

Supporting Information

DTBP-promoted site-selective α -alkoxyl C-H functionalization of alkyl esters: synthesis of 2-alkyl ester substituted chromanones

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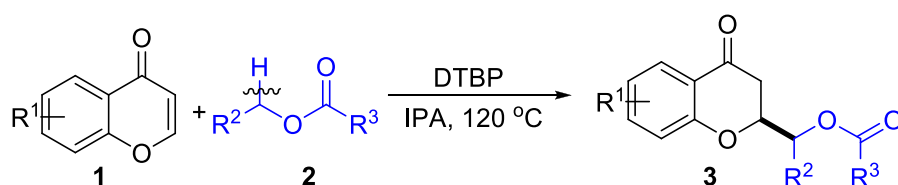
1. General experimental details.....	S2
2. Mechanism studies.....	S3
3. Characterization data of the products.....	S6
4. Copies of ^1H NMR and ^{13}C NMR spectra of the products.....	S19

General experimental details

General Information:

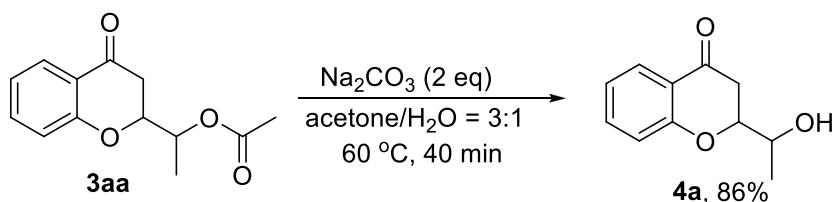
All chemicals were used as received without further purification unless stated otherwise. NMR spectra were recorded at ambient temperature on a 300 or 400 MHz NMR spectrometer. Chemical shifts (δ) are given in parts per million (ppm), and were referenced to CDCl_3 (7.26 or 77.0 ppm) as the internal standard. HRMS were recorded on a TOF LC/MS equipped with electrospray ionization (ESI) probe operating in positive or negative ion mode.

Experimental procedure:



Under N_2 , the mixture of **1** (0.2 mmol), **2** (1 mL), DTBP (1.2 mmol, 6 eq) and isopropanol (1 mmol, 5 eq) were added into the tube and sealed. The reaction mixture was vigorously stirred at 120 °C for 12 h. Then, solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography on silica gel to give the products **3**.

Experiment procedure for the Hydrolysis



A 10 mL reaction tube equipped with a magnetic stir bar was charged with 1-(4-oxochroman-2-yl)ethyl acetate (**3aa**, 0.2 mmol, 47 mg), sodium carbonate (Na_2CO_3 , 42 mg, 0.4 mmol), H_2O (0.5 mL) and acetone (2 mL). The reaction mixture was stirred at 60 °C for 40 min. After completion (checked by TLC), the mixture was concentrated under reduced pressure and the crude product was purified by silica gel column chromatography to afford 2-(1-hydroxyethyl)chroman-4-one **4a**. Yield: 33.0 mg, 86%. Colorless oil.

1. Mechanism Studies

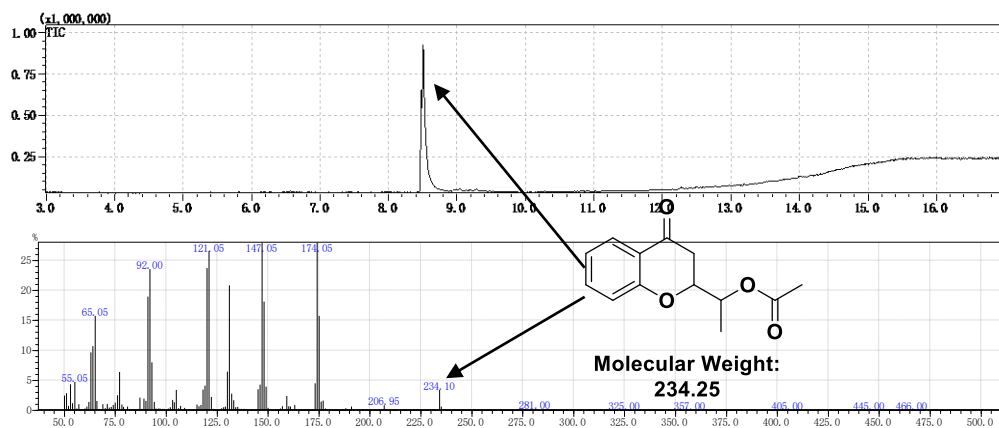
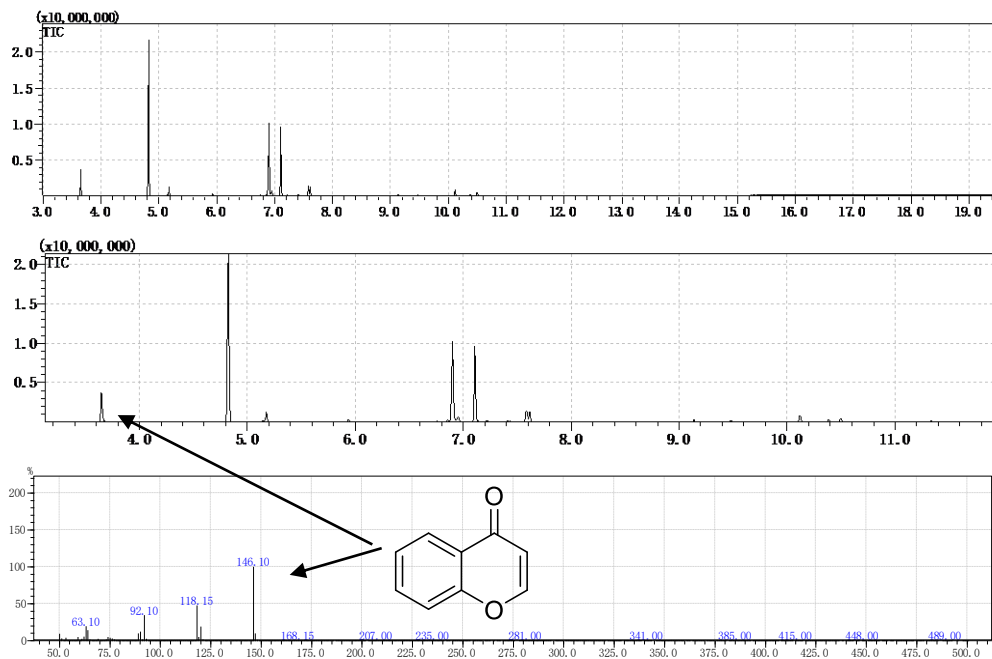
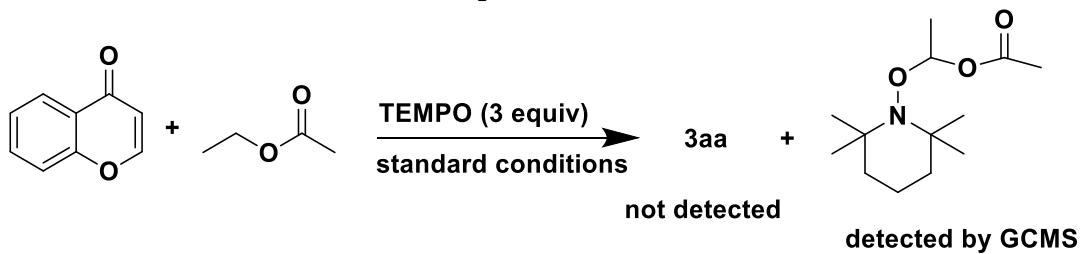


Figure S1 GC-MS spectra of the product 3aa

Standard Procedure + TEMPO (3.0 equiv)



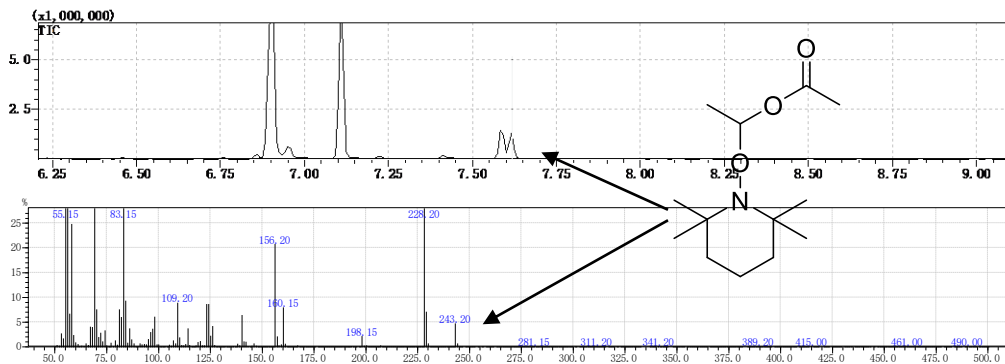
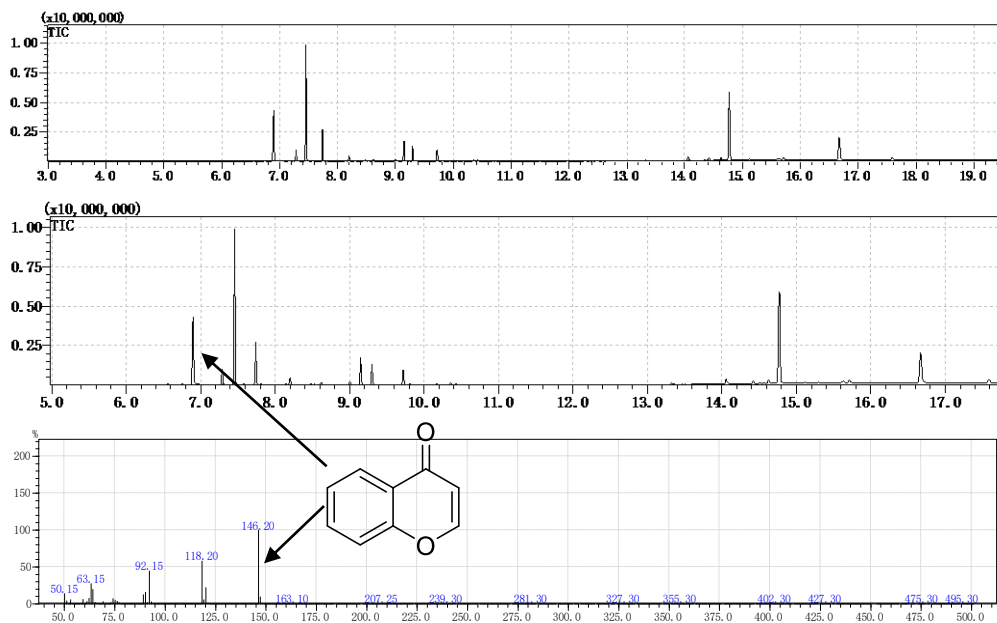
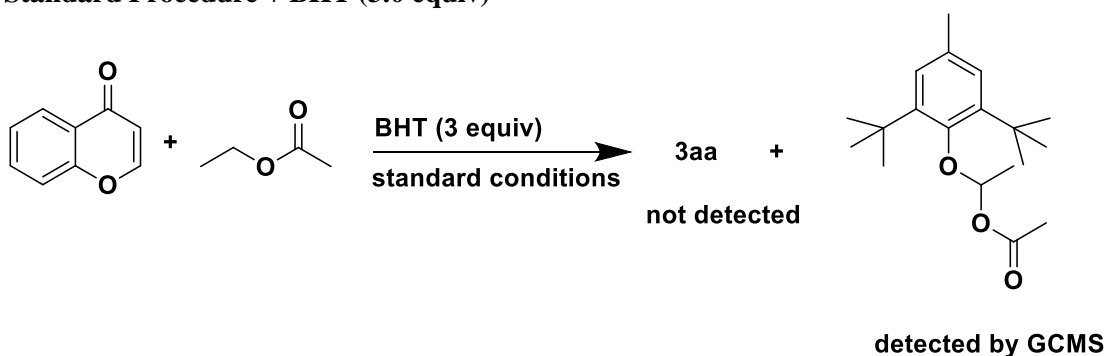


Figure S2 GC-MS spectra of the free radical capture results

Standard Procedure + BHT (3.0 equiv)



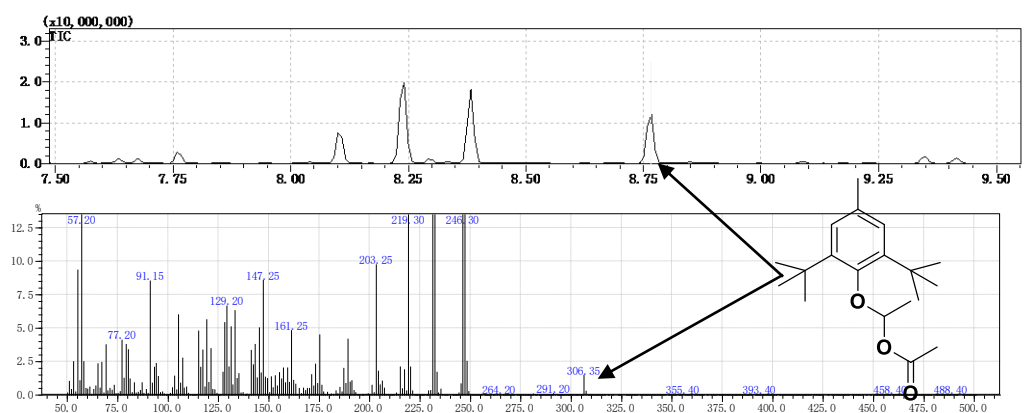
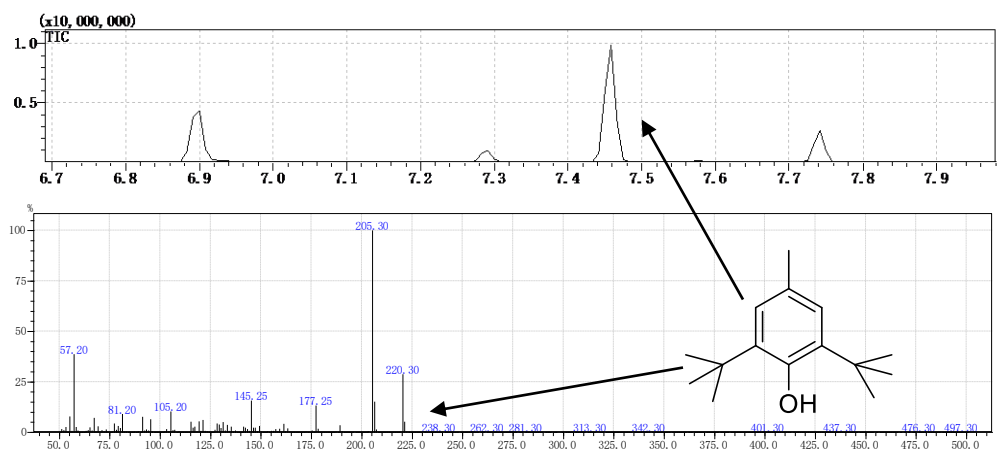
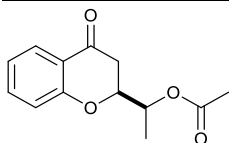


Figure S3 GC-MS spectra of the free radical capture results

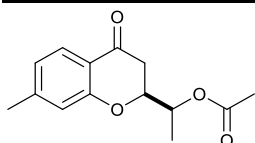
3. Characterization data of the products

1-(4-Oxochroman-2-yl)ethyl acetate (3aa)



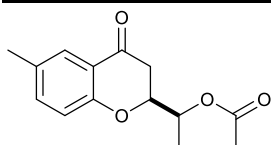
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3aa** as a yellow oil (33.2 mg, 71% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.87 (dd, $J = 7.8, 1.7$ Hz, 1H), 7.50-7.46 (m, 1H), 7.04-6.99 (m, 2H), 5.26-5.16 (m, 1H), 4.50-4.43 (m, 1H), 2.87-2.77 (m, 1H), 2.75-2.62 (m, 1H), 2.09 (s, 1.5H), 2.07 (s, 1.5H), 1.40 (d, $J = 6.6$ Hz, 1.5H), 1.36 (d, $J = 6.5$ Hz, 1.5H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 191.6, 191.5, 170.1, 170.1, 161.1, 161.0, 136.1, 136.1, 126.9, 126.9, 121.6, 120.9, 120.8, 117.9, 78.9, 78.4, 70.7, 70.3, 39.0, 38.3, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{14}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 257.0784, found 257.0781.

1-(7-Methyl-4-oxochroman-2-yl)ethyl acetate (3ba)



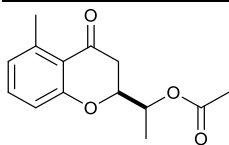
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.3$) give **3ba** as a yellow oil (43.6 mg, 88% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.75 (d, $J = 7.9$ Hz, 1H), 6.88-6.76 (m, 2H), 5.26-5.10 (m, 1H), 4.47-4.33 (m, 1H), 2.82-2.56 (m, 2H), 2.34 (s, 3H), 2.09 (s, 1.5H), 2.07 (s, 1.5H), 1.38 (d, $J = 6.6$ Hz, 1.5H), 1.34 (d, $J = 6.6$ Hz, 1.5H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 191.3, 191.2, 170.2, 170.1, 161.1, 161.0, 147.7, 147.6, 126.7, 126.7, 122.9, 122.9, 118.6, 118.5, 117.9, 78.8, 78.4, 70.7, 70.3, 38.9, 38.2, 21.9, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 271.0941, found 271.0935.

1-(6-Methyl-4-oxochroman-2-yl)ethyl acetate (3ca)



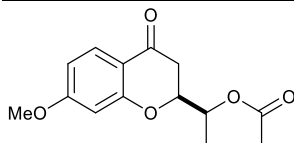
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.3$) give **3ca** as a yellow oil (40.2 mg, 81% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.66 (s, 1H), 7.29 (dd, $J = 8.4, 2.2$ Hz, 1H), 6.90 (d, $J = 8.4$ Hz, 1H), 5.25-5.11 (m, 1H), 4.50-4.35 (m, 1H), 2.85-2.53 (m, 2H), 2.30 (s, 3H), 2.09 (s, 1.5H), 2.08 (s, 1.5H), 1.39 (d, $J = 6.5$ Hz, 1.5H), 1.35 (d, $J = 6.5$ Hz, 1.5H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 191.9, 191.8, 170.2, 170.1, 159.1, 159.1, 137.2, 137.1, 131.0, 126.4, 126.4, 120.4, 120.4, 117.7, 78.9, 78.4, 70.7, 70.3, 39.0, 38.4, 21.1, 21.0, 20.4, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 271.0941, found 271.0936.

1-(5-Methyl-4-oxochroman-2-yl)ethyl acetate (3da)



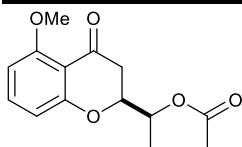
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3da** as a yellow oil (31.2 mg, 63% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.72 (d, $J = 7.0$ Hz, 1H), 7.34 (d, $J = 7.1$ Hz, 1H), 6.91 (t, 7.6 Hz, 1H), 5.30-5.20 (m, 1H), 4.47-4.38 (m, 1H), 2.85-2.60 (m, 2H), 2.24 (s, 3H), 2.10 (s, 1.55H), 2.07 (s, 1.44H), 1.39 (t, $J = 5.7$ Hz, 3H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 191.9, 191.9, 170.2, 170.1, 159.2, 159.2, 136.9, 127.2, 127.1, 124.4, 121.0, 120.5, 78.7, 78.5, 70.7, 70.3, 38.9, 38.4, 21.0, 21.0, 15.8, 15.6, 15.5, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_4^+[\text{M}+\text{Na}^+]$: 271.0941, found 271.0936.

1-(7-Methoxy-4-oxochroman-2-yl)ethyl acetate (3ea)



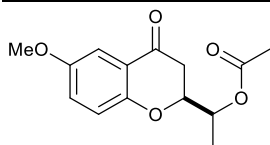
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.3$) give **3ea** as a yellow oil (37.0 mg, 70% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.79 (d, $J = 8.8$ Hz, 1H), 6.59-6.55 (m, 1H), 6.44-6.42 (m, 1H), 5.25-5.13 (m, 1H), 4.48-4.39 (m, 1H), 3.82 (d, $J = 1.4$ Hz, 3H), 2.82-2.69 (m, 1H), 2.67-2.52 (m, 1H), 2.09 (s, 1.45H), 2.07 (s, 1.55H), 1.38 (d, $J = 6.5$ Hz, 1.45H), 1.34 (d, $J = 6.5$ Hz, 1.55H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.2, 190.1, 170.2, 170.1, 166.1, 166.1, 163.1, 163.0, 128.6, 114.7, 114.7, 110.2, 110.2, 100.8, 100.7, 79.3, 78.8, 70.6, 70.3, 55.6, 38.6, 37.9, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_5^+[\text{M}+\text{Na}^+]$: 287.0890, found 287.0886.

1-(5-Methoxy-4-oxochroman-2-yl)ethyl acetate (3fa)



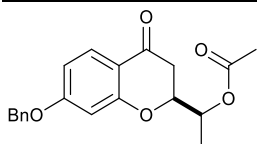
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3fa** as a yellow oil (40.7 mg, 77% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.37 (t, $J = 8.4$ Hz, 1H), 6.59 (d, $J = 8.3$ Hz, 1H), 6.51 (d, $J = 8.4$ Hz, 1H), 5.21-5.13 (m, 1H), 4.42-4.35 (m, 1H), 3.90 (s, 3H), 2.84-2.73 (m, 1H), 2.68-2.56 (m, 1H), 2.09 (s, 1.39H), 2.07 (s, 1.61H), 1.36 (d, $J = 6.6$ Hz, 1.4H), 1.33 ($J = 6.5$ Hz, 1.6H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.3, 170.2, 170.1, 162.7, 162.6, 160.5, 136.0, 135.9, 111.2, 110.0, 104.0, 78.3, 77.9, 70.5, 70.1, 56.1, 40.3, 39.7, 21.1, 21.0, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_5^+[\text{M}+\text{Na}^+]$: 287.0890, found 287.0886.

1-(6-Methoxy-4-oxochroman-2-yl)ethyl acetate (3ga)



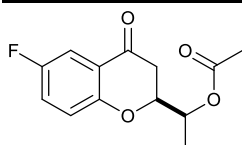
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.3$) give **3ga** as a yellow oil (32.7 mg, 62% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.28 (d, $J = 3.1$ Hz, 1H), 7.11-7.06 (m, 1H), 6.93 (d, $J = 9.0$ Hz, 1H), 5.22-5.16 (m, 1H), 4.45-4.36 (m, 1H), 3.78 (s, 3H), 2.82-2.69 (m, 1H), 2.67-2.52 (m, 1H), 2.09 (s, 1.45H), 2.07 (s, 1.55H), 1.38 (d, $J = 6.5$ Hz, 1.45H), 1.34 (d, $J = 6.5$ Hz, 1.55H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 191.7, 191.6, 170.2, 170.1, 155.8, 155.7, 154.2, 125.3, 125.2, 120.7, 120.7, 119.2, 107.2, 107.2, 79.0, 78.5, 70.7, 70.2, 55.7, 38.9, 38.3, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_5^+$ [$\text{M}+\text{Na}^+$]: 287.0890, found 287.0888.

1-(7-(Benzyloxy)-4-oxochroman-2-yl)ethyl acetate (3ha)



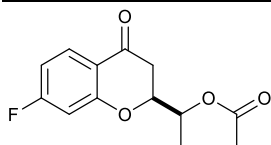
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 3:1, $R_f = 0.33$) give **3ha** as a yellow oil (53.0 mg, 78% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.82 (d, $J = 8.8$ Hz, 1H), 7.44-7.32 (m, 5H), 6.69-6.63 (m, 1H), 6.53 (d, $J = 2.4$ Hz, 1H), 5.26-5.14 (m, 1H), 5.08 (d, $J = 1.0$ Hz, 2H), 4.50-4.38 (m, 1H), 2.84-2.50 (m, 2H), 2.10 (s, 1.5H), 2.08 (s, 1.5H), 1.39 (d, $J = 6.6$ Hz, 1.5H), 1.35 (d, $J = 6.5$ Hz, 1.5H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.2, 190.11, 170.2, 170.1, 165.1, 163.0, 162.9, 135.7, 130.2, 128.6, 128.61, 128.3, 127.4, 114.9, 114.8, 110.7, 110.7, 101.3, 101.6, 79.2, 78.7, 70.6, 70.2, 38.6, 37.8, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{20}\text{NaO}_5^+$ [$\text{M}+\text{Na}^+$]: 363.1203, found 363.1200.

1-(6-Fluoro-4-oxochroman-2-yl)ethyl acetate (3ia)



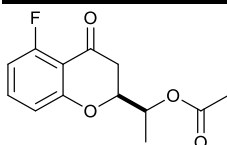
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3ia** as a yellow oil (33.8 mg, 67% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.51 (dd, $J = 8.2, 3.2$ Hz, 1H), 7.20 (td, $J = 8.3, 7.7, 4.6$ Hz, 1H), 6.99 (dd, $J = 9.1, 4.2$ Hz, 1H), 5.26-5.14 (m, 1H), 4.50-4.39 (m, 1H), 2.84-2.63 (m, 2H), 2.09 (s, 1.53H), 2.08 (s, 1.47H), 1.39 (d, $J = 6.6$ Hz, 1.53H), 1.35 (d, $J = 6.6$ Hz, 1.47H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.8, 190.8, 190.8, 190.8, 170.2, 170.10, 157.2 (d, $J_{\text{C-F}} = 240.8$ Hz), 157.3, 157.3, 157.2, 157.2, 123.8 (d, $J_{\text{C-F}} = 3.0$ Hz), 123.45 (d, $J_{\text{C-F}} = 3.0$ Hz), 121.3, 121.3, 121.2, 121.2, 119.7, 119.6, 111.9 (d, $J_{\text{C-F}} = 23.2$ Hz), 111.8 (d, $J_{\text{C-F}} = 22.5$ Hz), 79.1, 78.6, 70.5, 70.2, 38.7, 38.0, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{FNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 275.0690, found 275.0687.

1-(7-Fluoro-4-oxochroman-2-yl)ethyl acetate (3ja)



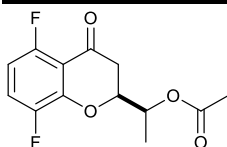
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3ja** as a yellow oil (37.8 mg, 75% yield); ^1H NMR (300 MHz, CDCl_3): δ 7.87 (dd, $J = 8.8, 6.6$ Hz, 1H), 6.76-6.65 (m, 2H), 5.25-5.13 (m, 1H), 4.51-4.43 (m, 1H), 2.83-2.74 (m, 1H), 2.72-2.59 (m, 1H), 2.07 (s, 1.55H), 2.06 (s, 1.45H), 1.38 (d, $J = 6.5$ Hz, 1.56H), 1.34 (d, $J = 6.6$ Hz, 1.44H). ^{13}C NMR (75 MHz, CDCl_3) δ 190.0, 189.9, 167.4 (d, $J_{\text{C-F}} = 255.0$ Hz), 162.7, 162.7, 162.6, 162.5, 129.44 (d, $J_{\text{C-F}} = 3.7$ Hz), 129.3 (d, $J_{\text{C-F}} = 3.7$ Hz), 117.8, 117.7, 117.7, 110.0 (d, $J_{\text{C-F}} = 22.5$ Hz), 104.7 (d, $J_{\text{C-F}} = 24.7$ Hz), 79.5, 79.0, 70.4, 70.1, 38.6, 37.9, 21.0, 20.9, 15.5, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{FNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 275.0690, found 275.0685.

1-(5-Fluoro-4-oxochroman-2-yl)ethyl acetate (3ka)



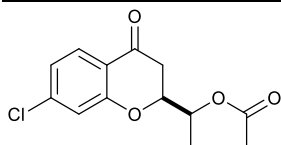
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.65$) give **3ka** as a yellow oil (25.7 mg, 51% yield); ^1H NMR (300 MHz, CDCl_3): δ 7.44-7.36 (m, 1H), 6.81 (dt, $J = 8.4, 1.1$ Hz, 1H), 6.69 (dd, $J = 10.5, 8.3$ Hz, 1H), 5.25-5.13 (m, 1H), 4.50-4.40 (m, 1H), 2.88-2.60 (m, 2H), 2.08 (s, 1.55H), 2.07 (s, 1.45H), 1.38 (d, $J = 6.5$ Hz, 1.56H), 1.34 (d, $J = 6.5$ Hz, 1.44H). ^{13}C NMR (75 MHz, CDCl_3) δ 189.1, 189.1, 170.1, 170.0, 161.5 (d, $J_{\text{C-F}} = 264.0$ Hz), 161.5 (d, $J_{\text{C-F}} = 264.0$ Hz), 161.9, 161.8, 161.8, 161.7, 159.7, 159.7, 136.0 (d, $J_{\text{C-F}} = 3.0$ Hz), 135.9 (d, $J_{\text{C-F}} = 3.0$ Hz), 113.7, 113.6, 111.1, 111.1, 110.9, 110.9, 109.1 (d, $J_{\text{C-F}} = 21.0$ Hz), 78.8, 78.4, 70.4, 70.1, 21.1, 21.0, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{FNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 275.0690, found 275.0685.

1-(5,8-Difluoro-4-oxochroman-2-yl)ethyl acetate (3la)



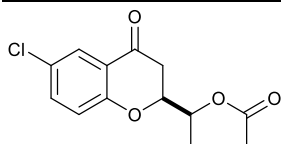
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3la** as a yellow oil (21.6 mg, 40% yield); ^1H NMR (300 MHz, CDCl_3): δ 7.36-7.30 (m, 1H), 7.11-7.04 (m, 1H), 5.26-5.20 (m, 1H), 4.56-4.45 (m, 1H), 2.87-2.76 (m, 2H), 2.08 (s, $J = 1.55$ H), 2.07 (s, 1.45H), 1.41 (d, $J = 6.6$ Hz, 1.55H), 1.37 (d, $J = 6.5$ Hz, 1.45H). ^{13}C NMR (75 MHz, CDCl_3) δ 189.5, 170.1, 167.0, 155.7 (d, $J_{\text{C-F}} = 252.7$ Hz), 155.3 (d, $J_{\text{C-F}} = 297.0$ Hz), 122.6, 122.5, 111.3, 111.3, 111.0, 111.0, 110.9, 110.6, 107.4, 107.3, 107.2, 107.1, 107.0, 106.9, 79.9, 79.4, 70.5, 70.0, 39.0, 38.4, 21.0, 20.9, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{12}\text{F}_2\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 293.0596, found 293.0599.

1-(7-Chloro-4-oxochroman-2-yl)ethyl acetate (3ma)



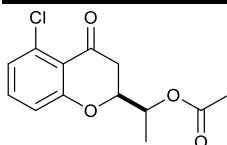
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3ma** as a yellow oil (47.7 mg, 89% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.79 (d, $J = 8.9$ Hz, 1H), 7.03-6.97 (m, 2H), 5.25-5.13 (m, 1H), 4.51-4.42 (m, 1H), 2.86-2.74 (m, 1H), 2.73-2.61 (m, 1H), 2.08 (s, 1.6H), 2.06 (s, 1.4H), 1.38 (d, $J = 6.5$ Hz, 1.6H), 1.34 (d, $J = 6.6$ Hz, 1.4H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.4, 190.3, 170.1, 170.0, 161.3, 161.3, 141.9, 141.9, 128.1, 128.0, 122.4, 119.4, 119.4, 118.1, 118.1, 79.3, 78.9, 70.4, 70.1, 38.8, 38.0, 21.03, 21.0, 15.6, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{ClNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 291.0395, found 291.0389.

1-(6-Chloro-4-oxochroman-2-yl)ethyl acetate (3na)



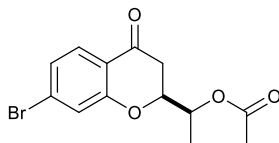
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.4$) give **3na** as a yellow oil (32.7 mg, 61% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.82 (d, $J = 2.7$ Hz, 1H), 7.44-7.40 (m, 1H), 6.96 (d, $J = 8.8$ Hz, 1H), 5.27-5.14 (m, 1H), 4.50-4.41 (m, 1H), 2.94-2.62 (m, 2H), 2.09 (s, 1.44H), 2.07 (s, 1.56H), 1.39 (d, $J = 6.5$ Hz, 1.45H), 1.35 (d, $J = 6.5$ Hz, 1.55H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.4, 190.3, 170.1, 170.1, 159.5, 159.4, 135.9, 135.9, 127.2, 126.2, 126.2, 121.6, 121.6, 119.7, 79.2, 78.7, 70.5, 70.2, 38.7, 38.0, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{ClNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 291.0395, found 291.0391.

1-(5-Chloro-4-oxochroman-2-yl)ethyl acetate (3oa)



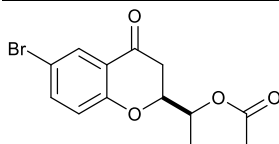
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 3:1, $R_f = 0.4$) give **3oa** as a yellow oil (22.5 mg, 42% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.35-7.29 (m, 1H), 7.03 (d, $J = 7.8$ Hz, 1H), 6.93 (d, $J = 8.3$ Hz, 1H), 5.25-5.13 (m, 1H), 4.49-4.40 (m, 1H), 2.92-2.64 (m, 2H), 2.08 (s, 1.6H), 2.06 (s, 1.4H), 1.37 (d, $J = 6.6$ Hz, 1.6H), 1.34 (d, $J = 6.5$ Hz, 1.4H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 189.5, 170.1, 170.0, 162.5, 162.4, 134.7, 134.7, 134.2, 134.2, 124.8, 118.2, 118.1, 117.0, 78.5, 78.0, 70.4, 70.1, 40.0, 39.3, 21.0, 21.0, 15.5, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{ClNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 291.0395, found 291.0389.

1-(7-Bromo-4-oxochroman-2-yl)ethyl acetate (3pa)



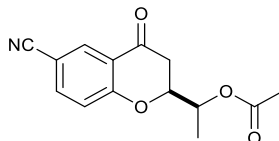
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3pa** as a yellow oil (45.1 mg, 72% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.71 (d, $J = 8.4$ Hz, 1H), 7.26-7.14 (m, 2H), 5.25-5.13 (m, 1H), 4.51-4.41 (m, 1H), 2.86-2.61 (m, 2H), 2.08 (s, 1.58H), 2.07 (s, 1.42H), 1.38 (d, $J = 6.5$ Hz, 1.58H), 1.34 (d, $J = 6.6$ Hz, 1.42H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.6, 190.5, 170.1, 170.0, 161.2, 161.1, 130.5, 130.4, 128.1, 128.0, 125.2, 121.2, 121.1, 119.8, 119.7, 79.3, 78.8, 70.4, 70.2, 38.8, 38.1, 21.0, 21.0, 15.6, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{BrNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 334.9889, found 334.9883.

