

Supplementary Information

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Arsenic and arsenic species in MOD, POD, and disposable POD electronic cigarette aerosols: a pilot study

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Description of contents:

Complete data for all As species and total As in all analyzed products; flow rate data of electronic cigarette aerosol collection system; aerosol density data; calibrator and sample chromatograms.

Supplementary Table 1. Arsenic species (DMA, MA, As(III), As(V)), total inorganic As (iAs), and total As concentrations in aerosol blanks and aerosol condensates from all e-cigarette products analyzed and limits of detection (LOD) (ng/g) prepared by pipetting liquid PG/VG into the pump tubing and pumping through the condensation system. Blank levels not subtracted in data shown. Ratios of non-oxidized to oxidized sums of species for each sample are also shown. POD and MOD aerosol samples were collected between May 2019 and February 2020. Samples from Zpod tobacco were collected in March 2020, while all Stig samples were collected in September 2020. All samples were analyzed for As species in October 2020

Sample type	Sample Name	DMA	MA	As(III)	As(V)	Total iAs	Total As	Non-ox./Ox. [%]
Blank	PG/VG aerosol blank, main study (1)	<u>0.41</u>	<u>0.47</u>	<u>0.27</u>	<u>0.79</u>	<u>0.79</u>	1.1	NR
Blank	PG/VG aerosol blank, main study (2)	<u>0.41</u>	<u>0.47</u>	<u>0.27</u>	<u>0.79</u>	<u>0.79</u>	0.93	NR
Blank	PG/VG aerosol blank, follow-up study (1)	NR	NR	NR	NR	NR	2.3	NR
Blank	PG/VG aerosol blank, follow-up study (2)	NR	NR	NR	NR	NR	2.1	NR
Blank	PG/VG aerosol blank, follow-up study (3)	NR	NR	NR	NR	NR	3.7	NR
Blank	PG/VG aerosol blank, follow-up study (4)	NR	NR	NR	NR	NR	3.4	NR
Blank	PG/VG aerosol blank, follow-up study (5)	NR	NR	NR	NR	NR	3.4	NR
Blank	PG/VG aerosol blank, follow-up study (6)	NR	NR	NR	NR	NR	3.1	NR
POD	Juul, Mint	NR	NR	NR	NR	4.6	16	150
POD	Uwell, Tropical fruit	NR	NR	NR	NR	4.1	15	160
POD	Juul, Fruity	NR	NR	NR	NR	4.3	16	65
POD	Juul, Virginia tobacco	NR	NR	NR	NR	3.8	14	100
MOD/ dripper	Unknown; Strawberry shortcake	NR	NR	NR	NR	3.0	11	180
MOD / dripper	Voopoo, Blueberry lemon swirl on ice	NR	NR	NR	NR	11	46	120
MOD / dripper	Sigelei, Peach	NR	NR	NR	NR	7.1	31	120
MOD / tank	Smok, Bankroll 15 (fruity)	NR	NR	NR	NR	3.5	14	160
MOD / tank	Billet Box, “Mallow man” (Marshmallow)	NR	NR	NR	NR	3.0	11	100
MOD / tank	Evod, Fruit burst	NR	NR	NR	NR	8.4	31	83
MOD / tank	Smok, “The Finest” (fruity)	NR	NR	NR	NR	2.6	10	150
MOD / tank	Unknown, Blueberry milk	NR	NR	NR	NR	6.2	25	110
d-POD	Zpod, Tobacco (1)	NR	NR	NR	NR	3.5	13	82
d-POD	Zpod, Tobacco (2)	NR	NR	NR	NR	3.2	13	85
d-POD	Zpod, Tobacco (3)	NR	NR	NR	NR	3.5	14	97
d-POD	Zpod, Tobacco (4)	NR	NR	NR	NR	3.7	13	83
d-POD	Stig, Cigar (1)	<u>0.41</u>	<u>0.47</u>	2.8	1.2	4.0	14	96

