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Supporting Information

Hybrid Chemoenzymatic Synthesis of C_7-Sugars for Molecular Evidence of *in vivo* Shikimate Pathway Inhibition

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SUPPORTING INFORMATION

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Experimental Procedures

Bioactivity assays against *A. variabilis* ATCC 29413

To evaluate the inhibitory potential of 7dSh derivatives, bioactivity assays with *Anabaena variabilis* ATCC 29413 were performed as described by Brilisauer et al.[1] For a first screening, *A. variabilis* was inoculated with an optical density of OD_{750}=0.05 in BG11 medium[2] in a 24-well plate (total volume 1 mL). 7dSh and derivatives were dissolved in water to obtain stock concentrations of 10 mM and then applied to the culture (final concentrations: 0, 5, 10, 50, 100, 250 µM). The cultures were cultivated for 4 days at 28 °C, 30 µE of illumination and continuous shaking (100 rpm). To quantify the growth of the cultures in the presence of 250 µM 7dSh and derivatives more precisely, the cell density measured as chlorophyll *a* content was determined. Therefore, the cultivation was performed as above mentioned but in a total volume of 1.5 mL which was inoculated with an optical density of OD_{750}=0.05 (corresponding to a chlorophyll *a* content of ~0.2 µg*mL^{-1}). Cell density expressed as chlorophyll *a* content was determined after 4 days. For that, 1 mL of culture was centrifuged, the supernatant was discarded, and the cell pellet was extracted with 1 mL 90 % MeOH (v/v) and incubated for 30 min in the dark. The cell debris was removed by centrifugation. Chlorophyll *a* was measured by the absorbance at 665 nm and the amount was calculated as described by Mackinney et al.[3]

Uptake assays in *A. variabilis* and DAHP accumulation

For the examination of the uptake of 7dSh and derivatives in *A. variabilis*, 10 mL BG11 medium was inoculated with *A. variabilis* with an optical density of OD_{750}=0.5. 250 µM of 7dSh or the derivatives were applied in water. At different time points (0, 5, 24, 48 h) 1 mL of the culture was harvested by centrifugation (25.000 x *g*, 1 min, 4 °C). 50 µL of the supernatant were mixed with 50 µL MeOH and analysed via HRMS (maXis 4 G ESI QTOF mass spectrometer (Bruker Daltonics)) in FIA mode (3 µL injection volume). The peak areas of the extracted ion chromatograms of the respective substance ([M+H], [M+Na]+) were used for a relative quantification of the derivatives in the supernatant. Therefore, the peak areas at the different time points were divided by the peak area at time point zero. To quantify DAHP accumulation the above-mentioned cell pellets were directly frozen in liquid nitrogen and the DAHP content was determined as described by Brilisauer et al via LC-HRMS.[1]

Cloning, enzyme expression and purification of DHQS from *A. variabilis* and from *A. thaliana*

Dehydroquinate synthase of *Arabidopsis thaliana* (AT5G66120) was amplified with primers 1 and 2 (Table S2). Vector pET22b and amplified gene was cut with NdeI/XhoI and ligated as described elsewhere and then transformed into *E. coli* Top10. With vector pET22b, a His-Tag was introduced on the C-terminus of the protein. The vector was verified by sequencing and then transformed into *E. coli* BL21 (DE3). For protein expression the strain was cultivated in 400 mL LB at 37 °C (150 rpm) until an optical density of around OD_{600}≈0.8. Protein expression was induced with IPTG with a final concentration of 500 µM. After overnight cultivation at 20 °C (150 rpm), the cells were harvested by centrifugation (6000 x *g*, 10 min, 4 °C). The pellet was resuspended in 40 mL lysis buffer (50 mM Tris-HCl pH 7.5, 300 mM NaCl, 10 mM imidazole, protease inhibitor (complete ULTRA tablets, Roche) and DNAseI). Cell disruption was performed via sonification (Branson, 5 mm tip). Cell debris was removed by centrifugation (40.000 x *g*, 45 min, 4 °C). The cell lysate was then filtered with a syringe filter (0.45 µm) and then applied to a HisTrap HP column (GE Healthcare Life Science). After washing of the column, the protein was eluted with elution buffer (50 mM Tris-HCl, 300mM NaCl, 250 mM imidazole, pH 7.5). Protein containing fractions were pooled and dialysed overnight (ZelluTrans MWCO 3500 Da, Roth; 50 mM Tris-HCl pH 8.0, 100 mM NaCl, 5 mM $MgCl_2$, 1 mM DTT, 0.5 mM ETDA, 50 % glycerol) and stored at −20 °C. Purity was confirmed by SDS-PAGE and protein concentration was determined with the Bradford method (RotiQuant, Roth). Expression and analysis of *A. variabilis* DHQS were performed as described in Rapp et al.[4]

DHQS activity assay

For the biochemical evaluation of the inhibitory effect of 7dSh and the derivatives towards DHQS an *in vitro* enzymatic assay was performed. In the dehydroquinate synthase mediated reaction DAHP is converted into 3-dehydroquinate by the release of phosphate. The activity of DHQS was determined by phosphate release as described by Zhu et al with malachite green.[5] The reaction was performed in a total volume of 200 µL. For the determination of the kinetic parameters of the native reaction, the prewarmed buffer (25 mM Tris-HCl pH 7.5) was mixed with 10 µM NAD, 2 nM of the enzyme and varying concentrations of DAHP (Carbosynth). The reaction was conducted at 29 °C. The reaction was stopped by the addition of 30 µL malachite green solution (Phosphate assay kit, abcam) to the enzymatic reaction in a 96-well plate. After 30 min incubation in the dark at room temperature, phosphate release was measured by the absorption at 650 nm in a microplate reader (Tecan Spark). For the determination of the

kinetic parameters of the natural reaction, phosphate release was monitored after 5, 7 and 10 min of reaction. With the slope through this time points, v_{max} and k_M were calculated. Enzyme activities were therefore expressed as phosphate release in micromoles per minute per µmol of the enzyme ($U*\mu mol_{enzyme}^{-1}$). The kinetic parameters were determined with GraphPad prism by fitting the data into the following equation: $v=v_{max}*[S]*(k_M+[S])^{-1}$. For IC_{50} determination, the pre-warmed buffer (25 mM Tris-HCl pH 7.5) was mixed with 10 µM NAD, 2 nM of the enzyme and varying concentrations of 7dSh and then pre-incubated for 5 min at 29 °C. To start the reaction, 2.5 µM DHAP was added and again incubated at 29 °C. Phosphate release was monitored after 5 min as described above. For time point zero, a blank without enzyme was used. For IC_{50} determination the relative activity (activity at a specific concentration divided by activity without inhibitor) was plotted over the inhibitory concentration. IC_{50}-values were determined by fitting the data to the formula (GraphPad prism): $Y=(Bottom+(Top-Bottom))*(1+(X*IC_{50}^{-1}))^{-1}$ with a standard Hill Slope of 1.0.

Seedling growth of *A. thaliana*

Arabidopsis thaliana seedling were germinated in half-strength Murashige and Skoog (MS) Medium (Duchefa Biochemie) agar plates (1.5% w/v, Bacto agar) without sugar under constant illumination at 22 °C for 7 days (for growth tests) or up to 20 days (for 7dSh uptake measurements). Compounds were added to lukewarm agar. For simultaneous growth of seedlings, seeds were stored at 4 °C for two days prior to initiation of germination. Plates were mounted vertically for growth. Root lengths were determined using Fiji software. Seedling sizes were compared through an unpaired t-test using GraphPad.

Quantification of 7dSh in plant material via GC–MS

Plant material was washed with ddH_2O up to five times to remove agar with residuing 7dSh and immediately frozen in liquid nitrogen. Samples were lyophilized overnight and subsequently, ground using a tissue (2x for 30s). For the extraction of 7dSh a previously described method[4, 6] was applied on 1 mg of the homogeneous plant powder with a few modifications. 700 µl of ice-cold extraction solution ($CHCl_3$/MeOH/H_2O in a ratio of 1/2.5/0.5 v/v/v) was added to the plant material and homogenized by vortexing, treated first in an ultrasonic bath (Emmi-H30, EMAG Technologies) for 10 min and afterwards by shaking for 10 min at RT (1000 rpm). The samples were incubated for 5 min on ice and centrifuged for 10 min, 16.000 xg at 4 °C. The supernatant was transferred to a new reaction tube and the extraction was repeated with 300 µl on the pellet as described before. The supernatants of both extracts were pooled and 300 µl ice-cold H_2O was added for phase separation. The samples were homogenized by vortexing, afterwards incubated on ice for 5 min, and centrifuged for 10 min, 16.000 xg at 4 °C. 900 µl of the polar phase was transferred to a new reaction tube and dried in a vacuum concentrator (Eppendorf, Concentrator plus, mode: V-AQ, 30 °C) for approximately 16 h.
Derivatization and GC-MS measurements of 7dSh were performed as described elsewhere.[7] For quantification of 7dSh calibration curve was established from 50-5000 pmol. As a control for extraction and derivatization efficiency, 1 nmol $^{13}C_5$-7dSh was added to 700 µl of the extraction solution.

Chemical synthesis:

General methods

Physiochemical characterization. All starting materials and reagents were commercially available and used without further purification. Thin-layer chromatography (TLC) was carried out on aluminium sheets coated with silica gel 60 (Merck). For detection, TLC plates were treated with anisaldehyd staining reagent (5 mL acetic acid, 2.5 mL H_2SO_4, 42.5 mL MeOH and 1mL anisaldehyde), followed by heating. Flash column chromatography was performed on Varian IntelliFlash with silica gel (RS 4 SiOH 40-63 mm; Macherey Nagel). High performance liquid chromatography (HPLC) was performed on Agilent Infinity II with ligand/ion-exchange column (HiPlex Ca, 300mm x 7.7 mm or 300mm x 10.7 mm, Agilent, temperature column oven: 85 °C). HPLC-High resolution mass spectrometry (HRMS) was performed on Dionex Ultimate 3000 HPLC system (Thermo Fisher Scientific) coupled to a maXis 4 G ESI-QTOF mass spectrometer (Bruker Daltonics). NMR spectra were recorded on Bruker Avance III HD 400, HDX 600 or HDX 700 spectrometers and chemical shifts were calibrated to CD_3OD, D_2O, $CDCl_3$ or CD_2Cl_2. Multiplicities are reported with the following abbreviations: s=singlet, d=doublet, q=quartett, m=multiplet, dd=doublet of doublet, dm=doublet of multiplet, qm=quartett of multiplet, ddd=doublet of doublet of doublet, ddm=doublet of doublet of multiplet, dq=doublet of quartett, dddd=doublet of doublet of doublet of doublet, ddq=doublet of doublet of multiplet, dqm=doublet of quartett of multiplet.

General operation procedure (GOP):

GOP1: Methyl- and acetonide protection
The compound was incubated in a 4:1 mixture of acetone/methanol with $SnCl_2x2H_2O$ (1 eq) and catalytic amounts of conc. H_2SO_4 at 45 °C for 20 h. After cooling to room temperature, the mixture was filtered, neutralised with $NaHCO_3$ solution, once again filtered and the organic solvent evaporated. The remaining aqueous solution was extracted with ethylacetate, dried over Na_2SO_4 and evaporated in vacuo to dryness.

GOP2: Insertion of the mesyl group
The compound was diluted in DCM with addition of TEA (2.5 eq). After cooling down with an ice-bath mesyl chloride (2.5 eq) were added slowly (5-10 min). The reaction mixture was stirred for 5 h under ice-bath conditions. Afterwards the reaction mixture was washed with 1N HCl, water, $NaHCO_3$ solution, NaCl solution and water. The organic solvent was dried over Na_2SO_4 and evaporated in vacuo to get a yellowish oil, which crystallize out in the fridge.

GOP3: Reduction of the mesyl group at C-5

The mesyl protected sugar was diluted in DMSO. After cooling down with an ice-bath $NaBH_4$ (5 eq.) were added slowly in small portions. Afterwards the reactions mixture was heated slowly to 85 °C and hold for 12 h. After cooling down with in an ice-bath 5% AcOH solution were added for quenching the remaining $NaBH_4$. The aqueous solution was extracted with DCM, washed with water, dried over Na_2SO_4 and evaporated in vacuo (40 °C, 750 mbar) to get the C-5 deoxy sugar.

GOP4: Selective acetonide deprotection

The protected sugar was diluted in methanol and cooled down with an ice-bath. Afterwards the same amount of 1% H_2SO_4 were added slowly. After 30 min of stirring the ice-bath was removed and the reaction was stirred over night at room temperature. On the next day, the reaction was determined by neutralisation with Na_2CO_3 solution and evaporated through lyophilisation. To remove the precipitated salt, the reaction mixture was extracted with methanol, filtered and evaporated in vacuo to dryness.

GOP5: Oxidative cleavage with $NaIO_4$ and subsequent reduction with $NaBH_4$

The compound with the free vicinal diol was solved in a 2:1 mixture of dioxane/water. $NaIO_4$ (1,2 eq) were added slowly in small portions. Afterwards the reactions mixture was stirred at room temperature for 3 h. The reaction was terminated through addition of ethanol. After further 30 min, a white solid was filtered off and the reaction mixture was again incubated with $NaBH_4$ (1 eq) and stirred for further 2 h at room temperature. Then the remaining $NaBH_4$ were quenched through neutralizing with AcOH, filtered and evaporated in vacuo to dryness.

GOP6: Deprotection

The protected sugar was diluted in 0.04 N H_2SO_4 and heated to 85 °C for 3 h. After cooling to room temperature, the reaction mixture was neutralised with $NaHCO_3$ solution and evaporated through lyophilisation. The final product was purified by MPLC and HPLC (Column: HiPlexCa, 85 °C, 250x10.7 mm, 1,5 mL/min, solvent: water) to get the deprotected sugar.

GOP7: Transketolase reaction

TPP (2 mM) and $MgCl_2x6H_2O$ (3 mM) were prediluted and the pH was adjusted to about 7.0. Afterwards the C_5-sugar and K-HPA were added and again the pH was adjusted to 7.0 and the reaction was initiated by addition of 130 µg transketolase (20 µL of a 6.5 mg/mL solution). The reaction mixture was shaken at 400 rpm and 30 °C for 7 days whereby every 24 h K-HPA (0,3 eq) were added and the pH was readjusted to 7.0. The reaction was stopped by lyophilisation. The transketolase was precipitated with methanol. After centrifugation the supernatant was evaporated in vacuo and purified by MPLC and HPLC (Column: HiPlexCa, 85 °C, 250x10.7 mm, 1,5 mL/min, solvent: water) to get the C_7-sugar.

Methyl-2,3-*O*-isopropylidene-β-D-ribofuranoside (8): 8 were synthesized and purified according to GOP1, started from D-ribose (**7**) (14.8 g, 97.5 mmol, 1 eq). **8** were obtained as a colourless oil (14.9 g, 73.0 mmol, 75%). TLC: R_f 0.58 (cyclohexane/ethylacetate 1:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=4.89 (s, 1H, 1-H), 4.73 (d, $J_{3,2}$=6.0 Hz, 1H, 3-H), 4.50 (d, $J_{2,3}$=6.0 Hz, 1H, 2-H), 4.32 (dd, $J_{4,5b}$=3.8 Hz, $J_{4,5a}$=3.0 Hz, 1H, 4-H), 3.59 (dd, $J_{5a,5b}$=12.4 Hz, $J_{5a,4}$=3.0 Hz, 1H, 5a-H), 3.53 (dd, $J_{5b,5a}$=12.4 Hz, $J_{5b,4}$=3.8 Hz, 1H, 5b-H), 3.34 (s, 3H, OCH_3), 1.40 and 1.24 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.1 ($C(CH_3)_2$), 109.8 (C-1), 88.2 (C-4), 85.7 (C-2), 81.5 (C-3), 63.9 (C-5), 55.4 (OCH_3), 26.3 and 24.7 ($C(CH_3)_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 205.1071, found: 205.1073; *m/z* calcd for $[M+Na]^+$: 227.0890, found: 227.0894.

Methyl-2,3-*O*-isopropylidene-5-*O*-mesyl-β-D-ribofuranoside (9): 9 were synthesized and purified according to GOP2, started from **8** (14.9 g, 72.9 mmol, 1 eq). **9** were obtained as a yellowish oil, which crystallizes in the fridge (19.7 g, 69.8 mmol, 96%). TLC: R_f 0.62 (cyclohexane/ethylacetate 1:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=4.98 (s, 1H, 1-H), 4.69 (dd, $J_{3,2}$=5,9 Hz, J=0.7 Hz, 1H, 3-H), 4.59 (d, $J_{2,3}$=5,9 Hz, 1H, 2-H), 4.40 (m, 1H, 4-H), 4.20 (s, 1H, 5a-H), 4.18 (d, J=1.6 Hz, 1H, 5b-H), 3.33 (s, 3H, OCH_3), 3.05 (s, 3H, Mesyl-CH_3), 1.47 and 1.31 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.9 ($C(CH_3)_2$), 109.7 (C-1), 85.0 (C-2), 83.9 (C-4), 81.5 (C-3), 68.6 (C-5), 55.4 (OCH_3), 37.9 (Mesyl-CH_3), 26.5 and 25.0 ($C(CH_3)_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 283.0846, found: 283.0846; *m/z* calcd for $[M+Na]^+$: 305.0665, found: 305.0664.

Methyl-2,3-*O*-isopropylidene-5-deoxy-β-D-ribofuranoside (10): 10 were synthesized and purified according to GOP3, started from **9** (9.6 g, 34.0 mmol, 1 eq). **10** were obtained as a colourless oil (5.5 g, 29.3 mmol, 86%). TLC: R_f 0.91 (cyclohexane/ethylacetate 1:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=4.88 (s, 1H, 1-H), 4.59 (d, $J_{2,3}$=5.9 Hz, 1H, 2-H), 4.46 (d, $J_{3,2}$=5.9 Hz, 1H, 3-H), 4.29 (q, $J_{4,5}$=7.1 Hz, 1H, 4-H), 3.28 (s, 3H, OCH_3), 1.43 and 1.26 (s, 3H, $C(CH_3)_2$), 1.24 (d, $J_{5,4}$=7.1 Hz, 3H, 5-H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.2 ($C(CH_3)_2$), 109.5 (C-1), 85.9 (C-2), 85.3 (C-3), 83.2 (C-4), 54.4 (OCH_3), 26.5 and 25.0 ($C(CH_3)_2$), 21.0 (C-5); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 211,0941, found: 211,0947.

5-Deoxy-D-ribofuranose (12): 12 were synthesized and purified according to GOP6, started from **10** (5.4 g, 28.6 mmol, 1 eq). Flash purification (0→30% chloroform/methanol) gave **12** as a colourless oil (3.0 g, 22.4 mmol, 78%). TLC: R_f 0.48 (chloroform/methanol 8:2); ^{1}H-NMR (400 MHz, D_2O) β-anomer: δ(ppm)=5.21 (d, J=1.8 Hz, 1H, 1-H), 4.06-3.97 (m, 3H, 2-H, 3-H, 4-H), 1.35 (d, J=6.1 Hz, 3H, 5-H); α-anomer: δ(ppm)=5.37 (d, $J_{1,2}$=4.3 Hz, 1H, 1-H), 4.16 (dm, $J_{2,1}$=4.3 Hz, 1H, 2-H), 4.15 (qm, $J_{4,5}$=6.4 Hz, 1H, 4-H), 3.83 (m, 1H, 3-H), 1.26 (d, $J_{5,4}$=6.4 Hz, 3H, 5-H); ^{13}C-NMR (100 MHz, D_2O) β-anomer: δ(ppm)=100.8 (C-1), 78.2 (C-4), 75.5 (C-2), 75.2 (C-3), 19.1 (C-5); α-anomer: δ(ppm)= 95.8 (C-1), 78.1 (C-4), 74.9 (C-3), 70.4 (C-2), 17.9 (C-5); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 157.0471, found: 157.0471.

Methyl-2,3-*O*-isopropylidene-5-deoxy-5-fluoro-β-D-ribofuranoside (11): Methyl-2,3-*O*-isopropylidene-5-*O*-mesyl-β-D-ribofuranoside (**9**, 1.8 g, 6.4 mmol, 1 eq) was dissolved in acetonitril (25 mL). After addition of TBAF (3.5 g, 13 mmol, 2 eq) the reaction mixture was stirred at reflux for 24 h. After cooling to rt, the solvent was evaporated in vacuo (evaporation not below 100 mbar at 45 °C). Flash purification (0→15%

cyclohexane/ethylacetate) gave **11** as a colourless oil (452.4 mg, 2.2 mmol, 34%). TLC: R_f 0.54 (cyclohexane/ethylacetate 8:2); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=4.98 (d, J=2.4 Hz, 1H, 1-H), 4.69 (d, $J_{3,2}$=6.0 Hz, 1H, 3-H), 4.58 (d, $J_{2,3}$=6.0 Hz, 1H, 2-H), 4,46-4.27 (m, 3H, H-4, H-5a, H-5b); 3.32 (s, 3H, OCH_3), 1.48 and 1.32 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)= 112.8 ($C(CH_3)_2$), 109.4 (C-1), 85.2 (C-2), 84.6 (d, $J_{C\text{-}4,F}$=22.3 Hz, C-4), 83.1 (d, $J_{C\text{-}5,F}$=172.2 Hz, C-5), 81.2 (d, $J_{C\text{-}3,F}$=4.3 Hz, C-3), 55.0 (OCH_3), 26.5 and 25.0 ($C(CH_3)_2$); ^{19}F-NMR (100 MHz, $CDCl_3$) δ(ppm)=-224.79 to -225.12 (m, 1F); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 207.1027, found: 207.1032; *m/z* calcd for $[M+Na]^+$: 229.0847, found: 229.0852.

5-Deoxy-5-fluoro-D-ribofuranose (13): 13 were synthesized and purified according to GOP6, started from **11** (430,2 mg, 2.1 mmol, 1 eq). Flash purification (0→30% chloroform/methanol) gave **13** as a colourless oil (247.2 mg, 1.6 mmol, 78%). TLC: R_f 0.44 (chloroform/methanol 8:2); ^{1}H-NMR (400 MHz, D_2O) β-anomer: δ(ppm)=5.30 (d, $J_{1,2}$=1.4 Hz 1H, 1-H), 4.70 (ddd, $J_{5a,F}$=47.8 Hz, $J_{5a,5b}$=10.7 Hz, J=2.4 Hz, 1H, 5a-H), 4.59 (ddm, $J_{5b,F}$=48,0 Hz, $J_{5b,5a}$=10.7 Hz, 1H, 5b-H), 4.33 (dd, J=7.0 Hz, $J_{3,2}$=4.7 Hz, 1H, 3-H), 4.15 (dm, $J_{4,F}$=26.0 Hz, 1H, 4-H), 4.03 (ddd, $J_{2,3}$=4.7 Hz, $J_{2,1}$=1.4 Hz, J=1.4 Hz, 1H, 2-H); α-anomer: δ(ppm)=5.43 (d, $J_{1,2}$=4.0 Hz, 1H, 1-H), 4.65 (ddd, $J_{5a,F}$=47.4 Hz, $J_{5a,5b}$=10.7 Hz, J=2.4 Hz, 1H, 5a-H), 4.58 (ddm, $J_{5b,F}$=46.7 Hz, $J_{5b,5a}$=10.7 Hz, 1H, 5b-H), 4.28 (dm, $J_{4,F}$=27.6 Hz, 1H, 4-H), 4.20 (m, 1H, 3-H), 4.13 (dm, $J_{2,1}$=4.0 Hz, 1H, 2-H); ^{13}C-NMR (100 MHz, D_2O) β-anomer: δ(ppm)=101.1 (C-1), 83.4 (d, $J_{C\text{-}5,F}$=168.7 Hz, C-5), 80.5 (d, $J_{C\text{-}4,F}$=18.1 Hz, C-4), 75.0 (d, $J_{C\text{-}2,F}$=1.7 Hz, C-2), 69.4 (d, $J_{C\text{-}3,F}$=6.9 Hz, C-3); α-anomer: δ(ppm)=96.5 (C-1), 82.9 (d, $J_{C\text{-}5,F}$=167.5 Hz, C-5), 81.0 (d, $J_{C\text{-}4,F}$=17.7 Hz, C-4), 70.6 (d, $J_{C\text{-}2,F}$=1.5 Hz, C-2), 69.2 (d, $J_{C\text{-}3,F}$=6.6 Hz, C-3); ^{19}F-NMR (565 MHz, D_2O) β-anomer: δ(ppm)=-228.62 (ddd, $J_{F,5b}$=48.0 Hz, $J_{F,5a}$=47.8 Hz, $J_{F,4}$=26.0 Hz, 1F, C^5-F); α-anomer: δ(ppm)=-230,97 (ddd, $J_{F,5a}$=47.4 Hz, $J_{F,5b}$=46.7 Hz, $J_{F,4}$=27.6 Hz, 1F, C^5-F). HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 175.0377, found: 175.0380.

7-Deoxy-sedoheptulose (1): 1 were synthesized and purified according to GOP7, started from **12** (50,0 mg, 370 µmol, 1 eq). Flash purification (0→40% chloroform/methanol) and subsequent HPLC (HiPlexCa, solvent: H_2O, column temperature: 85 °C, flow: 1.0 mL/min) gave **1** as a colourless oil (28.7 mg, 150 µmol, 40%). TLC: R_f 0.56 (chloroform/methanol 8:5); ^{1}H-NMR (600 MHz, D_2O) β-furanose: δ(ppm)=4.24 (dd, $J_{4,3}$=7.9 Hz, $J_{4,5}$=7.4 Hz, 1H, 4-H), 4.10 (d, $J_{3,4}$=7.9 Hz, 1H, 3-H), 3.97 (dq, $J_{6,5}$=4.4 Hz, $J_{6,7}$=6.5 Hz, 1H, 6-H), 3.72 (dd, $J_{5,4}$=7.4 Hz, $J_{5,6}$=4.4 Hz, 1H, 5-H), 3.61 (d, $J_{1a,1b}$=12.2 Hz, 1H, 1a-H), 3.56 (d, $J_{1b,1a}$=12.2 Hz, 1H, 1b-H), 1.23 (d, $J_{7,6}$=6.5 Hz, 3H, 7-H); α-pyranose: δ(ppm)=4.10 (m, 1H, 6-H), 4.05 (m, 1H, 4-H), 3.96 (m, 1H, 3-H), 3.69 (d, $J_{1a,1b}$=11.6 Hz, 1H, 1a-H), 3.61 (m, 1H, 5-H), 3.43 (d, $J_{1b,1a}$=11.6 Hz, 1H, 1b-H), 1.29 (d, J=6.3 Hz, 3H, 7-H); α-furanose: δ(ppm)=4.14 (dd, $J_{4,3}$=4.3 Hz, $J_{4,5}$=6.2 Hz, 1H, 4-H), 4.09 (m, 1H, 3-H), 4.02 (dq, $J_{6,7}$=6.6 Hz, $J_{6,5}$=4.0 Hz, 1H, 6-H), 3.94 (dd, $J_{5,4}$=6.2 Hz, $J_{5,6}$=4.0 Hz, 1H, 5-H), 3.69 (d, $J_{1a,1b}$=11.9 Hz, 1H, 1a-H), 3.66 (d, $J_{1b,1a}$=11.9 Hz, 1H, 1b-H), 1.24 (d, $J_{7,6}$=6.6 Hz, 3H, 7-H); ^{13}C-NMR (150 MHz, D_2O) β-furanose: δ(ppm)=101.3 (C-2), 83.6 (C-5), 75.8 (C-3), 74.7 (C-4), 67.7 (C-6), 62.5 (C-1), 17.0 (C-7); α-pyranose: δ(ppm)=97.7 (C-2), 70.9 (C-4), 69.0 (C-5), 68.1 (C-3), 64.5 (C-6), 63.9 (C-1), 16.9 (C-7); α-furanose: δ(ppm)=104.5 (C-2), 84.8 (C-5), 82.0 (C-3), 76.0 (C-4), 66.8 (C-6), 62.8 (C-1), 17.3 (C-7); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 217.0683, found: 217.0683.

7-Deoxy-7-fluoro-sedoheptulose (2): 2 were synthesized and purified according to GOP7, started from **13** (50,0 mg, 330 µmol, 1 eq). Flash purification (0→35% chloroform/methanol) and subsequent HPLC (HiPlexCa, solvent: H_2O, column temperature: 85 °C, flow: 1.0 mL/min) gave **2** as a colourless oil (17.04 mg, 80 µmol, 24%). TLC: R_f 0.56 (chloroform/methanol 8:5) ^{1}H-NMR (600 MHz, D_2O) β-furanose: δ(ppm)=4.65 (ddd, $J_{7a,F}$=48.3 Hz, $J_{7a,7b}$=10.2 Hz, $J_{7a,6}$=2.7 Hz, 1H, 7a-H), 4.57 (ddd, $J_{7b,F}$=47.7 Hz, $J_{7b,7a}$=10.2 Hz, $J_{7b,6}$=5.5 Hz, 1H, 7b-H), 4.33 (dd, $J_{4,3}$=7.8 Hz, $J_{4,5}$=6.8 Hz, 1H, 4-H), 4.11 (d, $J_{3,4}$=7.8 Hz, 1H, 3-H), 4.03 (dddd, $J_{6,F}$=24.1 Hz, $J_{6,5}$=6.5 Hz, $J_{6,7b}$=5.5 Hz, $J_{6,7a}$=2.7 Hz, 1H, 6-H), 3.83 (dd, $J_{5,4}$=6.8 Hz, $J_{5,6}$=6.5 Hz 1H, 5-H), 3.61 (d, $J_{1a,1b}$=12.1 Hz, 1H, 1a-H), 3.56 (d, $J_{1b,1a}$=12.1 Hz, 1H, 1b-H); α-pyranose: δ(ppm)=4.77 (ddd, $J_{7a,F}$=47.4 Hz, $J_{7a,7b}$=10.7 Hz, $J_{7a,6}$=3.7 Hz, 1H, 7a-H), 4.70 (ddd, $J_{7b,F}$=48.0 Hz, $J_{7b,7a}$=10.7 Hz, $J_{7b,6}$=1.4 Hz, 1H, 7b-H), 4.17 (dddd, $J_{6,F}$=28.8 Hz, $J_{6,5}$=11.6 Hz, $J_{6,7a}$=3.7 Hz, $J_{6,7b}$=1.4 Hz, 1H, 6-H), 4.12 (m, 1H, 4-H), 3.98 (dm, $J_{5,6}$=10.6 Hz, 1H, 5-H), 3.98 (m, 1H, 3-H), 3.72 (d, $J_{1a,1b}$=11.7 Hz, 1H, 1a-H), 3.49 (d, $J_{1b,1a}$=11.7 Hz, 1H, 1b-H); α-furanose: δ(ppm)= 4.65 (dm, $J_{7a,F}$=46.8 Hz, 1H, 7a-H), 4.57 (dm, $J_{7b,F}$=46.9 Hz, 1H, 7b-H), 4.21 (dd, $J_{4,5}$=5.3 Hz, $J_{4,3}$=4.1 Hz, 1H, 4-H), 4.11 (d, $J_{3,4}$=4.1 Hz, 1H, 3-H), 4.06 (m, 1H, 5-H), 4.05 (dm, $J_{6,F}$=24.8 Hz, 1H, 6-H), 3.68 (s, 2H, 1a-H and 1b-H); ^{13}C-NMR (150 MHz, D_2O) β-furanose: δ(ppm)=101.9 (C-2), 84.2 (d, $J_{7,F}$=165.3 Hz, C-7), 79.3 (d, $J_{5,F}$=7.7 Hz, C-5), 76.0 (C-4), 75.8 (C-3), 71.3 (d, $J_{6,F}$=18.3 Hz, C-6), 62.5 (C-1); α-pyranose: δ(ppm)=98.0 (C-2), 82.9 (d, $J_{7,F}$=167.7 Hz, C-7), 70.9 (C-4), 68.1 (C-3), 67.7 (d, $J_{6,F}$=17.9 Hz, C-6), 63.9 (C-1), 62.3 (d, $J_{5,F}$=7.0 Hz, C-5); α-furanose: δ(ppm)= 104.9 (C-2), 84.2 (d, $J_{7,F}$=165,6 Hz, C-7), 81.6 (C-3), 81.0 (d, $J_{5,F}$=7.5 Hz, C-5), 77.0 (C-4), 70.2 (d, $J_{6,F}$=18.4 Hz, C-6), 62.7 (C-1); ^{19}F-NMR (565 MHz, D_2O) β-furanose: δ(ppm)=-232.9 (ddd, $J_{F,7a}$=48.3 Hz, $J_{F,7b}$=47.7 Hz, $J_{F,6}$=24.1 Hz, 1F, C^7-F); α-pyranose: δ(ppm)=-235.0 (ddd, $J_{F,7b}$=48.3 Hz, $J_{F,7a}$=47.4 Hz, $J_{F,6}$=28.8 Hz, 1F, C^7-F); α-furanose: δ(ppm)=-232.3 (ddd, $J_{F,7b}$=46.9 Hz, $J_{F,7a}$=46.8 Hz, $J_{F,6}$=24.8 Hz, 1F, C^7-F); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 235.0588, found: 235.0589.

3-Deoxy-1,2;5,6-di-*O*-isopropylidene-3-fluoro-α-D-glucofuranose (16): Under inert conditions, 1,2;5,6-di-*O*-isopropylidene-D-allose (**15** ,5.0 g, 18.6 mmol, 1eq) was dissolved in anhydrous DCM (40 mL) with addition of anhydrous pyridine (5.1 mL, 62.6 mmol, 3,3 eq). After cooling down with an ice-bath DAST (4.1 mL, 29.5 mmol, 1.6 eq) were added slowly (5 min). After 30 min of stirring the ice-bath was removed and the reaction was stirred over night at rt. On the next day, the reaction was diluted with DCM (15 mL) and washed with $NaHCO_3$ solution, NaCl solution and water. The organic solvent was dried over Na_2SO_4 and evaporated in vacuo. Flash purification (14→20% cyclohexane/ethylacetate) gave **16** as a yellowish oil (2.3 g, 8.8 mmol, 47%). TLC: R_f 0.84 (cyclohexan/ethylacetate 1:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.94 (d, $J_{1,2}$=3.7 Hz, 1H, 1-H), 4.99 (dd, $J_{3,F}$=49.8 Hz, $J_{3,2}$=2.2 Hz, 1H, 3-H), 4.68 (dd, $J_{2,F}$=10.7 Hz, $J_{2,1}$=3.7 Hz, 1H, 2-H), 4.27 (ddd, $J_{5,4}$=8.3 Hz, $J_{5,6a}$=6.1 Hz, $J_{5,6b}$=4.9 Hz, 1H, 5-H), 4.11 (dd, $J_{6a,6b}$=8.8 Hz, $J_{6a,5}$=6.1 Hz, 1H, 6a-H), 4.11 (ddd, $J_{4,F}$=29.1 Hz, $J_{4,5}$=8.3 Hz, $J_{4,3}$=2.2 Hz, 1H, 4-H), 4.02 (dd, $J_{6b,6a}$=8.8 Hz, $J_{6b,5}$=4.8 Hz, 1H, 6b-H), 1.49, 1.43, 1.35 and 1.31 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.5 ($C(CH_3)_2$), 109.6 ($C(CH_3)_2$), 105.3 (C-1), 94.0 (d, $J_{3,F}$=183.9 Hz, C-3), 82.7 (d, $J_{2,F}$=32.9 Hz, C-2), 80.8 (d, $J_{4,F}$=19.1 Hz, C-4), 72.0 (d, $J_{5,F}$=7.2 Hz, C-5), 67.3 (C-6), 27.0, 26.8, 26.3 and 25.3 ($C(CH_3)_2$); ^{19}F-NMR (376 MHz, $CDCl_3$) δ(ppm)=-207.6 (ddd, $J_{F,3}$=49.8 Hz, $J_{F,4}$=29.1 Hz, $J_{F,2}$=10.7 Hz, 1F, C^3-F); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 263.1289, found: 263.1288; *m/z* calcd for $[M+Na]^+$: 285.1109, found: 285.1109.

3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-glucofuranose (17): 17 were synthesized and purified according to GOP4, started from **16** (2.3 g, 8.8 mmol, 1 eq). **17** was obtained as colourless oil (1.9 g, 8.5 mmol, 97%). TLC: R_f 0.31 (cyclohexane/ethylacetate 1:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.94 (d, $J_{1,2}$=3.8 Hz, 1H, 1-H), 5.08 (dd, $J_{3,F}$=49.8 Hz, $J_{3,4}$=2.1 Hz, 1H, 3-H), 4.68 (dd, $J_{2,F}$=10.8 Hz, $J_{2,1}$=3.8 Hz, 1H, 2-H), 4.11 (ddd, $J_{4,F}$=29.3 Hz, $J_{4,5}$=8.9 Hz, $J_{4,3}$=2.1 Hz, 1H, 4-H), 3.91 (ddd, $J_{5,4}$=8.9 Hz, $J_{5,6a}$=5.6 Hz, $J_{5,6b}$=2.8 Hz, 1H, 5-H), 3.83 (dd, $J_{6a,6b}$=11.7 Hz, $J_{6a,5}$=2.8 Hz, 1H, 6a-H), 3.69 (dd, $J_{6b,6a}$=11.7 Hz, $J_{6b,5}$=5.6 Hz, 1H, 6b-H), 1.47 and 1.30 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.5 ($C(CH_3)_2$), 105.2 (C-1), 94.1 (d, $J_{3,F}$=183.9 Hz, C-3), 82.4 (d, $J_{2,F}$=33.1 Hz, C-2), 79.7 (d, $J_{4,F}$=19.1 Hz, C-4), 68.4 (d, $J_{5,F}$=6.9 Hz, C-5), 64.1 (C-6), 26.6 and 26.3 ($C(CH_3)_2$); ^{19}F-NMR (376 MHz, $CDCl_3$) δ(ppm)=-207.9 (ddd, $J_{F,3}$=49.8 Hz, $J_{F,4}$=29.3 Hz, $J_{F,2}$=10.8 Hz, 1F, C^3-F); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 223.0976, found: 223.0977; *m/z* calcd for $[M+Na]^+$: 245.0796, found: 245.0797.

3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (18): 18 were synthesized and purified according to GOP5, started from **17** (1.8 g, 8.2 mmol, 1 eq). Flash purification (14→16% cyclohexane/ethylacetate) gave **18** as a colourless oil (1.2 g, 6.1 mmol, 74%). TLC: R_f 0.55 (cyclohexane/ethylacetate 1:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.97 (d, $J_{1,2}$=3.8 Hz, 1H, 1-H), 4.96 (dd, $J_{3,F}$=50.3 Hz, $J_{3,4}$=2.3 Hz, 1H, 3-H), 4.68 (dd, $J_{2,F}$=11.1 Hz, $J_{2,1}$=3.8 Hz, 1H, 2-H), 4.31 (dddd, $J_{4,F}$=30.2 Hz, $J_{4,5a}$=6.6 Hz, $J_{4,5b}$=5.7 Hz, $J_{4,3}$=2.3 Hz, 1H, 4-H), 3.89 (ddm, $J_{5a,5b}$=11.7 Hz, $J_{5a,4}$=6.6 Hz, 1H, 5a-H), 3.84 (dd, $J_{5b,5a}$=11.7 Hz, $J_{5b,4}$=5.7 Hz, 1H, 5b-H), 1.47 and 1.30 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.4 ($C(CH_3)_2$), 104.9 (C-1), 94.2 (d, $J_{3,F}$=183.3 Hz, C-3), 82.9 (d, $J_{2,F}$=32.5 Hz, C-2), 80.4 (d, $J_{4,F}$=19.0 Hz, C-4), 59.8 (d, $J_{5,F}$=9.7 Hz, C-5), 26.7 and 26.3 ($C(CH_3)_2$); ^{19}F-NMR (376 MHz, $CDCl_3$) δ(ppm)=-208.8 (ddd, $J_{F,3}$=50.3 Hz, $J_{F,4}$=30.2 Hz, $J_{F,2}$=11.1 Hz, 1F, C^3-F); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 193.0871, found: 193.0873; *m/z* calcd for $[M+Na]^+$: 215.0690, found: 215.0692.

3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-5-*O*-mesyl-α-D-xylofuranose: 3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-5-*O*-mesyl-α-D-xylofuranose were synthesized and purified according to GOP2, started from **18** (93 mg, 480 µmol, 1 eq). 3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-5-*O*-mesyl-α-D-xylofuranose were obtained as a yellowish oil, which crystallizes in the cold (125 mg, 460 µmol, 96%). TLC: R_f 0.49 (cyclohexane/ethylacetate 7:3); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.98 (d, $J_{1,2}$=3.7 Hz, 1H, 1-H), 4.99 (dd, $J_{3,F}$=50.3 Hz, $J_{3,4}$=2.3 Hz, 1H, 3-H), 4.70 (dd, $J_{2,F}$=10.8 Hz, $J_{2,1}$=3.7 Hz, 1H, 2-H), 4.47 (dddd, $J_{4,F}$=28.0 Hz, J=7.2 Hz, J=5.2 Hz, $J_{4,3}$=2.3 Hz, 1H, 4-H), 4.41 (m, 2H, 5a-H and 5b-H), 3.05 (s, 3H, Mesyl-CH_3), 1.47 and 1.31 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.8 ($C(CH_3)_2$), 105.2 (C-1), 93.8 (d, $J_{3,F}$=184.4 Hz, C-3), 82.4 (d, $J_{2,F}$=31.8 Hz, C-2), 77.5 (d, $J_{4,F}$=18.5 Hz, C-4), 66.0 (d, $J_{5,F}$=11.0 Hz, C-5), 37.6 (Mesyl-CH_3), 26.7 and 26.3 ($C(CH_3)_2$); ^{19}F-NMR (376 MHz, $CDCl_3$) δ(ppm)=-208.7 (dddd, $J_{F,3}$=50.3 Hz, $J_{F,4}$=28.0 Hz, $J_{F,2}$=10.8 Hz, $J_{F,2}$=2.3 Hz, 1F, C^3-F); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 271.0646, found: 271.0647; *m/z* calcd for $[M+Na]^+$: 293.0466, found: 293.0466.

