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HIGHLY FLUORINATED CHEMICALS (PFASS): DO THE BENEFITS JUSTIFY THE HARM?

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Introduction

Highly fluorinated chemicals, or poly- and per-fluoroalkyl substances (PFASs) are a class of compounds containing multiple bonds between fluorine and carbon. The unique strength of these bonds and other physicochemical attributes of PFASs contribute to their very useful waterproof, stain-resistant, and non-stick properties. However, the strong carbon-fluorine bonds also contribute to their extreme persistence.

Production of the first PFASs began in 1947 and now there are over 3000 on the market. Numerous PFASs are found in the environment, wildlife, and human tissue worldwide.[1] The few PFASs that have been extensively studied have been linked to a number of adverse health effects.[2] For example, PFOA (perfluorooctanoic acid) has been classified by the International Agency for Research on Cancer as a possible human carcinogen.[3] PFOS (perfluorooctane sulfonic acid) and PFOA have been found in nearly all humans studied as well as umbilical cord blood and breast milk.[4] Concentrations measured in children tend to be higher than in adults.[5]

Major sources of PFASs in the environment include industrial processes, military bases, airports, and firefighting operations as well as municipal wastewater and biosolids. PFASs can migrate from consumer products into air, household dust, food, soil, groundwater and surface water. They have been detected in drinking water[6,7] worldwide. Water and food are considered the major sources of human exposure, while exposures from household products and indoor air are less well understood.

An estimate was made that drinking water supplies for more than 4.5 million U.S. residents exceed the recent USEPA lifetime drinking water health advisory level of 70 ng/L for PFOS and PFOA separately or combined.[8] One of the major producers of PFASs, is currently the defendant in thousands of personal injury and dozens of wrongful death claims brought by residents, who were exposed by drinking water contaminated with discharges from a production plant.[9]

To protect the public from exposure to PFASs, a number of jurisdictions have issued drinking water guidelines. Some focus on individual PFASs, while others like the U.S., Sweden, and Denmark consider co-occurrence of 2-12 PFASs. However, according to Grandjean and Clapp, these advisory levels might not be sufficiently protective.[5] Also, the advisory levels are recommendations, not legal requirements.

Materials and methods

We have carried out a review of literature on the history and policies related to this class of chemicals. Using this information, we worked with about fifty manufacturers, retailers, and large purchasers to educate them about PFASs in the products they manufacture, sell, and/or purchase. Finally, in order to better understand the possible exposure to PFASs from food contact paper, we have investigated the use of fluorinated substances in food packaging by the U.S. fast-food industry.

Results and discussion

PFOS was classified as a persistent organic pollutant and restricted under the Stockholm Convention in 2009, decades after its persistence and toxicity became known.[10] Also, PFOA and PFOS are regulated in the EU and Canada and being voluntarily phased out in the U.S.[1]

These policies have resulted in a shift from production of long-chain PFASs (>C7) to many dozens of short-chain alternatives with similar structure, persistence, and potential for toxicity, the classic "regrettable substitution." For example, one chemical manufacturer replaced PFOA with more than 40 different short-chain alternatives. The manufacturers state that these replacements are safer, as they do not bioaccumulate and are more rapidly excreted from the body.[5] However, recent assessments suggests that these fluorinated alternatives may also pose risks to humans and the environment because of their environmental persistence, long-range transport, and potential for toxicity.[8,12] Also, while the levels of PFOA and PFOS in human blood samples and environmental media are now decreasing, at the same time the levels of short-chain replacements are increasing.[1]

In 2014, international scientists published the Helsingør Statement summarizing the key concerns over the increasing use of short-chain PFASs.[1] In 2015, Madrid Statement, which was signed by 230 scientists, documented the harm from the chemical class of PFASs and called on the international community to limit their production and develop safer non-fluorinated alternatives.[13]

Reducing the manufacture and use of an entire class of harmful chemicals such as PFASs, as opposed to focusing on individual chemicals, can help prevent the cycle of regrettable substitutions, where the phased out chemicals are often replaced with closely related “chemical cousins” that lack adequate toxicological data.

After learning about the health and environmental concerns associated with the use of the class of PFASs, several companies (e.g., Kaiser Permanente, IKEA, and Crate and Barrel) are choosing to phase out PFASs from the products they buy, produce, and/or sell. Some companies are reducing the use of these chemicals voluntarily, while others are responding to external pressures. Notably, the Greenpeace “Detox my Fashion” campaign secured commitments from 66 international brands, retailers and suppliers to phase out PFASs and other classes of chemicals of concern. Global apparel and footwear companies are also working together in the Zero Discharge of Hazardous Chemicals program to reduce the discharge of certain PFASs and other harmful chemicals throughout their supply chains.

Decisions by purchasers to reduce the use of the entire class of PFASs should provide a strong incentive to develop safer alternatives. Given their potential for harm, PFASs should only be used when necessary and when safer alternatives are not available.

