Electronic Supplementary Material (ESI) for Chemical Communications.


Supporting Information

# A Chiral Pool Approach for Asymmetric Syntheses of (–)-Antrocin, (+)-Asperolide C and (–)-*trans*-Ozic acid

*Fu-Zhuo Li, Shuang Li, Peng-Peng Zhang, Zhi-Hui Huang, Wei-Bin Zhang*, Jian-Xian Gong*, and Zhen Yang**

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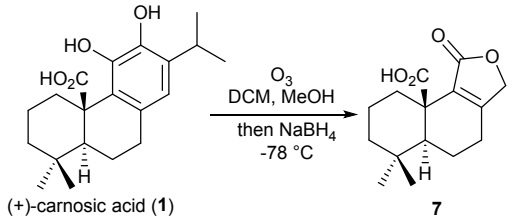
## Ⅰ. General Experimental

Unless otherwise mentioned, all reactions were carried out under a nitrogen atmosphere under anhydrous conditions and all reagents were purchased from commercial suppliers without further purification. Solvents purification was conducted according to Purification of Laboratory Chemicals (Peerrin, D. D.; Armarego, W. L. and Perrins, D. R., Pergamon Press: Oxford, 1980). Yields refer to chromatographically and spectroscopically ($^1$H NMR) homogeneous materials.

Cornosic acid, dehydroabietic acid were purchased from Nanjing Chemlin (China), Reactions were monitored by Thin Layer Chromatography on plates ($GF_{254}$) supplied by Yantai Chemicals (China) visualized by UV or stained with ethanolic solution of phosphomolybdic acid and cerium sulfate and basic solution of $KMnO_4$. NMR spectra were recorded on a Brüker Advance 400 ($^1$H: 400 MHz, $^{13}$C: 100 MHz) and Brüker Advance 500 ($^1$H: 500 MHz, $^{13}$C: 125 MHz). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad. IR spectra were recorded on an IR Prestige-21 FTIR spectrometer or Bio-Rad FTS-135 spectrometer with a KBr disc. High resolution mass spectrometric (HRMS) data were obtained using Brüker Apex IV RTMS or Finnigan MAT 90 instrument and a VG Auto Spec-3000 spectrometer, respectively.

## Ⅱ. Experimental Procedures and Spectroscopic Data of the Synthesized Compounds

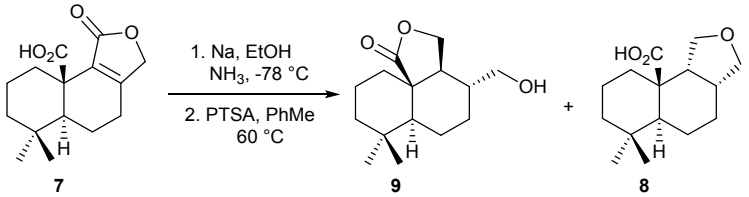
**Synthesis of Compound 7**




(+)-carnosic acid (**1**) **7**

Ozone was passed through a solution of (+)-carnosic acid **1** (25.0 g, 75.3 mmol, 1.0 equiv) in DCM-MeOH (400 ml of 3:1) at -78 °C for 1.5 h, and the resultant mixture was first treated with $NaBH_4$ (12.6 g, 450.0 mmol, 6.0 equiv) at -78 °C, and then stirred at room temperature for 1h. The solvent was removed under vacuum, and the residue was diluted with a saturated solution of $NH_4Cl$ (100 mL), and the mixture was then extracted with EtOAc (3 × 400 mL). The combined organic layers were washed with brine and dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (petroleum ether/ethyl acetate = 6:1 to 1:1) to give compound **7** (11.5 g, 58% yield) as white solids. [α]22 D= 126.5 (c = 0.1, $CHCl_3$); IR (thin film, $\nu$ $cm^{-1}$): 2956, 2917, 1768, 1447, 1345, 1216, 1023, 767; $^1H$ NMR (400 MHz, $CDCl_3$) δ 10.19 (s, 1H), 4.71 – 4.55 (m, 2H), 3.17 (m, 1H), 2.50 (m, 1H), 2.37 (m, 2H), 2.04 – 1.80 (m, 2H), 1.44 (m, 3H), 1.25 (td, $J$ = 13.5, 4.0 Hz, 1H), 1.04 (td, $J$ = 13.5, 4.0 Hz, 1H), 0.92 (s, 3H), 0.80 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 179.8, 171.4, 164.7, 128.4, 71.0, 53.1, 44.1, 41.7, 33.5, 32.2, 31.6, 24.3, 19.6, 19.1, 17.6; HRMS (ESI): m/z calcd for $C_{15}H_{20}O_4Na^+$ $[M + Na]^+$: 287.1254, found 287.1252.

**Synthesis of Compound 8 and 9**



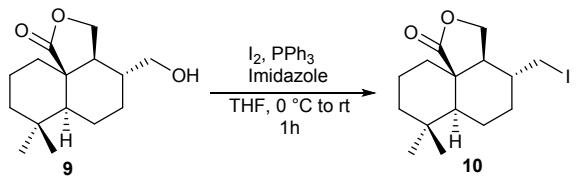

**7** **9** **8**

Compound **7** (9.0 g, 34.1 mmol, 1.0 equiv) was added to an ammonia solution (500 mL in a 1 L flask) at -78 °C, to this solution was added sodium (11.8 g, 511.5 mmol, 15.0 equiv) in small pieces slowly during 1 h. After completion, EtOH (10 ml, 170.5 ml, 5.0 equiv) was added to the above reaction mixture. The resultant mixture was then stirred at the same temperature for 2 h, followed by quenching with EtOH (100 mL) at -78 °C carefully. The ammonia was removed under vacuum, and the residue was then diluted with ether (250 mL). The mixture was first acidified with a solution of 6 M HCl to pH = 1 at -20 °C, and then extracted with EtOAc (3 × 300 mL). The combined organic layers were washed with brine and dried over $Na_2SO_4$. The solvent was removed in vacuum to give the crude

compound that was used in next step without purification.

To a solution of the crude product made above in PhMe (100 mL) was added PTSA (1.44 g, 10.2 mmol, 0.3 equiv) at room temperature, and the reaction mixture was then stirred at 60 °C for 1 h. After completion, the mixture was cooled to room temperature and quenched with a saturated solution of $NaHCO_3$ (100 mL), and extracted with EtOAc (3 × 300 mL). The combined organic layers were washed with brine, and dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 4/1 to 1/1) to give product **9** (4.76 g, 56% yield) and **8** (2.38 g, 28% yield) as white solids. Compound **9** [α]22 D= -19.7 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2931, 2866, 2364, 1762, 1458, 1189, 1089, 1045, 772; $^1H$ NMR (400 MHz, $CDCl_3$) δ 4.37 (dd, *J* = 9.2, 4.3 Hz, 1H), 4.06 (d, *J* = 9.2 Hz, 1H), 3.60 – 3.48 (m, 2H), 2.24 (s, 1H), 2.15 (dd, *J* = 13.3, 1.4 Hz, 1H), 1.96 – 1.87 (m, 1H), 1.78 (dd, *J* = 11.2, 4.2 Hz, 2H), 1.62 (dt, *J* = 13.6, 2.7 Hz, 1H), 1.57 – 1.43 (m, 4H), 1.28 (td, *J* = 13.3, 3.1 Hz, 1H), 1.23 – 1.16 (m, 3H), 1.14 (s, 3H), 0.93 (s, 3H); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ 177.81, 68.61, 65.94, 50.46, 49.11, 48.13, 41.56, 40.51, 34.67, 33.24, 33.10, 29.64, 22.79, 22.21, 18.66; HRMS (ESI): m/z calcd for $C_{15}H_{24}O_3Na^+$ $[M + Na]^+$ : 275.1618, found 275.1616; Compound **8** [α]22 D= -16.4 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2940, 2870, 1772, 1691, 1458, 1226, 1021, 890, 759; $^1H$ NMR (400 MHz, $CDCl_3$) δ 3.87 – 3.77 (m, 3H), 3.63 (d, *J* = 8.0 Hz, 1H), 2.42 (m, , 1H), 2.37 – 2.29 (m, 1H), 2.14 (ddd, *J* = 13.0, 9.5, 3.6 Hz, 2H), 1.78 (ddd, *J* = 13.2, 10.1, 3.3 Hz, 2H), 1.61 (dd, *J* = 13.1, 3.0 Hz, 1H), 1.50 – 1.35 (m, 4H), 1.28 – 1.16 (m, 2H), 0.92 (s, 3H), 0.87 (m, 1H), 0.80 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 182.7, 74.8, 66.4, 47.6, 45.8, 42.2, 36.8, 34.6, 33.7, 32.2, 27.3, 20.7, 20.6, 20.0; HRMS (ESI): m/z calcd for $C_{15}H_{25}O_3^+$ $[M + H]^+$ : 253.1798, found 253.1798.

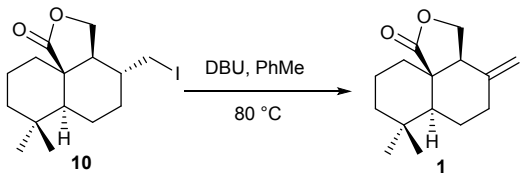
**Synthesis of Compound 10**




To a solution of **9** (1.0 g, 3.97 mmol, 1.0 equiv) in dry THF (40 ml) was added imidazole (405 mg, 5.95 mmol, 1.5 equiv), $PPh_3$ (1.35 g, 5.16 mmol, 1.3 equiv) and iodine (1.51 g, 5.95 mmol, 1.5 equiv) at 0 °C, and the resultant mixture was the stirred at room temperature for 1 h. The reaction mixture was quenched with a saturated solution of $NH_4Cl$ (30 mL), and then extracted with EtOAc (3 × 80 mL). The combined organic layers were washed with brine and dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 20/1 to 10/1) to give product **10** (1.44 g, 99% yield) as weak yellow

solids. When this reaction was carried out at 5-grams scale, the yield was reduced to 67%. Compound **10** [α]22 D= -16.5 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2927, 2391, 1767, 1099, 1043, 782; $^1H$ NMR (500 MHz, $CDCl_3$) δ 4.39 (dd, *J* = 9.4, 4.3 Hz, 1H), 3.90 (d, *J* = 9.4 Hz, 1H), 3.32 (dd, *J* = 10.3, 2.2 Hz, 1H), 3.19 (dd, *J* = 10.3, 5.2 Hz, 1H), 2.17 (d, *J* = 12.9 Hz, 1H), 1.97 (dd, *J* = 5.5, 3.1 Hz, 1H), 1.82 (d, *J* = 11.3 Hz, 1H), 1.76 (dd, *J* = 10.2, 4.2 Hz, 1H), 1.64 (dd, *J* = 15.1, 12.2 Hz, 1H), 1.56 – 1.46 (m, 2H), 1.34 (dd, *J* = 13.3, 3.1 Hz, 1H), 1.25 (m, 4H), 1.16 (s, 3H), 1.14 (d, *J* = 1.9 Hz, 1H), 0.96 (s, 3H); $^{13}C$ NMR (125 MHz, $CDCl_3$) δ 176.8, 67.8, 51.7, 50.6, 49.1, 41.6, 39.1, 34.8, 33.4, 33.3, 33.3, 22.7, 22.3, 18.8, 14.1; HRMS (ESI): m/z calcd for $C_{15}H_{23}IO_2Na^+$ $[M + Na]^+$: 385.0635, found 385.0634.

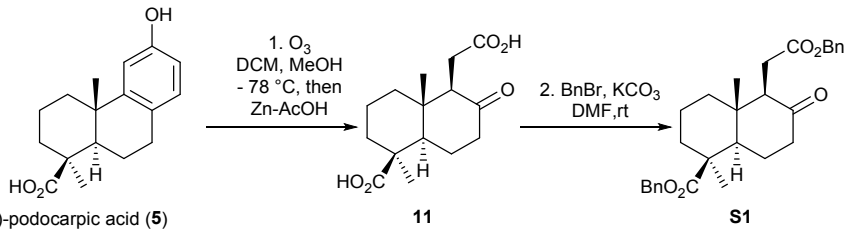
**Synthesis of Compound 1**




To a solution of **10** (2.1 g, 5.80 mmol, 1.0 equiv) in dry toluene (50 ml) was added DBU (8.6 ml, 58.0 mmol, 10.0 equiv) at room temperature, and the reaction mixture was stirred at 80 °C overnight. After completion, the mixture was cooled to room temperature and quenched with a saturated solution of $NH_4Cl$ (30 mL), and extracted with EtOAc (3 × 80 mL). The combined organic layers were washed with brine and dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 20/1) to give product **1** (680 mg, 50% yield) as yellowish solids. Compound **1** [α]22 D= -110.0 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2957, 2906, 2847, 1762, 1444, 1378, 1365, 1124, 1053, 987, 894; $^1H$ NMR (400 MHz, $CDCl_3$) δ 4.83 (s, 1H), 4.80 (s, 1H), 4.48 (dd, *J* = 9.5, 6.8 Hz, 1H), 4.15 (d, *J* = 9.5Hz, 1H), 2.67 (d, *J* = 6.8 Hz, 1H), 2.34 (m, 1H), 2.24 (m, 1H), 2.15 (dd, *J* = 13.4, 1.6 Hz, 1H), 1.81 (m, 1H), 1.76 (m, 1H), 1.56 (m, 1H), 1.53 (m, 1H), 1.49 (m, 1H), 1.38 (m, 1H), 1.34 (m, 1H), 1.23 (dd, *J* = 13.4, 3.0 Hz, 1H), 1.18 (s, 3H), 0.93 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 178.2, 146.5, 111.0, 69.2, 54.0, 48.3, 46.5, 41.8, 36.7, 33.1, 33.0, 30.2, 22.2, 22.0, 18.5; HRMS (ESI): m/z calcd for $C_{15}H_{22}O_2Na^+$ $[M + Na]^+$: 257.1512, found 257.1512.

According with this procedure, 22 grams of (-)-Antrocin has been obtained for the further biological studies.

**Synthesis of Compound S1**

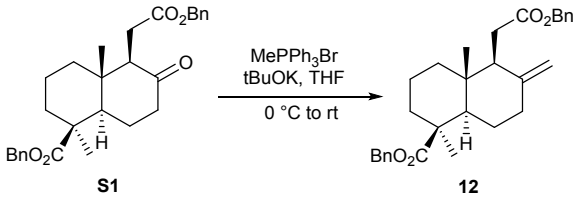



(+)-podocarpic acid (**5**) **11** **S1**

Ozone was passed through a solution of (+)-podocarpic acid **5** (700 mg, 2.55 mmol, 1.0 equiv) in DCM-MeOH (40 ml of 3:1) at -78 °C for 40 min, and the resultant mixture was first treated with Zn-dust (3.3 g, 50.8 mmol, 20.0 equiv) in AcOH (6.6 ml), and then stirred at room temperature for 2.5 h. The mixture was filtered off through a silica gel pad, and the filtrate was washed with MeOH. The filtrate was concentrated under vacuum, and the residue was diluted with $Et_2O$ (50 ml), and washed with 10% KOH aq. (50 ml). After separation, the aqueous were acidified with a solution of 2 M HCl to pH = 1 at -20 °C, and the mixture was extracted with EtOAc (3 × 50 mL). The combined organic layers were washed with brine and dried over $Na_2SO_4$. The solvent was removed under vacuum to give the crude compound **11** that was used in next step without purification. Compound **11** [α]22 D= -15.8 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2933, 2852, 1699, 1392, 1257, 1177, 893, 758; $^1H$ NMR (400 MHz, $CDCl_3$) δ 2.81 – 2.68 (m, 2H), 2.52 – 2.43 (m, 1H), 2.38 (m, 1H), 2.31 (m, 2H), 2.23 (m, 2H), 1.79 (m, 2H), 1.68 (d, *J* = 12.6 Hz, 1H), 1.60 – 1.51 (m, 1H), 1.34 (s, 3H), 1.32 – 1.24 (m, 2H), 1.13 (dd, *J* = 13.4, 10.1 Hz, 1H), 0.64 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 209.9, 183.2, 179.2, 58.6, 54.4, 44.1, 42.2, 41.8, 39.2, 37.5, 28.9, 27.7, 24.7, 19.4, 13.6; HRMS (ESI): m/z calcd for $C_{15}H_{22}O_5Na^+$ $[M + Na]^+$ : 305.1359, found 305.1359.

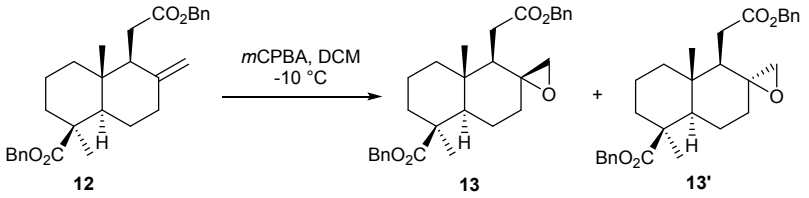
To a solution of the compound **11** in dry DMF (30 mL) was added $K_2CO_3$ (2.45 g, 17.8 mmol, 7.0 equiv) and BnBr (2.42 ml, 20.4 mmol, 8.0 equiv) at room temperature, and the resultant mixture was stirred overnight. The reaction mixture was quenched with a saturated solution of $NH_4Cl$ (30 mL), and the mixture was then extracted with EtOAc (3 × 80 mL). The combined organic layers were washed with brine and dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 8/1) to give product **S1** (885 mg, 75% yield) as colorless oil. Compound **S1** [α]22 D= -9.1 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2927, 2849, 1720, 1455, 1166, 1150, 749, 698; $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.28 (m, 10H), 5.16 – 5.01 (m, 4H), 2.82 – 2.70 (m, 2H), 2.44 (m, 1H), 2.31 (m, 2H), 2.25 (m, 2H), 2.16 (dd, *J* = 13.1, 4.8 Hz, 1H), 1.79 (m, 2H), 1.62 (d, *J* = 12.8 Hz, 1H), 1.57 – 1.49 (m, 1H), 1.31 (s, 3H), 1.28 (m, 1H), 1.13 (m, 1H), 0.49 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 210.1, 176.2, 173.1, 135.9, 135.6, 128.5, 128.5, 128.3, 128.2, 128.1, 66.3, 58.7, 54.6, 44.3, 42.2, 42.0, 39.3, 37.9, 28.8, 27.8, 25.0, 19.5, 13.5; HRMS (ESI): m/z calcd for $C_{29}H_{34}O_5Na^+$ $[M + Na]+$ : 485.2298, found 485.2295.

**Synthesis of Compound 12**




To a solution of $MePPh_3Br$ (1.48 g, 4.16 mmol, 3.5 equiv) in dry THF (12 ml) was added $^t$BuOK (2.1 ml, 3.57 mmol, 3.0 equiv) in THF (1.7 M) at 0 °C, and the resultant mixture was stirred at the same temperature for 1 h. To the reaction mixture was added the solution of **S1** (550 mg, 1.19 mmol, 1.0 equiv) in dry THF (3 ml), then the resultant mixture was warmed to room temperature and stirred for 2 h. After completion, the mixture was quenched with a saturated solution of $NH_4Cl$ (30 mL), followed by extraction with EtOAc (3 × 50 mL). The combined organic layers were washed with brine, and dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 20/1) to give product **12** (448 mg, 82% yield) as colorless oil. Compound **12** [α]22 D = 3.1 (c = 0.1, $CHCl_3$); IR (thin film, $\nu$ $cm^{-1}$): 2936, 2849, 1723, 1455, 1149, 892, 750, 696; $^1$H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.30 (m, 10H), 5.09 (m, 4H), 4.79 (s, 1H), 4.52 (s, 1H), 2.58 – 2.46 (m, 2H), 2.41 (m, 2H), 2.24 (m, 1H), 2.09 – 1.97 (m, 2H), 1.91 – 1.76 (m, 2H), 1.64 (d, $J$ = 12.6 Hz, 1H), 1.52 (m, 1H), 1.44 (dd, $J$ = 12.6, 2.4 Hz, 1H), 1.25 (s, 3H), 1.19 (m, 1H), 1.14 – 1.01 (m, 1H), 0.51 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 176.7, 173.5, 148.4, 136.0, 128.4, 128.4, 128.1, 128.1, 128.0, 106.4, 66.2, 66.0, 56.0, 51.8, 44.3, 39.5, 39.0, 38.1, 37.9, 31.0, 28.9, 25.7, 19.8, 12.8; HRMS (ESI): m/z calcd for $C_{30}H_{36}O_4Na^+$ $[M + Na]^+$: 483.2506, found 483.2505.

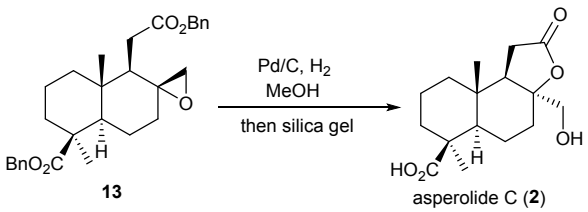
**Synthesis of Compound 13**




To a solution of **12** (368 mg, 0.80 mmol, 1.0 equiv) in dry DCM (8 ml) was added *m*CPBA (207 mg, 1.20 mmol, 1.5 equiv) at -10 °C slowly, and the resultant mixture was stirred at same temperature for 12h. The reaction mixture was quenched with a saturated solution of $Na_2S_2O_3$ (20 mL), and the resultant mixture was extracted with EtOAc (3 × 40 mL). The combined organic layers were washed with saturated solution of $NaHCO_3$, brine and dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 10/1) to give product **13** (305 mg, 80% yield) and the diastereoisomer **13'** (43 mg, 11%

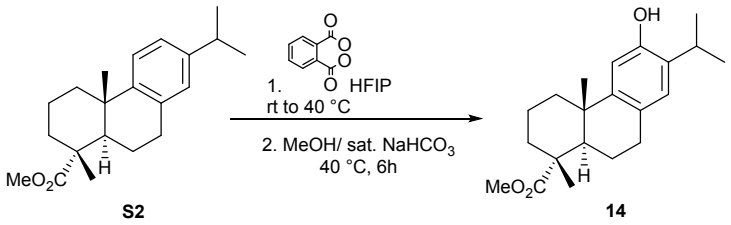
yield) as colorless oil. Compound **13** [α]22 D= -1.1 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2954, 2850, 1725, 1456, 1386, 1263, 1146, 750, 698; $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.29 (m, 10H), 5.18 – 4.99 (m, 4H), 2.62 (m, 1H), 2.50 (d, *J* = 4.0 Hz, 1H), 2.34 (t, *J* = 6.4 Hz, 1H), 2.22 (d, *J* = 13.2 Hz, 1H), 2.11 (m, 2H), 2.05 – 1.87 (m, 3H), 1.77 (m, 1H), 1.52 – 1.31 (m, 4H), 1.25 (s, 3H), 1.19 – 1.10 (m, 1H), 1.06 (td, *J* = 13.5, 3.8 Hz, 1H), 0.57 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 176.6, 173.3, 136.0, 135.9, 128.4, 128.4, 128.3, 128.2, 128.0, 66.3, 66.1, 58.4, 55.3, 50.0, 49.2, 44.1, 39.7, 38.7, 37.7, 36.0, 28.8, 27.6, 23.1, 19.2, 13.0; HRMS (ESI): m/z calcd for $C_{30}H_{36}O_5Na^+$ $[M + Na]^+$ : 499.2455, found 499.2456; Compound **13'** [α]22 D= 8.1 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2953, 2619, 2522, 1753, 1263, 1032, 891, 811; $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.29 (m, 10H), 5.26 – 4.94 (m, 4H), 2.36 (d, *J* = 3.6 Hz, 1H), 2.28 – 2.24 (m, 2H), 2.23 – 2.17 (m, 2H), 2.13 – 2.03 (m, 1H), 1.99 (m, 1H), 1.94 (m, 1H), 1.92 – 1.79 (m, 2H), 1.71 (d, *J* = 12.7 Hz, 1H), 1.54 – 1.45 (m, 1H), 1.34 (dd, *J* = 12.6, 2.5 Hz, 2H), 1.25 (s, 3H), 1.15 – 1.03 (m, 2H), 0.67 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 176.69, 173.92, 135.93, 135.78, 128.50, 128.41, 128.19, 128.15, 128.06, 127.98, 66.34, 66.06, 57.45, 55.49, 48.95, 46.98, 44.07, 39.31, 39.05, 37.94, 35.47, 28.74, 27.45, 21.41, 19.06, 13.24; HRMS (ESI): m/z calcd for $C_{30}H_{36}O_5Na^+$ $[M + Na]^+$ : 499.2455, found 499.2456.

**Synthesis of Compound 2**



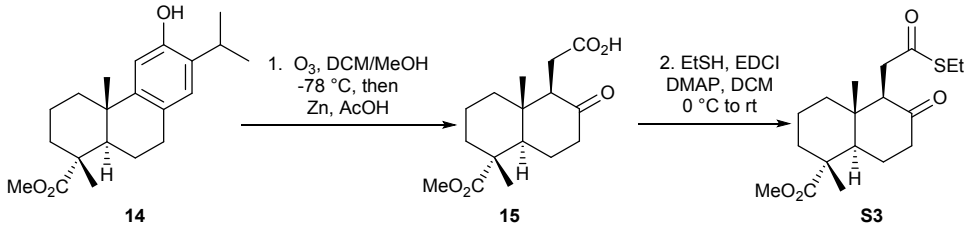

To a solution of **13** (230 mg, 0.48 mmol, 1.0 equiv) in MeOH (5 ml) was added palladium on carbon (53 mg, 0.05 mmol, 0.1 equiv, palladium 10% on carbon), and the reaction mixture was first degassed with hydrogen, and then stirred at room temperature for 5 h. To this mixture was added silica gel (100 mg), and the resultant mixture was stirred for 5 h. The mixture was filtered off through a silica gel pad, and the filtrate was concentrated under vacuum. The residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 1/1) to give product **2** (127 mg, 90% yield) as white solids. Compound **2** [α]22 D= 6.7 (c = 0.1, MeOH); IR (thin film, *v* $cm^{-1}$): 3440, 2934, 1755, 1645, 1464, 1205, 931; $^1H$ NMR (400 MHz, $CD_3OD$) δ 3.43 (d, *J* = 11.6 Hz, 1H), 3.39 (d, *J* = 11.6 Hz, 1H), 2.93 (dd, *J* = 18.1, 8.3 Hz, 1H), 2.37 (d, *J* = 18.1 Hz, 1H), 2.18 (dd, *J* = 13.4, 1.6 Hz, 1H), 2.09 (m, 1H), 2.06 (m, 1H), 1.90 (dd, *J* = 5.5, 3.3 Hz, 1H), 1.88 – 1.78 (m, 1H), 1.71 (m, 1H), 1.69 – 1.65 (m, 1H), 1.43 (m, 1H), 1.24 (s, 3H), 1.17 (dd, *J* = 9.7, 5.1 Hz, 1H), 1.09 (dd, *J* = 13.4, 3.8 Hz, 1H), 1.04 (m, 1H), 0.83 (s, 3H); $^{13}C$ NMR (101 MHz, $CD_3OD$) δ 181.0, 180.9, 88.8, 69.2, 53.3, 50.7, 44.5, 42.0, 38.9, 37.4, 33.5, 31.1, 29.3, 20.2, 20.0, 14.6; HRMS (ESI): m/z calcd for $C_{16}H_{25}O_5^+$ $[M + H]^+$: 297.1697, found 297.1696.

