The Discovery of Highly Efficient and Promising ABA Receptor Antagonists for Agricultural Applications Based on APAn Modification

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1. Physico-chemical data of the intermediates and APAn

7-methoxy-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**II**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (d, *J* = 2.9 Hz, 1H), 7.11 (d, *J* = 8.5 Hz, 1H), 7.02 (dd, *J* = 8.4, 2.9 Hz, 1H), 3.81 (s, 3H), 2.90 (t, *J* = 6.3 Hz, 2H), 1.95 (t, *J* = 6.3 Hz, 2H), 1.20 (s, 6H). Reddish brown oil, yield 99 %.

7-methoxy-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**III**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.7 Hz, 1H), 7.43 (d, *J* = 2.7 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.7 Hz, 1H), 3.91 (s, 3H), 2.85 (s, 2H), 1.28 (s, 6H). White solid, yield: 82 % m.p. 125.0 - 126.0 ℃.

7-hydroxy-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**IV**). ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.88 (s, 1H), 7.83 (d, *J* = 8.5 Hz, 1H), 7.27 (d, *J* = 2.6 Hz, 1H), 7.17 (dd, *J* = 8.4, 2.6 Hz, 1H), 2.91 (s, 2H), 1.19 (s, 6H). White solid, yield 88 % m.p. 135.0 - 136.0 ℃.

7-ethoxy-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-2**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.7 Hz, 1H), 7.45 (d, *J* = 2.7 Hz, 1H), 7.19 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.18 (q, *J* = 7.0 Hz, 2H), 2.88 (s, 2H), 1.47 (t, *J* = 7.0 Hz, 3H), 1.31 (s, 6H). Reddish brown solid, yield: 97 % m.p. 119.0 - 120.0 ℃.

2,2-dimethyl-7-propoxy-2,3-dihydronaphthalene-1,4-dione (**V-3**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.44 (d, *J* = 2.6 Hz, 1H), 7.18 (dd, *J* = 8.6, 2.7 Hz, 1H), 4.05 (t, *J* = 6.5 Hz, 2H), 2.86 (s, 2H), 1.84 (m, *J* = 13.9, 7.4, 6.5 Hz, 2H), 1.29 (s, 6H), 1.05 (t, *J* = 7.4 Hz, 3H). Reddish brown oil, yield 89 %.

7-butoxy-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-4**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.44 (d, *J* = 2.6 Hz, 1H), 7.18 (dd, *J* = 8.7, 2.6 Hz, 1H), 4.09 (t, *J* = 6.5 Hz, 2H), 2.87 (s, 2H), 1.89 – 1.71 (m, 2H), 1.59 – 1.42 (m, 2H), 1.29 (s, 6H), 0.98 (t, *J* = 7.4 Hz, 3H). Reddish brown oil, yield: 91 %.

2,2-dimethyl-7-(pentyloxy)-2,3-dihydronaphthalene-1,4-dione (**V-5**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.44 (d, *J* = 2.6 Hz, 1H), 7.18 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.08 (t, *J* = 6.5 Hz, 2H), 2.87 (s, 2H), 2.08 – 1.69 (m, 2H), 1.50 – 1.35 (m, 4H), 1.32 – 1.24 (m, 6H), 0.93 (t, *J* = 7.1 Hz, 3H). Reddish brown oil, yield 91 %.

7-(hexyloxy)-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-6**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.44 (d, *J* = 2.6 Hz, 1H), 7.18 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.08 (t, *J* = 6.5 Hz, 2H), 2.87 (s, 2H), 1.90 – 1.74 (m, 2H), 1.60 – 1.43 (m, 2H), 1.34 (m *J* = 3.1 Hz, 4H), 1.29 (s, 6H), 0.97 – 0.83 (m, 3H). Reddish brown oil, yield 88 %.

7-isopropoxy-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-7**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.6 Hz, 1H), 7.44 (d, *J* = 2.6 Hz, 1H), 7.16 (dd, *J* = 8.7, 2.6 Hz, 1H), 4.74 (p, *J* = 6.1 Hz, 1H), 2.88 (s, 2H), 1.39 (d, *J* = 6.0 Hz, 6H), 1.31 (s, 6H). Reddish brown oil, yield 94%.

7-isobutoxy-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-8**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.7 Hz, 1H), 7.45 (d, *J* = 2.6 Hz, 1H), 7.20 (dd, *J* = 8.7, 2.6 Hz, 1H), 3.86 (d, *J* = 6.5 Hz, 2H), 2.88 (s, 2H), 2.13 (m, *J* = 13.3, 6.7 Hz, 1H), 1.31 (s, 6H), 1.05 (d, *J* = 6.7 Hz, 6H). Reddish brown oil, yield 93 %.

7-(isopentyloxy)-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-9**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.6 Hz, 1H), 7.43 (d, *J* = 2.7 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.10 (t, *J* = 6.6 Hz, 2H), 2.86 (s, 2H), 1.83 (dt, *J* = 13.4, 6.7 Hz, 1H), 1.70 (q, *J* = 6.7 Hz, 2H), 1.28 (s, 6H), 0.96 (d, *J* = 6.7 Hz, 6H). Reddish brown oil, yield 95 %.

7-(3,3-dimethylbutoxy)-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-10**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.6 Hz, 1H), 7.45 (d, *J* = 2.6 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.14 (t, *J* = 7.2 Hz, 2H), 2.87 (s, 2H), 1.76 (t, *J* = 7.2 Hz, 2H), 1.30 (s, 6H), 1.00 (s, 9H). Reddish brown oil, yield 89 %.

2,2-dimethyl-7-(4-phenylbutoxy)-2,3-dihydronaphthalene-1,4-dione (**V-11**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.6 Hz, 1H), 7.36 (d, *J* = 2.6 Hz, 1H), 7.25 – 7.17 (m, 2H), 7.16 – 7.06 (m, 4H), 4.02 (t, *J* = 6.0 Hz, 2H), 2.79 (s, 2H), 2.62 (t, *J* = 7.2 Hz, 2H), 1.77 (m, *J* = 14.0, 7.1, 2.7 Hz, 4H), 1.22 (s, 6H). Reddish brown oil, yield: 92 %.

2,2-dimethyl-7-((4-methylpentyl)oxy)-2,3-dihydronaphthalene-1,4-dione (**V-12**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.43 (d, *J* = 2.6 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.06 (t, *J* = 6.6 Hz, 2H), 2.86 (s, 2H), 1.86 – 1.71 (m, 2H), 1.60 (dt, *J* = 13.3, 6.7 Hz, 1H), 1.38 – 1.31 (m, 2H), 1.29 (s, 6H), 0.91 (d, *J* = 6.7 Hz, 6H). Reddish brown oil, yield 87 %.

2,2-dimethyl-7-((3-methylpentyl)oxy)-2,3-dihydronaphthalene-1,4-dione (**V-13**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.44 (d, *J* = 2.6 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.7 Hz, 1H), 4.21 – 3.97 (m, 2H), 2.86 (s, 2H), 1.85 (d, *J* = 8.0 Hz, 1H), 1.67 – 1.56 (m, 2H), 1.41 (m, *J* = 12.5, 7.5, 5.1 Hz, 1H), 1.29 (s, 6H), 1.26 – 1.20 (m, 1H), 0.94 (d, *J* = 6.2 Hz, 3H), 0.90 (s, 3H). Reddish brown oil, yield 93 %.

2,2-dimethyl-7-((3,5,5-trimethylhexyl)oxy)-2,3-dihydronaphthalene-1,4-dione (**V-14**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.6 Hz, 1H), 7.43 (d, *J* = 2.7 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.09 (t, *J* = 6.5 Hz, 2H), 2.86 (s, 2H), 1.86 – 1.71 (m, 2H), 1.64 (dt, *J* = 13.3, 6.7 Hz, 1H), 1.28 (s, 6H), 1.24 (d, *J* = 3.6 Hz, 1H), 1.11 (dd, *J* = 14.0, 6.0 Hz, 1H), 0.98 (d, *J* = 6.6 Hz, 3H), 0.88 (s, 9H). Reddish brown oil, yield 91%.

7-((3,7-dimethyloctyl)oxy)-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-15**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.6 Hz, 1H), 7.43 (d, *J* = 2.7 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.6 Hz, 1H), 4.21 – 3.95 (m, 2H), 2.86 (s, 2H), 1.84 (m, *J* = 14.1, 6.9, 5.1 Hz, 1H), 1.71 – 1.55 (m, 2H), 1.51 (dt, *J* = 13.3, 6.7 Hz, 1H), 1.36 – 1.29 (m, 2H), 1.28 (s, 6H), 1.26 – 1.23 (m, 1H), 1.18 – 1.11 (m, 3H), 0.93 (d, *J* = 6.5 Hz, 3H), 0.85 (d, *J* = 6.7 Hz, 6H). Reddish brown oil, yield 89 %.

7-((3,7-dimethyloct-6-en-1-yl)oxy)-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-16**) ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.44 (d, *J* = 2.7 Hz, 1H), 7.17 (dd, *J* = 8.6, 2.6 Hz, 1H), 5.16 – 4.97 (m, 1H), 4.30 – 3.95 (m, 2H), 2.86 (s, 2H), 2.08 – 1.94 (m, 2H), 1.85 (m, *J* = 13.8, 6.8, 5.1 Hz, 1H), 1.71 – 1.68 (m, 1H), 1.67 (d, *J* = 1.4 Hz, 3H), 1.66 – 1.61 (m, 1H), 1.59 (d, *J* = 1.4 Hz, 3H), 1.39 (m, *J* = 13.4, 9.5, 6.4, 5.4 Hz, 1H), 1.29 (s, 6H), 1.25 – 1.20 (m, 1H), 0.95 (d, *J* = 6.5 Hz, 3H). Reddish brown oil, yield 94 %.

7-(2-ethoxyethoxy)-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-17**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.6 Hz, 1H), 7.49 (d, *J* = 2.6 Hz, 1H), 7.25 (dd, *J* = 8.7, 2.7 Hz, 1H), 4.31 – 4.19 (m, 2H), 3.89 – 3.77 (m, 2H), 3.61 (q, *J* = 7.0 Hz, 2H), 2.88 (s, 2H), 1.30 (s, 6H), 1.25 (t, *J* = 7.0 Hz, 3H). Reddish brown oil, yield 90 %.

7-(2-(2-methoxyethoxy)ethoxy)-2,2-dimethyl-2,3-dihydronaphthalene-1,4-dione (**V-18**) ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.6 Hz, 1H), 7.43 (d, *J* = 2.6 Hz, 1H), 7.19 (dd, *J* = 8.6, 2.7 Hz, 1H), 4.29 – 4.17 (m, 2H), 3.96 – 3.82 (m, 2H), 3.75 – 3.61 (m, 2H), 3.61 – 3.49 (m, 2H), 3.35 (s, 3H), 2.84 (s, 2H), 1.26 (s, 6H). Reddish brown oil, yield 94 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-7-methoxy-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-1**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.6 Hz, 1H), 7.37 (d, *J* = 2.6 Hz, 1H), 6.88 (dd, *J* = 8.6, 2.5 Hz, 1H), 5.88 (t, *J* = 7.0 Hz, 1H), 4.25 (s, 2H), 3.86 (s, 3H), 3.75 – 3.67 (m, 1H), 2.64 (m, *J* = 164.1, 24.2 Hz, 3H), 2.02 – 1.77 (m, 3H), 1.14 (s, 6H). Yellow oil, yield 49 %.

(Z)-7-ethoxy-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-2**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.6 Hz, 1H), 7.37 (d, *J* = 2.5 Hz, 1H), 6.91 (dd, *J* = 8.7, 2.6 Hz, 1H), 5.92 (q, *J* = 7.0, 5.2 Hz, 1H), 4.29 (d, *J* = 6.0 Hz, 2H), 4.14 (q, *J* = 7.0 Hz, 2H), 2.71 (m, *J* = 98.1 Hz, 3H), 2.01 – 1.67 (m, 3H), 1.68 (s, 1H), 1.45 (t, *J* = 7.0 Hz, 3H), 1.18 (s, 6H). Yellow oil, yield 48 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-7-propoxy-3,4-dihydronaphthalen-1(2H)-one (**VI-3**) ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.36 (d, *J* = 2.6 Hz, 1H), 6.89 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.16 – 5.71 (m, 1H), 4.26 (d, *J* = 6.1 Hz, 2H), 4.01 (td, *J* = 6.5, 1.1 Hz, 2H), 3.36 – 3.11 (m, 1H), 2.80 (s, 1H), 2.60 (s, 1H), 2.05 (s, 1H), 1.89 (d, *J* = 1.4 Hz, 3H), 1.83 (q, *J* = 7.0 Hz, 2H), 1.16 (s, 6H), 1.04 (t, *J* = 7.4 Hz, 3H). Yellow oil, yield 43 %.

(Z)-7-butoxy-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-4**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.7 Hz, 1H), 7.35 (d, *J* = 2.5 Hz, 1H), 6.87 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.00 – 5.75 (m, 1H), 4.25 (d, *J* = 6.8 Hz, 2H), 4.04 (t, *J* = 6.5 Hz, 2H), 3.53 (s, 1H), 2.78 (s, 1H), 2.59 (s, 1H), 2.36 (s, 1H), 1.91 – 1.83 (m, 3H), 1.77 (m, *J* = 8.9, 6.6 Hz, 2H), 1.48 (h, *J* = 7.4 Hz, 2H), 1.15 (s, 6H), 0.96 (t, *J* = 7.4 Hz, 3H). Yellow oil, yield 45 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-7-(pentyloxy)-3,4-dihydronaphthalen-1(2H)-one (**VI-5**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.7 Hz, 1H), 7.36 (d, *J* = 2.6 Hz, 1H), 6.90 (dd, *J* = 8.7, 2.5 Hz, 1H), 5.92 (dt, *J* = 13.1, 4.3 Hz, 1H), 4.30 (dd, *J* = 28.1, 6.3 Hz, 2H), 4.05 (td, *J* = 6.6, 1.1 Hz, 2H), 3.10 (s, 1H), 2.80 (s, 1H), 2.61 (s, 1H), 1.94 – 1.86 (m, 3H), 1.84 – 1.77 (m, 3H), 1.48 – 1.34 (m, 4H), 1.17 (s, 6H), 0.93 (t, *J* = 7.1 Hz, 3H). Yellow oil, yield 44 %.

(Z)-7-(hexyloxy)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-6**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.7 Hz, 1H), 7.37 (d, *J* = 2.5 Hz, 1H), 6.91 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.11 – 5.86 (m, 1H), 4.45 – 4.27 (m, 2H), 4.06 (t, *J* = 6.6 Hz, 2H), 2.81 (s, 1H), 2.62 (s, 1H), 1.94 – 1.89 (m, 4H), 1.81 (dd, *J* = 8.6, 6.4 Hz, 2H), 1.75 (s, 1H), 1.51 – 1.43 (m, 2H), 1.35 (dt, *J* = 7.5, 3.8 Hz, 4H), 1.18 (s, 6H), 0.97 – 0.88 (m, 3H). Yellow oil, yield 42 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-7-isopropoxy-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-7**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.7 Hz, 1H), 7.34 (d, *J* = 2.5 Hz, 1H), 6.85 (dd, *J* = 8.7, 2.5 Hz, 1H), 5.89 (t, *J* = 6.9 Hz, 1H), 4.67 (p, *J* = 6.1 Hz, 1H), 4.26 (d, *J* = 6.7 Hz, 2H), 3.43 (s, 1H), 2.79 (s, 1H), 2.57 (s, 1H), 2.28 (s, 1H), 1.87 (s, 3H), 1.35 (t, *J* = 6.5 Hz, 6H), 1.15 (d, *J* = 10.0 Hz, 6H). Yellow oil, yield 45 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-7-isobutoxy-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-8**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.7 Hz, 1H), 7.38 (d, *J* = 2.6 Hz, 1H), 6.90 (dd, *J* = 8.7, 2.5 Hz, 1H), 5.91 (t, *J* = 7.0 Hz, 1H), 4.28 (d, *J* = 6.6 Hz, 2H), 3.82 (d, *J* = 6.6 Hz, 2H), 3.40 (s, 1H), 2.82 (d, *J* = 20.2 Hz, 1H), 2.61 (s, 1H), 2.11 (m, 2H), 1.93 – 1.86 (m, 2H), 1.82 (s, 1H), 1.17 (s, 6H), 1.04 (dd, *J* = 6.8, 2.5 Hz, 6H). Yellow oil, yield 47 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-7-(isopentyloxy)-2,2-dimethyl-3,4-dihydro-naphthalen-1(2H)-one (**VI-9**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.6 Hz, 1H), 7.35 (d, *J* = 2.6 Hz, 1H), 6.88 (dd, *J* = 8.6, 2.5 Hz, 1H), 5.89 (t, *J* = 7.4 Hz, 1H), 4.25 (d, *J* = 6.6 Hz, 2H), 4.10 (t, *J* = 7.3 Hz, 2H), 3.55 (s, 1H), 2.79 (s, 1H), 2.35 (s, 1H), 2.19 (s, 1H), 1.79 (s, 3H), 1.74 - 1.66 (m, 1H), 1.64 - 1.57 (m, 1H), 1.52 - 1.41 (m, 1H), 1.36 (s, 3H), 1.31 (s, 3H), 0.92 (d, J = 6.8 Hz, 3H), 0.87 (d, J = 6.8 Hz, 3H). Yellow oil, yield 44 %.

