Supplemental Material for

Measurement of Endocrine Disrupting and Asthma-Associated Chemicals in Hair Products Used by Black Women

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Contents:

Table S1. Brand names and manufacturers of tested products.

Product ID	Product Name	Manufacturer
Hot Oil Treatment	Alberto V05 Moisturizing Hot Oil	Alberto-Culver USA
Anti-frizz/Polish #1	John Frieda Collection Frizz-Ease Hair Serum *Original Formula*	Kao Brands Company
Anti-frizz/Polish #2	Schwarzkopf Citre Shine Anti-frizz Serum	Henkel Consumer Goods Inc
Anti-frizz/Polish #3	Smooth N Shine Polishing Instant Repair Hair Polisher *Extra Strength*	Henkel Consumer Goods Inc
Leave-in Conditioner	in(fus)ium 23 leave-in treatment (repair)ologie	Procter & Gamble
Root Stimulator #1	Organic Root Stimulator Fertilizing Serum *Herbal Scalp Formula*	Namaste Laboratories LLC
Root Stimulator #2	Organic Root Stimulator Olive Oil *Extra Rich for Dry Thirsty Hair Crème de Cheveux*	Namaste Laboratories LLC
Root Stimulator #3	Organic Root Stimulator Carrot Oil *Strengthens Weak Damaged Hair*	Namaste Laboratories LLC
Root Stimulator #4	Organic Root Stimulator Hair Mayonnaise *Treatment For Damaged Hair*	Namaste Laboratories LLC
Hair Lotion #1	Queen Helene Cholesterol Hair Conditioning Cream	Para Laboratories Inc
Hair Lotion #2	Hask Placenta Henna n Placenta	Alleghany Pharmacal Corp
Hair Lotion #3	Lusters Pink Classic Light *Oil Moisturizer Hair Lotion*	Luster Products
Hair Lotion #4	BB Maximum Strength SuperGro conditioner *with Vitamin E*	Bronner Bros
Hair Lotion #5	Razac Perfect for Perms Finishing Crème *Daily Hairdressing & Scalp Conditioner*	Razac Products Janson Limited
Hair Lotion #6	Dax Pomade *with Lanolin Bergamot Olive Oil Castor Oil*	Imperial Dax Co Inc
Hair Relaxer #1	Soft & Beautiful Just for Me No-Lye Conditioning Relaxer (Children's Coarse)	Pro-line International Inc
Gel	PROTECTIVE GEL	
Pre-treatment	PROTECTION PRE-RELAXER TREATMENT	
Relaxing Cream	NO-LYE CONDITIONING CRÈME RELAXER	
Activator	LIQUID ACTIVATOR	
Shampoo and Conditioner	COLOR NEUTRALIZING SHAMPOO and HMC HAIR MOISTURIZING COMPLEX	
Lotion	OIL MOISTURIZING LOTION	
Hair Relaxer #2	Fabu-laxer Super	Colomer USA Inc
Relaxing Cream	RELAXER CRÈME	
Activator	COLOR INDICATOR LIQUID ACTIVATOR	
Shampoo and Conditioner	DEEP CLEAN NEUTRALIZING AND CONDITIONING SHAMPOO and STYLING CONDITIONER	
Hair Relaxer #3	PCJ Pretty-n-Silky No-Lye Conditioning Crème Relaxer (Children's Regular)	Luster Products
Relaxing Cream	NO-LYE CRÈME RELAXER	
Activator	COLOR MIX ACTIVATOR	
Shine	NUTRIENTSHEEN 2	
Shampoo and Conditioner	COLOR ALARM NEUTRALIZING CONDITIONING SHAMPOO 2 and EZ COMB CONDITIONER 2	

Table S2. Chemical class summaries, including uses, potential health effects, and compounds analyzed.

