Supplementary Materials

Does the presence of polychlorinated alkanes in plastic fruit stickers adhesive pose a threat to human health?

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Supplementary Text 1. Chemicals

Commercial SCCP mixtures (Cl degree: 51.5%, 55.5% and 63%), MCCP mixtures (Cl degree: 42%, 52%, and 57%), and LCCP mixtures (Cl degree: 36% and 49%) were purchased from Dr. Ehrenstorfer (Augsburg, Germany). $^{13}C_{12}$-1,5,5,6,6,10-hexachlorodecane was purchased from Cambridge Isotope Laboratories (Tewksbury, MA, USA). Liquid/gas chromatography grade dichloromethane (DCM), *n*-hexane, acetone, and acetonitrile (ACN) were purchased from Merck (Darmstadt, Germany). Kimwipes were purchased from Kimtech Science (Roswell, GA, USA). Silica gel (40-60 μm), and sulfuric acid (98%) were purchased from Sigma-Aldrich (Castle Hill, NSW, Australia). Silica gel was baked at 140 °C for 24 h before activation by addition of 40% sulfuric acid on a w/w basis.

Supplementary Text 2. Instrumental analysis

The instrumental method for the analysis of CPs were adopted from our previous publication.[1] Briefly, 10 μL of the sample was directly, without using a chromatographic column, injected into a quadrupole time-of-flight high resolution mass spectrometer (QToF-HRMS, TOF 5600 Sciex, Ontario, Canada), in negative atmospheric pressure chemical ionization (APCI) mode. ACN was used as eluent with an isocratic flow rate of 250 μL/min. To enhance the ionization of CPs, DCM was used as a dopant and mixed with the eluent just prior to entering the ion source, with the flow rate of 40 μL/min. The APCI-QToF-HRMS setting were as follow: nebulizer temperature at 200 °C, declustering potential (DP) at −20 V, collision energy (CE) at −10 V, and collision exit cell potential (CXP) at −10 V. The mass spectrometer was operated in TOF-MS mode measuring the full scan range of *m/z* 250−1050. The minimal resolution was 22,500. The window for extracting the *m/z* values was set as ± 0.0025. External mass calibration was performed before every 10 samples with the Sciex APCI Negative Calibration solution 5600. The *m/z* ratios for CPs were chosen as suggested by Bogdal *et al*.[2]

