ANALYSIS OF PFASs AND TOF IN PRODUCTS

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Daniel Borg, Jenny Ivarsson

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Summary

Per- and polyfluorinated substances (PFASs) make up a large group of man-made highly fluorinated substances that have been used in industrial and consumer applications for more than six decades. For the last twenty years PFASs have received increasing attention from scientists and regulators following their detection in wildlife and humans globally. It is today recognized that some PFASs are extremely persistent, bioaccumulative and toxic. There are thousands of PFASs on the global market and for many of these there is little information publicly available regarding their potential to affect human health and the environment.

This study is a follow-up of a NORAP (Nordic Risk Assessment Project) project from 2015 where 29 samples of different household products were analysed for 22 PFASs. The result of that study showed that all 29 products contained PFASs and that 12 of the 22 PFASs that were analysed for were detected. Here we have further analysed the products from the study in 2015 together with additional analysis of product types known to contain PFASs or suspected to contain PFASs. Since the targeted PFASs analysis of individual PFAS likely will not display the total PFASs-content of the products, we have analysed them for their total organic fluorine (TOF) content. The results of the TOF-analyses can be used to demonstrate to what extent the PFASs in the targeted analyses comprise the total organic fluorine content and thus provide an estimate of our knowledge about the use of PFASs in the products.

In total 17 new product samples collected in 2016 were in this project analysed for 19 individual PFASs as well as TOF. In addition, 27 samples from the 2015-project were re-analysed for TOF and eight textile samples collected in 2015 for a monitoring project by the Swedish Chemicals Agency were analysed for 22 individual PFASs as well as TOF.

The result of the targeted PFAS analyses of products collected in 2016 showed that PFASs is widely used in these products. PFASs were detected in 16 of the 17 products. All of these contained perfluorooctanoic acid (PFOA) which was the most frequently detected PFAS. Perfluorinated carboxylic acids (PFCA) was the most commonly detected subgroup. Of the perfluorinated sulfonic acids (PFSAs) only perfluorooctane sulfonate (PFOS) was detected, present in one sample. Among the fluorotelomer alcohols (FTOHs) only 6:2 FTOH was found. No fluorotelomer acrylates (FTAs), perfluorooctane sulphonamides (FOSAs) or perfluorooctane sulfonamidoethanols (FOSEs) were detected. Overall, the levels of PFCAs and PFSAs were in the low $\mu\text{g}/\text{m}^2$ and $\mu\text{g}/\text{l}$ range in the products and the levels of 6:2 FTOH were in the $\mu\text{g}/\text{m}^2$ range in food packaging and mg/l range in waterproofing products and one polish.

The result of the targeted PFAS analysis of textiles collected in 2015 showed that 6 out of 8 products contained PFASs. The most commonly detected PFAS was PFBA. Overall the levels of PFCAs were in the low $\mu\text{g}/\text{m}^2$ range and the level of 6:2 FTOH in the mg/m^2 range. No sample contained PFSAs, FTAs, FTSs, FOSAs or FOSEs.

The TOF analysis suffered some methodological problems. The method originally developed for TOF-analysis of paper and packaging experienced problems with the analysis of waterproofing treatment sprays and waxes. The TOF-concentrations in the successfully analysed samples spanned over several orders of magnitude for the products collected 2014, 2015 and 2016, respectively, from $\mu\text{g}/\text{m}^2$ to g/m^2 , $\mu\text{g}/\text{l}$ to mg/l , and $\mu\text{g}/\text{kg}$ to g/kg . The products containing highest concentration of TOF were dental floss ($310 \text{ g}/\text{kg}$), non-stick baking ware ($1.7 \text{ g}/\text{m}^2$) and table cloth ($0.9 \text{ g}/\text{m}^2$). The comparisons between the sums of detected PFASs to the TOF concentrations showed that for most samples the analysed PFAS constituted only a very minor part of the TOF (below or far below 1%). Some samples had TOF concentrations below the limit of detection, of which some did not detect PFASs in the targeted analyses, indicating that these products may be free of PFASs.

This study, important for the understanding of sources for human and environmental exposure to PFASs via consumer products, show that PFASs are widely used in all analysed product types. The large gap between the TOF and the sum of all targeted PFAS analysed illustrate large data gaps on which PFASs that are being used. Further, there is a need for improved TOF-analysis and a follow-up of the study after the implementation of the PFOA restriction would be valuable.

1. Introduction

1.1 About PFAS

Per- and polyfluorinated substances (PFASs) make up a large group of man-made highly fluorinated substances that have been used in industrial and consumer applications for more than six decades. For the last twenty years they have received increasing attention from scientists and regulators following their detection in wildlife and human blood globally, even in remote locations far from where they are being used. Initially, most attention was given to perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA), two PFASs commonly detected in humans and biota and also the most studied with regard to toxicity and ecotoxicity. Subsequently more attention has been given to other PFASs.

It is today recognized that some PFASs are extremely persistent with potential for long-range transport, e.g. perfluorinated carboxylic acids (PFCA) and perfluorinated sulfonic acids (PFSA). Some PFASs are also bioaccumulative and toxic. Commonly observed toxic effects in animal studies following PFASs exposure include liver toxicity, decreased body weight, effects on lipid metabolism and thyroid hormone levels, immunotoxicity, carcinogenicity and reproductive toxicity (DeWitt, 2015). Studies in human populations have shown associations between serum concentrations of different PFASs and e.g. serum lipid levels, thyroid disease, certain types of cancers, birth weight and immune response following vaccination (ATSDR, 2015). However, for many PFASs there is little knowledge and publicly available information regarding their potential to affect human health and the environment.

A large number of human biomonitoring studies have shown the presence of different PFASs in human blood globally (DeWitt, 2015). The most significant route of human exposure may differ for different PFAS. For highly bioaccumulative PFASs, such as PFOS, dietary intake of e.g. fish may constitute the major exposure route whereas for less bioaccumulative PFASs, such as perfluorohexanoic acid (PFHxA), inhalation of indoor dust may be the most significant route of exposure (Vestergren *et al.*, 2012) and where consumer products likely make up a major source.

1.2 Uses of PFASs

PFASs are used in many different articles and chemical products due to their properties such as being water-, grease-, and dirt-repellent, temperature resistant and film-forming. There are today a large number of PFASs in use. It has been estimated that more than 3,000 PFAS are available on the global market (Swedish Chemicals Agency, 2015). Known areas of use include as surface active agents, as synthesis chemicals of

fluoropolymers, in electronic and printing products, in fire-fighting foams, in impregnation of paper, textiles and leather and in pharmaceuticals, plant protection products and biocides (Swedish Chemicals Agency, 2015). Less well-known areas of use include in cosmetics, dental restorative materials, medical equipment and as dirt-repellent agents for building materials, smart phones and solar cells. Information acquired from a previous study on PFASs in consumer products showed that PFASs are widely used in e.g. food contact materials, impregnation sprays, polishes and waxes (Blom and Hanssen, 2015). However, for many PFASs there is limited qualitative and quantitative information on their use (Swedish Chemicals Agency, 2015). Approximately half of the estimated > 3,000 PFAS on the market lacked information on their use. One reason is that since these substances are highly effective, only low concentrations are needed in products and their usage volumes are relatively low, which results in low associated data requirements within REACH.