Chemical Class	Use in Products[a]	Potential Health Concerns[b]	Targeted Chemicals
parabens	preservative; anti-microbial agent	**endocrine disruption** (Aker et al. 2016; Boberg et al. 2016; Fernandez et al. 2016; Geer et al. 2017; Guerra et al. 2017; Guo et al. 2017; Hu et al. 2013; Hu et al. 2016; Hu et al. 2017; Kang et al. 2002; Kim et al. 2011; Koeppe et al. 2013; Morohoshi et al. 2005; Pan et al. 2016; Pereira-Fernandes et al. 2013; Pollock et al. 2017; Routledge et al. 1998; Smith et al. 2013; Wielogorska et al. 2015; Wu et al. 2017; Zhang et al. 2014)	methyl paraben ethyl paraben butyl paraben
phthalates	plastic additives; solvents in cosmetics and perfumes; inert ingredient in pesticides	**endocrine disruption** (Alur et al. 2015; Aydogan Ahbab and Barlas 2013; CHAP 2014; Ferguson et al. 2017; Gray et al. 2000; Hauser et al. 2016; Hauser et al. 2006; Heindel et al. 1989; Howdeshell et al. 2008; Ishido and Suzuki 2014; James-Todd et al. 2016; Johns et al. 2015; Karmaus et al. 2016; Kumar et al. 2014; Kumar et al. 2015; Mankidy et al. 2013; Manservisi et al. 2015; Meeker et al. 2009; Mendiola et al. 2012; Messerlian et al. 2016; Philippat et al. 2015; Sohn et al. 2016; Swan et al. 2005; Watkins et al. 2014) **asthma** (Bornehag and Nanberg 2010; Bornehag et al. 2004; Ku et al. 2015; Whyatt et al. 2014) **carcinogenicity** (IARC 2012b)	bis(2-ethylhexyl) adipate bis(2-ethyhexyl) phthalate benzylbutyl phthalate *di-cyclohexyl phthalate* *di-isobutyl phthalate* *di-isononyl phthalate* *di-n-butylphthalate* *di-n-hexyl phthalate* di-n-octyl phthalate di-n-propyl phthalate diethyl phthalate
bisphenol A	polycarbonate plastic and epoxy resins	**endocrine disruption** (ECHA-RAC 2014; FAO/WHO 2010; NTP-CERHR 2008),(Chavarro et al. 2016; Machtinger et al. 2013; Minguez-Alarcon et al. 2016) **asthma** (Donohue et al. 2013; Wang et al. 2016) **carcinogenicity** (Seachrist et al. 2016)	bisphenol A
antimicrobials	anti-microbial agent	**endocrine disruption** (Chen et al. 2008; Fang et al. 2015; Hinther et al. 2011; Johnson et al. 2016; Kumar et al. 2009; Orton et al. 2011; Paul et al. 2010; Rodriguez and Sanchez 2010; Stoker et al. 2010; Wu et al. 2016) **asthma** (Savage et al. 2014; Savage et al. 2012)	o-phenylphenol triclosan *triclocarban*

Chemical Class	Use in Products[a]	Potential Health Concerns[b]	Targeted Chemicals
ethanolamines	solvent in cleaners; emulsifier in creams and lotions	**asthma** (Kamijo et al. 2009; Makela et al. 2011; Piipari et al. 1998; Savonius et al. 1994) **carcinogenicity** (IARC 2012c)	monoethanolamine diethanolamine
alkylphenols	surfactant; disinfectant; inert ingredient in pesticides	**endocrine disruption** (Ajj et al. 2013; Balch and Metcalfe 2006; Chang et al. 2012; ECHA-RAC/SEAC 2014; El-Hefnawy et al. 2017; Jambor et al. 2016; Jie et al. 2010; Li et al. 2012; Thomas and Dong 2006)	4-t-octylphenol *octylphenol monoethoxylate* octylphenol diethoxylate 4-t-nonylphenol nonylphenol monoethoxylate nonylphenol diethoxylate
fragrances	scent; masking agent	**endocrine disruption** (Bitsch et al. 2002; Li et al. 2013; Schreurs et al. 2005; Seinen et al. 1999; van der Burg et al. 2008; Zhang et al. 2012) **asthma** (Kumar et al. 1995; Vethanayagam et al. 2013; Weinberg et al. 2017) **carcinogenicity** (IARC 2012d)	<u>natural</u> benzylcetate eugenol hexyl cinnemal limonene linalool *methyl eugenol* methyl salicylate *pinene* terpineol <u>synthetic</u> AHTN bucinal diphenyl ether *DPMI* HHCB isobornyl acetate methyl ionone *musk ketone* *musk xylene* phenethyl alcohol

