Supporting Information

Potential for Release of Pulmonary Toxic Ketene from Vaping Pyrolysis of Vitamin E Acetate

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General Methods.

Atmospheric-pressure chemical ionization (APCI) and electrospray ionization (ESI) mass spectra were acquired using Advion Expression Mass Spectrometer in positive and negative modes as required. ^{1}H NMR and ^{13}C NMR spectra were recorded at room temperature at 400 MHz and 100 MHz respectively, and calibrated using residual non-deuterated solvent as an internal reference. HPLC analysis used an Atlantis dC18 reverse phase column (5µM, 4.6 x 250 mm with UV-Vis detector at 254 and 220 nm). GC-MS analysis used a Waters GCT Premier Micromass system with an Optima 5 MS (length 15 m, inner diameter 0.25 mm, outer diameter 0.40 mm) GC column and ESI positive mode MS detector.

GC conditions: initial temperature: 50 ˚C; maximum temp 360 ˚C, equilibrium time: 0.20 min, inject. Inlet: initial temp: 260 ˚C, split ratio: 10.0; purge flow: 40.0 mL/min. Temp. ramp:

Rate (˚C/min)	Final temp (˚ C)	Hold time (min)	Total time (min)
35.00	120	0.0	3.1
10.00	250	0.0	16.1
35.00	300	4.0	21.5

All vaping experiments were carried out in a ventilated fumehood.

Computational Details.

All of the calculations reported in this work were carried out using the Gaussian 09e01 package from Irish Centre for High-End Computing (ICHEC). The M06-2X density-functional method in conjunction with the 6-311G(d,p) basis set was selected for all the geometry optimizations and frequency analysis. All geometries were optimized in gas phase. Frequency calculations at 298.15 K and 1 atm pressure on all the stationary points were carried out at the same level of theory as the geometry optimizations to ascertain the nature of the stationary points. All of the presented relative energies are free energies at 298.15 K with respect to the reactants, unless otherwise stated. Each TS was confirmed by IRC calculations and vibrational analysis showing a single imaginary frequency. A six-membered TS in which proton transfer to an *ortho*-aryl ring position followed by enolization to phenol has also been proposed for the loss of ketene from phenyl acetate (1). As the *ortho* aryl positions of **1** are methyl substituted loss of ketene is unlike to proceed through six-membered proton transfer to the aryl ring so the four membered TS was selected for comparative calculations.

1. E. Marquez, *et al*., Electrocyclic [1,5] hydrogen shift in the thermal elimination kinetics of phenyl acetate and *p*-tolyl-acetate in the gas phase: a density functional theory study. *Mol. Phys.*, **112**, 462-473 (2014).

Figure S1. APCI-MS cone-voltage study for phenyl acetate **3**.

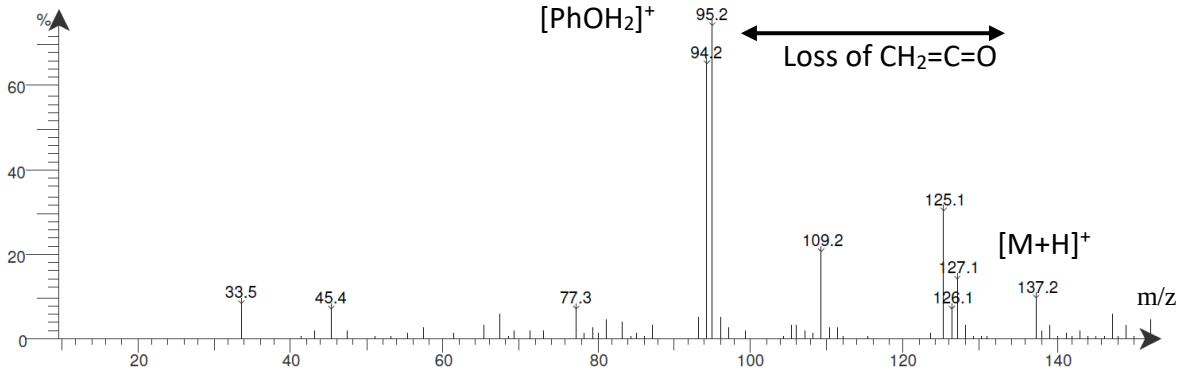


Fig. S1a: 10 eV, APCI-MS (positive mode).

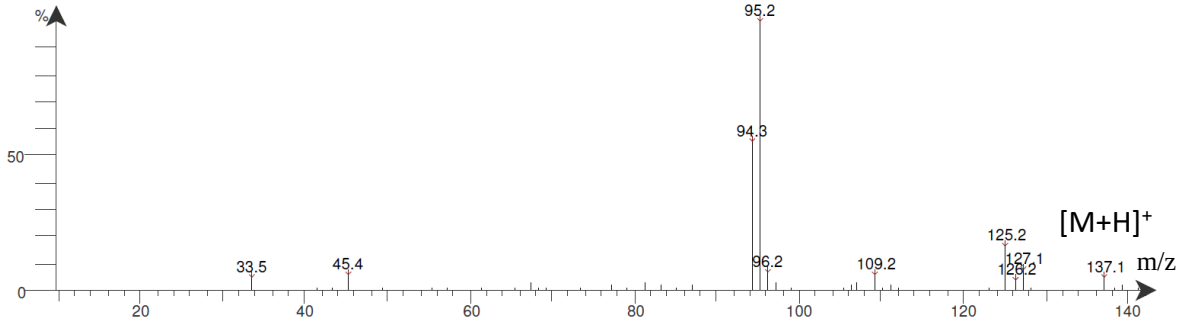


Fig. S1c: 20 eV, APCI-MS (positive mode).

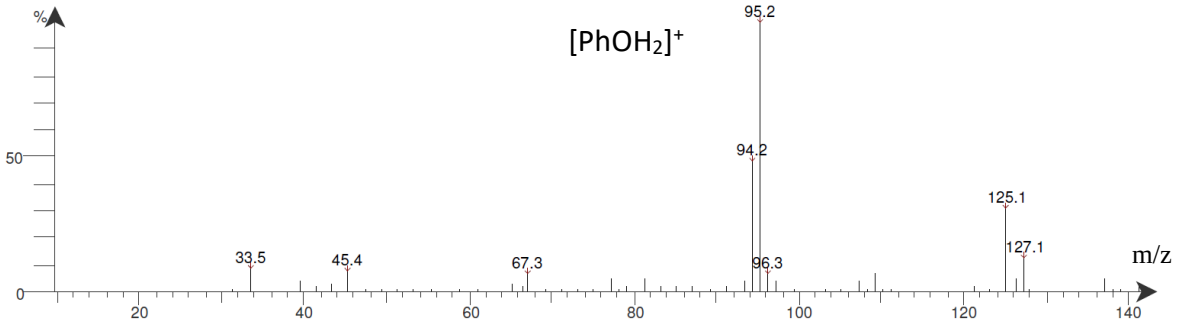


Fig. S1d: 25 eV, APCI-MS (positive mode).

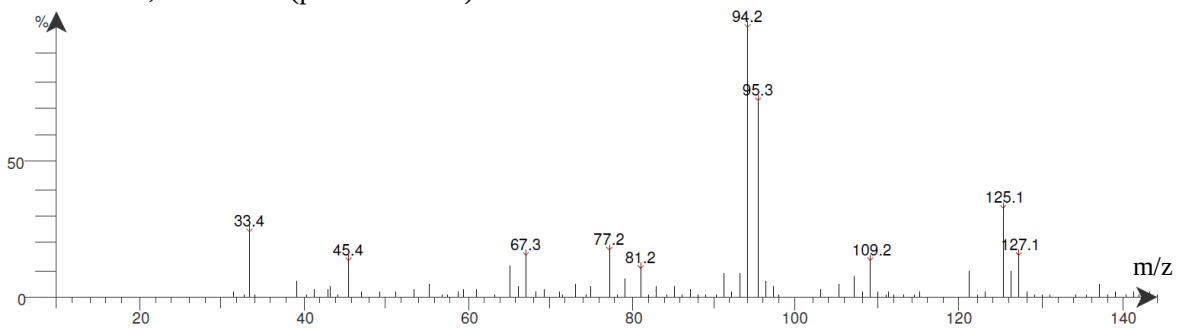


Fig. S1e: 30 eV, APCI-MS (positive mode).

Figure S2. APCI-MS cone-voltage studies for vitamin E acetate **1**

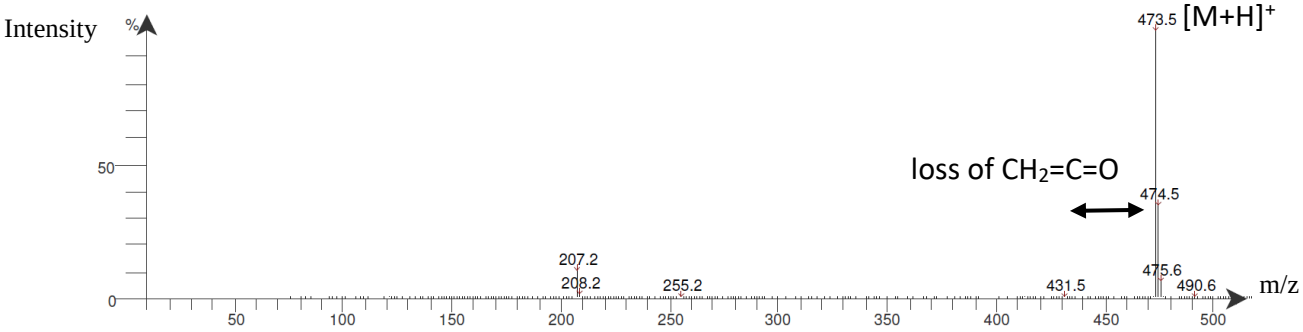


Fig. S2a: 5 eV, APCI-MS (positive mode).

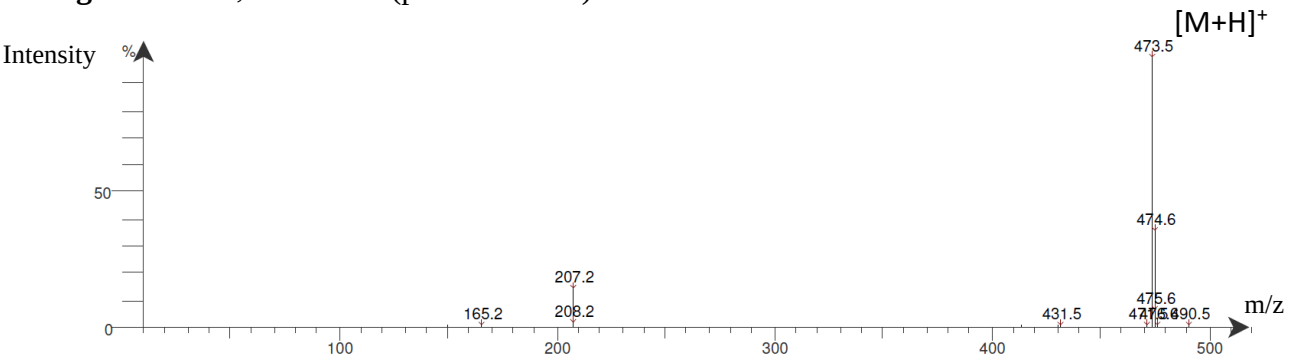


Fig. S2b: 10 eV, APCI-MS (positive mode).

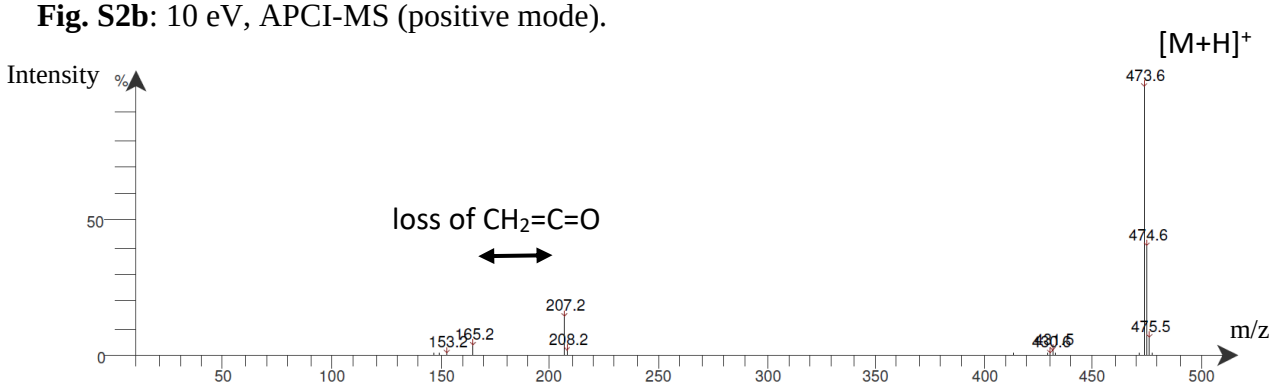


Fig. S2c: 15 eV, APCI-MS (positive mode).

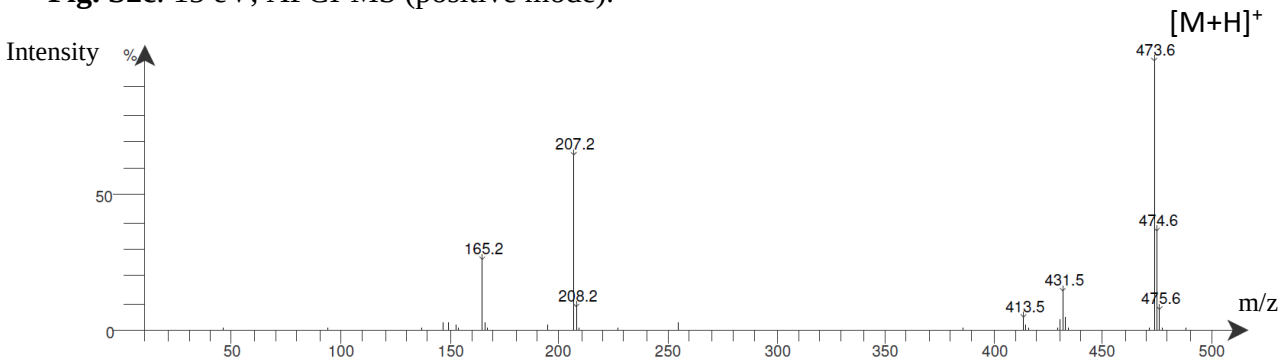


Fig. S2d: 20 eV, APCI-MS (positive mode).

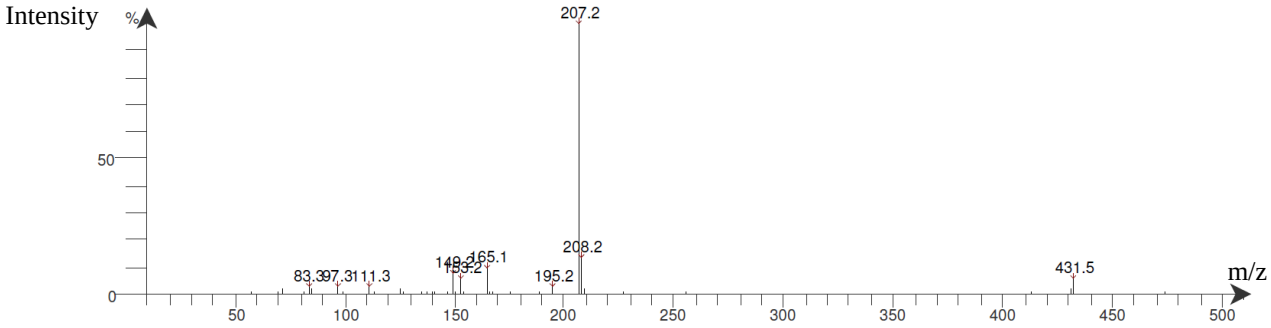


Fig. S2f: 30 eV, APCI-MS (positive mode).

Figure S3. APCI-MS cone-voltage studies for vitamin E **2**

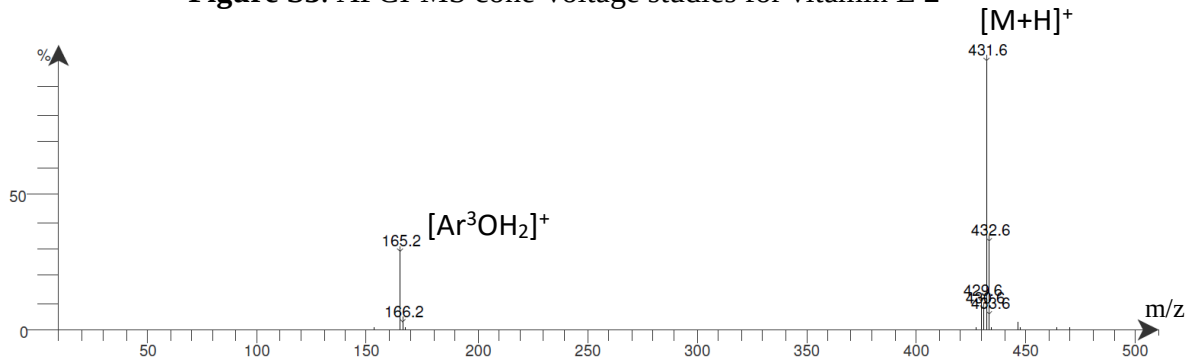


Fig. S3a: 5 eV, APCI-MS (positive mode).

