Lorillard

Comparison of Select Analytes in Exhaled Aerosol from E-cigarettes with Exhaled Smoke from a Traditional Cigarette and Exhaled breaths

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Organization

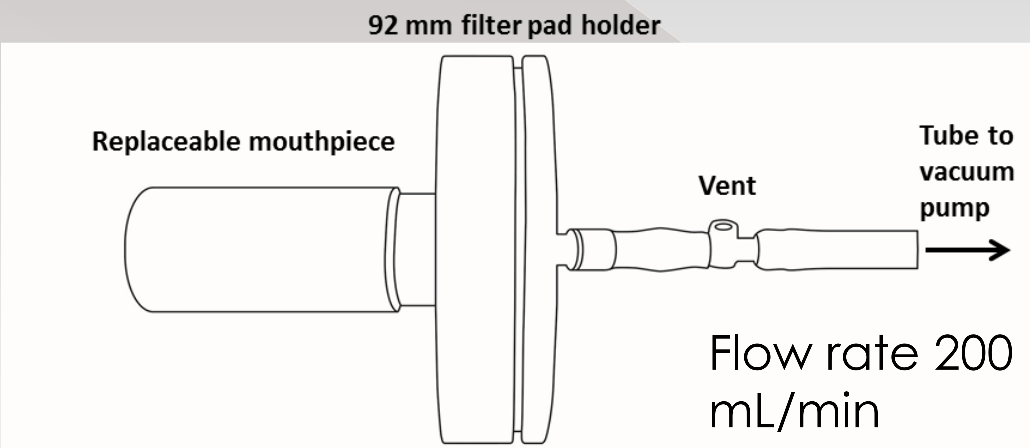
- Project scope
  - Exhaled smoke from conventional cigarettes
  - E-cigarette emissions
- Project overview
  - Study considerations
  - Experimental design
  - Work flow and sampling
  - Analytes and methods
- Results Summary
- Acknowledgments

Background: e-cigarette emissions

- Several studies have reported low levels of carbonyls in machine generated e-cigarette aerosols
- Cresols observed in headspace of an e-cigarette
- "Passive vaping" has been suggested as a potential bystander risk
- Baseline levels of constituents present analytical challenges
- Published results for the composition of exhaled e-cigarette vapor is deficient
  - Exhaled e-cigarette aerosol major components and mass balance
  - Compare phenolics and carbonyls in exhaled aerosol from a conventional cigarette to exhaled aerosol from e-cigarettes