Also, some governmental agencies are adopting the class approach for PFASs. For example, in November 2015, the Scientific Guidance Panel for California Biomonitoring voted unanimously to add the entire class of PFASs to their priority list of chemicals for biomonitoring.[14] This will allow the California Safer Consumer Products program to add all PFASs to their list of chemicals under consideration for regulation.

Jurisdictions have regulated aqueous film-forming foams (AFFFs) containing PFOA and PFOS due to concerns about their adverse health and environmental impacts. Some are restricting the use of the existing stockpile of PFOA and PFOS based foams; some are not using PFAS-containing foam during practices, and others are advocating employing non-fluorinated foam for all uses.[15]

Given the extreme persistence and potential toxicity of PFASs, we suggest the following to reduce exposure and the potential for harm from these chemicals:
(1) PFAS chemicals should be used only when essential, so their use during firefighting practices should be reduced or eliminated.
(2) Levels of a variety of PFASs should be measured in drinking water near possible sources of contamination such as production facilities, military bases, airports, etc.
(3) Contaminated drinking water should be traced back to its source for mitigation.
(4) Remediation of PFAS contamination impacting drinking water should be prioritized.

Additionally, the Hope College, Silent Spring Institute, the Environmental Working Group, and Green Science Policy Institute have recently investigated the use of PFASs in food contact papers, paperboards, and beverage containers used by the U.S. fast food industry. We found that among >400 samples collected from five regions of the U.S., 54% of food contact papers, and 25% of paperboard samples contained fluorine chemistry. By contrast, <3% of paper cups contained fluorinated chemicals (preliminary results).[16] The prevalence of fluorinated chemicals in fast-food packaging materials, coupled with prior studies that demonstrated their migration from packaging into food, suggests they may be a contributor to human PFAS exposure (Fig. 1).

The finding of many PFAS-free food contact papers used by the U.S. fast food industry (Fig. 1) indicates that alternatives to PFAS-containing food contact papers are available or that some of the PFASs uses are unnecessary. The use of PFAS-containing paper may be associated with local availability of these products as opposed to a conscious decision to use these products. This, as well as the examples of the recent decisions of the retail chain Coop Denmark to move away from the use of PFAS-containing packaging, suggests that, when provided with information regarding the use of PFASs, companies can choose products that do not contain these substances.

As discussed above, some manufacturers, retailers, and government agencies are deciding that the benefits associated with some uses of PFASs do not justify the potential for harm. They are taking the lead in reducing the use of this entire chemical class and restricting the use to necessary applications, where alternatives are not readily available. However, this process is hindered by a lack of transparency regarding where PFASs are used; a lack of education regarding their health and environmental impacts; and a lack of alternatives proven to be safer.

The Helsingør and Madrid Statements provide a summary of the impacts of PFASs as well as a helpful roadmap for stakeholders to reduce the use of and exposure to this chemical class. When a function of PFASs is indeed necessary, Green Chemistry can be used to create improved alternatives. However, toxicity testing of alternatives to avoid regrettable substitutions is critical. With, increased transparency, the education of stakeholders, and safer alternatives, the use of the class of PFASs can be reduced and human and ecosystem health improved.

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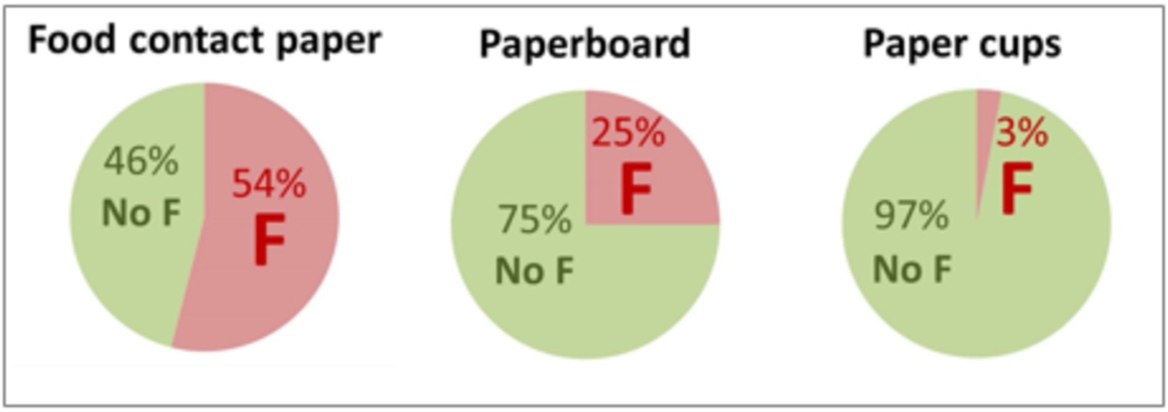

Data source: Schaider et al., 2016 submitted[16]

Figure 1. Screening for PFASs in food contact paper, paperboards, and beverage paper cups used by the U.S. fast food industry