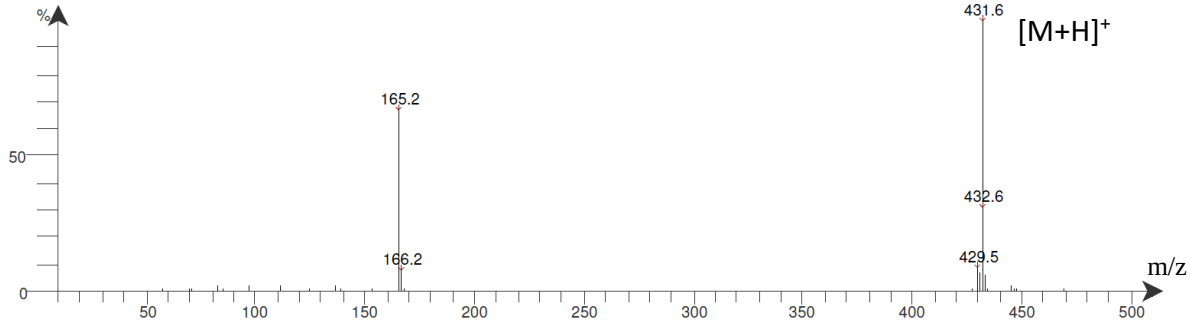


Fig. S3b: 10 eV, APCI-MS (positive mode).

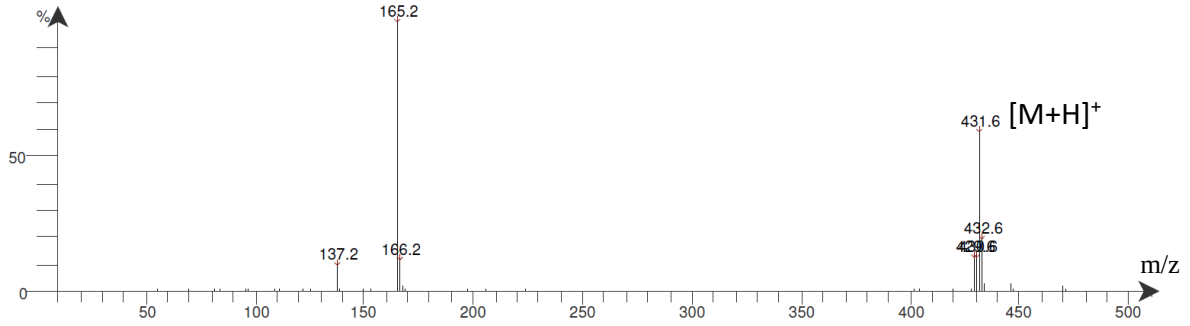


Fig. S3c: 20 eV, APCI-MS (positive mode).

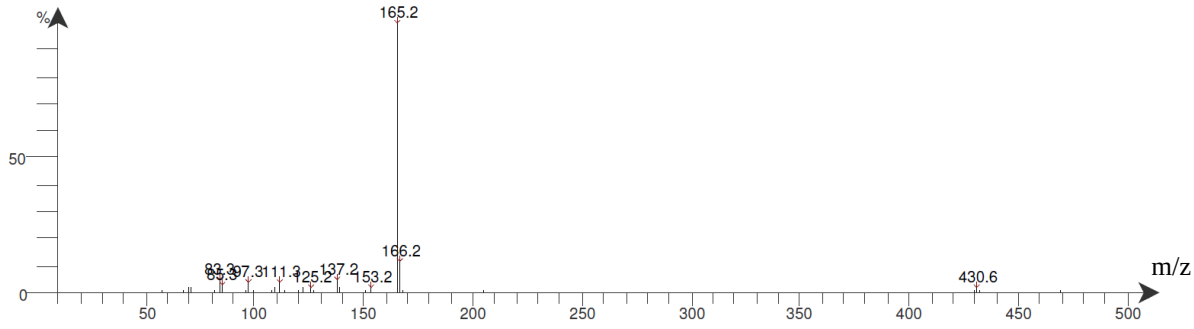


Fig. S3d: 30 eV, APCI-MS (positive mode).

Figure S4. DFT calculation data for **3** and transition state

Ground state structure of phenyl acetate **3**

E(RM062X) = -460.052680107
Zero-point correction= 0.143297 (Hartree/Particle)
Thermal correction to Energy = 0.152147
Thermal correction to Enthalpy = 0.153091
Thermal correction to Gibbs Free Energy = 0.108399
Sum of electronic and zero-point Energies = -459.909383
Sum of electronic and thermal Energies = -459.900533
Sum of electronic and thermal Enthalpies = -459.899589
Sum of electronic and thermal Free Energies = -459.944281
Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-2.461087	-1.071596	0.274742
2	6	0	-2.960549	0.213076	0.092541
3	6	0	-2.093537	1.249227	-0.236957
4	6	0	-0.731044	1.017001	-0.385217
5	6	0	-0.249634	-0.271794	-0.194087
6	6	0	-1.101048	-1.317314	0.133526
7	1	0	-3.128229	-1.886254	0.528666
8	1	0	-4.020091	0.406237	0.205620
9	1	0	-2.477563	2.252054	-0.379570
10	1	0	-0.053316	1.821804	-0.630791
11	1	0	-0.684038	-2.307996	0.265038
12	8	0	1.084015	-0.610537	-0.389011
13	6	0	2.077816	0.157872	0.139254
14	6	0	3.412590	-0.446371	-0.192692
15	1	0	3.500814	-0.567763	-1.272771
16	1	0	4.200639	0.198517	0.185922
17	1	0	3.484469	-1.436762	0.258890
18	8	0	1.893018	1.152982	0.770553

Ground state structure of ketene **4**

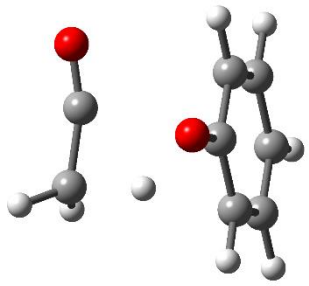
E(RM062X) = -152.578714584
Zero-point correction = 0.032023 (Hartree/Particle)
Thermal correction to Energy = 0.035501
Thermal correction to Enthalpy = 0.036445
Thermal correction to Gibbs Free Energy = 0.009110
Sum of electronic and zero-point Energies = -152.546692
Sum of electronic and thermal Energies = -152.543214
Sum of electronic and thermal Enthalpies = -152.542270
Sum of electronic and thermal Free Energies = -152.569605

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-0.000000	-0.000000	0.103973
2	8	0	-0.000000	-0.000000	1.258820
3	6	0	0.000000	0.000000	-1.204928
4	1	0	-0.000000	0.940447	-1.732415
5	1	0	-0.000000	-0.940447	-1.732415

Ground state structure of phenol **5**

```
E(RM062X) = -307.417355370
Zero-point correction =                           0.105600 (Hartree/Particle)
 Thermal correction to Energy =                    0.111050
 Thermal correction to Enthalpy =                  0.111994
 Thermal correction to Gibbs Free Energy =         0.076670
 Sum of electronic and zero-point Energies =          -307.311755
 Sum of electronic and thermal Energies =             -307.306305
 Sum of electronic and thermal Enthalpies =           -307.305361
 Sum of electronic and thermal Free Energies =        -307.340685
Standard orientation:
 ---------------------------------------------------------------------
 Center     Atomic      Atomic             Coordinates (Angstroms)
 Number     Number       Type              X           Y           Z
 ---------------------------------------------------------------------
      1          6           0       -1.127194    1.214015   -0.000000
      2          6           0        0.263486    1.194447    0.000000
      3          6           0        0.937438   -0.023909    0.000000
      4          6           0        0.220142   -1.218571    0.000000
      5          6           0       -1.166337   -1.185985   -0.000000
      6          6           0       -1.849530    0.027643   -0.000000
      7          1           0       -1.644688    2.165939   -0.000000
      8          1           0        0.825228    2.123497    0.000000
      9          1           0        0.769113   -2.151795    0.000000
     10          1           0       -1.718883   -2.118096   -0.000000
     11          1           0       -2.931768    0.046321   -0.000000
     12          8           0        2.295374   -0.110676    0.000000
     13          1           0        2.669969    0.773706    0.000001
 ---------------------------------------------------------------------
```



Transition state image of **3** → **4** + **5**

Transition state structure for **3** → **4** + **5**

```
 Imaginary Frequency: -1637.0775.
 E(RM062X) = -459.939805174
 Zero-point correction =                           0.135319 (Hartree/Particle)
 Thermal correction to Energy =                    0.144461
 Thermal correction to Enthalpy =                  0.145405
 Thermal correction to Gibbs Free Energy =         0.099782
 Sum of electronic and zero-point Energies =          -459.804486
 Sum of electronic and thermal Energies =             -459.795344
 Sum of electronic and thermal Enthalpies =           -459.794400
 Sum of electronic and thermal Free Energies =        -459.840023

Standard orientation:
 ---------------------------------------------------------------------
```

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	2.337300	-1.084505	-0.206101
2	6	0	1.049393	-1.220256	0.300383
3	6	0	0.267495	-0.085306	0.550677
4	6	0	0.804453	1.182431	0.287040
5	6	0	2.090228	1.303622	-0.219286
6	6	0	2.864656	0.173587	-0.472868
7	1	0	2.932915	-1.971434	-0.390245
8	1	0	0.642878	-2.198695	0.532814
9	1	0	0.197416	2.054695	0.501023
10	1	0	2.494613	2.290495	-0.414095
11	1	0	3.868617	0.275123	-0.865369
12	8	0	-0.988722	-0.201784	1.009236
13	1	0	-1.719082	-1.211474	0.552670
14	6	0	-2.467855	0.177694	-0.321309
15	8	0	-2.834906	1.252840	-0.264673
16	6	0	-2.424359	-1.207636	-0.553457
17	1	0	-3.375963	-1.628899	-0.864352
18	1	0	-1.580240	-1.456043	-1.199423

Figure S5. DFT calculation data for **1**† and its transition state

Ground state structure of **1**†

```
E(RM062X) = -848.518936312
Zero-point correction =                           0.351643 (Hartree/Particle)
 Thermal correction to Energy =                    0.371700
 Thermal correction to Enthalpy =                  0.372644
 Thermal correction to Gibbs Free Energy =         0.303642
 Sum of electronic and zero-point Energies =           -848.167293
 Sum of electronic and thermal Energies =              -848.147237
 Sum of electronic and thermal Enthalpies =            -848.146292
 Sum of electronic and thermal Free Energies =         -848.215295


Standard orientation:
 ---------------------------------------------------------------------
 Center     Atomic      Atomic             Coordinates (Angstroms)
 Number     Number       Type              X           Y           Z
 ---------------------------------------------------------------------
      1          6           0        1.060561    0.492672    0.067751
      2          6           0        0.631667   -0.829997   -0.074317
      3          6           0       -0.717081   -1.083801   -0.356313
      4          6           0       -1.591167   -0.008158   -0.456422
      5          6           0       -1.173743    1.316091   -0.312559
      6          6           0        0.170290    1.570826   -0.037893
      7          6           0       -3.841196   -0.431864    0.237451
      8          8           0       -2.926565   -0.259312   -0.763344
      9          8           0       -4.977089   -0.639519   -0.057574
     10          6           0       -1.212676   -2.496005   -0.529877
     11          1           0       -1.276123   -3.015600    0.432525
     12          1           0       -2.199160   -2.509559   -0.989559
     13          1           0       -0.534251   -3.072886   -1.161404
     14          6           0        0.667799    2.983101    0.126890
     15          1           0        0.734610    3.487120   -0.842678
     16          1           0       -0.011723    3.567133    0.750820
     17          1           0        1.655685    2.994653    0.580022
     18          6           0        1.608893   -1.971593    0.082420
     19          1           0        1.161610   -2.758595    0.695360
     20          1           0        1.808347   -2.425671   -0.895727
     21          6           0        2.909801   -1.494865    0.719213
     22          1           0        2.756098   -1.318641    1.788263
     23          1           0        3.694425   -2.248287    0.614721
     24          8           0        2.361133    0.817908    0.334202
     25          6           0        3.370095   -0.178788    0.094750
     26          6           0        3.596956   -0.298166   -1.411208
     27          1           0        2.669595   -0.534189   -1.936335
     28          1           0        3.975541    0.648081   -1.801796
     29          1           0        4.327300   -1.082793   -1.624213
     30          6           0        4.611956    0.352784    0.790182
     31          1           0        5.453428   -0.324650    0.630370
     32          1           0        4.870593    1.335502    0.391766
     33          1           0        4.431878    0.449023    1.862314
     34          6           0       -2.156619    2.449727   -0.450995
     35          1           0       -3.098373    2.105780   -0.874702
     36          1           0       -2.362903    2.914451    0.519055
     37          1           0       -1.754887    3.230472   -1.099939
     38          6           0       -3.328548   -0.343620    1.654308
     39          1           0       -4.168591   -0.509485    2.322752
     40          1           0       -2.551533   -1.089777    1.829909
     41          1           0       -2.883333    0.635239    1.841931
 ---------------------------------------------------------------------
```

† Simplified structure used for calculation without $C_{15}H_{32}$ alkyl group.

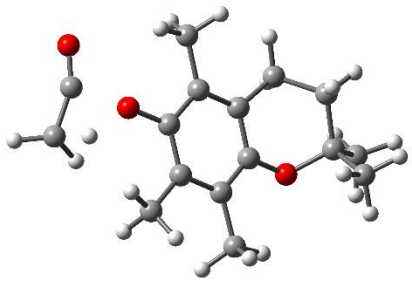
Ground state structure of **2**†

E(RM062X) = -695.883672263
Zero-point correction = 0.314338 (Hartree/Particle)
Thermal correction to Energy = 0.331069
Thermal correction to Enthalpy = 0.332013
Thermal correction to Gibbs Free Energy = 0.271751
Sum of electronic and zero-point Energies = -695.569334
Sum of electronic and thermal Energies = -695.552603
Sum of electronic and thermal Enthalpies = -695.551659
Sum of electronic and thermal Free Energies = -695.611922

Standard orientation:

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	-0.283099	0.458090	-0.145796
2	6	0	-0.027932	-0.914811	-0.137202
3	6	0	1.296994	-1.358301	-0.019870
4	6	0	2.328073	-0.422371	0.021265
5	6	0	2.075821	0.951546	-0.010932
6	6	0	0.755360	1.395518	-0.072893
7	8	0	3.641709	-0.815216	0.118103
8	6	0	1.637259	-2.827034	0.065591
9	1	0	0.771090	-3.429260	0.333071
10	1	0	2.022775	-3.216236	-0.884432
11	1	0	2.394934	-3.003976	0.834660
12	6	0	0.445369	2.869465	-0.087428
13	1	0	1.058146	3.403307	0.641581
14	1	0	0.655999	3.302600	-1.070692
15	1	0	-0.604079	3.044553	0.136085
16	6	0	-1.171140	-1.899852	-0.255704
17	1	0	-0.915041	-2.679023	-0.978114
18	1	0	-1.327252	-2.407563	0.703823
19	6	0	-2.456883	-1.204678	-0.692782
20	1	0	-2.405404	-0.966069	-1.759461
21	1	0	-3.321702	-1.854886	-0.537521
22	8	0	-1.551114	0.974663	-0.249052
23	6	0	-2.650527	0.108418	0.062989
24	6	0	-2.712547	-0.096973	1.576096
25	1	0	-1.769613	-0.489287	1.961746
26	1	0	-2.908208	0.857488	2.068278
27	1	0	-3.513087	-0.795022	1.833673
28	6	0	-3.881754	0.847681	-0.434304
29	1	0	-4.784640	0.276323	-0.207791
30	1	0	-3.952567	1.823263	0.050349
31	1	0	-3.818285	1.000968	-1.513083
32	6	0	3.218788	1.931512	0.034787
33	1	0	4.165969	1.426897	-0.140643
34	1	0	3.091373	2.713146	-0.717334
35	1	0	3.274258	2.423842	1.010799
36	1	0	3.717877	-1.735903	-0.140304

† Simplified structure used for calculation without $C_{15}H_{32}$ alkyl group.