1-(6-Bromo-4-oxochroman-2-yl)ethyl acetate (3qa)



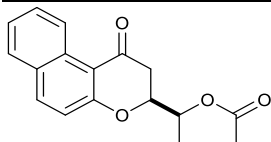
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3qa** as a yellow oil (32.4 mg, 52% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.98 (d, $J = 2.5$ Hz, 1H), 7.56 (dd, $J = 9.0, 2.0$ Hz, 1H), 6.91 (d, $J = 8.8$ Hz, 1H), 5.27-5.14 (m, 1H), 4.52-4.39 (m, 1H), 2.89-2.63 (m, 2H), 2.09 (s, 1.6H), 2.08 (s, 1.4H), 1.39 (d, $J = 6.5$ Hz, 1.6H), 1.35 (d, $J = 6.5$ Hz, 1.4H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.2, 190.2, 170.1, 170.03, 159.9, 159.8, 138.7, 138.7, 129.3, 129.3, 122.1, 122.0, 120.0, 114.3, 79.1, 78.6, 70.5, 70.1, 38.6, 37.9, 21.1, 21.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{13}\text{BrNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 334.9889, found 334.9884.

1-(6-Cyano-4-oxochroman-2-yl)ethyl acetate (3ra)



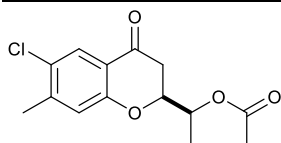
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3ra** as a yellow oil (32.6 mg, 63% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 8.19-8.18 (m, 1H), 7.73-7.69 (m, 1H), 7.11 (d, $J = 8.7$ Hz, 1H), 5.35-5.15 (m, 1H), 4.60-4.47 (m, 1H), 2.90-2.72 (m, 2H), 2.07 (s, 1.6H), 2.06 (s, 1.4H), 1.41 (d, $J = 6.6$ Hz, 1.6H), 1.36 (d, $J = 6.6$ Hz, 1.4H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 189.2, 167.0, 169.9, 163.5, 163.4, 138.4, 138.4, 132.1, 132.0, 121.2, 121.1, 119.6, 119.5, 117.9, 117.8, 105.6, 105.6, 79.6, 79.1, 70.3, 70.1, 38.6, 37.7, 21.0, 20.9, 15.6, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{13}\text{NNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 282.0737, found 282.0736.

1-(1-Oxo-2,3-dihydro-1H-benzof[chromen-3-yl)ethyl acetate (3sa)



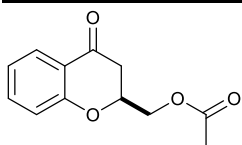
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 3:1, $R_f = 0.3$) give **3sa** as a yellow oil (40.9 mg, 72% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 9.43 (d, $J = 8.7$ Hz, 1H), 7.94 (d, $J = 9.0$ Hz, 1H), 7.75 (d, $J = 8.1$ Hz, 1H), 7.64 (t, $J = 7.8$ Hz, 1H), 7.44 (t, $J = 7.7$ Hz, 1H), 7.13 (d, $J = 9.0$ Hz, 1H), 5.32 – 5.21 (m, 1H), 4.62–4.52 (m, 1H), 3.00–2.68 (m, 2H), 2.12 (s, 1.58H), 2.10 (s, 1.42H), 1.43 (d, $J = 6.6$ Hz, 1.58H), 1.40 (d, $J = 6.5$ Hz, 1.42H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 192.6, 170.3, 170.2, 163.2, 163.1, 137.5, 137.5, 131.3, 129.7, 129.2, 128.3, 125.8, 125.8, 124.9, 118.6, 112.5, 78.9, 78.5, 70.5, 70.1, 40.1, 39.5, 21.1, 21.1, 15.6, 15.6. HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{16}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 307.0941, found 307.0933.

1-(6-Chloro-7-methyl-4-oxochroman-2-yl)ethyl acetate (3ta)



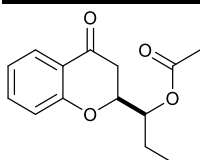
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3ta** as a yellow oil (35.0 mg, 62% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.80 (s, 1H), 6.90 (s, 1H), 5.24–5.15 (m, 1H), 4.47–4.36 (m, 1H), 2.81–2.59 (m, 2H), 2.38–2.35 (s, 3H), 2.09 (s, 1.6H), 2.07 (s, 1.4H), 1.38 (d, $J = 6.5$ Hz, 1.6H), 1.34 (d, $J = 6.6$ Hz, 1.4H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 190.3, 190.5, 170.2, 170.1, 159.3, 159.2, 145.2, 145.2, 127.8, 126.5, 126.5, 120.0, 119.8, 119.8, 79.1, 78.6, 70.5, 70.2, 38.7, 38.0, 21.1, 21.0, 20.8, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{15}\text{ClNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 305.0551, found 305.0550.

(4-Oxochroman-2-yl)methyl acetate (3ab)



Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.43$) give **3ab** as a yellow oil (29.0 mg, 66% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.88 (dd, $J = 7.9, 7.8$ Hz, 1H), 7.52–7.47 (m, 1H), 7.06–7.00 (m, 2H), 4.72–4.66 (m, 1H), 4.39–4.37 (m, 2H), 2.89–2.67 (m, 2H), 2.13 (s, 3H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 191.1, 170.6, 160.9, 136.2, 126.9, 121.7, 120.8, 117.9, 75.3, 65.0, 39.3, 20.7. HRMS (ESI) m/z calcd for $\text{C}_{12}\text{H}_{12}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 243.0628, found 243.0628.

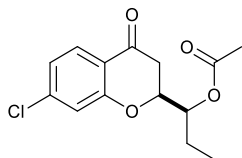
1-(4-Oxochroman-2-yl)propyl acetate (3ac)



Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3ac** as a yellow oil (31.7 mg, 64% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.86 (dd, $J = 7.8, 1.7$ Hz, 1H), 7.51–7.45 (m, 1H), 7.05–6.98 (m, 2H), 5.24–5.19 (m, 0.51H), 5.09–5.05 (m, 0.49H), 4.58–4.48 (m, 1H), 2.89–2.61 (m, 2H), 2.11 (s, 1.48H), 2.09 (s,

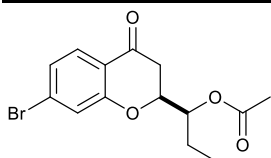
1.51H), 1.88-1.73 (m, 2H), 1.00-0.95 (m, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ 191.6, 191.6, 170.5, 170.3, 161.1, 161.0, 136.1, 136.0, 126.8, 121.5, 121.5, 120.9, 120.8, 117.9, 117.9, 77.8, 74.9, 74.9, 39.2, 38.3, 23.1, 22.9, 20.9, 20.8, 9.7, 9.6. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 271.0941, found 271.0938.

1-(7-Chloro-4-oxochroman-2-yl)propyl acetate (3mc)



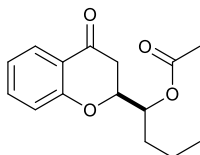
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3mc** as a yellow oil (29.3 mg, 52% yield); ^1H NMR (400 MHz, CDCl_3): δ 7.80 (d, $J = 8.4$ Hz, 1H), 7.03-6.99 (m, 2H), 5.22-5.17 (m, 0.49H), 5.08-5.03 (m, 0.51H), 4.58-4.49 (m, 1H), 2.84-2.62 (m, 2H), 2.10, 2.08 (s, 3H), 1.83-1.70 (m, 2H), 0.97 (m, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ 190.5, 170.4, 170.3, 161.4, 161.3, 142.0, 141.9, 128.1, 128.1, 122.4, 119.4, 119.4, 118.1, 118.1, 78.3, 77.6, 74.8, 74.7, 39.0, 38.0, 23.1, 23.0, 20.9, 20.8, 9.7, 9.6. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{15}\text{ClNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 305.0551, found 305.0549.

1-(7-Bromo-4-oxochroman-2-yl)propyl acetate (3pc)



Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3pc** as a yellow oil (31.3 mg, 48% yield); ^1H NMR (400 MHz, CDCl_3): δ 7.71 (d, $J = 8.4$ Hz, 1H), 7.21 (s, 1H), 7.16 (dt, $J = 8.4, 1.6$ Hz, 1H), 5.22-5.17 (m, 0.49H), 5.07-5.03 (m, 0.51H), 4.58-4.48 (m, 1H), 2.84-2.62 (m, 2H), 2.10 (s, 1.54H), 2.08 (s, 1.46H), 1.82-1.70 (m, 2H), 0.97 (m, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ 190.7, 170.4, 170.3, 161.3, 130.5, 130.4, 128.1, 128.0, 125.2, 121.2, 121.1, 119.8, 119.7, 78.3, 77.6, 74.8, 74.7, 39.0, 38.1, 23.1, 23.0, 20.9, 20.8, 9.7, 9.6. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{15}\text{BrNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 349.0046, found 349.0043.

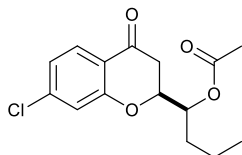
1-(4-Oxochroman-2-yl)butyl acetate (3ad)



Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.65$) give **3ad** as a yellow oil (27.8 mg, 53% yield); ^1H NMR (400 MHz, CDCl_3): δ 7.86 (dd, $J = 7.8, 1.8$ Hz, 1H), 7.50-7.45 (m, 1H), 7.04-6.98 (m, 2H), 5.32-5.27 (m, 0.48H), 5.17-5.13 (m, 0.52H), 4.55-4.46 (m, 1H), 2.89-2.61 (m, 2H), 2.8 (d, 3H), 1.78-1.67 (m, 2H), 1.46-1.33 (m, 2H), 0.98-0.94 (m, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ 191.73, 191.71, 170.5, 170.4, 161.1, 161.0, 136.1, 136.0, 126.9, 121.6, 121.5, 120.9, 120.8, 118.0, 117.9,

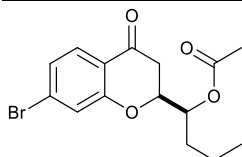
78.2, 73.5, 73.4, 39.2, 38.2, 32.1, 31.9, 29.7, 20.9, 20.8, 18.6, 18.5, 13.8, 13.8. HRMS (ESI) m/z calcd for $C_{15}H_{18}NaO_4^+$ [$M+Na^+$]: 285.1097, found 285.1093.

1-(7-Chloro-4-oxochroman-2-yl)butyl acetate (3md)



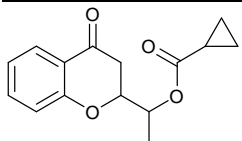
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3md** as a yellow oil (24.9 mg, 42% yield); 1H NMR (400 MHz, $CDCl_3$): δ 7.81 (d, $J = 2.6$ Hz, 1H), 7.43-7.39 (m, 1H), 6.96 (d, $J = 8.8, 3.2$ Hz, 1H), 5.31-5.26 (m, 0.51H), 5.17-5.12 (m, 0.49H), 4.54-4.45 (m, 1H), 2.85-2.63 (m, 2H), 2.08 (d, 3H), 1.77-1.60 (m, 2H), 1.44-1.33 (m, 2H), 0.98-0.93 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 190.5, 170.4, 170.2, 161.4, 161.3, 141.9, 141.9, 128.1, 128.1, 122.4, 119.5, 119.4, 118.1, 118.1, 78.7, 78.0, 73.3, 39.0, 38.0, 32.0, 31.9, 20.9, 20.8, 18.5, 13.9, 13.8. HRMS (ESI) m/z calcd for $C_{15}H_{17}ClNaO_4^+$ [$M+Na^+$]: 319.0708, found 319.0707.

1-(7-Bromo-4-oxochroman-2-yl)butyl acetate (3pd)



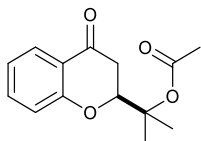
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3pd** as a yellow oil (23.8 mg, 35% yield); 1H NMR (400 MHz, $CDCl_3$): δ 7.72 (d, $J = 8.4$ Hz, 1H), 7.22 (d, $J = 1.2$ Hz, 1H), 7.18-7.15 (m, 1H), 5.30-5.26 (m, 0.54H), 5.16-5.12 (m, 0.45H), 4.56-4.47 (m, 1H), 2.88-2.59 (m, 2H), 2.08 (d, 3H), 1.79-1.61 (m, 2H), 1.48-1.31 (m, 2H), 0.98-0.94 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.7, 170.4, 170.3, 161.3, 161.2, 130.5, 130.4, 128.1, 128.0, 125.2, 121.2, 121.1, 119.8, 119.7, 78.7, 77.9, 73.3, 39.0, 38.0, 32.0, 31.9, 20.9, 20.8, 18.5, 14.2, 13.9, 13.8. HRMS (ESI) m/z calcd $C_{15}H_{17}BrNaO_4^+$ [$M+Na^+$]: 363.0202, found 363.0200.

1-(4-oxochroman-2-yl)ethyl cyclopropanecarboxylate (3ae)



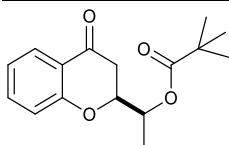
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3ae** as a yellow oil (35.9 mg, 69% yield); 1H NMR (400 MHz, $CDCl_3$): δ 8.87 (d, $J = 7.8, 1.8$ Hz, 1H), 7.51-7.46 (m, 1H), 7.05-6.99 (m, 2H), 5.26-5.17 (m, 1H), 4.50-4.43 (m, 1H), 2.87-2.62 (m, 2H), 1.66-1.58 (m, 1H), 1.40 (d, $J = 6.6$ Hz, 1.55H), 1.36 (d, $J = 6.5$ Hz, 1.45H), 1.03-0.98 (m, 2H), 0.91-0.85 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 191.8, 191.6, 174.1, 174.0, 161.12, 161.08, 136.12, 136.08, 126.9, 126.8, 121.6, 121.5, 120.9, 120.8, 117.9, 79.0, 78.5, 70.6, 70.1, 38.9, 38.4, 15.6, 15.6, 12.96, 12.90, 8.8, 8.7, 8.6. HRMS (ESI) m/z calcd for $C_{15}H_{16}NaO_4^+$ [$M+Na^+$]: 283.0941, found 283.0945.

2-(4-Oxochroman-2-yl)propan-2-yl acetate (3ag)



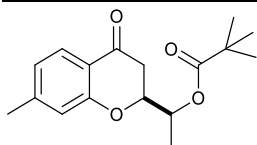
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.5$) give **3ag** as a yellow oil (23.3 mg, 47% yield); ^1H NMR (400 MHz, CDCl_3): δ 7.88 (dd, $J = 7.8, 6.0$ Hz, 1H), 7.51-7.47 (m, 1H), 7.05-6.99 (m, 2H), 4.58 (dd, $J = 13.1, 9.9$ Hz, 1H), 2.86-2.71 (m, 2H), 2.01 (s, 3H), 1.64 (s, 3H), 1.62 (s, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ 192.2, 170.0, 161.2, 136.0, 126.9, 121.5, 120.9, 117.8, 81.5, 81.3, 37.8, 22.6, 22.2, 21.4. HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{16}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 271.0941, found 271.0942.

1-(4-Oxochroman-2-yl)ethyl pivalate (3af)



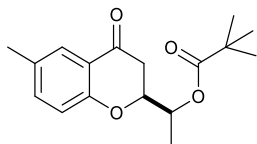
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3af** as a yellow oil (44.2 mg, 80% yield); ^1H NMR (300 MHz, CDCl_3): δ 7.87 (dd, $J = 7.8, 1.8$ Hz, 1H), 7.51-7.44 (m, 1H), 7.04-6.96 (m, 2H), 5.23-5.15 (m, 1H), 4.51-4.41 (m, 1H), 2.88-2.61 (m, 2H), 1.37 (d, $J = 6.5$ Hz, 1.59H), 1.34 (d, $J = 6.5$ Hz, 1.39H), 1.20 (s, 4.74H), 1.19 (s, 4.18H). ^{13}C NMR (100 MHz, CDCl_3) δ 191.6, 191.6, 177.6, 177.5, 161.1, 136.1, 136.1, 126.9, 121.5, 120.9, 120.8, 117.9, 79.0, 78.6, 70.4, 70.0, 38.9, 38.9, 38.8, 38.3, 27.1, 27.0, 15.7, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{20}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 299.1254, found 299.1255.

1-(7-Methyl-4-oxochroman-2-yl)ethyl pivalate (3bf)



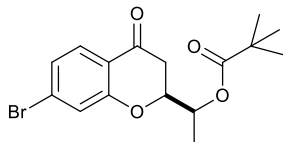
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3bf** as a yellow oil (44.7 mg, 77% yield); ^1H NMR (300 MHz, CDCl_3): δ 7.76 (d, $J = 8.0$ Hz, 1H), 6.85-6.78 (m, 2H), 5.22-5.15 (m, 1H), 4.48-4.38 (m, 1H), 2.81-2.57 (m, 2H), 2.35 (s, 3H), 1.36 (d, $J = 6.5$ Hz, 1.5H), 1.33 (d, $J = 6.5$ Hz, 1.5H), 1.21 (s, 4.5H), 1.19 (s, 4.5H). ^{13}C NMR (75 MHz, CDCl_3) δ 191.4, 191.3, 177.6, 177.5, 161.2, 147.7, 147.7, 126.8, 122.9, 118.6, 118.6, 117.9, 79.0, 78.6, 70.4, 70.0, 38.9, 38.3, 27.1, 27.0, 21.9, 21.9, 15.7, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{22}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 313.1410, found 313.1404.

1-(6-Methyl-4-oxochroman-2-yl)ethyl pivalate (3cf)



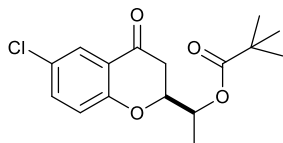
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3cf** as a yellow oil (41.8 mg, 72% yield); $^1\text{H NMR}$ (300 MHz, CDCl_3): δ 7.66 (s, 1H), 7.31-7.27 (m, 1H), 6.88 (dd, $J = 8.4, 2.2$ Hz, 1H), 5.21-5.15 (m, 1H), 4.47-4.37 (m, 1H), 2.85-2.56 (m, 2H), 2.30 (s, 3H), 1.35 (t, $J = 6.9$ Hz, 3H), 1.21 (d, 4.5H), 1.19 (s, 4.5H). $^{13}\text{C NMR}$ (75 MHz, CDCl_3) δ 192.0, 191.9, 177.6, 177.5, 159.2, 137.2, 137.2, 131.0, 126.4, 120.5, 120.4, 117.7, 79.0, 78.6, 70.4, 69.9, 39.0, 38.9, 38.4, 27.1, 27.0, 20.4, 15.7, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{22}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 313.1410, found 313.1404.

1-(7-Bromo-4-oxochroman-2-yl)ethyl pivalate (3pf)



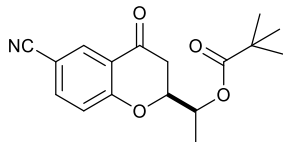
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3pf** as a yellow oil (52.5 mg, 74% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.71 (d, $J = 8.4$ Hz, 1H), 7.20-7.16 (m, 2H), 5.21-5.11 (m, 1H), 4.51-4.43 (m, 1H), 2.84-2.62 (m, 2H), 1.36 (d, $J = 6.5$ Hz, 1.5H), 1.32(d, $J = 6.5$ Hz, 1.5H), 1.19 (s, 4.5H), 1.18(s, 4.5H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 190.6, 190.6, 177.5, 177.4, 161.3, 130.5, 130.4, 128.1, 125.2, 125.2, 121.1, 119.7, 119.7, 79.5, 79.0, 70.1, 69.8, 38.8, 38.8, 38.1, 27.0, 27.0, 15.6, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{19}\text{BrNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 377.0359, found 377.0352.

1-(6-Chloro-4-oxochroman-2-yl)ethyl pivalate (3nf)



Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.6$) give **3nf** as a yellow oil (38.4 mg, 62% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.82 (d, $J = 2.6$ Hz, 1H), 7.41 (dt, $J = 8.9, 2.5$ Hz, 1H), 6.94 (dd, $J = 8.8, 2.4$ Hz, 1H), 5.24-5.12 (m, 1H), 4.47-4.40 (m, 1H), 2.81-2.67 (m, 2H), 1.36 (d, $J = 6.5$ Hz, 1.5H), 1.33 (d, $J = 6.5$ Hz, 1.5H), 1.20 (s, 4.5H), 1.18 (s, 4.5H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 190.4, 177.6, 159.5, 135.9, 135.9, 127.1, 126.2, 121.6, 119.6, 79.3, 78.8, 70.2, 69.8, 38.8, 38.6, 38.0, 27.0, 27.0, 15.7, 15.4. HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{19}\text{ClNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 333.0864, found 333.0861.

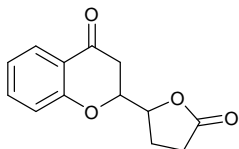
1-(6-Cyano-4-oxochroman-2-yl)ethyl pivalate (3rf)



Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 5:1, $R_f = 0.4$) give **3rf** as a yellow oil (39.1 mg, 65% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 8.17 (s, 1H), 7.72-7.68 (m, 1H), 7.09 (d, $J = 8.6$ Hz, 1H), 5.26-5.16 (m, 1H), 4.59-4.52 (m, 1H), 2.84-2.73 (m, 2H), 1.37 (d, $J = 6.5$ Hz, 1.47H), 1.33 (d, $J = 6.5$ Hz, 1.53H), 1.17 (s,

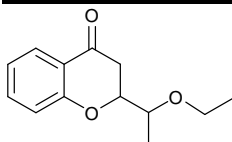
4.59H), 1.16 (s, 4.41H). ^{13}C NMR (75 MHz, CDCl_3) δ 189.3, 189.3, 177.5, 177.4, 163.5, 138.4, 138.4, 132.1, 132.1, 121.1, 121.1, 119.5, 117.8, 105.5, 105.5, 79.7, 79.2, 70.0, 69.7, 38.9, 38.8, 38.5, 37.7, 27.0, 15.6, 15.5. HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{19}\text{NNaO}_4^+$ [$\text{M}+\text{Na}^+$]: 324.1206, found 324.1206.

2-(5-oxotetrahydrofuran-2-yl)chroman-4-one (3ah)



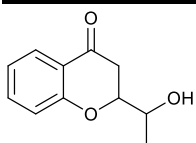
Flash column chromatography on silica gel (petroleum ether/ethyl acetate 5/1) gave **3ah** as a yellow liquid (16.2 mg, 35%). ^1H NMR (CDCl_3 , 400 MHz): δ 7.88 (dd, $J=7.8, 1.6$ Hz, 1H), 7.52-7.48 (m, 1H), 7.07-7.03 (m, 1H), 6.98 (d, $J=8.3$ Hz, 1H), 4.71-4.67 (m, 1H), 4.54-4.49 (m, 1H), 3.14-3.07 (m, 1H), 2.85-2.76 (m, 1H), 2.69-2.56 (m, 2H), 2.49-2.39 (m, 2H). ^{13}C NMR (CDCl_3 , 100 MHz): δ 191.1, 176.5, 160.6, 136.3, 127.1, 122.0, 120.7, 117.9, 79.5, 78.5, 39.4, 28.1, 23.4. HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{12}\text{NaO}_4^+$ [$\text{M}+\text{Na}^+$]: 255.0628, found 255.0631.

2-(1-ethoxyethyl)chroman-4-one (3ak)¹



Flash column chromatography on silica gel (petroleum ether/ethyl acetate 3/1) gave **3ak** as a yellow liquid (30.8 mg, 70%). ^1H NMR (CDCl_3 , 400 MHz): δ 7.87-7.84 (m, 1H), 7.48-7.43 (m, 1H), 7.01-6.97 (m, 2H), 4.45-4.39 (m, 0.46H), 4.35-4.30 (m, 0.54H), 3.75-3.63 (m, 2H), 3.59-3.49 (m, 1H), 2.97-2.75 (m, 1.54H), 2.64-2.60 (m, 0.47H), 1.32 (d, $J=6.4$ Hz, 1.4H), 1.27 (d, $J=6.3$ Hz, 1.64H), 1.22-1.17 (m, 3H). ^{13}C NMR (CDCl_3 , 75 MHz): δ 192.8, 192.6, 161.4, 161.3, 135.9, 135.8, 126.8, 126.7, 121.23, 121.21, 121.0, 118.0, 117.9, 80.6, 79.7, 75.9, 75.5, 65.3, 65.2, 38.9, 38.4, 16.2, 15.5, 15.4, 15.3.

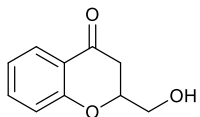
2-(1-Hydroxyethyl)chroman-4-one (4a)¹



Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 3:1, $R_f = 0.6$) give **4** as a colorless oil (24.8 mg, 86% yield); ^1H NMR (400 MHz, CDCl_3): 7.89-7.86 (m, 1H), 7.51-7.45 (m, 1H), 7.05-7.00 (m, 2H), 4.39-4.19 (m, 1.5H), 4.01-3.94 (m, 0.5H), 2.98-2.82 (m, 1H), 2.69-2.63 (m, 1H), 2.27 (d, $J=15.9$ Hz, 1H), 1.33 (d, $J=6.5$ Hz, 1.42H), 1.27 (d, $J=6.6$ Hz, 1.58H). ^{13}C NMR (100 MHz, CDCl_3) δ 192.5, 161.2, 160.8, 136.1, 136.0, 127.0, 126.9, 121.7, 121.5, 120.9, 117.8, 81.5, 81.2, 69.2, 68.4, 39.6, 36.9, 18.4, 17.6.

¹ R. Chen, J.-T. Yu and J. Cheng, *Org. Biomol. Chem.* 2018, **16**, 1823.

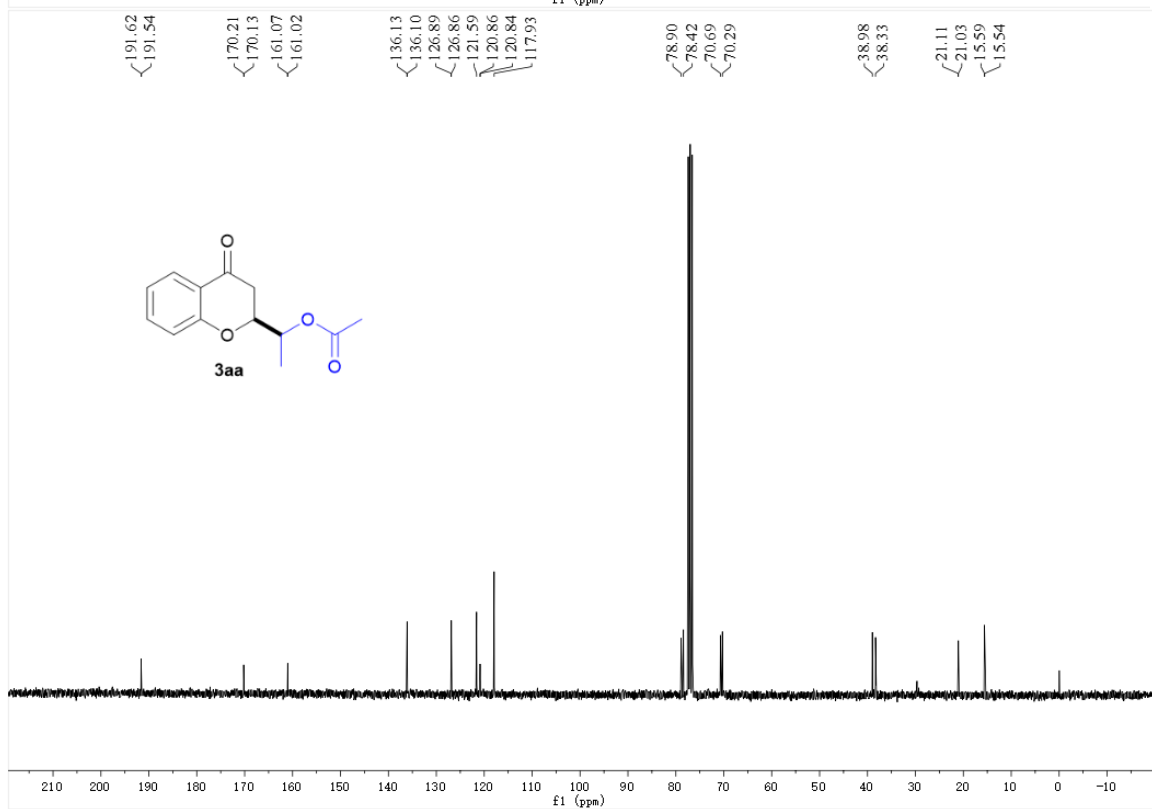
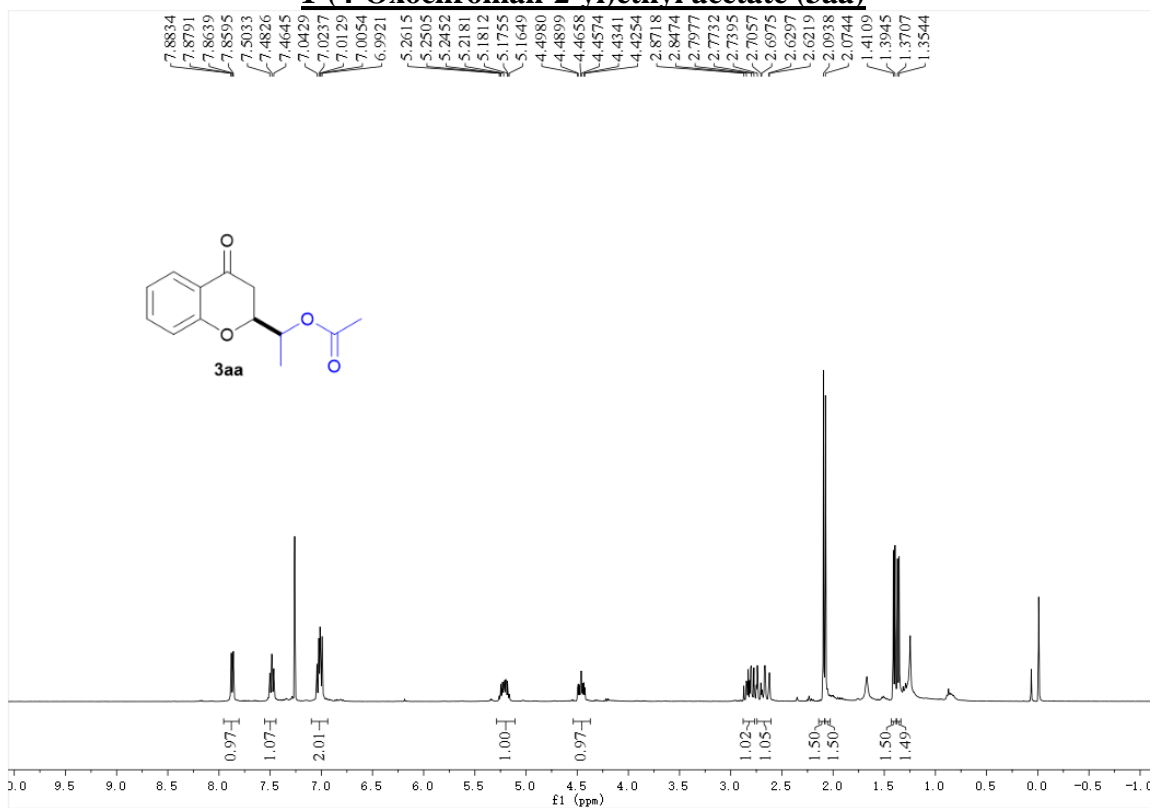
2-(Hydroxymethyl)chroman-4-one (4b)¹



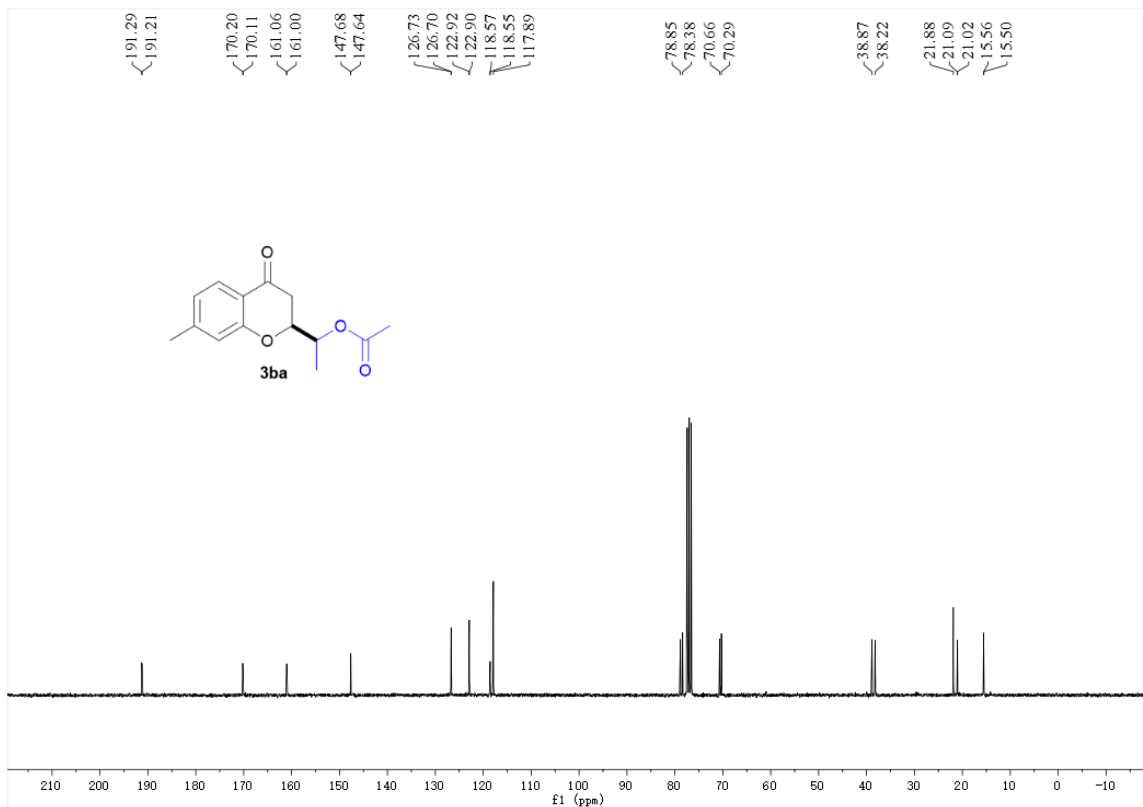
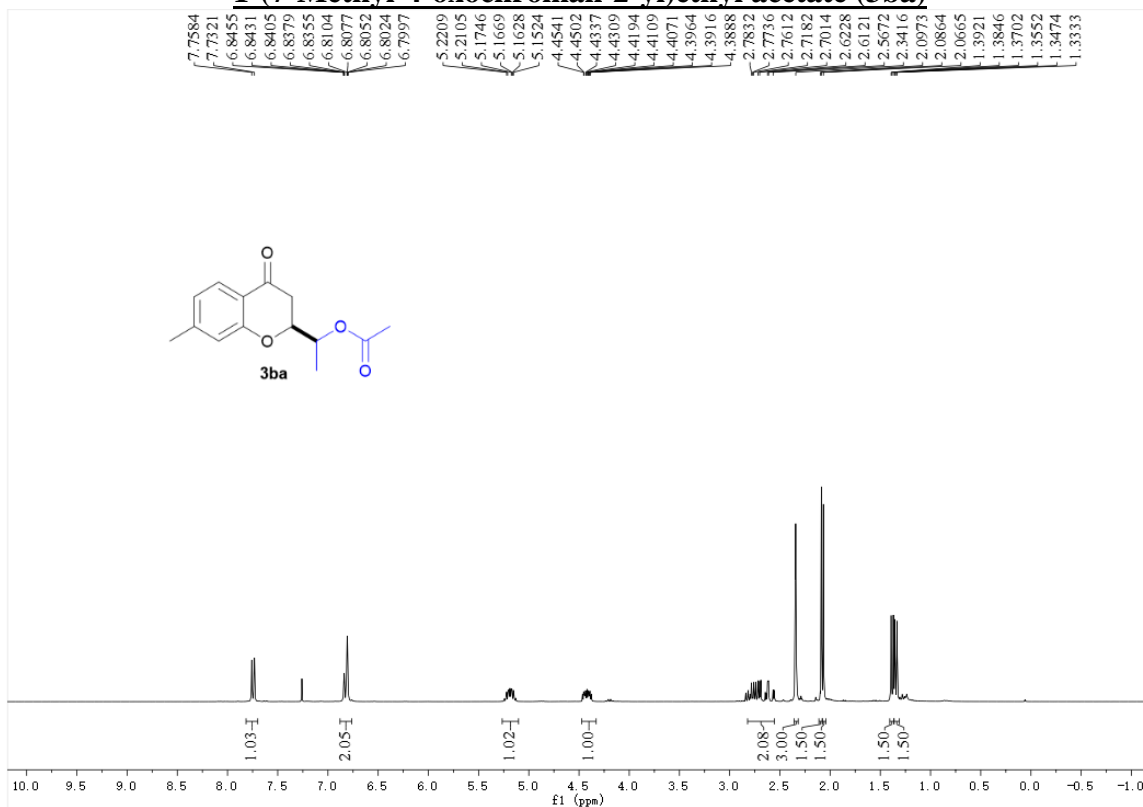
Flash column chromatography on a silica gel (petroleum ether : ethyl acetate, 3:1, $R_f = 0.6$) give **5** as a yellow oil (24.0 mg, 90% yield); $^1\text{H NMR}$ (400 MHz, CDCl_3): 7.88 (dd, $J = 7.9, 1.7$ Hz, 1H), 7.50-7.46 (m, 1H), 7.04-6.98 (m, 2H), 4.61-4.54 (m, 1H), 4.01-3.97 (m, 1H), 3.87-3.82 (m, 1H), 2.97-2.90 (m, 1H), 2.65-2.60 (m, 1H), 2.35-2.22 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 192.0, 161.0, 136.1, 127.0, 121.6, 120.8, 117.8, 78.1, 64.5, 39.0.

