Tandem Transformations via Friedel-Crafts Acylation Followed by Ring-Expansion, Ring-Opening, and Cycloisomerization Sequence

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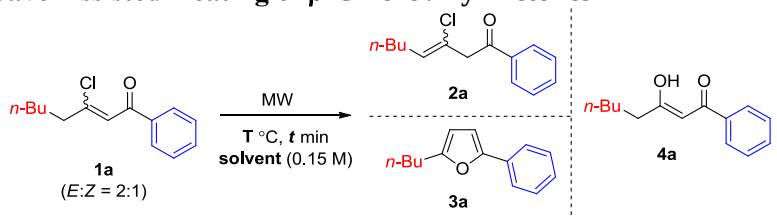
Reaction Optimization. Our initial assessment established the thermal stability of β-chlorovinyl ketones upto 150 °C in various solvents such as CH_3CN, DCE, $PhCH_3$, and DMF. To capitalize the microwave-assisted superheating methods, the initially tested solvents were heated under microwave irradiation (Table S1). A 2:1 mixture of (*E*/*Z*)-β-chlorovinyl ketone **1a** was subjected to the microwave irradiation in CH_3CN at a fixed temperature of 180 °C (entry 1). The analysis of the reaction mixture revealed that the β-chlorovinyl ketone **1a** primarily underwent the alkene isomerization, providing vinyl chlorides **2a** as a 1:4 mixture of (*E*/*Z*)-isomers in 68% yield. Gratifyingly, the formation of 2,5-disubstituted furan **3a** was observed in 14% yield. While the mechanistic rationale to the formation of the vinyl chlorides **2a** from the β-chlorovinyl ketone **1a** is not clear, given that we previously observed the formation of furans from the α-vinyl enolization of (*E*/*Z*)-β-chlorovinyl ketone **1a** via allene intermediates,[1] the formation of furan **3a** strongly implied the reaction pathway that involved the α-vinyl enolization of **1a** (*vide infra*). The recovered (*E*/*Z*)-β-chlorovinyl ketone **1a** remained as a 2:1 mixture, indicating no reactivity difference between (*E*)- and (*Z*)-stereoisomers under the microwave irradiation at 180 °C. The use of DCE as solvent under microwave irradiation at 180 °C resulted in the formation of the vinyl chlorides **2a** and the furan **2a** in 47% and 6% yield, respectively (entry 2). The microwave irradiation of **1a** in 1,4-dioxane at 180 °C led to the formation of the vinyl chlorides **2a** and diketone **4a** in 50% and 21% yield, respectively (entry 3). In DMF solvent the exclusive formation of the diketone **4a** was observed in quantitative yield (entry 4). Given that the heating characteristics of solvents under microwave irradiation are related to their dielectric properties, a mixed solvent system using CH_3CN and protic solvents was tested (entries 5-6). As anticipated, the reaction conversion improved upto 92% upon using a 3:1 mixture of CH_3CN:EtOH (entry 5), leading to the formation of the vinyl chlorides **2a** and diketone **4a**. A mixture of CH_3CN:EtOH solvent, however, led to the exclusive formation of the vinyl chlorides **2a** in a comparable yield of 86% (entry 6). It is conceivable that the hygroscopic nature of 1,4-dioxane, DMF, and EtOH causes the formation of diketone **4a** due to the inadvertent presence of water molecules in the solvents. Next, the reaction solvent was switched to the less hygroscopic, but low microwave absorbing, solvents. The microwave irradiation in $PhCH_3$ provided the formation of the vinyl chloride **2a** and 2,5-disubstituted furan **3a** in 13% and 31% yield, respectively (entry 7). The reaction in hexanes was less efficient, providing only 17% conversion (entry 8). To further optimize the reaction conditions, the microwave irradiation of **1a** was conducted at 230 °C (entry 9-11). While the formation of the vinyl chlorides **2a** prevailed in CH_3CN and DCE, the furan **3a** was observed as a dominant product in $PhCH_3$ (entry 11). Further fine-tuning of the reaction optimization was conducted at 250 °C (entry 12-15). With 3 min irradiation, the starting material **1a** displayed 80% conversion, and the products were comprised of 42% yield of vinyl chlorides **2a** and 48% of furan **3a** (entry 12). Upon 10 min irradiation, the starting material **1a** was completely consumed, but with the presence of the vinyl chlorides **2a** in 10% yield, the furan **3a** remained in 90% yield (entry 13). Finally, the irradiation of **1a** for 30 min at 250 °C provided an optimal reaction condition, providing the furan **3a** in an isolated yield of 82% (entry 14). A prolonged irradiation of **1a** gave the furan **3a** in a slightly low yield of 78% (entry 15).

Table S1. Microwave-Assisted Heating of β-Chlorovinyl Ketones[a]



entry	solvent	T (°C)	time (min)	conv. (%)[b]	yield (%)[c]
1	CH_3CN	180	60	82	**2a**, 68; **3a**, 14
2	DCE	180	60	53	**2a**, 47; **3a**, 6
3	Dioxane	180	60	71	**2a**, 50; **4a**, 21

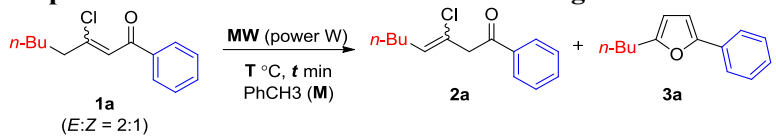
4	DMF	180	60	100	**4a**, 100
5[d]	CH_3CN/EtOH	180	60	92	**2a**, 21; **4a**, 71
6[d]	CH_3CN/PhOH	180	60	86	**2a**, 86
7	$PhCH_3$	180	60	43	**2a**, 13; **3a**, 31
8	Hex	180	60	17	**2a**, 13; **3a**, 3
9	CH_3CN	230	30	80	**2a**, 52; **3a**, 28
10	DCE	230	30	87	**2a**, 62; **3a**, 23
11	$PhCH_3$	230	30	58	**2a**, 23; **3a**, 35
12	$PhCH_3$	250	3	80	**2a**, 42; **3a**, 38
13	$PhCH_3$	250	10	100	**2a**, 10; **3a**, 90
14	$PhCH_3$	250	30	100	**3a**, 100 (82)
15	$PhCH_3$	250	60	100	**3a**, 100 (78)

[a]Reaction using **1a** (2:1 *E*/*Z* mixture, 0.3 mmol) in solvent (0.15 M). [b]Conversion by ^{1}H NMR analysis of crude mixture. [c]Yields calculated by ^{1}H NMR analysis. Values in parentheses are isolated yields. [d]A 3:1 mixture of CH_3CN:ROH.

Mechanistic Studies. The facile formation of 2,5-disubstituted furan **3a** from β-chlorovinyl ketone **1a** prompted more detailed studies to understand the microwave-assisted heating method (Table S2). The internal temperature of microwave reactor was measured using the built-in IR sensor, and the maximum internal temperature of $PhCH_3$ solution without the substrate **1a** was 220 °C, after which the microwave reactor shutting down automatically (entry 1). Thus, it was clear that the presence of β-chlorovinyl ketone **1a** in $PhCH_3$ solution is the key to raise the reaction temperature to 250 °C. The microwave-assisted heating effect was obvious since the conventional heating of 0.15 M $PhCH_3$ solution of β-chlorovinyl ketone **1a** at 250 °C only led to 47% conversion, yielding the vinyl chlorides **2a** in 26% and 2,5-disubstituted furan **3a** in 21% (entry 2). The effect of the reaction concentration was next investigated using a 0.30 M $PhCH_3$ solution of β-chlorovinyl ketone **1a** as opposed to our optimized concentration of 0.15 M. The microwave-assisted heating of the 0.30 M $PhCH_3$ solution of β-chlorovinyl ketone **1a** at 180 °C provided 24% conversion, leading to the vinyl chlorides **2a** and 2,5-disubstituted furan **3a** in 12% and 12% yield, respectively (entry 3). This result suggests that the higher concentration of the substrate **1a** negatively affect the reaction conversion since the 0.15 M $PhCH_3$ solution of **1a** at 180 °C provided 43% conversion (in Table 1, entry 7). However, such concentration effect was not obvious upon raising the temperature to 250 °C, where the 0.30 M $PhCH_3$ solution of **1a** provided the desired furan **3a** in 100% yield (entry 4). Thus, the microwave-assisted heating was applied to the 0.03 M $PhCH_3$ solution of **1a** at 250 °C, and the reaction provided the vinyl chlorides **2a** and 2,5-disubstituted furan **3a** in 9% and 91% yield, respectively (entry 5). The microwave-assisted heating of neat **1a** at 230 °C led to the formation of the furan **3a** in 22% yield in addition to **2a** and **4a** in 39% and 15% yield, respectively (entry 6). Thus, while the overall reaction conversion of neat **1a** improved to 76% as opposed to 58% from the 0.15 M $PhCH_3$ solution of **1a** (in Table 1, entry 11), upon delineating the formation of the diketone **4a** (15%) the reaction efficiencies became comparable, but the formation of the furan product **3a** was more effective in the $PhCH_3$ solution of **1a**. Likewise, the microwave-assisted heating of neat **1a** at 250 °C gave the vinyl chlorides **2a** in 13% yield, the furan **3a** in 56% yield, and the diketone **4a** in 31% yield (entry 7). In order to study the possibility of non-thermal effects in the microwave-assisted reaction, the 0.15 M $PhCH_3$ solution of **1a** was heated with "hit to temperature in time" mode in 110 W to reach the internal temperature of microwave reactor to 250 °C (entry 8). The time required for such setting was 10 min, and the conversion at this point was 75% (**2a** in 41% and **3a** in 34%). The microwave-assisted heating at 250 °C for 10 min using "heat as fast as possible" mode in 250-300 W with an initial pulsed microwave power upto 850 W provided 90% conversion (entry 9); **2a** in 38% and **3a** in 52%. Our results did not provide strong evidences for any specific non-thermal effect, even though a polar substrate **1a** was subjected to a non-polar, microwave transparent, medium. Furthermore, the stirring at 600 rpm of the microwave-assisted heating decreased the conversion to 93%, providing **2a** and **3a** in 19% and 74% yield, respectively (entry 10). Given that the phenomenon of the microwave-assisted

superheating occurs in unstirred liquids, the superheating effects are suppressed by stirring.[2] This is consistent with the suppressed reaction conversion upon stirring, where the microwave-assisted superheating effect was diminished.

Table S2. Control Experiments for Microwave-Assisted Heating[a]



1a (*E*:*Z* = 2:1) **2a** **3a**

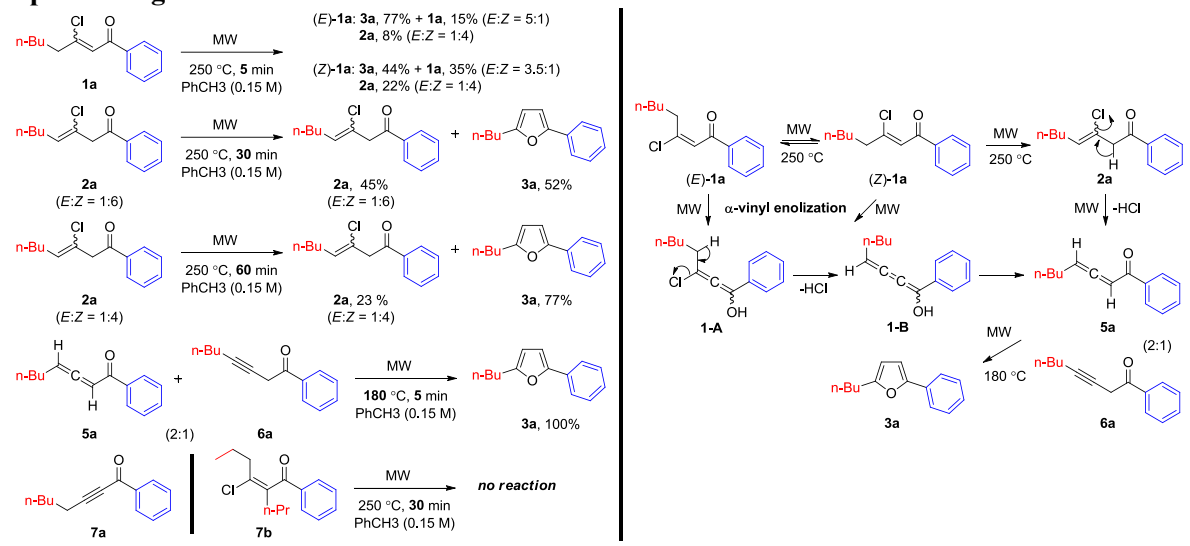
entry	conc'n (M)	T (°C)	time (min)	conv. (%)[b]	yield (%)[c]
1[d]	$PhCH_3$	220	12	-	-
2[e]	$PhCH_3$ (0.15)	250	30	47	**2a**, 26; **3a**, 21
3	$PhCH_3$ (0.30)	180	30	24	**2a**, 12; **3a**, 12
4	$PhCH_3$ (0.30)	250	30	100	**2a**, 0; **3a**, 100
5	$PhCH_3$ (0.03)	250	30	100	**2a**, 9; **3a**, 91
6[f]	**1a** (neat)	230	30	76	**2a**, 39; **3a**, 22
7[g]	**1a** (neat)	250	30	43	**2a**, 13; **3a**, 56
8[h]	$PhCH_3$ (0.15)	250	10	75	**2a**, 41; **3a**, 34
9[i]	$PhCH_3$ (0.15)	250	10	90	**2a**, 38; **3a**, 52
10[j]	$PhCH_3$ (0.15)	250	30	93	**2a**, 19; **3a**, 74

[a]Reaction using **1a** (2:1 *E*/*Z* mixture) in solvent (2 mL). [b]Conversion by ^{1}H NMR analysis of crude mixture. [c]Yields calculated by ^{1}H NMR analysis. [d]No substrate **1a**. [e]Under conventional heating in a metal jacket. [f]Formation of **4a** in 15% yield. [g]Formation of **4a** in 31% yield. [h]Under "heat to temperature in time" mode with constant power of 110 W. [i]Under "heat as fast as possible" mode in 250-300 W with an initial power upto 850 W. [j]Under stirring at 600 rpm.

Reaction Pathway. The microwave-assisted heating of stereodefined β-chlorovinyl ketone **1a** at 250 °C revealed that the (*E*)-**1a** underwent the faster reaction to the furan **2a** than (*Z*)-**1a** (Scheme S1). Also, the preferential formation of (*E*)-stereoisomer of **1a** from (*Z*)-**1a** strongly suggested the inter-conversion between the stereoisomeric β-chlorovinyl ketones **1a** under the microwave-assisted heating conditions at 250 °C. Indeed, our control experiments confirmed that the microwave-assisted heating of stereodefined β-chlorovinyl ketones **1a** at 180-230 °C did not promote the interconversion of β-chlorovinyl ketones **1a**, clearly demonstrating the importance of the reaction temperature of 250 °C. The observation of the vinyl chlorides **2a** suggested that the **2a** might be intermediates to the furan **3a**. To test such reaction pathways, a 1:6 mixture of **2a** was subjected to the microwave-assisted heating conditions (Scheme 2). The conversion of (*E*/*Z*)-**2a** to **3a** was considerably slow, thus after the 30 min of microwave heating, the conversion to the furan **3a** was only 52% yield. The recovered vinyl chlorides **2a** remained as a 1:6 mixture of stereoisomers, demonstrating the similar reaction rates for the stereoisomeric (*E*/*Z*)-**2a** to **3a**. To verify that the ratio of the vinyl chlorides did not come from the equilibrium state, a 1:4 mixture of **2a** was heated for 60 min, where the recovered vinyl chlorides retained the ratio of 1:4. Since the conversion of vinyl chlorides **2a** to the β-chlorovinyl ketones **1a** was not observed and the formation of the furan **3a** from the vinyl chlorides **2a** was considerably slower than our optimized conditions, a direct reaction pathway of (*E*/*Z*)-**2a** to **3a** must be operating. While the presence of other intermediate species was not been observed, the intermediacy of allenyl and propargyl ketones, derived from the thermal α-vinyl enolization of β-chlorovinyl ketone **1a**, was postulated. Thus, the authentic samples of the allenyl ketone **5a** and propargyl ketone **6a** were subjected to our microwave-assisted heating conditions. It turned out that the mixture of **5a** and **6a** underwent the thermal cycloisomerization to **3a** in 5 min at 180 °C. This result explains why the allenyl and propargyl ketone intermediates could not be observed during the reaction due to their facile cycloisoemrization pathways with much less energy input. It has been previously reported that the metal-catalyzed [1,3]-prototropic isomerization of alkynyl ketones to allenyl ketones prompted the synthesis of **7a**.[3] The subjection of the alkynyl ketone **7a** under our microwave-assisted superheating

conditions did not provide the furan **3a**. Also, the (*E*)-β-chlorovinyl ketone **7b** without α-hydrogen was inert under the microwave-assisted heating condition. Putting all data together, the following conclusion could be made; (1) the α-hydrogen in β-chlorovinyl ketone is needed, (2) the formation of alkynyl ketone via *syn*-/*anti*-dehydrochlorination of β-chlorovinyl ketone does not occur, (3) the stereoisomeric β-chlorovinyl ketones equilibrate at 250 °C, (4) the vinyl chlorides do not equilibrate nor convert to β-chlorovinyl ketones. As such, β-chlorovinyl ketones are proposed to undergo the α-vinyl enolization to the allenol **1-A**. A subsequent elimination of HCl leads to the formation of the [3]cumulenol **1-B**, spontaneously isomerizing to the allenyl ketone **5a** and propargyl ketone **6a**. Another reaction pathway involves the vinyl chlorides to **5a** and **6a**,[4] although this reaction pathway to the furan **3a** appears to be a high energy-requiring process. As our control experiment indicated the conversion of the allenyl ketone **5a** and propargyl ketone **6a** proceeds to the furan **3a** with low energy inputs.

Scheme S1. Reaction Pathways of β-Chlorovinyl Ketones to Furan under Microwave-Assisted Superheating Conditions



[1] Kim, H. Y.; Li, J.-Y.; Oh, K. Studies on Elimination Pathways of β-Halovinyl Ketones Leading to Allenyl and Propargyl Ketones and Furans under the Action of Mild Bases. *J. Org. Chem.* **2012**, *77*, 11132-11145.

[2] (a) Chemat, F.; Esveld, E. Microwave Super-Heating Boiling of Organic Liquids: Origin, Effect and Application. *Chem. Eng. Technol.* **2001**, *24*, 735-744. (b) Dudley, G.; Stiegman, A. E.; Rosana, M. R. Correspondence on Microwave Effects in Organic Synthesis. *Angew. Chem. Int. Ed.* **2013**, *52*, 7918-7923.

[3] Kel'I, A. V.; Gevorgyan, V. Efficient Synthesis of 2-Mono- and 2,5-Disubstituted Furans via the CuI-Catalyzed Cycloisomerization of Alkynyl Ketones. *J. Org. Chem.* **2002**, *67*, 95-98.

[4] For the vinyl halide elimination using *t*-BuOK at 220 °C, see: (a) Christi, M.; Groetsch, S. Cyclohexa−1,2,4−triene from 1−Bromocyclohexa−1,4−diene. *Eur. J. Org. Chem.* **2000**, 1871-1874. (b) Kilbas, B.; Azizoglu, A.; Balci, M. Incorporation of an Allene Unit into *α*−Pinene *via β*−Elimination. *Helv. Chim. Acta* **2006**, *89*, 1449-1456.

[5] (*E*)/(*Z*)-2a was confirmed from ^{1}H crude NMR. The compound **7a** and **7b** in **Scheme S1** were prepared by the same method reported in the previous study.[1]

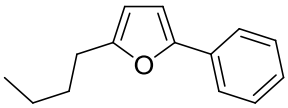
General Methods. All reactions were carried out with oven-dried glassware. The progress of all reactions was monitored by thin-layer chromatography on Dynamic Adsorbent, Inc. precoated silica gel plates (250 μm) and visualized by ultra-violet light or by staining with $KMnO_4$ stain. HPLC grade dichloromethane and toluene were further dried through alumina columns. Unless otherwise specified, all chemicals were obtained from Alfa Aesar, TCI, or Acros, and all solvents were purchased from Fischer Scientific. The microwave assisted reactions were carried out in Anton Paar microwave 400 synthesis reactor. The ^{1}H NMR and ^{13}C NMR spectra were obtained on JEOL 600 MHz Fourier transform spectrometers. Chemical Shifts are reported in units of parts per million downfield from tetramethylsilane and all coupling constants are reported in Hertz. The infrared spectra were obtained using a Thermo Nicolet IR 300 Spectrometer. Silica gel (32-64u, Dynamic Adsorbent, Inc.) was used for column chromatography. Melting points were recorded on a Buchi-B-450 melting point apparatus and the melting point values were uncorrected.

General Procedure A: Synthesis of β-Chlorovinyl Ketones and Microwave Assisted Reaction

β-Chlorovinyl ketones were synthesized by the literature method.[1] To a stirred suspension of aluminum chloride (47 mg, 0.35 mmol) in dry dichloromethane (1 mL) at 0 ^{o}C, were added alkyne (0.3 mmol) and acyl chloride (0.3 mmol) dropwise at the same time. The resulting solution was continued to stir at the same temperature until the reaction was complete by TLC (20-40 min). The reaction was then quenched with several drops of H_2O and concentrated under the reduced pressure. The residue ((*E*)/(*Z*) mixtures of β-chlorovinyl ketones) was dissolved in 5mL of ethyl acetate and hexanes mixture (v:v=10:90) and filtered through short silica gel. Silica gel was further flushed with 5mL of ethyl acetate and hexanes mixture (v:v=10:90). After drying over $MgSO_4$, the solution was concentrated under the reduced pressure and transferred into a 10 mL microwave reaction vial with 2 mL toluene. The vial was loaded in a microwave reactor. The reaction mixture was then irradiated to reach the target temperature (250 ^{o}C) in 10 min and continued to irradiate at this temperature for 3 -

60 min depending on the reaction with 100-120 W of an initial microwave power. After cooling to ambient temperature, the solvent was removed under the reduced pressure and the product was purified by column chromatography with 0-20% ethyl acetate in hexanes eluent.

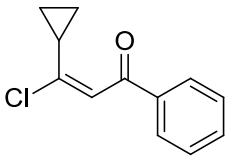
1mmol Scale Reaction:



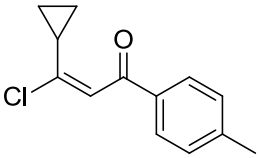
To a stirred suspension of aluminum chloride (160 mg, 1.2 mmol) in dry dichloromethane (5 mL) at 0 °C, were added 1-heptyne (1.0 mmol, 133 μL) and benzoyl chloride (1.0 mmol, 133 μL) dropwise at the same time. The resulting solution was continued to stir at same temperature until the reaction was complete by TLC (30 min). The reaction was then quenched with several drops of H_2O and concentrated under the reduced pressure. The residue (a 1:1 (*E*)/(*Z*) mixture of β-chlorovinyl ketones) was dissolved in 15 mL of ethyl acetate and hexanes mixture (v:v=10:90) and filtered through a short silica gel. Silica gel was further flushed with 15 mL of ethyl acetate and hexanes mixture (v:v=10:90). After drying over $MgSO_4$, the solution was concentrated under the reduced pressure and transferred into a 30 mL microwave reaction vial with 7 mL toluene. The vial was loaded in a microwave reactor. The reaction mixture was then irradiated to reach the target temperature (250 °C) in 10 min and continued to irradiate at this temperature for 30 min with an initial microwave power of 100-120 W. After cooling the vial to ambient temperature, the solvent was removed under the reduced pressure and the product was isolated by column chromatography with hexanes in 79% (158 mg) yield.

Synthesis and Characterization of Compounds (4a-i) in Scheme 4.

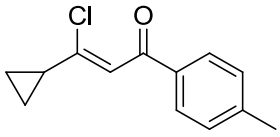
(*E*)-cyclopropyl-substituted β-chlorovinyl ketones **(4a-i)** were synthesized and isolated by the previous method[1] with cyclopropyl acetylene (**2i**). For the microwave-assisted reaction, only (*E*)-cyclopropyl-substituted β-chlorovinyl ketone was employed.



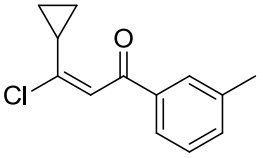
(*E*)-3-Chloro-3-cyclopropyl-1-phenylprop-2-en-1-one (**4a**) : yellow viscous oil; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.92-7.94 (m, 2H), 7.52-7.55 (m, 1H), 7.44-7.46 (m, 2H), 6.99-7.02 (m, 1H), 4.97-5.01 (m, 1H), 3.29-3.34 (m, 1H), 2.98-3.04 (m, 1H), 2.69-2.75 (m, 1H), 2.32-2.39 (m, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 190.1, 164.8, 138.2, 132.9, 128.7, 128.3, 117.3, 54.7, 31.4, 30.3; IR (neat): 3020, 2954, 1764, 1651, 1384, 762 cm^{-1}; HRMS (ESI): m/z calcd for $C_{12}H_{12}ClO$ $[M+H]^+$ 207.0570 Found 207.0571.



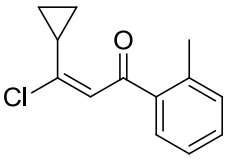
(*E*)-3-Chloro-3-cyclopropyl-1-(*p*-tolyl)prop-2-en-1-one (**4b**): yellow viscous oil; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.84 (d, 2H, *J* = 7.8 Hz), 7.25 (d, 2H, J = 7.8 Hz), 6.97-7.01 (m, 1H), 4.98-5.00 (m, 1H), 3.28-3.38 (m, 1H), 2.98-3.05 (m, 1H), 2.71-2.75 (m, 1H), 2.40 (s, 3H), 2.36-2.40 (m, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 189.7, 164.4, 143.8, 135.7, 129.4, 128.4, 117.4, 54.7, 31.4, 30.3, 21.7; IR (neat): 3020, 2853, 1786, 1685, 1385, 1023, 801 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{14}ClO$ $[M+H]^+$ 221.0727 Found 221.0730.



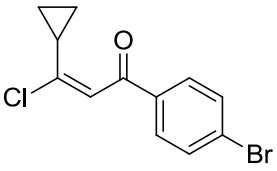
(*Z*)-3-Chloro-3-cyclopropyl-1-(*p*-tolyl)prop-2-en-1-one (***Z*-4b**): yellow viscous oil; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.82 (d, 2H, *J* = 8.4 Hz), 7.25 (d, 2H, *J* = 8.4 Hz), 7.15 (s, 1H), 3.43-3.47 (m, 1H), 2.40 (s, 3H), 1.10-1.12 (m, 2H), 0.96-0.98 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 188.5, 159.8, 143.7, 136.1, 129.3, 128.4, 122.5, 21.7, 16.1, 9.0 (2C); IR (neat): 3016, 2902, 2896, 1786, 1685, 1254, 1023, 756 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{14}ClO$ $[M+H]^+$ 221.0727 Found 221.0735.



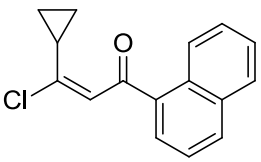
(*E*)-3-Chloro-3-cyclopropyl-1-(*m*-tolyl)prop-2-en-1-one (**4c**): yellow viscous oil; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.72-7.74 (m, 2H), 7.33-7.35 (m, 2H), 6.19-7.01 (m, 1H), 4.97-5.01 (m, 1H), 3.30-3.35 (m, 1H), 2.98-3.03 (m, 1H), 2.71-2.76 (m, 1H), 2.40 (s, 3H), 2.33-2.40 (m, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 190.3, 164.5, 138.5, 138.3, 133.7, 128.8, 128.6, 125.5, 117.5, 54.7, 31.4, 30.3, 21.4; IR (neat): 3018, 2922, 1768, 1644, 1399, 1070, 774 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{14}ClO$ $[M+H]^+$ 221.0727 Found 221.0731.



(*E*)-3-Chloro-3-cyclopropyl-1-(*o*-tolyl)prop-2-en-1-one (**4d**): light yellow solid, m.p. 78-81 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.50-7.52 (m, 1H), 7.34 (t, 1H, *J* = 7.8 Hz), 7.21-7.25 (m, 2H), 6.66-6.70 (m, 1H), 4.92-4.98 (m, 1H), 3.02-3.09 (m, 1H), 2.83-2.86 (m, 1H), 2.67-2.69 (m, 1H), 2.45 (s, 3H), 2.25-2.33 (m, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 194.7, 163.8, 139.4, 137.3, 131.6, 131.0, 128.3, 125.8, 121.5, 54.6, 31.2, 29.9, 20.5; IR (neat): 3020, 2853, 1786, 1685, 1385, 1023, 801 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{14}ClO$ $[M+H]^+$ 221.0727 Found 221.0730.

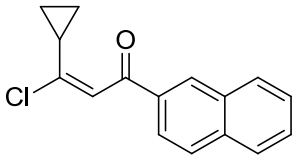


(*E*)-1-(4-Bromophenyl)-3-chloro-3-cyclopropylprop-2-en-1-one (**4e**): yellow solid, m.p. 115-117 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.80 (d, 2H, *J* = 9.0 Hz), 7.59 (d, 2H, *J* = 9.0 Hz), 6.96-6.97 (m, 1H), 4.95-5.01 (m, 1H), 3.28-3.32 (m, 1H), 2.98-3.07 (m, 1H), 2.75-2.77 (m, 1H), 2.39-2.43 (m, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 188.9, 165.7, 136.9, 132.0, 129.8, 128.1, 116.8, 54.6, 31.4, 30.4; IR (neat): 2924, 2853, 1768, 1588, 1478, 1384, 912, 809 cm^{-1}; HRMS (ESI): m/z calcd for $C_{12}H_{11}BrClO$ $[M+H]^+$ 284.9676 Found 284.9678.

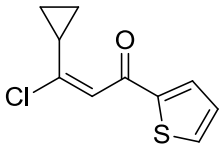


(*E*)-3-Chloro-3-cyclopropyl-1-(naphthalen-1-yl)prop-2-en-1-one (**4f**): sticky material; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.44 (d, 1H, *J* = 8.4 Hz), 7.96 (d, 1H,

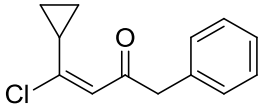
J = 8.4 Hz), 7.87 (d, 1H, *J* = 7.8 Hz), 7.78 (d, 1H, *J* = 6.6 H z), 7.55-7.58 (m, 1H), 7.49-7.54 (m, 2H), 6.83-6.84 (m, 1H), 4.98-5.01 (m, 1H), 3.09-3.13 (m, 1H), 2.84-2.88 (m, 1H), 2.68-2.73 (m, 1H), 2.33-2.38 (m, 1H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 194.1, 164.3, 137.3, 133.9, 132.2, 130.2, 128.5, 127.7, 127.5, 126.5, 125.6, 124.6, 122.0, 54.6, 31.2, 30.1; IR (neat): 3058, 2954, 1733, 1685, 1359, 1258, 1024, 922 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{14}ClO$ $[M+H]^+$ 257.0727 Found 257.0726.



(*E*)-3-Chloro-3-cyclopropyl-1-(naphthalen-2-yl)prop-2-en-1-one (**4g**): light yellow solid, m.p. 80-82 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.45 (s, 1H), 8.02 (dd, 1H, J = 7.8, 2.4 Hz), 7.97 (d, 1H, *J* = 8.4 Hz), 7.90 (d, 1H, *J* = 7.8 Hz), 7.87 (d, 1H, *J* = 7.8 Hz), 7.53-7.60 (m, 2H), 7.19-7.20 (m, 1H), 5.03-5.06 (m, 1H), 3.35-3.39 (m, 1H), 3.06-3.08 (m, 1H), 2.75-2.77 (m, 1H), 2.39-2.43 (m, 1H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 189.9, 164.7, 135.5, 132.6, 129.9, 129.6(9), 129.6(6), 128.6, 128.5, 127.8, 126.8, 124.1, 117.4, 54.7, 31.4, 30.4; IR (neat): 3058, 2581, 1735, 1616, 1359, 1125, 922, 758 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{14}ClO$ $[M+H]^+$ 257.0727 Found 257.0722.

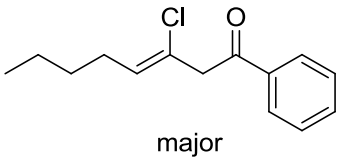


(*E*)-3-Chloro-3-cyclopropyl-1-(thiophen-2-yl)prop-2-en-1-one (**4h**): dark yellow gummy material; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.74 (d, 1H, *J* = 3.0 Hz), 7.63 (d, 1H, *J* = 4.8 Hz), 7.13 (dd, 1H, *J* = 3.0, 4.8 Hz), 6.85-6.89 (m, 1H), 4.96-5.02 (m, 1H), 3.32-3.34 (m, 1H), 3.02-3.04 (m, 1H), 2.72-2.76 (m, 1H), 2.33-2.41 (m, 1H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 182.3, 164.6, 145.8, 134.0, 131.7, 128.3, 117.2, 54.6, 31.4, 30.3; IR (neat): 3094, 2968, 1654, 1411, 1246, 1022, 801 cm^{-1}; HRMS (ESI): m/z calcd for $C_{10}H_{10}ClOS$ $[M+H]^+$ 213.0135 Found 213.0142.

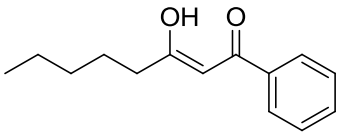


(*E*)-4-Chloro-4-cyclopropyl-1-phenylbut-3-en-2-one (**4i**): light yellow oil; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.31-7.34 (m, 2H), 7.25-7.27 (m, 1H), 7.20-7.22 (m, 2H), 6.28-6.29 (m, 1H), 4.84-4.88 (m, 1H), 3.76 (s, 2H), 3.22-3.27 (m, 1H), 2.87-2.92 (m, 1H), 2.66-2.68 (m, 1H), 2.27-2.33 (m, 1H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 197.1, 163.4, 134.0,

129.6, 128.8, 127.1, 120.2, 54.3, 50.7, 31.2, 30.1; IR (neat): 2958, 1685, 1585, 1396, 1220 ,1008, 822 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{14}ClO$ $[M+H]^+$ 221.0727 Found 221.0737.

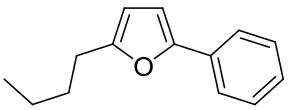


(*Z*)-3-Chloro-1-phenyloct-3-en-1-one (**2a in Table S1**): ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.96 (d, 2H, *J* = 8.4 Hz), 7.55-7.60 (m. 1H), 7.45-7.49 (m, 2H), 5.64 (t, 1H, *J* = 7.2 Hz), 3.96 (s, 2H), 2.21-2.45 (m, 2H), 1.32-1.37 (m, 4H), 0.89 (t, 3H, *J* = 7.4 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 195.7, 137.5, 134.1, 131.0, 128.7, 128.4, 126.7, 48.5, 30.7, 29.1, 23.0, 14.1.

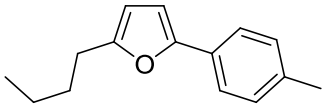


(*Z*)-3-Hydroxy-1-phenyloct-2-en-1-one (**4a in Table S1**): ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[2] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.86-7.90 (m, 2H), 7.50 (t, 1H, *J* = 7.0 Hz), 7.43 (t, 2H, *J* = 7.7 Hz), 6.16 (s, 1H), 2.41 (t, 2H, *J* = 7.2 Hz), 1.66-1.70 (m, 2H), 1.33-1.35 (m, 4H), 0.90 (t, 3H, *J* = 7.4 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 197.1, 183.5, 135.1, 132.3, 128.6, 127.0, 96.1, 39.3, 31.5, 25.6, 22.5, 14.0.

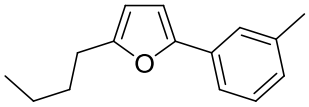
Characterization of Compounds in Scheme 3



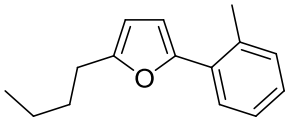
2-Butyl-5-phenylfuran (**3a**): The compound was synthesized using benzoyl chloride (35 μL) and 1-heptyne (40 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 44 mg (74%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.62-7.65 (m, 2H), 7.34-7.37 (m, 2H), 7.19-7.23 (m, 1H), 6.55 (d, 1H, *J* = 3.0 Hz), 6.06 (d, 1H, *J* = 3.0 Hz), 2.69 (t, 2H, *J* = 7.8 Hz), 1.66-1.71 (m, 2H), 1.39-1.45 (m, 2H), 0.96 (t, 3H, *J* = 7.4 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 156.5, 152.1, 131.3, 128.6, 126.7, 123.4, 106.9, 105.7, 30.3, 27.9, 22.4, 13.9.



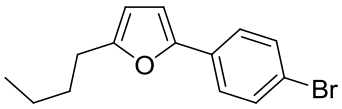
2-Butyl-5-(*p*-tolyl)furan (**3b**): The compound was synthesized using *p*-toluoyl chloride (40 μL) and 1-heptyne (40 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 45 mg (70%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.51 (d, 2H, *J* = 8.4 Hz), 7.14 (d, 2H, *J* = 8.4 Hz), 6.47 (d, 1H, *J* = 3.0 Hz), 6.03 (d, 1H, *J* = 3.0 Hz), 2.67 (t, 2H, *J* = 7.2 Hz), 2.34 (s, 3H), 1.65-1.6 (m, 2H), 1.38-1.42 (m, 2H), 0.94 (t, 3H, *J* = 7.6 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 156.1, 152.3, 136.5, 129.3, 128.7, 123.3, 106.7, 104.9, 30.3, 27.9, 22.3, 21.3, 13.9.



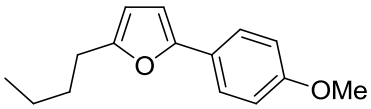
2-Butyl-5-(*m*-tolyl)furan (**3c**): The compound was synthesized using *m*-toluoyl chloride (40 μL) and 1-heptyne (40 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 46 mg (71%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[3] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.41-7.46 (m, 2H), 7.24 (t, 1H, *J* = 7.2 Hz), 7.02 (d, 1H, *J* = 7.8 Hz), 6.52 (d, 1H, *J* = 3.2 Hz), 6.05 (d, 1H, *J* = 6.05 Hz), 2.68 (t, 2H, *J* = 7.2 Hz), 2.38 (s, 3H), 1.66-1.71 (m, 2H), 1.40-1.44 (m, 2H), 0.95 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 156.4, 152.3, 138.2, 131.2, 128.5, 127.6, 124.0, 120.6, 106.8, 105.6, 30.3, 27.9, 22.4, 21.6, 13.9.



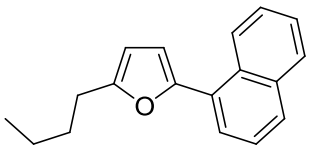
2-Butyl-5-(*o*-tolyl)furan (**3d**): The compound was synthesized using *o*-toluoyl chloride (39 μL) and 1-heptyne (40 μL)by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 42 mg (65%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[4] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.69 (dd, 1H, *J* = 7.8, 1.8 Hz), 7.21-7.25 (m, 2H), 7.15-7.18 (m, 1H), 6.55 (d, 1H, *J* = 3.0 Hz), 6.09 (d, 1H, *J* = 3.0 Hz), 2.70 (t, 2H, *J* = 7.8 Hz), 2.49 (s, 3H), 1.67-1.72 (m, 2H), 1.40-1.44 (m, 2H), 0.96 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 156.0, 151.7, 134.1, 131.1, 130.6, 126.9, 126.6, 126.0, 109.3, 106.6, 30.3, 27.9, 22.4, 22.0, 12.9.



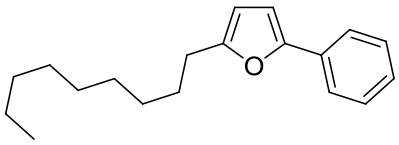
2-(4-Bromophenyl)-5-butylfuran (**3e**): The compound was synthesized using 4-bromobenzoyl chloride (66 mg) and 1-heptyne (40 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 66 mg (79%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.44-7.49 (m, 4H), 6.53 (d, 1H, *J* = 2.4 Hz), 6.04 (d, 1H, *J* = 2.4 Hz), 2.66 (t, 2H, *J* = 7.2 Hz), 1.63-1.67 (m, 2H), 1.37-1.43 (m, 2H), 0.94 (t, 3H, *J* = 7.8 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 156.9, 151.1, 131.7, 130.2, 124.8, 120.3, 107.1, 106.3, 30.2, 27.9, 22.3, 13.9.



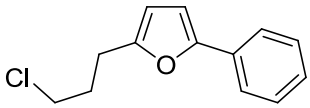
2-Butyl-5-(4-methoxyphenyl)furan (**3f**): The compound was synthesized using *p*-methoxybenzoyl chloride (41 μL) and 1-heptyne (40 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 46 mg (67%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.54 (d, 2H, *J* = 9.0 Hz), 6.89 (d, 2H, *J* = 9.0 Hz), 6.39 (d, 1H, *J* = 2.4 Hz), 6.01 (d, 1H, *J* = 2.4 Hz) 3.81 (s, 3H), 2.66 (t, 2H, *J* = 7.2 Hz), 1.63-1.67 (m, 2H), 1.39-1.42 (m, 2H), 0.94 (t, 3H, *J* = 7.6 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 158.6, 155.8, 152.1, 124.8, 124.5, 114.1, 106.7, 104.0, 55.3, 30.3, 27.9, 22.3, 13.9.



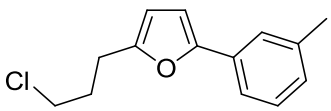
2-Butyl-5-(naphthalen-1-yl)furan (**3g**): The compound was synthesized using 1-naphthoyl chloride (45 μL) and 1-heptyne (40 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 43 mg (57%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[5] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.42 (d, 1H, *J* = 8.4 Hz), 7.69-7.87 (m, 3H), 7.47-7.53 (m, 3H), 6.61 (d, 1H, *J* = 3.0 Hz), 6.16 (d, 1H, *J* = 3.0 Hz), 2.75 (t, 2H, *J* = 7.8 Hz), 1.70-1.75 (m, 2H), 1.4201.46 (m, 2 H), 0.96 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ156.8, 151.5, 134.0, 130.3, 129.0, 128.5, 128.0, 126.4, 125.8, 125.7, 125.6, 125.4, 110.0, 106.6, 30.3, 28.0, 22.4, 13.9.



2-Nonyl-5-phenylfuran (**3h**): The compound was synthesized using benzoyl chloride (40 μL) and 1-dodecyne (64 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 59 mg (73%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.61-7.63 (m, 2H), .35-7.36 (m, 2H), 7.19-7.21 (m, 1H), 6.53 (d, 1H, *J* = 3.0 Hz), 6.04 (d, 1H, *J* = 3.0 Hz), 2.67 (t, 2H, *J* = 7.2 Hz), 1.65-1.69 (m, 2H), 1.27-1.37 (m, 12H), 0.87 (t, 3H, *J* = 7.4 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 156.5, 152.1, 131.3, 128.6, 126.7, 123.3, 106.8, 106.7, 31.9, 29.6, 29.4(9), 29.4(1), 29.3, 28.3, 28.1, 22.7, 14.2.

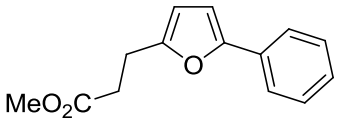


2-(3-Chloropropyl)-5-phenylfuran (**3i**): The compound was synthesized using benzoyl chloride (40 μL) and 6-chloro-1-hexyne (36 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 40 mg (61%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data. ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.61-7.62 (m, 2H), 7.34-7.36 (m, 2H), 7.20-7.23 (m, 1H), 6.54 (d, 1H, *J* = 3.6 Hz), 6.11 (d, 1H, *J* = 3.6 Hz), 3.60 (t, 2H, *J* = 6.6 Hz), 2.86 (t, 2H, *J* = 7.2 Hz), 2.13-2.28 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.1, 152.7, 131.0, 128.7, 127.0, 123.4, 107.9, 105.7, 44.2, 31.0, 25.4.

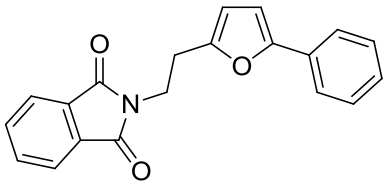


2-(3-Chloropropyl)-5-(m-tolyl)furan (**3j**): The compound was synthesized using *m*-toluoyl chloride (40 μL) and 6-chlorohexyne (36 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 41 mg (58%); yellow liquid; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.41-7.44 (m, 2H), 7.23-7.25 (m, 1H), 7.03 (d, 1H, *J* = 7.8 Hz), 6.52 (d, 1H, *J* = 3.0 Hz), 6.10 (d, 1H, *J* = 3.0 Hz), 3.60 (t, 2H, *J* = 6.6 Hz), 2.86 (t, 2H, *J* = 7.2 Hz), 2.37 (s, 3H), 2.13-2.18 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.0, 152.9, 138.3, 131.0,

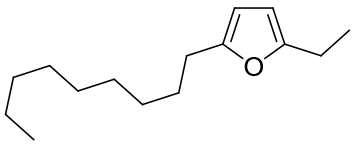
128.6, 127.8, 124.6, 120.6, 107.9, 105.6, 44.2, 31.0, 25.4, 21.5; IR (neat): 2962, 2872, 1694, 1527, 1286, 1064, 736 cm^{-1}; HRMS (ESI): m/z calcd for $C_{14}H_{16}ClO$ $[M+H]^+$ 235.0884 Found 235.0890.



Methyl 3-(5-phenylfuran-2-yl)propanoate (**3k**): The compound was synthesized using benzoyl chloride (40 μL) and methyl 5-hexynoate (38 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 55 mg (79%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.59-7.61 (m, 2H), 7.30-7.36 (m, 2H), 7.20-7.22 (m, 1H), 6.52 (d, 1H, *J* = 3.6 Hz), 6.10 (d, 1H, *J* = 3.6 Hz), 3.69 (s, 3H), 3.03 (t, 2H, *J* = 7.8 HZ), 2.71 (t, H, *J* = 7.8 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 173.0, 153.8, 152.7, 131.0, 128.6, 127.0, 123.4, 107.6, 105.7, 51.9, 32.6, 23.7.



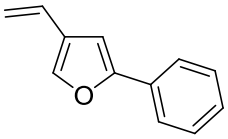
2-(2-(5-Phenylfuran-2-yl)ethyl)isoindoline-1,3-dione (**3l**): The compound was synthesized using benzoyl chloride (40 μL) and N-(4-pentynyl)phthalimide (64 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 69 mg (73%); ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[1] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.80-7.82 (m, 2H), 7.67-7.69 (m, 2H), 7.50 (d, 2H, *J* = 7.8 Hz), 7.24-7.28 (m, 2H), 7.17-7.18 (m, 1H), 6.49 (d, 1H, *J* = 3.6 Hz), 6.15 (d, 1H, *J* = 3.6 Hz), 4.02 (t, 2H, *J* = 7.2 Hz), 3.09 (t, 2H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 168.2, 153.1, 151.8, 134.0, 132.1, 130.8, 128.6, 127.0, 123.5, 123.3, 108.8, 105.7, 36.8, 27.2.



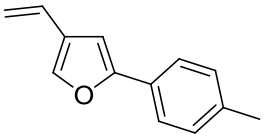
2-Ethyl-5-nonylfuran (**3m**): The compound was synthesized using propionyl chloride (26 μL) and 1-dodecyne (64 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 30 min. 47 mg (71%); pale yellow oil; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 5.83 (s, 2H), 2.53-2.60 (m, 4H), 1.57-1.60 (m, 2H), 1.25-1.33 (m, 12H), 1.19 (t, 3H, *J* = 7.2 Hz), 0.86 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150

MHz): δ 155.9, 154.8, 104.8, 104.1, 31.9, 29.6, 29.4, 29.3(9), 29.3(2), 28.2, 28.1, 22.7, 21.4, 14.2, 12.2; IR (neat): 2925, 2872, 1665, 1608, 1512, 1017, 845 cm^{-1}; HRMS (ESI): m/z calcd for $C_{15}H_{27}O$ $[M+H]^+$ 223.2057 Found 223.2064.

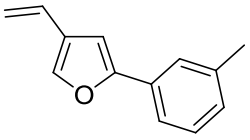
Characterization of Compounds in Scheme 4



2-Phenyl-4-vinylfuran (**5a**): Irradiated the compound (*E*)-**4a** at 250 °C for 60 min. 36 mg (71%); yellow gum; ^1H NMR ($CDCl_3$, 600 MHz): δ 7.66 (d, 2H, J = 7.2 Hz), 7.44 (s, 1H), 7.36-7.39 (t, 2H, J = 7.2 Hz), 7.24-7.28 (m 1H), 6.81 (s, 1H), 6.57 (dd, 1H, *J* = 10.8, 16.8 Hz), 5.52 (d, 1H, *J* = 16.8 Hz), 5.18 (d, 1H, *J* = 10.8 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.7, 140.1, 130.6, 128.7, 127.7, 126.7, 126.6, 123.9, 113.7, 102.3; IR (neat): 2924, 2865, 1685, 1384, 1095, 773 cm^{-1}; HRMS (ESI): m/z calcd for $C_{12}H_{11}O$ $[M+H]^+$ 171.0804 Found 171.0809.

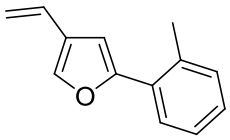


2-(*p*-Tolyl)-4-vinylfuran (**5b**): Irradiated the compound (*E*)-**4b** at 250 °C for 60 min. 39 mg (70%); yellow gum; ^1H NMR ($CDCl_3$, 600 MHz): δ 7.55 (d, 2H, *J* = 7.2 Hz), 7.42 (s, 1H), 7.18 (d, 2H, *J* = 7.2 Hz), 6.75 (s, 1H), 6.56 (dd, 1H, *J* = 10.8, 17.4 Hz), 5.51 (d, 1H, *J* = 17.4 Hz), 5.16 (d, 1H, *J* = 10.8 Hz), 2.35 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 155.0, 139.8, 137.5, 129.4, 128.0, 126.7, 126.6, 123.9, 113.6, 101.6, 21.3; IR (neat): 2924, 2855, 1768, 1675, 1384, 1071, 6929 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{13}O$ $[M+H]^+$ 185.0961 Found 185.0968.

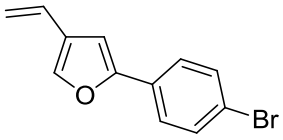


2-(*m*-Tolyl)-4-vinylfuran (**5c**): Irradiated the compound (*E*)-**4c** at 250 °C for 60 min. 40 mg (73%); yellow solid, m.p. 83-85 °C;^1H NMR ($CDCl_3$, 600 MHz): δ 7.49 (s, 1H), 7.46 (d, 1H, *J* = 7.2 Hz), 7.43 (s, 1H), 7.26 (t, 1H, *J* = 7.8 Hz), 7.08 (d, 1H, *J* = 7.2 Hz), 6.79 (s, 1H), 6.56 (dd, 1H, *J* = 16.8, 10.8 Hz), 5.51 (d, 1H, *J* = 16.8 Hz), 5.16 (d, 1H, *J* = 10.8 Hz), 2.37 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.9, 140.0, 138.3,

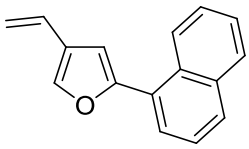
130.6, 128.6, 128.5, 126.7(2), 126.7(0), 124.6, 121.1, 113.6, 102.2, 21.5; IR (neat): 2922, 2854, 1768, 1643, 1384, 1042, 784 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{13}O$ $[M+H]^+$ 185.0961 Found 185.0966.



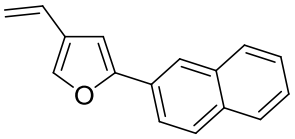
2-(*o*-Tolyl)-4-vinylfuran (**5d**): Irradiated the compound (*E*)-**4d** at 250 °C for 60 min. 38 mg (68%); yellow gum;^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.66 (d, 1H, *J* = 7.8 Hz), 7.48 (s, 1H), 7.21-7.24 (m, 3H), 6.67 (s, 1H), 6.59 (dd, 1H, *J* = 17.4, 10.8 Hz), 5.52 (d, 1H, *J* = 17.4 Hz), 5.17 (d, 1H, *J* = 10.8 Hz), 2.50 (s, 3H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.9, 139.7, 134.8, 131.2, 130.0, 127.8, 127.2, 126.8, 126.3, 126.0, 113.5, 105.9, 21.8; IR (neat): 2923, 2851, 1585, 1384, 1399, 1071, 770 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{13}O$ $[M+H]^+$ 185.0961 Found 185.0968.



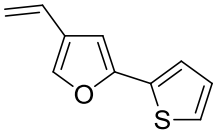
2-(4-Bromophenyl)-4-vinylfuran (**5e**): Irradiated the compound (*E*)-**4e** at 250 °C for 60 min. 49 mg (65%); yellow solid, m.p. 78-79 °C;^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.48-7.52 (m, 4H), 7.44 (s, 1H), 6.80 (s, 1H), 6.55 (dd, 1H, *J* = 18.0, 11.4 Hz), 5.51 (d, 1H, *J* = 180. Hz), 5.18 (d, 1H, *J* = 11.4 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 153.7, 140.3, 131.9, 129.5, 126.8, 126.4, 125.4, 121.5, 114.0, 102.9; IR (neat): 2942, 2853, 1768, 1585, 1478, 1384, 1399, 912, 809 cm^{-1}; HRMS (ESI): m/z calcd for $C_{12}H_{10}BrO$ $[M+H]^+$ 248.9910 Found 248.9918.



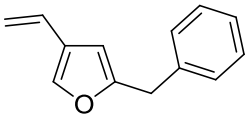
2-(Naphthalen-1-yl)-4-vinylfuran (**5f**): Irradiated the compound (*E*)-**4f** at 250 °C for 60 min. 43 mg (65%); yellow gum; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.39 (d, 1H, *J* = 8.4 Hz), 7.88 (d, 1H, *J* = 7.2 Hz), 7.84 (d, 1H, *J* = 7.8 Hz), 7.72 (d, 1H, *J* = 7. 2Hz), 7.60 (s, 1H), 7.49-7.55 (m, 3H), 6.87 (s, 1H), 6.65 (dd, 1H, *J* = 16.8, 10.2 Hz), 5.58 (d, 1H, *J* = 16.8 Hz), 5.22 (d, 1H, *J* = 10.2 Hz) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.3, 140.4, 134.0, 130.5, 128.9, 128.6, 128.4, 126.7(7), 126.7(1), 126.5, 126.3, 126.0, 125.5, 125.3, 113.8, 106.7; IR (neat): 3050, 2959, 2853, 1793, 1685, 1385, 1095, 800 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{13}O$ $[M+H]^+$ 221.0961 Found 221.0966.



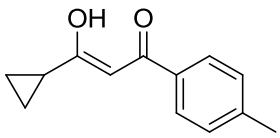
2-(Naphthalen-2-yl)-4-vinylfuran (**5g**): Irradiated the compound (*E*)-**4g** at 250 °C for 60 min. 46 mg (70%); yellow solid, m. p. 83-87 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.13 (s, 1H), 7.84 (t, 2H, *J* = 7.8 Hz), 7.80 (d, 1H, *J* = 7.2 Hz), 7.75-7.77 (m, 1H), 7.50 (s, 1H), 7.43-7.49 (m, 2H), 6.93 (s, 1H), 6.60 (dd, 1H, *J* = 17.4, 10.8 Hz), 5.56 (d, 1H, *J* = 17.4 HZ), 5.20 (d, 1H, *J* = 10.8 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.8, 140.3, 133.5, 132.8, 128.4, 128.2, 127.9, 127.8, 126.9, 126.6, 126.5, 126.1, 122.4, 122.3, 113.8, 103.0; IR (neat): 3050, 2924, 1684, 1504, 1259, 1023, 801, 773 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{13}O$ $[M+H]^+$ 221.0961 Found 221.0969.



2-(Thiophen-2-yl)-4-vinylfuran (**5h**): Irradiated the compound (*E*)-**4h** at 250 °C for 60 min. 25 mg (48%); yellow sticky material; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.37 (s, 1H), 7.25 (d, 1H, *J* = 6.0 Hz) 7.22 (d, 1H, *J* = 4.8 Hz), 7.03 (dd, 1H, *J* = 6.0, 4.8 Hz), 6.65 (s, 1H), 6.53 (dd, 1H, *J* = 16.8, 10.8 Hz), 5.49 (d, 1H, *J* = 16.8 Hz), 5.17 (d, 1H, *J* = 10.8 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 150.2, 139.6, 133.5, 127.7, 126.7, 126.4, 124.5, 123.0, 113.9, 102.4; IR (neat): 32959, 2906, 1711, 1602, 1466, 1385, 1016, 775 cm^{-1}; HRMS (ESI): m/z calcd for $C_{10}H_9OS$ $[M+H]^+$ 177.0369 Found 177.0382.



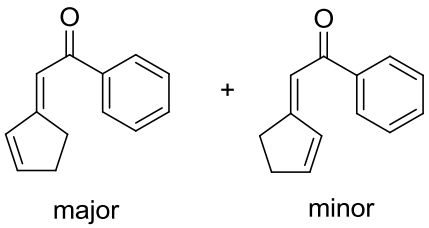
2-Benzyl-4-vinylfuran (**5i**): Irradiated the compound (*E*)-**4i** at 250 °C for 60 min. 32 mg (57%); yellow oil; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.30 (t, 2H, *J* = 8.4 Hz), 7.29 (s, 1H), 7.21-7.24 (m, 3H), 6.49 (dd, 1H, *J* = 18.0, 10.8 Hz), 6.16 (s, 1H), 5.37 (d, 1H, *J* = 18.0 Hz), 5.06 (d, 1H, *J* = 10.8 Hz), 3.92 (s, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 155.7, 139.6, 137.8, 128.8, 128.6, 126.8, 126.6, 125.6, 113.6, 103.9, 34.6; IR (neat): 3010, 2856, 1698, 1574, 1324, 1023 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{13}O$ $[M+H]^+$ 185.0961 Found 185.0954.



