Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Supporting Information

Chemical synthesis of new compounds

General procedure A : Fischer glycosylation and acetylation :[1]

Acidic silica (5mg/mmol) was added to a mixture of L-Fucose (1 eq) and acceptor propargyl alcohol (3eq). The mixture was heated at 70°C overnight, filtered through cotton and concentrated under reduced pressure. The residue was purified on silica gel (dichloromethane/methanol) to eliminate acceptor alcohol. The mix α/β anomers was dissolved in dichlorometane and acetic anhydride (6 eq), TEA (6 eq) and DMAP (0.1 eq) were added at 0°C. The mixture was stirred for 12h at room temperature, concentrated under reduced pressure, dissolved in dichloromethane, washed with aqueous sat. $NaHCO_3$ anddried over $MgSO_4$. The organic layer was concentrated under reduced pressure and the residue was purified on silica gel (Petroleum Ether/ Ethyl Acetate) to lead to the desired fucoside.

General procedure B : Click chemistry:

B1 : To a solution of fucoside (1eq) and 2-[2-[2-(2-azidoethoxy)ethoxy]ethoxy]-ethanol[2] (1.1 eq) in dioxane/water (4:1), was added sodium ascorbate (1.2 eq) and copper sulfate pentahydrate (2.4 eq). The mixture was stirred at 60°C overnight then Chelex resin was added and the mixture was stirred 30 minutes before filtration. Resin was flushed with MeOH and the filtrate was evaporated under reduce pressure. The residue was purified on silica gel.

B2 : To a solution of Cyclodextrin (1eq) and fucoside (6.6 eq) in dioxane/water (2:1), were added sodium ascorbate (2.4 eq) and copper sulfate pentahydrate (4.8 eq). The mixture was stirred at 60°C overnight then Chelex resin was added and the mixture was stirred 30 minutes before filtration. The resin was flushed with MeOH and the filtrate was evaporated under reduced pressure. The residue was purified on silica gel (Dichloromethane/MeOH) to afford the desired compound.

General procedure C : Deacetylation:

C1 : Acetylated compound was placed in MeoH/H_2O (1:1) with Amberlite IRN78 resin at room temperature and stirred overnight. The resin was filtrated and flushed with MeOH then the filtrate was concentrated under reduced pressure to afford the expected compound.

C2 : Acetylated compound was placed in MeOH at 0°C. MeONa solution (5.4M in MeOH) (0.1 eq by acetyl group) was added and the mixture was stirred for 1h. Resin Dowex H^+ was added to neutralize the solution and the mixture was stirred for 30 min. The resin was filtrated, flushed with MeOH and H_2O then the filtrate was concentrated under reduced pressure.

General procedure D : Propargylation:

D1 : Propargyl bromide (1 eq) was added to a solution of diol (4 eq) and NaH (4eq) in DMF at 0°C, and the mixture was stirred overnight at rt. The mixture was diluted in DCM, the organic layer washed with ice water, saturated aqueous $NaHCO_3$, and brine. The organic layer was dried over $MgSO_4$, filtered and

[1] H. Hashimoto, K. Shimada, S. Horito, *Tetrahedron- Asymmetr.*. **1994**, 5, 2351-2366.
[2] L.N. Goswami, Z.H. Houston, S.J. Sarma, S.S. Jalisatgi, M.F. Hawthorne, *Org. Biomol. Chem.*, **2013**, 11, 1116 - 1126

concentrated under reduced pressure. The residue was purified on silica gel (Petroleum ether/Ethyl acetate) to afford the expected compound.

D2 : A solution of fucoside (1 eq) and K_2CO_3 (10eq) in acetone (10 mg.mL^{-1}) were stirred 1h at 60°C. Propargyl bromide (10 eq) was added and the mixture was stirred overnight. The mixture was concentrated under reduce pressure, the residue was diluted in DCM and washed with water, saturated aqueous $NaHCO_3$ and brine. The organic layer was dried over $MgSO_4$, filtered and concentrated under reduced pressure.

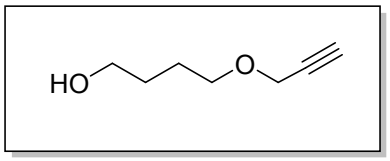
General procedure E : *One pot S*-deacetylation and *S*-alkylation

NaSMe (1.1eq)/K_2CO_3 (0.5eq) was added to a solution of fucoside (1eq) in MeOH (10 mg.mL^{-1}) at 0°C. The solution was stirred for 45min then alkyl bromide (2.2eq) was added to the mixture. Stirring was kept 1h at rt and resin Dowex H^+ was added to neutralize the mixture. The resin was filtrated and washed with MeOH and the solvent was concentrated in vacuo.

General procedure F : *S*-deacetylation and click thiolene

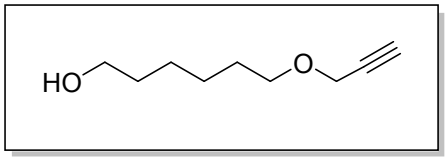
NaSMe (1.1eq)/K_2CO_3 (0.5eq) was added to a solution of fusoside (1eq) in MeOH (10 mg.mL^{-1}) at 0°C. The solution was stirred for 45min and resin Dowex H^+ was added to neutralize the mixture. The resin was fitrated and washed with MeOH. The residue was placed in THF (60 mg.mL^{-1}) with commercial phenol (1.2 eq) and DPAP (0.1 eq). The reaction was photoactivated (365nm) and stirred for 2h, then the mixture was concentrated under reduced pressure.

Compound 12



12 (1.28 g, 71%, yellow oil) was obtained from butan-1,4-diol following general procedure D1. Flash chromatography (petroleum ether/EtOAc 8/2). The analytical data of **12** are in agreement with literature.[3]

Compound 13

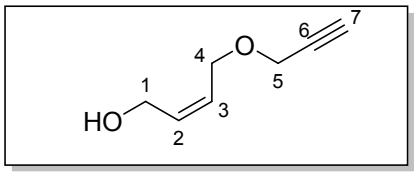


13 (1.25 g, 72%, yellow oil) was obtained from hexan-1,6-diol following general procedure D1. Flash chromatography (petroleum ether/EtOAc 8/2). The analytical data of **13** are in agreement with literature.[4]

[3] L. Yi, J. Shi, S. Gao, S. Leng, C. Niu, Z. Xi, *Tetrahedron Lett.* **2009**, *50*, 759-762.

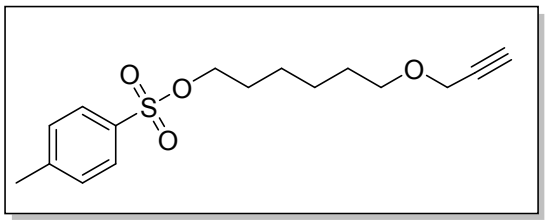
[4] N. Ranjan, S. Story, G. Fulcrand, F. Leng, M. Ahmad, A. King, S. Sur, W. Wang, Y-C. Tse-Dinh, D.P. Arya, *J. Med.*

Compound 14



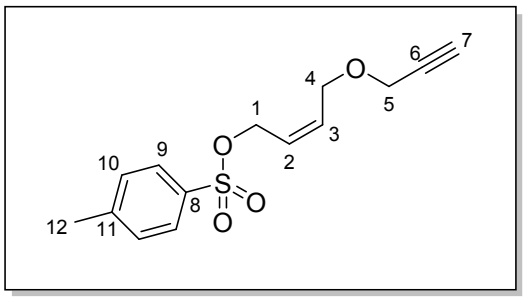
14 (1.58 g, 80%, yellow oil) was obtained from cis-2-buten-1,4-diol following general procedure D1. Flash chromatography (Petroleum Ether/EtOAc 8/2). ^{1}H NMR (300 MHz, $CDCl_3$) δ 5.79 (dtt, J = 11.2, 6.4, 1.3 Hz, 1H, H2 or H3), 5.67 – 5.55 (m, 1H, H2 or H3), 4.21 – 4.09 (m, 6H, H1, H4, H5), 2.65 (s, 1H, O*H*), 2.45 (t, J = 2.4 Hz, 1H, H7); ^{13}C NMR (75 MHz, CDCl3) δ 133.2, 127.1 (C-2, C-3), 79.4 (C-6), 74.9 (C-7), 64.9, 58.3, 57.2 (C-1, C-4, C-5); HRMS-ESI m/z calcd for $C_7H_{10}O_2Na$ $[M+Na]^+$ 149.0578 found 149.0583.

Compound 26



A solution of tosyl chloride (2.42 g, 12.3 mmol) in CH_2Cl_2 (3 mL) at 0°C was added dropwise to a solution of **13** (500 mg, 4.23 mmol) in CH_2Cl_2 (10 mL) and anhydrous trimethylamine (5.0 mL, 35.8 mmol). The mixture stirred overnight at 0°C to RT. After addition of H_2O (15 mL) and vigorous stirring for 1h, the mixture was extracted with CH_2Cl_2 (3x15mL), a saturated $NaHCO_3$ solution (3x15mL), and then dried over $MgSO_4$. The organic layer was concentrated under reduced pressure and the residue was purified on silica gel (cyclohexane/ ethyl Acetate 90/10) to give Chain **26** (1.25 mg, 72%, yellow oil) The analytical data of **26** were in complete agreement with literature data.[5]

Compound 27



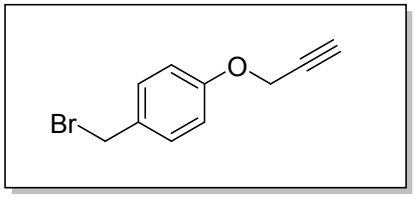
tosyl chloride (904 mg, 4.74 mmol) in CH_2Cl_2 (4 mL) at 0°C was added dropwise to a solution of **14** (200mg, 1.58 mmol) in CH_2Cl_2 (5 mL) and anhydrous trimethylamine (3.3 mL, 23.7 mmol). The mixture was stirred for 45min at 0°C then dissolved in dichloromethane, washed with aqueous sat. $NaHCO_3$, and dried over $MgSO_4$. The organic layer was concentrated under reduced pressure and the residue was purified on silica gel (cyclohexane/ ethyl acetate 95/5) to give **27** (195 mg, 45%, yellow oil). 1H NMR (300 MHz, $CDCl_3$) δ 7.87 – 7.71 (m, 2H), 7.44 – 7.32 (m, 2H), 5.85 – 5.57 (m, 2H H2, H3), 4.67 (dd,

Chem **2017**, 60, 4904-4922.

[5] D. Basak, S. Christensen, S.K. Surampudi, C. Versek, D.T. Toscano, M.T. Tuominen, R.C. Hayward, D. Venkataraman, *Chem. Commun.*, 2011, **47**, 5566–5568

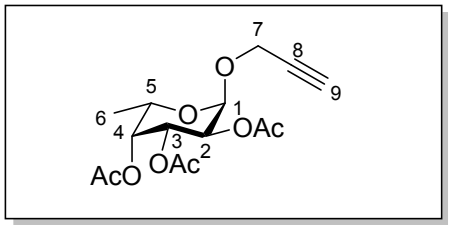
J = 6.5, 0.8 Hz, 2H, H5), 4.17 – 4.02 (m, 4H, H1, H4), 2.55 – 2.39 (m, 4H, H12, H7); ^{13}C NMR (75 MHz, $CDCl_3$) δ 144.97, 133.22 (C-8, C-11), 131.62 (C-2 or C-3), 129.95, 127.99 (C-9, C-10), 125.44 (C-2 or C-3), 79.23 (C-6), 75.00 (C-7), 65.81, 64.92, 57.46 (C-1, C-4, C-5), 21.71 (C-12).

Compound 28 :



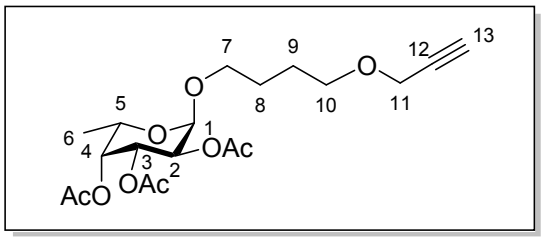
28 was obtained following a previously described protocole and the analytical data were in agreement.[6]

Compound 15:



15 (256 mg, 26%, white solid) was obtained by Fischer glycosylation of L-Fucose (500 mg, 3.04 mmol) with propargyl alcohol following general procedure A. The analytical data of **15** were in agreement with lit.[7]

Compound 16:



16 (221.8 mg, 16%, yellow oil) was obtained by Fischer glycosylation of L-Fucose (546mg 3.32 mmol) with 4-(prop-2-ynyloxy)butan-1-ol (**12**) following the general procedure A.

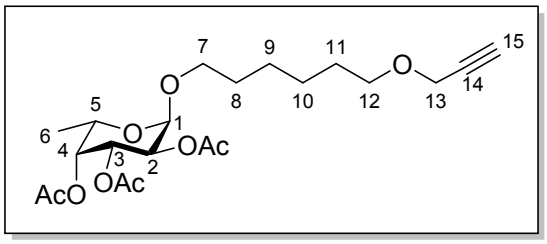
16: Flash chromatography (Petroleum Ether/EtOAc 8/2). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -119; ^{1}H NMR (300 MHz, $CDCl_3$) δ 5.31 (dd, *J* = 10.6, 3.4 Hz, 1H, H3), 5.25 (dd, *J* = 3.4, 1.1 Hz, 1H, H4), 5.06 (dd, *J* = 10.6, 3.7 Hz, 1H, H2), 5.00 (d, *J* = 3.7 Hz, 1H, H1), 4.16 – 4.07 (m, 3H, H5, H11), 3.73 – 3.62 (m, 1H, C*H*H H7 or H10), 3.53 – 3.47 (m, 2H, CH_2 H7 or H10), 3.44 – 3.34 (m, 1H, C*H*H H7 or H10), 2.41 (t, *J* = 2.4 Hz, 1H, H13), 2.13 (s, 3H, CH_3), 2.03 (s, 3H, CH_3), 1.95 (s, 3H, CH_3), 1.68 – 1.59 (m, 4H, H8, H9), 1.10 (d, *J* = 6.6 Hz, 3H, H6); ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.7, 170.5, 170.1 (3 CH_3CO), 96.1 (C-1), 79.9 (C-12), 74.34 (C-

[6] S. Kanamathareddy, C.D. Gutsche, *J. Org. Chem.*, 1996, **61**, 2511–2516

[7] B. Roy and B. Mukhopadhyay, *Tetrahedron Lett.* **2007**, *48*, 3783-3787.

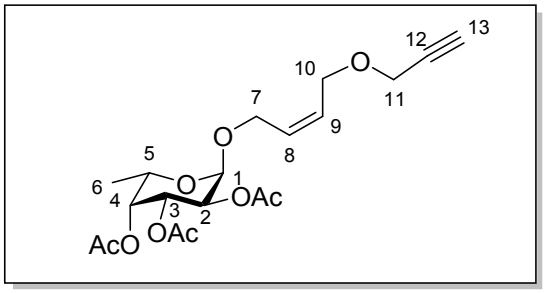
13), 71.2 (C-4), 69.6 (C-7 or C-10), 68.3 (C-2), 68.1 (C-3, C-7 or C-10), 64.3 (C-5), 58.1 (C-11), 26.2, 26.1 (C-8, C-9), 20.8, 20.7, 20.7 (3 *C*H_3CO), 15.9 (C-6); HRMS-ESI m/z calcd for $C_{19}H_{28}O_9Na$ [M+Na]$^+$ 423.1631 found 423.1619.

Compound 17 :



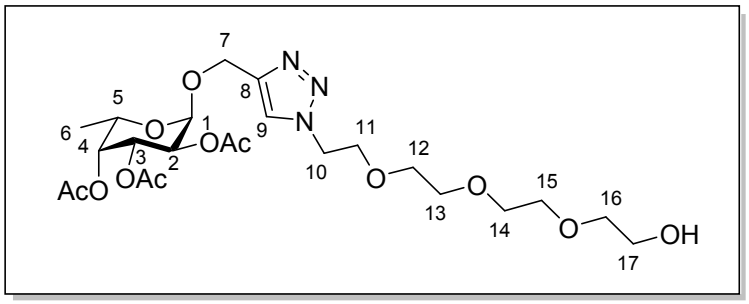
17 (159.7 mg, 20%, yellow oil) was obtained by Fischer glycosylation of L-Fucose (294mg, 1.79 mmol) with 6-(prop-2-ynyloxy)hexan-1-ol (**13**) following the general procedure A. Flash chromatography (Petroleum Ether/EtOAc 8/2). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -117; ^{1}H NMR (300 MHz, $CDCl_3$) δ 5.32 (dd, *J* = 10.6, 3.4 Hz, 1H, H3), 5.27 (dd, *J* = 3.4, 1.2 Hz, 1H, H4), 5.07 (dd, *J* = 10.6, 3.7 Hz, 1H, H2), 5.01 (d, *J* = 3.7 Hz, 1H, H1), 4.12 (m, 3H, H5, H13), 3.64 (dt, *J* = 9.8, 6.5 Hz, 1H, C*H*H H7 or H12), 3.49 (t, *J* = 6.5 Hz, 2H, C*H*$_2$ H7 or H12), 3.37 (dt, *J* = 9.8, 6.5 Hz, 1H, C*H*H H7 or H12), 2.41 (t, *J* = 2.4 Hz, 1H, H15), 2.14 (s, 3H, C*H*$_3$), 2.04 (s, 3H, C*H*$_3$), 1.96 (s, 3H, C*H*$_3$), 1.57 (td, *J* = 6.7, 4.0 Hz, 4H, H8, H11), 1.41 – 1.30 (m, 4H, H9, H10), 1.11 (d, *J* = 6.6 Hz, 3H, H6); 13C NMR (75 MHz, $CDCl_3$) δ 170.7, 170.5, 170.2 (3 CH_3*C*O), 96.1 (C-1), 80.0 (C-14), 74.2 (C-15), 71.3 (C-4), 70.1, 68.4 (C-7, C-12), 68.4, 68.2 (C-2, C-3), 64.3 (C-5), 58.1 (C-13), 29.5, 29.3, 25.9, 25.9 (C-8, C-9, C-10, C-11), 20.9, 20.8, 20.7 (3 *C*H_3CO), 15.98 (C-6); HRMS-ESI m/z calcd for $C_{21}H_{32}O_9Na$ [M+Na]$^+$ 451.1944 found 451.1942.

Compound 18 :



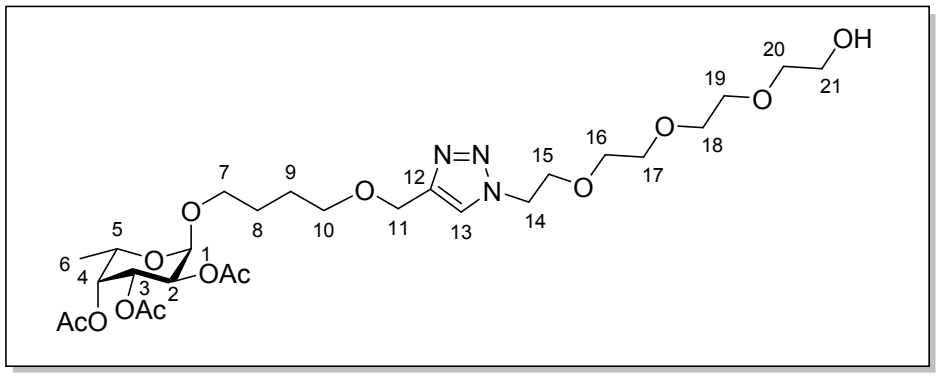
18 (63.5 mg, yellow oil) was obtained by Fischer glycosylation of L-Fucose (425 mg, 2.6 mmol) with (Z)-4-(prop-2-ynyloxy)but-2-en-1-ol (**14**) following the general procedure A. Flash chromatography (petroleum ether/etOAc 8/2). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -145; ^{1}H NMR (300 MHz, $CDCl_3$) δ 5.77 – 5.63 (m, 2H, H8, H9), 5.33 (dd, J = 10.6, 3.4 Hz, 1H, H3), 5.26 (dd, J = 3.4, 1.2 Hz, 1H, H4), 5.09 (dd, J = 10.6, 3.7 Hz, 1H, H2), 5.05 (d, J = 3.7 Hz, 1H, H1), 4.26 – 4.05 (m, 7H, H5, H11, H7, H10), 2.43 (t, J = 2.4 Hz, 1H, H13), 2.13 (s, J = 2.2 Hz, 3H, C*H*$_3$), 2.05 (s, 3H, C*H*$_3$), 1.95 (s, 3H, C*H*$_3$), 1.12 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.6, 170.5, 170.0 (3 CH_3*C*O), 129.4, 129.0 (C-8, C-9), 95.5 (C-1), 79.5 (C-12), 74.7 (C-13), 71.2 (C-4), 68.1, 68.0 (C-2, C-3), 65.0, 64.5 (C-7 or C-10, C-5), 63.5 (C-7 or C-10), 57.2 (C-11), 20.9, 20.7, 20.7 (3 *C*H_3CO), 15.9 (C-6); HRMS-ESI m/z calcd for $C_{19}H_{26}O_9Na$ [M+Na]$^+$ 421.1475 found 421.1466.

Compound 19 :



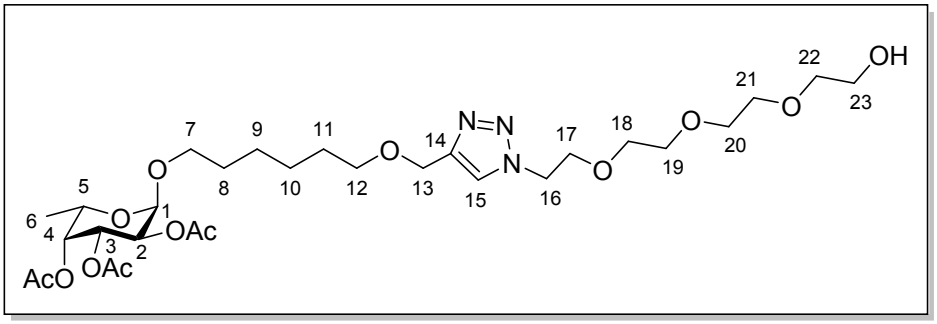
19 (170 mg, 90%, colorless oil) was obtained from compound **15** (115 mg, 0.35 mmol) following the general procedure B1. Flash chromatography (DCM/MeOH 96/4) $[\alpha]_D$ ($CHCl_3$, c=1, 20°C) = -32,2. ^{1}H NMR (300 MHz, MeOD) δ 8.12 (d, J = 7.3 Hz, 1H, H9), 5.36 – 5.27 (m, 2H, H3, H4), 5.16 (d, J = 3.7 Hz, 1H, H1), 5.04 (dd, J = 10.6, 3.7 Hz, 1H, H2), 4.81 (d, J = 12.5 Hz, 1H, H7a), 4.69 (d, J = 12.5 Hz, 1H, H7b), 4.65 – 4.58 (m, 2H, H10), 4.31 – 4.21 (m, 1H, H5), 3.97 – 3.88 (m, 2H, H11), 3.71 – 3.53 (m, 13H, 6 C*H*$_2$O, O*H*), 2.16 (s, 3H, C*H*$_3$), 2.01 (s, 3H, C*H*$_3$), 1.96 (s, 3H, C*H*$_3$), 1.13 (d, J = 6.5 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 172.2, 171.8, 171.5 (3 CH_3*C*O), 144.9 (C-8), 126.4 (C-9), 96.7 (C-1), 73.6 (CH2), 72.5 (C-4), 71.5 - 70.3 (5 CH_2O), 69.3, 69.2 (C-2, C-3), 65.9 (C-5), 62.2 (CH_2), 61.6 (C-7), 51.4 (C-10), 20.6, 20.4 (3 *C*H_3CO), 16.1 (C-6); HRMS-ESI m/z calcd for $C_{23}H_{37}N_3O_{12}Na$ $[M+Na]^+$ 570.2275 found 570.2280.

Compound 20 :



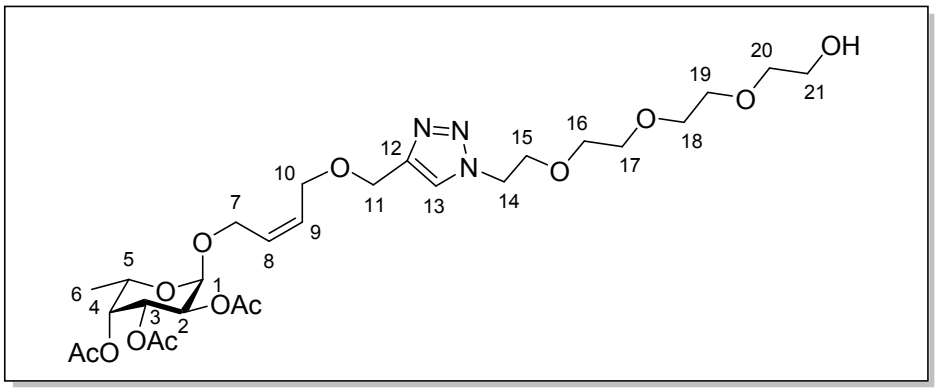
20 (71.7 mg, 77%, colorless oil) was obtained from compound **17** (60mg, 0.15 mmol) following the general procedure B1. Flash chromatography (DCM/MeOH 96/4); $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -63,0. ^{1}H NMR (300 MHz, MeOD) δ 8.04 (s, 1H, H13), 5.38 – 5.25 (m, 2H, H3, H4), 5.11 – 4.97 (m, 2H, H2, H1), 4.66 – 4.56 (m, 4H H11, H14), 4.24 – 4.15 (m, 1H, H5), 3.98 – 3.87 (m, 2H, H15), 3.80 – 3.39 (m, 18H 6 C*H*$_2$O, H7, H10, OH), 2.16 (s, 3H, C*H*$_3$), 2.05 (s, 3H, C*H*$_3$), 1.97 (s, 3H, C*H*$_3$), 1.77 – 1.64 (m, 4H, H8, H9), 1.12 (d, J = 6.5 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 172.2, 171.9, 171.6 (3 CH_3*C*O), 145.9 (C-12), 125.7 (C-13), 97.4 (C-1), 73.6 (CH_2), 72.5 (C-4), 71.5 - 71.1 (5 CH_2), 70.3 (C-15), 69.6, 69.5 (C-2, C-3), 69.1 (C-7 or C-10), 65.6 (C-5), 64.6 (C-11) , 62.1 (CH_2), 51.3 (C-14), 27.3, 27.2 (C-8, C-9), 20.6, 20.4 (3 *C*H_3CO), 16.1 (C-6); HRMS-ESI m/z calcd for $C_{27}H_{45}N_3O_{13}Na$ $[M+Na]^+$ 642.2850 found 642.2852.

Compound 21 :



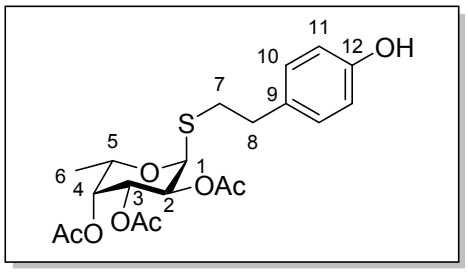
21 (45.6 mg, 75%, colorless oil) was obtained from compound **17** (40mg, 0.093 mmol) following the general procedure B1. Flash chromatography (DCM/MeOH 97/3) $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -61,7; ^{1}H NMR (300 MHz, MeOD) δ 8.03 (s, 1H, H15), 5.38 – 5.22 (m, 2H, H3, H4), 5.08 – 5.01 (m, 2H, H2, H1), 4.65 – 4.57 (m, 4H, H13, H16), 4.27 – 4.15 (m, 1H, H5), 3.98 – 3.88 (m, 2H, H17), 3.78 – 3.38 (m, 17H, 6 CH_2O, H7, H12, OH), 2.16 (s, 3H, CH_3), 2.05 (s, 3H, CH_3), 1.97 (s, 3H, CH_3), 1.72 – 1.54 (m, 4H, H8, H11), 1.51 – 1.35 (m, 4H, H9, H10), 1.14 (t, J = 6.1 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 172.2, 171.9, 171.6 (3 CH_3*C*O), 145.9 (C-14), 125.7 (C-15), 97.3 (C-1), 73.6 (*C*H_2), 72.5 (C-4), 71.5 - 71.3 (5 *C*H_2), 70.3 (C-17), 69.6, 69.5 (C-2, C-3), 69.3 (C-7 or C-12), 65.6 (C-5), 64.6 (C-13), 62.20 (CH_2), 51.3 (C-16), 30.6, 30.3 (C-8, C-11), 27.0, 26.9 (C-9, C-10), 20.6, 20.4 (3 *C*H_3CO), 16.1 (C-6); HRMS-ESI m/z calcd for $C_{29}H_{49}N_3O_{13}Na$ $[M+Na]^+$ 670.3163 found 670.3163.

Compound 22 :



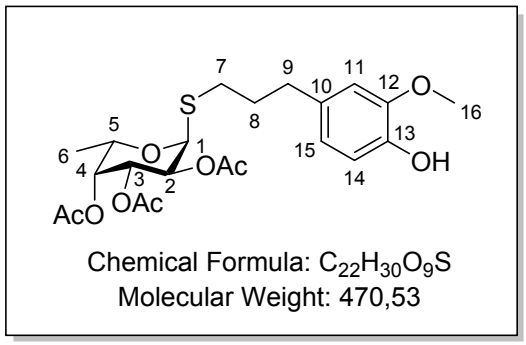
22 (67.8 mg, 77%, colorless oil) was obtained from compound **18** (60 mg, 0.15 mmol) following the general procedure B1. Flash chromatography (DCM/MeOH 95/5 $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -68,1. ^{1}H NMR (300 MHz, MeOD) δ 8.07 (s, 1H, H13), 5.88 – 5.67 (m, 2H, H8, H9), 5.39 – 5.24 (m, 2H, H3, H4), 5.12 – 5.05 (m, 2H, H2, H1), 4.66 – 4.55 (m, 4H, H11, H14), 4.33 – 4.13 (m, 5H, H5, H7, H10), 3.99 – 3.86 (m, 2H, H15), 3.77 – 3.52 (m, 13H, 6 CH_2O, OH), 2.19 (s, 3H, CH_3), 2.07 (s, 3H, CH_3), 1.99 (s, 3H, CH_3), 1.15 (d, J = 6.5 Hz, 3H, 6); ^{13}C NMR (75 MHz, MeOD) δ 172.2, 171.9, 171.6 (3 CH_3*C*O), 145.6 (C-12), 131.0, 129.4 (C-8, C-9), 125.8 (C-13), 96.6 (C-1), 73.6 (CH_2), 72.5 (C-4), 71.5, 71.4, 71.3 (4 CH_2), 70.3 (C-15), 69.4, 69.3 (C2, C3), 66.8 (C7 or C-10), 65.8 (C-5), 64.4 (C-7 or C-10), 64.0 (C-11), 62.1 (CH_2), 51.3 (C-14), 20.6, 20.6, 20.5 (3 *C*H_3CO), 16.1 (C-6).); HRMS-ESI m/z calcd for $C_{27}H_{43}N_3O_{13}Na$ $[M+Na]^+$ 640.2694 found 642.2710.

Compound 31 :



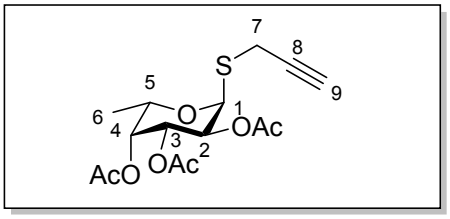
Compound **31** (100.0 mg, 57%, colorless oil) was obtained from 2,3,4-Tri-*O*-acetyl-1-*S*-acetyl-1-thio-α-L-fucopyranose (150 mg, 0.43 mmol) and commercial vinyl phenol (10% in propylene glycol) (580 µL, 0.47 mmol) following the procedure F. Flash chromatography (toluene/EtOAc 8/2). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -201; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.09 – 6.96 (m, 2H, H10), 6.79 – 6.73 (m, 2H, H11), 5.68 (d, *J* = 5.3 Hz, 1H, H1), 5.31 – 5.23 (m, 1H, H4, H2), 5.20 (dd, *J* = 10.7, 3.3 Hz, 1H, H3), 4.43 (q, *J* = 6.4 Hz, 1H, H5), 2.86 – 2.63 (m, 4H, H7, H8), 2.16 (s, 3H, CH_3), 2.05 (s, 3H, CH_3), 1.98 (s, 3H, CH_3), 1.13 (d, *J* = 6.5 Hz, 1H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.8, 170.5, 170.2 (3 CH_3*C*O), 154.6 (C-12), 132.3 (C-10), 129.8 (C-11), 115.5 (C-9), 82.4 (C-1), 71.2 (C-4), 68.8 (C-3), 68.3 (C-2), 64.9 (C-5), 35.3 (C-8), 31.8 (C-7), 21.0, 20.8, 20.7 (3 *C*H_3CO), 16.1 (C-6); HRMS-ESI m/z calcd for $C_{20}H_{26}O_8SNa$ $[M+Na]^+$ 449.1246 found 449.1241.

Compound 32 :



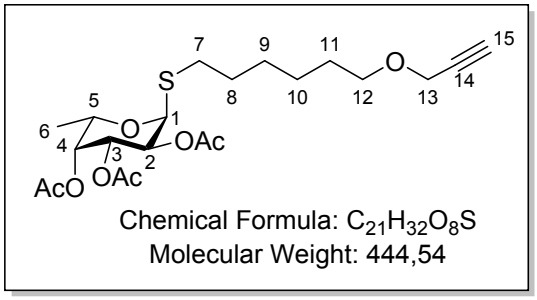
Compound **32** (100.0 mg, 50%, yellow oil) was obtained from 2,3,4-Tri-*O*-acetyl-1-*S*-acetyl-1-thio-α-L-fucopyranose (150 mg, 0.43 mmol) and commercial eugenol (77 µL, 0.50 mmol) following the procedure F. Flash chromatography (cyclohexane/EtOAc 7/3). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -157; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.82 (m, 1H, H14), 6.68 – 6.63 (m, 2H, H11, H15), 5.68 (d, *J* = 4.7 Hz, 1H, H1), 5.50 (s, 1H, OH), 5.32 – 5.22 (m, 3H, H4, H2, H3), 4.51 – 4.41 (m, 1H, H5), 3.87 (s, 3H, H16), 2.66 – 2.60 (m, 2H, H9), 2.59 – 2.53 (m, 1H, H7a), 2.48 (dt, *J* = 12.9, 7.3 Hz, 1H, H7b), 2.16 (s, 3H, CH_3), 2.06 (s, 3H, CH_3), 1.99 (s, 3H, CH_3), 1.93 – 1.82 (m, 2H, H8), 1.12 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.7, 170.4, 170.1 (3 CH_3*C*O), 146.6, 144.0 (C-12, C-13), 133.2 (C-10), 121.2 (C-15), 114.4 (C-14), 111.2 (C-12), 82.5 (C-1), 71.1 (C-4), 68.8 (C-3), 68.3 (C-2), 64.9 (C-5), 56.0 (C-16), 34.5 (C-9), 31.4 (C-8), 29.6 (C-7), 21.0, 20.8, 20.7 (3 *C*H_3CO), 16.0 (C-6); HRMS-ESI m/z calcd for $C_{22}H_{30}O_9SNa$ $[M+Na]^+$ 493.1508 found 493.1504.

Compound 33



NaSMe (1.1eq) was added to a solution of 2,3,4-tri-*O*-acetyl-1-*S*-acetyl-1-thio-α-L-fucopyranose[8] (1eq) in MeOH at 0°C. The solution was stirred for 45min then propargyl bromide (2.2eq) was added to the mixture. Stirring was kept 1h at rt and resin Dowex H^+ was added to neutralize the mixture. The resin was fitered, washed with MeOH and the solvent was concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether/EtOAc 8/2) to give **33** as a colorless oil (200 mg, 63%). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -231,2. ^{1}H NMR (400 MHz, CDCl3) δ 5.85 (d, J = 5.7 Hz, 1H, H1), 5.31 (dd, J = 10.9, 5.7 Hz, 1H, H2), 5.27 (d, J = 1.8 Hz, 1H, H4), 5.17 (dd, J = 10.9, 3.3 Hz, 1H, H3), 4.42 (q, J = 6.4 Hz, 1H, H5), 3.30 (dd, J = 16.7, 2.6 Hz, 1H, H7a), 3.14 (dd, J = 16.7, 2.6 Hz, 1H, H7b),2.21 (t, J = 2.6 Hz, 1H, H9), 2.14 (s, 3H, C*H*$_3$), 2.04 (s, 3H, C*H*$_3$), 1.96 (s, 3H, C*H*$_3$), 1.14 (d, J = 6.5 Hz, 3H, H6).^{13}C NMR (101 MHz, CDCl3) δ 170.5, 170.0, 169.9 (3 CH_3*C*O), 81.8 (C-1), 79.2 (C-8), 71.4 (C-9), 70.9 (C-4), 68.8 (C-3), 67.7 (C-2), 65.4 (C-5), 20.8, 20.7, 20.6 (3 *C*H_3CO), 17.3 (C-7), 15.9 (C-6). HRMS-ESI m/z calcd for $C_{15}H_{20}O_7SNa$ $[M+Na]^+$ 367.0827 found 367.0822.

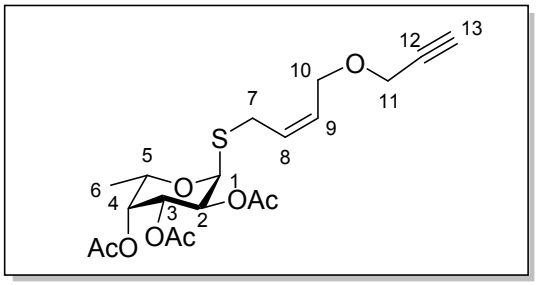
Compound 34 :



34 (114.0 mg, 60%, yellow oil) was obtained from 2,3,4-tri-*O*-acetyl-1-*S*-acetyl-1-thio-α-L-fucopyranose (150 mg, 0.41 mmol) and **26** (267mg, 0.86 mmol) following procedure E. Flash chromatography (cyclohexane/EtOAc 8/2). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -173,4; ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.64 (d, *J* = 5.1 Hz, 1H, H1), 5.29 – 5.25 (m, 1H, H4), 5.23 (dd, *J* = 10.8, 5.0 Hz, 1H, H2), 5.19 (dd, *J* = 10.8, 3.0 Hz, 1H, H3), 4.51 – 4.42 (m, 1H, H5), 4.10 (d, *J* = 2.4 Hz, 2H, H13), 3.48 (t, *J* = 6.5 Hz, 2H, H12), 2.50 (ddt, *J* = 30.6, 12.8, 7.5 Hz, 2H, H7), 2.40 (t, *J* = 2.4 Hz, 1H, H15), 2.14 (s, 3H, C*H*$_3$), 2.04 (s, 3H, C*H*$_3$), 1.96 (s, 3H, C*H*$_3$), 1.63 – 1.52 (m, 4H, H8, H11), 1.43 – 1.32 (m, 4H, H9, H10), 1.13 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.7, 170.4, 170.1 (3 CH_3*C*O), 82.6 (C-1), 80.2 (C-14), 74.3 (C-15), 71.2 (C-4), 70.2 (C-12), 68.9 (C-3), 68.3 (C-2), 64.9 (C-5), 58.2 (C-13), 30.3 (C-7), 29.7, 29.6 (C-8, C-11), 28.8, 25.9 (C-9, C-10), 21.0, 20.9, 20.8 (3 *C*H_3CO), 16.1 (C-6); HRMS-ESI m/z calcd for $C_{21}H_{32}O_8SNa$ $[M+Na]^+$ 467.1716 found 467.1711.

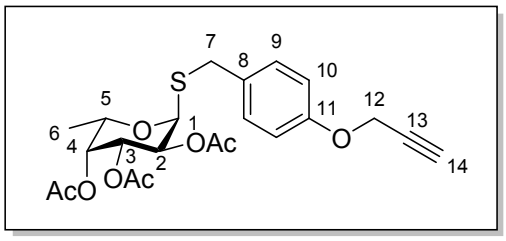
Compound 35 :

[8] H. Hashimoto, K. Shimada, S. Horito, *Tetrahedron- Asymmetr.*. **1994**, 5, 2351-2366.



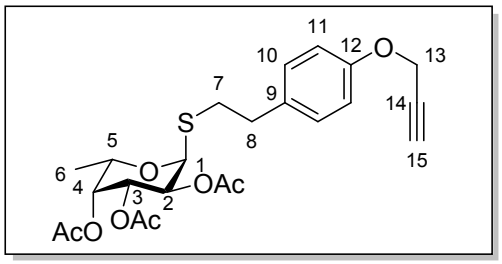
35 (82.8 mg, 64%, yellow oil) was obtained from 2,3,4-tri-*O*-acetyl-1-*S*-acetyl-1-thio-α-L-fucopyranose (110 mg, 0.32 mmol) and **27** (190 mg, 0.69 mmol) following procedure E. Flash chromatography (Cyclohexan/EtOAc 7/3). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -125; ^{1}H NMR (300 MHz, $CDCl_3$) δ 5.77 – 5.51 (m, 3H, H1, H8, H9), 5.33 – 5.13 (m, 3H, H4, H2, H3), 4.45 (q, *J* = 6.5 Hz, 1H, H5), 4.22 – 4.02 (m, 4H, H11, H10), 3.39 – 3.27 (m, 1H, H7a), 3.14 – 2.98 (m, 1H,H7b), 2.43 (t, *J* = 2.4 Hz, 1H, H13), 2.14 (s, 3H, CH_3), 2.03 (s, *J* = 3.7 Hz, 3H, CH_3), 1.96 (s, *J* = 7.3 Hz, 1H, CH_3), 1.15 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.6, 170.2, 170.0 (3 CH_3CO), 129.0, 128.7 (C-8, C-9), 81.1 (C-1), 79.8 (C-12), 74.7 (C-13), 71.0 (C-4), 68.8 (C-3), 67.9 (C-2), 64.8 (C-5), 64.6 (C-10), 57.2 (C-11), 26.2 (C-7), 20.9, 20.8, 20.7 (3 CH_3CO), 16.04 (C-6); HRMS-ESI m/z calcd for $C_{19}H_{26}O_8SNa$ $[M+Na]^+$ 437.1246 found 437.1246.

Compound 36 :



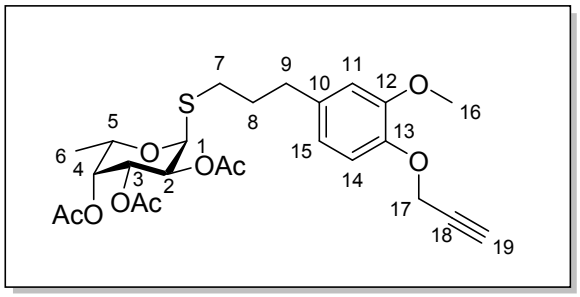
36 (153 mg, 80%, yellow oil) was obtained from 2,3,4-Tri-*O*-acetyl-1-*S*-acetyl-1-thio-α-L-fucopyranose (150 mg, 0.43 mmol) and **28** (400mg, 1.08 mmol) following procedure E. Flash chromatography (petroleum ether/EtOAc 6/4). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -189; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.20 (d, *J* = 8.7 Hz, 2H, H9), 6.88 (d, *J* = 8.7 Hz, 2H, H10), 5.52 (d, *J* = 4.9 Hz, 1H, H1), 5.29 – 5.21 (m, 2H, H4, H2), 5.18 (dd, *J* = 10.7, 3.0 Hz, 1H, H3), 4.65 (d, *J* = 2.4 Hz, 2H, H12), 4.41 (q, *J* = 6.5 Hz, 1H, H5), 3.65 (q, *J* = 13.5 Hz, 2H, H7), 2.51 (t, *J* = 2.4 Hz, 1H, H14), 2.13 (s, 3H, CH_3), 1.99 (s, 3H, CH_3), 1.95 (s, 3H, CH_3), 1.07 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (75 MHz, $CDCl_3$) δ 170.6, 170.0, 169.9 (3 CH_3CO), 156.7 (C-11), 130.7 (C-8), 130.0 (C-9), 115.0 (C-10), 81.7 (C-1), 78.6 (C-13), 75.7 (C-14), 71.0 (C-4), 68.9 (C-3), 67.8 (C-2), 65.0 (C-5), 55.9 (C-12), 33.6 (C-7), 20.9, 20.7, 20.7 (3 CH_3CO), 15.9 (C-6); HRMS-ESI m/z calcd for $C_{22}H_{26}O_8SNa$ $[M+Na]^+$ 473.1246 found 474.1242.

Compound 37 :



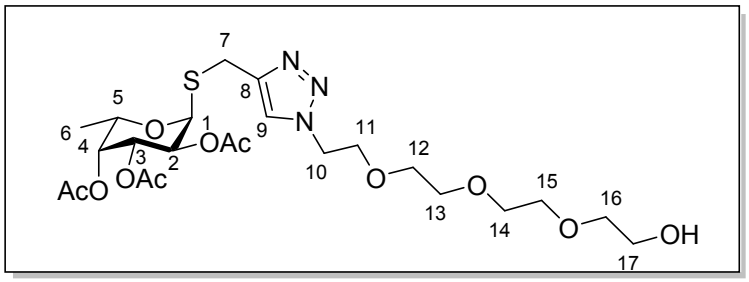
37 (73.0 mg, 67%, colorless oil) was obtained from compound **29** (100 mg, 0.23 mmol) following propargylation procedure D2. Flash chromatography (cyclohexan/EtOAc 8/2). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -169;^{1}H NMR (400 MHz, $CDCl_3$) δ 7.14 – 7.07 (m, 2H, H10), 6.94 – 6.86 (m, 2H, H11), 5.69 (d, *J* = 5.3 Hz, 1H, H1), 5.30 – 5.23 (m, 2H, H4, H2), 5.19 (dd, *J* = 10.7, 3.3 Hz, 1H, H3), 4.66 (d, *J* = 2.4 Hz, 1H, H13), 4.42 (q, *J* = 6.6 Hz, 1H, H5), 2.89 – 2.63 (m, 4H, H7, H8), 2.51 (t, *J* = 2.4 Hz, 1H, H15), 2.15 (s, 3H, C*H*$_3$), 2.04 (s, 3H, C*H*$_3$), 1.97 (s, 3H, C*H*$_3$), 1.13 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 170.3, 170.0 (3 CH_3*C*O), 156.3 (C-12), 133.4 (C-10), 129.6 (C-11), 115.1 (C-9), 82.3 (C-1), 78.8 (C-14), 75.6 (C-15), 71.1 (C-4), 68.7 (C-3), 68.2 (C-2), 64.9 (C-5), 56.0 (C-13), 35.2 (C-8), 31.7 (C-7), 21.0, 20.8, 20.7 (3 *C*H_3CO), 16.0 (C-6); HRMS-ESI m/z calcd for $C_{25}H_{32}O_9SNa$ $[M+Na]^+$ 487.1403 found 487.1396.

Compound 38



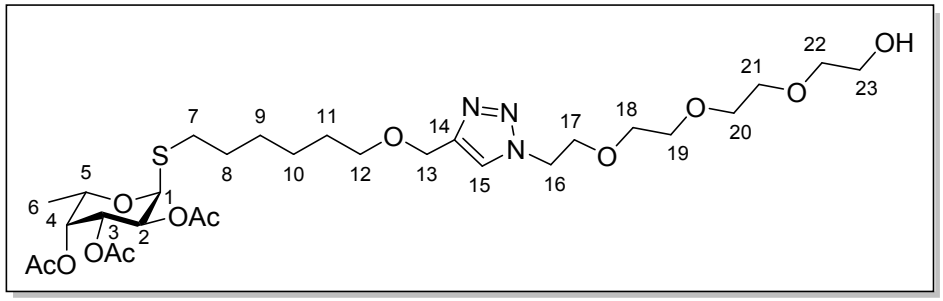
38 (50.0 mg, 66%, colorless oil) was obtained from compound **30** (70 mg, 0.15 mmol) following propargylation procedure D2. Flash chromatography (cyclohexane/EtOAc 8/2 $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -122; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.94 (d, *J* = 8.2 Hz, 1H, H14), 6.76 – 6.64 (m, 2H, H11, H15), 5.67 (d, *J* = 4.7 Hz, 1H, H1), 5.32 – 5.16 (m, 3H, H4, H2, H3), 4.71 (d, *J* = 2.4 Hz, 2H, H17), 4.54 – 4.38 (m, 1H, H5), 3.85 (s, 3H, H16), 2.70 – 2.60 (m, 2H, H9) 2.59 – 2.42 (m, 3H, H7, H19), 2.14 (s, 3H, C*H*$_3$), 2.05 (s, 3H, C*H*$_3$), 1.97 (s, 3H, C*H*$_3$), 1.95 – 1.83 (m, 2H, H8), 1.11 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 170.3, 170.0 (3 CH_3*C*O), 149.8, 145.2 (C-12, C-13), 135.6 (C-10), 120.3 (C-15), 115.0 (C-14), 112.4 (C-11), 82.4 (C-1), 78.9 (C-18), 75.7 (C-19), 71.1 (C-4), 68.7 (C-3), 68.2 (C-2), 64.9 (C-5), 57.1 (C-17), 56.0 (C-16), 34.4 (C-9), 31.1 (C-8), 29.5 (C-7), 20.9, 20.7, 20.7 (3 *C*H_3CO), 16.0 (C-6).); HRMS-ESI m/z calcd for $C_{25}H_{32}O_9SNa$ $[M+Na]^+$ 531.1665 found 531.1660.