Supplementary Table 1. Detection rate (%) of each congener group studied

Group	Congener	DF (%)	Group	Congener	DF (%)	Group	Congener	DF (%)
PCA-$C_{<10}$	$C_6H_{10}Cl_4$	0	PCA-$C_{14\text{-}17}$	$C_{14}H_{23}Cl_7$	40	PCA-$C_{18\text{-}21}$	$C_{18}H_{26}Cl_{12}$	0
PCA-$C_{<10}$	$C_6H_9Cl_5$	0	PCA-$C_{14\text{-}17}$	$C_{14}H_{22}Cl_8$	20	PCA-$C_{18\text{-}21}$	$C_{18}H_{25}Cl_{13}$	0
PCA-$C_{<10}$	$C_6H_8Cl_6$	0	PCA-$C_{14\text{-}17}$	$C_{14}H_{21}Cl_9$	27	PCA-$C_{18\text{-}21}$	$C_{18}H_{24}Cl_{14}$	0
PCA-$C_{<10}$	$C_7H_{12}Cl_4$	0	PCA-$C_{14\text{-}17}$	$C_{14}H_{20}Cl_{10}$	13	PCA-$C_{18\text{-}21}$	$C_{18}H_{23}Cl_{15}$	0
PCA-$C_{<10}$	$C_7H_{11}Cl_5$	0	PCA-$C_{14\text{-}17}$	$C_{14}H_{19}Cl_{11}$	0	PCA-$C_{18\text{-}21}$	$C_{18}H_{22}Cl_{16}$	0
PCA-$C_{<10}$	$C_7H_{10}Cl_6$	7	PCA-$C_{14\text{-}17}$	$C_{14}H_{18}Cl_{12}$	0	PCA-$C_{18\text{-}21}$	$C_{18}H_{21}Cl_{17}$	0
PCA-$C_{<10}$	$C_7H_9Cl_7$	0	PCA-$C_{14\text{-}17}$	$C_{14}H_{17}Cl_{13}$	0	PCA-$C_{18\text{-}21}$	$C_{18}H_{20}Cl_{18}$	0
PCA-$C_{<10}$	$C_8H_{15}Cl_3$	40	PCA-$C_{14\text{-}17}$	$C_{14}H_{16}Cl_{14}$	0	PCA-$C_{18\text{-}21}$	$C_{19}H_{39}Cl_1$	100
PCA-$C_{<10}$	$C_8H_{14}Cl_4$	47	PCA-$C_{14\text{-}17}$	$C_{15}H_{31}Cl_1$	93	PCA-$C_{18\text{-}21}$	$C_{19}H_{38}Cl_2$	100
PCA-$C_{<10}$	$C_8H_{13}Cl_5$	7	PCA-$C_{14\text{-}17}$	$C_{15}H_{30}Cl_2$	100	PCA-$C_{18\text{-}21}$	$C_{19}H_{37}Cl_3$	100
PCA-$C_{<10}$	$C_8H_{12}Cl_6$	0	PCA-$C_{14\text{-}17}$	$C_{15}H_{29}Cl_3$	100	PCA-$C_{18\text{-}21}$	$C_{19}H_{36}Cl_4$	47
PCA-$C_{<10}$	$C_8H_{11}Cl_7$	0	PCA-$C_{14\text{-}17}$	$C_{15}H_{28}Cl_4$	73	PCA-$C_{18\text{-}21}$	$C_{19}H_{35}Cl_5$	33
PCA-$C_{<10}$	$C_8H_{10}Cl_8$	0	PCA-$C_{14\text{-}17}$	$C_{15}H_{27}Cl_5$	87	PCA-$C_{18\text{-}21}$	$C_{19}H_{34}Cl_6$	13
PCA-$C_{<10}$	$C_9H_{17}Cl_3$	33	PCA-$C_{14\text{-}17}$	$C_{15}H_{26}Cl_6$	67	PCA-$C_{18\text{-}21}$	$C_{19}H_{33}Cl_7$	0
PCA-$C_{<10}$	$C_9H_{16}Cl_4$	7	PCA-$C_{14\text{-}17}$	$C_{15}H_{25}Cl_7$	20	PCA-$C_{18\text{-}21}$	$C_{19}H_{32}Cl_8$	0
PCA-$C_{<10}$	$C_9H_{15}Cl_5$	0	PCA-$C_{14\text{-}17}$	$C_{15}H_{24}Cl_8$	7	PCA-$C_{18\text{-}21}$	$C_{19}H_{31}Cl_9$	7
PCA-$C_{<10}$	$C_9H_{14}Cl_6$	20	PCA-$C_{14\text{-}17}$	$C_{15}H_{23}Cl_9$	13	PCA-$C_{18\text{-}21}$	$C_{19}H_{30}Cl_{10}$	0
PCA-$C_{<10}$	$C_9H_{13}Cl_7$	0	PCA-$C_{14\text{-}17}$	$C_{15}H_{22}Cl_{10}$	7	PCA-$C_{18\text{-}21}$	$C_{19}H_{29}Cl_{11}$	0
PCA-$C_{<10}$	$C_9H_{12}Cl_8$	7	PCA-$C_{14\text{-}17}$	$C_{15}H_{21}Cl_{11}$	0	PCA-$C_{18\text{-}21}$	$C_{19}H_{28}Cl_{12}$	0