**Synthesis of Compound 14**




To a solution of **S2** in HFIP (hexafluoroisopropanol) was added phthaloyl peroxide slowly at room temperature, and the reaction mixture was then stirred at 40 °C for 12 h. After cooled to room temperature, the solvent was removed under vacuum at 23 °C, and the residue was diluted by deoxygenated methanol and a saturated aqueous sodium bicarbonate solution, and the resultant mixture was stirred at 40 °C for 6 h. Upon complete consumption of the phthalate ester, the reaction was diluted with phosphate buffer (pH 7.0), followed by extraction with ethyl acetate (3 × 150 mL). The combined organic extracts were washed with brine, dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 8/1) to give product **14** (4.16 g, 67% yield) as colorless oil. Compound **14** [α]22 D= 30.7 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 3441, 2927, 1696, 1416, 1256, 1230, 861, 793; $^1H$ NMR (400 MHz, $CDCl_3$) δ 6.83 (s, 1H), 6.65 (s, 1H), 5.03 (s, 1H), 3.68 (s, 3H), 3.20 – 3.08 (m, 1H), 2.82 (dd, *J* = 8.4, 3.8 Hz, 2H), 2.22 (m, 2H), 1.76 (m, 2H), 1.71 – 1.62 (m, 2H), 1.42 (m, 2H), 1.28 (s, 3H), 1.24 (t, *J* = 6.6 Hz, 6H), 1.20 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 179.3, 150.8, 147.8, 131.8, 126.8, 126.6, 110.7, 51.9, 47.6, 44.8, 37.9, 36.8, 36.5, 29.2, 26.7, 24.9, 22.7, 22.5, 21.8, 18.5, 16.4; HRMS (ESI): m/z calcd for $C_{21}H_{30}O_3Na^+$ $[M + Na]^+$ : 353.2087, found 353.2097.

**Synthesis of Compound S3**

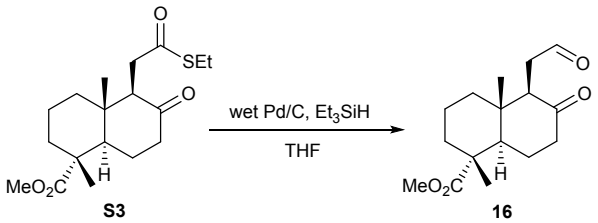



Ozone was passed through a solution of **14** (6.0 g, 18.2 mmol, 1.0 equiv) in 200 ml of 3:1 DCM-MeOH at -78 °C for 1.5 h. The resultant was treated with a mixture of Zn-dust (24.0 g, 360 mmol, 20.0 equiv) in AcOH (50 ml), and the resultant mixture was stirred at room temperature for 2.5 h. The mixture was then filtered off through a silica gel pad, and the filtrate was concentrated under vacuum. The residue was diluted with $Et_2O$ (100 ml) and washed with 10% KOH aq. (100 ml), followed by extraction with $Et_2O$ (3 × 300 mL). The combined organic layers were washed with brine, dried over $Na_2SO_4$. The solvent was removed under vacuum to give compound **15** that was used

in next step without purification. Compound **15** [α]22 D= -20.6 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2917, 2849, 2360, 1713, 1251, 1113, 756, 668; $^1H$ NMR (400 MHz, $CDCl_3$) δ 3.67 (s, 3H), 2.79 (dd, *J* = 9.6, 2.4 Hz, 1H), 2.71 (dd, *J* = 16.5, 9.6 Hz, 1H), 2.45 – 2.35 (m, 3H), 2.25 – 2.17 (m, 1H), 1.80 – 1.66 (m, 2H), 1.65 – 1.47 (m, 5H), 1.31 (td, *J* = 12.3, 3.7 Hz, 1H), 1.16 (s, 3H), 0.72 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 209.8, 178.7, 178.6, 59.6, 52.2, 47.8, 47.0, 41.0, 40.5, 37.9, 36.8, 27.3, 25.2, 17.5, 16.5, 15.0; HRMS (ESI): m/z calcd for $C_{16}H_{24}O_5Na^+$ $[M + Na]^+$ : 319.1516, found 319.1517.

To a solution of compound **15** in dry DCM (150 ml) was added EtSH (4.76 ml, 63.7 mmol, 3.5 equiv), EDCI (8.7 g, 45.5 mmol, 2.5 equiv) and DMAP (890 mg, 7.28 mmol, 0.4 equiv) at 0 °C, and the mixture was warmed to room temperature and stirred overnight. The reaction mixture was quenched with a saturated solution of $NH_4Cl$ (50 mL), and extracted with DCM (3 × 150 mL). The combined organic layers were washed with brine, dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 15/1) to give product **S3** (4.16 g, 67% yield) as colorless oil. Compound **S3** [α]22 D= -29.5 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2932, 1725, 1692, 1454, 1248, 1049, 776; $^1H$ NMR (500 MHz, $CDCl_3$) δ 3.68 (s, 3H), 3.04 (dd, *J* = 16.3, 8.9 Hz, 1H), 2.95 (dd, *J* = 8.9, 3.1 Hz, 1H), 2.84 (m, 2H), 2.46 – 2.37 (m, 4H), 1.76 (m, 1H), 1.70 (m, 1H), 1.62 – 1.55 (m, 4H), 1.50 (m, 1H), 1.35 – 1.27 (m, 1H), 1.21 (t, *J* = 14.8 Hz, 3H), 1.17 (s, 3H), 0.73 (s, 3H); $^{13}C$ NMR (125 MHz, $CDCl_3$) δ 209.4, 198.8, 178.6, 59.7, 52.2, 48.0, 47.2, 41.3, 40.9, 38.1, 37.1, 36.9, 25.4, 23.4, 17.6, 16.7, 15.2, 14.7; HRMS (ESI): m/z calcd for $C_{18}H_{28}O_4SNa^+$ $[M + Na]^+$ : 363.1601, found 363.1600.

**Synthesis of Compound 16**

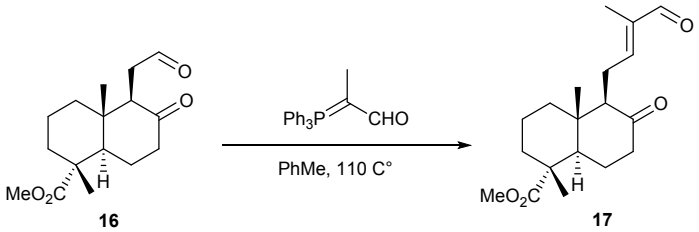


**S3** **16**

To a solution of **S3** (1.80 g, 5.29 mmol, 1.0 equiv) in dry THF (50 ml) was added palladium on carbon (564 mg, 0.53 mmol, 0.1 equiv, palladium 10% on carbon) and $Et_3SiH$ (4.2 ml, 26.5 mmol, 5.0 equiv), and the resultant mixture was stirred at room temperature overnight. The mixture was filtered off through a silica gel pad, and the filtrate was concentrated under vacuum. The residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 8/1) to give product **16** (1.40 g, 95% yield) as colorless oil. Compound **16** [α]22 D= -24.9 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2948, 2728, 1725, 1450, 1390, 1250, 1115, 737; $^1H$ NMR (500 MHz, $CDCl_3$) δ 9.79 (s, 1H), 3.68 (s, 3H), 2.92 (dd, *J* = 6.9, 4.5 Hz, 2H), 2.47 – 2.38 (m, 3H), 2.27 – 2.16 (m, 1H), 1.83 – 1.68 (m, 2H),

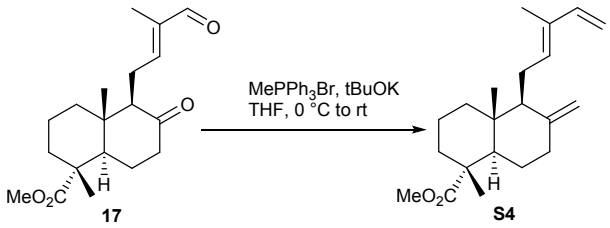
1.67 – 1.50 (m, 5H), 1.34 – 1.22 (m, 1H), 1.18 (s, 3H), 0.75 (s, 3H); $^{13}$C NMR (125 MHz, $CDCl_3$) δ 209.5, 200.9, 178.5, 58.2, 52.2, 47.9, 47.2, 41.1, 40.4, 38.3, 36.9, 36.8, 25.3, 17.6, 16.7, 15.4; HRMS (ESI): m/z calcd for $C_{16}H_{24}O_4Na^+$ $[M + Na]^+$: 303.1567, found 303.1566.

**Synthesis of Compound 17**




To a stirred solution of **16** (1.0 g, 3.57 mmol, 1.0 equiv) in toluene (30 mL) was added 2-(triphenylphosphoranylidene)propionaldehyde (2.3 g, 7.14 mmol, 2.0 equiv) at room temperature, and the resulting mixture was then stirred at 110 °C for 24 h. After cooling to room temperature, the solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 8/1) to give product **17** (810 mg, 71% yield) as colorless oil. Compound **17** [α]22 D= -4.1 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2924, 2849, 1725 1683, 1248, 1189, 801; $^1$H NMR (500 MHz, $CDCl_3$) δ 9.32 (s, 1H), 6.43 (s, 1H), 3.70 (s, 3H), 2.68 (dd, *J* = 13.8, 7.4 Hz, 1H), 2.48 – 2.28 (m, 5H), 1.82 (dd, *J* = 13.4, 9.1 Hz, 1H), 1.77 (s, 3H), 1.75 (s, 1H), 1.76 – 1.53 (m, 5H), 1.35 (td, *J* = 12.8, 4.1 Hz, 1H), 1.27 – 1.23 (m, 1H), 1.21 (s, 3H), 0.83 (s, 3H); $^{13}$C NMR (125 MHz, $CDCl_3$) δ 209.5, 195.2, 177.0, 154.1, 139.4, 64.0, 52.2, 48.4, 47.3, 41.9, 41.8, 38.5, 37.0, 25.7, 22.1, 17.8, 16.7, 15.0, 9.2; HRMS (ESI): m/z calcd for $C_{19}H_{29}O_4^+$ $[M + H]^+$: 321.2060, found 321.2062.

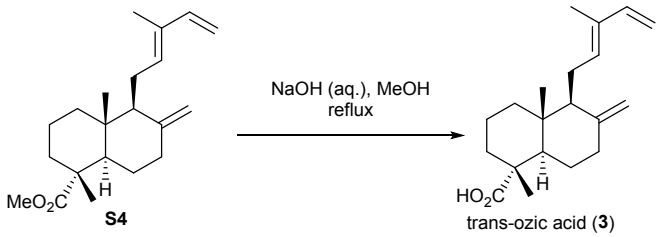
**Synthesis of Compound S4**




To a solution of $MePPh_3Br$ (10 g, 28.0 mmol, 6.0 equiv) in dry THF (50 ml) was added $^t$BuOK (13.8 ml, 23.4 mmol, 5.0 equiv) in THF (1.7 M) at 0 °C, and the resultant mixture was stirred at the same temperature for 1 h. To the reaction mixture was added the solution of **17** (1.50 g, 4.68 mmol, 1 equiv) in THF (10 ml), and the mixture was then warmed to room temperature and stirred for 2 h. The reaction mixture was quenched with a saturated solution of $NH_4Cl$ (40 mL), and the mixture was extracted with EtOAc (3 × 80 mL). The combined organic layers were

washed with brine, dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 20/1) to give product **S4** (1.35 g, 91% yield) as colorless oil. Compound **S4** [α]22 D= 14.3 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2939, 2845, 1724, 1434, 1387, 1243, 1129, 889, 802; $^1H$ NMR (400 MHz, $CDCl_3$) δ 6.33 (dd, *J* = 17.4, 10.7 Hz, 1H), 5.41 (t, *J* = 6.5 Hz, 1H), 5.05 (d, *J* = 17.4 Hz, 1H), 4.89 (d, *J* = 10.7 Hz, 1H), 4.82 (d, *J* = 1.3 Hz, 1H), 4.48 (d, *J* = 1.1 Hz, 1H), 3.67 (s, 3H), 2.42 – 2.29 (m, 2H), 2.21 – 2.11 (m, 1H), 2.06 (td, *J* = 12.9, 4.9 Hz, 1H), 2.00 – 1.93 (m, 1H), 1.84 (m, 3H), 1.76 (d, *J* = 0.5 Hz, 3H), 1.64 – 1.58 (m, 3H), 1.46 (m, 1H), 1.27 – 1.19 (m, 2H), 1.16 (s, 3H), 0.76 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 179.2, 147.8, 141.5, 133.6, 133.4, 109.9, 108.0, 57.0, 51.8, 49.7, 47.7, 38.8, 38.1, 37.5, 36.9, 26.5, 22.9, 18.4, 16.6, 14.6, 11.8; HRMS (ESI): m/z calcd for $C_{19}H_{29}O_4^+$ $[M + H]^+$: 317.2475, found 317.2486.

**Synthesis of Compound 3**




To a solution of **S4** (260 mg, 0.82 mmol, 1.0 equiv) in MeOH (10 ml) and $H_2O$ (2 ml) was added KOH (500 mg, 8.20 mmol,10.0 equiv) and LiOH•$H_2O$ (300 mg, 6.60 mmol, 8.0 equiv), and the resultant mixture was stirred under refluxing for 24 h. After cooling to room temperature, the resulting mixture was acidified with the solution of 3 M HCl to pH = 1. The mixture was extracted with $Et_2O$ (3 × 80 mL), and the combined organic layers were washed with brine, dried over $Na_2SO_4$. The solvent was removed under vacuum, and the residue was purified by a flash column chromatography on silica gel (hexane/EtOAc: 2/1) to give product **3** (202 mg, 91% yield) as white foam. Compound **3** [α]22 D= -17.1 (c = 0.1, $CHCl_3$); IR (thin film, *v* $cm^{-1}$): 2876, 2853, 1699, 1444, 1387, 1273, 988, 889; $^1H$ NMR (400 MHz, $CDCl_3$) δ 6.34 (dd, *J* = 17.3, 10.8 Hz, 1H), 5.42 (s, 1H), 5.06 (d, *J* = 17.4 Hz, 1H), 4.89 (d, *J* = 10.7 Hz, 1H), 4.84 (d, *J* = 1.0 Hz, 1H), 4.49 (s, 1H), 2.42 – 2.29 (m, 2H), 2.21 – 2.04 (m, 2H), 2.00 (dd, *J* = 12.3, 2.8 Hz, 1H), 1.84 (m, 3H), 1.76 (s, 3H), 1.65 – 1.59 (m, 2H), 1.49 (m, 1H), 1.37 (m, 1H), 1.17 (s, 3H), 0.89 (m, 1H), 0.77 (s, 3H); $^{13}C$ NMR (100 MHz, $CDCl_3$) δ 185.0, 147.7, 141.5, 133.6, 133.5, 110.0, 108.1, 56.9, 49.3, 47.4, 38.7, 38.0, 37.5, 37.0, 26.5, 22.9, 18.4, 16.3, 14.6, 11.8; HRMS (ESI): m/z calcd for $C_{20}H_{30}O_2Na^+$ $[M + Na]^+$ : 325.2138, found 325.2140.

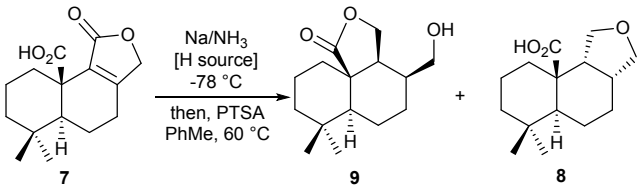
## Ⅲ. Optimization for the $Na/NH_3$ Reduction of Compound 7

**General Procedure**

Compound **7** (100 mg, 0.38 mmol, 1.0 equiv) was added to an ammonia solution (8 mL) at -78 °C, to this solution was added sodium (130 mg, 5.70 mmol, 15.0 equiv) in small pieces slowly. After completion, H source ($^t$BuOH, EtOH, $^i$PrOH, 5.0 equiv) was added to the above reaction mixture. The resultant mixture was then stirred at the same temperature for 1 h, followed by quenching with corresponding H source (5 mL) at -78 °C carefully. The ammonia was removed under vacuum, and the residue was then diluted with ether (8 mL). The mixture was first acidified with a solution of 6 M HCl to pH = 1 at -20 °C, and then extracted with EtOAc (3 × 30 mL). The combined organic layers were washed with brine and dried over $Na_2SO_4$. The solvent was removed in vacuum to give the crude compound that was used in next step without purification.

To a solution of the crude product made above in PhMe (5 mL) was added PTSA (20 mg, 0.11 mmol, 0.3 equiv) at room temperature, and the reaction mixture was then stirred at 60 °C for 1 h. After completion, the mixture was cooled to room temperature and quenched with a saturated solution of $NaHCO_3$ (10 mL), and extracted with EtOAc (3 × 30 mL). The combined organic layers were washed with brine, and dried over $Na_2SO_4$. The ratio of product **9** and **8** could be confirmed by GC, crude NMR spectra and the isolation with a flash column chromatography on silica gel.

**Table S1.** Optimization for the $Na/NH_3$ Reduction of Compound 7

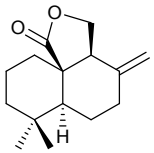



| Entry | H source | Ratio （**9:8**） | | | Yield (%) |
|---|---|---|---|---|---|
| | | GC ratio | NMR ratio | FC ratio | |
| 1 | None | 1:2 | 1:1.5 | - | - |
| 2 | $^t$BuOH (1.0 equiv) | 1:1 | 1:1 | - | - |
| 3 | $^t$BuOH (5.0 equiv) | 1.2:1 | 1:1 | - | - |

| | | | | | |
|---|---|---|---|---|---|
| 4 | $^{t}$BuOH (10.0 equiv) | 1.2:1 | 1:1 | - | - |
| 5 | EtOH (1.0 equiv) | 1.4:1 | 2:1 | - | - |
| 6 | EtOH (5.0 equiv) | 1.7:1 | 2:1 | 2.2:1 | **9** (61) |
| 7 | EtOH (10.0 equiv) | 1.6:1 | 2:1 | - | - |
| 8 | $^{i}$PrOH (5.0 equiv) | 1.7:1 | 2.5:1 | 2.2:1 | **9** (43) |

## Ⅳ. Comparison of the Spectra of Natural and Synthetic Antrocin, Asperolide C and *tran*-Ozic Aicd

**Table S2.** Comparison of $^{1}$H NMR data for Antrocin in $CDCl_3$

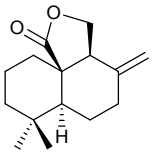


Antrocin (**1**)

| **No.** | **Natural** $\delta$H [ppm, mult, *J* (Hz)] 400 MHz | **Synthetic** $\delta$H [ppm, mult, *J* (Hz)] 400 MHz | **Err** (Natural - Synthetic) Δδ (ppm) |
|---|---|---|---|
| **1α** | 1.35 m | 1.34 m | 0.01 |
| **1β** | 2.15 m | 2.15 (dd, *J* = 13.4, 1.6 Hz) | - |
| **2α** | 1.50 m | 1.49 m | 0.01 |
| **2β** | 1.80 m | 1.81 m | -0.01 |
| **3** | 1.21 m | 1.23 (dd, *J* = 13.4, 3.0 Hz) | -0.02 |
| **4** | 1.55 m | 1.56 m | -0.01 |
| **5** | 1.36 m | 1.38 m | -0.02 |
| **6α** | 1.53 m | 1.53 m | - |
| **6β** | 1.80 m | 1.76 m | 0.04 |
| **7** | 2.25 m | 2.24 m | 0.01 |
| **8** | 2.35 m | 2.34 m | 0.01 |
| **9** | 2.66 d (J = 6.8 Hz) | 2.67 d (J = 6.8 Hz) | -0.01 |
| **11α** | 4.14 d (J = 9.1 Hz) | 4.15 d (J = 9.5 Hz) | -0.01 |
| **11β** | 4.48 dd (J = 6.8, 9.1) | 4.48 dd (J = 6.8, 9.5 Hz) | - |
| **12α** | 4.80 s | 4.80 s | - |
| **12β** | 4.83 s | 4.83 s | - |

| | | | |
|---|---|---|---|
| **13** | 0.93 s | 0.93 s | - |
| **14** | 1.18 s | 1.18 s | - |

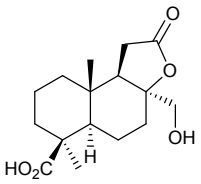
**Table S3.** Comparison of $^{13}C$ NMR data for Antrocin in $CDCl_3$



Antrocin (**1**)

| **No.** | **Natural**<br>δC (ppm)<br>100 MHz | **Synthetic**<br>δC (ppm)<br>100 MHz | **Err**<br>(Natural - Synthetic)<br>Δδ (ppm) |
|---|---|---|---|
| **1** | 36.7 | 36.7 | - |
| **2** | 18.6 | 18.5 | 0.1 |
| **3** | 41.9 | 41.8 | 0.1 |
| **4** | 33.1 | 33.1 | - |
| **5** | 46.6 | 46.5 | 0.1 |
| **6** | 22.1 | 22.2 | -0.1 |
| **7** | 30.3 | 30.2 | 0.1 |
| **8** | 146.5 | 146.5 | - |
| **9** | 54.0 | 54.0 | - |
| **10** | 48.3 | 48.3 | - |
| **11** | 69.2 | 69.2 | - |
| **12** | 111.0 | 111.0 | - |
| **13** | 33.1 | 33.0 | 0.1 |
| **14** | 22.2 | 22.2 | - |
| **15** | 178.2 | 178.2 | - |

**Table S4.** Comparison of $^{1}H$ NMR data for Asperolide C in $CD_3OD$

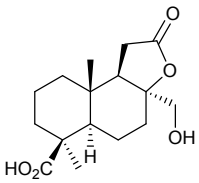


asperolide C (**2**)

| No. | **Natural** $\delta$H [ppm, mult, *J* (Hz)] 500 MHz | **Synthetic** $\delta$H [ppm, mult, *J* (Hz)] 400 MHz | **Err** (Natural - Synthetic) Δδ (ppm) |
|---|---|---|---|
| **1α** | 1.07 m | 1.04 m | 0.03 |
| **1β** | 1.70 m | 1.71 m | -0.01 |
| **2α** | 1.52 m | 1.43 m | 0.09 |
| **2β** | 1.86 m | 1.88 – 1.78 m | - |
| **3α** | 1.08 m | 1.09 dd (*J* = 13.4, 3.8 Hz) | -0.01 |
| **3β** | 1.74 m | 1.71 m | 0.03 |
| **5** | 1.16 (dd, *J* = 10.5, 4.5 Hz) | 1.17 dd (*J* = 9.7, 5.1 Hz) | -0.01 |
| **6α** | 1.87 m | 1.88 – 1.78 m | - |
| **6β** | 1.46 (dd, *J* =14.2, 3.2 Hz) | 1.43 m | 0.03 |
| **7α** | 2.07 (dd, *J* =14.2, 3.2 Hz) | 2.06 m | 0.01 |
| **7β** | 1.72 m | 1.71 m | 0.01 |
| **9** | 2.24 m | 2.09 m | 0.15 |
| **11α** | 2.90 m | 2.93 dd (*J* = 18.1, 8.3 Hz) | -0.03 |
| **11β** | 2.35 d (*J* = 18.2 Hz) | 2.37 d (*J* = 18.1 Hz) | -0.02 |
| **17α** | 3.40 d (*J* = 10.3 Hz) | 3.43 d (*J* = 11.6 Hz) | -0.03 |
| **17β** | 3.34 dt (*J* = 10.3, 2.1 Hz) | 3.39 d (*J* = 11.6 Hz) | -0.05 |

| | | | |
|---|---|---|---|
| **18** | 1.24 s | 1.24 s | - |
| **20** | 0.84 s | 0.83 s | 0.01 |

**Table S5.** Comparison of $^{13}C$ NMR data for Asperolide C in $CD_3OD$

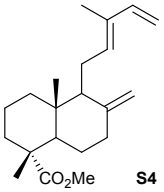


asperolide C (**2**)

| **No.** | **Natural** δC (ppm) 125 MHz | **Synthetic** δC (ppm) 100 MHz | **Err** (Natural - Synthetic) Δδ (ppm) |
|---|---|---|---|
| **1** | 42.0 | 42.0 | - |
| **2** | 20.0 | 20.0 | - |
| **3** | 38.6 | 88.8 | -0.2 |
| **4** | 44.6 | 44.5 | 0.1 |
| **5** | 53.3 | 53.3 | - |
| **6** | 20.1 | 20.2 | -0.1 |
| **7** | 31.0 | 31.1 | -0.1 |
| **8** | 88.9 | 88.8 | 0.1 |
| **9** | 50.8 | 50.7 | 0.1 |
| **10** | 37.5 | 37.4 | 0.1 |
| **11** | 33.5 | 33.5 | - |
| **12** | 180.3 | 180.9 | -0.6 |
| **17** | 69.3 | 69.2 | 0.1 |
| **18** | 29.3 | 29.3 | - |
| **19** | 181.0 | 181.0 | - |
| **20** | 14.6 | 14.6 | -0.2 |

**Table S6.** Comparison of $^{13}C$ NMR data for *trans*-Methyl Ozate in $CDCl_3$*

*The isolation paper only provide the full $^{13}C$ NMR data of the methylated derivative of trans-ozic acid.

