Supplementary Material (ESI) for Organic & Biomolecular Chemistry

Sialic Acid C-Glycosides with Aromatic Residues: Investigating Enzyme binding and Inhibition of *Trypanosoma cruzi* Trans-sialidase

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Supporting Information

General methods

Commercially available starting materials were used without further purification. Solvents were dried according to standard methods. TLC was performed on precoated aluminium plates (Silica Gel 60 F254, Merck 5554) employing UV-absorption and charring with 10% H_2SO_4 in ethanol for visualisation. For column chromatography Silica Gel 60, 230–400 mesh, 40–63 μm (Merck) was used.

^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker AMX-400 (400.25 MHz for ^{1}H, 100.65 MHz for ^{13}C), Bruker AV-400 (400.25 MHz for ^{1}H, 100.65 MHz for ^{13}C) and on Bruker DRX-500 (500.13 MHz for ^{1}H, 125.77 MHz for ^{13}C) at 300 K. Chemical shifts were calibrated to solvent residual peaks.[26] The signals were assigned by HH-COSY, HSQC, HMBC and if necessary NOESY experiments. *J* values are given in Hz.

Optical rotations were measured using a Perkin Elmer 241 (546 nm) or a Krüss Optronic P8000 (589 nm) at 20 °C; $[\alpha]_D$ values are given in 10^{-1} deg cm^2 g^{-1}.

Mass spectra were recorded on a Bruker Biflex III in positive reflector mode (MALDI-TOF), on a VG Analytical VG/70-250 F (FAB) and on a Thermo Finnigan MAT 95 XL mass spectrometer (ESI).

Allyl *C*-sialosides **3**, **6**, **8**[10] and substituted styrenes **4b** and **4c**[12] were synthesised as described and the data were consistent with those published. The syntheses of *C*-sialosides **5a**, **10**, **11** and **33** were published before in a short communication.[11]

General procedure for cross metathesis with styrenes (GP1):

The allyl *C*-sialoside was dissolved under nitrogen in anhydrous dichloromethane to yield a 0.002 M solution and the styrene (8–10-fold excess) was added. After addition of the ruthenium catalyst, the reaction was stirred under reflux for 24 h. The removal of the solvent *in vacuo* and column chromatography on silica gel (toluene–acetone or pure ethyl acetate) yielded the product.

General procedure for acetylation (GP2):

The compound was dissolved in pyridine and an excess of acetic anhydride was added. The solution was stirred at room temperature until TLC indicated complete consumption of starting material. The solvent was removed *in vacuo* and the residue was coevaporated with toluene before column chromatography (silica gel, toluene/acetone or pure ethyl acetate).

General procedure for deacetylation (GP3):

The compound was dissolved in dry methanol and sodium methoxide (1 molar) in dry methanol was added drop wise until a pH of 9-10. The reaction was stirred at room temperature until TLC showed complete deacetylation. After neutralisation with acidic ion exchanger and filtration the solvent was removed *in vacuo*. Column chromatography on silica gel (dichloromethane–methanol) yielded the product.

General procedure for ester saponification (GP4):

The ester was dissolved in aqueous sodium hydroxide (0.1 M) and stirred at room temperature until TLC showed complete conversion. After neutralisation with acidic ion exchanger and filtration the material was freeze dried.

General procedure for catalytic hydrogenation (GP5):

The unsaturated compound was dissolved in methanol under nitrogen. After adding a catalytic amount of palladium on charcoal (5%, wet) the reaction vessel was carefully evaporated and flushed with hydrogen. The reaction was stirred under hydrogen at room temperature until TLC showed complete conversion of the starting material. Column chromatography on silica gel (dichloromethane–methanol) yielded the product.

Syntheses of new compounds

(*E*)-Methyl-5-acetamido-4,7,8,9-tetra-*O*-acetyl-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-methoxyphenyl)-prop-2-enyl)-D-*erythro*-L-*manno*-nononate (5b):

a) Compound **3** (240 mg, 466 µmol) was reacted with **4b** (540 mg, 4.02 mmol) according to **GP1** using catalyst **2** (25 mg, 40 µmol) to give **5b** in a mixture with starting material **3** (136 mg, 47%; calculated from NMR) as a colourless oil;
b) 7b (13 mg, 29 µmol) was acetylated according to **GP2** to give **5b** (18 mg, 100%) as a colourless oil;
$[\alpha]_D^{25}$ -13.8 (*c* 1 in $CHCl_3$); δ_H (500 MHz, $CDCl_3$) 7.31 (2 H, d, *J* 8.7, arom. H), 6.84 (2 H, d, *J* 8.7, arom. H), 6.31 (1 H, d, *J* 15.8, -CH=C*H*-Ph), 6.00 (1 H, ddd, *J* 15.8, 8.0 and 6.8, -CH_2-C*H*=), 5.40 (1 H, ddd, $J_{8,7}$ 6.9, $J_{8,9b}$ 6.0, $J_{8,9a}$ 2.6, H-8), 5.34 (1 H, dd, $J_{7,8}$ 6.9, $J_{7,6}$ 1.1, H-7), 5.17 (1 H, d, $J_{NH,5}$ 9.6, N*H*), 4.84 (1 H, ddd, $J_{4,3ax}$ 11.7, $J_{4,5}$ 10.0, $J_{4,3eq}$ 4.6, H-4), 4.42 (1 H, dd, $J_{9a,9b}$ 12.4, $J_{9a,8}$ 2.6, H-9a), 4.15 (1 H, dd, $J_{9b,9a}$ 12.4, $J_{9b,8}$ 6.0, H-9b), 4.05-4.00 (2 H, m, H-5, H-6), 3.80 (3 H, s, arom. OCH_3), 3.70 (3 H, s, OCH_3), 2.65-2.50 (2 H, m, -CH_2-CH=), 2.51 (1 H, dd, $J_{3eq,3ax}$ 12.9, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.12, 2.11, 2.02, 2.01, (each 3 H, 4x s, 4x AcCH_3), 1.87 (3 H, s, NHAcCH_3), 1.83 (1 H, dd, $J_{3ax,3eq}$ 12.9, $J_{3ax,4}$ 11.7, H-3_{ax}); δ_C (125 MHz, $CDCl_3$) 171.77 (*C*O_2CH_3), 171.23, 170.86, 170.43, 170.35, 170.24 (5x Ac*C*=O), 159.26 (arom. C), 133.63 (-CH=*C*H-Ph), 129.96 (arom. C), 127.69 (arom. C), 120.48 (-CH_2-*C*H=), 114.04 (arom. C), 80.97 (C-2), 73.66 (C-6), 70.37 (C-4), 69.87 (C-8), 68.08 (C-7), 62.55 (C-9), 55.43 (arom. O*C*H_3), 52.52 (O*C*H_3), 49.81 (C-5), 43.74 (-*C*H_2-CH=), 37.52 (C-3), 23.35 (NHAc*C*H_3), 21.26, 21.04 (2x Ac*C*H_3), 20.94 (2x Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 622.249966; found: 622.250854.

(*E,Z*)-Methyl-5-acetamido-4,7,8,9-tetra-*O*-acetyl-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-nitrophenyl)-prop-2-enyl)-D-*erythro*-L-*manno*-nononate (5c):

Compound **3** (115 mg, 223 µmol) was reacted with **4c** (298 mg, 2.00 mmol) according to **GP1** using catalyst **2** (17.1 mg, 27.3 µmol) to give **5c** (152 mg, 100%) as a yellow oil that was a 1:5 mixture of *cis*/*trans* isomers according to NMR spectra; $[\alpha]_D^{25}$ -16.7 (*c* 1 in $CHCl_3$); *cis* compound: δ_H (500 MHz, C_6D_6) 7.83 (2 H, d, *J* 8.8, arom. H), 6.80 (2 H, d, *J* 8.8, arom. H), 6.35 (1 H, d, *J* 11.8, -CH=C*H*-Ph), 6.02-5.96 (1 H, m, -CH_2-C*H*=), 3.24 (3

H, s, OC*H*$_3$), 2.61 (1 H, ddd, *J* 15.6, 8.0 and 1.6, C*H*$_2$), 2.50-2.44 (1 H, m, C*H*$_2$), 2.13, 1.97, 1.78, 1.64 (each 3 H, 4x s, 4x AcC*H*$_3$); δ_C not detected; *trans* compound: δ_H (500 MHz, C_6D_6) 7.97 (2 H, d, *J* 8.8, arom. H), 7.23 (2 H, d, *J* 8.8, arom. H), 6.43 (1 H, ddd, *J* 15.7, 8.9 and 5.7, -CH$_2$-C*H*=), 5.98 (1 H, d, *J* 15.7, -CH=C*H*-Ph), 5.84 (1 H, ddd, $J_{8,7}$ 7.9, $J_{8,9b}$ 6.5, $J_{8,9a}$ 2.5, H-8), 5.49 (1 H, dd, $J_{7,8}$ 7.9, $J_{7,6}$ 2.4, H-7), 4.76 (1 H, ddd, $J_{4,3ax}$ 11.8, $J_{4,5}$ 10.7, $J_{4,3eq}$ 4.5, H-4), 4.72 (1 H, dd, $J_{9a,9b}$ 12.3, $J_{9a,8}$ 2.5, H-9a), 4.38 (1 H, ddd, $J_{5,4}$ 10.7, $J_{5,6}$ 10.7, $J_{5,NH}$ 10.6, H-5), 4.31 (1 H, dd, $J_{9b,9a}$ 12.3, $J_{9b,8}$ 6.5, H-9b), 4.07 (1 H, dd, $J_{6,5}$ 10.7, $J_{6,7}$ 2.4, H-6), 3.28 (3 H, s, OC*H*$_3$), 2.46 (1 H, dd, $J_{3eq,3ax}$ 12.7, $J_{3eq,4}$ 4.5, H-3$_{eq}$), 2.41 (1 H, ddd, *J* 14.4, 5.7 and 1.4, C*H*$_2$), 2.30 (1 H, br dd, *J* 14.4, *J* 8.9, C*H*$_2$), 2.07, 1.99, 1.76, 1.67 (each 3 H, 4x s, 4x AcC*H*$_3$), 1.62-1.55 (1 H, m, H-3$_{ax}$), 1.60 (3 H, s, NHAcC*H*$_3$); δ_C (125 MHz, C_6D_6) 170.18, 170.11, 170.06, 169.98 (4x Ac*C*=O), 169.39 (Ac*C*ONH), 147.43 (arom. C), 143.14 (arom. C), 132.12 (PhH*C*=), 128.35 (CH$_2$H*C*=), 127.22 (arom. C), 124.02 (arom. C), 80.72 (C-1), 73.84 (C-6), 70.09 (C-4), 69.70 (C-8), 67.93 (C-7), 63.04 (C-9), 51.91 (O*C*H$_3$), 49.30 (C-5), 43.93 (-*C*H$_2$-CH=), 38.61 (C-3), 24.82 (NHAc*C*H$_3$), 21.17, 20.78 (4x Ac*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 637.224479; found: 637.226555.

(*E*)-Methyl-5-acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-phenylprop-2-enyl)-D-*erythro*-L-*manno*-nononate (7a):

Compound **5a** (210 mg, 354 µmol) was deacetylated according to **GP3** to give **7a (**150 mg, 100%**)**; $[\alpha]_D^{25}$ +6.8 (*c* 1 in MeOH); δ_H (500 MHz, [D4]MeOH) 7.36-7.34 (2 H, m, arom. H), 7.30-7.26 (2 H, m, arom. H), 7.22-7.18 (1 H, m, arom. H), 6.45 (1 H, d, *J* 15.8, -CH=C*H*-Ph), 6.21 (1 H, ddd, *J* 15.8, 7.5 and 7.5, -CH$_2$-C*H*=), 3.89 (1 H, ddd, $J_{8,7}$ 8.8, $J_{8,9b}$ 5.6, $J_{8,9a}$ 2.7, H-8), 3.85 (1 H, dd, $J_{9a,9b}$ 11.4, $J_{9a,8}$ 2.7, H-9a), 3.76 (3 H, s, OC*H*$_3$), 3.73 (1 H, dd, $J_{5,6}$ 10.4, $J_{5,4}$ 10.1, H-5), 3.65 (1 H, dd, $J_{9b,9a}$ 11.4, $J_{9b,8}$ 5.6, H-9b), 3.66-3.61 (1 H, m, H-4), 3.53 (1 H, dd, $J_{6,5}$ 10.4, $J_{6,7}$ 1.5, H-6), 3.51 (1 H, dd, $J_{7,8}$ 8.8, $J_{7,6}$ 1.5, H-7), 2.69-2.64 (2 H, m, -C*H*$_2$-CH=), 2.63 (1 H, dd, $J_{3eq,3ax}$ 13.0, $J_{3eq,4}$ 4.6, H-3$_{eq}$), 2.00 (3 H, s, AcC*H*$_3$), 1.66 (1 H, dd, $J_{3ax,3eq}$ 13.0, $J_{3ax,4}$ 11.8, H-3$_{ax}$); δ_C (100 MHz, [D4]MeOH) 175.26 (C-1), 138.57 (arom. C), 135.27 (PhH*C*=), 129.55 (arom. C), 128.48 (arom. C), 127.30 (arom. C), 124.10 (CH$_2$H*C*=), 82.11 (C-2), 75.93 (C-7), 72.86 (C-5), 70.20 (C-6), 69.12 (C-4), 64.64 (C-9), 53.09 (O*C*H$_3$), 44.84 (-*C*H$_2$-CH=), 41.48 (C-3), 22.63 (Ac*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 424.197141; found: 424.197289.

(*E*)-Methyl-5-acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-methoxyphenyl)-prop-2-enyl)-D-*erythro*-L-*manno*-nononate (7b):

Compound **5b** (136 mg, 0.230 mmol) was deacetylated according to **GP3** to give **7b** (97 mg, 100%) as a colourless oil; $[\alpha]_D^{25}$ +4.2 (*c* 1 in MeOH); δ_H (400 MHz, [D4]MeOH) 7.28 (2 H, d, *J* 8.8, arom. H), 6.84 (2 H, d, *J* 8.8, arom. H), 6.38 (1 H, d, *J* 15.8, -CH=C*H*-Ph), 6.05 (1 H, ddd, *J* 15.8, 7.5 and 7.5, -CH_2-C*H*=), 3.89 (1 H, ddd, $J_{8,7}$ 8.9, $J_{8,9b}$ 5.7, $J_{8,9a}$ 2.8, H-8), 3.85 (1 H, dd, $J_{9a,9b}$ 11.3, $J_{9a,8}$ 2.8, H-9a), 3.77 (3 H, s, arom. OCH_3), 3.75 (3 H, s, OCH_3), 3.73 (1 H, dd, $J_{5,6}$ 10.2, $J_{5,4}$ 10.1, H-5), 3.68-3.60 (2 H, m, H-4, H-9b), 3.52 (1 H, dd, $J_{6,5}$ 10.2, $J_{6,7}$ 1.6, H-6), 3.51 (1 H, dd, $J_{7,8}$ 8.9, $J_{7,6}$ 1.6, H-7), 2.65-2.59 (3 H, m, -CH_2-CH= and H-3_{eq}), 2.00 (3 H, s, AcCH_3), 1.65 (1 H, dd, $J_{3ax,3eq}$ 13.1, $J_{3ax,4}$ 11.5, H-3_{ax}); δ_C (100 MHz, [D4]MeOH) 175.24 (2x *C*=O), 160.72 (arom. C), 134.74 (-CH=*C*H-Ph), 131.34 (arom. C), 128.47 (arom. C), 121.66 (-CH_2-*C*H=), 114.96 (arom. C), 82.19 (C-2), 75.95 (C-6), 72.91 (C-8), 70.26 (C-7), 69.14 (C-4), 64.67 (C-9), 55.71 (arom. O*C*H_3), 54.19 (C-5), 53.04 (O*C*H_3), 44.90 (-*C*H_2-CH=), 41.46 (C-3), 22.64 (Ac*C*H_3); HRMS (ESI): *m*/*z* calcd. for $[M+Na]^+$: 476.1891; found: 476.1897.

(*E,Z*)-Methyl-5-acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-nitrophenyl)-prop-2-enyl)-D-*erythro*-L-*manno*-nononate (7c):

Compound **5c** (79 mg, 0.12 mmol) was deacetylated according to **GP3** to give **7c** (49 mg, 84%) as a yellow oil (mixture of *cis*/*trans* isomers 1:5 according to NMR); $[\alpha]_D^{25}$ +1.8 (*c* 0.5 in MeOH); *cis* compound: δ_H (500 MHz, [D4]MeOH) 8.21 (2 H, d, *J* 8.8, arom. H), 7.53 (2 H, d, *J* 8.8, arom. H), 6.68 (1 H, d, *J* 11.7, -CH=C*H*-Ph), 5.94 (1 H, ddd, *J* 11.7 and 2x 7.6, -CH_2-C*H*=), 3.71 (3 H, s, OCH_3), 2.80 (2 H, m, -CH_2-CH=), 2.58 (1 H, dd, $J_{3eq,3ax}$ 13.2, $J_{3eq,4}$ 4.7, H-3_{eq}), 2.00 (3 H, s, AcCH_3), 1.63 (1 H, dd, $J_{3ax,3eq}$ 13.2, $J_{3ax,4}$ 12.0, H-3_{ax}); δ_C (125 MHz, [D4]MeOH) 174.89 (C-1), 174.75 (Ac*C*=O), 147.96 (arom. C), 144.90 (arom. C), 131.49 (-CH=*C*H-Ph), 130.79 (arom. C), 129.38 (-CH_2-*C*H=), 124.51 (arom. C), 81.22 (C-2), 75.90 (C-6), 72.73 (C-8), 70.21 (C-7), 68.89 (C-4), 62.21 (C-9), 54.65 (C-5), 53.10 (O*C*H_3), 41.66 (C-3), 39.81 (-*C*H_2-CH=), 22.66 (Ac*C*H_3); *trans* compound: δ_H (500 MHz, [D4]MeOH) 8.17 (2 H, d, *J* 8.8, arom. H), 7.60 (2 H, d, *J* 8.8, arom. H), 6.59 (1 H, d, *J* 15.8, -CH=C*H*-Ph), 6.50 (1 H, ddd, *J* 15.8 and 2x 7.3, -CH_2-C*H*=), 3.88 (1 H, ddd, $J_{8,7}$ 8.8, $J_{8,9b}$ 5.7, $J_{8,9a}$ 2.5, H-8), 3.85 (1 H, dd, $J_{9a,9b}$ 11.4, $J_{9a,8}$ 2.5, H-9a), 3.78 (3 H, s, OCH_3), 3.74 (1 H, dd, $J_{5,6}$ 10.4, $J_{5,4}$ 10.1, H-5), 3.68-3.61 (2 H, m, H-4, H-9b), 3.55

(1 H, dd, $J_{6,5}$ 10.4, $J_{6,7}$ 1.6, H-6), 3.51 (1 H, dd, $J_{7,8}$ 8.8, $J_{7,6}$ 1.6, H-7), 2.71 (2 H, m, -CH_2-CH=), 2.64 (1 H, dd, $J_{3eq,3ax}$ 13.2, $J_{3eq,4}$ 4.7, H-3_{eq}), 2.00 (3 H, s, AcCH_3), 1.67 (1 H, dd, $J_{3ax,3eq}$ 13.2, $^3J_{3ax,4}$ 11.7, H-3_{ax}); δ_C (125 MHz, [D4]MeOH) 175.22 (Ac*C*=O), 175.00 (C-1), 148.21 (arom. C), 145.10 (arom. C), 133.30 (-CH=*C*H-Ph), 129.79 (-CH_2-*C*H=), 128.08 (arom. C), 124.86 (arom. C), 81.76 (C-2), 75.90 (C-6), 72.82 (C-8), 70.21 (C-7), 69.01 (C-4), 64.64 (C-9), 54.09 (C-5), 53.20 (O*C*H_3), 44.62 (-*C*H_2-CH=), 41.42 (C-3), 22.66 (Ac*C*H_3); HRMS (ESI): *m*/*z* calcd. for $[M+Na]^+$: 491.1636; found: 491.1625.

(*E*)-5-Acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-phenyl-prop-2-enyl)-D-*erythro*-L-*manno*-nononic acid (9a):

Compound **7a** (24 mg, 57 µmol) was saponified according to **GP4** to give **9a** (23 mg, 100%) as a white solid; mp 154 °C; $[\alpha]_D^{25}$ -12.5 (*c* 1 in H_2O); δ_H (500 MHz, [D4]MeOH) 7.37-7.34 (2 H, m, arom. H), 7.27-7.23 (2 H, m, arom. H), 7.17-7.13 (1 H, m, arom. H), 6.43 (1 H, d, *J* 15.8, -CH=C*H*-Ph), 6.37-6.30 (1 H, m, -CH_2-C*H*=), 3.90 (1 H, ddd, $J_{8,7}$ 9.1, $J_{8,9b}$ 5.7, $J_{8,9a}$ 2.5, H-8), 3.82 (1 H, dd, $J_{9a,9b}$ 11.7, $J_{9a,8}$ 2.5, H-9a), 3.72 (1 H, ddd, $J_{4,3ax}$ 11.4, $J_{4,5}$ 9.8, $^3J_{4,3eq}$ 4.7, H-4), 3.64 (1 H, dd, $J_{5,6}$ 10.1, $J_{5,4}$ 9.8, H-5), 3.62 (1 H, dd, $J_{9b,9a}$ 11.7, $J_{9b,8}$ 5.7, H-9), 3.56 (1 H, dd, $J_{6,5}$ 10.1, $J_{6,7}$ 1.9, H-6), 3.49 (1 H, dd, $J_{7,8}$ 9.1, $J_{7,6}$ 1.9, H-7), 2.69 (1 H, dd, $J_{3eq,3ax}$ 12.6, $J_{3eq,4}$ 4.7, H-3_{eq}), 2.64-2.53 (2 H, m, -CH_2-CH=), 2.01 (3 H, s, AcCH_3), 1.51 (1 H, dd, $J_{3ax,3eq}$ 12.6, $J_{3ax,4}$ 11.4, H-3_{ax}); δ_C (125 MHz, [D4]MeOH) 175.52 (Ac*C*=O), 139.21 (arom. C), 133.86 (-CH=*C*H-Ph), 129.37 (arom. C), 127.94 (arom. C), 127.27 (arom. C), 126.32 (-CH_2-*C*H=), 82.54 (C-2), 75.53 (C-6), 73.06 (C-8), 70.40 (C-7), 69.86 (C-4), 64.61 (C-9), 54.53 (C-5), 45.07 (-*C*H_2-CH=), 42.24 (C-3), 22.55 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 410.181492; found: 410.182190.

(*E*)-5-Acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-methoxy-phenyl)-prop-2-enyl)-D-*erythro*-L-*manno*-nononic acid (9b):

Compound **7b** (12 mg, 26 µmol) was saponified according to **GP4** to give **9b** (12 mg, 100%) as a yellow amorphous solid; $[\alpha]_D^{25}$ +7.0 (*c* 0.5 in MeOH); δ_H (400 MHz, D_2O) 7.41 (2 H, d, *J* 8.8, arom. H), 6.97 (2 H, d, *J* 8.8, arom. H), 6.49 (1 H, d, *J* 15.9, -CH=C*H*-Ph), 6.12 (1 H, ddd, *J* 15.9 and 2x 7.5, -CH_2-C*H*=), 3.89 (1 H, ddd, $J_{8,7}$ 8.6, $J_{8,9b}$ 6.2, $J_{8,9a}$ 2.7, H-8), 3.90-3.84 (1 H, m, H-9a), 3.83 (3 H, s, arom. OCH_3), 3.83-3.78 (1 H, m, H-5), 3.74 (1 H, ddd, $J_{4,3ax}$ 11.7, $J_{4,5}$ 10.0, $J_{4,3eq}$ 4.6, H-4), 3.66 (1 H, dd, $J_{6,5}$ 10.2, $J_{6,7}$ 1.5, H-6), 3.66-

3.62 (1 H, m, H-9b), 3.59 (1 H, dd, $J_{7,8}$ 8.6, $J_{7,6}$ 1.5, H-7), 2.66 (1 H, dd, $J_{3eq,3ax}$ 13.0, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.65-2.64 (2 H, m, -CH_2-CH=), 2.05 (3 H, s, AcCH_3), 1.69 (1 H, dd, $J_{3ax,3eq}$ 13.0, $J_{3ax,4}$ 11.7, H-3_{ax}); δ_C (100 MHz, D_2O) 176.75 (*C*=O), 132.95 (-CH=*C*H-Ph), 130.37 (arom. C), 127.58 (arom. C), 121.67 (-CH_2-*C*H=), 114.32 (arom. C), 81.01 (C-2), 73.76 (C-6), 71.90 (C-8), 68.38, 68.35 (C-4, C-7), 62.80 (C-9), 55.43 (arom. O*C*H_3), 52.24 (C-5), 43.05 (-*C*H_2-CH=), 39.71 (C-3), 22.06 (Ac*C*H_3); MS (MALDI-TOF): *m*/*z* = 440.5 ($[M+H]^+$), 462.4 ($[M+Na]^+$), 478.4 ($[M+K]^+$); MS (FAB): *m*/*z* = 462.3 ($[M+Na]^+$), 478.3 ($[M+K]^+$).

(*E,Z*)-5-Acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-nitro-phenyl)-prop-2-enyl)-D-*erythro*-L-*manno*-nononic acid (9c):

Compound **7c** (25 mg, 53 µmol) was saponified according to **GP4** to give **9c** (21 mg, 87%) as a yellow amorphous solid (mixture of *cis*/*trans* isomers 1:10 according to NMR); $[\alpha]_D^{25}$ -2.3 (*c* 0.3 in MeOH); *cis* compound: δ_H (500 MHz, D_2O) 8.22 (2 H, d, *J* 8.5, arom. H), 7.51 (2 H, d, *J* 8.5, arom. H), 6.74 (1 H, d, *J* 12.0, -CH=C*H*-Ph), 5.98 (1 H, ddd, *J* 12.0 and 2x 7.6, -CH_2-C*H*=), 2.90-2.69 (2 H, m, -CH_2-CH=), 2.60 (1 H, dd, $J_{3eq,3ax}$ 13.2, $J_{3eq,4}$ 4.5, H-3_{eq}), 2.04 (3 H, s, AcCH_3), 1.69-1.62 (1 H, m, H-3_{ax}); δ_C not detected; *trans* compound: δ_H (500 MHz, D_2O) 8.18 (2 H, d, *J* 8.0, arom. H), 7.59 (2 H, d, *J* 8.0, arom. H), 6.64 (1 H, d, *J* 15.8, -CH=C*H*-Ph), 6.48 (1 H, ddd, *J* 15.8 and 2x 7.4, -CH_2-C*H*=), 3.92-3.84 (2 H, m, H-8, H-9a), 3.84 (1 H, dd, $J_{5,4}$ 10.1, $J_{5,6}$ 9.9, H-5), 3.75 (1 H, ddd, $J_{4,3ax}$ 11.4, $J_{4,5}$ 10.1, $J_{4,3eq}$ 4.5, H-4), 3.68 (1 H, dd, $J_{6,5}$ 9.9, $J_{6,7}$ 1.1, H-6), 3.65 (1 H, dd, $J_{9a,9b}$ 12.1, $J_{9a,8}$ 6.5, H-9b), 3.59 (1 H, dd, $J_{7,8}$ 8.7, $J_{7,6}$ 1.1, H-7), 2.74 (2 H, d, *J* 7.4, -CH_2-CH=), 2.68 (1 H, dd, $J_{3eq,3ax}$ 13.1, $J_{3eq,4}$ 4.5, H-3_{eq}), 2.05 (3 H, s, AcCH_3), 1.71 (1 H, dd, $J_{3ax,3eq}$ 13.1, $J_{3ax,4}$ 11.5, H-3_{ax}); δ_C (125 MHz, D_2O) 132.17 (-CH=*C*H-Ph), 128.63 (-CH_2-*C*H=), 126.88 (arom. C), 124.06 (arom. C), 73.73 (C-6), 71.82 (C-8), 68.32 (C-7), 68.22 (C-4), 62.75 (C-9), 52.17 (C-5), 43.03 (-*C*H_2-CH=), 39.70 (C-3), 22.04 (Ac*C*H_3); MS (ESI-): *m*/*z* 453.25 ($[M-H]^-$), 907.59 ($[2M-H]^-$).

5-Acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-phenylpropyl)-D-*erythro*-L-*manno*-nononic acid (12):

Compound **10**[11] (4.6 mg, 11 µmol) was saponified according to **GP4** to give **12** (4.5 mg, 100 %) as a white amorphous solid; $[\alpha]_D^{25}$ +9.2 (*c* 0.5 in MeOH); δ_H (500 MHz, D_2O) 7.39-

7.34 (2 H, m, arom. H), 7.30-7.24 (3 H, m, arom. H), 3.88-3.82 (2 H, m, H-8, H-9a), 3.75 (1 H, dd, $J_{5,4}$ 10.2, $J_{5,6}$ 10.2, H-5), 3.67 (1 H, dd, $J_{4,3ax}$ 11.7, $J_{4,5}$ 10.2, $J_{4,3eq}$ 4.6, H-4), 3.65-3.60 (2 H, m, H-6, H-9b), 3.54 (1 H, dd, $J_{7,8}$ 8.5, $J_{7,6}$ 1.6, H-7), 2.66-2.61 (2 H, m, CH_2c), 2.58 (1 H, dd, $J_{3eq,3ax}$ 13.1, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.03 (3 H, s, AcCH_3), 1.79-1.69 (3 H, m, CH_2a, CH_2b), 1.64-1.58 (1 H, m, CH_2b), 1.54 (1 H, dd, $J_{3ax,3eq}$ 13.1, $J_{3ax,4}$ 11.7, H-3_{ax}); δ_C (100 MHz, D_2O) 178.11 (C-1), 175.36 (Ac*C*=O), 142.96 (arom. *C*), 129.00 (arom. C), 128.97 (arom. C), 126.38 (arom. C), 81.28 (C-2), 73.89 (C-6), 72.13 (C-8), 68.83 (C-4), 68.70 (C-7), 63.13 (C-9), 52.66 (C-5), 40.66 (C-3), 39.42 (*C*H_2a), 35.21 (*C*H_2c), 25.22 (*C*H_2b), 22.40 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 412.197142; found: 412.198914.

5-Acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-phenylpropyl)-D-*erythro*-L-*gluco*-nononic acid (13):

Compound **11**[11] (10.4 mg, 24.4 µmol) was saponified according to **GP4** to give **13** (7.2 mg, 72%) as a white amorphous solid; $[\alpha]_D^{25}$ -3.3 (*c* 0.15 in MeOH); δ_H (500 MHz, D_2O) 7.39-7.35 (2 H, m, arom. H), 7.31-7.25 (3 H, m, arom. H), 3.96 (1 H, ddd, $J_{4,3ax}$ 11.4, $J_{4,5}$ 10.2, $J_{4,3eq}$ 4.9, H-4), 3.86 (1 H, ddd, $J_{8,7}$ 8.6, $J_{8,9b}$ 5.6, $J_{8,9a}$ 2.9, H-8), 3.81 (1 H, dd, $J_{9a,9b}$ 12.1, $J_{9a,8}$ 2.9, H-9a), 3.78 (1 H, dd, $J_{5,4}$ 10.2, $J_{5,6}$ 10.2, H-5), 3.68-3.62 (2 H, m, H-6, H-9b), 3.52 (1 H, dd, $J_{7,8}$ 8.6, $J_{7,6}$ 1.6, H-7), 2.72-2.60 (2 H, m, CH_2c), 2.25 (1 H, dd, $J_{3eq,3ax}$ 13.1, $J_{3eq,4}$ 4.9, H-3_{eq}), 2.10-2.04 (1 H, m, CH_2a), 2.03 (3 H, s, AcCH_3), 1.80-1.73 (2 H, m, CH_2a, CH_2b), 1.70 (1 H, dd, $J_{3ax,3eq}$ 13.1, $J_{3ax,4}$ 11.4, H-3_{ax}), 1.48-1.39 (1 H, m, CH_2b); δ_C (100 MHz, D_2O) 178.23 (C-1), 175.18 (Ac*C*=O), 142.66 (arom. C), 129.06 (arom. C), 128.96 (arom. C), 126.41 (arom. C), 80.24 (C-2), 70.69 (C-6), 70.50 (C-8), 68.70 (C-7), 67.47 (C-4), 63.70 (C-9), 52.83 (C-5), 39.94 (C-3), 34.91 (-*C*H_2c), 30.64 (-*C*H_2a), 24.39 (-*C*H_2b), 22.48 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 412.197142; found: 412.198639.

Methyl-5-acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-aminophenyl)-propyl)-D-*erythro*-L-*manno*-nononate (14):

Compound **7c** (49 mg, 0.10 mmol) was hydrogenated according to **GP5** to give **14** (46 mg, 100%) as a colourless oil; $[\alpha]_D^{25}$ 2.4 (*c* 0.5 in MeOH); δ_H (500 MHz, [D4]MeOH) 6.90 (2 H, d, *J* 8.3, arom. H), 6.67 (2 H, d, *J* 8.3, arom. H), 3.85-3.80 (2 H, m, H-8, H-9a), 3.75 (3 H,

s, OCH_3), 3.68 (1 H, dd, $J_{5,4}$ 10.1, $J_{5,6}$ 10.1, H-5), 3.62 (1 H, dd, $J_{9a,9b}$ 12.0, $J_{9a,8}$ 6.3, H-9b), 3.58 (1 H, ddd, $J_{4,3ax}$ 11.7, $J_{4,5}$ 10.1, $J_{4,3eq}$ 4.6, H-4), 3.48 (1 H, dd, $J_{6,5}$ 10.1, $J_{6,7}$ 1.6, H-6), 3.47 (1 H, dd, $J_{7,8}$ 8.7, $J_{7,6}$ 1.6, H-7), 2.56 (1 H, dd, $J_{3eq,3ax}$ 13.1, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.52-2.40 (2 H, m, CH_2c), 1.99 (3 H, s, AcCH_3), 1.79-1.63 (3 H, m, CH_2a, CH_2b), 1.54 (1 H, dd, $J_{3ax,3eq}$ 13.1, $J_{3ax,4}$ 11.7, H-3_{ax}), 1.49-1.38 (1 H, m, CH_2b); δ_C (125 MHz, [D4]MeOH) 175.65 (C-1), 175.27 (Ac*C*=O), 146.05 (arom. C), 133.09 (arom. C), 130.01 (arom. C), 117.06 (arom. C), 81.63 (C-2), 75.75 (C-6), 72.87 (C-8), 70.19 (C-7), 69.08 (C-4), 64.59 (C-9), 54.19 (C-5), 53.06 (O*C*H$_3$), 42.10 (C-3), 40.82 (*C*H$_2$a), 35.77 (*C*H$_2$c), 26.64 (*C*H$_2$b), 22.62 (Ac*C*H$_3$); MS (MALDI-TOF): *m*/*z* 463.8 ([M+Na]$^+$), 479.7 ([M+K]$^+$).