Due to regulatory and voluntary actions in recent years there has been a shift from long-chain to short-chain PFASs as well as perfluorinated ethers and polyethers. The reduction in the use of long-chain PFASs has therefore led to an increase in the use of their replacements. The use of PFASs in the EU currently involves mainly PFASs with six perfluorinated carbons (Swedish Chemicals Agency, 2015). Many of these are precursors of e.g. PFCA and PFSA to which they have the ability to degrade and for many there is inadequate information about their toxicity and environmental fate.

1.3 Rationale for this project

In 2015 a NORAP project analysed 29 samples of household products for 22 different PFASs (Blom and Hanssen, 2015). The result showed that all products contained PFASs and that 12 out of the 22 of the PFASs that were analysed for were detected.

This project is a follow-up to the 2015 study where we further analyse products of types known to contain PFASs from the previous study in 2015 supplemented with additional analysis of product types suspected to contain PFASs. However, since the targeted PFASs analysis likely will not display the total PFASs-content of the products they were also analysed for their total organic fluorine (TOF) content. The results of the TOF-analyses can be used to demonstrate to what extent the PFAS in targeted PFAS analyses comprise the TOF content and thus provide an estimate of our knowledge about the use of PFASs in the products. In total 17 new products samples were in this project analysed for 19 individual PFASs as well as TOF. In addition, 27 samples from the 2015-project were re-analysed for TOF and eight textile samples collected in 2015 were analysed for 22 individual PFASs and TOF.

This project is important for the understanding of sources for human and environmental exposure to PFASs via consumer products.

2. Material and methods

2.1 Analysis of products collected in 2016 for targeted PFAS and TOF

2.1.1 Selection of samples

The choice of consumer product types in this study was based on the outcome of the study from Blom and Hanssen (2015) where PFASs were found in e.g. ski waxes, paper and board food packaging and non-stick coating products. In addition, a few additional product types were included. In total 17 products were randomly selected from shelves in a number of Swedish retail stores and supermarkets for analysis. See Table 1 for a list of the analysed products. For a more detailed description of the products, see Annex 3.

Table 1: Articles collected in 2016 for analysis of targeted PFASs and total organic fluorine (TOF)

Sample ID	Product	Brand	Product name	Tested
1	Cupcake forms	Toppits	Bakformar	Inside of form
2	Microwave popcorn bag	OLW	Popcorn, smörsmak	Inside of paper package
3	Microwave popcorn bag	Garant	Mikro Pop, saltade	Inside of paper package
4	Microwave popcorn bag	Garant	Mikro Pop, smörsmak	Inside of paper package
5	Microwave popcorn bag	Garant	Ekologiska Mikropopcorn	Inside of paper package
6	Rinse Aid	Finish	Finish Shine & protect	Liquid content
7	Rinse Aid	Fixa	Spolglans miljömärkt	Liquid content
8	Waterproofing shoe treatment	Springyard	Universal Waterproofer Classic Shoe Care, Protect 3	Liquid content
9	Waterproofing shoe treatment	Fibertec	Blue Guard Footwear	Liquid content
10	Waterproofing textile treatment	Fibertec	Blue Guard Textile	Liquid content
11	Waterproofing textile treatment	Fibertec	Pro Wash (Bluesign approved)	Liquid content
12	Waterproofing textile/leather treatment	Imprenex	Waterproofing Express	Liquid content
13	Shoe wax	Springyard	Shoe Wax Care 02	liquid/wax content
14	Floor polish	Nitor	Golvp polish	Liquid content
15	Furniture polish	MP52	Möbelpolish, Möbelpolish	Liquid content
16	Car wax	Turtle wax	Turtle wax original	liquid/wax content
17	Car wax	Sonax	Flytande hårdvax	liquid/wax content

2.1.2 Analyses

The products collected in 2016 were analysed for:

- Perfluorinated carboxylic acids (PFCAs): PFBA, PFHxA, PFOA, PFNA, PFDA.
- Perfluorinated sulfonic acids (PFSAs): PFBS, PFHxS, PFOS.
- Fluorotelomer alcohols (FTOHs): 4:2 FTOH, 6:2 FTOH, 8:2 FTOH, 10:2 FTOH.
- Fluorotelomer acrylates (FTAs): 6:2 FTA, 8:2 FTA, 10:2 FTA.
- Perfluorooctane sulphonamides (FOSAs): MeFOSA, EtFOSA.
- Perfluorooctane sulfonamidoethanols (FOSEs): MeFOSE, EtFOSE.
- Total Organic Fluorine (TOF).

2.2 Re-analysis of products collected in 2014 for TOF

2.2.1 Selection of samples

In total 29 samples of consumer products were collected in the previous study by Blom and Hanssen (2015, Table 2). For a detailed description of the samples and their selection see Blom and Hanssen (2015).

2.2.2 Analyses

These samples have previously been analysed for PFCAs, PFSAs, FTOHs, FTSs and PAPs. They were here re-analysed for only TOF, to be compared with the results from the targeted PFASs-analysis in 2014.

2.3 Analysis of textiles collected in 2015 for targeted PFASs and TOF

2.3.1 Selection of samples

During the autumn of 2015, the Swedish Chemicals Agency monitored samples of articles from Swedish companies, which included shoes and jackets, and were analysed for PFOS and PFOA (Swedish Chemicals Agency, 2016). Eight textile samples from that monitoring project were here selected for analysis (Table 3).

Table 2: Products collected in 2014 that was previously analysed for PFASs and now subject to analysis of total organic fluorine (TOF)

Sample ID	Product / Type of product
1	Table cloth 1
2	Table cloth 2, Maud Teflonduk
3	Baking paper 1, Unik
4	Baking paper 2
5	Sandwich paper, Unik
6	Cupcake forms, Unik
7A	Microwave popcorn paper 1 Eldorado (salt)
7B	Microwave popcorn paper 2 Maarud (salt)
8	Car wax/polish 1 Turtle wax
9	Car wax/polish 2 Autoglym
10	Dishwasher liquid 1, Sun
11	Dishwasher liquid 2, Finish
12	Waterproofing shoe treatment product 1, waterguard
13	Waterproofing shoe treatment product 2, Kiwi
14 A and B	Waterproofing textile treatment product 1, two pack TX
15	Waterproofing textile treatment product 2, textile proof
16	Glider for skis 1, HF7 Violet
17	Glider for skis 2, VR 55 S+LV/Fiolet
18	Ski wax 1, LF6 Blue
19	Lubricant for bicycles, Teflon greasetube
20	Dental floss 1, Easyslide
21	Dental floss 2, Colgate, mint
22	Non-stick baking ware, silicon 1
23	Non-stick baking ware 2 ¹
24	Non-stick baking ware, cupcakes 1
25	Non-stick baking ware, silicon cupcakes 2 ²
26	Reusable baking liner 1
27	Reusable baking liner 2

Note: ¹ Referred to as Non-stick baking ware, silicon 2, Patisse, in Blom and Hanssen (2015).

