Supporting Information

for

Photoredox-Catalyzed 1,2-Oxo-Alkylation of Vinyl Arenes with 1,3-Diketones: An Approach to 1,4-Dicarbonyls via C-C Activation

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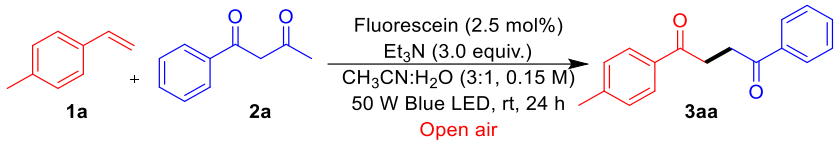
1. General Information

^{1}H NMR was recorded on a Bruker (500 MHz and 400 MHz), and ^{13}C NMR spectra were recorded on a Bruker (125 MHz/101 MHz). The chemical shift (δ) values are given in parts per million (ppm), and the coupling constants (*J*) are given in hertz (Hz). The spectra were recorded using $CDCl_3$ solvent. ^{1}H NMR chemical shifts are referenced to tetramethylsilane (TMS, 0 ppm), and ^{13}C NMR is referenced to $CDCl_3$ (77.0 ppm). HRMS was recorded with QTOF-ESI source M/S Bruker Daltonik GmbH, Germany, Waters - Xevo G2-XS-QTOF, Agilent 6530 Accurate-Mass Q-TOF LC/MS in ESI mode and Agilent 6230B, TOF in ESI mode. GC-MS was carried out on a GCMS - QP2010 Plus – Shimadzu. Cyclic voltammetry measurements were done with a computer-controlled potentiostat OriogaLys, SAS, Model OGF 500 (OrigaLys Electrochem, SAS, France). The progress of the reaction was monitored by TLC using Merck pre-coated TLC sheets. The Melting points of compounds were determined using a digital melting point apparatus (Model 935) from Deep Vision Electronics PVT. LTD. IP66 50 W Blue LED light from VistaRa fine lighting, China, irradiated the reaction mixture with a portable fan to maintain room temperature (~25 °C to 30 °C). Column chromatography was performed on 100–120 mesh silica gel using hexane/ethyl acetate as eluent, and all the solvents were used without further distillation. All commercial chemicals were purchased from Sigma-Aldrich, Alfa Aesar, Spectrochem, Carbanio, Avra and SRL.

2. Parameter variation studies

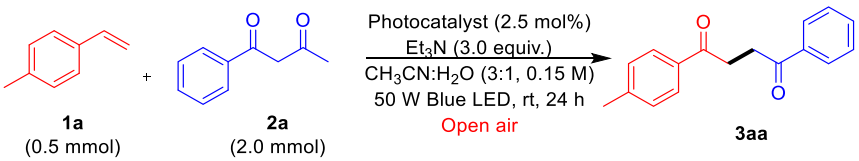
Table S1. 1,4-Diketone and Styrene equivalent variation studies[a]



s.no	ratio of 2a:1a	yield of 3aa (%)[b]
1	1:1	20
2	1:2	24
3	2:1	57
4	3:1	78
5	3.5:1	79
6	**4:1**	**84**
7	4.5:1	42

[a]All reactions were carried out using 0.5 mmol of **1a.** [b]Isolated yield

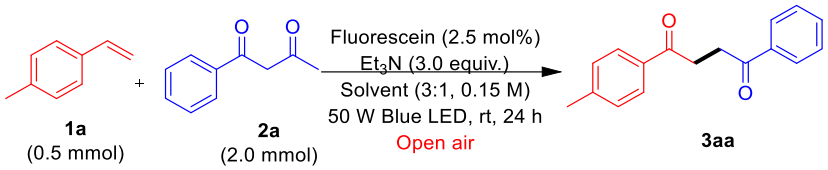
Table S2. Screening of photocatalysts[a]



s.no	Photocatalyst	yield of 3aa (%)[b]
1	EY	60
2	RB	63
3	Methylene Blue	13
4	Riboflavin	38
5	Ru	63
6	4-CzIPN	64

[a]All reactions were carried out using 0.5 mmol of **1a.** [b]Isolated yield

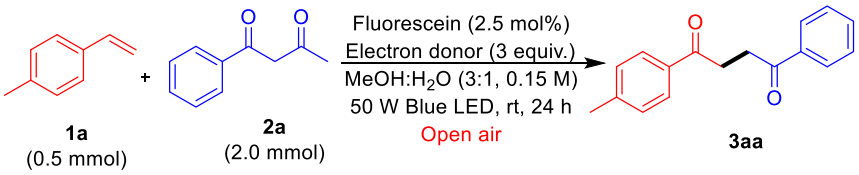
Table S3. Screening of solvents[a]



s.no	solvent	yield of 3aa (%)[b]
1	**MeOH:H_2O**	**90**
2	Acetone:H_2O	57
3	DMSO:H_2O	N.D.
4	DMF:H_2O	N.D.
5	1,4-dioxane:H_2O	N.D.

[a]All reactions were carried out using 0.5 mmol of **1a.** [b]Isolated yield. N.D. Not detected.

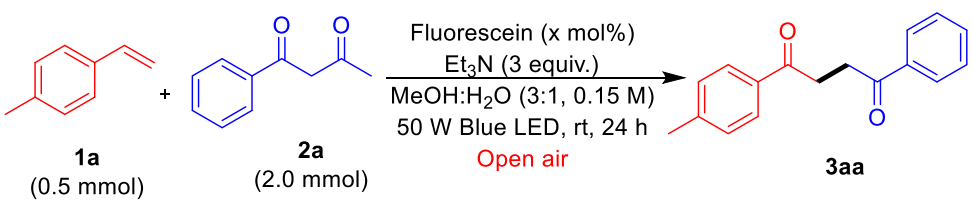
Table S4. Screening of electron donors[a]



s.no	electron donor	yield of 3aa (%)[b]
1	Hantzsch Ester	N.D.
2	DIPEA	50
3	TEOA	15
4	DMAP	30

[a]All reactions were carried out using 0.5 mmol of **1a.** [b]Isolated yield. N.D. Not detected.

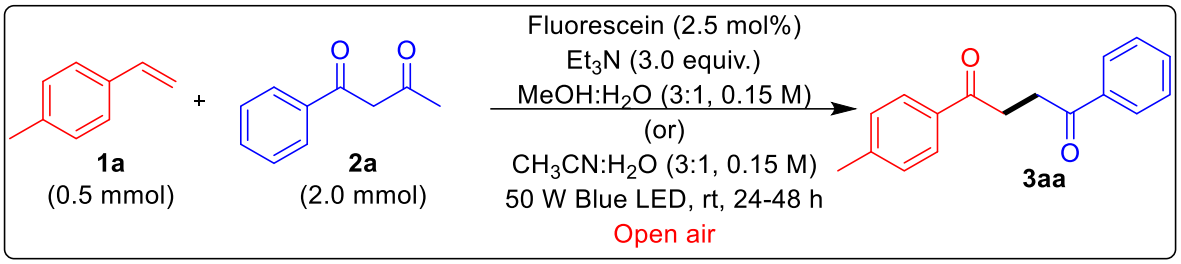
Table S5. Equivalent screening of electron donor and photocatalyst[a]



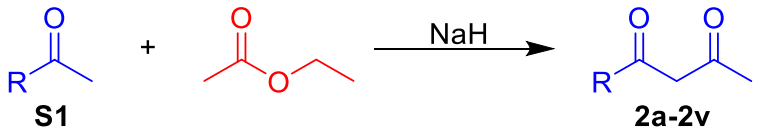
s.no	fluorescein (FL) (mol%)	Et_3N (equiv.)	yield of 3aa (%)[b]
1	2.5	Et_3N (2)	76
2	2.5	Et_3N (4)	78
3	2.0	Et_3N (3)	76
4	3.0	Et_3N (3)	61

[a]All reactions were carried out using 0.5 mmol of **1a.** [b]Isolated yield

Optimized conditions

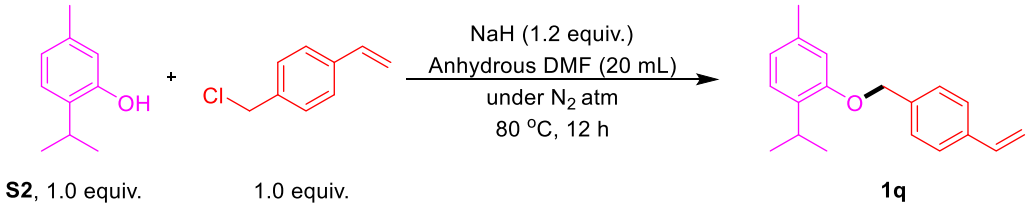


3. General experimental procedure for the synthesis of compounds 2a-v[1]



Acetophenone or substituted acetophenone (**S1**, 10.0 mmol, 1.0 equiv.) in ethyl acetate (20 mL) was slowly added to a suspension of NaH (60% dispersion in mineral oil 40 mmol, 4.0 equiv.) in ethyl acetate (**S2**, 20 mL) at 0 °C. Then, the resultant mixture was stirred at room temperature for 12 h. After completion of the reaction, the reaction mixture was carefully treated with 10% aq. NH_4Cl (30 mL) and the pH were adjusted to 5 using diluted HCl (5 N). The aqueous phase was then separated and extracted with ethyl acetate. The combined ethyl acetate layers were dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to obtain the crude reaction product. The obtained crude was purified using column chromatography (silica gel, hexane/ethyl acetate) to afford the desired product.

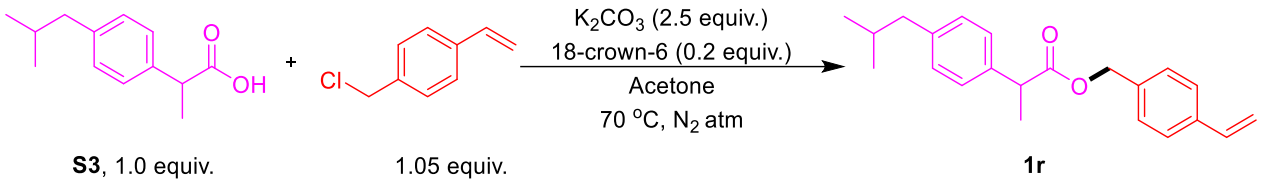
4. Experimental procedure for Synthesis of compound (1q)[2]



To a stirred solution of thymol (**S2**, 3.0 mmol) in anhydrous DMF (20 mL) was added NaH 60% in mineral oil (3.6 mmol) at 0 °C (ice bath). After stirring for 30 min, 1-(chloromethyl)-4-vinylbenzene (3.0 mmol) was added at 0 °C under N_2. The reaction mixture was stirred at 80 °C with an oil bath for 12 h. After the reaction,

the mixture was quenched with 10 mL of water. The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane to afford the desired product (**1q**).

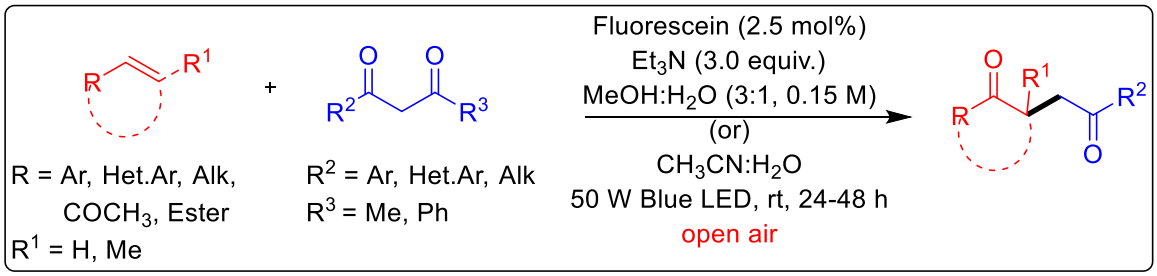
5. Experimental procedure for Synthesis of compound (1r)[3]



S3, 1.0 equiv. 1.05 equiv. **1r**

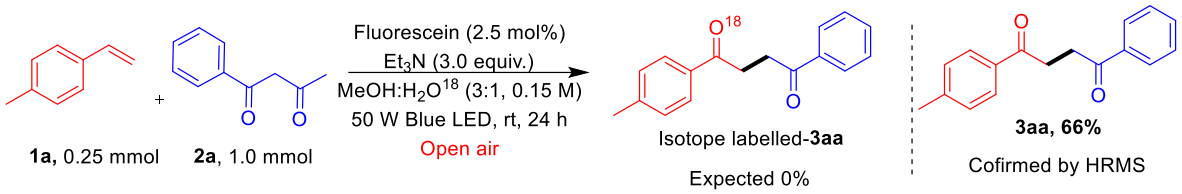
In a 25 mL round-bottom flask, ibuprofen (**S3**, 1.0 equiv.), K_2CO_3 (2.5 equiv), and 18-crown-6 (0.2 equiv) were added and dissolved in acetone. Then this mixture was purged with N_2 and added 1-(chloromethyl)-4-vinylbenzene (1.05 equiv). The reaction solution was vigorously stirred under N_2 and heated at 70 °C. The completion of the reaction was monitored by TLC chromatography. After completion, the reaction mixture was diluted with 10 mL of water. The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane to afford the desired product (**1r**).

6. General experimental procedure (A) for 1,4-diketones 3aa-aw, 3ba-gw, 3na-3ra

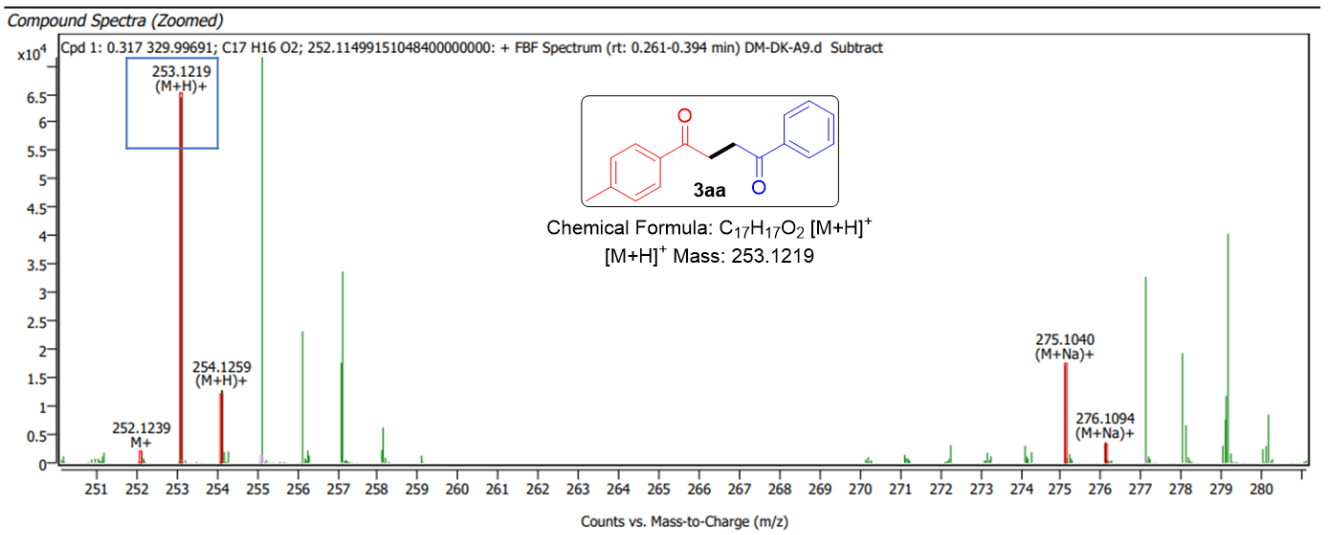


Compound **2a-2z** (2.0 mmol) was dissolved in 0.15 M of solvent (MeOH:H_2O or CH_3CN:H_2O (3:1, 3.3 mL) followed by the addition of triethylamine (3.0 equiv.), fluorescein (2.5 mol %), and alkenes **1a-1r** (0.5 mmol). The reaction mixture was stirred under the 50 W blue LED in the open air until completion of the reaction, monitored by TLC chromatography (~24-48 h). The reaction mixture was diluted with 10 mL of water. The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane/ethyl acetate to afford the desired product **3aa-aw, 3ba-gw, 3na-3ra** in average to good reaction yields.

7. Experimental procedure for the H_2O^{18} studies



The reaction was performed with standard conditions using MeOH:H_2O^{18} (3:1, 0.15M) on a 0.25mmol scale of **1a**. The reaction completion was monitored by TLC chromatography. The reaction mixture was diluted with 10 mL of water. The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane/ethyl acetate (3%) to afford the desired product **3aa** in 83 mg yield of 66% as a white solid. HRMS (ESI) calculated for $C_{17}H_{17}O_2$ $[M+H]^+$: 253.1219 found 253.1219.



Compound Details

Cpd. 1: C17 H16 O2

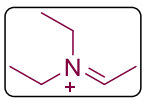
Formula	m/z	Observed M/Z	Difference_Da	Difference_PPM	Score
C17 H16 O2	253.1219	253.12188922933	-0.0382445159345934	-0.151694708450181	85.07

Figure S1. HRMS analysis data of H_2O^{18} studies

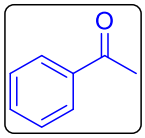
8. Reaction monitoring studies by GC-MS analysis

GC-MS chromatogram analysis of the reaction mixture of **3aa** was performed on GCMS - QP2010 Plus – Shimadzu during the courses of reaction (2 h, 6 h, 10 h, 18 h, 24 h) and the intermediates are verified. We have detected the following intermediates, product **3aa** and the minor side products. This strongly suggests that the mechanism goes via proposed in the manuscript.

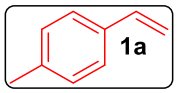
Chemical Formula: C_2H_4O
m/z: 44



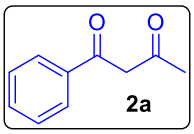
Chemical Formula: $C_6H_{14}N^+$
m/z: 100



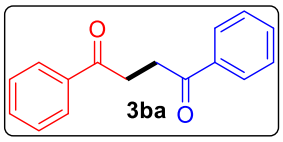
Chemical Formula: C_8H_8O
m/z: 120



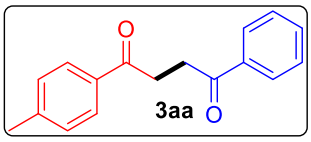
Chemical Formula: C_9H_{10}
m/z: 118



Chemical Formula: $C_{10}H_{10}O_2$
m/z: 162



Chemical Formula: $C_{17}H_{16}O_2$
m/z: 252



Chemical Formula: $C_{17}H_{16}O_2$
m/z: 252

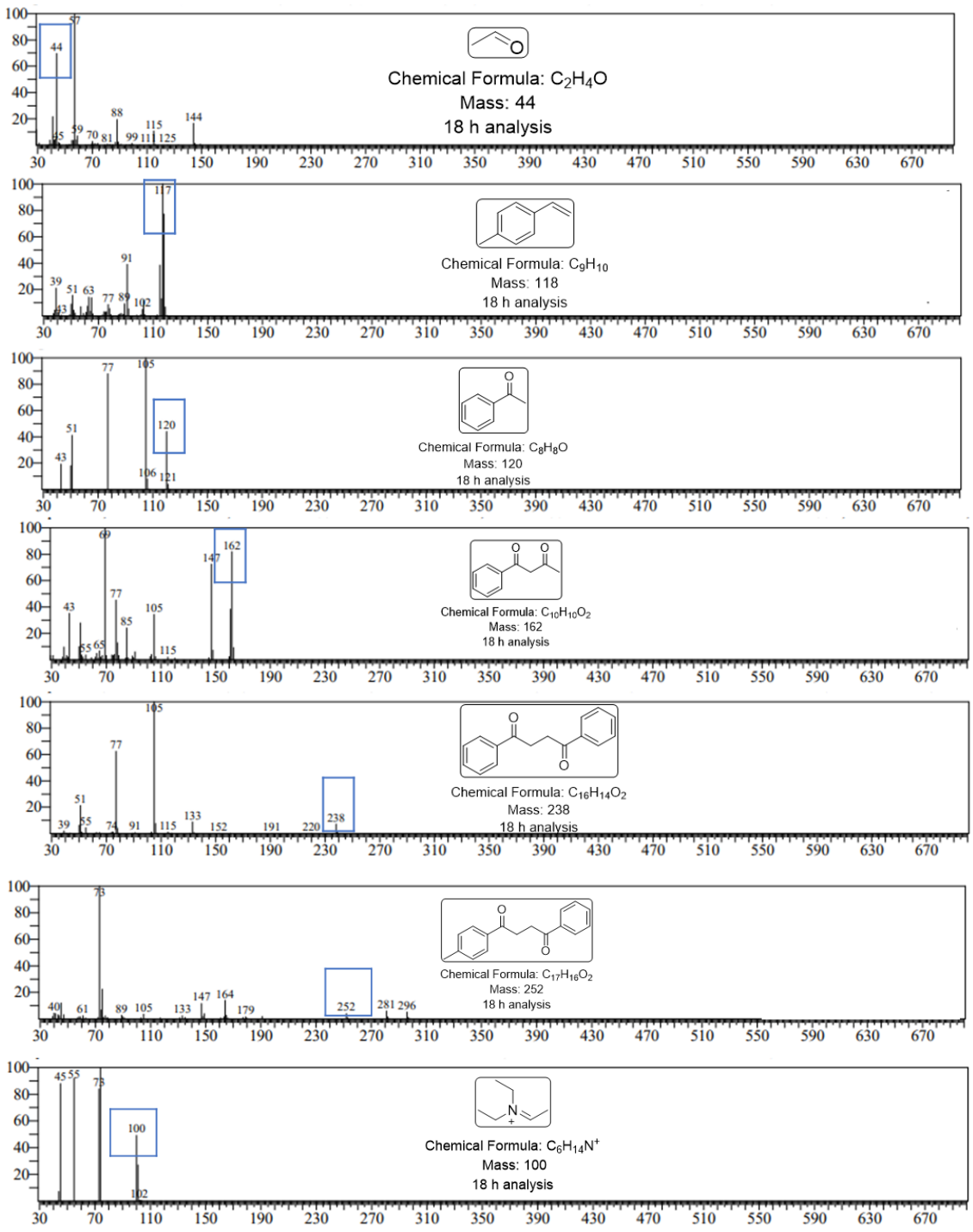
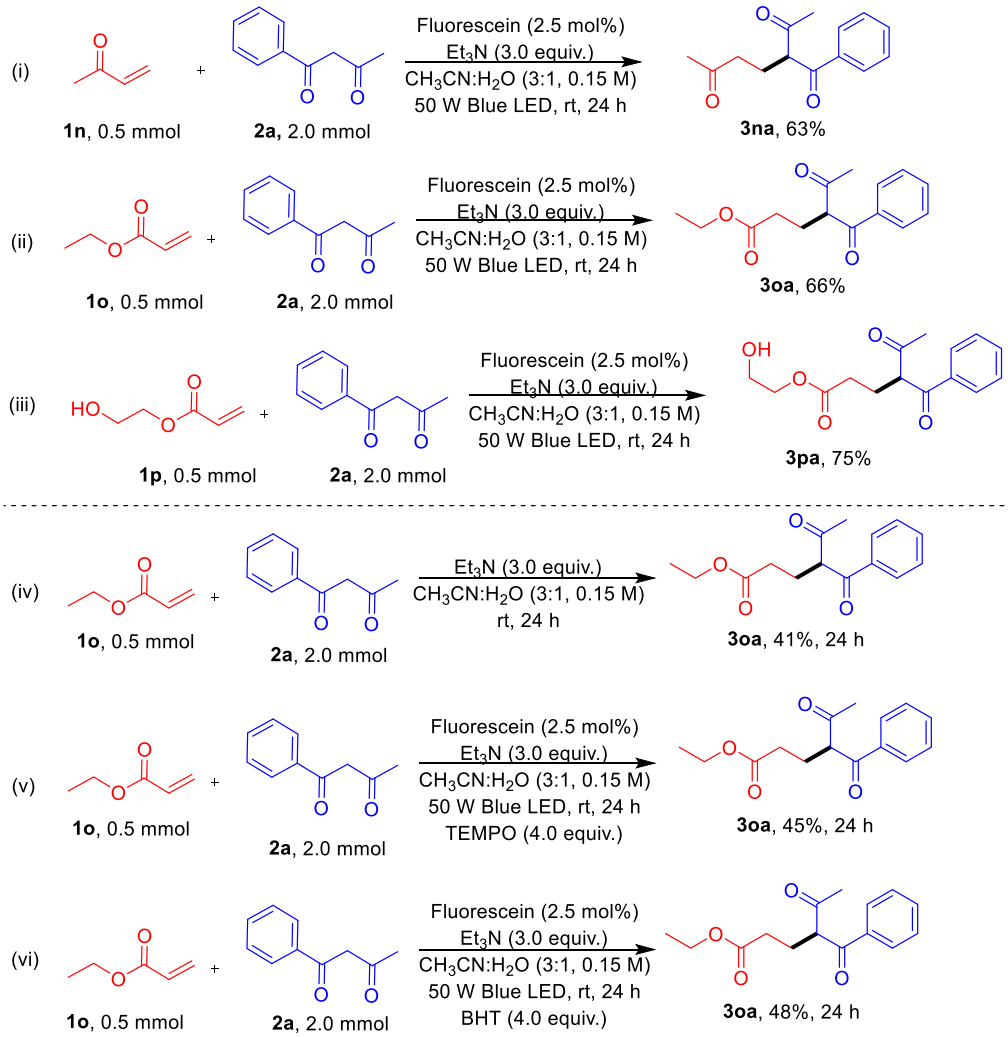


Figure S2. GC-MS analysis data of reaction

9. Control experiment for activated alkenes

While testing the scope of reaction with activated alkenes such as vinyl ketone (**2n**) and vinyl esters (**2o-p**). Interestingly, the reaction gave 1,2-hydroalkylation product **3oa-pa** in 63% - 75% yields. To confirm the role

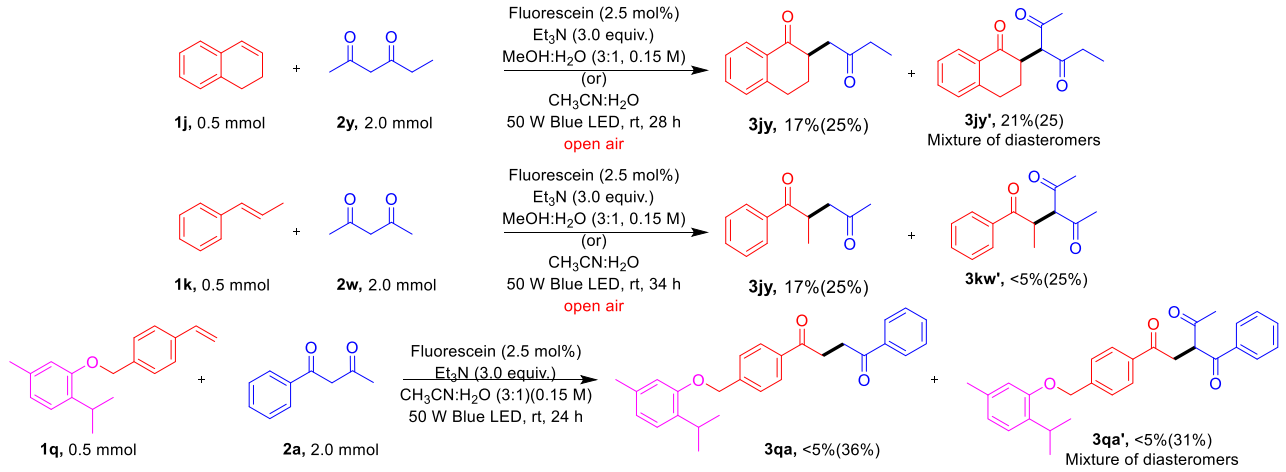
of visible-light photocatalysis in the 1,2-hydroalkylation reaction, we have performed the reaction of ethyl acrylate (**2o**) at room temperature without light/photocatalyst and also with radical scavengers (TEMPO & BHT). The reaction proceeded moderately, and the obtained reaction yields less than that of light-mediated reactions. These results weakly suggest that the visible light can drive to a better product yield.



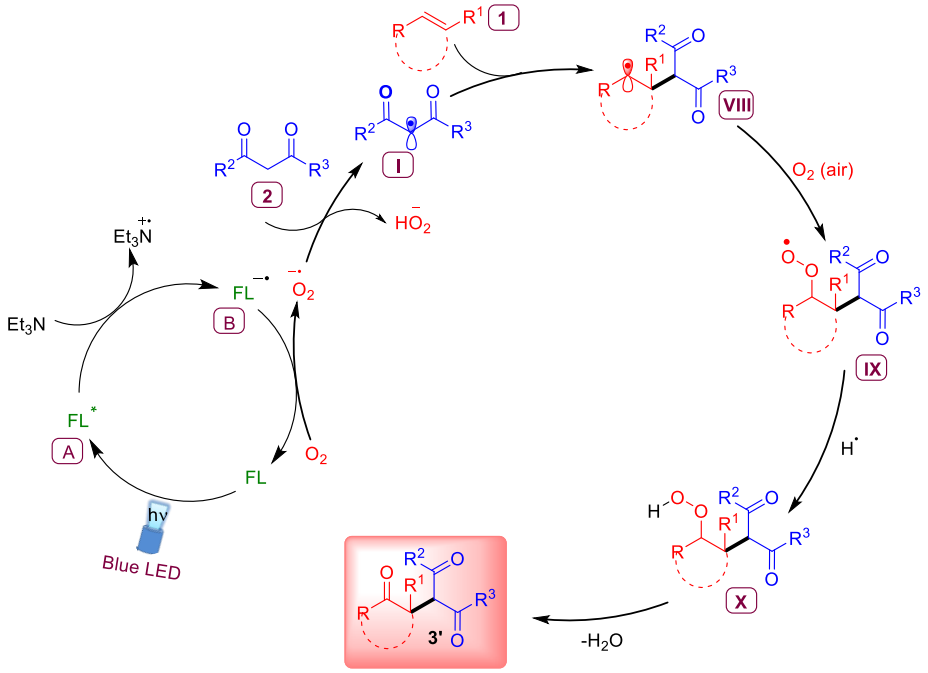
Scheme S1. Reaction of activated alkenes and control studies with ethylacrylate (**1o**).

10. Mechanism for minor side product

When we performed the reaction using $CH_3CN:H_2O$ (Table 1, entry 5) conditions, we observed the formation of a 1,2-oxo-alkylation reaction of styrenes with 1,3- dicarbonyls before initiation of C-C activation to deliver the compounds **3jy'**, **3kw'** and **3qa'** as a side-product. In all the cases when the reaction was carried out in $CH_3CN:H_2O$, the formation of 1,2-oxo-alkylation was observed by trapping 1,3-diketone-α-carbon radical (**I**) with vinyl arenes before the C-C activation step to afford triketones in 5% to 10%, and it was traced in the case of $MeOH:H_2O$ as a solvent. In this regard, we have isolated three derivatives which are formed more than 10% of the yield, as mentioned in Scheme S2. A plausible mechanism was also proposed for the triketones based on the reaction outcomes, as shown in Scheme S3.



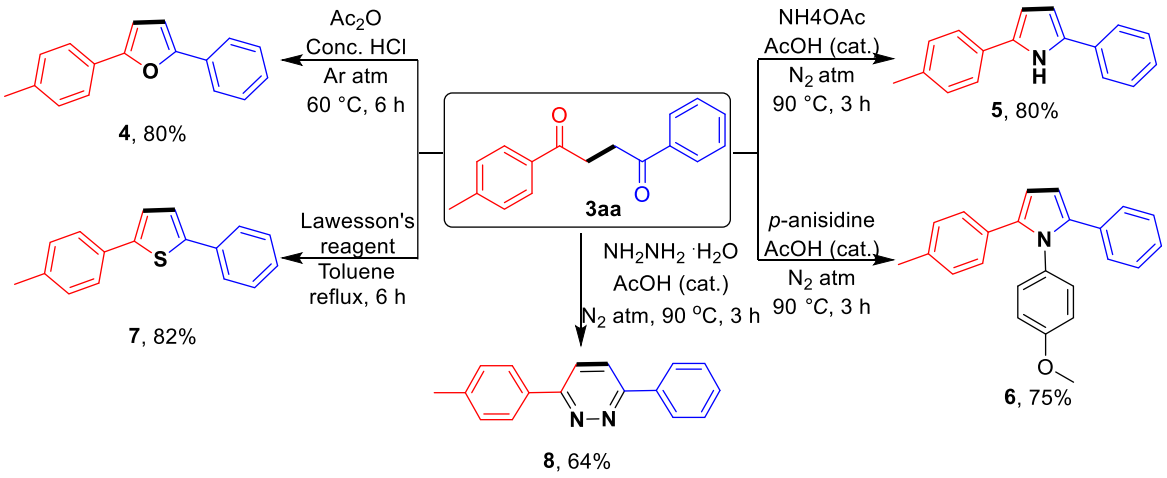
Scheme S2. Reactions for minor by-products. Yields mentioned in the brackets correspond to $CH_3CN:H_2O$ condition



Scheme S3. Plausible reaction mechanism for the minor by-product

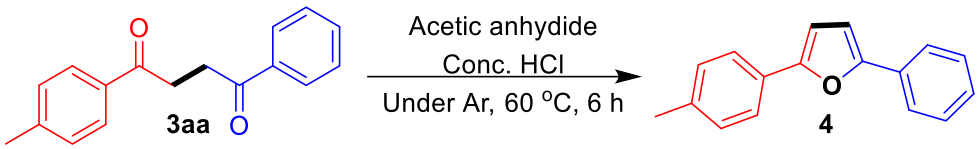
11. Synthetic applications

With the successful outcome of a variety of 1,4-diketones, we next stepped into their utilization as a potential building block for synthesizing five- and six-membered heterocyclic compounds. In this context, compound 3aa was chosen as a representative 1,4-diketone for synthesizing 2,4-disubstituted furan (**4**), 2,5-disubstituted pyrrole (**5**&**6**), 2,5-disubstituted thiophene (**7**) and 3,6-disubstituted pyridazine (**8**) with suitable coupling partners as shown in Scheme S4.[4,5] All the reactions underwent smooth conversion to afford the above-said heterocycles in 64%-82% yields.



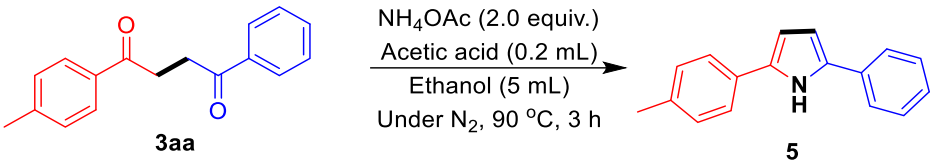
Scheme S4. Synthetic applications

12. Experimental procedure (B) for the synthesis of 2-Phenyl-5-(*p*-tolyl)furan (4)[4]



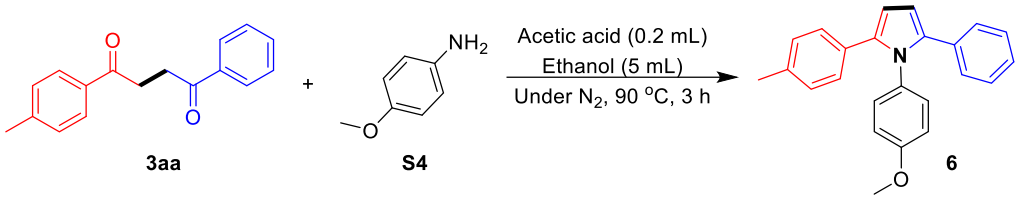
The title compound was synthesized following the modified procedure: The 2.5 mL of conc. HCl was added drop wise to a stirred suspension of **3aa** (0.5 mmol, 127 mg) in 2.5 mL of Ac_2O at 0 °C under an argon atmosphere, and the solution was allowed to stir at 60 °C for 6 h. The reaction was then neutralized with sat. $NaHCO_3$ and was extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was given a water wash, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane to afford the desired product in 80% yield.

13. Experimental procedure (C) for the synthesis of 2-Phenyl-5-(*p*-tolyl)-1*H*-pyrrole (5)[5]



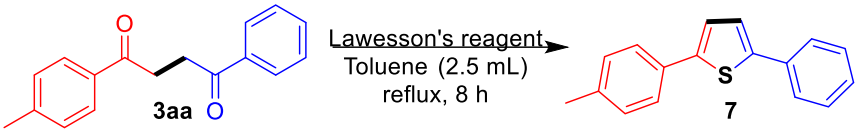
The title compound was synthesized following the modified procedure: The compound **3aa** (0.5 mmol, 127 mg) was dissolved in 5 mL of ethanol and then added NH_4OAc (1 mmol, 77 mg) followed by 0.2 mL acetic acid drop wise under nitrogen atmosphere. After adding acetic acid, the solution was stirred at 90 °C for 3 h. The reaction was neutralized with sat. $NaHCO_3$ and extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was given a water wash, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane to afford the desired product **5** in 80% yield.

14. Experimental procedure (D) for the synthesis of 1-(4-Methoxyphenyl)-2-phenyl-5-(*p*-tolyl)-1*H*-pyrrole (6)[5]



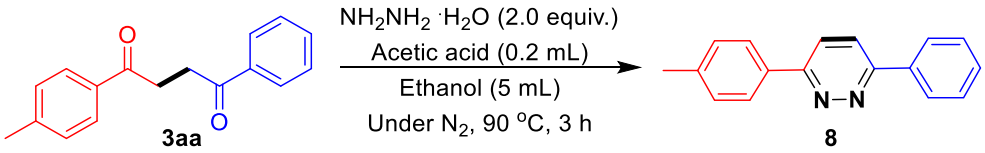
The title compound was synthesized following the modified procedure: The compound **3aa** (0.5 mmol, 127 mg) dissolved in 5 mL of ethanol and then added 4-methoxyaniline (**S4**,1.0 mmol, 123 mg) followed by 0.2 mL acetic acid drop wise under nitrogen atmosphere. After adding acetic acid, the solution was stirred at 90 °C for 3 h. The reaction was neutralized with sat. $NaHCO_3$ was then extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was given a water wash, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane to afford the desired product **6** in 75% yield.

15. Experimental procedure (E) for the synthesis of 2-Phenyl-5-(*p*-tolyl)thiophenes (7)[4]



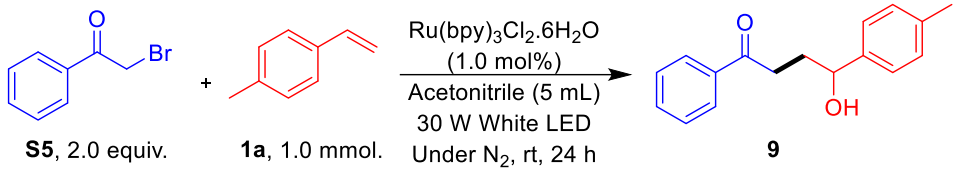
A mixture of **3aa** (0.5 mmol, 127 mg) and Lawesson's reagent (250 mg, 1.2 equiv) was heated under reflux in toluene (2.5 mL) for 6 h. The solution was allowed to cool to room temperature and then extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was given a water wash, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The crude obtained was purified using column chromatography by eluting hexane to afford the desired product **7** of 82% yield.

16. Experimental procedure (F) for the synthesis of 3-Phenyl-6-(*p*-tolyl)pyridazines (8)[5]



The title compound was synthesized following the modified procedure: The compound **3aa** (0.5 mmol, 127 mg) dissolved in 5 mL of ethanol and then added $NH_2NH_2{\cdot}H_2O$ (1.0 mmol, 123 mg) followed by 0.2 mL acetic acid drop wise under nitrogen atmosphere. After adding acetic acid, the solution was stirred at 90 °C for 3 h. The reaction was neutralized with sat. $NaHCO_3$ was then extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was given a water wash, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane to afford the desired product **8** in 64% yield.

17. Experimental procedure (G) for the synthesis of 4-hydroxy-1-phenyl-4-(*p*-tolyl)butan-1-one (9)[6]



α-Bromoacetophenone (**S5**, 2.0 equiv.), *p*-methylstyrene (**1a**, 1.0 mmol.), $Ru(bpy)_3Cl_2 \cdot 6H_2O$ (1.0 mol%) and $NaHCO_3$ (1.0 equiv.) are weighed under a nitrogen atmosphere in a 25 mL glass vial. To this reaction mixture, acetonitrile (3.0 mL) and water (1.0 equiv.) were added and stirred for 24 h at room temperature under a 30 W white LED lamp. After the reaction is completed, the reaction mixture was diluted with 10 mL of water. The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined ethyl acetate layer was dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to get a crude compound. The obtained crude was purified using column chromatography by eluting hexane/ethyl acetate to afford the desired product **9**.

18. Electrochemical measurements of 1-phenylbutane-1,3-dione (2a)

Samples for electrochemical measurements were prepared with 0.1 M of *tetra-n*-butylammonium hexafluorophosphate solution in MeOH:H_2O (3:1) and 0.05 M of 1-phenylbutane-1,3-dione (**2a**). Cyclic voltammetry measurements were done with a computer-controlled potentiostat OriogaLys, SAS, Model OGF 500. Cyclic Voltammetry was recorded using an undivided cell equipped with glassy carbon as the working electrode, platinum wire as the counter electrode and Ag/AgCl as a reference electrode. The ferrocene/ ferrocenium couple (Fc/Fc^+) was also measured in the same electrochemical system, and the electrode potential was reported as values referring to the system's apparent standard potential. Reductions were measured by scanning potentials in the negative direction and oxidations in the positive direction; the glassy carbon electrode was polished between scans. A scan rate was used, 100 mV/s.

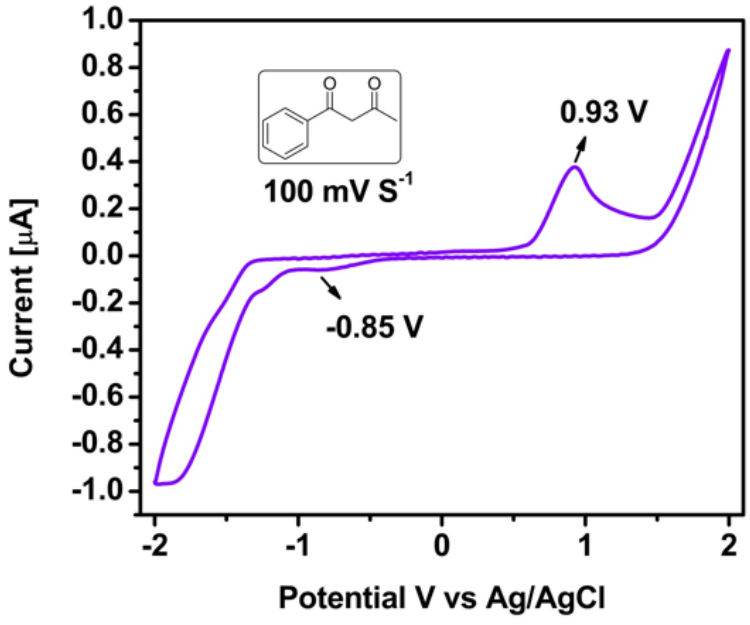
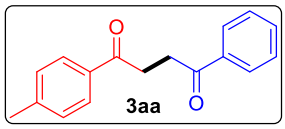


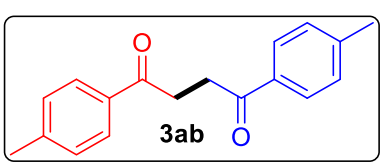
Figure S3. Cyclic Voltammogram of 1-phenylbutane-1,3-dione (**2a**).

19. Spectral Characterization

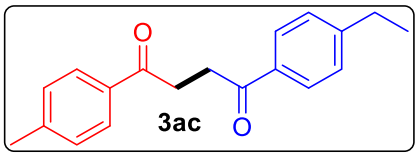
1-Phenyl-4-(*p*-tolyl)butane-1,4-dione (3aa).[7] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white solid (MeOH:H_2O – 113 mg, 90% & CH_3CN:H_2O – 106 mg, 84%); mp 114-116 ºC (lit. 116-118 ºC); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.06 – 8.03 (m, 2H), 7.94 (d, *J* = 8.0 Hz, 2H), 7.60 – 7.56 (m, 1H), 7.48 (t, *J* = 7.7 Hz, 2H), 7.28 (d, *J* = 8.3 Hz, 2H), 3.45 (s, 4H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 125 MHz): δ 198.7, 198.2, 143.9, 136.8, 134.3, 133.1, 129.3, 128.6, 128.2, 128.1, 32.5, 32.4, 21.6; HRMS (ESI) calculated for $C_{17}H_{17}O_2$ $[M+H]^+$: 253.1244 found 253.1244.



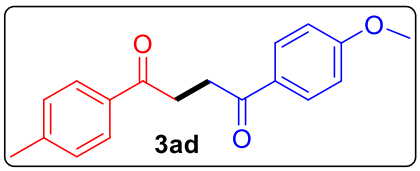
1,4-Di-*p*-tolylbutane-1,4-dione (3ab).[8] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 30 h and the product was isolated by column chromatography (Ethyl acetate/Hexane: 2%) to afford a white solid (MeOH:H_2O – 118 mg, 89% & CH_3CN:H_2O – 104 mg, 78%); mp 158-159 ºC (lit. 159-160 ºC); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.94 (d, *J* = 8.2 Hz, 4H), 7.29 – 7.25 (m, 4H), 3.43 (s, 4H), 2.42 (s, 6H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): 198.7, 144.1, 134.5, 129.5, 128.4, 32.7, 21.8; HRMS (ESI) calculated for $C_{18}H_{19}O_2$ $[M+H]^+$: 267.1497 found 267.1497.



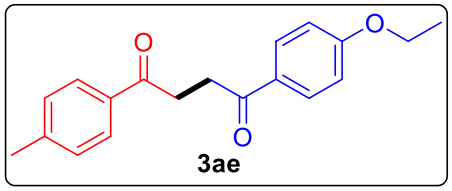
1-(4-Ethylphenyl)-4-(*p*-tolyl)butane-1,4-dione (3ac). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 2%) to afford a white solid (MeOH:H_2O – 131 mg, 97% & CH_3CN:H_2O – 119 mg, 85%); mp 117-118 ºC; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.96 (d, *J* = 8.0 Hz, 2H), 7.94 (d, *J* = 8.0 Hz, 2H), 7.3 (d, *J* = 8.0 Hz, 2H), 3.43 (s, 4H), 2.72 (q, *J* = 7.5 Hz, 2H), 2.42 (s, 3H), 1.27 (t, *J* = 7.5 Hz, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.7, 150.3, 144.1, 134.8, 134.5, 129.5, 128.5, 128.4, 128.3, 32.7, 29.1, 21.8, 15.4; HRMS (ESI) calculated for $C_{19}H_{20}O_2Na$ $[M+Na]^+$: 303.1361 found 303.1389.



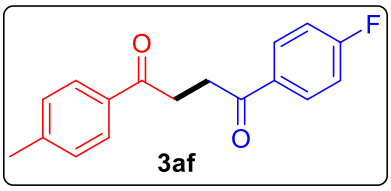
1-(4-Methoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (3ad).[8] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a pale white solid (MeOH:H_2O – 74 mg, 53% & CH_3CN:H_2O – 72 mg, 51%); mp 109-111 ºC (lit. 108-109 ºC); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.02 (d, *J* = 8.5 Hz, 2H), 7.94 (d, *J* = 7.8 Hz, 2H), 7.27 (d, *J* = 8.9 Hz, 2H), 6.95 (d, *J* = 8.5 Hz, 2H), 3.88 (s, 3H), 3.42 (s, 4H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.7, 197.5, 163.7, 144.0, 134.5, 130.5, 130.1, 129.4, 128.4, 113.9, 55.6, 32.7, 32.4, 21.8; HRMS (ESI) calculated for $C_{18}H_{19}O_3$ $[M+H]^+$: 283.1335 found 283.1335.



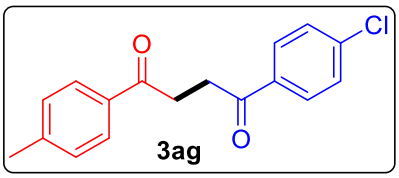
1-(4-Ethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (3ae). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a white solid (MeOH:H_2O – 55 mg, 37% & CH_3CN:H_2O – 58 mg, 39%); mp 121-122 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.01 (d, *J* = 8.8 Hz, 2H), 7.94 (d, *J* = 8.1 Hz, 2H), 7.27 (d, *J* = 8.8 Hz, 2H), 6.93 (d, *J* = 8.8 Hz, 2H), 4.11 (q, *J* = 7.0 Hz, 2H), 3.46 – 3.38 (m, 4H), 2.42 (s, 3H), 1.45 (t, *J* = 7.0 Hz, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 125 MHz): δ 198.5, 197.3, 162.9, 143.8, 134.3, 130.3, 129.7, 129.2, 128.2, 114.1, 63.7, 32.5, 32.2, 21.6, 14.7; HRMS (ESI) calculated for $C_{19}H_{20}O_3Na$ $[M+Na]^+$: 319.1310 found 319.1302.



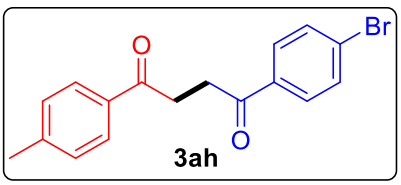
1-(4-Fluorophenyl)-4-(*p*-tolyl)butane-1,4-dione (3af).[9] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white solid (MeOH:H_2O – 75 mg, 56% & CH_3CN:H_2O – 68 mg, 50%); mp 120-122 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.10 – 8.05 (m, 2H), 7.94 (d, *J* = 8.1 Hz, 2H), 7.28 (d, *J* = 8.4 Hz, 2H), 7.18 – 7.13 (m, 2H), 3.47 – 3.39 (m, 4H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 125 MHz): δ 198.2, 197.2, 165.7 ($J_{C\text{-}F}$ = 253 Hz), 144.0, 134.2, 133.2, 130.7 ($J_{C\text{-}F}$ = 9.25 Hz), 129.3, 128.2, 115.6 ($J_{C\text{-}F}$ = 21.75 Hz), 32.4, 21.6; HRMS (ESI) calculated for $C_{17}H_{16}FO_2$ $[M+H]^+$: 271.1124 found 271.1124.



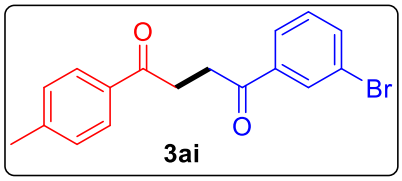
1-(4-Chlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (3ag).[10] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a pale yellow solid (MeOH:H_2O – 88 mg, 62%); mp 147-150 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.99 – 7.96 (m, 2H), 7.93 (d, *J* = 8.0 Hz, 2H), 7.45 (d, *J* = 8.4 Hz, 2H), 7.27 (d, *J* = 8.4 Hz, 2H), 3.43 – 3.40 (m, 4H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 125 MHz): δ 198.1, 197.6, 144.0, 139.5, 135.1, 134.1, 129.5, 129.3, 128.9, 128.2, 32.5, 32.4, 21.6; HRMS (ESI) calculated for $C_{17}H_{16}ClO_2$ $[M+H]^+$: 287.0857 found 287.0857.



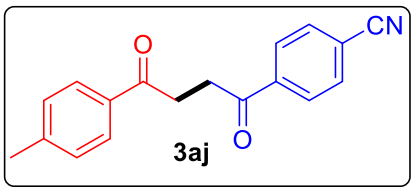
1-(4-Bromophenyl)-4-(*p*-tolyl)butane-1,4-dione (3ah).[9] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white crystalline solid (MeOH:H_2O – 82 mg, 49% & CH_3CN:H_2O –80 mg, 48%); mp 165-167 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.91 (d, *J* = 8.3 Hz, 2H), 7.62 (d, *J* = 8.3 Hz, 2H), 7.28 (d, *J* = 8.3 Hz, 2H), 3.46 – 3.39 (m, 4H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): 13C NMR (101 MHz, CDCl3) δ 196.5, 196.2, 142.4, 133.9, 132.5, 130.3, 128.0, 127.7, 126.6, 30.9, 30.8, 20.0; HRMS (ESI) calculated for $C_{17}H_{16}BrO_2$ $[M+H]^+$: 333.0298 found 333.0298.



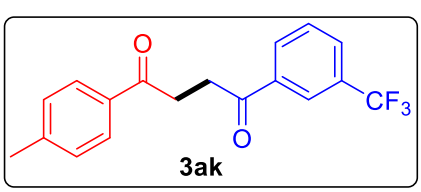
1-(3-Bromophenyl)-4-(*p*-tolyl)butane-1,4-dione (3ai). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white crystalline solid (MeOH:H_2O – 116 mg, 70% & CH_3CN:H_2O – 118 mg, 71%); mp 108-110 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.16 (t, *J* = 1.7 Hz, 1H), 7.96 (d, *J* = 7.8 Hz, 1H), 7.93 (d, *J* = 8.2 Hz, 2H), 7.70 (d, *J* = 7.9 Hz, 1H), 7.39 – 7.34 (m, 1H), 7.28 (d, *J* = 8.1 Hz, 2H), 3.47 – 3.39 (m, 4H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.3, 197.7, 144.3, 138.7, 136.2, 134.3, 131.4, 130.4, 129.5, 128.4, 126.9, 123.2, 32.8, 32.6, 21.9; HRMS (ESI) calculated for $C_{17}H_{15}BrO_2Na$ $[M+Na]^+$: 353.0153 found 353.0183.



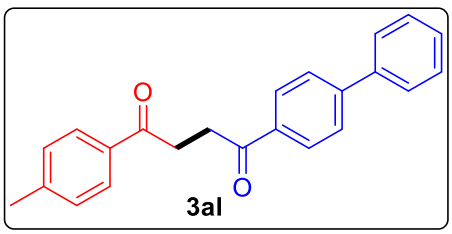
4-(4-Oxo-4-(*p*-tolyl)butanoyl)benzonitrile (3aj).[11] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a white solid (MeOH:H_2O – 50 mg, 39% & CH_3CN:H_2O – 54 mg, 36%); mp 132-134 °C (lit. 134-136 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.13 (d, *J* = 8.2 Hz, 2H), 7.93 (d, *J* = 7.9 Hz, 2H), 7.80 (d, *J* = 8.2 Hz, 2H), 7.29 (d, *J* = 7.7 Hz, 2H), 3.48 – 3.42 (m, 4H), 2.43 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 197.8, 197.6, 144.2, 139.8, 133.9, 132.5, 129.3, 128.5, 128.2, 118.0, 116.3, 32.7, 32.4, 21.7; HRMS (ESI) calculated for $C_{18}H_{16}NO_2$ $[M+H]^+$: 278.1178 found 278.1178.



1-(*p*-Tolyl)-4-(3-(trifluoromethyl)phenyl)butane-1,4-dione (3ak). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 4%) to afford a white solid (MeOH:H_2O – 52 mg, 33% & CH_3CN:H_2O – 88 mg, 55%); mp 94-96 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.30 (s, 1H), 8.23 (d, *J* = 7.8 Hz, 1H), 7.94 (d, *J* = 8.2 Hz, 2H), 7.84 (d, *J* = 7.8 Hz, 1H), 7.64 (t, *J* = 7.8 Hz, 1H), 7.29 (d, *J* = 8.0 Hz, 2H), 3.52 – 3.44 (m, 4H), 2.43 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.0, 197.5, 144.1, 137.3, 134.1, 131.3, 131.0, 129.5, 129.3, 128.2, 125.0, 122.3, 32.6, 32.4, 21.6; HRMS (ESI) calculated for $C_{18}H_{16}F_3O_2$ $[M+H]^+$: 321.1102 found 321.1108.

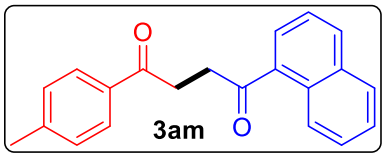


1-([1,1'-biphenyl]-4-yl)-4-(*p*-tolyl)butane-1,4-dione (3al). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a white solid (MeOH:H_2O – 91 mg, 55% & CH_3CN:H_2O – 77 mg, 47%); mp 179-181 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.12 (d, *J* = 8.4 Hz, 2H), 7.95 (d, *J* = 8.2 Hz, 2H), 7.70 (d, *J* = 8.4 Hz, 2H), 7.66 – 7.63 (m, 2H), 7.48 (t, J = 7.5 Hz, 2H), 7.40 (t, J = 7.3 Hz, 1H), 7.28 (d, *J* = 8.0 Hz, 2H), 3.48 (t, *J* = 3.7 Hz, 4H), 2.43 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 125 MHz): δ 198.4, 198.4, 145.7, 143.9, 139.9, 135.5, 134.3, 129.3,

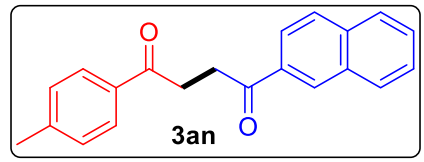


128.9, 128.7, 128.2, 127.3, 127.2, 32.6, 32.5, 21.7; HRMS (ESI) calculated for $C_{23}H_{20}O_2Na$ $[M+Na]^+$: 351.1361 found 351.1375.

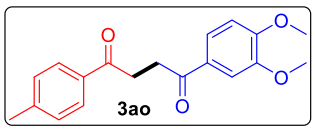
1-(Naphthalen-1-yl)-4-(*p*-tolyl)butane-1,4-dione (3am).[9] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a white solid (MeOH:H_2O – 78 mg, 52% & CH_3CN:H_2O – 74 mg, 49%); mp 98-100 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.59 (d, *J* = 8.6 Hz, 1H), 8.05 (d, *J* = 7.2 Hz, 1H), 7.99 (d, *J* = 8.2 Hz, 1H), 7.96 (d, *J* = 8.1 Hz, 2H), 7.87 (d, *J* = 8.1 Hz, 1H), 7.57 (t, *J* = 7.0 Hz, 1H), 7.52 (t, *J* = 7.0 Hz, 2H), 7.28 (d, *J* = 7.8 Hz, 2H), 3.54 – 3.48 (m, 4H), 2.42 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 203.0, 198.3, 144.0, 136.0, 134.3, 133.9, 132.6, 130.1, 129.3, 128.4, 128.3, 127.9, 127.7, 126.4, 125.9, 124.5, 77.4, 77.2, 76.9, 36.0, 32.98, 21.7; HRMS (ESI) calculated for $C_{21}H_{22}NO_2$ $[M+NH_4]^+$: 320.1636 found 320.1636.



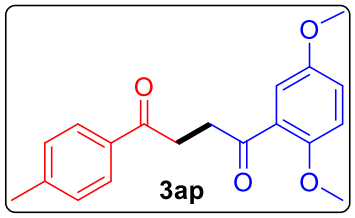
1-(Naphthalen-2-yl)-4-(*p*-tolyl)butane-1,4-dione (3an). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a white solid (MeOH:H_2O – 101 mg, 67% & CH_3CN:H_2O – 63 mg, 42%); mp 155-157 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.59 (s, 1H), 8.08 (dd, *J* = 8.6, 1.4 Hz, 1H), 7.99 – 7.95 (m, 3H), 7.90 (d, *J* = 8.5 Hz, 1H), 7.88 (d, *J* = 8.5 Hz, 1H), 7.60 (t, *J* = 7.0 Hz, 1H), 7.55 (t, *J* = 7.0 Hz, 1H), 7.28 (d, *J* = 8.0 Hz, 2H), 3.59 (t, *J* = 6.4 Hz, 2H), 3.50 (t, *J* = 6.4 Hz, 2H), 2.42 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 101 MHz): δ 199.0, 198.6, 144.2, 135.8, 134.5, 134.3, 132.7, 130.1, 129.8, 129.5, 128.6, 128.5, 128.0, 127.0, 124.1, 32.9, 32.8, 21.9; HRMS (ESI) calculated for $C_{21}H_{18}O_2Na$ $[M+Na]^+$: 325.1205 found 325.1222.



1-(3,4-Dimethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (3ao).[12] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 8%) to afford a pale white solid (MeOH:H_2O – 51 mg, 33% & CH_3CN:H_2O – 56 mg, 36%); mp 114-118 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 7.95 (d, *J* = 8.1 Hz, 2H), 7.71 (dd, *J* = 8.4, 1.9 Hz, 1H), 7.57 (d, *J* = 1.8 Hz, 1H), 7.27 (d, *J* = 9.0 Hz, 2H), 6.92 (d, *J* = 8.4 Hz, 1H), 3.96 (s, 3H), 3.94 (s, 3H), 3.43 (s, 4H), 2.42 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 101 MHz): δ 198.8, 197.6, 153.5, 149.1, 144.1, 134.5, 130.2, 129.5, 128.4, 123.0, 110.3, 110.2, 56.3, 56.2, 32.8, 32.4, 21.9; HRMS (ESI) calculated for $C_{19}H_{21}O_4$ $[M+H]^+$: 313.1434 found 313.1434.

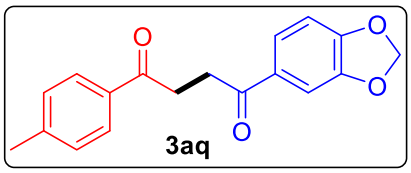


1-(2,5-dimethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (3ap). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 8%) to afford a white solid (MeOH:H_2O – 53 mg, 34% & CH_3CN:H_2O – 68 mg, 44%); mp 74-76 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 7.94 (d, *J* = 8.0 Hz, 2H), 7.33 (d, *J* =

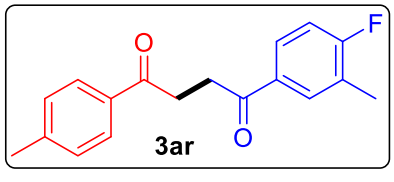


3.1 Hz, 1H), 7.27 (d, J = 7.5 Hz, 2H), 7.04 (dd, J = 8.9, 3.1 Hz, 1H), 6.93 (d, J = 9.0 Hz, 1H), 3.89 (s, 3H), 3.79 (s, 3H), 3.46 (t, J = 6.2 Hz, 2H), 3.38 (t, J = 6.2 Hz, 2H), 2.42 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 200.2, 198.7, 153.4, 153.4, 143.7, 134.4, 129.2, 128.2, 127.9, 120.3, 113.9, 113.2, 56.1, 55.8, 38.0, 32.8, 21.6; HRMS (ESI) calculated for $C_{19}H_{20}O_4Na$ $[M+Na]^+$; 335.1259 found 335.1256; HRMS (ESI) calculated for $C_{19}H_{21}O_4$ $[M+H]^+$: 313.1434 found 313.1434.