Background: Applying conventional cigarette methodology

- Vacuum-assisted filter pad collection

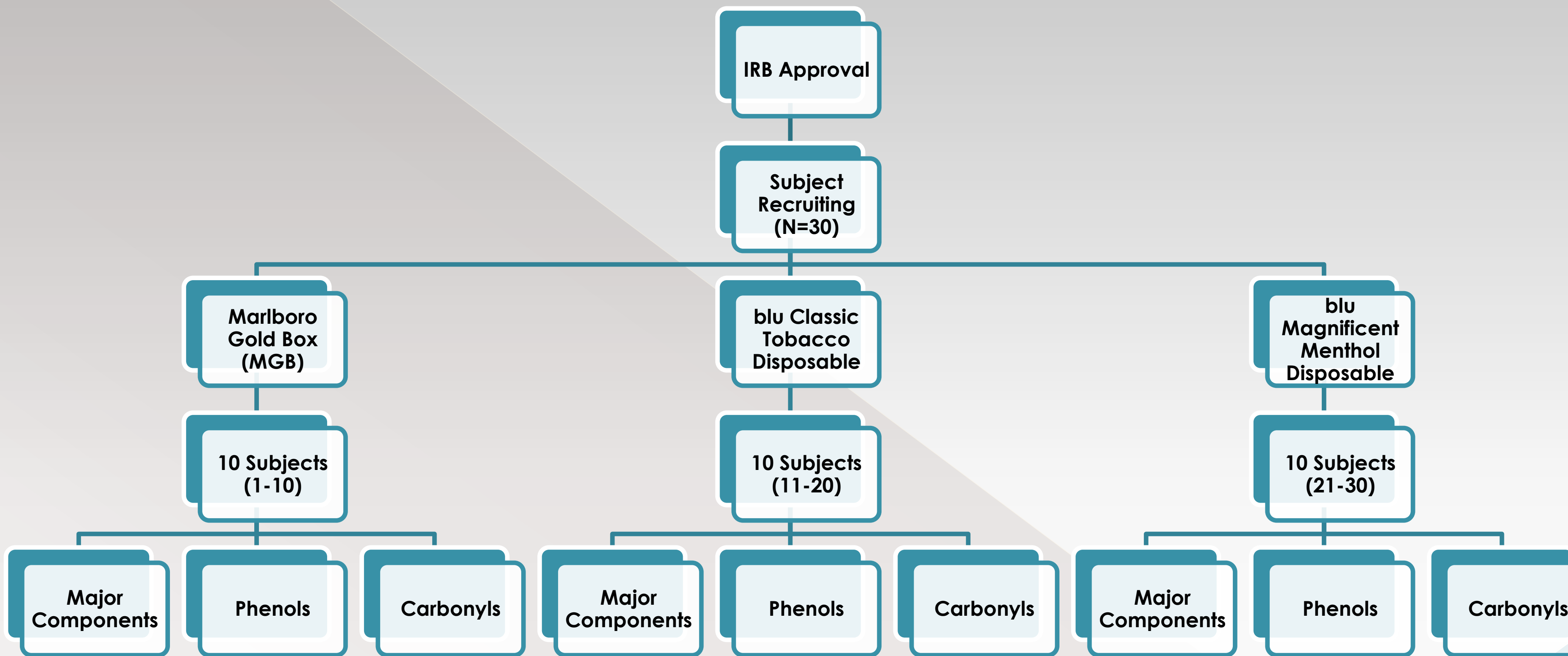


- Same approach used for quantitation of benzene, toluene, carbonyls, phenolics, PAH, TSNA in environmental tobacco smoke.

Project considerations

- Variability between subjects
  - Multiple subjects and replicates
- Suitable blanks
  - Exhaled breaths and room air (carbonyls)
- Anticipated low/ND levels of analytes (especially e-cigarettes)
  - Establish method limits and capabilities