² Referred to as Non-stick baking ware, cupcakes 2, Patisse, in Blom and Hanssen (2015).

Source: Blom and Hanssen (2015).

Table 3: Textiles collected in 2015 for analysis of targeted PFASs and total organic fluorine (TOF)

Sample ID	Product	Brand	Product name	Tested
124	Childrens jacket	Galvin Green	Richie Rainproof jacket junior	Outer material: bluegreen textile
125	Jacket	Galvin Green	Robin Windstopper mintgrön	Outer material: bluegreen textile
147	Jacket	Five seasons	Latitude jacket marine	Outer material: blue textile
150	Childrens jacket	Peak Performance	Down jacket, child JRHELIUMJ	Outer material: blue textile
155	Childrens shoe	DC	DC Shoe Toddler trace TX Fuchsia	Outer material: pink textile
177	Shoe	JOBI	JOBI walkingsko herr	Outer material: grey fabric (textile)
184	Childrens jacket	Didriksson	Wylie Kid's Jacket	Outer material: blue textile
185	Childrens rain Clothing	Didriksson	Makalu Kid's Set	Outer material: red textile

2.3.2 Analyses

The textiles collected in 2015 were analysed for:

- Perfluorinated carboxylic acids (PFCAs): PFBA, PFHxA, PFOA, PFNA, PFDA.
- Perfluorinated sulfonic acids (PFSAs): PFBS, PFHxS, PFOS.
- Fluorotelomer alcohols (FTOHs): 4:2 FTOH, 6:2 FTOH, 8:2 FTOH, 10:2 FTOH.
- Fluorotelomer acrylates (FTAs): 6:2 FTA, 8:2 FTA, 10:2 FTA.
- Fluorotelomer sulfonates (FTSs): 4:2 FTS, 6:2 FTS, 8:2 FTS.
- Perfluorooctane sulphonamides (FOSAs): MeFOSA, EtFOSA.
- Perfluorooctane sulfonamidoethanols (FOSEs): MeFOSE, EtFOSE.
- Total organic fluorine (TOF).

2.4 Choice of analytes

The PFASs to be analysed for in the targeted analysis were selected based on the laboratory's availability of analyses in combination with previous knowledge and experience of PFASs in consumer products, i.e. from the NORAP 2015-study (Blom and Hanssen *et al.*, 2015). Since there has been a shift in the use of long-chain PFASs to short-chain PFASs both of these groups were of interest. Table 4 shows which substances that were included in the analyses.

Table 4: PFASs analysed in the targeted analysis of PFASs in products sampled 2016 and in textiles sampled 2015. Abbreviations are explained in annex 1. Substances in bold are short-chain PFASs

Number of carbons	Perfluorinated carboxylic acids (PFCAs)	Perfluorinated sulfonic acids (PFSAs)	Fluorotelomer alcohols (FTOHs)	Fluorotelomer sulfonates (FTSs)	Perfluorinated sulphonamides (FOSAs)	Perfluorinated sulfonamido-ethanols (FOSEs)
C ₄	PFBA CAS: 375-22-4	PFBS CAS: 29420-49-3 (potassium salt)	-	-	-	-
C ₆	PFHxA CAS: 307-24-4	PFHxS CAS: 3871-99-6 (potassium salt)	4:2 FTOH CAS: 2043-47-2	4:2 FTS CAS: 757124-72-4	-	-
C ₈	PFOA CAS: 335-67-1	PFOS CAS: 1763-23-1 (sodium salt)	6:2 FTOH CAS: 647-42-7	6:2 FTS CAS: 29420-49-3	MeFOSA CAS: 31506-32-8 EtFOSA CAS: 4151-50-2	MeFOSE CAS: 2448-09-7 EtFOSE CAS: 1691-99-2
C ₉	PFNA CAS: 375-95-1	-	-	-	-	-
C ₁₀	PFDA CAS: 335-76-2	-	8:2 FTOH CAS: 678-39-7	-	-	-

2.5 Chemical analyses

2.5.1 Targeted PFAS analysis

In brief, the sample was homogenized by mixing, stirring, milling and / or cutting with respect to the sample matrix. The sample was spiked by internal isotope-labeled standards for later quantification. The sample was then extracted by ultrasonic extraction of the homogenised sample material with matrix-dependent solvents (multi)-step-sample clean-up. Analysis was done by liquid chromatography coupled with mass spectrometry (LC/MS-MS). (Agilent HPLC 1290 Infinity Serie coupled with Agilent 6460A Triple Quad LC/MS-MSMS). Identification was performed via retention time and molecule or fragment ions. Quantification of the native PFC components was calculated via internal isotope-labeled standards (isotope dilution method).

2.5.2 Analysis of total organic fluorine (TOF)

This method has originally been developed for cardboard and paper, as a collaboration between Eurofins and the Ministry of Food, Agriculture and Fisheries of Denmark.

The sample (paper or cardboard) was shredded using a Retsch ultra centrifugal mill ZM 200. After homogenization the fluff was pressed to pellets using a handheld press. The pellets which have a weight of approx. 100 to 120 mg are cut in half to fit the TOX crucible. The two halves were weighed and placed in the crucible.

The combustion was carried out using an Envirotech TOX-100 TOX-oven. About 10 pellets must be processed to sustain a LOQ of 1 mg/kg fluorine. The combustion gases were absorbed in 10 ml of a buffer solution of 0.0018 mol/l Na_2CO_3 and 0.0020 mol/l NaHCO_3 . All 10 combustions were absorbed by the same solution step by step. The technique is based, in part, on DIN 51723 and EN ISO 10304-1.

The fluoride was measured in the solution using a Methrom 882 compact IC plus (LOQ fluoride = 0.1 mg/l). The results were calculated using the sum of the weighed sample and the volume of the absorber solution. In addition blanks were analysed using the same conditions/method.

3. Results

3.1 Products collected in 2016

3.1.1 Analysis of PFCAs and PFSA

The result of the targeted PFAS analysis showed that all products contained PFASs, except the furniture polish (sample 15) (Tables 5, 6).

All samples containing PFASs also contained PFOA, which was the most commonly detected PFAS, ranging between 0.03–0.20 µg/m² and 0.23–2.8 µg/l, respectively (Table 5). PFBA and PFHxA were frequently detected in approximately half of the samples (9/17), whereas PFDA was less frequent (3/17) and PFNA not detected at all. PFHxA was measured at the highest concentrations of the PFCAs and PFSA, up to 5.3 µg/L in the floor polish (sample 14). One product, a microwave popcorn bag (sample 2), contained PFOS at a concentration of 0.14 µg/m². No other PFSA was detected in any sample.