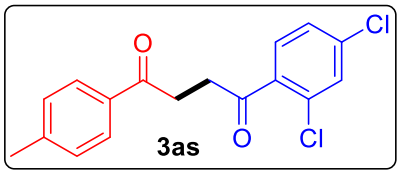
1-(Benzo[*d*][1,3]dioxol-5-yl)-4-(*p*-tolyl)butane-1,4-dione (3aq). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 40 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a pale white solid (MeOH:H_2O – 104 mg, 70% & CH_3CN:H_2O – 90 mg, 61%); mp 153-155 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 7.93 (d, J = 8.2 Hz, 2H), 7.66 (dd, J = 8.2, 1.6 Hz, 1H), 7.48 (d, J = 1.6 Hz, 1H), 7.31 – 7.26 (m, 2H), 6.87 (d, J = 8.2 Hz, 1H), 6.05 (s, 2H), 3.43 – 3.35 (m, 4H), 2.42 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 198.4, 196.8, 151.7, 148.1, 143.9, 134.2, 131.6, 129.2, 128.2, 124.4, 107.94, 107.91, 101.8, 32.6, 32.3, 21.6; HRMS (ESI) calculated for $C_{18}H_{16}O_4Na$ $[M+Na]^+$: 319.0946 found 319.0938.



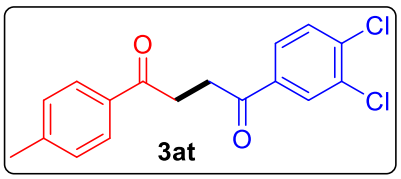
1-(4-Fluoro-3-methylphenyl)-4-(*p*-tolyl)butane-1,4-dione (3ar). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a white solid (MeOH:H_2O – 69 mg, 49% & CH_3CN:H_2O – 55 mg, 39%); mp 100-102 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 7.99 – 7.83 (m, 4H), 7.27 (d, J = 8.5 Hz, 2H), 7.08 (t, J = 8.8 Hz, 1H), 3.46 – 3.38 (m, 4H), 2.42 (s, 3H), 2.34 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 101 MHz): δ 198.3, 197.5, 165.6, 163.1, 143.9, 134.2, 132.9, 131.9 (J_{CF} = 6.5 Hz), 128.7 (J_{CF} = 105.2 Hz), 128.04 (J_{CF} = 9.2 Hz), 125.3 (J_{CF} = 18 Hz), 115.2 (J_{CF} = 22.9 Hz), 32.5, 32.4, 21.6, 14.5; HRMS (ESI) calculated for $C_{18}H_{17}FO_2Na$ $[M+Na]^+$: 307.1110 found 307.1188.



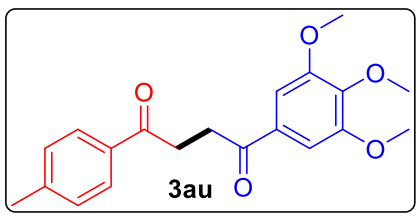
1-(2,4-Dichlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (3as). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol continued for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white solid (MeOH:H_2O – 74 mg, 46% & CH_3CN:H_2O – 71 mg, 44%); mp 51-53 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 7.90 (d, J = 8.2 Hz, 2H), 7.64 (d, J = 8.3 Hz, 1H), 7.44 (d, J = 1.9 Hz, 1H), 7.33 (dd, J = 8.3, 2.0 Hz, 1H), 7.26 (d, J = 8.0 Hz, 2H), 3.45 (dd, J = 7.1, 5.4 Hz, 2H), 3.32 (dd, J = 6.7, 5.4 Hz, 2H), 2.41 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 200.6, 197.7, 144.1, 137.4, 137.2, 133.9, 131.9, 130.6, 130.3, 129.3, 128.2, 127.3, 36.7, 33.1, 21.6; HRMS (ESI) calculated for $C_{17}H_{15}Cl_2O_2$ $[M+H]^+$: 321.0449 found 321.0451.



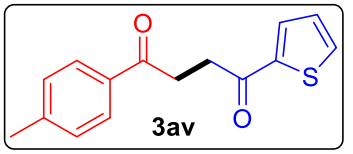
1-(3,4-Dichlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (3at). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a pale white solid (MeOH:H_2O – 55 mg, 34% & CH3CN:H_2O – 75 mg, 47%); mp 115-119 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.11 (s, 1H), 7.92 (d, *J* = 7.9 Hz, 2H), 7.86 (d, *J* = 8.3 Hz, 1H), 7.57 (d, *J* = 8.3 Hz, 1H), 7.27 (d, *J* = 7.5 Hz, 2H), 3.45 (t, *J* = 5.8 Hz, 2H), 3.38 (d, *J* = 6.1 Hz, 2H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.0, 196.8, 144.3, 137.8, 136.6, 134.3, 133.5, 130.9, 130.3, 129.5, 128.4, 127.3, 32.7, 32.6, 21.8; HRMS (ESI) calculated for $C_{17}H_{15}Cl_2O_2$ $[M+H]^+$: 321.0449 found 321.0446.



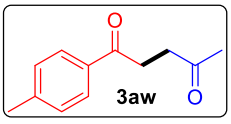
1-(*p*-Tolyl)-4-(3,4,5-trimethoxyphenyl)butane-1,4-dione (3au). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 10%) to afford a white solid (MeOH:H_2O – 75 mg, 44% & CH_3CN:H_2O – 80 mg, 47%); mp 108-111 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.95 (d, *J* = 8.0 Hz, 2H), 7.31 – 7.27 (m, 4H), 3.92 (s, 9H), 3.44 (s, 4H), 2.43 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.6, 197.8, 153.3, 144.2, 142.8, 134.4, 132.3, 129.5, 128.4, 105.8, 61.1, 56.5, 32.8, 32.6, 21.9; HRMS (ESI) calculated for $C_{19}H_{21}O_5$ $[M+H]^+$: 343.1546 found 343.1580.



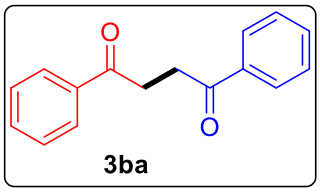
1-(Thiophen-2-yl)-4-(*p*-tolyl)butane-1,4-dione (3av).[15] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 48 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a pale yellow solid (MeOH:H_2O – 88 mg, 68%); mp 120-122 °C (lit. 120 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.92 (d, *J* = 8.2 Hz, 2H), 7.85 – 7.81 (m, 1H), 7.64 (dd, *J* = 4.9, 1.0 Hz, 1H), 7.27 (d, *J* = 8.3 Hz, 2H), 7.16 (t, J = 5.0 Hz, 1H), 3.45 – 3.37 (m, 4H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.3, 192.0, 144.2, 134.3, 133.7, 132.2, 129.5, 128.4, 128.3, 33.4, 32.7, 21.9; HRMS (ESI) calculated for $C_{15}H_{15}O_2S$ $[M+H]^+$: 259.0808 found 259.0808.



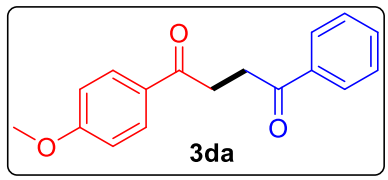
1-(*p*-Tolyl)pentane-1,4-dione (3aw).[8] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 40 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 2%) to afford yellow oil (MeOH:H_2O – 51 mg, 54% & CH3CN:H_2O – 47 mg, 49%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.88 (d, *J* = 7.7 Hz, 2H), 7.26 (d, *J* = 7.0 Hz, 2H), 3.26 (t, *J* = 5.5 Hz, 2H), 2.88 (t, *J* = 6.3 Hz, 2H), 2.41 (s, 3H), 2.26 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 207.6, 198.3, 144.0, 134.3, 129.3, 128.3, 37.2, 32.4, 30.2, 21.7; HRMS (ESI) calculated for $C_{12}H_{15}O_2$ $[M+H]^+$: 191.1067 found 191.1071.



1,4-Diphenylbutane-1,4-dione (3ba).[7] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 2%) to white solid (MeOH:H_2O – 71 mg, 76%); mp 144-145 °C (lit. 144-145 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.06 – 8.03 (m, 4H), 7.58 (tt, *J* = 6.8, 1.2 Hz, 2H), 7.48 – 7.46 (m, 4H), 3.46 (s, 4H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 198.7, 136.7, 133.1, 128.6, 128.1, 32.5; HRMS (ESI) calculated for $C_{12}H_{15}O_3$ $[M+H]^+$: 229..0835 found 229.0836.

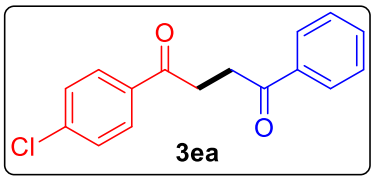


1-Phenyl-4-(*m*-tolyl)butane-1,4-dione (3ca).[14] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol continued for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white solid (MeOH:H_2O – 71 mg, 56% & CH_3CN:H_2O – 89 mg, 71%); mp 80-82 °C (No report); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.05 (d, *J* = 7.4 Hz, 2H), 7.86-7.83 (m, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.41 – 7.35 (m, 2H), 3.46 (s, 4H), 2.43 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 198.9, 198.7, 138.3, 136.7, 133.9, 133.1, 128.6, 128.6, 128.5, 128.1, 125.3, 32.6, 21.4; HRMS (ESI) calculated for $C_{17}H_{17}O_2$ $[M+H]^+$: 253.1239 found 253.1239.

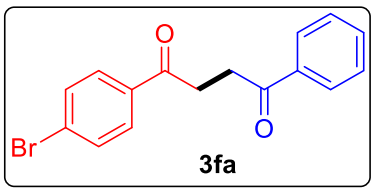


1-(4-Methoxyphenyl)-4-phenylbutane-1,4-dione (3da).[7] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a yellow solid (MeOH:H_2O – 90 mg, 67% & CH_3CN:H_2O – 95 mg, 71%); mp 102-104 °C (lit. 99-100 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.07 – 8.00 (m, 4H), 7.60 – 7.54 (m, 1H), 7.47 (t, *J* = 8.0 Hz, 2H), 6.95 (d, *J* = 9.0 Hz, 2H), 3.88 (s, 3H), 3.47 – 3.40 (m, 4H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 198.9, 197.2, 163.5, 136.8, 133.1, 130.4, 129.8, 128.6, 128.1, 113.7, 55.4, 32.6, 32.2; HRMS (ESI) calculated for $C_{17}H_{17}O_3$ $[M+H]^{+:}$ 269.1179 found 269.1179.

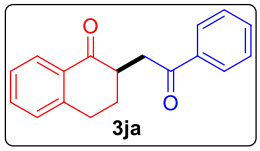
1-(4-Chlorophenyl)-4-phenylbutane-1,4-dione (3ea).[7] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white solid (MeOH:H_2O – 78 mg, 58% & CH_3CN:H_2O – 65 mg, 48%); mp 114-116 °C (lit. 114-115 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.06 – 8.03 (m, 2H), 7.98 (d, *J* = 8.6 Hz, 1H), 7.60 – 7.57 (m, 1H), 7.53 – 7.43 (m, 4H), 3.51 – 3.40 (m, 4H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 101 MHz): δ 198.9, 198.7, 197.7, 139.8, 136.8, 135.3, 133.4, 133.4, 129.7, 129.1, 128.8, 128.3, 32.7; HRMS (ESI) calculated for $C_{16}H_{14}ClO_2$ $[M+H]^+$: 273.0657 found 273.657.



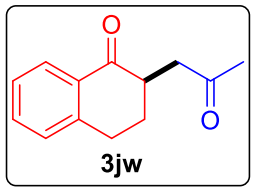
1-(4-Bromophenyl)-4-phenylbutane-1,4-dione (3fa).[14] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a pale white solid (MeOH:H_2O – 119 mg, 75% & CH_3CN:H_2O – 95 mg, 60%); mp 100-103 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.03 (d, *J* = 7.8 Hz, 2H), 7.91 (d, *J* = 8.2 Hz, 2H), 7.63 (d, *J* = 8.2 Hz, 2H), 7.59 (t, *J* = 7.2 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 3.44 (dq, *J* = 11.6, 5.9 Hz, 4H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.7, 197.9, 136.8, 135.7, 133.4, 132.1, 129.9, 128.8, 128.5, 128.3, 32.7; HRMS (ESI) calculated for $C_{16}H_{14}BrO_2$ $[M+H]^+$: 319.0135 found 319.0135.



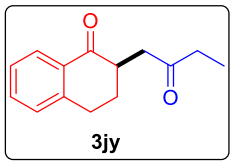
2-(2-Oxo-2-phenylethyl)-3,4-dihydronaphthalen-1(2*H*)-one (3ja).[16] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 30 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 4%) to afford a white solid (CH_3CN:H_2O – 81 mg, 76%); mp 90-92 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.04 (d, *J* = 7.7 Hz, 3H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.9 Hz, 3H), 7.31 (t, *J* = 7.5 Hz, 1H), 7.28 – 7.24 (m, 1H), 3.86 (dd, *J* = 17.5, 4.7 Hz, 1H), 3.33 (ddt, *J* = 9.2, 7.1, 4.6 Hz, 1H), 3.23 – 3.15 (m, 1H), 3.02 – 2.95 (m, 2H), 2.30 (dt, *J* = 7.3, 4.4 Hz, 1H), 1.99 (qd, *J* = 13.0, 4.2 Hz, 1H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 199.1, 198.7, 144.2, 137.1, 133.5, 133.2, 132.4, 128.9, 128.7, 128.3, 127.6, 126.7, 44.3, 39.1, 29.7, 29.5; HRMS (ESI) calculated for $C_{18}H_{16}O_2Na$ $[M+Na]^+$: 287.1033 found 287.1033.



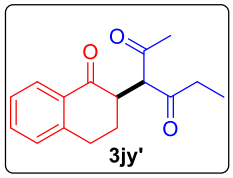
2-(2-Oxopropyl)-3,4-dihydronaphthalen-1(2*H*)-one (3jw).[17] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 4%) to afford a yellow oil (MeOH:H_2O – 45 mg, 44% & CH_3CN:H_2O – 34 mg, 33%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.00 (d, *J* = 7.8 Hz, 1H), 7.47 (t, *J* = 7.5 Hz, 1H), 7.30 (t, *J* = 7.5 Hz, 1H), 7.24 (d, *J* = 7.7 Hz, 1H), 3.23 – 3.10 (m, 3H), 3.00 – 2.92 (m, 1H), 2.45 (dt, *J* = 10.7, 5.5 Hz, 1H), 2.27 (s, 3H), 2.23 – 2.15 (m, 1H), 1.92 (qd, *J* = 13.0, 4.3 Hz, 1H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 207.4, 199.2, 144.3, 133.6, 132.4, 129.0, 127.6, 126.8, 44.4, 44.1, 30.7, 29.7, 29.6.



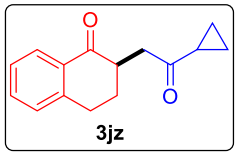
2-(2-Oxobutyl)-3,4-dihydronaphthalen-1(2*H*)-one (3jy).[18] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 28 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 2-3%) to afford a yellow oil (MeOH:H_2O – 18 mg, 17% & CH_3CN:H_2O – 27 mg, 25%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.00 (d, *J* = 7.8 Hz, 1H), 7.46 (t, *J* = 7.4 Hz, 1H), 7.30 (t, *J* = 7.5 Hz, 1H), 7.24 (d, *J* = 7.6 Hz, 1H), 3.20 – 3.09 (m, 3H), 2.96 (m, 1H), 2.64 (m, 1H), 2.52 (m 1H), 2.46 – 2.40 (m, 1H), 2.22 – 2.14 (m, 1H), 1.92 (qd, *J* = 12.9, 4.0 Hz, 1H), 1.11 (*t*, *J* = 7.3 Hz, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 210.0, 199.3, 144.2, 133.4, 132.3, 128.8, 127.5, 126.7, 44.3, 42.7, 36.6, 29.6, 29.5, 7.9.



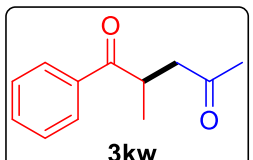
3-(-1-Oxo-1,2,3,4-tetrahydronaphthalen-2-yl)hexane-2,4-dione (3jy'). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol continued for 28 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6-8%) to afford a mixture of diastereomers as yellow oil (MeOH:H_2O – 27 mg, 21% & CH_3CN:H_2O – 32 mg, 25%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.98 – 7.92 (m, 2H), 7.52 – 7.46 (m, 2H), 7.30 (t, *J* = 7.6 Hz, 2H), 7.24 (d, *J* = 7.7 Hz, 2H), 4.23 (d, *J* = 8.8 Hz, 1H), 4.16 (d, *J* = 9.0 Hz, 1H), 3.64 – 3.56 (m, 2H), 3.20 – 3.10 (m, 2H), 3.02 – 2.95 (m, 2H), 2.84 (dq, *J* = 18.2, 7.2 Hz, 1H), 2.71 – 2.42 (m, 4H), 2.35 (s, 3H), 2.23 (s, 3H), 2.08 – 2.00 (m, 2H), 1.96 – 1.83 (m, 2H), 1.14 (t, *J* = 7.2 Hz, 3H), 1.07 (t, *J* = 7.2 Hz, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 206.1, 205.4, 203.7, 202.6, 198.0, 197.8, 143.8, 143.7, 133.9, 132.0, 128.8, 127.6, 126.9, 68.5, 68.2, 49.7, 49.6, 36.7, 36.6, 34.7, 34.2, 29.9, 29.8, 29.6, 29.5, 27.3, 22.4, 14.2, 7.9, 7.6. HRMS (ESI) calculated for $C_{16}H_{18}O_3Na$ [M+Na]$^+$: 281.1142 found 281.1142.



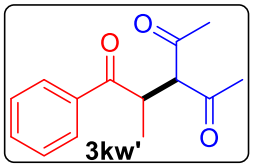
2-(2-Cyclopropyl-2-oxoethyl)-3,4-dihydronaphthalen-1(2*H*)-one (3jz). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 26 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 4%) to afford a yellow oil (MeOH:H_2O – 40 mg, 35% & CH_3CN:H_2O – 35 mg, 31%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.02 (d, *J* = 7.8 Hz, 1H), 7.46 (td, *J* = 7.5, 1.2 Hz, 1H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.24 (d, *J* = 7.6 Hz, 1H), 3.37 (dd, *J* = 17.5, 5.0 Hz, 1H), 3.18 – 3.08 (m, 2H), 2.99 – 2.92 (m, 1H), 2.63 (dd, *J* = 17.5, 6.9 Hz, 1H), 2.23 – 2.17 (m, 1H), 2.07 – 1.99 (m, 1H), 1.91 (qd, *J* = 13.0, 4.3 Hz, 1H), 1.13 – 1.04 (m, 2H), 0.99 – 0.87 (m, 2H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 209.3, 199.1, 144.2, 133.4, 132.4, 128.8, 127.5, 126.7, 44.0, 43.6, 31.0, 29.5, 29.4, 21.1, 10.9. HRMS (ESI) calculated for $C_{15}H_{16}O_2Na$ [M+Na]$^+$: 251.1035 found 251.1035.



2-Methyl-1-phenylpentane-1,4-dione (3kw).[19] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 34 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3-4%) to afford a yellow oil (MeOH:H_2O – 38 mg, 40% & CH_3CN:H_2O – 22 mg, 23%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.98 (dd, *J* = 8.3, 1.1 Hz, 2H), 7.59 – 7.53 (m, 1H), 7.47 (dd, *J* = 10.6, 4.6 Hz, 2H), 3.97 (dqd, *J* = 14.4, 7.2, 5.1 Hz, 1H), 3.17 (dd, *J* = 18.1, 8.5 Hz, 1H), 2.56 (dd, *J* = 18.1, 5.05 Hz, 1H), 2.18 (s, 3H), 1.19 (d, *J* = 7.2 Hz, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 207.3, 203.5, 136.2, 133.2, 128.8, 128.7, 47.0, 36.4, 30.3, 18.0.

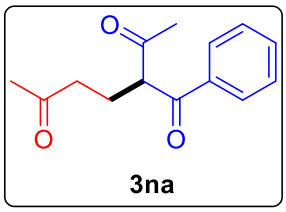


3-Acetyl-2-methyl-1-phenylpentane-1,4-dione (3kw'). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 34 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6-8%) to afford a yellow oil (MeOH:H_2O – <5% & CH_3CN:H_2O – 26 mg, 22%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.98 (d, *J* = 7.3 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.7 Hz, 2H), 4.33 (ddd, *J* = 11.7, 10.6, 7.0 Hz, 2H), 2.34 (s, 3H), 2.26 (s, 3H), 1.15 (d, *J* = 6.9 Hz, 3H).^{13}C{^{1}H} NMR ($CDCl_3$, 101

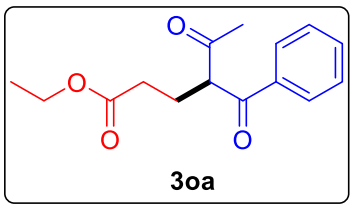


MHz): δ 203.0, 202.5, 202.1, 135.5, 133.5, 128.9, 128.7, 71.5, 41.6, 30.5, 30.4, 16.2. HRMS (ESI) calculated for $C_{14}H_{16}O_3Na$ $[M+Na]^+$: 255.0987 found 255.0987.

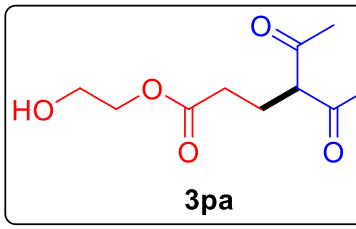
3-Benzoylheptane-2,6-dione (3na).[20] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a yellow oil (MeOH:H_2O – <5% & CH_3CN:H_2O – 78 mg, 63%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.05 – 8.01 (m, 2H), 7.63 – 7.58 (m, 1H), 7.53 – 7.47 (m, 2H), 4.60 – 4.54 (m, 1H), 2.63 – 2.44 (m, 2H), 2.28 – 2.16 (m, 2H), 2.15 (d, J = 2.1 Hz, 3H), 2.12 (d, J = 2.0 Hz, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 208.0, 204.1, 196.7, 136.2, 134.0, 129.0, 128.8, 61.2, 40.6, 30.1, 28.7, 22.5.



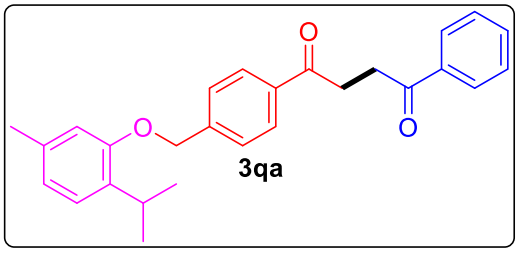
Ethyl 4-benzoyl-5-oxohexanoate (3oa).[21] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a yellow oil (MeOH:H_2O – <5% & CH_3CN:H_2O – 86 mg, 66%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.06 – 8.00 (m, 2H), 7.64 – 7.59 (m, 1H), 7.52 – 7.48 (m, 2H), 4.63 (t, J = 6.8 Hz, 1H), 4.13 (qd, J = 7.1, 1.2 Hz, 2H), 2.45 – 2.22 (m, 4H), 2.16 (S, 3H), 1.24 (td, J = 7.1, 1.3 Hz, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 203.7, 196.4, 172.9, 136.3, 134.0, 129.0, 128.9, 61.5, 60.7, 31.6, 28.6, 23.8, 14.3; HRMS (ESI) calculated for $C_{15}H_{18}O_4Na$ $[M+Na]^+$: 285.1085 found 285.1085.



2-Hydroxyethyl 4-benzoyl-5-oxohexanoate (3pa). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 80-90%) to afford a yellow oil (MeOH:H_2O – <5% & CH_3CN:H_2O – 99 mg, 75%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.02 (d, J = 7.4 Hz, 2H), 7.62 (t, J = 7.4 Hz, 1H), 7.51 (t, J = 7.7 Hz, 2H), 4.62 (t, J = 6.9 Hz, 1H), 4.26 – 4.16 (m, 2H), 3.82 (t, J = 4.6 Hz, 2H), 2.51 – 2.23 (m, 5H), 2.16 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 203.9, 196.3, 173.1, 136.2, 134.1, 129.1, 128.9, 66.3, 61.5, 61.1, 31.6, 28.6, 23.8; HRMS (ESI) calculated for $C_{15}H_{18}O_5Na$ $[M+Na]^+$: 301.1047 found 301.1047.

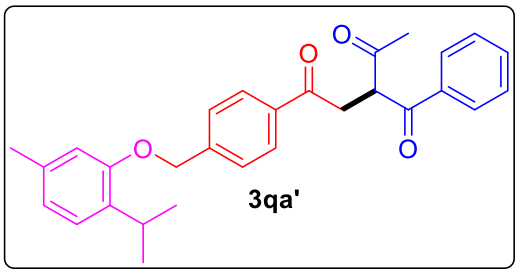


1-(4-((2-Isopropyl-5-methylphenoxy)methyl)phenyl)-4-phenylbutane-1,4-dione (3qa). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a white solid (MeOH:H_2O – <5% & CH_3CN:H_2O – 72 mg, 36%); mp 122-124 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.08 (d, J = 8.3 Hz, 2H), 8.06 – 8.03 (m, 2H), 7.61 – 7.54 (m, 3H), 7.48 (dd, J = 10.5, 4.8 Hz, 2H), 7.14 (d, J = 7.7 Hz, 1H), 6.79 (d, J = 7.7 Hz, 1H), 6.71 (s, 1H), 5.14 (s, 2H), 3.48 (s, 4H), 3.38 (dt, J = 13.8, 6.9 Hz, 1H), 2.32 (s, 3H), 1.24 (d, J = 6.9 Hz, 6H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 198.8, 198.4, 155.6, 143.2, 136.9, 136.5, 136.3,

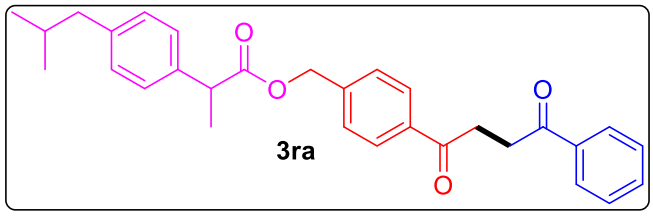


134.4, 133.3, 128.7, 128.5, 128.2, 127.0, 126.2, 121.8, 112.7, 69.4, 32.7, 26.8, 22.9, 21.4; HRMS (ESI) calculated for $C_{27}H_{28}O_3Na$ $[M+Na]^+$: 423.1925 found 423.1925.

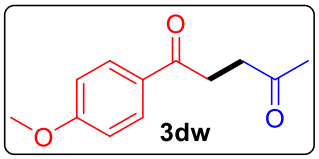
3-Benzoyl-1-(4-((2-isopropyl-5-methylphenoxy)methyl)phenyl)pentane-1,4-dione (3qa'). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a mixture of diastereomers as yellow oil (MeOH:H_2O – <5% & CH_3CN:H_2O – 51 mg, 23%); ^1H NMR ($CDCl_3$, 500 MHz): δ 8.09 (dd, J = 8.3, 1.1 Hz, 2H), 8.02 (d, J = 8.3 Hz, 2H), 7.67 – 7.61 (m, 1H), 7.57 – 7.51 (m, 4H), 7.13 (d, J = 7.7 Hz, 1H), 6.78 (d, J = 7.5 Hz, 1H), 6.69 (s, 1H), 5.31 (s, 1H), 5.13 (s, 2H), 3.80 (dd, J = 18.2, 6.8 Hz, 1H), 3.65 – 3.58 (m, 1H), 3.37 (dq, J = 13.8, 6.8 Hz, 1H), 2.31 (s, 3H), 2.25 (s, 3H), 1.24 (s, 3H), 1.22 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 101 MHz): δ 202.4, 196.6, 196.4, 155.5, 143.7, 136.5, 136.2, 135.5, 134.4, 134.0, 129.1, 129.0, 128.8, 128.7, 128.3, 127.0, 126.2, 121.9, 112.6, 69.3, 57.0, 38.2, 29.7, 26.8, 22.9, 21.5. HRMS (ESI) calculated for $C_{29}H_{30}O_4Na$ $[M+Na]^+$: 465.2036 found 465.2025.



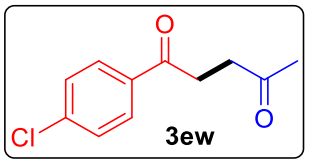
4-(4-Oxo-4-phenylbutanoyl)benzyl 2-(4-isobutylphenyl)propanoate (3ra). The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a white solid (MeOH:H_2O – <5% & CH_3CN:H_2O – 71 mg, 31%); mp 96-98 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.04 (d, J = 7.7 Hz, 2H), 7.96 (d, J = 8.2 Hz, 2H), 7.58 (t, J = 7.4 Hz, 1H), 7.48 (t, J = 7.6 Hz, 2H), 7.29 (d, J = 8.1 Hz, 2H), 7.21 (d, J = 8.0 Hz, 2H), 7.11 (d, J = 8.0 Hz, 2H), 5.23 – 5.12 (m, 2H), 3.78 (q, J = 7.1 Hz, 1H), 3.50 – 3.40 (m, 4H), 2.46 (d, J = 7.2 Hz, 2H), 1.86 (dp, J = 13.5, 6.8 Hz, 1H), 1.53 (d, J = 7.2 Hz, 3H), 0.91 (d, J = 6.6 Hz, 6H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 101 MHz): δ 198.7, 198.3, 174.5, 141.6, 140.9, 137.5, 136.9, 136.4, 133.3, 129.5, 128.7, 128.4, 128.2, 127.5, 127.3, 65.6, 45.2, 45.1, 32.7, 30.3, 22.5, 18.4; HRMS (ESI) calculated for $C_{30}H_{33}O_4$ $[M+H]^+$: 457.2367 found 457.2367.



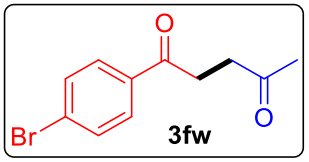
1-(4-Methoxyphenyl)pentane-1,4-dione (3dw).[15] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 30 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 5%) to afford a pale white solid (MeOH:H_2O – 66 mg, 64% & CH_3CN:H_2O – 55 mg, 53%); mp 48-50 °C (lit. 51-52 °C); ^1H NMR ($CDCl_3$, 500 MHz): δ 7.99 – 7.95 (m, 2H), 6.96 – 6.92 (m, 2H), 3.87 (s, 3H), 3.24 (t, J = 6.4 Hz, 2H), 2.87 (t, J = 6.3 Hz, 2H), 2.26 (s, 3H). $^{13}C\{^1H\}$ NMR ($CDCl_3$, 125 MHz): δ 207.6, 197.0, 163.5, 130.3, 129.7, 113.7, 55.4, 37.1, 32.0, 30.1; HRMS (ESI) calculated for $C_{12}H_{15}O_2$ $[M+H]^+$: 191.1071 found 191.1067.



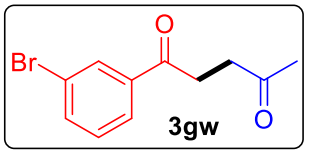
1-(4-Chlorophenyl)pentane-1,4-dione (3ew).[15] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 30 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white crystalline solid (MeOH:H_2O – 24 mg, 23% & CH_3CN:H_2O – 24 mg, 23%); mp 70-72 °C (lit. 69-71 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.92 (d, *J* = 8.5 Hz, 2H), 7.43 (d, *J* = 8.5 Hz, 2H), 3.24 (t, *J* = 6.2 Hz, 2H), 2.89 (t, *J* = 6.2 Hz, 2H), 2.26 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 125 MHz): δ 207.2, 197.3, 139.6, 134.9, 129.4, 128.9, 37.0, 32.3, 30.1; HRMS (ESI) calculated for $C_{11}H_{11}ClO_2Na$ $[M+Na]^+$: 233.033 found 233.0333.



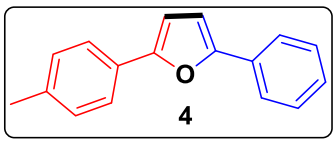
1-(4-Bromophenyl)pentane-1,4-dione (3fw).[15] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 30 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white crystalline solid (MeOH:H_2O – 83 mg, 65% & CH_3CN:H_2O – 46 mg, 36%); mp 86-89 °C (lit. 80-81 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.85 (d, *J* = 8.6 Hz, 2H), 7.61 (d, *J* = 8.6 Hz, 2H), 3.23 (t, *J* = 6.2 Hz, 2H), 2.89 (t, *J* = 6.2 Hz, 2H), 2.26 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 125 MHz): δ 207.3, 197.6, 135.5, 132.0, 129.7, 128.4, 37.1, 32.4, 30.2; HRMS (ESI) calculated for $C_{11}H_{12}BrO_2$ $[M+H]^+$: 255.0013 found 255.0015.



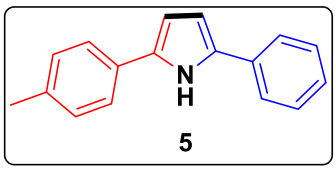
1-(3-Bromophenyl)pentane-1,4-dione (3gw).[22] The title compound was prepared according to the general experimental procedure A on a 0.5 mmol for 36 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford yellow oil (MeOH:H_2O – 45 mg, 35% & CH_3CN:H_2O – 51 mg, 40%); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.10 (s, 1H), 7.89 (d, *J* = 7.8 Hz, 1H), 7.68 (d, *J* = 7.9 Hz, 1H), 7.34 (t, *J* = 7.9 Hz, 1H), 3.23 (t, *J* = 6.2 Hz, 2H), 2.89 (t, *J* = 6.2 Hz, 2H), 2.25 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 207.1, 197.3, 138.5, 136.1, 131.3, 130.3, 126.7, 123.1, 37.1, 32.6, 30.1; HRMS (ESI) calculated for $C_{11}H_{12}BrO_2$ $[M+H]^+$: 255.0005found 255.0015.



2-Phenyl-5-(*p*-tolyl)furan (4).[23] The title compound was prepared according to the general experimental procedure B on a 0.5 mmol for 6 h, and the product was isolated by column chromatography (100% Hexane) to afford a white solid (94 mg, 80%); mp 105-107 °C (lit. 101-102 °C); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.74 (d, *J* = 7.5 Hz, 2H), 7.64 (d, *J* = 6.5 Hz, 2H), 7.40 (t, *J* = 8.0 Hz, 2H), 7.28 – 7.24 (m, 2H), 7.21 (d, *J* = 7.9 Hz, 2H), 6.74 – 6.67 (m, 2H), 2.38 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 153.6, 152.9, 137.2, 130.8, 129.3, 128.6, 128.1, 127.1, 123.7, 123.6, 107.1, 106.4, 21.2; HRMS (ESI) calculated for $C_{17}H_{15}O$ $[M+H]^+$: 235.1106 found 235.1106.

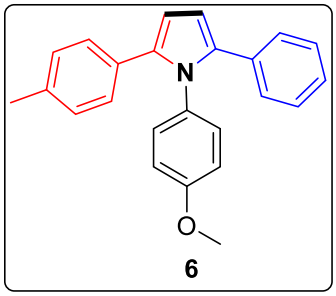


2-Phenyl-5-(*p*-tolyl)-1*H*-pyrrole (5).[24] The title compound was prepared according to the general experimental procedure C on a 0.5 mmol for 3 h, and the product was isolated by column chromatography (100% Hexane) to afford a white solid (94 mg, 80%); mp 142-144 ºC (lit. 142-143 ºC); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.54 (s, 1H), 7.54 – 7.50 (m, 2H), 7.43 (d, *J* = 8.0 Hz, 2H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.24 – 7.19 (m, 3H), 6.57 (t, *J* = 3.0 Hz, 1H), 6.53 (t, *J* = 2.5 Hz, 1H), 2.36 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 136.6, 133.7, 133.2, 133.0, 130.2, 130.1, 129.4, 126.7, 124.2, 124.2, 108.3, 107.8, 21.62 HRMS (ESI) calculated for $C_{17}H_{15}N$ $[M+H]^+$: 234.1255 found 234.1255.



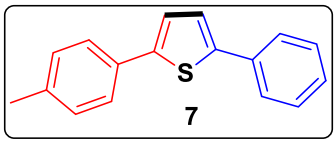
5

1-(4-Methoxyphenyl)-2-phenyl-5-(*p*-tolyl)-1*H*-pyrrole (6).[25] The title compound was prepared according to the general experimental procedure D on a 0.5 mmol for 3 h, and the product was isolated by column chromatography (100% Hexane) to afford a white solid (128 mg, 75%); mp 195-197 ºC; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.19 – 7.11 (m, 3H), 7.08 (d, *J* = 7.0 Hz, 2H), 7.00 – 6.94 (m, 6H), 6.76 (d, *J* = 8.8 Hz, 2H), 6.45 (d, J = 3.5 Hz, 1H), 6.42 (d, J = 3.5 Hz, 1H), 3.78 (s, 3H), 2.28 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 158.4, 136.0, 135.8, 135.6, 133.4, 132.0, 130.4, 129.8, 128.6, 128.5, 127.8, 126.0, 113.9, 109.5, 109.2, 55.3, 21.1; HRMS (ESI) calculated for $C_{24}H_{22}NO$ $[M+H]^+$: 340.1698 found 340.1698.



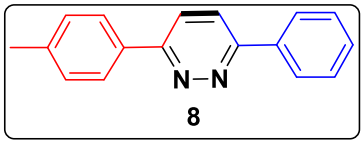
6

2-Phenyl-5-(*p*-tolyl)thiophene (7).[26] The title compound was prepared according to the general experimental procedure E on a 0.5 mmol for 6 h, and the product was isolated by column chromatography (100% Hexane) to afford a white solid (102 mg, 82%); mp 146-148 ºC (lit. 150-152 ºC); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.63 (d, *J* = 7.4 Hz, 2H), 7.53 (d, *J* = 8.0 Hz, 2H), 7.38 (t, *J* = 7.7 Hz, 2H), 7.30 – 7.24 (m, 4H), 7.20 (d, *J* = 7.9 Hz, 2H), 2.37 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 143.8, 143.0, 137.4, 134.3, 131.5, 129.5, 128.8, 127.3, 125.5, 123.9, 123.6, 123.4, 21.1; HRMS (ESI) calculated for $C_{17}H_{15}S$ $[M+H]^+$: 251.2878 found 251.2889.



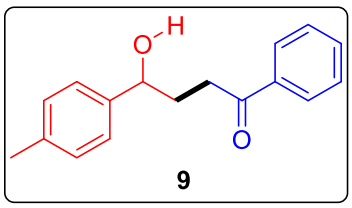
7

3-Phenyl-6-(*p*-tolyl)pyridazine (8).[27] The title compound was prepared according to the general experimental procedure F on a 0.5 mmol for 3 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 3%) to afford a white solid (79 mg, 64%); mp 182-184 ºC (lit. 187-189 ºC); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.16 (d, *J* = 7.1 Hz, 2H), 8.07 (d, *J* = 8.1 Hz, 2H), 7.91 (s, 2H), 7.56 – 7.49 (m, 3H), 7.35 (d, *J* = 7.9 Hz, 2H), 2.45 (s, 3H). ^{13}C{^{1}H} NMR ($CDCl_3$, 101 MHz): δ 157.5, 157.3, 140.2, 136.2, 133.2, 129.9, 129.7, 129.0, 126.8, 126.8, 124.1, 123.8, 21.3; HRMS (ESI) calculated for $C_{17}H_{15}N_2$ $[M+H]^+$: 247.1230 found 247.1230.



8

4-Hydroxy-1-phenyl-4-(*p*-tolyl)butan-1-one (9).[6] The title compound was prepared according to the general experimental procedure G on a 1.0 mmol for 24 h, and the product was isolated by column chromatography (Ethyl acetate/Hexane: 6%) to afford a yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.7 Hz, 2H), 7.53 (t, *J* = 7.3 Hz, 1H), 7.42 (t, *J* = 7.7 Hz, 2H), 7.25 (d, *J* = 7.8 Hz, 2H), 7.14 (d, *J* = 7.8 Hz, 2H), 4.76 (t, *J* = 6.3 Hz, 1H), 3.07 (t, *J* = 7.0 Hz, 2H), 2.32 (s, 3H), 2.20 – 2.13 (m, 2H); HRMS (ESI) calculated for $C_{16}H_{13}BrO_2$ $C_{17}H_{19}O_2$ $[M+H]^+$: 277.1235 found 277.1235.



9

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21. Copies of ^{1}H and ^{13}C Data

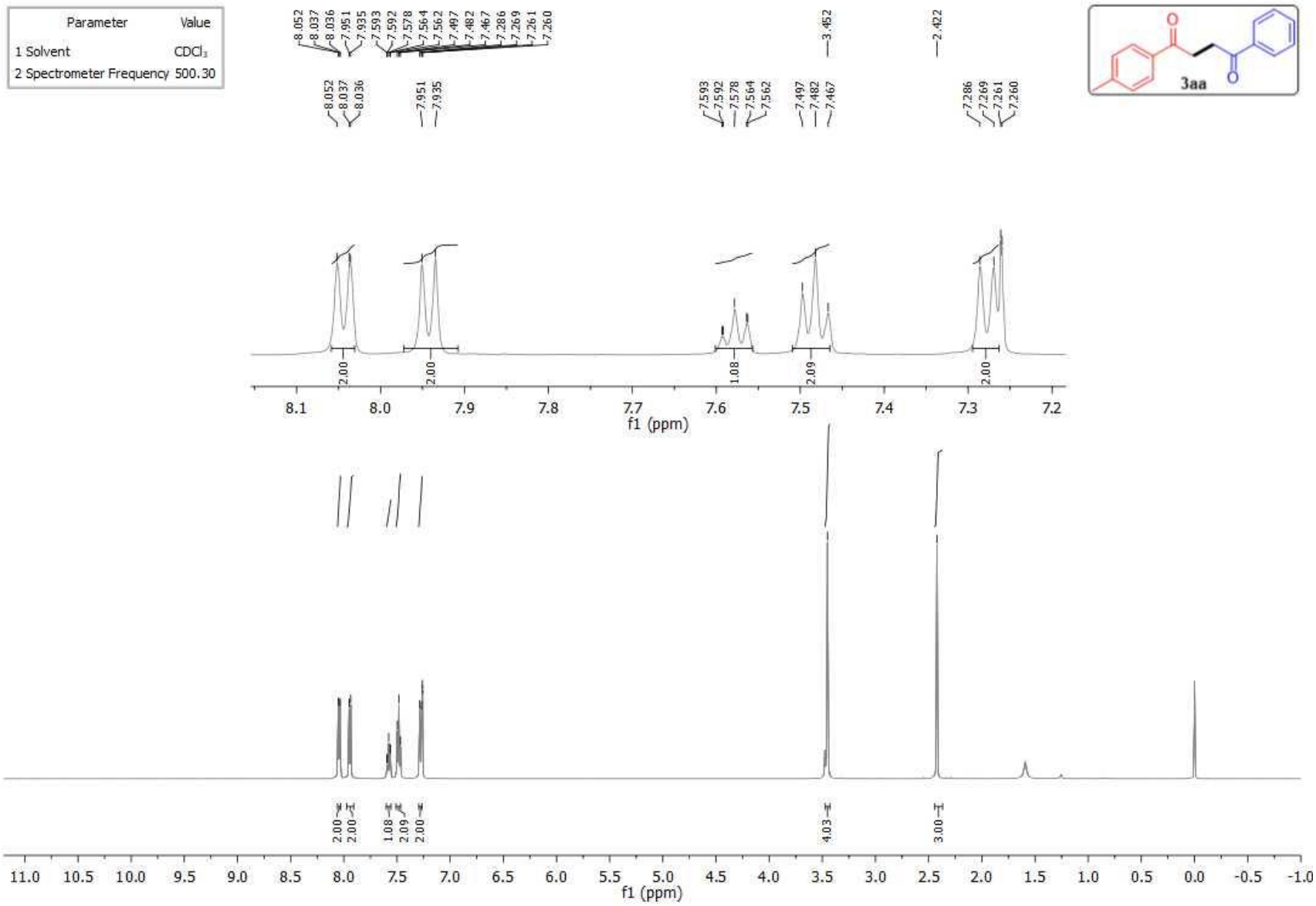

Figure S4. ^{1}H NMR spectrum of 1-Phenyl-4-(*p*-tolyl)butane-1,4-dione (**3aa**).

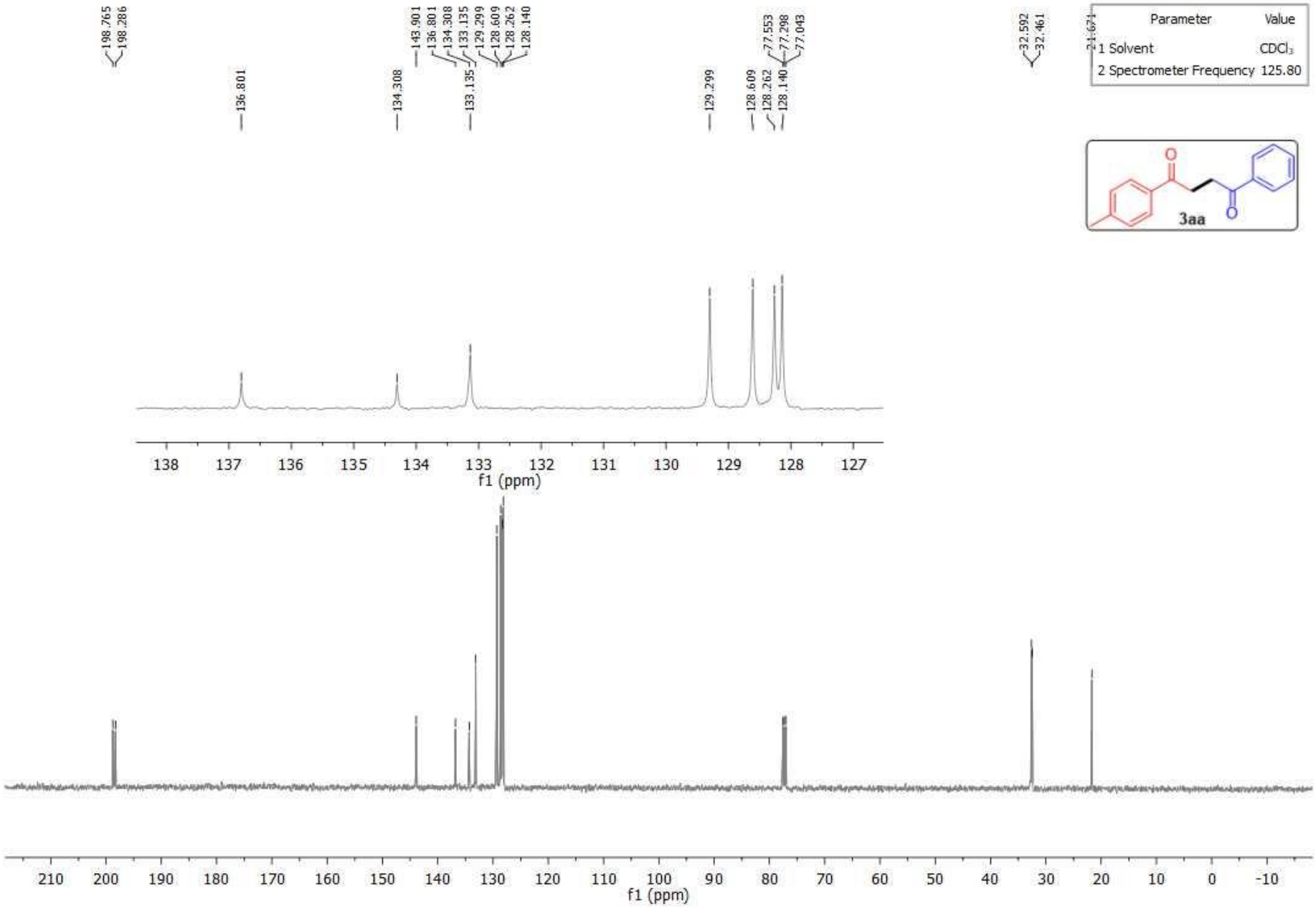

Figure S5. ^{13}C NMR spectrum of 1-Phenyl-4-(*p*-tolyl)butane-1,4-dione (**3aa**).

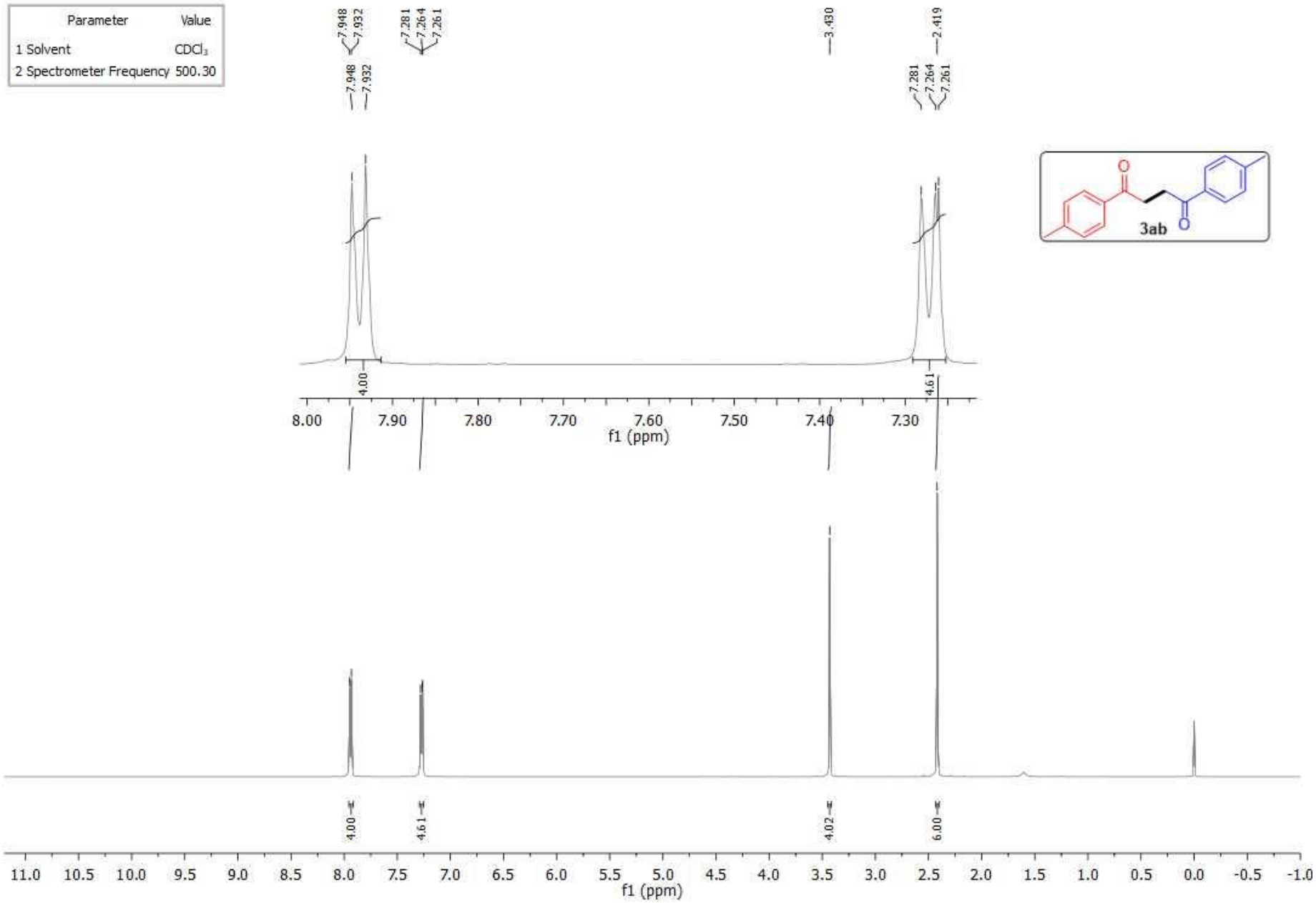

Figure S6. ^{1}H NMR spectrum of 1,4-Di-*p*-tolylbutane-1,4-dione (**3ab**).

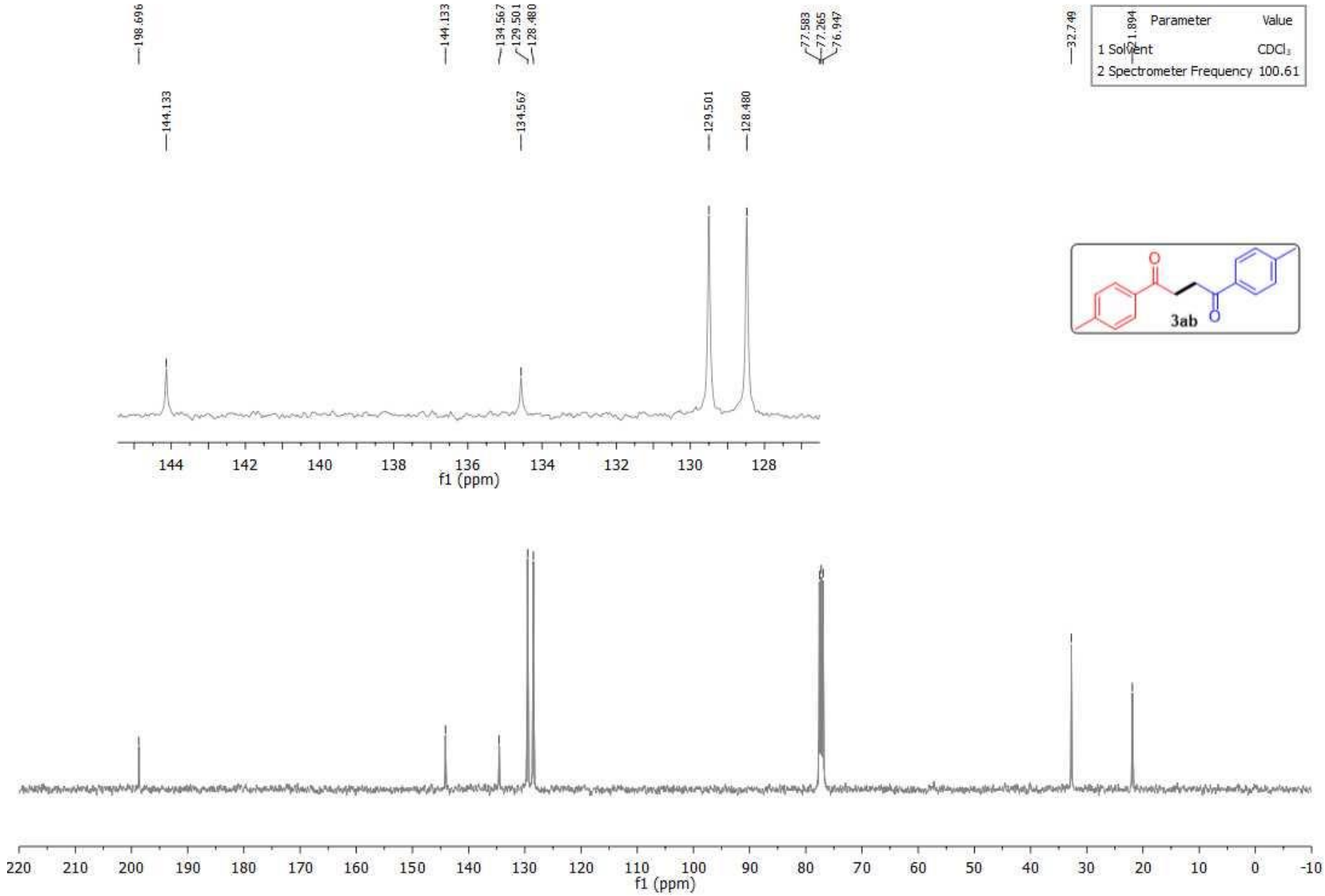

Figure S7. ^{13}C NMR spectrum of 1,4-Di-*p*-tolylbutane-1,4-dione (**3ab**).

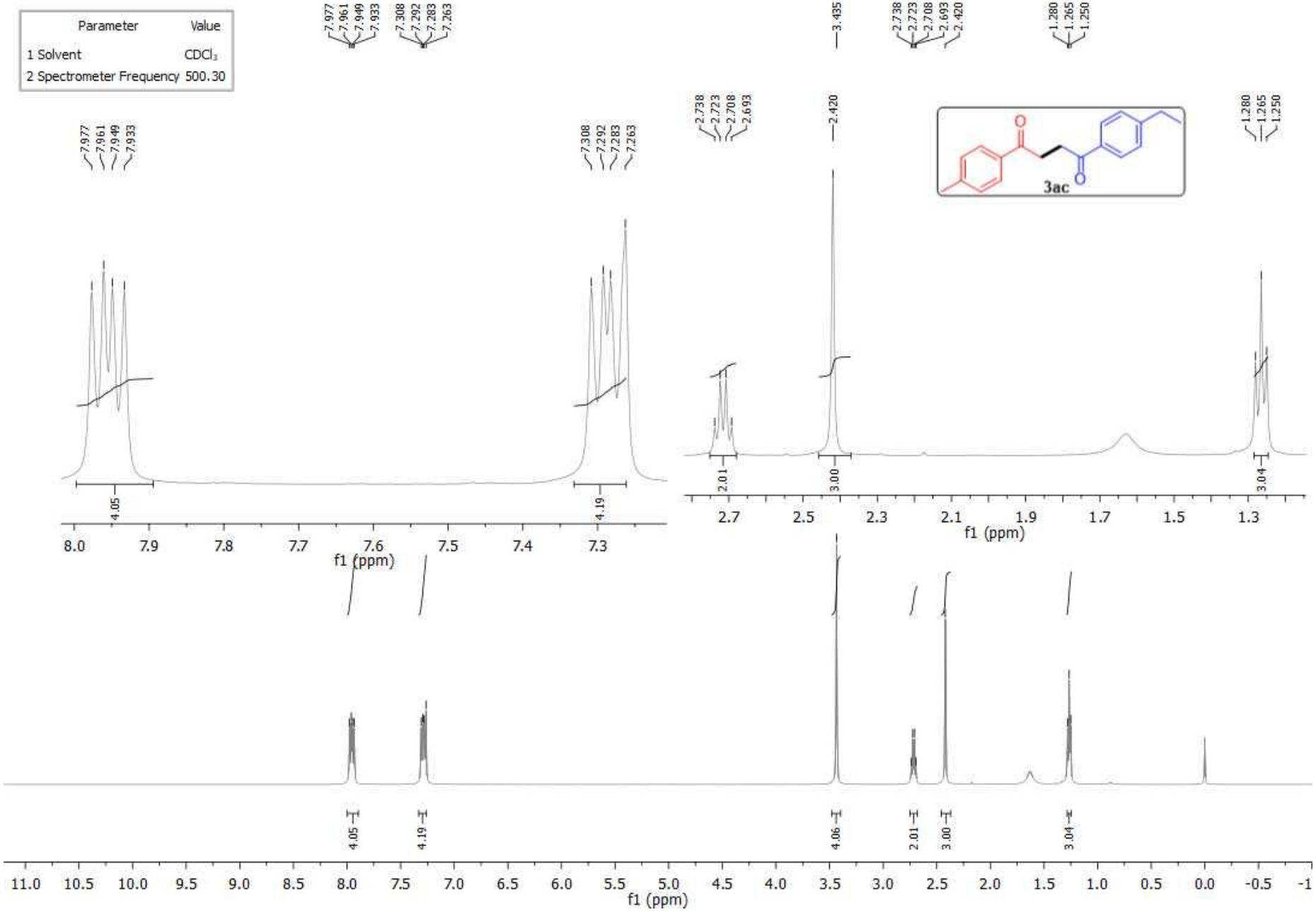

Figure S8. ^{1}H NMR spectrum of 1-(4-Ethylphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ac**).

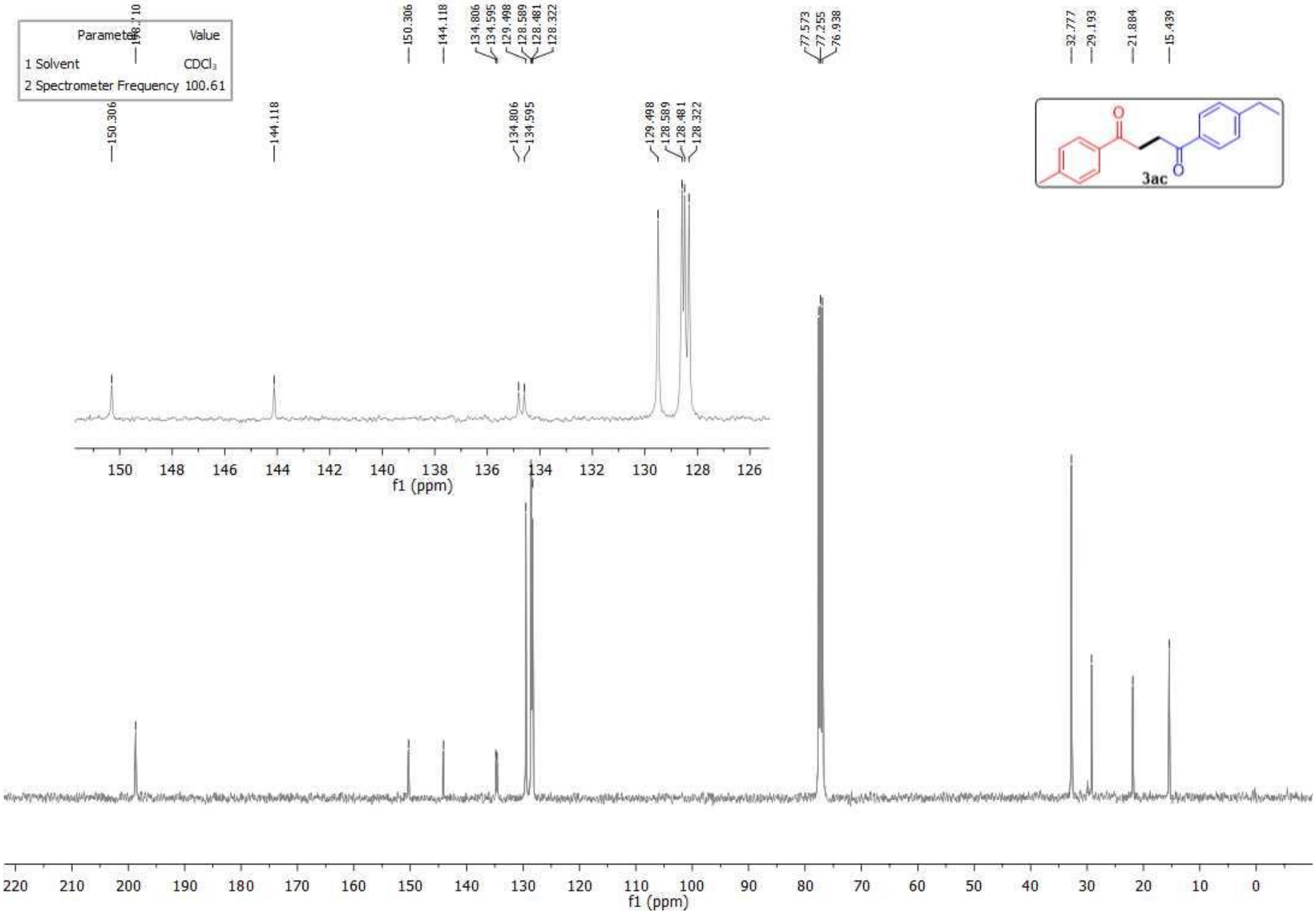

Figure S9. ^{13}C NMR spectrum of 1-(4-Ethylphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ac**).

