Electronic supplementary materials *Mendeleev Commun.*, 2024, **34**, 22–24

Synthesis and antiproliferative activity of novel organotin complexes bearing abiraterone drug moiety

Dmitry B. Shpakovsky, Daria A. Berseneva, Yulia A. Gracheva, Taisiya A. Antonenko, Yury F. Oprunenko, Vladimir V. Britikov, Elena V. Britikova and Elena R. Milaeva

1. Materials and methods

Starting organotin compounds Me_2SnCl_2, Et_2SnCl_2, Bu_2SnCl_2, Ph_2SnCl_2, Me_3SnCl, Ph_3SnCl (Sigma-Aldrich, 98%), abiraterone acetate (Farmoslavl, 97%) were used as supplied. Solvents ethanol (96%), hexane were used with no further purification.

The NMR spectra were recorded on a Bruker Avance-400 spectrometer operating at 400.1 MHz (^{1}H), 100.6 MHz (^{13}C) and Agilent 400-MR at 149.1 MHz (^{119}Sn) in $CDCl_3$. IR spectra were recorded using a Thermo Nicolet iS5 FTIR by sampling ATR (Thermo Fisher Scientific, Waltham, MA, USA). Elemental analyses were performed at the Vario Micro Cube analyzer (Elementar). The UV-Vis spectra were recorded at Evolution 300 (Thermo Scientific, USA) cuvette spectrophotometer. The MTT test was performed on a Zenyth200rt (Anthos) multiwall-plate reader.

2. Synthesis of compounds

2.1. Abiraterone (AbOH).

Hydrolysis of commercial AbOAc with equimolar amount of solid KOH was carried out in EtOH. To a solution of abiraterone acetate (392 mg, 1 mmol) in 7 ml EtOH (7 ml) KOH (56 mg, 1 mmol) was added. The mixture was stirred at 40 ^{o}C for 30 min. The white crystalline precipitate formed was filtered off, washed with EtOH, H_2O and dried in air. Yield 283 mg (81%). M.p. = 215-217 ^{o}C (M.p. = 212-215 ^{o}C [S. Ma, J. Li, H. Tang, F. Xu, *Heterocycles*, 2018, **96**, 461.].

IR (ν, cm^{-1}): ν(OH) 3221 (s); ν(C-H) 2817-3030 (s); ν(C=C) 1595 (m); 1459 (s); 1446 (s); 1417 (s); 1377 (m); 1063 (s); 802 (s); 711 (s). ^{1}H NMR (δ, ppm): 1.05 (s, 3H, CH_3); 1.07 (s, 3H, CH_3); 1.09-1.16 (m, 1H); 1.45-1.90 (м, 11H); 2.00-2.15 (m, 3H); 2.20-2.40 (m, 3H); 3.50-3.60 (m, 1H, CH); 5.39 (d, $^3J_{H\text{-}H}$ = 4 Hz, 1H, C=CH); 6.00 (d, $^3J_{H\text{-}H}$ = 4 Hz; 1H, C=CH); 7.18-7.24 (m, 1H, CH Py); 7.60-7.70 (m, 1H, CH Py); 8.42-8.48 (m, 1H, CH Py); 8.62 (s, 1H, CH Py). ^{13}C NMR (δ, ppm): 16.16; 18.92; 20.45; 30.03; 31.10; 31.21; 31.39; 34.32; 34.87; 36.28; 36.76; 41.89; 46.92; 49.94; 57.13; 71.24; 120.90; 122.60; 128.81; 132.55; 133.26; 140.75; 147.41; 147.49; 151.27.

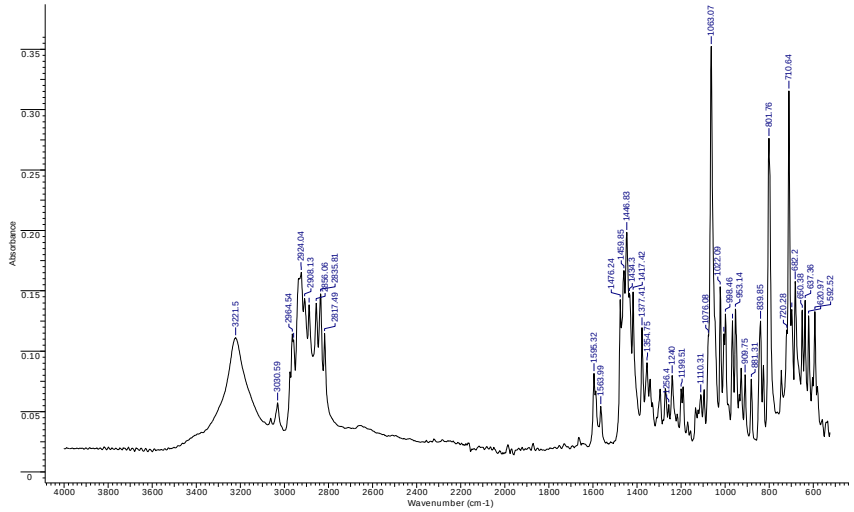
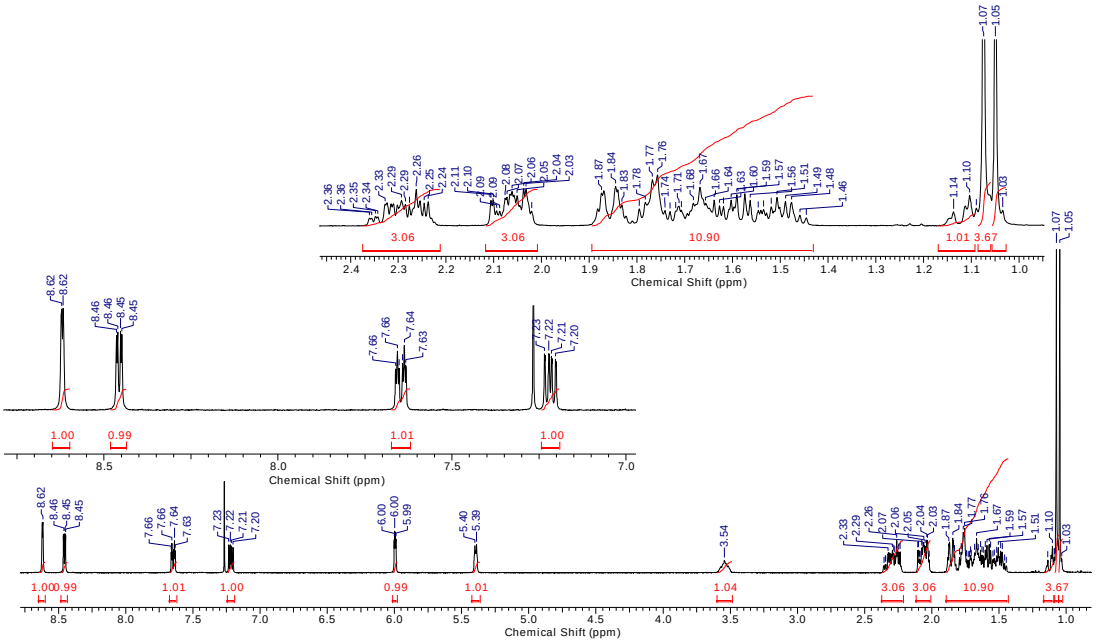


Figure S1 IR spectrum of AbOH.

a



b

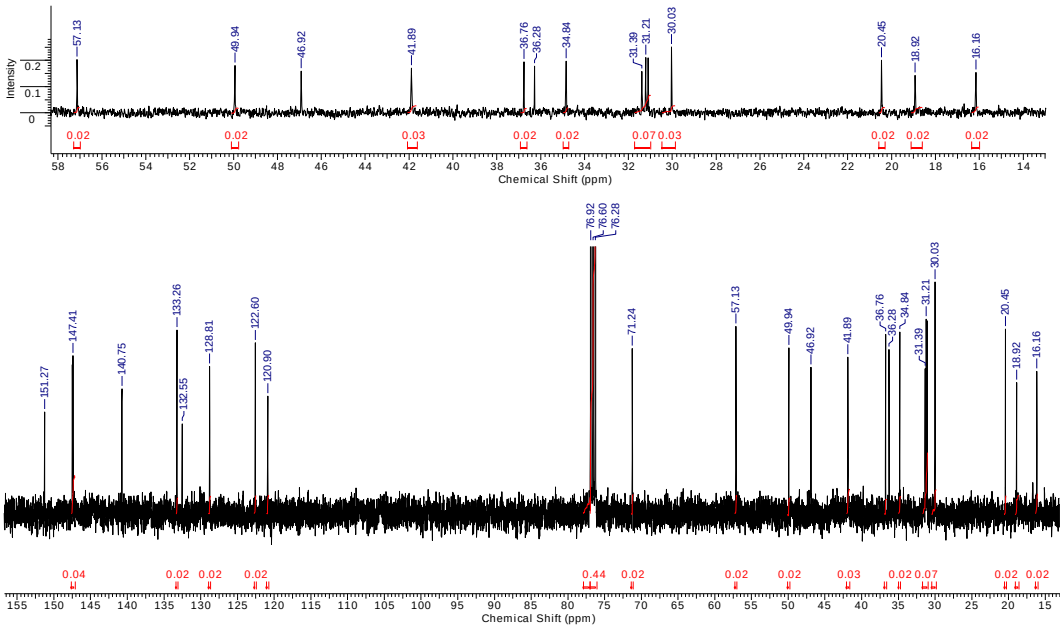


Figure S2. ^{1}H (a) and ^{13}C (b) NMR spectra of AbOH.

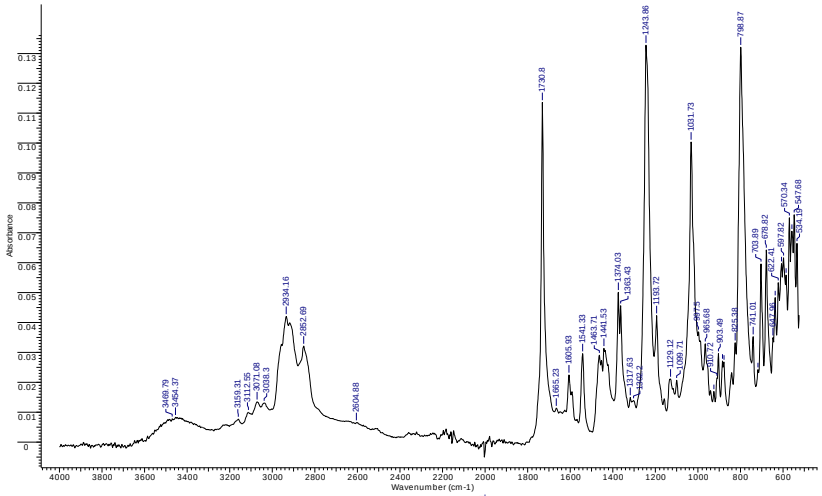
2.2. Synthesis of complexes 1-12 (general method). A mixture of AbOAc or AbOH (1 mmol) with organotin chlorides (1 mmol) in EtOH (10 ml) was stirred for 4 h at 50-60 ºC. The solvent was removed in vacuum. The oily residue was solidified by adding of hexane with several drops of $CHCl_3$ and left in refrigerator. The solid precipitate formed was washed by hexane and dried in vacuum yielding complexes **1-12** (Scheme 1).

2.3. Complex of abiraterone acetate with dimethyltin dichloride (1, $Me_2SnCl_2 \cdot AbOAc$**)**

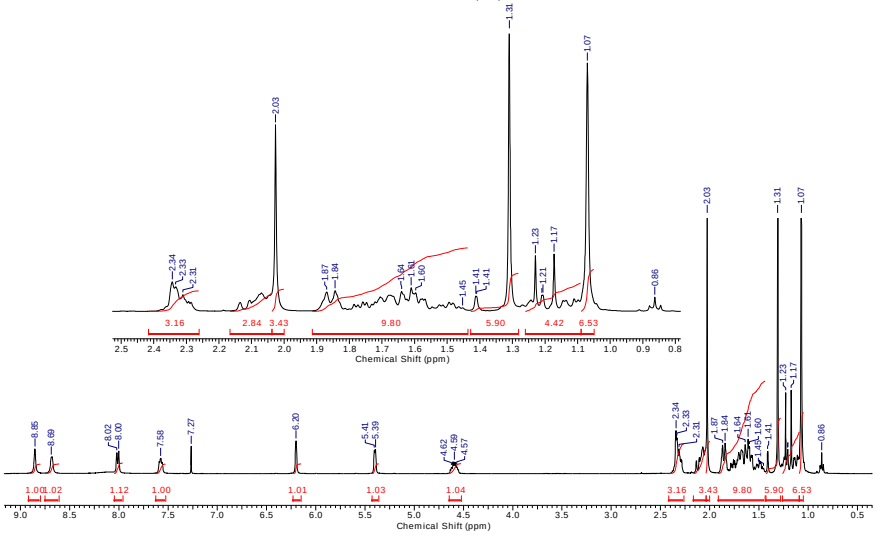
Yield 71%; white powder; m.p. 125-130 °C (decomp.). Anal. Calcd for $C_{28}H_{39}NO_2SnCl_2$ (611.22) (%): C, 55.02; H, 6.43; N, 2.39. Found (%): C, 55.26; H, 6.57; N, 2.21.

IR (ν, cm^{-1}): ν(C-H) 2852-3071 (s); ν(C=O) 1731 (s); 1605 (w); 1374 (m); 1363 (m); 1244 (s); 1031 (s); 799 (s). ^{1}H NMR (*δ*, ppm): 1.07 (br s, 6H, 2 CH_3); 1.10-1.30 (m, 4 H); 1.31 (s, 6H, $Sn(CH_3)_2$, $^2J_{H\text{-}Sn}$ = 80 Hz); 1.45-1.87 (м, 9H); 2.03 (s, 3H, $COCH_3$); 2.05-2.39 (m, 6H); 4.50-4.65 (m, 1H, CH); 5.40 (d, $^3J_{H\text{-}H}$ = 8 Hz, 1H, C=CH); 6.15-6.25 (m, 1H, C=CH); 7.55-7.61 (m, 1H, CH Py); 8.01 (d, 1H, $^3J_{H\text{-}H}$ = 8 Hz; CH Py); 8.60-8.70 (m, 1H, CH Py); 8.85 (s, 1H, CH Py). ^{13}C NMR (*δ*, ppm): 13.42 (Sn-CH_3); 16.20; 18.83; 20.35; 21.05; 22.27; 29.85; 30.97; 31.62; 34.55; 36.32; 36.45; 37.67; 46.94; 49.65; 56.97; 73.40; 121.68; 124.79; 132.58; 134.98 137.80; 139.61; 142.85; 142.88; 149.16; 170.19 (C=O). ^{119}Sn NMR (δ, ppm): -116.23; -63.99.

