Supporting Information

Enantioselective total syntheses of (-)-clavaminol A and deacetyl (+)-clavaminol H

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Experimental

Materials and methods

All reactions were carried out under argon or nitrogen in oven-dried glassware using standard glass syringes, cannulas and septa. Solvents and reagents were purified and dried by standard methods prior to use. Optical rotations were measured at room temperature. IR spectra were recorded on an FT-IR instrument. ^{1}H NMR spectra were recorded on 400 MHz and are reported in parts per million (δ) downfield relative to Me_4Si as internal standard and ^{13}C NMR spectra were recorded at 100 MHz and assigned in parts per million (δ) relative to internal standard Me_4Si. Column chromatography was performed on silica gel (60-120 and 100-200 mesh) using a mixture of Hexane, ethyl acetate, DCM, MeOH as the eluent.

Ethyl (*E*)-dodec-2-enoate, 10

To a solution of oxalyl chloride (3.01 g, 2.04 mL, 23.73 mmol) in dry CH_2Cl_2 (10 mL) at -78 °C was added dropwise DMSO (3.83 g, 3.48 mL, 49.05 mmol) in CH_2Cl_2 (10 mL) over 15 min. The reaction mixture was stirred for 30 min and a solution of 1-decanol **9** (2.5 g, 15.82 mmol) in CH_2Cl_2 (30 mL) was added dropwise over 15 min. The reaction mixture was stirred for 30 min at -60 °C and then Et_3N (7.05 g, 9.70 mL, 69.62 mmol) was added dropwise and stirred for 30 min. The reaction mixture was poured into saturated solution of $NaHCO_3$ (60 mL) and the organic layer separated. The aqueous layer was extracted with CH_2Cl_2 (3 x 30 mL) and the combined organic layer was washed with brine, dried over Na_2SO_4 and concentrated *in vacuo* to give the crude aldehyde, which was used as such for the next step without further purification.

To a stirred solution of above aldehyde (2.47 g, 15.80 mmol) in THF (30 mL) was added dropwise a suspension of stabilized ylide ($Ph_3P = CHCO_2Et$, 6.61 g, 18.97 mmol) in THF (20 mL) under nitrogen atmosphere at rt. After being stirred for 12 h, the reaction mixture was concentrated under reduced pressure. Silica gel chromatography of the crude product

(EtOAc/hexane 1:49) afforded (*E*)-alkene ester **10** (3.26 g, 14.40 mmol, 91%) as a colourless liquid. Spectroscopic data are in consistence with the literature data. [7, 4b]

^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.96 (td, J = 15.6, 6.84 Hz, 1H), 5.81 (td, J = 15.6 Hz, 1.40 1H), 4.18 (q, J = 7.32 Hz, 2H), 2.19 (dq, J = 7.36, 1.84 Hz, 2H), 1.47-1.41 (m, 1H), 1.31-1.26 (m, 16H), 0.88 (t, J = 15.6, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 166.8, 149.6, 121.1, 60.1, 32.2, 31.8, 29.5, 29.4, 29.3, 29.1, 27.9, 22.7, 14.3, 14.1.

Ethyl (2*R*,3*S*)-2,3-dihydroxydodecanoate, 8

To a solution of H_2O (40 mL) and *t*-BuOH (40 mL) were sequentially added K_2CO_3 (4.03 g, 29.16 mmol), $K_3Fe(CN)_6$ (3.20 g, 9.72 mmol), $CH_3SO_2NH_2$ (840 mg, 8.84 mmol), and $(DHQ)_2PHAL$ (69 mg, 0.09 mmol) and OsO_4 (0.1 M solution in toluene, 0.44 mL, 0.04 mmol) at 0 °C. After stirring for 5 min at 0 °C, the olefin **10** (2.0 g, 8.84 mmol) was added directly in one portion. Stirring was continued for 6 h at the same temperature, then the reaction mixture was quenched with solid sodium sulfite (840 mg), and the mixture continued to stir for an additional 30 min. After extraction of the aq. layer with EtOAc (3 × 30 mL), the combined organic layer was dried over Na_2SO_4, and concentrated under reduced pressure. The crude compound was purified by silica gel chromatography (EtOAc/hexane 1 : 4) to furnish the diol **8** (2.12 g, 8.14 mmol, 92%) as a white solid; m.p. 52-53 °C; $[\alpha]_D^{25}$ -10.55 (*c* 1.0, $CHCl_3$); {lit.[9] $[\alpha]_D^{20}$ -10.54 (*c* 1.0, $CHCl_3$)}; IR (CH_2Cl_2) ν: 3380, 2891, 2858, 1737, 1374, 1135, 1091cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 4.30 (q, J = 7.32 Hz, 2H), 4.12 (q, J = 6.88 Hz, 1H), 4.09 (brs, 1H), 3.89 (br t, J = 6.88 Hz, 1H), 3.09 (br s, 1H), 1.63-1.59 (m, 2H), 1.33 (t, J = 6.84 Hz, 3H), 1.30-1.25 (m, 14H), 0.88 (t, J = 6.88 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.7, 72.9, 72.5, 62.1, 33.8, 31.9, 29.5, 29.4, 29.3, 25.7, 22.7, 14.2, 14.1; HRMS (ESI), calcd for $C_{14}H_{28}O_4Na$ $[M + Na]^+$ 283.1880; found 283.1877.

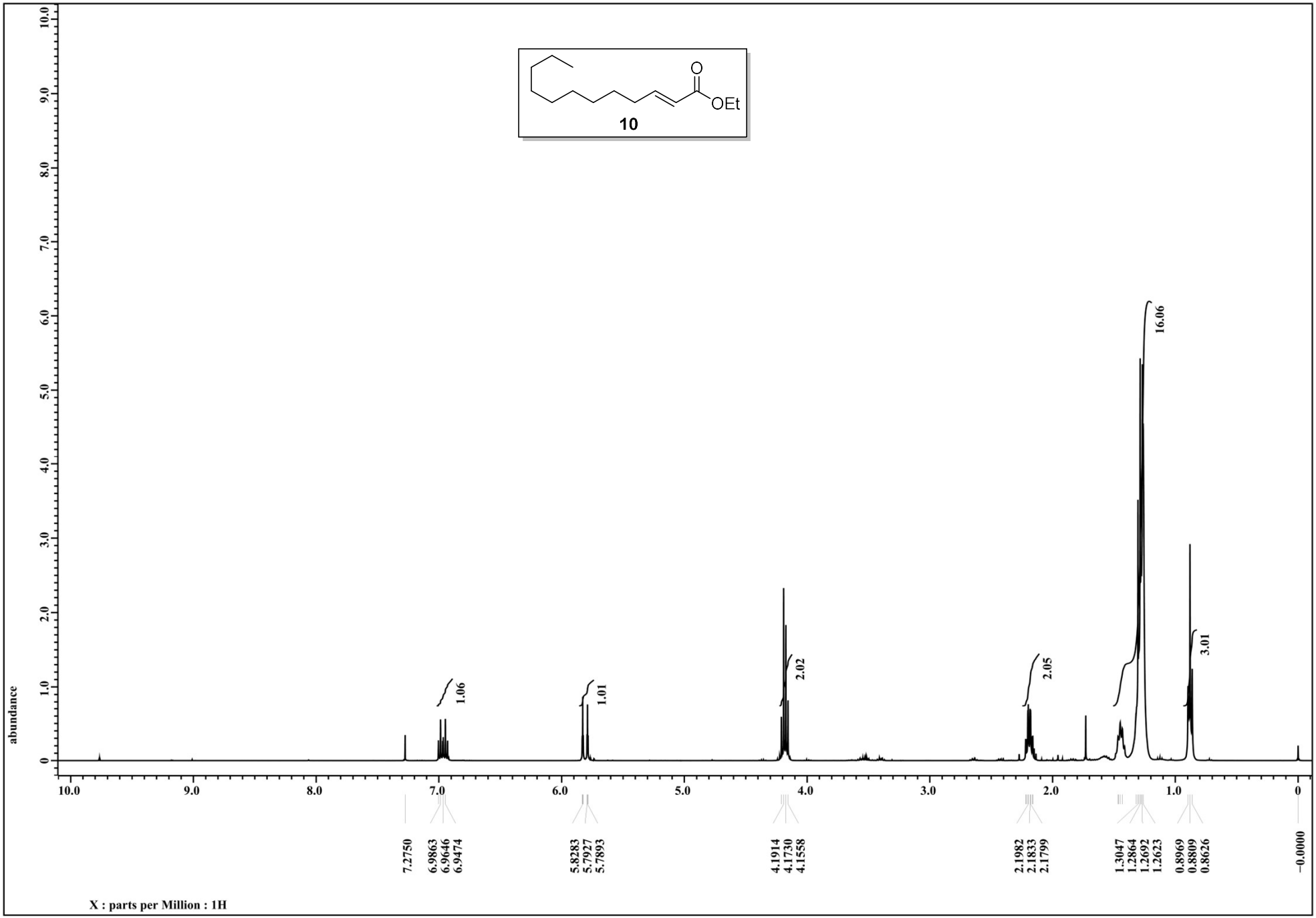
(*S*)-1-((*S*)-oxiran-2-yl)decan-1-ol, 11

$LiAlH_4$ (175 mg, 4.60 mmol) was added to an ice cooled solution of compound **8** (600 mg, 2.30 mmol) in dry THF (20 mL) under nitrogen atmosphere and stirred for 2 h at 0 °C to room temperature. After completion of the reaction, 10% aq. NaOH followed by EtOAc were added. Then the organic layer was separated and the aq. layer was extracted with EtOAc (2 x 20 mL). The combined organic layer was dried over Na_2SO_4 (anhydrous), concentrated *in vacuo* and filter column purification on neutral alumina furnished the triol intermediate which was used in next step directly.

To a stirred solution of above triol (500 mg, 2.29 mmol) in CH_2Cl_2 (20 mL) under N_2 atmosphere at 0 °C were added dibutyl tin oxide (114 mg, 0.46 mmol), Et_3N (0.32 mL, 2.29 mmol) and TsCl (436 mg, 2.29 mmol). The resulting suspension was stirred for 1 h at 0 °C to rt. Then the reaction mixture was diluted with H_2O (15 mL) and extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layer was dried over anhydrous Na_2SO_4 and concentrated *in vacuo* to get the residue.