5-Acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-amino-phenyl)-propyl)-D-*erythro*-L-*manno*-nononic acid (15):

Compound **14** (8 mg, 0.02 mmol) was dissolved in water (2 mL) and a few drops of triethylamine were added. The mixture was stirred at room temperature until TLC showed complete conversion. Ethanol was added (2 mL) and the solution was concentrated *in vacuo* to half of its volume before freeze drying. **15** was obtained as its triethylammonium salt (9 mg, 100%); $[\alpha]_D^{25}$ +26.8 (*c* 0.5 in MeOH); δ_H (400 MHz, D_2O) 7.13 (2 H, d, *J* 8.3, arom. H), 6.85 (2 H, d, *J* 8.3, arom. H), 3.88-3.82 (2 H, m, H-8, H-9), 3.72 (1 H, dd, $J_{5,4}$ 9.8, $J_{5,6}$ 9.8, H-5), 3.68-3.60 (2 H, m, H-4, H-9), 3.57 (1 H, dd, $J_{6,5}$ 9.8, $J_{6,7}$ 1.6, H-6), 3.55 (1 H, dd, $J_{7,8}$ 8.6, $J_{7,6}$ 1.6, H-7), 3.21 (6 H, q, *J* 7.3, NCH_2CH$_3$), 2.58 (1 H, dd, $J_{3eq,3ax}$ 12.8, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.58-2.53 (2 H, m, CH_2c), 2.04 (3 H, s, AcCH_3), 1.73-1.52 (3 H, m, CH_2a, CH_2b), 1.48 (1 H, dd, $J_{3ax,3eq}$ 12.8, $J_{3ax,4}$ 11.4, H-3_{ax}), 1.34-1.26 (1 H, m, CH_2b), 1.29 (9 H, t, *J* 7.3, NCH$_2$CH_3); δ_C (100 MHz, D_2O) 129.41 (arom. C), 116.75 (arom. C), 81.89 (C-2), 73.43 (C-6), 72.04 (C-8), 69.01 (C-7), 68.36 (C-4), 62.69 (C-9), 52.44 (C-5), 46.74 (N*C*H$_2$CH$_3$), 41.02 (C-3), 39.34 (*C*H$_2$a), 34.19 (*C*H$_2$c), 25.37 (*C*H$_2$b), 22.01 (Ac*C*H$_3$), 8.26 (NCH$_2$*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for [M+H]$^+$: 427.208041; found: 427.207977.

Methyl-5-acetamido-4,7,8,9-tetra-*O*-acetyl-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-acetamidophenyl)-propyl)-D-*erythro*-L-*manno*-nononate (16):

Compound **14** (13 mg, 30 µmol) was acetylated according to **GP2** to give **16** (20 mg,

100%) as a slightly yellow oil; $[\alpha]_D^{25}$ -14.7 (*c* 1 in $CHCl_3$); δ_H (500 MHz, $CDCl_3$) 7.39 (2 H, d, *J* 8.3, arom. H), 7.10 (2 H, d, *J* 8.3, arom. H), 5.35 (1 H, ddd, $J_{8,7}$ 8.3, $J_{8,9b}$ 5.9, $J_{8,9a}$ 2.4, H-8), 5.31-5.29 (1 H, m, H-7), 5.21 (1 H, br d, $J_{NH,5}$ 9.7, 5-N*H*Ac), 4.78 (1 H, ddd, $J_{4,3ax}$ 11.8, $J_{4,5}$ 10.1, $J_{4,3eq}$ 4.5, H-4), 4.38 (1 H, dd, $J_{9a,9b}$ 12.4, $J_{9a,8}$ 2.4, H-9a), 4.10 (1 H, dd, $J_{9b,9a}$ 12.4, $J_{9b,8}$ 5.9, H-9b), 4.02-3.96 (2 H, m, H-5, H-6), 3.71 (3 H, s, OCH_3), 2.63-2.48 (2 H, m, CH_2c), 2.44 (1 H, dd, $J_{3eq,3ax}$ 12.9, $J_{3eq,4}$ 4.5, H-3_{eq}), 2.16 (3 H, s, AcCH_3), 2.12 (3 H, s, AcCH_3), 2.11 (3 H, s, arom. NHAcCH_3), 2.02 (3 H, s, AcCH_3), 2.00 (3 H, s, AcCH_3), 1.86 (5-NHAcCH_3), 1.77-1.67 (4 H, m, CH_2a, CH_2b, H-3_{ax}), 1.45-1.35 (1 H, m, CH_2b); δ_C (125 MHz, $CDCl_3$) 172.13 (C-1), 171.22, 170.89, 170.37, 170.24 (Ac*C*=O), 137.78, (arom. C), 135.91 (arom. C), 129.02 (arom. C), 120.16 (arom. C), 80.38 (C-2), 73.46 (C-6), 70.34 (C-4), 69.79 (C-8), 68.08 (C-7), 62.60 (C-9), 52.49 (O*C*H_3), 49.87 (C-5), 39.41 (*C*H_2c), 38.03 (C-3), 34.94 (*C*H_2a), 24.65 (*C*H_2b), 23.33 (NHAc*C*H_3), 21.27, 21.04, 20.94 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 651.276515; found: 651.275387.

Methyl-5-acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-acetamidophenyl)-propyl)-D-*erythro*-L-*manno*-nononate (17):

Compound **16** (15 mg, 23 µmol) was deacetylated according to **GP3** to give **17** (6 mg, 54%) as a colourless oil; $[\alpha]_D^{25}$ +0.7 (*c* 1 in MeOH); δ_H (500 MHz, [D4]MeOH) 7.44 (2 H, d, *J* 8.5, arom. H), 7.12 (2 H, d, *J* 8.5, arom. H), 3.87-3.82 (2 H, m, H-8, H-9a), 3.77 (3 H, s, OCH_3), 3.70 (1 H, dd, $J_{5,4}$ 10.1, $J_{5,6}$ 10.1, H-5), 3.64 (1 H, dd, $J_{9b,9a}$ 12.1, $J_{9b,8}$ 6.5, H-9b), 3.63-3.57 (1 H, m, H-4), 3.51 (1 H, dd, $J_{6,5}$ 10.1, $J_{6,7}$ 1.7 Hz, H-6), 3.49 (1 H, dd, $J_{7,8}$ 8.8, $J_{7,6}$ 1.7, H-7), 2.59 (1 H, dd, $J_{3eq,3ax}$ 13.1, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.63-2.53 (2 H, m, CH_2c), 2.11 (3 H, s, arom. NHAcCH_3), 2.01 (3 H, s, NHAcCH_3), 1.82-1.71 (3 H, m, CH_2a, CH_2b), 1.57 (1 H, dd, $J_{3ax,3eq}$ 13.1, $J_{3ax,4}$ 11.6, H-3_{ax}), 1.59-1.48 (1 H, m, CH_2b); δ_C (125 MHz, [D4]MeOH) 174.51 (*C*=O), 139.03 (arom. C), 137.74 (arom. C), 129.70 (arom. C), 121.41 (arom. C), 81.60 (C-2), 75.79 (C-6), 72.88 (C-8), 70.25 (C-7), 69.08 (C-4), 64.64 (C-9), 54.21 (C-5), 53.06 (O*C*H_3), 42.09 (C-3), 40.78 (*C*H_2a), 35.96 (*C*H_2c), 26.38 (*C*H_2b), 23.71 (arom. NHAc*C*H_3), 22.61 (NHAc*C*H_3); MS (MALDI-TOF): *m*/*z* 483.1 ($[M+H]^+$), 505.1 ($[M+Na]^+$), 521.1 ($[M+K]^+$).

5-Acetamido-2,6-anhydro-3,5-dideoxy-2-*C*-(3-(4-acetamido-phenyl)-propyl)-D-*erythro*-L-*manno*-nononic acid (18):

Compound **17** (6 mg, 0.01 mmol) was saponified according to **GP4** to give **18** (4 mg, 69%) as a white amorphous solid; $[\alpha]_D^{25}$ +14.5 (*c* 1, MeOH); δ_H (500 MHz, D_2O) 7.37 (2 H, d, *J* 8.4, arom. H), 7.29 (2 H, d, *J* 8.4, arom. H), 3.92-3.85 (2 H, m, H-8, H-9a), 3.81 (1 H, dd, $J_{5,4}$ 10.4, $J_{5,6}$ 10.2, H-5), 3.73 (1 H, ddd, $J_{4,3ax}$ 11.6, $J_{4,5}$ 10.4, $J_{4,3eq}$ 4.6, H-4), 3.69-3.64 (2 H, m, H-6, H-9b), 3.58 (1 H, dd, $J_{7,8}$ 8.5, $J_{7,6}$ 1.3, H-7), 2.68-2.64 (2 H, m, CH_2c), 2.61 (1 H, dd, $J_{3eq,3ax}$ 13.3, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.19 (3 H, s, arom. NHAcCH_3), 2.06 (3 H, s, NHAcCH_3), 1.86-1.72 (3 H, m, CH_2a, CH_2b), 1.68-1.60 (1 H, m, CH_2b), 1.62 (1 H, dd, $J_{3ax,3eq}$ 13.3, $J_{3eq,4}$ 11.6, H-3_{ax}); δ_C (125 MHz, D_2O) 132.09 (arom. C), 125.23 (arom. C), 83.32 (C-2), 76.57 (C-6), 74.59 (C-8), 71.35 (C-7), 71.10 (C-4), 65.83 (C-9), 55.20 (C-5), 41.75 (C-3), 41.40 (*C*H_2a), 37.15 (*C*H_2c), 27.50 (*C*H_2b), 25.04 (2x NHAc*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 469.218606; found: 469.218689.

Methyl-5-acetamido-2,6-anhydro-8,9-*O*-benzyliden-3,5-dide-oxy-2-*C*-(prop-2-enyl)-D-*erythro*-L-*manno*-nononate (19) and methyl-5-acetamido-2,6-anhydro-7,9-*O*-benzyliden-3,5-dideoxy-2-*C*-(prop-2-enyl)-D-*erythro*-L-*manno*-nononate (20):

Compound **6** (200 mg, 0.576 mmol) and benzaldehyde dimethyl acetal (173 µL, 1.15 mmol) were dissolved in dry acetonitrile. The solution was cooled to 0 °C and a catalytic amount (8 mg, 0.04 mmol) of *p*-toluene sulfonic acid monohydrate was added. The reaction was stirred at room temperature until TLC showed complete consumption of the starting material. After adding a few drops of triethyl amine the solvent was removed *in vacuo* and the products were separated by column chromatography (dichloromethane/ methanol); **19 (**143 mg, 57%, 1:1 mixture of diastereomers**)**: mp 112 °C; $[\alpha]_D^{25}$ +83 (*c* 0.1 in CH_2Cl_2); δ_H (500 MHz, [D4]MeOH) 7.50-7.46 (2 H, m, arom. H), 7.38-7.35 (3 H, m, arom. H), 5.87 (0.5 H, s, PhCH^I), 5.85-5.74 (2 H, m, CH=CH_2^I, CH=CH_2^{II}), 5.76 (1 H, s, PhCH^{II}), 5.12-5.06 (4 H, m, CH=CH_2^I, CH=CH_2^{II}), 4.40-4.34 (2 H, m, H-8), 4.27 (1 H, dd, $J_{9a,9b}$ 8.5, $J_{9a,8}$ 6.7, H-$9a^I$), 4.24 (1 H, dd, $J_{9a,9b}$ 8.3, $J_{9a,8}$ 5.2, H-$9a^{II}$), 4.11 (1 H, dd, $J_{9b,9a}$ 8.5, $J_{9b,8}$ 7.6, H-$9b^I$), 4.09 (1 H, dd, $J_{9b,9a}$ 8.3, $J_{9b,8}$ 7.3, H-$9b^{II}$), 3.82 (1 H, dd, $J_{7,8}$ 5.2, $J_{7,6}$ 1.1, H-7^I), 3.75 (1 H, dd, $J_{5,4}$ 10.2, $J_{5,6}$ 10.2, H-5^I), 3.74 (1 H, dd, $J_{5,4}$ 10.2, $J_{5,6}$ 10.2, H-5^{II}), 3.69-3.59 (3 H, m, H-7^{II}, H-4^I, H-4^{II}), 3.66 (3 H, s, OCH_3), 3.65 (3 H, s, OCH_3), 3.50 (1 H, dd, $J_{6,5}$ 10.2, $J_{6,7}$ 1.1, H-6^{II}), 3.47 (1 H, dd, $J_{6,5}$ 10.2, $J_{6,7}$ 1.1, H-6^I),

2.56-2.44 (6 H, m, CH_2^{I}, CH_2^{II}, H-3$_{eq}^{I}$, H-3$_{eq}^{II}$), 2.01 (3 H, s, AcCH_3), 1.98 (3 H, s, AcCH_3), 1.54 (1 H, dd, $J_{3ax,3eq}$ 12.8, $J_{3ax,4}$ 11.7, H-3$_{ax}$), 1.53 (1 H, dd, $J_{3ax,3eq}$ 12.8, $J_{3ax,4}$ 11.7, H-3$_{ax}$); δ_C (125 MHz, [D4]MeOH) 139.59 (arom. C), 133.21, 133.16 (-*C*H=CH$_2$), 130.31, 130.14, 129.23, 127.97, 127.68 (arom. C), 119.26, 119.17 (-CH=*C*H$_2$), 105.08 (Ph*C*H^{II}), 104.84 (Ph*C*H^{I}), 81.99, 81.88 (C-2), 78.11, 77.92 (C-8), 76.72, 76.31 (C-6), 70.93, 70.89 (C-7), 69.07, 68.92 (C-4), 68.59, 68.48 (C-9), 54.11 (C-5), 52.46, 52.43 (O*C*H$_3$), 45.64, 45.61 (*C*H$_2$), 41.27 (C-3), 22.72 (Ac*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for [M+H]$^+$: 436.197142; found: 436.197968; **20 (**88 mg, 35%**)**: mp 83-84 °C; $[\alpha]_D^{25}$ -21.4 (*c* 0.5 in MeOH); δ_H (500 MHz, [D4]MeOH) 7.59-7.56 (2 H, m, arom. H), 7.37-7.30 (3 H, m, arom. H), 5.88-5.75 (1 H, m, C*H*=CH$_2$), 5.43 (1 H, s, PhC*H*), 5.07-5.03 (2 H, m, CH=C*H*$_2$), 4.27 (1 H, dd, $J_{9a,9b}$ 10.6, $J_{9a,8}$ 5.4, H-9a), 4.04 (1 H, ddd, $J_{8,9b}$ 10.0, $J_{8,7}$ 9.7, $J_{8,9a}$ 5.4, H-8), 4.02 (1 H, dd, $J_{5,6}$ 10.5, $J_{5,4}$ 10.3, H-5), 3.87 (1 H, dd, $J_{6,5}$ 10.5, $J_{6,7}$ 1.1, H-6), 3.74 (3 H, s, OC*H*$_3$), 3.60 (1 H, ddd, $J_{4,3ax}$ 11.9, $J_{4,5}$ 10.3, $J_{4,3eq}$ 4.7, H-4), 3.56 (1 H, dd, $J_{9b,9a}$ 10.6, $J_{9b,8}$ 10.0, H-9b), 3.55 (1 H, dd, $J_{7,8}$ 9.7, $J_{7,6}$ 1.1, H-7), 2.54-2.42 (3 H, m, C*H*$_2$, H-3$_{eq}$), 1.99 (3 H, s, AcC*H*$_3$), 1.54 (1 H, dd, $J_{3ax,3eq}$ 12.8, $J_{3ax,4}$ 11.9, H-3$_{ax}$); δ_C (125 MHz, [D4]MeOH) 133.41 (-*C*H=CH$_2$), 129.50, 128.84, 127.50 (arom. C), 118.89 (-CH=*C*H$_2$), 102.24 (Ph*C*H), 81.77 (C-2), 80.78 (C-7), 73.16 (C-6), 72.62 (C-9), 69.76 (C-4), 61.36 (C-8), 52.75 (C-5), 52.55 (O*C*H$_3$), 45.58 (*C*H$_2$), 41.11 (C-3), 22.93 (Ac*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for [M+H]$^+$: 436.197142; found: 436.197968.

Methyl-5-acetamido-2,6-anhydro-9-*O*-benzyl-3,5-dideoxy-2-*C*-(prop-2-enyl)-D-*erythro*-L-*manno*-nononate (21):

Compound **19** (160 mg, 367 µmol), trimethyl amine borane adduct (0.11 g, 1.5 mmol) and aluminium chloride (294 mg, 2.20 mmol) were dissolved in 8.4 mL dry tetrahydrofurane. After stirring for 5 min water (9.9 µL, 0.55 mmol) was added and the reaction was stirred at room temperature for 4 hours. After TLC showed complete consumption of starting material the reaction was stopped by adding water (4.2 mL) and 0.1 molar HCl (4.2 mL). The solution was diluted with dichloromethane (42 mL) and washed twice with 5% sodium bicarbonate solution (2x 20 mL) and with water (20 mL). The organic phase was dried over sodium sulphate, filtrated and concentrated in vacuo. The residue was purified by column chromatography (dichloromethane/methanol) to give **21** (82 mg, 51%) as a white solid; mp 101 °C; $[\alpha]_D^{25}$ -104 (*c* 0.2 in CH_2Cl_2); δ_H (500 MHz, [D4]MeOH) 7.38-7.31 (5 H, m, arom. H), 5.84-5.74 (1 H, m, C*H*=CH$_2$), 5.11-5.06 (2 H, m, CH=C*H*$_2$), 4.59-4.57

(2 H, m, PhCH_2), 3.97 (1 H, ddd, $J_{8,7}$ 8.8, $J_{8,9b}$ 5.7, $J_{8,9a}$ 2.3, H-8), 3.78 (1 H, dd, $J_{9a,9b}$ 10.3, $J_{9a,8}$ 2.3, H-9a), 3.75 (3 H, s, OCH_3), 3.70 (1 H, dd, $J_{5,4}$ 10.2, $J_{5,6}$ 10.2, H-5), 3.65-3.58 (1 H, m, H-4), 3.62 (1 H, dd, $J_{9b,9a}$ 10.3, $J_{9b,8}$ 5.7, H-9b), 3.55 (1 H, dd, $J_{7,8}$ 8.8, $J_{7,6}$ 1.4, H-7), 3.51 (1 H, dd, $J_{6,5}$ 10.2, $J_{6,7}$ 1.4, H-6), 2.57 (1 H, dd, $J_{3eq,3ax}$ 13.2, $J_{3eq,4}$ 4.6, H-3_{eq}), 2.54-2.44 (2 H, m, CH_2), 1.98 (3 H, s, AcCH_3), 1.45 (1 H, dd, $J_{3ax,3eq}$ 13.2, $J_{3ax,4}$ 11.4, H-3_{ax}); δ_C (100 MHz, [D4]MeOH) 175.22 (C-1), 139.85 (arom C), 132.94 (-*C*H=CH_2), 129.33 (arom. C), 128.84 (arom. C), 128.59 (arom. C), 119.37 (-CH=*C*H_2), 81.75 (C-2), 75.78 (C-6), 74.41 (Ph*C*H_2), 72.90 (C-9), 71.82 (C-8), 70.16 (C-7), 69.04 (C-4), 54.17 (C-5), 52.95 (O*C*H_3), 45.71 (*C*H_2), 41.45 (C-3), 22.63 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 438.212792; found: 438.211823.

5-Acetamido-2,6-anhydro-9-*O*-benzyl-3,5-dideoxy-2-*C*-(prop-2-enyl)-D-*erythro*-L-*manno*-nononic acid (22):

Compound **21** (62 mg, 0.14 mmol) was saponified according to **GP4** to give **22** (60 mg, 100%) as a white solid; mp 147 °C; $[\alpha]_D^{25}$ -22 (*c* 0.1 in H_2O); δ_H (500 MHz, [D4]MeOH) 7.37-7.23 (5 H, m, arom. H), 5.94-5.85 (1 H, m, C*H*=CH_2), 5.08-4.99 (2 H, m, CH=CH_2), 4.59 (1 H, d, *J* 12.3, PhCH_2a), 4.54 (1 H, d, *J* 12.3, PhCH_2b), 3.99 (1 H, ddd, $J_{8,7}$ 8.8, $J_{8,9b}$ 5.7, $J_{8,9a}$ 2.2, H-8), 3.76 (1 H, dd, $J_{9a,9b}$ 10.4, $J_{9a,8}$ 2.2, H-9a), 3.70 (1 H, ddd, $J_{4,3ax}$ 11.4, $J_{4,5}$ 9.8, $J_{4,3eq}$ 4.7, H-4), 3.61 (1 H, dd, $J_{5,6}$ 0.4, $J_{5,4}$ 9.8, H-5), 3.60 (1 H, dd, $J_{9b,9a}$ 10.4, $J_{9b,8}$ 5.7, H-9b), 3.54 (1 H, dd, $J_{6,5}$ 10.4, $J_{6,7}$ 1.9, H-6), 3.52 (1 H, dd, $J_{7,8}$ 8.8, $J_{7,6}$ 1.9, H-7), 2.63 (1 H, dd, $J_{3eq,3ax}$ 12.6, $J_{3eq,4}$ 4.7, H-3_{eq}), 2.48-2.38 (2 H, m, CH_2), 1.99 (3 H, s, AcCH_3), 1.45 (1 H, dd, $J_{3ax,3eq}$ 12.6, $J_{3ax,4}$ 11.4, H-3_{ax}); δ_C (125 MHz, [D4]MeOH) 175.47 (Ac*C*=O), 134.62 (*C*H=CH_2), 129.29 (arom. C), 128.80 (arom. C), 128.51 (arom. C), 117.87 (CH=*C*H_2), 75.31 (C-6), 74.30 (Ph*C*H_2), 72.75 (C-9), 71.98 (C-8), 70.34 (C-7), 69.78 (C-4), 54.47 (C-5), 45.95 (*C*H_2), 42.16 (C-3), 22.54 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 424.197142; found: 424.196808.

Methyl-5-acetamido-4,7,8-tri-*O*-acetyl-2,6-anhydro-9-*O*-benzyl-3,5-dideoxy-2-*C*-(prop-2-enyl)-D-*erythro*-L-*manno*-nononate (23):

Compound **21** (17 mg, 39 µmol) was acetylated according to **GP2** to give **23** (22 mg, 100%) as a white amorphous solid; $[\alpha]_D^{25}$ +106 (*c* 0.1 in $CHCl_3$); δ_H (500 MHz, $CDCl_3$) 7.42-7.31 (5 H, m, arom. H), 5.79-5.68 (1 H, m, C*H*=CH_2), 5.37-5.32 (2 H, m, H-7, H-8), 5.09

(1 H, dd, *J* 10.3, *J* 1.5, CH=CH_2a), 5.04 (1 H, dd, *J* 16.9, *J* 1.5, CH=CH_2b), 4.88-4.81 (1 H, m, H-4), 4.54-4.46 (2 H, m, PhCH_2), 4.00-3.96 (2 H, m, H-5, H-6), 3.78 (1 H, dd, $J_{9a,9b}$ 11.0, $J_{9a,8}$ 2.3, H-9a), 3.73 (3 H, s, OCH_3), 3.50 (1 H, dd, $J_{9b,9a}$ 11.0, $J_{9b,8}$ 5.3, H-9b), 2.46 (1 H, dd, $J_{3eq,3ax}$ 12.9, $J_{3eq,4}$ 4.6, H-3$_{eq}$), 2.45-2.42 (2 H, m, CH_2), 2.13 (3 H, s, AcCH_3), 2.05 (3 H, s, AcCH_3), 2.01 (3 H, s, AcCH_3), 1.87 (3 H, s, NHAcCH_3), 1.76 (1 H, dd, $J_{3ax,3eq}$ 12.9, $J_{3ax,4}$ 11.9, H-3$_{ax}$); δ_C (100 MHz, $CDCl_3$) 131.51 (*C*H=CH_2), 128.49, 128.01 (arom. C), 119.29 (CH=*C*H_2), 80.77 (C-2), 73.72 (C-6), 73.34 (Ph*C*H_2), 70.50 (C-4), 70.39 (C-8), 68.76 (C-9), 68.63 (C-7), 52.40 (O*C*H_3), 49.88 (C-5), 44.34 (*C*H_2), 37.26 (C-3), 23.40 (NHAc*C*H_3), 21.07 (Ac*C*H_3), 20.97 (Ac*C*H_3), 20.79 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 564.244487; found: 564.243652.

(*E*)-Methyl-5-acetamido-4,7,8,9-tetra-*O*-acetyl-2,6-anhydro-9-*O*-benzyl-3,5-dideoxy-2-*C*-(3-phenylprop-2-enyl)-D-*erythro*-L-*manno*-nononate (24):

Compound **23** (18 mg, 32 µmol) was reacted with styrene (36 µl, 0.31 mmol) using catalyst **1** (3.6 mg, 4.2 µmol) according to **GP1** to give **24** (16 mg, 78%) as a colourless oil; $[\alpha]_D^{25}$ +37 (*c* 0.1 in CH_2Cl_2); δ_H (500 MHz, $CDCl_3$) 7.40-7.19 (10 H, m, arom. H), 6.36 (1 H, d, *J* 15.9, CH=C*H*-Ph), 6.22-6.14 (1 H, m, C*H*=CH-Ph), 5.43-5.37 (1 H, m, H-8), 5.38 (1 H, dd, $J_{7,8}$ 7.3, $J_{7,6}$ 1.8, H-7), 5.12 (1 H, d, $J_{NH,5}$ 9.5, N*H*), 4.85 (1 H, ddd, $J_{4,3ax}$ 11.9, $J_{4,5}$ 9.9, $J_{4,3eq}$ 4.6, H-4), 4.53-4.45 (2 H, m, PhCH_2), 4.04 (1 H, dd, $J_{6,5}$ 10.8, $J_{6,7}$ 1.8, H-6), 4.01 (1 H, ddd, $J_{5,6}$ 10.8, $J_{5,4}$ 9.9, $J_{5,NH}$ 9.5, H-5), 3.79 (1 H, dd, $J_{9a,9b}$ 10.9, $J_{9a,8}$ 3.0, H-9a), 3.71 (3 H, s, OCH_3), 3.51 (1 H, dd, $J_{9b,9a}$ 10.9, $J_{9b,8}$ 5.4, H-9b), 2.67-2.54 (2 H, m, CH_2), 2.51 (1 H, dd, $J_{3eq,3ax}$ 12.9, $J_{3eq,4}$ 4.6, H-3$_{eq}$), 2.12 (3 H, s, AcCH_3), 2.05 (3 H, s, AcCH_3), 2.01 (3 H, s, AcCH_3), 1.87 (3 H, s, NHAcCH_3), 2.51 (1 H, dd, $J_{3ax,3eq}$ 12.9, $J_{3ax,4}$ 11.9, H-3$_{ax}$); δ_C (100 MHz, $CDCl_3$) 171.78, 171.15, 170.54, 170.21 (Ac*C*=O), 134.19 (CH=*C*H-Ph), 128.66, 128.47, 128.02, 127.77, 127.62, 126.52 (arom. C), 122.97 (-*C*H=CH-Ph), 80.76 (C-2), 73.76 (C-6), 73.38 (Ph*C*H_2), 70.39 (C-4), 70.36 (C-8), 68.86 (C-9), 68.67 (C-7), 52.51 (O*C*H_3), 49.91 (C-5), 43.64 (*C*H_2), 37.47 (C-3), 23.39 (NHAc*C*H_3), 21.40 (Ac*C*H_3), 21.05 (Ac*C*H_3), 20.95 (Ac*C*H_3); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 640.275787; found: 640.277527.

(*E*)-Methyl-5-acetamido-2,6-anhydro-9-*O*-benzyl-3,5-dideoxy-2-*C*-(3-phenylprop-2-enyl)-D-*erythro*-L-*manno*-nononate (25):

Compound **24** (12 mg, 19 µmol) was deacetylated according to **GP3** to give **25** (10 mg, 100%) as a white solid; mp 108 °C; $[\alpha]_D^{25}$ -42 (*c* 0.2 in MeOH); δ_H (500 MHz, [D4]MeOH) 7.36-7.30 (6 H, m, arom. H), 7.28-7.24 (3 H, m, arom. H), 7.20-7.17 (1 H, m, arom. H), 6.45 (1 H, d, *J* 15.8, CH=C*H*-Ph), 6.20 (1 H, ddd, *J* 15.8 and 2x 7.5, C*H*=CH-Ph), 4.56-4.53 (2 H, m, PhCH_2), 4.03 (1 H, ddd, $J_{8,7}$ 8.4, $J_{8,9b}$ 5.9, $J_{8,9a}$ 2.3, H-8), 3.81 (1 H, dd, $J_{9a,9b}$ 10.3, $J_{9a,8}$ 2.3, H-9a), 3.73 (1 H, dd, $J_{5,4}$ 10.1, $J_{5,6}$ 10.1, H-5), 3.67-3.61 (1 H, m, H-4), 3.63 (1 H, dd, $J_{9b,9a}$ 10.3, $J_{9b,8}$ 5.9, H-9b), 3.56 (1 H, dd, $J_{7,8}$ 8.4, $J_{7,6}$ 1.6, H-7), 3.54 (1 H, dd, $J_{6,5}$ 10.1, $J_{6,7}$ 1.6, H-6), 2.66-2.63 (2 H, m, CH_2), 2.62 (1 H, dd, $J_{3eq,3ax}$ 13.0, $J_{3eq,4}$ 4.6, H-3_{eq}), 1.99 (3 H, s, AcCH_3), 1.66 (1 H, dd, $J_{3ax,3eq}$ 13.0, $J_{3ax,4}$ 11.6, H-3_{ax}); δ_C (125 MHz, [D4]MeOH) 175.19 (Ac*C*=O), 175.14 (C-1), 139.84 (arom. C), 138.58 (arom. C), 135.29 (CH=*C*H-Ph), 129.55 (arom. C), 129.33 (arom. C), 128.84 (arom. C), 128.58 (arom. C), 128.45 (arom. C), 127.29 (arom. C), 124.12 (-*C*H=CH-Ph), 82.05 (C-2), 75.81 (C-6), 74.34 (Ph*C*H_2), 72.92 (C-9), 71.79 (C-8), 70.24 (C-7), 69.10 (C-4), 54.15 (C-5), 53.07 (O*C*H_3), 44.78 (*C*H_2), 41.50 (C-3), 22.64 (Ac*C*H_3); MS (MALDI-TOF): *m*/*z* 514.5 ($[M+H]^+$), 536.5 ($[M+Na]^+$), 552.4 ($[M+K]^+$).

(*E*)-5-Acetamido-2,6-anhydro-9-*O*-benzyl-3,5-dideoxy-2-*C*-(3-phenylprop-2-enyl)-D-*erythro*-L-*manno*-nononic acid (26):

Compound **25** (3.7 mg, 7.2 µmol) was saponified according to **GP4** to give **26** (3.6 mg, 100%) as a white solid; mp 129-130 °C; $[\alpha]_D^{25}$ -33 (*c* 0.1 in H_2O); δ_H (500 MHz, [D4]MeOH) 7.37-7.29 (6 H, m, arom. H), 7.27-7.21 (3 H, m, arom. H), 7.18-7.13 (1 H, m, arom. H), 6.44 (1 H, d, *J* 15.9, CH=C*H*-Ph), 6.36-6.28 (1 H, m, -C*H*=CH-Ph), 4.59-4.51 (2 H, m, PhCH_2), 4.05 (1 H, ddd, $J_{8,7}$ 8.9, $J_{8,9b}$ 5.8, $J_{8,9a}$ 2.0, H-8), 3.77 (1 H, dd, $J_{9a,9b}$ 10.4, $J_{9a,8}$ 2.0, H-9a), 3.72 (1 H, ddd, $J_{4,3ax}$ 11.9, $J_{4,5}$ 10.3, $J_{4,3eq}$ 4.7, H-4), 3.65 (1 H, dd, $J_{5,4}$ 10.3, $J_{5,6}$ 9.9, H-5), 3.61 (1 H, dd, $J_{9b,9a}$ 10.4, $J_{9b,8}$ 5.8, H-9b), 3.58 (1 H, dd, $J_{6,5}$ 9.9, $J_{6,7}$ 1.8, H-6), 3.54 (1 H, dd, $J_{7,8}$ 8.9, $J_{7,6}$ 1.8, H-7), 2.68 (1 H, dd, $J_{3eq,3ax}$ 12.8, $J_{3eq,4}$ 4.7, H-3_{eq}), 2.65-2.55 (2 H, m, CH_2), 2.00 (3 H, s, AcCH_3), 1.53 (1 H, dd, $J_{3ax,3eq}$ 12.8, $J_{3ax,4}$ 11.9, H-3_{ax}); δ_C (100 MHz, [D4]MeOH) 134.14 (CH=*C*H-Ph), 129.39, 129.27, 128.80, 128.48, 127.99, 127.27 (arom. C), 125.98 (*C*H=CH-Ph), 82.29 (C-2), 75.45 (C-6), 74.23 (Ph*C*H_2), 72.81 (C-9), 71.99 (C-8), 70.43 (C-7), 69.78 (C-4), 54.48 (C-5), 44.99 (*C*H_2),

42.21 (C-3), 22.55 (Ac*C*H$_3$); MS (MALDI-TOF): *m*/*z* 500.4 ([M+H]$^+$), 522.4 ([M+Na]$^+$), 538.4 ([M+K]$^+$).