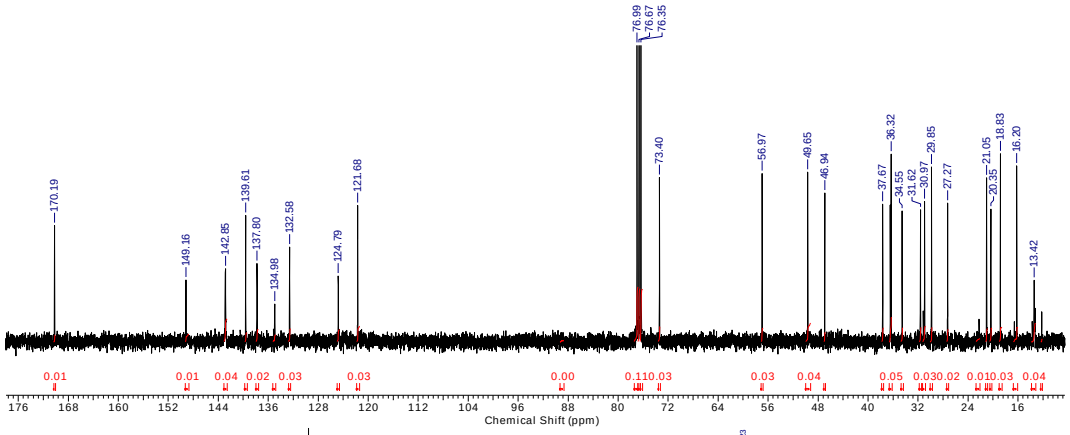
a



b



c



d

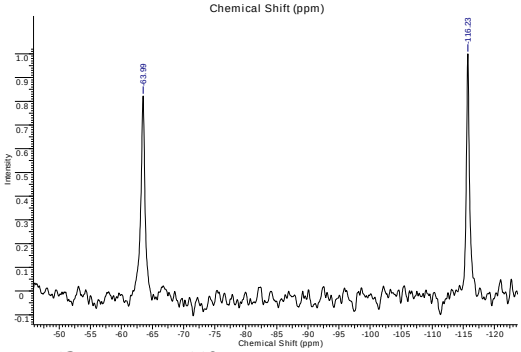


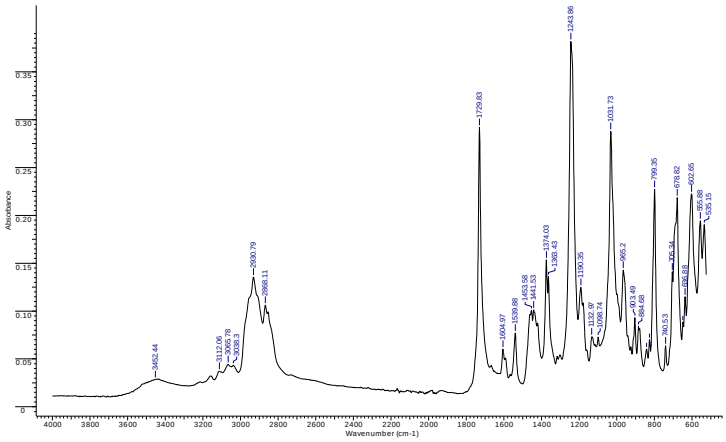
Figure S3. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **1** ($Me_2SnCl_2 \cdot AbOAc$).

2.4. Complex of abiraterone acetate with diethyltin dichloride (**2**, $Et_2SnCl_2 \cdot AbOAc$)

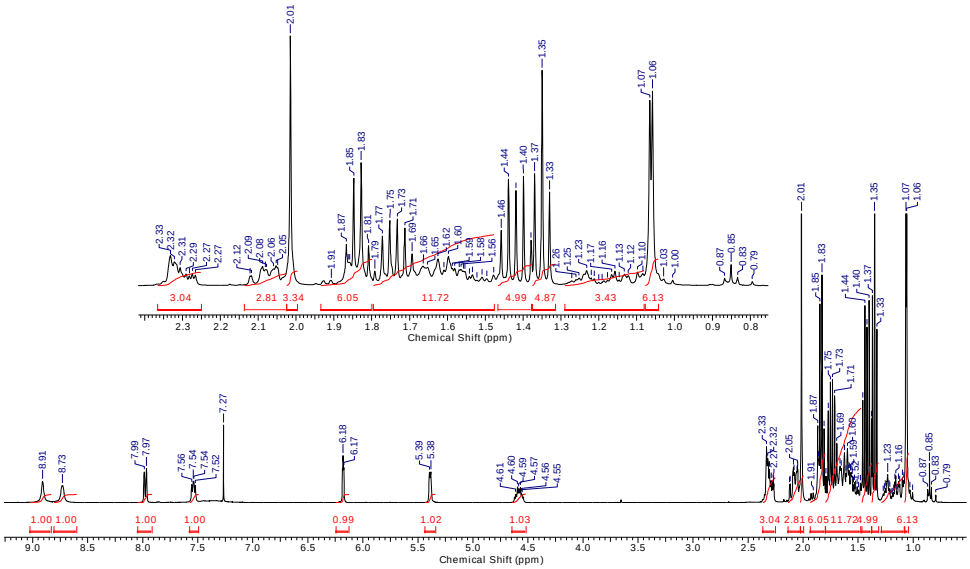
Yield 66 %; white powder; m.p. (decomp.) 125-127 °C. Anal. Calcd for $C_{30}H_{43}NO_2SnCl_2$ (639,27) (%): C, 56.37; H, 6.78; N, 2.19. Found (%): C, 56.52; H, 6.84; N, 2.29.

IR (ν, cm^{-1}): ν(C-H) 2850-3066 (s); ν(C=O) 1730 (s); 1540 (w); 1374 (m); 1363 (m); 1244 (s); 1032 (s); 799 (s); 679 (s); 602 (s). ^{1}H NMR (*δ*, ppm): 1.06 (s, 3H, CH_3); 1.07 (s, 3H, CH_3); 1.10-1.30 (m, 3H); 1.35 (t, $^{3}J_{H\text{-}H}$ = 8 Hz, 6H, 3C$\underline{H}_3CH_2$); 1.50-1.90 (m, 13H); 2.01 (s, 3H, $COCH_3$); 2.05-2.39 (m, 6H); 4.50-4.66 (m, 1H, CH); 5.38 (d, $^{3}J_{H\text{-}H}$ = 4 Hz, 1H, C=CH); 6.10-6.20 (m, 1H, C=CH); 7.54 (dd, 1H, $^{3}J_{H\text{-}H}$ = 8 Hz; 8 Hz, CH Py); 7.98 (d, 1H, $^{3}J_{H\text{-}H}$ = 8 Hz; CH Py); 8.65-8.75 (m, 1H, CH Py); 8.91 (s, 1H, CH Py). ^{13}C NMR (*δ*, ppm): 9.63 (Sn-CH_3); 16.20; 18.82; 20.35; 21.03; 25.09; 27.27; 29.84; 30.97; 31.58; 34.51; 36.32; 36.44; 37.66; 46.90; 49.67; 56.97; 73.40; 121.70; 124.58; 132.18; 134.63 137.39; 139.60; 143.48; 143.56; 149.37; 170.18 (C=O). ^{119}Sn NMR (δ, ppm): -139.25; -92.42.

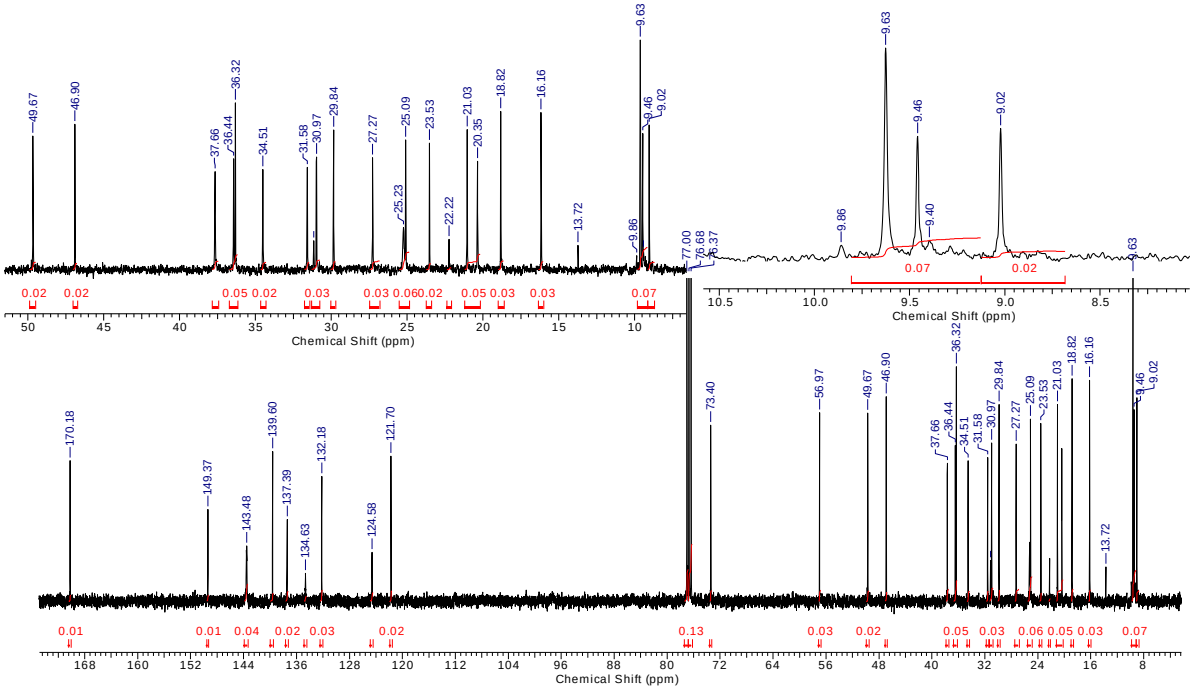
a



b



c



d

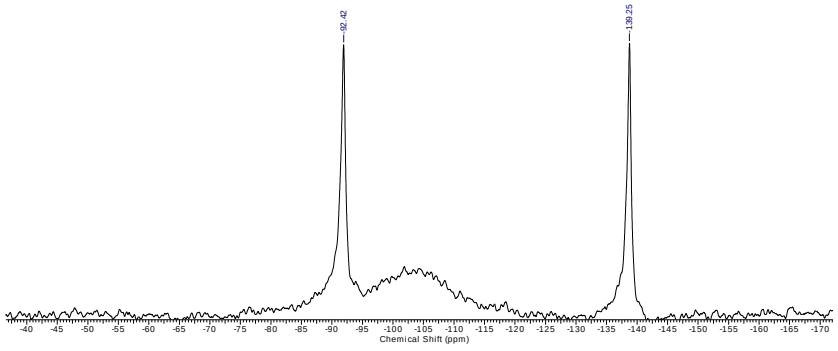


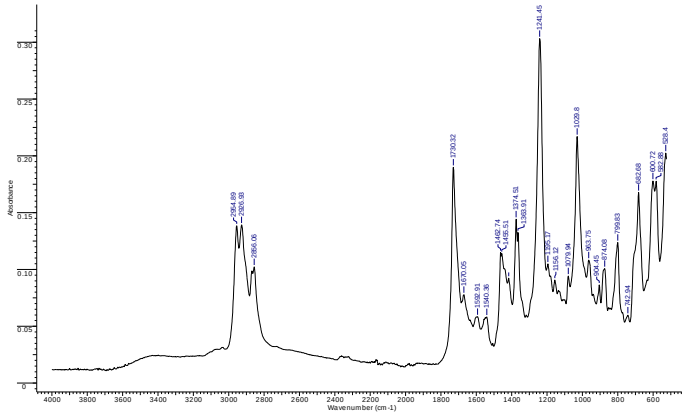
Figure S4. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **2** ($Et_2SnCl_2 \cdot AbOAc$).

2.5. Complex of abiraterone acetate with dibutyltin dichloride (3, $Bu_2SnCl_2 \cdot AbOAc$**)**

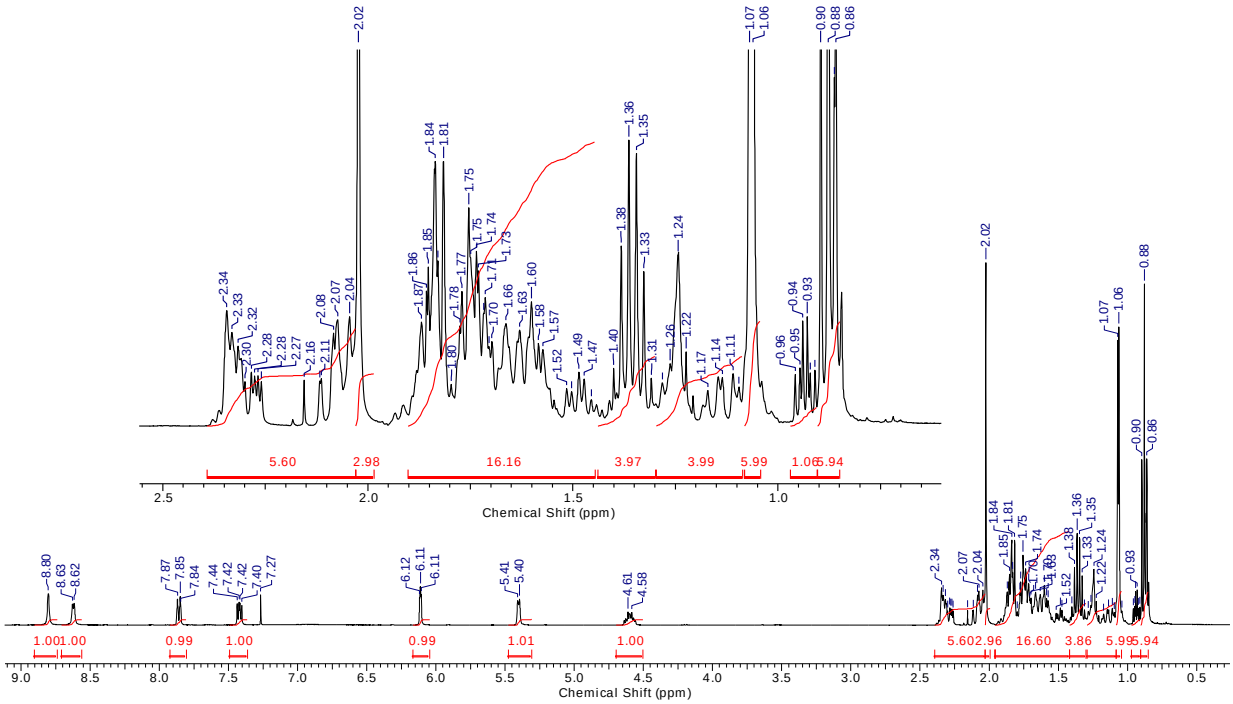
Yield 68 %; white powder; m.p. 123-125 °C. Anal. Calcd for $C_{34}H_{51}NO_2SnCl_2$ (695,38) (%): C, 58.73; H, 7.39; N, 2.01. Found (%): C, 59.05; H, 7.53; N, 2.15.

IR (ν, cm^{-1}): ν(C-H) 2856-2955 (s); ν(C=O) 1730 (s); 1463 (w); 1374 (m); 1364 (m); 1241 (s); 1030 (s); 800 (s); 682 (s); 601 (s). ^1H NMR (*δ*, ppm): 0.88 (t, $^3J_{H-H}$ = 8 Hz, 6H, 2 CH-C<u>H</u>$_3$); 0.90-0.97 (m, 1H); 1.06 (s, 3H, CH_3); 1.07 (s, 3H, CH_3); 1.10-1.95 (m, 23H); 2.02 (s, 3H, $COCH_3$); 2.04-2.40 (m, 6H); 4.55-4.65 (m, 1H, CH); 5.40 (d, $^3J_{H-H}$ = 4 Hz, 1H, C=CH); 6.10-6.15 (m, 1H, C=CH); 7.42 (dd, 1H, $^3J_{H-H}$ = 8 Hz; 8 Hz, CH Py); 7.86 (d, 1H, $^3J_{H-H}$ = 8 Hz; CH Py); 8.62 (d, 1H, $^3J_{H-H}$ = 4 Hz; CH Py); 8.80 (s, 1H, CH Py). ^{13}C NMR (*δ*, ppm): 13.15; 16.15; 18.81; 20.35; 21.01; 22.22; 25.81 ($^1J_{C-Sn}$= 102 Hz); 26.95 ($^2J_{C-Sn}$= 36 Hz); 27.28; 29.90; 31.00; 31.50; 34.63; 36.33; 36.46; 37.68; 46.90; 49.72; 56.99; 73.39; 121.74; 123.88; 130.97; 131.02; 133.94 135.97; 139.61; 144.85; 150.02; 170.13 (C=O). ^{119}Sn NMR (δ, ppm): -138.21; -90.94.