PCA-$C_{<10}$	$C_9H_{11}Cl_9$	0	PCA-$C_{14\text{-}17}$	$C_{15}H_{20}Cl_{12}$	0	PCA-$C_{18\text{-}21}$	$C_{19}H_{27}Cl_{13}$	0
PCA-$C_{10\text{-}13}$	$C_{10}H_{19}Cl_3$	67	PCA-$C_{14\text{-}17}$	$C_{15}H_{19}Cl_{13}$	0	PCA-$C_{18\text{-}21}$	$C_{19}H_{26}Cl_{14}$	0
PCA-$C_{10\text{-}13}$	$C_{10}H_{18}Cl_4$	40	PCA-$C_{14\text{-}17}$	$C_{15}H_{18}Cl_{14}$	0	PCA-$C_{18\text{-}21}$	$C_{19}H_{25}Cl_{15}$	0
PCA-$C_{10\text{-}13}$	$C_{10}H_{17}Cl_5$	33	PCA-$C_{14\text{-}17}$	$C_{15}H_{17}Cl_{15}$	0	PCA-$C_{18\text{-}21}$	$C_{19}H_{24}Cl_{16}$	0
PCA-$C_{10\text{-}13}$	$C_{10}H_{16}Cl_6$	7	PCA-$C_{14\text{-}17}$	$C_{16}H_{33}Cl_1$	100	PCA-$C_{18\text{-}21}$	$C_{19}H_{23}Cl_{17}$	0
PCA-$C_{10\text{-}13}$	$C_{10}H_{15}Cl_7$	13	PCA-$C_{14\text{-}17}$	$C_{16}H_{32}Cl_2$	93	PCA-$C_{18\text{-}21}$	$C_{19}H_{22}Cl_{18}$	0
PCA-$C_{10\text{-}13}$	$C_{10}H_{14}Cl_8$	7	PCA-$C_{14\text{-}17}$	$C_{16}H_{31}Cl_3$	1	PCA-$C_{18\text{-}21}$	$C_{19}H_{21}Cl_{19}$	0
PCA-$C_{10\text{-}13}$	$C_{10}H_{13}Cl_9$	0	PCA-$C_{14\text{-}17}$	$C_{16}H_{30}Cl_4$	73	PCA-$C_{18\text{-}21}$	$C_{20}H_{41}Cl_1$	100
PCA-$C_{10\text{-}13}$	$C_{10}H_{12}Cl_{10}$	0	PCA-$C_{14\text{-}17}$	$C_{16}H_{29}Cl_5$	60	PCA-$C_{18\text{-}21}$	$C_{20}H_{40}Cl_2$	100
PCA-$C_{10\text{-}13}$	$C_{11}H_{22}Cl_2$	47	PCA-$C_{14\text{-}17}$	$C_{16}H_{28}Cl_6$	40	PCA-$C_{18\text{-}21}$	$C_{20}H_{39}Cl_3$	100
PCA-$C_{10\text{-}13}$	$C_{11}H_{21}Cl_3$	67	PCA-$C_{14\text{-}17}$	$C_{16}H_{27}Cl_7$	40	PCA-$C_{18\text{-}21}$	$C_{20}H_{38}Cl_4$	47
PCA-$C_{10\text{-}13}$	$C_{11}H_{20}Cl_4$	27	PCA-$C_{14\text{-}17}$	$C_{16}H_{26}Cl_8$	7	PCA-$C_{18\text{-}21}$	$C_{20}H_{37}Cl_5$	33
PCA-$C_{10\text{-}13}$	$C_{11}H_{19}Cl_5$	0.2	PCA-$C_{14\text{-}17}$	$C_{16}H_{25}Cl_9$	0	PCA-$C_{18\text{-}21}$	$C_{20}H_{36}Cl_6$	47
PCA-$C_{10\text{-}13}$	$C_{11}H_{18}Cl_6$	47	PCA-$C_{14\text{-}17}$	$C_{16}H_{24}Cl_{10}$	0	PCA-$C_{18\text{-}21}$	$C_{20}H_{35}Cl_7$	20
PCA-$C_{10\text{-}13}$	$C_{11}H_{17}Cl_7$	33	PCA-$C_{14\text{-}17}$	$C_{16}H_{23}Cl_{11}$	0	PCA-$C_{18\text{-}21}$	$C_{20}H_{34}Cl_8$	7
PCA-$C_{10\text{-}13}$	$C_{11}H_{16}Cl_8$	0	PCA-$C_{14\text{-}17}$	$C_{16}H_{22}Cl_{12}$	0	PCA-$C_{18\text{-}21}$	$C_{20}H_{33}Cl_9$	0
PCA-$C_{10\text{-}13}$	$C_{11}H_{15}Cl_9$	33	PCA-$C_{14\text{-}17}$	$C_{16}H_{21}Cl_{13}$	0	PCA-$C_{18\text{-}21}$	$C_{20}H_{32}Cl_{10}$	0
PCA-$C_{10\text{-}13}$	$C_{11}H_{14}Cl_{10}$	33	PCA-$C_{14\text{-}17}$	$C_{16}H_{20}Cl_{14}$	0	PCA-$C_{18\text{-}21}$	$C_{20}H_{31}Cl_{11}$	0
PCA-$C_{10\text{-}13}$	$C_{11}H_{13}Cl_{11}$	0	PCA-$C_{14\text{-}17}$	$C_{16}H_{19}Cl_{15}$	0	PCA-$C_{18\text{-}21}$	$C_{20}H_{30}Cl_{12}$	0

