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Concentrations of polyfluorinated alkyl substances in the Swedish  
Market Basket 2015

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## Concentrations of polyfluorinated alkyl substances in the Swedish Market Basket 2015

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<p><b>Rapporttitel</b> Koncentrationer av polyfluorerade alkylsubstanter i Matkorgsundersökningen 2015</p>	<p><b>Beställare</b> Naturvårdsverket 106 48 Stockholm <b>Finansiering</b> Nationell hälsorelaterad miljöövervakning</p>
<p><b>Nyckelord för plats</b> Uppsala</p>	
<p><b>Nyckelord för ämne</b> Polyfluorerade alkylsubstanter</p>	
<p><b>Tidpunkt för insamling av underlagsdata</b> 2015</p>	
<p><b>Sammanfattning</b> Livsmedelsverket utför regelbundet s.k. matkorgsstudier, där representativa livsmedelsprover från den svenska marknaden analyseras avseende innehåll av både näringsämnen och toxiska ämnen. Syftet med undersökningen är att få en övergripande bild av hur föroreningssituationen ser ut gällande både väl kända kemikalier och så kallade "nya kemikalier". Resultaten används som underlag för Livsmedelsverkets riskvärdering av kemikalier i livsmedel med målet att livsmedel på den svenska marknaden ska vara säkra ur en hälsomässig synvinkel. Resultaten ingår också som underlag för Livsmedelsverkets miljömålsarbete med målet "En Giffri Miljö". I denna rapport redovisas halter av polyfluorerade alkylsubstanter som ingår i en grupp av tusentals högfluorerade kemikalier som har många olika användningsområden. Många av dessa kemikalier är så kallade prekursorer och bryts ner till perfluorerade alkylsubstanter, som i sin tur praktiskt taget inte alls bryts ner i naturen och i människor. Flera perfluorerade alkylsubstanter bioackumulerar i människor och misstänks orsaka oönskade effekter vid höga kroppsbelastningar.</p> <p>De inhandlade livsmedlen 2015 står för mer än 90 % (viktsbasis) av den totala per kapitakonsumtionen av livsmedel i Sverige. Sammanlagt 60 prover inkluderades i studien, bestående av samlingsprover av kött, fisk, mejeriprodukter, ägg, oljor/fett, cerealier, bakverk, frukt, grönsaker, potatis, socker och sötsaker, och drycker inköpta från 5 olika livsmedelskedjor i Uppsala. Endast några få av de 28 PFAS som analyserades förekom i halter över kvantifieringsgränsen. I samlingsproverna av kött och ägg hade över 50 % mätbara koncentrationer av 8:2 FTS (median: 0.40 och 2.1 ng/kg). 4:2 FTS kunde uppmätas i två samlingsprover av cerealier (ca 20 ng/kg), i två köttprover (ca 10-20 ng/kg), ett prov av mejeriprodukter (ca 20 ng/kg) och i två äggprover (ca 10-15 ng/kg). Mediankoncentrationen av 6:2/6:2 diPAP i fiskproverna uppskattades till 56 ng/kg, och uppmättes också i två prov av ägg (ca 30-35 ng/kg), ett prov av olja/fett (ca 10 ng/kg) och i ett fruktprov (ca 40 ng/kg). 6:2/14:2 diPAP hittades i ett prov av socker/sötsaker (ca 30 ng/kg) och FOSAA var mätbar i ett fiskprov (ca 20 ng/kg).</p>	

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## **INTRODUCTION**

Poly- and perfluorinated alkyl substances (PFASs) is a group of over 3000 chemicals that have many uses in society. They are surface active and fat/oil/water repellent and are used for treatment of textiles and paper and in products such as lubricants, paints and fire-fighting foams. Some PFASs are very persistent in the environment and bioaccumulate in humans (Cousins et al. 2016). Knowledge about human exposure is still limited, but it has been shown that both food and drinking water are major sources of human exposure to some PFASs. Recently the results of the Swedish National Food Agency's Market Basket 2015 study was published, reporting results for 15 perfluoroalkyl acids (PFAA) and perfluorooctane sulfonamide (FOSA) (Livsmedelsverket 2017). Here results of 28 other PFAS, including PFAA-precursors, are presented.