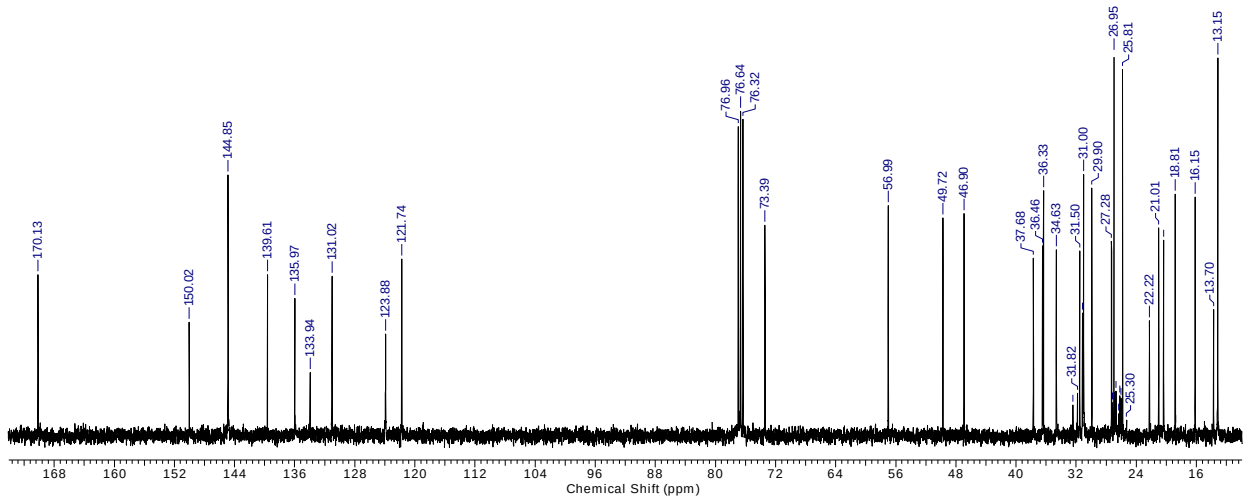
a



b



c



d

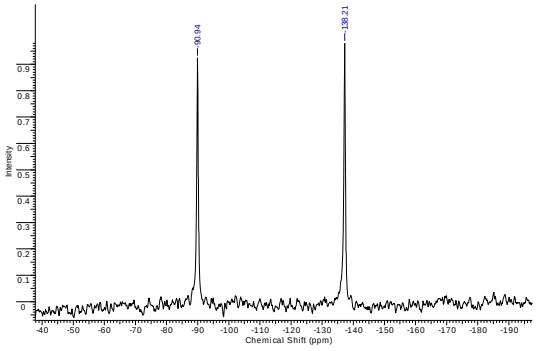


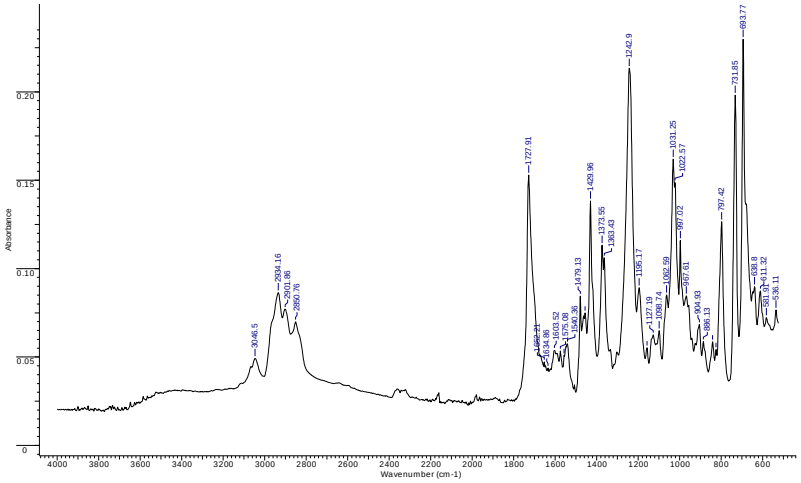
Figure S5. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **3** (Bu_2SnCl_2·AbOAc).

2.6. Complex of abiraterone acetate with diphenyltin dichloride (4, Ph_2SnCl_2·AbOAc)

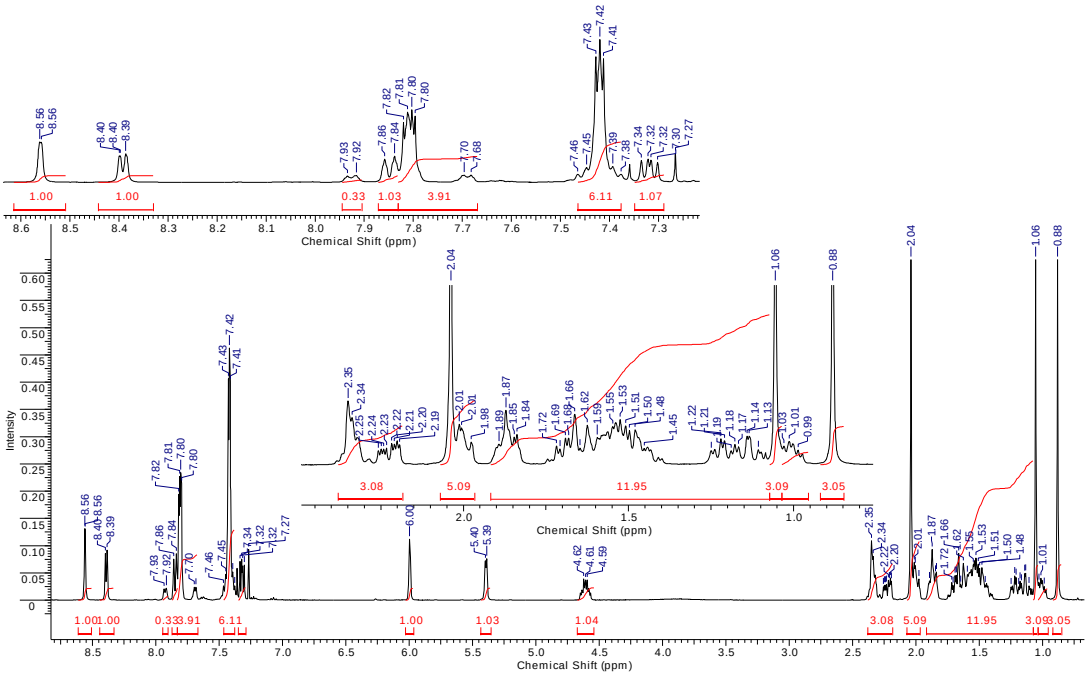
Yield 69 %; white powder; m.p. 130-135 °C (decomp.). Anal. Calcd for $C_{38}H_{43}NO_2SnCl_2$ (735,36) (%): C, 62.07; H, 5.89; N, 1.90. Found (%): C, 62.18; H, 5.97; N, 2.04.

IR (ν, cm^{-1}): ν(C-H) 2850-3050 (s); ν(C=O) 1728 (s); 1430 (s); 1374 (m); 1363 (m); 1243 (s); 1031 (s); 797 (s); 732 (s); 694 (s). ^{1}H NMR (*δ*, ppm): 0.88 (s, 3H, CH_3); 0.99-1.03 (m, 1 H); 1.06 (s, 3H, CH_3); 1.08-1.90 (m, 11H); 1.98-2.02 (m, 2H); 2.04 (s, 3H, $COCH_3$); 2.19-2.40 (m, 3H); 4.50-4.65 (m, 1H, CH); 5.39 (d, $^{3}J_{H\text{-}H}$ = 4 Hz, 1H, C=CH); 6.00 (s, 1H, C=CH); 7.30-7.35 (m, 1H); 7.38-7.46 (m, 6H, 2Ph); 7.65-7.83 (m, 4 H, 2Ph); 7.85 (d, 1H, $^{3}J_{H\text{-}H}$ = 8 Hz; CH Py); 8.39 (d, 1H, $^{3}J_{H\text{-}H}$ = 4 Hz; CH Py); 8.56 (s, 1H, CH Py). ^{13}C NMR (*δ*, ppm): 15.87; 18.81; 20.24; 21.05; 27.29; 29.78; 30.97; 31.50; 34.05; 36.29; 36.44; 37.68; 46.61; 49.61; 56.85; 73.46; 121.73; 124.24; 128.39 ($^{2}J_{C\text{-}Sn}$= 100 Hz); 128.73; 129.75; 131.86; 134.02; 135.11 ($^{3}J_{C\text{-}Sn}$= 64 Hz); 135.71; 135.51; 139.59; 144.33; 149.21; 170.24 (C=O). ^{119}Sn NMR (δ, ppm): -211.76; -297.62.

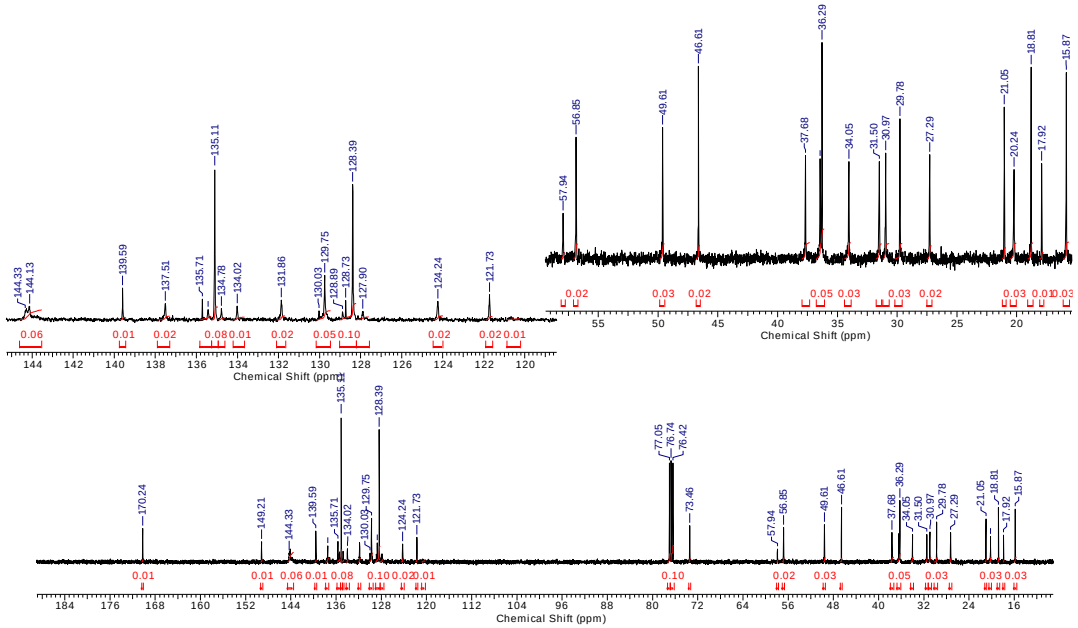
a


Absorbance
Wavenumber (cm-1)

b


Intensity
Chemical Shift (ppm)

c


Chemical Shift (ppm)

d

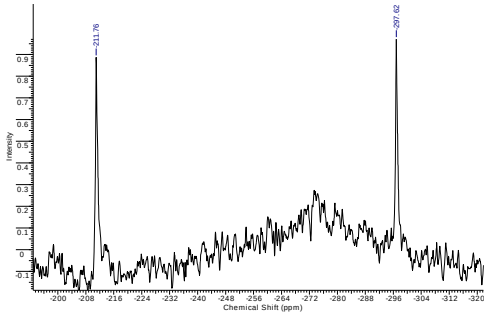


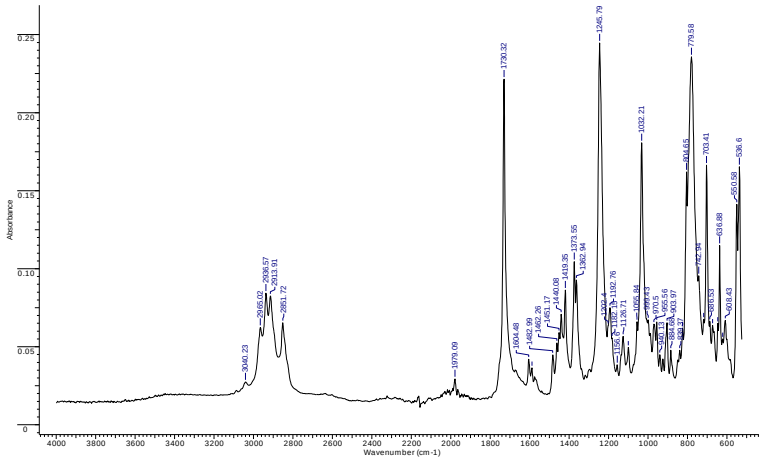
Figure S6. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **4** (Ph_2SnCl_2·AbOAc).

2.7. Complex of abiraterone acetate with trimethyltin chloride (**5**, Me_3SnCl·AbOAc)

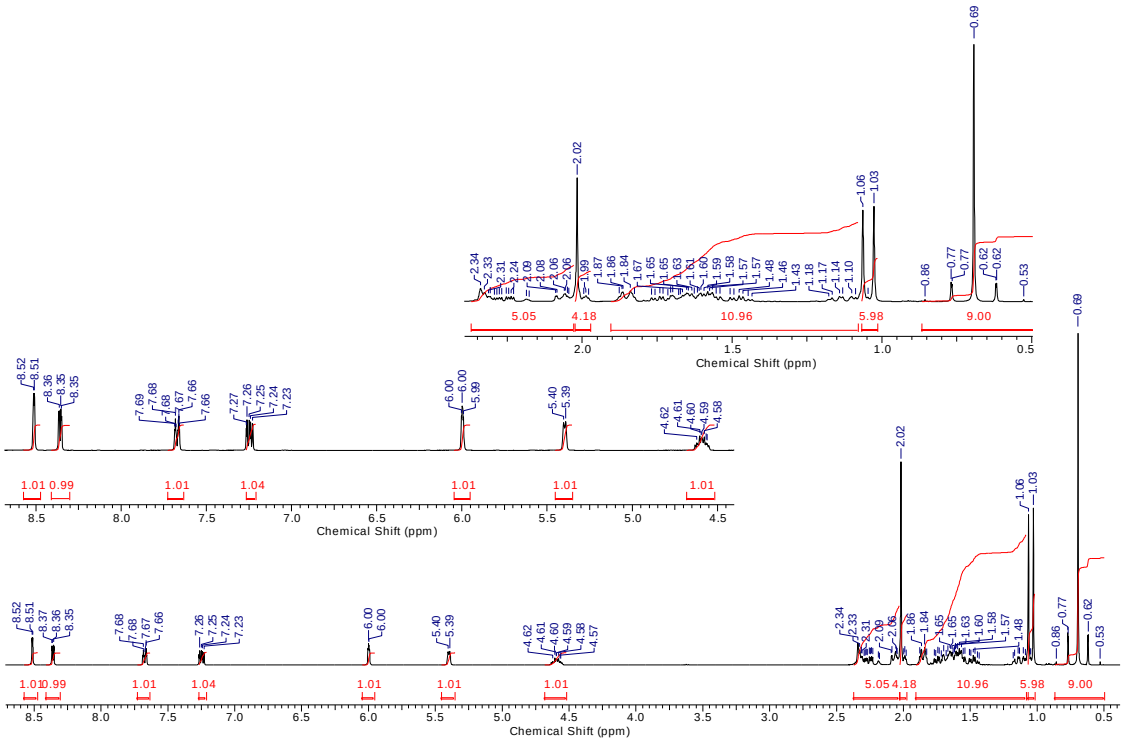
Yield 62 %; white powder; m.p. 110-112 °C (decomp.). Anal. Calcd for $C_{29}H_{42}NO_2SnCl$ (590,80) (%): C, 58.96; H, 7.17; N, 2.37. Found (%): C, 59.14; H, 7.28; N, 2.51.