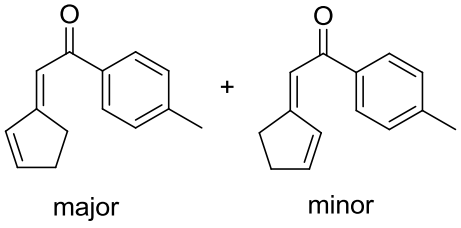
(*Z*)-3-Cyclopropyl-3-hydroxy-1-(*p*-tolyl)prop-2-en-1-one (**4ba**): Irradiated the compound (*Z*)-**4b** at 250 °C for 60 min. yellow oil; ^{1}H NMR ($CDCl_3$,

600 MHz): δ 7.83 (d, 2H, *J* = 8.4 Hz), 7.25 (d, 2H, *J* = 8.4 Hz), 6.98 (s, 1H), 2.40 (s, 3H), 1.88-1.92 (m, 1H), 1.56 (brs, 1H), 1.02-1.05 (m, 2H), 0.88-0.90 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 188.5, 150.0, 143.8, 135.6, 129.3, 118.6, 119.3, 21.7, 20.3, 7.6 (2C); IR (neat): 3310, 2954, 2836, 1724, 1524, 1294, 1104, 924 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{15}O_2$ $[M+H]^+$ 203.1068 Found 203.1064.

Characterization of Compounds in Scheme 5

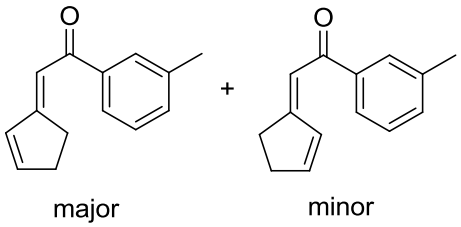


2-(Cyclopent-2-en-1-ylidene)-1-phenylethanone (**6a**): The compound was synthesized using benzoyl chloride (40 μL) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 34 mg (61%); yellow viscous oil; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.94 (d, 2H, *J* = 8.6 Hz), 7.50 (t, 1H, *J* = 7.8 Hz), 7.42-7.45 (m, 2H), 6.97 (s, 1H), 6.77-6.79 (m, 1H), 6.43-6.45 (m, 1H), 3.18-3.20 (m, 2H), 2.66-2.69 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): 190.8, 169.8, 150.2, 139.7, 135.6, 131.9, 128.4, 127.9, 112.9, 33.8, 31.3; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.93 (d, 2H, *J* = 7.8 Hz), 7.63 (m, 1H), 7.50 (t, 1H, *J* = 7.8 Hz), 7.42-7.45 (m, 2H), 6.79-6.82 (m, 1H), 6.30 (s, 1H), 2.77-2.78 (m, 2H), 2.56-2.57 (m, 2H) ^{13}C NMR ($CDCl_3$, 150 MHz): δ 190.8, 169.8, 151.7, 139.7, 133.1, 132.0, 138.4, 128.0, 112.0, 31.9, 31.3; IR (neat): 2985, 2921, 1698, 1534, 1422, 1264, 1011, 755 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{13}O$ $[M+H]^+$ 185.0961 Found 185.0960.

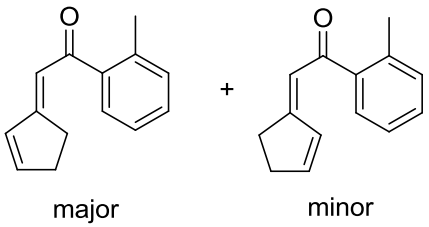


2-(Cyclopent-2-en-1-ylidene)-1-(*p*-tolyl)ethanone (**6b**): The compound was synthesized using *p*-toluoyl chloride (40 μL) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 39 mg (65%); yellow viscous oil; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.85 (d, 2H, *J* = 8.4 Hz), 7.23 (d, 2H, *J* = 8.4 Hz), 6.96 (s, 1H), 6.74-6.76 (m, 1H), 6.42-6.43 (m, 1H), 3.17-3.19 (m, 2H), 2.66-2.67 (m, 2H), 2.38 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): 190.5, 169.3, 149.9, 142.6, 137.2, 133.1, 129.2, 128.0, 112.9, 33.8,

31.3, 21.6; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.84 (d, 2H, *J* = 8.2 Hz), 7.61-7.62 (m, 1H), 7.24 (d, 2H, *J* = 8.2 Hz), 6.76-6.78 (m, 2H), 2.75-2.77 (m, 2H), 2.56-2.57 (m, 2H), 2.38 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 189.7, 166.8, 151.3, 142.6, 137.1, 133.1, 129.4, 129.1. 128.6, 31.8, 31.3, 21.6; IR (neat): 3001, 2967, 2954, 1643, 1584, 1413, 1265, 1022, 771 cm^{-1}; HRMS (ESI): m/z calcd for $C_{14}H_{15}O$ $[M+H]^+$ 199.1118 Found 199.1120.

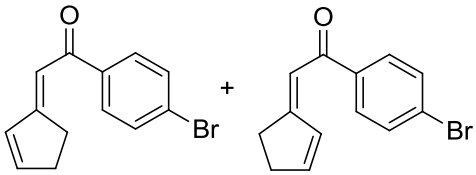


2-(Cyclopent-2-en-1-ylidene)-1-(*m*-tolyl)ethanone (**6c**): The compound was synthesized using *m*-toluoyl chloride (40 μL) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 31 mg (52%); yellow viscous oil; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.72-7.76 (m, 2H), 7.31-7.34 (m, 2H), 6.94 (s, 1H), 6.76-6.78 (m, 1H), 6.43-6.45 (m, 1H), 3.17-3.19 (m, 2H), 2.67-2.68 (m, 2H), 2.40 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): 191.4, 169.6, 150.4, 139.8, 138.2, 136.6, 132.7, 128.5, 128.3, 125.0, 113.2, 33.8, 31.3, 21.5; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.72-7.75 (m, 2H), 7.61-7.62 (m, 1H), 7.32-7.36 (m, 2H), 6.79-6.80 (m, 1H), 6.77 (s, 1H), 2.77-2.78 (m, 2H), 2.56-2.57 (m, 2H), 2.40 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 190.3, 169.6, 151.5, 139.8, 138.2, 133.2, 132.8, 128.7, 128.3, 125.3, 112.2, 31.9, 31.3, 21.4; IR (neat): 3015, 1925, 1854, 1695, 1584, 1414, 1264, 1004, 801 cm^{-1}; HRMS (ESI): m/z calcd for $C_{14}H_{15}O$ $[M+H]^+$ 199.1118 Found 199.1118.

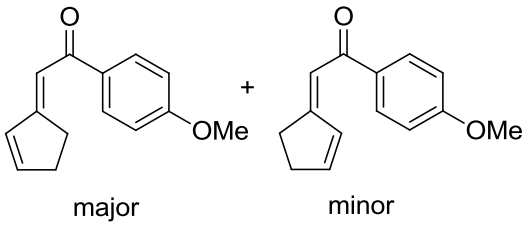


2-(Cyclopent-2-en-1-ylidene)-1-(*o*-tolyl)ethanone (**6d**): The compound was synthesized using *o*-toluoyl chloride (39 μL) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 36 mg (60%); yellow viscous oil; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.48 (d, 1H, *J* = 7.8 Hz), 7.28-7.31 (m, 1H), 7.19-7.22 (m, 2H), 6.74-6.76 (m, 1H), 6.60 (s, 1H), 6.36-6.37 (m, 1H), 3.09-3.11 (m, 2H), 2.65-2.66 (m, 2H), 2.45 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): 195.7, 168.7, 150.1, 141.4, 136.6, 135.5, 131.3,

130.0, 127.6, 125.6, 117.0, 33.8, 31.0, 20.4; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.45-7.47 (m, 1H), 7.36-7.38 (m, 1H), 7.28-7.31 (m, 1H), 7.19-7.22 (m, 2H), 6.74-6.76 (m, 1H), 6.40 (s, 1H), 2.72-2.74 (m, 2H), 2.54-2.55 (m, 2H), 2.44 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 195.0, 166.4, 151.5, 141.4, 136.6, 135.5, 131.5, 131.3, 127.7, 125.6, 116.2, 31.8, 31.2, 20.3; IR (neat): 2998, 2923, 1654, 1587, 1445, 1246, 1032, 771 cm^{-1}; HRMS (ESI): m/z calcd for $C_{14}H_{15}O$ $[M+H]^+$ 199.1118 Found 199.1125.

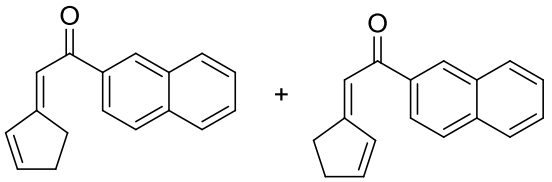


1-(4-Bromophenyl)-2-(cyclopent-2-en-1-ylidene) ethanone (**6e**): The compound was synthesized using *p*-bromobenzoyl chloride (66 mg) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 45 mg (57%); yellow sticky gum; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.80 (d, 2H, *J* = 7.8 Hz), 7.56 (d, 2H, *J* = 7.8 Hz), 6.90 (s, 1H), 6.80-6.81 (m, 1H), 6.43-6.44 (m, 1H), 3.16-3.18 (m, 2H), 2.67-2.68 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): 189.6, 170.7, 150.9, 138.5, 135.5, 131.7, 129.5, 126.9, 112.4, 33.9, 31.5; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.78-7.80 (m, 2H), 7.60-7.62 (m, 1H), 7.55-7.58 (m, 2H), 6.83-6.84 (m, 1H), 6.71 (s, 1H), 2.76-2.78 (m, 2H), 2.56-2.58 (m, 2H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 188.8, 168.1, 152.4, 138.4, 133.1, 131.7, 129.7, 127.0, 111.4, 32.0, 31.3; IR (neat): 3010, 2962, 2821, 1704, 1582, 1453, 1264, 940, 697 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{12}BrO$ $[M+H]^+$ 263.0066 Found 263.0070.



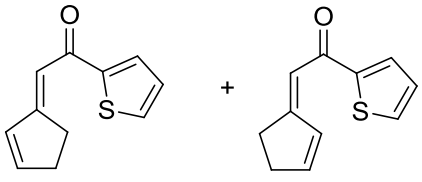
2-(Cyclopent-2-en-1-ylidene)-1-(4-methoxyphenyl) ethanone (**6f**): The compound was synthesized using *p*-methoxybenzoyl chloride (41 μL) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 46 mg (72%); yellow viscous oil; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.94 (d, 2H, *J* = 8.2 Hz), 6.94 (s, 1H), 6.92 (d, 2H, *J* = 8.2 Hz), 6.76-6.74 (m, 1H), 6.41-6.43 (m, 1H),

3.87 (s, 3H), 3.17-3.18 (m, 2H), 2.65-2.66 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): 189.5, 169.0, 162.9, 149.6, 135.6, 132.7, 130.1, 113.6, 112.8, 55.4, 33.8, 31.2; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.92-9.94 (m, 2H), 7.60-7.61 (m 1H), 6.90-6.92 (m, 2H), 6.75-6.77 (m, 2H), 3.87 (s, 3H), 2.75-2.77 (m, 2H), 2.54-2.56 (m, 2H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 188.8, 166.3, 162.7, 151.0, 145.8, 133.1, 130.4 ,113.6, 111.9, 55.4, 31.8, 31.2; IR (neat): 3044, 2978, 2821, 1735, 1638, 1566, 1356, 1063, 892 cm^{-1}; HRMS (ESI): m/z calcd for $C_{14}H_{15}O_2$ $[M+H]^+$ 215.1067 Found 215.1072.



major minor

2-(Cyclopent-2-en-1-ylidene)-1-(naphthalen-2-yl) ethanone (**6g**): The compound was synthesized using 2-naphthoyl chloride (57 mg) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 46 mg (66%); yellow amorphous gum; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.45 (s, 1H), 8.04-8.06 (m, 1H), 7.95 (d, 1H, *J* = 7.8 Hz), 7.85-7.89 (m, 2H), 7.51-7.57 (m, 2H), 7.14 (s, 1H), 6.79-6.81 (m, 1H), 6.49-6.57 (m, 1H), 3.23-3.25 (m, 2H), 2.73-2.75 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): 190.7, 169.9, 150.3, 137.1, 135.7, 135.1, 132.7, 129.5, 128.9, 128.3, 127.9, 127.8, 126.5, 124.4, 113.0, 33.9, 31.4; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.45 (s, 1H), 8.03-8.05 (m, 1H), 7.95 (d, 1H, *J* = 7.8 Hz), 7.85-7.89 (m, 2H), 7.67-7.68 (m, 1H), 7.51-7.57 (m, 2H), 6.95 (s, 1H), 6.82-6.84 (m, 1H), 2.82-2.84 (m, 2H), 2.59-2.60 (m, 2H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 189.9, 167.3, 151.8, 137.1, 135.1, 133.2, 132.7, 130.2, 129.5, 129.2, 129.1, 128.3, 127.9, 124.5, 112.1, 32.0, 31.3; IR (neat): 3044, 2968, 2934, 1654, 1584, 1432, 1246, 1022, 775 cm^{-1}; HRMS (ESI): m/z calcd for $C_{17}H_{15}O$ $[M+H]^+$ 235.1117 Found 235.1125.

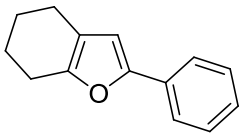


major minor

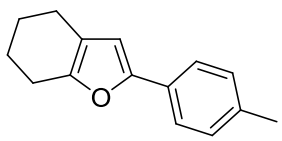
2-(Cyclopent-2-en-1-ylidene)-1-(thiophen-2-yl)ethanone (**6h**): The compound was synthesized using 2-thenoyl chloride (32 μL) and **2j** (25 mg) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 27 mg (48%); yellow

amorphous gum; major (*E*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.68 (d, 1H, *J* = 3.8 Hz), 7.55 (d, 1H, *J* = 4.2 Hz), 7.09 (dd, 1H, *J* = 4.2, 3.8 Hz), 6.82 (s, 1H), 6.76-6.77 (m, 1H), 6.41-6.42 (m, 1H), 3.16-3.21 (m, 2H), 2.66-2.67 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): 183.2, 169.6, 150.5, 147.3, 136.4, 132.4, 130.1, 128.0, 112.8, 33.9, 31.3; minor (*Z*)- ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.69 (d, 1H, *J* = 3.8 Hz), 7.64-7.66 (m, 1H), 7.55 (d, 1H, *J* = 4.2 Hz), 7.09 (dd, 1H, *J* = 4.2, 3.8 Hz), 6.77-6.79 (m, 1H), 6.65 (s, 1H), 2.75-2.77 (m, 2H), 2.55-2.56 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 182.1, 167.2, 151.8, 147.1, 133.2, 132.6, 130.4, 128.0, 111.6, 31.8, 31.3; IR (neat): 3099, 2962, 2922, 2854, 1631, 1566, 1414, 1246, 1063, 801, 717 cm^{-1}; HRMS (ESI): m/z calcd for $C_{11}H_{11}OS$ $[M+H]^+$ 191.0525 Found 191.0529.

Characterization of Compounds in Scheme 6

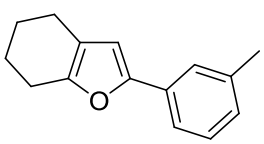


2-Phenyl-4,5,6,7-tetrahydrobenzofuran (**7a**): The compound was synthesized using benzoyl chloride (40 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 42 mg (70%); yellow solid; ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[6] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.61 (d, 2H, *J* = 7.2 Hz), 7.33 (t, 2H, *J* = 7.2 Hz), 7.17-7.21 (m, 1H), 6.46 (s, 1H), 2.65 (t, 2H, *J* = 6.2 Hz), 2.45 (t, 2H, *J* =6.0 Hz), 1.84-1.88 (m, 2H), 1.72-1.76 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 151.6, 150.8, 131.5, 128.6, 126.6, 123.3, 119.0, 106.0, 23.3, 23.2, 23.1, 22.2.

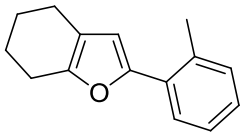


2-(*p*-Tolyl)-4,5,6,7-tetrahydrobenzofuran (**7b**): The compound was synthesized using *p*-toluoyl chloride (40 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 39 mg (62%); yellow solid; ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[6] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.51 (d, 2H, *J* = 8.4 Hz), 7.15 (d, 2H, *J* = 8.4 Hz), 6.41 (s, 1H), 2.66 (t, 2H, *J* = 6.2 Hz), 2.45 (t, 2H, *J* = 6.2 Hz), 2.34 (s, 3H), 1.83-1.87

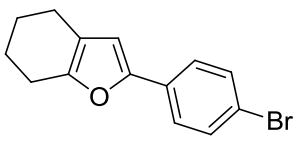
(m, 2H), 1.74-1.77 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 151.9, 150.4, 136.3, 129.3, 128.8, 123.3, 118.9, 105.3, 23.3, 23.2(6), 23.2(2), 22.2, 21.3.



2-(*m*-Tolyl)-4,5,6,7-tetrahydrobenzofuran (**7c**): The compound was synthesized using *m*-toluoyl chloride (40 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 44 mg (69%); yellow amorphous gum; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.44 (s, 1H), 7.40 (d, 1H, *J* = 7.8 Hz), 7.23-7.25 (m, 1H), 7.01 (d, 1H, *J* = 7.2 Hz), 6.44 (s, 1H), 2.65 (t, 2H, *J* = 6.2 Hz), 2.45 (t, 2H, *J* = 6.0 Hz), 2.36 (s, 3H), 1.83-1.87 (m, 2H), 1.72-1.76 (m, 2H) ; ^{13}C NMR ($CDCl_3$, 150 MHz): δ 151.8, 150.7, 138.2, 131.4, 128.5, 127.4, 123.9, 120.5, 119.0, 105.9, 23.3, 23.2, 23.1, 22.4, 21.5; IR (neat): 2934, 2860, 1676, 1448, 1384, 761 cm^{-1}; HRMS (ESI): m/z calcd for $C_{15}H_{17}O$ $[M+H]^+$ 213.1274 Found 213.1278.

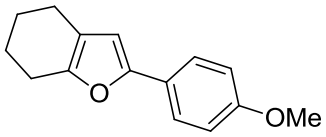


2-(*o*-Tolyl)-4,5,6,7-tetrahydrobenzofuran (**7d**): The compound was synthesized using *o*-toluoyl chloride (39 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 39 mg (62%); yellow amorphous gum; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.68 (d, 1H, *J* = 8.2 Hz), 7.21-7.23 (m, 2H), 7.14-7.16 (m, 1H), 6.35 (s, 1H), 2.67 (t, 2H, *J* = 6.0 Hz), 2.48 (t, 2H, *J* = 6.0 Hz), 2.48 (s, 3H), 1.85-1.89 (m, 2H), 1.75-1.79 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 151.1, 150.3, 134.0, 131.1, 130.8, 126.7, 126.5, 125.9, 118.7, 109.8, 23.3, 23.2(7), 23.2(2), 22.2, 22.1; IR (neat): 2956, 2854, 1631, 1449, 1187, 746 cm^{-1}; HRMS (ESI): m/z calcd for $C_{15}H_{17}O$ $[M+H]^+$ 213.1274 Found 213.1281.

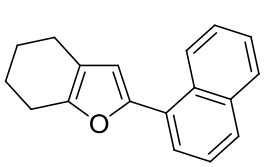


2-(4-Bromophenyl)-4,5,6,7-tetrahydrobenzofuran (**7e**): The compound was synthesized using *p*-bromobenzoyl chloride (66 mg) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 49 mg (59%); yellow solid, m.p. 113-115 °C ; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.43-7.48 (m, 4H),

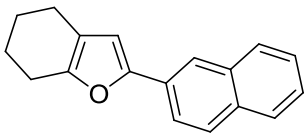
6.45 (s, 1H), 2.63 (t, 2H, *J* = 6.0 Hz), 2.44 (t, 2H, *J* = 6.0 H z), 1.83-1.87 (m, 2H), 1.72-1.76 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 151.3, 150.6, 131.7, 130.4, 124.7, 120.1, 119.3, 106.7, 23.3, 23.1(7), 23.1(1), 22.1; IR (neat): 2930, 2848, 1477, 1393, 1300, 822, 806 cm^{-1}; HRMS (ESI): m/z calcd for $C_{14}H_{14}BrO$ $[M+H]^+$ 277.0223 Found 277.0229.



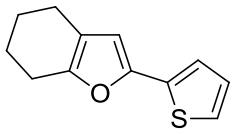
2-(4-Methoxyphenyl)-4,5,6,7-tetrahydrobenzofuran (**7f**): The compound was synthesized using *p*-methoxybenzoyl chloride (41 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 48 mg (70%); yellow solid, m.p. 108-110 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.54 (d, 2H, *J* = 8.6 Hz), 6.88 (d, 2H, *J* = 8.6 Hz), 6.33 (s, 1H), 3.81 (s, 3H), 2.64 (t, 2H, *J* = 6.2 Hz), 2.44 (t, 2H, *J* = 6.2 Hz), 1.84-1.86 (m, 2H), 1.73-1.75 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 158.6, 151.7, 150.0, 124.7(8), 124.7(3), 118.9, 114.1, 104.5, 55.3, 23.3, 23.2(7), 23.2(3), 22.2; IR (neat): 2926, 2849, 1609, 1498, 1252, 1026, 831, 771 cm^{-1}; HRMS (ESI): m/z calcd for $C_{15}H_{17}O_2$ $[M+H]^+$ 229.1223 Found 229.1229.



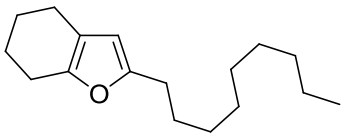
2-(Naphthalen-1-yl)-4,5,6,7-tetrahydrobenzofuran (**7g**): The compound was synthesized using 1-naphthoyl chloride (45 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 43 mg (58%); yellow amorphous gum; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.46 (d, 1H, *J* = 7.8 Hz), 7.86 (d, 1H, *J* = 7.8 Hz), 7.78 (d, 1H, *J* = 8.0 Hz), 7.70 (d, 1H, *J* = 7.6 Hz), 7.46-7.53 (m, 3H), 6.55 (s, 1H), 2.73 (t, 2H, *J* = 6.6 Hz), 2.54 (t, 2H, *J* = 6.6 Hz), 1.89-1.93 (m, 2H), 1.79-1.83 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 151.1, 151.0, 134.1, 130.3, 129.2, 128.5, 127.9, 126.3, 125.8(2C), 125.5, 125.4, 118.8, 110.5, 23.4, 23.2(8), 23.2(4), 22.3; IR (neat): 2931, 2849, 1591, 1442, 1396, 918, 773 cm^{-1}; HRMS (ESI): m/z calcd for $C_{18}H_{17}O$ $[M+H]^+$ 249.1274 Found 249.1281.



2-(Naphthalen-2-yl)-4,5,6,7-tetrahydrobenzofuran (**7h**): The compound was synthesized using 2-naphthoyl chloride (57 mg) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 44 mg (62%); yellow gum; ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[7] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.02 (s, 1H), 7.83 (d, 1H, *J* = 8.4 Hz), 7.93 (t, 2H, *J* = 8.4 H z), 7.70-7.73 (m, 1H), 7.40-7.47 (m, 2H), 6.59 (s, 1H), 2.71 (t, 2H, *J* = 6.6 Hz), 2.49 (t, 2H *J* = 6.6 Hz), 1.87-1.90 (m, 2H), 1.74-1.79 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 151.7, 151.2, 133.7. 132.4, 128.8, 128.3, 128.1, 127.8, 126.4, 125.5, 122.3, 121.2, 119.3, 106.8, 23.4, 23.2(4), 23.2(0), 22.2.



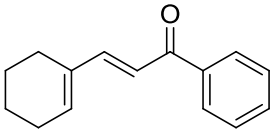
2-(Thiophen-2-yl)-4,5,6,7-tetrahydrobenzofuran (**7i**): The compound was synthesized using 2-thenoyl chloride (32 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 33 mg (54%); yellow amorphous gum; ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[8] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.15 (d, 1H, *J* = 3.6 Hz), 7.14 (d, 1H, *J* = 4.8 Hz), 6.98 (dd, 1H, *J* = 4.8, 3.6 Hz), 6.31 (s, 1H), 2.62 (t, 2H, *J* = 6.0 Hz), 2.42 (t, 2H, *J* = 6.0 Hz), 1.83-1.85 (m, 2H), 1.72-1.74 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 150.5, 147.2, 134.6, 127.5, 123.2, 121.4, 119.0, 106.1, 23.3, 23.1(5), 23.1(2), 22.1.n



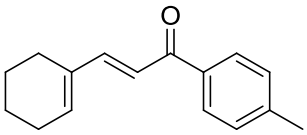
2-Nonyl-4,5,6,7-tetrahydrobenzofuran (**7j**): The compound was synthesized using decanoyl chloride (62 μL) and **2k** (35 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 10 min. 51 mg (69%); yellow amorphous gum; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 5.77 (s, 1H), 2.53-2.56 (m, 4H), 2.36-2.37 (m, 2H), 1.79-1.81 (m, 2H), 1.69-1.70 (m, 2H), 1.58-1.61 (m, 2H), 1.26-1.34 (m, 12H), 0.88 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 154.3, 148.6, 117.1, 105.4, 31.9, 29.6, 29.5,

29.4, 29.3, 28.4, 28.2, 23.3(4), 23.3(0), 23.2, 22.7, 22.2, 14.2; IR (neat): 2925, 2815, 1678, 1458, 1220, 1096, 989, 758 cm^{-1}; HRMS (ESI): m/z calcd for $C_{17}H_{29}O$ $[M+H]^+$ 249.2213 Found 249.2221.

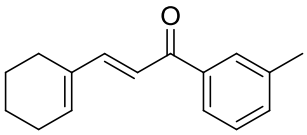
Characterization of Compounds in Scheme 7



(*E*)-3-(Cyclohex-1-en-1-yl)-1-phenylprop-2-en-1-one (**8a**): The compound was synthesized using benzoyl chloride (40 μL) and **2l** (39 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 52 mg (81%); yellow solid; ^{1}H NMR and ^{13}C NMR spectra for this compound are consistent with the previously reported literature data.[9] ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.92-7.94 (m, 2H), 7.52-7.54 (m, 1H), 7.45 (t, 2H, *J* = 7.8 Hz), 7.40 (d, 1H, *J* = 15.6 Hz), 6.83 (d, 1H, *J* = 15.6 Hz), 6.27-6.29 (m, 1H), 2.23-2.26 (m, 4H), 1.70-1.74 (m, 2H), 1.63-1.66 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 191.3, 148.6, 140.9, 138.6, 135.6, 132.4, 128.5, 128.4, 118.9, 26.8, 24.4, 22.1(6), 22.6(1).

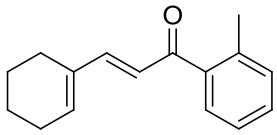


(*E*)-3-(Cyclohex-1-en-1-yl)-1-(*p*-tolyl)prop-2-en-1-one (**8b**): The compound was synthesized using *p*-toluoyl chloride (40 μL) and **2l** (39 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 47 mg (69%); yellow solid, m. p. 115-117 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.84 (d, 2H, *J* = 7.8 Hz), 7.40 (d, 1H, *J* = 15.6 Hz), 7.24 (d, 2H, *J* = 7.8 Hz), 6.83 (d, 1H, *J* = 15.6 Hz), 6.26-6.27 (m, 1H), 2.39 (s, 3H), 2.21-2.26 (m, 4H), 1.70- 1.73 (m, 2H), 1.62-1.65 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 190.8, 148.1, 143.2, 140.5, 136.0, 135.6, 129.2, 128.6, 118.8, 26.7, 24.4, 22.1(8), 22.1(4), 21.7; IR (neat): 3039, 2025, 2865, 1660, 1564, 1278, 775 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{19}O$ $[M+H]^+$ 227.1430 Found 227.1435.

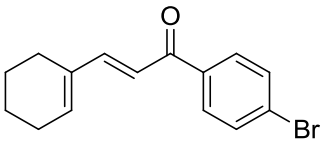


(*E*)-3-(cyclohex-1-en-1-yl)-1-(*m*-tolyl)prop-2-en-1-one (**8c**): The compound was synthesized using *m*-toluoyl chloride (40 μL) and **2l** (39

μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 47 mg (69%); yellow solid, m. p. 120-122 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.71-7.73 (m, 2H), 7.39 (d, 1H, *J* = 15.6 Hz), 7.32-7.34 (m, 2H), 6.82 (d, 1H, *J* = 15.6 Hz), 6.27-6.28 (m, 1H), 2.40 (s, 3H), 2.23-2.27 (m, 4H), 1.71-1.75 (m, 2H), 1.62-1.66 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 191.5, 148.4, 140.6, 138.7, 138.3, 135.6, 133.2, 128.9, 128.3, 125.6, 119.0, 26.8, 24.4, 22.1(0), 22.1(3), 21.4; IR (neat): 3021, 1954, 1894, 1669, 1497, 1230, 769 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{19}O$ $[M+H]^+$ 227.1430 Found 227.1431.

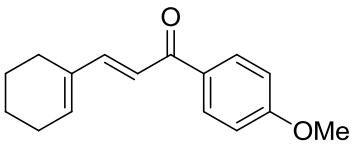


(*E*)-3-(Cyclohex-1-en-1-yl)-1-(*o*-tolyl)prop-2-en-1-one (**8d**): The compound was synthesized using *o*-toluoyl chloride (39 μL) and **2l** (39 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 52 mg (77%); yellow amorphous gum; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.36 (d, 1H, *J* = 7.2 Hz), 7.32 (dd, 1H, *J* = 7.2, 1.8 Hz), 7.20-7.23 (m, 2H), 7.02 (d, 1H, *J* = 15.6 Hz), 6.42 (d, 1H, *J* = 15.6 Hz), 6.13-6.16 (m, 1H), 2.37 (s, 3H), 2.19-2.21 (m, 4H), 1.68-1.71 (m, 2H), 1.60-1.63 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 197.7, 149.9, 140.8, 139.6, 136.5, 135.5, 131.1, 130.0, 127.9, 125.4, 123.9, 26.7, 24.3, 22.1, 22.0, 20.1; IR (neat): 3020, 2929, 2858, 1669, 1584, 1292, 769 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{19}O$ $[M+H]^+$ 227.1430 Found 227.1440.

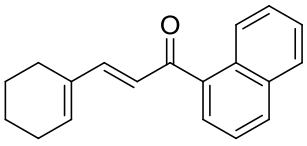


(*E*)-1-(4-Bromophenyl)-3-(cyclohex-1-en-1-yl)prop-2-en-1-one (**8e**): The compound was synthesized using *p*-bromobenzoyl chloride (66 mg) and **2l** (39 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 57 mg (65%); yellow solid, m. p. 124-126 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.79 (d, 2H, *J* = 9.0 Hz), 7.59 (d, 2H, *J* = 9.0 Hz), 7.40 (d, 1H, *J* = 15.0 HZ), 6.77 (d, 1H, *J* = 15.0 Hz), 6.29-6.30 (m, 1H), 2.24-2.25 (m, 4H), 1.70-1.74 (m, 2H), 1.63-1.66 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 190.1, 149.1 141.5, 137.3, 135.5, 131.8, 130.0, 127.4, 118.2, 26.8, 24.4, 22.1, 22.0; IR (neat):

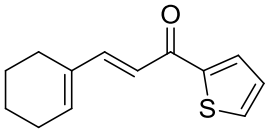
3029, 2922, 2853, 1603, 1445, 1235, 769 cm^{-1}; HRMS (ESI): m/z calcd for $C_{15}H_{16}BrO$ $[M+H]^+$ 291.0379 Found 291.0381.



(*E*)-3-(Cyclohex-1-en-1-yl)-1-(4-methoxyphenyl)prop-2-en-1-one (**8f**): The compound was synthesized using *p*-methoxylbenzoyl chloride (41 μL) and **2l** (40 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 49 mg (68%); yellow solid, m. p. 98-101 °C;; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.94-7.95 (m, 2H), 7.39(d, 1H, *J* = 15.0 Hz), 6.92-6.94 (m, 2H), 6.84 (d, 1H, *J* = 15.0 Hz), 6.26-6.27 (m, 1H), 3.85 (s, 3H), 2.22-2.26 (m, 4H), 1.71-1.73 (m, 2H), 1.62-1.64 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 189.5, 163.1, 147.7, 140.2, 136.6, 131.5, 130.7, 118.5, 113.7, 55.5, 26.7, 24.4, 22.1(9), 22.1(5); IR (neat): 3021, 1965, 2896, 1669, 1445, 1396, 1058, 954 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{19}O_2$ $[M+H]^+$ 243.1380 Found 243.1383.

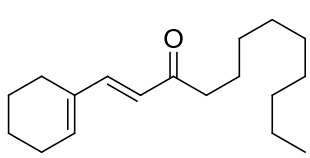


(*E*)-3-(Cyclohex-1-en-1-yl)-1-(naphthalen-1-yl)prop-2-en-1-one (**8g**): The compound was synthesized using 1-naphtholyl (45 μL) and **2l** (39 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 56 mg (71%); yellow amorphous gum; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.44 (s, 1H), 8.03 (dd, 1H, *J* = 9.0, 1.8 Hz), 7.96 (d, 1H, *J* = 8.4 Hz), 7.89 (d, 1H, *J* = 9.0 Hz), 7.26 (d, 1H, *J* = 7.8 Hz), 7.52-7.58 (m, 2H), 7.47 (d, 1H, *J* = 15.0 Hz), 5.99 (d, 1H, *J* = 15.0 Hz), 6.30-6.31 (m, 1H), 2.24-2.33 (m, 4H), 1.74-1.78 (m, 2H), 1.62-1.67 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 191.1, 148.5, 140.8, 136.0, 135.7, 135.4, 132.6, 129.6, 129.5, 128.4, 128.2, 127.8, 126.7, 124.6, 118.9, 26.8, 24.5, 22.2, 22.1; IR (neat): 3058, 3016, 2928, 2860, 1602, 1446, 1260, 775 cm^{-1}; HRMS (ESI): m/z calcd for $C_{19}H_{19}O$ $[M+H]^+$ 263.1431 Found 263.1438.



(*E*)-3-(Cyclohex-1-en-1-yl)-1-(thiophen-2-yl)prop-2-en-1-one (**8h**): The compound was synthesized using 2-thenoyl chloride (32 μL) and **2l** (39 μL)

by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 44 mg (67%); yellow solid, m. p. 112-115 °C; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.75 (d, 1H, *J* = 4.2 Hz), 7.61 (d, 1H, *J* = 4.8 Hz), 7.44 (d, 1H, J = 15.0 Hz), 7.13 (dd, 1H, *J* = 4.8, 4.2 Hz), 6.74 (d, 1H, *J* = 15.0 Hz), 6.29-6.30 (m, 1H), 2.24-2.25 (m, 4H), 1.71-1.74 (m, 2H), 1.62-1.66 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 182.7, 147.7, 145.9, 141.1, 135.4, 133.3, 131.3, 128.1, 118.3, 26.8, 24.4, 22.1(4), 22.1(0); IR (neat): 3025, 2959, 2906, 1627, 1318, 1124, 820, 724 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{15}OS$ $[M+H]^+$ 219.0838 Found 219.0844.



(*E*)-1-(Cyclohex-1-en-1-yl)dodec-1-en-3-one (**8i**): The compound was synthesized using decanoyl chloride (62 μL) and **2l** (39 μL) by the General Procedure A. The reaction was irradiated at 250 °C for 3 min. 59 mg (75%); yellow amorphous solid; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.13 (d, 1H, *J* = 16.2 Hz), 6.19-6.20 (m, 1H), 6.05 (d, 1H, *J* = 16.2 Hz), 2.53 (t, 2H, *J* = 7.2 Hz), 2.12-2.21 (m, 4H), 1.66-1.69 (m, 2H), 1.60-1.62 (m, 4H), 1.23-1.28 (m, 12H), 0.85 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz): δ 201.5, 146.0, 139.7, 135.3, 123.3, 40.6, 31.9, 29.5 (2C), 29.4, 29.3, 26.7, 24.6, 24.2, 22.7, 22.1(4), 22.1(1), 14.1; IR (neat): 2926, 2854, 1677, 1629, 1458, 1260, 992, 758 cm^{-1}; HRMS (ESI): m/z calcd for $C_{18}H_{31}O$ $[M+H]^+$ 263.2369 Found 263.2375.

References

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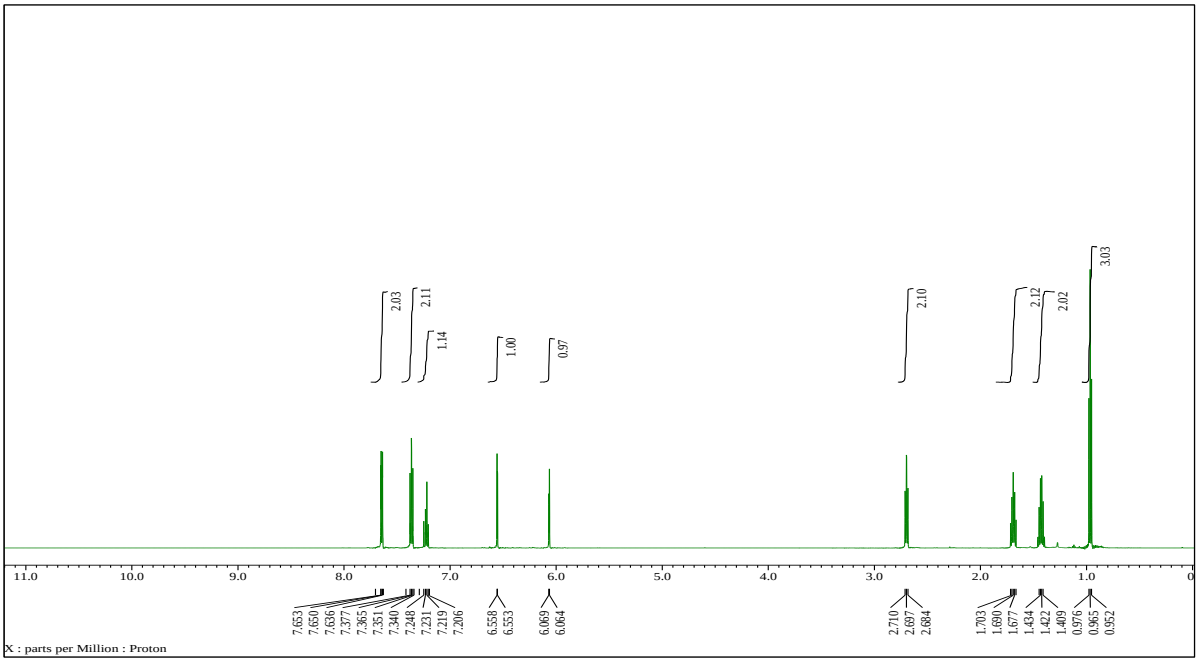
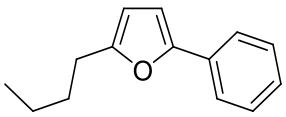
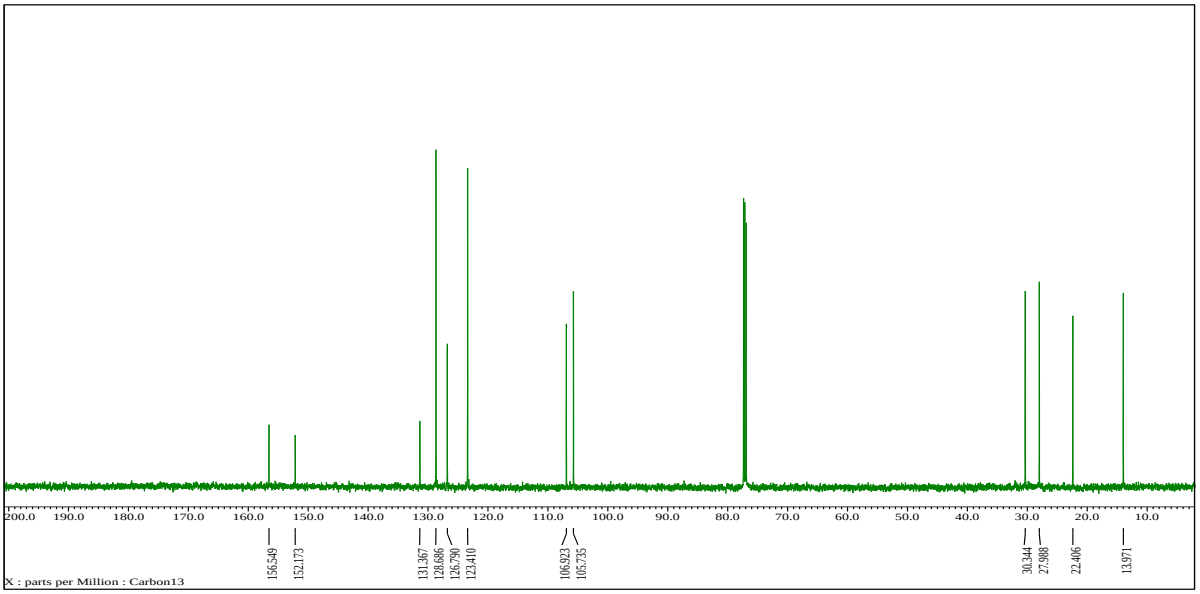
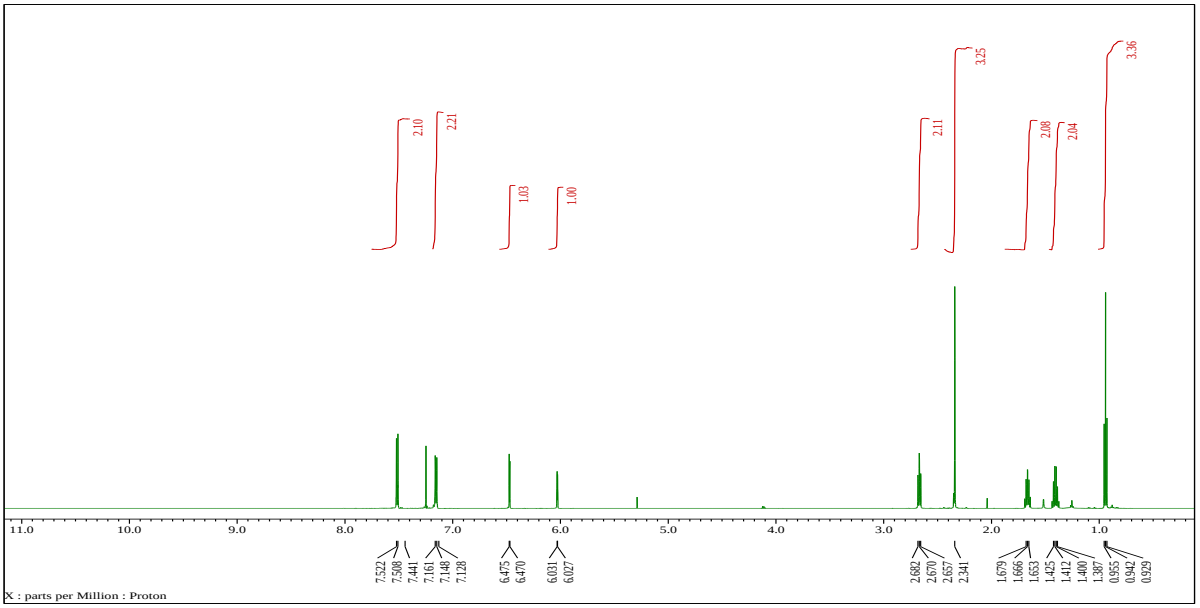
NMR Spectra





3a

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6.027
2.682
2.670
2.657
2.341
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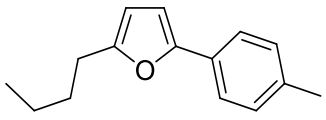
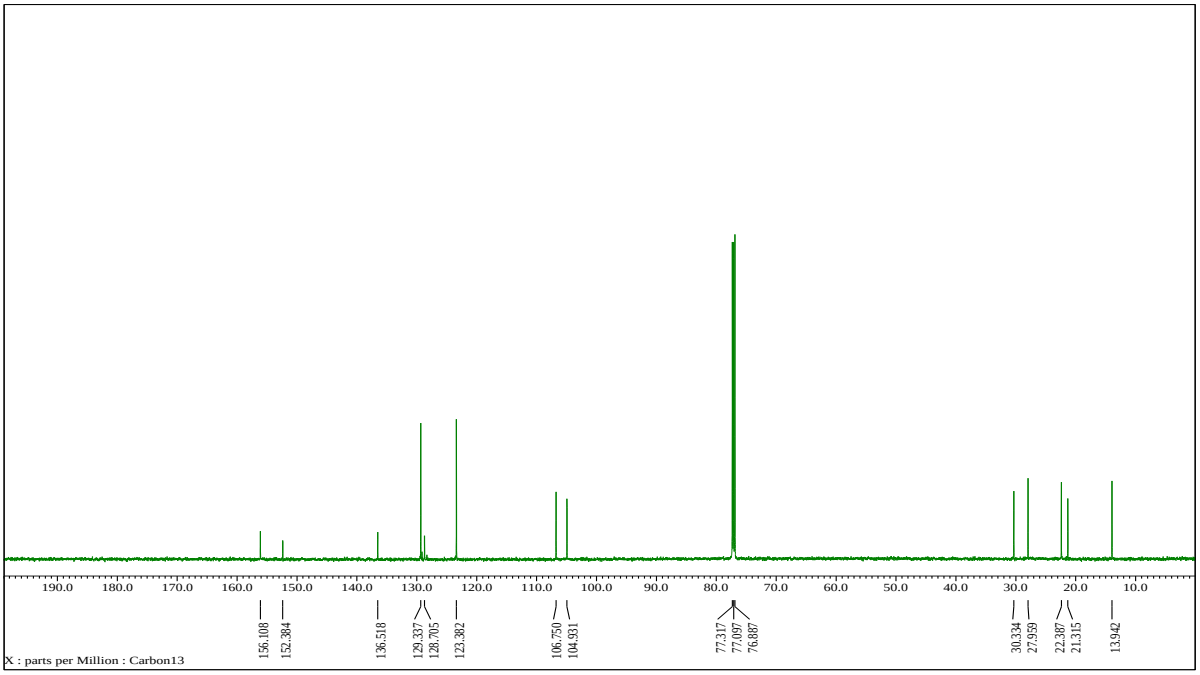

O

3b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10.0
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152.384
136.518
129.337
128.705
123.382
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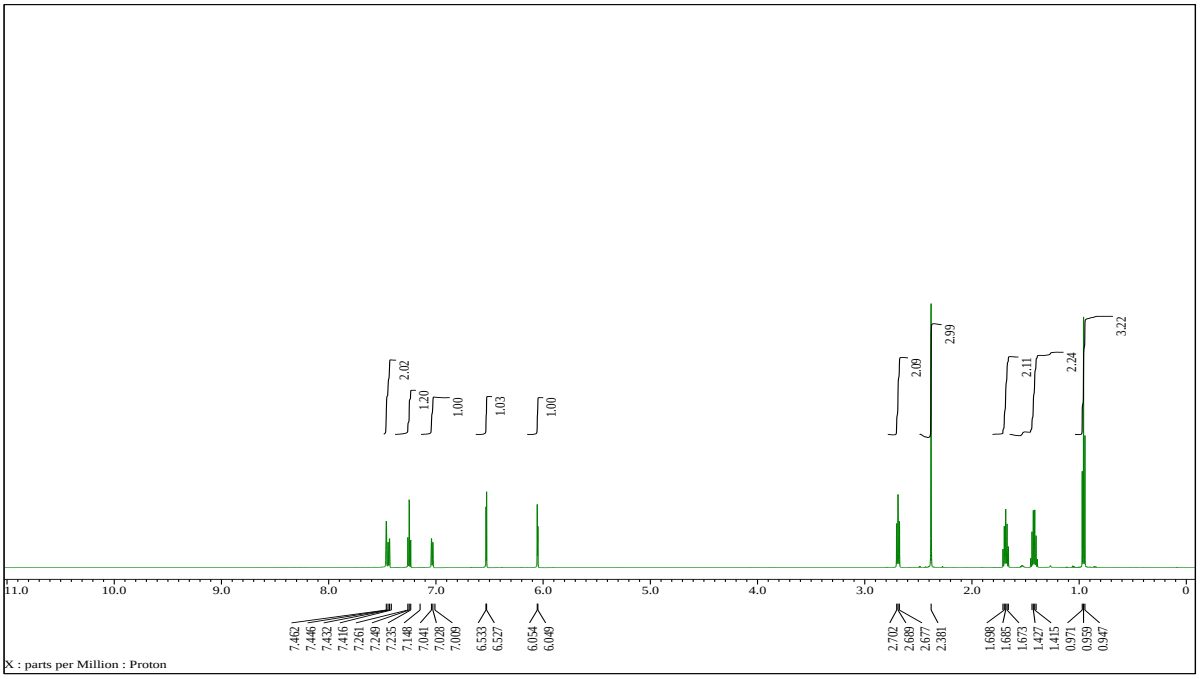
77.097
76.887
30.334
27.959
22.387
21.315
13.942
X : parts per Million : Carbon13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2.11
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3.22
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7.0
6.0
5.0
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3.0
2.0
1.0
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7.446
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7.416
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6.527
6.054
6.049
2.702
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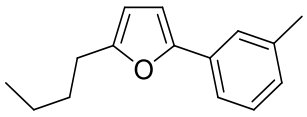
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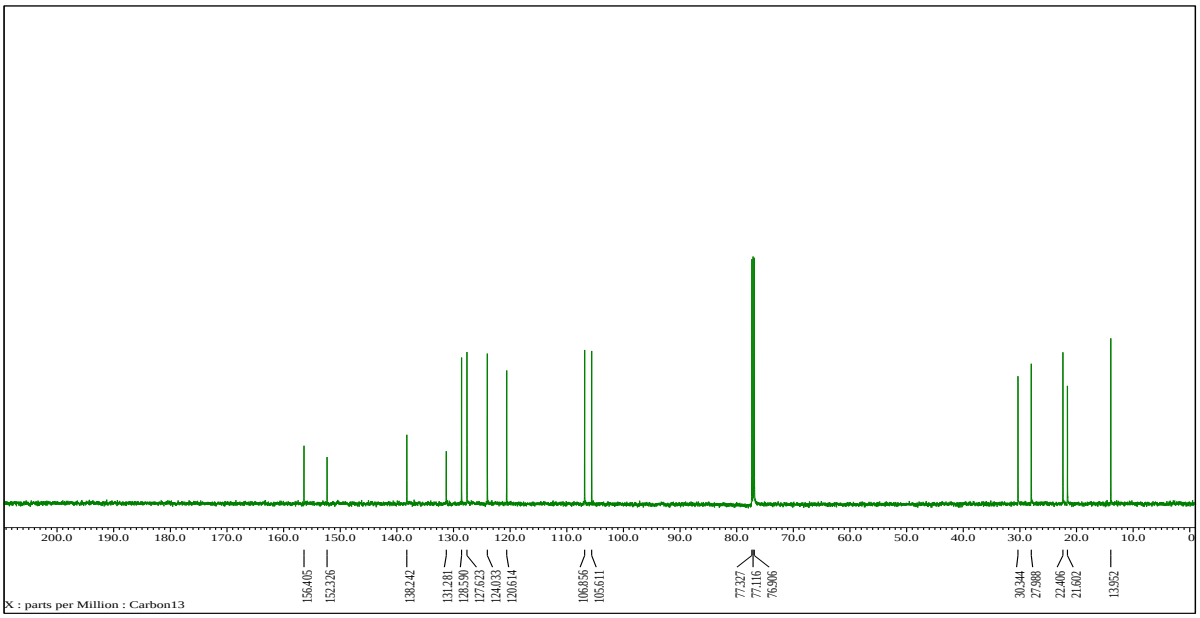
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152.326
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128.590
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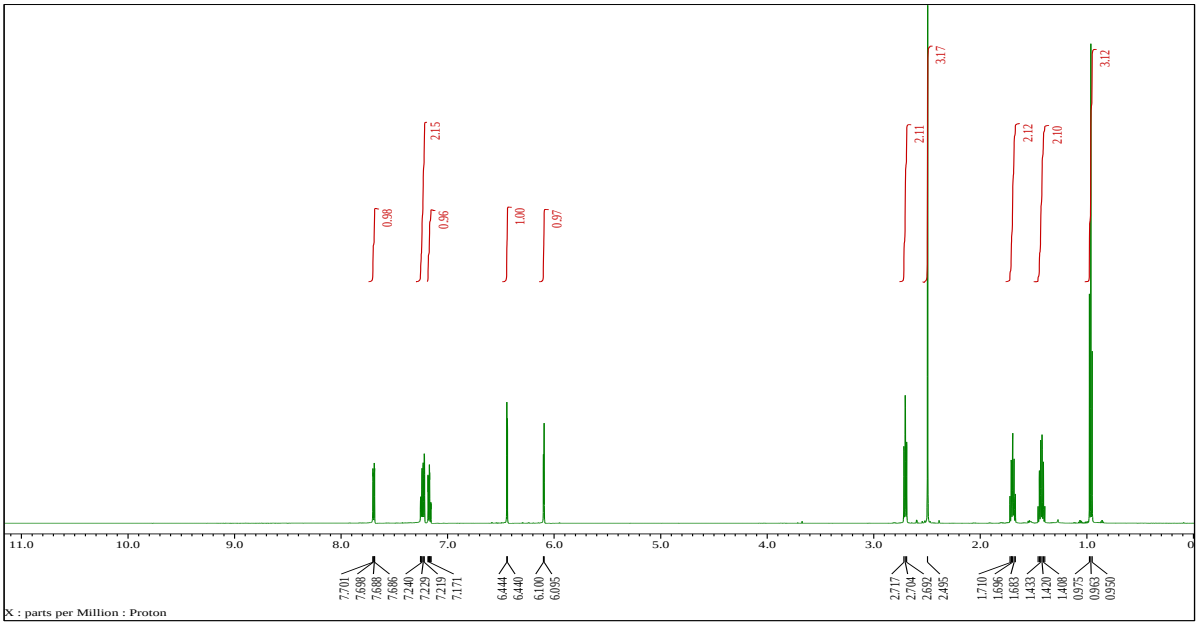
13.952
X : parts per Million : Carbon13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1.0
0
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6.100
6.095
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2.704
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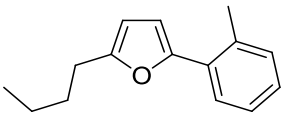
X : parts per Million : Proton



