Supporting Information

Effect-Directed Analysis of Human Peroxisome Proliferator-Activated Nuclear Receptors (PPARγ1) ligands in Indoor Dust

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CONTENTS

Text S1, Chemical Identification. Fractions with significant PPARγ activity were subjected to qualitative mass spectrometric analysis by gas chromatography mass spectrometry (Agilent GC 6890N, MS 5975, Newark, DE) operated in full-scan mode (*m/z* 50 to 1050) under the electron ionization (EI) mode (GC/EI-MS). The chemical identification was based on our previous study (Fang et al. 2014a) and fully described in Supplemental Material, Chemical Identification. A 0.25 mm (i.d.) × 15 m fused silica capillary column coated with 5% phenyl methylpolysiloxane (0.25 μm film thickness) was used for separation of the analytes. Splitless injections were performed with a PTV inlet maintained at 250°C and 10 psi. The nitrogen flow rate was 1.3 mL min^{-1} and the oven temperature program was as follows: after holding at 40°C for 0.6 min, the temperature was increased at 10°C/min until reaching 280°C, at which point isothermal conditions were maintained for 14 min before returning to initial conditions. The transfer line temperature was maintained at 280°C, and the ion source was held at 230°C. Structural elucidation was performed using MS-Chemstation software (version E.02.01.1177) from Agilent (Palo Alto, CA 94306 United States) equipped with the NIST mass spectral library (version 2005) and NIST Mass Spectral Search Program (Version 2.0d). The mass spectrum of each non-targeted component was extracted and its peaks assigned identities by the automated mass spectral deconvolution and identification system (AMDIS) and the NIST-05-library. Peaks with a signal-to-noise ratio (S/N) above 20 were library searched and assigned structures based on the presence of a corresponding mass signature with a match factor of at least 60 (out of 100). For several tentatively identified chemicals, further confirmation was achieved by comparing retention times (RT) and mass spectral to those of authentic standards.

Table S1. Elution profile of prepared standard mixtures in the NP-HPLC

DEHP																						
TBB																						
TBPH																						
PBDEs																						
TPP																						
TCPP																						
TCEP																						
Triclosan																						
2,4,6-TBP																						
2,4,5-TBP																						
TBBPA																						
6-OH-BDE47																						
Monochlorophenyl																						
BPA																						
TBMEHP																						
TBBA																						
MEHP																						
TPT chloride																						
TBT chloride																						
RT (min)	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Table 1 (Continued)

DEHP																					
TBB																					
TBPH																					
PBDEs																					
TPP																					
TCPP																					
TCEP																					
Triclosan																					
2,4,6-TBP																					
2,4,5-TBP																					
TBBPA																					
6-OH-BDE47																					
Monochlorophenyl																					
BPA																					
TBMEHP																					
TBBA																					
MEHP																					
TPT chloride																					
TBT chloride																					
RT (min)	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50

Table S2. Quantifier and qualifiers of several FAs, phthalates, and organophosphates analyzed using GC/EI-MS.

	Compounds	Quantifier	Qualifier 1	Qualifier 2	RT (min)
Fatty Acid	OA	264	284		12.3
	PA	256	213	129	11.0
	31D-PA	287	237	141	10.8
	SA	284	241	129	12.4
	MA	228	185	129	9.9
Phthalates	DMP	163	77	194	7.8
	DEP	149	177	222	8.8
	dDEP	153	181	226	
	DBP	149	205	223	11.0
	d-DBP	153	209	227	
	DiBP	149	205	223	10.5
	BBP	149	91	206	14.1
	d-BBP	153	210	91	
	DEHP	149	167	279	16.3
	dDEHP	153	171	283	
	DiNP	293	149	127	19.5
Organophosphates	TBP	99	155	211	9.1
	d-TBP	103	167	231	
	TPP	325	326		14.8
	d-TPP	341	340		

Table S3. Compounds identified in PPARγ active fractions from Dust I, II and III (confirmed with standards or with a match factor more than 50%)

Numbers	Compound identified	Abbreviation	CAS number	Identified by	Match Factor
1	Arachidic acid	AA	506-30-9	SM	70%
2	Azelaic acid	AzA	123-99-9	SM	60%
3	Behenic acid	BA	112-85-6	SM	90%
4	Benzyl butyl phthalate	BBP	85-68-7	AS	
5	Bis(2-ethylhexyl) fumarate	BEHF	141-02-6	AS	
6	Bis(2-ethylhexyl) phthalate	DEHP	117-81-7	AS	
7	Dibutyl phthalate	DBP	84-74-2	AS	
8	Diethyl phthalate	DEP	84-66-2	AS	
9	Diisononyl phthalate	DiNP	28553-12-0	AS	
10	Docosahexaenoic acid	DHA	6217-54-5	SM	74%
11	Hexadecanamide	HDM	629-54-9	SM	60%
12	Lauric acid	LA	143-07-7	SM	90%
13	Myristic acid	MA	544-63-8	AS	
14	Octadecanamide	ODM	124-26-5	SM	61%
15	Oleamide	OM	301-02-0	SM	50%
16	Oleic Acid	OA	112-80-1	AS	
17	Palmitoleic acid	POA	373-49-9	SM	90%
18	Palmitic acid	PA	57-10-3	AS	
19	Pentadecanoic acid	PDA	1002-84-2	SM	90%
20	Piperine	PP	94-62-2	SM	91%
21	Stearic acid	SA	57-11-4	AS	
22	Triphenyl phosphate	TPP	115-86-6	AS	
23	Tris(1,3-dichloro-2-propyl)phosphate	TDCPP	13674-87-8	AS	
24	Tris-(2-butoxyethyl)-phosphate	TBEP	78-51-3	AS	

AS=authentic standard; SM=spectral match (these compounds were identified by match to spectra in the National Institute of Standards and Technology's 2005 spectral library with a match factor > 50%).