Compound 39 :



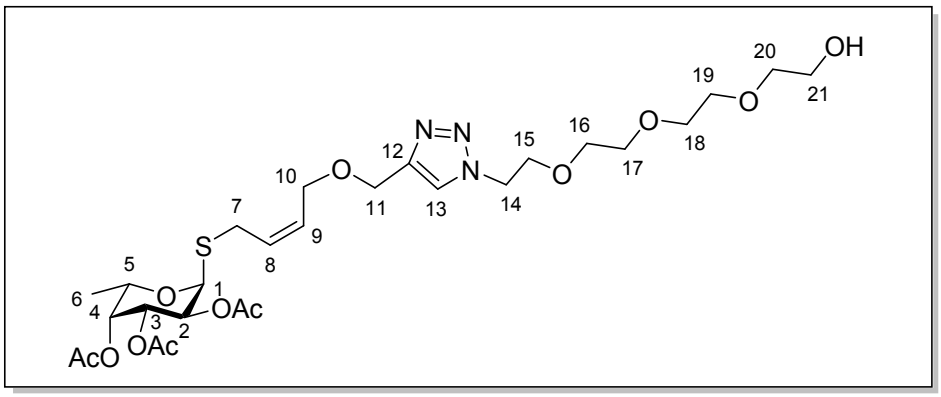
Compound **39** (32.4 mg, 50%, colorless oil) was obtained from **33** (40 mg, 0.12 mmol) following general procedure B1. Flash chromatography (DCM/MeOH 96/4); $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -95; ^{1}H NMR (300 MHz, MeOD) δ 7.95 (s, 1H, H9), 5.66 – 5.58 (m, 1H, H1), 5.30 (d, J = 1.1 Hz, 1H, H4), 5.26 – 5.12 (m, 2H, H2, H3), 4.61 – 4.55 (m, 2H, H10), 4.55 – 4.46 (m, 1H, H5), 3.95 – 3.79 (m, 4H, H7, H11), 3.72 – 3.55 (m, 13H, 6 C*H*$_2$O, O*H*), 2.17 (s, 3H, C*H*$_3$), 2.01 (s, 3H, C*H*$_3$), 1.97 (s, 3H, C*H*$_3$), 1.13 (d, J = 6.5 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 172.1, 171.4 (3 CH_3*C*O), 145.4 (C-8), 125.2 (C-9), 82.87 (C-1), 73.6 (CH_2), 72.24 (C-4), 71.5 - 71.4 (4 CH_2), 70.3 (C-11), 70.0, 69.1 (C-2, C-3), 66.4 (C-5), 62.2 (CH_2), 51.4 (C-10), 24.3 (C-7), 20.5, 20.5, 20.4 (3 *C*H_3CO), 16.1 (C-6); HRMS-ESI m/z calcd for $C_{23}H_{37}N_3O_{11}SNa$ $[M+Na]^+$ 586.2046 found 586.2049.

Compound 40 :



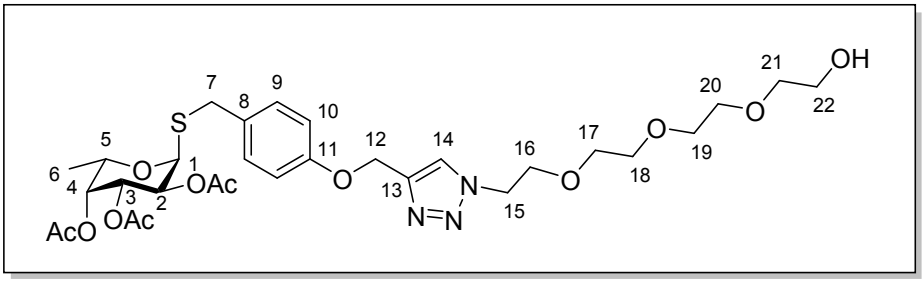
40 (39 mg, 67%, colorless oil) was obtained from compound **34** (40 mg, 0.09 mmol) following general procedure B1. Flash chromatography (DCM/MeOH 97/3). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -155; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (s, 1H, H15), 5.63 (d, *J* = 5.0 Hz, 1H, H1), 5.29 – 5.20 (m, 2H, H4, H2), 5.20 – 5.16 (m, 1H, H3), 4.59 (s, 2H, H13), 4.55 – 4.50 (m, 2H, H16), 4.48 – 4.41 (m, 1H, H5), 3.88 – 3.83 (m, 2H, H17), 3.72 – 3.67 (m, 2H, CH_2O), 3.66 – 3.61 (m, 2H, CH_2O), 3.61 – 3.56 (m, 8H, CH_2O), 3.49 (t, *J* = 6.6 Hz, 2H, H12), 2.77 (s, 1H, OH), 2.48 (ddt, *J* = 27.7, 12.8, 7.5 Hz, 2H, H7), 2.13 (s, 3H, C*H*$_3$), 2.04 (s, 3H, C*H*$_3$), 1.96 (s, 2H, C*H*$_3$), 1.61 – 1.51 (m, 4H, H8, H22), 1.40 – 1.29 (m, 4H, H9, H10), 1.12 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 170.3, 170.0 (3 CH_3*C*O), 145.3 (C-14), 123.8 (C-15), 82.4 (C-1), 72.6 (CH_2), 71.1 (C-4), 70.7, 70.6, 70.5, 70.4 (5 CH_2), 69.6 (C-17), 68.8 (C-3), 68.2 (C-2), 64.8 (C-5), 64.4(C-13), 61.7 (CH_2), 50.3 (C-16), 30.2 (C-7), 29.6, 29.6 (C-8 and C-11), 28.7, 25.8 (C-9 and C-10), 20.9, 20.7, 20.6 (3 *C*H_3CO), 16.0 (C-6); HRMS-ESI m/z calcd for $C_{29}H_{49}O_{12}N_3SNa$ $[M+Na]^+$ 686.2935 found 686.2927.

Compound 41 :



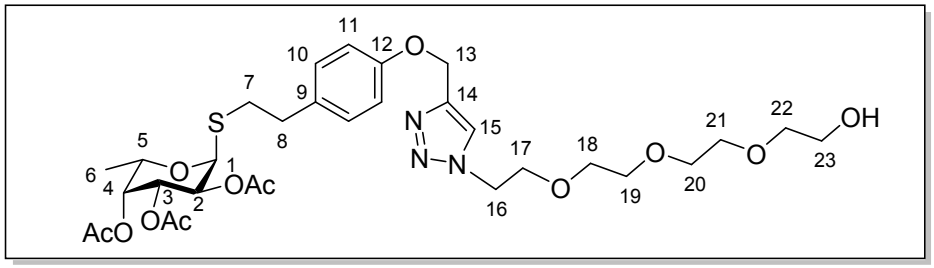
41 (99.2 mg, 78%, colorless oil) was obtained from **35** (83 mg, 0.20 mmol) following general procedure B1. Flash chromatography (DCM/MeOH 97/3); $[\alpha]_D$ ($CHCl_3$, c=1, 20°C) = -86; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (s, 1H, H13), 5.76 – 5.67 (m, 1H, H9), 5.64 – 5.56 (m, 2H, H1, H8), 5.30 – 5.23 (m, 2H, H4, H2), 5.20 (dd, *J* = 10.8, 3.2 Hz, 1H, H3), 4.62 (s, 2H, H11), 4.57 – 4.52 (m, 2H, H14), 4.46 (q, *J* = 6.1 Hz, 1H, H5), 4.19 – 4.08 (m, 2H, H10), 3.89 – 3.85 (m, 2H, H15), 3.74 – 3.69 (m, 2H, CH_2O), 3.68 – 3.64 (m, 2H, CH_2O), 3.63 – 3.58 (m, 8H, 4 CH_2O), 3.31 (dd, *J* = 14.1, 9.2 Hz, 1H, H7a), 3.06 (dd, *J* = 13.9, 6.5 Hz, 1H, H7b), 2.15 (s, *J* = 1.7 Hz, 3H, C*H*$_3$), 2.04 (s, 3H, C*H*$_3$), 1.97 (s, 3H, C*H*$_3$), 1.15 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.7, 170.2, 170.0 (3 CH_3*C*O), 145.1 (C-12), 129.4 (C-9), 128.4 (C-8), 124.0 (C-13), 81.3 (C-1), 72.6 (CH_2), 71.1 (C-4), 70.7, 70.7, 70.6, 70.5 (4 CH_2), 69.7 (C-15), 68.9 (C-3), 68.0 (C-2), 65.6 (C-10), 65.0 (C-5), 63.9 (C-11), 61.8 (CH_2), 50.4 (C-14), 26.4 (C-7), 20.9, 20.8, 20.7 (3 *C*H_3CO), 16.1 (C-6); HRMS-ESI m/z calcd for $C_{27}H_{43}O_{12}N_3SNa$ $[M+Na]^+$ 656.2465 found 656.2463.

Compound 42



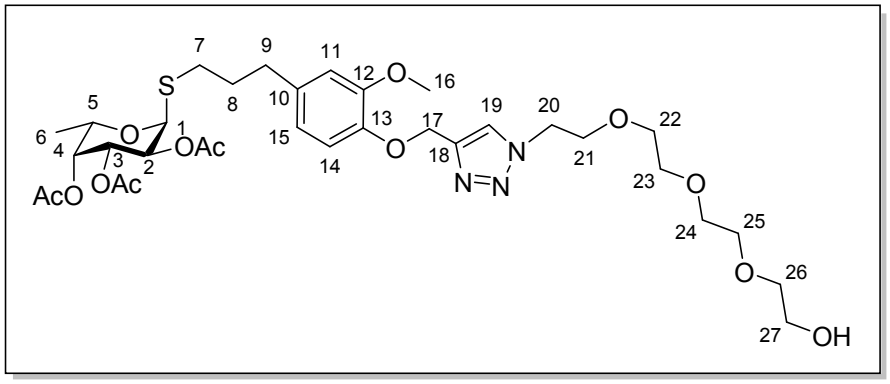
42 (35.8 mg, 75%, colorless oil) was obtained from compound **36** (33 mg, 0.072 mmol) following general procedure B1. Flash chromatography (DCM/MeOH 97/3). $[\alpha]_D$ ($CHCl_3$, c=1, 20°C) = -97; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (s, 1H, H14), 7.23 – 7.16 (m, 2H, H9), 6.94 – 6.89 (m, 2H, H10), 5.52 (d, *J* = 4.9 Hz, 1H, H1), 5.30 – 5.20 (m, 3H, H4, H2, H3), 5.18 (br s, 2H, H12), 4.57 – 4.52 (m, 2H, H15), 4.43 (q, *J* = 6.4 Hz, 1H, H5), 3.90 – 3.85 (m, 2H, H16), 3.72 – 3.55 (m, 14H, H12, CH_2O), 2.14 (s, 3H, C*H*$_3$), 1.99 (s, 3H, C*H*$_3$), 1.96 (s, 3H, C*H*$_3$), 1.09 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 170.1, 170.0 (3 CH_3*C*O), 157.6 (C-11), 144.0 (C-13), 130.3 (C-8), 130.1 (C-9), 124.2 (C-14), 115.0 (C-10), 81.6 (C-1), 72.6 (CH_2), 71.1 (C-4), 70.7, 70.6, 70.5, 70.4 (4 CH_2), 69.6 (C-16), 68.9 (C-3), 67.9 (C-2), 65.1 (C-5), 62.3 (C-12), 61.8 (CH_2), 50.5 (C-15), 33.6 (C-7), 20.9, 20.8, 20.7 (3 *C*H_3CO), 16.0 (C-6); HRMS-ESI m/z calcd for $C_{30}H_{43}O_{12}N_3SNa$ $[M+Na]^+$ 692.2465 found 692.2458.

Compound 43 :



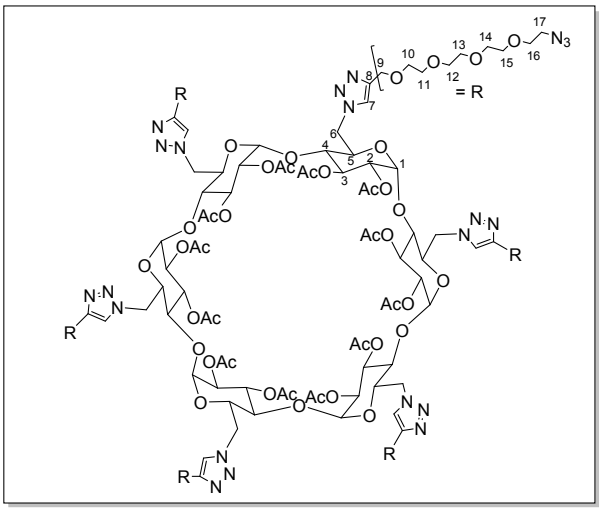
43 (33.2 mg, 56%, colorless oil) was obtained from compound **37** (40 mg, 0.086 mmol) following general procedure B1. Flash chromatography (DCM/MeOH 97/3); $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -97; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (br s, 1H, H15), 7.08 (d, *J* = 8.5 Hz, 2H, H10), 6.91 (d, *J* = 8.6 Hz, 2H, H11), 5.68 (d, *J* = 5.3 Hz, 1H, H1), 5.30 – 5.14 (m, 5H, H4, H2, H3, H13), 4.54 (t, *J* = 5.0 Hz, 2H, H16), 4.43 (q, *J* = 6.4 Hz, 1H, H5), 3.87 (t, *J* = 5.0 Hz, 2H, H17), 3.72 – 3.67 (m, 2H, CH_2O), 3.66 – 3.61 (m, 2H, CH_2O), 3.61 – 3.54 (m, 8H, CH_2O), 2.88 – 2.60 (m, 4H, H7, H8), 2.15 (s, 3H, C*H*$_3$), 2.04 (s, 3H, C*H*$_3$), 1.97 (s, 3H, C*H*$_3$), 1.13 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 170.3, 170.0 (3 CH_3CO), 157.1 (C-12), 145.9 (C-14), 132.9 (C-9), 129.6 (C-10), 124.8 (C-15), 114.9 (C-11), 82.3 (C-1), 72.5 (CH_2), 71.1 (C-4), 70.7, 70.6, 70.5, 70.4 (4 CH_2), 69.6 (C-17), 68.7 (C-3), 68.2 (C-2), 64.9 (C-5), 62.2 (C-13), 61.8 (CH_2), 50.5 (C-16), 35.2 (C-8), 31.7 (C-7), 20.9, 20.8, 20.7 (3 *C*H_3CO), 16.0 (C-6); HRMS-ESI m/z calcd for $C_{31}H_{45}O_{12}N_3SNa$ $[M+Na]^+$ 706.2622 found 706.2611.

Compound 44 :



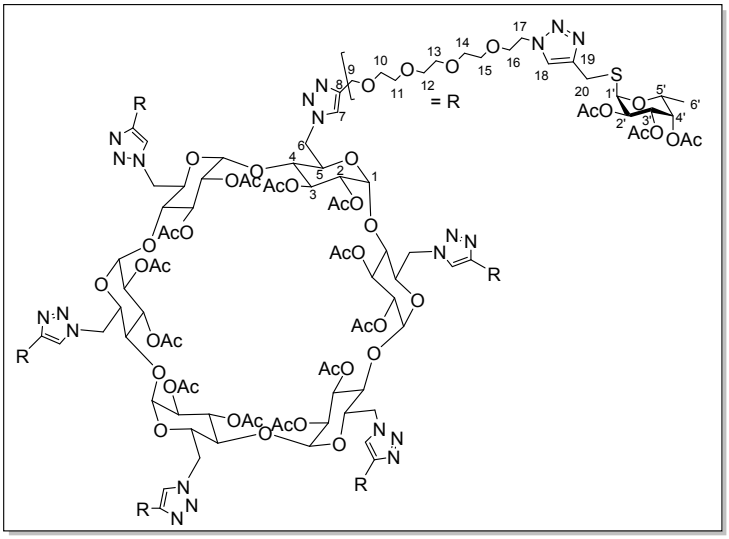
44 (39 mg, 66%, colorless oil) was obtained from compound **38** (37 mg, 0.073 mmol) following general procedure B1. Flash chromatography (DCM/MeOH 97/3); $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -92; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (s, 1H, H19), 6.95 (d, *J* = 8.1 Hz, 1H, H14), 6.73 – 6.62 (m, 2H, H11, H15), 5.66 (d, *J* = 4.7 Hz, 1H, H1), 5.30 – 5.16 (m, 5H, H4, H2, H3, H17), 4.55 – 4.49 (m, 2H, H20), 4.45 (q, *J* = 6.3 Hz, 1H, H5), 3.88 – 3.84 (m, 2H, H21), 3.83 (s, 3H, H16), 3.70 – 3.67 (m, 2H, CH_2O), 3.64 – 3.61 (m, 2H, CH_2O), 3.60 – 3.55 (m, 8H, 4 CH_2O), 2.66 – 2.59 (m, 2H, H9), 2.58 – 2.43 (m, 2H, H7), 2.14 (s, 3H, C*H*$_3$), 2.05 (s, 3H, C*H*$_3$), 1.97 (s, 3H, C*H*$_3$), 1.93 – 1.80 (m, 2H, H8), 1.11 (d, *J* = 6.5 Hz, 3H, H6); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 170.3, 170.0 (3 CH_3CO), 149.7, 146.1 (C-12, C-13), 144.4 (C-18), 135.0 (C-10), 124.3 (C-19), 120.5 (C-15), 114.7 (C-14), 112.4 (C-11), 82.4 (C-1), 72.5 (CH_2), 71.1 (C-4), 70.7, 70.6, 70.5, 70.4 (4 CH_2), 69.6 (C-21), 68.7 (C-3), 68.2 (C-2), 64.8 (C-5), 63.5 (C-17), 61.7 (CH_2), 56.0 (C-16), 50.4 (C-20), 34.4 (C-9), 31.2 (C-8), 29.6 (C-7), 20.9, 20.8, 20.7 (3 *C*H_3CO), 16.0 (C-6); HRMS-ESI m/z calcd for $C_{33}H_{49}O_{13}N_3SNa$ $[M+Na]^+$ 750.2884 found 750.2867.

Compound 45



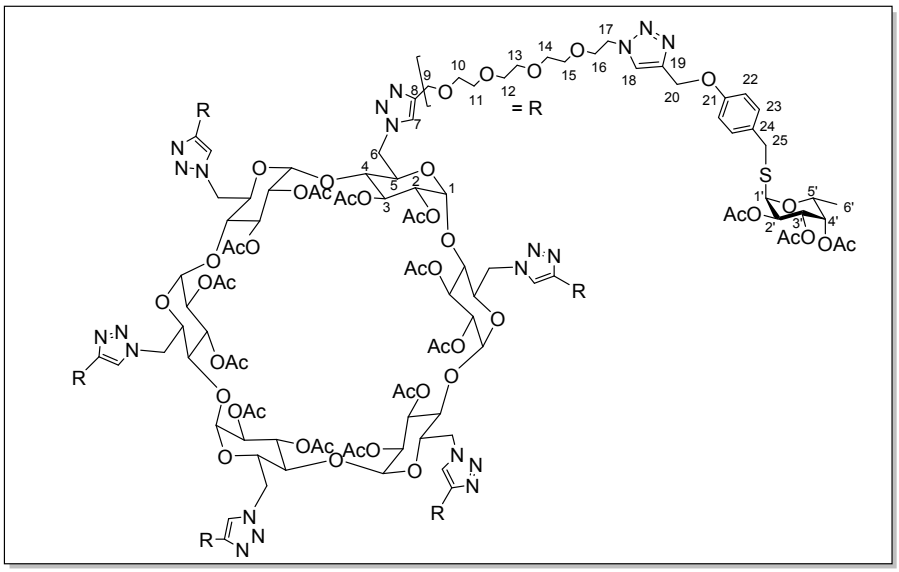
Sodium ascorbate (2.4 eq) and copper sulfate pentahydrate (4.8 eq) were added to a solution of 6-azido α-cyclodextrin (330 mg, 0.20 mmol) and 1-azido-tetraethyleneglycol (415 mg, 1.34 mmol, 6.6 eq) in dioxane/water (2:1). The mixture was stirred at 60°C overnight then Chelex resin was added and the mixture was stirred 30 minutes before filtration. The resin was flushed with MeOH and the filtrate was evaporated under reduced pressure. The residue and NaN_3 (240 mg, 3.65 mmol, 18 eq) were diluted in DMF (20 mL). The mixture was heated at 50°C and stirred overnight. The solvent was evaporated under reduced pressure and the residue was purified on silica gel by flash chromatography (DCM/MeOH 9/1) to give compound **45** (173 mg, 30%, yellow oil).$[\alpha]_D$ ($CHCl_3$, c=1, 20°C) = +27,7; ^{1}H NMR (300 MHz, CDCl3) δ 7.68 (s, J = 25.8 Hz, 6H), 5.55 – 5.29 (m, 12H, H1, H3), 4.73 – 4.48 (m, 36H, H2, H5, H6, H9), 3.73 – 3.46 (m, 90H, 7 CH_2, H4), 3.39 – 3.26 (m, H17, 12H), 2.00 (s, CH_3, 18H), 1.96 (s, CH_3, 18H); 13C NMR (75 MHz, CDCl3) δ 170.3, 169.2 (CH_3CO), 144.7 (C-8), 125.7 (C-7), 96.4 (C-1), 76.9 (C-4), 70.9 (C-3), 70.6 - 69.8 (C-2, C-9, CH_2), 64.4 (C-6), 50.6 (C-16), 50.4 (C-5), 20.7. HRMS-ESI m/z calcd for $C_{126}H_{195}N_{36}O_{60}Na_3$ $[M+3H]^{3+}$ 1057.4438 found 1057.4399. Compound previously reported in assailly, coralie; bridot, clarisse; saumonneau, amélie; lottin, paul; Roubinet, Benoit; Krammer, Eva-Maria; et al. (2020): Polyvalent transition-state analogues of sialyl substrates strongly inhibit bacterial sialidases.. ChemRxiv. Preprint. https://doi.org/10.26434/chemrxiv.13013291.v2.

Compound 46



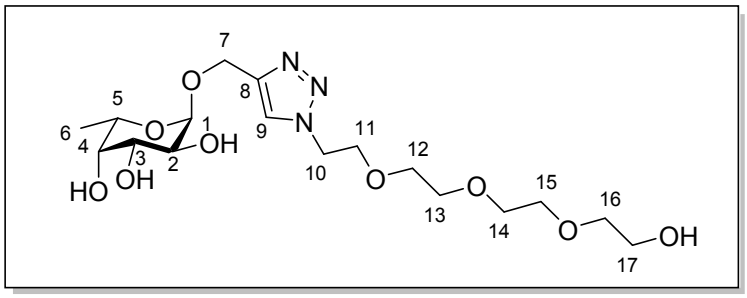
46 (41 mg, 50%, yellow oil) was obtained from compound **45** (50 mg, 0.015 mmol) and compound **33** (35 mg, 0.104 mmol, 6.6eq) following general procedure B2. Flash chromatography (DCM/MeOH 9/1). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -66; 1H NMR (400 MHz, $CDCl_3$) δ 7.72 (br s, 6H, H7), 7.55 (s, 6H, H18), 5.58 (d, J = 5.2 Hz, 6H, H1'), 5.54 – 5.33 (m, 12H, H3, H1), 5.24 – 5.08 (m, 18H, H4', H3', H2'), 5.02 – 4.35 (m, 50H), 3.89 – 3.68 (m, 24H, H16, H20), 3.68 – 3.39 (m, 78H), 2.14 – 1.86 (m, 90H, C*H*$_3$), 1.06 (d, J = 6.5 Hz, 18H, H6'); 13C NMR (101 MHz, $CDCl_3$) δ 170.4 - 169.8 (CH_3*C*O), 144.81, 143.96 (C-8 and C-19), 125.71, 123.09 (C-7 and C-18), 96.86 (C-1), 81.69 (C-1'), 70.9 (C-4'), 70.5 - 69.4 (CH_2), 68.7 (C-3'), 67.7 (C-2'), 65.0 (C-5'), 64.4 (CH_2), 50.2 (C-17), 23.9 (C-20), 20.7- 20.6 (*C*H_3CO), 15.9 (C-6'); HRMS-ESI m/z calcd for $C_{216}H_{312}N_{36}O_{102}S_6Na_4$ $[M+4Na]^{4+}$ 1331.4562 found 1331.4565.

Compound 47 :



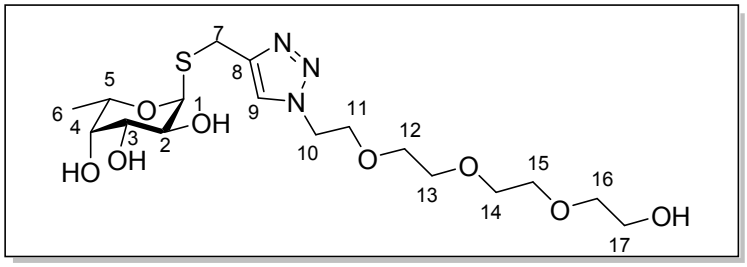
47 (145 mg, 56%, yellow oil) was obtained from compound **45** (140 mg, 0.045 mmol) and compound **36** (131 mg, 0.291 mmol, 6.6eq) following general procedure B2. Flash chromatography (DCM/MeOH 9/1). $[\alpha]_D$ ($CHCl_3$, c=0.5, 20°C) = -62. ^{1}H NMR (400 MHz, CDCl3) δ 7.77 (s, 6H, H18), 7.67 (s, 6H, H7), 7.16 (d, J = 8.6 Hz, 12H, H23), 6.87 (d, J = 8.6 Hz, 12H, H22), 5.55 – 5.34 (m, 18H, H1', H3, H1), 5.34 – 5.08 (m, 15H, H4', H2', H3', H20), 4.95 – 4.33 (m, 54H, H2, H5, H6, H5', H17 , CH_2), 3.82 (t, J = 5.0 Hz, 16H, H16), 3.77 – 3.42 (m, 90H, H4, CH_2), 2.20 – 1.85 (m, 90H, CH_3), 1.06 (d, J = 6.5 Hz, 18H, H6'). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5 - 169.1 (CH_3*C*O), 157.5 (C-21), 144.6 (C-8), 143.8 (C-19), 130.1 (C-24), 130.0 (C-23), 125.7 (C-7), 124.0 (C-18), 114.8 (C-22), 96.5 (C-1), 81.5 (C-1'), 77.3 (C-4), 70.9 - 70.4 (C-3 and CH_2), 69.9 (C-2 and C-5), 69.3 (C-16), 68.8 (C-3'), 67.7 (C-2'), 64.9 (C-5'), 64.4 (C-6), 62.0 (C-20), 50.3 (C-17), 33.4 (C-25), 20.7 - 20.6 (*C*H_3CO), 15.8 (C-6'); HRMS-ESI m/z calcd for $C_{258}H_{348}N_{36}O_{108}S_6Na_4$ $[M+4Na]^{4+}$ 1490.5190 found 1490.5250.

Compound 1



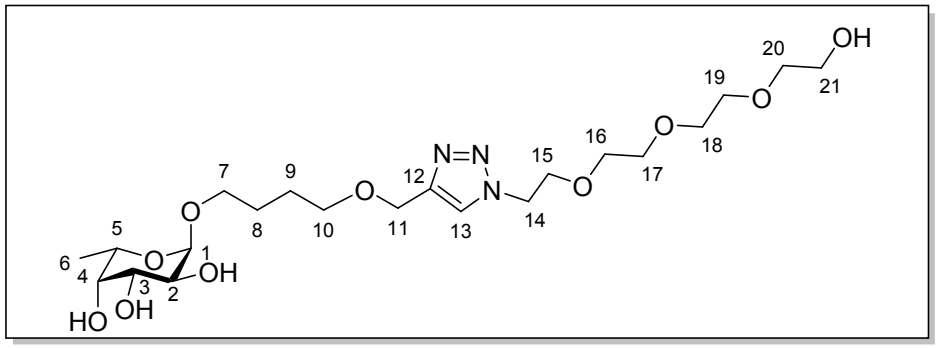
2 (116 mg, 96%, colorless oil) was obtained from compound **20** (158 mg, 0.29 mmol) following general deprotection procedure C1. $[\alpha]_D$ (MeOH, c=1, 20°C) = -72; ^{1}H NMR (300 MHz, MeOD) δ 8.09 (s, 1H, H9), 4.90 (m, 1H, H1), 4.79 (d, J = 12.5 Hz, 1H, H7a), 4.66 (d, J = 12.4 Hz, 1H, H7b), 4.62 – 4.58 (m, 2H, H10), 4.02 – 3.94 (m, 1H, H5), 3.94 – 3.88 (m, 2H, H11), 3.80 – 3.71 (m, 2H, H2, H3), 3.70 – 3.54 (m, 13H, H4, 6 C*H*$_2$O), 1.21 (d, J = 6.6 Hz, 3H, H6); 13C NMR (75 MHz, MeOD) δ 145.5 (C-8), 125.9 (C-9), 100.1 (C-1), 73.64 (C-4), 73.62 (CH_2), 71.60 (C-2 or C-3), 71.5 - 71.3 (4 CH_2), 70.34 (C-11), 69.9 (C-2 or C-3), 67.8 (C-5), 62.2 (C-7), 61.6 (CH_2), 51.4 (C-10), 16.6 (C-6); HRMS-ESI m/z calcd for $C_{17}H_{31}N_3O_9Na$ $[M+Na]^+$ 444.1958 found 444.1951.

Compound 2 :



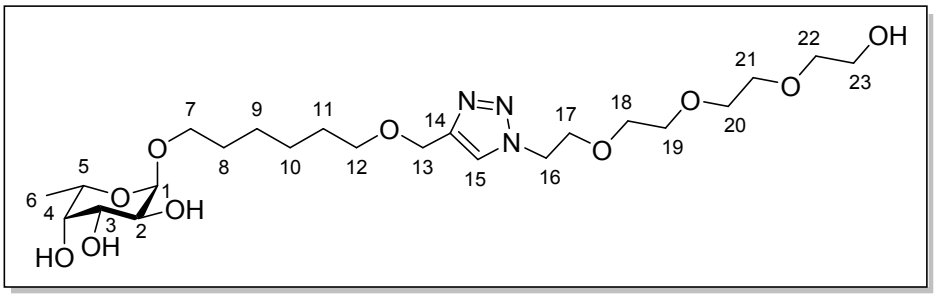
3 (19.8 mg, 93%, colorless oil) was obtained from compound **40** (27.5 mg, 0.049 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=1, 20°C) = -64; ^{1}H NMR (300 MHz, MeOD) δ 7.94 (s, 1H, H9), 5.32 (d, J = 5.6 Hz, 1H, H1), 4.58 – 4.52 (m, 2H, H10), 4.25 (q, J = 6.7 Hz, 1H, H5), 4.05 (dd, J = 10.0, 5.6 Hz, 1H, H2), 3.91 – 3.81 (m, 3H, H11, H7a), 3.76 (d, J = 14.4 Hz, 1H, H7b), 3.70 – 3.53 (m, 14H, 6 CH_2O, H3, H4), 1.20 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 146.2 (C-8), 125.1 (C-9), 86.7 (C-1), 73.64 (CH_2), 73.39, 72.47 (C-3, C-4), 71.5 - 71.4 (4 CH_2), 70.3 (C-11), 69.3 (C-2), 68.1 (C-5), 62.21 (CH_2), 51.41 (C-10), 24.21 (C-7), 16.66 (C-6); HRMS-ESI m/z calcd for $C_{17}H_{31}N_3O_8SNa$ $[M+Na]^+$ 460.1730 found 460.1723.

Compound 3



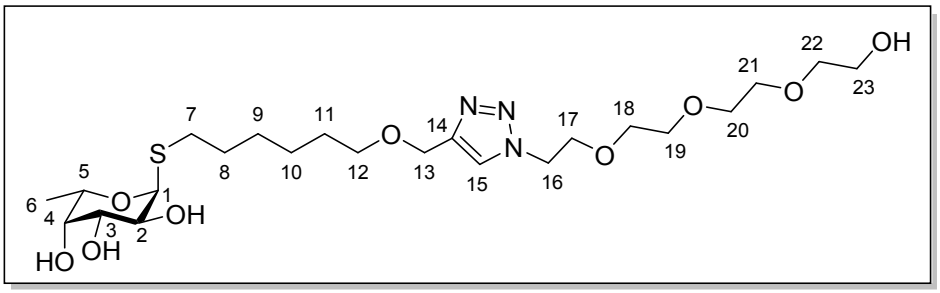
3 (47.7 mg, 92%, colorless oil) was obtained from compound **20** (65mg, 0.105 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=1, 20°C) = -67; ^{1}H NMR (300 MHz, MeOD) δ 8.05 (s, 1H, H13), 4.75 (d, J = 1.9 Hz, 1H, H1), 4.63 – 4.58 (m, 4H, H11, H14), 3.98 – 3.88 (m, 3H, H5, H15), 3.75 – 3.72 (m, 2H, H2, H3), 3.71 – 3.40 (m, 18H, H4, H7, H10, 6 C*H*$_2$O, O*H*), 1.78 – 1.64 (m, 4H, H8, H9), 1.21 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 145.9 (C-12), 125.8 (C-13), 100.4 (C-1), 73.7 (CH_2), 73.6 (C-4), 71.6 (C-2 or C-3), 71.5 - 71.3 (5 CH_2), 70.3 (C-15), 70.0 (C-2 or C-3), 68.9 (CH_2), 67.4 (C-5), 64.6 (C-11), 62.1 (CH_2), 51.3 (C-14), 27.4, 27.3 (C-8, C-9), 16.6 (C-6); HRMS-ESI m/z calcd for $C_{21}H_{39}N_3O_{10}Na$ $[M+Na]^+$ 516.2533 found 51-.2531.

Compound 4



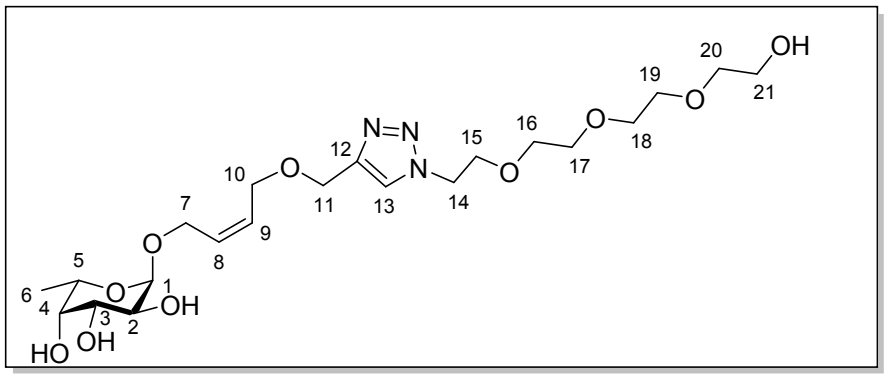
4 (30.8 mg, 96%, colorless oil) was obtained from compound **21** (40 mg, 0.062 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=1, 20°C) = -72; ^{1}H NMR (300 MHz, MeOD) δ 8.03 (s, 1H, H15), 4.74 (d, J = 2.3 Hz, 1H, H1), 4.63 – 4.56 (m, 4H, H7, H16), 3.99 – 3.86 (m, 3H, H5, H17), 3.77 – 3.38 (m, 20H, H2, H3, H4, H7, H12, 6 C*H*$_2$O, O*H*), 1.72 – 1.53 (m, 4H, H8, H11), 1.48 – 1.34 (m, 4H, H9, H10), 1.20 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 145.9 (C-14), 125.8 (C-15), 100.44 (C-1), 73.7, 73.6 (C-4, CH_2), 71.69 (C-2 or C-3), 71.5 - 71.3 (5 CH_2), 70.3 (C-17), 70.0 (C-2 or C-3), 69.15 (CH_2), 67.4 (C-5), 64.6 (C-13), 62.2 (CH_2), 51.3 (C-16), 30.6, 30.5 (C8, C-11), 27.1, 27.0 (C-9, C-10), 16.6 (C-6); HRMS-ESI m/z calcd for $C_{23}H_{43}N_3O_{10}$ $[M+Na]^+$ 544.2846 found 544.2849.

Compound 5



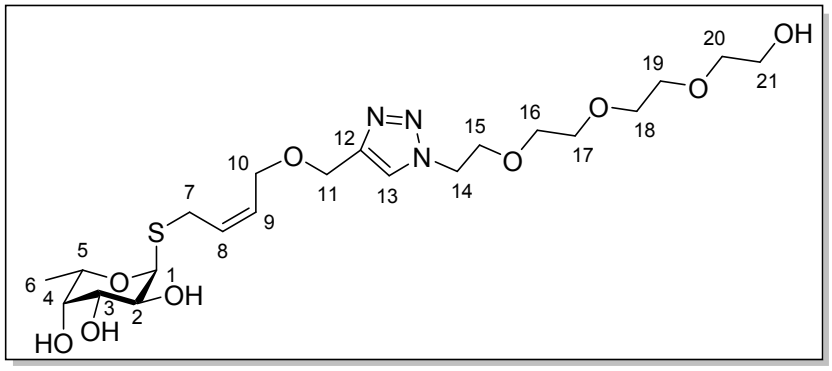
5 (26 mg, 90%, colorless oil) was obtained from compound **40** (36 mg, 0.054 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=0.5, 20°C) = -95,7; ^{1}H NMR (400 MHz, MeOD) δ 8.08 (s, 1H, H15), 5.36 (d, J = 5.6 Hz, 1H, H1), 4.70 – 4.62 (m, 4H, H13, H16), 4.34 (q, J = 6.6 Hz, 1H, H5), 4.10 (dd, J = 10.1, 5.6 Hz, 1H, H2), 4.01 – 3.93 (m, 2H, H17), 3.77 – 3.56 (m, 16H, H3, H4, H12, 6 CH_2O), 2.72 – 2.51 (m, 2H, H7), 1.77 – 1.62 (m, 4H, H8, H11), 1.54 – 1.41 (m, 4H, H9, H10), 1.28 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (101 MHz, MeOD) δ 146.0 (C-14), 125.7 (C-15), 87.8 (C-1), 73.6 (CH_2), 73.4, 72.4 (C-3 and C-4), 71.5, 71.4, 71.4 (4 CH_2, C-12), 70.3 (C-17), 69.5 (C-2), 67.9 (C-5), 64.6 (C-13), 62.2 (CH_2), 51.4 (C-16), 31.1 (C-7), 30.8, 30.5 (C-8 and C-11), 29.6, 26.7 (C-9 and C-10), 16.6 (C-6); HRMS-ESI m/z calcd for $C_{23}H_{44}O_9N_3S$ $[M+H]^+$ 538.2798 found 538.2794.

Compound 6



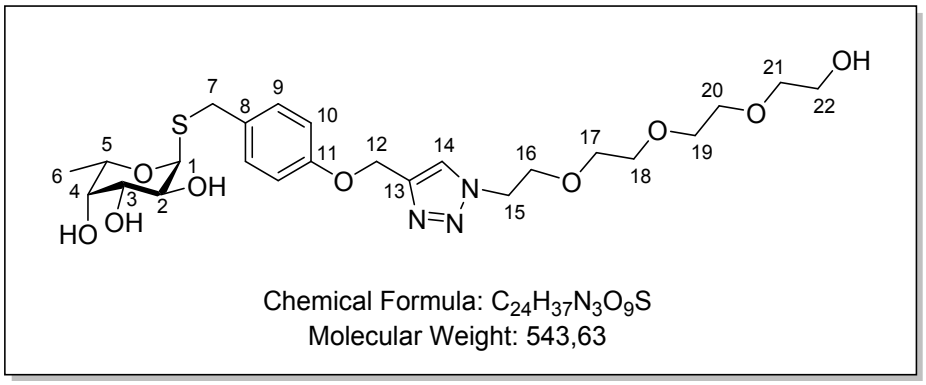
6 (44.3 mg, 93%, colorless oil) was obtained from compound **23** (60 mg, 0.97 mmol) following general procedure C1; $[\alpha]_D$ (MeOH, c=1, 20°C) = -70,5; ^{1}H NMR (300 MHz, MeOD) δ 8.05 (s, 1H, H13), 5.87 – 5.66 (m, 2H, H8, H9), 4.79 (d, J = 1.7 Hz, 1H, H1), 4.64 – 4.56 (m, 4H, H11, H15), 4.27 – 4.09 (m, 4H, H7, H10), 3.99 – 3.87 (m, 3H, H5, H15), 3.78 – 3.69 (m, 2H, H2, H3), 3.69 – 3.47 (m, 14H, H4, 6CH_2O, O*H*), 1.21 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (75 MHz, MeOD) δ 145.6 (C-12), 130.3, 130.2 (C-8, C-9), 125.9 (C-13), 99.7 (C-1), 73.6 (CH_2), 73.5 (C-4), 71.6 (C-2 or C-3), 71.5 - 71.3 (4 CH_2), 70.3 (C-15), 69.8 (C-2 or C-3), 67.6 (C-5), 66.8, 64.1 (C-7, C-10), 64.0 (C-11), 62.1 (CH_2), 51.3 (C-14), 16.7 (C-6); HRMS-ESI m/z calcd for $C_{21}H_{37}N_3O_{10}Na$ $[M+Na]^+$ 514.2377 found 514.2377.

Compound 7



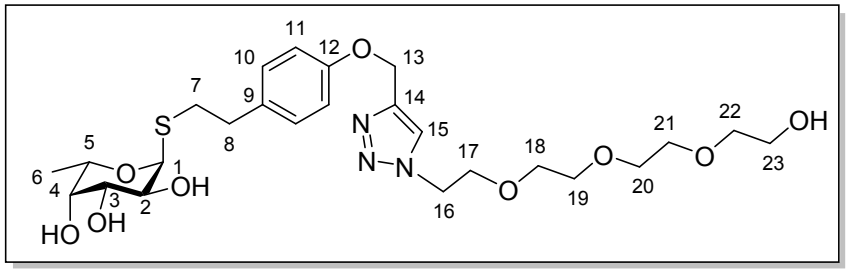
8 (79 mg, quant, colorless oil) was obtained from compound **41** (99 mg, 0.16 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=0.5, 20°C) = -112; ^{1}H NMR (400 MHz, MeOD) δ 8.15 (s, 1H, H13), 5.81 – 5.70 (m, 2H, H8, H9), 5.37 (d, *J* = 5.7 Hz, 1H, H1), 4.70 – 4.64 (m, 4H, H11, H14), 4.35 (q, *J* = 6.5 Hz, 1H, H5), 4.28 – 4.20 (m, 2H, H10), 4.13 (dd, *J* = 10.1, 5.7 Hz, 1H, H2), 3.98 (t, *J* = 5.1 Hz, 2H, H15), 3.78 – 3.61 (m, 14H, H4, H3, 6 CH_2O), 3.48 – 3.41 (m, 1H, H7a), 3.18 – 3.10 (m, 1H, H7b), 1.32 (d, *J* = 6.6 Hz, 3H, H6); ^{13}C NMR (101 MHz, MeOD) δ 145.8 (C-12), 130.4, 129.4 (C-8; C-9), 126.0 (C-13), 85.9 (C-1), 73.6 (CH_2), 73.4 (C-4), 72.5 (C-3), 71.5, 71.4, 71.3 (4 CH_2), 70.3 (C-15), 69.3 (C-2), 68.0 (C-5), 66.5 (C-10), 64.1 (C-11), 62.2 (CH_2), 51.4 (C-14), 26.7 (C-7), 16.8 (C-6); HRMS-ESI m/z calcd for $C_{21}H_{38}O_9N_3S$ $[M+H]^+$ 508.2329 found 508.2325.

Compound 8



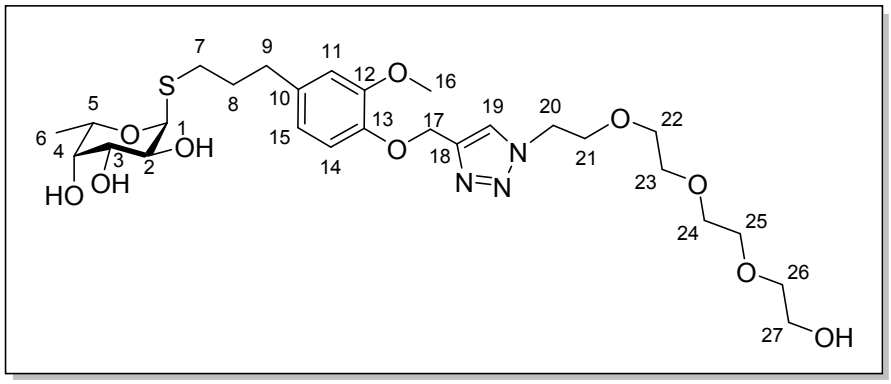
8 (26.4 mg, 93%, colorless oil) was obtained from compound **42** (35 mg, 0.052 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=0.5, 20°C) = -170; 1H NMR (400 MHz, MeOD) δ 8.17 (s, 1H, H14), 7.33 (d, J = 8.7 Hz, 2H, H9), 7.01 (d, J = 8.7 Hz, 2H, H10), 5.26 (d, J = 5.7 Hz, 1H, H1), 5.22 (s, 2H, H12), 4.69 – 4.61 (m, 2H, H15), 4.39 – 4.30 (m, 1H, H5), 4.07 (dd, J = 10.0, 5.6 Hz, 1H, H2), 4.00 – 3.91 (m, 2H, H16), 3.84 – 3.55 (m, 16H, 6 CH_2O, H3, H4, H7), 1.28 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (101 MHz, MeOD) δ 158.7 (C-11), 144.9 (C-13), 132.5 (C-8), 131.2 (C-9), 126.1 (C-14), 115.8 (C-10), 86.2 (C-1), 73.6 (CH_2), 73.4, 72.5 (C-3 and C-4), 71.5, 71.5, 71.4, 71.3, 70.2 (4 CH_2, C-16), 69.4 (C-2), 67.9 (C-5), 62.4 (CH_2), 62.2 (C-12), 51.4 (C-15), 33.9 (C-7), 16.6 (C-6); HRMS-ESI m/z calcd for $C_{24}H_{38}O_9N_3S$ $[M+H]^+$ 544.2329 found 544.2332.

Compound 9



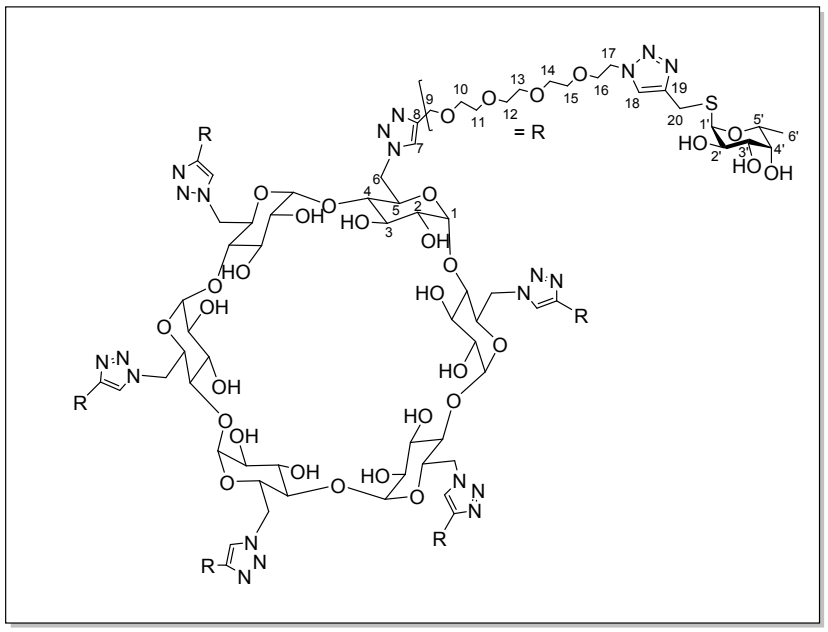
9 (21.1 mg, 90%, colorless oil) was obtained from compound **43** (29.0 mg, 0.042 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=0.5, 20°C) = -122; ^{1}H NMR (400 MHz, MeOD) δ 8.16 (s, 1H, H15), 7.22 (d, J = 8.7 Hz, 2H, H10), 7.00 (d, J = 8.7 Hz, 2H, H11), 5.40 (d, J = 5.6 Hz, 1H, H1), 5.21 (s, 2H, H13), 4.73 – 4.56 (m, 2H, H16), 4.36 – 4.23 (m, 1H, H5), 4.10 (dd, J = 10.1, 5.6 Hz, 1H, H2), 4.02 – 3.89 (m, 2H, H17), 3.83 – 3.49 (m, 14H, H3, H4, 6 CH_2O), 2.99 – 2.69 (m, 4H, H7, H8), 1.28 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (101 MHz, MeOD) δ 158.3 (C-12), 145.0 (C-14), 134.9 (C-9), 130.6 (C-10), 126.1 (C-15), 115.9 (C-11), 87.7 (C-1), 73.6 (CH_2), 73.4, 72.4 (C-3 and C-4), 71.6, 71.5, 71.4 (4 CH_2), 70.3 (C-17), 69.6 (C-2), 68.0 (C-5), 62.5 (CH_2), 62.2 (C-13), 51.5 (C-16), 36.6 (C-8), 32.9 (C-7), 16.7 (C-6); HRMS-ESI m/z calcd for $C_{25}H_{40}N_3O_9S$ $[M+H]^+$ 558.2485 found 558.2485.