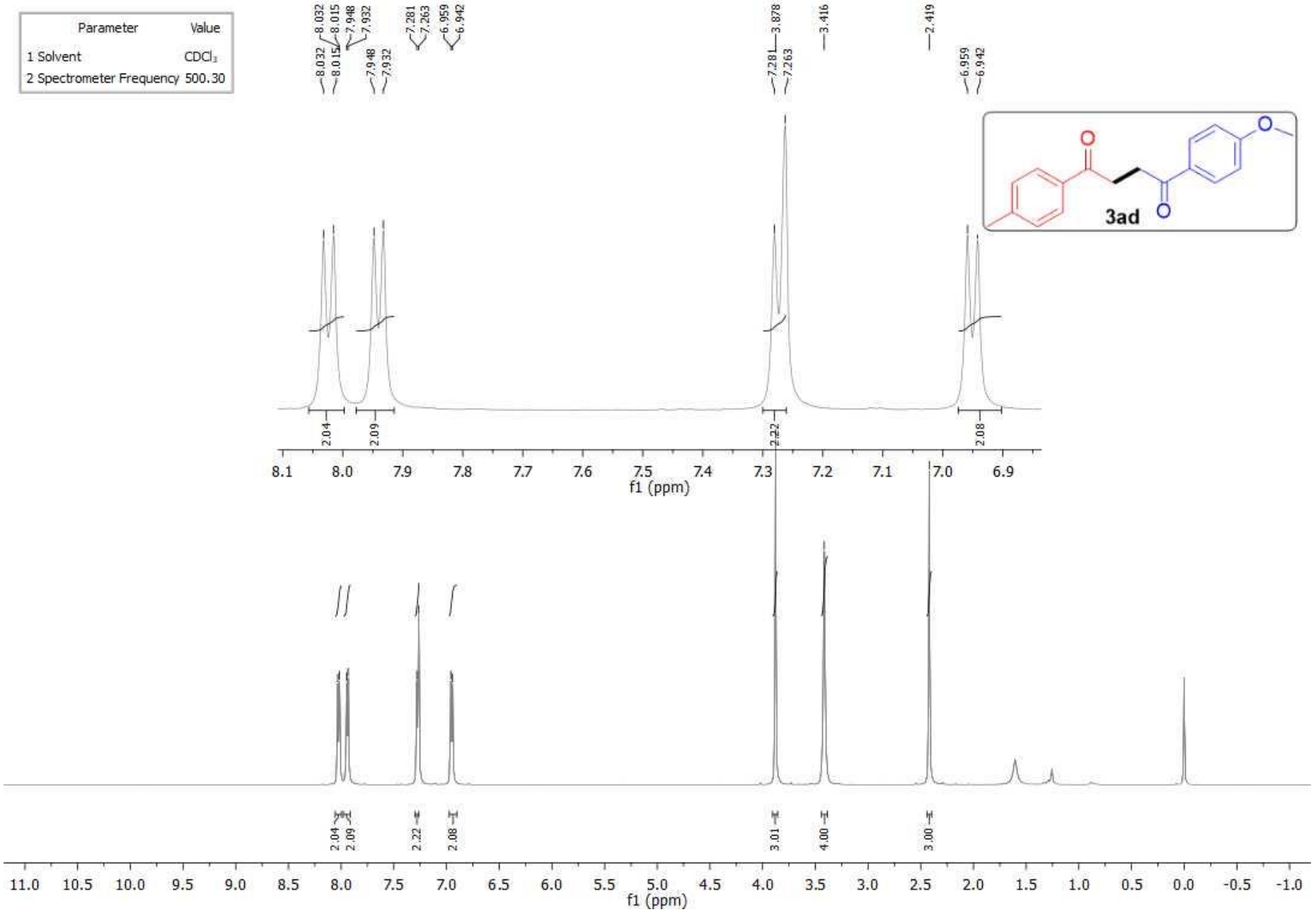

Figure S10. ^{1}H NMR spectrum of 1-(4-Methoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ad**).

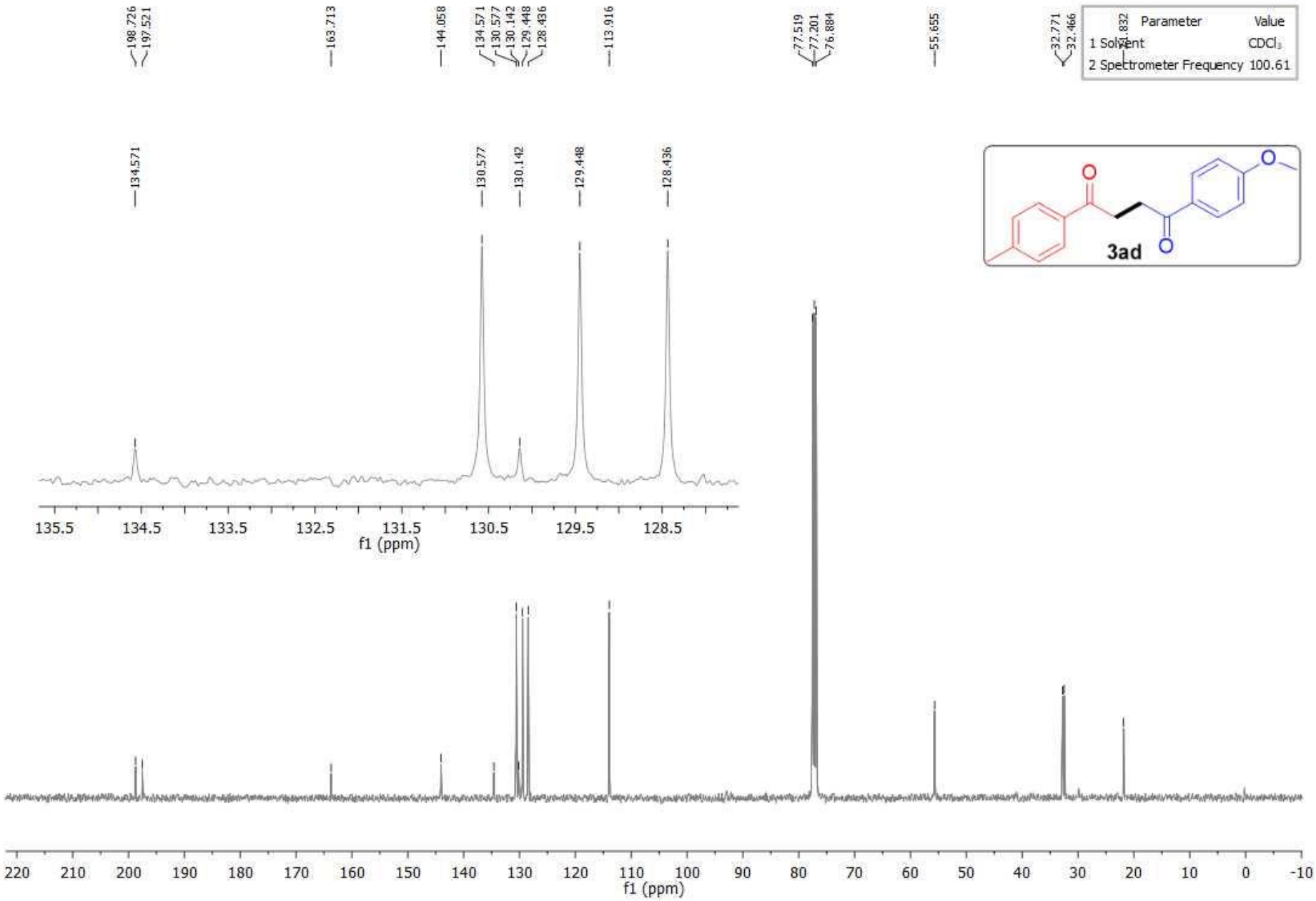

Figure S11. ^{13}C NMR spectrum of 1-(4-Methoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ad**).

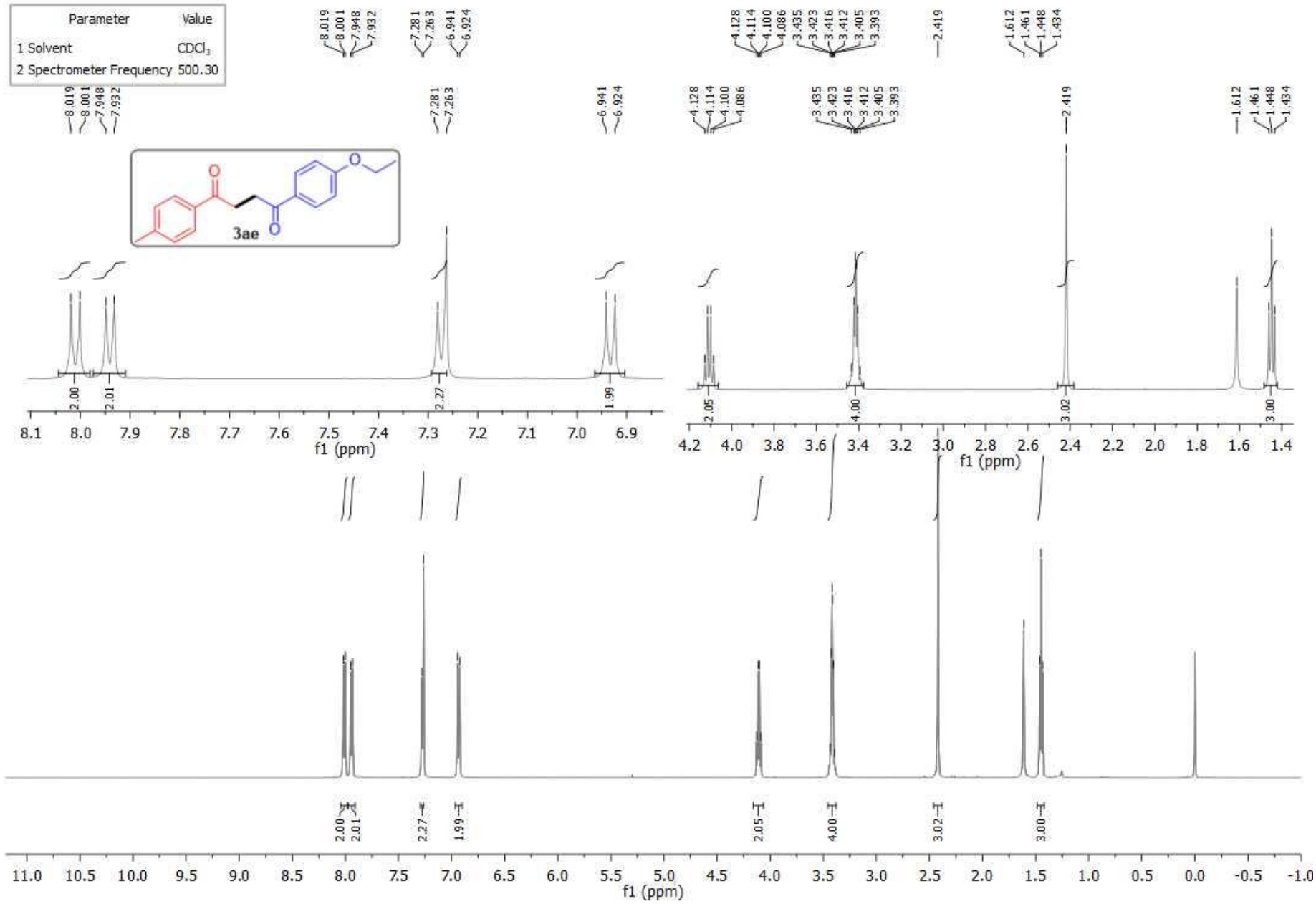

Figure S12. ^{1}H NMR spectrum of 1-(4-Ethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ae**).

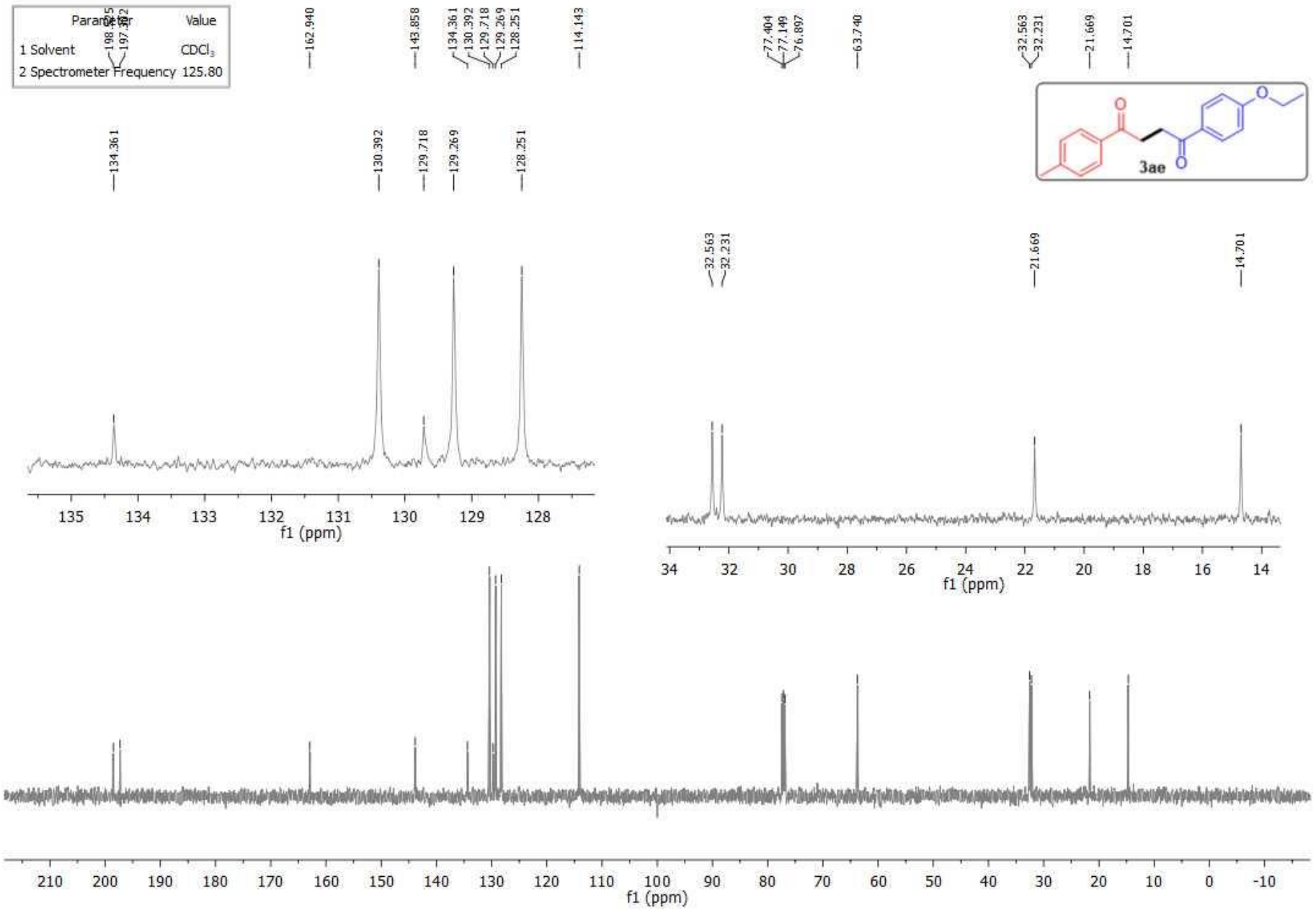

Figure S13. ^{13}C NMR spectrum of 1-(4-Ethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ae**).

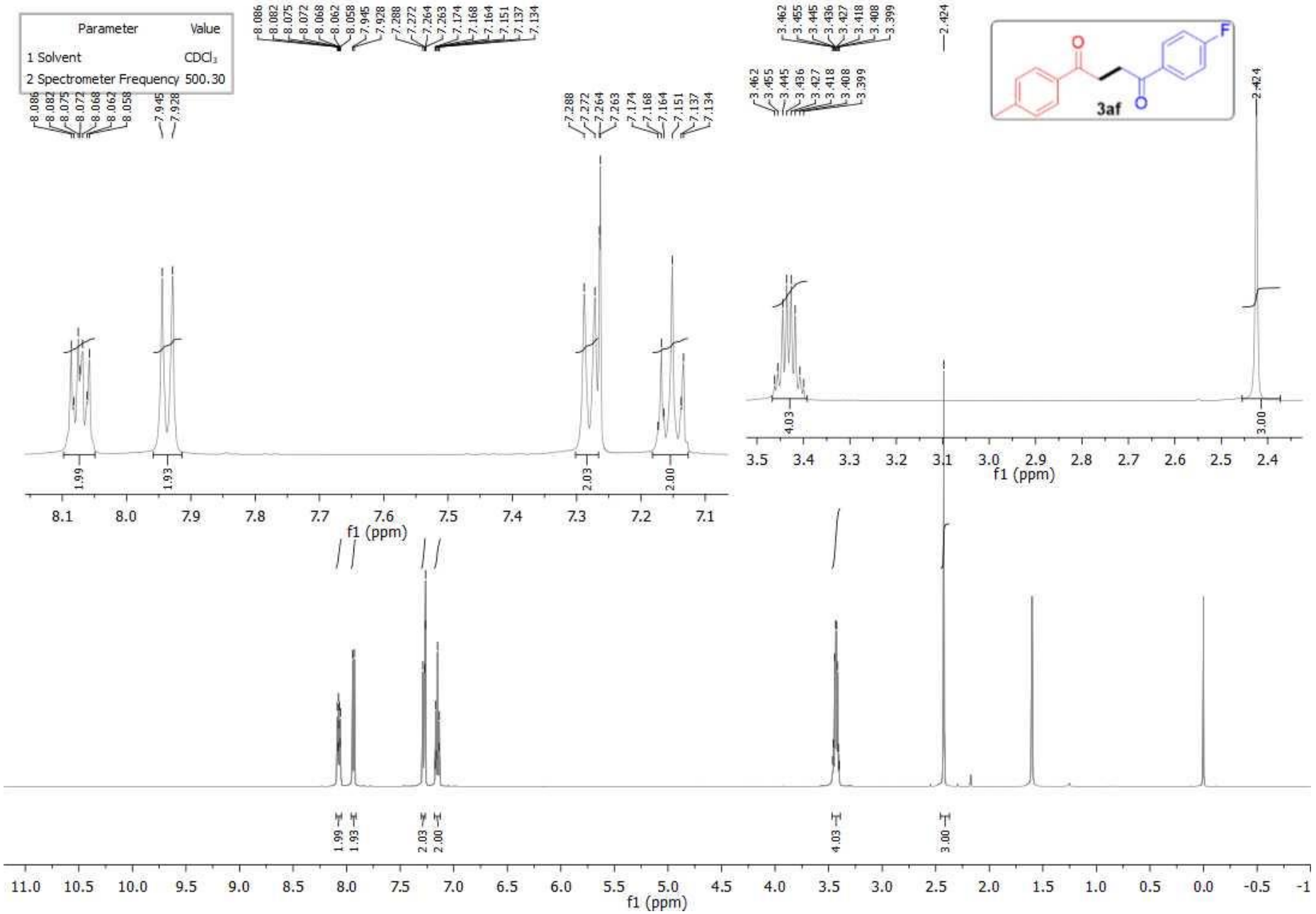

Figure S14. ^{1}H NMR spectrum of 1-(4-Fluorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3af**).

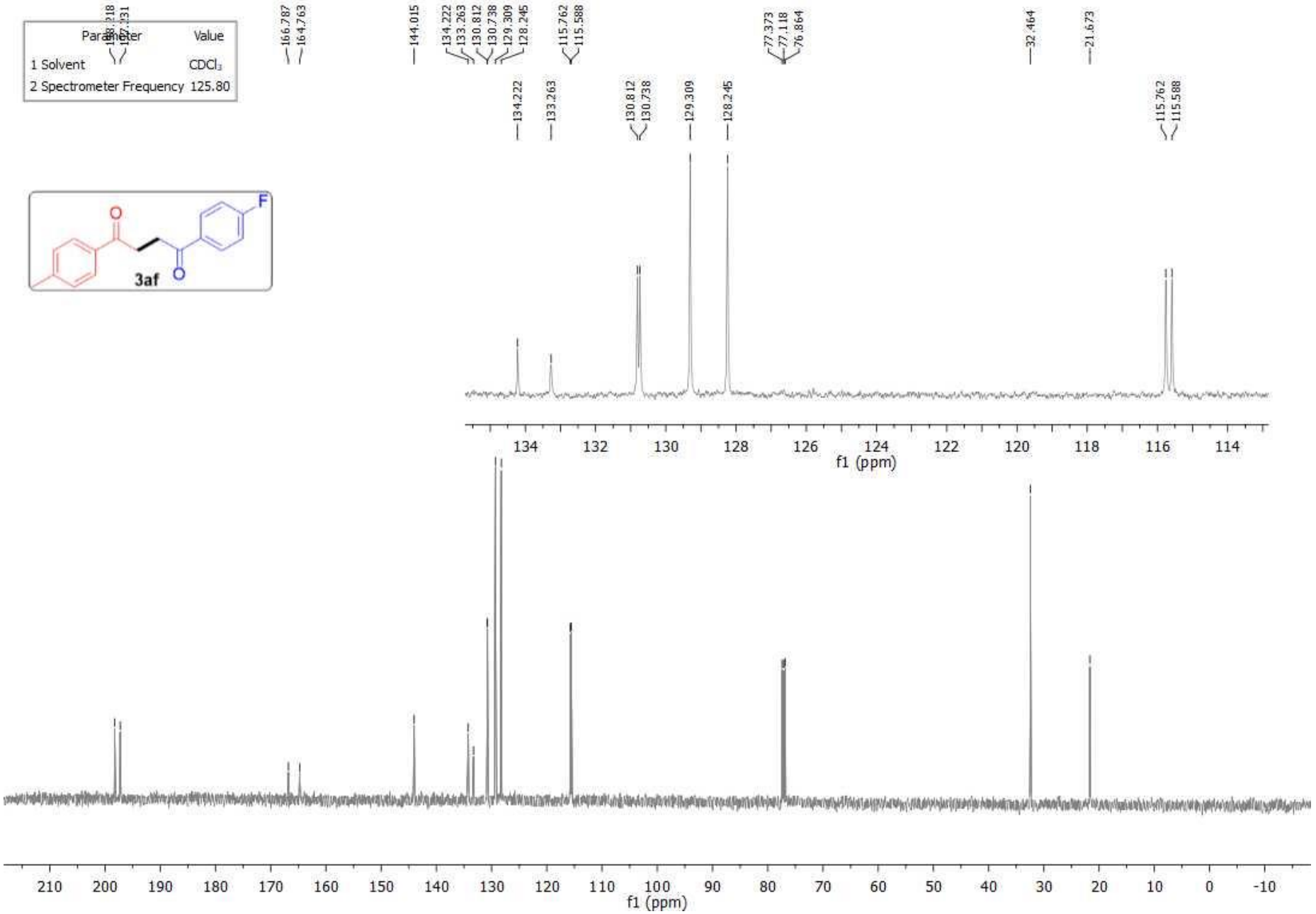

Figure S15. ^{13}C NMR spectrum of 1-(4-Fluorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3af**).

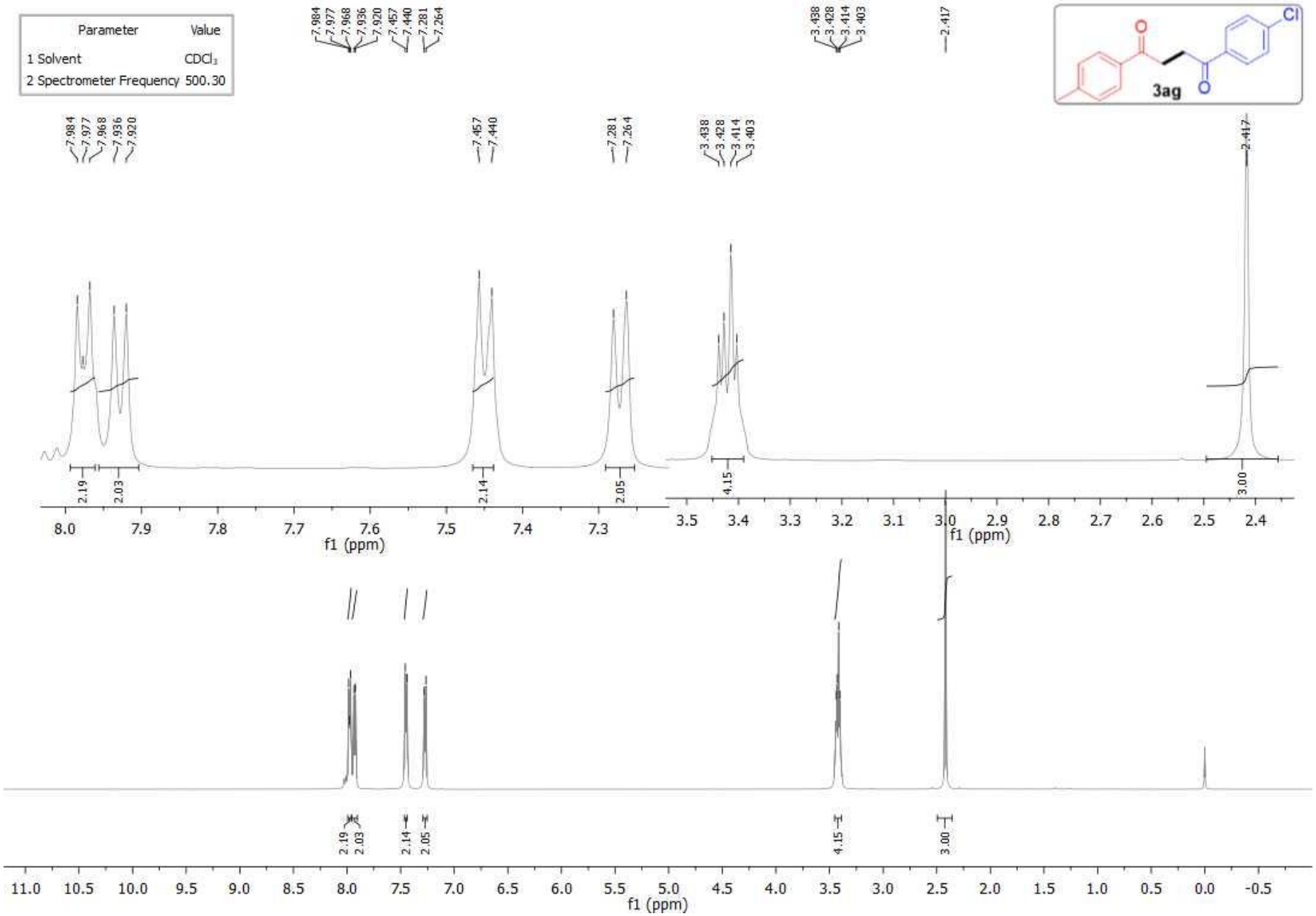

Figure S16. ^{1}H NMR spectrum of 1-(4-Chlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ag**).

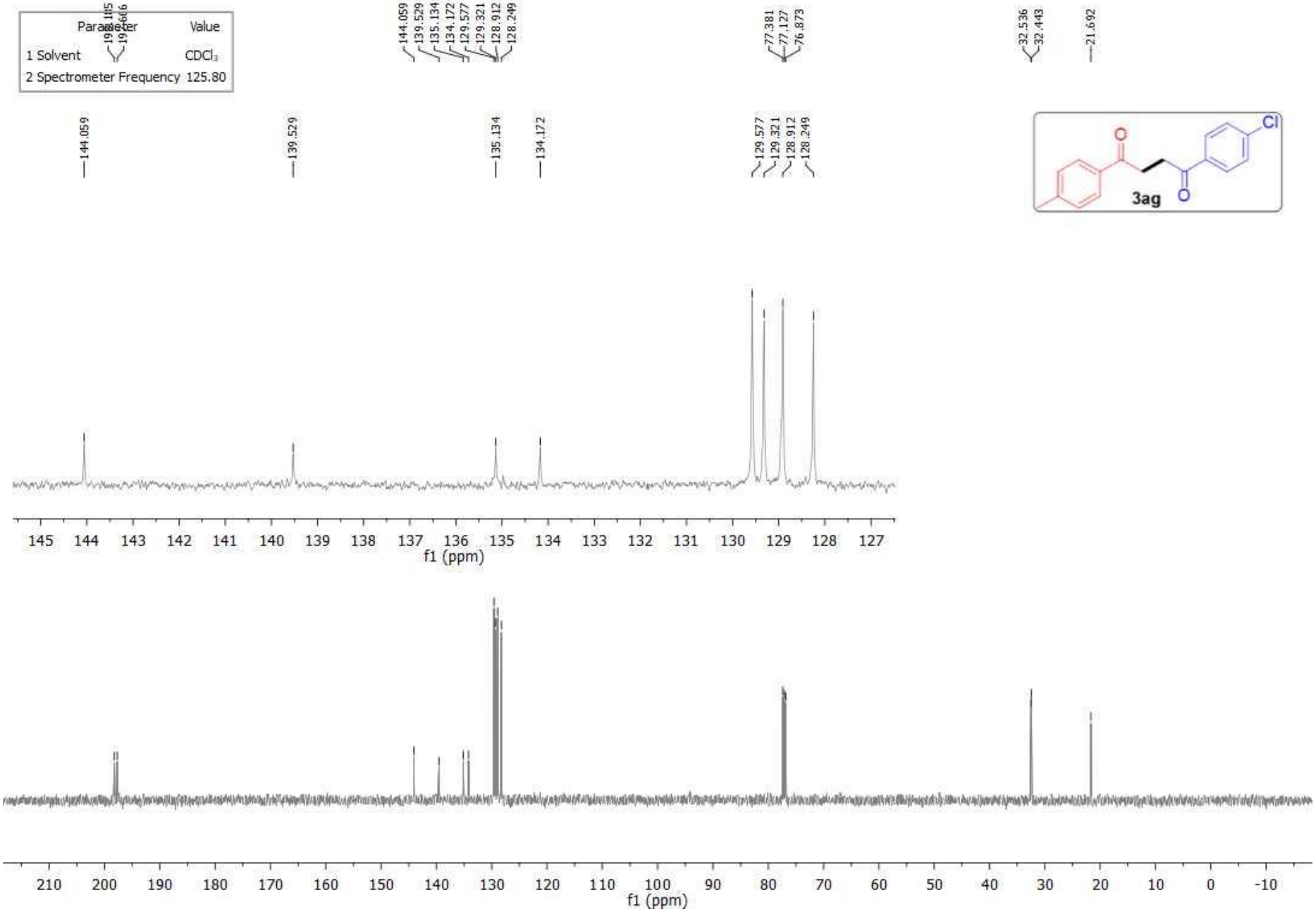

Figure S17. ^{13}C NMR spectrum of 1-(4-Chlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ag**).

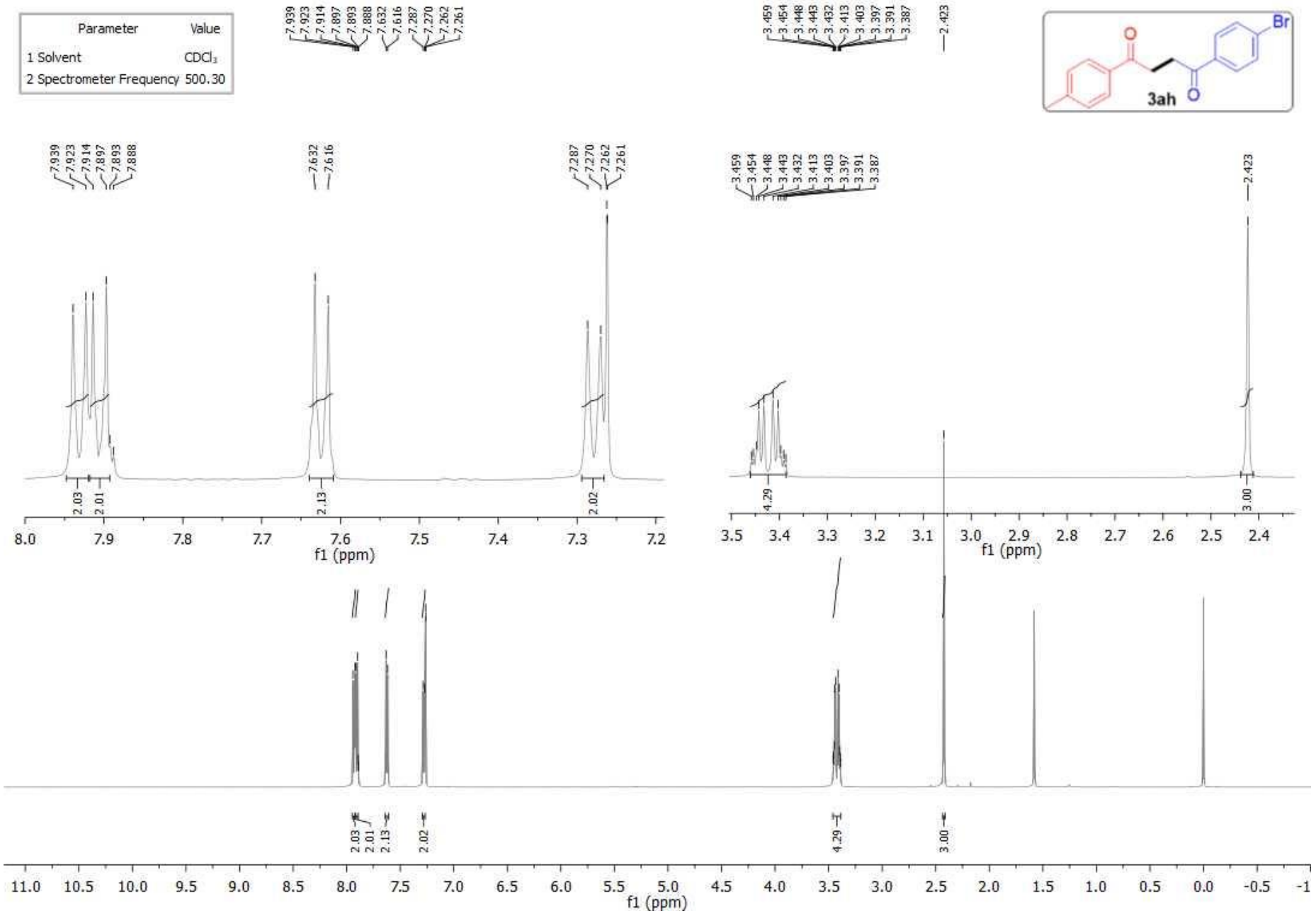

Figure S18. ^{1}H NMR spectrum of 1-(4-Bromophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ah**).

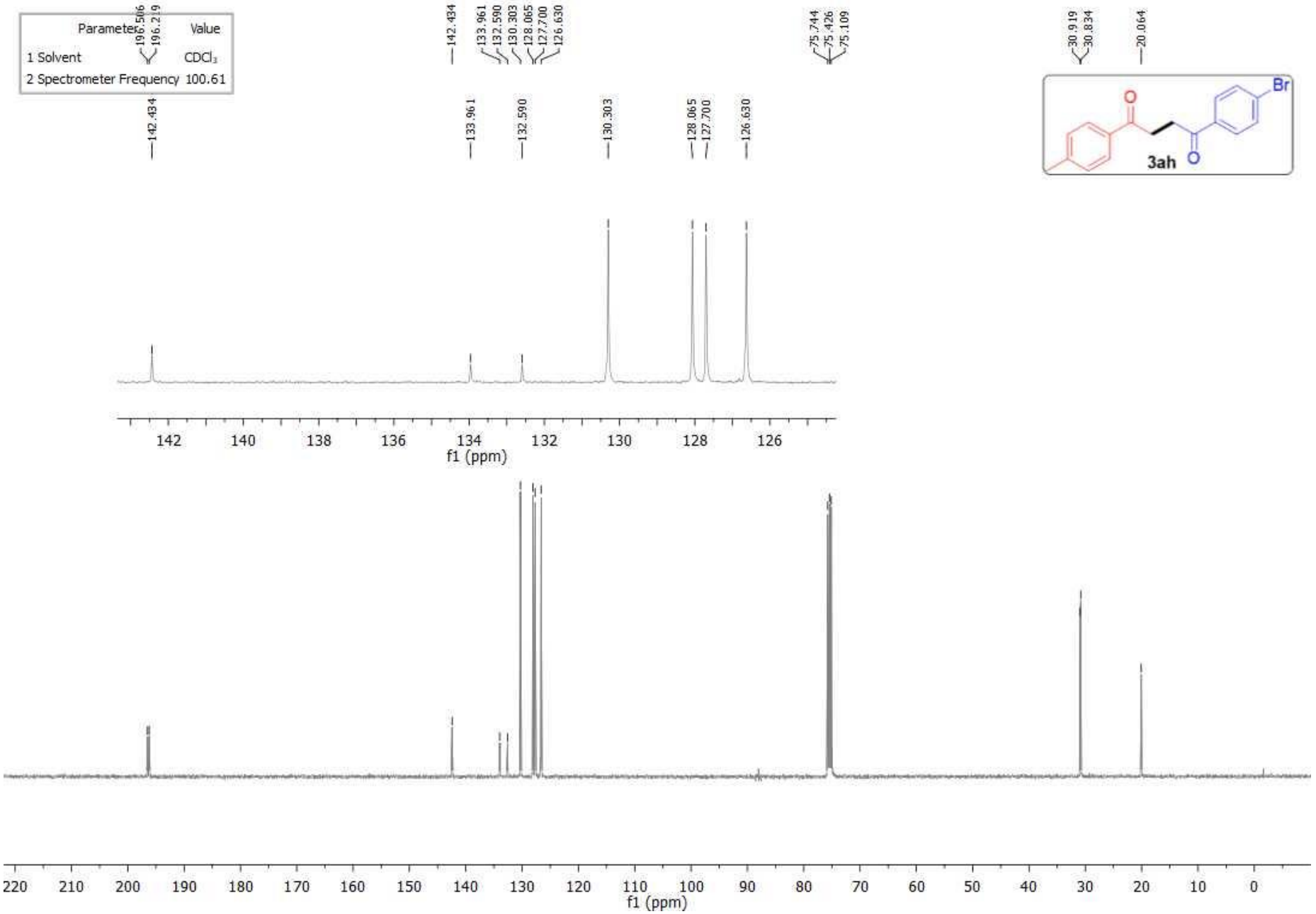

Figure S19. ^{13}C NMR spectrum of 1-(4-Bromophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ah**).

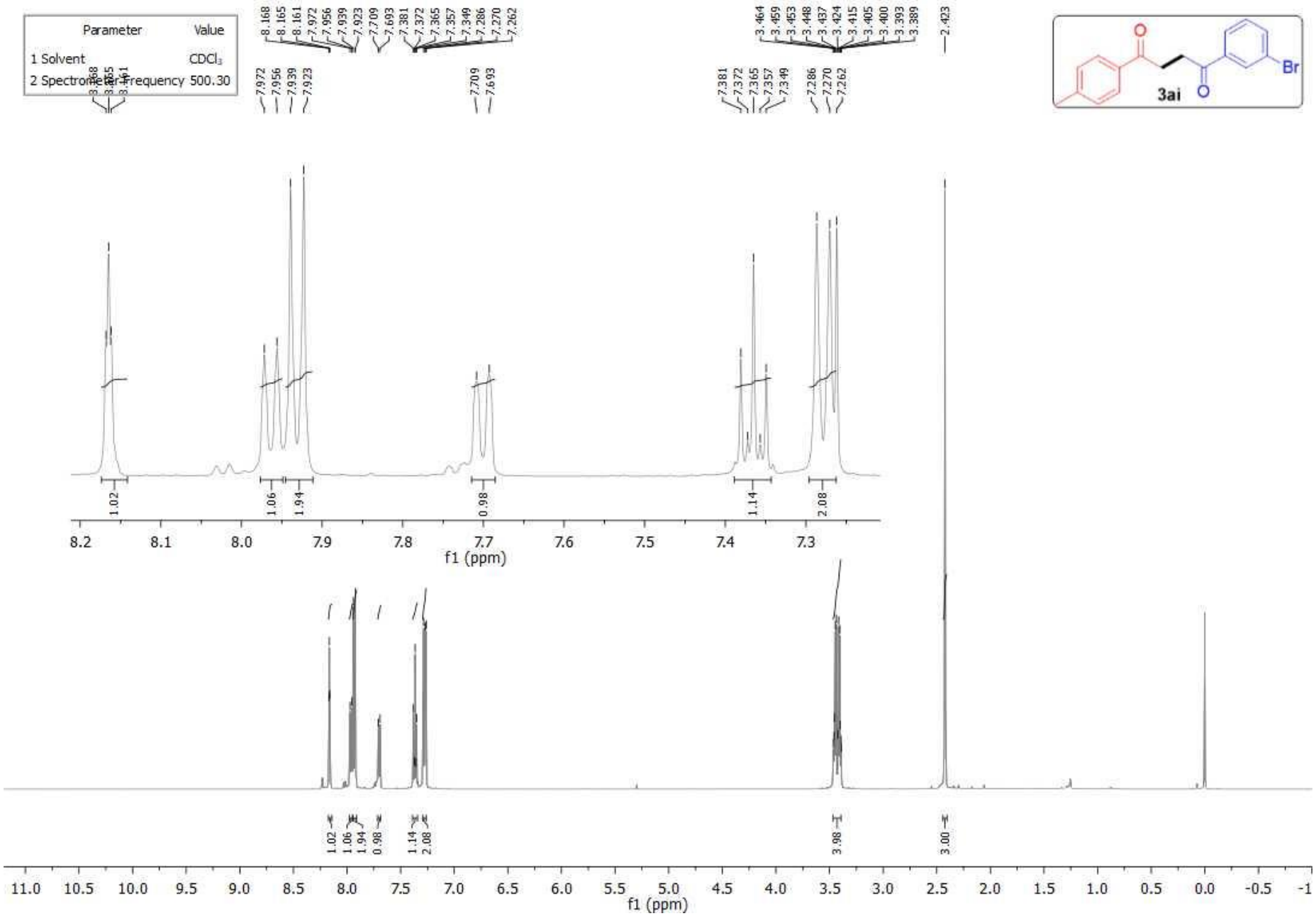

Figure S20. ^{1}H NMR spectrum of 1-(3-Bromophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ai**).

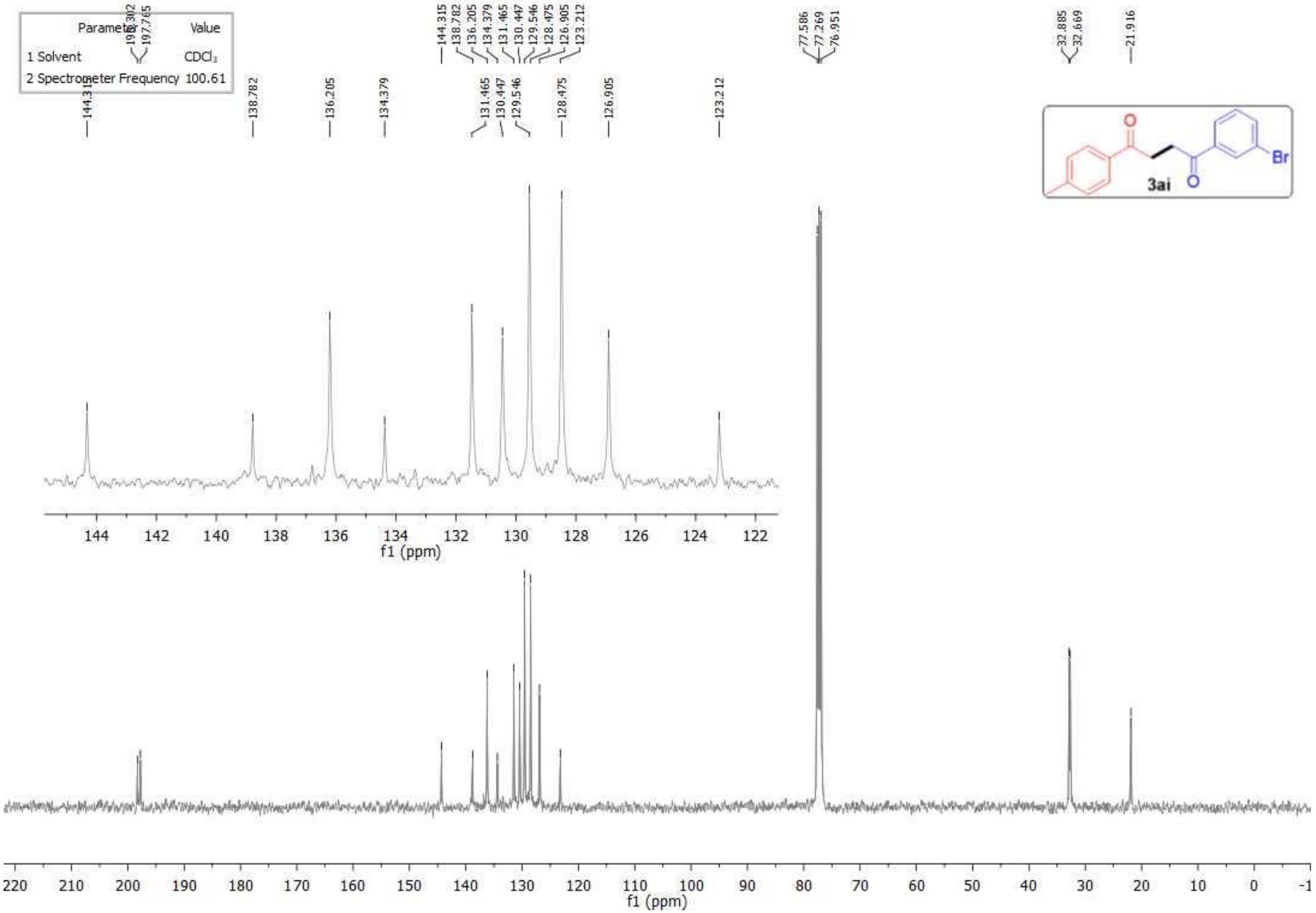

Figure S21. ^{13}C NMR spectrum of 1-(3-Bromophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ai**).

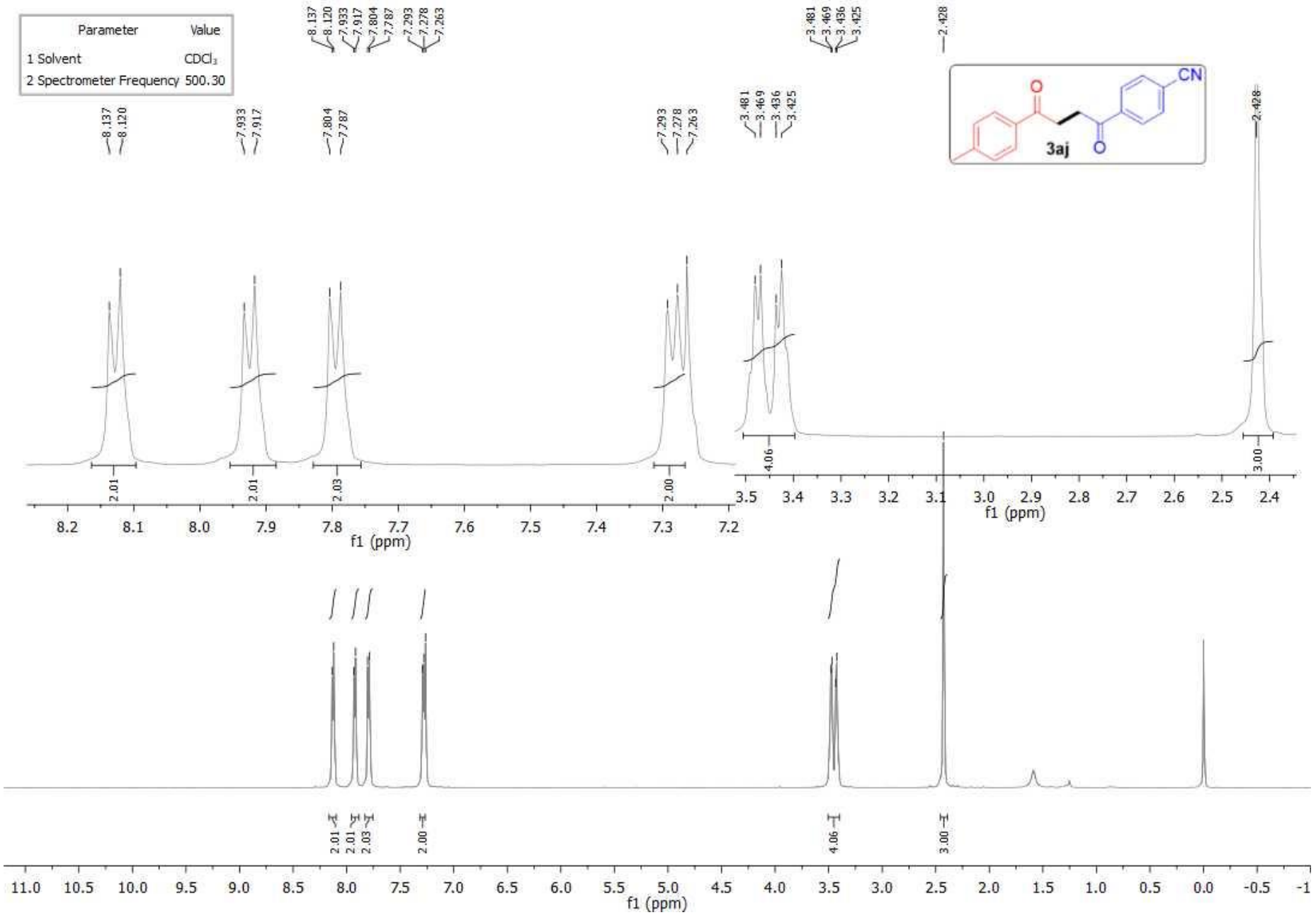

Figure S22. ^{1}H NMR spectrum of 4-(4-Oxo-4-(*p*-tolyl)butanoyl)benzonitrile (**3aj**).

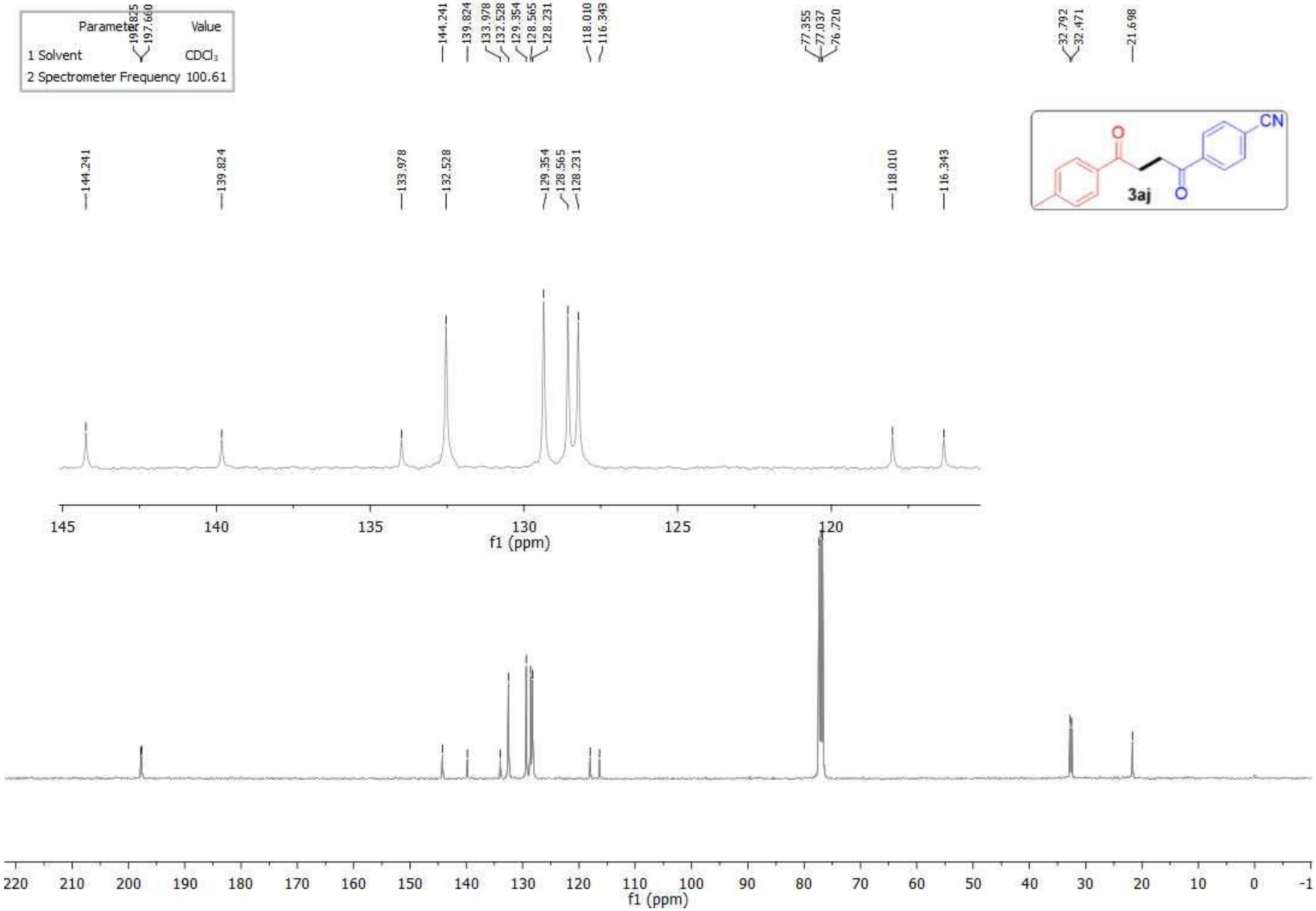

Figure S23. ^{13}C NMR [1]spectrum of 4-(4-Oxo-4-(*p*-tolyl)butanoyl)benzonitrile (**3aj**).

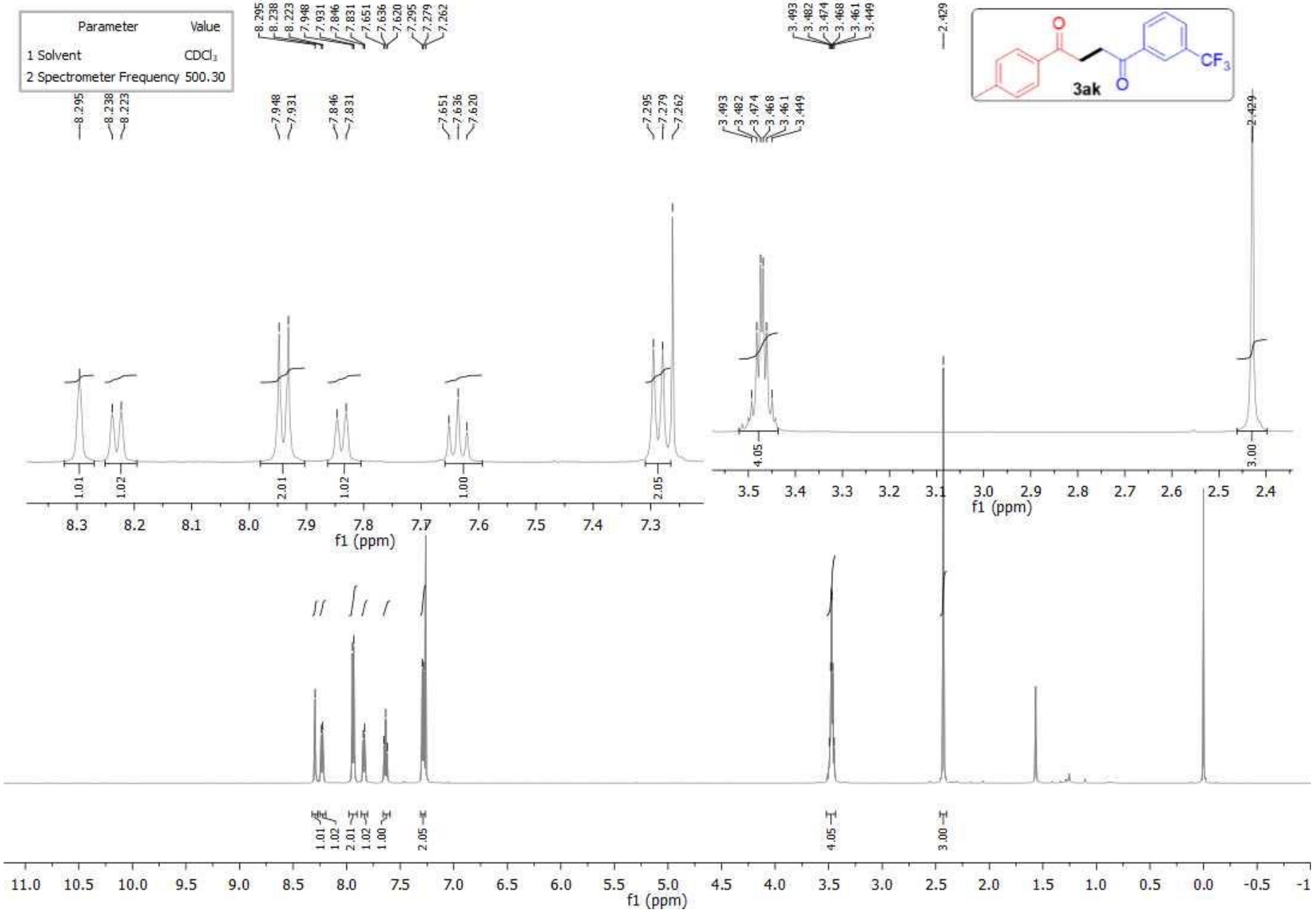

Figure S24. ^{1}H NMR spectrum of 1-(*p*-Tolyl)-4-(3-(trifluoromethyl)phenyl)butane-1,4-dione (**3ak**).

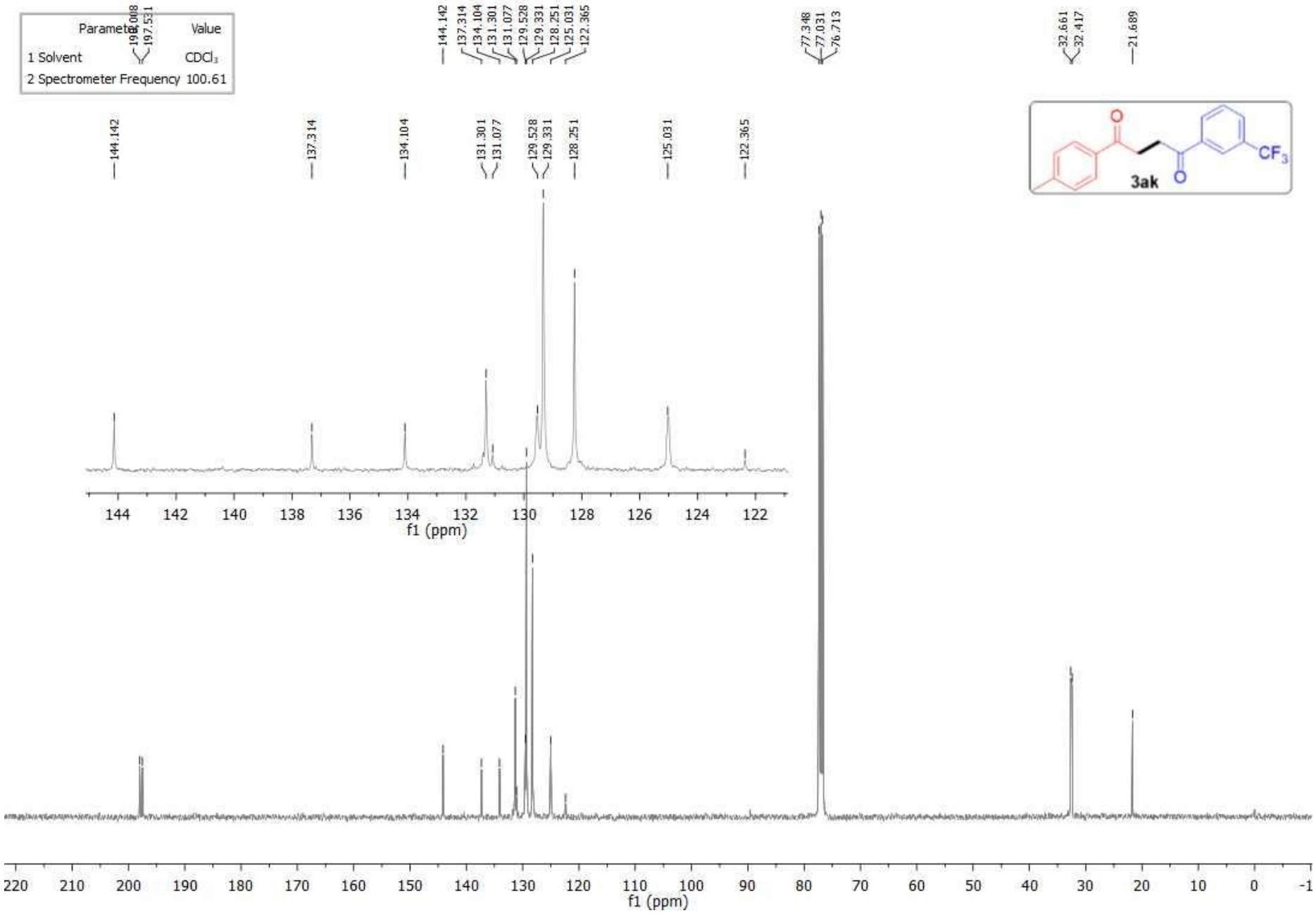

Figure S25. ^{13}C NMR spectrum of 1-(*p*-Tolyl)-4-(3-(trifluoromethyl)phenyl)butane-1,4-dione (**3ak**).