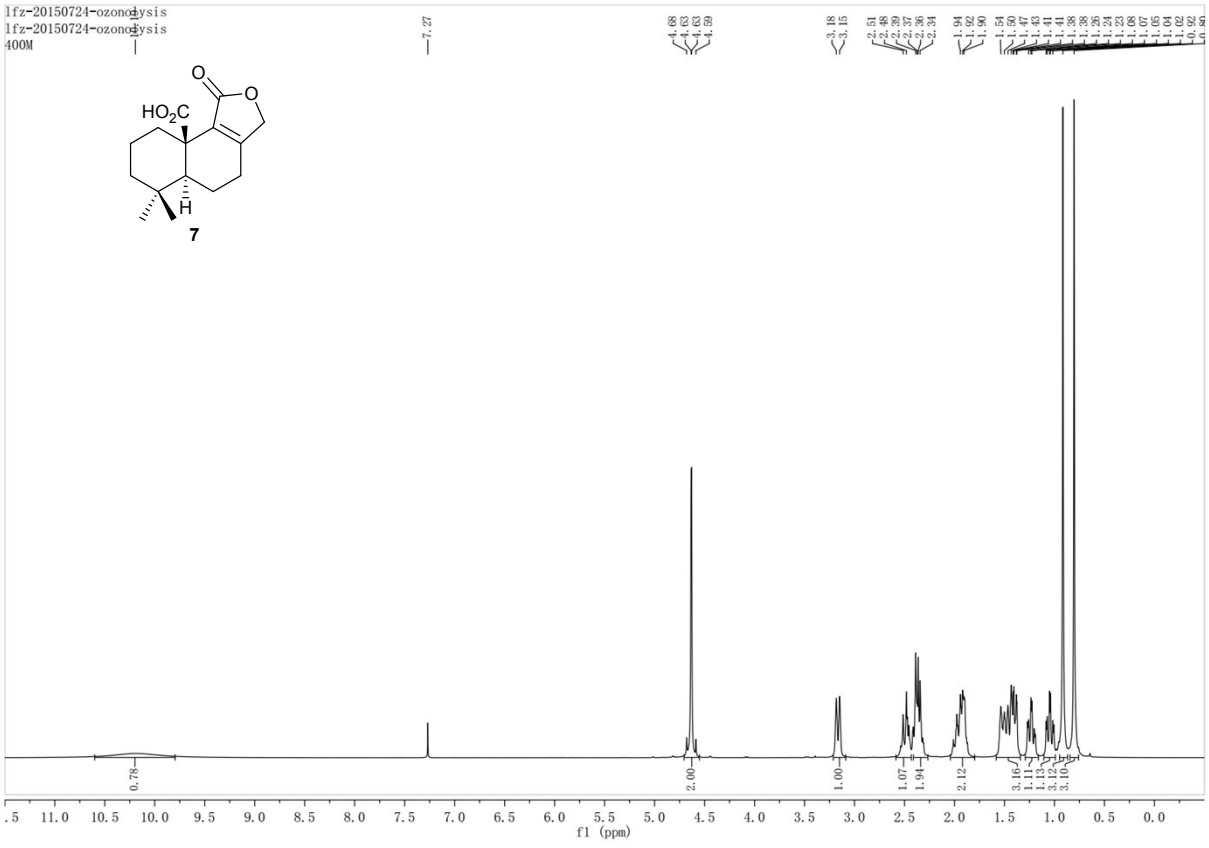


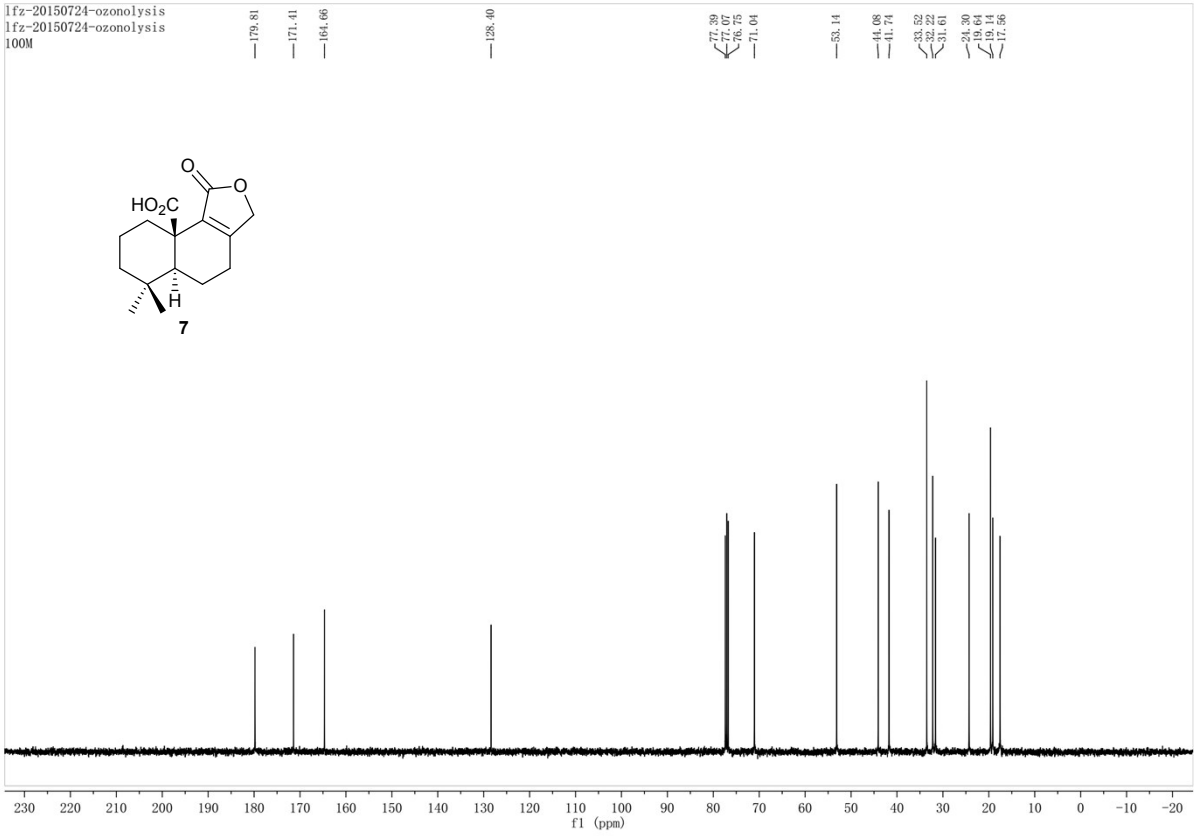

S4

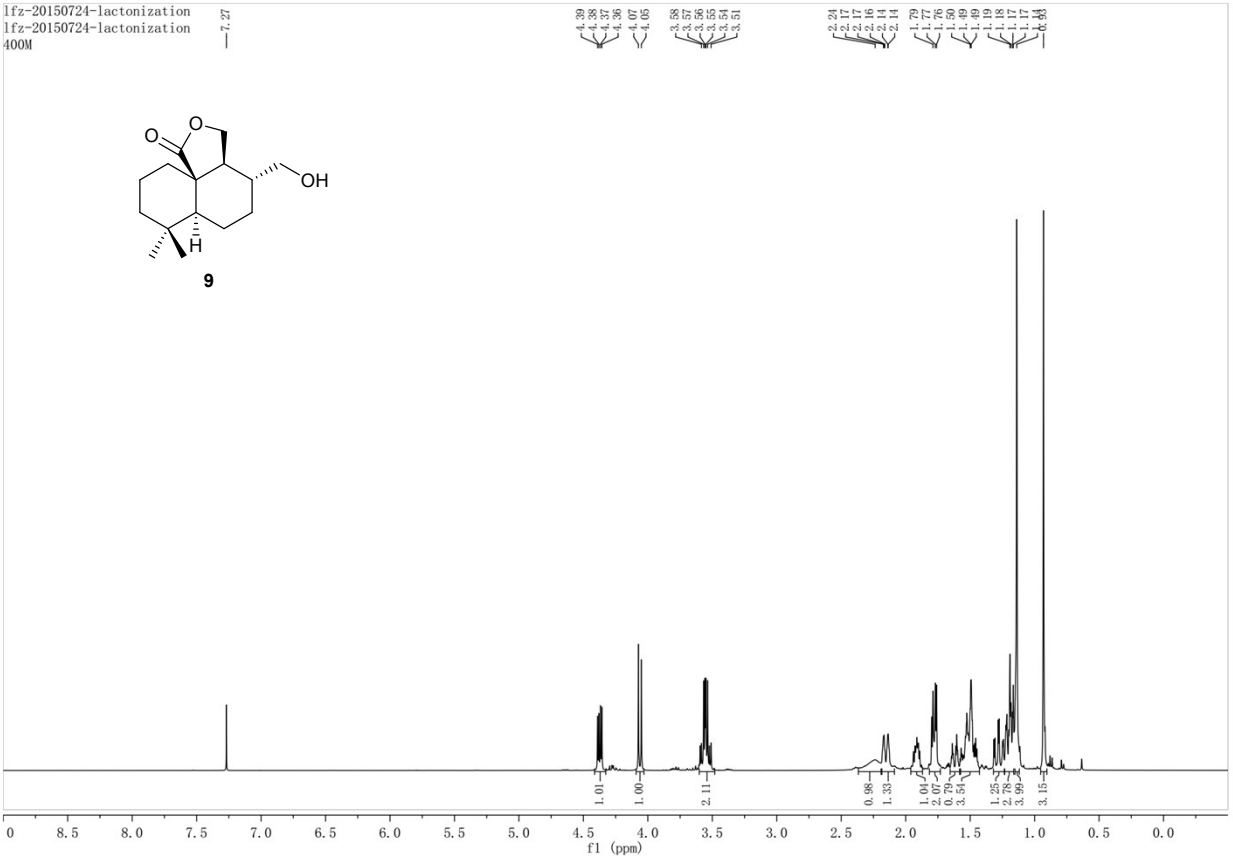
| No. | **Natural** δC (ppm) - | **Synthetic** δC (ppm) 100 MHz | **Err** (Natural - Synthetic) Δδ (ppm) |
|---|---|---|---|
| **1** | 38.2 | 38.1 | 0.1 |
| **2** | 18.4 | 18.4 | - |
| **3** | 37.6 | 37.5 | 0.1 |
| **4** | 47.7 | 47.7 | - |
| **5** | 49.8 | 49.7 | 0.1 |
| **6** | 26.6 | 26.5 | 0.1 |
| **7** | 37.0 | 36.9 | 0.1 |
| **8** | 147.8 | 147.8 | - |
| **9** | 57.0 | 57.0 | - |
| **10** | 38.9 | 38.8 | 0.1 |
| **11** | 23.0 | 22.9 | 0.1 |
| **12** | 133.4 | 133.4 | - |
| **13** | 133.4 | 133.6 | -0.2 |
| **14** | 141.5 | 141.5 | - |
| **15** | 109.7 | 109.9 | -0.2 |
| **16** | 11.7 | 11.8 | -0.1 |

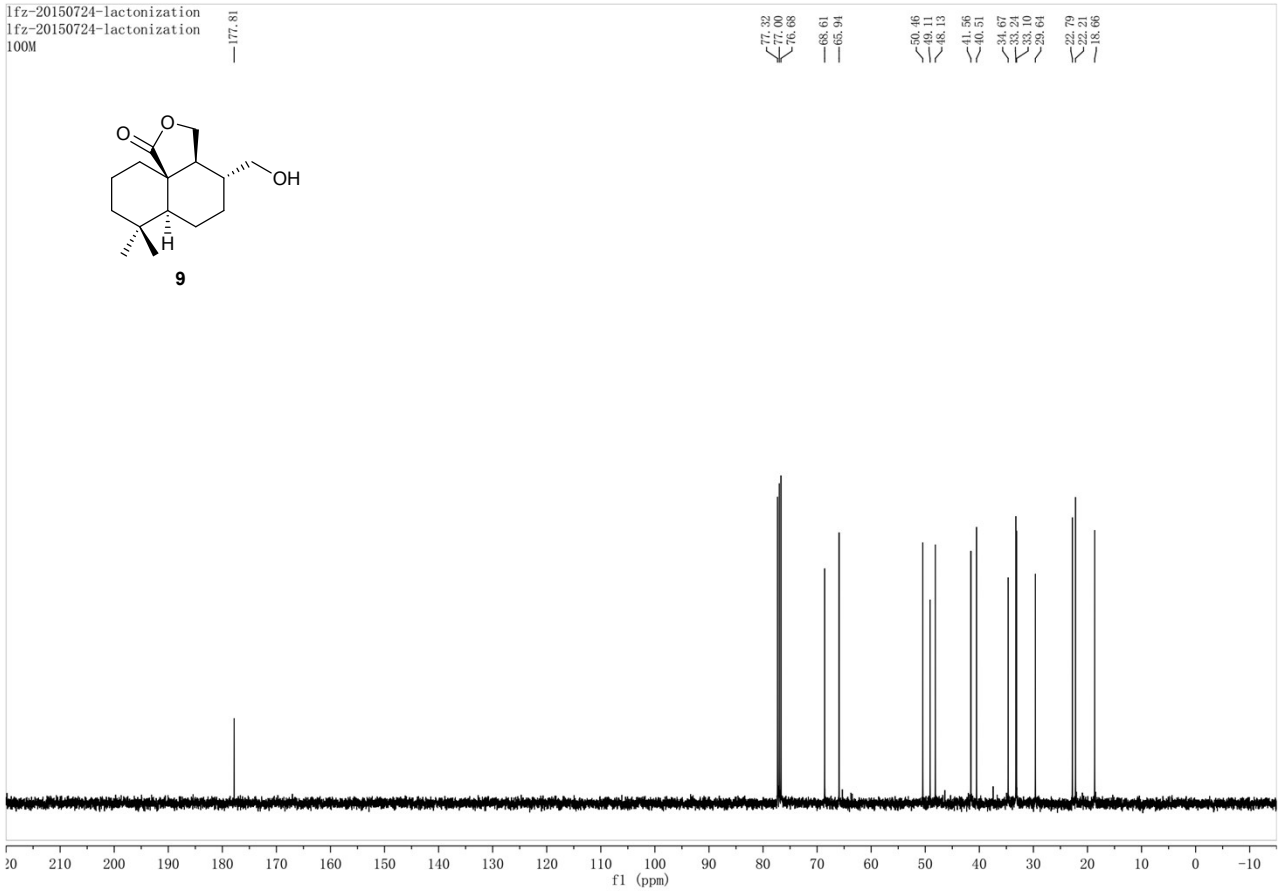
| | | | |
|---|---|---|---|
| **17** | 107.9 | 108.0 | -0.1 |
| **18** | 179.0 | 179.2 | -0.2 |
| **19** | 16.6 | 16.6 | - |
| **20** | 14.6 | 14.6 | - |
| **$OCH_3$** | 51.7 | 51.8 | -0.1 |

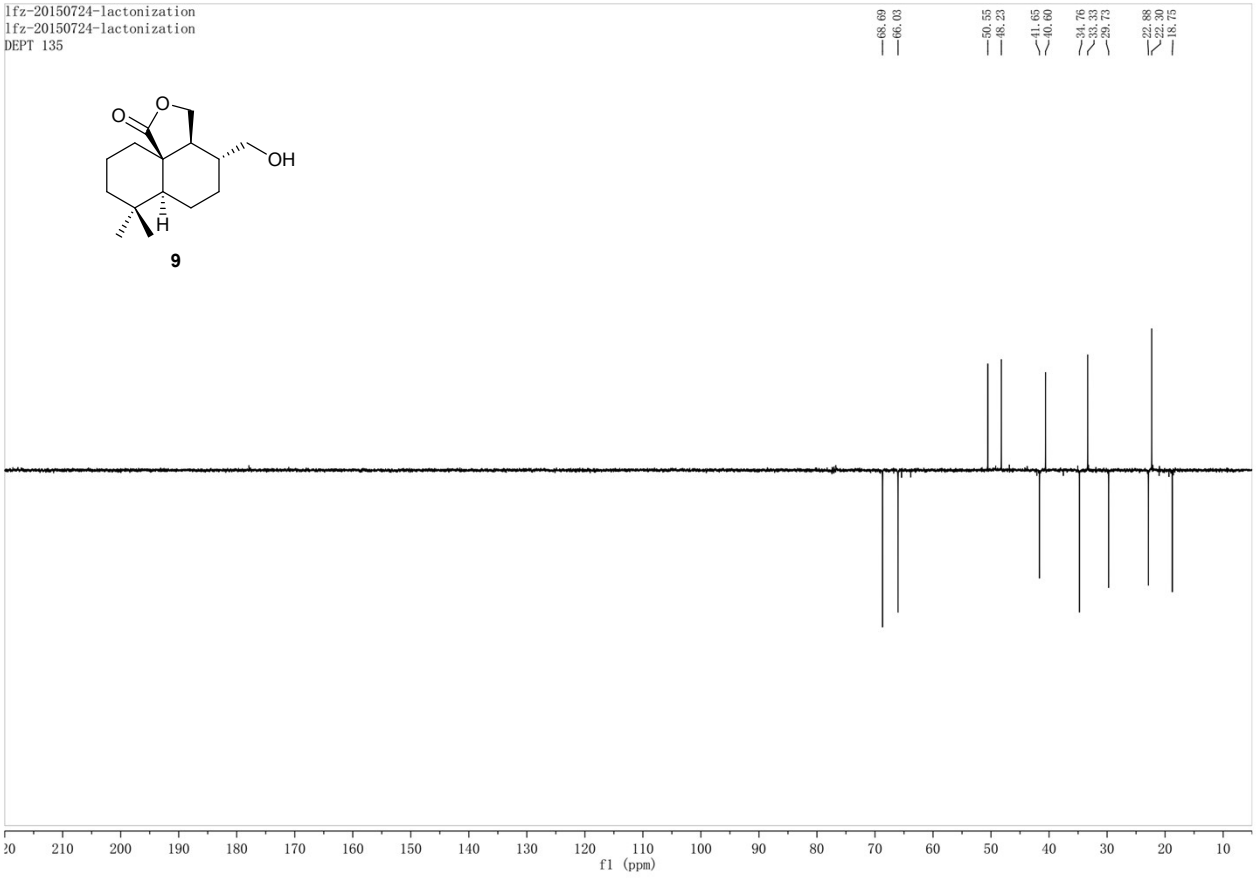
## Ⅴ. NMR Spectra for the Synthesized Compounds

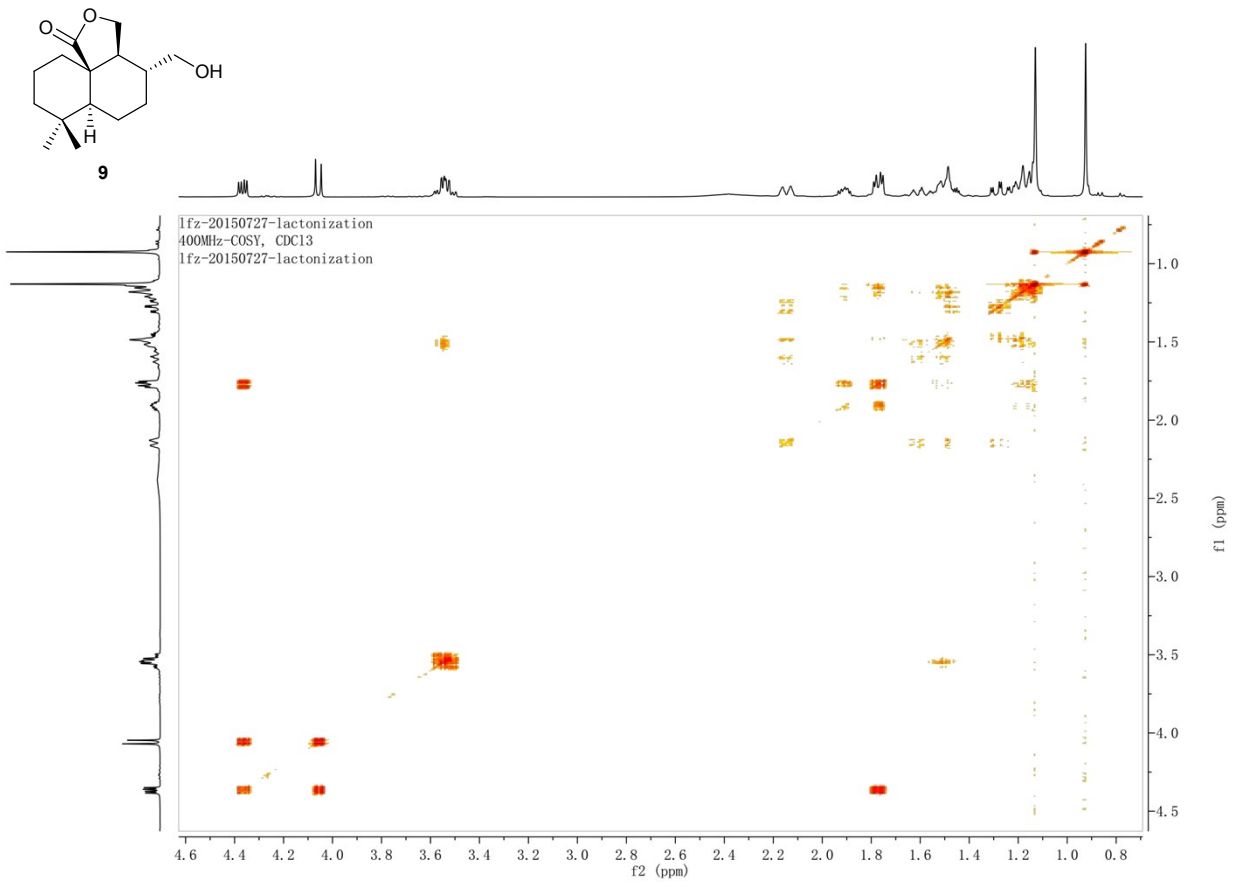


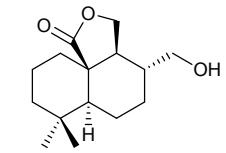

lfz-20150724-ozonolysis
lfz-20150724-ozonolysis
100M
179.81
171.41
164.66
128.40
77.39
77.07
76.75
71.04
53.14
44.08
41.74
33.52
32.22
31.61
24.30
19.64
19.14
17.56
HO2C
O
O
H
7
f1 (ppm)


lfz-20150724-lactonization
lfz-20150724-lactonization
400M
7.27
4.39
4.38
4.37
4.36
4.07
4.05
3.58
3.57
3.56
3.55
3.54
3.51
2.24
2.17
2.17
2.16
2.14
2.14
1.79
1.77
1.76
1.50
1.49
1.49
1.19
1.18
1.17
1.17
1.14
0.93
1.01
1.00
2.11
0.98
1.33
1.04
2.07
0.79
3.54
1.25
2.78
3.99
3.15
OH
O
O
H
9
f1 (ppm)

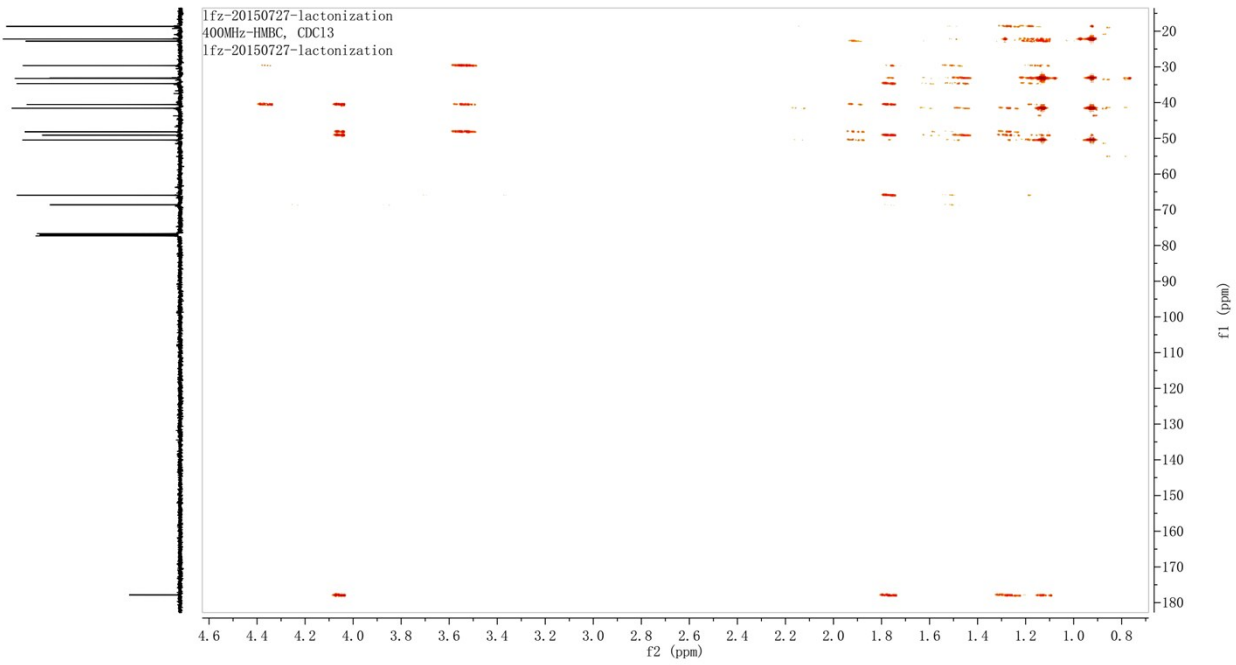

lfz-20150724-lactonization
lfz-20150724-lactonization
100M
177.81
77.32
77.00
76.68
68.61
65.94
50.46
49.11
48.13
41.56
40.51
34.67
33.24
33.10
29.64
22.79
22.21
18.66
O
O
OH
H
9
f1 (ppm)

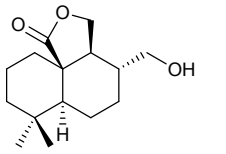

1fz-20150724-lactonization
1fz-20150724-lactonization
DEPT 135
68.69
66.03
50.55
48.23
41.65
40.60
34.76
33.33
29.73
22.88
22.30
18.75
O
O
OH
H
9
f1 (ppm)


O
O
OH
H
9
1fz-20150727-lactonization
400MHz-COSY, CDCl3
1fz-20150727-lactonization
f2 (ppm)
f1 (ppm)


O
O
OH
H

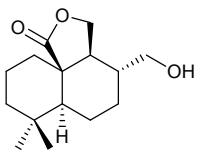
**9**


1fz-20150727-lactonization
400MHz-HMBC, CDCl3
1fz-20150727-lactonization
f2 (ppm)
f1 (ppm)


O
O
OH
H

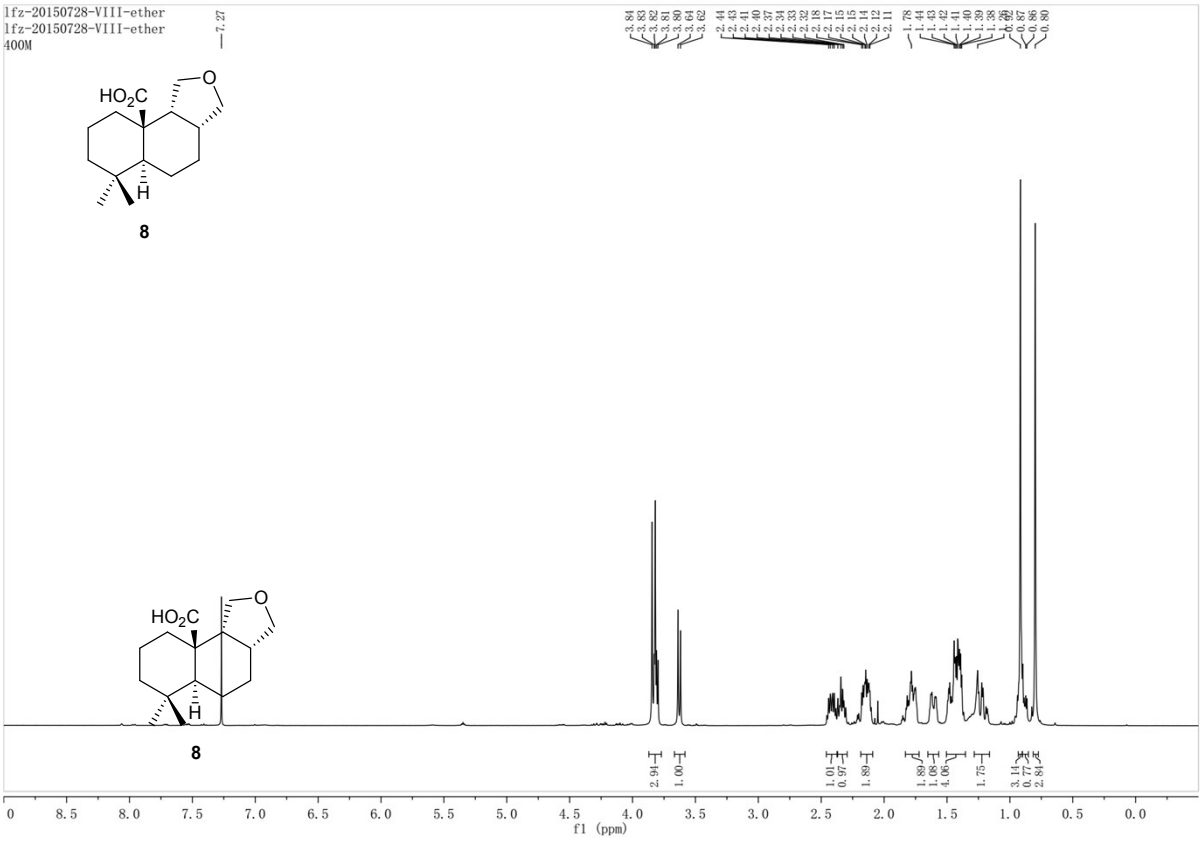
**9**


1fz-20150727-lactonization
400M-HSQC, CDCl3
1fz-20150727-lactonization
f2 (ppm)
f1 (ppm)