Table S4. Concentration (μg/g dust) of several organophosphates, phthalates and FAs in the 25 house dust extracts cleaned by GPC.

Sample ID	Concentration (μg/g dust)												
	TBP	DiBP	DBP	BBP	TPP	DEHP	DiNP	DEP	DMP	OA	PA	SA	MA
A-1	0.43	12.06	15.55	11.20	1.17	250.26	127.55	1.55	0.34	1549.97	1320.50	324.66	462.53
A-2	0.59	4.49	11.72	9.21	0.71	72.26	107.47	2.21	0.14	3731.56	1610.53	419.71	275.61
A-3	0.29	0.23	1.98	0.36	0.11	1.98	0.00	1.48	NA	425.46	113.68	25.32	51.42
A-4	0.34	7.20	16.52	54.27	2.03	338.46	105.65	3.60	0.43	1253.57	4150.54	1780.95	832.17
A-5	0.79	24.68	17.71	68.74	1.10	284.31	202.13	4.37	NA	2554.66	3501.86	988.83	695.86
A-6	0.68	12.53	31.93	31.82	2.45	103.50	87.69	10.94	0.43	1164.23	1824.89	708.66	269.07
A-7	0.40	17.05	7.61	7.86	0.42	115.68	59.60	1.24	NA	429.27	485.66	164.88	101.23
B-1	0.48	10.33	275.95	17.36	2.04	2029.78	129.41	18.33	NA	0.00	15.91	7.70	3.89
B-2	0.45	38.51	236.15	33.60	6.78	1236.48	238.10	14.45	0.34	55.74	316.40	129.60	65.63
B-3	0.81	9.28	284.41	149.22	60.67	657.94	81.04	20.54	0.22	6.34	98.18	44.88	23.87
C-1	0.64	38.39	154.91	11.51	1.23	100.94	129.57	16.65	NA	1103.75	1560.99	439.08	310.01
C-2	1.02	20.66	136.16	181.11	0.47	324.32	172.33	9.80	NA	1274.46	3466.45	1038.95	531.43
C-3	0.65	7.15	124.92	16.19	0.86	116.37	67.63	17.82	NA	674.34	2463.82	819.62	304.23
D-1	0.46	8.25	14.88	5.87	1.13	113.00	131.82	4.05	NA	2192.43	3224.51	844.10	420.35
D-2	0.00	8.93	28.84	15.43	1.26	88.83	134.54	6.46	NA	2313.52	1981.21	616.44	387.80
D-3	4.73	11.69	28.51	94.57	0.48	139.49	125.35	46.71	NA	3160.36	2157.56	682.31	387.97
D-4	NA	4.05	13.36	6.07	0.19	191.71	117.36	11.24	0.19	2513.01	604.20	149.25	87.00
D-5	NA	3.71	27.58	16.06	1.01	113.50	121.10	2.01	NA	2085.21	1408.77	449.81	364.05
D-6	0.28	25.22	10.44	9.27	0.40	106.48	74.50	2.35	NA	595.36	3248.12	1361.14	244.08
E-1	1.39	3.02	20.28	18.52	0.78	99.46	148.84	3.03	0.74	648.35	195.55	61.85	49.68
E-2	1.00	5.82	15.43	13.15	1.00	112.64	118.83	4.87	NA	448.43	551.28	294.55	81.39
E-3	1.39	2.07	15.42	7.20	0.43	63.71	34.14	2.56	NA	191.86	187.30	62.59	33.09
E-4	3.94	3.77	15.77	58.92	1.42	217.27	146.52	3.35	NA	2071.82	843.07	283.19	200.86
E-5	0.25	0.78	4.65	66.35	0.23	20.34	19.00	0.87	0.00	103.39	742.51	204.37	61.97
SRM2585	0.94	0.48	3.75	2.72	0.10	3.49	0.00	3.86	1.60	78.66	82.69	7.55	39.64
Median	0.64	8.25	16.52	16.06	1.00	113.50	118.83	4.05	0.34	1103.75	1320.50	324.66	244.08
Max	4.73	38.51	284.41	181.11	60.67	2029.78	238.10	46.71	1.60	3731.56	4150.54	1780.95	832.17
Min	0.00	0.23	1.98	0.36	0.10	1.98	0.00	0.87	0.00	0.00	15.91	7.55	3.89

Table S5. Concentration (μg/g dust) of several organophosphates, phthalates and FAs in the 10 raw house dust extracts.