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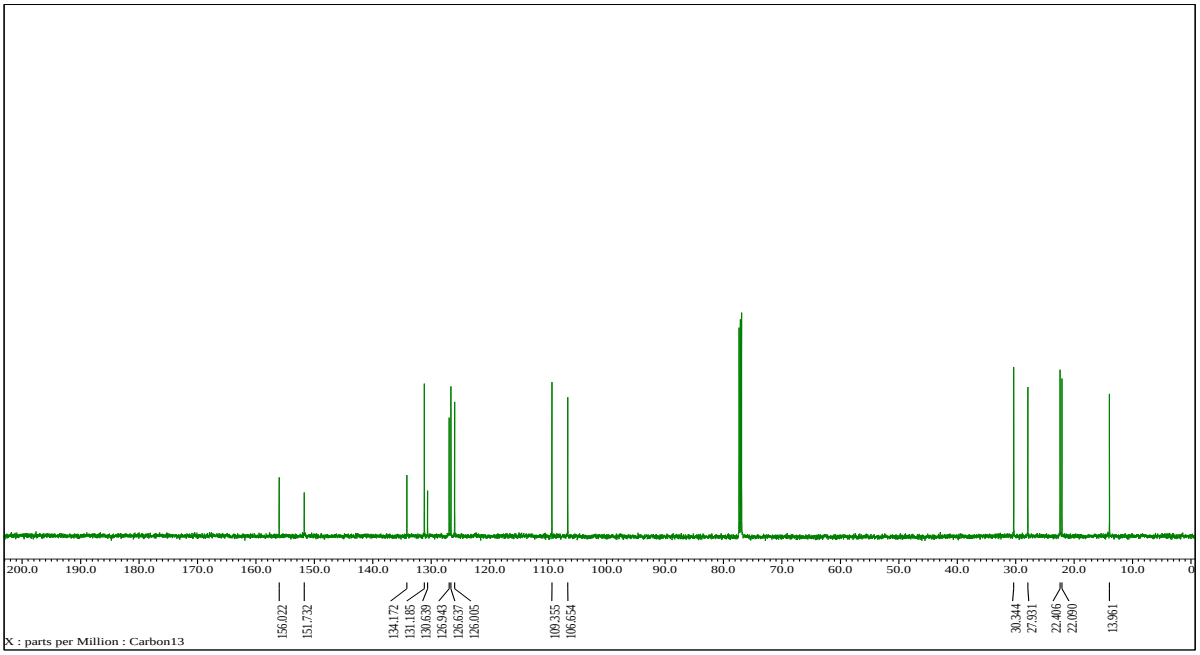
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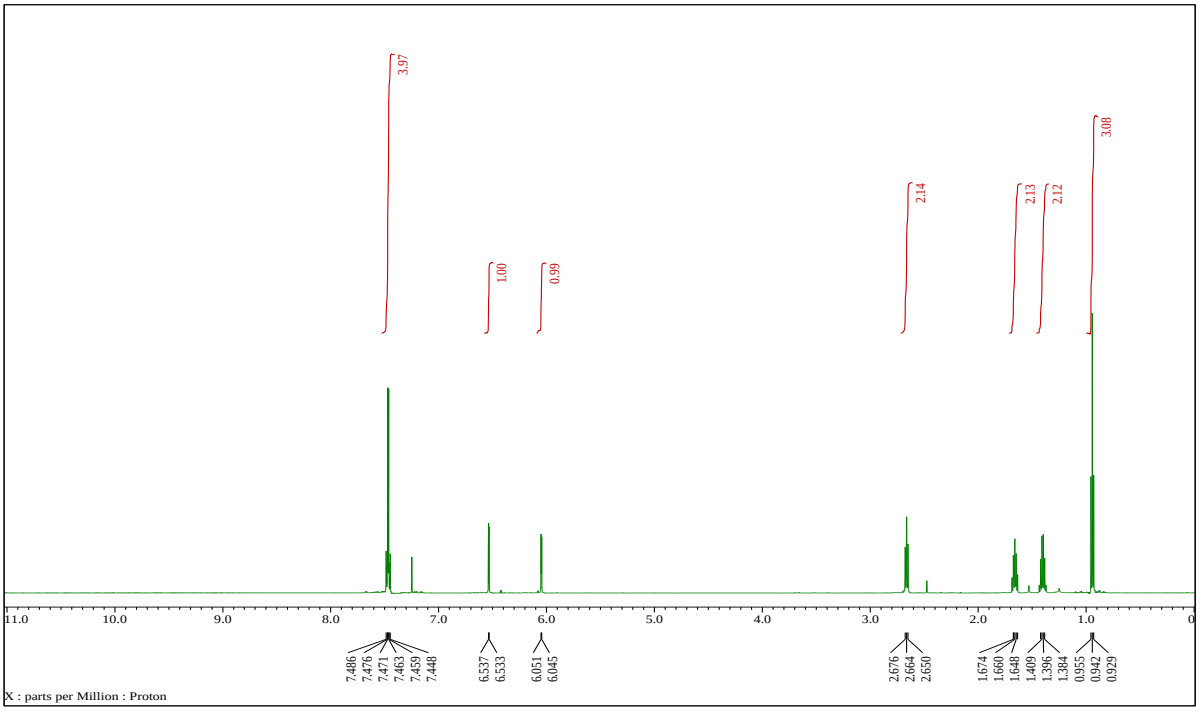
X : parts per Million : Carbon13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7.463
7.459
7.448
6.537
6.533
6.051
6.045
2.676
2.664
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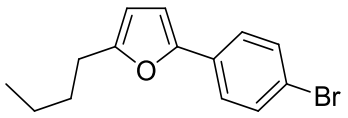
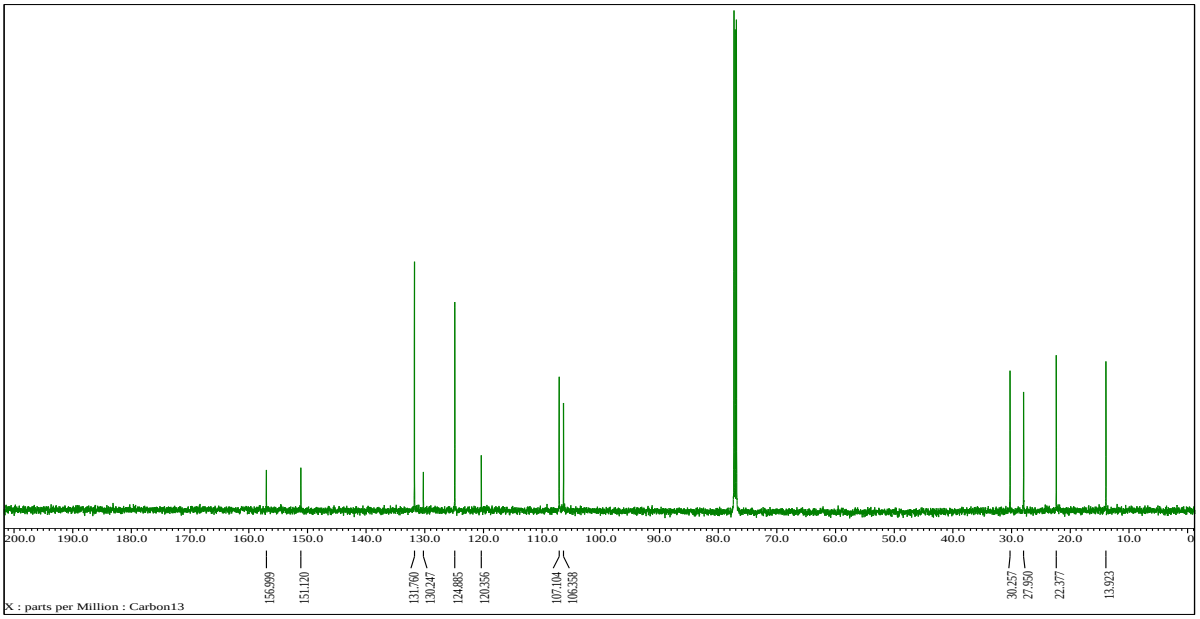
1.648
1.409
1.396
1.384
0.955
0.942
0.929
X : parts per Million : Proton


O
Br

3e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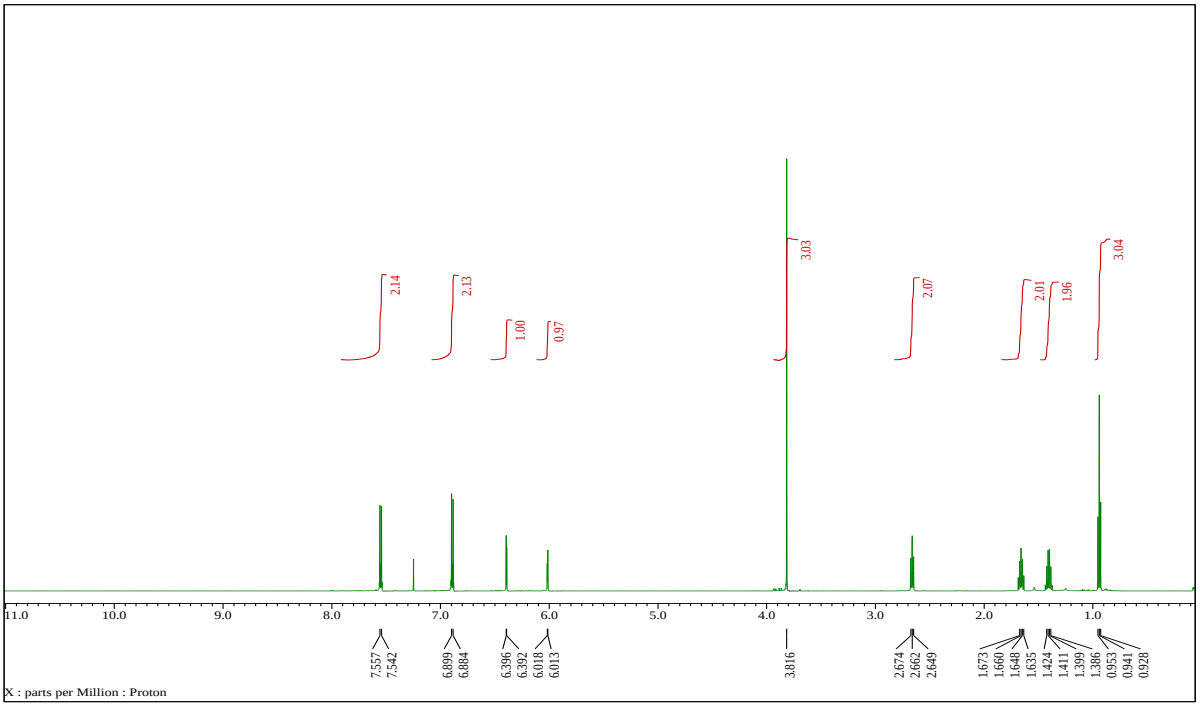
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2.662
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1.673
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0.941
0.928
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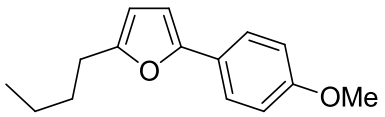
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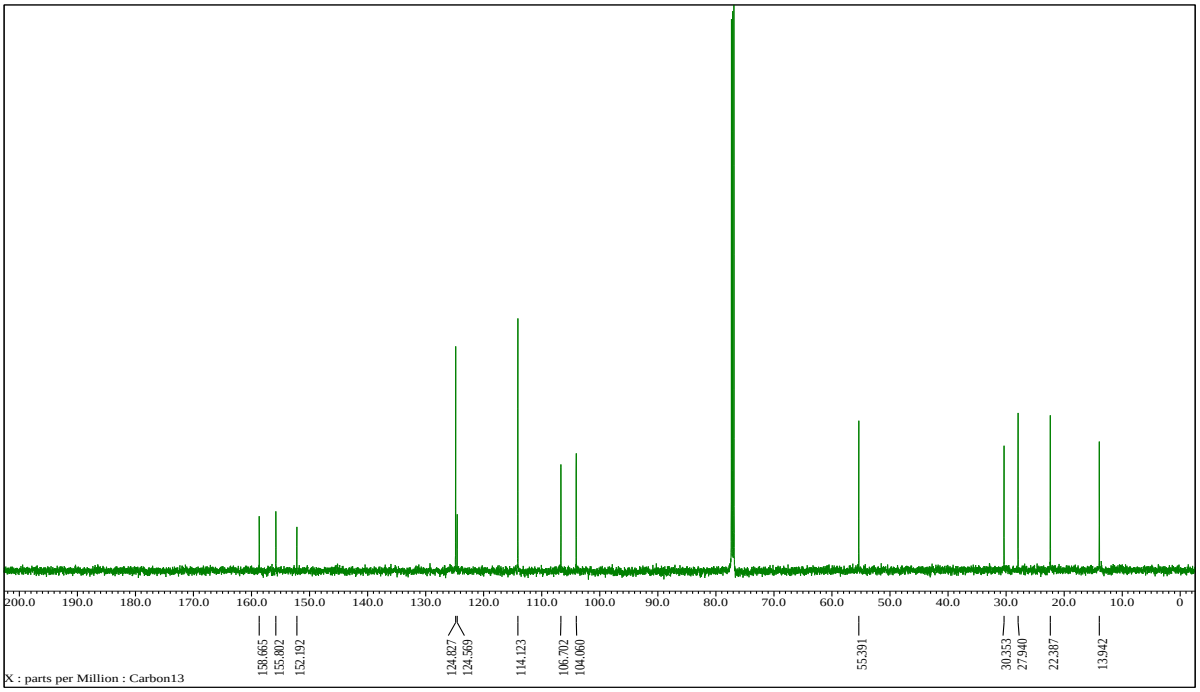
OMe

3f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70.0
60.0
50.0
40.0
30.0
20.0
10.0
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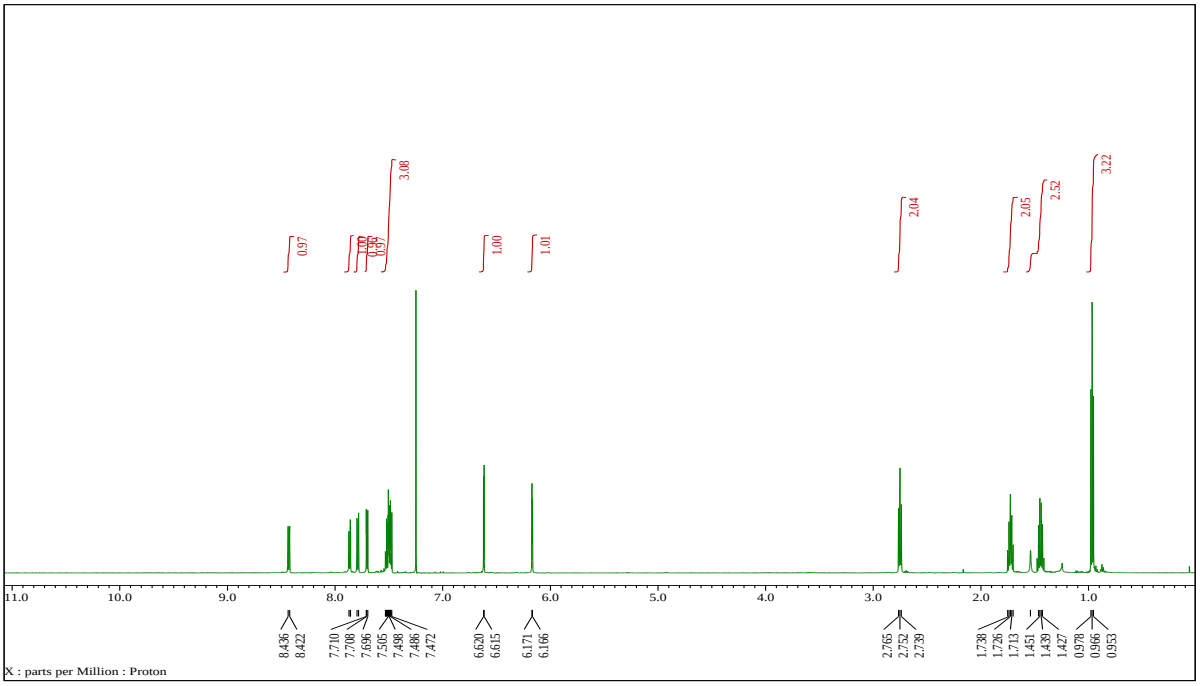
22.387
13.942
X : parts per Million : Carbon13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3.0
2.0
1.0
8.436
8.422
7.710
7.708
7.696
7.505
7.498
7.486
7.472
6.620
6.615
6.171
6.166
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2.752
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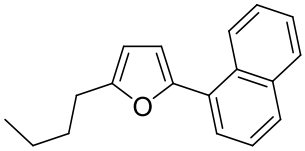
1.439
1.427
0.978
0.966
0.953
X : parts per Million : Proton



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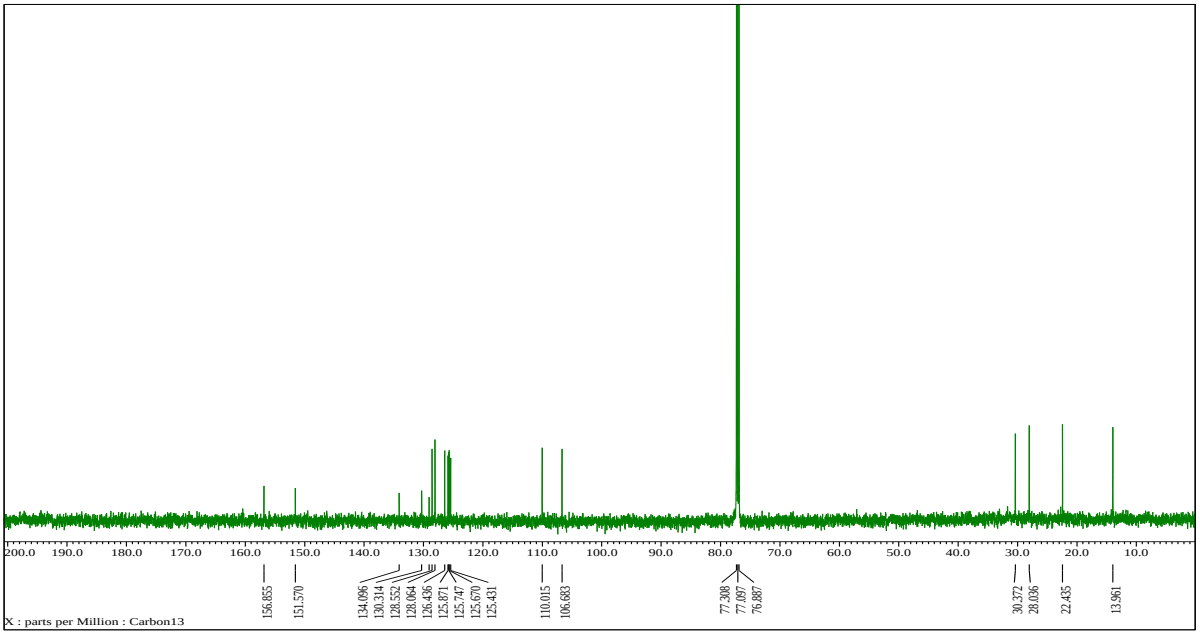
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110.0
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80.0
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60.0
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40.0
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10.0
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151.570
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130.314
128.552
128.064
126.436
125.871
125.747
125.670
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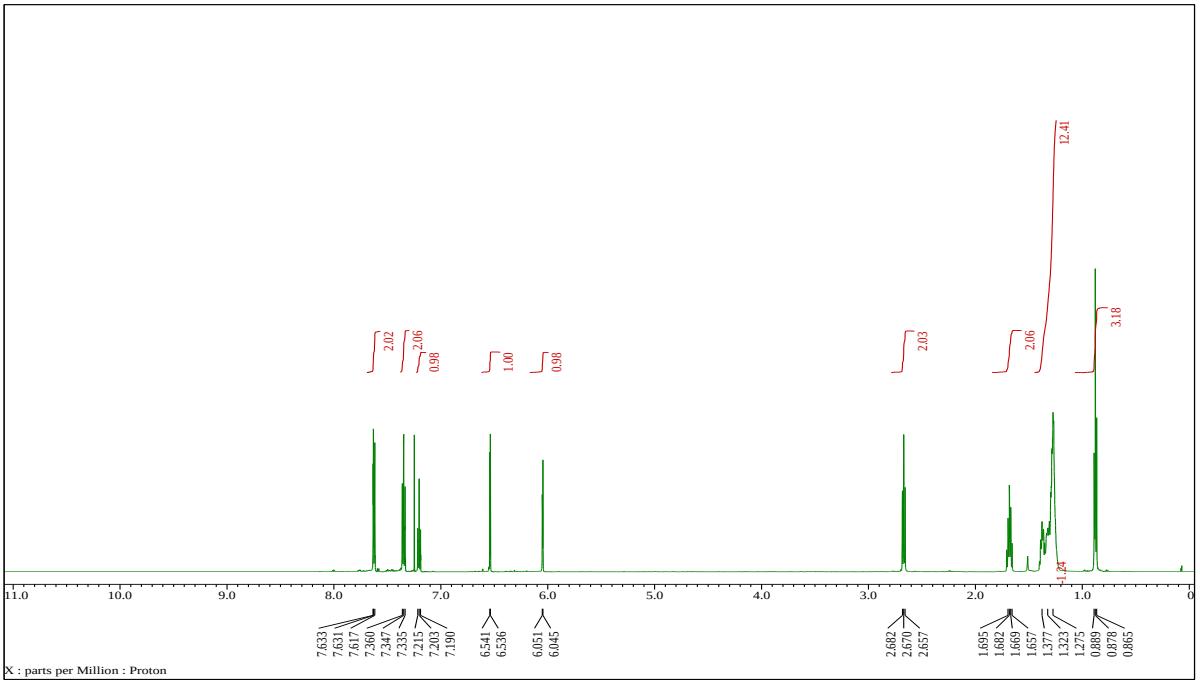
13.961
X : parts per Million : Carbon13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2.0
1.0
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7.631
7.617
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7.347
7.335
7.215
7.203
7.190
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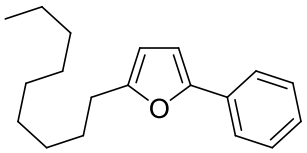
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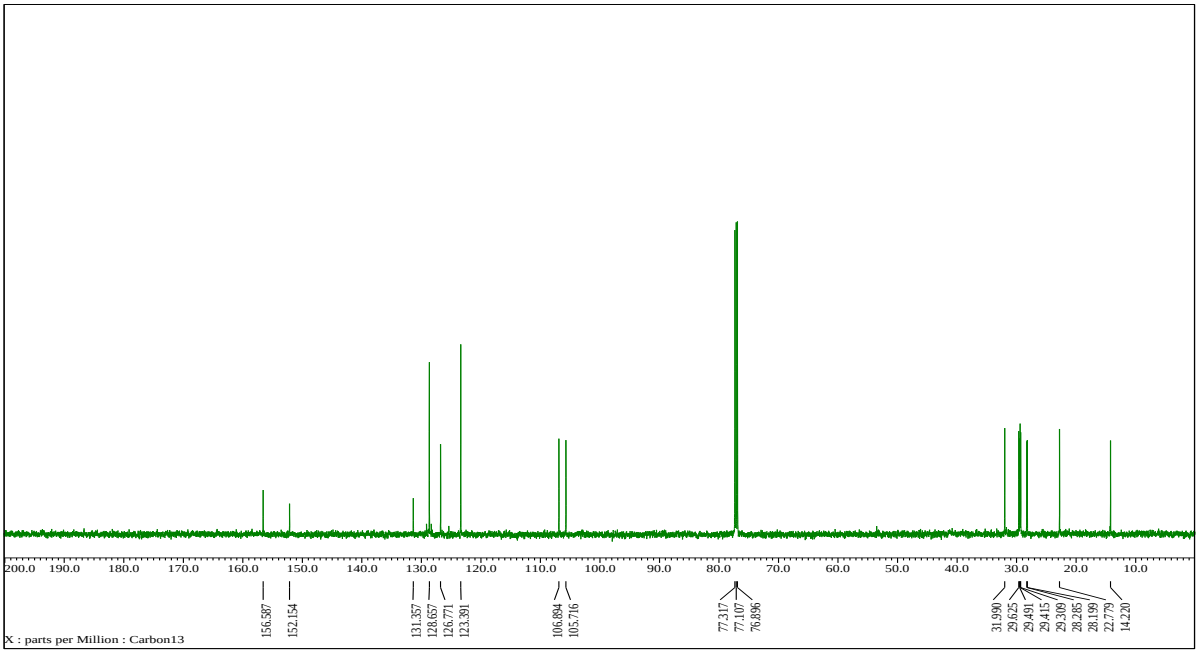
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110.0
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90.0
80.0
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60.0
50.0
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20.0
10.0
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152.154
131.357
128.657
126.771
123.391
106.894
105.716
77.317
77.107
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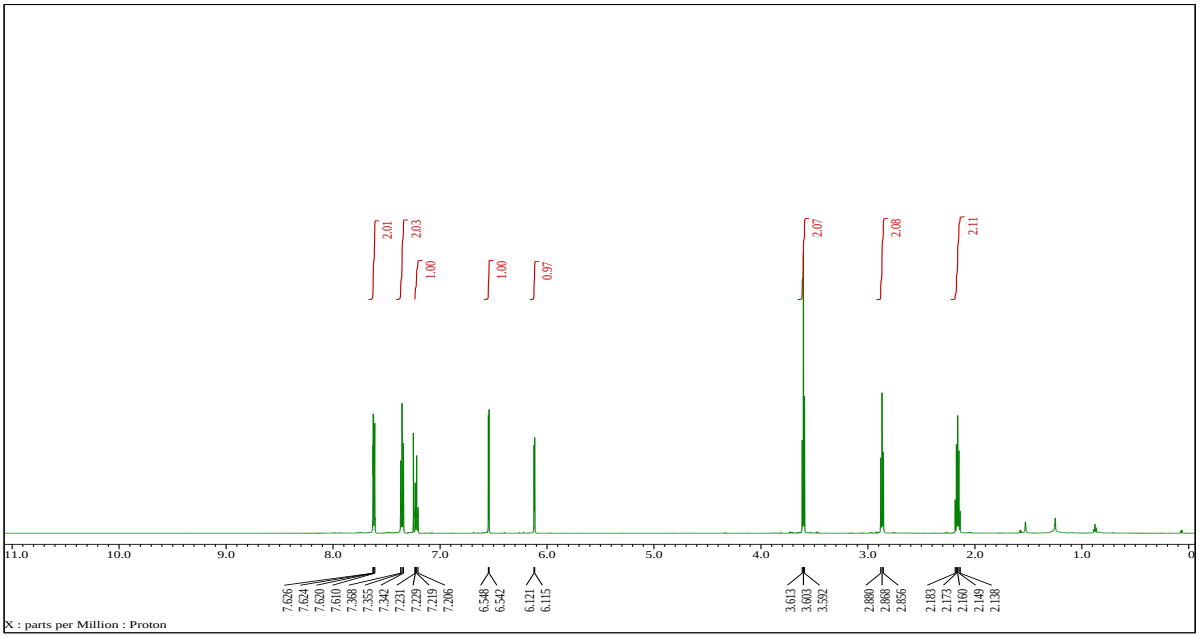
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1.0
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7.624
7.620
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7.368
7.355
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7.229
7.219
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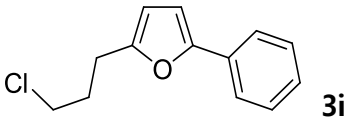
Cl
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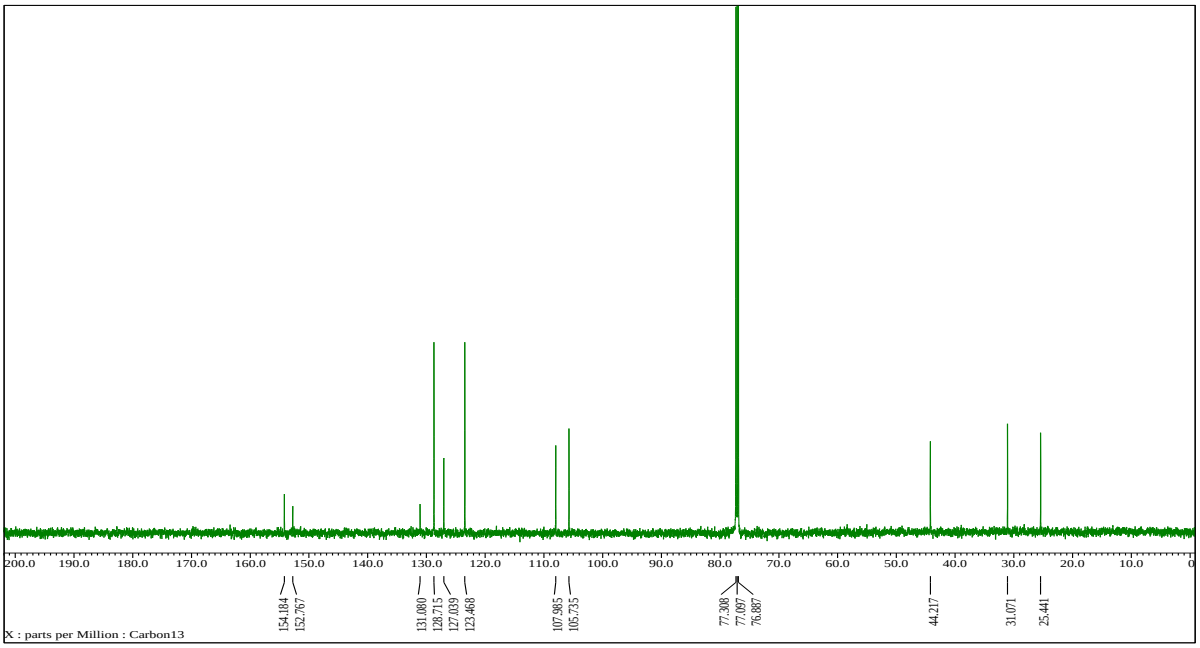
3i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80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
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152.767
131.080
128.715
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76.887
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31.071
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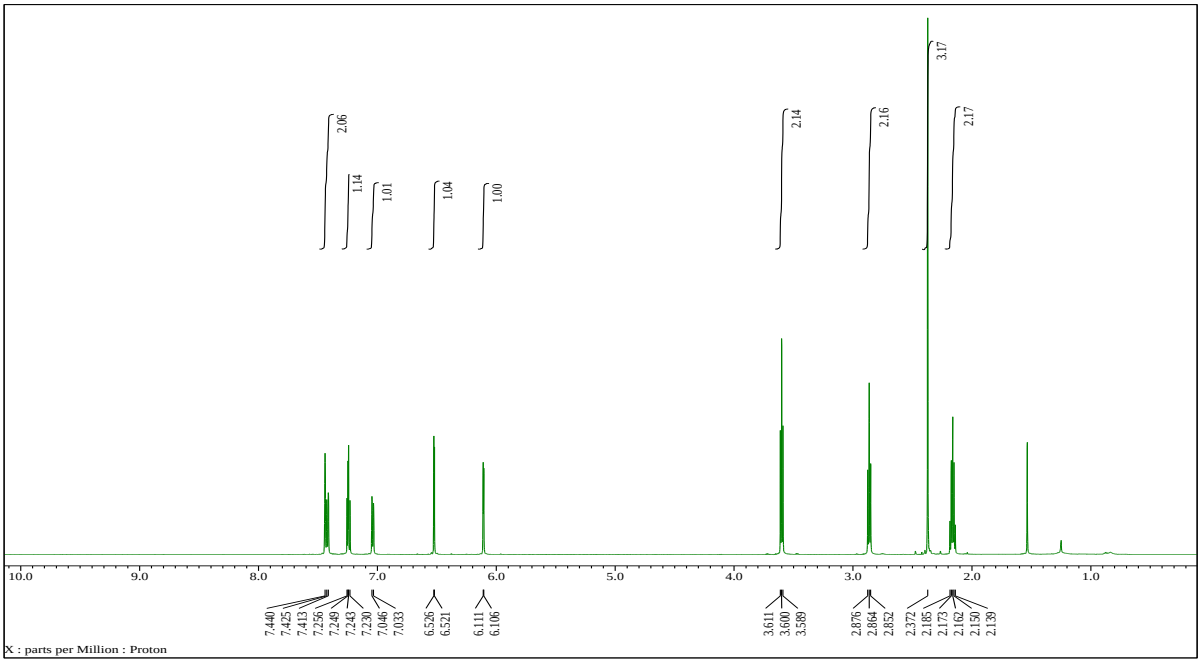
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7.033
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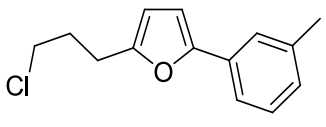
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O

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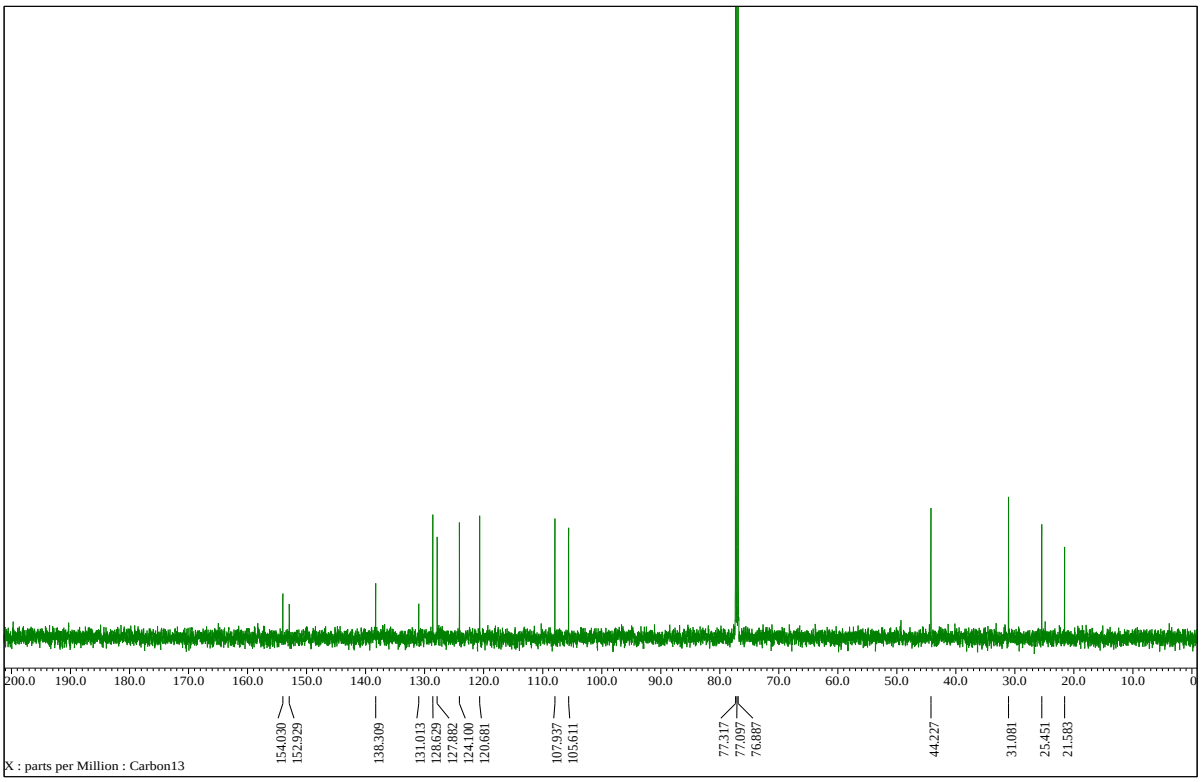
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127.882
124.100
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77.097
76.887
44.227
31.081
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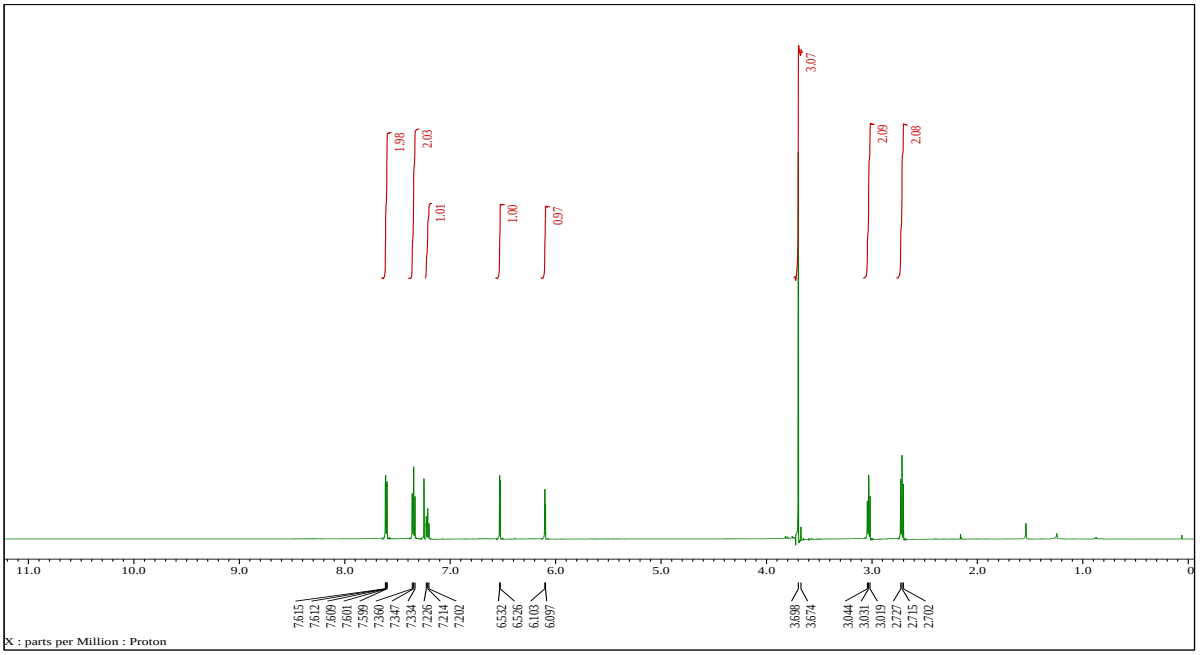
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2.08
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10.0
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7.0
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3.0
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7.612
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7.599
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7.347
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7.202
6.532
6.526
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2.702
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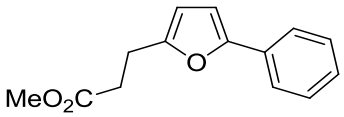
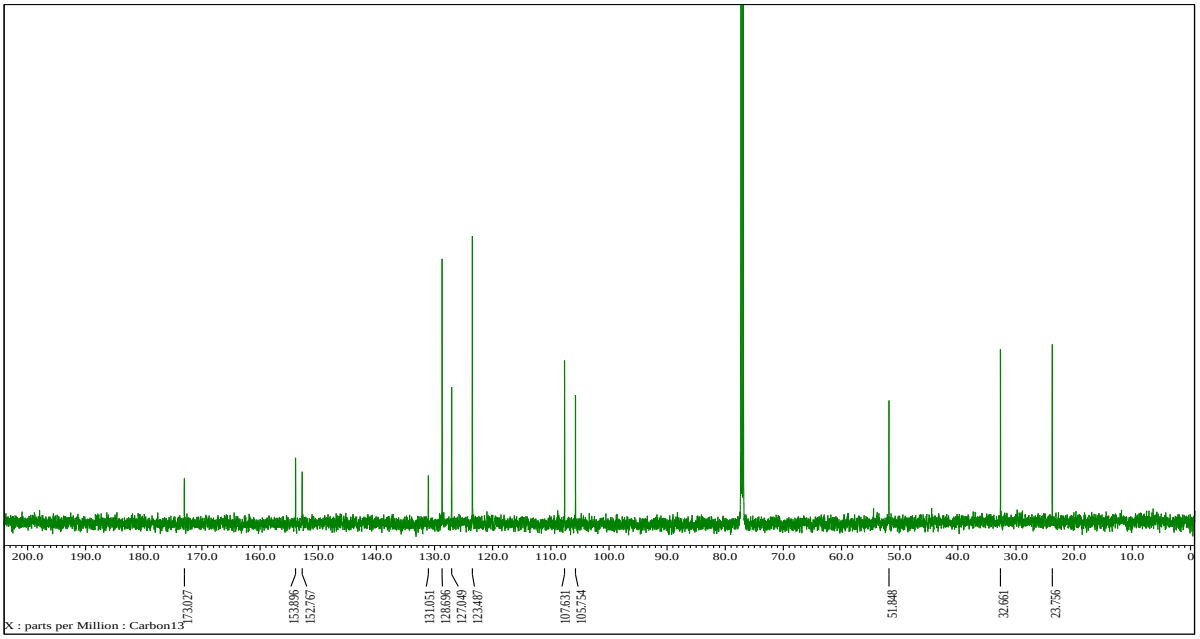

MeO2C
O

3k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10.0
0
173.027
153.896
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51.848
32.661
23.756
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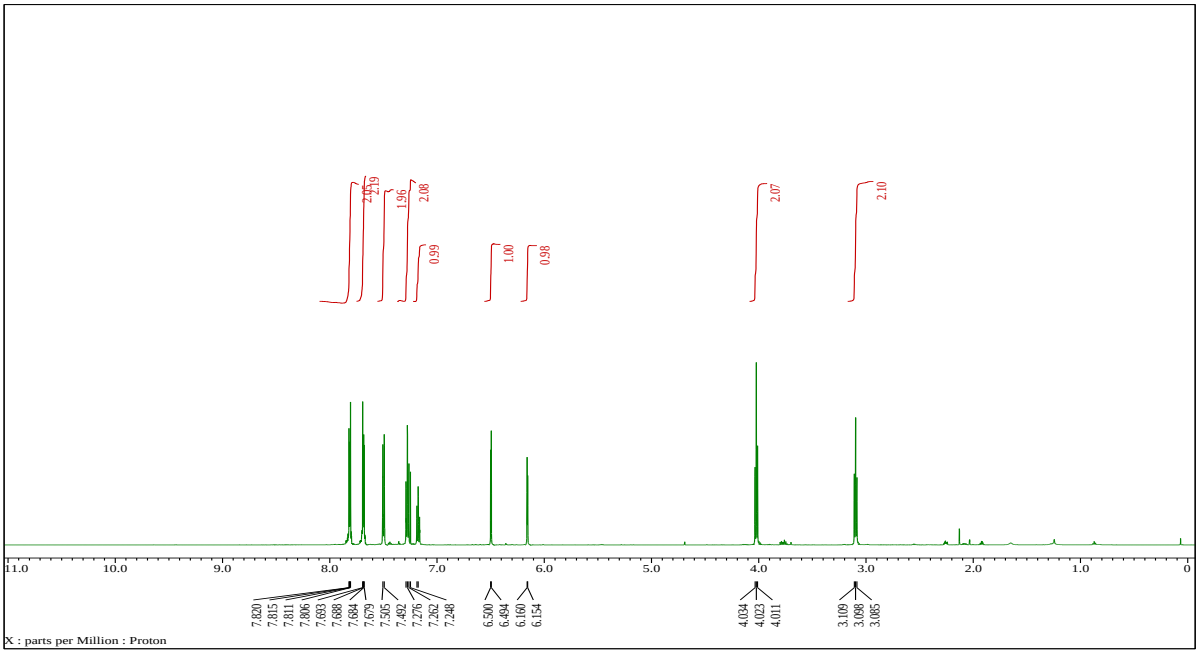
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6.160
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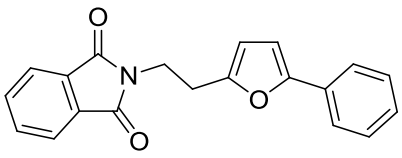
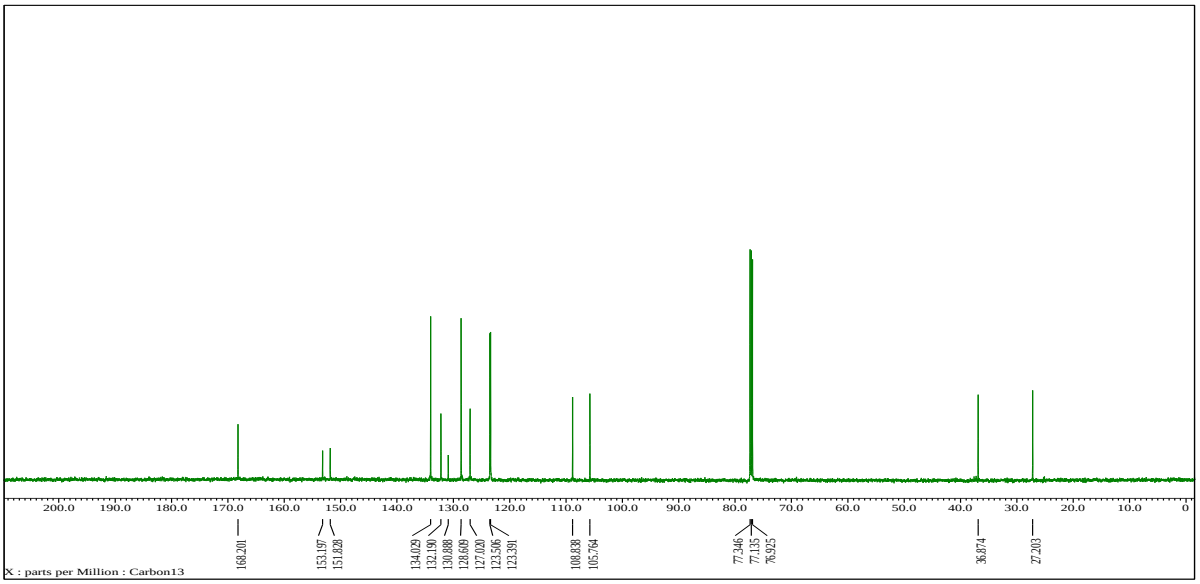
3.098
3.085
X : parts per Million : Proton


O
N
O
O

3l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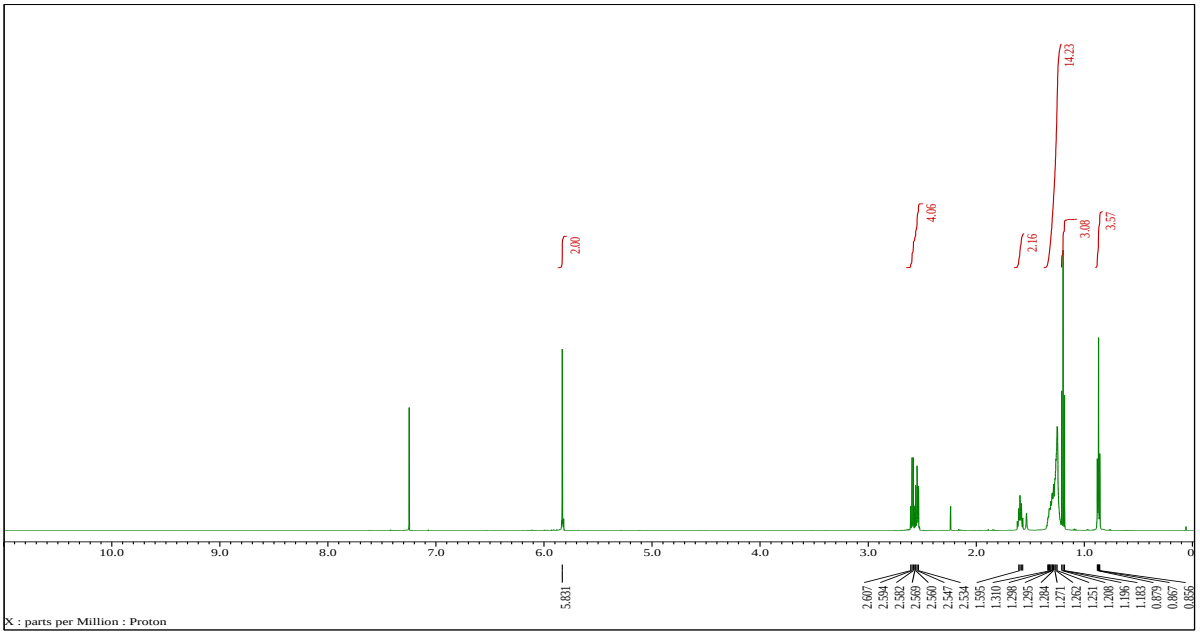
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
168.201
153.197
151.828
134.025
132.190
130.888
128.609
127.020
123.506
123.391
108.838
105.764
77.346
77.135
76.925
36.874
27.203
X : parts per Million : Carbon13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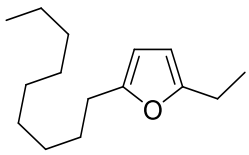
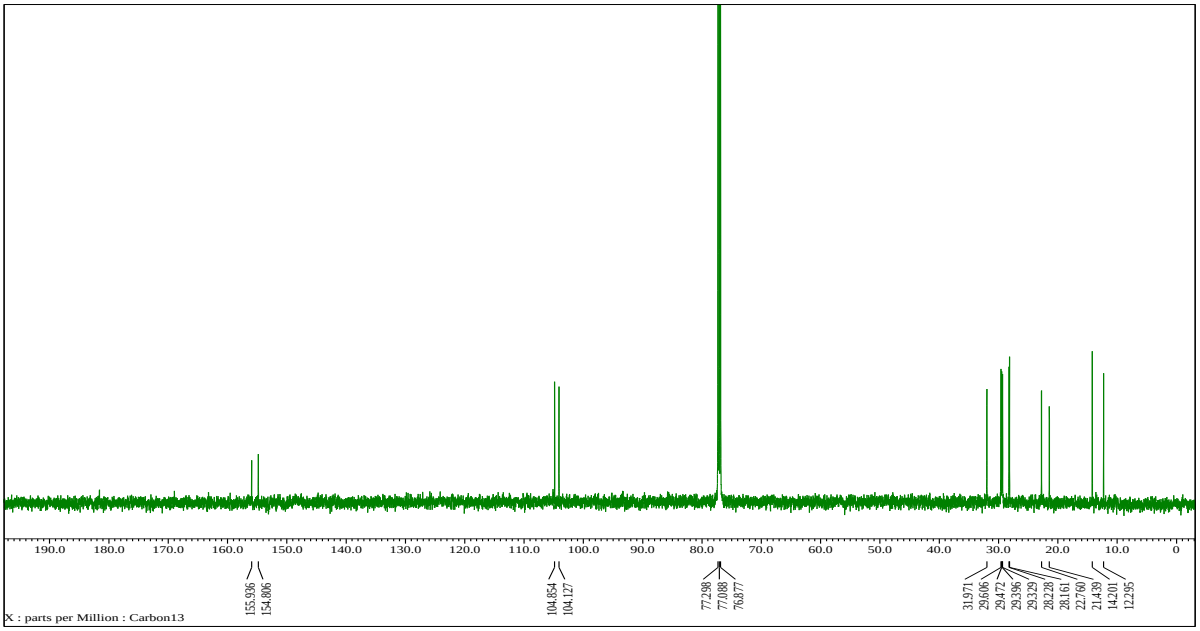
2.16
3.08
3.57
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
5.831
2.607
2.594
2.582
2.560
2.560
2.547
2.534
1.595
1.310
1.298
1.295
1.284
1.271
1.262
1.251
1.208
1.196
1.183
0.879
0.867
0.856
X : parts per Million : Proton



3m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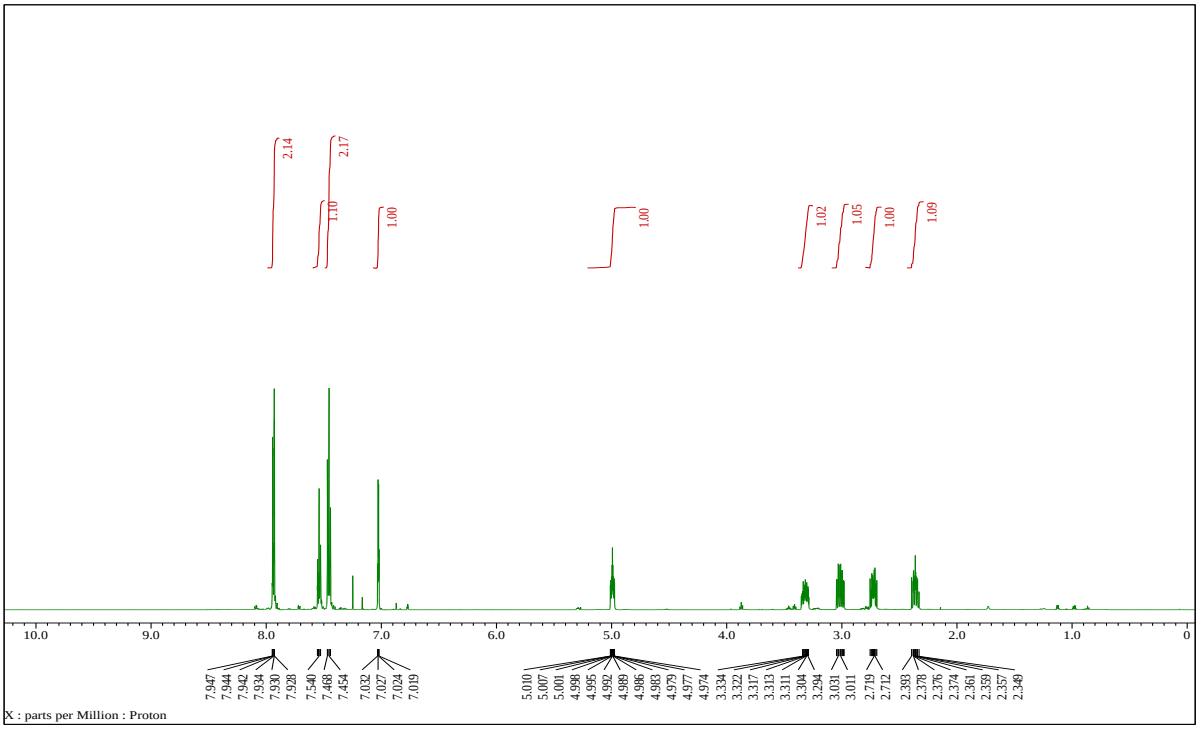
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
155.936
154.806
104.854
104.127
77.298
77.088
76.877
31.971
29.606
29.472
29.396
29.329
28.228
28.161
22.760
21.439
14.201
12.295
X : parts per Million : Carbon13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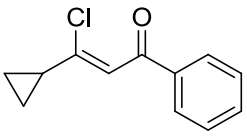
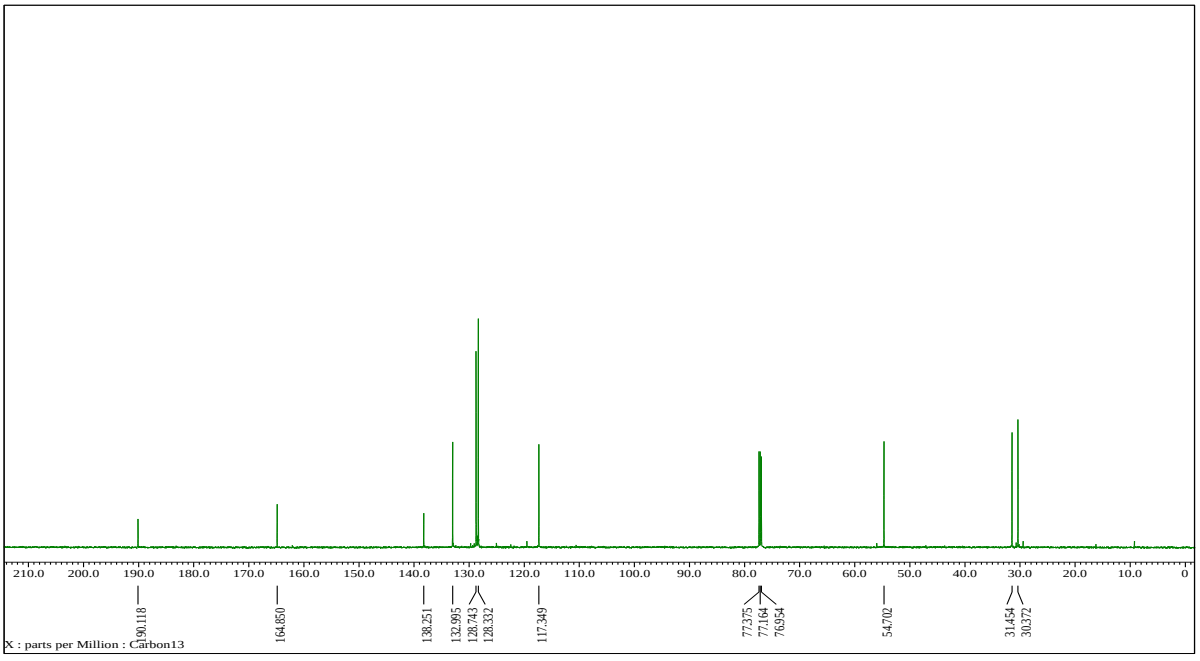
2.17
1.10
1.00
1.00
1.02
1.05
1.00
1.09
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.947
7.944
7.942
7.934
7.930
7.928
7.540
7.468
7.454
7.032
7.027
7.024
7.019
5.010
5.007
5.001
4.998
4.995
4.992
4.989
4.986
4.983
4.979
4.977
4.974
3.334
3.322
3.317
3.313
3.311
3.304
3.294
3.031
3.011
2.719
2.712
2.393
2.378
2.376
2.374
2.361
2.359
2.357
2.349
X : parts per Million : Proton


Cl
O

4a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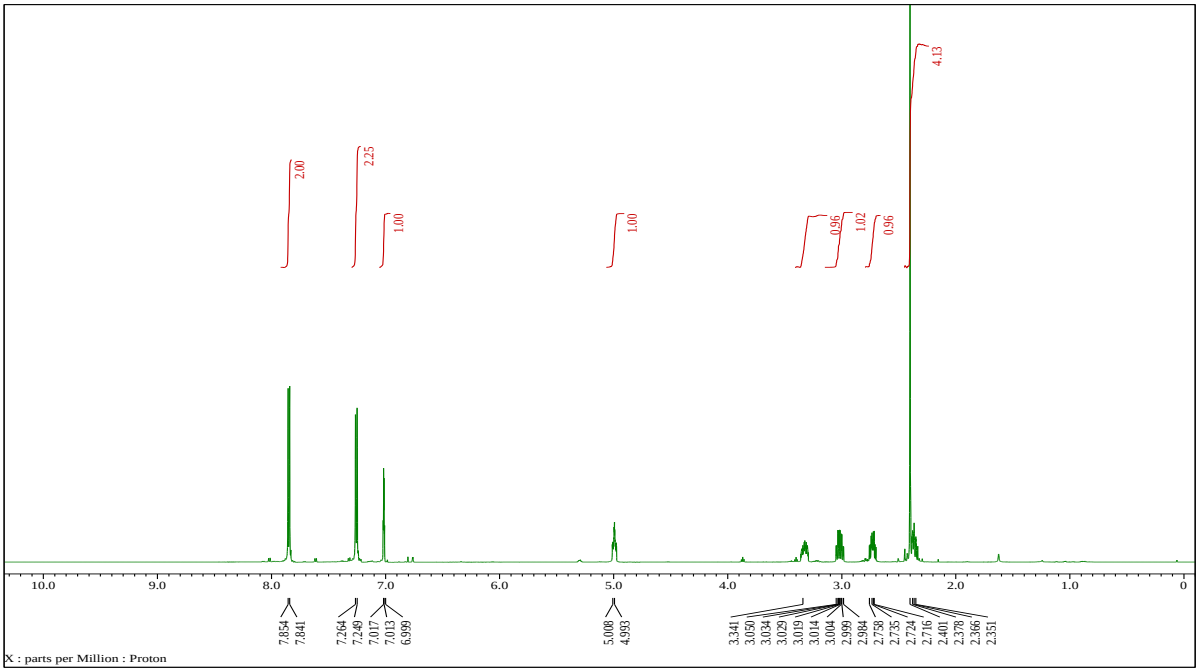
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
190.118
164.850
138.251
132.995
128.743
128.332
117.349
77.375
77.164
76.954
54.702
31.454
30.372
X : parts per Million : Carbon13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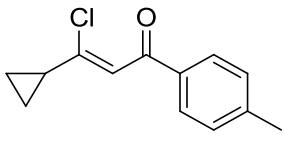
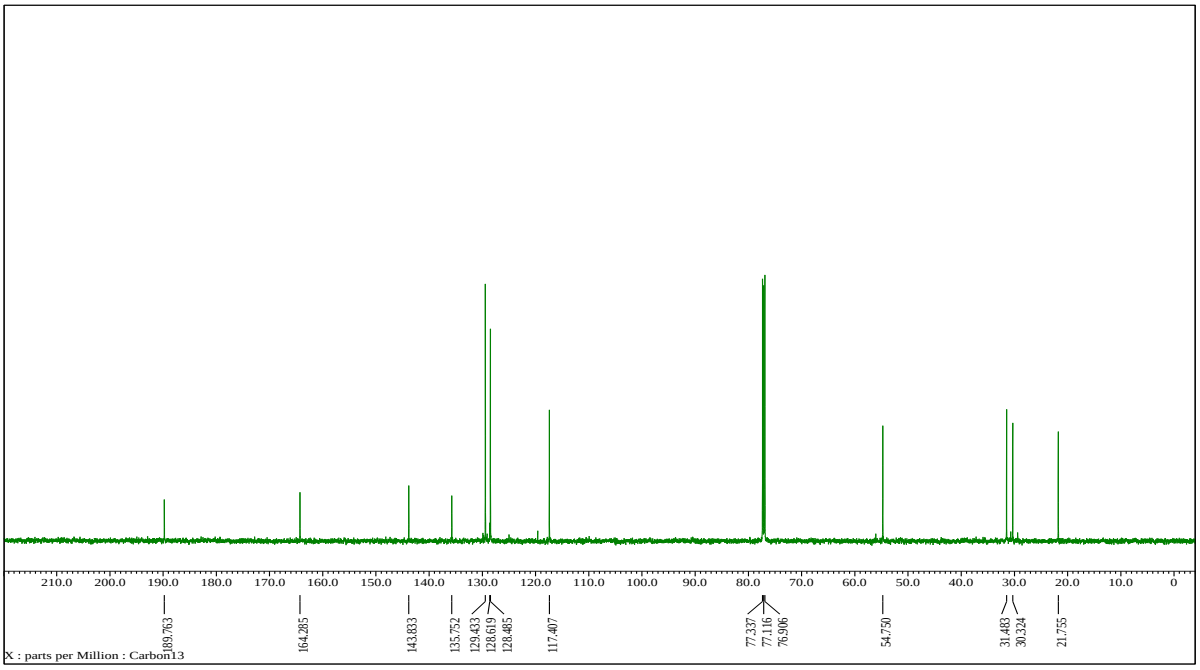
2.00
2.25
1.00
1.00
0.96
1.02
0.96
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.854
7.841
7.264
7.249
7.017
7.013
6.999
5.008
4.993
3.341
3.050
3.034
3.029
3.019
3.014
3.004
2.999
2.984
2.758
2.735
2.724
2.716
2.401
2.378
2.366
2.351
X : parts per Million : Proton