Transition state image of **1** → **4** + **2**

Transition state structure of **1**† → **4** + **2**†

```
Imaginary Frequency: -1669.7490.
E(RM062X) = -848.401721573
Zero-point correction =                           0.344957 (Hartree/Particle)
 Thermal correction to Energy =                    0.364819
 Thermal correction to Enthalpy =                  0.365763
 Thermal correction to Gibbs Free Energy =         0.297155
 Sum of electronic and zero-point Energies =          -848.056765
 Sum of electronic and thermal Energies =             -848.036903
 Sum of electronic and thermal Enthalpies =           -848.035958
 Sum of electronic and thermal Free Energies =        -848.104567

Standard orientation:
 ---------------------------------------------------------------------
 Center     Atomic      Atomic             Coordinates (Angstroms)
 Number     Number       Type              X           Y           Z
 ---------------------------------------------------------------------
      1          6           0        0.311464    1.545022    0.080560
      2          6           0       -1.028275    1.409248   -0.312785
      3          6           0       -1.571673    0.127753   -0.495900
      4          6           0       -0.782920   -1.029314   -0.362773
      5          6           0        0.540078   -0.882043    0.043397
      6          6           0        1.063625    0.390805    0.272670
      7          8           0       -2.889845   -0.012276   -0.813806
      8          1           0       -3.720235    0.824572   -0.277777
      9          6           0       -4.081070   -0.680882    0.564528
     10          8           0       -4.314516   -1.796517    0.467180
     11          6           0       -4.288407    0.661315    0.926738
     12          1           0       -5.243116    0.854665    1.405848
     13          1           0       -3.418745    1.065087    1.446098
     14          6           0       -1.376921   -2.383282   -0.662730
     15          6           0        1.530699   -1.999922    0.228214
     16          6           0       -1.857670    2.643468   -0.575608
     17          6           0        0.930281    2.901113    0.298344
     18          6           0        2.817194   -1.592510   -0.499638
     19          8           0        2.345900    0.484498    0.753788
     20          6           0        3.373221   -0.267151    0.063798
     21          1           0       -1.257287    3.411118   -1.066566
     22          1           0       -2.703409    2.420487   -1.225910
     23          1           0       -2.247019    3.085583    0.347915
     24          1           0        1.055206    3.431464   -0.651164
     25          1           0        0.302427    3.525743    0.938483
     26          1           0        1.909108    2.798887    0.762022
     27          1           0       -0.710181   -2.968524   -1.299251
     28          1           0       -1.552927   -2.961843    0.249092
     29          1           0       -2.329140   -2.272406   -1.178173
     30          1           0        1.739272   -2.135579    1.296105
     31          1           0        1.153051   -2.948149   -0.153324
     32          1           0        2.585878   -1.478712   -1.562607
```

33	1	0	3.586055	-2.364809	-0.412374
34	6	0	4.422055	-0.530287	1.134092
35	6	0	3.919916	0.616378	-1.051342
36	1	0	4.697634	0.407010	1.620471
37	1	0	4.025768	-1.209198	1.892595
38	1	0	4.680334	0.084653	-1.629319
39	1	0	3.107781	0.900219	-1.726240
40	1	0	4.362887	1.523109	-0.633805
41	1	0	5.314759	-0.977273	0.691203

† Simplified structure used for calculation without $C_{15}H_{32}$ alkyl group.

Figure S6. DFT calculation data of **6** and its transition state

Ground state structure of **6**

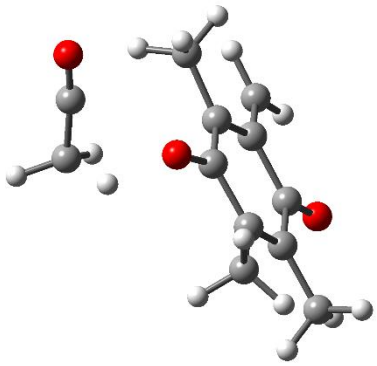
```
E(RM062X) = -691.255415027
Zero-point correction=                           0.236042 (Hartree/Particle)
 Thermal correction to Energy=                    0.251804
 Thermal correction to Enthalpy=                  0.252748
 Thermal correction to Gibbs Free Energy=         0.192424
 Sum of electronic and zero-point Energies=           -691.019373
 Sum of electronic and thermal Energies=              -691.003611
 Sum of electronic and thermal Enthalpies=            -691.002667
 Sum of electronic and thermal Free Energies=         -691.062991

Standard orientation:
 ---------------------------------------------------------------------
 Center     Atomic      Atomic             Coordinates (Angstroms)
 Number     Number       Type              X           Y           Z
 ---------------------------------------------------------------------
      1          6           0        1.638646    1.290650    0.009154
      2          6           0        2.311849   -0.056226    0.100299
      3          6           0        1.464417   -1.259614   -0.054193
      4          6           0        0.140542   -1.119873   -0.290424
      5          6           0       -0.472026    0.210974   -0.360972
      6          6           0        0.196316    1.367247   -0.228511
      7          8           0       -1.838881    0.244807   -0.638032
      8          6           0       -2.687053   -0.047579    0.389520
      9          6           0       -4.109735   -0.001232   -0.086873
     10          1           0       -4.259363   -0.775618   -0.841369
     11          1           0       -4.776616   -0.164359    0.755049
     12          1           0       -4.311663    0.961558   -0.557195
     13          8           0       -2.312280   -0.309450    1.491708
     14          6           0       -0.762682   -2.304502   -0.495771
     15          1           0       -1.339017   -2.496020    0.414800
     16          1           0       -1.470832   -2.112999   -1.303915
     17          1           0       -0.193832   -3.198923   -0.738834
     18          6           0        2.157817   -2.589701    0.052739
     19          1           0        1.622675   -3.264977    0.722654
     20          1           0        2.235782   -3.075581   -0.924502
     21          1           0        3.166427   -2.440717    0.432871
     22          6           0       -0.472784    2.707483   -0.306267
     23          1           0       -1.529150    2.604651   -0.542655
     24          1           0       -0.376474    3.238013    0.644893
     25          1           0       -0.006753    3.324124   -1.079072
     26          6           0        2.410406    2.373025    0.170801
     27          8           0        3.508860   -0.140831    0.288547
     28          1           0        2.012901    3.379318    0.128974
     29          1           0        3.470042    2.241400    0.353496
 ---------------------------------------------------------------------
```

Ground state structure of **8**

```
E(RM062X) = -538.618811938
Zero-point correction =                          0.197824 (Hartree/Particle)
 Thermal correction to Energy =                   0.209617
 Thermal correction to Enthalpy =                 0.210562
 Thermal correction to Gibbs Free Energy =        0.160403
 Sum of electronic and zero-point Energies =          -538.420988
 Sum of electronic and thermal Energies =             -538.409194
 Sum of electronic and thermal Enthalpies =           -538.408250
 Sum of electronic and thermal Free Energies =        -538.458409
Standard orientation:
```

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	1.030883	-1.112045	-0.003198
2	6	0	-0.434815	-1.468541	0.004811
3	6	0	-1.414396	-0.356234	0.001811
4	6	0	-0.973073	0.919557	-0.001491
5	6	0	0.465755	1.231678	-0.001329
6	6	0	1.434185	0.291780	0.009974
7	8	0	0.694505	2.574115	-0.011066
8	6	0	-1.899904	2.101948	-0.004249
9	1	0	-1.706769	2.733565	0.865887
10	1	0	-1.713534	2.723230	-0.883321
11	1	0	-2.942863	1.795414	0.001688
12	6	0	-2.869714	-0.738090	0.004128
13	1	0	-3.380318	-0.348429	0.887953
14	1	0	-3.382859	-0.347917	-0.877998
15	1	0	-2.958021	-1.822317	0.004200
16	6	0	2.904772	0.606326	0.025230
17	1	0	3.128447	1.670079	0.121317
18	1	0	3.392136	0.109957	0.868468
19	1	0	3.389721	0.254386	-0.889869
20	6	0	1.898767	-2.133475	-0.029933
21	8	0	-0.795567	-2.628221	0.011721
22	1	0	2.971170	-1.986515	-0.043418
23	1	0	1.518043	-3.146968	-0.041667
24	1	0	1.638581	2.740930	-0.053011



Transitions state image of **6** → **4** + **8**

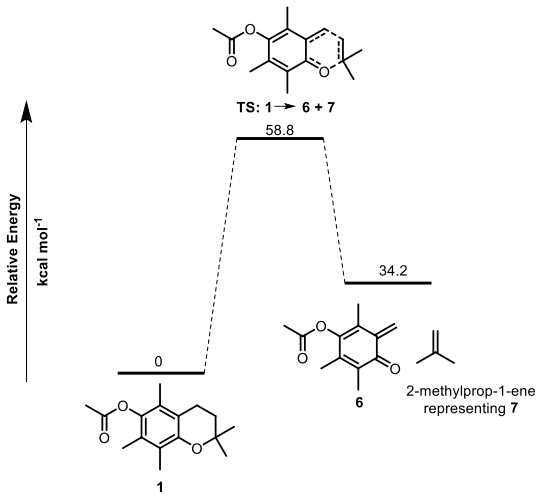
Transition state structure of **6** → **4** + **8**

```
Imaginary Frequency: -886.8120.
E(RM062X) = -691.142913169
Zero-point correction =                           0.228994 (Hartree/Particle)
 Thermal correction to Energy =                    0.245075
 Thermal correction to Enthalpy =                  0.246020
 Thermal correction to Gibbs Free Energy =         0.184954
 Sum of electronic and zero-point Energies =           -690.913920
 Sum of electronic and thermal Energies =              -690.897838
 Sum of electronic and thermal Enthalpies =            -690.896894
 Sum of electronic and thermal Free Energies =         -690.957959

Standard orientation:
```

Center Number	Atomic Number	Atomic Type	Coordinates (Angstroms) X	Y	Z
1	6	0	2.062301	-0.740116	-0.032863
2	6	0	0.859372	-1.274797	0.264801
3	6	0	-0.366336	-0.443774	0.444835
4	6	0	-0.288484	0.926184	0.383844
5	6	0	0.973130	1.575833	0.065969
6	6	0	2.204983	0.729829	-0.153238
7	8	0	-1.488696	-1.092041	0.601300
8	1	0	-2.038285	-1.315044	-0.871127
9	6	0	-3.506101	-0.176497	-0.494674
10	8	0	-4.302903	0.016581	0.271477
11	6	0	-2.629112	-0.536344	-1.525041
12	1	0	-3.160008	-0.794197	-2.439480
13	1	0	-1.847951	0.230481	-1.633316
14	6	0	-1.494985	1.756501	0.718996
15	1	0	-2.049687	2.116074	-0.164681
16	1	0	-2.175196	1.181244	1.348327
17	1	0	-1.210968	2.650108	1.278814
18	6	0	1.130728	2.902027	-0.084000
19	6	0	0.661687	-2.755281	0.430000
20	1	0	-0.072844	-2.943424	1.212115
21	1	0	0.257794	-3.191774	-0.490514
22	1	0	1.595532	-3.264044	0.663359
23	6	0	3.308563	-1.557109	-0.244060
24	1	0	3.682371	-1.958423	0.702952
25	1	0	3.124325	-2.400277	-0.912712
26	1	0	4.087302	-0.927995	-0.670823
27	8	0	3.278201	1.236100	-0.418512
28	1	0	0.311746	3.600869	0.030149
29	1	0	2.108581	3.292539	-0.334587

Figure S7. DFT calculation data for chroman retro Diels-Alder transition state for **1**†

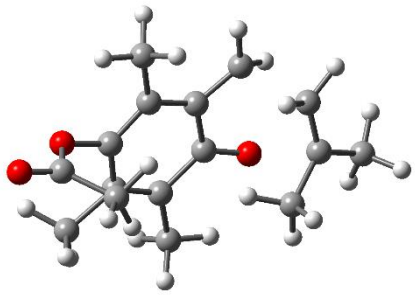


Calculated (gas phase at the M06-2X/6-311G (d,p) level) energy profile for the retro Diels-Alder pyrolysis of vitamin E acetate (calculation version). Relative free energies (kcal mol^{-1}) for starting materials, transition state and products formed for the pyrolysis of **1**† leading to the formation of **6** and **7**††.

† Simplified structure used for calculation without $C_{15}H_{32}$ alkyl group. ††2-Methylprop-1-ene representing **7**.

Ground state structure of 2-methylprop-1-ene (representing **7)**.

```
E(RM062X) = -157.179383224
Zero-point correction=                           0.108660 (Hartree/Particle)
 Thermal correction to Energy =                    0.113879
 Thermal correction to Enthalpy =                  0.114824
 Thermal correction to Gibbs Free Energy =         0.081493
 Sum of electronic and zero-point Energies =          -157.070724
 Sum of electronic and thermal Energies =             -157.065504
 Sum of electronic and thermal Enthalpies =           -157.064560
 Sum of electronic and thermal Free Energies =        -157.097890
Standard orientation:
 ---------------------------------------------------------------------
 Center     Atomic      Atomic             Coordinates (Angstroms)
 Number     Number       Type              X           Y           Z
 ---------------------------------------------------------------------
      1          6           0        0.001250   -1.455560   -0.000009
      2          6           0        0.000028   -0.126264   -0.000013
      3          6           0        1.270638    0.679225    0.000011
      4          1           0        2.153773    0.040007   -0.000100
      5          1           0        1.311438    1.330002   -0.879051
      6          1           0        1.311589    1.329940    0.879096
      7          6           0       -1.271800    0.677270    0.000016
      8          1           0       -1.313397    1.328320    0.878849
      9          1           0       -1.313684    1.327697   -0.879257
     10          1           0       -2.154080    0.036912    0.000323
     11          1           0        0.927383   -2.019514    0.000036
     12          1           0       -0.923721   -2.021392    0.000071
 ---------------------------------------------------------------------
```



Transitions state image representing **1**→ **6** + **7**

Transition state structure of **1**† → **6** + **7**††

```
Imaginary Frequency: -398.8034.
E(RM062X) = -848.418968657
Zero-point correction=                           0.346404 (Hartree/Particle)
 Thermal correction to Energy =                    0.367276
 Thermal correction to Enthalpy =                  0.368220
 Thermal correction to Gibbs Free Energy =         0.297471
 Sum of electronic and zero-point Energies =           -848.072565
 Sum of electronic and thermal Energies =              -848.051692
 Sum of electronic and thermal Enthalpies =            -848.050748
 Sum of electronic and thermal Free Energies =         -848.121498

Standard orientation:
 ---------------------------------------------------------------------
 Center     Atomic      Atomic             Coordinates (Angstroms)
 Number     Number       Type              X           Y           Z
 ---------------------------------------------------------------------
      1          6           0       -2.770997   -1.863904    0.410401
      2          6           0       -1.774072   -1.444261   -1.344134
      3          6           0       -0.727366   -0.559637   -1.082001
      4          6           0       -1.150724    0.798246   -0.782195
      5          6           0       -3.163314   -0.648196    0.926375
      6          6           0        0.641940   -0.953758   -0.946331
      7          6           0       -0.127152    1.780199   -0.439513
      8          6           0        1.182064    1.389294   -0.387710
      9          6           0        1.540050    0.014960   -0.614014
     10          8           0       -2.370488    1.051556   -0.732664
     11          1           0       -1.931147   -2.376050    0.868544
     12          1           0       -3.514242   -2.497048   -0.062753
     13          1           0       -2.669044   -1.018852   -1.779611
     14          1           0       -1.557305   -2.476747   -1.596290
     15          6           0       -2.266920    0.040433    1.903486
     16          1           0       -2.509502    1.098247    2.001620
     17          1           0       -2.342116   -0.438890    2.885773
     18          1           0       -1.221647   -0.053643    1.579735
     19          6           0       -4.525795   -0.093204    0.661680
     20          1           0       -5.184249   -0.324416    1.507709
     21          1           0       -4.484006    0.987881    0.537994
     22          1           0       -4.961277   -0.534481   -0.236232
     23          6           0        1.059393   -2.378626   -1.186417
     24          1           0        0.599494   -3.053117   -0.456285
     25          1           0        0.743825   -2.709358   -2.178835
     26          1           0        2.140582   -2.489116   -1.125606
     27          6           0       -0.582845    3.188068   -0.166489
     28          1           0       -1.670977    3.218171   -0.172243
     29          1           0       -0.224931    3.547431    0.801490
```

30	1	0	-0.218737	3.880399	-0.931000
31	6	0	2.302132	2.349150	-0.082728
32	1	0	1.962648	3.381991	-0.116886
33	1	0	2.725482	2.166945	0.911333
34	1	0	3.116193	2.217840	-0.797375
35	8	0	2.896123	-0.291536	-0.528037
36	6	0	3.438048	-0.662086	0.670843
37	8	0	4.611250	-0.859986	0.732630
38	6	0	2.484595	-0.815673	1.832797
39	1	0	1.920939	0.103202	2.005253
40	1	0	1.759926	-1.605216	1.622884
41	1	0	3.070788	-1.071470	2.711044

† Simplified structure used for calculation without $C_{15}H_{32}$ alkyl group. ††2-Methylprop-1-ene representing **7**.