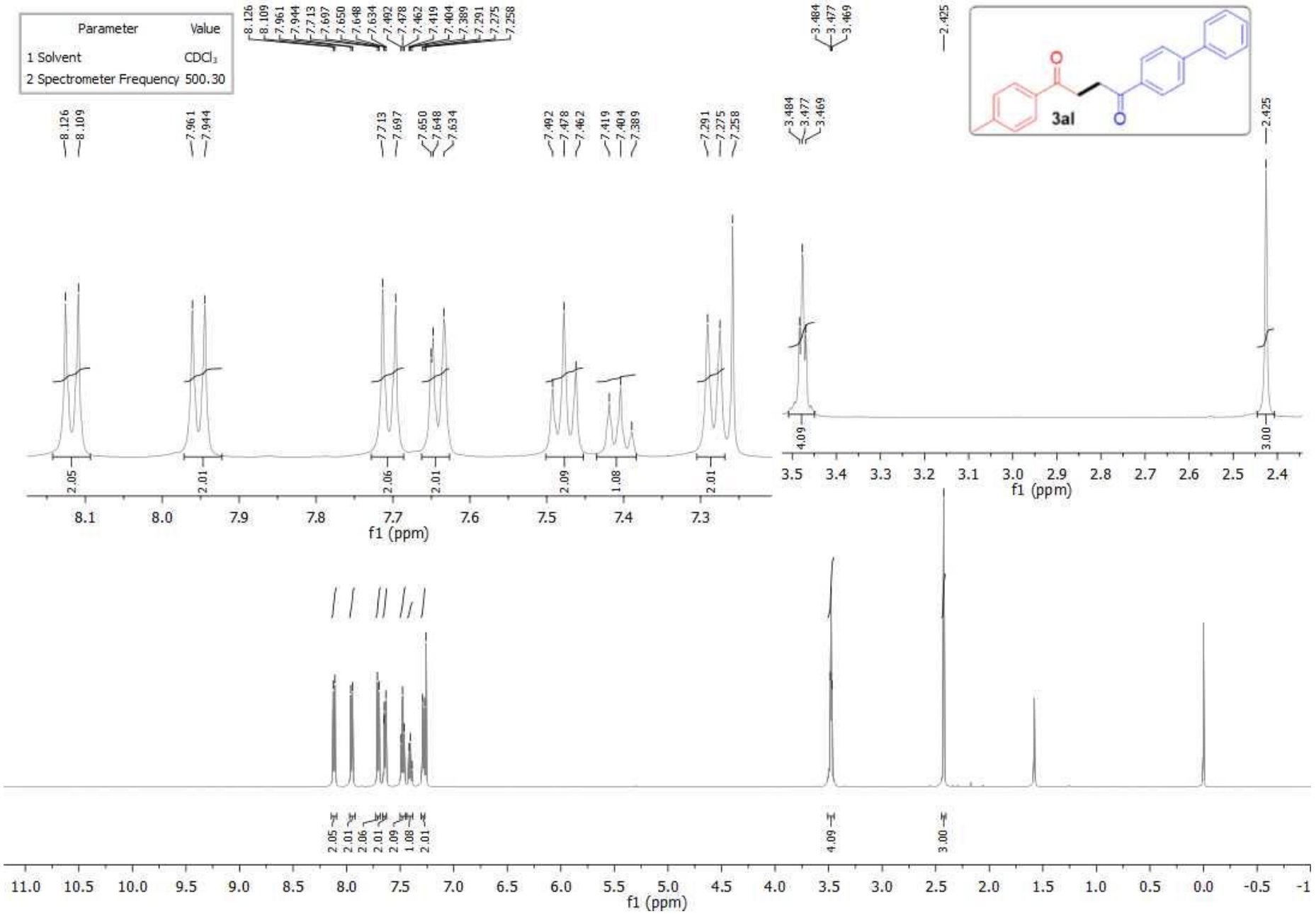

Figure S26. ^{1}H NMR spectrum of 1-([1,1'-Biphenyl]-4-yl)-4-(p-tolyl)butane-1,4-dione (**3al**).

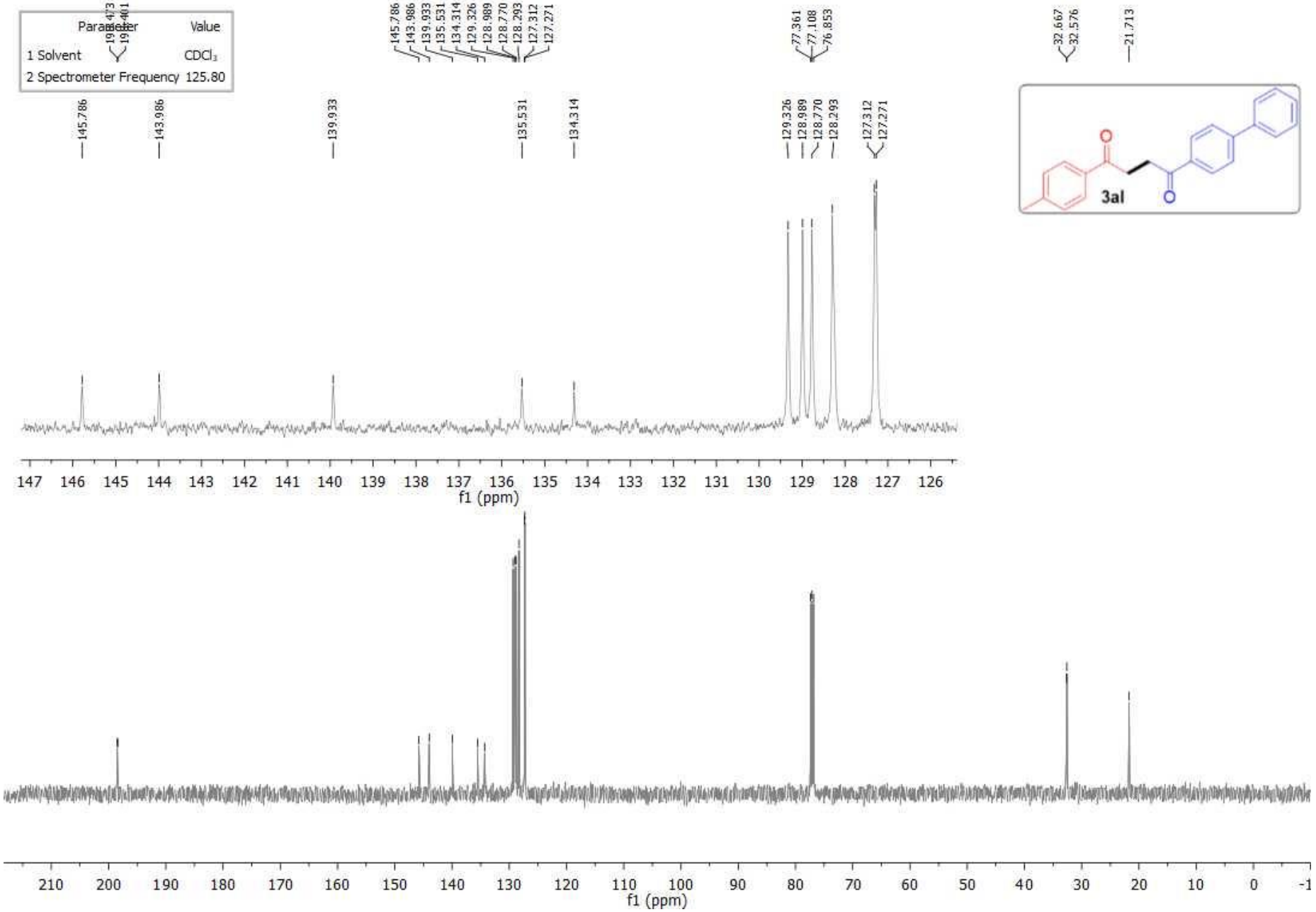

Figure S27. ^{13}C NMR spectrum of 1-([1,1'-Biphenyl]-4-yl)-4-(p-tolyl)butane-1,4-dione (**3al**).

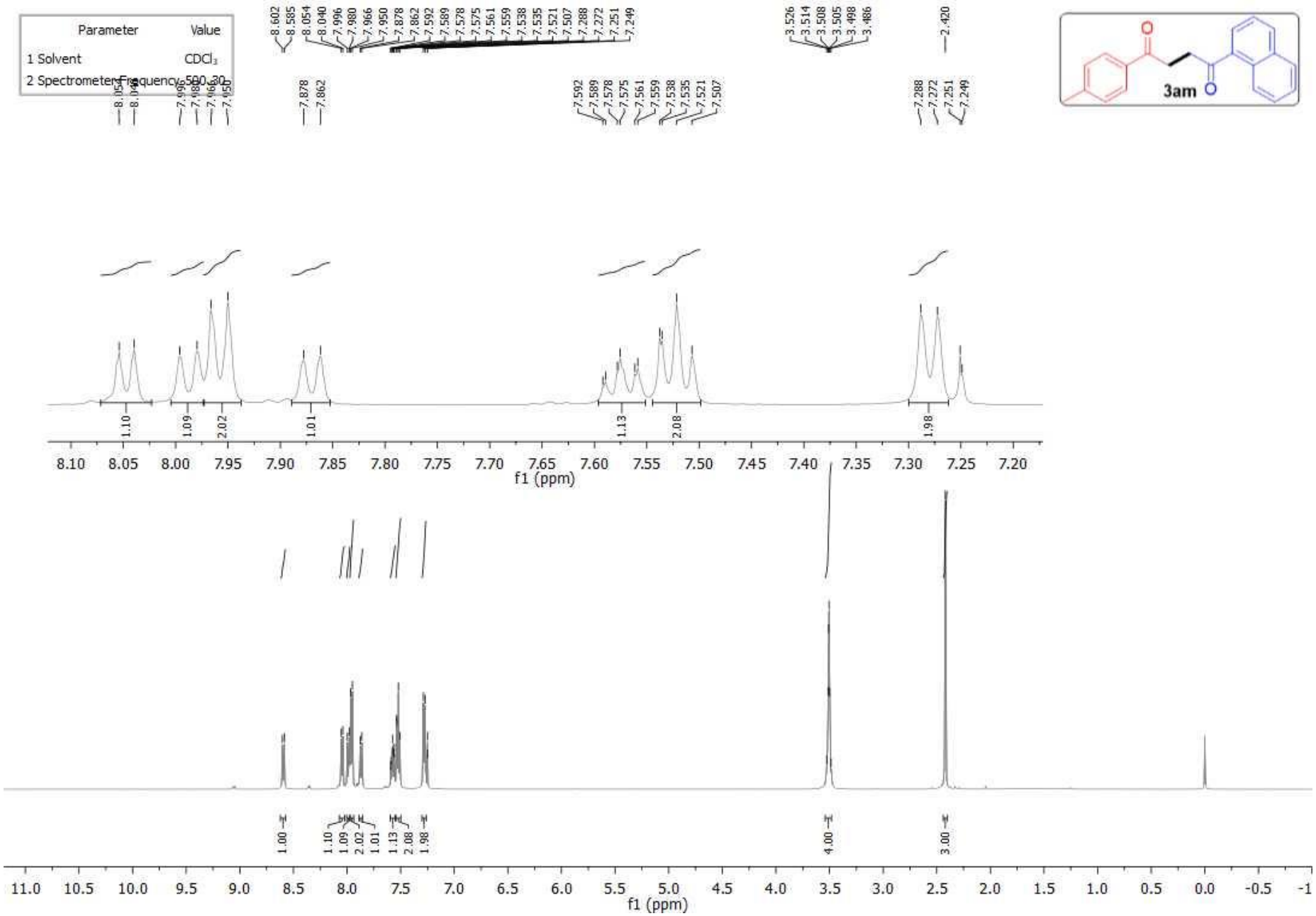

Figure S28. ^{1}H NMR spectrum of 1-(Naphthalen-1-yl)-4-(*p*-tolyl)butane-1,4-dione (**3am**).

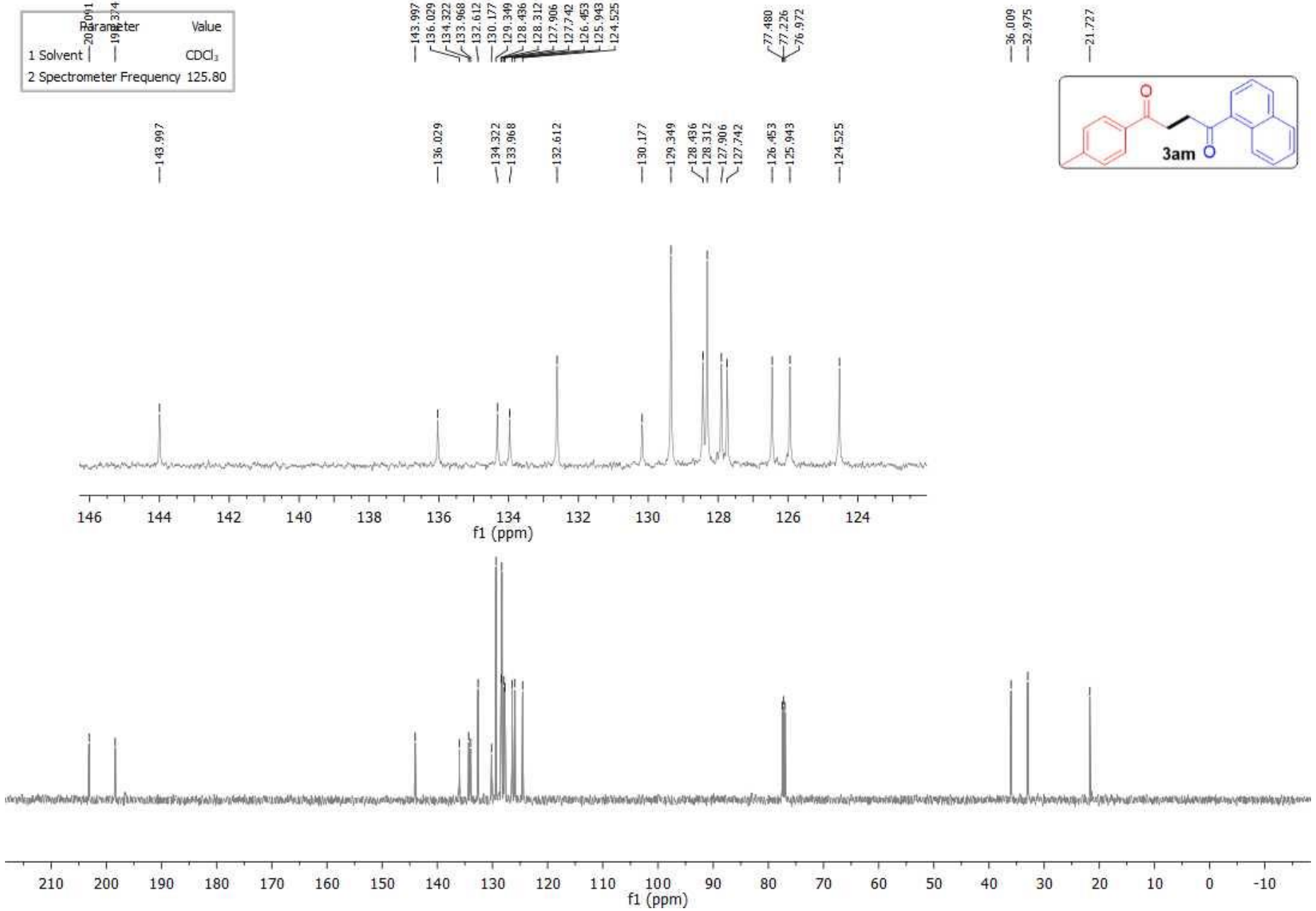

Figure S29. ^{13}C NMR spectrum of 1-(Naphthalen-1-yl)-4-(*p*-tolyl)butane-1,4-dione (**3am**).

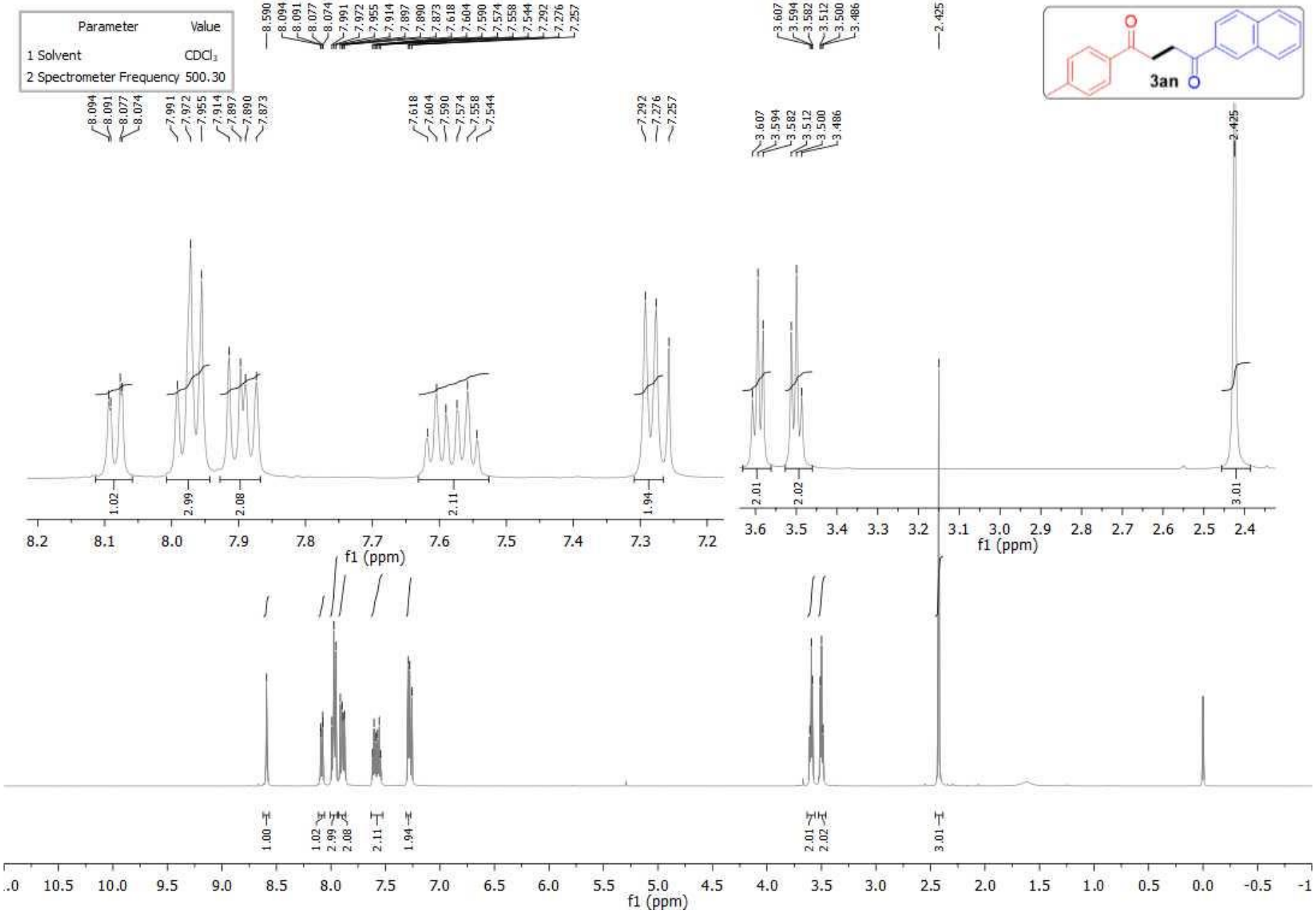

Figure S30. ^{1}H NMR spectrum of 1-(Naphthalen-2-yl)-4-(*p*-tolyl)butane-1,4-dione (**3an**).

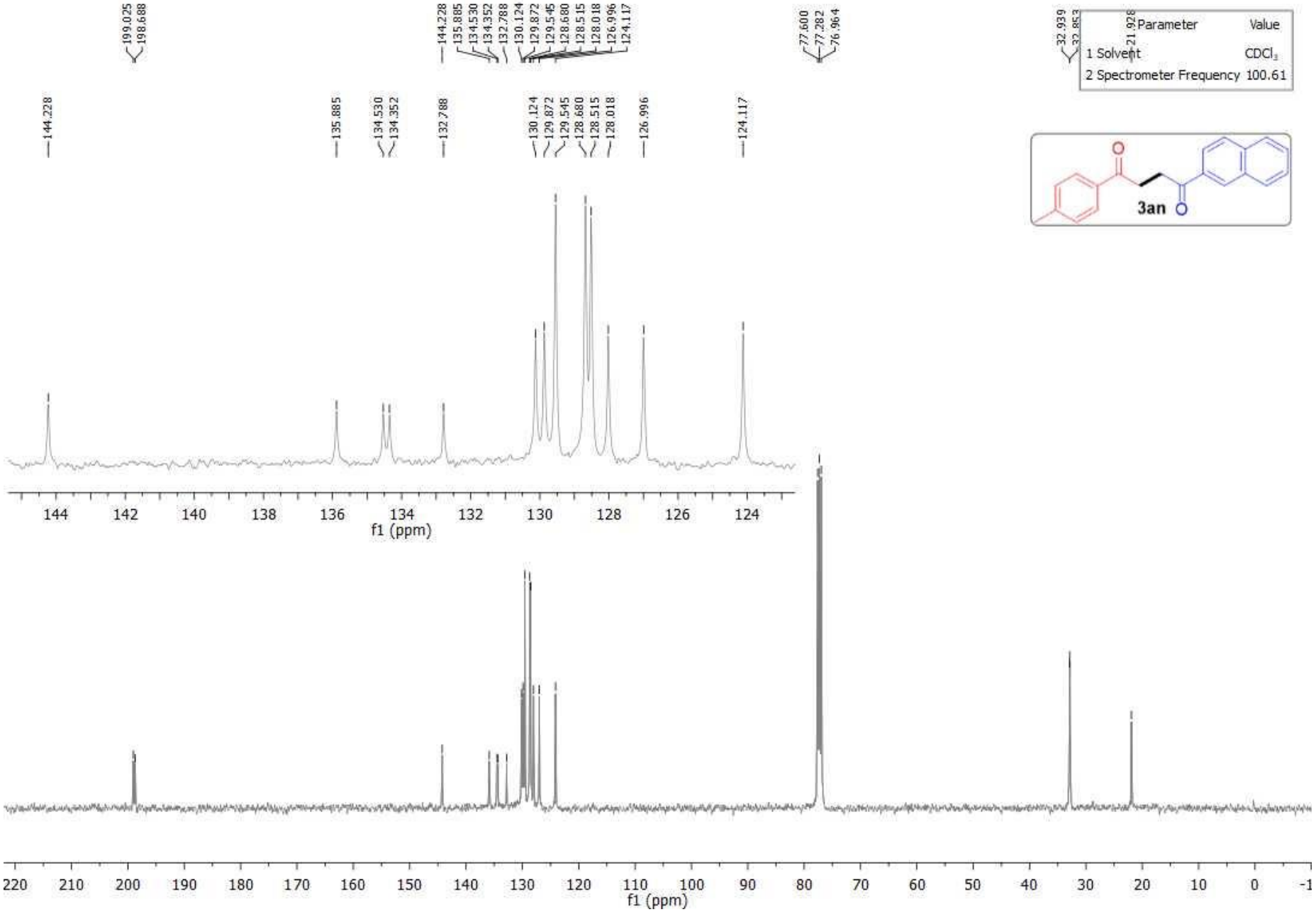

Figure S31. ^{13}C NMR spectrum of 1-(Naphthalen-2-yl)-4-(*p*-tolyl)butane-1,4-dione (**3an**).

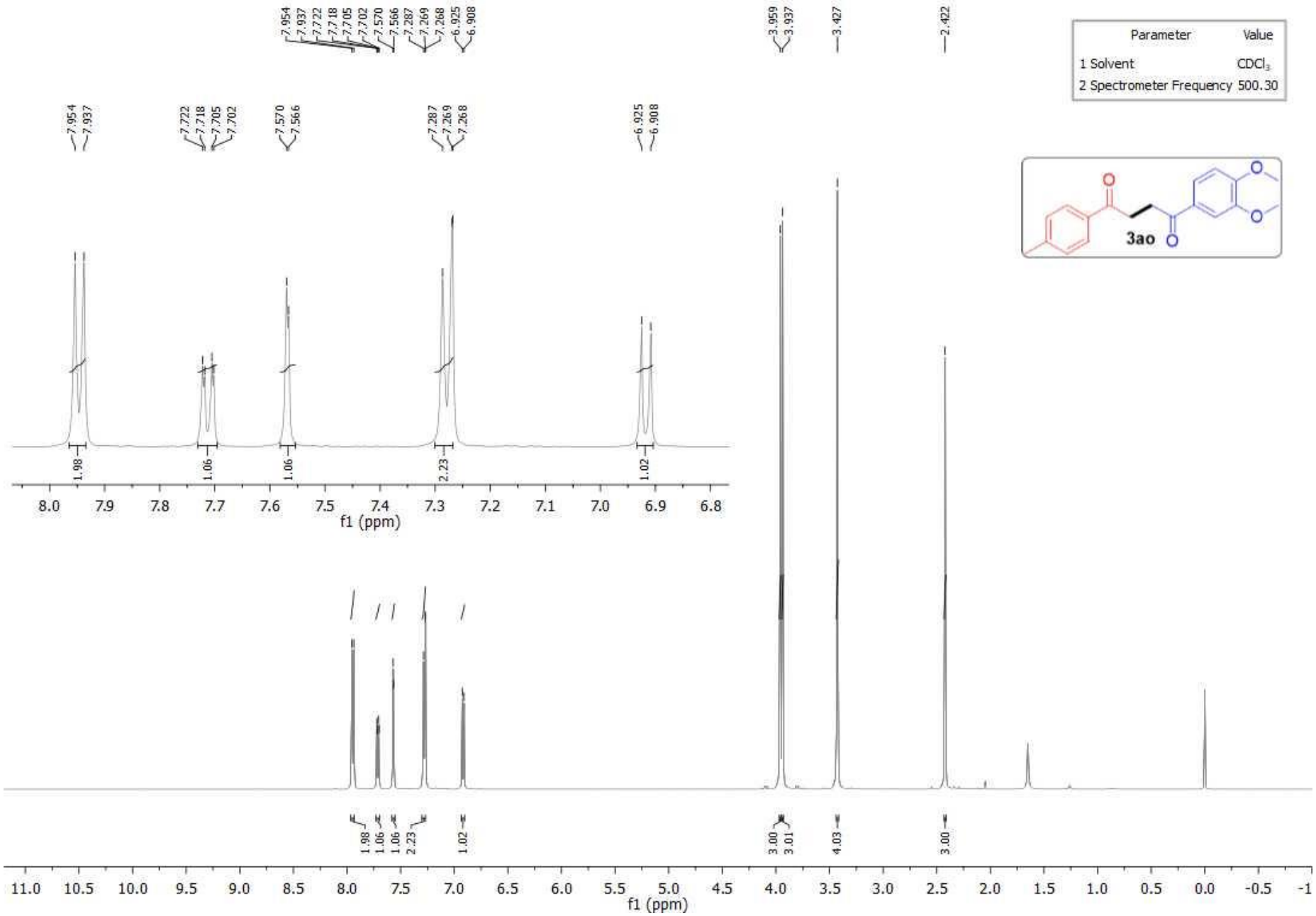

Figure S32. ^{1}H NMR spectrum of 1-(3,4-Dimethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ao**).

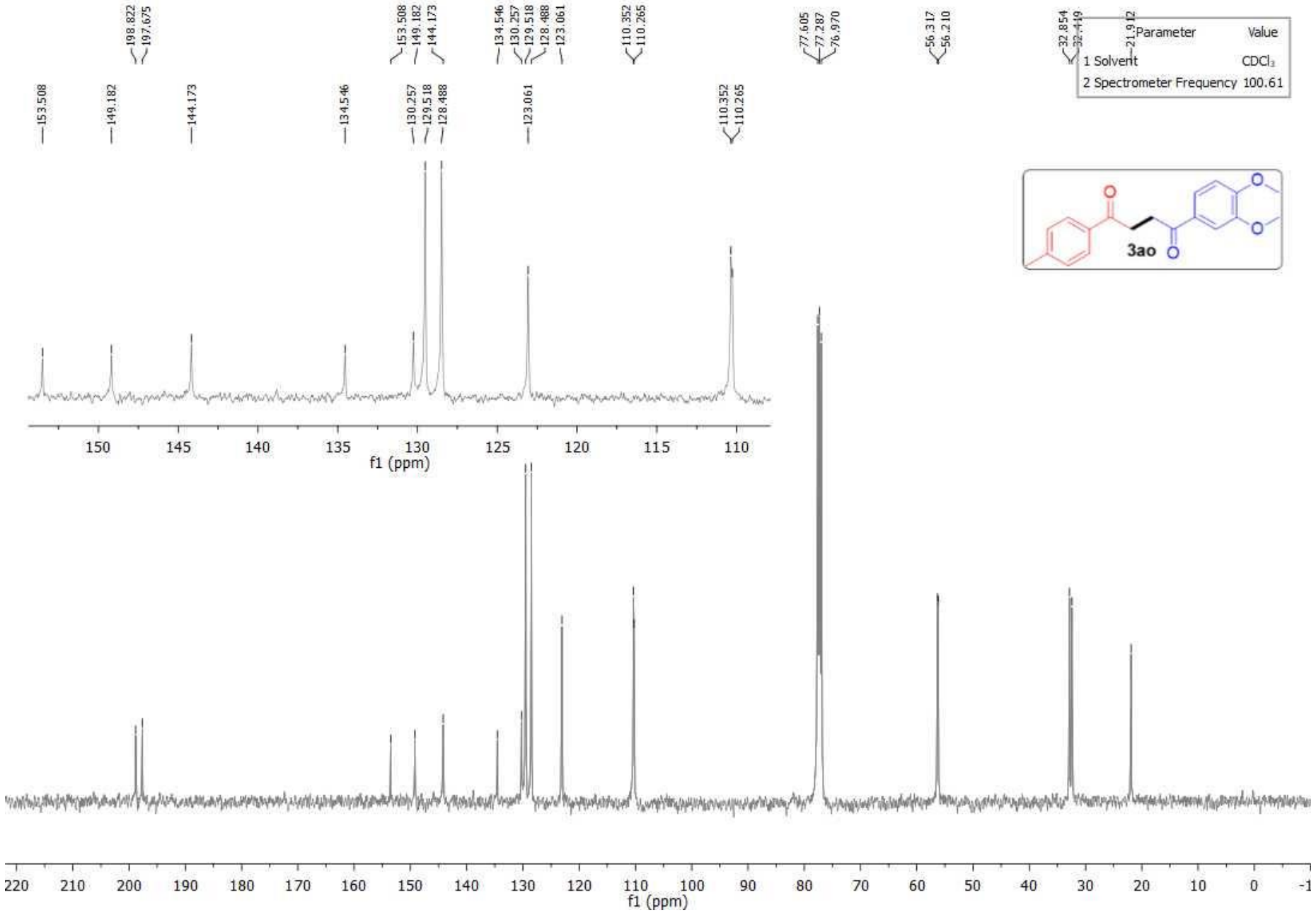

Figure S33. ^{13}C NMR spectrum of 1-(3,4-Dimethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ao**).

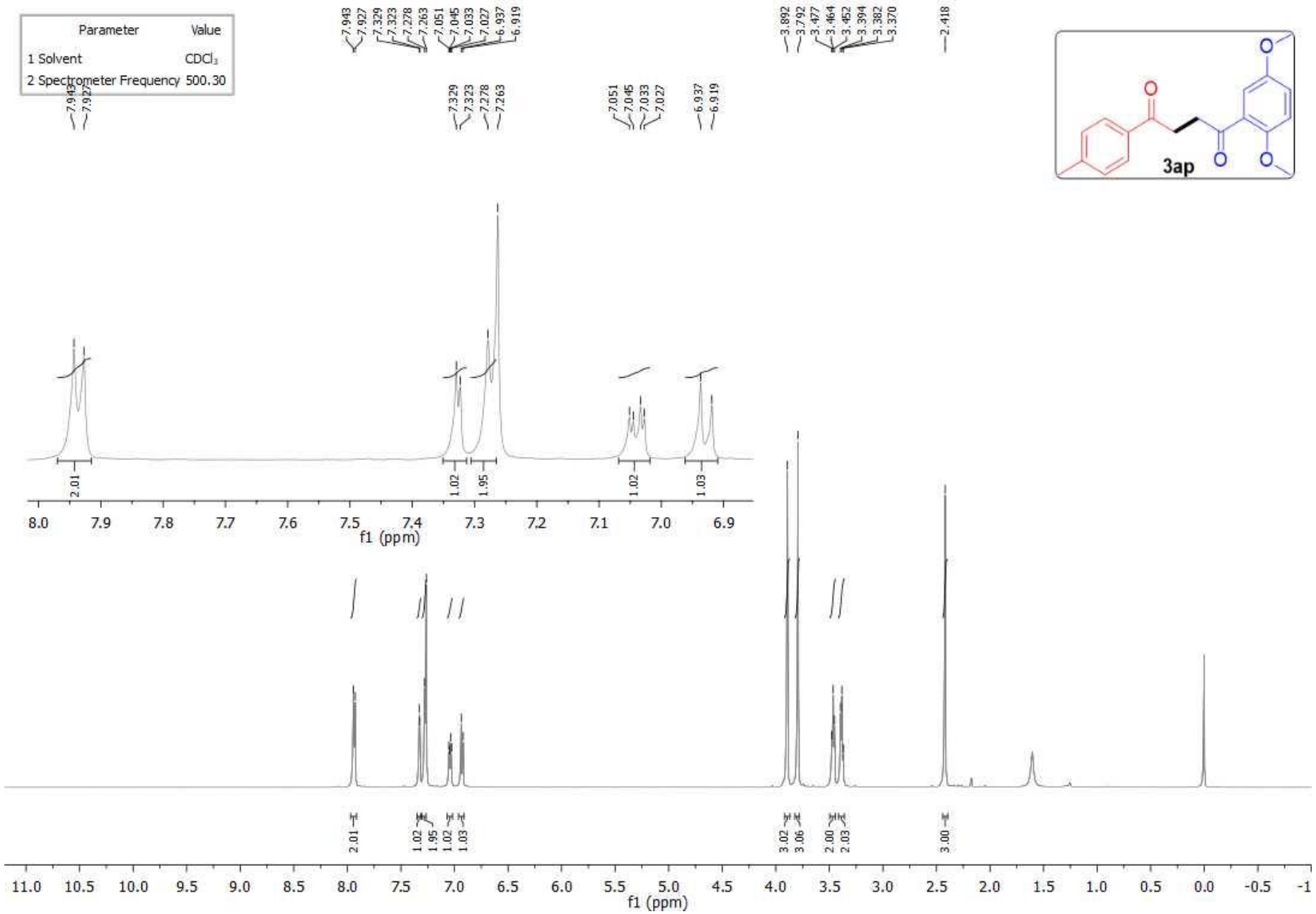

Figure S34. ^{1}H NMR spectrum of 1-(2,5-dimethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ap**).

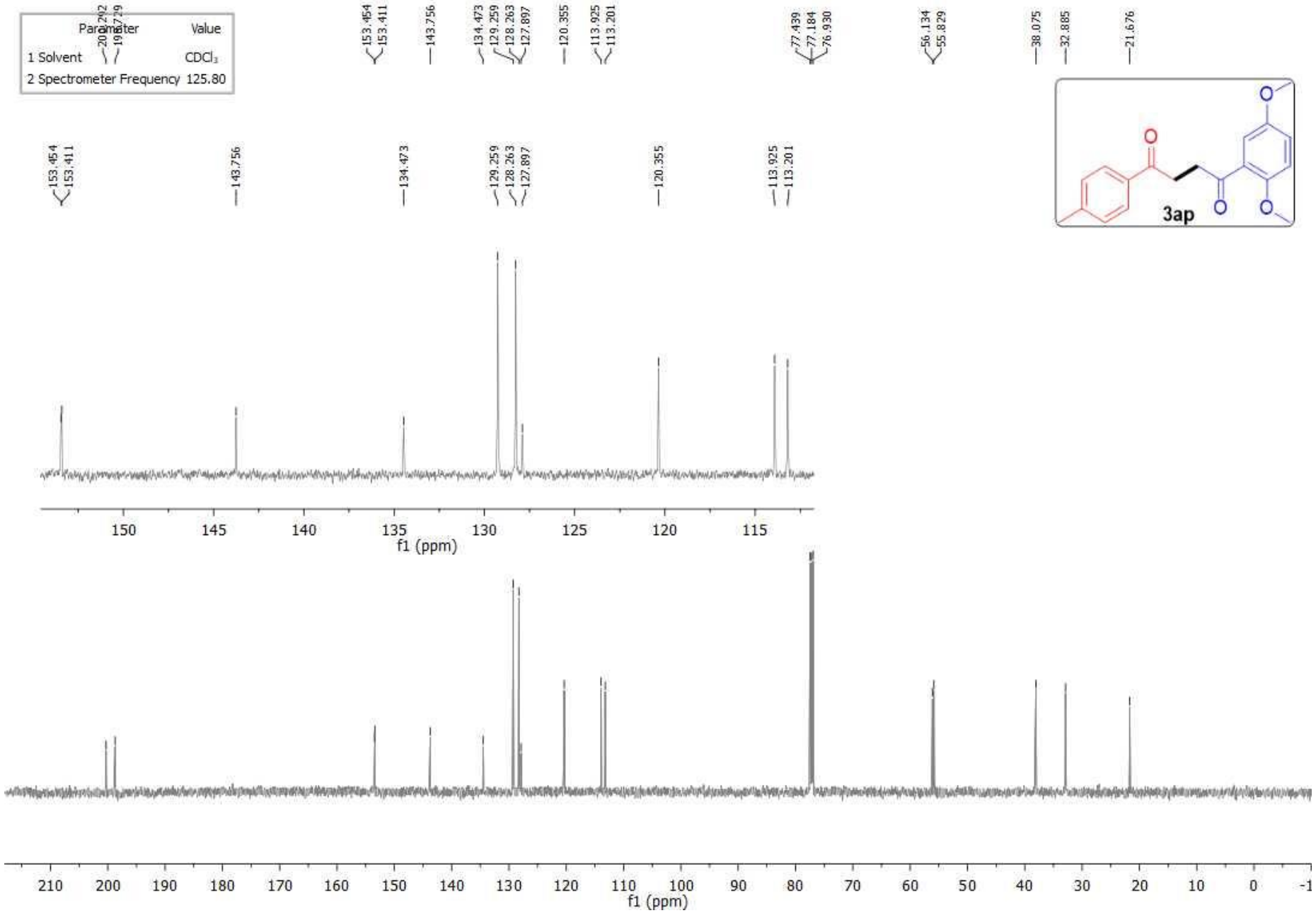

Figure S35. ^{13}C NMR spectrum of 1-(2,5-dimethoxyphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ap**).

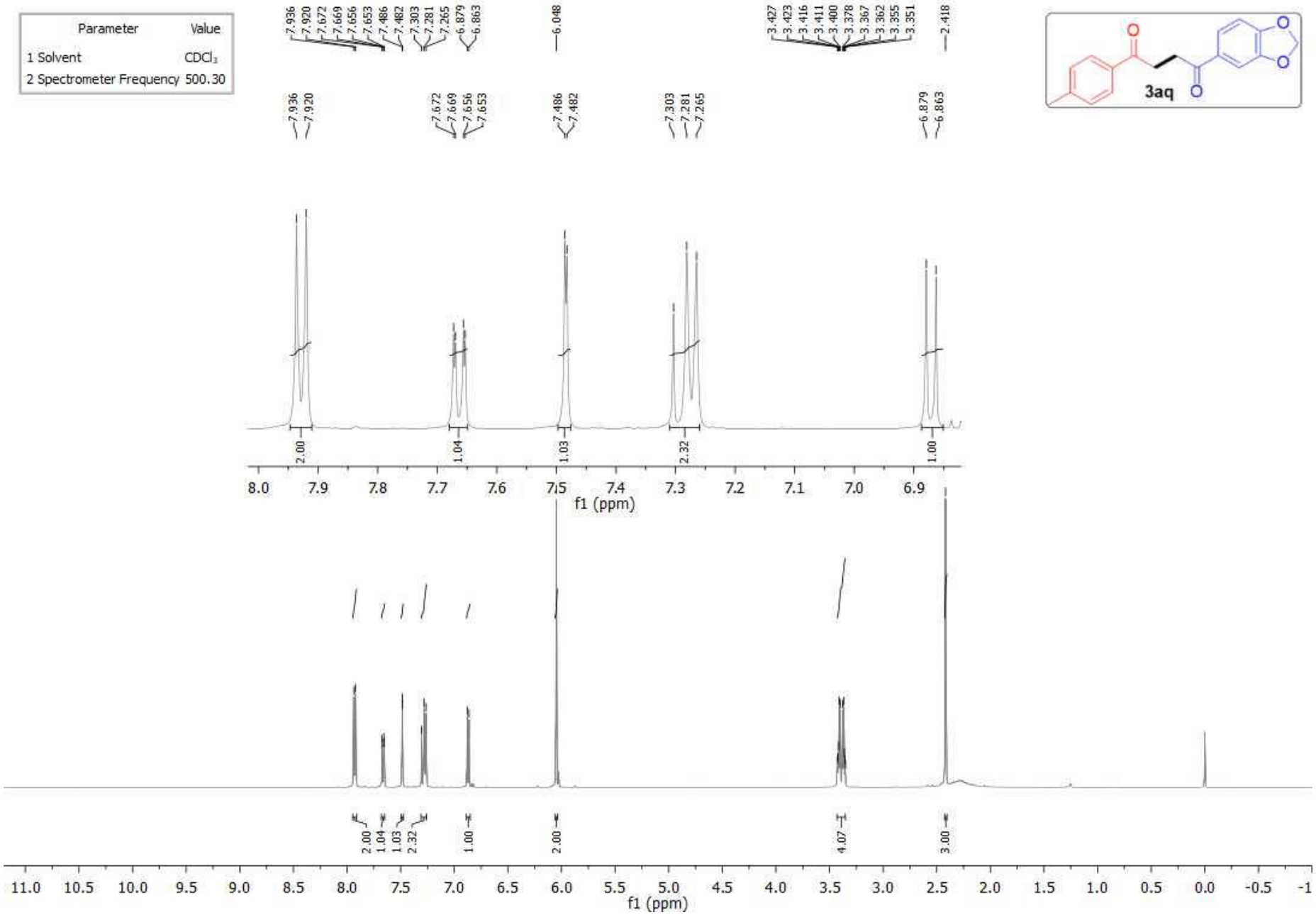

Figure S36. ^{1}H NMR spectrum of 1-(Benzo[*d*][1,3]dioxol-5-yl)-4-(p-tolyl)butane-1,4-dione (**3aq**).

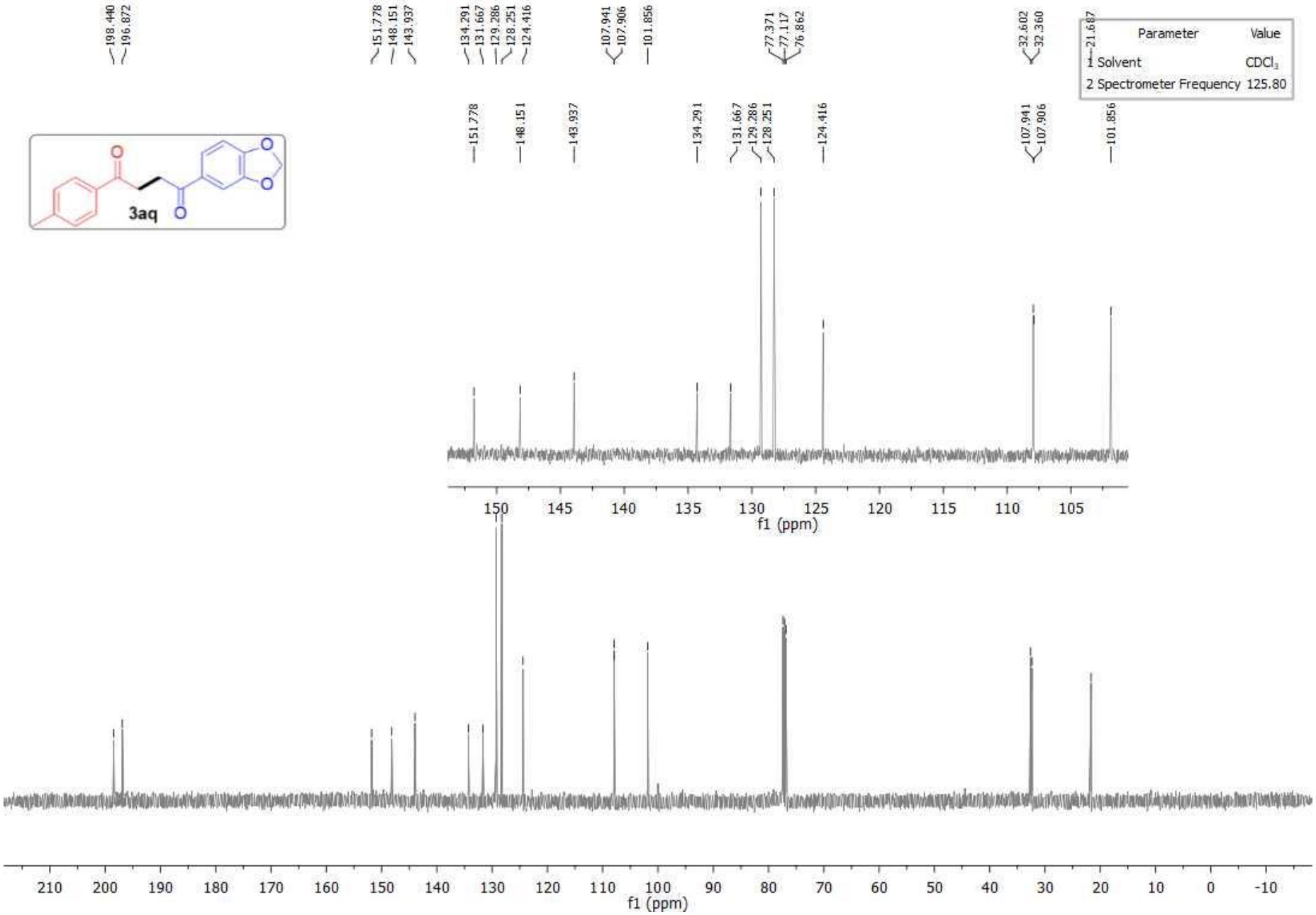

Figure S37. ^{13}C NMR spectrum of 1-(Benzo[*d*][1,3]dioxol-5-yl)-4-(p-tolyl)butane-1,4-dione (**3aq**).

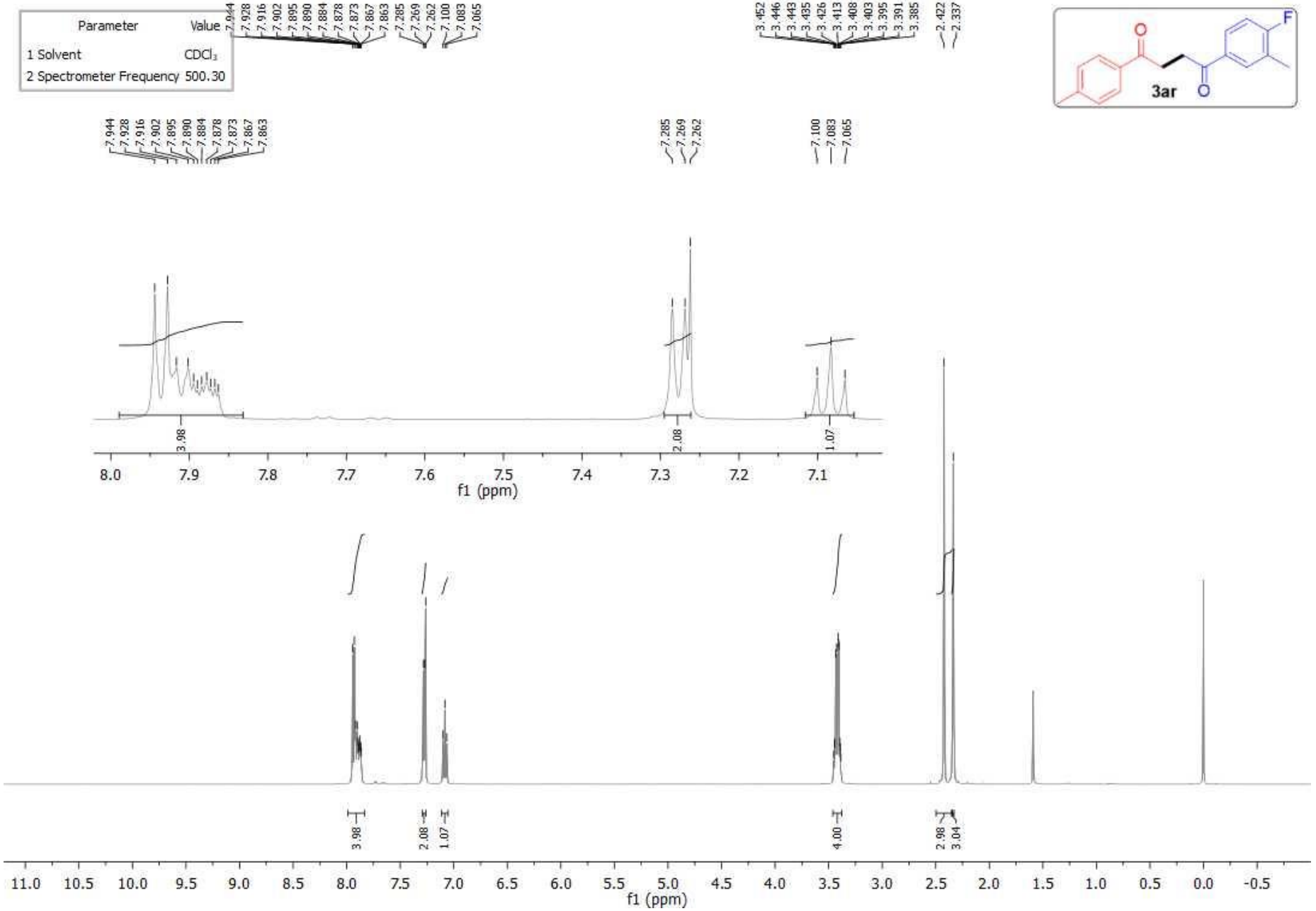

Figure S38. ^{1}H NMR spectrum of 1-(4-Fluoro-3-methylphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ar**).

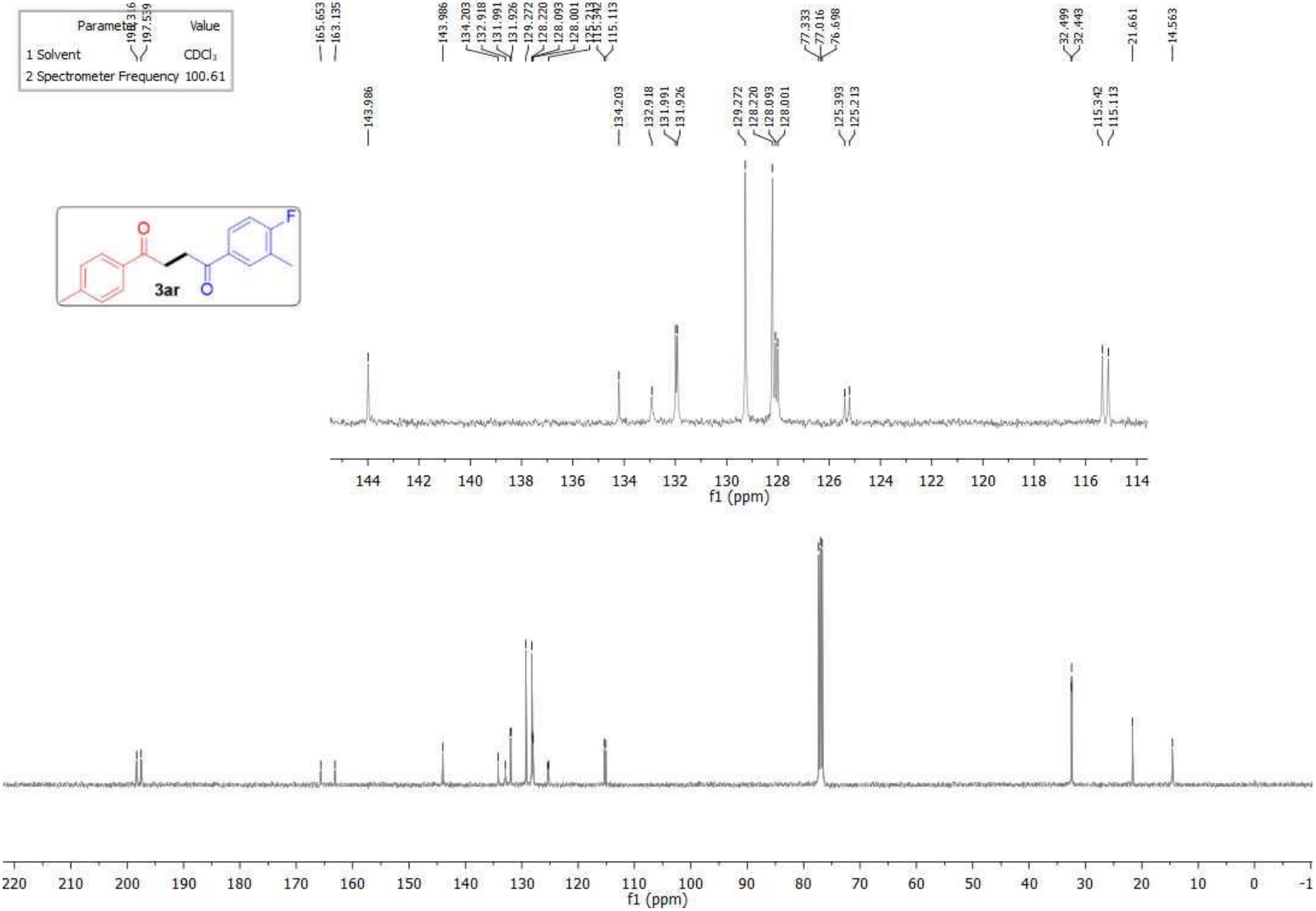

Figure S39. ^{13}C NMR spectrum of 1-(4-Fluoro-3-methylphenyl)-4-(*p*-tolyl)butane-1,4-dione (**3ar**).

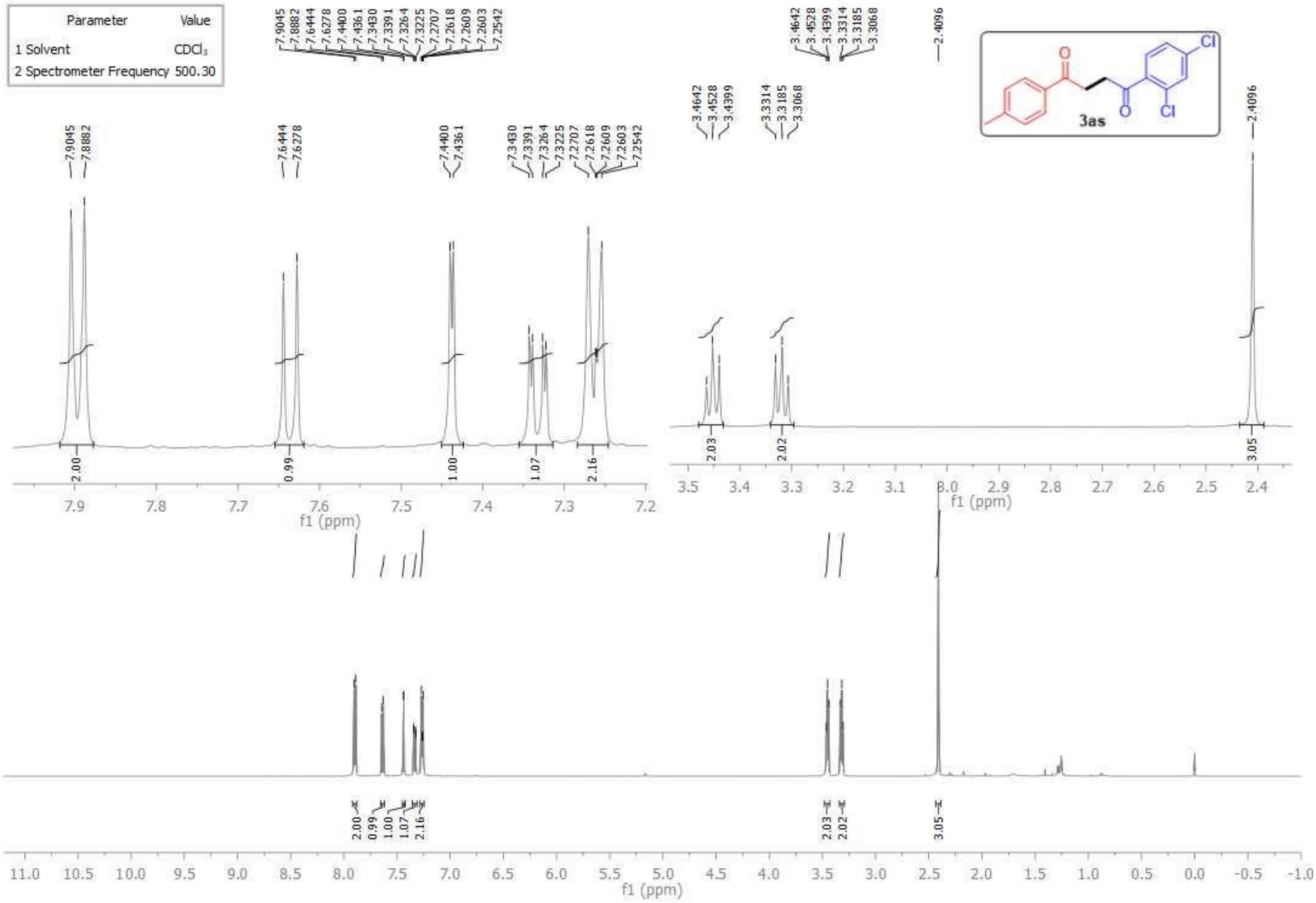

Figure S40. ^{1}H NMR spectrum of 1-(2,4-Dichlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3as**).

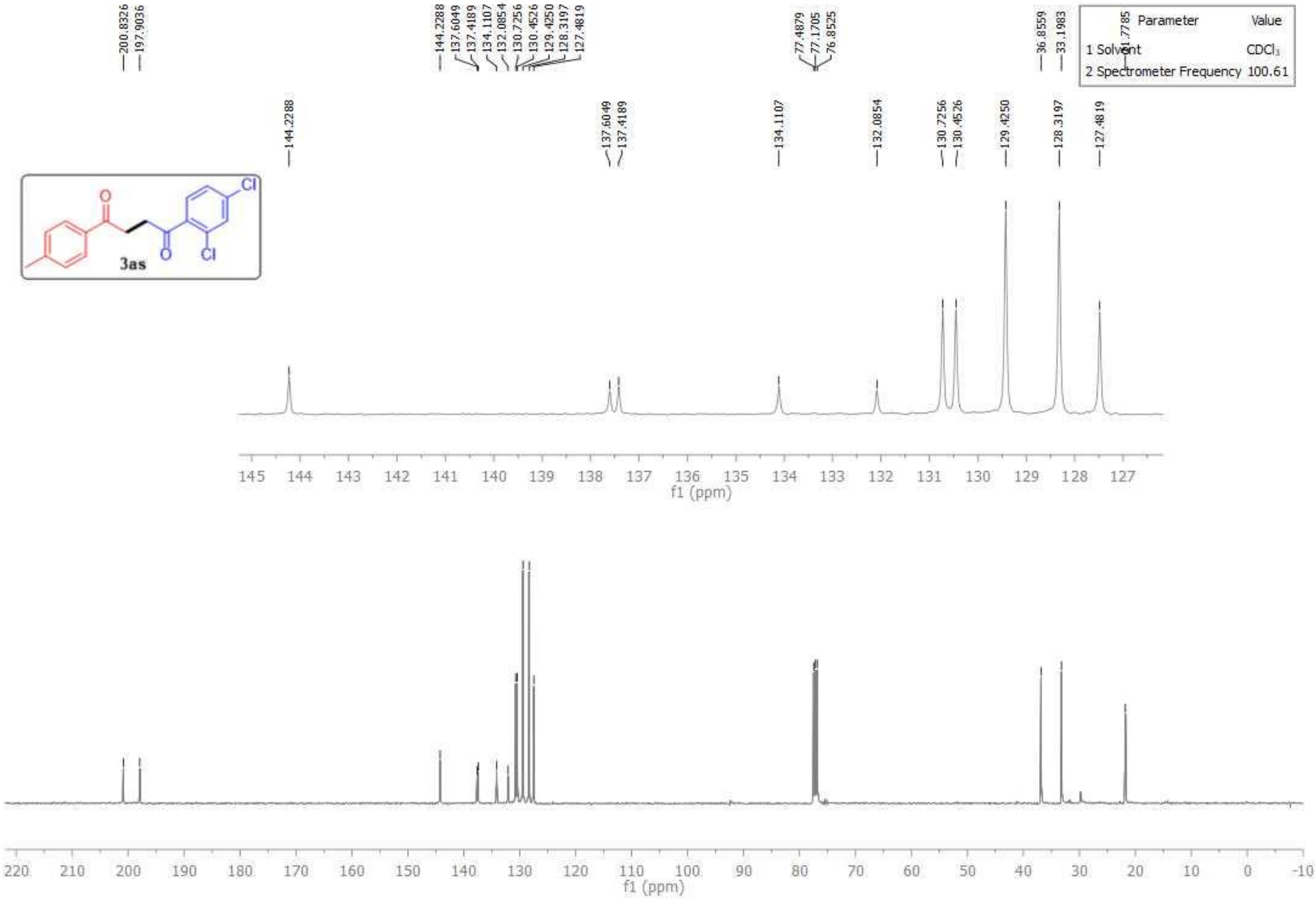

Figure S41. ^{13}C NMR spectrum of 1-(2,4-Dichlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3as**).

