SUPPORTING INFORMATION:

The effects of common e-liquid flavorants and added nicotine on toxicant formation during vaping analyzed by ^{1}H NMR Spectroscopy

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Materials & methods and additional NMR data for the multiple addition product (MAP):

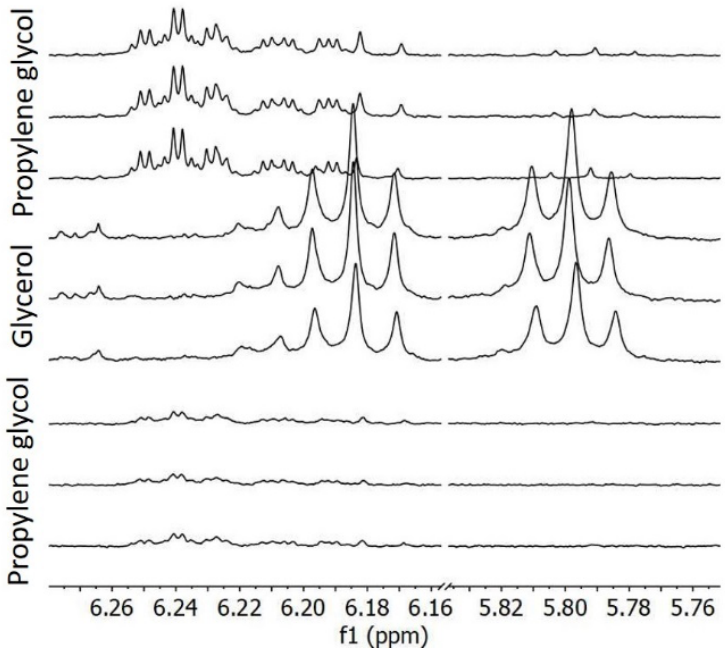


Figure S1. Spectra depict the single formaldehyde addition products (6.24 and 6.19 ppm) and the theorized multiple formaldehyde addition product (5.80 ppm MAP) by ^{1}H NMR in either vaped propylene glycol (PG) or glycerol (GL) aerosol samples, respectively. Samples/spectra were generated in order from the bottom to the top. Three samples were collected for each condition and each sample contained 3 puffs. A Kangertech subtank mini was filled with PG, conditioned per methods described in the main manuscript, and vaped at 26 watts (bottom 3 spectra). The tank was emptied, cleaned with ethanol and lint-free tissues, and filled with GL. Wicking puffs were generated per methods described herein. Three vaped GL samples were collected. The tank was emptied, cleaned, and again filled with PG. Three samples were generated. The same 1.2 Ω coil was used for all samples. The single formaldehyde addition product was previously identified by Jensen et al.,[1, 2] and can form from the addition of formaldehyde to either propylene glycol or glycerol. The 5.8 ppm MAP (shown in this figure) and 5.3 ppm MAP (not shown in this figure) only appears in the presence of glycerol and is theorized to form from the multiple addition of formaldehyde to glycerol, based on similarities to the spectra presented by Jensen et al. and 2D NMR experiments we conducted (Figure S2); these 2D experiments indicated connectivity of the 5.8 ppm triplet to at 4.6 doublet and another peak (splitting was not able to be observed due to peak overlap) at 3.4 ppm.