Sample ID	Concentration (μg/g dust)											
	TBP	DiBP	DBP	BBP	TPP	DEHP	DiNP	DEP	OA	PA	SA	MA
D-7	0.42	6.71	4.71	5.51	0.24	170.15	483.61	3.70	1807.49	1352.46	451.64	107.98
D-8	0.48	7.05	11.57	115.51	0.52	226.65	183.47	3.88	7075.05	6485.11	1402.41	341.56
D-9	NA	7.15	5.79	13.34	0.95	89.28	61.14	7.95	874.26	161.37	19.92	25.60
D-10	0.78	60.04	6.63	8.61	0.61	206.50	110.85	8.25	571.14	181.51	38.19	22.78
D-11	NA	10.55	12.24	30.05	1.83	198.16	150.09	41.54	957.67	1207.73	297.76	220.81
E-6	2.93	4.29	9.08	6.73	1.46	315.88	85.53	6.30	512.47	1131.41	341.57	110.52
E-7	1.42	3.14	20.83	126.58	0.49	83.75	205.45	4.95	1404.40	1158.66	185.69	118.82
E-8	0.59	4.17	7.07	21.66	0.22	205.25	39.65	2.61	271.54	881.73	35.74	91.63
E-9	NA	2.76	8.23	41.36	0.87	41.87	48.78	7.26	1039.08	612.23	115.21	130.92
E-10	NA	1.37	10.33	5.65	0.42	29.47	28.38	5.80	146.94	435.70	107.81	136.07
Median	0.68	5.50	8.65	17.50	0.56	184.15	98.19	6.05	915.97	1006.57	150.45	114.67
Max	2.93	60.04	20.83	126.58	1.83	315.88	483.61	41.54	7075.05	6485.11	1402.41	341.56
Min	NA	1.37	4.71	5.51	0.22	29.47	28.38	2.61	146.94	161.37	19.92	22.78

Table S6. Pearson Correlation Analysis between the concentration of several organophosphates, phthalates and FAs with PPARγ activation potency in 25 dust extracts at 6 different doses (Dose 1: 8 μg DEQ/mL; Dose 2: 25 μg DEQ/mL; Dose 3: 74 μg DEQ/mL; Dose 4: 222 μg DEQ/mL; Dose 2: 667 μg DEQ/mL; Dose 6: 2000 μg DEQ/mL). All the correlation with $p < 0.05$ was marked in red.

	Dose 5	Dose 4	Dose 3	Dose 2	Dose 1	TBP	DiBP	DBP	BBP	TPP	DEHP	DiNP	DEP	DMP	OA	PA	SA	MA
Dose 6	0.421	0.14	-0.284	-0.127	-0.0574	-0.403	-0.318	-0.537	-0.0811	-0.446	-0.484	-0.47	-0.467	-0.322	-0.272	-0.355	-0.364	-0.339
	0.347	0.765	0.538	0.786	0.903	0.371	0.488	0.213	0.863	0.316	0.271	0.287	0.291	0.481	0.555	0.435	0.422	0.457
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Dose 5		0.698	0.176	-0.273	-0.107	-0.0822	0.114	-0.131	-0.0628	0.108	-0.0482	0.262	0.268	-0.518	0.647	0.247	0.158	0.334
		0.0006	0.459	0.244	0.654	0.73	0.632	0.583	0.793	0.651	0.84	0.264	0.254	0.0193	0.002	0.294	0.506	0.15
		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Dose 4			0.587	0.214	0.0759	-0.0178	0.0011	-0.354	0.113	-0.192	-0.262	0.252	0.0436	-0.293	0.743	0.666	0.571	0.732
			0.0021	0.304	0.718	0.933	0.996	0.0824	0.589	0.358	0.206	0.225	0.836	0.155	2E-05	0.0003	0.00286	0.0000322
			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Dose 3				0.614	0.469	-0.137	-0.188	-0.457	-0.0413	-0.175	-0.271	-0.0339	-0.305	-0.0176	0.5	0.278	0.257	0.279
				0.0011	0.0179	0.514	0.368	0.0216	0.844	0.404	0.19	0.872	0.139	0.934	0.0109	0.178	0.214	0.177
				25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Dose 2					0.77	-0.0692	-0.35	-0.568	-0.13	-0.289	-0.312	-0.138	-0.508	-0.037	0.118	-0.0297	-0.0307	-0.0298
					7E-06	0.742	0.086	0.0031	0.534	0.161	0.129	0.509	0.0096	0.861	0.574	0.888	0.884	0.887
					25	25	25	25	25	25	25	25	25	25	25	25	25	25
Dose 1						0.071	-0.339	-0.351	-0.126	-0.0237	-0.156	-0.0436	-0.213	0.0785	0.0793	-0.273	-0.238	-0.242
						0.736	0.0971	0.0858	0.547	0.91	0.456	0.836	0.308	0.709	0.706	0.187	0.252	0.244
						25	25	25	25	25	25	25	25	25	25	25	25	25
TBP							-0.0906	-0.0872	0.335	-0.0224	-0.0811	0.139	0.538	-0.0379	0.277	-0.0273	-0.0415	0.00721
							0.667	0.679	0.102	0.915	0.7	0.509	0.0056	0.857	0.181	0.897	0.844	0.973
							25	25	25	25	25	25	25	25	25	25	25	25
DiBP								0.44	0.153	0.0221	0.295	0.57	0.243	-0.191	-0.0597	0.287	0.262	0.233
								0.0279	0.465	0.917	0.152	0.003	0.241	0.36	0.777	0.164	0.206	0.263
								25	25	25	25	25	25	25	25	25	25	25
DBP									0.39	0.584	0.785	0.324	0.475	-0.097	-0.392	-0.204	-0.198	-0.223
									0.0536	0.0022	3E-06	0.114	0.0164	0.645	0.0528	0.329	0.342	0.284
									25	25	25	25	25	25	25	25	25	25
BBP										0.508	0.14	0.264	0.387	-0.139	0.0274	0.268	0.23	0.264
										0.0095	0.504	0.203	0.0557	0.507	0.897	0.196	0.269	0.202
										25	25	25	25	25	25	25	25	25
TPP											0.243	-0.0287	0.263	0.0334	-0.252	-0.224	-0.194	-0.211
											0.243	0.891	0.204	0.874	0.223	0.282	0.353	0.31
											25	25	25	25	25	25	25	25
DEHP												0.402	0.303	-0.067	-0.306	-0.225	-0.19	-0.192
												0.0463	0.141	0.75	0.136	0.28	0.362	0.358
												25	25	25	25	25	25	25
DiNP													0.209	-0.209	0.378	0.304	0.222	0.395
													0.315	0.317	0.0623	0.139	0.285	0.0505
													25	25	25	25	25	25
DEP														-0.126	0.148	0.0284	0.00961	0.00088
														0.548	0.479	0.893	0.964	0.997
														25	25	25	25	25
DMP															-0.244	-0.244	-0.188	-0.162
															0.24	0.239	0.367	0.44
															25	25	25	25
OA																0.458	0.323	0.546
																0.0212	0.115	0.00476
																25	25	25
PA																	0.961	0.896
																	2.63E-14	1.49E-09
																	25	25
SA																		0.841
																		1.42E-07
																		25