## **MATERIALS AND METHODS**

### ***Chemical analyses***

#### *Overview*

This method is suitable for the analysis of a suite of perfluoroalkyl acids and selected precursors in various food matrixes. Target compounds and corresponding internal standard are listed in Tables 1 and 2.

**Table 1. Precursors**

Target Compounds	Acronym <sup>1</sup>	Supplier	Internal standard
N-Methyl perfluorooctane sulfonamide	MeFOSA	Wellington	d3-MeFOSA
N-Ethyl perfluorooctane sulfonamide	EtFOSA	Wellington	d3-MeFOSA
Perfluorooctane sulfonamidoacetic acid	FOSAA	Wellington	d3-MeFOSAA
N-Methyl Perfluorooctane sulfonamidoacetic acid	MeFOSAA	Wellington	d3-MeFOSAA
N-Ethyl Perfluorooctane sulfonamidoacetic acid	EtFOSAA	Wellington	d3-MeFOSAA
N-Methyl Perfluorobutane sulfonamide	MeFBSA	Wellington	d3-MeFOSA
Sodium 1H, 1H, 2H, 2H-perfluorohexane sulfonate (4:2)	4:2 FTS	Wellington	(M2) 6:2 FTS
Sodium 1H, 1H, 2H, 2H-perfluorooctane sulfonate (6:2)	6:2 FTS	Wellington	(M2) 6:2 FTS
Sodium 1H, 1H, 2H, 2H-perfluorodecane sulfonate (8:2)	8:2 FTS	Wellington	(M2) 6:2 FTS
2-[[((6-Chloro-1,1,2,2,3,3,4,4,5,5,6,6-dodecafluorohexyl)oxy)-1,1,2,2-tetrafluoroethanesulfonic acid	F-53B	Shanghai Synica Co., Ltd.	<sup>13</sup> C <sub>2</sub> -PFDA
3-Perfluoropropyl propanoic acid (3:3)	FPrPA	Wellington	<sup>13</sup> C <sub>2</sub> -PFHxA
3-Perfluoropropyl propanoic acid (5:3)	FPePA	Wellington	<sup>13</sup> C <sub>2</sub> -PFHxA
3-Perfluoropropyl propanoic acid (7:3)	FHpPA	Wellington	<sup>13</sup> C <sub>2</sub> -PFHxA
<b>Recovery Standards</b>			
<sup>13</sup> C <sub>8</sub> labeled Perfluorooctanoic acid	M8-PFOA	Wellington	
<sup>13</sup> C <sub>8</sub> labeled Perfluorooctane sulfonic acid	M8-PFOS	Wellington	

<sup>1</sup> Acronyms are according to (Buck et al., 2011).

**Table 2. PAPs**

Target Compounds	Acronym <sup>1</sup>	Supplier	Internal standard
4:2 Fluorotelomer phosphate monoester	4:2 monoPAP	Xenia Trier	<sup>13</sup> C <sub>2</sub> -6:2 monoPAP
6:2 Fluorotelomer phosphate monoester	6:2 monoPAP	Wellington	<sup>13</sup> C <sub>2</sub> -6:2 monoPAP
8:2 Fluorotelomer phosphate monoester	8:2 monoPAP	Wellington	<sup>13</sup> C <sub>2</sub> -8:2 monoPAP
10:2 Fluorotelomer phosphate monoester	10:2 monoPAP	Chiron	<sup>13</sup> C <sub>2</sub> -8:2 monoPAP
4:2 Fluorotelomer phosphate diester	4:2/4:2 diPAP	Xenia Trier	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
4:2/6:2 Fluorotelomer phosphate diester	4:2/6:2 diPAP	Zonyl®-RP	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
6:2 Fluorotelomer phosphate diester	6:2/6:2 diPAP	Wellington	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
6:2/8:2 Fluorotelomer phosphate diester	6:2/8:2 diPAP	Zonyl®-RP	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
8:2 Fluorotelomer phosphate diester	8:2/8:2 diPAP	Wellington	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
6:2/10:2 Fluorotelomer phosphate diester	6:2/10:2 diPAP	Zonyl®-RP	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
8:2/10:2 Fluorotelomer phosphate diester	8:2/10:2 diPAP	Zonyl®-RP	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
6:2/12:2 Fluorotelomer phosphate diester	6:2/12:2 diPAP	Zonyl®-RP	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
10:2 Fluorotelomer phosphate diester	10:2/10:2 diPAP	Chiron	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
8:2/12:2 Fluorotelomer phosphate diester	8:2/12:2 diPAP	Zonyl®-RP	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
6:2/14:2 Fluorotelomer phosphate diester	6:2/14:2 diPAP	Zonyl®-RP	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
<b>Recovery Standards</b>			
<sup>13</sup> C <sub>8</sub> labeled Perfluorooctanoic acid	M8-PFOA		
<sup>13</sup> C <sub>8</sub> labeled Perfluorooctane sulfonic acid	M8-PFOS		