Cl
O

4b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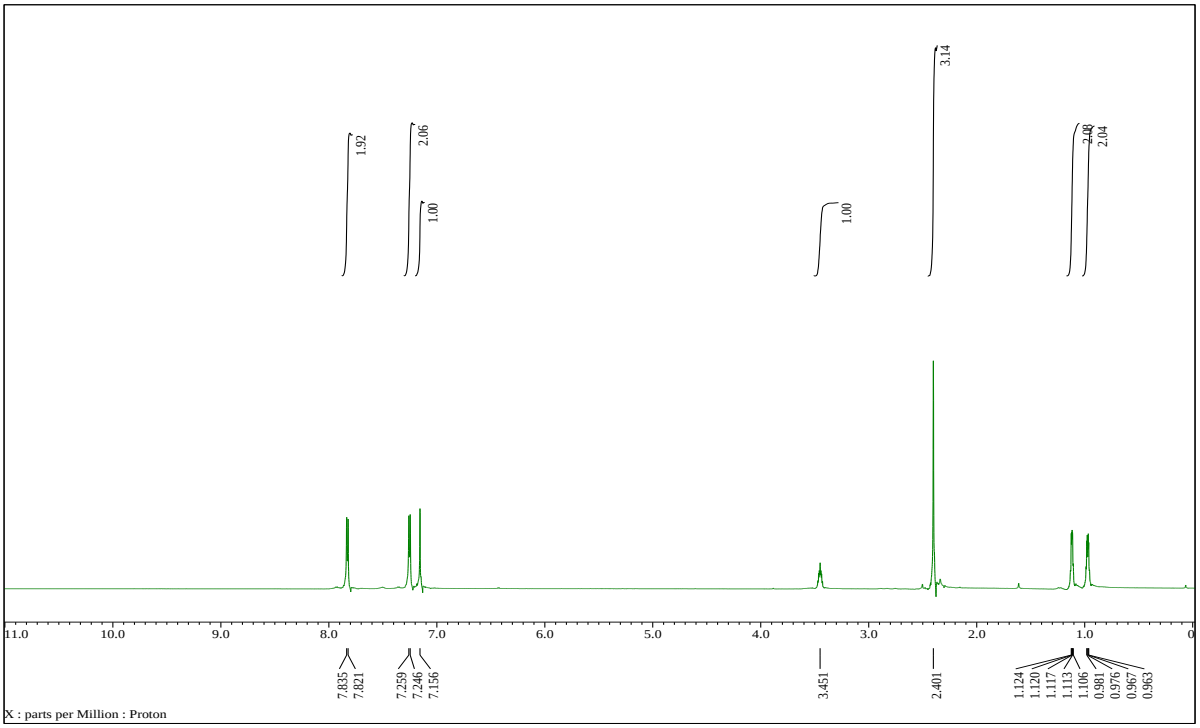
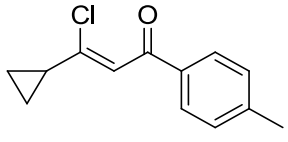
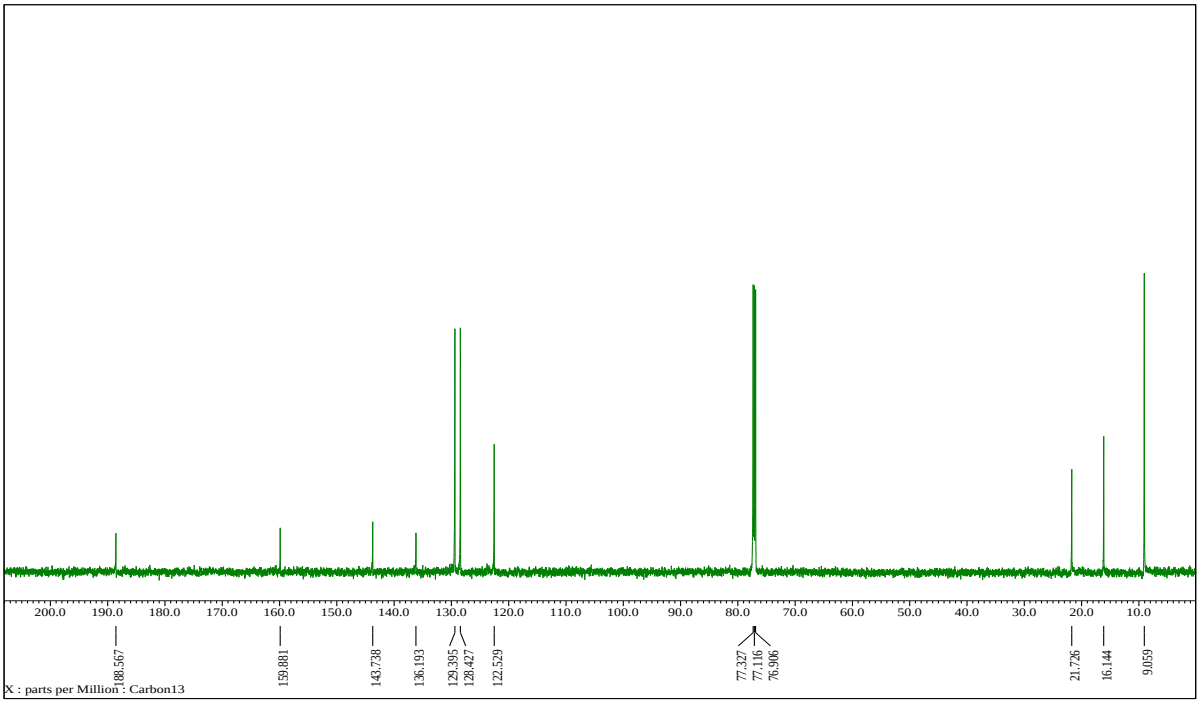
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
189.763
164.285
143.833
135.752
129.433
128.619
128.485
117.407
77.337
77.116
76.906
54.750
31.483
30.324
21.755
X : parts per Million : Carbon13


1.92
2.06
1.00
1.00
3.14
2.08
2.04
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.835
7.821
7.259
7.246
7.156
3.451
2.401
1.124
1.120
1.117
1.113
1.106
0.981
0.976
0.967
0.963
X : parts per Million : Proton


Cl
O

(*Z*)-4b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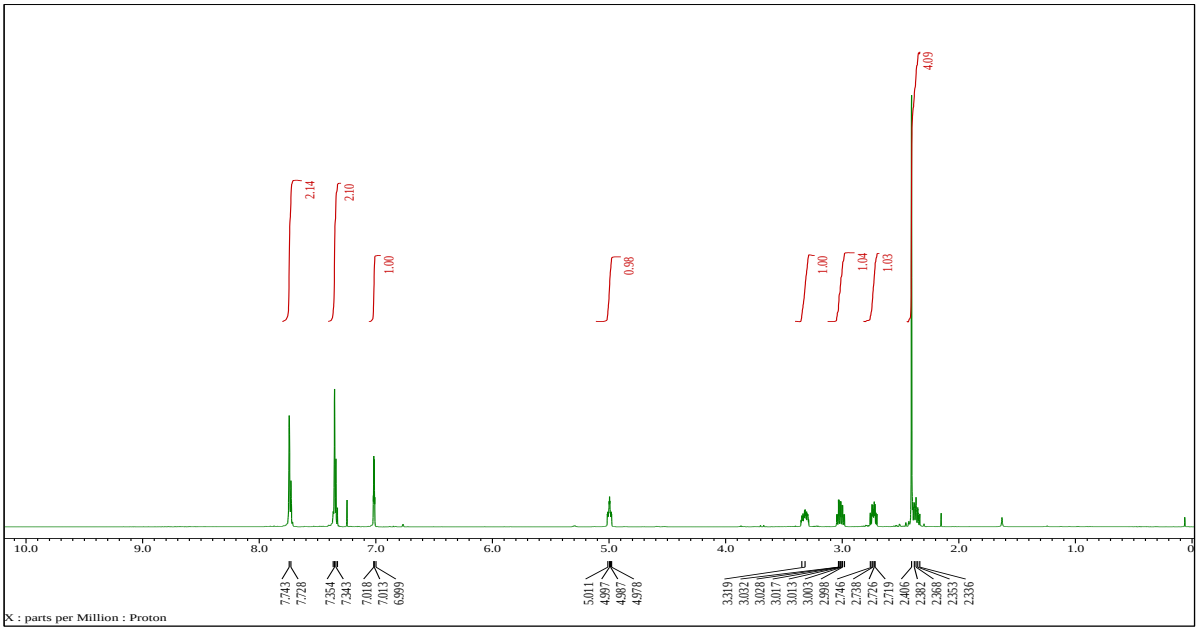
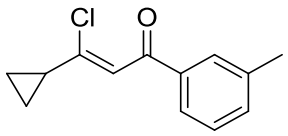
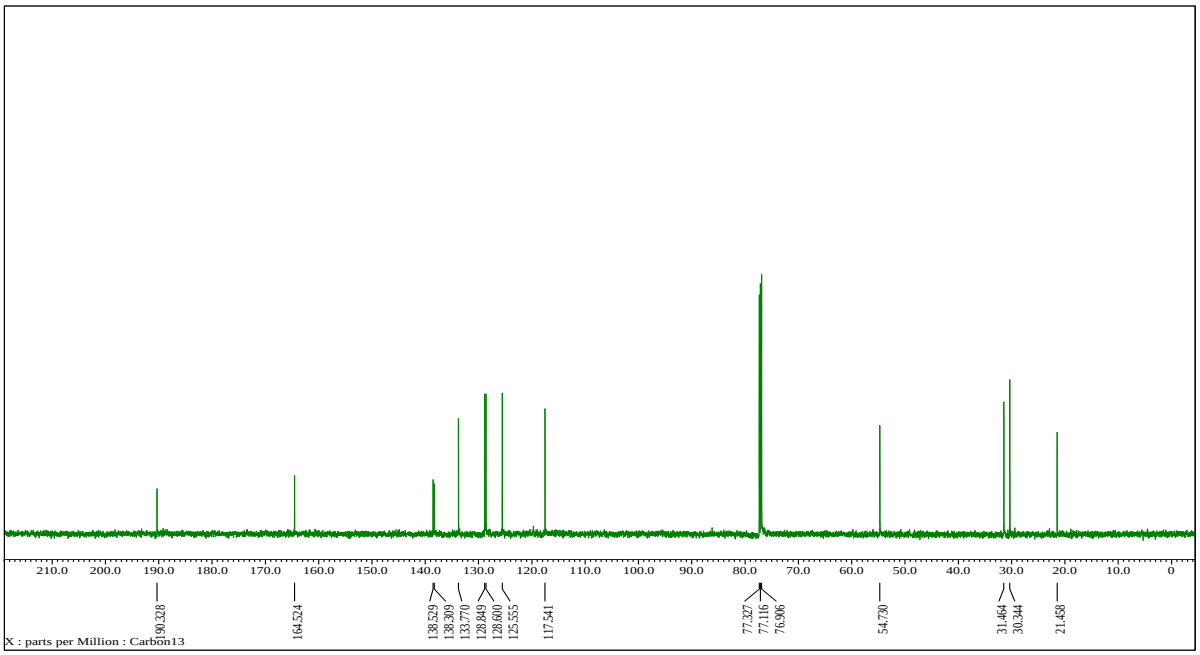
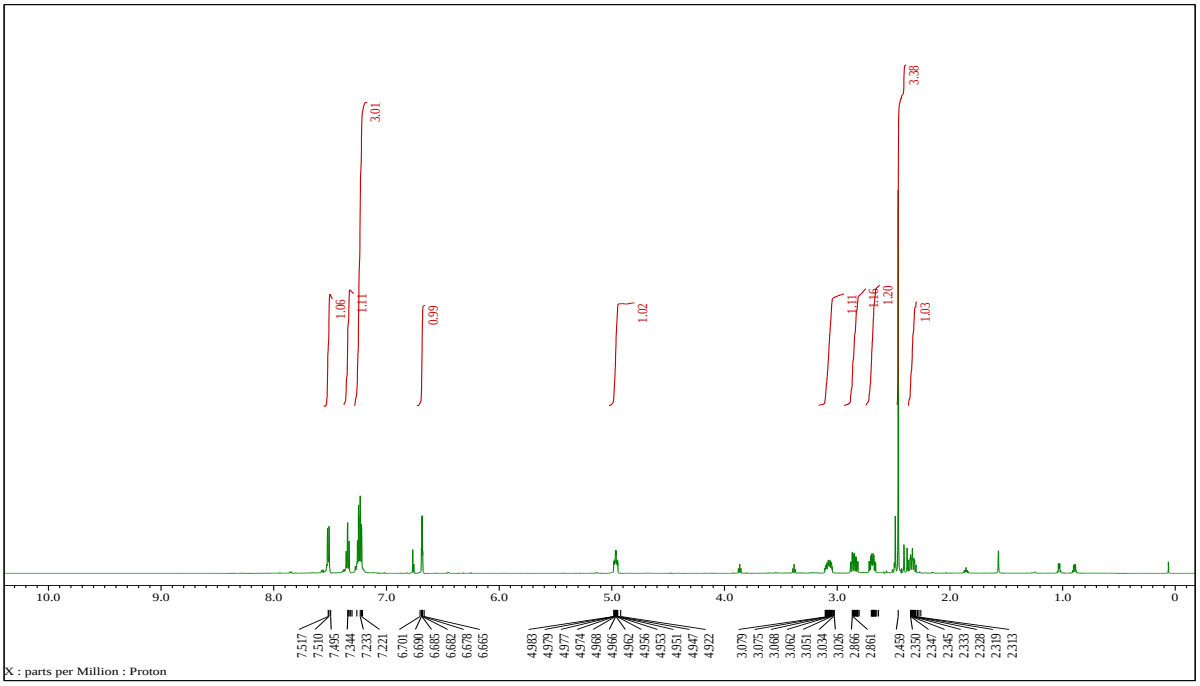
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
188.567
159.881
143.738
136.193
129.395
128.427
122.529
77.327
77.116
76.906
21.726
16.144
9.059
X : parts per Million : Carbon13


4.09
2.14
2.10
1.00
0.98
1.00
1.04
1.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.743
7.728
7.354
7.343
7.018
7.013
6.999
5.011
4.997
4.987
4.978
3.319
3.032
3.028
3.017
3.013
3.003
2.998
2.746
2.738
2.726
2.719
2.406
2.382
2.368
2.353
2.336
X : parts per Million : Proton


Cl
O

4c


210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
190.328
164.524
138.529
138.309
133.770
128.849
128.600
125.555
117.541
77.327
77.116
76.906
54.730
31.464
30.344
21.458
X : parts per Million : Carbon13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1.02
1.11
1.16
1.20
1.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.517
7.510
7.495
7.344
7.233
7.221
6.701
6.690
6.685
6.682
6.678
6.665
4.983
4.979
4.977
4.974
4.968
4.966
4.962
4.956
4.953
4.951
4.947
4.922
3.079
3.075
3.068
3.062
3.051
3.034
3.026
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2.861
2.459
2.350
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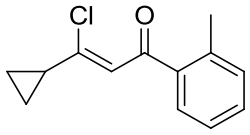
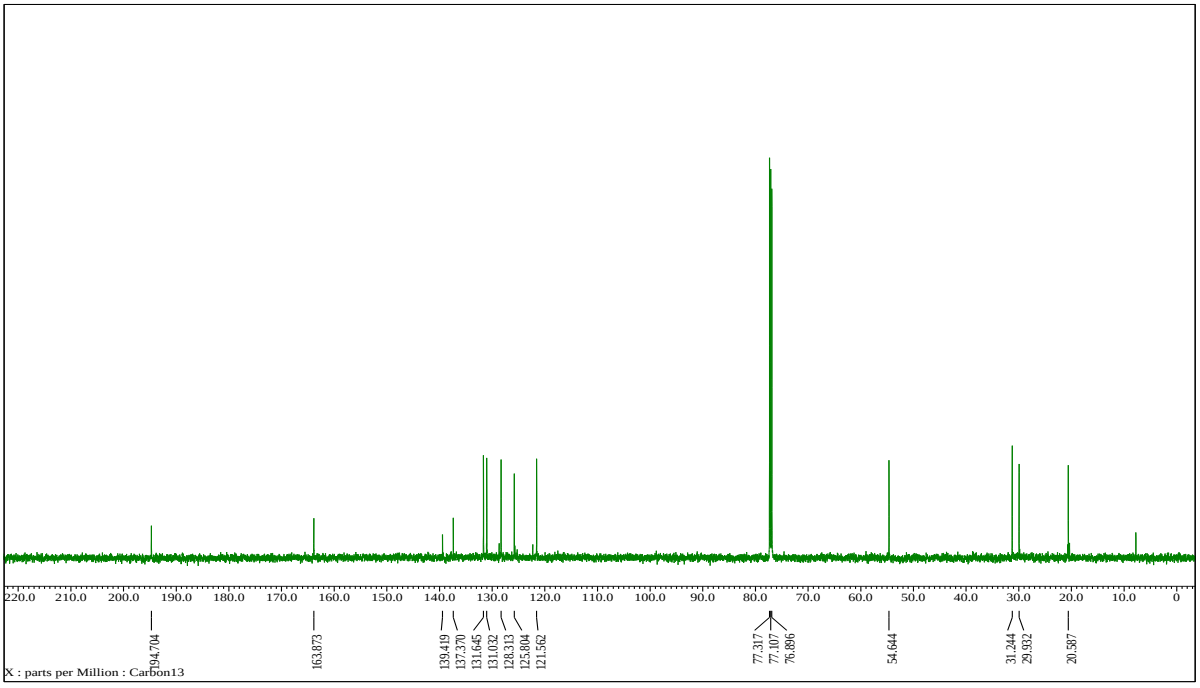
2.345
2.333
2.328
2.319
2.313
X : parts per Million : Proton


Cl
O

4d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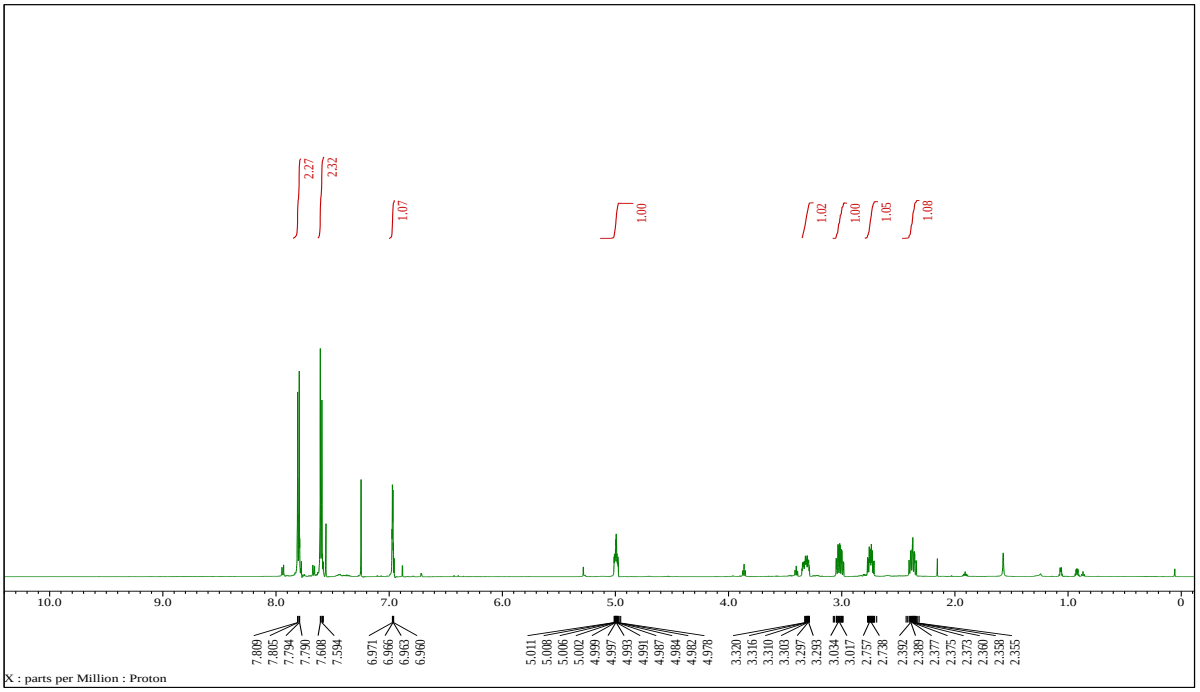
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
194.704
163.873
139.419
137.370
131.645
131.032
128.313
125.804
121.562
77.317
77.107
76.896
54.644
31.244
29.932
20.587
X : parts per Million : Carbon13


2.27
2.32
1.07
1.00
1.02
1.00
1.05
1.08
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.809
7.805
7.794
7.790
7.608
7.594
6.971
6.966
6.963
6.960
5.011
5.008
5.006
5.002
4.999
4.997
4.993
4.991
4.987
4.984
4.982
4.978
3.320
3.316
3.310
3.303
3.297
3.293
3.034
3.017
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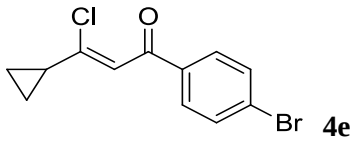
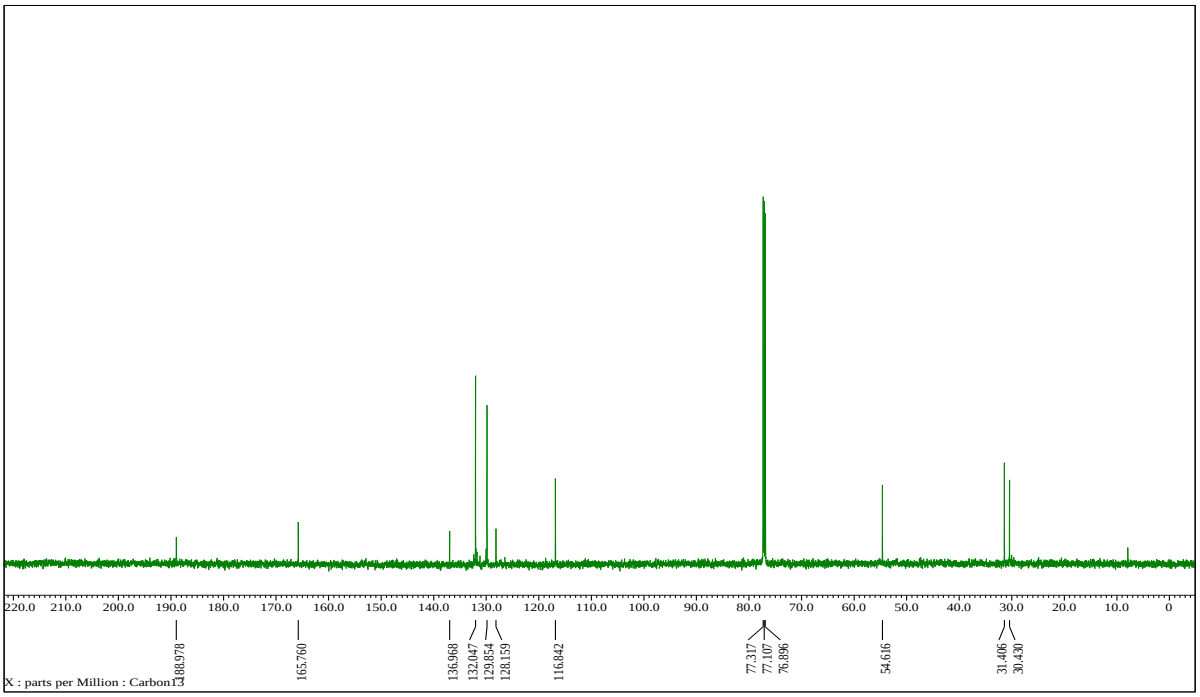
2.738
2.392
2.388
2.377
2.375
2.373
2.360
2.358
2.355
X : parts per Million : Proton


Cl
O
Br

4e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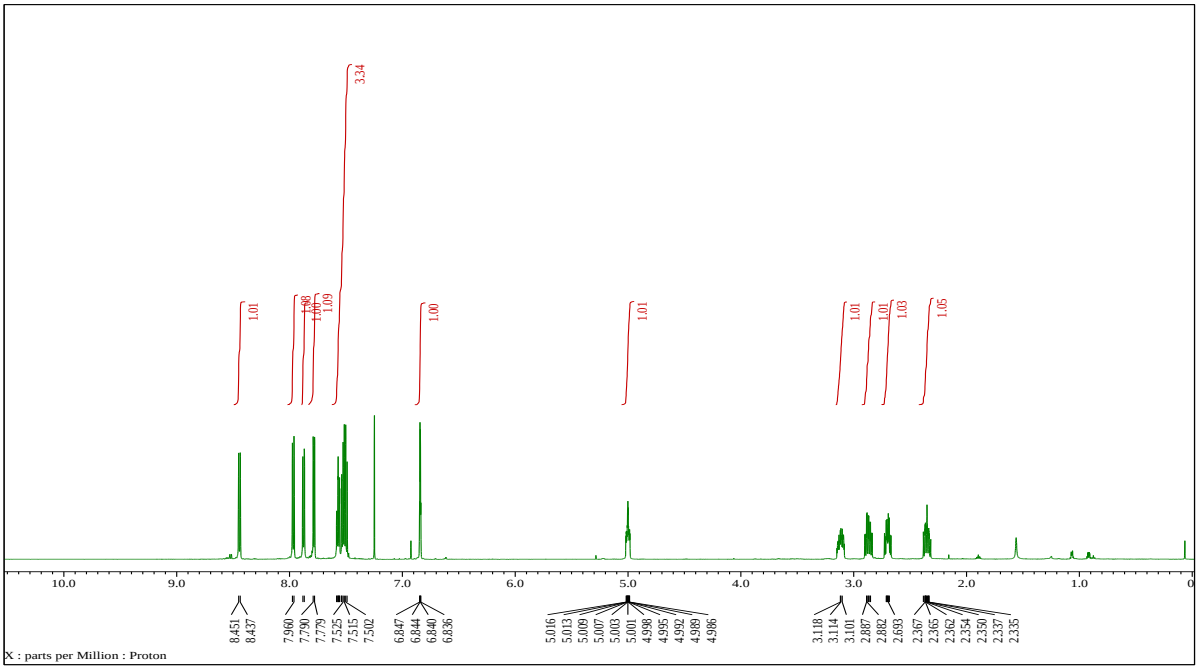
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
188.978
165.760
136.968
132.047
129.854
128.159
116.842
77.317
77.107
76.896
54.616
31.406
30.430
X : parts per Million : Carbon13


3.34
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1.00
1.01
1.01
1.01
1.03
1.05
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.451
8.437
7.960
7.790
7.779
7.525
7.515
7.502
6.847
6.844
6.840
6.836
5.016
5.013
5.009
5.007
5.003
5.001
4.998
4.995
4.992
4.989
4.986
3.118
3.114
3.101
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2.882
2.693
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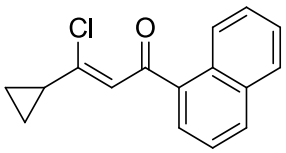
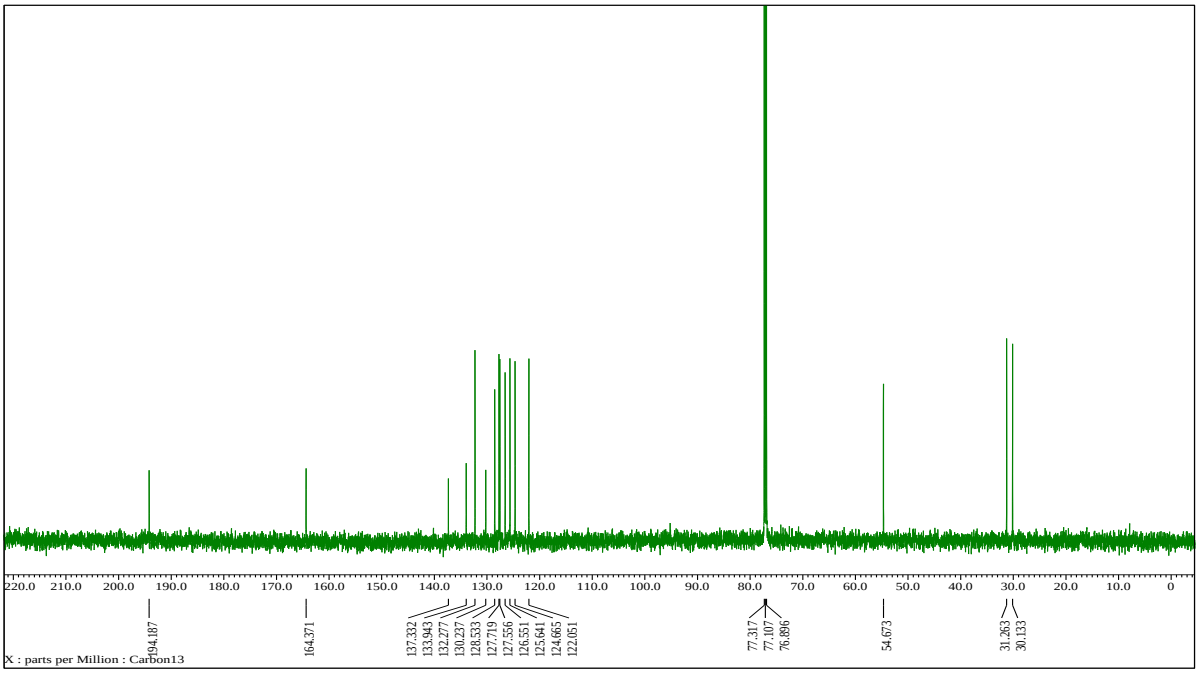
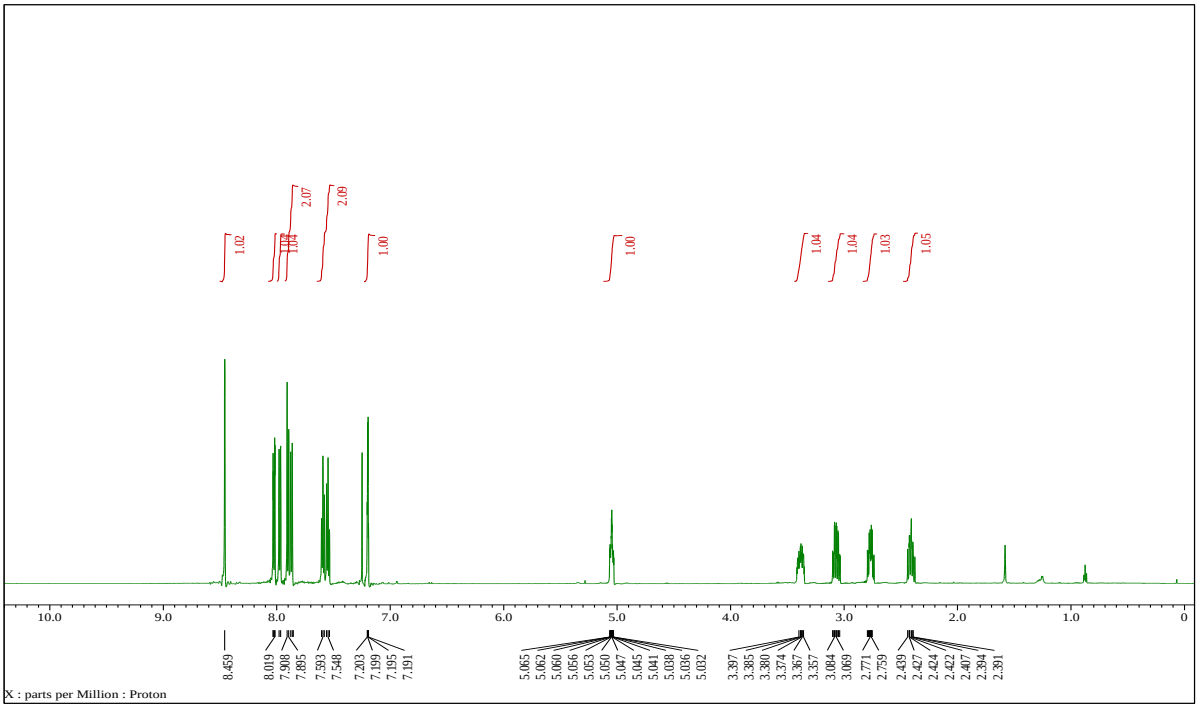
2.365
2.362
2.354
2.350
2.337
2.335
X : parts per Million : Proton


Cl
O

4f


220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
194.187
164.371
137.322
133.943
132.277
130.237
128.533
127.719
127.556
126.551
125.641
124.665
122.051
77.317
77.107
76.896
54.673
31.263
30.133
X : parts per Million : Carbon13


1.02
2.07
2.09
1.00
1.00
1.04
1.04
1.03
1.05
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.459
8.019
7.908
7.895
7.593
7.548
7.203
7.199
7.195
7.191
5.065
5.062
5.060
5.056
5.053
5.050
5.047
5.045
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3.367
3.357
3.084
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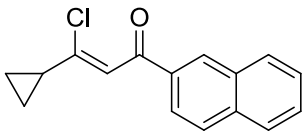
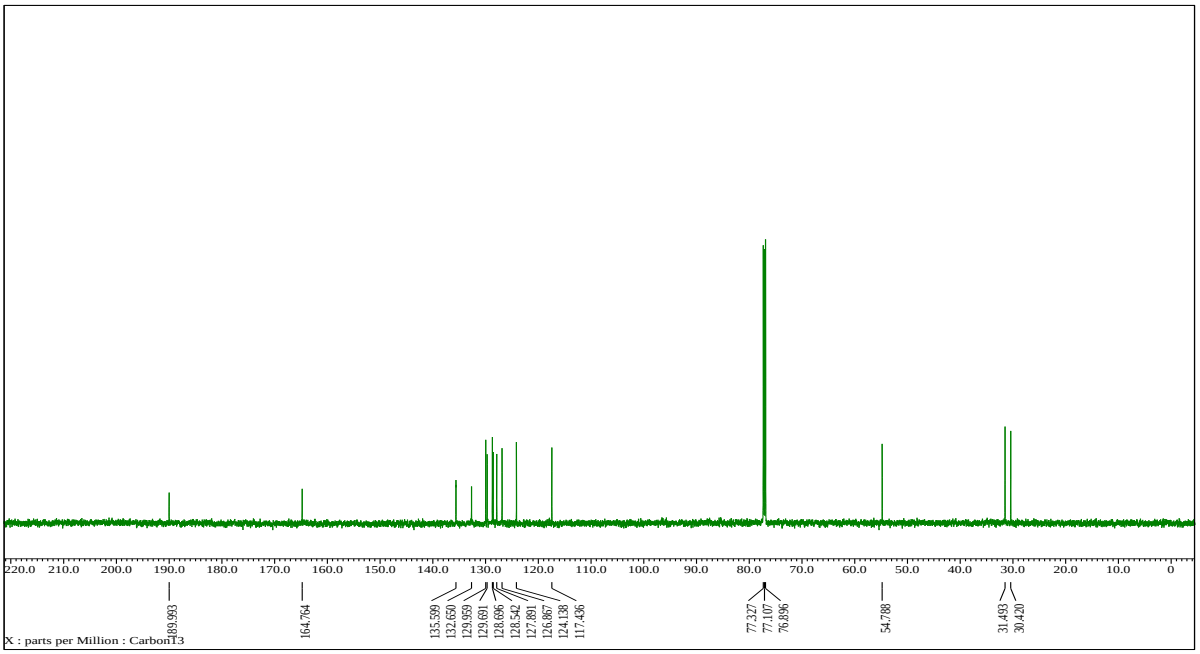
2.759
2.439
2.427
2.424
2.422
2.407
2.394
2.391
X : parts per Million : Proton


Cl
O

4g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170.0
160.0
150.0
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130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
189.993
164.764
135.599
132.650
129.959
129.691
128.696
128.542
127.891
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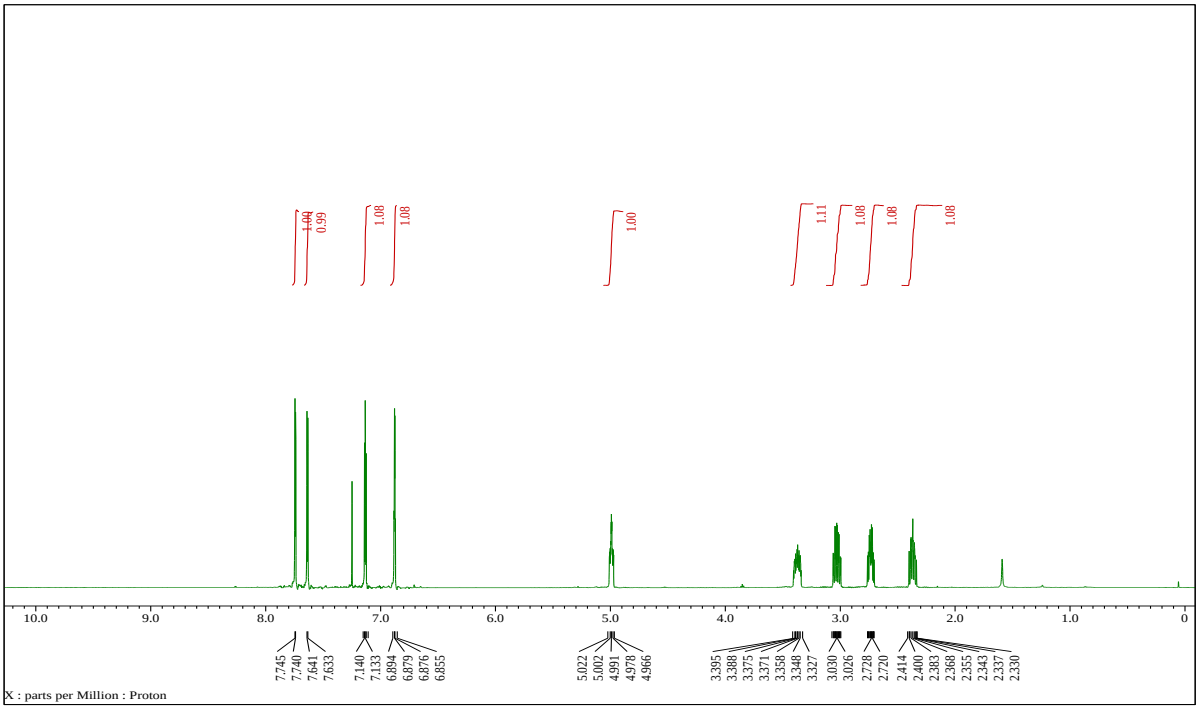
117.436
77.327
77.107
76.896
54.788
31.493
30.420
X : parts per Million : Carbon13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1.08
1.00
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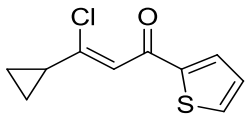
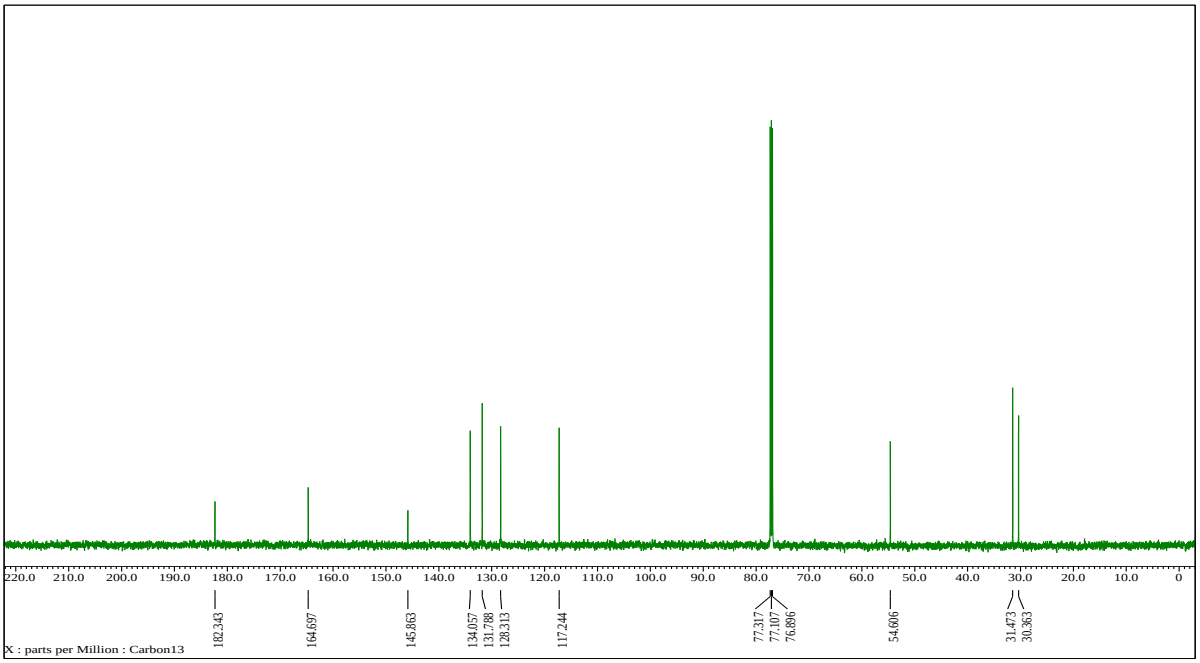
1.08
1.08
1.08
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.745
7.740
7.641
7.633
7.140
7.133
6.894
6.879
6.876
6.855
5.022
5.002
4.991
4.978
4.966
3.395
3.388
3.375
3.371
3.358
3.348
3.327
3.030
3.026
2.728
2.720
2.414
2.400
2.383
2.368
2.355
2.343
2.337
2.330
X : parts per Million : Proton


Cl
O
S

4h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120.0
110.0
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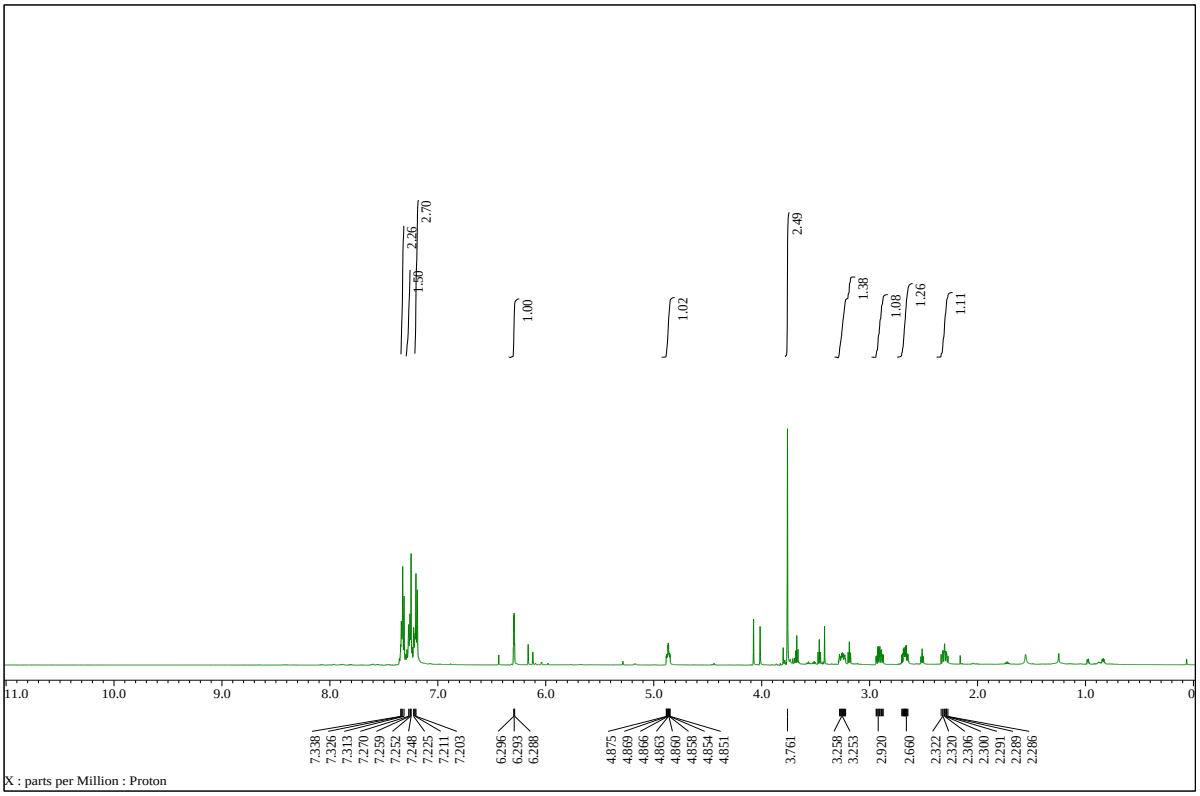
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
182.343
164.697
145.863
134.057
131.788
128.313
117.244
77.317
77.107
76.896
54.606
31.473
30.363
X : parts per Million : Carbon13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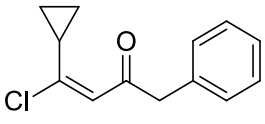
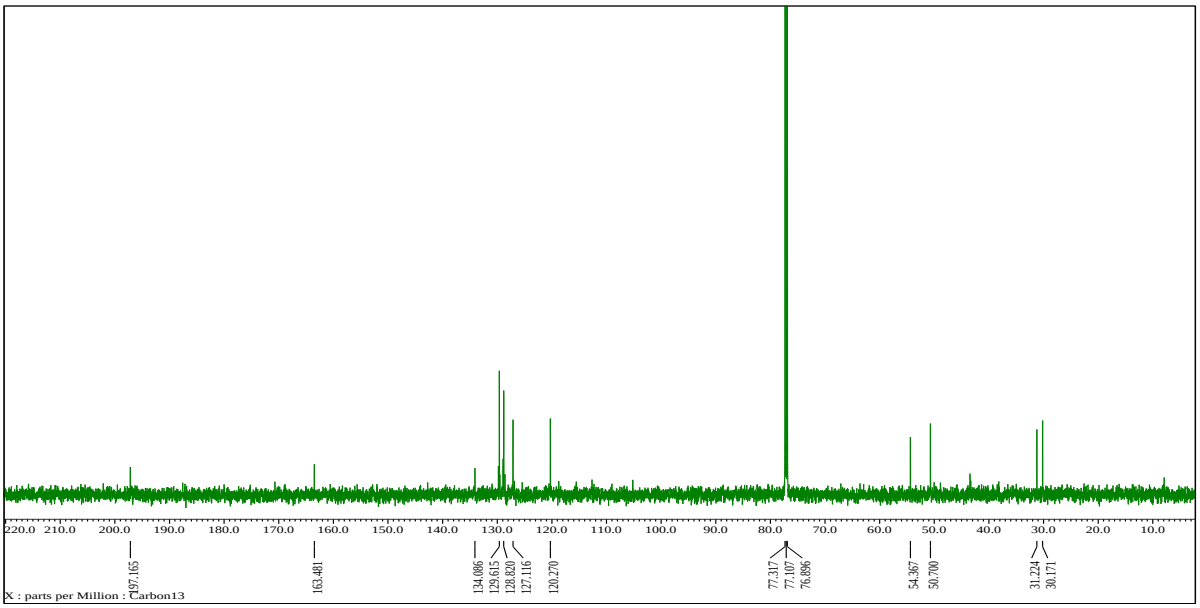
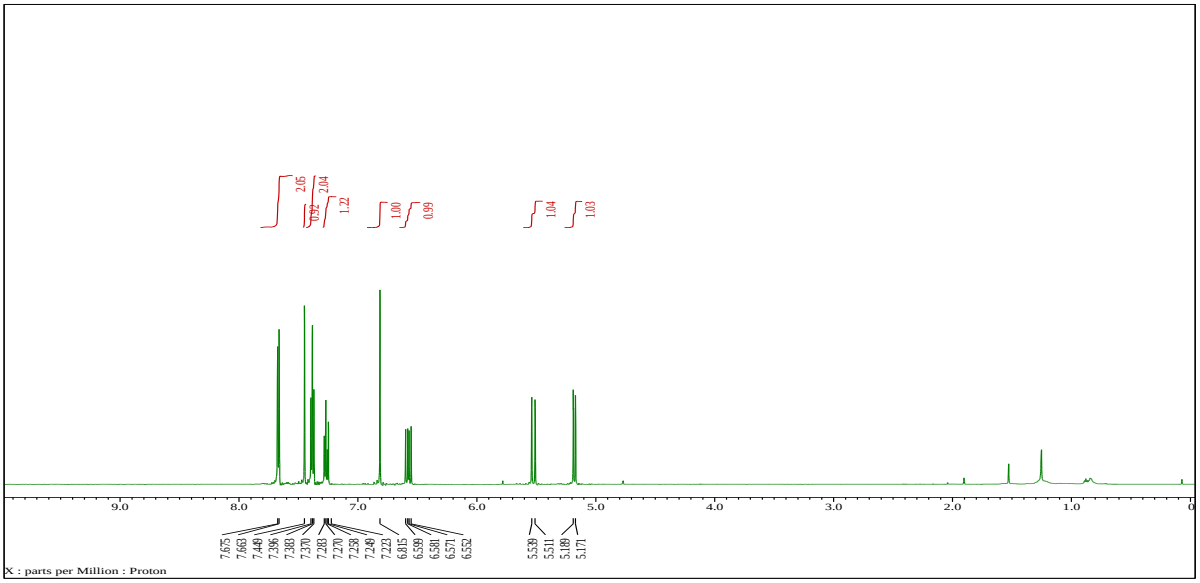
2.26
1.50
1.00
1.02
2.49
1.38
1.08
1.26
1.11
11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0
7.338 7.326 7.313 7.270 7.259 7.252 7.248 7.225 7.211 7.203
6.296 6.293 6.288
4.875 4.869 4.866 4.863 4.860 4.858 4.854 4.851
3.761
3.258 3.253
2.920
2.660
2.322 2.320 2.306 2.300 2.291 2.289 2.286
X : parts per Million : Proton


O
Cl

4i


220.0 210.0 200.0 190.0 180.0 170.0 160.0 150.0 140.0 130.0 120.0 110.0 100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0
197.165
163.481
134.086
129.615
128.820
127.116
120.270
77.317
77.107
76.896
54.367
50.700
31.224
30.171
X : parts per Million : Carbon13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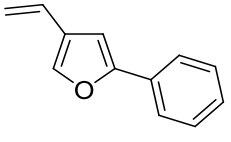
2.04
0.92
1.22
1.00
0.99
1.04
1.03
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.675
7.663
7.449
7.396
7.383
7.370
7.283
7.270
7.259
7.249
7.223
6.815
6.599
6.581
6.571
6.552
5.539
5.511
5.189
5.171
X : parts per Million : Proton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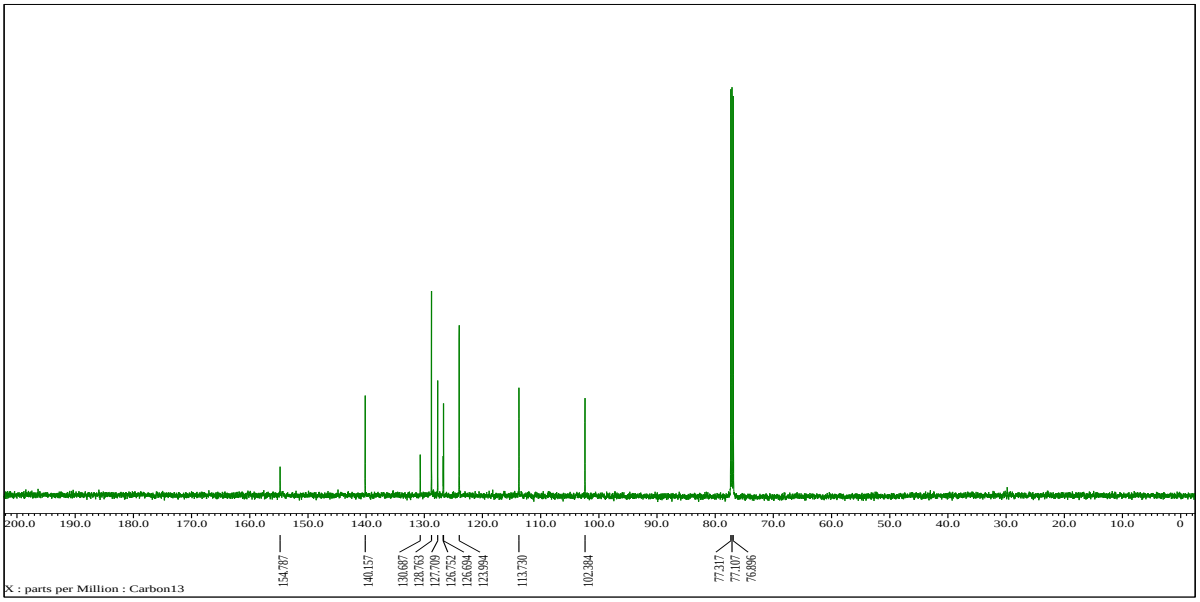
5a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180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
154.787
140.157
130.687
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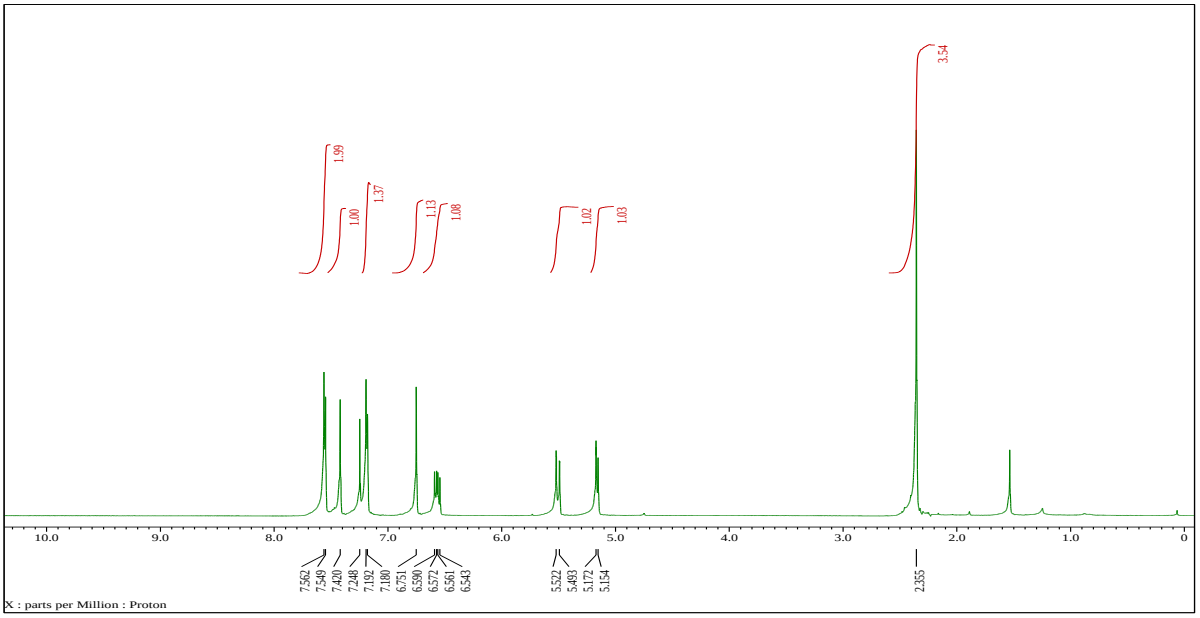
127.709
126.752
126.694
123.994
113.730
102.384
77.317
77.107
76.896
X : parts per Million : Carbon13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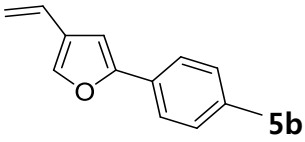
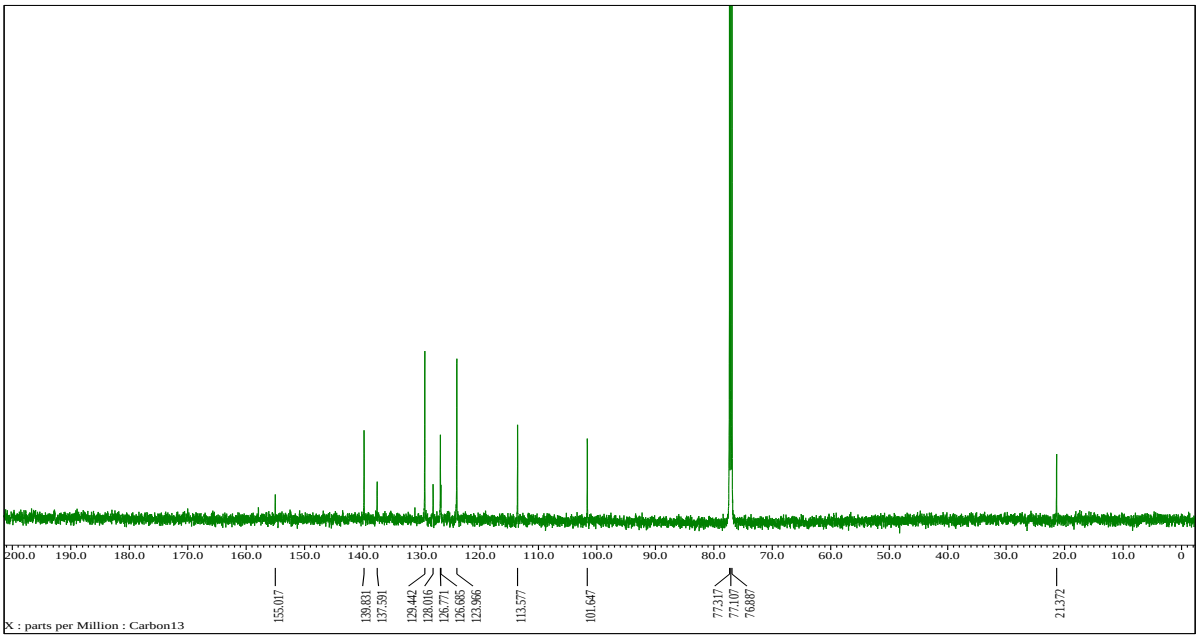
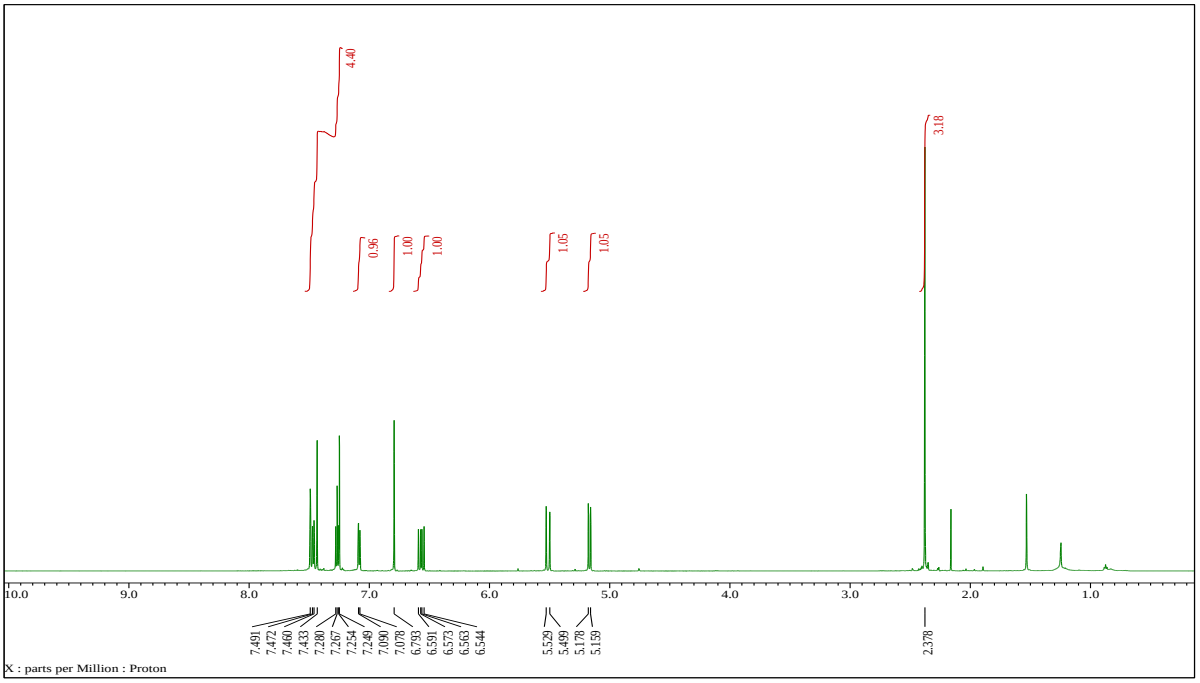
1.99
1.00
1.37
1.13
1.08
1.02
1.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.562
7.549
7.420
7.248
7.192
7.180
6.751
6.590
6.572
6.561
6.543
5.522
5.493
5.172
5.154
2.355
X : parts per Million : Proton