Figure **S8**. APCI-MS cone-voltage study of vaped vitamin E acetate **1**

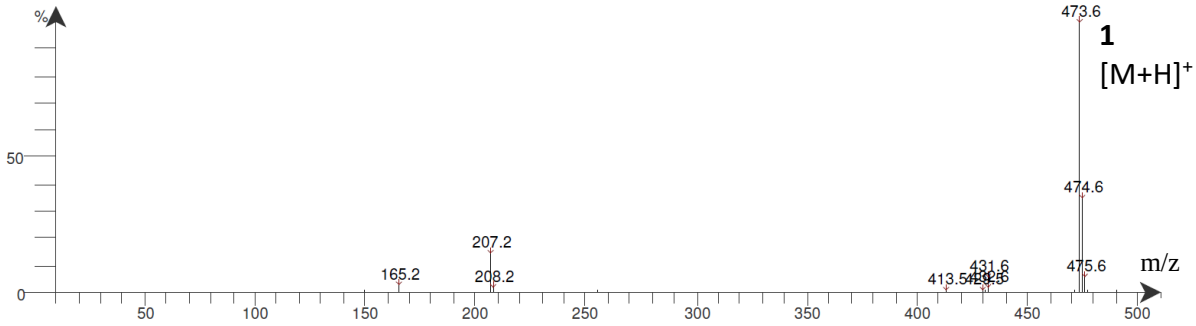


Fig. S8a: 5 eV, APCI (positive mode).

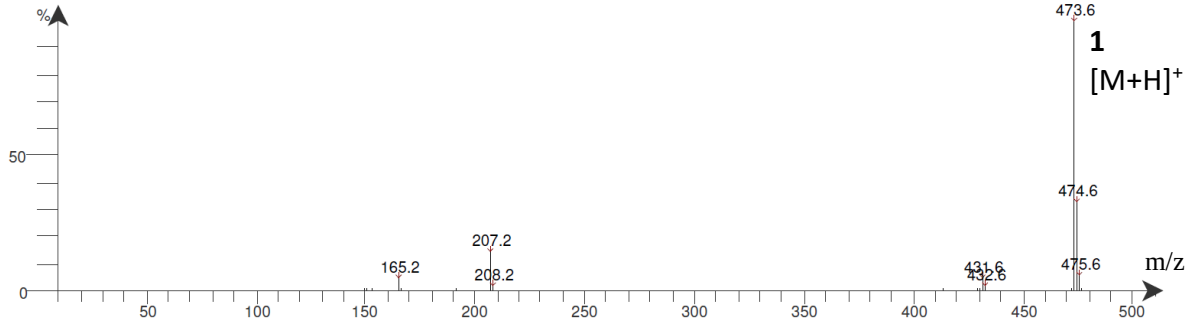


Fig. S8b: 10 eV, APCI (positive mode).

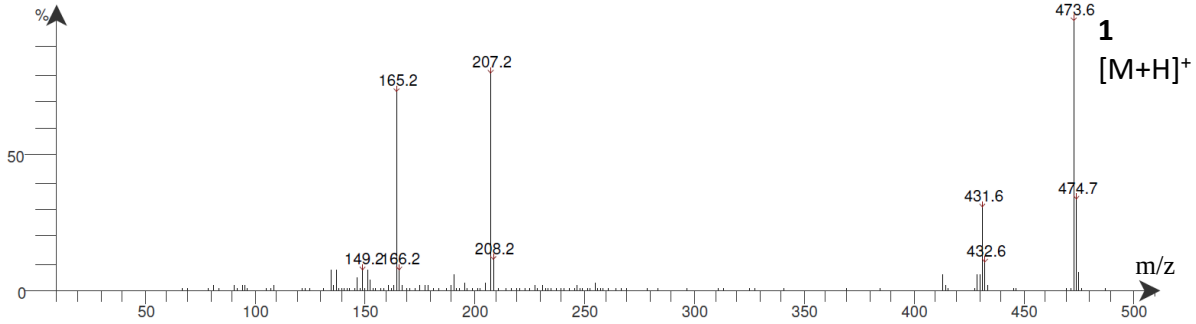


Fig. S8c: 20 eV, APCI (positive mode).

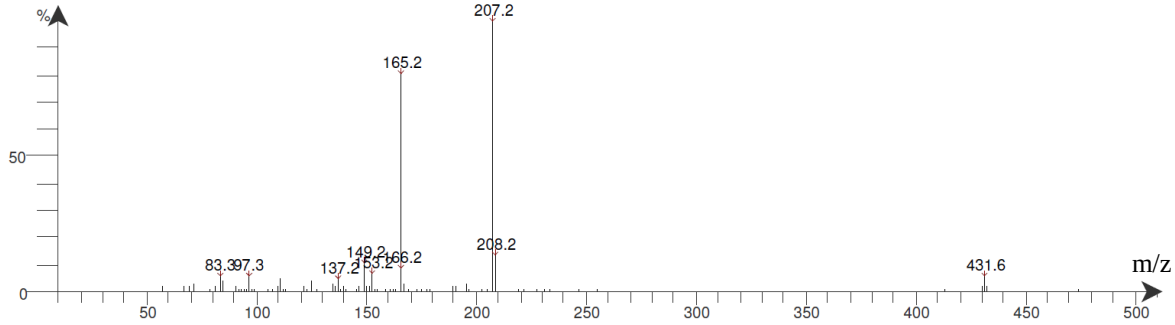


Fig. S8d: 30 eV, APCI (positive mode).

Figure **S9**. ^{1}H NMR spectrum of isolated mixture from vaped **1** and pure vitamin E acetate **1**

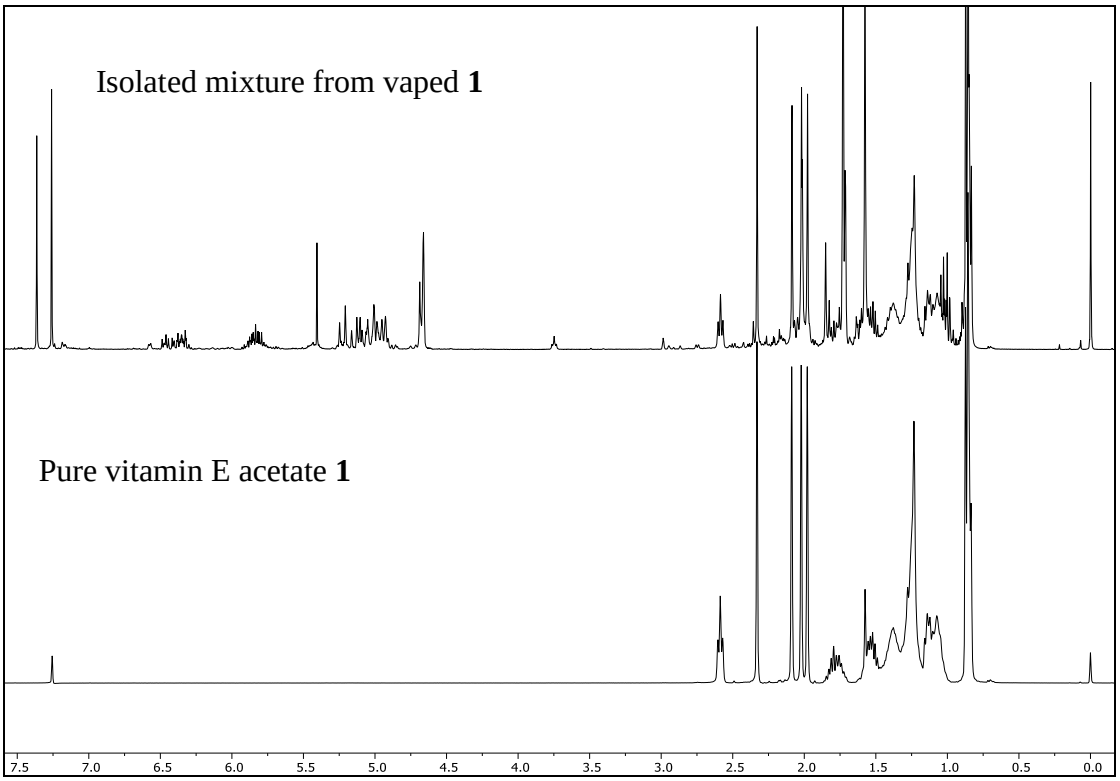
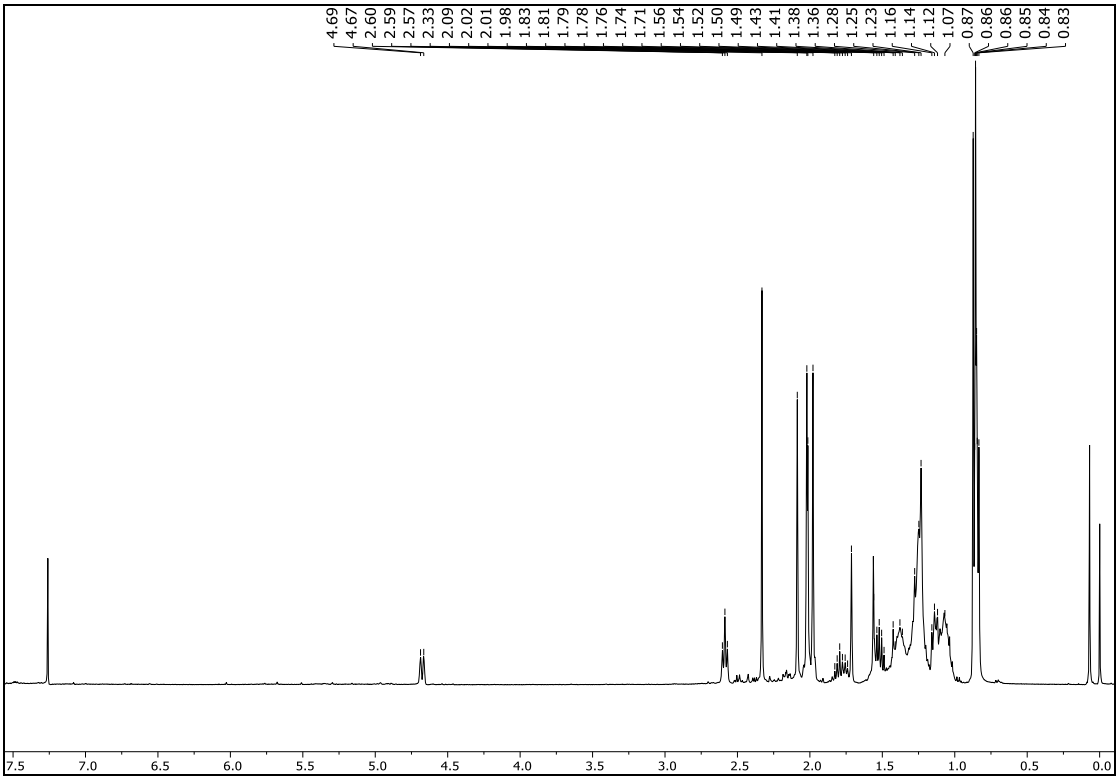


Figure S10 ^{1}H NMR spectrum of the non-volatile component (NVC) of isolated mixture from vaped **1**

^{1}H NMR ($CDCl_3$, 400 MHz)



^{13}C NMR ($CDCl_3$, 100 MHz)

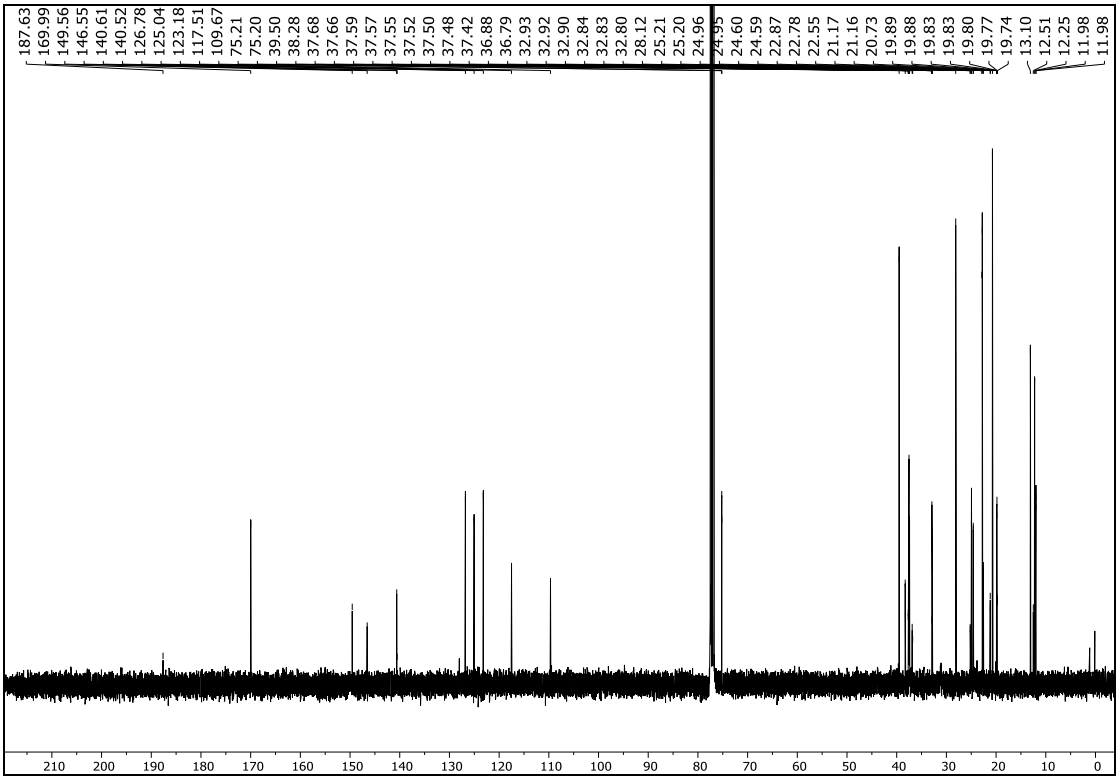
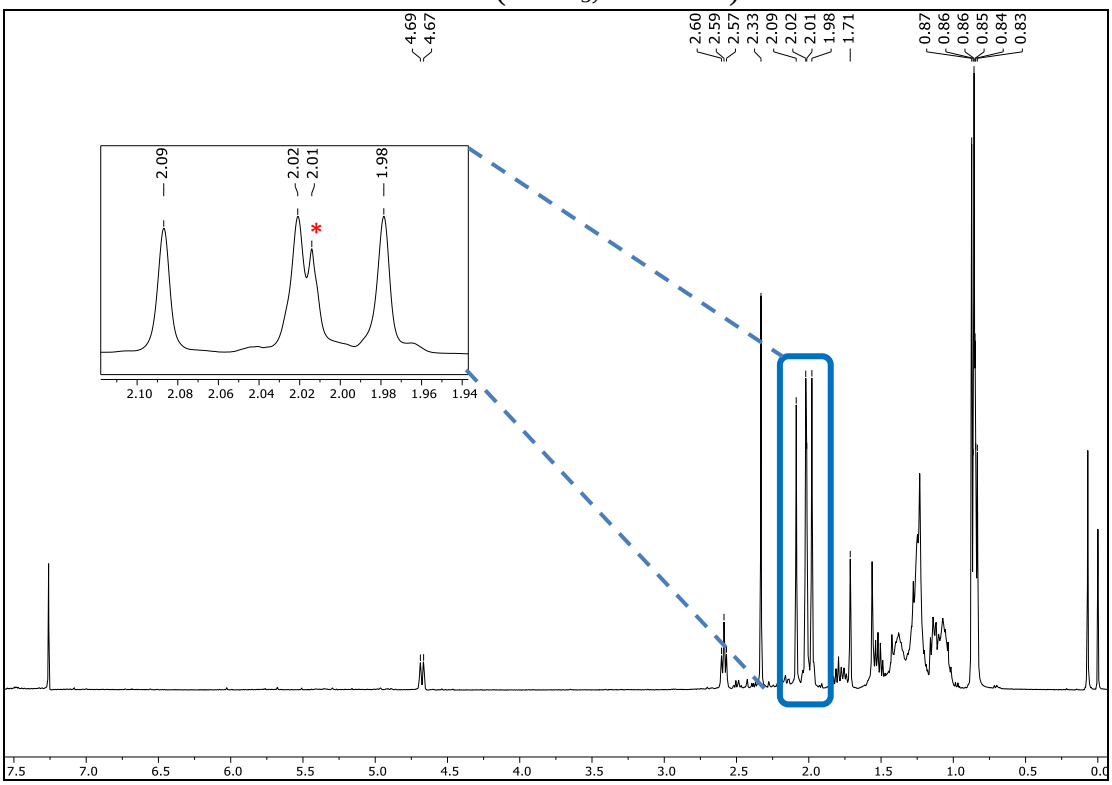
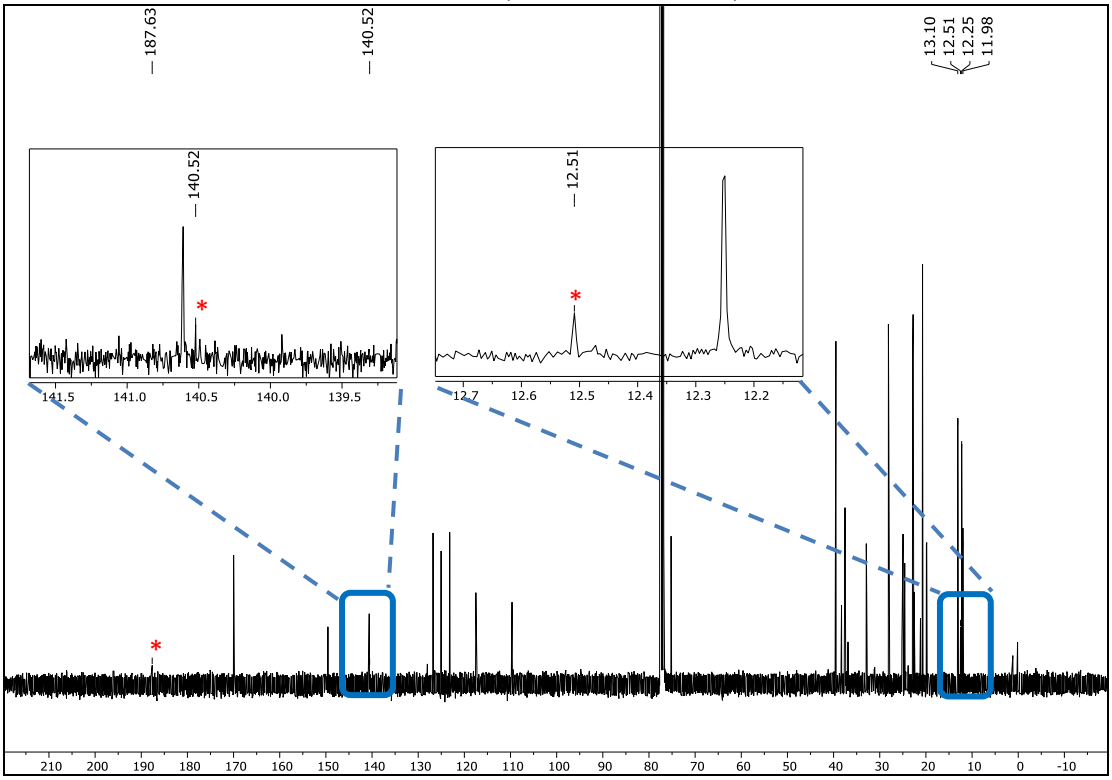


Figure S11. Identification of duroquinone **8** and prist-1-ene **7** in non-volatile component (NVC) of isolated mixture from vaped **1**.