4. Copies of ^1H NMR and ^{13}C NMR spectra of the products

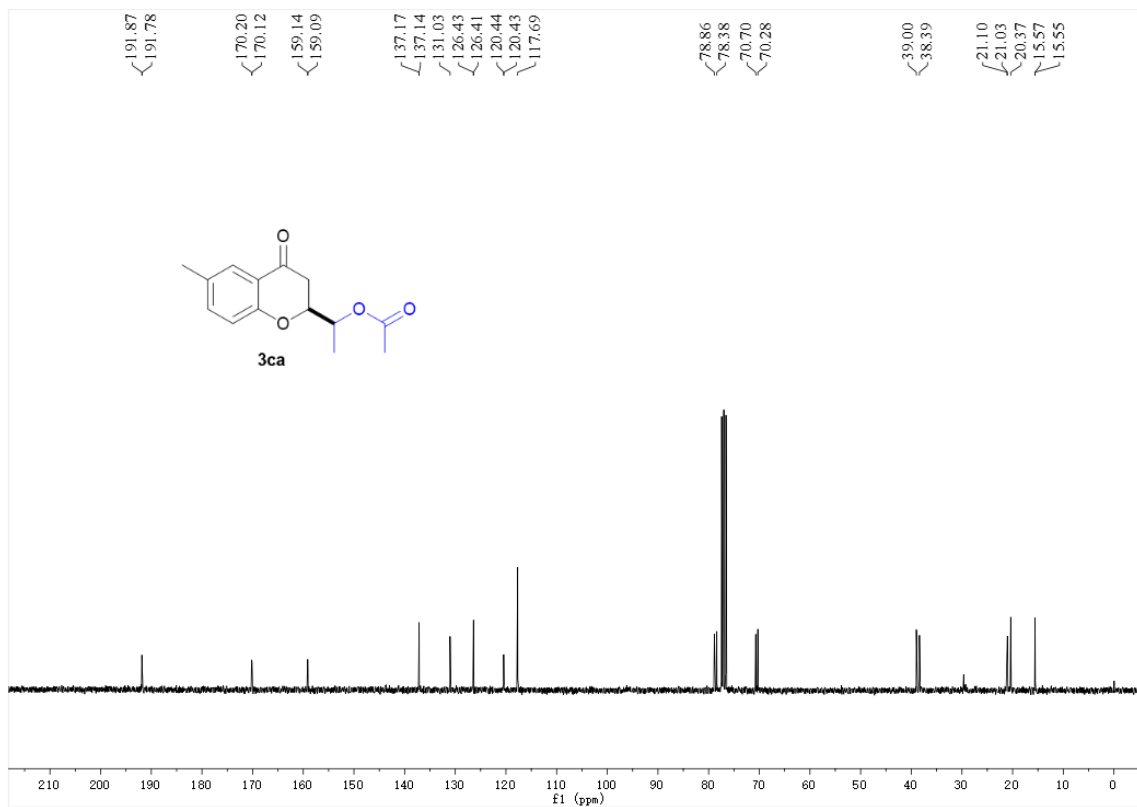
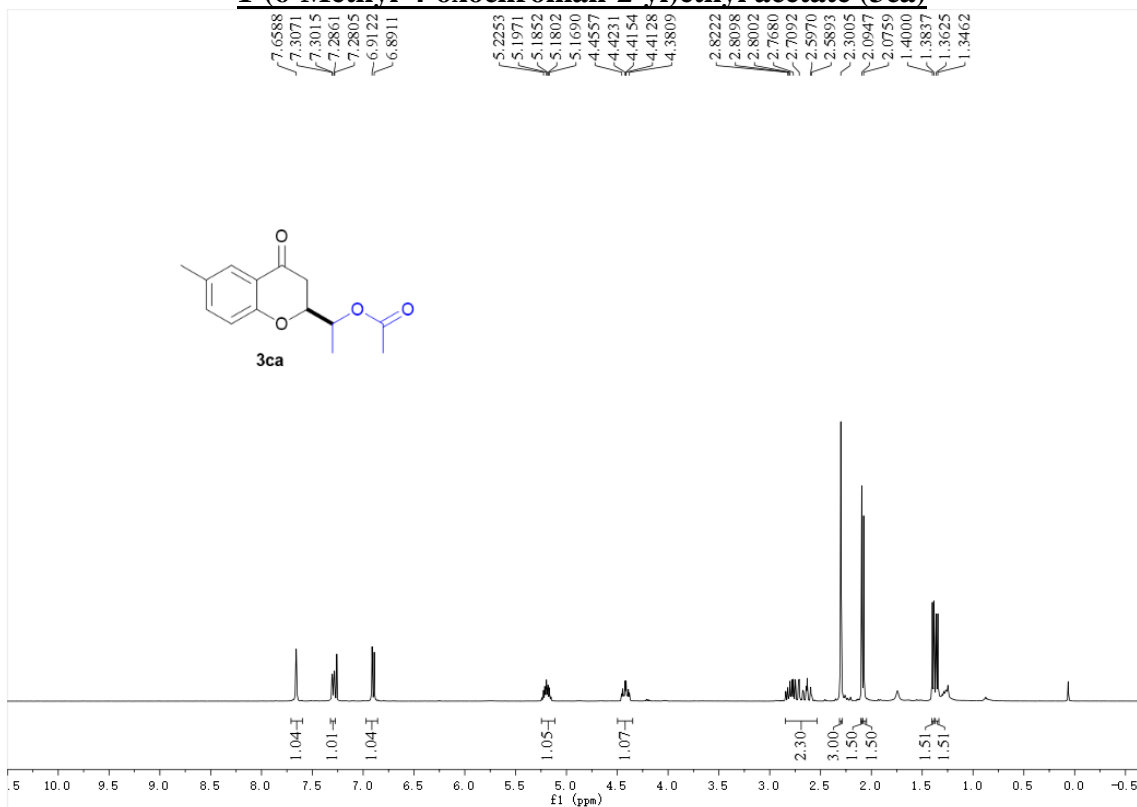
1-(4-Oxochroman-2-yl)ethyl acetate (3aa)



1-(7-Methyl-4-oxochroman-2-yl)ethyl acetate (3ba)

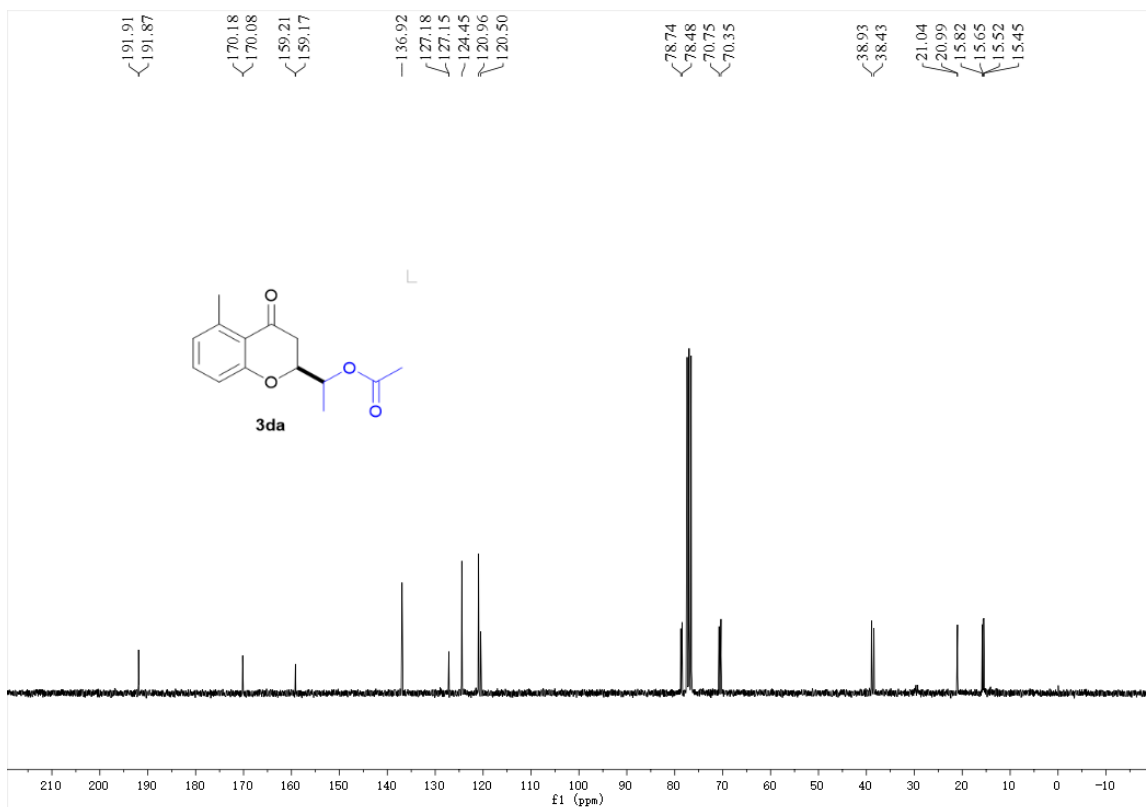
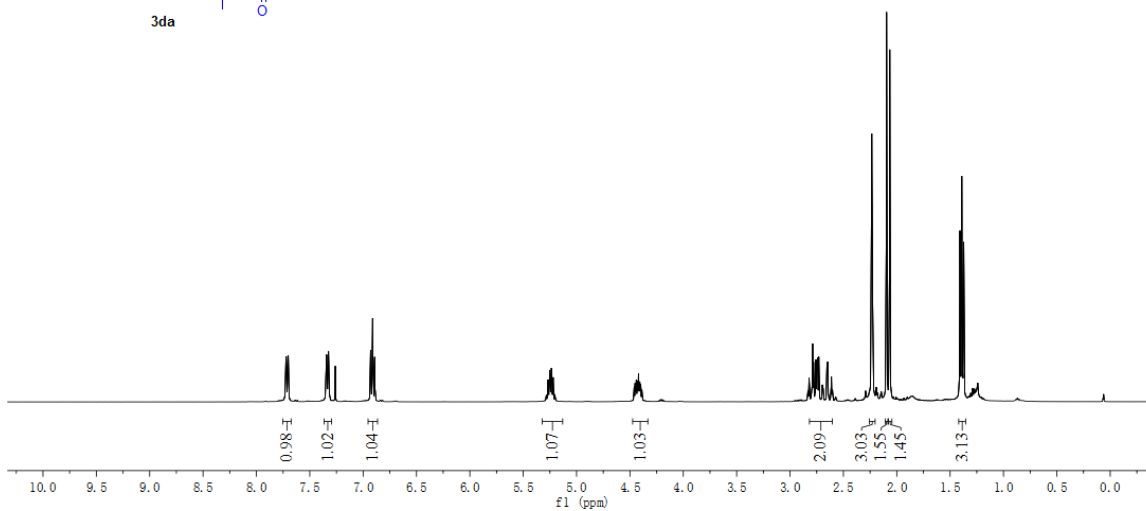
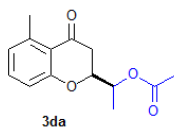


1-(6-Methyl-4-oxochroman-2-yl)ethyl acetate (3ca)

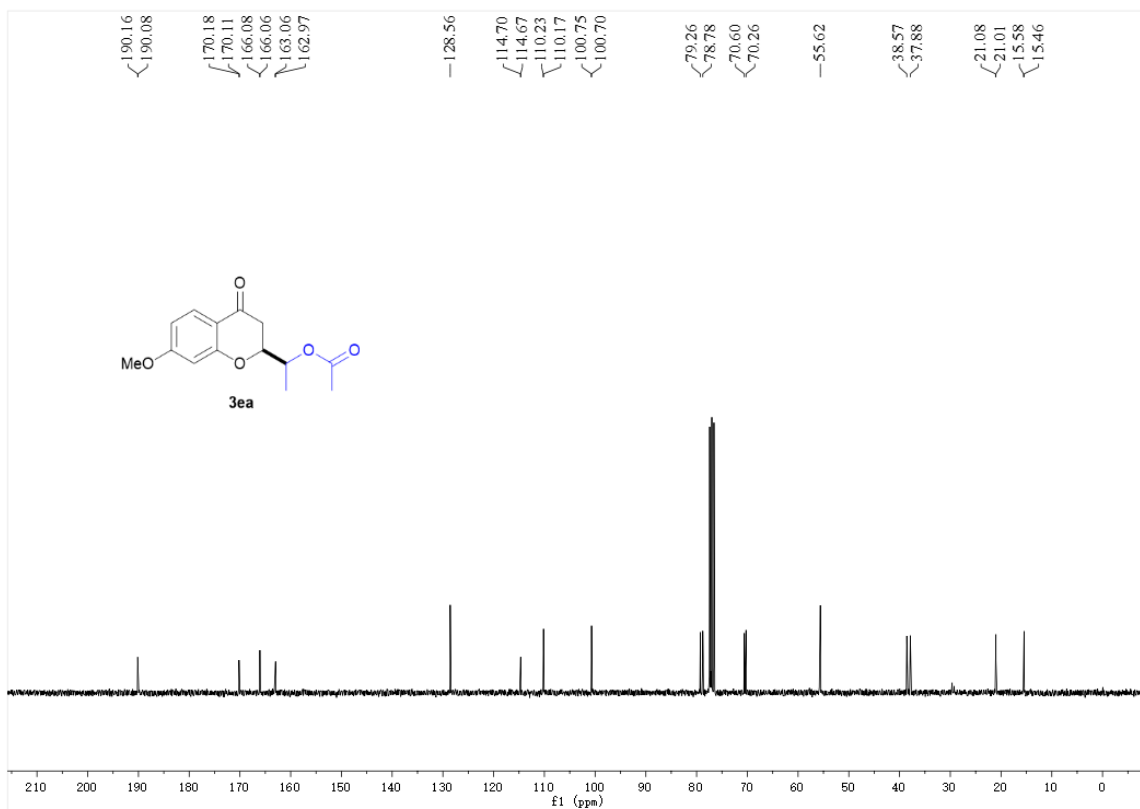
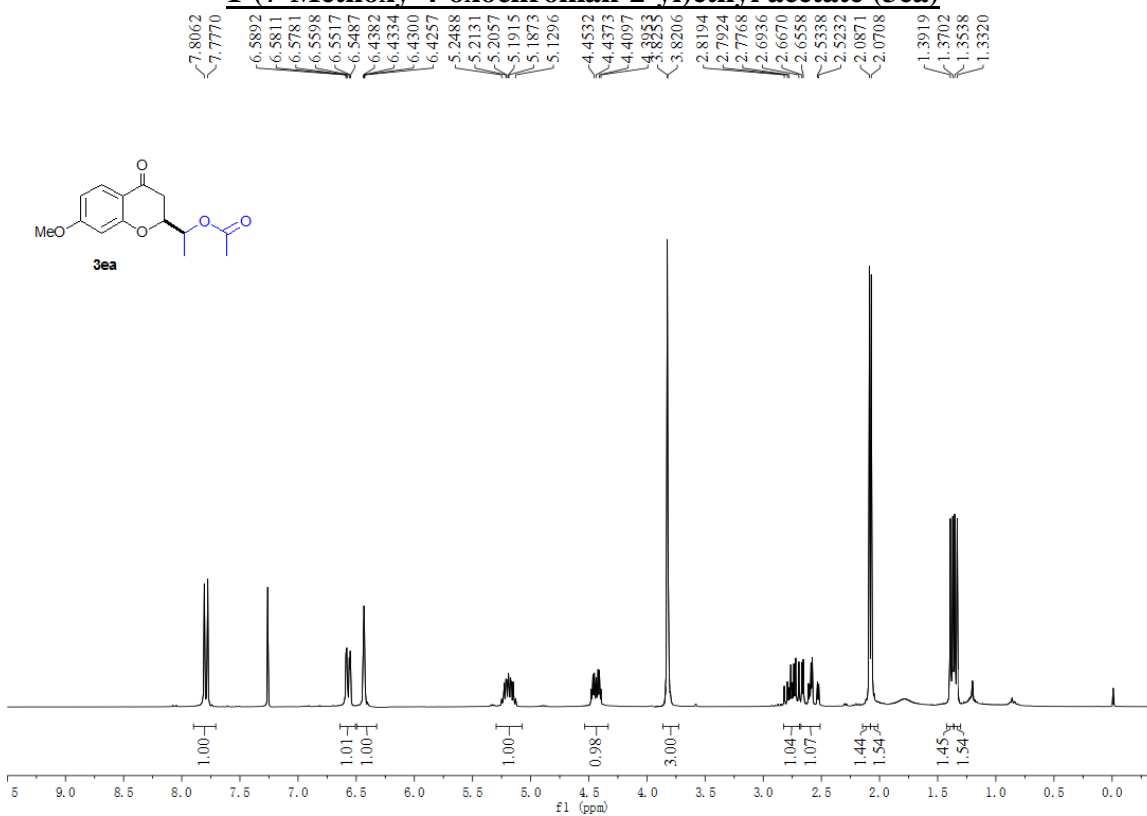


1-(5-Methyl-4-oxochroman-2-yl)ethyl acetate (3da)

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7.3402
7.3379
7.3289
7.3265
7.3219
7.3197
6.9298
6.9109
6.8919
5.2669
5.2544
5.2480
5.2317
5.2199
4.4595
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4.4198
4.4071
4.3892
2.7887
2.7575
2.7473
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1.4078
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1.3888
1.3726

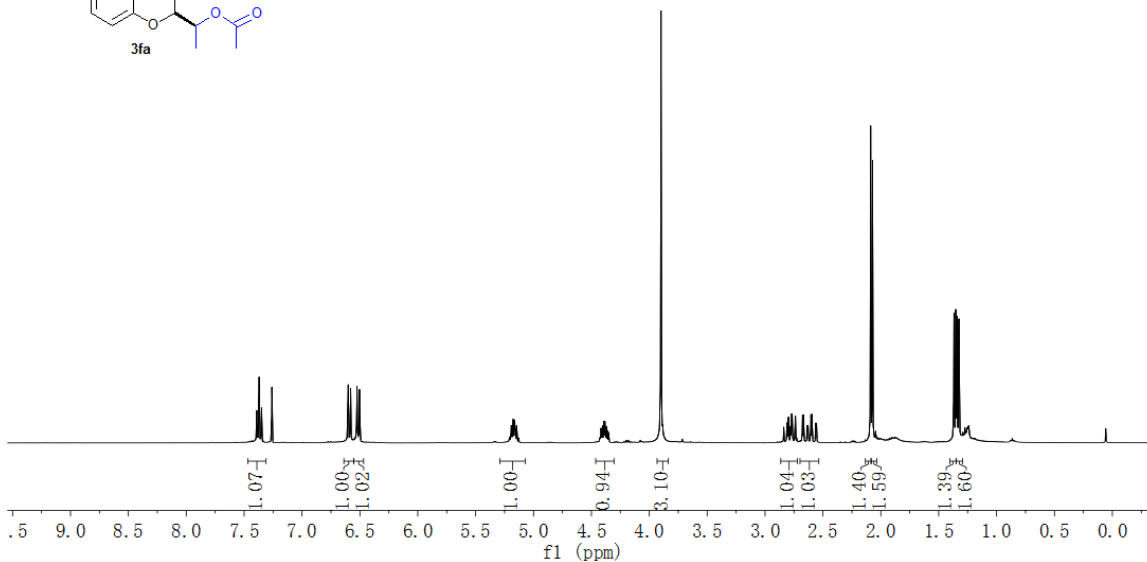
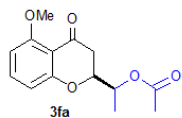


1-(7-Methoxy-4-oxochroman-2-yl)ethyl acetate (3ea)

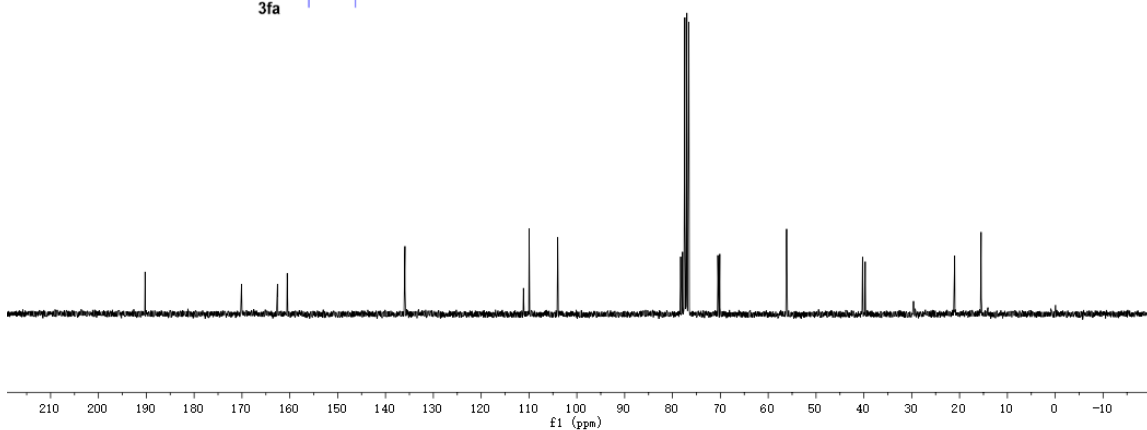
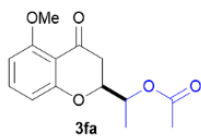


1-(5-Methoxy-4-oxochroman-2-yl)ethyl acetate (3fa)

7.3911
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6.5250
6.5041
5.1969
5.1919
5.1808
5.1749
5.1626
5.1576
5.1460
5.1413
4.4044
4.3913
4.3839
4.3688
2.7978
2.7705
2.7649
2.7376
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1.3411
1.3248

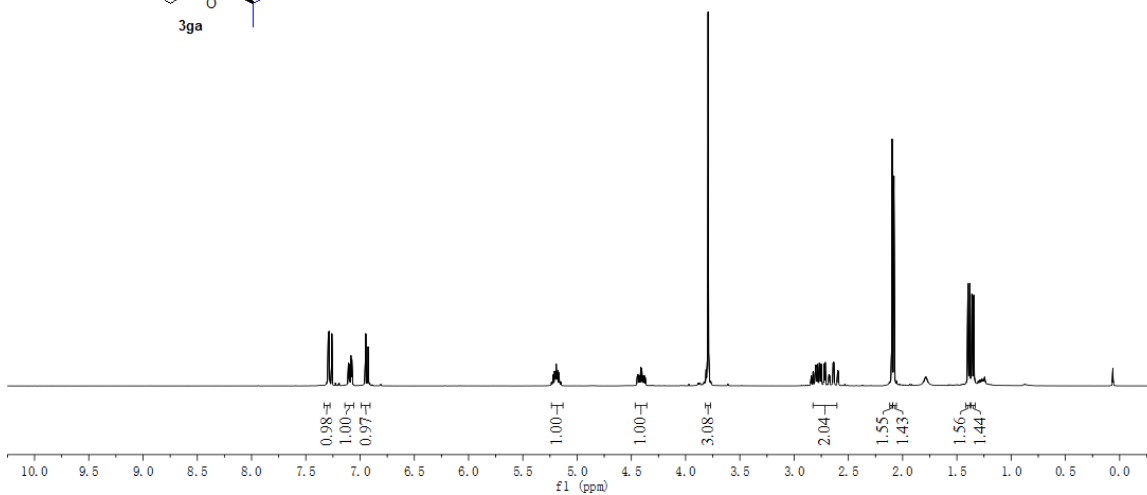
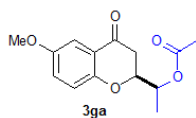


190.26
170.18
170.10
162.66
162.58
160.54
135.96
135.93
111.17
109.97
103.99
78.31
77.90
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70.12
56.15
40.28
39.72
21.09
21.02
15.49

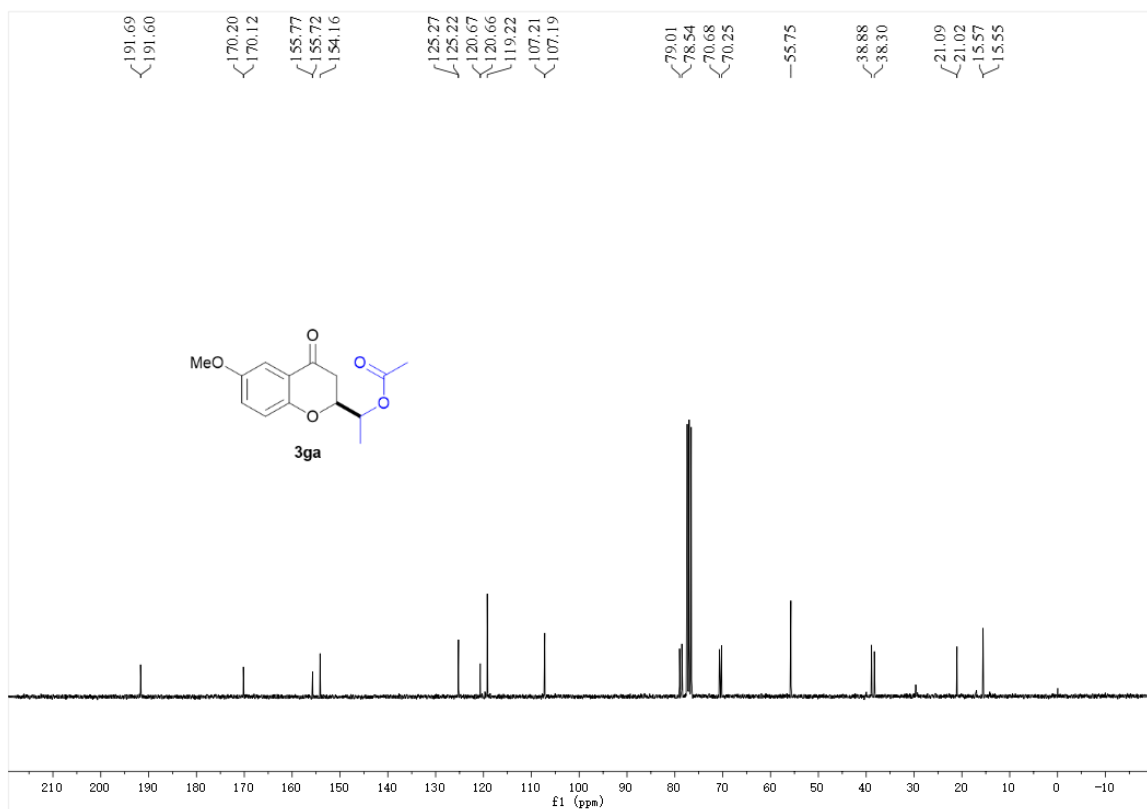
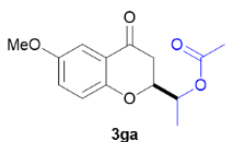


1-(6-Methoxy-4-oxochroman-2-yl)ethyl acetate (3ga)

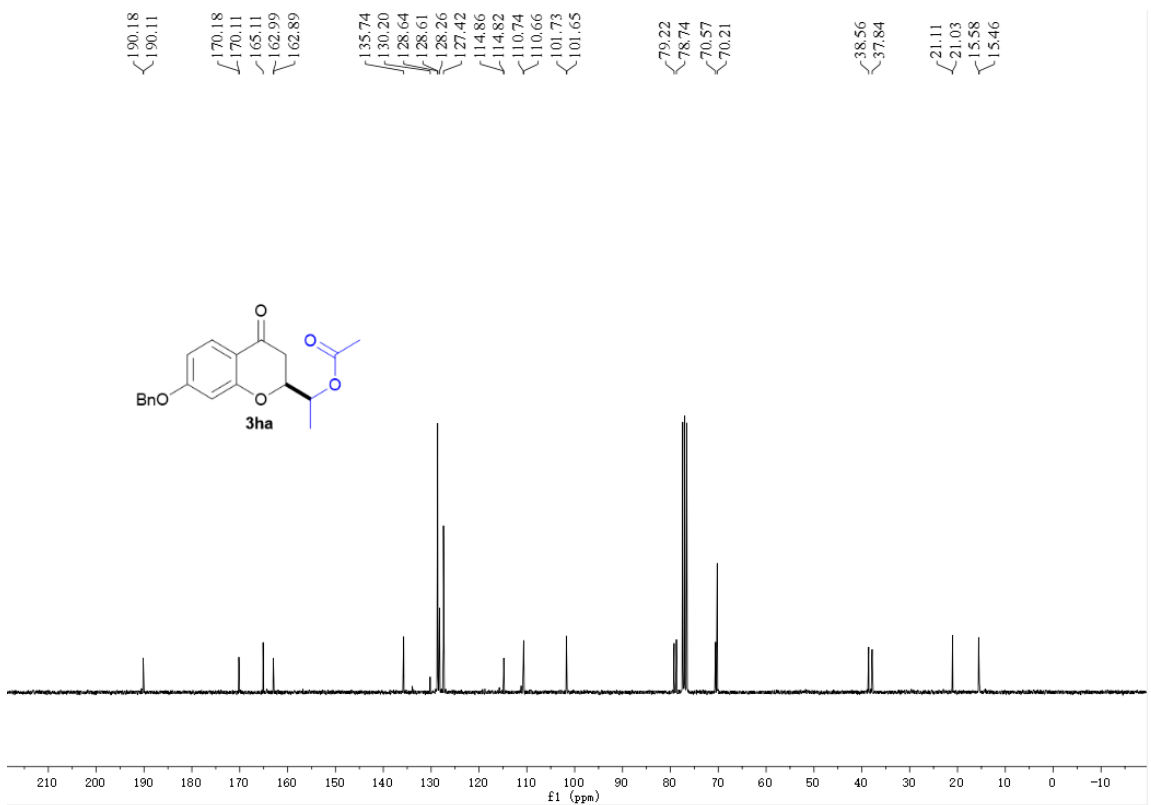
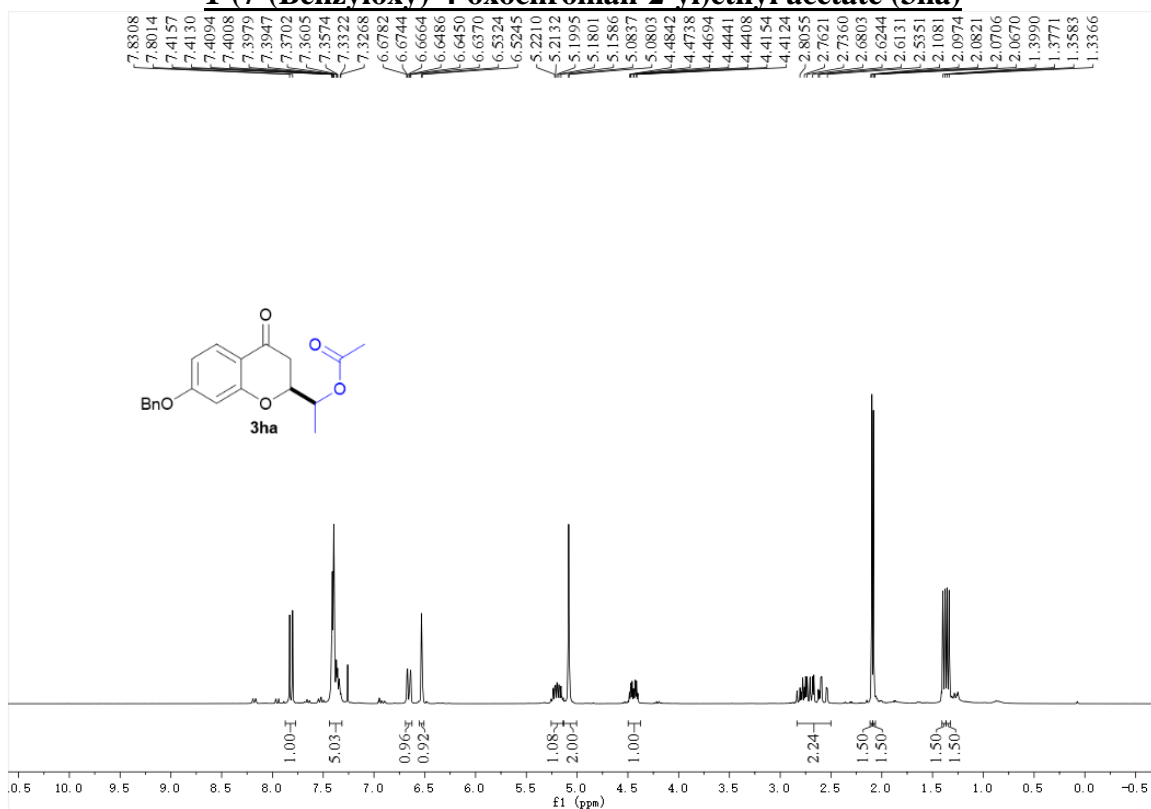
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7.0994
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6.9465
6.9258
6.9239
5.2353
5.2246
5.2084
5.1924
5.1820
5.1763
5.1493
4.4460
4.4277
4.4048
4.4019
3.7894
3.7874
2.7994
2.7672
2.7215
2.7133
2.6328
2.5984
2.5894
2.5874
2.0802
1.3985
1.3820
1.3615
1.3451