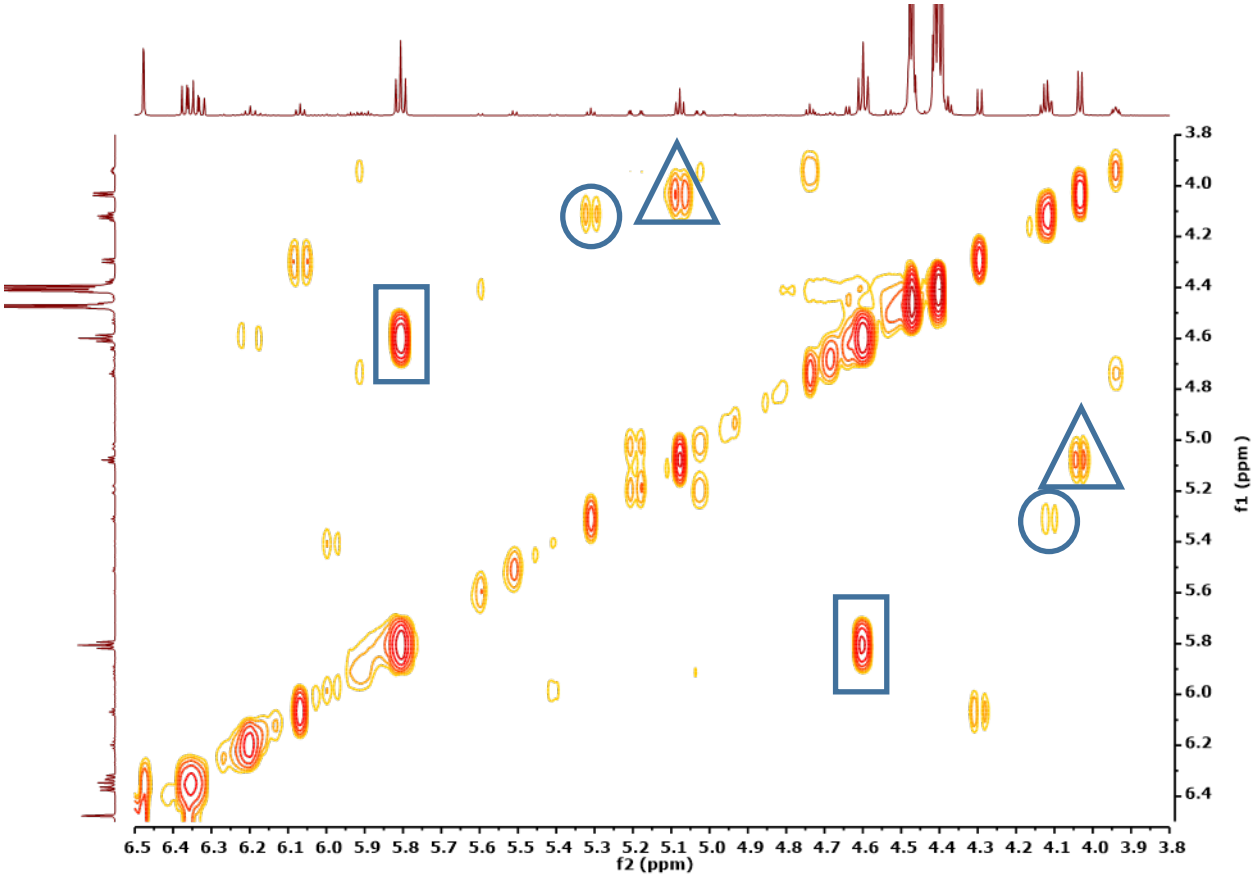


Figure S2. TOCSY of a vaped "Unicorn Blood" e-liquid sample containing the 5.8, 5.3, and 5.1 ppm MAPs (multiple addition products) showing connectivity between the MAP peaks at 5.8 (t) and 4.6 ppm (d); 5.3 ppm (t) and 4.1 ppm (d); and 5.1 ppm (t) and 4.0 ppm (d). The 5.8 (t), 5.3 (t), and 5.1 (t) ppm peaks disappeared when D_2O was added to the sample. The 4.6 (d), 4.1 (d), and 4.0 (d) ppm peaks became singlets when the hemiacetal $–CH_2–O\mathbf{H}$ is exchanged by D_2O to form $–CH_2–O\mathbf{D}$. These resonances show TOCSY/COSY connectivities to the downfield triplets and are designated by boxes, circles, and triangles, respectively.

Additional information regarding the aerosolization of e-liquids with nicotine:

Table S1. The average % aerosol collected from the experiments with and without added nicotine

		Average % aerosol collected ± standard deviation			
		PG+GL	PG+GL+6 mg/mL nicotine	PG+GL	Overall
Nicotine (6 mg/mL)	*Trial 1*	62 ± 12	69 ± 4	60 ± 6	63 ± 5
	Trial 2	41 ± 6	52 ± 9	53 ± 16	49 ± 7
	Trial 3	58 ± 1	58 ± 0	49 ± 3	55 ± 5

Table S2. The degradation levels of acetaldehyde, acrolein, and total formaldehyde[α] normalized relative to PG+GL from aerosolization of equimolar PG+GL, followed by sequential addition of 6 mg/mL nicotine

		Amount of degradation (normalized relative to PG+GL) ± standard deviation		
		Acetaldehyde	Acrolein	Total formaldehyde[α]
Trial 1	*PG+GL*	1.0 ± 0.1	1.0 ± 0.1	1.0 ± 0.1
	+6 mg/mL Nicotine	1.0 ± 0.1	1.1 ± 0.1	0.9 ± 0.1
Trial 2	*PG+GL*	1.0 ± 0.2	1.0 ± 0.1	1.0 ± 0.1
	+6 mg/mL Nicotine	1.0 ± 0.1	0.8 ± 0.1	0.9 ± 0.1
Trial 3	*PG+GL*	1.0 ± 0.1	1.0 ± 0.2	1.0 ± 0.1
	+6 mg/mL Nicotine	1.2 ± 0.1	1.0 ± 0.1	1.1 ± 0.1

[α] Formaldehyde+formaldehyde hemiacetal+total MAP; total MAPs = the 5.8+5.3+5.1 ppm multiple addition products.

Additional data for the levels of degradation from each experiment:

Table S3. The levels of degradation for each degradation product normalized relative to PG+GL from aerosolization of equimolar PG+GL, followed by sequential addition of flavorant, then 6 mg/mL nicotine.

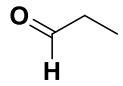
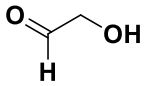
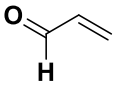
	Degradation product (as a % of remaining PG by ^{1}H NMR) ± standard deviation							
	Propanal 	Acetaldehyde 	Glycolaldehyde 	Acrolein 	Formaldehyde 	Formaldehyde Hemiacetals (6.2 ppm)	Total MAPs[α] (5.8, 5.3, 5.1 ppm)	Total Formaldehyde[β]
Benzaldehyde trial 1								
PG+GL	0.14 ± 0.01	1.00 ± 0.14	0.57 ± 0.03	0.39 ± 0.04	0.39 ± 0.14	0.72 ± 0.02	1.70 ± 0.08	2.81 ± 0.20
+2.5 mg/mL benzaldehyde	0.26 ± 0.03	1.64 ± 0.20	0.70 ± 0.11	0.55 ± 0.09	1.40 ± 0.44	0.78 ± 0.09	2.21 ± 0.22	4.40 ± 0.63
+6 mg/mL nicotine	0.18 ± 0.01	1.30 ± 0.06	0.37 ± 0.02	0.49 ± 0.02	0.60 ± 0.37	1.00 ± 0.24	1.64 ± 0.09	3.25 ± 0.17
PG+GL	0.22 ± 0.01	1.63 ± 0.02	0.62 ± 0.01	0.58 ± 0.03	0.99 ± 0.24	0.95 ± 0.10	2.71 ± 0.07	4.65 ± 0.07
Benzaldehyde trial 2								
PG+GL	0.05 ± 0.01	0.32 ± 0.01	0.23 ± 0.02	0.14 ± 0.01	0.24 ± 0.05	0.33 ± 0.02	0.64 ± 0.03	1.21 ± 0.04
+2.5 mg/mL benzaldehyde	0.07 ± 0.01	0.53 ± 0.07	0.33 ± 0.04	0.21 ± 0.04	0.64 ± 0.17	0.41 ± 0.03	0.89 ± 0.09	1.94 ± 0.28
+6 mg/mL nicotine	0.06 ± 0.01	0.37 ± 0.03	0.14 ± 0.02	0.16 ± 0.02	0.42 ± 0.14	0.29 ± 0.03	0.49 ± 0.01	1.20 ± 0.13
PG+GL	0.05 ± 0.02	0.34 ± 0.07	0.21 ± 0.01	0.09 ± 0.03	0.17 ± 0.03	0.43 ± 0.05	0.61 ± 0.05	1.21 ± 0.13
Benzaldehyde trial 3								
PG+GL	0.03 ± 0.01	0.22 ± 0.07	0.23 ± 0.02	0.11 ± 0.04	0.29 ± 0.09	0.23 ± 0.06	0.62 ± 0.07	1.14 ± 0.20
+2.5 mg/mL benzaldehyde	0.04 ± 0.01	0.37 ± 0.03	0.26 ± 0.02	0.18 ± 0.01	0.54 ± 0.06	0.32 ± 0.06	0.73 ± 0.06	1.59 ± 0.06
+6 mg/mL nicotine[γ]	0.03 ± 0.01	0.23 ± 0.01	0.15 ± 0.01	0.14 ± 0.02	0.34 ± 0.09	0.24 ± 0.04	0.53 ± 0.03	1.11 ± 0.02
Vanillin trial 1								
PG+GL	0.04 ± 0.01	0.37 ± 0.02	0.28 ± 0.01	0.15 ± 0.02	0.53 ± 0.05	0.24 ± 0.01	0.45 ± 0.02	1.22 ± 0.03
+31 mg/mL vanillin	0.18 ± 0.05	0.79 ± 0.08	0.34 ± 0.06	0.54 ± 0.04	0.45 ± 0.38	0.73 ± 0.21	0.94 ± 0.26	2.12 ± 0.45
+6 mg/mL nicotine	0.11 ± 0.03	0.33 ± 0.06	0.15 ± 0.03	0.21 ± 0.03	0.06 ± 0.04	0.54 ± 0.05	0.47 ± 0.07	1.07 ± 0.08
PG+GL	0.10 ± 0.01	0.78 ± 0.01	0.55 ± 0.02	0.37 ± 0.04	0.82 ± 0.23	0.59 ± 0.11	1.75 ± 0.03	3.16 ± 0.14

Table S3. Continued.