Compound 10



10 (20 mg, 84%, colorless oil) was obtained from compound **44** (29 mg, 0.040 mmol) following general procedure C1. $[\alpha]_D$ (MeOH, c=0.5, 20°C) = -108; ^{1}H NMR (400 MHz, MeOD) δ 8.14 (s, 1H, H19), 7.02 (d, J = 8.1 Hz, 1H,H14), 6.90 (d, J = 1.9 Hz, 1H, H11), 6.79 (dd, J = 8.1, 1.9 Hz, 1H, H15), 5.37 (d, J = 5.6 Hz, 1H, H1), 5.21 (s, 2H, H17), 4.72 – 4.59 (m, 2H, H20), 4.33 (q, J = 6.5 Hz, 1H, H5), 4.10 (dd, J = 10.1, 5.6 Hz, 1H, H2), 3.99 – 3.91 (m, 2H, H21), 3.88 (s, 3H, H16), 3.80 – 3.53 (m, 14H, 4 CH_2, H3, H4), 2.74 (t, J = 7.4 Hz, 2H, H9), 2.70 – 2.51 (m, 2H, H7), 2.05 – 1.94 (m, 2H, H8), 1.26 (d, J = 6.6 Hz, 3H, H6); ^{13}C NMR (101 MHz, MeOD) δ 151.40, 147.21(C-12 and C-13), 145.10 (C-18), 137.33 (C-10), 126.25 (C-19), 121.73 (C-15), 116.81 (C-14), 114.07 (C-11), 87.85 (C-1), 73.62 (CH_2), 73.41, 72.42 (C-3 and C-4), 71.54, 71.45, 71.41, 71.38 (4 CH_2), 70.32 (C-21), 69.53 (C-2), 68.01 (C-5), 64.04 (C-17), 62.20 (CH_2), 56.45 (C-16), 51.44 (C-20), 35.30 (C-9), 32.64 (C-8), 30.61 (C-7), 16.62 (C-6); HRMS-ESI m/z calcd for $C_{27}H_{44}N_3O_{10}S$ $[M+H]^+$ 602.2747 found 602.2744.

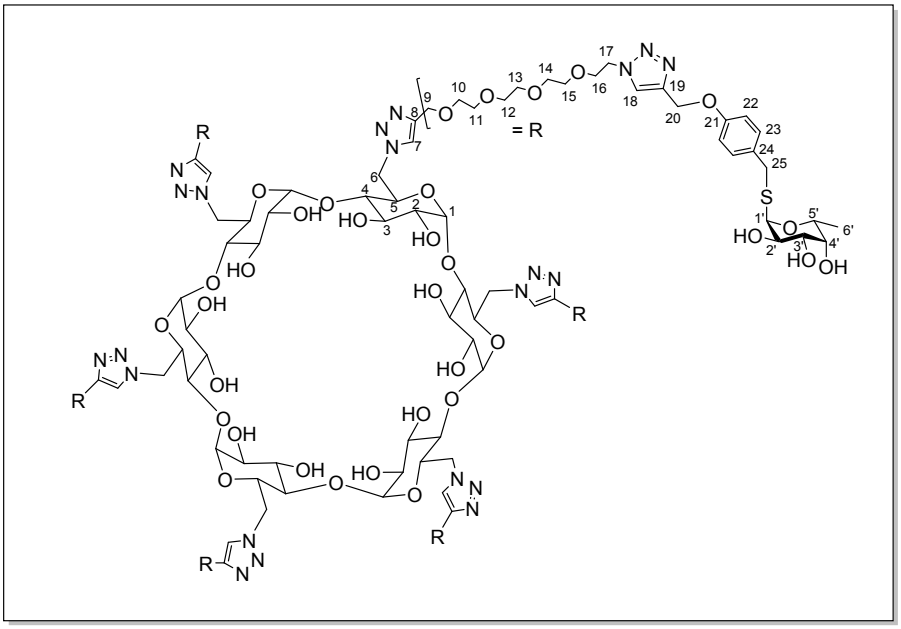
Compound 48



48 (18.3 mg, 70%, colorless oil) was obtained from compound **46** (50 mg, 0.015 mmol) following general deacetylation procedure C2. Purification on Sephadex LH-20 (MeOH/H_2O 1/1). $[\alpha]_D$ (MeOH, c=0.5, 20°C) = -26; ^{1}H NMR (400 MHz, D2O) δ 8.13 (s, 18H, H7), 8.03 (s, 18H, H18), 5.46 (d, J = 5.7 Hz, 6H, H1'), 5.23 (d, J = 2.7 Hz, 6H, H1'), 4.74 – 4.24 (m, 54H, H5',H6, H5, CH_2), 4.24 – 3.73 (m, 60H, H2', H3, H4', H3', H20, CH_2), 3.73 – 3.40 (m, 96H, H2, H4, CH_2), 1.15 (d, J = 6.5 Hz, 18H, H6'); ^{13}C NMR (101 MHz, D2O) δ 145.2 (C-19), 144.0 (C-8), 126.8 (C-7), 124.4 (C-18), 101.3 (C-1), 85.7 (C-1'), 82.3 (C-4),

72.6 (C-3), 71.6 (C-4'), 71.3 (C-2), 70.4 (C-3'), 70.1 (C-5), 69.7 - 68.7 (*C*H_2), 67.6 (C-2'), 67.2 (C-5'), 63.0 (*C*H_2), 50.4 (C-6), 50.0 (C-17), 23.5 (C-20), 15.2 (C-6'); HRMS-ESI m/z calcd for $C_{156}H_{256}N_{36}O_{72}S_6$ $[M+4H]^{4+}$ 994.3950 found 994.3909.

Compound 49:



Compound **49** (99 mg, 90%, White powder) was obtained from compound **49** (140 mg, 0.024 mmol) following general deacetylation procedure C2. Purification on Sephadex LH-20 (MeOH/H_2O 1/1). $[\alpha]_D$ (MeOH/H_2O, c=0.5, 20°C) = -88; ^{1}H NMR (400 MHz, DMSO) δ 8.18 (d, J = 20.2 Hz, 6H, H18), 8.04 – 7.83 (m, 6H, H7), 7.22 (dd, J = 15.8, 8.7 Hz, 12H, H23), 6.98 (dd, J = 26.5, 8.6 Hz, 12H, H22), 5.81 – 5.38 (m, 12H, O*H*), 5.21 – 4.86 (m, 30H, H1, H1', H20, O*H*), 4.70 – 4.00 (m, 60H, H-17, H-5',H6, H5, C*H*$_2$, O*H*), 3.92 – 3.70 (m, 24H, H2', H3, C*H*$_2$), 3.68 – 3.35 (m, 90H, H3', H4', H25 C*H*$_2$), 3.29 – 3.13 (m, 12H, H4, H2), 1.12 (d, J = 6.5 Hz, 18H, H6'); ^{13}C NMR (101 MHz, DMSO) δ 156.81 (C-21), 143.61 (C-8), 142.57 (C-19), 130.92 (C-24), 129.88 (C-23), 125.45 (C-7), 124.77 (C-18), 114.42 (C-22), 101.37 (C-1), 84.47 (C-1'), 82.86 (C-4), 72.43 (C-3), 71.28 (C-4'), 70.64 (C-3'), 69.63 - 68.62 (C-2, C-5, *C*H_2), 67.37 (C-2'), 66.52 (C-5'), 63.19 (*C*H_2), 61.08(C-20), 49.36 (C-17 and C-6), 31.82 (C-25), 16.39 (C-6'); HRMS-ESI m/z calcd for $C_{198}H_{291}N_{36}O_{78}S_6$ $[M+3H]^{3+}$ 1537.6078 found 1537.6027.

Crystallization and structure determination:

FleA was expressed in E coli using the pET-TEV-afl plasmid and purified as described previously.{Lehot, 2018 #10} The vapour diffusion method with hanging drop was used to obtain co-crystals of the complex of FleA with compound 9. FleA concentrated at 8.1 mg mL-1 in 20 mM Tris pH 8.0 and 40 mM NaCl was preincubated with 1 mM of compound 9 for 30 minutes at room temperature. Drops of 2 µL were made, mixing 50 % protein complex solution and 50 % crystallizing solution. Rod clusters were obtained in a few days from the BCS screen solution 1-32 (Molecular Dimension Ltd) containing 50 mM L-Arg, 50 mM L-Glu, 28% PEG Smear Broad and 5% glycerol. A broken rod was directly mounted in a cryoloop and flash-frozen in liquid nitrogen. Diffraction data were collected at 100 K at the SOLEIL synchrotron, Saint Aubin, France on the Proxima 1 beamline using a EIGER-X 16M detector (Dectris Ltd.). Since the crystal was triclinic 360 degrees were collected at chi angle 0, 20 and 35.

The data were processed using XDSME {Kabsch, W. *Acta Crystallogr*. 2010, 66, 125–132; Legrand P., 2017, GitHub repository https://github.com/legrandp/xdsme 'XDSME: XDS Made Easier', Synchrotron SOLEIL, Gif-sur-Yvette, France }. All further computing was performed using the CCP4 suite {Winn, M.D.; et al. *Acta Crystallogr. Sect. D*, 2011, 67, 235–242}. Molecular replacement was used to solve the structure using the dimer coordinates of PDB-ID 4AH4 as search model in PHASER 2.8.2 { McCoy, A.J. et al. *J. Appl. Crystallogr*. 2007, 40, 658–674}. Restrained maximum likelihood refinement using REFMAC 5.8.0258 and local NCS restraints {Murshudov, G.N. et al. *Acta Crystallogr. Sect. D Biol. Crystallogr*. 2011, 67, 355–367} was iterated with manual rebuilding in Coot { Emsley, P.; Lohkamp, B. *Acta Crystallogr. Sect. D* 2010, 66, 486–501} to refine the structure. Five percent of the observations were set aside for cross-validation analyses, and hydrogen atoms were added in their riding positions. The ligand library was constructed using Sketcher and Libcheck in CCP4i. The wwPDB Validation server: http://wwpdb-validation.wwpdb.org. and Molprobity { Williams, C.J. et al. *Protein Sci*. 2018, 27, 1, 293-315.} were used to validate the model prior to deposition in the Protein Data Bank under accession code 6Z6C. Data quality and refinement statistics can be found in Table S1.

Table S1. Data collection and refinement statistics for the structure of FleA in complex with compound 9.

Data collection		
Beamline	SOLEIL Proxima 1	
Wavelength	0.97857	
Space group	P1	
Unit cell dimensions a, b, c (Å) α, β, χ (°)	 45.09 46.87 80.19 103.12 98.51 108.53	
Resolution (Å)	42.53-1.40 (1.42-1.40)	
Rmerge	0.052 (0.300)	
Rpim	0.032 (0.236)	
Mean I / σI	16.1 (3.1)	
Completeness (%)	99.2 (96.4)	
Redundancy	6.5 (4.7)	
CC1/2	0.998 (0.963)	
Nb. / Nb. unique reflections	752822 / 115240	
Refinement		
Resolution (Å)	42.53-1.40	
Nb. reflections / Nb. free reflections	109477 / 5702	
Rwork / Rfree	11.8 / 15.8	
R.m.s Bond lengths (Å)	0.015	
Rmsd Bond angles (°)	1.820	
Rmsd Chiral (Å3)	0.103	
No. atoms / Bfac (Å2) Protein Ligand Heterogen Waters	Chain A 2494 / 18.2 91 / 26.0 6 / 30.5 367 / 31.4	Chain B 2522 / 19.8 69 / 27.0 16 / 23.9 362 / 31.9
Ramachandran Allowed Favored Outliers	 99.8 97.9 1	
PDB Code	6Z6C	

*Values in parentheses are for highest-resolution shell.

Isothermal titration calorimetry.

Lyophilized FleA was dissolved in 20 mM Tris-HCl pH 7.5 and 100 mM NaCl prior centrifugation and its concentration was determined at 280 nm using a NanoDrop 2000 spectrophotometer (Ozyme) and a theoretical extinction coefficient of 87,320 $M^{-1}.cm^{-1}$. Carbohydrate ligands were dissolved in the same buffer prior degassing and loaded in the injection syringe.

For titration with compounds **1-10,** the measurements were performed using a VP-ITC microcalorimeter (Malvern Panalytical) at 25°C. The concentrations used were of 50 µM for the protein and 10 mM for the ligand. The 1.4478 ml sample cell was filled with the protein solution and titration was performed with 20 s of 10 µl of carbohydrate ligand for 10 second every 3 min. Data were fitted with MicroCal Origin 7 software according to standard procedures and a one binding site model and the stoichiometry fixed to 6 since the measurements were done in ligand excess.

For titration with compounds **48-49**, following unavailiability of VP-ITC, the measurements were performed using a PEAQ-ITC microcalorimeter (Malvern Panalytical at 25°C. The concentrations used were of 15 µM for the protein and 0.15 mM for the ligands. A reference measurements was done with MF at 3 mM and the protein at 50 µM. The 200µl sample cell was filled with the protein solution and titration was performed with 20 injections of 1µL for the first injection to 2µl for the others of carbohydrate ligand for 2 second for the first injection to 4 second for the others every 150 seconds. Data were fitted with MicroCal Peaq ITC Analysis software according to standard procedures and a one binding site model.

The stoichiometry (n), the association constant (K_a) and the enthalpy of binding (ΔH) could be obtained from fitted data. Other thermodynamic parameters (the free energy ΔG and the entropy ΔS) were calculated from the equation $\Delta G = \Delta H - T\Delta S = -RT \ln K_a$, where T is the absolute temperature and R = 8.314 J/mol/K. At least two independent titrations were performed for each ligand tested.

A) B)

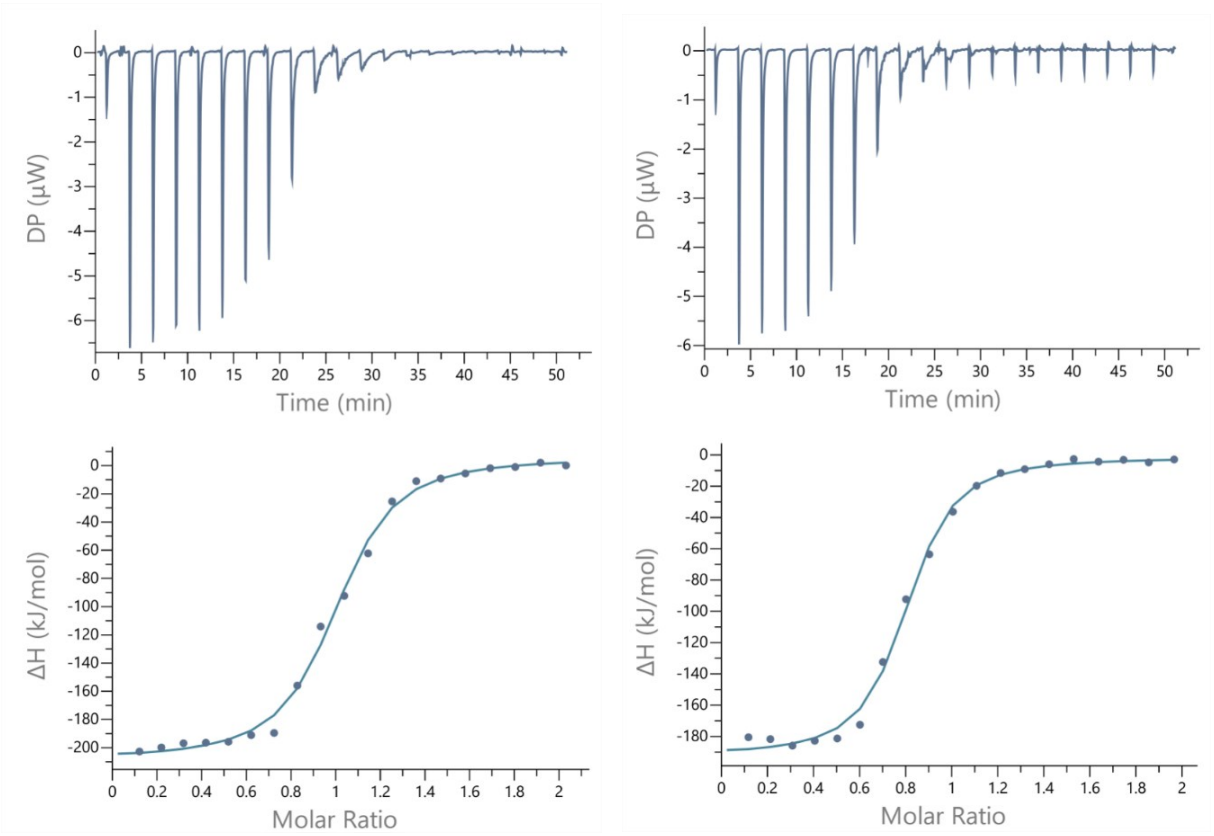
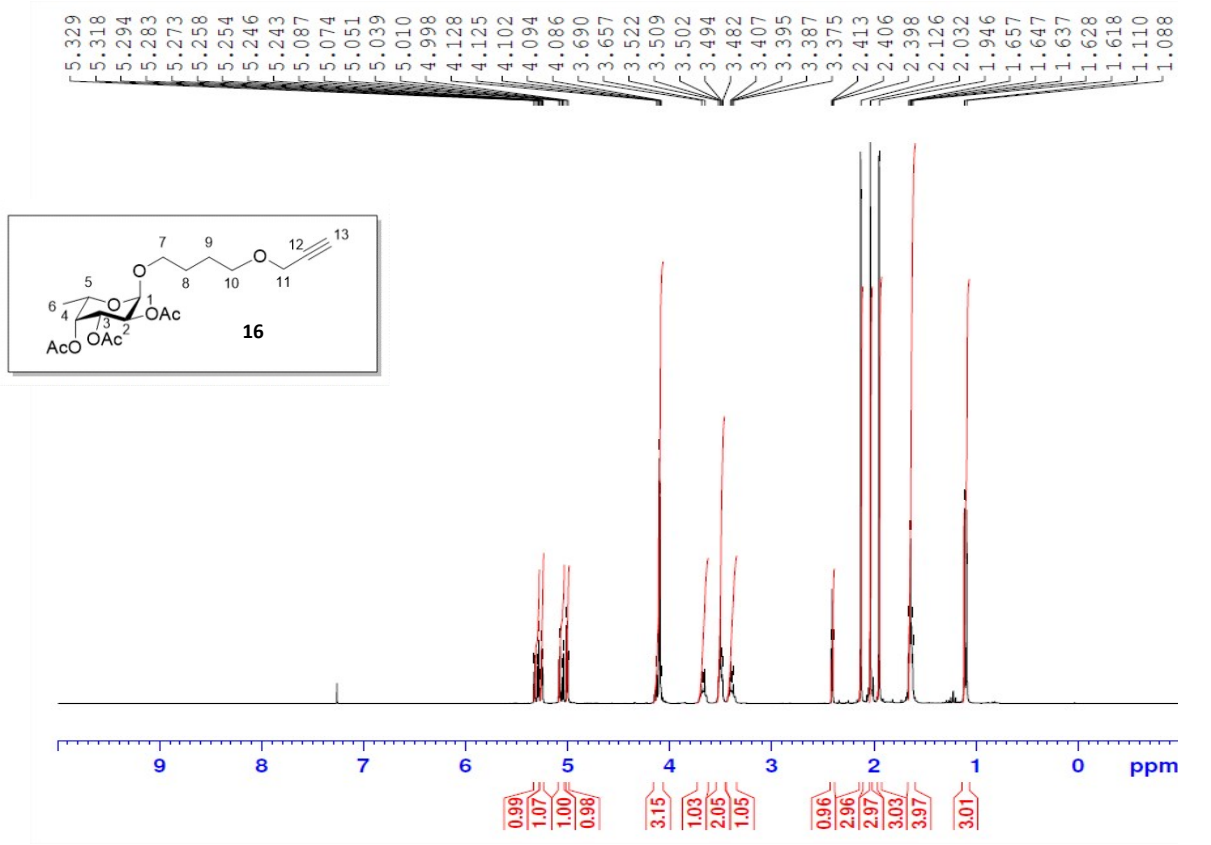
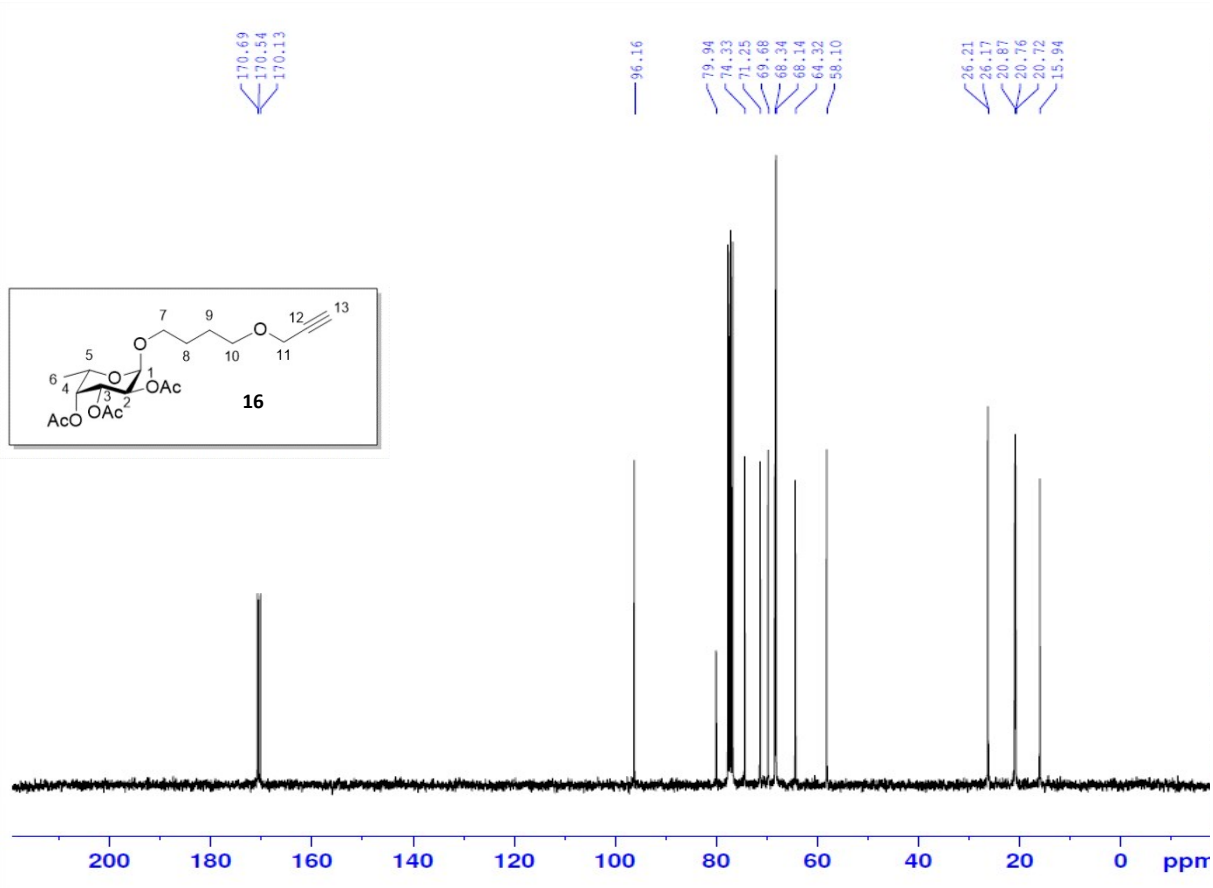


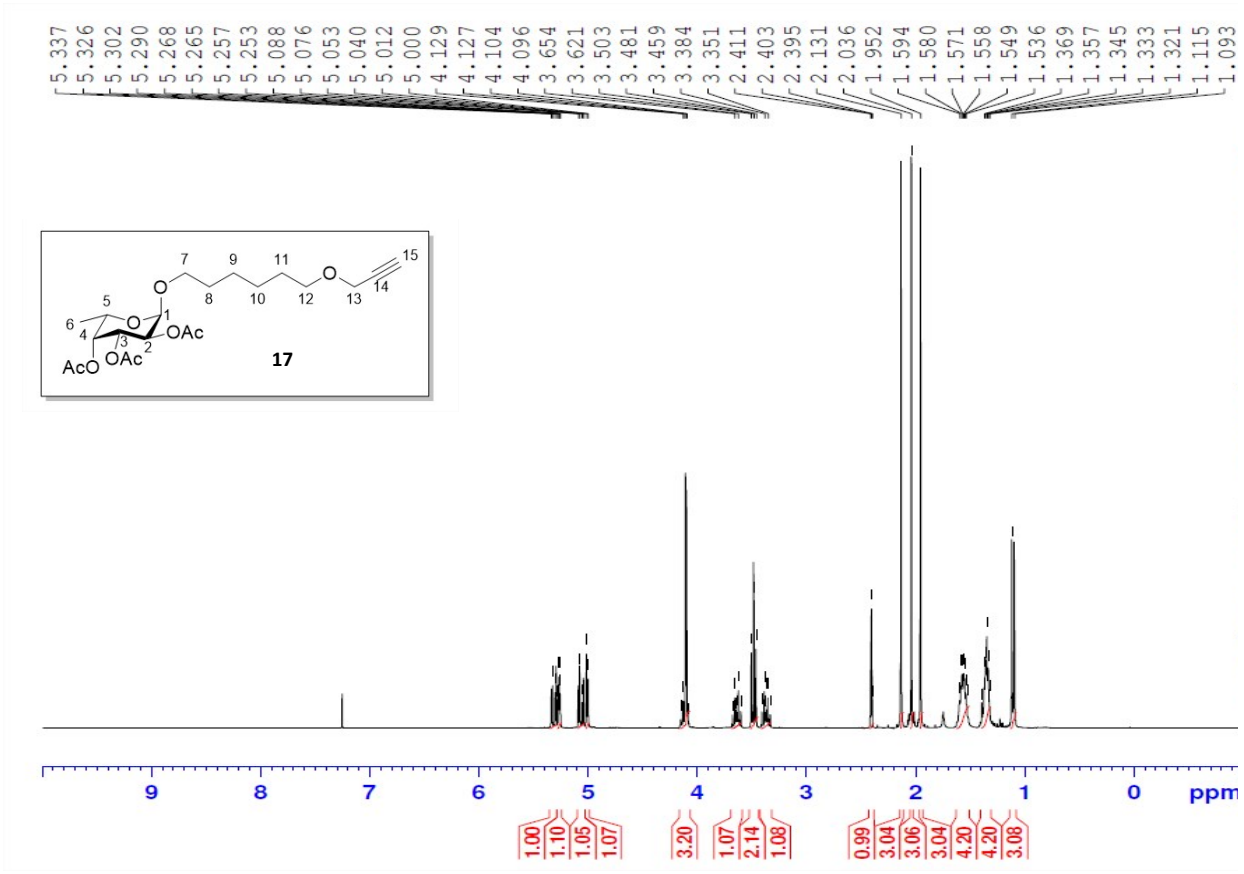
Figure S1: representative ITC curves for A) **48** and B) **49**.

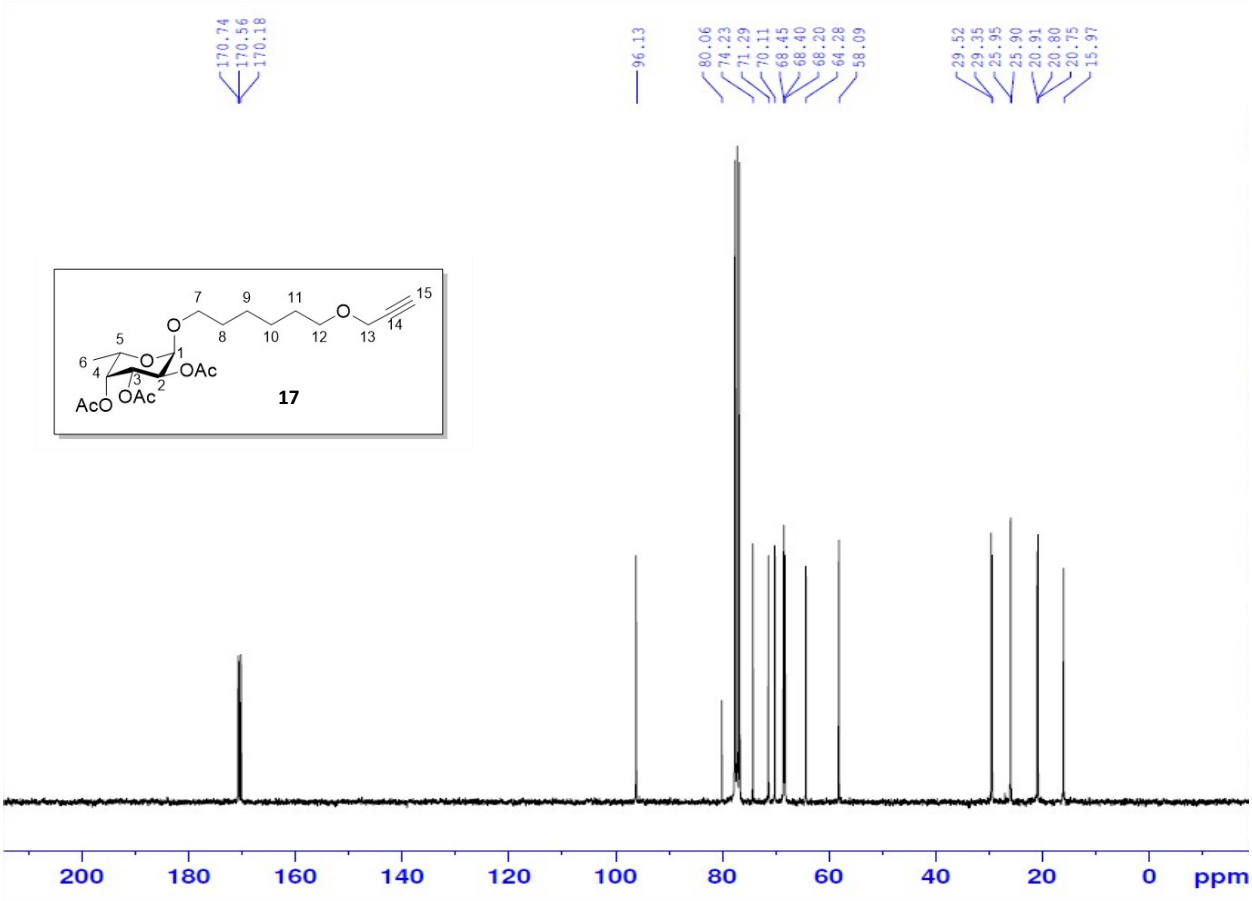
Effect of FleA inhibition on galactomannan release

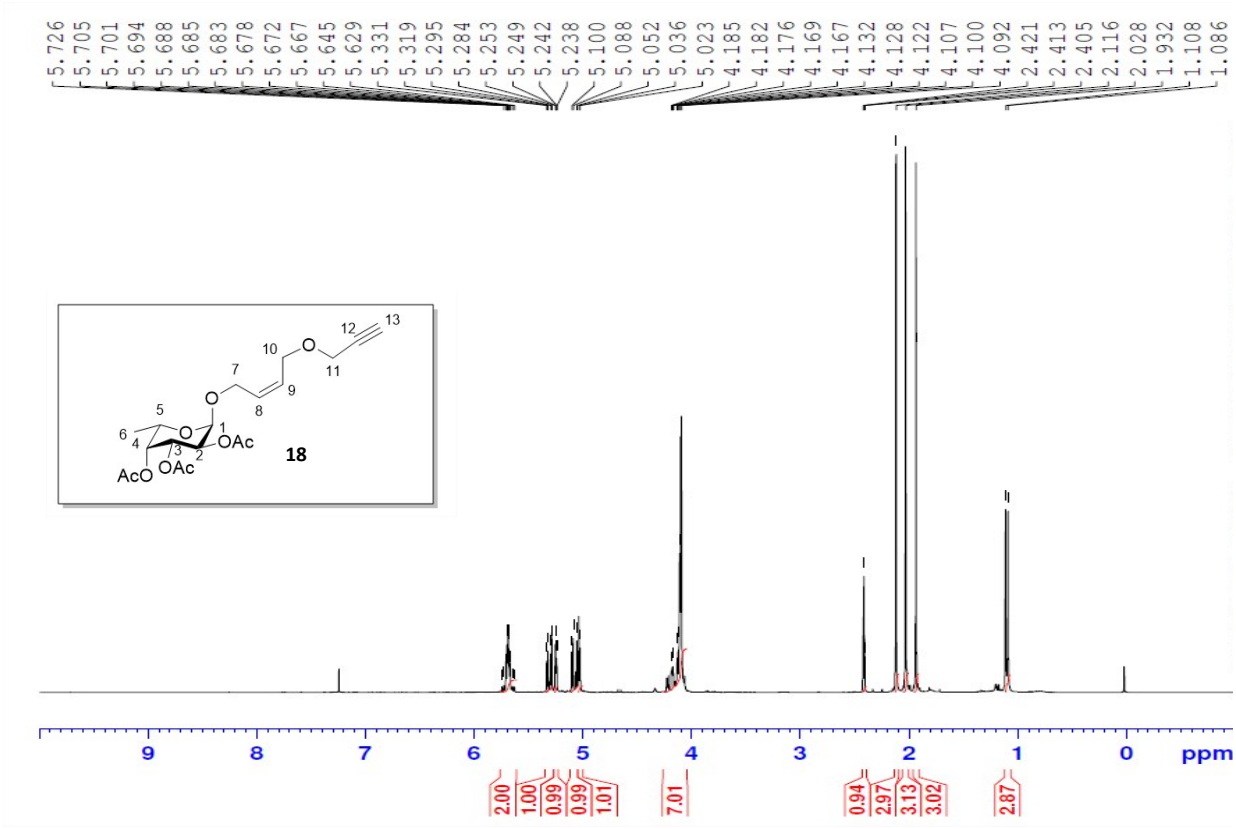
- *A. fumigatus* (Af) ($3x10^3$ conidia/mL) was co-incubated or not (Af) with 100 µM methyl-α-L-fucopyranoside (Af+**MF**) or 100 µM **49** (Af+**49**) 1 h before and during infection (15 h) of BEAS-2B cells. In parallel, effect of cell-receptors saturation with recombinant FleA was confirmed by incubating bronchial epithelial cells with 1 µM recombinant FleA (FleA/Af), 1 h before and during infection (15 h) with conidia ($3x10^3$ conidia/mL). Supernatant were collected to measure galactomannan release (Platelia Aspergillus EIA kit - Biorad). Values, expressed in optical density (O.D.), are presented as mean ± SEM ****$p < 0.0001$, *$p < 0.05$, ns: not significant (ANOVA test, followed by Bonferroni's multiple comparison test).

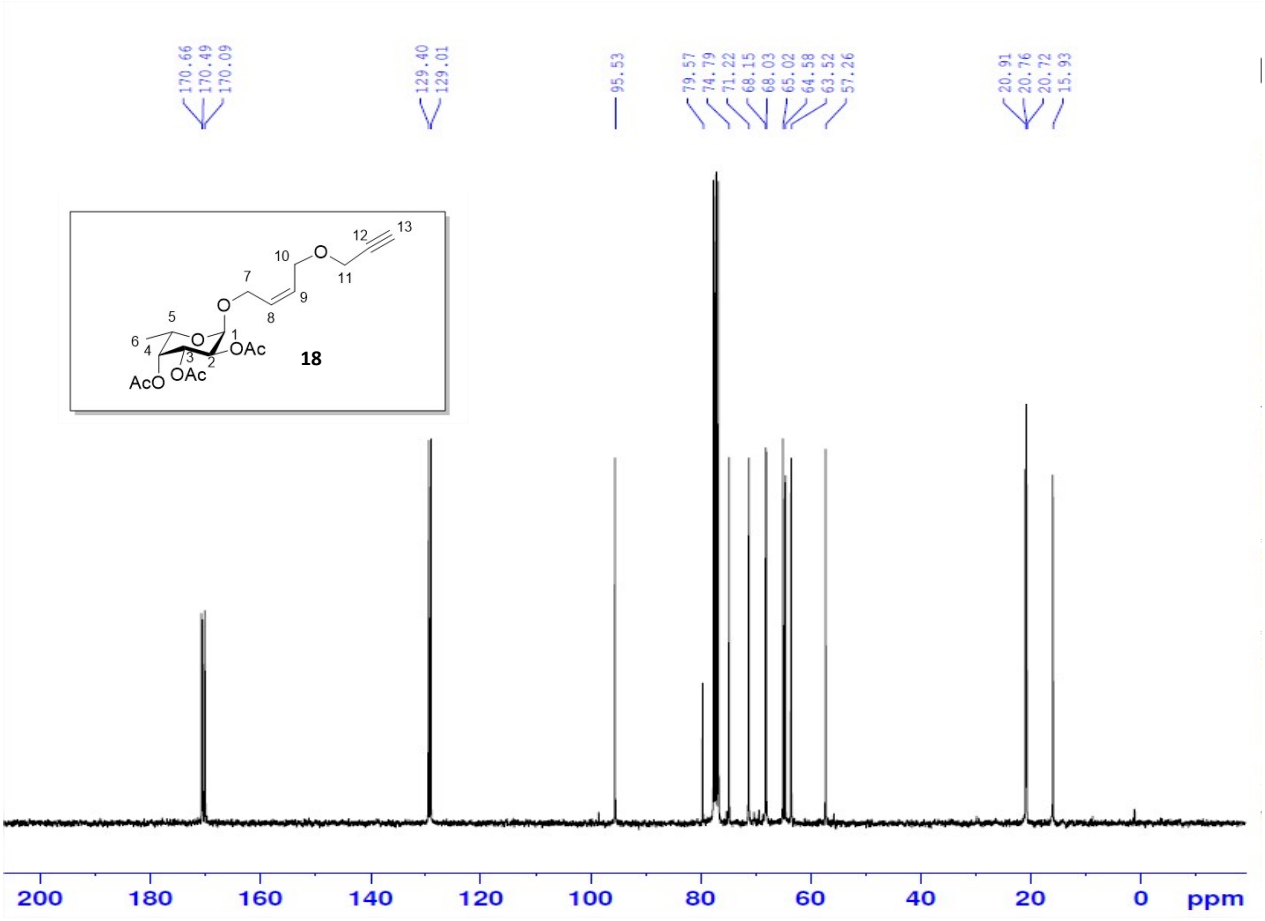

5.329
5.318
5.294
5.283
5.273
5.258
5.254
5.246
5.243
5.087
5.074
5.051
5.039
5.010
4.998
4.128
4.125
4.102
4.094
4.086
3.690
3.657
3.522
3.509
3.502
3.494
3.482
3.407
3.395
3.387
3.375
2.413
2.406
2.398
2.126
2.032
1.946
1.657
1.647
1.637
1.628
1.618
1.110
1.088
16
9
8
7
6
5
4
3
2
1
0
ppm
0.99
1.07
1.00
0.98
3.15
1.03
2.05
1.05
0.96
2.96
2.97
3.03
3.97
3.01

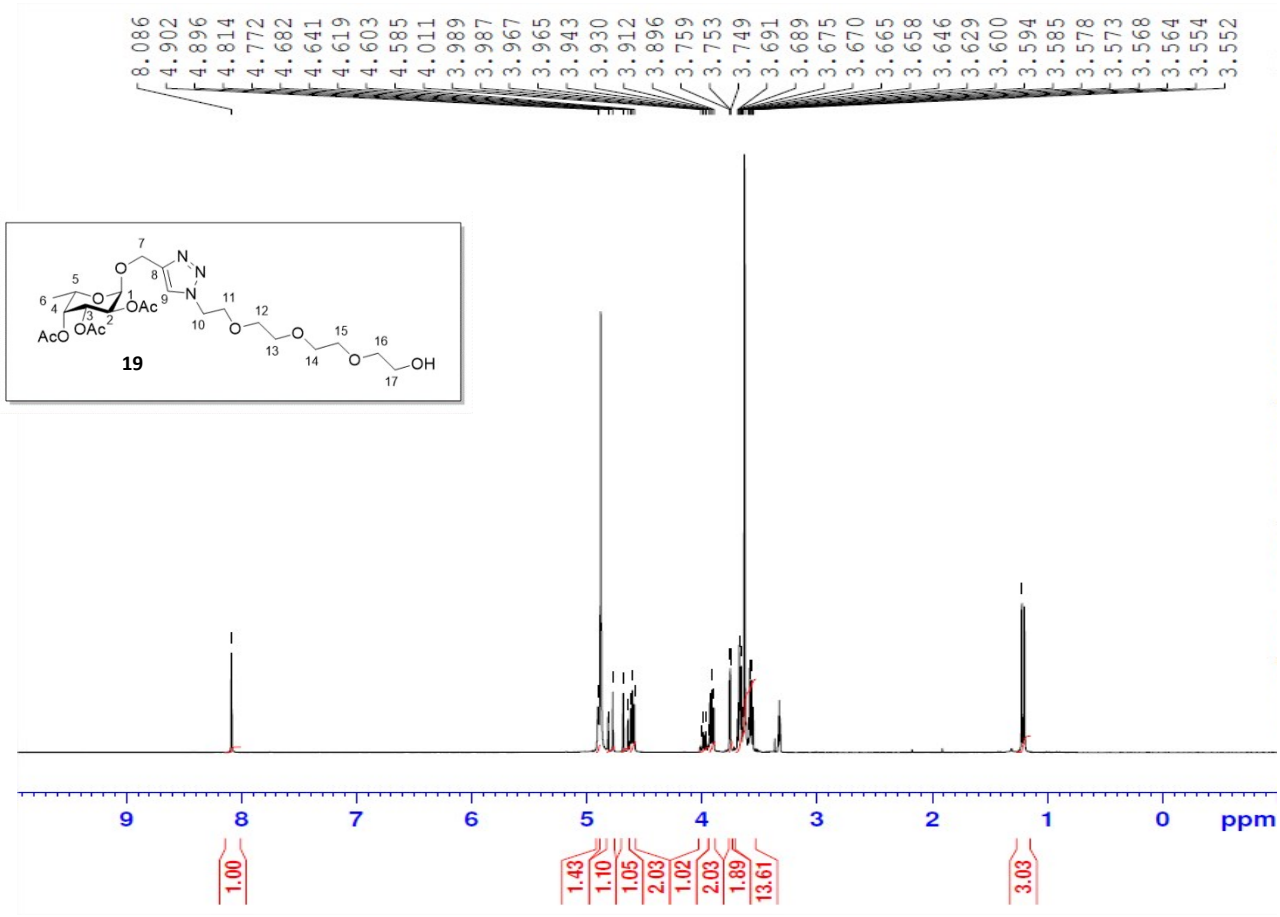

170.69
170.54
170.13
96.16
79.94
74.33
71.25
69.68
68.34
68.14
64.32
58.10
26.21
26.17
20.87
20.76
20.72
15.94
16
200
180
160
140
120
100
80
60
40
20
0
ppm

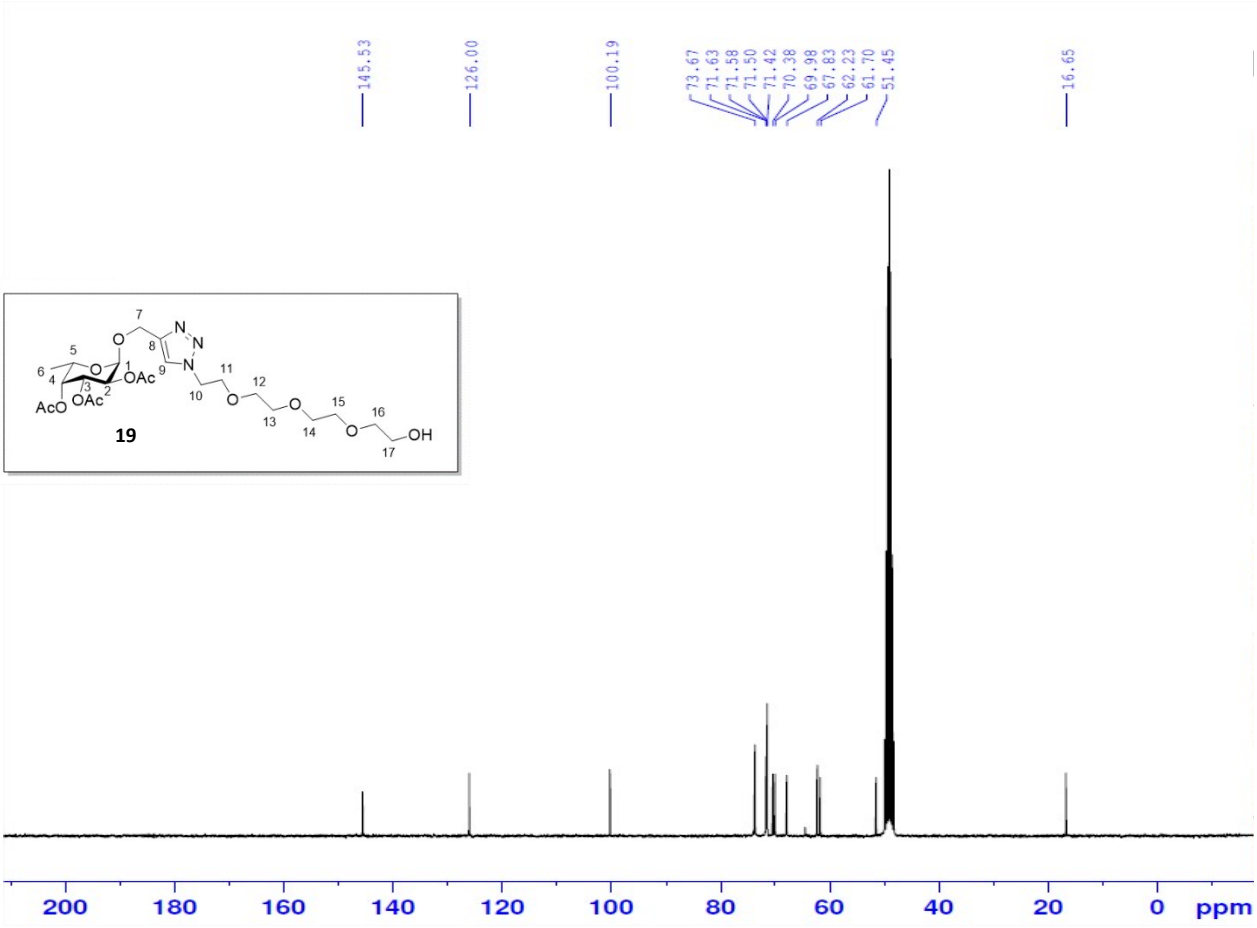

5.337
5.326
5.302
5.290
5.268
5.265
5.257
5.253
5.088
5.076
5.053
5.040
5.012
5.000
4.129
4.127
4.104
4.096
3.654
3.621
3.503
3.481
3.459
3.384
3.351
2.411
2.403
2.395
2.131
2.036
1.952
1.594
1.580
1.571
1.558
1.549
1.536
1.369
1.357
1.345
1.333
1.321
1.115
1.093
17
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.10
1.05
1.07
3.20
1.07
2.14
1.08
0.99
3.04
3.06
3.04
4.20
4.20
3.08