K_2CO_3 (475 mg, 3.43 mmol) was added to a mixture of above crude primary alcohol tosylated diol in MeOH (15 mL) and stirred for 30 min at rt. The MeOH was evaporated under reduced pressure, and then the residue was diluted with water and EtOAc. The aqueous layer was extracted with EtOAc (2 x 15 mL). The collective organic layer was dried over anhydrous Na_2SO_4, concentrated under reduced pressure and purified by silica gel column chromatography (EtOAc/hexane 1:3) to give epoxide **11** (347 mg, 1.73 mmol, 75%) as a white solid; m.p. 39-40 °C; $[\alpha]_D^{25}$ -3.83 (*c* 1.0, CH_2Cl_2) {lit.[10] $[\alpha]_D^{20}$ -3.80 (*c* 1.3, CH_2Cl_2); IR (CH_2Cl_2) *v*: 3406, 2935, 2922, 2853, 1448 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ: 3.43-3.41 (br m, 1H), 3.01-2.97 (m, 1H), 2.84 (t, J = 4.6 Hz, 1H), 2.73 (dd, J = 5.04, 2.72 Hz, 1H), 1.86 (brs, 1H), 1.61-1.46 (m, 2H), 1.30 (br s, 14H), 0.88 (t, J = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 71.7, 55.4, 45.2, 34.4, 31.9, 29.6, 29.5, 29.3 (two signals), 25.3, 22.7, 14.1; HRMS (ESI), m/z calcd for $C_{12}H_{24}O_2Na$ $[M + Na]^+$ 223.1668; found 223.1666.

^{1}H NMR (400 MHz, $CDCl_3$/TMS)



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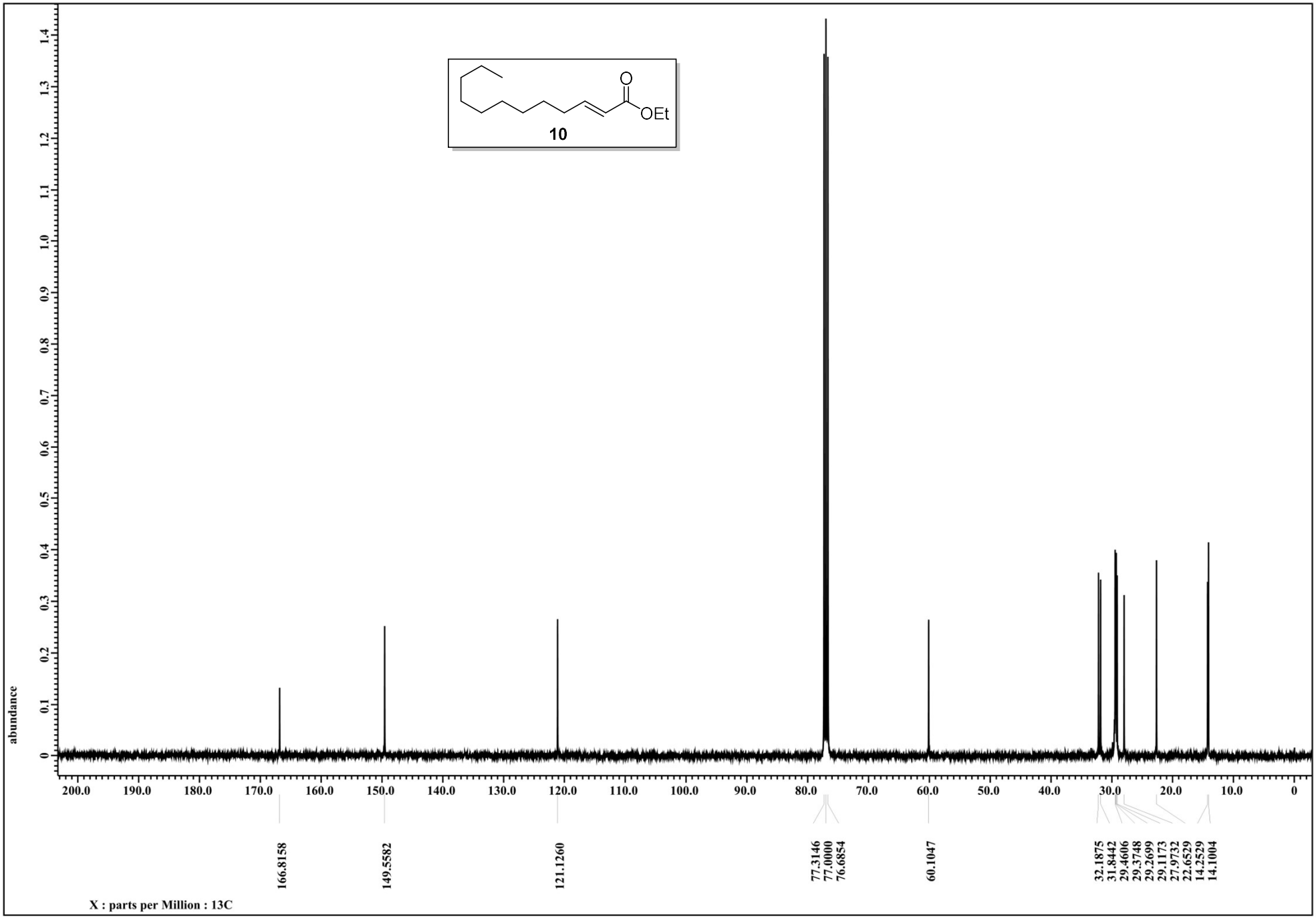

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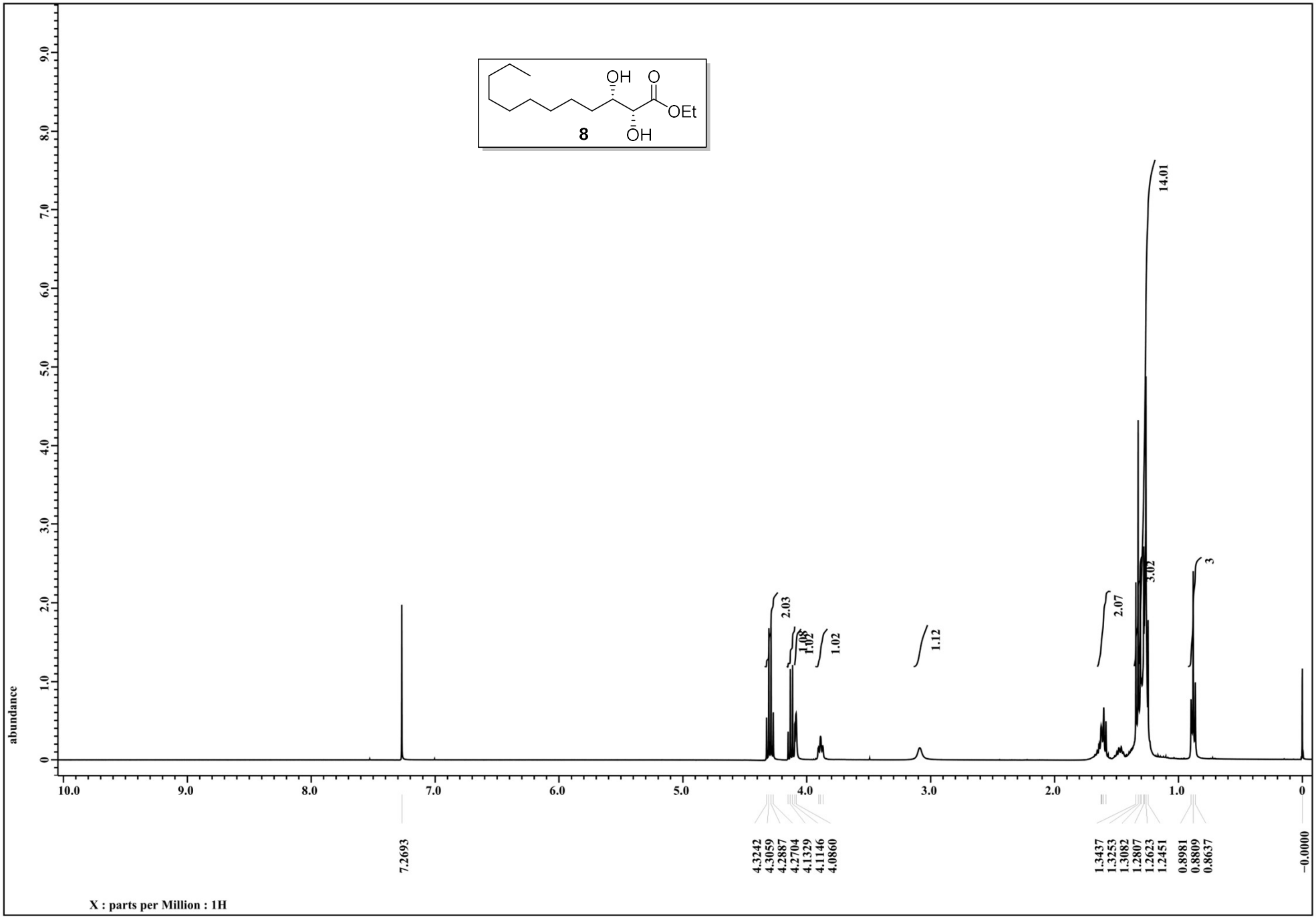