Chemical Class	Use in Products[a]	Potential Health Concerns[b]	Targeted Chemicals
glycol ethers	solvent	**asthma** (Choi et al. 2010)	*2-butoxylethanol* 2-phenoxylethanol 2-benzyloxyethanol *2,2-methoxyethoxyethanol* 2,2-ethyoxyethoxyethanol *2,2-butoxyethoxyethanol*
cyclosiloxanes	enhance lubrication and spreading	**endocrine disruption** (Quinn et al. 2007) **carcinogenicity** (EU-SCCS 2016)	octamethylcyclotetrasiloxane (D4) decamethylcyclopentasiloxane (D5) dodecamethylcyclohexylsiloxane (D6)
UV filters	sun protection; product stability and durability	**endocrine disruption** (Habauzit et al. 2017; Kinnberg et al. 2015; Kunz and Fent 2006; Schlumpf et al. 2004; Wielogorska et al. 2015) **carcinogenicity** (IARC 2012a; Sharma et al. 2017)	benzophenone benzophenone-1 benzophenone-2 benzophenone-3 oxtinoxate octadimethyl PABA

[a] General use categories are from the NLM Hazardous Substance Data Bank and/or scientific literature
[b] Health effects have not necessarily been reported for all chemicals within the chemical class. Among the EDCs in this study, parabens, phthalates, BPA, and triclosan have supporting evidence of endocrine-related health effects from human studies. All asthma associations are based on human studies.
Italicized chemicals were not detected in any product

Table S3. Summary of chemical concentrations in hair products.

Chemical Class	Chemical	% > MRL[b]	Median (μg/g)	Maximum (μg/g)
UV block	octyl dimethyl PABA	6%	--	206
	octinoxate	22%	--	646
	benzophenone-3[a]	11%	--	36
	benzophenone-2	17%	--	22
	benzophenone-1[a]	28%	--	36
	benzophenone	17%	--	20
cyclosiloxane	dodecamethylcyclohexylsiloxane[a]	50%	2	16500
	decamethylcyclopentasiloxane[a]	56%	30	457000
	octamethylcyclotetrasiloxane[a]	61%	13	2590
glycol ether	2,2-butoxyethoxyethanol	0%	--	--
	2,2-ethoxyethoxyethanol	6%	--	104
	2,2-methoxyethoxyethanol	0%	--	--
	2-benzyloxyethanol	6%	--	4
	2-phenoxyethanol	17%	--	412
	2-butoxyethanol	0%	--	--
fragrance	phenethyl alcohol	39%	--	608
	musk xylene	0%	--	--
	musk ketone	0%	--	--
	methyl ionone	39%	--	588
	isobornyl acetate	28%	--	68
	HHCB	61%	10	104
	DPMI	0%	--	--
	diphenyl ether	28%	--	52
	bucinal	33%	--	56
	AHTN	28%	--	120
	terpineol	28%	--	790
	pinene	0%	--	--
	methyl salicylate	6%	--	4
	methyl eugenol	0%	--	--
	linalool	72%	100	498
	limonene	61%	25	1870
	hexyl cinnemal	33%	--	402
	eugenol	28%	--	214
	benzylacetate	50%	12	576
alkylphenol	nonylphenol diethoxylate	33%	--	373
	nonylphenol monoethoxylate	33%	--	54
	4-t-nonylphenol	28%	--	13
	octylphenol diethoxylate	6%	--	2
	octylphenol monoethoxylate	0%	--	--
	4-t-octylphenol	6%	--	22
ethanolamine	diethanolamine[a]	17%	--	314
	monoethanolamine[a]	11%	--	18
antimicrobial	triclosan[a]	6%	--	56
	triclocarban	0%	--	--
	o-phenylphenol	11%	--	6
bisphenol A	bisphenol A[a]	17%	--	46
phthalate	diethyl phthalate	78%	47	2450
	di-n-propyl phthalate	6%	--	6

	di-n-octyl phthalate	6%	--	6
	di-n-hexyl phthalate	0%	--	--
	di-n-butylphthalate	0%	--	--
	di-isononyl phthalate	0%	--	--
	di-isobutyl phthalate	0%	--	--
	di-cyclohexyl phthalate	0%	--	--
	benzylbutyl phthalate	6%	--	20
	bis(2-ethylhexyl) phthalate	17%	--	90
	bis(2-ethylhexyl) adipate	6%	--	410
paraben	butyl paraben[a]	17%	--	36
	ethyl paraben[a]	22%	--	22
	methyl paraben[a]	72%	453	2100

MRL = method reporting limit. The MRL is 1 µg/g unless elevated due to blank detects

[a] Elevated MRL due to blank detect

[b] Percent of 18 products (including the three combined relaxer kit concentrations) with targeted chemical above the MDL

-- Insufficient number of data available above the MRL to calculate the summary statistic.

