PFAS IN SELECTED PRODUCTS IN INDONESIA

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IPEN
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We take this opportunity to thank all those who were instrumental in compiling and shaping this study.

This report presents new data on the PFAS content found in products in Indonesia. The report also recommends action items different stakeholders should take to protect the community from exposure to PFAS.

Nexus Foundation for Environmental Health and Development, or Nexus3 Foundation (previously known as BaliFokus Foundation), works to safeguard the public, especially vulnerable populations, from the impact of development on their health and the environment, towards a just, toxic-free, and sustainable future.

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IPEN is an international NGO network of health and environmental organizations from all regions of the world in which Nexus3 participates. IPEN is a leading global organization working to establish and implement safe chemical policies and practices to protect human health and the environment. Its mission is a toxics-free future for all. IPEN helps build the capacity of its member organizations to implement on-the-ground activities, learn from each other's work, and work at the international level to set priorities and achieve new policies.

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This report has been prepared by:

Yuyun Ismawati
Joseph DiGangi
Anantika Anissa
Mochamad Adi Septiono
Jitka Straková

With contributions from:

Sara Brosché
Krishna Zaki

LIST OF ABBREVIATIONS

AFFF	Aqueous Film Forming Foam	**PFHxA**	Perfluorohexanoic acid
BPOM	*Badan Pengawas Obat dan Makanan* (Food and Drugs Administration)	**PFNA**	Perfluorononanoic acid
BPPT	*Badan Pengembangan dan Pengkajian Teknologi* (Technology Development and Assessment Agency)	**PFOA**	Perfluorooctanoic acid
BSN	*Badan Standardisasi Nasional* (National Standardisation Agency)	**PFUdA**	Perfluoroundecanoic acid
EC	European Commission	**PFOS**	Perfluorooctane sulfonate
EU	European Union	**PFPeA**	Perfluoropentanoic acid
HA	Health Advisory	**PFTeDA**	Perfluorotetradecanoic acid
KLHK	Kementerian Lingkungan Hidup dan Kehutanan (Ministry of Environment and Forestry)	**PFTrDA**	Perfluorotridecanoic acid
LOQ	Limit of Quantitation is a term used to describe the most negligible concentration of a measurement that an analytical procedure can reliably measure.	**6:2 FTOH**	6:2 Fluorotelomer alcohol
PFASs	Per- and polyfluoroalkyl substances	**8:2 FTOH**	8:2 Fluorotelomer alcohol
PFBA	Perfluorobutanoic acid	**6:2 diPAP**	6:2/6:2 Fluorotelomer phosphate diester
PFDA	Perfluorodecanoic acid	**6:2 8:2 diPAP**	6:2/8:2 Fluorotelomer phosphate diester
PFDoA	Perfluorododecanoic acid	**POPs**	Persistent Organic Pollutants
PFHpA	Perfluoroheptanoic acid	**US EPA**	United States Environmental Protection Agency

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EXECUTIVE SUMMARY

PFAS (Per- and polyfluoroalkyl substances) or "Forever Chemicals" are an environmental and health concern because they are highly persistent and they have negative impacts on human health. They are widely used as water- and grease-resistant additives in many products. Humans are continuously exposed to PFAS in their diet, drinking water, and personal care and consumer products.

PFAS persist in the body, where they are mainly detected in blood, liver, breastmilk, and kidneys. Animal studies have found that certain PFAS can cause reproductive and developmental disruption; liver and kidney, and immunological effects; effects on birth weight, growth, learning, behavior, and pregnancy; and effects on the endocrine system, such as increased cholesterol, and alterations in thyroid function. One study showed a positive association with kidney and testicular cancer among people living near chemical plants who were exposed to the PFAS chemical, Perfluorooctanoic acid (PFOA).

Microwave popcorn bags containing PFAS have been shown to be a source of PFAS in the body. PFAS in microwave popcorn bags migrate into the oil, making them available for ingestion. A 2019 study of human exposure found that microwave popcorn consumption was associated with significantly higher levels of PFAS in blood. Studies have also shown that PFAS in clothing and other textiles are released during use and washing.

Safer alternatives are available for PFAS use in both textiles and paper packaging. Paraffin and silicone-based chemistries are substitutes that provide water repellence. Non-chemical alternatives for textiles include tightly woven fabrics and plant-based materials. For paper packaging, a fluorine-free alternative is high-density paper, which prevents transmission of oils.

This study was conducted from 2019 to 2022 and is a follow-up to the PFAS Country Situation Report of Indonesia (2019)[1] that documented the use, disposal, and impacts of PFAS in Indonesia. For the current study we analyzed 48 products, testing each product for PFAS in an accredited laboratory in Czechia. Up to 56 PFAS chemicals were tested.

Thirty-seven products were purchased in Indonesia, including:

- Thirteen samples of common textiles, clothing, and apparel.
- Eighteen samples of microwave popcorn bags.
- Four samples of common paper food packaging.
- One sample of thermal paper.
- One sample of rubber crumbs.