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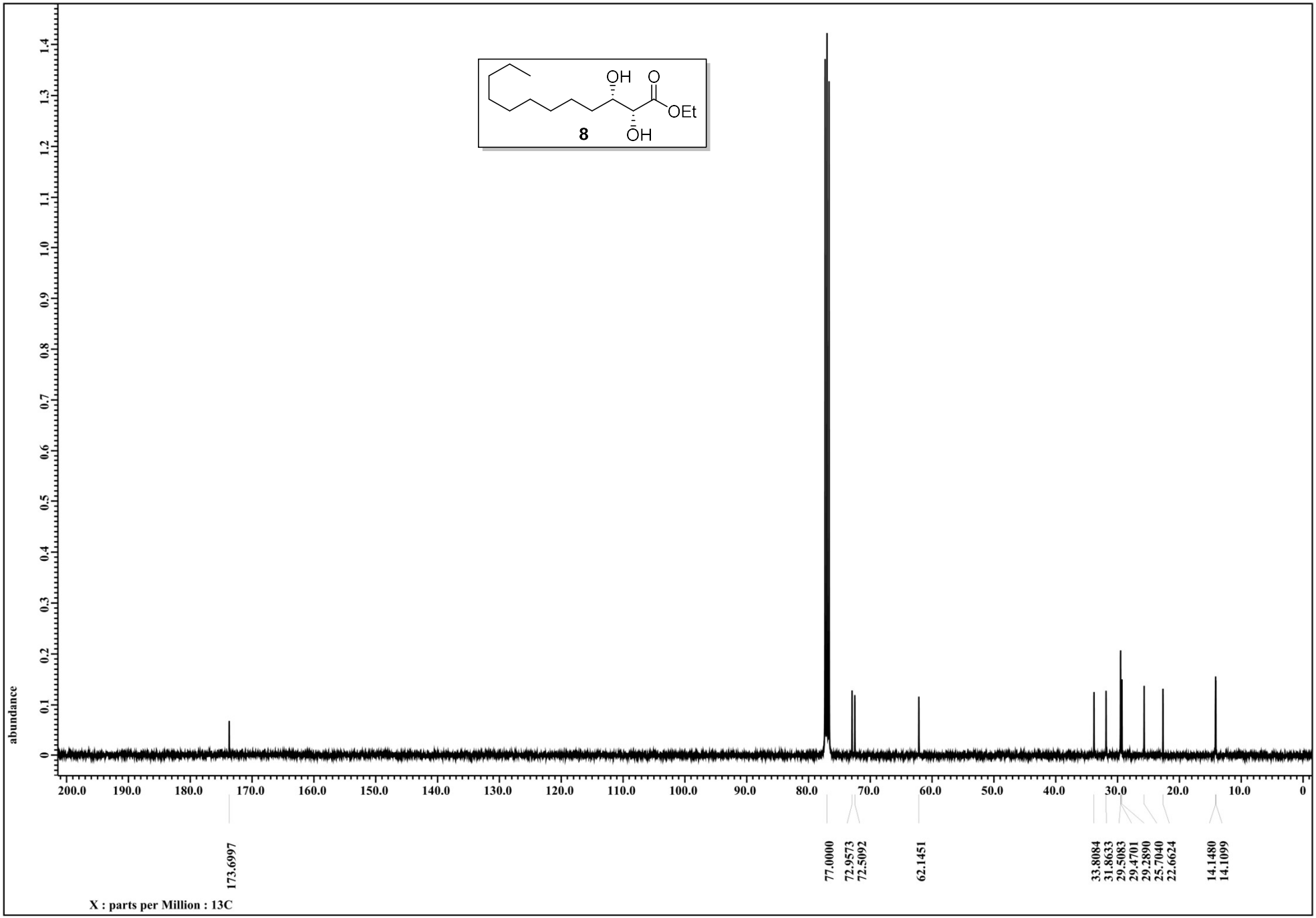

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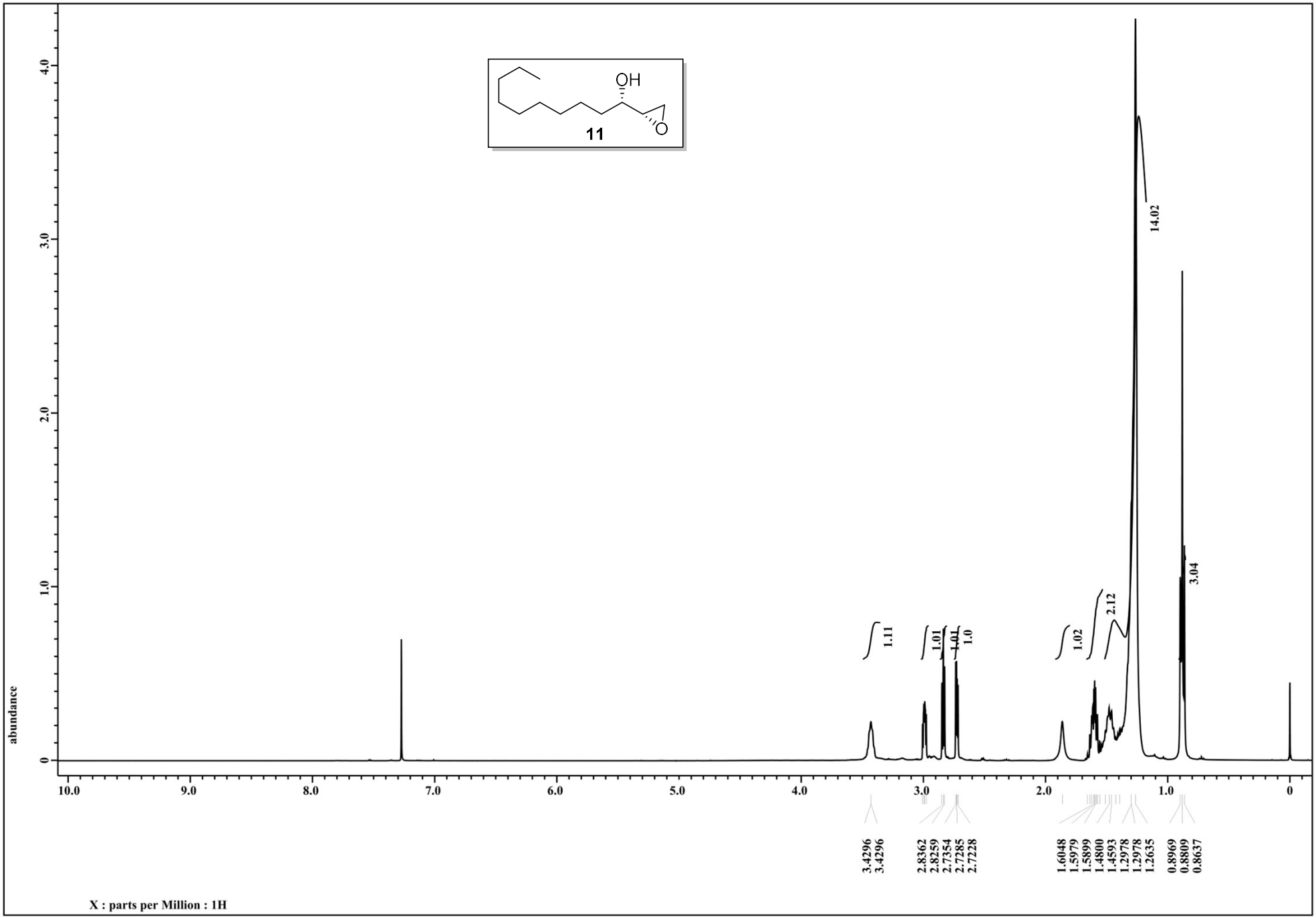

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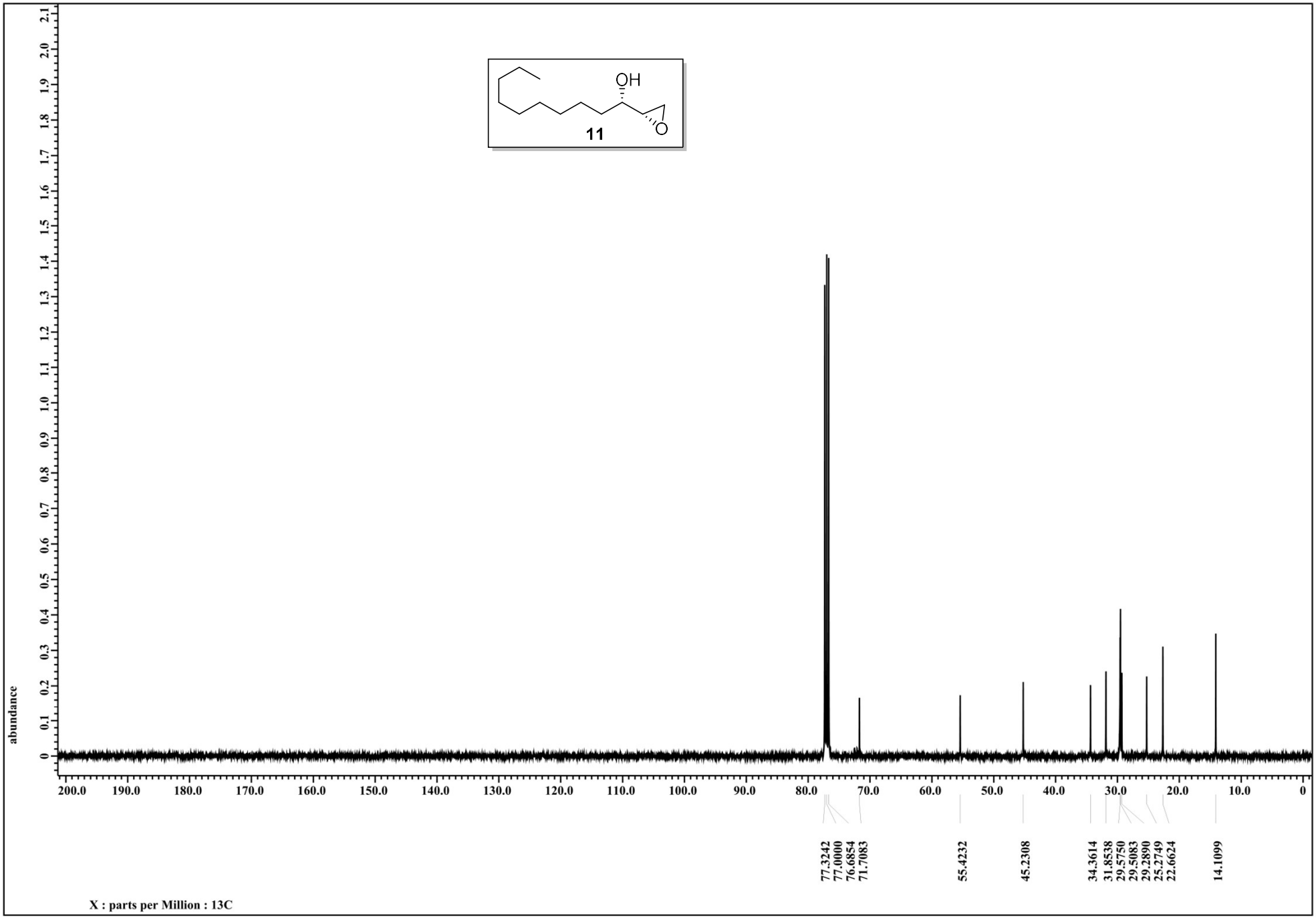