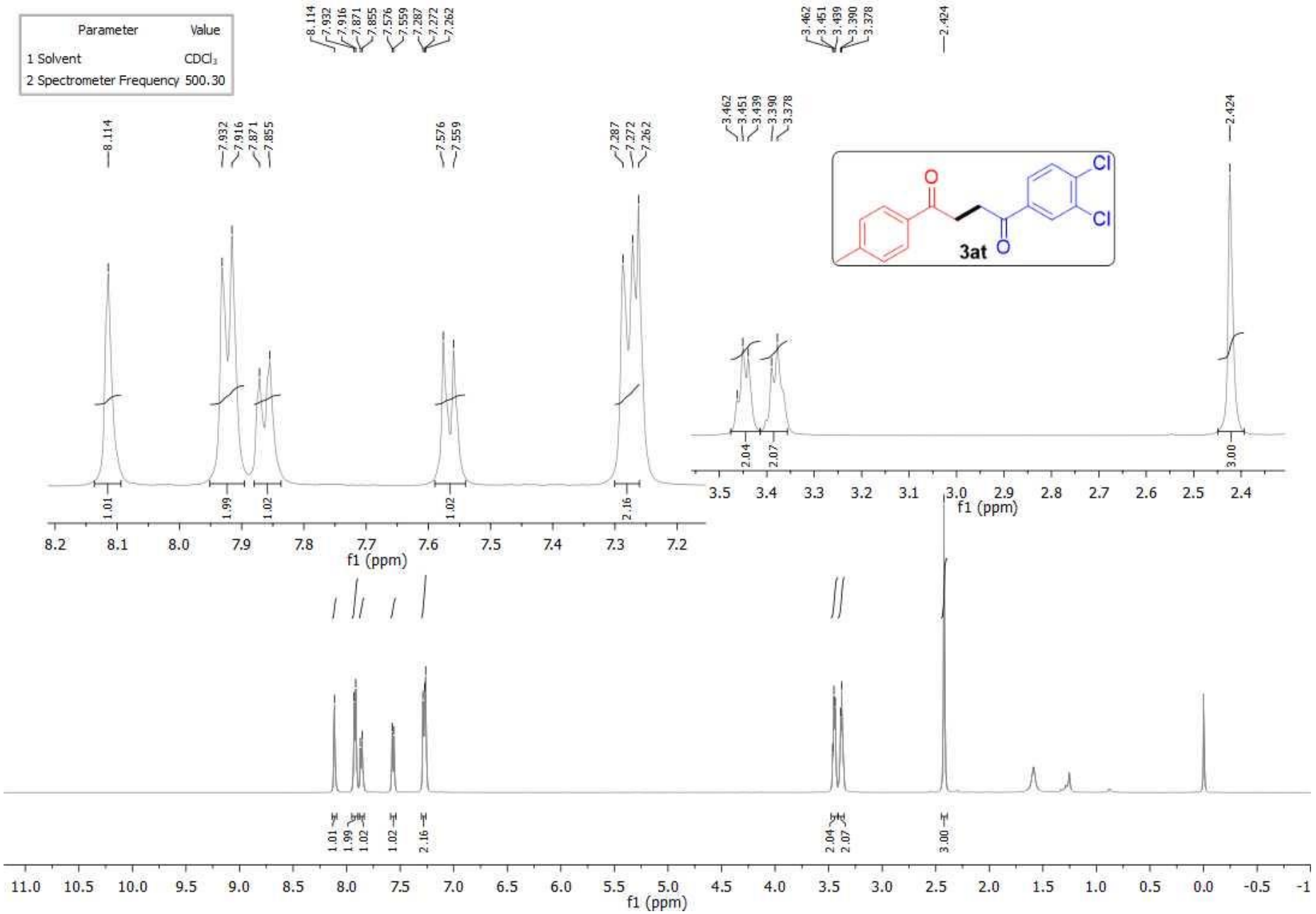

Figure S42. ^{1}H NMR spectrum of 1-(3,4-Dichlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3at**).

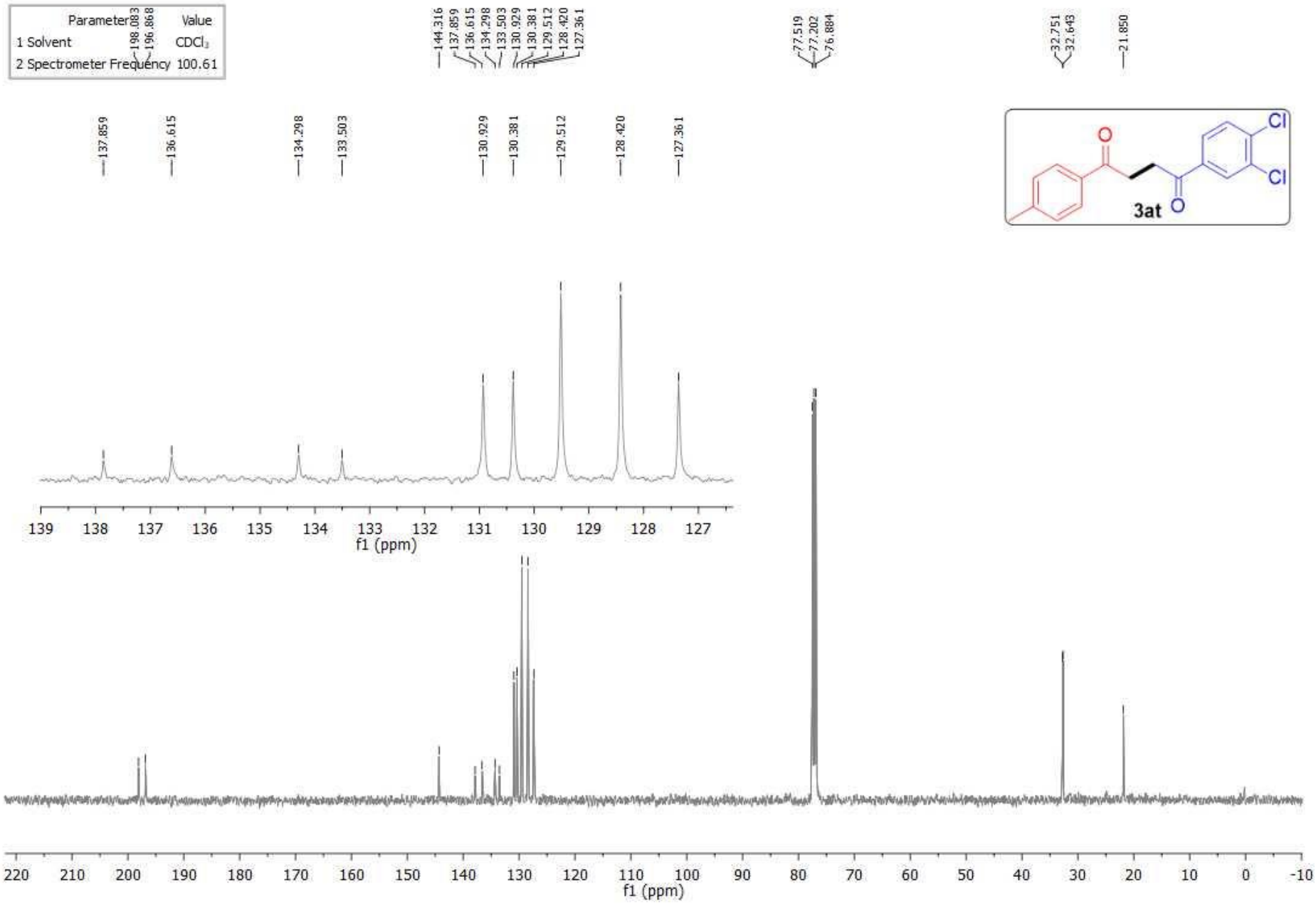

Figure S43. ^{13}C NMR spectrum of 1-(3,4-Dichlorophenyl)-4-(*p*-tolyl)butane-1,4-dione (**3at**).

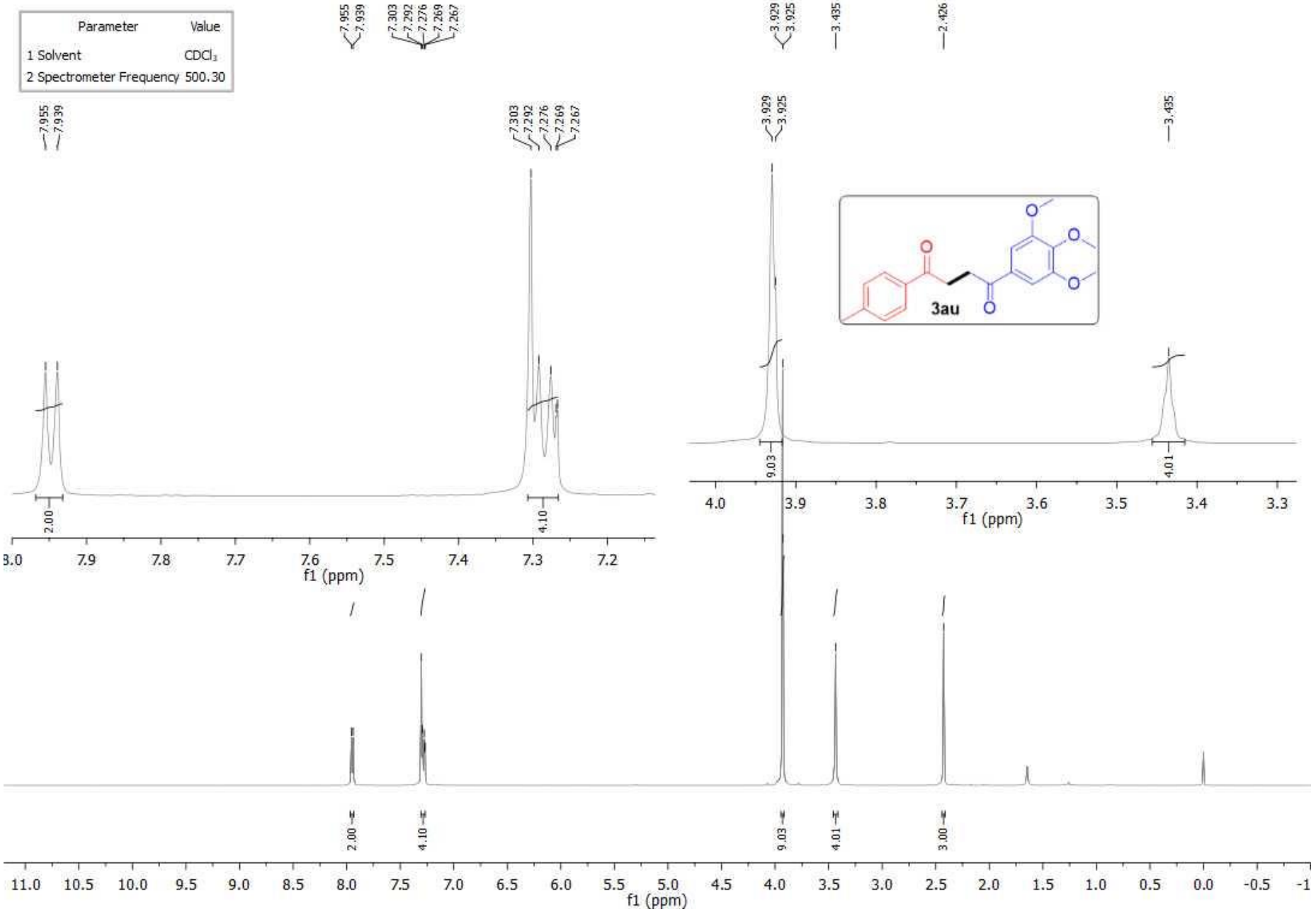

Figure S44. ^{1}H NMR spectrum of 1-(*p*-Tolyl)-4-(3,4,5-trimethoxyphenyl)butane-1,4-dione (**3au**).

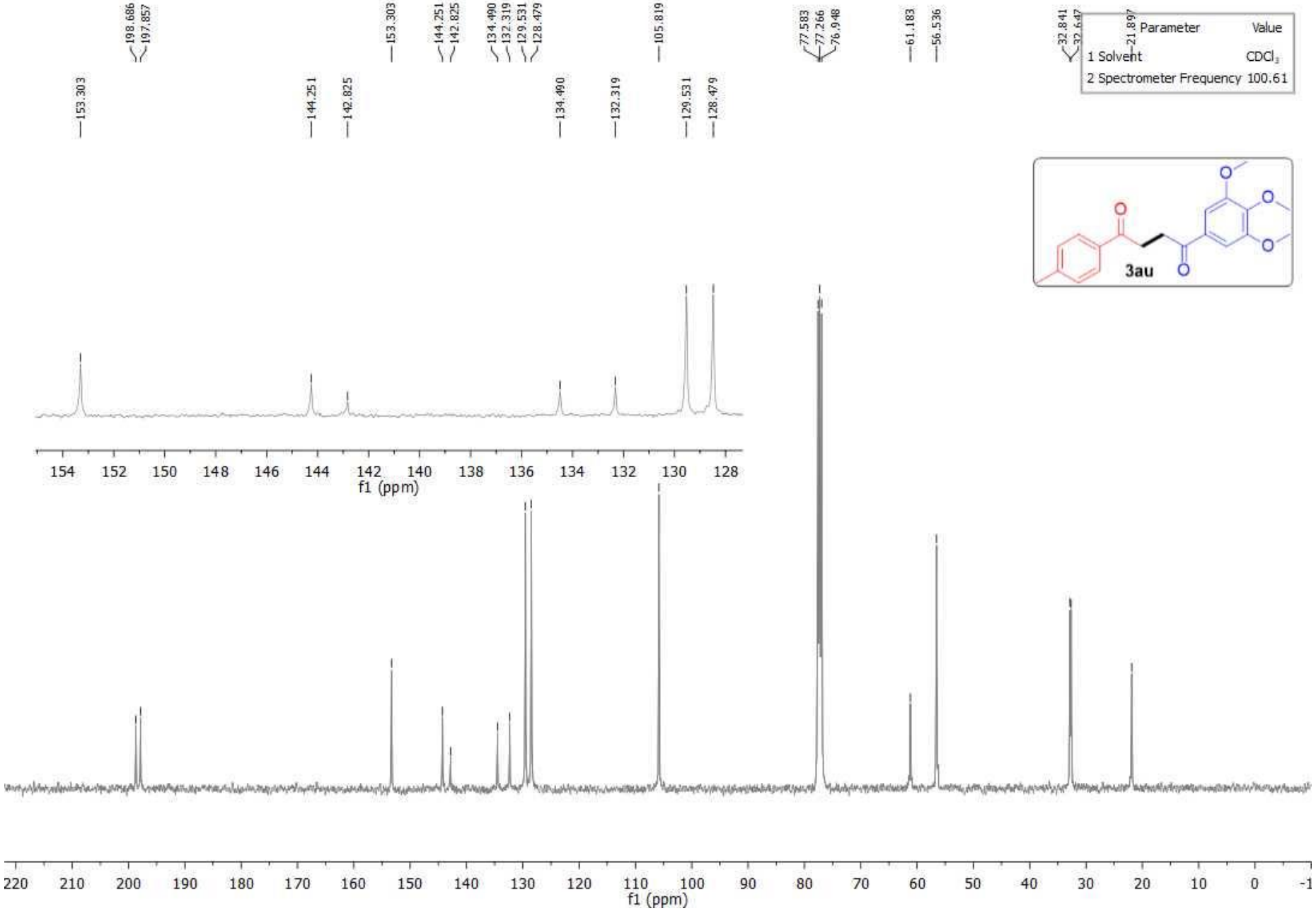

Figure S45. ^{13}C NMR spectrum of 1-(*p*-Tolyl)-4-(3,4,5-trimethoxyphenyl)butane-1,4-dione (**3au**).

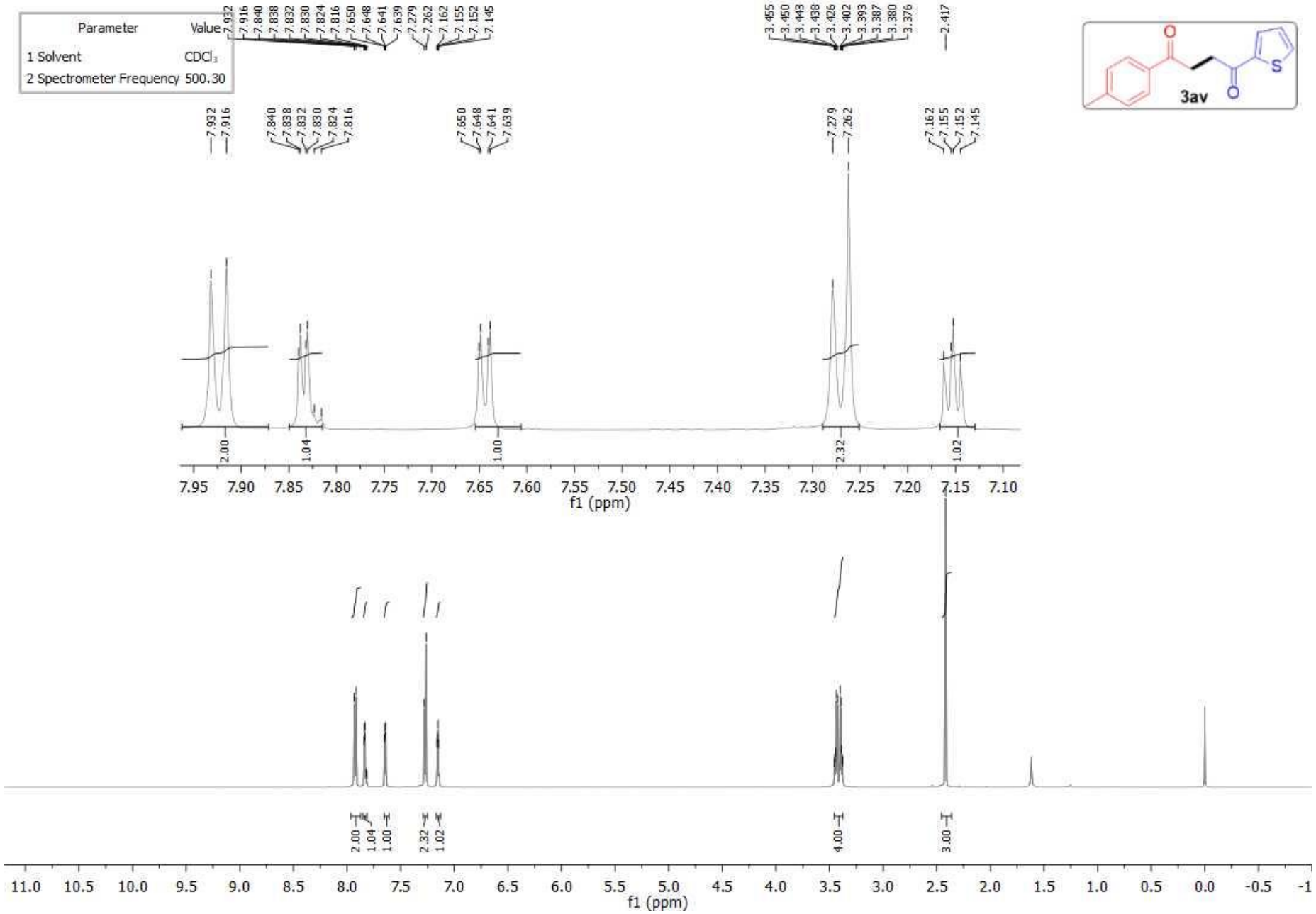

Figure S46. ^{1}H NMR spectrum of 1-(Thiophen-2-yl)-4-(*p*-tolyl)butane-1,4-dione (**3av**).

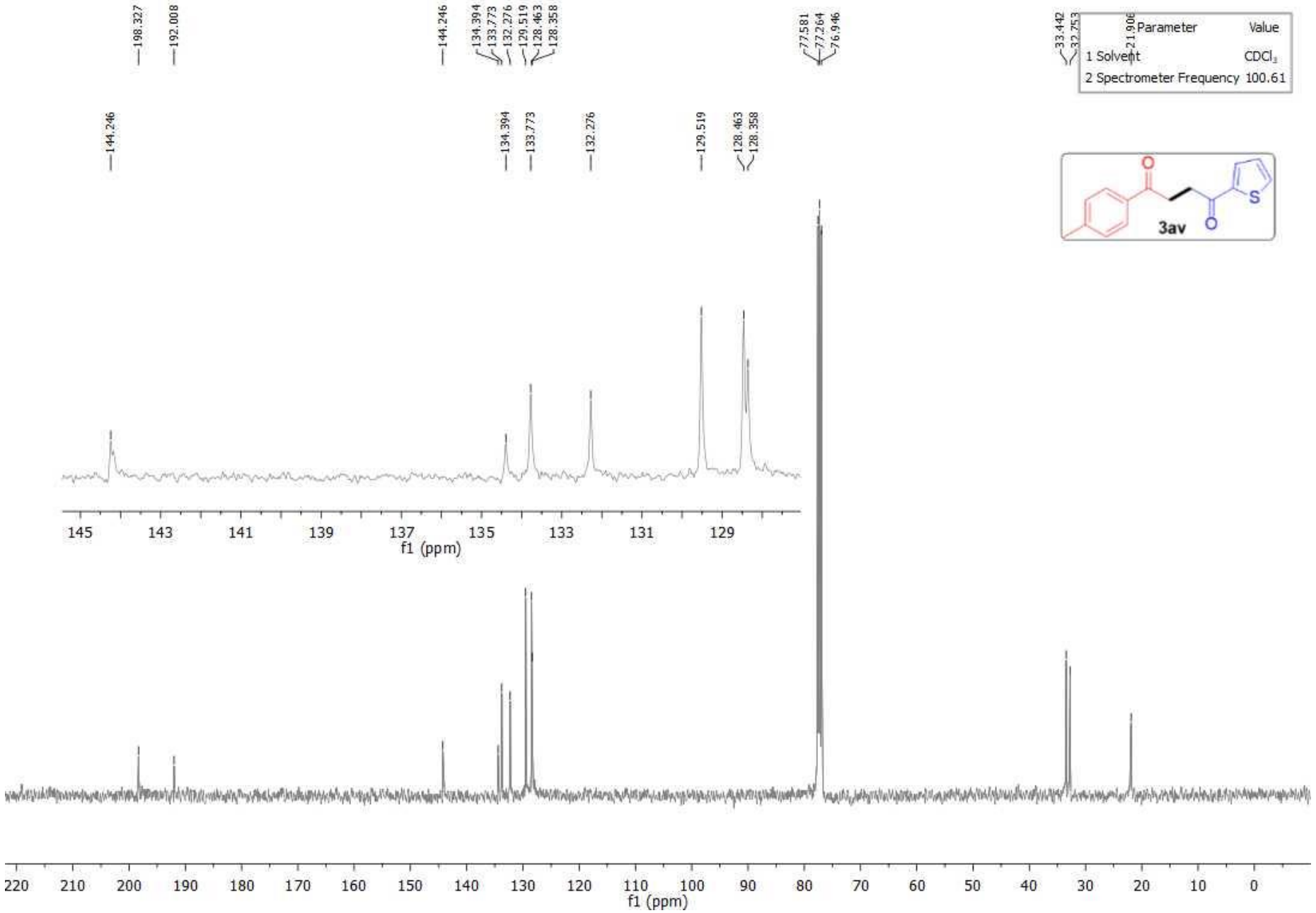

Figure S47. ^{13}C NMR spectrum of 1-(Thiophen-2-yl)-4-(*p*-tolyl)butane-1,4-dione (**3av**).

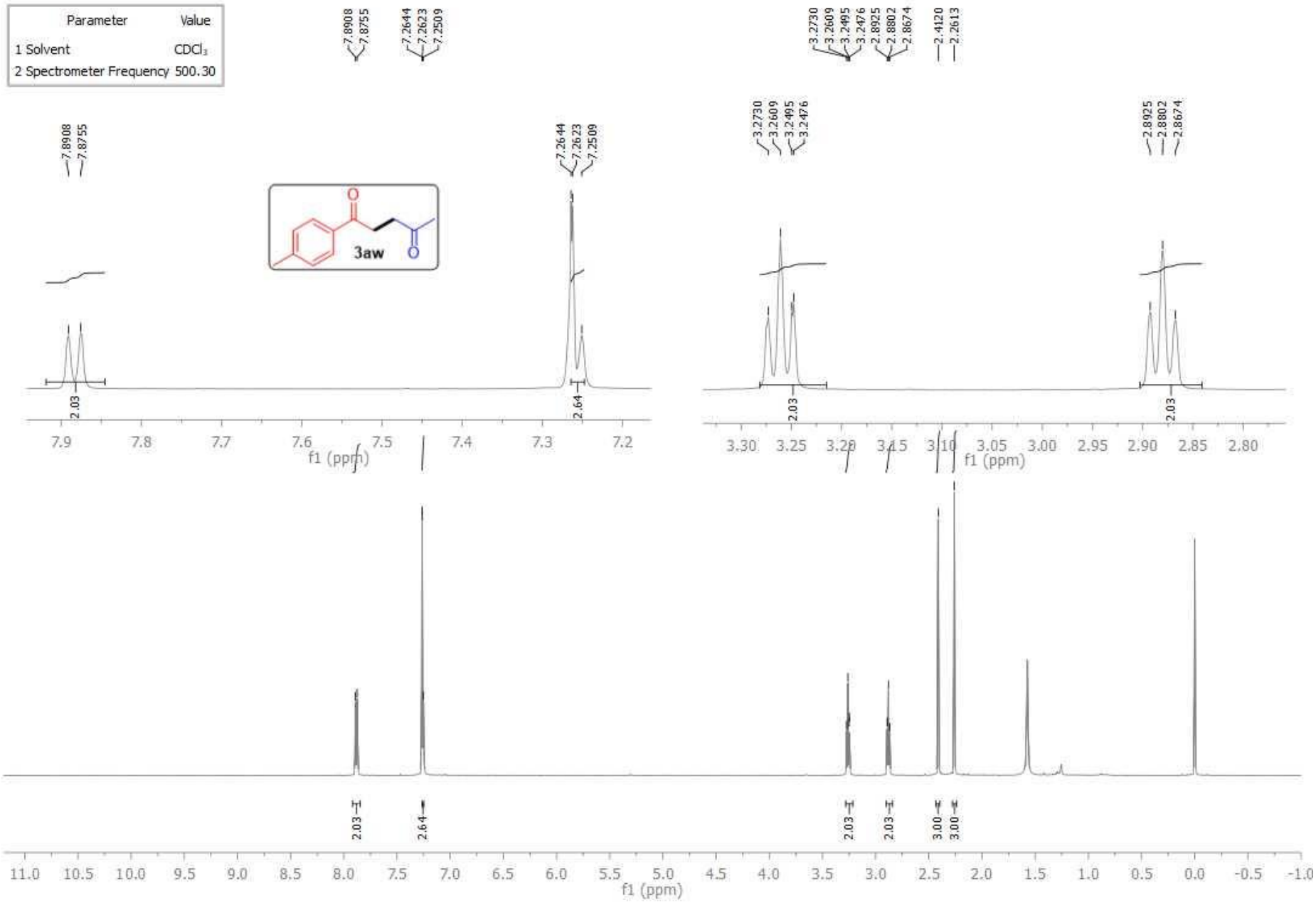

Figure S48. ^{1}H NMR spectrum of 1-(*p*-Tolyl)pentane-1,4-dione (**3aw**).

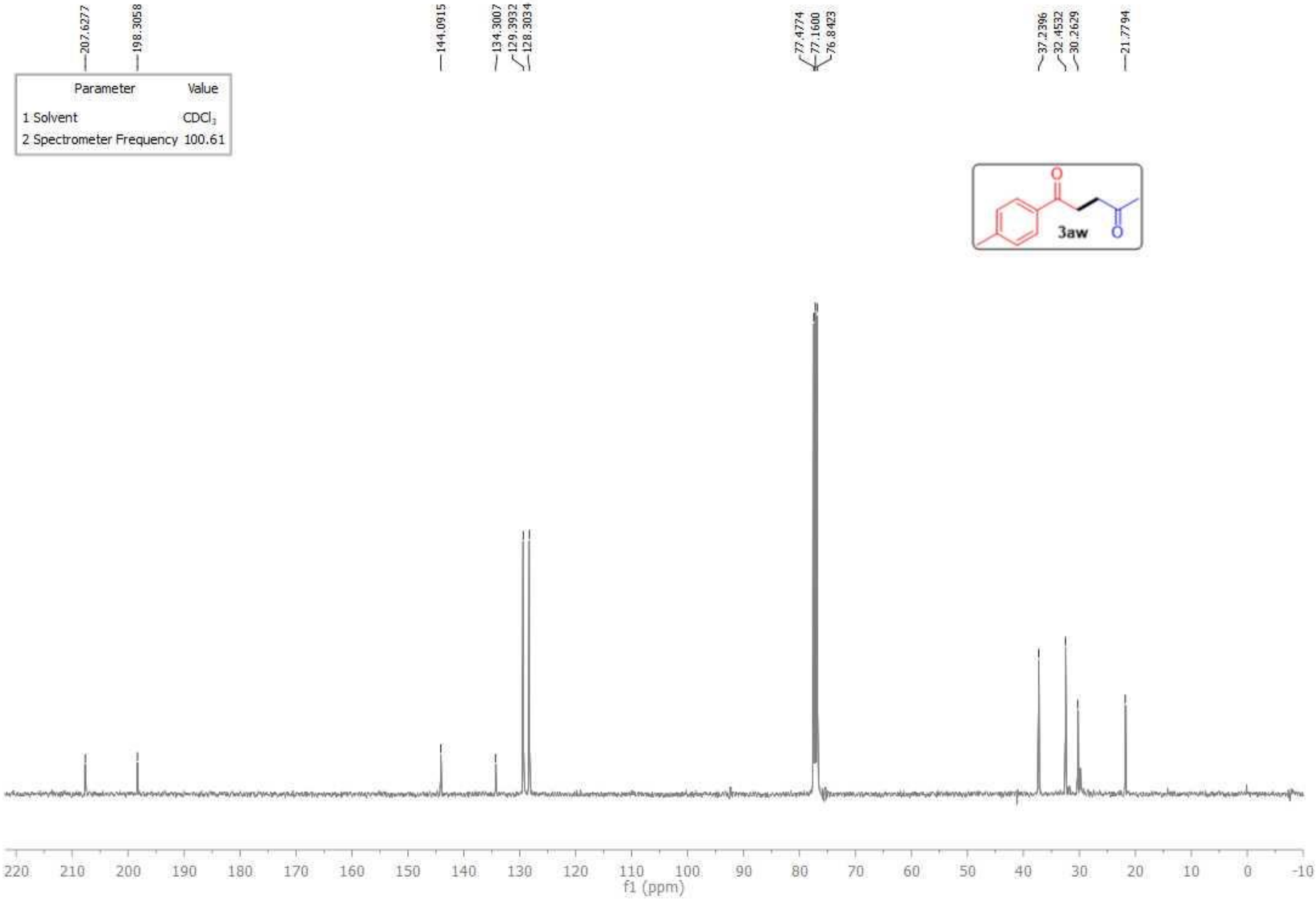

Figure S49. ^{13}C NMR spectrum of 1-(*p*-Tolyl)pentane-1,4-dione (**3aw**).

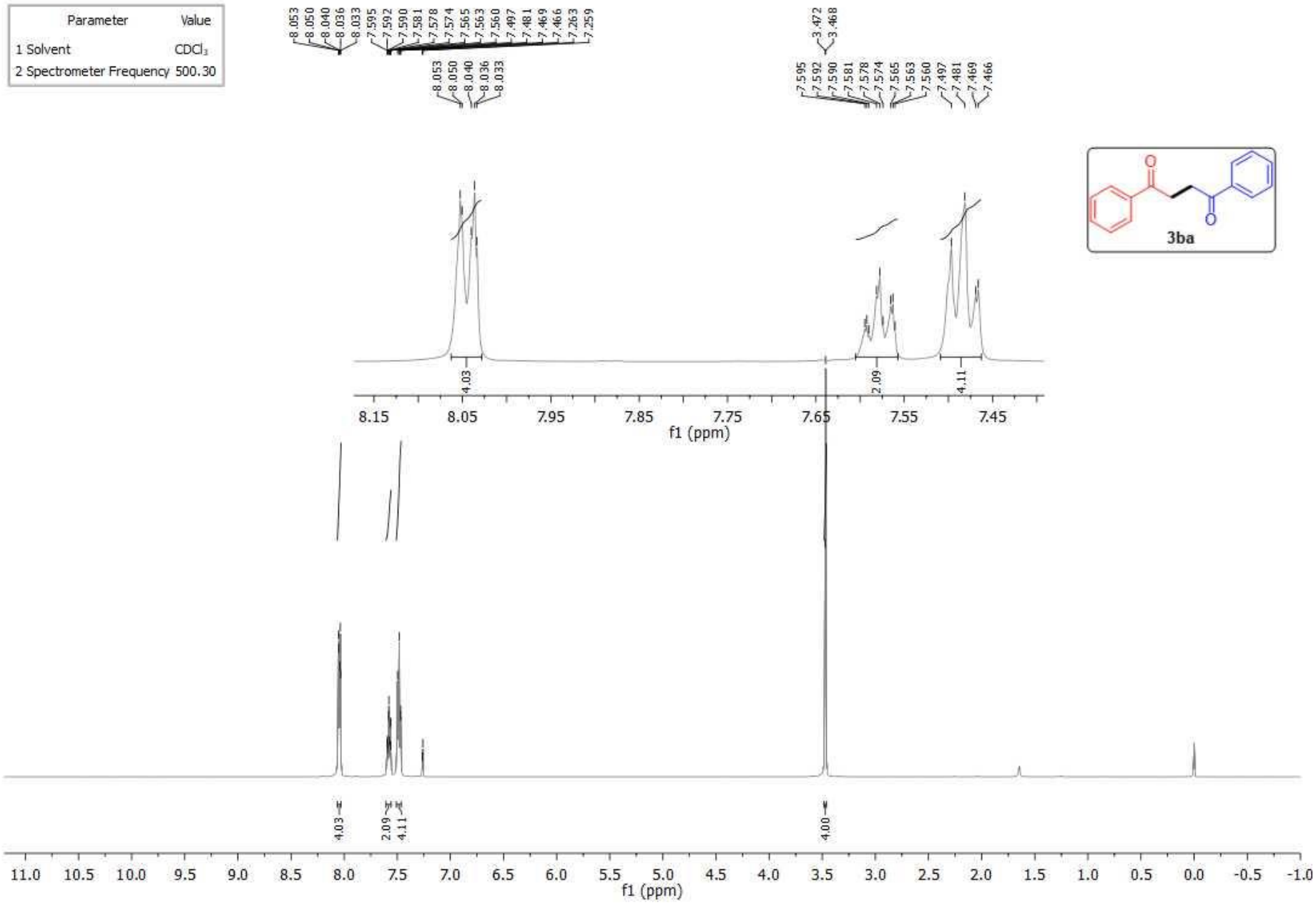

Figure S50. ^{1}H NMR spectrum of 1,4-Diphenylbutane-1,4-dione (**3ba**).

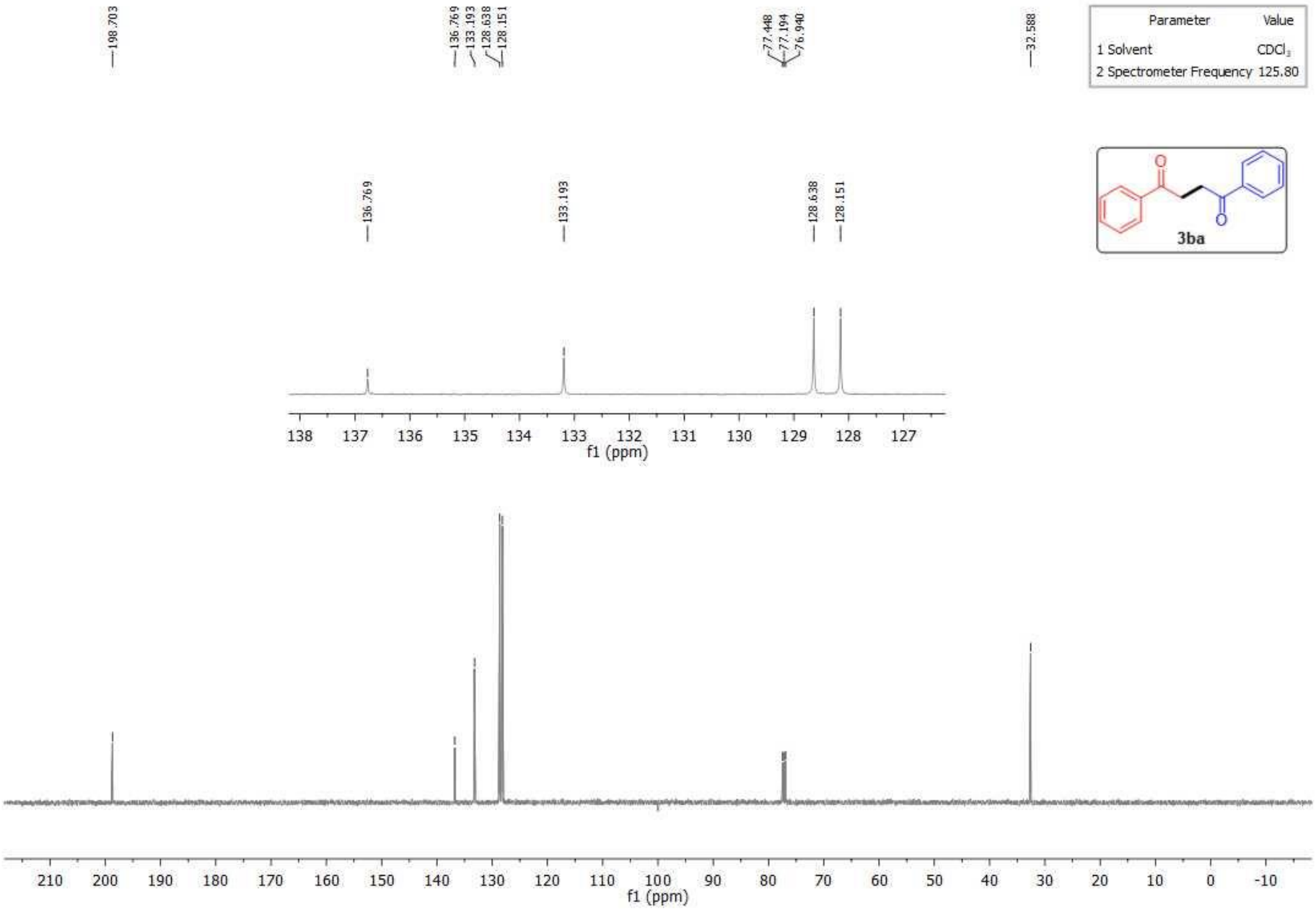

Figure S51. ^{13}C NMR spectrum of 1,4-Diphenylbutane-1,4-dione (**3ba**).

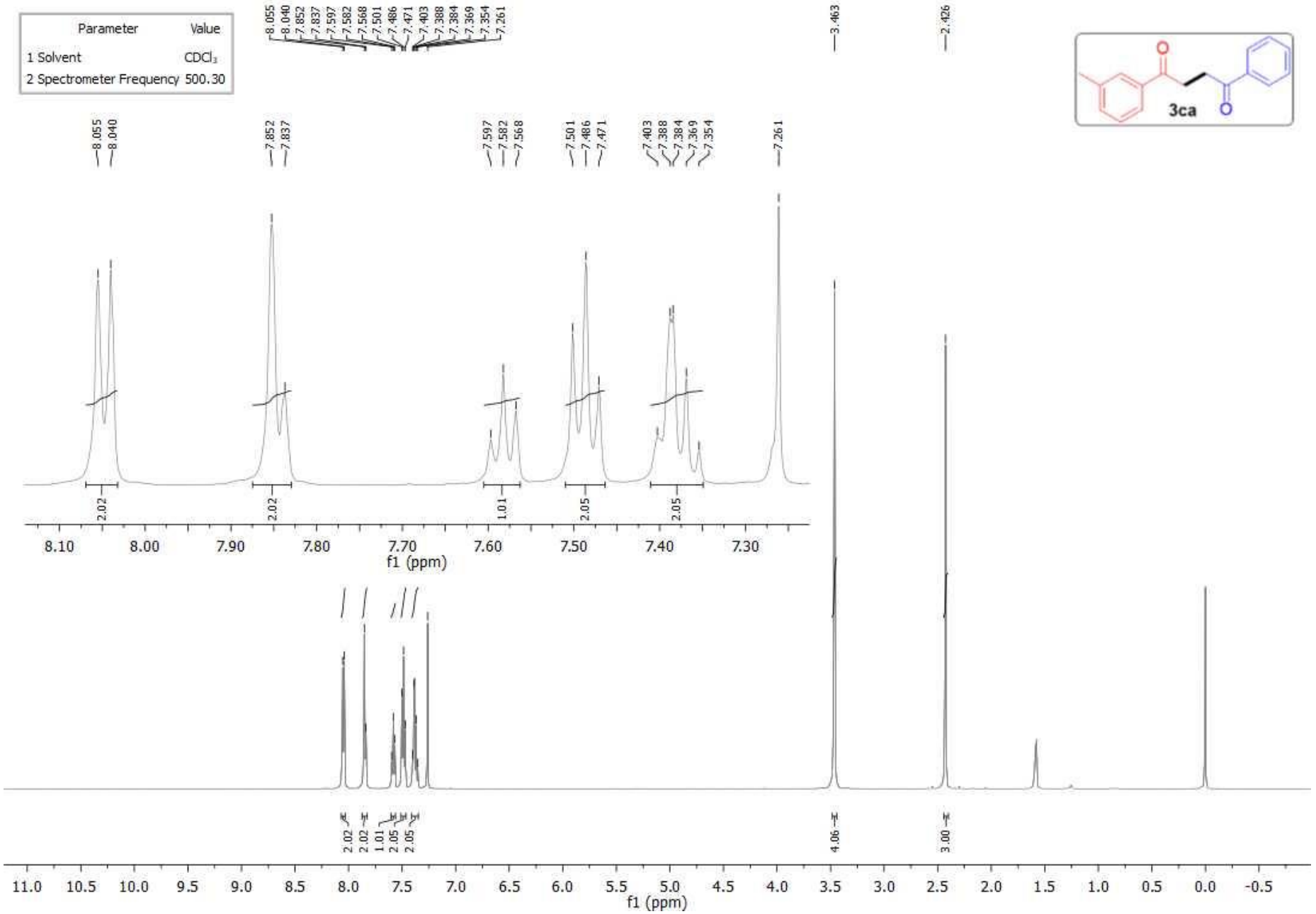

Figure S52. ^{1}H NMR spectrum of 1-Phenyl-4-(*m*-tolyl)butane-1,4-dione (**3ca**).

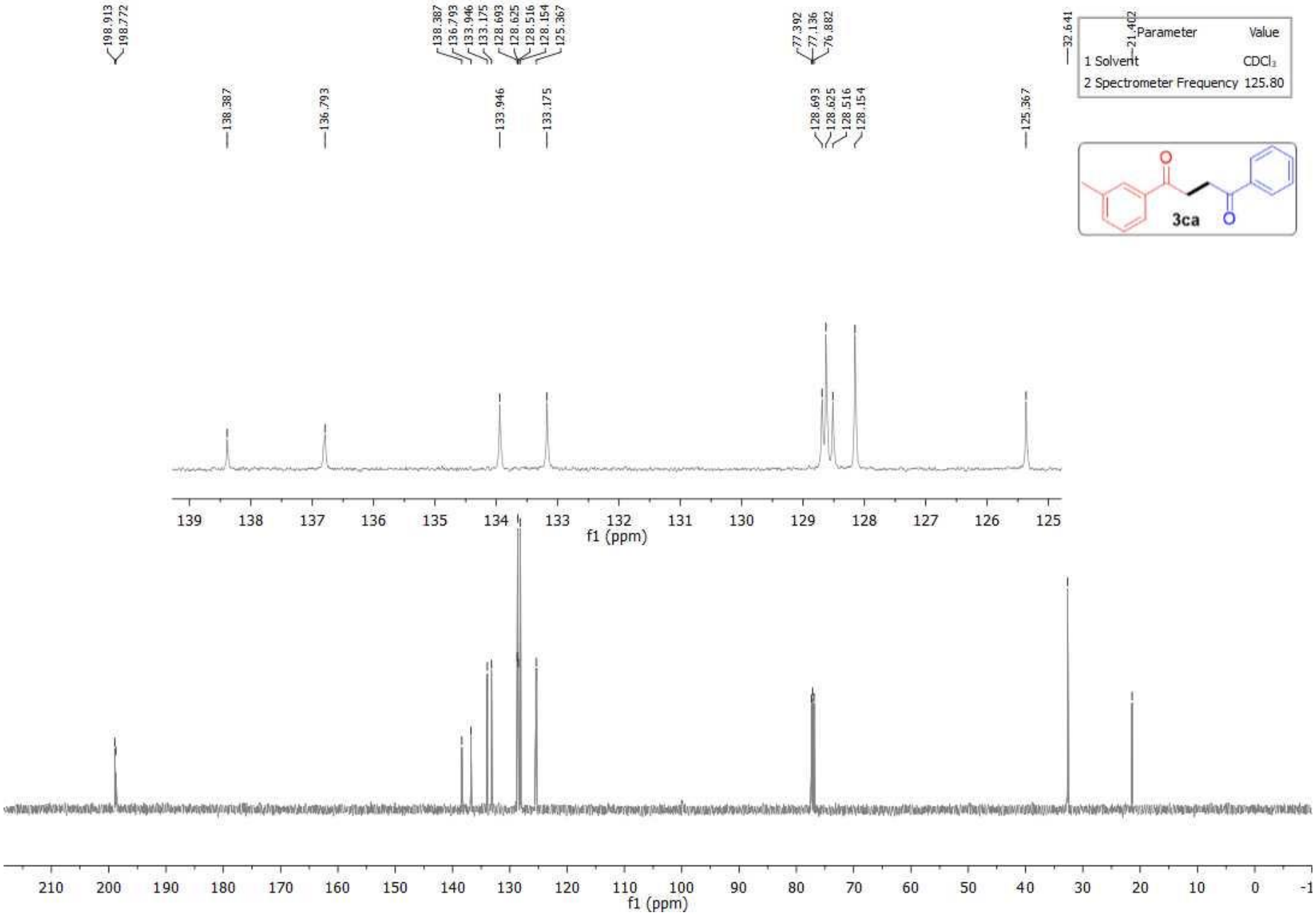

Figure S53. ^{13}C NMR spectrum of 1-Phenyl-4-(*m*-tolyl)butane-1,4-dione (**3ca**).

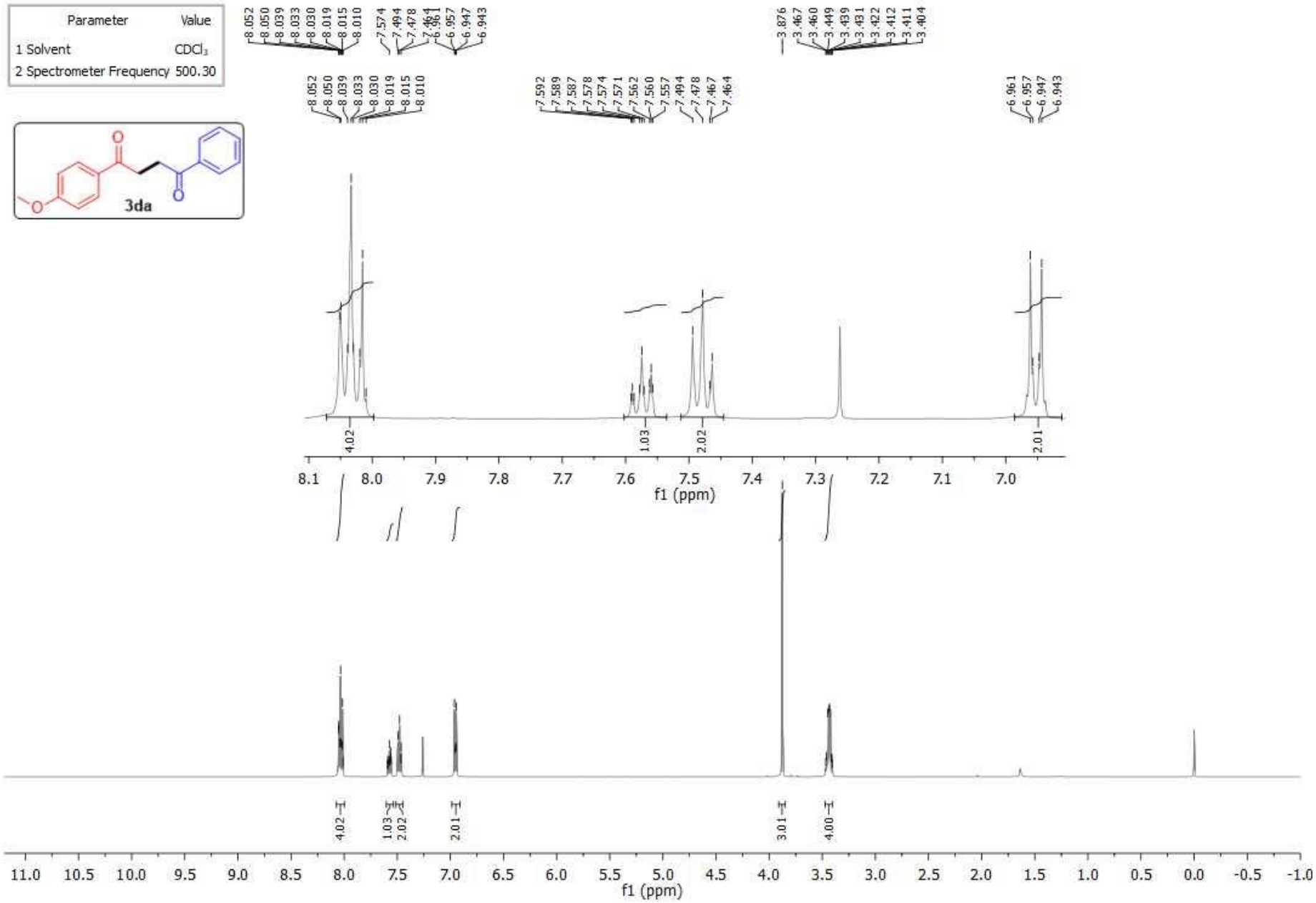

Figure S54. ^{1}H NMR spectrum of 1-(4-Methoxyphenyl)-4-phenylbutane-1,4-dione (**3da**).

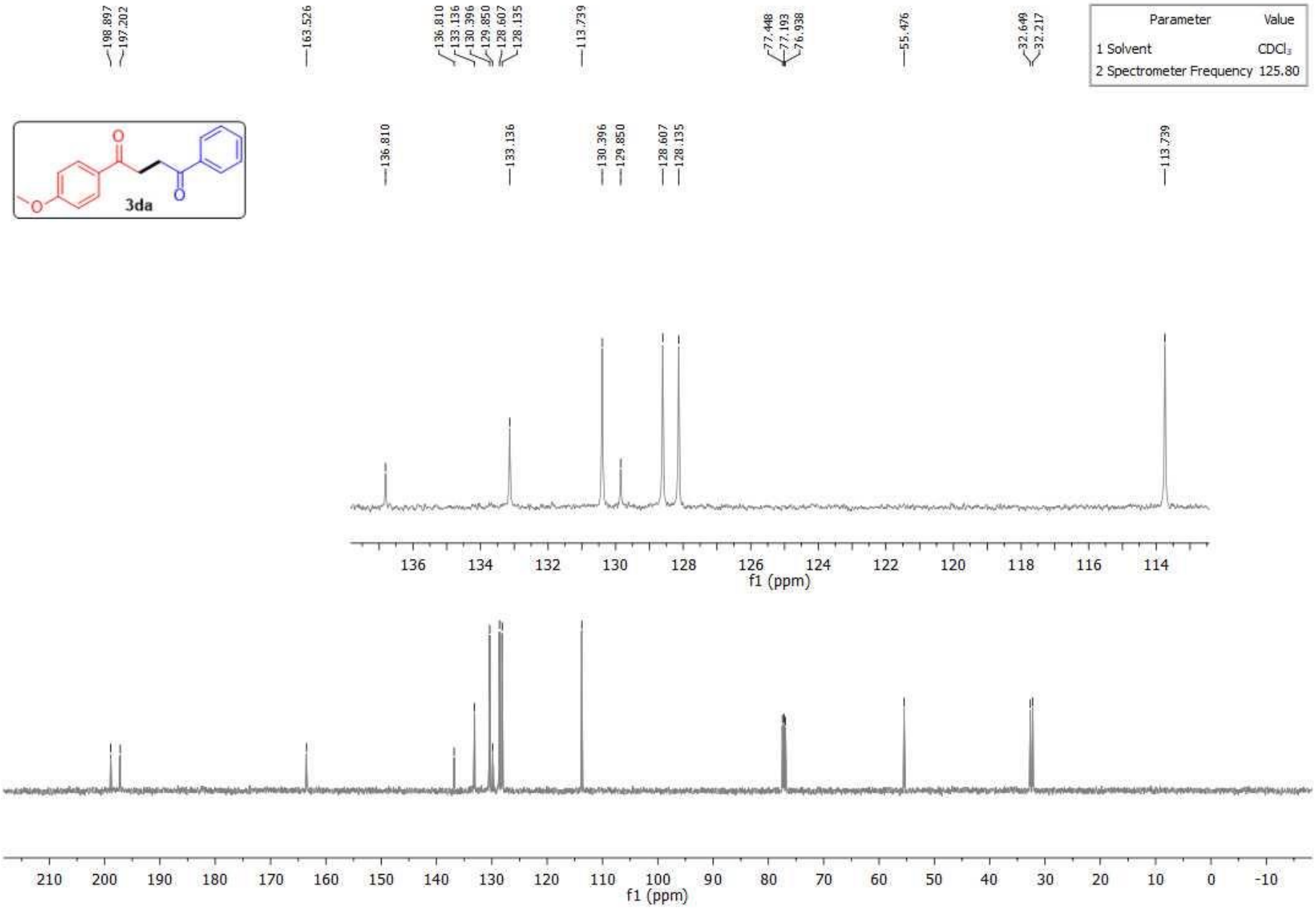

Figure S55. ^{13}C NMR spectrum of 1-(4-Methoxyphenyl)-4-phenylbutane-1,4-dione (**3da**).

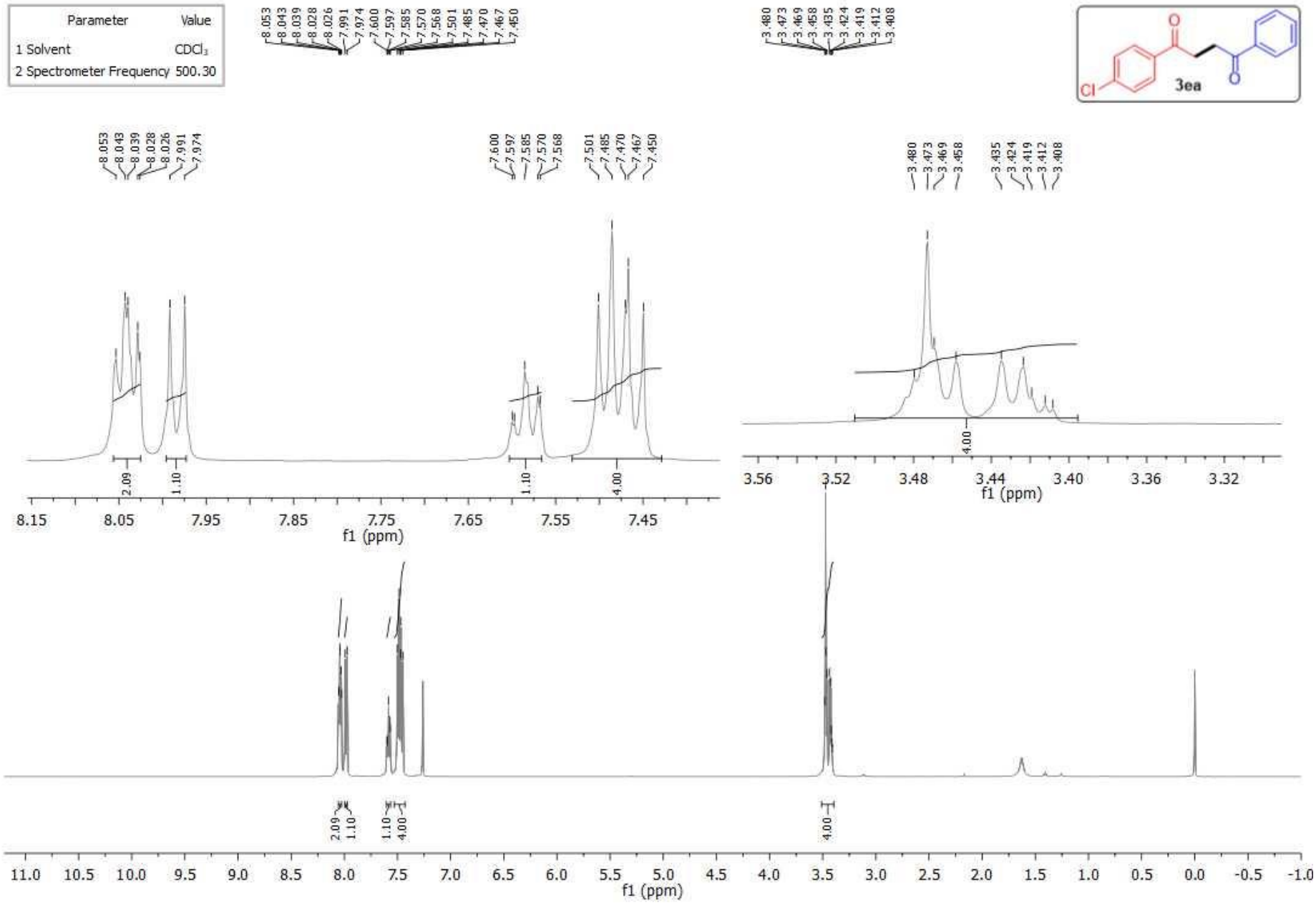

Figure S56. ^{1}H NMR spectrum of 1-(4-Chlorophenyl)-4-phenylbutane-1,4-dione (**3ea**).

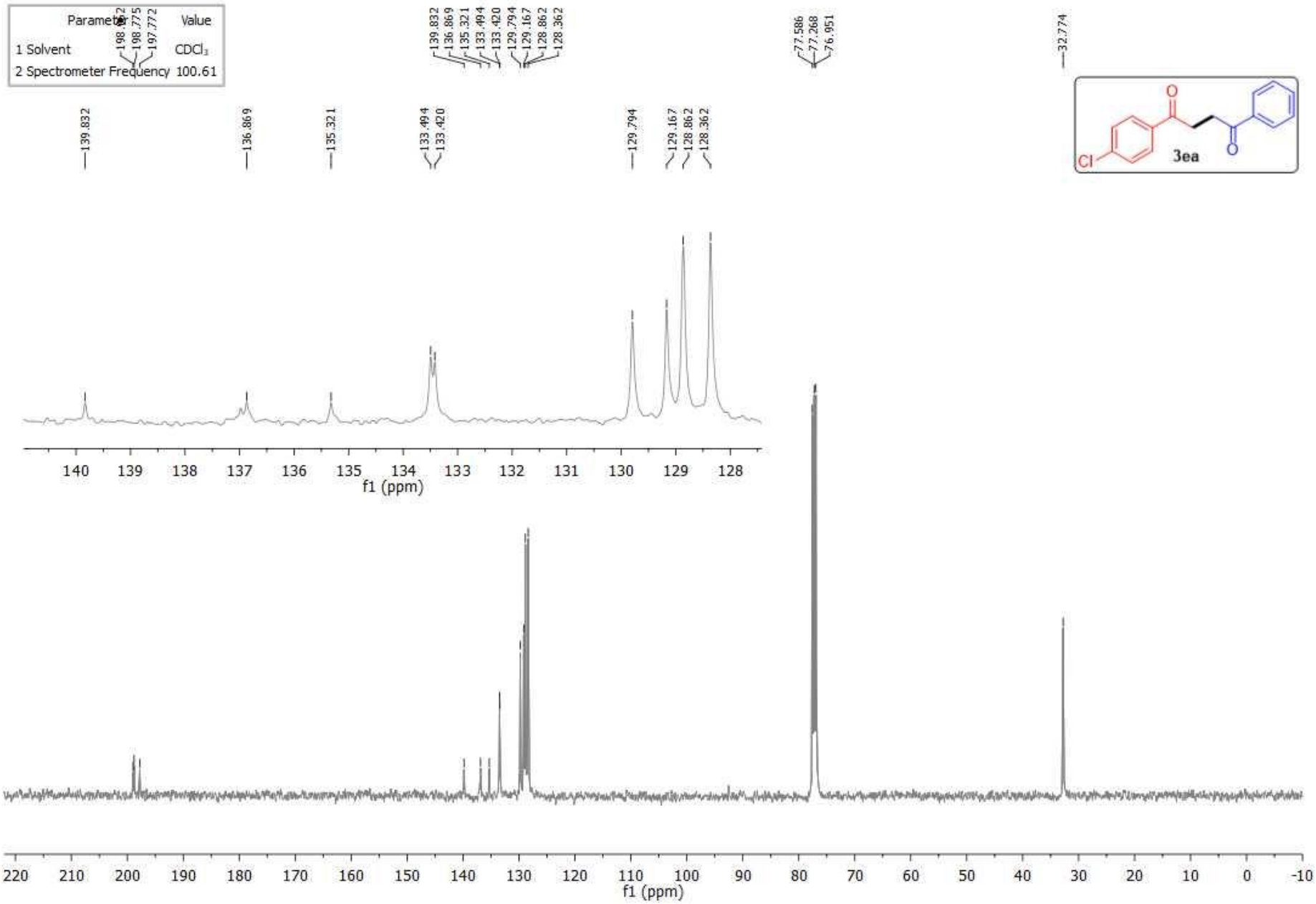

Figure S57. ^{13}C NMR spectrum of 1-(4-Chlorophenyl)-4-phenylbutane-1,4-dione (**3ea**).