For comparison, eleven microwave popcorn bags from U.S. brands on the market in Indonesia were also purchased in the U.S. and included in the survey. The data on PFAS in microwave popcorn bags from Indonesia and the U.S. were previously published in the Nexus3-IPEN report "Toxic Hazards in Microwave Popcorn"[2] in March 2023.

We found evidence of PFAS use in the overwhelming majority of analyzed products. Overall, of the 48 products, 45 samples or 93.75% tested positive for one or more PFAS. PFAS identified in the products are associated with severe health risks. They include PFOA, which has been listed for global elimination under the Stockholm Convention.

MAIN FINDINGS OF THIS STUDY

- 34 out of 37 (**91%**) of the samples purchased in Indonesian markets tested positive for PFAS, including:
  - 11 out of 13 (**84.6%**) of textile samples,
  - 22 out of 23 (**95.6%**) of paper samples, including 18 microwave popcorn bags, and
  - One sample of rubber crumbs.
- Majority of the samples from Indonesia, 23 of 37 (62%) exceeded the proposed restriction limit of 25 ppb for any PFAS in the EU.
- All microwave popcorn bags (Jolly Time, Preferred and ACT II) purchased in the Indonesian market tested positive for PFAS at levels exceeding the proposed restriction limit in the EU.
- All microwave popcorn bags (Jolly Time, Preferred and Cousin Willie's) purchased in the U.S. market tested positive for PFAS at levels exceeding the proposed restriction limit in the EU.
- Initial samples purchased were analysed for 30 PFAS, while samples purchased and tested later were analysed for up to 56 PFAS.
- 22 PFAS chemicals (**PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFODA, 6:2 FTOH** (**FHET**), **8:2 FTOH, 12:2 FTOH, 6:2 diPAP, 8:2 diPAP, 6:2 8:2 diPAP, 6:2 FTS, 6:2 monoPAP** and **8:2 monoPAP**) were identified in the analyzed items.
- The PFAS with the highest concentration (**30,178 ng/g**) in textile was **6:2 diPAP**, found in a water-proof hijab purchased in Indonesia.
- The PFAS with the highest concentration (**2,043 ng/g**) in food packaging paper was **6:2 diPAP**, found in a microwave popcorn bag imported from the U.S.
- Samples of microwaves popcorn bags from Indonesia and the U.S. market contained **6:2 FTOH, PFHxA,** and **PFBA**.
- The most frequently detected PFAS chemicals were **6:2 FTOH, PFHxA, PFBA, PFHpA, 6:2 diPAP,** and **PFOA**.

RECOMMENDATIONS

The use of PFAS in disposable food packaging and clothing is an unwanted source of environmental pollution and repeated toxic exposures to consumers. To address the problem of PFAS substances, the Nexus3 Foundation and IPEN propose the following recommendations:

For the Indonesian government as a Party to the Stockholm and Basel Conventions:

- Work for a class-based approach of listing all PFAS for global elimination under the Stockholm Convention.
- Define all PFAS-contaminated waste as hazardous waste based on their H11 (delayed or chronic toxicity) characteristics.
- Work for a PFAS waste limits ("low POPs content levels") no higher than 0.025 mg/kg for PFOS, PFOA or PFHxS and their salts and 10 mg/kg for the sum of PFOS, PFOA, PFHxS and their related compounds.
- Promote the replacement of PFAS with safe alternatives.

For the Ministry of Environment and Forestry:

- Implement Stockholm Convention amendments listing PFOA, PFOS, and PFHxS in national regulations and support the removal of all exemptions and acceptable purposes.

- Prohibit PFAS as a class, including implementing the Stockholm Convention prohibitions of PFOS, PFOA, and PFHxS.
- Update the National Implementation Plan of Stockholm Convention in Indonesia.
- Monitor PFAS substances in the environment.
- Add PFAS as a class to the list of hazardous substances.
- Determine a health-protective standard for PFAS content in drinking water and the environment.
- Develop an action plan to manage PFAS containing wastes.

For Indonesia's Food and Drug Administration:

- Prohibit sale and importation of PFAS-treated food contact materials (e.g., microwave popcorn).
- Prohibit PFAS use in food contact materials and packaging in Indonesia.

For the Ministry of Trade:

- Prohibit manufacturing and importation of consumer goods containing PFAS, including kitchen utensils, food packaging, textiles, textile products and toys, among other uses.
- Producers must provide information regarding PFAS in products sold in Indonesia.

For the Ministry of Industry:

- Prohibit PFAS as a class, including its use in textiles, textile products, fire-fighting foams (AFFF), paper, and in electronics industries.
- Producers must provide information regarding PFAS in products manufactured in Indonesia.

For the Ministry of Agriculture:

- Prohibit PFAS as a class use as an active or inert additive ingredient for pesticides.