IR (ν, cm^{-1}): ν(C-H) 2850-2965 (s); ν(C=O) 1730 (s); 1419 (m); 1374 (m); 1362 (m); 1246 (s); 1032 (s); 779 (s); 703 (s); 637 (m); 537 (s). ^{1}H NMR (δ, ppm): 0.69 (s, $^{2}J_{Sn\text{-}H}$ 60 Hz, 9H, $Sn(CH_3)_3$); 1.03 (s, 3H, CH_3); 1.06 (s, 3H, CH_3); 1.10-1.95 (m, 12H); 2.02 (s, 3H, $COCH_3$); 2.05-2.40 (m, 5H); 4.50-4.65 (m, 1H, CH); 5.39 (d, $^{3}J_{H\text{-}H}$ = 4 Hz, 1H, C=CH); 6.00 (s, 1H, C=CH); 7.22-7.28 (m, 1H, CH Py); 7.65-7.70 (m, 1 H, CH Py); 8.35 (d, 1H, $^{3}J_{H\text{-}H}$ = 4 Hz; CH Py); 8.51 (s, 1H, CH Py). ^{13}C NMR (δ, ppm): 0.26 ($^{1}J_{C\text{-}Sn}$ = 404 Hz, $(CH_3)Sn$); 16.17; 18.81; 20.36; 21.01; 27.27; 29.92; 31.03; 31.39; 34.73; 36.32; 36.45; 37.66; 46.88; 49.76; 56.99; 73.46; 121.82; 123.12; 129.51; 133.09; 134.00; 139.55; 146.44; 146.47; 150.76; 170.22 (C=O). ^{119}Sn NMR (δ, ppm): 120.18.

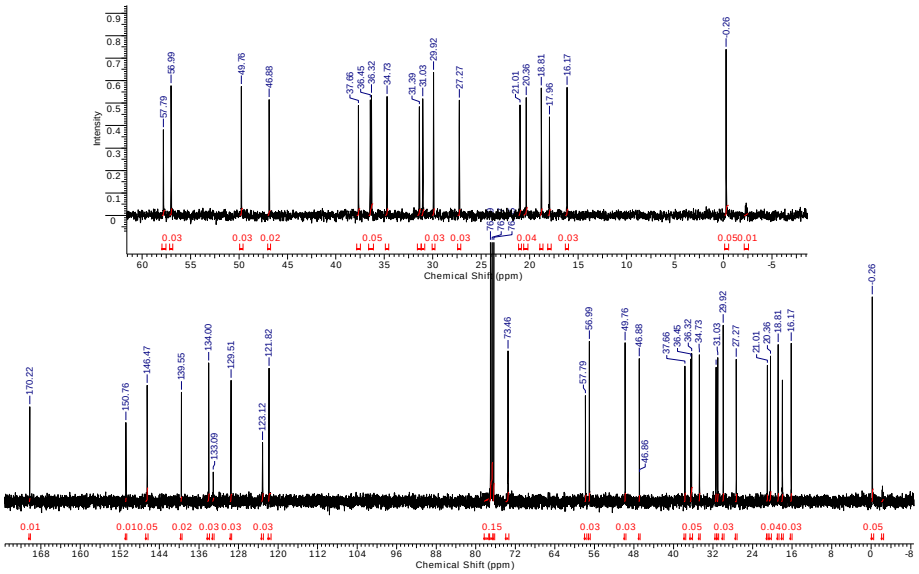
a



b



c



d

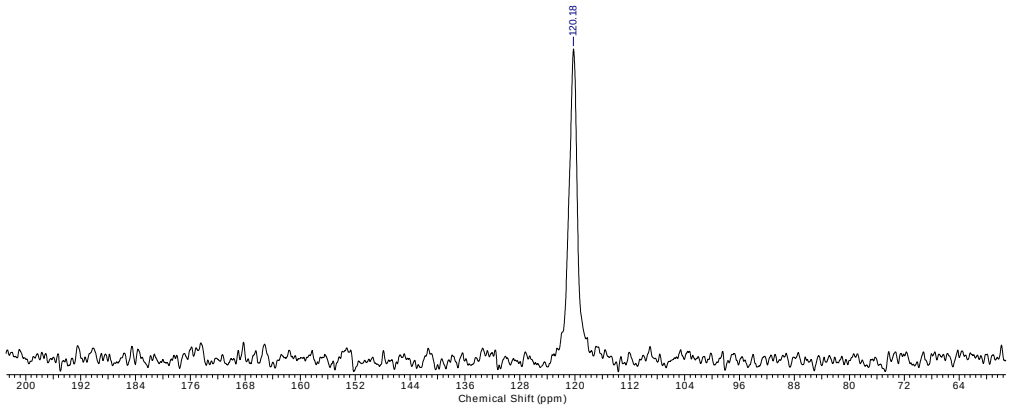


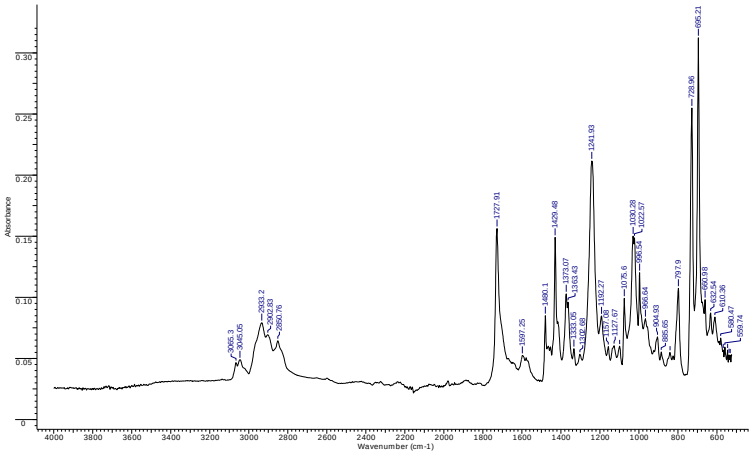
Figure S7. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **5** ($Me_3SnCl \cdot AbOAc$).

2.8. Complex of abiraterone acetate with triphenyltin chloride (6, $Ph_3SnCl \cdot AbOAc$**)**

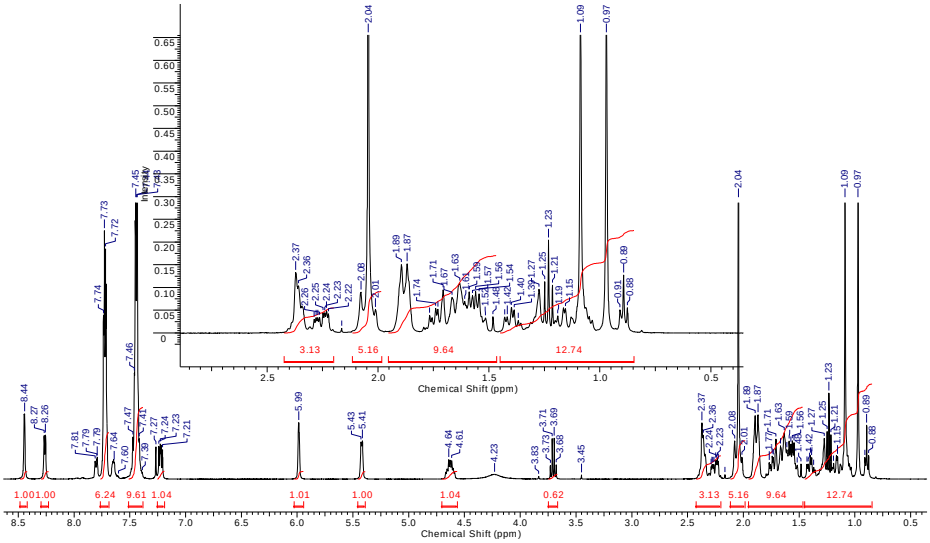
Yield 75 %; white powder; m.p. 112-113 °C. Anal. Calcd for $C_{44}H_{48}NO_2SnCl$ (777.02) (%): C, 68.01; H, 6.23; N, 1.80. Found (%): C, 67.64; H, 6.02; N, 1.63.

IR (ν, cm^{-1}): ν(C-H) 2850-3065(s); ν(C=O) 1728 (s); 1480 (m); 1429 (s); 1373 (m); 1363 (m); 1242 (s); 1030 (s); 798 (m); 729 (s); 695 (s). ^{1}H NMR (*δ*, ppm): 0.97 (s, 3H, CH_3); 1.09 (s, 3H, CH_3); 1.10-1.90 (m, 14H); 2.04 (s, 3H, $COCH_3$); 2.08-2.40 (m, 5H); 4.50-4.70 (m, 1H, CH); 5.42 (d, $^3J_{H\text{-}H}$ = 8 Hz, 1H, C=CH); 5.99 (s, 1H, C=CH); 7.19-7.26 (m, 1H, CH Py); 7.35-7.50 (m, 9 H, Ph); 7.60-7.80 (m, 6 H, $^3J_{H\text{-}Sn}$ 60 Hz, Ph); 8.26 (d, 1H, $^3J_{H\text{-}H}$ = 4 Hz; CH Py); 8.44 (s, 1H, CH Py). ^{13}C NMR (*δ*, ppm): 16.06; 18.85; 20.33; 21.05; 27.32; 29.91; 31.05; 31.43; 34.53; 36.35; 36.49; 37.71; 46.77; 49.75; 56.97; 73.44; 121.83; 123.28; 128.62 ($^2J_{C\text{-}Sn}$ = 64 Hz, (C_6H_5)Sn); 129.73 ($^4J_{C\text{-}Sn}$ = 13 Hz, (C_6H_5)Sn); 129.97; 133.11; 134.76; 135.82 ($^3J_{C\text{-}Sn}$ = 48 Hz, (C_6H_5)Sn); 138.25; 139.61; 145.92; 146.04; 150.43; 170.17 (C=O). ^{119}Sn NMR (δ, ppm): -69.32.

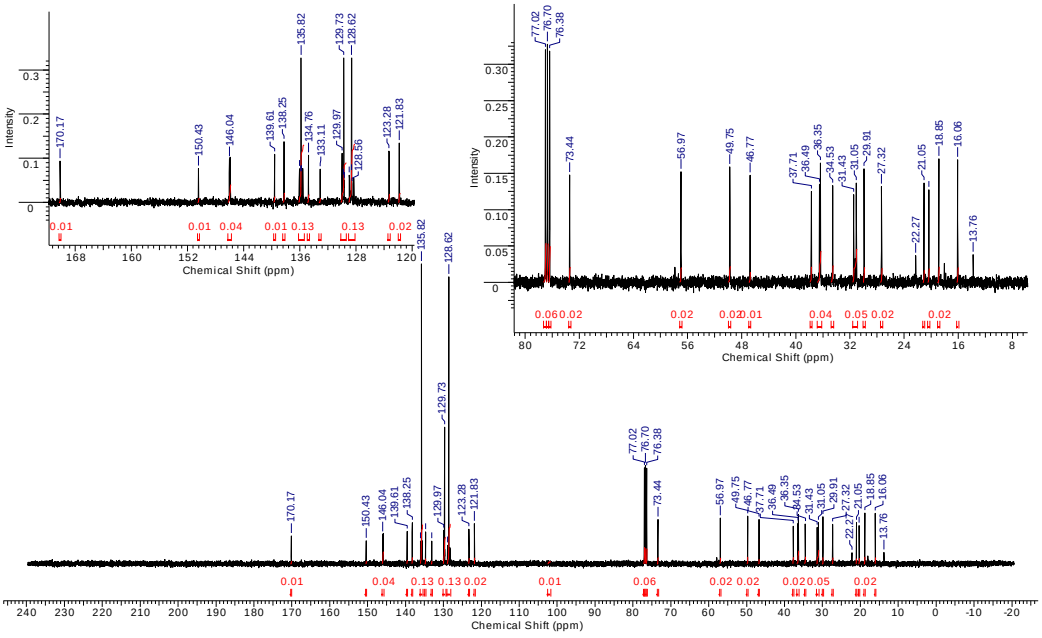
a



b



c



d

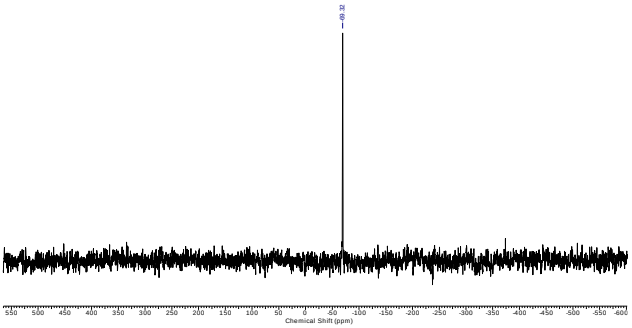


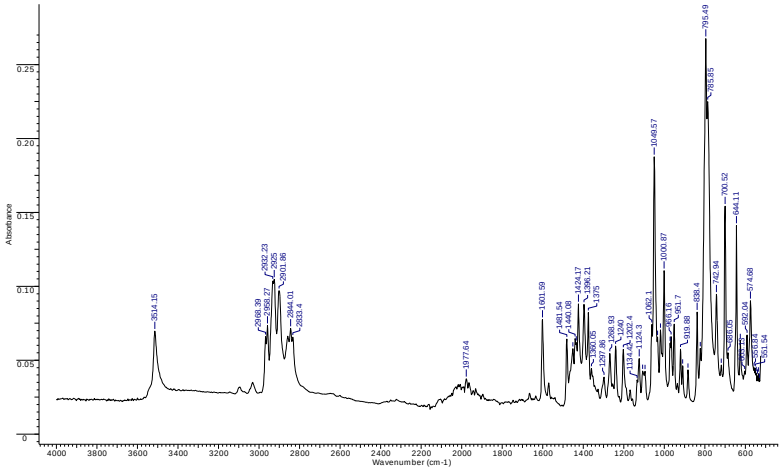
Figure S8. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **6** (Ph_3SnCl·AbOAc).

2.9. Complex of abiraterone with dimethyltin dichloride (**7**, Me_2SnCl_2·AbOH)

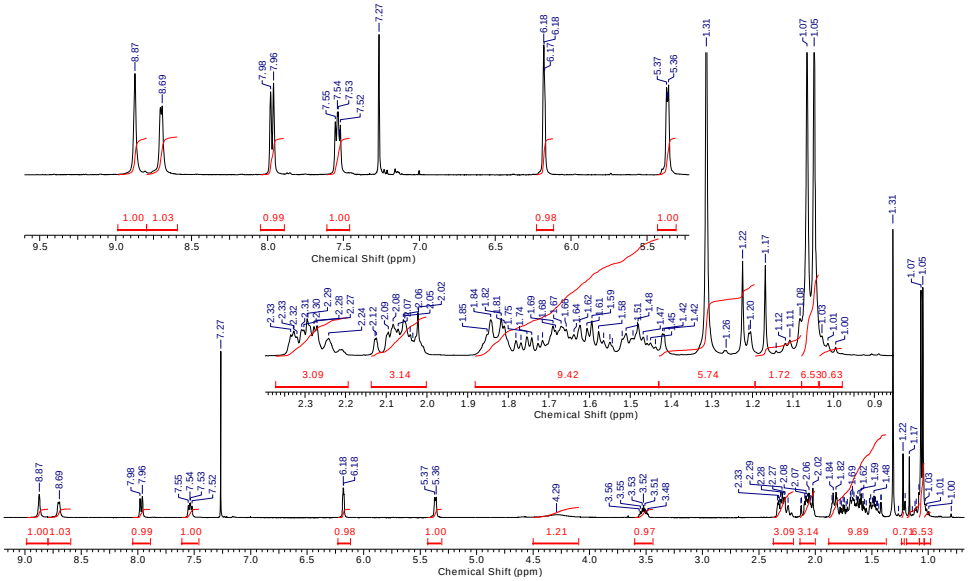
Yield 69%; white powder; m.p. 218-220 °C (decomp.). Anal. Calcd for $C_{26}H_{37}NOSnCl_2$ (569.18) (%): C, 54.87; H, 6.55; N, 2.46. Found (%): C, 54.32; H, 6.31; N, 2.27.