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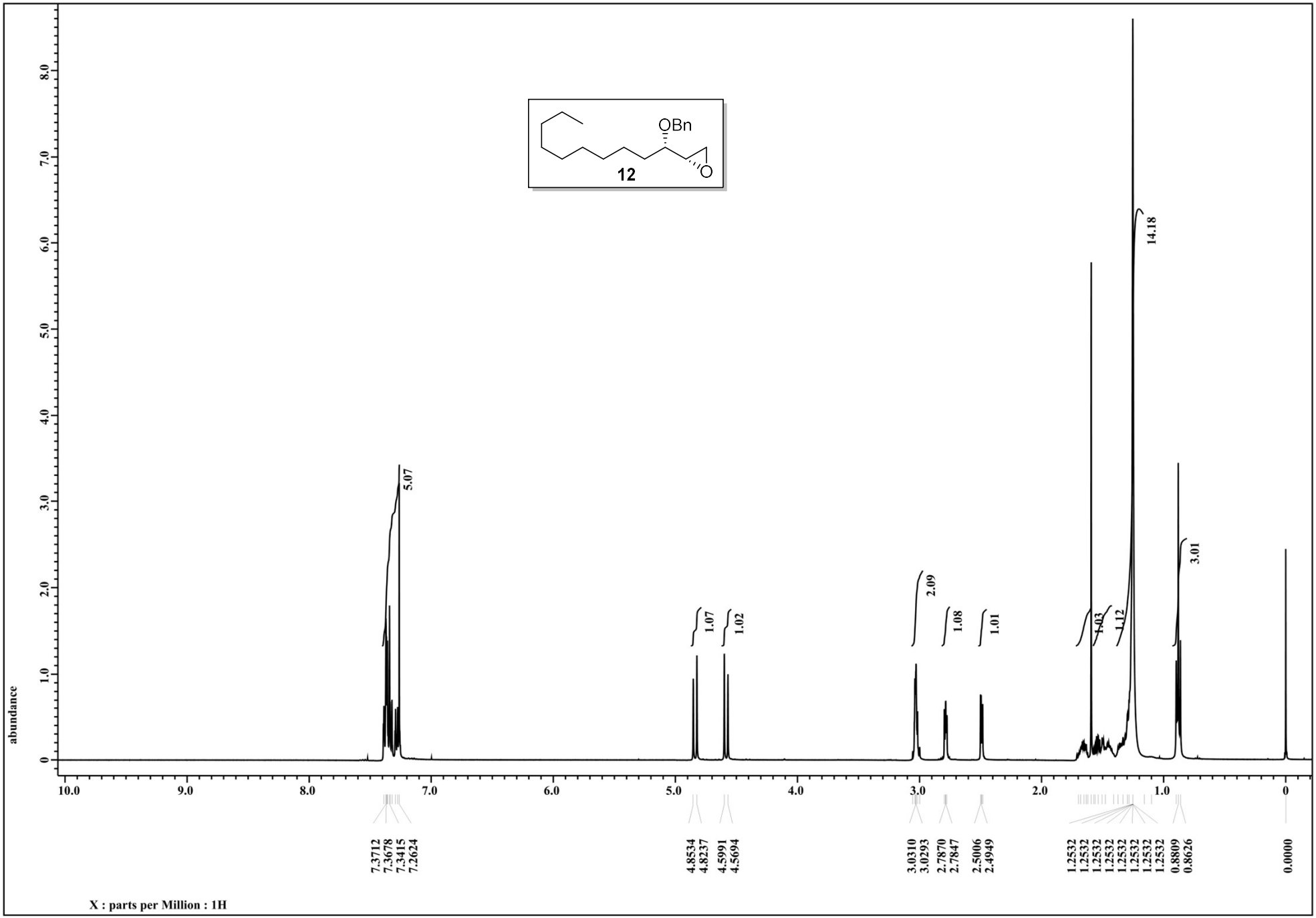

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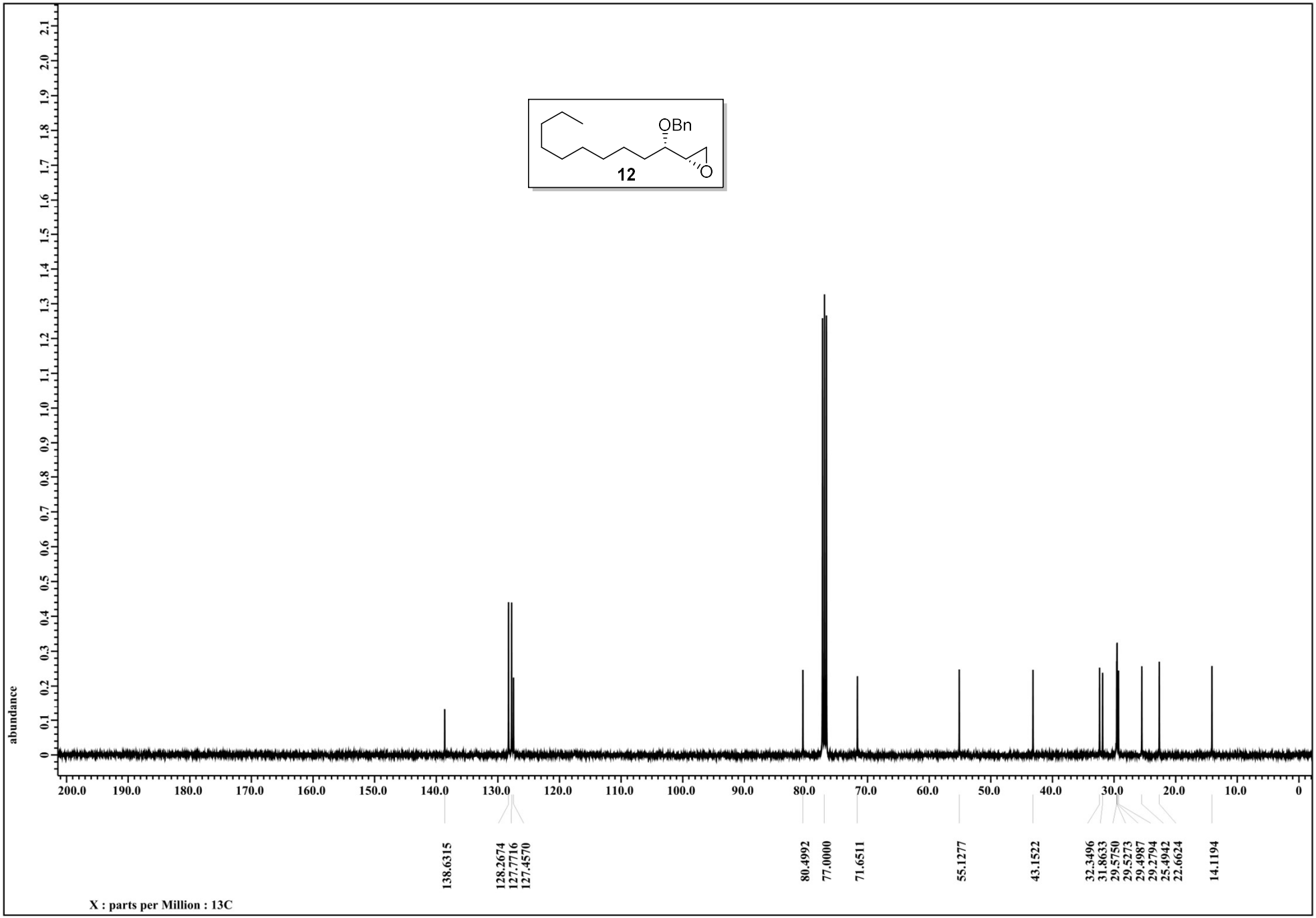