(Z)-7-(3,3-dimethylbutoxy)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-10**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.6 Hz, 1H), 7.35 (d, *J* = 2.6 Hz, 1H), 6.88 (dd, *J* = 8.6, 2.5 Hz, 1H), 5.89 (t, *J* = 7.4 Hz, 1H), 4.25 (d, *J* = 6.6 Hz, 2H), 4.10 (t, *J* = 7.3 Hz, 2H), 3.55 (s, 1H), 2.79 (s, 1H), 2.35 (s, 1H), 2.18 – 2.04 (m, 1H), 1.94 – 1.83 (m, 3H), 1.73 (t, *J* = 7.3 Hz, 2H), 1.15 (s, 6H), 0.98 (s, 9H). Yellow oil, yield 44 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-7-(4-phenylbutoxy)-3,4-dihydronaphthalen-1(2H)-one (**VI-11**) ^{1}H NMR (500 MHz, $CDCl_3$). δ 7.96 (d, *J* = 8.7 Hz, 1H), 7.37 (d, *J* = 2.5 Hz, 1H), 7.31 – 7.24 (m, 2H), 7.19 (d, *J* = 7.4 Hz, 3H), 6.87 (dd, *J* = 8.7, 2.5 Hz, 1H), 5.89 (t, *J* = 7.0 Hz, 1H), 4.32 – 4.22 (m, 2H), 4.05 (t, *J* = 5.9 Hz, 2H), 3.59 (s, 1H), 2.80 (s, 1H), 2.69 (t, *J* = 7.1 Hz, 2H), 2.59 (d, *J* = 15.4 Hz, 1H), 2.40 (s, 1H), 1.99 – 1.85 (m, 3H), 1.85 – 1.80 (m, 4H), 1.16 (s, 6H). Yellow oil, yield 47 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-7-((4-methylpentyl)oxy)-3,4-dihydronaphthalen-1(2H)-one (**VI-12**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.7 Hz, 1H), 7.37 (d, *J* = 2.6 Hz, 1H), 6.89 (dd, *J* = 8.7, 2.6 Hz, 1H), 5.91 (d, *J* = 6.9 Hz, 1H), 4.27 (d, *J* = 6.7 Hz, 2H), 4.03 (t, *J* = 6.7 Hz, 2H), 3.61 (s, 1H), 2.79 (s, 1H), 2.60 (s, 1H), 2.45 (d, *J* = 40.1 Hz, 1H), 1.92 – 1.87 (m, 3H), 1.85 – 1.75 (m, 2H), 1.61 (dp, *J* = 13.4, 6.7 Hz, 1H), 1.39 – 1.30 (m, 2H), 1.17 (s, 6H), 0.92 (d, *J* = 6.7 Hz, 6H). Yellow oil, yield 47 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-7-((3-methylpentyl)oxy)-3,4-dihydronaphthalen-1(2H)-one (**VI-13**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.36 (d, *J* = 2.5 Hz, 1H), 6.89 (dd, *J* = 8.6, 2.5 Hz, 1H), 5.90 (t, *J* = 7.1 Hz, 1H), 4.26 (d, *J* = 6.8 Hz, 2H), 4.08 (dd, *J* = 6.5, 3.1 Hz, 2H), 3.39 (s, 1H), 2.78 (s, 1H), 2.63 (d, *J* = 28.7 Hz, 1H), 2.21 (s, 1H), 2.01 (s, 1H), 1.88 (s, 3H), 1.60 (td, *J* = 8.7, 4.3 Hz, 2H), 1.40 (m, *J* = 13.0, 7.5, 5.1 Hz, 1H), 1.27 – 1.11 (m, 7H), 0.93 (d, *J* = 6.0 Hz, 3H), 0.90 (t, *J* = 7.4 Hz, 3H). Yellow oil, yield 47 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-7-((3,5,5-trimethylhexyl)oxy)-3,4-dihydronaphthalen-1(2H)-one (**VI-14**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.6 Hz, 1H), 7.36 (d, *J* = 2.6 Hz, 1H), 6.88 (dd, *J* = 8.7, 2.5 Hz, 1H), 5.89 (t, *J* = 6.9 Hz, 1H), 4.26 (d, *J* = 6.4 Hz, 2H), 4.12 – 3.95 (m, 2H), 3.38 (s, 1H), 2.79 (s, 1H), 2.59 (s, 1H), 2.36 – 2.18 (m, 1H), 1.88 (s, 3H), 1.81 (dt, *J* = 12.9, 6.5 Hz, 1H), 1.74 (dt, *J* = 6.5, 3.3 Hz, 1H), 1.62 (dd, *J* = 13.5, 6.8 Hz, 1H), 1.27 – 1.23 (m, 1H), 1.20 – 1.08 (m, 6H), 0.98 (d, *J* = 6.6 Hz, 3H), 0.89 (d, *J* = 1.2 Hz, 9H), 0.86 – 0.84 (m, 1H). Yellow oil, yield 41 %.

(Z)-7-((3,7-dimethyloctyl)oxy)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-15**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.6 Hz, 1H), 7.36 (d, *J* = 2.5 Hz, 1H), 6.89 (dd, *J* = 8.7, 2.5 Hz, 1H), 5.90 (t, *J* = 6.7 Hz, 1H), 4.26 (d, *J* = 6.5 Hz, 2H), 4.08 (m, *J* = 6.4, 2.3 Hz, 2H), 3.26 (s, 1H), 2.79 (s, 1H), 2.60 (s, 1H), 2.11 (s, 1H), 1.92 – 1.77 (m, 4H), 1.72 – 1.45 (m, 3H), 1.36 – 1.11 (m, 12H), 0.94 (d, *J* = 6.5 Hz, 3H), 0.86 (d, *J* = 6.6 Hz, 6H). Yellow oil, yield 44 %.

(Z)-7-((3,7-dimethyloct-6-en-1-yl)oxy)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-16**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.7 Hz, 1H), 7.36 (d, *J* = 2.5 Hz, 1H), 6.88 (dd, *J* = 8.7, 2.6 Hz, 1H), 5.89 (t, *J* = 6.9 Hz, 1H), 5.16 – 5.00 (m, 1H), 4.25 (d, *J* = 6.7 Hz, 2H), 4.07 (m, *J* = 6.3, 3.1 Hz, 2H), 3.60 (d, *J* = 6.1 Hz, 1H), 3.59 – 3.55 (m, 1H), 2.78 (s, 1H), 2.60 (s, 1H), 2.37 (s, 1H), 2.06 – 1.94 (m, 2H), 1.87 (s, 3H), 1.68 – 1.65 (m, 3H), 1.59 (s, 3H), 1.45 – 1.39 (m, 1H), 1.24 – 1.11 (m, 7H), 0.95 (d, *J* = 6.5 Hz, 3H), 0.89 (t, *J* = 7.1 Hz, 2H). Yellow oil, yield 42 %.

(Z)-7-(2-ethoxyethoxy)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-17**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.7 Hz, 1H), 7.41 (d, *J* = 2.6 Hz, 1H), 6.91 (dd, *J* = 8.7, 2.6 Hz, 1H), 5.89 (t, *J* = 6.8 Hz, 1H), 4.25 (d, *J* = 6.7 Hz, 2H), 4.19 (dd, *J* = 5.6, 4.0 Hz, 2H), 3.79 (dd, *J* = 5.7, 4.0 Hz, 2H), 3.58 (q, *J* = 7.0 Hz, 2H), 3.42 (s, 1H), 2.80 (s, 1H), 2.56 (d, *J* = 18.1 Hz, 1H), 2.42 – 2.23 (m, 1H), 1.87 (s, 3H), 1.25 – 1.11 (m, 9H). Yellow oil, yield 47 %.

(Z)-4-hydroxy-4-(5-hydroxy-3-methylpent-3-en-1-yn-1-yl)-7-(2-(2-methoxyethoxy)ethoxy)-2,2-dimethyl-3,4-dihydronaphthalen-1(2H)-one (**VI-18**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.6 Hz, 1H), 7.42 (d, *J* = 2.5 Hz, 1H), 6.89 (dd, *J* = 8.6, 2.5 Hz, 1H), 5.88 (t, *J* = 6.9 Hz, 1H), 4.30 – 4.23 (m, 2H), 4.21 (dd, *J* = 5.7, 4.0 Hz, 2H), 3.84 (dd, *J* = 5.7, 3.9 Hz, 2H), 3.67 (dd, *J* = 5.5, 3.8 Hz, 2H), 3.61 (s,

1H), 3.57 – 3.52 (m, 2H), 3.34 (s, 3H), 2.81 (s, 1H), 2.56 (s, 2H), 1.87 (s, 3H), 1.12 (s, 6H). Yellow oil, yield 46 %.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-6-methoxy-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-1**) ^{1}H NMR (500 MHz, DMSO-d_6). δ 7.38 (d, *J* = 8.6 Hz, 1H), 6.90 (d, *J* = 2.7 Hz, 1H), 6.80 (dd, *J* = 8.6, 2.8 Hz, 1H), 6.38 (d, *J* = 15.6 Hz, 1H), 5.92 (d, *J* = 15.5 Hz, 1H), 5.37 (t, *J* = 6.6 Hz, 1H), 5.07 (d, *J* = 6.8 Hz, 1H), 5.00 (s, 1H), 4.57 (t, *J* = 5.2 Hz, 2H), 4.02 (dd, *J* = 6.9, 5.1 Hz, 2H), 3.70 (s, 3H), 1.80 (dd, *J* = 13.3, 6.8 Hz, 1H), 1.76 – 1.68 (m, 4H), 0.88 (d, *J* = 16.8 Hz, 6H). Light yellow solid, yield 59 % m.p. 138.0 - 139.0 °C.

6-ethoxy-1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-2**). ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.36 (d, *J* = 8.4 Hz, 1H), 6.87 (d, *J* = 2.7 Hz, 1H), 6.78 (dd, *J* = 8.5, 2.7 Hz, 1H), 6.38 (d, *J* = 15.6 Hz, 1H), 5.91 (d, *J* = 15.6 Hz, 1H), 5.37 (t, *J* = 6.6 Hz, 1H), 5.05 (d, *J* = 6.7 Hz, 1H), 4.97 (s, 1H), 4.57 (q, *J* = 4.5, 3.7 Hz, 2H), 4.02 (dd, *J* = 6.9, 4.8 Hz, 2H), 3.95 (dt, *J* = 6.8, 3.4 Hz, 2H), 1.83 – 1.75 (m, 1H), 1.67 (d, *J* = 41.3 Hz, 4H), 1.29 (t, *J* = 7.0 Hz, 3H), 0.87 (d, *J* = 14.8 Hz, 6H). Light yellow solid, yield 64 % m.p. 135.0 - 136.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-6-propoxy-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-3**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.5 Hz, 1H), 6.95 (d, *J* = 2.7 Hz, 1H), 6.86 (dd, *J* = 8.5, 2.7 Hz, 1H), 6.40 (d, *J* = 15.7 Hz, 1H), 6.01 (d, *J* = 15.6 Hz, 1H), 5.55 (t, *J* = 7.1 Hz, 1H), 4.81 (d, *J* = 7.9 Hz, 1H), 4.16 (dd, *J* = 6.8, 3.0 Hz, 2H), 3.90 (td, *J* = 6.6, 3.1 Hz, 2H), 2.06 (dd, *J* = 13.6, 6.8 Hz, 2H), 1.89 (s, 1H), 1.83 (s, 3H), 1.81 – 1.74 (m, 3H), 1.48 (s, 1H), 1.05 – 1.01 (m, 6H), 0.99 (s, 3H). Light yellow solid, yield 56 % m.p. 132.0 - 133.0 °C.

6-butoxy-1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-4**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 (d, *J* = 8.6 Hz, 1H), 6.94 (d, *J* = 2.7 Hz, 1H), 6.83 (dd, *J* = 8.6, 2.6 Hz, 1H), 6.32 (d, *J* = 15.7 Hz, 1H), 6.00 (d, *J* = 15.7 Hz, 1H), 5.51 (t, *J* = 7.2 Hz, 1H), 4.81 – 4.73 (m, 1H), 4.13 – 4.02 (m, 2H), 3.92 (td, *J* = 6.5, 2.7 Hz, 2H), 2.63 (s, 1H), 2.13 (s, 1H), 2.05 – 1.96 (m, 2H), 1.81 (d, *J* = 1.4 Hz, 3H), 1.77 – 1.68 (m, 3H), 1.51 – 1.41 (m, 2H), 1.02 (s, 3H), 0.98 – 0.92 (m, 6H). Light yellow solid, yield 58 % m.p. 134.0 - 135.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-6-(pentyloxy)-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-5**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.6 Hz, 1H), 6.94 (d, *J* = 2.7 Hz, 1H), 6.85 (dd, *J* = 8.6, 2.7 Hz, 1H), 6.37 (d, *J* = 15.7 Hz, 1H), 6.00 (d, *J* = 15.7 Hz, 1H), 5.54 (t, *J* = 7.2 Hz, 1H), 4.80 (d, *J* = 7.6 Hz, 1H), 4.17 – 4.10 (m, 2H), 3.93 (td, *J* = 6.6, 3.0 Hz, 2H), 2.23 (d, *J* = 7.3

Hz, 1H), 2.03 (dd, *J* = 13.5, 6.8 Hz, 1H), 1.96 (s, 1H), 1.82 (s, 3H), 1.78 – 1.73 (m, 2H), 1.71 (s, 2H), 1.44 – 1.32 (m, 4H), 1.03 (s, 3H), 0.98 (s, 3H), 0.92 (t, *J* = 7.1 Hz, 3H). Light yellow solid, yield: 53 % m.p. 127.0 - 128.0 °C.

6-(hexyloxy)-1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-6**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46 – 7.40 (m, 1H), 6.94 (d, *J* = 2.7 Hz, 1H), 6.85 (dd, *J* = 8.6, 2.7 Hz, 1H), 6.36 (d, *J* = 15.7 Hz, 1H), 6.00 (d, *J* = 15.7 Hz, 1H), 5.54 (t, *J* = 7.2 Hz, 1H), 4.79 (d, *J* = 7.5 Hz, 1H), 4.12 (dt, *J* = 7.2, 3.5 Hz, 2H), 3.92 (td, *J* = 6.6, 3.0 Hz, 2H), 2.28 (d, *J* = 7.4 Hz, 1H), 2.06 – 2.03 (m, 1H), 1.98 (s, 1H), 1.82 (d, *J* = 1.3 Hz, 3H), 1.78 – 1.71 (m, 4H), 1.44 (m, *J* = 10.8, 5.0, 2.7 Hz, 2H), 1.32 (m, *J* = 4.7, 3.1 Hz, 4H), 1.03 (s, 3H), 0.98 (s, 3H), 0.91 – 0.86 (m, 3H). Light yellow solid, yield 51 % m.p. 131.0 - 132.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-6-isopropoxy-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-7**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 (d, *J* = 8.7 Hz, 1H), 6.94 (d, *J* = 2.6 Hz, 1H), 6.84 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.37 (d, *J* = 15.7 Hz, 1H), 6.01 (d, *J* = 15.7 Hz, 1H), 5.53 (t, *J* = 7.2 Hz, 1H), 4.82 – 4.74 (m, 1H), 4.54 (p, *J* = 6.0 Hz, 1H), 4.13 (t, *J* = 7.1 Hz, 2H), 2.30 (d, *J* = 7.1 Hz, 1H), 2.06 – 2.00 (m, 2H), 1.98 (s, 1H), 1.82 (s, 3H), 1.79 (s, 1H), 1.32 (d, *J* = 6.1 Hz, 3H), 1.29 (d, *J* = 6.0 Hz, 3H), 1.03 (s, 3H), 0.99 (s, 3H). Light yellow solid, yield 60 % m.p. 134.0 - 135.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-6-isobutoxy-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-8**). ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.36 (d, *J* = 8.4 Hz, 1H), 6.88 (d, *J* = 2.7 Hz, 1H), 6.79 (dd, *J* = 8.5, 2.7 Hz, 1H), 6.38 (d, *J* = 15.6 Hz, 1H), 5.91 (d, *J* = 15.7 Hz, 1H), 5.37 (t, *J* = 6.6 Hz, 1H), 5.06 (d, *J* = 6.8 Hz, 1H), 4.99 (s, 1H), 4.56 (dt, *J* = 10.0, 6.1 Hz, 2H), 4.02 (dd, *J* = 6.9, 4.9 Hz, 2H), 3.71 – 3.59 (m, 2H), 1.98 (q, *J* = 7.0 Hz, 1H), 1.80 – 1.75 (m, 1H), 1.74 – 1.67 (m, 3H), 0.99 (s, 1H) 0.97 (t, *J* = 5.2 Hz, 6H), 0.87 (d, *J* = 16.0 Hz, 6H). Light yellow solid, yield 65 % m.p. 132.0 - 133.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-6-(isopentyloxy)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-9**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46 (d, *J* = 8.6 Hz, 1H), 6.97 (d, *J* = 2.6 Hz, 1H), 6.88 (dd, *J* = 8.6, 2.6 Hz, 1H), 6.37 (d, *J* = 15.4 Hz, 1H), 6.05 (d, *J* = 15.4 Hz, 1H), 5.53 (t, *J* = 7.3 Hz, 1H), 4.84 (s, 1H), 4.14 (d, *J* = 7.2 Hz, 2H), 4.03 (t, *J* = 7.4 Hz, 2H), 2.12 (m, 2H), 1.99 (s, 1H), 1.88 (d, *J* = 1.3 Hz, 3H), 1.81 (dd, *J* = 13.5, 9.2 Hz, 1H), 1.73 (t, *J* = 7.4 Hz, 2H), 1.42 (s, 1H), 1.24 (m, 1H), 1.02 (s, 3H), 0.99 (s, 3H), 0.98 (s, 6H). Light yellow solid, yield 61 % m.p. 122.0 - 123.0 °C.