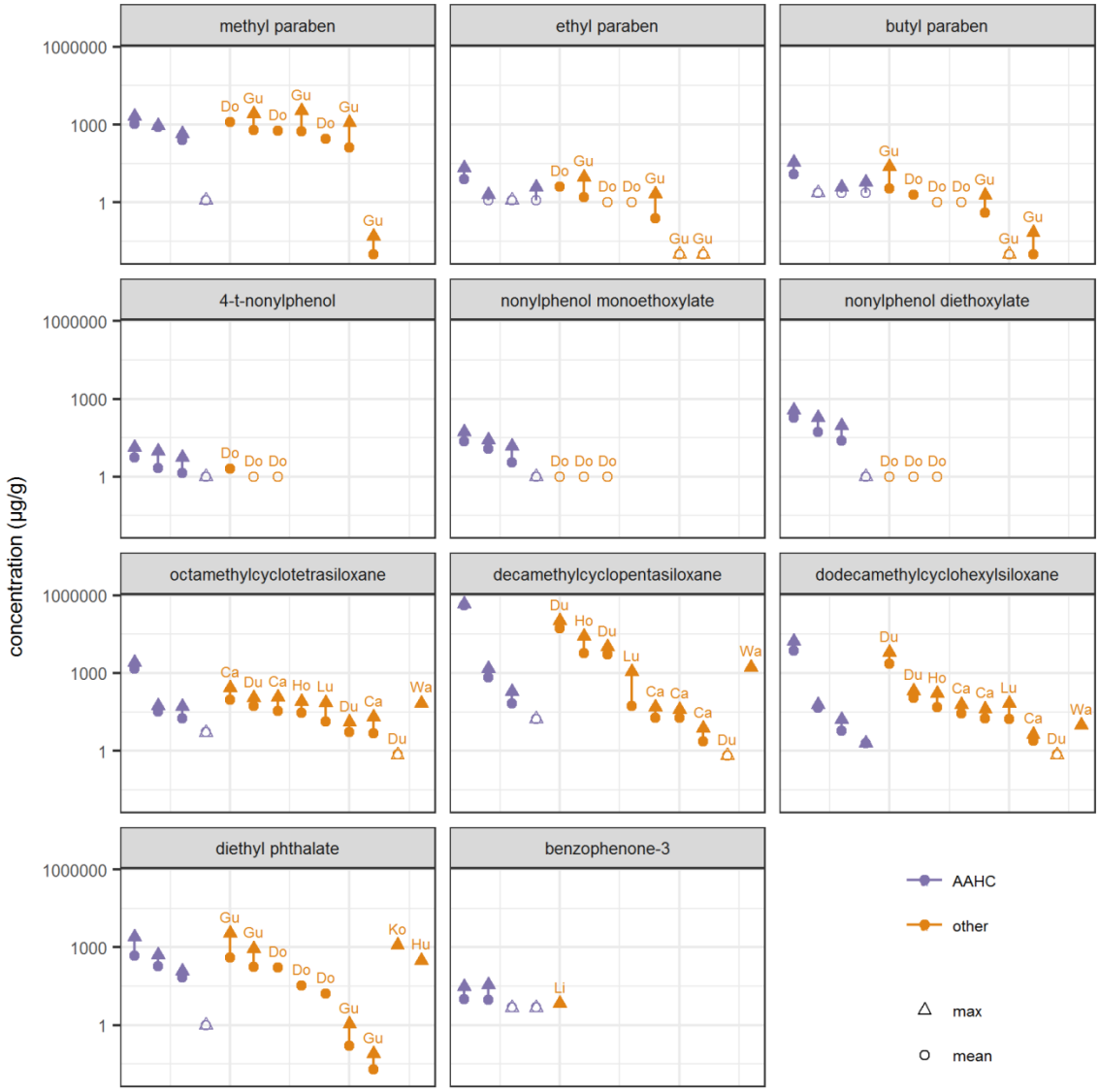
Table S4. Detected chemicals regulated by California's Proposition 65 (Prop 65) or the EU Cosmetics Directive (EU)