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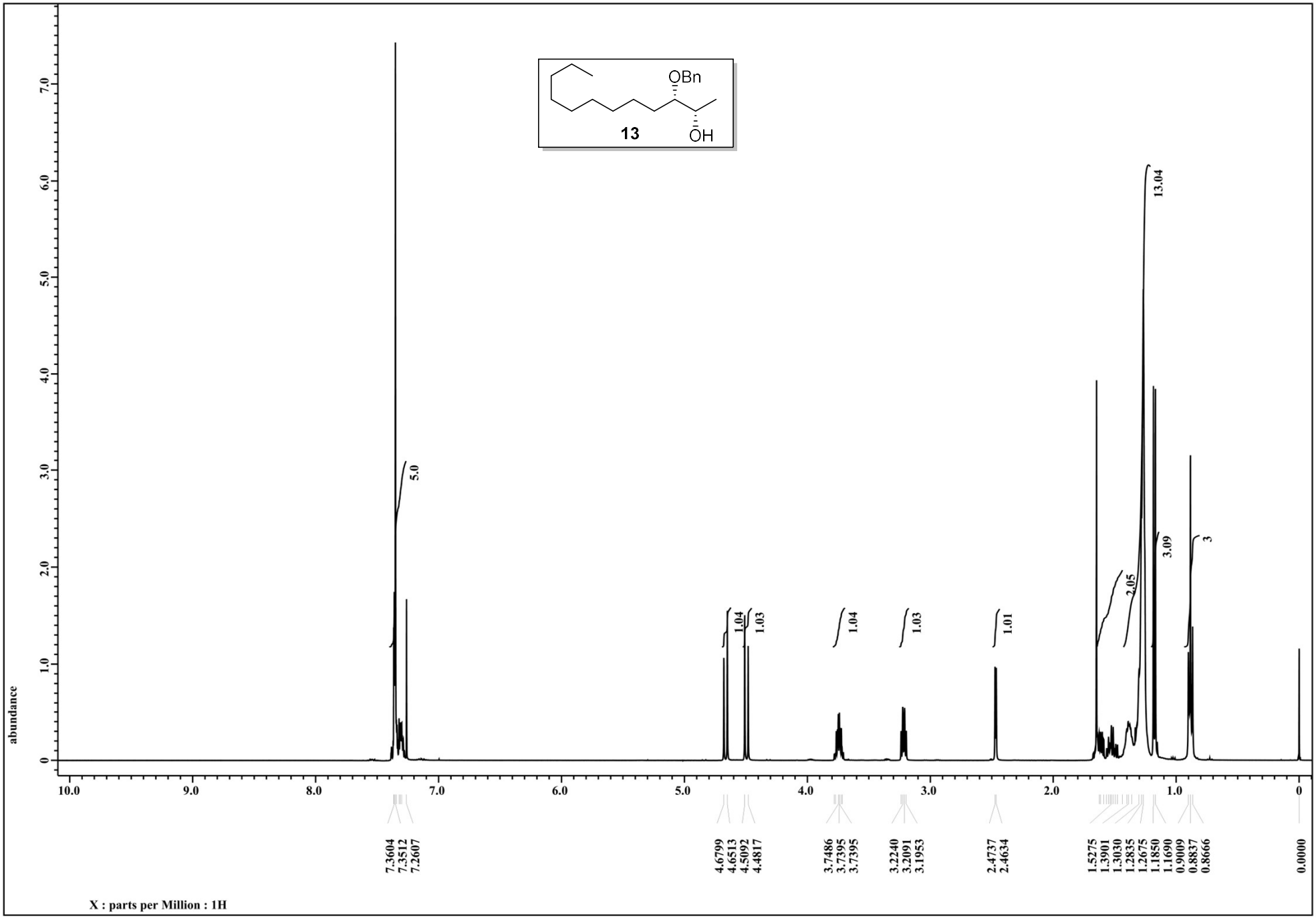

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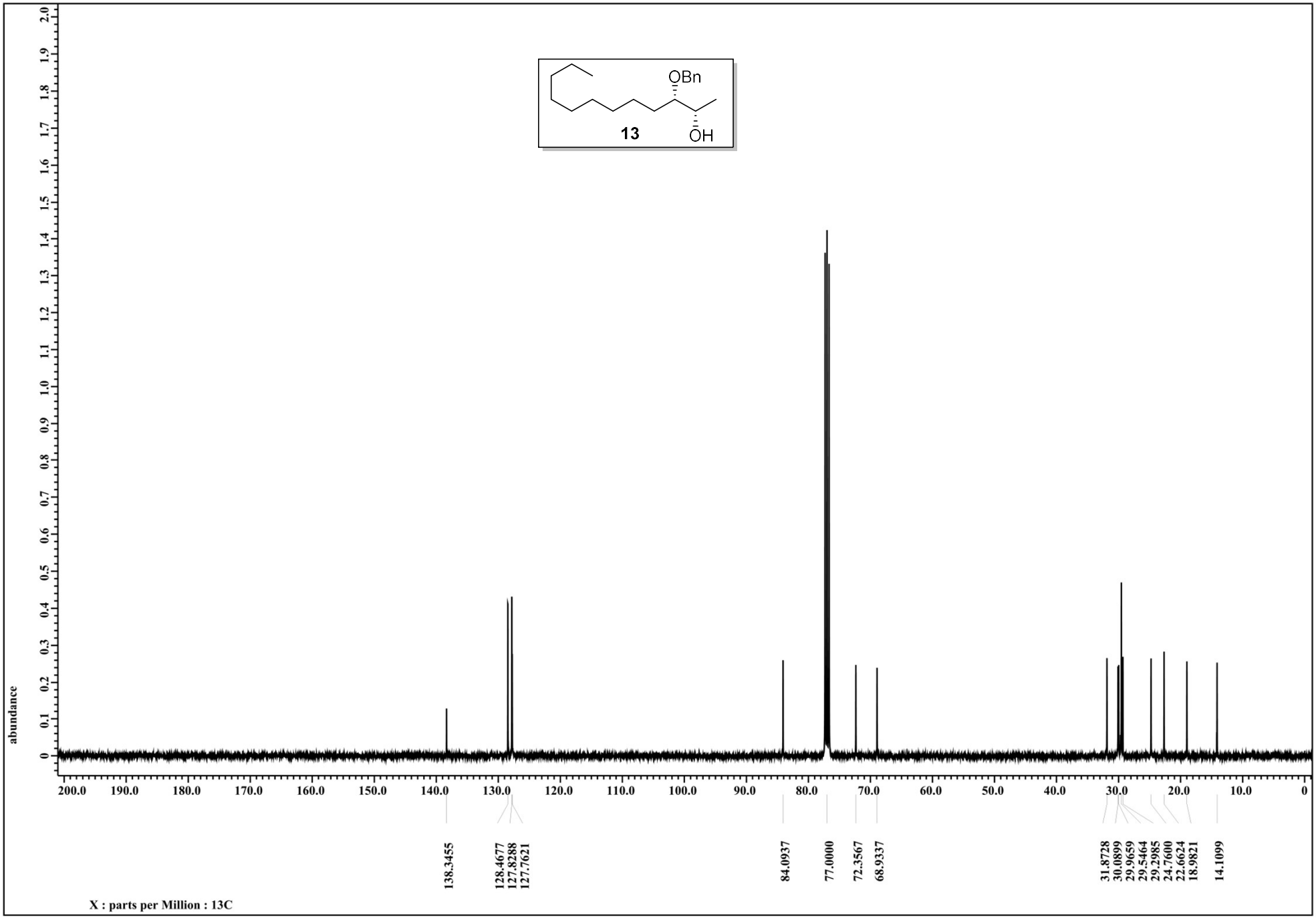

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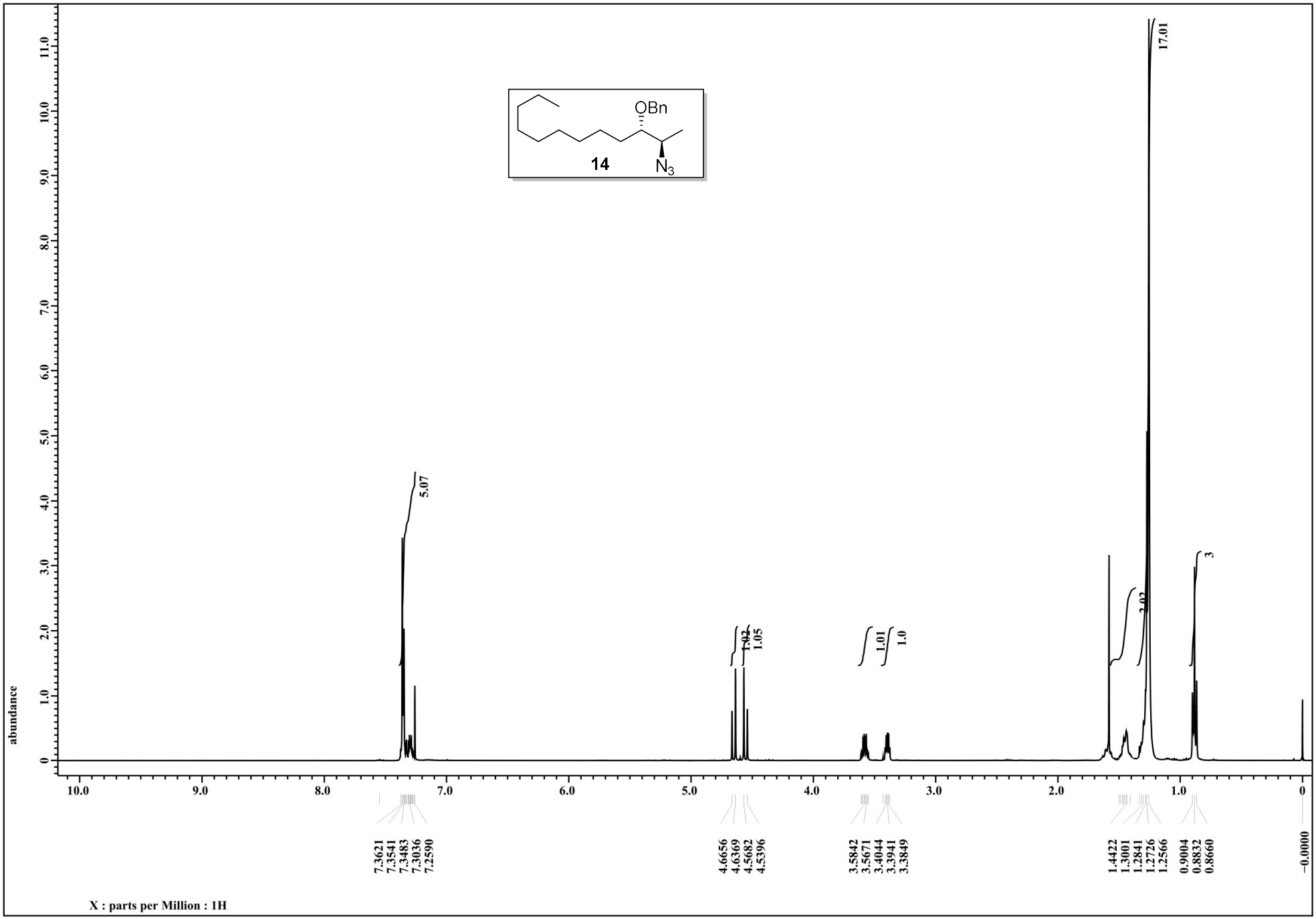