6-(3,3-dimethylbutoxy)-1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-10**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.5 Hz, 1H), 6.95 (d, *J*

= 2.7 Hz, 1H), 6.86 (dd, J = 8.6, 2.7 Hz, 1H), 6.39 (d, J = 15.7 Hz, 1H), 6.01 (d, J = 15.7 Hz, 1H), 5.56 (t, J = 7.2 Hz, 1H), 4.82 (s, 1H), 4.16 (d, J = 7.1 Hz, 2H), 4.00 (t, J = 7.3 Hz, 2H), 2.06 (m, 2H), 1.90 (s, 1H), 1.83 (d, J = 1.3 Hz, 3H), 1.78 (dd, J = 13.5, 9.2 Hz, 1H), 1.70 (t, J = 7.4 Hz, 2H), 1.46 (s, 1H), 1.04 (s, 3H), 0.99 (s, 3H), 0.98 (s, 9H). Light yellow solid, yield 56 % m.p. 121.0 - 122.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-6-(4-phenylbutoxy)-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-11**). ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.35 (d, J = 8.5 Hz, 1H), 7.28 (t, J = 7.6 Hz, 2H), 7.24 – 7.14 (m, 4H), 6.87 (d, J = 2.6 Hz, 1H), 6.78 (dd, J = 8.5, 2.7 Hz, 1H), 6.38 (d, J = 15.6 Hz, 1H), 5.91 (d, J = 15.6 Hz, 1H), 5.37 (t, J = 6.6 Hz, 1H), 5.05 (d, J = 6.8 Hz, 1H), 4.97 (s, 1H), 4.56 (dt, J = 10.7, 6.0 Hz, 2H), 4.02 (t, J = 6.0 Hz, 2H), 3.95 – 3.87 (m, 2H), 2.62 (t, J = 4.9 Hz, 2H), 1.70 (d, J = 3.6 Hz, 8H), 0.87 (d, J = 15.3 Hz, 6H). Light yellow solid, yield 62 % m.p. 142.0 - 143.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-6-((4-methylpentyl)oxy)-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-12**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 (d, J = 8.6 Hz, 1H), 6.95 (d, J = 2.7 Hz, 1H), 6.84 (dd, J = 8.5, 2.7 Hz, 1H), 6.32 (d, J = 15.7 Hz, 1H), 6.00 (d, J = 15.7 Hz, 1H), 5.52 (t, J = 7.1 Hz, 1H), 4.77 (dd, J = 9.3, 6.8 Hz, 1H), 4.09 (td, J = 10.5, 7.1 Hz, 2H), 3.91 (m, J = 5.7, 2.5 Hz, 2H), 2.65 (d, J = 15.7 Hz, 1H), 2.18 (s, 1H), 1.99 (m, J = 13.5, 6.8, 1.3 Hz, 1H), 1.81 (d, J = 1.4 Hz, 3H), 1.78 – 1.72 (m, 3H), 1.61 – 1.54 (m, 1H), 1.35 – 1.28 (m, 3H), 1.02 (s, 3H), 0.97 (s, 3H), 0.90 (d, J = 6.6 Hz, 6H). Light yellow solid, yield 57 % m.p. 130.0 - 131.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-6-((3-methylpentyl)oxy)-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-13**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (d, J = 8.5 Hz, 1H), 6.95 (d, J = 2.7 Hz, 1H), 6.86 (dd, J = 8.5, 2.7 Hz, 1H), 6.39 (d, J = 15.6 Hz, 1H), 6.01 (d, J = 15.7 Hz, 1H), 5.55 (t, J = 7.1 Hz, 1H), 4.82 (d, J = 9.0 Hz, 1H), 4.21 – 4.10 (m, 2H), 3.97 (m, J = 6.5, 4.6 Hz, 2H), 2.05 (m, J = 16.5, 8.3 Hz, 2H), 1.89 (s, 1H), 1.85 – 1.72 (m, 5H), 1.59 – 1.52 (m, 2H), 1.51 – 1.34 (m, 2H), 1.21 (dt, J = 14.0, 7.2 Hz, 1H), 1.03 (s, 3H), 0.99 (s, 3H), 0.95 – 0.86 (m, 6H). Light yellow solid, yield 60 % m.p. 127.0 - 128.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-6-((3,5,5-trimethylhexyl)oxy)-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-14**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 (d, J = 8.5 Hz, 1H), 6.94 (d, J = 2.7 Hz, 1H), 6.83 (dd, J = 8.6, 2.6 Hz, 1H), 6.29 (dd, J = 15.7, 2.5 Hz, 1H), 6.00 (d, J = 15.7 Hz, 1H), 5.51 (t, J = 7.3 Hz, 1H), 4.77 (dd, J = 9.3, 6.8 Hz, 1H), 4.06 (dd, J = 9.2, 7.3 Hz, 2H), 3.94 (td, J = 6.6, 2.1 Hz, 2H), 2.65 (s, 1H), 2.14 (s, 1H), 1.99 (dd, J = 13.5, 6.8 Hz, 1H), 1.86 (dd, J = 18.8, 1.3 Hz, 1H), 1.81 (s, 3H), 1.79 – 1.69 (m, 3H), 1.57 (dd, J = 12.9, 6.6 Hz, 1H), 1.30 – 1.20 (m, 2H), 1.09 (dd, J

= 13.9, 5.9 Hz, 1H), 1.02 (s, 3H), 0.96 (d, *J* = 6.3 Hz, 5H), 0.88 (d, *J* = 1.2 Hz, 9H). Light yellow solid, yield 52 % m.p. 119.0 - 120.0 °C.

6-((3,7-dimethyloctyl)oxy)-1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-15**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.5 Hz, 1H), 6.95 (d, *J* = 2.6 Hz, 1H), 6.85 (dd, *J* = 8.6, 2.7 Hz, 1H), 6.36 (dd, *J* = 15.7, 1.7 Hz, 1H), 6.01 (d, *J* = 15.7 Hz, 1H), 5.54 (t, *J* = 7.2 Hz, 1H), 4.80 (dd, *J* = 9.2, 6.7 Hz, 1H), 4.12 (dd, *J* = 7.2, 5.2 Hz, 2H), 3.96 (m, *J* = 6.7, 4.7 Hz, 2H), 2.07 – 1.99 (m, 2H), 1.87 – 1.75 (m, 6H), 1.65 (q, *J* = 6.2 Hz, 1H), 1.54 (m, *J* = 16.7, 13.2, 6.7 Hz, 2H), 1.34 – 1.24 (m, 4H), 1.19 – 1.12 (m, 3H), 1.03 (s, 3H), 0.98 (s, 3H), 0.93 (dd, *J* = 6.6, 1.5 Hz, 3H), 0.87 (d, *J* = 6.6 Hz, 6H). Light yellow solid, yield 54 % m.p. 134.0 - 135.0 °C.

6-((3,7-dimethyloct-6-en-1-yl)oxy)-1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-16**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.6 Hz, 1H), 6.95 (d, *J* = 2.6 Hz, 1H), 6.85 (dd, *J* = 8.5, 2.7 Hz, 1H), 6.37 (dd, *J* = 15.7, 1.8 Hz, 1H), 6.01 (d, *J* = 15.7 Hz, 1H), 5.54 (t, *J* = 7.2 Hz, 1H), 5.10 (td, *J* = 7.2, 6.3, 3.5 Hz, 1H), 4.80 (d, *J* = 8.2 Hz, 1H), 4.14 (dd, *J* = 7.4, 3.2 Hz, 2H), 3.96 (qt, *J* = 7.2, 3.2 Hz, 2H), 2.17 (s, 1H), 2.07 – 1.99 (m, 2H), 1.95 – 1.93 (m, 1H), 1.82 (s, 3H), 1.68 (s, 6H), 1.60 (m, 5H), 1.37 (m, *J* = 10.0, 7.4, 5.0 Hz, 1H), 1.26 – 1.17 (m, 2H), 1.03 (s, 3H), 0.98 (s, 3H), 0.94 (dd, *J* = 6.8, 1.4 Hz, 3H). Light yellow solid, yield 62 % m.p. 115.0 - 116.0 °C.

6-(2-ethoxyethoxy)-1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-3,3-dimethyl-1,2,3,4-tetra-hydronaphthalene-1,4-diol (**VII-17**). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 (d, *J* = 8.6 Hz, 1H), 6.92 (d, *J* = 2.8 Hz, 1H), 6.80 (dd, *J* = 8.6, 2.7 Hz, 1H), 6.27 (d, *J* = 15.5 Hz, 1H), 5.92 (d, *J* = 15.8 Hz, 1H), 5.46 (t, *J* = 7.1 Hz, 1H), 4.71 (dd, *J* = 9.3, 6.7 Hz, 1H), 4.05 – 4.00 (m, 4H), 3.69 (t, *J* = 4.8 Hz, 2H), 3.55 – 3.49 (m, 2H), 2.05 – 1.98 (m, 1H), 1.94 (dd, *J* = 13.5, 6.8 Hz, 1H), 1.74 (s, 3H), 1.70 (dd, *J* = 13.5, 9.4 Hz, 1H), 1.20 – 1.13 (m, 5H), 0.95 (s, 3H), 0.90 (s, 3H). Light yellow solid, yield 61 % m.p. 145.0 - 146.0 °C.

1-((1E,3Z)-5-hydroxy-3-methylpenta-1,3-dien-1-yl)-6-(2-(2-methoxyethoxy)ethoxy)-3,3-dimethyl-1,2,3,4-tetrahydronaphthalene-1,4-diol (**VII-18**). ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.37 (d, *J* = 8.6 Hz, 1H), 6.89 (d, *J* = 2.7 Hz, 1H), 6.80 (dd, *J* = 8.5, 2.7 Hz, 1H), 6.39 (d, *J* = 15.6 Hz, 1H), 5.91 (d, *J* = 15.6 Hz, 1H), 5.37 (t, *J* = 6.6 Hz, 1H), 5.08 (d, *J* = 6.8 Hz, 1H), 5.00 (s, 1H), 4.62 – 4.52 (m, 2H), 4.04-4.00 (m, 4H), 3.70 (t, *J* = 4.7 Hz, 2H), 3.60 – 3.53 (m, 2H), 3.48 – 3.41 (m, 2H), 3.24 (s, 3H), 1.84 – 1.75 (m, 1H), 1.71 (d, *J* = 1.6 Hz, 4H), 0.87 (d, *J* = 14.4 Hz, 6H). Light yellow solid, yield 64 % m.p. 136.0 - 137.0 °C.

*Data for **APA7***. White powder, yield 35%, m.p. 167 - 168 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (d, *J* = 8.7 Hz, 1H), 7.79 (d, *J* = 16.0 Hz, 1H), 7.00 (s, 1H), 6.87 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.40 (d, *J* = 16.0 Hz, 1H), 5.74 (s, 1H), 4.66 (p, *J* = 6.1 Hz, 1H), 2.71 (s, 1H), 2.58 (d, *J* = 17.0 Hz, 1H), 2.04 (s, 3H), 1.35 (dd, *J* = 13.1, 6.1 Hz, 6H), 1.08 (d, *J* = 13.8 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.90, 170.65, 163.17, 152.00, 148.46, 139.22, 129.47, 128.10, 124.13, 117.55, 114.75, 78.45, 70.19, 49.64, 41.11, 24.93, 24.33, 23.43, 21.98, 21.82, 20.09. HRMS (*m/z*) calcd. for $C_{21}H_{26}O_5$ $[M + H]^+$ 359.1853, found 359.1852.

*Data for **APA8***. White powder, yield 33%, m.p. 153 - 154 °C. ^{1}H NMR (500 MHz, DMSO-d_6) δ 12.08 (s, 1H), 7.82 (d, *J* = 8.7 Hz, 1H), 7.63 (d, *J* = 14.5 Hz, 1H), 7.04 (s, 1H), 6.96 (dd, *J* = 8.6, 2.7 Hz, 1H), 6.41 (d, *J* = 16.0 Hz, 1H), 5.65 (s, 1H), 5.59 (s, 1H), 3.81 (dd, *J* = 6.5, 1.9 Hz, 2H), 2.72 – 2.55 (m, 1H), 2.48 (s, 1H), 2.03 (td, *J* = 13.0, 6.3 Hz, 1H), 1.95 (s, 3H), 1.02 – 0.96 (m, 9H), 0.91 (s, 3H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 195.61, 167.36, 163.71, 150.05, 149.56, 140.45, 128.61, 127.62, 124.60, 118.97, 113.98, 113.21, 77.62, 74.38, 49.81, 41.25, 40.25, 28.13, 24.50, 23.82, 21.25, 19.45. HRMS (*m/z*) calcd. for $C_{22}H_{28}O_5$ $[M + H]^+$ 373.2010, found 373.2004.

*Data for **APA9***. White powder, yield 37%, m.p. 162 - 163 °C. ^{1}H NMR (500 MHz, DMSO-d_6) δ 12.10 (s, 1H), 7.83 (d, *J* = 8.7 Hz, 1H), 6.98 (d, *J* = 8.5 Hz, 1H), 6.46 (d, *J* = 15.6 Hz, 1H), 6.36 (d, *J* = 15.8 Hz, 1H), 5.75 (s, 1H), 5.61 (s, 1H), 4.06 (t, *J* = 6.6 Hz, 2H), 2.63 (d, *J* = 14.2 Hz, 1H), 2.19 (s, 3H), 1.83 – 1.72 (m, 1H), 1.62 (q, *J* = 6.7 Hz, 2H), 0.98 (s, 3H), 0.95 – 0.87 (m, 9H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 195.61, 168.18, 163.63, 150.97, 149.71, 139.32, 133.07, 128.74, 124.47, 120.61, 114.01, 113.22, 77.49, 66.71, 49.73, 41.21, 37.71, 24.99, 24.50, 23.84, 22.87, 22.84, 14.19. HRMS (*m/z*) calcd. for $C_{23}H_{30}O_5$ $[M + H]^+$ 387.2166, found 387.2160.

*Data for **APA10***. White powder, yield 45%, m.p. 134 - 135 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02 (d, *J* = 8.7 Hz, 1H), 7.76 (d, *J* = 16.0 Hz, 1H), 7.02 (s, 1H), 6.89 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.39 (d, *J* = 16.0 Hz, 1H), 5.74 (s, 1H), 4.08 (t, *J* = 7.3 Hz, 2H), 2.68 (s, 1H), 2.59 (d, *J* = 17.1 Hz, 1H), 2.03 (s, 3H), 1.72 (t, *J* = 7.3 Hz, 2H), 1.10 (s, 3H), 1.06 (s, 3H), 0.98 (s, 9H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.03, 169.61, 163.19, 150.84, 147.47, 138.17, 128.41, 127.20, 123.35, 116.67, 113.25, 111.12, 77.54, 64.73, 49.76, 48.66, 41.19, 40.13, 28.75, 28.69, 23.27, 22.40, 20.42. HRMS (*m/z*) calcd. for $C_{24}H_{32}O_5$ $[M + H]^+$ 401.2323, found 401.2322.

*Data for **APA11***. White powder, yield 42%, m.p. 133 - 134 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (d, *J* = 8.7 Hz, 1H), 7.76 (d, *J* = 15.9 Hz, 1H), 7.26 (d, *J* = 4.7 Hz, 2H), 7.21 – 7.14 (m, 3H), 7.01 (s, 1H), 6.87

(dd, J = 8.7, 2.5 Hz, 1H), 6.37 (d, J = 16.0 Hz, 1H), 5.72 (s, 1H), 4.01 (d, J = 3.0 Hz, 2H), 2.67 (t, J = 7.0 Hz, 3H), 2.58 (d, J = 17.3 Hz, 1H), 2.01 (s, 3H), 1.80 (dd, J = 7.7, 4.3 Hz, 4H), 1.07 (d, J = 20.0 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.98, 170.62, 164.21, 151.85, 148.45, 141.99, 139.08, 129.42, 128.39, 128.35, 128.22, 125.84, 124.42, 117.70, 114.25, 112.04, 78.55, 68.10, 49.66, 41.13, 35.51, 28.67, 27.71, 24.28, 23.40, 21.45. HRMS (*m/z*) calcd. for $C_{28}H_{32}O_5$ $[M + H]^+$ 449.2323, found 449.2309.