Table 5: Concentrations of PFCAs and PFSA in products collected in 2016

Sample ID	Article	Concentration (µg/m ²)							
		PFBA	PFHxA	PFOA	PFNA	PFDA	PFBS	PFHxS	PFOS
1	Cupcake forms	0.05	< LOD	0.03	< LOD	< LOD	< LOD	< LOD	< LOD
2	Microwave popcorn bag	0.34	0.15	0.19	< LOD	< LOD	< LOD	< LOD	0.14
3	Microwave popcorn bag	0.35	< LOD	0.19	< LOD	< LOD	< LOD	< LOD	< LOD
4	Microwave popcorn bag	0.21	0.06	0.20	< LOD	0.14	< LOD	< LOD	< LOD
5	Microwave popcorn bag	0.43	0.65	0.13	< LOD	< LOD	< LOD	< LOD	< LOD
6	Rinse Aid	< LOD	< LOD	0.75	< LOD	< LOD	< LOD	< LOD	< LOD
7	Rinse Aid	< LOD	< LOD	0.75	< LOD	0.47	< LOD	< LOD	< LOD
8	Waterproofing shoe treatment	< LOD	< LOD	0.53	< LOD	< LOD	< LOD	< LOD	< LOD
9	Waterproofing shoe treatment	0.33	2.5	0.23	< LOD	< LOD	< LOD	< LOD	< LOD
10	Waterproofing textile treatment	0.80	3.6	1.4	< LOD	0.45	< LOD	< LOD	< LOD
11	Waterproofing textile treatment	0.78	2.3	0.48	< LOD	< LOD	< LOD	< LOD	< LOD
12	Waterproofing textile/leather treatment	< LOD	< LOD	0.49	< LOD	< LOD	< LOD	< LOD	< LOD
13	Shoe wax	< LOD	4.7	0.53	< LOD	< LOD	< LOD	< LOD	< LOD
14	Floor polish	0.47	5.3	0.59	< LOD	< LOD	< LOD	< LOD	< LOD
15	Furniture polish	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
16	Car wax	< LOD	0.54	1.4	< LOD	< LOD	< LOD	< LOD	< LOD
17	Car wax	< LOD	< LOD	2.8	< LOD	< LOD	< LOD	< LOD	< LOD

3.1.2 Analysis of FTOHs and FTAs

The analysis of FTOHs and FTAs detected only 6:2 FTOH that was present in 5 of the 17 samples (Table 6). The concentrations of 6:2 FTOH were the highest of all the analysed PFAS, 26.7 µg/m² in a microwave popcorn bag (sample 5) and ranging between 1,834–120,300 µg/l in the floor polish (sample 15) and a waterproofing shoe treatment (sample 9), respectively. The highest concentrations overall were found in waterproofing treatment products.

Table 6: Concentrations of FTOHs and FTAs in articles collected in 2016

Sample ID	Article	Concentration (µg/m ²)						
		4:2 FTOH	6:2 FTOH	8:2 FTOH	10:2 FTOH	6:2 FTA	8:2 FTA	10:2 FTA
1	Cupcake forms	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
2	Microwave popcorn bag	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
3	Microwave popcorn bag	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
4	Microwave popcorn bag	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
5	Microwave popcorn bag	< LOD	26.6	< LOD	< LOD	< LOD	< LOD	< LOD
6	Rinse Aid	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
7	Rinse Aid	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
8	Waterproofing shoe treatment	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
9	Waterproofing shoe treatment	< LOD	120,300	< LOD	< LOD	< LOD	< LOD	< LOD
10	Waterproofing textile treatment	< LOD	43,070	< LOD	< LOD	< LOD	< LOD	< LOD
11	Waterproofing textile treatment	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
12	Waterproofing textile/leather treatment	< LOD	12,340	< LOD	< LOD	< LOD	< LOD	< LOD
13	Shoe wax	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
14	Floor polish	< LOD	1,834	< LOD	< LOD	< LOD	< LOD	< LOD
15	Furniture polish	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
16	Car wax	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
17	Car wax	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD

3.1.3 Analysis of FOSAs and FOSEs

FOSAs and FOSEs were not detected in any samples (data not shown).

3.1.4 TOF analysis and comparison to the targeted PFASs analysis

Analysis of TOF was successful for 10 of 17 samples (Table 7). All food-contact materials were possible to analyse for TOF, however the analyses of waterproofing treatments and waxes suffered from methodological problems. For the successfully analysed samples, 7 out of 10 samples had TOF-concentrations above the detection limit.

The result showed TOF-concentrations in food-contact materials ranging from 470 µg/m² in the sampled cupcake forms (sample 1) to 93,000 µg/m² in a microwave popcorn bag (sample 2) (Table 7). In the liquid samples, the concentrations of TOF ranged from < 1,000 to 18,500 µg/L in the floor polish (sample 14).

Comparison of the sum of concentrations of all detected PFASs in samples to their respective TOF-concentrations showed that for most samples only a very small fraction (< 1%) of the TOF content could be explained by the analysed PFASs. The only sample where the TOF to some extent (10%) could be explained by the analysed PFASs was the floor polish (sample 14).

Table 7: Sum of concentrations of all detected PFAS in products collected 2016, the total organic fluorine (TOF) content of the samples and a quantitative comparison between these

Sample ID	Product	Concentration (µg/m ²)		
		ΣPFAS (detected)	TOF	ΣPFAS/TOF (%)
1	Cupcake forms	0.08	470	0.02
2	Microwave popcorn bag	0.81	93,000	0.001
3	Microwave popcorn bag	0.54	83,000	0.001
4	Microwave popcorn bag	0.62	91,650	0.001
5	Microwave popcorn bag	27.8	52,750	0.05
6	Rinse Aid	0.75	< 1,000	> 0.08
7	Rinse Aid	1.2	2,000	0.06
8	Waterproofing shoe treatment	0.53	N.A.	-
9	Waterproofing shoe treatment	120,303	N.A.	-
10	Waterproofing textile treatment	43,076	N.A.	-
11	Waterproofing textile treatment	3.6	< 1,000	> 0.36
12	Waterproofing textile/leather treatment	12,341	N.A.	-
13	Shoe wax	5.2	N.A.	-
14	Floor polish	1,840	18,500	10.0
15	Furniture polish	0	< 1,000	-
16	Car wax	2.0	N.A.	-
17	Car wax	2.8	N.A.	-

3.2 Re-analysis of products collected in 2014

3.2.1 Targeted analysis of individual PFASs

The results of the targeted PFAS-analyses showed that 15 out of 22 PFASs that were analysed for were detected in the 28 product samples. For a detailed description of the results, see Blom and Hanssen (2015).

3.2.2 TOF analysis and comparison with targeted analysis

The TOF analysis was successfully completed for 19 out of 28 samples (Table 8). Methodological problems were encountered primarily for waterproofing treatments and waxes. For the successfully analysed samples, 17 out of the 19 samples had TOF-concentrations above the detection limit.