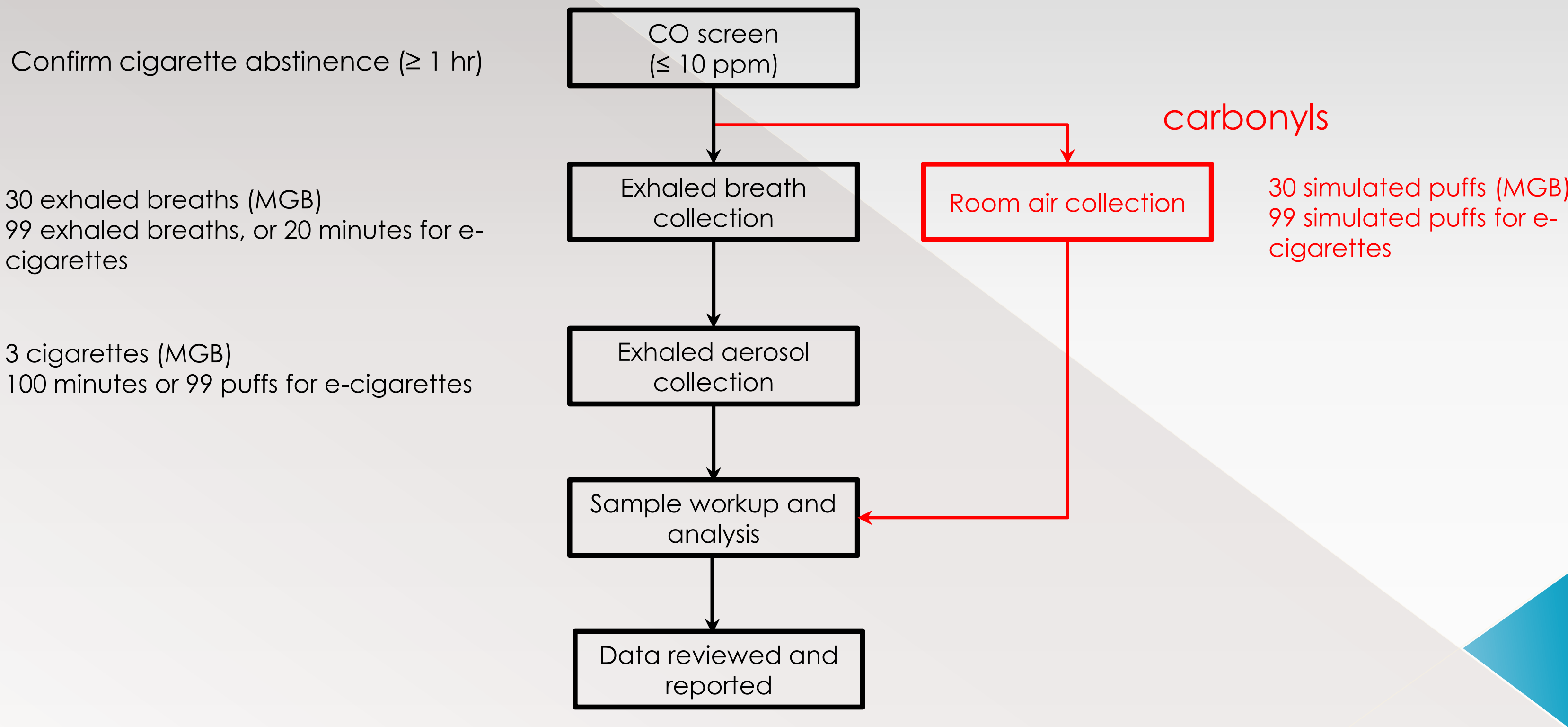
Design of Experiment



Major Components:	Glycerin, nicotine, water
Phenols:	hydroquinone, resorcinol, catechol, phenol, m,p-cresol, o-cresol
Carbonyls:	formaldehyde, acetaldehyde, acetone, acrolein, propionaldehyde, crotonaldehyde, methylethylketone, butyraldehyde

Session workflow and sampling

- Subjects limited to one session/day
- Subjects participate in a total of nine (9) sessions
    - major components (3 sessions)
    - phenolics (3 sessions)
    - carbonyls (3 sessions w/DNPH treated pads)



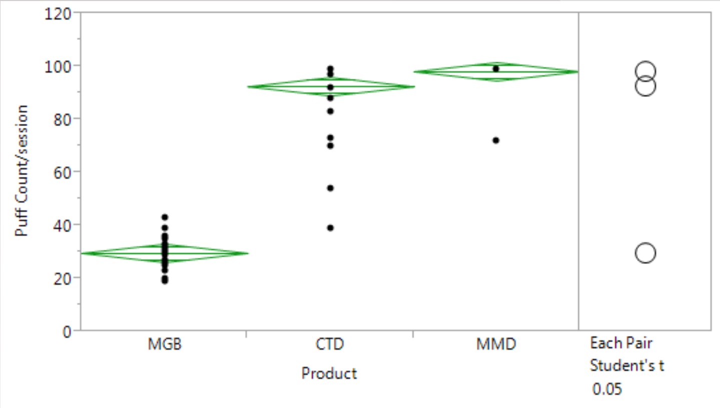
Methods: Quantitation Limits & Method Uncertainty

Analyte		Method	LOD	LOQ	Accuracy (%)	Precision (%)
Major Comp.	Nicotine	GC-MS	0.69	4.86	108	2
	Glycerin	GC-FID	0.0059	1.51	101	2
	Water	KF	ND	31	99	0
Phenolics	Hydroquinone	UPLC-FLR	0.37	2.00	113	2
	Resorcinol	UPLC-FLR	0.06	0.40	109	2
	Catechol	UPLC-FLR	0.47	2.00	114	2
	Phenol	UPLC-FLR	0.09	0.32	108	2
	m,p-Cresol	UPLC-FLR	0.60	4.00	110	2
	o-Cresol	UPLC-FLR	0.16	1.00	113	1
Carbonyls	Formaldehyde	UPLC-PDA	0.10	12.45	97	0
	Acetaldehyde	UPLC-PDA	0.39	5.20	96	1
	Acetone	UPLC-PDA	0.61	13.64	96	3
	Acrolein	UPLC-PDA	0.13	12.34	97	0
	Propionaldehyde	UPLC-PDA	0.21	1.89	98	2
	Crotonaldehyde	UPLC-PDA	0.21	2.17	95	1
	Methylethylketone	UPLC-PDA	0.24	2.06	97	2
	Butyraldehyde	UPLC-PDA	0.18	5.30	95	1