Data for ***APA12***. White powder, yield 39%, m.p. 135 - 136 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02 (d, J = 8.6 Hz, 1H), 7.77 (d, J = 16.0 Hz, 1H), 7.02 (s, 1H), 6.89 (dd, J = 8.7, 2.5 Hz, 1H), 6.39 (d, J = 16.0 Hz, 1H), 5.74 (s, 1H), 4.00 (td, J = 6.6, 3.5 Hz, 2H), 2.69 (s, 1H), 2.59 (d, J = 16.8 Hz, 1H), 2.03 (s, 3H), 1.82 – 1.74 (m, 2H), 1.59 (m, 1H), 1.36 – 1.29 (m, 2H), 1.08 (d, J = 18.7 Hz, 6H), 0.91 (d, J = 6.7 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.96, 170.57, 164.30, 151.91, 148.42, 139.13, 129.43, 128.18, 124.37, 117.63, 114.26, 112.05, 78.55, 68.65, 49.67, 41.14, 35.04, 27.82, 27.00, 24.29, 23.40, 22.52, 21.46. HRMS (*m/z*) calcd. for $C_{24}H_{32}O_5$ $[M + H]^+$ 401.2323, found 401.2306.

Data for ***APA13***. White powder, yield 38%, m.p. 152 - 153 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02 (d, J = 8.7 Hz, 1H), 7.77 (d, J = 16.0 Hz, 1H), 7.07 – 6.98 (m, 1H), 6.89 (dd, J = 8.7, 2.5 Hz, 1H), 6.39 (d, J = 16.0 Hz, 1H), 5.74 (s, 1H), 4.11 – 3.99 (m, 2H), 2.68 (s, 1H), 2.59 (d, J = 17.1 Hz, 1H), 2.06 – 1.99 (m, 3H), 1.87 – 1.78 (m, 1H), 1.64 – 1.54 (m, 2H), 1.40 (m, 1H), 1.25 – 1.16 (m, 1H), 1.08 (d, J = 17.6 Hz, 6H), 0.94 – 0.87 (m, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.01, 169.67, 163.28, 150.87, 147.47, 138.18, 128.40, 127.16, 123.34, 116.66, 113.26, 111.10, 77.54, 65.70, 48.66, 40.13, 34.59, 30.27, 28.45, 23.27, 22.39, 20.43, 18.09, 10.21. HRMS (*m/z*) calcd. for $C_{24}H_{32}O_5$ $[M + H]^+$ 401.2323, found 401.2300.

Data for ***APA14***. White powder, yield 35%, m.p. 125 - 126 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (d, J = 8.7 Hz, 1H), 7.82 – 7.69 (m, 1H), 7.02 (s, 1H), 6.88 (dd, J = 8.7, 2.5 Hz, 1H), 6.38 (d, J = 16.0 Hz, 1H), 5.73 (s, 1H), 4.02 (d, J = 6.8 Hz, 2H), 2.76 – 2.52 (m, 2H), 2.02 (s, 3H), 1.78 (m, 1H), 1.75 – 1.68 (m, 1H), 1.60 (dt, J = 13.4, 6.8 Hz, 1H), 1.28 – 1.18 (m, 2H), 1.09 (s, 3H), 1.05 (s, 3H), 0.97 (d, J = 6.6 Hz, 3H), 0.88 (d, J = 1.9 Hz, 9H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.07, 169.60, 163.27, 150.85, 147.48, 138.20, 128.40, 127.13, 123.32, 116.66, 113.29, 111.08, 77.53, 76.22, 65.66, 50.13, 48.65, 40.13, 37.25, 30.11, 28.92, 26.28, 25.11, 23.28, 22.40, 21.66, 20.43. HRMS (*m/z*) calcd. for $C_{27}H_{38}O_5$ $[M + H]^+$ 443.2792, found 443.2779.

Data for ***APA15***. White powder, yield 34%, m.p. 132 - 133 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02 (d, J = 8.7 Hz, 1H), 7.76 (d, J = 16.0 Hz, 1H), 7.02 (s, 1H), 6.89 (dd, J = 8.7, 2.5 Hz, 1H), 6.38 (d, J = 16.0 Hz, 1H), 5.73 (s, 1H), 4.04 (tt, J = 9.1, 4.2 Hz, 2H), 2.68 (s, 1H), 2.58 (d, J = 17.1 Hz, 1H), 2.05 – 2.00

(m, 3H), 1.87 – 1.77 (m, 1H), 1.70 – 1.62 (m, 1H), 1.54 (m, 2H), 1.35 – 1.22 (m, 4H), 1.17 – 1.12 (m, 2H), 1.09 (s, 3H), 1.06 (s, 3H), 0.92 (dd, *J* = 6.6, 1.6 Hz, 3H), 0.86 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 196.05, 170.70, 164.31, 151.87, 139.21, 129.44, 128.19, 124.36, 117.70, 114.25, 112.17, 78.55, 66.71, 60.44, 49.68, 41.16, 39.22, 37.28, 36.05, 29.77, 27.96, 24.63, 24.30, 23.42, 22.65, 21.45, 19.61. HRMS (*m/z*) calcd. for $C_{28}H_{40}O_5$ $[M + H]^+$ 457.2949, found 457.2930.

*Data for **APA16***. White powder, yield 36%, m.p. 135 - 1136 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.7 Hz, 1H), 7.76 (d, *J* = 16.0 Hz, 1H), 7.02 (s, 1H), 6.88 (dd, *J* = 8.8, 2.5 Hz, 1H), 6.38 (d, *J* = 16.0 Hz, 1H), 5.72 (s, 1H), 5.11 – 5.04 (m, 1H), 4.03 (q, *J* = 9.1, 7.8 Hz, 2H), 2.67 (s, 1H), 2.57 (d, *J* = 17.1 Hz, 1H), 2.07 – 1.91 (m, 5H), 1.85 – 1.76 (m, 1H), 1.66 (s, 3H), 1.59 (m, 4H), 1.40 – 1.31 (m, 1H), 1.28 – 1.12 (m, 2H), 1.09 (s, 3H), 1.05 (s, 3H), 0.93 (dd, *J* = 6.6, 1.4 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.10, 169.82, 163.27, 150.86, 147.50, 138.20, 130.35, 128.40, 127.17, 123.54, 116.71, 113.21, 111.15, 77.52, 65.61, 48.64, 40.14, 36.07, 34.93, 28.39, 24.70, 24.39, 23.27, 22.40, 20.44, 18.49, 16.65. HRMS (*m/z*) calcd. for $C_{28}H_{38}O_5$ $[M + H]^+$ 455.2792, found 455.2772.

*Data for **APA17***. White powder, yield 35%, m.p. 153 - 154 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02 (d, *J* = 8.7 Hz, 1H), 7.76 (d, *J* = 16.0 Hz, 1H), 7.08 (s, 1H), 6.93 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.39 (d, *J* = 16.1 Hz, 1H), 5.73 (s, 1H), 4.18 (td, *J* = 4.5, 2.5 Hz, 2H), 3.79 (t, *J* = 4.7 Hz, 2H), 3.58 (q, *J* = 7.0 Hz, 2H), 2.70 (s, 1H), 2.58 (d, *J* = 17.1 Hz, 1H), 2.03 (s, 3H), 1.22 (t, *J* = 7.0 Hz, 3H), 1.08 (d, *J* = 16.7 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 196.03, 170.73, 163.90, 151.83, 148.43, 139.09, 129.37, 128.30, 124.67, 117.76, 114.41, 112.43, 78.50, 68.65, 67.70, 66.93, 49.68, 41.14, 24.30, 23.42, 21.48, 15.10. HRMS (*m/z*) calcd. for $C_{22}H_{28}O_6$ $[M + H]^+$ 389.1959, found 389.1942.

*Data for **APA18***. White powder, yield 31%, m.p .157 - 158 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.7 Hz, 1H), 7.73 (d, *J* = 16.0 Hz, 1H), 7.07 (s, 1H), 6.90 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.38 (d, *J* = 16.0 Hz, 1H), 5.72 (s, 1H), 4.19 (q, *J* = 4.3 Hz, 2H), 3.84 (t, *J* = 4.7 Hz, 2H), 3.72 – 3.65 (m, 2H), 3.55 (dd, *J* = 5.8, 3.1 Hz, 2H), 3.35 (s, 3H), 2.69 (s, 1H), 2.57 (d, *J* = 17.1 Hz, 1H), 2.01 (s, 3H), 1.06 (d, *J* = 18.5 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 196.04, 170.54, 163.83, 151.70, 148.48, 139.05, 129.30, 128.41, 124.67, 117.81, 114.53, 112.35, 78.44, 77.25, 71.90, 70.61, 69.54, 67.63, 58.99, 49.67, 41.12, 24.29, 23.40, 21.47. HRMS (*m/z*) calcd. for $C_{23}H_{30}O_7$ $[M + Na]^+$ 441.1884, found 441.1874.

2. ^{1}H NMR, ^{13}C NMR and HRMS spectra of APA7~APA18

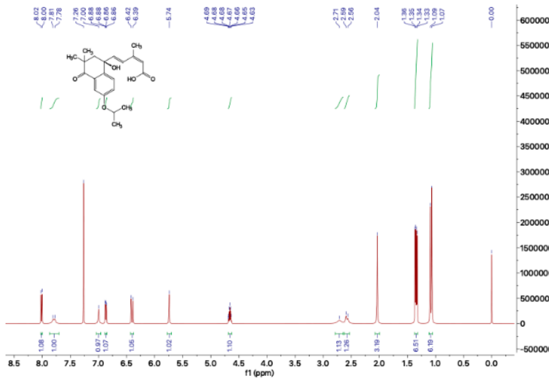


Figure S1. ^{1}HNMR of **APA7**

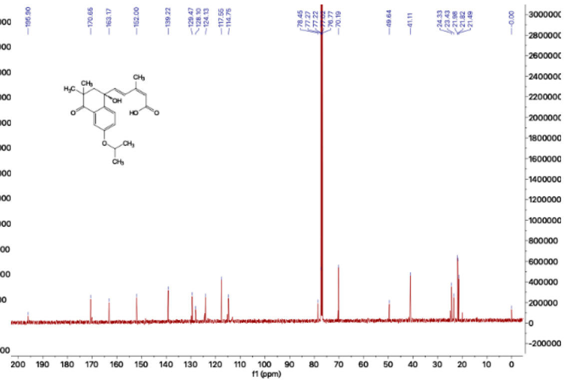


Figure S2. ^{13}CNMR of **APA7**

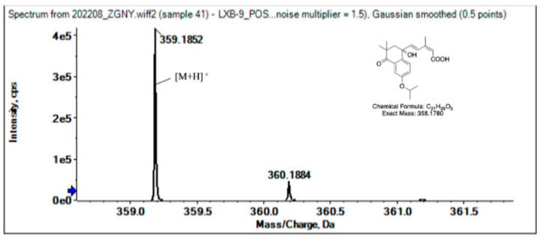


Figure S3. HRMS of **APA7**

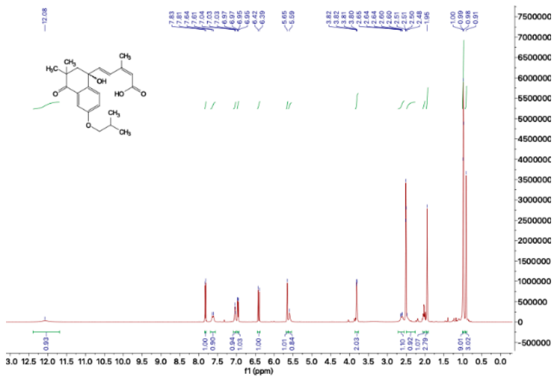


Figure S4. ^{1}HNMR of **APA8**

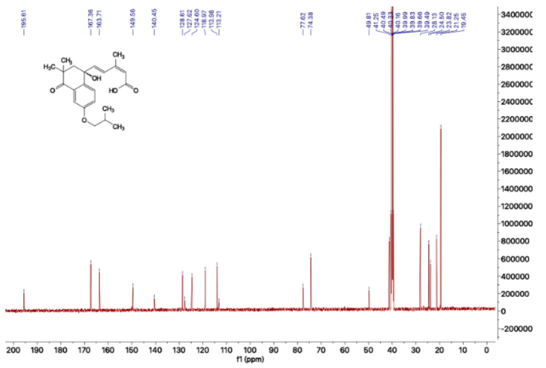


Figure S5. ^{13}CNMR of **APA8**

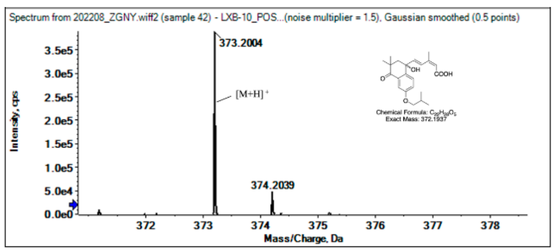
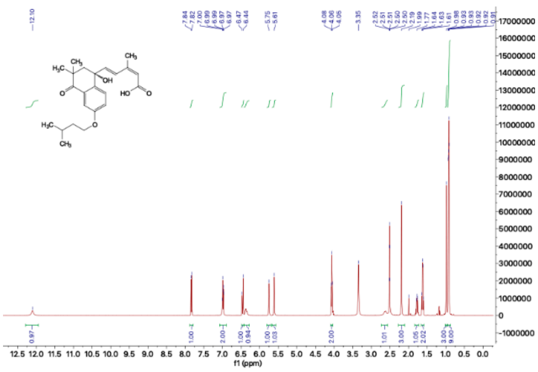


Figure S6. HRMS of **APA8**



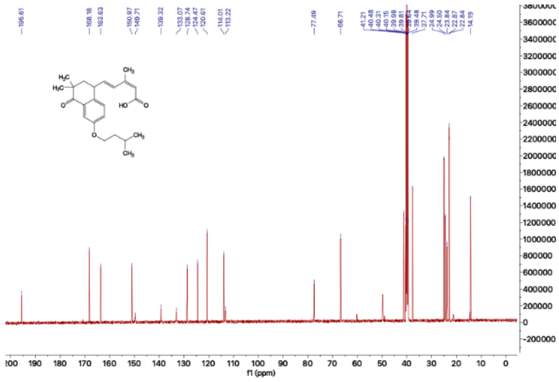
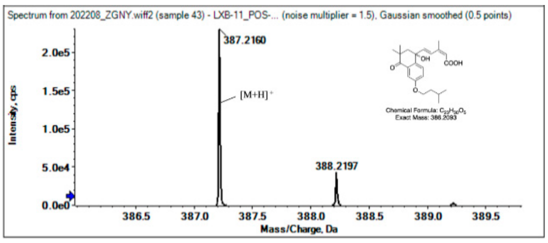


Figure S7. ^{1}HNMR of **APA9**

Figure S8. ^{13}CNMR of **APA9**



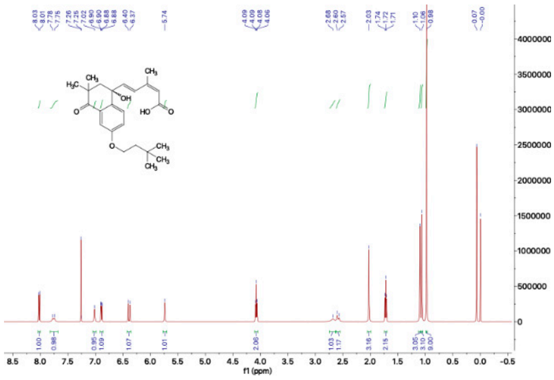
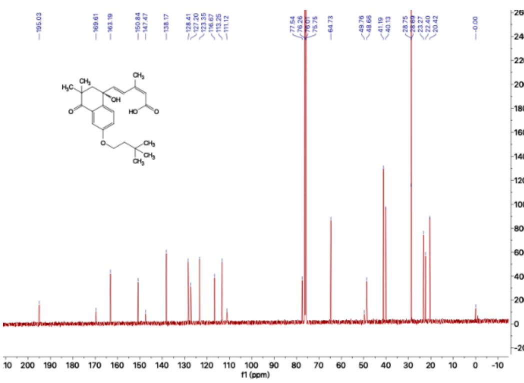