Table S7. Spearman Correlation Analysis between the concentration of several organophosphates, phthalates and fatty acids with PPARγ activation potency in 10 raw dust extracts at 3 different doses (Dose 1: 222 μg DEQ/mL; Dose 2: 667 μg DEQ/mL; Dose 3: 2000 μg DEQ/mL). All the correlation with $p < 0.05$ was marked in red.

	Dose 2	Dose 1	TBP	DiBP	DBP	BBP	TPP	DEHP	DiNP	DEP	OA	PA	SA	MA
Dose 3	--	0	0	0	0	0	0	0	0	0	0	0	0	0
	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Dose 2		0.873	0.0793	-0.00131	0.297	0.585	0.0407	0.334	0.148	-0.132	0.896	0.873	0.88	0.778
		0.00463	0.852	0.998	0.475	0.128	0.924	0.419	0.726	0.755	0.00261	0.0046	0.00395	0.0229
		8	8	8	8	8	8	8	8	8	8	8	8	8
Dose 1			0.0248	-0.15	0.267	0.591	-0.168	0.288	0.498	-0.0783	0.922	0.934	0.966	0.831
			0.946	0.68	0.455	0.072	0.643	0.419	0.143	0.83	0.000149	0.0000752	5.81E-06	0.00288
			10	10	10	10	10	10	10	10	10	10	10	10
TBP				0.0104	0.23	0.0749	0.178	0.606	0.0158	-0.285	-0.0839	0.0185	0.0553	-0.131
				0.977	0.522	0.837	0.623	0.0631	0.965	0.425	0.818	0.96	0.879	0.719
				10	10	10	10	10	10	10	10	10	10	10
DiBP					-0.249	-0.222	-0.0209	0.254	-0.0194	0.0742	-0.105	-0.178	-0.168	-0.356
					0.488	0.537	0.954	0.478	0.958	0.839	0.773	0.624	0.643	0.313
					10	10	10	10	10	10	10	10	10	10
DBP						0.786	0.1	-0.174	-0.0211	0.166	0.182	0.223	0.159	0.378
						0.007	0.783	0.63	0.954	0.646	0.615	0.535	0.66	0.282
						10	10	10	10	10	10	10	10	10
BBP							-0.165	-0.0965	0.132	-0.107	0.663	0.641	0.551	0.58
							0.649	0.791	0.715	0.768	0.0368	0.0458	0.0989	0.0786
							10	10	10	10	10	10	10	10
TPP								0.308	-0.252	0.773	-0.172	-0.122	-0.0597	0.138
								0.387	0.482	0.0088	0.635	0.737	0.87	0.704
								10	10	10	10	10	10	10
DEHP									0.163	0.117	0.227	0.347	0.387	0.194
									0.653	0.747	0.528	0.325	0.269	0.591
									10	10	10	10	10	10
DiNP										-0.0406	0.316	0.251	0.366	0.153
										0.911	0.375	0.485	0.298	0.674
										10	10	10	10	10
DEP											-0.144	-0.106	-0.0713	0.259
											0.691	0.771	0.845	0.469
											10	10	10	10
OA												0.971	0.957	0.791
												0.00000287	0.000014	0.00643
												10	10	10
PA													0.979	0.865
													8.54E-07	0.00123
													10	10
SA														0.855
														0.00161
														10

Table S8. Concentration (μg/g dust) of four FAs in cat hair, dog hair, human hair, human skin debris, fish liver oil, and two vegetable oil.