IR (ν, cm^{-1}): ν(O-H) 3514 (s); ν(C-H) 2833-2969 (s); ν(C=C) 1601 (m); 1481(m); 1424 (m); 1375 (m); 1049 (s); 795 (s); 786 (s); 701 (s); 644 (m). ^{1}H NMR (δ, ppm): 1.05 (s., 3H, CH_3); 1.07 (s., 3H, CH_3); 1.08-1.25 (m, 2H); 1.31 (s, 6H, $Sn(CH_3)_2$, $^{2}J_{H\text{-}Sn}$ = 88 Hz); 1.47-1.87 (м, 9H); 2.00-2.35 (m, 6H); 3.45-3.60 (m, 1H, CH); 4.29 (s. wide, 1H, OH); 5.36 (d, $^{3}J_{H\text{-}H}$ = 4 Hz, 1H, C=CH); 6.18 (s, 1H, C=CH); 7.50-7.60 (m, 1H, CH Py); 7.97 (d, 1H, $^{3}J_{H\text{-}H}$ = 8 Hz; CH Py); 8.69 (d, 1H, $^{3}J_{H\text{-}H}$ = 4 Hz; CH Py); 8.87 (s, 1H, CH Py). ^{13}C NMR (δ, ppm): 15.03 (Sn-CH_3); 16.20; 18.93; 20.41; 29.90; 30.99; 31.12; 31.60; 34.60; 36.24; 36.72; 41.78; 46.94; 49.76; 57.05; 71.20; 120.74; 124.59; 132.20; 134.74 137.31; 140.74; 143.39; 143.45; 149.38. ^{119}Sn NMR (δ, ppm): -116.12; -65.12.

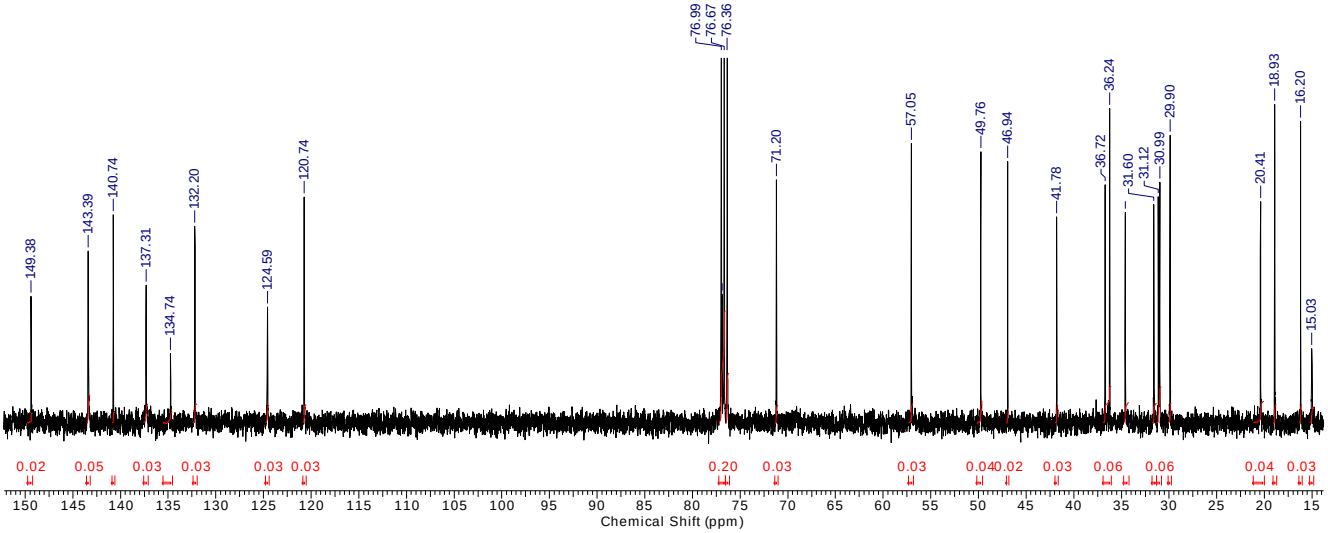
a


Absorbance
Wavenumber (cm-1)

b


Chemical Shift (ppm)

c


Chemical Shift (ppm)

d

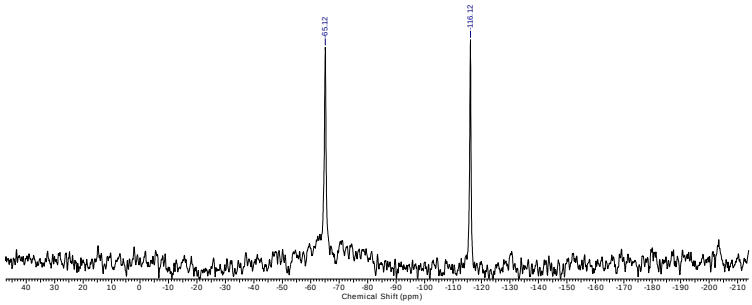


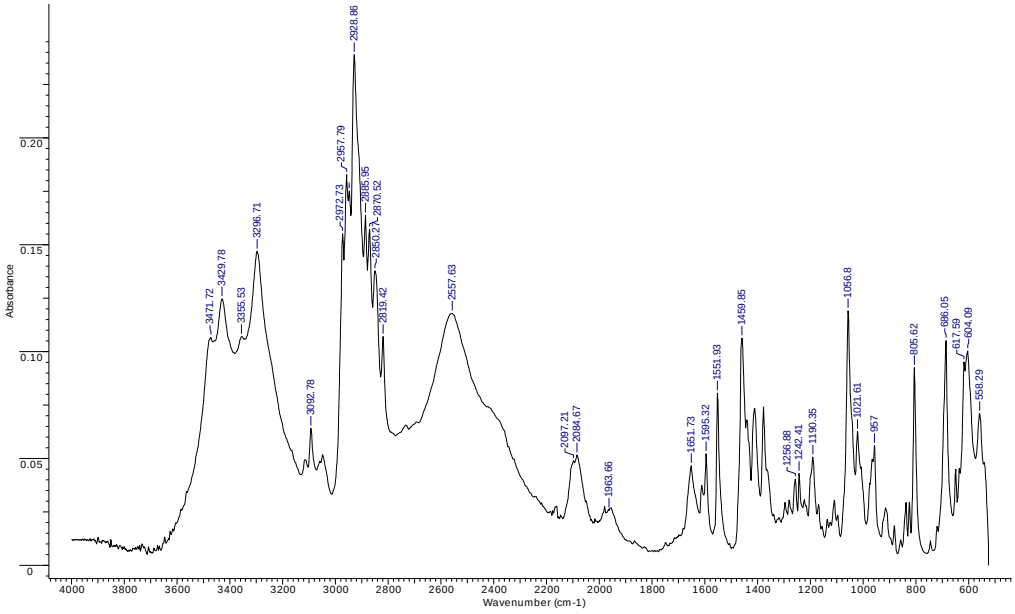
Figure S9. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **7** ($Me_2SnCl_2 \cdot AbOH$).

2.10. Complex of abiraterone with diethyltin dichloride (8, $Et_2SnCl_2 \cdot AbOH$)

Yield 65 %; white powder; m.p. 150-153 °C (decomp.). Anal. Calcd for $C_{28}H_{41}NOSnCl_2$ (597.23) (%): C, 56.31; H, 6.92; N, 2.35. Found (%): C, 56.13; H, 6.73; N, 2.21.

IR (ν, cm^{-1}): ν(O-H) 3471-3297 (s, wide); ν(C-H) 2819-2972 (s); ν(C=C) 1652 (w); 1551 (w); 1460 (m); 1411 (w); 1377 (m); 1190 (w); 1057 (s); 957 (w); 805 (s); 686 (s); 604 (s). ^{1}H NMR (*δ*, ppm): 1.05 (s, 3H, CH_3); 1.06 (s, 3H, CH_3); 1.08-1.30 (m, 3H); 1.38 (t, $^{3}J_{H\text{-}H}$ = 8 Hz, 6H, 3C$\underline{H}_3$CH_2); 1.42-1.90 (m, 14H); 2.04-2.33 (m, 6H); 3.34 (s, 1H, OH); 3.50-3.60 (m, 1H, CH); 5.37 (d, $^{3}J_{H\text{-}H}$ = 4 Hz, 1H, C=CH); 6.13-6.20 (m, 1H, C=CH); 7.51 (dd, 1H, $^{3}J_{H\text{-}H}$ = 4 Hz; 4 Hz, CH Py); 7.95 (d, 1H, $^{3}J_{H\text{-}H}$ = 8 Hz; CH Py); 8.66 (s. wide, 1H, CH Py); 8.83 (s. wide, 1H, CH Py). ^{13}C NMR (*δ*, ppm): 9.53; 16.16; 18.90; 20.41; 24.67; 29.93; 31.00; 31.13; 31.58; 34.64; 36.25; 36.73; 41.80; 46.95; 49.81; 57.08; 71.19; 120.72; 124.33; 127.18; 131.87; 137.00; 140.77; 143.69; 143.76; 149.60. ^{119}Sn NMR (δ, ppm): -138.7; -91.0.

a



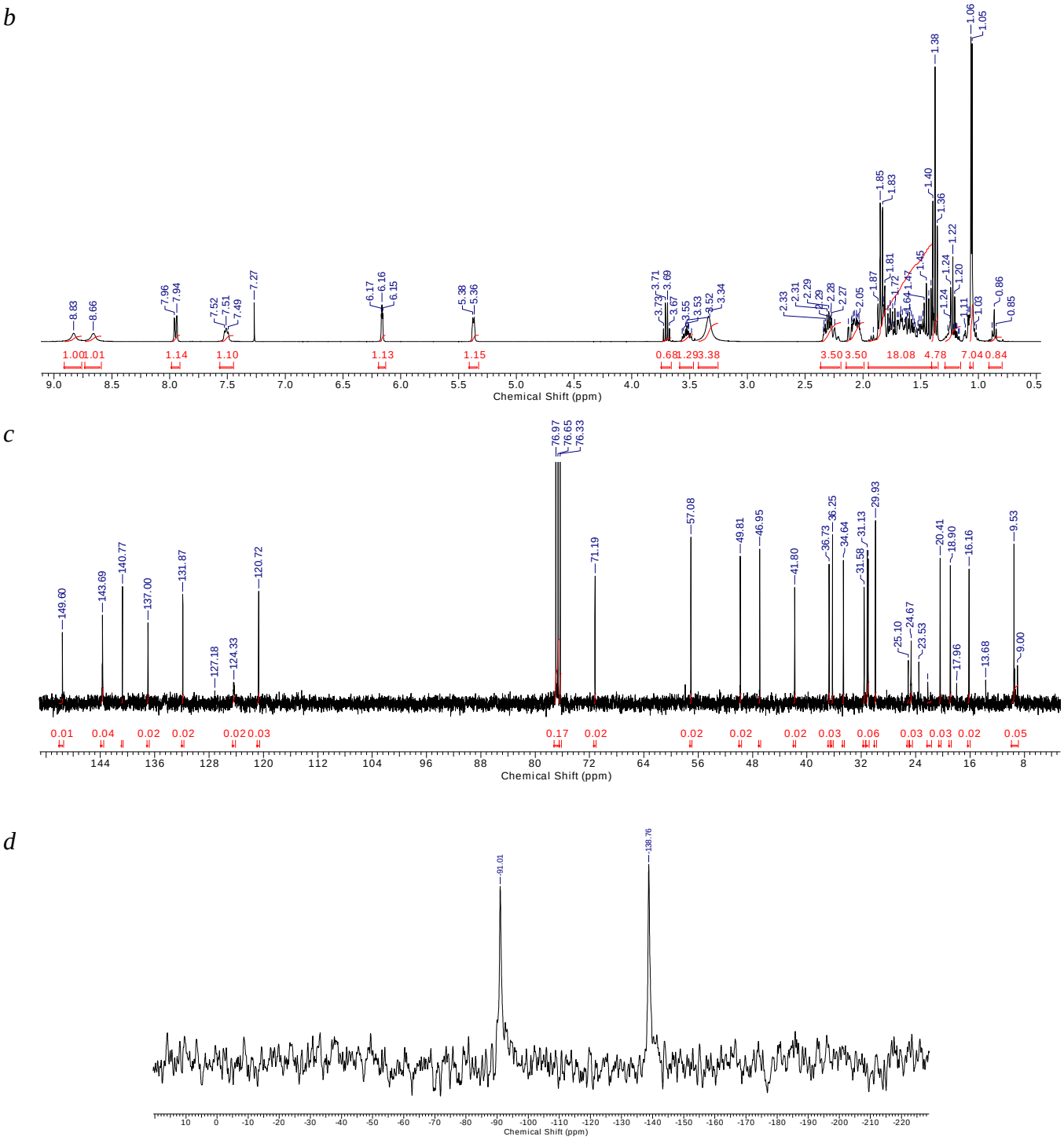


Figure S10. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **8** ($Et_2SnCl_2 \cdot AbOH$).

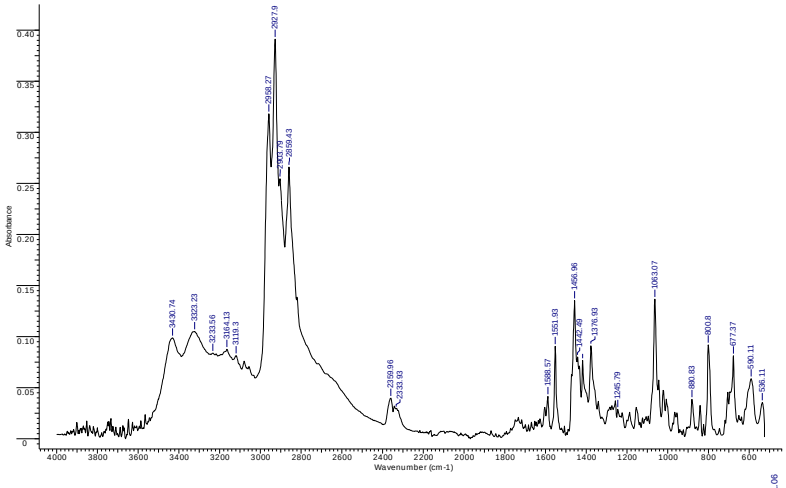
2.11. Complex of abiraterone with dibutyltin dichloride (**9**, $Bu_2SnCl_2 \cdot AbOH$)

Yield 64 %; white powder; m.p. 128-130 °C (decomp.). Anal. Calcd for $C_{32}H_{49}NOSnCl_2$ (653,34) (%): C, 58.83; H, 7.56; N, 2.14. Found (%): C, 59.05; H, 7.68; N, 2.27.