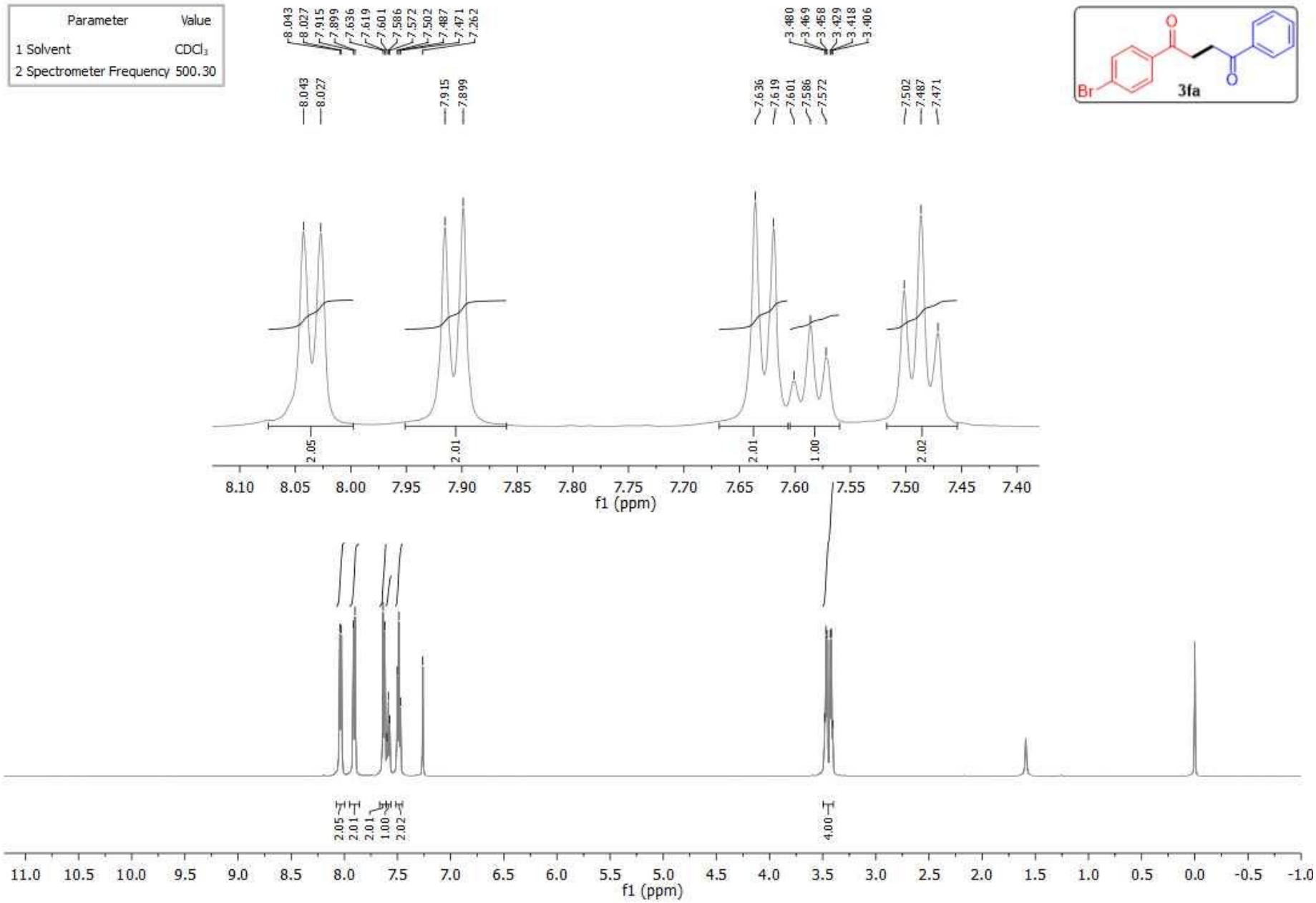

Figure S58. ^{1}H NMR spectrum of 1-(4-Bromophenyl)-4-phenylbutane-1,4-dione (**3fa**).

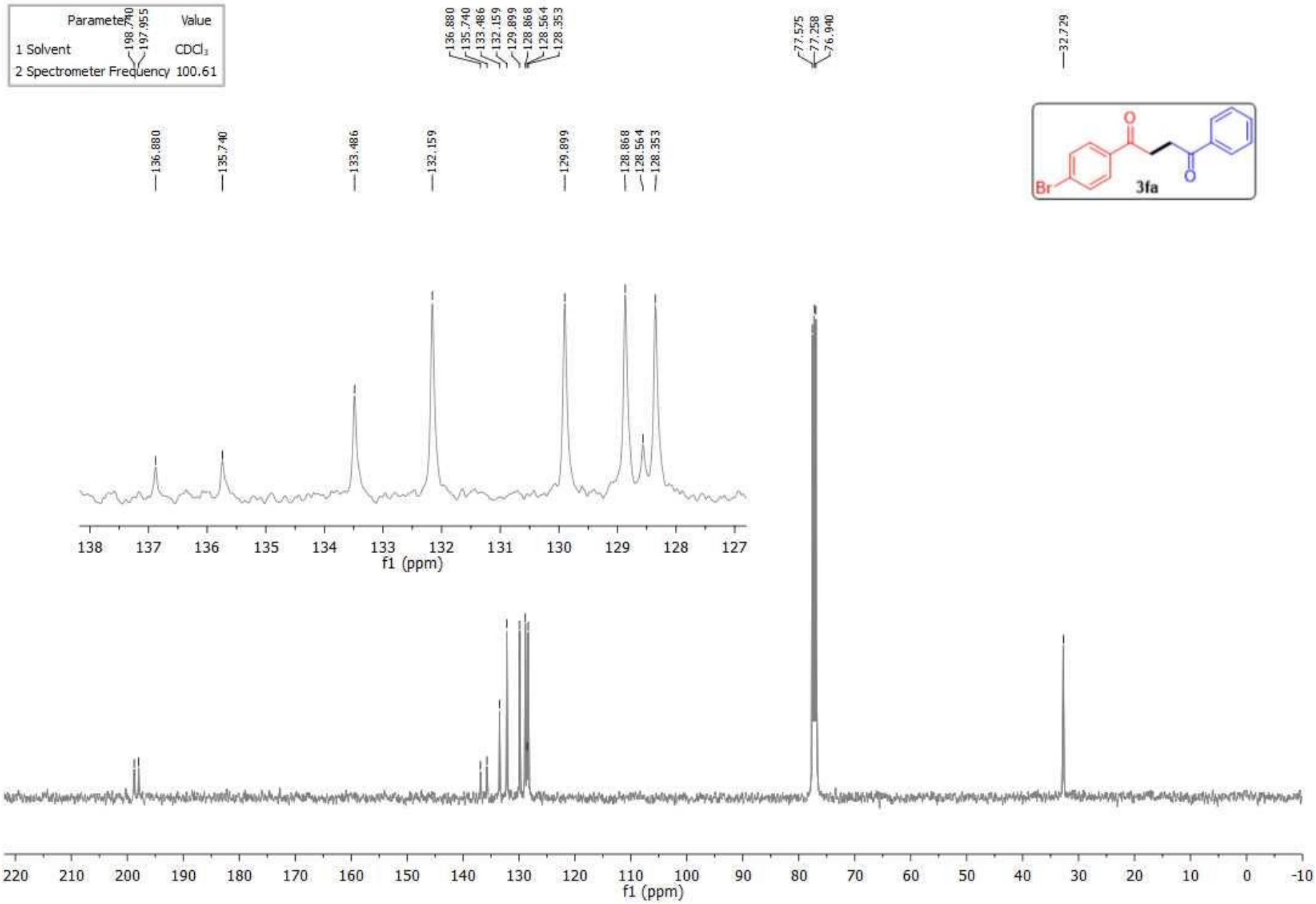

Figure S59. ^{13}C NMR spectrum of 1-(4-Bromophenyl)-4-phenylbutane-1,4-dione (**3fa**).

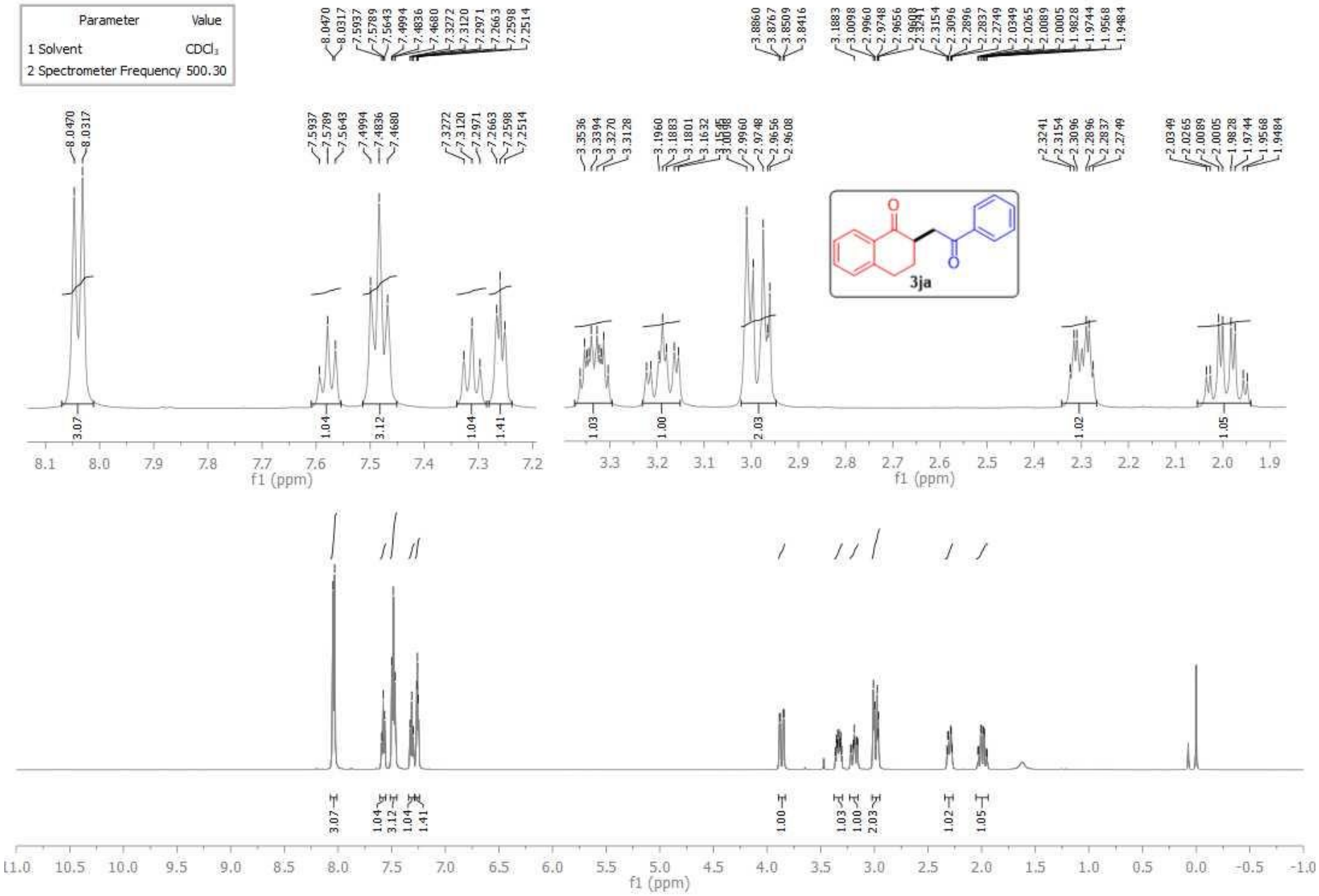

Figure S60. ^{1}H NMR spectrum of 2-(2-Oxo-2-phenylethyl)-3,4-dihydronaphthalen-1(2*H*)-one **(3ja).**

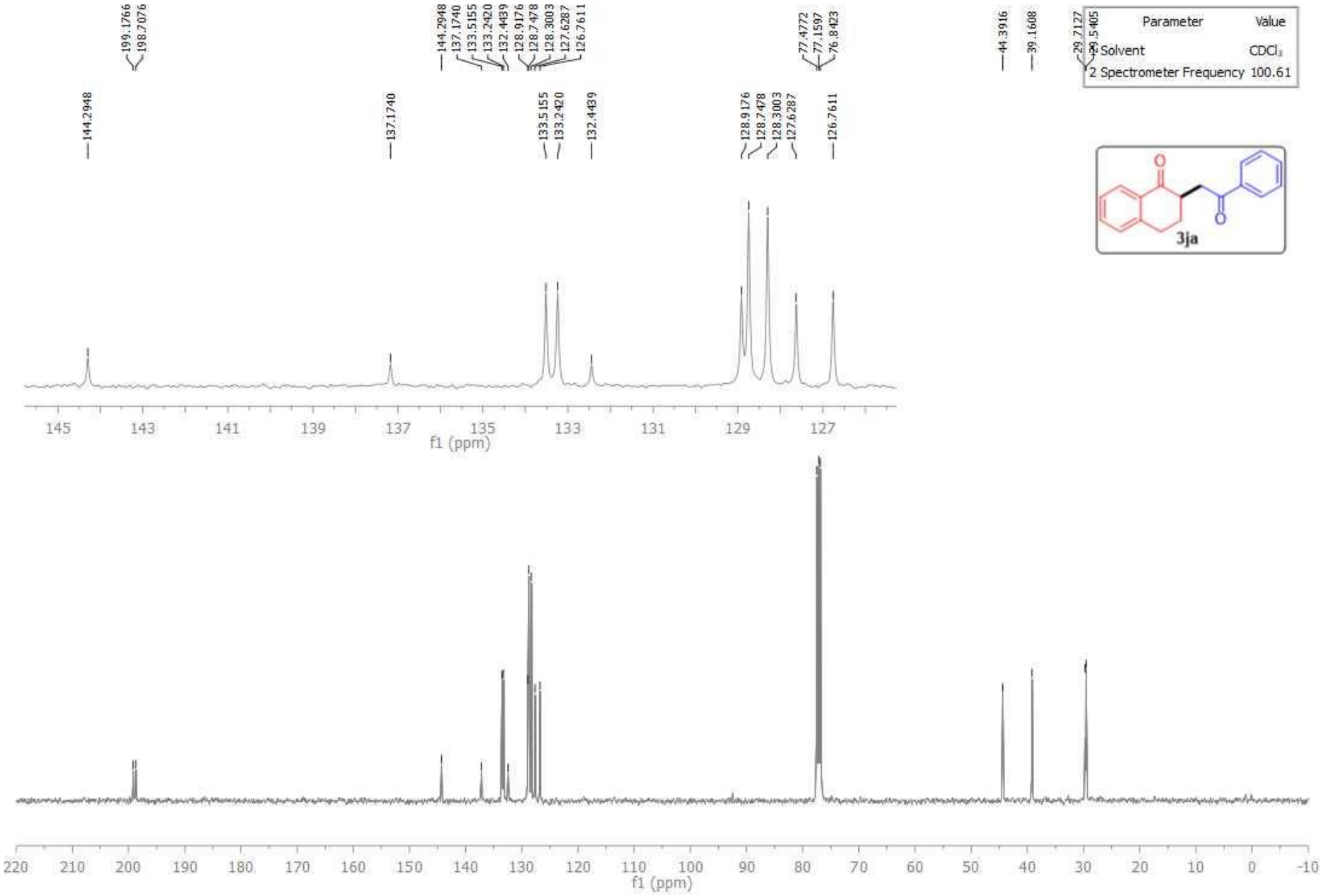

Figure S61. ^{13}C NMR spectrum of 2-(2-Oxo-2-phenylethyl)-3,4-dihydronaphthalen-1(2*H*)-one **(3ja).**

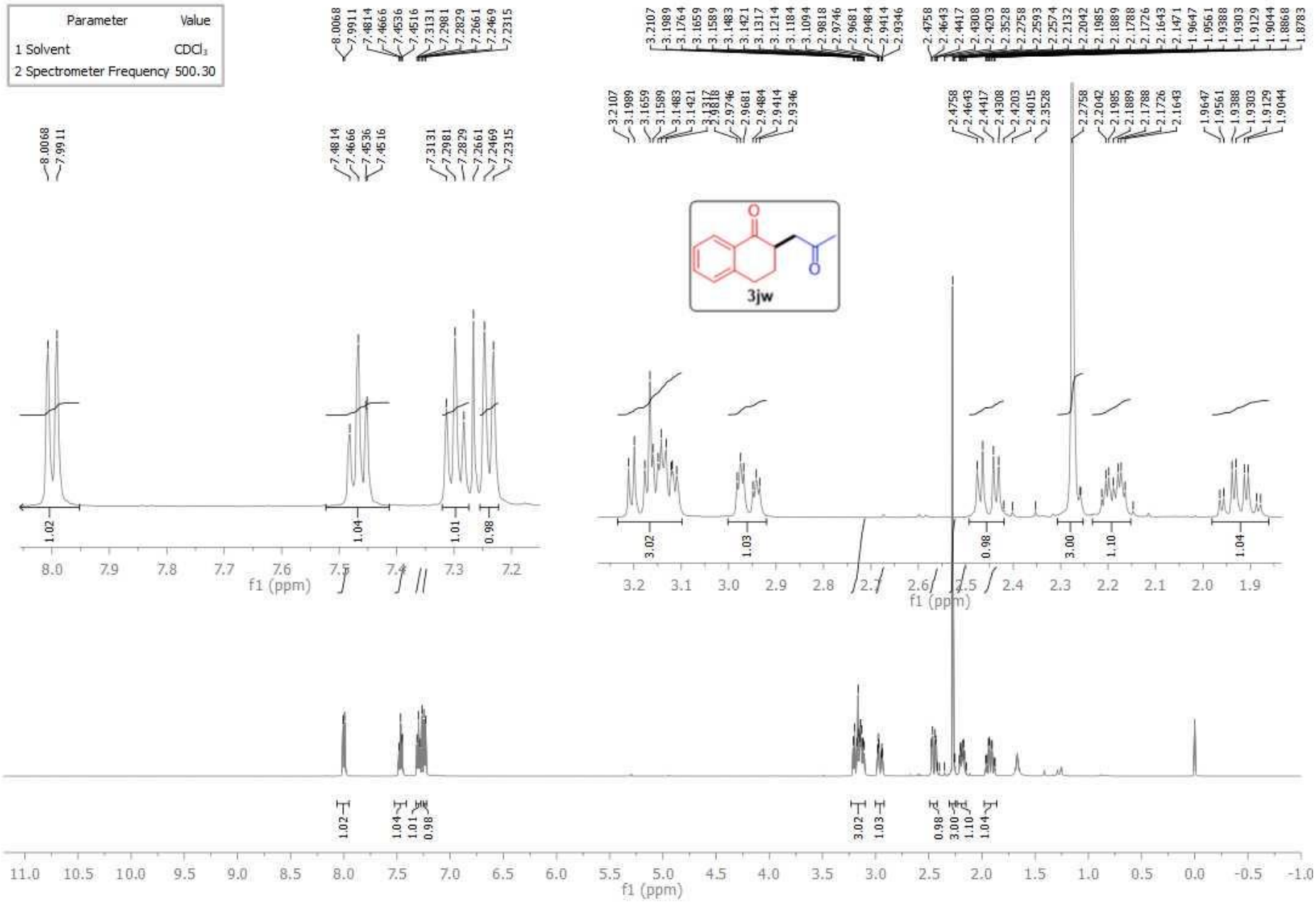

Figure S62. ^{1}H NMR spectrum of 2-(2-Oxopropyl)-3,4-dihydronaphthalen-1(2*H*)-one (**3jw**).

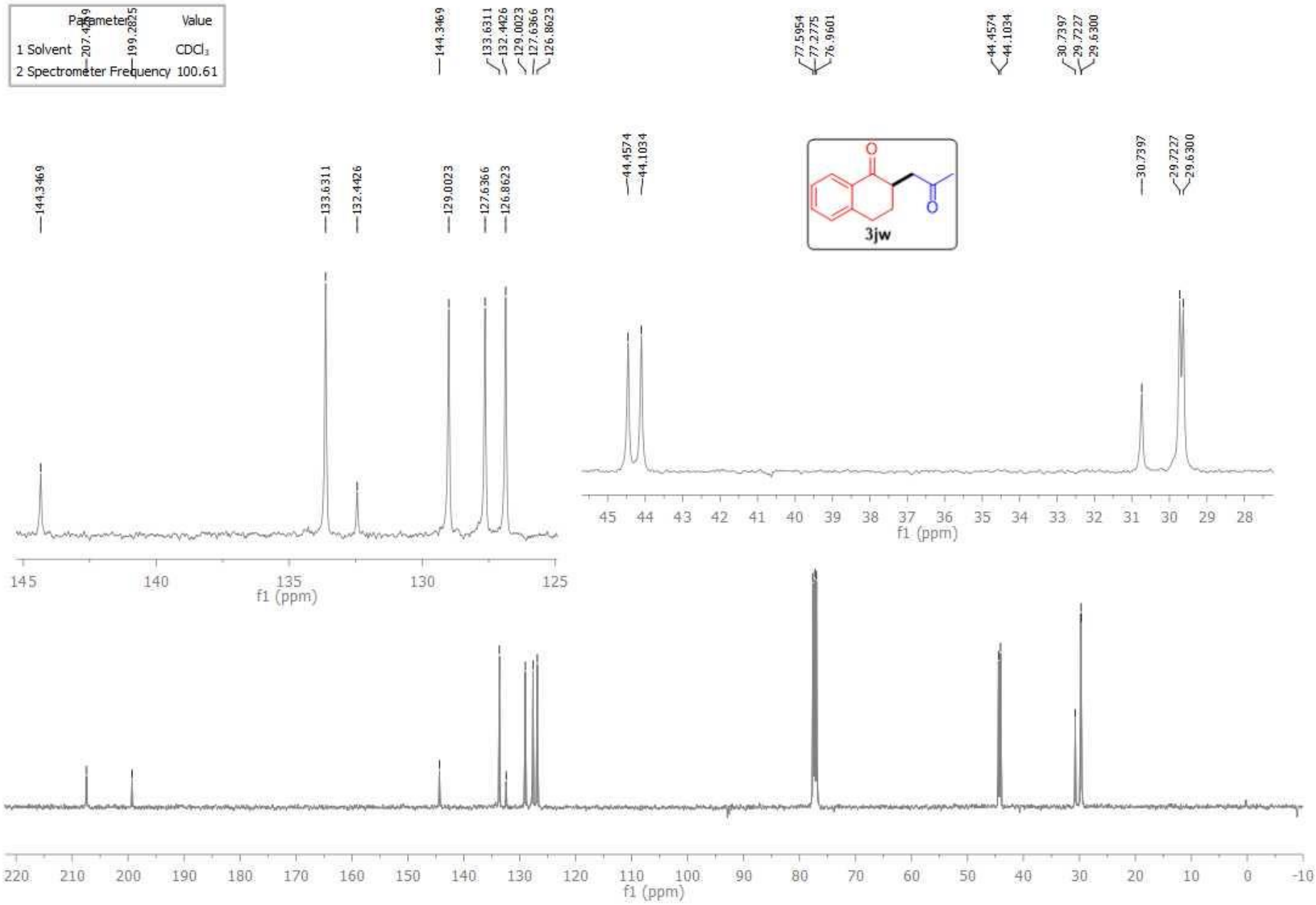

Figure S63. ^{13}C NMR spectrum of 2-(2-Oxopropyl)-3,4-dihydronaphthalen-1(2*H*)-one (**3jw**).

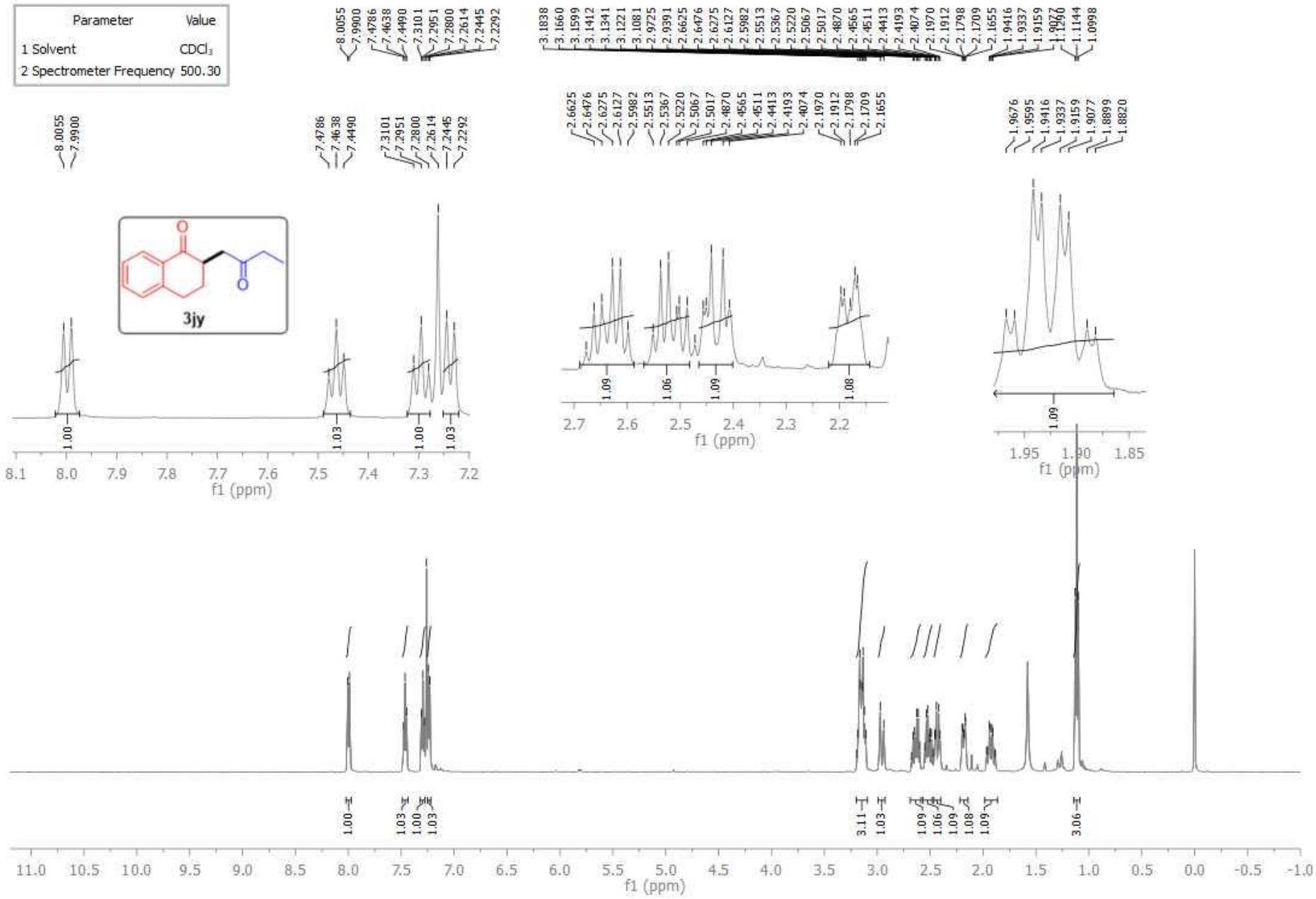

Figure S64. ^{1}H NMR spectrum of 2-(2-Oxobutyl)-3,4-dihydronaphthalen-1(2*H*)-one (**3jy**).

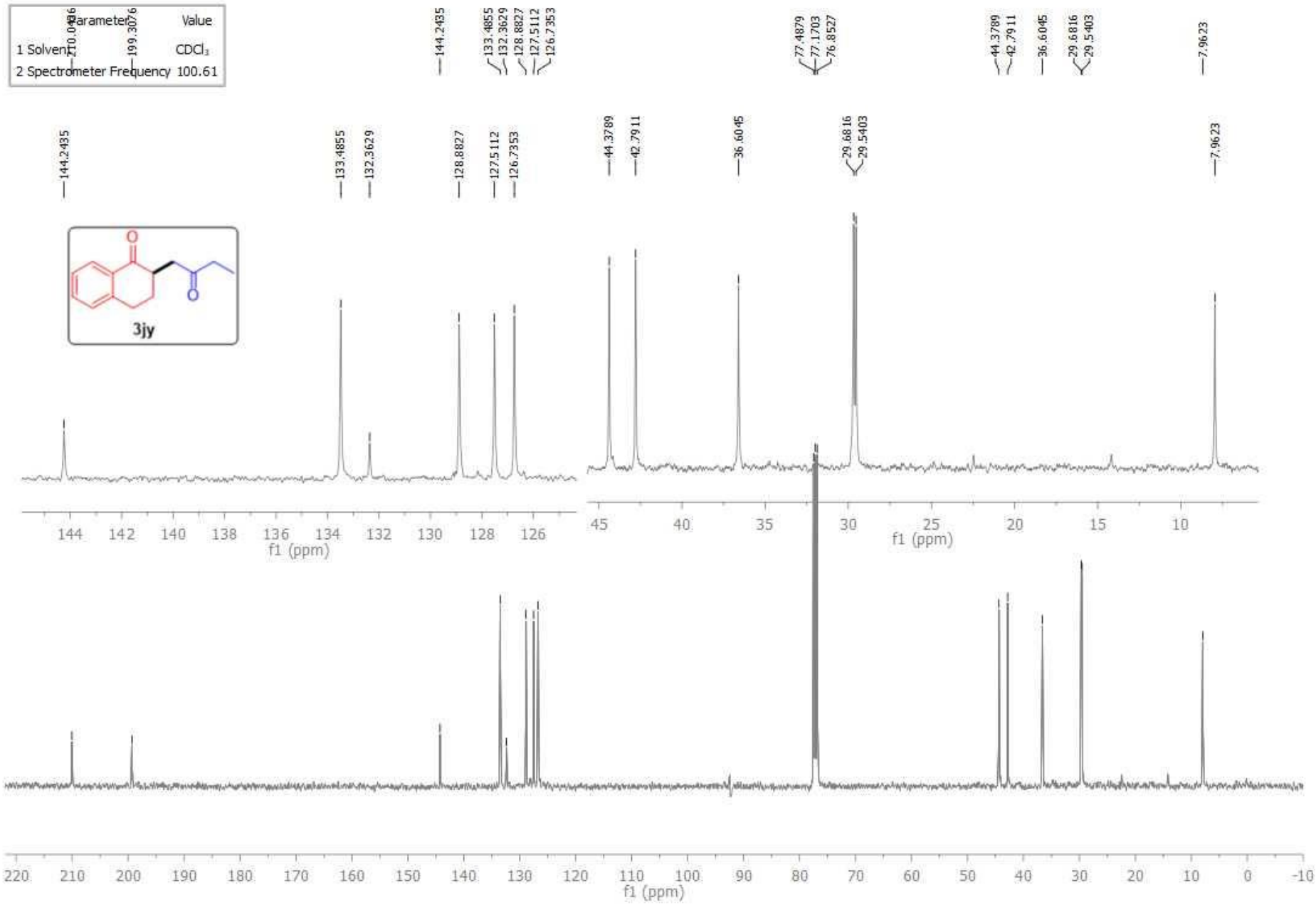

Figure S65. ^{13}C NMR spectrum of 2-(2-Oxobutyl)-3,4-dihydronaphthalen-1(2*H*)-one (**3jy**).

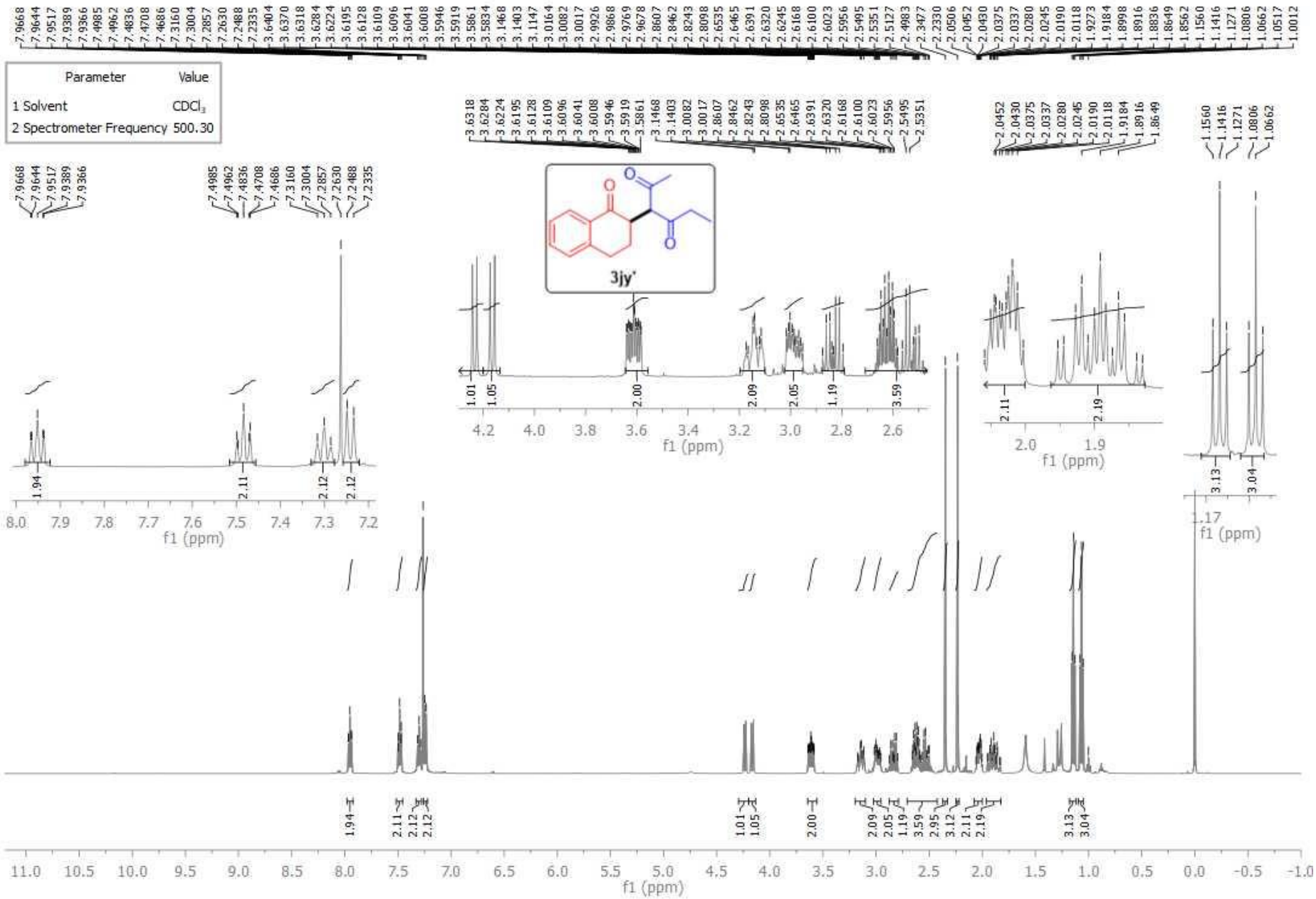

Figure S66. ^{1}H NMR spectrum of 3-(-1-Oxo-1,2,3,4-tetrahydronaphthalen-2-yl)hexane-2,4-dione **(3jy')**.

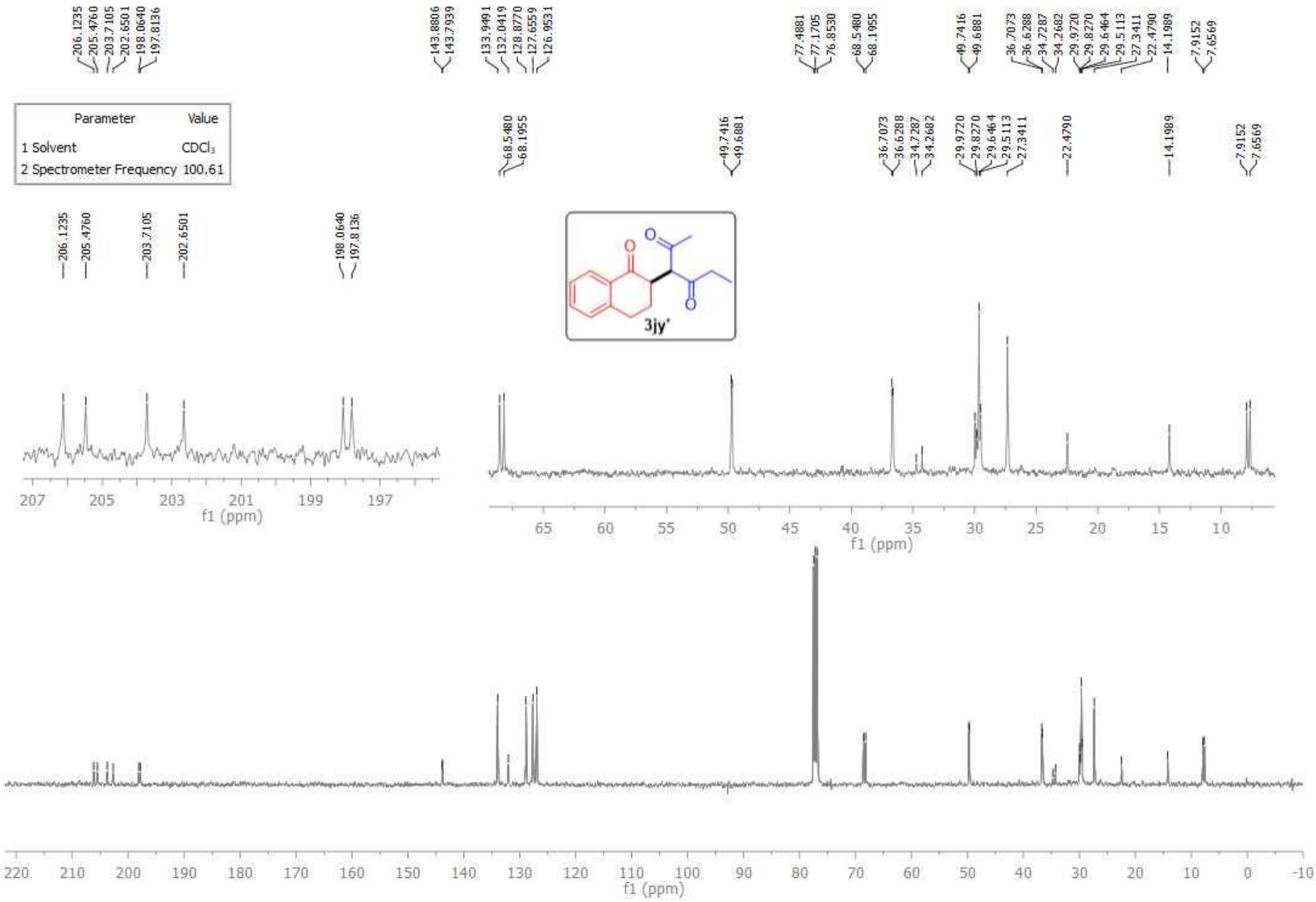

Figure S67. ^{13}C NMR spectrum of 3-(-1-Oxo-1,2,3,4-tetrahydronaphthalen-2-yl)hexane-2,4-dione **(3jy')**.

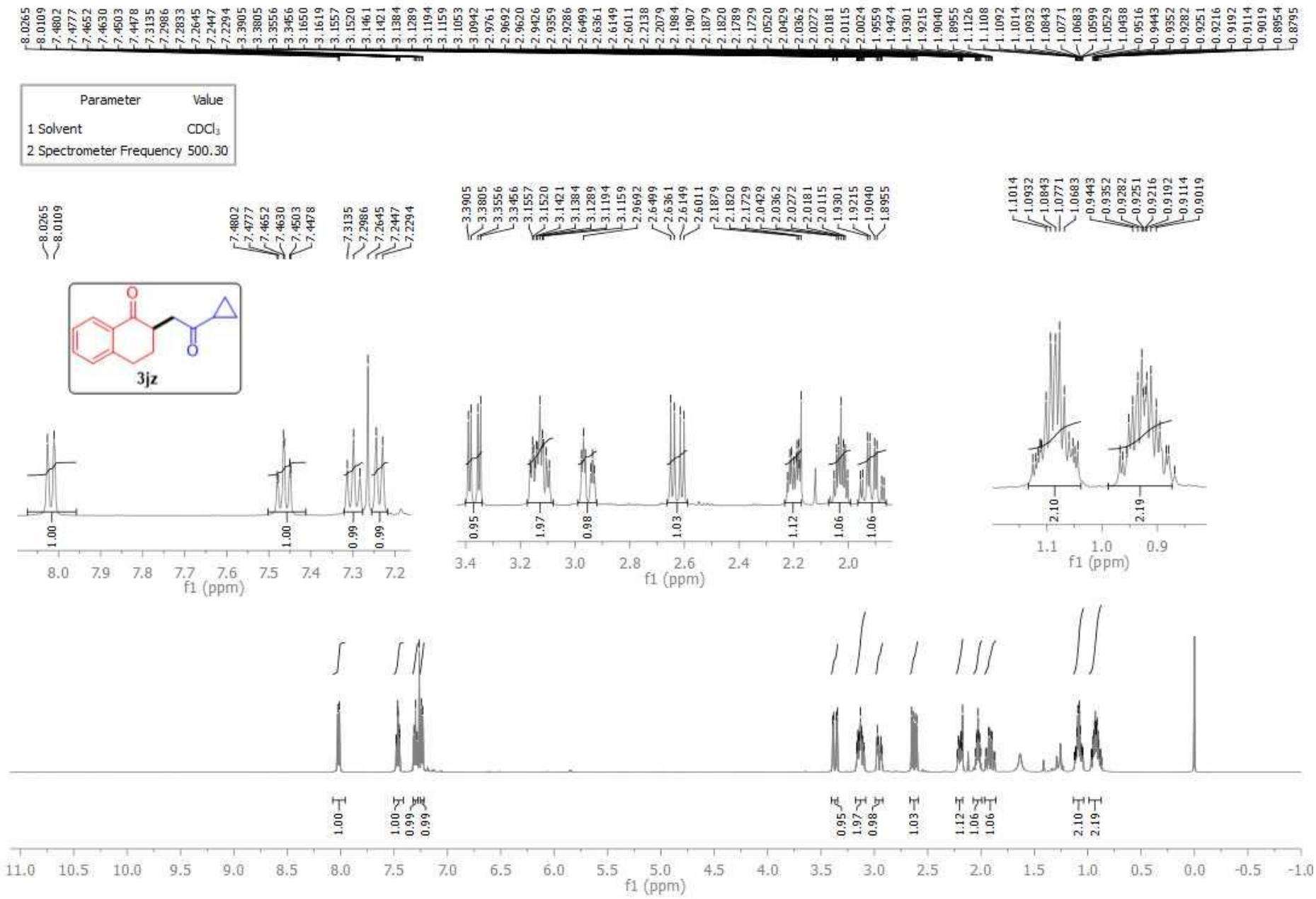

Figure S68. ^{1}H NMR spectrum of 2-(2-cyclopropyl-2-oxoethyl)-3,4-dihydronaphthalen-1(2*H*)-one (**3jz**).

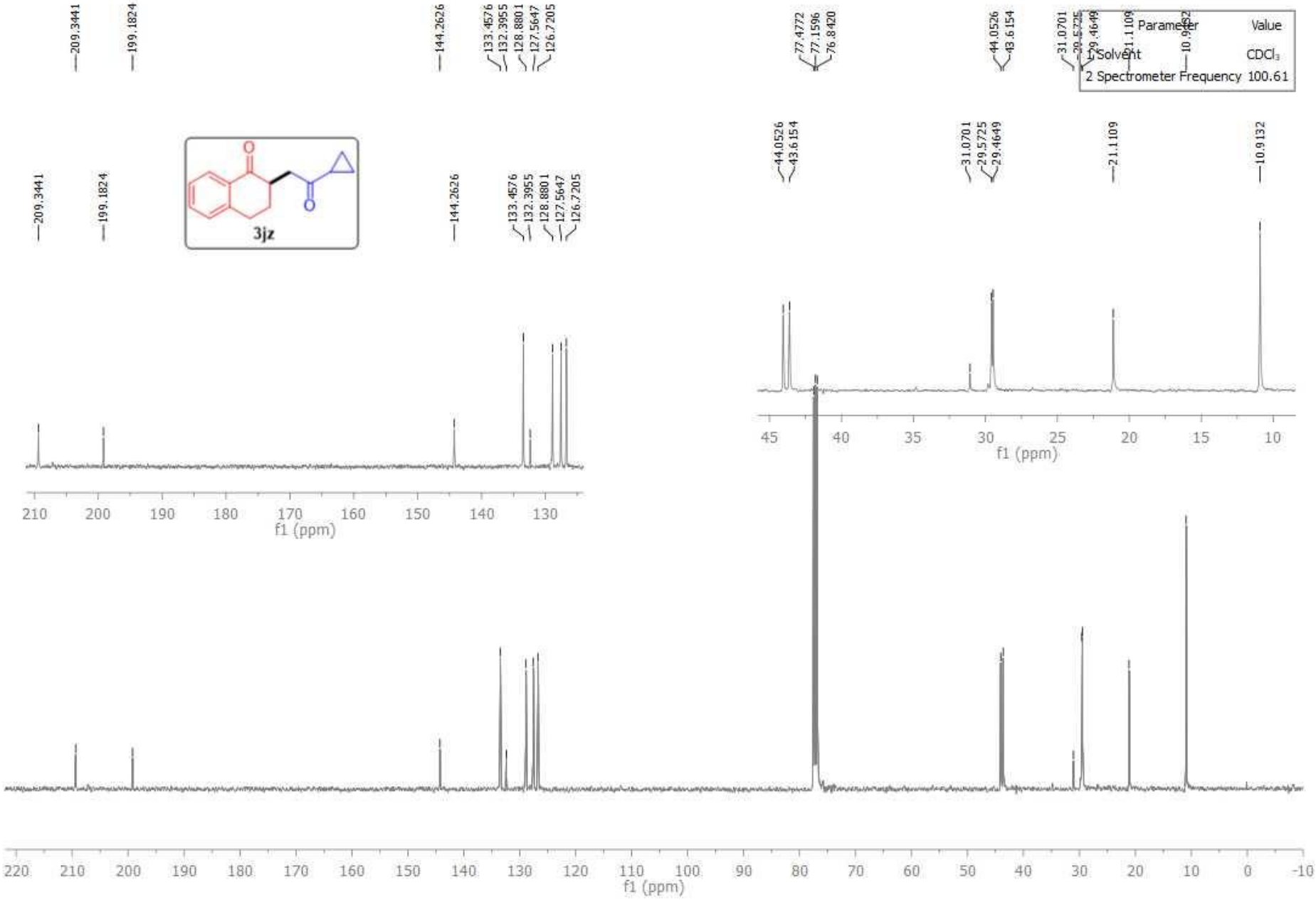

Figure S69. ^{13}C NMR spectrum of 2-(2-cyclopropyl-2-oxoethyl)-3,4-dihydronaphthalen-1(2*H*)-one (**3jz**).

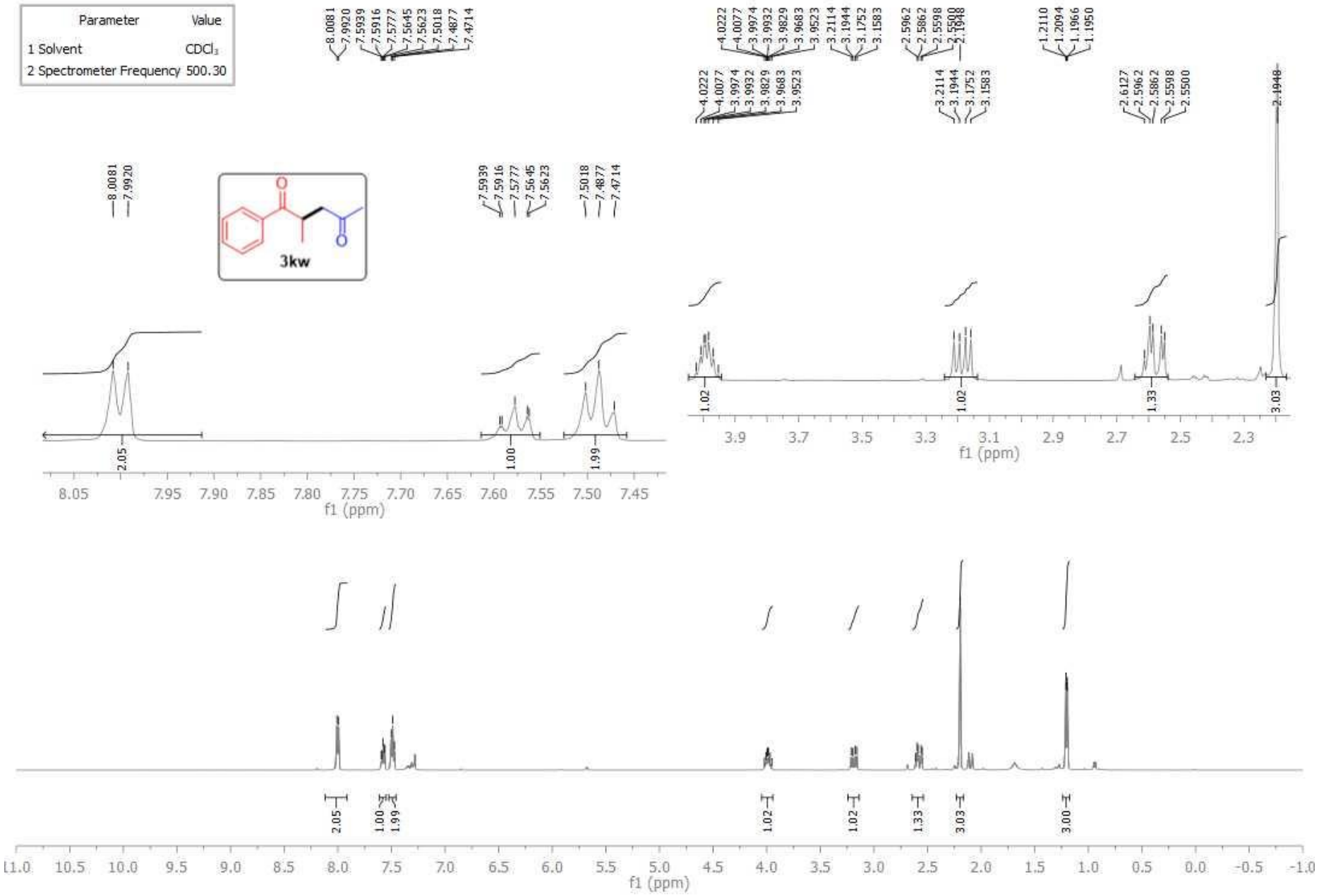

Figure S70. ^{1}H NMR spectrum of 2-Methyl-1-phenylpentane-1,4-dione (**3kw**).

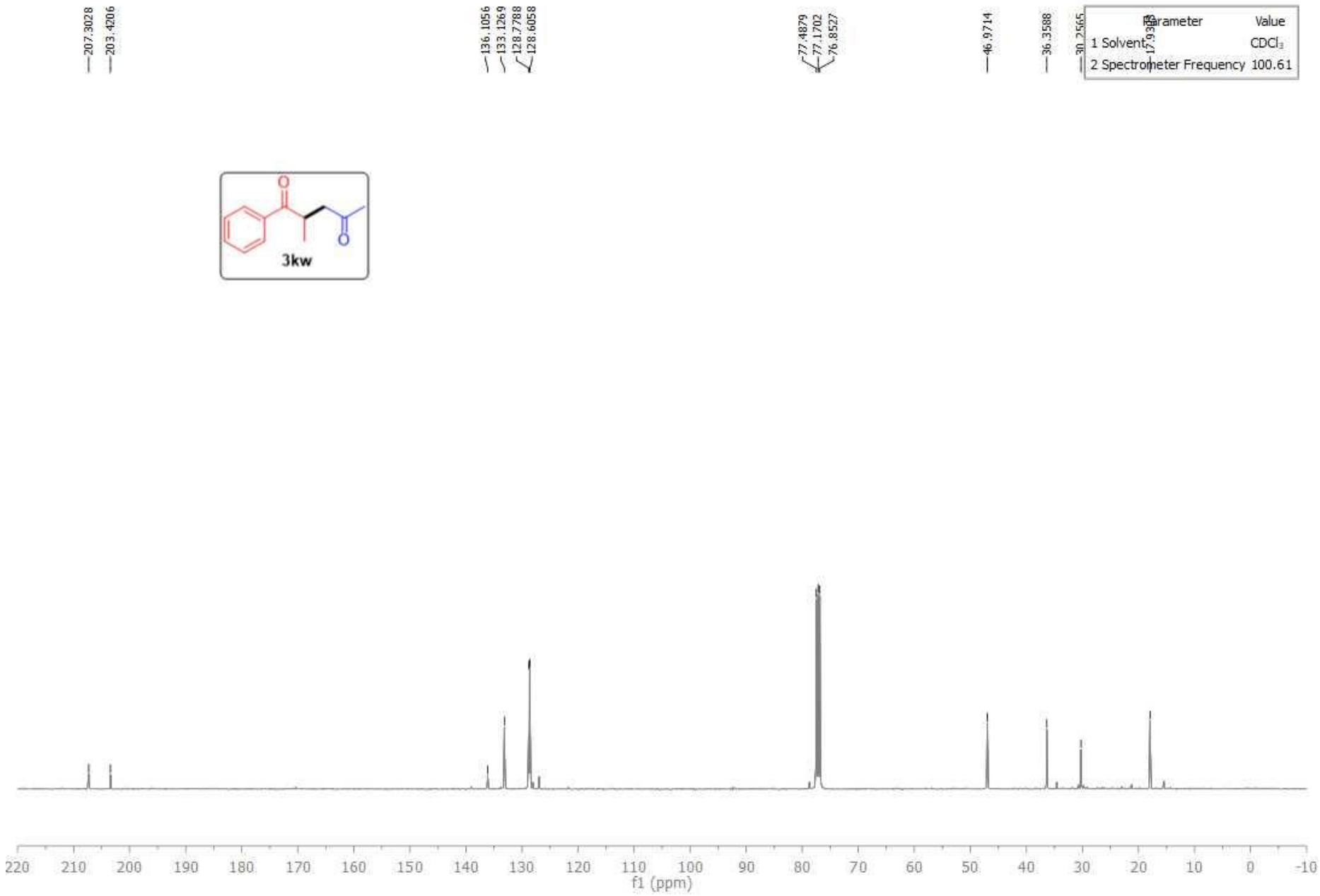

Figure S71. ^{13}C NMR spectrum of 2-Methyl-1-phenylpentane-1,4-dione (**3kw**).

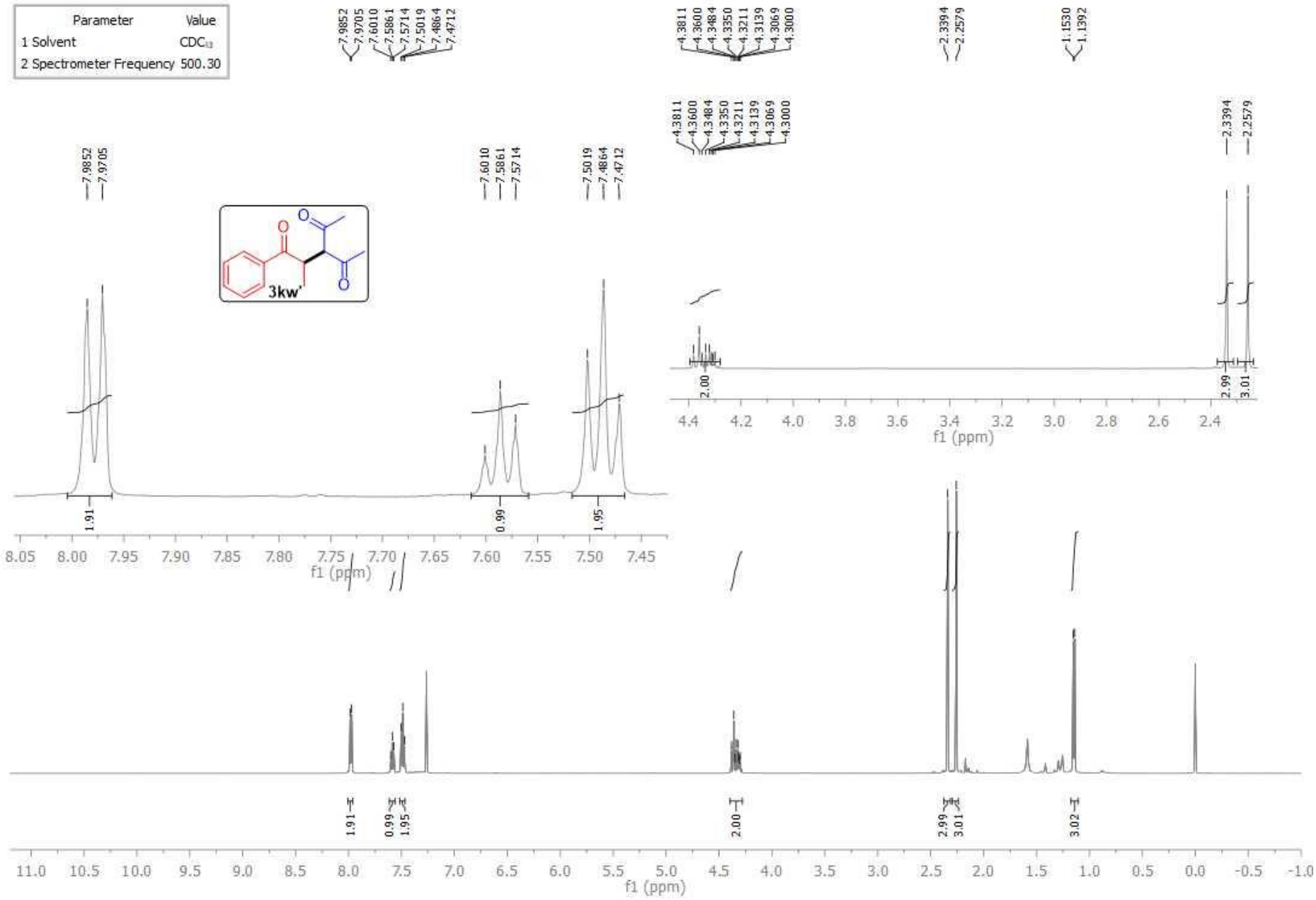

Figure S72. ^{1}H NMR spectrum of 3-Acetyl-2-methyl-1-phenylpentane-1,4-dione **(3kw')**.

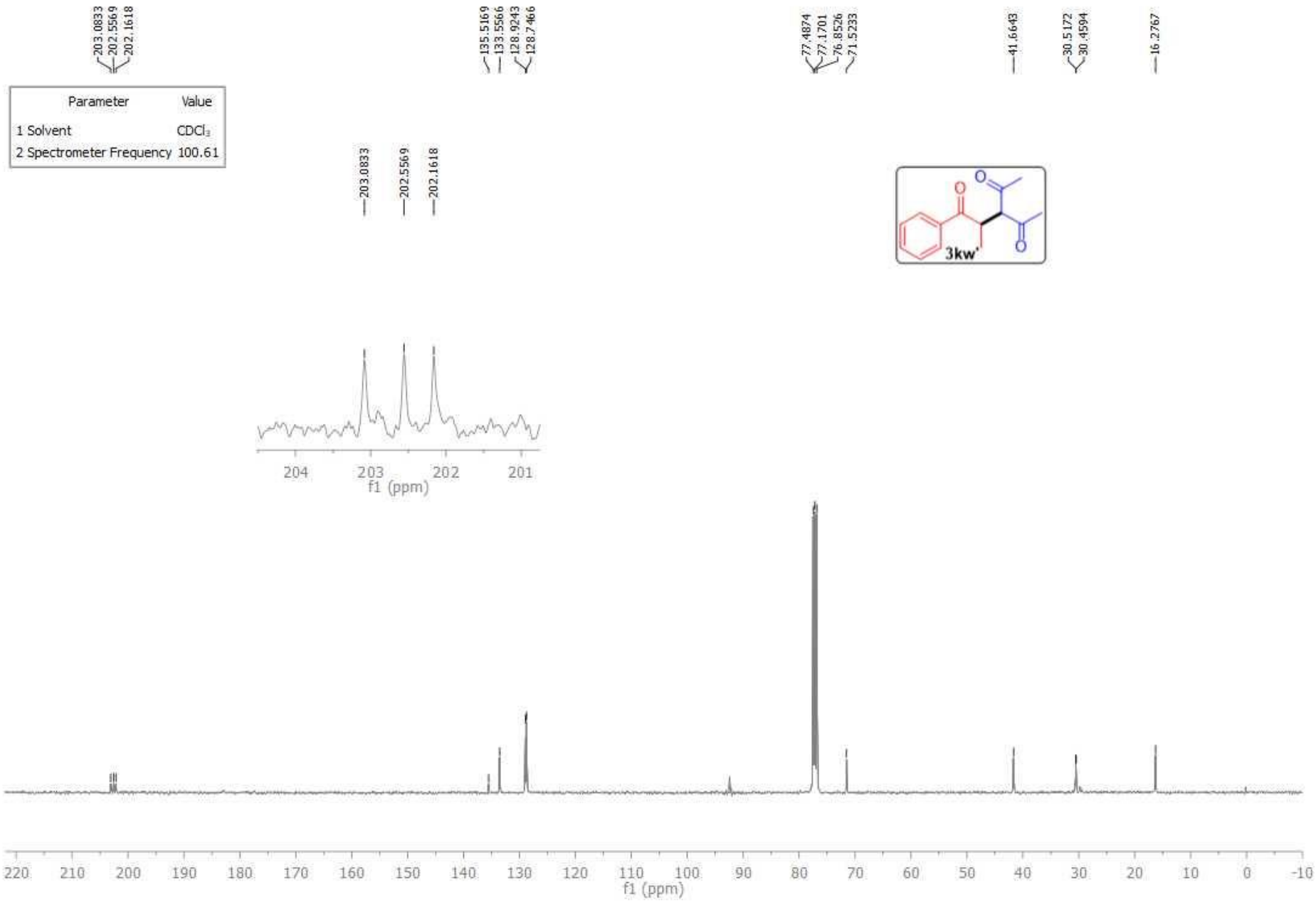

Figure S73. ^{13}C NMR spectrum of 3-Acetyl-2-methyl-1-phenylpentane-1,4-dione **(3kw')**.