Group	Congener	DF (%)	Group	Congener	DF (%)	Group	Congener	DF (%)
PCA-C_{10-13}	$C_{12}H_{24}Cl_2$	73	PCA-C_{14-17}	$C_{16}H_{18}Cl_{16}$	0	PCA-C_{18-21}	$C_{20}H_{29}Cl_{13}$	0
PCA-C_{10-13}	$C_{12}H_{23}Cl_3$	93	PCA-C_{14-17}	$C_{17}H_{35}Cl_1$	100	PCA-C_{18-21}	$C_{20}H_{28}Cl_{14}$	0
PCA-C_{10-13}	$C_{12}H_{22}Cl_4$	40	PCA-C_{14-17}	$C_{17}H_{34}Cl_2$	100	PCA-C_{18-21}	$C_{20}H_{27}Cl_{15}$	0
PCA-C_{10-13}	$C_{12}H_{21}Cl_5$	53	PCA-C_{14-17}	$C_{17}H_{33}Cl_3$	100	PCA-C_{18-21}	$C_{20}H_{26}Cl_{16}$	0
PCA-C_{10-13}	$C_{12}H_{20}Cl_6$	47	PCA-C_{14-17}	$C_{17}H_{32}Cl_4$	40	PCA-C_{18-21}	$C_{20}H_{25}Cl_{17}$	0
PCA-C_{10-13}	$C_{12}H_{19}Cl_7$	33	PCA-C_{14-17}	$C_{17}H_{31}Cl_5$	80	PCA-C_{18-21}	$C_{20}H_{24}Cl_{18}$	0
PCA-C_{10-13}	$C_{12}H_{18}Cl_8$	7	PCA-C_{14-17}	$C_{17}H_{30}Cl_6$	7	PCA-C_{18-21}	$C_{20}H_{23}Cl_{19}$	0
PCA-C_{10-13}	$C_{12}H_{17}Cl_9$	20	PCA-C_{14-17}	$C_{17}H_{29}Cl_7$	13	PCA-C_{18-21}	$C_{20}H_{22}Cl_{20}$	0
PCA-C_{10-13}	$C_{12}H_{16}Cl_{10}$	7	PCA-C_{14-17}	$C_{17}H_{28}Cl_8$	7	PCA-C_{18-21}	$C_{21}H_{43}Cl_1$	100
PCA-C_{10-13}	$C_{12}H_{15}Cl_{11}$	0	PCA-C_{14-17}	$C_{17}H_{27}Cl_9$	0	PCA-C_{18-21}	$C_{21}H_{42}Cl_2$	100
PCA-C_{10-13}	$C_{12}H_{14}Cl_{12}$	0	PCA-C_{14-17}	$C_{17}H_{26}Cl_{10}$	7	PCA-C_{18-21}	$C_{21}H_{41}Cl_3$	93
PCA-C_{10-13}	$C_{13}H_{27}Cl_1$	93	PCA-C_{14-17}	$C_{17}H_{25}Cl_{11}$	0	PCA-C_{18-21}	$C_{21}H_{40}Cl_4$	67
PCA-C_{10-13}	$C_{13}H_{26}Cl_2$	100	PCA-C_{14-17}	$C_{17}H_{24}Cl_{12}$	0	PCA-C_{18-21}	$C_{21}H_{39}Cl_5$	40
PCA-C_{10-13}	$C_{13}H_{25}Cl_3$	73	PCA-C_{14-17}	$C_{17}H_{23}Cl_{13}$	0	PCA-C_{18-21}	$C_{21}H_{38}Cl_6$	0