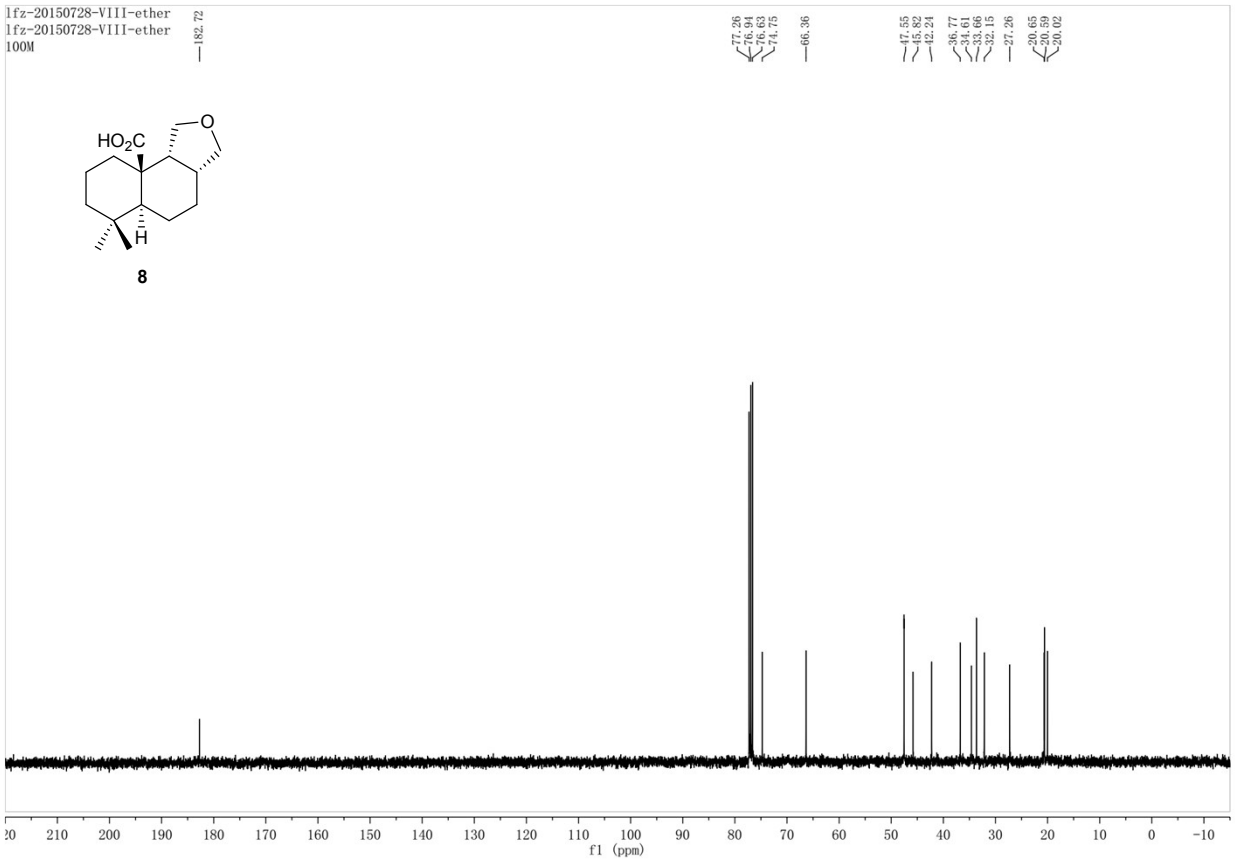

O
O
OH
H

**9**

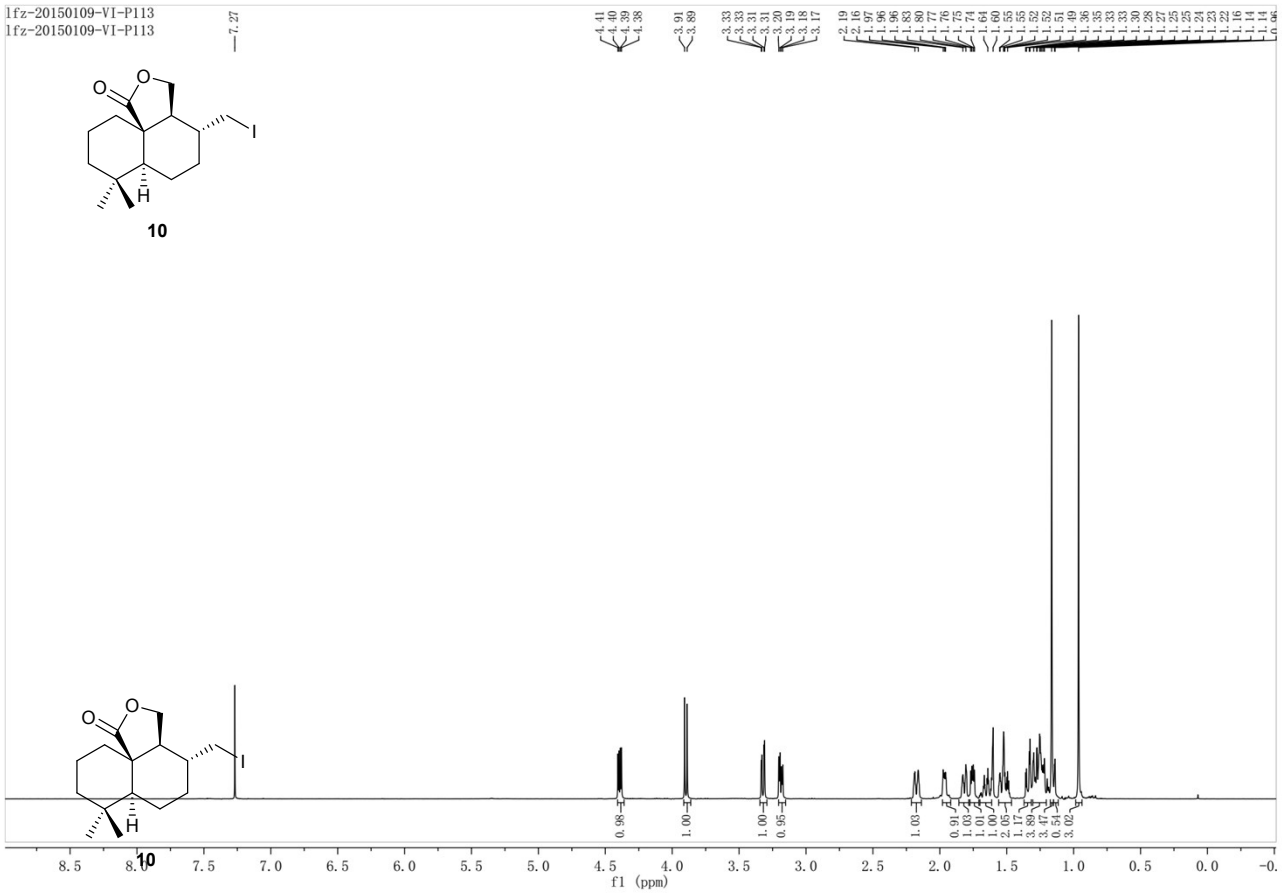

lfz-20150727-lactonization
400M-NOESY, CDCl3
lfz-20150727-lactonization
f2 (ppm)
f1 (ppm)


lfz-20150728-VIII-ether
lfz-20150728-VIII-ether
400M
HO2C
O
H
f1 (ppm)

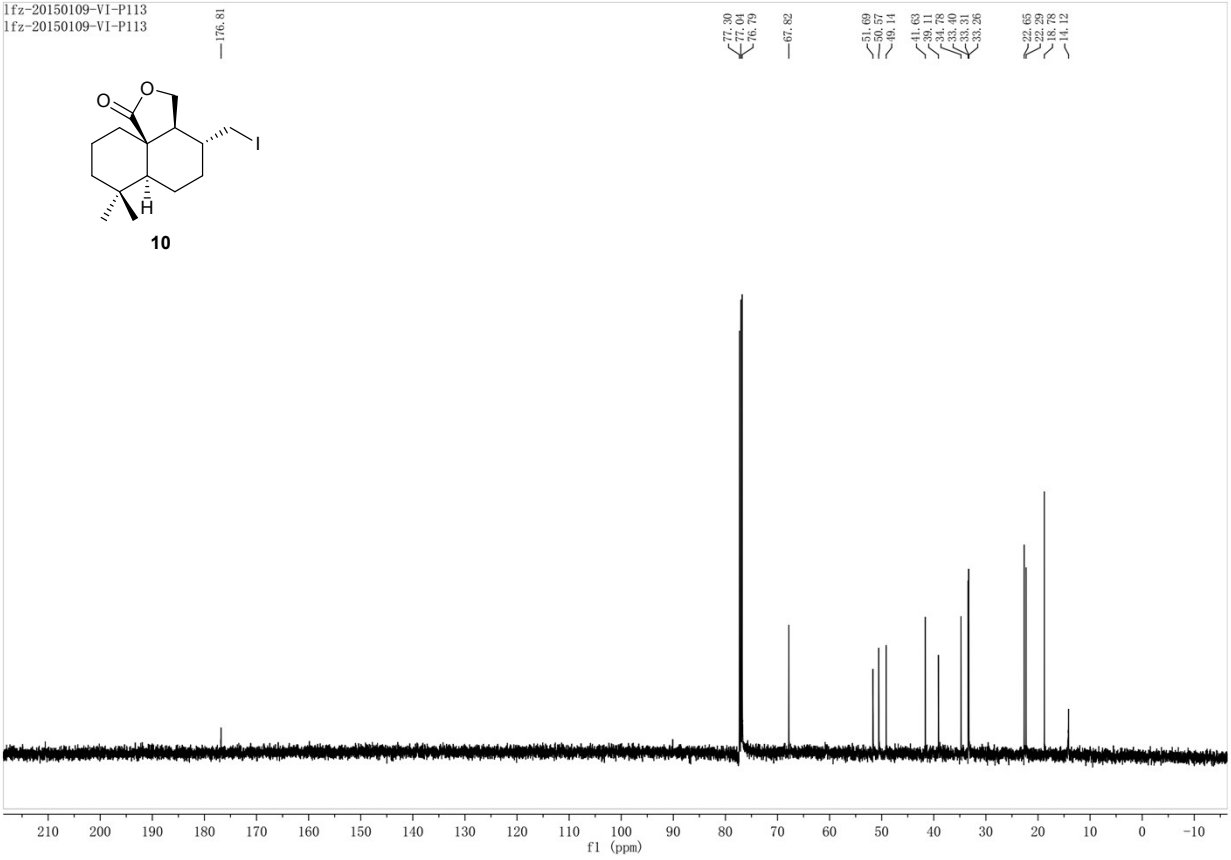
**8**

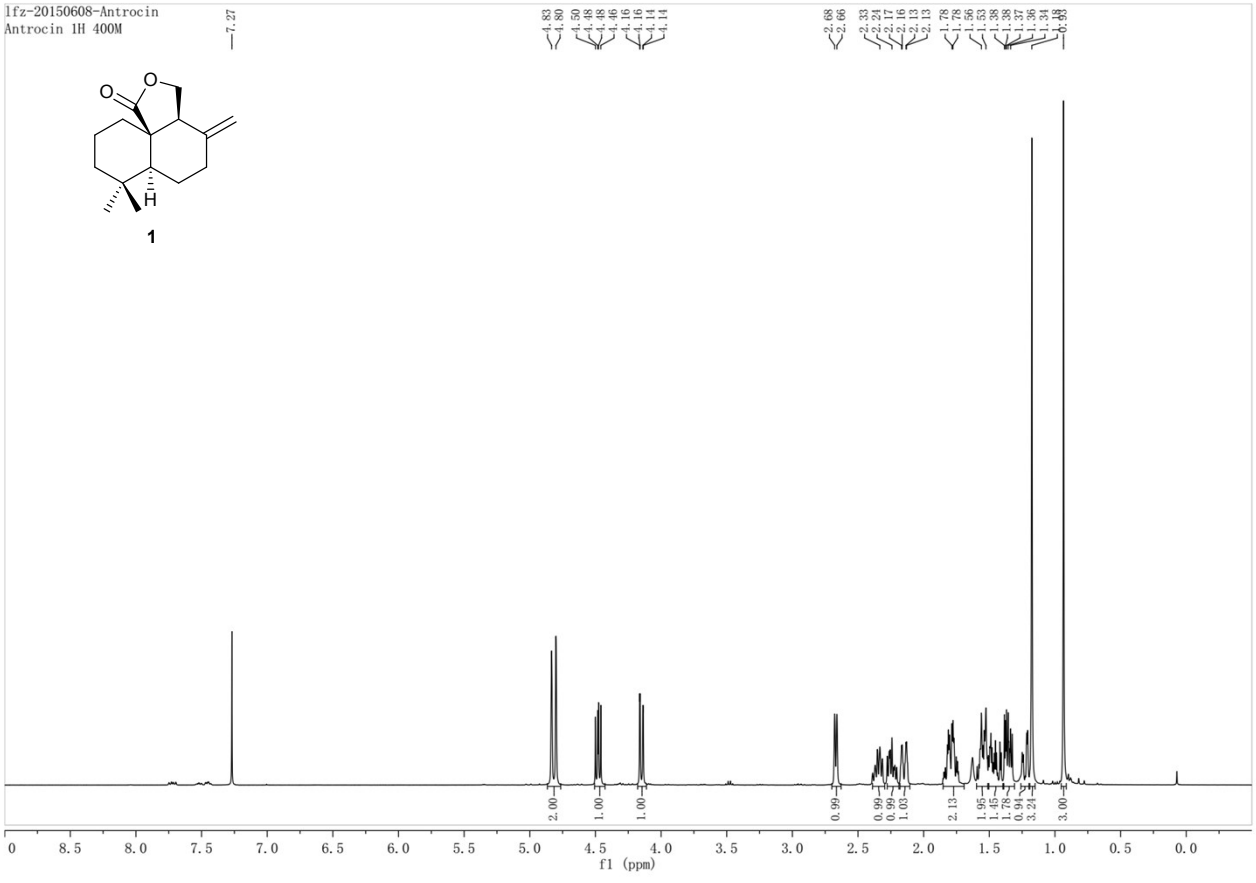

lfz-20150728-VIII-ether
lfz-20150728-VIII-ether
100M
182.72
77.26
76.94
76.63
74.75
66.36
47.55
45.82
42.24
36.77
34.61
33.66
32.15
27.26
20.65
20.59
20.02
HO2C
O
H
f1 (ppm)

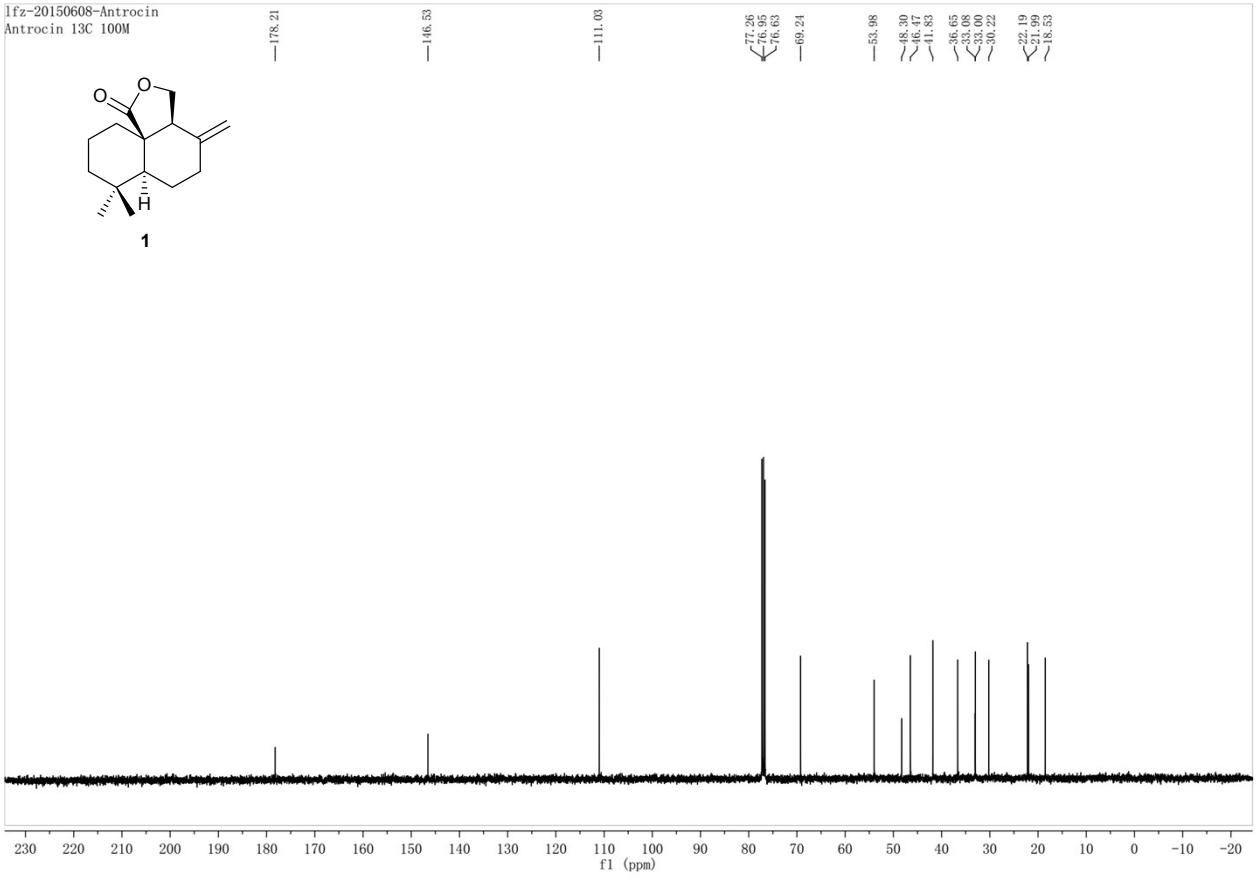
**8**

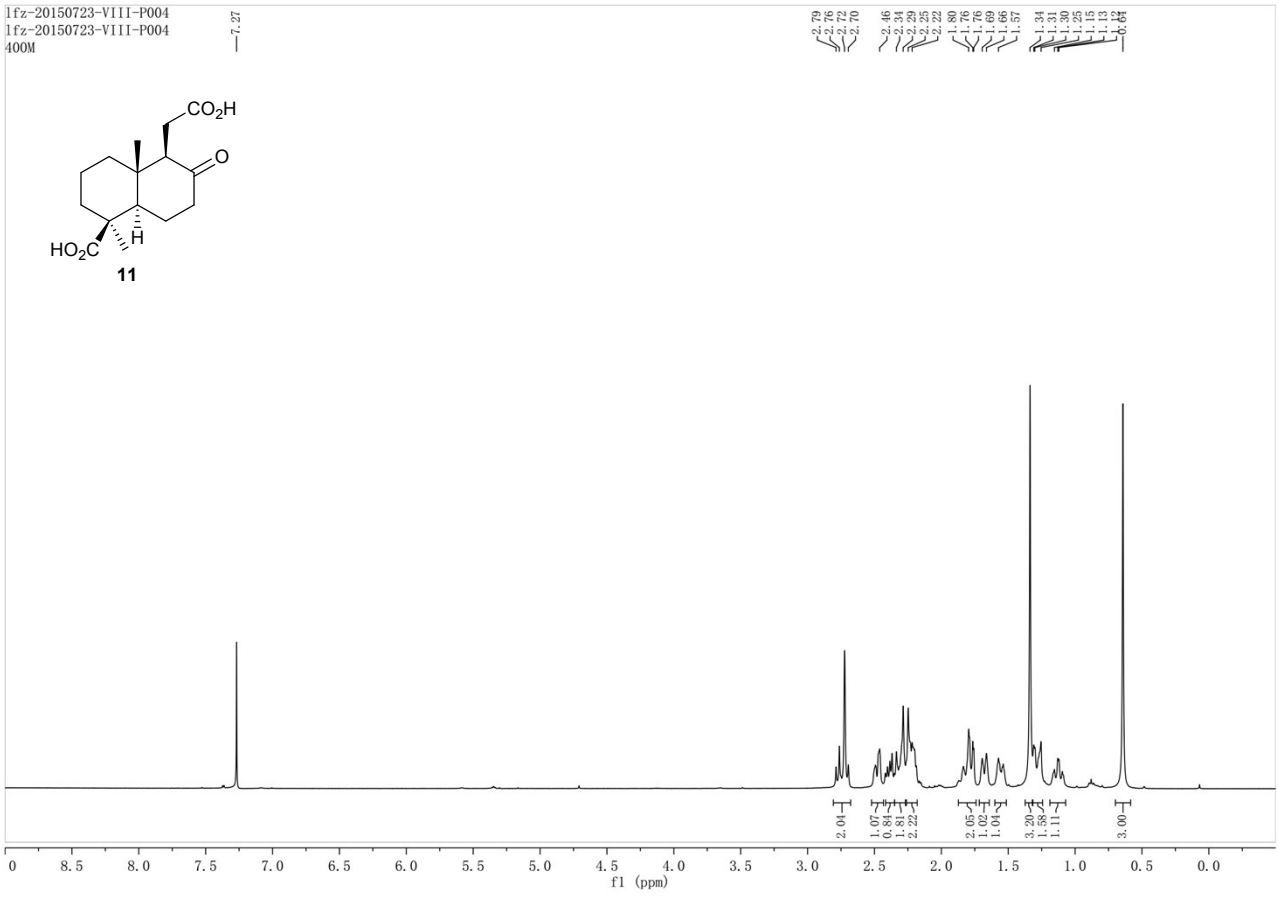

lfz-20150109-VI-P113
lfz-20150109-VI-P113
7.27
4.41
4.40
4.39
4.38
3.91
3.89
3.33
3.33
3.31
3.31
3.20
3.19
3.18
3.17
2.19
2.16
1.97
1.96
1.96
1.83
1.80
1.77
1.76
1.75
1.74
1.64
1.60
1.55
1.55
1.52
1.52
1.51
1.49
1.36
1.35
1.33
1.33
1.30
1.28
1.27
1.25
1.25
1.24
1.23
1.22
1.16
1.14
1.14
0.98
1.00
1.00
0.95
1.03
0.91
1.03
1.01
1.00
2.05
1.17
3.89
3.47
3.54
3.02
O
I
H
f1 (ppm)

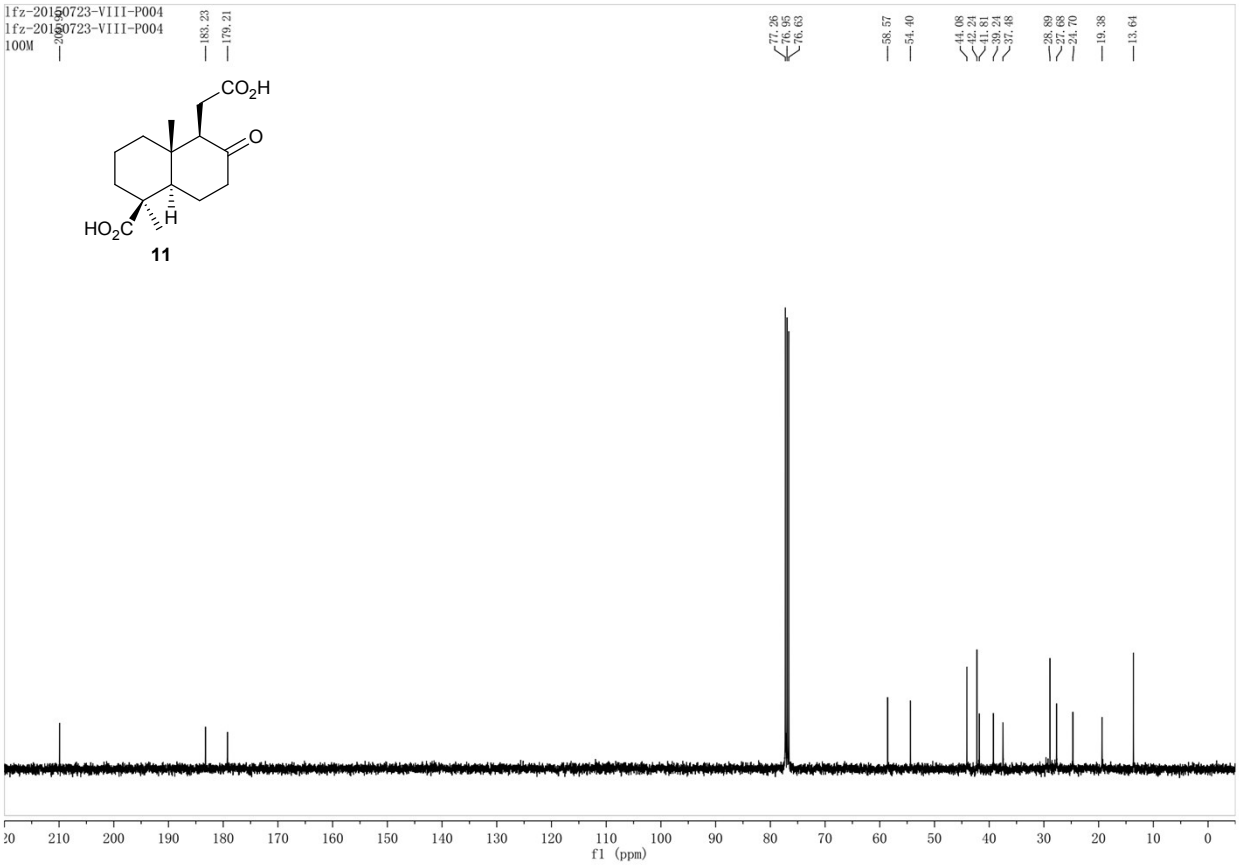
**10**

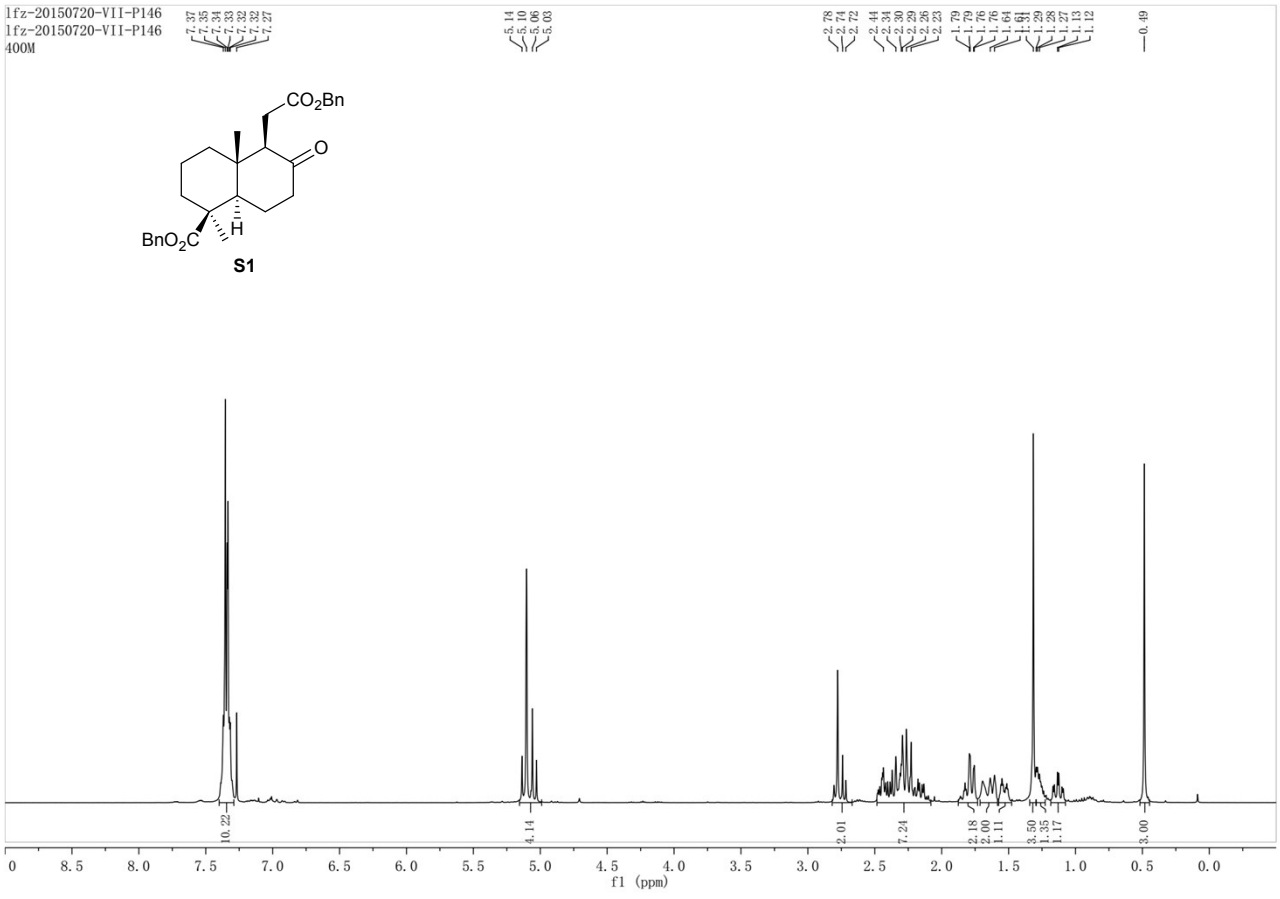

lfz-20150109-VI-P113
lfz-20150109-VI-P113
176.81
77.30
77.04
76.79
67.82
51.69
50.57
49.14
41.63
39.11
34.78
33.40
33.31
33.26
22.65
22.29
18.78
14.12
O
O
I
H
10
f1 (ppm)