Figure S9. HRMS of **APA9**

Figure S10. ^{1}HNMR of **APA10**



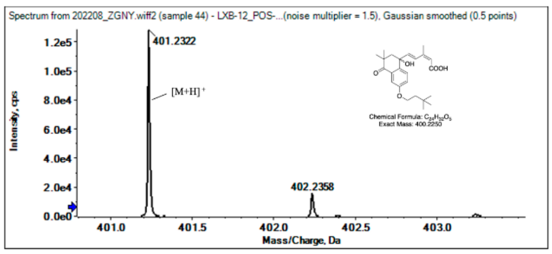


Figure S11. ^{13}CNMR of **APA10**

Figure S12. HRMS of **APA10**

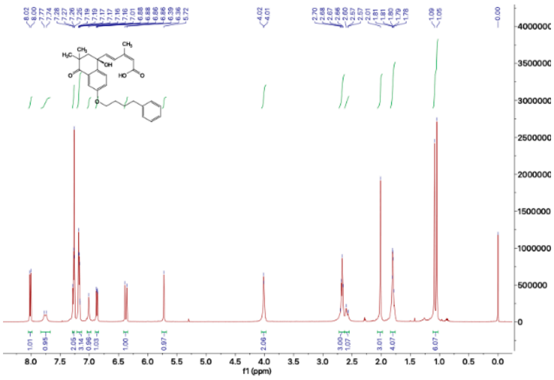


Figure S13. ^{1}HNMR of **APA11**

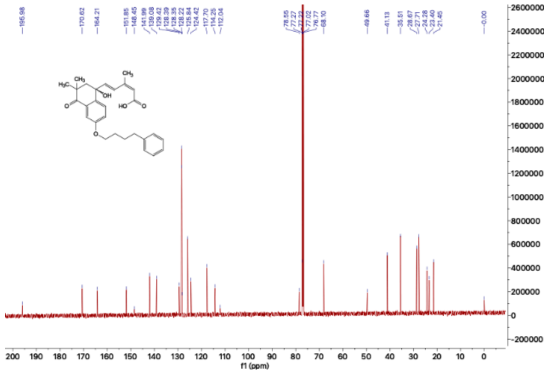


Figure S14. ^{13}CNMR of **APA11**

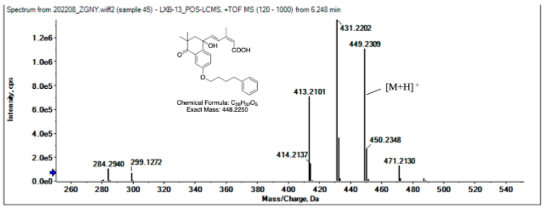


Figure S15. HRMS of **APA11**

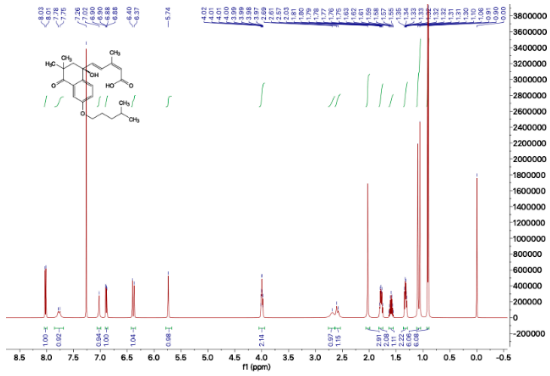


Figure S16. ^{1}HNMR of **APA12**

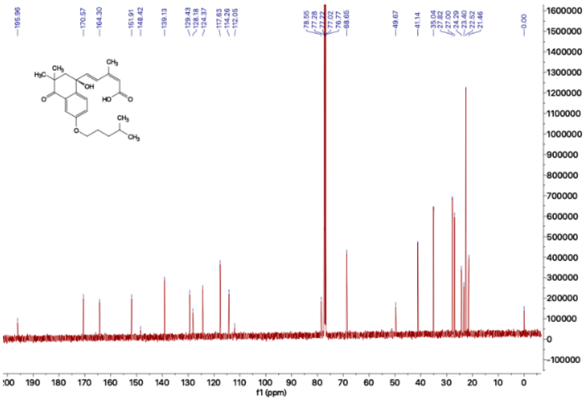


Figure S17. ^{13}CNMR of **APA12**

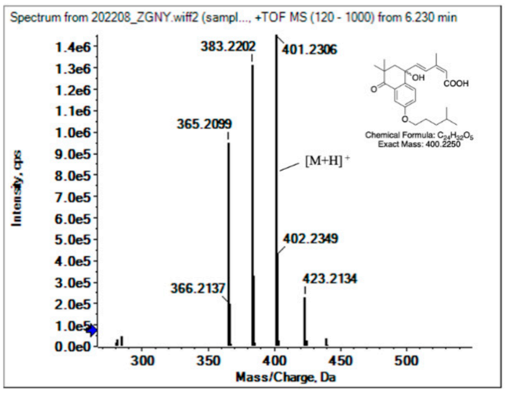


Figure S18. HRMS of **APA12**

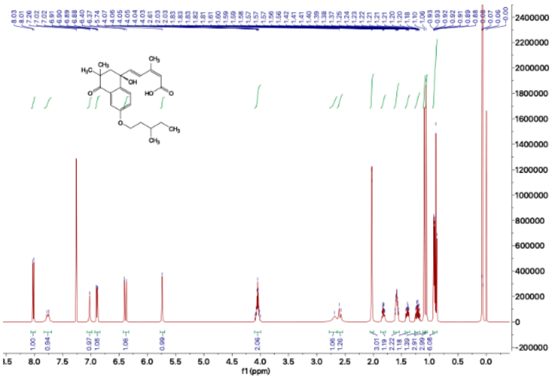


Figure S19. ^{1}HNMR of **APA13**

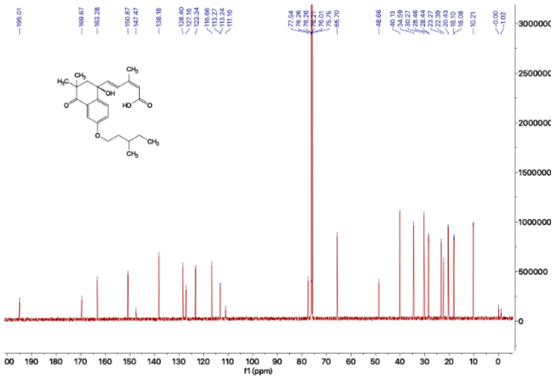


Figure S20. ^{13}CNMR of **APA13**

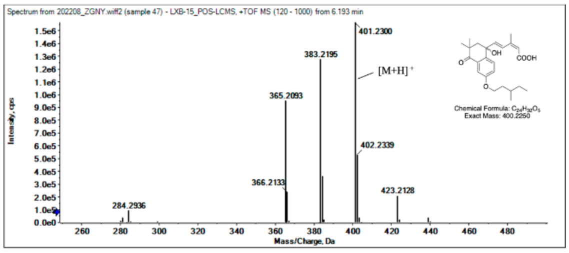


Figure S21. HRMS of **APA13**

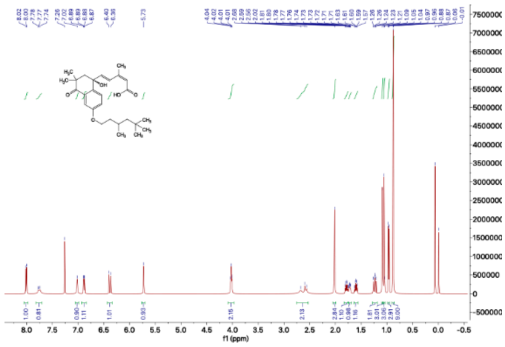


Figure S22. ^{1}HNMR of **APA14**

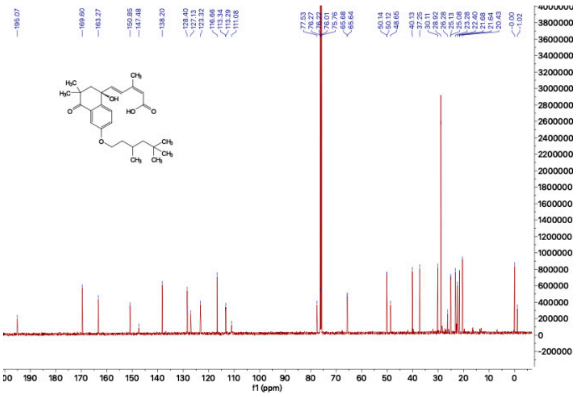


Figure S23. ^{13}CNMR of **APA14**

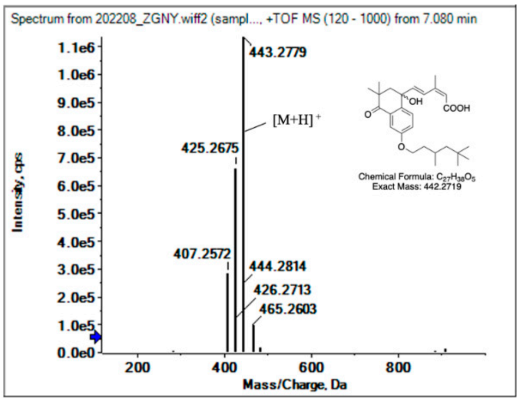


Figure S24. HRMS of **APA14**

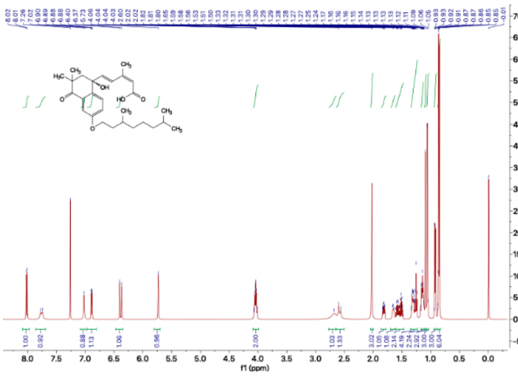


Figure S25. ^{1}HNMR of **APA15**

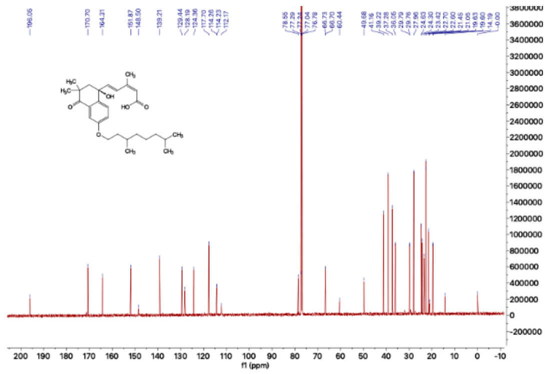


Figure S26. ^{13}CNMR of **APA15**

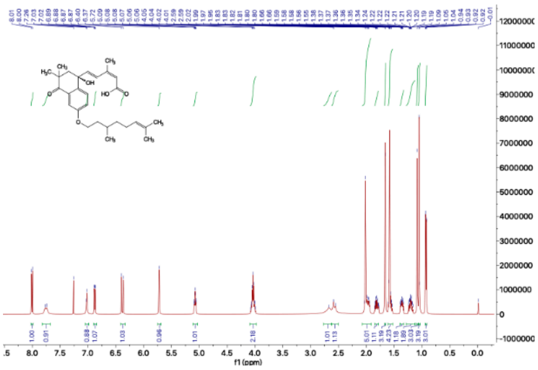


Figure S27. HRMS of **APA15**

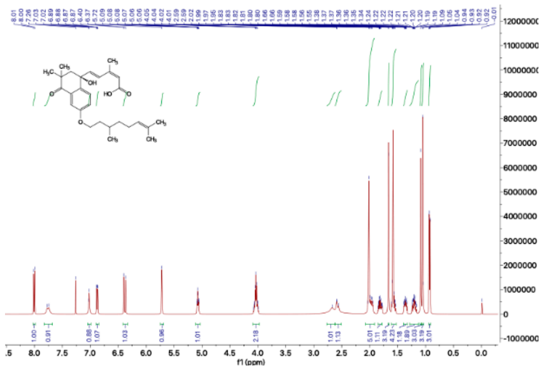


Figure S28. ^{1}HNMR of **APA16**

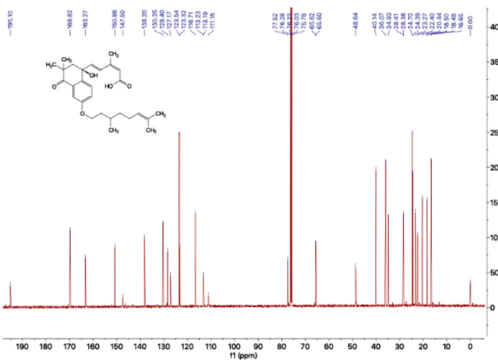


Figure S29. ^{13}CNMR of **APA16**

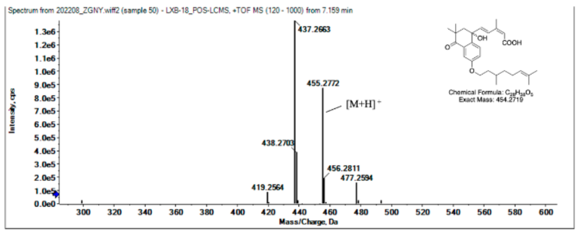


Figure S30. HRMS of **APA16**

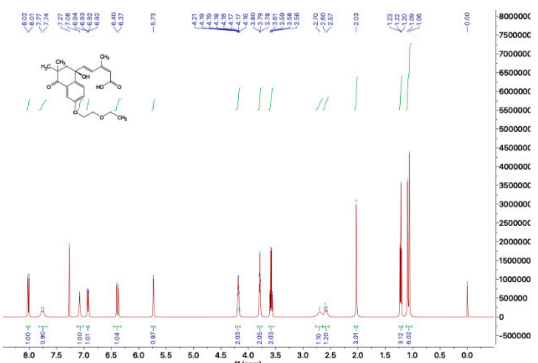


Figure S31. ^{1}HNMR of **APA17**

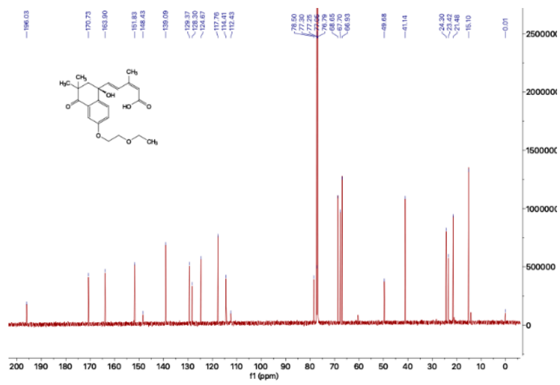


Figure S32. ^{13}CNMR of **APA17**

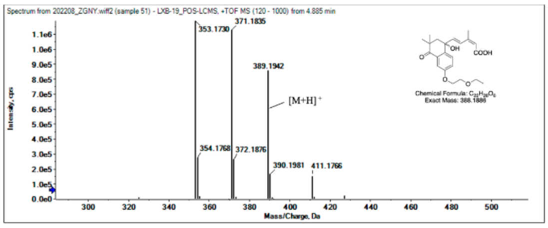


Figure S33. HRMS of **APA17**

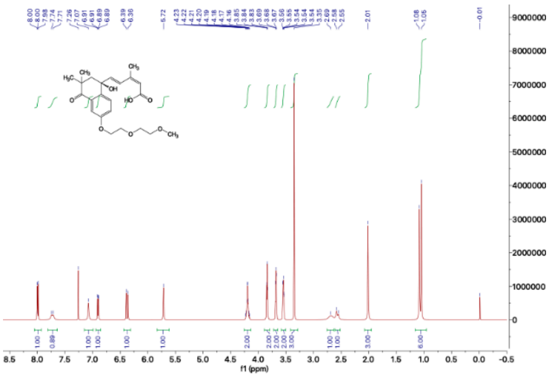


Figure S34. [1]HNMR of **APA18**

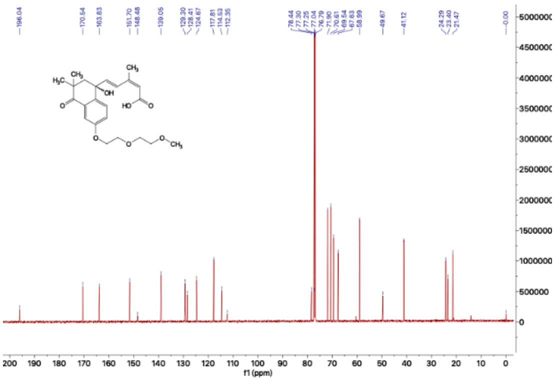


Figure S35. [13]CNMR of **APA18**

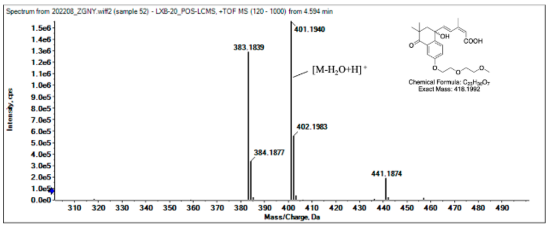


Figure S36. HRMS of **APA18**

4. **MST analysis of the binding of APAn and control agents to ABA receptors**

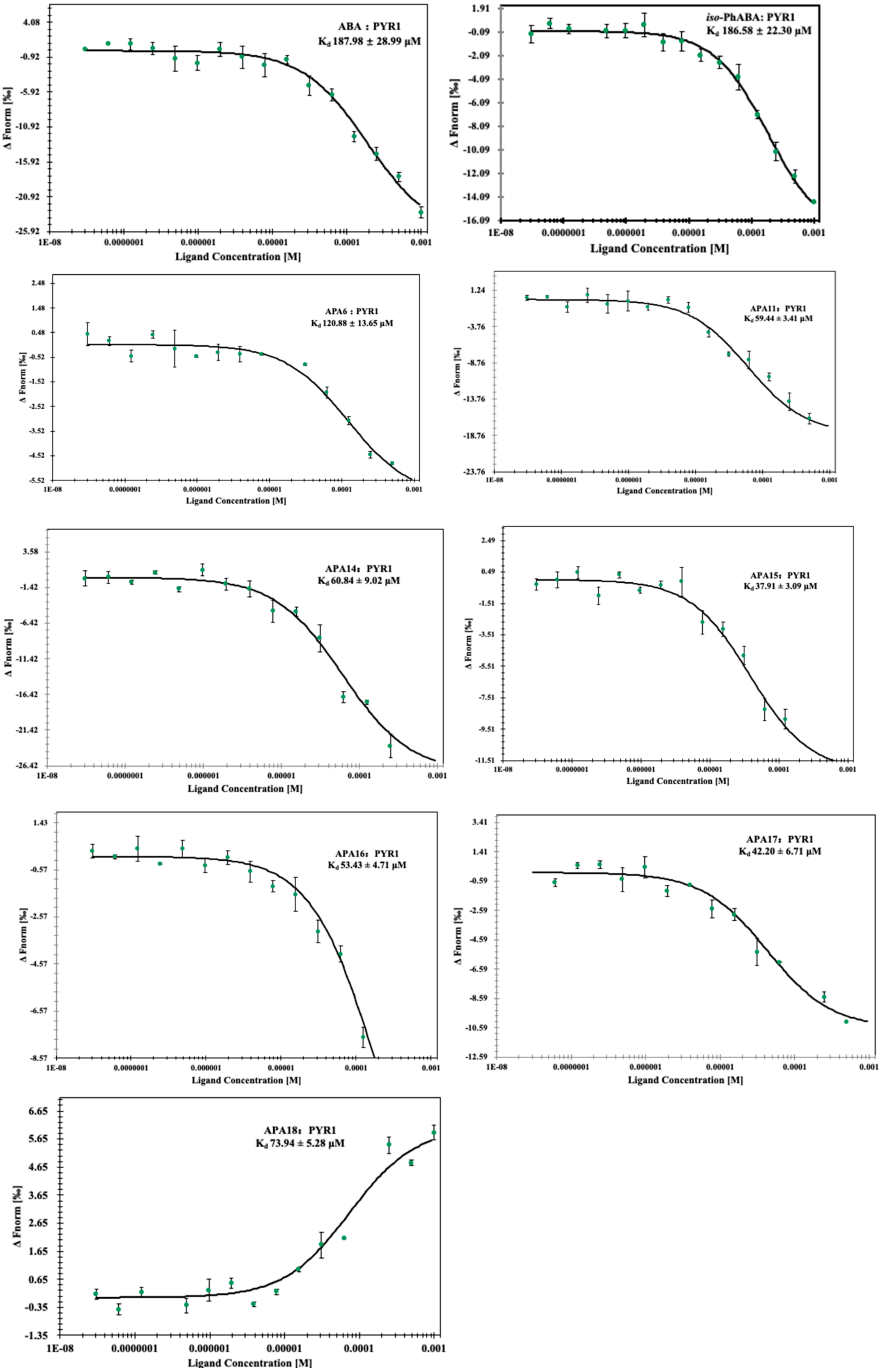


Figure S37. MST analysis of the binding of APAn and control agents to PYR1

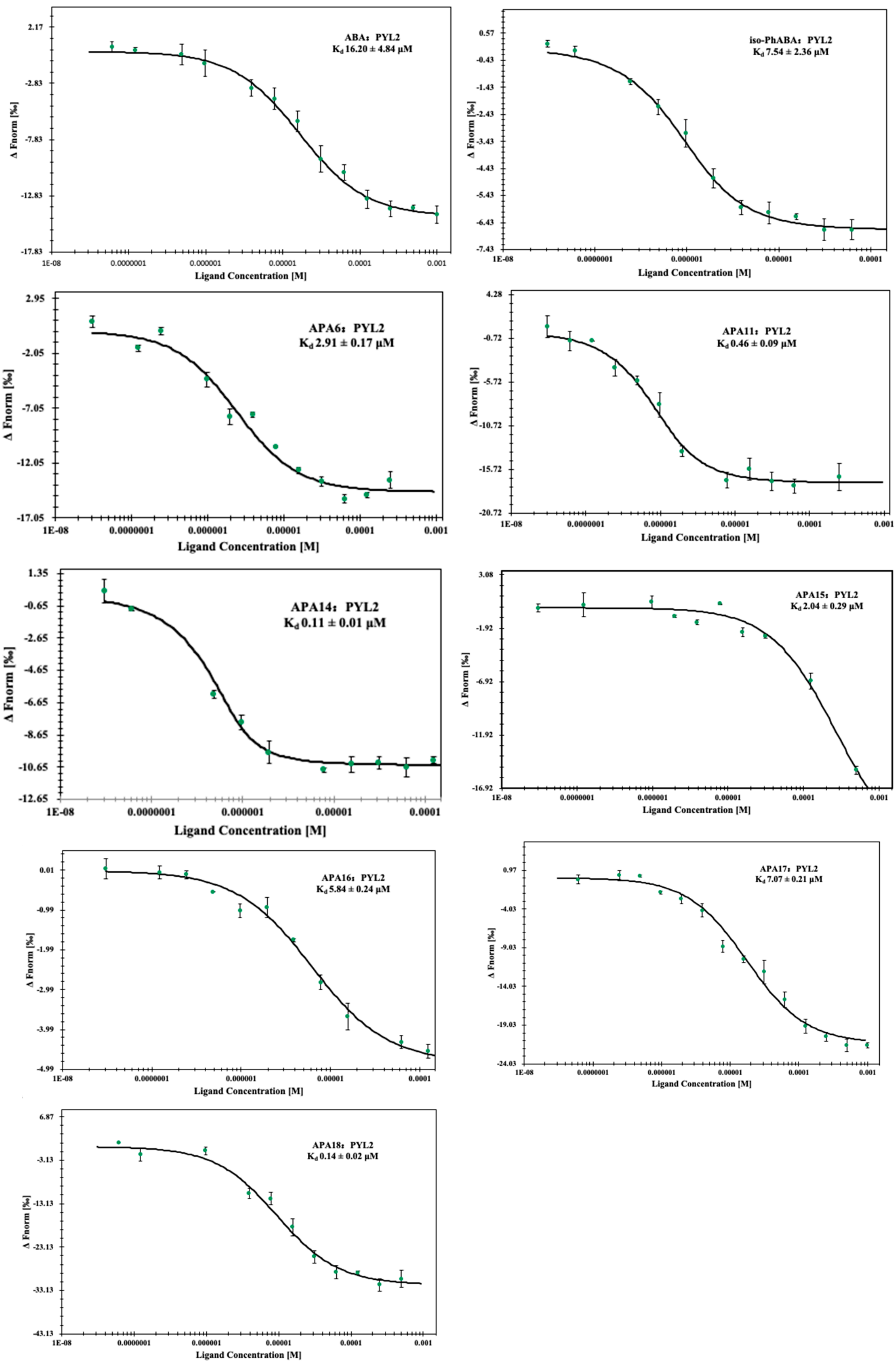


Figure S38. MST analysis of the binding of APAn and control agents to PYL2

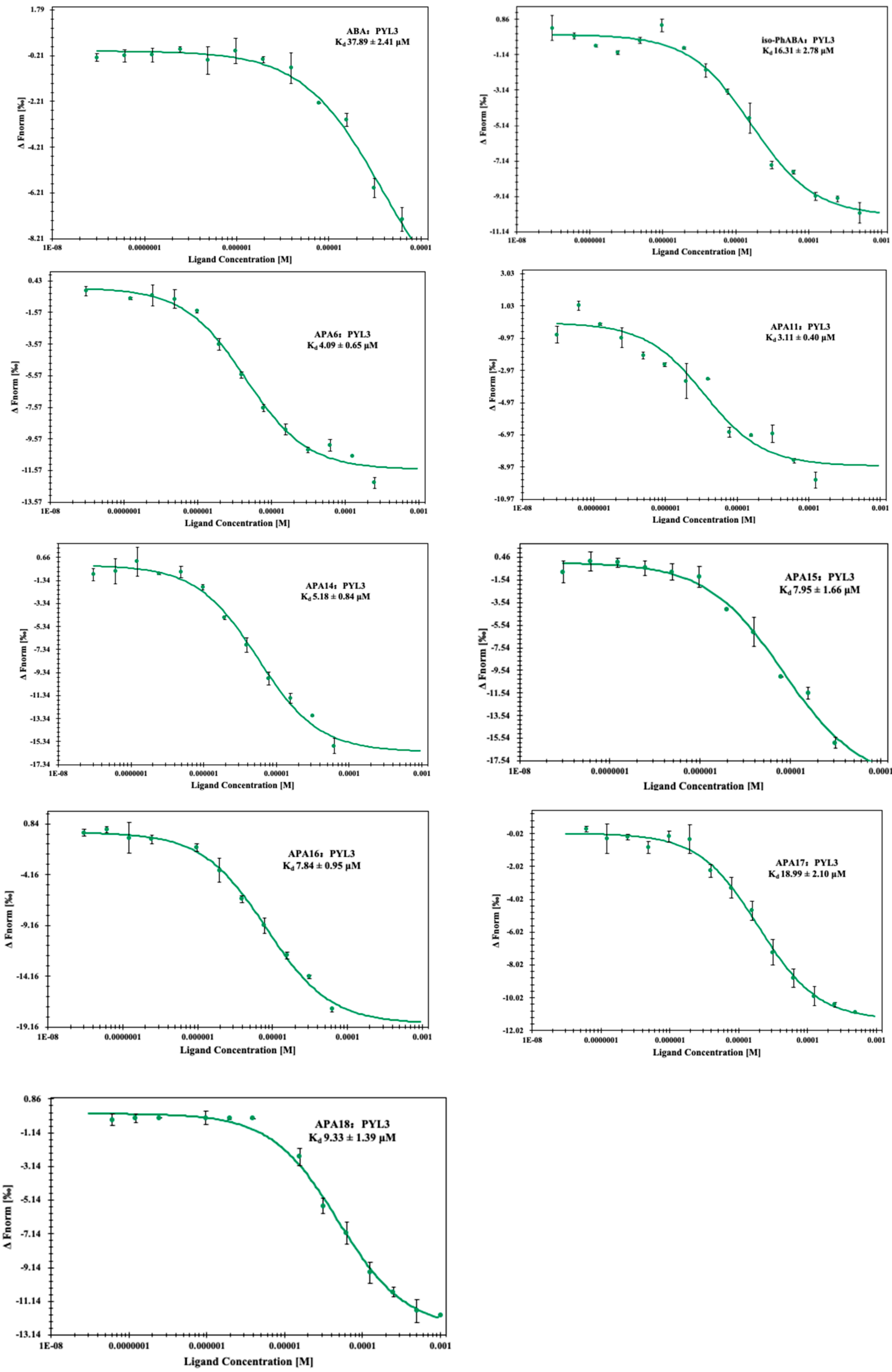


Figure S39. MST analysis of the binding of APAn and control agents to PYL3

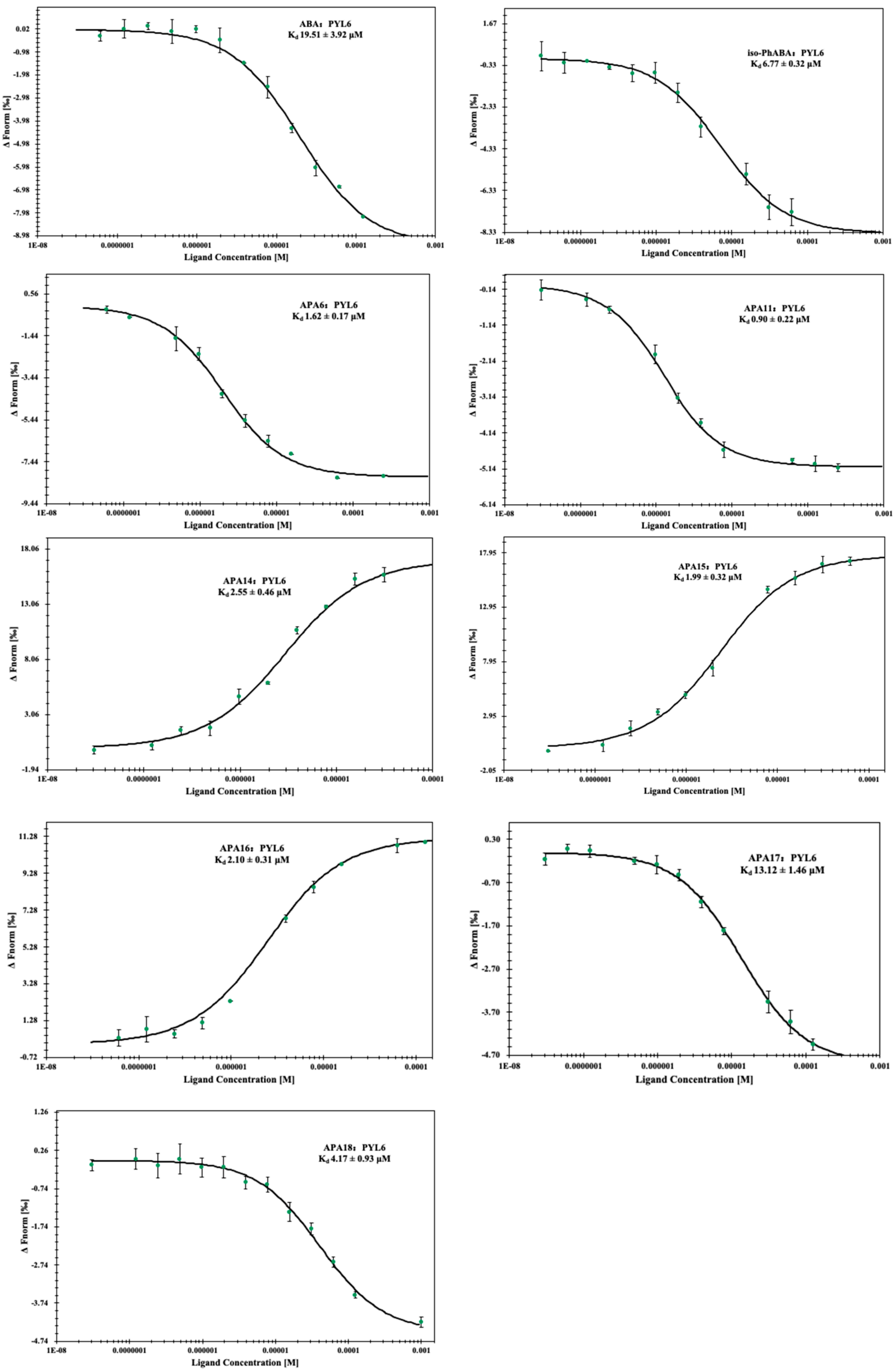