3,5-Dideoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (19): 19 were synthesized and purified according to GOP3, started from 3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-5-*O*-mesyl-α-D-xylofuranose (366.8 mg, 1.4 mmol, 1 eq). **19** was obtained as colourless oil (150.5 mg, 850 µmol, 63%). TLC: R_f 0.78 (pentane/diethylether 8:2); ^{1}H-NMR (400 MHz, CD_2Cl_2) δ(ppm)= 5.90 (d, $J_{1,2}$=4.0 Hz, 1H, 1-H); 4.72 (dd, $J_{3,F}$=50.4 Hz, $J_{3,4}$=2.2 Hz, 1H, 3-H); 4.66 (dd, $J_{2,F}$=11.0 Hz, $J_{2,1}$=4.0 Hz, 1H, 2-H); 4.47 (ddq, $J_{4,F}$=29.5 Hz, $J_{4,5}$=6.5 Hz, $J_{4,3}$=2.2 Hz, 1H, 4-H); 1.45 and 1.29 (s, 3H, $C(CH_3)_2$); 1.28 (dd, $J_{5,4}$=6.5 Hz, J=1.2 Hz, 3H, 5-H); ^{13}C-NMR (100 MHz, CD_2Cl_2) δ(ppm)=112.0 ($C(CH_3)_2$); 105.0 (C-1); 95.8 (d, $J_{3,F}$=184.1 Hz, C-3); 83.5 (d, $J_{2,F}$=32.9 Hz, C-2); 76.0 (d, $J_{4,F}$=20.2 Hz, C-4); 26.7 and 26.3 ($C(CH_3)_2$); 12.6 (d, $J_{5,F}$=9.0 Hz, C-5); ^{19}F-NMR (376 MHz, CD_2Cl_2) δ(ppm)=-209.3 (ddd, $J_{F,3}$=50.4 Hz, $J_{F,4}$=29.5 Hz, $J_{F,2}$=11.0 Hz, 1F, C^3-F); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 177,0921, found: 177,0928; *m/z* calcd for $[M+Na]^+$: 199,0741, found: 199,0749.

3,5-Dideoxy-3-fluoro-D-xylose (20): 20 were synthesized and purified according to GOP6, started from **19** (1.2 g, 6.7 mmol, 1 eq). Flash purification (20→85% cyclohexane/ethylacetate) gave **20** as a colourless oil (502.7 mg, 3.7 mmol, 55%). TLC: R_f 0.55 (cyclohexane/ethylacetate 25:75); ^{1}H-NMR (400 MHz, D_2O) β-anomer: δ(ppm)=5.24 (s, 1H, 1-H), 4.86 (dd, $J_{3,F}$=50.1 Hz, $J_{3,4}$=3.3 Hz, 1H, 3-H), 4.42 (ddq, $J_{4,F}$=29.8 Hz, $J_{4,5}$=6.7 Hz, $J_{4,3}$=3.3 Hz, 1H, 4-H), 4.28 (d, $J_{2,F}$=13.3 Hz, 1H, 2-H), 1.36 (dd, $J_{5,4}$=6.6 Hz, $J_{5,F}$=1.9 Hz, 3H, 5-H); α-anomer: δ(ppm)=5.49 (d, 1H, $J_{1,2}$=4.5 Hz, 1-H), 4.95 (ddd, $J_{3,F}$=52.3 Hz, $J_{3,4}$=3.6 Hz, $J_{3,2}$=2.2 Hz, 1H, 3-H), 4.47 (ddq, $J_{4,F}$=27.3 Hz, $J_{4,5}$=6.6 Hz, $J_{4,3}$=3.6 Hz, 1H, 4-H), 4.38 (ddd, $J_{2,F}$=19.2 Hz, $J_{2,1}$=4.5 Hz, $J_{2,3}$=2.2 Hz, 1H, 2-H), 1.27 (dd, $J_{5,4}$=6.6 Hz, $J_{5,F}$=2.2 Hz, 3H, 5-H); open chair: δ(ppm)=5.06 (d, 1H, $J_{1,2}$=6,8 Hz, 1-H), 4.50 (ddd, $J_{3,F}$=47.7 Hz, $J_{3,4}$=7.3 Hz, $J_{3,2}$=2.0 Hz, 1H, 3-H), 4.13 (ddq, $J_{4,F}$=15.4 Hz, $J_{4,3}$=7.3 Hz, $J_{4,5}$=6.5 Hz, 1H, 4-H), 3.59 (ddd, $J_{2,F}$=28.9 Hz, $J_{2,1}$=6.8 Hz, $J_{2,3}$=2.0 Hz, 1H, 2-H), 1.23 (dd, $J_{5,4}$=6.5 Hz, $J_{5,F}$=0.7 Hz, 3H, 5-H); ^{13}C-NMR (100 MHz, D_2O) β-anomer: δ(ppm)= 101.8 (C-1), 96.0 (d, $J_{3,F}$=183.3 Hz, C-3), 79.0 (d, $J_{2,F}$=27.4 Hz, C-2), 77.6 (d, $J_{4,F}$=21.1 Hz, C-4), 13.3 (d, $J_{5,F}$=11.1 Hz, C-5); α-anomer: δ(ppm)= 97.6 (d, $J_{3,F}$=182.4 Hz, C-3), 95.5 (d, $J_{1,F}$=3.7 Hz, C-1), 75.0 (d, $J_{2,F}$=28.2 Hz, C-2), 74.4 (d, $J_{4,F}$=21.0 Hz, C-4), 12.6 (d, $J_{5,F}$=11.0 Hz, C-5); open chair: δ(ppm)= 96.1 (d, $J_{3,F}$=174.3 Hz, C-3), 89.1 (d, $J_{1,F}$=7.0 Hz, C-1), 72.5 (d, $J_{2,F}$=18.0 Hz, C-2), 66.7 (d, $J_{4,F}$=19.5 Hz, C-4), 17.1 (d, $J_{5,F}$=7.8 Hz, C-5); ^{19}F-NMR (376 MHz, D_2O): β-anomer: δ(ppm)=-201.3 (ddd, $J_{F,3}$=50.1 Hz, $J_{F,4}$=29.8 Hz, $J_{F,2}$=13.3 Hz, 1F, C^3-F); α-anomer: δ(ppm)=-202.7 (ddd, $J_{F,3}$=52.3 Hz, $J_{F,4}$=27.3 Hz, $J_{F,2}$=19.2 Hz, 1F, C^3-F); open chair: δ(ppm)=-208.6 (ddd, $J_{F,3}$=47.7 Hz, $J_{F,2}$=28.9 Hz, $J_{F,4}$=15.4 Hz, 1F, C^3-F); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 159.0428, found: 159.0432.

5,7-Dideoxy-5-fluoro-idoheptulose (3): 3 were synthesized and purified according to GOP7, started from **20** (14.3 mg, 105.1 µmol, 1 eq). Flash purification (0→20% chloroform/methanol) and subsequent HPLC (HiPlexCa, solvent: H_2O, column temperature: 85 °C, flow: 1.0 mL/min) gave **3** as a colourless oil (2.6 mg, 12.3 µmol, 13%). TLC: R_f 0.48 (chloroform/methanol 8:2) ^{1}H-NMR (700 MHz, D_2O) α/β-pyranose: δ(ppm)=4.47 (dm, $J_{5,F}$=45.0 Hz, 1H, 5-H), 4.41 (dqm, $J_{6,F}$=33.6 Hz, $J_{6,7}$=6.8 Hz, 1H, 6-H), 4.15 (ddm, $J_{4,F}$=10.3 Hz, $J_{4,3}$=3.4 Hz, 1H, 4-H), 3.74 (d, $J_{3,4}$=3.4 Hz, 1H, 3-H), 3.72 (d, $J_{1a,1b}$=11.7 Hz, 1H, 1a-H), 3.51 (d, $J_{1b,1a}$=11.7 Hz, 1H, 1b-H), 1.29 (d, $J_{7,6}$=6.8 Hz, 3H, 7-H); open chair: δ(ppm)= 4.64 (d, $J_{1a,1b}$=19.5 Hz, 1H, 1a-H), 4.54 (d, $J_{1b,1a}$=19.5 Hz, 1H, 1b-H), 4.53 (m, 1H, 3-H), 4.48 (dm, $J_{5,F}$=47.4 Hz, 1H, 5-H), 4.25 (ddd, $J_{4,F}$=20.6 Hz, J=5.3 Hz, J=3.2 Hz, 1H, 4-H), 4.09 (ddq, $J_{6,F}$=23.3 Hz, $J_{6,7}$=6.7 Hz, J=4.4 Hz, 1H, 6-H), 1.28 (d, $J_{7,6}$=6.7 Hz, 3H, 7-H); β/α-pyranose: δ(ppm)= 4.56 (ddd, $J_{5,F}$=49.0 Hz, $J_{5,4}$=7.4 Hz, J=5.3 Hz, 1H, 5-H), 4.34 (ddm, $J_{6,F}$=12.3 Hz, $J_{6,7}$=6.9 Hz, 1H, 6-H), 4.16 (ddd, $J_{4,F}$=13.2 Hz, $J_{4,3}$=9.2 Hz, $J_{4,5}$=7.4 Hz, 1H, 4-H), 3.68 (d, $J_{1a,1b}$=11.8 Hz, 1H, 1a-H), 3.65 (d, $J_{3,4}$=9.2 Hz, 1H, 3-H), 3.47 (d, $J_{1b,1a}$=11.8 Hz, 1H, 1b-H), 1.36 (dd, $J_{7,6}$=7.0 Hz, $J_{7,F}$=2.8 Hz, 3H, 7-H); ^{13}C-NMR

(176 MHz, D_2O) α/β-pyranose: δ(ppm)=97.9 (C-2), 90.3 (d, $J_{5,F}$=179.4 Hz, C-5), 68.5 (d, $J_{4,F}$=25.6 Hz, C-4), 66.5 (C-3), 64.2 (C-1), 63.1 (d, $J_{6,F}$=19.6 Hz, C-6), 14.6 (d, $J_{7,F}$=7.7 Hz, C-7); open chair: δ(ppm)=212.0 (C-2), 96.3 (d, $J_{5,F}$=174.0 Hz, C-5), 75.2 (d, $J_{5,F}$=6.0 Hz, C-3), 70.6 (d, $J_{4,F}$=20.0 Hz, C-4), 65.9 (C-1), 65.8 (d, $J_{6,F}$=19.7 Hz, C-6), 17.8 (d, $J_{7,F}$=6.7 Hz, C-7); β/α-pyranose: δ(ppm)= 98.3 (C-2), 92.1 (d, $J_{5,F}$=181.7 Hz, C-5), 69.5 (d, $J_{6,F}$=22.2 Hz, C-6), 69.1 (d, $J_{3,F}$=7.0 Hz, C-3), 68.8 (d, $J_{4,F}$=20.5 Hz, C-4), 63.4 (C-1), 15.7 (d, $J_{7,F}$=4.6 Hz, C-7); ^{19}F-NMR (658 MHz, D_2O) α/β-pyranose: δ(ppm)=-202.7 (ddd, $J_{F,5}$=45.0 Hz, $J_{F,6}$=33.6 Hz, $J_{F,4}$=10.3 Hz, 1F, C^5-F); open chair: δ(ppm)=-209.2 (ddd, $J_{F,5}$=47.4 Hz, $J_{F,6}$=23.3 Hz, $J_{F,4}$=20.6 Hz, 1F, C^5-F); β/α-pyranose: δ(ppm)=-197.8 (ddd, $J_{F,5}$=49.6 Hz, $J_{F,4}$=13.2 Hz, $J_{F,6}$=12.3 Hz, 1F, C^5-F); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 219.0639, found: 219.0634.

1,2;5,6-Di-*O*-isopropylidene-3-methoxy-α-D-allofuranose (21): To a solution of 1,2;5,6-Di-*O*-isopropylidene-α-D-allofuranose (**15**, 5.0 g, 18.7 mmol, 1 eq) in dioxane (50 mL) KOH (3.4 g, 60.2 mmol, 3.2 eq) was added under inert conditions. The reaction was reflux for 1 h, subsequent cooled to rt and later with an ice-bath. While further cooling MeI (2.6 mL, 41.8 mmol, 2.2 eq) was added dropwise. After 20 min of stirring the ice-bath was removed and the reaction was stirred over night at rt. On the next day MeI was quenched through addition of KOH solution and the solvent was evaporated in vacuo. The reaction mixture was resolved in water and 3x extracted with ethylacetate. The combined organic solvent was washed 3x with NaCl solution, dried over Na_2SO_4 and evaporated in vacuo to get **21** (5.1 g, 18.4, 98%) as a colourless oil. TLC: R_f 0.31 (chloroform/methanol 8:2) ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.76 (d, $J_{1,2}$=3.7 Hz, 1H, 1-H), 4.68 (dd, $J_{2,3}$=4.3 Hz, $J_{2,1}$=3.7 Hz, 1H, 2-H), 4.37 (ddd, $J_{5,6a}$=7.3 Hz, $J_{5,6b}$=6.9 Hz, $J_{5,4}$=3.1 Hz, 1H, 5-H), 4.03 (dd, $J_{4,3}$=8.7 Hz, $J_{4,5}$=3.1 Hz, 1H, 4-H), 3.99 (d, $J_{6a,5}$=7.3 Hz, 1H, 6a-H), 3.99 (d, $J_{6b,5}$=6.9 Hz, 1H, 6b-H), 3.74 (dd, $J_{3,4}$=8.7 Hz, $J_{3,2}$=4.3 Hz, 1H, 3-H), 3.48 (s, 3H, OCH_3), 1.56, 1.43, 1.36 and 1.34 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=113.0 ($C(CH_3)_2$), 109.8 ($C(CH_3)_2$), 103.8 (C-1), 80.4 (C-3), 77.8 (C-4), 77.5 (C-2), 74.8 (C-5), 65.1 (C-6), 58.3 (OCH_3), 26.9, 26.6, 26.2 und 25.3 ($C(CH_3)_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 275.1489, found: 275.1490; *m/z* calcd for $[M+Na]^+$: 297.1309, found: 297.1310.

1,2-*O*-Isopropylidene-3-methoxy-α-D-allofuranose (22): 22 were synthesized and purified according to GOP4, started from **21** (5.0 g, 18.2 mmol, 1 eq). Flash purification (0→15% chloroform/methanol) gave **22** as a colourless oil (3.5 g, 14.9 mmol, 82%). TLC: R_f 0.39 (chloroform/methanol 9:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.78 (d, $J_{1,2}$=3.6 Hz, 1H, 1-H), 4.70 (dd, $J_{2,3}$=4.3 Hz, $J_{2,1}$=3.6 Hz, 1H, 2-H), 4.05-3.99 (m, 2H, 4-H and 5-H), 3.80 (dm, $J_{3,2}$=4.3 Hz, 1H, 3-H), 3.69 (m, 2H, 6a-H and 6b-H), 3.49 (s, 3H, OCH_3), 1.57 and 1.35 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=113.4 ($C(CH_3)_2$), 104.2 (C-1), 79.3 (C-3), 78.9 (C-4), 77.0 (C-2), 70.9 (C-5), 63.1 (C-6), 57.9 (OCH_3); 26.9 and 26.6 ($C(CH_3)_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 235.1176, found: 235.1181; *m/z* calcd for $[M+Na]^+$: 257.0996, found: 257.0999.

1,2-*O*-Isopropylidene-3-methoxy-α-D-ribofuranose (23): 23 were synthesized and purified according to GOP5, started from **22** (3.5 g, 14.9 mmol, 1 eq). Flash purification (50→100% cyclohexane/ethylacetate) gave **23** as a colourless oil (2.5 g, 12.2 mmol, 82%). TLC: R_f 0.52 (ethylacetate); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.76 (d, $J_{1,2}$=3.6 Hz, 1H, 1-H), 4.69 (dd, $J_{2,3}$=4.3 Hz, $J_{2,1}$=3.6 Hz, 1H, 2-H), 4.04 (ddd, $J_{4,3}$=9.1 Hz, $J_{4,5b}$=3.0 Hz, $J_{4,5a}$=2.5 Hz, 1H, 4-H), 3.94 (dd, $J_{5a,5b}$=12.5 Hz, $J_{5a,4}$=2.5 Hz, 1H, 5a-H), 3.71 (dd, $J_{3,4}$=9.1 Hz, $J_{3,2}$=4.3 Hz, 1H, 3-H), 3.67 (dd, $J_{5b,5a}$=12.5 Hz, $J_{5b,4}$=3.0 Hz, 1H, 5b-H), 3.49 (s, 3H, OCH_3), 1.57 and 1. 36 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=113.3 ($C(CH_3)_2$), 104.1 (C-1), 79.4 (C-3), 78.8 (C-4), 77.4 (C-2), 60.8 (C-5), 58.6 (OCH_3), 26.9 and 26.6 ($C(CH_3)_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 205.1071, found: 205.1073; *m/z* calcd for $[M+Na]^+$: 227.0890, found: 227.0891.

1,2-*O*-Isopropylidene-5-mesyl-3-methoxy-α-D-ribofuranose: 1,2-*O*-Isopropylidene-5-mesyl-3-methoxy-α-D-ribofuranose were synthesized and purified according to GOP2, started from **23** (1.2 g, 5.8 mmol, 1 eq). 1,2-*O*-Isopropylidene-5-mesyl-3-methoxy-α-D-ribofuranose were obtained as a yellowish oil, which crystallizes in the cold (1.6 g, 5.7 mmol, 98%). TLC: R_f 0.86 (chloroform/methanol 9:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.75 (d, $J_{1,2}$=3.6 Hz, 1H, 1-H), 4.68 (dd, $J_{2,3}$=4.2 Hz, $J_{2,1}$=3.6 Hz, 1H, 2-H), 4.49 (dd, $J_{5a,5b}$=11.8 Hz, $J_{5a,4}$=2.1 Hz, 1H, 5a-H), 4.32 (dd, $J_{5b,5a}$=11.8 Hz, $J_{5b,4}$=4.0 Hz, 1H, 5b-H), 4.15 (ddd, $J_{4,3}$=9.2 Hz, $J_{4,5b}$=4.0 Hz, $J_{4,5a}$=2.1 Hz, 1H, 4-H), 3.62 (dd, $J_{3,4}$=9.2 Hz, $J_{3,2}$=4.2 Hz, 1H, 3-H), 3.48 (s, 3H, OCH_3), 3.03 (s, 3H, Mesyl-CH_3), 1.55 and 1.34 (s, 3H, $C(CH_3)_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=113.5 ($C(CH_3)_2$), 104.1 (C-1), 79.7 (C-3), 76.7 (C-2), 76.2 (C-4), 68.0 (C-5), 58.5 (OCH_3), 37.6 (Mesyl-CH_3), 26.8 and 26.5 ($C(CH_3)_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 283.0846, found: 283.0848; *m/z* calcd for $[M+Na]^+$: 305.0665, found: 305.0667.

5-Deoxy-1,2-*O*-isopropylidene-3-methoxy-α-D-ribofuranose (24): 24 were synthesized and purified according to GOP3, started from 1,2-*O*-Isopropylidene-5-mesyl-3-methoxy-α-D-ribofuranose (1.6 g, 5.7 mmol, 1 eq). Flash purification (pentane/diethylether 8:2) gave **24** as a colourless oil (752.1 mg, 4.0 mmol, 70%). TLC: R_f 0.33 (pentane/diethylether 8:2); ^{1}H-NMR (400 MHz, CD_2Cl_2) δ(ppm)=5.70 (d, $J_{1,2}$=3.9 Hz, 1H, 1-H), 4.62 (dd, $J_{2,3}$=4.3 Hz, $J_{2,1}$=3.9 Hz, 1H, 2-H), 3.94 (dq, $J_{4,3}$=8.9 Hz, $J_{4,5}$=6.1 Hz, 1H, 4-H), 3.42 (s, 3H, OCH_3), 3.14 (dd, $J_{3,4}$=8.9 Hz, $J_{3,2}$=4.3 Hz, 1H, 3-H), 1.50 and 1.31 (s, 3H, $C(CH_3)_2$), 1.25 (d, $J_{5,4}$=6,1 Hz, 1H, H-5); ^{13}C-NMR (100 MHz, CD_2Cl_2) δ(ppm)=112.6 ($C(CH_3)_2$), 104.3 (C-1), 86.5 (C-3), 77.3 (C-2), 74.2 (C-4), 58.2 (OCH_3), 26.7 and 26.6 ($C(CH_3)_2$), 17.6 (C-5); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 189.1121, found: 189.1121; *m/z* calcd for $[M+Na]^+$: 211.0941, found: 211.0943.

5-Deoxy-3-methoxy-D-ribose (25): 25 were synthesized and purified according to GOP6, started from **24** (652.4 mg, 3.5 mmol, 1 eq). Flash purification (cyclohexane/ethylacetate 3:7) gave **25** as a colourless oil (38.2 mg, 2.6 mmol, 76%). TLC: R_f 0.48 (ethylacetate); ^{1}H-NMR (400 MHz, D_2O) β-anomer: δ(ppm)=5.19 (d, $J_{1,2}$=1.8 Hz, 1H, 1-H), 4.18 (dd, $J_{2,3}$=4.6 Hz, $J_{2,1}$=1.8 Hz, 1H, 2-H), 4.06 (dq, $J_{4,3}$=6.6 Hz, $J_{4,5}$=6.4 Hz, 1H, 4-H), 3.71 (dd, $J_{3,4}$=6.6 Hz, $J_{3,2}$=4.6 Hz, 1H, 3-H), 3.43 (s, 1H, OCH_3), 1.34 (d, $J_{5,4}$=6.4 Hz, 3H, 5-H); α-anomer: δ(ppm)= 5.32 (d, $J_{1,2}$=4.2 Hz, 1H, 1-H), 4.27 (dd, $J_{2,3}$=5.3 Hz, $J_{2,1}$=4.2 Hz, 1H, 2-H), 4.20 (dq, $J_{4,5}$=6.5 Hz, $J_{4,3}$=5.4 Hz, 1H, 4-H), 3.54 (dd, $J_{3,4}$=5.4 Hz, $J_{3,2}$=5.3 Hz, 1H, 3-H), 3.42 (s, 1H, OCH_3), 1.24 (d, $J_{5,4}$=6.5 Hz, 3H, 5-H); ^{13}C-NMR (100 MHz, D_2O) β-anomer: δ(ppm)=101.1 (C-1), 84.6 (C-3), 76.6 (C-4), 73.2 (C-2), 57.7 (OCH_3), 19.7 (C-5). α-anomer: δ(ppm)= 95.7 (C-1), 83.9 (C-3), 76.5 (C-4), 69.3 (C-2), 57.6 (OCH_3), 18.5 (C-5); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 171.0628, found: 171.0630.

7-Deoxy-5-methoxy-sedoheptulose (4): 4 were synthesized and purified according to GOP7, started from **25** (50.3 mg, 339 µmol, 1 eq). Flash purification (0→30% chloroform/methanol) gave **4** as a white solid (43,5 mg, 209 µmol, 62%). TLC: R_f 0.51 (chloroform/methanol 8:2) ^{1}H-NMR (400 MHz, D_2O) α-pyranose: δ(ppm)=4.28 (dd, $J_{4,3}$=3.8 Hz, $J_{4,5}$=3.1 Hz, 1H, 4-H), 4.07 (dq, $J_{6,5}$=10.0, Hz, $J_{6,7}$=6.2 Hz, 1H, 6-H), 3.95 (d, $J_{3,4}$=3.8 Hz, 1H, 3-H), 3.65 (d, $J_{1a,1b}$=11.6 Hz, 1H, 1a-H), 3.41 (s, 3H, OCH_3), 3.39 (d, $J_{1b,1a}$=11.6 Hz, 1H, 1b-H), 3.27 (dd, $J_{5,6}$=10.0 Hz, $J_{5,4}$=3.1 Hz, 1H, 5-H), 1.26 (d, $J_{7,6}$=6.2 Hz, 3H, 7-H); β-pyranose: δ(ppm)= 4.23 (dq, $J_{6,7}$=7.2 Hz, $J_{6,5}$=2.6 Hz, 1H, 6-H), 4.17 (dd, $J_{4,3}$=9.4 Hz, $J_{4,5}$=3.3 Hz, 1H, 4-H), 3.80 (d, $J_{3,4}$=9.4 Hz, 1H, 3-H), 3.64 (d, $J_{1a,1b}$=11.7 Hz, 1H, 1a-H), 3.52 (dd, $J_{5,4}$=3.3 Hz, $J_{5,6}$=2.6 Hz, 1H, 5-H), 3.48 (d, $J_{1b,1a}$=11.7 Hz, 1H, 1b-H), 3.41 (s, 3H, OCH_3), 1.37 (d, $J_{7,6}$=7.2 Hz, 3H, 7-H); ^{13}C-NMR (100 MHz, D_2O) α-pyranose: δ(ppm)=97.6 (C-2), 78.5 (C-5), 67.7 (C-3), 66.7 (C-4), 63.9 (C-1), 63.4 (C-6), 56.3 (OCH_3), 17.0 (C-7); β-pyranose: δ(ppm)= 98.8 (C-2), 82.4 (C-5), 70.8 (C-6), 67.7 (C-3), 66.3 (C-4), 64.0 (C-1), 57.6 (OCH_3), 19.4 (C-7); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 231.0839, found: 231.0841.

3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-erythro-hex-3-enofuranose (27): To a solution of 1,2;5,6-Di-*O*-isopropylidene-α-D-glucofuranose (**26**, 5.0 g, 18.9 mmol, 1 eq) in DCM (50 mL) pyridine (10 mL, 122.6 mmol, 6.5 eq) was added and cooled under ice-bath conditions. While further cooling trifluoromethanesulfonic anhydride (8.5 mL, 49.5 mmol, 2.6 eq) were added tropwise within 10 min and stirred further for 2 h under these conditions. Afterwards the reaction mixture was washed with 2x NaCl solution and 2x water. The organic solvent was dried over Na_2SO_4 and evaporated in vacuo. Subsequent the intermediate product was solved in DMSO (10 mL) with addition of DBU (5.7 mL, 37.6 mmol, 2 eq) stirred over night at rt. On the next day the reaction mixture was diluted in chloroform (75 mL) and washed 3x with NaCl solution. The organic solvent was dried over Na_2SO_4 and evaporated in vacuo. Flash purification (0→25% cyclohexane/ethylacetate) gave **27** as a white solid (2.9 g, 12.0 mmol, 64%). TLC: R_f 0.60 (cyclohexane/ethylacetate 3:1); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=6.07 (d, $J_{1,2}$=5.3 Hz, 1H, H-1), 5.29 (ddd, $J_{2,1}$=5.3 Hz, $J_{2,3}$=2.3 Hz, $J_{2,5}$=1.5 Hz, 1H, H-2), 5.24 (dd, $J_{3,2}$=2.3 Hz, $J_{3,5}$=1.1 Hz, 1H, H-3), 4.58 (dddd, $J_{5,6a}$=6.8 Hz, $J_{5,6b}$=5.8 Hz, $J_{5,2}$=1.5 Hz, $J_{5,3}$=1.1 Hz, 1H, H-5), 4.14 (dd, $J_{6a,6b}$=8.5 Hz, $J_{6a,5}$=6.8 Hz, 1H, H-6a), 3.96 (dd, $J_{6b,6a}$=8.5 Hz, $J_{6b,5}$=5.8 Hz, 1H, H-6b), 1.46, 1.46, 1.44 and 1.38 (s, 3H, C(CH_3)$_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=160.2 (C4), 112.4 (*C*(CH_3)$_2$), 110.5 (*C*(CH_3)$_2$), 106.7 (C-1), 99.1 (C-3), 83.5 (C-2), 71.4 (C-5), 67.1 (C-6), 28.4, 28.1, 26.4 and 25.7 (C*(*CH_3*)*$_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 243.1227, found: 243.1228; *m/z* calcd for $[M+Na]^+$: 265.1046, found: 265.1046.

3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-gulofuranose: To a solution of **27** (2.9 g, 11.9 mmol, 1 eq) in ethylacetate (30 mL) 10% Pd/C (180 mg) was added under inert conditions. The reaction was started by substituting the inert gas with H_2 (Ballon pressure) while stirring at rt. After 3 h the reaction mixture was filtered through celite and evaporated in vacuo to dryness. Flash purification (0→40% cyclohexane/ethylacetate) gave 3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-gulofuranose as a white solid (985.8 mg, 4.0 mmol, 34%). TLC: R_f 0.41 (cyclohexane/ethylacetate 7:3); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.79 (d, $J_{1,2}$=3.8 Hz, 1H, H-1), 4.71 (ddd, $J_{2,3a}$=6.2 Hz, $J_{2,1}$=3.8 Hz, $J_{2,3b}$=1.2 Hz, 1H, H-2), 4.42 (ddd, $J_{5,4}$=8.4 Hz, $J_{5,6b}$=6.9 Hz, $J_{5,6a}$=6.5 Hz, 1H, H-5), 4.10 (ddd, $J_{4,3a}$=8.5 Hz, $J_{4,5}$=8.4 Hz, $J_{4,3b}$=4.0 Hz, 1H, H-4), 4.03 (dd, $J_{6a,6b}$=8.2 Hz, $J_{6a,5}$=6.5 Hz, 1H, H-6a), 3.60 (dd, $J_{6b,6a}$=8.2 Hz, $J_{6b,5}$=6.9 Hz, 1H, H-6b), 2.19 (ddd, $J_{3a,3b}$=14.3 Hz, $J_{3a,4}$=8.5 Hz, $J_{3a,2}$=6.2 Hz, 1H, H-3a), 1.81 (ddd, $J_{3b,3a}$=14.3 Hz, $J_{3b,4}$=4.0 Hz, $J_{3b,2}$=1.2 Hz, 1H, H-3b), 1.56, 1.43, 1.36 and 1.31 (s, 3H, C(CH_3)$_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=113.0 (*C*(CH_3)$_2$), 110.1 (*C*(CH_3)$_2$), 106.6 (C-1), 81.6 (C-4), 80.6 (C-2), 77.8 (C-5), 66.2 (C-6), 33.7 (C-3), 27.5, 26.9, 26.4 and 25.4 (C*(*CH_3*)*$_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 267.1203, found: 267.1207.

3-Deoxy-1,2-*O*-isopropylidene-α-D-gulofuranose (28): To an ice-cold solution of 3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-gulofuranose (956.0 mg, 3.9 mmol, 1 eq) in THF (8 mL) 30% $HClO_4$ (3.2 mL, precooled) were added. After 10 min the reaction was terminated through neutralization with Na_2CO_3 solution and evaporated in vacuo to dryness. Flash purification (0→20% chloroform/methanol) gave **28** as a white solid (417.1 mg, 2.0 mmol, 52%). TLC: R_f 0.31 (cyclohexane/ethylacetate 1:9); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.81 (d, $J_{1,2}$=3.9 Hz, 1H, H-1), 4.76 (ddd, $J_{2,3a}$=6.2 Hz, $J_{2,1}$=3.9 Hz, $J_{2,3b}$=1.1 Hz, 1H, H-2), 4.22 (ddd, $J_{4,3a}$=8.4 Hz, $J_{4,5}$=8.2 Hz, $J_{4,3b}$=3.0 Hz, 1H, H-4), 4.37 (ddd, $J_{5,4}$=8.2 Hz, $J_{5,6b}$=4.8 Hz, $J_{5,6a}$=3.6 Hz, 1H, H-5), 3.74 (dd, $J_{6a,6b}$=11.7 Hz, $J_{6a,5}$=3.6 Hz, 1H, H-6a), 3.55 (dd, $J_{6b,6a}$=11.7 Hz, $J_{6b,5}$=4.8 Hz, 1H, H-6b), 2.21 (ddd, $J_{3a,3b}$=14.4 Hz, $J_{3a,4}$=8.4 Hz, $J_{3a,2}$=6.2 Hz, 1H, H-3a), 2.05 (ddd, $J_{3b,3a}$=14.4 Hz, $J_{3b,4}$=3.0 Hz, $J_{3b,2}$=1.1 Hz, 1H, H-3b), 1.54 and 1.30 (s, 3H, C(CH_3)$_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.7 (*C*(CH_3)$_2$), 106.3 (C-1), 81.2 (C-4), 80.8 (C-2), 72.9 (C-5), 63.5 (C-6), 33.6 (C-3), 27.0 and 26.0 (C*(*CH_3*)*$_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 205.1071, found: 205.1075; *m/z* calcd for $[M+Na]^+$: 227.0890, found: 227.0895.

3-Deoxy-1,2-*O*-isopropylidene-α-L-lyxofuranose (29): 29 were synthesized and purified according to GOP5, started from **28** (1.04 g, 5.1 mmol, 1 eq). Flash purification (50→100% cyclohexane/ethylacetate) gave **29** as a colourless oil (613.7 mg, 3.5 mmol, 69%). TLC: R_f 0.57 (ethylacetate); ^{1}H-NMR (400 MHz, $CDCl_3$) δ(ppm)=5.79 (d, $J_{1,2}$=3.9 Hz, 1H, H-1), 4.73 (m, 1H, H-2), 4.29 (m, 1H, H-4), 3.80 (dd, $J_{5a,5b}$=11.6 Hz, *J*=8.0 Hz, 1H, H-5a), 3.57 (dd, $J_{5b,5a}$=11.6 Hz, *J*=4.3 Hz, 1H, H-5b), 2.17 (dm, $J_{3a,3b}$=14.4 Hz, 1H, H-3a), 1.96 (dm, $J_{3b,3a}$=14.4 Hz, 1H, H-3b), 1.52 and 1.29 (s, 3H, C(CH_3)$_2$); ^{13}C-NMR (100 MHz, $CDCl_3$) δ(ppm)=112.5 (*C*(CH_3)$_2$), 106.5 (C-1), 81.8 (C-4), 80.8 (C-2), 65.1 (C-5), 33.2 (C-3), 27.1 and 26.0 (C*(*CH_3*)*$_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 175.0965, found: 175.0967; *m/z* calcd for $[M+Na]^+$: 197.0784, found: 197.0786.

3-Deoxy-1,2-*O*-isopropylidene-5-mesyl-α-L-lyxofuranose: 3-Deoxy-1,2-*O*-isopropylidene-5-mesyl-α-L-lyxofuranose were synthesized and purified according to GOP2, started from **29** (708.9 mg, 4.1 mmol, 1 eq). 3-Deoxy-1,2-*O*-isopropylidene-5-mesyl-α-L-lyxofuranose were obtained as a yellowish oil (183.6 mg, 770 µmol, 19%). TLC: R_f 0.60 (cyclohexane/ethylacetate 3:7); ^{1}H-NMR (600 MHz, CD_2Cl_2) δ(ppm)=5.83 (d, $J_{1,2}$=3.9 Hz, 1H, H-1), 4.76 (ddd, $J_{2,3a}$=5.8 Hz, $J_{2,1}$=3.9 Hz, $J_{2,3b}$=0.6 Hz, 1H, H-2), 4.51 (dd, $J_{5a,5b}$=10.7 Hz, $J_{5a,4}$=8.7 Hz, 1H, H-5a), 4.43 (dddd, $J_{4,5a}$=8.7 Hz, $J_{4,3a}$=8.7 Hz, $J_{4,5b}$=4.3 Hz, $J_{4,3b}$=2.0 Hz, 1H, H-4), 4.17 (dd, $J_{5b,5a}$=10.7 Hz, $J_{5b,4}$=4.3 Hz, 1H, H-5b), 3.83 (s, 3H, Mesyl-CH_3), 2.24 (ddd, $J_{3a,3b}$=14.6 Hz, $J_{3a,4}$=8.7 Hz, $J_{3a,2}$=5.8 Hz, 1H, H-3a), 2.03 (dddm, $J_{3b,3a}$=14.6 Hz, $J_{3b,4}$=2.0 Hz, $J_{3b,2}$=0.6 Hz, 1H, H-3b), 1.56 and 1.30 (s, 3H, C(CH_3)$_2$); ^{13}C-NMR (100 MHz, CD_2Cl_2) δ(ppm)=112.7 (*C*(CH_3)$_2$), 107.5 (C-1), 80.6 (C-2), 78.8 (C-4), 72.3 (C-5), 38.2 (Mesyl-CH_3), 33.9 (C-3), 26.8 and 25.7 (C*(*CH_3*)*$_2$); HR-(+)ESI-MS: *m/z* calcd for $[M+H]^+$: 253.0740, found: 253.0750; *m/z* calcd for $[M+Na]^+$: 275.0560, found: 275.0568.

SUPPORTING INFORMATION

3,5-Dideoxy-α-L-lyxofuranose (31): 31 were obtained over **30**, which were synthesized and purified according to GOP3, started from 3-Deoxy-1,2-*O*-isopropylidene-5-mesyl-α-L-lyxofuranose (183,6 mg, 770 µmol, 1 eq). Only the temperature were increased to 100 °C (TLC: R_f 0.71 (cyclohexane/ethylacetate 1:1)). 3-Deoxy-1,2-*O*-isopropylidene-5-mesyl-α-L-lyxofuranose were directly further used for the synthesis of **31** according to GOP6 because of its instability. Flash purification (0→30% chloroform/methanol) gave **31** as a colourless oil (5.7 mg, 48.2 µmol, 6.6%). TLC: R_f 0.55 (chloroform/methanol 8:2); ^{1}H-NMR (600 MHz, MeOD) β-anomer: δ(ppm)=5.16 (s, 1H, H-1), 4.33 (ddq, $J_{4,3a}$=6.9 Hz, $J_{4,3b}$=6.5 Hz, $J_{4,5}$=6.2 Hz, 1H, H-4), 4.10 (ddm, $J_{2,3a}$=6.4 Hz, $J_{2,3b}$=3.4 Hz, 1H, H-2), 2.40 (ddd, $J_{3a,3b}$=13.3 Hz, $J_{3a,4}$=6.9 Hz, $J_{3a,2}$=6.4 Hz, 1H, H-3a), 1.42 (ddd, $J_{3b,3a}$=13.3 Hz, $J_{3a,4}$=6.5 Hz, $J_{3a,2}$=3.4 Hz, 1H, H-3b), 1.29 (d, $J_{5,4}$=6.2 Hz, 3H, H-5); α-anomer: δ(ppm)= 5.04 (d, $J_{1,2}$=4.4 Hz, 1H, H-1), 4.11 (ddd, $J_{2,3b}$=9.7 Hz, $J_{2,3a}$=7.2 Hz, $J_{2,1}$=4.4 Hz, 1H, H-2), 4.04 (ddq, $J_{4,3b}$=9.4 Hz, $J_{4,3a}$=6.2 Hz, $J_{4,5}$=6.1 Hz, 1H, H-4), 2.25 (ddd, $J_{3a,3b}$=12.0 Hz, $J_{3a,2}$=7.2 Hz, $J_{3a,4}$=6.1 Hz, 1H, H-3a), 1.61 (ddd, $J_{3b,3a}$=12.0 Hz, $J_{3a,2}$=9.7 Hz, $J_{3a,4}$=9.4 Hz, 1H, H-3b), 1.30 (d, $J_{5,4}$=6.2 Hz, 3H, H-5); ^{13}C-NMR (150 MHz, MeOD) β-anomer: δ(ppm)=104.5 (C-1), 78.4 (C-2), 75.3 (C-4), 40.8 (C-3), 22.3 (C-5); α-anomer: δ(ppm)=97.2 (C-1), 73.9 (C-4), 73.4 (C-2), 39.2 (C-3), 23.3 (C-5); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 141.0522, found: 141.0526.