All units are µg except glycerin and water (mg). ND - LOD for water was not determined. Instrument methods based on modified ISO 17025 conventional cigarette smoke analysis

Results: Puff count and e-liquid consumed

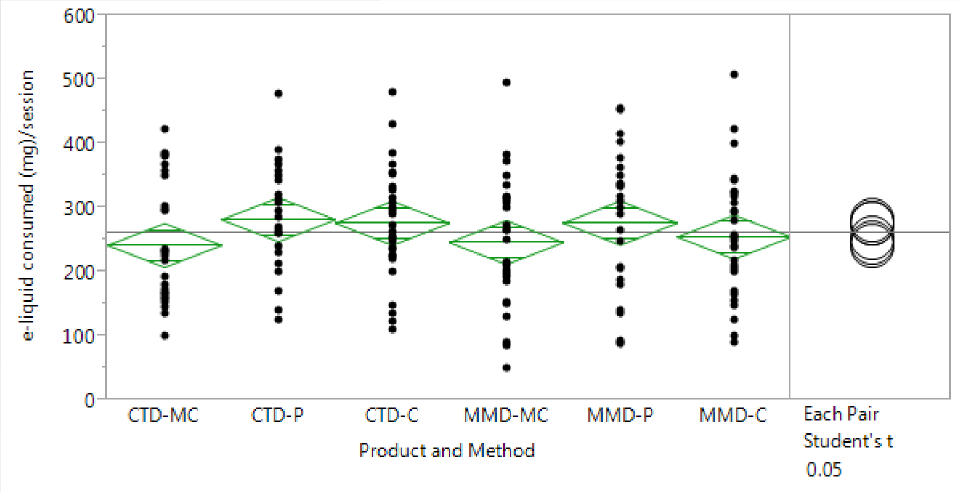
Important considerations: (1) How many puffs were taken by product type, and (2) was a consistent amount of e-liquid consumed across study participants?



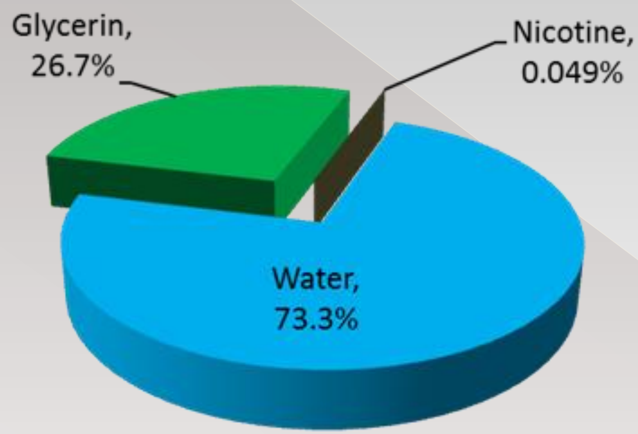
Puff Count/session
MGB 30
CTD 92
MMD 98

e-liquid consumed/session

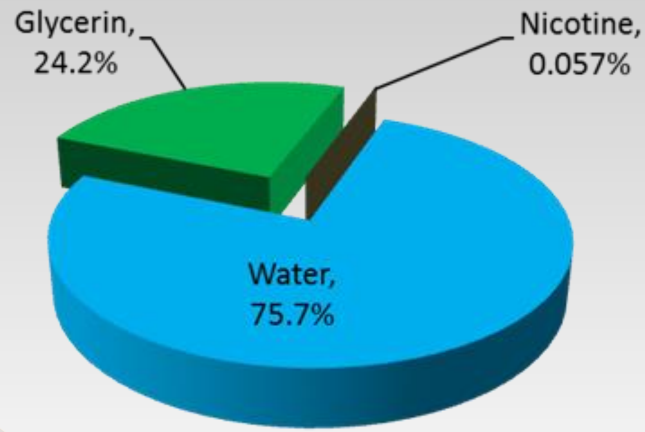
Analyte	blu CTD	blu MMD
Major Components (-MC)	242	246
Phenolics (-P)	282	277
Carbonyls (-C)	276	255