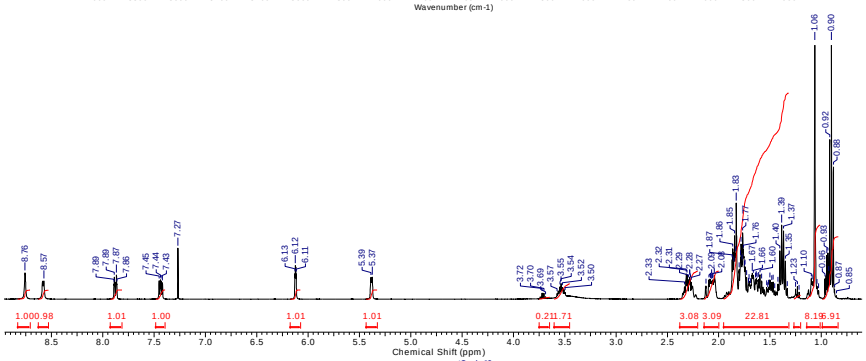
IR (ν, cm−1): ν(O-H) 3450-3300 (wide); ν(C-H) 2859-2958 (s); ν(C=C) 1558 (w); 1552; 1457 (s); 1376 (m); 1063 (s); 881 (w); 801 (w); 677 (w). ^{1}H NMR (δ, ppm): 0.90 (t, $^{3}J_{H\text{-}H}$ = 8 Hz, 6H, 2 CH-C$\underline{H}_3$); 1.06 (s. wide, 6H, $2CH_3$); 1.10-1.95 (m, 23H); 2.00-2.40 (m, 6H); 3.45-4.65 (m, 1H, CH); 5.38 (d, $^{3}J_{H\text{-}H}$ = 8 Hz, 1H, C=CH); 6.10-6.15 (m, 1H, C=CH); 7.44 (dd, 1H, $^{3}J_{H\text{-}H}$ = 8 Hz; 4 Hz, CH Py);

7.88 (d, 1H, $^{3}J_{H\text{-}H}$ = 8 Hz; CH Py); 8.57 (d, 1H, $^{3}J_{H\text{-}H}$ = 4 Hz; CH Py); 8.76 (s, 1H, CH Py). ^{13}C NMR (δ, ppm): 13.16; 16.18; 18.92; 20.41; 25.85; 26.87 ($^{2}J_{C\text{-}Sn}$= 36 Hz); 29.93; 30.27; 31.02; 31.16; 31.55; 34.68; 36.25; 36.73; 41.83; 46.93; 49.81; 57.08; 71.21; 120.78; 123.93; 131.19; 134.06; 136.13; 140.76; 144.51; 144.56; 149.96. ^{119}Sn NMR (δ, ppm): -90.93; -138.05.

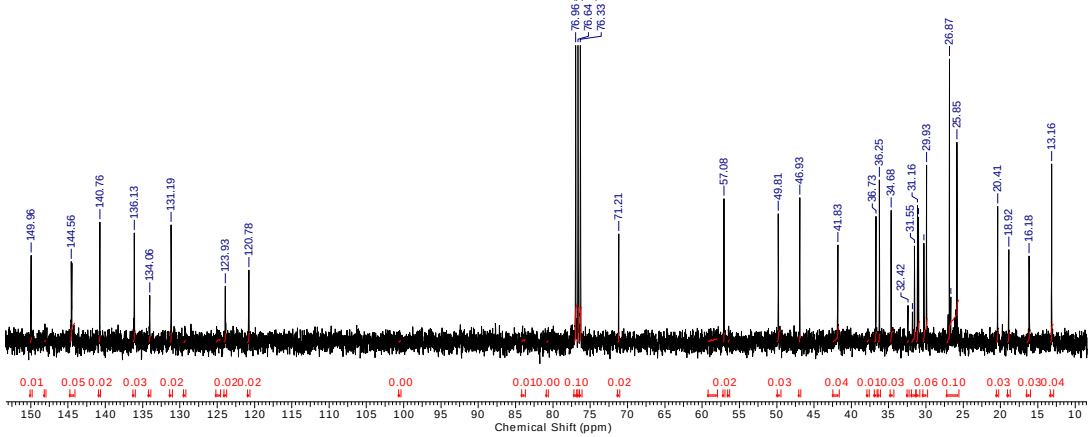
a



b



c



d

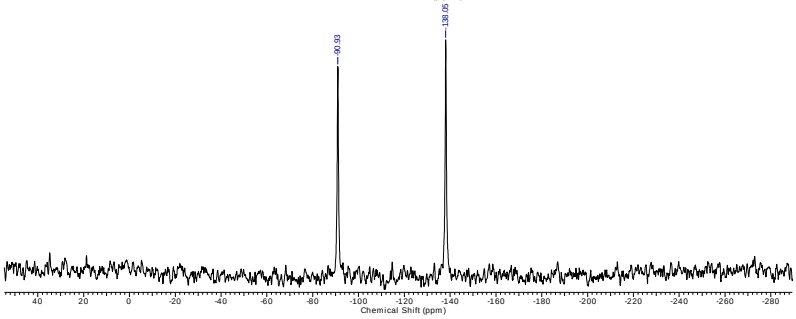


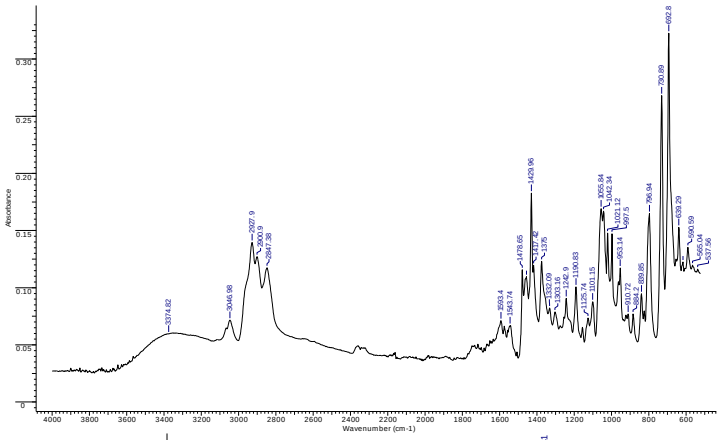
Figure S11. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **9** (Bu_2SnCl_2·AbOH).

2.12. Complex of abiraterone with diphenyltin dichloride (10, $Ph_2SnCl_2 \cdot AbOH$**)**

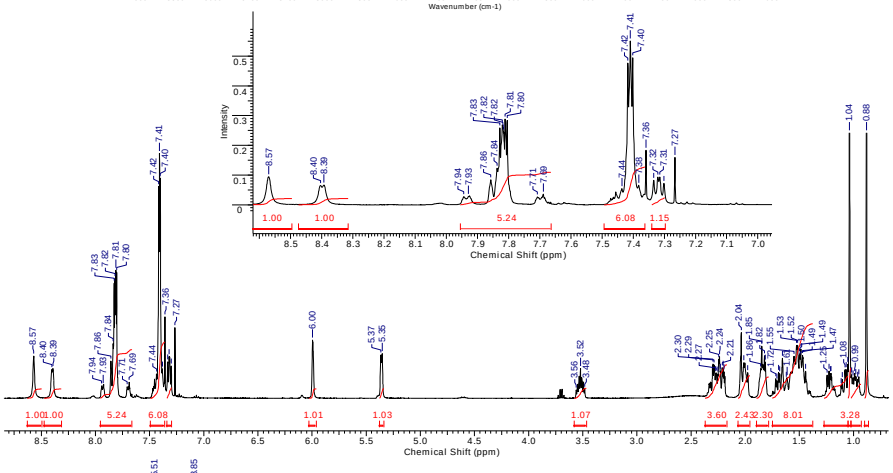
Yield 61 %; white powder; m.p. 130-135 °C (decomp). Anal. Calcd for $C_{36}H_{41}NOSnCl_2$ (693.33) (%): C, 62.37; H, 5.96; N, 2.02. Found (%): C, 62.21; H, 5.83; N, 1.92.

IR (ν, cm^{-1}): ν(O-H) 3200-3500 (wide); ν(C-H) 2847-3047 (s); ν(C=C) 1593 (w); 1543 (w); 1478 (m); 1430 (m); 1375 (m); 1055 (s); 1021 (w); 997 (s); 797 (s); 731 (s); 693 (s). ^{1}H NMR (δ, ppm): 0.88 (s, 3H, CH_3); 1.04 (s, 3H, CH_3); 1.05-2.35 (m, 19H); 3.40-3.60 (m, 1H, CHOH); 5.36 (d, $^3J_{H\text{-}H}$ = 8 Hz, 1H, C=CH); 6.00 (s, 1H, C=CH); 7.31 (dd, 1H, $^3J_{H\text{-}H}$ = 4Hz; $^3J_{H\text{-}H}$ =8 Hz; CH Py); 7.35-7.50 (m, 6H, 2 Ph); 7.60-7.95 (m, 4 H, 2Ph; CH Py); 8.39 (d, 1H, $^3J_{H\text{-}H}$ = 4 Hz; CH Py); 8.57 (s, 1H, CH Py). ^{13}C NMR (δ, ppm): 15.89; 18.89; 20.30; 29.84; 30.99; 31.15; 31.49; 34.11; 36.21; 36.71; 41.81; 46.63; 49.72; 56.94; 71.25; 121.77; 123.94; 128.43 ($^2J_{C\text{-}Sn}$= 100 Hz); 128.80; 131.37; 133.78; 135.11 ($^3J_{C\text{-}Sn}$= 66 Hz); 136.85; 140.73; 145.03; 145.00; 149.54. ^{119}Sn NMR (δ, ppm): -211.92; -297.70.

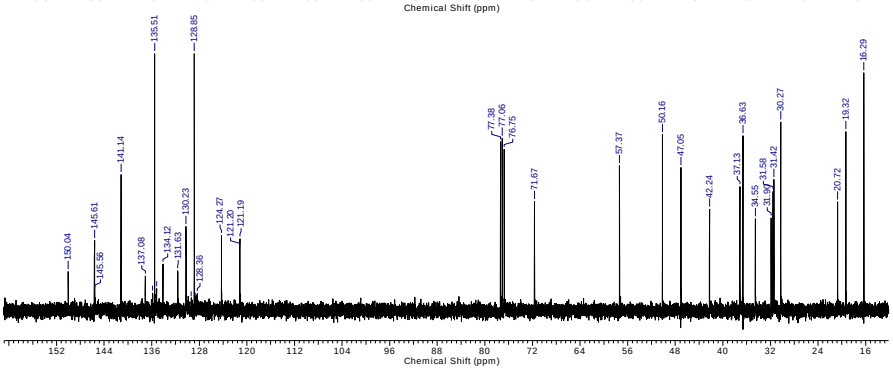
a



b



c



d

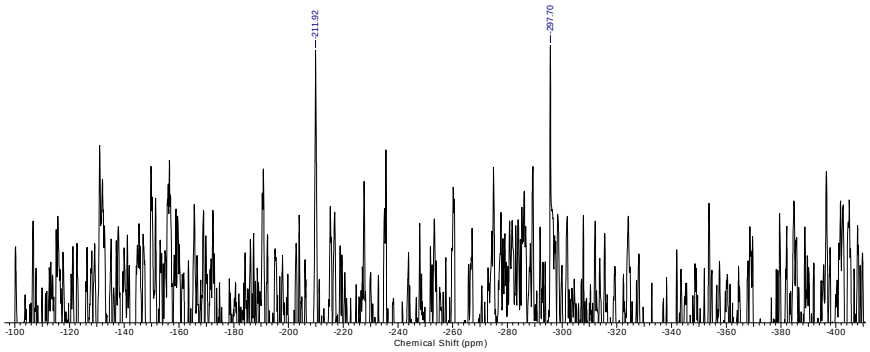


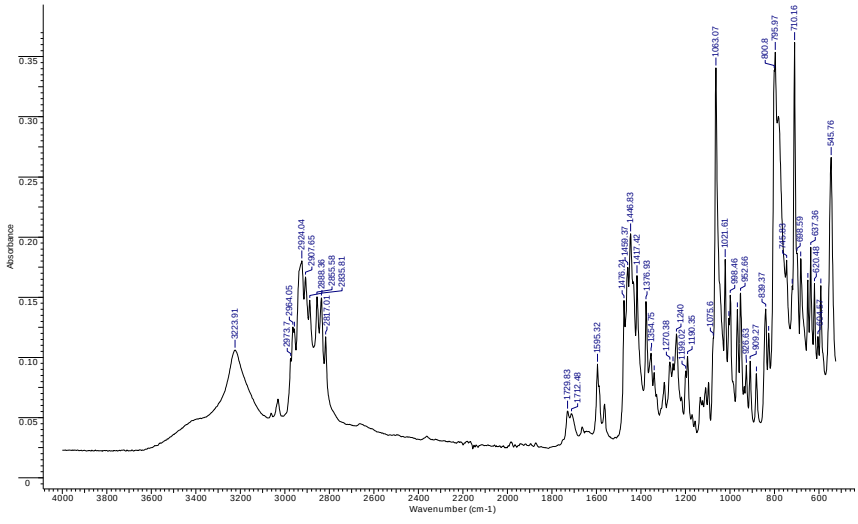
Figure S12. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn(d) NMR spectra ($CDCl_3$) of compound **10** (Ph_2SnCl_2·AbOH).

2.13. Complex of abiraterone with trimethyltin chloride (11, Me_3SnCl·AbOH**)**.

Yield 58 %; white powder; m.p. 225-227°C (decomp.). Anal. Calcd for $C_{27}H_{40}NOSnCl$ (548,77) (%): C, 59.10; H, 7.35; N, 2.55. Found (%): C, 59.23; H, 7.48; N, 2.69.

IR (ν, cm^{-1}): ν(O-H) 3224 (s); ν(C-H) 2817-2973 (s); ν(C=C) 1595 (m); 1447 (s); 1417 (s); 13774 (s); 1240 (m); 1063 (s); 1021 (m); 796 (s); 710 (s); 546 (s). ^{1}H NMR (*δ*, ppm): 0.69 (s, $^{2}J_{Sn-H}$ 60 Hz, 9H, $Sn(CH_3)_3$); 1.03 (s, 3H, CH_3); 1.06 (s, 3H, CH_3); 1.10-1.90 (m, 11H); 1.99-2.35 (m, 6H); 3.45-3.60 (m, 1H, CH); 5.37 (d, $^{3}J_{H-H}$ = 4 Hz, 1H, C=CH); 6.00 (s, 1H, C=CH); 7.23-7.25 (m, 1H, CH Py); 7.65-7.70 (m, 1 H, CH Py); 8.37 (d, 1H, $^{3}J_{H-H}$ = 8 Hz; CH Py); 8.53 (s, 1H, CH Py). ^{13}C NMR (*δ*, ppm): 0.37 ($^{1}J_{C-Sn}$ = 411 Hz, $(CH_3)Sn$); 16.19; 18.92; 20.44; 29.99; 31.07; 31.17; 31.42; 34.81; 36.27; 36.76; 41.86; 46.91; 49.89; 57.10; 71.16; 120.81; 123.03; 129.41; 133.01; 133.86; 140.79; 146.60; 146.66; 150.88. ^{119}Sn NMR (δ, ppm): 126.69.

a



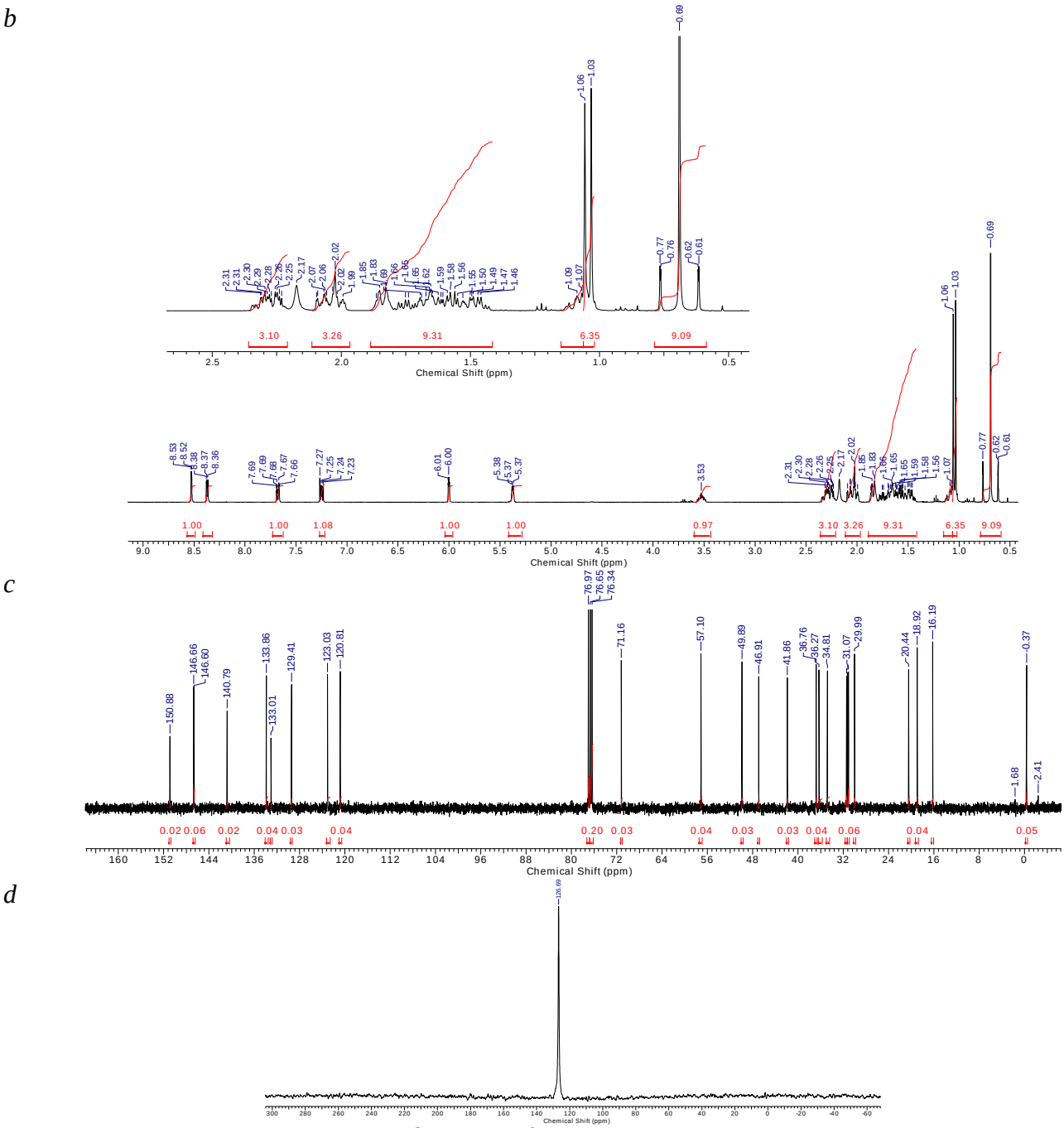


Figure S13. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **11** ($Me_3SnCl \cdot AbOH$).