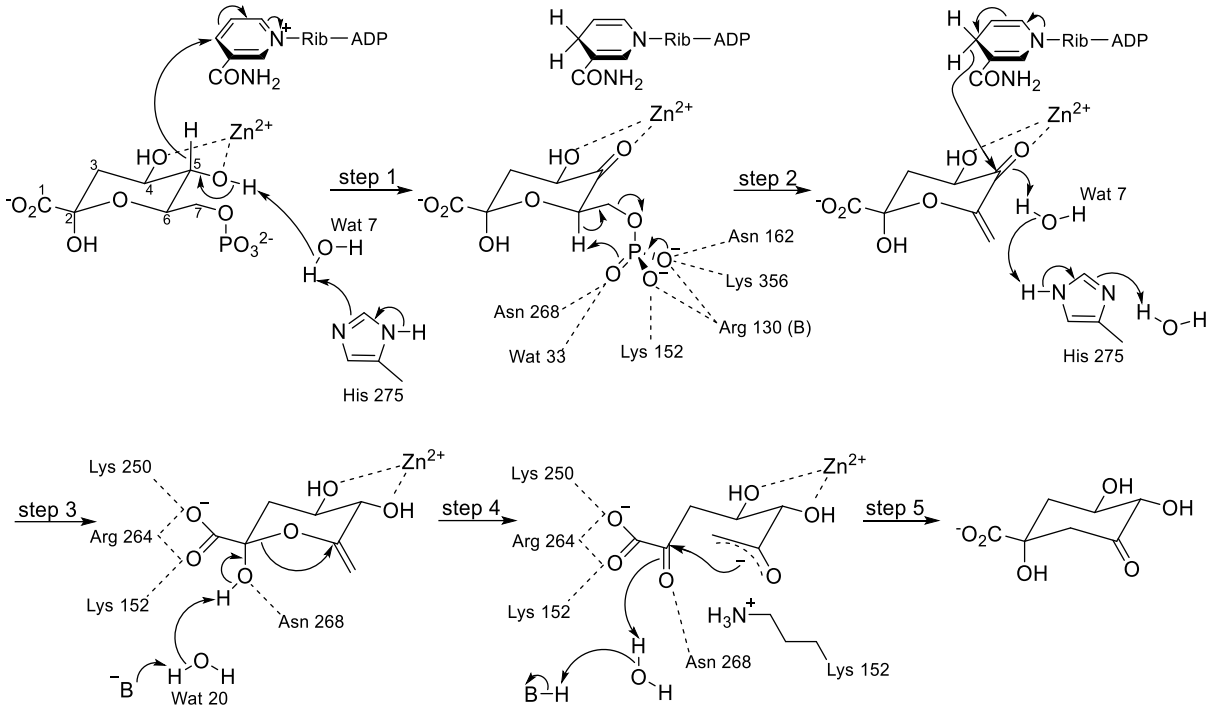
5,7-Dideoxy-α-L-glucoheptulose (6): 6 were synthesized and purified according to GOP7, started from **31** (5.7 mg, 48,2 µmol, 1 eq). Flash purification (0→20% chloroform/methanol) gave **6** as a colourless oil (1.2 mg, 6.7 µmol, 14%). TLC: R_f 0.27 (chloroform/methanol 8:2); ^{1}H-NMR (600 MHz, D_2O) α-pyranose: δ(ppm)=4.13 (ddq, $J_{6,5b}$=12.6 Hz, $J_{6,7}$=6.3 Hz, $J_{6,5a}$=2.0 Hz, 1H, H-6), 3.94 (ddd, $J_{4,5b}$=11.6 Hz, $J_{4,3}$=9.5 Hz, $J_{4,5a}$=5.0 Hz, 1H, H-4), 3.70 (d, $J_{1a,1b}$=11.7 Hz, 1H, H-1a), 3.50 (d, $J_{1b,1a}$=11.7 Hz, 1H, H-1b), 3.44 (d, $J_{3,4}$=9.5 Hz, 1H, H-3), 2.06 (ddd, $J_{5a,5b}$=12.8 Hz, $J_{5a,4}$=5.0 Hz, $J_{5a,6}$=2.0 Hz, 1H, H-5a), 1.38 (ddd, $J_{5b,5a}$=12.8 Hz, $J_{5b,6}$=12.6 Hz, $J_{5b,4}$=11.6 Hz, 1H, H-5b), 1.20 (d, $J_{7,6}$=6.3 Hz, 3H, H-7); ^{13}C-NMR (150 MHz, D_2O) α-pyranose: δ(ppm)= 97.9 (C-2), 72.1 (C-3), 68.2 (C-4), 65.3 (C-6), 63.8 (C-1), 40.0 (C-5), 20.0 (C-7); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 201.0733, found: 201.0736.

7-Deoxy-α-L-glucoheptulose (5): 5 were synthesized and purified according to GOP7, started from 5-deoxy-L-arabinose (**14**, 50 mg, 370 µmol, 1 eq). Differences to GOP7 were no daily pH readjustment and reaction begin at pH 7.5. Flash purification (0→20% chloroform/methanol) and subsequent HPLC (HiPlexCa, solvent: H_2O, column temperature: 85 °C, flow: 0.5 mL/min) gave **5** as a colourless oil (18 mg, 93 µmol, 25%). TLC: R_f 0.51 (chloroform/methanol 8:5); ^{1}H-NMR (600 MHz, D_2O) α-pyranose: δ(ppm)=3,86 (dq, $J_{6,5}$=9.7 Hz, $J_{6,7}$=6.3 Hz, 1H, H-6), 3.69 (dd, $J_{4,3}$=9.6 Hz, $J_{4,5}$=9.4 Hz, 1H, H-4), 3.69 (d, $J_{1a,1b}$=11.7 Hz, 1H, H-1a), 3.52 (d, $J_{1b,1a}$=11.7 Hz, 1H, H-1b), 3.53 (d, $J_{3,4}$=9.6 Hz, 1H, H-3), 3.15 (dd, $J_{5,6}$=9.7 Hz, $J_{5,4}$=9.4 Hz, 1H, H-5), 1.27 (d, $J_{7,6}$=6.3 Hz, 3H, H-7); ^{13}C-NMR (150 MHz, D_2O) α-pyranose: δ(ppm)= 97.3 (C-2), 75.1 (C-5), 73.4 (C-4), 70.6 (C-3), 68.2 (C-6), 63.6 (C-1), 16.7 (C-7); HR-(+)ESI-MS: *m/z* calcd for $[M+Na]^+$: 217.0683, found: 217.0683.

DAHP: ^{1}H-NMR (600 MHz, D_2O) α-pyranose: δ(ppm)=4.11 (m, 1H, 7a-H), 3.95 (ddd, $J_{4,3b}$=11.8 Hz, $J_{4,5}$=9.5 Hz, $J_{4,3a}$=5.2 Hz, 1H, 4-H), 3.94 (m, 1H, 7b-H), 3.81 (dm, $J_{6,5}$=9.7 Hz, 1H, 6-H), 3.61 (dd, $J_{5,6}$=9.7 Hz, $J_{5,4}$=9.5 Hz, 1H, 5-H), 2.19 (dd, $J_{3a,3b}$=13.0 Hz, $J_{3a,4}$=5.2 Hz, 1H, 3a-H), 1.84 (dd, $J_{3b,3a}$=13.0 Hz, $J_{3b,4}$=11.8 Hz, 1H, 3b-H); ^{13}C-NMR (150 MHz, D_2O) α-pyranose: δ(ppm)=176.5 (C-1), 96.5 (C-2), 73.4 (d, $J_{C\text{-}2,P}$=6.6 Hz, C-6), 70.5 (C-5), 68.5 (C-4), 63.1 (d, $J_{C\text{-}7,P}$=4.5 Hz, C-7), 39.3 (C-3).

SUPPORTING INFORMATION

Results and Discussion



Scheme S1: Proposed mechanism for conversion of DAHP to 3-dehydroquinate. Modified from Carpenter et al.[8]

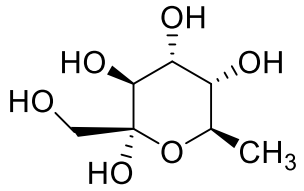
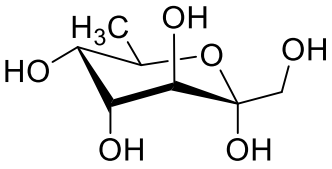
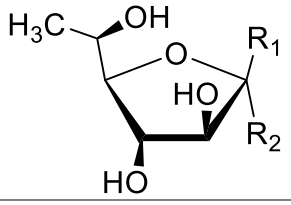
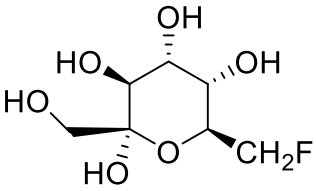
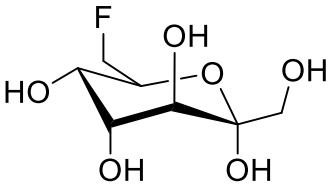
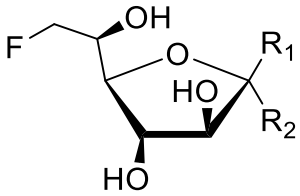
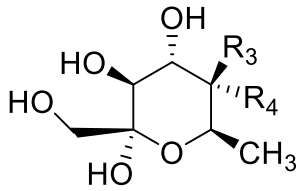
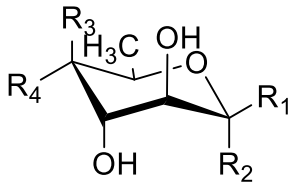
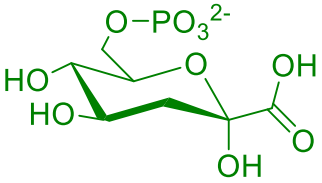
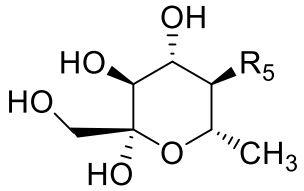
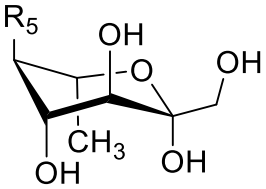
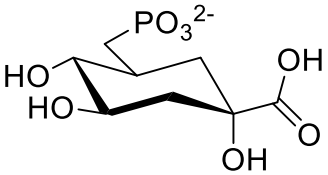
	β-Anomer: R_1 = OH, R_2 = CH_2OH α-Anomer: R_1 = CH_2OH, R_2 = OH	
		
7dSh (**1**)	21% α-Pyranose	64% β-Furanose 15% α-Furanose
		
7d7FSh (**2**)	21% α-Pyranose	67% β-Furanose 11% α-Furanose
		
5,7dd5FIh (**3**): R_3 = F; R_4 = H 7d5MSh (**4**): R_3 = H; R_4 = OMe	**3**: 60% α- or β-Pyranose 20% α- or β-Pyranose 20% open chain **4**: 82% α-Pyranose 18% β-Pyranose	DAHP 100% α-Pyranose
		
7dGh (**5**): R_5 = OH 5,7ddGh (**6**): R_5 = H	**5**: 100% α-Pyranose **6**: 100% α-Pyranose	Carbaphosphonate (**C1**)

Figure S1: Stereoisomers of bioactive C_7-sugars **1**-**3**, **5**-**6** compared to DAHP and **C1**. Spatial appearance in water of DAHP, 7dSh (**1**) and **2**–**6**. Conformations were determined by NMR (in D_2O). 5,7dd5FIh (**3**) and 7dGh (**5**) are not individually assigned to α- and β-conformers due to NMR-signal overlay.

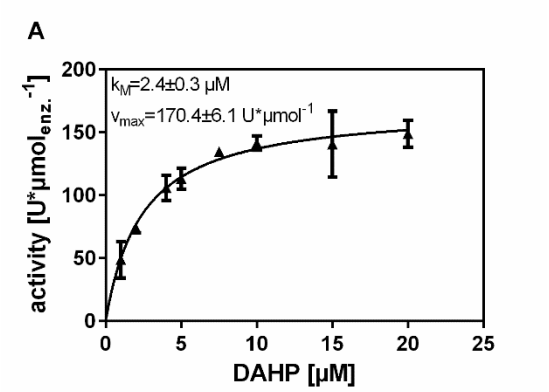


Figure S2: Michaelis-Menten kinetic of DHQS-mediated conversion of DAHP into 3-dehydroquinate from *A. thaliana*. Values represent mean and standard deviation of three independent replicates. enz. – enzyme.

SUPPORTING INFORMATION

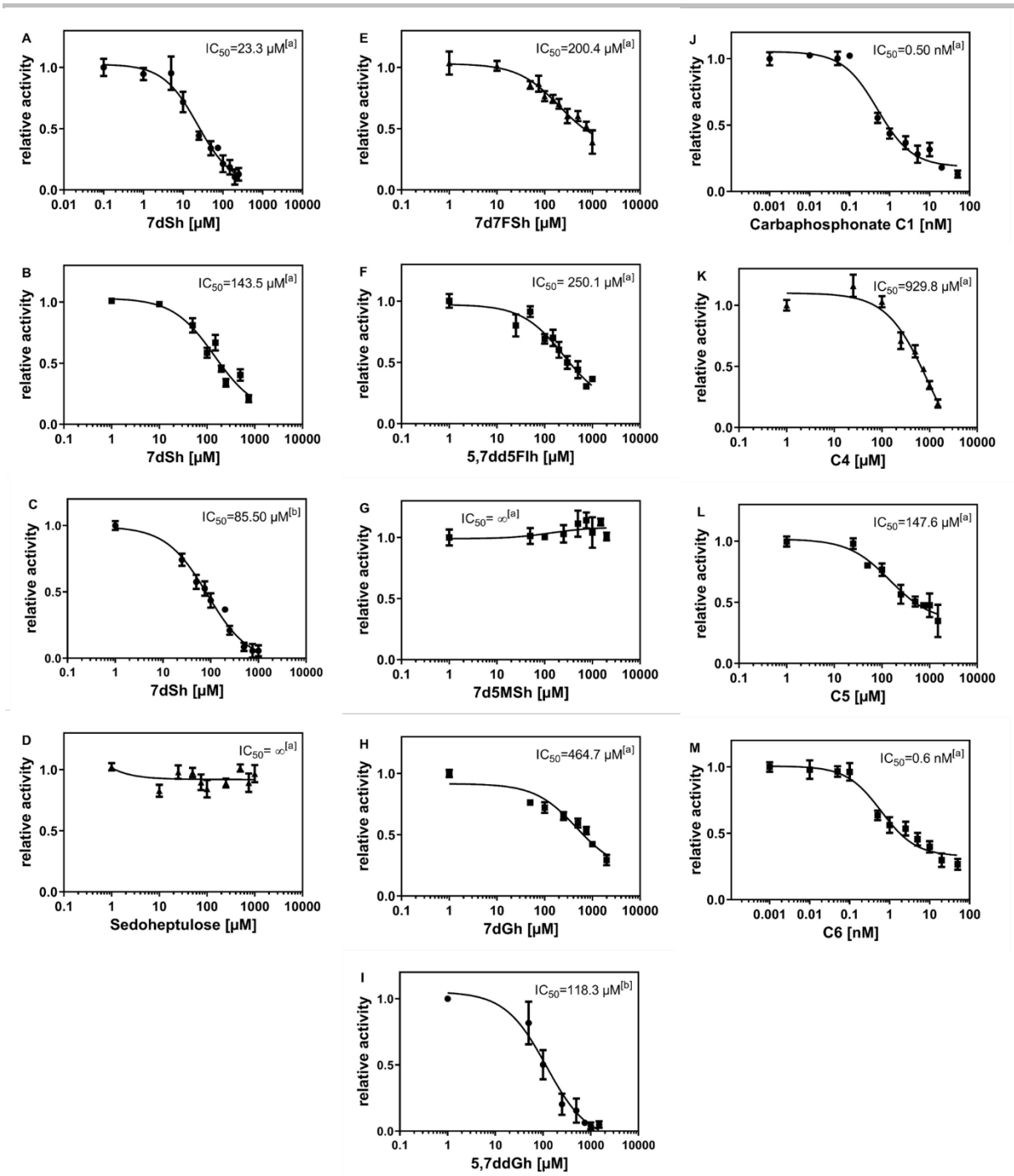


Figure S3: Inhibition of the DHQS-mediated conversion of DAHP into 3-dehydroquinate by various compounds. [a], [b] Values of different series of experiments with two different preparations of enzyme from synthetic gene of *A. thaliana* expressed and purified from *E. coli*. (A) Inhibition of AvDHQS by 7dSh. (B)/(C) Inhibition of AtDHQS by 7dSh. (D) Inhibition of AtDHQS by sedoheptulose. (E)-(I) Inhibition of AtDHQS by 7dSh derivates. (J)-(M) Inhibition of AtDHQS by carbaphosphonate derivates. Relative activity (activity at a certain inhibitor concentration/activity without inhibitor) was plotted via the inhibitor concentration. IC_{50} values were determined by fitting the data to the following equation: Y=Bottom+(Top-Bottom)/(1+(X/IC50)) with a standard Hill Slope of 1.0. Data represent mean and standard deviation of 3-4 replicates.

SUPPORTING INFORMATION

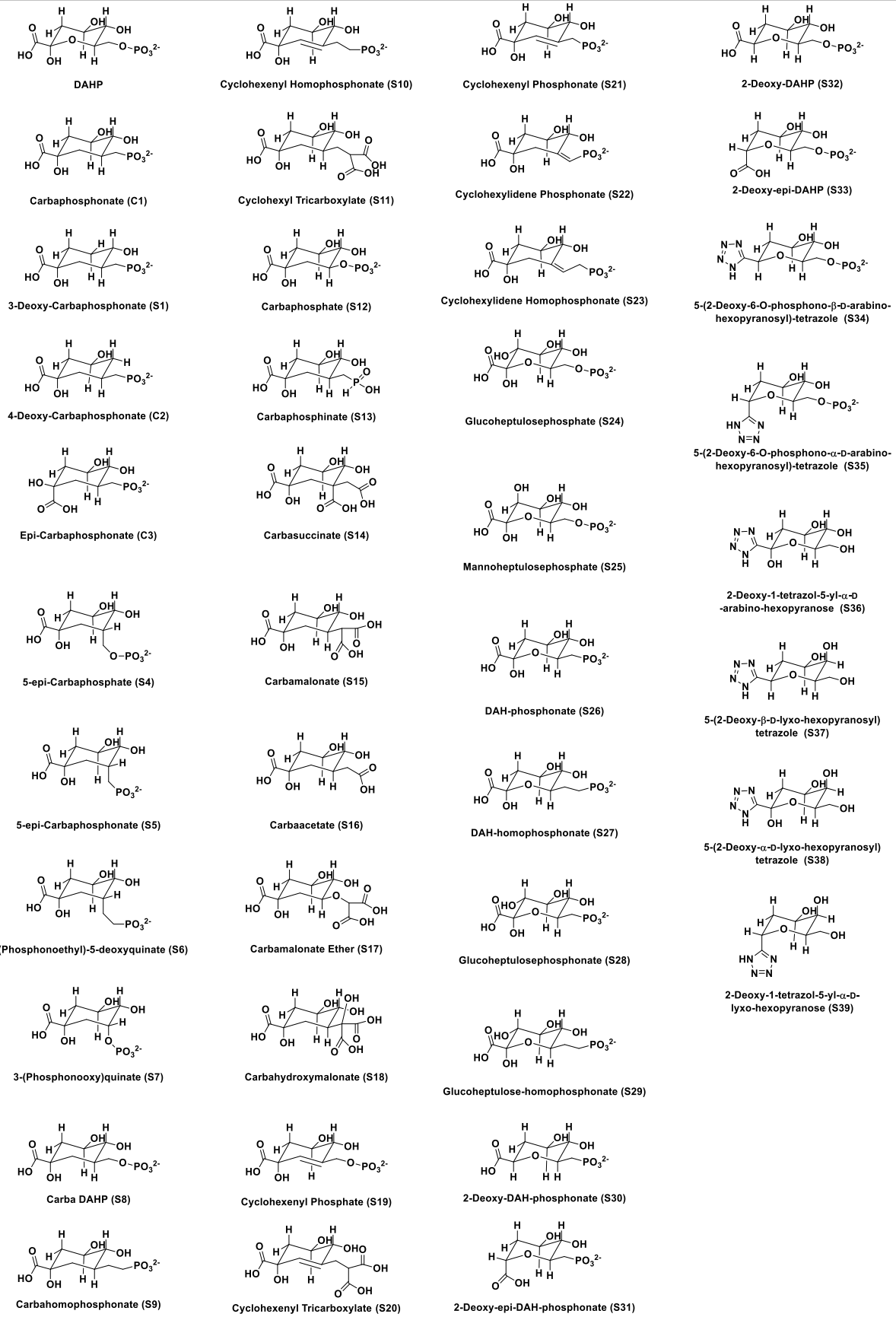


Figure S4: Chemical structures of literature known carbaphosphonates and similar analogues.

SUPPORTING INFORMATION

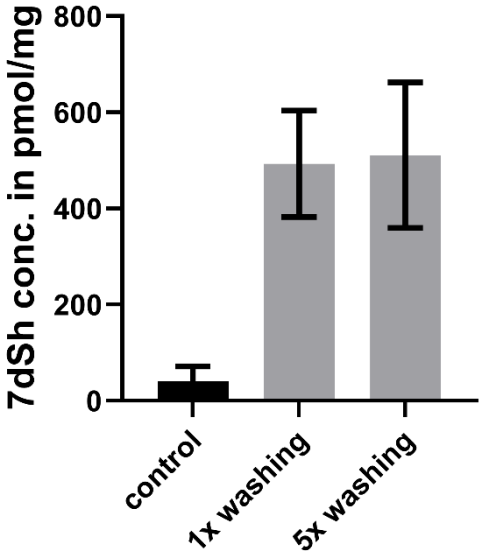
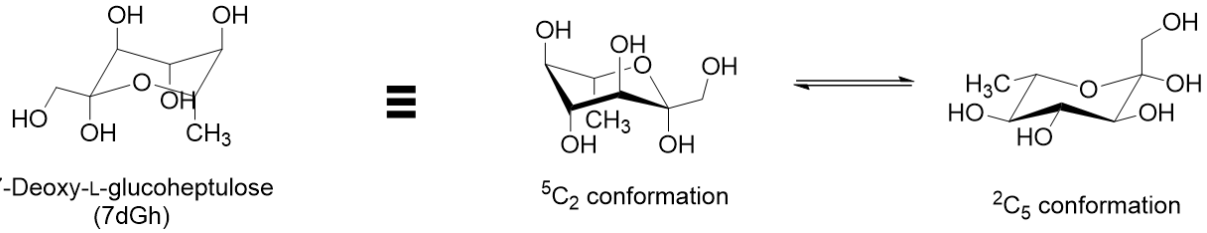


Figure S5: 7dSh measurements of *Arabidopsis* seedlings (fresh weight) washed up to five times before extraction. *Arabidopsis thaliana* seedlings were germinated for 12 d on medium with 100 µM 7dSh. After harvest they were washed either one or five times to remove residuing 7dSh from the medium on the outside of plant material. Means of measurements (n=3) between both washing procedures were not significantly different. Significance was calculated with a Wilcox-Test (non-parametric) between washing steps. Error bars: SD.



Scheme S2: 7dGh with its two different possible conformations ($^5C_2$ and $^2C_5$).

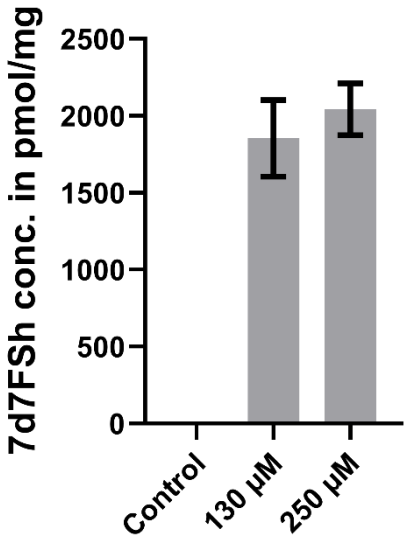


Figure S6: Intracellular accumulation of 7d7FSh in *Arabidopsis* seedlings (dry weight). Shown is the mean concentration of 7d7FSh in 7 d old *Arabidopsis thaliana* seedlings either untreated or treated with 130 µM or 260 µM 7d7FSh, respectively, and afterwards, extensively washed. Error bars: SD (n=3).

SUPPORTING INFORMATION

Table S1: K_i values of literature known carbaphosphonates and similar analogues.

Compound	Activity
Carbaphosphonate (**C1**)	K_i: $0.8x10^{-9}$ [9];K_i: $5.4x10^{-9}$ [10]; K_i: $5.4x10^{-9}$ [11]; K_i: $8.3x10^{-10}$ [12]
3-Deoxy-Carbaphosphonate (**S1**)	K_i: $2.2x10^{-7}$ [10]
4-Deoxy-Carbaphosphonate (**C2**)	K_i: $5.4x10^{-7}$ [10]
Epi-Carbaphosphonate (**C3**)	K_i: $7.3x10^{-9}$ [13]
5-Epi-Carbaphosphate / 5-[(Phosphono)-methyl]-5-deoxyquinate (**S4**)	K_i: $3.0x10^{-8}$ [11]
5-Epi-Carbaphosphonate / 5-(Phosphonooxy)-methyl-5-deoxyquinate (**S5**)	K_i: $5.5x10^{-8}$ [11]
5-(Phosphonoethyl)-5-deoxyquinate (**S6**)	K_i: $3.0x10^{-5}$ [11]
3-(Phosphonooxy)quinate (**S7**)	K_i: $5.3x10^{-5}$ [11]
Carba DAHP (**S8**)	K_i: $1.2x10^{-7}$ [11]
Carbahomophosphonate (**S9**)	K_i: $1.7x10^{-6}$ [11]
Cyclohexenyl Homophosphonate (**S10**)	K_i: $30x10^{-9}$ [12]
Cyclohexyl Tricarboxylate (**S11**)	K_i: $6.0x10^{-6}$ [12]
Carbaphosphate (**S12**)	K_i: $1.7x10^{-6}$ [11]
Carbaphoshinate (**S13**)	K_i: $20x10^{-6}$ [14]
Carbasuccinate (**S14**)	K_i: $5.0x10^{-6}$ [14]
Carbamalonate (**S15**)	K_i: $0.7x10^{-6}$ [14]
Carbaacetate (**S16**)	K_i: $3.0x10^{-6}$ [14]
Carbamalonate Ether (**S17**)	K_i: $7.0x10^{-6}$ [14]
Carbahydroxymalonate (**S18**)	K_i: $0.3x10^{-6}$ [14]
Cyclohexenyl Phosphate (**S19**)	K_i: $1.2x10^{-10}$ [12]
Cyclohexenyl Tricarboxylate (**S20**)	K_i: $8.6x10^{-9}$ [12]
Cyclohexenyl Phosphonate (**S21**)	K_i: $1.2x10^{-9}$ [12]
Cyclohexylidene Phosphonate (**S22**)	K_i: $2.9x10^{-9}$ [12]
Cyclohexylidene Homophosphonate (**S23**)	K_i: $3.2x10^{-9}$ [12]
Glucoheptulosephosphate (**S24**)	K_i: $0.3x10^{-3}$ [15]; K_i: $0.8x10^{-4}$ [16]
Mannoheptulosephosphate (**S25**)	K_i: $0.3x10^{-2}$ [15]
DAH-phosphonate (**S26**)	K_i: $2.5x10^{-6}$ [16]; K_i: $1.1x10^{-6}$ [17]; K_i: $0.8x10^{-6}$ [18]
DAH-homophosphonate (**S27**)	K_i: $260x10^{-6}$ [16]; K_i: 0 [17]; K_i: 0 [18]
Glucoheptulosephosphonate (**S28**)	K_i: $5.0x10^{-6}$ [16]
Glucoheptulose-homophosphonate (**S29**)	K_i: $1200x10^{-6}$ [16]
2-Deoxy-DAH-phosphonate (**S30**)	K_i: 0 [18]
2-Deoxy-epi-DAH-phosphonate (**S31**)	K_i: $129x10^{-6}$ [17]; K_i: $296x10^{-6}$ [18]
2-Deoxy-DAHP (**S32**)	K_i: $193x10^{-6}$ [17]
2-Deoxy-epi-DAHP (**S33**)	K_i: $33x10^{-6}$ [17]
5-(2-Deoxy-6-O-phosphono-β-D-arabino-hexopyranosyl)-tetrazole (**S34**)	K_i: 0 [19]
5-(2-Deoxy-6-O-phosphono-α-D-arabino-hexopyranosyl)-tetrazole (**S35**)	K_i: 0 [19]
2-Deoxy-1-tetrazol-5-yl-α-D-arabino-hexopyranose (**S36**)	K_i: 0 [19]
5-(2-Deoxy-β-D-lyxo-hexopyranosyl)tetrazole (**S37**)	K_i: 0 [19]
5-(2-Deoxy-α-D-lyxo-hexopyranosyl)tetrazole (**S38**)	K_i: 0 [19]
2-Deoxy-1-tetrazol-5-yl-α-D-lyxo-hexopyranose (**S39**)	K_i: 0 [19]

Table S2: Oligonucleotides for PCR amplification. Underlined sections indicate restriction sites.

Name	**Sequence (5' → 3')**
1_At AroB fw	GAGAGACATATGGCAGCCAACACCATTTC
2_At AroB rev His	GAGAGACTCGAGGGATTTGGAGAATGCACG

NMR Spectra

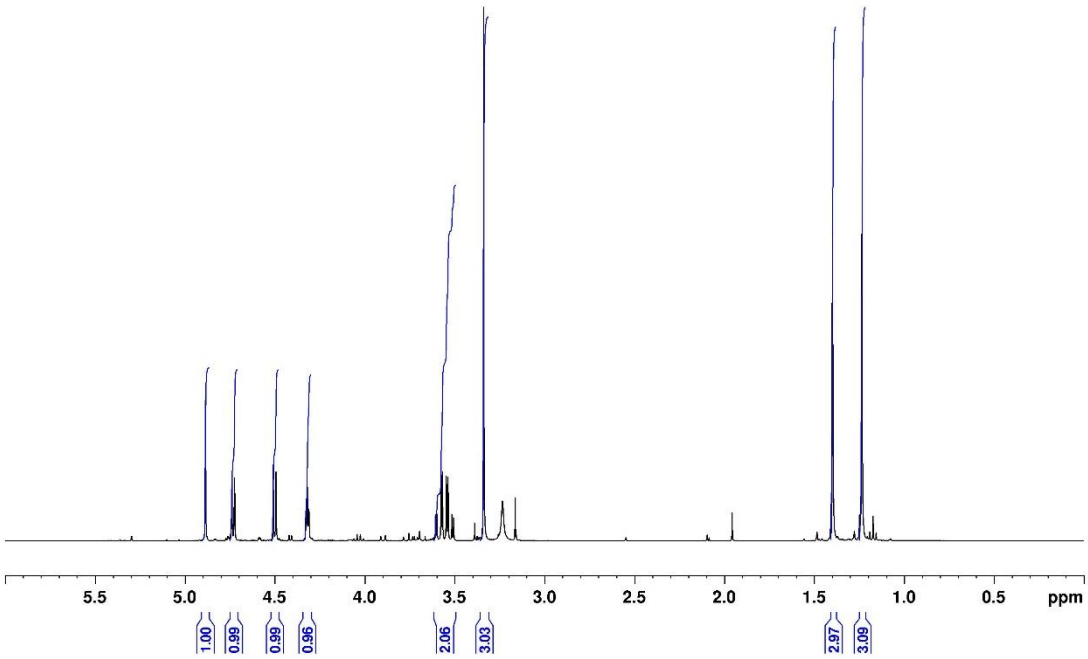


Figure S6: ^{1}H NMR spectrum of **Methyl-2,3-*O*-isopropylidene-β-D-ribofuranoside (8)**

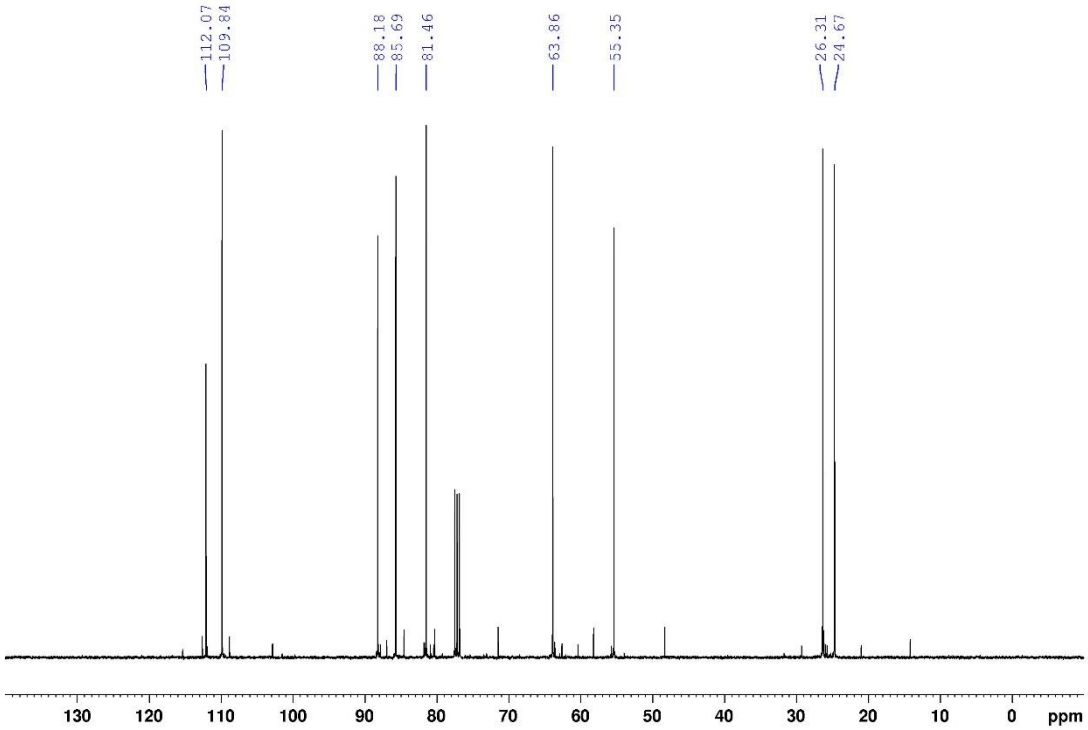


Figure S7: ^{13}C NMR spectrum of **Methyl-2,3-*O*-isopropylidene-β-D-ribofuranoside (8)**

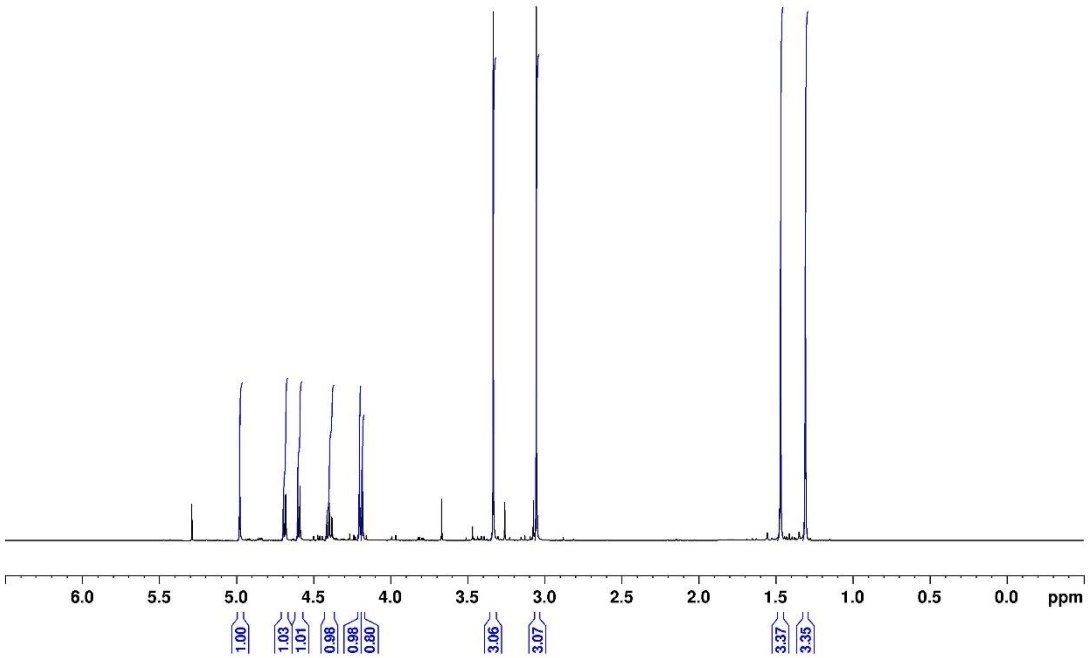


Figure S8: ^{1}H NMR spectrum of **Methyl-2,3-*O*-isopropylidene-5-*O*-mesyl-β-D-ribofuranoside (9)**

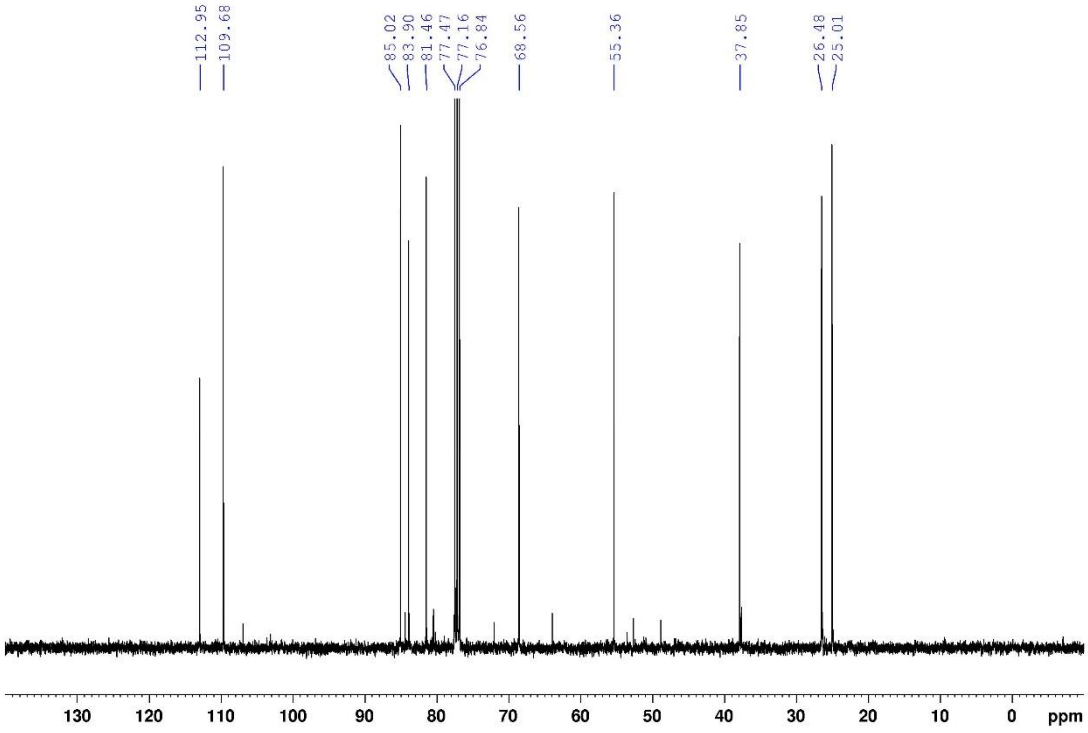


Figure S9: ^{13}C NMR spectrum of **Methyl-2,3-*O*-isopropylidene-5-*O*-mesyl-β-D-ribofuranoside (9)**

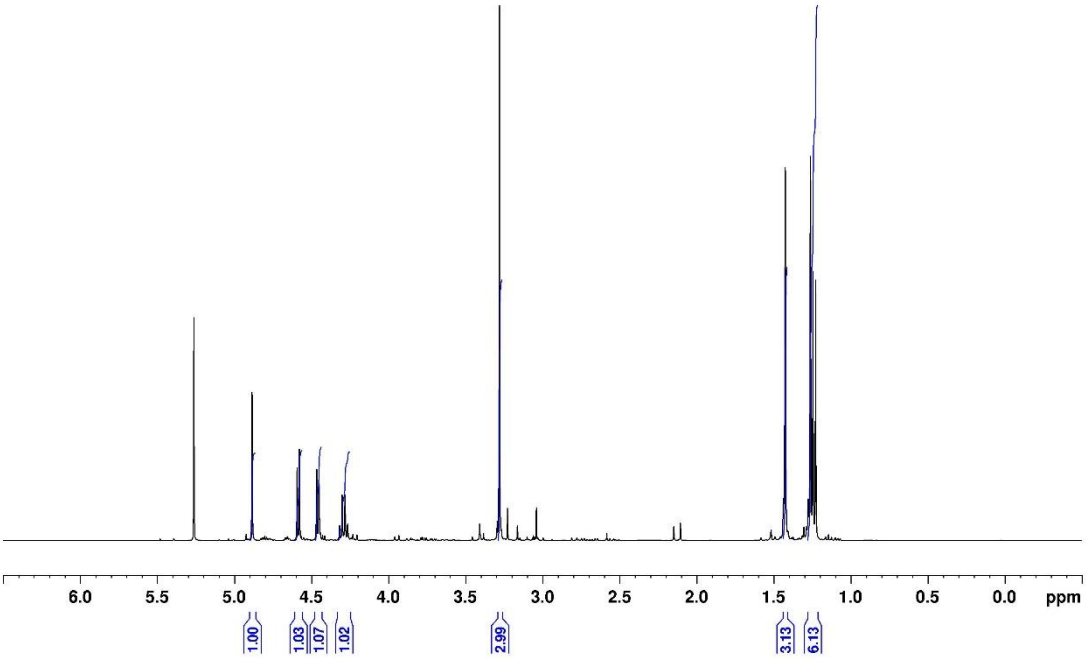


Figure S10: ^{1}H NMR spectrum of **Methyl-2,3-*O*-isopropylidene-5-deoxy-β-D-ribofuranoside (10)**