<sup>1</sup> Acronyms are according to (Buck et al., 2011).

### Sample preparation

A portion of homogenized sample (see Table 3 for sample size for each food group) was weighed into a 13 mL polypropylene tube and spiked with 50 µL of a 10 pg/µL internal standard solution. Four mL of acetonitrile along with 8-10 stainless steel beads (4.8 mm) were added and the samples were homogenized using a bead blender (SPEX SamplePrep 1600 MiniG ®) for 4 minutes at 1500 rpm. The organic phase was transferred to a new 13 mL polypropylene tube and the extraction was repeated twice (total of 3 extractions). The

combined extracts were concentrated to ~1 mL under a stream of nitrogen, then fortified with 9 mL water. WAX SPE cartridges (150 mg, 6 mL, Waters) were conditioned with 6 mL 2% ammonium hydroxide solution in methanol, 6 mL methanol, and 6 mL water. The sample extracts were then loaded onto the cartridges and washed with 1 mL 1% formic acid and 2 mL water, then dried under vacuum for ~5 minutes. Analytes were eluted with 4 mL 1% ammonium hydroxide solution in methanol into a 13 mL polypropylene tube. After evaporating to dryness under a stream of nitrogen the extracts were reconstituted in 150  $\mu$ L methanol. The tubes were vortexed and the extract was filtered using centrifuge filters (modified nylon 0.2  $\mu$ m, 500  $\mu$ L, VWR International). Extracts were transferred to auto sampler vials and 50  $\mu$ L recovery standard (10 pg/ $\mu$ L) was added prior to UPLC-MS/MS analysis.

**Table 3. Sample amounts (wet weight)**

<b>Matrix</b>	<b>Amount (g)</b>
Cereals	1.0
Pastries	1.5
Eggs	1.5
Meat/meat products	1.5
Dairy	3.5
Fish/fish products	1.5
Fats/oils	1.5
Potatoes/potato products	3.5
Fruits	3.5
Vegetables	3.5
Sugar/sweets	1.5
Soft drinks	2.0

#### *Instrumental analysis and quantification*

Extracts were analyzed twice, first for PFCAs, PFSAAs and precursors then for mono- and di-PAPs. An Acquity UPLC system (Waters) equipped with a BEH C18 (50  $\times$  2.1 mm, 1.7  $\mu$ m particle size, Waters) analytical column was used for all instrumental analyses. Mobile phase A was composed of 95% water and 5% methanol, while mobile phase B was composed of 75% methanol, 20% acetonitrile, and 5% water; both contained 2 mM ammonium acetate and 5 mM 1-methyl piperidine. Tables 4 and 5 show the mobile phases, gradient programs, and flow rates for the corresponding groups of compounds analyzed. The injection volume was 5  $\mu$ L and the column temperature was set to 40°C. The UPLC system was coupled to a Xevo TQ-S triple quadrupole mass spectrometer (Waters), which was operated in negative ion electrospray ionization (ESI-) mode. The source and desolvation temperatures were set to 150°C and 350°C, respectively, and the desolvation and cone gas flows were set to 650 L/h

and 150 L/h, respectively. The capillary voltage was set to 3.0 kV. Optimized cone-voltages and collision energies for each compound are provided in Table 6.

**Table 4. Mobile phase gradient program for, PFSAs, PFCAs, and precursors**

Time	Mobile phase A (%) <sup>1</sup>	Mobile phase B (%) <sup>2</sup>
0.0	90	10
0.5	90	10
5.0	20	80
5.1	0	100
8.0	0	100
10.0	90	10

Note: Flow rate was 0.4 mL/min, column temperature was 40 °C, and injection volume was 5 µL.