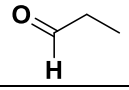
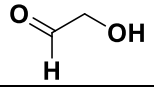
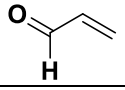
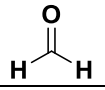
	Degradation product (as a % of remaining PG by ^{1}H NMR) ± standard deviation							
	Propanal 	Acetaldehyde 	Glycolaldehyde 	Acrolein 	Formaldehyde 	Formaldehyde Hemiacetals (6.2 ppm)	Total MAP$^{\alpha}$ (5.8, 5.3, 5.1 ppm)	Total Formaldehyde$^{\beta}$
Vanillin trial 2								
PG+GL	0.04 ± 0.01	0.06 ± 0.02	0.07 ± 0.02	0.03 ± 0.01	0.04 ± 0.01	0.06 ± 0.01	0.18 ± 0.01	0.28 ± 0.02
+31 mg/mL vanillin	0.06 ± 0.01	0.18 ± 0.03	0.09 ± 0.01	0.12 ± 0.03	0.05 ± 0.02	0.13 ± 0.01	0.28 ± 0.01	0.45 ± 0.01
+6 mg/mL nicotine	0.02 ± 0.01	0.06 ± 0.02	0.02 ± 0.01	0.03 ± 0.01	0.01 ± 0.01	0.05 ± 0.02	0.18 ± 0.01	0.23 ± 0.02
PG+GL	0.02 ± 0.01	0.25 ± 0.06	0.20 ± 0.03	0.13 ± 0.02	0.10 ± 0.06	0.26 ± 0.03	0.16 ± 0.04	0.53 ± 0.11
Vanillin trial 3								
PG+GL	0.28 ± 0.06	1.63 ± 0.35	0.49 ± 0.05	0.90 ± 0.29	1.01 ± 0.78	0.80 ± 0.07	1.16 ± 0.15	2.97 ± 0.61
+31 mg/mL vanillin	0.73 ± 0.23	3.20 ± 0.82	0.72 ± 0.04	1.88 ± 0.55	1.38 ± 0.35	1.53 ± 0.51	1.88 ± 0.33	4.79 ± 0.37
+6 mg/mL nicotine$^{\gamma}$	0.69 ± 0.07	1.73 ± 0.30	0.37 ± 0.10	1.24 ± 0.19	0.31 ± 0.29	1.31 ± 0.02	0.87 ± 0.25	2.49 ± 0.55
Benzyl alcohol trial 1								
PG+GL	0.01 ± 0.01	0.11 ± 0.01	0.10 ± 0.01	0.05 ± 0.01	0.12 ± 0.03	0.12 ± 0.01	0.35 ± 0.01	0.58 ± 0.01
+39 mg/mL benzyl alcohol	0.08 ± 0.01	0.77 ± 0.07	0.39 ± 0.04	0.32 ± 0.02	0.19 ± 0.04	0.73 ± 0.10	1.14 ± 0.13	2.05 ± 0.18
+6 mg/mL nicotine	0.06 ± 0.01	0.56 ± 0.05	0.19 ± 0.01	0.24 ± 0.01	0.09 ± 0.07	0.64 ± 0.02	0.85 ± 0.03	1.59 ± 0.08
PG+GL	0.02 ± 0.01	0.19 ± 0.04	0.17 ± 0.06	0.09 ± 0.01	0.28 ± 0.07	0.15 ± 0.07	0.52 ± 0.13	0.94 ± 0.22
Benzyl alcohol trial 2								
PG+GL	0.01 ± 0.01	0.05 ± 0.04	0.03 ± 0.01	0.03 ± 0.02	0.01 ± 0.01	0.06 ± 0.04	0.17 ± 0.05	0.24 ± 0.07
+39 mg/mL benzyl alcohol	0.10 ± 0.01	0.47 ± 0.03	0.22 ± 0.03	0.24 ± 0.02	0.48 ± 0.13	0.23 ± 0.03	0.80 ± 0.04	1.51 ± 0.15
+6 mg/mL nicotine	0.08 ± 0.01	0.38 ± 0.02	0.09 ± 0.01	0.20 ± 0.01	0.27 ± 0.10	0.32 ± 0.03	0.68 ± 0.03	1.27 ± 0.10
PG+GL	0.04 ± 0.01	0.25 ± 0.06	0.15 ± 0.02	0.14 ± 0.02	0.16 ± 0.09	0.22 ± 0.03	0.47 ± 0.03	0.84 ± 0.12
Benzyl alcohol trial 3								
PG+GL	0.01 ± 0.01	0.08 ± 0.03	0.04 ± 0.01	0.04 ± 0.01	0.01 ± 0.01	0.09 ± 0.03	0.21 ± 0.02	0.30 ± 0.04
+39 mg/mL benzyl alcohol	0.68 ± 0.03	3.03 ± 0.22	0.71 ± 0.06	1.40 ± 0.08	2.30 ± 0.63	1.21 ± 0.21	3.24 ± 0.62	6.75 ± 0.32
+6 mg/mL nicotine$^{\gamma}$	0.60 ± 0.08	2.19 ± 0.33	0.53 ± 0.06	1.05 ± 0.18	1.32 ± 0.52	1.16 ± 0.05	3.04 ± 0.46	5.52 ± 0.85

Table S3. Continued.