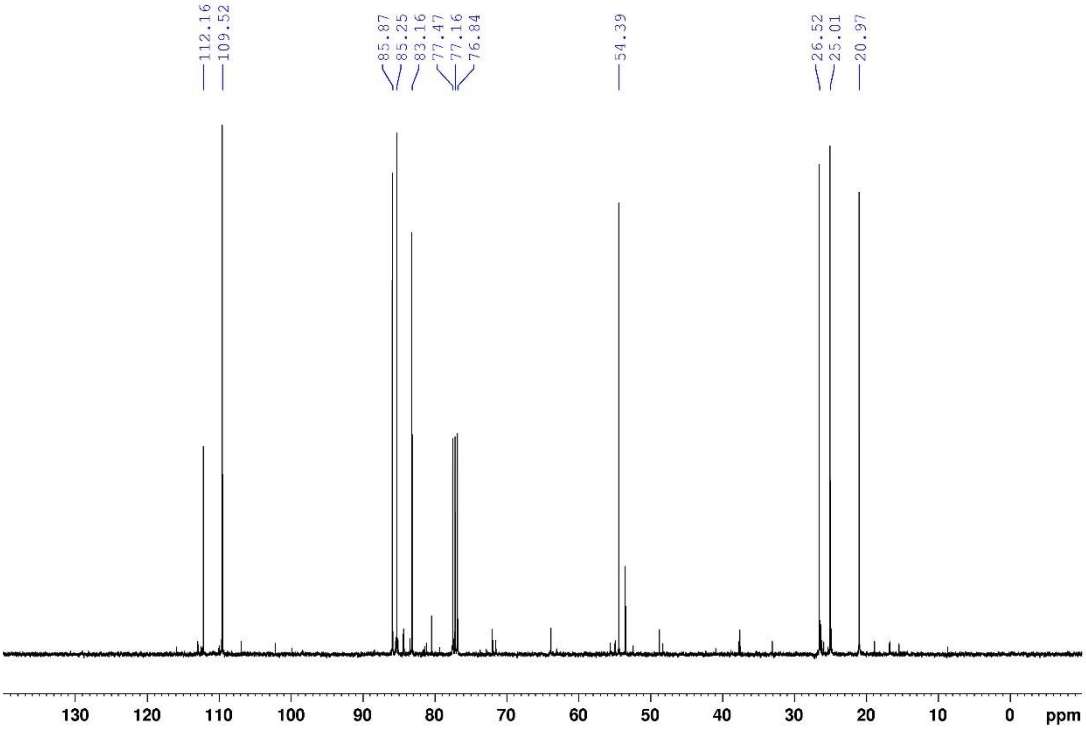


Figure S11: ^{13}C NMR spectrum of **Methyl-2,3-*O*-isopropylidene-5-deoxy-β-D-ribofuranoside (10)**

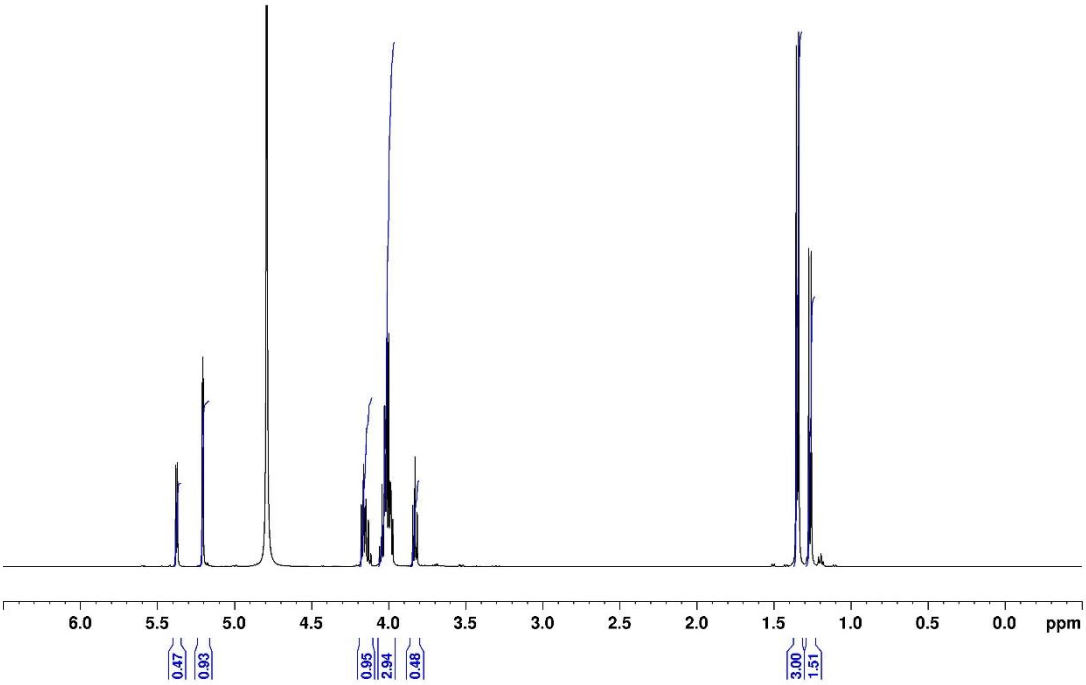


Figure S12: ^{1}H NMR spectrum of **5-Deoxy-D-ribofuranose (12)**

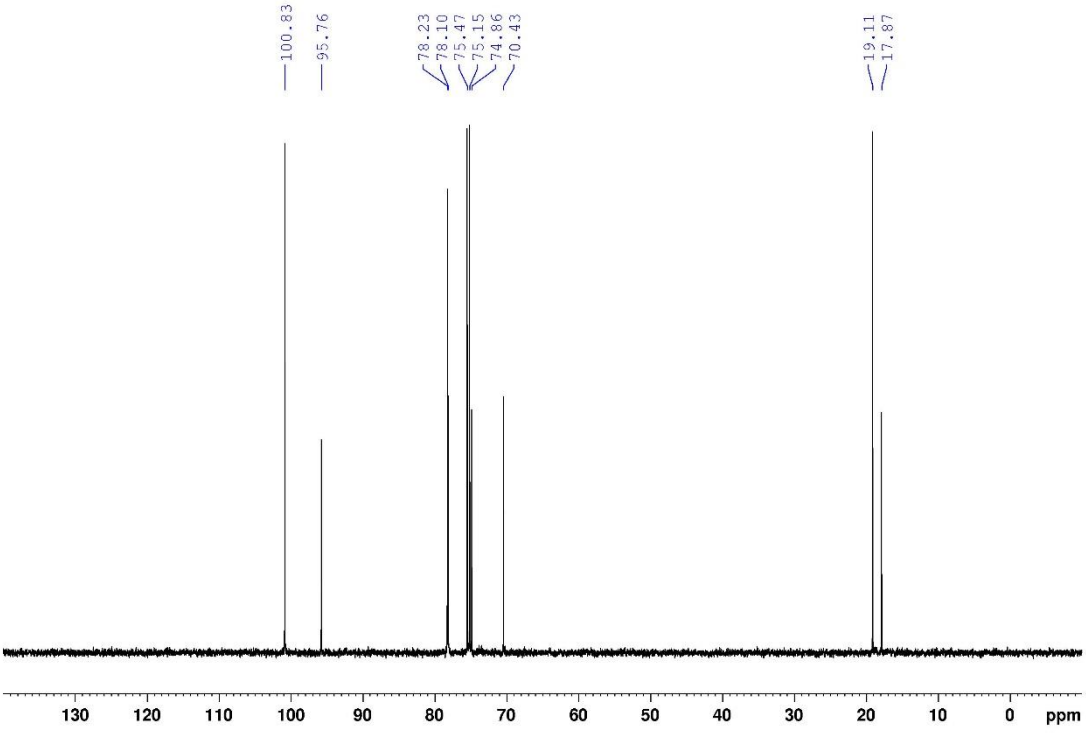


Figure S13: ^{13}C NMR spectrum of **5-Deoxy-D-ribofuranose (12)**

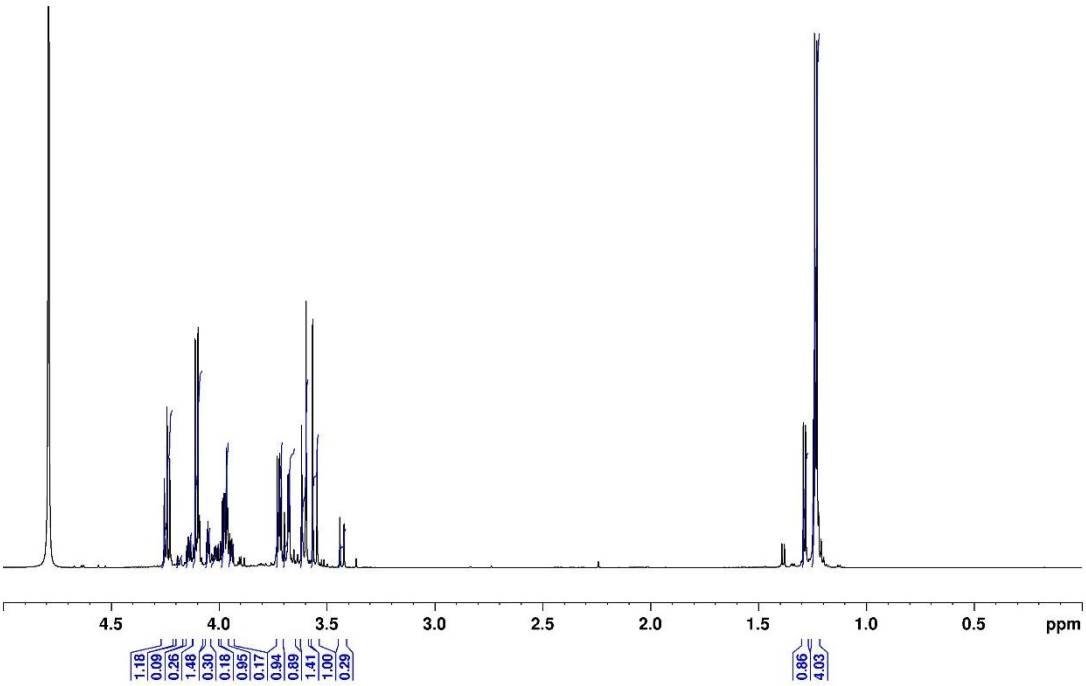


Figure S14: ^{1}H NMR spectrum of **7-Deoxy-sedoheptulose (1)**

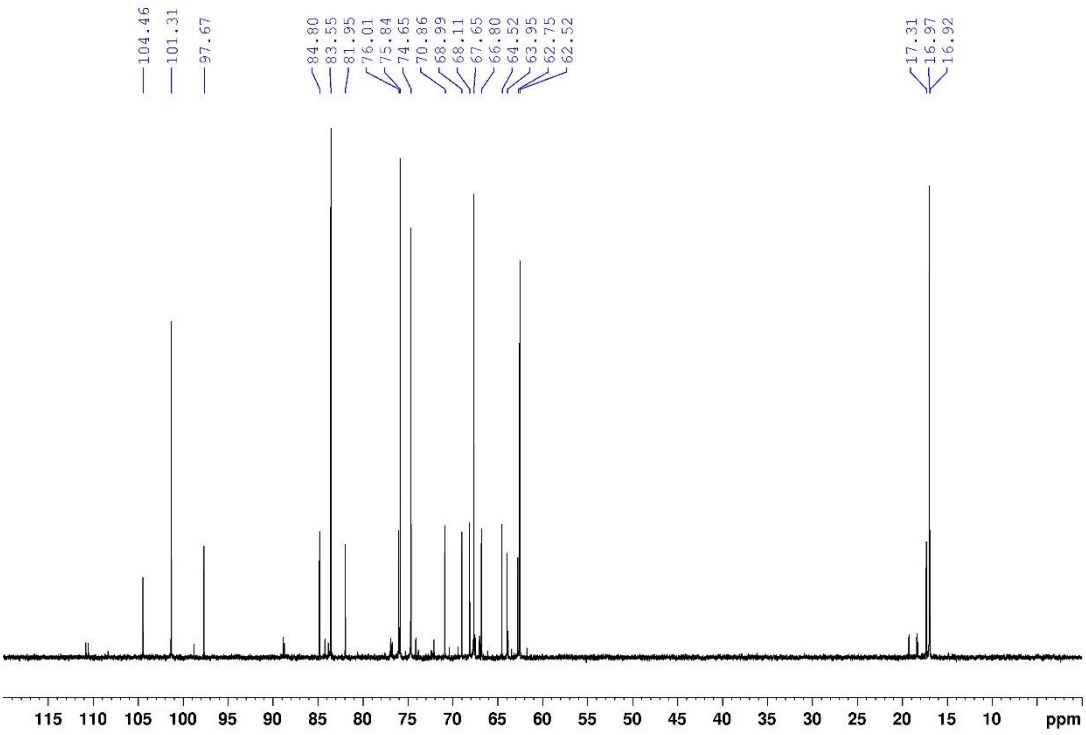


Figure S15: ^{13}C NMR spectrum of **7-Deoxy-sedoheptulose (1)**

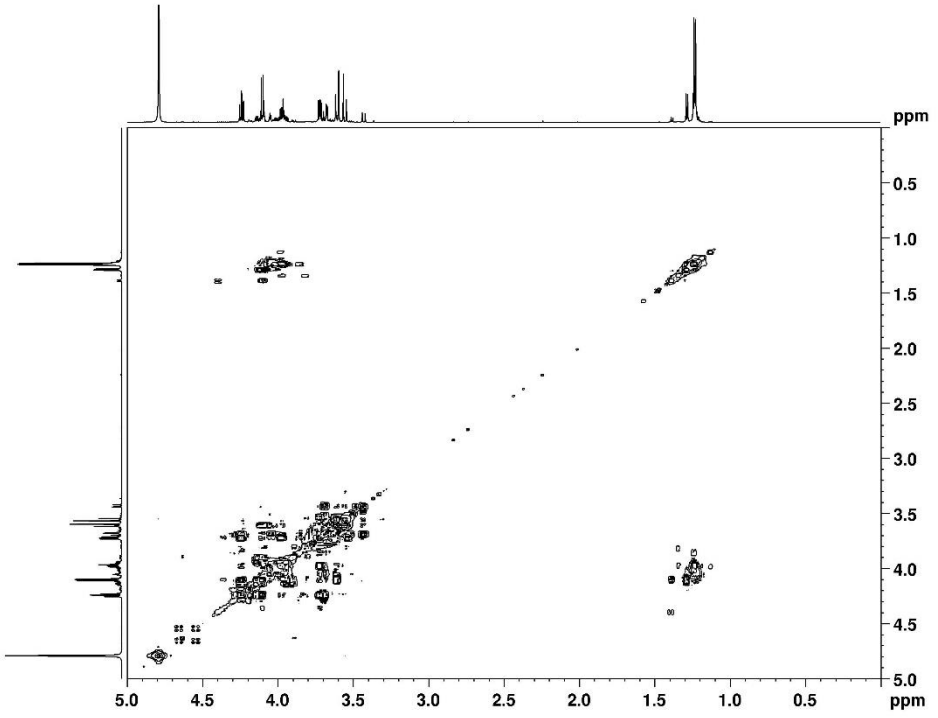


Figure S16: H-H-correlation (COSY) spectrum of **7-Deoxy-sedoheptulose (1)**

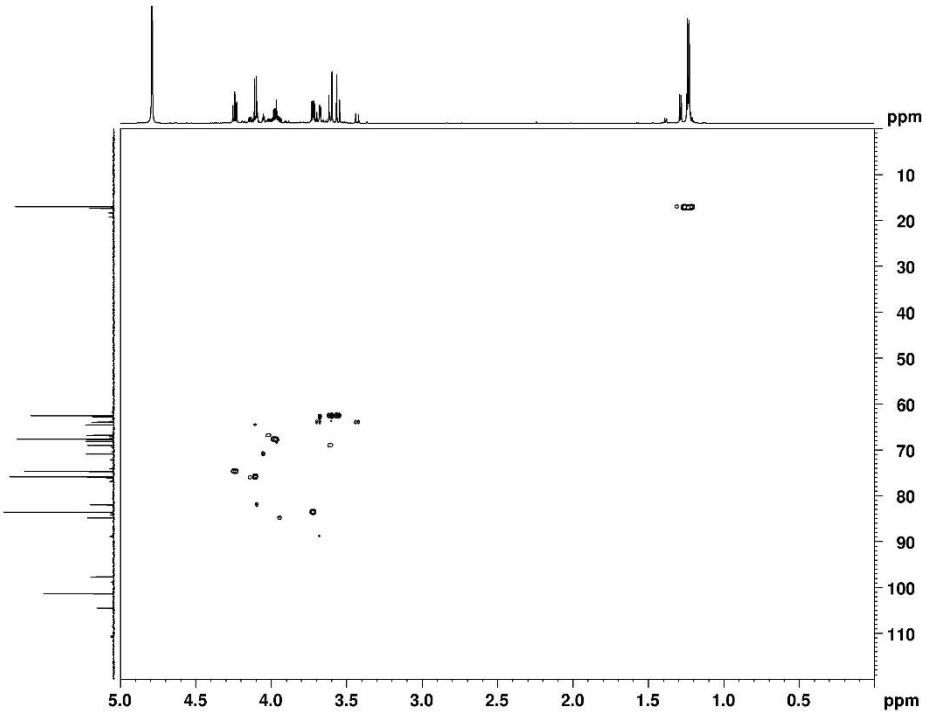


Figure S17: CH-correlation (HSQC) spectrum of **7-Deoxy-sedoheptulose (1)**

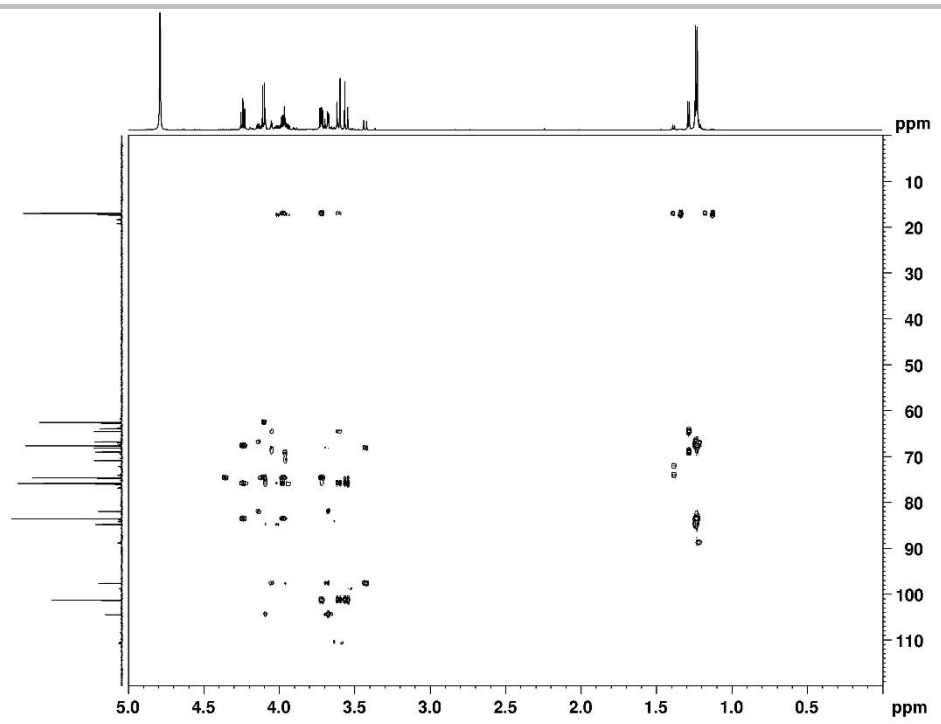


Figure S18: Multiple bond CH-correlation (HMBC) spectrum of **7-Deoxy-sedoheptulose (1)**

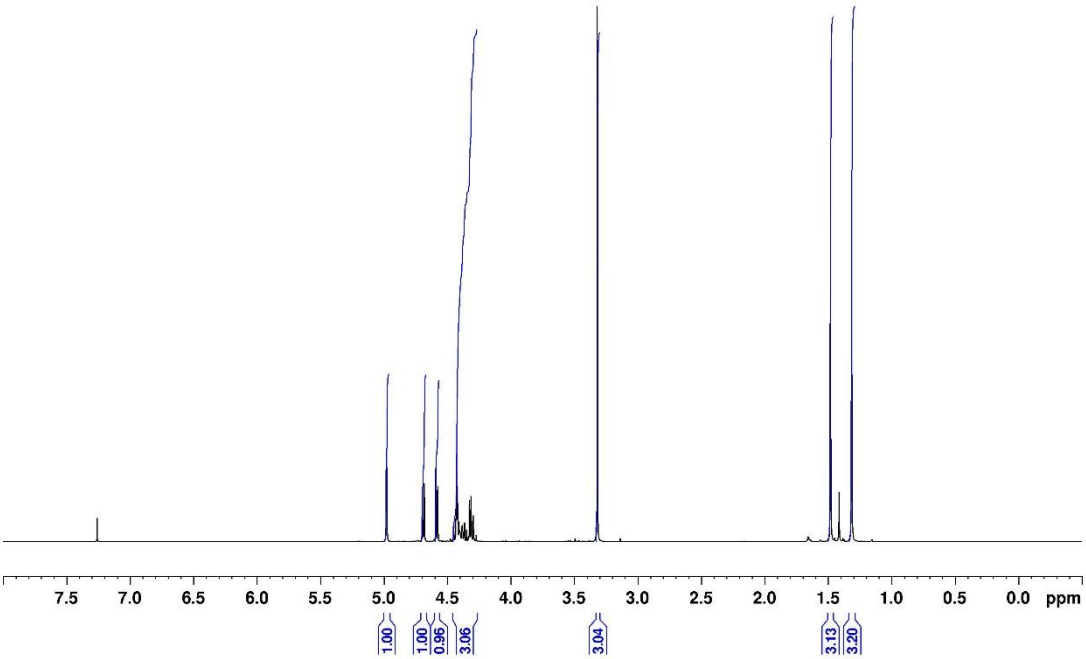


Figure S19: ^{1}H NMR spectrum of **Methyl-2,3-*O*-isopropylidene-5-deoxy-5-fluoro-β-D-ribofuranoside (11)**

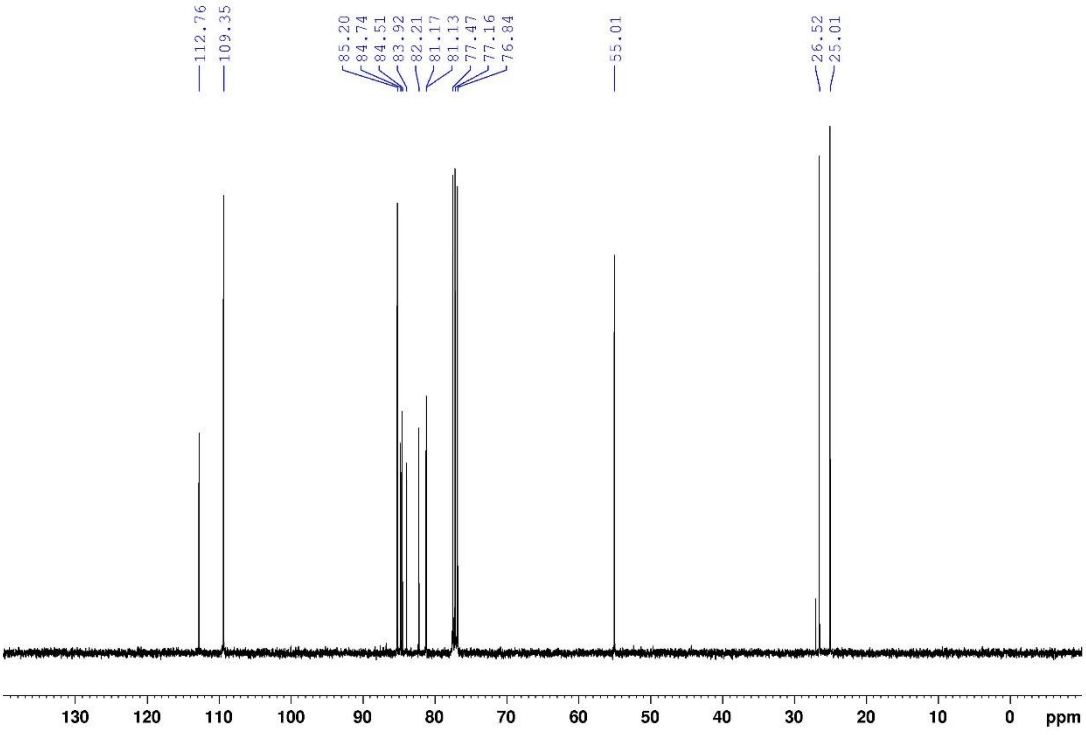


Figure S20: ^{13}C NMR spectrum of **Methyl-2,3-*O*-isopropylidene-5-deoxy-5-fluoro-β-D-ribofuranoside (11)**

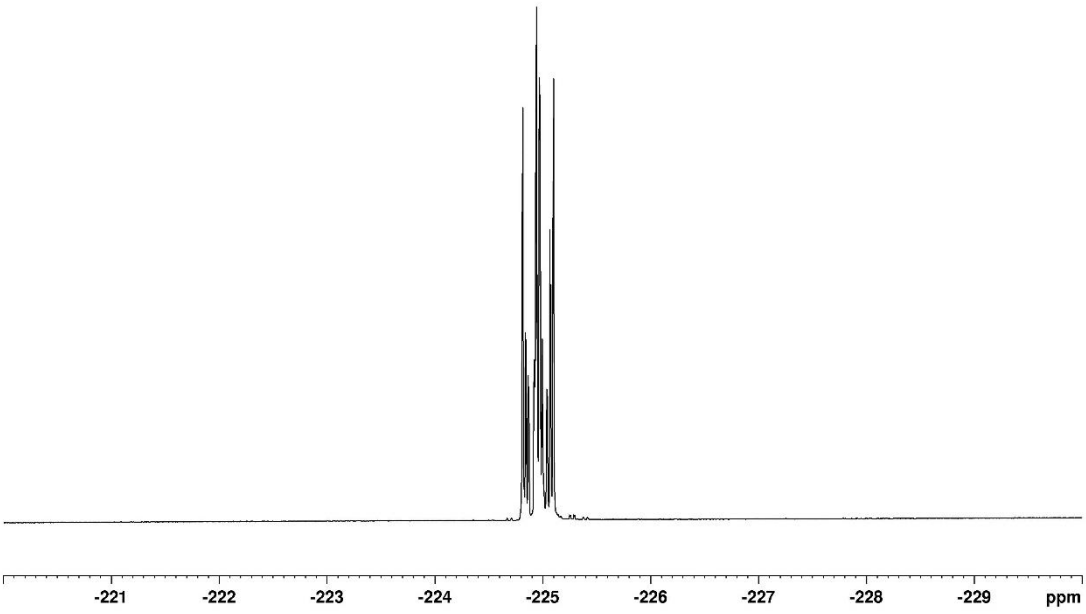


Figure S21: ^{19}F NMR spectrum of **Methyl-2,3-*O*-isopropylidene-5-deoxy-5-fluoro-β-D-ribofuranoside (11)**

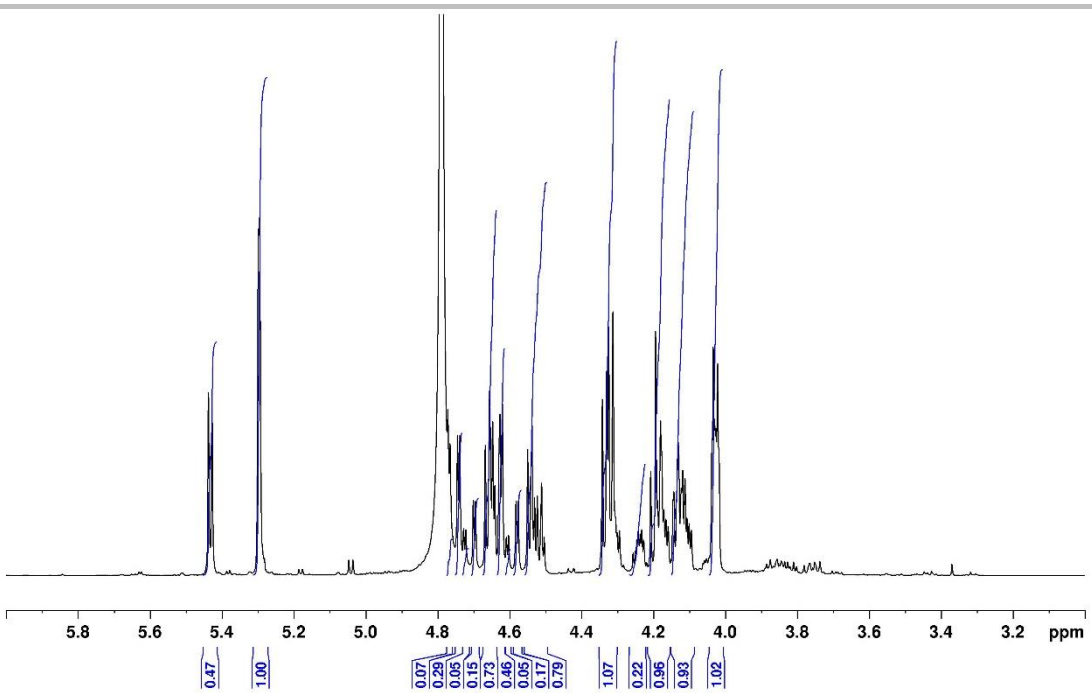


Figure S22: ^{1}H NMR spectrum of **5-Deoxy-5-fluoro-D-ribofuranose (13)**

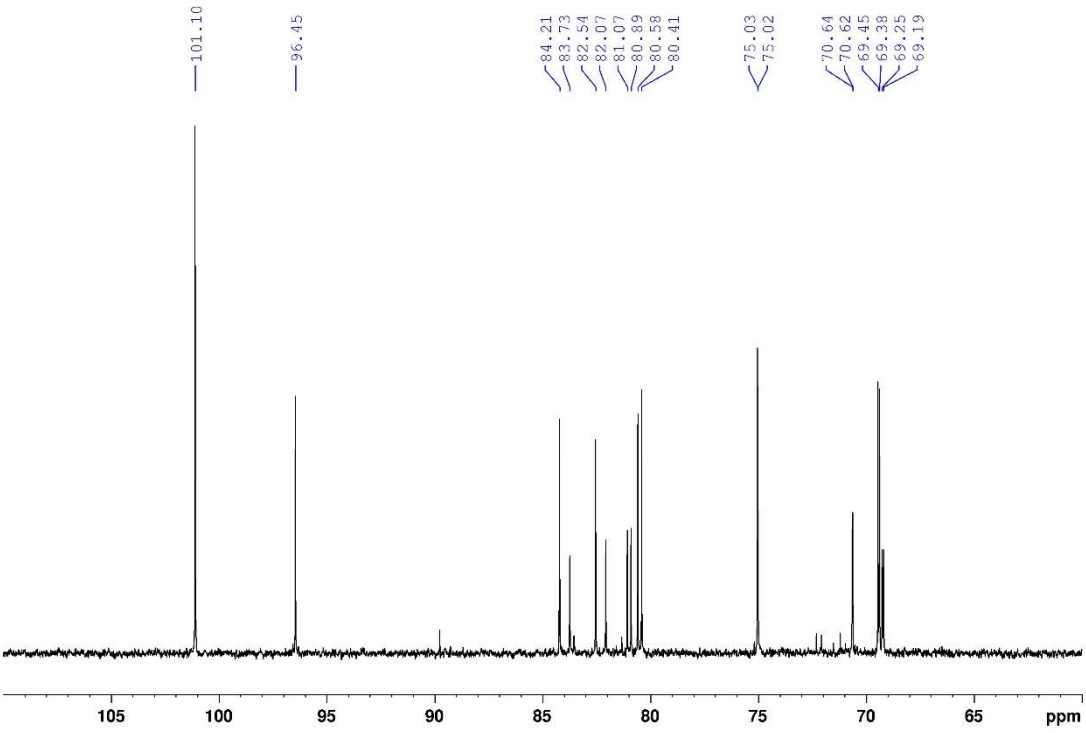


Figure S23: ^{13}C NMR spectrum of **5-Deoxy-5-fluoro-D-ribofuranose (13)**

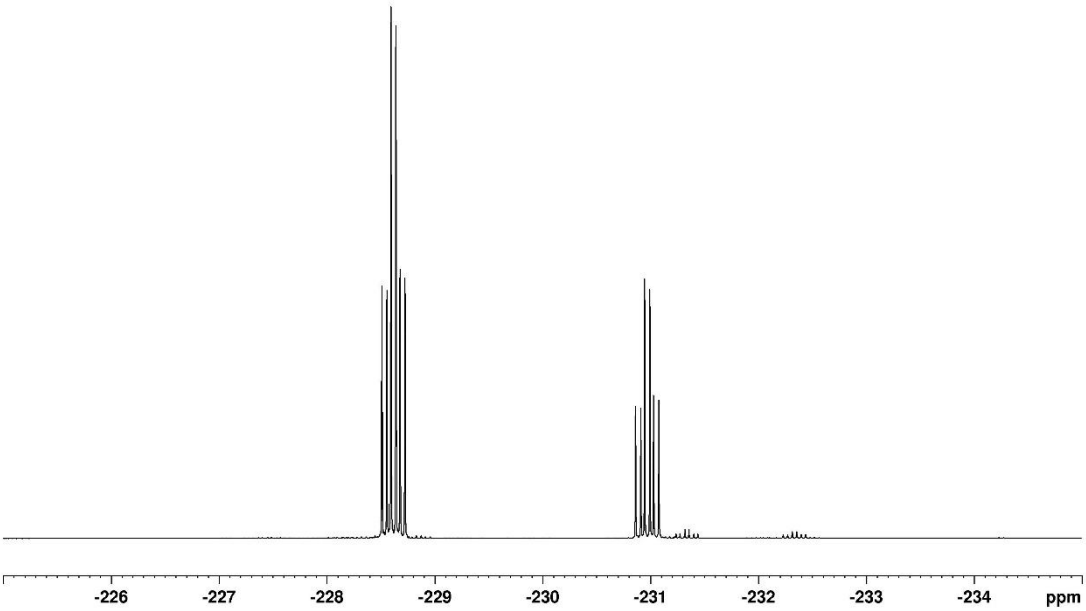


Figure S24: ^{19}F NMR spectrum of **5-Deoxy-5-fluoro-D-ribofuranose (13)**

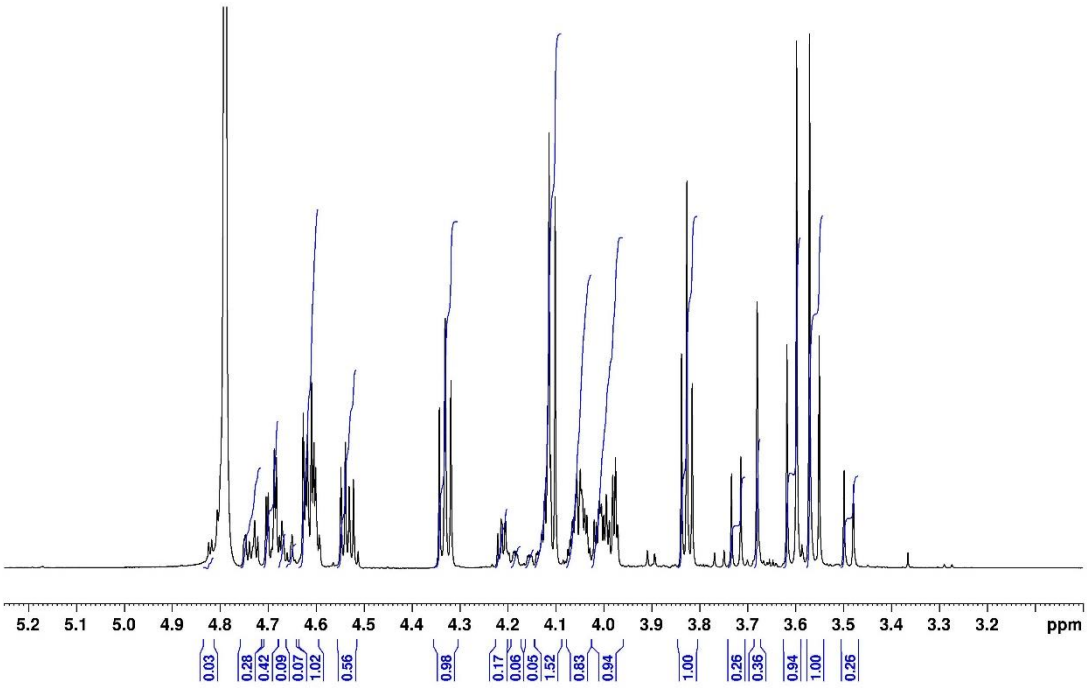


Figure S25: ^{1}H NMR spectrum of **7-Deoxy-7-fluoro-sedoheptulose (2)**

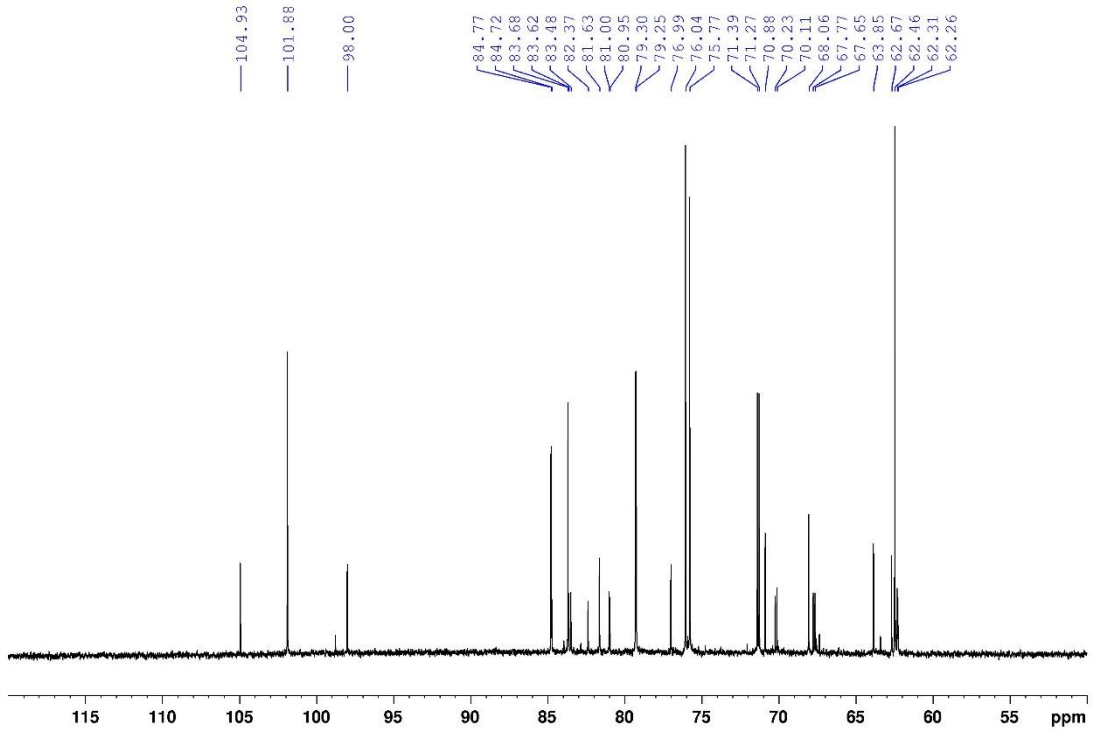


Figure S26: ^{13}C NMR spectrum of **7-Deoxy-7-fluoro-sedoheptulose (2)**

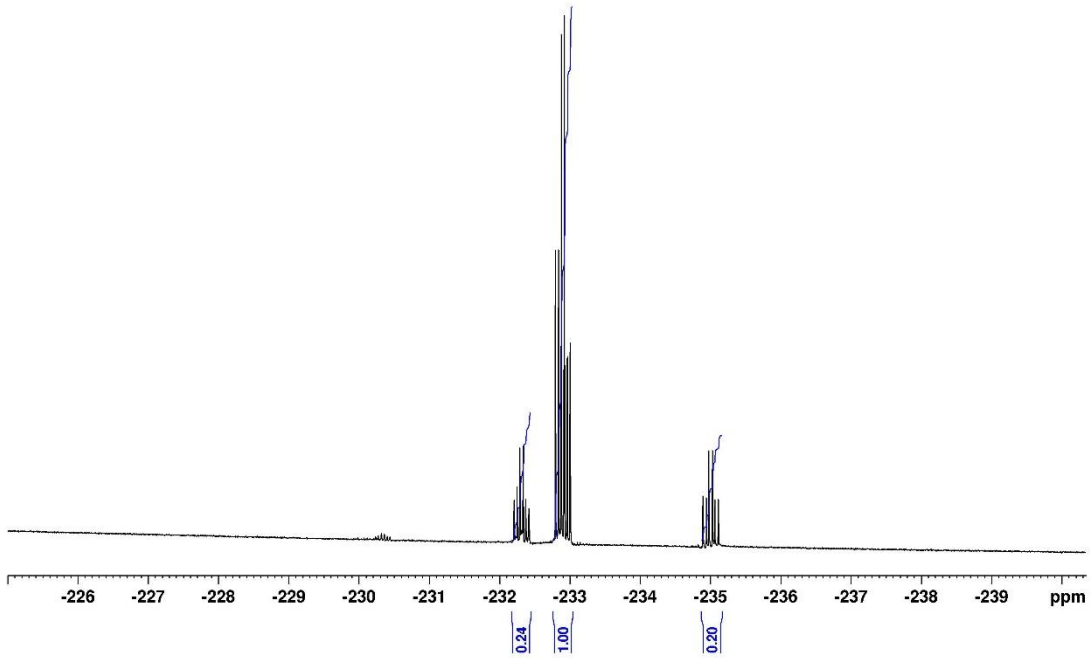


Figure S27: ^{19}F NMR spectrum of **7-Deoxy-7-fluoro-sedoheptulose (2)**

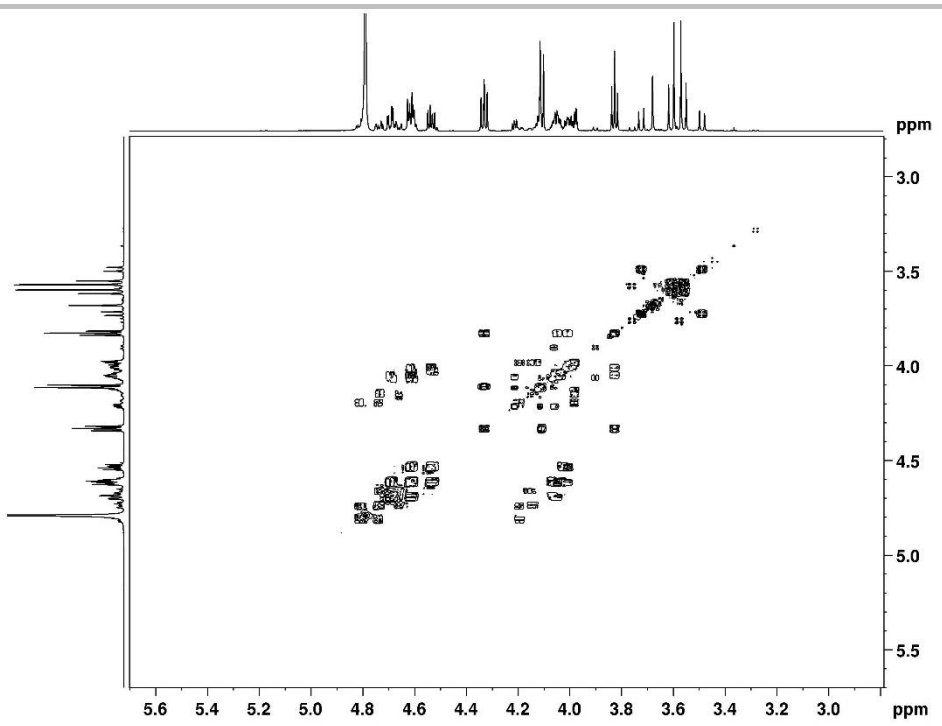


Figure S28: H-H-correlation (COSY) spectrum of **7-Deoxy-7-fluoro-sedoheptulose (2)**