The results showed TOF-concentrations in food-contact materials ranging from 50 µg/m² in baking paper (sample 4) to 1,700,000 µg/m² in a non-stick baking ware

(sample 23) (Table 8). Relatively high TOF-concentrations were found in table cloths, up to 933,500 µg/m² (sample 2). The highest TOF-concentrations were detected in the dental floss samples, both at 310,000,000 µg/kg (samples 20 and 21).

Comparison of the sum of concentrations of all detected PFASs in samples to their respective TOF-concentrations showed that for most samples only a small fraction of the TOF content could be explained by the analysed PFASs. The samples where the TOF could be explained by the analysed PFASs to more than 5% was one of the popcorn bags (sample 7b) and the baking papers (samples 3 and 4) as well as the non-stick cupcake baking ware (sample 24).

Table 8: Sum of concentrations of all detected PFAS in products collected 2014, the total organic fluorine (TOF) content of the samples and a quantitative comparison between these

Sample ID	Product	Concentration (µg/m ²)		
		ΣPFAS (detected)	TOF	ΣPFAS/TOF (%)
1	Table cloth 1	10.9	246,000	0.005
2	Table cloth 2	512	933,500	0.06
3	Baking paper 1	4.9	65	8.2
4	Baking paper 2	5.2	50	11.3
5	Sandwich paper	10.3	25,400	0.04
6	Cupcake forms	3.2	330	1.1
7a	Popcorn paper 1	4.5	91,100	0.005
7b	Popcorn paper 2	91.7	578	15.9
8	Car polish 1	3.8	3,000	0.14
9	Car polish 2	3.6	8,000	0.05
10	Rinse aid 1 ¹	11.4	14,500	0.08
11	Rinse aid 2 ²	2.6	< 1,000	0.3
12	Waterproofing product, shoes 1	1.3	N.A.	-
13	Waterproofing product, shoes 2	45.5	N.A.	-
14A/B	Waterproofing product, textiles 1	0.66	< 1,000	0.10
15	Waterproofing product, textiles 2	261	N.A.	-
16	Glider for skis 1	157	N.A.	-
17	Glider for skis 1	1.2	N.A.	-
18	Ski wax	9.9	N.A.	-
19	Lubricant for bicycles	59.0	N.A.	-
20	Dental floss 1	3.0	310,000,000	0.000001
21	Dental floss 2	19.5	310,000,000	0.000006
22	Non-stick silicon baking ware 1	73.8	N.A.	-
23	Non-stick baking ware 2 ³	5.9	1,700,000	0.0004
24	Non-stick cupcake baking ware, 1	1.4	38,500	0.005
25	Non-stick silicon cupcake baking ware 2 ⁴	83.4	2,820	3.0
26	Reusable baking liner 1	24.7	N.A.	-
27	Reusable baking liner 2	172	41,150	0.4

¹ Referred to as Dishwasher liquid 1 in Blom and Hanssen (2015).

² Referred to as Dishwasher liquid 2 in Blom and Hanssen (2015).

³ Referred to as Non-stick baking ware, silicon 2, Patisse, in Blom and Hanssen (2015).

⁴ Referred to as Non-stick baking ware, cupcakes 2, Patisse, in Blom and Hanssen (2015).

3.3 Analysis of textiles collected in 2015

3.3.1 Targeted analysis of PFCAs and PFSA

The result of the targeted PFAS analysis of samples of textiles collected in 2014 showed that 6 out of 8 products contained PFASs (Tables 9, 10). The two products that did not contain PFAS (samples 184 and 185) were childrenswear.

The most commonly detected PFAS was perfluorobutanoic acid (PFBA), present in 4 out of 8 products followed by PFHxA and PFOA (3/8 products) and perfluorononanoic acid (PFNA)/perfluorodecanoic acid (PFDA) (1 product each). Of the PFCAs, PFOA was detected at the highest concentrations, up to 6.6 µg/kg (sample 125). No sample contained PFSA.

Table 9: Concentrations of PFCAs and PFSA in textiles collected in 2015

ID	Product	Concentration (µg/kg)							
		PFBA	PFHxA	PFOA	PFNA	PFDA	PFBS	PFHxS	PFOS
124	Richie Rainproof jacket junior	0.95	11.0	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
125	Robin Windstopper	< LOD	2.6	6.6	0.45	2.7	< LOD	< LOD	< LOD
147	Latitude Jacket Marine	0.38	0.33	1.7	< LOD	< LOD	< LOD	< LOD	< LOD
150	Down jacket, child JRHELIUMJ	< LOD	< LOD	4.6	< LOD	< LOD	< LOD	< LOD	< LOD
155	DC Shoe Toddler trace TX Fuchsia	0.15	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
177	JOBI walkingsko herr	0.85	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
184	Wylie Kid's Jacket	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
185	Makalu Kid's Set	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD

3.3.2 Targeted analysis of FTOHs and FTAs

The analysis of FTOHs and FTAs detected only 6:2 FTOH in one samples (Table 10). The concentrations of 6:2 FTOH were the highest of all the analysed PFASs in textiles, 1,405 µg/kg (sample 124). FTAs or FTSs were not detected in any sample.

Table 10: Concentrations of FTOHs, FTAs and FTSs in textiles collected in 2015

ID	Product	Concentration (µg/kg)									
		4:2 FTOH	6:2 FTOH	8:2 FTOH	10:2 FTOH	6:2 FTA	8:2 FTA	10:2 FTA	4:2 FTS	6:2 FTS	8:2 FTS
124	Richie Rainproof jacket junior	< LOD	1,405	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
125	Robin Windstopper	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
147	Latitude Jacket Marine	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
150	Down jacket, child JRHELIUMJ	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
155	DC Shoe Toddler trace TX Fuchsia	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
177	JOBI walkingsko herr	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
184	Wylie Kid's Jacket	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
185	Makalu Kid's Set	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD

3.3.3 TOF analysis and comparison to the targeted PFASs analysis

Comparison of the sum of concentrations of all detected PFASs in samples to their respective TOF-concentrations showed that for all samples only a very small fraction (< 1%) of the TOF content could be explained by the analysed PFASs (table 11). The two samples showing no detected PFASs in the targeted analyses showed TOF-concentrations below the LOD, indicating that the products may be PFAS-free.