Sample	Concentration (μg/g)				
	OA	PA	SA	MA	Total
Cat Hair	41.3	108.6	35.8	40.6	226.2
Dog Hair	25.3	86.5	29.9	44.8	186.5
Human Hair	331.8	889.1	49.3	191.1	1461.3
Human Skin Debris	3061.1	9368.1	548.9	1890.0	14868.1
Fish Liver oil	1533.5	1445.4	172.0	257.9	3408.8
Vegetable oil1	3544.9	1174.2	441.2	26.1	5186.3
Vegetable oil2	3262.0	998.0	425.7	20.5	4706.2

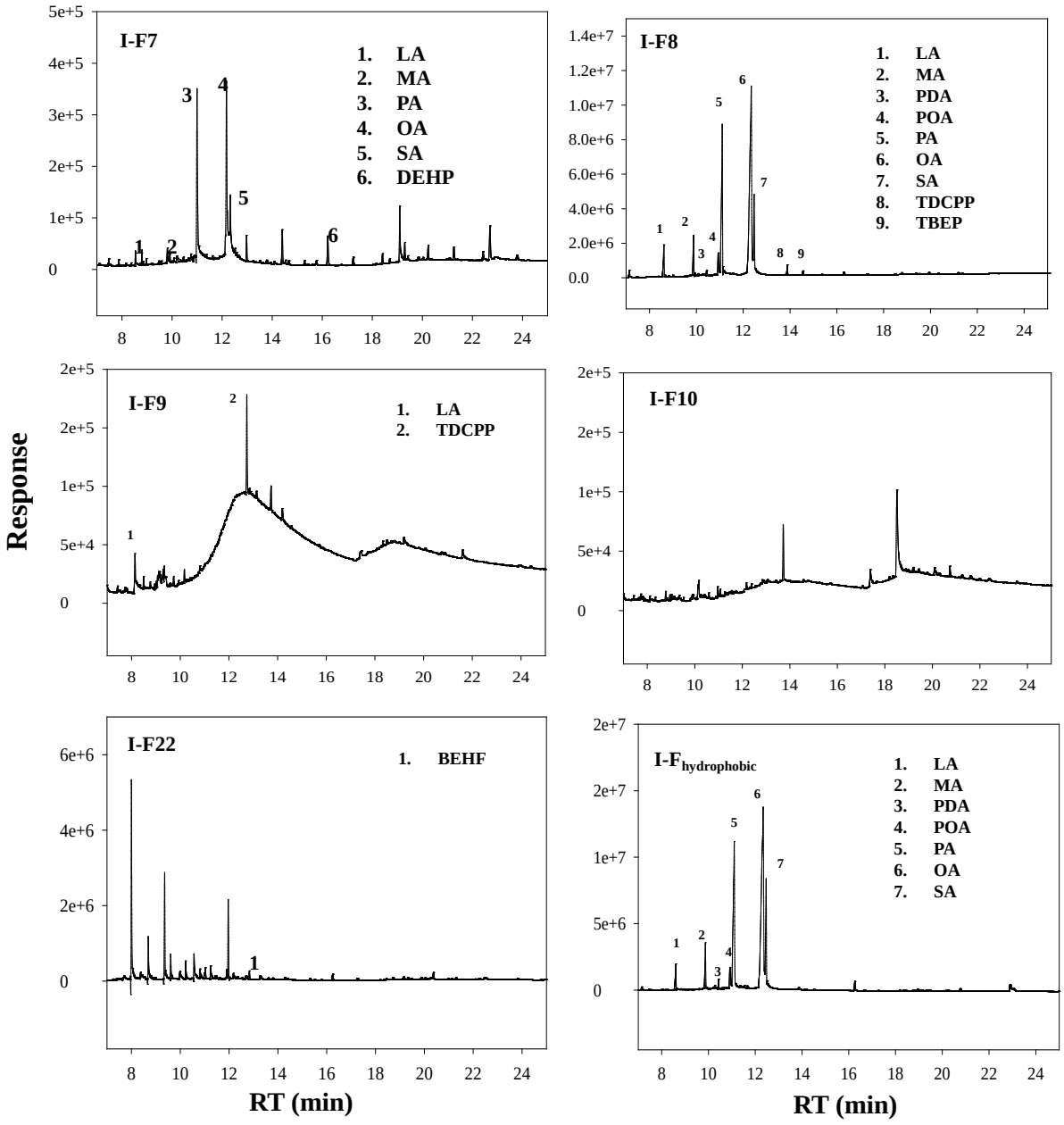

Figure S1. Full scan of PPARγ active fractions (F7, F8, F9, F10, and F22, 1.5 min/fraction; I-$F_{hydrophobic}$ is the insoluble fraction attached to the vial bottom in methanol:H_2O (1:1, V/V)) and the identified chemicals in Dust I using GC-MS/EI based on authentic standards or spectral match. See Table 1 for the abbreviation and other information for the chemicals.