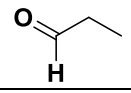
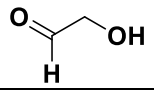
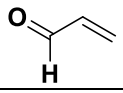
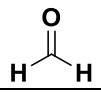
	Degradation product (as a % of remaining PG by ^{1}H NMR) ± standard deviation							
	Propanal 	Acetaldehyde 	Glycolaldehyde 	Acrolein 	Formaldehyde 	Formaldehyde Hemiacetals (6.2 ppm)	Total MAP[α] (5.8, 5.3, 5.1 ppm)	Total Formaldehyde[β]
***Trans*-cinnamaldehyde trial 1**								
PG+GL	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	NA[ε]	0.08 ± 0.03	NA[ε]
+39 mg/mL *trans*-cinnamaldehyde	0.07 ± 0.01	0.25 ± 0.01	0.16 ± 0.01	0.16 ± 0.01	0.33 ± 0.03	NA[ε]	0.47 ± 0.01	NA[ε]
+6 mg/mL nicotine	0.31 ± 0.01	0.77 ± 0.02	0.29 ± 0.05	0.54 ± 0.02	0.73 ± 0.08	NA[ε]	1.16 ± 0.08	NA[ε]
PG+GL	0.12 ± 0.01	0.55 ± 0.05	0.33 ± 0.01	0.40 ± 0.01	0.73 ± 0.04	NA[ε]	1.08 ± 0.04	NA[ε]
***Trans*-cinnamaldehyde trial 2**								
PG+GL	0.01 ± 0.01	0.01 ± 0.01	0.03 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	NA[ε]	0.14 ± 0.02	NA[ε]
+39 mg/mL *trans*-cinnamaldehyde	0.32 ± 0.01	1.43 ± 0.19	0.36 ± 0.06	0.97 ± 0.07	1.25 ± 0.13	NA[ε]	2.03 ± 0.15	NA[ε]
+6 mg/mL nicotine	0.62 ± 0.04	2.55 ± 0.12	0.62 ± 0.03	1.63 ± 0.14	2.33 ± 0.18	NA[ε]	2.19 ± 0.16	NA[ε]
PG+GL	0.18 ± 0.01	1.03 ± 0.14	0.50 ± 0.02	0.62 ± 0.05	1.34 ± 0.20	NA[ε]	1.69 ± 0.02	NA[ε]
***Trans*-cinnamaldehyde trial 3**								
PG+GL	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	NA[ε]	0.09 ± 0.01	NA[ε]
+39 mg/mL *trans*-cinnamaldehyde	0.22 ± 0.01	1.16 ± 0.03	0.20 ± 0.03	0.89 ± 0.06	0.74 ± 0.08	NA[ε]	1.83 ± 0.02	NA[ε]
+6 mg/mL nicotine	0.66 ± 0.01	2.18 ± 0.09	0.35 ± 0.02	1.63 ± 0.06	1.57 ± 0.15	NA[ε]	1.83 ± 0.05	NA[ε]
PG+GL	0.38 ± 0.04	1.57 ± 0.31	0.42 ± 0.08	1.25 ± 0.11	1.51 ± 0.27	NA[ε]	2.03 ± 0.16	NA[ε]
***Trans*-cinnamaldehyde trial 1**								
PG+GL	0.02 ± 0.01	0.07 ± 0.01	0.06 ± 0.02	0.04 ± 0.01	0.04 ± 0.03	NA[ε]	0.22 ± 0.06	NA[ε]
+155 mg/mL *trans*-cinnamaldehyde	1.35 ± 0.11	3.54 ± 0.90	0.89 ± 0.15	2.82 ± 0.58	2.93 ± 0.58	NA[ε]	3.46 ± 0.68	NA[ε]
+6 mg/mL nicotine	4.40 ± 0.31	12.02 ± 1.86	1.10 ± 0.20	9.05 ± 1.39	6.45 ± 1.56	NA[ε]	7.97 ± 1.47	NA[ε]
PG+GL	0.54 ± 0.18	1.95 ± 0.46	0.51 ± 0.14	1.33 ± 0.22	1.18 ± 0.54	NA[ε]	2.45 ± 0.25	NA[ε]
***Trans*-cinnamaldehyde trial 2**								
PG+GL	0.38 ± 0.02	1.71 ± 0.11	0.52 ± 0.04	0.63 ± 0.07	1.52 ± 0.17	NA[ε]	1.92 ± 0.01	NA[ε]
+155 mg/mL *trans*-cinnamaldehyde	1.74 ± 0.12	7.32 ± 0.26	1.42 ± 0.04	5.54 ± 0.75	6.44 ± 0.11	NA[ε]	7.25 ± 0.55	NA[ε]
+6 mg/mL nicotine	7.93 ± 0.24	25.53 ± 1.24	2.19 ± 0.07	19.76 ± 1.02	15.45 ± 0.67	NA[ε]	18.54 ± 0.31	NA[ε]
PG+GL	0.30 ± 0.01	1.89 ± 0.17	0.74 ± 0.10	0.95 ± 0.09	1.75 ± 0.22	NA[ε]	2.55 ± 0.10	NA[ε]

Table S3. Continued.