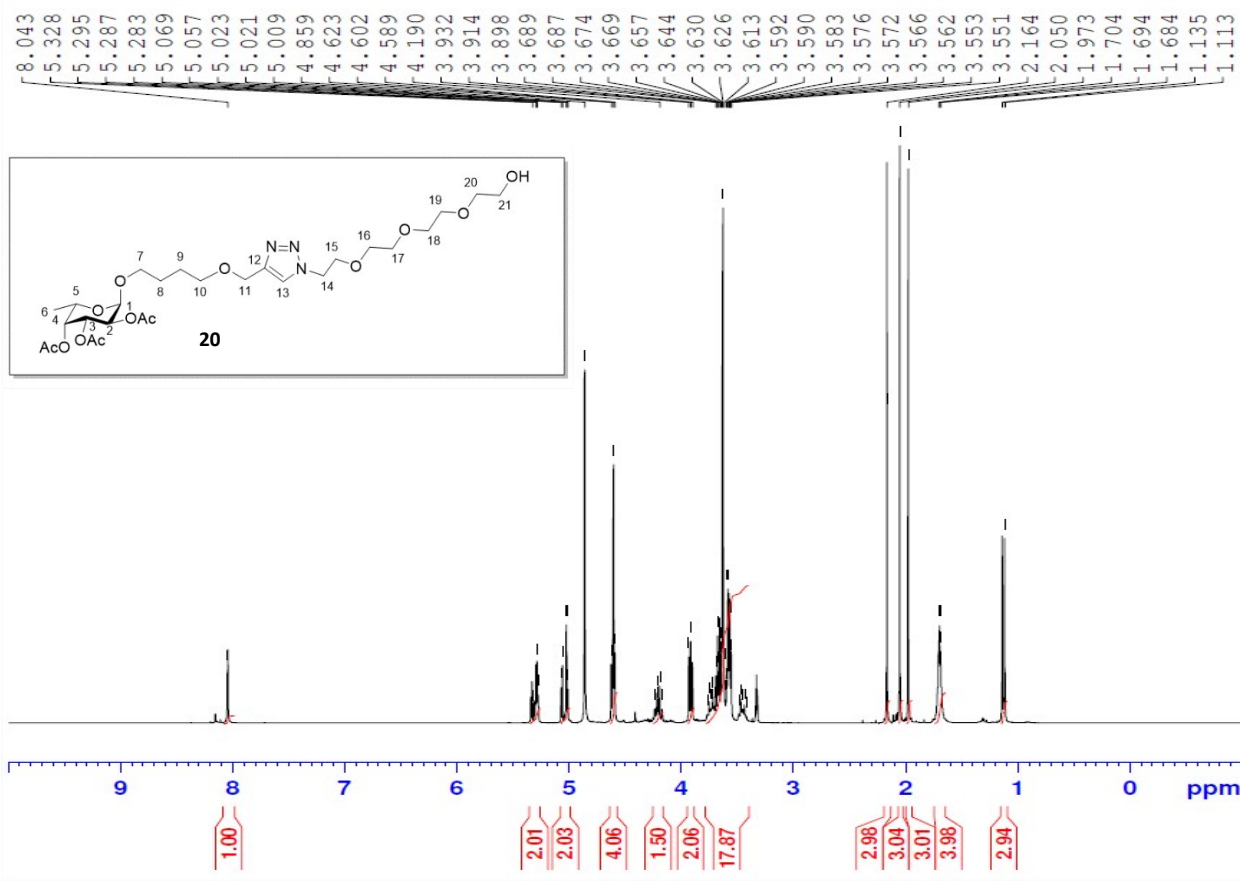

170.74
170.56
170.18
96.13
80.06
74.23
71.29
70.11
68.45
68.40
68.20
64.28
58.09
29.52
29.35
25.95
25.90
20.91
20.80
20.75
15.97
17
200
180
160
140
120
100
80
60
40
20
0
ppm

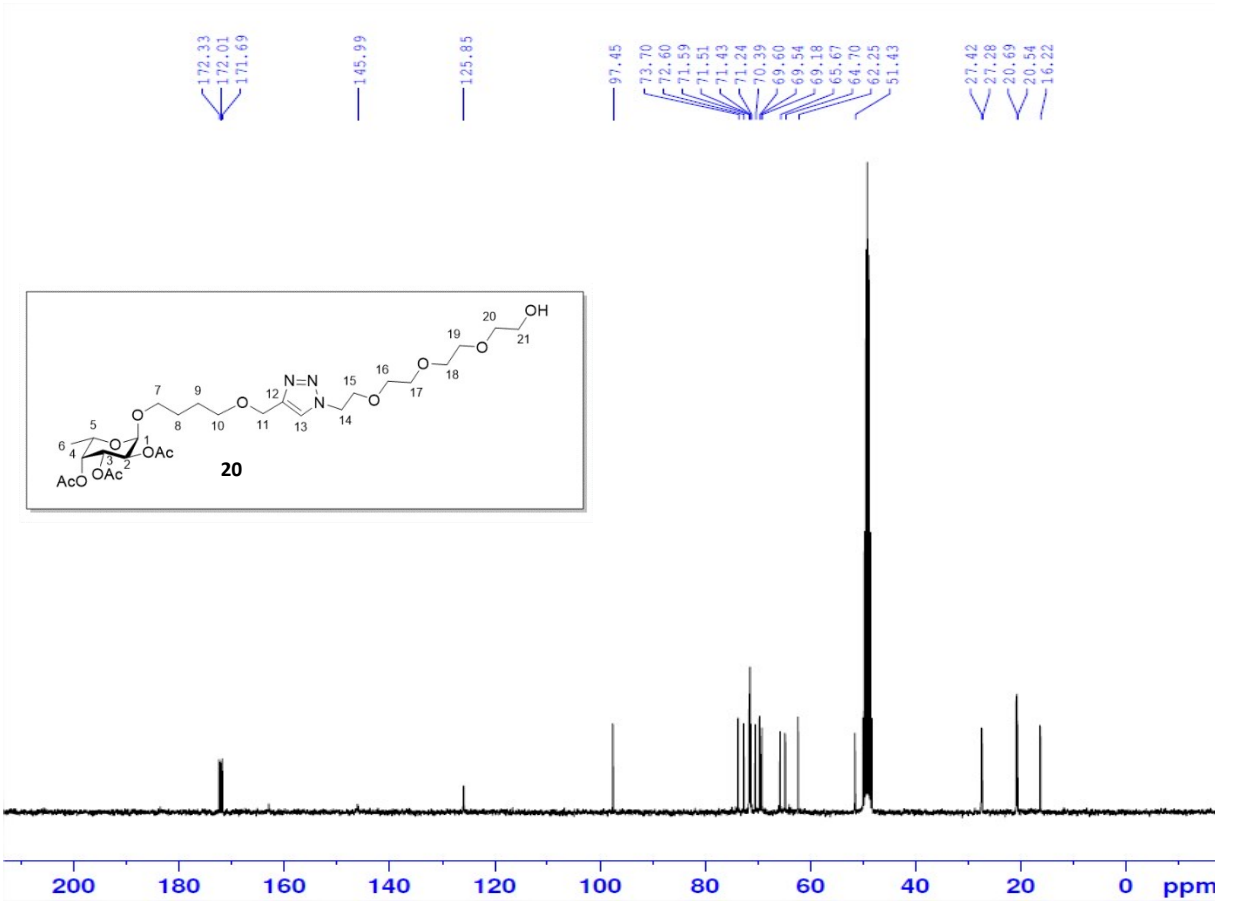

5.726
5.705
5.701
5.694
5.688
5.685
5.683
5.678
5.672
5.667
5.645
5.629
5.331
5.319
5.295
5.284
5.253
5.249
5.242
5.238
5.100
5.088
5.052
5.036
5.023
4.185
4.182
4.176
4.169
4.167
4.132
4.128
4.122
4.107
4.100
4.092
2.421
2.413
2.405
2.116
2.028
1.932
1.108
1.086
18
9
8
7
6
5
4
3
2
1
0
ppm
2.00
1.00
0.99
0.99
1.01
7.01
0.94
2.97
3.13
3.02
2.87

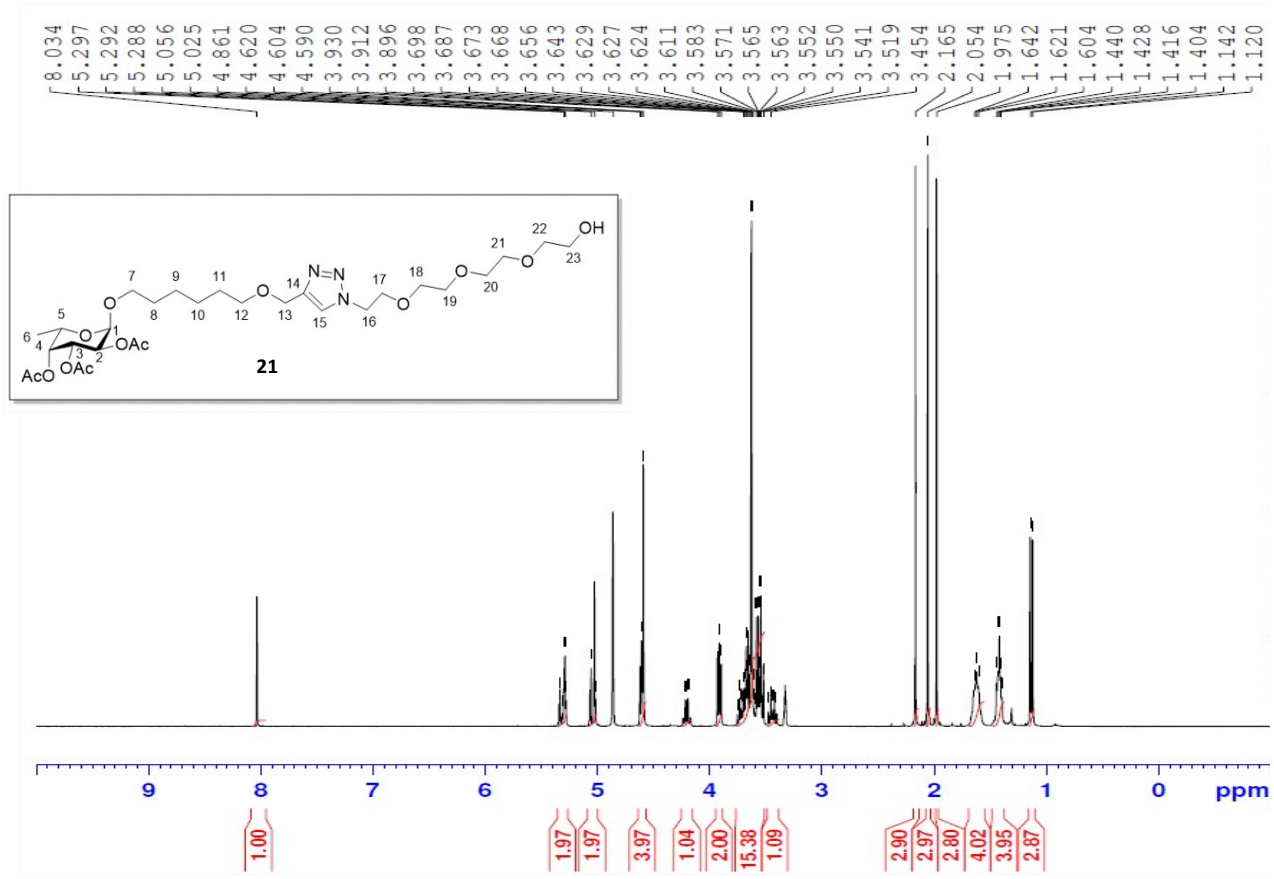

170.66
170.49
170.09
129.40
129.01
95.53
79.57
74.79
71.22
68.15
68.03
65.02
64.58
63.52
57.26
20.91
20.76
20.72
15.93
18
200
180
160
140
120
100
80
60
40
20
0
ppm

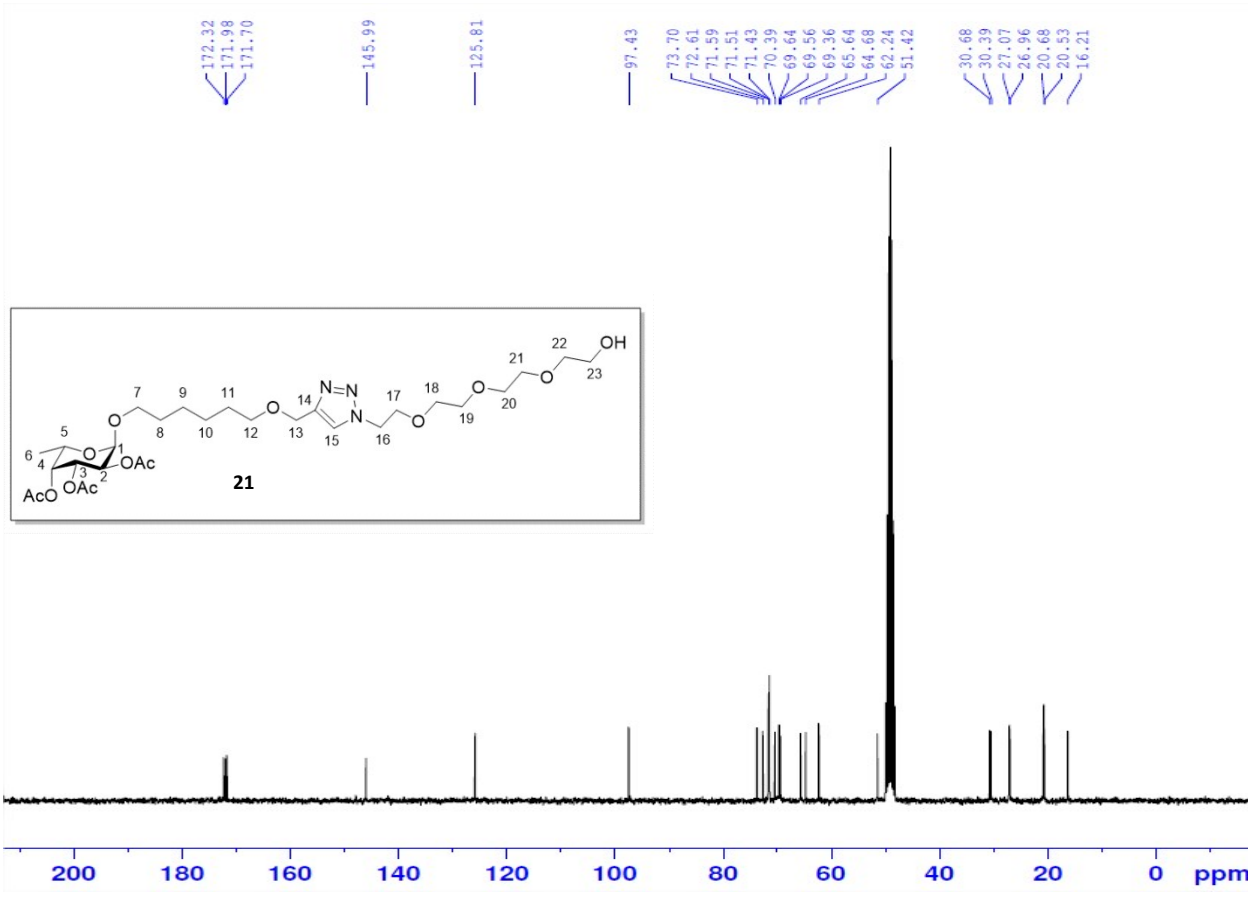

8.086
4.902
4.896
4.814
4.772
4.682
4.641
4.619
4.603
4.585
4.011
3.989
3.987
3.967
3.965
3.943
3.930
3.912
3.896
3.759
3.753
3.749
3.691
3.689
3.675
3.670
3.665
3.658
3.646
3.629
3.600
3.594
3.585
3.578
3.573
3.568
3.564
3.554
3.552
19
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.43
1.10
1.05
2.03
1.02
2.03
1.89
13.61
3.03

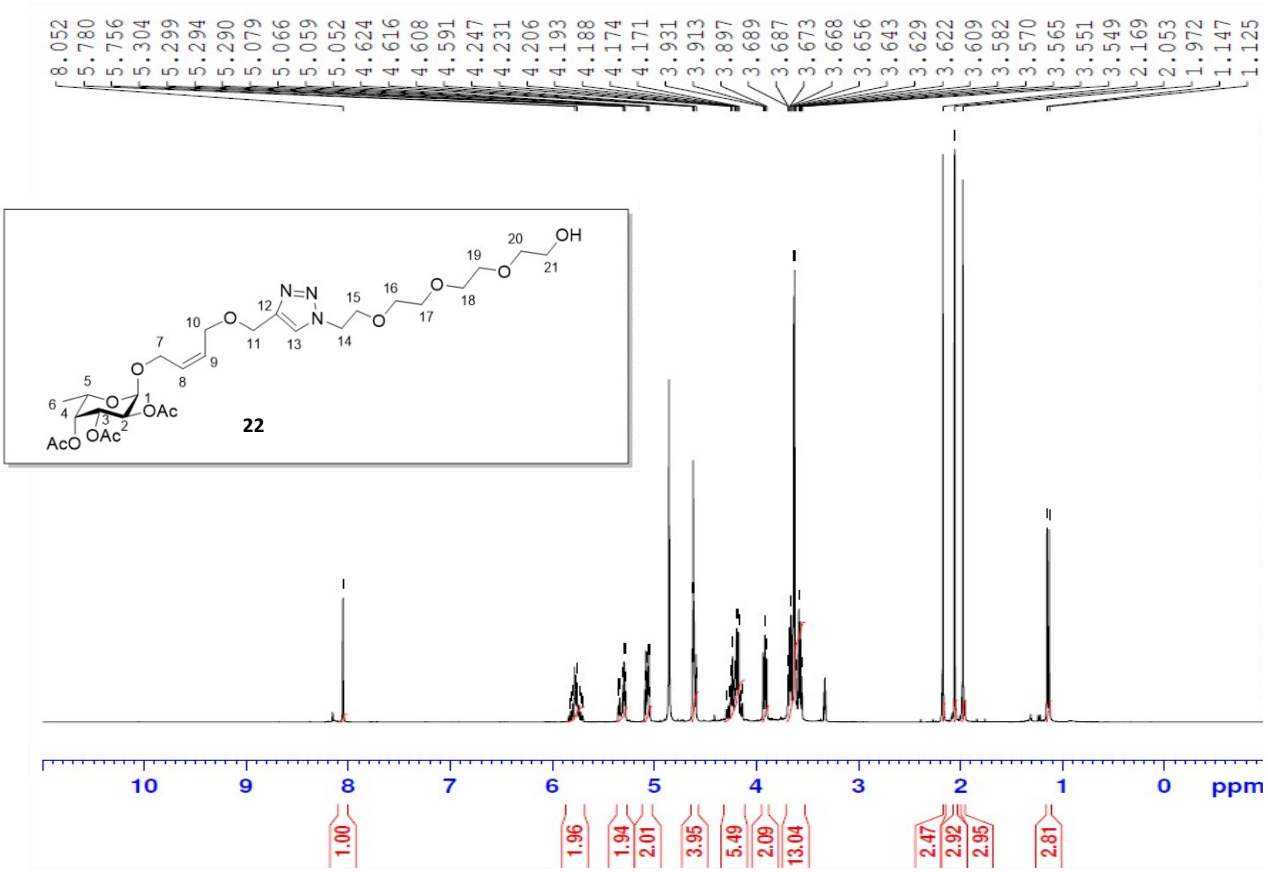

145.53
126.00
100.19
73.67
71.63
71.58
71.50
71.42
70.38
69.98
67.83
62.23
61.70
51.45
16.65
19
200
180
160
140
120
100
80
60
40
20
0
ppm

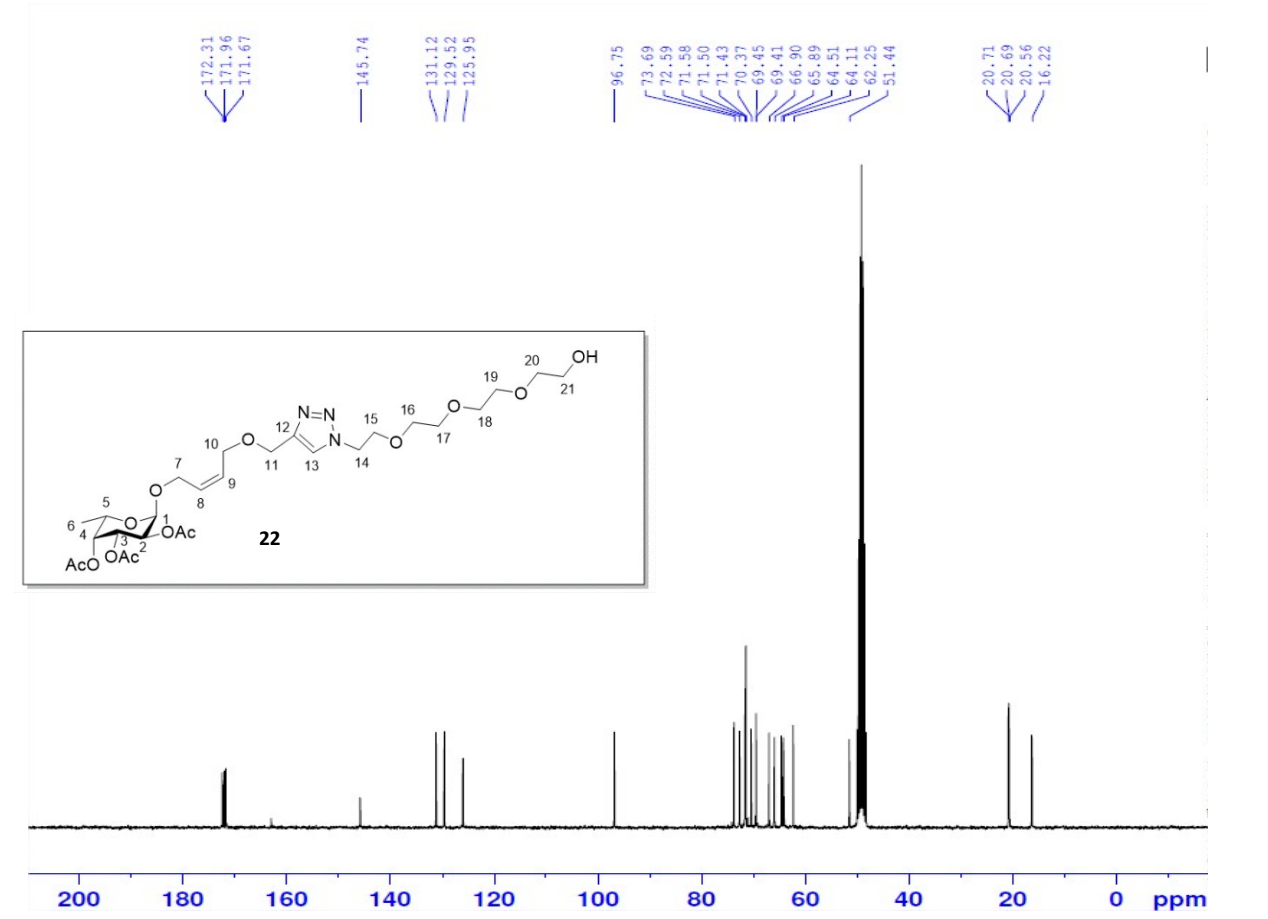

8.043
5.328
5.295
5.287
5.283
5.069
5.057
5.023
5.021
5.009
4.859
4.623
4.602
4.589
4.190
3.932
3.914
3.898
3.689
3.687
3.674
3.669
3.657
3.644
3.630
3.626
3.613
3.592
3.590
3.583
3.576
3.572
3.566
3.562
3.553
3.551
2.164
2.050
1.973
1.704
1.694
1.684
1.135
1.113
20
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.01
2.03
4.06
1.50
2.06
17.87
2.98
3.04
3.01
3.98
2.94

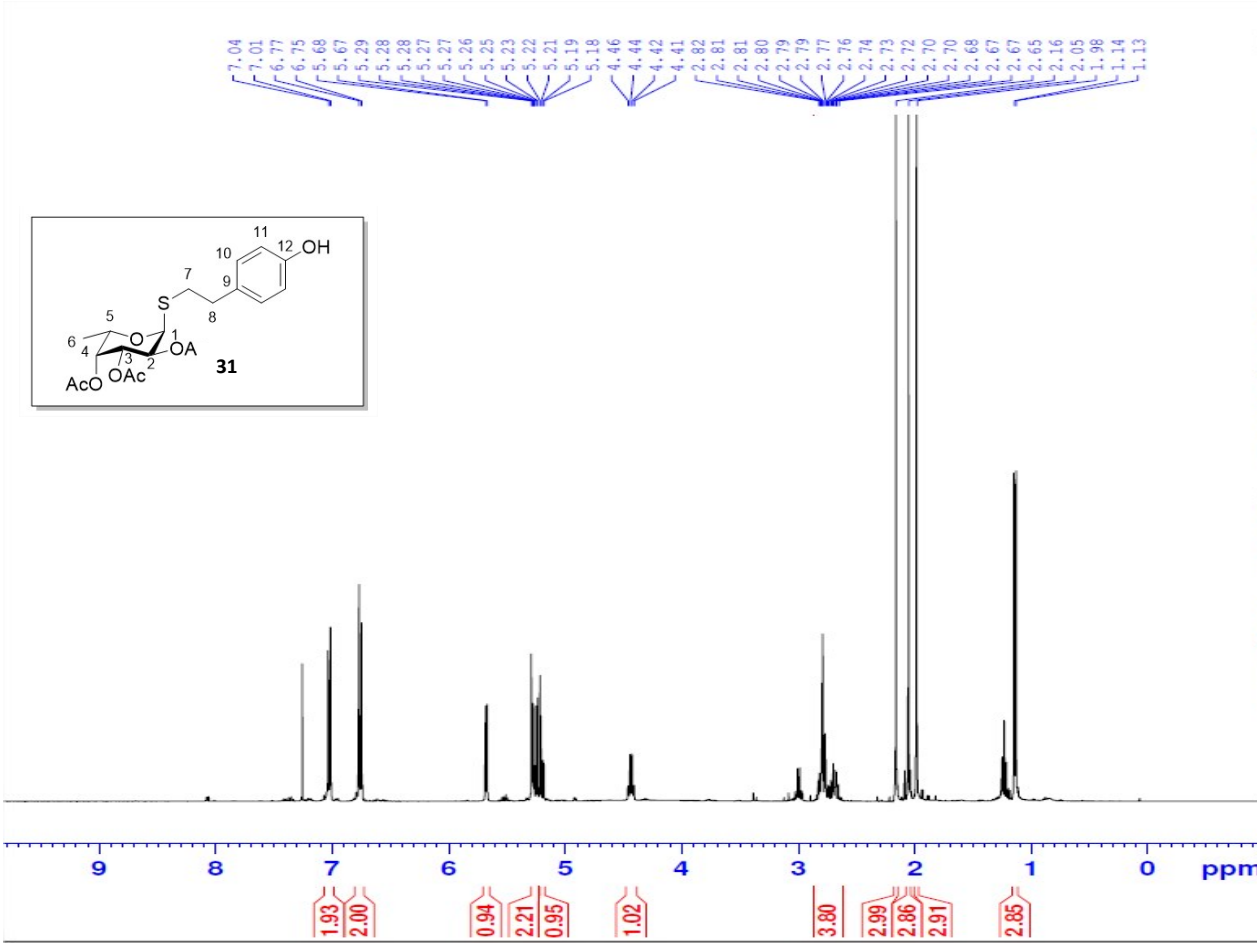

172.33
172.01
171.69
145.99
125.85
97.45
73.70
72.60
71.59
71.51
71.43
71.24
70.39
69.60
69.54
69.18
65.67
64.70
62.25
51.43
27.42
27.28
20.69
20.54
16.22
20
200
180
160
140
120
100
80
60
40
20
0
ppm

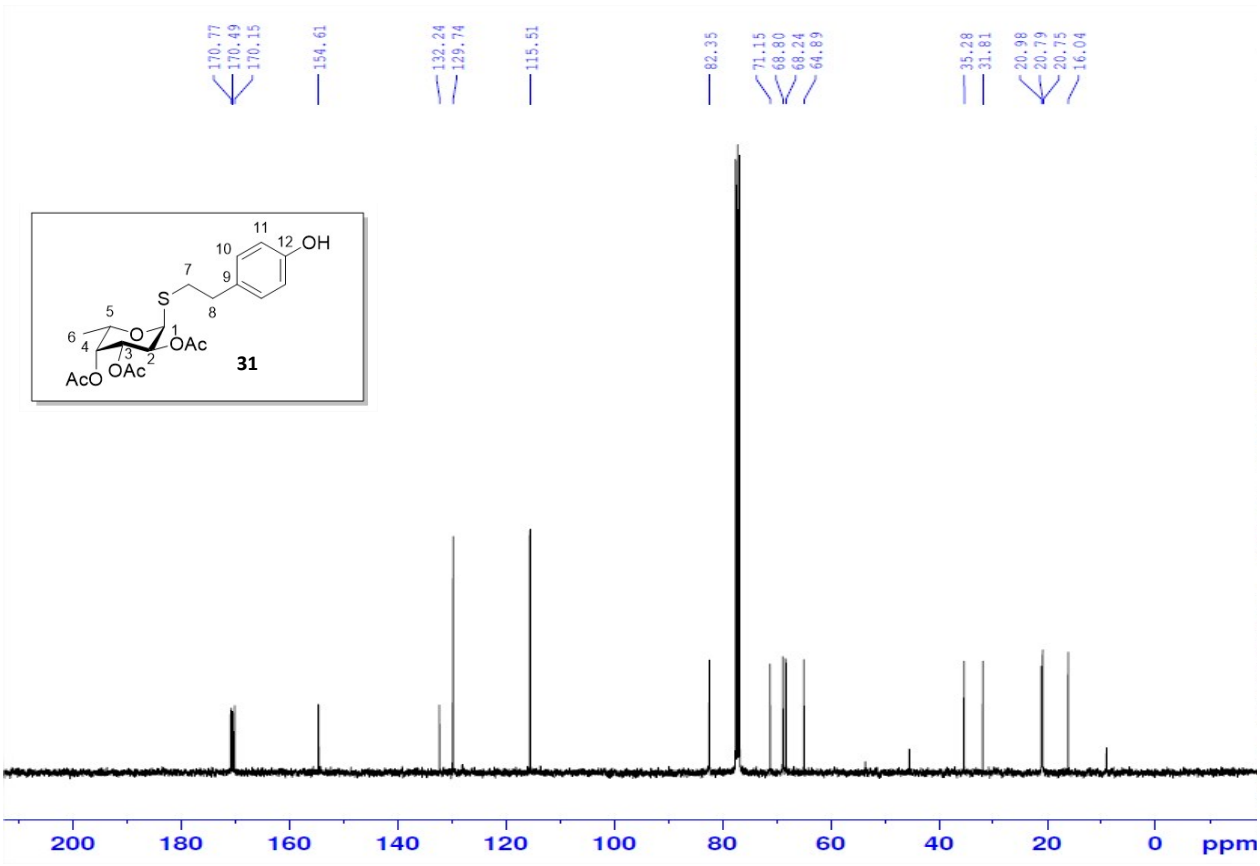

8.034
5.297
5.292
5.288
5.056
5.025
4.861
4.620
4.604
4.590
3.930
3.912
3.896
3.698
3.687
3.673
3.668
3.656
3.643
3.629
3.627
3.624
3.611
3.583
3.571
3.565
3.563
3.552
3.550
3.541
3.519
3.454
2.165
2.054
1.975
1.642
1.621
1.604
1.440
1.428
1.416
1.404
1.142
1.120
OH
OAc
AcO
OAc
21
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.97
1.97
3.97
1.04
2.00
15.38
1.09
2.90
2.97
2.80
4.02
3.95
2.87

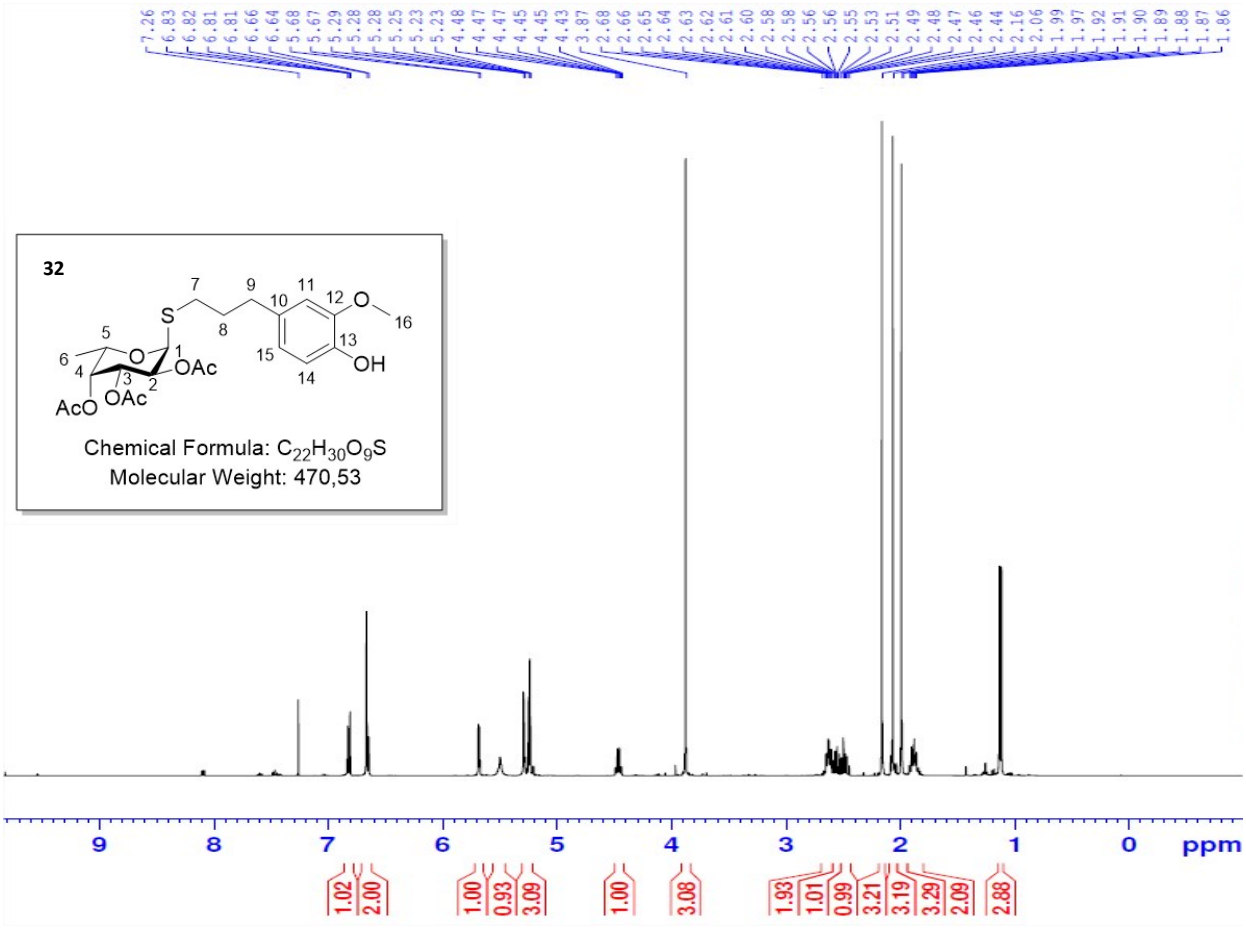

172.32
171.98
171.70
145.99
125.81
97.43
73.70
72.61
71.59
71.51
71.43
70.39
69.64
69.56
69.36
65.64
64.68
62.24
51.42
30.68
30.39
27.07
26.96
20.68
20.53
16.21
OH
OAc
AcO
OAc
21
200
180
160
140
120
100
80
60
40
20
0
ppm

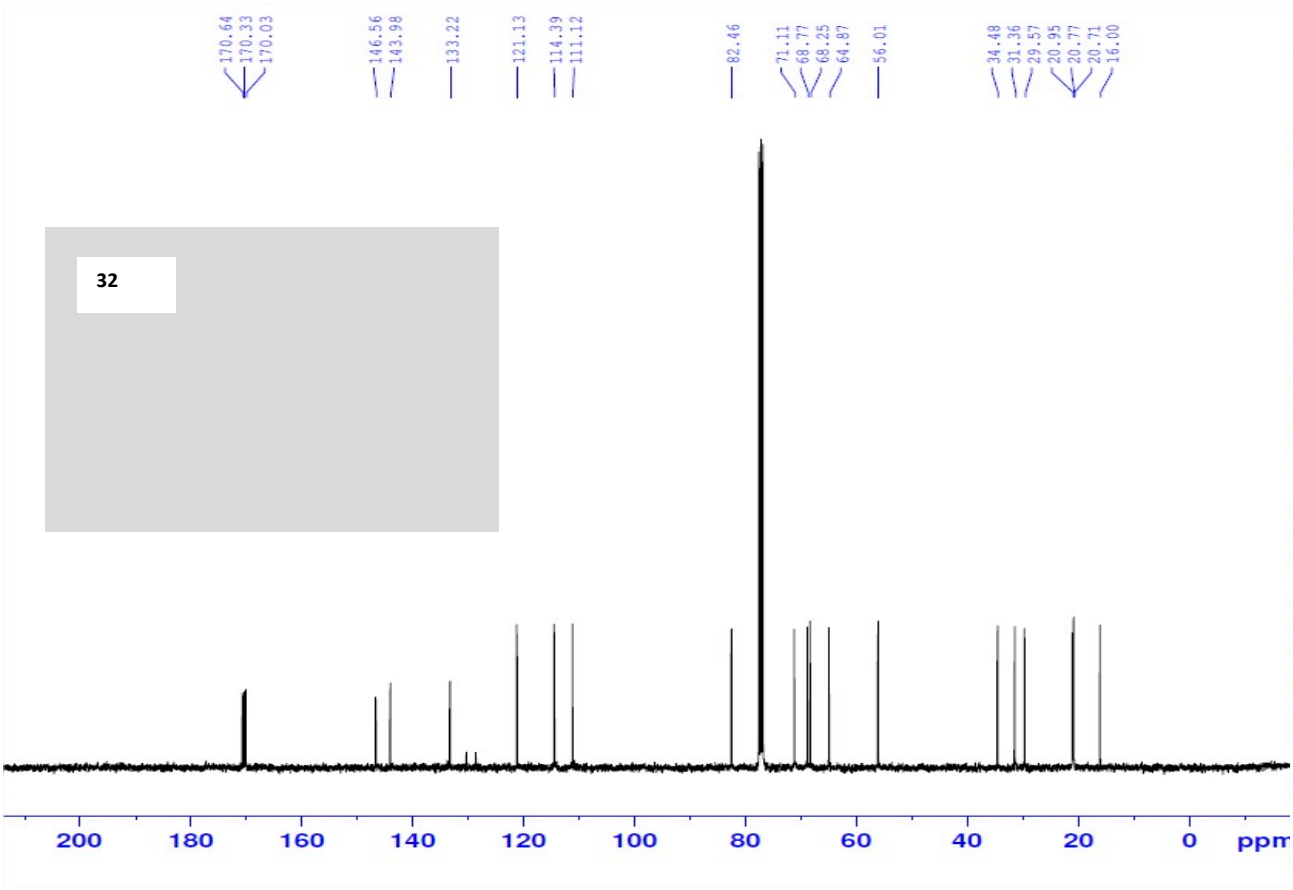

8.052
5.780
5.756
5.304
5.299
5.294
5.290
5.079
5.066
5.059
5.052
4.624
4.616
4.608
4.591
4.247
4.231
4.206
4.193
4.188
4.174
4.171
3.931
3.913
3.897
3.689
3.687
3.673
3.668
3.656
3.643
3.629
3.622
3.609
3.582
3.570
3.565
3.551
3.549
2.169
2.053
1.972
1.147
1.125
OH
OAc
AcO
OAc
22
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.96
1.94
2.01
3.95
5.49
2.09
13.04
2.47
2.92
2.95
2.81

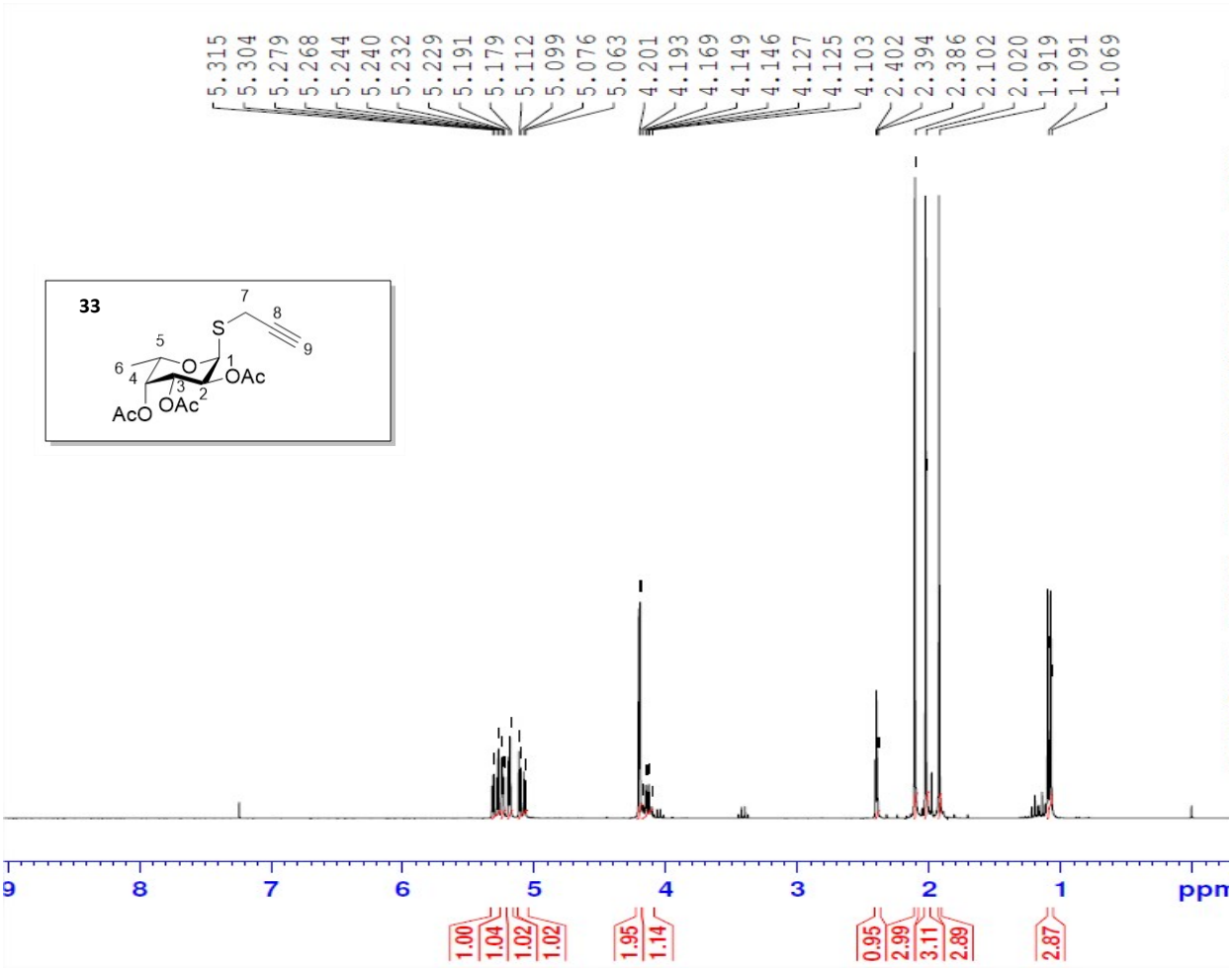

172.31
171.96
171.67
145.74
131.12
129.52
125.95
96.75
73.69
72.59
71.58
71.50
71.43
70.37
69.45
69.41
66.90
65.89
64.51
64.11
62.25
51.44
20.71
20.69
20.56
16.22
OH
OAc
AcO
OAc
22
200
180
160
140
120
100
80
60
40
20
0
ppm

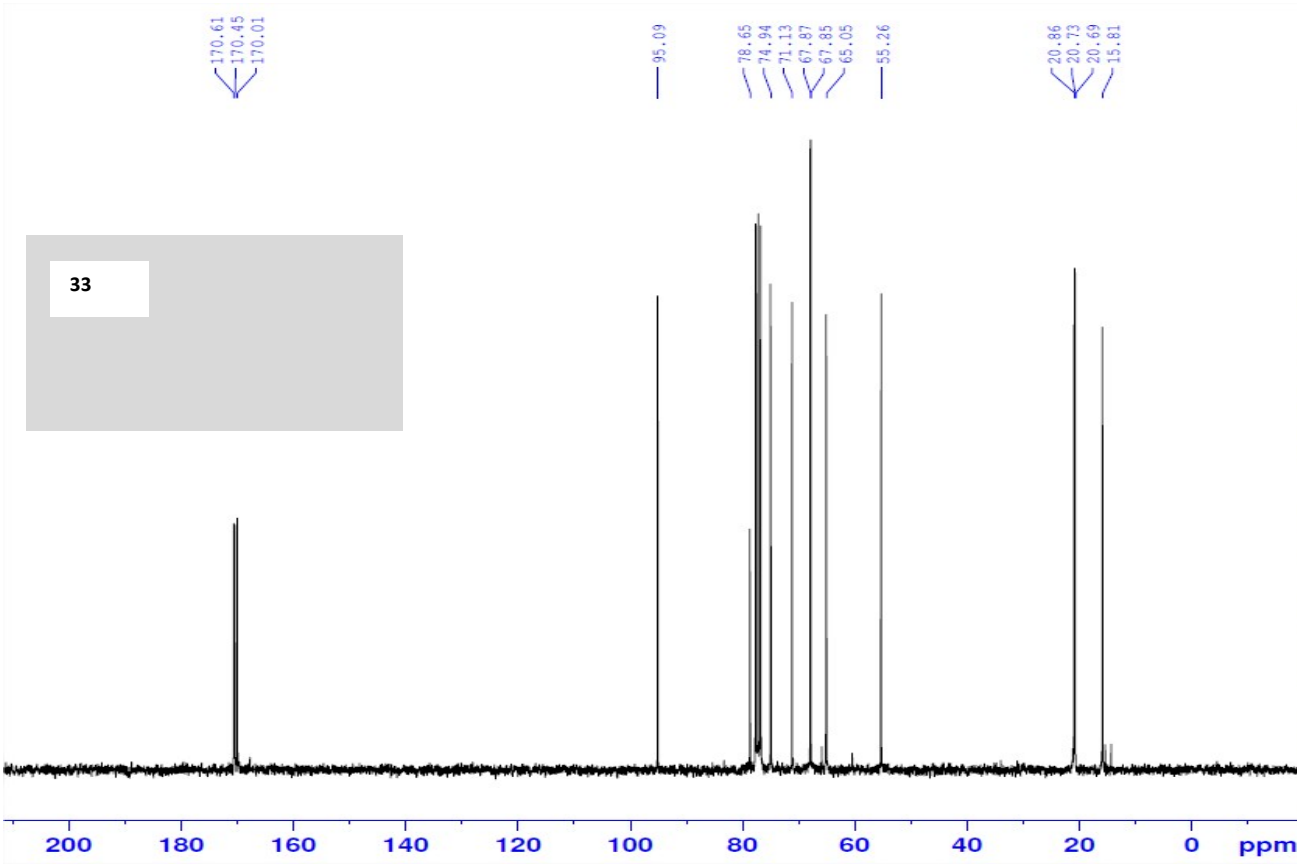

7.04
7.01
6.77
6.75
5.68
5.67
5.29
5.28
5.28
5.27
5.27
5.26
5.25
5.23
5.22
5.21
5.19
5.18
4.46
4.44
4.42
4.41
2.82
2.81
2.81
2.80
2.79
2.79
2.77
2.76
2.74
2.73
2.72
2.70
2.70
2.68
2.67
2.67
2.65
2.16
2.05
1.98
1.14
1.13
OH
AcO
OAc
OA
31
9
8
7
6
5
4
3
2
1
0
ppm
1.93
2.00
0.94
2.21
0.95
1.02
3.80
2.99
2.86
2.91
2.85

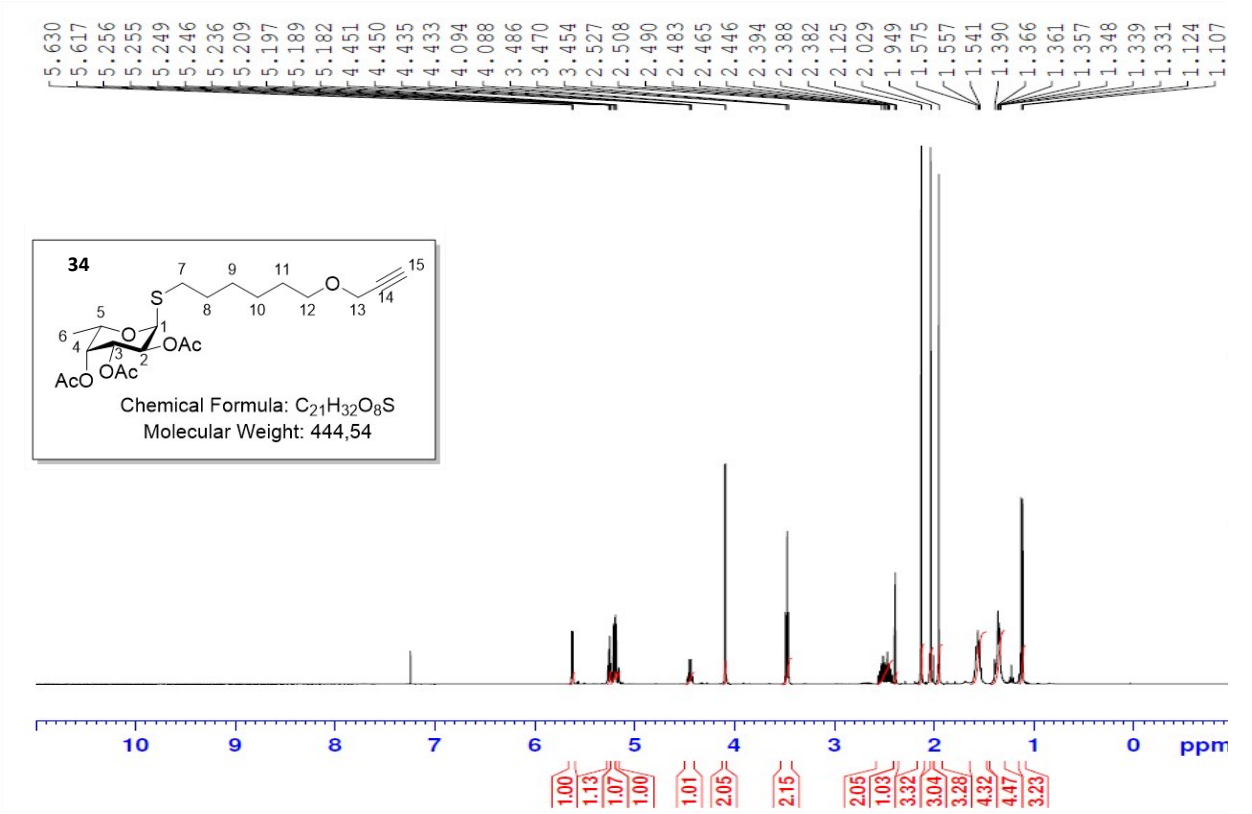

170.77
170.49
170.15
154.61
132.24
129.74
115.51
82.35
71.15
68.80
68.24
64.89
35.28
31.81
20.98
20.79
20.75
16.04
OH
AcO
OAc
OAc
31
200
180
160
140
120
100
80
60
40
20
0
ppm