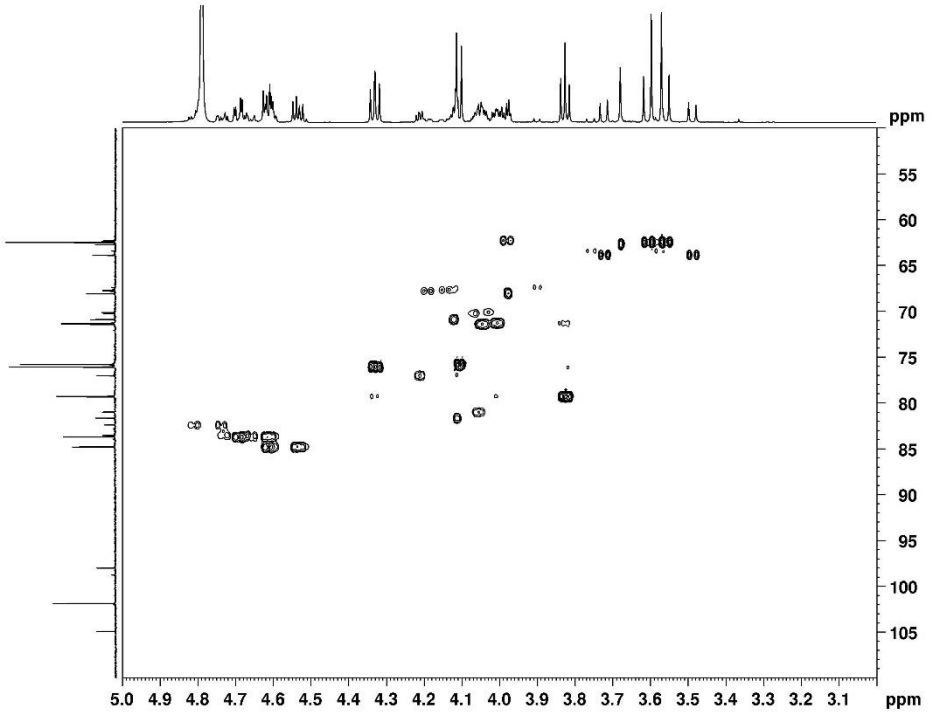


Figure S29: CH-correlation (HSQC) spectrum of **7-Deoxy-7-fluoro-sedoheptulose (2)**

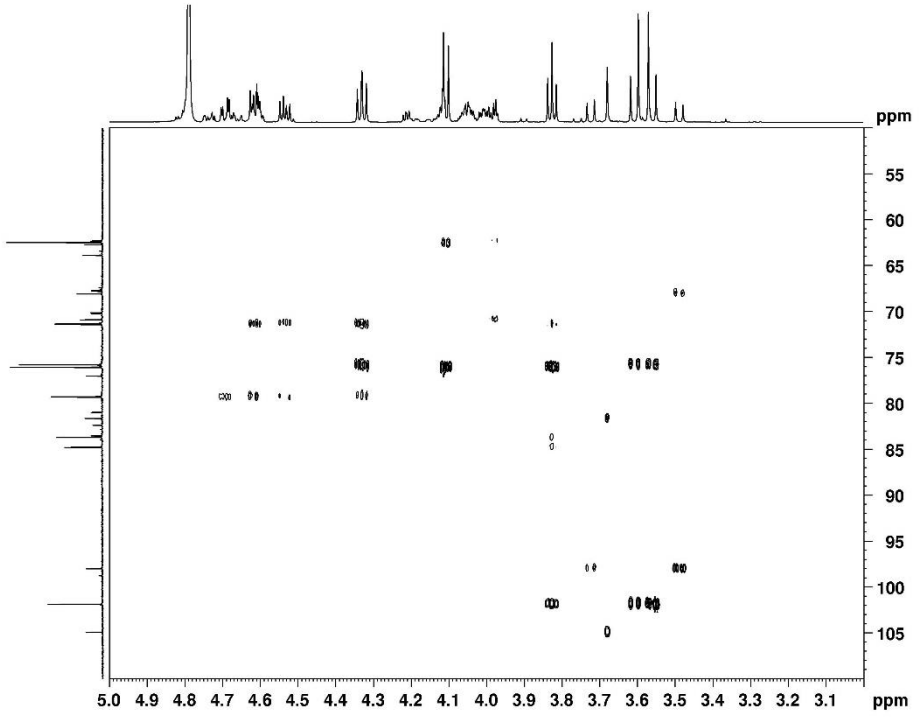


Figure S30: Multiple bond CH-correlation (HMBC) spectrum of **7-Deoxy-7-fluoro-sedoheptulose (2)**

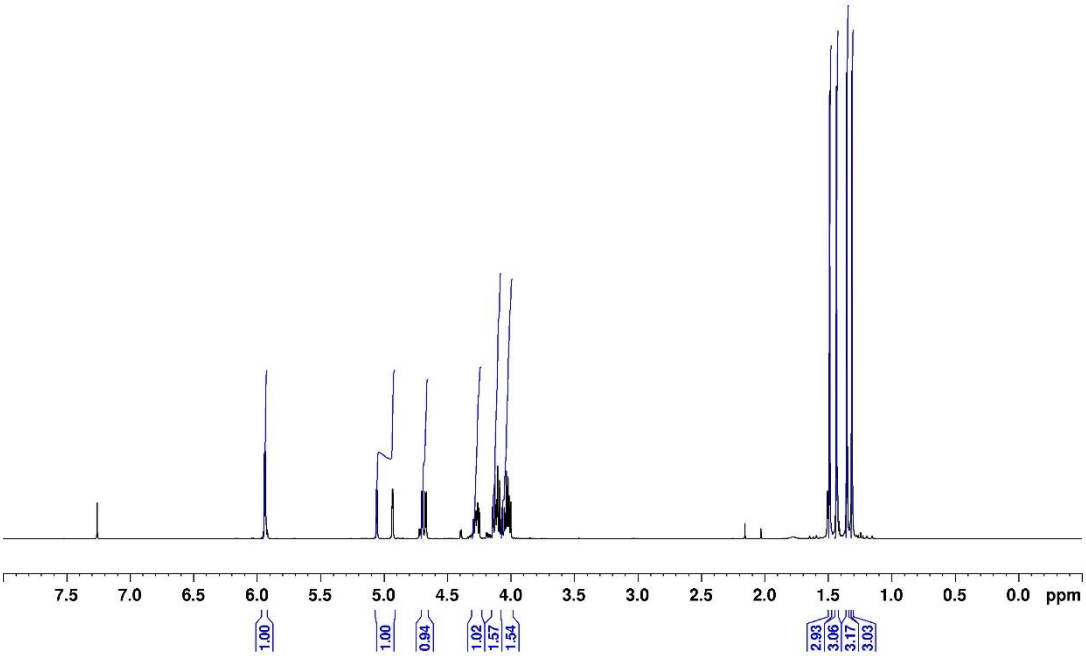


Figure S31: ^{1}H NMR spectrum of **3-Deoxy-1,2;5,6-di-*O*-isopropylidene-3-fluoro-α-D-glucofuranose (16)**

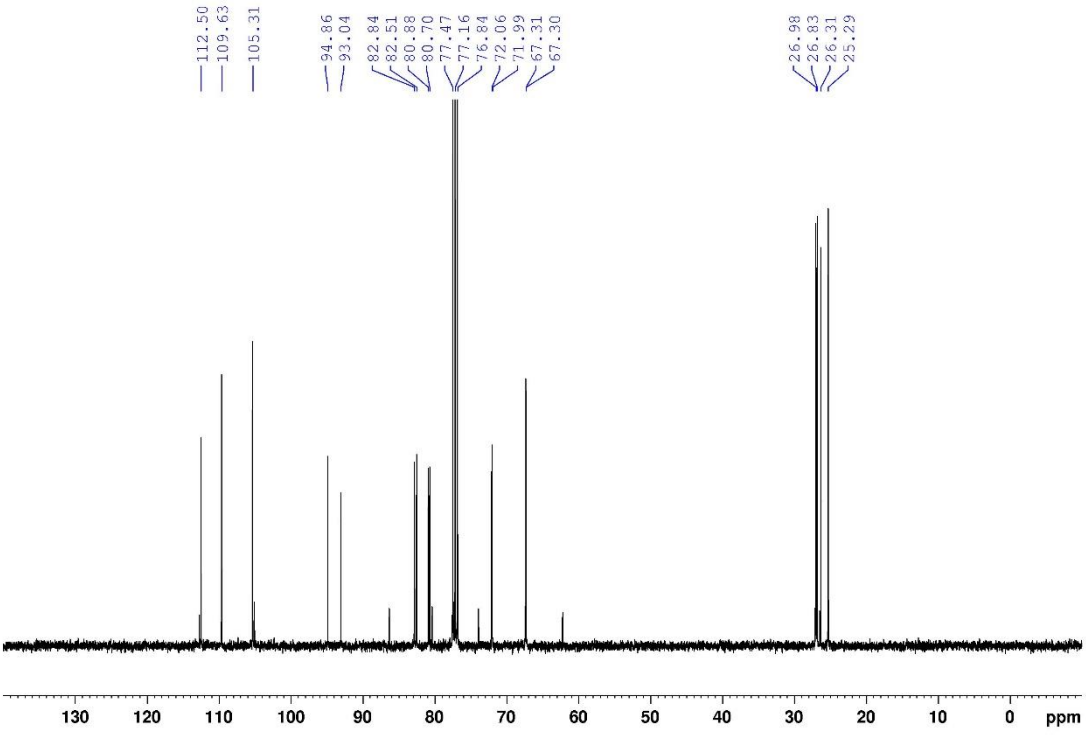


Figure S32: ^{13}C NMR spectrum of **3-Deoxy-1,2;5,6-di-*O*-isopropylidene-3-fluoro-α-D-glucofuranose (16)**

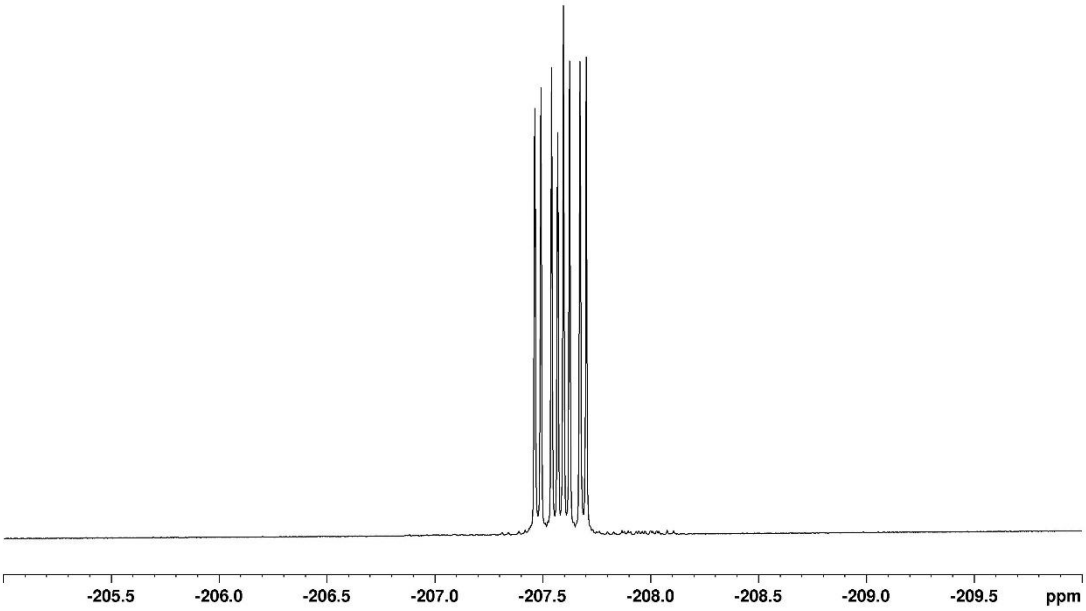


Figure S33: ^{19}F NMR spectrum of **3-Deoxy-1,2;5,6-di-*O*-isopropylidene-3-fluoro-α-D-glucofuranose (16)**

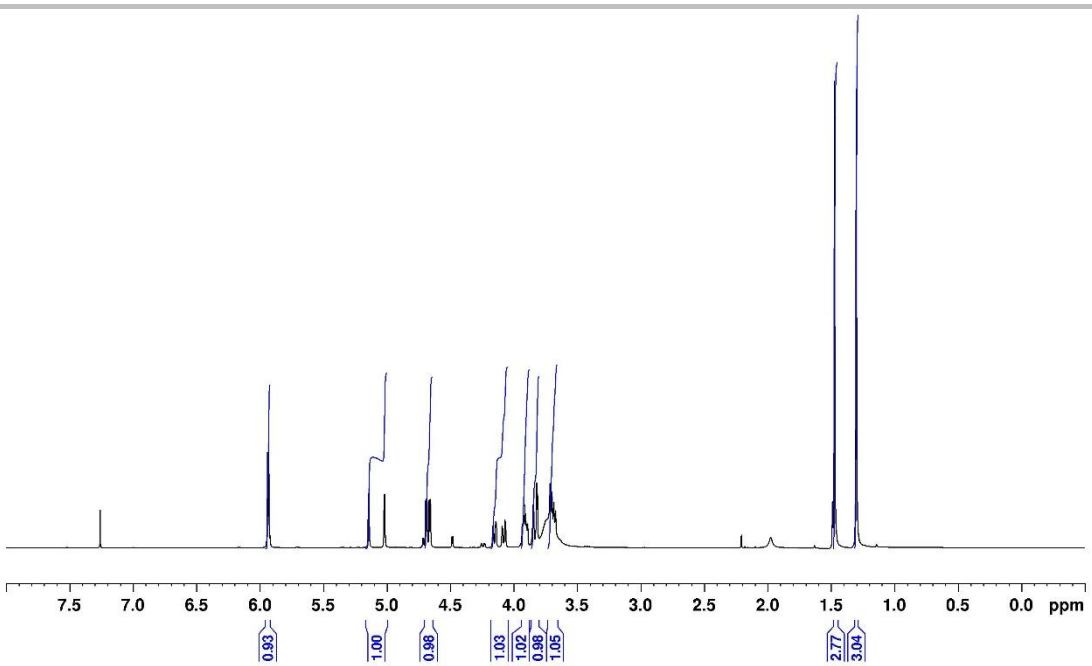


Figure S34: ^{1}H NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-glucofuranose (17)**

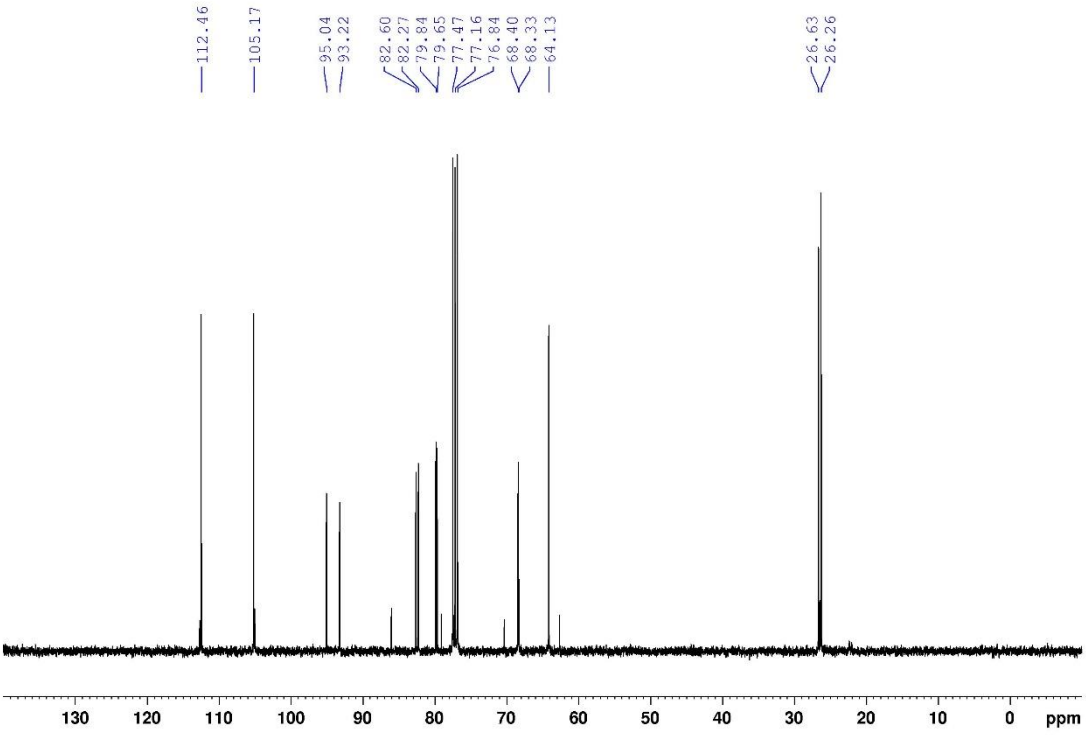


Figure S35: ^{13}C NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-glucofuranose (17)**

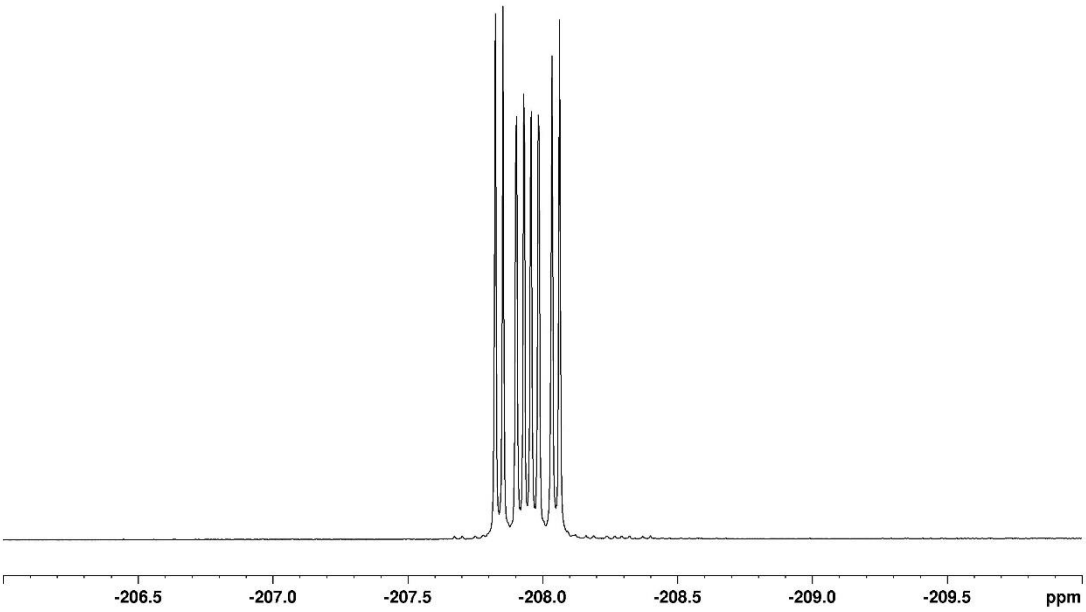


Figure S36: ^{19}F NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-glucofuranose (17)**

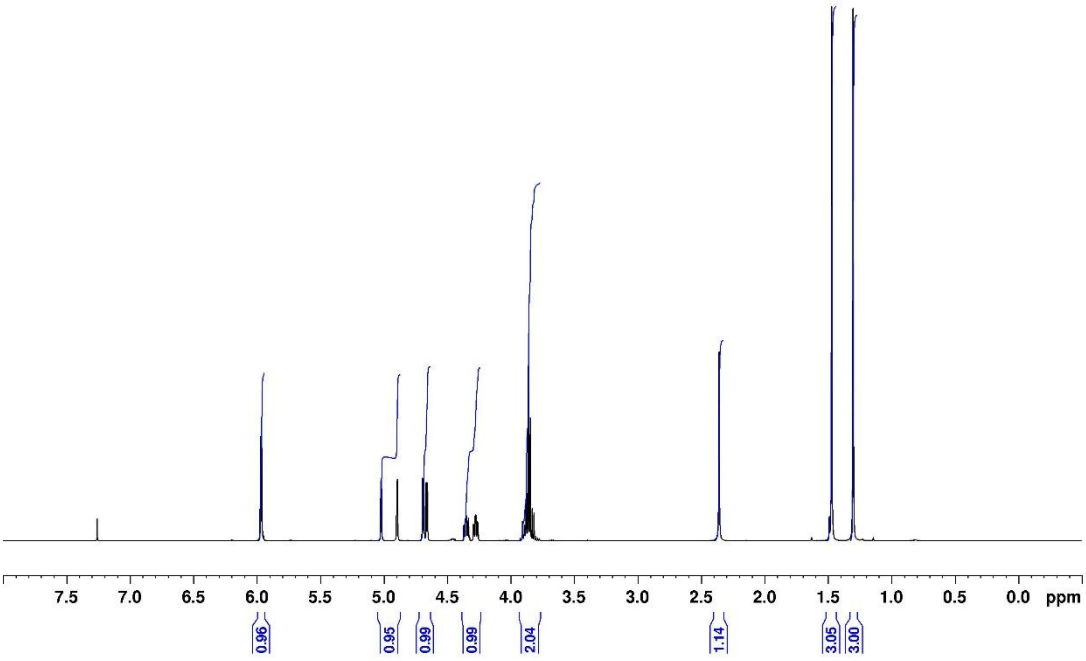


Figure S37:. ^{1}H NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (18)**

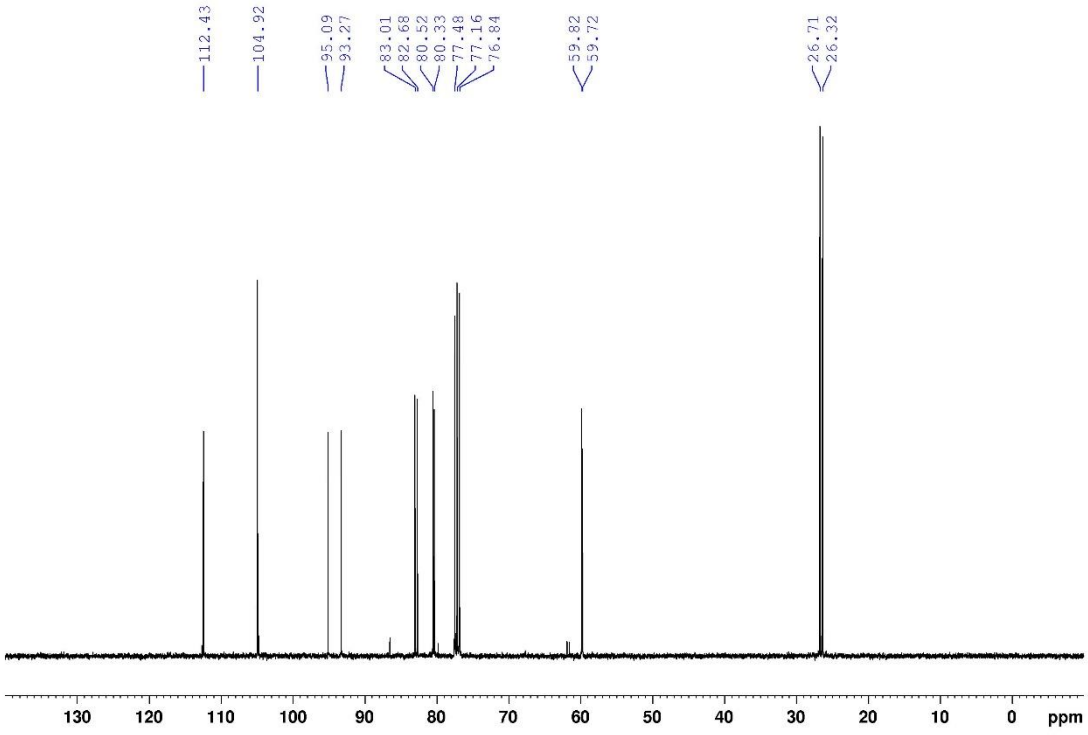


Figure S38: ^{13}C NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (18)**

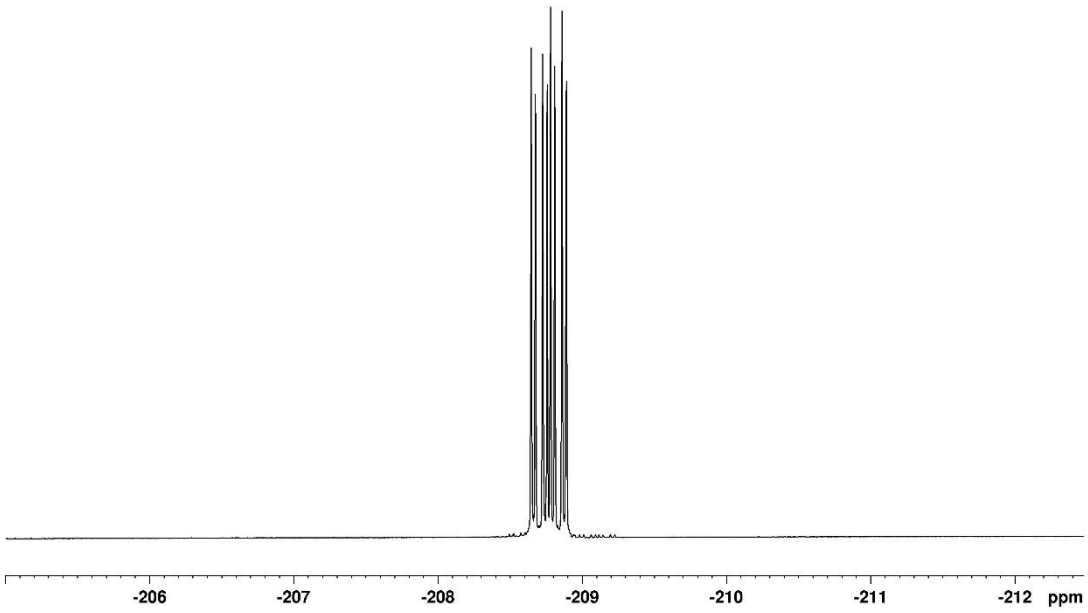


Figure S39: ^{19}F NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (18)**

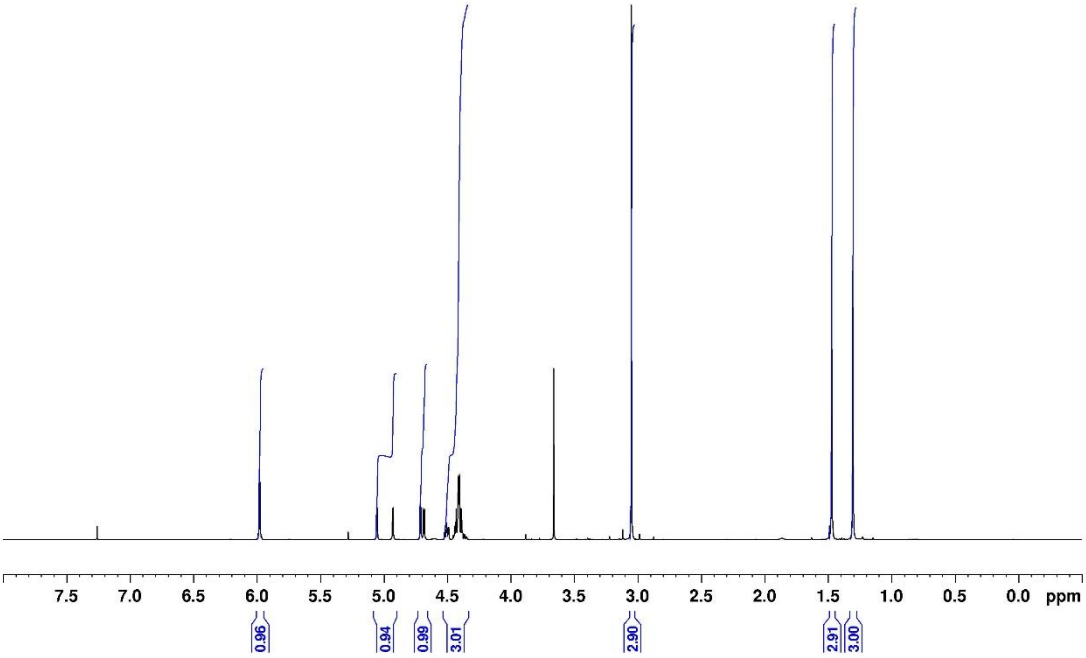


Figure S40: ^{1}H NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-5-*O*-mesyl-α-D-xylofuranose**

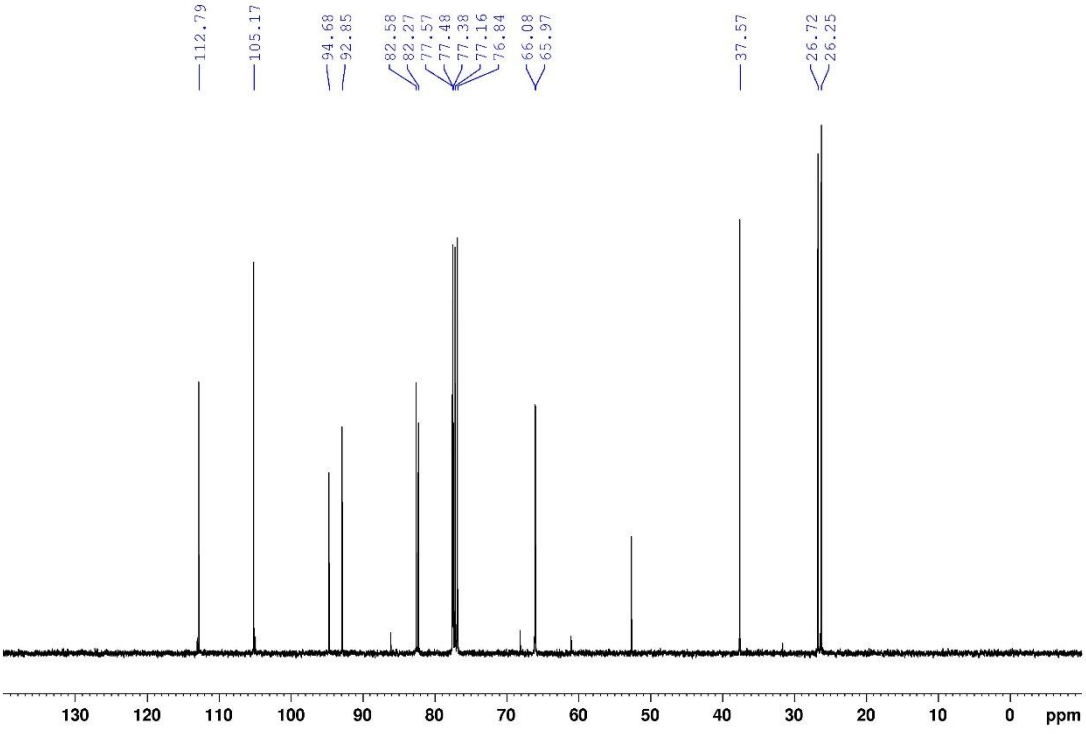


Figure S41: ^{13}C NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-5-*O*-mesyl-α-D-xylofuranose**

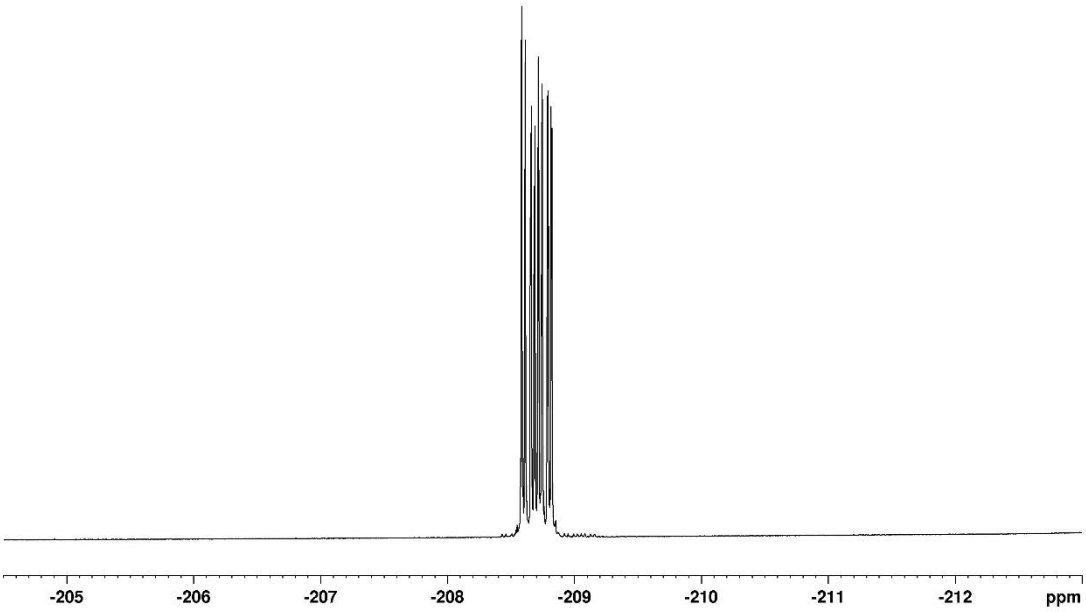


Figure S42: ^{19}F NMR spectrum of **3-Deoxy-3-fluoro-1,2-*O*-isopropylidene-5-*O*-mesyl-α-D-xylofuranose**

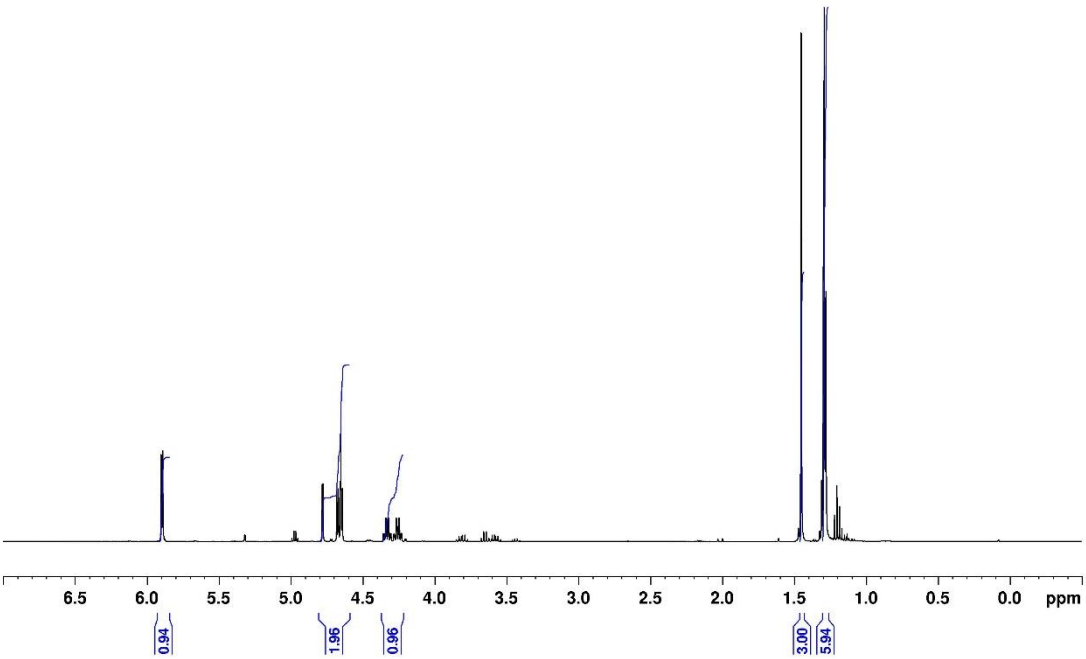


Figure S43: ^{1}H NMR spectrum of **3,5-Dideoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (19)**

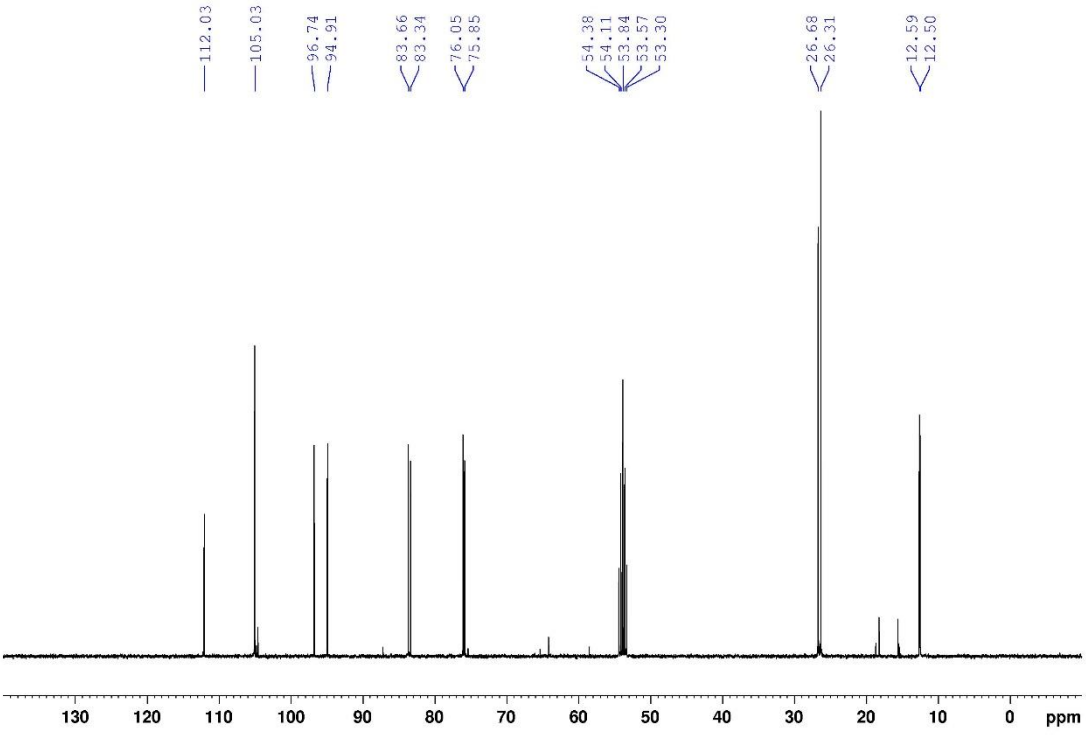


Figure S44: ^{13}C NMR spectrum of **3,5-Dideoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (19)**

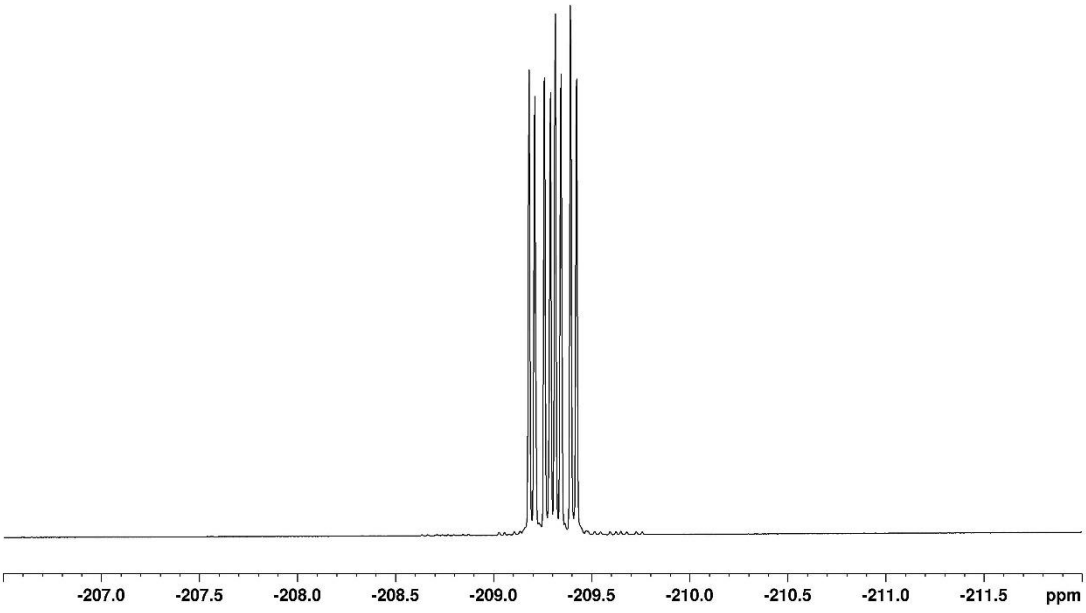


Figure S45: ^{19}F NMR spectrum of **3,5-Dideoxy-3-fluoro-1,2-*O*-isopropylidene-α-D-xylofuranose (19)**