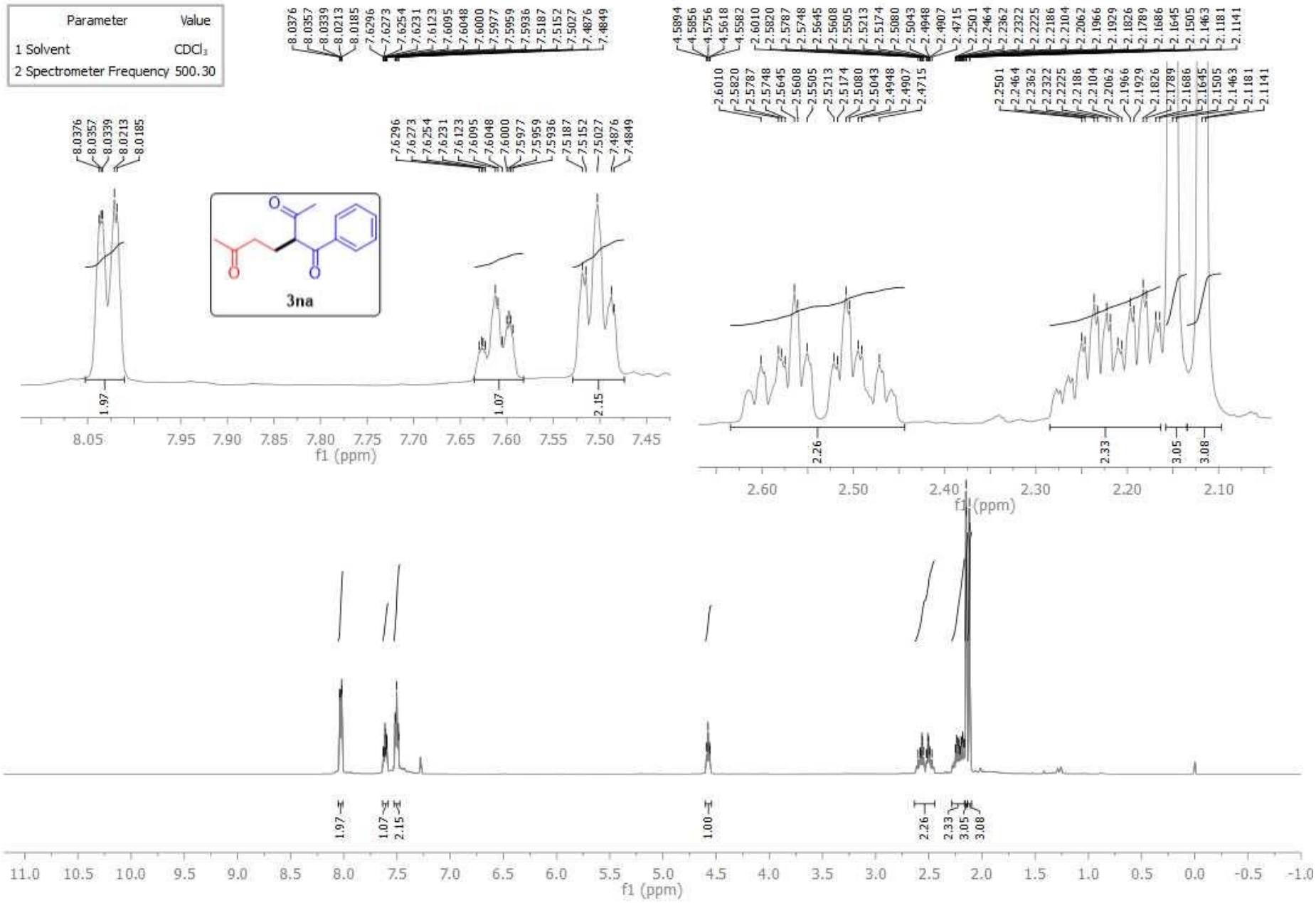

Figure S74. ^{1}H NMR spectrum of 3-Benzoylheptane-2,6-dione **(3na)**.

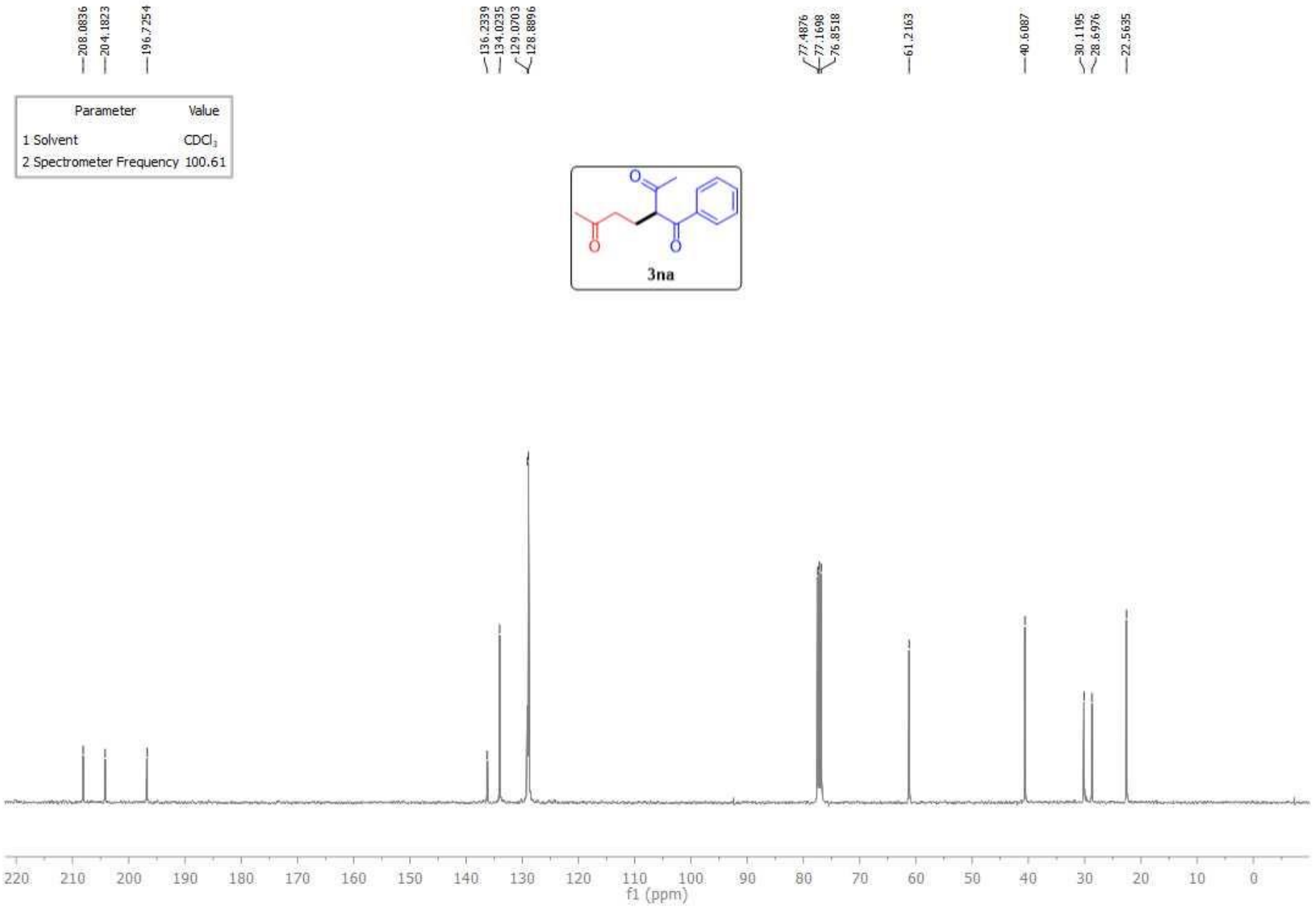

Figure S75. ^{13}C NMR spectrum of 3-Benzoylheptane-2,6-dione **(3na)**.

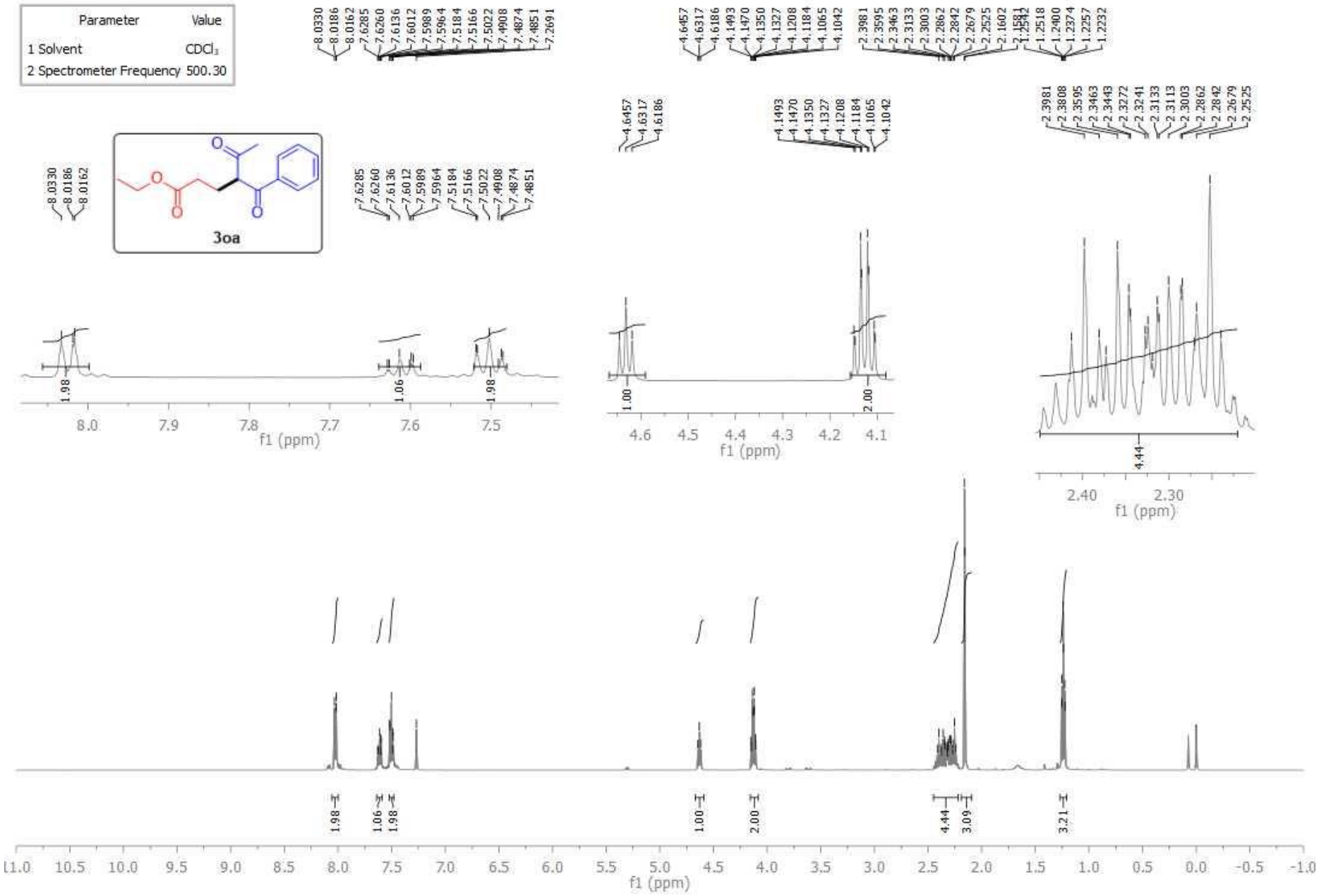

Figure S76. ^{1}H NMR spectrum of Ethyl 4-benzoyl-5-oxohexanoate **(3oa)**

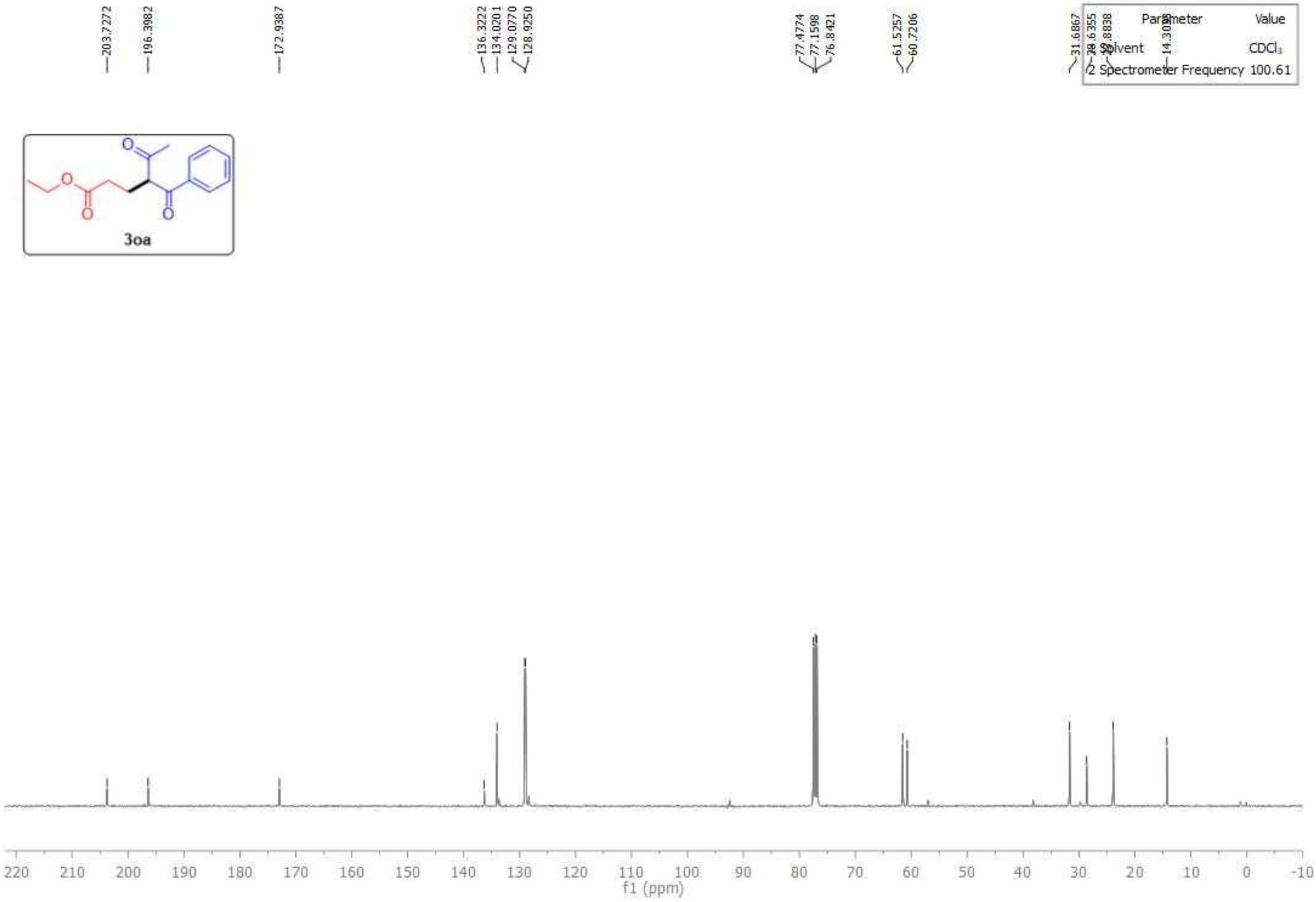

Figure S77. ^{13}C NMR spectrum of Ethyl 4-benzoyl-5-oxohexanoate **(3oa)**.

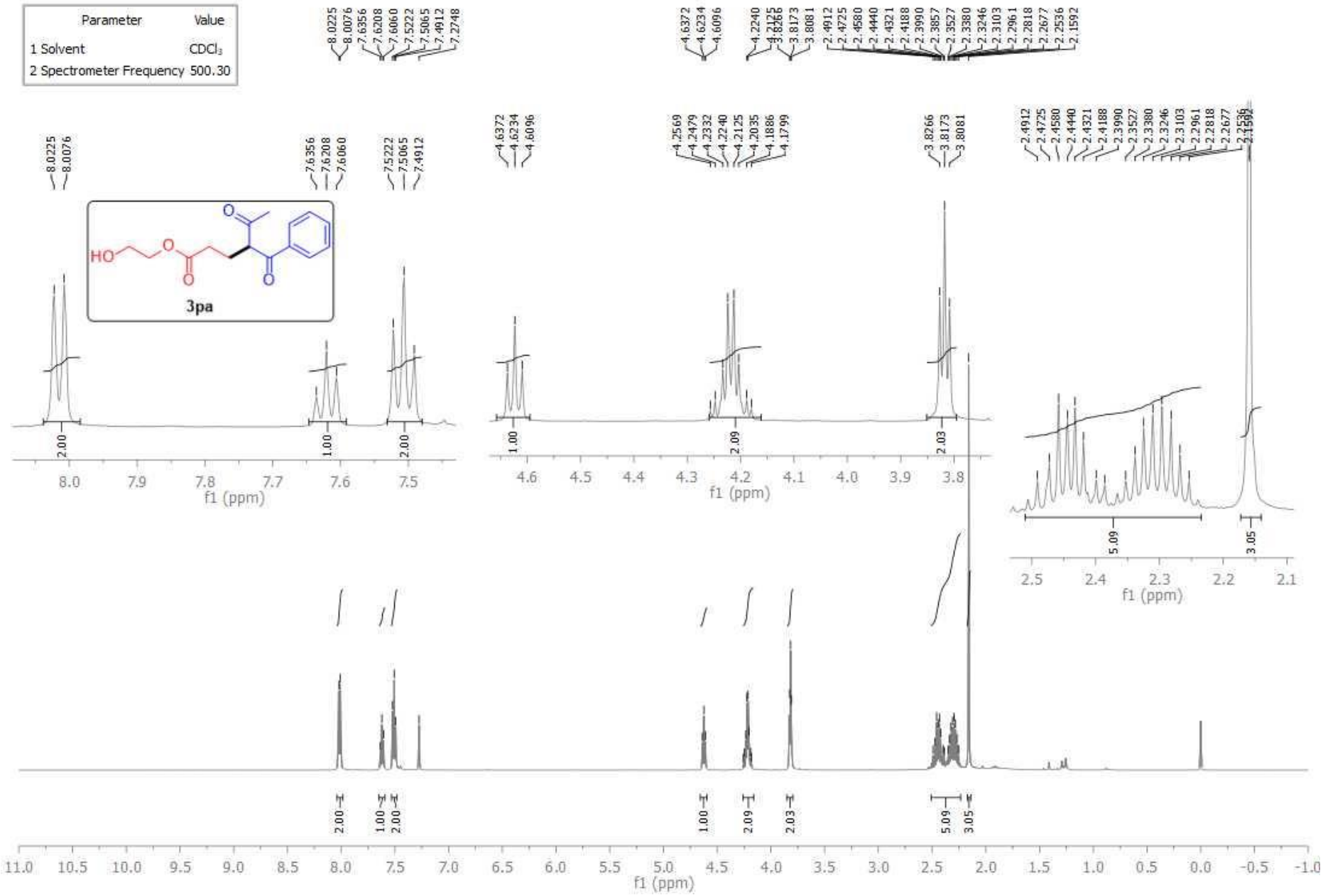

Figure S78. ^{1}H NMR spectrum of 2-Hydroxyethyl 4-benzoyl-5-oxohexanoate **(3pa)**.

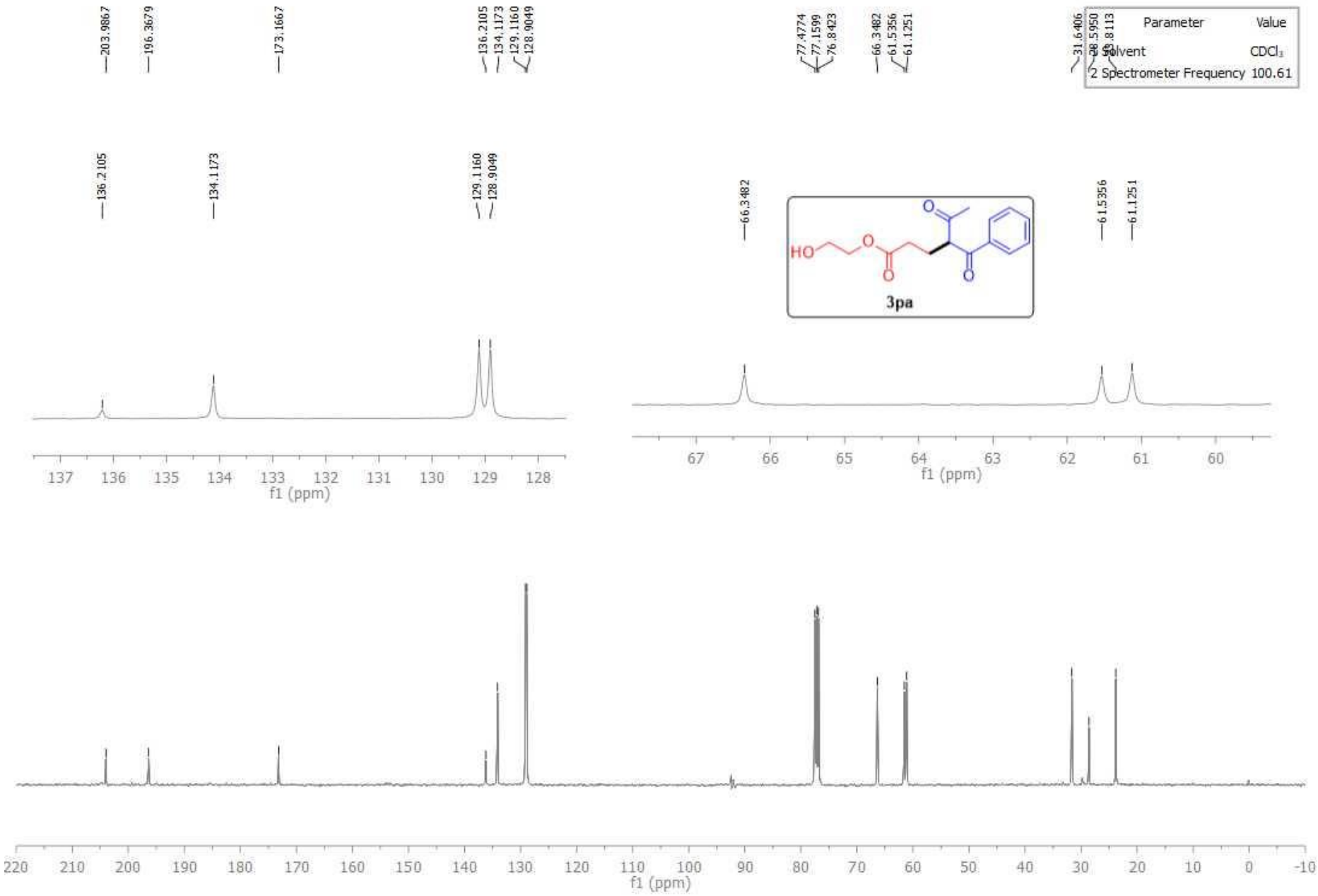

Figure S79. ^{13}C NMR spectrum of 2-Hydroxyethyl 4-benzoyl-5-oxohexanoate **(3pa)**.

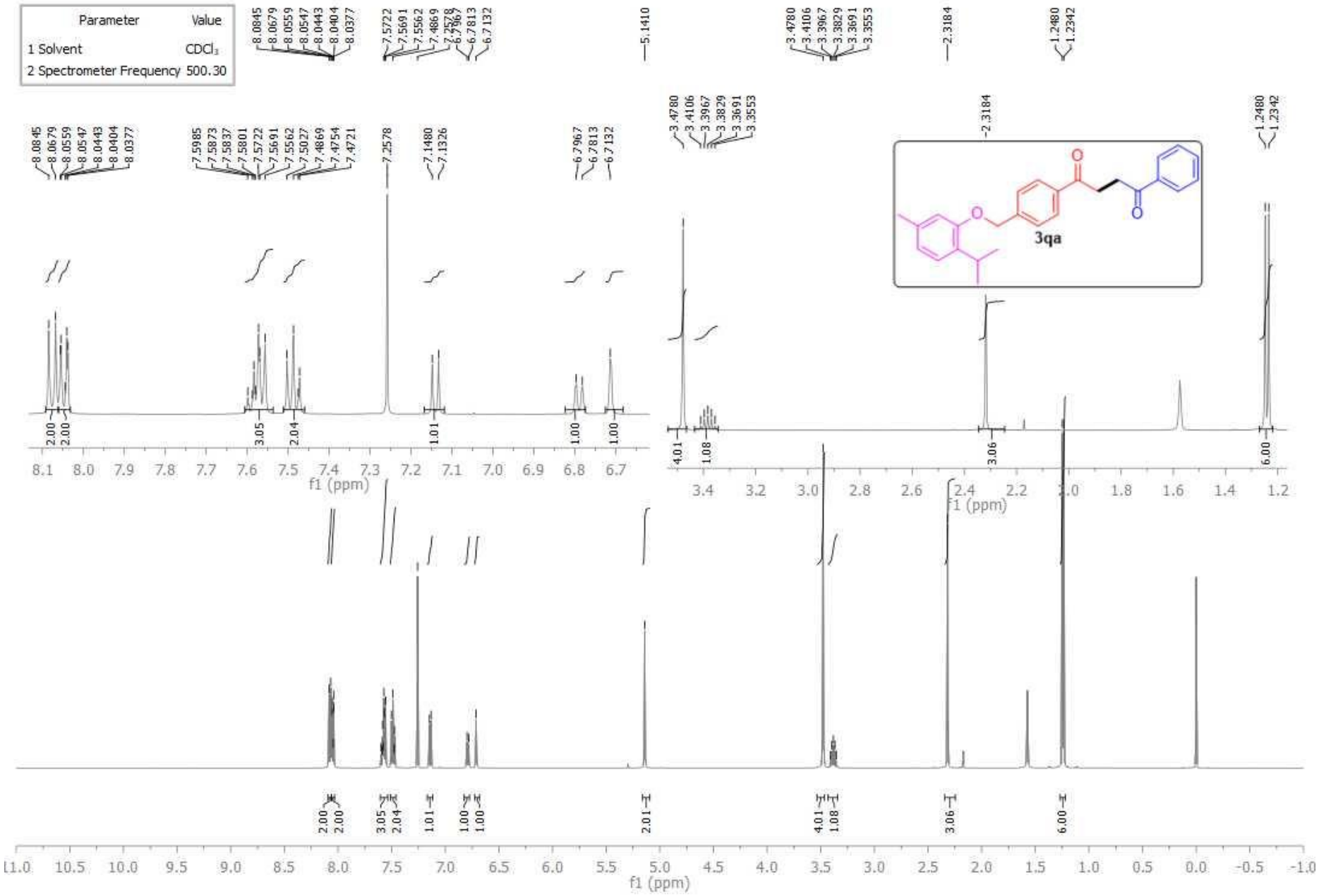

Figure S80. ^{1}H NMR spectrum of 1-(4-((2-Isopropyl-5-methylphenoxy)methyl)phenyl)-4-phenylbutane-1,4-dione **(3qa)**.

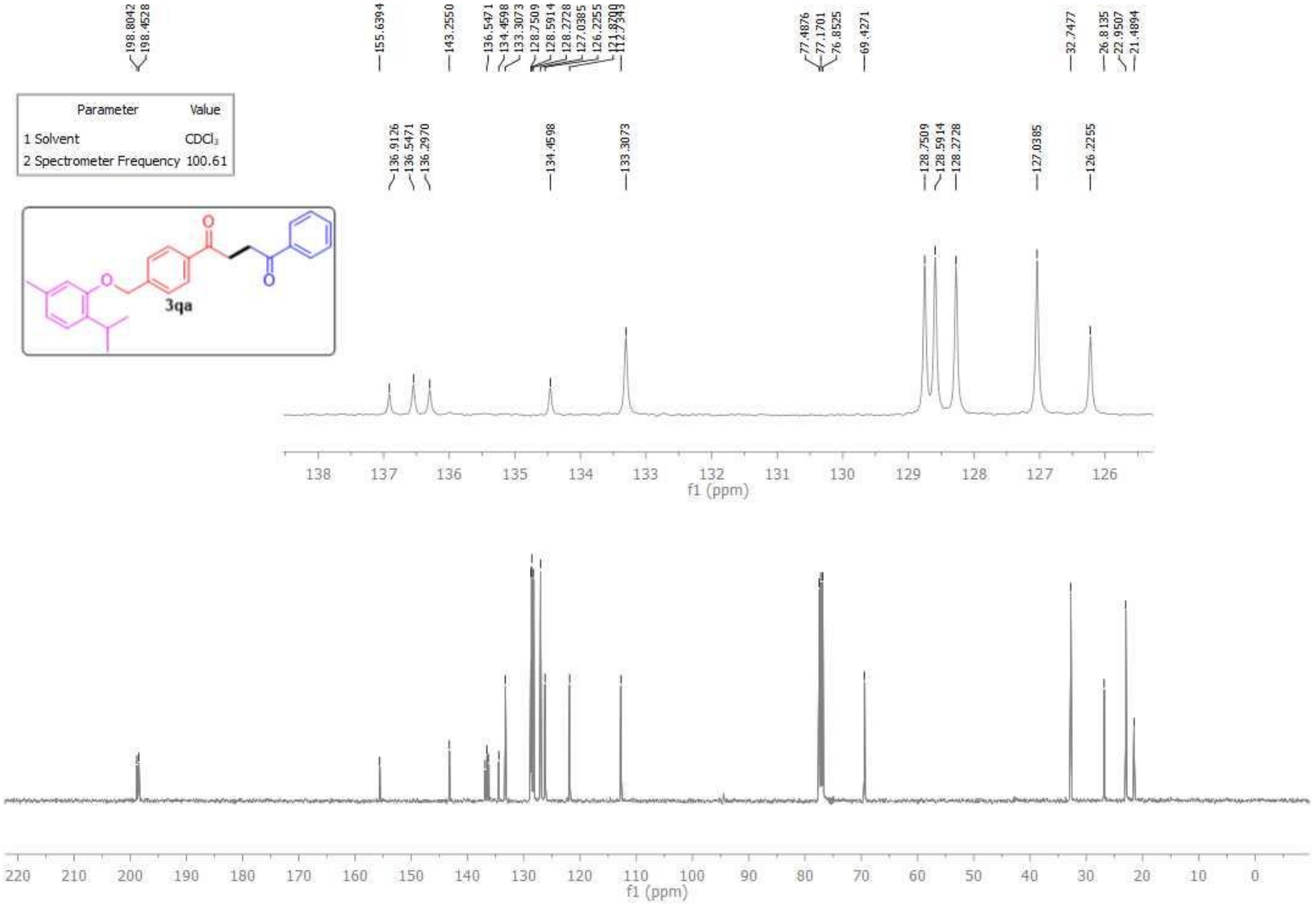

Figure S81. ^{13}C NMR spectrum of 1-(4-((2-Isopropyl-5-methylphenoxy)methyl)phenyl)-4-phenylbutane-1,4-dione **(3qa)**.

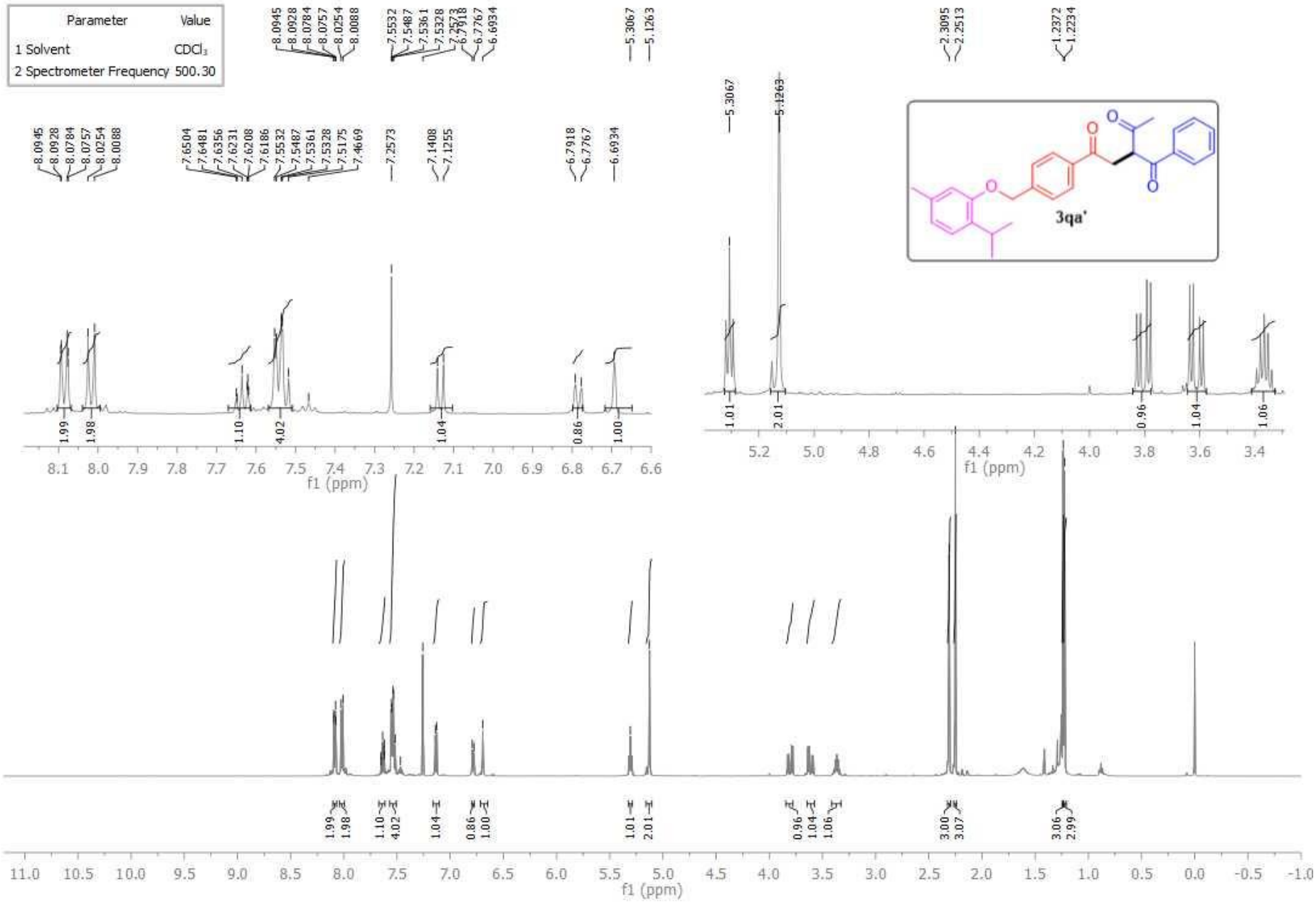

Figure S82. [1]H NMR spectrum of 3-Benzoyl-1-(4-((2-isopropyl-5-methylphenoxy)methyl)phenyl)pentane-1,4-dione **(3qa')**.

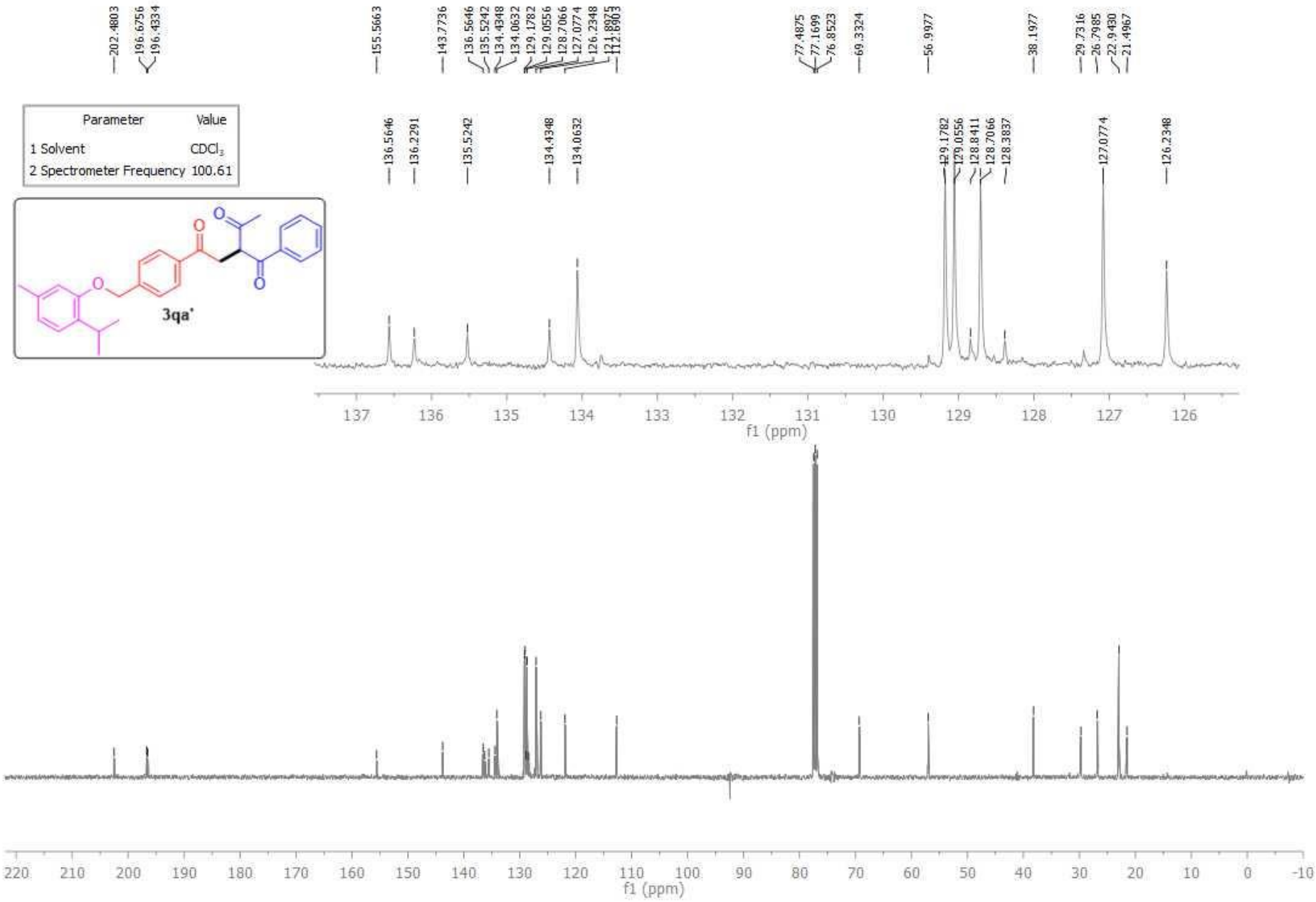

Figure S83. ^{13}C NMR spectrum of 3-Benzoyl-1-(4-((2-isopropyl-5-methylphenoxy)methyl)phenyl)pentane-1,4-dione **(3qa')**.

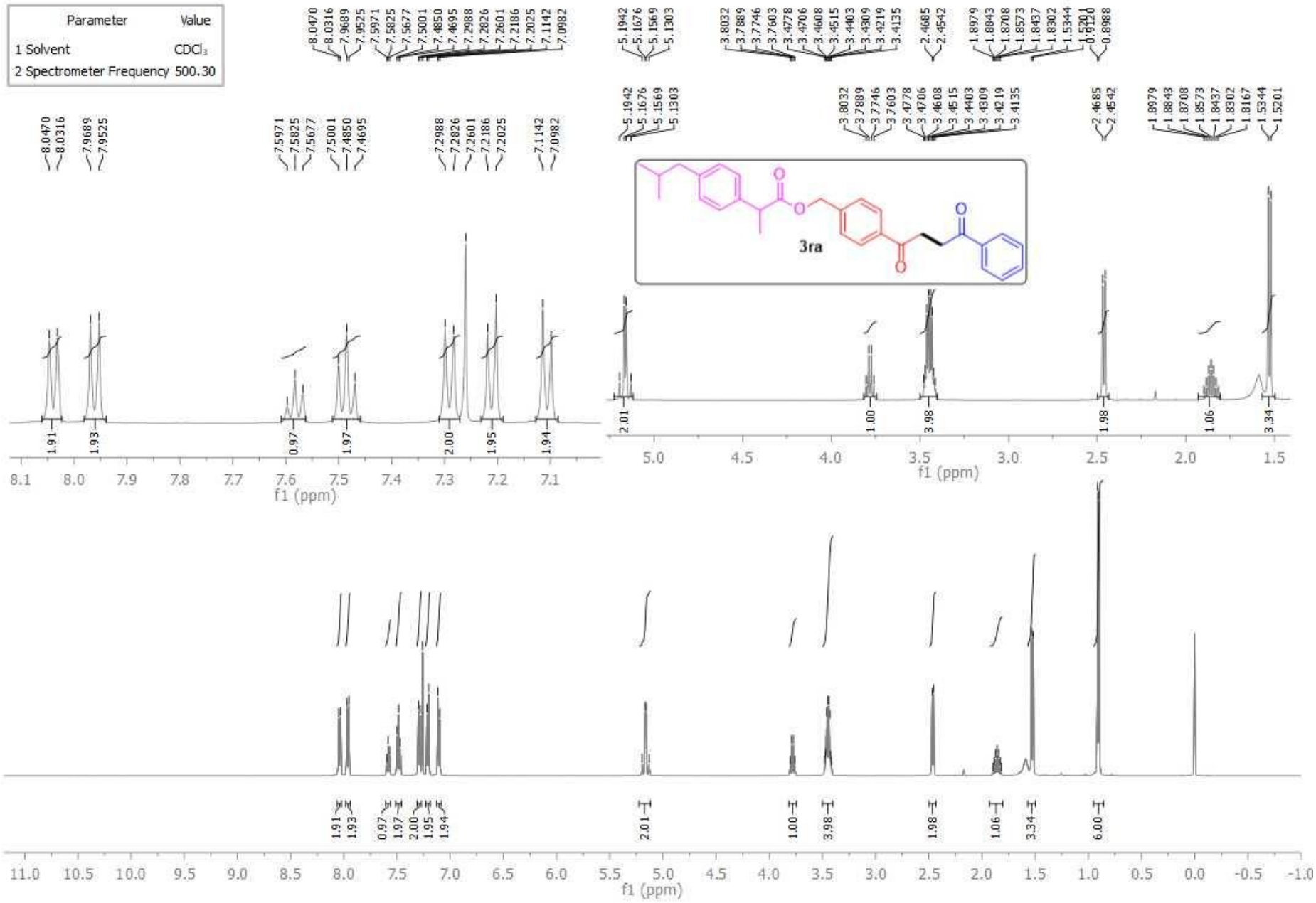

Figure S84. ^{1}H NMR spectrum of 4-(4-Oxo-4-phenylbutanoyl)benzyl 2-(4-isobutylphenyl)propanoate **(3ra)**.

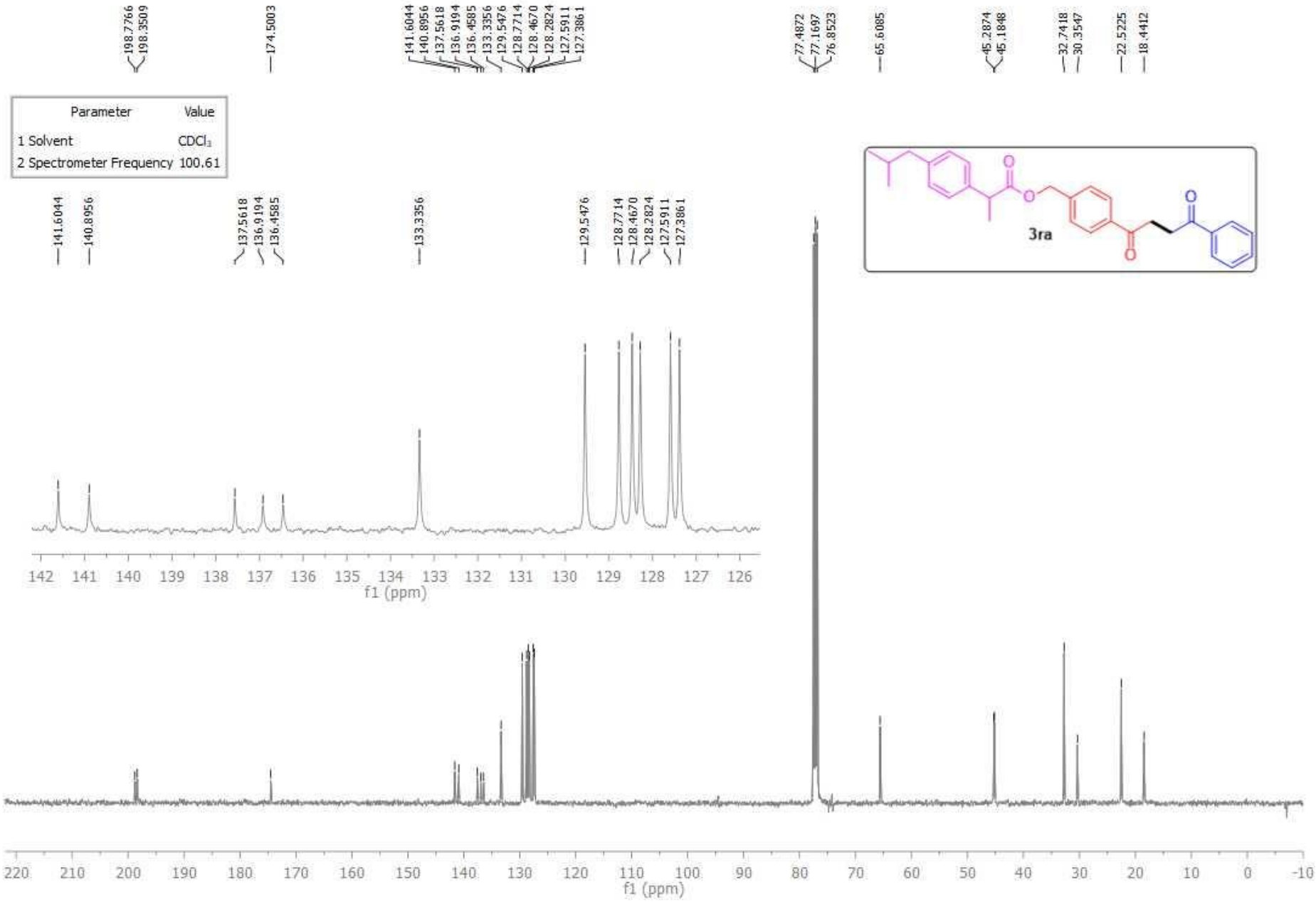

Figure S85. ^{13}C NMR spectrum of 4-(4-Oxo-4-phenylbutanoyl)benzyl 2-(4-isobutylphenyl)propanoate **(3ra)**.

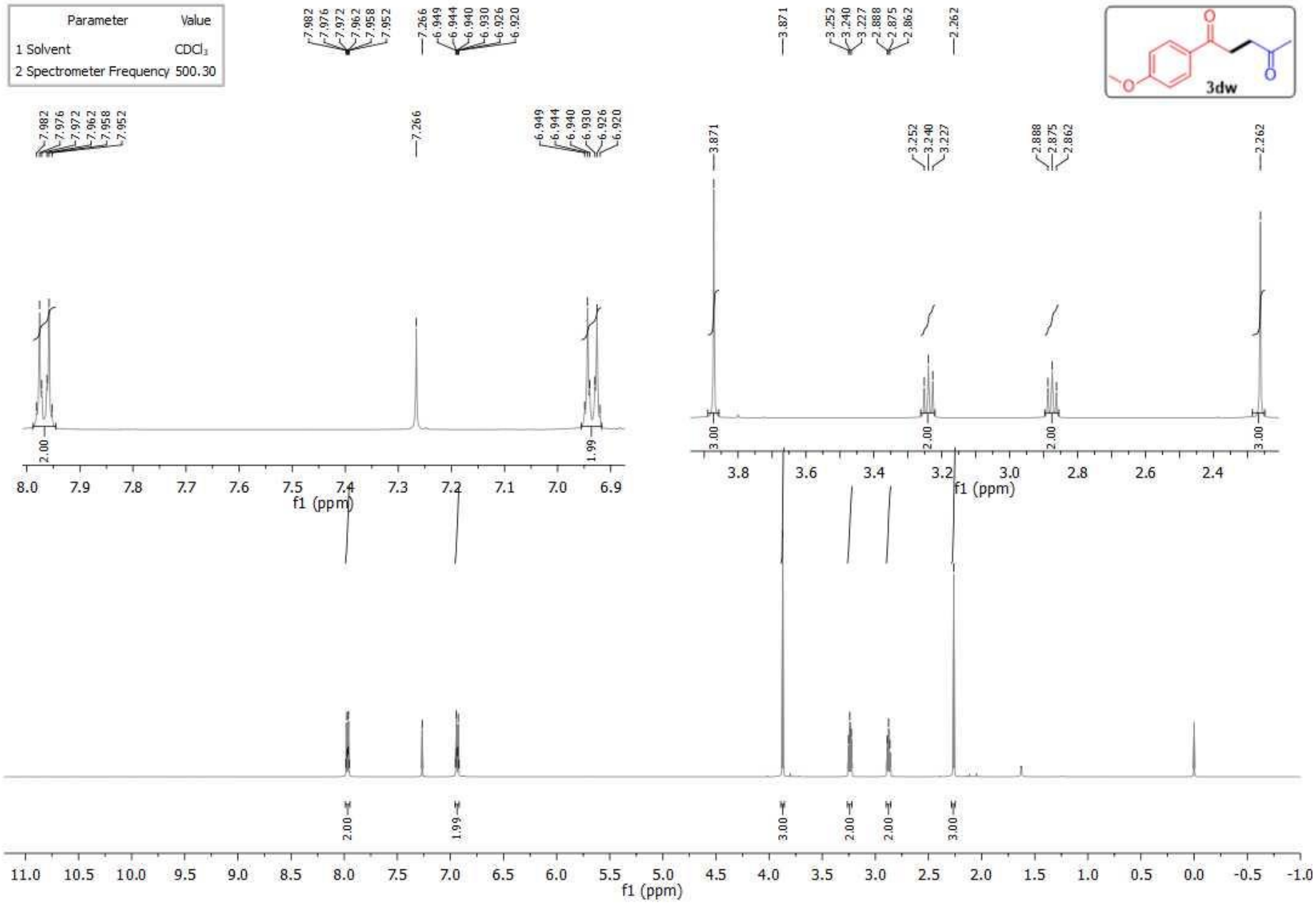

Figure S86. ^{1}H NMR spectrum of 1-(4-Methoxyphenyl)pentane-1,4-dione (**3dw**).

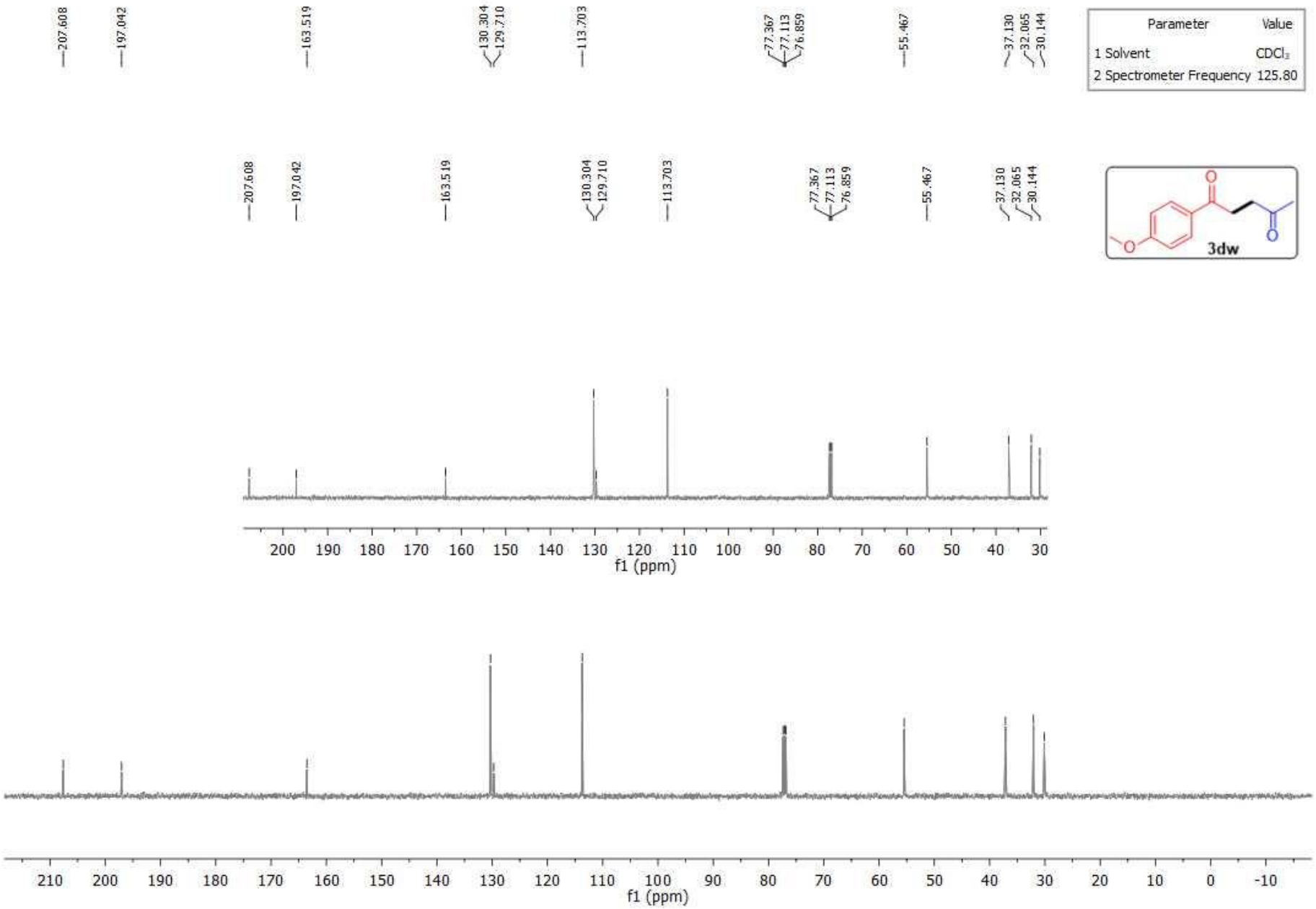

Figure S87. ^{13}C NMR spectrum of 1-(4-Methoxyphenyl)pentane-1,4-dione (**3dw**).

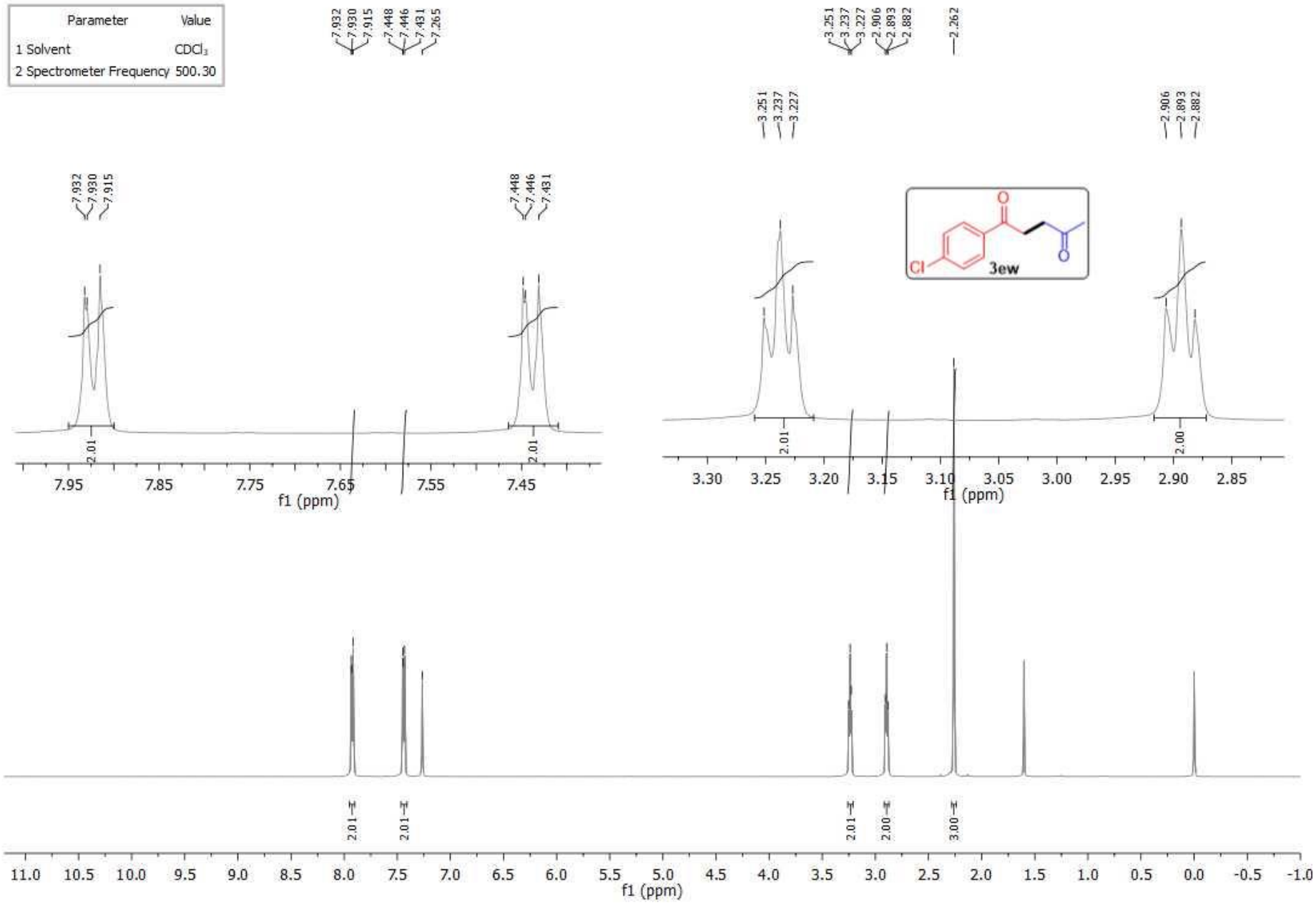

Figure S88. ^{1}H NMR spectrum of 1-(4-Chlorophenyl)pentane-1,4-dione (**3ew**).

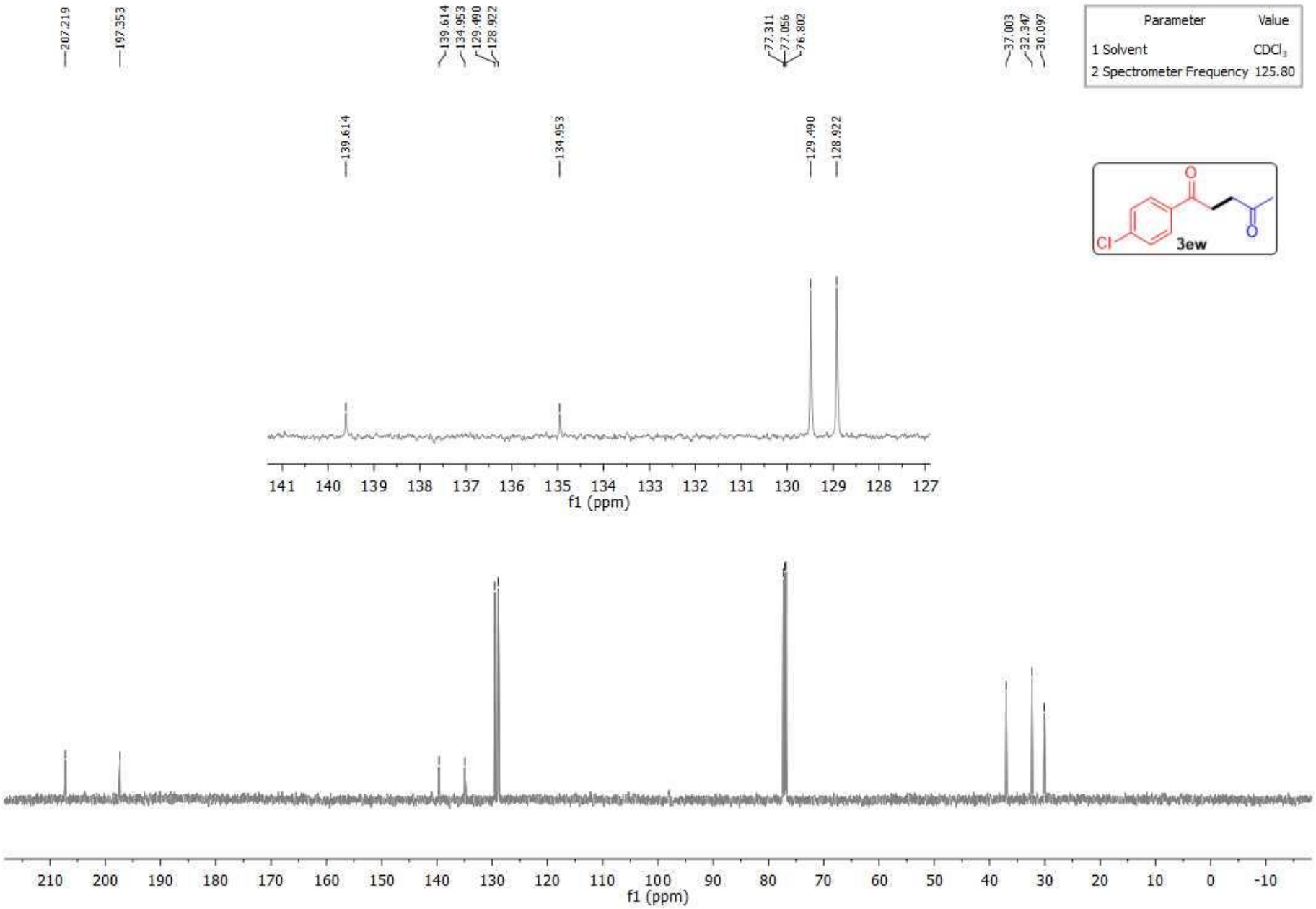

Figure S89. ^{13}C NMR spectrum of 1-(4-Chlorophenyl)pentane-1,4-dione (**3ew**).