For the Ministry of Health:

- Conduct human biomonitoring related to occupational health in paper, textile, firefighting, and other industries that potentially use PFAS in their process.
- Determine a health-protective standard for PFAS content in drinking water, food, and human biomarkers.

For the National Standardization Agency (BSN):

- Determine a health-protective standards for PFAS content in products, drinking water, food, and the environment.

For industries:

- Stop the use of PFAS in new products and publicly disclose PFAS content in existing products with clear warning signs/labels/ icons on products.
- Companies that have shifted to fluorine-free alternatives should have their products certified through independent, third-party verification procedures to increase consumers' ability to choose products with no added PFAS.

For public health groups, consumer organizations and other concerned entities:

- Support the elimination of PFAS and conduct activities to inform the public about PFAS exposure.

For all stakeholders:

- Come together and unite in alerting the public about the hidden pollution and harms posed by PFAS substances and support and implement a strong policy to eliminate PFAS in Indonesia.

Table PFAS in tested samples

SAMPLE CODE	PRODUCT TYPE	COUNTRY OF PURCHASE	BATCH/YEAR	PFAS CHEMICALS DETECTED
IDN-TX-01	Waterproof hijab	Indonesia	1/2019	PFBA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFDoA, PFTeDA
IDN-TX-02	Waterproof shirt	Indonesia	1/2019	PFPeA, PFHxA, PFHpA, PFOA, PFDA, PFDoA
IDN-TX-03	Waterproof kids' clothes	Indonesia	1/2019	PFOA
IDN-TX-04	Waterproof kids' clothes	Indonesia	1/2019	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PF-HxDA, PFODA
IDN-TX-05	Fire suit (gloves)	Indonesia	1/2019	PFOA
IDN-TX-06	Waterproof pants	Indonesia	1/2019	PFHxA, PFHpA, PFOA
IDN-TX-07	Tracksuits	Indonesia	1/2019	-
IDN-TX-08	Fire blanket	Indonesia	1/2019	-
IDN-TX-09	Adult t-shirt	Indonesia	2/2020	FOET (8:2 FTOH)
IDN-TX-10	Hiking gloves	Indonesia	2/2020	FOET (8:2 FTOH)
IDN-TX-11	Hijab	Indonesia	2/2020	FOET (8:2 FTOH), 6:2 diPAP, 6:2 8:2 diPAP
IDN-TX-12	Short pant	Indonesia	2/2020	FOET (8:2 FTOH)
IDN-TX-13	Gloves	Indonesia	2/2020	FOET (8:2 FTOH), 12:2 FTOH
IDN-PA-01	Thermal paper	Indonesia	1/2019	-
IDN-PA-02	Burger wrap paper	Indonesia	1/2019	PFHxA
IDN-PA-03	Popcorn bag	Indonesia	1/2019	PFBA, PFPeA, PFHxA, PFHpA, PFOA
IDN-PA-04	Food paper bag	Indonesia	1/2019	PFBA, PFHxA, PFHpA, PFOA
IDN-PA-05	Food box	Indonesia	1/2019	PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFT-eDA
IDN-PA-06	Popcorn bag	Indonesia	2/2020	FHET (6:2 FTOH)
IDN-PA-07	Food box	Indonesia	2/2020	FHET (6:2 FTOH)
IDN-PA-08	Popcorn bag	Indonesia	2/2020	FHET (6:2 FTOH)
IDN-PA-09	Popcorn bag	Indonesia	2/2020	FHET (6:2 FTOH)
IDN-PA-10	Popcorn bag	Indonesia	2/2020	FHET (6:2 FTOH)
IDN-PA-11	Popcorn bag	Indonesia	2/2020	PPFBA, PFPeA, PFHxA, FHET (6:2 FTOH)
IDN-PA-12	Popcorn bag	Indonesia	2/2020	PFHxA, FHET (6:2 FTOH)