O

5b


200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
155.017
139.831
137.591
129.442
128.016
126.771
126.685
123.966
113.577
101.647
77.317
77.107
76.687
21.372
X : parts per Million : Carbon13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1.00
1.05
1.05
3.18
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.491
7.472
7.460
7.433
7.280
7.267
7.254
7.249
7.090
7.078
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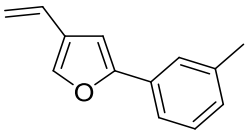
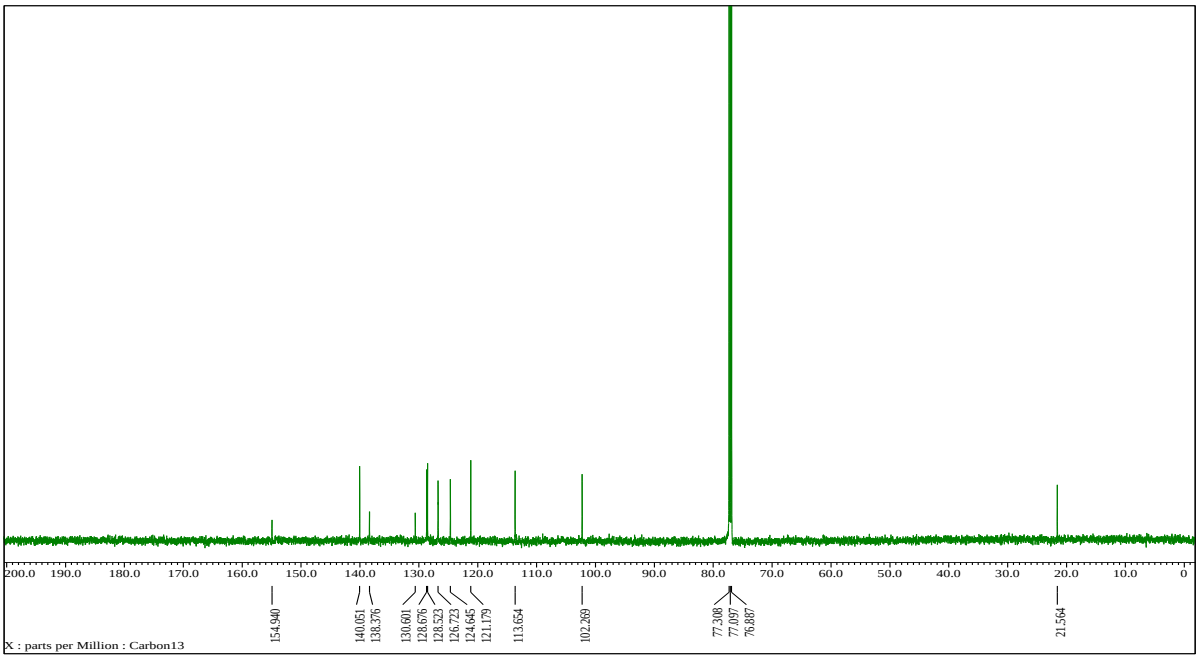
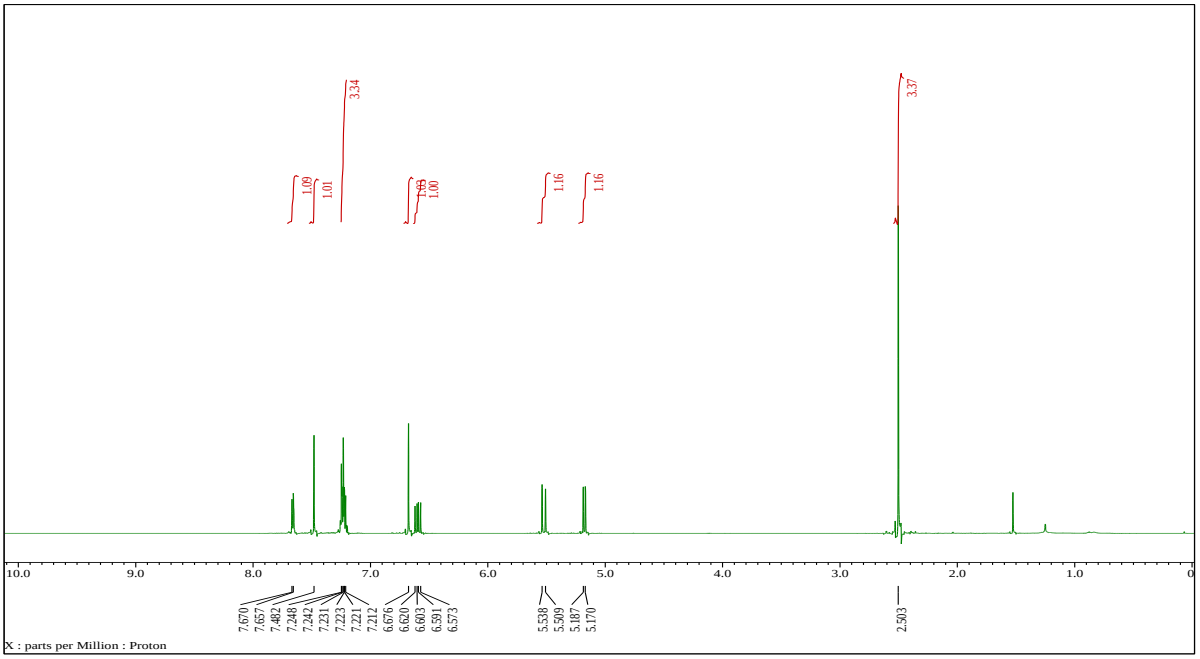
6.573
6.563
6.544
5.529
5.499
5.178
5.159
2.378
X : parts per Million : Proton



5c


200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
154.940
140.051
138.376
130.601
128.676
128.523
126.723
124.645
121.179
113.654
102.269
77.308
77.097
76.887
21.564
X : parts per Million : Carbon13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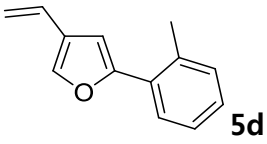
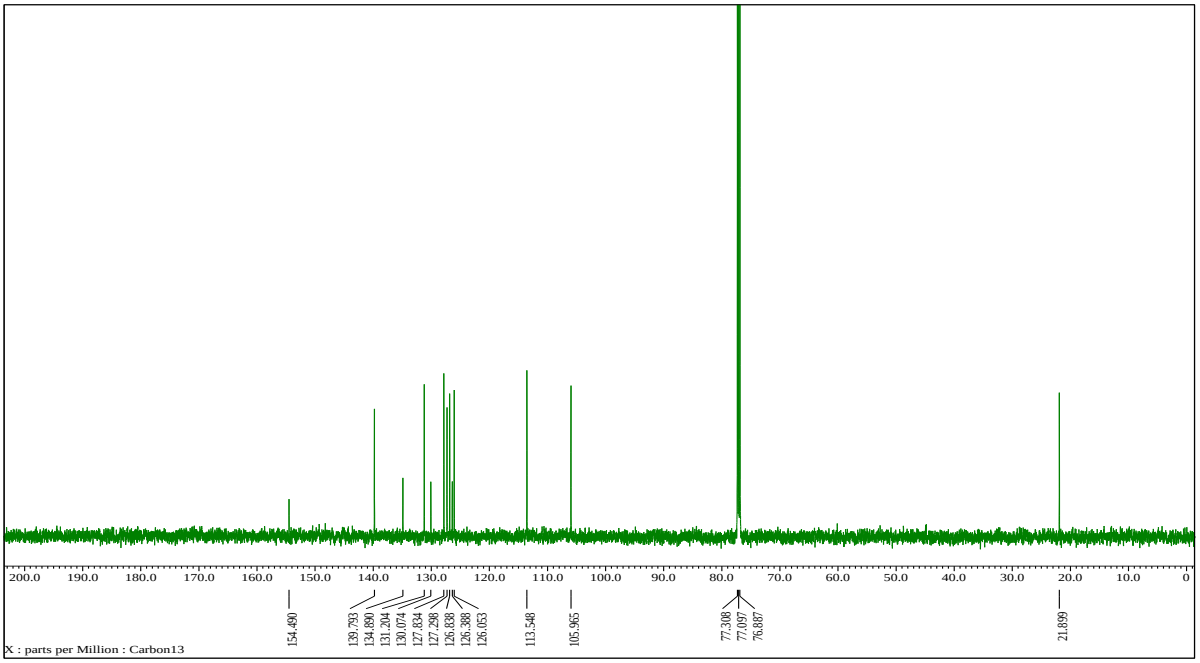
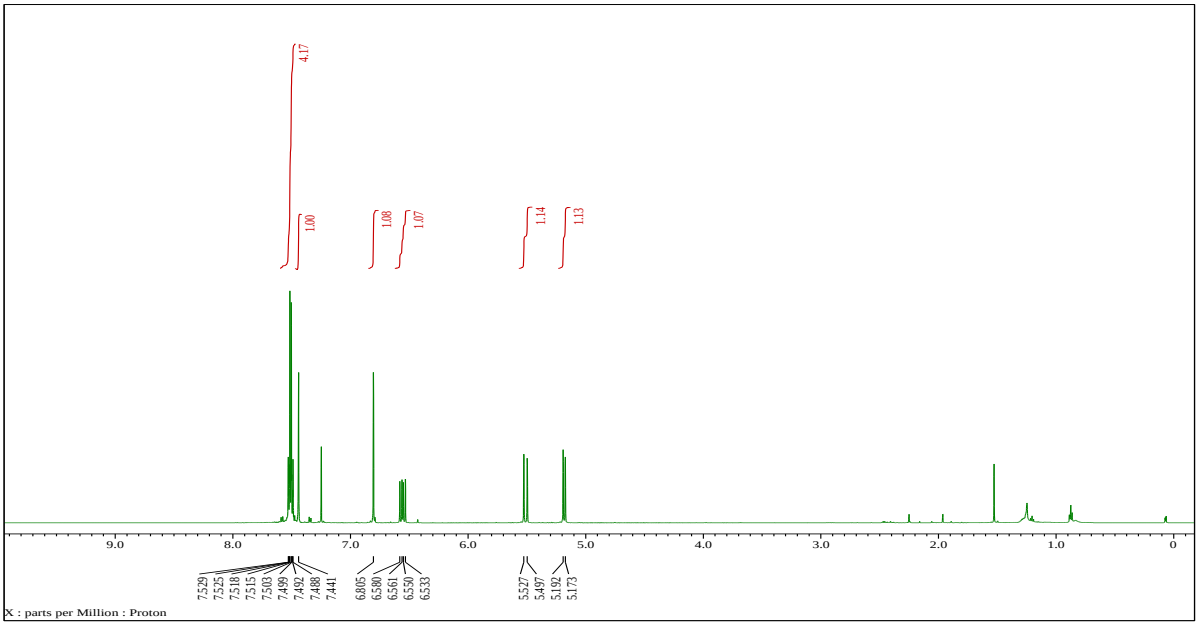
1.09
1.01
1.03
1.00
1.16
1.16
3.37
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.670
7.657
7.482
7.248
7.242
7.231
7.223
7.221
7.212
6.676
6.620
6.603
6.591
6.573
5.538
5.509
5.187
5.170
2.503
X : parts per Million : Proton



5d


200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
154.490
139.793
134.890
131.204
130.074
127.834
127.296
126.838
126.388
126.053
113.548
105.965
77.308
77.097
76.887
21.899
X : parts per Million : Carbon13


4.17
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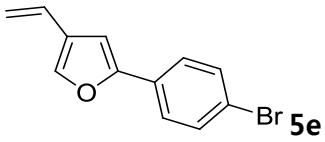
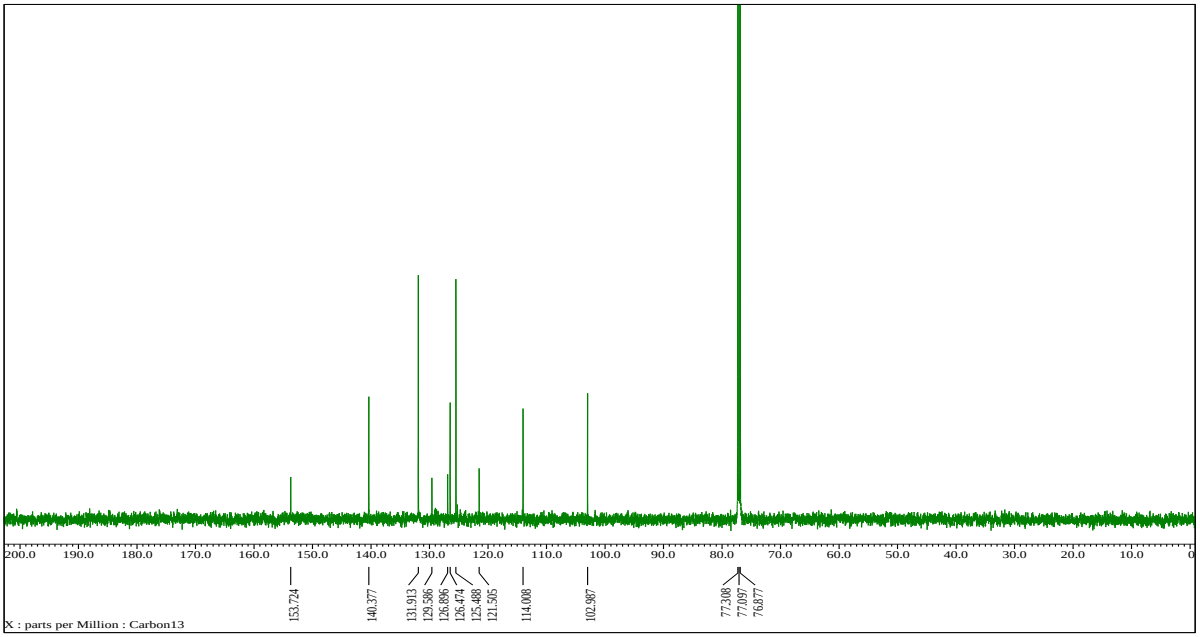
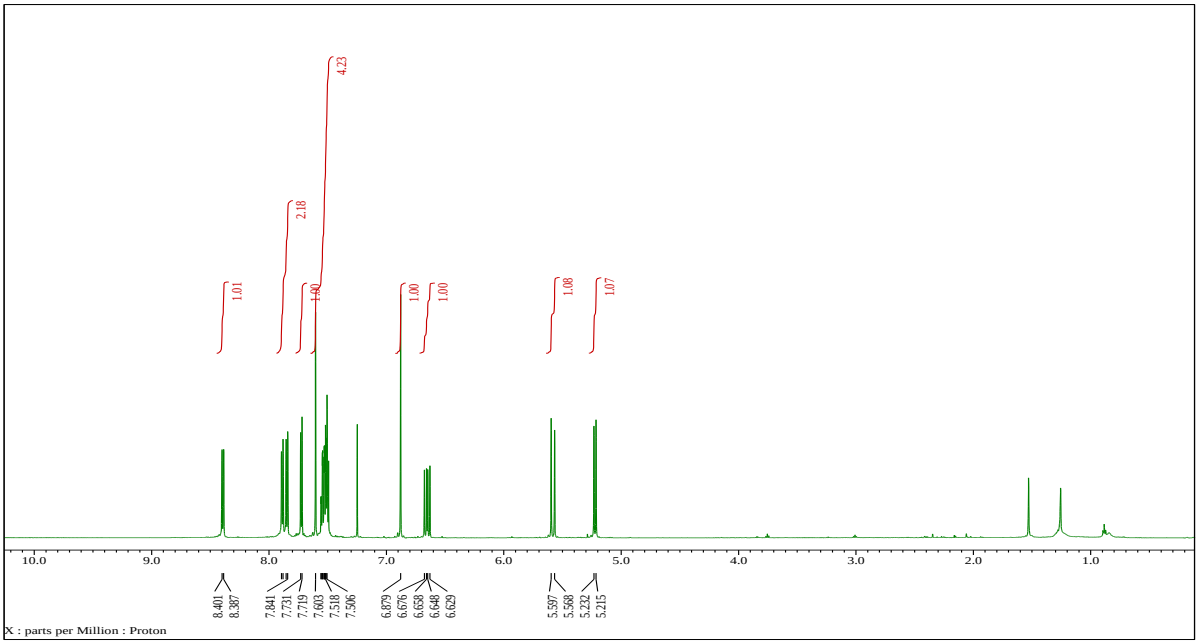
1.08
1.07
1.14
1.13
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.529
7.525
7.518
7.515
7.503
7.499
7.492
7.488
7.441
6.805
6.580
6.561
6.550
6.533
5.527
5.497
5.192
5.173
X : parts per Million : Proton


O
Br

5e


200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
153.724
140.377
131.913
129.586
126.896
126.474
125.488
121.505
114.008
102.987
77.308
77.097
76.877
X : parts per Million : Carbon13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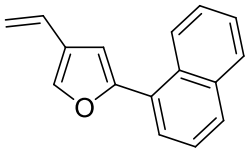
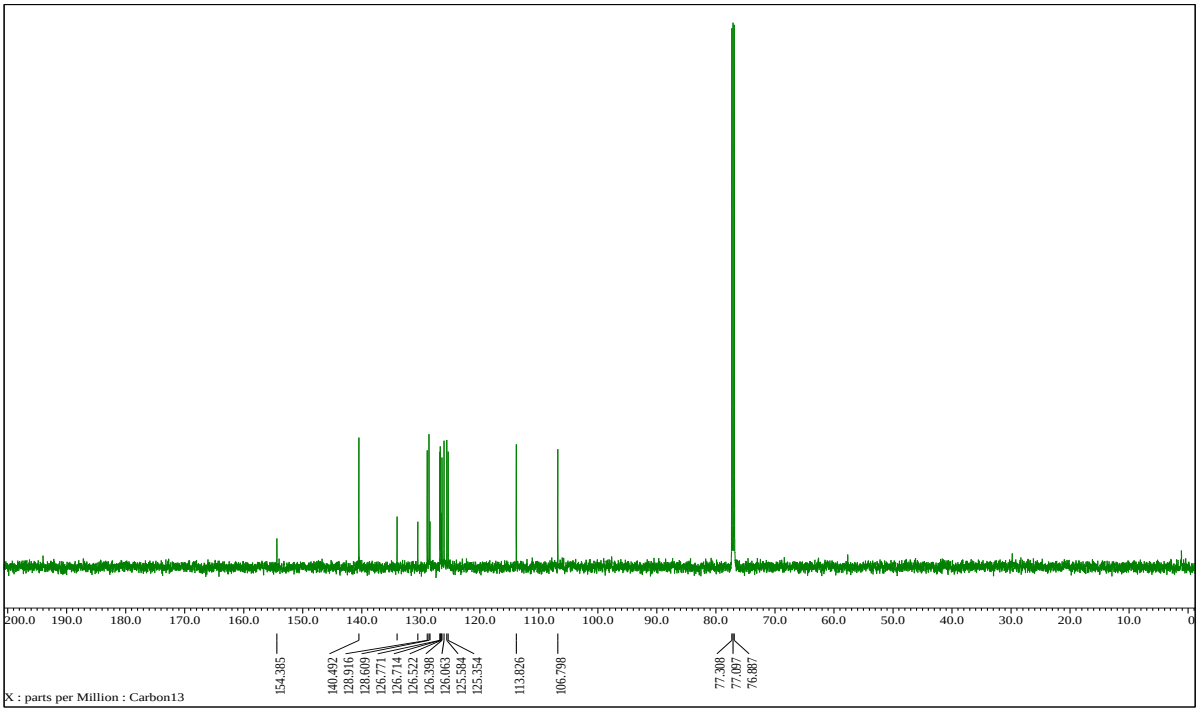
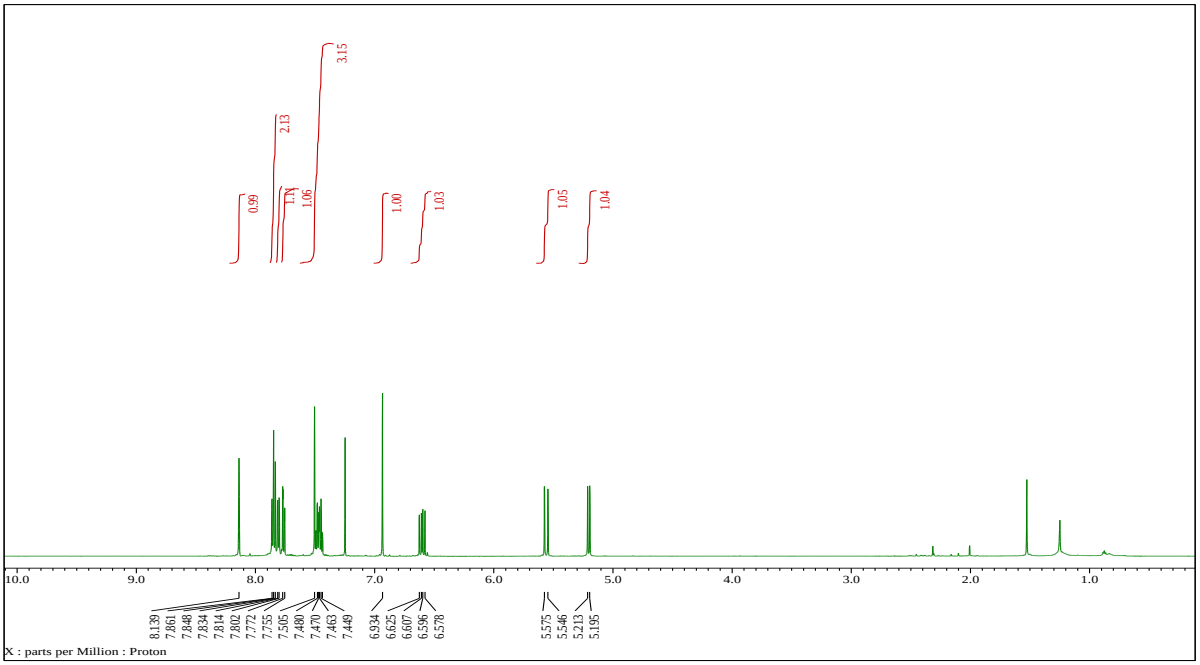
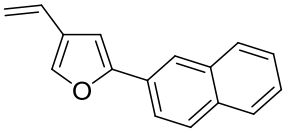
2.18
1.01
1.40
1.00
1.00
1.08
1.07
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
8.401
8.387
7.841
7.731
7.719
7.603
7.518
7.506
6.879
6.676
6.638
6.648
6.629
5.597
5.568
5.232
5.215
X : parts per Million : Proton



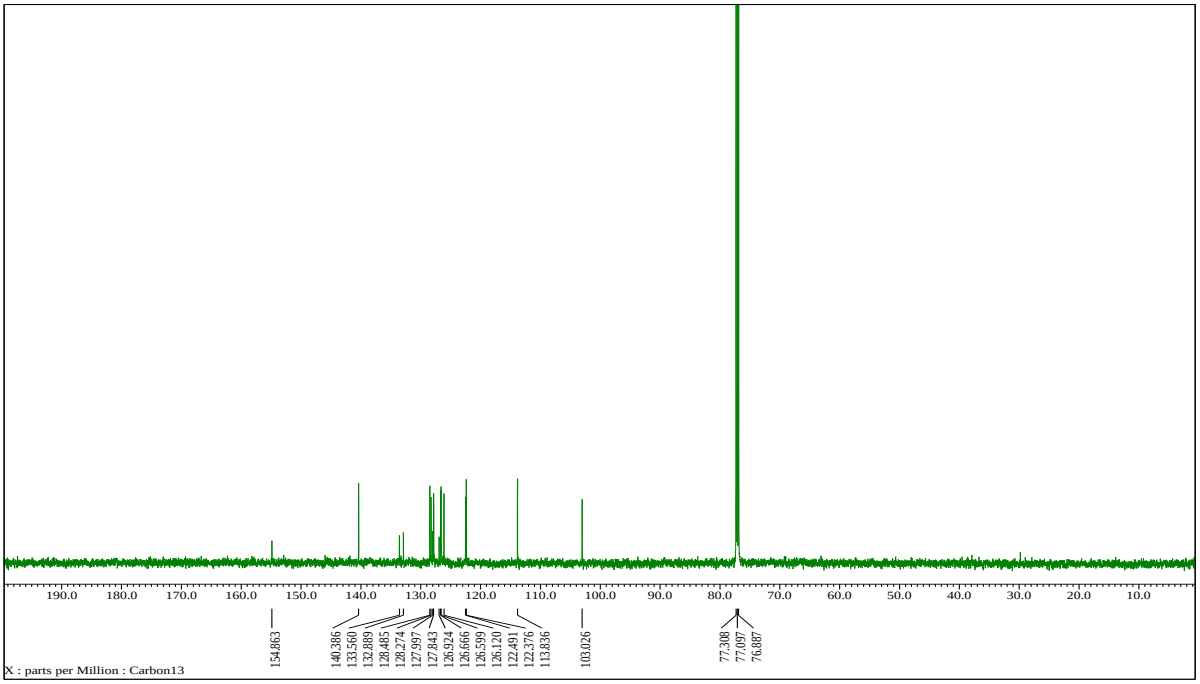
5f

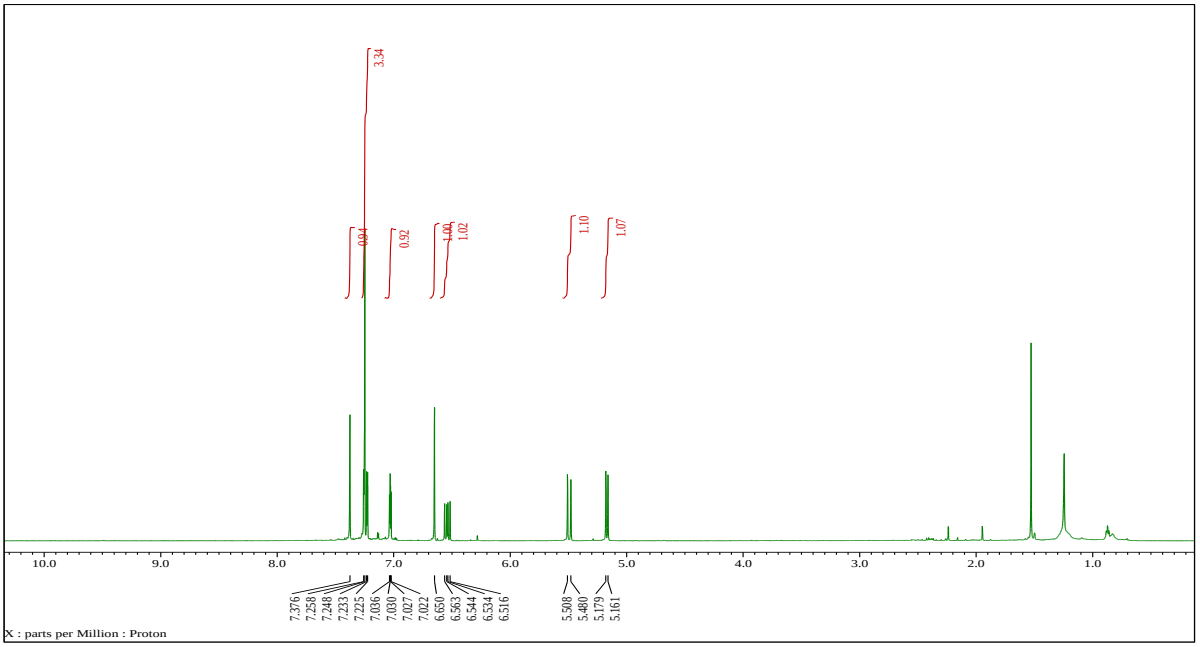

200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
154.385
140.492
128.916
128.609
126.771
126.714
126.522
126.398
126.063
125.584
125.354
113.826
106.798
77.308
77.097
76.887
X : parts per Million : Carbon13


3.15
2.13
1.14
1.06
0.99
1.00
1.03
1.05
1.04
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
8.139
7.861
7.848
7.834
7.814
7.802
7.772
7.755
7.505
7.480
7.470
7.463
7.449
6.934
6.625
6.607
6.596
6.578
5.575
5.546
5.213
5.195
X : parts per Million : Proton



5g


190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
154.863
140.386
133.560
132.889
128.485
128.274
127.997
127.843
126.924
126.666
126.599
126.120
122.491
122.376
113.836
103.026
77.308
77.097
76.887
X : parts per Million : Carbon13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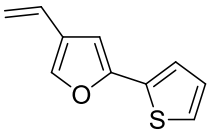
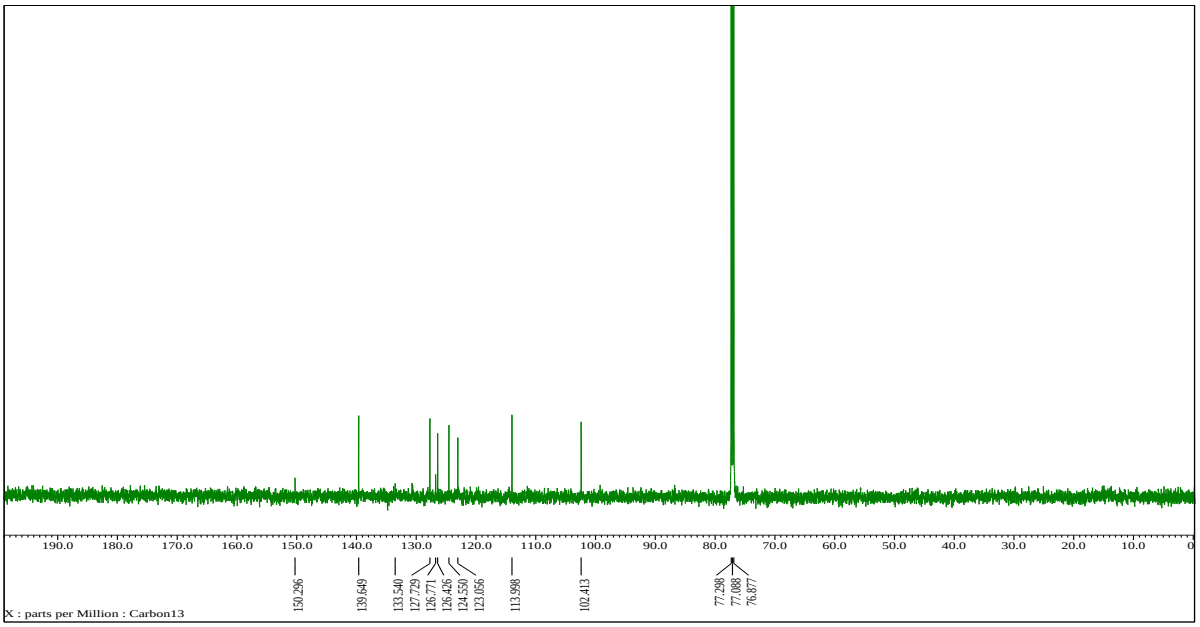
1.00
1.02
1.10
1.07
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.376
7.258
7.248
7.233
7.225
7.036
7.030
7.027
7.022
6.650
6.563
6.544
6.534
6.516
5.508
5.480
5.179
5.161
X : parts per Million : Proton


O
S

5h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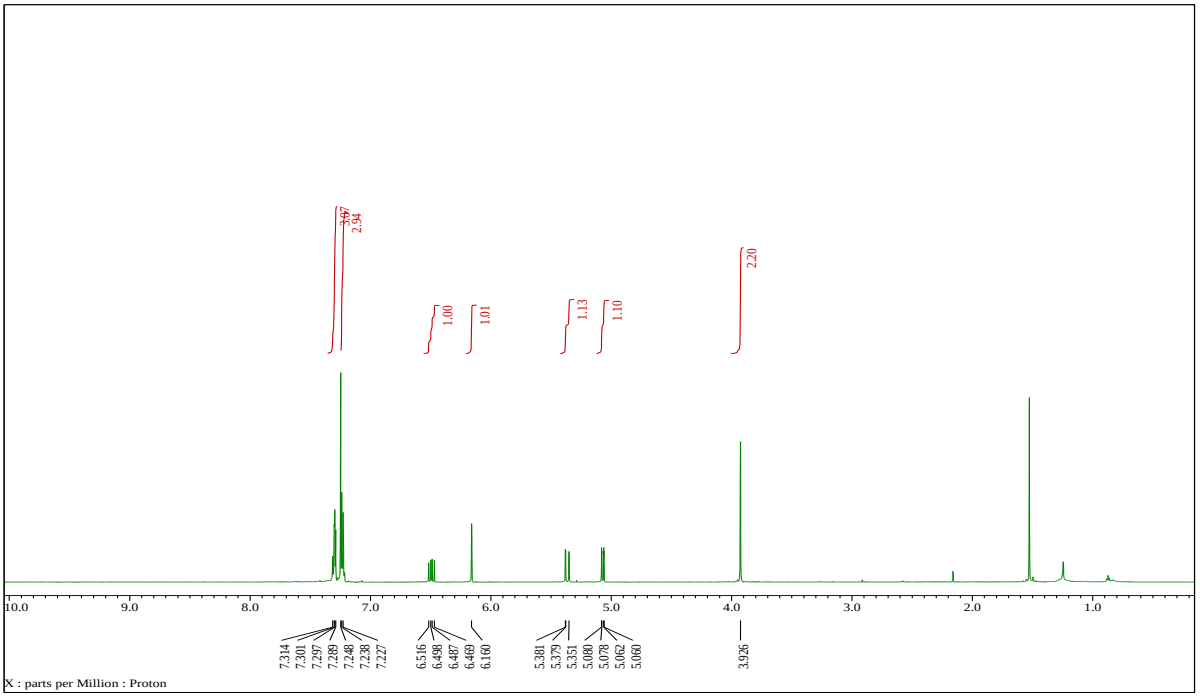
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
150.296
139.649
133.540
127.729
126.771
126.426
124.550
123.056
113.998
102.413
77.298
77.088
76.877
X : parts per Million : Carbon13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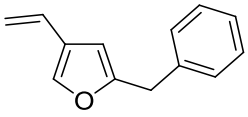
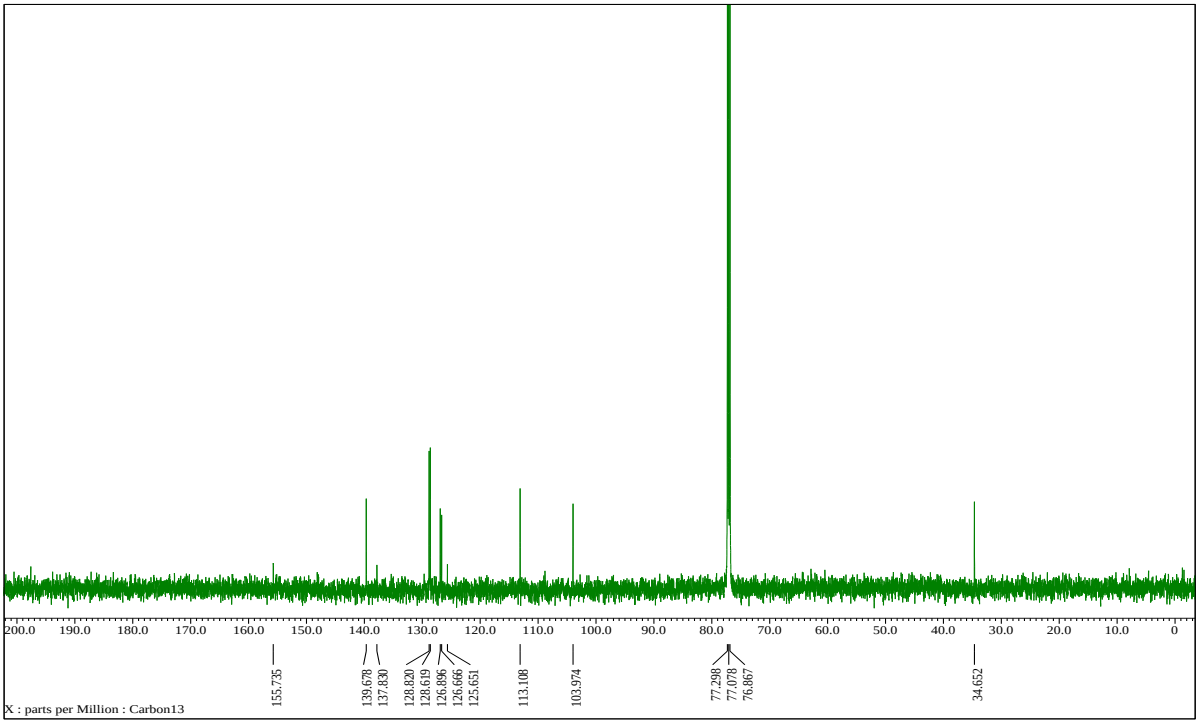
2.94
1.00
1.01
1.13
1.10
2.20
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.314
7.301
7.297
7.289
7.248
7.238
7.227
6.516
6.498
6.487
6.469
6.160
5.381
5.379
5.351
5.080
5.078
5.062
5.060
3.926
X : parts per Million : Proton



5i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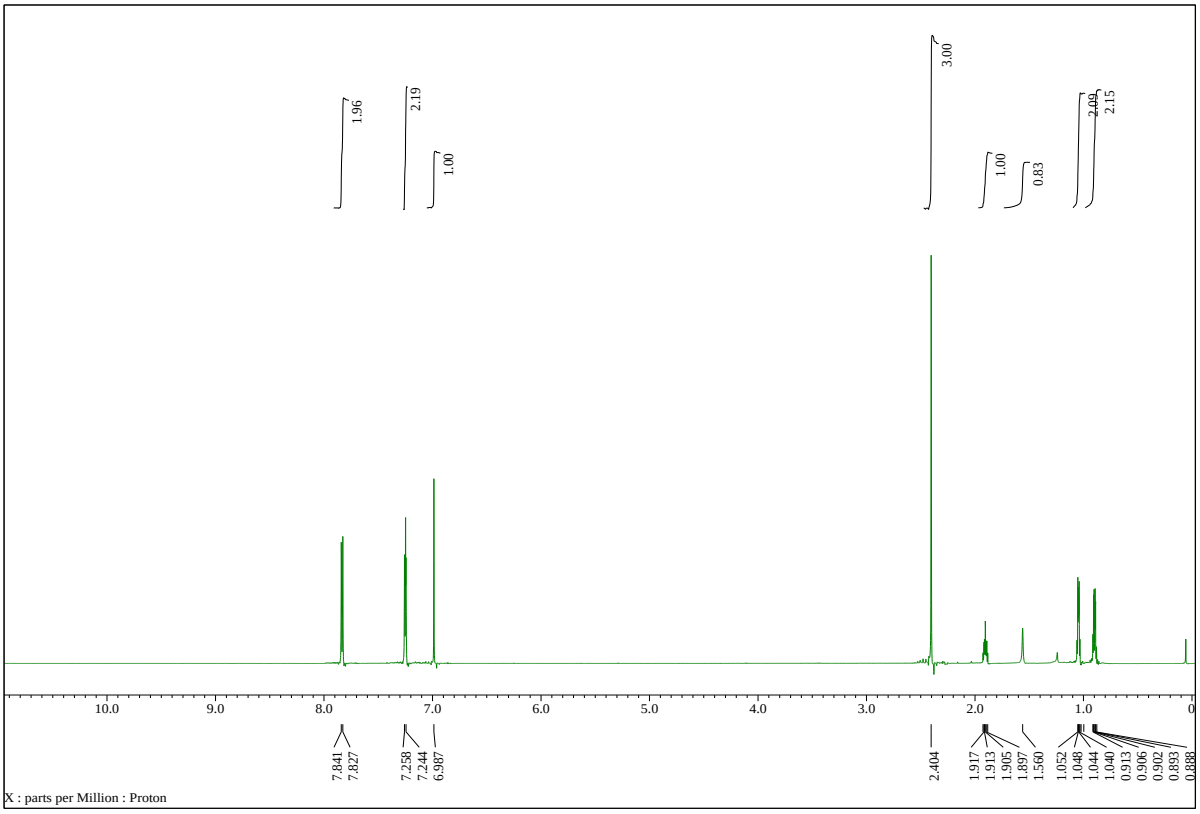
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
155.735
139.678
137.830
128.820
128.619
126.896
126.666
125.651
113.108
103.974
77.298
77.078
76.867
34.652
X : parts per Million : Carbon13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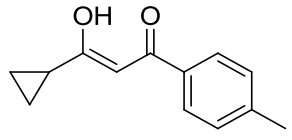
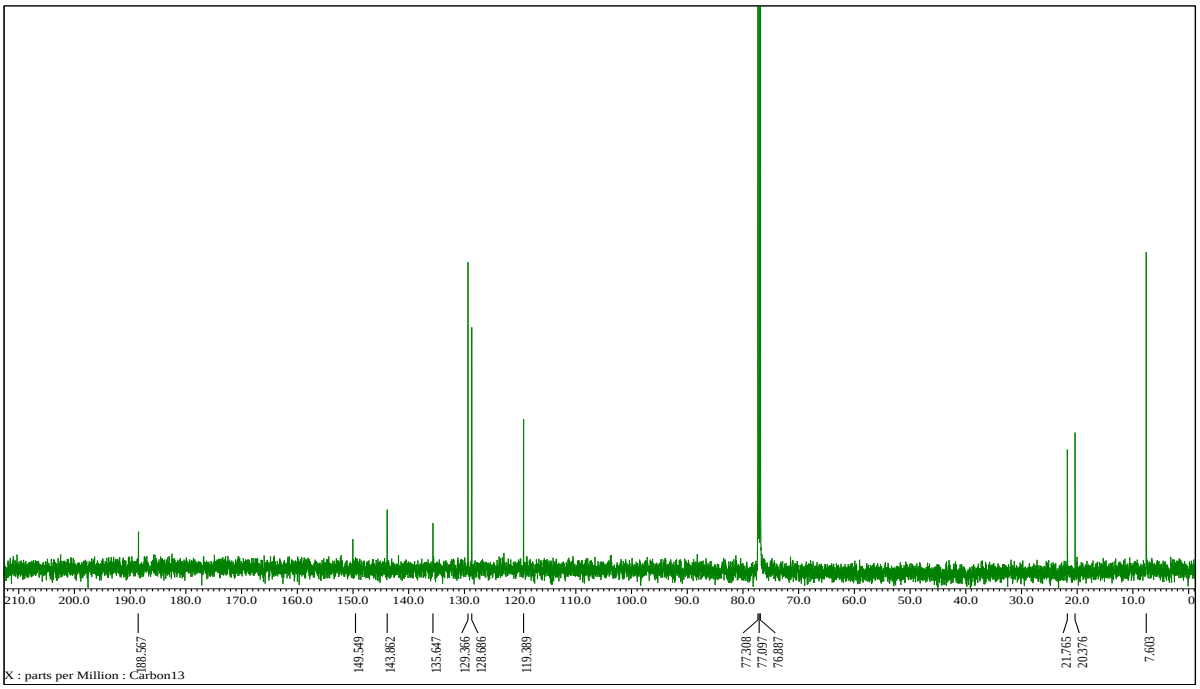
2.19
1.00
3.00
1.00
0.83
2.09
2.15
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.841
7.827
7.258
7.244
6.987
2.404
1.917
1.913
1.905
1.897
1.560
1.052
1.048
1.044
1.040
0.913
0.906
0.902
0.893
0.888
X : parts per Million : Proton


OH
O

(*Z*)-4ba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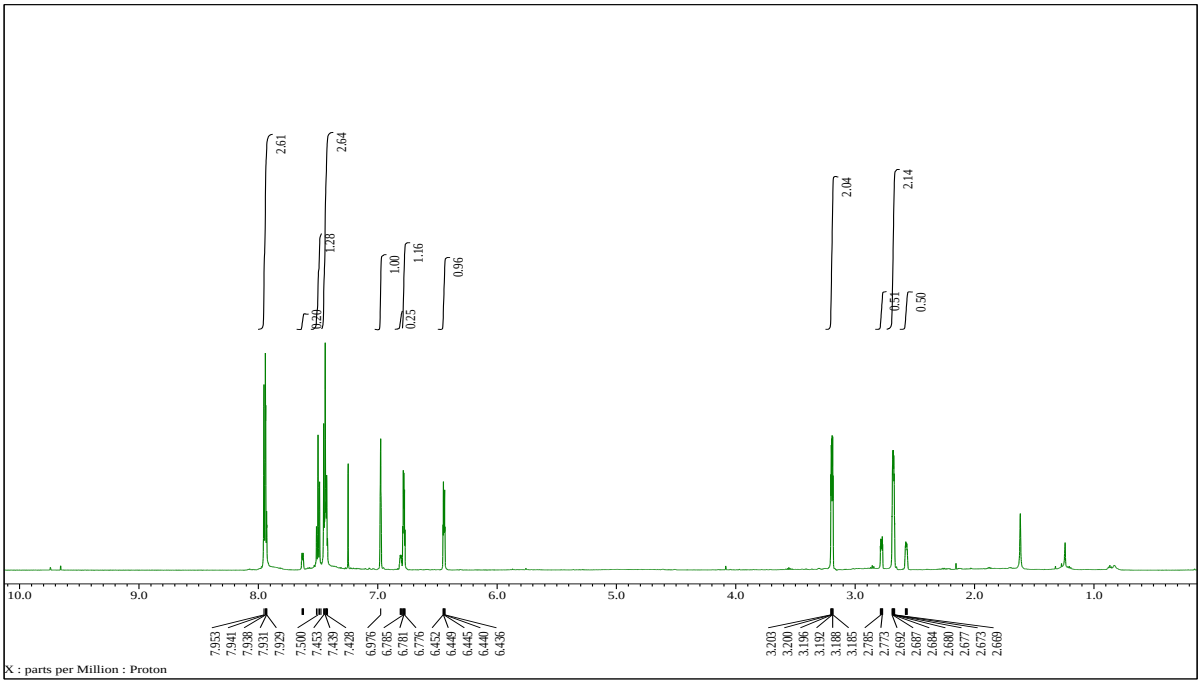
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
188.567
149.549
143.862
135.647
129.366
128.686
119.389
77.308
77.097
76.887
21.765
20.376
7.603
X : parts per Million : Carbon13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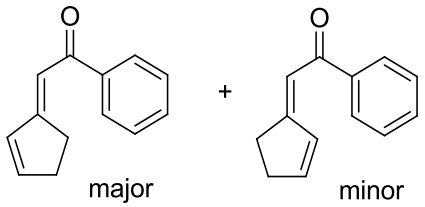
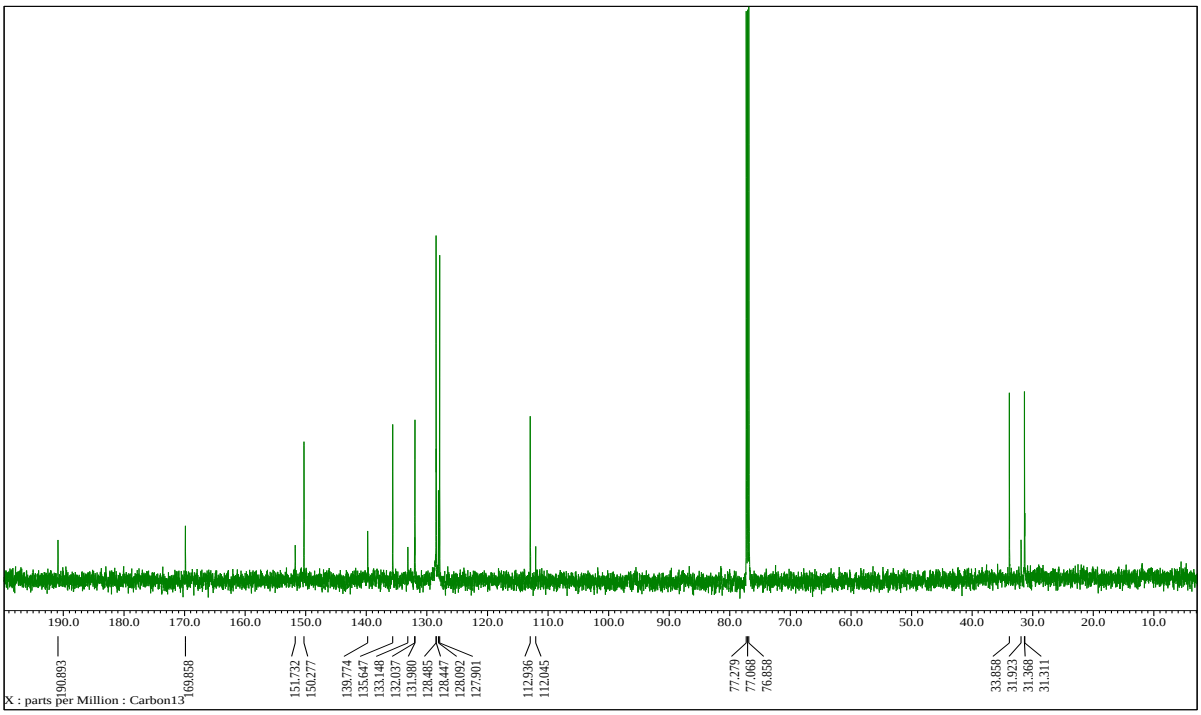
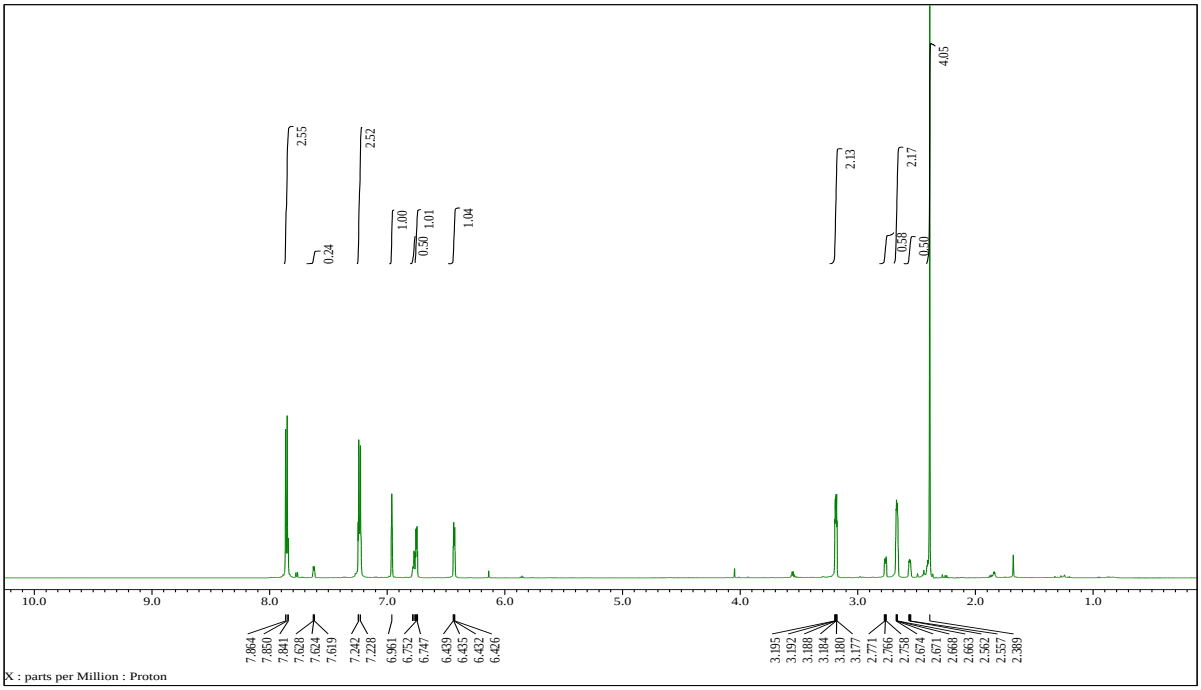
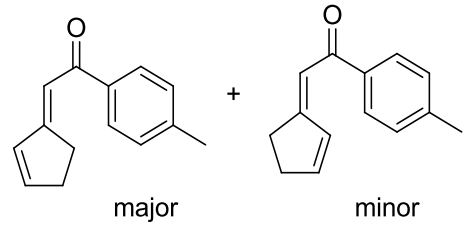
2.64
1.28
1.00
1.16
0.96
0.25
2.04
2.14
0.51
0.50
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.953
7.941
7.938
7.931
7.929
7.500
7.453
7.439
7.428
6.976
6.785
6.781
6.776
6.452
6.449
6.445
6.440
6.436
3.203
3.200
3.196
3.192
3.188
3.185
2.785
2.773
2.692
2.687
2.684
2.680
2.677
2.673
2.669
X : parts per Million : Proton