Figure S40. MST analysis of the binding of APAn and control agents to PYL6

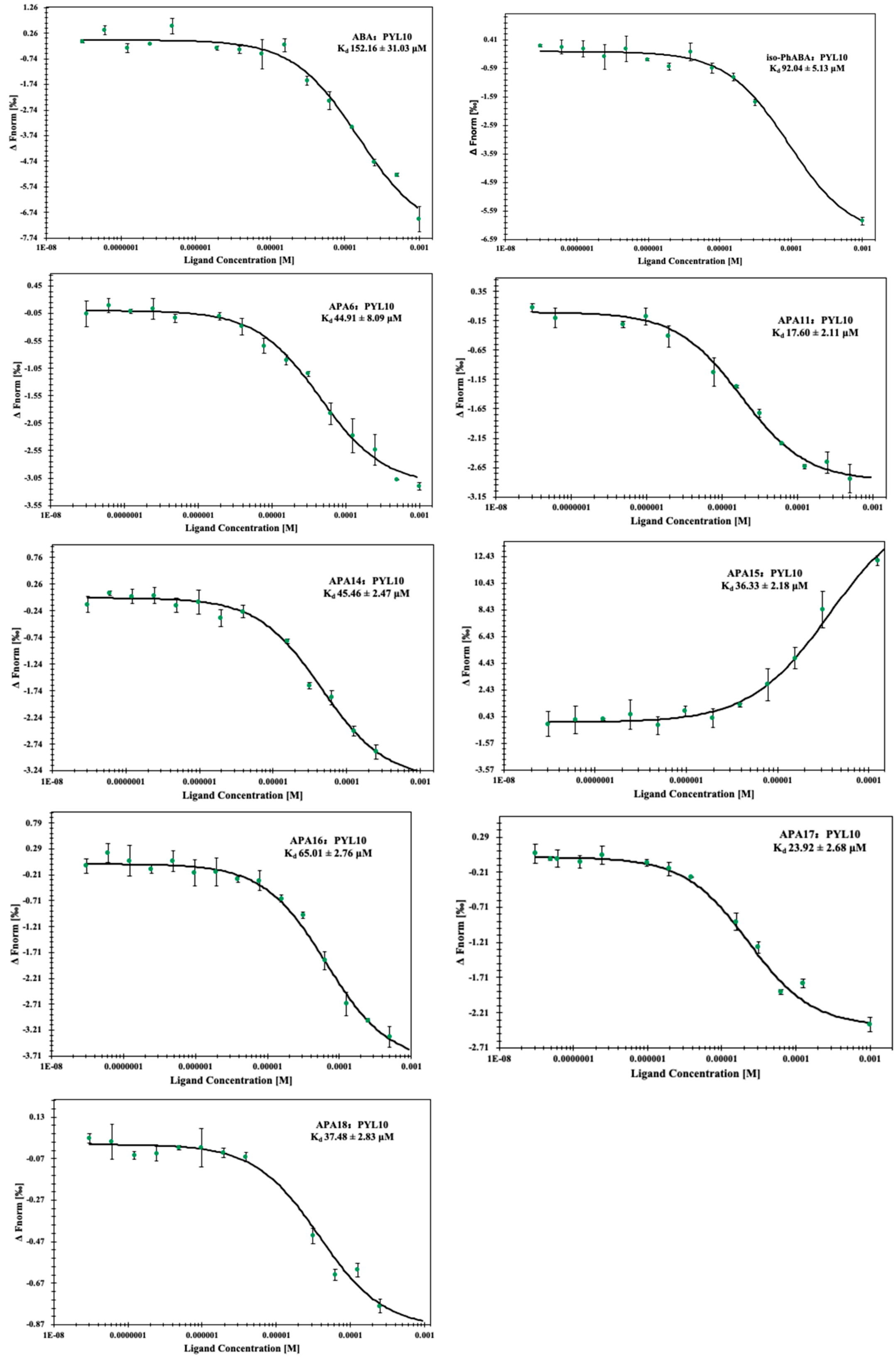


Figure S41. MST analysis of the binding of APAn and control agents to PYL10

4. Calculated values of the decomposition free energy

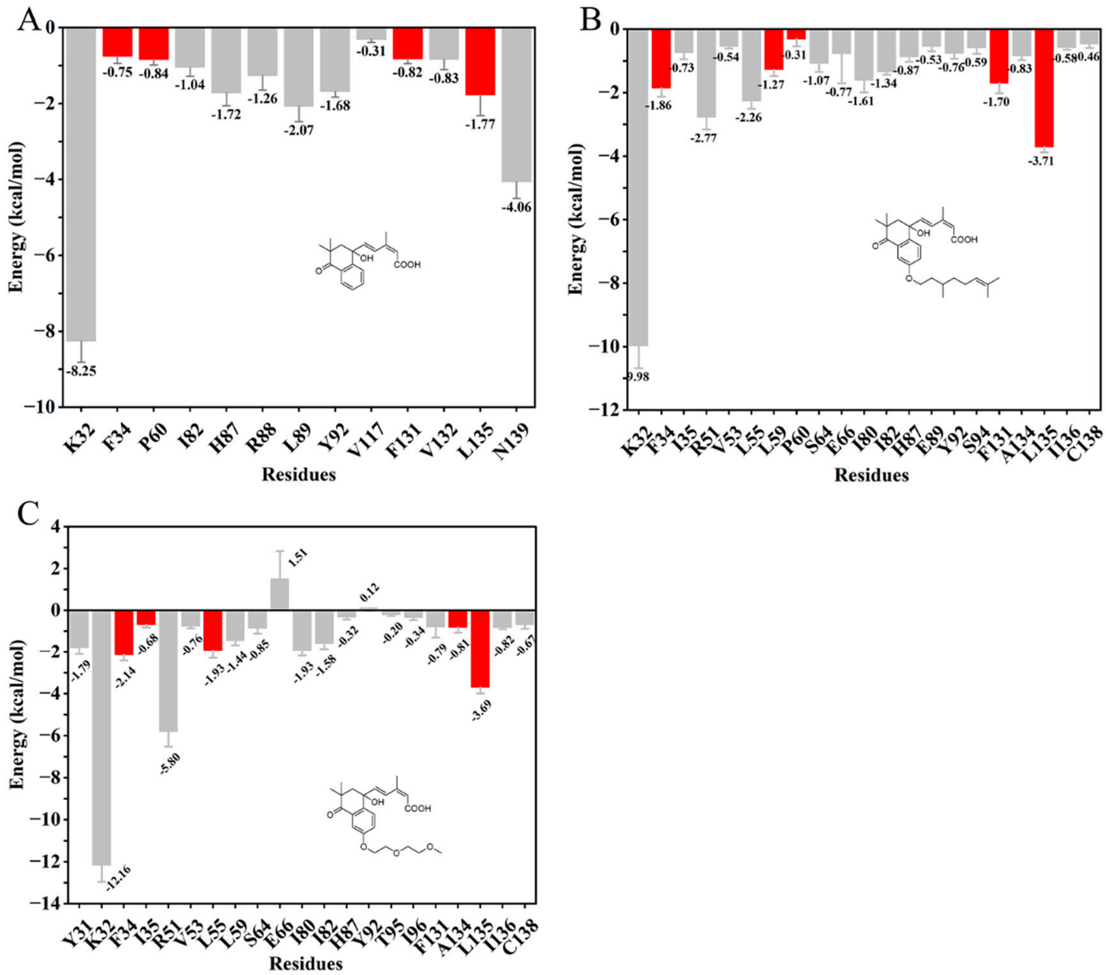


Figure S42. Calculated values of the decomposition free energy. (The red residues in the figure were hydrophobic residues around the 3'-tunnel.)

5. Seed germination promotion activity

Table S1. The effect of agent treatment on *A. thaliana* seed germination (48 h). Values represent means ± SD, and those marked with the same letter are statistically significant ($p < 0.05$).

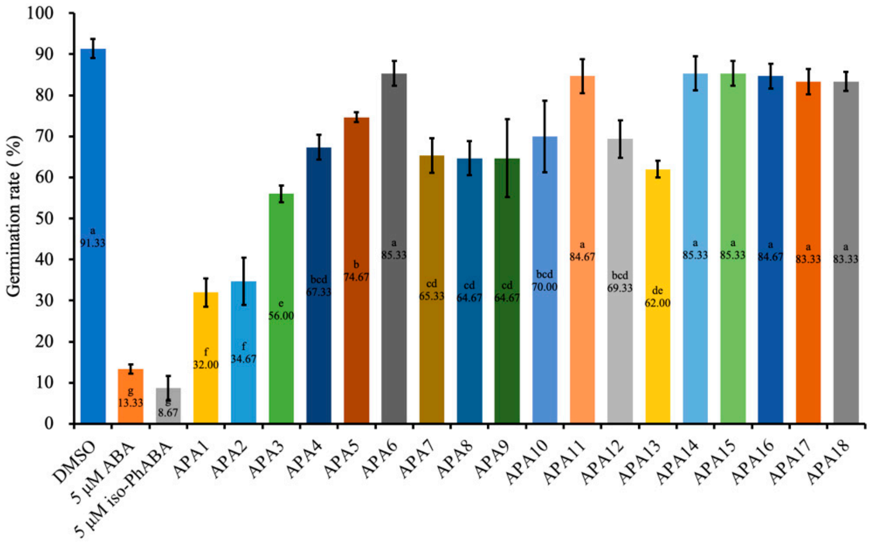
Treatment 1[a]	Germination rate (%)	Treatment 2[b]	Germination rate (%)	Treatment 3[c]	Germination rate (%)
DMSO	91.33±2.31 A	DMSO	92.67±2.31 A	DMSO	93.33±3.06 A
ABA	13.33±1.15 G	ABA	31.33±3.06 F	ABA	10.67±3.06 G
iso-PhABA	8.67±3.06 G	*iso*-PhABA	22.67±1.15 GH	*iso*-PhABA	7.33±2.31 G
/	/	/	/	NaCl	48.67±6.11 E
APA1	32.00±3.46 F	ABA+APA1	11.33±3.06 I	APA1+NaCl	29.33±4.16 F
APA2	34.67±5.77 F	ABA+APA2	18.67±1.15 H	APA2+NaCl	33.33±5.03 F
APA3	56.00±2.00 E	ABA+APA3	25.33±3.06 G	APA3+NaCl	43.33±2.31 E
APA4	67.33±3.06 BCD	ABA+APA4	52.00±3.46 DE	APA4+NaCl	61.33±4.16 D
APA5	74.67±1.15 B	ABA+APA5	67.33±1.15 C	APA5+NaCl	71.33±2.31 C
APA6	85.33±3.06 A	ABA+APA6	78.67±3.06 B	APA6+NaCl	82.67±3.06 B
APA7	65.33±4.16 CD	ABA+APA7	48.00±2.00 E	APA7+NaCl	62.00±3.46 D
APA8	64.67±4.16 CD	ABA+APA8	50.67±4.16 DE	APA8+NaCl	62.00±5.29 D
APA9	64.67±9.45 CD	ABA+APA9	50.67±4.62 DE	APA9+NaCl	60.00±8.00 D
APA10	70.00±8.72 BCD	ABA+APA10	54.67±3.06 D	APA10+NaCl	61.33±3.06 D
APA11	84.67±4.16 A	ABA+APA11	75.33±6.11 B	APA11+NaCl	81.33±4.16 B
APA12	69.33±4.62 BCD	ABA+APA12	50.00±5.29 DE	APA12+NaCl	60.67±5.03 D
APA13	62.00±2.00 DE	ABA+APA13	46.67±4.16 E	APA13+NaCl	56.67±3.06 D
APA14	85.33±4.16 A	ABA+APA14	78.67±4.16 B	APA14+NaCl	86.00±2.00 B
APA15	85.33±3.06 A	ABA+APA15	74.67±1.15 B	APA15+NaCl	85.33±1.15 B
APA16	84.67±3.06 A	ABA+APA16	76.67±1.15 B	APA16+NaCl	84.00±4.00 B
APA17	83.33±3.06 A	ABA+APA17	75.33±3.06 B	APA17+NaCl	82.67±3.06 B
APA18	83.33±2.31 A	ABA+APA18	76.00±2.00 B	APA18+NaCl	84.00±3.46 B

[a] *A. thaliana* seeds were treated with 5 μM corresponding compound APAn alone. 5 μM ABA or 5 μM *iso*-PhABA treatment were used as control groups.

[b] *A. thaliana* seeds were treated with a mixture of 1 μM ABA and 5 μM APAn. 1 μM ABA or 1 μM *iso*-PhABA treatment were used as control groups.