Table, continued PFAS in tested samples

SAMPLE CODE	PRODUCT TYPE	COUNTRY OF PURCHASE	BATCH/YEAR	PFAS CHEMICALS DETECTED
IDN-PA-13	Popcorn bag	Indonesia	2/2020	PFHxA, FHET (6:2 FTOH)
IDN-PA-14	Popcorn bag	Indonesia	2/2020	PFHxA, FHET (6:2 FTOH)
IDN-PA-15	Popcorn bag	Indonesia	2/2020	PFHxA, 6:2 FTOH, 6:2 diPAP, 6:2 8:2 diPAP
IDN-PA-16	Instant noodle cup	Indonesia	2/2020	FHET (6:2 FTOH)
IDN-PA-17	Popcorn bag	Indonesia	3/2022	PFBA, PFHxA, FHET, 6:2 FTS, 6:2 monoPAP, 8:2 monoPAP, 6:2 diPAP, 6:2 8:2 diPAP, 8:2 diPAP
IDN-PA-18	Popcorn bag	Indonesia	3/2022	PFBA, PFHxA, FHET, 6:2 monoPAP, 8:2 mono-PAP, 6:2 diPAP, 6:2 8:2 diPAP, 8:2 diPAP
IDN-PA-19	Popcorn bag	Indonesia	3/2022	PFBA, PFHxA, PFHpA, FHET, 6:2 monoPAP, 8:2 monoPAP, 6:2 diPAP, 6:2 8:2 diPAP, 8:2 diPAP
IDN-PA-20	Popcorn bag	Indonesia	3/2022	PFBA, PFHxA, FHET, 8:2 monoPAP, 6:2 diPAP, 6:2 8:2 diPAP
IDN-PA-21	Popcorn bag	Indonesia	3/2022	PFBA, 6:2 diPAP
IDN-PA-22	Popcorn bag	Indonesia	3/2022	PFBA, PFHxA, PFHpA, FHET
IDN-PA-23	Popcorn bag	Indonesia	3/2022	PFBA, PFHxA, PFHpA, FHET, 6:2 diPAP
IDN-RB-01	Rubber crumb	Indonesia	1/2019	PFHxA
USA-PA-01	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-02	Popcorn bag	USA	2/2020	PFBA, PFHxA, FHET (6:2 FTOH)
USA-PA-03	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-04	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-05	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-06	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-07	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-08	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-09	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-10	Popcorn bag	USA	2/2020	FHET (6:2 FTOH)
USA-PA-11	Popcorn bag	USA	3/2022	PFBA, PFHxA, FHET

PFAS IN SELECTED PRODUCTS IN INDONESIA

1. BACKGROUND

1.1 BACKGROUND ON PFAS OR "FOREVER CHEMICALS"

Per- and polyfluoroalkyl substances (PFAS) are a large class of synthetic substances that include non-polymeric PFAS (i.e., perfluoroalkyl carboxylic acids, perfluorocarbons, perfluoroalkane sulfonic acids and trifluoromethyl substituted substances) as well as polymeric PFAS (fluoropolymers, perfluoropolyethers and side-chain fluorinated polymers).

PFAS are widely distributed in the global environment due to their high solubility in water and low/moderate sorption to soils and sediments as well as high resistance to biological and chemical degradation. The properties of PFAS have resulted in their extensive uses as water- and grease-resistant surfactants and surface-active agents in products.[3] In addition to well-known uses of PFAS, such as textile impregnation, food packaging, non-stick cookware, fire-fighting foam, and electroplating, PFAS are also used in ammunition, climbing ropes, guitar strings, artificial turf, and soil remediation.[4]

All PFAS contain very strong chemical bonds between the carbon (C) and fluorine (F) atoms. These bonds provide the high stability of the PFAS molecules and earn them the metaphoric name of 'Forever Chemicals'. Three widely used members of this class have been perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexanesulfonic acid (PFHxS). As these three substances have come under regulatory pressure, the industry has shifted to other PFAS chemicals with similar properties.

Contrary to non-polymeric PFAS (i.e., PFOS, PFOA, PFHxA, PFHxS, GenX), fluoropolymers (e.g., PTFE marketed as "Teflon") have been understood as polymers of low concern until recently. This conclusion was derived from incomplete characteristics that failed to cover problems occurring during all fluoropolymer production phases and disposal of finished articles at their end-of-life. An exhaustive life-cycle assessment associated the production, use and disposal phases of fluoropolymers with serious non-polymeric PFAS emissions and human exposures.[5] A class approach to phase out all non-essential uses of PFAS is the only adequate response to prevent further, irreversible harm of PFAS on human health and the environment.

1.2 HEALTH IMPACTS OF PFAS EXPOSURE

Common sources of human exposure to PFAS substances are food, water, air, and dust. These substances bind to proteins – not to fats – and persist in the body, where they are mainly detected in blood, liver, breastmilk, and kidneys.[6,7,8,9] Evaluations performed by the Stockholm Convention POPs Review Committee indicate that PFOA and PFOS can cause reproductive and developmental disruption, liver and kidney, and immunological effects in laboratory animals. Both chemicals cause tumors in animal studies along with a variety of other effects on infant birth weight, growth, learning, infant behavior, pregnancy, endocrine system, increased cholesterol, and thyroid function.[10] In 2017, the Stockholm Convention POPs Review Committee (POPRC) noted the links[11] between PFOA and serious illnesses in humans, including diagnosed high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer, and pregnancy-induced hypertension.