191.69
191.60
170.20
170.12
155.77
155.72
154.16
125.27
125.22
120.67
120.66
119.22
107.21
107.19
79.01
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38.88
38.30
21.09
21.02
15.57
15.55

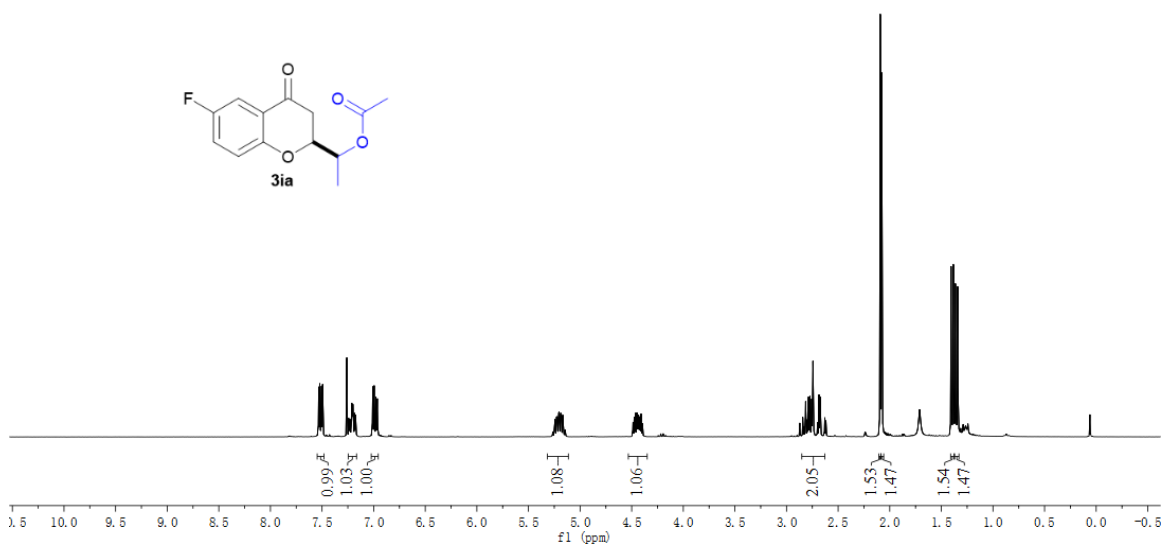
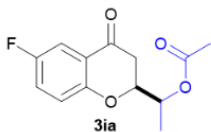


1-(7-(Benzyloxy)-4-oxochroman-2-yl)ethyl acetate (3ha)

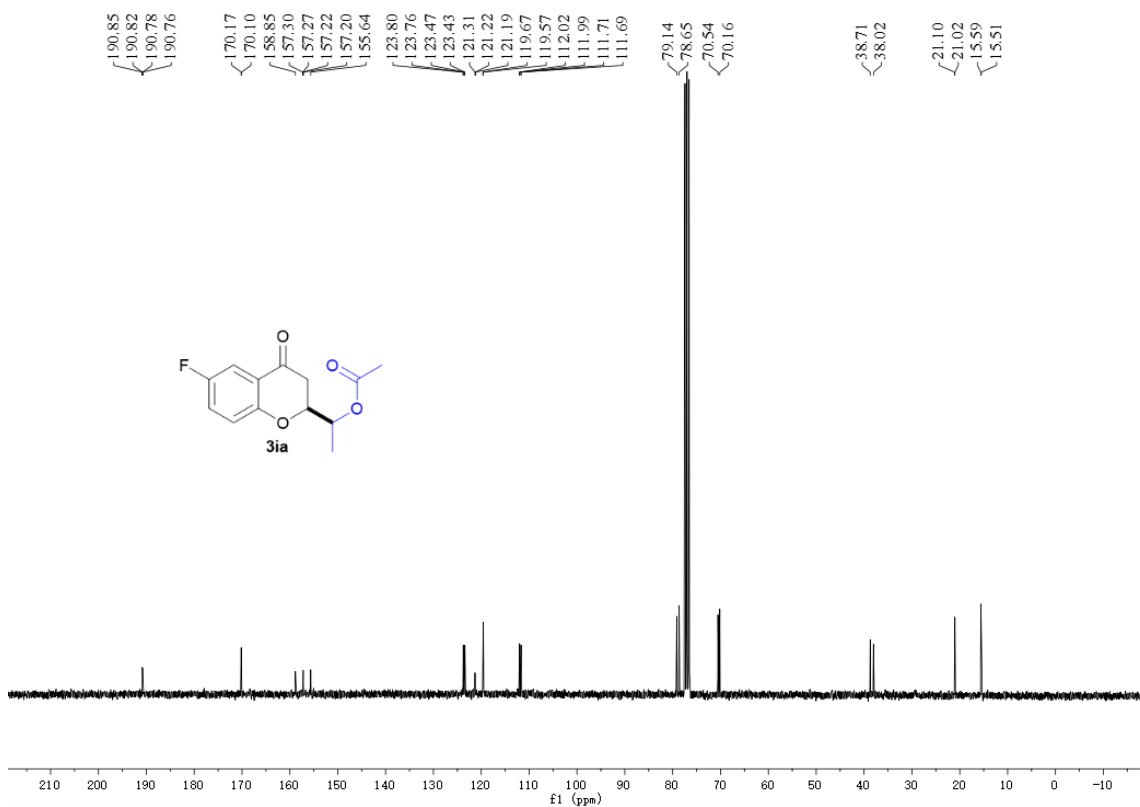
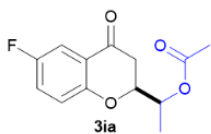


1-(6-Fluoro-4-oxochroman-2-yl)ethyl acetate (3ia)

7.5322, 7.5216, 7.5050, 7.4944, 7.2417, 7.2382, 7.2161, 7.2054, 7.1973, 7.1751, 7.1716, 7.0089, 6.9950, 6.9788, 6.9647, 5.2648, 5.2508, 5.2072, 5.1887, 5.1814, 5.1453, 4.4871, 4.4759, 4.4730, 4.4448, 4.4369, 4.4090, 2.8151, 2.7867, 2.7738, 2.7561, 2.7439, 2.6856, 2.6296, 2.0775, 1.4055, 1.3837, 1.3639, 1.3421

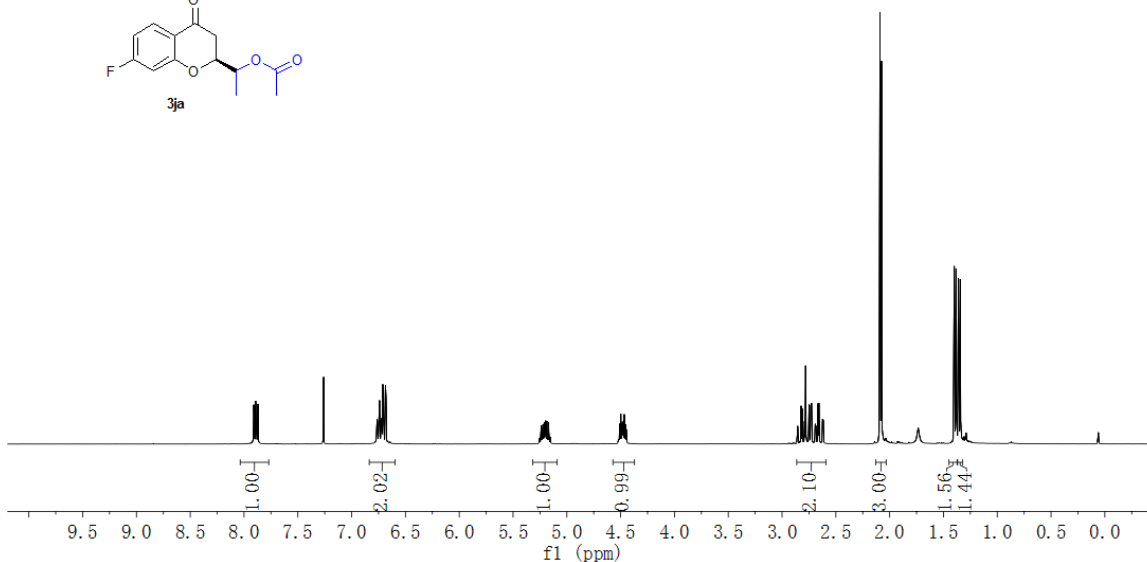
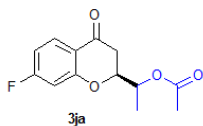


190.85, 190.82, 190.78, 190.76, 170.17, 170.10, 158.85, 157.30, 157.27, 157.22, 157.20, 155.64, 123.80, 123.76, 123.47, 123.43, 121.31, 121.22, 121.19, 119.67, 119.57, 112.02, 111.99, 111.71, 111.69, 79.14, 78.65, 70.54, 70.16, 38.71, 38.02, 21.10, 21.02, 15.59, 15.51

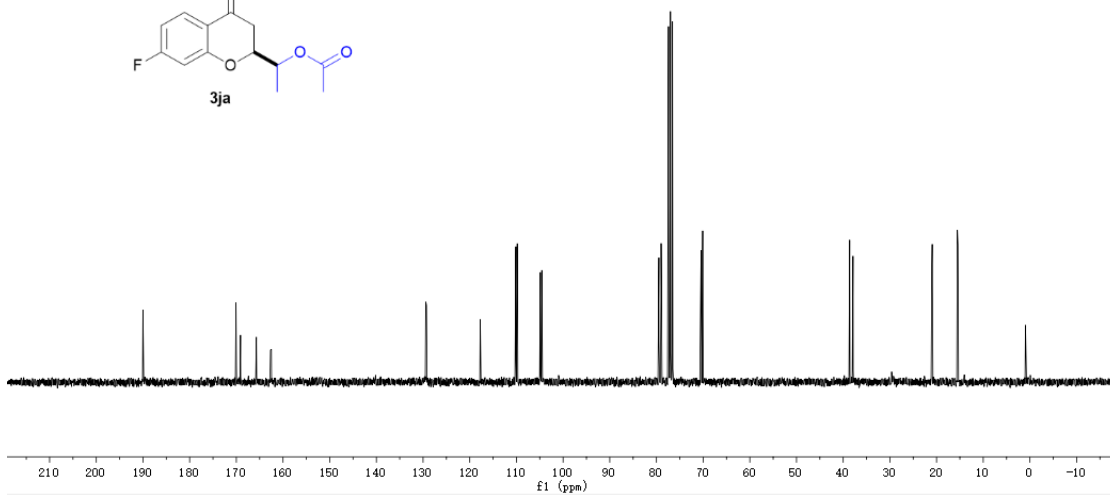
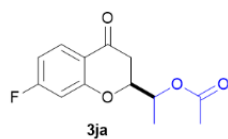


1-(7-Fluoro-4-oxochroman-2-yl)ethyl acetate (3ja)

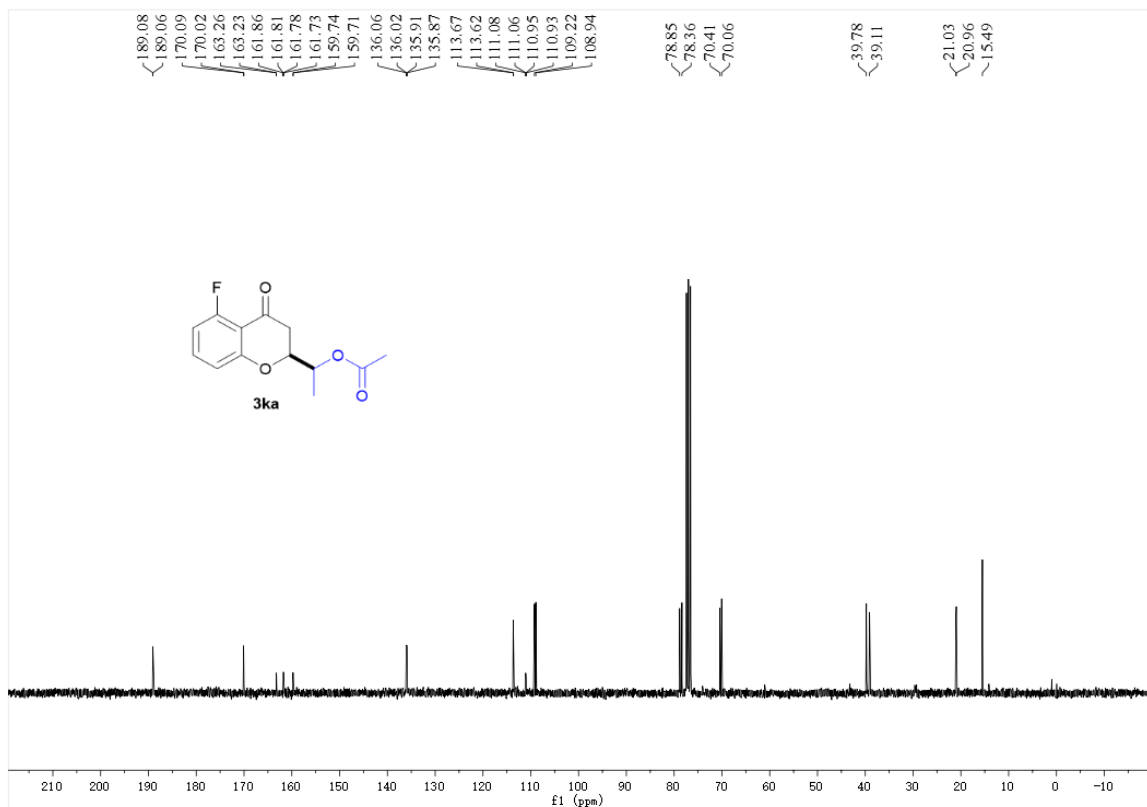
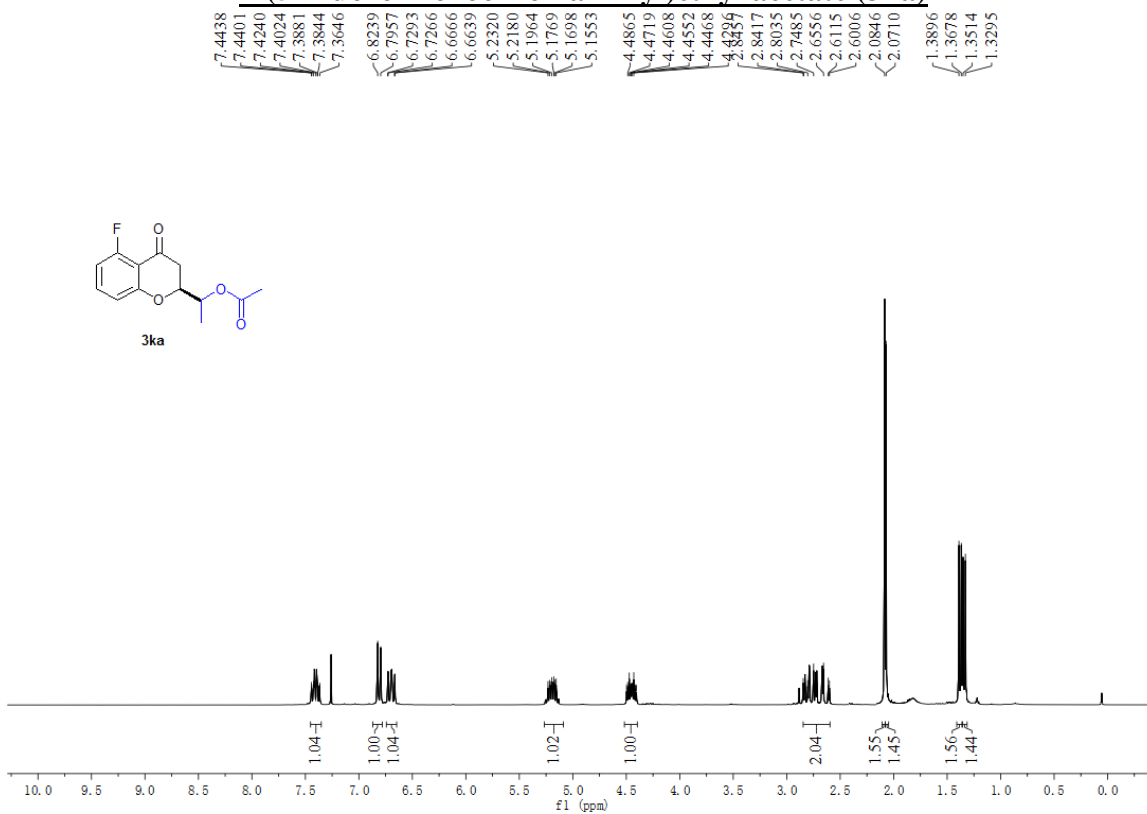
7.9090
7.8924
7.8873
7.8707
-7.2606
6.7667
6.7630
6.7409
6.7105
6.7046
6.6860
6.6891
5.2332
5.2369
5.2102
5.1697
5.1533
4.5171
4.4984
4.4771
4.4664
4.4478
2.8549
2.8228
2.7809
2.7678
2.7254
2.6658
2.6577
2.6158
2.0892
2.0758
1.3994
1.3830
1.3601
1.3437



190.01
189.94
170.07
170.00
169.11
165.71
162.75
162.68
162.57
162.50
129.47
129.42
129.32
129.27
117.78
117.75
117.72
110.12
109.82
104.89
104.56
79.48
79.00
70.43
70.10
38.60
37.89
21.01
20.93
15.54
15.41

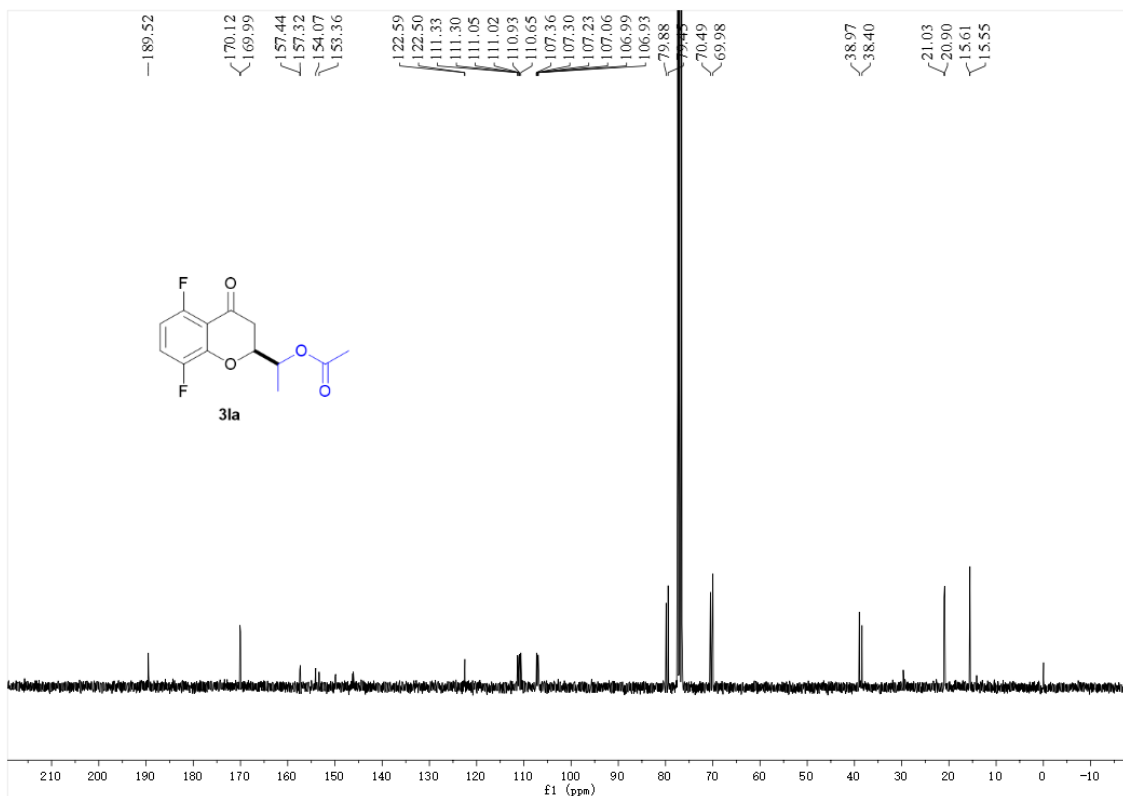
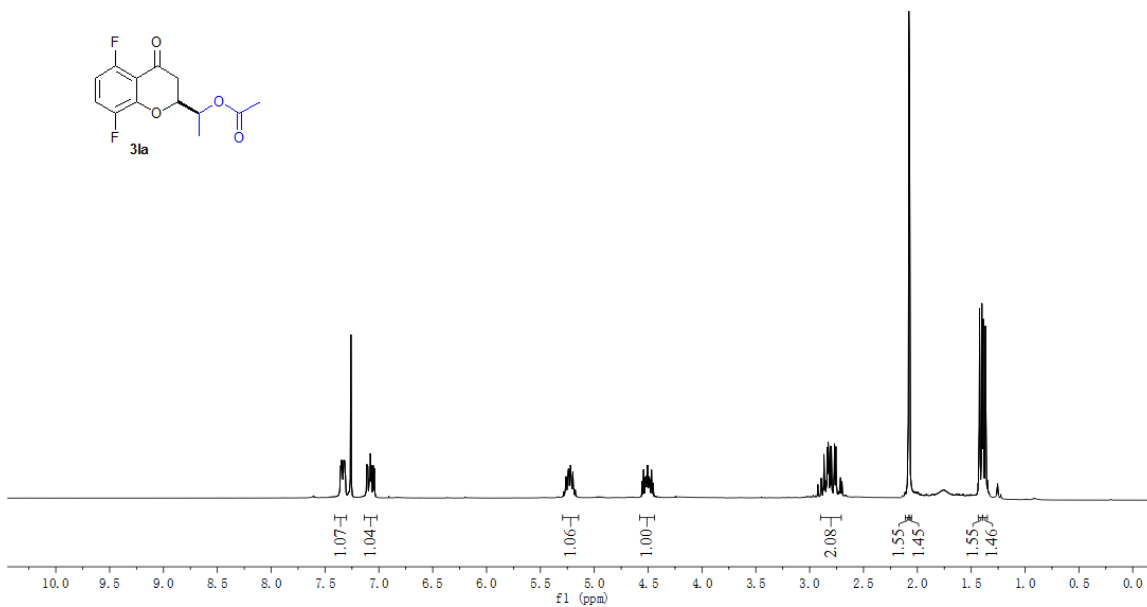
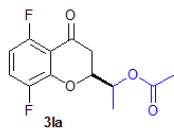


1-(5-Fluoro-4-oxochroman-2-yl)ethyl acetate (3ka)

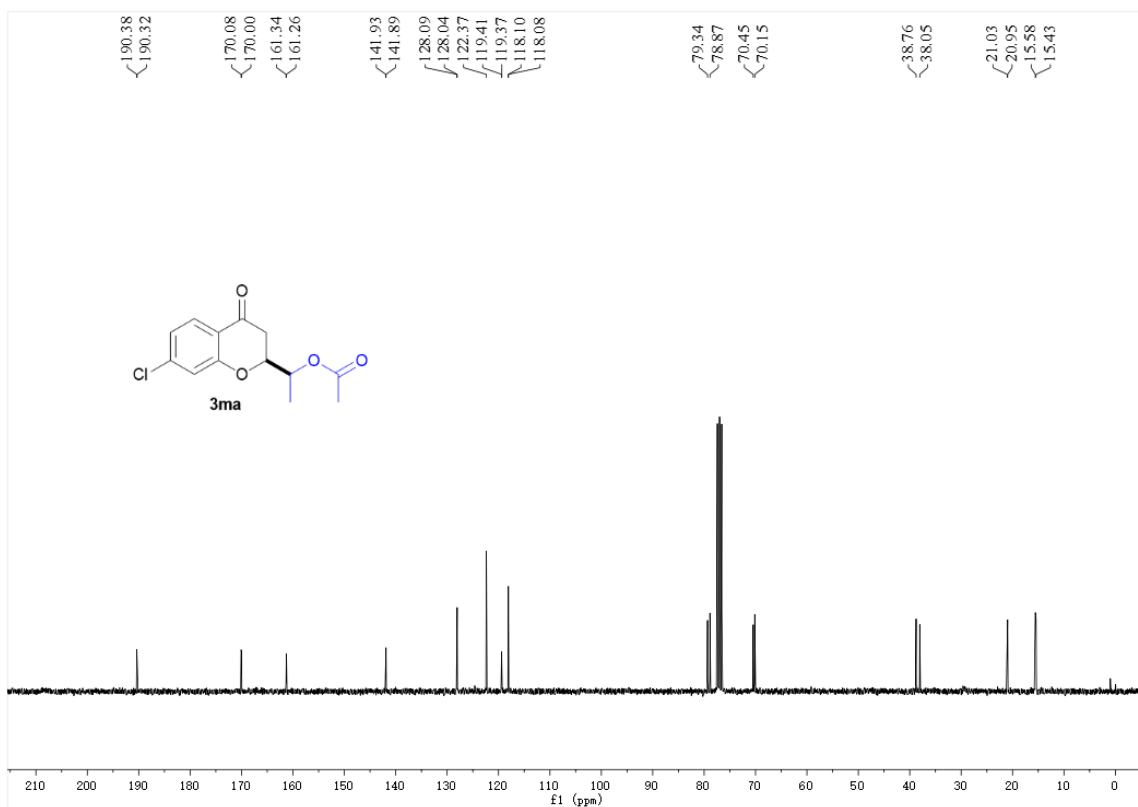
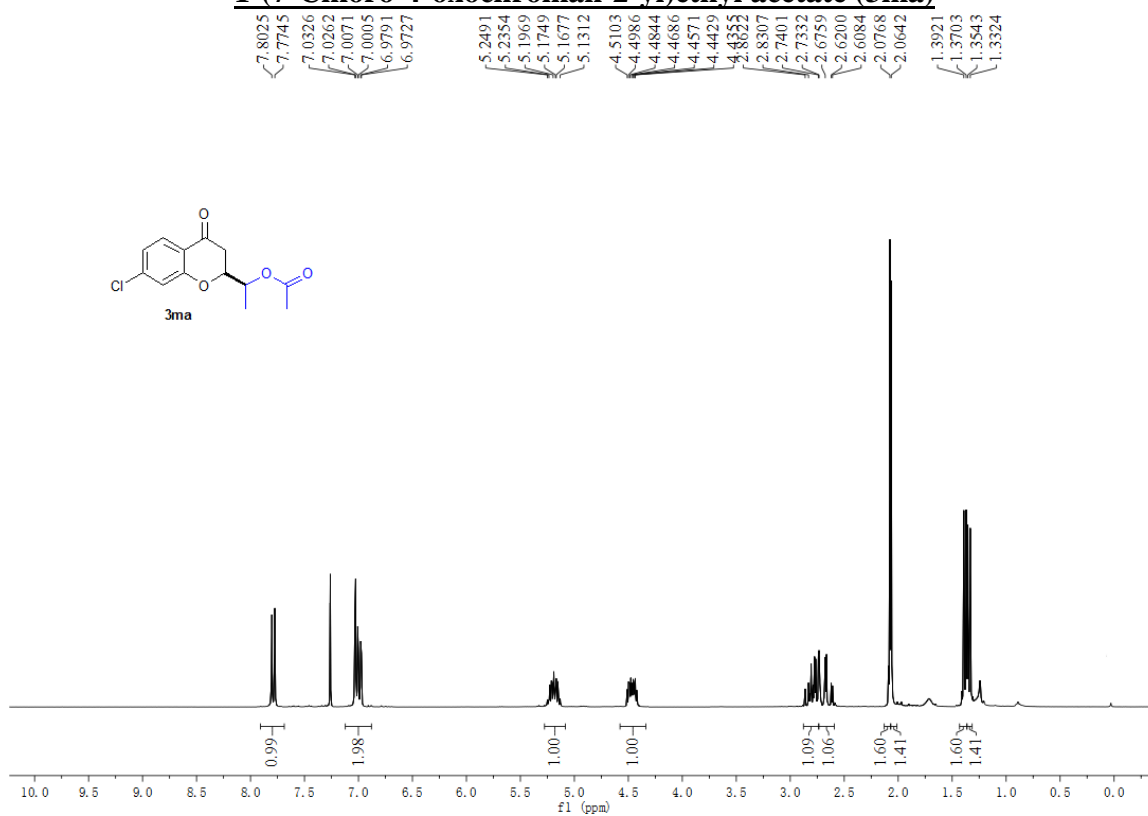


1-(5,8-Difluoro-4-oxochroman-2-yl)ethyl acetate (3la)

7.3590
7.3531
7.3479
7.3429
7.3370
7.3323
7.3265
7.3213
7.3164
7.3106
7.1125
7.1023
7.0861
7.0788
7.0758
7.0688
7.0527
7.0424
5.2404
5.2350
5.2253
5.2202
5.2134
5.1986
4.5419
4.5279
4.5160
4.5078
4.5024
4.4686
2.8672
2.8376
2.8280
2.8094
2.7982
2.7693
2.7588
2.0729
1.4228
1.4009
1.3892
1.3676

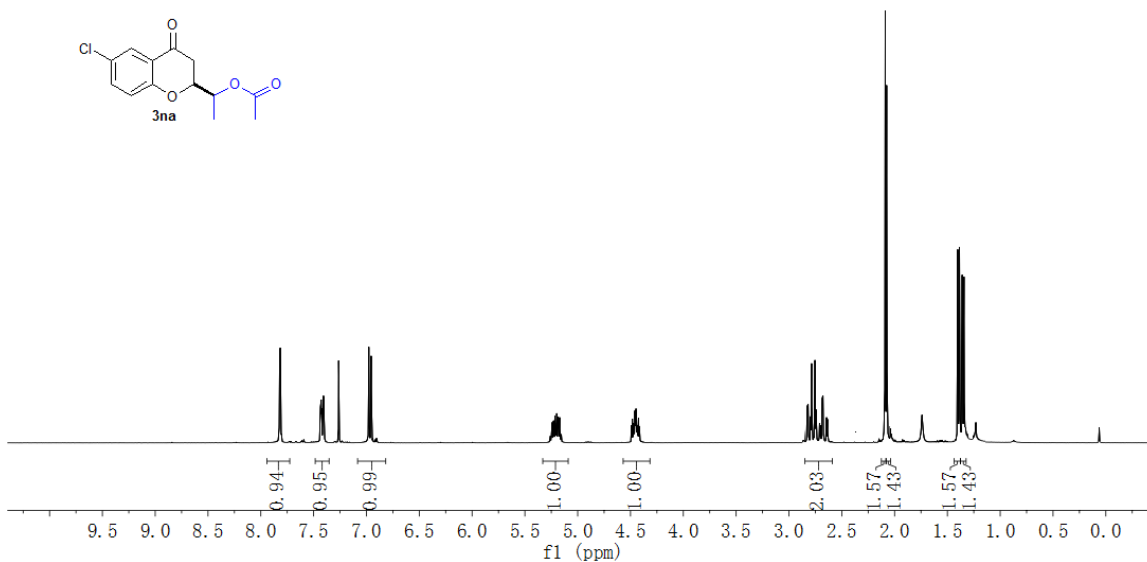
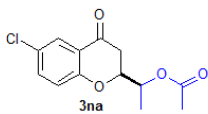


1-(7-Chloro-4-oxochroman-2-yl)ethyl acetate (3ma)

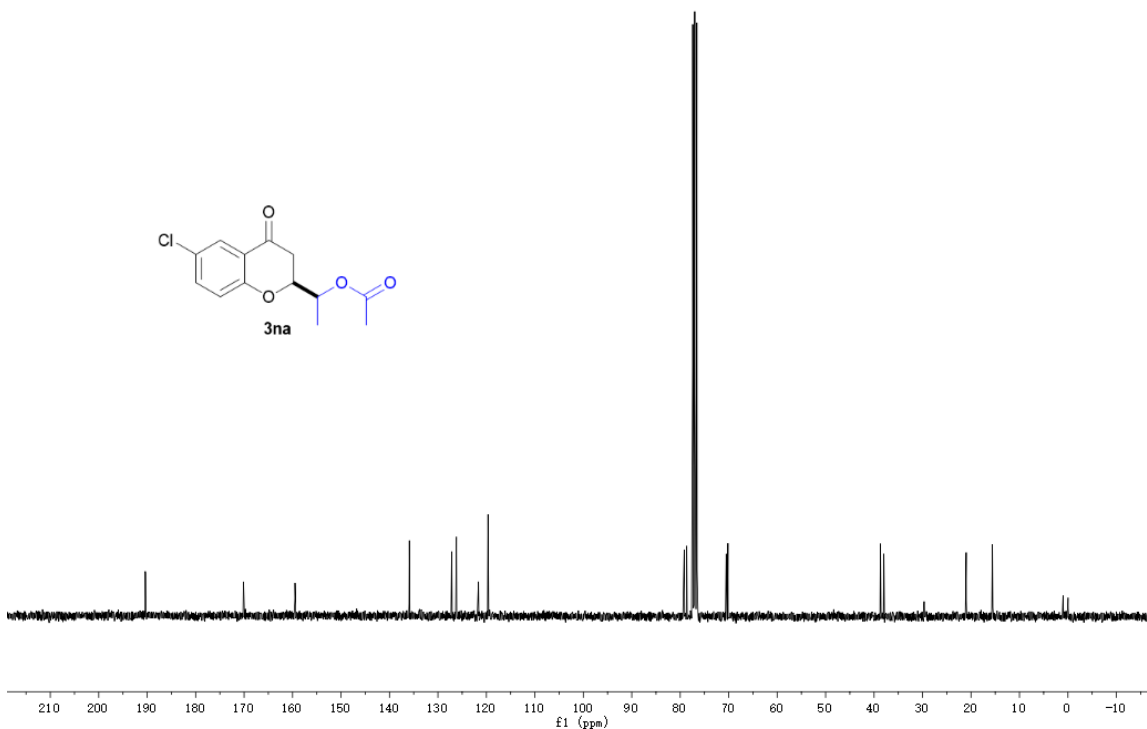
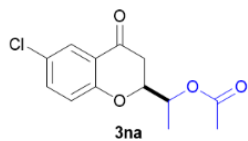