O
O
+
major
minor

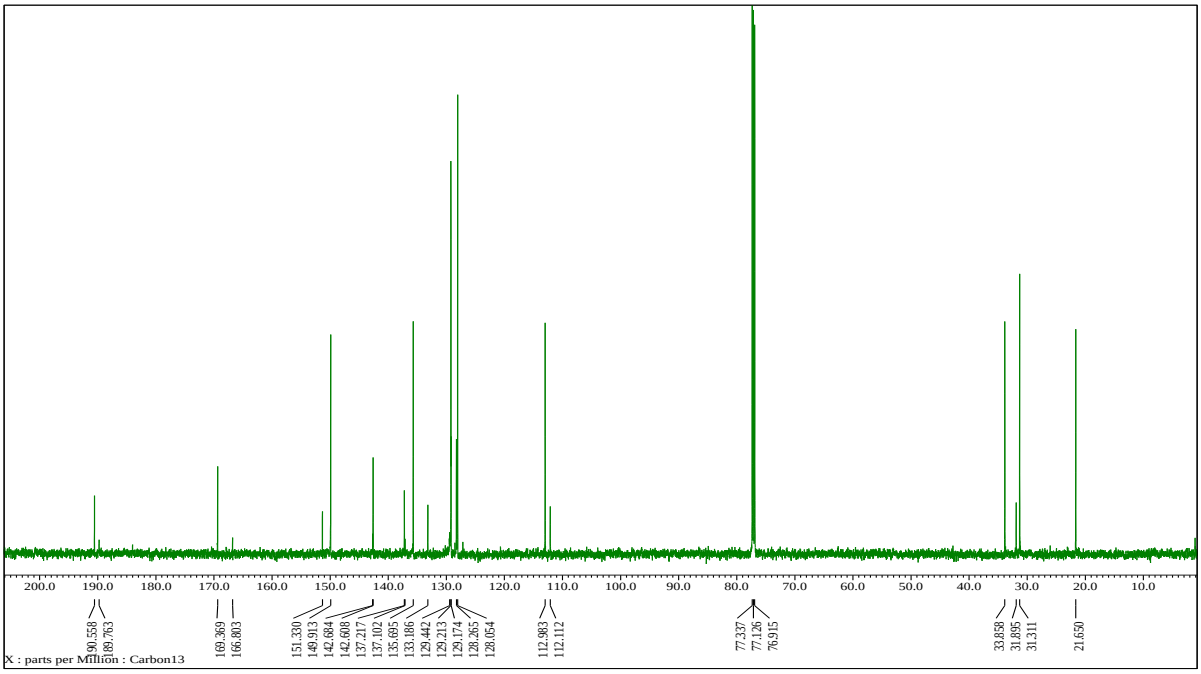
6a

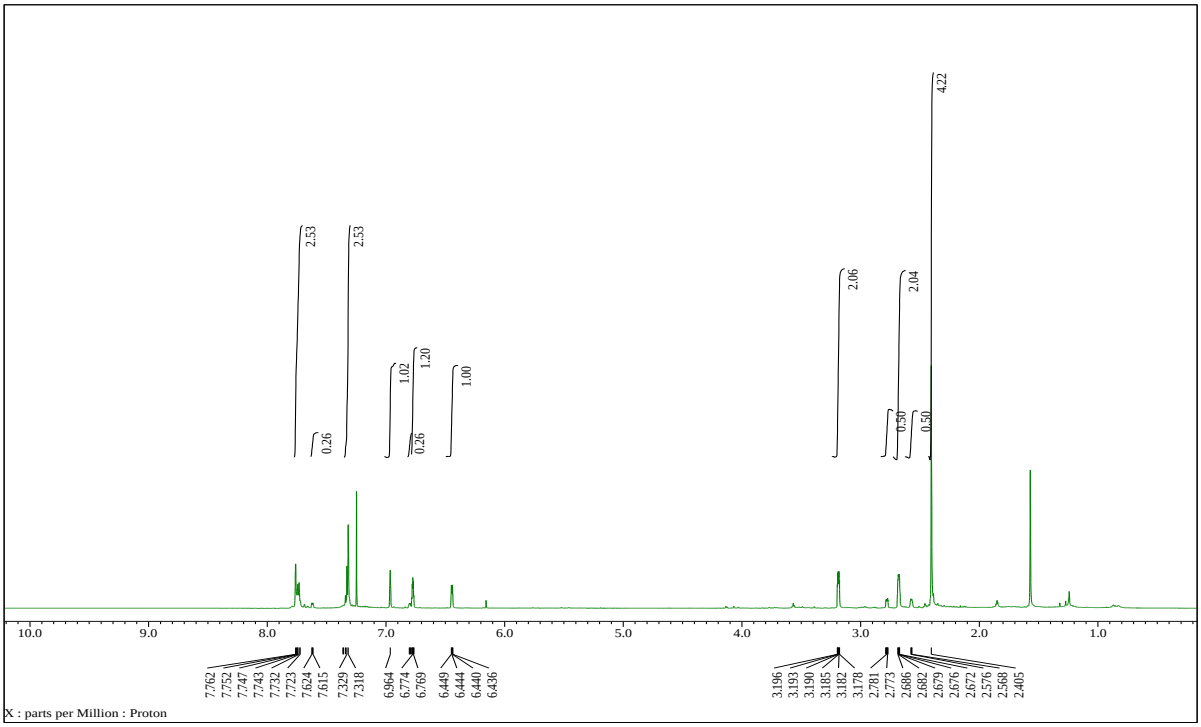

190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
190.893
169.858
151.732
150.277
139.774
135.647
133.148
132.037
131.980
128.485
128.447
128.092
127.901
112.936
112.045
77.279
77.068
76.858
33.858
31.923
31.368
31.311
X : parts per Million : Carbon13

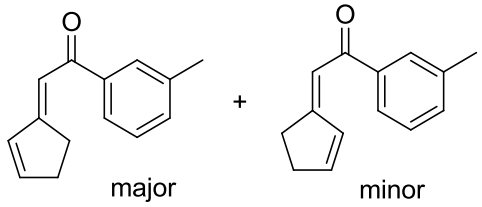

4.05
2.55
2.52
2.13
2.17
1.00
1.01
1.04
0.24
0.58
0.50
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.864
7.850
7.841
7.628
7.624
7.619
7.242
7.228
6.961
6.752
6.747
6.439
6.435
6.432
6.426
3.195
3.192
3.188
3.184
3.180
3.177
2.771
2.766
2.758
2.674
2.671
2.668
2.663
2.562
2.557
2.389
X : parts per Million : Proton


O
O
+
major
minor

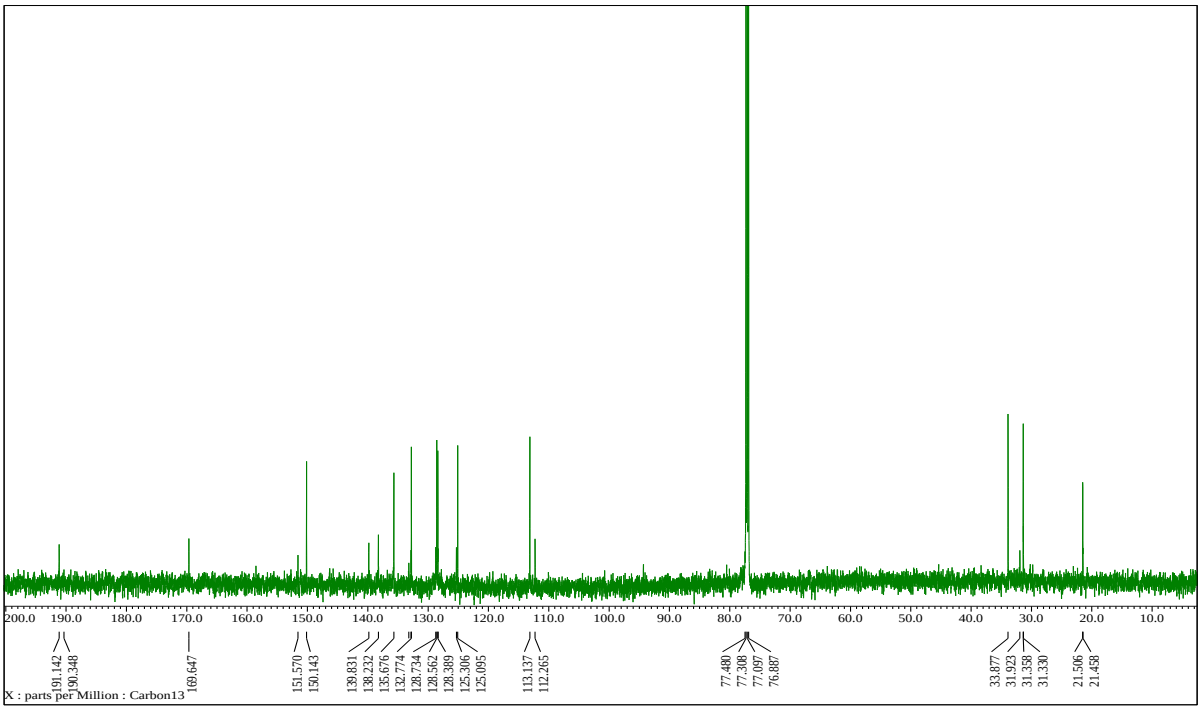
6b

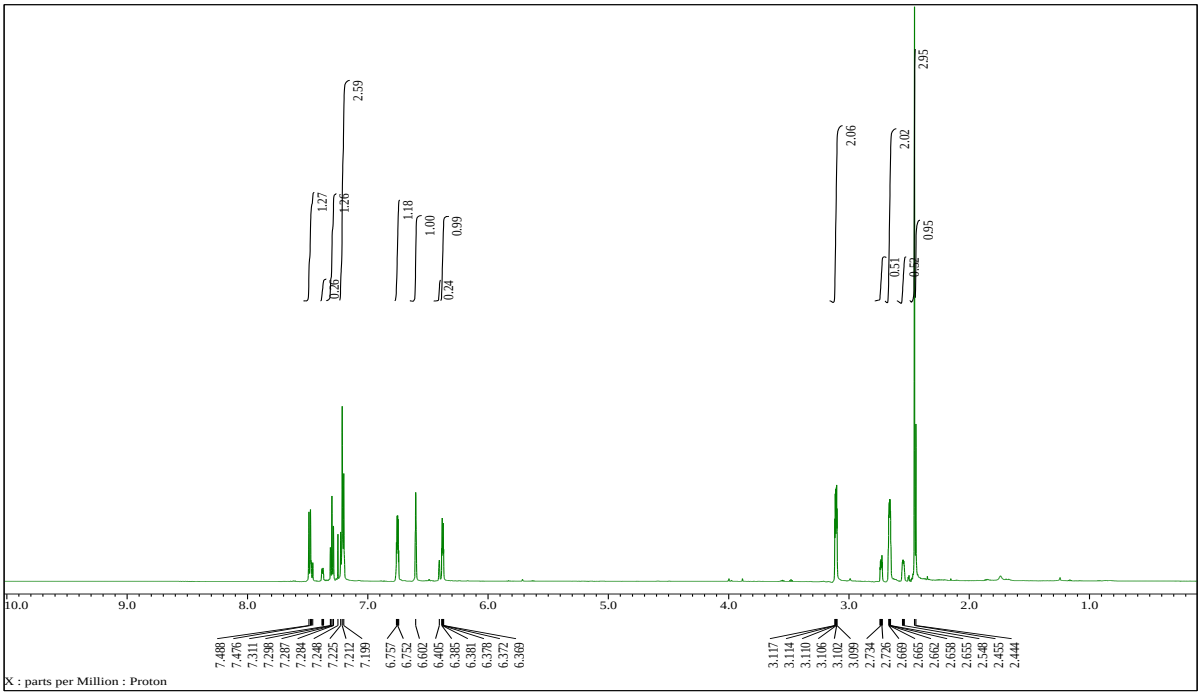

200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
190.558
189.763
169.369
166.803
151.330
149.913
142.684
142.608
137.217
137.102
135.695
133.186
129.442
129.213
129.174
128.265
128.054
112.983
112.112
77.337
77.126
76.915
33.858
31.695
31.311
21.650
X : parts per Million : Carbon13


2.53
2.53
0.26
1.02
1.20
0.26
1.00
2.06
2.04
0.39
0.50
4.22
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.762
7.752
7.747
7.743
7.732
7.723
7.624
7.615
7.329
7.318
6.964
6.774
6.769
6.449
6.444
6.440
6.436
3.196
3.193
3.190
3.185
3.182
3.178
2.781
2.773
2.686
2.682
2.679
2.676
2.672
2.576
2.568
2.405
X : parts per Million : Proton


O
O
+
major
minor

6c


200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
191.142
190.348
169.647
151.570
150.143
139.831
138.232
135.676
132.774
128.734
128.562
128.389
125.306
125.095
113.137
112.265
77.480
77.308
77.097
76.887
33.877
31.923
31.358
31.330
21.506
21.458
X : parts per Million : Carbon13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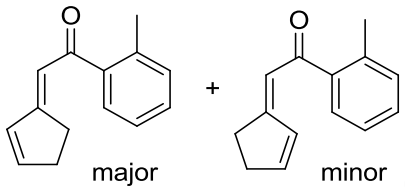
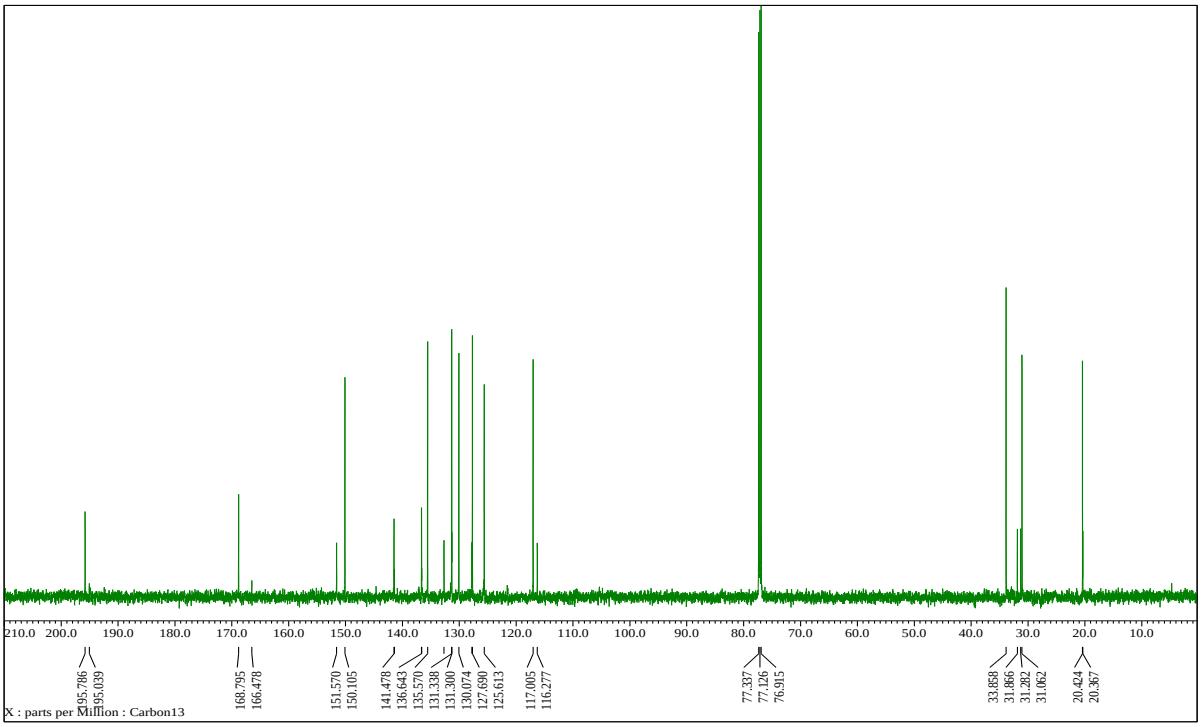
1.27
1.26
0.26
1.18
1.00
0.99
0.24
2.06
2.95
2.02
0.51
0.52
0.95
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.488
7.476
7.311
7.298
7.287
7.284
7.240
7.225
7.212
7.199
6.757
6.752
6.602
6.405
6.385
6.381
6.378
6.372
6.369
3.117
3.114
3.110
3.106
3.102
3.099
2.734
2.726
2.669
2.665
2.662
2.658
2.655
2.540
2.455
2.444
X : parts per Million : Proton


O
+
O
major
minor

6d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180.0
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160.0
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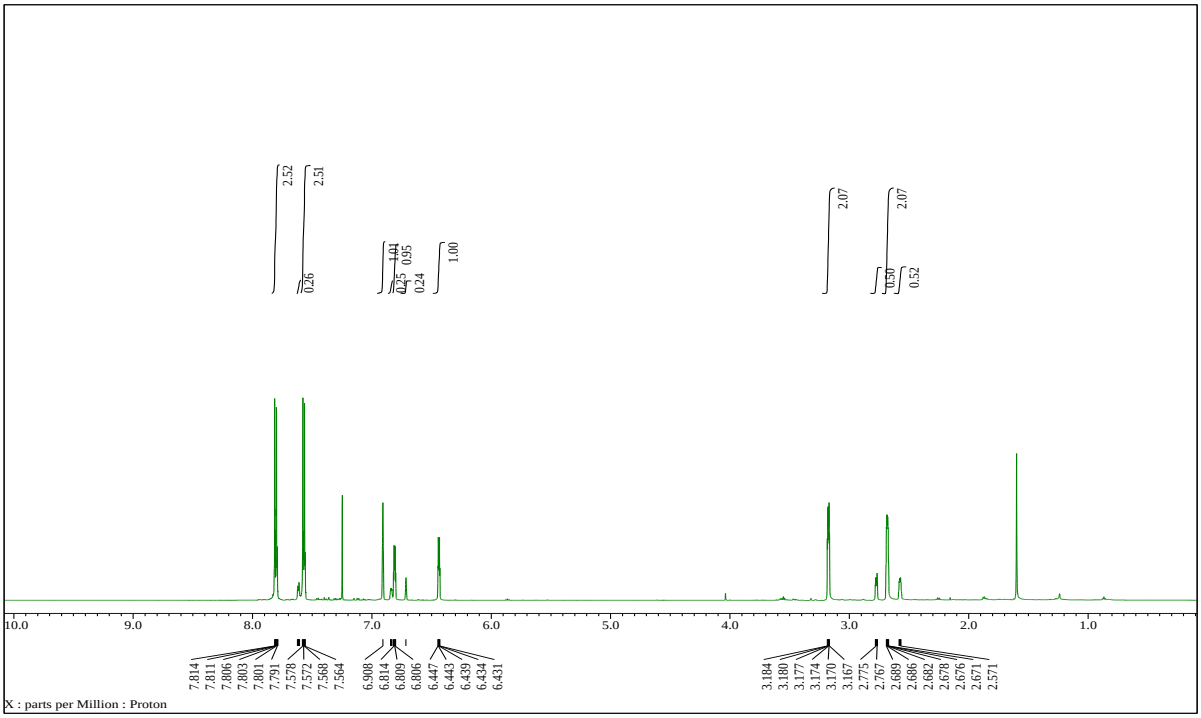
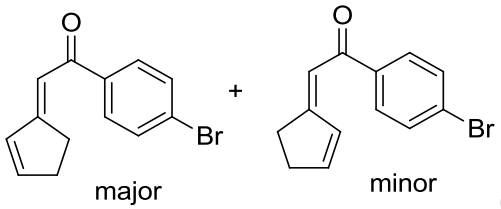
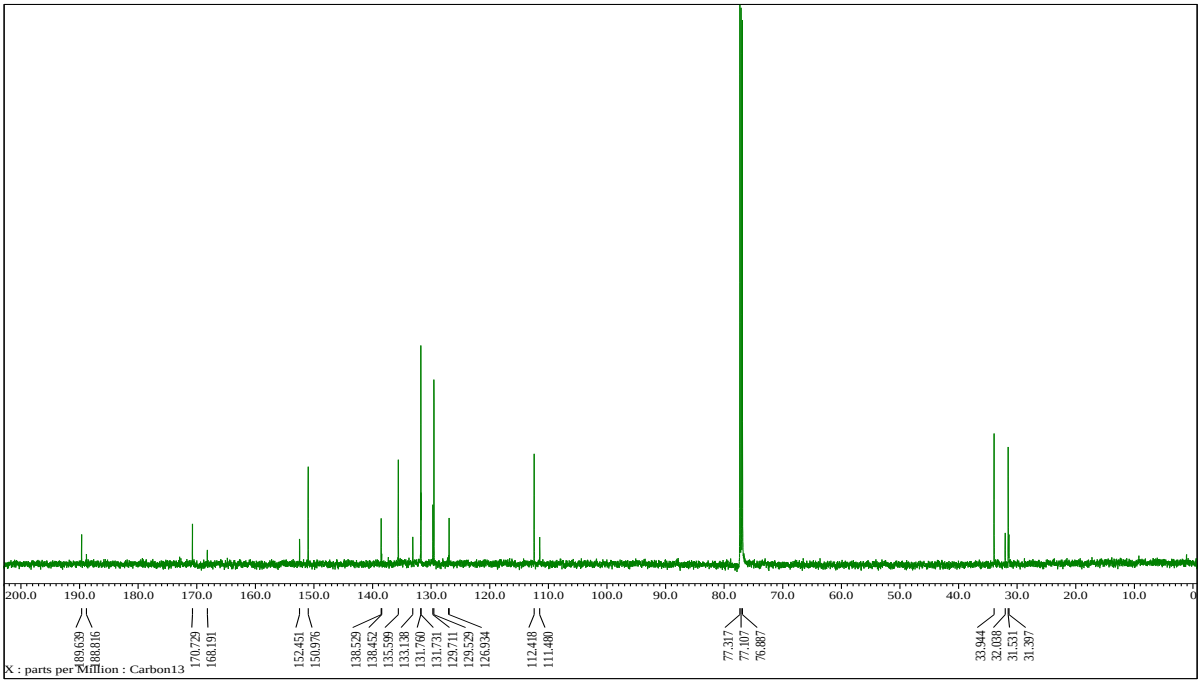
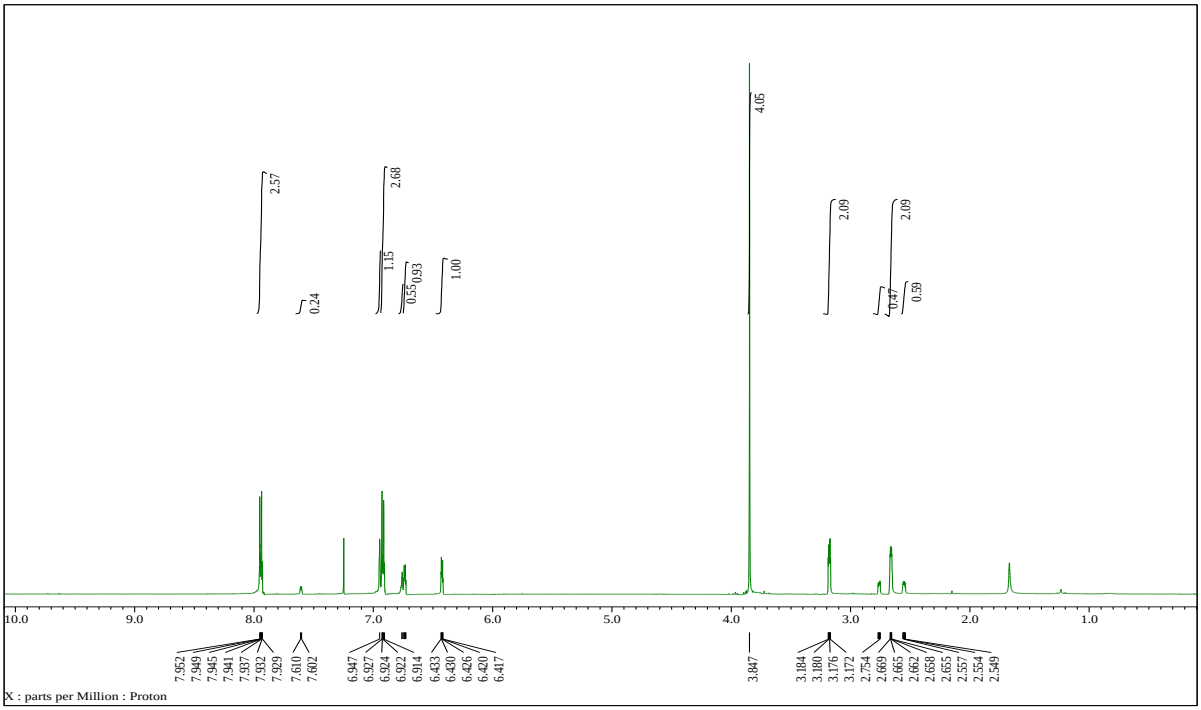
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
195.786
195.039
168.795
166.478
151.570
150.105
141.478
136.643
135.570
131.338
131.300
130.074
127.690
125.613
117.005
116.277
77.337
77.126
76.915
33.858
31.866
31.282
31.062
20.424
20.367
X : parts per Million : Carbon13

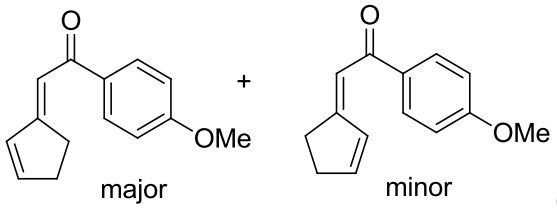

2.52
2.51
0.26
1.41
1.41
0.95
0.25
0.24
1.00
2.07
2.07
0.50
0.52
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.814
7.811
7.806
7.803
7.801
7.791
7.578
7.572
7.568
7.564
6.908
6.814
6.809
6.806
6.447
6.443
6.439
6.434
6.431
3.184
3.180
3.177
3.174
3.170
3.167
2.775
2.767
2.689
2.686
2.682
2.678
2.676
2.671
2.571
X : parts per Million : Proton


O
Br
+
O
Br
major
minor

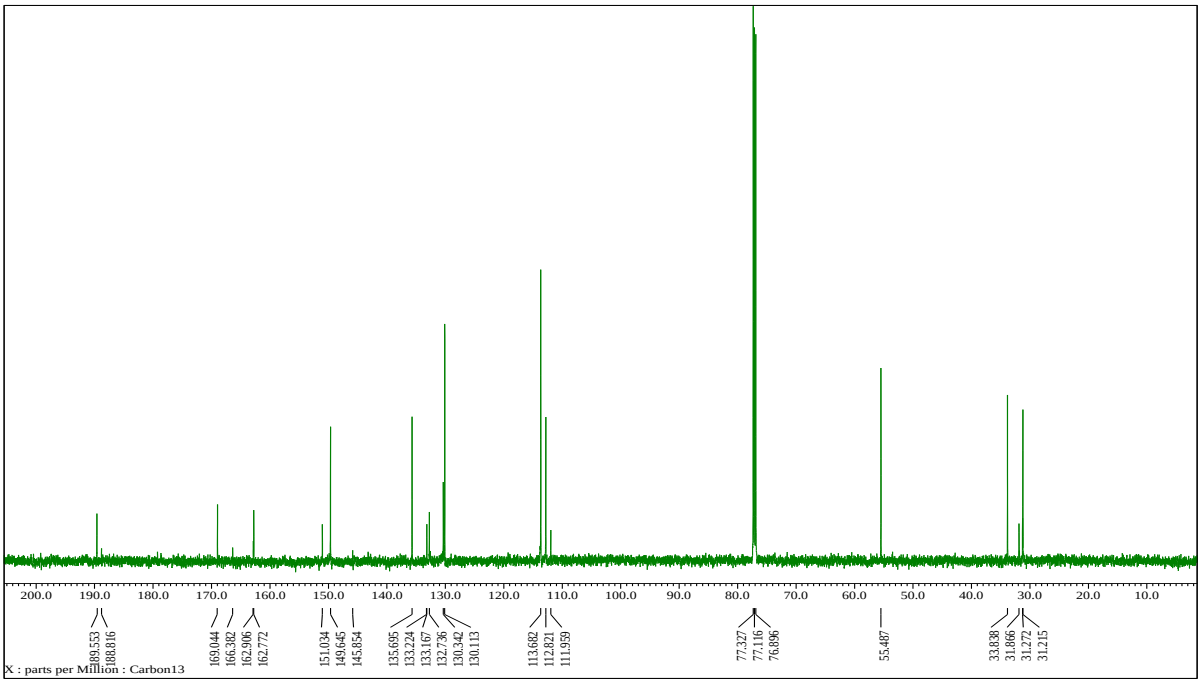
6e

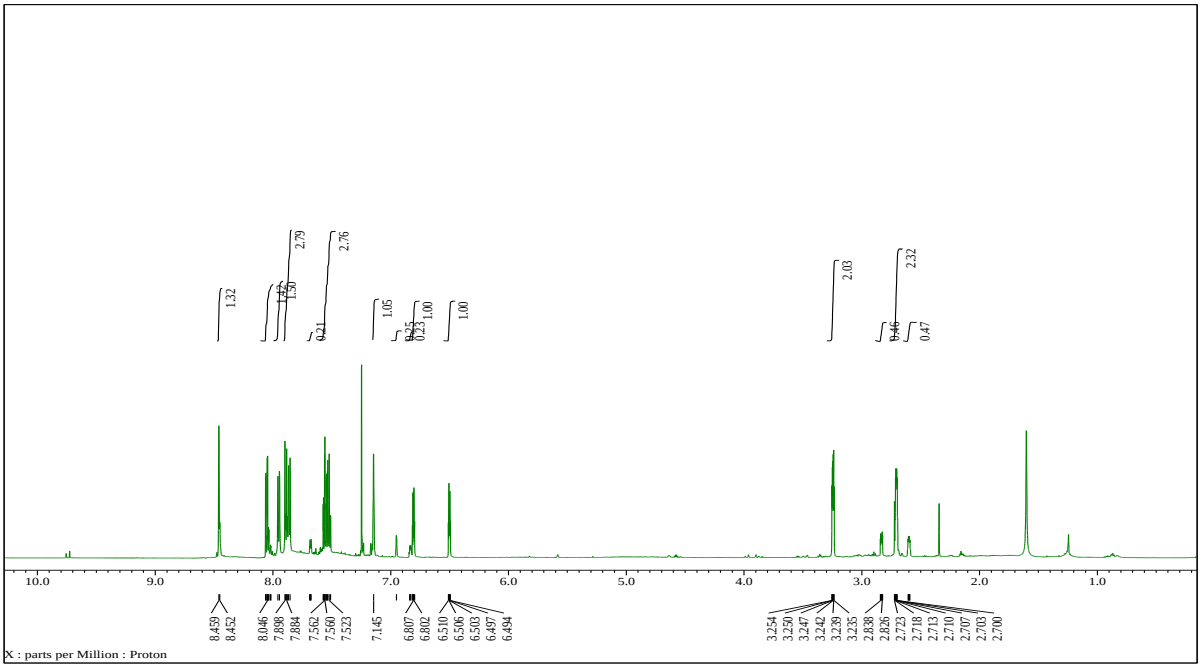

200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
189.639
188.816
170.729
168.191
152.451
150.976
138.529
138.452
135.599
133.138
131.760
131.731
129.711
129.529
126.934
112.418
111.480
77.317
77.107
76.897
33.944
32.038
31.531
31.397
X : parts per Million : Carbon13


4.05
2.57
2.68
2.09
2.09
1.15
0.93
0.55
1.00
0.24
0.47
0.39
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.952
7.949
7.945
7.941
7.397
7.392
7.929
7.610
7.602
6.947
6.927
6.924
6.922
6.914
6.433
6.430
6.426
6.420
6.417
3.847
3.184
3.180
3.176
3.172
2.754
2.669
2.665
2.662
2.658
2.655
2.557
2.554
2.549
X : parts per Million : Proton


O
OMe
+
O
OMe
major
minor

6f


200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
189.553
188.816
169.044
166.382
162.906
162.772
151.034
149.645
145.854
135.695
133.224
133.167
132.736
130.342
130.113
113.682
112.821
111.959
77.327
77.116
76.896
55.487
33.838
31.866
31.272
31.215
X : parts per Million : Carbon13


1.32
1.42
1.50
2.79
2.76
0.21
1.05
0.25
0.23
1.00
1.00
2.03
0.46
2.32
0.47
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
8.459
8.452
8.046
7.898
7.884
7.562
7.560
7.523
7.145
6.807
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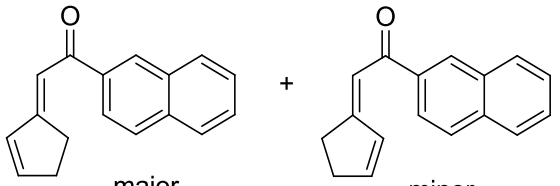
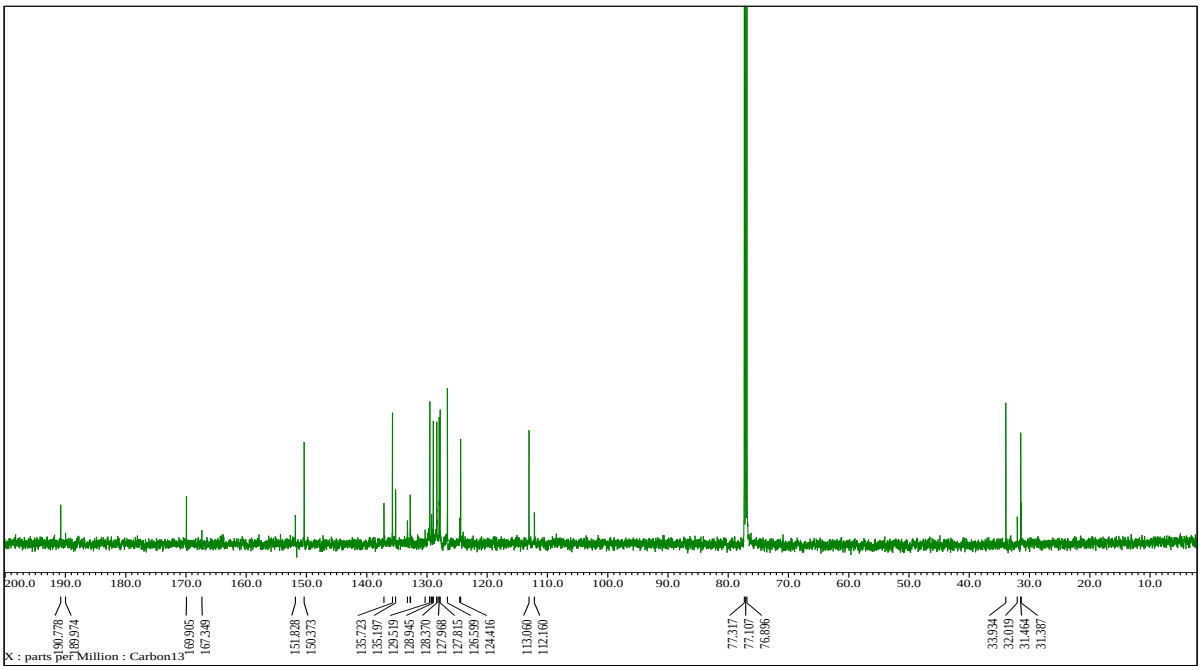
6.510
6.506
6.503
6.497
6.494
3.254
3.250
3.247
3.242
3.239
3.235
2.838
2.826
2.723
2.718
2.713
2.710
2.707
2.703
2.700
X : parts per Million : Proton


O
O
+
major
minor

6g


200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
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167.349
151.828
150.373
135.723
135.197
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128.945
128.370
127.968
127.815
126.599
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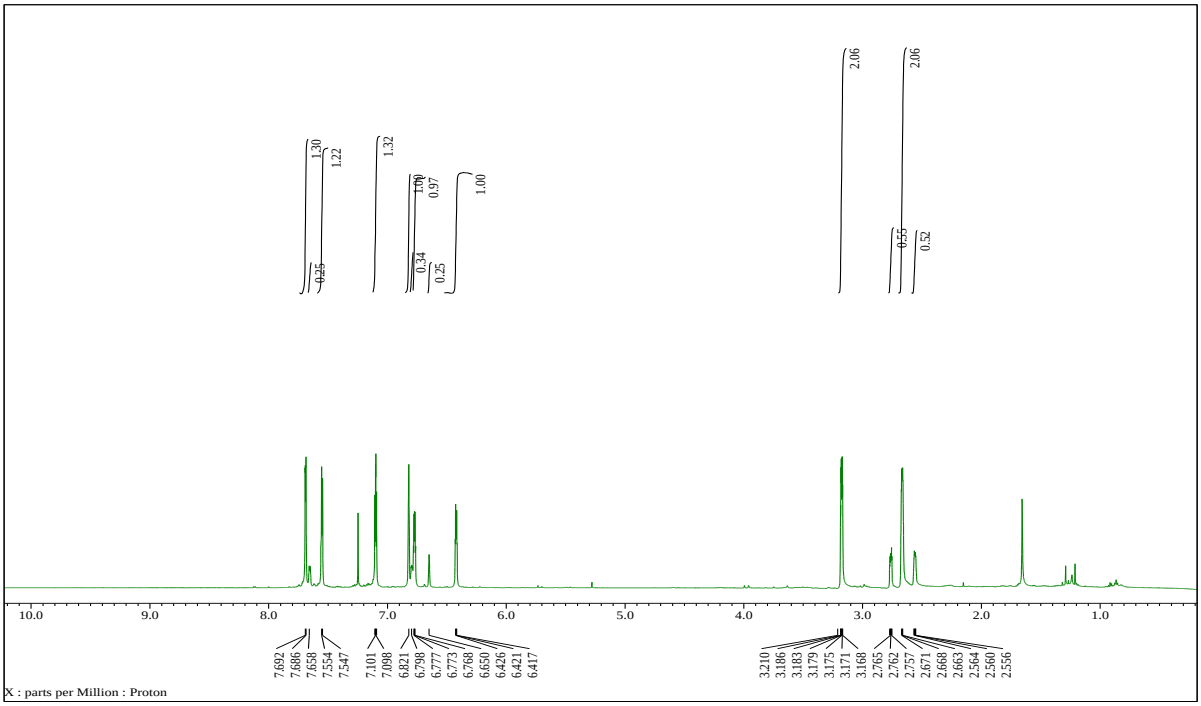
77.107
76.896
33.934
32.019
31.464
31.387
X : parts per Million : Carbon13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2.06
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1.00
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0.52
0.26
0.34
0.25
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.692
7.686
7.658
7.554
7.547
7.101
7.098
6.821
6.798
6.777
6.773
6.768
6.650
6.426
6.421
6.417
3.210
3.186
3.183
3.179
3.175
3.171
3.168
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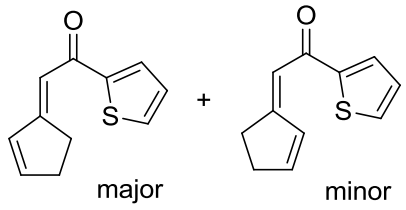
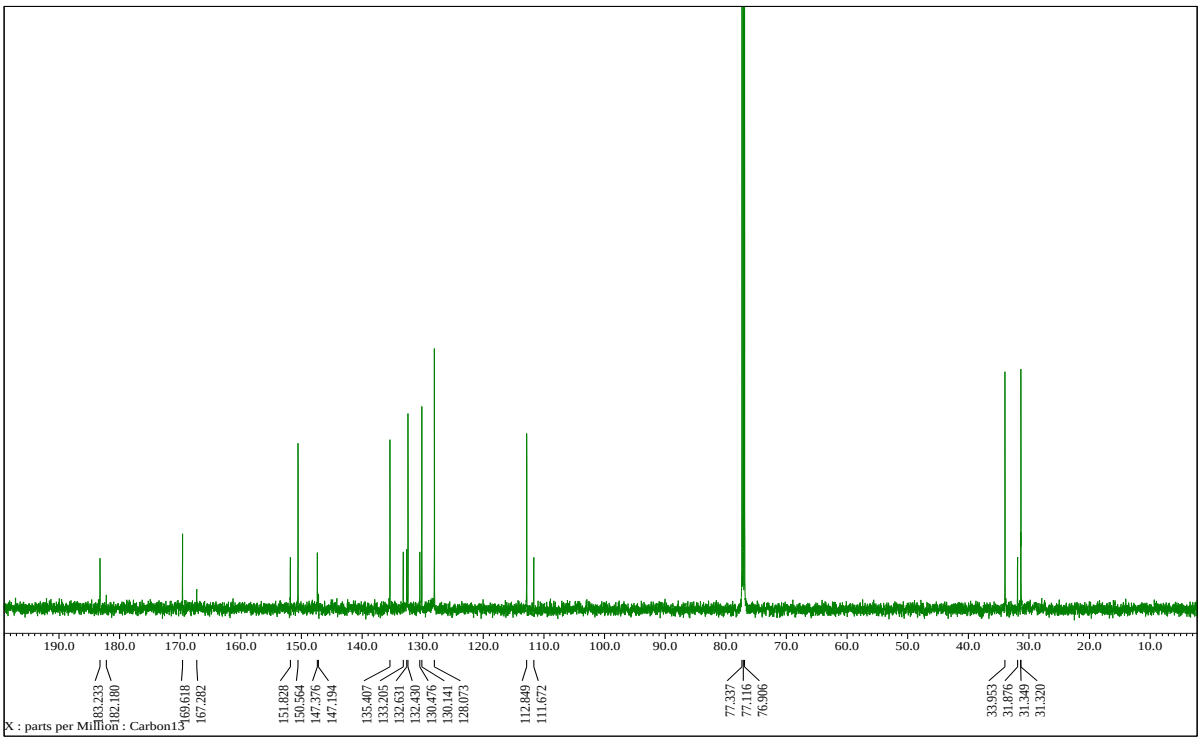
2.762
2.757
2.671
2.668
2.663
2.564
2.560
2.556
X : parts per Million : Proton


O
S
+
O
S
major
minor

6h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30.0
20.0
10.0
183.233
182.180
169.618
167.282
151.828
150.564
147.376
147.194
135.407
133.205
132.631
132.430
130.476
130.141
128.073
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111.672
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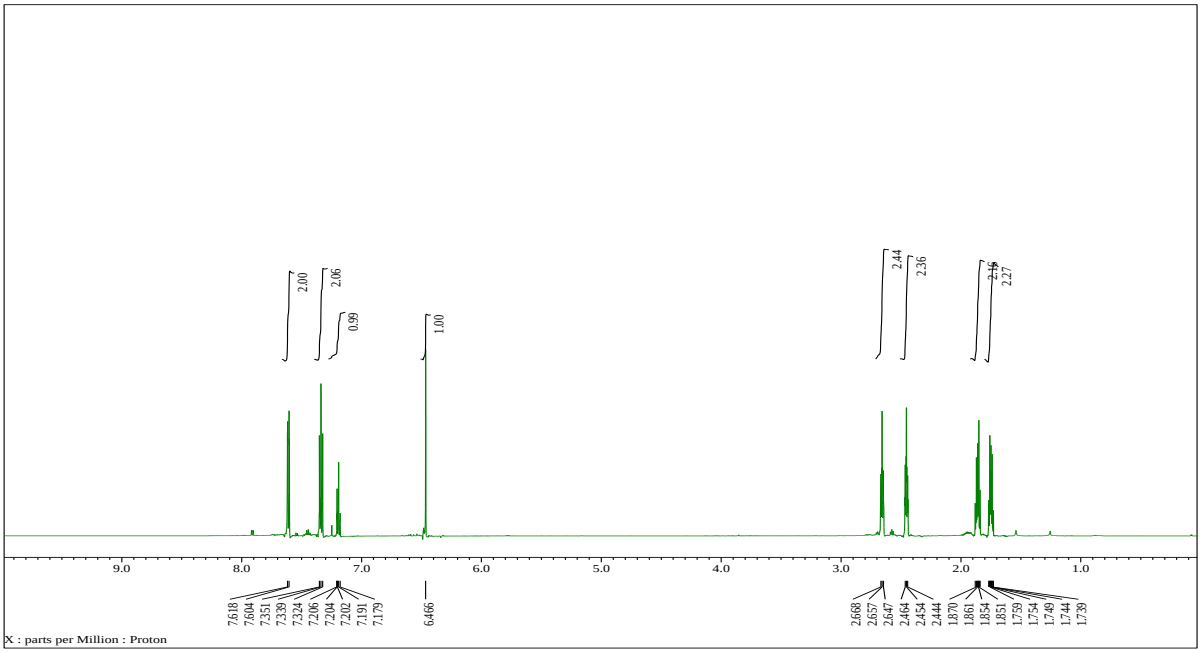
76.906
33.953
31.876
31.349
31.320
X : parts per Million : Carbon13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7.0
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5.0
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3.0
2.0
1.0
7.618
7.604
7.351
7.339
7.324
7.206
7.204
7.202
7.191
7.179
6.466
2.668
2.657
2.647
2.464
2.454
2.444
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1.759
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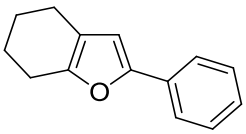
1.749
1.744
1.739
X : parts per Million : Proton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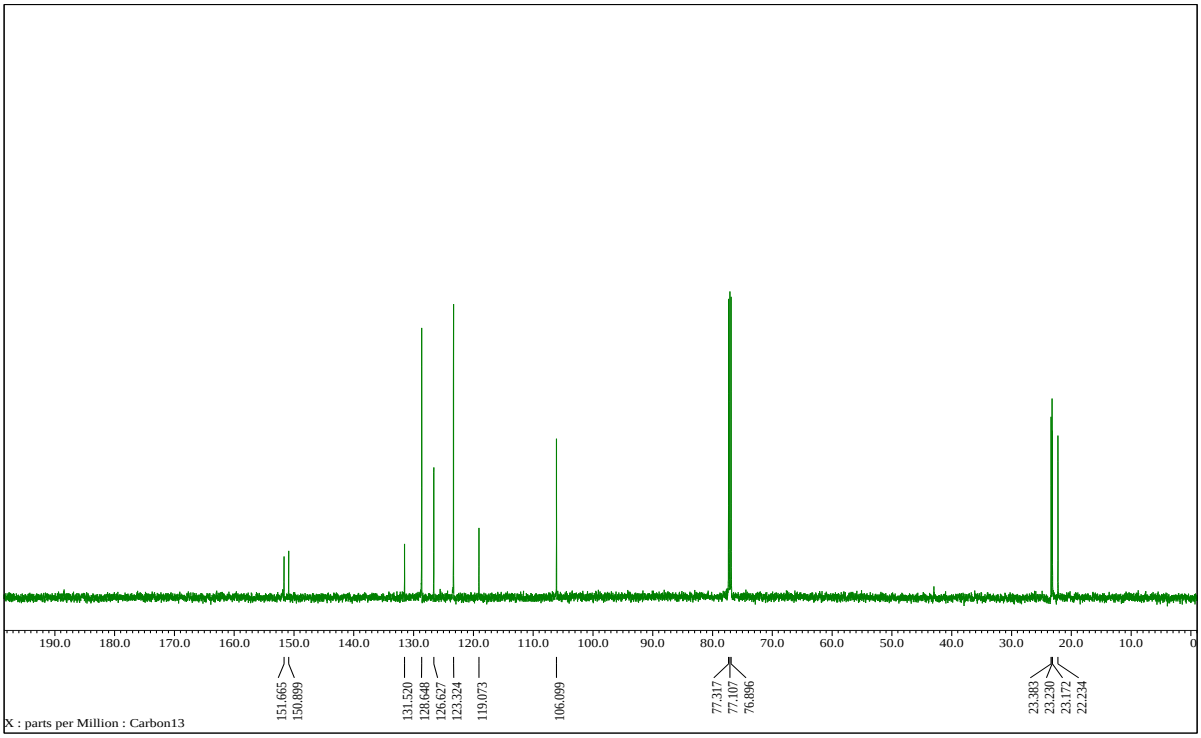
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130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
151.665
150.899
131.520
128.648
126.627
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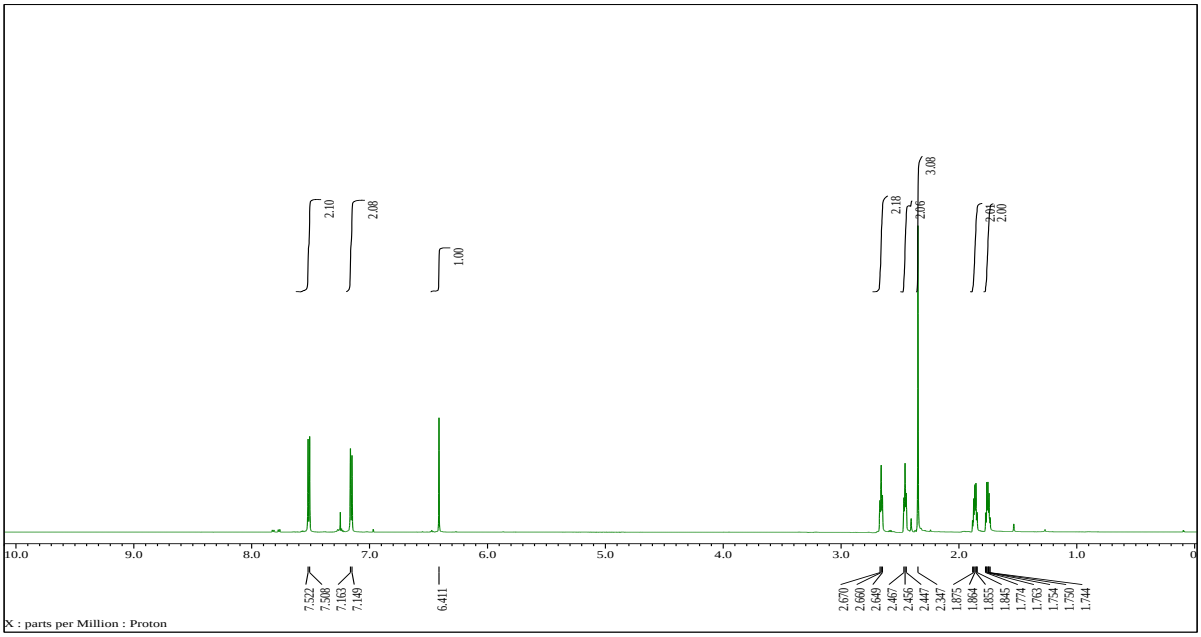
119.073
106.099
77.317
77.107
76.896
23.383
23.230
23.172
22.234
X : parts per Million : Carbon13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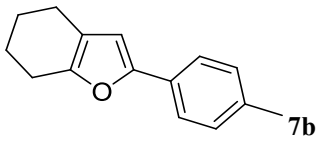
2.06
3.08
2.01
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.522
7.508
7.163
7.149
6.411
2.670
2.660
2.649
2.467
2.456
2.447
2.347
1.875
1.864
1.855
1.845
1.774
1.763
1.754
1.750
1.744
X : parts per Million : Proton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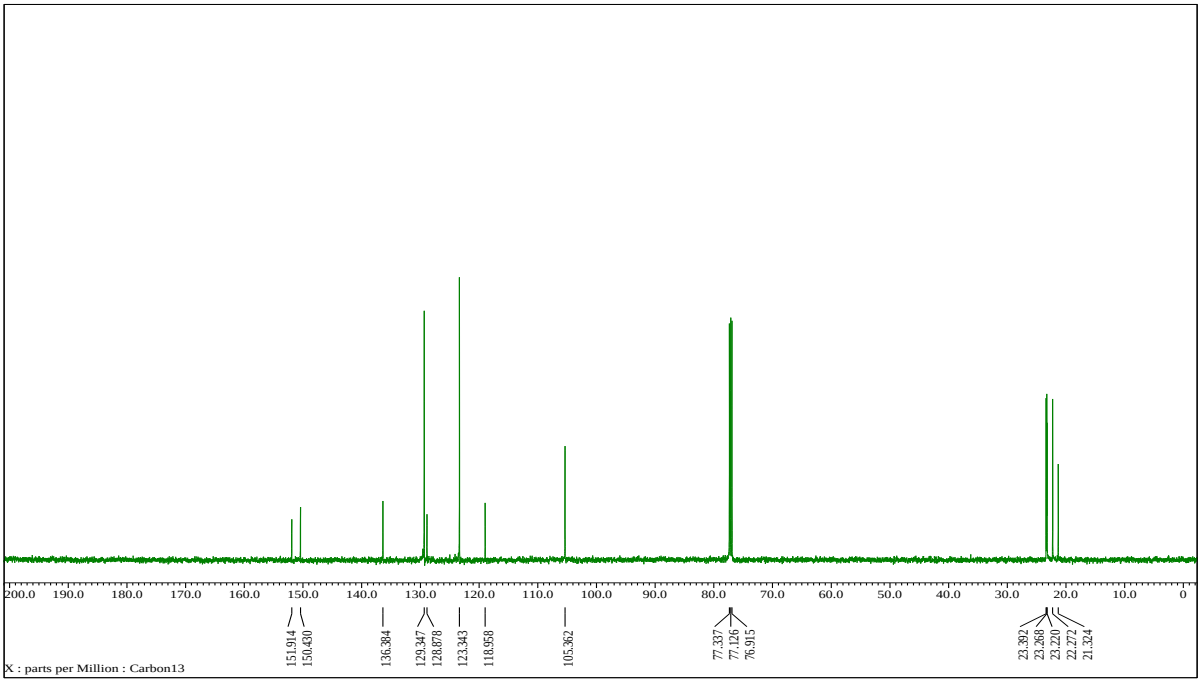
7b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150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
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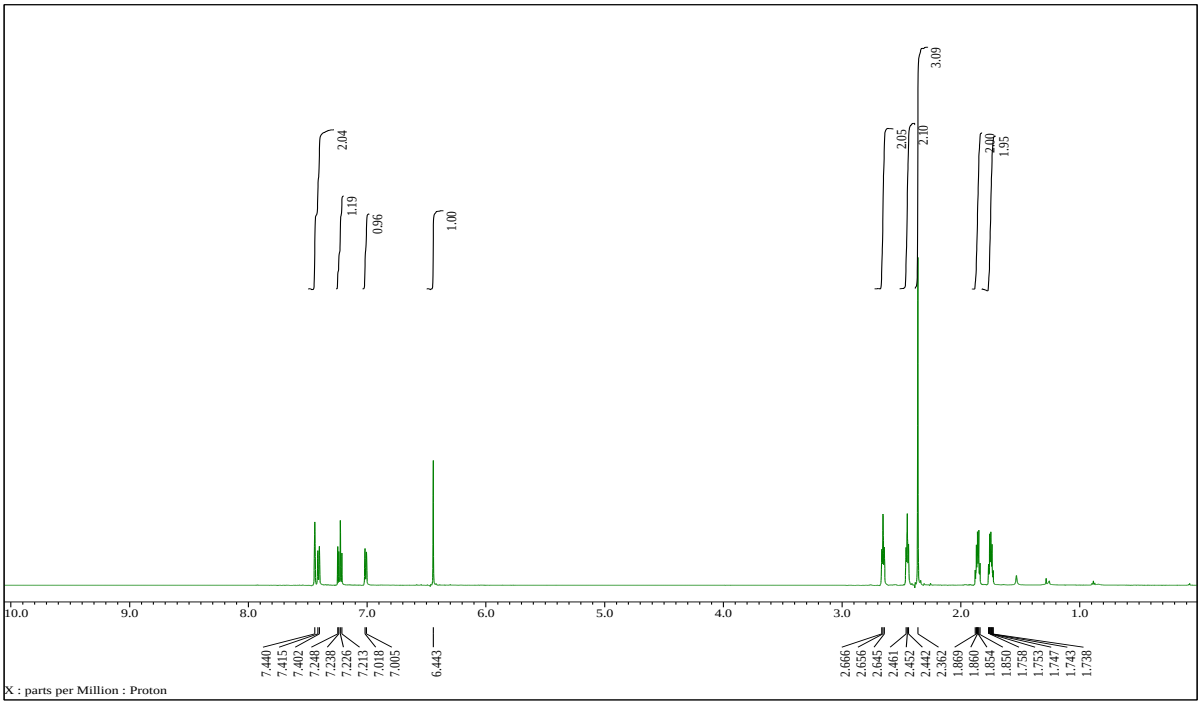
150.430
136.384
129.347
128.878
123.343
118.958
105.362
77.337
77.126
76.915
23.392
23.268
23.220
22.272
21.324
X : parts per Million : Carbon13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2.10
3.09
2.00
1.95
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.440
7.415
7.402
7.248
7.238
7.226
7.213
7.018
7.005
6.443
2.666
2.656
2.645
2.461
2.452
2.442
2.362
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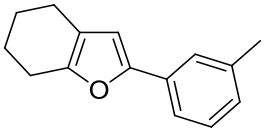
1.854
1.850
1.758
1.753
1.747
1.743
1.738
X : parts per Million : Proton