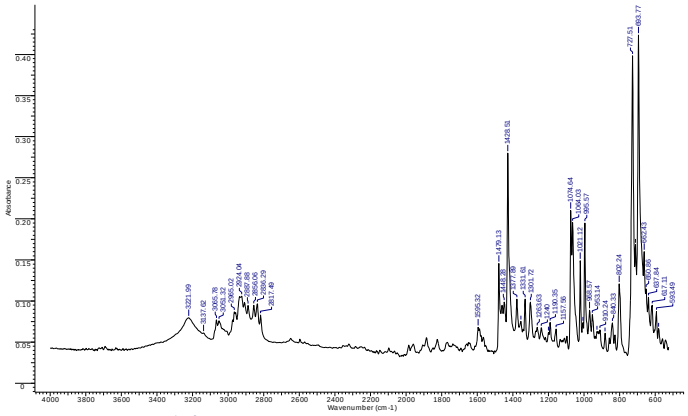
2.14. Complex of abiraterone with triphenyltin chloride (12, $Ph_3SnCl \cdot AbOH$)

Yield 78 %; white powder; m.p. 170-172 °C (decomp.). Anal. Calcd for $C_{42}H_{46}NOSnCl$ (734.98) (%): C, 68.64; H, 6.31; N, 1.91. Found (%): C, 68.90; H, 6.42; N, 2.12.

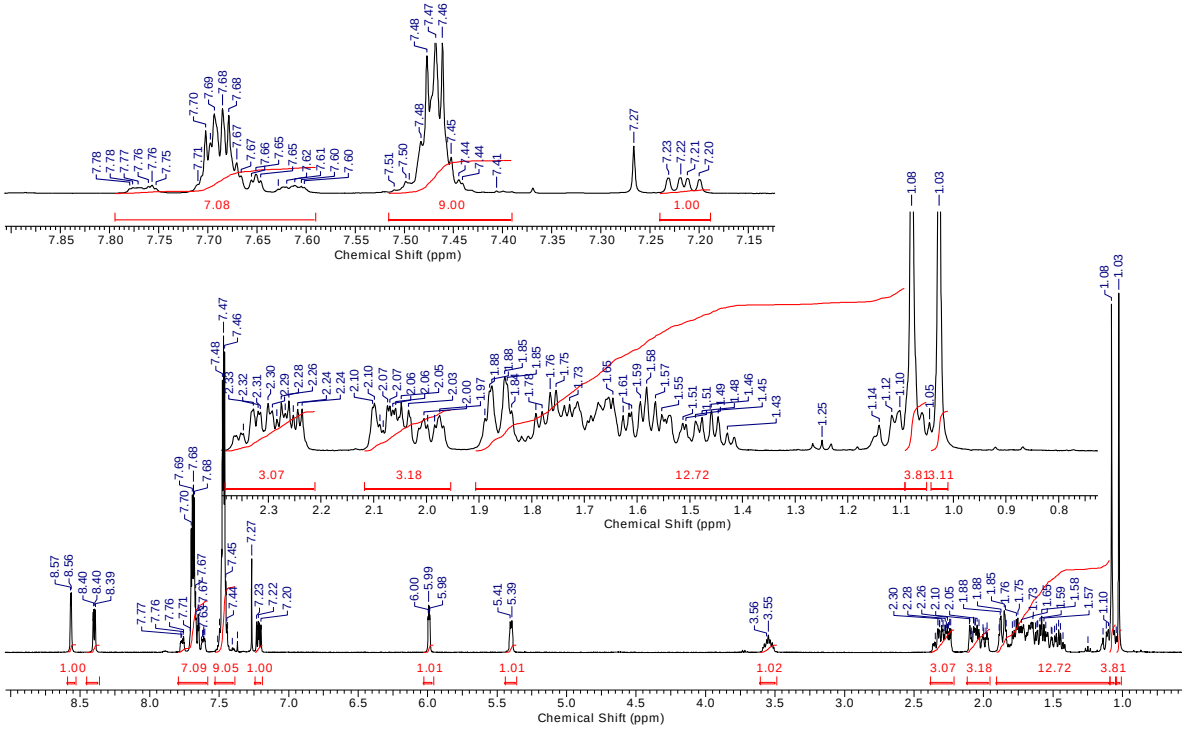
IR (ν, cm−1): ν(O-H) 3100-3300 (m); ν(C-H) 2817-3065(m); ν(C=C) 1595 (m); 1479 (s); 1428 (s); 1378 (m); 1301 (m); 1074 (s); 1064 (s); 1021 (s); 995 (s); 802 (m); 727 (s); 694 (s). ^{1}H NMR (δ, ppm): 1.03 (s, 3H, CH_3); 1.05-1.07 (m, 1H); 1.08 (s, 3H, CH_3); 1.10-1.90 (m, 13H); 1.95-2.35 (m, 6H); 3.50-3.60 (m, 1H, CH); 5.40 (d, $^{3}J_{H\text{-}H}$ = 8 Hz, 1H, C=CH); 5.99 (s, 1H, C=CH); 7.18-7.24 (m, 1H, CH Py); 7.40-7.50 (m, 9 H, 3Ph); 7.60-7.80 (m, 7H, Ph+1H); 8.40 (d, 1H, $^{3}J_{H\text{-}H}$ = 4 Hz; CH Py); 8.57 (s, 1H,

CH Py). ^{13}C NMR (δ, ppm): 16.13; 18.93; 20.44; 30.02; 31.10; 31.21; 31.39; 34.78; 36.28; 36.76; 41.89; 46.89; 49.93; 57.12; 71.26; 120.90; 122.70; 128.70 ($^{2}J_{C\text{-}Sn}$ = 62 Hz, (C_6H_5)Sn); 128.96; 129.96; 132.62; 133.46; 135.74 ($^{3}J_{C\text{-}Sn}$ = 49 Hz, (C_6H_5)Sn); 137.30; 140.75; 147.29; 147.35; 151.16. ^{119}Sn NMR (δ, ppm): -68.42.

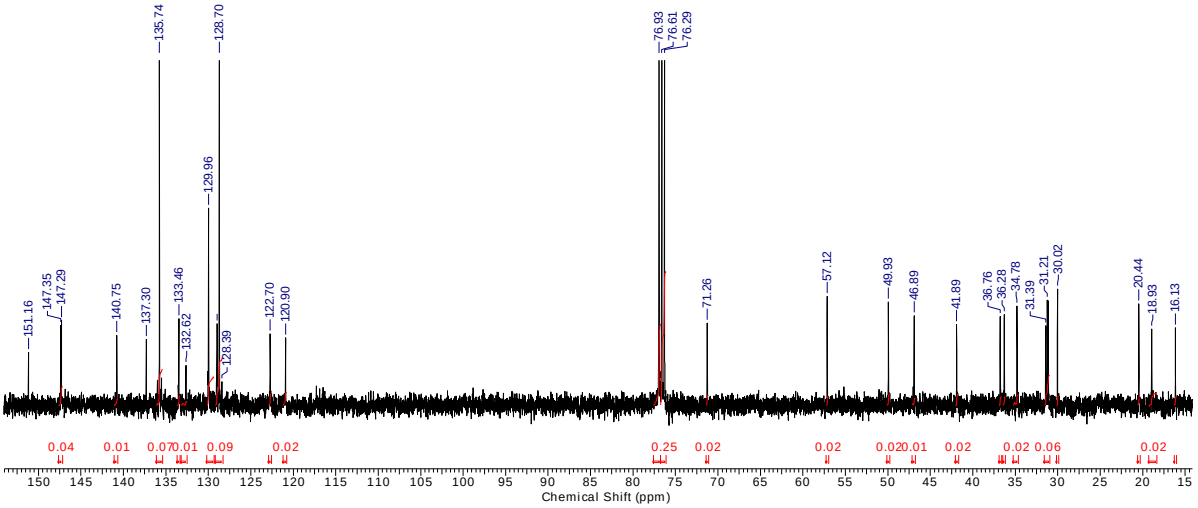
a



b



c



d

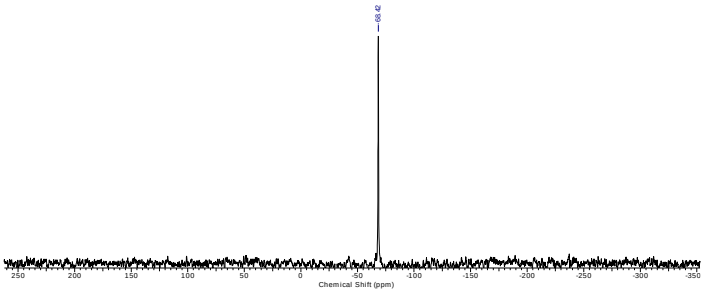
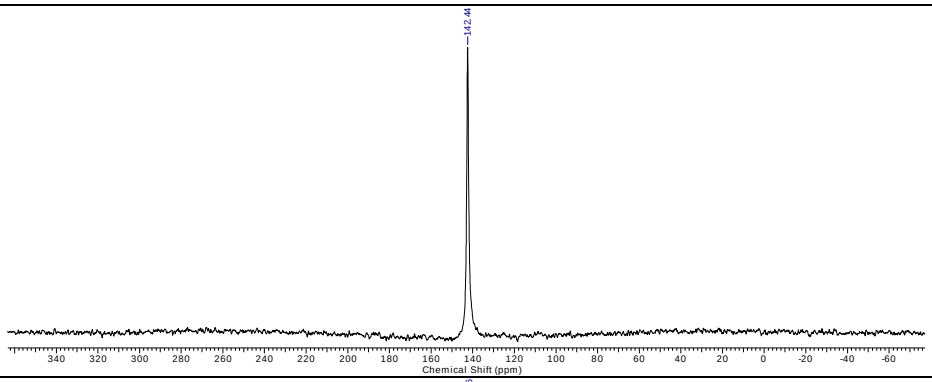
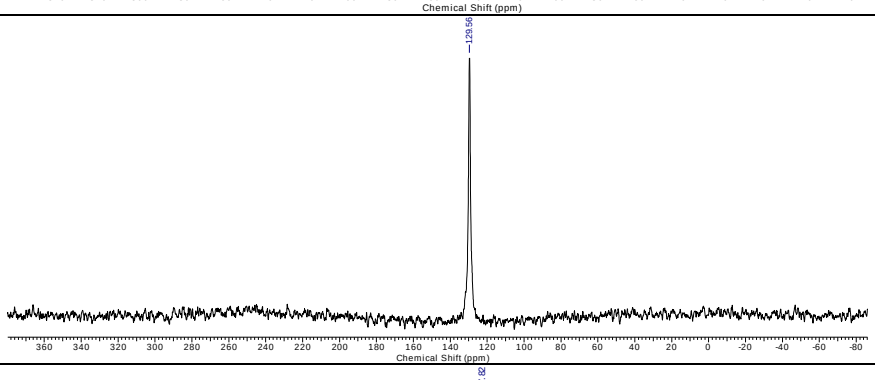
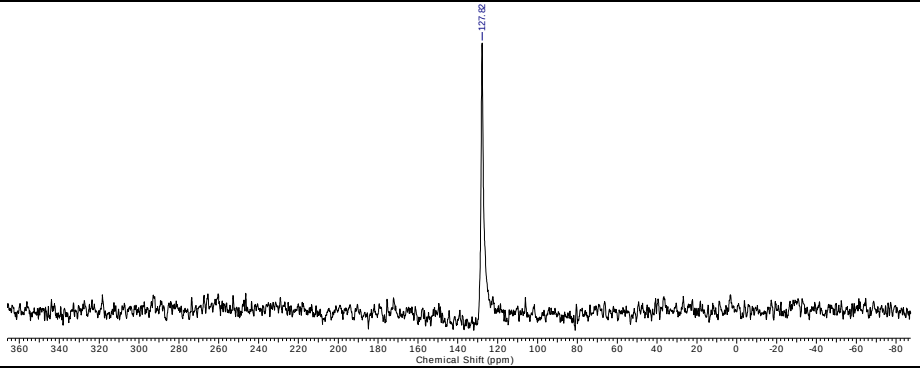


Figure S14. IR (a) and ^{1}H (b), ^{13}C (c), ^{119}Sn (d) NMR spectra ($CDCl_3$) of compound **12** ($Ph_3SnCl \cdot AbOH$).