<sup>1</sup> Mobile phase A: 95 % water and 5 % methanol containing 2 mM ammonium acetate and 5 mM 1-methyl piperidine (1-MP).

<sup>2</sup> Mobile phase B: 75 % methanol, 20 % acetonitrile, and 5 % water containing 2 mM ammonium acetate and 5 mM 1-methyl piperidine (1-MP).

**Table 5. Mobile phase gradient program for mono- and diPAPs.**

Time	Mobile phase A (%) <sup>1</sup>	Mobile phase B (%) <sup>2</sup>
0.0	80	20
4.0	0	100
6.0	0	100
7.5	80	20
9.0	80	20

Note: Flow rate was 0.3 mL/min, column temperature was 40 °C, and injection volume was 5 µL.

<sup>1</sup> Mobile phase A: 95 % water and 5 % methanol containing 2 mM ammonium acetate and 5 mM 1-methyl piperidine (1-MP).

<sup>2</sup> Mobile phase B: 75 % methanol, 20 % acetonitrile, and 5 % water containing 2 mM ammonium acetate and 5 mM 1-methyl piperidine (1-MP).

**Table 6. Target compounds and selected instrumental parameters for quantification of each compound by UPLC/ESI-MS/MS.**

Compound <sup>1</sup>	Precursors > product ion (qualitative product ion) <sup>2</sup>	Cone voltage (V)	Collision energy (eV)	Internal standard <sup>3</sup>
MeFOSA	512 > 169 (219)	44	28	d3-MeFOSA
EtFOSA	526 > 169 (219)	32	28	d3-MeFOSA
FOSAA	556 > 498 (419)	8	26	d3-MeFOSAA
MeFOSAA	570 > 419 (483)	8	20	d3-MeFOSAA
EtFOSAA	584 > 419 (526)	8	22	d3-MeFOSAA
F-53B	531 > 351 (83)	82	24	<sup>13</sup> C <sub>2</sub> -PFDA
4:2 FTS	327 > 80 (307)	40	24	<sup>13</sup> C <sub>2</sub> 6:2 FTS
6:2 FTS	427 > 80 (407)	66	24	<sup>13</sup> C <sub>2</sub> 6:2 FTS
8:2 FTS	527 > 80 (507)	18	24	<sup>13</sup> C <sub>2</sub> 6:2 FTS
FPrPA	241 > 117 (137)	20	10	<sup>13</sup> C <sub>2</sub> -PFHxA
FPePA	341 > 217 (407)	10	22	<sup>13</sup> C <sub>2</sub> -PFHxA
FHpPA	441 > 317 (507)	20	10	<sup>13</sup> C <sub>2</sub> -PFHxA
4:2 monoPAP <sup>4</sup>	343 > 97 (323)	20	14	<sup>13</sup> C <sub>2</sub> -6:2 monoPAP
6:2 monoPAP	443 > 97 (423)	10	14	<sup>13</sup> C <sub>2</sub> -6:2 monoPAP
8:2 monoPAP	543 > 97 (523)	16	20	<sup>13</sup> C <sub>2</sub> -8:2 monoPAP
10:2 monoPAP	643 > 97 (623)	14	26	<sup>13</sup> C <sub>2</sub> -8:2 monoPAP
4:2/4:2 diPAP	589 > 343 (97)	20	16	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
4:2/6:2 diPAP <sup>5</sup>	689 > 443 (343)	20	28	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
6:2/6:2 diPAP	789 > 443 (97)	20	20	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
6:2/8:2 diPAP <sup>5</sup>	889 > 443 (543)	14	32	<sup>13</sup> C <sub>4</sub> -6:2/6:2 diPAP
8:2/8:2 diPAP	989 > 543 (97)	16	24	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
6:2/10:2 diPAP <sup>6</sup>	989 > 443 (643)	16	22	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
8:2/10:2 diPAP <sup>6</sup>	1089 > 543 (643)	20	28	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
6:2/12:2 diPAP <sup>6</sup>	1089 > 443 (743)	20	26	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
10:2/10:2 diPAP	1189 > 643 (97)	50	28	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
8:2/12:2 diPAP <sup>7</sup>	1189 > 543 (743)	50	28	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
6:2/14:2 diPAP <sup>7</sup>	1189 > 443 (843)	50	28	<sup>13</sup> C <sub>4</sub> -8:2/8:2 diPAP
<b>Recovery Standards</b>				
<sup>13</sup> C <sub>8</sub> -PFOA <sup>8</sup>	421 > 376	22	11	
<sup>13</sup> C <sub>8</sub> -PFOS <sup>8</sup>	507 > 80	65	42	

<sup>1</sup> Acronyms are according to (Buck et al., 2011).