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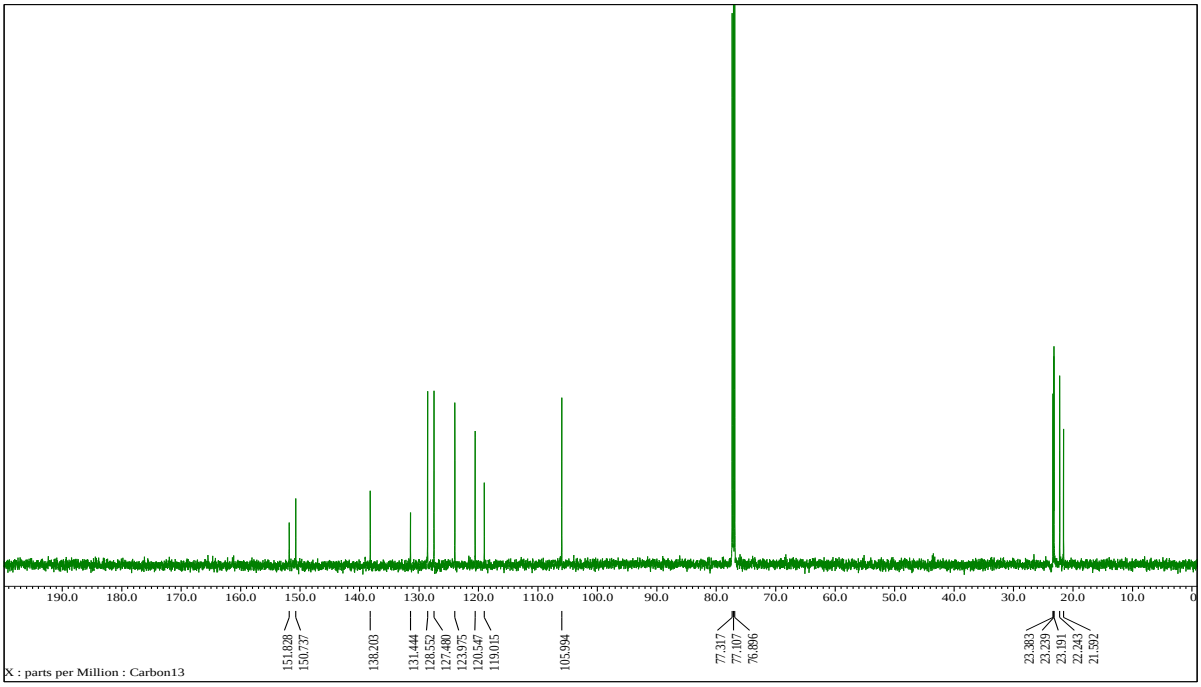
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160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
151.028
150.737
138.203
131.444
128.552
127.480
123.975
120.547
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77.317
77.107
76.896
23.303
23.239
23.191
22.243
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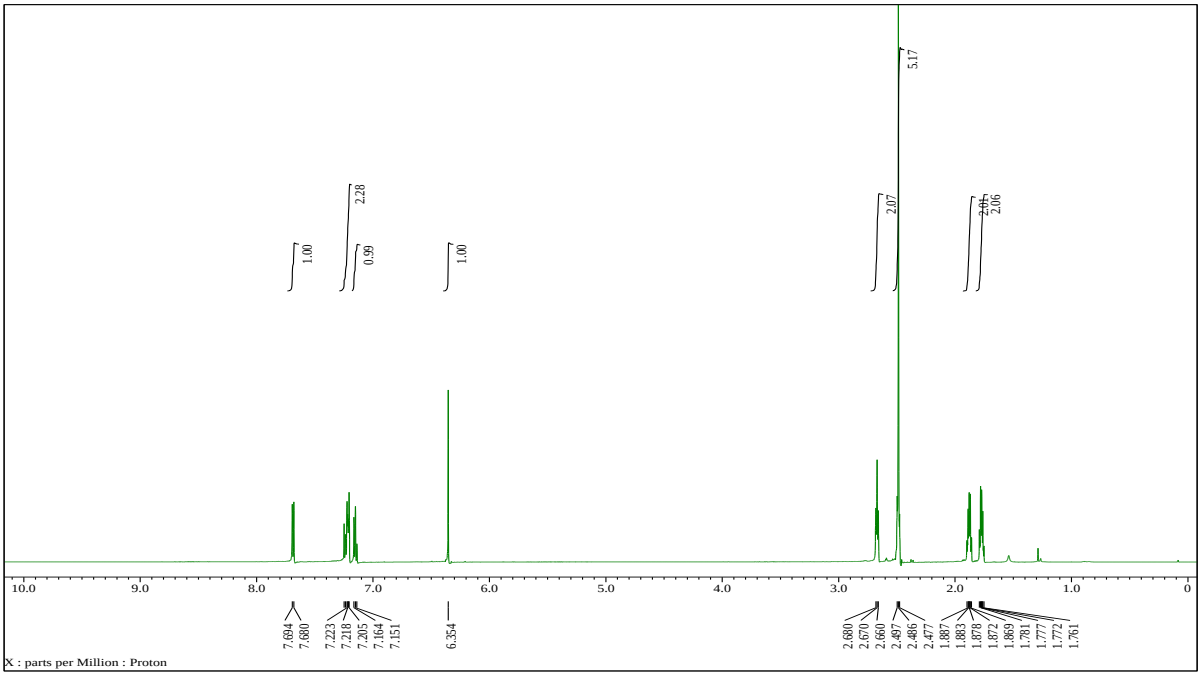
X : parts per Million : Carbon13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2.06
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0.99
1.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
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7.680
7.223
7.218
7.205
7.164
7.151
6.354
2.680
2.670
2.660
2.497
2.486
2.477
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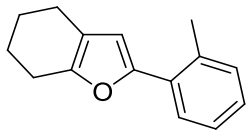
1.878
1.872
1.869
1.781
1.777
1.772
1.761
X : parts per Million : Proton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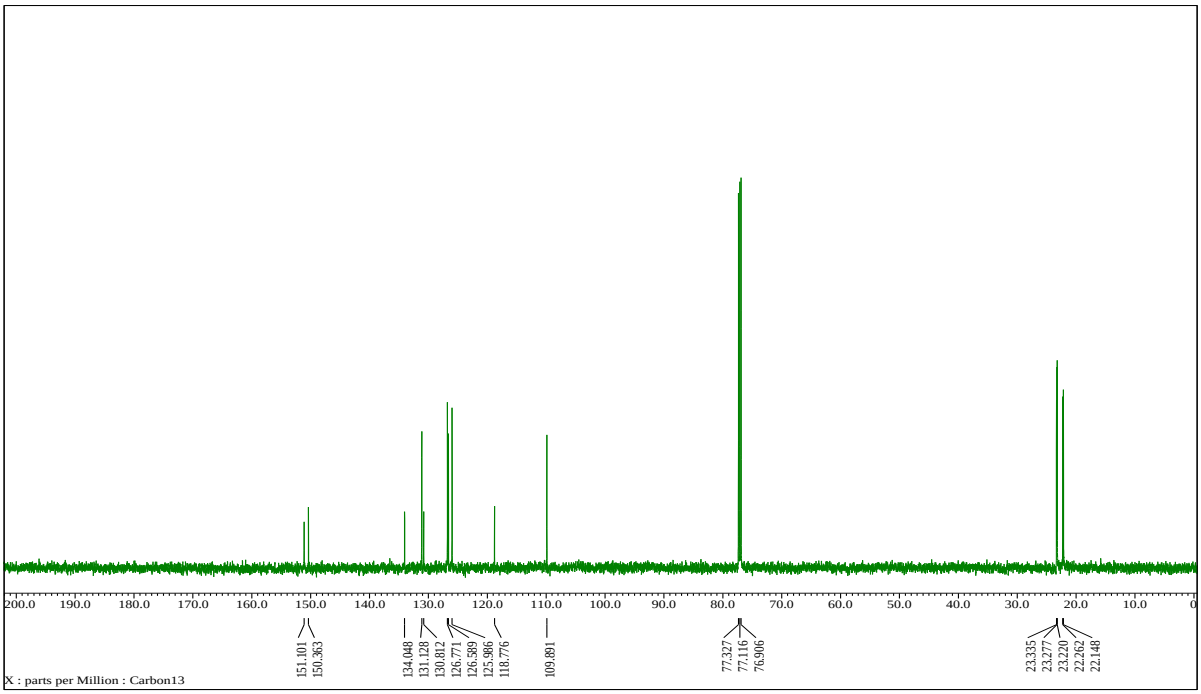
7d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150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
151.101
150.363
134.048
131.128
130.812
126.771
126.589
125.986
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109.891
77.327
77.116
76.906
23.335
23.277
23.220
22.262
22.148
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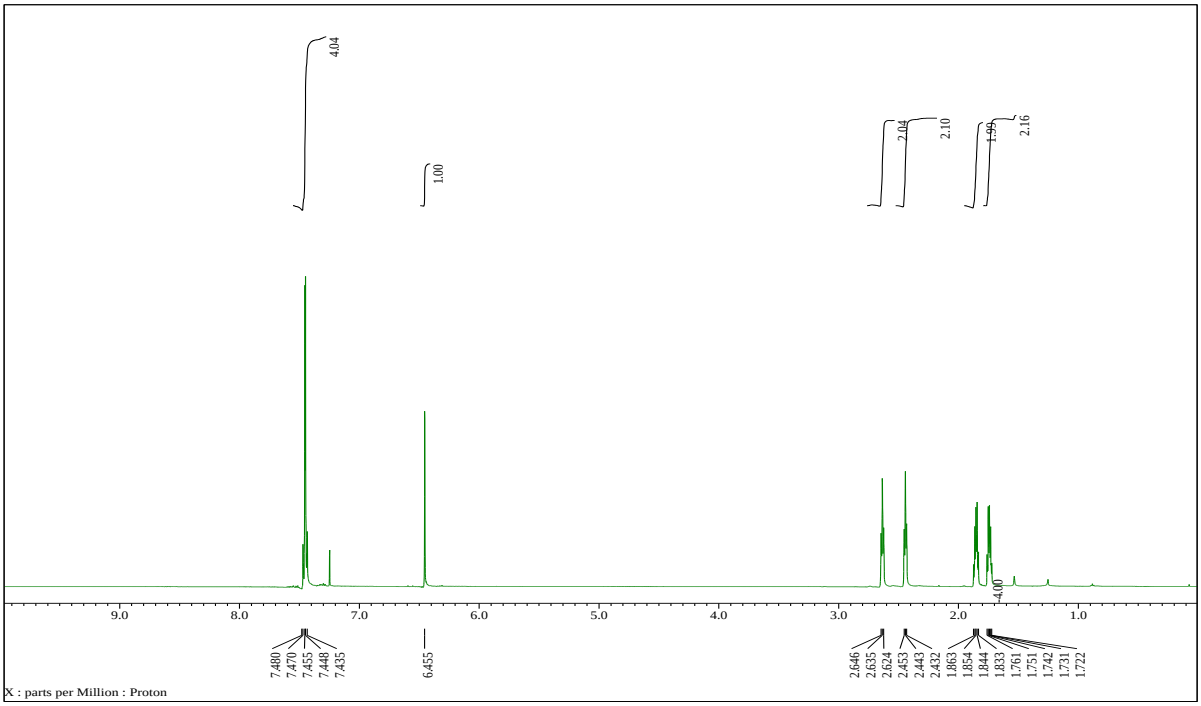
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2.16
4.00
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.480
7.470
7.455
7.448
7.435
6.455
2.646
2.635
2.624
2.453
2.443
2.432
1.863
1.854
1.844
1.833
1.761
1.751
1.742
1.731
1.722
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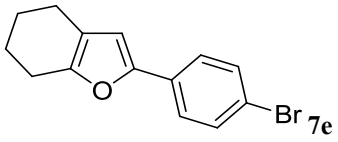
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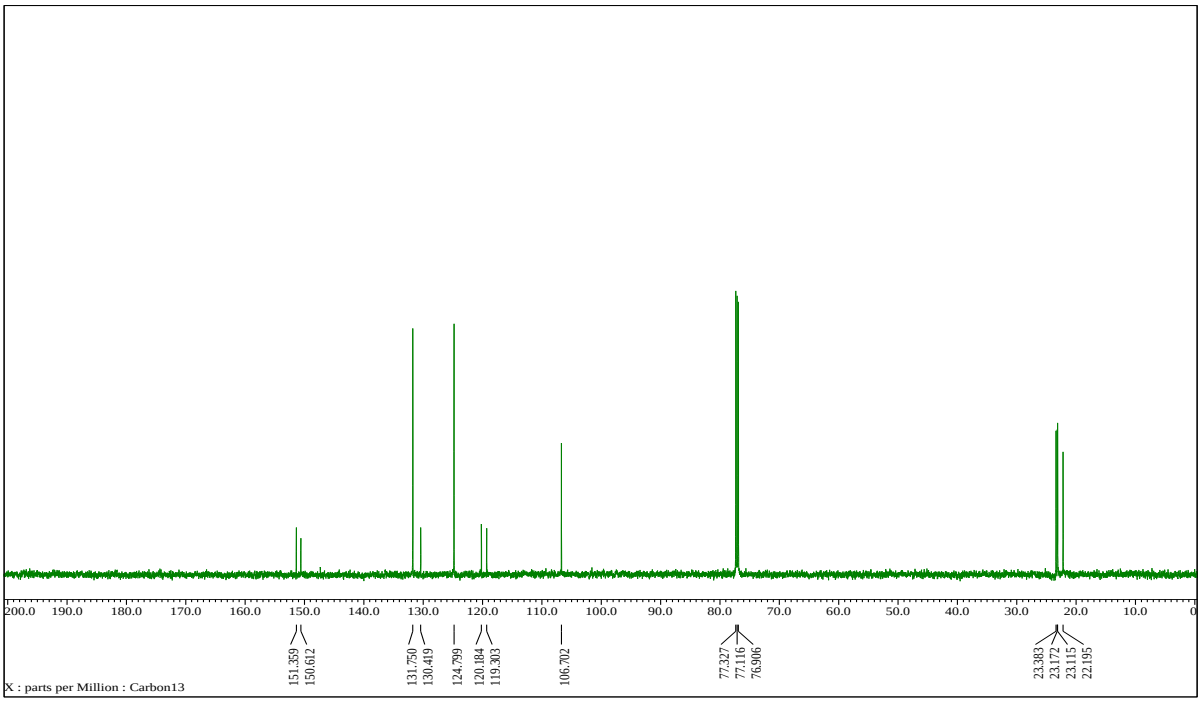
Br

7e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150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
151.359
150.612
131.750
130.419
124.799
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106.702
77.327
77.116
76.906
23.383
23.172
23.115
22.195
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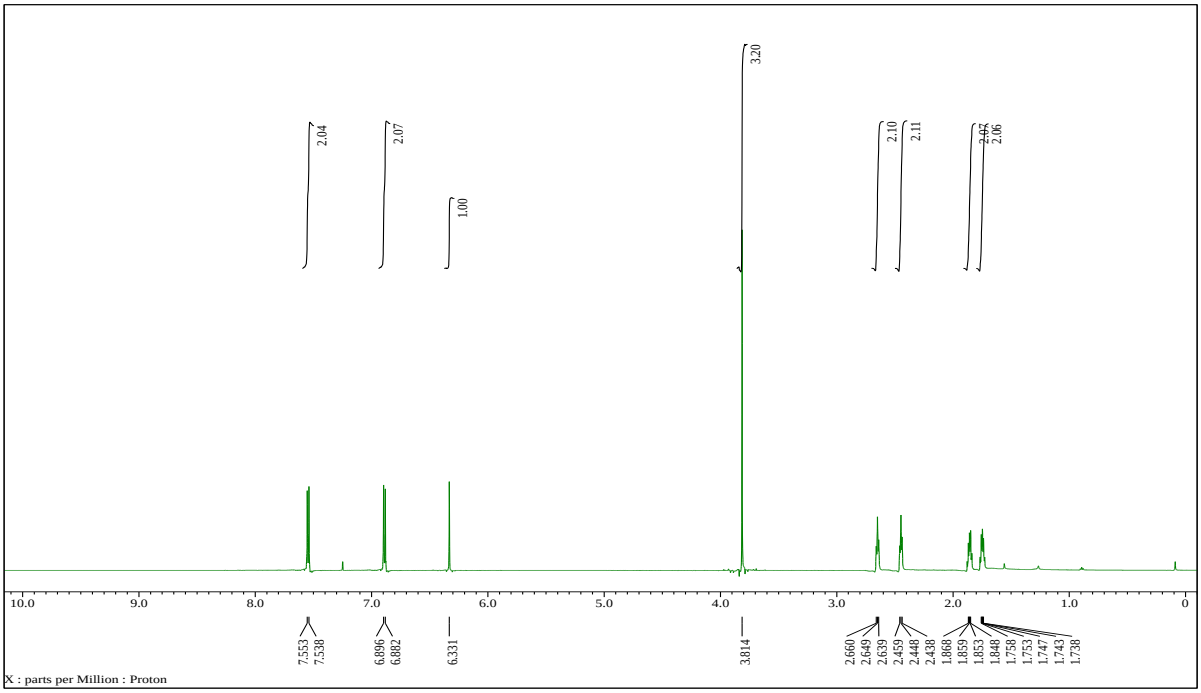
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2.11
2.06
10.0
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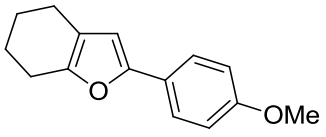
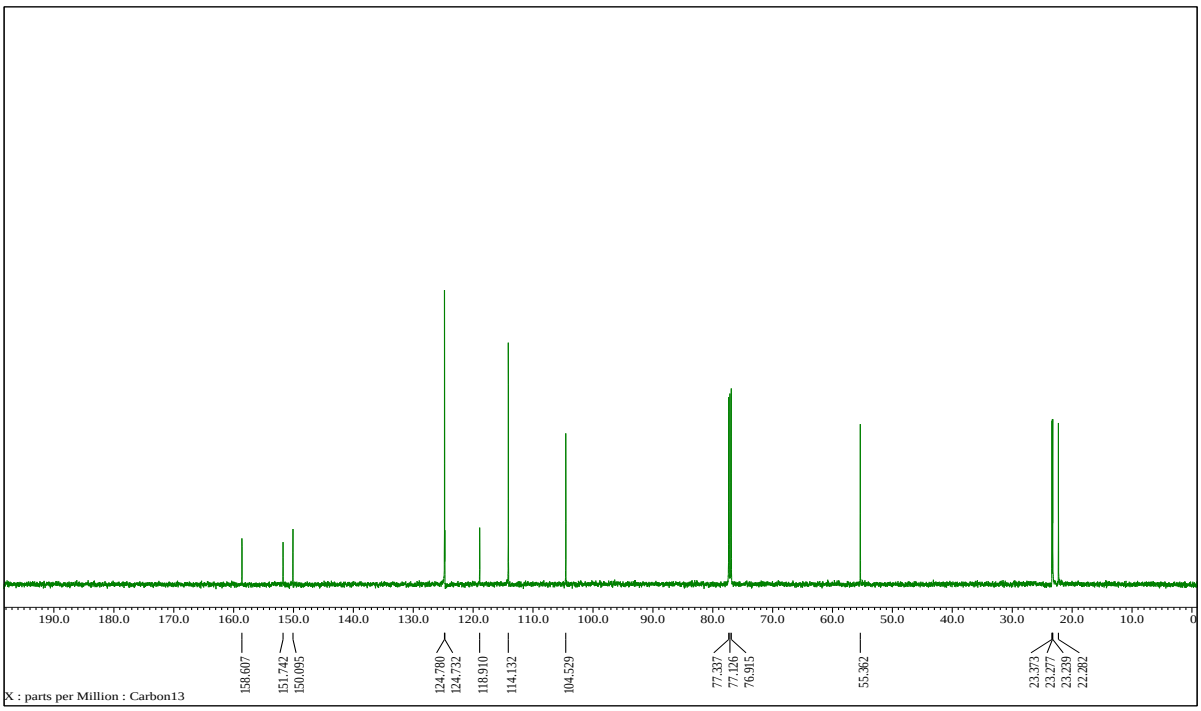
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.553
7.538
6.896
6.882
6.331
3.814
2.660
2.649
2.639
2.459
2.448
2.438
1.868
1.859
1.853
1.848
1.758
1.753
1.747
1.743
1.738
X : parts per Million : Proton


O
OMe

7f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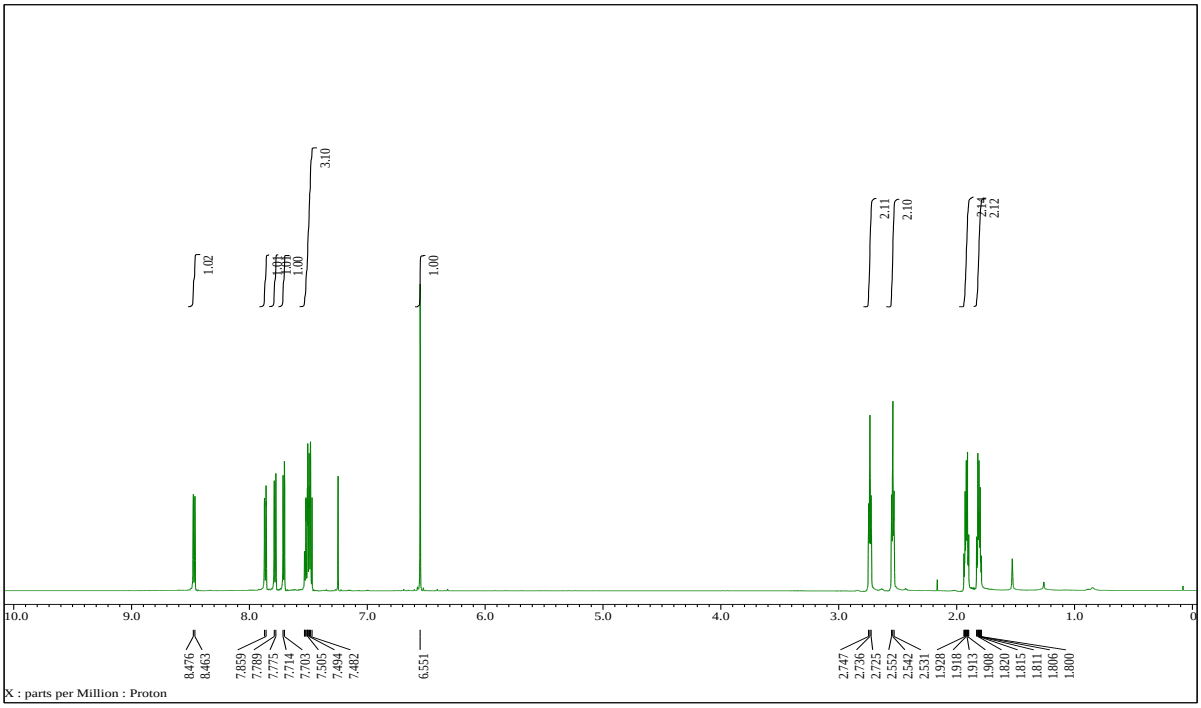
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
158.607
151.742
150.095
124.780
124.732
118.910
114.132
104.529
77.337
77.126
76.915
55.362
23.373
23.277
23.239
22.282
X : parts per Million : Carbon13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7.0
6.0
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4.0
3.0
2.0
1.0
0
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7.789
7.775
7.714
7.703
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7.494
7.482
6.551
2.747
2.736
2.725
2.552
2.542
2.531
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1.913
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1.820
1.815
1.811
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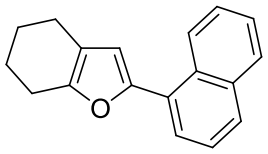
X : parts per Million : Proton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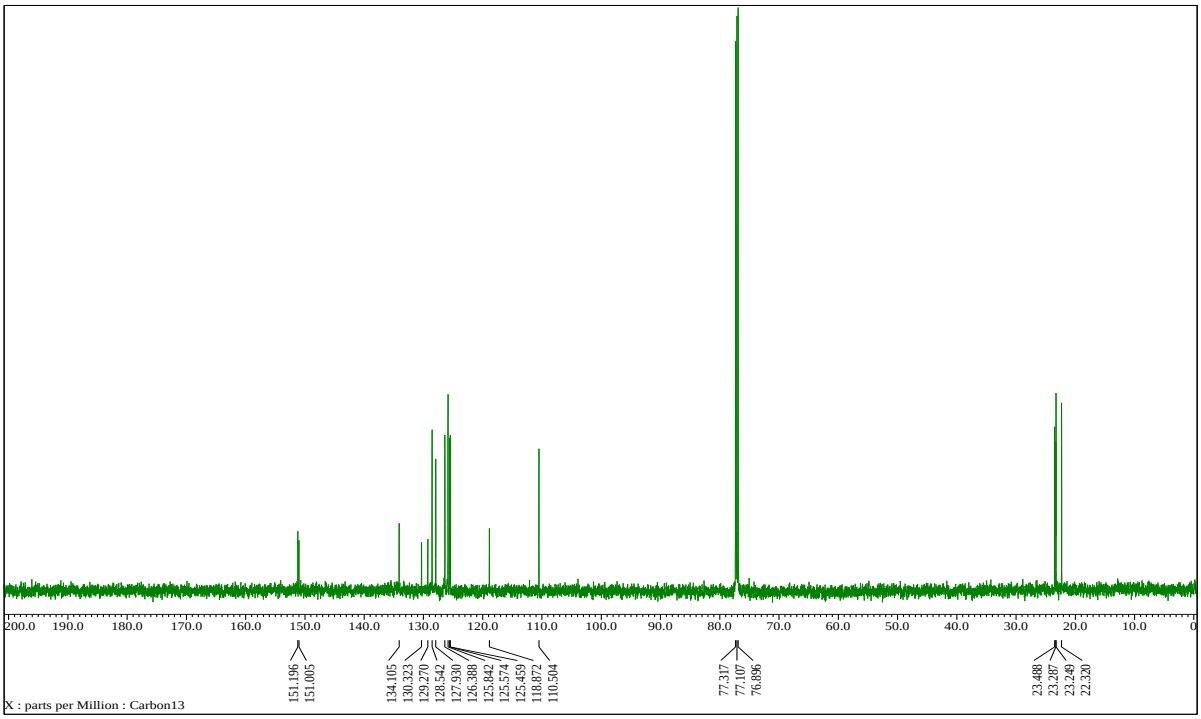
7g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140.0
130.0
120.0
110.0
100.0
90.0
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126.388
125.842
125.574
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110.504
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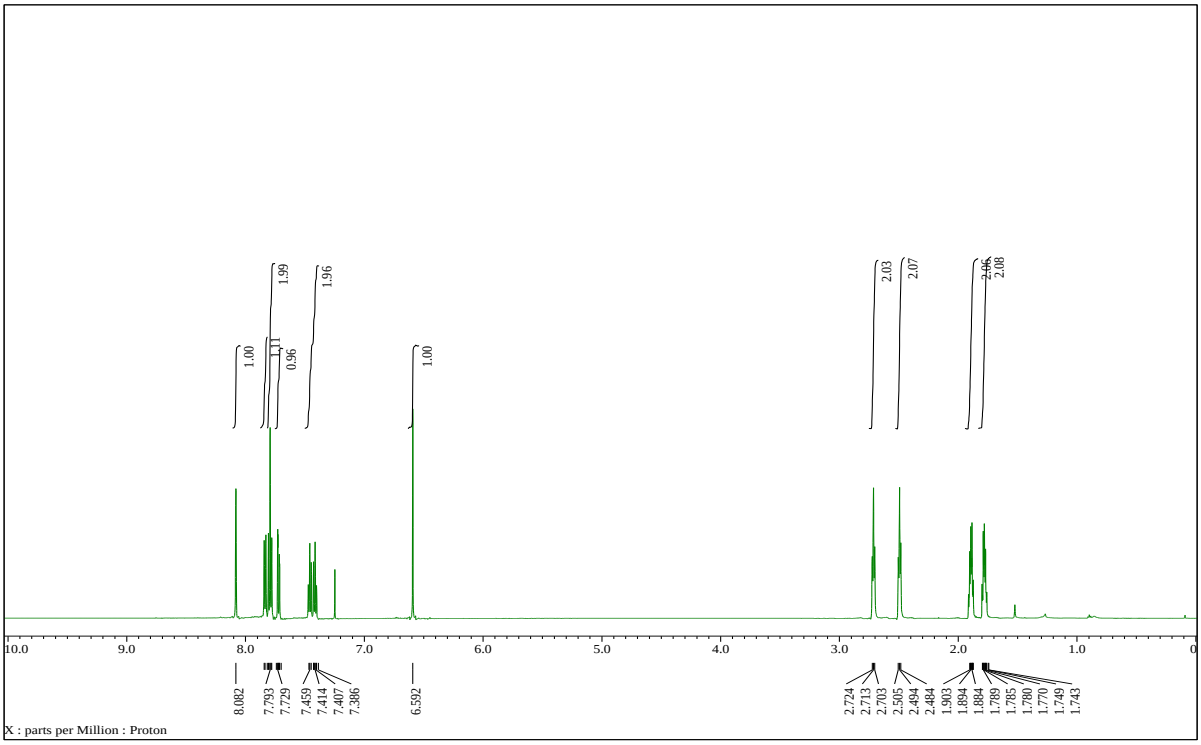
77.107
76.896
23.488
23.287
23.249
22.320
X : parts per Million : Carbon13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2.06
2.08
10.0
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8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
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7.414
7.407
7.386
6.592
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2.713
2.703
2.505
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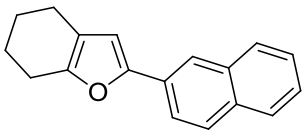
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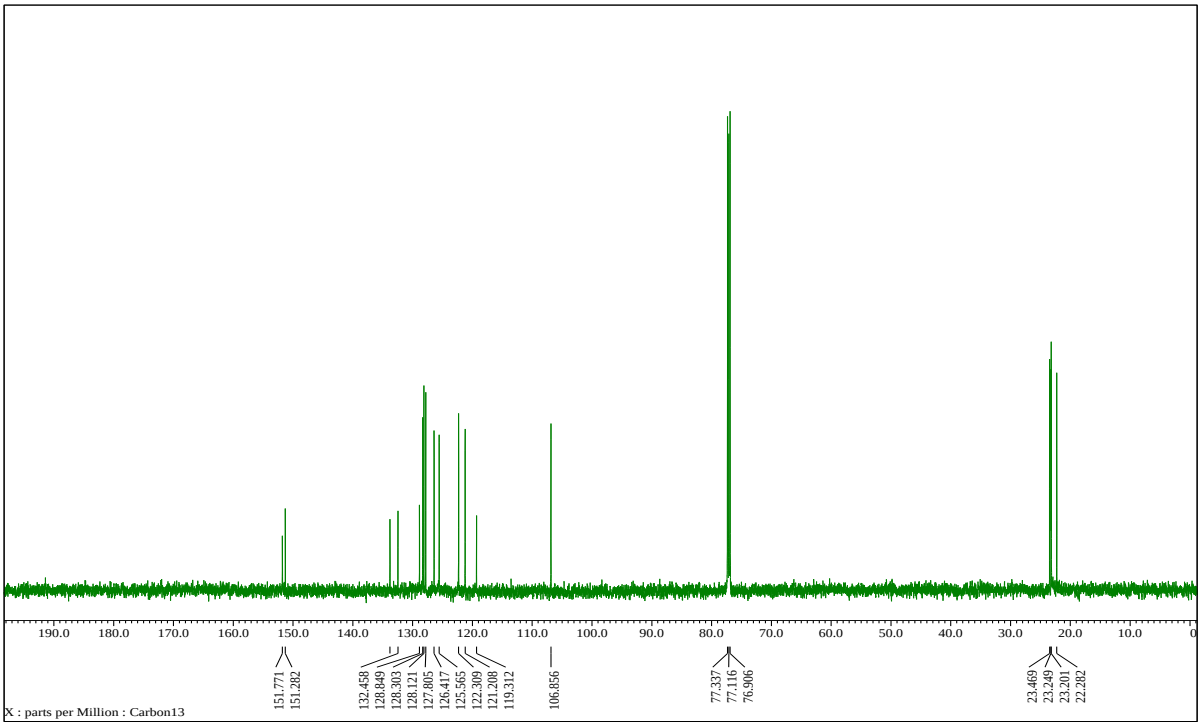
7h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120.0
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100.0
90.0
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70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
151.771
151.282
132.458
128.849
128.303
128.121
127.805
126.417
125.565
122.309
121.208
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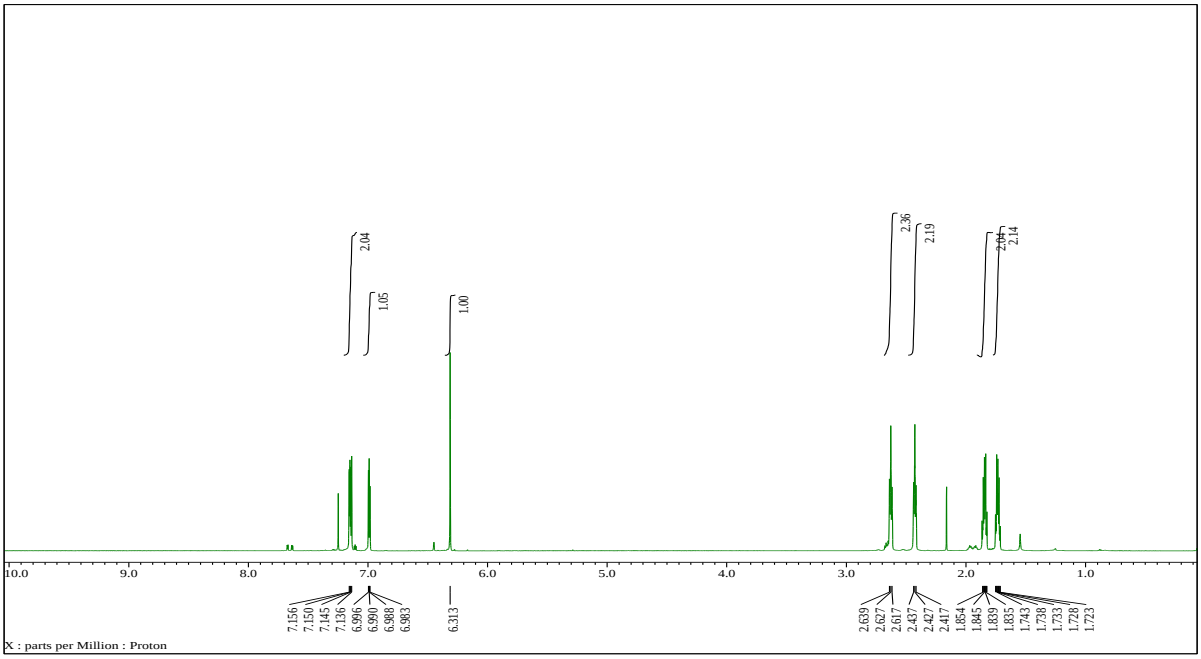
106.856
77.337
77.116
76.906
23.469
23.249
23.201
22.282
X : parts per Million : Carbon13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6.0
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2.0
1.0
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6.988
6.983
6.313
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2.427
2.417
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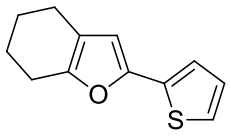
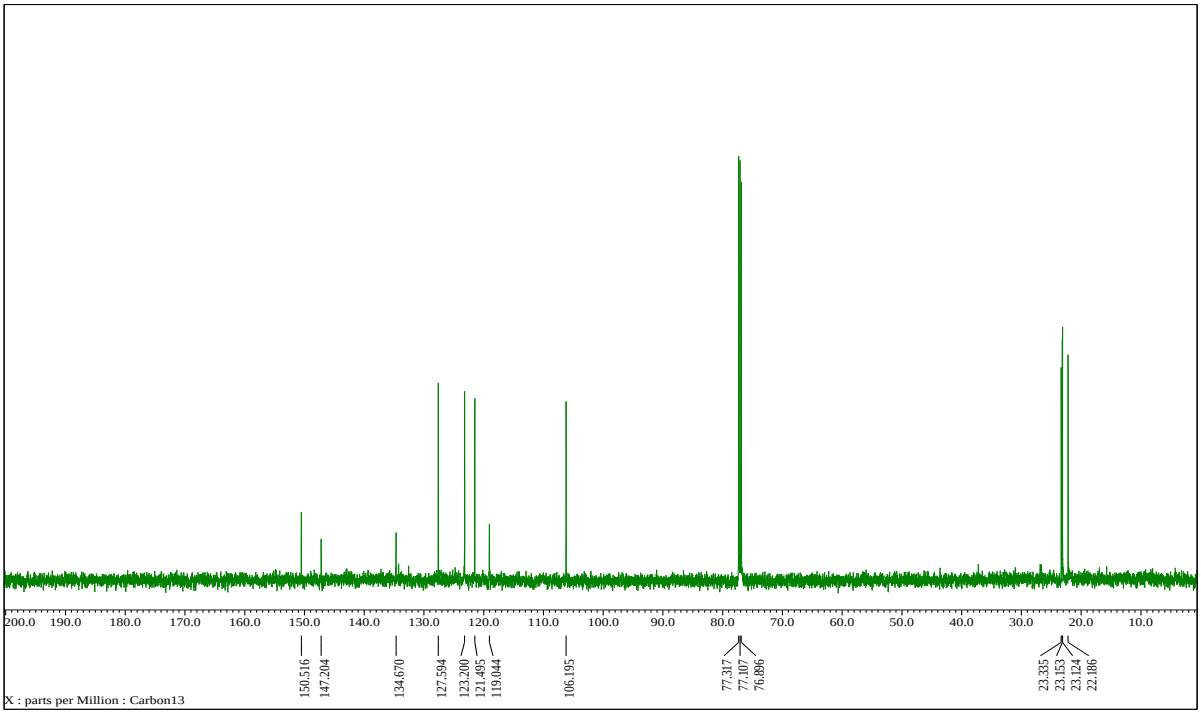
1.738
1.733
1.728
1.723
X : parts per Million : Proton


O
S

7i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130.0
120.0
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100.0
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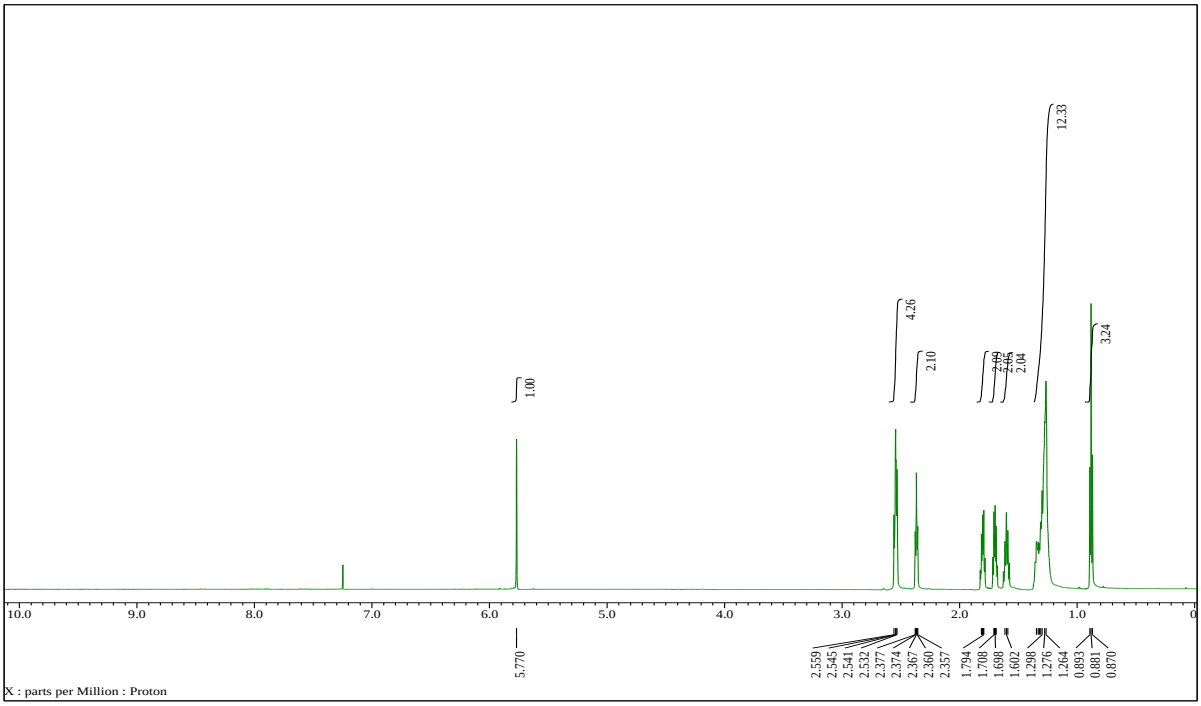
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
150.516
147.204
134.670
127.594
123.200
121.495
119.044
106.195
77.317
77.107
76.896
23.335
23.153
23.124
22.186
X : parts per Million : Carbon13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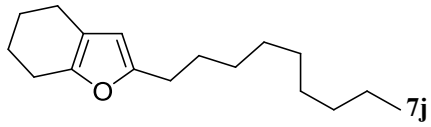
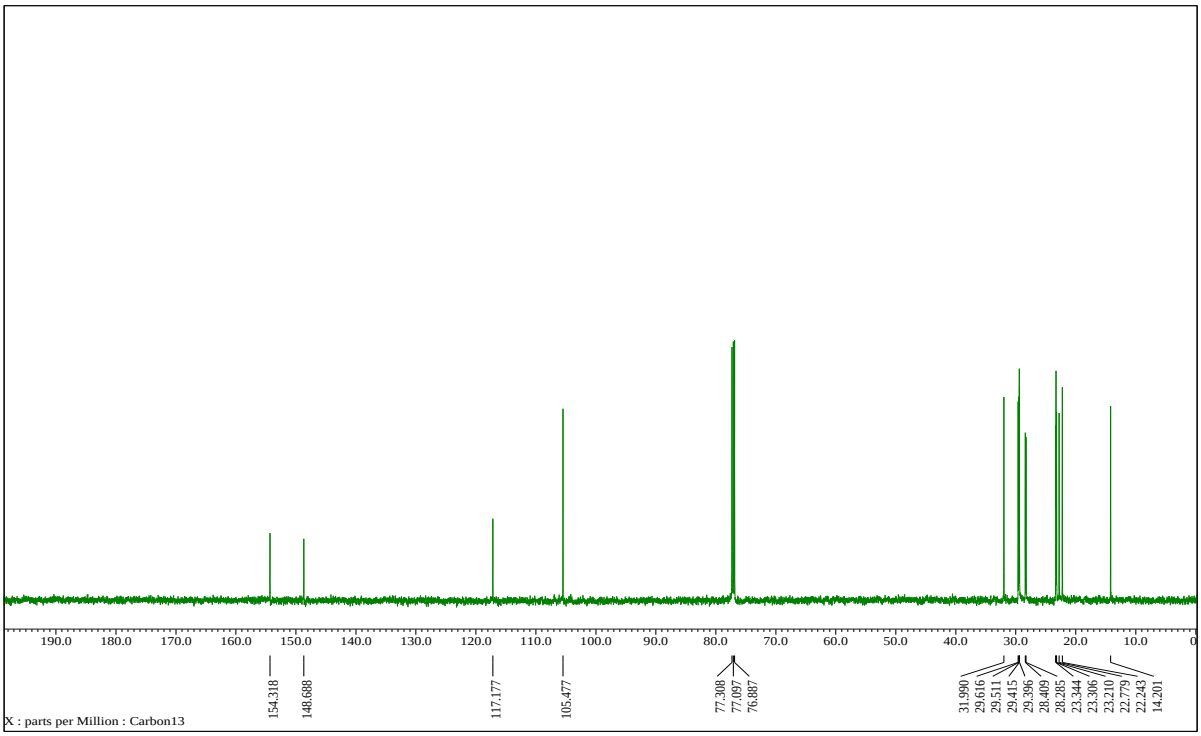
4.26
3.24
2.10
2.09
2.05
2.04
1.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
5.770
2.559
2.545
2.541
2.532
2.377
2.374
2.367
2.360
2.357
1.794
1.708
1.698
1.602
1.298
1.276
1.264
0.893
0.881
0.870
X : parts per Million : Proton


O

7j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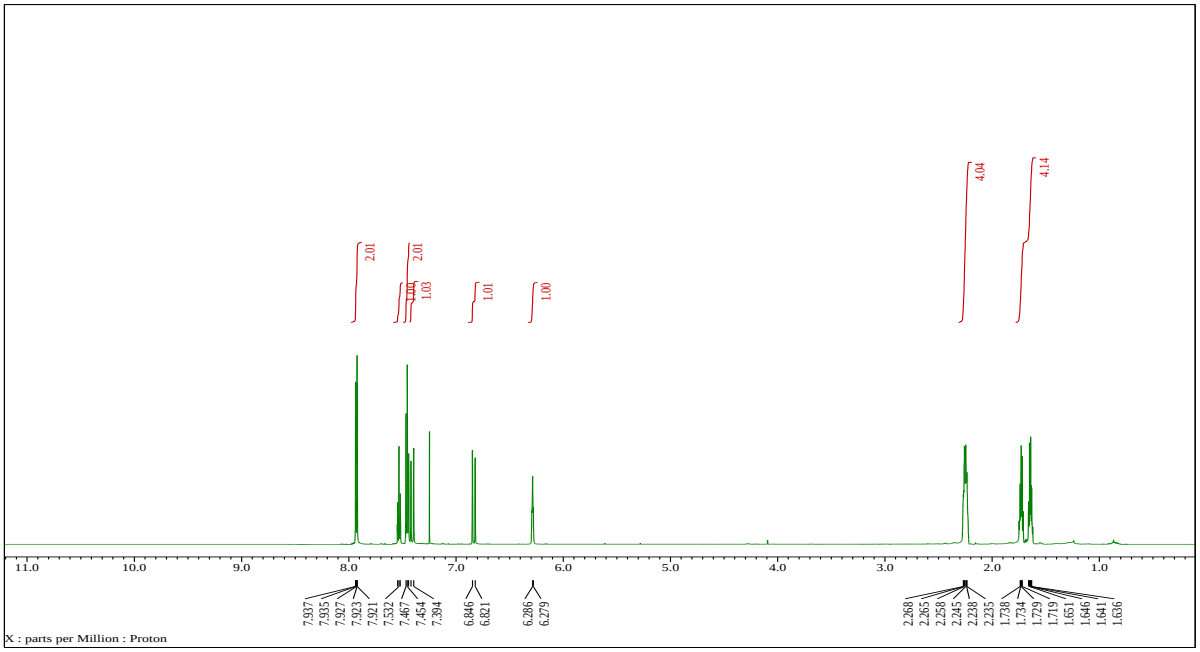
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
154.318
148.688
117.177
105.477
77.308
77.097
76.887
31.990
29.616
29.511
29.415
29.396
28.409
28.285
23.344
23.306
23.210
22.779
22.243
14.201
X : parts per Million : Carbon13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2.01
1.00
1.03
1.01
1.00
4.04
4.14
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.937
7.935
7.927
7.923
7.921
7.532
7.467
7.454
7.394
6.846
6.821
6.286
6.279
2.268
2.265
2.258
2.245
2.238
2.235
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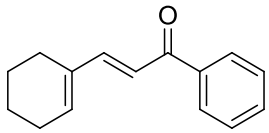
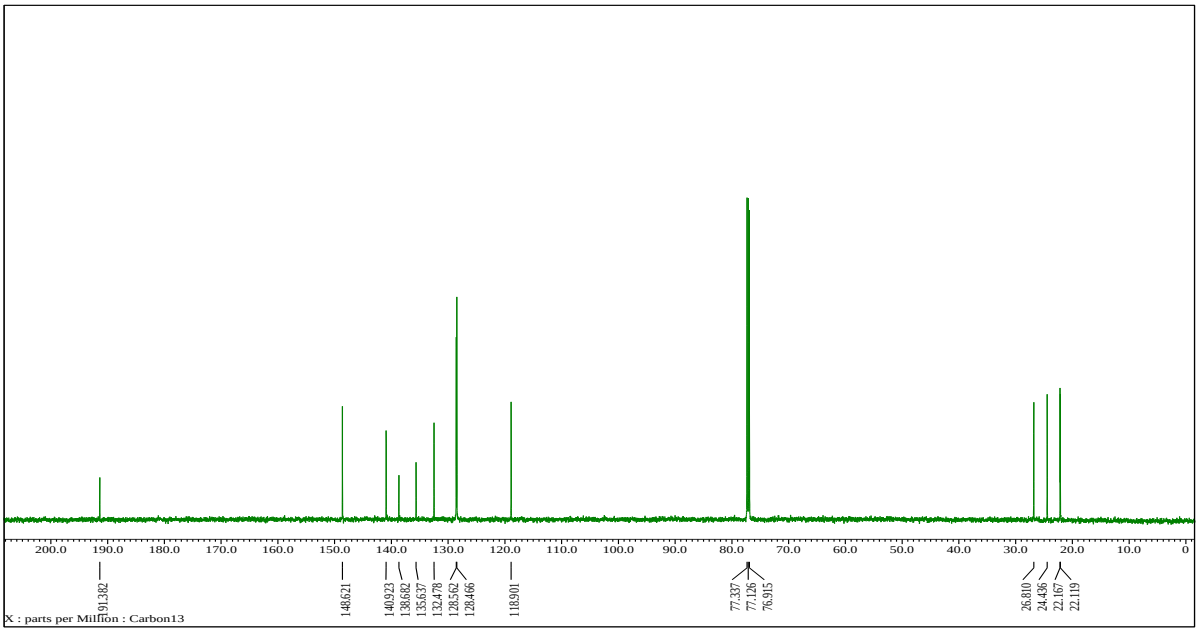
1.734
1.729
1.719
1.651
1.646
1.641
1.636
X : parts per Million : Proton


O

8a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140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
191.382
148.621
140.923
138.682
135.637
132.478
128.562
128.466
118.901
77.337
77.126
76.915
26.810
24.436
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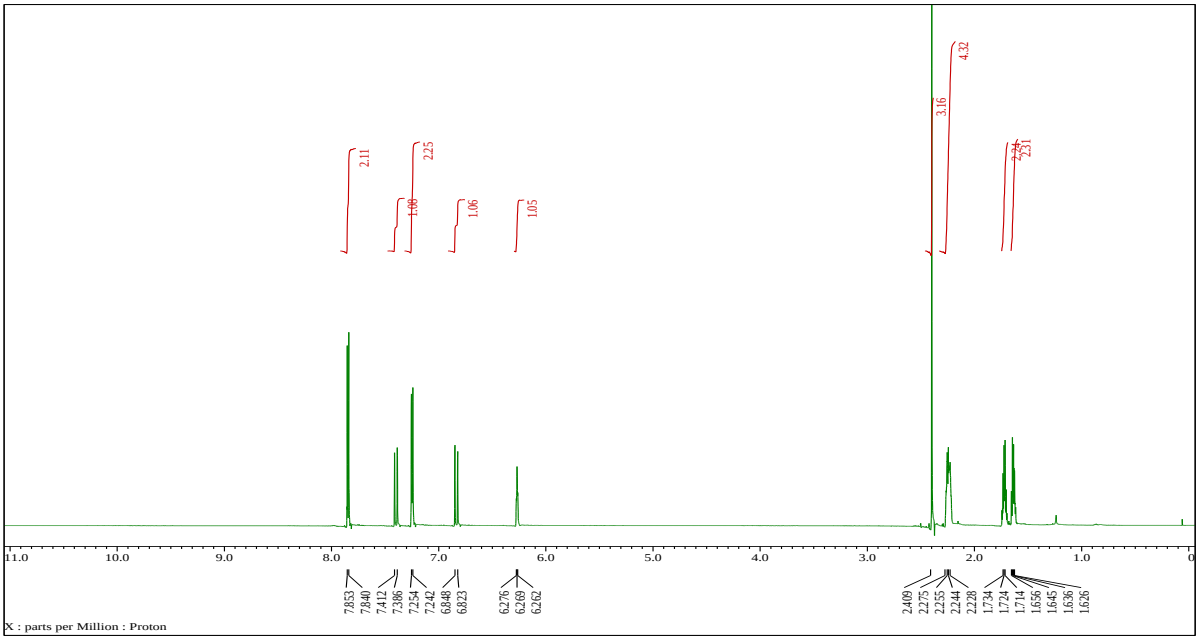
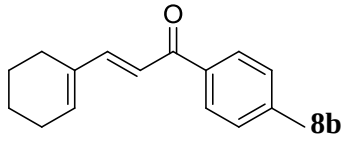
22.119
X : parts per Million : Carbon13


4.32
3.16
2.11
2.25
1.08
1.06
1.05
2.31
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.853
7.840
7.412
7.386
7.254
7.242
6.848
6.823
6.276
6.269
6.262
2.409
2.275
2.255
2.244
2.228
1.734
1.724
1.714
1.656
1.645
1.636
1.626
X : parts per Million : Proton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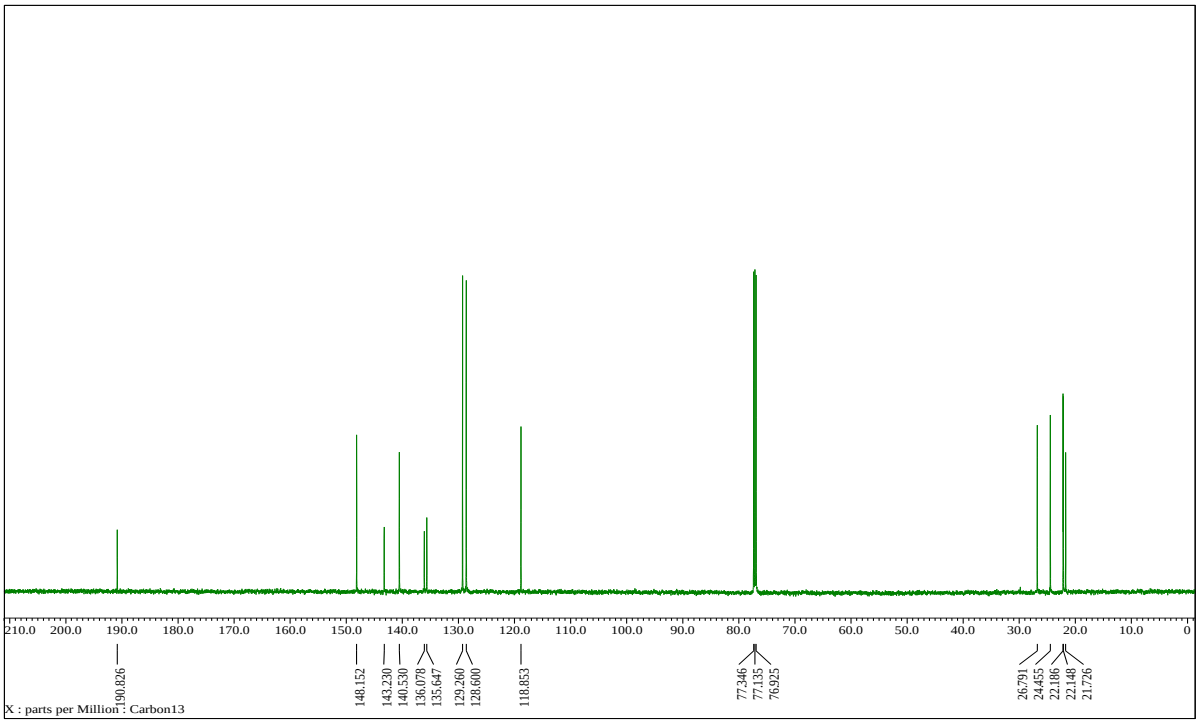
8b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160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
190.826
148.152
143.230
140.530
136.078
135.647
129.260
128.600
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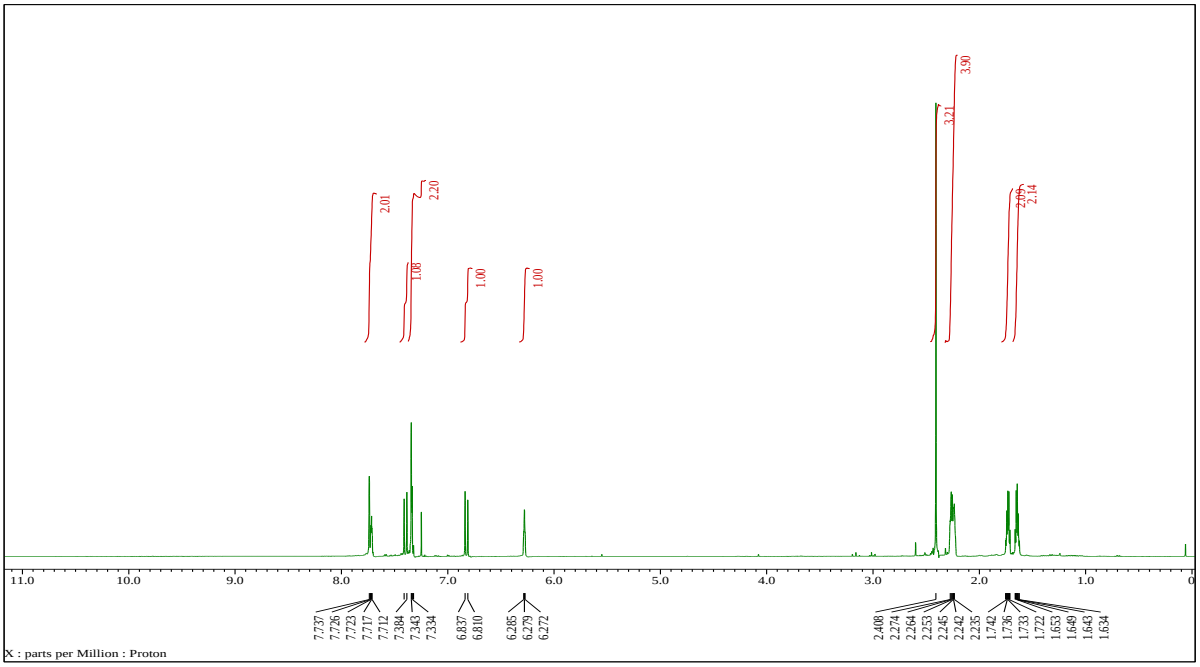
77.346
77.135
76.925
26.791
24.455
22.186
22.148
21.726
X : parts per Million : Carbon13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2.20
1.08
1.00
1.00
3.90
3.21
2.05
2.14
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.737
7.726
7.723
7.717
7.712
7.384
7.343
7.334
6.837
6.810
6.285
6.279
6.272
2.408
2.274
2.264
2.253
2.245
2.242
2.235
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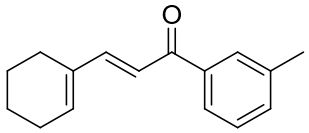
1.736
1.733
1.722
1.653
1.649
1.643
1.634
X : parts per Million : Proton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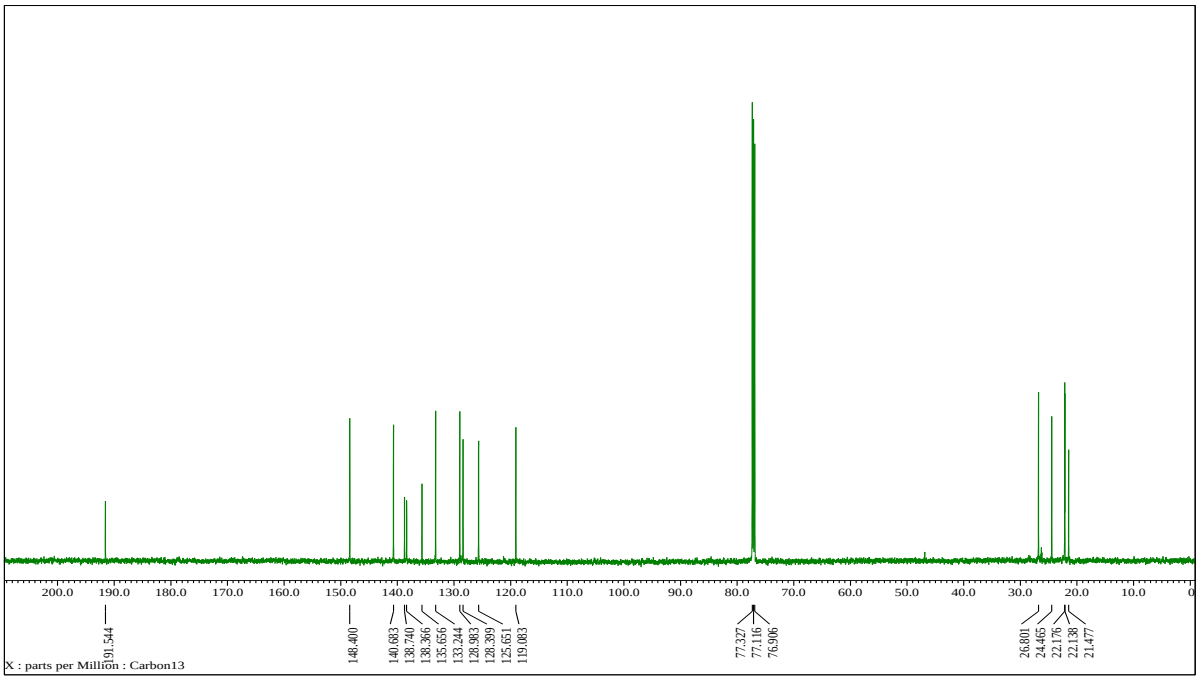
8c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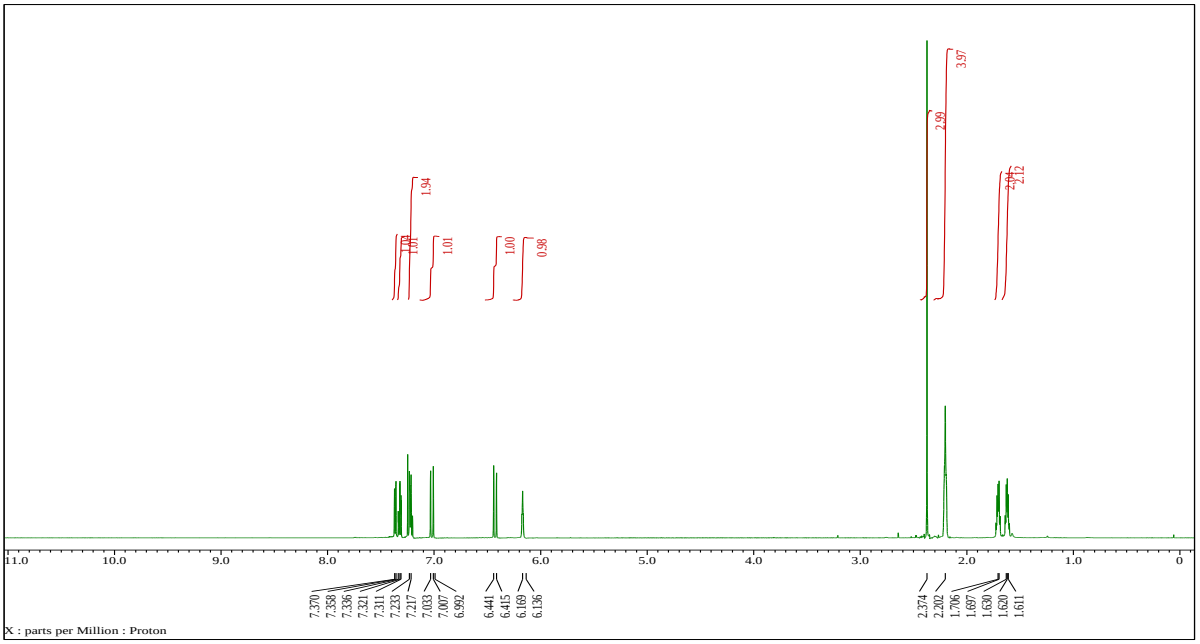
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
191.544
148.400
140.683
138.740
138.366
135.656
133.244
128.983
128.399
125.651
119.083
77.327
77.116
76.906
26.801
24.465
22.176
22.138
21.477
X : parts per Million : Carbon13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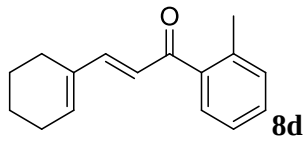
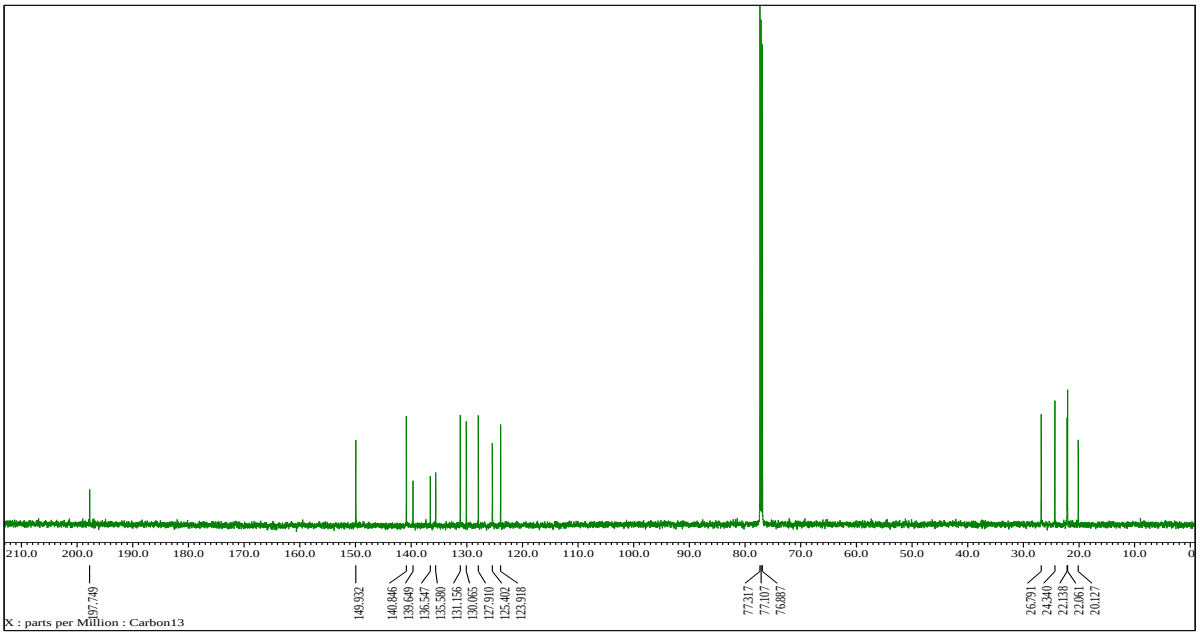
1.01
1.00
0.98
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.370
7.338
7.336
7.321
7.311
7.233
7.217
7.033
7.007
6.992
6.441
6.415
6.169
6.136
2.374
2.202
1.706
1.697
1.630
1.620
1.611
X : parts per Million : Proton