Chemical Class	Chemical	Prop 65	EU	>MRL (#)[b]	Maximum (%)[c]
UV block	octyl dimethyl PABA	NR	permit up to 10%	1	0.0206
UV block	octinoxate	NR	permit up to 10%	4	0.0646
UV block	benzophenone-3 [a]	NR	permit up to 10%	2	0.0036
UV block	benzophenone	cancer	NR	3	0.002
glycol ether	2,2-ethoxyethoxyethanol	NR	permit in rinse-off up to 10%, leave-in up to 2.5%	1	0.0104
glycol ether	2-phenoxyethanol	NR	permit up to 1%	3	0.0412
fragrance	bucinal	NR	label when present at over 0.001% in leave-on products	6	0.0056
fragrance	AHTN	NR	permit in leave-on products at up to 0.1%, rinse-off at 0.2%	5	0.012
fragrance	linalool	NR	label when present at over 0.001% in leave-on products, 0.01% in rinse-off products	13	0.0498
fragrance	limonene	NR	label when present at over 0.001% in leave-on products, 0.01% in rinse-off products	11	0.1872
fragrance	hexyl cinnemal	NR	label when present at over 0.001% in leave-on products, 0.01% in rinse-off products	6	0.0402
fragrance	eugenol	NR	label when present at over 0.001% in leave-on products, 0.01% in rinse-off products	5	0.0214
alkylphenol	4-t-nonylphenol	NR	prohibited	5	0.00132
ethanolamine	diethanolamine [a]	cancer	prohibited	3	0.0314
ethanolamine	monoethanolamine [a]	NR	limit secondary amine concentration to 0.5%	2	0.0018
antimicrobial	triclosan [a]	NR	permit in toothpastes, hand soaps, body soaps/shower gels, deodorants (non-spray), face powders and blemish concealers, nail cleaners up to 0.3%, mouthwash up to 0.2%.	1	0.0056
antimicrobial	o-phenylphenol	cancer	permit up to 0.2%	2	0.0006
bpa	bisphenol A [a]	female reproductive toxicity	prohibited	3	0.0046
phthalate	benzylbutyl phthalate	developmental toxicity	prohibited	1	0.002
phthalate	bis(2-ethylhexyl) phthalate	cancer	prohibited	3	0.009

paraben	butyl paraben	NR	permit as preservative up to 0.14% or 0.8% for paraben mixtures	3	0.0036
paraben	ethyl paraben	NR	permit as preservative up to 0.4% or 0.8% for paraben mixtures	4	0.0022
paraben	methyl paraben	NR	permit as preservative up to 0.4% or 0.8% for paraben mixtures	13	0.21

MRL = method reporting limit. The MRL is 1 μg/g unless elevated due to blank detects
NR = not regulated
[a] Elevated MRL due to blank detect
[b] Number of 18 products (including the three combined relaxer kit concentrations) with targeted chemical above the MDL
[c] For comparison with EU regulatory language, concentrations in μg/g are converted to % on a mass basis.

Figure S1. Comparison of chemical concentrations in hair products used by Black women with the previously published literature



Comparison of max (Δ) and mean (o) concentrations of detected chemicals in each of the four product types with multiple samples (purple) with previously published literature (orange). Detects above the method reporting limit (MRL) or Level of Quantitation (LOQ) are shown with solid symbols (•), while detects below the MRL or LOQ are set equal to the MRL/LOQ and are shown with open symbols (o). Ca= (Capela et al. 2016), Do= (Dodson et al. 2012), Gu=(Guo and Kannan 2013), Du=(Dudzina et al. 2014), Ho=(Horii and Kannan 2008), Hu=(Hubinger 2010), Ko=(Koniecki et al. 2011), Li= (Liao and Kannan 2014), Lu=(Lu et al. 2011), Wa=(Wang et al. 2009). Dodson 2012 measured composited samples, displayed as a mean without a maximum measurement.

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