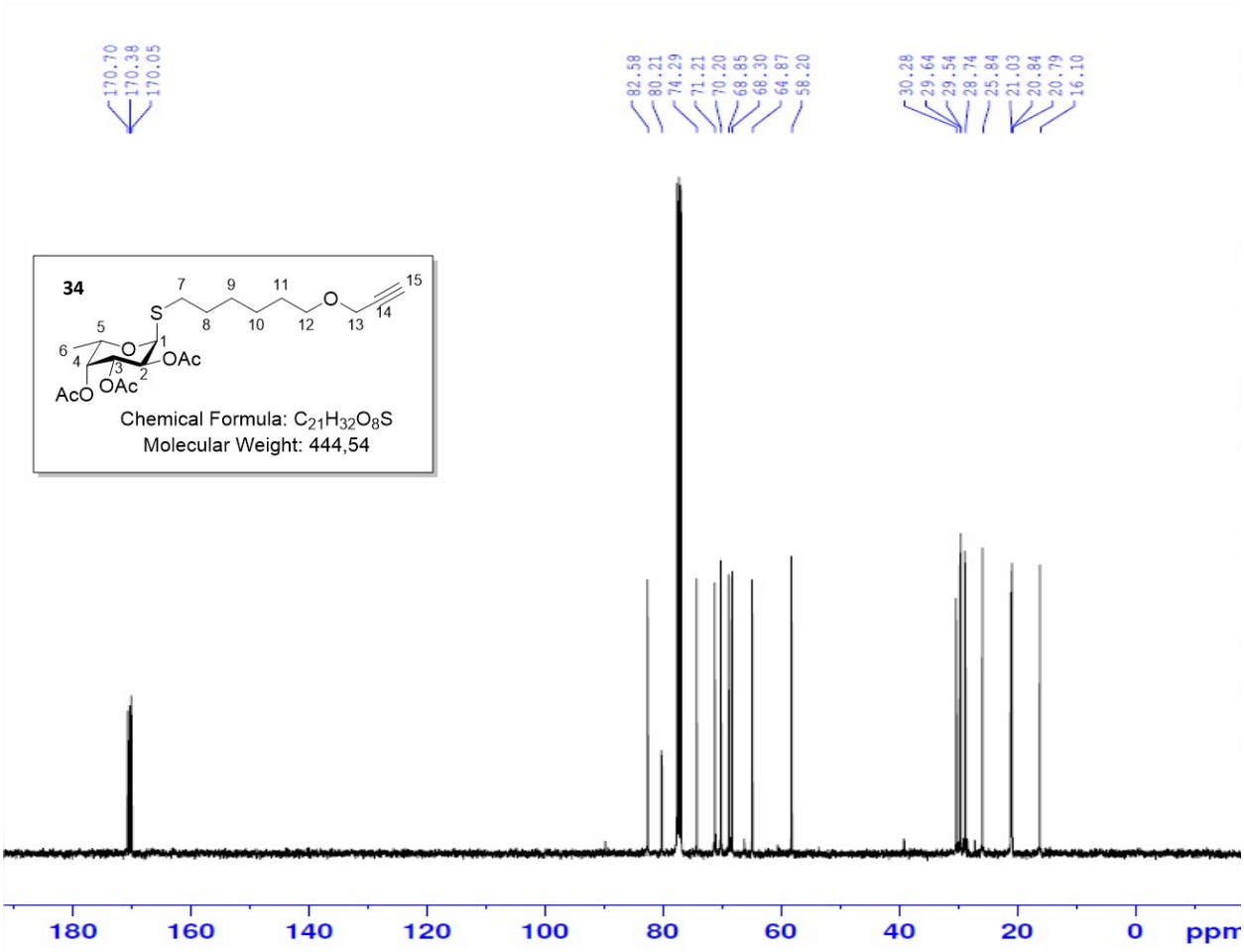

7.26
6.83
6.82
6.81
6.81
6.66
6.64
5.68
5.67
5.29
5.28
5.28
5.25
5.23
5.23
4.48
4.47
4.47
4.45
4.45
4.43
3.87
2.68
2.66
2.65
2.64
2.63
2.62
2.61
2.60
2.58
2.58
2.56
2.56
2.55
2.53
2.51
2.49
2.48
2.47
2.46
2.44
2.16
2.06
1.99
1.97
1.92
1.91
1.90
1.89
1.88
1.87
1.86
32
Chemical Formula: C22H30O9S
Molecular Weight: 470,53
9
8
7
6
5
4
3
2
1
0
ppm
1.02
2.00
1.00
0.93
3.09
1.00
3.08
1.93
1.01
0.99
3.21
3.19
3.29
2.09
2.88

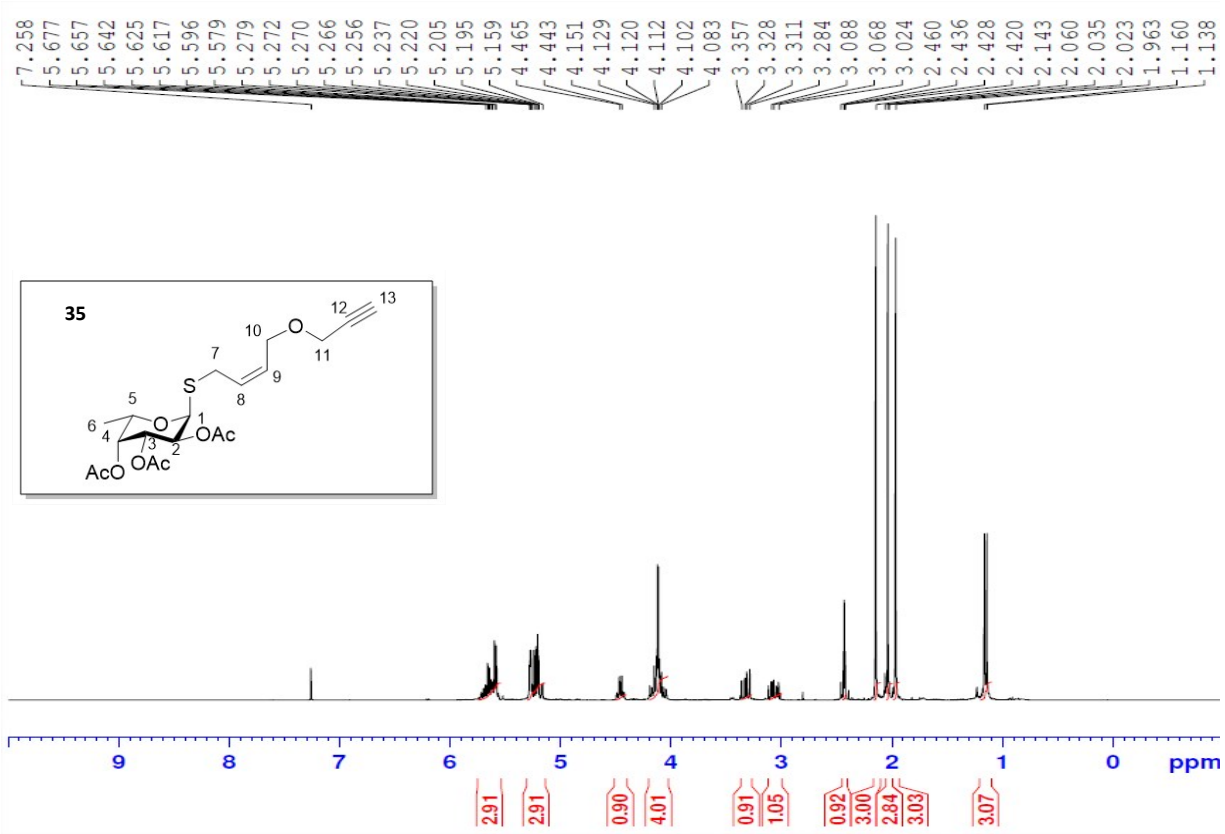

170.64
170.33
170.03
146.56
143.98
133.22
121.13
114.39
111.12
82.46
71.11
68.77
68.25
64.87
56.01
34.48
31.36
29.57
20.95
20.77
20.71
16.00
32
200
180
160
140
120
100
80
60
40
20
0
ppm

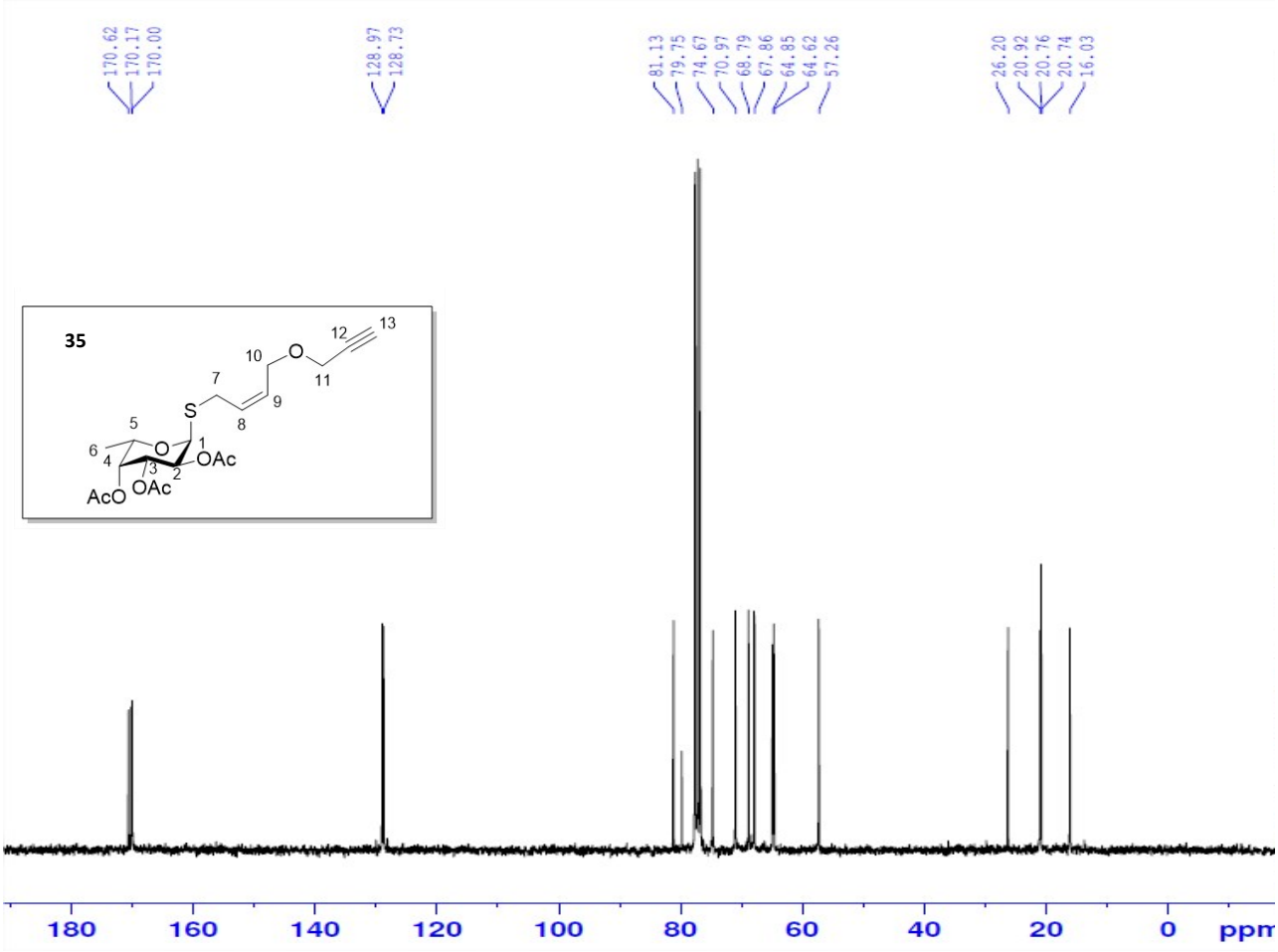

5.315
5.304
5.279
5.268
5.244
5.240
5.232
5.229
5.191
5.179
5.112
5.099
5.076
5.063
4.201
4.193
4.169
4.149
4.146
4.127
4.125
4.103
2.402
2.394
2.386
2.102
2.020
1.919
1.091
1.069
33
S
OAc
AcO
OAc
9
8
7
6
5
4
3
2
1
ppm
1.00
1.04
1.02
1.02
1.95
1.14
0.95
2.99
3.11
2.89
2.87

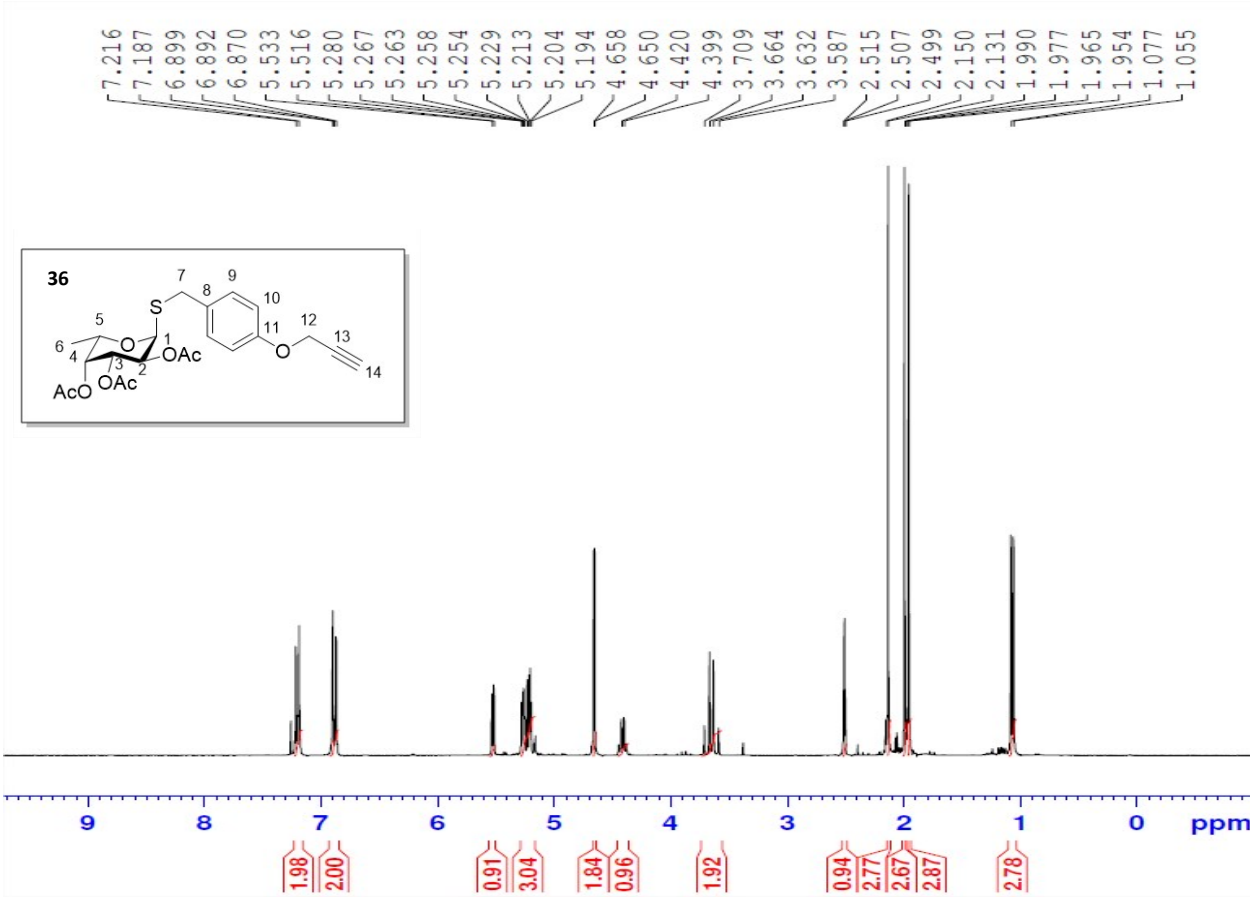

170.61
170.45
170.01
95.09
78.65
74.94
71.13
67.87
67.85
65.05
55.26
20.86
20.73
20.69
15.81
33
200
180
160
140
120
100
80
60
40
20
0
ppm

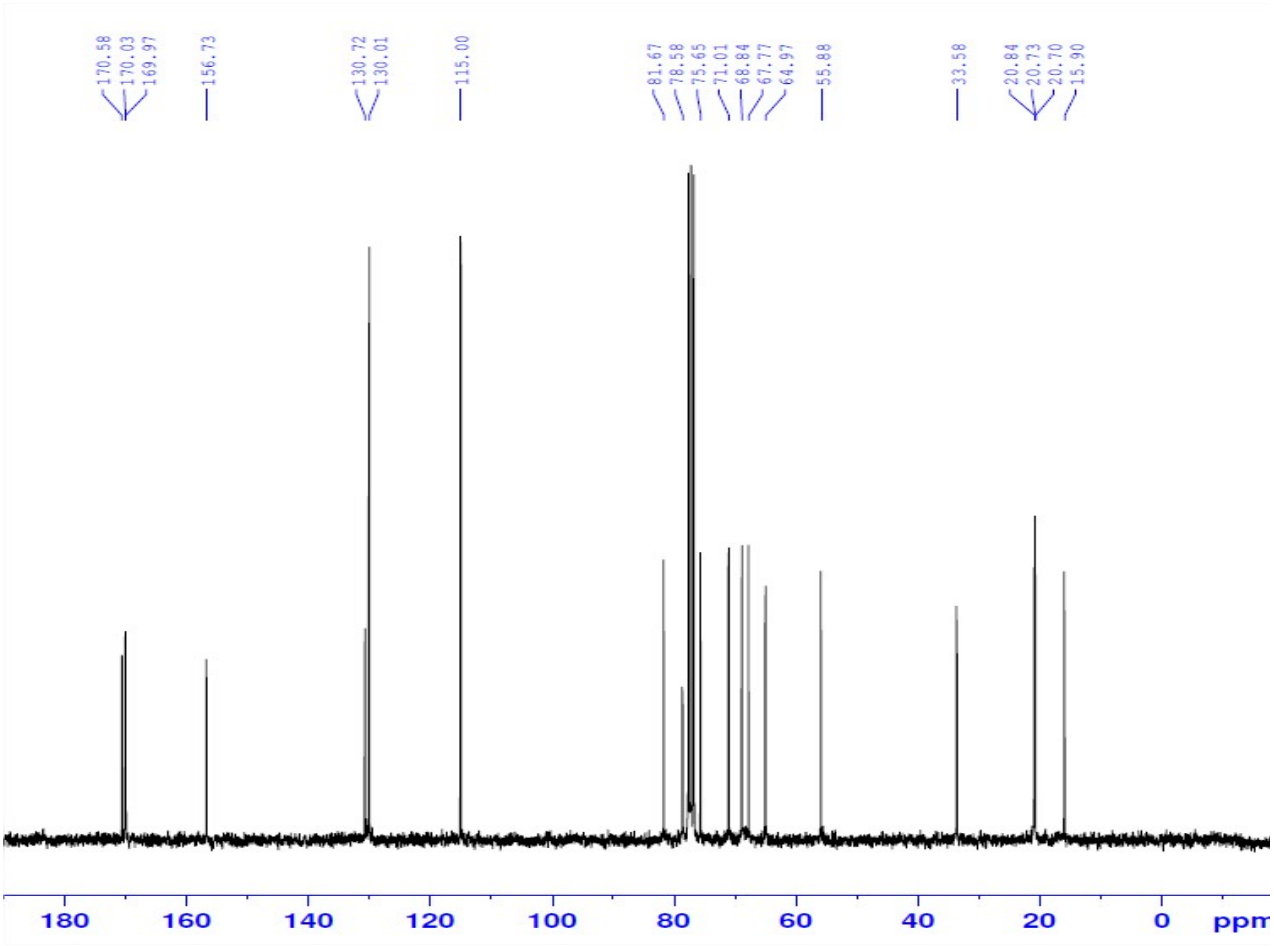

5.630
5.617
5.256
5.255
5.249
5.246
5.236
5.209
5.197
5.189
5.182
4.451
4.450
4.435
4.433
4.094
4.088
3.486
3.470
3.454
2.527
2.508
2.490
2.483
2.465
2.446
2.394
2.388
2.382
2.125
2.029
1.949
1.575
1.557
1.541
1.390
1.366
1.361
1.357
1.348
1.339
1.331
1.124
1.107
34
Chemical Formula: C21H32O8S
Molecular Weight: 444,54
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.13
1.07
1.00
1.01
2.05
2.15
2.05
1.03
3.32
3.04
3.28
4.32
4.47
3.23

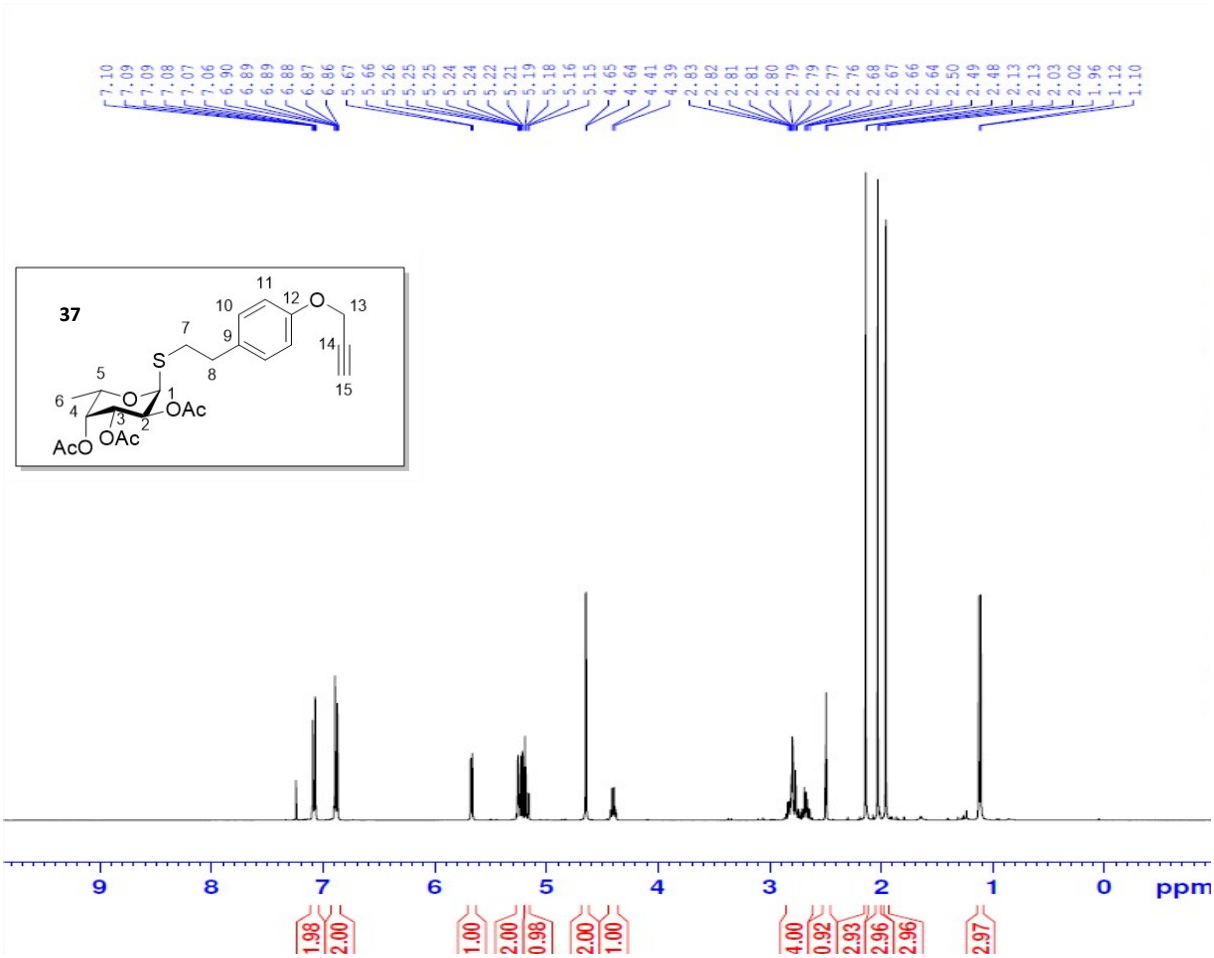

170.70
170.38
170.05
82.58
80.21
74.29
71.21
70.20
68.85
68.30
64.87
58.20
30.28
29.64
29.54
28.74
25.84
21.03
20.84
20.79
16.10
34
Chemical Formula: C21H32O8S
Molecular Weight: 444,54
180
160
140
120
100
80
60
40
20
0
ppm

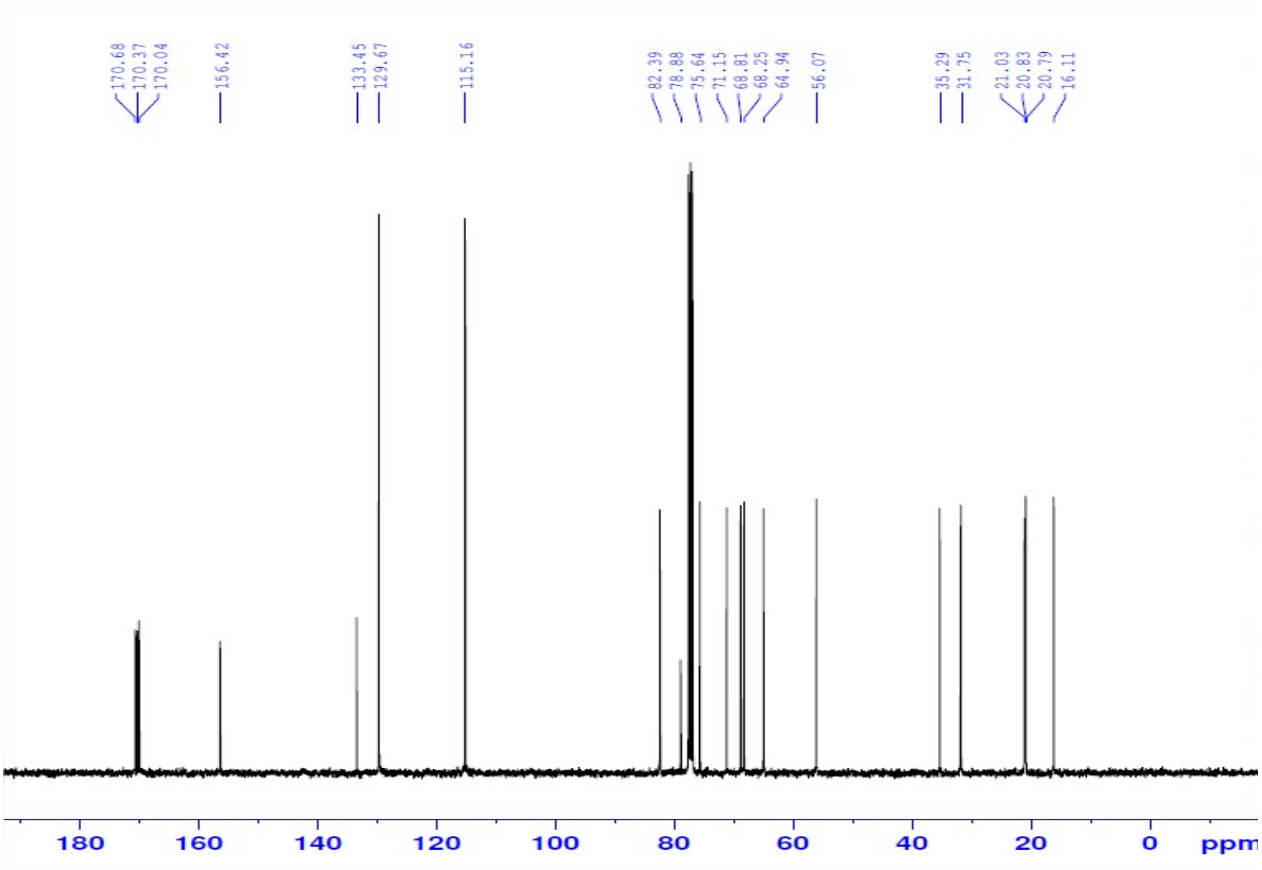

7.258
5.677
5.657
5.642
5.625
5.617
5.596
5.579
5.279
5.272
5.270
5.266
5.256
5.237
5.220
5.205
5.195
5.159
4.465
4.443
4.151
4.129
4.120
4.112
4.102
4.083
3.357
3.328
3.311
3.284
3.088
3.068
3.024
2.460
2.436
2.428
2.420
2.143
2.060
2.035
2.023
1.963
1.160
1.138
35
AcO
OAc
OAc
ppm
2.91
2.91
0.90
4.01
0.91
1.05
0.92
3.00
2.84
3.03
3.07

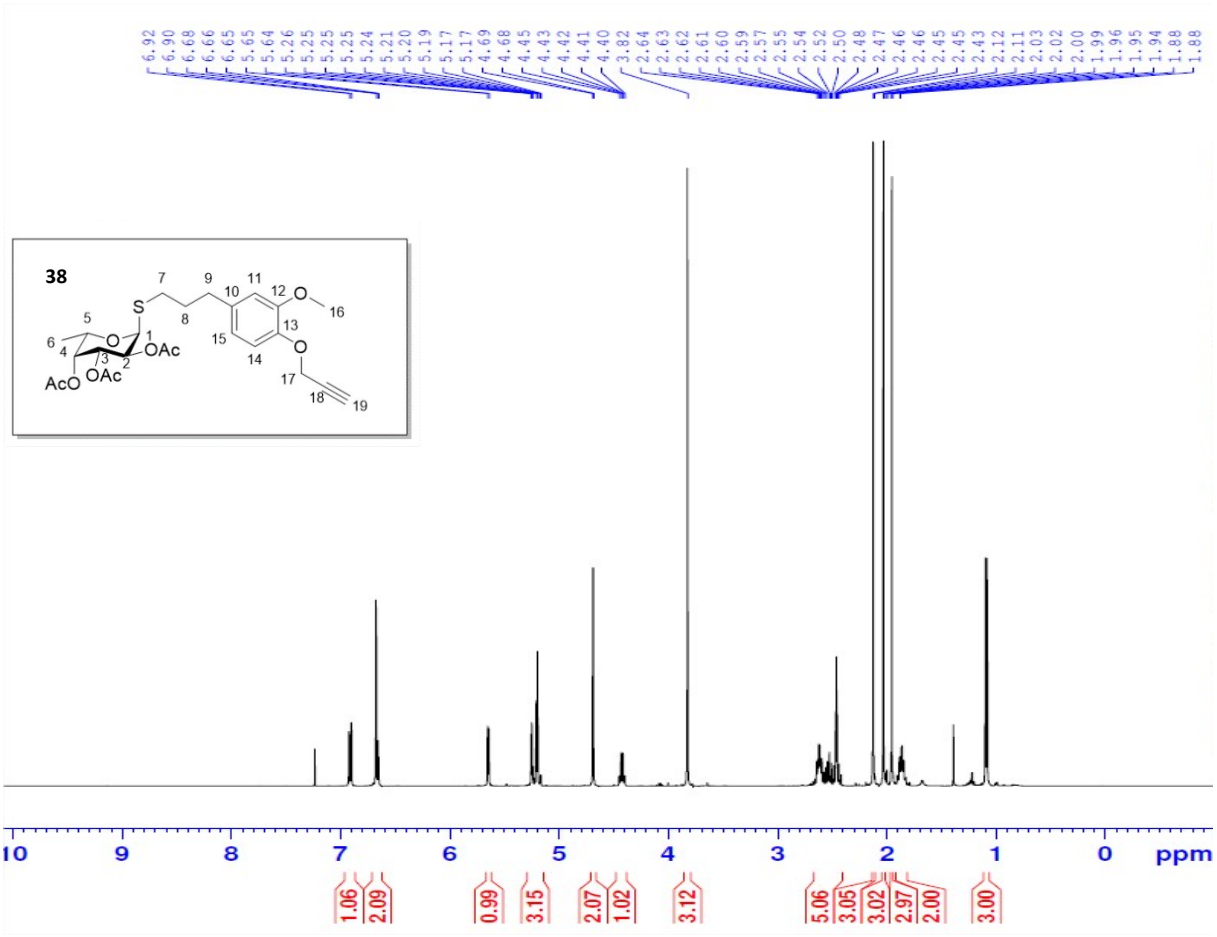

170.62
170.17
170.00
128.97
128.73
81.13
79.75
74.67
70.97
68.79
67.86
64.85
64.62
57.26
26.20
20.92
20.76
20.74
16.03
35
AcO
OAc
OAc
ppm

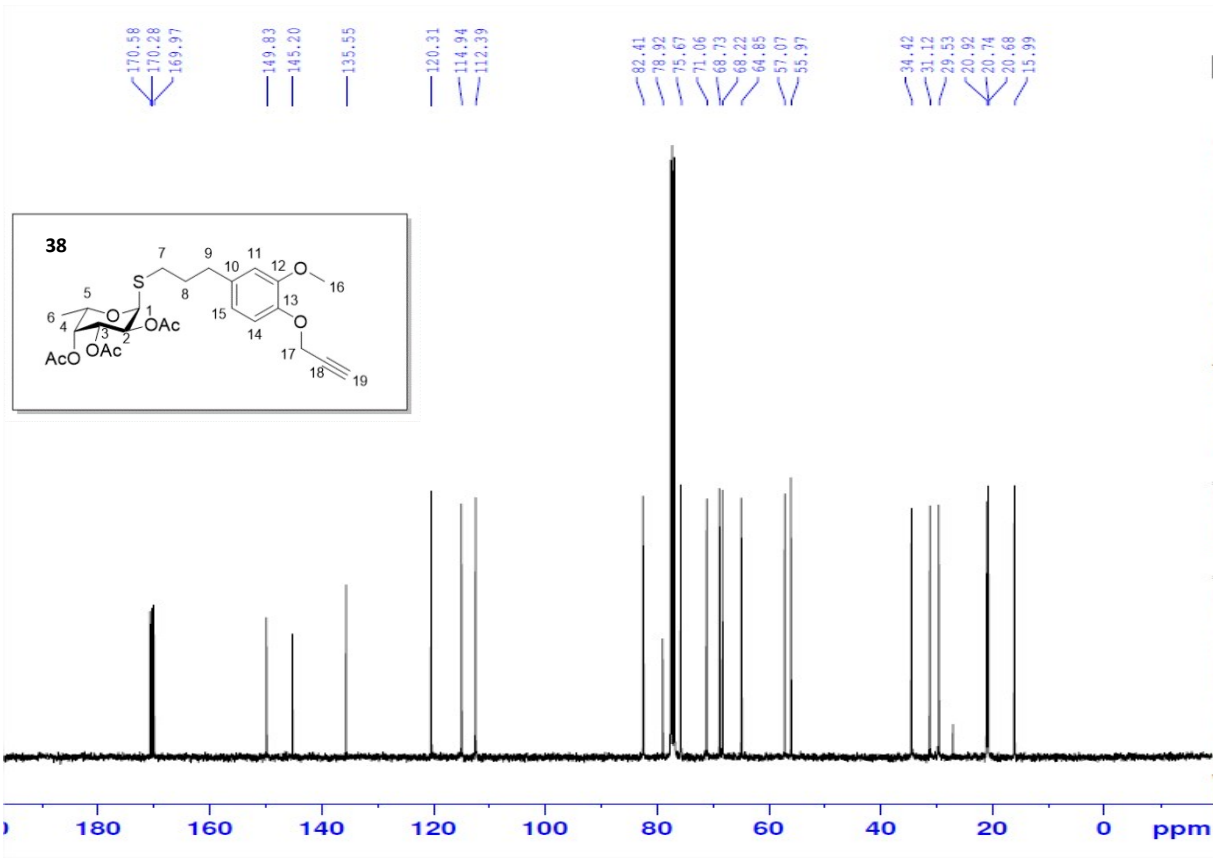

7.216
7.187
6.899
6.892
6.870
5.533
5.516
5.280
5.267
5.263
5.258
5.254
5.229
5.213
5.204
5.194
4.658
4.650
4.420
4.399
3.709
3.664
3.632
3.587
2.515
2.507
2.499
2.150
2.131
1.990
1.977
1.965
1.954
1.077
1.055
36
S
OAc
AcO
OAc
O
9
8
7
6
5
4
3
2
1
0
ppm
1.98
2.00
0.91
3.04
1.84
0.96
1.92
0.94
2.77
2.67
2.87
2.78

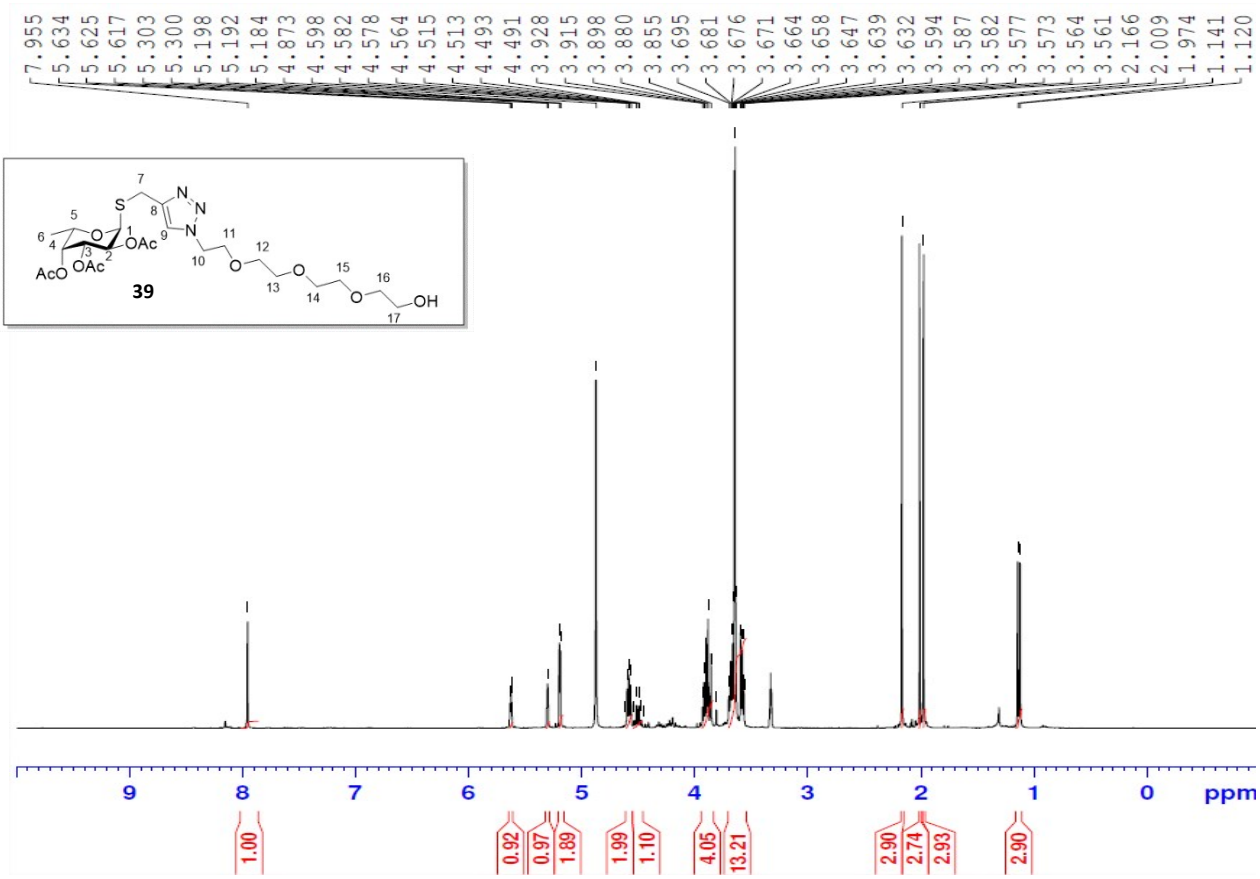

170.58
170.03
169.97
156.73
130.72
130.01
115.00
81.67
78.58
75.65
71.01
68.84
67.77
64.97
55.88
33.58
20.84
20.73
20.70
15.90
180
160
140
120
100
80
60
40
20
0
ppm

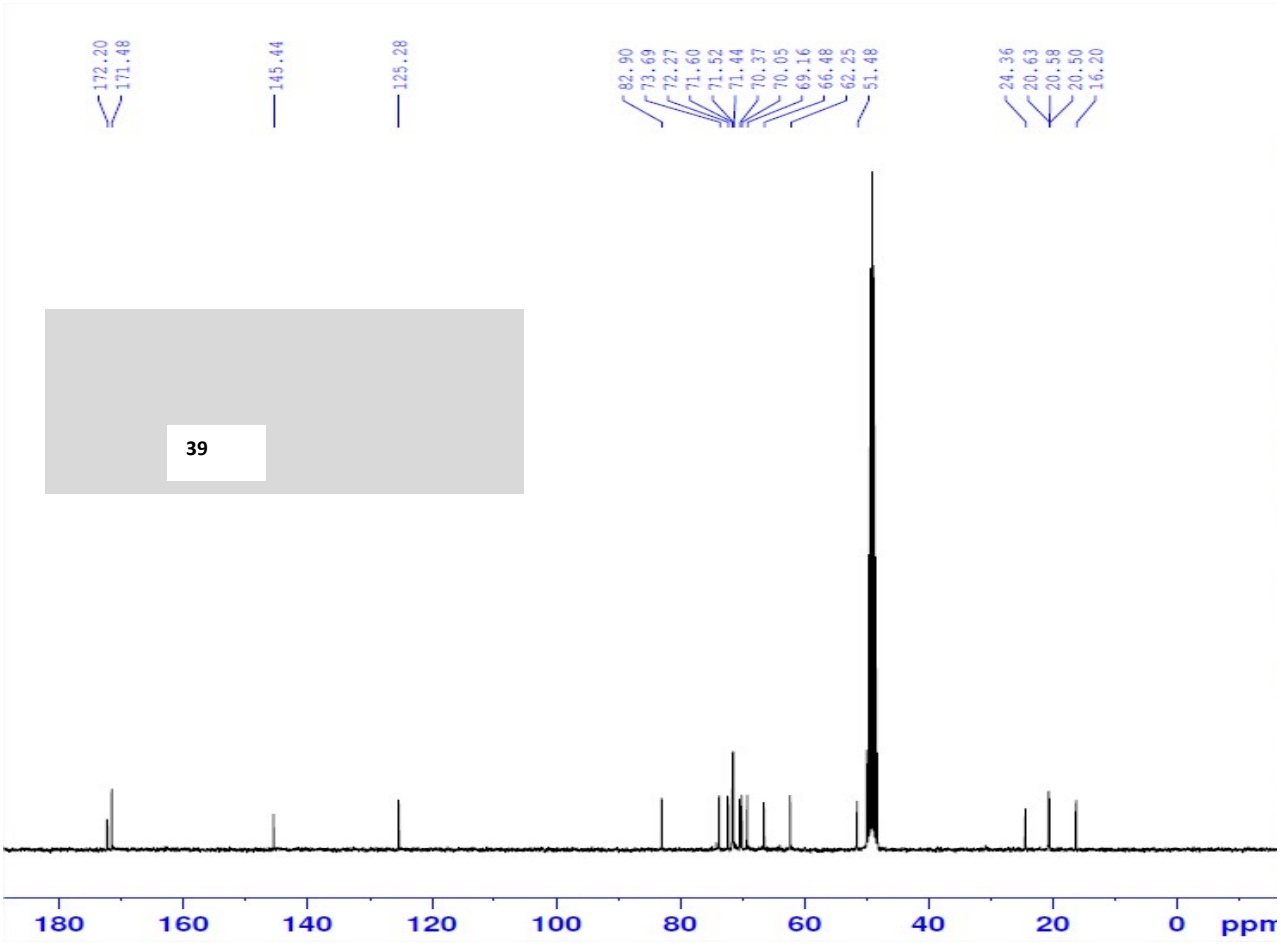

37
AcO
OAc
OAc
OAc
S
O
9
10
11
12
13
14
15
ppm

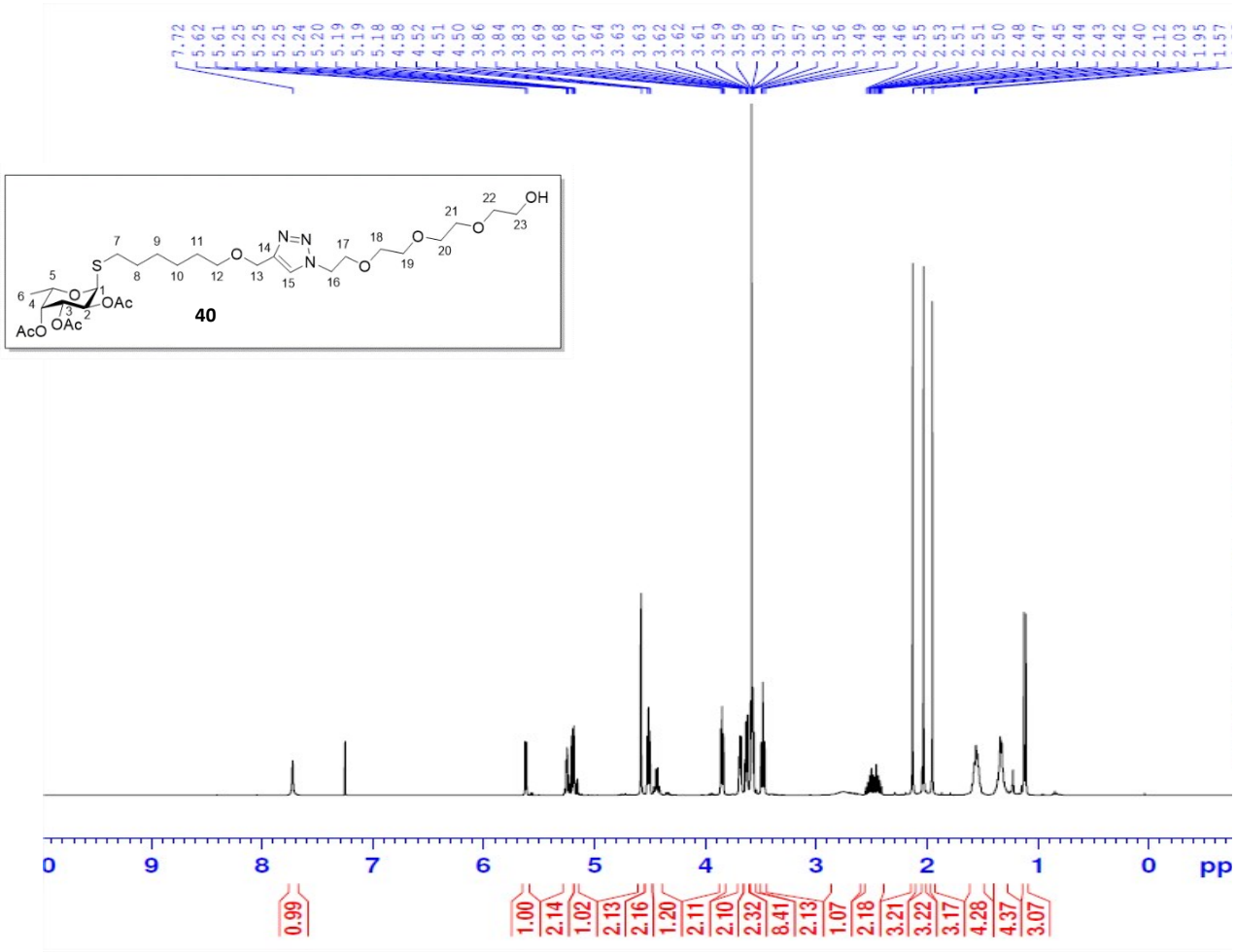

170.68
170.37
170.04
156.42
133.45
129.67
115.16
82.39
78.88
75.64
71.15
68.81
68.25
64.94
56.07
35.29
31.75
21.03
20.83
20.79
16.11
180
160
140
120
100
80
60
40
20
0
ppm