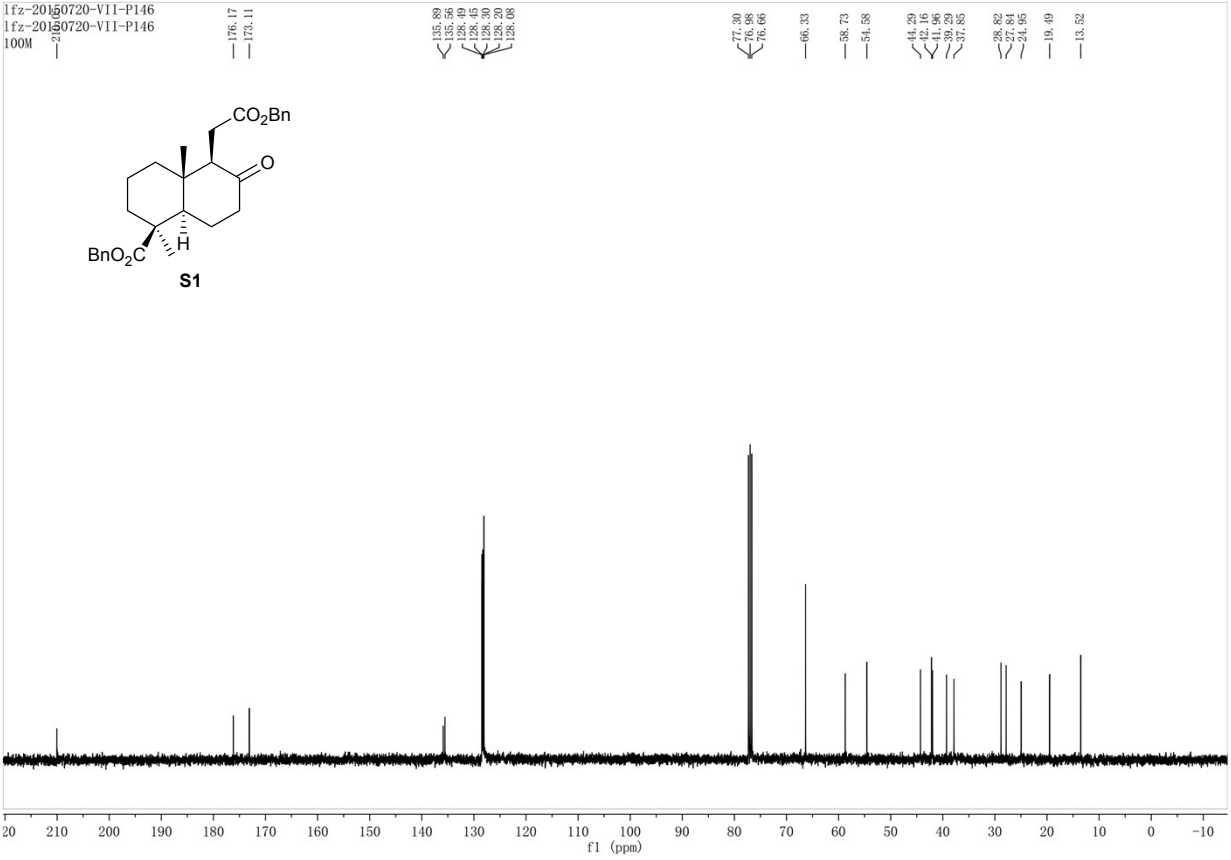

lfz-20150608-Antrocin
Antrocin 1H 400M
7.27
4.83
4.80
4.50
4.48
4.48
4.46
4.16
4.16
4.14
4.14
2.68
2.66
2.33
2.24
2.17
2.16
2.13
2.13
1.78
1.78
1.56
1.53
1.38
1.38
1.37
1.36
1.34
1.33
0.93
2.00
1.00
1.00
0.99
0.99
0.99
1.03
2.13
1.95
1.45
1.78
0.94
3.24
3.00
O
O
H
1
f1 (ppm)

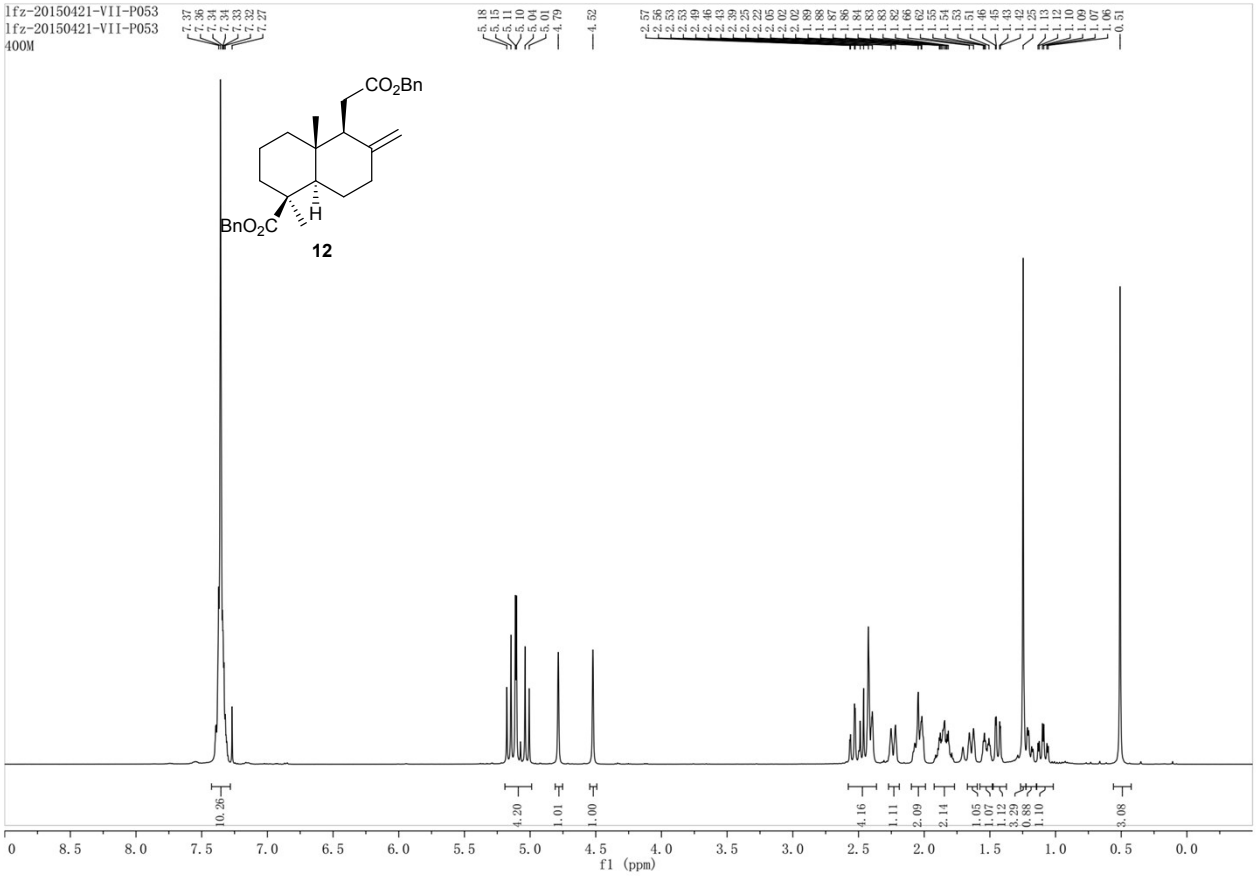

lfz-20150608-Antrocin
Antrocin 13C 100M
178.21
146.53
111.03
77.26
76.95
76.63
69.24
53.98
48.30
46.47
41.83
36.65
33.08
33.00
30.22
22.19
21.99
18.53
O
O
H
1
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

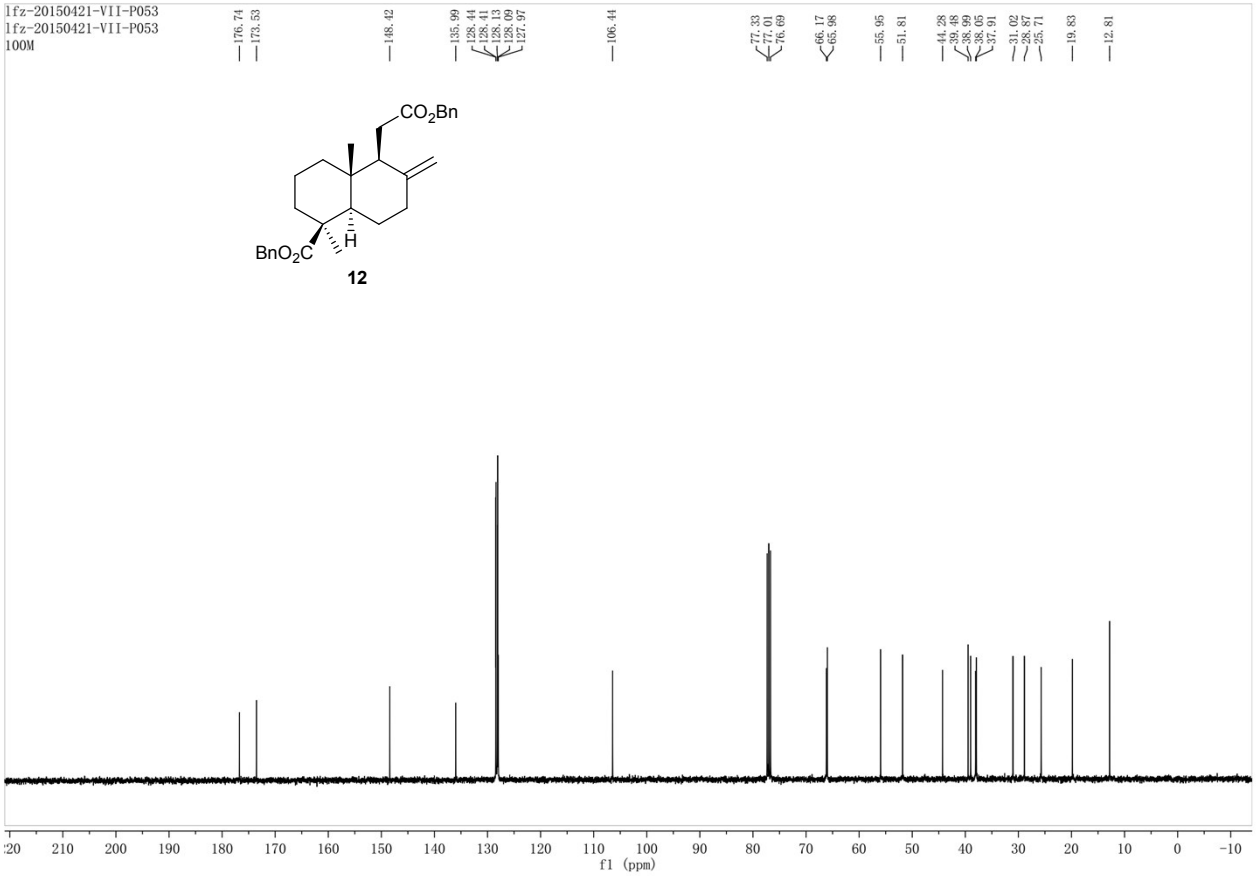

lfz-20150723-VIII-P004
lfz-20150723-VIII-P004
400M
7.27
2.79
2.76
2.72
2.70
2.46
2.34
2.29
2.25
2.22
1.80
1.76
1.76
1.69
1.66
1.57
1.34
1.31
1.30
1.25
1.15
1.13
0.84
CO2H
O
HO2C
H
11
2.04
1.07
0.84
1.81
2.22
2.05
1.02
1.04
3.29
1.58
1.11
3.00
0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

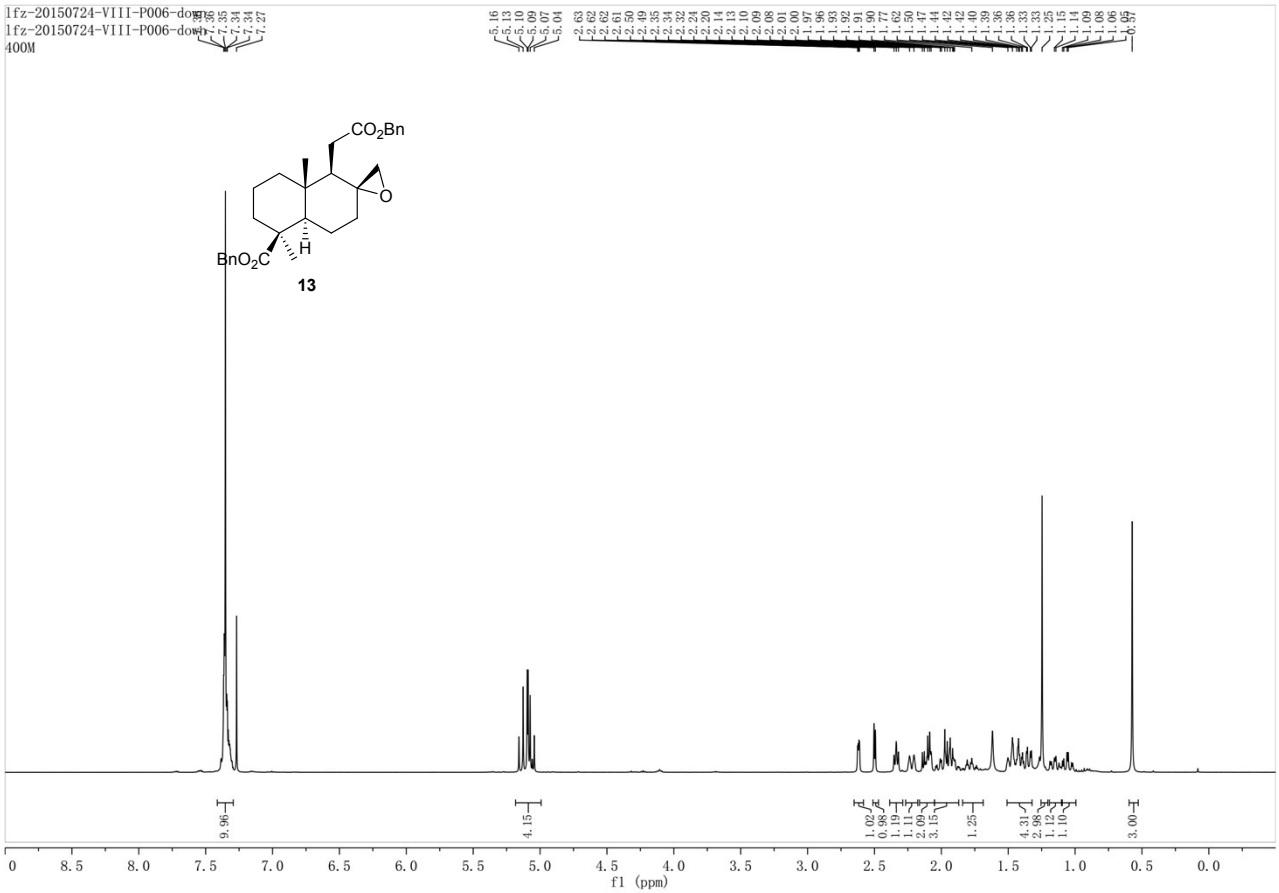

lfz-20150723-VIII-P004
lfz-20150723-VIII-P004
100M
183.23
179.21
77.26
76.95
76.63
58.57
54.40
44.08
42.23
41.81
39.24
37.48
28.89
27.68
24.70
19.38
13.64
CO2H
O
HO2C
H
11
f1 (ppm)

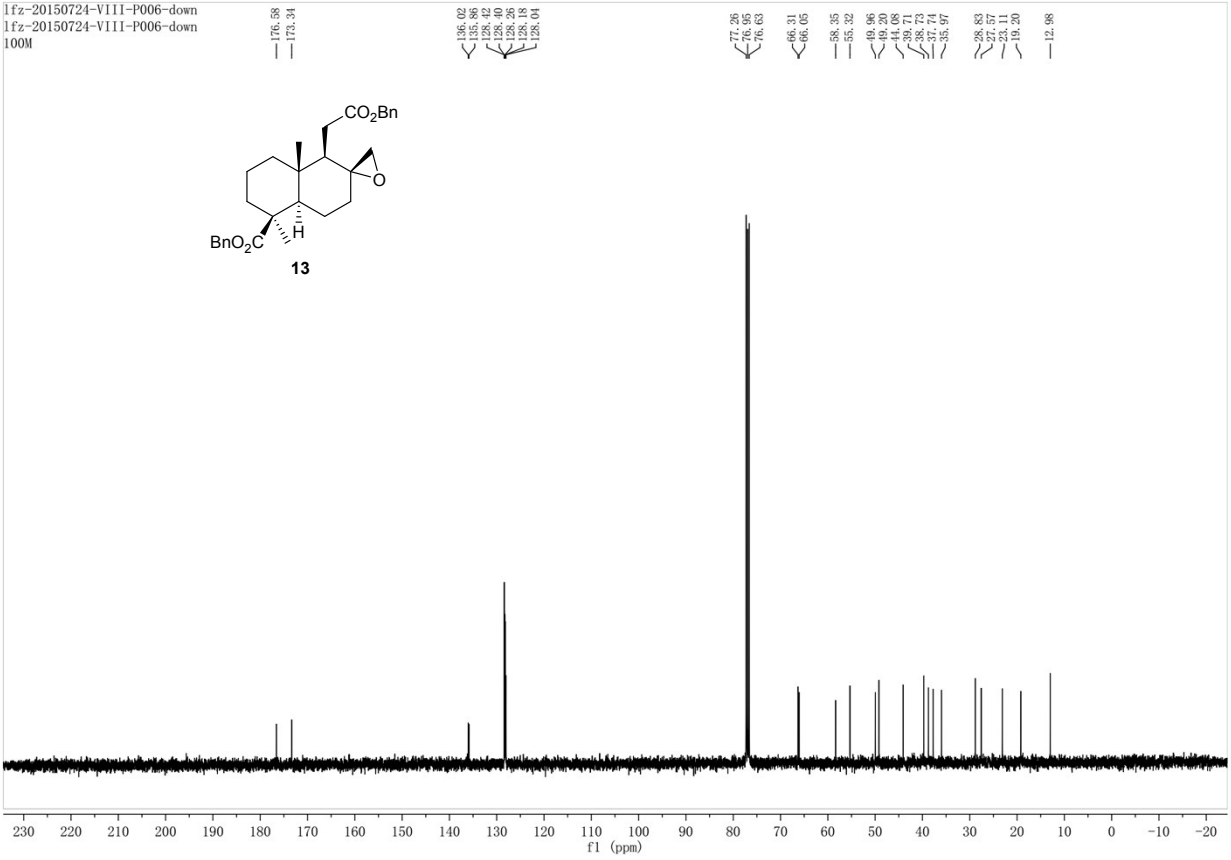

lfz-20150720-VII-P146
lfz-20150720-VII-P146
400M
7.37
7.35
7.34
7.33
7.32
7.32
7.27
5.14
5.10
5.06
5.03
2.78
2.74
2.72
2.44
2.34
2.30
2.29
2.26
2.23
1.79
1.79
1.76
1.76
1.64
1.61
1.29
1.28
1.27
1.13
1.12
0.49
CO2Bn
O
BnO2C
H
S1
10.22
4.14
2.01
7.24
2.18
2.00
1.11
3.59
1.35
1.17
3.00
f1 (ppm)

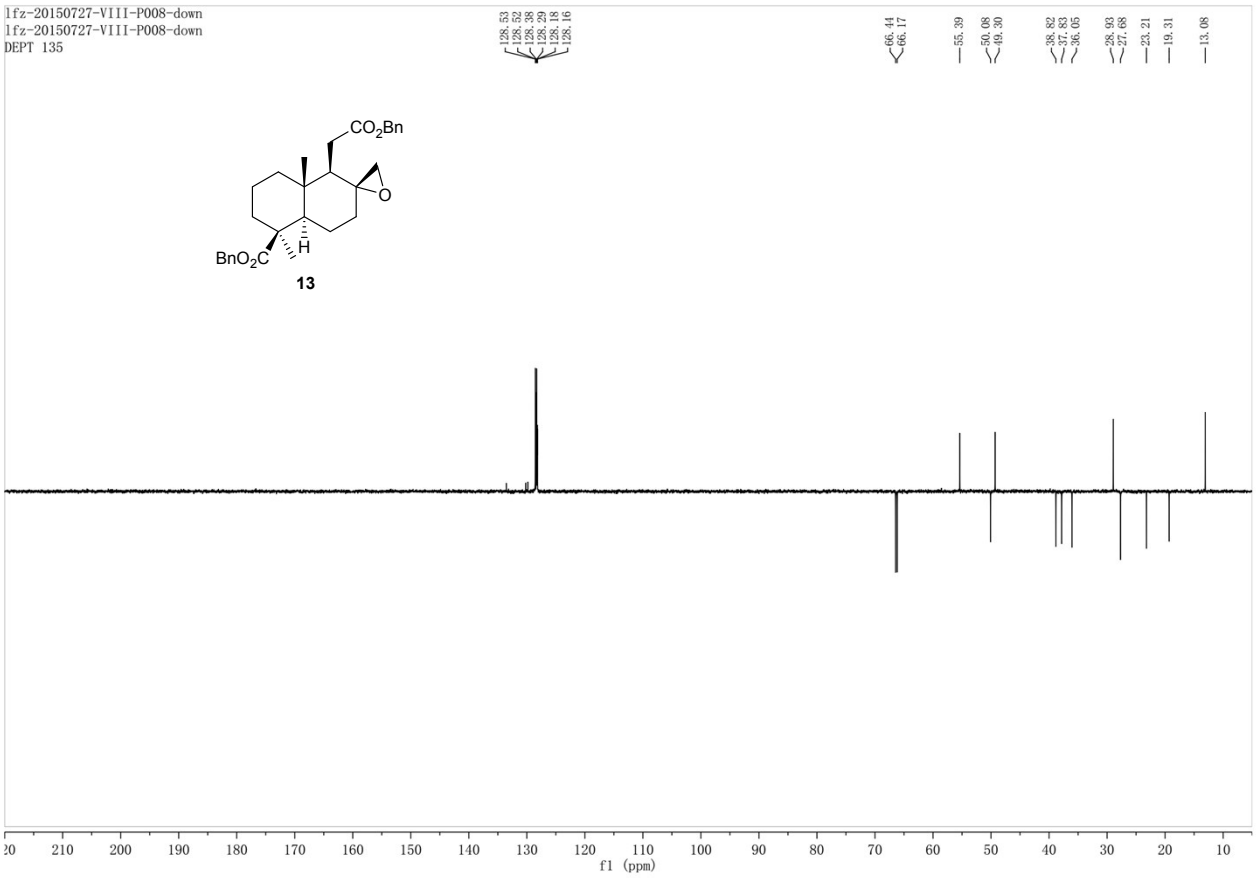

lfz-20150720-VII-P146
lfz-20150720-VII-P146
100M
176.17
173.11
135.89
135.56
128.49
128.45
128.30
128.20
128.08
77.30
76.98
76.66
66.33
58.73
54.58
44.29
42.16
41.96
39.29
37.85
28.82
27.84
24.95
19.49
13.52
CO2Bn
O
BnO2C
H
S1
f1 (ppm)