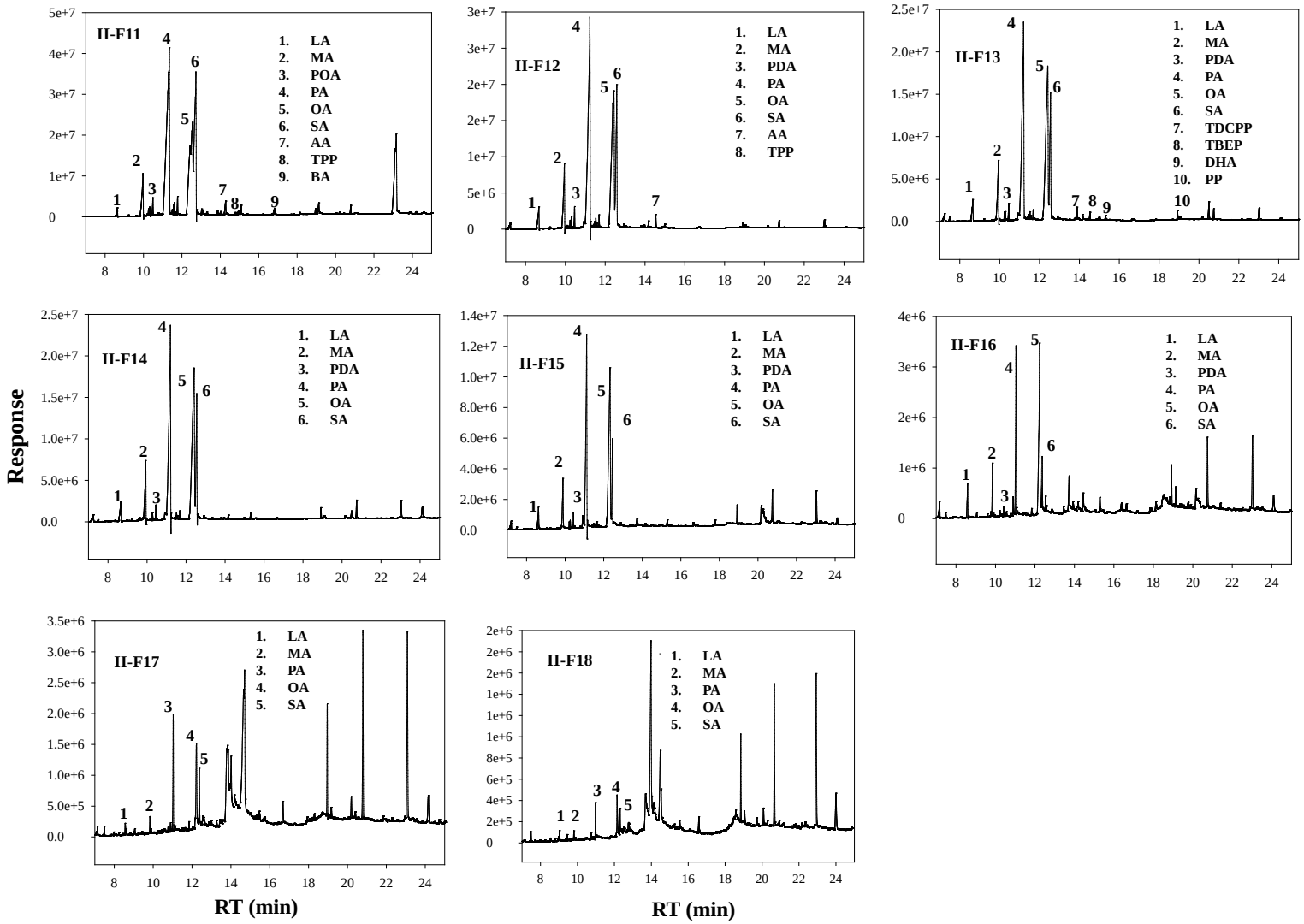

Figure S2. Full scan of PPARγ active fraction and the identified chemicals in Dust II using GC-MS/EI based on authentic standards or spectral match. See Table 1 for the abbreviation and other information for the chemicals.