d-POD	Stig, Cigar (2)	<u>0.41</u>	<u>0.47</u>	5.7	3.7	9.3	34	88
d-POD	Stig, Mint (1)	<u>0.41</u>	0.71	7.2	<u>0.79</u>	7.2	34	83
d-POD	Stig, Mint (2)	<u>0.41</u>	0.95	11	2.0	13	58	90
d-POD	Stig, Mint (3)	<u>0.41</u>	1.0	11	2.8	13	68	96
d-POD	Stig, Mint (4)	<u>0.41</u>	0.89	11	1.4	12	56	89
d-POD	Stig, Mint (5)	<u>0.41</u>	1.0	10	2.1	12	60	93
<i>LOD</i>		<i>0.59</i>	<i>0.66</i>	<i>0.38</i>	<i>1.1</i>	<i>1.1</i>	<i>0.02</i>	

Underline: Value below LOD and imputed as $LOD/\sqrt{2}$.

Supplementary Table 2. Flow rates through the condensation system used in this study with and without a connected Juul e-cigarette device. Seven replicates were tested per condition using a Bios Defender 520 M Primary Standard Calibrator. The peristaltic pump was set to 1 L/min for all measurements (1-minute continuous pumping). Flow rates in the two conditions do not differ significantly (two-tailed *t*-test assuming equal variance, $t = 1.62$, $P = 0.13$).

Replicate	Flow rates (L/minute)	
	No device	With device connected
1	0.960	0.957
2	0.969	0.962
3	0.969	0.964
4	0.960	0.953
5	0.971	0.955
6	0.955	0.959
7	0.958	0.960
<i>Average</i>	<i>0.963</i>	<i>0.959</i>
<i>Standard Deviation</i>	<i>0.006</i>	<i>0.004</i>

Supplementary Table 3. Arsenic species (As(III), As(V)), total inorganic As (iAs), and total As concentrations in aerosol blanks and aerosol condensates from all e-cigarette products analyzed ($\mu\text{g}/\text{m}^3$). Blank levels not subtracted in data shown. POD and MOD aerosol samples were collected between May 2019 and February 2020. Samples from Zpod tobacco were collected in March 2020, while all Stig samples were collected in September 2020. All samples were analyzed for As species in October 2020.

Sample type	Sample Name	As(III)	As(V)	Total iAs	Total As
Blank	PG/VG aerosol blank, main study (1)	< LOD	< LOD	<LOD	0.091
Blank	PG/VG aerosol blank, main study (2)	< LOD	< LOD	< LOD	0.077
Blank	PG/VG aerosol blank, follow-up study (1)	NR	NR	NR	0.12
Blank	PG/VG aerosol blank, follow-up study (2)	NR	NR	NR	0.14
Blank	PG/VG aerosol blank, follow-up study (3)	NR	NR	NR	0.17
Blank	PG/VG aerosol blank, follow-up study (4)	NR	NR	NR	0.39
Blank	PG/VG aerosol blank, follow-up study (5)	NR	NR	NR	0.31
Blank	PG/VG aerosol blank, follow-up study (6)	NR	NR	NR	0.22
Pod	Juul, Mint	NR	NR	0.32	1.1
Pod	Uwell, Tropical fruit	NR	NR	2.2	8.0
Pod	Juul, Fruity	NR	NR	0.38	1.4
Pod	Juul, Virginia tobacco	NR	NR	0.18	0.65
Mod/ dripper	Unknown; Strawberry shortcake	NR	NR	1.2	4.4
Mod/ dripper	Voofoo, Blueberry lemon swirl on ice	NR	NR	5.1	21
Mod/ dripper	Sigelei, Peach	NR	NR	2.3	9.9
Mod/ tank	Smok, Bankroll 15 (fruity)	NR	NR	1.4	5.5
Mod/ tank	Billet Box, "Mallow man" (Marshmallow)	NR	NR	1.5	5.6
Mod/ tank	Evod, Fruit burst	NR	NR	3.3	12
Mod/ tank	Smok, "The Finest" (fruity)	NR	NR	1.8	7.2
Mod/ tank	Unknown, Blueberry milk	NR	NR	3.8	15
Disposable	Zpod, Tobacco Device 1	NR	NR	0.055	0.21
Disposable	Zpod, Tobacco Device 2	NR	NR	0.12	0.51
Disposable	Zpod, Tobacco Device 3	NR	NR	0.28	1.1
Disposable	Zpod, Tobacco Device 4	NR	NR	0.29	1.1
Disposable	Stig, Cigar Device 1	0.22	0.10	0.31	1.1
Disposable	Stig, Cigar Device 2	0.55	0.35	0.90	3.3
Disposable	Stig, Mint Device 1	0.13	< LOD	0.13	0.65
Disposable	Stig, Mint Device 2	0.94	0.17	1.1	5.1
Disposable	Stig, Mint Device 3	0.78	0.21	0.99	5.0
Disposable	Stig, Mint Device 4	0.26	0.035	0.29	1.4
Disposable	Stig, Mint Device 5	0.31	0.065	0.37	1.8