[c] *A. thaliana* seeds were treated with the combination of 10 mM NaCl and 5 μM APAn. 5 μM ABA or 5 μM *iso*-PhABA treatment were used as control groups.

A



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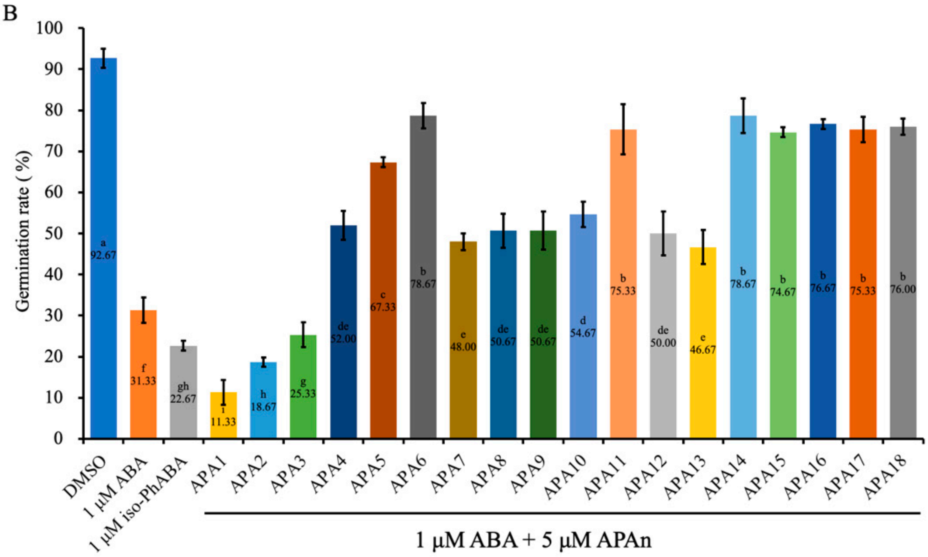

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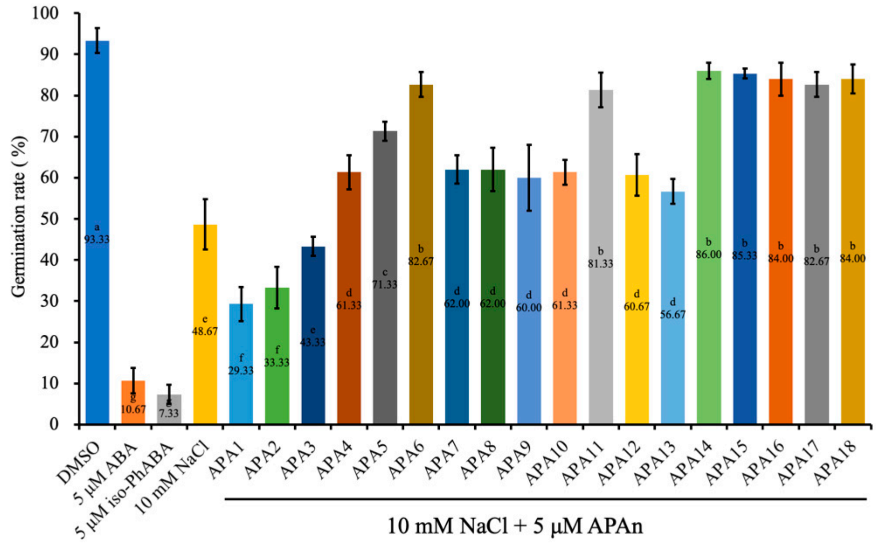


Figure S43. The effect of agent treatment on *A. thaliana* seed germination. Values represent means ± SD, and those marked with the same letter are statistically significant ($p < 0.05$).

Table S2. The effect of agent treatment on colza seed germination (48 h). Values represent means ± SD, and those marked with the same letter are statistically significant ($p < 0.05$).

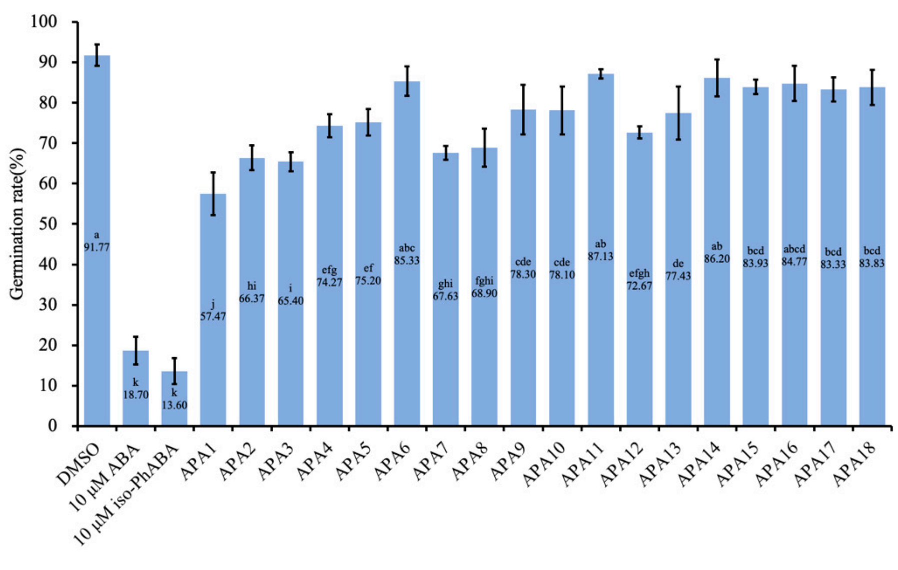
Treatment 1[a]	Germination rate (%)	Treatment 2[b]	Germination rate (%)	Treatment 3[c]	Germination rate (%)
DMSO	91.77±2.75 ^{A}	DMSO	89.52±3.30 ^{A}	DMSO	91.43±5.71 ^{A}
ABA	18.70±3.92 ^{K}	ABA	49.52±3.30 ^{K}	ABA	2.86±2.86 ^{K}
iso-PhABA	13.60±3.29 ^{K}	*iso*-PhABA	21.90±4.36 ^{K}	*iso*-PhABA	0 ^{K}
/	/	/	/	NaCl	42.86±1.00 ^{H}
APA1	57.47±5.31 ^{J}	ABA+APA1	47.62±3.30 ^{J}	APA1+NaCl	25.71±5.71 ^{J}
APA2	66.37±3.04 ^{HI}	ABA+APA2	49.52±4.36 ^{HI}	APA2+NaCl	32.24±1.65 ^{IJ}
APA3	65.40±2.36 ^{I}	ABA+APA3	50.48±5.95 ^{I}	APA3+NaCl	34.29±7.56 ^{HIJ}
APA4	74.27±2.85 ^{EFG}	ABA+APA4	64.76±3.30 ^{EFG}	APA4+NaCl	37.14±7.56 ^{HI}
APA5	75.20±3.29 ^{EF}	ABA+APA5	72.38±4.36 ^{EF}	APA5+NaCl	62.86±4.95 ^{FG}
APA6	85.33±3.65 ^{ABC}	ABA+APA6	82.86±2.86 ^{ABC}	APA6+NaCl	77.14±2.86 ^{BCD}
APA7	67.63±1.67 ^{GHI}	ABA+APA7	56.19±4.36 ^{GHI}	APA7+NaCl	37.14±2.86 ^{HI}
APA8	68.90±4.70 ^{FGHI}	ABA+APA8	58.10±3.30 ^{FGHI}	APA8+NaCl	25.71±2.86 ^{J}
APA9	78.30±6.09 ^{CDE}	ABA+APA9	67.62±4.36 ^{CDE}	APA9+NaCl	65.71±8.57 ^{EFG}
APA10	78.10±5.98 ^{CDE}	ABA+APA10	68.57±2.86 ^{CDE}	APA10+NaCl	69.52±4.36 ^{DEF}
APA11	87.13±1.15 ^{AB}	ABA+APA11	80.95±3.30 ^{AB}	APA11+NaCl	77.14±4.95 ^{BCD}
APA12	72.67±1.48 ^{EFGH}	ABA+APA12	71.43±4.95 ^{EFGH}	APA12+NaCl	59.05±5.95 ^{G}
APA13	77.43±6.54 ^{DE}	ABA+APA13	65.71±4.95 ^{DE}	APA13+NaCl	69.52±5.95 ^{DEF}
APA14	86.20±4.56 ^{AB}	ABA+APA14	75.24±3.30 ^{AB}	APA14+NaCl	75.24±6.00 ^{CD}
APA15	83.93±1.79 ^{BCD}	ABA+APA15	75.24±4.36 ^{BCD}	APA15+NaCl	73.33±3.30 ^{CDE}
APA16	84.77±4.38 ^{ABCD}	ABA+APA16	76.19±4.36 ^{ABCD}	APA16+NaCl	80.95±4.36 ^{BC}
APA17	83.33±2.97 ^{BCD}	ABA+APA17	83.81±4.36 ^{BCD}	APA17+NaCl	85.71±7.56 ^{AB}
APA18	83.83±4.38 ^{BCD}	ABA+APA18	81.90±5.95 ^{BCD}	APA18+NaCl	82.86±4.95 ^{ABC}

[a] *Colza* seeds treated with 10 µM corresponding APAn compounds alone.