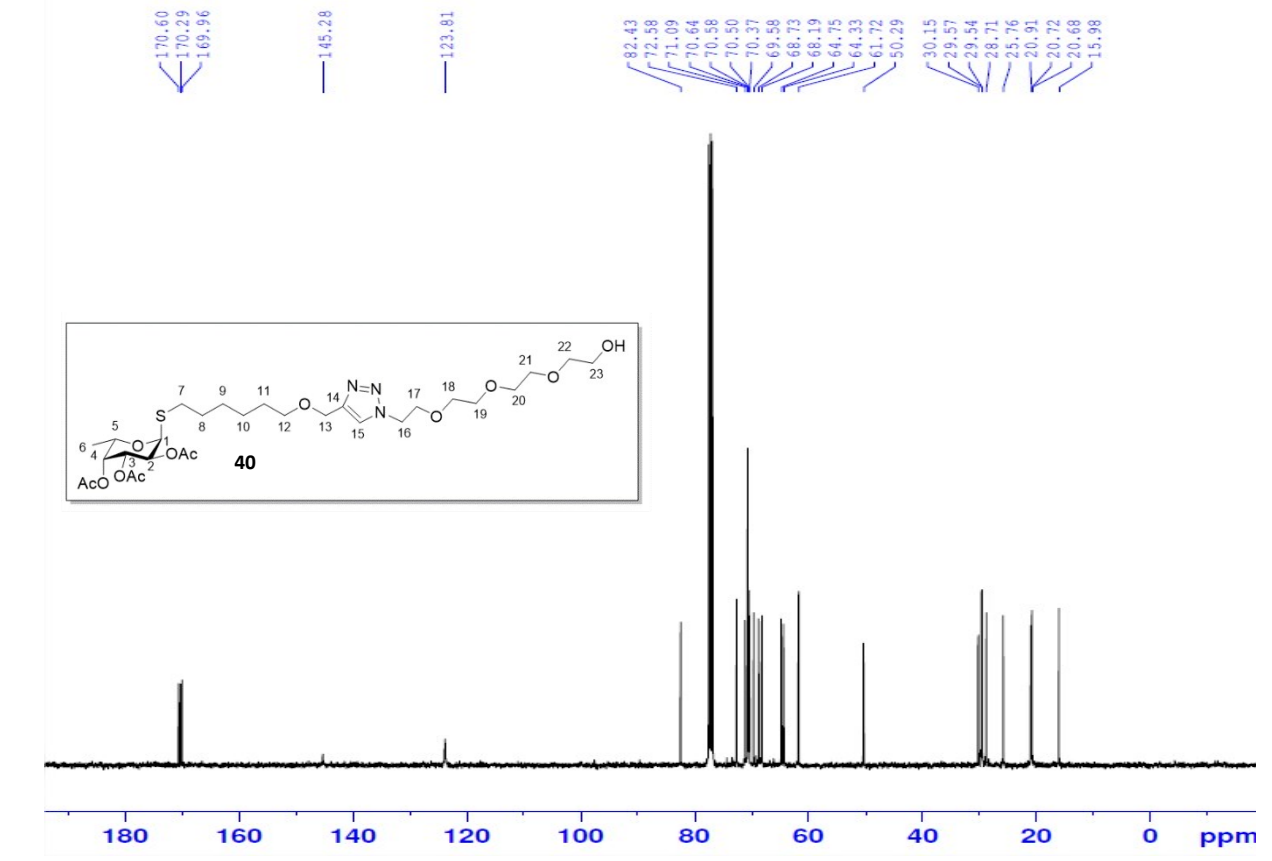

38
ppm

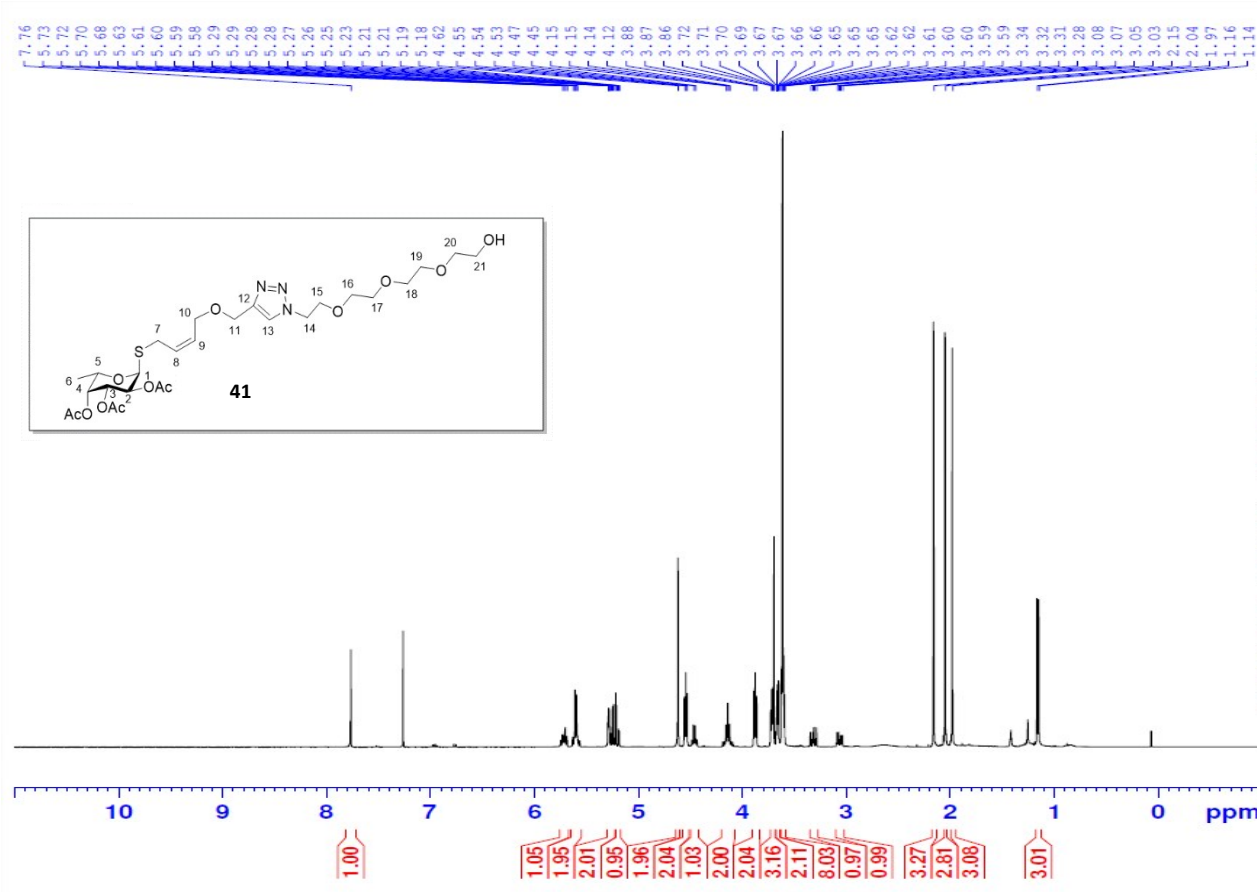

38
ppm

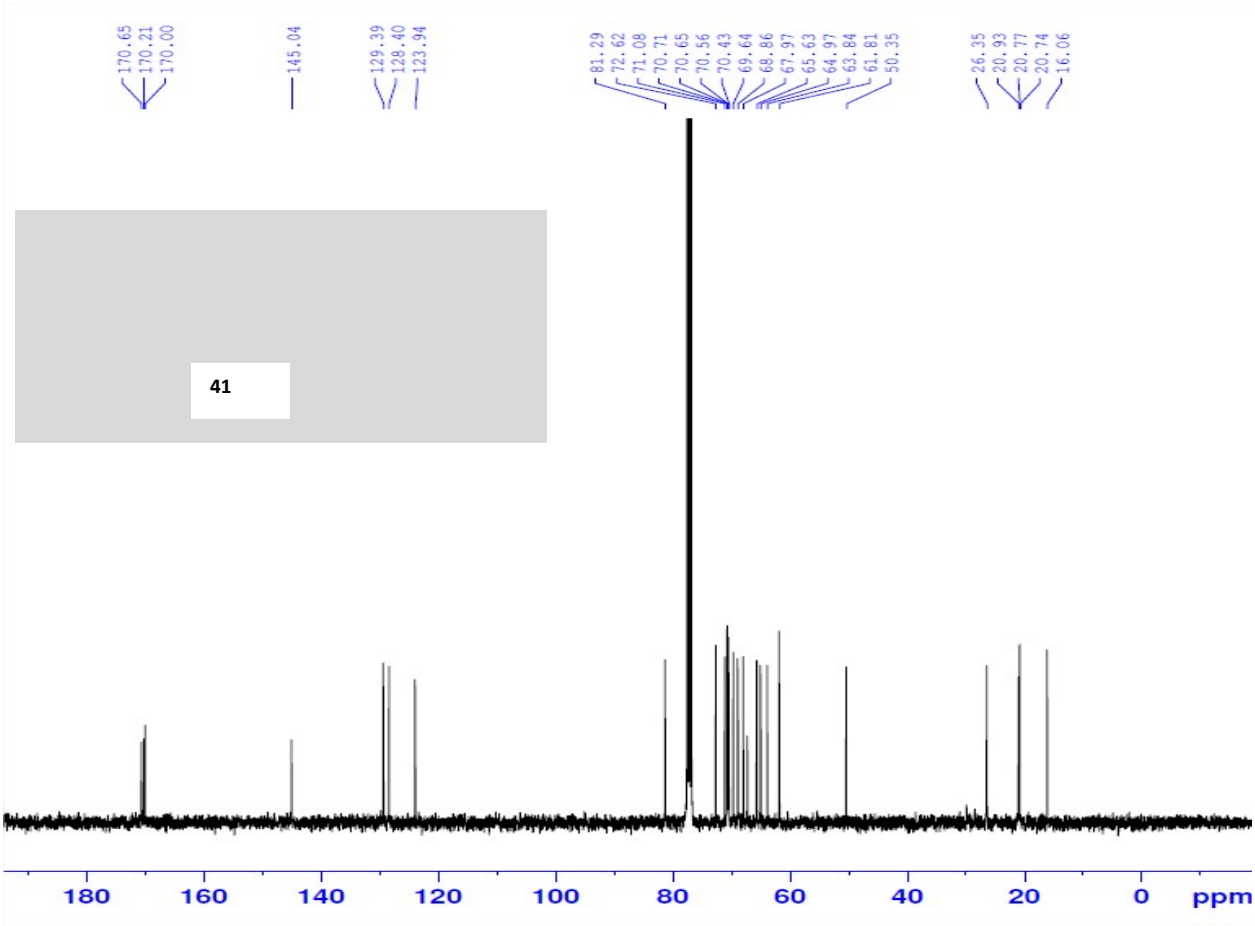

7.955
5.634
5.625
5.617
5.303
5.300
5.198
5.192
5.184
4.873
4.598
4.582
4.578
4.564
4.515
4.513
4.493
4.491
3.928
3.915
3.898
3.880
3.855
3.695
3.681
3.676
3.671
3.664
3.658
3.647
3.639
3.632
3.594
3.587
3.582
3.577
3.573
3.564
3.561
2.166
2.009
1.974
1.141
1.120
AcO
OAc
OAc
OH
39
9
8
7
6
5
4
3
2
1
0
ppm
1.00
0.92
0.97
1.89
1.99
1.10
4.05
13.21
2.90
2.74
2.93
2.90

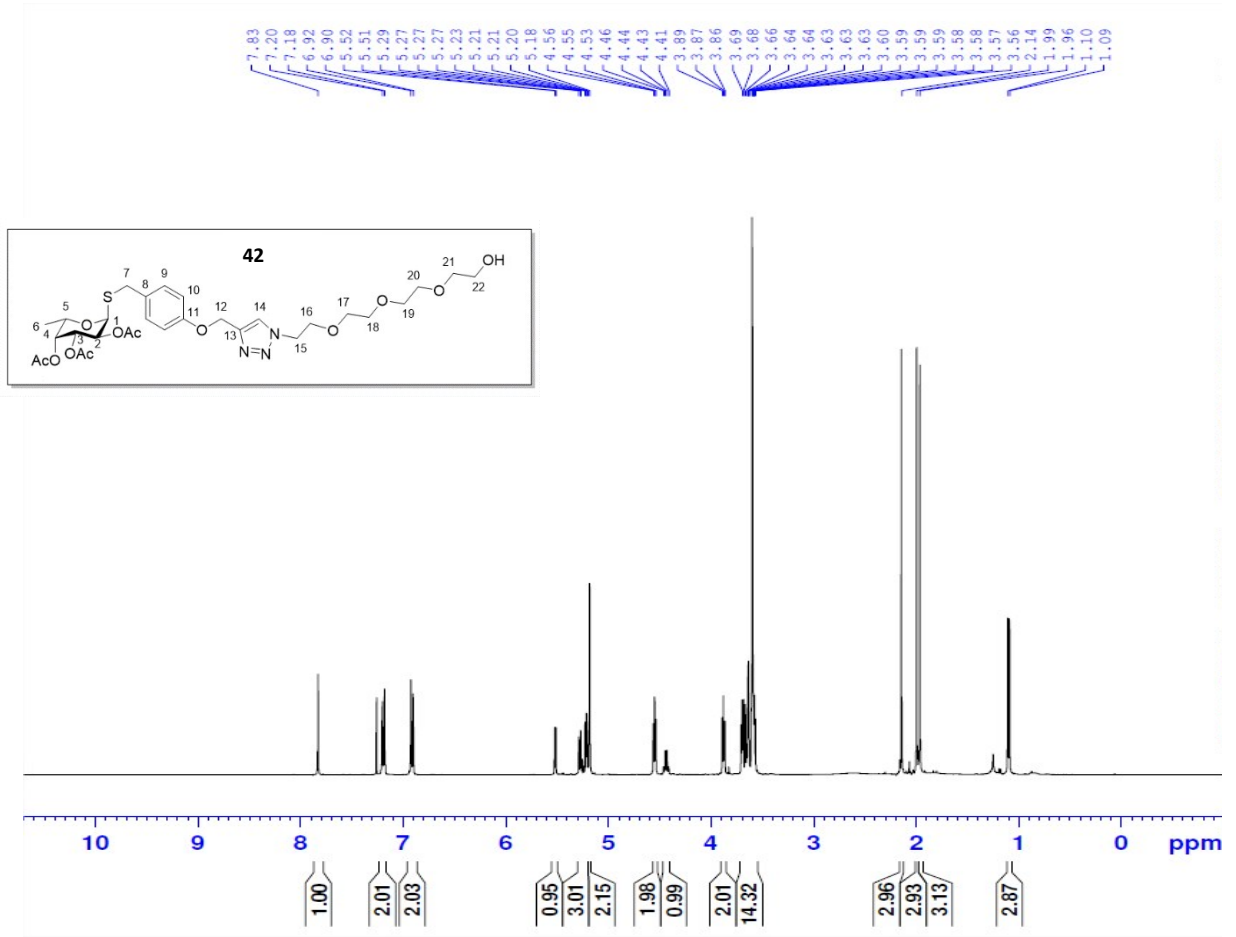

172.20
171.48
145.44
125.28
82.90
73.69
72.27
71.60
71.52
71.44
70.37
70.05
69.16
66.48
62.25
51.48
24.36
20.63
20.58
20.50
16.20
39
180
160
140
120
100
80
60
40
20
0
ppm

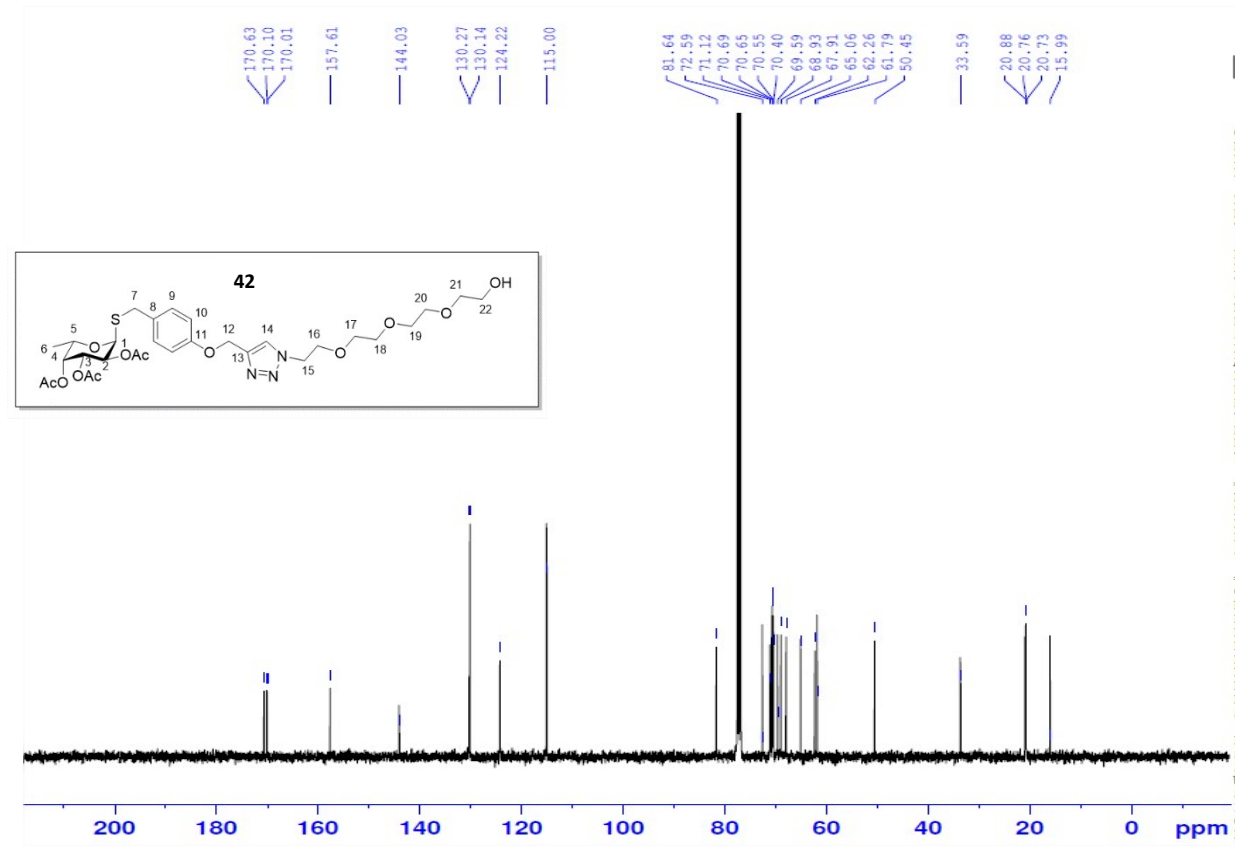

40

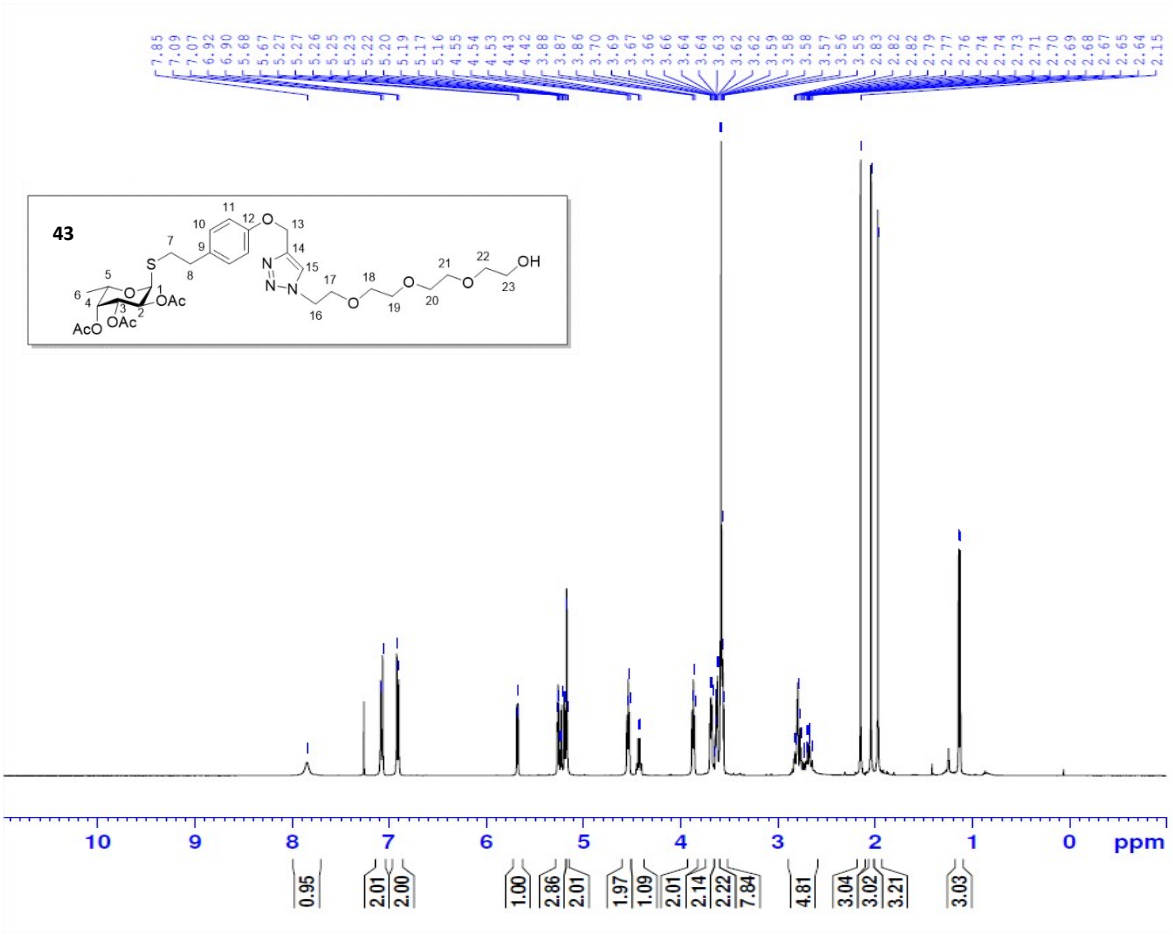

40

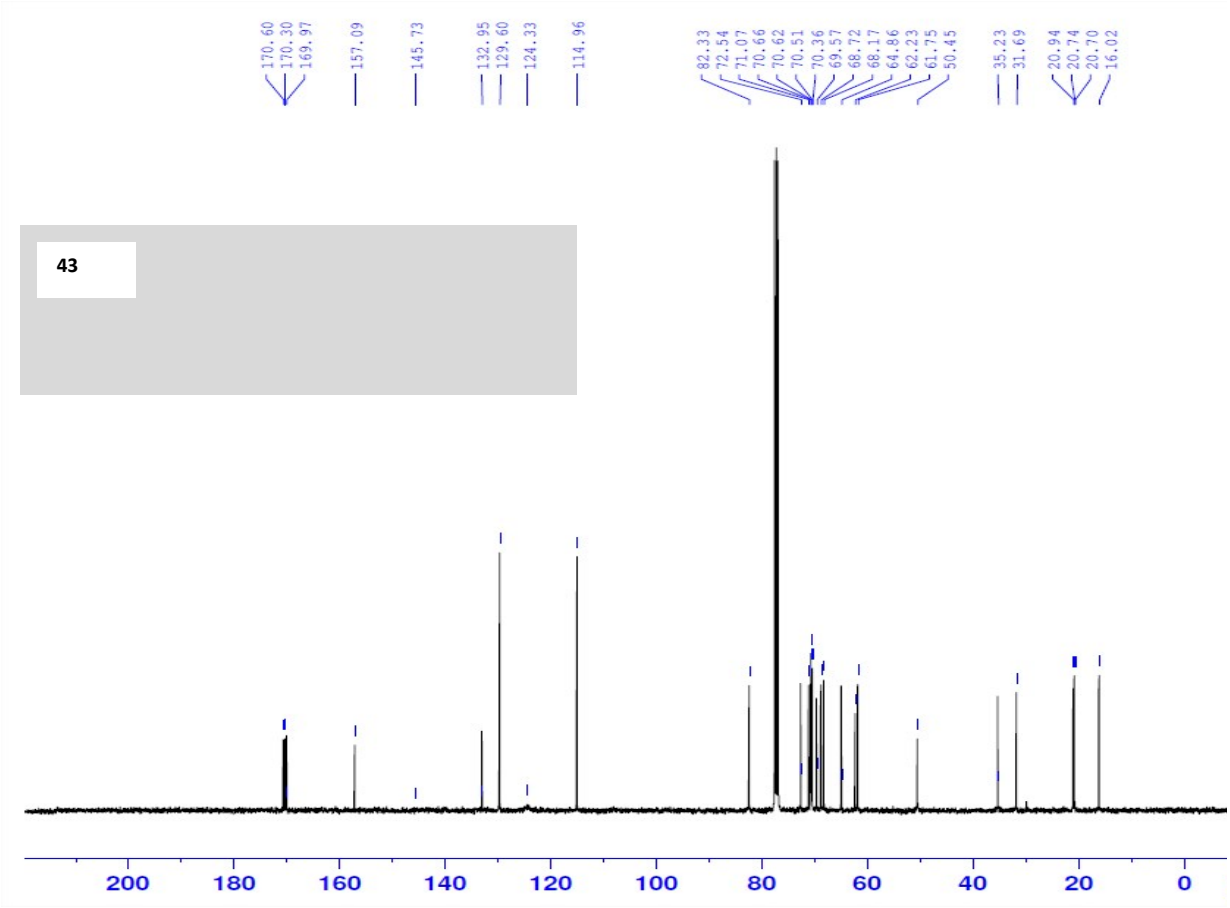

41
10
9
8
7
6
5
4
3
2
1
0
ppm

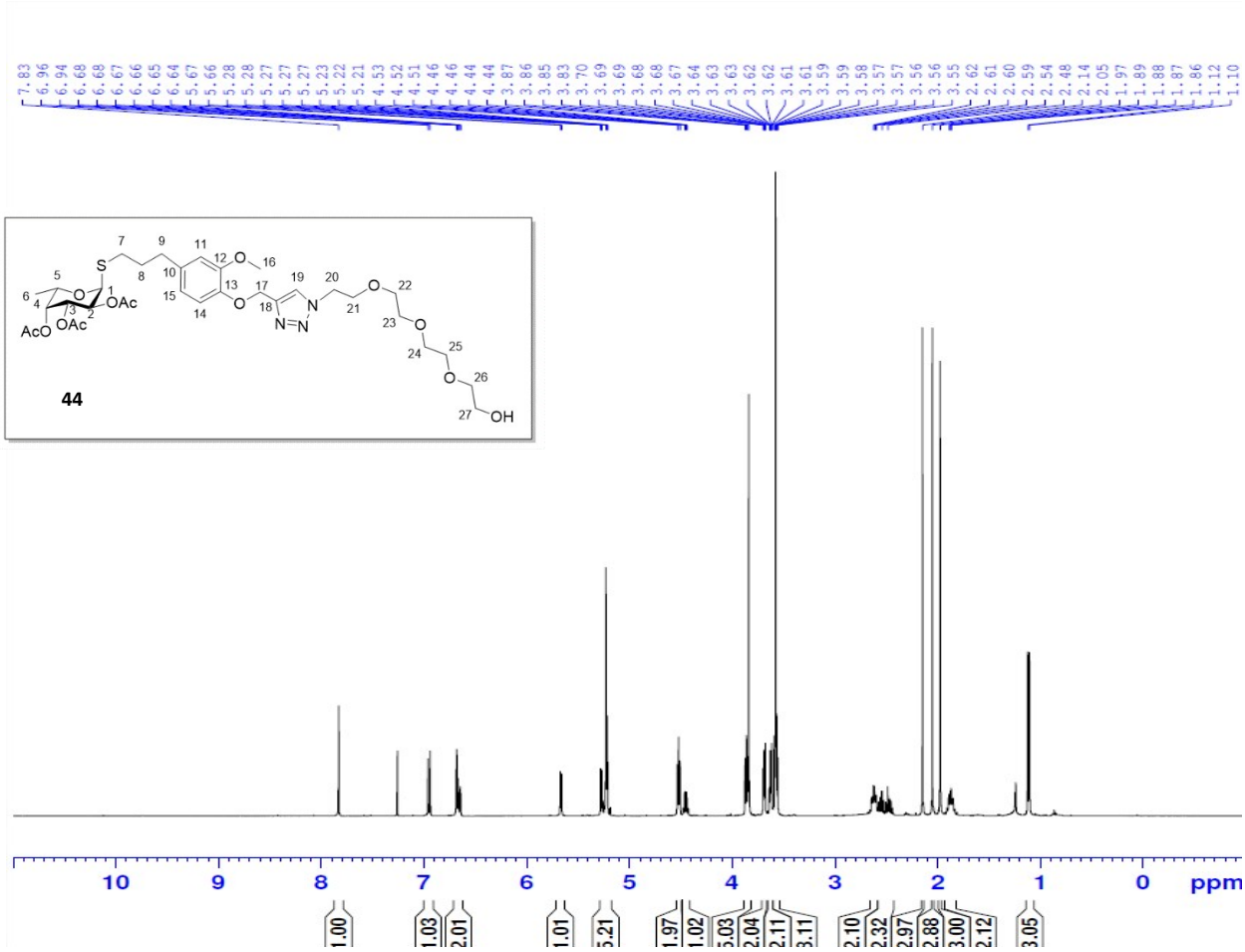

170.65
170.21
170.00
145.04
129.39
128.40
123.94
81.29
72.62
71.08
70.71
70.65
70.56
70.43
69.64
68.86
67.97
65.63
64.97
63.84
61.81
50.35
26.35
20.93
20.77
20.74
16.06
41
180
160
140
120
100
80
60
40
20
0
ppm

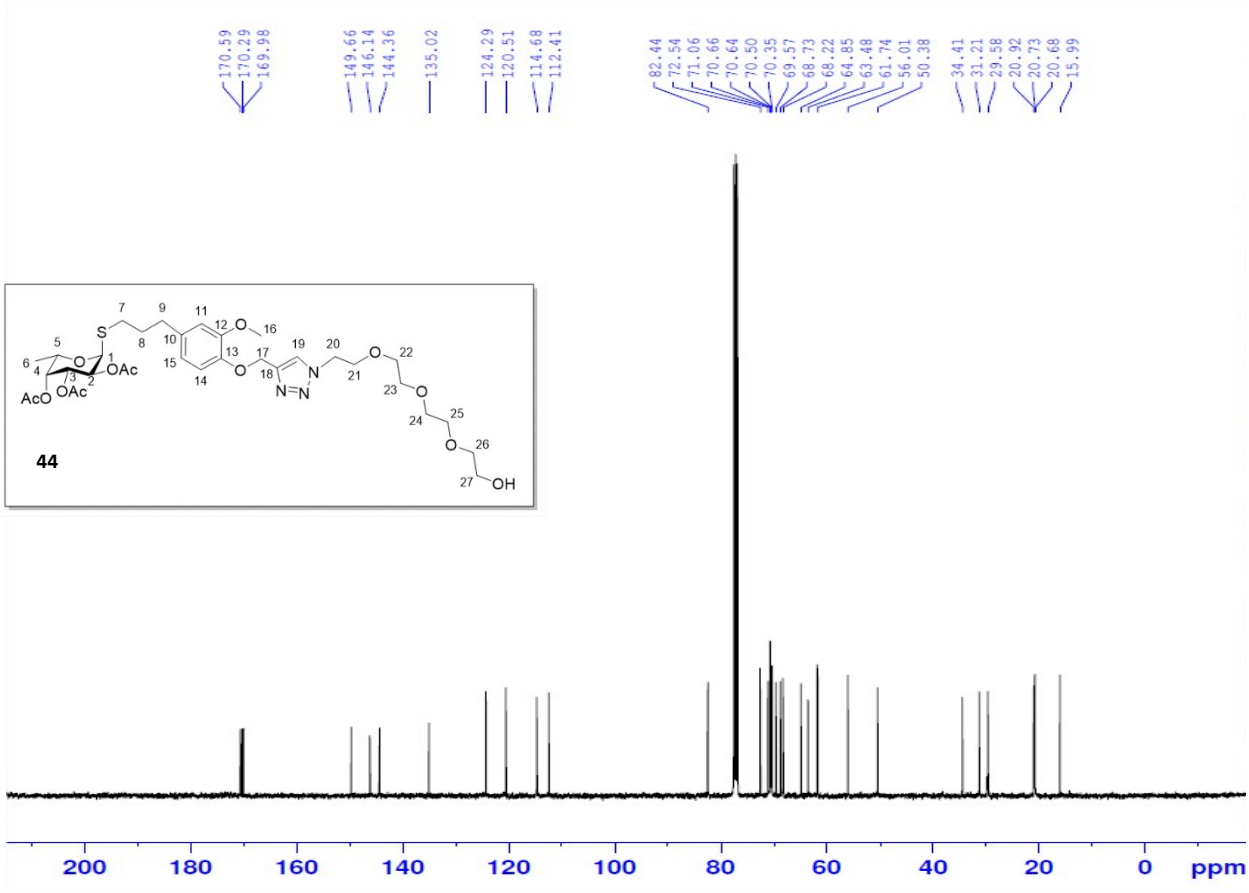

42
7.83
7.20
7.18
6.92
6.90
5.52
5.51
5.29
5.27
5.27
5.27
5.23
5.21
5.21
5.20
5.18
4.56
4.55
4.53
4.46
4.44
4.43
4.41
3.89
3.87
3.86
3.69
3.68
3.66
3.64
3.64
3.63
3.63
3.63
3.60
3.59
3.59
3.59
3.58
3.58
3.57
3.56
2.14
1.99
1.96
1.10
1.09
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.01
2.03
0.95
3.01
2.15
1.98
0.99
2.01
14.32
2.96
2.93
3.13
2.87

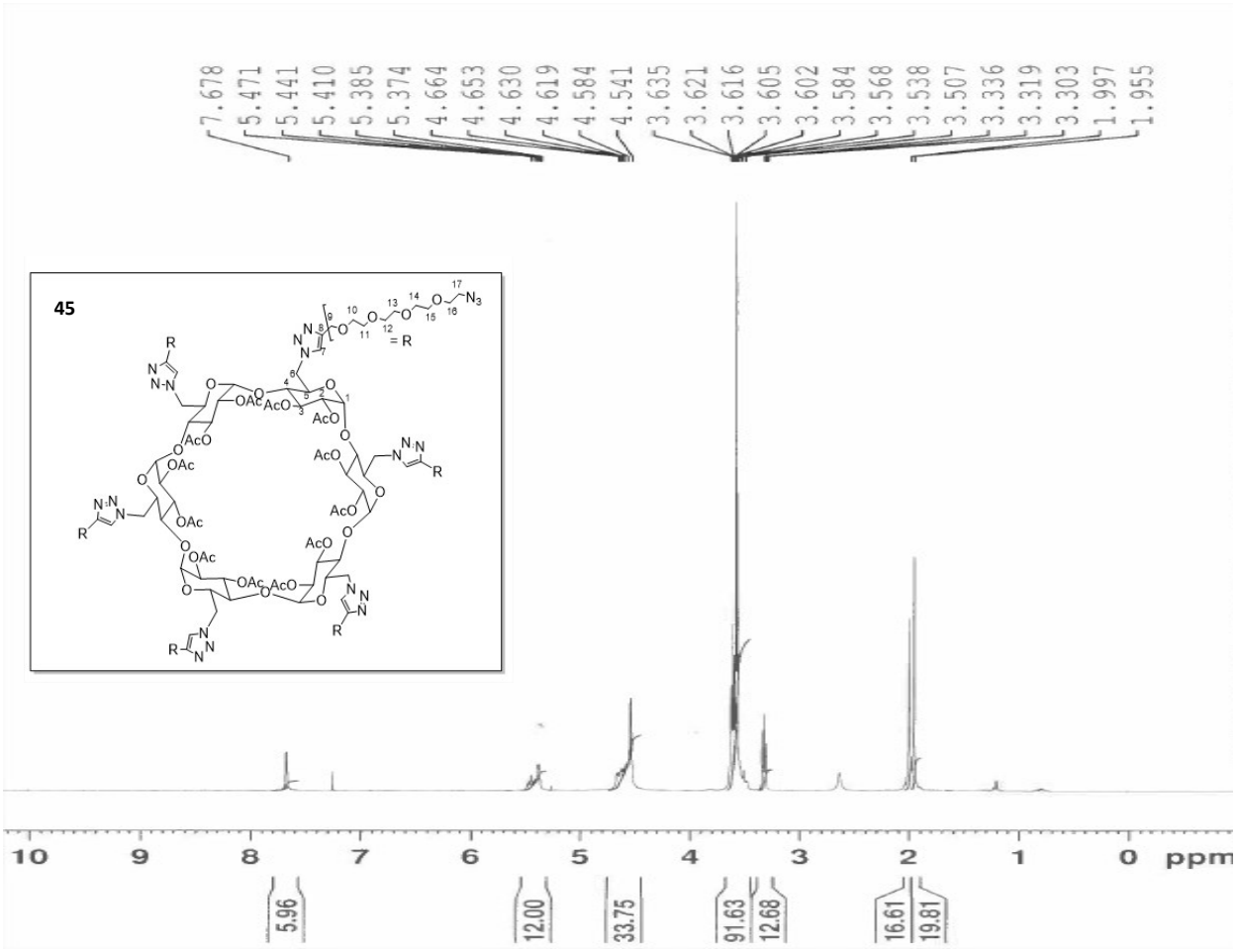

42
170.63
170.10
170.01
157.61
144.03
130.27
130.14
124.22
115.00
81.64
72.59
71.12
70.69
70.65
70.55
70.40
69.59
68.93
67.91
65.06
62.26
61.79
50.45
33.59
20.88
20.76
20.73
15.99
200
180
160
140
120
100
80
60
40
20
0
ppm

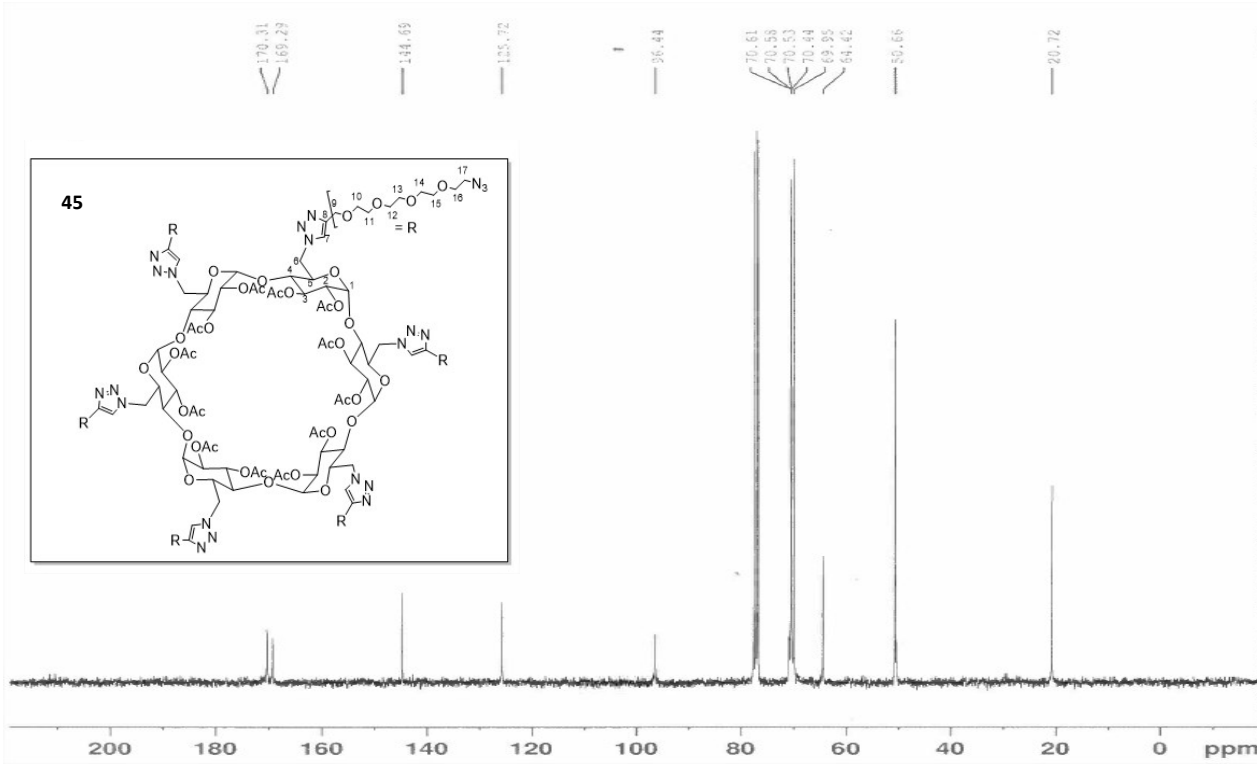

43
7.85
7.09
7.07
6.92
6.90
5.68
5.67
5.27
5.27
5.26
5.25
5.23
5.22
5.20
5.19
5.17
5.16
4.55
4.54
4.53
4.43
4.42
3.88
3.87
3.86
3.70
3.69
3.67
3.66
3.66
3.64
3.64
3.63
3.62
3.62
3.59
3.58
3.58
3.57
3.56
3.55
2.83
2.82
2.82
2.79
2.77
2.76
2.74
2.74
2.73
2.71
2.70
2.69
2.68
2.67
2.65
2.64
2.15
10
9
8
7
6
5
4
3
2
1
0
ppm
0.95
2.01
2.00
1.00
2.86
2.01
1.97
1.09
2.01
2.14
2.22
7.84
4.81
3.04
3.02
3.21
3.03

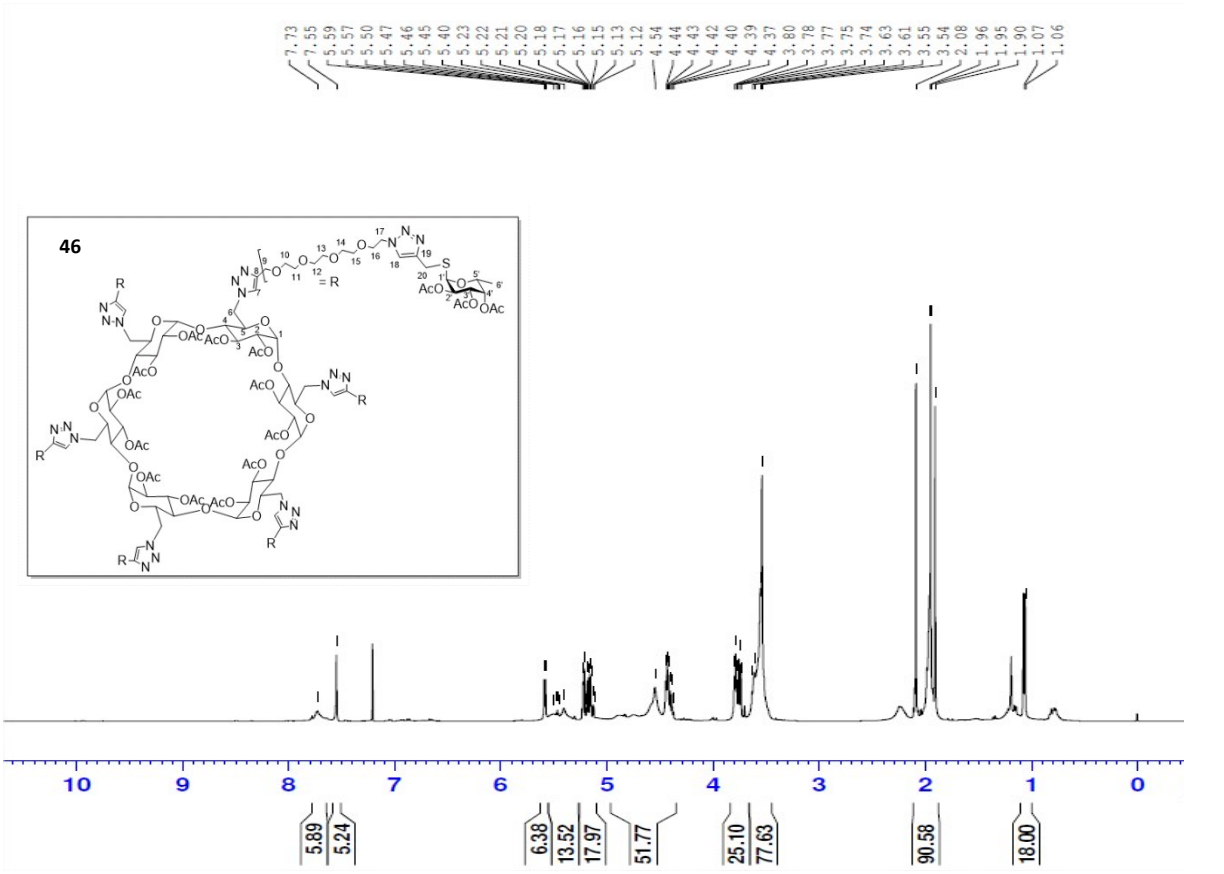

170.60
170.30
169.97
157.09
145.73
132.95
129.60
124.33
114.96
82.33
72.54
71.07
70.66
70.62
70.51
70.36
69.57
68.72
68.17
64.86
62.23
61.75
50.45
35.23
31.69
20.94
20.74
20.70
16.02
43
200
180
160
140
120
100
80
60
40
20
0