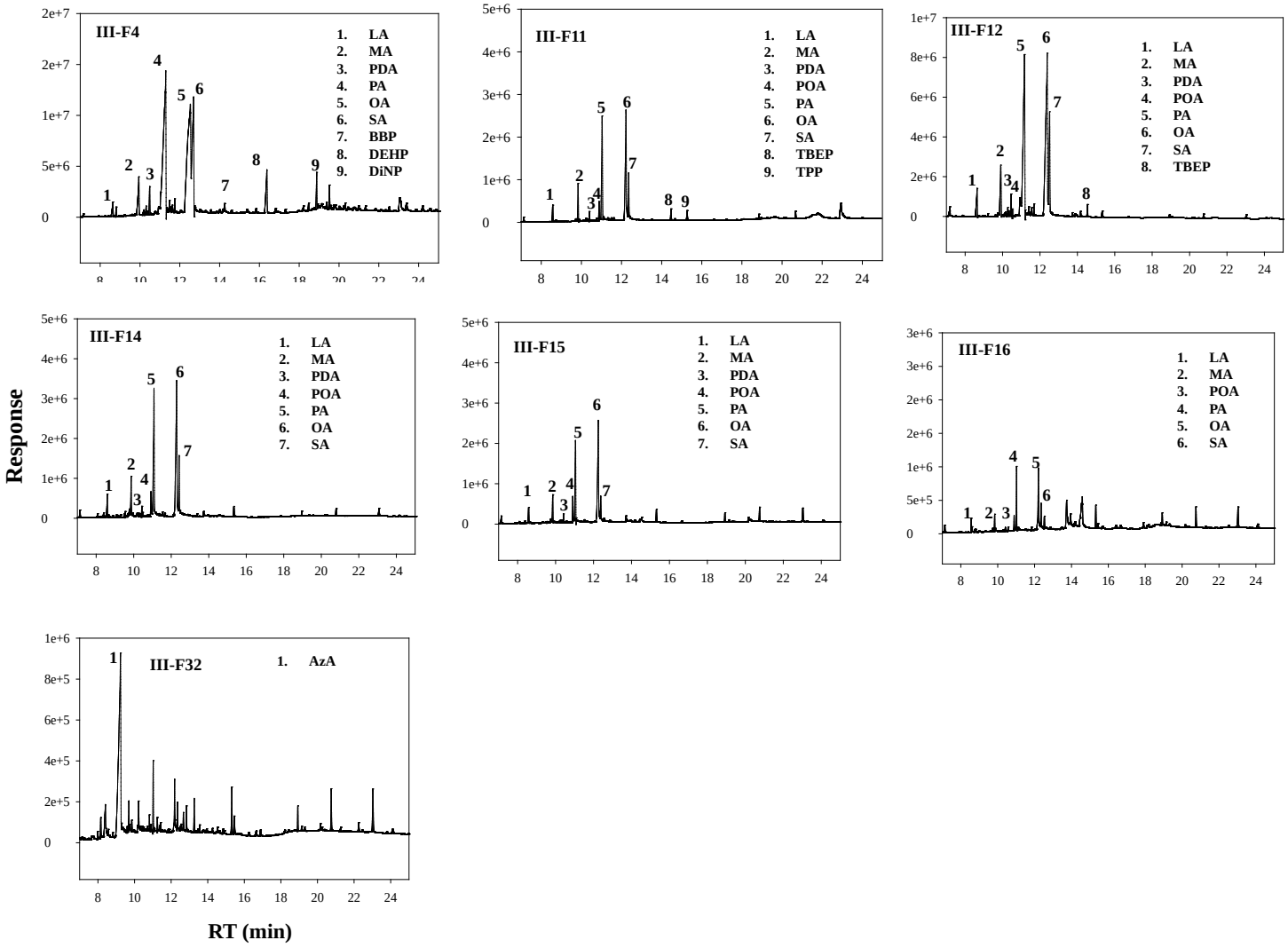

Figure S3. Full scan of PPARγ active fraction (F4, F11, F12, F14, F15, F16, and F32) and the identified chemicals in Dust III using GC-MS/EI based on authentic standards or spectral match. See Table 1 for the abbreviation and other information for the chemicals.

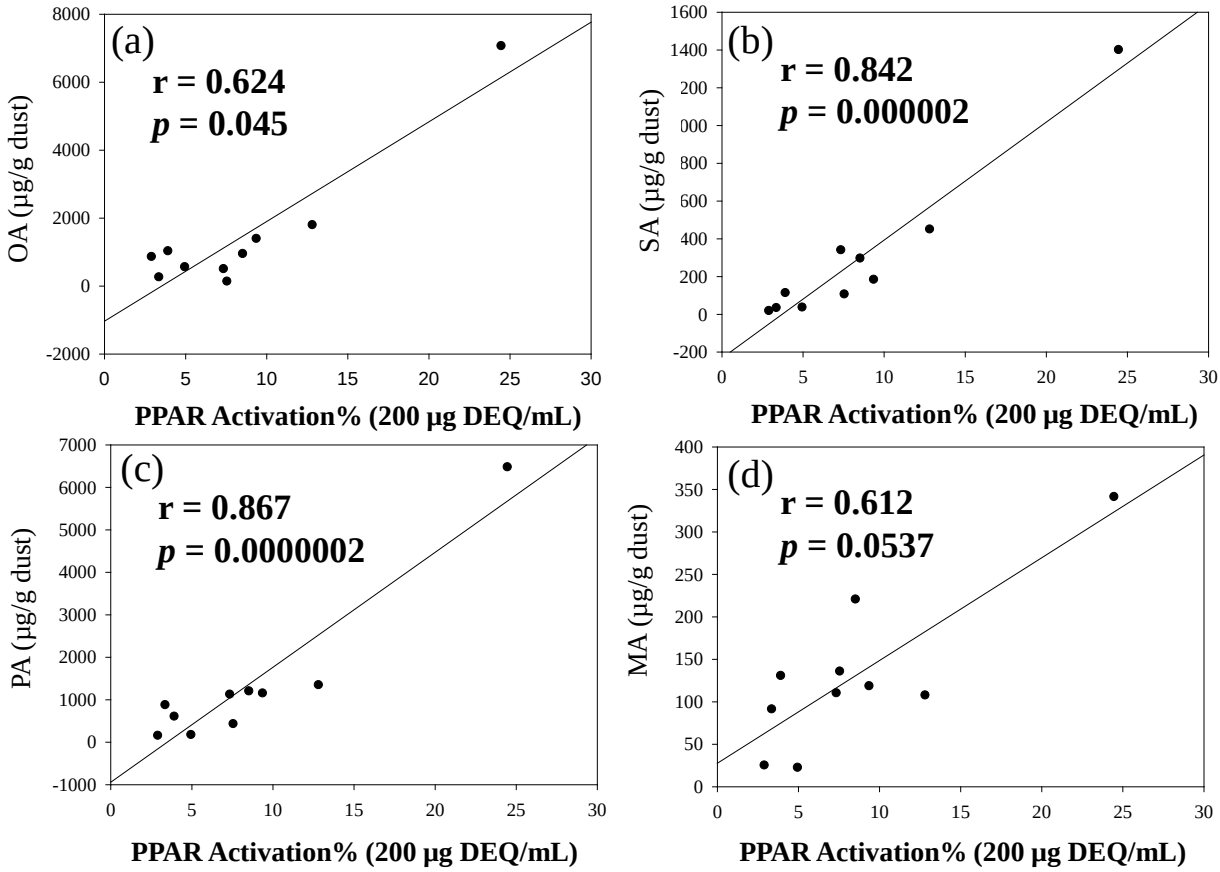

Figure S4. Linear regression between the PPARγ activation (%) at the dose of 200 µg DEQ/mL and the concentration of (a) OA, (b) PA, (c) SA, and (d) MA in 10 raw dust extracts.