Results: Distribution and mass balance of exhaled e-cigarette aerosol



blu CTD
Average: 104 ± 18 % mass balance



blu MMD
Average: 101 ± 7 % mass balance

Average mass balance for nicotine, glycerin and water in exhaled aerosol from the conventional cigarette was (83 ± 21%).

Data treatment – Example data

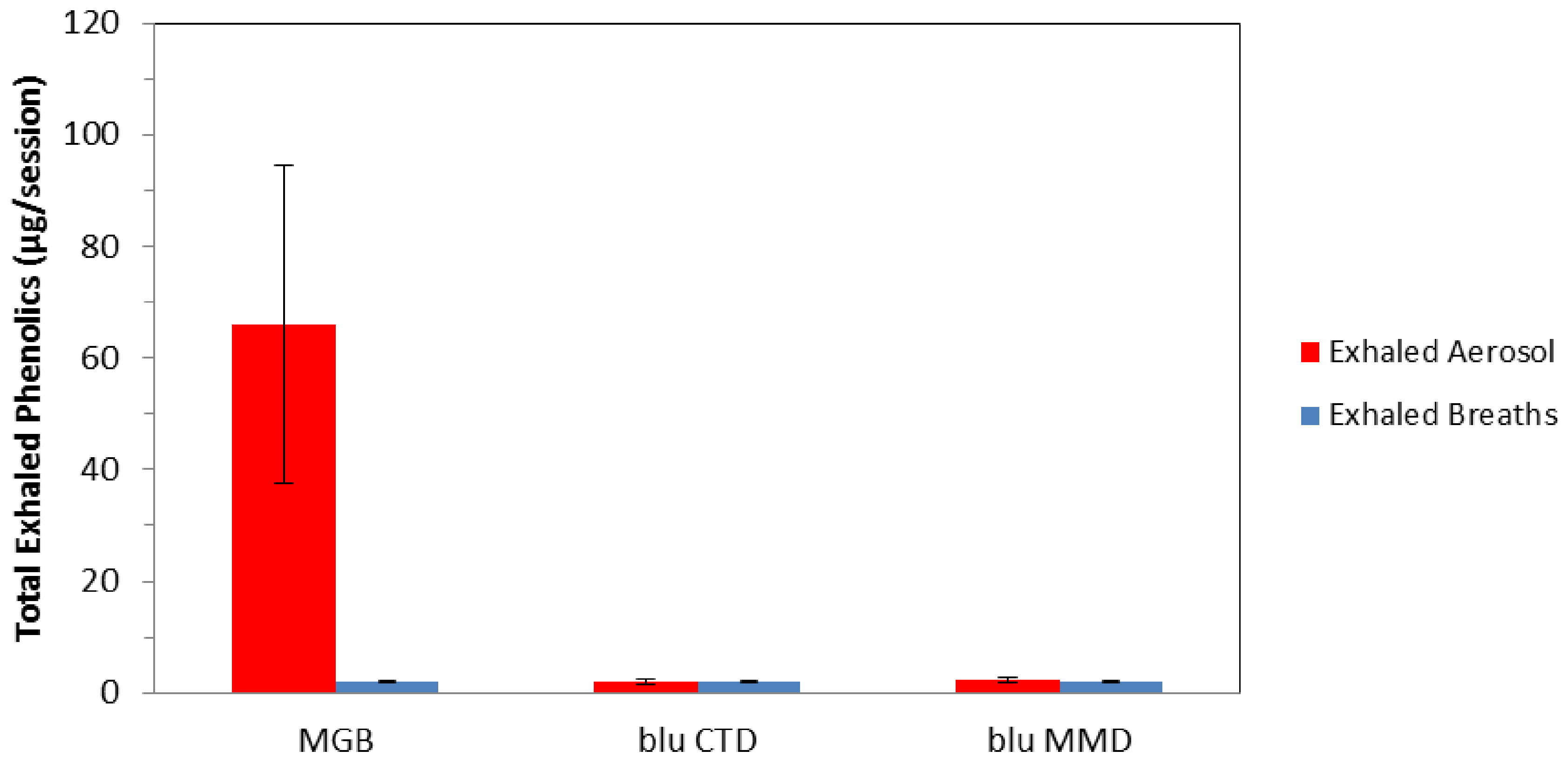
MGB			blu CTD			blu MMD		
Subject	Acetaldehyde	Hydroquinone	Subject	Acetaldehyde	Hydroquinone	Subject	Acetaldehyde	Hydroquinone
1	227.6	70.6	11	<LOQ	<LOD	21	16.7	<LOD
	186.0	60.0		<LOQ	<LOD		35.3	<LOD
	221.0	69.1		<LOQ	<LOD		38.9	<LOD
2	134.7	41.3	12	<LOQ	<LOD	22	<LOQ	<LOD
	129.8	33.2		<LOQ	<LOD		<LOQ	<LOD
	107.7	31.9		<LOQ	<LOD		<LOQ	<LOD
3	131.2	32.2	13	<LOQ	<LOD	23	<LOQ	<LOD
	169.0	47.4		86.4	<LOD		<LOQ	<LOD
	128.1	52.5		44.2	<LOD		<LOQ	<LOD
4	115.6	48.5	14	<LOQ	<LOD	24	5.4	<LOD