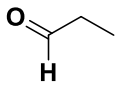
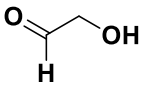
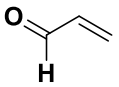
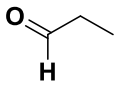
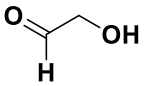
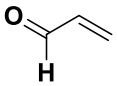
	Degradation product (as a % of remaining PG by ^{1}H NMR) ± standard deviation							
	Propanal 	**Acetaldehyde** 	**Glycolaldehyde** 	**Acrolein** 	**Formaldehyde** 	**Formaldehyde Hemiacetals (6.2 ppm)**	**Total MAP[α] (5.8, 5.3, 5.1 ppm)**	**Total Formaldehyde[β]**
***Trans*-cinnamaldehyde trial 3**								
PG+GL	0.37 ± 0.02	2.38 ± 0.23	0.84 ± 0.058	1.162 ± 0.21	1.32 ± 0.41	NA[ε]	4.06 ± 1.12	NA[ε]
+155 mg/mL *trans*-cinnamaldehyde	2.52 ± 0.34	12.99 ± 1.20	1.95 ± 0.03	9.99 ± 1.19	10.17 ± 0.92	NA[ε]	11.68 ± 1.25	NA[ε]
+6 mg/mL nicotine[γ]	7.75 ± 2.46	22.66 ± 4.56	1.86 ± 0.43	19.71 ± 4.40	16.58 ± 7.28	NA[ε]	9.50 ± 2.07	NA[ε]
Flavorant mixture trial 1								
PG+GL	0.01 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	NA[ε]	0.10 ± 0.01	NA[ε]
+flavorant mixture[δ]	0.11 ± 0.01	0.32 ± 0.01	0.16 ± 0.01	0.23 ± 0.01	0.31 ± 0.01	NA[ε]	0.64 ± 0.03	NA[ε]
+6 mg/mL nicotine	0.07 ± 0.01	0.25 ± 0.02	0.11 ± 0.01	0.15 ± 0.02	0.21 ± 0.01	NA[ε]	0.49 ± 0.02	NA[ε]
PG+GL	0.02 ± 0.01	0.15 ± 0.04	0.20 ± 0.03	0.08 ± 0.02	0.27 ± 0.05	NA[ε]	0.50 ± 0.07	NA[ε]
Flavorant mixture trial 2								
PG+GL	0.01 ± 0.01	0.02 ± 0.01	0.04 ± 0.02	0.01 ± 0.01	0.02 ± 0.01	NA[ε]	0.14 ± 0.01	NA[ε]
+flavorant mixture[δ]	0.10 ± 0.01	0.41 ± 0.04	0.20 ± 0.01	0.31 ± 0.04	0.49 ± 0.05	NA[ε]	0.74 ± 0.03	NA[ε]
+6 mg/mL nicotine	0.10 ± 0.01	0.29 ± 0.04	0.11 ± 0.01	0.20 ± 0.04	0.21 ± 0.04	NA[ε]	0.60 ± 0.08	NA[ε]
PG+GL	0.06 ± 0.01	0.40 ± 0.05	0.27 ± 0.01	0.20 ± 0.01	0.54 ± 0.04	NA[ε]	0.67 ± 0.06	NA[ε]
Flavorant mixture trial 3								
PG+GL	0.01 ± 0.01	0.05 ± 0.04	0.08 ± 0.01	0.02 ± 0.01	0.01 ± 0.01	NA[ε]	0.25 ± 0.05	NA[ε]
+flavorant mixture[δ]	0.14 ± 0.02	0.47 ± 0.03	0.24 ± 0.04	0.38 ± 0.05	0.54 ± 0.01	NA[ε]	0.85 ± 0.07	NA[ε]
+6 mg/mL nicotine	0.08 ± 0.01	0.19 ± 0.03	0.11 ± 0.01	0.13 ± 0.02	0.18 ± 0.03	NA[ε]	0.47 ± 0.04	NA[ε]
PG+GL	0.03 ± 0.01	0.21 ± 0.04	0.15 ± 0.03	0.10 ± 0.01	0.26 ± 0.04	NA[ε]	0.40 ± 0.07	NA[ε]
Nicotine trial 1								
PG+GL	0.14 ± 0.01	0.90 ± 0.06	0.48 ± 0.01	0.35 ± 0.04	1.10 ± 0.08	0.32 ± 0.05	0.50 ± 0.02	1.05 ± 0.10
+6 mg/mL nicotine	0.16 ± 0.01	0.88 ± 0.10	0.28 ± 0.02	0.37 ± 0.03	0.71 ± 0.01	0.54 ± 0.09	0.37 ± 0.02	0.95 ± 0.06
PG+GL	0.14 ± 0.01	0.84 ± 0.10	0.50 ± 0.06	0.36 ± 0.05	1.11 ± 0.17	0.29 ± 0.03	0.57 ± 0.10	1.07 ± 0.12

Table S3. Continued.

	Degradation product (as a % of remaining PG by ^{1}H NMR) ± standard deviation							
	Propanal 	**Acetaldehyde** 	**Glycolaldehyde** 	**Acrolein** 	**Formaldehyde** 	**Formaldehyde Hemiacetals (6.2 ppm)**	**Total MAP[α] (5.8, 5.3, 5.1 ppm)**	**Total Formaldehyde[β]**
Nicotine trial 2								
PG+GL	0.04 ± 0.01	0.27 ± 0.05	0.17 ± 0.01	0.11 ± 0.01	0.31 ± 0.08	0.23 ± 0.02	1.53 ± 0.06	2.95 ± 0.03
+6 mg/mL nicotine	0.04 ± 0.01	0.27 ± 0.03	0.09 ± 0.02	0.09 ± 0.01	0.34 ± 0.09	0.24 ± 0.04	1.30 ± 0.09	2.55 ± 0.19
PG+GL	0.03 ± 0.01	0.21 ± 0.03	0.18 ± 0.04	0.09 ± 0.02	0.35 ± 0.07	0.15 ± 0.07	1.49 ± 0.06	2.88 ± 0.18
Nicotine trial 3								
PG+GL	0.12 ± 0.01	0.96 ± 0.13	0.50 ± 0.05	0.36 ± 0.07	1.10 ± 0.17	0.49 ± 0.17	1.44 ± 0.12	3.02 ± 0.08
+6 mg/mL nicotine	0.14 ± 0.01	1.11 ± 0.06	0.41 ± 0.05	0.36 ± 0.02	0.91 ± 0.28	0.82 ± 0.09	1.50 ± 0.11	3.22 ± 0.28
PG+GL	0.08 ± 0.01	0.77 ± 0.13	0.59 ± 0.04	0.32 ± 0.12	1.05 ± 0.31	0.37 ± 0.10	1.40 ± 0.06	2.82 ± 0.28

[α] Total MAPs = the 5.8+5.3+5.1 ppm multiple addition products.

[β] Total formaldehyde = formaldehyde+formaldehyde hemiacetal+total MAPs.

[γ] PG+GL was not aerosolized again after the *+6 mg/mL nicotine* addition.

[δ] Flavorant mixture = 0.025 mg/mL benzaldehyde; 7.75 mg/mL vanillin; 9.75 mg/mL benzyl alcohol; 39 mg/mL *trans*-cinnamaldehyde.

[ε] Not able to be analyzed due to peak overlap.

^{1}H NMR of aged e-liquids with *trans*-cinnamaldehyde:

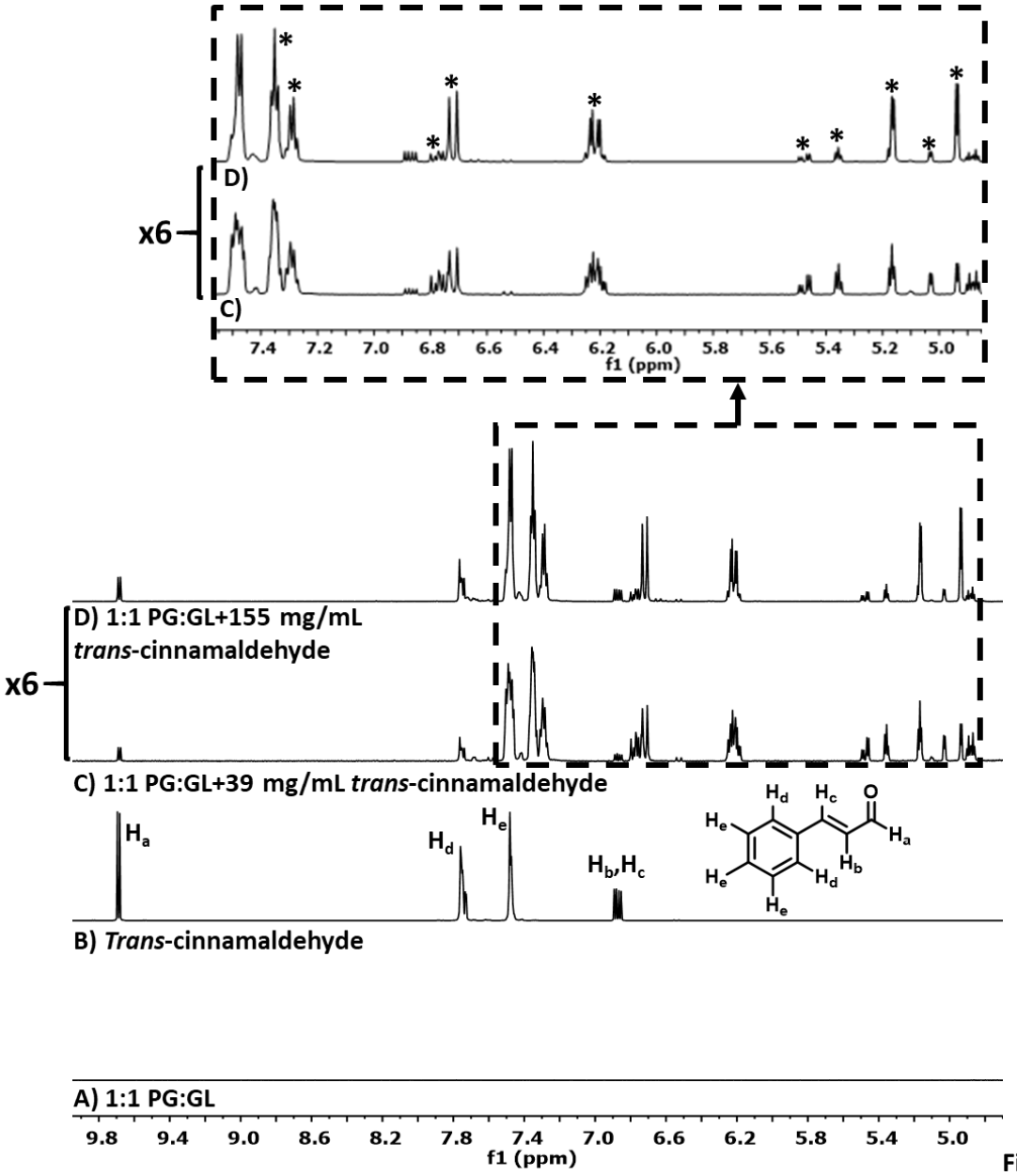


Figure S3. ^{1}H NMR spectra for the unvaped (A) equimolar PG:GL, (B) *trans*-cinnamaldehyde standard, (C) PG:GL+39 mg/mL *trans*-cinnamaldehyde (~2 weeks old), and (D) PG:GL+155 mg/mL *trans*-cinnamaldehyde (~2 months old) in DMSO-d_6. The (D) PG:GL+155 mg/mL *trans*-cinnamaldehyde was formulated first, followed by the (C) PG:GL+39 mg/mL *trans*-cinnamaldehyde ~6 weeks later, and then ~2 weeks later we analyzed both (D) and (C) with ^{1}H NMR spectroscopy. E-liquids in spectra (C) and (D) reached equilibrium sometime within their incubation time. Spectra A, C, and D were normalized to the PG methyl peak at ~1.05 ppm, and spectrum C was expanded by x6. The peaks with an "*" above them are not from PG, GL, or *trans*-cinnamaldehyde, and are from PG- and GL-*trans*-cinnamaldehyde acetals. The region between 5.0 and 7.4 ppm for spectra C and D show many of the peaks associated with the PG- and GL-*trans*-cinnamaldehyde acetals.

^{1}H of spiked aerosol samples:

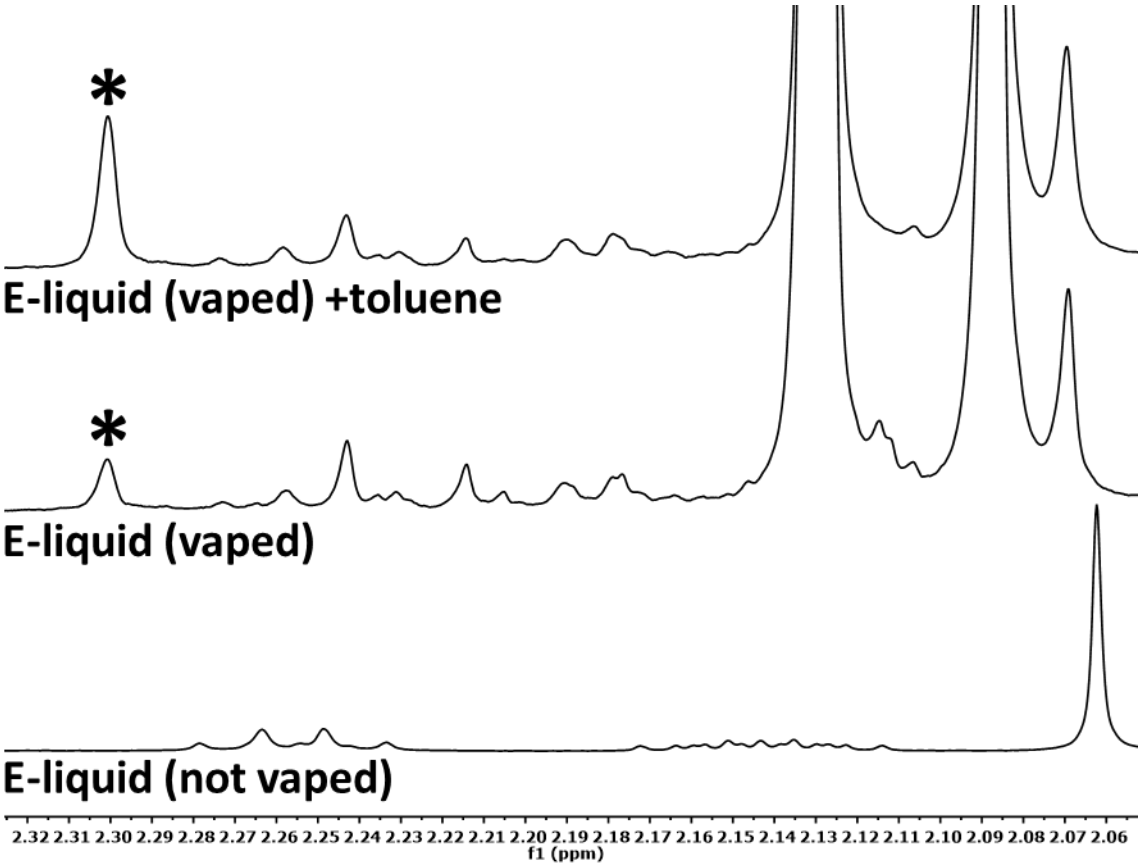


Figure S4. A vaped e-liquid (PG+GL+155 mg/mL *trans*-cinnamaldehyde+6 mg/mL nicotine) sample was spiked with toluene which resulted in an increase for the unknown peak at ~2.30 ppm (shown with an "*" above the peak) in the ^{1}H NMR spectra. This suggests that toluene was formed during aerosolization and is a degradation product of the PG+GL+155 mg/mL *trans*-cinnamaldehyde+6 mg/mL nicotine e-liquid.

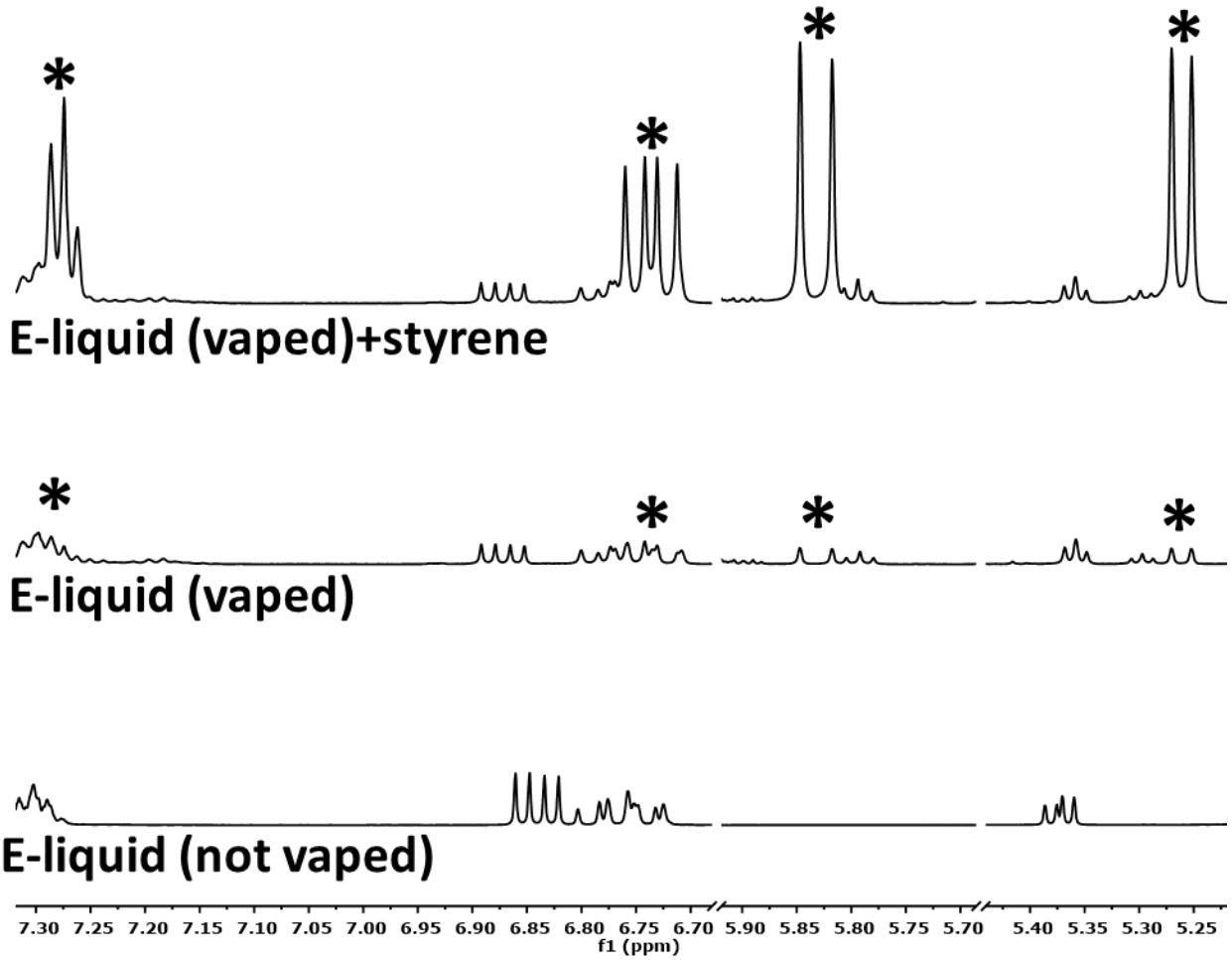


Figure S5. The peaks at 5.25, 5.83, 6.70-6.75 and 7.30 ppm (shown with an "*" above the peaks) in the ^{1}H NMR spectra increased when styrene was added to a vaped e-liquid sample containing PG+GL+155 mg/mL *trans*-cinnamaldehyde+6 mg/mL nicotine. This suggests that styrene was formed during aerosolization and is a degradation product of the PG+GL+155 mg/mL *trans*-cinnamaldehyde+6 mg/mL nicotine e-liquid.

