(2B) | 6143 | 6978 | 1270 | 60 |
| H(4A) | 4753 | 4849 | 2391 | 112 |
| H(4B) | 3872 | 5275 | 1871 | 112 |
| H(4C) | 3997 | 6718 | 2271 | 112 |
| H(6) | 11769 | 7697 | 696 | 70 |
| H(7) | 11911 | 8827 | -90 | 84 |
| H(9) | 6525 | 11054 | 111 | 77 |
| H(10) | 6442 | 10064 | 900 | 73 |
| H(11) | 9670 | 8754 | 2102 | 49 |
| H(12) | 7741 | 11352 | 1805 | 58 |
| H(13) | 10490 | 13285 | 1700 | 62 |

Table 6. Torsion angles [deg] for cd20181.

| | |
|-----------------------|-----------|
| C(5)-C(1)-C(2)-C(3) | 158.6(3) |
| C(11)-C(1)-C(2)-C(3) | -75.3(4) |
| C(1)-C(2)-C(3)-O(1) | -4.0(5) |
| C(1)-C(2)-C(3)-C(4) | 176.9(3) |
| C(11)-C(1)-C(5)-C(6) | 91.8(4) |
| C(2)-C(1)-C(5)-C(6) | -143.3(3) |
| C(11)-C(1)-C(5)-C(10) | -86.4(4) |
| C(2)-C(1)-C(5)-C(10) | 38.5(5) |
| C(10)-C(5)-C(6)-C(7) | -1.0(5) |
| C(1)-C(5)-C(6)-C(7) | -179.3(4) |
| C(5)-C(6)-C(7)-C(8) | 0.2(6) |
| C(6)-C(7)-C(8)-C(9) | -1.1(6) |
| C(6)-C(7)-C(8)-Br(1) | -179.6(3) |
| C(7)-C(8)-C(9)-C(10) | 2.8(6) |
| Br(1)-C(8)-C(9)-C(10) | -178.7(3) |
| C(8)-C(9)-C(10)-C(5) | -3.6(6) |
| C(6)-C(5)-C(10)-C(9) | 2.7(6) |
| C(1)-C(5)-C(10)-C(9) | -179.0(4) |

| | |
|-------------------------|-----------|
| C(14)-O(3)-C(11)-C(12) | 2.2(4) |
| C(14)-O(3)-C(11)-C(1) | 128.3(3) |
| C(5)-C(1)-C(11)-O(3) | -66.6(4) |
| C(2)-C(1)-C(11)-O(3) | 166.9(3) |
| C(5)-C(1)-C(11)-C(12) | 51.6(4) |
| C(2)-C(1)-C(11)-C(12) | -74.9(4) |
| O(3)-C(11)-C(12)-C(13) | -1.5(4) |
| C(1)-C(11)-C(12)-C(13) | -123.3(3) |
| C(11)-C(12)-C(13)-C(14) | 0.3(4) |
| C(11)-O(3)-C(14)-O(2) | 177.9(3) |
| C(11)-O(3)-C(14)-C(13) | -2.1(4) |
| C(12)-C(13)-C(14)-O(2) | -178.8(4) |
| C(12)-C(13)-C(14)-O(3) | 1.1(4) |

Symmetry transformations used to generate equivalent atoms:

Table 7. Hydrogen bonds for cd20181 [A and deg.].

| D-H...A | d(D-H) | d(H...A) | d(D...A) | <(DHA) |
|---------|--------|----------|----------|--------|
|---------|--------|----------|----------|--------|

H: References

¹ Fukuyama, T.; Cheung, M.; Kan, T. *synlett.* **1999**, 8, 1301-1303.