Table 11: Sum of concentrations of all detected PFASs in textiles collected 2015, the total organic fluorine (TOF) content of the samples and a quantitative comparison between these

ID	Product	Concentration (µg/kg)		
		ΣPFAS (detected)	TOF	ΣPFAS/TOF (%)
124	Richie Rainproof jacket junior	1417.0	8,750,000	0.02
125	Robin Windstopper	12.3	9,550,000	0.0001
147	Latitude Jacket Marine	2.4	81,500	0.003
150	Down jacket, child JRHELIUMJ	4.6	295,000	0.002
155	DC Shoe Toddler trace TX Fuchsia	0.2	< 1,000	0.02
177	JOBI walkingsko herr	0.9	120,000	0.0007
184	Wylie Kid's Jacket	Not detected	< 1,000	-
185	Makalu Kid's Set	Not detected	< 1,000	-

3.4 Summary of results

3.4.1 Targeted PFAS analyses

The result of the targeted PFAS analysis of products collected in 2016 showed that PFASs are widely used in these products, all products except the furniture polish contained PFASs. All samples that contained PFASs also contained PFOA, which was most commonly detected. PFBA and PFHxA were frequently detected whereas PFDA was less frequent and PFNA not detected at all. Of the PFSA only PFOS was detected, in one sample. Among the FTOHs only 6:2 FTOH was found. No FTAs, FOSAs or FOSEs were detected. Overall, the levels of PFCAs and PFSA were in the low $\mu\text{g}/\text{m}^2$ and $\mu\text{g}/\text{l}$ range, some close to the limit of detection, and the levels of 6:2 FTOH in the $\mu\text{g}/\text{m}^2$ range in food packaging and mg/l range, the highest levels of the analysed PFASs, in waterproofing products and one polish.

The result of the targeted PFAS analysis of textiles collected in 2015 showed that 6 out of 8 products contained PFASs. The most commonly detected PFAS was PFBA followed by PFHxA and PFOA. Overall, the levels of PFCAs were in the low $\mu\text{g}/\text{m}^2$ range, some close to the limit of detection, and the level of 6:2 FTOH in the mg/m^2 range. No sample contained PFSA, FTAs, FTSs, FOSAs or FOSEs.

3.4.2 TOF analyses and comparison to the targeted PFASs analyses

The analysis of TOF suffered from some methodological problems. The method, originally developed for TOF-analysis of paper and packaging, experienced problems with analysis of waterproofing treatment sprays and waxes.

The TOF-concentrations in the successfully analysed samples spanned over several orders of magnitude for the products collected 2014, 2015 and 2016, respectively, from $\mu\text{g}/\text{m}^2$ to g/m^2 , $\mu\text{g}/\text{l}$ to mg/l , and $\mu\text{g}/\text{kg}$ to g/kg , respectively. The products containing the highest concentration of TOF were dental floss (310 g/kg), non-stick baking ware (1.7 g/m^2) and table cloth (0.9 g/m^2).

The comparisons between the sums of detected PFASs to the TOF concentrations showed that for most samples the analysed PFAS constituted only a very minor part of the TOF. Some samples had TOF concentrations below the limit of detection, of which some did not detect PFASs in the targeted analysis, indicating that these products may be free of PFASs.

4. Discussion

The analyses showed that PFASs are widely used in the sampled products: food-contact materials, waterproofing treatment sprays, waxes, polishes, rinsing aids and textiles.

The most commonly detected PFASs in the samples collected in 2016 were PFOA followed by PFHxA/PFBA (Figure 1). PFOA, which is a long-chain PFAS, was measured in all products that contained PFASs, though there has been a general shift from long-chain PFASs to short-chain PFASs (Swedish Chemicals Agency, 2015). A restriction on the use of PFOA and its related substances (i.e. precursors) in products at levels above 1,000 parts per billion (ppb), i.e. 1,000 µg/kg, will be imposed in the EU likely during 2020 (European Commission, 2016). The levels of PFOA as such and its precursor 8:2 FTOH were below 1,000 ppb in all the products included in this report. However, it cannot be excluded that other PFOA-related substances not analysed could be present in the products, given their higher levels of TOF. Thus, a follow-up study after the implementation of the PFOA-restriction in the EU would be of interest in order to review its effect on the use of PFOA. PFOS was detected in one popcorn bag. There is no regulation prohibiting the use of PFOS in food contact materials; however the manufacturer of the popcorn bag does intentionally not add PFOS to their papers which was made of non-recycled fibers (Malmström, personal communication). The level of PFOS was relatively low (1 of 2 samples below LOD) indicating that the presence of PFOS may be due to some kind of background contamination. This manufacturer of microwave popcorn, and likely also other brands, has since the sampling changed to PFAS-free popcorn bag (Malmström, personal communication).

The levels of PFASs in the products varied. Some were close to the limit of detection, indicating that they may represent impurities and/or degradation products of precursors, such as fluorinated polymers, while some were present at higher levels indicating that they are used as functional additives. 6:2 FTOH was found at levels one order of magnitude higher than the PFCAs in waterproofing treatments and one floor polish, showing that this substance constitute a major component in these products. Among the textiles sampled in 2015, PFBA was the most commonly found PFAS, followed by PFHxA and PFOA.

A comparison of the detection frequency of individual PFASs in the products collected in 2014 to the products collected in 2016 indicate a possible decrease in the use of 8:2 FTOH and 6:2 FTOH and an increase in the use of PFOA and PFHxA (Figure 1).

The comparisons between the sums of detected targeted PFASs to the TOF content of the products showed, for the majority of the products, these could only explain a very small proportion of the TOF. One likely explanation is that many of the individual PFASs measured represent degradation products of precursor PFAS, either as stable end-stage products such as the PFCAs and PFSA, or possible intermediate breakdown products such as the FTOHs. Polymers with fluorinated

side-chains are commonly used for surface treatments of various materials to make them water-, grease- and dirt-repellent (Swedish Chemicals Agency, 2015). It has been estimated that approximately 80% of the release of PFCA to the environment are derived from fluoropolymer manufacture and use (Prevedouros *et al.*, 2006) and that 80% of fluorotelemers are used in polymers (Ellis *et al.*, 2003). The method for TOF-analysis, that has been developed for paper and packaging, was unfortunately not applicable to liquid impregnation sprays and waxes, due to soot formation, and it was therefore not possible to make a comparison of targeted PFAS to TOF for those. Thus, there is a need for method development to also cover these types of matrices.

Figure 1: Percentage of the 17 products sampled in 2016 with detected PFASs compared to the products sampled in 2014

The highest TOF contents, in the g/kg-range were found in dental floss, one non-stick baking product and in two jackets. The high TOF-contents of the dental floss products can be explained by that they are based on polytetrafluoroethylene (PTFE) (Colgate, 2017; Jordan, 2017). The non-stick baking product is also fluoropolymer-based (Wilson, personal communication) which likely explains the result. For the jackets, it cannot be excluded that a fluoropolymer, such as PTFE, that is commonly used in these products was part of the textile samples.

In conclusion, the result of this study show that PFASs are widely used in the analysed product types. The large gap between the TOF and the amount of all targeted PFAS that were analysed illustrate the large data gaps on which PFASs that are being used. In addition to the need for better knowledge on which PFASs that are being used there is also a need for improved TOF-analysis of other matrices than the ones that were successfully analysed here. Also, a follow-up of the study after the implementation of the PFOA restriction would be valuable.

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Sammanfattning

Per- och polyfluorerade ämnen (PFAS) utgör en stor grupp av högfluorerade ämnen som har använts inom industrin och i konsumentprodukter i mer än sex årtionden. Under de senaste tjugo åren har PFAS fått ökad uppmärksamhet från forskare och myndigheter efter att de hittats i vilda djur och människor globalt. Det är idag känt att vissa PFAS är extremt svårnedbrytbara, bioackumulerande och giftiga. Det finns tusentals PFAS på den globala marknaden och för många av dessa saknas tillgänglig information om hur de kan påverka människors hälsa och miljön.