(*E*)-Methyl-5-acetamido-2,6-anhydro-3,5-dideoxy-8,9-*O*-iso-propyliden-2-*C*-(3-phenylprop-2-enyl)-D-*erythro*-L-*manno*-nononate (27):

Compound **7a** (80 mg, 0.19 mmol) was dissolved in dry acetone (27 ml) under argon atmosphere. After addition of 2,2-dimethoxy propane (240 µl, 1.95 mmol) and ion exchanger (DOWEX 50x8, H^+, 80 mg) the solution was stirred overnight at room temperature. When the consumption of starting material was complete (TLC) the yellow solution was filtered, the solvent removed in vacuo and the residue purified by column chromatography (dichloromethane/ methanol, containing 0.5% triethyl amine) to give **27** (70 mg, 80%); mp 178 °C; $[\alpha]_D^{25}$ +47 (*c* 0.15 in CH_2Cl_2); δ_H (400 MHz, $CDCl_3$) 7.34-7.26 (4 H, m, arom. H), 7.24-7.19 (1 H, m, arom. H), 6.41 (1 H, d, *J* 15.9, CH=C*H*-Ph), 6.08 (1 H, ddd, *J* 15.9 and 2x 7.5, -C*H*=CH-Ph), 5.62 (1 H, d, $J_{NH,5}$ 7.7, N*H*), 4.32 (1 H, ddd, $J_{8,7}$ 6.4, $J_{8,9a}$ 6.3, $J_{8,9b}$ 6.3, H-8), 4.14 (1 H, dd, $J_{9a,9b}$ 8.6, $J_{9a,8}$ 6.3, H-9a), 4.07 (1 H, dd, $J_{9b,9a}$ 8.6, $J_{9b,8}$ 6.3, H-9b), 3.80 (1 H, ddd, $J_{5,6}$ 10.1, $J_{5,4}$ 10.0, $J_{5,NH}$ 7.7, H-5), 3.75-3.66 (1 H, m, H-4), 3.71 (3 H, s, OC*H*$_3$), 3.58 (1 H, dd, $J_{7,8}$ 6.4, $J_{7,6}$ 1.0, H-7), 3.37 (1 H, dd, $J_{6,5}$ 10.1, $J_{6,7}$ 1.0, H-6), 2.73-2.60 (3 H, m, C*H*$_2$, H-3$_{eq}$), 2.05 (3 H, s, AcC*H*$_3$), 1.62 (1 H, dd, $J_{3ax,3eq}$ 13.0, $J_{3ax,4}$ 11.0, H-3$_{ax}$), 1.40 (3 H, s, C(C*H*$_3$)$_2$), 1.37 (3 H, s, C(C*H*$_3$)$_2$); δ_C (100 MHz, $CDCl_3$) 173.10, 172.85 (Ac*C*=O), 137.10 (arom. C), 134.38 (CH=*C*H-Ph), 128.71, 127.69, 126.41 (arom. C), 122.79 (-*C*H=CH-Ph), 108.71 (*C*(CH$_3$)$_2$), 81.11 (C-2), 75.74 (C-8), 75.55 (C-6), 70.16 (C-7), 79.11 (C-4), 66.89 (C-9), 53.86 (C-5), 52.29 (O*C*H$_3$), 43.64 (C*H*$_2$), 40.50 (C-3), 26.98, 25.70 (C(*C*H$_3$)$_2$), 23.40 (Ac*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for [M+H]$^+$: 464.228442; found: 464.228058.

(*E*)-Methyl-5-acetamido-2,6-anhydro-3,5-dideoxy-8,9-*O*-iso-propyliden-2-*C*-(3-phenylprop-2-enyl)-D-*glycero*-D-*galacto*-non-4-ulosonate (28):

Compound **27** (70 mg, 0.15 mmol) was dissolved in dry dichloromethane (4 mL). After addition of powdered mol sieve (4Å, 280 mg) and pyridinium chlorochromate (130 mg, 603 µmol) the solution was stirred at room temperature until TLC showed complete conversion. The solution was diluted with diethyl ether, filtrated and concentrated in vacuo. The residue was purified by column chromatography (dichloromethane/methanol)

to give **28** (45 mg, 65%) as a colourless oil; $[\alpha]_D^{25}$ +21 (*c* 0.2 in CH_2Cl_2); δ_H (500 MHz, $CDCl_3$) 7.38-7.29 (5 H, m, arom. H), 6.47 (1 H, d, *J* 15.7, CH=C*H*-Ph), 6.15 (1 H, d, *J* 15.7, *J* 7.5, -C*H*=CH-Ph), 4.67 (1 H, dd, $J_{5,6}$ 10.7, $J_{5,NH}$ 6.8, H-5), 4.09 (1 H, ddd, $J_{8,7}$ 9.0, $J_{8,9b}$ 5.2, $J_{8,9a}$ 3.7, H-8), 3.96 (1 H, dd, $J_{9a,9b}$ 11.2, $J_{9a,8}$ 3.7, H-9a), 3.78 (1 H, dd, $J_{9b,9a}$ 11.2, $J_{9b,8}$ 5.2, H-9b), 3.76 (3 H, s, OCH_3), 3.63 (1 H, dd, $J_{6,5}$ 10.7, $J_{6,7}$ 1.6, H-6), 3.53 (1 H, dd, $J_{7,8}$ 9.0, $J_{7,6}$ 1.6, H-7), 3.22 (1 H, d, $J_{3a,3b}$ 14.0, H-3a), 2.84-2.76 (3 H, m, H-3b, CH_2), 2.09 (3 H, s, AcCH_3), 1.37 (3 H, s, C(CH_3)$_2$), 1.36 (3 H, s, C(CH_3)$_2$); δ_C (125 MHz, $CDCl_3$) 135.63 (CH=*C*H-Ph), 128.68, 127.97, 126.39 (arom. C), 121.21 (*C*H=CH-Ph), 111.89 (*C*(CH$_3$)$_2$), 83.47 (C-2), 78.54 (C-6), 70.62 (C-8), 70.10 (C-7), 64.56 (C-9), 56.95 (C-5), 53.36 (O*C*H$_3$), 46.63 (C-3), 44.04 (*C*H$_2$), 27.74, 26.42 (C(*C*H$_3$)$_2$), 23.15 (Ac*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 462.212792; found: 462.211456.

Methyl-5-acetamido-2,6-anhydro-3,4,5-trideoxy-4-ethoxy-carbonylmethyliden-8,9-*O*-isopropyliden-2-*C*-((*E*)-3-phenyl-prop-2-enyl)-D-*glycero*-D-*galacto*-nononate (29):

Compound **28** (36 mg, 78 µmol) was dissolved in dry tetrahydrofurane and ethoxycarbonylmethylene triphenyl-phosphorane (54 mg, 0.16 mmol) was added under argon atmosphere. The solution was stirred for 24 hours at room temperature. When TLC showed complete conversion the solution was filtered, concentrated in vacuo and the residue was purified by column chromatography (dichloromethane/methanol) to give **29** (19 mg, 45%) as a white solid; mp 122 °C; $[\alpha]_D^{25}$ -38 (*c* 0.15 in MeOH); δ_H (500 MHz, [D4]MeOH) 7.37-7.35 (2 H, m, arom. H), 7.30-7.26 (2 H, m, arom. H), 7.22-7.18 (1 H, m, arom. H), 6.47 (1 H, d, *J* 15.9, CH=C*H*-Ph), 6.23 (1 H, ddd, *J* 15.9 and 2x 7.5, -C*H*=CH-Ph), 5.76 (1 H, dd, *J* 1.3 and 1.2, =*H*C-CO$_2$Et), 4.72 (1 H, dd, $J_{5,6}$ 10.4, *J* 1.2, H-5), 4.46 (1 H, d, $J_{3a,3b}$ 13.9, H-3a), 4.26 (1 H, ddd, $J_{8,9b}$ 7.0, $J_{8,9a}$ 6.5, $J_{8,7}$ 5.2, H-8), 4.19-4.13 (2 H, m, OCH_2CH$_3$), 4.09 (1 H, dd, $J_{9a,9b}$ 8.4, $J_{9a,8}$ 6.5, H-9a), 4.04 (1 H, dd, $J_{9b,9a}$ 8.4, $J_{9b,8}$ 7.0, H-9b), 3.82 (1 H, dd, $J_{6,5}$ 10.4, $J_{6,7}$ 1.2, H-6), 3.76 (1 H, dd, $J_{7,8}$ 5.2, $J_{7,6}$ 1.2, H-7), 3.62 (3 H, s, OCH_3), 2.71 (2 H, d, *J* 7.5, -CH_2CH=), 2.30 (1 H, dd, $J_{3b,3a}$ 13.9, *J* 1.3, H-3b), 2.03 (3 H, s, AcCH_3), 1.39 (3 H, s, C(CH_3)$_2$), 1.33 (3 H, s, C(CH_3)$_2$), 1.26 (3 H, t, *J* 7.1, OCH$_2$CH_3); δ_C (125 MHz, [D4]MeOH) 154.62 (C-4), 135.19 (CH=*C*H-Ph), 129.55, 128.44, 127.27 (arom. *C*), 124.43 (-*C*H=CH-Ph), 114.90 (=H*C*-CO$_2$Et), 84.66 (C-2), 78.25 (C-6), 78.23 (C-8), 70.74 (C-7), 67.17 (C-9), 61.21 (O*C*H$_2$CH$_3$), 52.35 (O*C*H$_3$), 51.81 (C-5), 44.45 (-*C*H$_2$CH=), 36.92 (C-3), 26.92, 25.78 (C(*C*H$_3$)$_2$), 22.73 (Ac*C*H$_3$), 14.56 (OCH$_2$*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 532.254657; found: 532.253052.

Methyl-5-acetamido-2,6-anhydro-3,4,5-trideoxy-4-ethoxy-carbonylmethyl-8,9-*O*-isopropyliden-2-*C*-(3-phenylpropyl)-D-*erythro*-L-*manno*-nononate (30):

Compound **29** (60 mg, 0.11 mmol), was hydrogenated according to **GP5** to give **30** (60 mg, 100%) as a white solid; mp 115 °C; $[\alpha]_D^{25}$ -73 (*c* 0.1 in MeOH); δ_H (500 MHz, [D4]MeOH) 7.27-7.22 (2 H, m, arom. H), 7.18-7.13 (3 H, m, arom. H), 4.22 (1 H, ddd, $J_{8,7}$ 7.0, $J_{8,9b}$ 6.9, $J_{8,9a}$ 6.5, H-8), 4.15-4.08 (2 H, m, OCH_2CH$_3$), 4.04 (1 H, dd, $J_{9a,9b}$ 8.4, $J_{9a,8}$ 6.5, H-9a), 3.97 (1 H, dd, $J_{9b,9a}$ 8.4, $J_{9b,8}$ 6.9, H-9b), 3.73-3.67 (1 H, m, H-5), 3.71 (3 H, s, OCH_3), 3.61 (1 H, dd, $J_{7,8}$ 7.0, $J_{7,6}$ 1.5, H-7), 3.54 (1 H, dd, $J_{6,5}$ 9.9, $J_{6,7}$ 1.5, H-6), 2.65-2.51 (2 H, m, CH_2c), 2.49 (1 H, dd, *J* 15.4 and 4.3, CH_2CO$_2$Et), 2.33 (1 H, dd, $J_{3eq,3ax}$ 13.4, $J_{3eq,4}$ 3.6, H-3$_{eq}$), 2.11 (1 H, dd, *J* 15.4 and 8.7, CH_2CO$_2$Et), 2.03-1.96 (1 H, m, H-4), 1.94 (3 H, s, AcCH_3), 1.73-1.68 (3 H, m, CH_2a, CH_2b), 1.54-1.46 (1 H, m, CH_2b), 1.41-1.33 (1 H, m, H-3$_{ax}$), 1.37 (3 H, s, C(CH_3)$_2$), 1.33 (3 H, s, C(CH_3)$_2$), 1.25 (3 H, t, *J* 7.1, OCH$_2$CH_3); δ_C (125 MHz, [D4]MeOH) 129.41 (arom. C), 129.35 (arom. C), 126.87 (arom. C), 109.54 (*C*(CH$_3$)$_2$), 81.61 (C-2), 78.05 (C-8), 77.04 (C-6), 70.55 (C-7), 67.09 (C-9), 61.64 (O*C*H$_2$CH$_3$), 52.40 (C-5), 50.52 (O*C*H$_3$), 40.67 (*C*H$_2$a), 38.88 (C-3), 38.77 (*C*H$_2$CO$_2$Et), 36.69 (*C*H$_2$c), 36.28 (C-4), 26.96 (C(*C*H$_3$)$_2$), 26.62 (*C*H$_2$b), 25.81 (C(*C*H$_3$)$_2$), 22.55 (Ac*C*H$_3$), 14.54 (OCH$_2$*C*H$_3$); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 536.285957; found: 536.286560.

Methyl-5-acetamido-2,6-anhydro-3,4,5-trideoxy-4-ethoxy-carbonylmethyl-2-*C*-(3-phenylpropyl)-D-*erythro*-L-*manno*-nononate (31):

Compound **30** (58 mg, 0.11 mmol) was suspended in water and a catalytic amount of ion exchanger (DOWEX 50x8, H^+) was added. The suspension was stirred overnight at 60 °C and became clear during the course of the reaction. After TLC showed complete consumption of the starting material the solution was filtered and freeze dried to give **31** (40 mg, 75%) as a white solid; mp 62 °C; $[\alpha]_D^{25}$ -42 (*c* 0.1 in MeOH); δ_H (500 MHz, [D4]MeOH) 7.26-7.22 (2 H, m, arom. H), 7.16-7.13 (3 H, m, arom. H), 4.18-4.08 (2 H, m, OCH_2CH$_3$), 3.86-3.80 (2 H, m, H-8, H-9a), 3.79 (3 H, s, OCH_3), 3.69 (1 H, dd, $J_{5,4}$ 10.5, $J_{5,6}$ 10.2, H-5), 3.65-3.60 (1 H, m, H-9b), 3.58 (1 H, dd, $J_{6,5}$ 10.2, $J_{6,7}$ 1.5, H-6), 3.49 (1 H, dd, $J_{7,8}$ 8.6, $J_{7,6}$ 1.5, H-7), 2.62-2.51 (3 H, m, CH_2c, CH_2CO$_2$H), 2.43 (1 H, dd, $J_{3eq,3ax}$ 13.3, $J_{3eq,4}$ 3.7, H-3$_{eq}$), 2.19-2.12 (1 H, m, CH_2CO$_2$H), 2.04-1.98 (1 H, m, H-4), 1.96 (3 H, s, AcCH_3), 1.75-1.67 (3 H, m, CH_2a, CH_2b), 1.50-1.41 (1 H, m, CH_2b), 1.45 (1 H, dd,

$J_{3ax,3eq}$ 13.3, $J_{3ax,4}$ 12.7, H-3_{ax}), 1.26 (3 H, t, *J* 7.1, OCH_2CH_3); δ_C (100 MHz, [D4]MeOH) 179.27 (C-1), 175.86 (CH_2CO_2Et), 129.42 (arom. C), 129.36 (arom. C), 126.88 (arom. C), 81.54 (C-2), 76.59 (C-6), 73.05 (C-8), 70.26 (C-7), 64.57 (C-9), 61.67 (OCH_2CH_3), 52.97 (OCH_3), 50.51 (C-5), 43.66 (CH_2a), 39.19 (C-3), 38.51 (CH_2CO_2Et), 36.63 (CH_2c), 36.41 (C-4), 26.49 (CH_2b), 22.51 ($AcCH_3$), 14.55 (OCH_2CH_3); MS (MALDI-TOF): *m*/*z* 496.5 ($[M+H]^+$), 518.5 ($[M+Na]^+$), 534.4 ($[M+K]^+$).

5-Acetamido-2,6-anhydro-3,4,5-trideoxy-4-carboxymethyl-2-*C*-(3-phenylpropyl)-D-*erythro*-L-*manno*-nononic acid (32):

Compound **31** (40 mg, 81 µmol) was saponified according to **GP4** to give **32** (18 mg, 49%) as a white solid; mp 183-185 °C; $[\alpha]_D^{25}$ -32.2 (c 0.45 in MeOH); δ_H (400 MHz, [D4]MeOH) 7.23-7.07 (5 H, m, arom. H), 3.86 (1 H, ddd, $J_{8,7}$ 8.9, $J_{8,9b}$ 5.6, $J_{8,9a}$ 2.6, H-8), 3.80 (1 H, dd, $J_{9a,9b}$ 11.3, $J_{9a,8}$ 2.6, H-9a), 3.62-3.56 (2 H, m, H-6, H-9b), 3.46 (1 H, dd, $J_{7,8}$ 8.9, $J_{7,6}$ 2.1, H-7), 3.44 (1 H, dd, $J_{5,4}$ 10.4, $J_{5,6}$ 10.4, H-5), 2.58-2.52 (2 H, m, CH_2c), 2.52 (1 H, dd, $J_{3eq,3ax}$ 13.2, $J_{3eq,4}$ 3.5, H-3_{eq}), 2.34 (1 H, dd, *J* 14.5 and 5.4 Hz, CH_2COOH), 2.16-2.09 (1 H, m, H-4), 2.04 (1 H, dd, *J* 14.5 and 6.6, CH_2COOH), 1.96 (3 H, s, $AcCH_3$), 1.88-1.59 (4 H, m, CH_2a, CH_2b), 1.26 (1 H, dd, $J_{3ax,3eq}$ 13.2, $J_{3ax,4}$ 12.3, H-3_{ax}). δ_C (100 MHz, [D4]MeOH) 179.86 (C-1), 175.26 (CH_2COOH), 129.47 (arom. C), 129.16 (arom. C), 126.51 (arom. C), 82.78 (C-2), 76.89 (C-6), 72.95 (C-8), 70.79 (C-7), 64.67 (C-9), 52.98 (C-5), 42.52 (CH_2a), 41.92 (CH_2COOH), 41.12 (C-3), 37.40 (CH_2c), 37.03 (C-4), 27.24 (CH_2b), 22.49 ($AcCH_3$); HRMS (FAB): *m*/*z* calcd. for $[M+H]^+$: 454.207707; found: 454.209564.

Affinity measurements by SPR

Immobilisation of the enzyme on the sensor chip:

120 µL of a TcTS solution in phosphate buffer (100 mM, pH 7.5, 0.17 mg/mL) was diluted with 880 µL of acetate buffer (10 mM, pH 6.06). A commercial CM5 sensor chip (BIACORE) was activated in the BIACORE T100 instrument by flushing with EDC/NHS solution for 10 min. and the enzyme was immobilised on the chip by automatically injecting the prepared solution for 10 min. This step was repeated once (for 20 min) to yield an overall response of approximately 12000 RU (response units). The flow rate in all steps was 10µL/min. The chip can be stored in buffer solution at 4 °C for months without losing activity.

Surface plasmon resonance measurements:

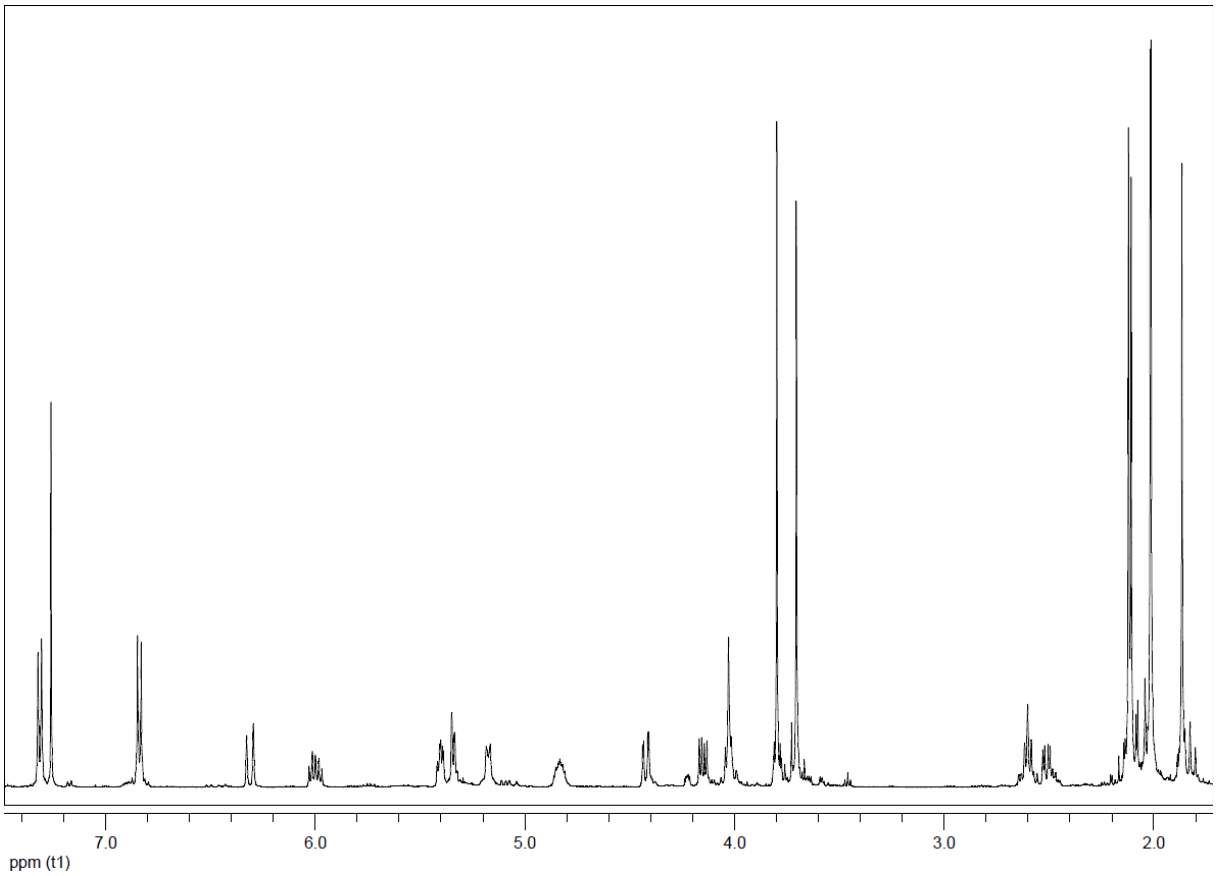
The ligand was dissolved in running buffer (Tris-HCl, 100 mM, pH 7.46) to yield a 5 mM solution. Different concentrations needed for SPR measurements were made by diluting the solution with running buffer.

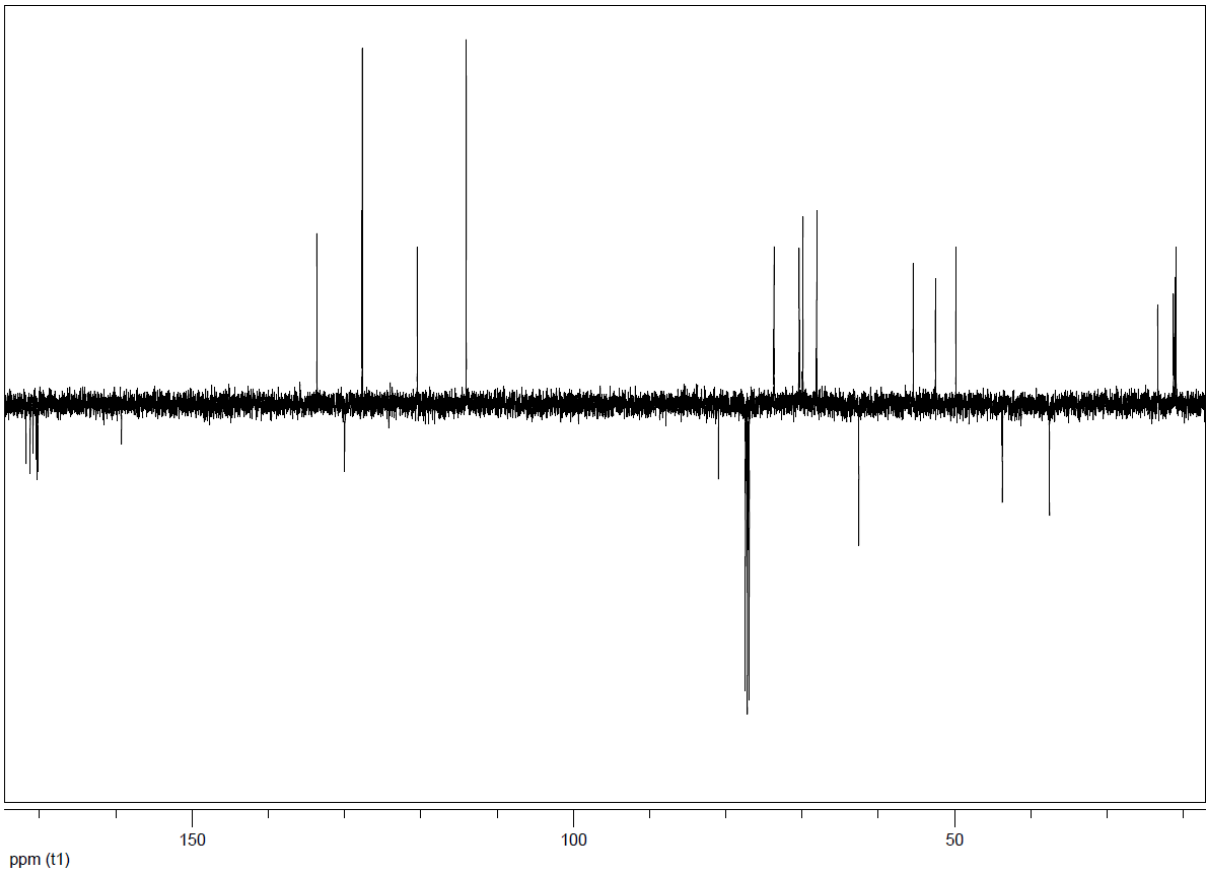
The affinity measurements were conducted by injecting the concentrations into the BIACORE T100 instrument (contact time 180 seconds) at a flow rate of 20 µL/min, followed by flushing with buffer (dissociation time 300 sec). A washing step was included between ligand injections. The response was in a range of about 40 to 200 RU for the highest concentrations of the measured ligands.

NMR based inhibition assay

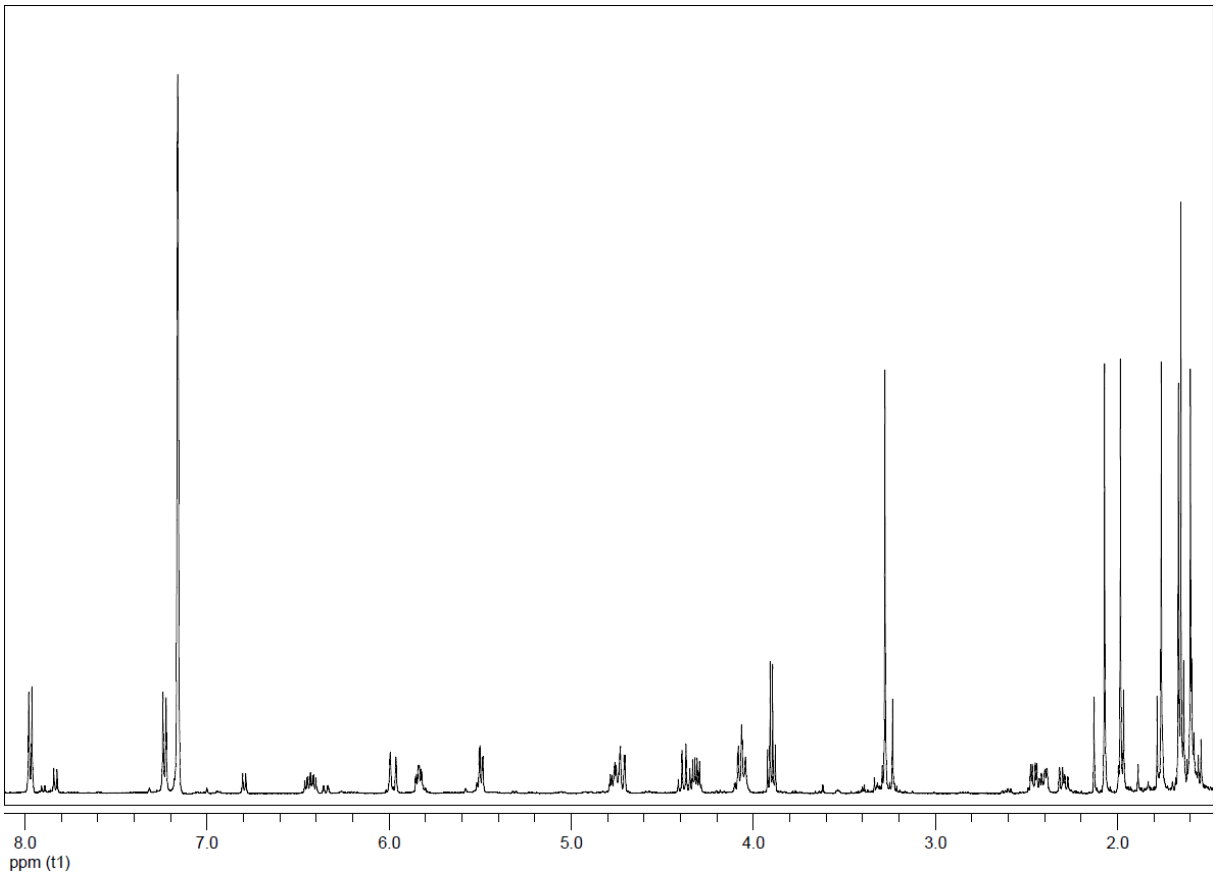
TRIS-HCl buffer (100 mM, pH 7.5) was lyophilised and redissolved in the same volume of D_2O twice. The same was done to a solution of TcTS (0.9 mg/mL) in TRIS-HCl buffer. Methyl α-allolactoside (35 µmol) and *p*NP-sialoside (25 µmol)[27] were dissolved in 1 mL of TRIS-HCl (D_2O) and 80 µL of the TcTS solution (D_2O) were added. The mixture was incubated at 23 °C. Samples (100 µL) were taken after the indicated reaction time (scheme 8) and added to previously prepared NMR tubes containing a 1:1 mixture of D_2O/[D4]MeOH. The ratio of free *p*-nitrophenol to *p*NP-sialoside was determined by the ratio of integrated aromatic proton signals in the proton NMR spectra. Since hydrolysis can be neglected in the presence of a suitable acceptor molecule,[3] conversion rates can be measured easily with this method.