^{1}H NMR ($CDCl_3$, 400 MHz)

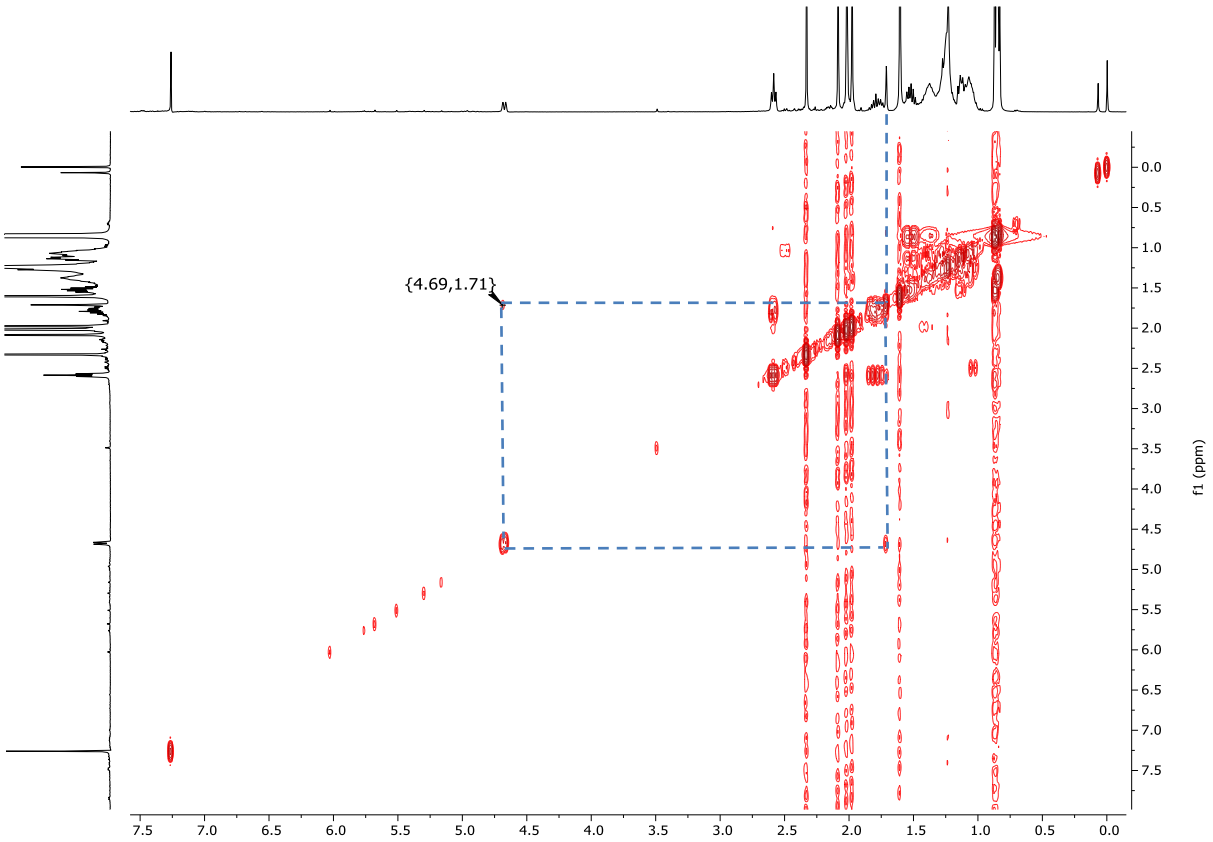


^{13}C NMR ($CDCl_3$, 100 MHz)

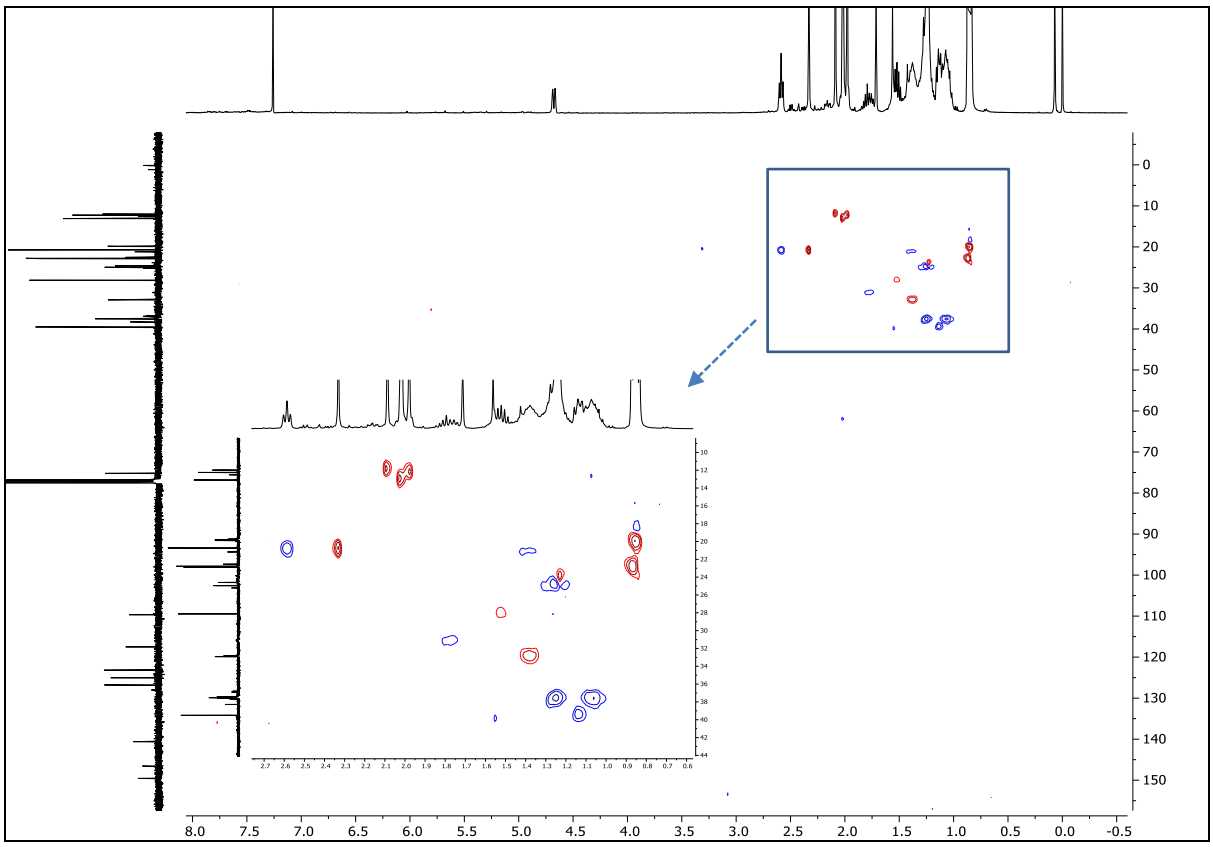


*: Duroquinone **8**. ^{1}H NMR (400 MHz, $CDCl_3$) δ:2.01 (s, 12H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$) δ:187.6, 140.5, 12.5 ppm.

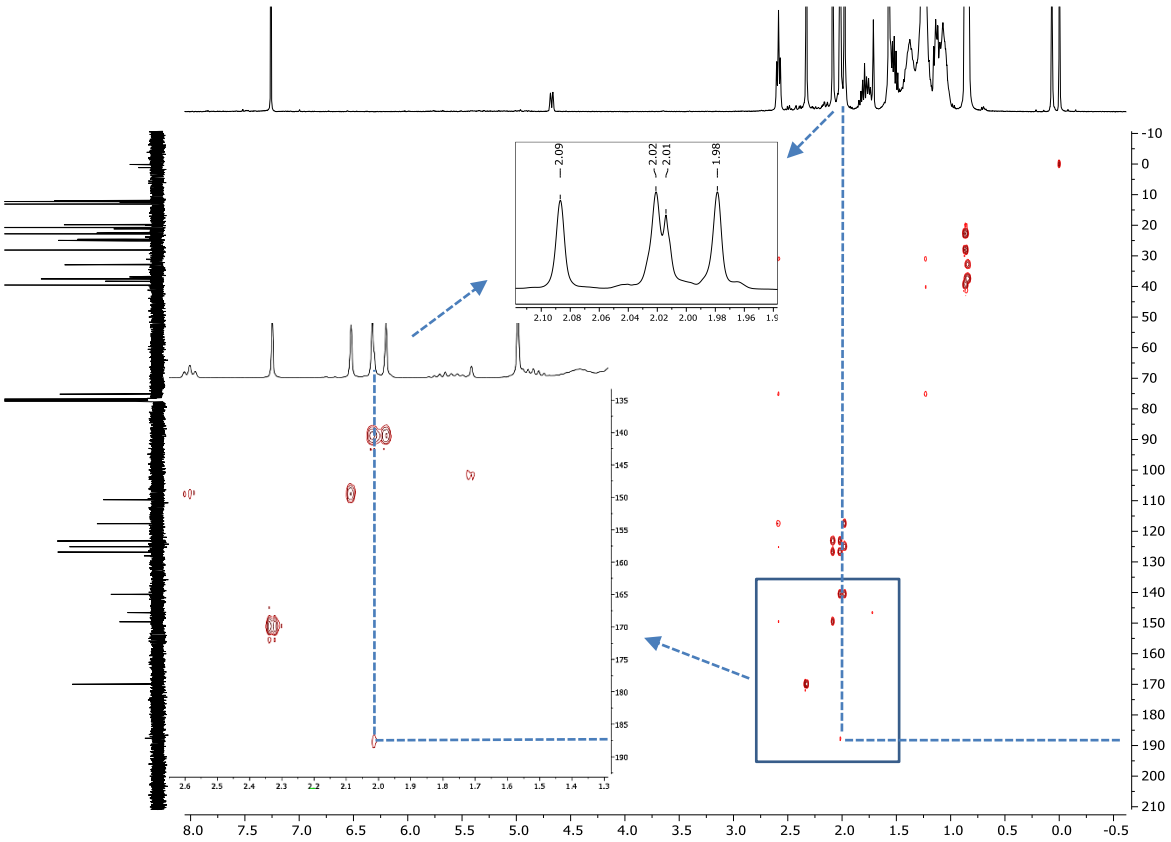
^{1}H COSY



HSQC



HMBC



Confirmatory spiking NMR spectra. Top spectrum: vape mixture containing duroquinone **8** (red asterisk). Bottom spectrum: vaped mixture containing duroquinone following spiking with pure duroquinone **8.**

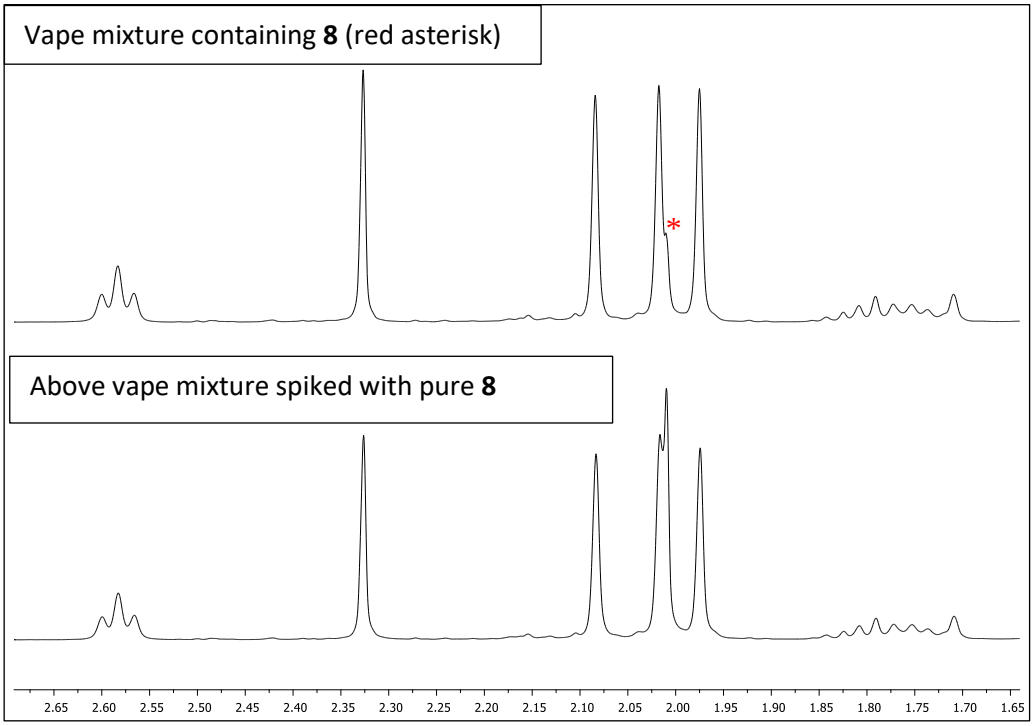
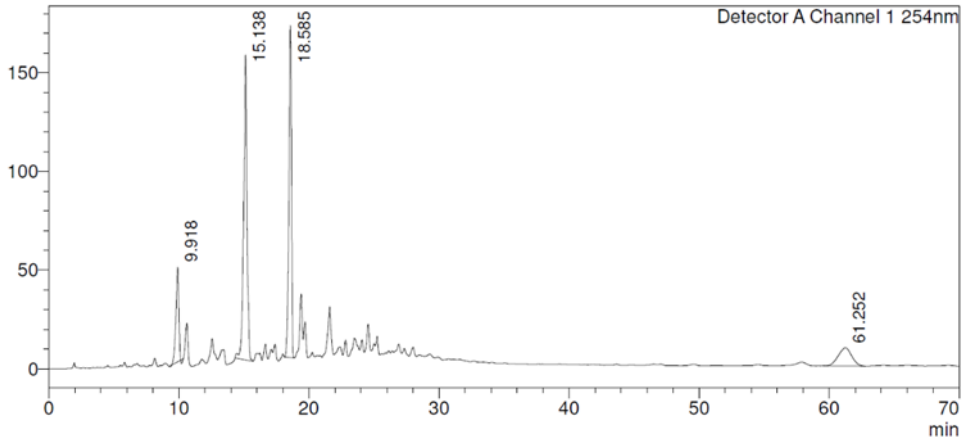
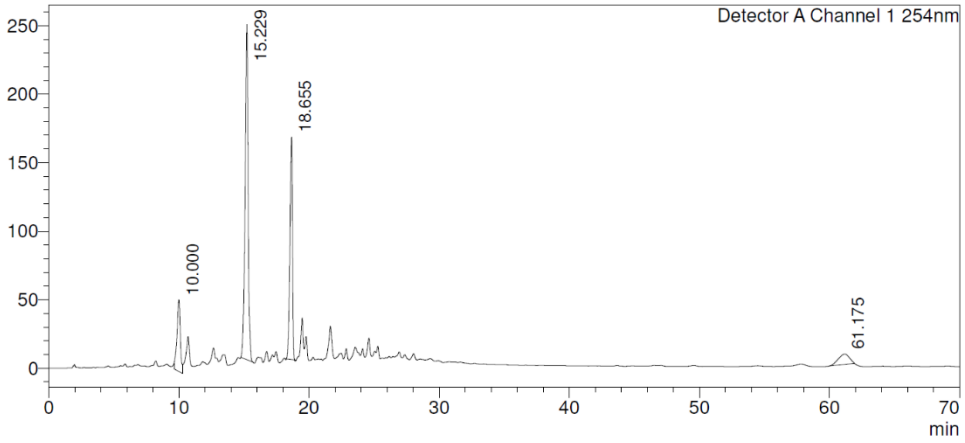