Me_2SnCl_2	
Et_2SnCl_2	
Bu_2SnCl_2	

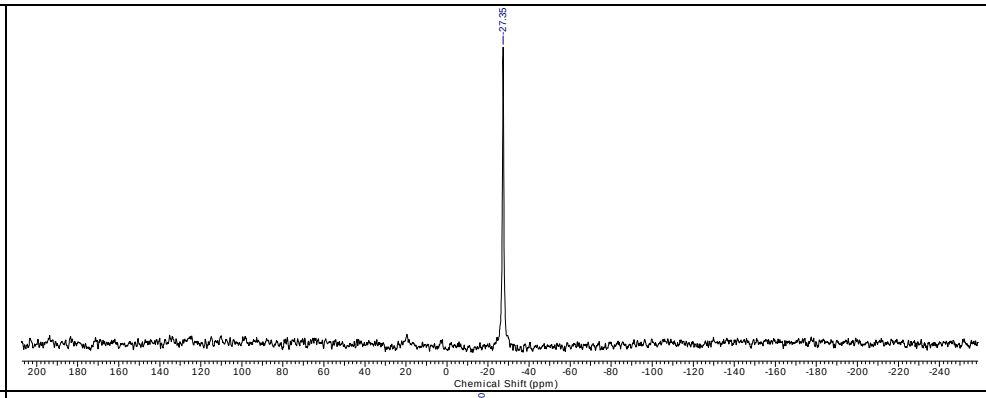
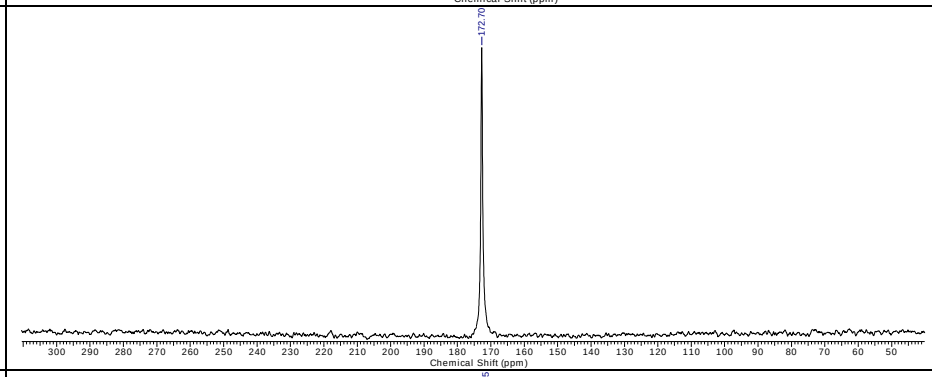
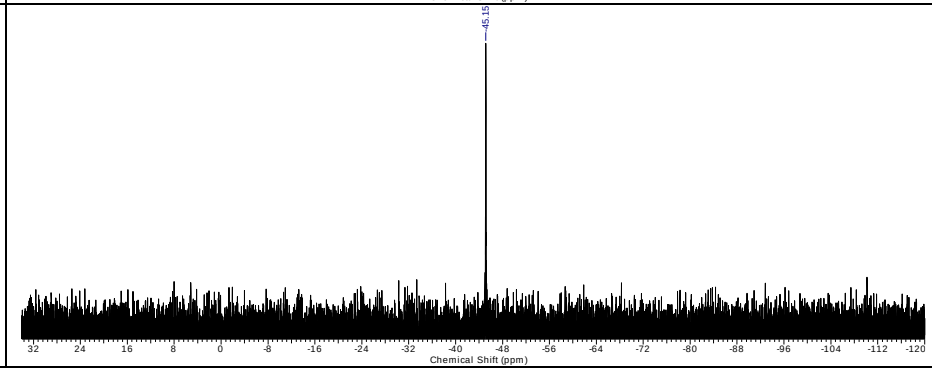
Ph_2SnCl_2	
Me_3SnCl	
Ph_3SnCl	

Figure S15. ^{119}Sn NMR spectra ($CDCl_3$) of starting organotin chlorides.

3. Hydrolysis

The study of compounds in buffer media (phosphate buffer, pH 5.5) was carried out using an Evolution 300 cuvette spectrophotometer in the range of 200-750 nm at room temperature. The initial concentration of solutions of compounds **6**, **12**, AbOAc and AbOH in dimethyl sulfoxide was 2 mM (Figure S16).

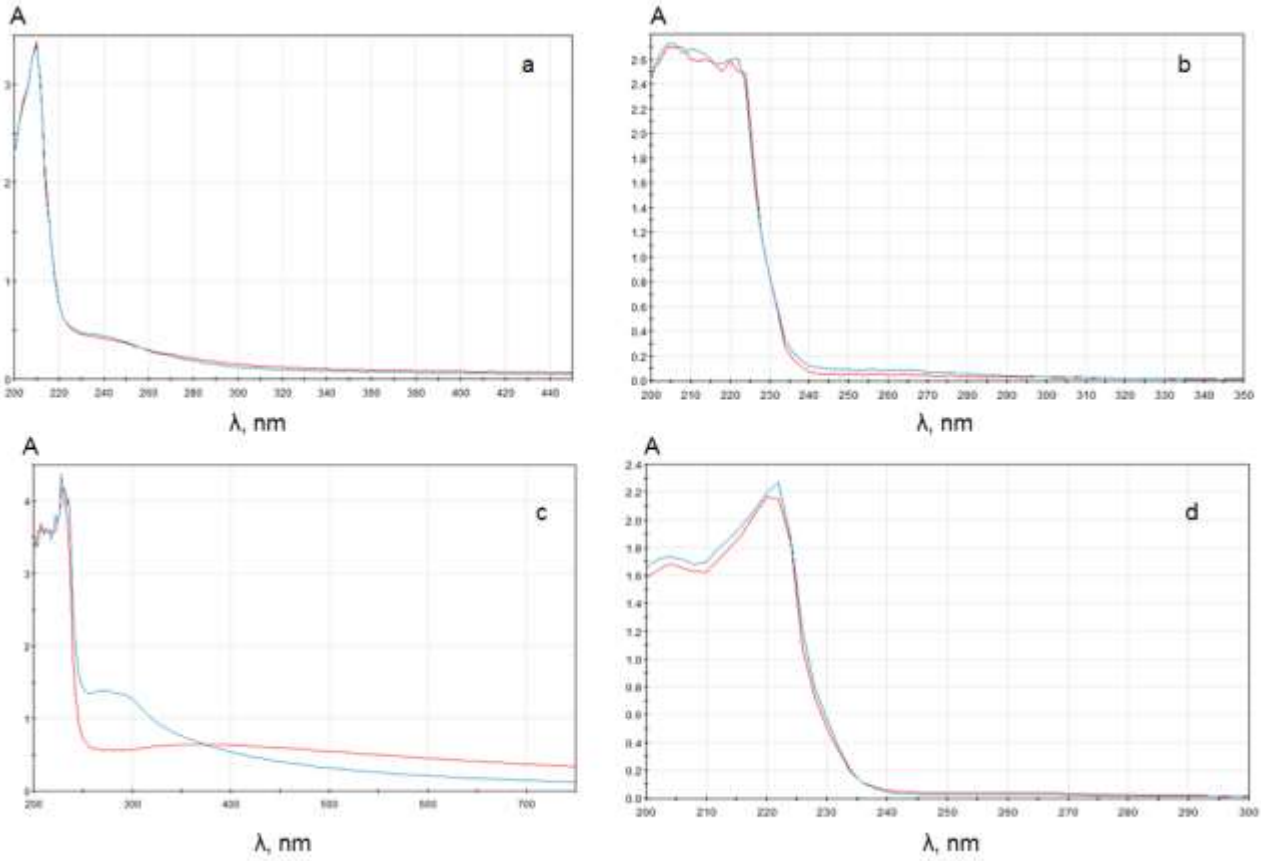


Figure S16. Changes in the absorption spectra of **6** (a), **12** (b), AbOAc (c) and AbOH (d), phosphate buffer, pH 5.5. Blue color indicates the absorption spectrum at the beginning of the experiment, red – after 20 h (after 2 h in the case of AbOAc).

4. CUPRAC assay (Cu^{2+} ion reducing)

Copper Reducing Antioxidant Capacity (CUPRAC) assay proposed by Apak *et al*. [R. Apak, K. Güçlü, M. Özyürek, S.E. Karademir, *J. Agric. Food. Chem*., 2004, **52**, 7970-7981] was used with slight modification [T.A. Antonenko, Yu.A. Gracheva, D.B. Shpakovsky, M.A. Vorobyev, D.M. Mazur, V.A. Tafeenko, Yu.F. Oprunenko, E.F. Shevtsova, P.N. Shevtsov, A.A. Nazarov, E.R. Milaeva, *Int. J. Mol. Sci*., 2023, **24**, 2024]. For this reason, 0.05 ml of $CuCl_2$ solution (0.01 M), 0.05 ml of methanol neocuproine solution (7.5 mM) and 0.25 ml of sodium acetate buffer solution (0.5 M, pH 7.0) were added to a test tube, followed by mixing with the tested compounds in (0.5 mM) concentration. The mixtures were kept at room temperature. Absorbance was measured at 450 nm on Multiskan Go microplate spectrophotometer (Thermo Fisher Sci., Waltham, Massachusetts, USA) against a reagent blank 35 min later. The increase in the reaction mixture absorbance in comparison with control indicates the reduction capability of the test compound. Results were presented in Trolox (6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid) equivalents. TEAC (Trolox equivalents

antioxidant capacity) values were obtained graphically using absorbance data and a linear calibration curve plotted as absorbance *vs*. Trolox concentration. The data of reduction ability is presented in Table S1.

Table S1. The TEAC (Trolox equivalents antioxidant capacity) values* of Cu^{2+} reducing activity in CUPRAC test for AbOAc, AbOH and compounds **1-12****.

Comp.	AbOAc	**1**	**2**	**3**	**4**	**5**	**6**
TEAC	0.06 ±0.01	0.13±0.01	0.09±0.01	0.11±0.01	0.23±0.01	0.08±0.01	0.38±0.01
Comp.	AbOH	**7**	**8**	**9**	**10**	**11**	**12**
TEAC	0.07 ±0.01	0.11±0.01	0.09±0.02	0.17±0.02	0.42±0.02	0.07±0.01	0.33±0.01

*Results presented as mean ± SD obtained using at least from three independent experiments.

**TEAC for Trolox is 1.00±0.03. TEAC for control methanol solution is 0.05 ±0.01. TEAC values for Ph_2SnCl_2 and Ph_3SnCl are 0.22 ±0.02 and 0.40±0.02, respectively.

MTT test

MTT test is based on the ability of living cell dehydrogenases, in particular, succinate dehydrogenase, to reduce uncolored forms of 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazole (MTT) to blue formazan soluble in DMSO. The MTT test was conducted *via* a published procedure with slight modifications [M. Niks, M. Otto, *J. Immunol. Meth.* **1990**, *130*, 149]. Solutions of studied compounds with concentrations of 1.00, 0.25, 0.0625, 0.015, and 0.00375 mM in DMEM were prepared from. If necessary, the substances were preliminarily dissolved in DMSO (the DMSO concentration was not higher than 0.5% of the final solution volume). The prepared solutions of the studied substances were introduced into a sterile planar-bottom 96-well plate containing cell cultures with 5- and 10-μL micropipettes in such a way that the final concentrations of the substance in the wells would be 50, 25, 12.5, 6.4, 3.2, 1.6, 0.8, 0.4, 0.2, and 0.1 μM. The plate with the cells and studied substances was placed in a CO_2 incubator for 72 h. Then 10 μL of a solution of MTT (5 μg/ml) were introduced into each well of the plate with the primary culture and studied substance, and incubation was conducted at 37°C for 2 h in a wet atmosphere with 5% CO_2. After 2 h of exposure, the living cells reduce yellow MTT to dark violet granules of formazan. The formazan granules were dissolved in DMSO (150 μL), and the amount of the reduced product was measured by spectrophotometry on a Zenyth 2000rt plate reader at a wavelength of 570 nm. The test results were presented as a plot of the dependence of % survived cells on the concentration of the studied substances. Cisplatin was applied as the standard. The experiments with the tested compounds were carried out in three repetitions.

Cell death

HCT-116 (colon carcinoma) cells (4×105 cells in 2 ml of DMEM) were seeded in a 6-well plate and incubated with at $2\times IC_{50}$ **6**, **12** and cisplatin (values based on MTT assay) for 24 and 48 h. After incubation, the cells were harvested by trypsinization, precipitated by centrifugation (3000 rpm), washed with cold PBS, recentrifuged. Aliquots of cells were processed as recommended in the Muse Annexin V&Dead Cell Kit and Muse Caspase-3/7 Kit (Luminex). The results were recorded on a Muse Cell Analyzer flow cytometer (Merck, USA).

Cell cycle analysis

For the cell cycle analysis HCT116 cells (5×105 cells in 2 ml of DMEM) were seeded in a 6-well plate and incubated with at ½ IC_{50} **6**, **12** (values based on MTT assay) for 24 h. After incubation, the cells were harvested by trypsinization, and precipitated by centrifugation (3500 rpm). After precipitation, the supernatant was removed, washed with PBS, centrifuged, fixed with 75% ethanol and incubated for at least 3 h at -20° C. After incubation, 200 µl of the cell suspension was collected, centrifuged, the supernatant was removed, and washed with 200 µl of PBS. Then, the cells were stained 200 µl of the Muse Cell Cycle Reagent and incubated for 60 min at room temperature in the dark. Cell cycle analysis was performed using a Muse Cell Analyzer flow cytometer (Merck, USA).

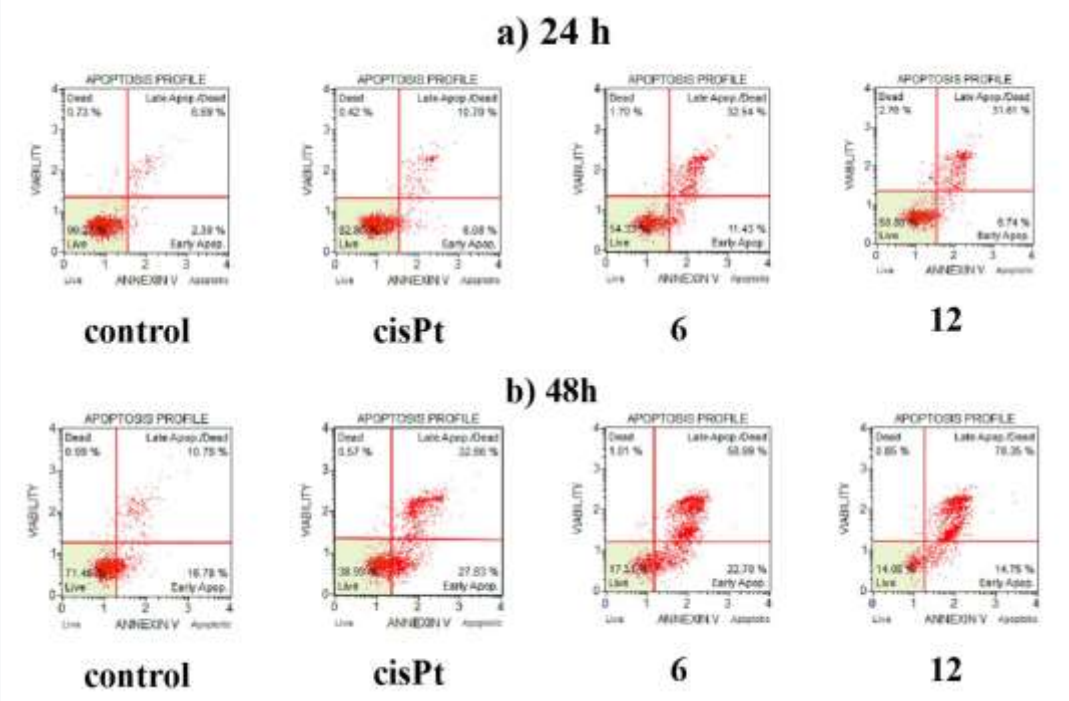
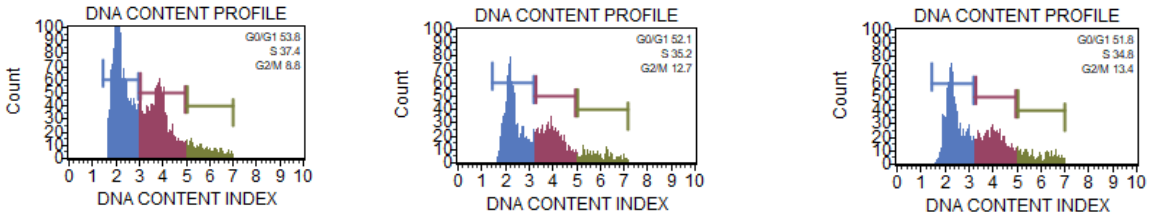


Figure S17. Apoptotic profile of cancer cells HCT-116 after treatment with compounds **6** and **12**, cisplatin after 24 h (a) and 48 h (b). Concentration of compounds 2× IC_{50} (µM).



control **6** **12**

Figure S18. Cell cycle analysis in HCT116 cells after treatment with compounds **6**, **12.** Cells were treated with ½ IC_{50} concentrations for 24h and then harvested for cell cycle analysis measured by flow cytometry.