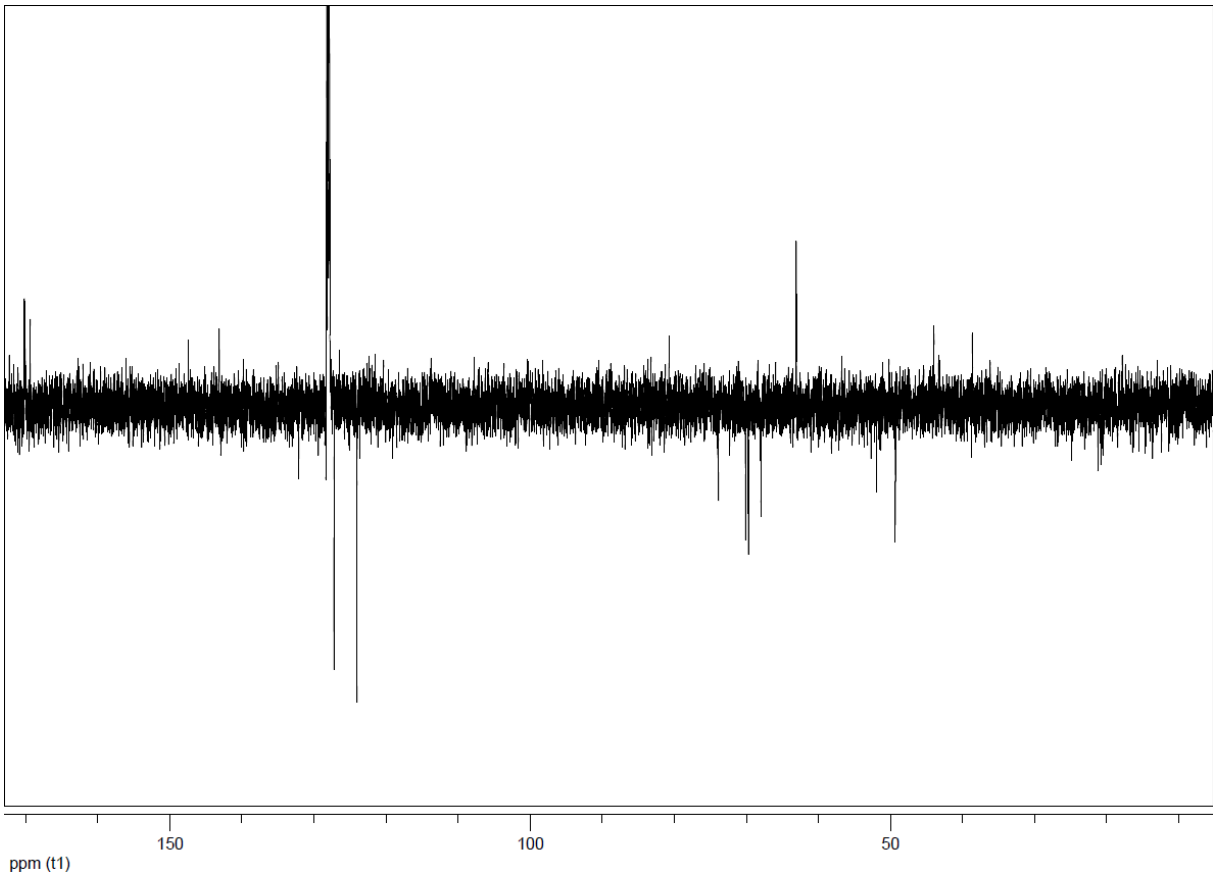
Compound **5b**



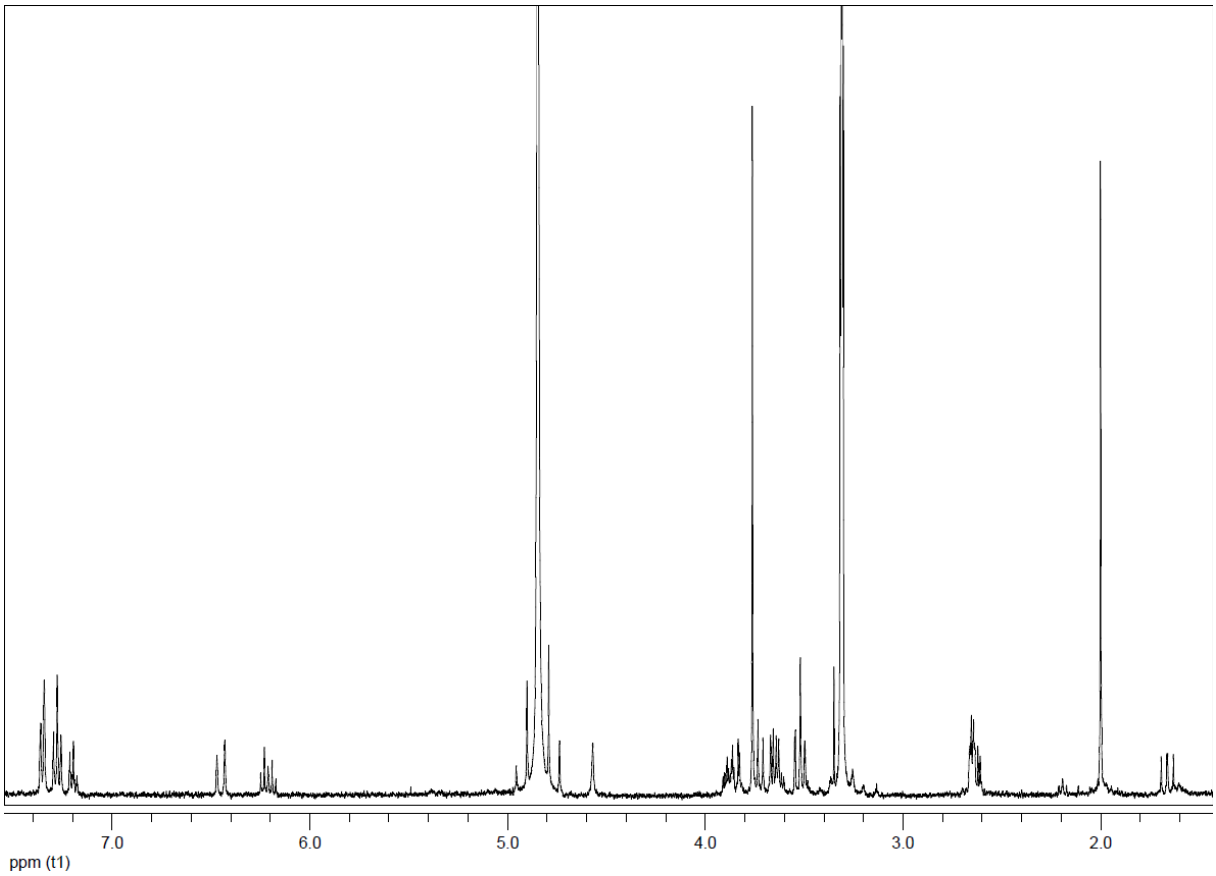


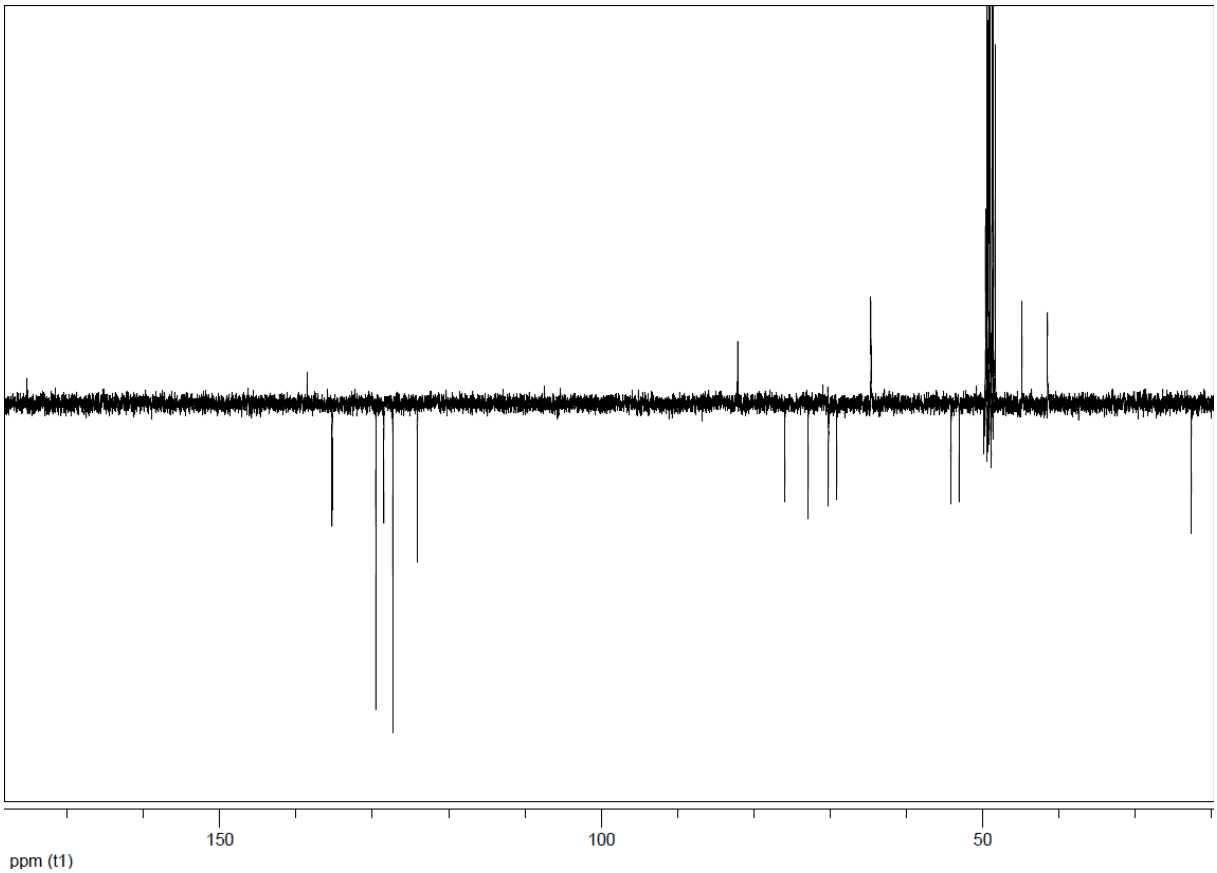
Compound **5c**



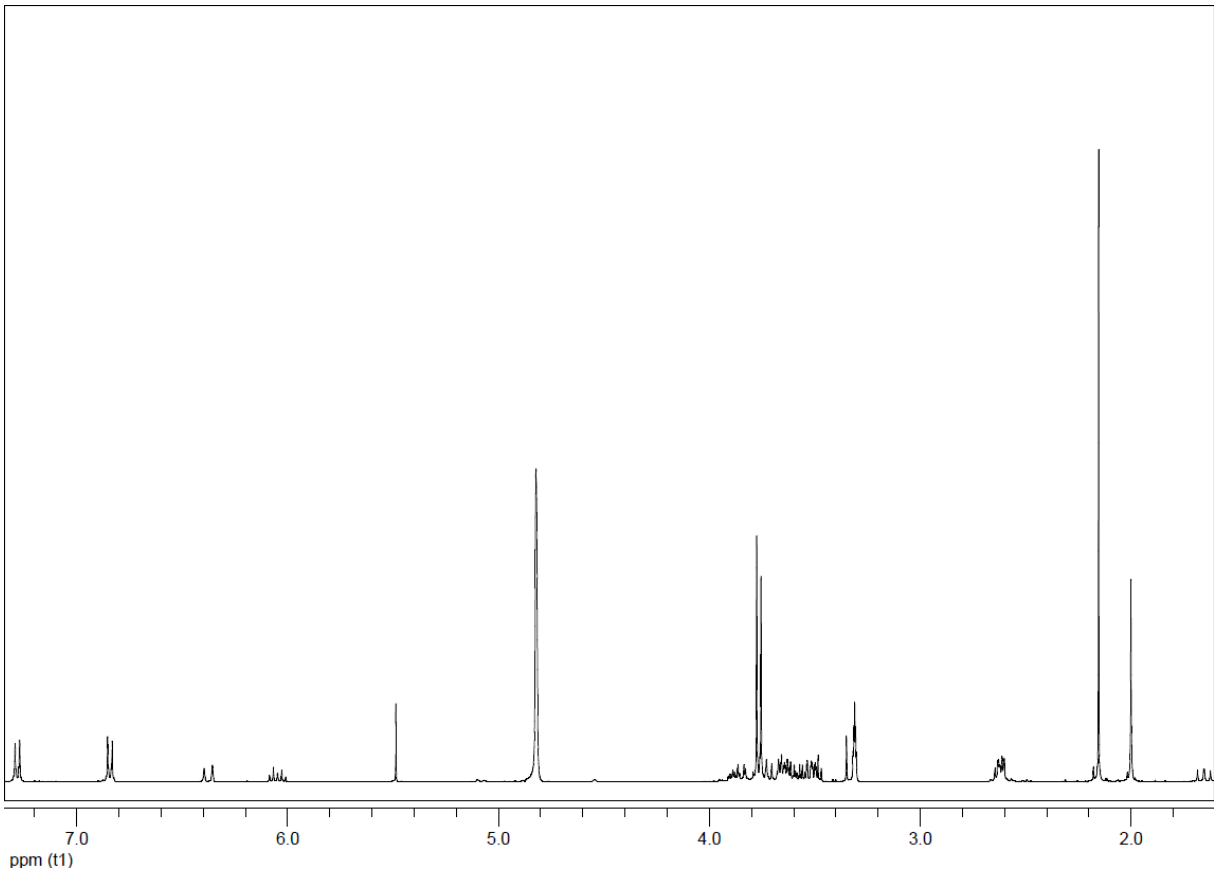


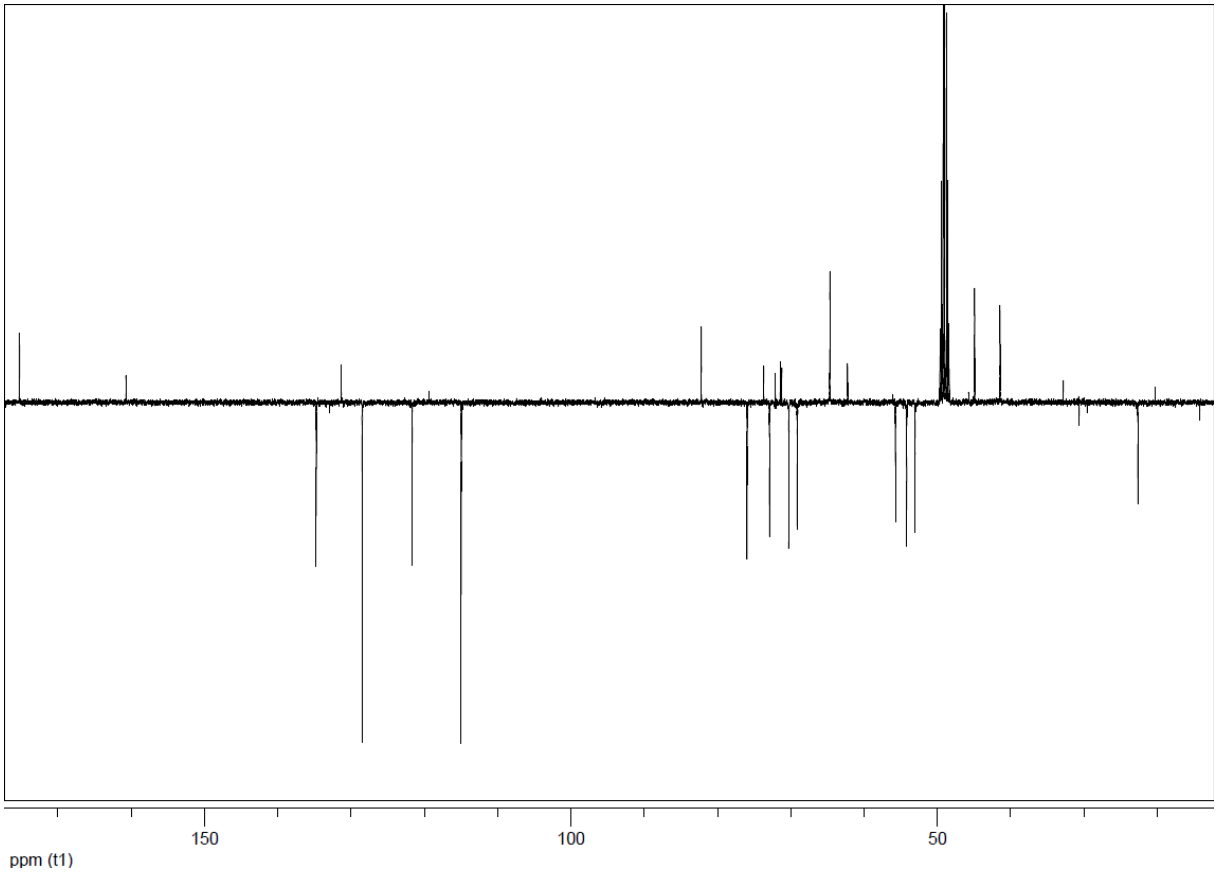
Compound **7a**





Compound **7b**





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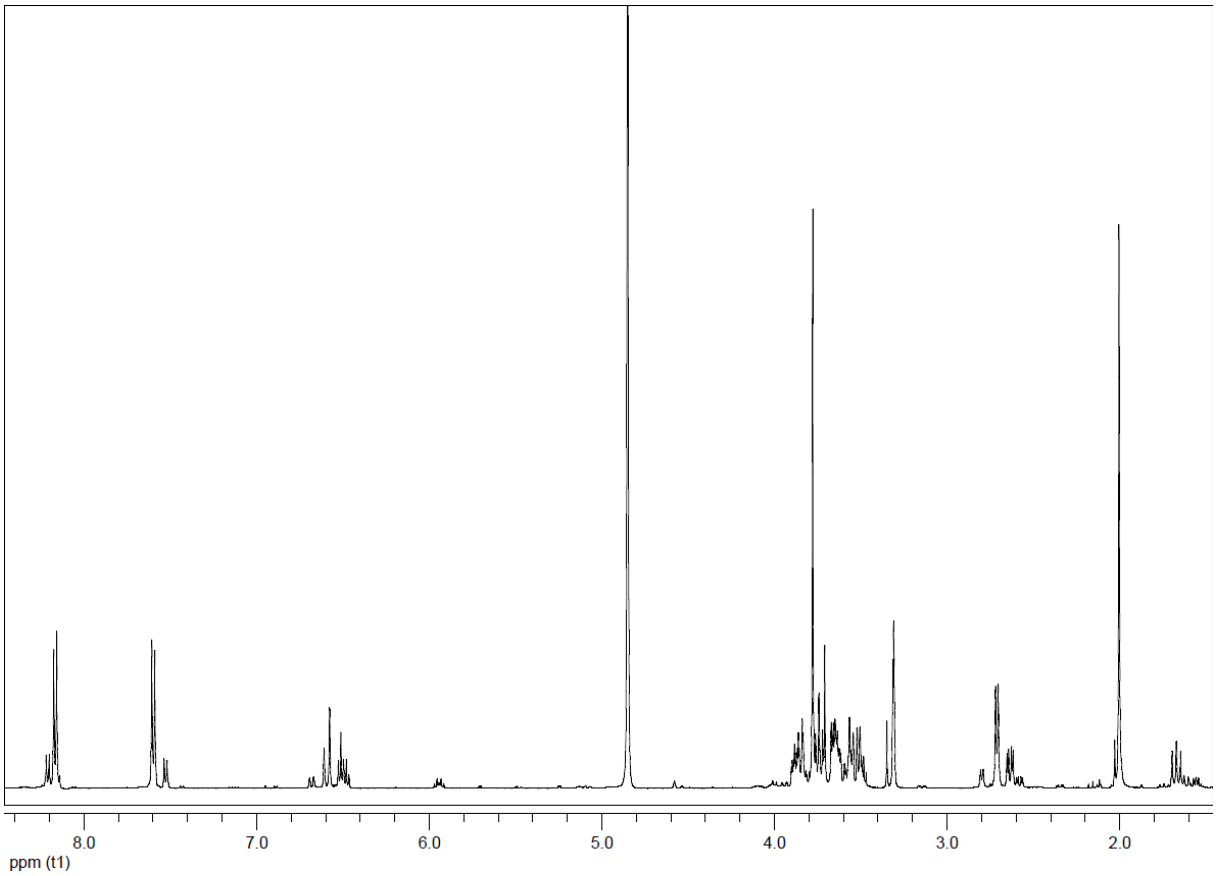
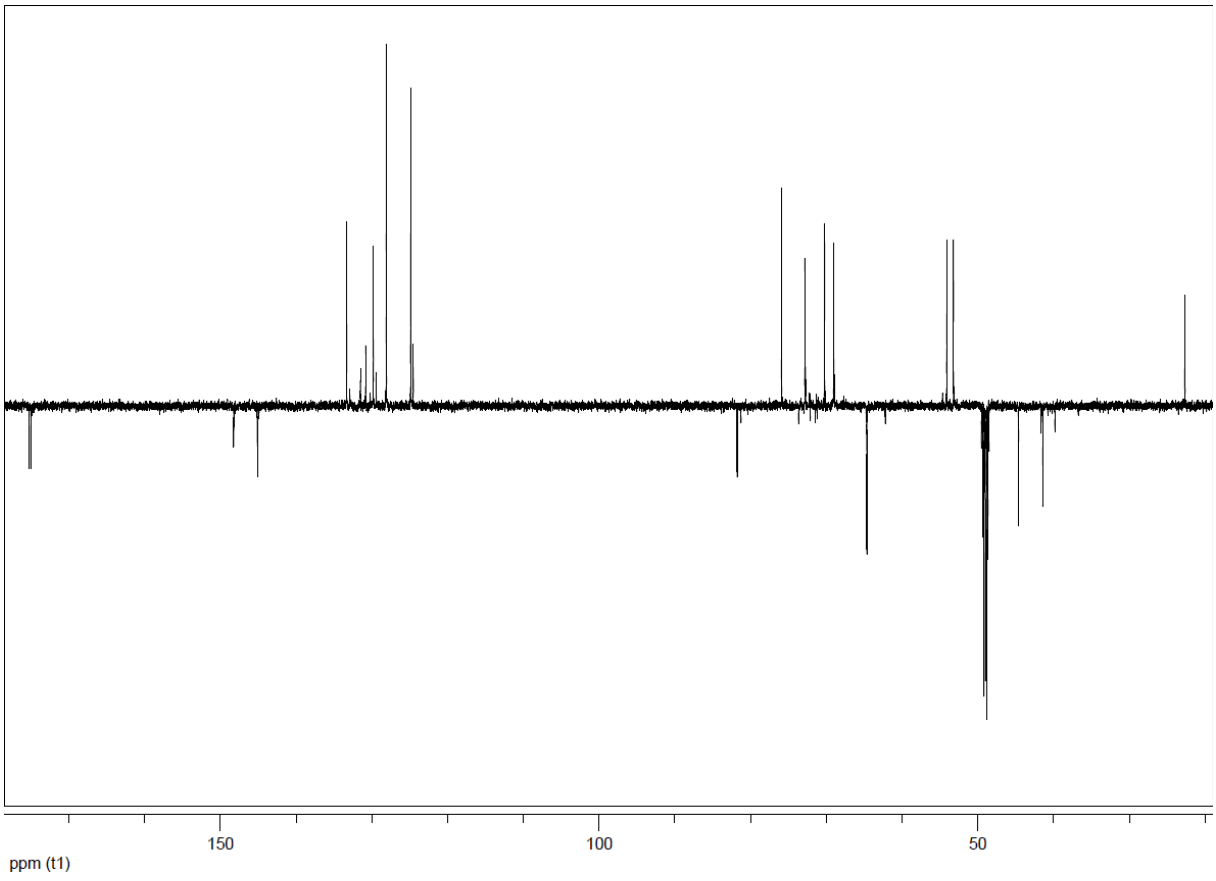
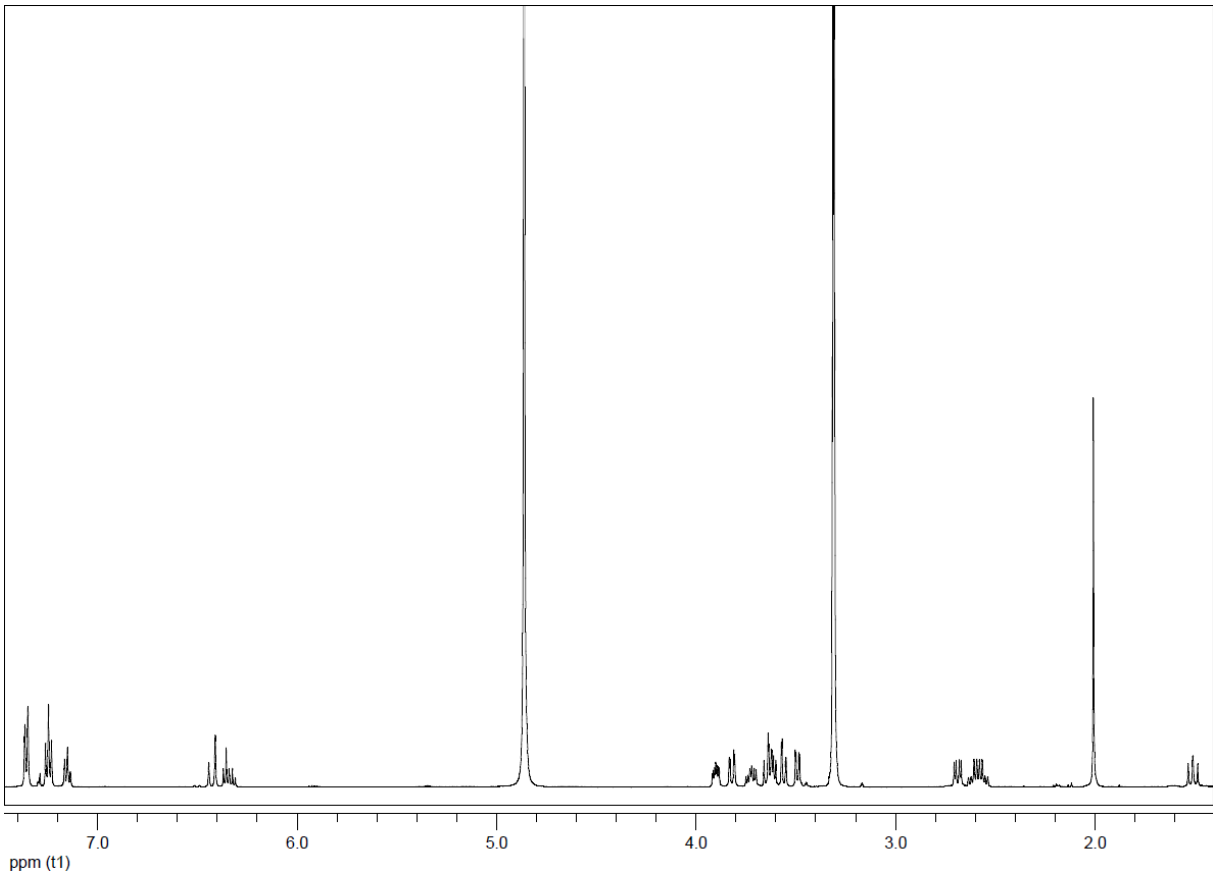
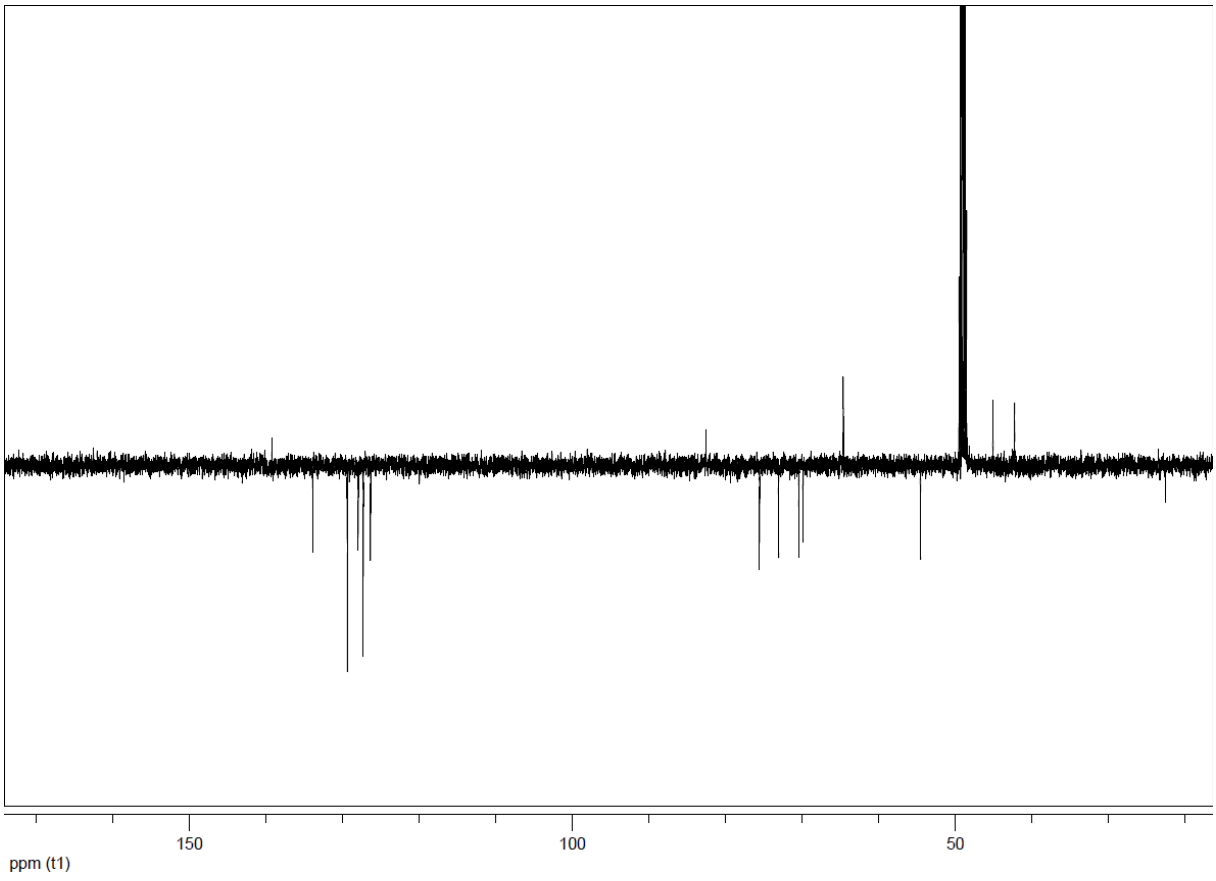