Figure S12. HPLC identification of duroquinone **8** in non-volatile component (NVC) of isolated mixture from vaped **1**

HPLC of NVC from vaped **1** with duroquinone **8** identified at RT of 15.1 min



HPLC of NVC from vaped **1** spiked with pure **8**



HPLC of pure duroquinone **8** (RT 15.1 min)

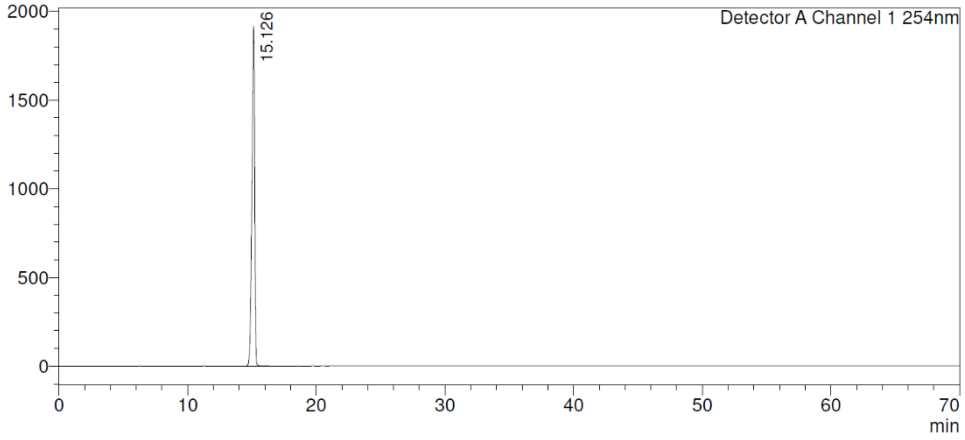
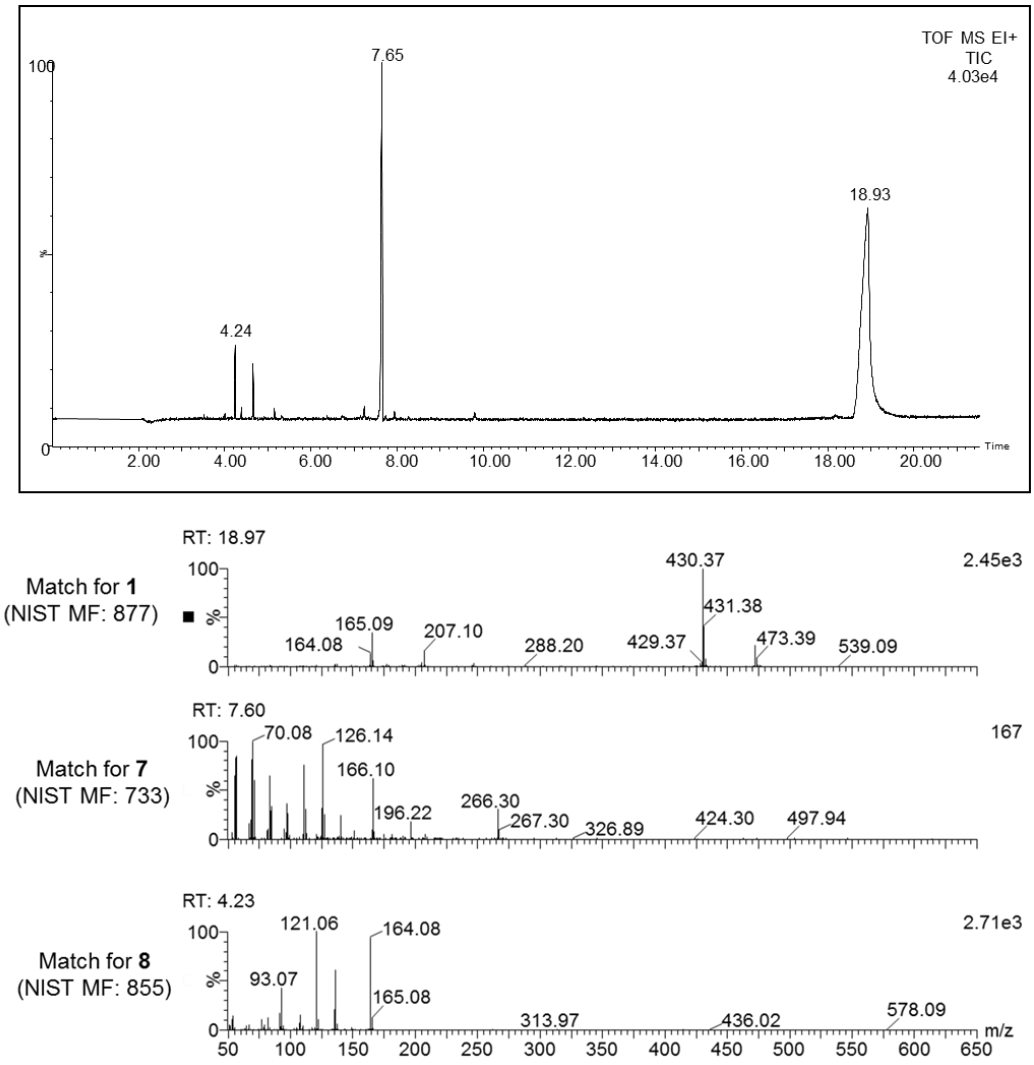


Figure S13. GC-MS identification of duroquinone **8** in non-volatile component (NVC) of isolated mixture from vaped **1**



Accurate mass report for duroquinone **8**

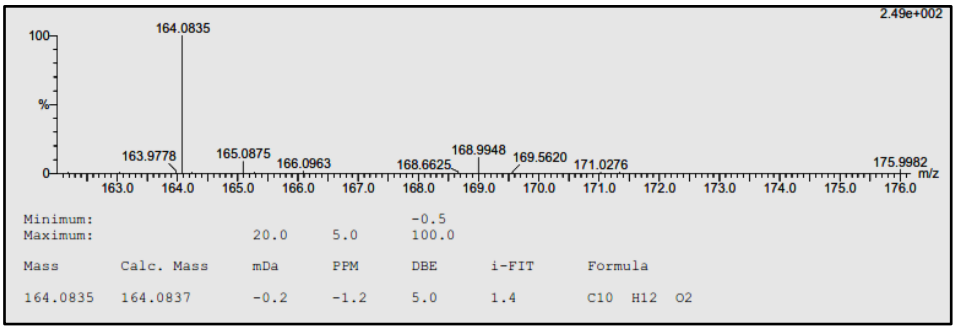
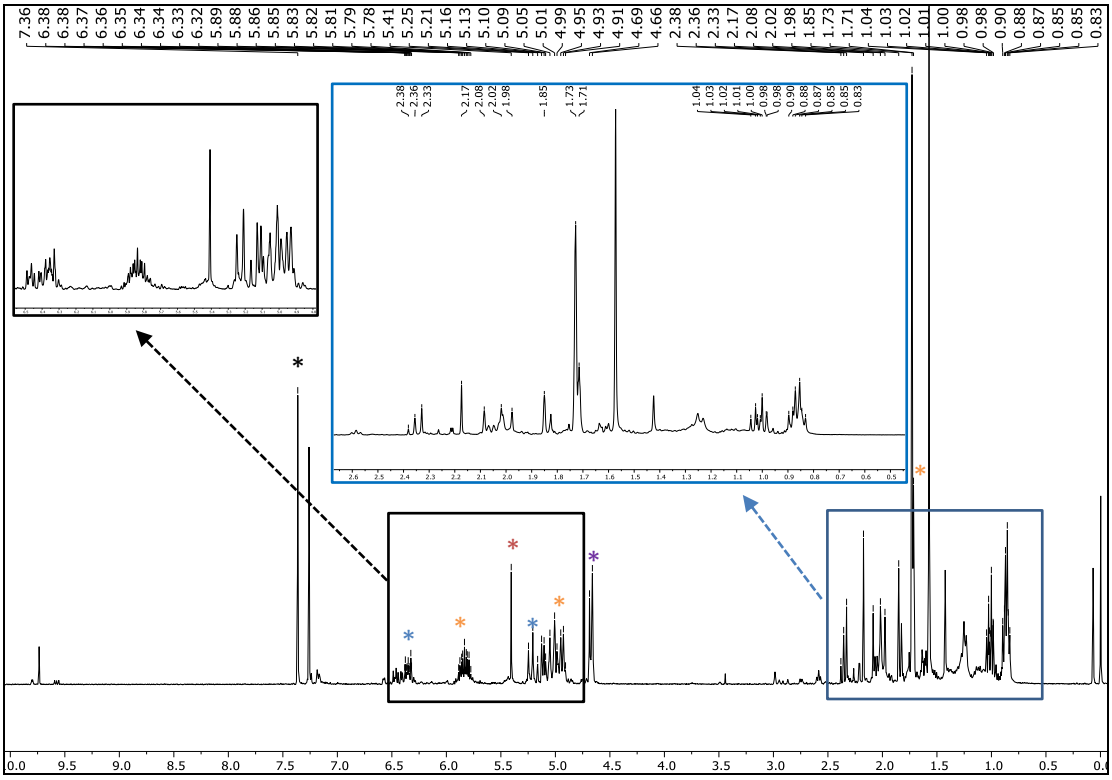
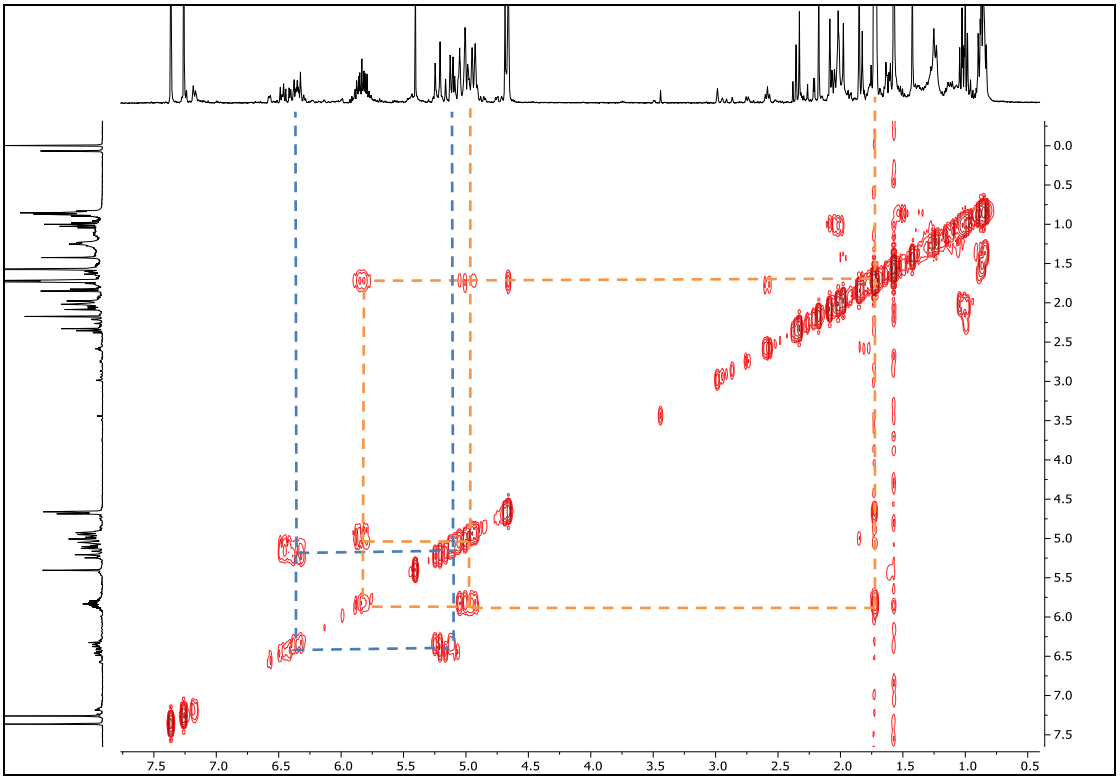


Figure S14. Identification of benzene, ethene, propene, butadiene, THF, 2-methylprop-1-ene in volatile component (VC) of isolated mixture from vaped **1**.

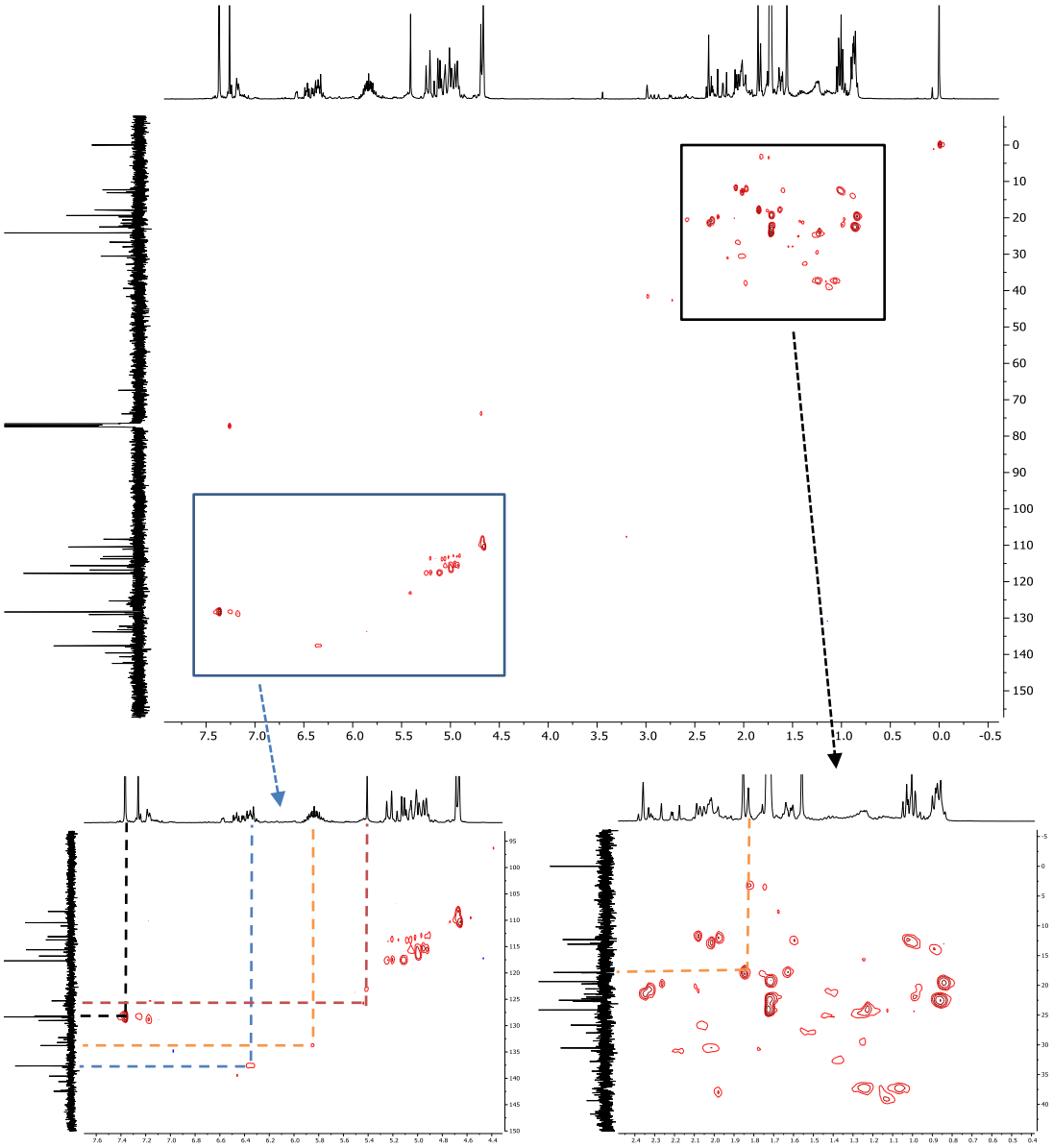
^{1}H NMR ($CDCl_3$, 400 MHz)