8d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180.0
170.0
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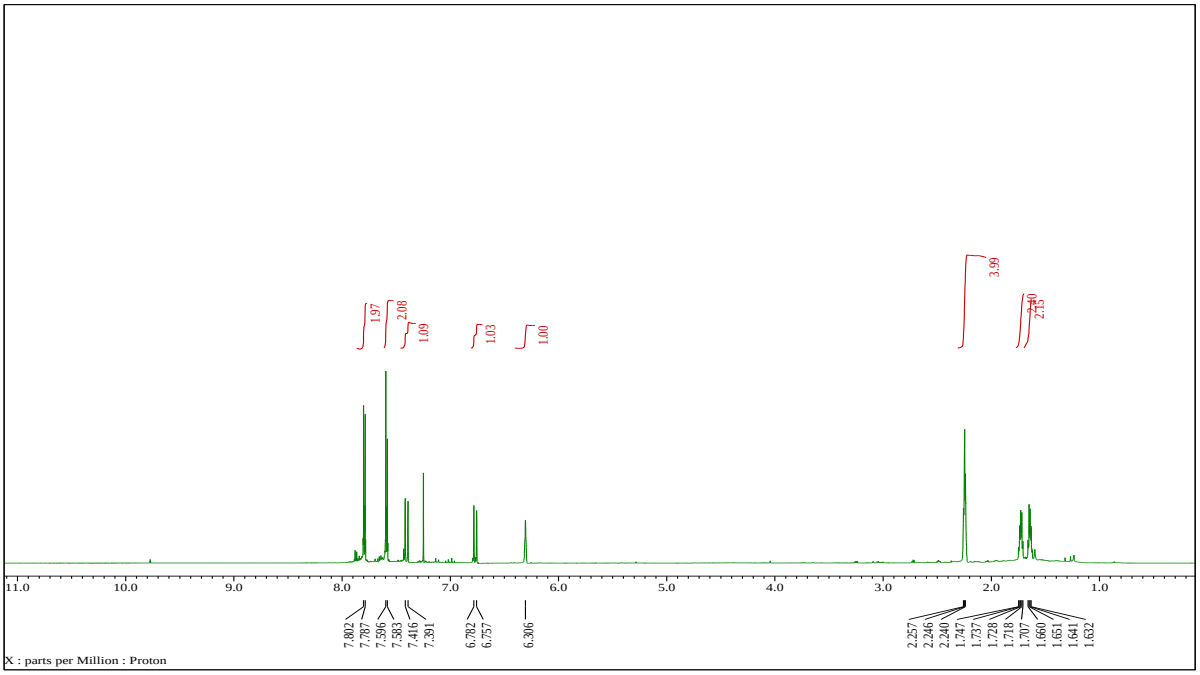
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
197.749
149.932
140.846
139.649
136.547
135.580
131.156
130.065
127.910
125.402
123.918
77.317
77.107
76.887
26.791
24.340
22.138
22.061
20.127
X : parts per Million : Carbon13


1.97
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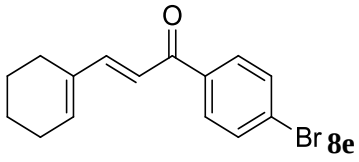
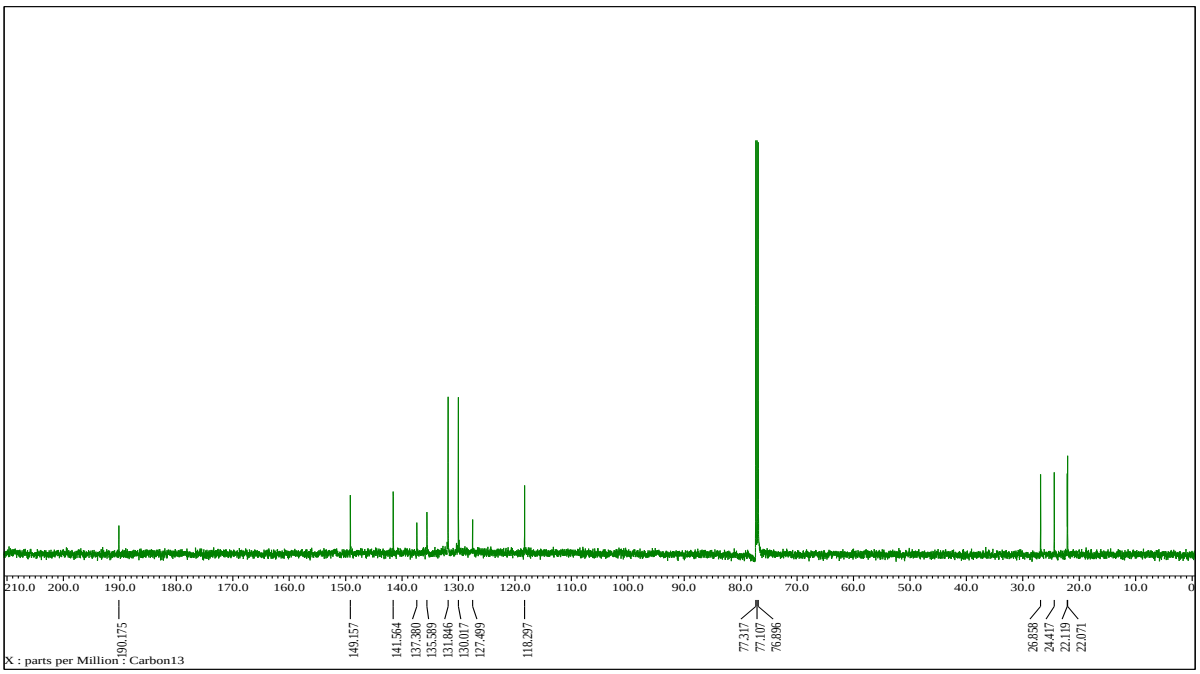
1.09
1.03
1.00
3.99
2.10
2.13
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.802
7.787
7.596
7.583
7.416
7.391
6.782
6.757
6.306
2.257
2.246
2.240
1.747
1.737
1.728
1.718
1.707
1.660
1.651
1.641
1.632
X : parts per Million : Proton


O
Br

8e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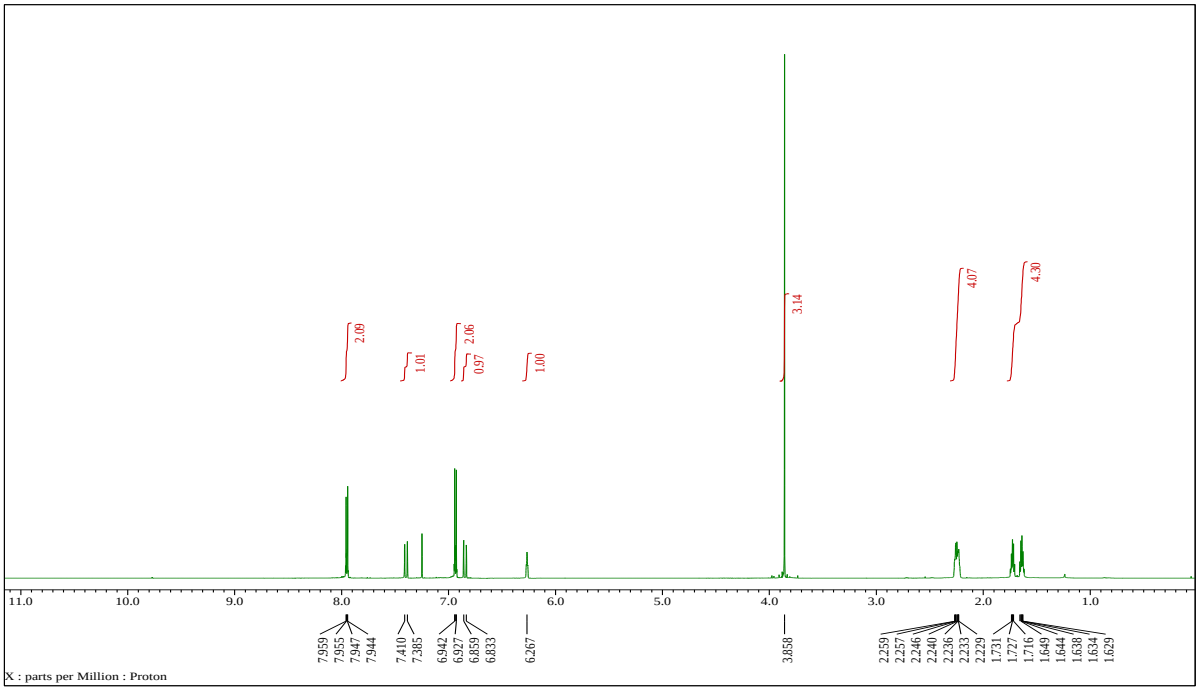
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
190.175
149.157
141.564
137.380
135.589
131.846
130.017
127.499
118.297
77.317
77.107
76.896
26.858
24.417
22.119
22.071
X : parts per Million : Carbon13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1.01
2.06
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1.00
3.14
4.07
4.30
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.959
7.955
7.947
7.944
7.410
7.385
6.942
6.927
6.859
6.833
6.267
3.858
2.259
2.257
2.246
2.240
2.236
2.233
2.229
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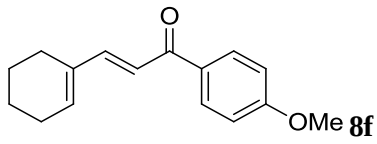
1.727
1.716
1.649
1.644
1.638
1.634
1.629
X : parts per Million : Proton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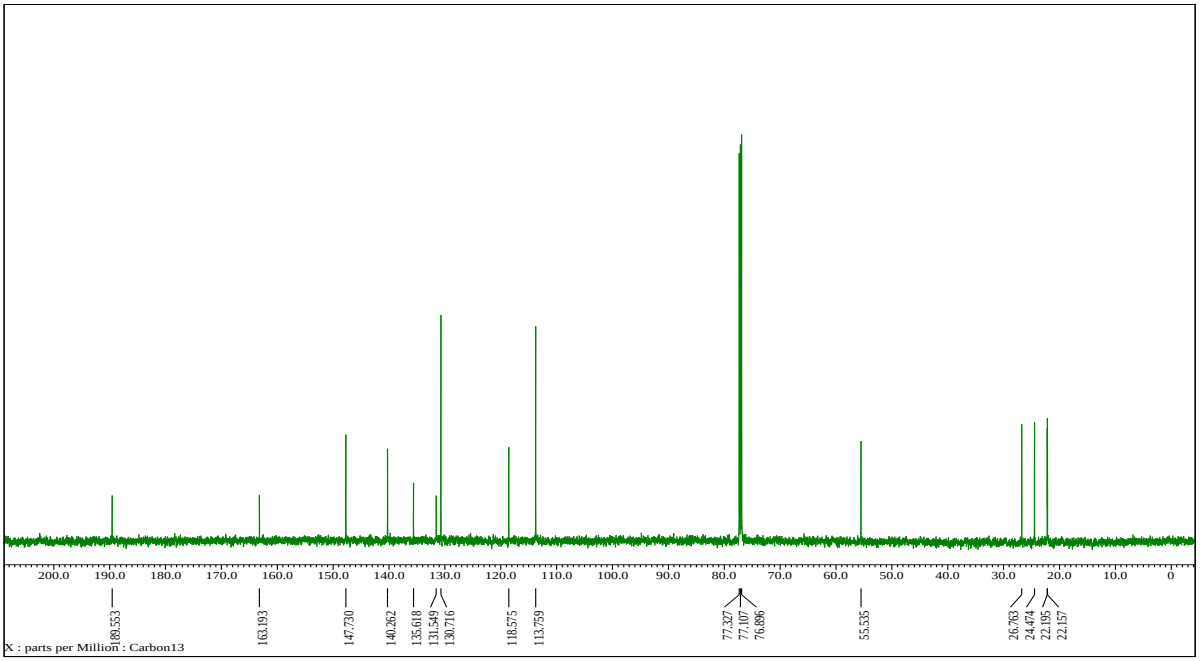
OMe

8f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160.0
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140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
189.553
163.193
147.730
140.262
135.618
131.549
130.716
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77.327
77.107
76.886
55.535
26.763
24.474
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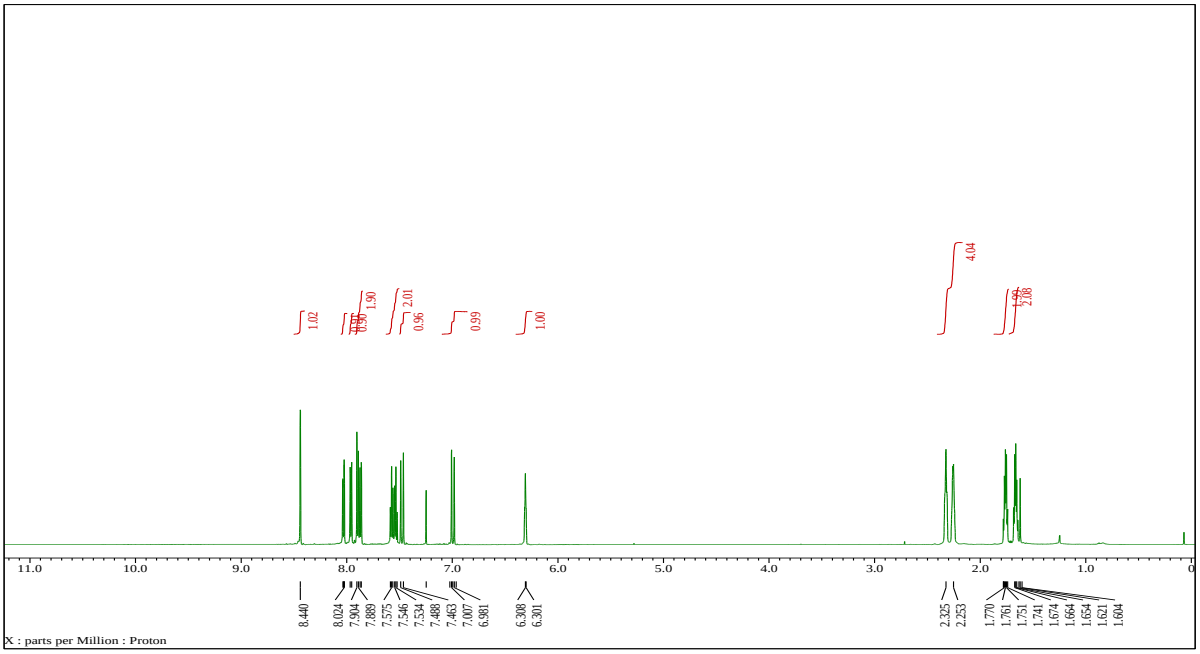
22.157
X : parts per Million : Carbon13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1.90
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0.99
1.00
4.04
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.440
8.024
7.904
7.889
7.575
7.546
7.534
7.488
7.463
7.007
6.881
6.308
6.301
2.325
2.253
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1.751
1.741
1.674
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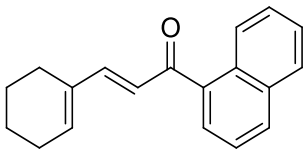
1.654
1.621
1.604
X : parts per Million : Proton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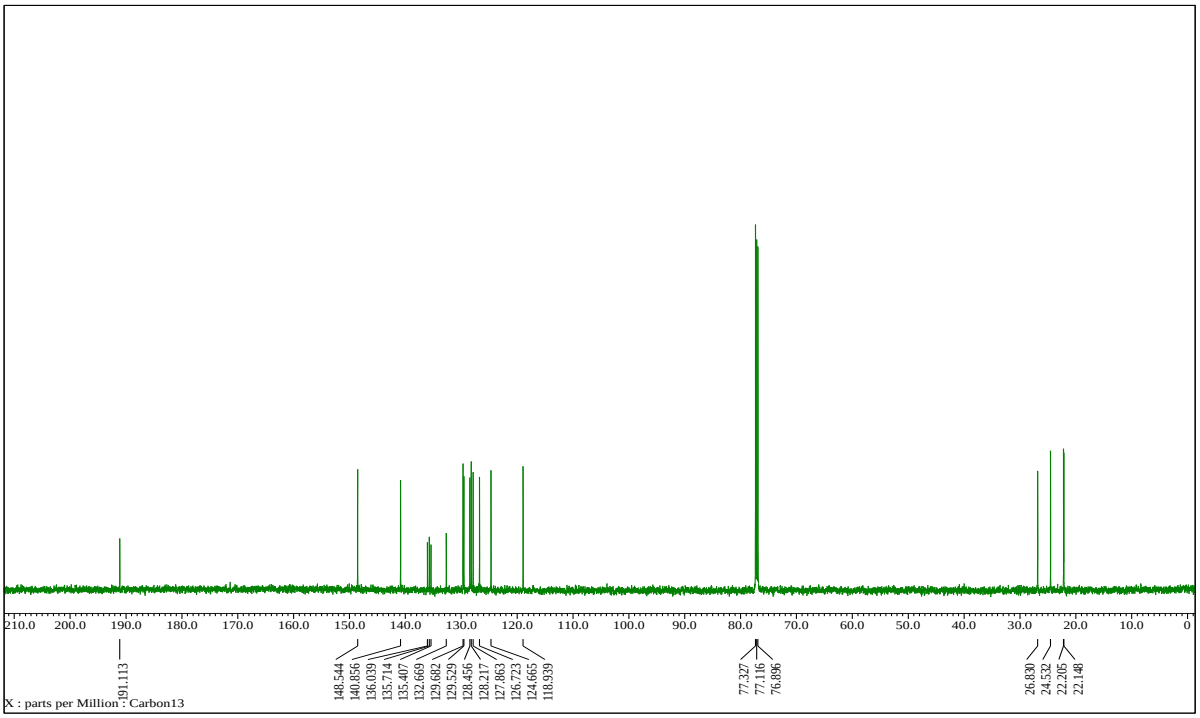
8g


210.0
200.0
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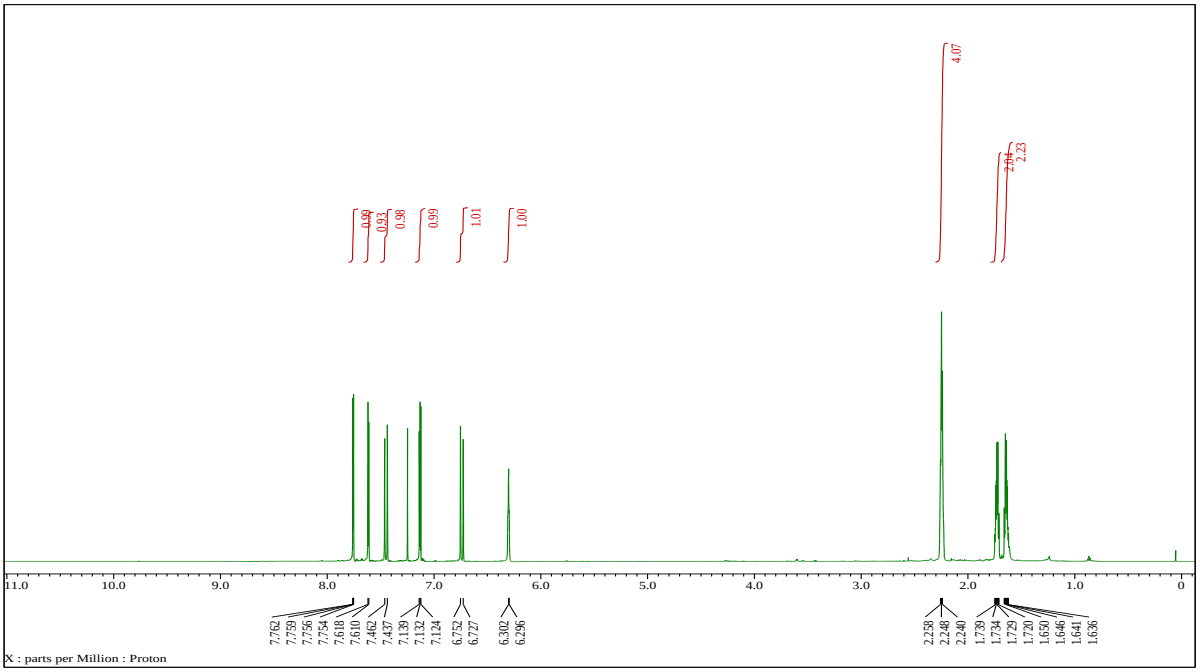
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
191.113
148.544
140.856
136.039
135.714
135.407
132.669
129.682
129.529
128.456
128.217
127.863
126.723
124.665
118.939
77.327
77.116
76.896
26.830
24.532
22.205
22.140
X : parts per Million : Carbon13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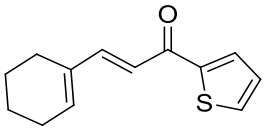
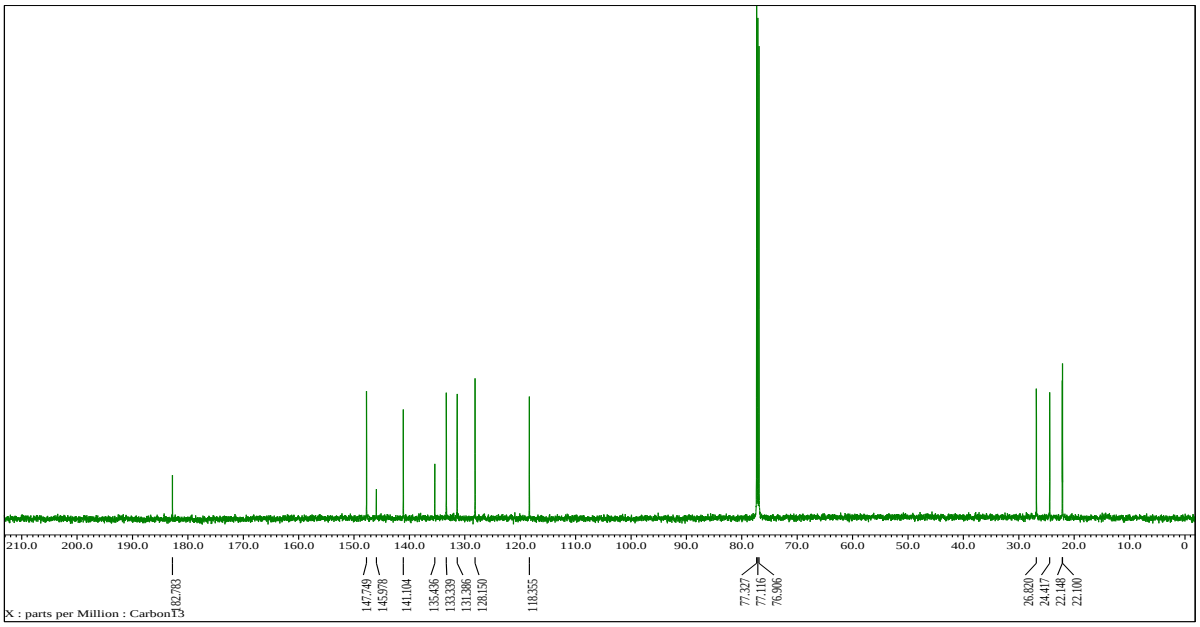
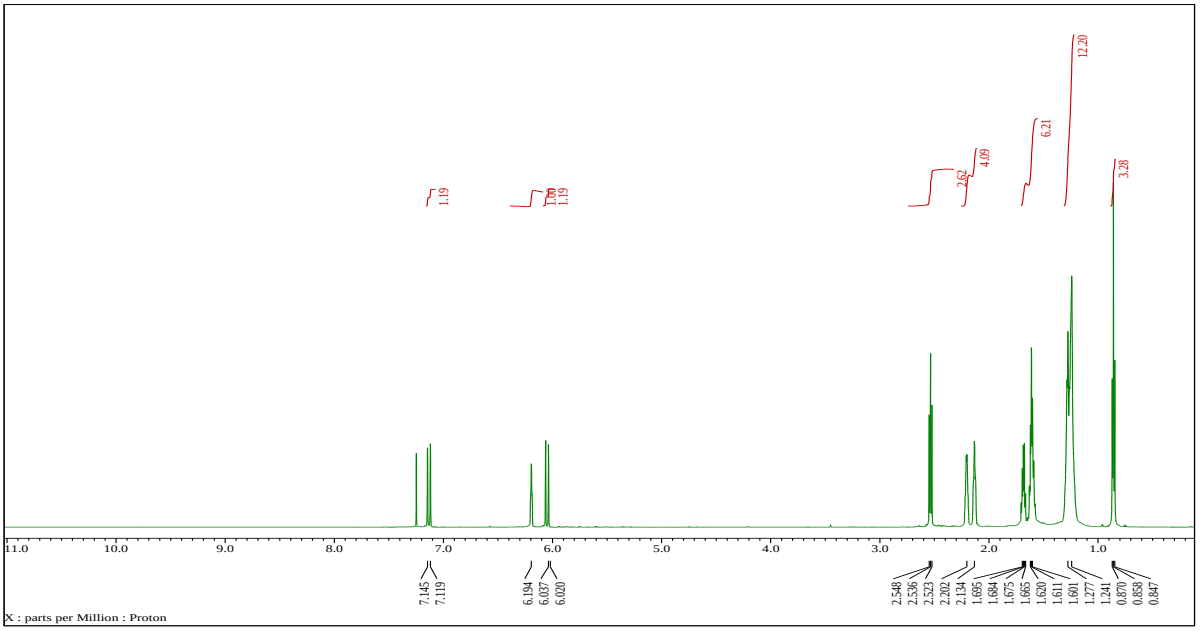
0.93
0.98
0.99
1.01
1.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.762
7.759
7.756
7.754
7.618
7.610
7.462
7.437
7.139
7.132
7.124
6.752
6.727
6.302
6.296
2.258
2.248
2.240
1.739
1.734
1.729
1.720
1.650
1.646
1.641
1.636
X : parts per Million : Proton


O
S

8h


210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
182.783
147.749
145.978
141.104
135.436
133.339
131.386
128.150
118.355
77.327
77.116
76.906
26.820
24.417
22.148
22.100
X : parts per Million : Carbon13


12.20
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1.19
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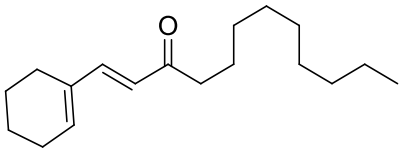
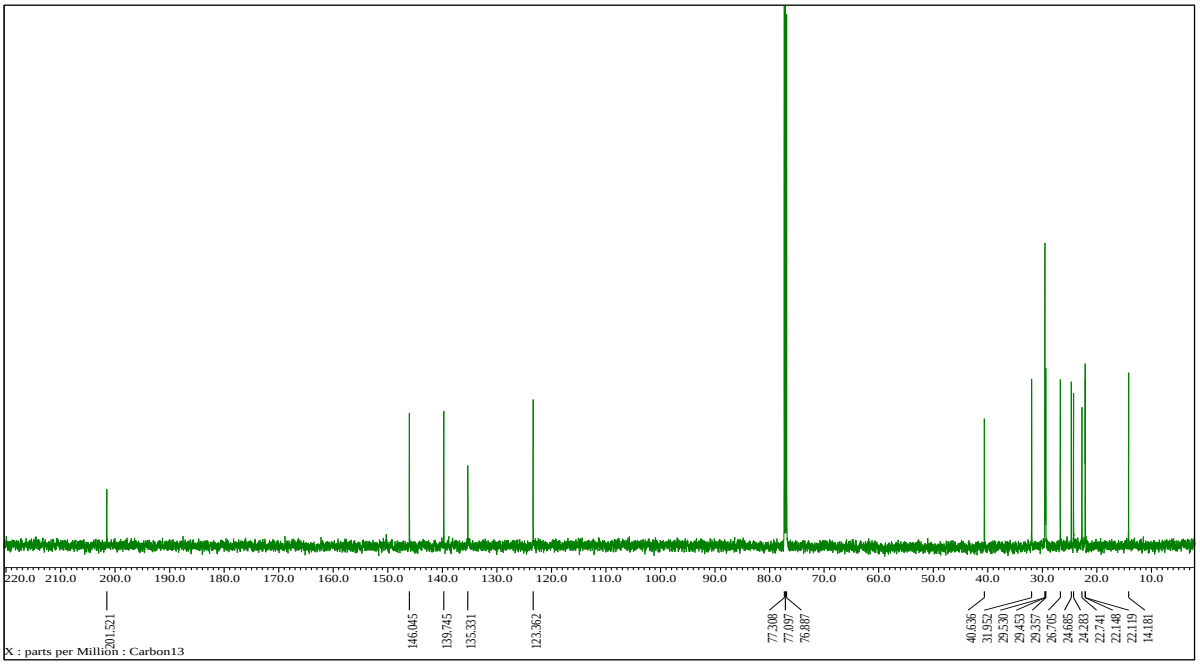
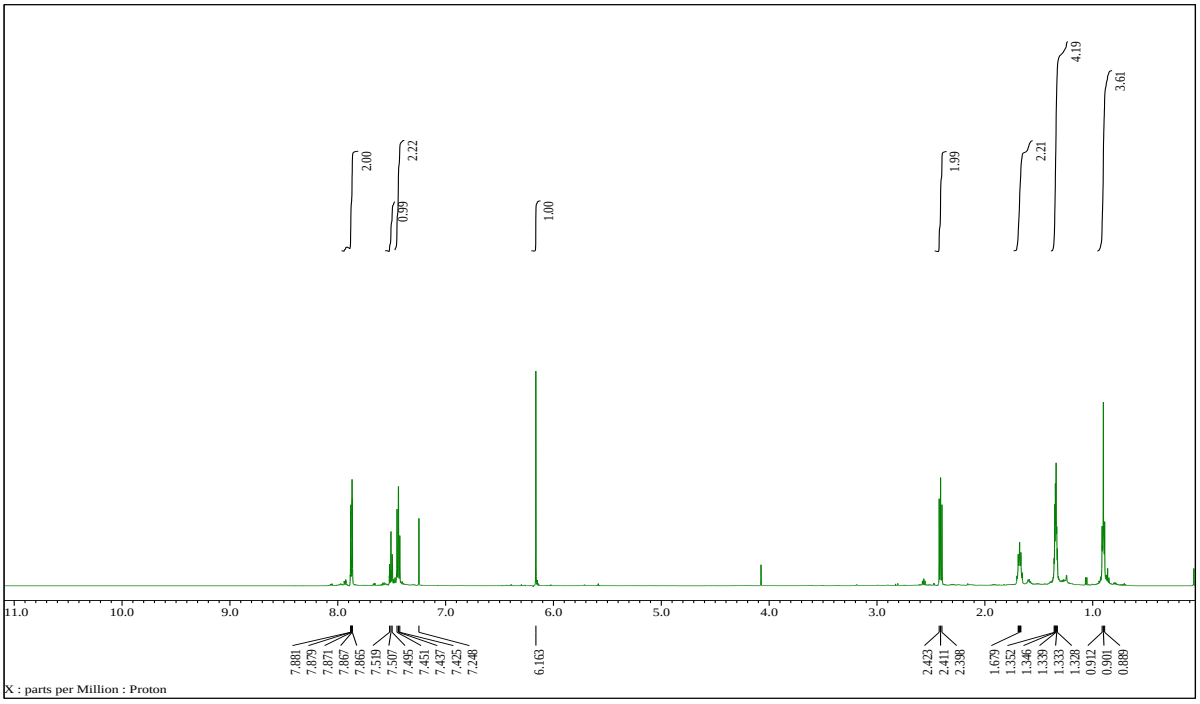
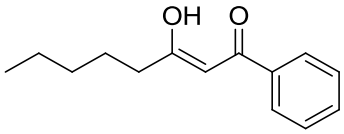
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.145
7.119
6.194
6.037
6.020
2.548
2.536
2.523
2.202
2.134
1.695
1.684
1.675
1.665
1.620
1.611
1.601
1.277
1.241
0.870
0.858
0.847
X : parts per Million : Proton


O

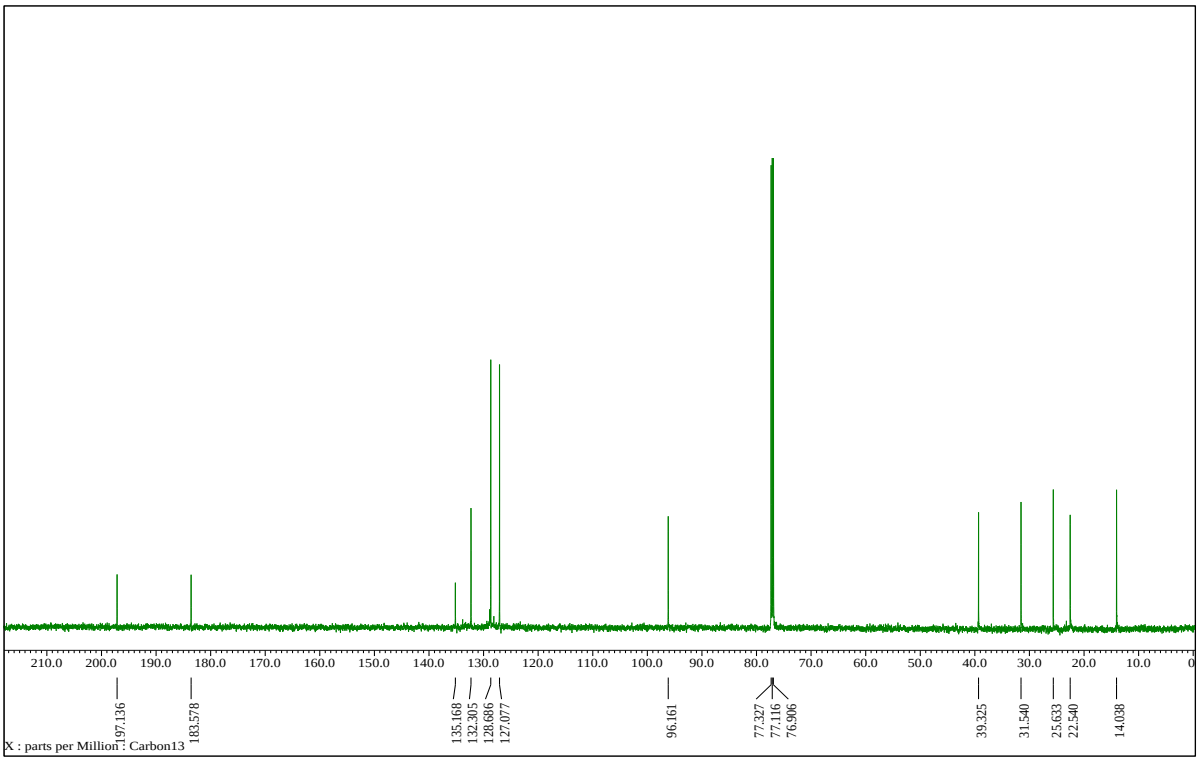
8i


220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
201.521
146.045
139.745
135.331
123.362
77.308
77.097
76.887
40.636
31.952
29.530
29.453
29.357
26.705
24.685
24.203
22.741
22.148
22.119
14.181
X : parts per Million : Carbon13

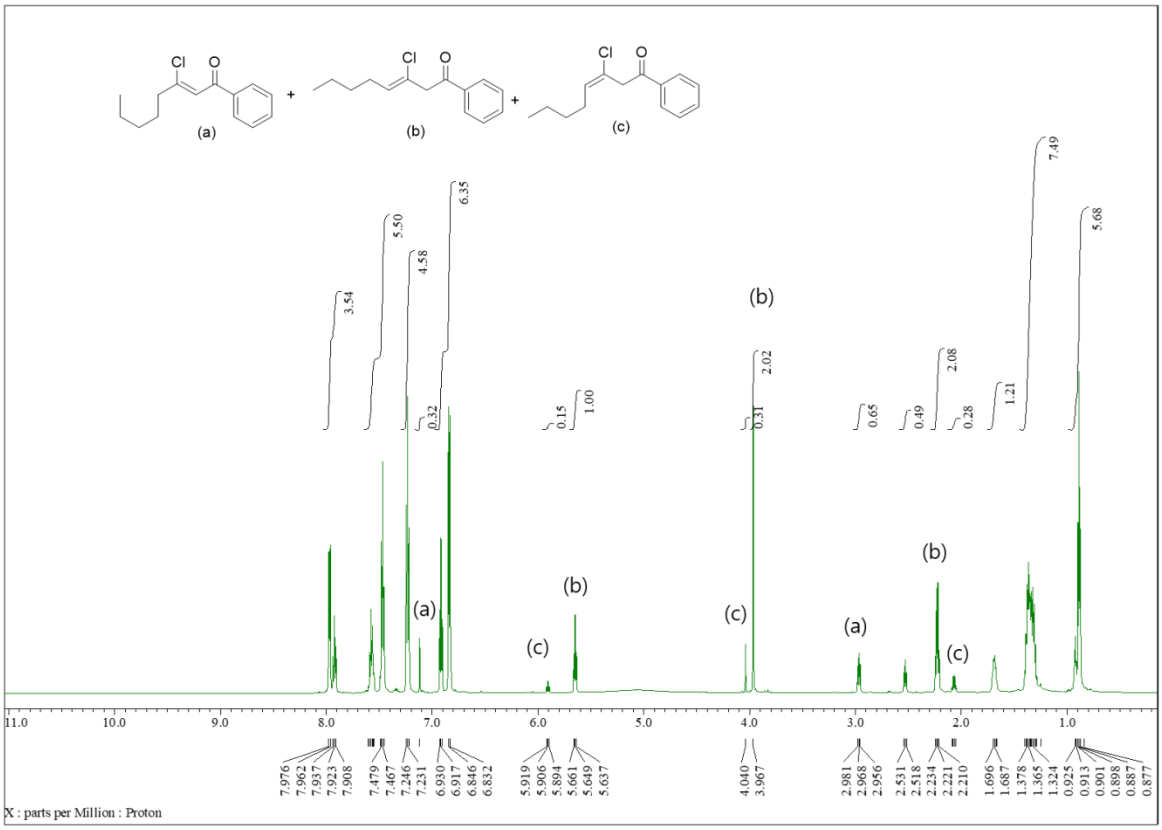




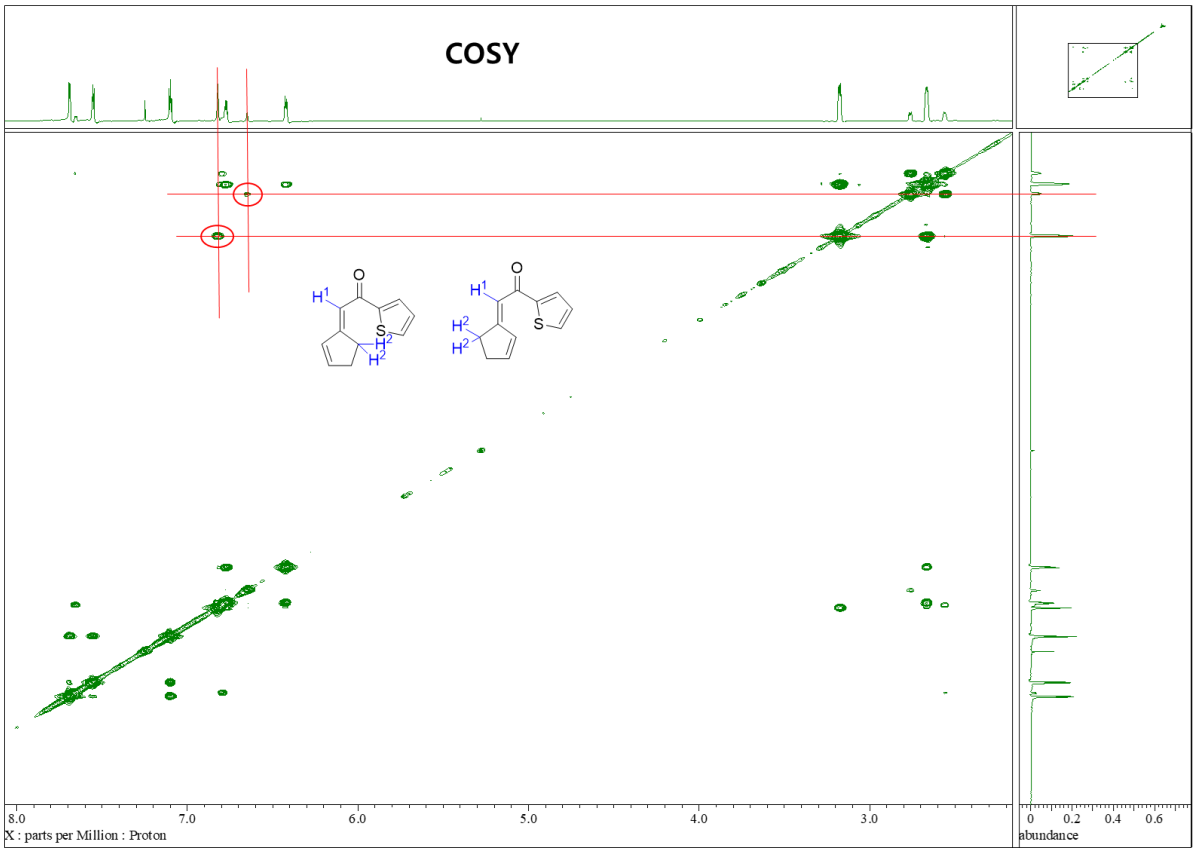
4a (in Table S-1)

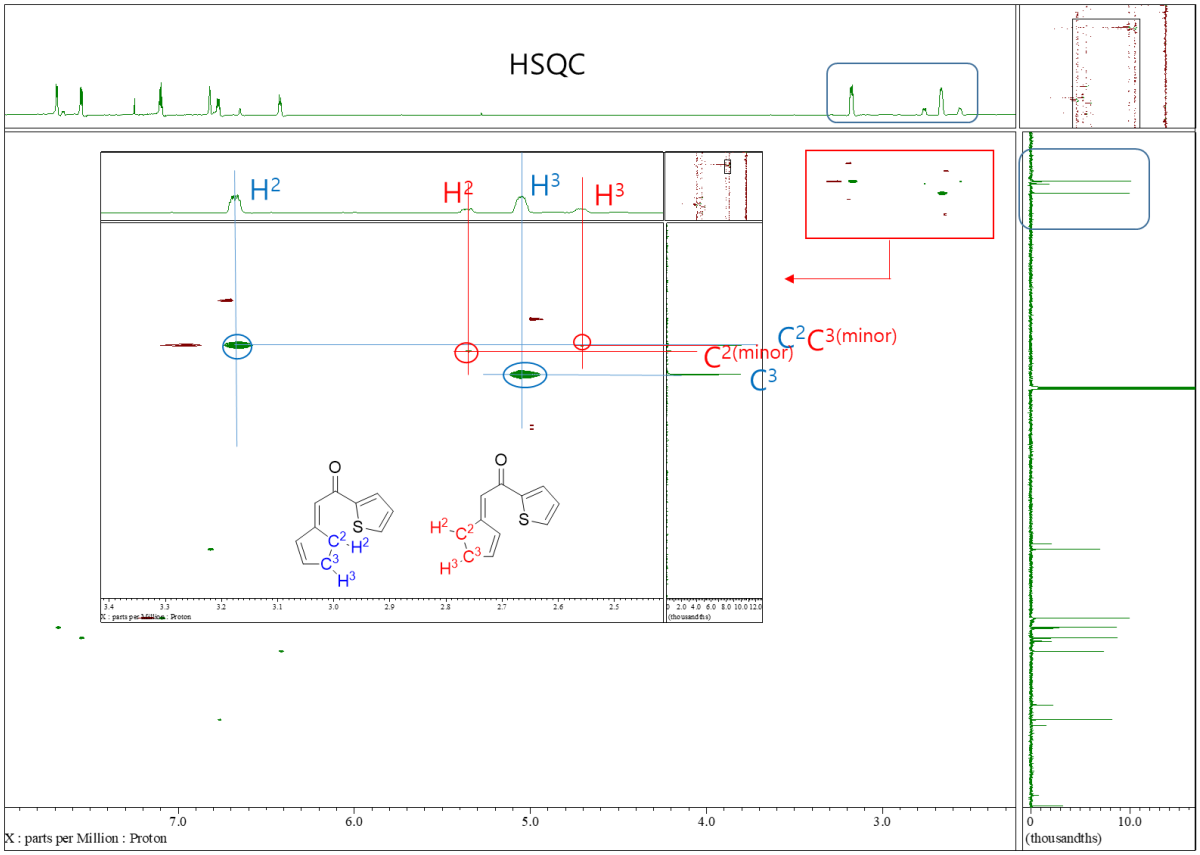


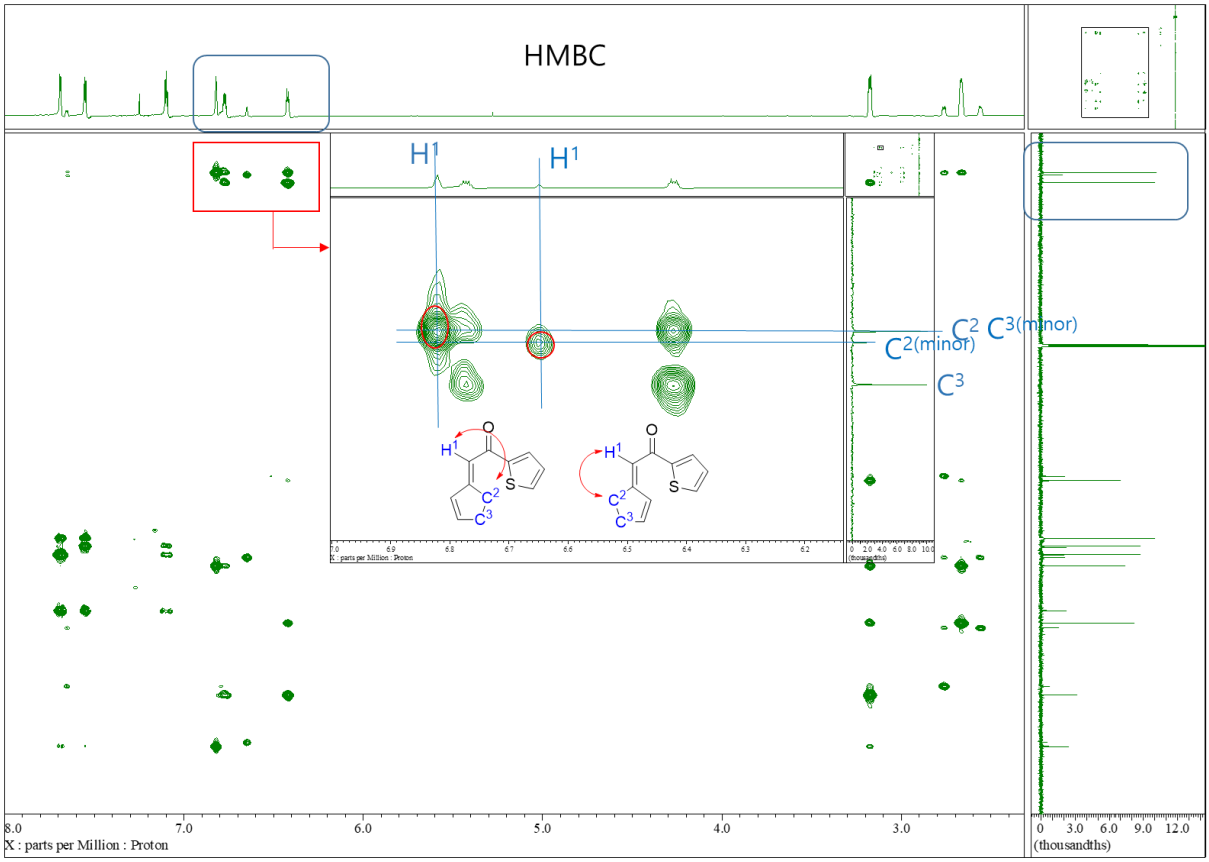
Crude ^{1}H NMR (**2a** *Z*(b)/*E*(c)) in **Table S-1**

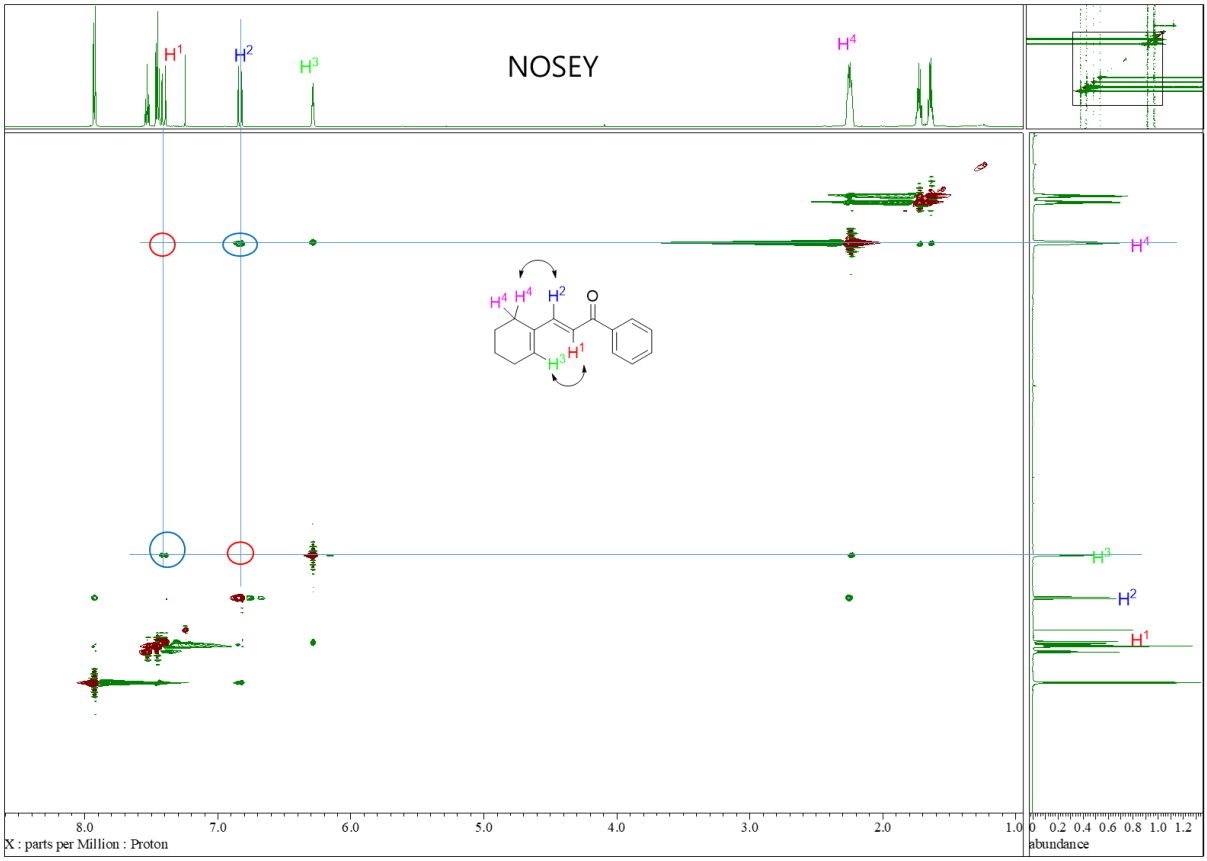


Stereochemistry Determination




HSQC
H2
H2
H3
H3
C2C3(minor)
C2(minor)
C3
O
S
C2
H2
C3
H3
H2
C2
H3
C3
O
S
7.0
6.0
5.0
4.0
3.0
X : parts per Million : Proton
0
10.0
(thousandths)


HMBC
H1
H1
C2
C3(minor)
C2(minor)
C3
H1
O
S
C2
C3
H1
O
S
C2
C3
8.0
7.0
6.0
5.0
4.0
3.0
X : parts per Million : Proton
0
3.0
6.0
9.0
12.0
(thousandths)


NOSEY
H1
H2
H3
H4
H4 H4 H2
H3 H1
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
X : parts per Million : Proton
0 0.2 0.4 0.6 0.8 1.0 1.2
abundance