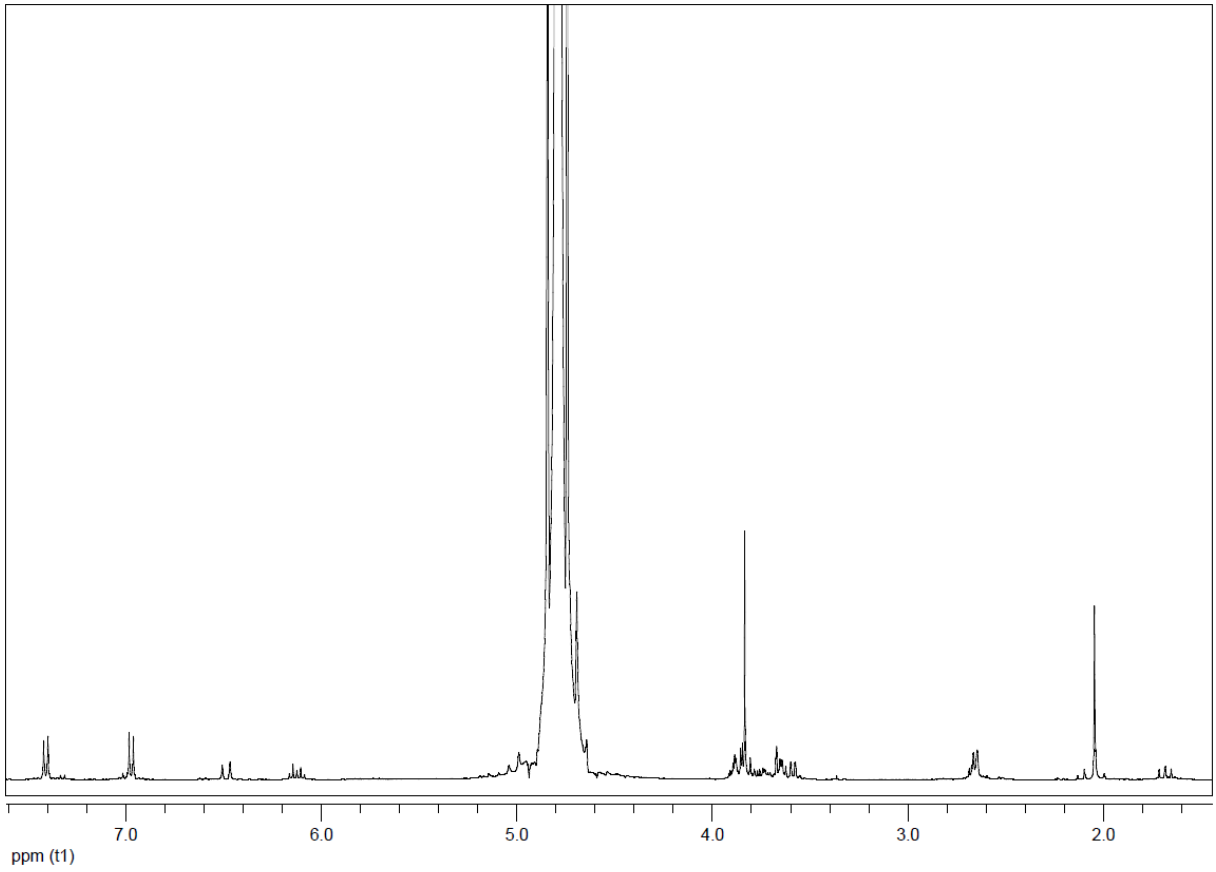


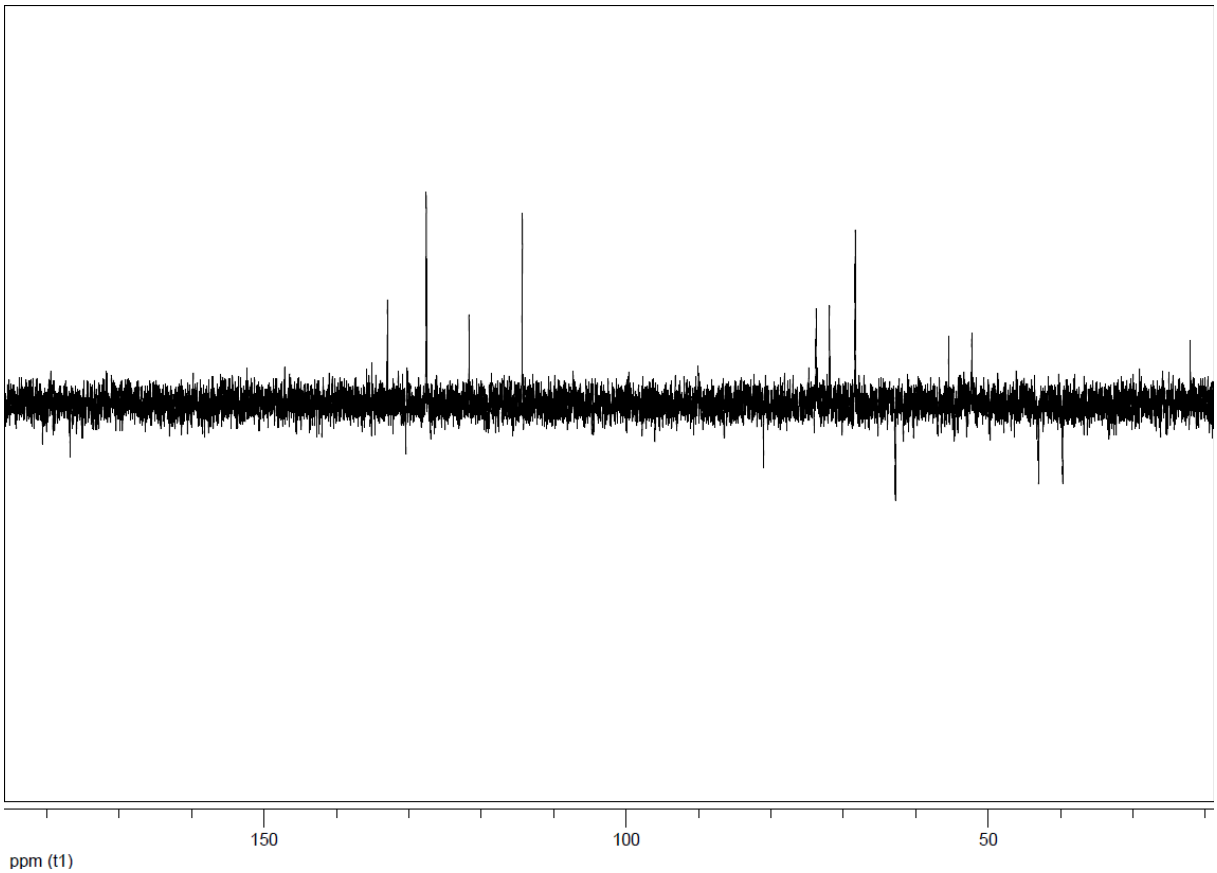
Compound **9a**



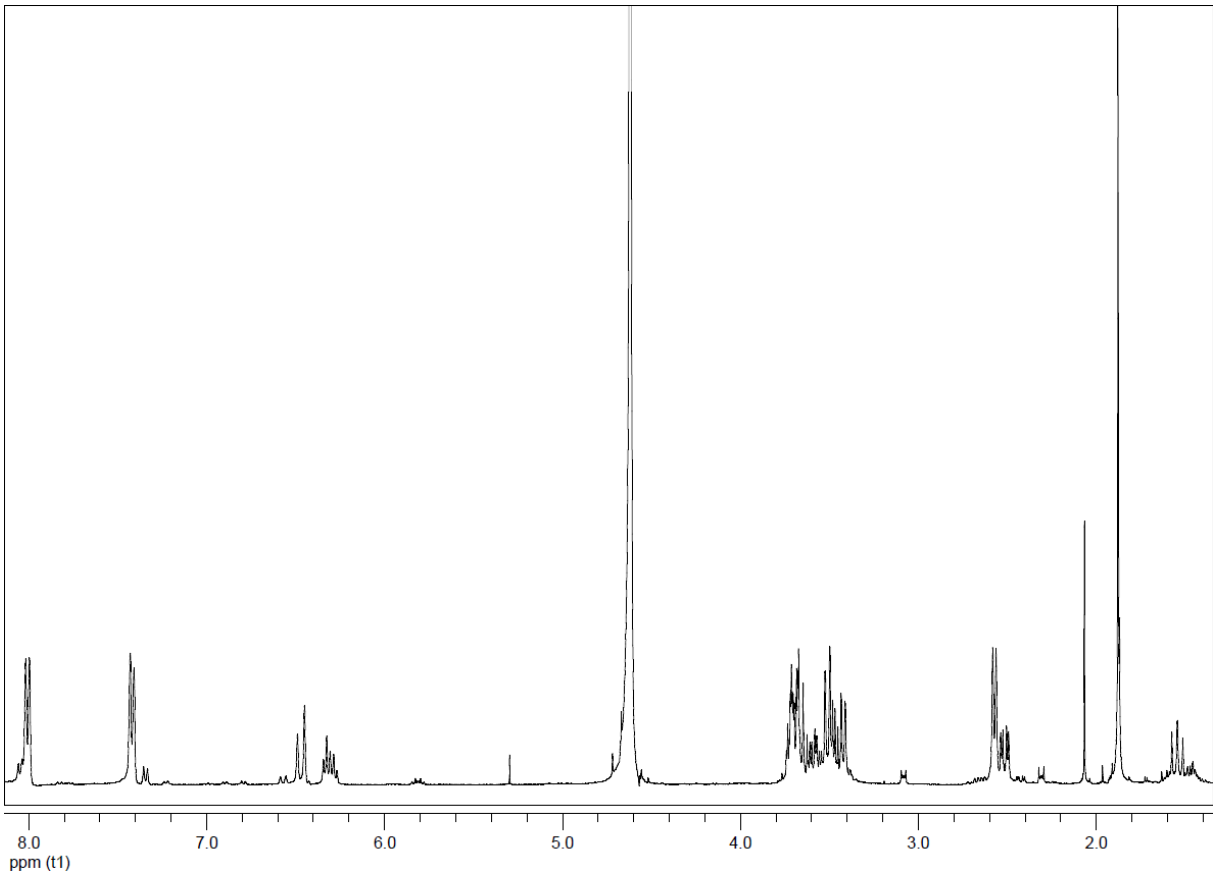


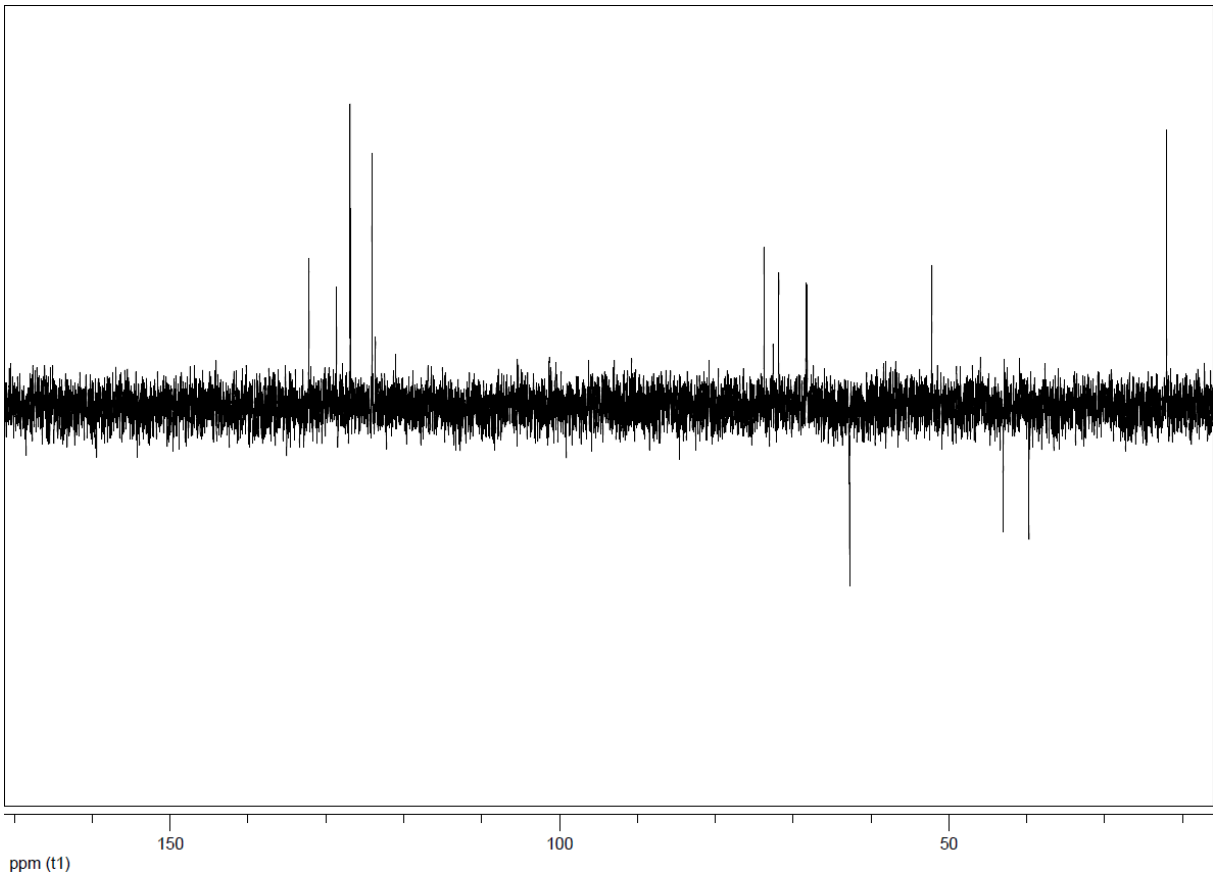
Compound **9b**





Compound **9c**





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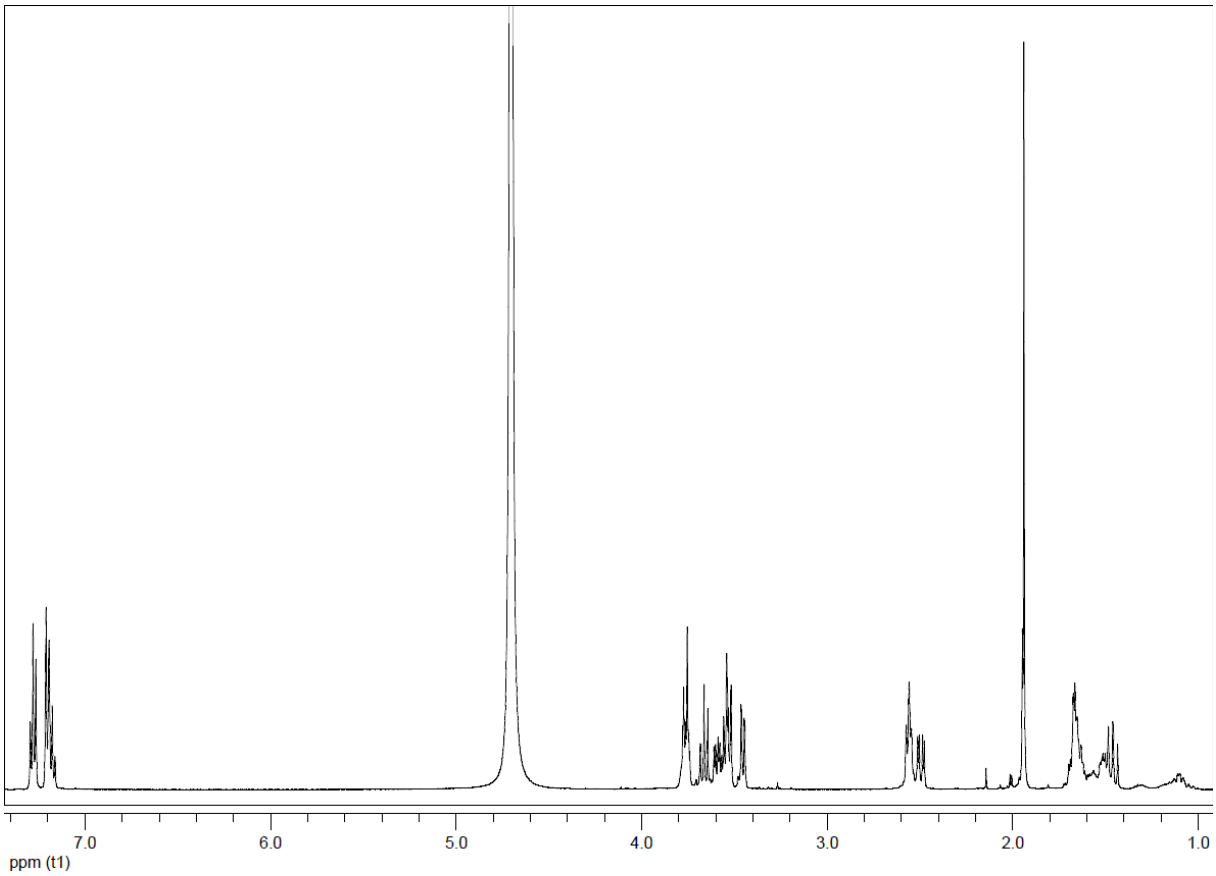

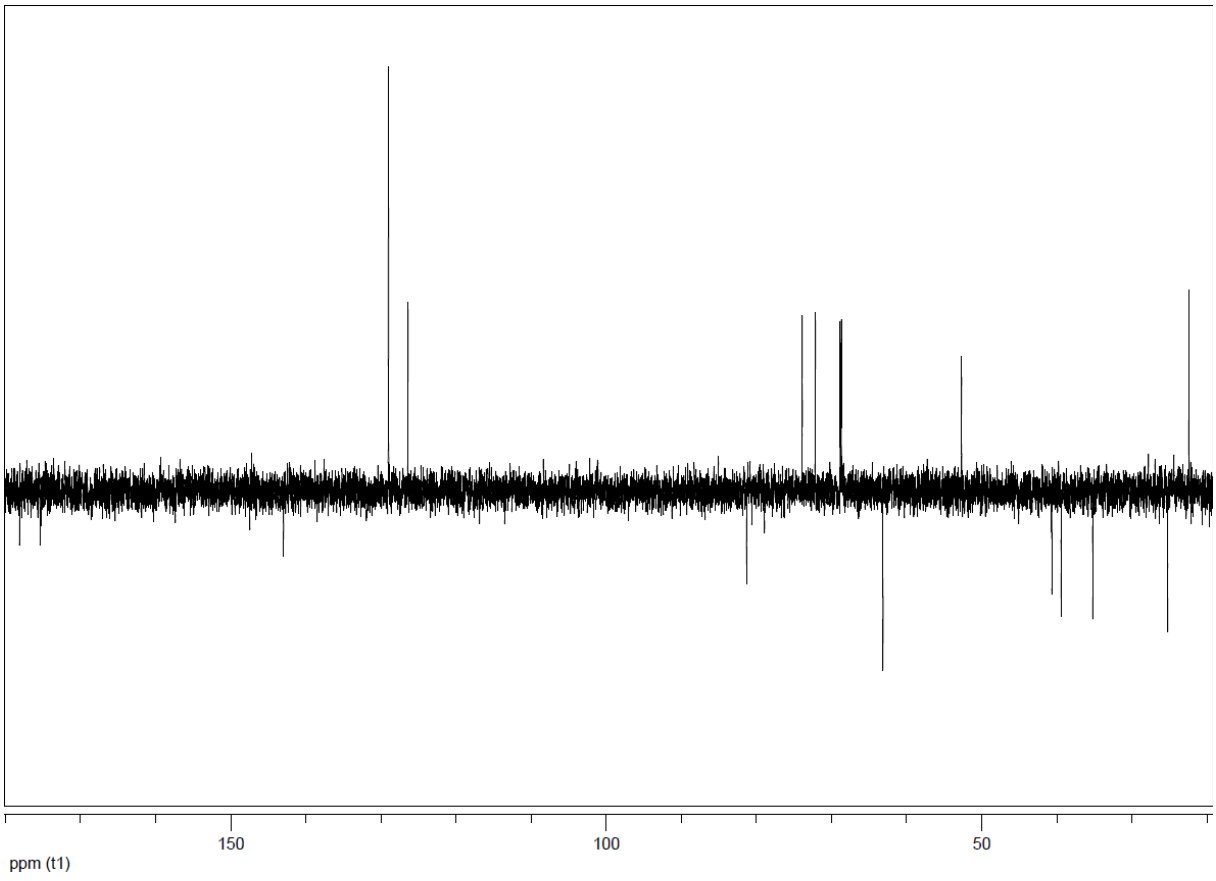

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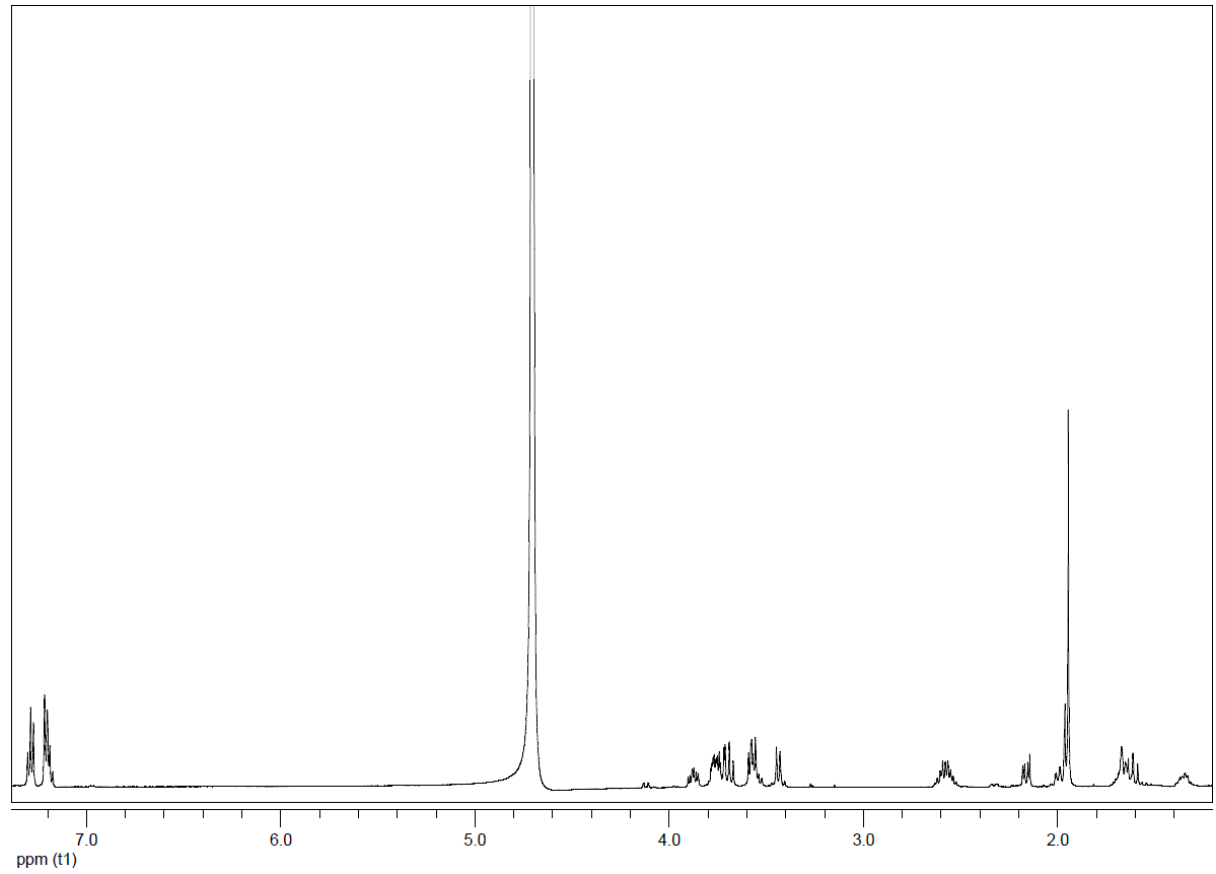

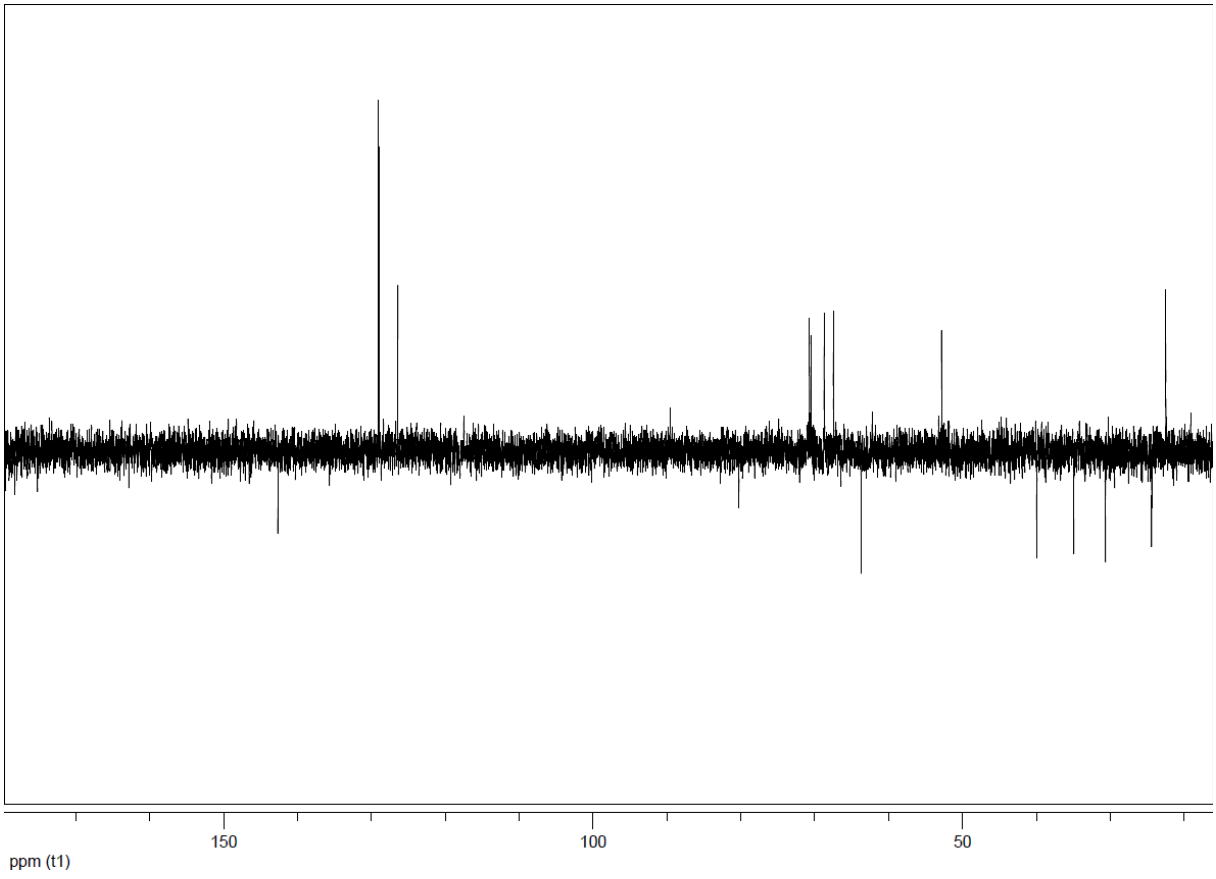

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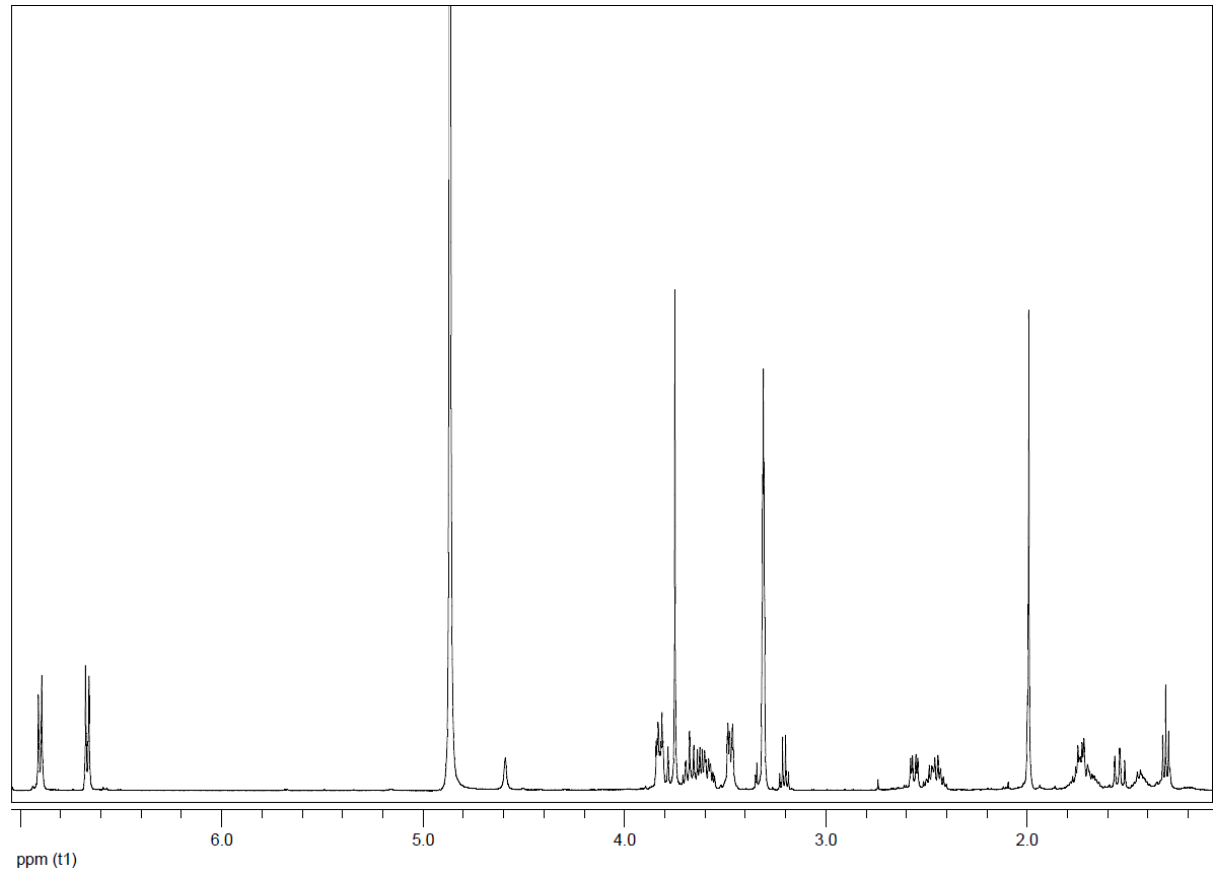

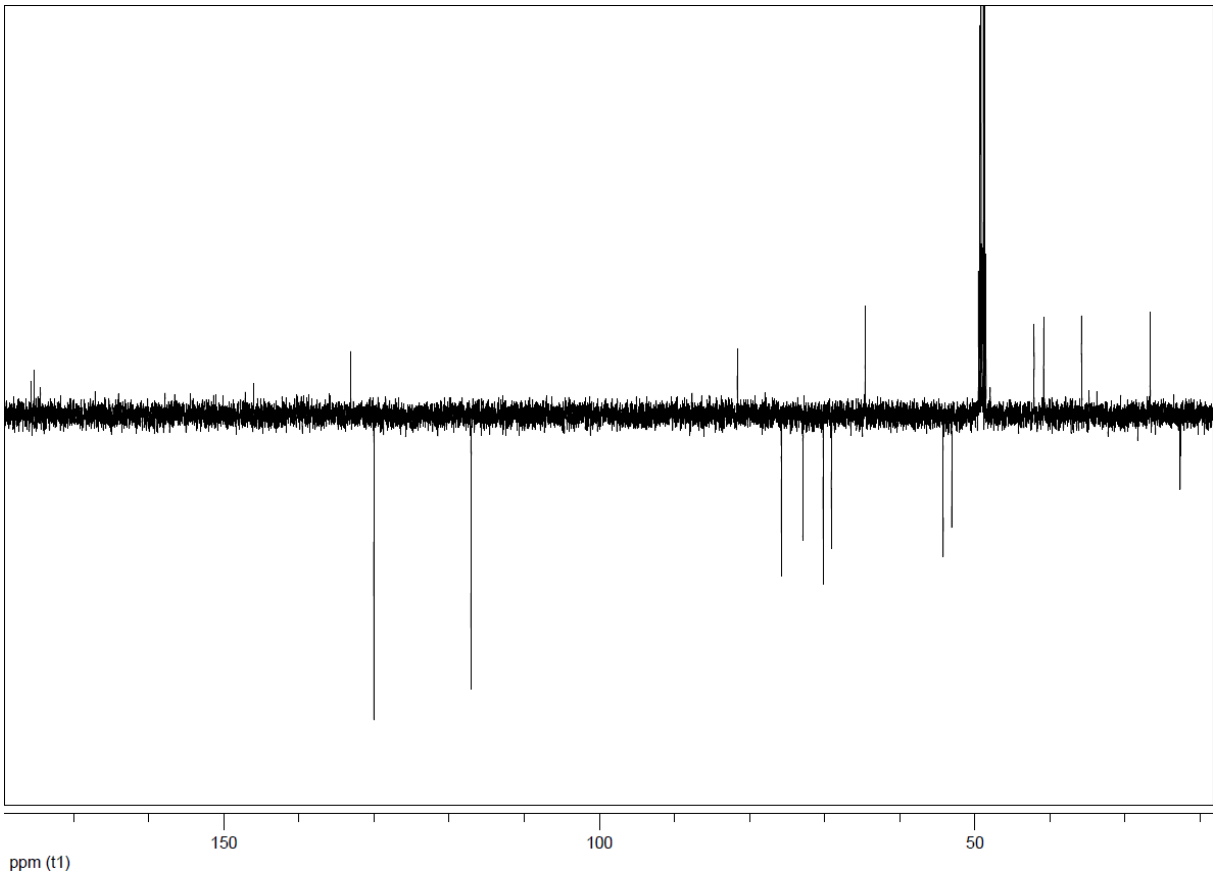

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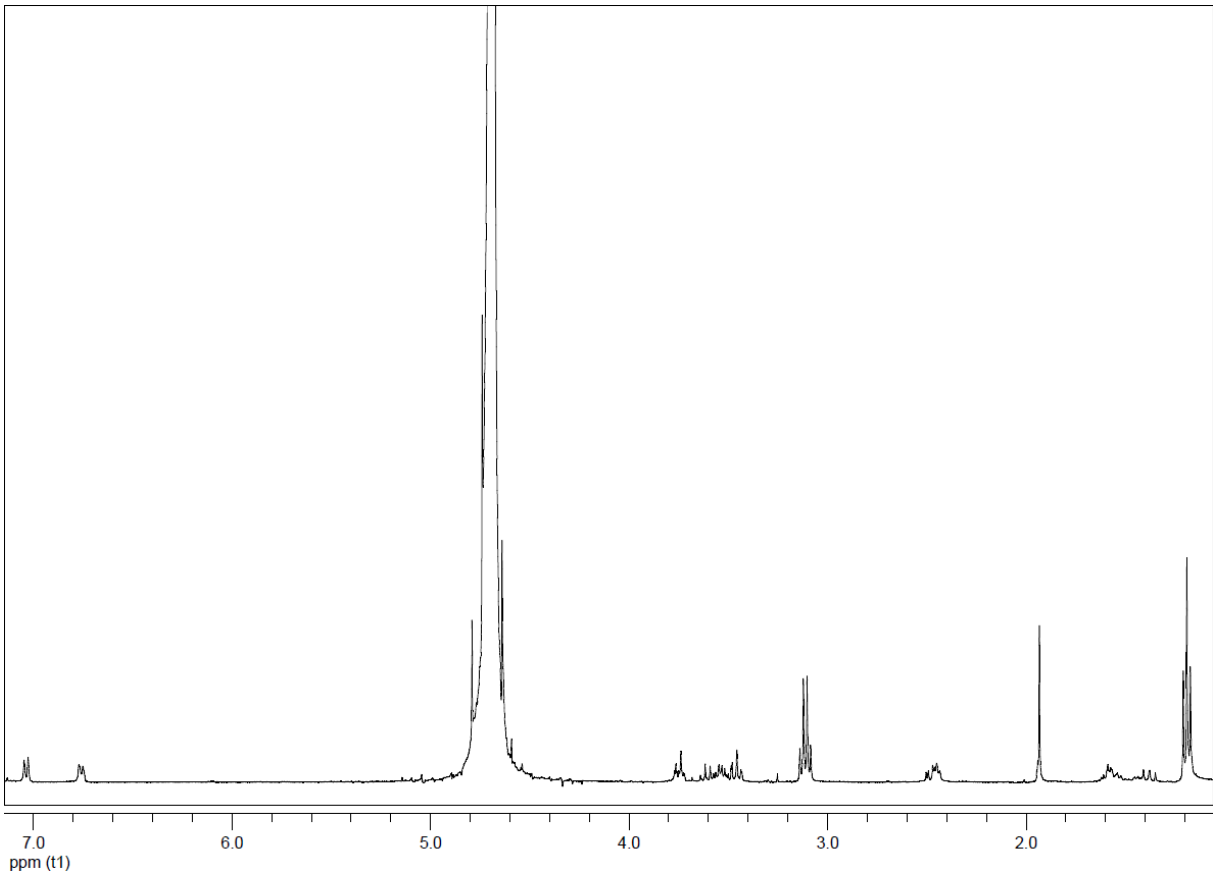

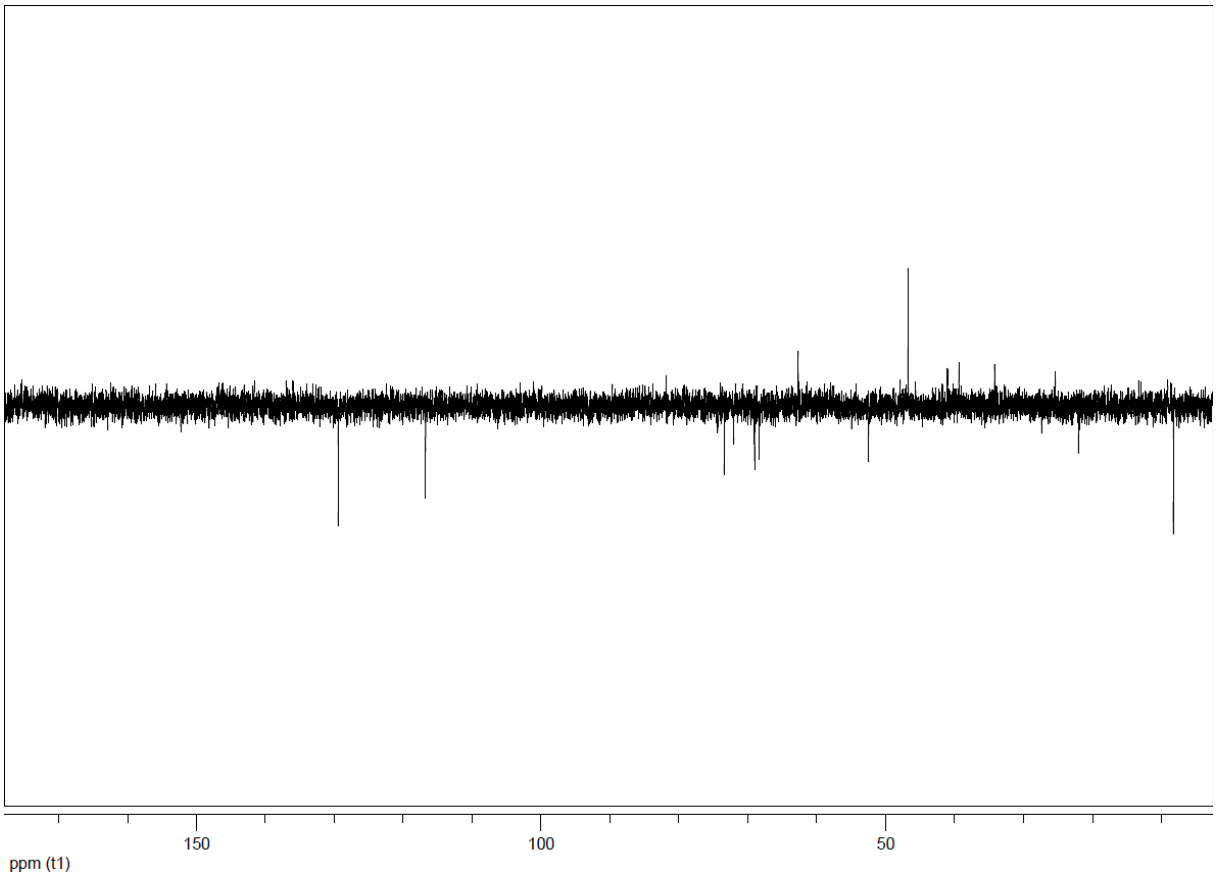

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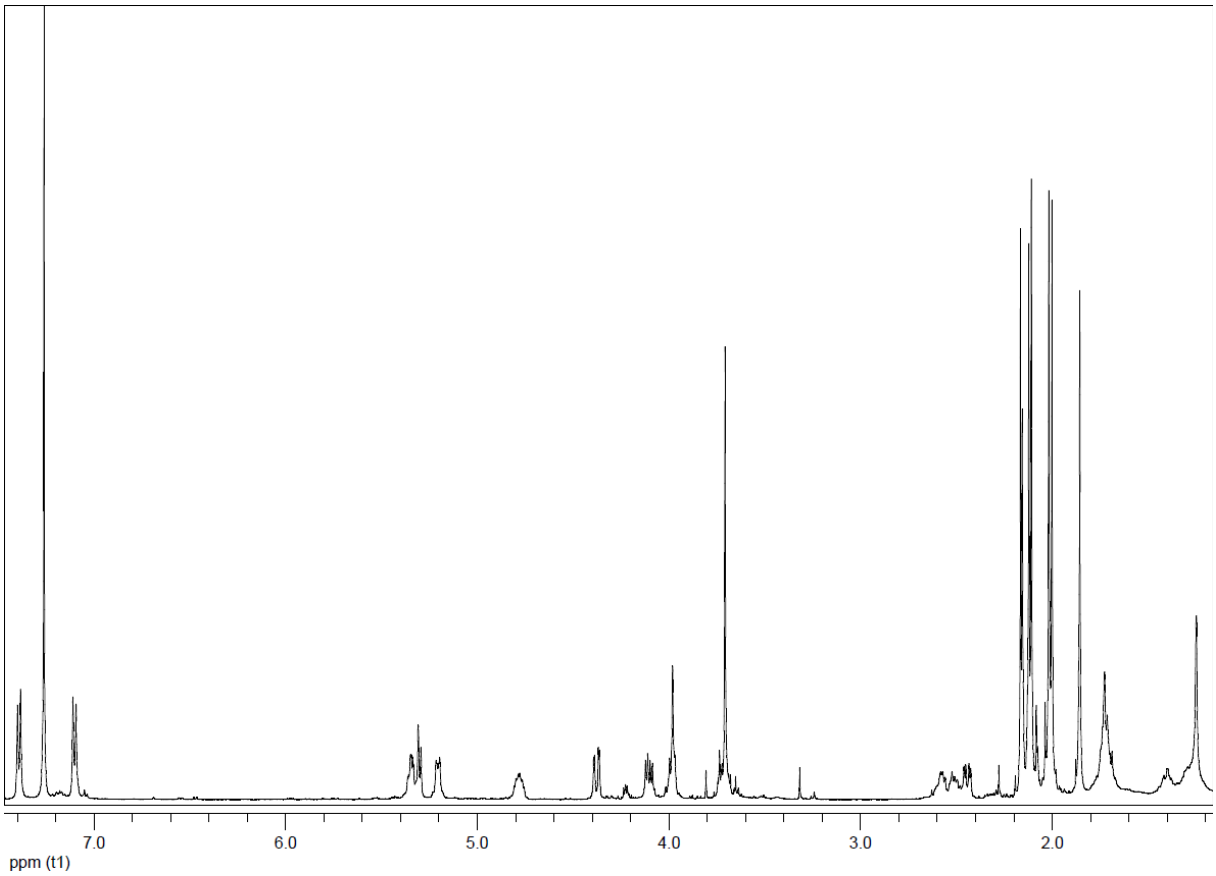