	119.3	47.3		<LOQ	<LOD		7.2	<LOD
	124.1	42.5		<LOQ	<LOD		9.9	<LOD
5	195.4	18.4	15	<LOQ	<LOD	25	<LOQ	<LOD
	122.0	13.3		<LOQ	<LOD		<LOQ	<LOD
	196.3	20.0		<LOQ	<LOD		<LOQ	<LOD
6	208.0	99.5	16	<LOQ	<LOD	26	<LOQ	<LOD
	116.9	103.5		<LOQ	<LOD		<LOQ	<LOD
	116.0	83.9		<LOQ	<LOD		<LOQ	<LOD
7	41.6	22.8	17	<LOQ	<LOD	27	<LOQ	<LOD
	88.1	8.79		<LOQ	<LOD		<LOQ	<LOD
	48.1	25.9		<LOQ	<LOD		6.2	<LOD
8	380.2	29.1	18	<LOD	<LOD	28	<LOQ	<LOD
	193.7	37.7		24.2	<LOD		<LOQ	<LOD
	189.7	30.9		<LOQ	<LOD		7.1	<LOD
9	285.2	73.0	19	<LOQ	<LOD	29	6.5	<LOD
	126.6	26.8		<LOQ	<LOD		8.9	<LOD
	104.6	81.6		<LOQ	<LOD		7.6	<LOD
10	217.6	43.0	20	6.9	<LOD	30	<LOQ	<LOD
	162.7	46.2		<LOQ	<LOD		<LOQ	<LOD
	114.1	64.0		<LOQ	<LOQ		5.4	<LOD
Avg*	156.7	46.8		< 9.73*	< 0.421*		< 8.29*	< 0.367*
SD	68.8	24.7		16.5	0.3		8.2	0.0
LOQ	41.6	2.00		5.20	2.00		5.20	2.00
LOD	0.390	0.367		0.390	0.367		0.390	0.367