Various studies have shown relatively consistent evidence of modest positive associations of PFAS with lipid profiles (i.e., cholesterol and triglycerides) and less compatibility with metabolic diseases (i.e., diabetes, obesity, heart disease).[12] A study of 5 and 7 year-old children from the Faroe Islands in the Atlantic showed that commonly prevalent exposures to PFOS, PFOA, PFHxS, PFNA,[13] and PFDA measured in blood serum were associated with lower antibody responses to childhood immunizations (vaccinations) and an increased risk of antibody concentrations below the level needed to provide long-term protection against diphtheria and tetanus.[14]

Other studies found that the increased concentrations of PFOA, PFNA, PFHxS, and PFOS in maternal blood were found to be associated with decreased antibody levels to the rubella vaccine in three year-old children. Furthermore, increased levels of PFOA and PFHxS were associated with an increased number of episodes of common cold and gastroenteritis.[15]

A study by Rosenmai et.al in 2016 revealed that, in vitro, PFAS have estrogenic activity and those technical mixtures showed estrogenic activities, but the short-chain PFCAs did not.[16] Another research shows that PFOA-exposed communities from nearby chemical plants are correlative with occurrences of cancer, especially positively associated with kidney and testicular cancer.[17]

Recent studies have linked a variety of PFAS substances to many human health effects: cardiovascular disease,[18] markers of asthma,[19] damage to semen quality,[20] ovarian insufficiency,[21] altered glucose metabolism,[22] lower testosterone levels in male adolescents,[23] association with shorter birth length in girls,[24] elevated blood pressure,[25] abnormal menstruation,[26] lower birth weight in infants,[27] possible increased risk of female infertility due to endometriosis,[28] and decreased lung function in children with asthma.[29] Another US government study suggests that "PFOA is an immunotoxin chemical following dermal exposure."[30]

Exposure to PFAS pose a health risk not only for humans, but also for wildlife. Forever Chemicals continue to be detected in aquatic biota across the globe including the Arctics.[31, 32] PFAS ubiquity may exacerbate the effects of other anthropogenic impacts such as climate change and loss of habitats faced by wildlife species and may be fueling the biodiversity crisis.[33, 34] Toxic effects of selected PFAS chemicals are summarized in table 1.

Table 1 Toxic effects of selected PFAS chemicals

SUBSTANCE	PROPERTIES
PFOA (Perfluorooctanoic Acid)	In 2017, the Stockholm Convention POPs Review Committee noted the link between PFOA and serious human illnesses, including high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer, and pregnancy-induced hypertension. PFOA is also associated with attenuated vaccine response in children.
PFDoA (Perfluorododecanoic Acid)	PFDoA is associated with lower birth weight in infants and impacts on thyroid function. Prenatal exposure increases the risk of atopic dermatitis in girls. PFDoA is also associated with increased risk of polycystic ovarian syndrome related infertility. In animal studies, PFDoA impacts the male reproductive system in rats and is associated with oxidative damage in Arctic seabirds and developmental neurotoxicity in zebrafish.
PFHxA (Perfluorohexanoic Acid)	Studies indicate that PFHxA displays similar toxicity to the liver as PFOA and is associated with damage to the male reproductive system. PFHxA is found in amniotic fluid, negatively associated with testosterone levels in adolescents, and modulates immune response in laboratory studies.
PFTeDA (Perfluorotetradecanoic Acid)	PFTeDA binds thyroid hormone transport proteins, elevates cholesterol levels in children, and bioconcentrates in carp.
PFDA (Perfluorodecanoic Acid)	PFDA is associated with lower steroid hormone levels in female infants, lower infant birth weight, increased risk of developmental problems with social skills in children, and elevated levels of lipids and lipoproteins linked to increased cardiovascular risk.
PBFA (Perfluorobutanoic Acid)	Studies indicate that PFBA displays similar toxicity to the liver as PFOA and is associated with damage to the male reproductive system.
PFPeA (Perfluoropentanoic Acid)	PFPeA has been found to be a dominant contributor to PFAS in PM10. PFPeA is readily taken up by rice and a wetland plant, Juncus effuses. PFPeA is also found in vegetables grown in areas with PFAS contamination of ground water and industrially contaminated sewage sludge. PFPeA is associated with alterations in thyroid hormones and laboratory studies with human red blood cells indicate that PFPeA causes alternations leading to lipid peroxidation and oxidative injury. PFPeA is found in breast milk and in children.
FTOHs	The toxicological effects of FTOH and its metabolites are associated with hepatotoxicity, development of mammary gland cancer, developmental disorders, and affects on the reproductive system.
6:2 FTS	6:2 FTS toxicity has been associated with adverse effects on the liver and kidneys and skin irritation.
diPAPs	diPAPs cause destructive endocrine effects, including antiandrogenic and estrogenic effects, which influence the reproductive system.