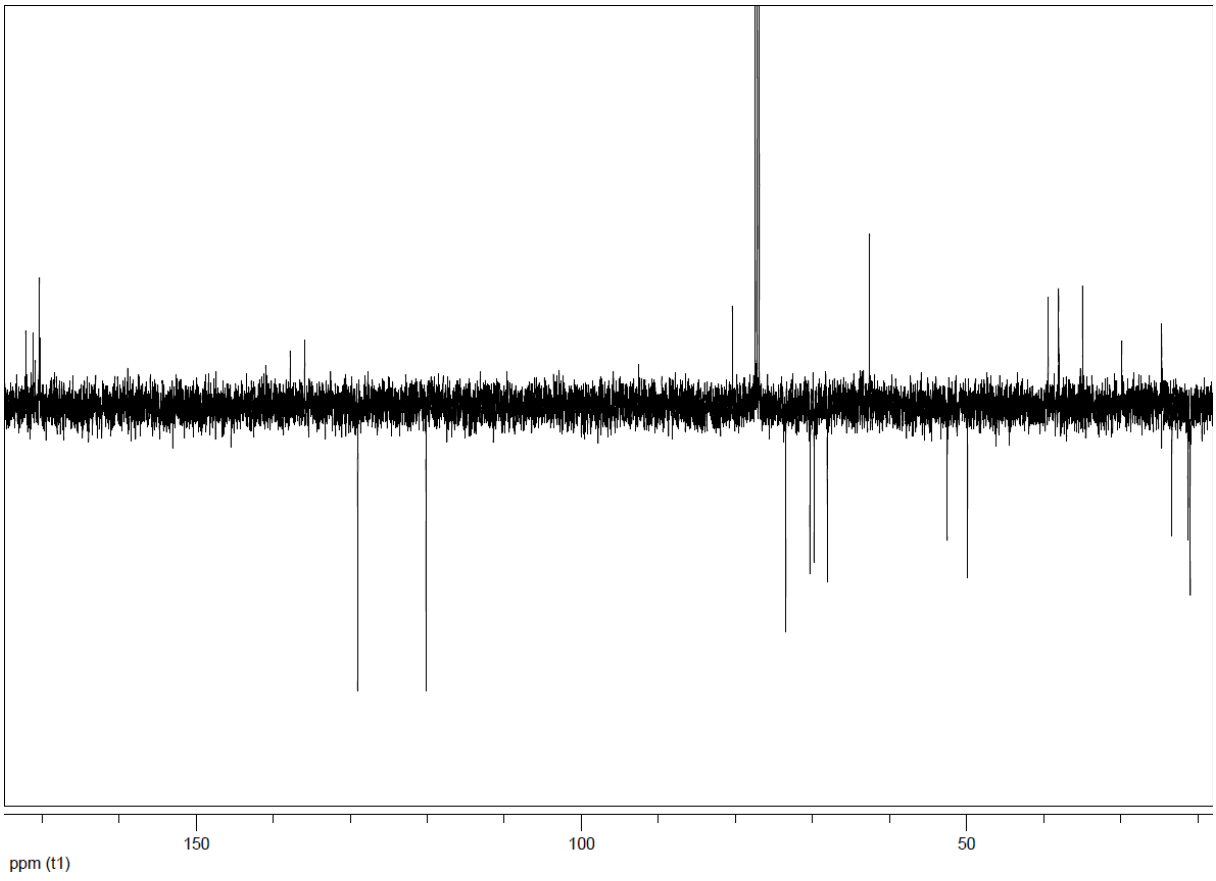

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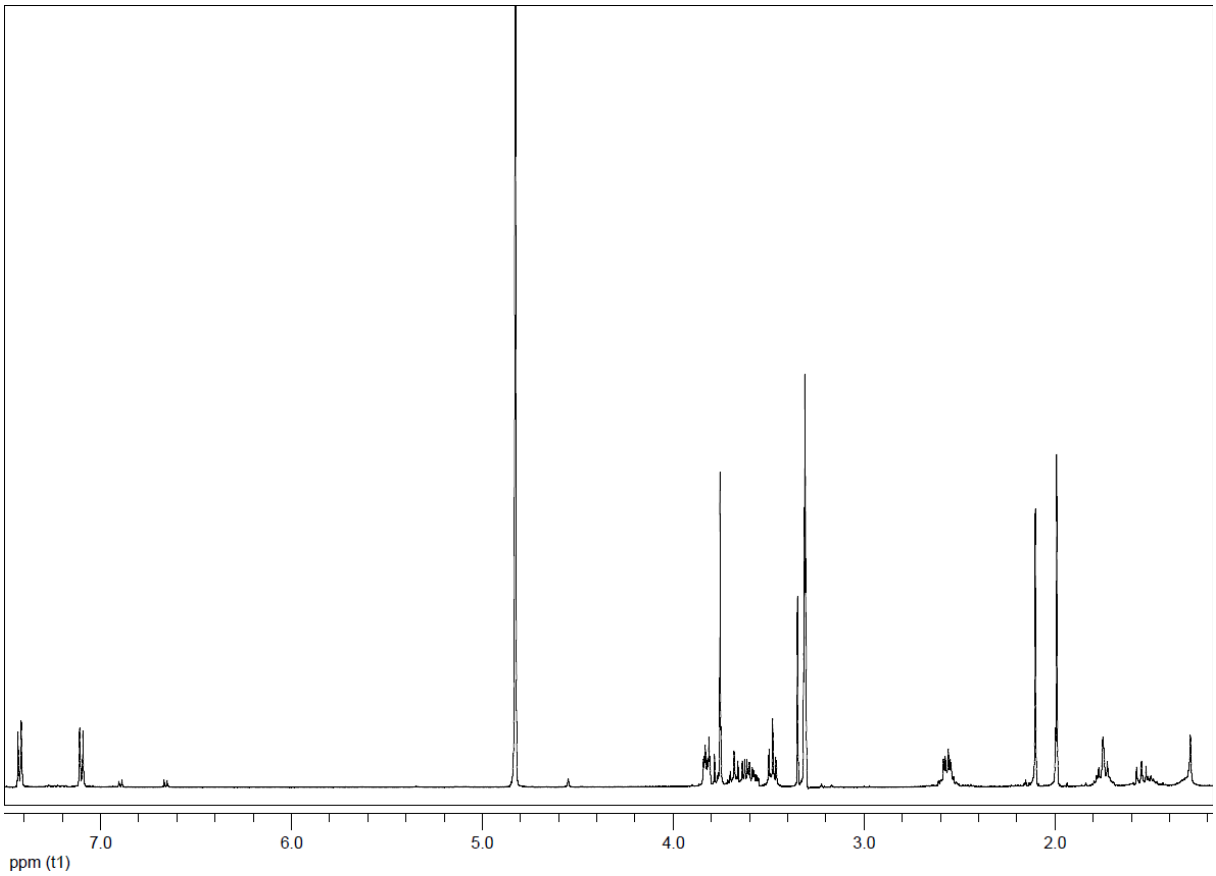

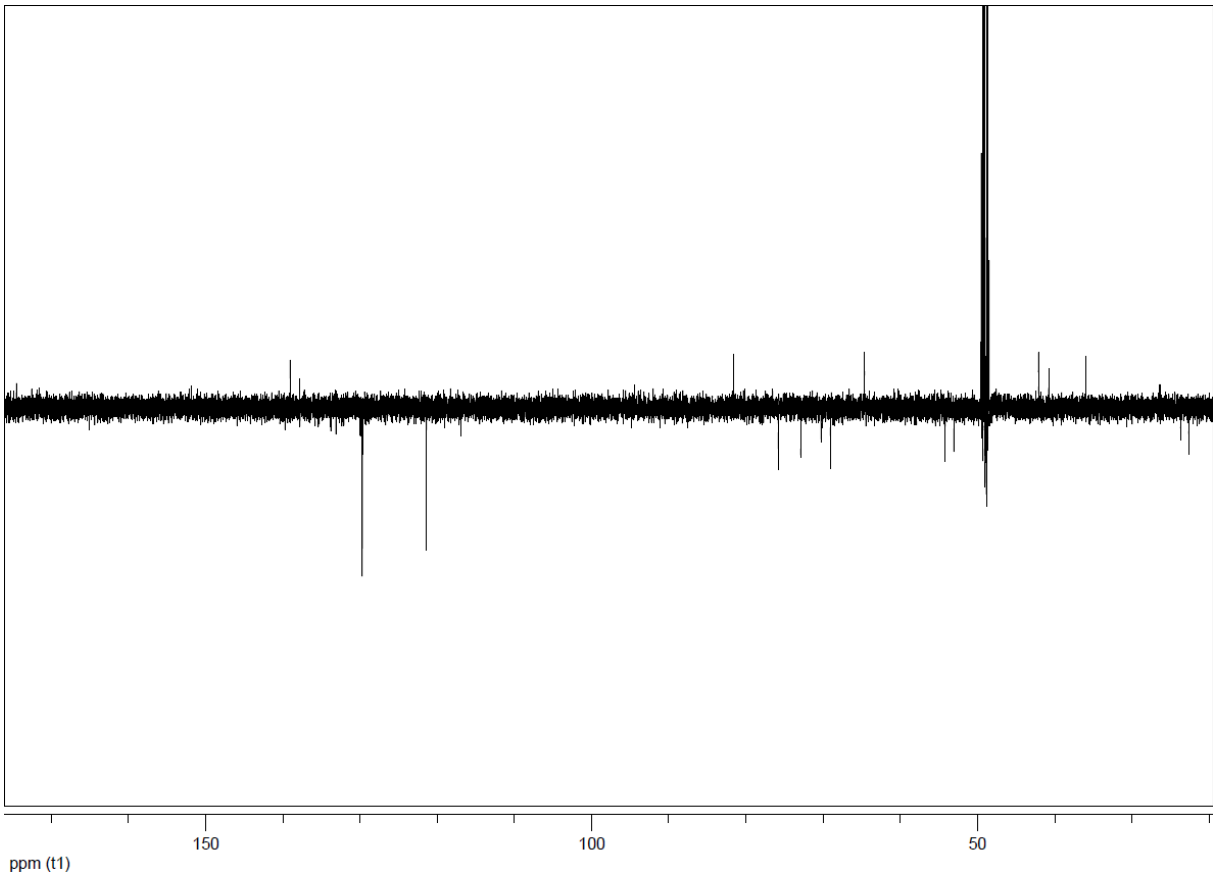

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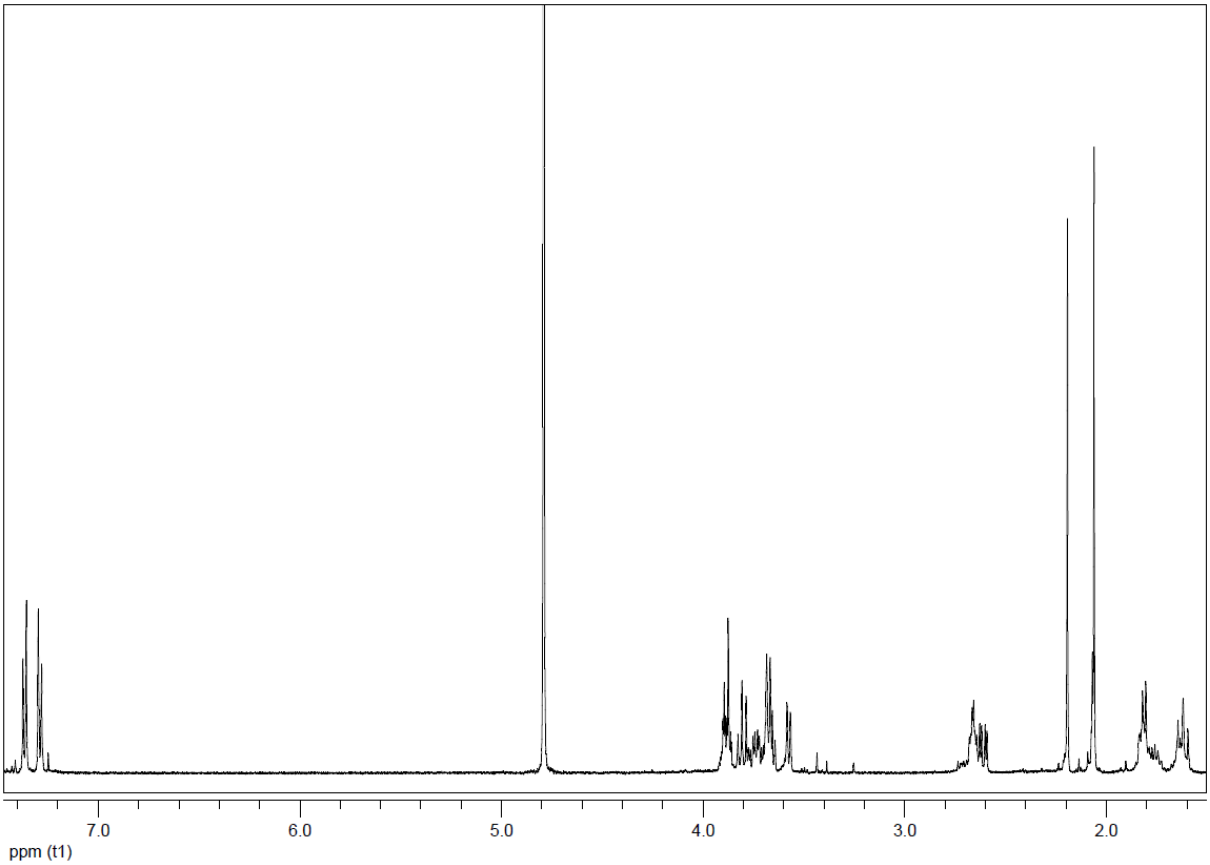

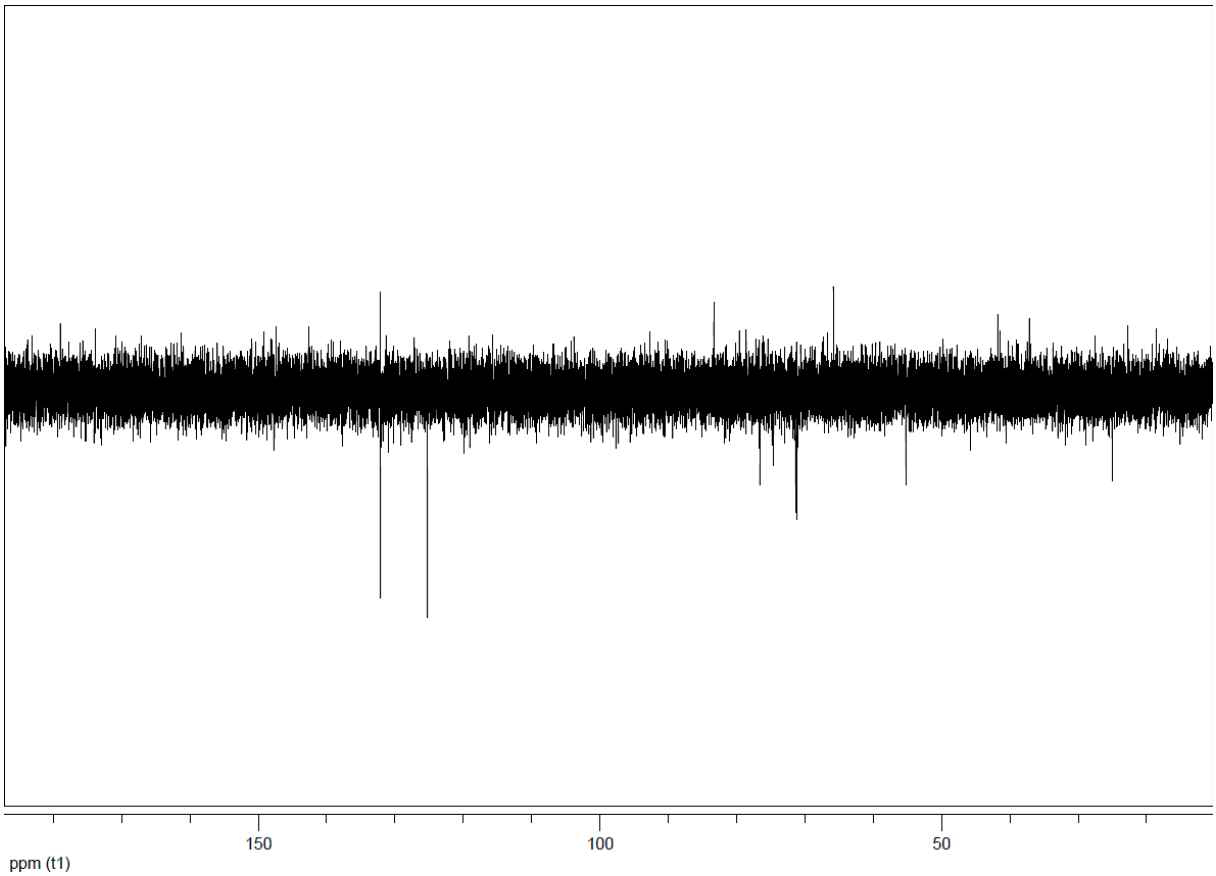

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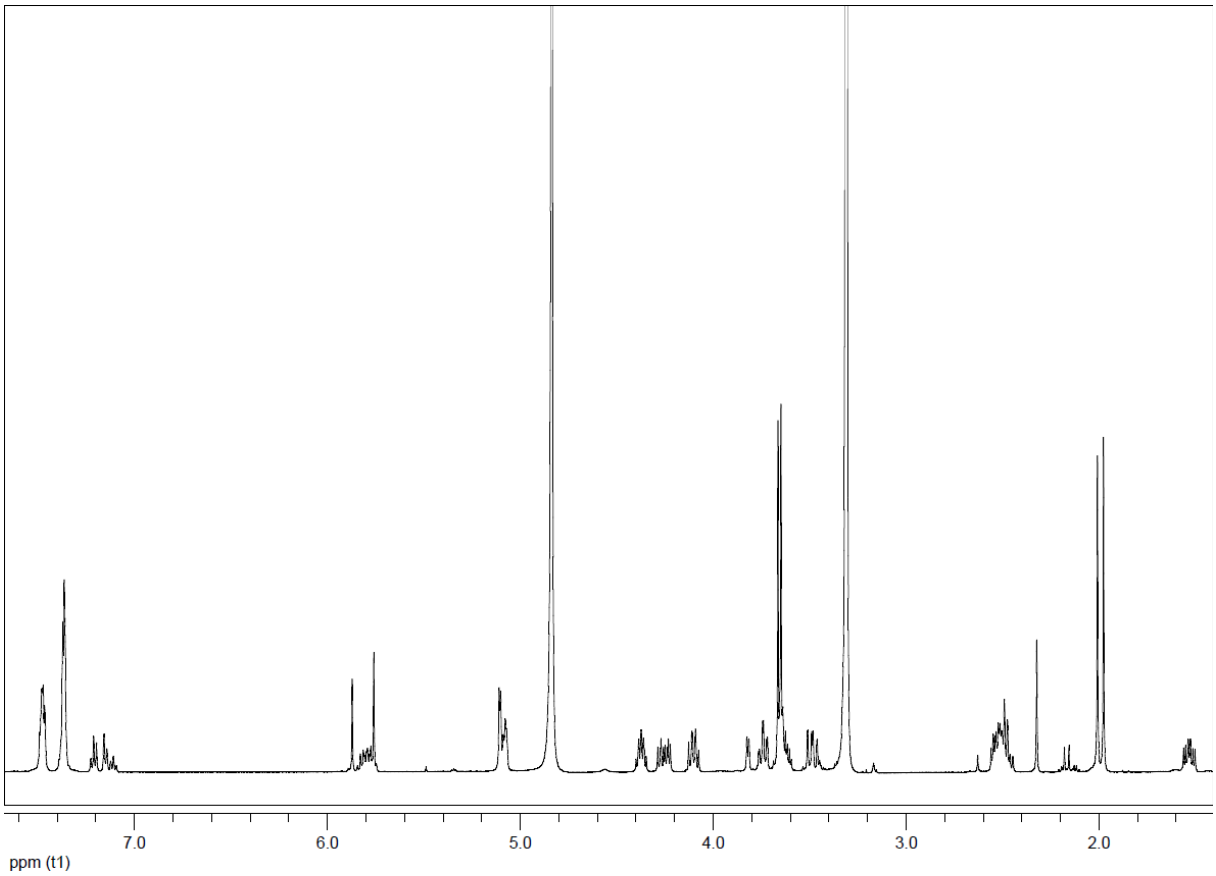

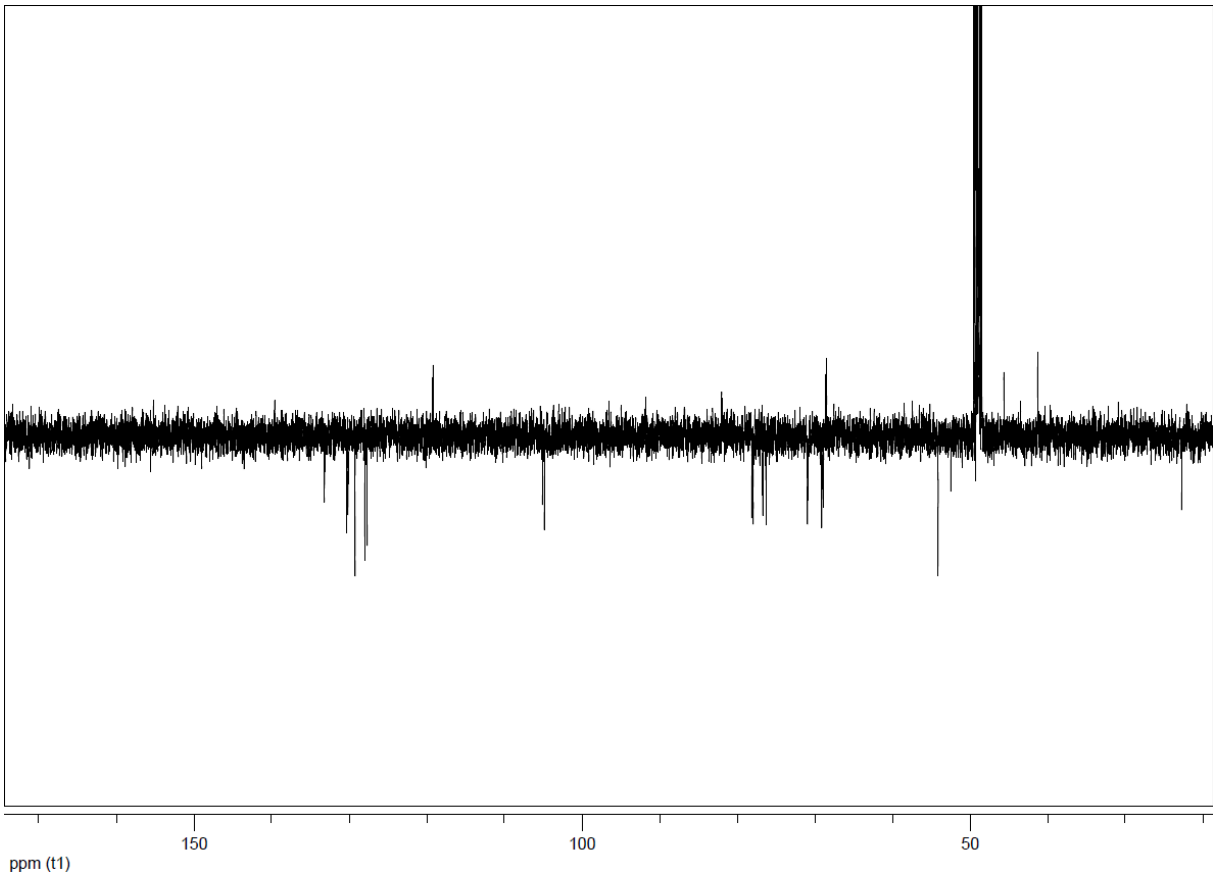

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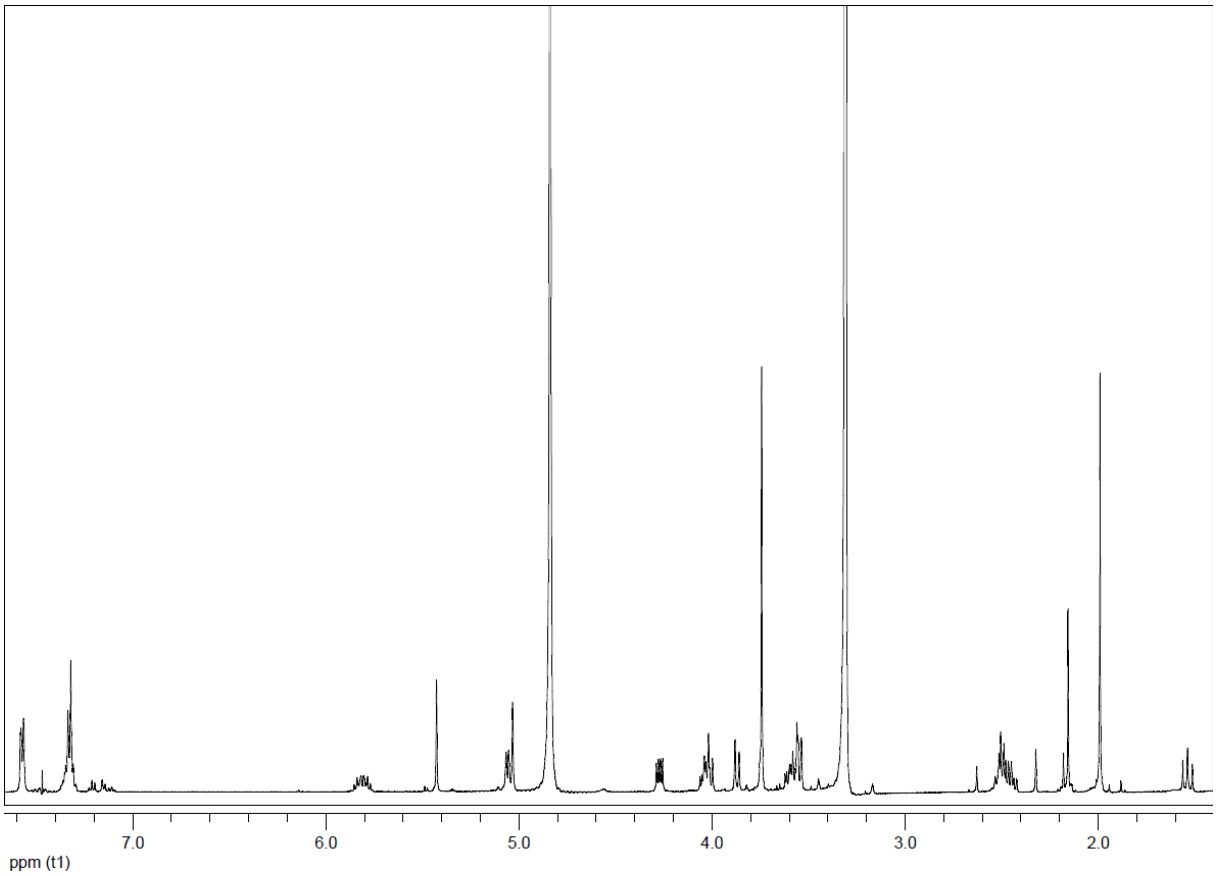

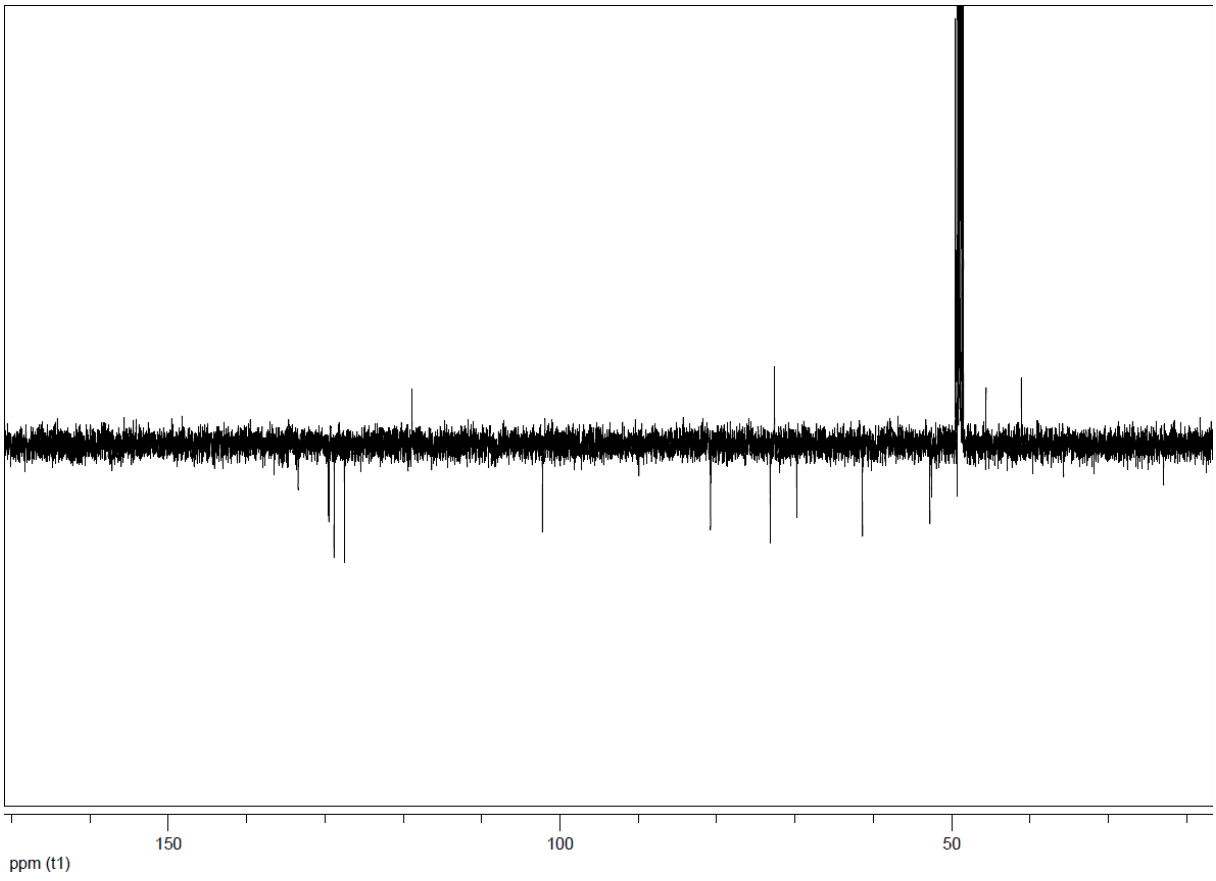

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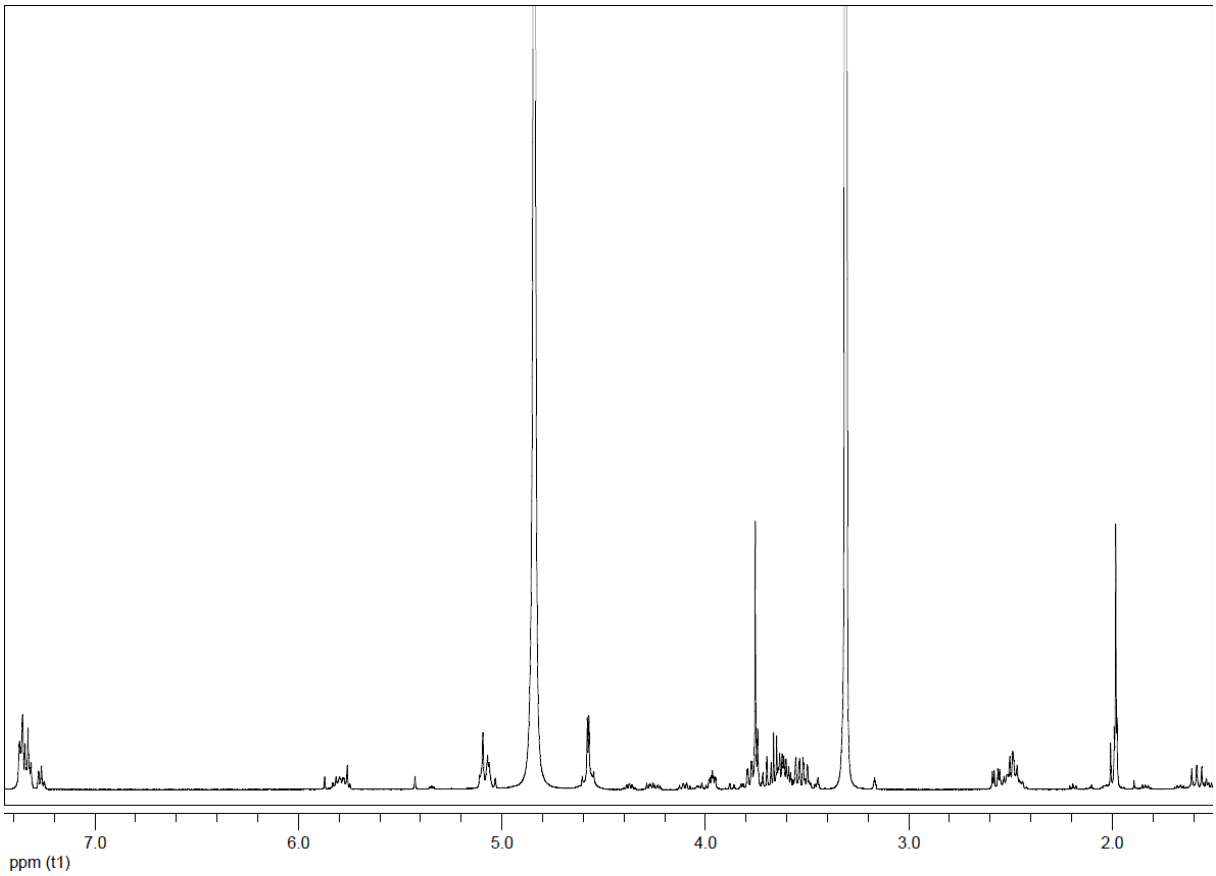