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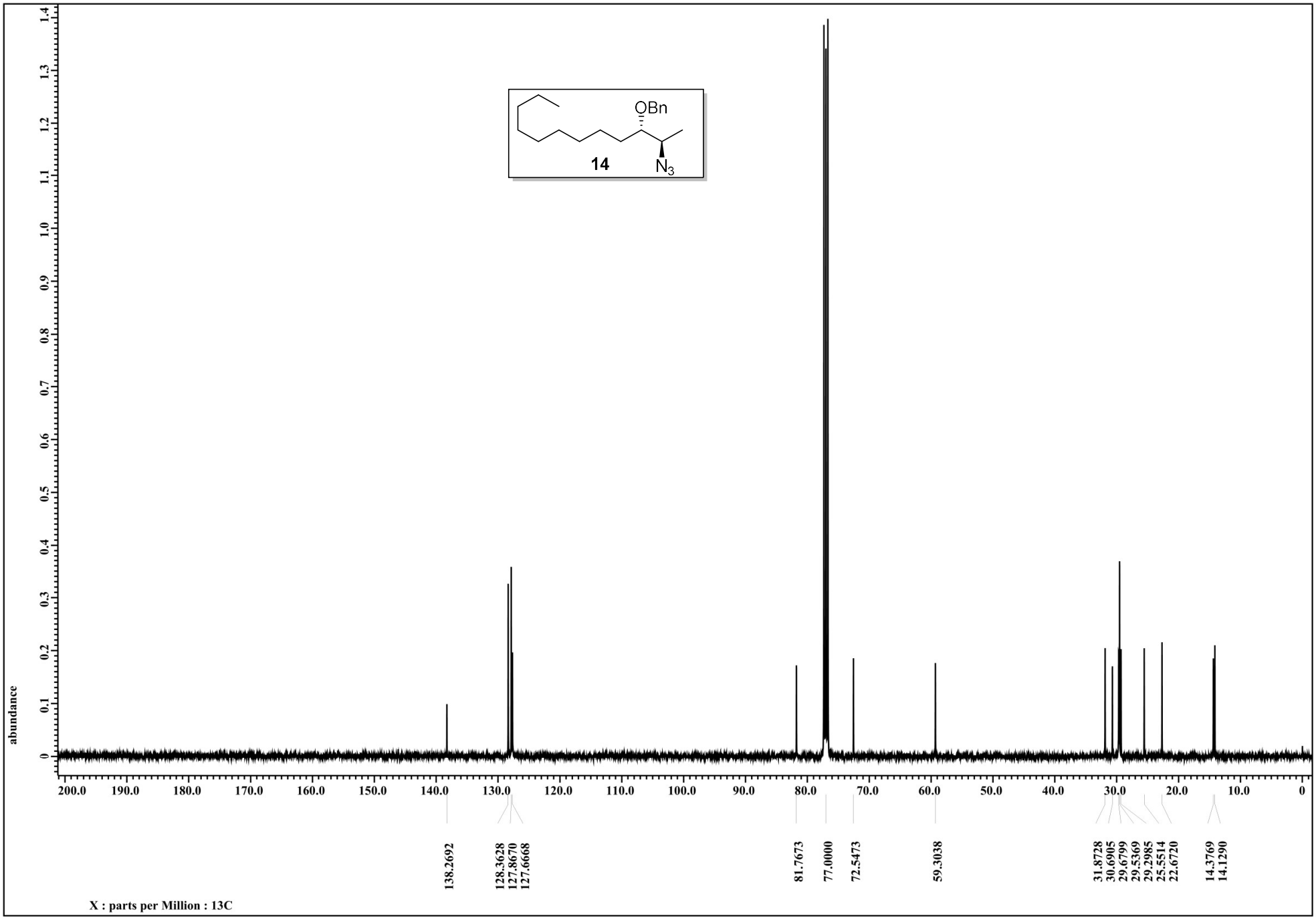

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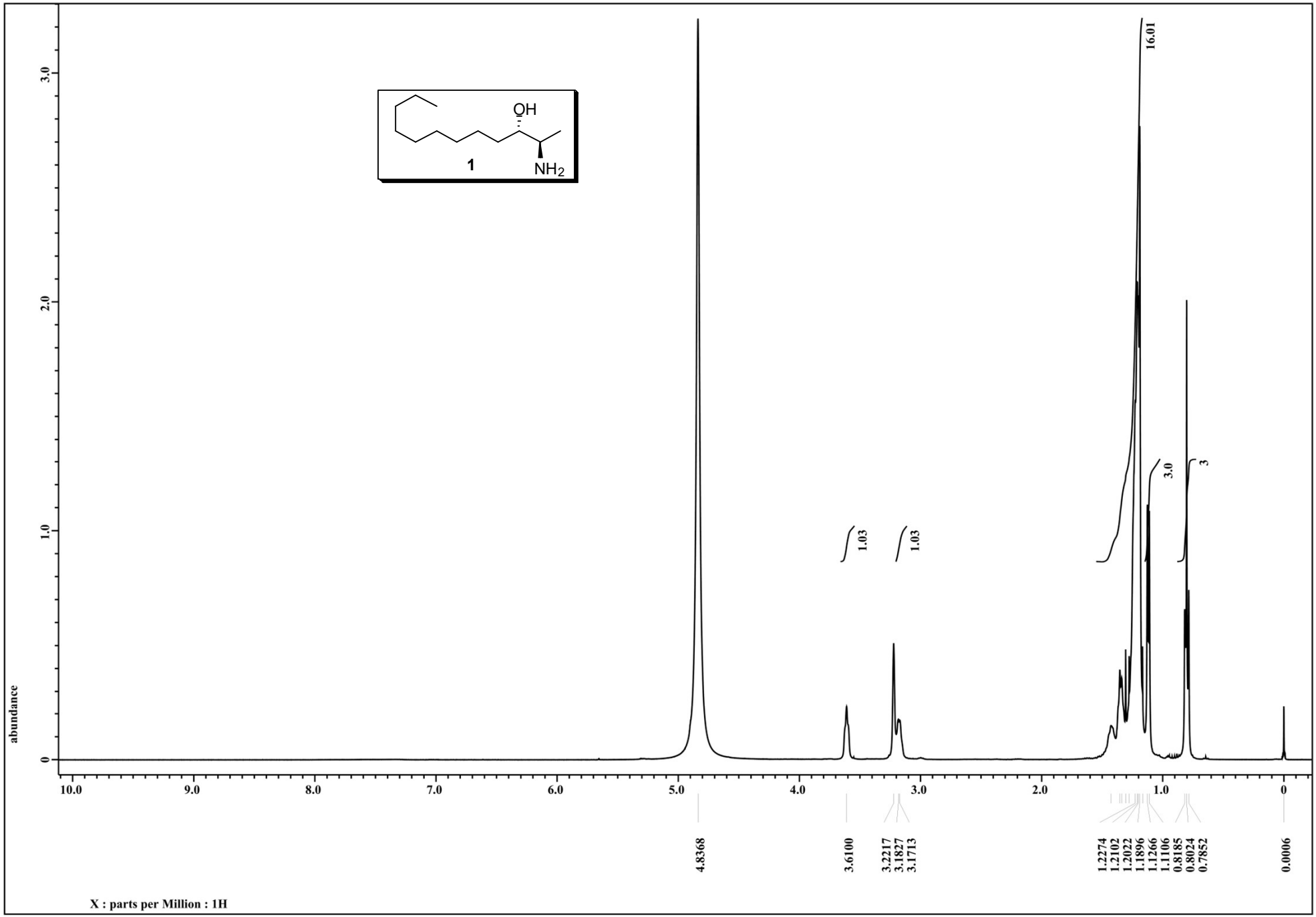

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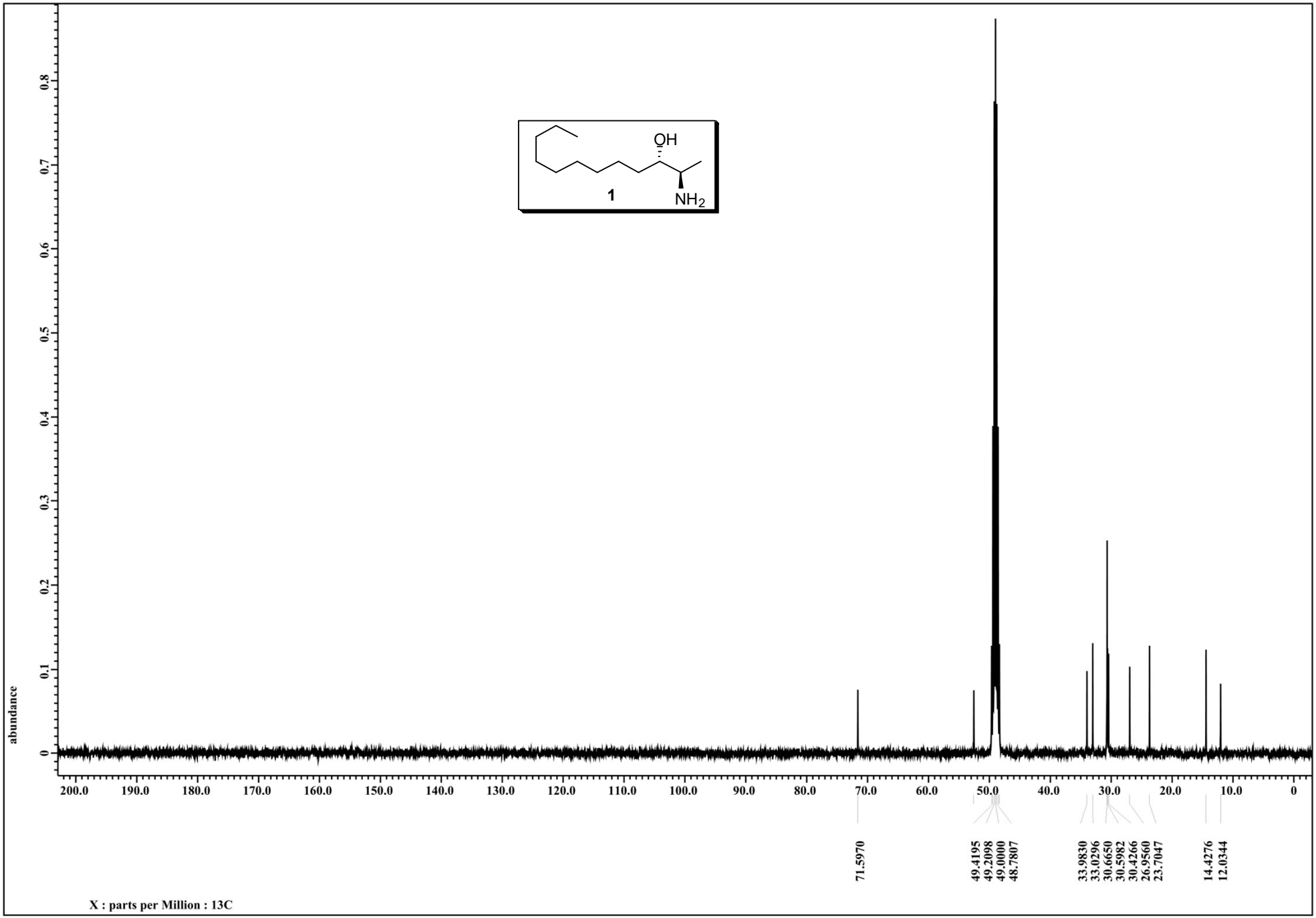