The most notorious PFAS pollution spill scandal occurred at a DuPont plant in Parkersburg, West Virginia, U.S., which had been contaminating the local water supply with perfluorooctanoic acid (PFOA) used in Teflon production. The contamination was linked to illnesses among the local population, including kidney and testicular cancer.[35] Both DuPont and their PFAS (PFOA) supplier 3M knew decades ago that the substances were harmful, but produced and marketed them anyway.[36] In 2023, 3M reacted to rising legal pressures over damage caused by PFAS and set a 2025 deadline to stop making "Forever Chemicals."[37]

1.3 PFAS USE IN PRODUCTS

PFAS are used by many industries, including aerospace, construction, automotive, textiles, paper and pulp and electronics, because of their ability to reduce friction on surfaces and provide grease- and water-resistance. Products containing PFAS include some stain-resistant and waterproof clothing and furniture; floor polishes; adhesives; firefighting foams; insulation for electrical wires; paper; products for food packaging, such as pizza boxes, microwavable popcorn bags, and fast-food wrappers; personal care products, such as shampoo and dental floss; and heat-resistant and non-stick coatings on cookware.[38, 39]

One well known use of PFAS is in firefighting foams, also known as Aqueous Film-Forming Foams (AFFFs). Due to their direct release to the environment, the use of fluorinated AFFFs has caused widespread contamination of soil, groundwater, surface water and drinking water, which are very costly to remediate.[40, 41, 42] Fluorine-free firefighting foams are cost effective, viable alternatives that do not contain PFAS.[43]

In Indonesia, PFAS use in various products, includes fire extinguishers [44] for home use (PFOS and PFOA), different types of soccer shoes [45] (PFOA and PFBS), children's apparel,[46] and coats containing a variety of PFAS.[47]

1.3.1 HUMAN EXPOSURE DURING USE OF PFAS-TREATED PRODUCTS

A presence of various PFAS-treated products at home contributes to human exposures via inhalation of house dust or via skin contact with the products. PFAS from a variety of sources end up on the skin, including the hands. PFAS levels on skin have been correlated with PFAS in house dust and PFAS precursors in indoor air.[48]

Several studies revealed that PFOA can penetrate human and mouse skin.[49, 50] Researchers expressed concern about potential dermal exposure to PFOA in both occupationally exposed individuals and the general population.

1.3.2 FOOD CONTACT MATERIALS RELEASE PFAS INTO FOOD

PFAS are used in producing disposable grease- and water-resistant food packaging and tableware items. PFAS can be added to the pulp or applied as coatings on the surface of paper or board. The perceived added value of PFAS comes from their ability to create a chemical barrier on the surface of the wrapping material, which repels the grease coming from the food.

The presence of PFAS in food packaging raises concerns as migration of PFAS from food contact materials into food may also contribute to a major route of PFAS exposure via diet.[51]

PFAS migration increases with higher temperatures from food-contact material, along with longer contact time, and presence of emulsifiers.[52] In addition, storing dry food in packaging materials with high concentrations of PFAS may be risky, especially those in contact with fatty food.[53]

Dietary PFAS can be readily absorbed by the intestine and enter the circulatory system or accumulate directly at intestinal sites, which could interact with the intestine and cause the destruction of the intestinal barrier.[54]

PFAS chemicals have been found in variety of foods including in fish, seafood, meat and meat products, and microwave popcorn.[55, 56, 57]

1.3.3 TEXTILES RELEASE PFAS INTO THE ENVIRONMENT

PFAS chemicals are used in textiles as finishing agents to achieve water, oil, and dirt repellency of the materials, while at the same time maintaining the breathability of the fabric. About 50% of PFAS produced globally are used in textiles. PFAS in textiles are not bound and can be released to dust or water during use and washing.

Laboratory weathering of textiles containing PFAS to mimic the lifespan of outdoor clothing resulted in significant releases and conversion to other PFAS substances.[58] In fact, in one study, samples that initially met regulatory standards for PFOA exceeded the limit after weathering due to increased PFOA formation from precursors present in the product.[59] Another study found a significant conversion of PFAS precursors to PFOA and PFDA in jackets that were stored in a sealed bag in the dark for 3.5 years.[60]

Release to wash water can result in direct contamination of waterways as well as contaminating wastewater treatment plants that release PFAS into waterways. People can be exposed to PFAS when wastewater contaminates drinking water or food. The amount of PFCA released into the laundry water represented an average of 12.2% of the content of the materials.[61] A study in Thailand found that approximately 30% of the PFOS and 99% of the PFOA were released after washing, indicating that textiles *"could be a significant direct and indirect source of PFOS and PFOA exposure for both humans and the environment."*[62]

1.3.4 END-OF-LIFE OF PFAS-TREATED PRODUCTS: THREATS TO PEOPLE AND ENVIRONMENT

Many PFAS-treated products end up in landfills or are incinerated. Disposal of end-of-life products in municipal incinerators leads to emissions of PFAS, fluorinated greenhouse gases, and other products of incomplete combustion to the surrounding environment.[63, 64, 65] Some PFAS remain in the after-incineration ash,[66] and then contribute to the further environmental exposures when the ash is landfilled or used in construction materials.[67]

The recycling of PFAS-treated consumer products leads not only to exposure of consumers, but also of workers and communities living nearby recycling plants. Workers can be exposed to PFAS when waste material is shredded and ground, and surrounding communities are exposed when PFAS are emitted into the water.[68, 69]

Moreover, single use food packaging sold as compostable could lead to PFAS-contaminated compost, leading to an accumulation of PFAS in crops grown in that soil.