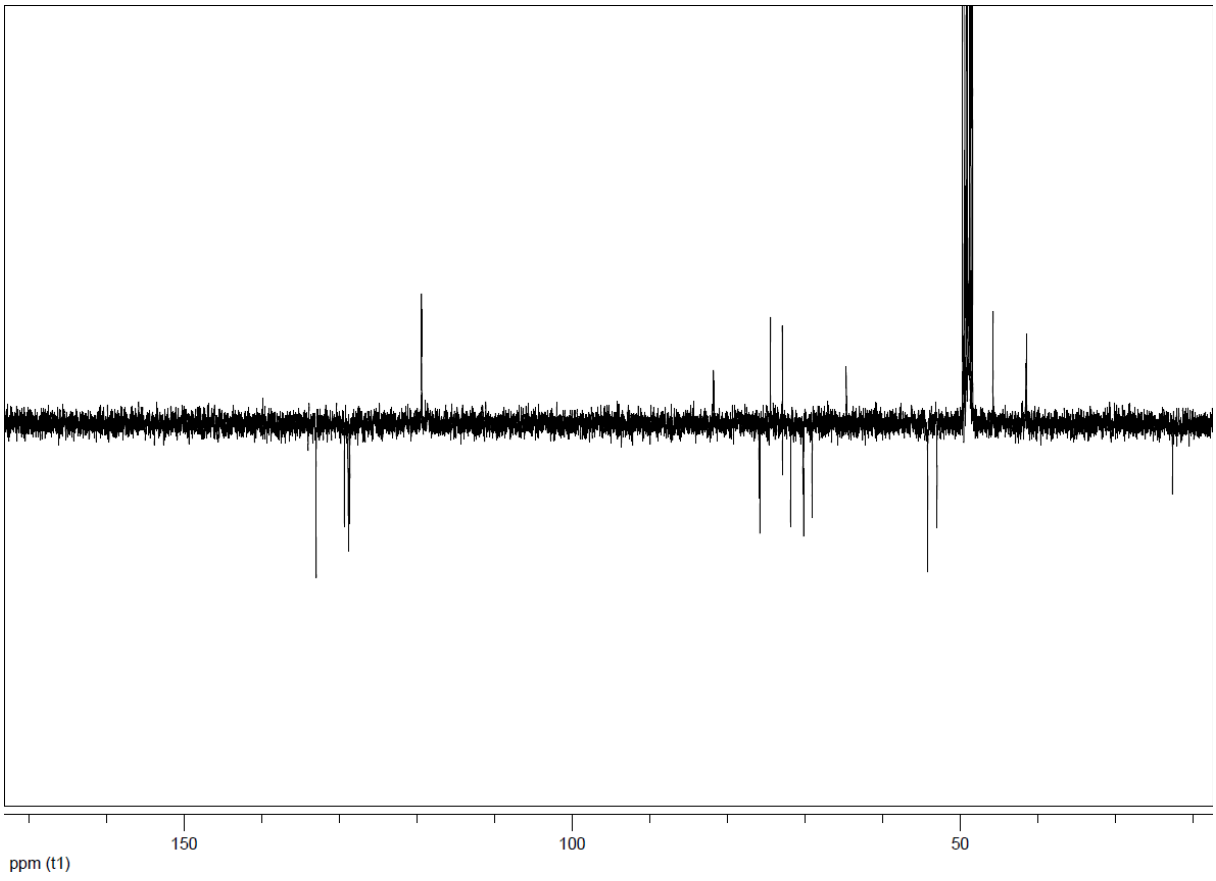

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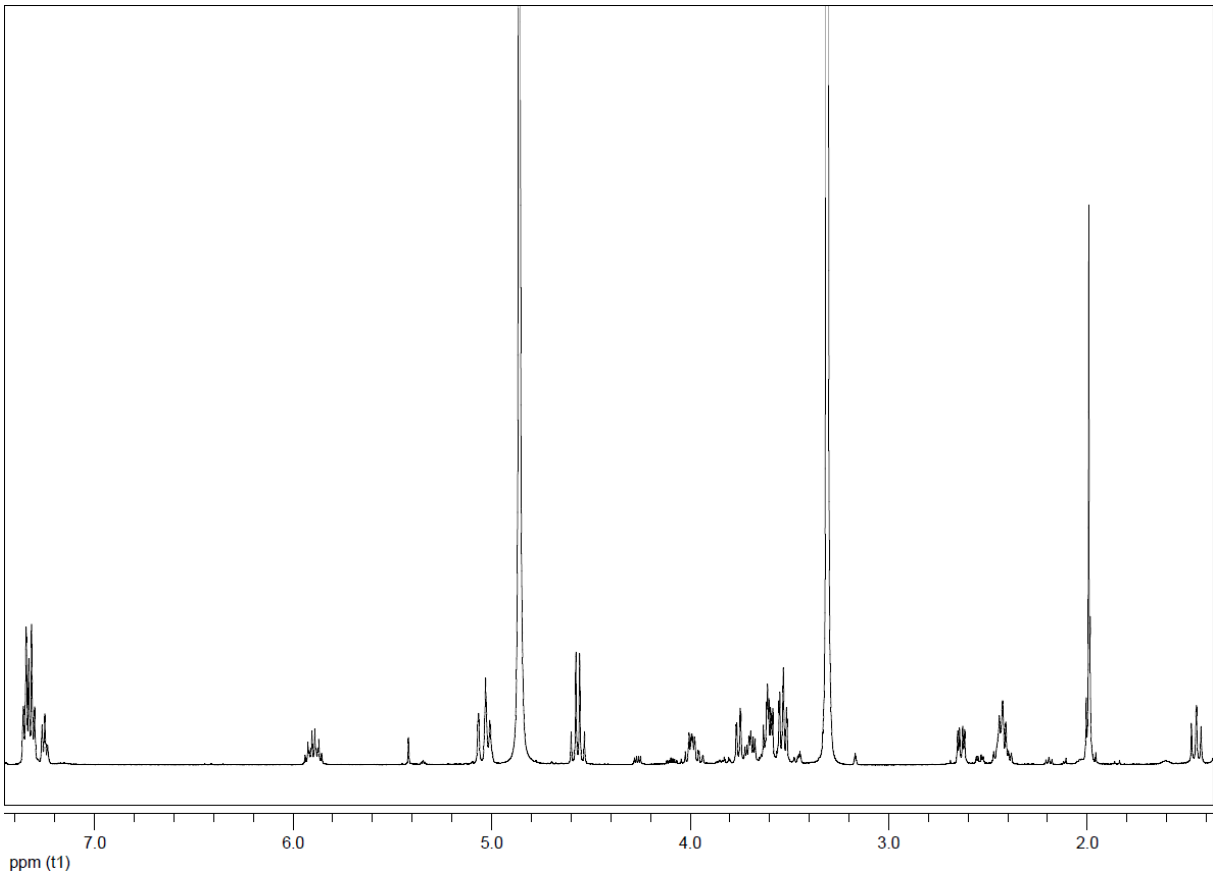

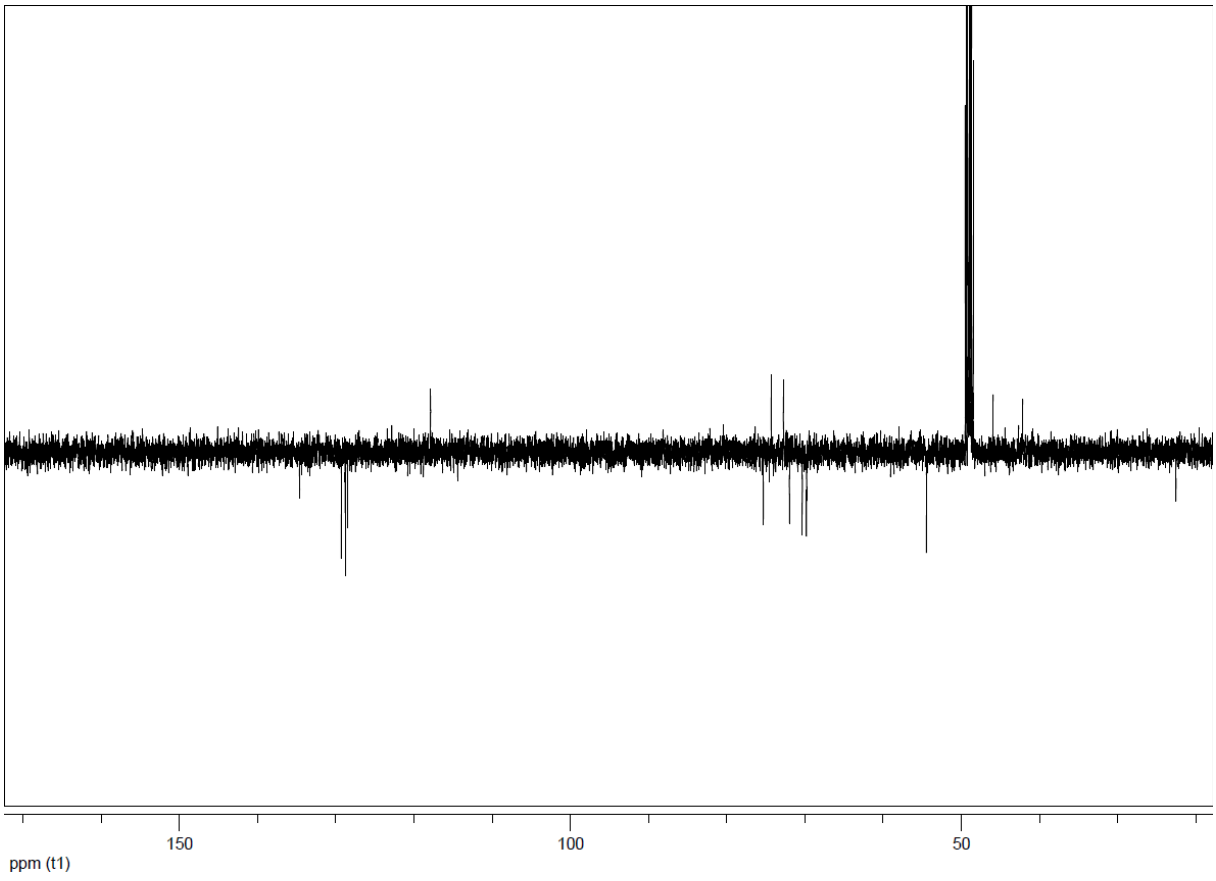

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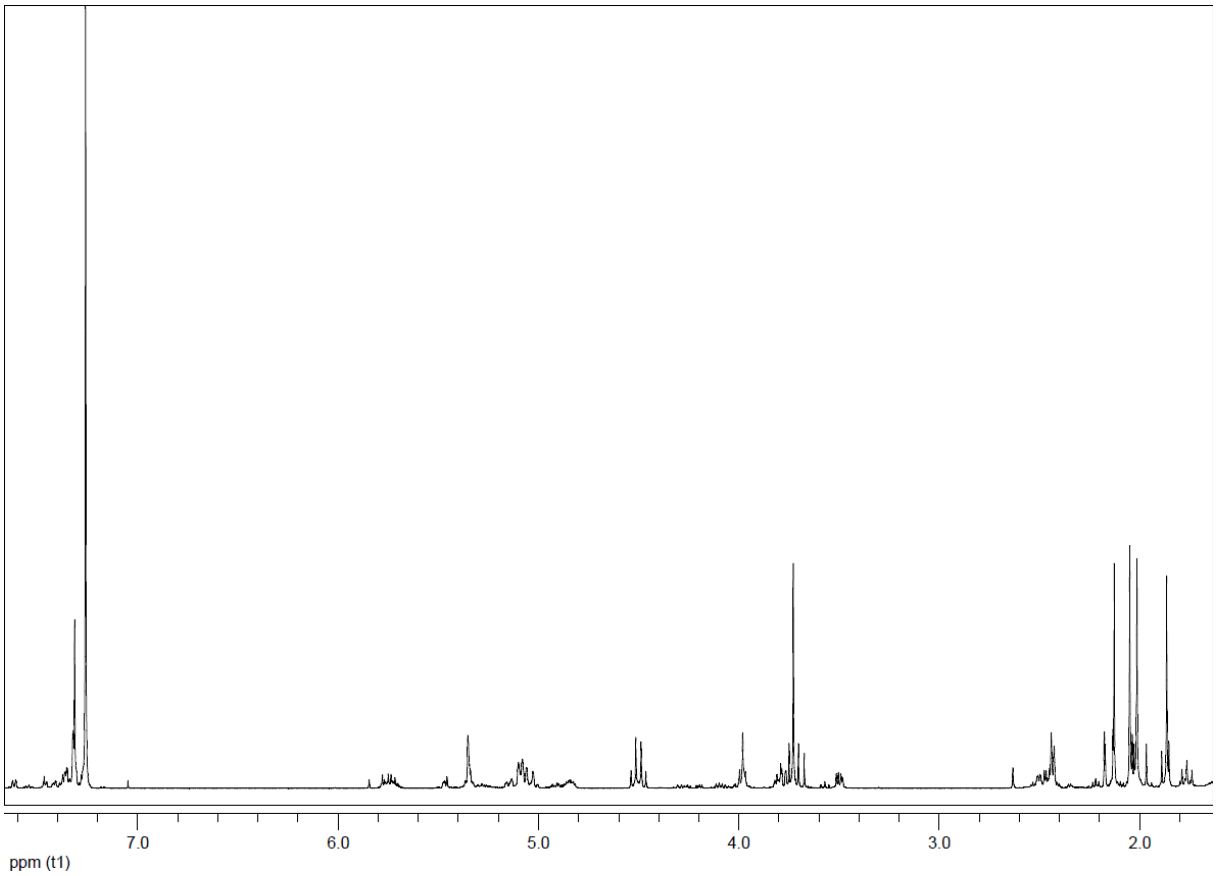

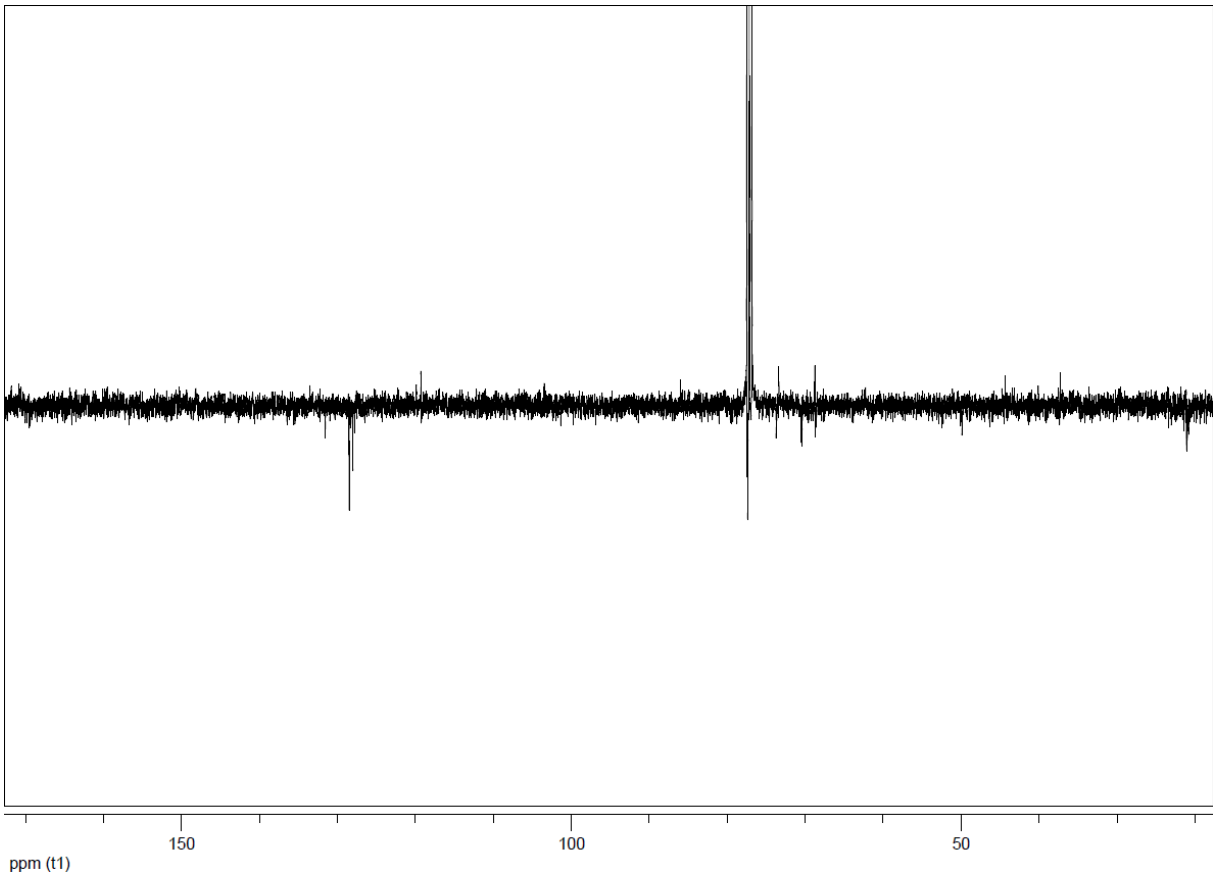

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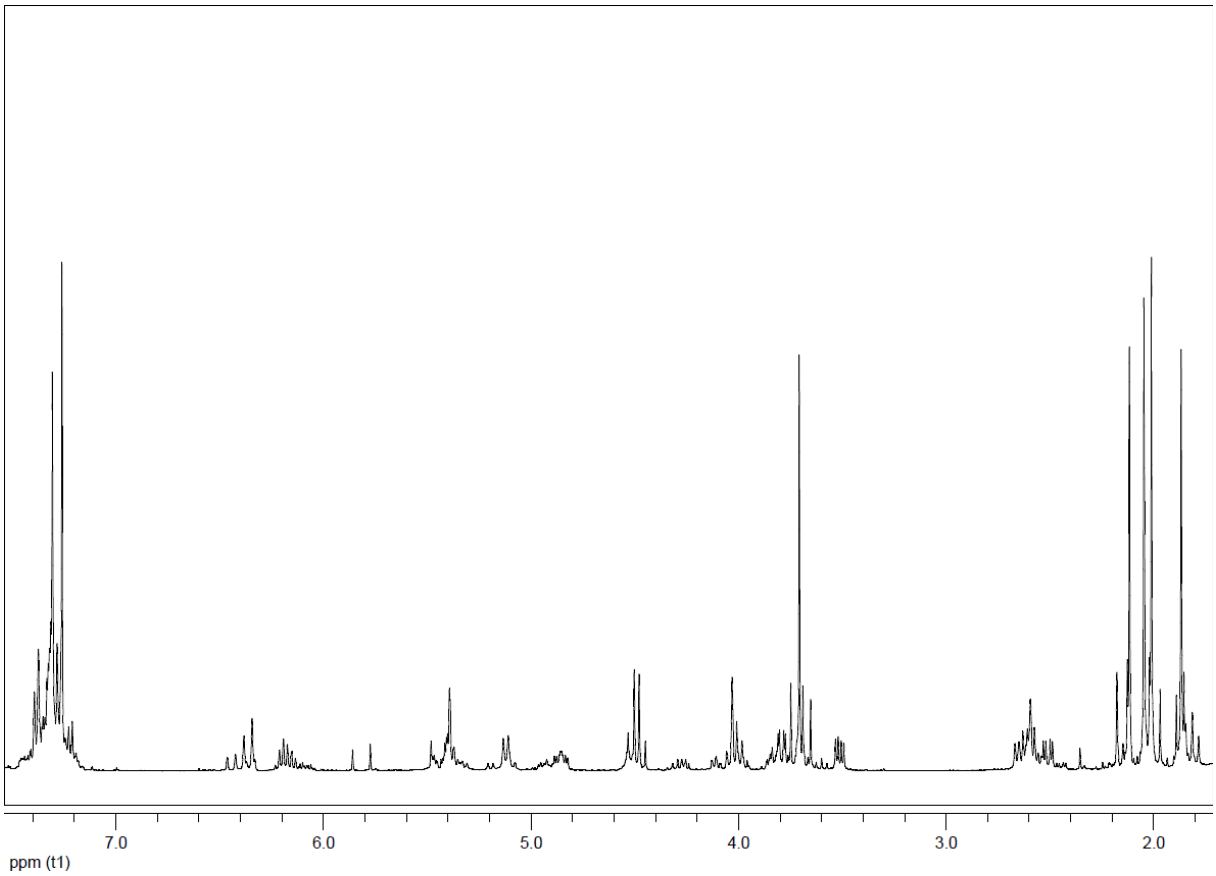

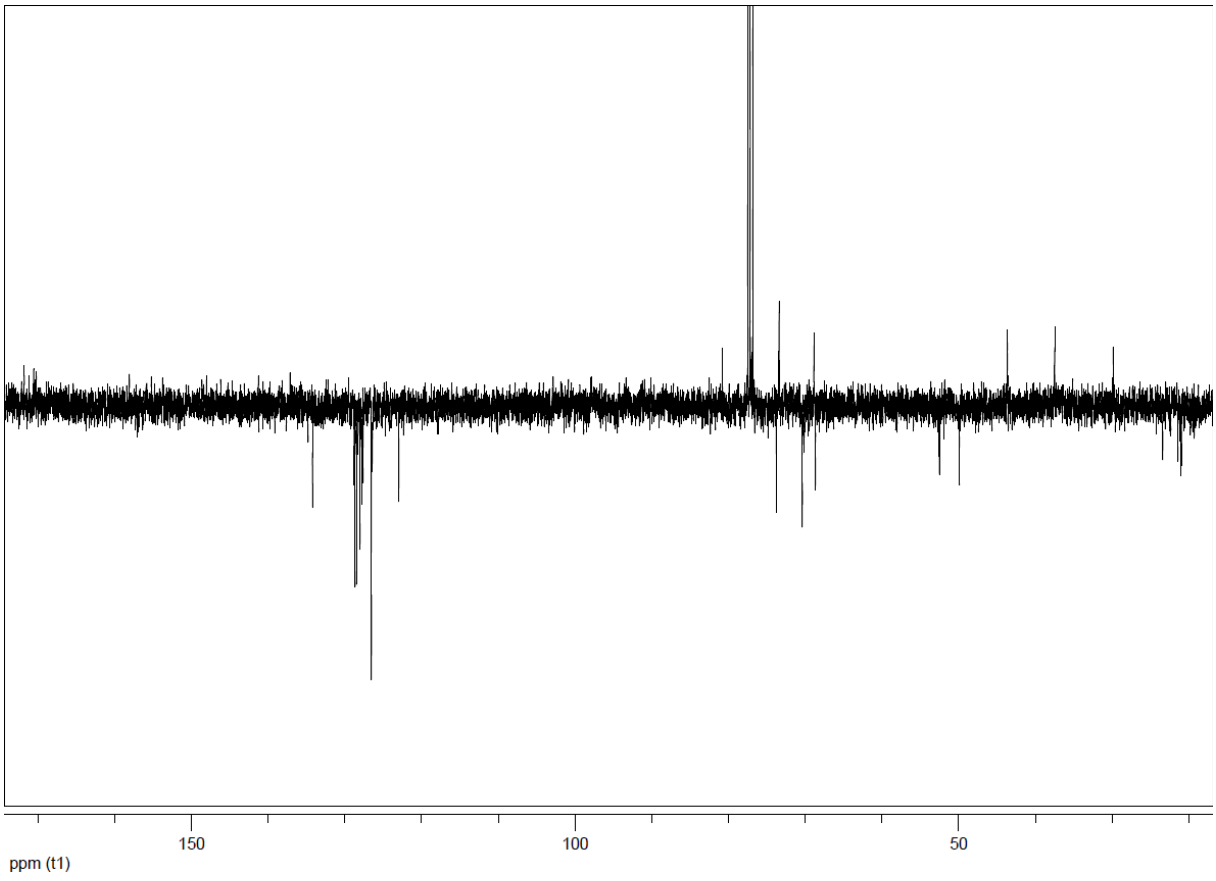

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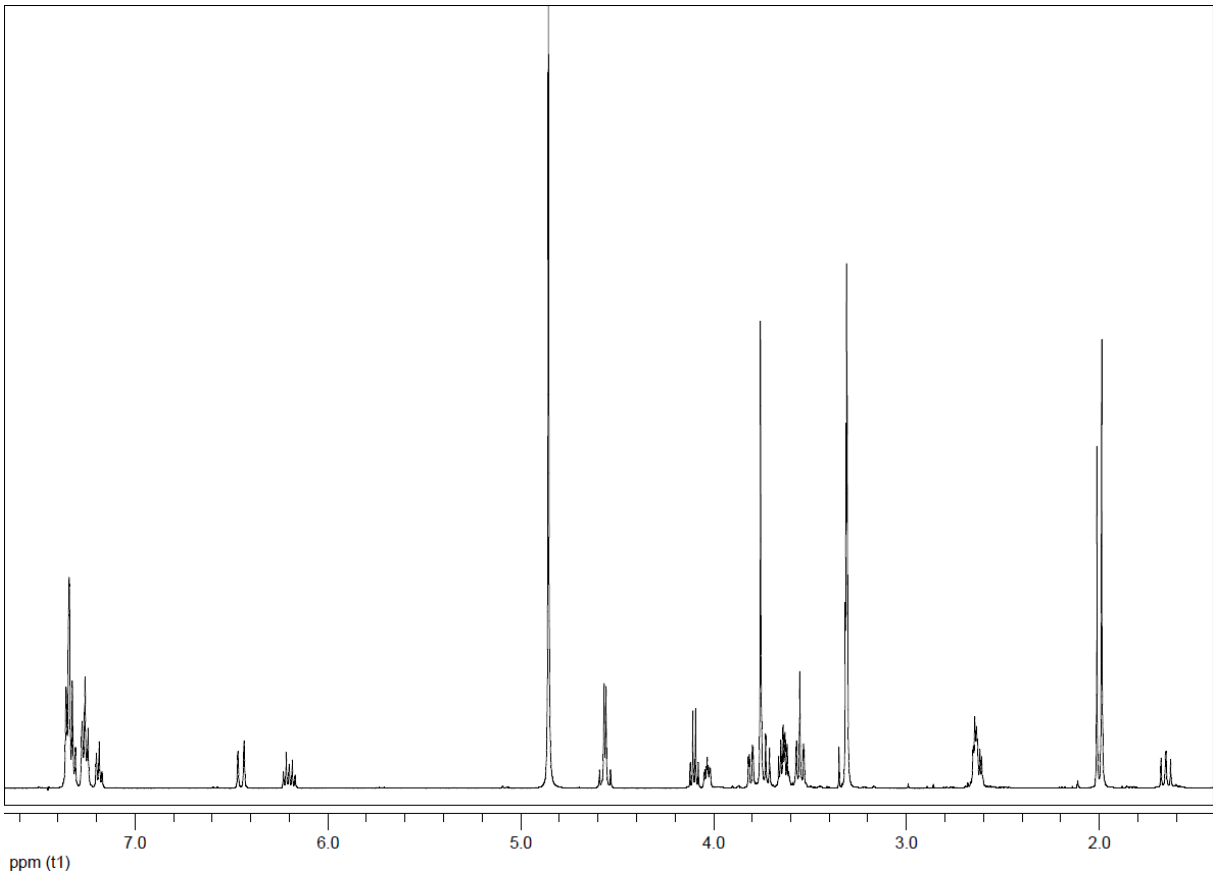

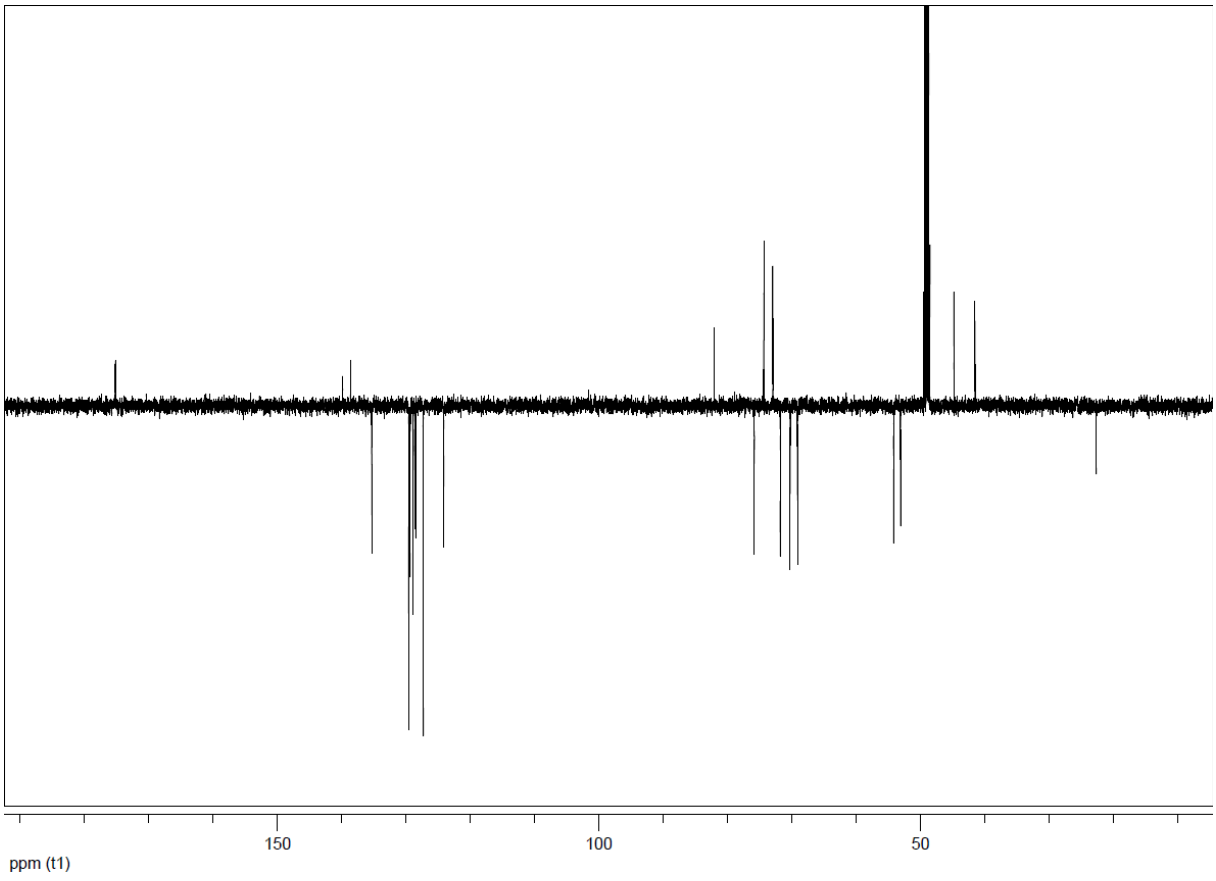

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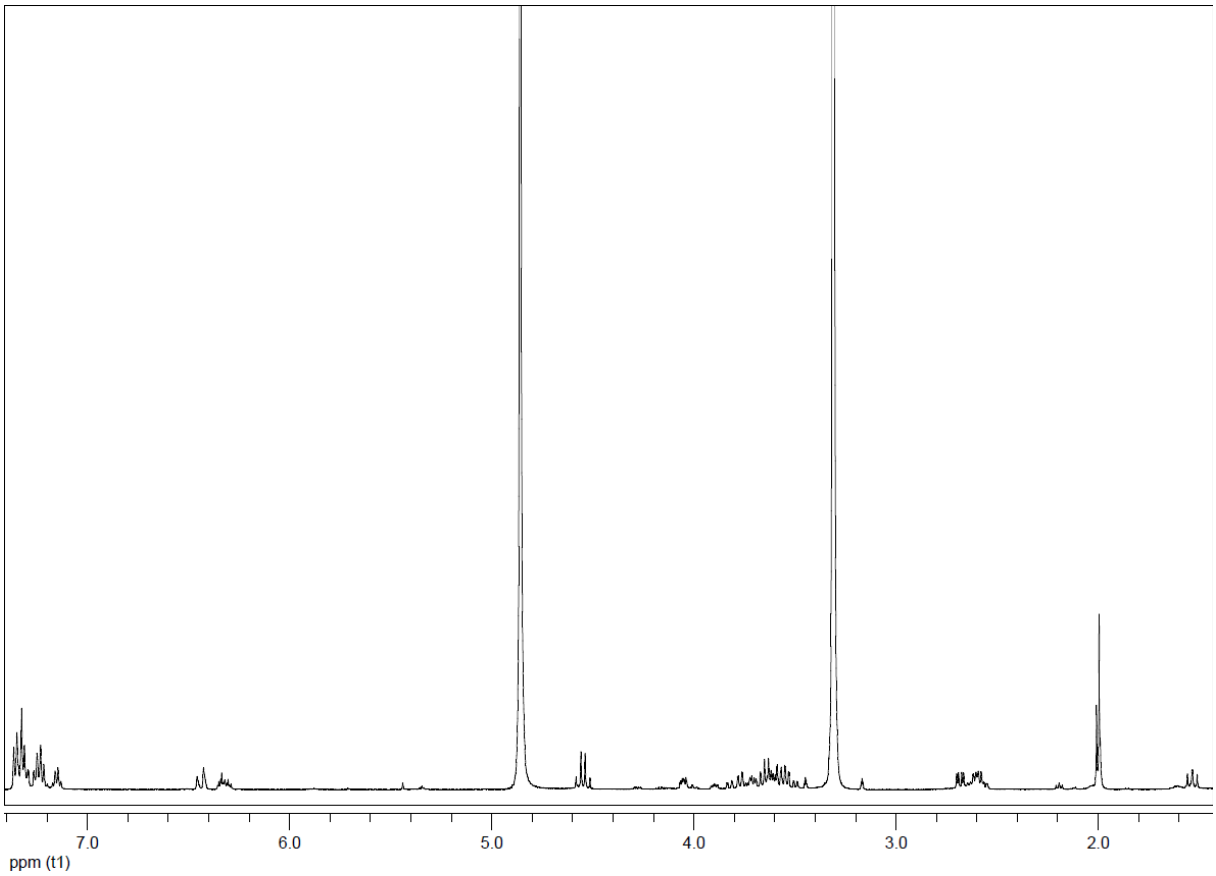