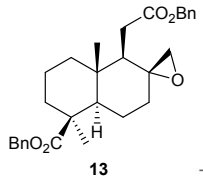

lfz-20150421-VII-P053
lfz-20150421-VII-P053
400M
7.37
7.36
7.34
7.34
7.33
7.32
7.27
5.18
5.15
5.11
5.10
5.04
5.01
4.79
4.52
2.57
2.56
2.53
2.53
2.49
2.46
2.43
2.39
2.35
2.22
2.05
2.02
2.02
1.89
1.88
1.87
1.86
1.84
1.83
1.82
1.66
1.62
1.55
1.54
1.53
1.51
1.46
1.45
1.43
1.42
1.25
1.13
1.12
1.10
1.09
1.07
1.06
0.51
CO2Bn
BnO2C
H
12
10.26
4.20
1.01
1.00
4.16
1.11
2.09
2.14
1.05
1.07
1.12
3.29
0.88
1.10
3.08
f1 (ppm)


lfz-20150421-VII-P053
lfz-20150421-VII-P053
100M
176.74
173.53
148.42
135.99
128.44
128.41
128.13
128.09
127.97
106.44
77.33
77.01
76.69
66.17
65.98
55.95
51.81
44.28
39.48
38.99
38.05
37.91
31.02
28.87
25.71
19.83
12.81
CO2Bn
BnO2C
H
12
f1 (ppm)


lfz-20150724-VIII-P006-down
lfz-20150724-VIII-P006-down
400M
CO2Bn
O
BnO2C
H
13
9.96
4.15
1.02
0.98
1.19
1.11
2.09
3.15
1.25
4.31
2.98
1.12
1.10
3.00
f1 (ppm)

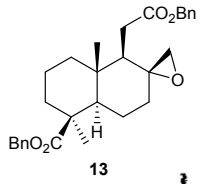

lfz-20150724-VIII-P006-down
lfz-20150724-VIII-P006-down
100M
176.58
173.34
136.02
135.86
128.42
128.40
128.26
128.18
128.04
77.26
76.95
76.63
66.31
66.05
58.35
55.32
49.96
49.20
44.08
39.71
38.73
37.74
35.97
28.83
27.57
23.11
19.20
12.98
CO2Bn
O
BnO2C
H
13
f1 (ppm)


lfz-20150727-VIII-P008-down
lfz-20150727-VIII-P008-down
DEPT 135
128.53
128.52
128.38
128.29
128.18
128.16
66.44
66.17
55.39
50.08
49.30
38.82
37.83
36.05
28.93
27.68
23.21
19.31
13.08
CO2Bn
O
BnO2C
H
13
f1 (ppm)


CO2Bn
O
H
BnO2C

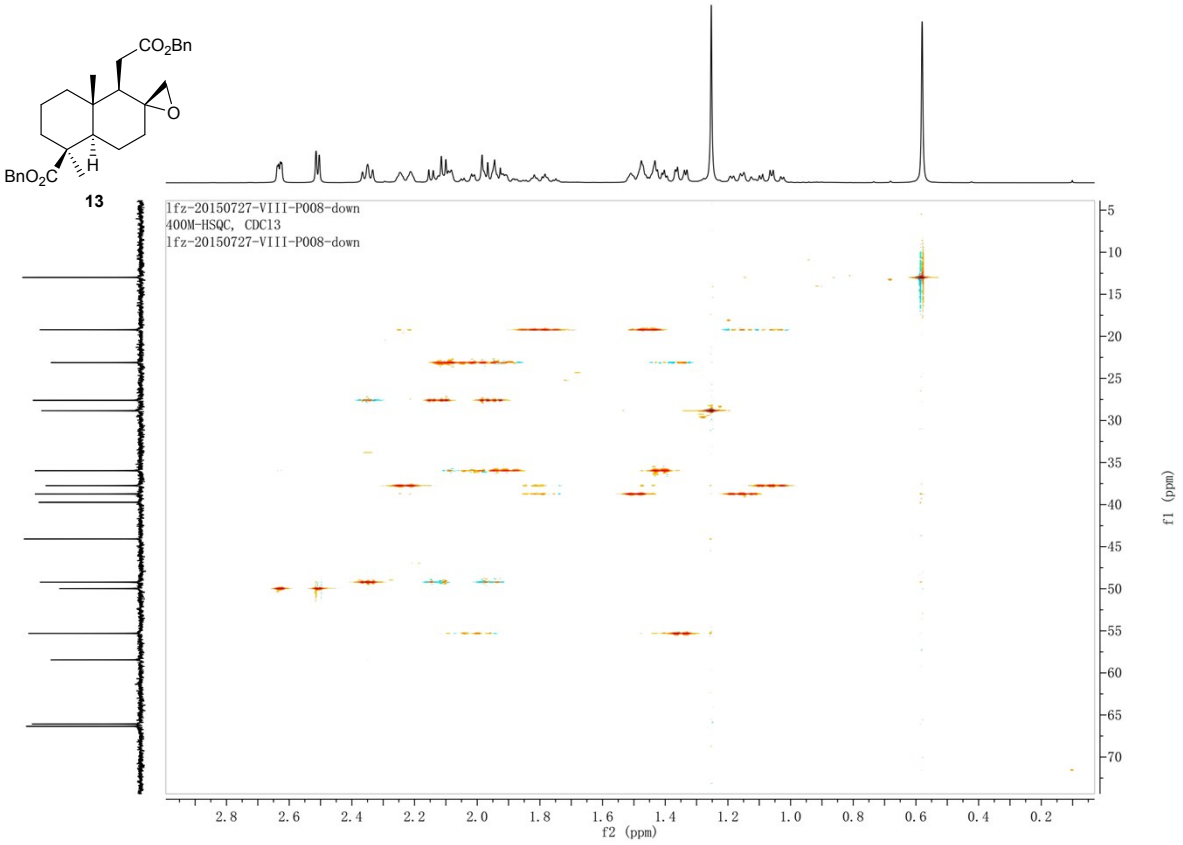
13

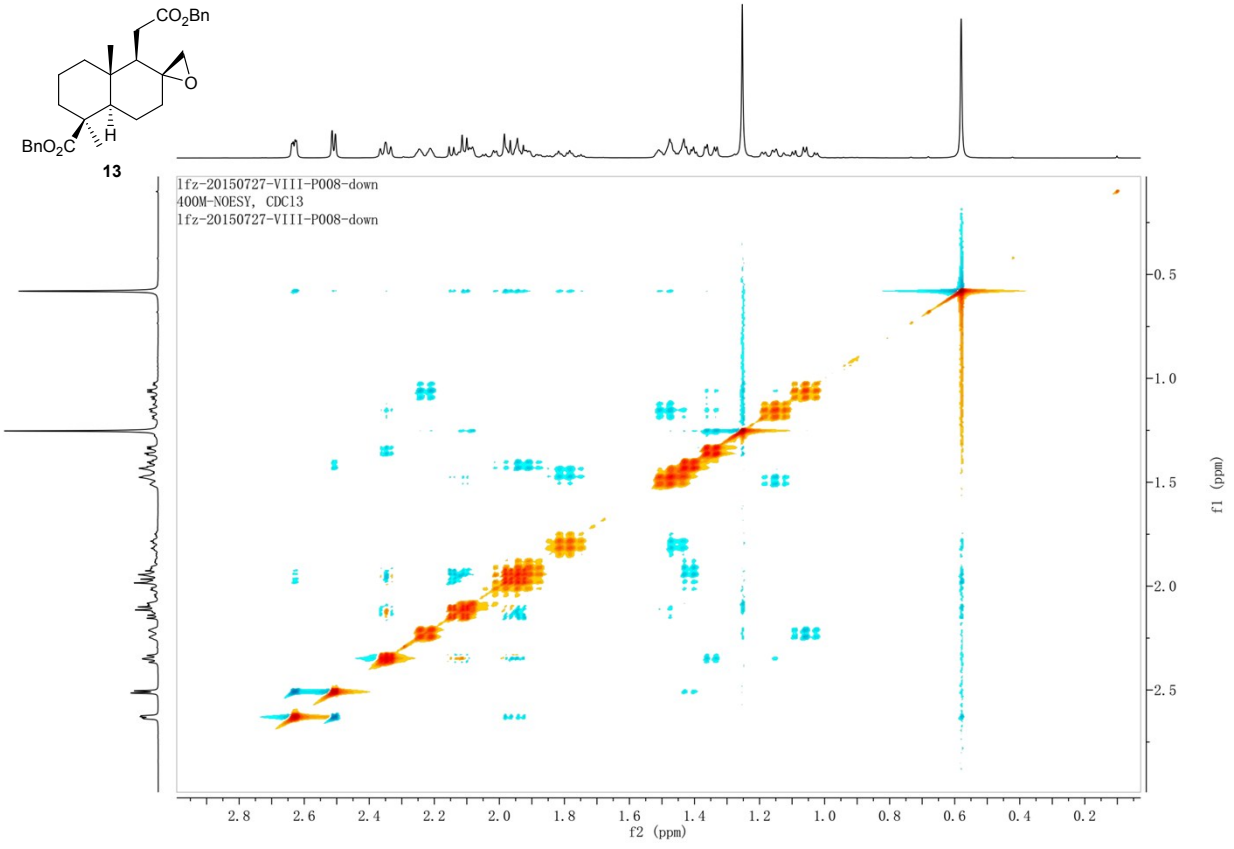

1fz-20150727-VIII-P008-down
400MHz-COSY, CDCl3
1fz-20150727-VIII-P008-down
f2 (ppm)
f1 (ppm)

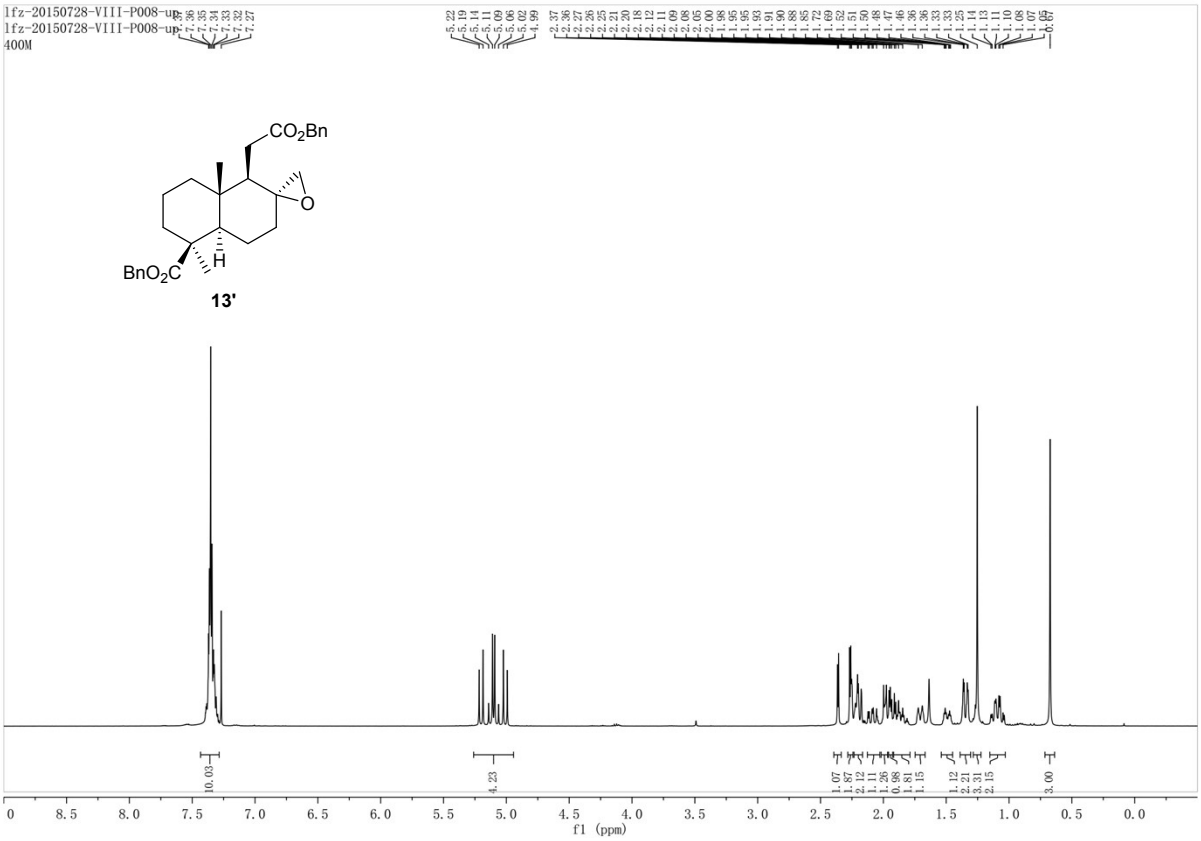

CO2Bn
O
H
BnO2C

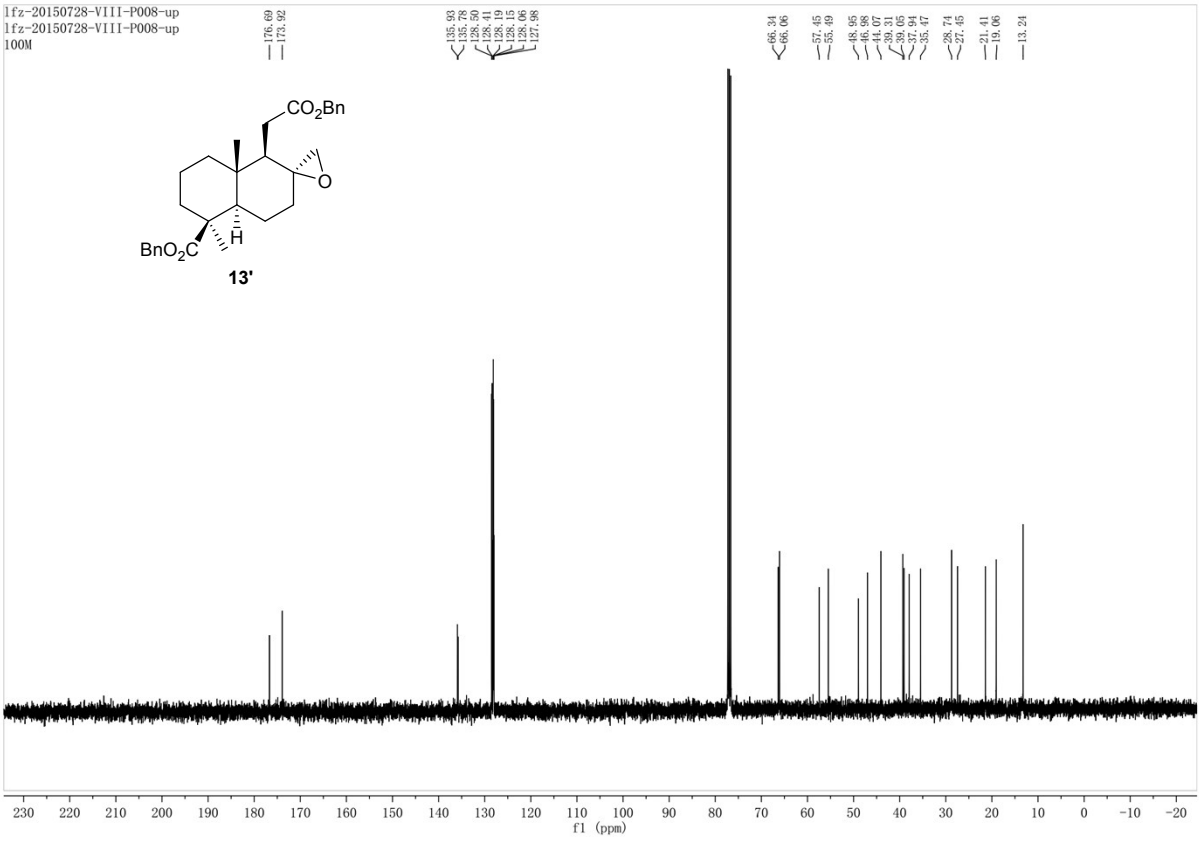
13

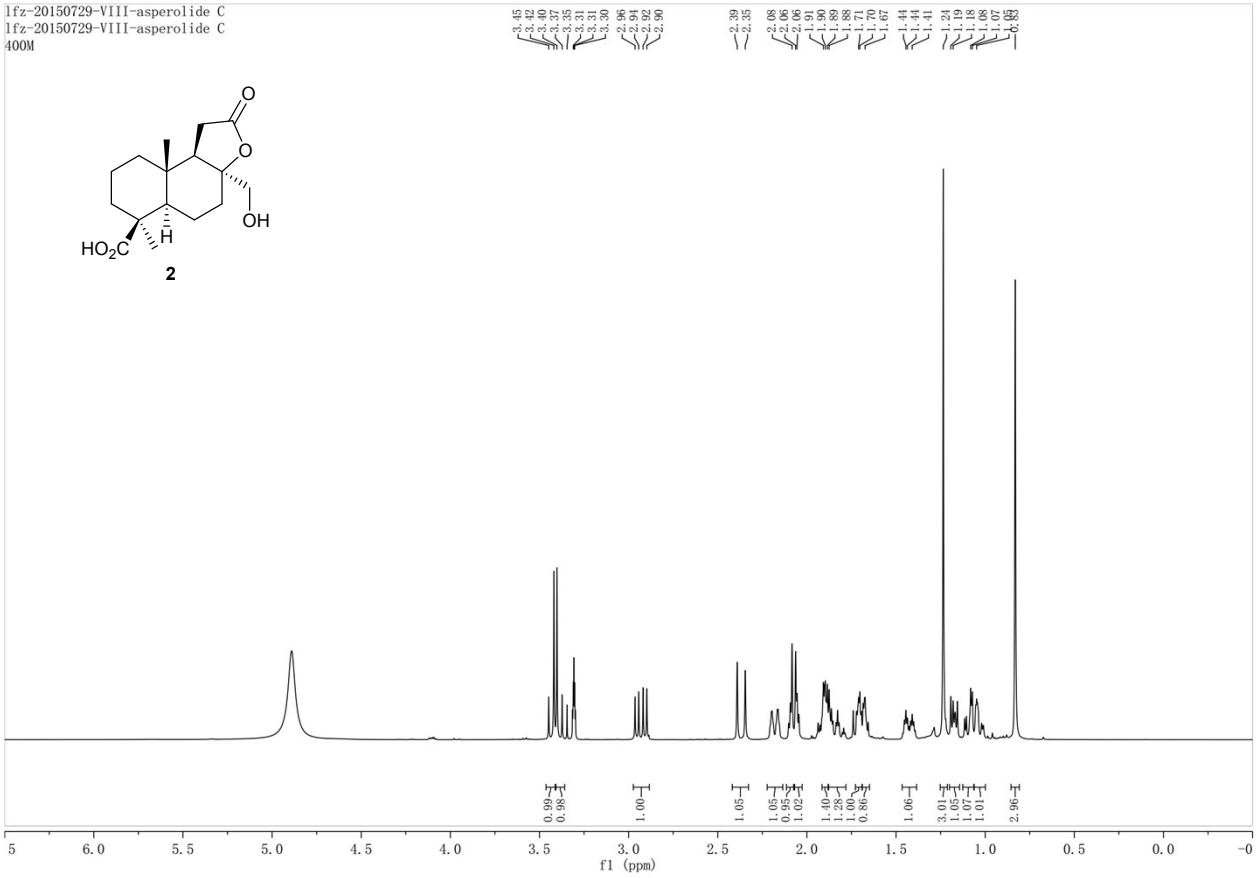

1fz-20150727-VIII-P008-down
400MHz-HMBC, CDCl3
1fz-20150727-VIII-P008-down
f2 (ppm)
f1 (ppm)

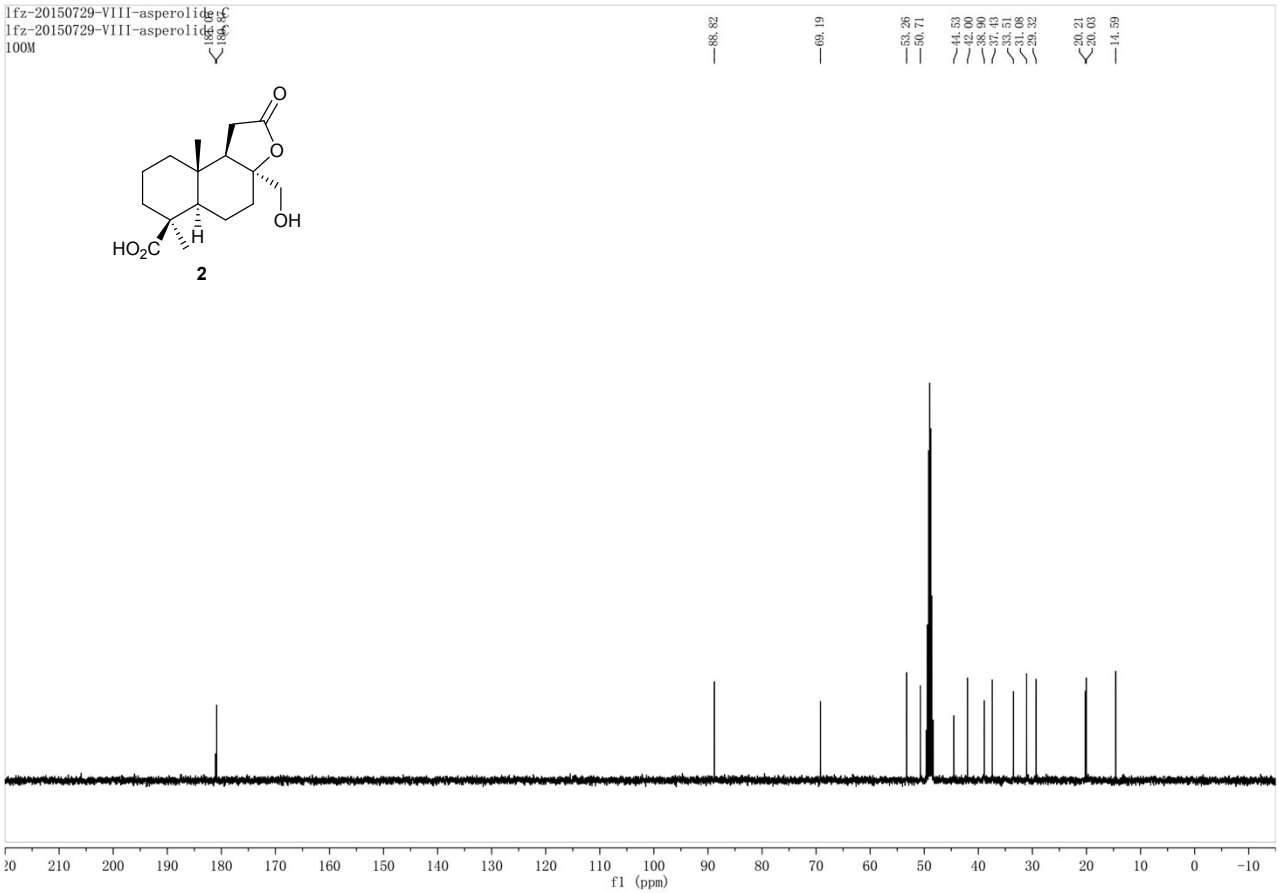

CO2Bn
O
H
BnO2C
13
1fz-20150727-VIII-P008-down
400M-HSQC, CDCl3
1fz-20150727-VIII-P008-down
f2 (ppm)
f1 (ppm)

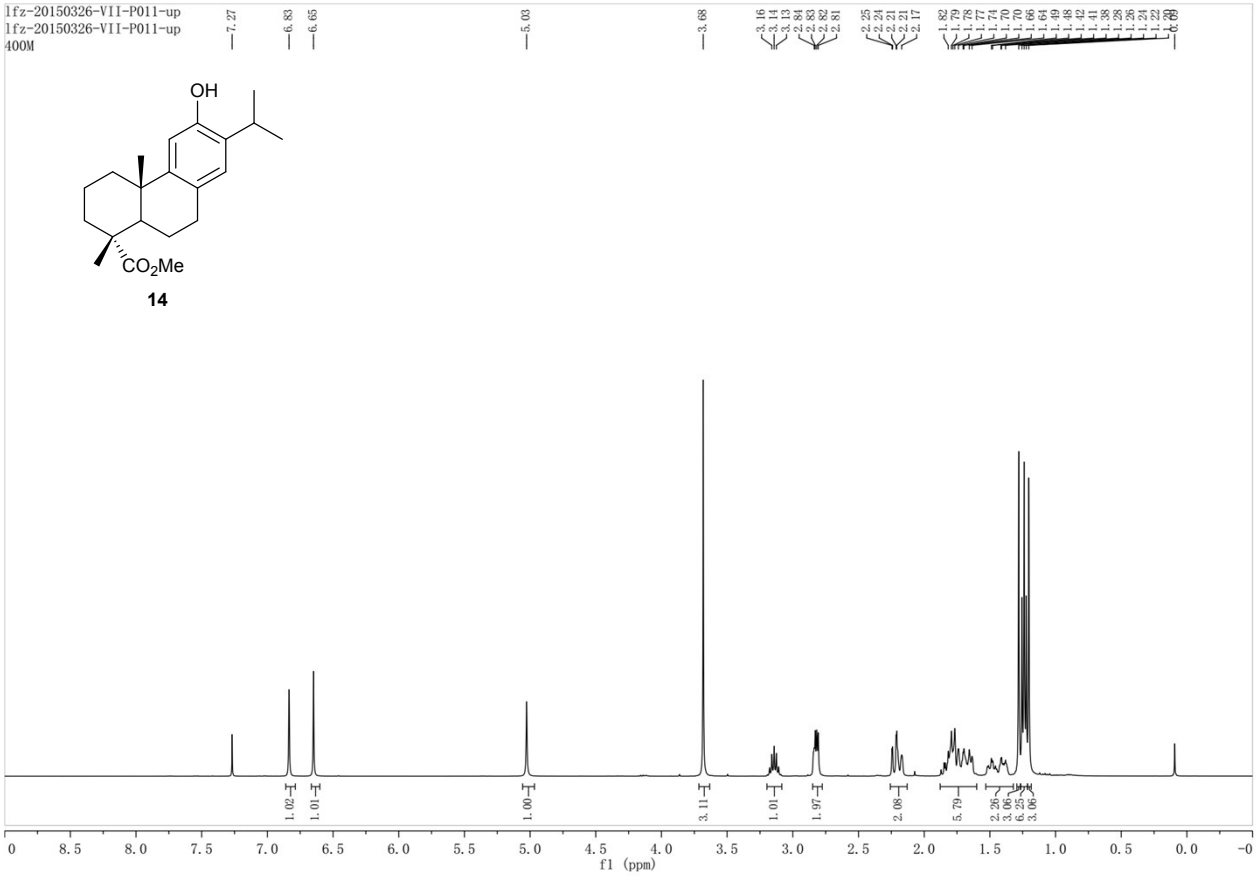

CO2Bn
O
H
BnO2C
13
1fz-20150727-VIII-P008-down
400M-NOESY, CDCl3
1fz-20150727-VIII-P008-down
f2 (ppm)
f1 (ppm)