← µg/session

*Reporting convention:
If <LOQ, use LOQ value
If <LOD, use LOD value

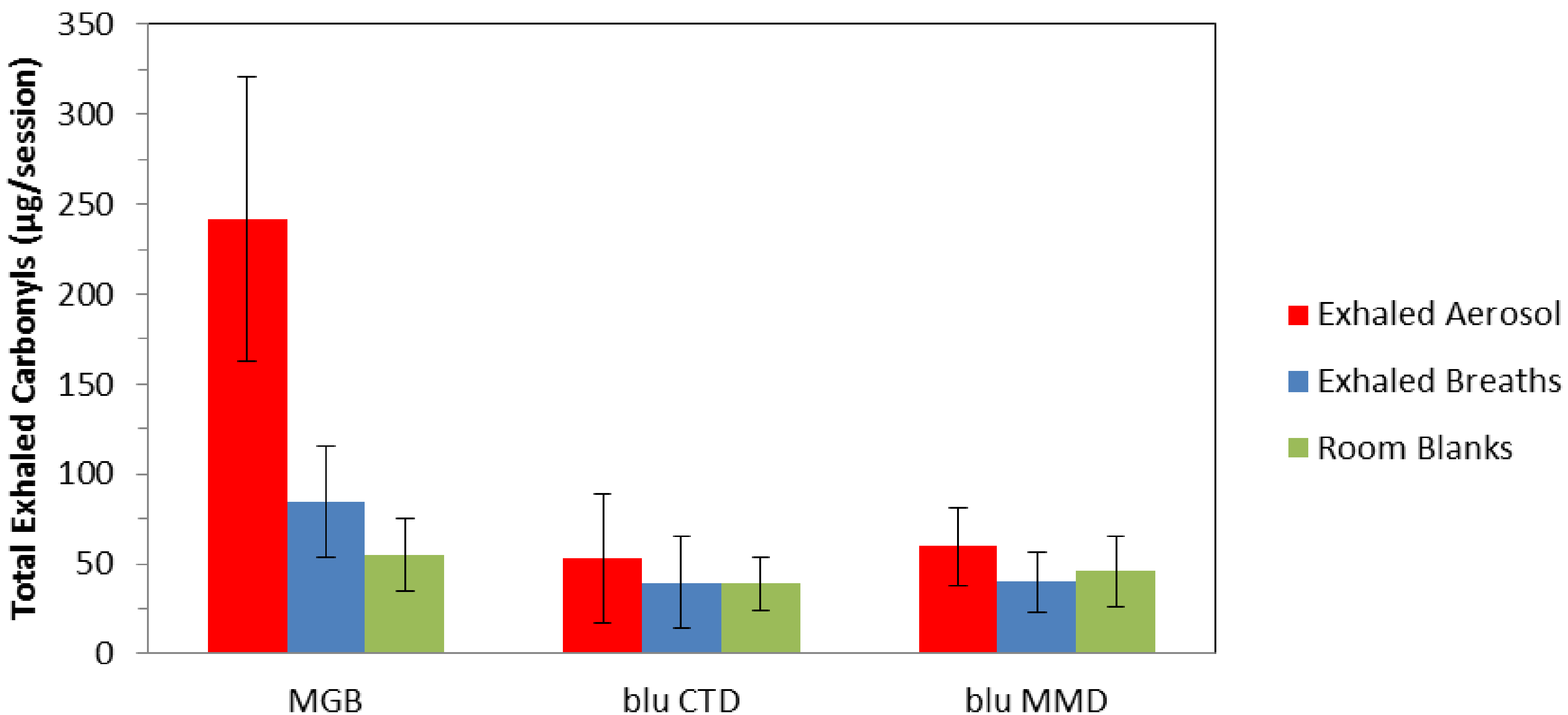
Provides worst case estimate and allows comparison between products

Results: Phenolics



For e-cigarettes, ANOVA comparisons confirm Phenolics (exhaled aerosol) = Phenolics (exhaled breath)

Results: Carbonyls



For e-cigarettes, ANOVA comparisons confirm Carbonyls (exhaled aerosol) = Carbonyls (exhaled breath)

High-level Result Summary

- Exhaled e-cigarette aerosol >99.9% water and glycerin
- Mass balance of exhaled e-cigarette aerosol is quantitative (~100% for both products)
- Phenolics and carbonyls in exhaled e-cigarette aerosol were typically below the quantitation or detection limits and not distinguishable from exhaled breaths
- Phenolics and carbonyls in exhaled cigarette smoke were in quantitation range and similar to previously reported data

Acknowledgements

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