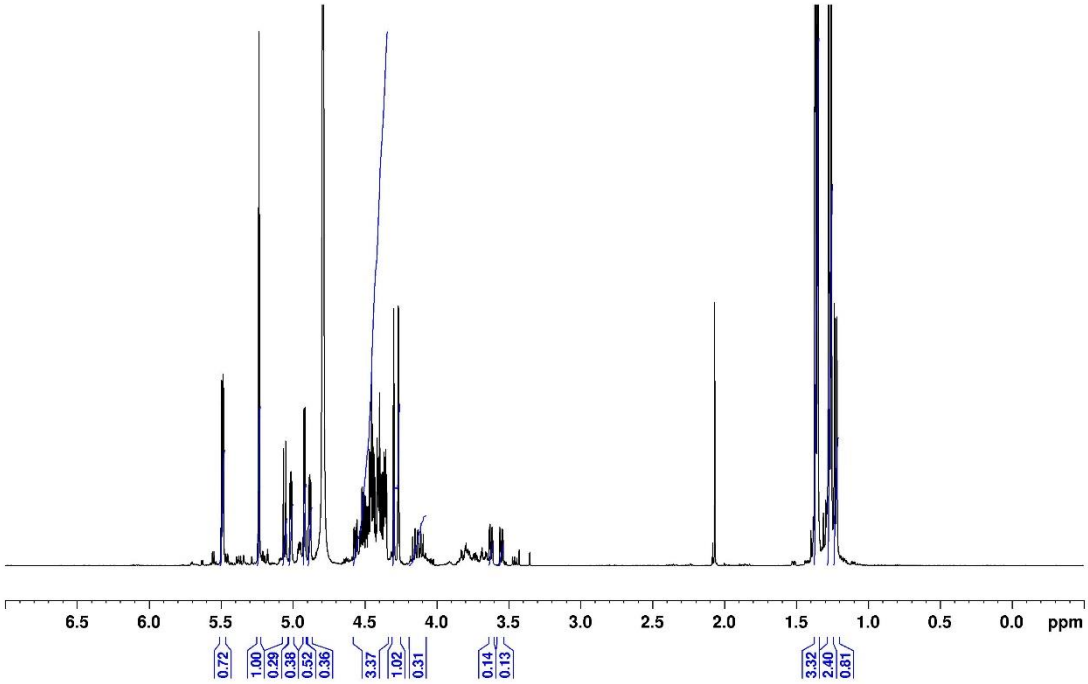


Figure S46: [1]H NMR spectrum of **3,5-Dideoxy-3-fluoro-D-xylose (20)**

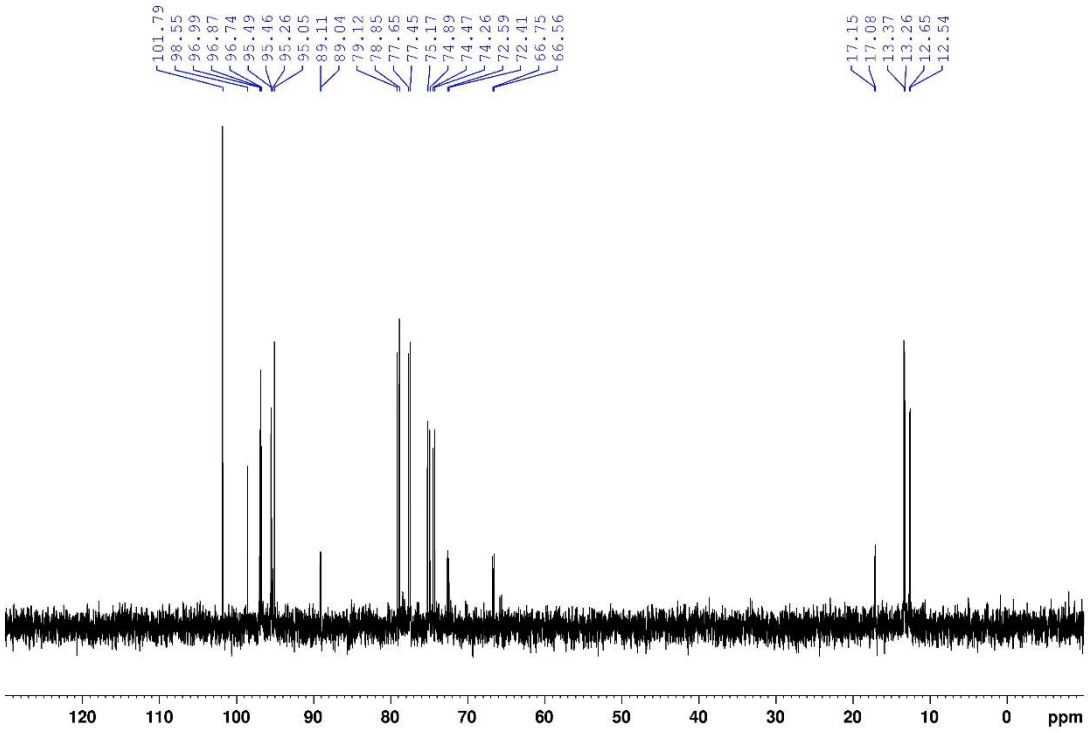


Figure S47: [13]C NMR spectrum of **3,5-Dideoxy-3-fluoro-D-xylose (20)**

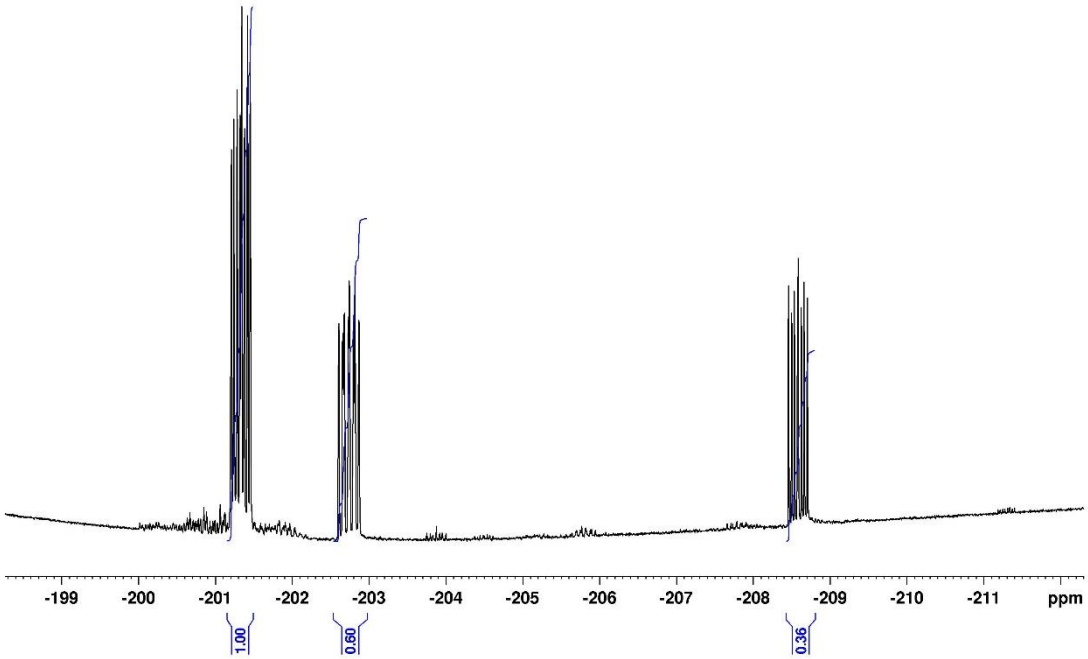


Figure S48: ^{19}F NMR spectrum of **3,5-Dideoxy-3-fluoro-D-xylose (20)**

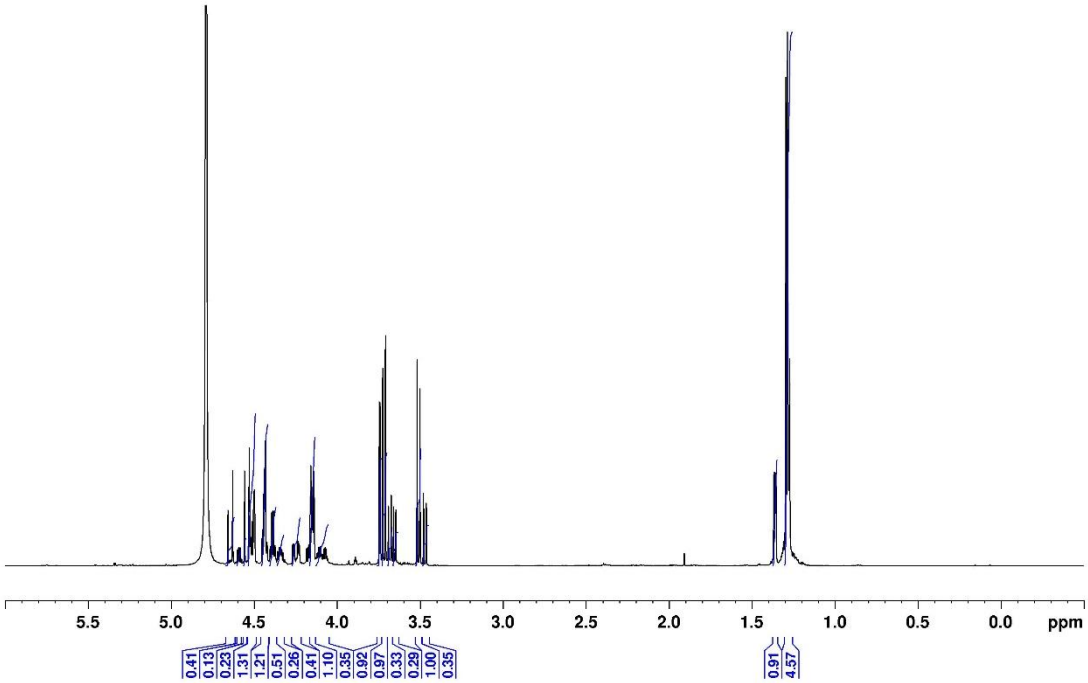


Figure S49: ^{1}H NMR spectrum of **5,7-Dideoxy-5-fluoro-idoheptulose (3)**

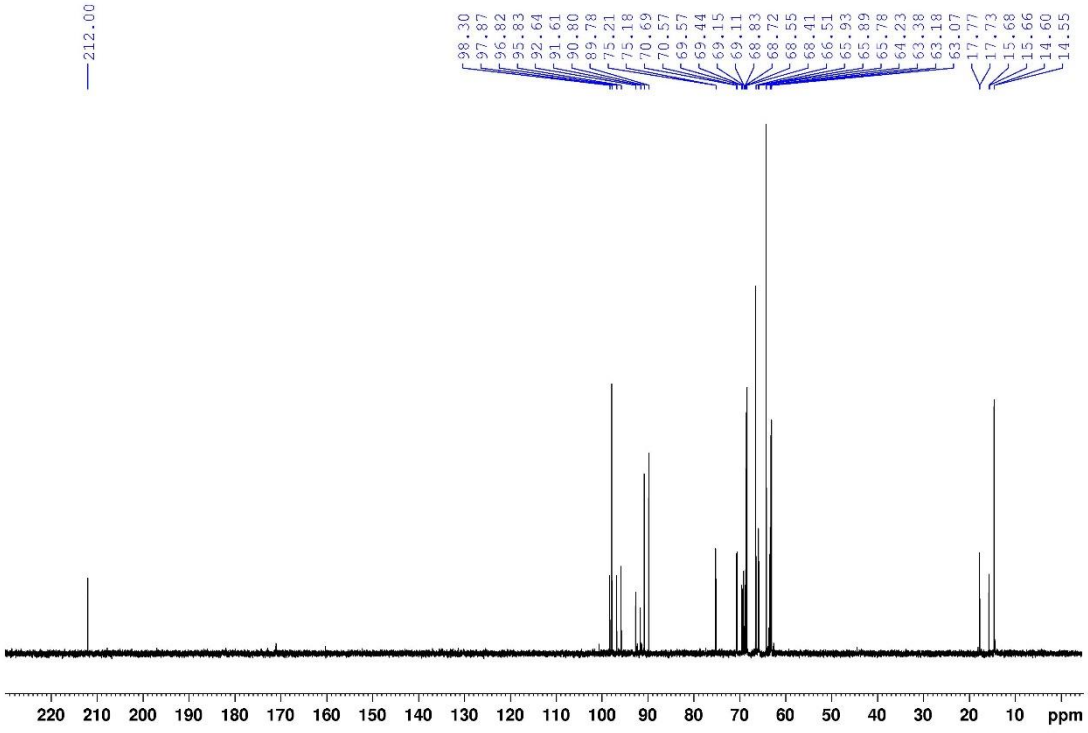


Figure S50: ^{13}C NMR spectrum of **5,7-Dideoxy-5-fluoro-idoheptulose (3)**

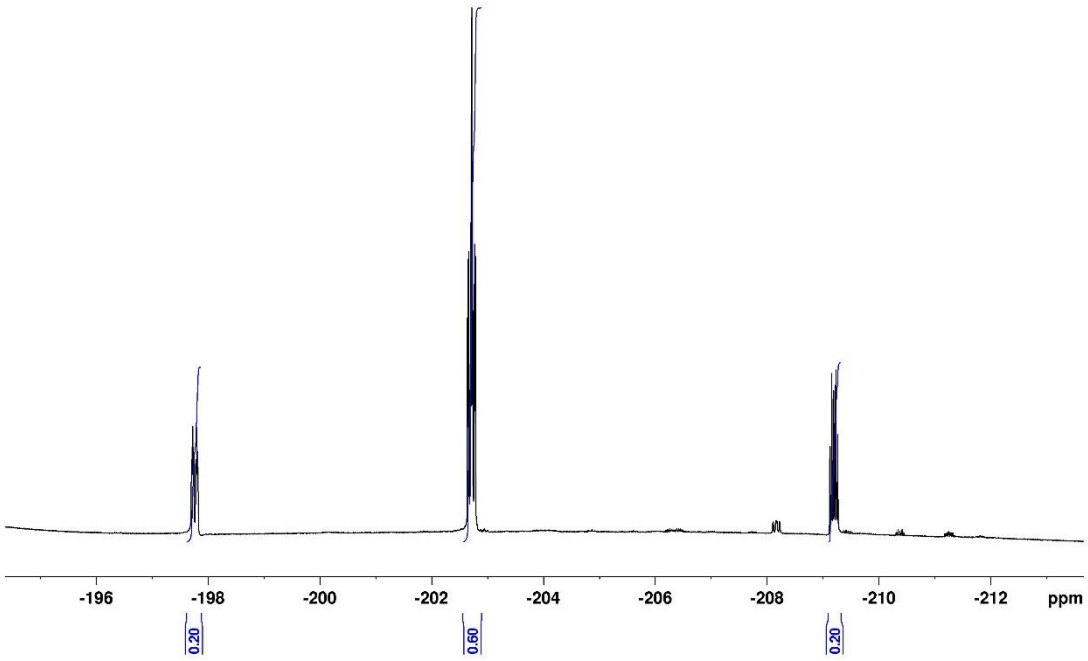


Figure S51: ^{19}F NMR spectrum of **5,7-Dideoxy-5-fluoro-idoheptulose (3)**

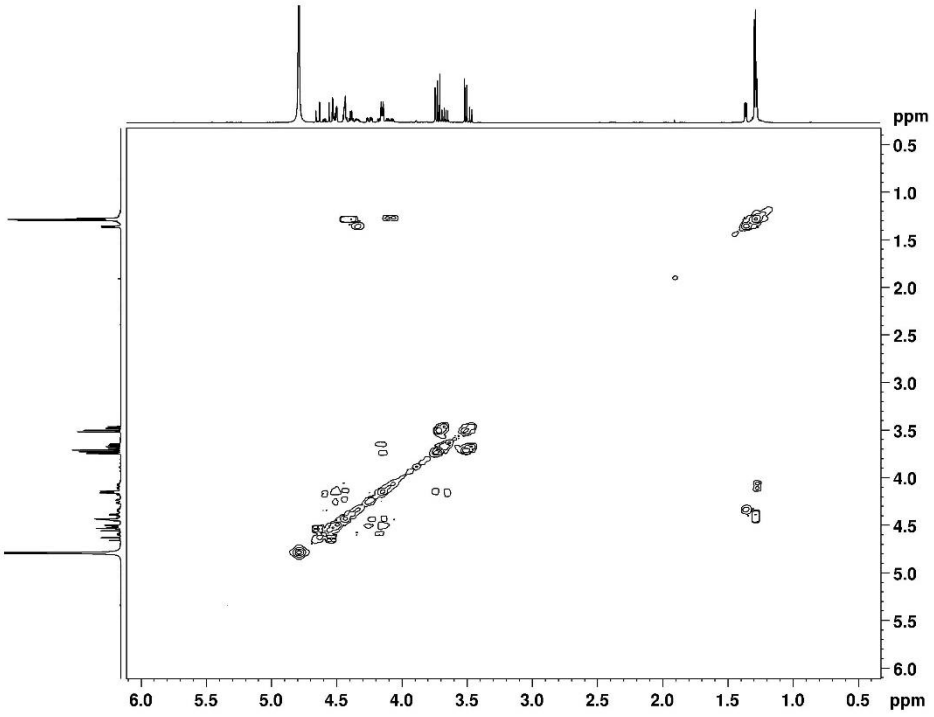


Figure S52: H-H-correlation (COSY) spectrum of **5,7-Dideoxy-5-fluoro-idoheptulose (3)**

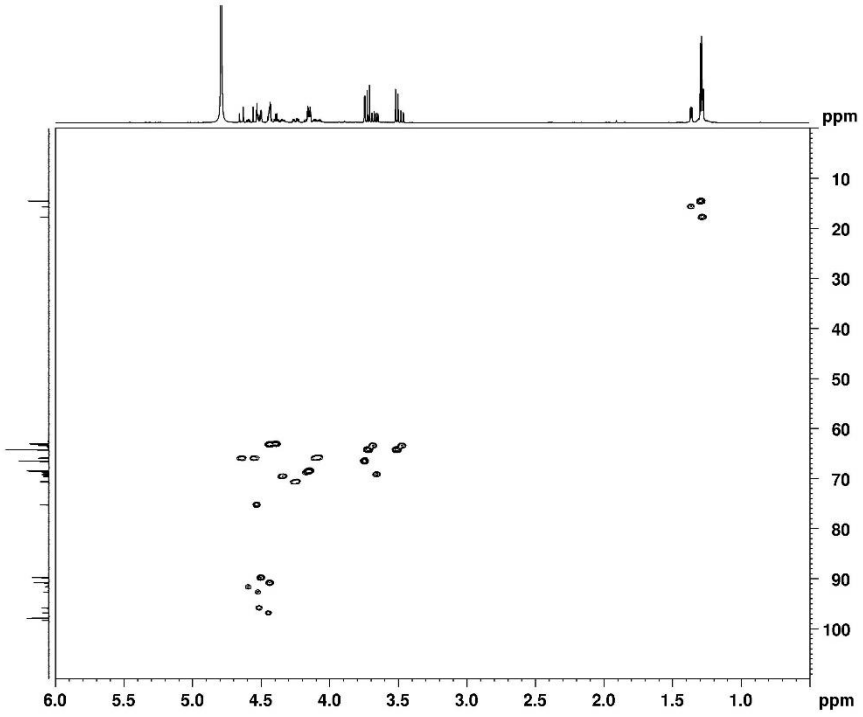


Figure S53: CH-correlation (HSQC) spectrum of **5,7-Dideoxy-5-fluoro-idoheptulose (3)**

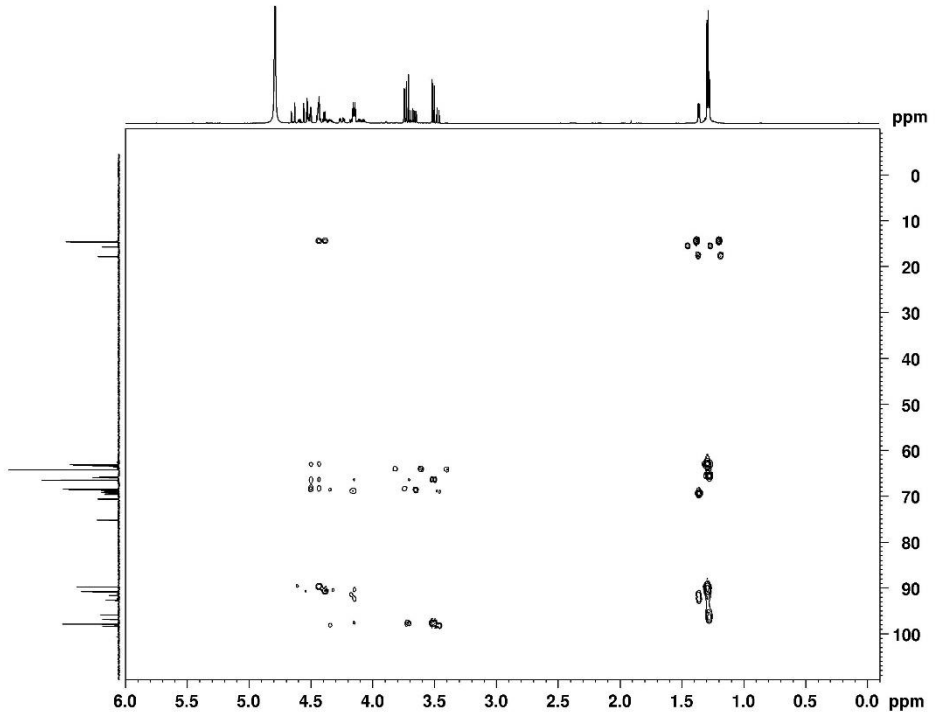


Figure S54: Multiple bond CH-correlation (HMBC) spectrum of **5,7-Dideoxy-5-fluoro-idoheptulose (3)**

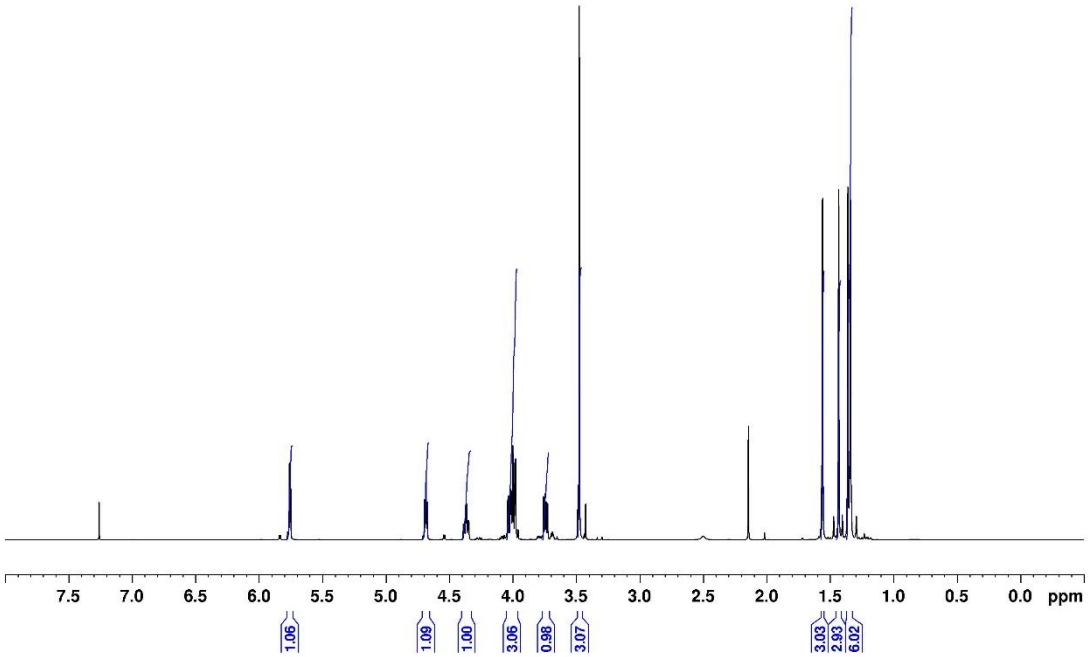


Figure S55: ^{1}H NMR spectrum of **1,2;5,6-Di-*O*-isopropylidene-3-methoxy-α-D-allofuranose (21)**

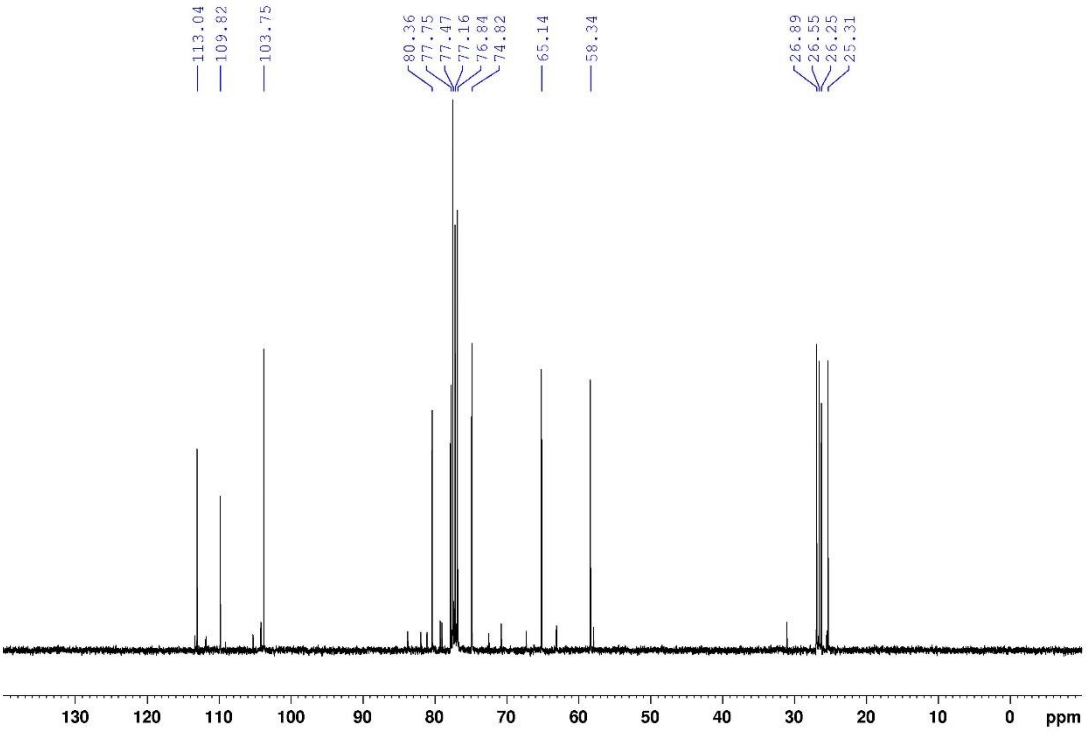


Figure S56: ^{13}C NMR spectrum of **1,2;5,6-Di-*O*-isopropylidene-3-methoxy-α-D-allofuranose (21)**

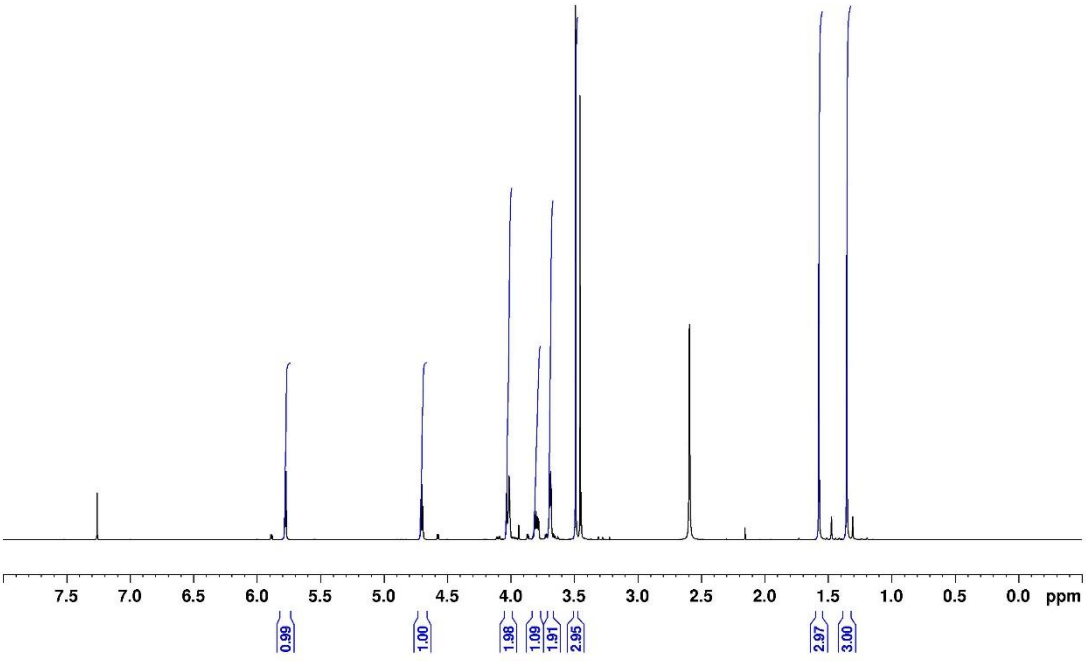


Figure S57: ^{1}H NMR spectrum of **1,2-*O*-Isopropylidene-3-methoxy-α-D-allofuranose (22)**

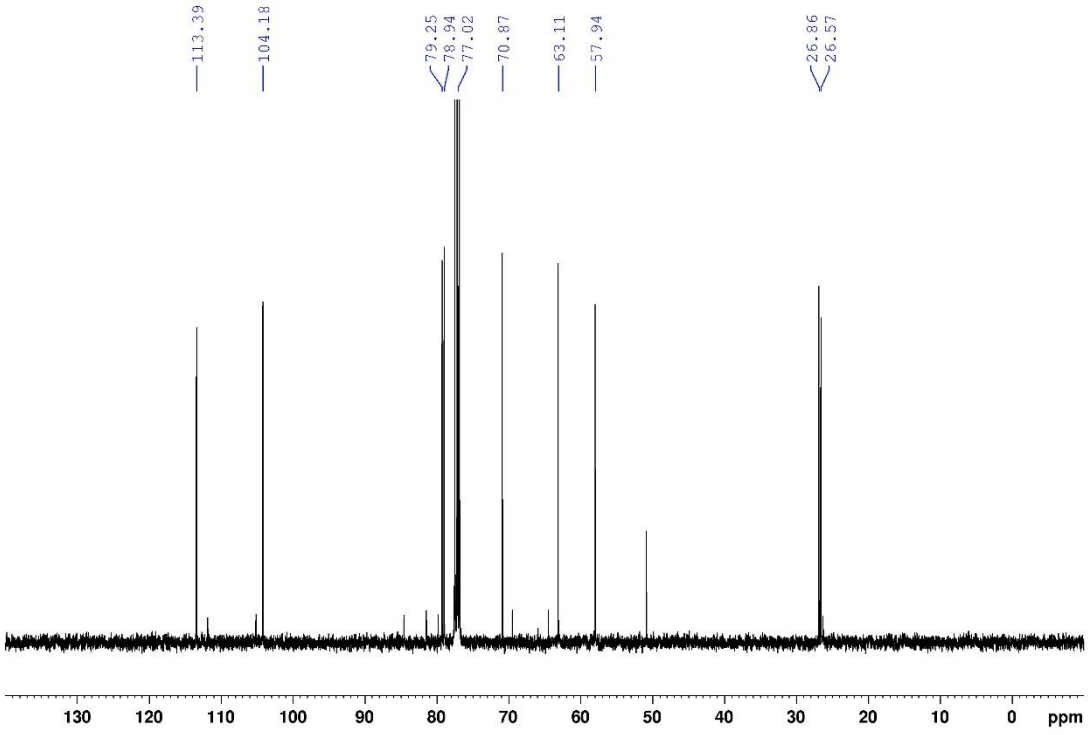


Figure S58: ^{13}C NMR spectrum of **1,2-*O*-Isopropylidene-3-methoxy-α-D-allofuranose (22)**

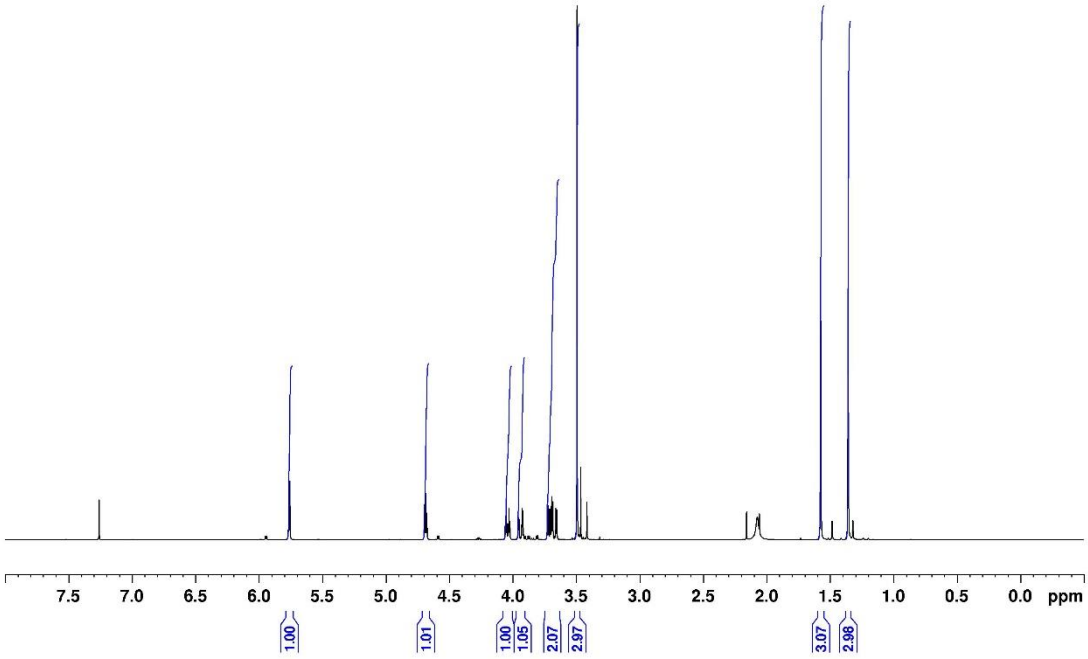


Figure S59: ^{1}H NMR spectrum of **1,2-*O*-Isopropylidene-3-methoxy-α-D-ribofuranose (23)**

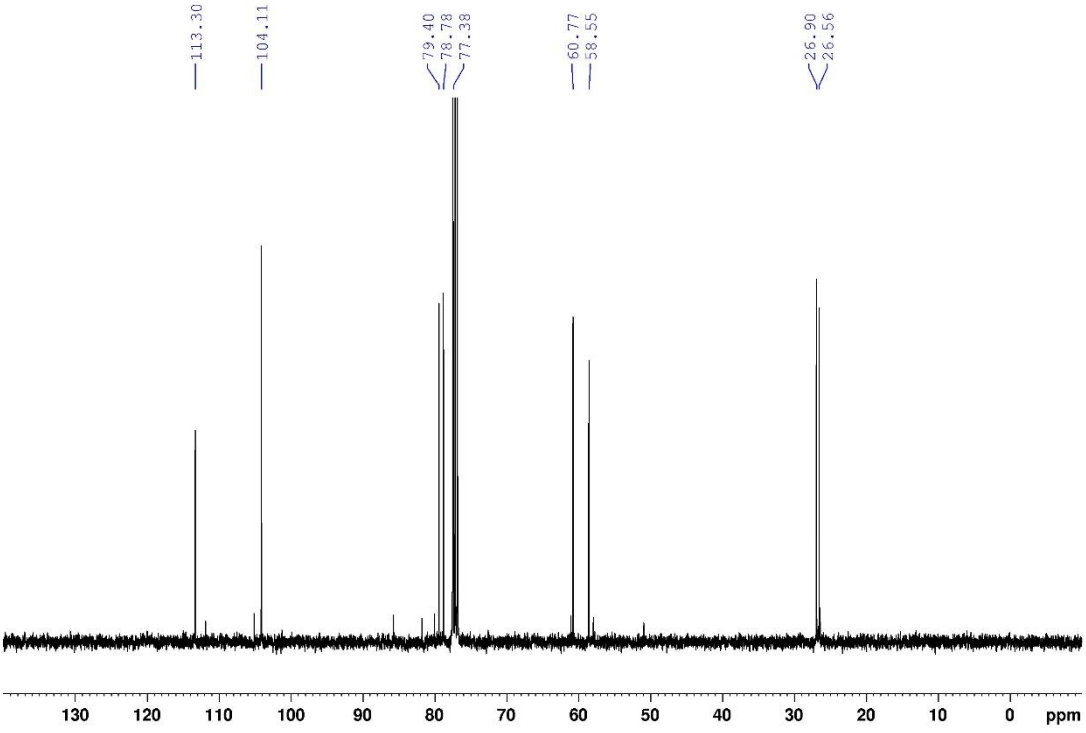


Figure S60: ^{13}C NMR spectrum of **1,2-*O*-Isopropylidene-3-methoxy-α-D-ribofuranose (23)**

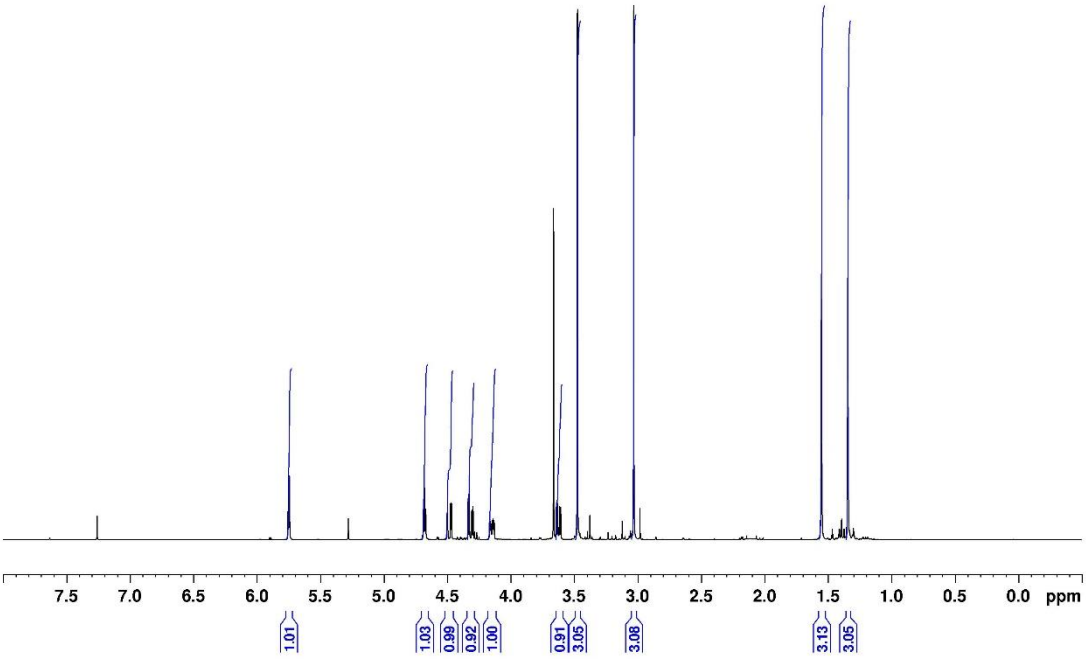


Figure S61: ^{1}H NMR spectrum of **1,2-*O*-Isopropylidene-5-mesyl-3-methoxy-α-D-ribofuranose**

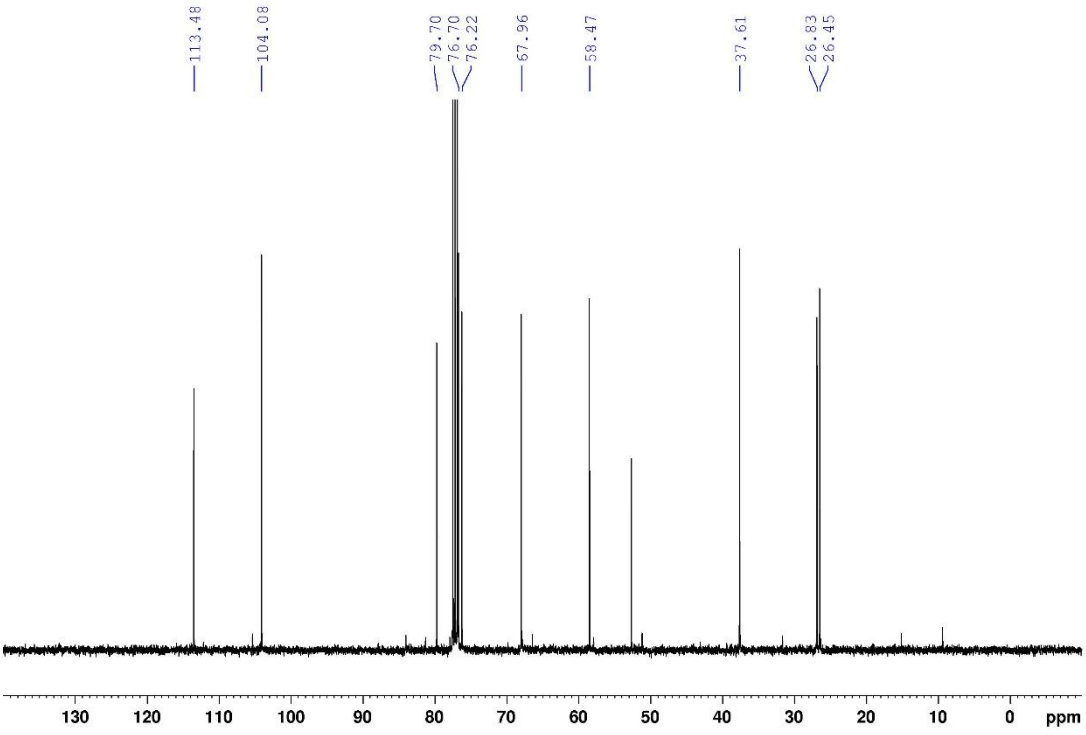


Figure S62: ^{13}C NMR spectrum of **1,2-*O*-Isopropylidene-5-mesyl-3-methoxy-α-D-ribofuranose**