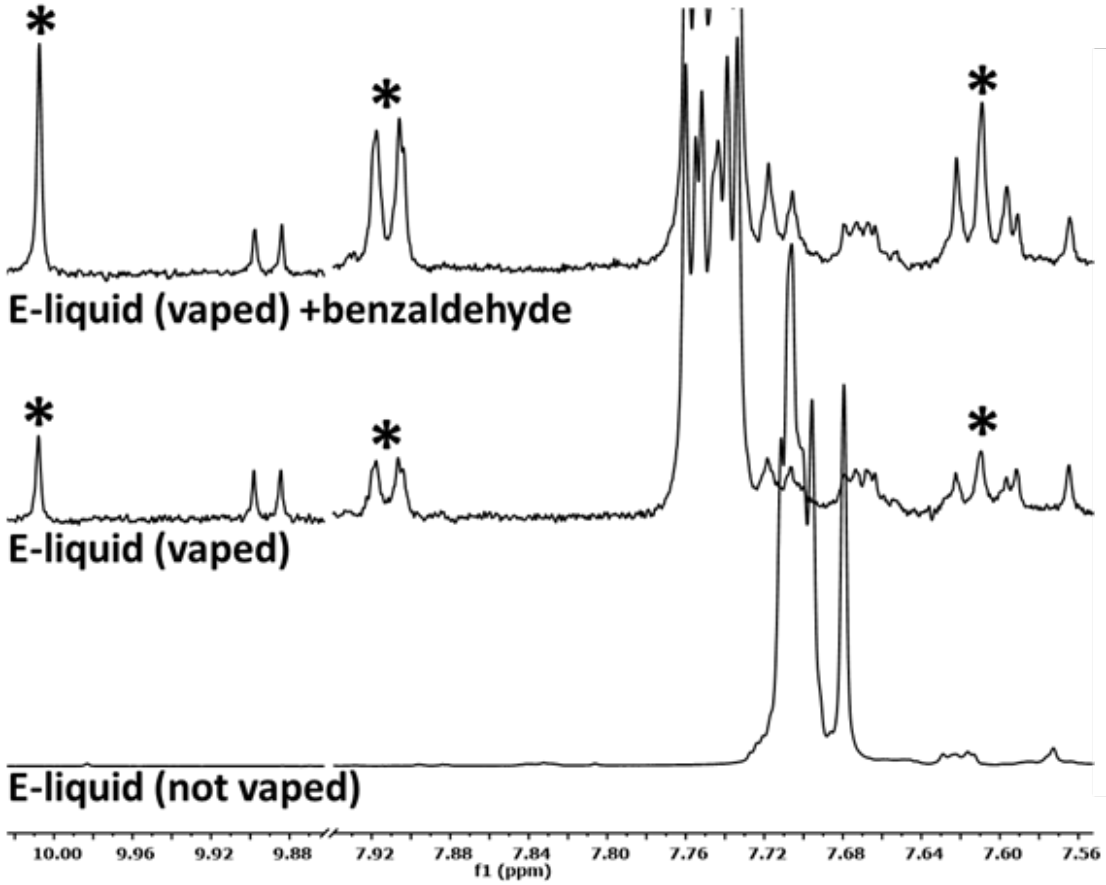


Figure S6. Benzaldehyde was added to a vaped e-liquid composed of PG+GL+155 mg/mL *trans*-cinnamaldehyde+6 mg/mL nicotine which resulted in an increase of the peaks at 7.61, 7.91, and 10.01 ppm (shown with an "*" above the peaks) in the ^{1}H NMR spectra. This suggests that benzaldehyde was formed during aerosolization and is a degradation product of the PG+GL+155 mg/mL *trans*-cinnamaldehyde+6 mg/mL nicotine e-liquid.

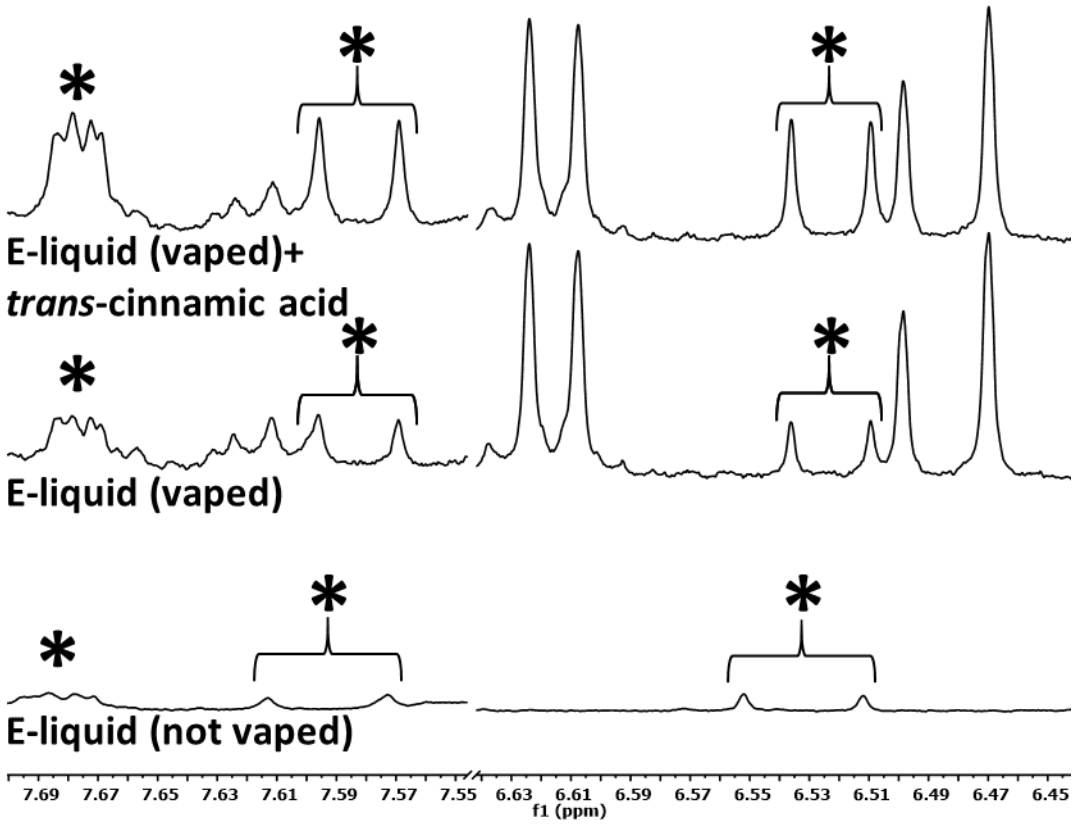


Figure S7. There was an increase in the unknown peaks at 6.52, 7.58, and 7.68 ppm (shown with an "*" above the peaks) in the ^{1}H NMR spectra when *trans*-cinnamic acid was added to a vaped e-liquid containing PG+GL+155 mg/mL *trans*-cinnamaldehyde. The J-coupling for the doublets at 6.52 and 7.58 ppm were confirmed to be similar values. This suggests that *trans*-cinnamic acid was formed during aerosolization and is a degradation product of the PG+GL+155 mg/mL *trans*-cinnamaldehyde e-liquid.

REFERENCES

(1) Jensen, R. P.; Luo, W.; Pankow, J. F.; Strongin, R. M.; Peyton, D. H. Hidden formaldehyde in e-cigarette aerosols. *N Engl J Med* **2015**, *372* (4), 392-394. DOI: 10.1056/NEJMc1413069.

(2) Jensen, R. P.; Strongin, R. M.; Peyton, D. H. Solvent Chemistry in the Electronic Cigarette Reaction Vessel. *Sci Rep* **2017**, *7*, 42549. DOI: 10.1038/srep42549.