1-(6-Chloro-4-oxochroman-2-yl)ethyl acetate (3na)

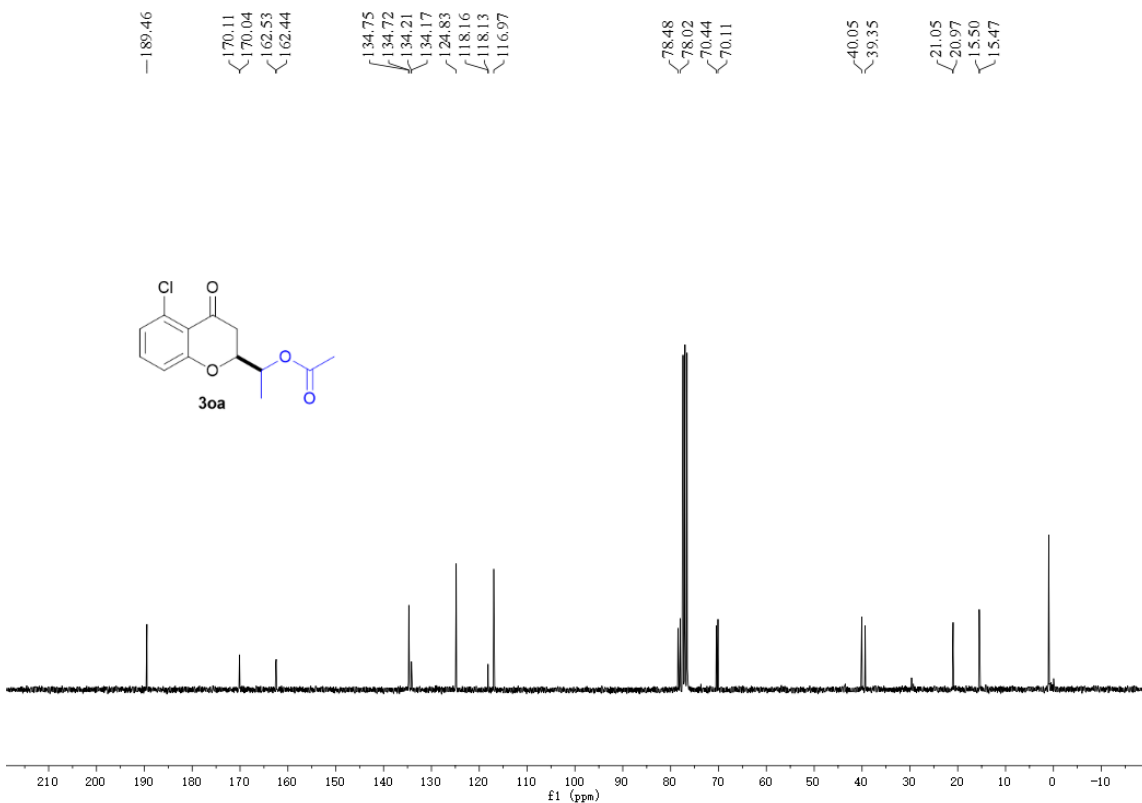
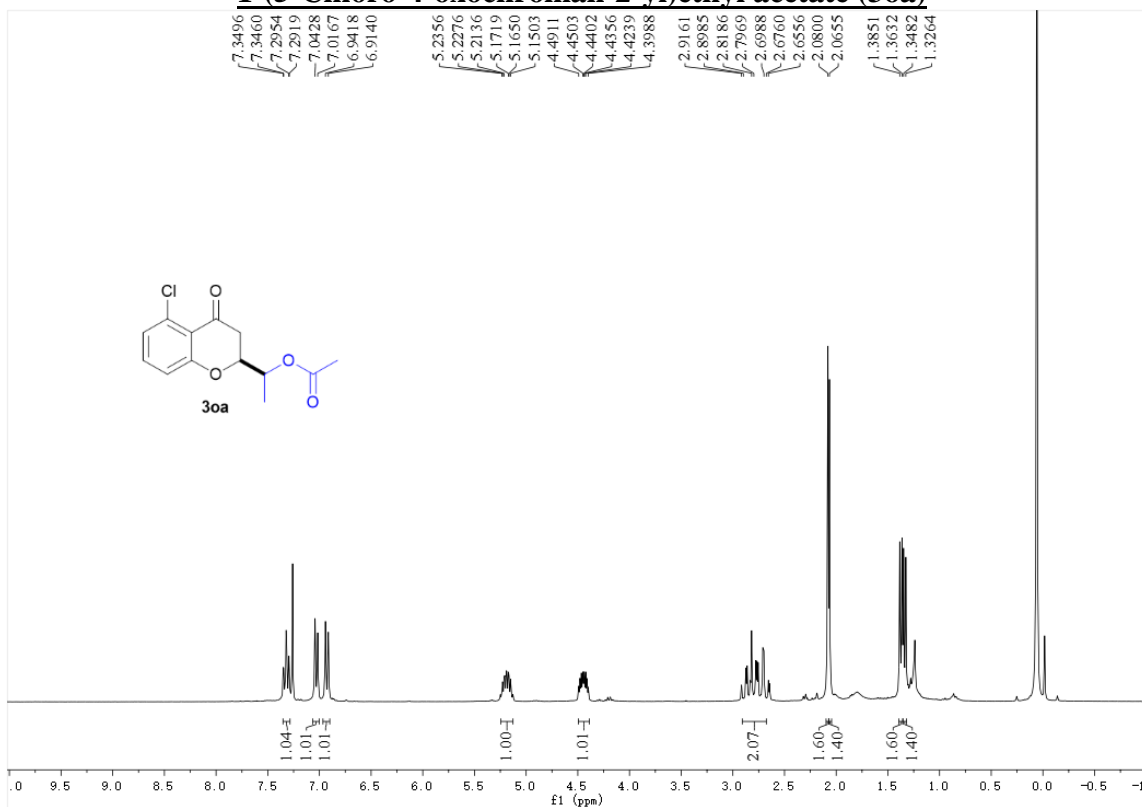
7.8216
7.8150
7.4346
7.4305
7.4284
7.4247
7.4126
7.4085
7.4064
7.4026
7.2628
6.9778
6.9557
5.2589
5.2321
5.2155
5.1985
5.1713
5.1549
4.4909
4.4721
4.4574
4.4481
4.4248
4.4154
2.8276
2.8180
2.7857
2.7532
2.7444
2.6859
2.6677
2.6488
2.0749
1.4018
1.3854
1.3598
1.3434



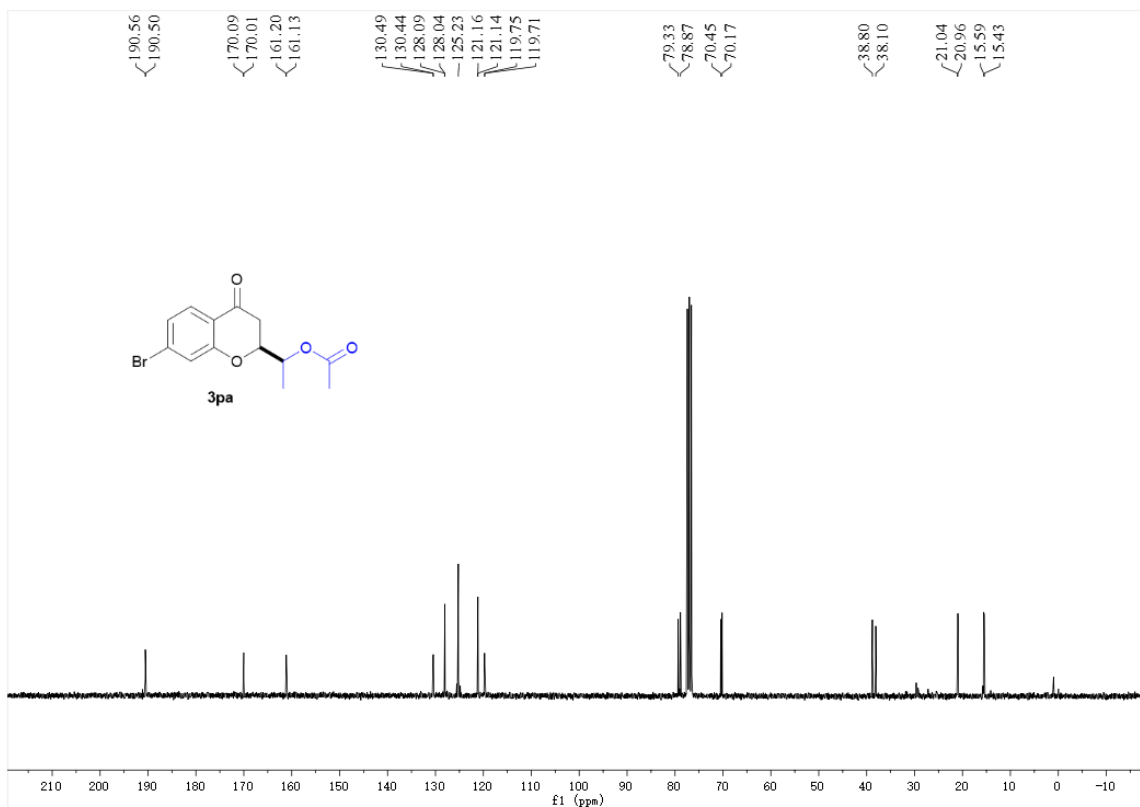
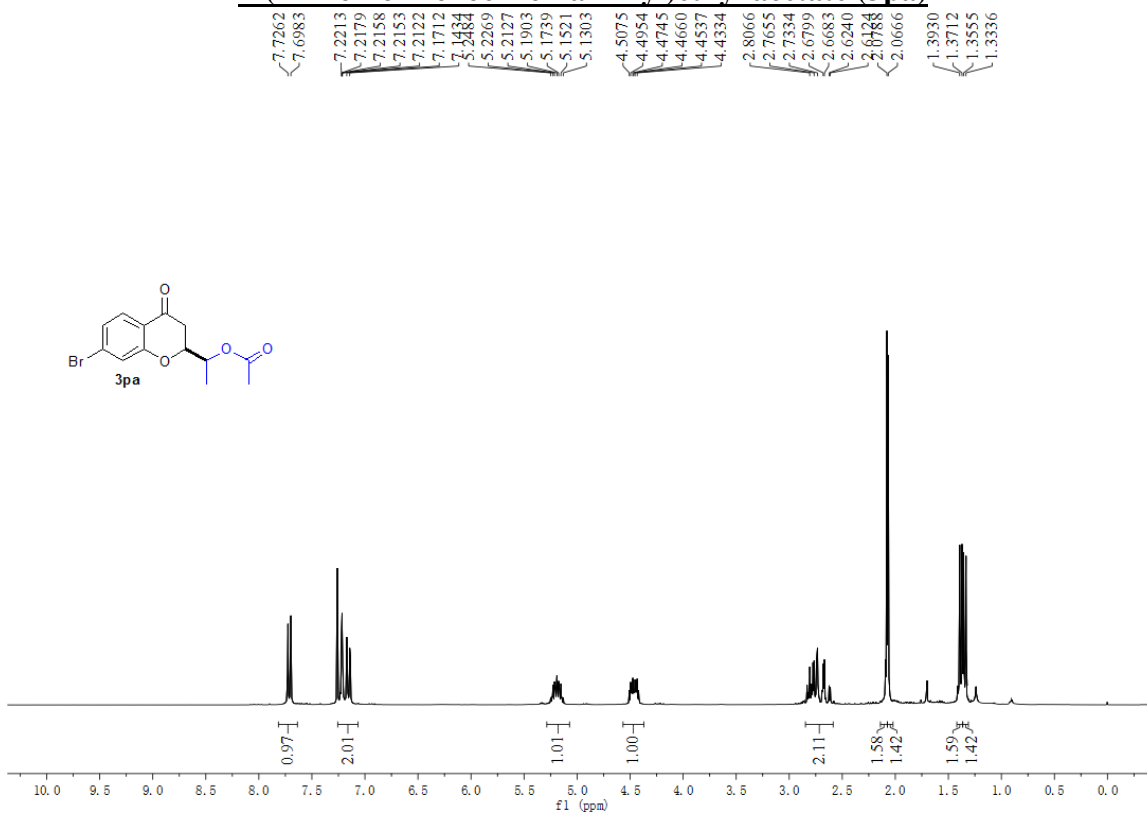
190.40
190.35
170.13
170.05
159.50
159.42
135.93
135.90
127.16
126.22
126.19
121.64
121.60
119.67
79.17
78.66
70.51
70.16
38.69
37.99
21.07
20.99
15.59
15.52



1-(5-Chloro-4-oxochroman-2-yl)ethyl acetate (30a)

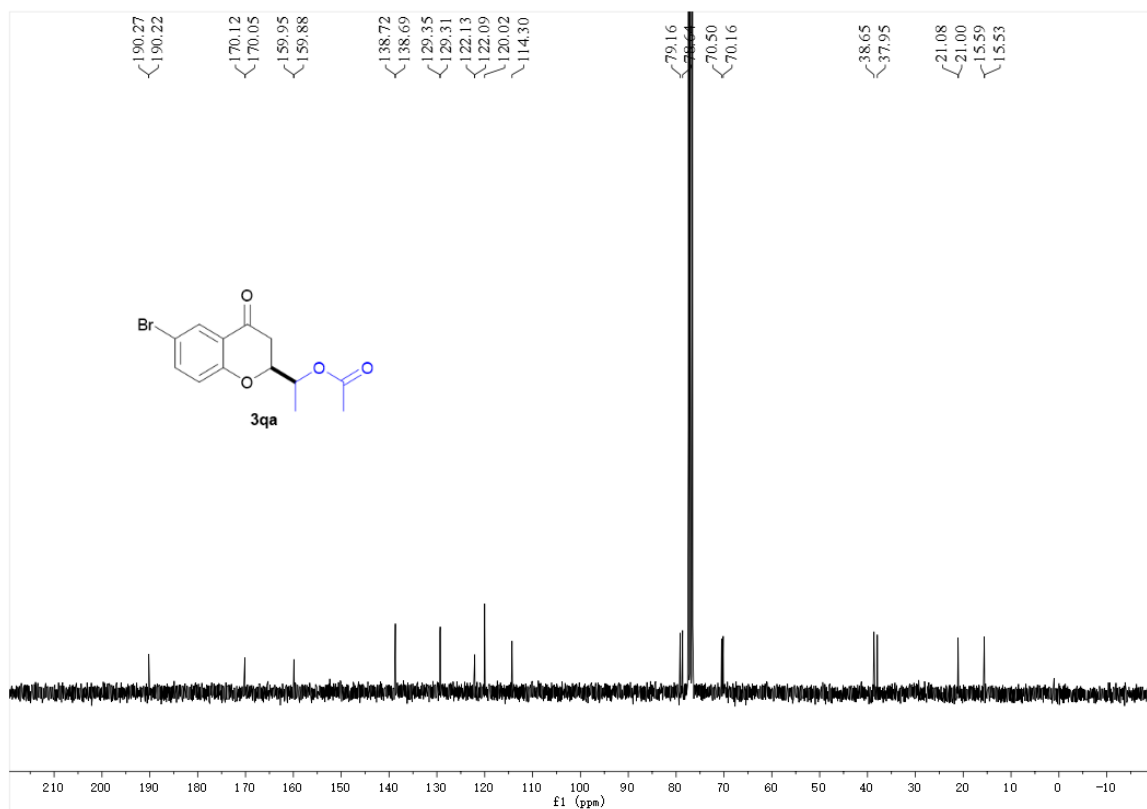
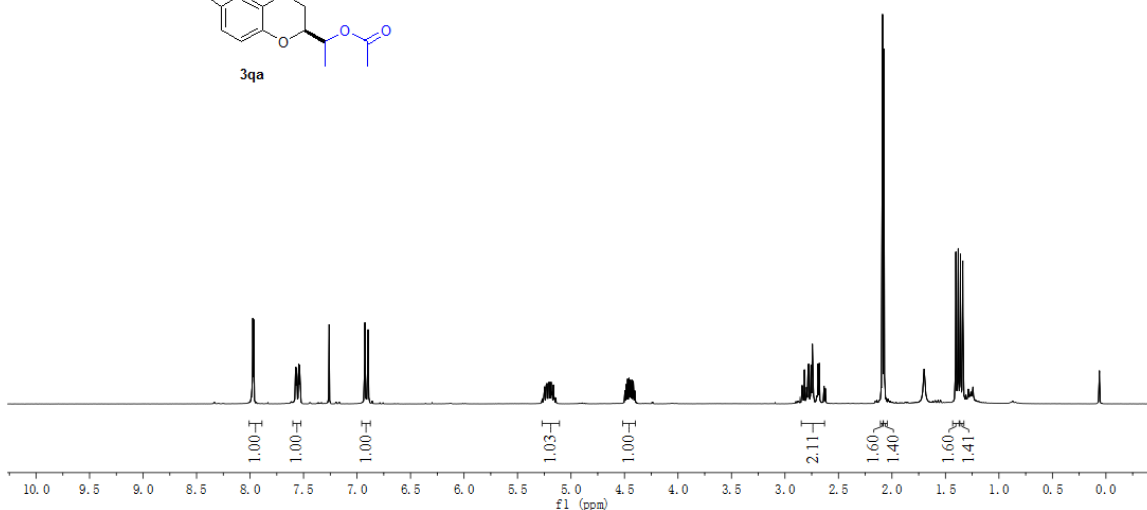
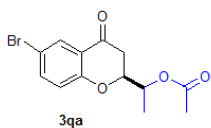


1-(7-Bromo-4-oxochroman-2-yl)ethyl acetate (3pa)



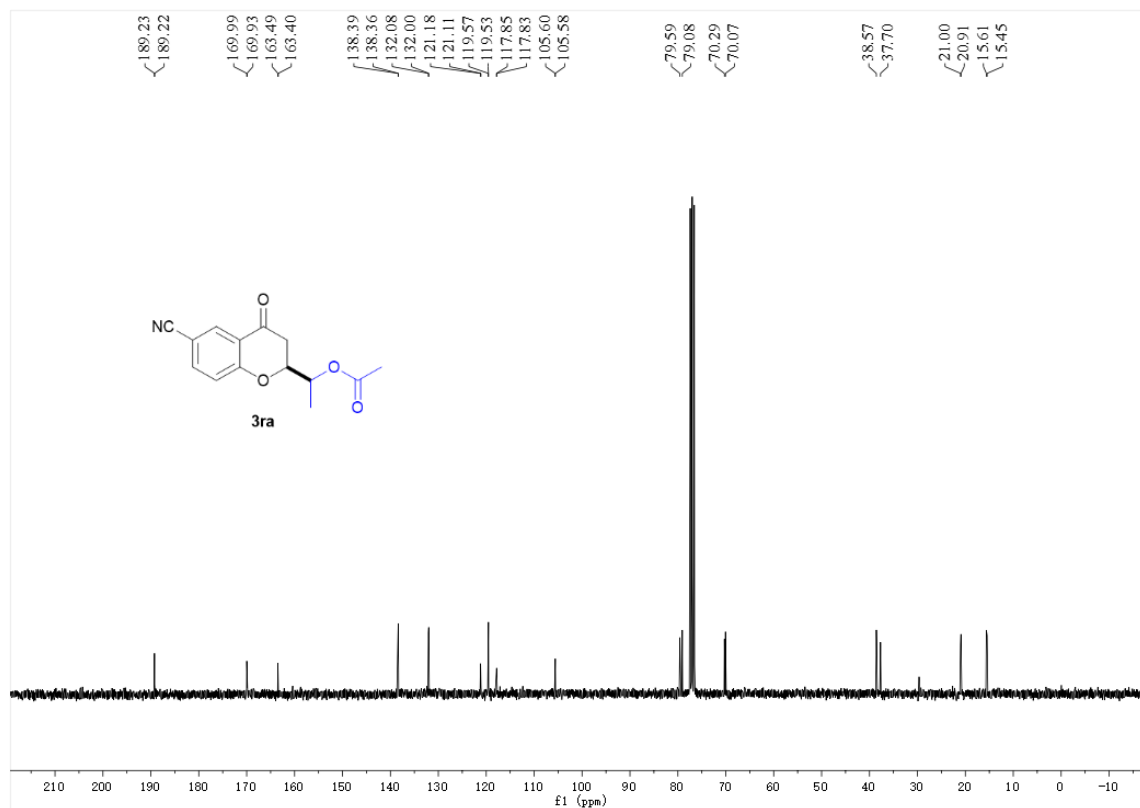
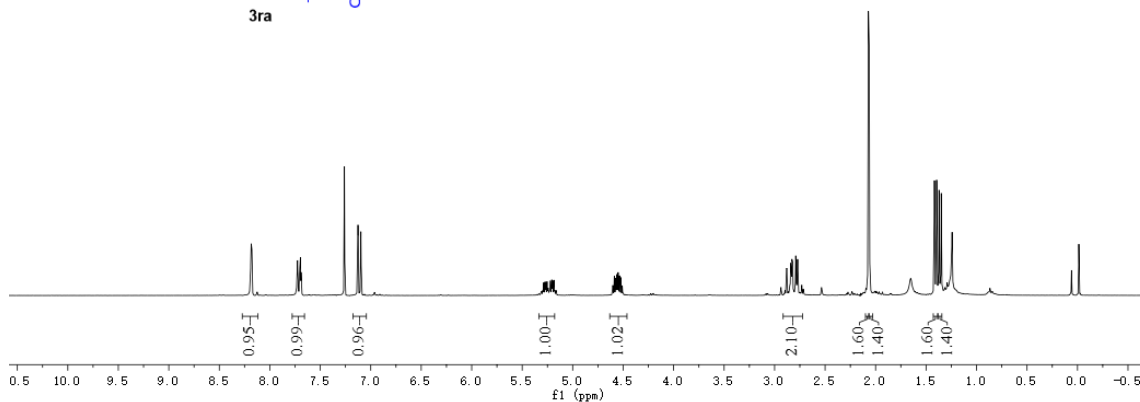
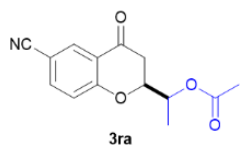
1-(6-Bromo-4-oxochroman-2-yl)ethyl acetate (3qa)

7.9741, 7.9656, 7.5750, 7.5455, 7.5272, 6.9248, 6.8955, 5.2679, 5.2541, 5.2460, 5.2102, 5.1784, 5.1425, 4.4848, 4.4585, 4.4547, 4.4444, 4.4409, 4.4171, 2.8399, 2.8183, 2.7770, 2.7568, 2.7005, 2.6347, 2.6883, 2.0742, 1.4025, 1.3806, 1.3600, 1.3382



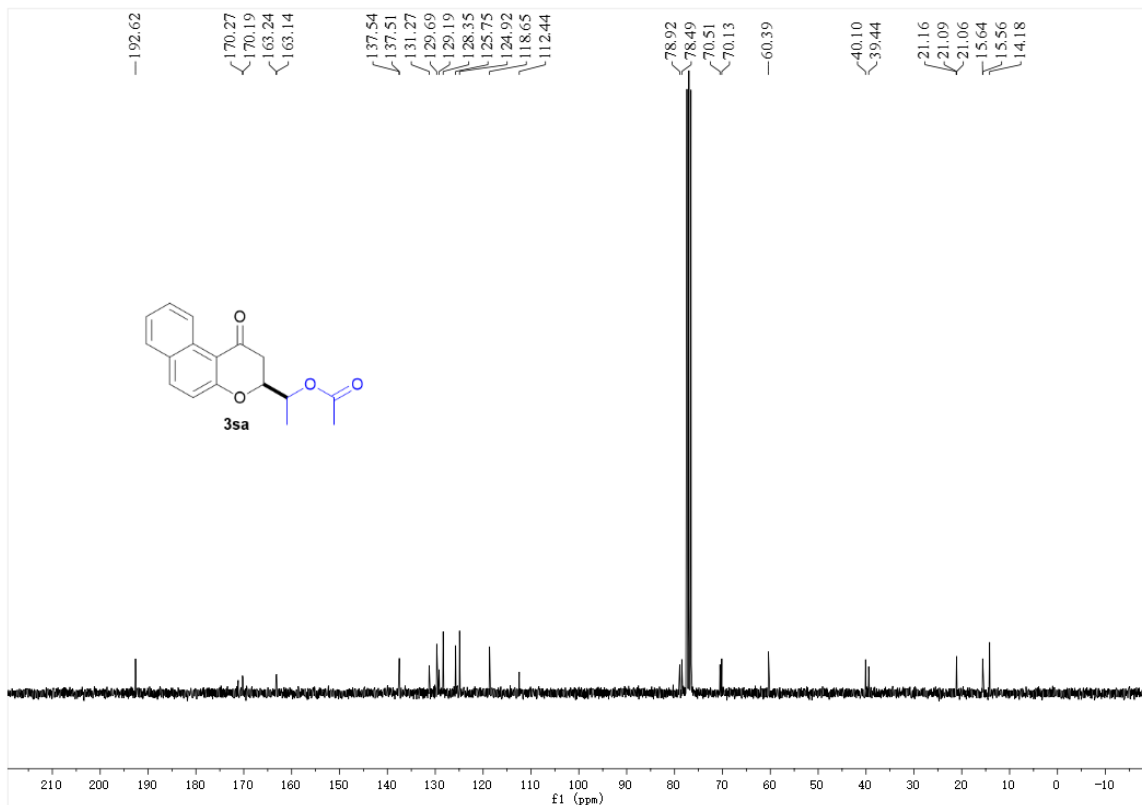
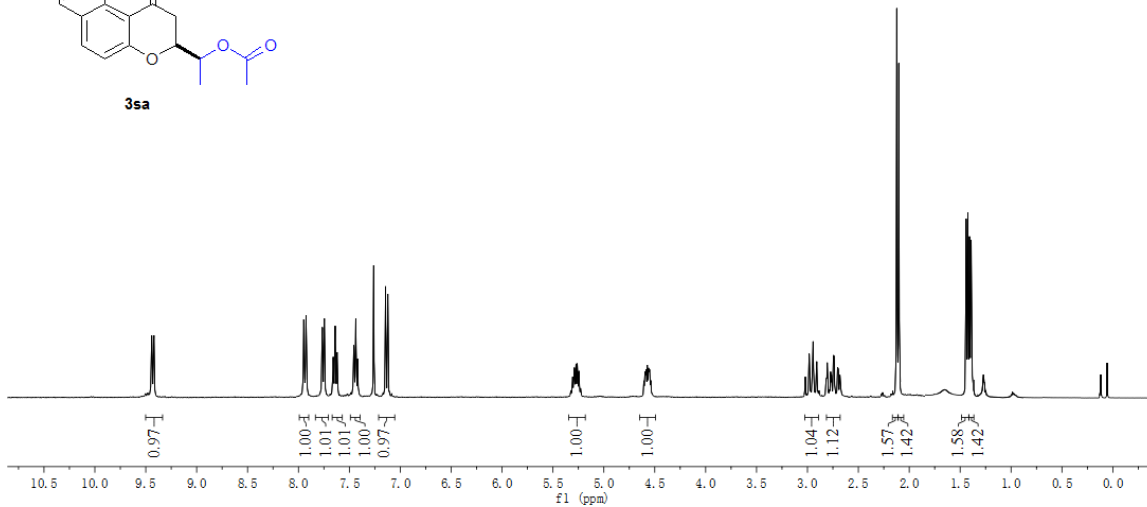
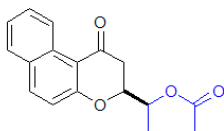
1-(6-Cyano-4-oxochroman-2-yl)ethyl acetate (3ra)

8.1877
8.1841
8.1807
8.1769
7.7318
7.7252
7.7191
7.7028
7.6964
7.6903
7.1265
7.0976
5.3106
5.2975
5.2887
5.2667
5.2438
5.2304
5.2211
5.1994
5.1854
5.1699
5.1635
4.6020
4.5876
4.5361
4.5090
4.4973
2.8974
2.8802
2.7870
2.7720
2.7158
2.0712
2.0623
1.4170
1.3951
1.3714
1.3495

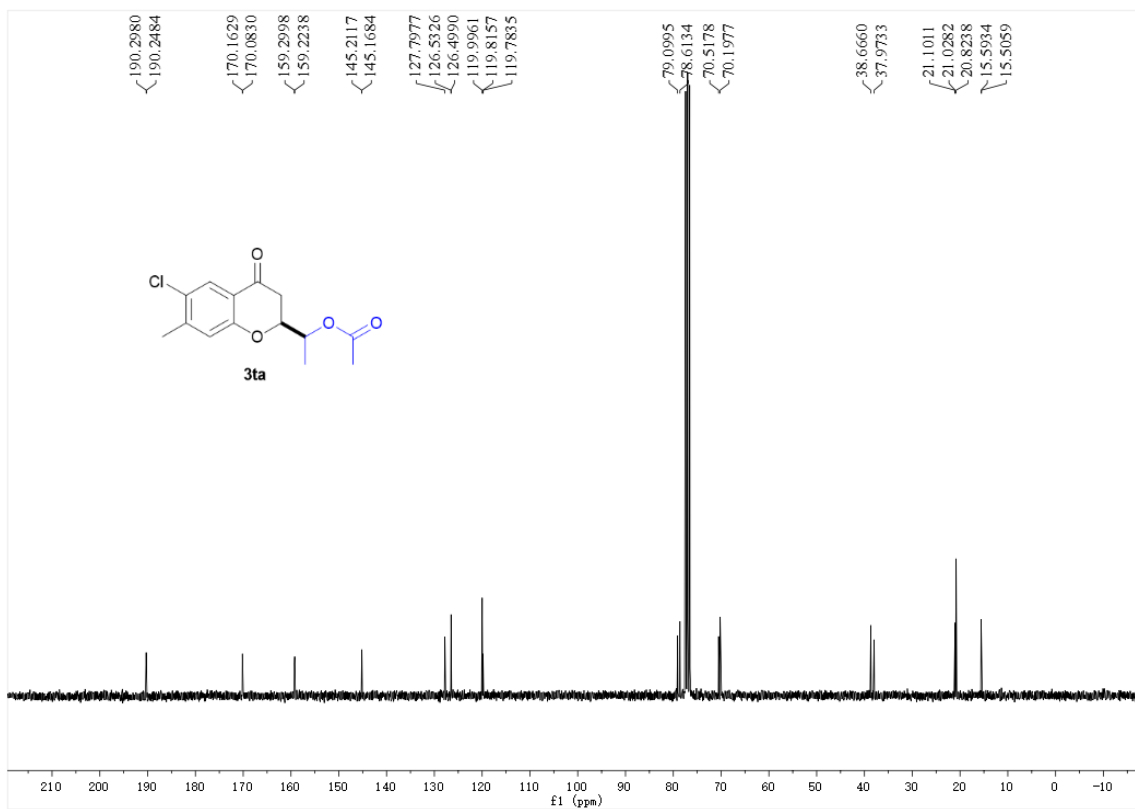
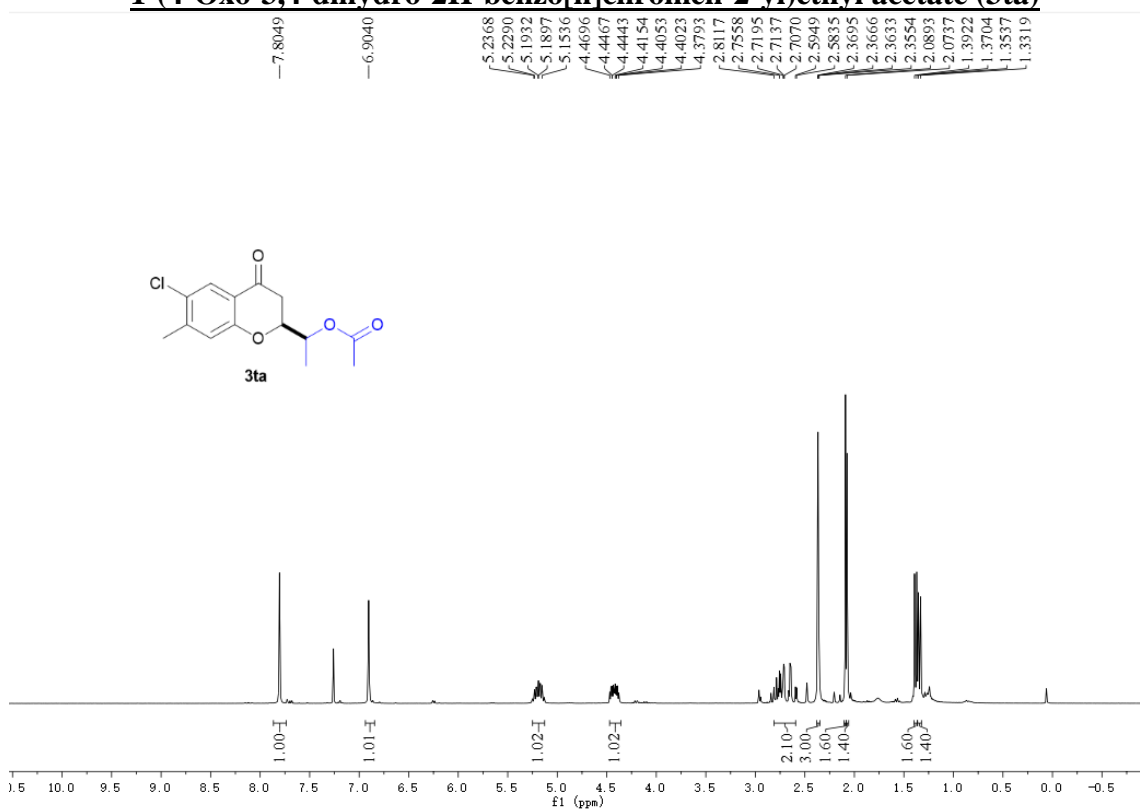