1.4 REGULATORY FRAMEWORK

1.4.1 INTERNATIONAL TREATY INCLUDES SOME PFAS

PFOS,[70] PFOA,[71] and PFHxS [72] are listed in the Stockholm Convention for global restriction and elimination. Indonesia became a Party [73] to the Stockholm Convention in 2009 and the treaty added PFOS [74] to its global restriction list the same year. This amendment entered into legal force in Indonesia in 2010. In 2019 and 2022, the Parties added PFOA and PFHxS, respectively, to the Stockholm Convention for global elimination. The PFOA amendment entered into force for Indonesia and most countries on 3 December 2020.[75] The PFHxS amendment [76] will enter into force for Indonesia and most other countries in November 2024.

In 2009, when PFOS was listed in the Stockholm Convention, many loopholes accompanied its listing that permitted continued production and use. However, in 2019 at COP9, governments ended the following loopholes for PFOS due to the availability of technically feasible alternatives: photo-imaging; photo-resist and anti-reflective coatings for semiconductors; etching agents for compound semiconductors and ceramic filters; aviation hydraulic fluid; certain medical devices; photo masks in semiconductor and LCD industries; hard metal plating; decorative metal plating; electric and electronic parts for some colour printers and color copy machines; insecticides for control of red imported fire ants and termites; and chemically-driven oil production. Some exemptions for PFOS still remain, but not for any of the products analyzed in this report.

The Stockholm Convention allowed a five-year exemption for PFOA use in textiles, but only for *"the protection of workers from dangerous liquids that comprise risks to their health and safety."* This indicates that new production and sale of food packaging, consumer product textiles, and clothing containing PFOA should not be permitted because the amendment entered into force on 3 December 2020.[77]

PFHxS was listed in the Stockholm Convention without exemptions. When the amendment enters into force in November 2024, no new production or sale of products containing this substance will be permitted.

1.4.2 REGULATORY FRAMEWORK IN THE EU

The EU POPs Regulation 2019/1021 sets a maximum concentration of 0.025 mg/kg (25 ng/g or ppm) for PFOA and any of its salts, and a maximum concentration of 1 mg/kg for PFOA-related compounds, where they are present in articles. PFOS and derivatives may not be used in concentrations above 10 mg/kg. Both PFOS and PFOA may not be used in quantities of more than 1 μg/m^2 of the surface of the treated material. [78]

Since 2020, the governments of Denmark, Sweden, Germany, and the Netherlands have started developing an EU-wide restriction of all non-essential uses of PFAS with the support of the European Chemical Agency (ECHA). The PFAS restriction proposal was published by ECHA in February 2023.[79] It is based on the following restriction limits:

1. 25 ppb for any PFAS (except polymeric PFAS; measured by targeted PFAS analysis),
2. 250 ppb for the sum of PFAS, optionally with prior degradation of precursors (measured, for example, by TOP assay), and
3. 50 ppm for PFAS, including polymeric PFAS (measured as total organic fluorine).

Several PFAS are identified as substances of very high concern (SVHCs) under the EU REACH legislation (e.g., GenX, PFBS), and others are proposed for restriction or were recently restricted (i.e. C9-C14 PFCAs, PFHxA, or PFHxS).

1.4.3 REGULATORY FRAMEWORK IN THE US

Although the United States has no federal legislation on PFAS, several states have adopted some regulations on PFAS, including labelling requirements and banning PFAS in certain product groups, including food packaging, firefighting foam, and personal care products. For example, eleven states have enacted phase-outs of PFAS in food packaging.[80] Maine has banned PFAS in fabric treatments, carpets, and rugs as of January 1, 2023, and in all new products by 2030. In March 2023, the U.S. Environmental Protection Agency (EPA) proposed establishing legally enforceable levels for six PFAS in drinking water.[81]

1.4.4 REGULATORY FRAMEWORK IN INDONESIA

In 2014, Indonesia updated its Stockholm Convention National Implementation Plan (NIP) and noted that PFOS and related substances are not regulated in Indonesia.[82] The NIP (2014) also noted that *"information on the quantitative data of POPs, stockpiles and contaminated soil in Indonesia is still limited."* Preliminary assessment of PFAS priority sectors included specialized paper industries, firefighting foam, textile/apparel, synthetic carpets and synthetic carpet manufacturers. The NIP acknowledged that PFOS-containing fire-fighting foams are present, but the total volume is unknown.

As one of the Parties to the Stockholm Convention, Indonesia has ratified the international agreement and adopted Law No. 19/2009 as an umbrella policy for POPs regulation. In addition, other regulations may serve as a proxy to regulate POPs as hazardous chemicals and waste management. In reality, the Indonesian Government Regulation (GR) No. 74/2001 regulates hazardous chemicals management, while the Government Regulation No. 22/2021 regulates hazardous waste management.