PCA-C_{10-13}	$C_{13}H_{24}Cl_4$	33	PCA-C_{14-17}	$C_{17}H_{22}Cl_{14}$	0	PCA-C_{18-21}	$C_{21}H_{37}Cl_7$	0
PCA-C_{10-13}	$C_{13}H_{23}Cl_5$	33	PCA-C_{14-17}	$C_{17}H_{21}Cl_{15}$	0	PCA-C_{18-21}	$C_{21}H_{36}Cl_8$	0
PCA-C_{10-13}	$C_{13}H_{22}Cl_6$	33	PCA-C_{14-17}	$C_{17}H_{20}Cl_{16}$	0	PCA-C_{18-21}	$C_{21}H_{35}Cl_9$	0
PCA-C_{10-13}	$C_{13}H_{21}Cl_7$	20	PCA-C_{14-17}	$C_{17}H_{19}Cl_{17}$	0	PCA-C_{18-21}	$C_{21}H_{34}Cl_{10}$	0
PCA-C_{10-13}	$C_{13}H_{20}Cl_8$	27	PCA-C_{18-21}	$C_{18}H_{37}Cl_1$	100	PCA-C_{18-21}	$C_{21}H_{33}Cl_{11}$	0
PCA-C_{10-13}	$C_{13}H_{19}Cl_9$	13	PCA-C_{18-21}	$C_{18}H_{36}Cl_2$	93	PCA-C_{18-21}	$C_{21}H_{32}Cl_{12}$	0
PCA-C_{10-13}	$C_{13}H_{18}Cl_{10}$	0	PCA-C_{18-21}	$C_{18}H_{35}Cl_3$	93	PCA-C_{18-21}	$C_{21}H_{31}Cl_{13}$	0
PCA-C_{10-13}	$C_{13}H_{17}Cl_{11}$	7	PCA-C_{18-21}	$C_{18}H_{34}Cl_4$	60	PCA-C_{18-21}	$C_{21}H_{30}Cl_{14}$	0
PCA-C_{10-13}	$C_{13}H_{16}Cl_{12}$	0	PCA-C_{18-21}	$C_{18}H_{33}Cl_5$	47	PCA-C_{18-21}	$C_{21}H_{29}Cl_{15}$	0
PCA-C_{10-13}	$C_{13}H_{15}Cl_{13}$	100	PCA-C_{18-21}	$C_{18}H_{32}Cl_6$	13	PCA-C_{18-21}	$C_{21}H_{28}Cl_{16}$	0
PCA-C_{14-17}	$C_{14}H_{29}Cl_1$	100	PCA-C_{18-21}	$C_{18}H_{31}Cl_7$	0	PCA-C_{18-21}	$C_{21}H_{27}Cl_{17}$	0
PCA-C_{14-17}	$C_{14}H_{28}Cl_2$	100	PCA-C_{18-21}	$C_{18}H_{30}Cl_8$	0	PCA-C_{18-21}	$C_{21}H_{26}Cl_{18}$	0
PCA-C_{14-17}	$C_{14}H_{27}Cl_3$	100	PCA-C_{18-21}	$C_{18}H_{29}Cl_9$	7	PCA-C_{18-21}	$C_{21}H_{25}Cl_{19}$	0
PCA-C_{14-17}	$C_{14}H_{26}Cl_4$	100	PCA-C_{18-21}	$C_{18}H_{28}Cl_{10}$	0	PCA-C_{18-21}	$C_{21}H_{24}Cl_{20}$	0
PCA-C_{14-17}	$C_{14}H_{25}Cl_5$	47	PCA-C_{18-21}	$C_{18}H_{27}Cl_{11}$	0	PCA-C_{18-21}	$C_{21}H_{23}Cl_{21}$	0
PCA-C_{14-17}	$C_{14}H_{24}Cl_6$	47						