1-(1-Oxo-2,3-dihydro-1H-benzo[f]chromen-3-yl)ethyl acetate (3sa)

9.4413, 9.4197, 7.9479, 7.9254, 7.7656, 7.7454, 7.6569, 7.6390, 7.6348, 7.6178, 7.4572, 7.4186, 7.1445, 7.1221, 5.2953, 5.2899, 5.2899, 5.2732, 5.2448, 4.6067, 4.5946, 4.5732, 4.5650, 4.5529, 4.5392, 2.9838, 2.9487, 2.9087, 2.8054, 2.7369, 2.7041, 2.6962, 2.1227, 2.1024, 1.4409, 1.4246, 1.4081, 1.3917

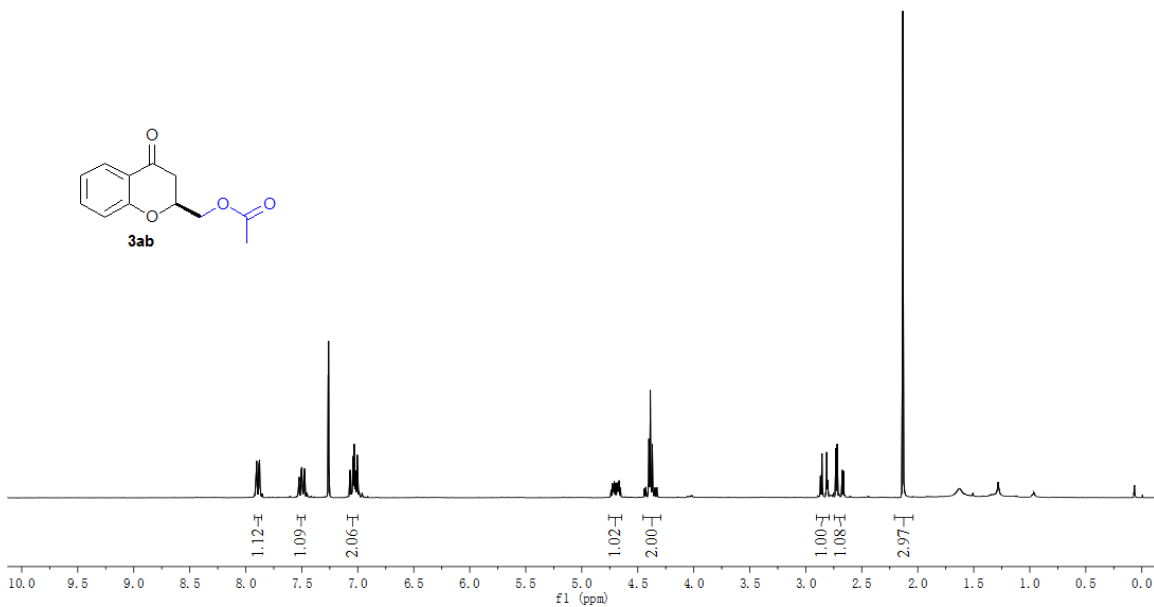
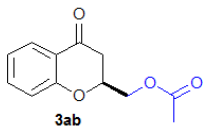


1-(4-Oxo-3,4-dihydro-2H-benzo[h]chromen-2-yl)ethyl acetate (3ta)

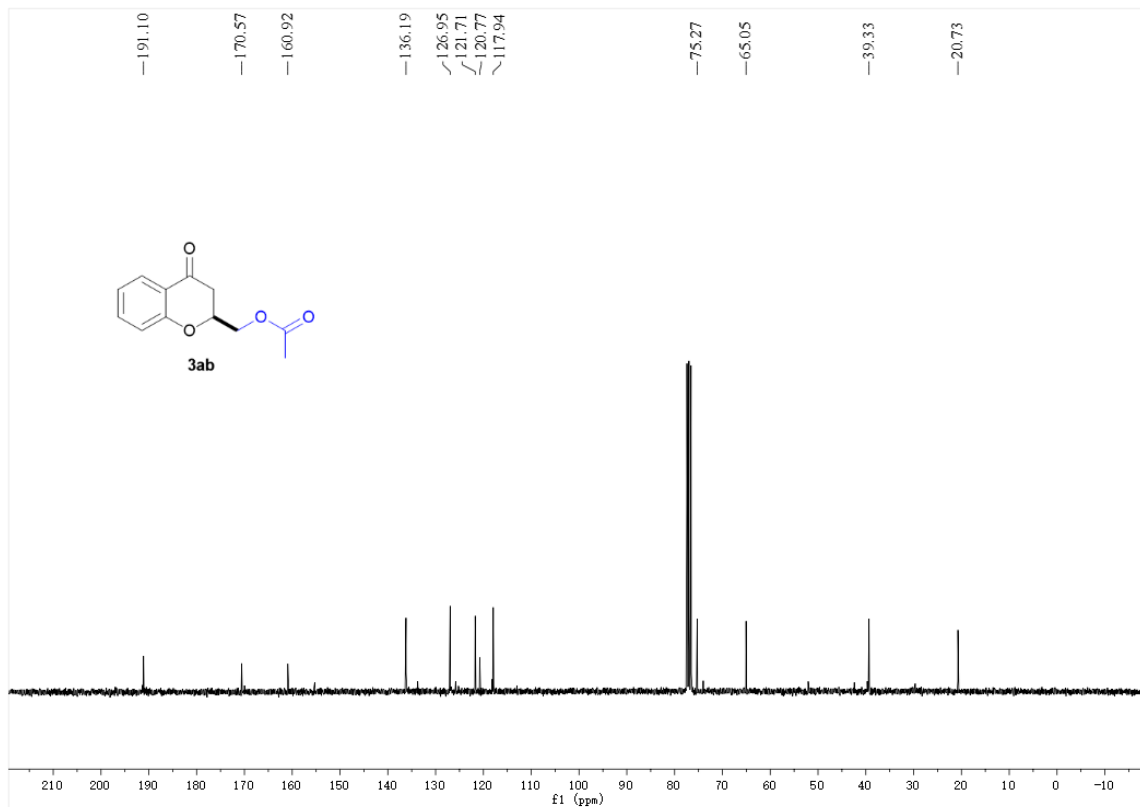
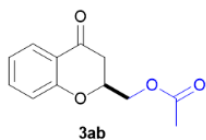


(4-Oxochroman-2-yl)methyl acetate (3ab)

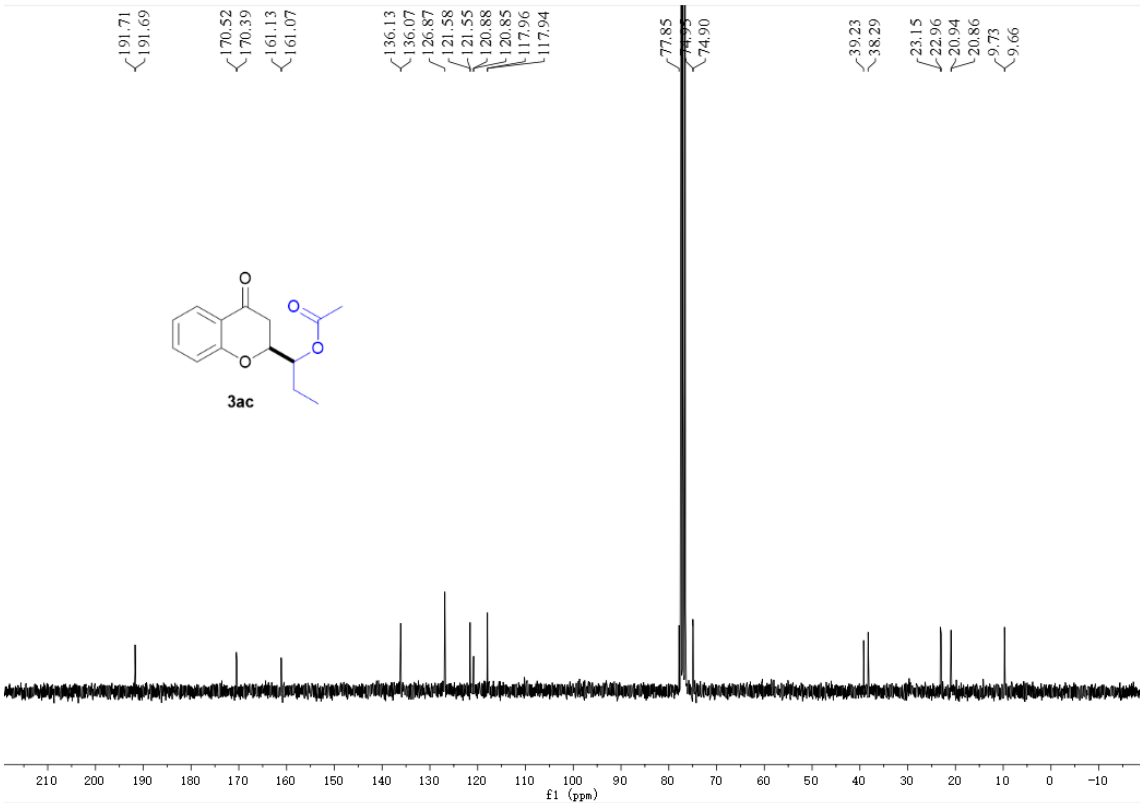
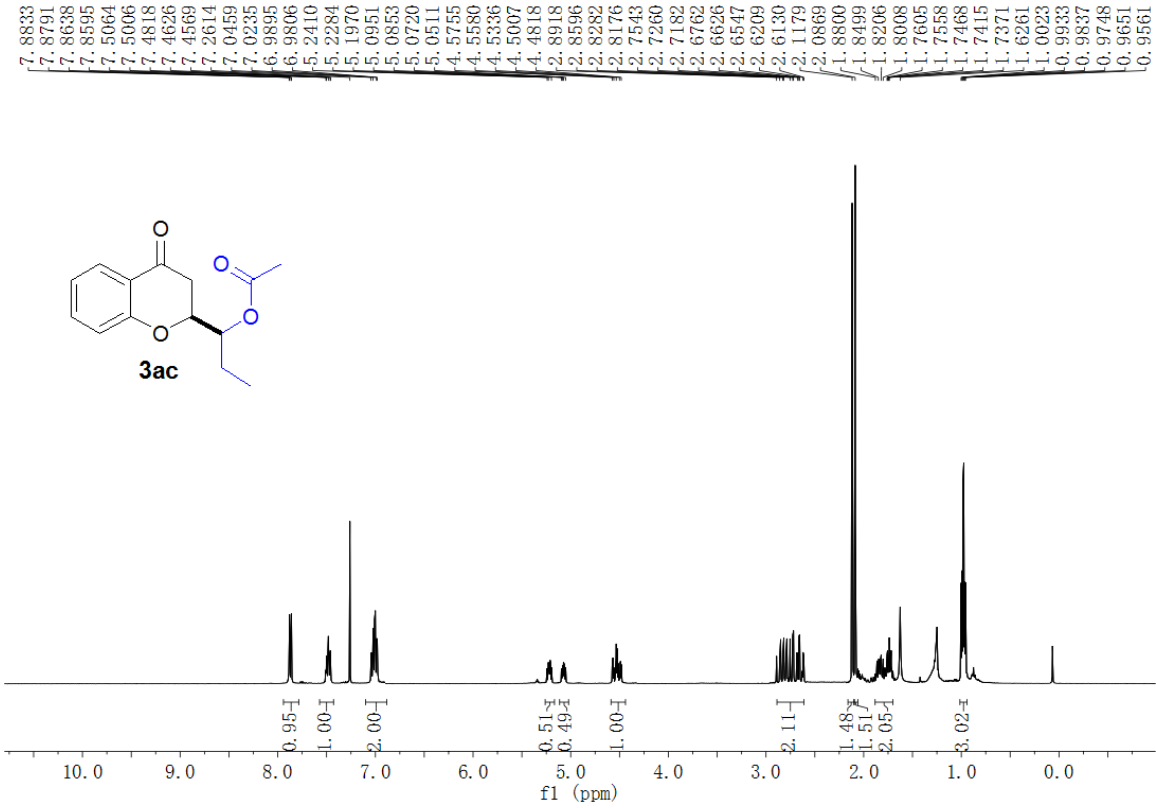
7.9075
7.9034
7.8815
7.8772
7.5298
7.5238
7.5056
7.5017
7.4998
7.4962
7.4720
7.0709
7.0673
7.0432
7.0413
7.0322
7.0206
7.0172
7.0044
4.9388
4.7155
4.6971
4.6843
4.6669
4.6551
4.4286
4.4005
4.3878
4.3697
4.3293
2.8690
2.8556
2.8130
2.7308
2.7200
2.6748
2.6533



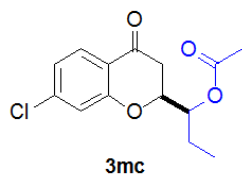
191.10
170.57
160.92
136.19
126.95
121.71
120.77
117.94
75.27
65.05
39.33
20.73



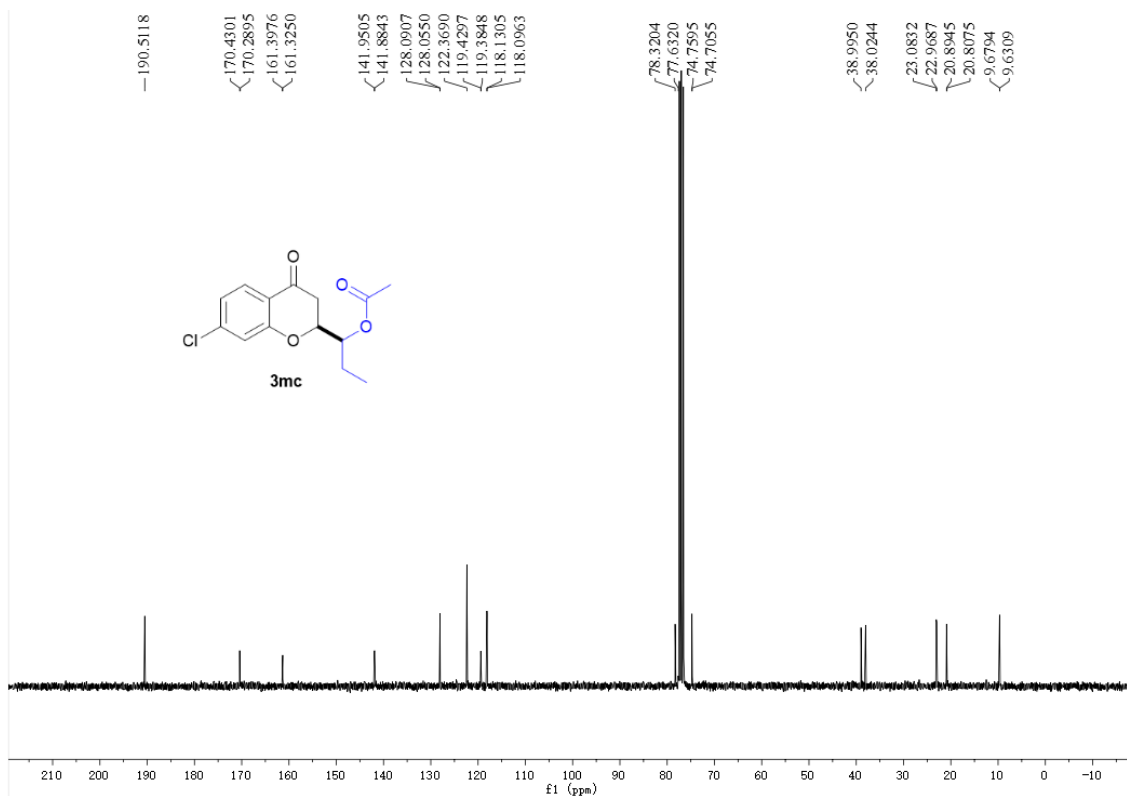
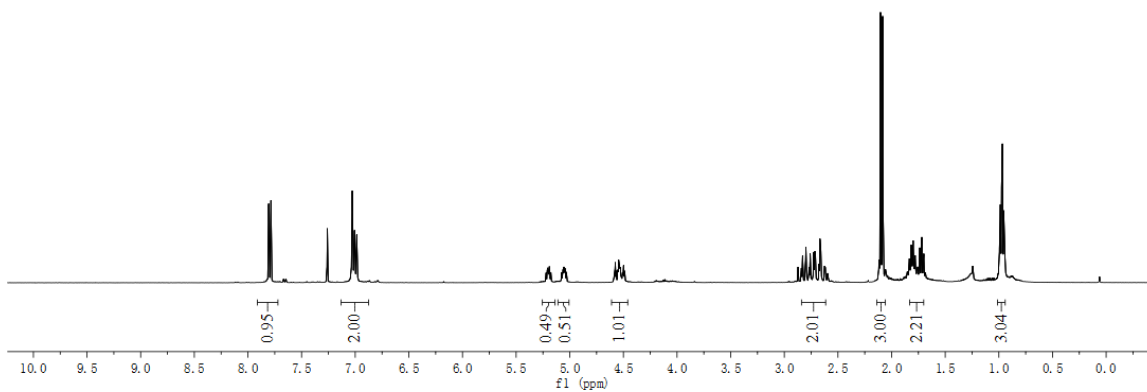
1-(4-Oxochroman-2-yl)propyl acetate (3ac)



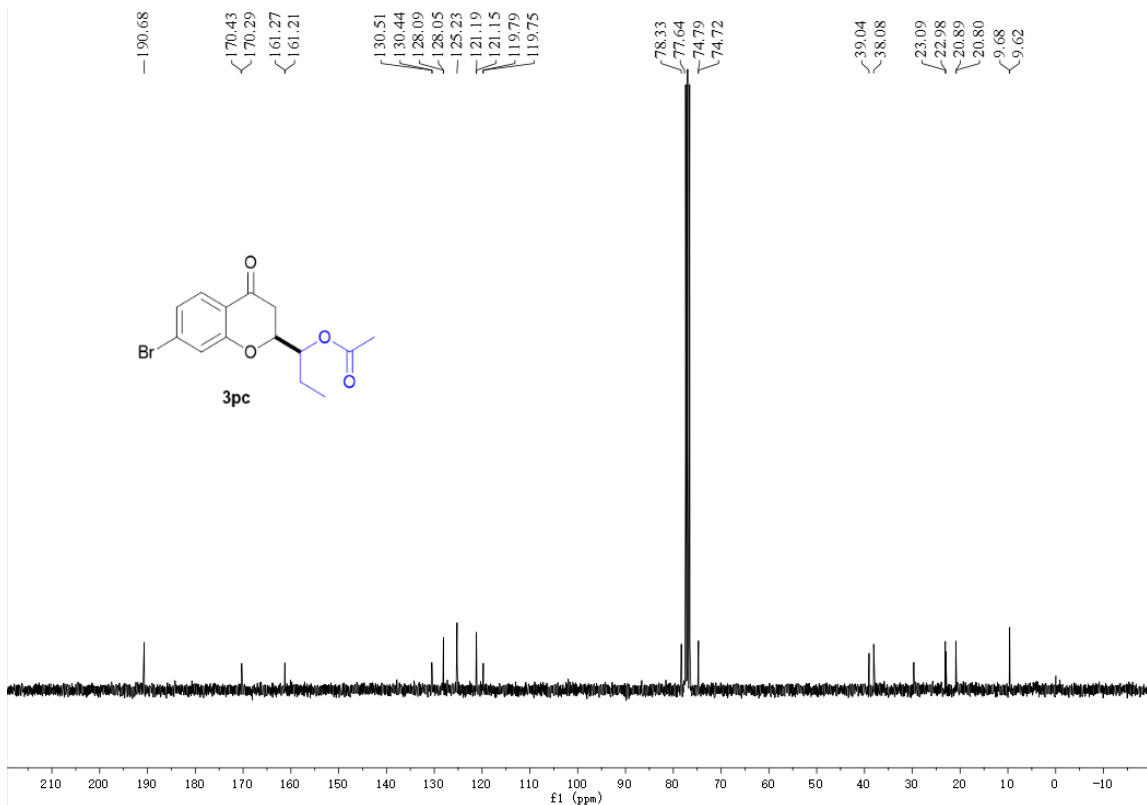
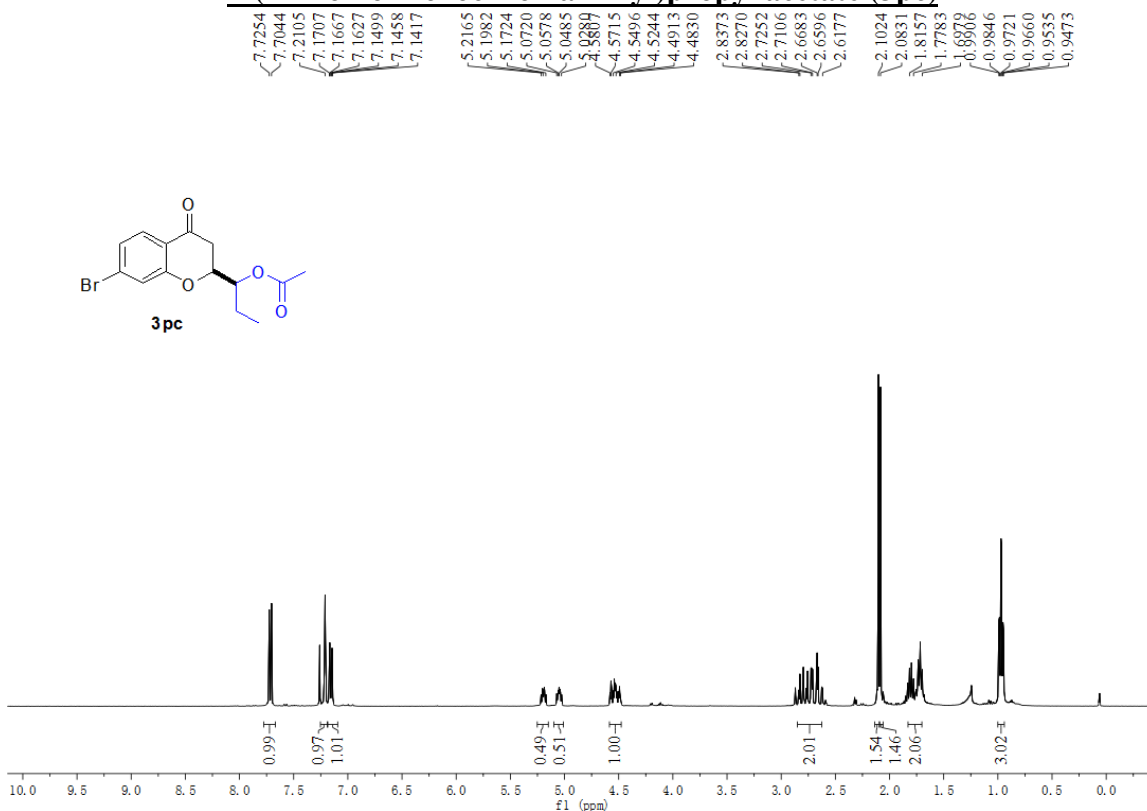
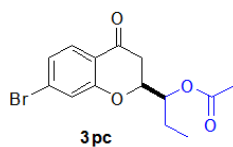
1-(7-Chloro-4-oxochroman-2-yl)propyl acetate (3mc)



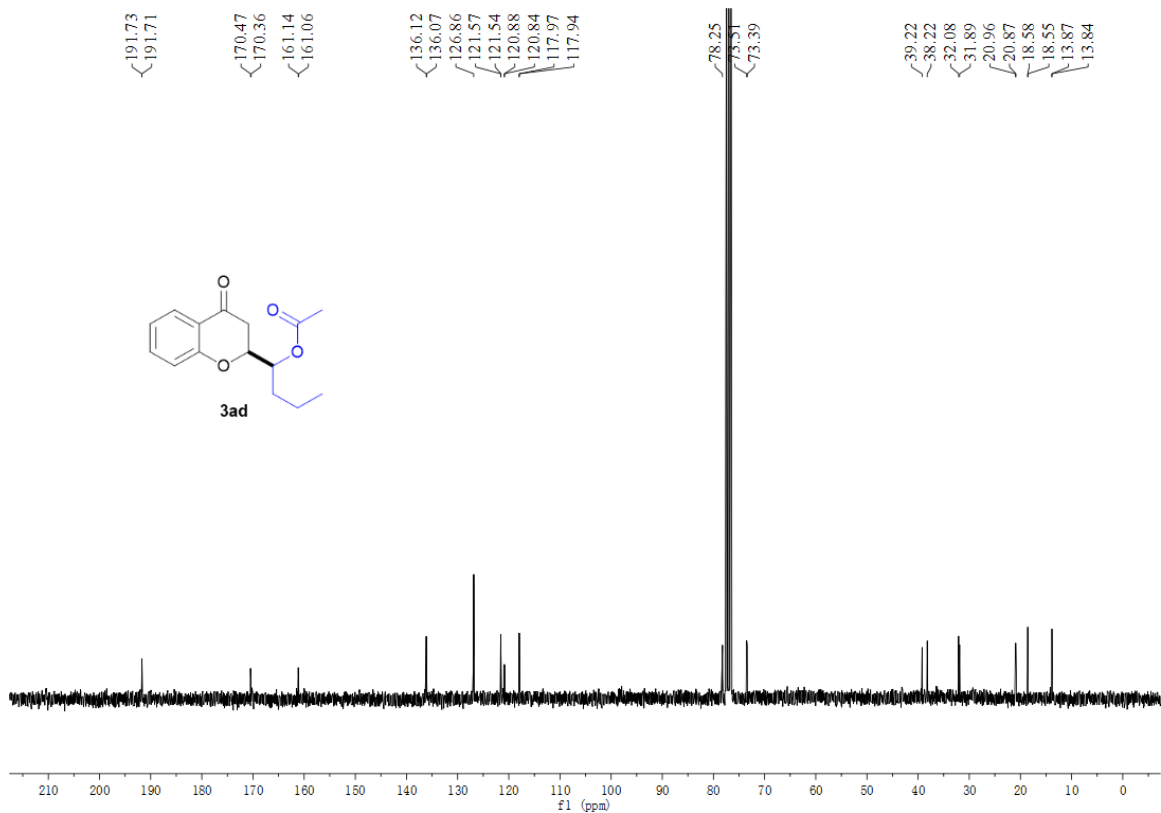
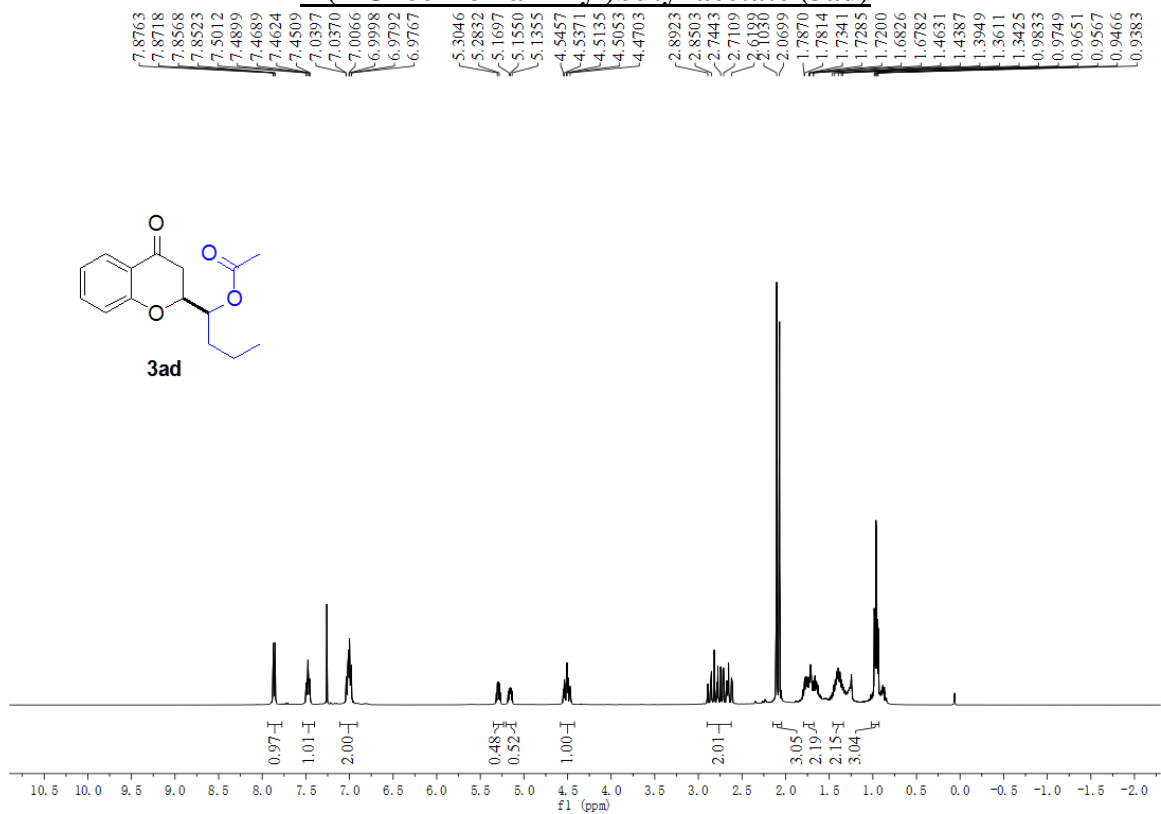
7.8067, 7.7857, 7.2597, 7.0321, 7.0278, 7.0065, 6.9856, 5.2202, 5.2093, 5.1947, 5.1870, 5.1762, 5.0760, 5.0556, 5.0523, 5.0321, 4.5847, 4.5759, 4.5667, 4.5446, 4.4980, 4.4880, 2.8298, 2.7586, 2.7274, 2.6678, 2.6257, 2.6172, 2.1037, 2.0834, 1.7991, 1.7368, 1.7181, 0.9916, 0.9855, 0.9731, 0.9668, 0.9545, 0.9481



1-(7-Bromo-4-oxochroman-2-yl)propyl acetate (3pc)

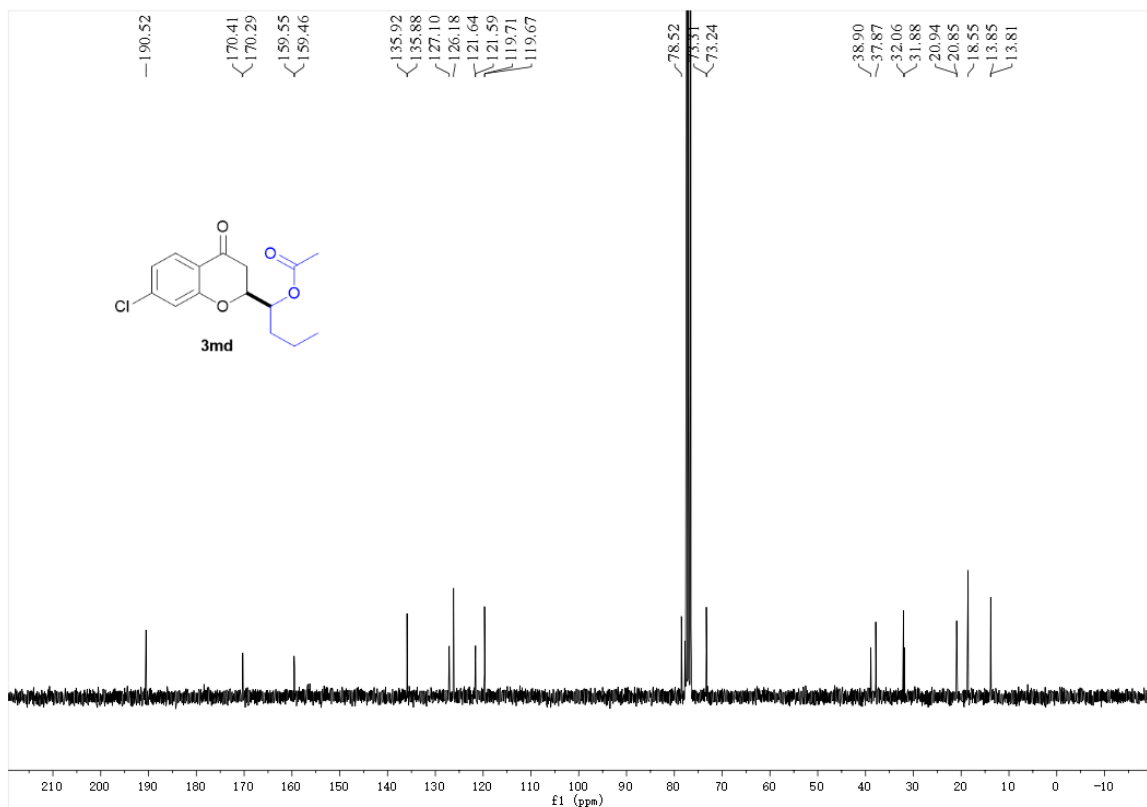
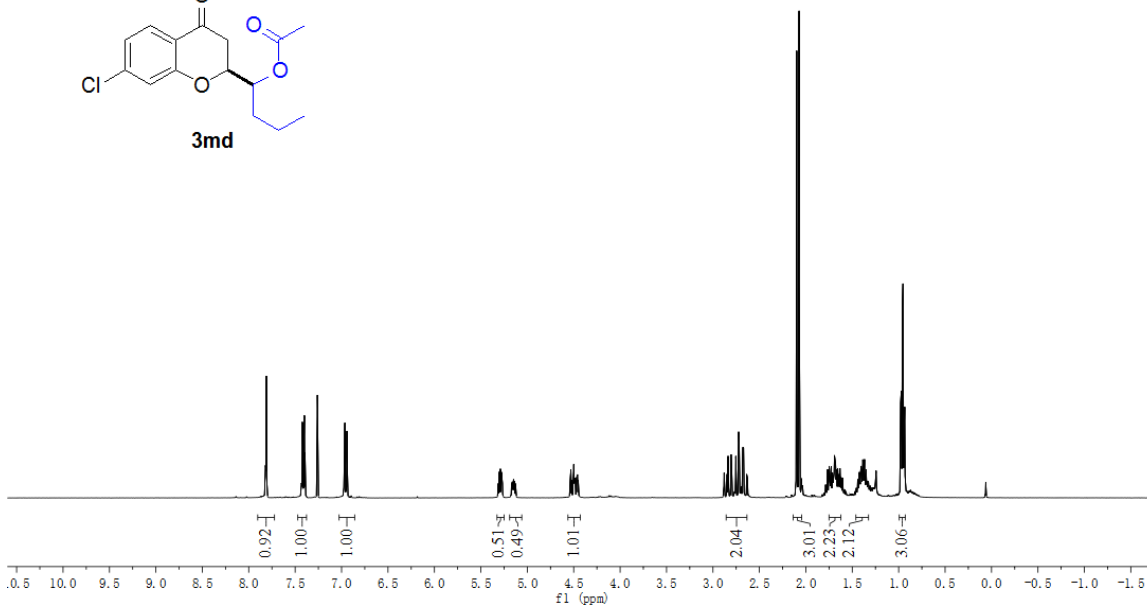
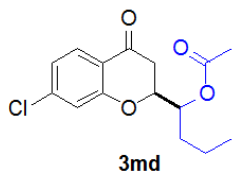