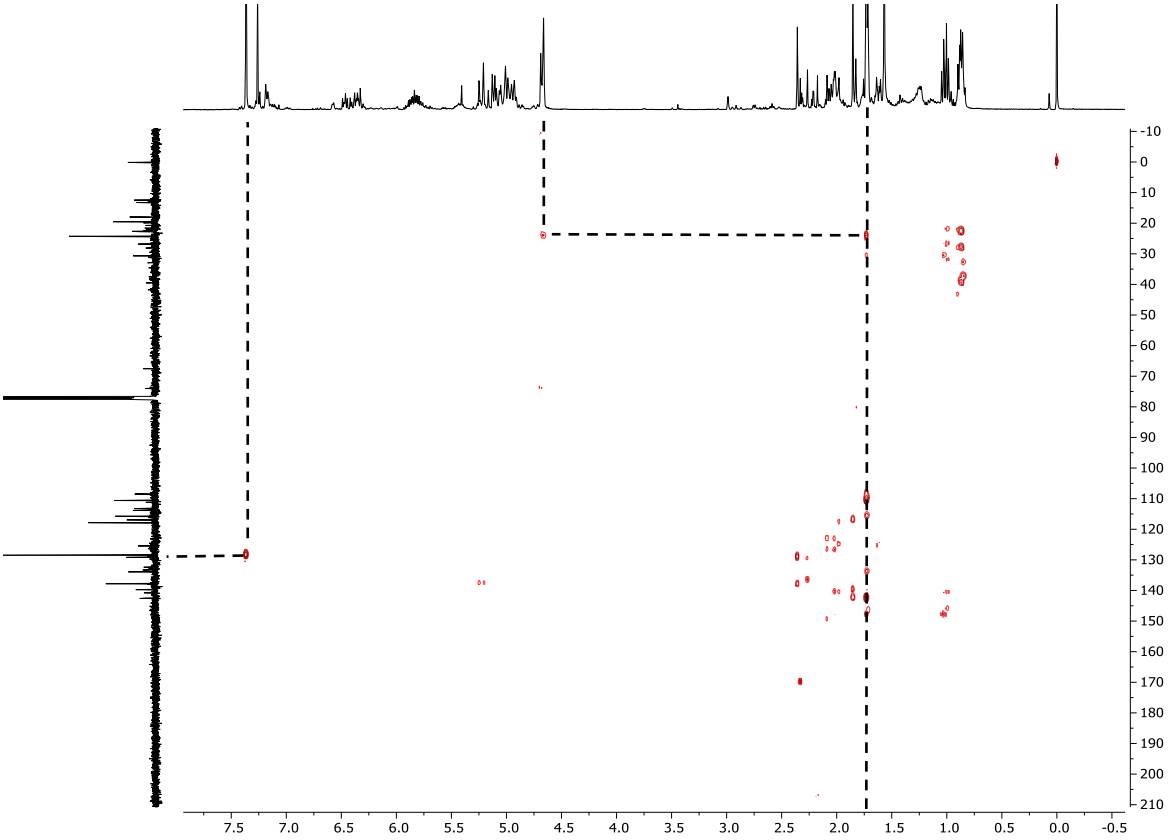
^{1}H COSY



HSQC



HMBC



* **Benzene**: ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.36 (s) ppm.

* **Ethene**: ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 5.41 (s) ppm.

* **Propene:** ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 5.93-5.72 (ddq =CH, 1H), 4.97 (dd, *J* = 21.9 Hz, *J* = 9.8 Hz, CH_2=, 2H), 2.01 (d, *J* = 5.5 Hz, CH_3, 3H) ppm.

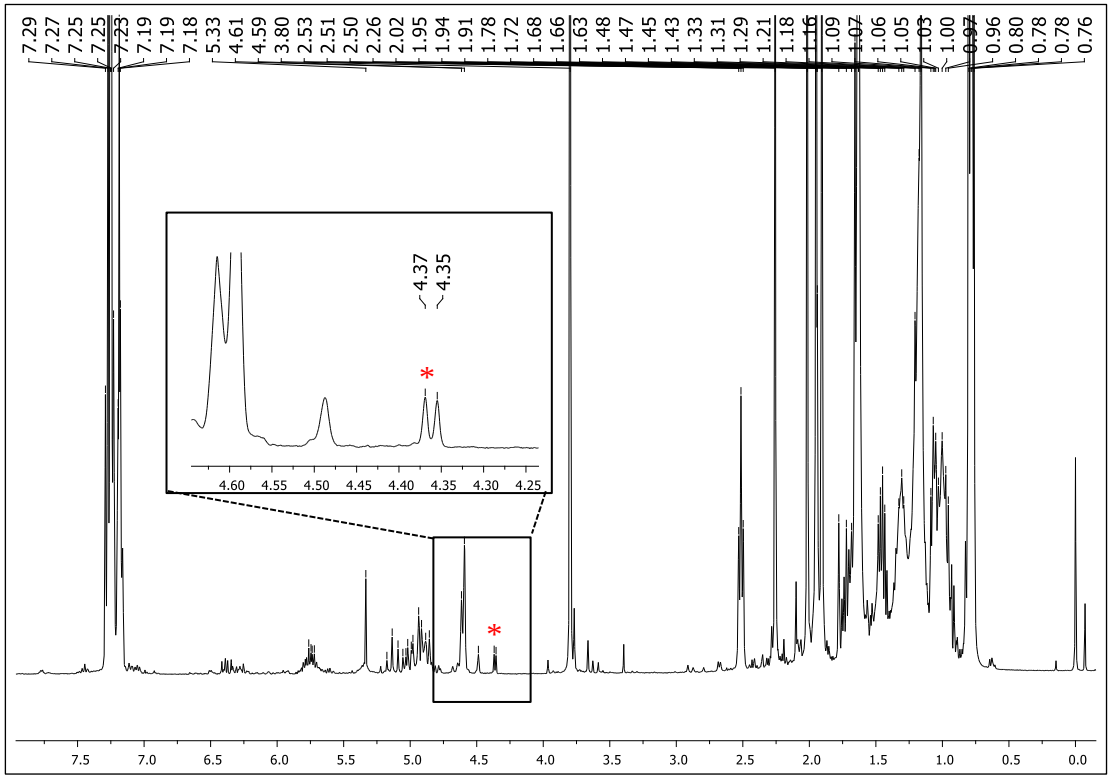
* **Butadiene**: ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 6.41-6.29 (m, 2H) ppm, 5.23 (d, *J* = 16.2 Hz, 2H), 5.12 (d, *J* = 9.5 Hz, 2H) ppm.

THF: ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 3.76 (m, 4H), 1.85 (m, 4H) ppm.

2-Methylprop-1-ene: ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 4.66 (s, CH_2=, 2H), 1.71 (s, CH_3, 6H) ppm.

Figure S15. ^{1}H NMR spectra of isolated vaped **1** with benzylamine **9** as trap for ketene.

^{1}H NMR ($CDCl_3$, 400 MHz) of vape mixture containing benzylamide **10** (red asterisk)



Confirmatory spiking NMR spectra. Top spectrum: vape mixture containing benzylamide**10** (red asterisk). Bottom spectrum: vaped mixture containing benzylamide **10** following spiking with pure benzylamide.

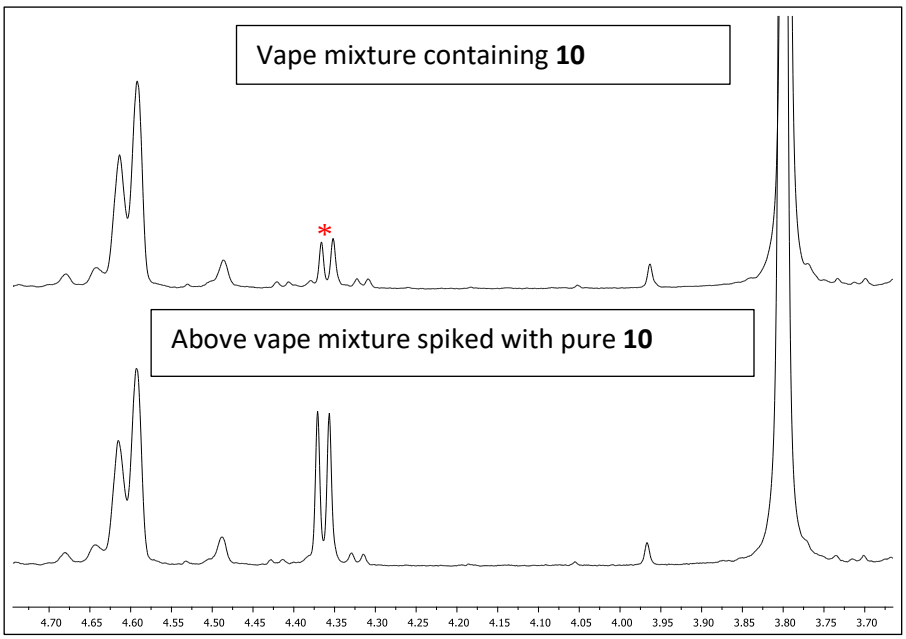
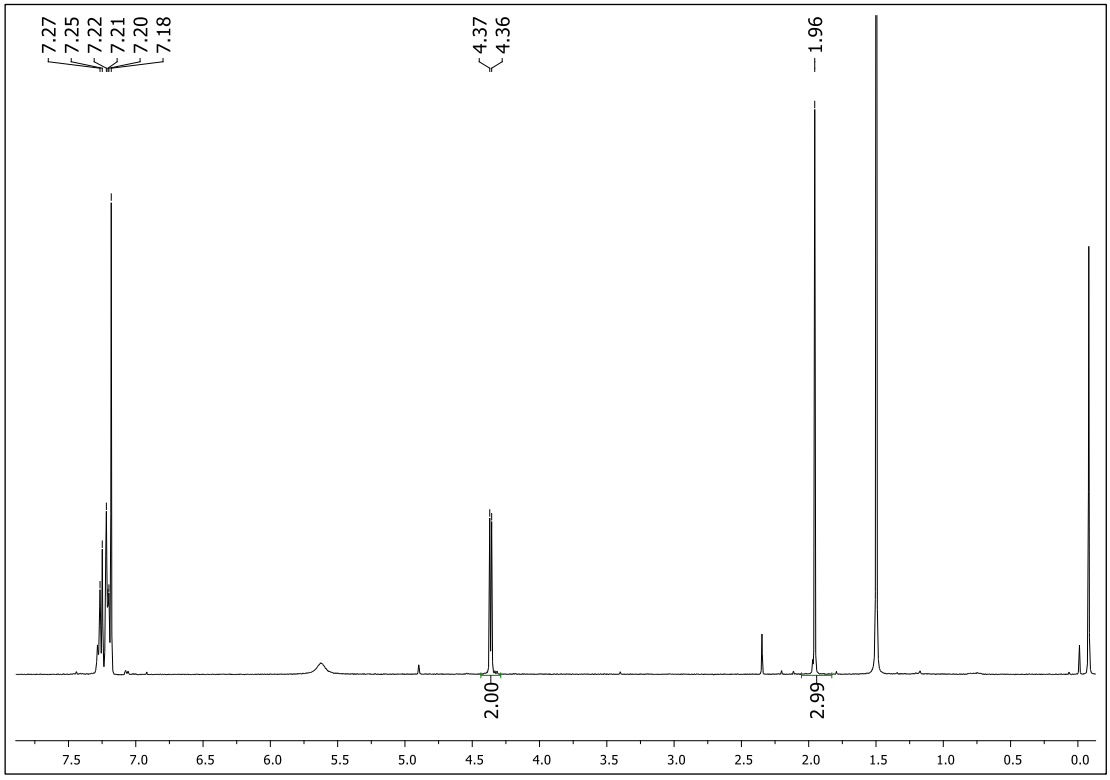


Figure S16. ^{1}H NMR spectrum of synthesized benzylamide **10**.

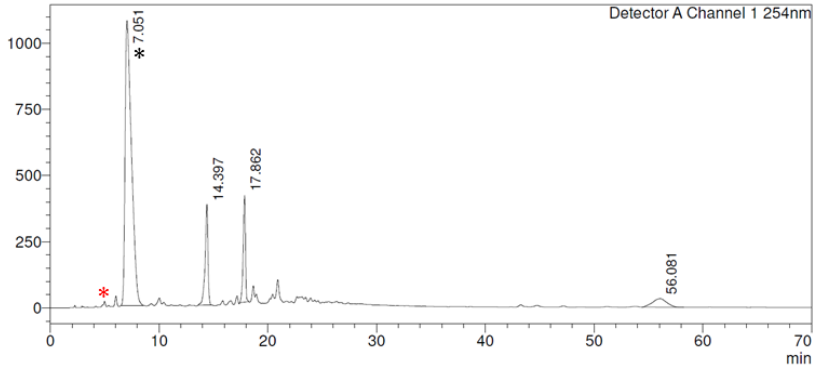
^{1}H NMR ($CDCl_3$, 400 MHz)



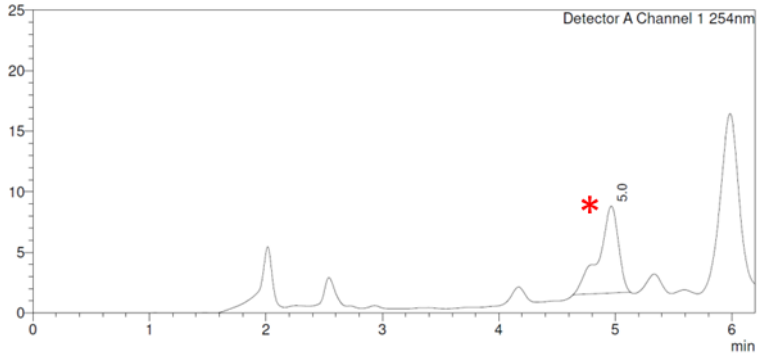
Procedure for synthesis of benzylamide 10

Triethylamine (7.66 mL, 54.9 mmol) was added to a solution of acetylchloride (3.71 mL, 52 mmol) in THF (5 mL), at 0 °C with stirring to in situ form ketene.[†] Benzylamine **9** (5.46 mL, 50 mmol) in THF (15 mL) was added and the reaction mixture stirred for 3 h, warmed to rt, and quenched with saturated Na_2CO_3 solution (30 mL). The phases were separated and the aqueous layer was washed with CH_2Cl_2 (3 × 20 mL). The combined organic layers were dried over Na_2SO_4 and concentrated. The crude product was recrystallized in CH_2Cl_2 / cyclohexane (1:1) to give *N*-benzylacetamide **10** as a solid (4.7 g, 63%, mp 61 °C). ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.27-7.18 (m, 5H), 5.65 (s, br, 1H), 4.37 (d, *J* = 5.6 Hz, 2H), 1.96 (s, 3H) ppm.
[†]Tidwell, T.T, Ketene. *Sci. Synth*. **23**, 19-21 (2006).