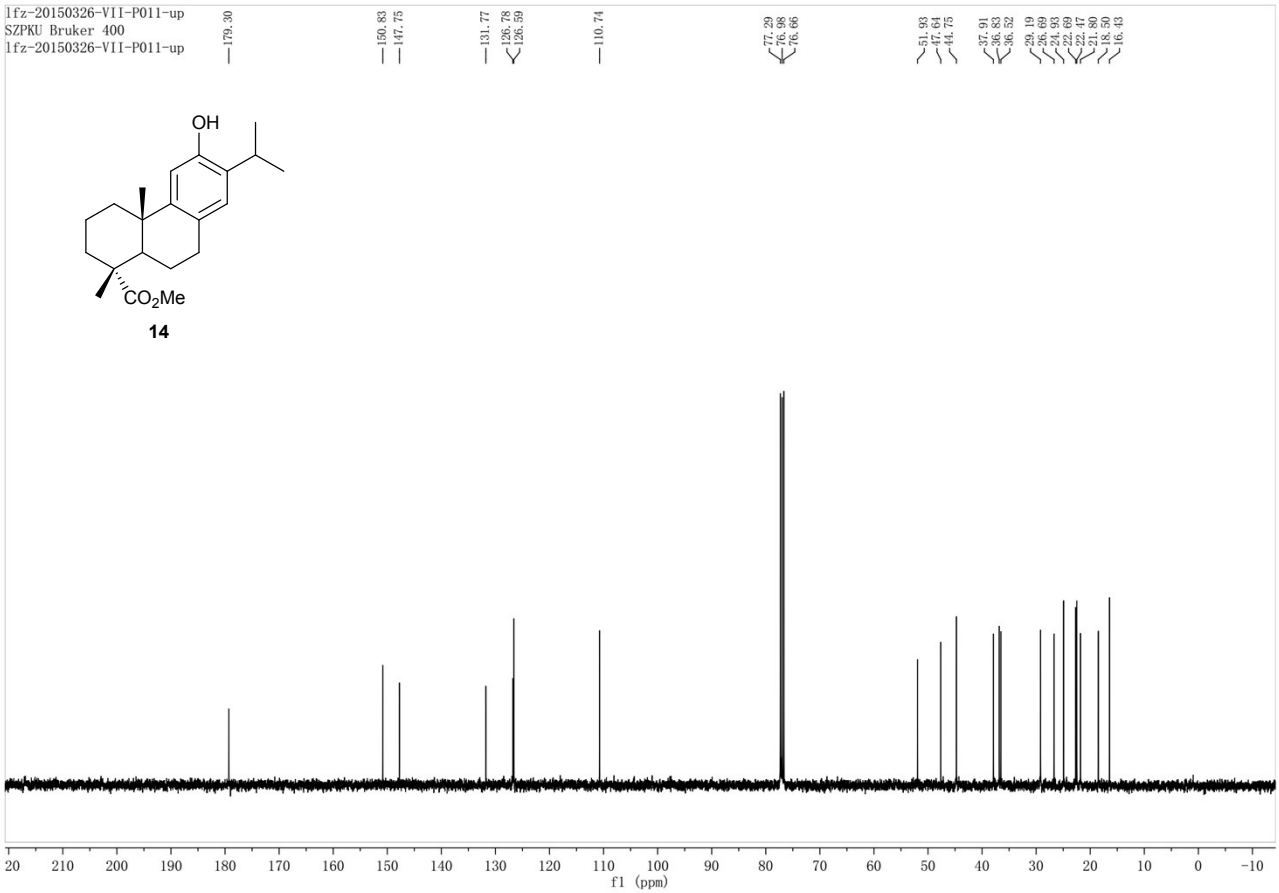

lfz-20150728-VIII-P008-up
lfz-20150728-VIII-P008-up
400M
CO2Bn
O
H
BnO2C
13'
f1 (ppm)

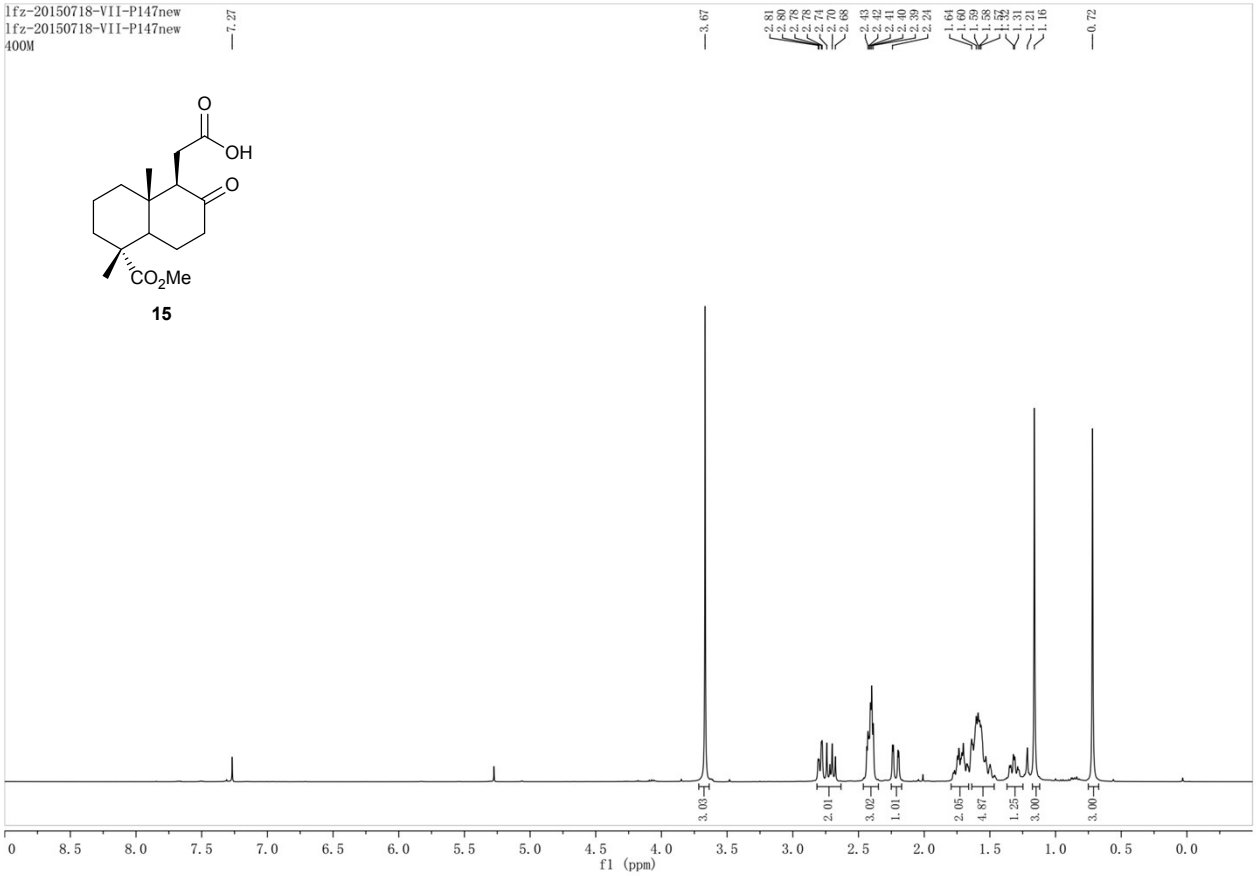

lfz-20150728-VIII-P008-up
lfz-20150728-VIII-P008-up
100M
CO2Bn
O
H
BnO2C
13'
f1 (ppm)

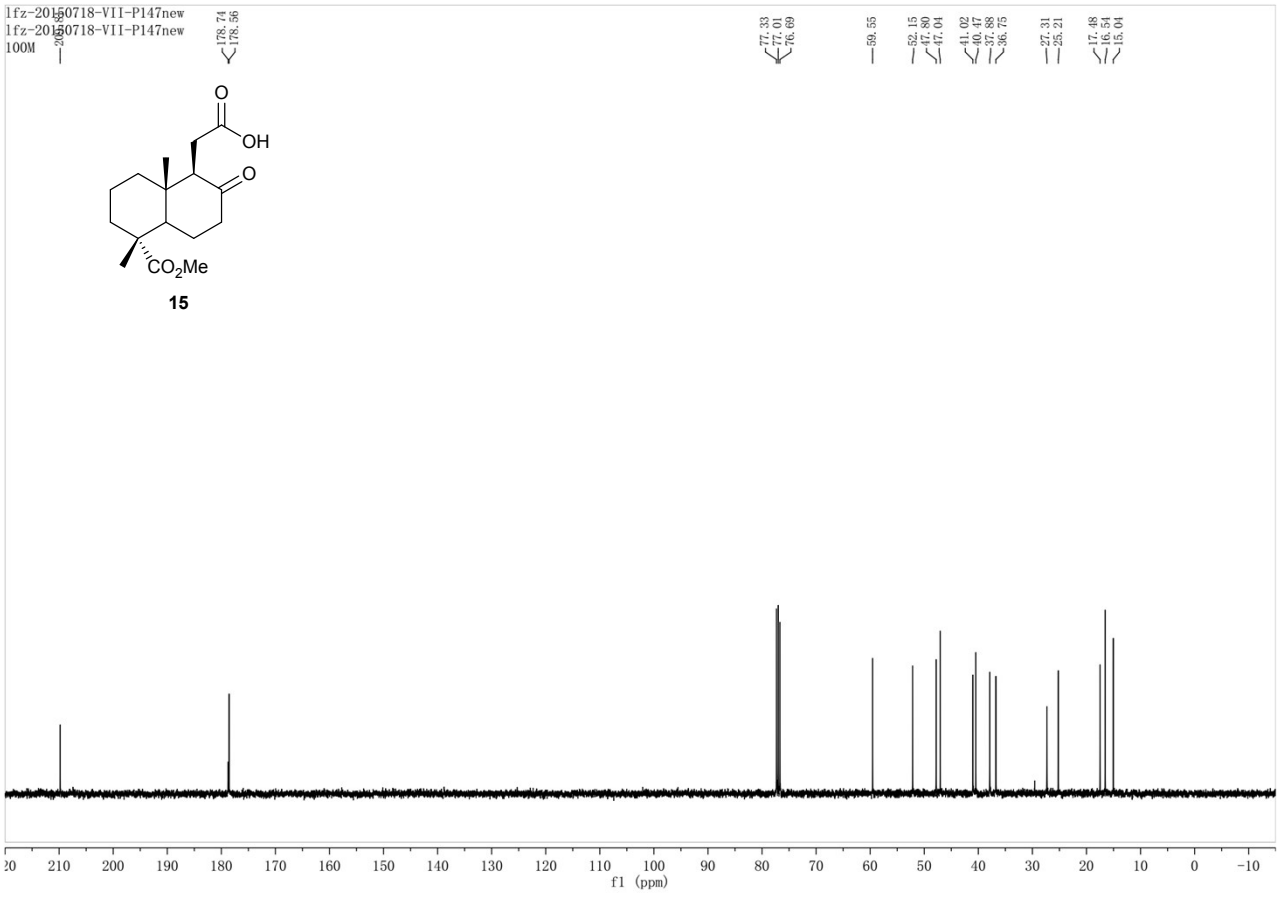

lfz-20150729-VIII-asperolide C
lfz-20150729-VIII-asperolide C
400M
O
O
OH
HO2C
H
2
f1 (ppm)

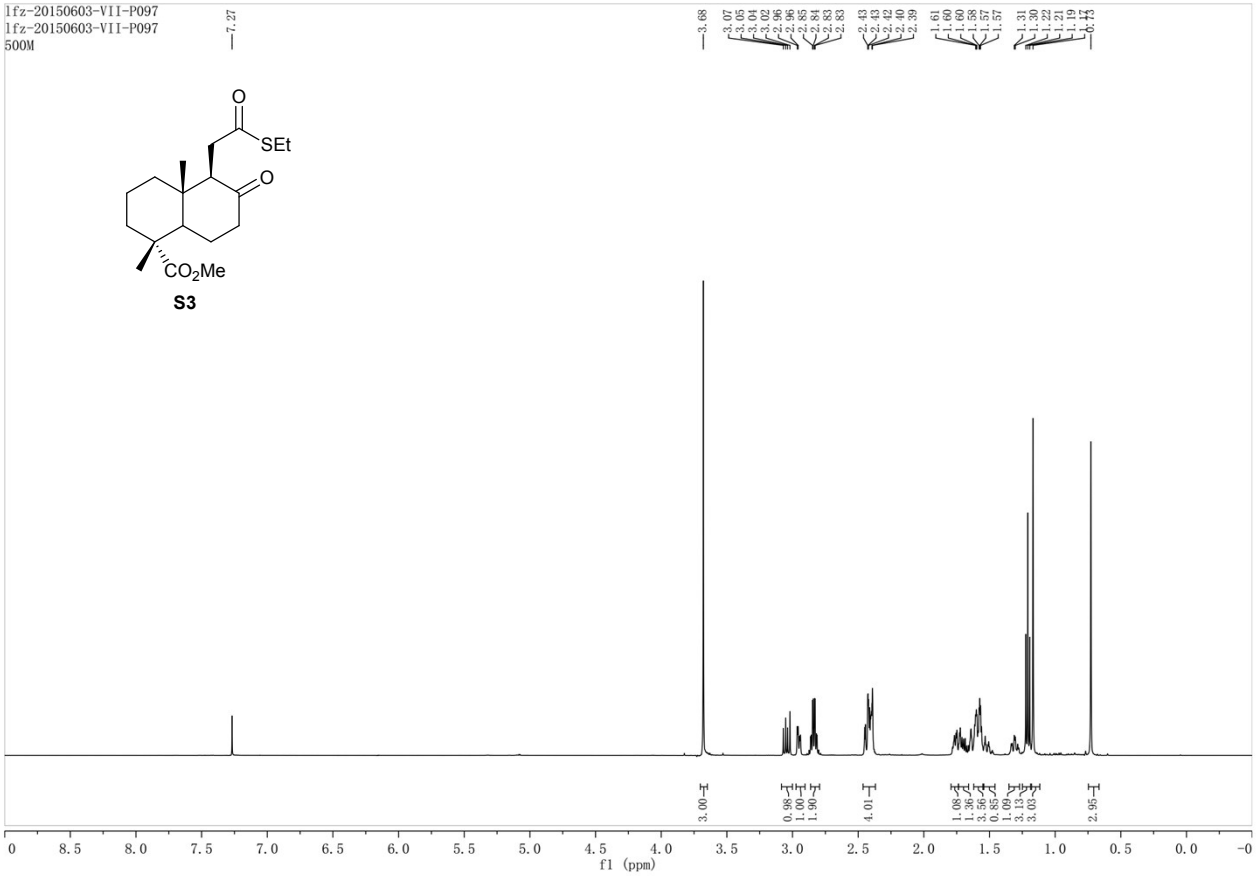

lfz-20150729-VIII-asperolide C
lfz-20150729-VIII-asperolide C
100M
O
O
OH
HO2C
H
2
f1 (ppm)

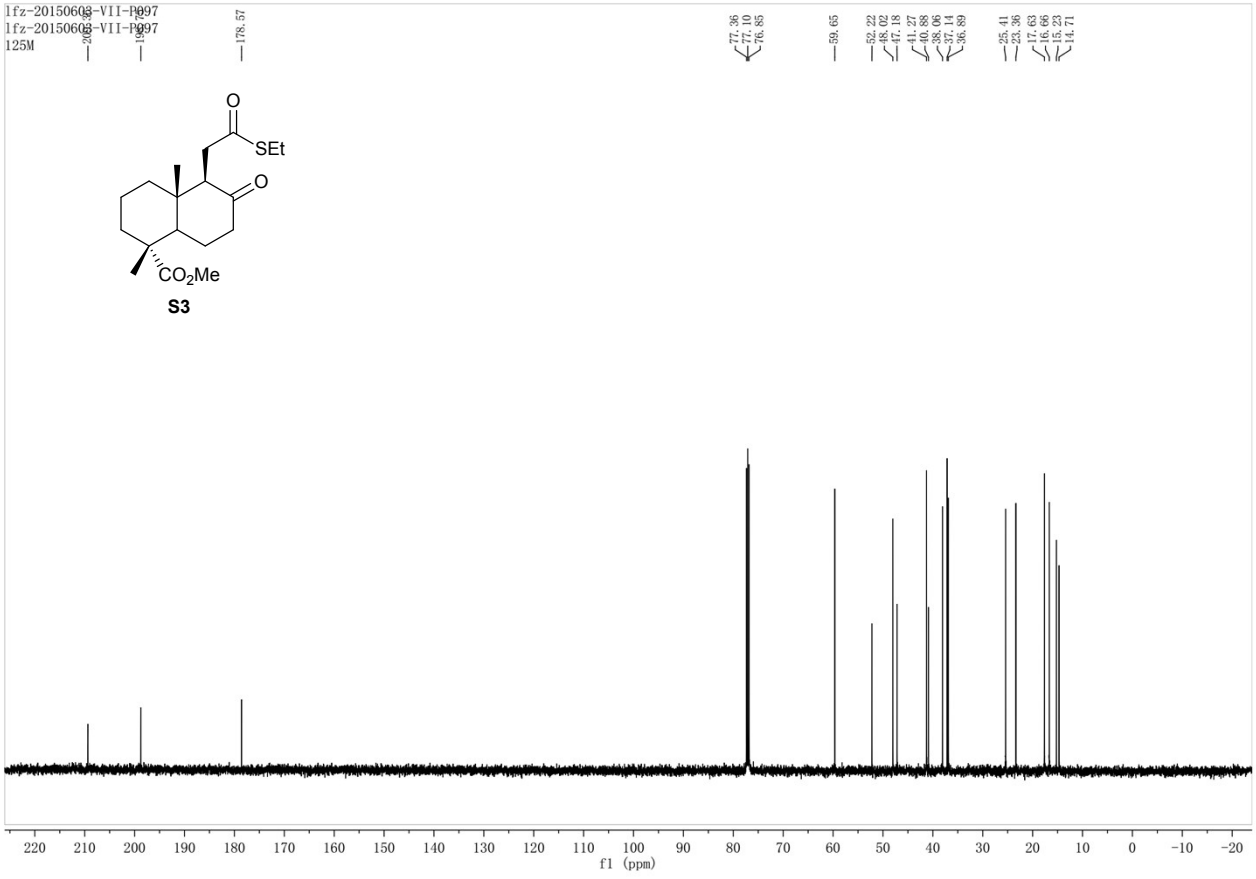

lfz-20150326-VII-P011-up
lfz-20150326-VII-P011-up
400M
OH
CO2Me
14
f1 (ppm)

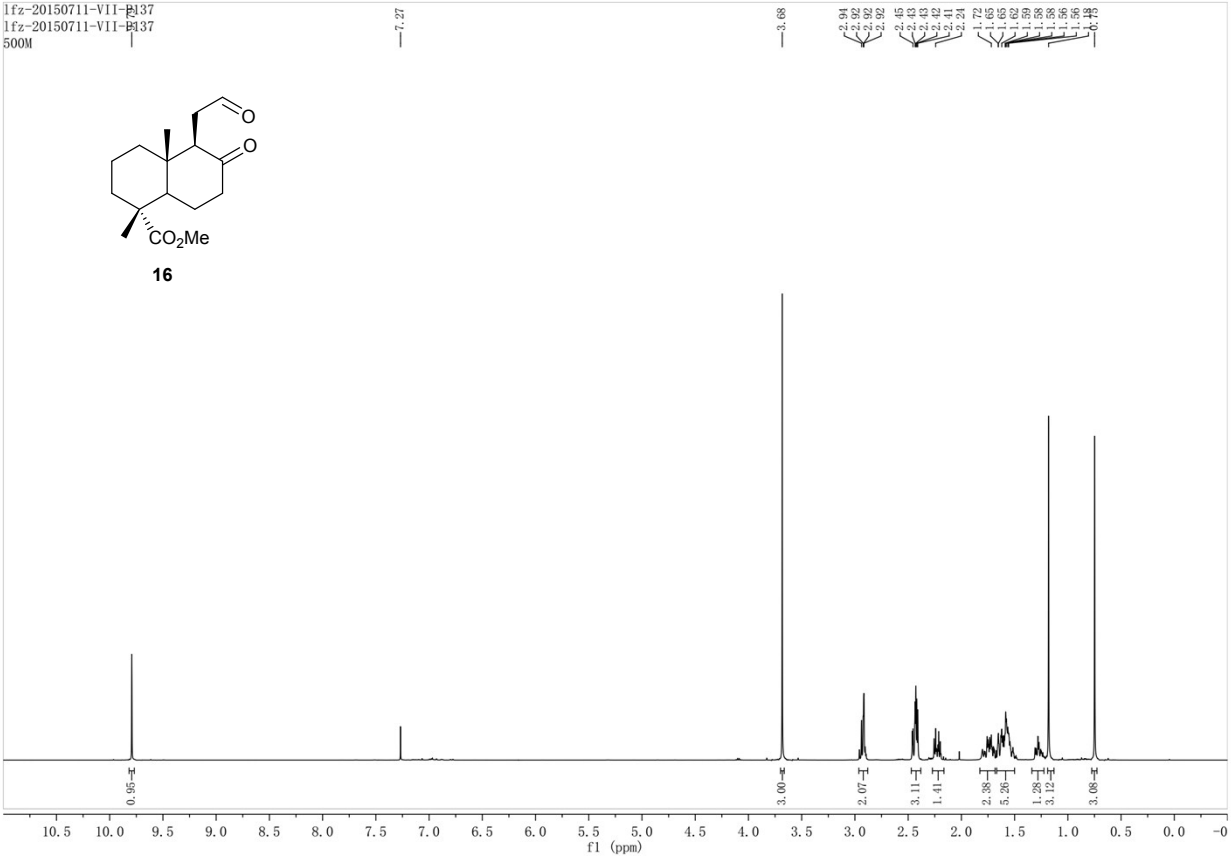

lfz-20150326-VII-P011-up
SZPKU Bruker 400
lfz-20150326-VII-P011-up
OH
CO2Me
14
f1 (ppm)

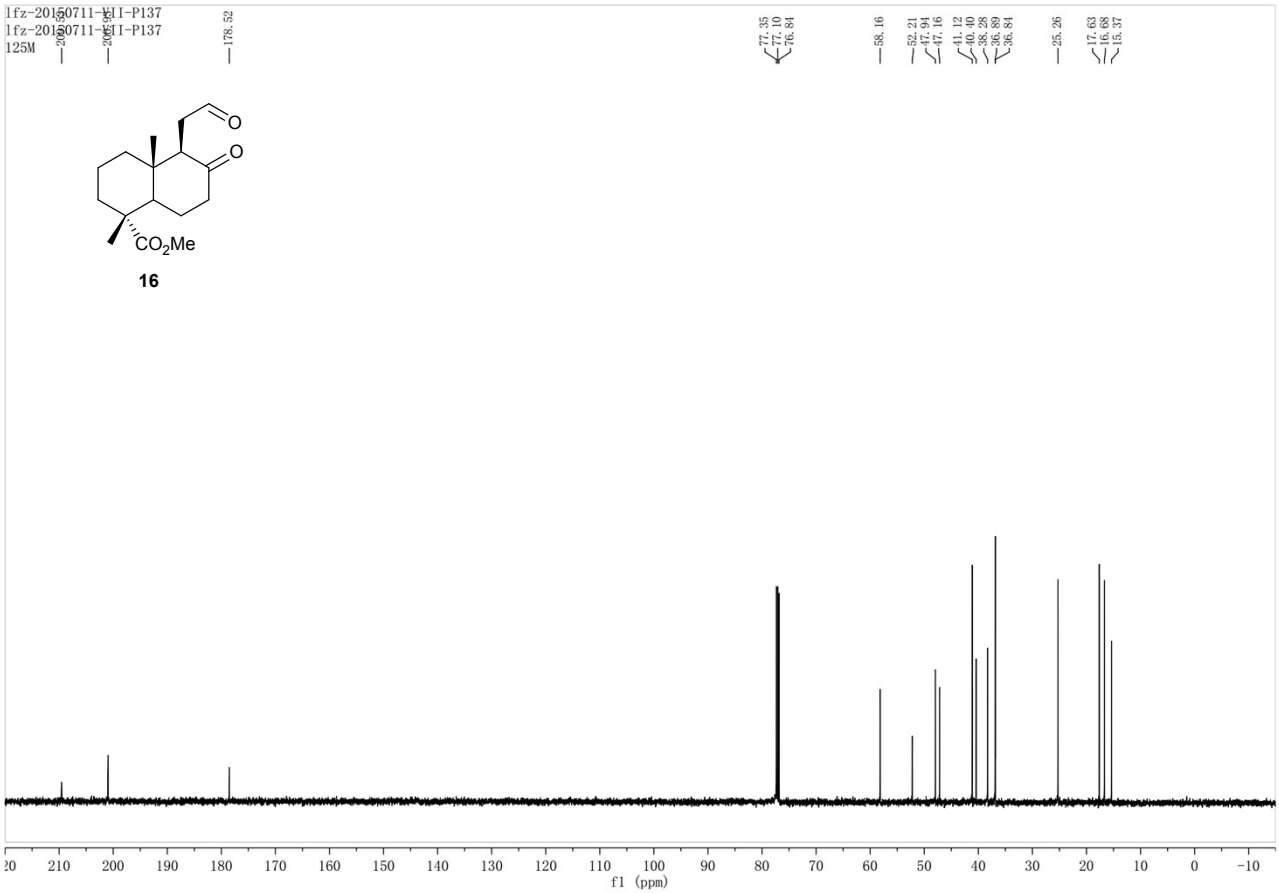

lfz-20150718-VII-P147new
lfz-20150718-VII-P147new
400M
7.27
3.67
2.81
2.80
2.78
2.78
2.74
2.70
2.68
2.43
2.42
2.41
2.40
2.39
2.24
1.64
1.60
1.59
1.58
1.52
1.31
1.21
1.16
0.72
O
OH
O
CO2Me
15
3.03
2.01
3.02
1.01
2.05
4.87
1.25
3.00
3.00
f1 (ppm)