<sup>2</sup> Product ions in brackets were used as confirmation ions.

<sup>3</sup> All internal standards were purchased at Wellington Laboratories.

<sup>4</sup> 4:2 monoPAP and 4:2/4:2 diPAP were donated by Dr. Xenia Trier (National Food Institute, Denmark).

<sup>5</sup> DiPAPs were identified using Zonyl-RP technical mixture; quantification was done using the 6:2/6:2 diPAP calibration curve.

<sup>6</sup> DiPAPs were identified using Zonyl-RP technical mixture; quantification was done using the 8:2/8:2 diPAP calibration curve.

<sup>7</sup> DiPAPs were identified using Zonyl-RP technical mixture; quantification was done using the 10:2/10:2 diPAP calibration curve.

<sup>8</sup> <sup>13</sup>C<sub>8</sub>-PFOA and <sup>13</sup>C<sub>8</sub>-PFOS were used as recovery internal standards.

### Quality control

Accuracy and precision were evaluated by analyzing spiked, portions of each matrix (single sample or homogenized pool; Table 7) in triplicate. The native spiking concentration was approximately 10 times the IS concentrations. Two procedural blanks were analyzed alongside the samples in each batch.

**Table 7. Sample amount quality control samples (wet weight)**

Matrix	Amount (g)	Sample ID (SLV)
Cereals	1.0	2
Pastries	1.5	20
Eggs	1.5	91
Meat/meat products	1.5	37
Diary	3.5	Pooled
Fish/fish products	1.5	112
Fats/oils	1.5	62
Potatoes/potato products	3.5	Pooled
Fruits	3.5	Pooled
Vegetables	3.5	Pooled
Sugar/sweets	1.5	195
Soft drinks	2.0	Pooled

## RESULTS AND DISCUSSION

The samples in the 2015 market basket study had concentrations of many of the studied PFAS below LOQ. For PFPrPA (LOQ=34.3-224 ng/kg) all concentrations were below LOQ, which was also the case for N-Me-FBSA (1.7-2.0 ng/kg), br-MeFOSAA (0.3-1.0 ng/kg), lin-MeFOSAA (0.3-1.0 ng/kg), br-EtFOSAA (0.3-1.0 ng/kg), lin-EtFOSAA (0.3-1.0 ng/kg), 6:2 FTS (921-2188 ng/kg), F-53B (0.5-3.0 ng/kg), lin-MeFOSA (1.1-32 ng/kg), br-MeFOSA (1.1-32 ng/kg), br-EtFOSA (3.9-32 ng/kg), lin-EtFOSA (3.9-32 ng/kg), FPePA (8.7-12 ng/kg), and FHpPA (8.7-14 ng/kg). Among the mono- and diPAPS concentrations were also mostly <LOQ. For the following PAP substances all samples had concentrations below LOQ: 4:2 monoPAP (3-46 ng/kg), 6:2 monoPAP (1-9 ng/kg), 8:2 monoPAP (1-15.4 ng/kg) 10:2 monoPAP (5-78 ng/kg), 4:2/4:2 di PAP (1-20 ng/kg), 4:2/6:2 diPAP (1-2 ng/kg), 6:2/8:2 diPAP (1-1.7 ng/kg), 8:2/8:2 diPAP (1-5 ng/kg), 6:2/10:2 diPAP (1-5 ng/kg), 8:2/10:2 diPAP (1-5 ng/kg), 6:2/12:2 diPAP (1-5 ng/kg), 10:2/10:2 diPAP (9.1-67 ng/kg), and 8:2/12:2 diPAP (9.1-67 ng/kg).