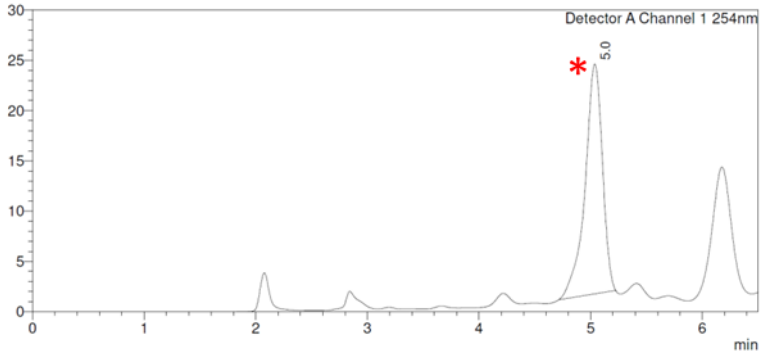
Figure S17. HPLC of isolated vaped **1** mixture with benzylamine **9** (black asterisk) as trap for ketene forming benzylamide **10** (red asterisk)



Expanded view of above HPLC trace showing benzylamide **10** (red asterisk)



Above HPLC following spiking with pure **10** (red asterisk)



HPLC of pure benzylamide **10**

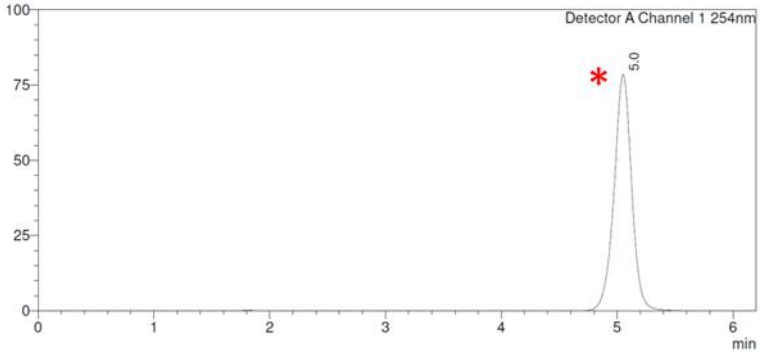
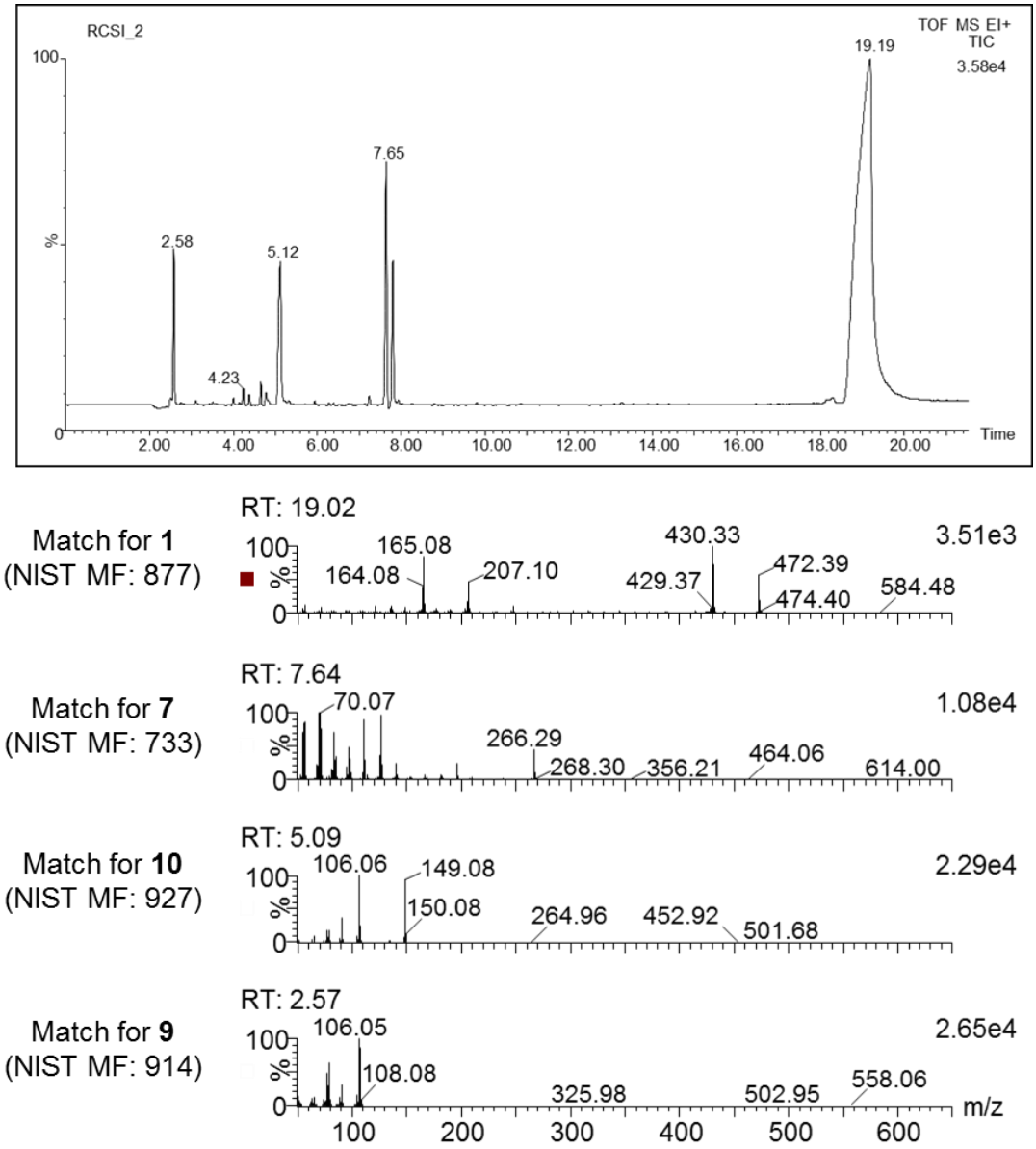


Figure S18. GC-MS spectra of isolated vaped **1** mixture with **9** as trap for ketene



Accurate mass report for benzylamide **10**

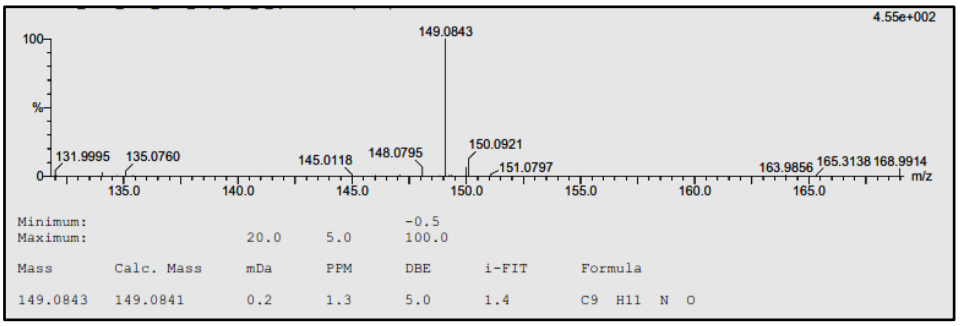
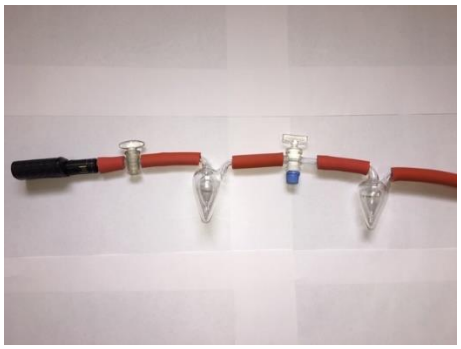


Figure S19. Photographs of experimental setup for Fig. 11A-C

Apparatus set up as shown in Fig. 11A and C

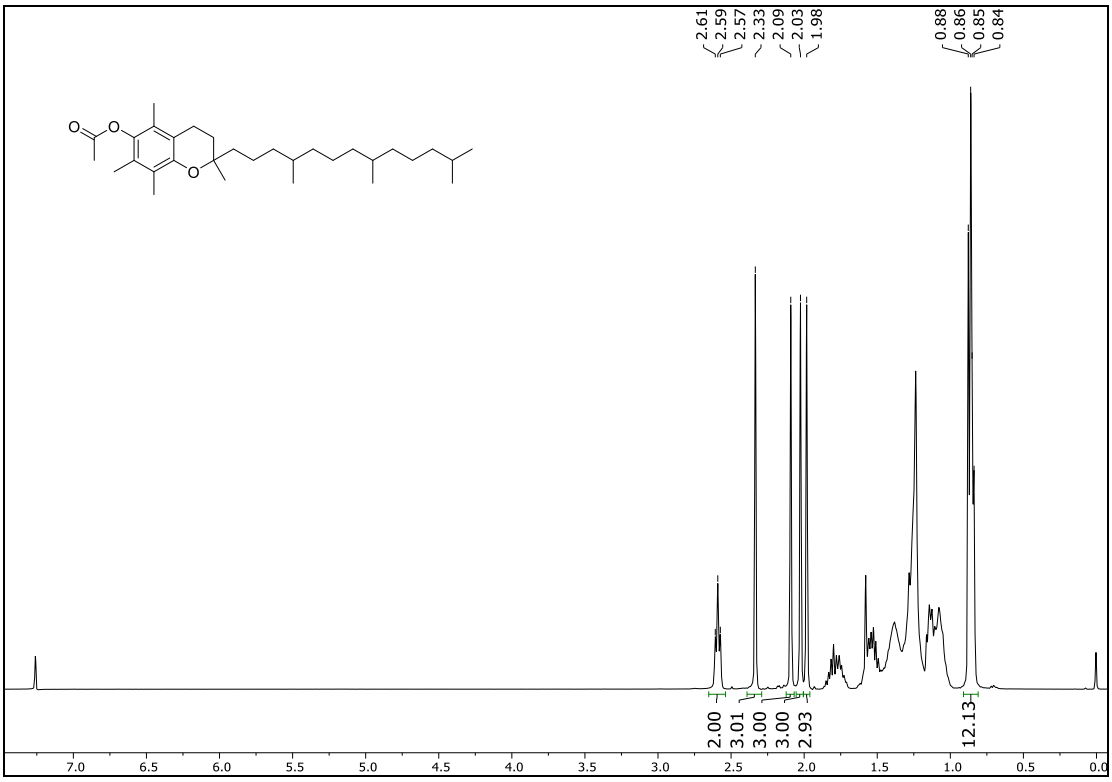
Apparatus set up as shown Fig. 11B



Appendix NMR spectra of pure 1, 2, 8 and 9

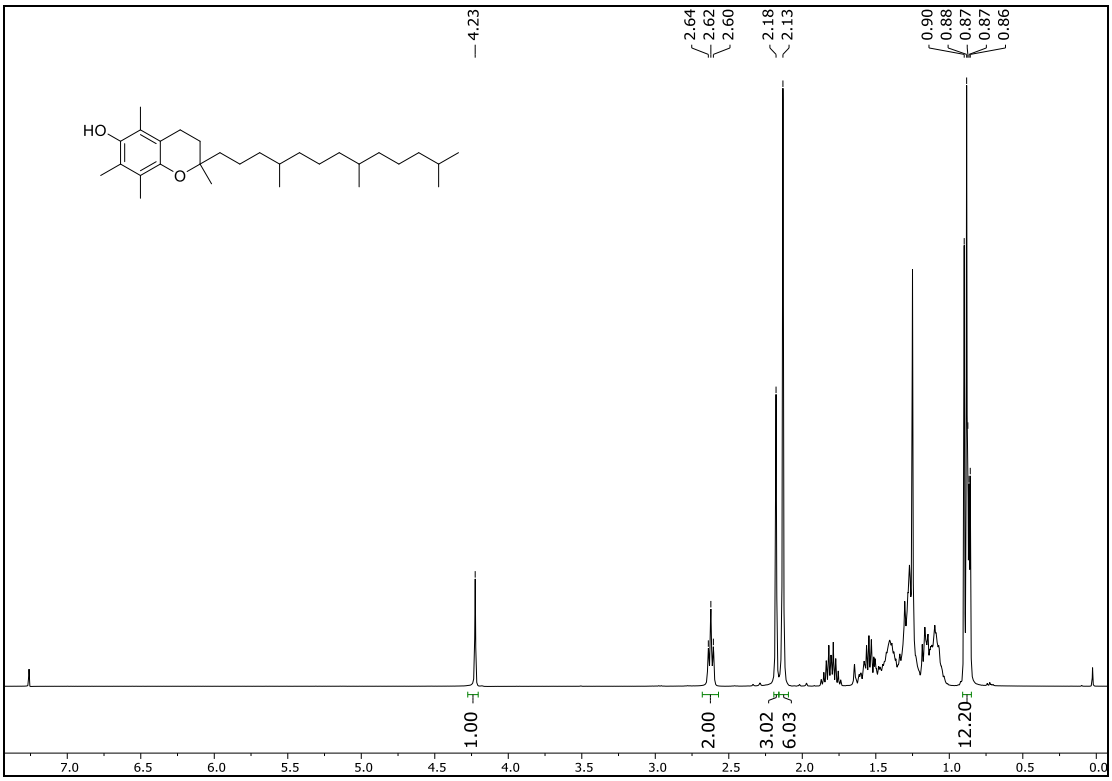
Vitamin E acetate **1**

^{1}H NMR ($CDCl_3$, 400 MHz)



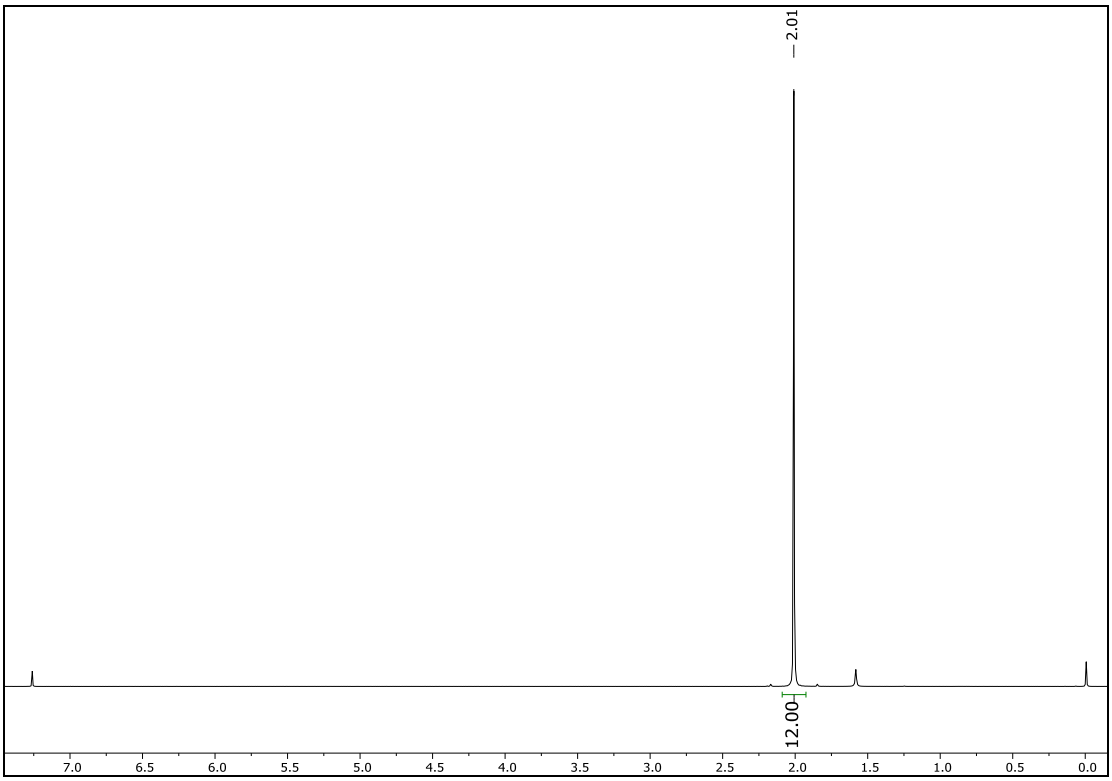
Vitamin E **2**

^{1}H NMR ($CDCl_3$, 400 MHz)

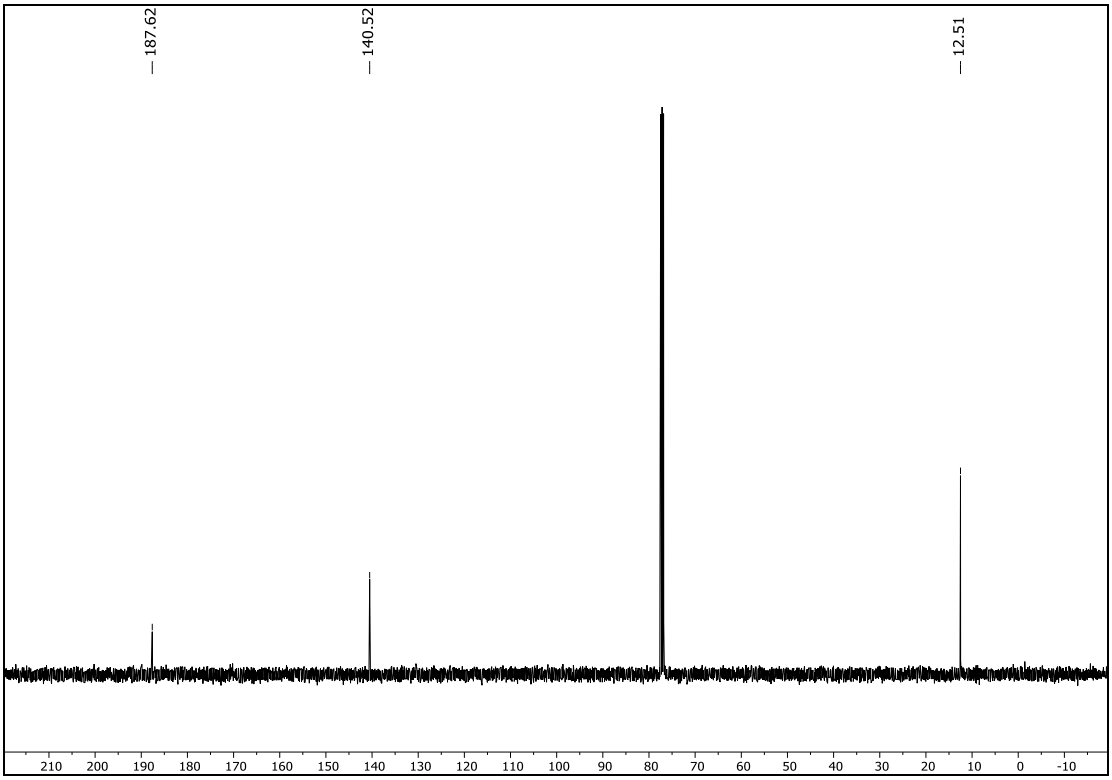


Duroquinone **8**

^{1}H NMR ($CDCl_3$, 400 MHz)



^{13}C NMR ($CDCl_3$, 100 MHz)



Benzylamine **9**

^{1}H NMR ($CDCl_3$, 400 MHz)