1-(4-Oxochroman-2-yl)butyl acetate (3ad)

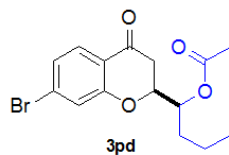


1-(7-Chloro-4-oxochroman-2-yl)butyl acetate (3md)

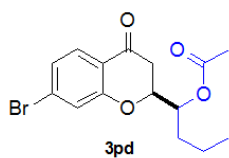
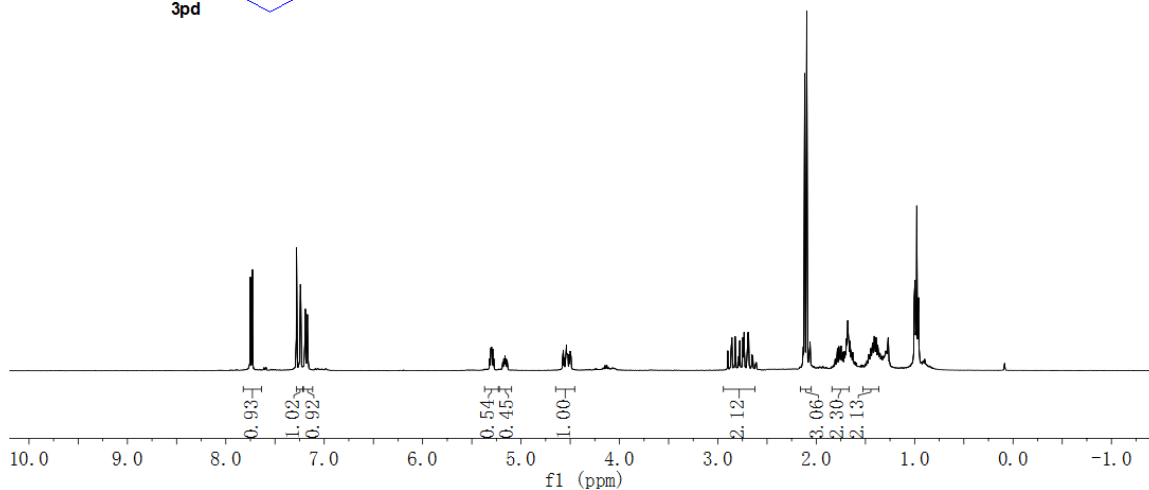
7.8169
7.8103
7.4296
7.4227
7.4157
7.4075
7.4005
7.3936
6.9721
6.9640
6.9499
6.9420
5.3003
5.2895
5.2786
5.2677
5.1480
5.1360
4.5081
4.4834
4.4592
4.4512
2.8373
2.8052
2.7542
2.6826
2.6792
2.6704
2.6584
2.0726
1.7715
1.7294
1.6916
1.6400
1.6049
1.4413
1.4091
1.3679
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1.3422
1.3331
0.9791
0.9714
0.9608
0.9531
0.9424
0.9348



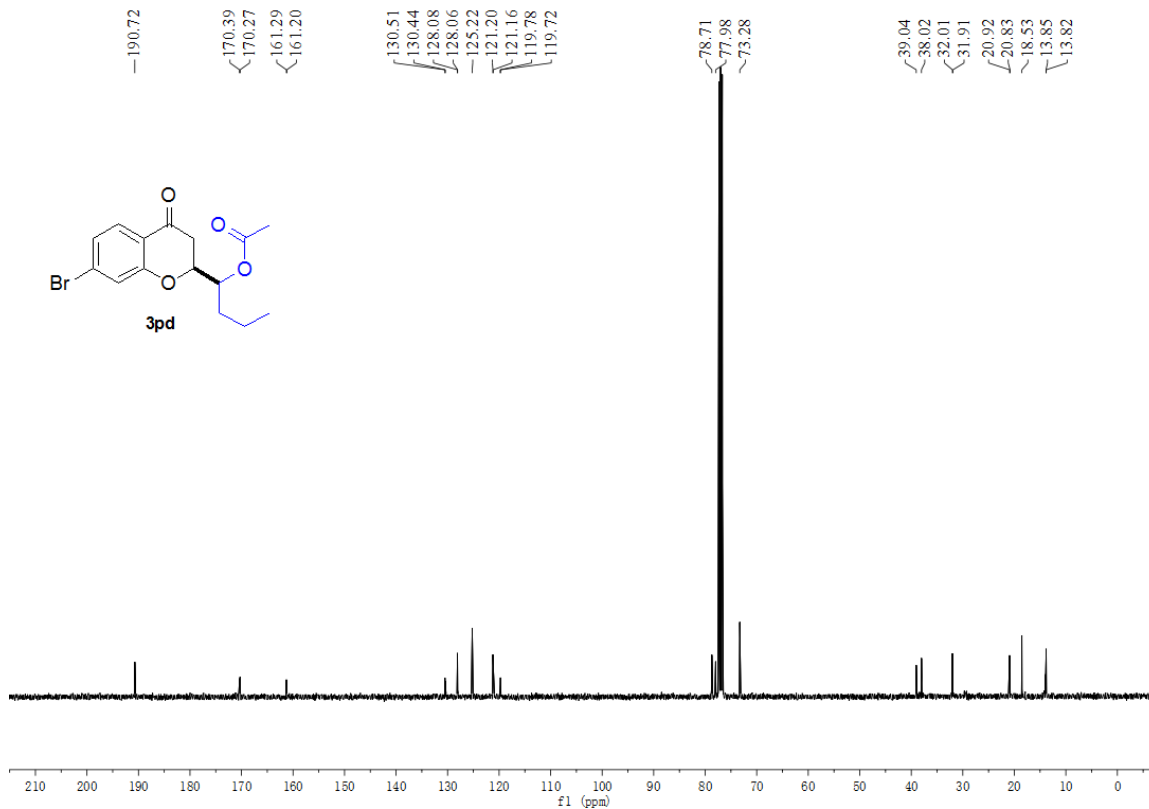
1-(7-Bromo-4-oxochroman-2-yl)butyl acetate (3pd)



7.7507
7.7297
7.2815
7.2417
7.2386
7.1921
7.1877
7.1711
5.3090
5.2982
5.2874
5.1708
5.1620
5.1505
4.5787
4.5698
4.5607
4.5477
4.5099
4.5000
4.4917
2.8988
2.8244
2.7329
2.6541
2.6092
2.1179
2.0966
1.8068
1.7659
1.7380
1.7032
1.6287
1.4991
1.4623
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1.3683
1.3334
1.0043
0.9963
0.9860
0.9781
0.9676
0.9597

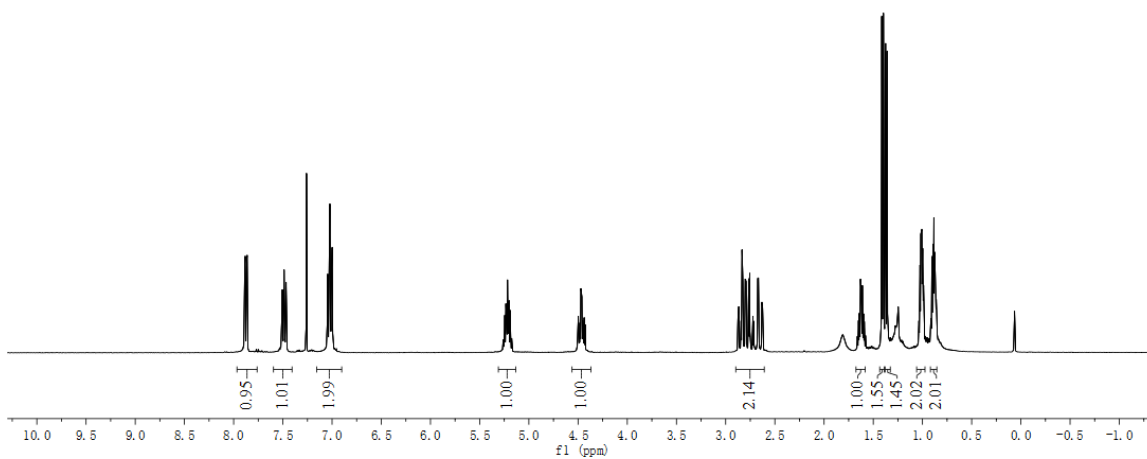
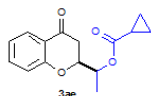


190.72
170.39
170.27
161.29
161.20
130.51
130.44
128.08
128.06
123.22
121.20
121.16
119.78
119.72
78.71
77.98
73.28
39.04
38.02
32.01
31.91
20.92
20.83
18.53
13.85
13.82

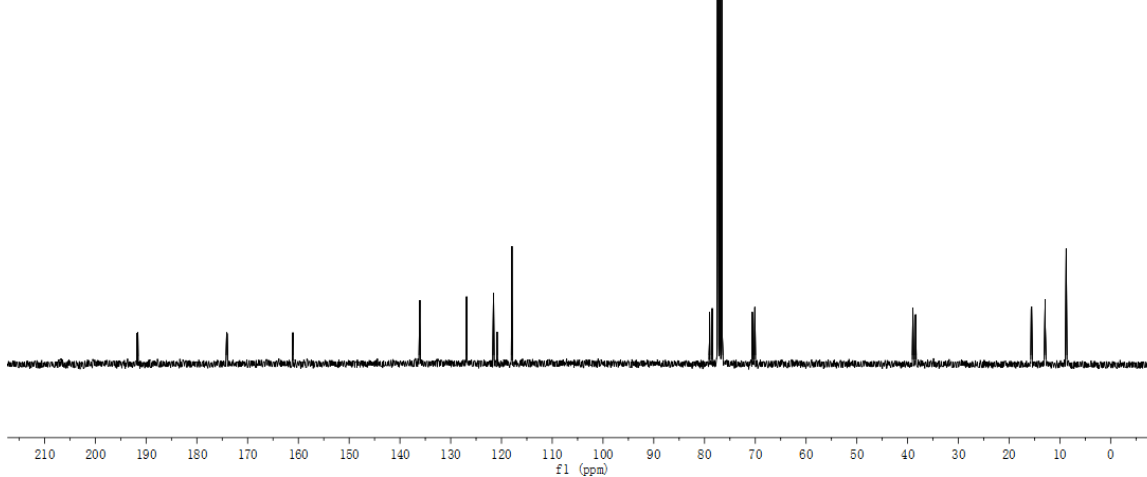
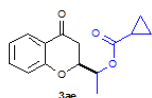


1-(4-oxochroman-2-yl)ethyl cyclopropanecarboxylate (3ae)

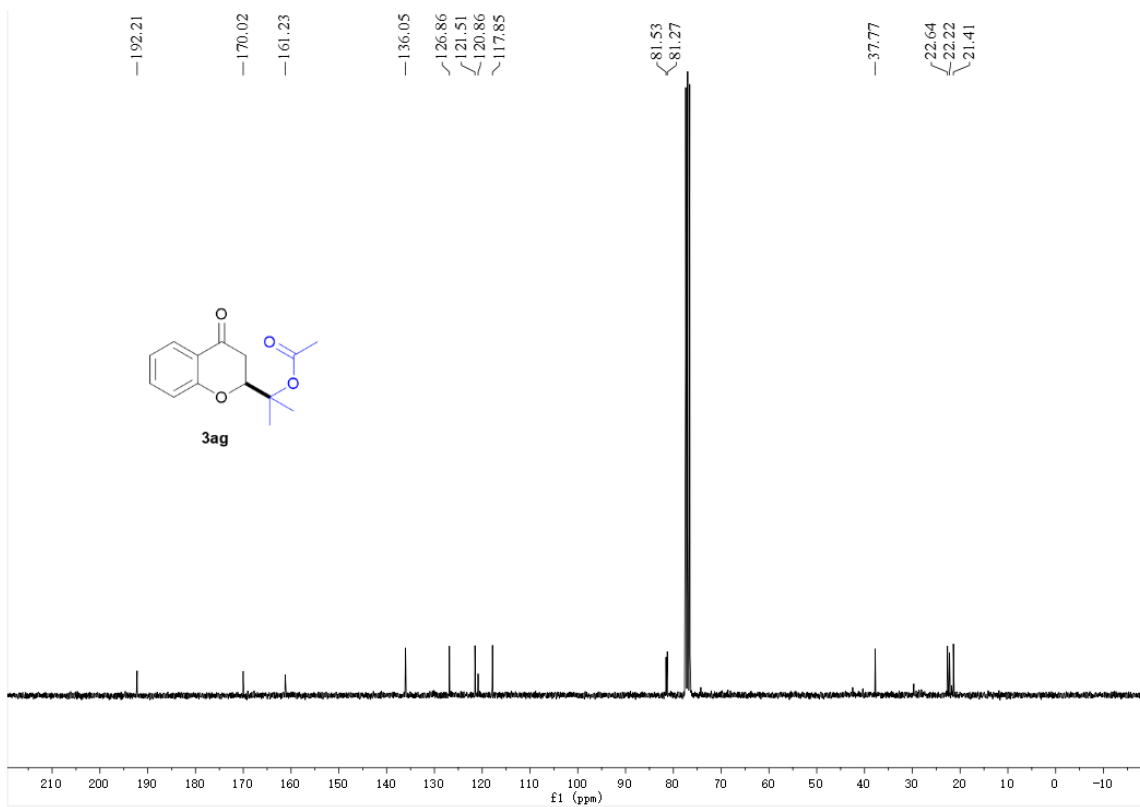
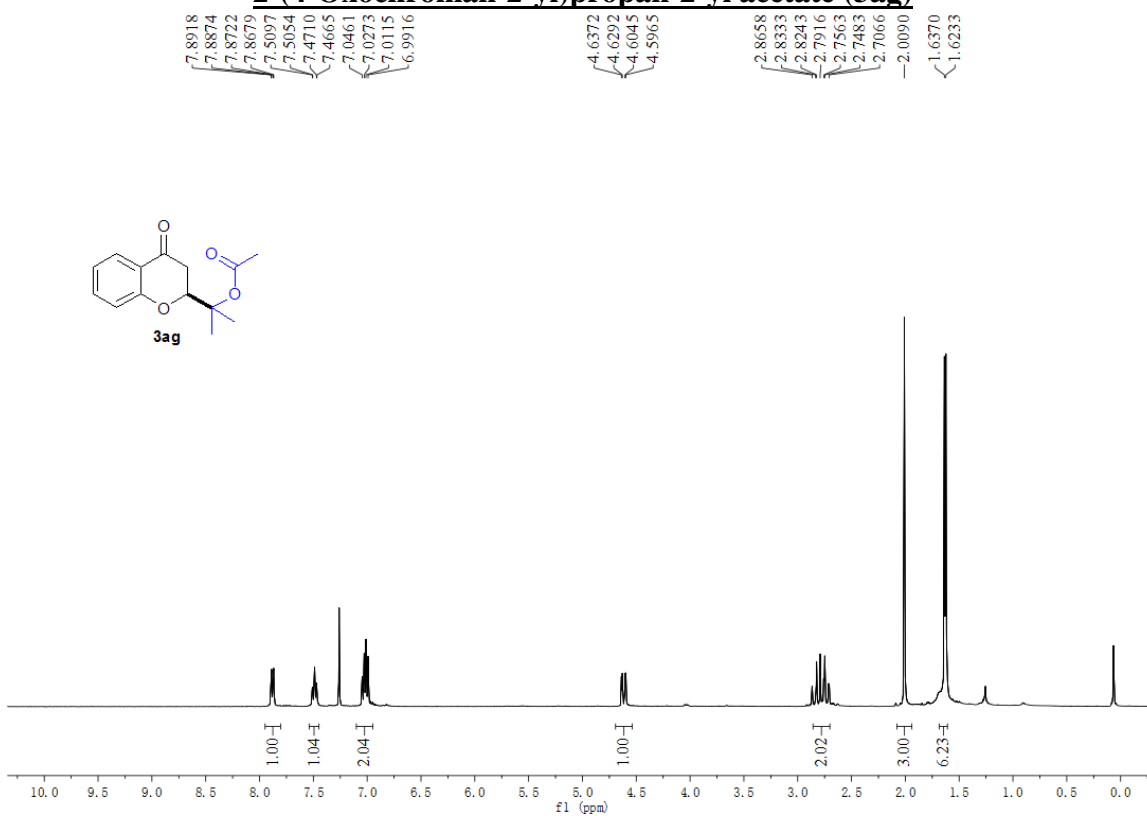
7.8869, 7.8825, 7.8674, 7.8629, 7.5100, 7.5056, 7.4878, 7.4848, 7.4624, 7.0466, 7.0439, 7.0286, 7.0090, 6.9952, 5.2606, 5.2443, 5.2011, 5.1743, 4.5048, 4.4718, 4.4690, 4.4540, 4.4374, 4.4290, 2.8666, 2.8335, 2.7561, 2.7227, 2.6527, 2.6251, 1.6612, 1.6378, 1.6223, 1.6184, 1.5795, 1.4136, 1.3971, 1.3752, 1.3590, 1.0359, 1.0062, 0.9822, 0.9126, 0.8978, 0.8843, 0.8603, 0.8531



191.77, 191.62, 174.13, 174.03, 161.12, 161.08, 136.12, 136.08, 126.89, 126.87, 121.56, 121.54, 120.87, 120.85, 117.95, 79.00, 78.49, 70.60, 70.08, 38.96, 38.43, 15.64, 15.57, 12.96, 12.90, 8.77, 8.76, 8.68

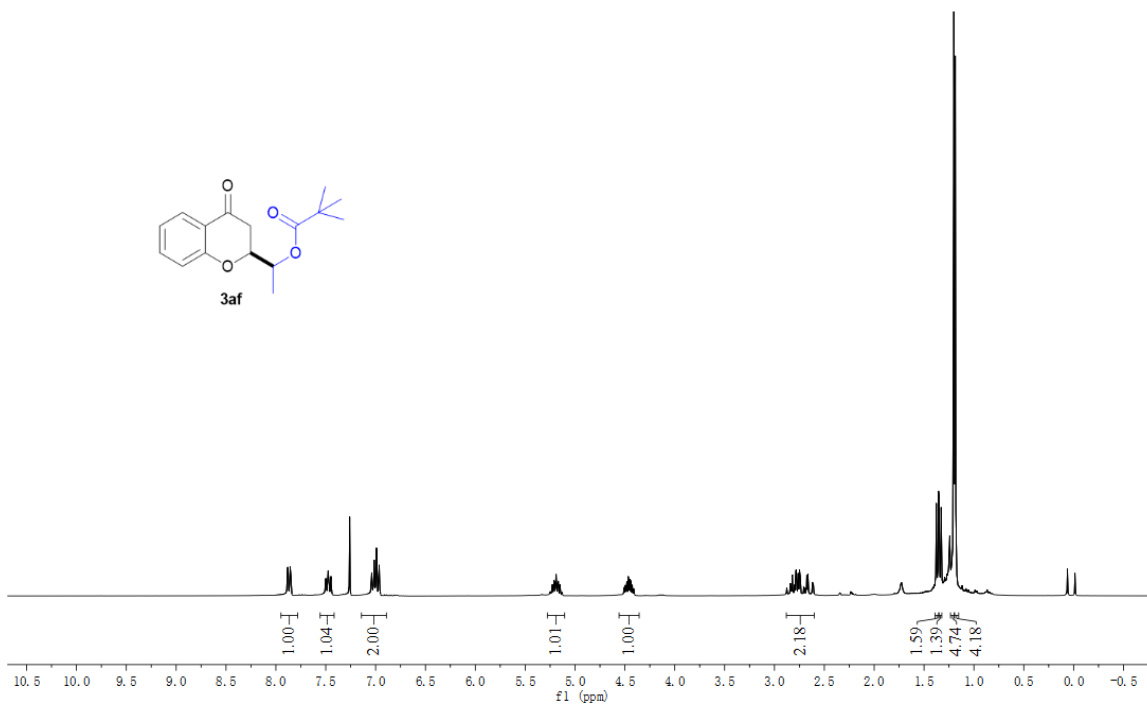
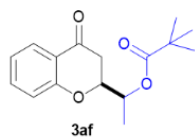


2-(4-Oxochroman-2-yl)propan-2-yl acetate (3ag)

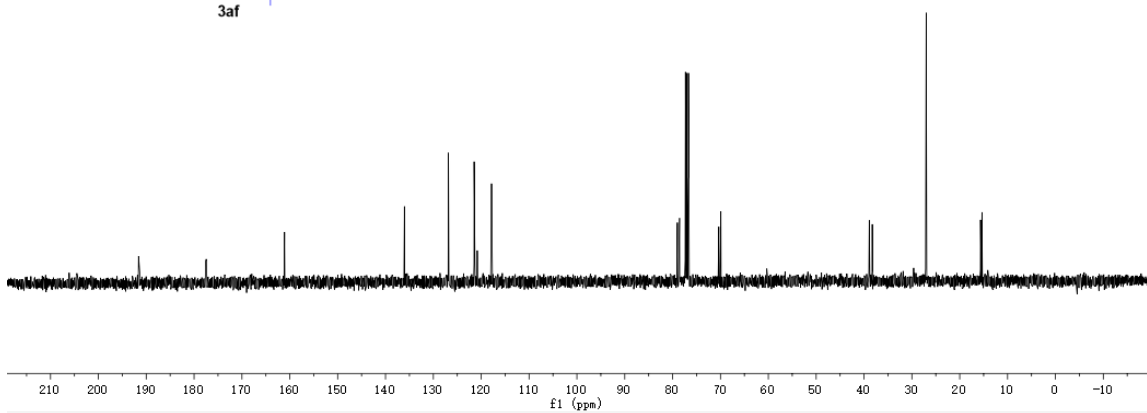
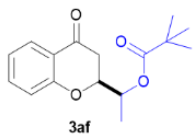


1-(4-Oxochroman-2-yl)ethyl pivalate (3af)

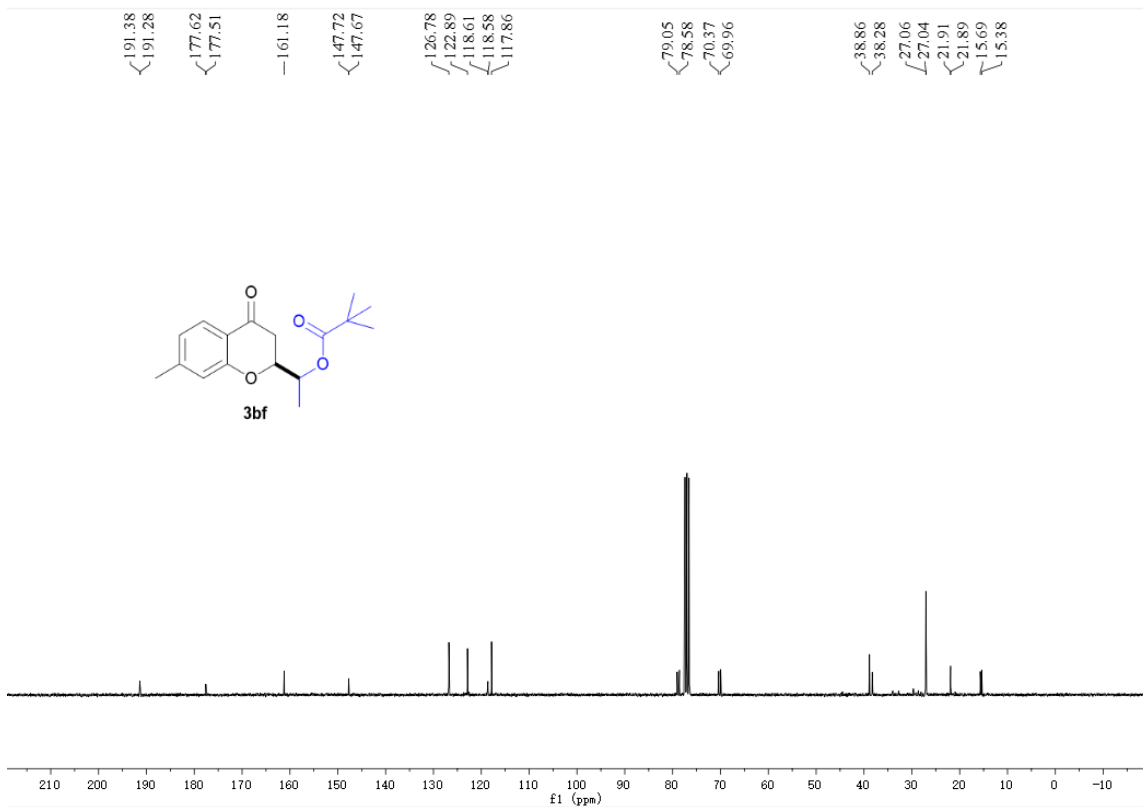
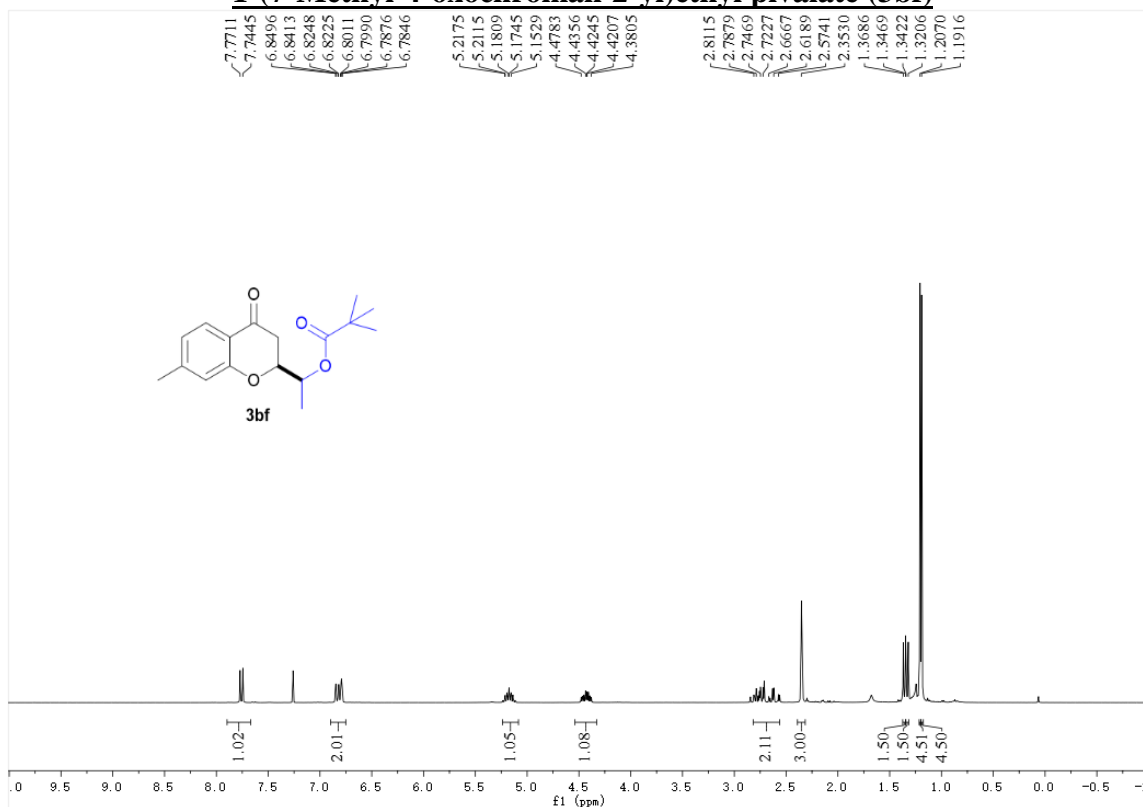
7.8832, 7.8772, 7.8571, 7.8511, 7.5056, 7.4935, 7.4816, 7.4760, 7.4538, 7.4417, 7.0392, 7.0154, 7.0126, 6.9921, 6.9638, 5.2332, 5.2271, 5.2054, 5.1954, 5.1675, 5.1517, 4.5082, 4.4807, 4.4659, 4.4394, 4.4112, 2.8767, 2.8362, 2.7987, 2.7804, 2.7493, 2.7062, 2.6759, 2.6646, 2.6088, 1.3769, 1.3552, 1.3498, 1.3282, 1.2012, 1.1865



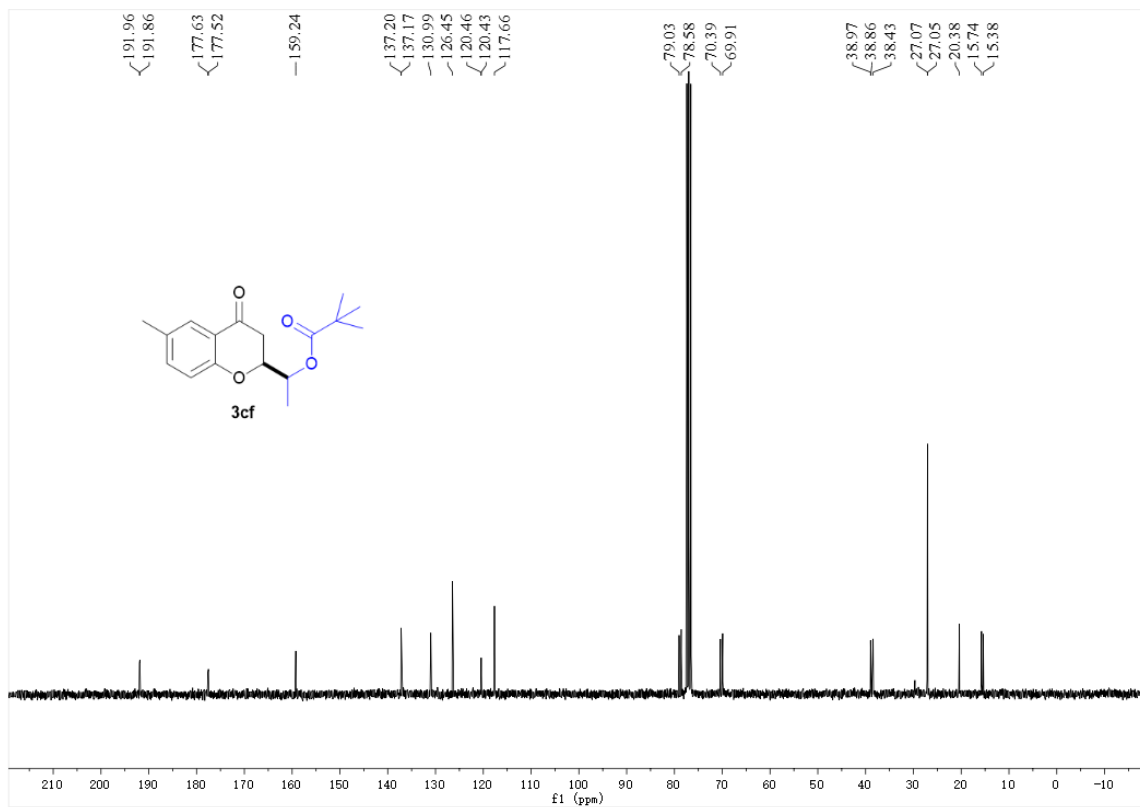
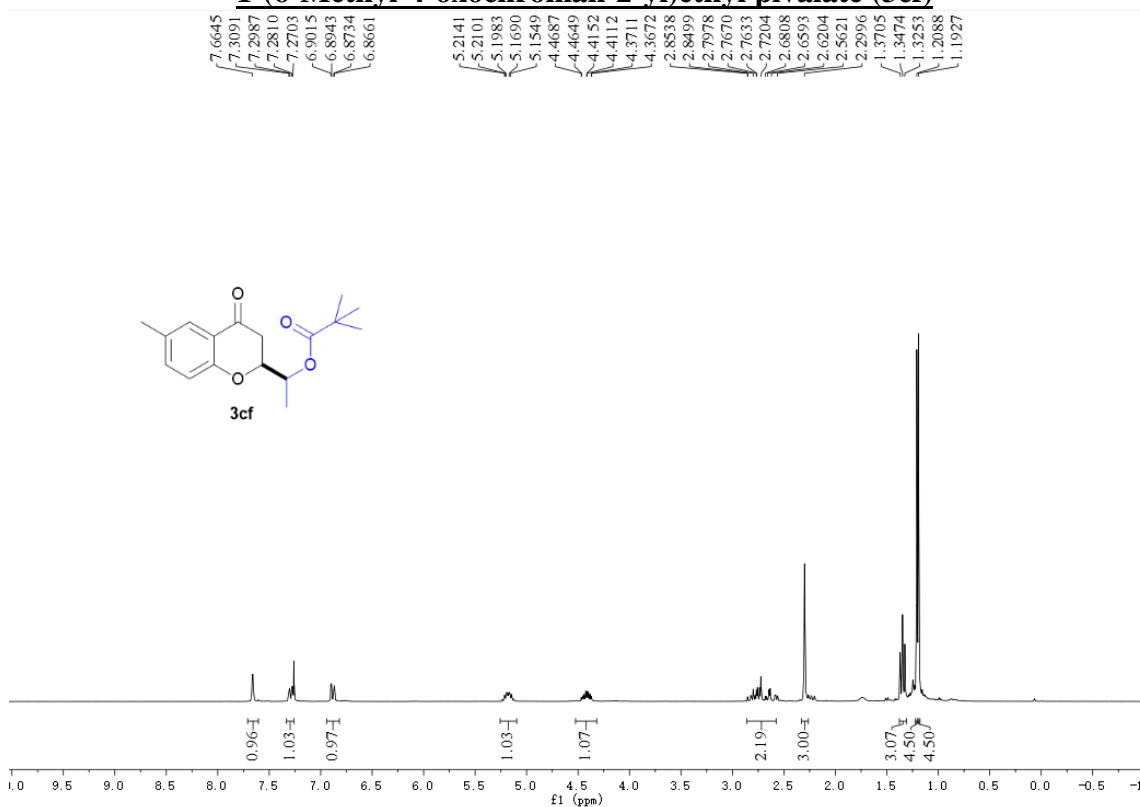
191.60, 191.52, 177.56, 177.45, -161.10, 136.08, 136.05, 126.85, 121.48, 120.82, 120.79, 117.84, 79.00, 78.55, 70.34, 69.92, 38.90, 38.80, 38.28, 27.01, 26.99, 15.65, 15.35