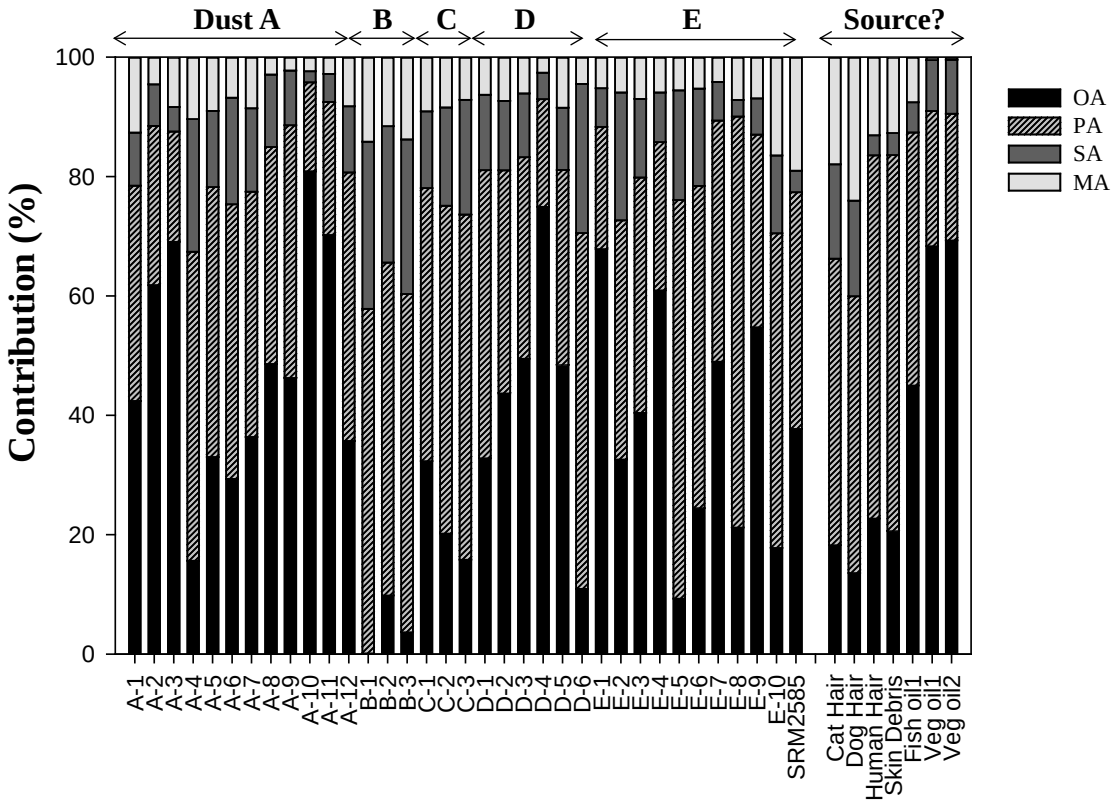

Figure S5. The contribution (%) of OA, PA, SA, and MA to the sum of the FAs in 35 house dust extracts and several possible sources.

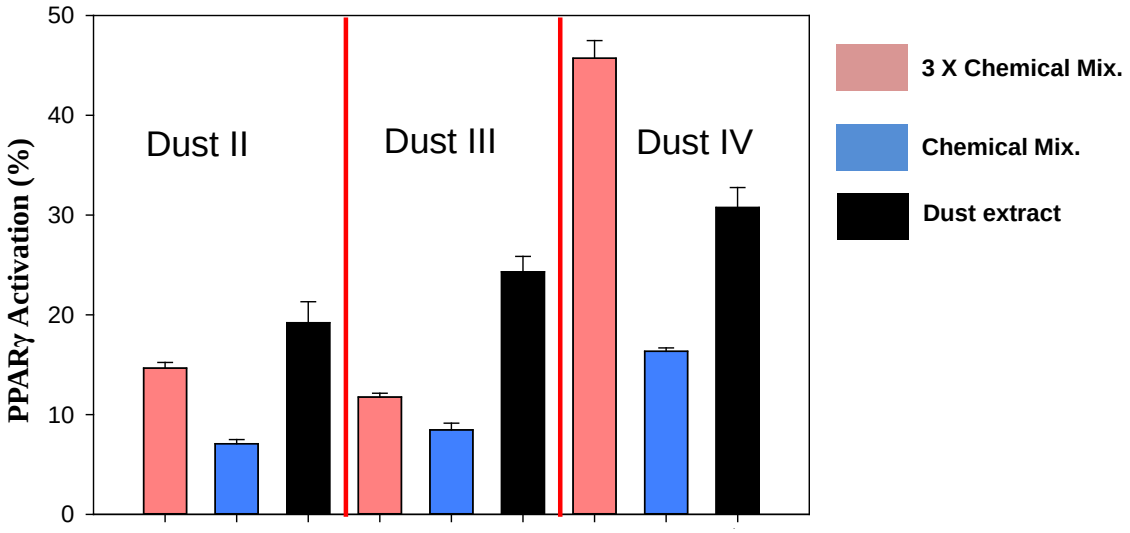

Figure S6. PPARγ activation (%) observed in the three dust extracts (~606 µg DEQ/mL) and the fatty acid mixture containing equivalent concentrations of OA, PA, SA, and MA. The fatty acid mixture was tested at the median concentration measured in the dust extract and at a concentration equivalent to three times the median concentration. Samples II and III were the dust extracts used in the NP-HPLC fractionation and Sample IV was one of the fresh dust extracts tested.