However, among the meat and egg basket samples more than 50% had concentrations of 8:2 FTS above LOQ, with medians of 0.40 and 2.1 ng/kg, respectively (Table 8). For 6:2/6:2 diPAP in the fish baskets median concentration was estimated to 56 ng/kg. Concentrations of 6:2/6:2 diPAPs above LOQ were also found in cereals (1 sample), eggs (2 samples), fats/oils (1 sample) and fruits (1 sample). FOSAA was above LOQ in 1 fish basket. For 4:2 FTS concentrations above LOQ was observed in 2 cereal baskets, 2 meat baskets, 1 dairy basket, and 2 egg baskets. Finally for 6:2/14:2 diPAP one sample of the sugar/sweets basket had a concentration above LOQ (Table 8).



**Table 8. Median (min-max) concentrations of PFASs in market basket samples from 2015 (ng/kg). Food groups having at least one basket with concentrations >LOQ in bold.**

Sample cat.	FOSAA	4:2 FTS	8:2 FTS	6:2/6:2 diPAP	6:2/14:2 diPAP
Cereals	<1.0 (<1.0)	<b>&lt;18 (&lt;18-19.3)</b>	<2.0 (<2.0)	<b>&lt;16 (&lt;16-17)</b>	<29 (<29)
Pastries	<1.0 (<1.0)	<18 (<18)	<2.0 (<2.0)	<16 (<16)	<29 (<29)
Meat	<1.0 (<1.0)	<b>&lt;12 (&lt;12-18.3)</b>	<b>0.40 (&lt;0.20-1.9)</b>	<30.2 (<30.2)	<45 (<45)
Fish	<b>&lt;1.0 (&lt;1.0-9.2)</b>	<12 (<12)	<0.20 (<0.20)	<b>56 (&lt;30.2-584)</b>	<45 (<45)
Dairy	<1.1 (<1.1)	<b>&lt;15 (&lt;15-20.5)</b>	<0.4 (<0.4)	<8.3 (<8.3)	<67 (<67)
Eggs	<1.0 (<1.0)	<b>&lt;12 (&lt;12-16.2)</b>	<b>2.1 (&lt;0.20-3.1)</b>	<b>&lt;30 (&lt;30-38)</b>	<45 (<45)
Fats, oils	<1.1 (<1.1)	<15.3 (<15.3)	<0.4 (<0.4)	<b>&lt;8.3 (&lt;8.3-9.7)</b>	<67 (<67)
Vegetables	<0.7 (<0.7)	<9.6 (<9.6)	<0.9 (<0.9)	<15 (<15)	<9.1 (<9.1)
Fruit	<0.7 (<0.7)	<9.6 (<9.6)	<0.9 (<0.9)	<b>&lt;15 (&lt;15-38)</b>	<9.1 (<9.1)
Potatoes	<0.7 (<0.7)	<9.6 (<9.6)	<0.9 (<0.9)	<15 (<15)	<9.1 (<9.1)
Sugar etc	<1.0 (<1.0)	<18 (<18)	<2.0 (<2.0)	<16 (<16)	<b>&lt;29 (&lt;29-32)</b>
Beverages	<1.1 (<1.1)	<15.3 (<15.3)	<0.4 (<0.4)	<8.3 (<8.3)	<67 (<67)
N<LOQ (%)	59 (98)	53 (88)	52 (87)	52 (87)	59 (98)

The LOQ varied depending on substance making it difficult to draw conclusions about contribution of different PFAS to the total concentrations of PFAS in the food samples. Moreover, the pooling of the foods into food groups may in some cases have resulted in a dilution effect of PFAS in individual foods with concentrations above LOQ. Nevertheless it was possible to detect FOSAA, 4:2 FTS, 8:2 FTS, 6:2/6:2 diPAP and 6:2/14:2 diPAP in some food groups. FOSAA can be broken down to perfluorooctane sulfonate (PFOS) and the fluorotelomer sulfonates 4:2 FTS and 8:2 FTS may be degraded to PFCAs (Liu and Mejia 2013). 6:2/6:2 diPAP may be a precursor to short-chain PFCAs whereas 6:2/14:2 diPAP to some extent also may be degraded to long-chain PFCAs (Liu and Liu 2016). To what extent human exposure to these precursors contribute to the body burdens of perfluorinated alkyl acids is still not clear.

## REFERENCES

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