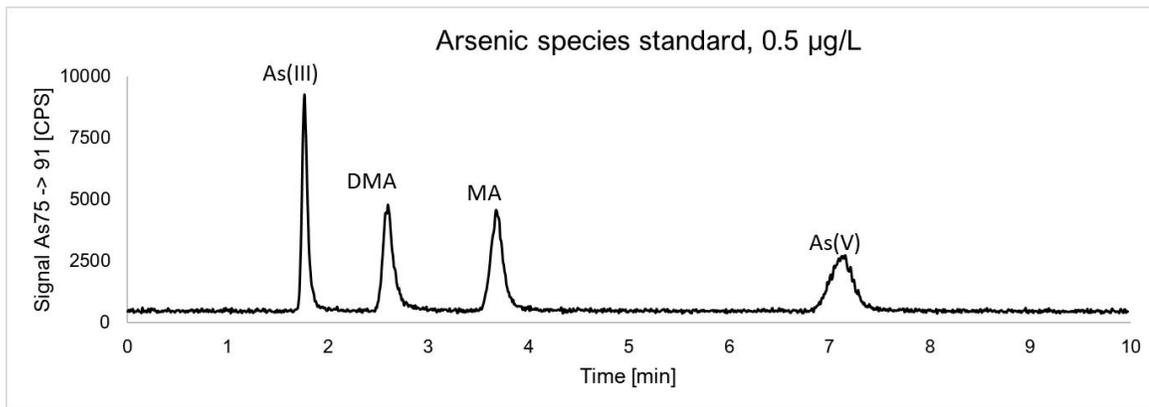
NR: Not reported; see manuscript text for details.

Supplementary Table 4. LODs for As species.