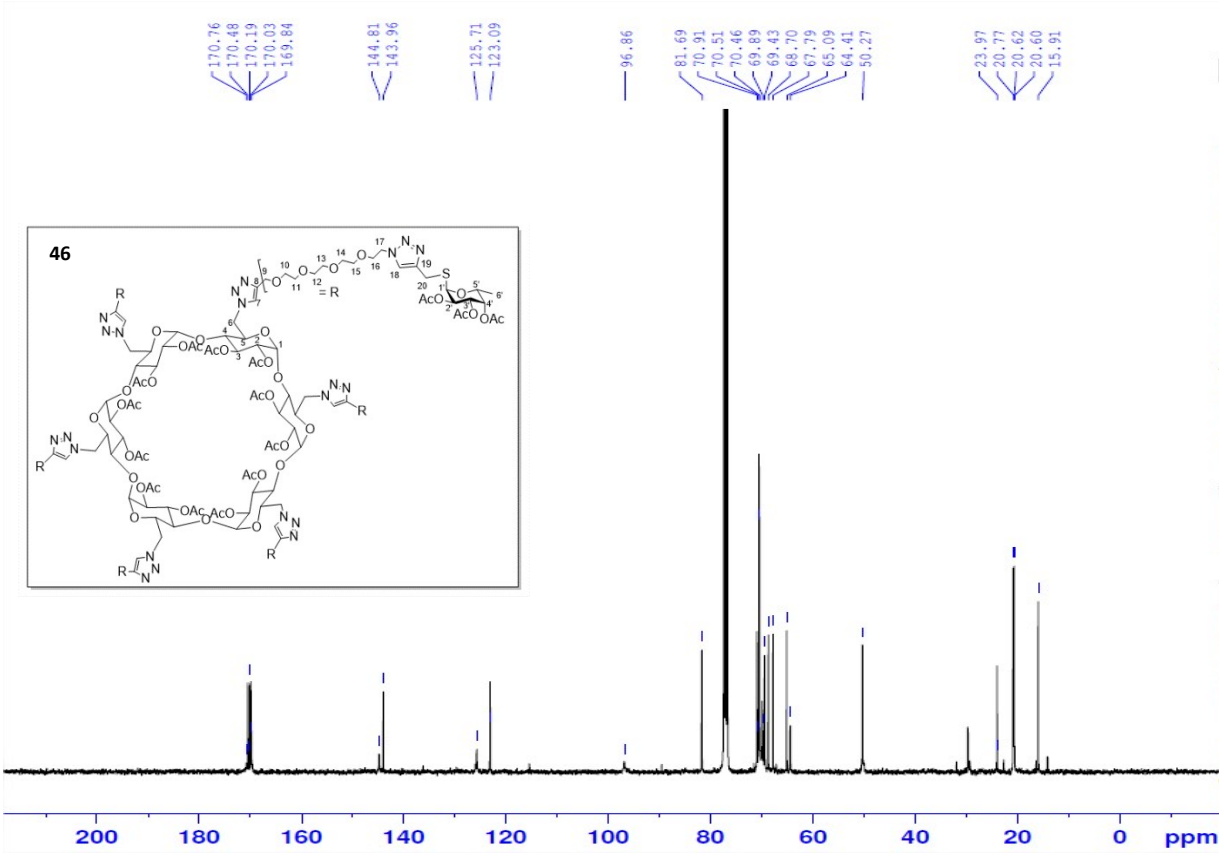

44
ppm

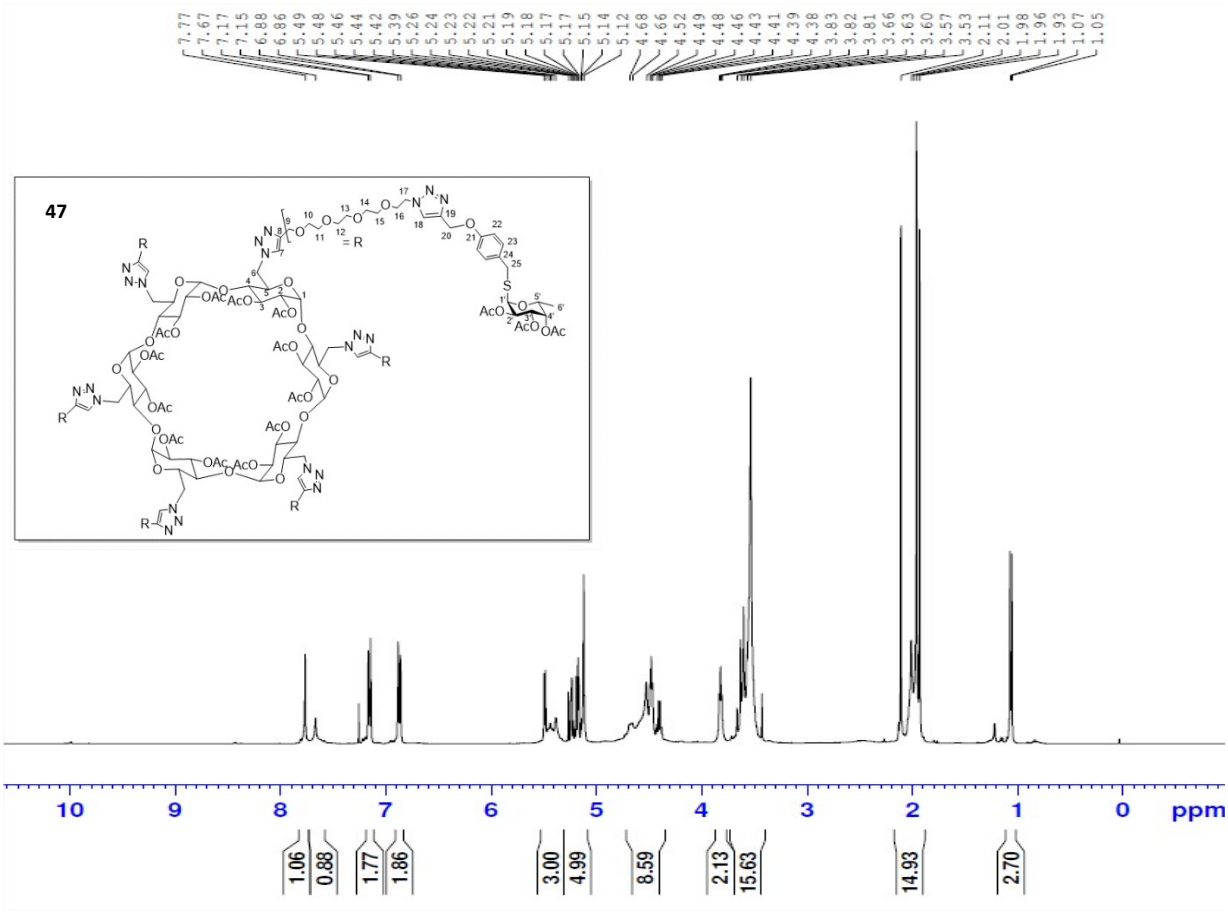

44
ppm

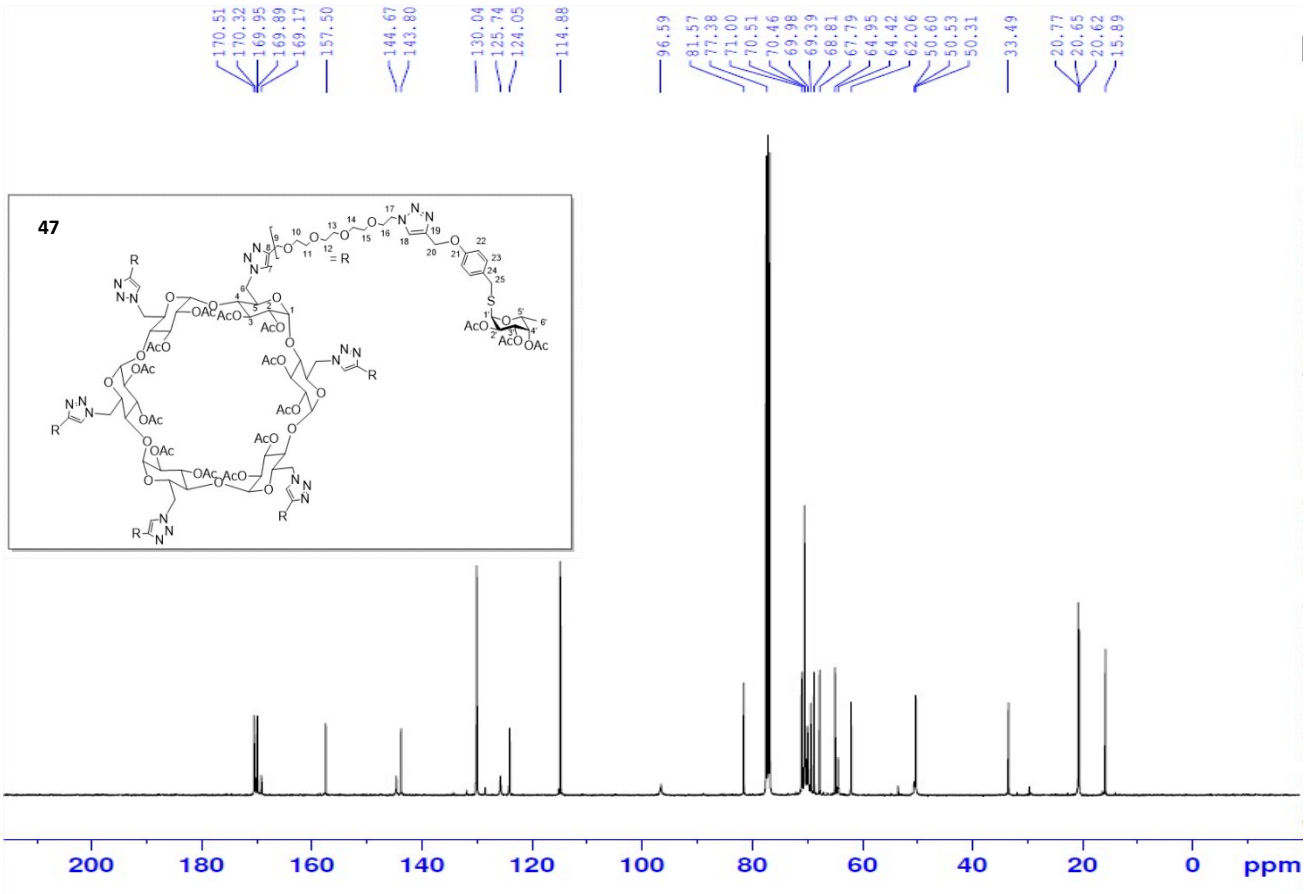

7.678
5.471
5.441
5.410
5.385
5.374
4.664
4.653
4.630
4.619
4.584
4.541
3.635
3.621
3.616
3.605
3.602
3.584
3.568
3.538
3.507
3.336
3.319
3.303
1.997
1.955
45
10 9 8 7 6 5 4 3 2 1 0 ppm
5.96
12.00
33.75
91.63
12.68
16.61
19.81

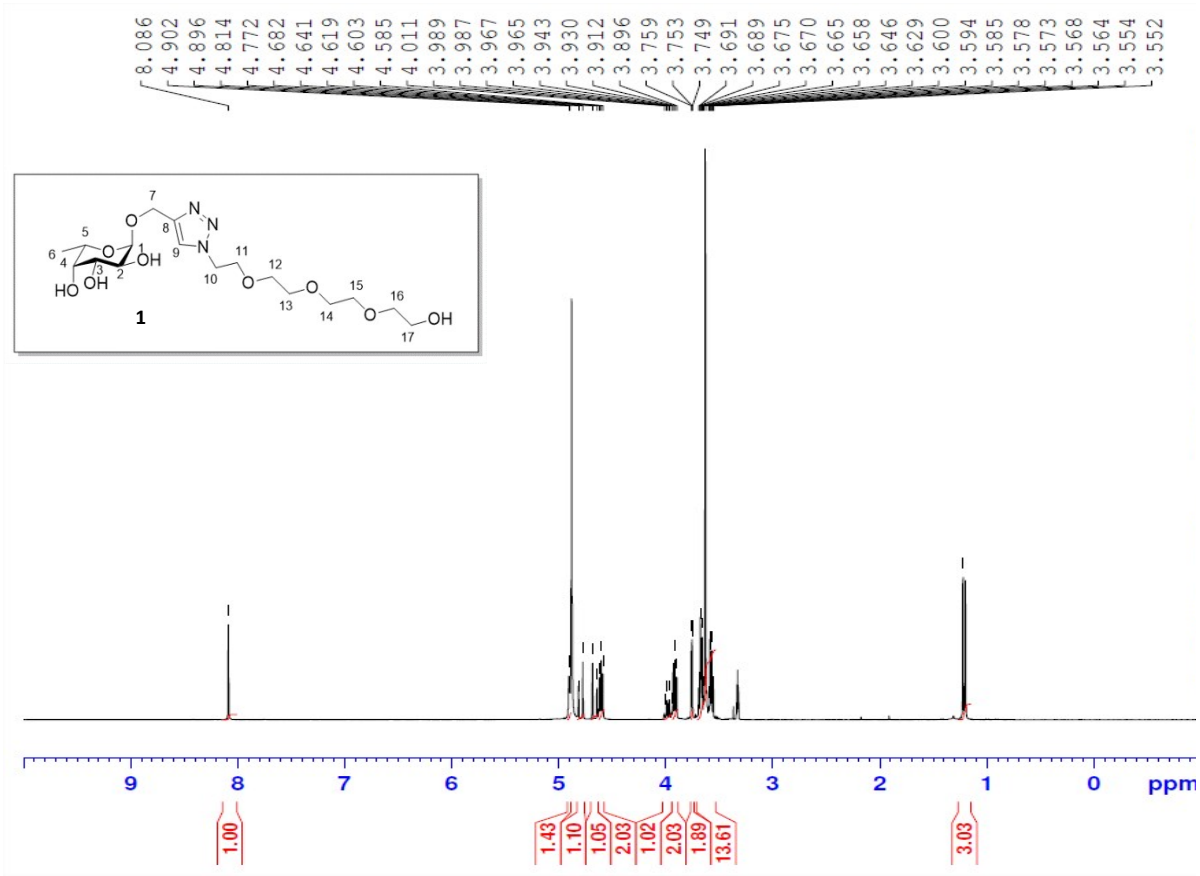

170.31
169.29
144.69
125.72
96.44
70.61
70.56
70.53
70.44
69.95
64.42
50.66
20.72
45
200 180 160 140 120 100 80 60 40 20 0 ppm

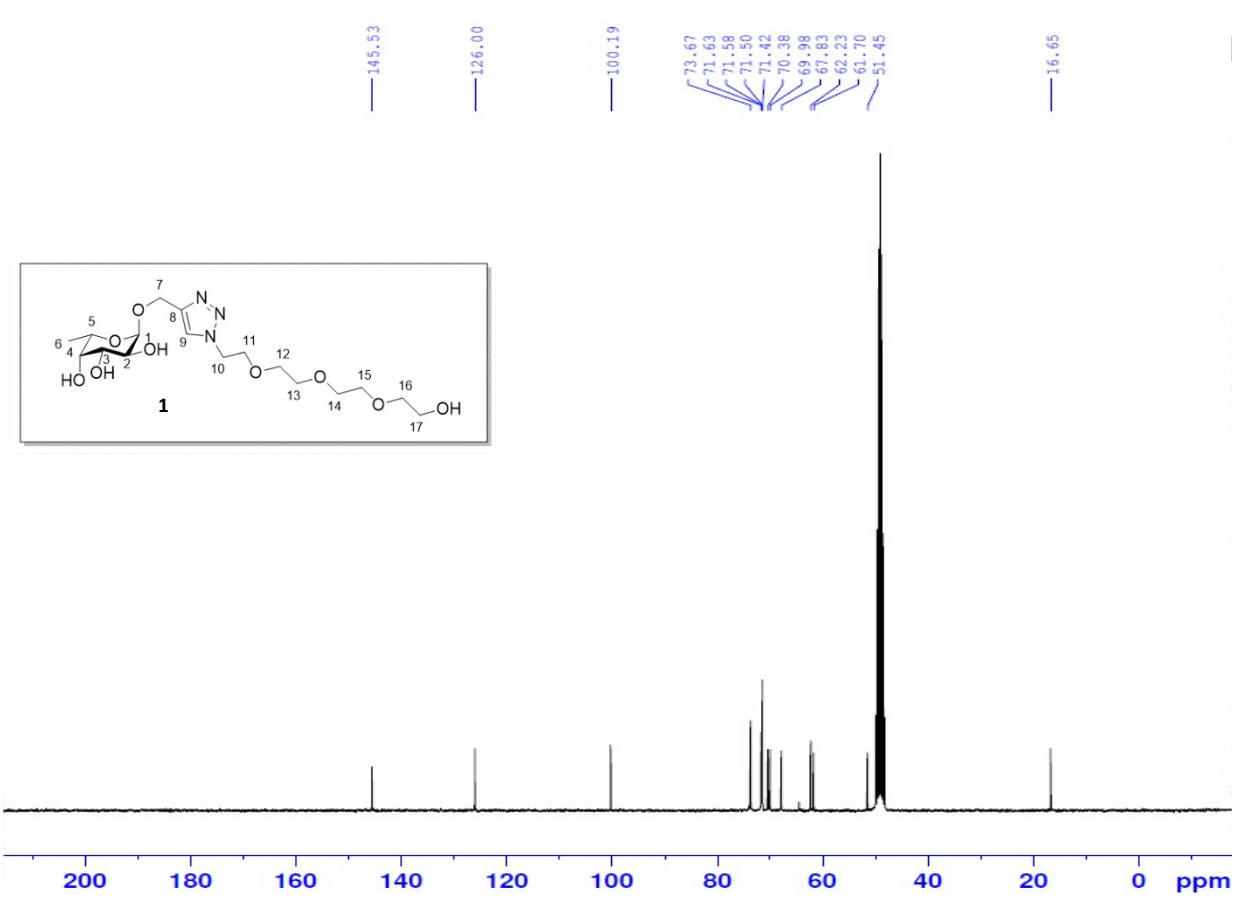

7.73
7.55
5.59
5.57
5.50
5.47
5.46
5.45
5.40
5.23
5.22
5.21
5.20
5.18
5.17
5.16
5.15
5.13
5.12
4.54
4.44
4.43
4.42
4.40
4.39
4.37
3.80
3.78
3.77
3.75
3.74
3.63
3.61
3.55
3.54
2.08
1.96
1.95
1.90
1.07
1.06
46
= R
10
9
8
7
6
5
4
3
2
1
0
5.89
5.24
6.38
13.52
17.97
51.77
25.10
77.63
90.58
18.00

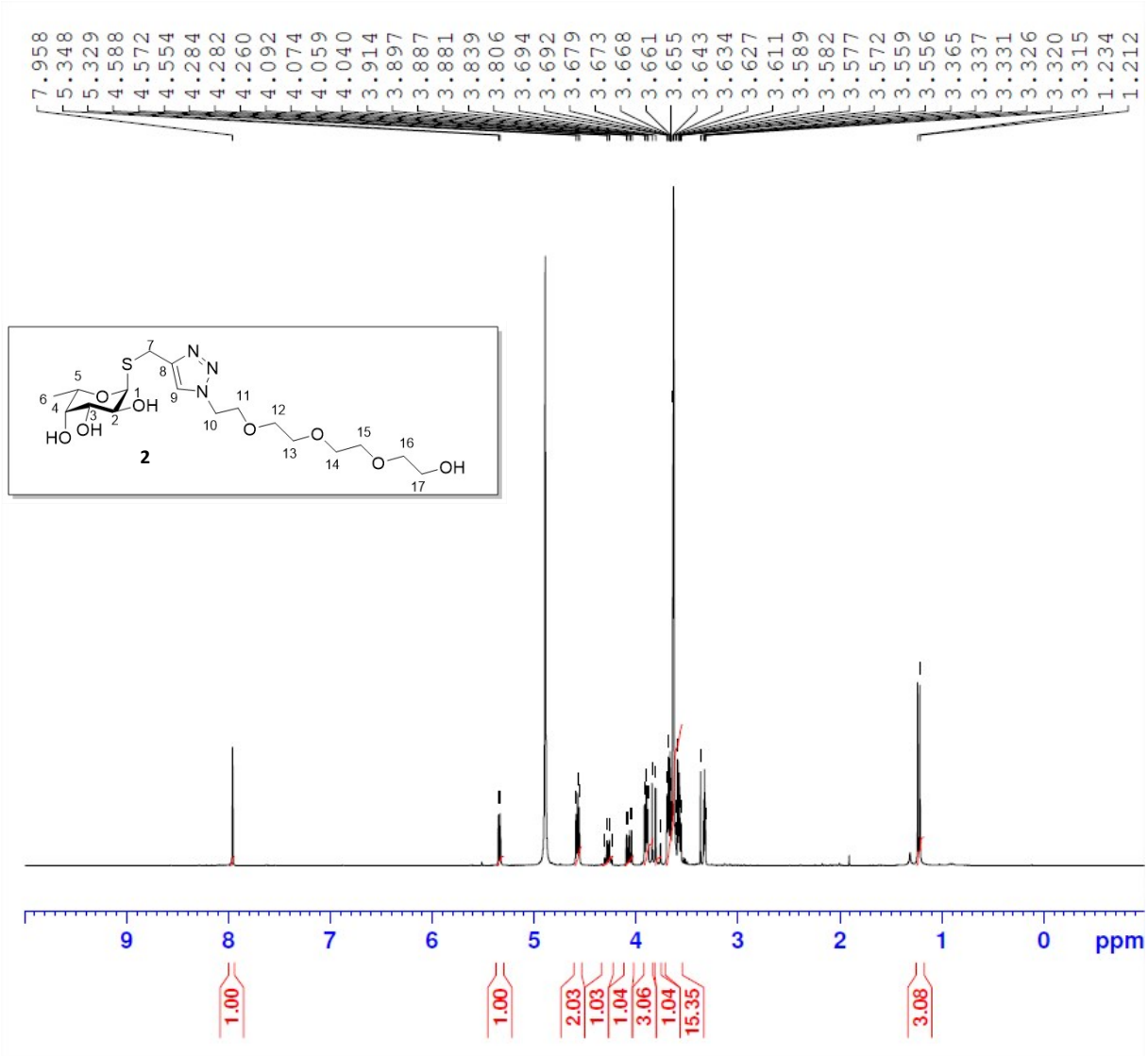

170.76
170.48
170.19
170.03
169.84
144.81
143.96
125.71
123.09
96.86
81.69
70.91
70.51
70.46
69.89
69.43
68.70
67.79
65.09
64.41
50.27
23.97
20.77
20.62
20.60
15.91
46
= R
200
180
160
140
120
100
80
60
40
20
0
ppm

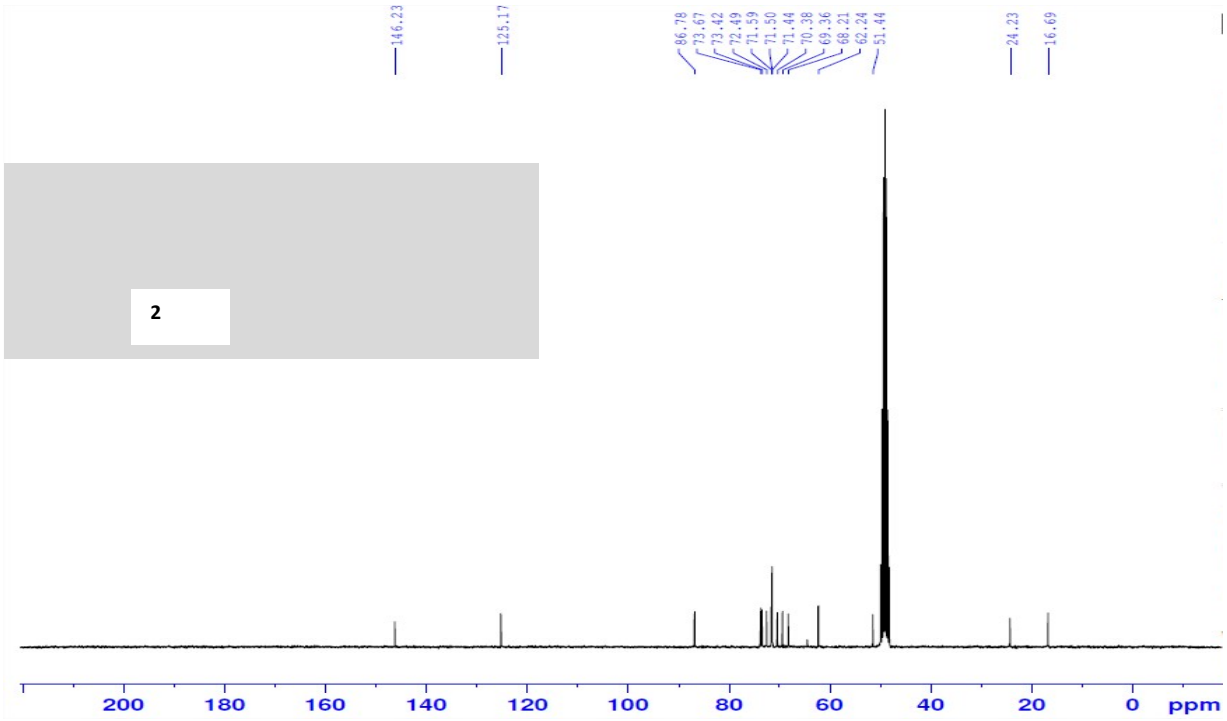

47
7.77
7.67
7.17
7.15
6.88
6.86
5.49
5.48
5.46
5.44
5.42
5.39
5.26
5.24
5.23
5.22
5.21
5.19
5.18
5.17
5.17
5.15
5.14
5.12
4.68
4.66
4.52
4.49
4.48
4.46
4.43
4.41
4.39
4.38
3.83
3.82
3.81
3.66
3.63
3.60
3.57
3.53
2.11
2.01
1.98
1.96
1.93
1.07
1.05
10
9
8
7
6
5
4
3
2
1
0
ppm
1.06
0.88
1.77
1.86
3.00
4.99
8.59
2.13
15.63
14.93
2.70

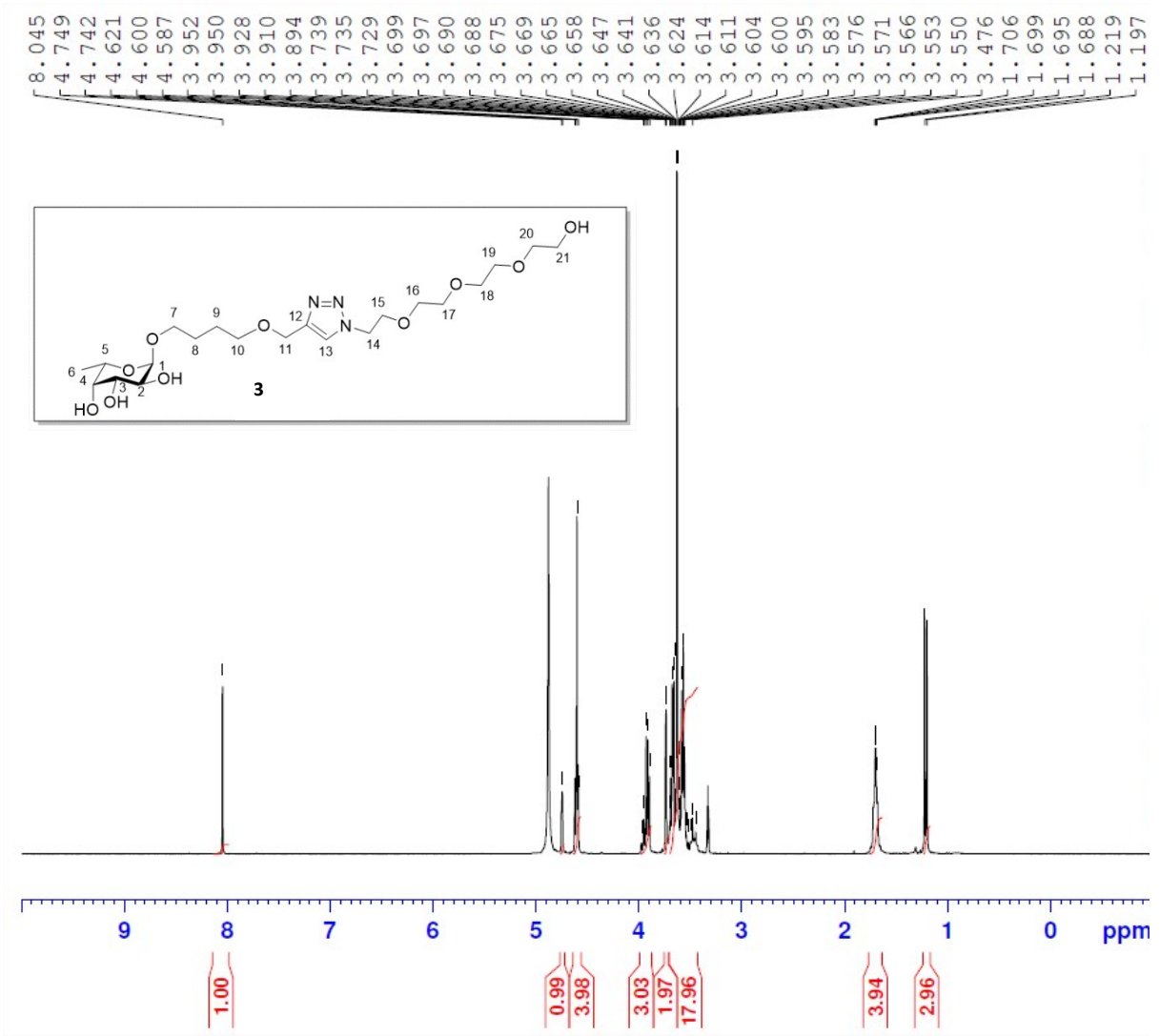

47
170.51
170.32
169.95
169.89
169.17
157.50
144.67
143.80
130.04
125.74
124.05
114.88
96.59
81.57
77.38
71.00
70.51
70.46
69.98
69.39
68.81
67.79
64.95
64.42
62.06
50.60
50.53
50.31
33.49
20.77
20.65
20.62
15.89
200
180
160
140
120
100
80
60
40
20
0
ppm

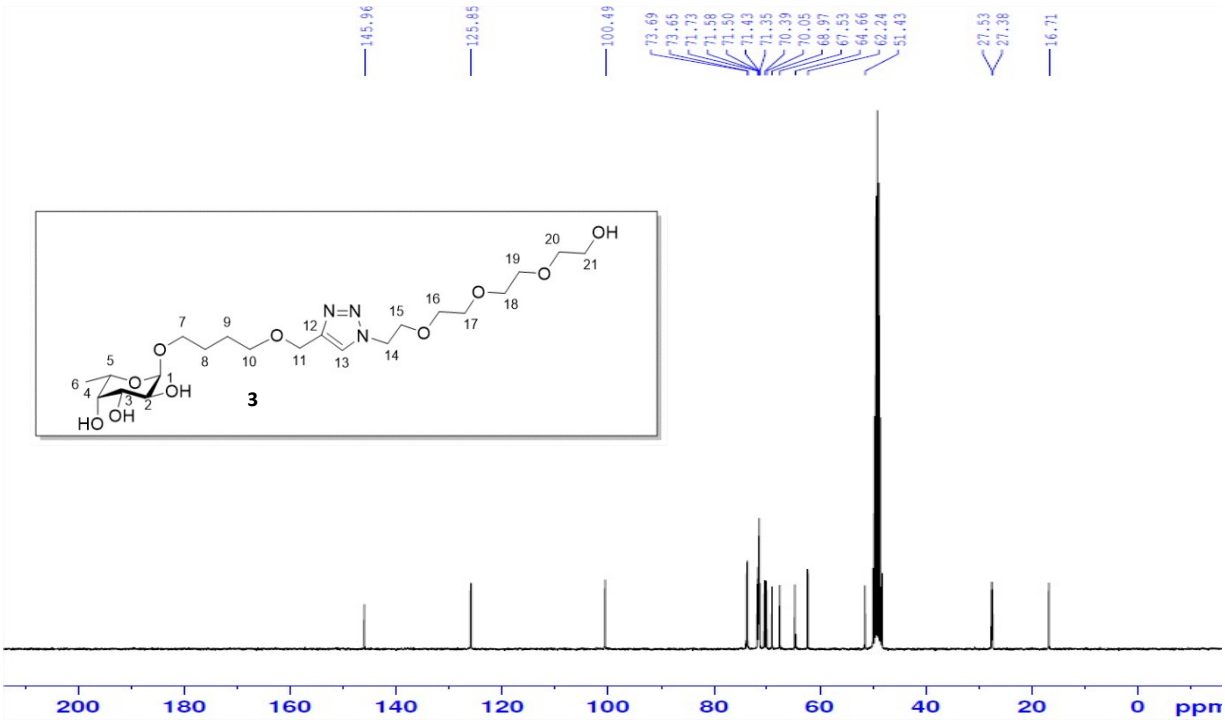

8.086
4.902
4.896
4.814
4.772
4.682
4.641
4.619
4.603
4.585
4.011
3.989
3.987
3.967
3.965
3.943
3.930
3.912
3.896
3.759
3.753
3.749
3.691
3.689
3.675
3.670
3.665
3.658
3.646
3.629
3.600
3.594
3.585
3.578
3.573
3.568
3.564
3.554
3.552
1
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.43
1.10
1.05
2.03
1.02
2.03
1.89
13.61
3.03

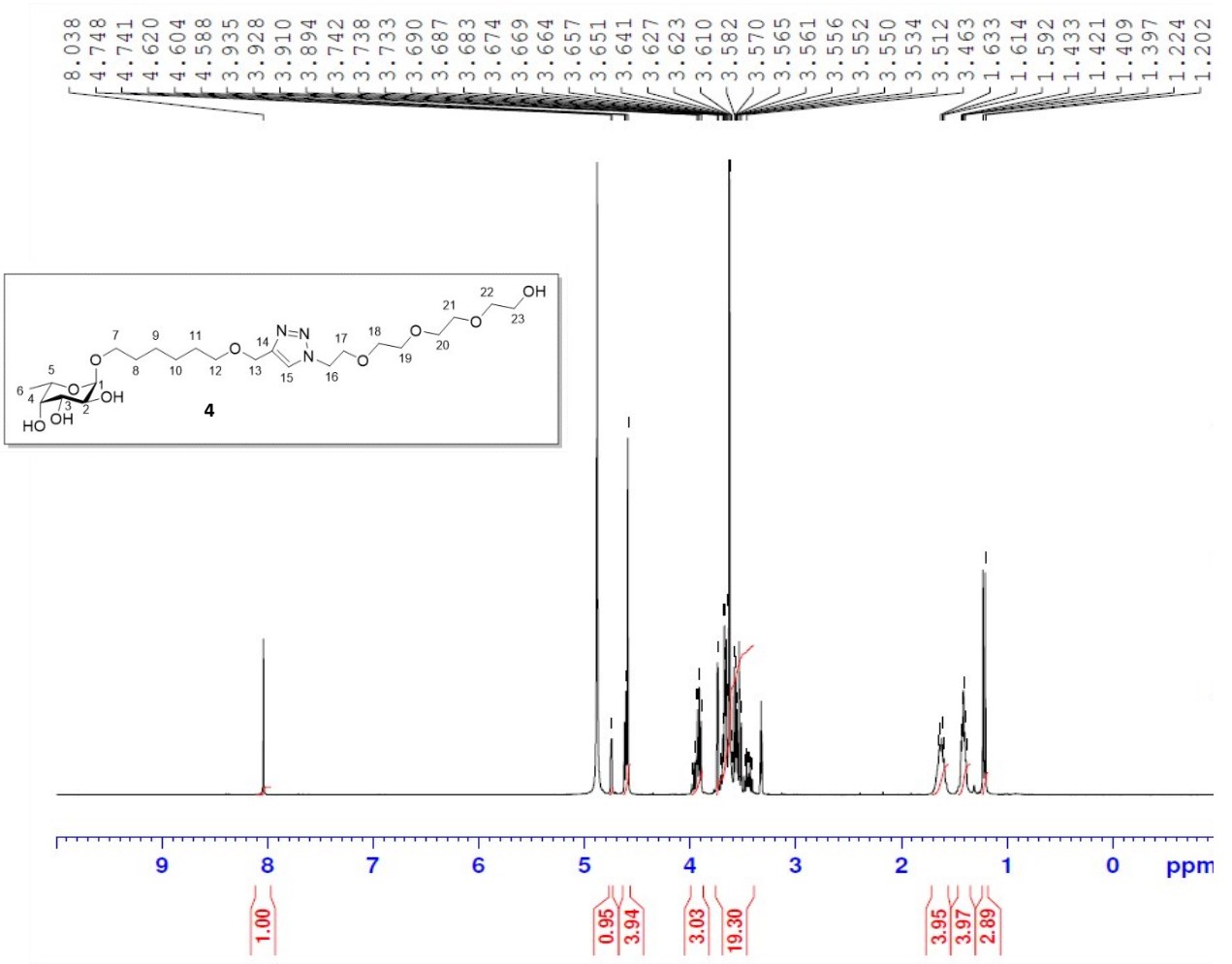

145.53
126.00
100.19
73.67
71.63
71.58
71.50
71.42
70.38
69.98
67.83
62.23
61.70
51.45
16.65
1
200
180
160
140
120
100
80
60
40
20
0
ppm

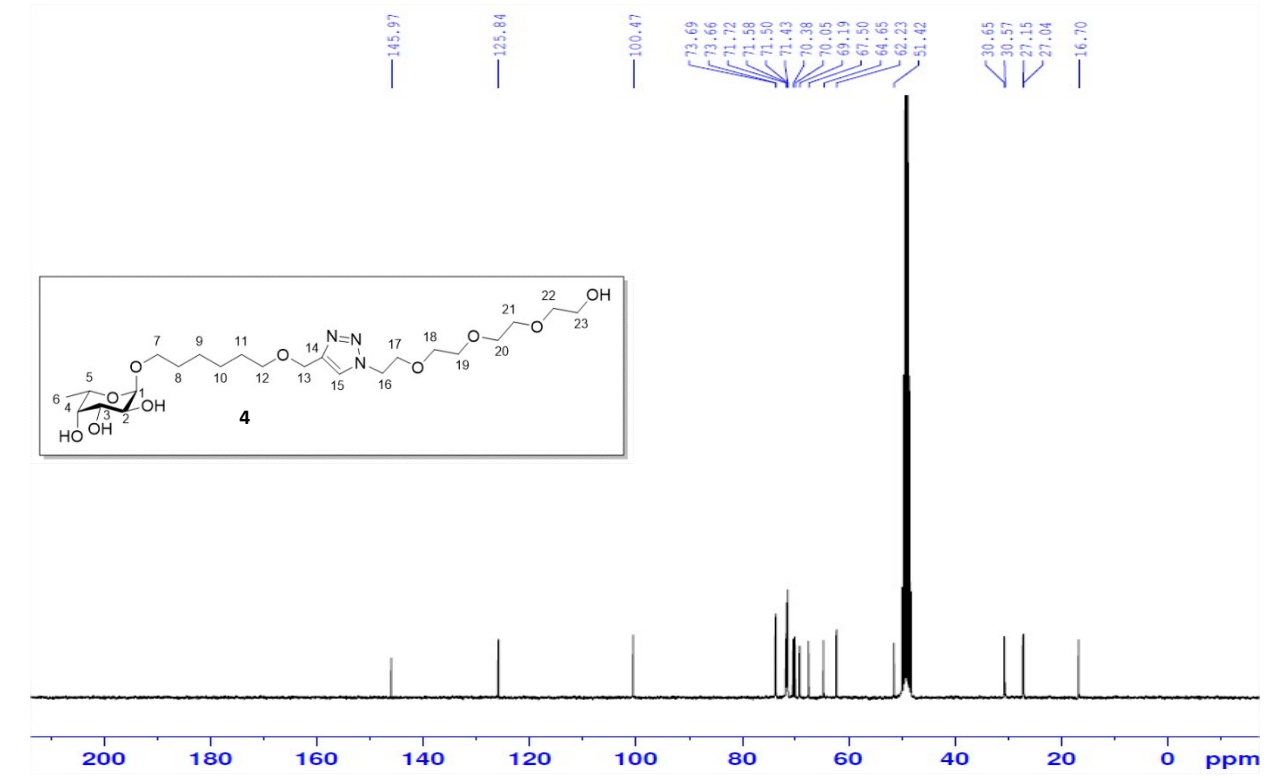

7.958
5.348
5.329
4.588
4.572
4.554
4.284
4.282
4.260
4.092
4.074
4.059
4.040
3.914
3.897
3.887
3.881
3.839
3.806
3.694
3.692
3.679
3.673
3.668
3.661
3.655
3.643
3.634
3.627
3.611
3.589
3.582
3.577
3.572
3.559
3.556
3.365
3.337
3.331
3.326
3.320
3.315
1.234
1.212
2
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.00
2.03
1.03
1.04
3.06
1.04
15.35
3.08

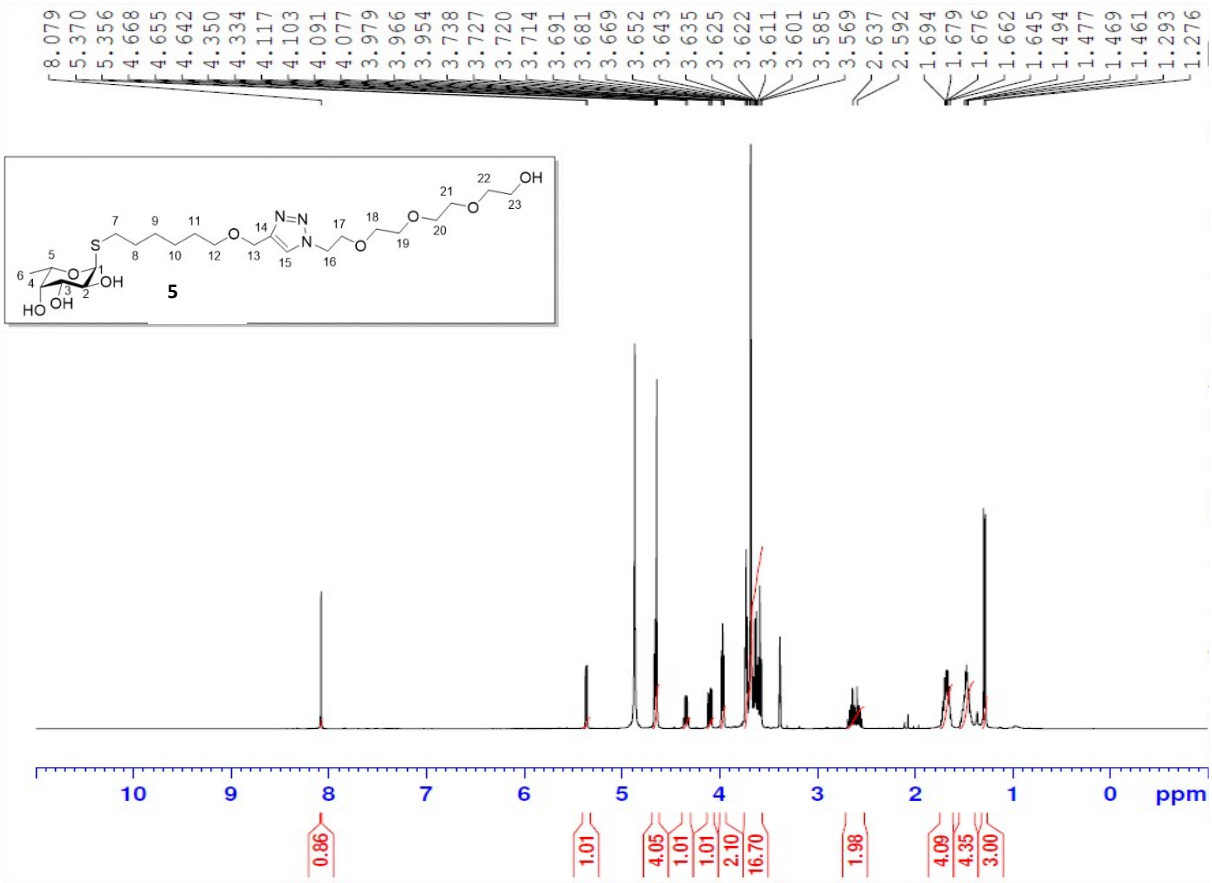

146.23
125.17
86.78
73.67
73.42
72.49
71.59
71.50
71.44
70.38
69.36
68.21
62.24
51.44
24.23
16.69
2
200
180
160
140
120
100
80
60
40
20
0
ppm


8.045
4.749
4.742
4.621
4.600
4.587
3.952
3.950
3.928
3.910
3.894
3.739
3.735
3.729
3.699
3.697
3.690
3.688
3.675
3.669
3.665
3.658
3.647
3.641
3.636
3.624
3.614
3.611
3.604
3.600
3.595
3.583
3.576
3.571
3.566
3.553
3.550
3.476
1.706
1.699
1.695
1.688
1.219
1.197
3
9
8
7
6
5
4
3
2
1
0
ppm
1.00
0.99
3.98
3.03
1.97
17.96
3.94
2.96

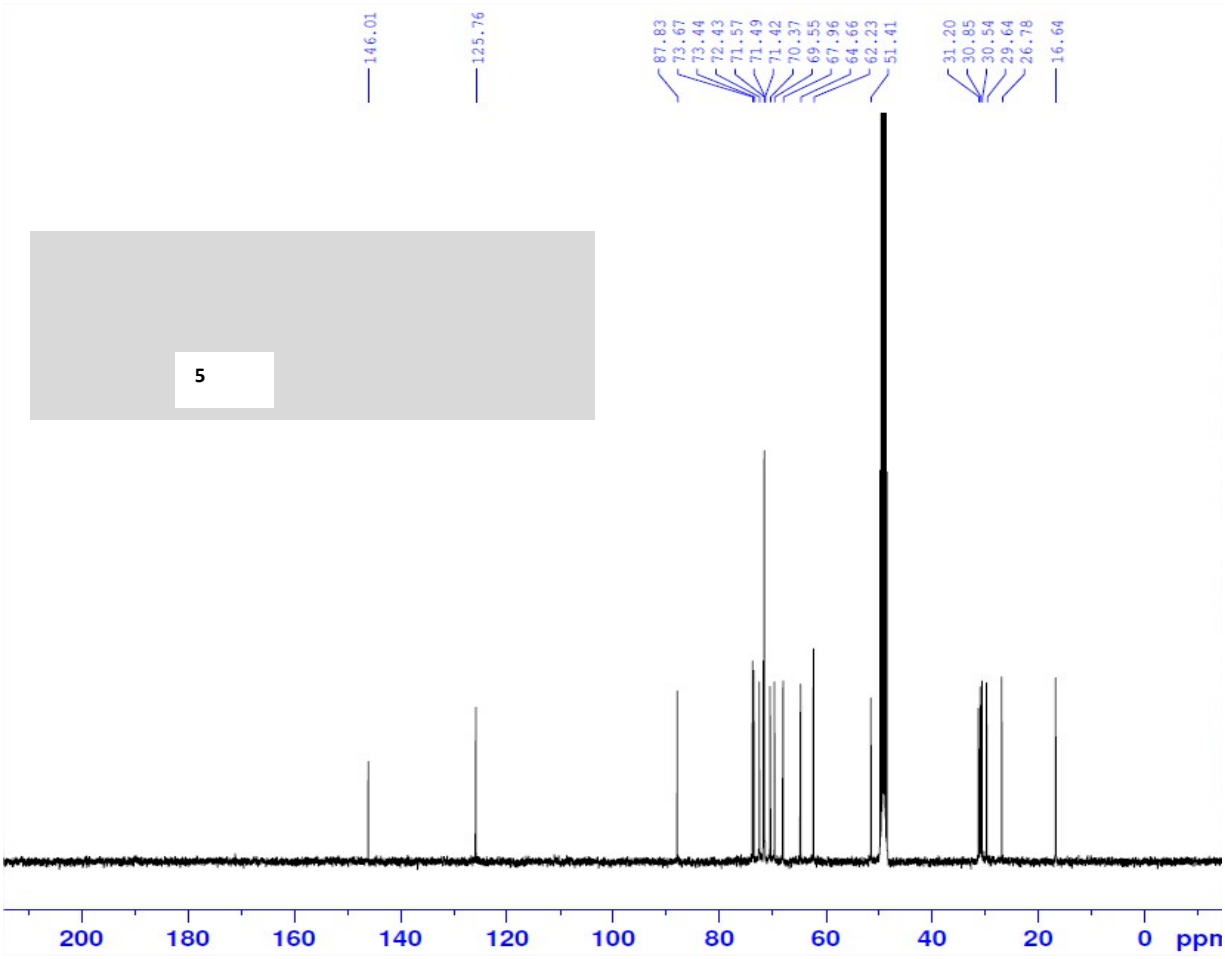

145.96
125.85
100.49
73.69
73.65
71.73
71.58
71.50
71.43
71.35
70.39
70.05
68.97
67.53
64.66
62.24
51.43
27.53
27.38
16.71
3
200
180
160
140
120
100
80
60
40
20
0
ppm

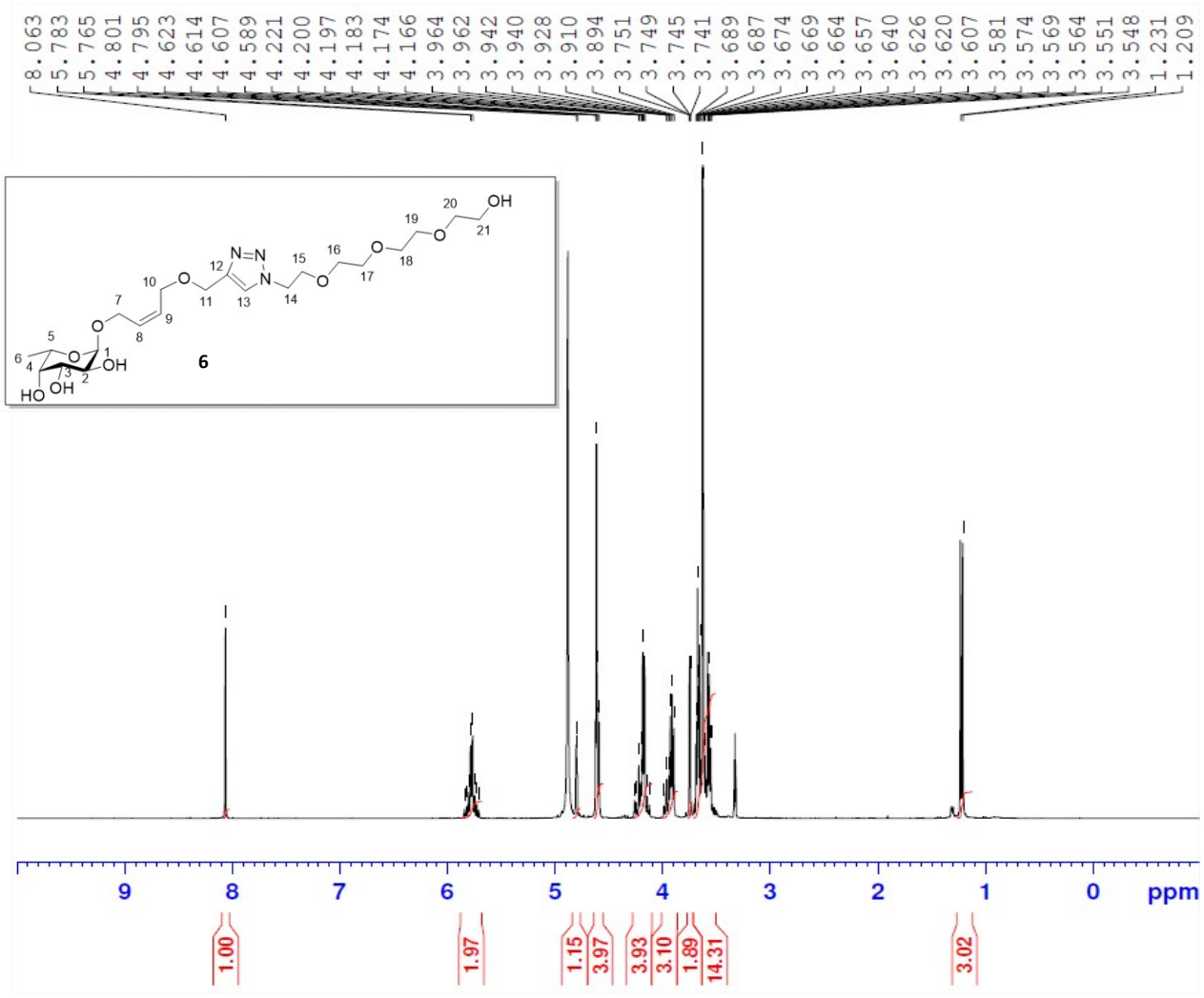

8.038
4.748
4.741
4.620
4.604
4.588
3.935
3.928
3.910
3.894
3.742
3.738
3.733
3.690
3.687
3.683
3.674
3.669
3.664
3.657
3.651
3.641
3.627
3.623
3.610
3.582
3.570
3.565
3.561
3.556
3.552
3.550
3.534
3.512
3.463
1.633
1.614
1.592
1.433
1.421
1.409
1.397
1.224
1.202
4
9
8
7
6
5
4
3
2
1
0
ppm
1.00
0.95
3.94
3.03
19.30
3.95
3.97
2.89

