



PERFLUOROOCTANOIC ACID (PFOA)
AND PERFLUOROOCTANESULFONIC
ACID (PFOS)

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TO HUMANS

Table S1.13 Occurrence of PFOA in food

Sample type	Location and collection date	No. of samples	PFOA concentration (pg/g)		Analytical method (LOD)	Comments	Reference
			Mean (range)	Median (IQR)			
Vegetables	26 developing countries ^a , 2018–19	10	7.58 (< LOQ to 27.2)	3.24	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 50% Concentrations below the LOQ were set at zero	Fiedler et al. (2022)
Vegetables and vegetable products	Europe, 2000–2016 ^d	489	6	NR	NR	DF, 14% Includes fungi; concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Vegetables	China, 2003–2019 ^b	NR	150	NR	NR	DF, NR	Fan et al. (2021)
Fruits and vegetables	USA, 2021	42	< MDL	< MDL	LC-HRMS (MDL, 20 pg/g)	DF, 0%	US FDA (2022)
Fruit and fruit products	Europe, 2000–2016 ^b	144	9	NR	NR	DF, 37% Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Fruit and fruit products	China, 2003–2019 ^b	NR	20	NR	NR	DF, NR	Fan et al. (2021)
Grains and grain-based products	Europe, 2000–2016 ^b	86	0.05	NR	NR	DF, 1% Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Grains and grain-based products	China, 2003–2019 ^b	NR	140	NR	NR	DF, NR	Fan et al. (2021)
Grains and grain-based products	USA, 2021	17	< MDL	< MDL	LC-HRMS (MDL, 41 pg/g)	DF, 0%	US FDA (2022)

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Fish and other seafood	26 developing countries ^a , 2018–2019	76	12.4 (< LOQ to 160)	8.87 (NR)	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 88% Concentrations below the LOQ were set at zero	Fiedler et al. (2022)
Fish and other seafood (fish meat)	Europe, 2000–2016 ^b	2273	117 (NR)	NR	NR	DF, 5% concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Fish and other seafood (fish offal)	Europe, 2000–2016 ^b	208	< LOQ	NR	NR	DF, 0%	Schrenk et al. (2020)
Fish and other seafood (fish and shrimp)	China, 2003–2019 ^b	NA	970	NR	NR	DF, NA	Fan et al. (2021)
Fish and other seafood products	USA, 2021	5	< MDL	NR	LC-HRMS (MDL, 90 pg/g)	DF, 0%	US FDA (2022)
Fish and other seafood	Washington (DC), USA 2021–2022	81	NR (< LOQ to 20 133)	NR	LC-MS/MS (MDL, 68–90 pg/g)	DF, 38%	Young et al. (2022)
Meat and meat products (beef)	26 developing countries ^a , 2018–2019	9	6.44 (< LOQ to 14.8)	7.19 (NR)	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 78%, Concentrations below the LOQ were set at zero	Fiedler et al. (2022)
Meat and meat products (sheep)	26 developing countries ^a , 2018–2019	2	15.6 (14.2–17.1)	15.6 (NR)	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 100%, Concentrations below the LOQ were set at zero	Fiedler et al. (2022)

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Meat and meat products (chicken)	26 developing countries ^a , 2018–2019	14	4.61 (< LOQ to 48.5)	< LOQ	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 21%	Fiedler et al. (2022)
Meat and meat products (livestock meat)	Europe, 2000–2016 ^b	459	28 (NR)	NR	NR	DF, 4% Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Meat and meat products (poultry)	Europe, 2000–2016 ^b	185	2.3	NR	NR	DF, 2% Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Meat and meat products (game mammals)	Europe, 2000–2016 ^b	572	380 (NR)	NR	NR	DF, 9% Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Meat and meat products	China, 2003–2019 ^b	NR	700 (NR)	NR	NR	DF, NR	Fan et al. (2021)
Meat and meat products	USA, 2021	8	< MDL	NR	LC-HRMS (MDL, 24 pg/g)	DF, 0%	US FDA (2022)
Milk and dairy products (butter)	26 developing countries ^a , 2018–2019	13	8.09 (< LOQ to 54.1)	< LOQ	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 46% Concentrations below the LOQ were set at zero	Fiedler et al. (2022)
Milk and dairy products (milk)	26 developing countries ^a , 2018–2019	7	0.99 (< LOQ to 6.92)	< LOQ	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 14% Concentrations below the LOQ were set at zero	Fiedler et al. (2022)