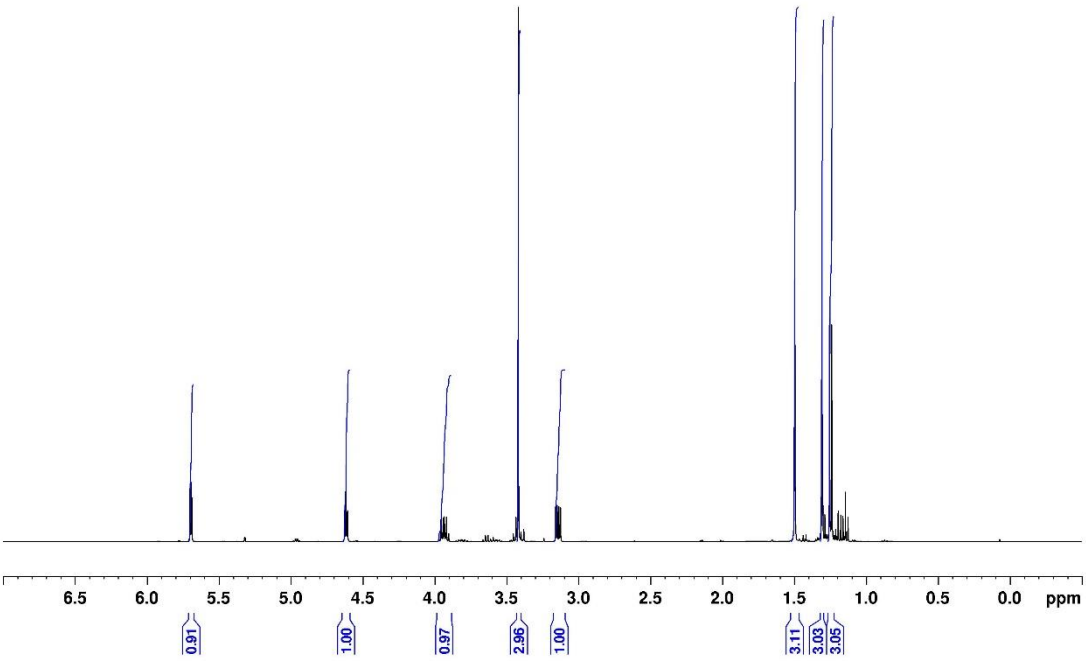


Figure S63: ^{1}H NMR spectrum of **5-Deoxy-1,2-*O*-isopropylidene-3-methoxy-α-D-ribofuranose (24)**

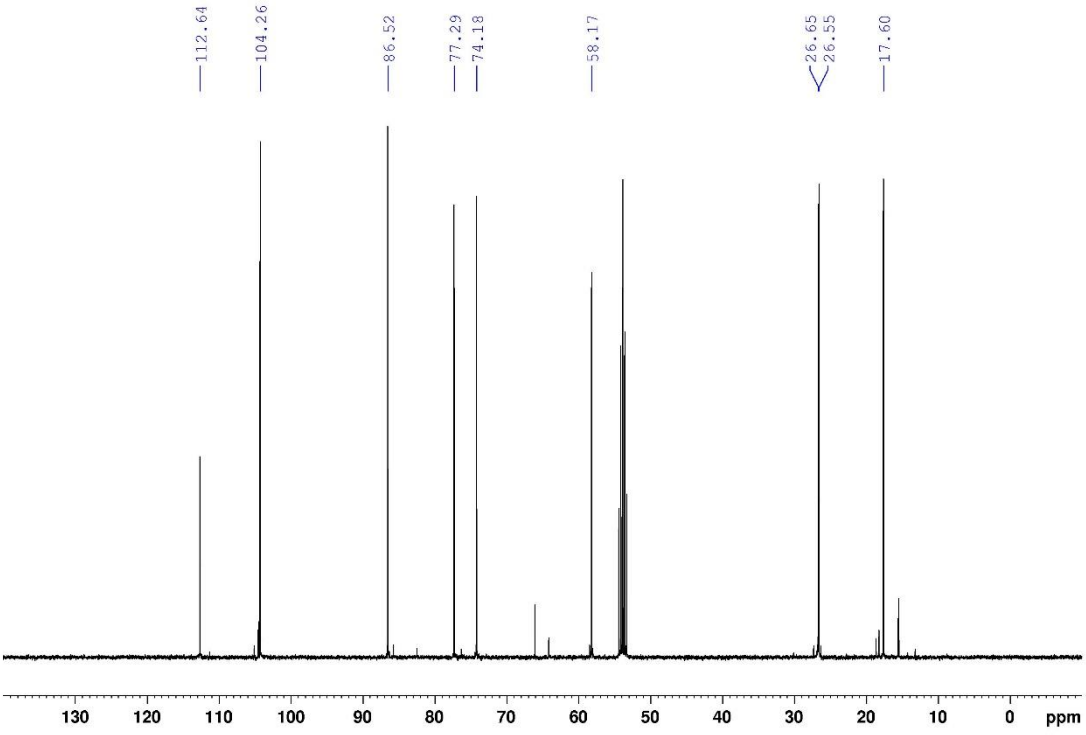


Figure S64: ^{13}C NMR spectrum of **5-Deoxy-1,2-*O*-isopropylidene-3-methoxy-α-D-ribofuranose (24)**

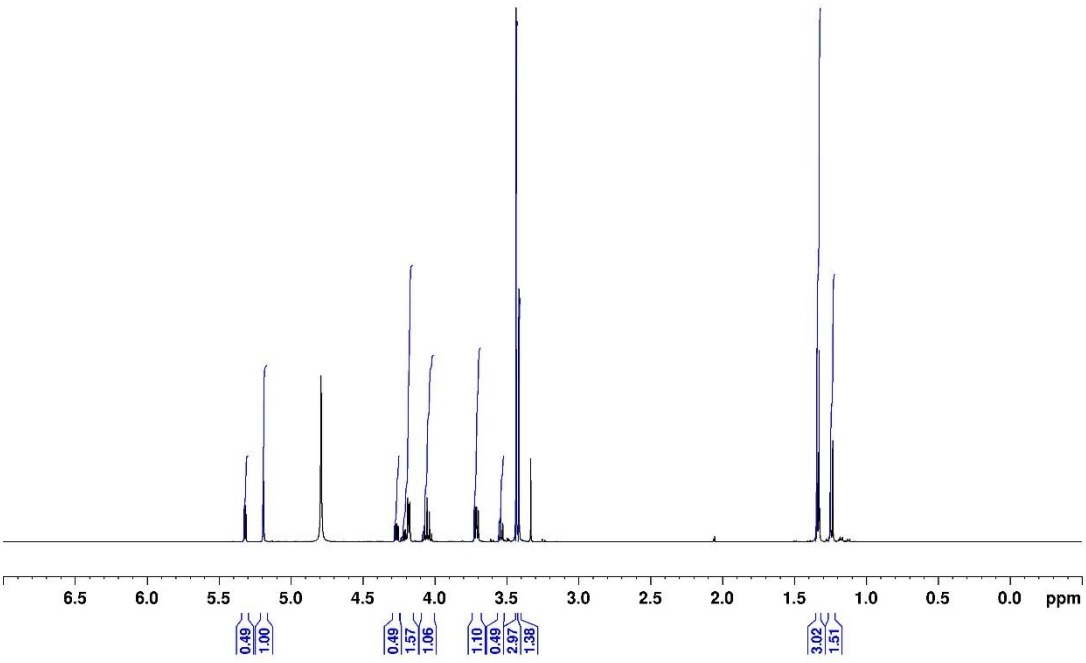


Figure S65: ^{1}H NMR spectrum of **5-Deoxy-3-methoxy-D-ribose (25)**

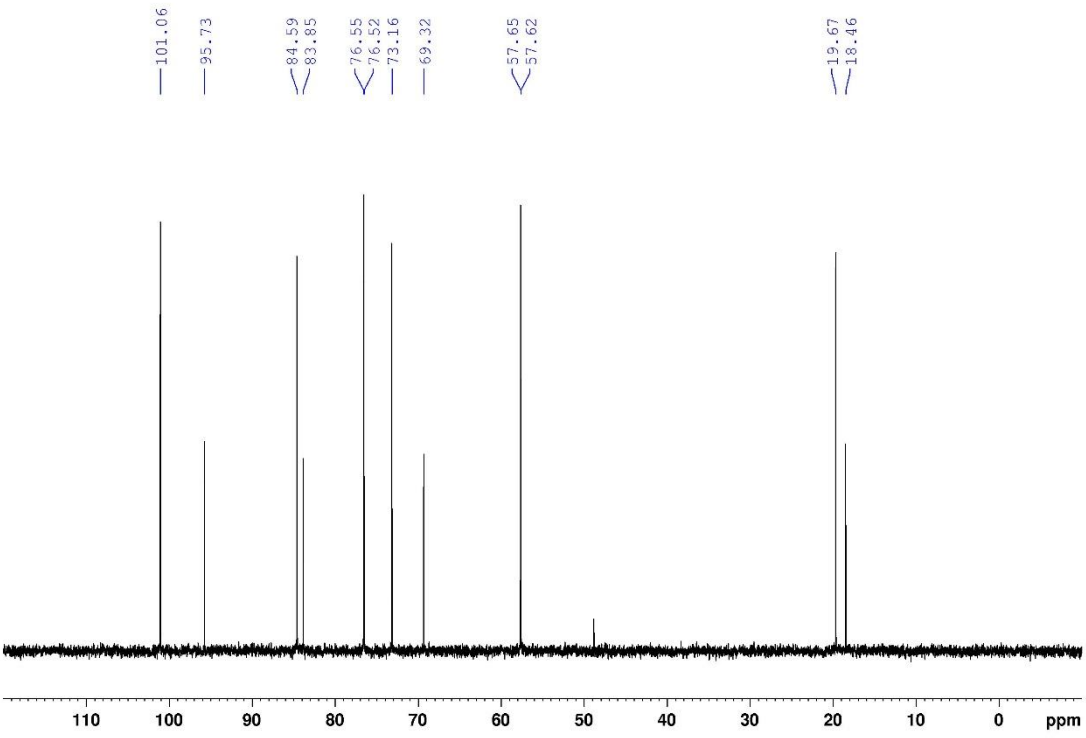


Figure S66: ^{13}C NMR spectrum of **5-Deoxy-3-methoxy-D-ribose (25)**

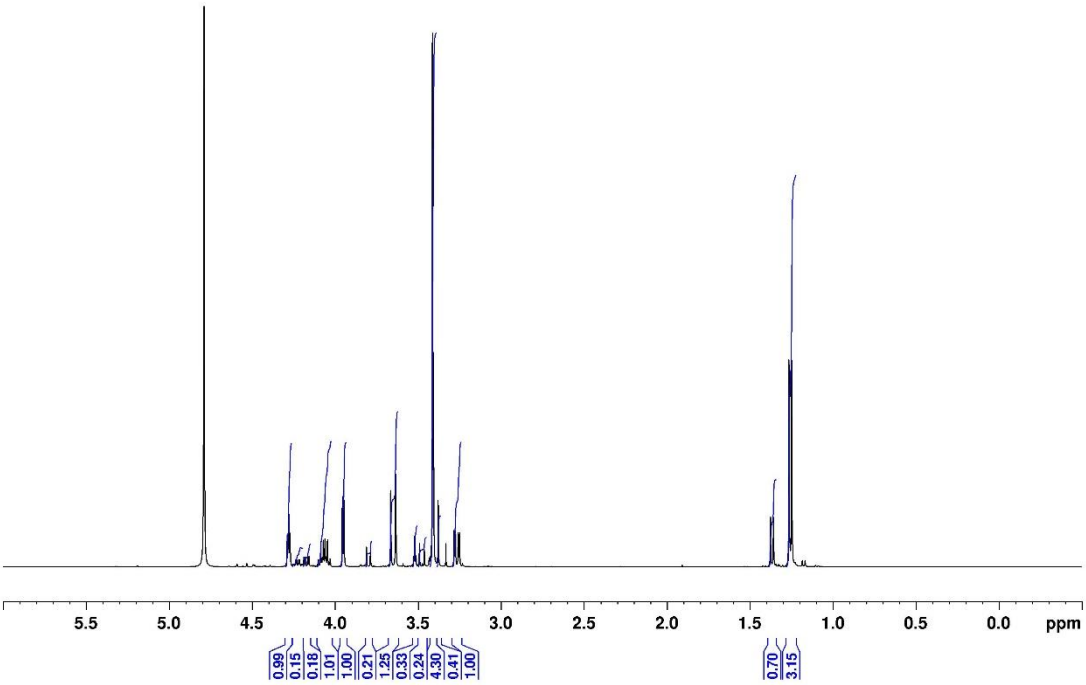


Figure S67: ^{1}H NMR spectrum of **7-Deoxy-5-methoxy-sedoheptulose (4)**

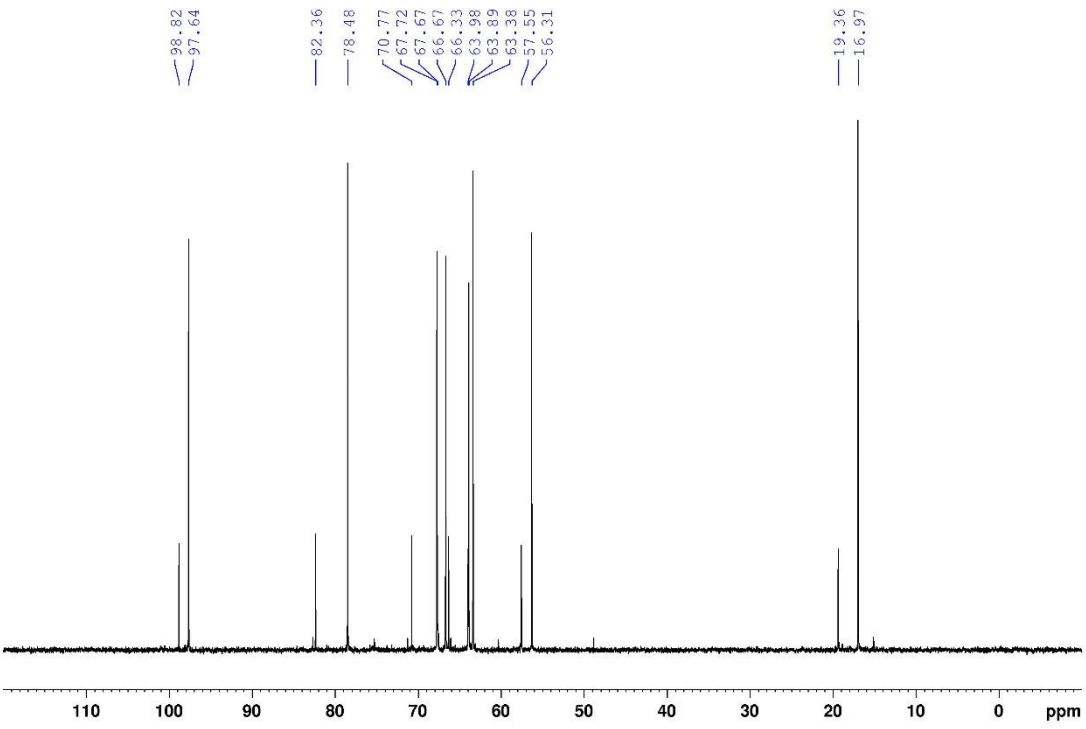


Figure S68: ^{13}C NMR spectrum of **7-Deoxy-5-methoxy-sedoheptulose (4)**

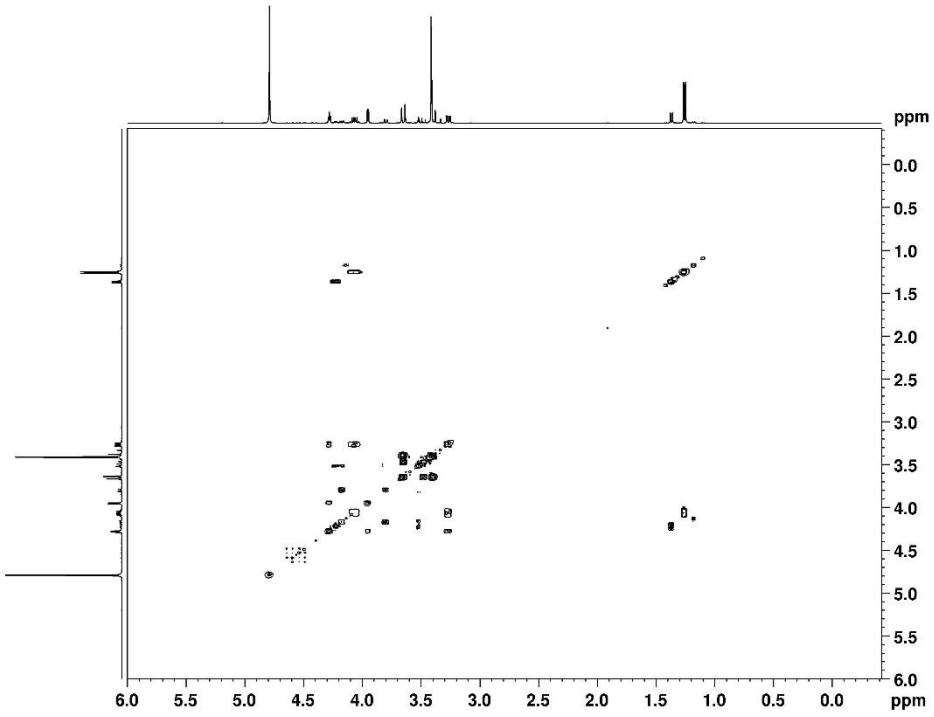


Figure S69: H-H-correlation (COSY) spectrum of **7-Deoxy-5-methoxy-sedoheptulose (4)**

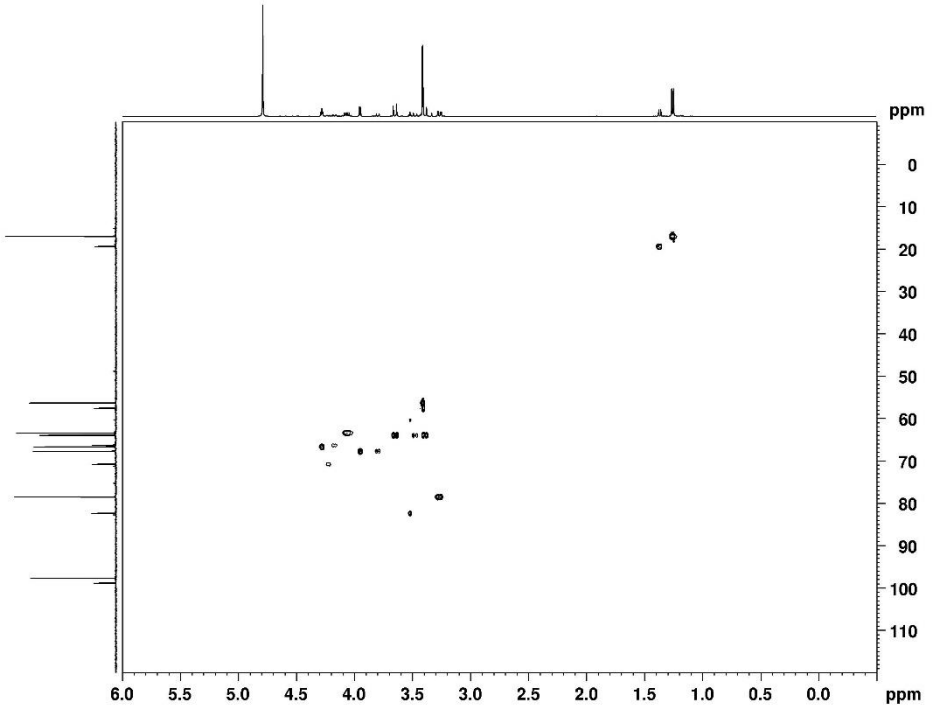


Figure S70: CH-correlation (HSQC) spectrum of **7-Deoxy-5-methoxy-sedoheptulose (4)**

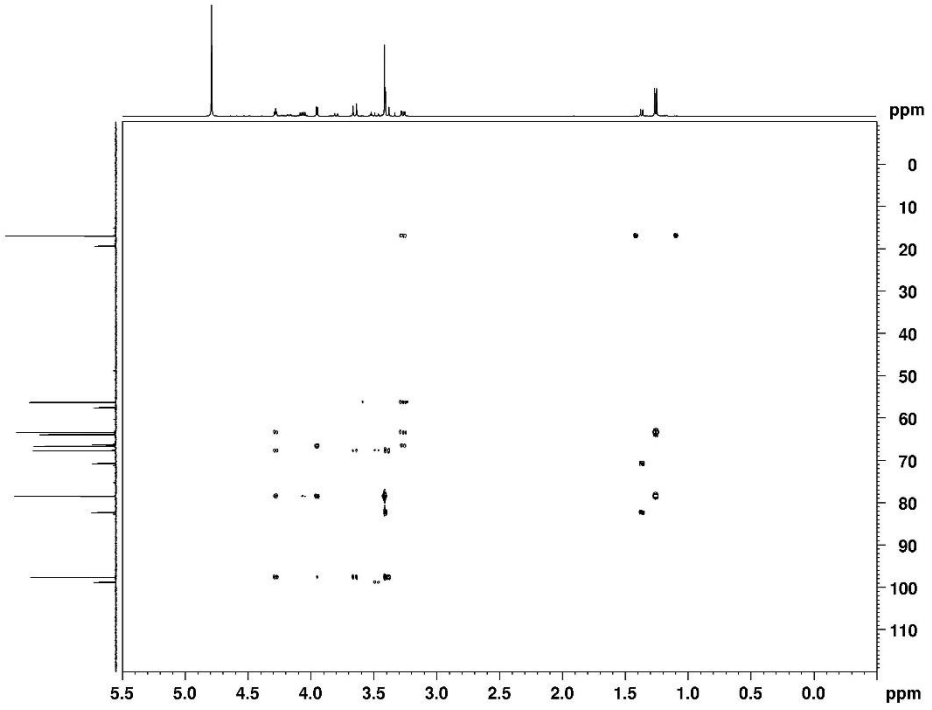


Figure S71: Multiple bond CH-correlation (HMBC) spectrum of **7-Deoxy-5-methoxy-sedoheptulose (4)**

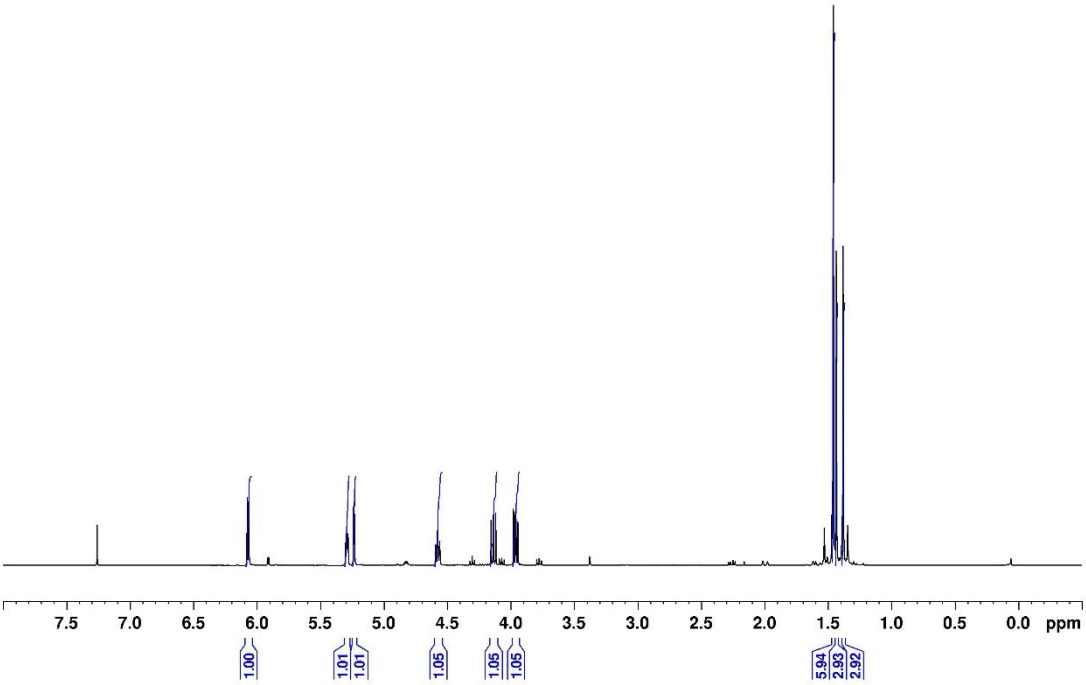


Figure S72: ^{1}H NMR spectrum of **3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-erythro-hex-3-enofuranose (27)**

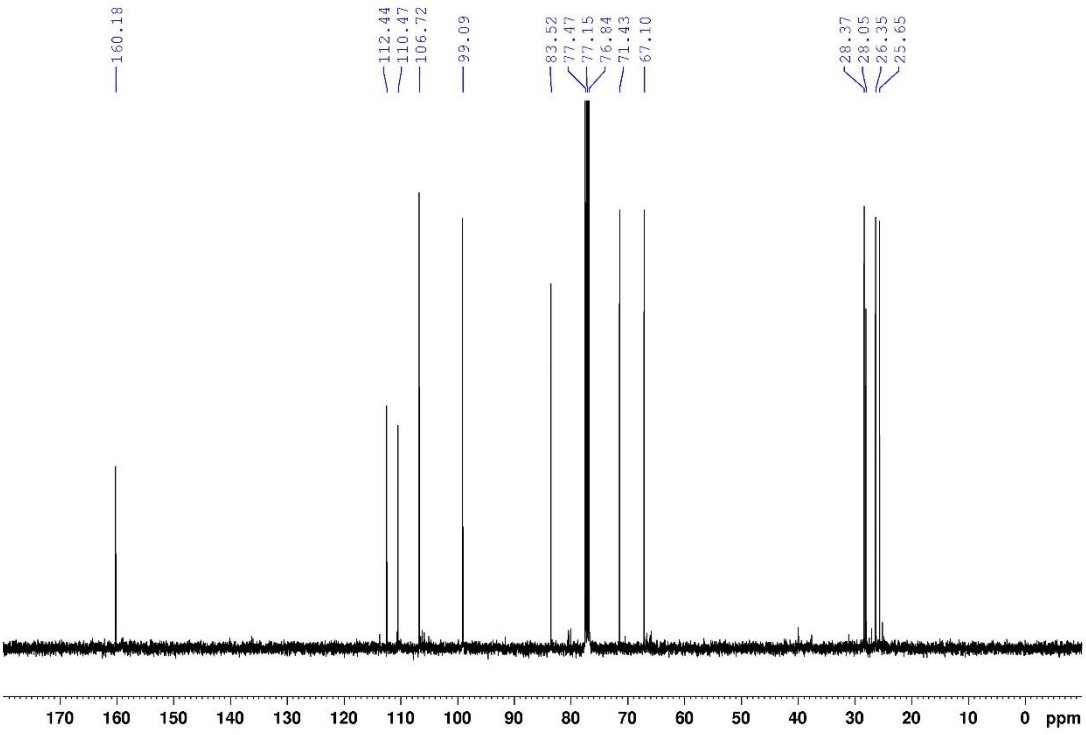


Figure S73: ^{13}C NMR spectrum of **3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-erythro-hex-3-enofuranose (27)**

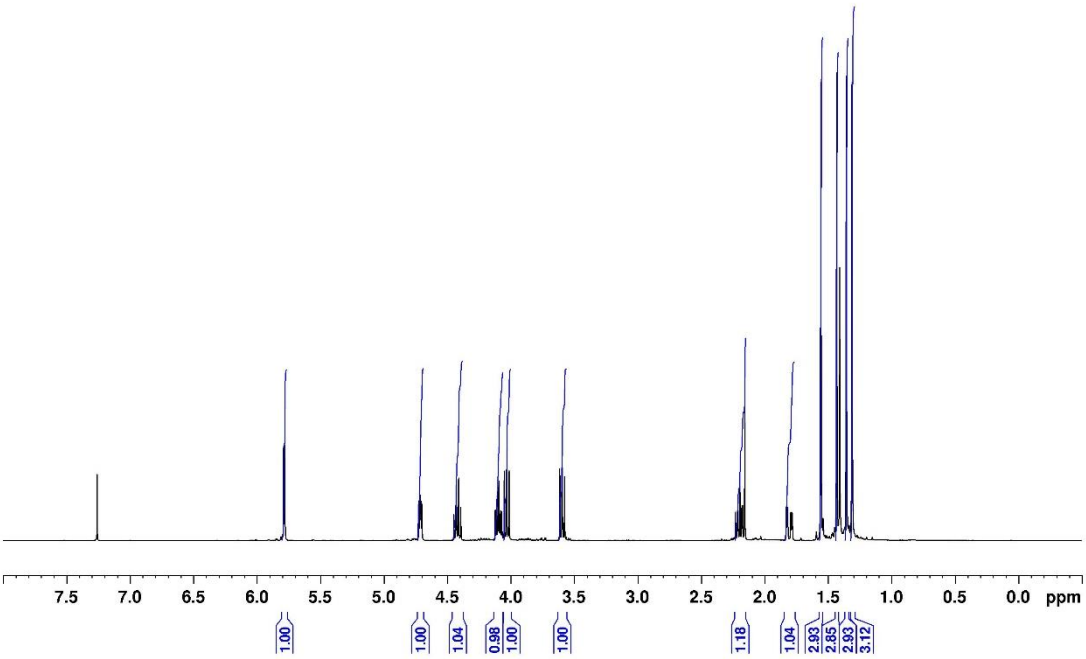


Figure S74: ^{1}H NMR spectrum of **3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-gulofuranose**

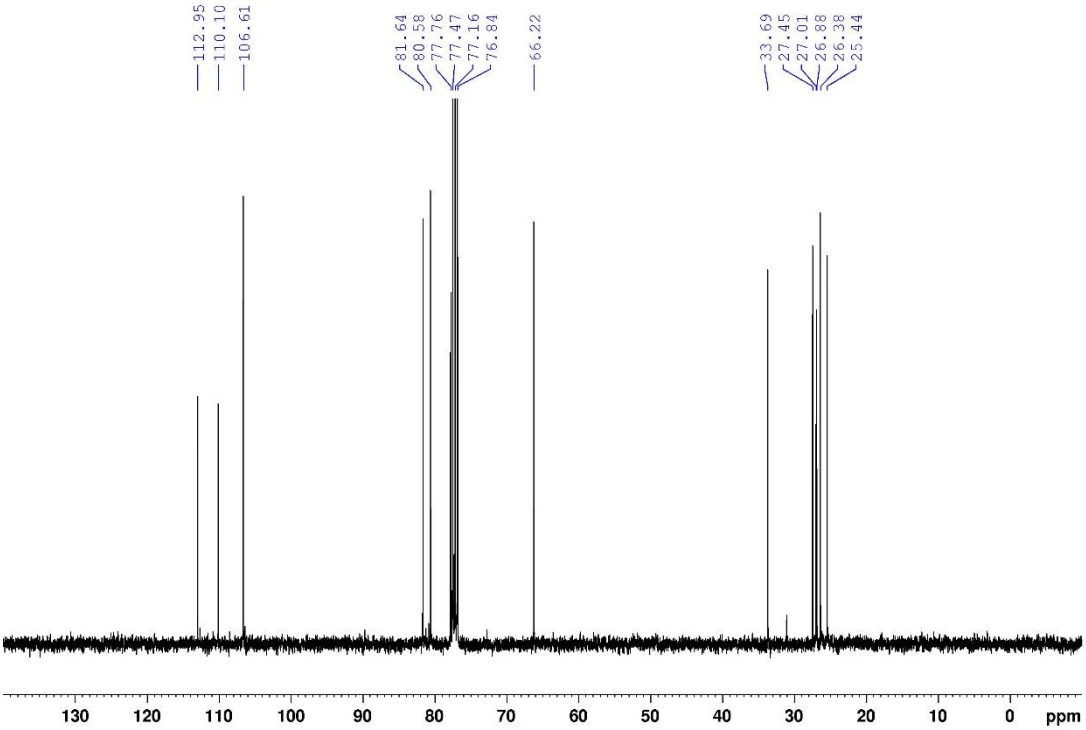


Figure S75: ^{13}C NMR spectrum of **3-Deoxy-1,2;5,6-di-*O*-isopropylidene-α-D-gulofuranose**

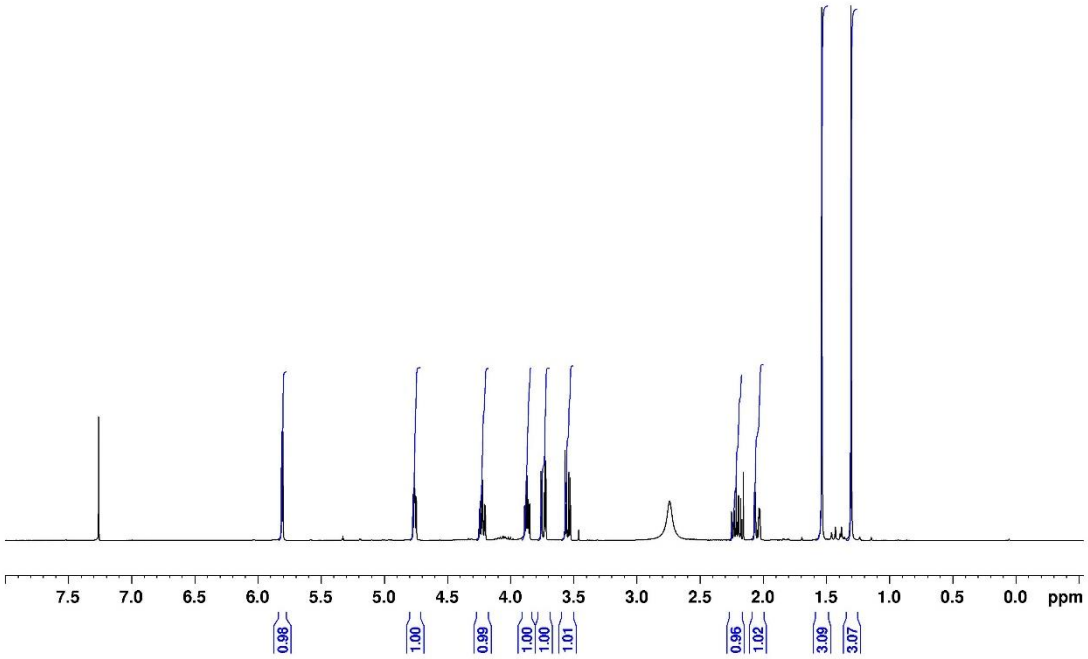


Figure S76: ^{1}H NMR spectrum of **3-Deoxy-1,2-*O*-isopropylidene-α-D-gulofuranose (28)**

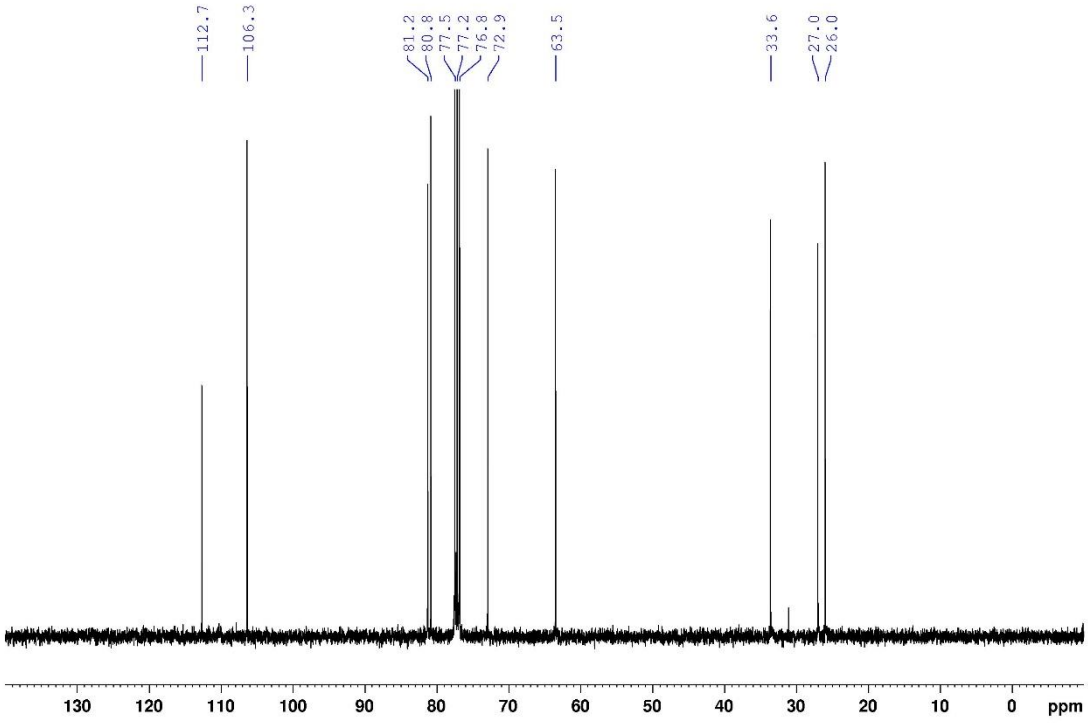


Figure S77: ^{13}C NMR spectrum of **3-Deoxy-1,2-*O*-isopropylidene-α-D-gulofuranose (28)**

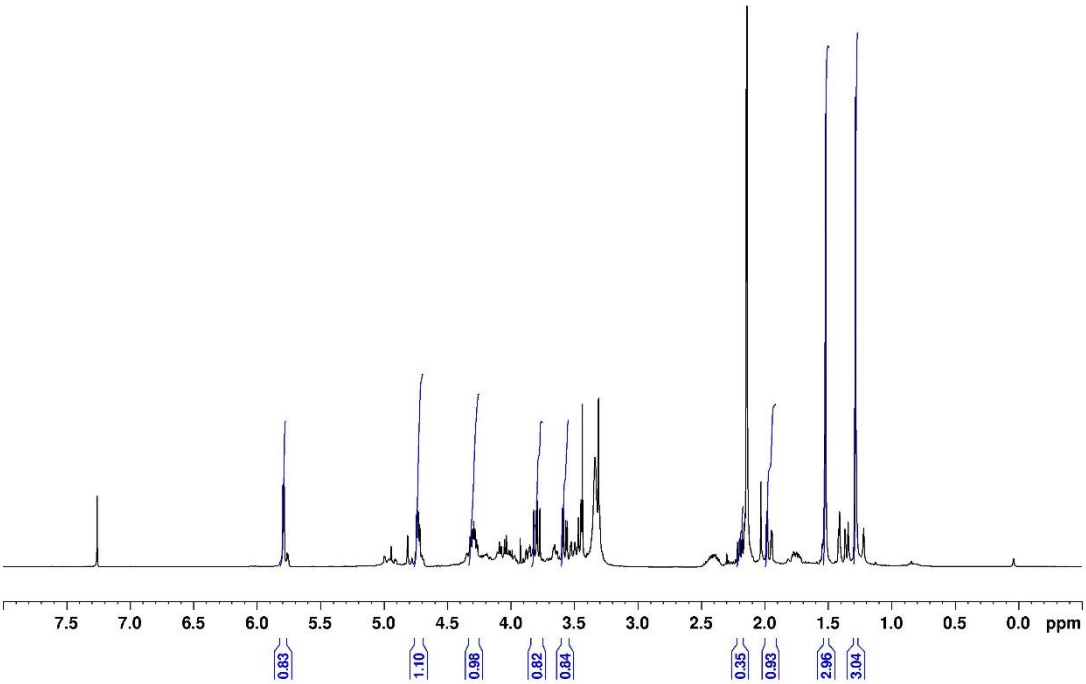


Figure S78: [1]H NMR spectrum of **3-Deoxy-1,2-*O*-isopropylidene-α-L-lyxofuranose (29)**