Denna studie är en uppföljning av ett projekt från NORAP (Nordic Risk Assessment Project) från 2015 där 29 olika konsumentprodukter analyserades för 22 olika PFAS. Resultatet av den studien visade att alla 29 produkter innehöll PFAS och att 12 av 22 analyserade PFAS kunde detekteras. Här har vi analyserat produkterna från den studien vidare tillsammans med analyser av ytterligare produkter som kan misstänkas innehålla PFAS. Eftersom analyser av enskilda PFAS sannolikt inte kommer att spegla det totala PFAS-innehållet i produkterna har vi analyserat dem också för deras innehåll av totalt organiskt fluor (TOF). Resultaten av TOF-analyserna kan användas för att visa i vilken utsträckning PFAS i de riktade analyserna utgör den totala organiska fluorhalten och därigenom ge en uppskattning av vår kunskap om den totala användningen av PFAS i produkterna.

Sammanlagt 17 nya produktprover som samlats in 2016 analyserades i detta projekt för 19 enskilda PFAS samt TOF. Dessutom analyserades 27 prover från 2015-projektet för TOF samt åtta textilprover som samlats in 2015 för ett tillsynsprojekt av Kemikalieinspektionen för 22 individuella PFAS samt TOF.

Resultatet av de riktade PFAS-analyserna av produkter som samlats in 2016 visade att PFAS används i nästan alla av dessa produkter. PFAS fanns i 16 av 17 produkter. Vanligast förekommande var PFOA som hittades i samtliga av dessa produkter. Perfluorerade karboxysyror (PFCA) var den mest frekvent detekterade PFAS-gruppen. Av de perfluorerade sulfonsyror (PFSA) detekterades endast perfluoroktansulfonat (PFOS) som förekom i ett prov. Bland fluorotelomeralkoholerna (FTOH) fanns endast 6:2 FTOH. Inga fluorotelomerakrylater (FTA), perfluoroktansulfonamider (FOSA) eller perfluoroktansulfonamidoetanoler (FOSE) detekterades. Sammantaget förekom PFCA och PFSA i låga $\mu\text{g}/\text{m}^2$ - och $\mu\text{g}/\text{l}$ -nivåer och 6:2 FTOH i $\mu\text{g}/\text{m}^2$ -nivåer i livsmedelsförpackningar och mg/l -nivåer i impregneringssprayer och en polish.

Resultatet av den riktade PFAS-analysen av textilier som samlats in 2015 visade att 6 av 8 produkter innehöll PFAS. Den vanligast förekommande var PFBA. Totalt förekom PFCA i låga $\mu\text{g}/\text{m}^2$ -nivåer och 6:2 FTOH i mg/m^2 -nivåer. Inga av textilproverna innehöll PFSA, FTA, FTS, FOSA eller FOSE.

TOF-analysen hade en del metodologiska problem. Metoden, som ursprungligen utvecklades för TOF-analys av papper och förpackningar, fungerade inte för

impregneringssprayer och vaxer. TOF-koncentrationerna i de framgångsrikt analyserade proverna sträckte sig över flera storleksordningar för produkterna som insamlats 2014, 2015 och 2016 – från $\mu\text{g}/\text{m}^2$ till g/m^2 , $\mu\text{g}/\text{l}$ till mg/l samt $\mu\text{g}/\text{kg}$ till g/kg . De produkter som innehöll högst koncentrationer av TOF var tandtråd ($310 \text{ g}/\text{kg}$), en non-stick-bakform ($1,7 \text{ g}/\text{m}^2$) samt en bordsduk ($0,9 \text{ g}/\text{m}^2$). Jämförelserna mellan summan av koncentrationerna av detekterade PFAS mot TOF visade att för de flesta prover utgjorde de detekterade PFAS endast en mycket liten del av TOF (under eller långt under 1 %). Några prover hade TOF-koncentrationer under detektionsgränsen, som inte heller visade några PFAS i de riktade analyserna, vilket indikerar att dessa produkter inte innehåller PFAS.

Denna studie är viktig för att förstå källor till människors och miljöns exponering för PFASs via konsumentprodukter. Studien visar att PFAS används utbrett i alla analyserade produkttyper. Den stora skillnaden mellan TOF och summan av detekterade PFAS visar på stora kunskapsluckor gällande vilka PFAS som används. Vidare finns ett behov av en förbättrad TOF-analysmetodik samt en uppföljning av studien efter genomförandet av EUs PFOA-begränsning.

Annex 1. Abbreviations and detection limits

Table 1: PFASs abbreviations and internal standards

Abbreviation	Full name	Detection limit
PFBA	Perfluorobutanoic acid	
PFCA	Perfluorinated carboxylic acids	
PFHxA	Perfluorohexanoic acid	
PFOA	Perfluorooctanoic acid	
PFNA	Perfluorononanoic acid	
PFDA	Perfluorodecanoic acid	
PFBS	Perfluoro butane sulfonic acid	
PFHxS	Perfluorohexane sulfonic acid	
PFOS	Perfluorooctane sulfonic acid	
PFSA	Perfluorinated sulfonic acids	
FOSA	Perfluorooctane sulfonamide	
FOSE	Perfluorooctane sulfonamidoethanol	
4:2 FTS	4:2 Fluorotelomer sulfonic acid	
6:2 FTS	6:2 Fluorotelomer sulfonic acid	
8:2 FTS	8:2 Fluorotelomer sulfonic acid	
4:2 FTOH	4:2 Fluorotelomer alcohol	
6:2 FTOH	6:2 Fluorotelomer alcohol	
8:2 FTOH	8:2 Fluorotelomer alcohol	
10:2 FTOH	10:2 Fluorotelomer alcohol	
4:2 FTA	4:2 Fluorotelomer acrylate	
6:2 FTA	6:2 Fluorotelomer acrylate	
8:2 FTA	8:2 Fluorotelomer acrylate	
MeFOSA	N-Methyl perfluorooctane sulfonamide	
EtFOSA	N-Ethyl perfluorooctane sulfonamide	
MeFOSE	N-Methyl perfluorooctane sulfonamidoethanol	
EtFOSE	N-Ethyl perfluorooctane sulfonamidoethanol	

Annex 2. Details of analysed products sampled in 2016

Table 1: Articles sampled in 2016

Sample ID	Product	Brand	Product name	Tested	Image
1	Cupcake forms	Toppits	Bakformar/240st	Inside of form
2	Microwave popcorn bag	OLW	Popcorn, smörsmak/3x100g	Inside of bag
3	Microwave popcorn bag	Garant	Mikro Pop, saltade/3x100g	Inside of bag
4	Microwave popcorn bag	Garant	Mikro Pop, smörsmak/3x100g	Inside of bag