[b] *Colza* seeds treated both with 1 µM ABA and 10 µM corresponding APAn compounds, 1 µM ABA and 1 µM *iso*-PhABA treated as control groups.

[c] *Colza* seeds treated both with 25 mM NaCl and 25 µM corresponding APAn compounds, 25 µM ABA and 25 µM *iso*-PhABA treated as control groups.

A



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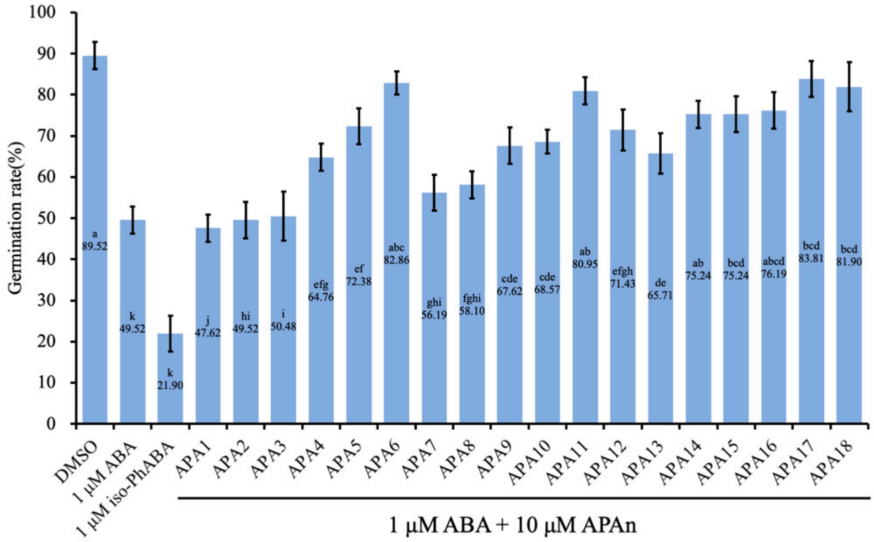

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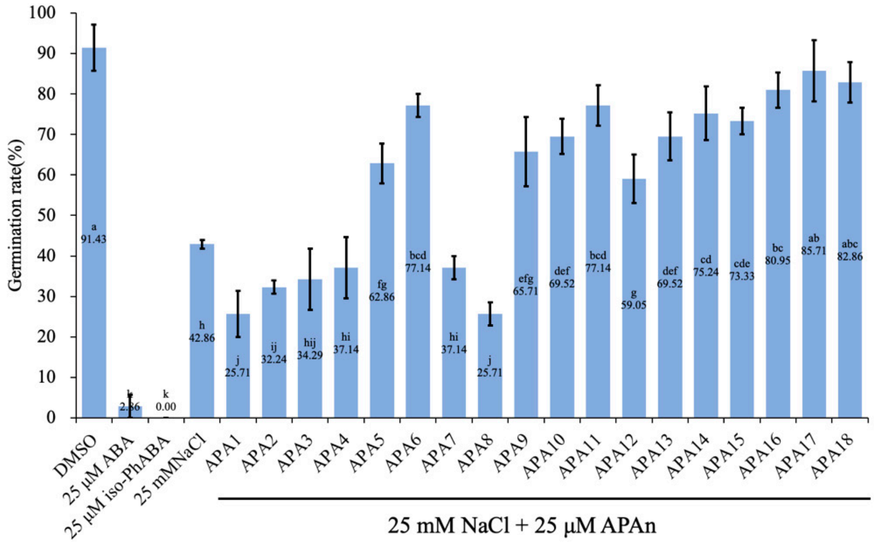

Figure S44. The effect of agent treatment on *colza* seed germination. Values represent means ± SD, and those marked with the same letter are statistically significant ($p < 0.05$).

Table S3. The germination parameters of rice seeds under different treatments. Values represent means ± SD, and those marked with the same letter are statistically significant ($p < 0.05$).

treatment		Germination potential(%)	Germination rate(%)	Germination index	Cotyledons length(cm)	Roots length(cm)	Vitality index
compd.	additive						
DMSO	none	77.33±3.06 A	97.33±3.06 AB	15.34±0.44 ABC	6.19±0.67 A	8.08±0.57 A	94.93±10.13 A
10 μM ABA	none	36.00±4.00 G	97.33±2.31 AB	13.50±0.36 E	4.42±0.40 F	4.93±0.67 G	63.07±5.71 DE
10 μM *iso*-PhABA	none	18.00±2.00 H	98.00±1.46 AB	12.92±0.30 F	3.76±0.51 G	4.51±0.42 G	48.57±6.38 E
10 μM APA1	none	58.67±4.16 F	98.33±1.15 A	14.84±0.34 ABCD	5.25±0.47 DE	5.68±0.34 F	77.93±6.96 BCD
10 μM APA2	none	59.33±5.03 F	96.67±2.31 AB	14.46±0.48 D	5.51±0.27 BCDE	5.72±0.68 F	79.66±4.35 BCD
10 μM APA3	none	59.33±4.62 F	98.00±2.00 AB	14.71±0.46 BCD	5.13±0.25 E	6.09±0.94 DEF	75.43±4.04 CDE
10 μM APA4	none	67.33±3.06 DE	95.33±3.06 AB	14.67±0.34 CD	5.37±0.28 CDE	5.98±0.54 EF	78.80±4.22 BCD
10 μM APA5	none	68.67±4.16 CDE	96.67±1.15 AB	14.88±0.07 ABCD	5.39±0.53 CDE	6.64±0.63 BCD	80.20±7.68 BCD
10 μM APA6	none	73.33±2.31 ABCD	97.33±1.15 AB	15.17±0.26 ABC	5.81±0.46 ABC	6.99±0.52 BC	88.16±6.89 ABC
10 μM APA7	none	68.00±2.00 CDE	97.33 ±2.31 AB	14.98±0.31 ABCD	5.43±0.25 BCDE	6.36±0.59 DE	81.36±3.92 BC
10 μM APA8	none	68.67±6.43 CDE	97.33±1.15 AB	15.03±0.38 ABCD	5.52±0.46 BCDE	6.17±0.54 DEF	82.97±6.91 ABC
10 μM APA9	none	65.33±4.16 EF	96.67±1.15 AB	14.79±0.11 ABCD	5.58±0.59 BCDE	6.20±0.60 DEF	82.53±8.49 ABC
10 μM APA10	none	69.33±3.06 BCDE	95.33±1.15 AB	14.79±0.15 ABCD	5.18±0.20 DE	6.01±0.64 EF	76.61±2.98 BCD
10 μM APA11	none	73.33±3.06 ABCD	96.67±2.31 AB	15.12±0.19 ABCD	5.63±0.35 BCD	7.00±0.81 BC	85.14±5.18 ABC
10 μM APA12	none	74.67±4.62 ABCD	98.67±1.15 A	15.41±0.19 A	5.75±0.52 ABC	7.11±0.57 BC	88.61±7.81 AB
10 μM APA13	none	68.67±3.06 CDE	96.67±3.06 AB	14.93±0.50 ABCD	5.44±0.38 BCDE	6.52±0.51 CDE	81.20±5.93 BC
10 μM APA14	none	77.33±2.31 A	94.00±2.00 B	14.94±0.24 ABCD	5.75±0.49 ABC	6.98±0.71 BC	85.91±7.13 ABC
10 μM APA15	none	74.67±4.62 ABCD	98.67±1.15 A	15.41±0.37 A	5.73±0.51 BC	7.17±0.40 B	88.30±7.84 ABC
10 μM APA16	none	76.67±6.11 AB	95.33±3.06 AB	15.36±0.64 AB	5.62±0.39 BCD	7.07±0.56 BC	86.34±6.55 ABC
10 μM APA17	none	75.33±4.16 ABC	96.67±1.15 A	15.42±0.36 A	5.78±0.60 ABC	7.12±0.46 BC	89.13±9.09 AB
10 μM APA18	none	76.67±3.06 AB	96.67±1.15 AB	15.26±0.24 ABC	5.87±0.36 AB	7.10±0.67 BC	89.58±5.46 AB
DMSO	none	77.33±3.06 A	97.33±3.06 AB	15.34±0.44 A	6.19±0.67 A	8.08±0.57 A	94.93±10.13 A
1 μM ABA	none	51.33±2.31 DE	96.67±3.06 AB	14.27±0.37 BCDEF	5.03±0.23 EF	6.27±0.42 EF	67.91±3.30 D
1 μM *iso*-PhABA	none	26.67±8.33 G	97.33±2.31 AB	13.33±0.71 H	4.86±0.47 F	5.43±0.35 H	64.77±6.75 E
10 μM APA1	1 μM ABA	41.33±2.31 F	97.33±1.06 AB	13.86±0.43 EFGH	4.85±0.62 F	5.41±0.44 H	67.20±8.48 DE
10 μM APA2	1 μM ABA	45.33±1.15 EF	97.33±1.15 AB	14.02±0.21 DEFGH	5.41±0.19 CDE	5.59±0.28 GH	75.87±2.76 BCDE
10 μM APA3	1 μM ABA	48.67±5.03 DEF	96.00±2.00 AB	14.01±0.48 DEFGH	5.15±0.28 DEF	6.01±0.65 FG	72.15±4.32 DE
10 μM APA4	1 μM ABA	54.67±1.15 CD	97.33±2.31 AB	14.43±0.24 BCDEF	5.45±0.48 CDE	6.02±0.60 FG	78.63±6.76 BCD
10 μM APA5	1 μM ABA	54.67±4.16 CD	96.00±2.00 AB	14.24±0.40 BCDEF	5.63±0.52 BCD	6.76±0.59 BCDE	80.19±7.43 BCD
10 μM APA6	1 μM ABA	62.00±2.00 BC	96.67±2.31 A	14.88±0.27 AB	5.93±0.32 ABC	7.01±0.50 BC	88.26±4.79 AB
10 μM APA7	1 μM ABA	46.00±3.46 EF	94.67±3.06 AB	13.73±0.53 FGH	5.65±0.51 BCD	6.37±0.61 DEF	77.59±7.26 BCD
10 μM APA8	1 μM ABA	44.67±4.16 EF	95.33±3.06 AB	13.99±0.34 DEFGH	5.74±0.75 ABC	6.13±0.60 FG	80.34±10.2 BCD
10 μM APA9	1 μM ABA	50.67±3.06 DE	96.00±2.00 AB	14.09±0.16 CDEFG	5.18±0.39 DEF	6.10±0.81 FG	73.00±5.29 CDE
10 μM APA10	1 μM ABA	42.67±6.11 F	94.00±2.00 B	13.51±0.07 GH	5.01±0.70 EF	6.28±0.53 EF	67.69±9.09 DE
10 μM APA11	1 μM ABA	60.67±3.06 BC	95.33±3.06 AB	14.69±0.50 ABCD	5.91±0.32 ABC	6.97±0.51 BC	86.86±5.18 ABC
10 μM APA12	1 μM ABA	55.33±2.31 CD	95.33±3.06 AB	14.47±0.46 BCDE	5.64±0.63 BCD	6.92±0.78 BCD	81.63±9.00 ABCD
10 μM APA13	1 μM ABA	46.00±5.29 EF	97.33±2.31 AB	14.08±0.42 CDEFG	5.43±0.37 CDE	6.55±0.89 CDEF	76.47±5.31 BCDE
10 μM APA14	1 μM ABA	62.00±6.00 BC	97.33±1.15 AB	14.73±0.36 ABCD	6.02±0.63 AB	7.27±0.67 B	88.67±9.09 AB
10 μM APA15	1 μM ABA	60.00±5.29 BC	98.00±0.00 AB	14.72±0.25 ABCD	6.01±0.81 AB	7.25±0.46 B	88.45±11.55 AB
10 μM APA16	1 μM ABA	59.33±1.15 BC	98.00±0.00 AB	14.69±0.05 ABCD	6.11±0.69 AB	7.06±0.51 BC	89.76±9.74 AB
10 μM APA17	1 μM ABA	64.00±4.00 B	97.33±1.15 AB	14.83±0.22 AB	6.06±0.55 AB	7.16±0.68 B	89.89±8.01 AB
10 μM APA18	1 μM ABA	62.67±4.62 BC	97.33±1.15 AB	14.78±0.29 ABC	6.12±0.46 AB	7.08±0.45 BC	90.43±6.78 AB
DMSO	none	77.33±3.06 A	97.33±3.06 A	15.34±0.44 A	6.19±0.67 A	8.08±0.57 A	94.93±10.13 A
50 μM ABA	none	0 I	97.33±2.31 A	11.28±0.33 G	4.10±0.77 I	4.48±0.77 J	46.26±8.49 H
50 μM *iso*-PhABA	none	0 I	49.33±3.06 B	5.42±0.33 H	3.41±0.84 J	2.58±0.39 K	18.47±4.47 I
none	100 mM NaCl	46.67±1.15 B	96.00±0.00 A	13.94±0.05 AB	4.93±0.51 GH	5.71±0.85 FGHI	68.76±6.81 FG
50 μM APA1	100 mM NaCl	33.33±6.11 EF	97.33±2.31 A	13.46±0.35 EF	4.62±0.81 H	5.27±0.75 I	62.17±10.59 G
50 μM APA2	100 mM NaCl	42.00±2.00 H	98.67±1.15 A	14.05±0.25 F	5.22±0.71 EFG	5.38±0.74 HI	73.34±9.68 FG
50 μM APA3	100 mM NaCl	45.33±3.06 FG	97.33±1.15 A	14.02±0.28 DEF	5.35±0.60 EFG	5.90±0.63 FGHI	75.02±8.20 EF
50 μM APA4	100 mM NaCl	51.33±2.31 EFG	94.67±3.06 A	13.96±0.49 DEF	5.56±0.36 DEF	6.25±0.75 FG	77.58±5.32 BCDEF
50 μM APA5	100 mM NaCl	60.00±3.46 DE	97.33±2.31 A	14.62±0.25 EF	5.47±0.36 EF	6.51±0.77 CDEF	80.06±5.25 BCDEF
50 μM APA6	100 mM NaCl	64.00±4.00 BC	95.33±1.15 A	14.55±0.31 BCD	6.11±0.70 ABC	7.37±0.61 AB	88.90±9.89 ABCD
50 μM APA7	100 mM NaCl	48.00±2.00 B	98.00±2.00 A	14.20±0.30 BCDE	5.63±0.43 BCDE	6.40±0.78 DEFG	79.95±6.02 BCDEF
50 μM APA8	100 mM NaCl	40.00±5.29 EF	96.00±2.00 A	13.60±0.47 CDE	5.61±0.49 BCDEF	6.09±0.73 FGH	76.30±6.78 DEF
50 μM APA9	100 mM NaCl	46.67±3.06 G	96.67±2.31 A	14.01±0.31 F	5.52±0.42 EF	6.29±0.78 EFG	77.34±5.87 CDEF
50 μM APA10	100 mM NaCl	54.67±3.06 EF	96.67±2.31 A	14.54±0.28 DEF	5.08±0.55 FGH	5.63±0.55 GHI	73.74±7.87 FG
50 μM APA11	100 mM NaCl	61.33±1.15 CD	96.00±2.00 A	14.51±0.29 BCDE	6.12±0.39 ABC	7.13±0.92 BCD	88.76±5.67 ABCD
50 μM APA12	100 mM NaCl	66.00±4.00 B	96.00±2.00 A	14.67±0.21 BCDE	5.58±0.46 CDEF	7.05±1.11 BCDE	81.74±6.62 BCDEF

50 μM APA13	100 mM NaCl	50.00±6.00 B	98.67±1.15 A	14.37±0.29 BC	6.10±0.37 ABC	7.28±1.18 BC	87.62±5.27 ABCDE
50 μM APA14	100 mM NaCl	64.00±4.00 DE	97.33±1.15 A	14.82±0.06 BCDE	6.12±0.32 ABC	7.34±0.58 AB	90.68±4.57 ABC
50 μM APA15	100 mM NaCl	60.00±4.00 B	96.67±1.15 A	14.55±0.06 ABC	6.16±0.28 AB	7.42±0.65 AB	89.63±3.94 ABCD
50 μM APA16	100 mM NaCl	60.67±3.06 BC	96.00±4.00 A	14.51±0.44 BCDE	6.06±0.34 ABCD	7.46±1.03 AB	87.95±5.29 ABCDE
50 μM APA17	100 mM NaCl	61.33±1.15 B	98.00±2.00 A	14.72±0.30 BCDE	6.15±0.44 AB	7.19±0.84 BCD	90.53±6.41 ABC
50 μM APA18	100 mM NaCl	66.00±3.46 B	96.67±1.15 A	14.83±0.58 ABC	6.13±0.17 AB	7.18±0.97 BCD	90.95±3.82 AB