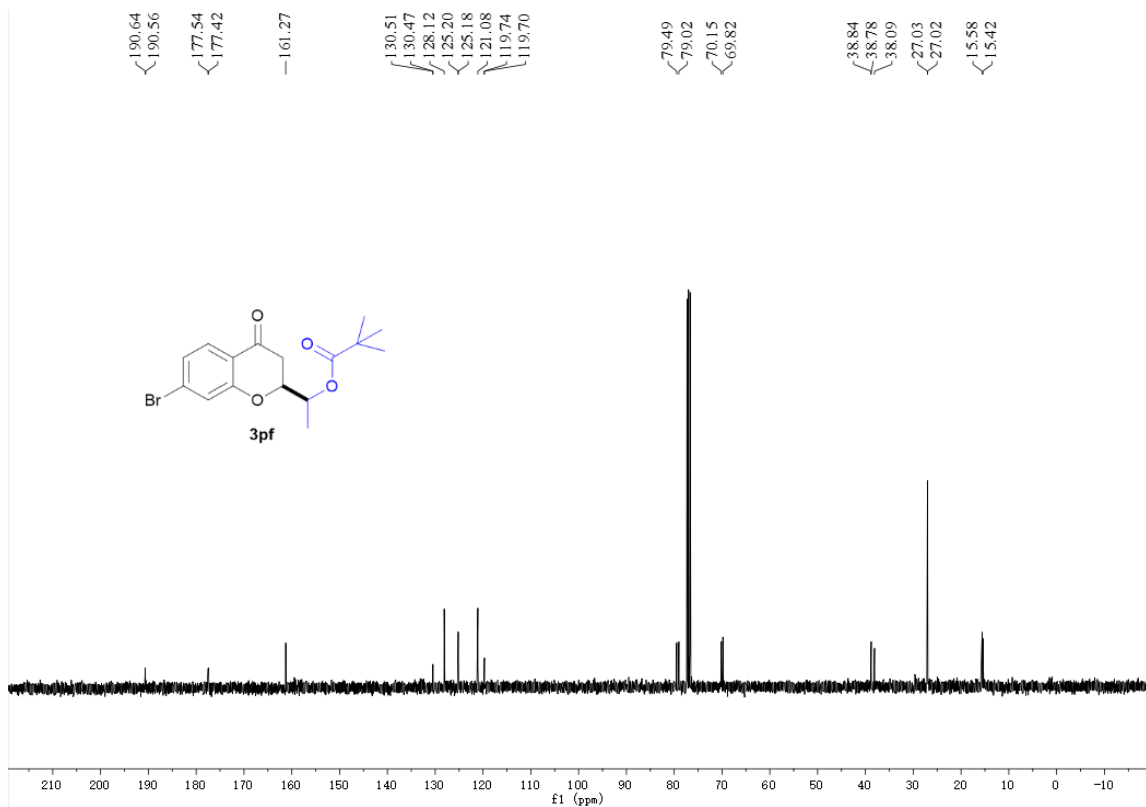
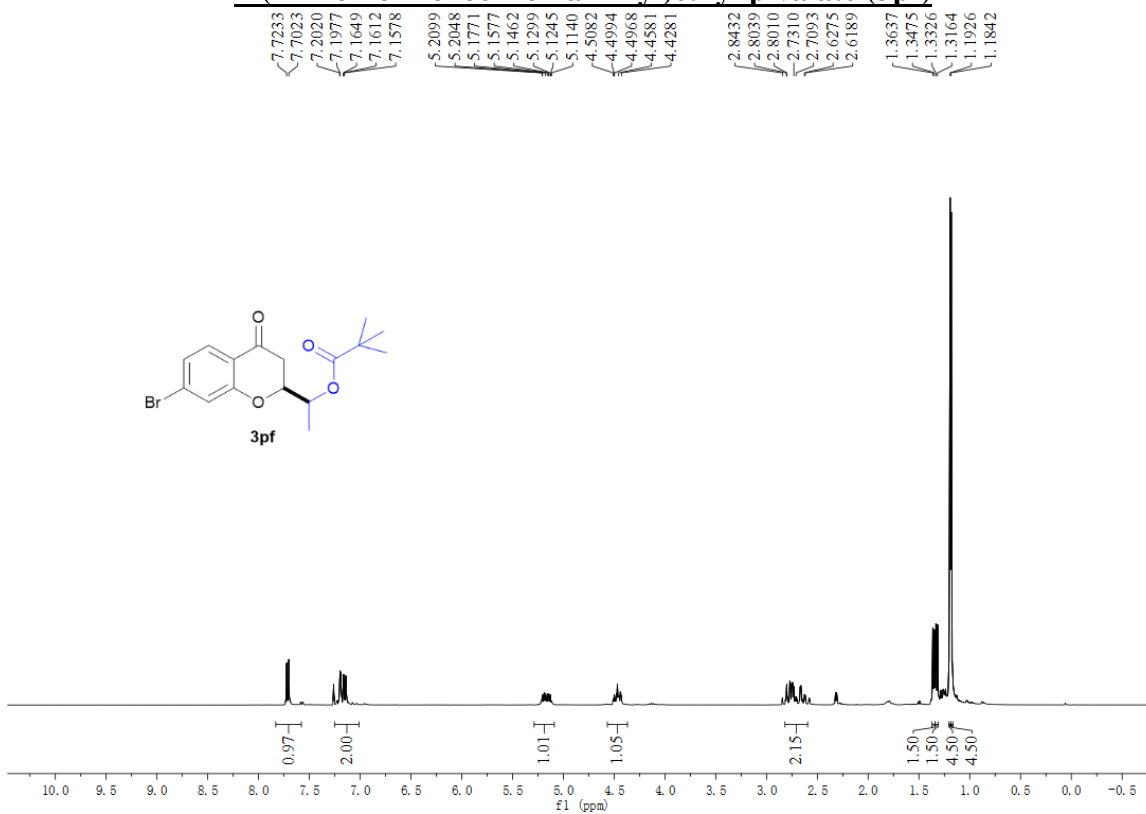
1-(7-Methyl-4-oxochroman-2-yl)ethyl pivalate (3bf)



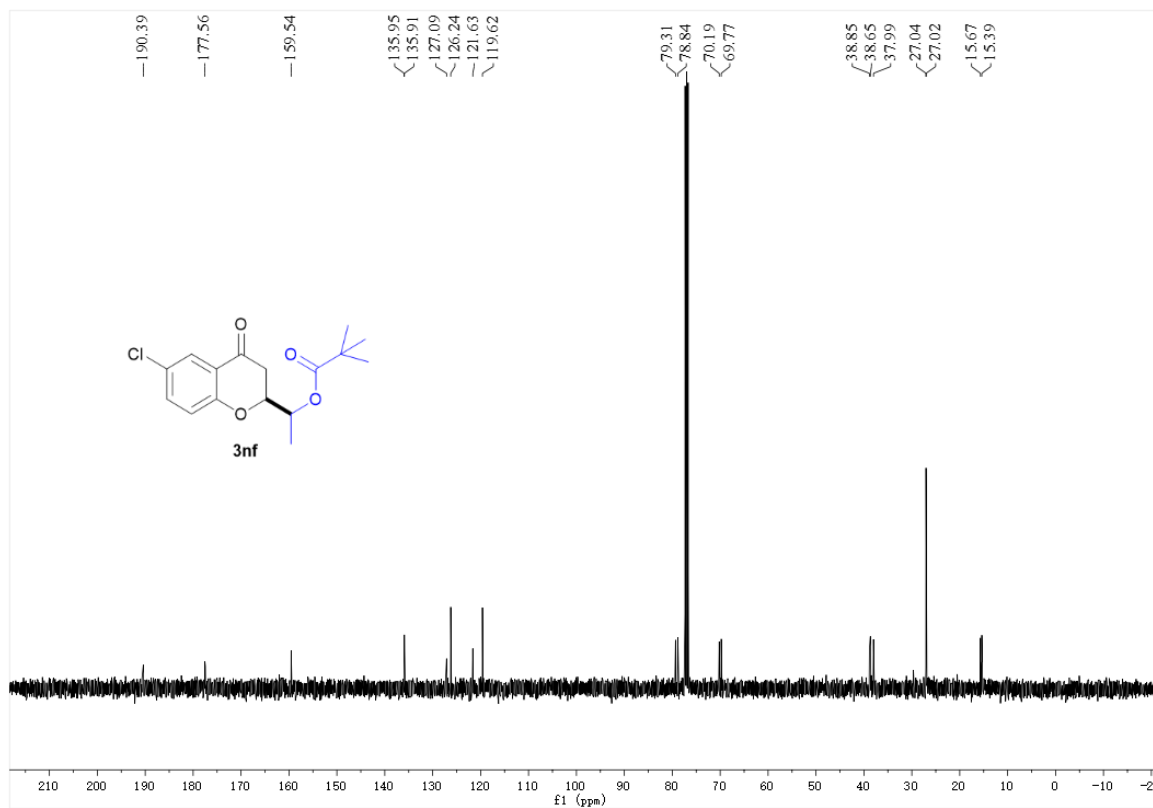
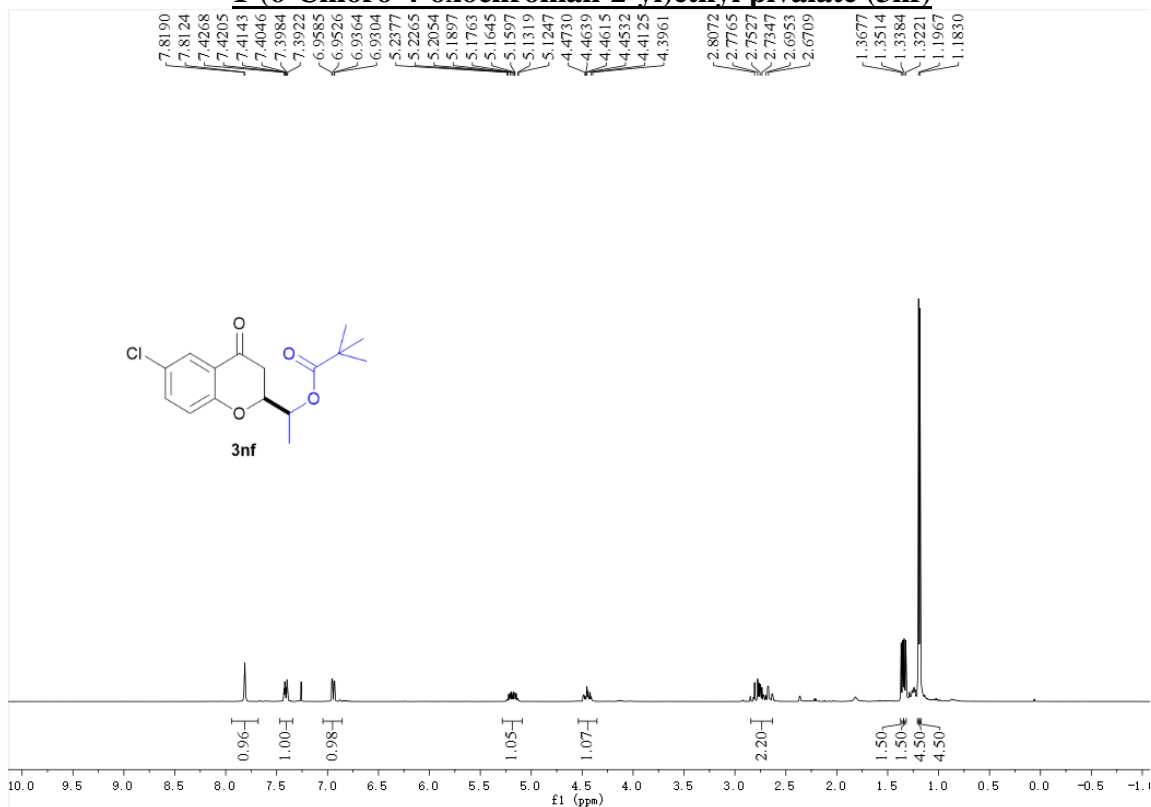
1-(6-Methyl-4-oxochroman-2-yl)ethyl pivalate (3cf)



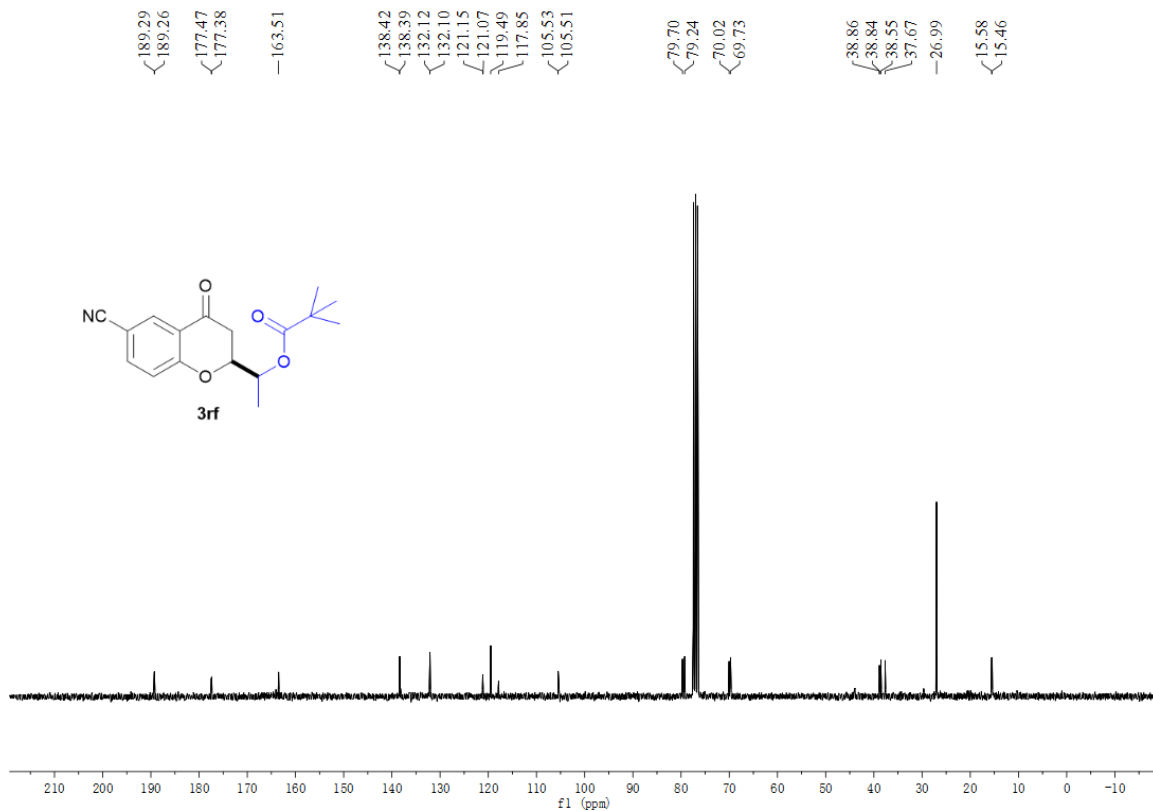
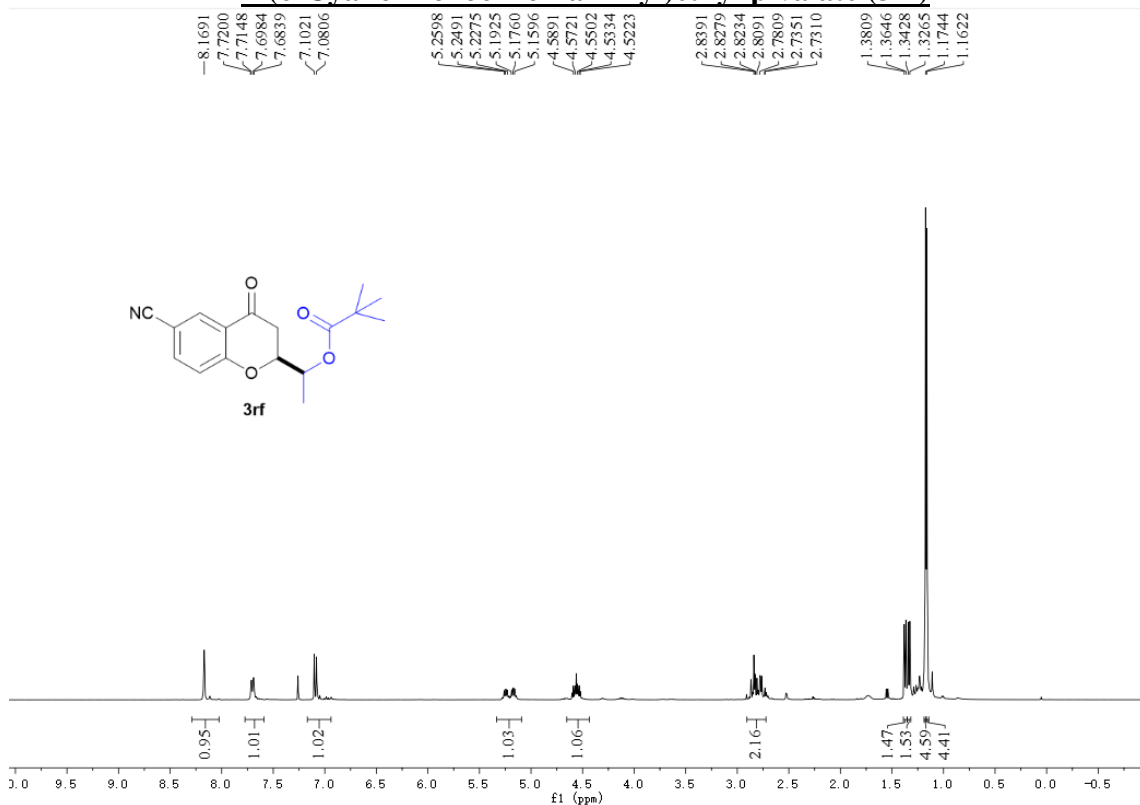
1-(7-Bromo-4-oxochroman-2-yl)ethyl pivalate (3pf)



1-(6-Chloro-4-oxochroman-2-yl)ethyl pivalate (3nf)

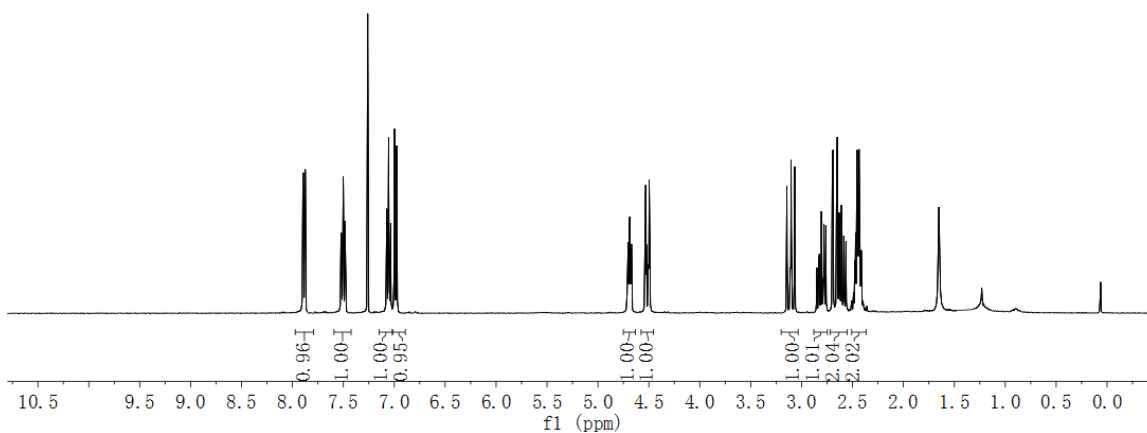
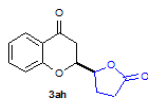


1-(6-Cyano-4-oxochroman-2-yl)ethyl pivalate (3rf)

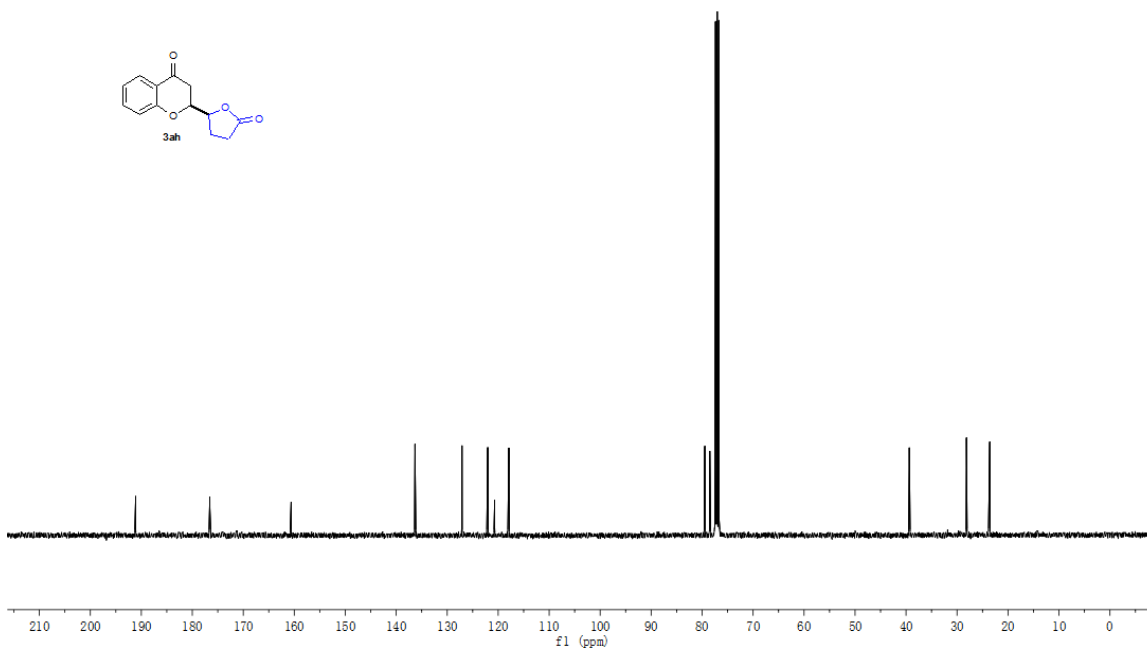
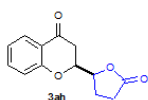


2-(5-oxotetrahydrofuran-2-yl)chroman-4-one (3ah)

7.8968
7.8927
7.8772
7.8730
7.5229
7.5012
7.4840
7.4796
7.2606
7.0753
7.0731
7.0553
7.0377
7.0355
6.9967
6.9759
4.7029
4.6876
4.6762
4.6689
4.6689
4.5382
4.5313
4.5244
4.5036
4.4966
4.4838
4.4838
3.1097
3.1024
3.0678
2.8495
2.8301
2.7869
2.7806
2.7626
2.6974
2.6908
2.6554
2.6314
2.6088
2.5856
2.5646
2.4904
2.4763
2.4356
2.4115
2.3945

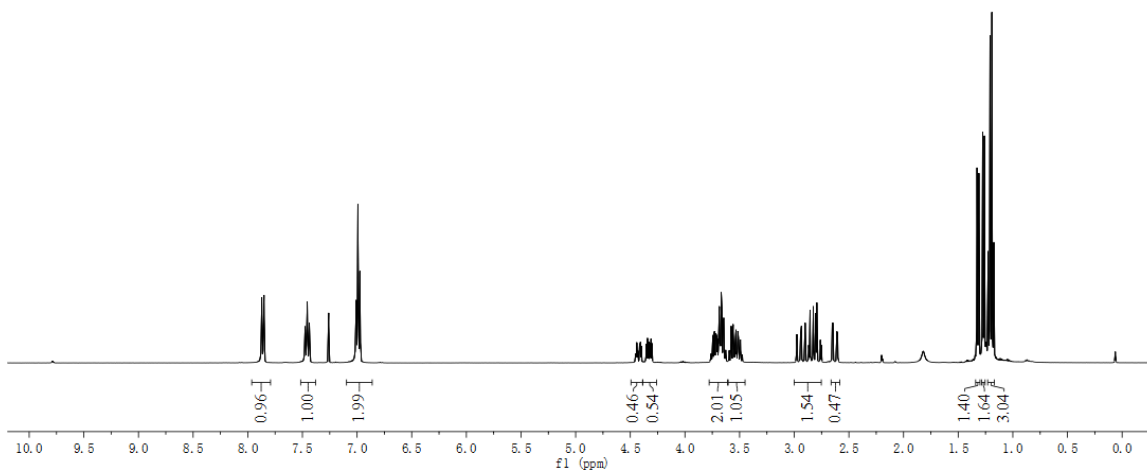
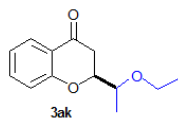


-191.10
-176.56
-160.61
-136.32
-127.10
-122.04
-120.70
-117.91
79.46
78.49
77.36
77.04
76.72
-39.35
-28.14
-23.57

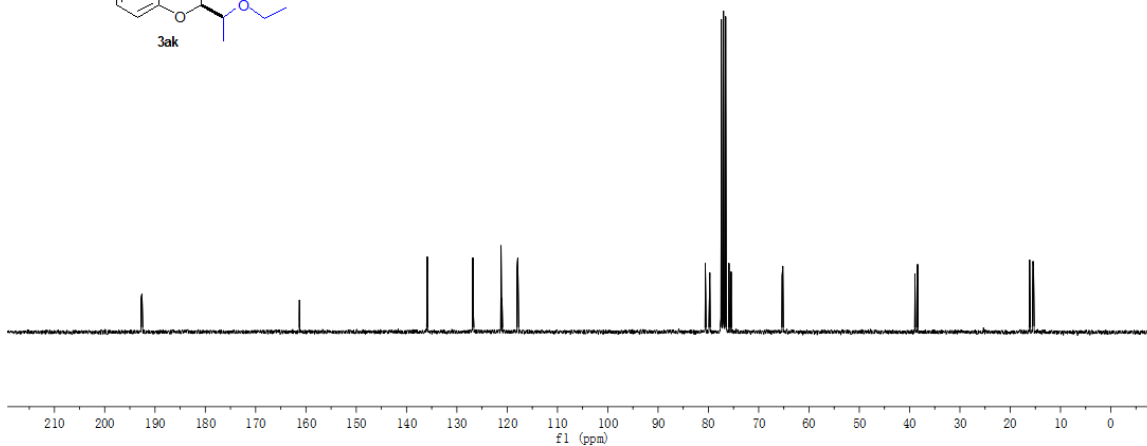
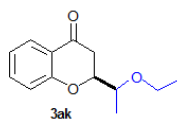


2-(1-ethoxyethyl)chroman-4-one (3ak)

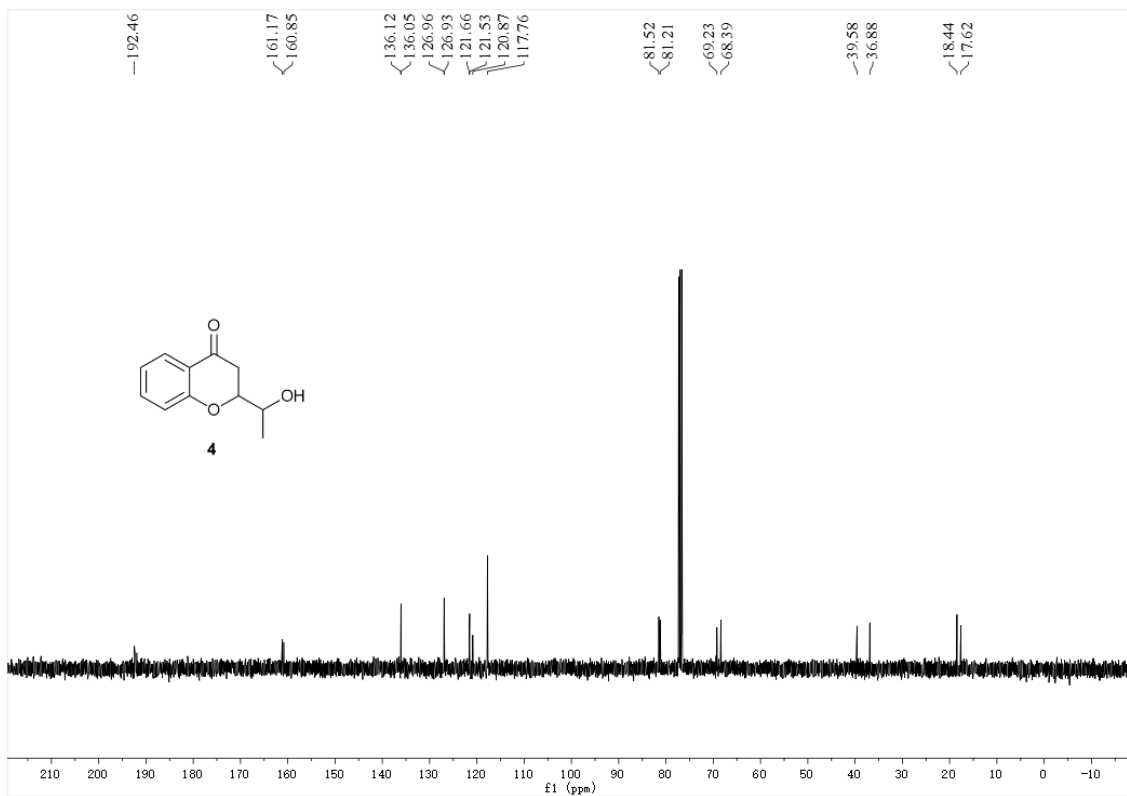
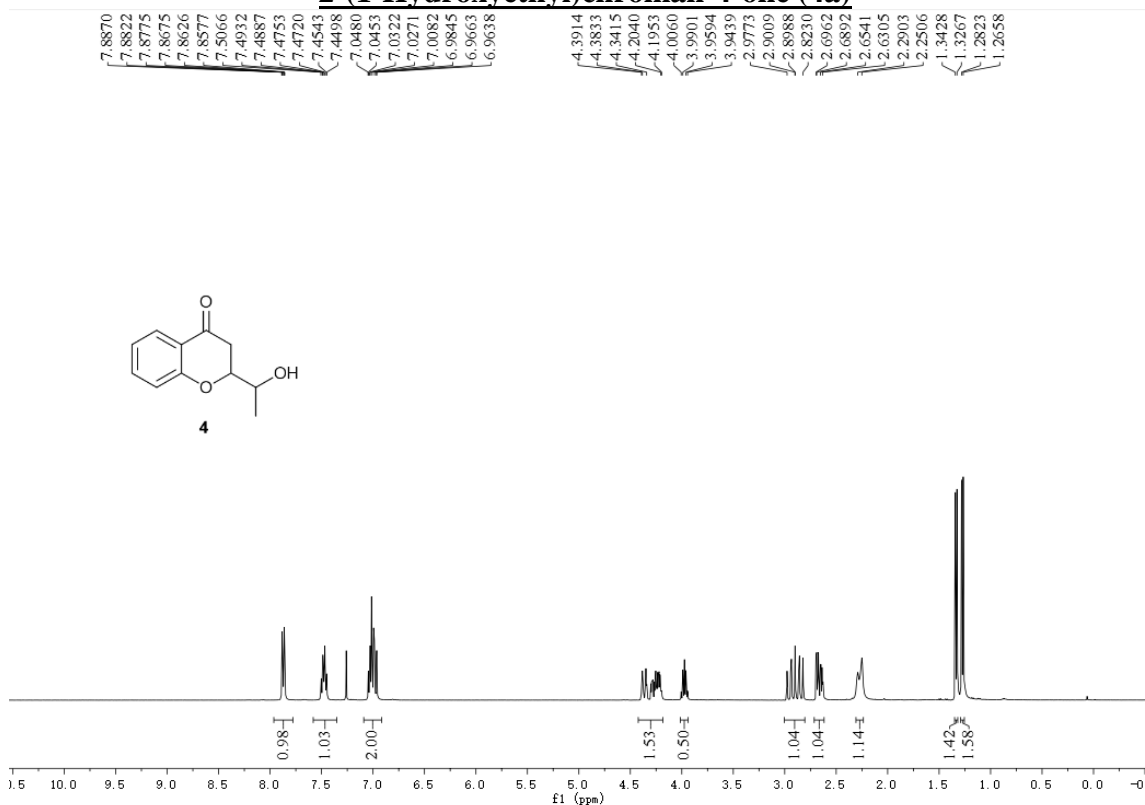
$\left. \begin{array}{l} 7.8764 \\ 7.8719 \\ 7.8518 \\ 7.8475 \end{array} \right\}$
 $\left. \begin{array}{l} 7.4555 \\ 7.4492 \\ 7.4432 \end{array} \right\}$
 $\left. \begin{array}{l} 7.0072 \\ 6.9928 \\ 6.9714 \end{array} \right\}$
 $\left. \begin{array}{l} 4.4489 \\ 4.4317 \\ 4.4056 \\ 4.3985 \\ 4.3519 \\ 4.3311 \\ 4.3219 \\ 4.3010 \end{array} \right\}$
 $\left. \begin{array}{l} 3.7451 \\ 3.6448 \\ 3.5771 \\ 3.5331 \end{array} \right\}$
 $\left. \begin{array}{l} 2.9339 \\ 2.9005 \\ 2.8555 \\ 2.8030 \\ 2.6450 \\ 2.6450 \end{array} \right\}$
 $\left. \begin{array}{l} 1.6293 \\ 1.6113 \\ 1.2762 \\ 1.2604 \\ 1.2262 \\ 1.2088 \\ 1.1915 \\ 1.1741 \end{array} \right\}$



$\left. \begin{array}{l} 192.77 \\ 192.59 \end{array} \right\}$
 $\left. \begin{array}{l} 161.43 \\ 161.27 \end{array} \right\}$
 $\left. \begin{array}{l} 135.89 \\ 135.84 \\ 126.82 \\ 126.76 \\ 121.23 \\ 121.21 \\ 121.03 \\ 121.00 \\ 118.02 \\ 117.88 \end{array} \right\}$
 $\left. \begin{array}{l} 80.61 \\ 79.73 \\ 75.92 \\ 75.49 \\ 65.33 \\ 65.20 \end{array} \right\}$
 $\left. \begin{array}{l} 38.94 \\ 38.41 \end{array} \right\}$
 $\left. \begin{array}{l} 16.16 \\ 15.46 \\ 15.42 \\ 15.36 \end{array} \right\}$



2-(1-Hydroxyethyl)chroman-4-one (4a)



2-(Hydroxymethyl)chroman-4-one (4b)

7.8946, 7.8903, 7.8749, 7.8705, 7.5046, 7.5002, 7.4864, 7.4658, 7.4614, 7.0453, 7.0267, 6.9836, 4.6056, 4.5984, 4.5852, 4.5648, 4.5584, 4.5440, 4.0065, 3.9990, 3.9760, 3.9684, 3.8672, 3.8540, 3.8367, 3.8234, 2.9743, 2.9410, 2.9324, 2.8986, 2.6519, 2.6448, 2.6097, 2.6025, 2.3468, 2.2978, 2.2542, 2.2185