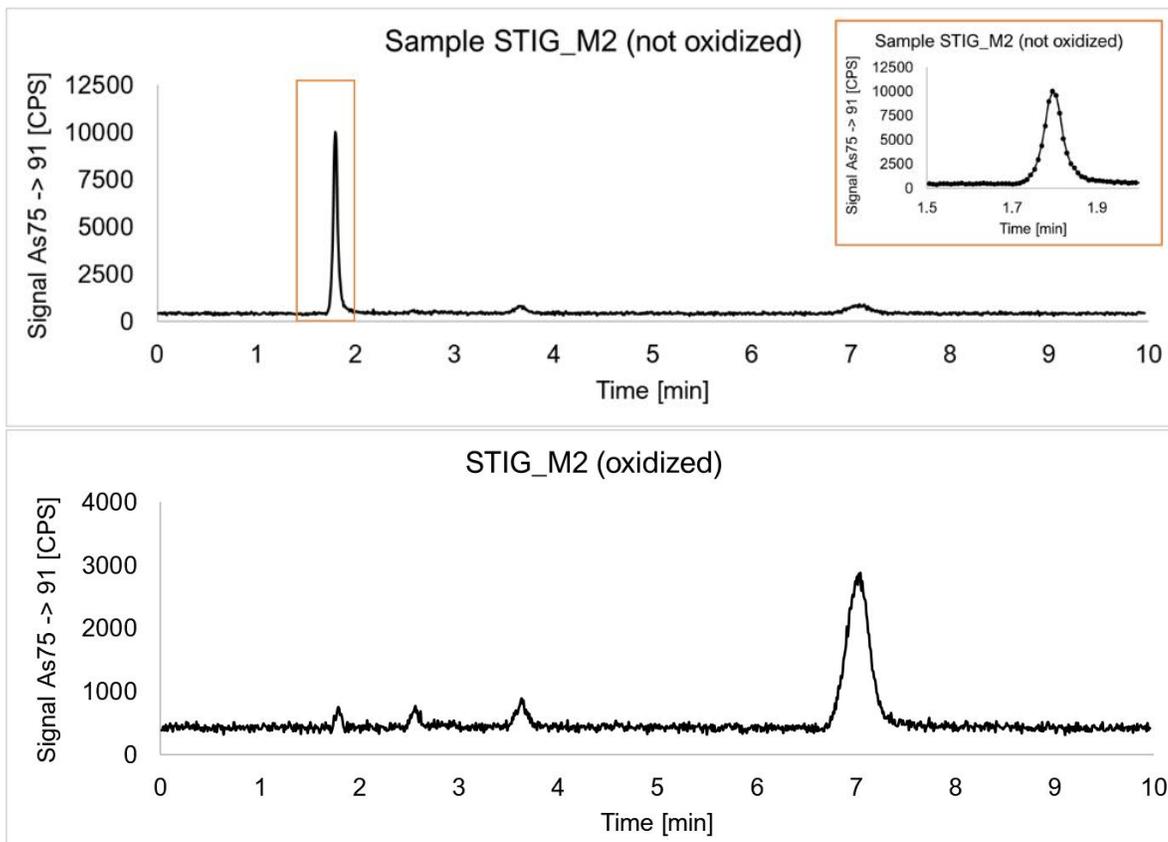
	LOD ($\mu\text{g/L}$)	LOD (ng/g)
As ^{III}	0.015	0.38
DMA	0.023	0.59
MA	0.026	0.66
As ^V	0.044	1.12

Supplementary Table 5. Density measurements of condensed aerosols generated from three replicates each of four commercial products and a PG/VG vaping blank. Densities were obtained by dividing measured masses (using microbalance) by volumes (using pipette).

Device	E-Liquid	Replicate	Density (g/mL)
Juul	Virginia Tobacco	1	1.118
Juul	Virginia Tobacco	2	1.192
Juul	Virginia Tobacco	3	1.166
Blu Disposable	Classic Tobacco	1	1.182
Blu Disposable	Classic Tobacco	2	1.195
Blu Disposable	Classic Tobacco	3	1.040
Vuse Alto	Golden Tobacco	1	1.149
Vuse Alto	Golden Tobacco	2	1.102
Vuse Alto	Golden Tobacco	3	1.208
Smok ProColor	MiSalt Tobacco	1	1.168
Smok ProColor	MiSalt Tobacco	2	1.093
Smok ProColor	MiSalt Tobacco	3	1.209
Vaping blank, Juul-Blankz pod	PG/VG (40/60)	1	1.128
Vaping blank, Juul-Blankz pod	PG/VG (40/60)	2	1.000
Vaping blank, Juul-Blankz pod	PG/VG (40/60)	3	1.120
<i>Average</i>			<i>1.138</i>
<i>Standard Deviation</i>			<i>0.061</i>



Supplementary Figure 1: Chromatogram of As(III), DMA, MA, and As(V) species in 0.5 µg/L standard.



Supplementary Figure 2: Chromatogram of As species in Stig-Mint sample. Top: before oxidation, with zoomed inset of arsenite peak showing no front peak. Bottom: after oxidation.