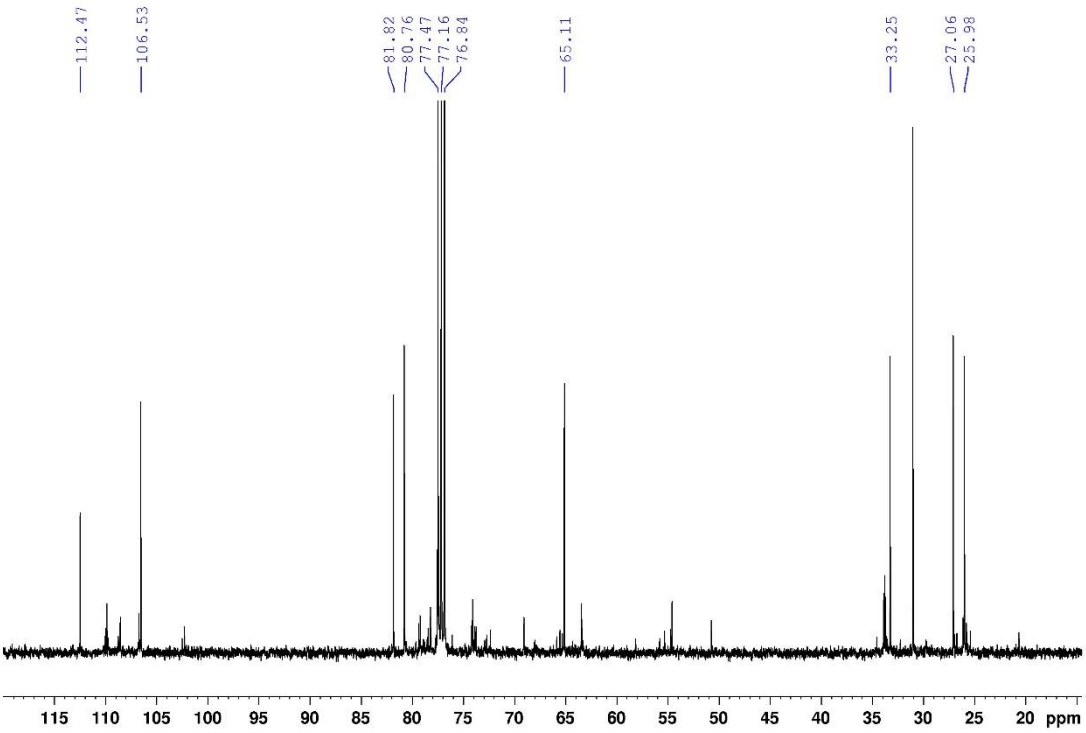


Figure S79: [13]C NMR spectrum of **3-Deoxy-1,2-*O*-isopropylidene-α-L-lyxofuranose (29)**

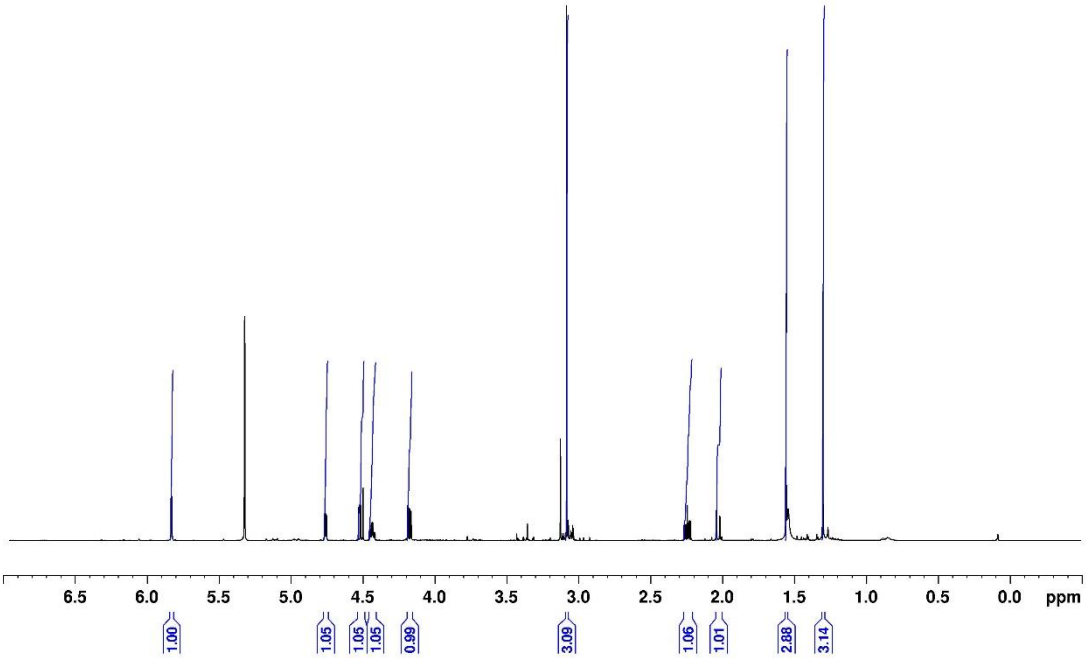


Figure S80: [1]H NMR spectrum of **3-Deoxy-1,2-*O*-isopropylidene-5-mesyl-α-L-lyxofuranose**

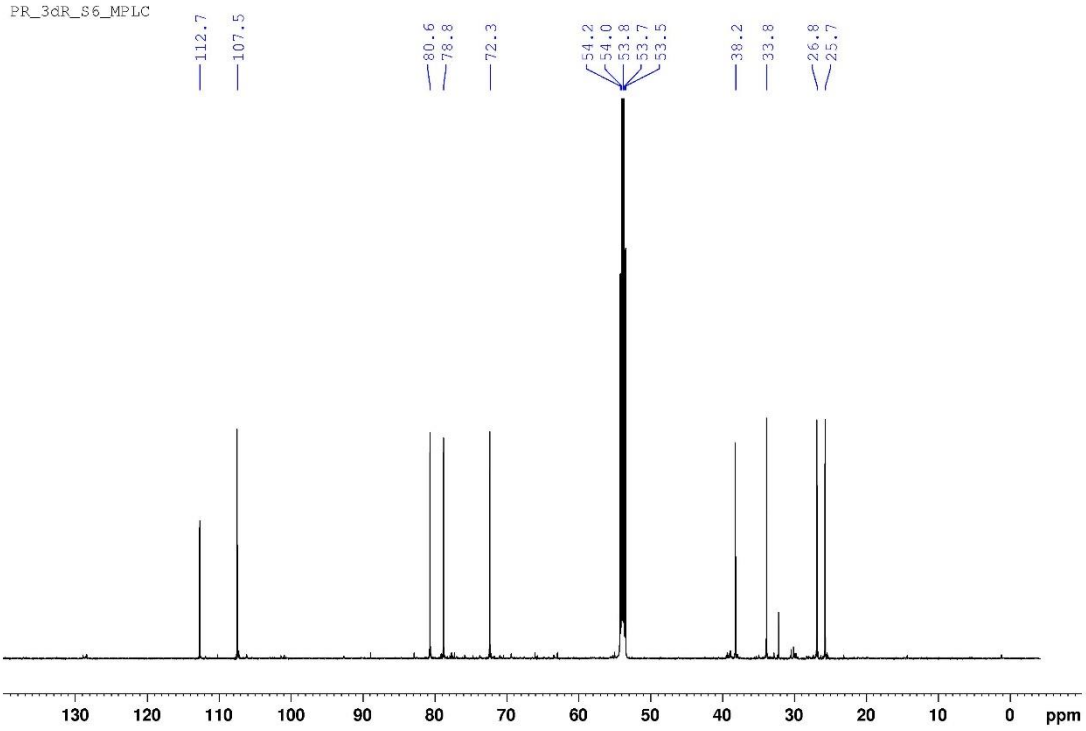


Figure S81: [13]C NMR spectrum of **3-Deoxy-1,2-*O*-isopropylidene-5-mesyl-α-L-lyxofuranose**

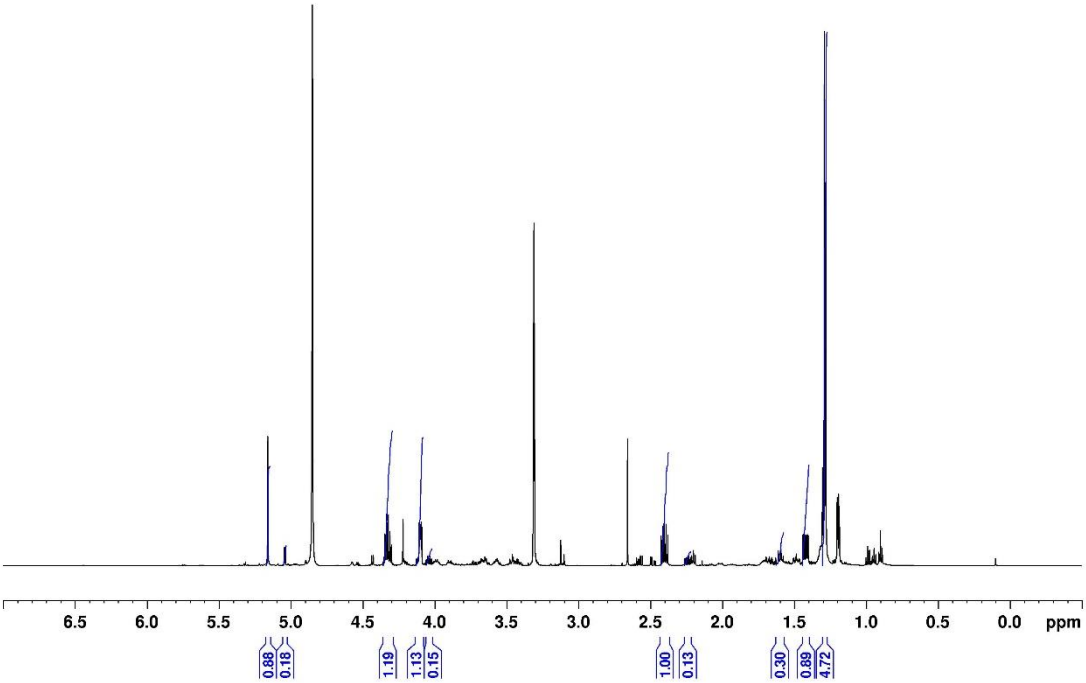


Figure S82: ^{1}H NMR spectrum of **3,5-Dideoxy-α-L-lyxofuranose (31)**

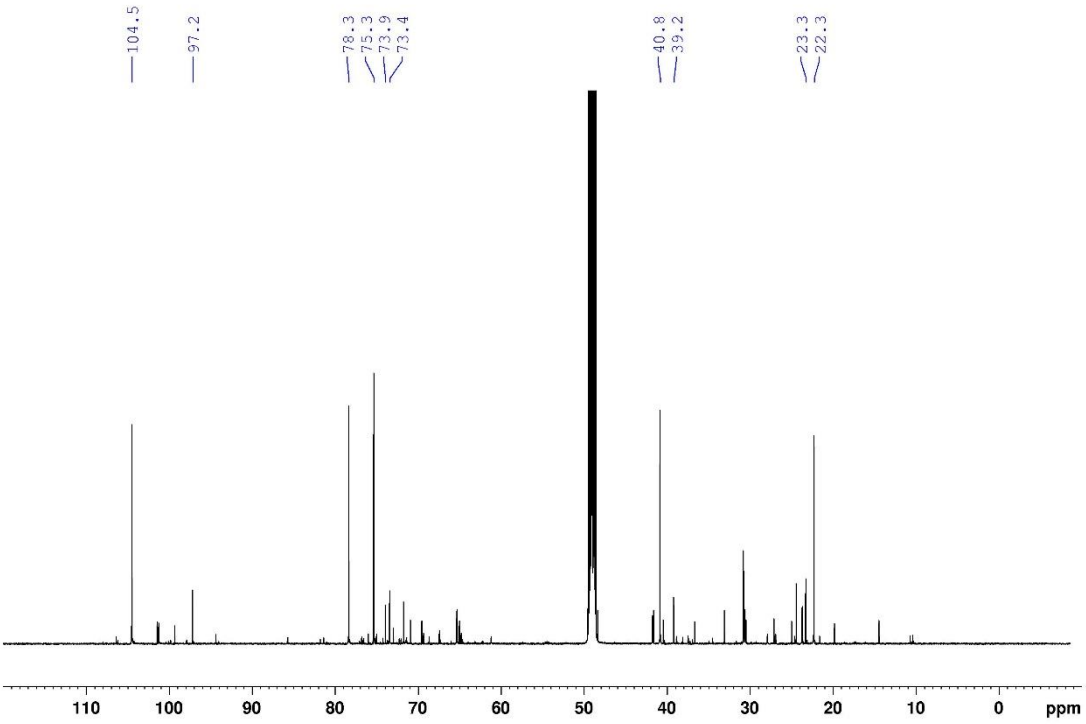


Figure S83: ^{13}C NMR spectrum of **3,5-Dideoxy-α-L-lyxofuranose (31)**

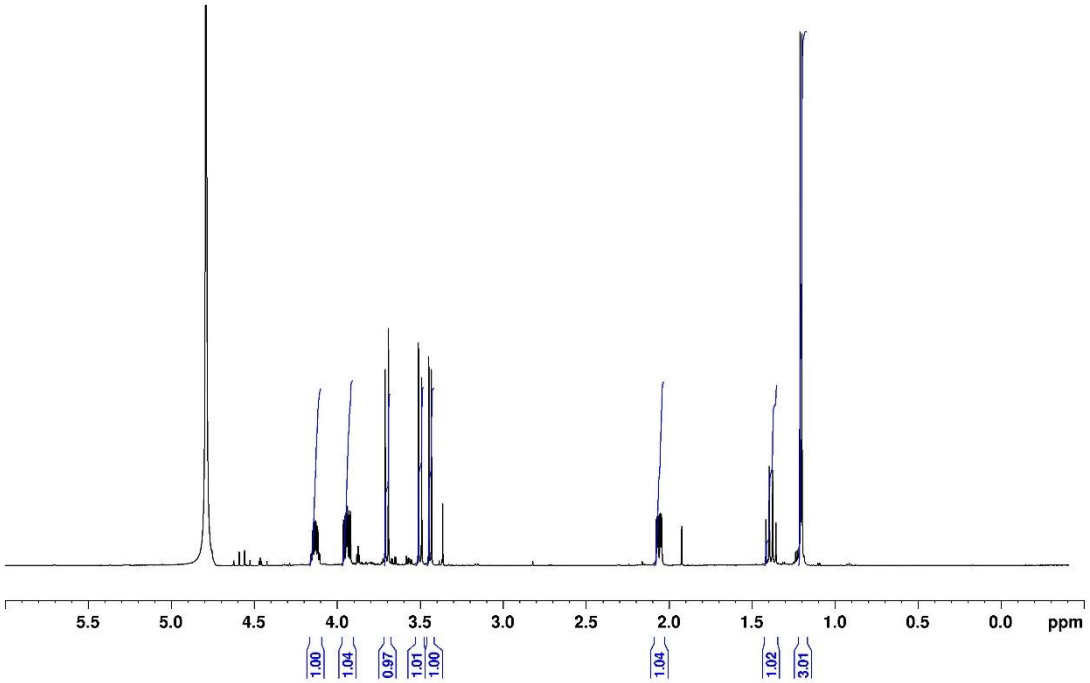


Figure S84: [1]H NMR spectrum of **5,7-Dideoxy-α-L-glucoheptulose (6)**

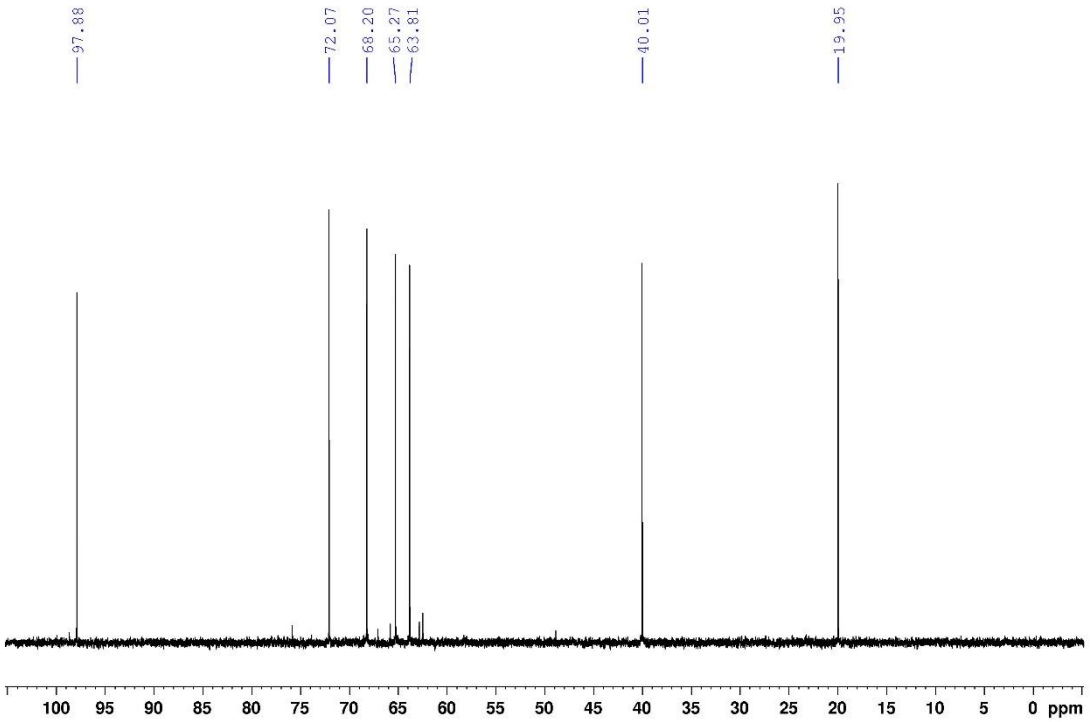


Figure S85: [13]C NMR spectrum of **5,7-Dideoxy-α-L-glucoheptulose (6)**

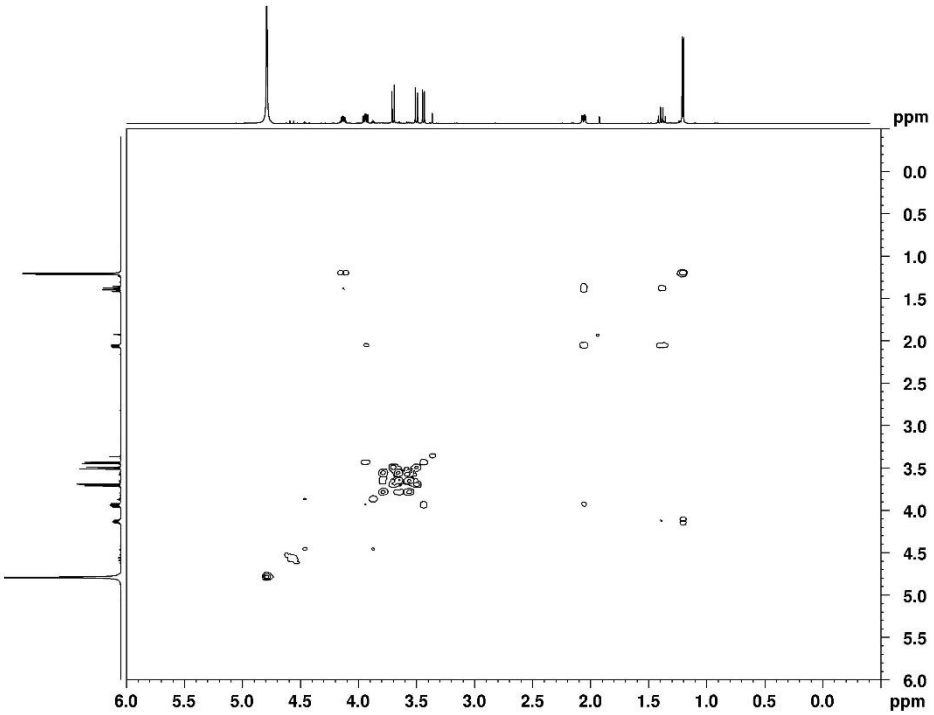


Figure S86: H-H-correlation (COSY) spectrum of **5,7-Dideoxy-α-L-glucoheptulose (6)**

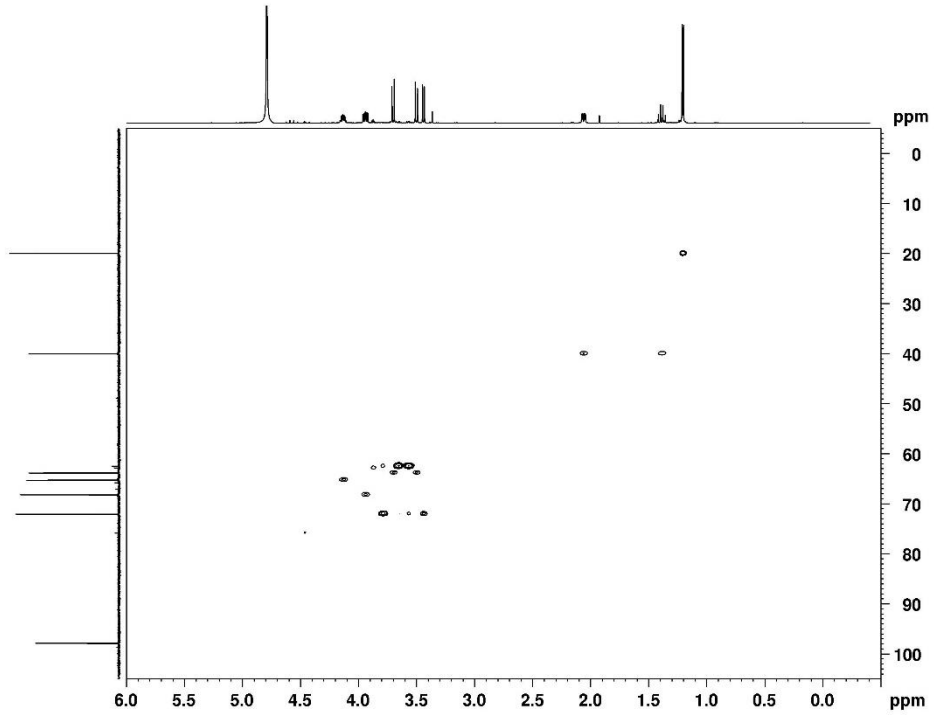


Figure S87: CH-correlation (HSQC) spectrum of **5,7-Dideoxy-α-L-glucoheptulose (6)**

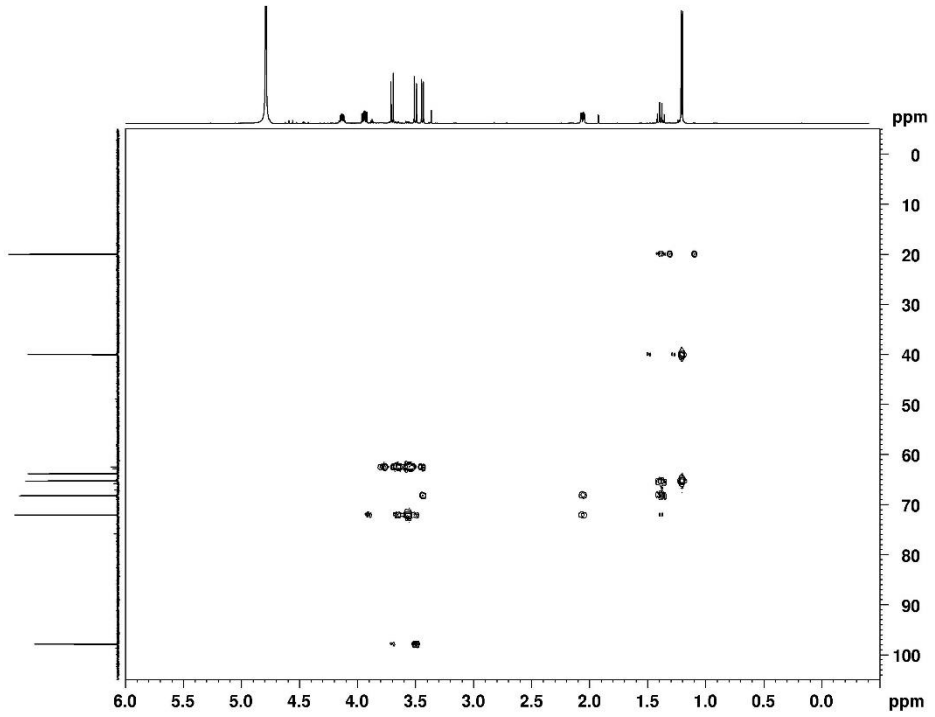


Figure S88: Multiple bond CH-correlation (HMBC) spectrum of **5,7-Dideoxy-α-L-glucoheptulose (6)**

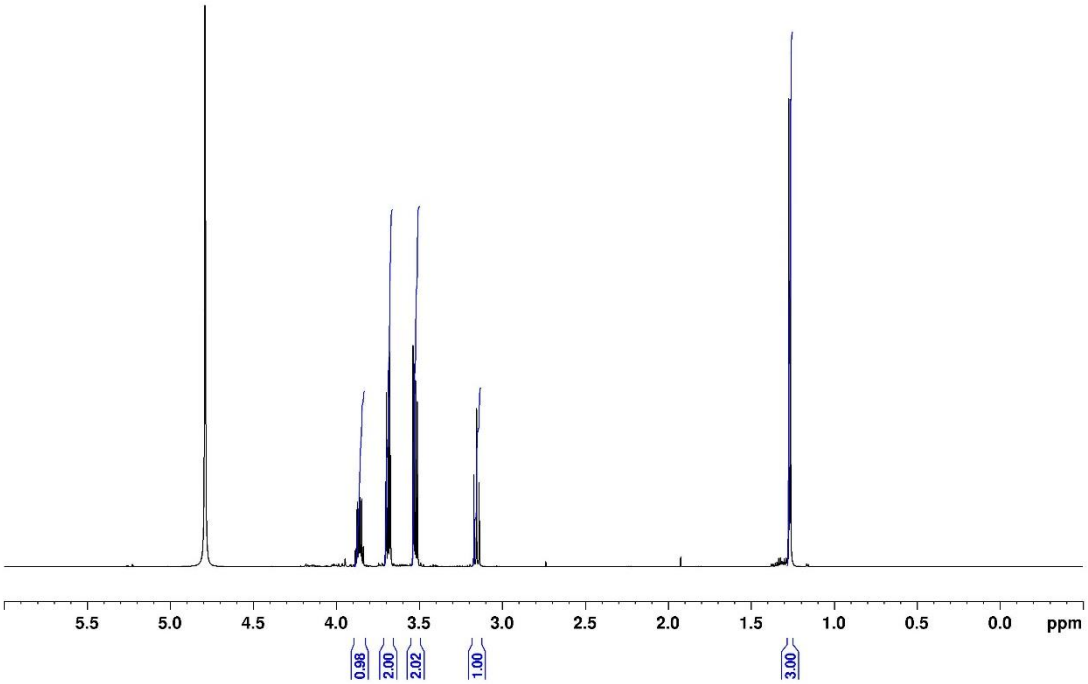


Figure S89: ^{1}H NMR spectrum of **7-Deoxy-α-L-glucoheptulose (5)**

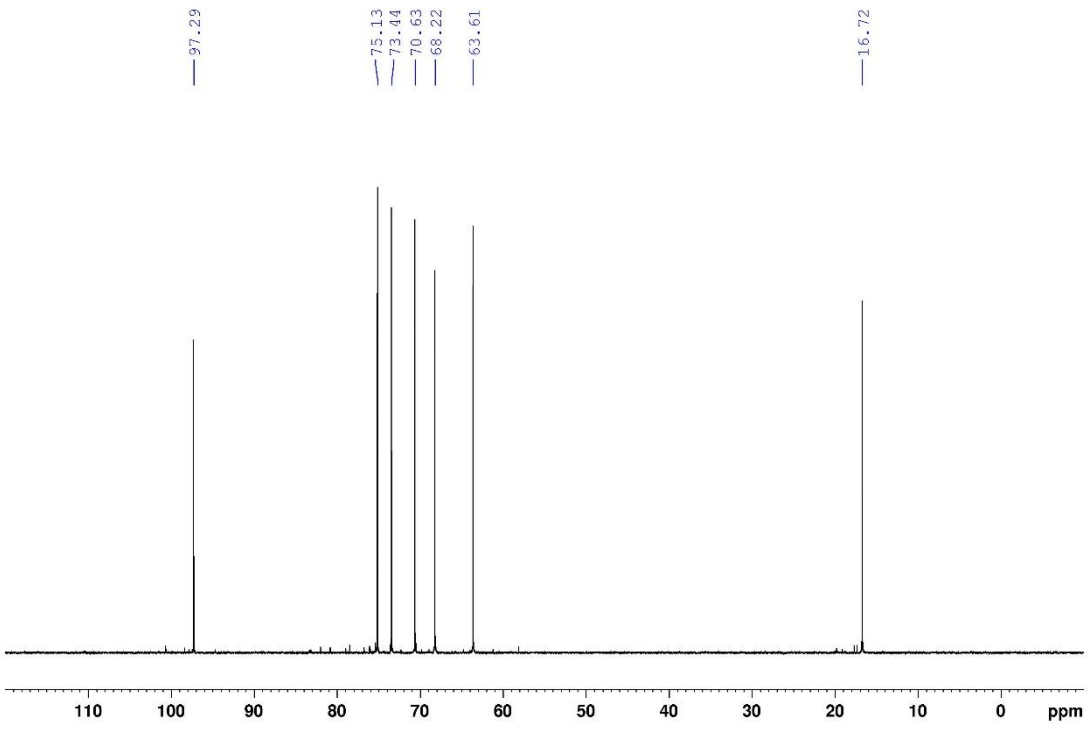


Figure S90: ^{13}C NMR spectrum of **7-Deoxy-α-L-glucoheptulose (5)**

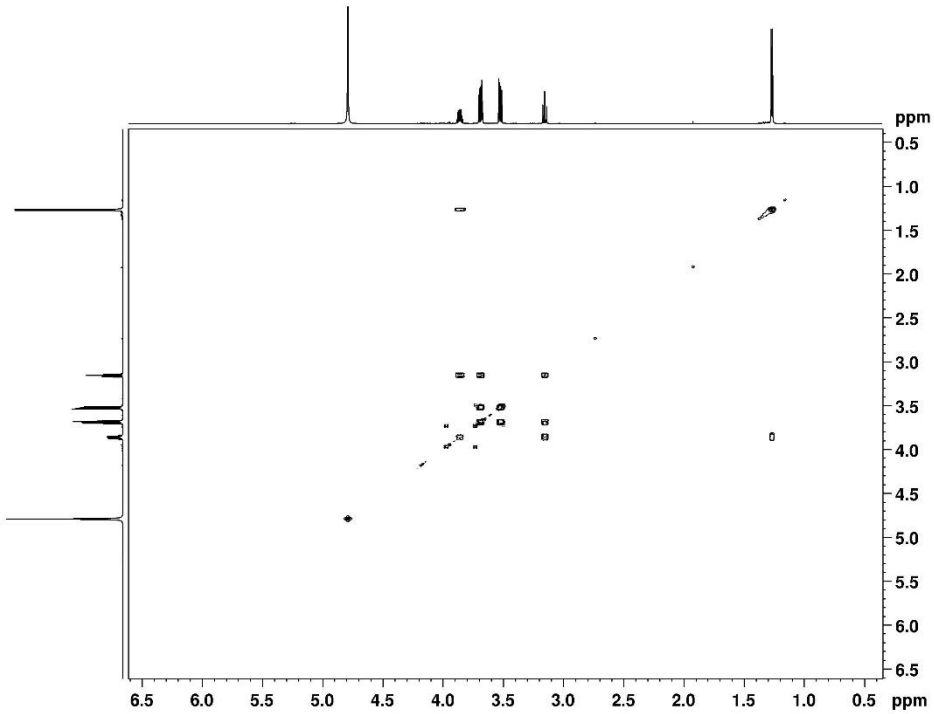


Figure S91: H-H-correlation (COSY) spectrum of **7-Deoxy-α-L-glucoheptulose (5)**

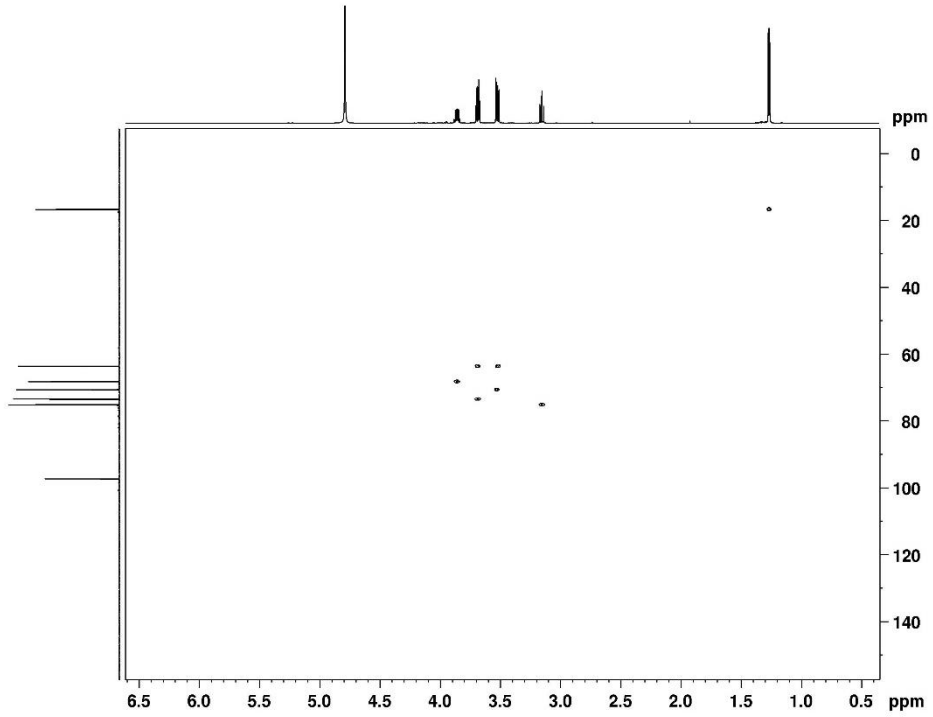


Figure S92: CH-correlation (HSQC) spectrum of **7-Deoxy-α-L-glucoheptulose (5)**

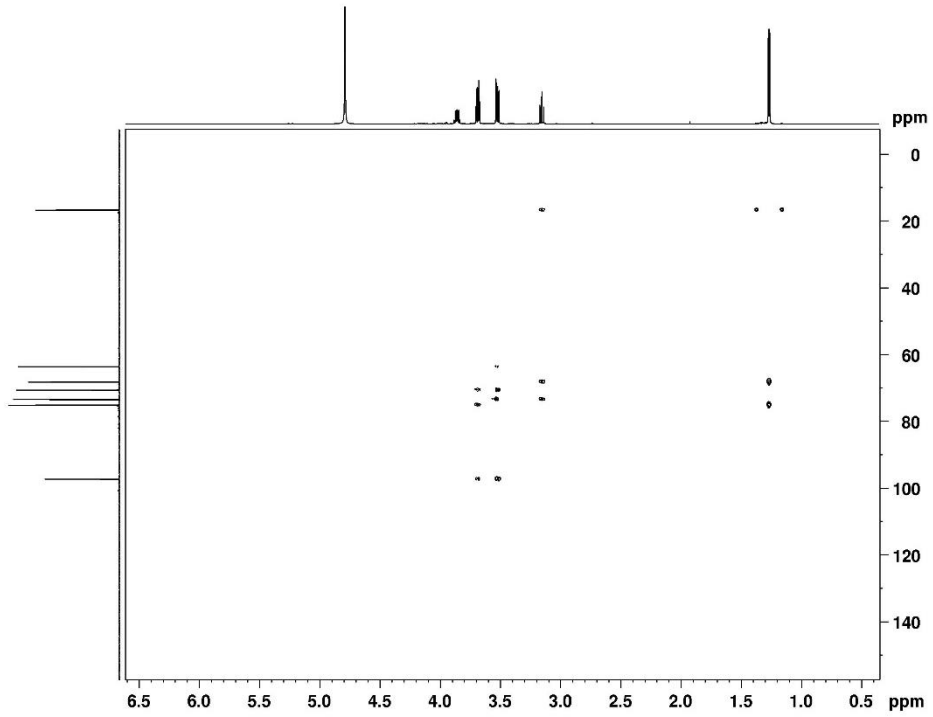


Figure S93: Multiple bond CH-correlation (HMBC) spectrum of **7-Deoxy-α-L-glucoheptulose (5)**

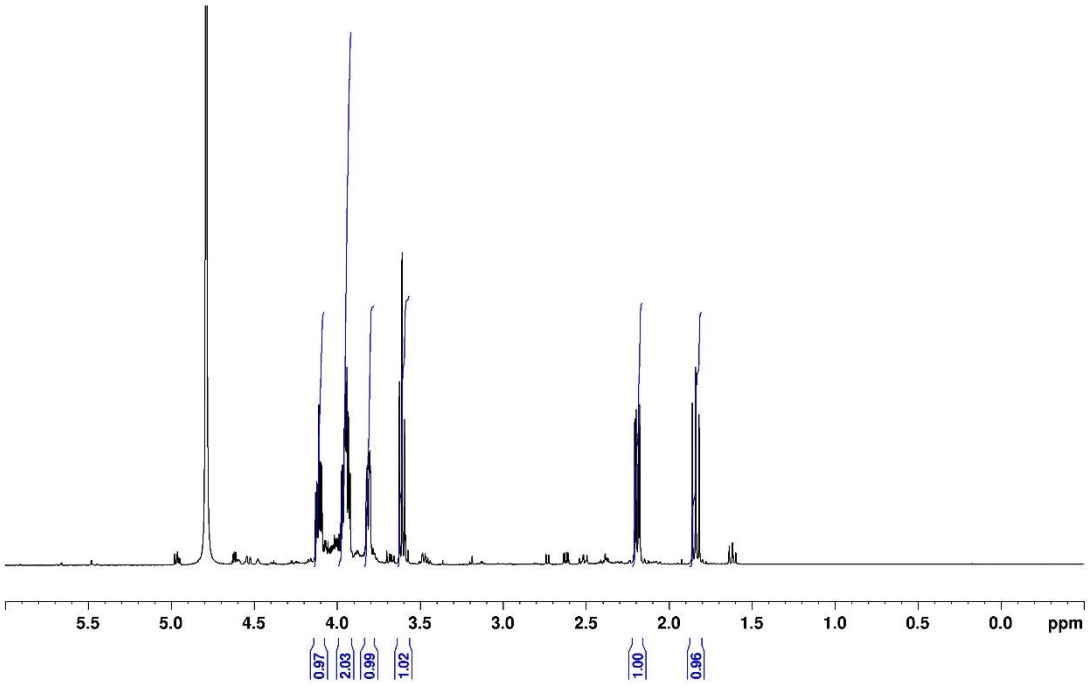


Figure S94: ^{1}H NMR spectrum of compound DAHP

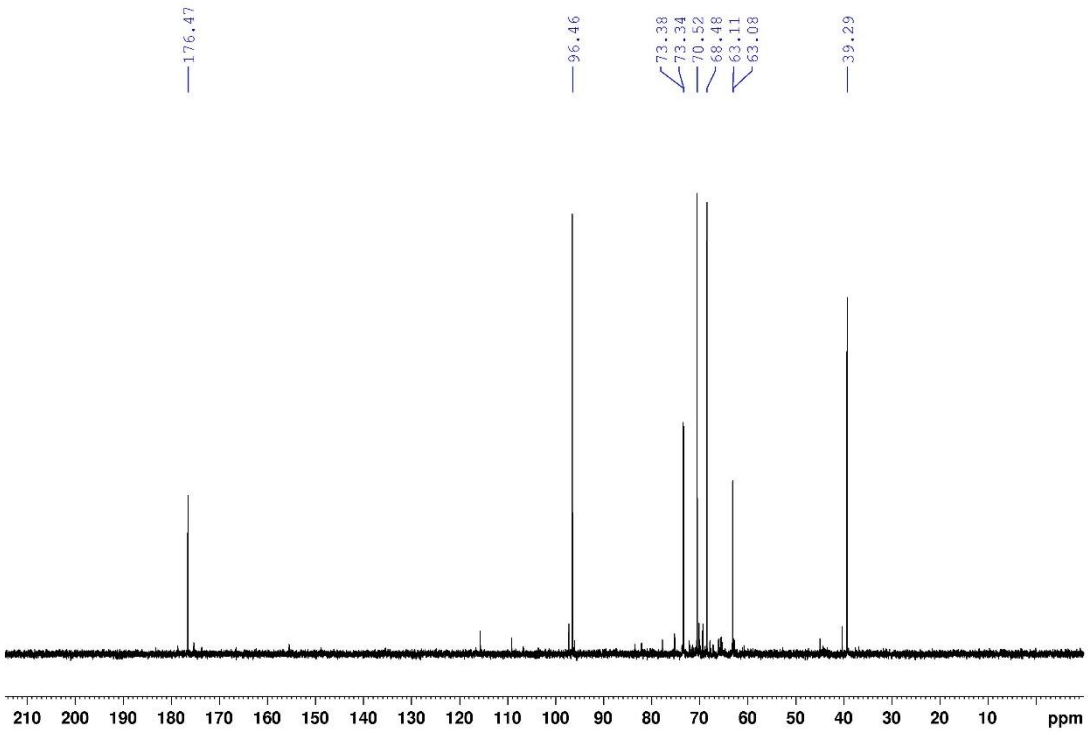


Figure S95: ^{13}C NMR spectrum of compound DAHP

SUPPORTING INFORMATION

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Author Contributions

Pascal Rath (P.R.) designed and performed synthesis and purification of heptuloses **1** – **4**, **6**, and chemical analyses of all compounds, designed and performed *Arabidopsis* plant assays and respective statistical analysis;

Johanna Rapp (J.R.) synthesized and purified **5**, designed and performed *in vitro* assays with purified DHQS and *in vivo* assays with *A. variabilis* as well as respective statistical analysis;

Üner Kolukisaoglu (Ü.K.) supported and analysed plant assays;

Marvin Braun (M.B.) performed all 7dSh measurements in plant extracts; all authors fueled the study with valuable discussions and optimized the manuscript;

P.R., J.R., M.B., Ü.K, S.G. designed the study, analysed results, and wrote the paper;

Karl Forchhammer (K.F.), Klaus Brilisauer (K.B.) supported designing the study, analyzing the results, and proofreading the manuscript.