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Milk and dairy products (milk)	Europe, 2000–2016 ^b	236	< LOQ	NR	NR	DF, 0%, Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Milk and dairy products (cheese)	Europe, 2000–2016 ^b	115	7.1	< LOQ	NR	DF, 0%, Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Milk and dairy products	China, 2003–2019 ^b	NR	13 pg/mL	NR	NR	DF, NR	Fan et al. (2021)
Milk	USA, 2021	10	< MDL	< MDL	LC-HRMS (MDL, 42 pg/g)	DF 0%	US FDA (2022)
Eggs and egg products	26 developing countries ^a , 2018–2019	36	8.34 (< LOQ to 28.1)	6.94 (NR)	HPLC-MS/MS (LOQ, 6.2 pg/g)	DF, 72% Concentrations below the LOQ were set at zero	Fiedler et al. (2022)
Eggs and egg products	Europe, 2000–2016 ^b	177	106	NR	NR	DF, 8% Concentrations below the LOQ were set at zero	Schrenk et al. (2020)
Eggs and egg products	China, 2003–2019 ^b	NR	150	NR	NR	DF, NR	Fan et al. (2021)
Eggs and egg products	USA, 2021	177	< MDL	NR	LC-HRMS (MDL, 90 pg/g)	DF, 0%	US FDA (2022)

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DC, District of Columbia; DF, detection frequency; HPLC-MS/MS, high-performance liquid chromatography-tandem mass spectrometry; HRMS, high-resolution mass spectrometry; IQR, interquartile range; LC, liquid chromatography; LOD, limit of detection; LOQ, limit of quantification; MDL, method detection limit; NA, not applicable; NR, not reported; PFOA, perfluorooctanoic acid; USA, United States of America.

^a Twenty-six developing countries in Africa ($n = 10$), Asia ($n = 4$), Group of Latin America and the Caribbean countries (GRULAC; $n = 8$), and the Pacific Islands (PAC; $n = 4$).

^b Reported data from several studies.

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References

- 2 Fan X, Wang Z, Li Y, Wang H, Fan W, Dong Z (2021). Estimating the dietary exposure and risk of persistent organic pollutants in China: a national analysis. *Environ Pollut.* 288:117764.
3 <https://doi.org/10.1016/j.envpol.2021.117764> PMID:34280741
- 4 Fiedler H, Sadia M, Baabish A, Sobhane S (2022). Perfluoroalkane substances in national samples from global monitoring plan projects (2017–2019). *Chemosphere.* 307(Pt 3):136038.
5 <https://doi.org/10.1016/j.chemosphere.2022.136038> PMID:35977568
- 6 Schrenk D, Bignami M, Bodin L, Chipman JK, Del Mazo J, Grasl-Kraupp B, et al. (2020). Risk to human health related to the presence of perfluoroalkyl substances in food. *EFSA J.* 18(9):e06223. <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2020.6223> PMID:32994824
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- 8 US FDA (2022). Analytical results of testing food for PFAS from environmental contamination. Silver Spring (MD), USA: United States Food and Drug Administration. Available
9 from: <https://www.fda.gov/food/process-contaminants-food/analytical-results-testing-food-pfas-environmental-contamination>, accessed October 2024.
- 10 Young W, Wiggins S, Limm W, Fisher CM, DeJager L, Genualdi S (2022). Analysis of per- and poly(fluoroalkyl) substances (PFASs) in highly consumed seafood products from US
11 markets. *J Agric Food Chem.* 70(42):13545–53. <https://doi.org/10.1021/acs.jafc.2c04673> PMID:36251396