Sample ID	Product	Brand	Product name	Tested	Image
5	Microwave popcorn bag	Garant	Ekologiska Mikropopcorn/3x90g	Inside of bag
6	Rinse Aid	Finish	Finish Shine & protect/500ml	Liquid content
7	Rinse Aid	Fixa	Spolglans miljömärkt/500ml	Liquid content
8	Waterproofing shoe treatment	Springyard	Universal Waterproofer Classic Shoe Care, Protect 3/300ml	Liquid content
9	Waterproofing shoe treatment	Fibertec	Blue Guard Footwear/200ml	Liquid content

Sample ID	Product	Brand	Product name	Tested	Image
10	Waterproofing textile treatment	Fibertec	Blue Guard Textile/200ml	Liquid content
11	Waterproofing textile treatment	Fibertec	Pro Wash (Bluesign approved)/250ml	Liquid content
12	Waterproofing textile/leather treatment	Imprenex	Waterproofing Express/400ml	Liquid content
13	Shoe wax	Springyard	Shoe Wax Care 02	liquid/wax content
14	Floor polish	Nitor	Golvpolish/750ml	Liquid content

Sample ID	Product	Brand	Product name	Tested	Image
15	Furniture polish	MP52	Möbelpolish, Møbelpolish/250ml	Liquid content
16	Car wax	Turtle wax	Turtle wax original/500ml	liquid/wax content
17	Car wax	Sonax	Flytande hårdvax/250ml	liquid/wax content

Annex 3. Details of analysed products sampled in 2014

Table 1: Products sampled in 2014

Sample ID	Product / Type of product	Product
1	Table cloth 1
2	Table cloth 2, Maud Teflonduk
3	Baking paper 1, Unik
4	Baking paper 2, Toppits
5	Sandwich paper, Unik

Sample ID	Product / Type of product	Product
6	Cupcake forms, Unik	A box of Unik Muffinsformer cupcake liners, labeled 'Kvartens papper' and '7-267/16', next to a single white paper liner.
7A	Microwave popcorn paper 1 Eldorado (salt)	A box of Maarud Popcorn, labeled 'SALTET' and 'MICROPOP MED SALT', with a green label '7-267/17'.
7B	Microwave popcorn paper 2 Maarud (salt)	A box of Eldorado Micropop popcorn, labeled 'SALTET' and '3 pk', with a green label '7-267/17'.
8	Car wax/polish 1 Turtle wax	A bottle of Turtle Wax Original car wax, labeled 'THE WORLD'S NO.1 SHINE' and 'Hard Shell Shine Car Wax', with a green label '7-267/18'.
9	Car wax/polish 2 Autoglym	A can of Autoglym cockpit glass interior glass spray, labeled 'cockpit glass interior glass', with a green label '7-267/19'.

Sample ID	Product / Type of product	Product
10	Dishwasher liquid 1, Sun
11	Dishwasher liquid 2, Finish
12	Waterproofing shoe treatment product 1, Waterguard
13	Waterproofing shoe treatment product 2, Kiwi

Sample ID	Product / Type of product	Product
14A and B	Waterproofing textile treatment product 1, Nikwax two pack TX
15	Waterproofing textile treatment product 2, textile proof, Toko
16	Glider for skis 1, Swix HF7 Violet
17	Ski wax, Swix VR 55 S+LV/Fiolet

Sample ID	Product / Type of product	Product
18	Glider 1, Swix LF6 Blue	A yellow and blue package for Swix LF6 wax. The text on the package includes 'CERA NAVA', 'Swix', 'HIGH PERFORMANCE GLIDEWAX', 'COE DE GLISSE HAUTE PERFORMANCE', 'FLUORWAX', 'FLUORE', 'LF6', '-6 C/-12 C', '60g/2.1 oz', and 'Made in Norway'.
19	Lubricant for bicycles, TF2 Teflon greasetube	A green tube of TF2 Bike Grease. The text on the tube includes 'TF2 LUBRICANT', 'Bike Grease with Teflon surface protector', and '150ml'.
20	Dental floss 1, Jordan Easyslide	Two packages of Jordan Easyslide dental floss. One is a small white box with a green label, and the other is a larger blue and white blister pack. Both have the text 'Easyslide' and 'JORDAN'.
21	Dental floss 2, Colgate, mint	Two packages of Colgate dental floss. One is a small white box with a red label, and the other is a larger silver and white blister pack. Both have the text 'Colgate'.
22	Non-stick baking ware, silicon 1, Invite	A red silicone baking tray with the brand name 'INVITE' printed on it. The tray is shown with some food items inside.

Sample ID	Product / Type of product	Product
23	Non-stick baking ware, Patisse ¹
24	Non-stick baking ware, cupcakes 1, Invite
25	Non-stick baking ware, silicon, cupcakes 2, Patisse ²
26	Reusable baking liner 1, Invite
27	Reusable baking liner 2

Note: ¹ Referred to as Non-stick baking ware, silicon 2, Patisse, in Blom and Hanssen (2015).
² Referred to as Non-stick baking ware, cupcakes 2, Patisse, in Blom and Hanssen (2015).

Source: Blom and Hanssen, 2015.

Annex 4. Details of textiles samples in 2015

Table 1: Textiles sampled in 2015

Sample ID	Product	Brand	Product name	Tested	Image
124	Childrens jacket	Galvin Green	Richie Rainproof jacket junior	Outer material: bluegreen textile
125	Jacket	Galvin Green	Robin Windstopper mintgrön	Outer material: bluegreen textile
147	Jacket	Five seasons	Latitude jacket marine	Outer material: blue textile
150	Childrens jacket	Peak Performance	Down jacket, child JRHELIUMJ	Outer material: blue textile

Sample ID	Product	Brand	Product name	Tested	Image
155	Childrens shoe	DC	DC Shoe Toddler trace TX Fuchsia	Outer material: pink textile
177	Shoe	JOBi	JOBi walkingsko herr	Outer material: grey fabric (textile)
184	Childrens jacket	Didriksson	Wylie Kid's Jacket	Outer material: blue textile
185	Childrens rain clothing	Didriksson	Makalu Kid's Set	Outer material: red textile

Nordic Council of Ministers
Nordens Hus
Ved Stranden 18
DK-1061 Copenhagen K
www.norden.org

ANALYSIS OF PFASs AND TOF IN PRODUCTS

Per- and polyfluorinated substances (PFASs) are a large group of substances used in industrial and consumer applications. There are thousands of PFASs on the global market, for many of which there is little information on their use. This study is a follow-up of a NORAP project from 2015 where different household products were analysed for PFASs. Here we further analysed these products for total organic fluorine (TOF) together with new analyses for individual PFASs and TOF in product types that are known to or suspected to contain PFASs. The analyses of new products showed that PFASs are widely used. The comparisons between analysed individual PFASs and TOF concentrations showed that for most samples the detected individual PFAS constituted only a very minor part of the TOF, illustrating large data gaps in our knowledge on which PFASs that are being used in these products.

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