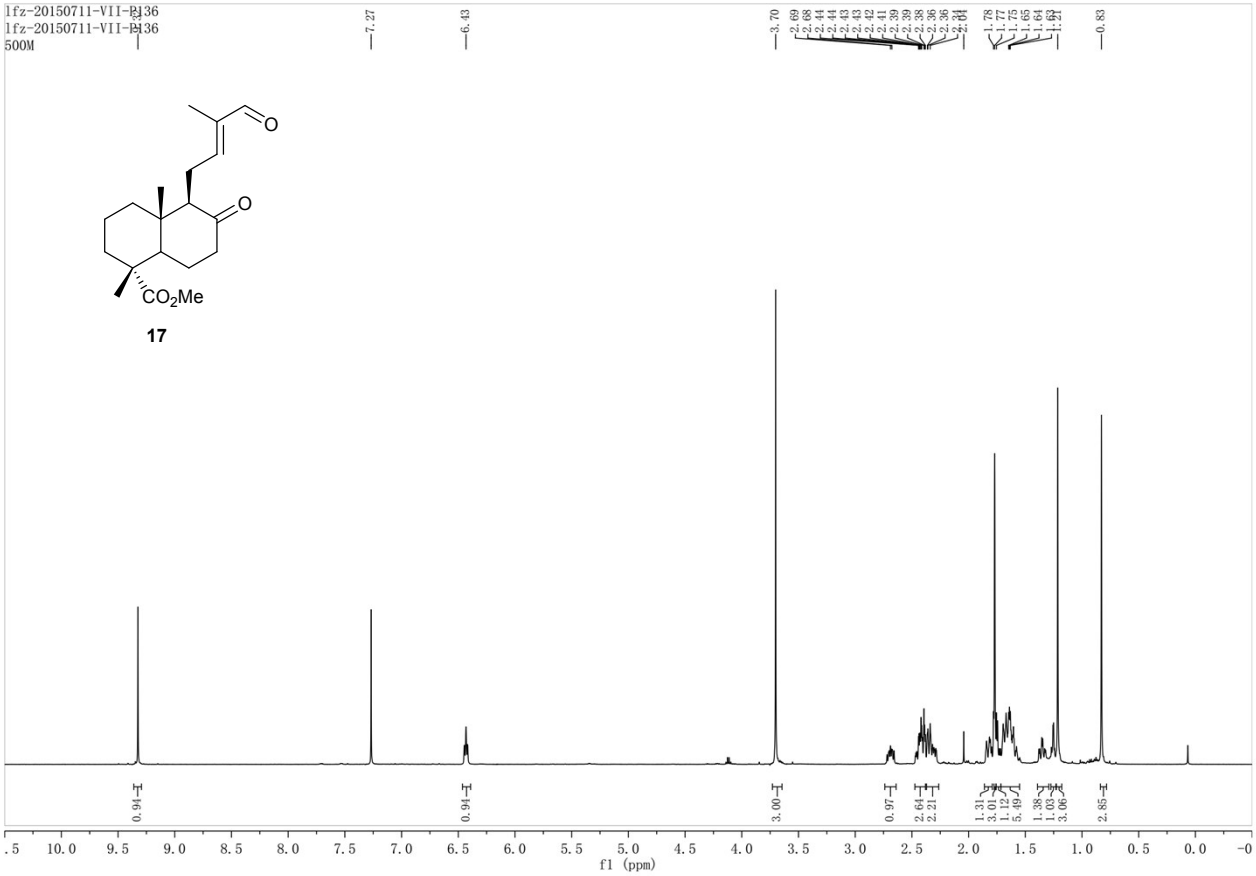

lfz-20150718-VII-P147new
lfz-20150718-VII-P147new
100M
178.74
178.56
77.33
77.01
76.69
59.55
52.15
47.80
47.04
41.02
40.47
37.88
36.75
27.31
25.21
17.48
16.54
15.04
O
OH
O
CO2Me
15
f1 (ppm)

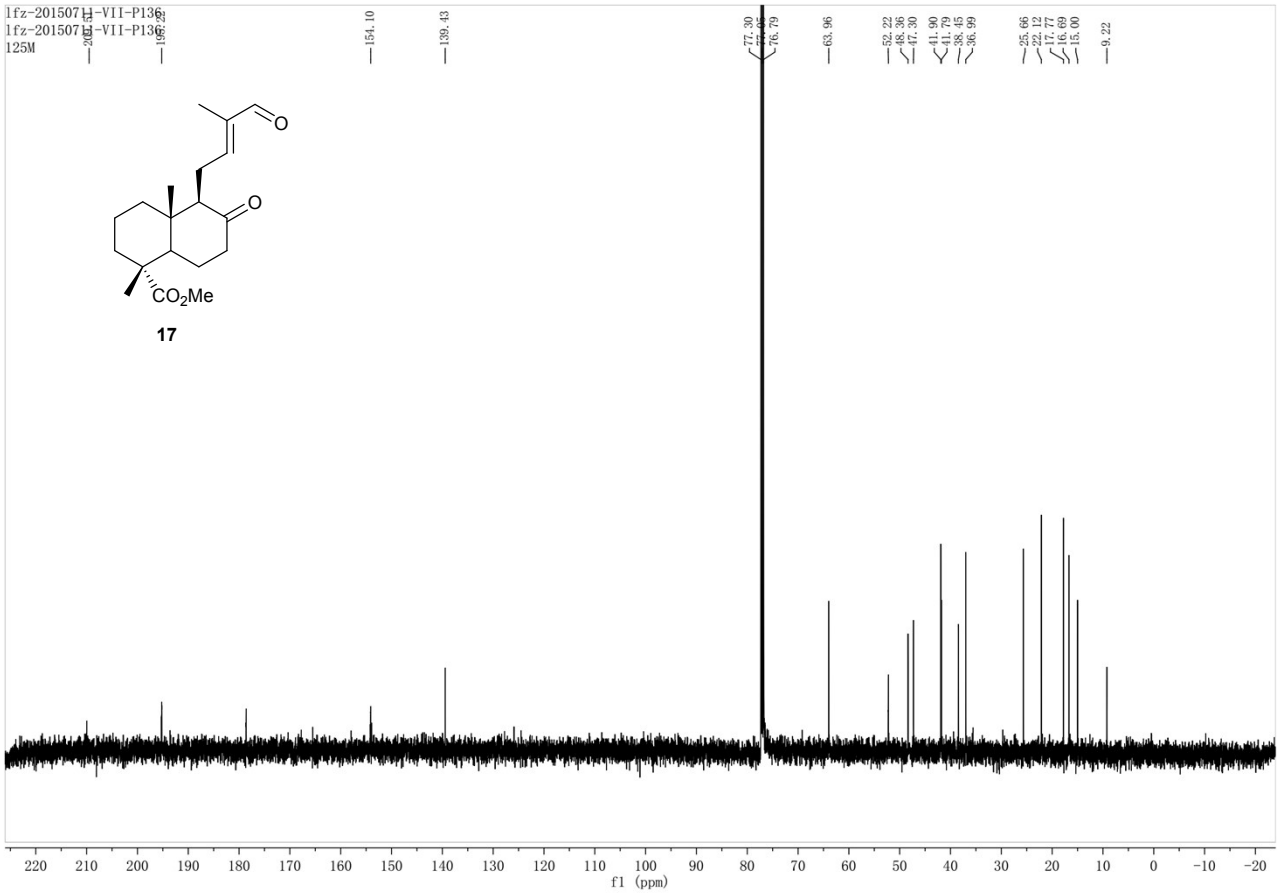

lfz-20150603-VII-P097
lfz-20150603-VII-P097
500M
O
SEt
O
CO2Me
S3
f1 (ppm)

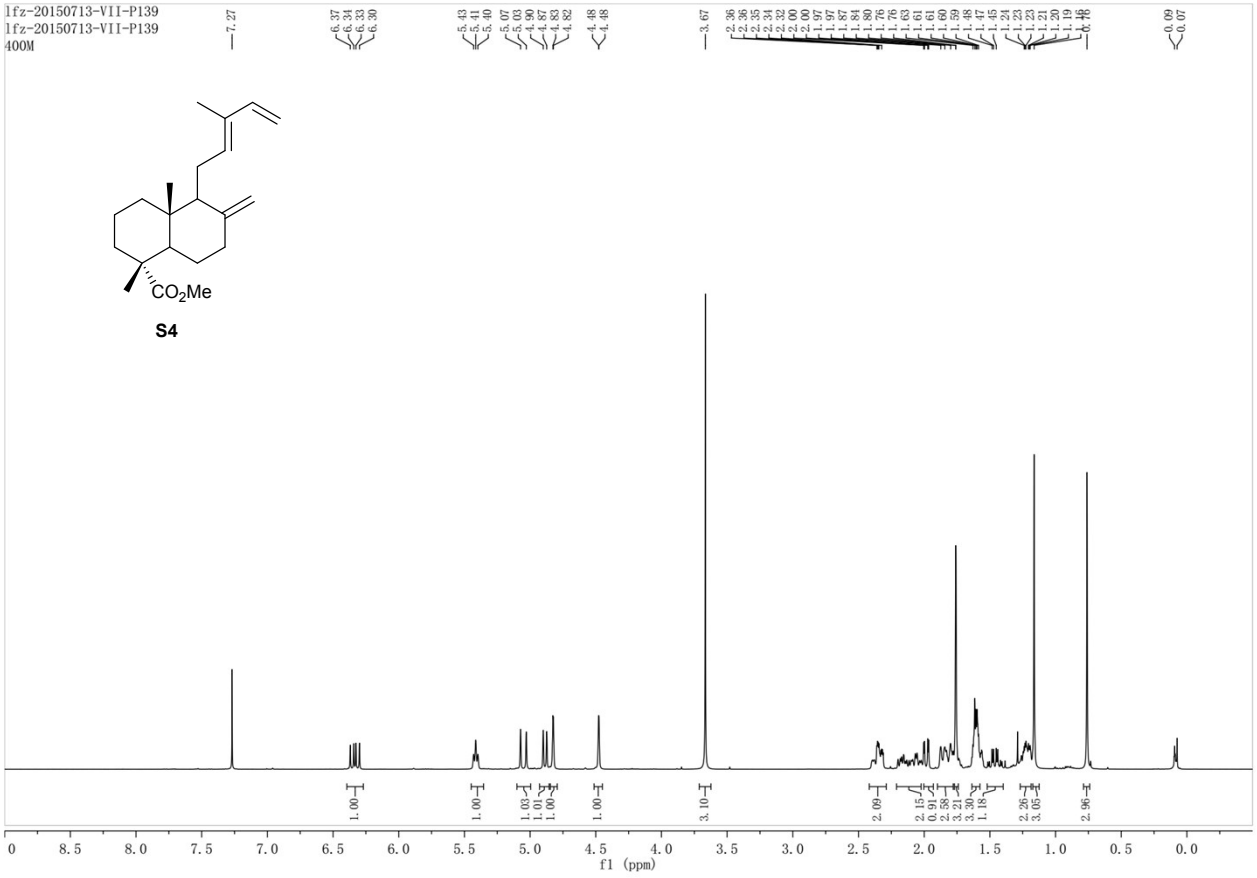

lfz-20150603-VII-P097
lfz-20150603-VII-P097
125M
O
SEt
O
CO2Me
S3
f1 (ppm)

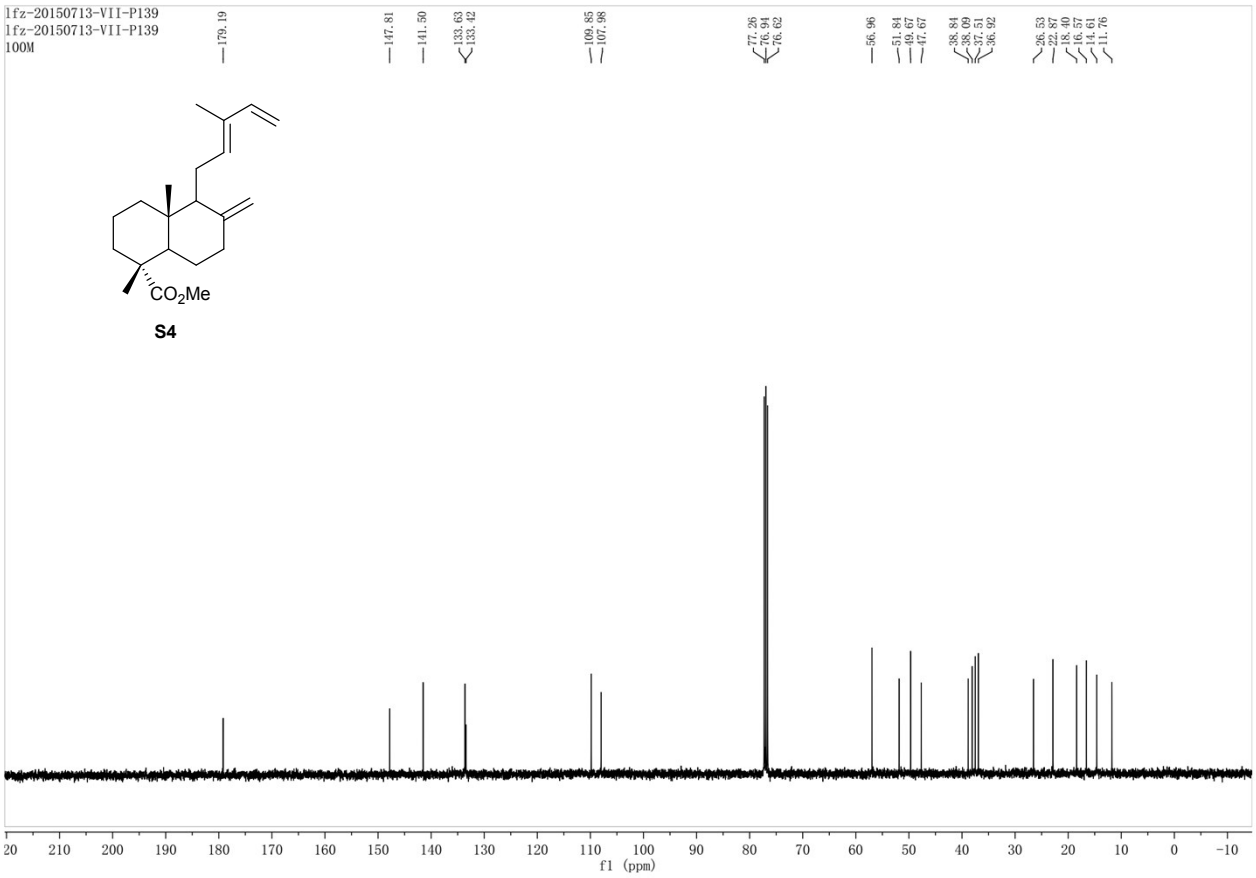

lfz-20150711-VII-P137
lfz-20150711-VII-P137
500M
7.27
3.68
2.94
2.92
2.92
2.92
2.45
2.43
2.43
2.42
2.41
2.24
1.72
1.65
1.65
1.62
1.59
1.58
1.58
1.56
1.56
1.48
1.43
O
O
CO2Me
16
0.95
3.00
2.07
3.11
1.41
2.38
5.26
1.28
3.12
3.08
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

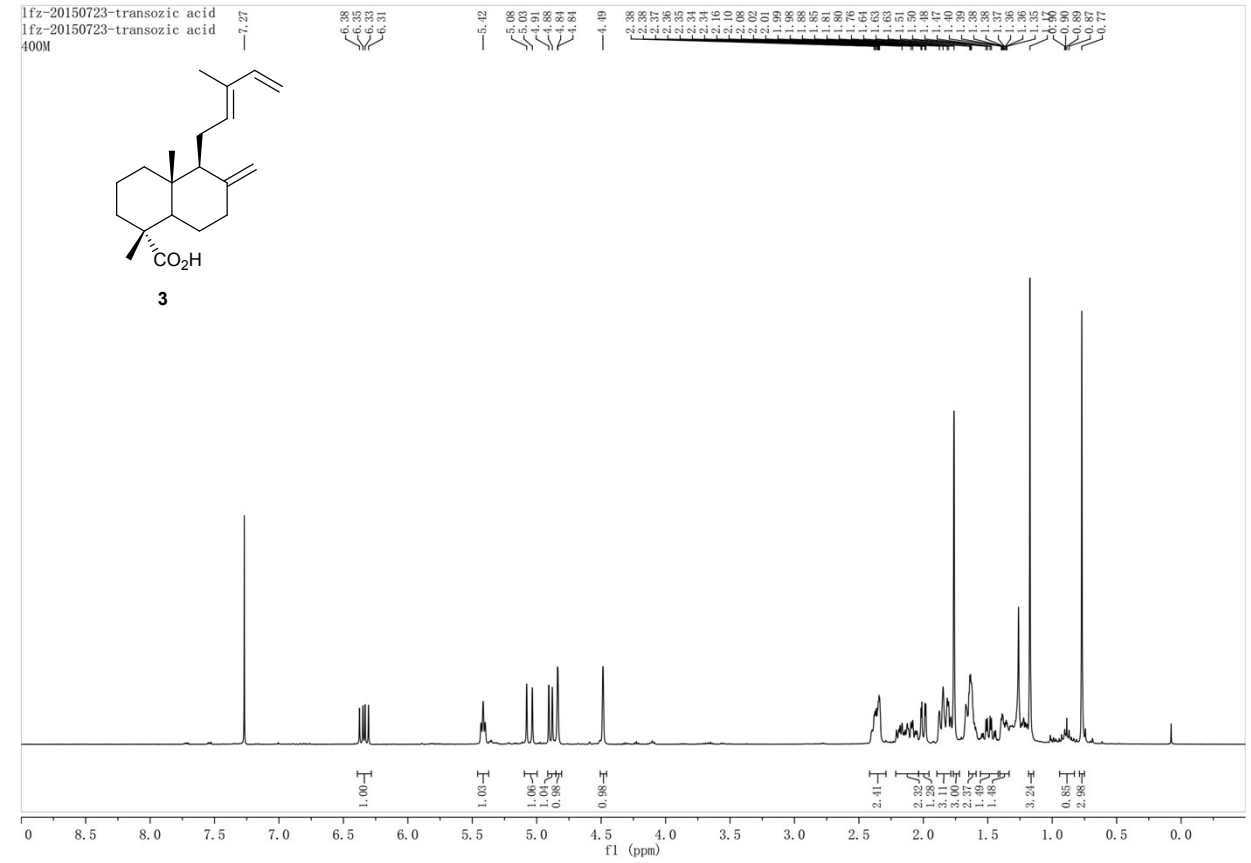

lfz-20150711-VII-P137
lfz-20150711-VII-P137
125M
178.52
77.35
77.10
76.84
58.16
52.21
47.94
47.16
41.12
40.40
38.28
36.89
36.84
25.26
17.63
16.68
15.37
O
O
CO2Me
16
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

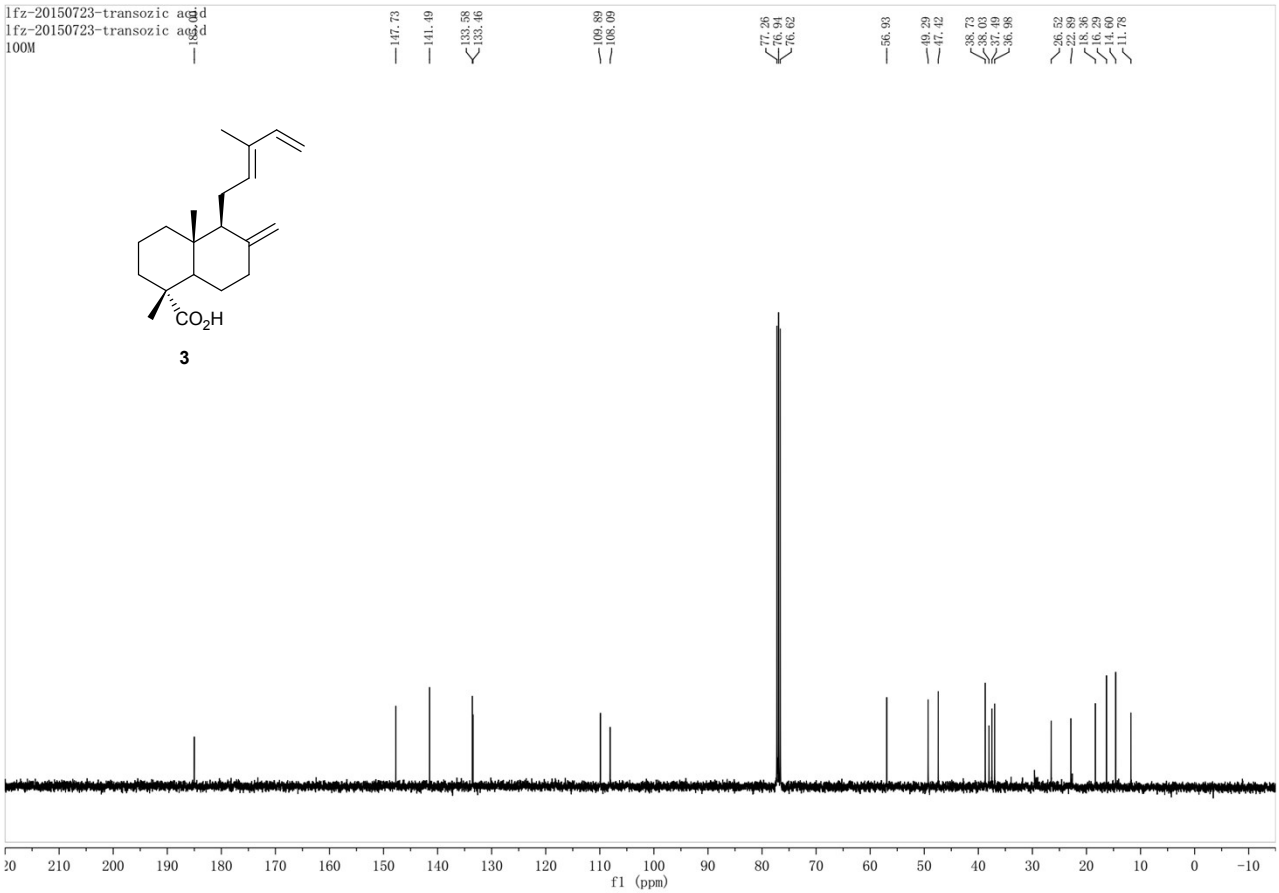

lfz-20150711-VII-P136
lfz-20150711-VII-P136
500M
7.27
6.43
3.70
0.83
O
O
CO2Me
17
0.94
0.94
3.00
0.97
2.64
2.21
1.31
3.01
1.12
5.49
1.38
1.03
3.06
2.85
f1 (ppm)


lfz-201507[illegible]-VII-P136
lfz-20150711-VII-P136
125M
154.10
139.43
77.30
76.79
63.96
52.22
48.36
47.30
41.90
41.79
38.45
36.89
25.66
22.12
17.77
16.69
15.00
9.22
O
O
CO2Me
17
f1 (ppm)


lfz-20150713-VII-P139
lfz-20150713-VII-P139
400M
CO2Me
S4
f1 (ppm)


lfz-20150713-VII-P139
lfz-20150713-VII-P139
100M
CO2Me
S4
f1 (ppm)


lfz-20150723-transozic acid
lfz-20150723-transozic acid
400M
CO2H
3
f1 (ppm)


lfz-20150723-transozic acid
lfz-20150723-transozic acid
100M
CO2H
3
f1 (ppm)

## Ⅵ. X-Ray Crystallographic Data for Compound 8

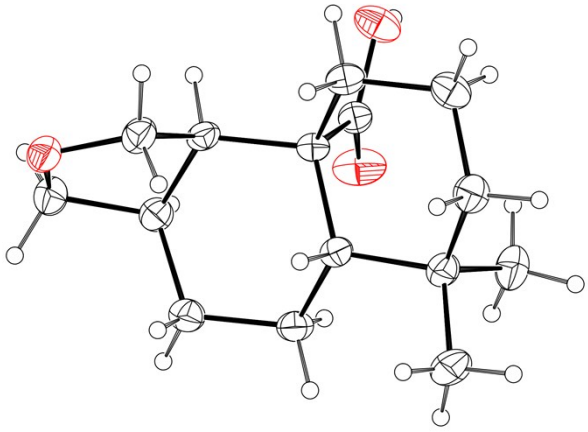
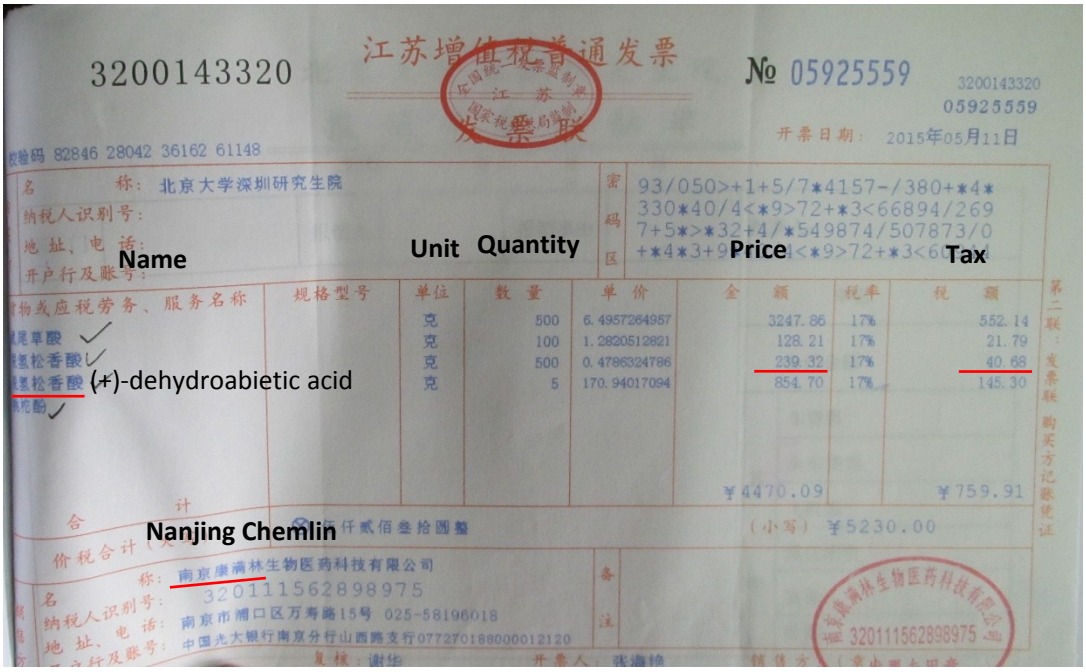


**Table S7.** Crystal data and structure refinement for e1.

| | | |
|---|---|---|
| Identification code | shelx | |
| Empirical formula | C15 H24 O3 | |
| Formula weight | 252.34 | |
| Temperature | 293(2) K | |
| Wavelength | 1.54187 Å | |
| Crystal system | Monoclinic | |
| Space group | P 21 | |
| Unit cell dimensions | a = 9.97920(10) Å | a= 90°. |
| | b = 6.68480(10) Å | b= 96.735(7)°. |
| | c = 10.2099(7) Å | g = 90°. |
| Volume | 676.39(5) $Å^3$ | |
| Z | 2 | |
| Density (calculated) | 1.239 $Mg/m^3$ | |
| Absorption coefficient | 0.673 $mm^{-1}$ | |
| F(000) | 276 | |
| Crystal size | 0.30 x 0.20 x 0.12 $mm^3$ | |
| Theta range for data collection | 6.602 to 68.165°. | |
| Index ranges | -10<=h<=11, -8<=k<=7, -12<=l<=12 | |
| Reflections collected | 9042 | |
| Independent reflections | 2363 [R(int) = 0.0573] | |
| Completeness to theta = 67.687° | 98.9 % | |
| Absorption correction | Semi-empirical from equivalents | |

| | |
|---|---|
| Max. and min. transmission | 0.937 and 0.739 |
| Refinement method | Full-matrix least-squares on $F^2$ |
| Data / restraints / parameters | 2363 / 2 / 168 |
| Goodness-of-fit on $F^2$ | 1.157 |
| Final R indices [I>2sigma(I)] | R1 = 0.0457, wR2 = 0.1109 |
| R indices (all data) | R1 = 0.0547, wR2 = 0.1346 |
| Absolute structure parameter | -0.01(17) |
| Extinction coefficient | n/a |
| Largest diff. peak and hole | 0.232 and -0.346 e.$Å^{-3}$ |

## Ⅶ. The Invoices of (+)-Carnosic Acid and (+)-Dehydroabietic Acid


As we can see from the receipts above, both (+)-carnosic acid and (+)-dehydroabietic acid were purchased in large quantities from Nanjing Chemlin (China). “鼠尾草酸” means (+)-carnosic acid (CAS: 3650-09-7 ), which was priced at ￥6800/ kg ($1.1/g); “脱氢松香酸” means (+)-dehydroabietic acid (CAS: 1740-19-8), which was priced at ￥280/ 500g ($85/kg).