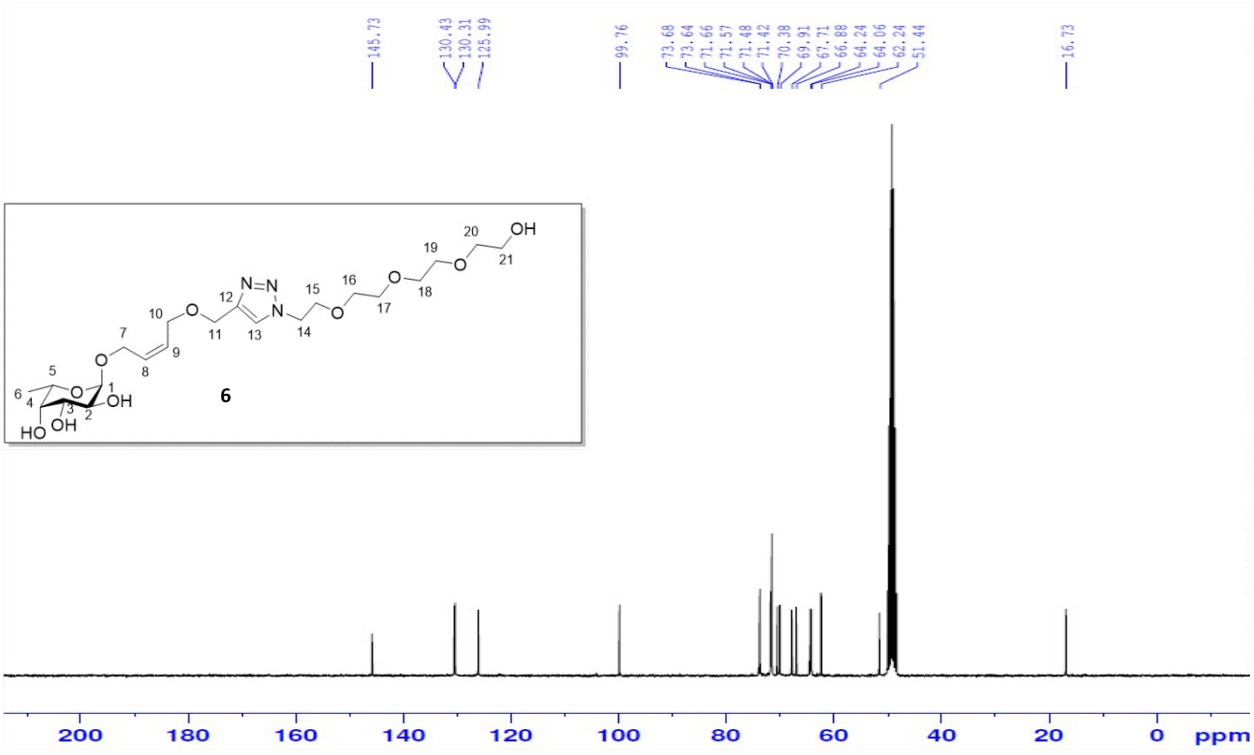

145.97
125.84
100.47
73.69
73.66
71.72
71.58
71.50
71.43
70.38
70.05
69.19
67.50
64.65
62.23
51.42
30.65
30.57
27.15
27.04
16.70
4
200
180
160
140
120
100
80
60
40
20
0
ppm

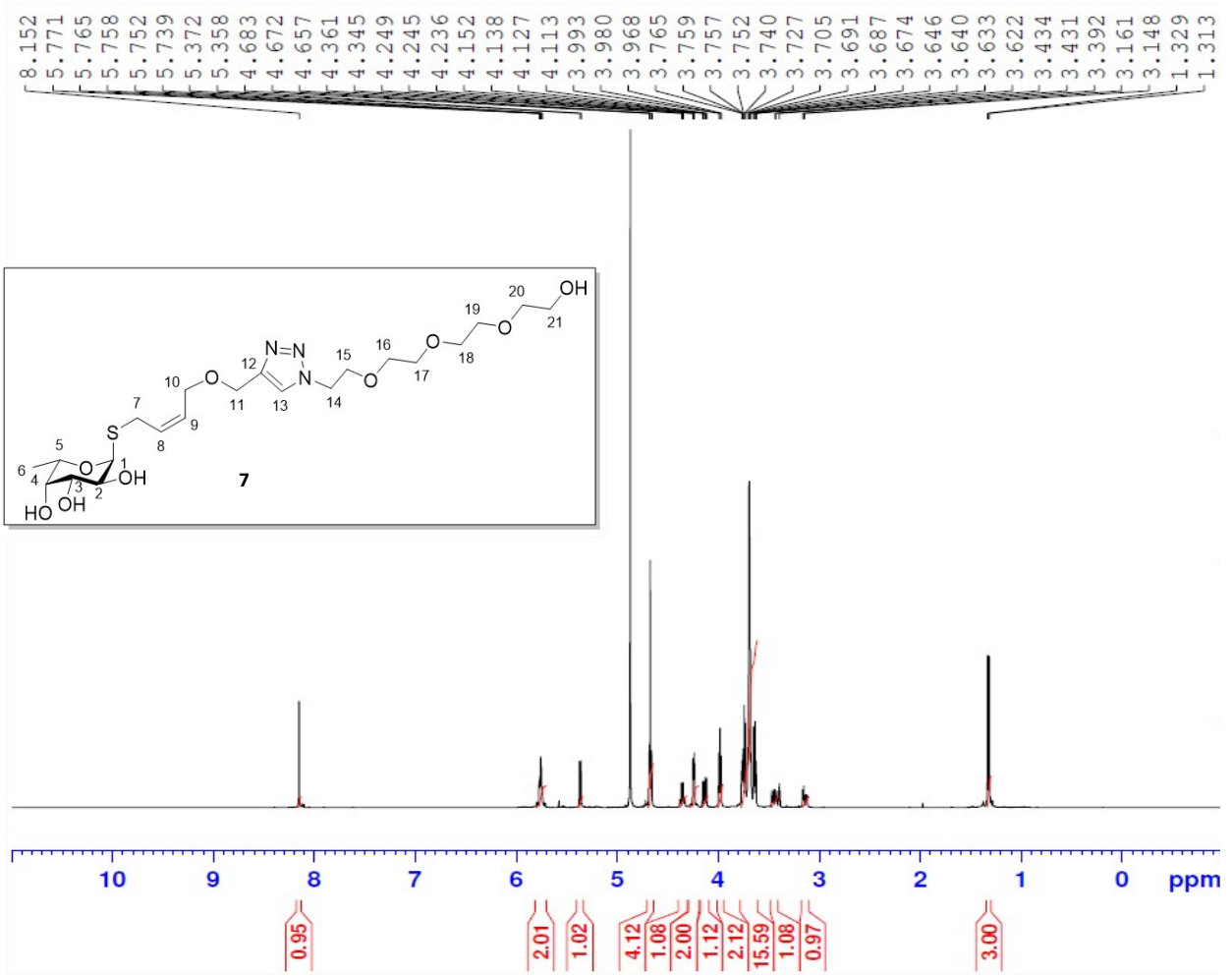

8.079
5.370
5.356
4.668
4.655
4.642
4.350
4.334
4.117
4.103
4.091
4.077
3.979
3.966
3.954
3.738
3.727
3.720
3.714
3.691
3.681
3.669
3.652
3.643
3.635
3.625
3.622
3.611
3.601
3.585
3.569
2.637
2.592
1.694
1.679
1.676
1.662
1.645
1.494
1.477
1.469
1.461
1.293
1.276
5
10 9 8 7 6 5 4 3 2 1 0 ppm
0.86
1.01
4.05
1.01
1.01
2.10
16.70
1.98
4.09
4.35
3.00

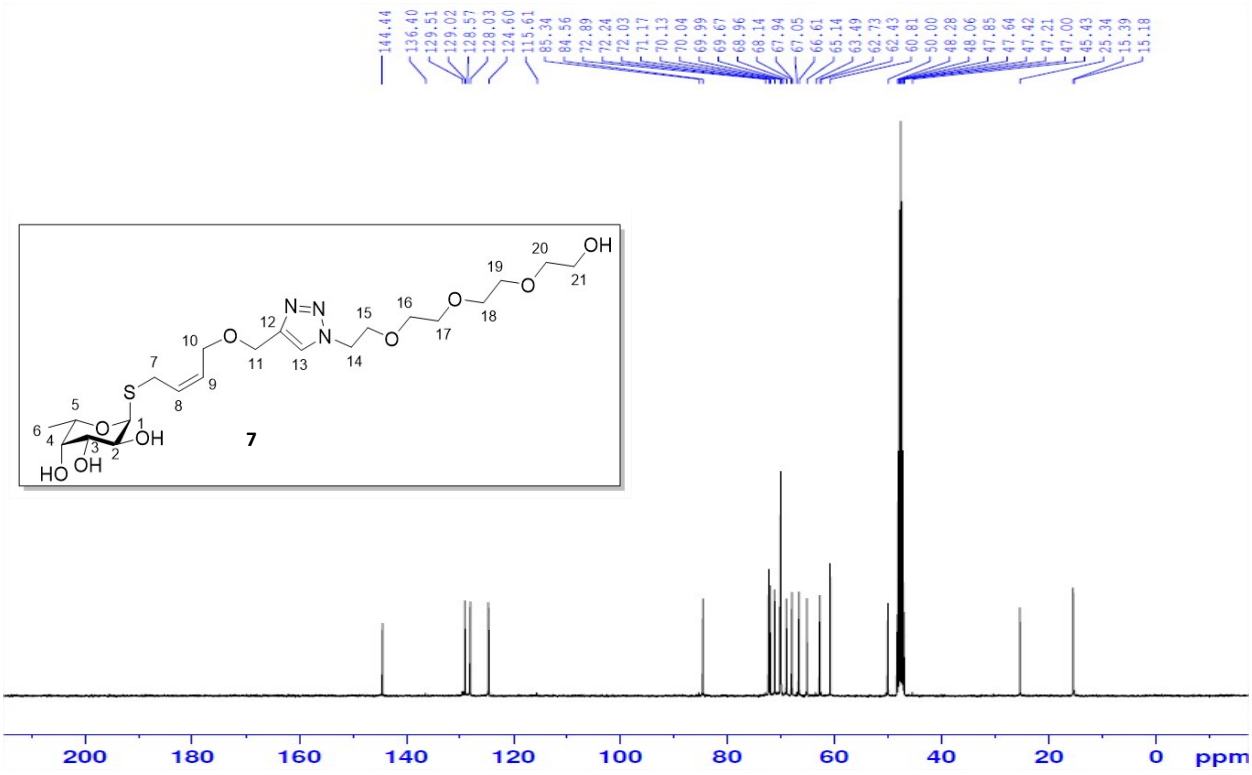
5

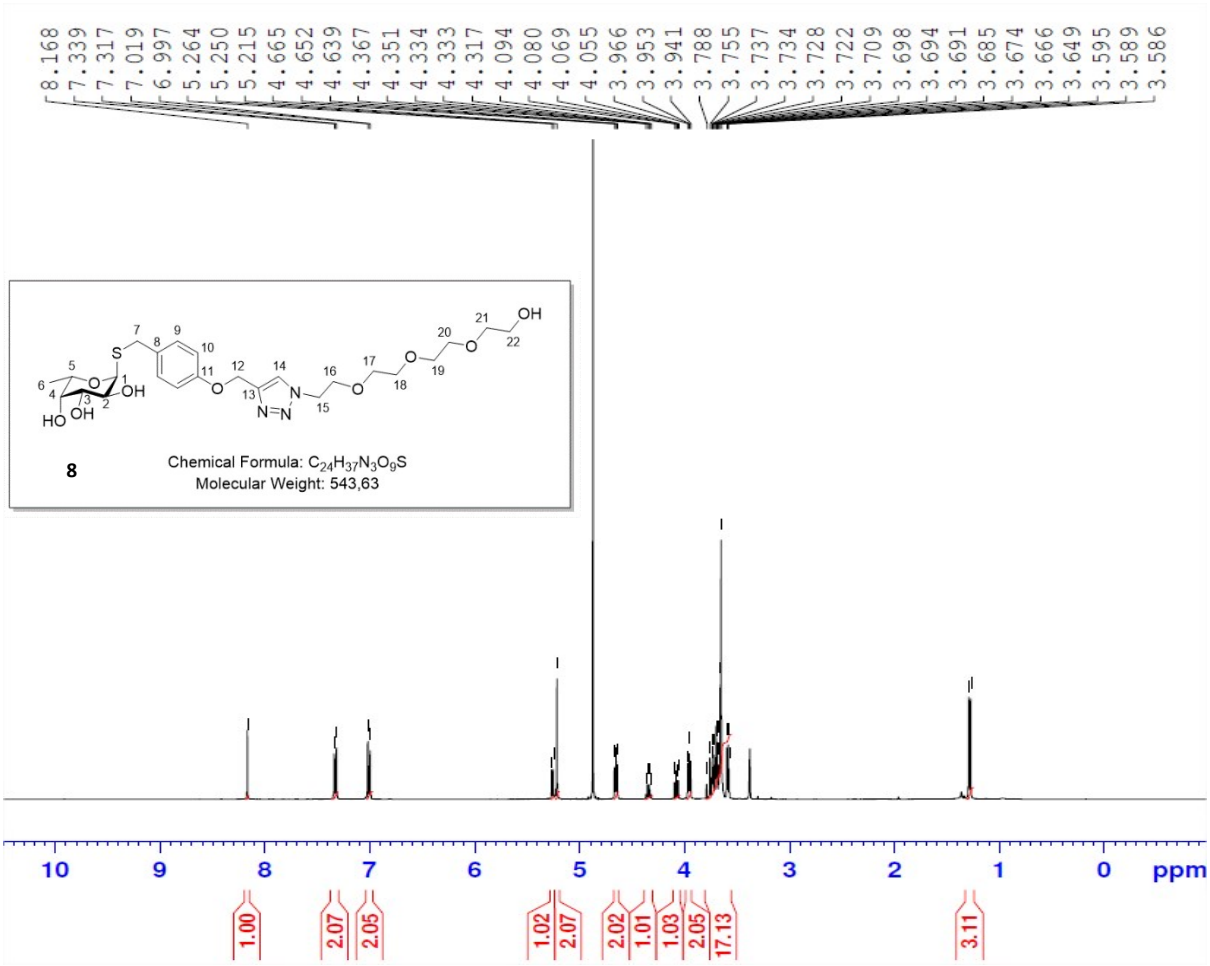

146.01
125.76
87.83
73.67
73.44
72.43
71.57
71.49
71.42
70.37
69.55
67.96
64.66
62.23
51.41
31.20
30.85
30.54
29.64
26.78
16.64
5
200
180
160
140
120
100
80
60
40
20
0
ppm

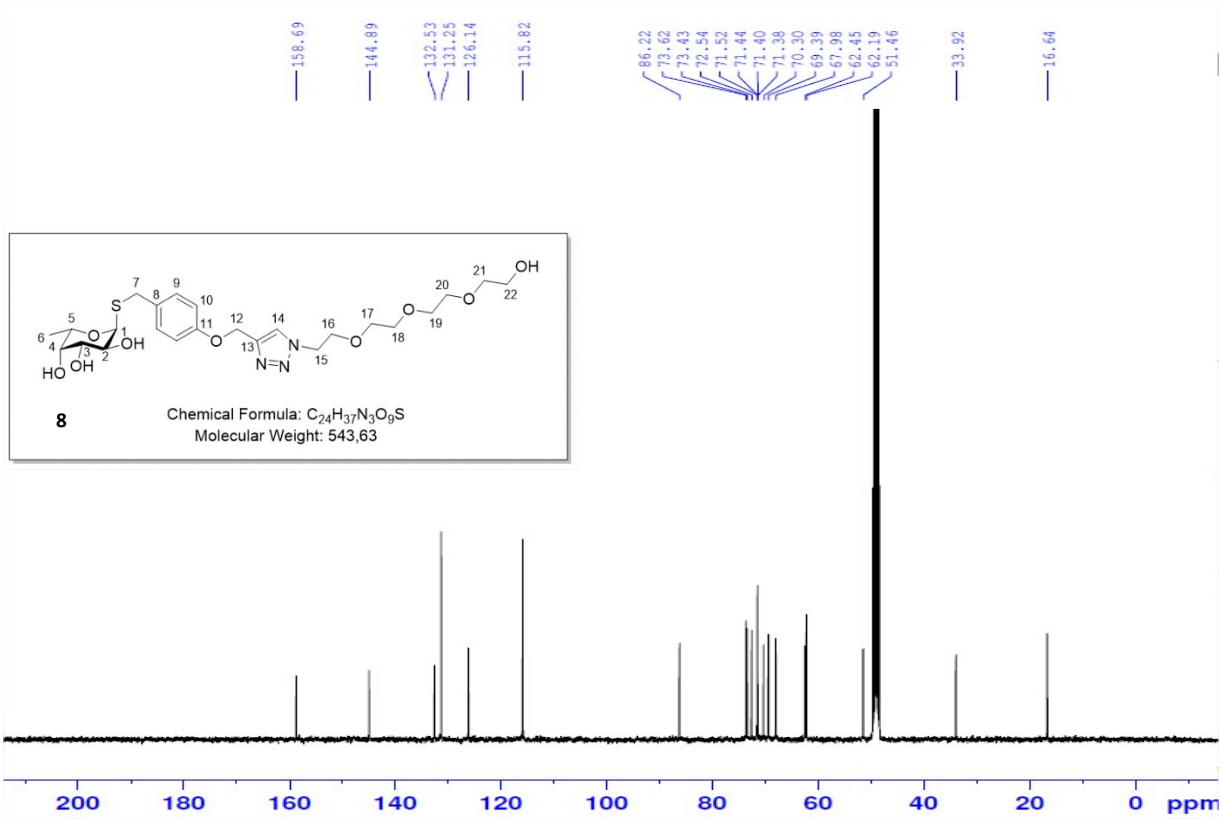

8.063
5.783
5.765
4.801
4.795
4.623
4.614
4.607
4.589
4.221
4.200
4.197
4.183
4.174
4.166
3.964
3.962
3.942
3.940
3.928
3.910
3.894
3.751
3.749
3.745
3.741
3.689
3.687
3.674
3.669
3.664
3.657
3.640
3.626
3.620
3.607
3.581
3.574
3.569
3.564
3.551
3.548
1.231
1.209
6
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.97
1.15
3.97
3.93
3.10
1.89
14.31
3.02

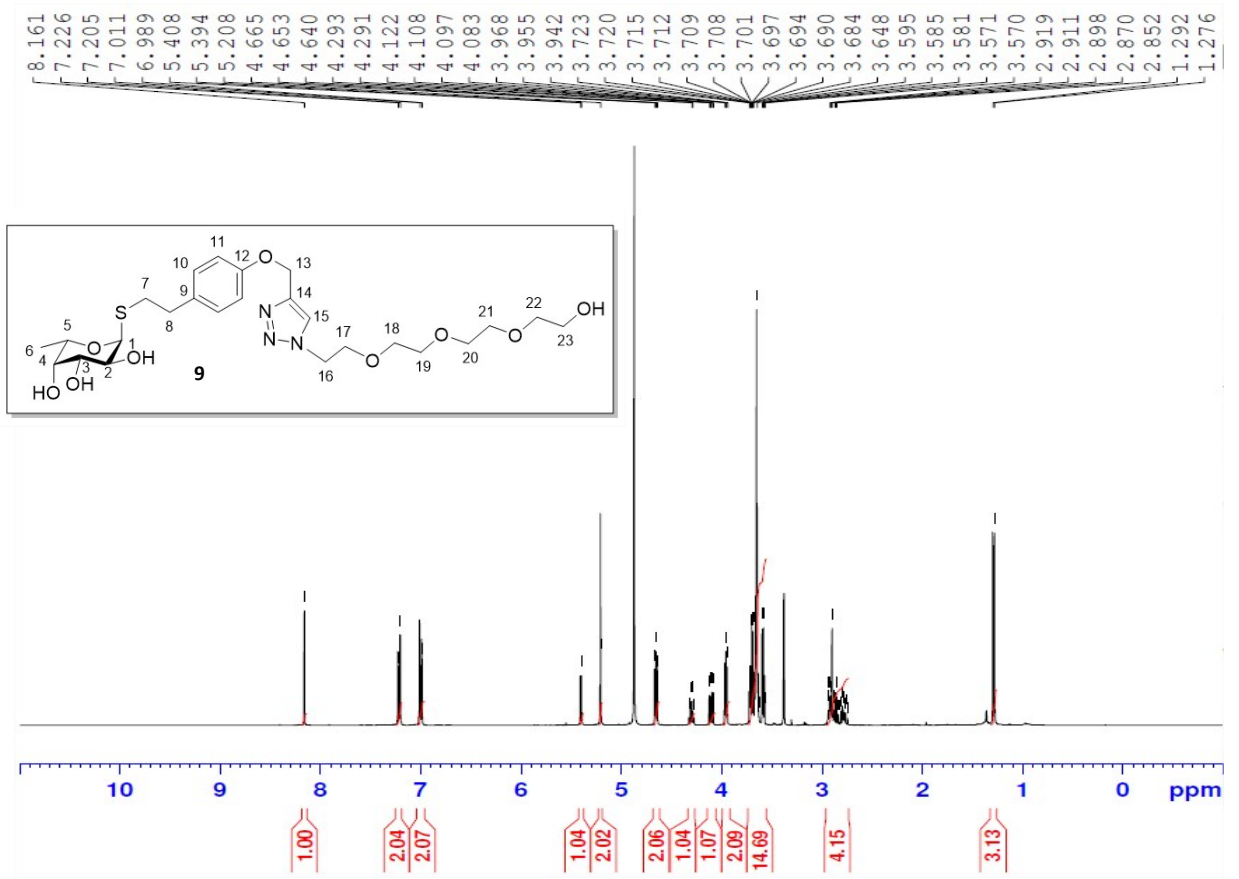

145.73
130.43
130.31
125.99
99.76
73.68
73.64
71.66
71.57
71.48
71.42
70.38
69.91
67.71
66.88
64.24
64.06
62.24
51.44
16.73
6
200
180
160
140
120
100
80
60
40
20
0
ppm

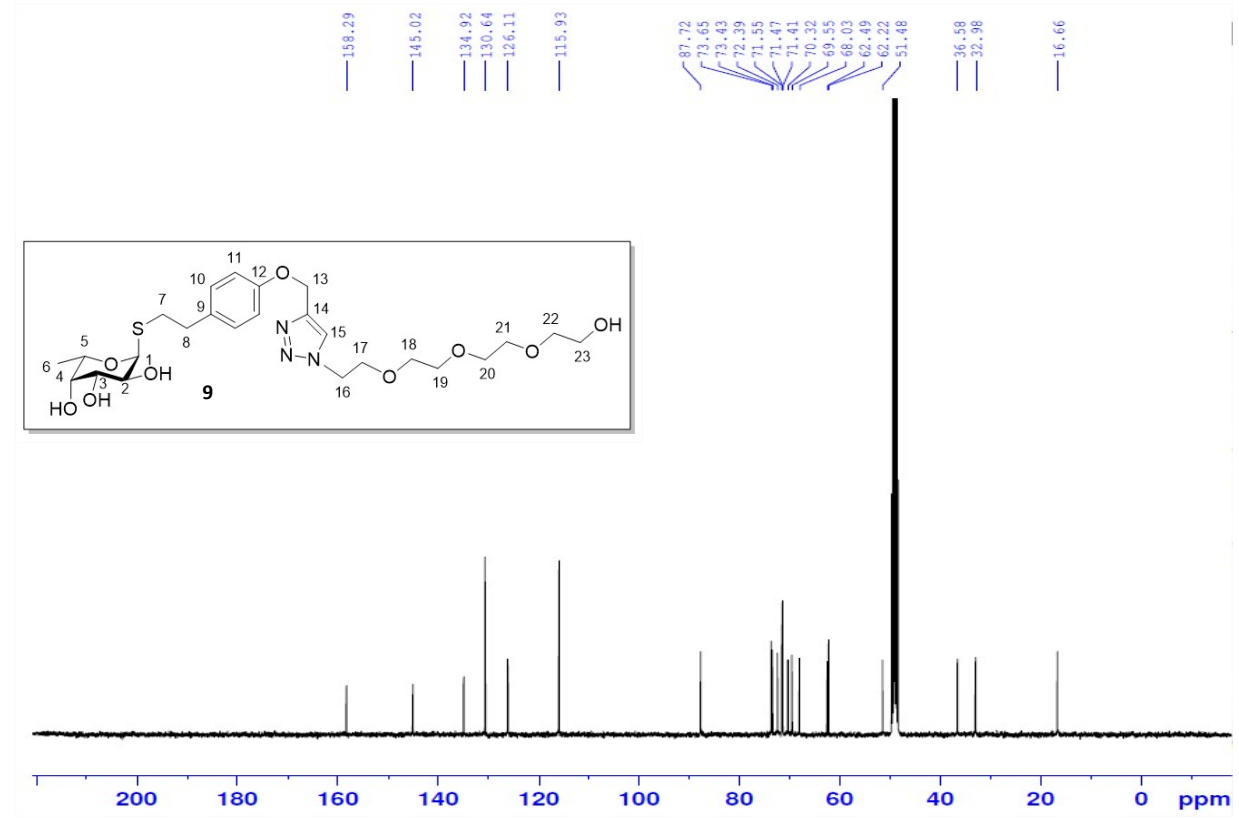

8.152
5.771
5.765
5.758
5.752
5.739
5.372
5.358
4.683
4.672
4.657
4.361
4.345
4.249
4.245
4.236
4.152
4.138
4.127
4.113
3.993
3.980
3.968
3.765
3.759
3.757
3.752
3.740
3.727
3.705
3.691
3.687
3.674
3.646
3.640
3.633
3.622
3.434
3.431
3.392
3.161
3.148
1.329
1.313
7
10 9 8 7 6 5 4 3 2 1 0 ppm
0.95
2.01
1.02
4.12
1.08
2.00
1.12
2.12
15.59
1.08
0.97
3.00

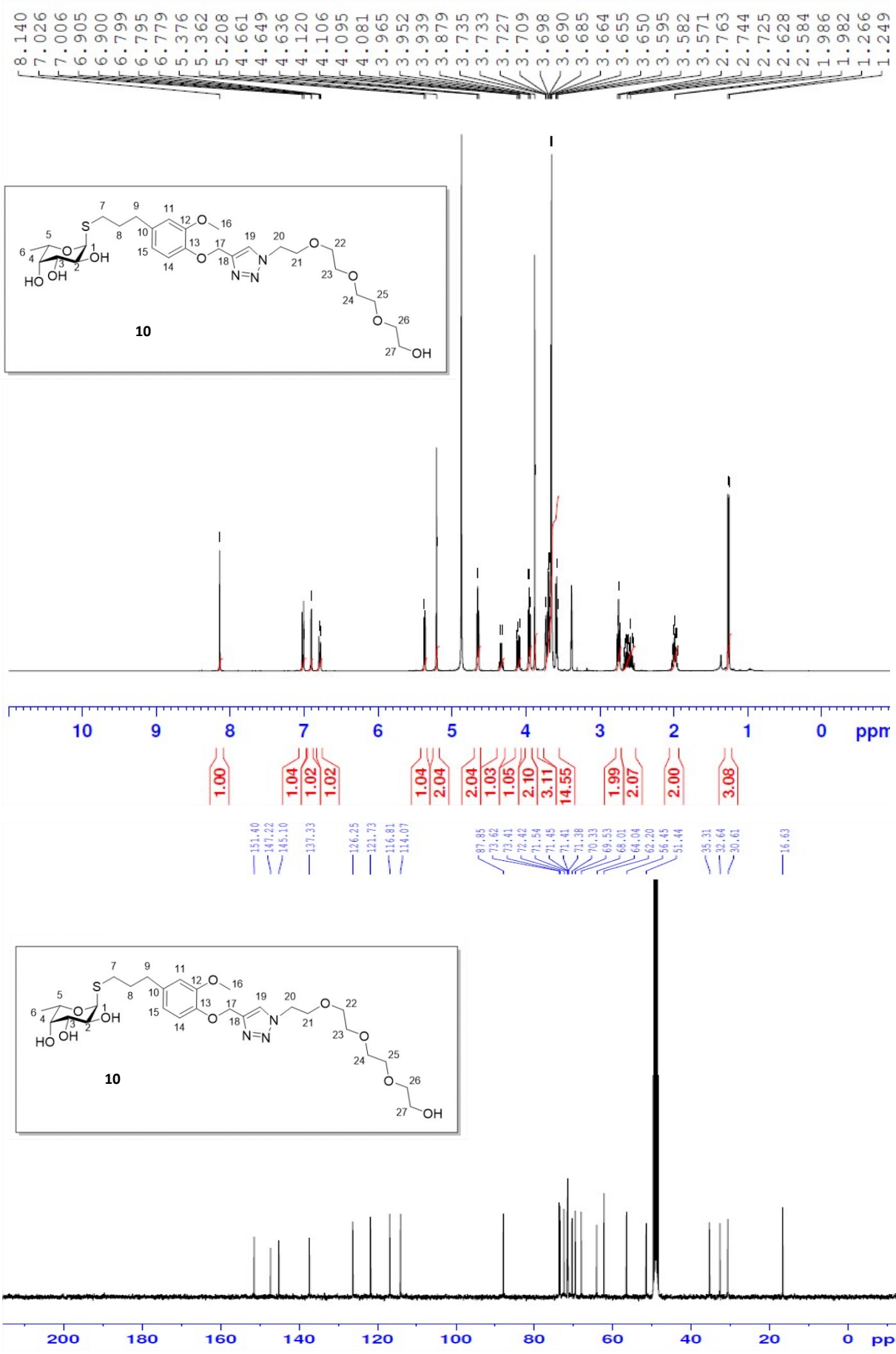

144.44
136.40
129.51
129.02
128.57
128.03
124.60
115.61
85.34
84.56
72.89
72.24
72.03
71.17
70.13
70.04
69.99
69.67
68.96
68.14
67.94
67.05
66.61
65.14
63.49
62.73
62.43
60.81
50.00
48.28
48.06
47.85
47.64
47.42
47.21
47.00
45.43
25.34
15.39
15.18
7
200 180 160 140 120 100 80 60 40 20 0 ppm

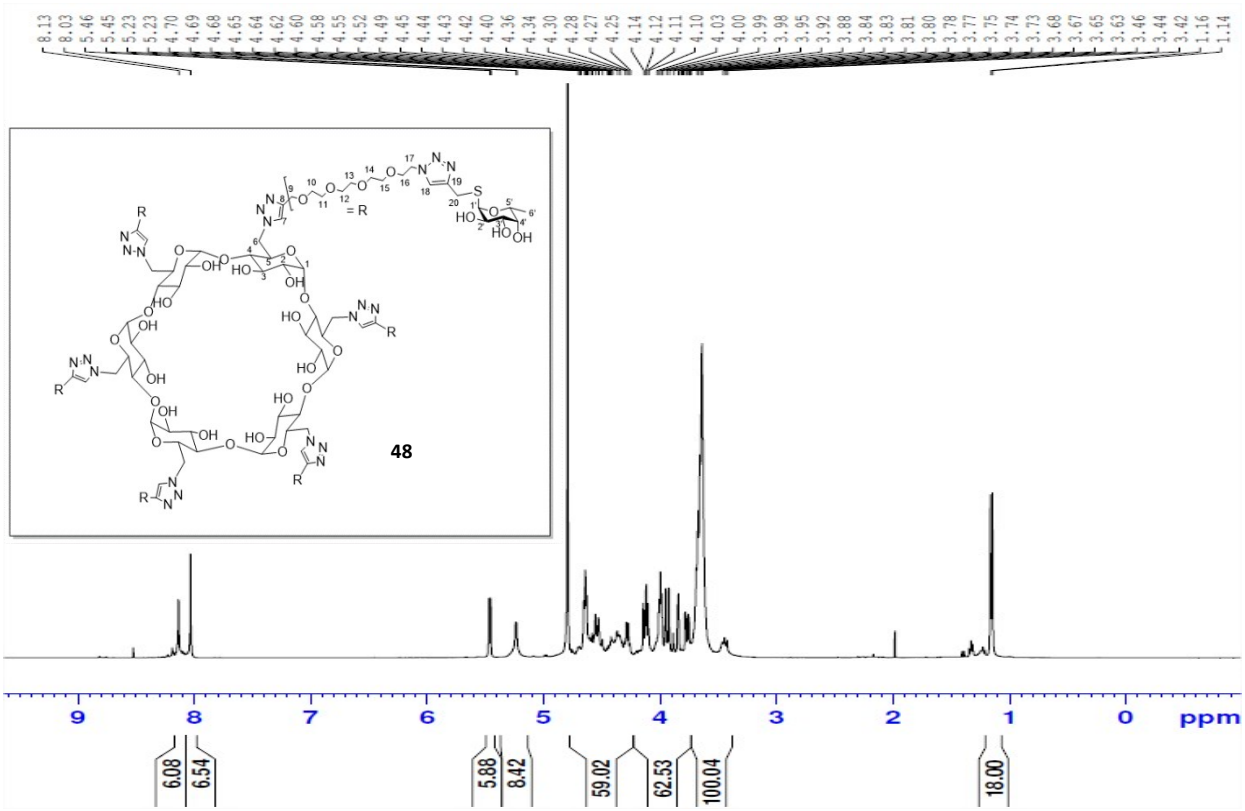

8.168
7.339
7.317
7.019
6.997
5.264
5.250
5.215
4.665
4.652
4.639
4.367
4.351
4.334
4.333
4.317
4.094
4.080
4.069
4.055
3.966
3.953
3.941
3.788
3.755
3.737
3.734
3.728
3.722
3.709
3.698
3.694
3.691
3.685
3.674
3.666
3.649
3.595
3.589
3.586
8
Chemical Formula: C24H37N3O9S
Molecular Weight: 543,63
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.07
2.05
1.02
2.07
2.02
1.01
1.03
2.05
17.13
3.11

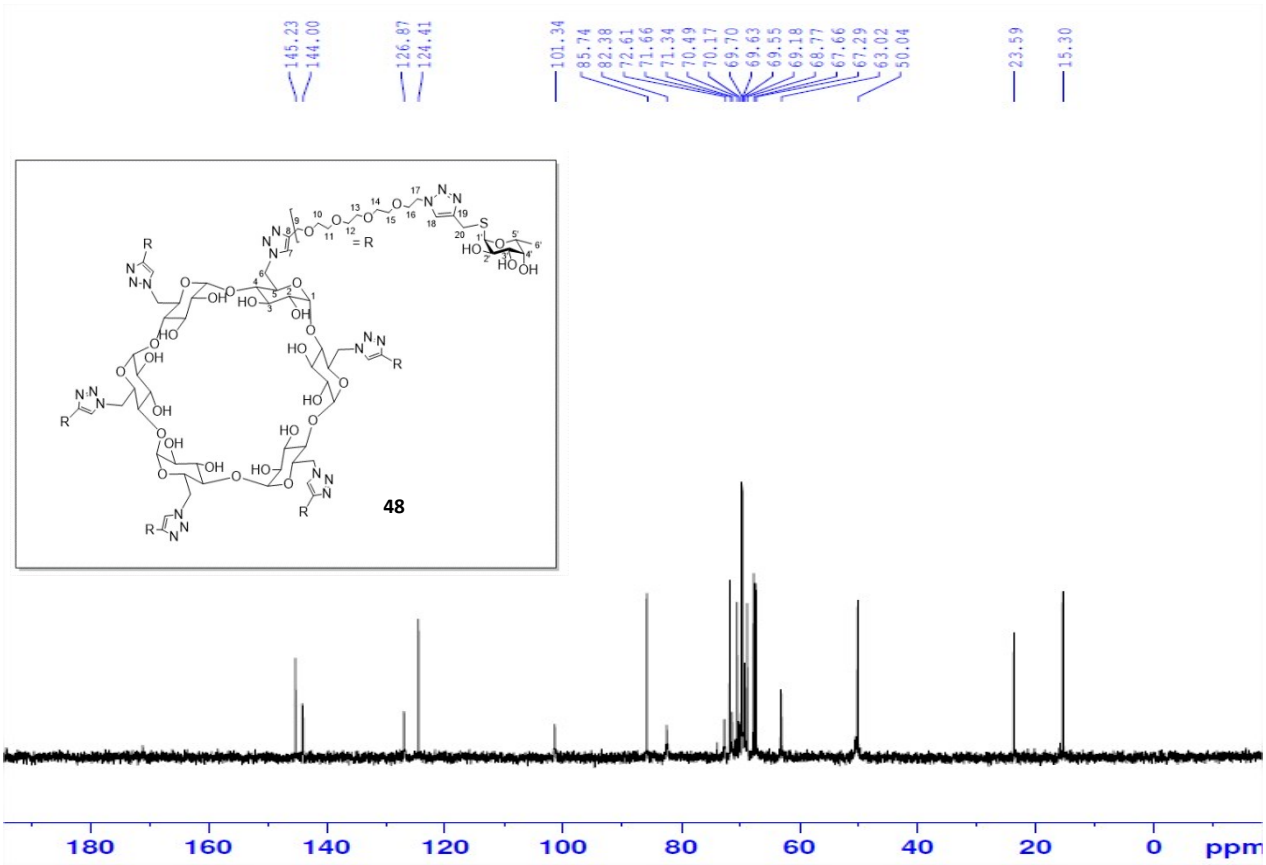

158.69
144.89
132.53
131.25
126.14
115.82
86.22
73.62
73.43
72.54
71.52
71.44
71.40
71.38
70.30
69.39
67.98
62.45
62.19
51.46
33.92
16.64
8
Chemical Formula: C24H37N3O9S
Molecular Weight: 543,63
200
180
160
140
120
100
80
60
40
20
0
ppm

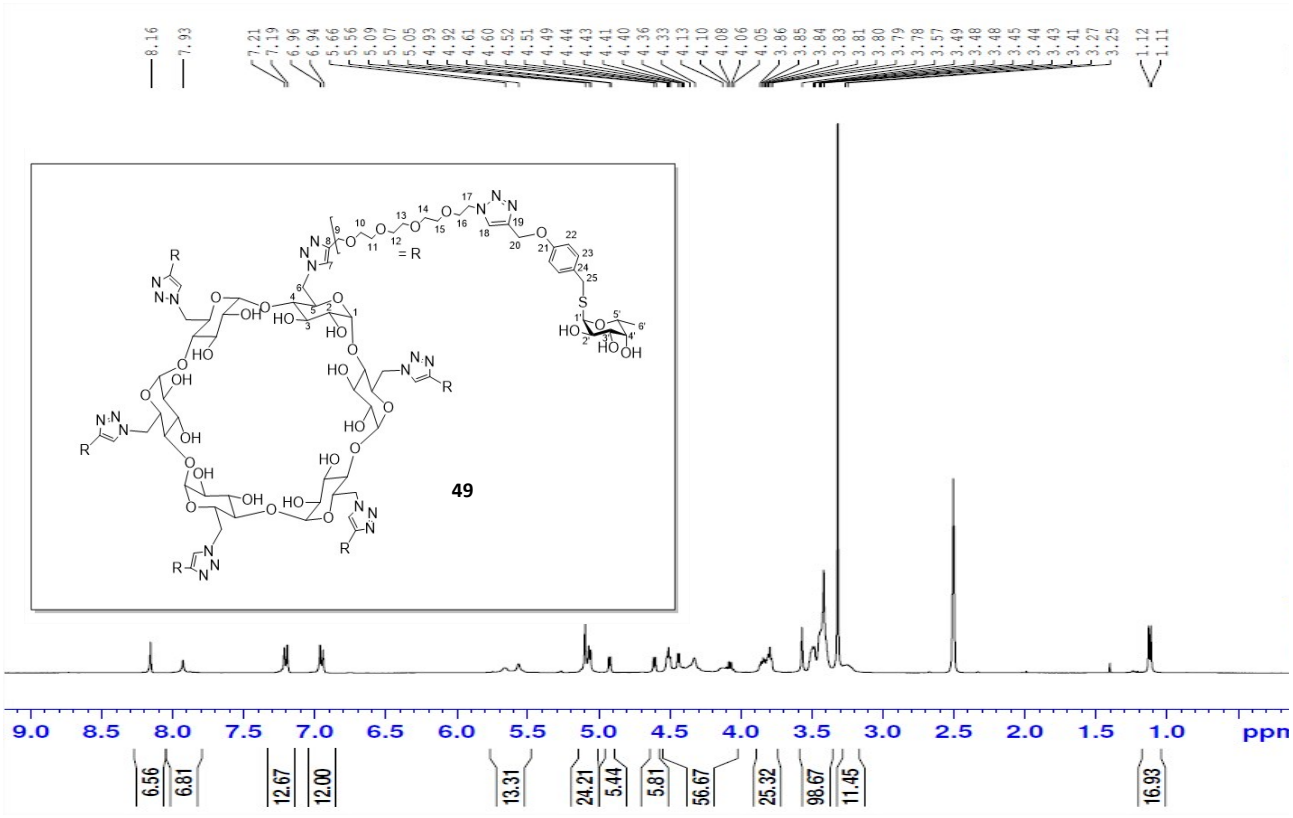

8.161
7.226
7.205
7.011
6.989
5.408
5.394
5.208
4.665
4.653
4.640
4.293
4.291
4.122
4.108
4.097
4.083
3.968
3.955
3.942
3.723
3.720
3.715
3.712
3.709
3.708
3.701
3.697
3.694
3.690
3.684
3.648
3.595
3.585
3.581
3.571
3.570
2.919
2.911
2.898
2.870
2.852
1.292
1.276
9
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.04
2.07
1.04
2.02
2.06
1.04
1.07
2.09
14.69
4.15
3.13

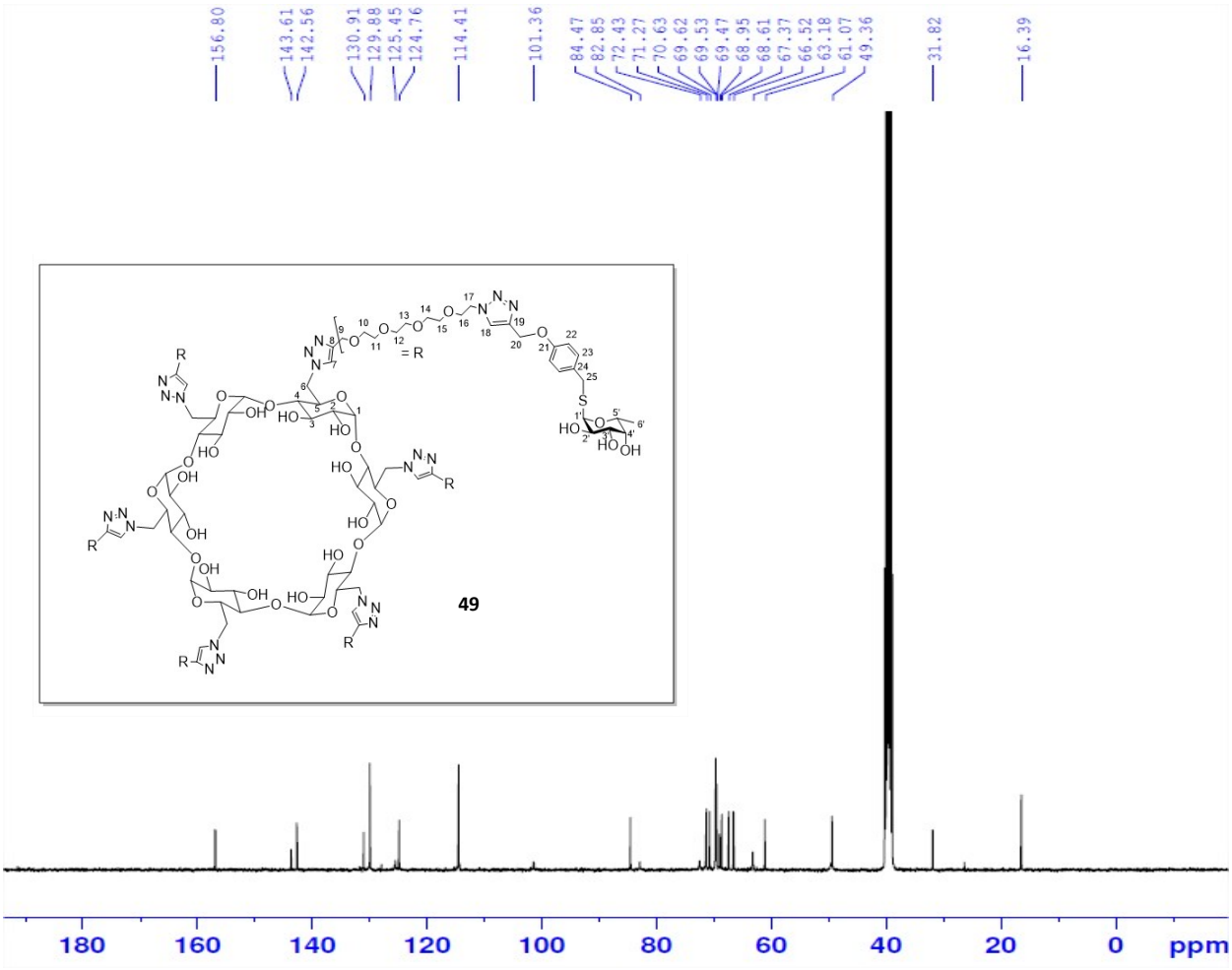

158.29
145.02
134.92
130.64
126.11
115.93
87.72
73.65
73.43
72.39
71.55
71.47
71.41
70.32
69.55
68.03
62.49
62.22
51.48
36.58
32.98
16.66
9
200
180
160
140
120
100
80
60
40
20
0
ppm


8.140
7.026
7.006
6.905
6.900
6.799
6.795
6.779
5.376
5.362
5.208
4.661
4.649
4.636
4.120
4.106
4.095
4.081
3.965
3.952
3.939
3.879
3.735
3.733
3.727
3.709
3.698
3.690
3.685
3.664
3.655
3.650
3.595
3.582
3.571
2.763
2.744
2.725
2.628
2.584
1.986
1.982
1.266
1.249
10
ppm
1.00
1.04
1.02
1.02
1.04
2.04
2.04
1.03
1.05
2.10
3.11
14.55
1.99
2.07
2.00
3.08
151.40
147.22
145.10
137.33
126.25
121.73
116.81
114.07
87.85
73.62
73.41
72.42
71.54
71.45
71.41
71.38
70.33
69.53
68.01
64.04
62.20
56.45
51.44
35.31
32.64
30.61
16.63
10
ppm


8.13 8.03 5.46 5.45 5.23 5.23 4.70 4.69 4.68 4.65 4.64 4.62 4.60 4.58 4.55 4.52 4.49 4.45 4.44 4.43 4.42 4.40 4.36 4.34 4.30 4.28 4.27 4.25 4.14 4.12 4.11 4.10 4.03 4.00 3.99 3.98 3.95 3.92 3.88 3.84 3.83 3.81 3.80 3.78 3.77 3.75 3.74 3.73 3.68 3.67 3.65 3.63 3.46 3.44 3.42 1.16 1.14
= R
48
9 8 7 6 5 4 3 2 1 0 ppm
6.08 6.54 5.88 8.42 59.02 62.53 100.04 18.00


145.23 144.00 126.87 124.41 101.34 85.74 82.38 72.61 71.66 71.34 70.49 70.17 69.70 69.63 69.55 69.18 68.77 67.66 67.29 63.02 50.04 23.59 15.30
= R
48
180 160 140 120 100 80 60 40 20 0 ppm


8.16
7.93
7.21
7.19
6.96
6.94
5.66
5.56
5.09
5.07
5.05
4.93
4.92
4.61
4.60
4.52
4.51
4.49
4.44
4.43
4.41
4.40
4.36
4.33
4.13
4.10
4.08
4.06
4.05
3.86
3.85
3.84
3.83
3.81
3.80
3.79
3.78
3.57
3.49
3.48
3.45
3.44
3.43
3.41
3.27
3.25
1.12
1.11
= R
49
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
ppm
6.56
6.81
12.67
12.00
13.31
24.21
5.44
5.81
56.67
25.32
98.67
11.45
16.93


156.80
143.61
142.56
130.91
129.88
125.45
124.76
114.41
101.36
84.47
82.85
72.43
71.27
70.63
69.62
69.53
69.47
68.95
68.61
67.37
66.52
63.18
61.07
49.36
31.82
16.39
= R
49
180
160
140
120
100
80
60
40
20
0
ppm