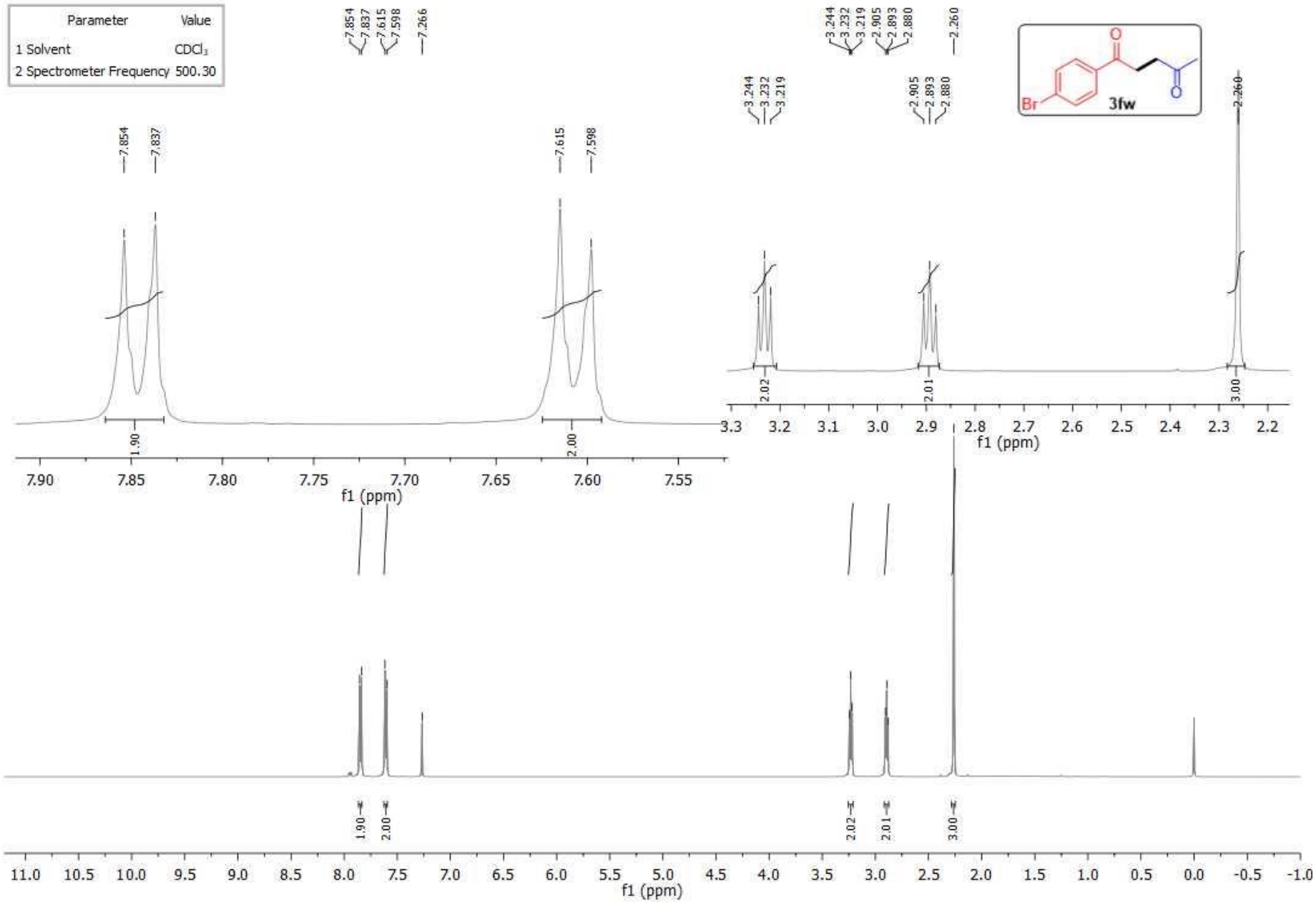

Figure S90. ^{1}H NMR spectrum of 1-(4-Bromophenyl)pentane-1,4-dione (**3fw**).

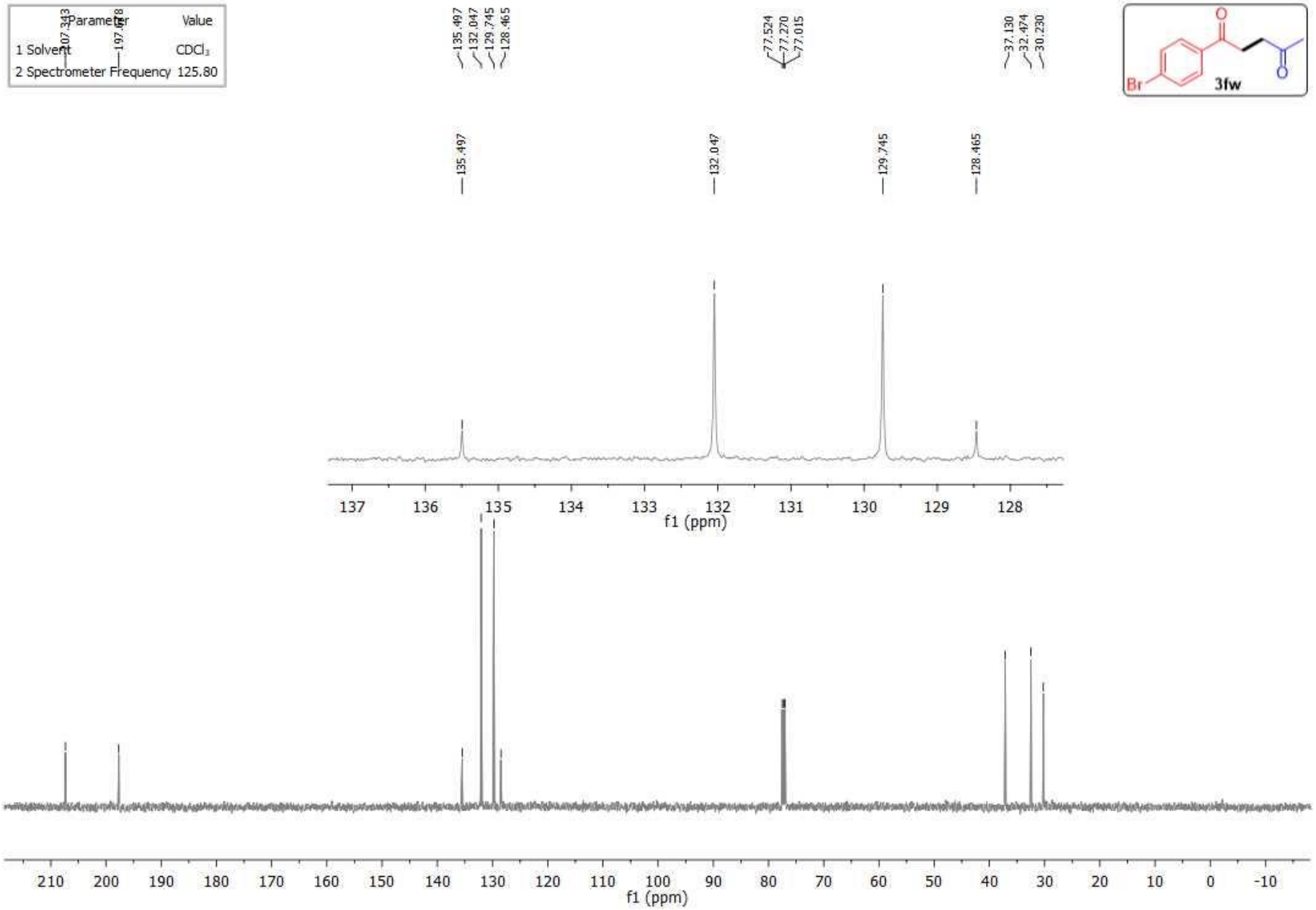

Figure S91. ^{13}C NMR spectrum of 1-(4-Bromophenyl)pentane-1,4-dione (**3fw**).

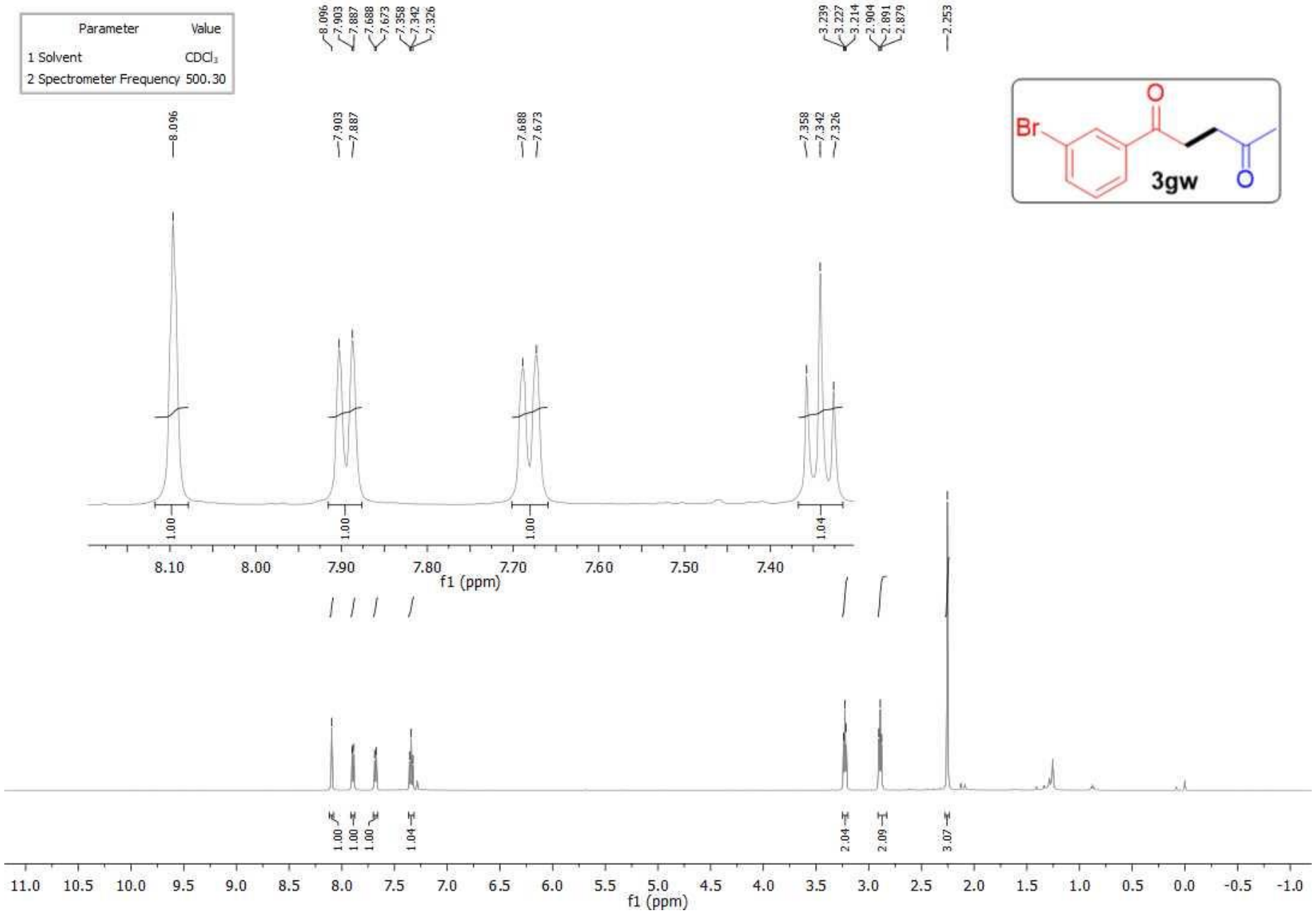

Figure S92. ^{1}H NMR spectrum of 1-(3-Bromophenyl)pentane-1,4-dione (**3gw**).

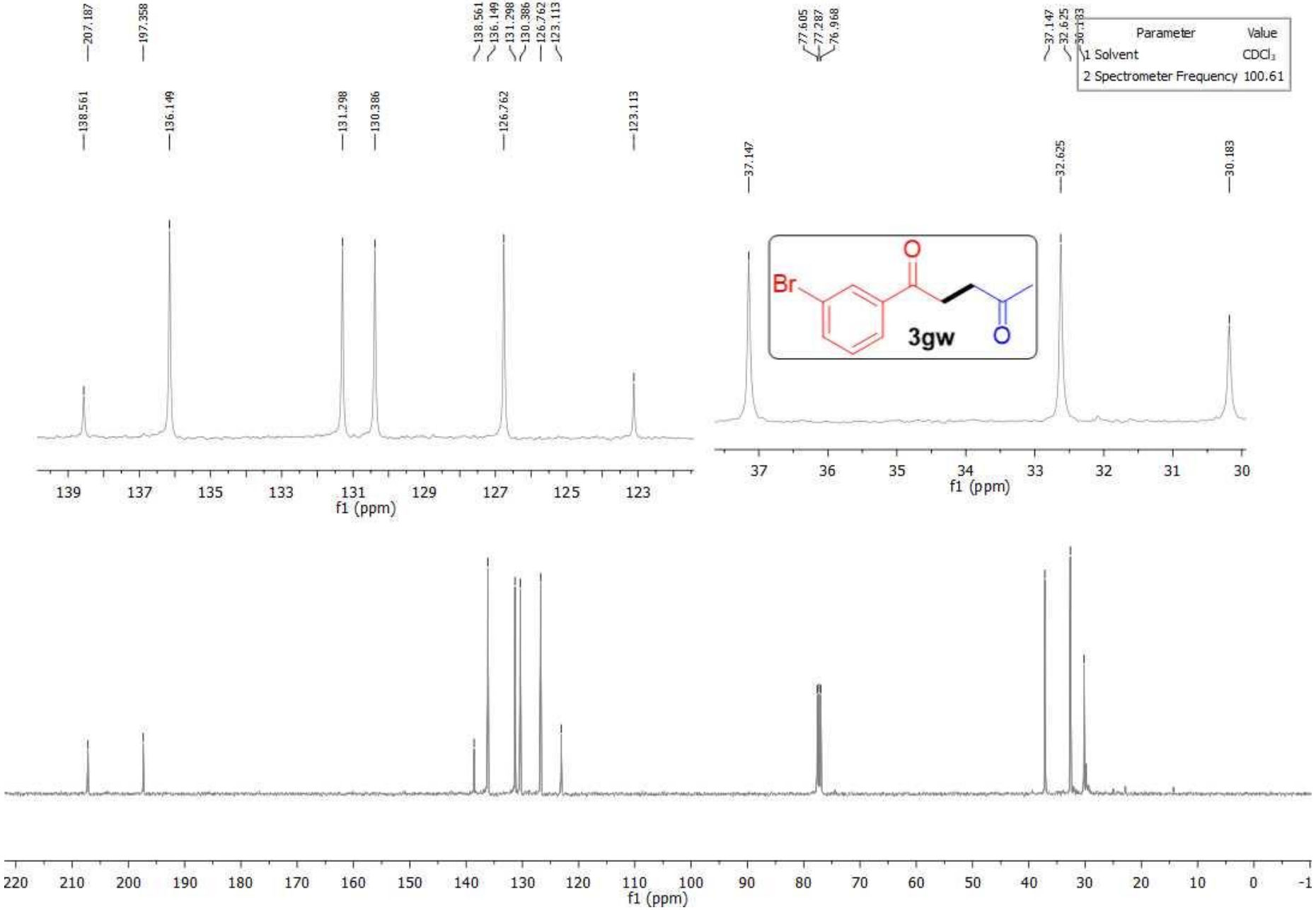

Figure S93. ^{13}C NMR spectrum of 1-(3-Bromophenyl)pentane-1,4-dione (**3gw**).

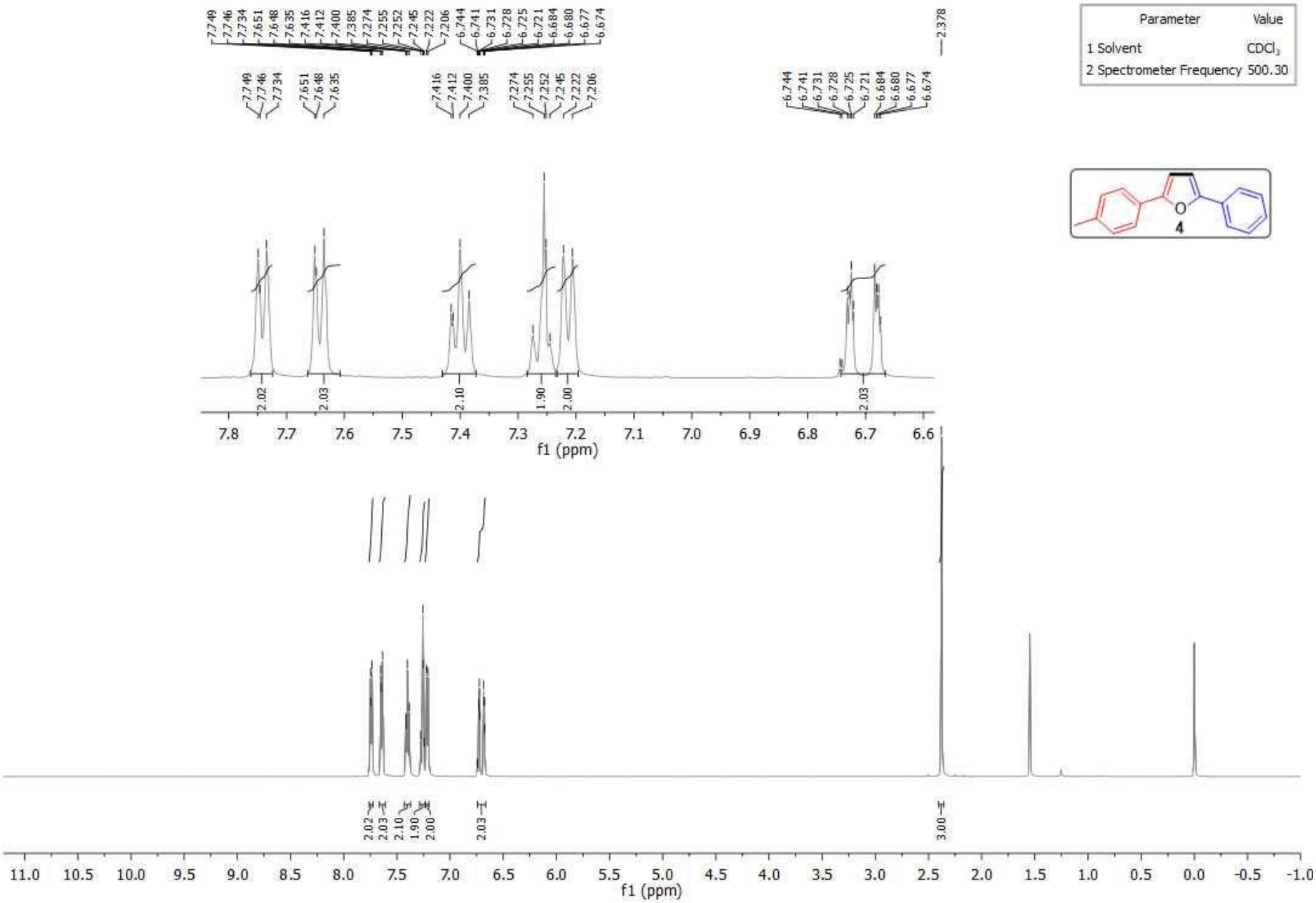

Figure S94. ^{1}H NMR spectrum of 2-Phenyl-5-(*p*-tolyl)furan (**4**).

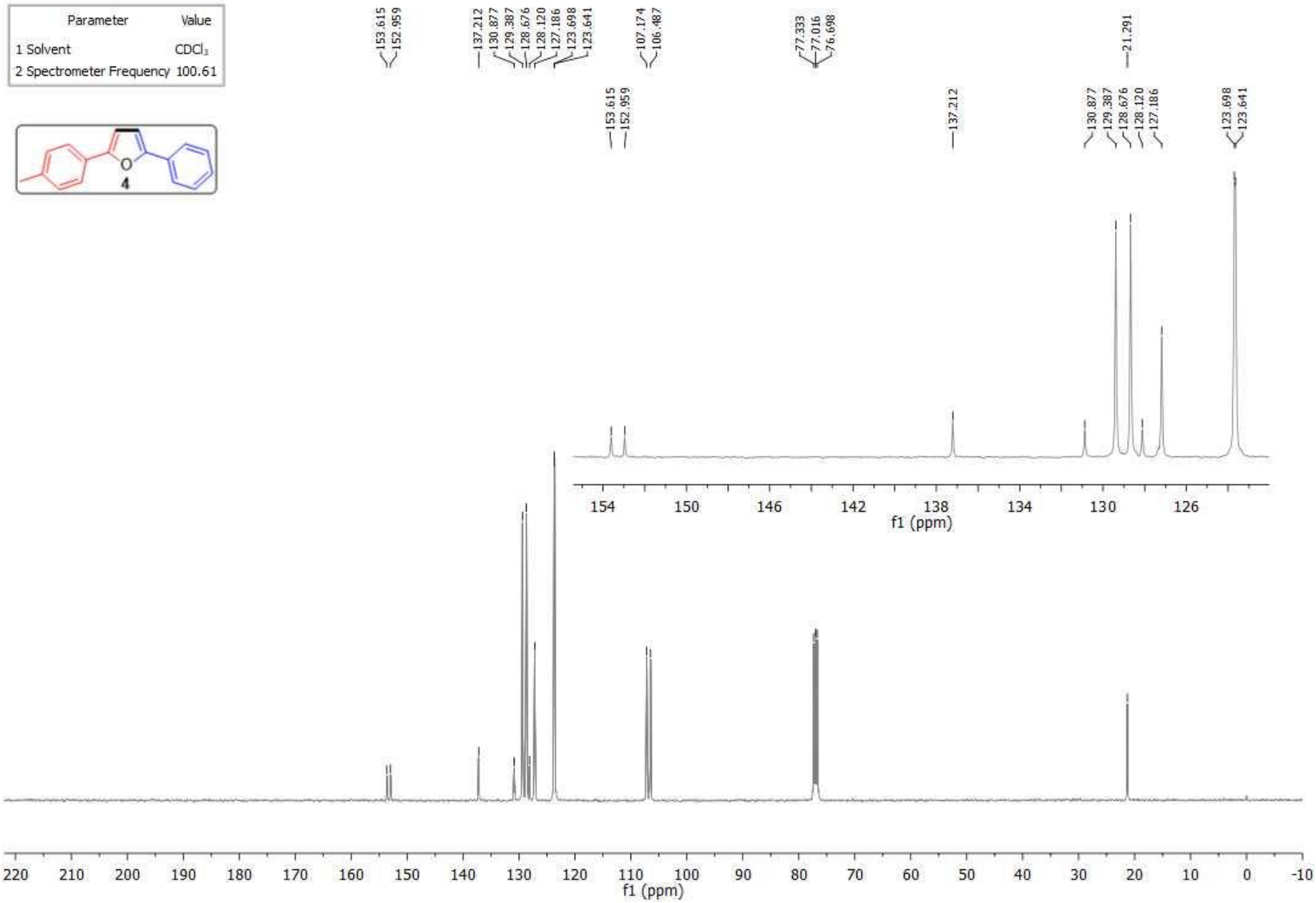

Figure S95. ^{13}C NMR spectrum of 2-Phenyl-5-(*p*-tolyl)furan (**4**).

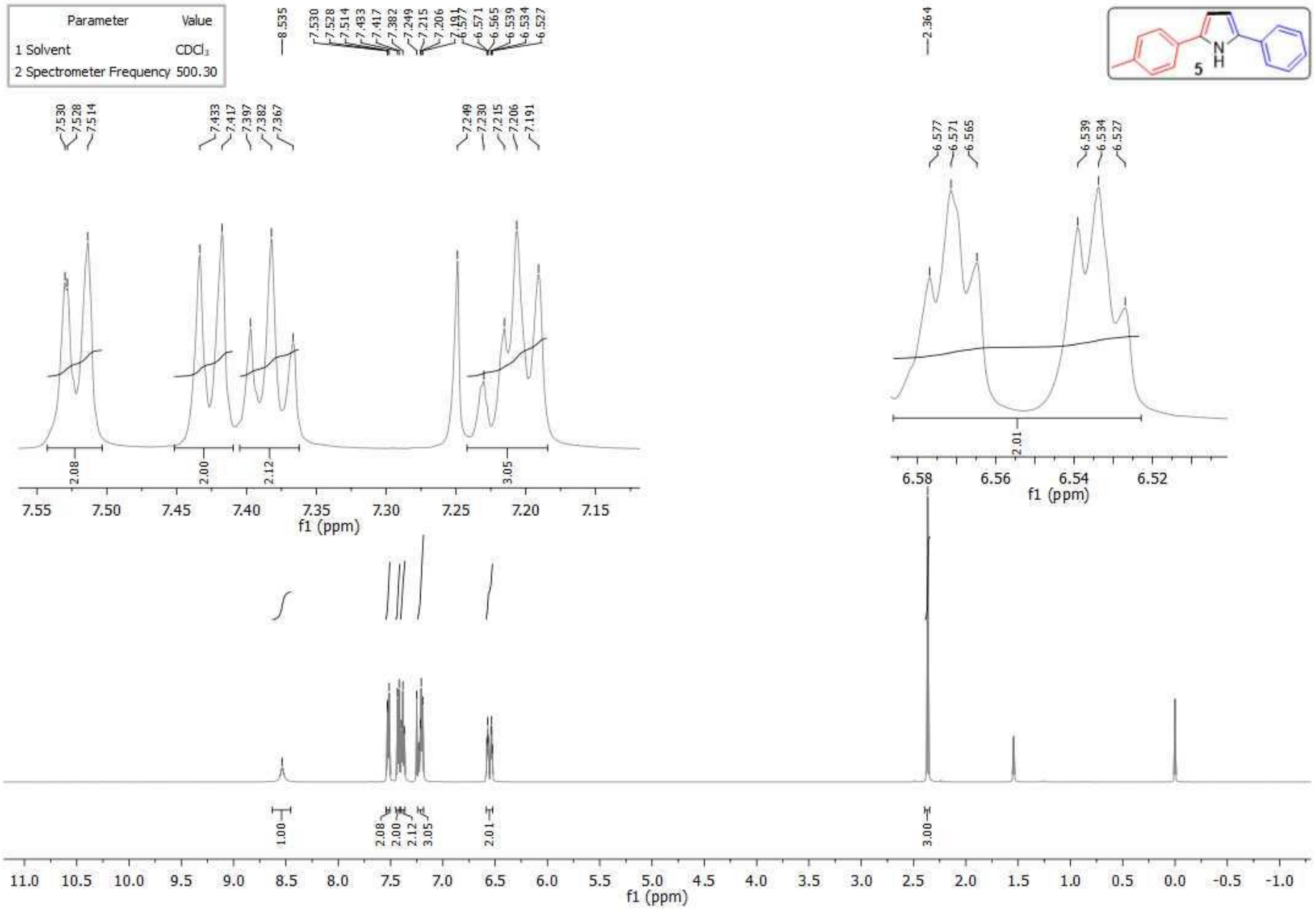

Figure S96. ^{1}H NMR spectrum of 2-Phenyl-5-(*p*-tolyl)-1*H*-pyrrole (**5**).

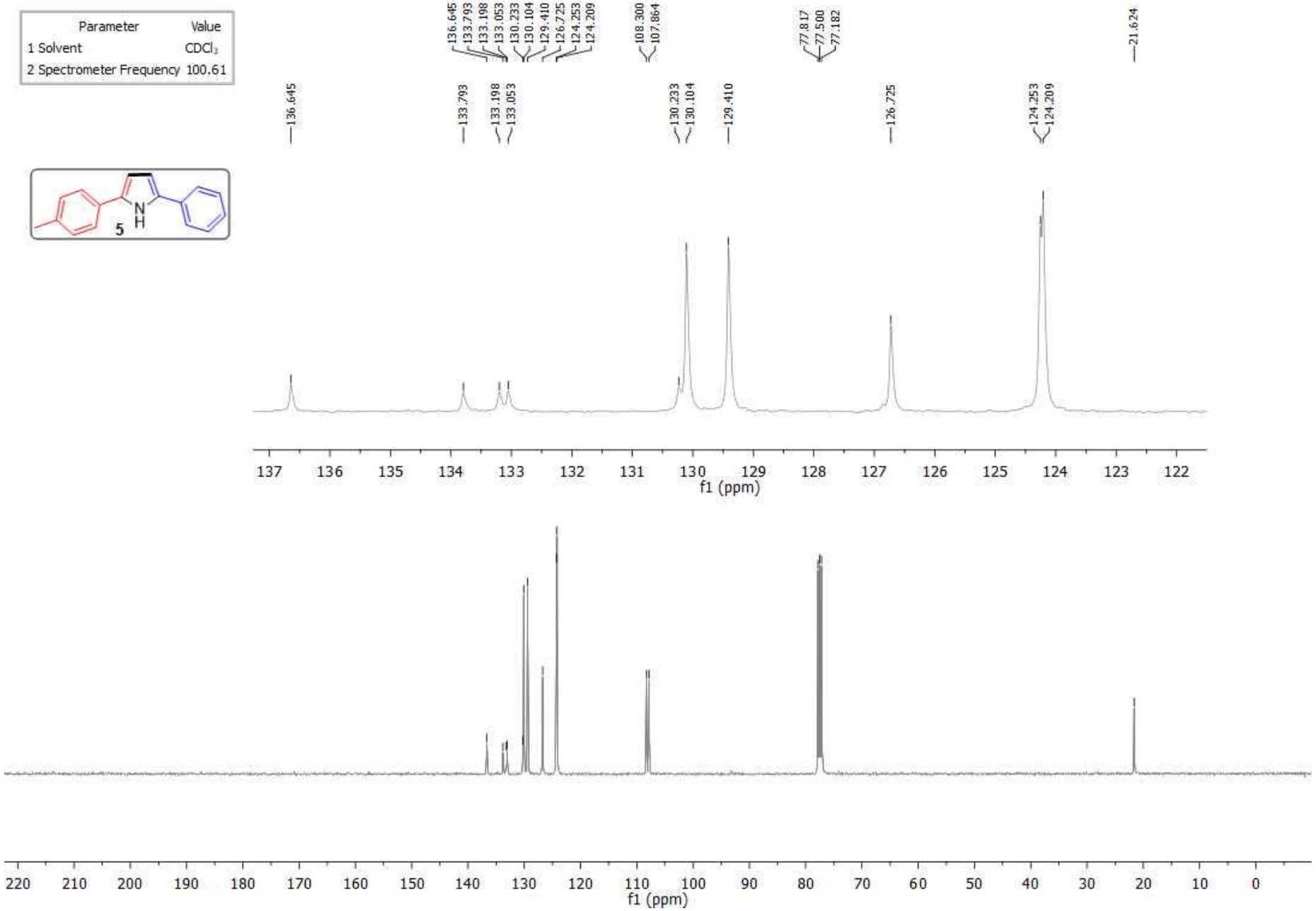

Figure S97. ^{13}C NMR spectrum of 2-Phenyl-5-(*p*-tolyl)-1*H*-pyrrole (**5**).

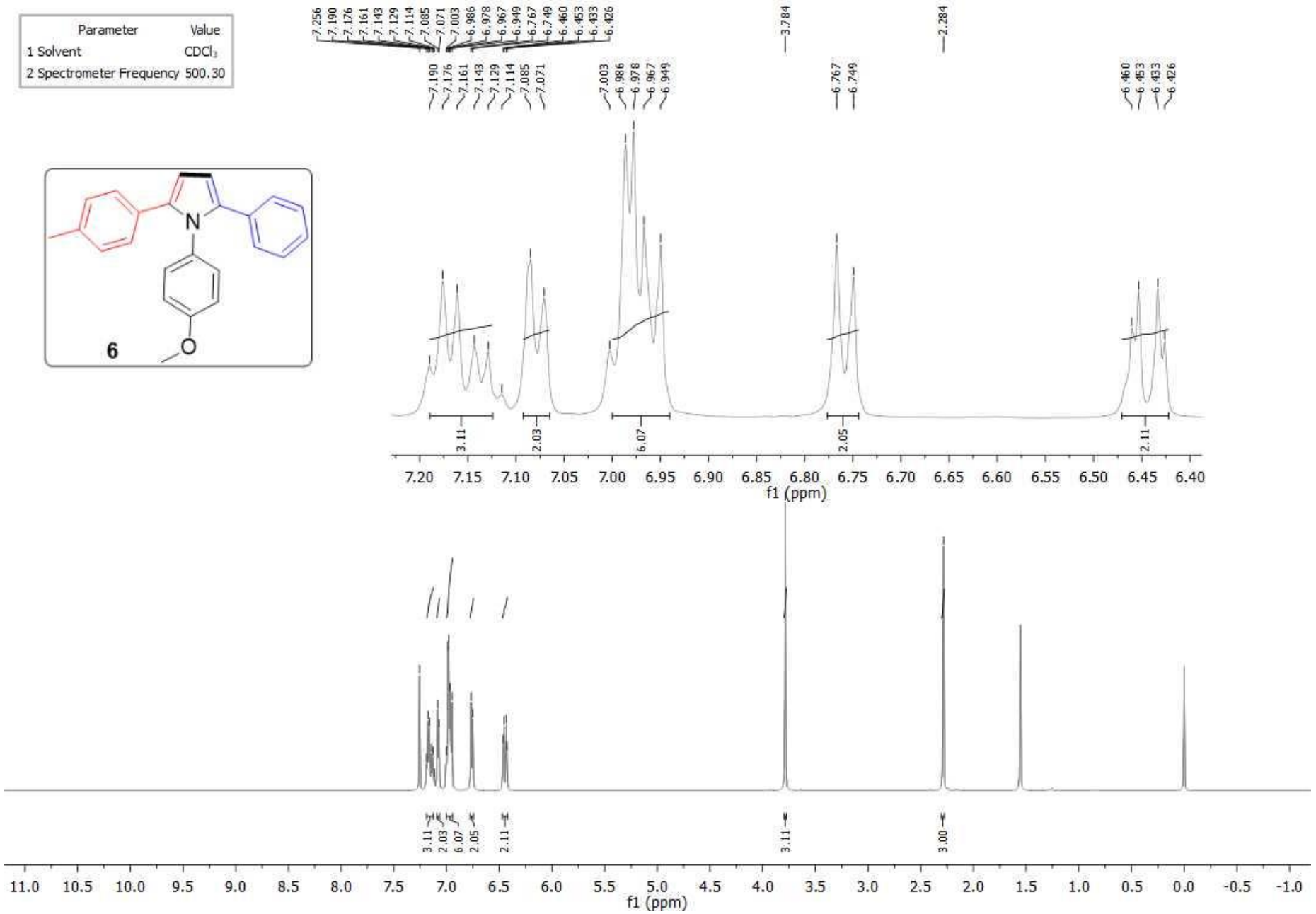

Figure S98. ^{1}H NMR spectrum of 1-(4-Methoxyphenyl)-2-phenyl-5-(*p*-tolyl)-1*H*-pyrrole (**6**).

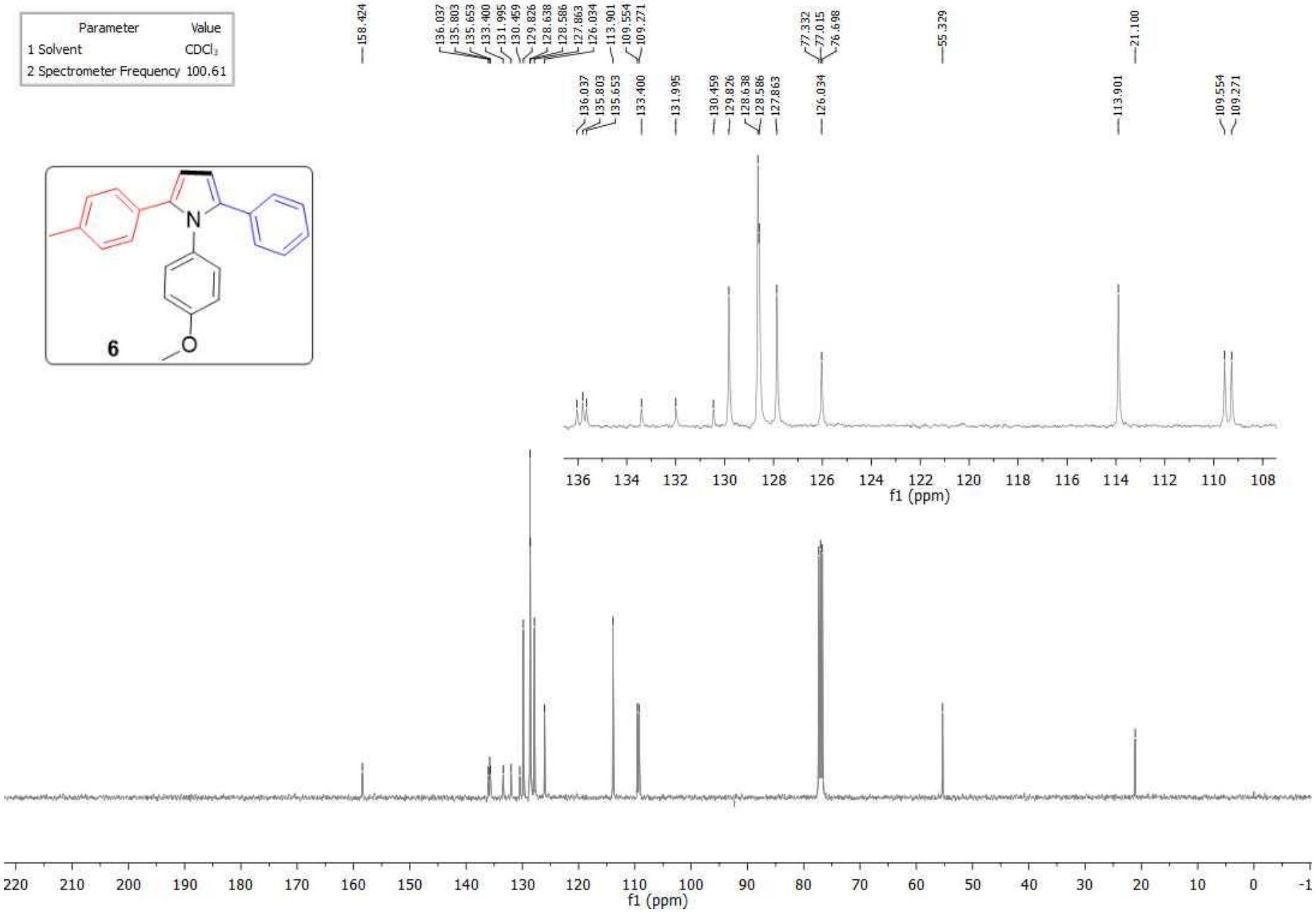

Figure S99. ^{13}C NMR spectrum of 1-(4-Methoxyphenyl)-2-phenyl-5-(*p*-tolyl)-1*H*-pyrrole (**6**).

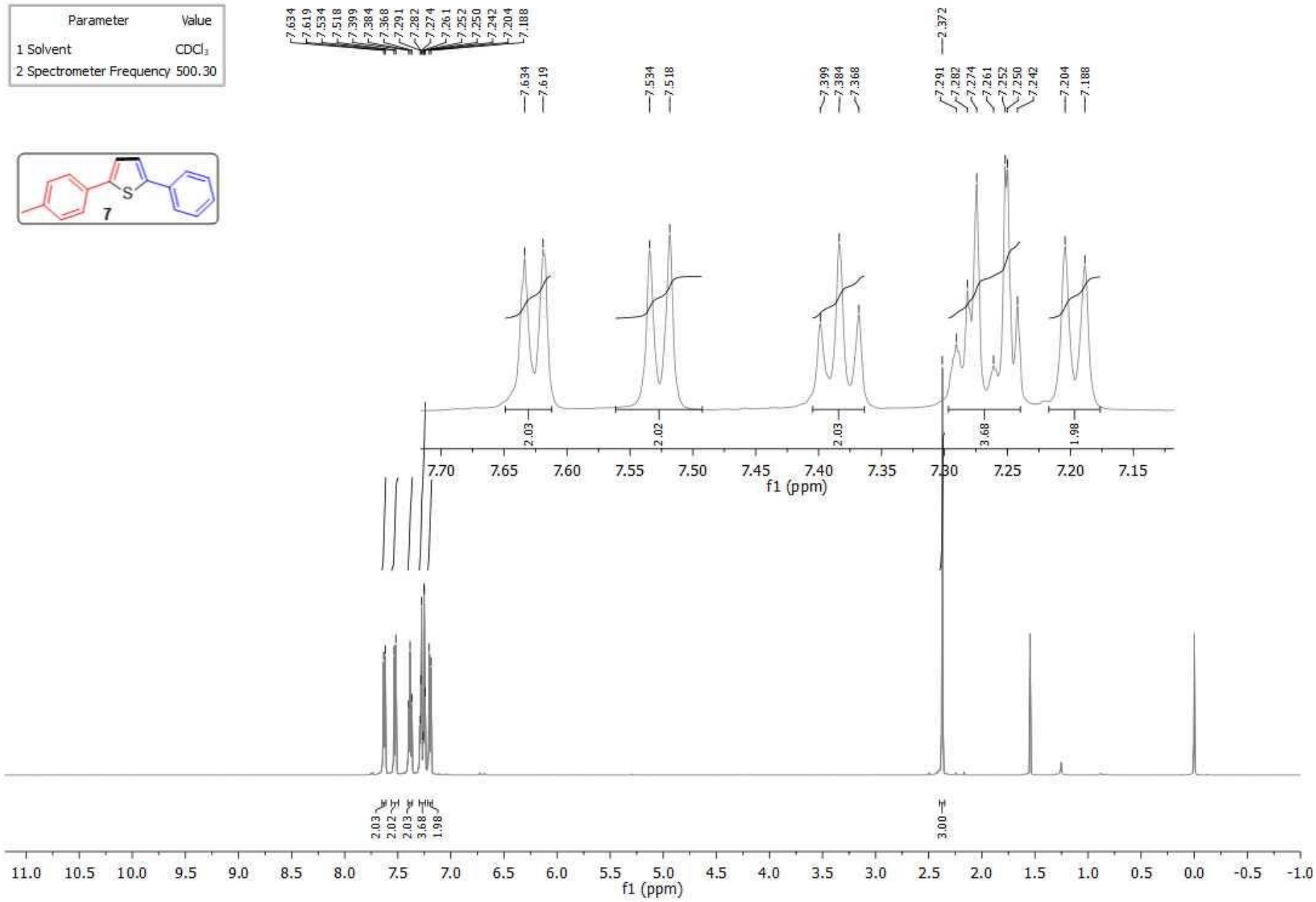

Figure S100. [1]H NMR spectrum of 2-Phenyl-5-(*p*-tolyl)thiophene (**7**).

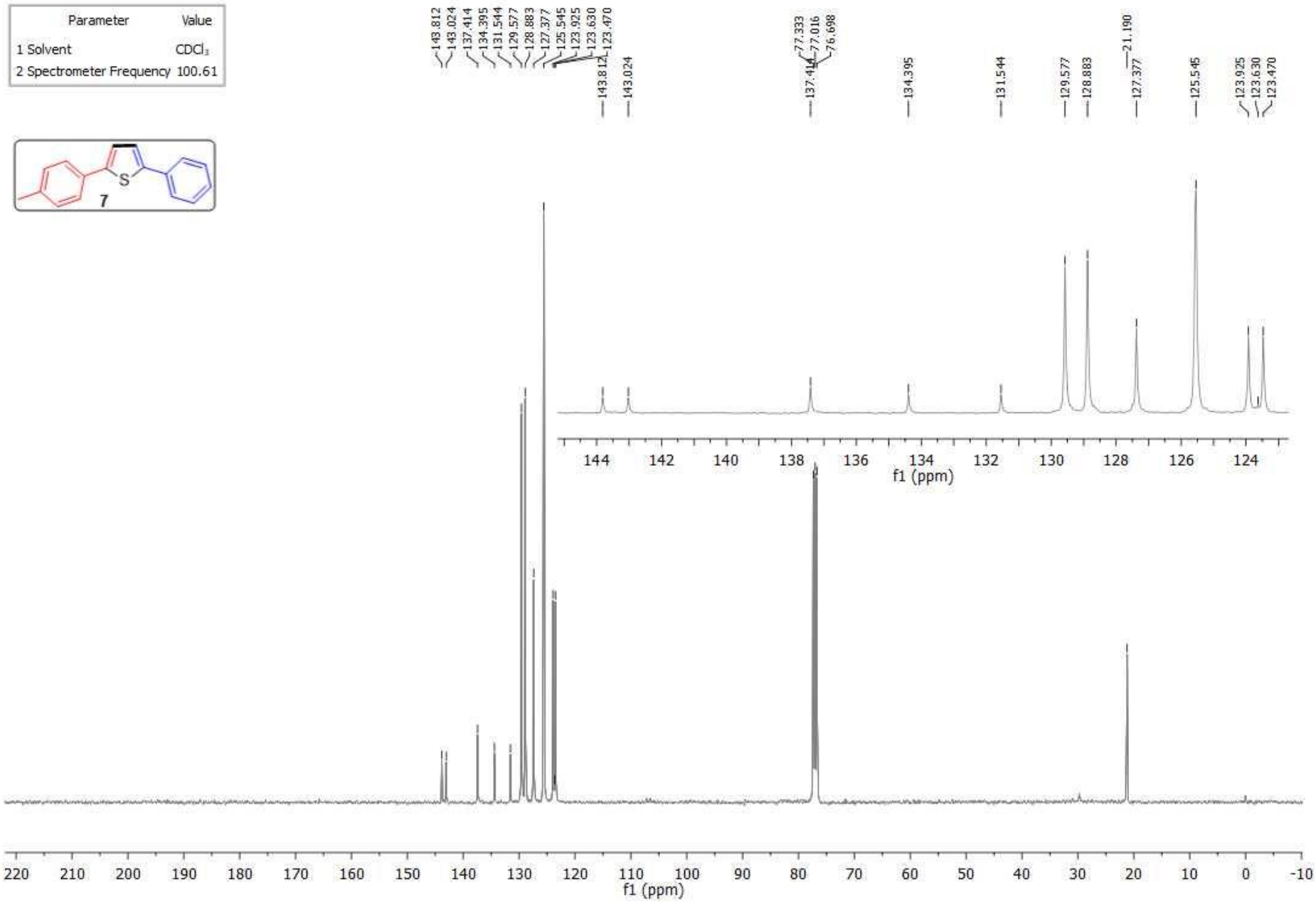

Figure S101. ^{13}C NMR spectrum of 2-Phenyl-5-(*p*-tolyl)thiophene (**7**).

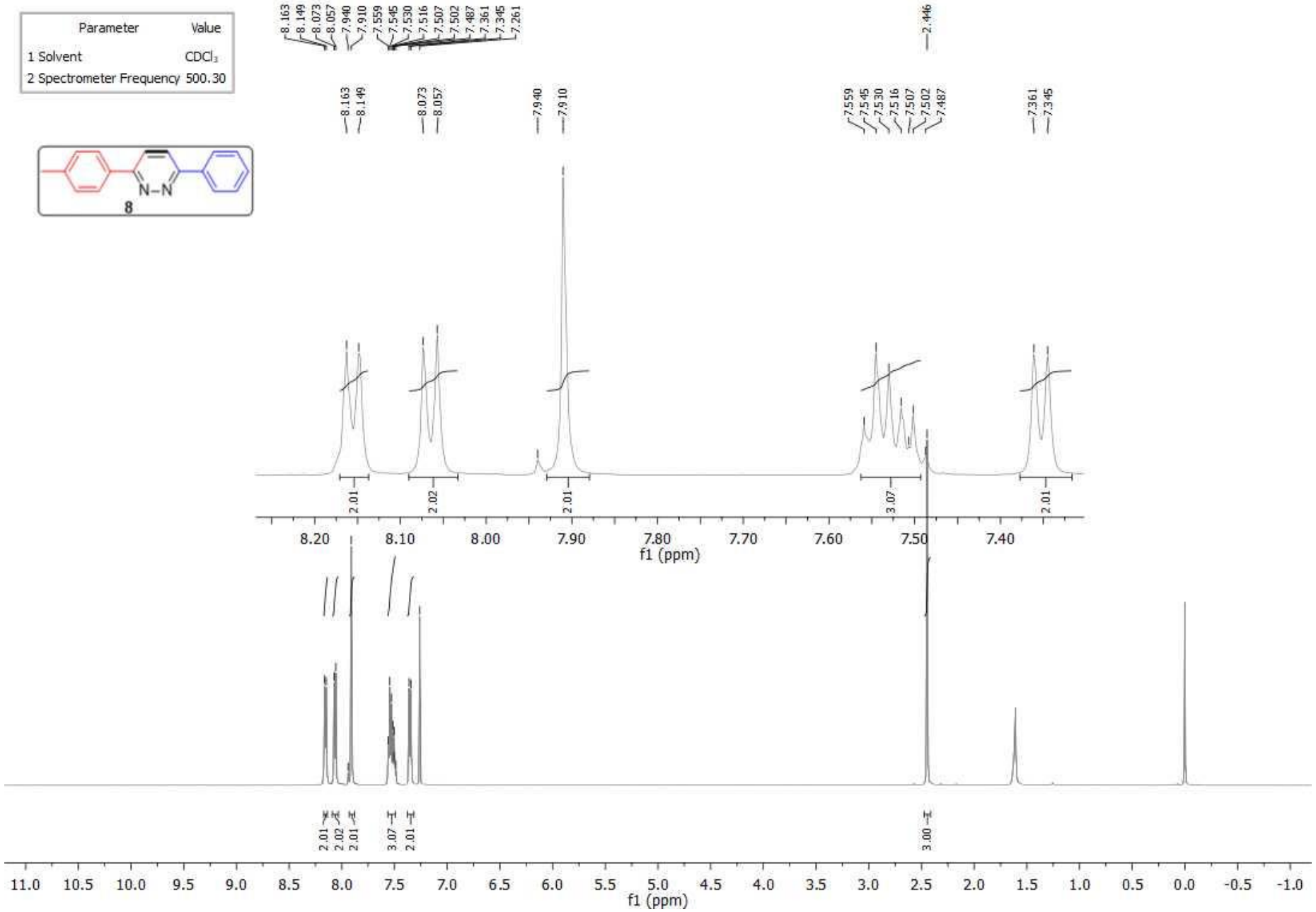

Figure S102. ^{1}H NMR spectrum of 3-Phenyl-6-(*p*-tolyl)pyridazine (**8**).

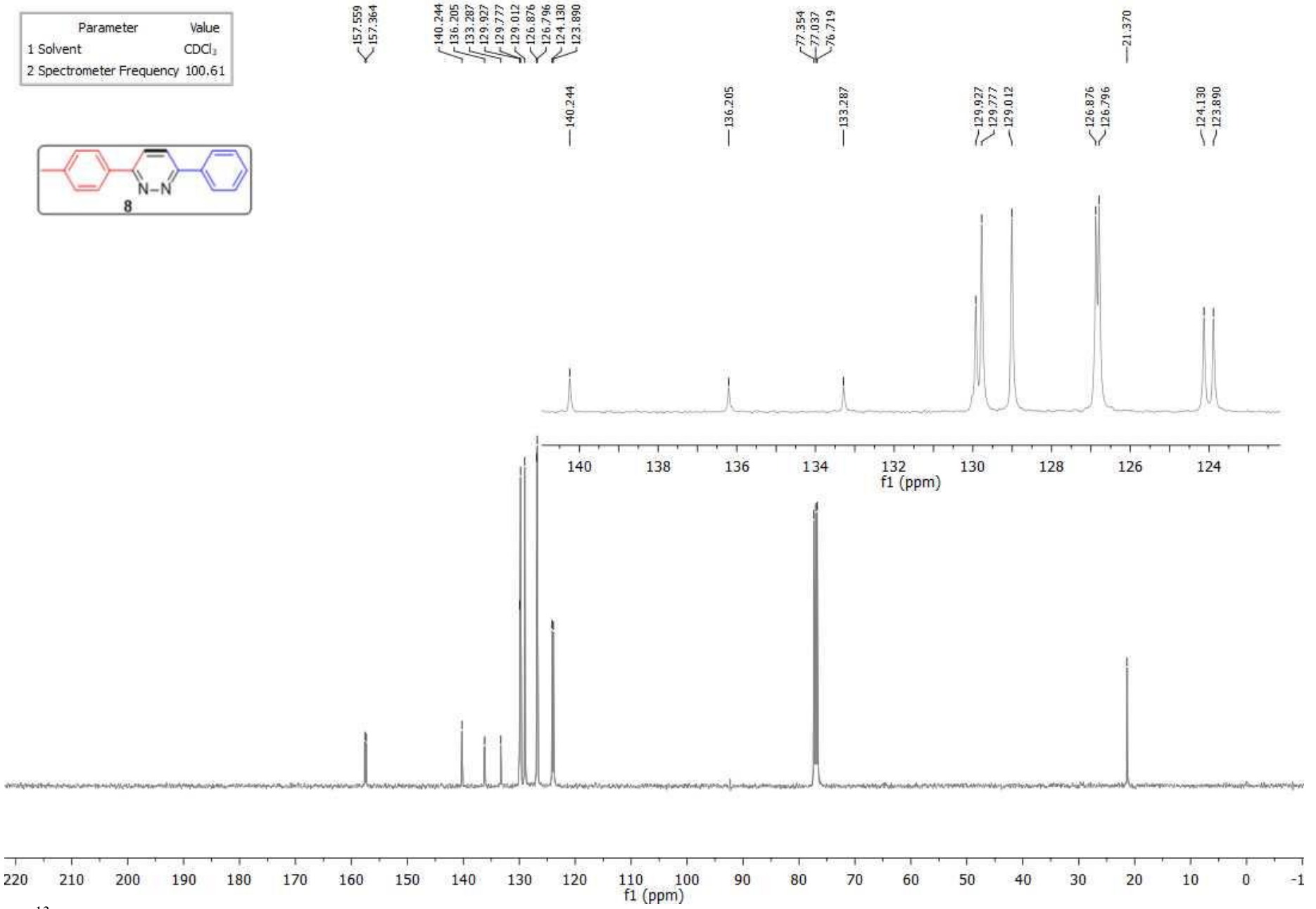

Figure S103. ^{13}C NMR spectrum of 3-Phenyl-6-(*p*-tolyl)pyridazine (**8)**

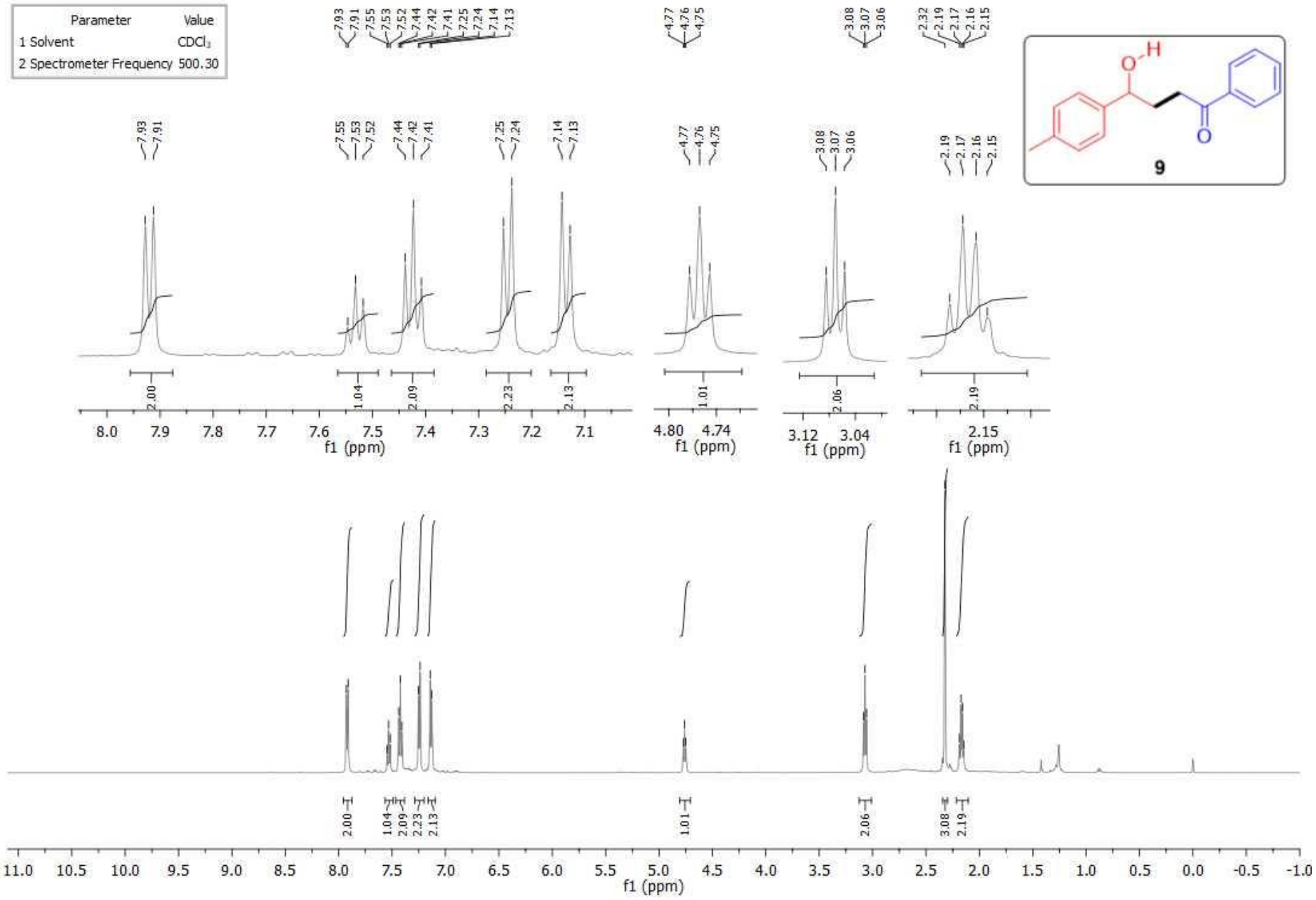

Figure S104. ^{1}H NMR spectrum of 4-Hydroxy-1-Phenyl-4-(*p*-tolyl)butane-1-one (**9**).

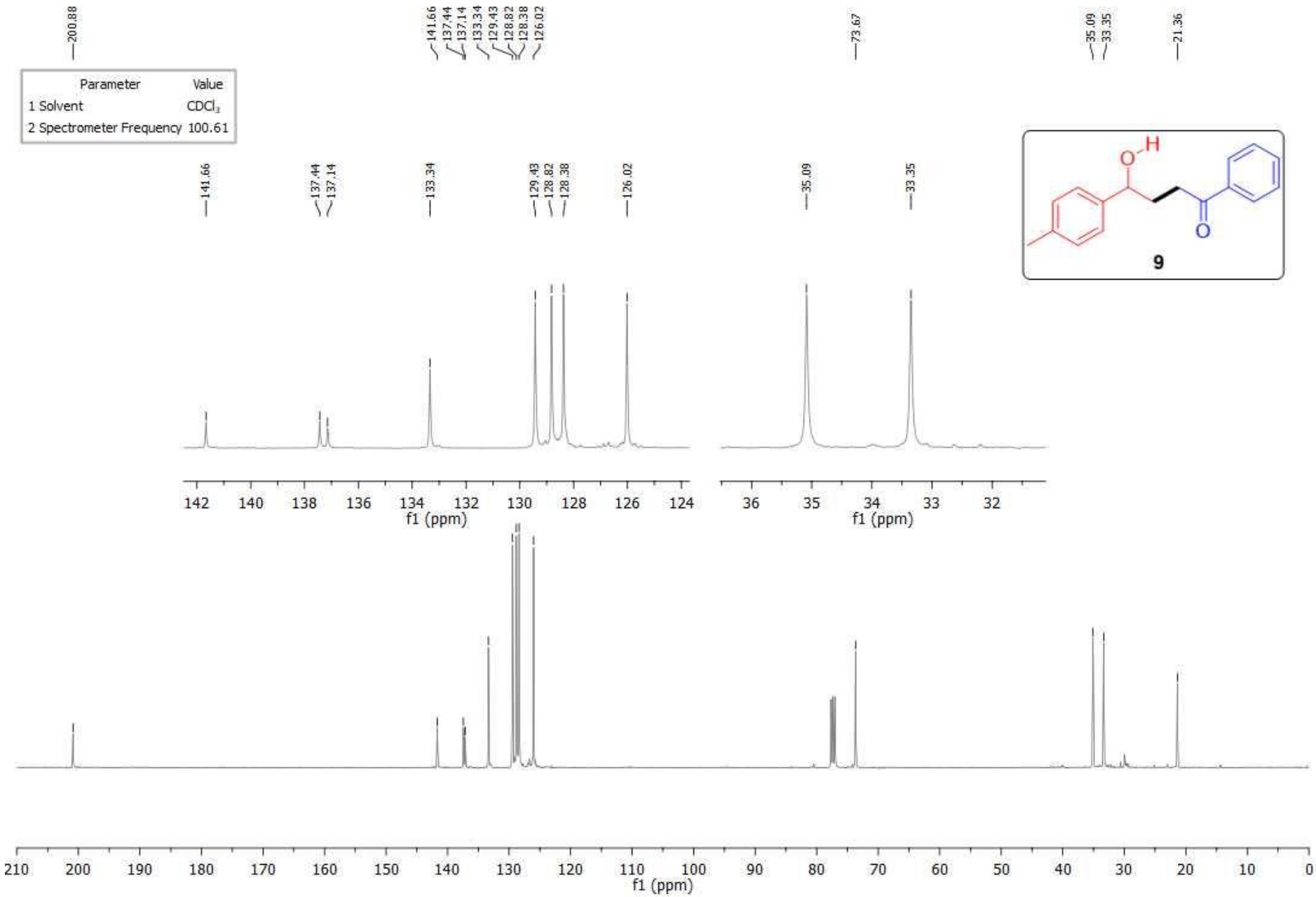

Figure S105. ^{13}C NMR spectrum of 4-Hydroxy-1-Phenyl-4-(*p*-tolyl)butane-1-one (**9**).