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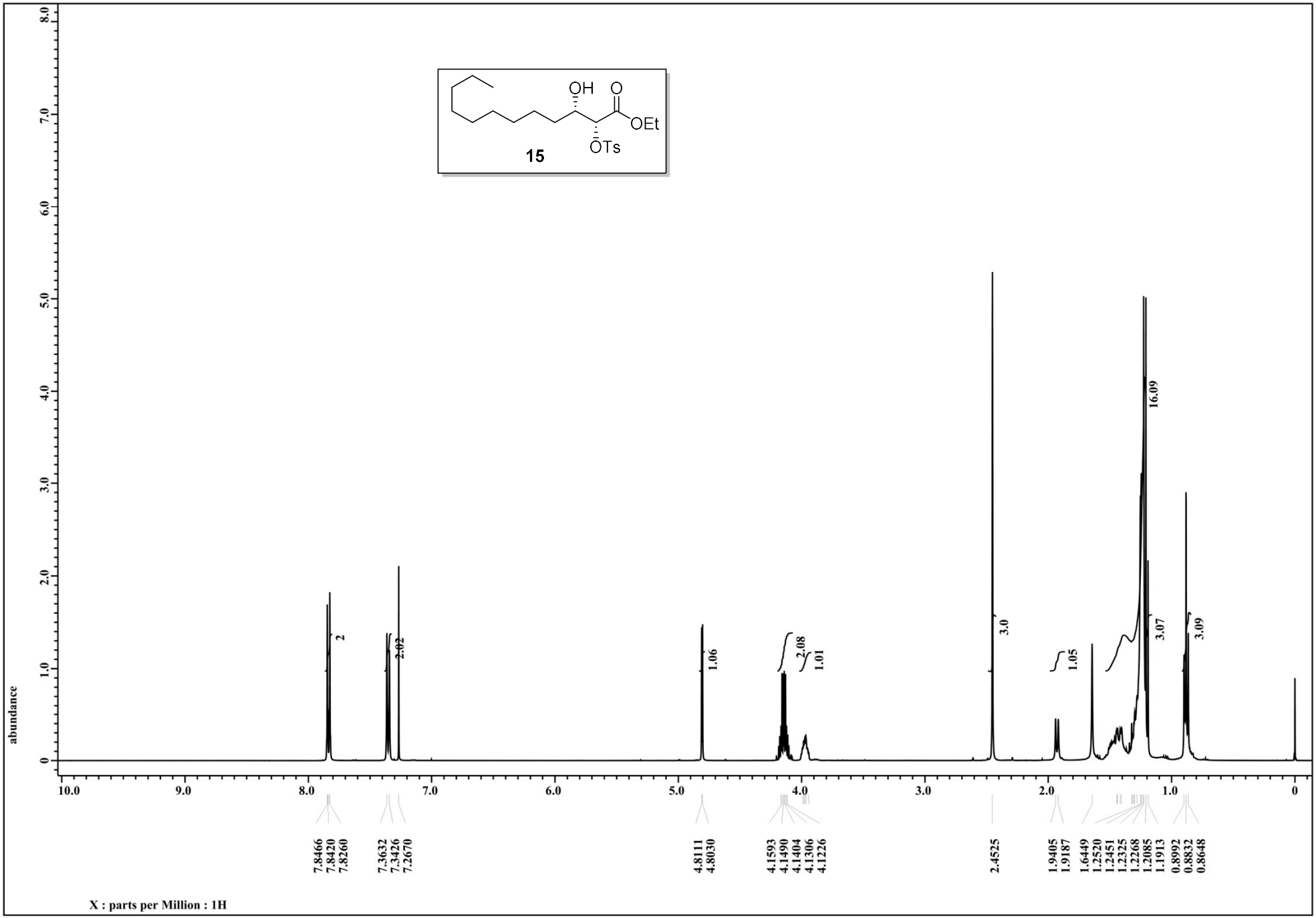

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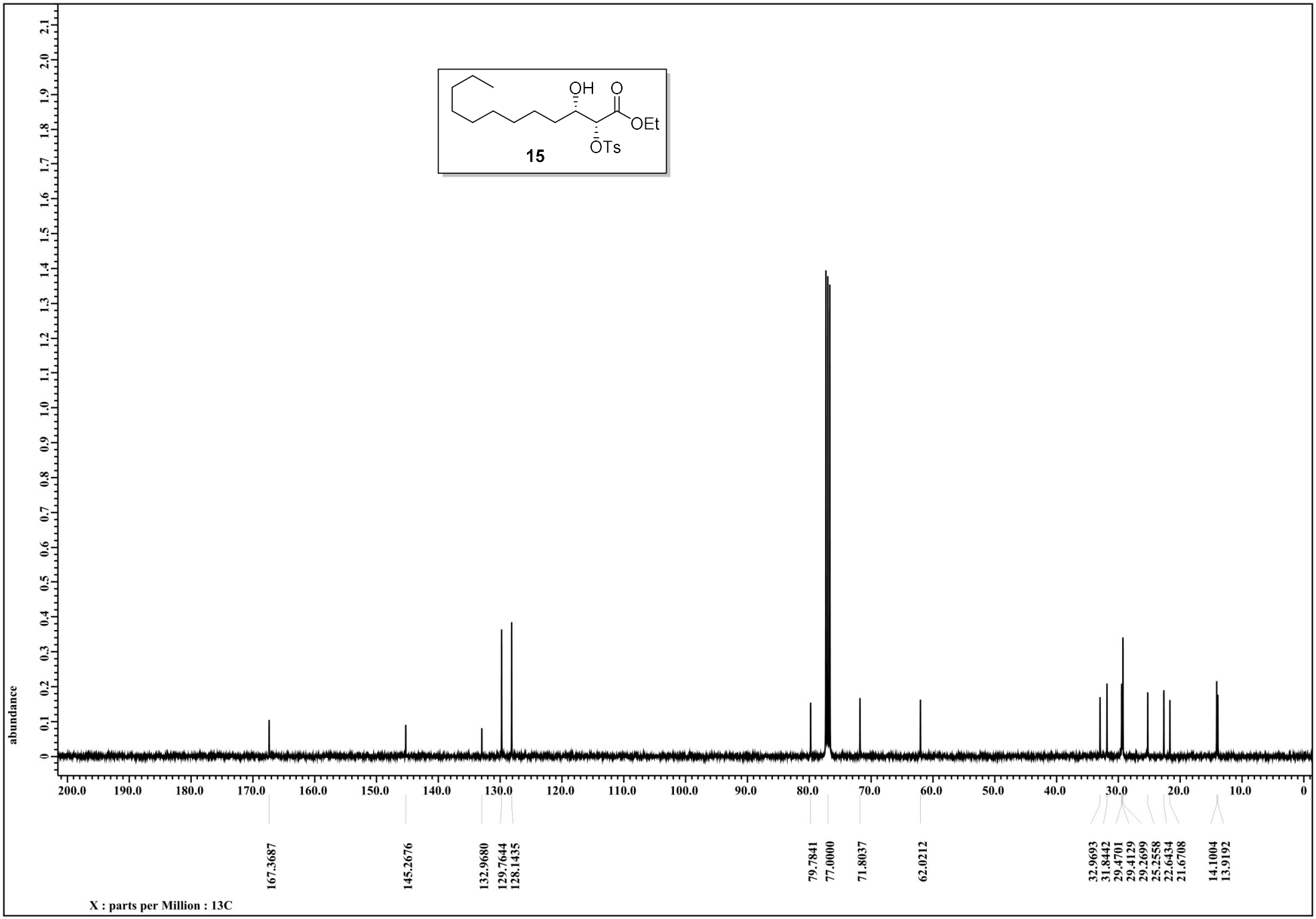