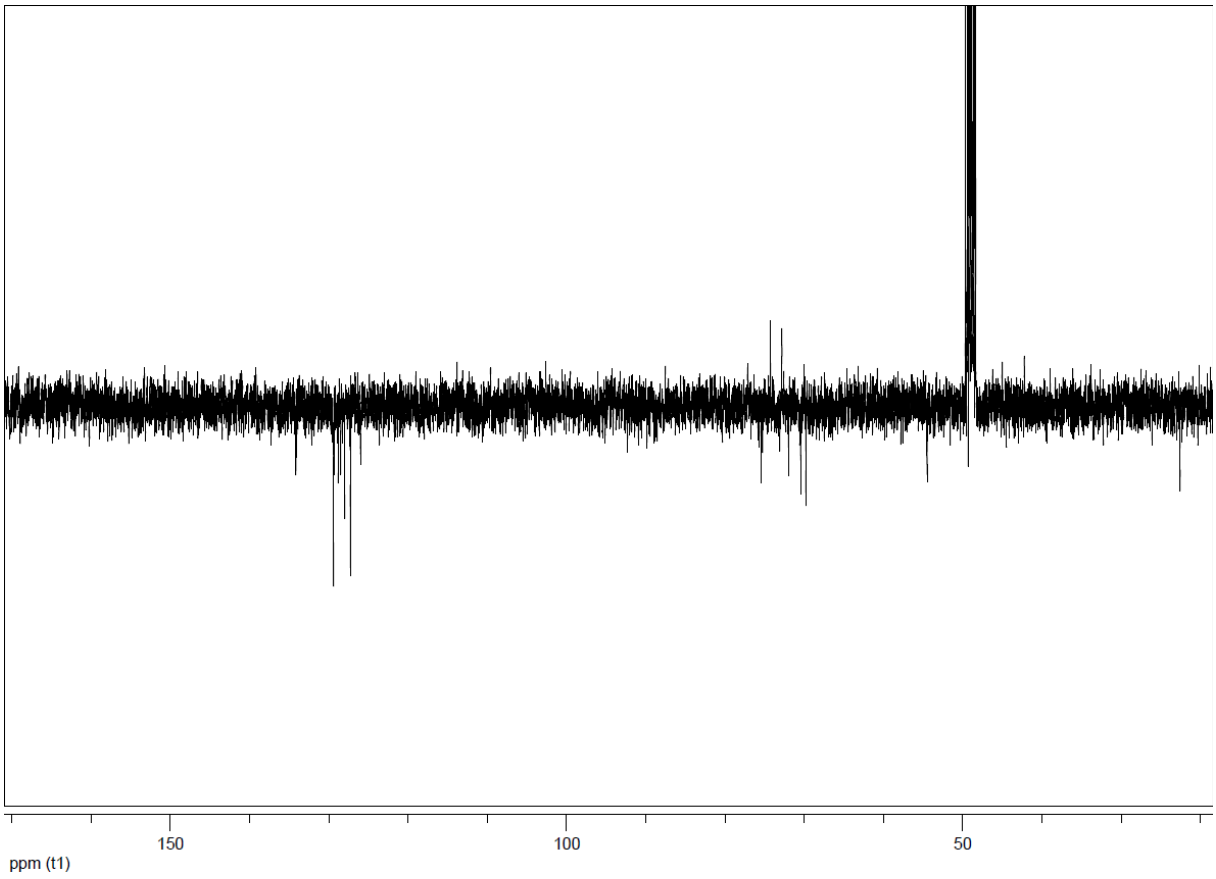

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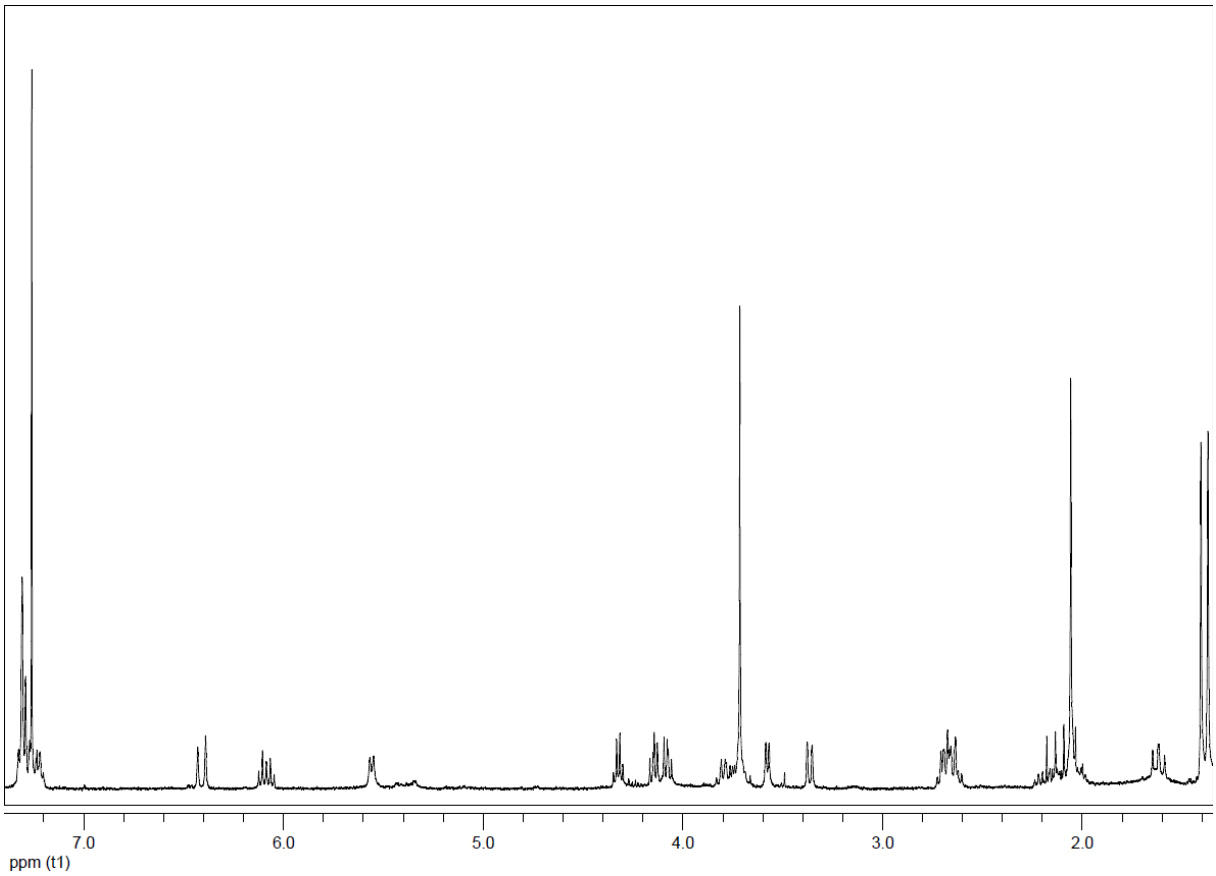

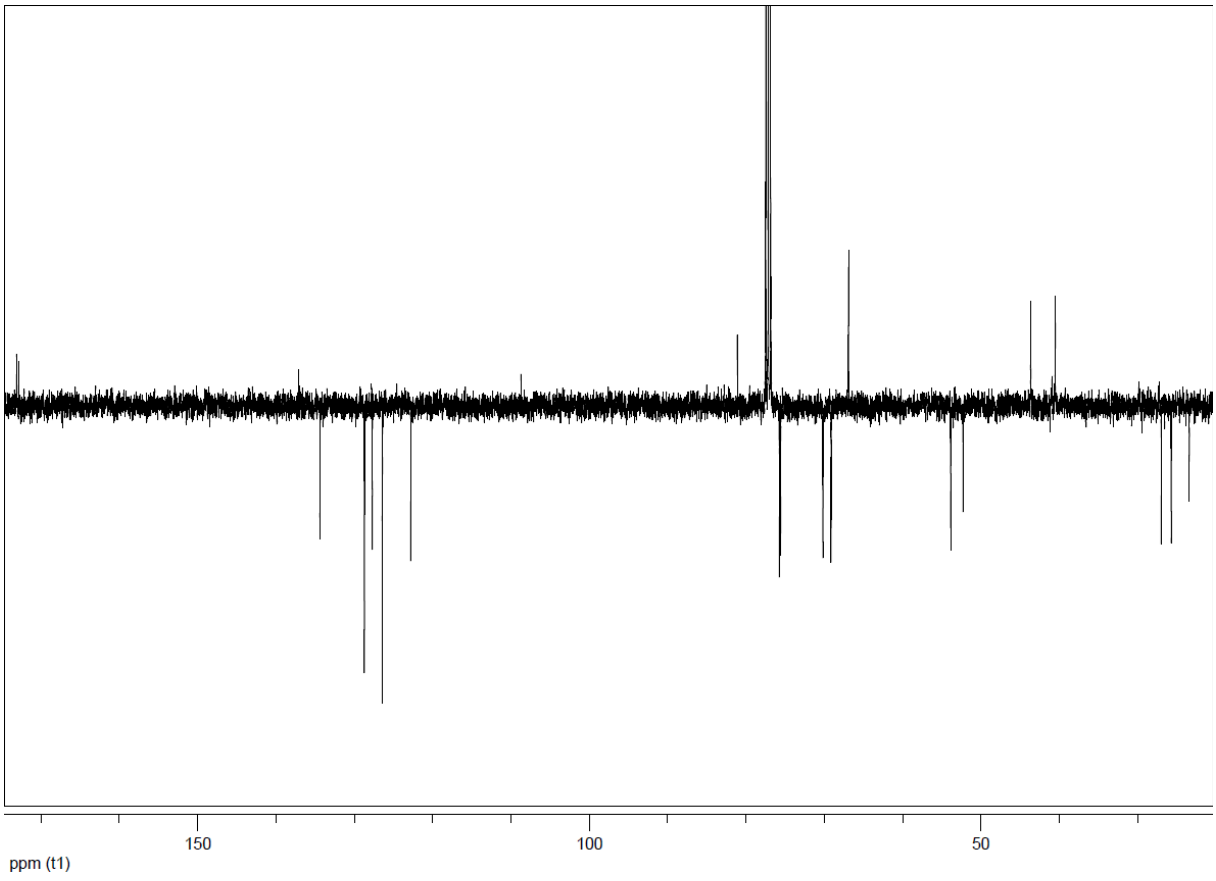

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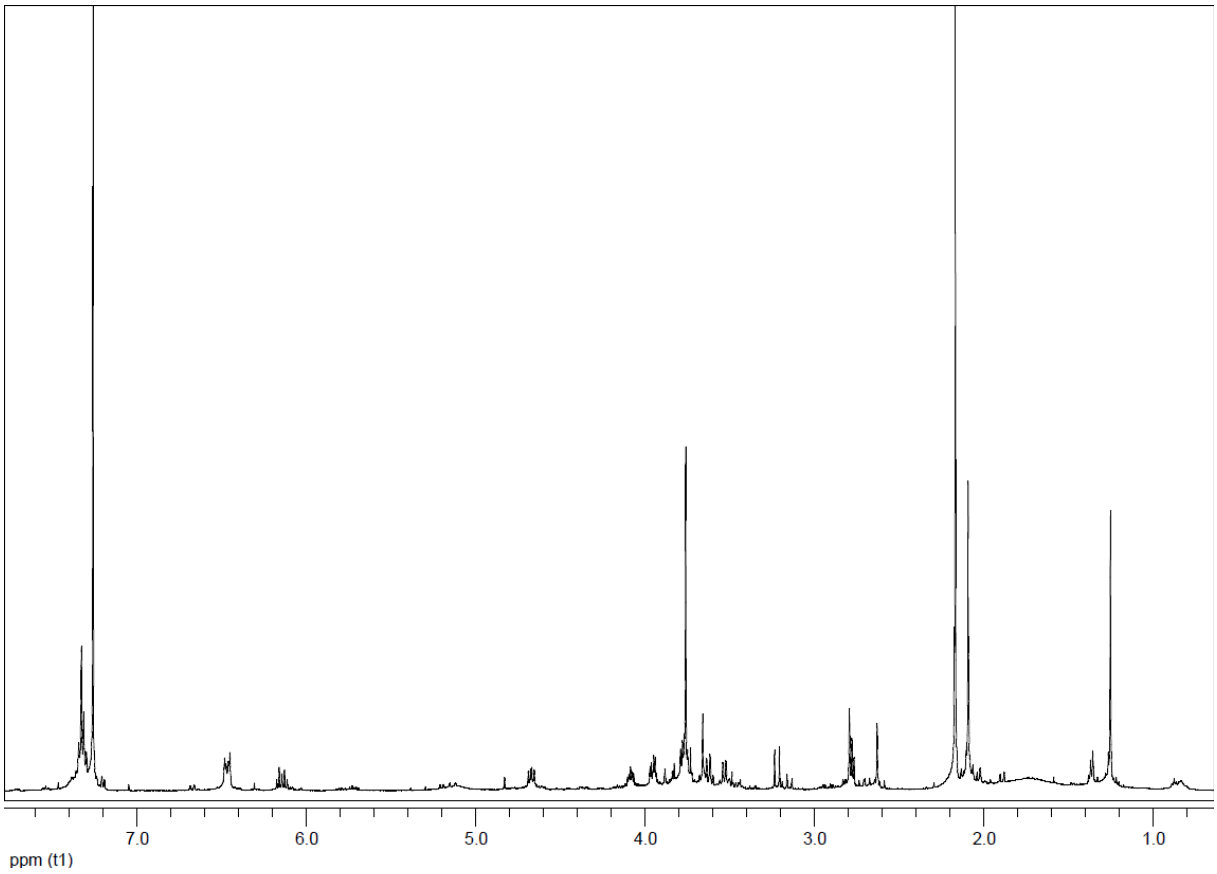

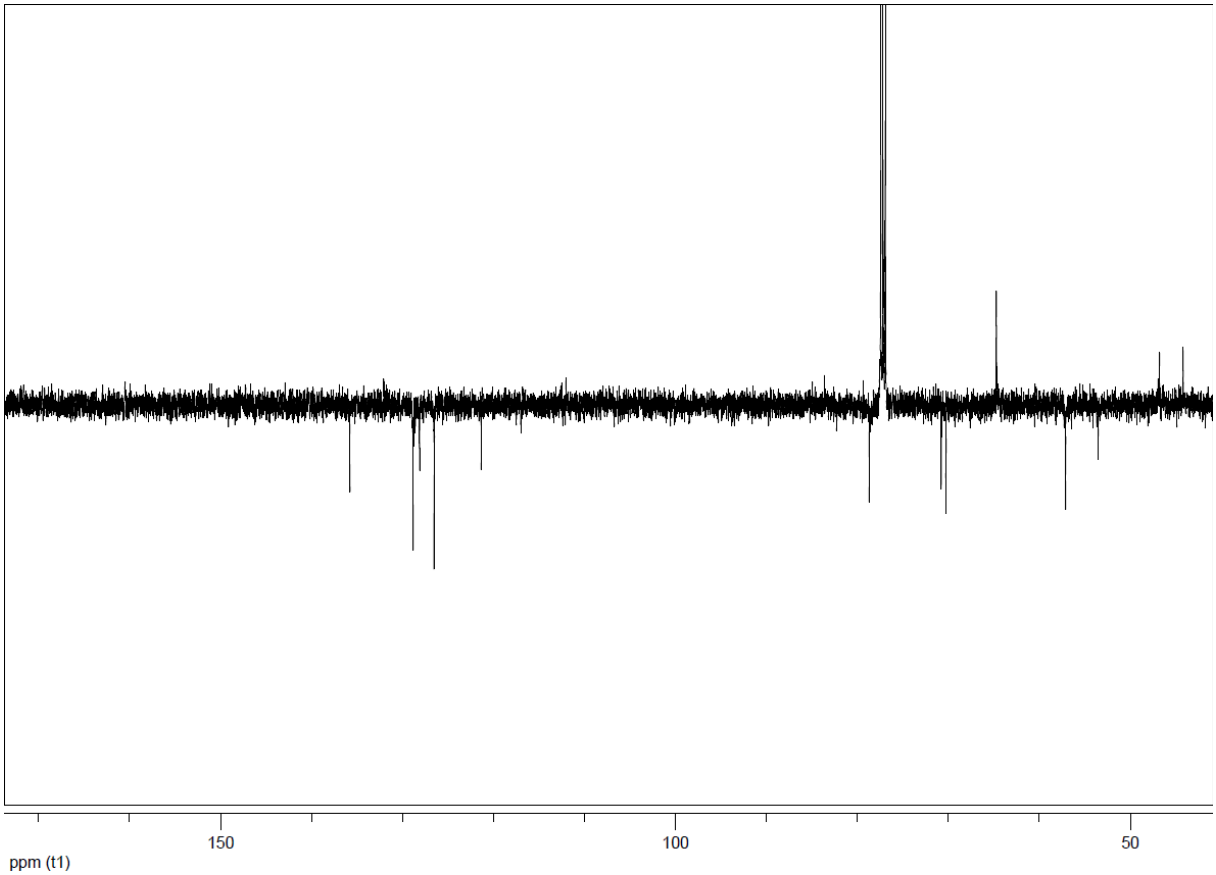

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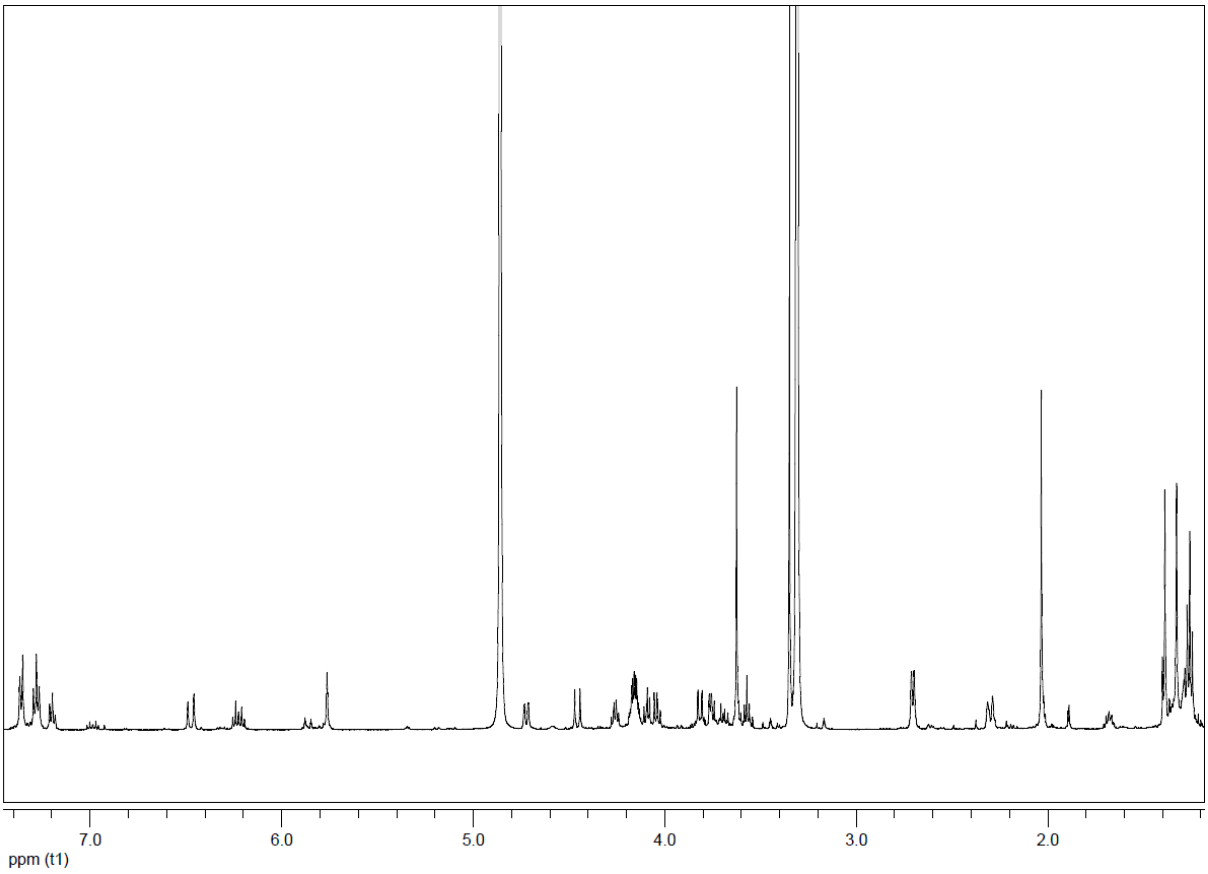

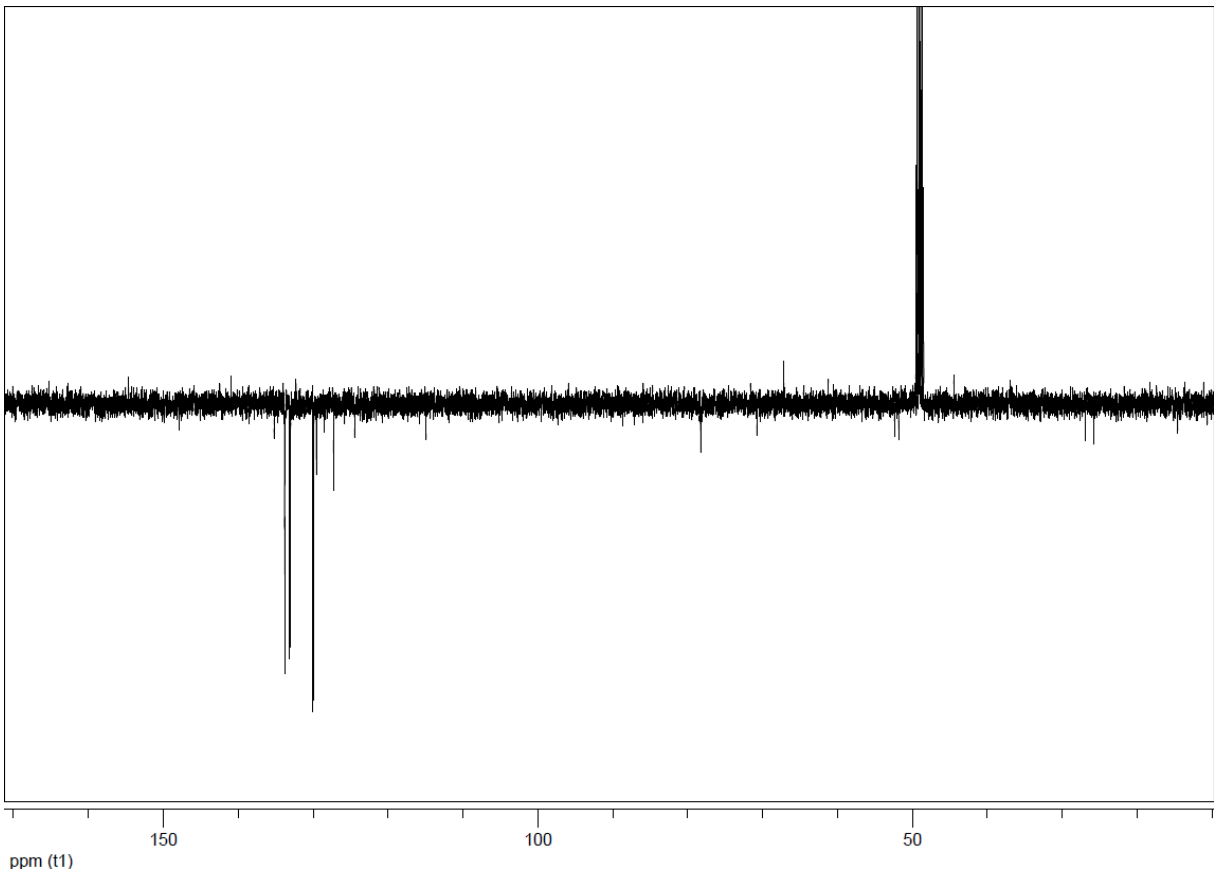

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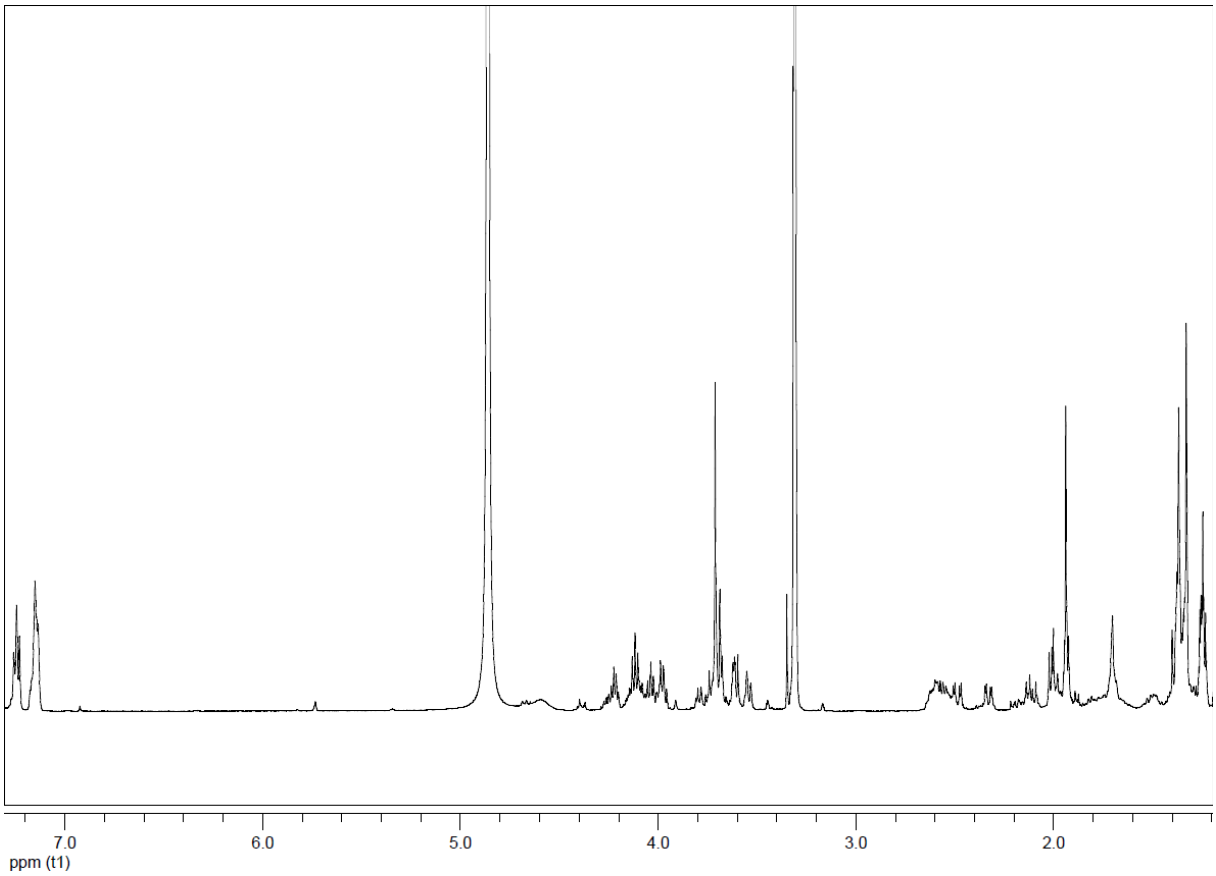

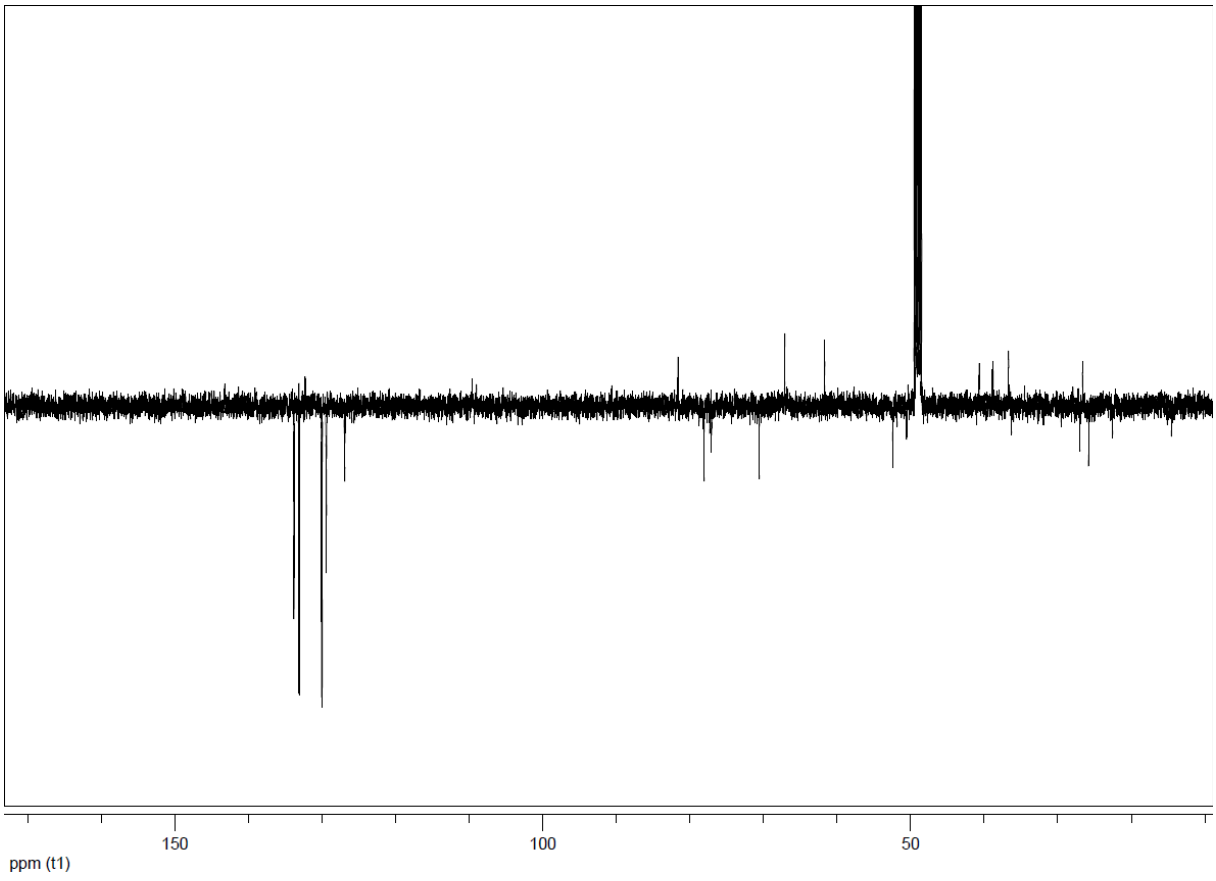

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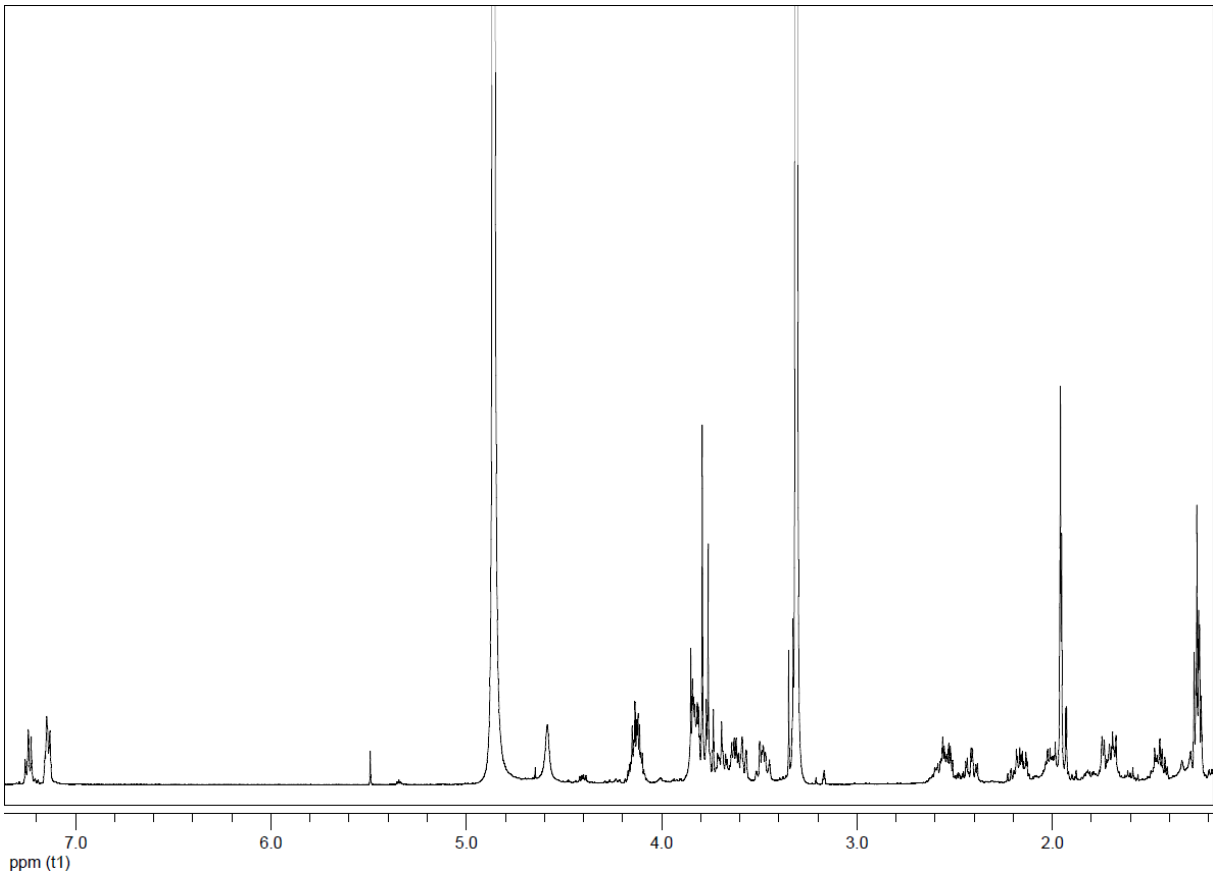

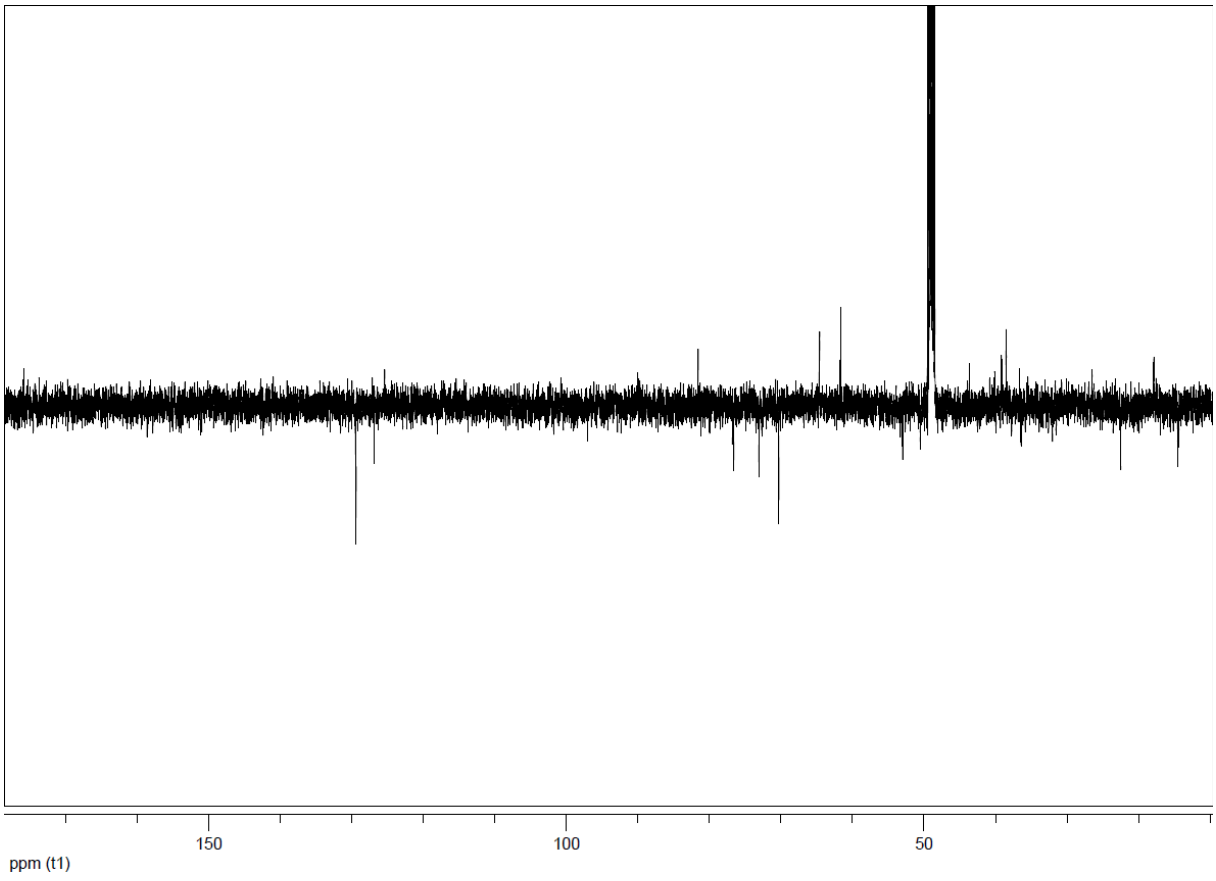

Compound **32**