Supplementary Table 2. Concentrations of PCA detected in fruit stickers (ng/sticker)

ID	PCA-C_{6-10}	PCA-C_{10-13}	PCA-C_{14-17}	PCA-C_{18-21}	PCA-C_{6-21}
Sticker #1	<0.40	5.7±0.3[a]	23±4[a]	27±3[a]	56
Sticker #2	<0.40	9.7±3.2[a]	23±3[a]	35±1[a]	68
Sticker #3	<0.40	7.0±0.4[a]	17±1[a]	31±1[a]	56
Sticker #4	<0.40	4.7±0.2[a]	<8.7	27±4[a]	36
Sticker #5	2.3	16	27	53	98
Sticker #6	1.1	30	40	80	150
Sticker #7	<0.40	<4.3	17	18	39
Sticker #8	<0.40	19±3	36±8	42±5	97
Sticker #9	<0.40	14	37	35	86
Sticker #10	1.1	8.2	31	68	110
Sticker #11	<0.40	9.6	41	34	86
Sticker #12	0.60	9.5	35	76	120
Sticker #13	1.1	9.5	35	48	93
Sticker #14	2.4	15	29	83	130
Sticker #15	1.3	12	23	44	80
LOD	0.40	4.3	8.7	8.8	

[a]: Data are presented as average ± standard variation based on the replicate samples analyzed for Sticker #1-4.

Supplementary Table 3. Summary of PCA concentrations in food contact materials

Material type	PCA-C_{10-13} (μg/g)	PCAs-C_{14-17} (μg/g)	Reference
Polypropylene (PP) packaging	9.750 (0.170-16100)	0.245 (0.026-29.8)	Wu et al. 2024 [3]
Polypropylene (PP) packaging	3.969 (n.d.-69.303)	2.537 (n.d.-36.074)	Wang et al. 2018 [4]
Paper packaging	2.830 (0.835-4.870)	0.135 (0.0315-1.760)	Wu et al. 2024 [3]
Aluminum foil	2.060 (0.107-30)	0.119 (0.063-0.498)	Wu et al. 2024 [3]
Polyethylene (PE)	0.150 (0.0232-0.275)	0.0208 (n.d.-0.180)	Wang et al. 2018 [4]
Polyethylene terephthalate (PET)	0.2335 (n.d.-3.382)	0.03737 (n.d.-0.101)	Wang et al. 2018 [4]
Food packaging (general)	1.888 (0.0140-8.334)	0.6443 (n.d.-10.338)	Wang et al. 2018 [4]
Fruit stickers	9.5 (<4.3-30)	31 (<8.7-41)	This study

Values are medians, with ranges in parentheses.

Supplementary Table 4. Different amounts of CPs detected in the double labelled stickers and its potential transfer to fruit (ng/sticker)

	Top sticker	Bottom sticker	Potential transfer	transfer rate
vSCCP	<0.40	<0.40	n/a	n/a
SCCP	22	16	6	26%
MCCP	43	28	16	36%
LCCP	49	37	11	23%
∑CPs	110	81	32	29%

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