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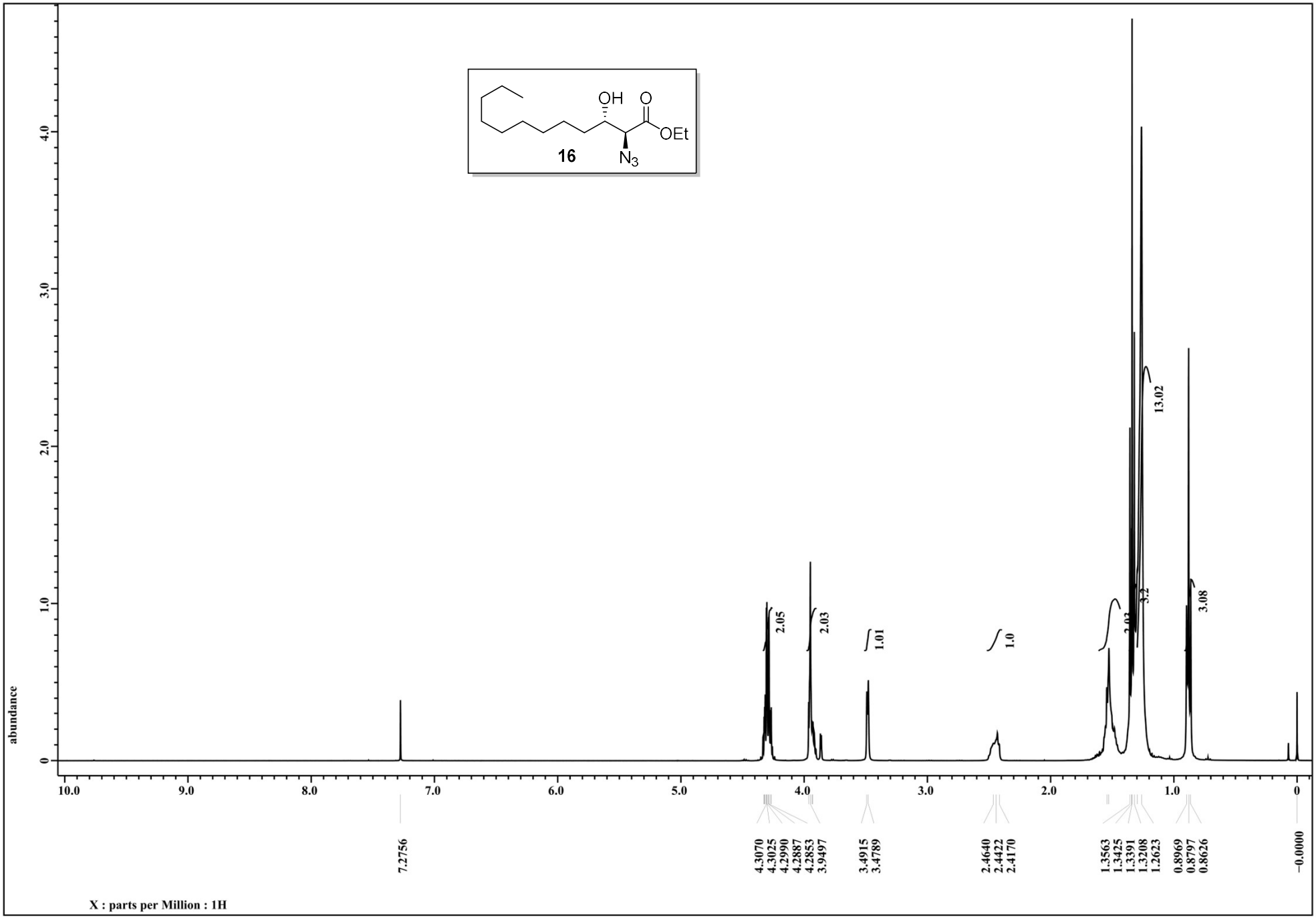

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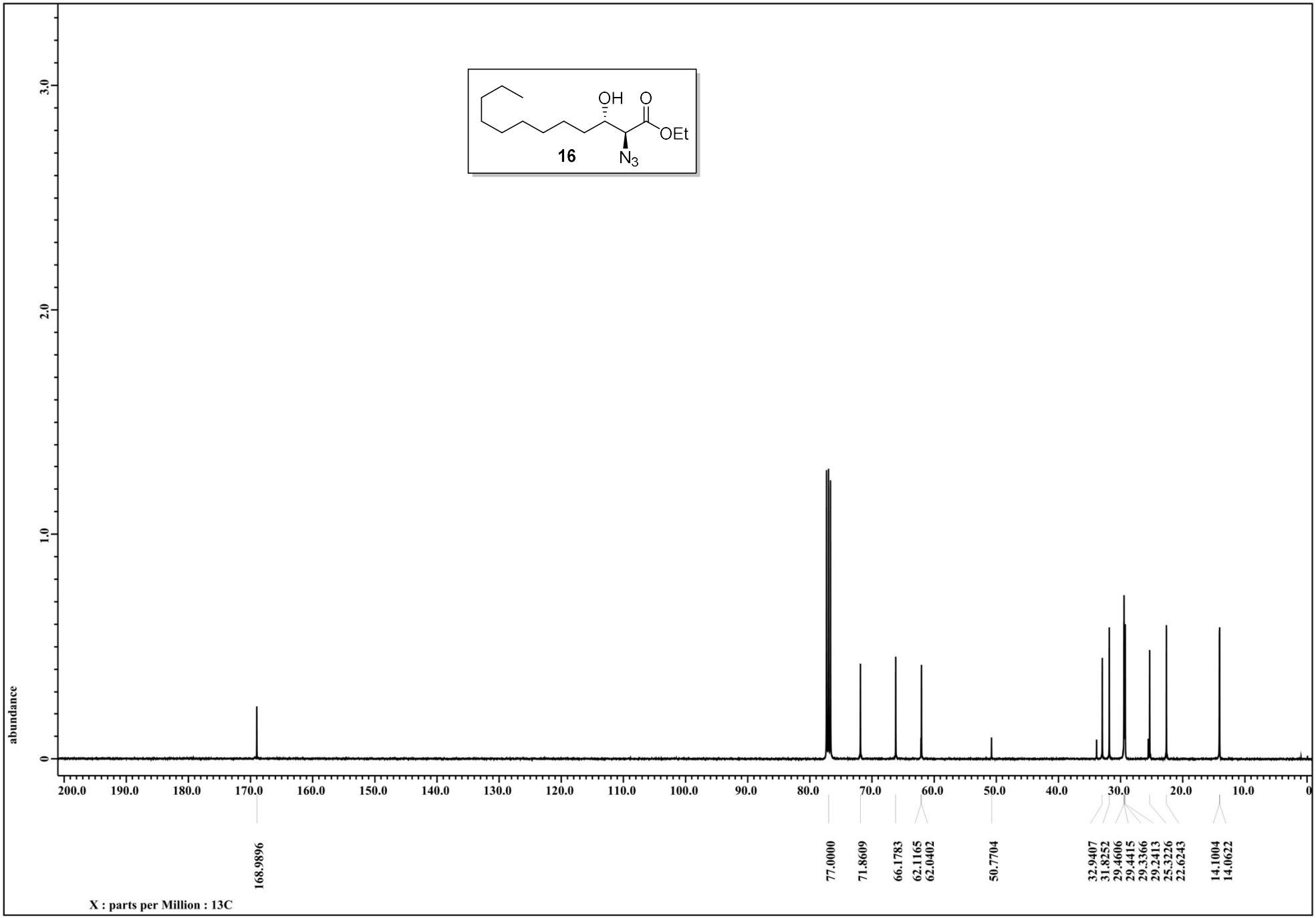

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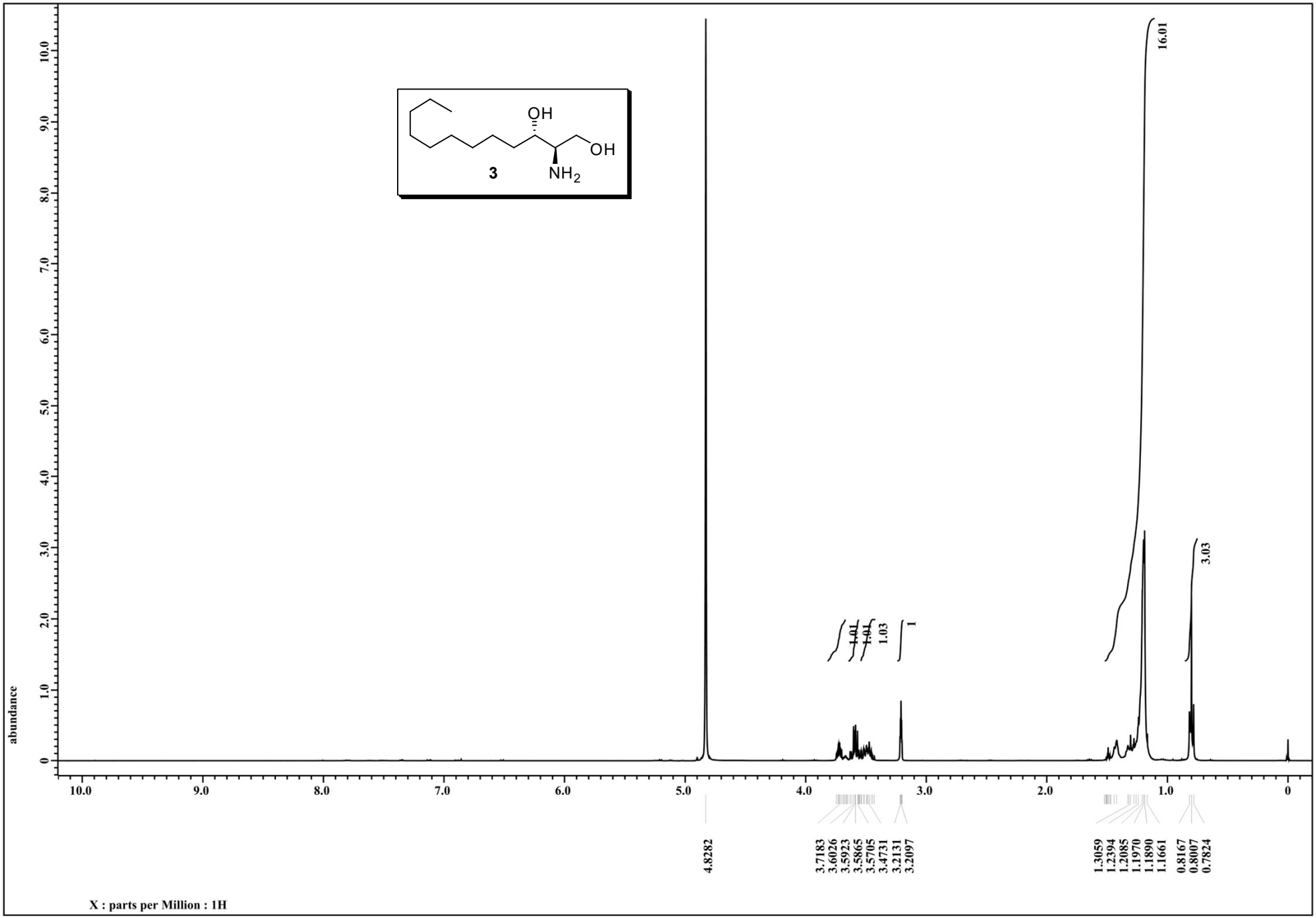

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