Government Regulation No. 74 of 2001[83] concerning Hazardous and Toxic Substances Management puts the obligation of registration on the importer or producer of hazardous chemicals (B3), especially for B3 chemicals imported for the first time. Such registration is conducted within the framework of INSW (Indonesia National Single Window) at the Ministry of Environment and Forestry, enacted in 2010.[84]

The INSW system enables the single submission of data and information and single decision-making for custom release and cargo clearance. Further, the B3 electronic registration system aims to handle customs documents that relate to permits and/or import and/or export of B3 within the framework of INSW. However, there is no obligation for owners to register.[85] Clearly, GR 74/2001 was not drafted with the phasing-out of POPs or other hazardous chemicals in mind. Furthermore, the B3-INSW system - if, in the future, it can be sufficiently linked to the list of prohibited POPs - will likely only capture chemicals which are imported as 'substances' or 'mixtures' but not chemicals which are inside of equipment, articles, or products.[86]

Further, the upcoming revision of Government Regulation No. 74/2001 would acknowledge PFOA trade within the HS Code of 2915.90.90.[87] A ministry-level regulation controls several PFAS to support the market mechanism, specifically for pesticide ingredients, textile products, and production processes. The Ministry of Agriculture prohibits PFOS from being used in active and additive ingredients for pesticides by including PFOS in the list of Annex I in the ministry regulation.[88]

The Ministry of Industry includes the obligation to acknowledge PFOS concentration in the textile production processes (i.e., dyeing, printing, and finishing) for companies looking for certification as green textiles following the industry standards.[89] The disclosure is made when a zero-decimal concentration of PFOS and/or PFOA is detected, which are 1 s in µg/g (or ppm) expressed in concentration or 1 s in µg/m^2 (1, 2, 3, and so on — not every 1.1 or 2.6 for example, and not below 1 µg/g or 1 µg/m^2) expressed in area density. Recently, the National Standardization Agency (*Badan Standardisasi Nasional* or BSN) has established PFOS and PFOA monitoring standards in textile products.[90]

Table 2 Regulatory framework on PFAS in Indonesia

LEADING SECTOR	DETAILS ON REGULATION DOCUMENTS
Ministry of Agriculture (MoA)	MoA Decree No. 43/2019 on Pesticide Registration, Annex I. Prohibited active ingredients and additives for pesticides: • Perfluorooctane sulfonic acid (PFOS) and its salt.
Ministry of Industry (MoI)	MoI Decree No. 13/2019 on Green Industry Standards for Dyeing, Printing, and Finishing Textile Industry For products, the textile industry must verify PFOS content information by providing: • Safety Data Sheet (SDS). • Product test results from an accredited laboratory/institution as according to ISO/IEC 17025. • Test methods based on SNI 7334: 2009 methods for extracted metal content tests or testing standards procedures that have been internationally recognized.
National Standardization Agency (Badan Standarisasi Nasional/BSN)	Head of BSN Decree No. 84/KEP/BSN/3/2017 concerning National Standard 8360:2017: • Textile Standard Testing on PFOS and PFOA.
Ministry of Trade (MOT)	MoT decree No. 18/2019 on Testing Methods, Procedures for Registration, Supervision, Termination of Trading Activities and Withdrawal of Goods Related to Security, Safety, Health and Environment: • Standard on PFOS and PFOA in textiles, bed covers, and blankets.

Currently, only a few ministry-level regulations and no national environmental legislation includes PFAS monitoring in the environment or in products and waste in Indonesia. Furthermore, at the time of this study, no national agencies in Indonesia have any program for environmental monitoring of PFOS or human biomonitoring or monitoring in products. Reasons for this may include:

- A lack of regulations.
- Low capacity of laboratory infrastructure and human resources.
- The high cost of laboratory sampling and analysis.

The presence of PFOS in humans and biota from Indonesia have, however, been noted by monitoring studies of foreign researchers with the involvement of Indonesian researchers.[91]

2. METHODOLOGY

2.1 SAMPLES COLLECTIONS

Nexus3 and IPEN collected 48 samples from Indonesia and the U.S. with potential PFAS treatment or contamination including clothing/apparel products, microwave popcorn bags, paper food packaging, thermal paper, and one sample of rubber crumbs (See table 3).

The rubber crumbs in this study were purchased from an e-commerce platform. The product is described as styrene-butadiene rubber (SBR) with particle size 20-80 mesh.

The collection method for clothing/apparel products, microwave popcorn bags, paper food packaging, and thermal paper used random selection from market-available products on Indonesian e-commerce platforms or in conventional markets. Apparel and paper products with at least one detail, including keywords of 'waterproof', 'water-resistant', or 'non-stick', were preferably included in the selection.

Figure 1 Examples of products from Indonesia tested for PFAS

The Indonesian samples were collected/purchased in three different batches from four provinces, namely DKI Jakarta Province, West Java Province (Bekasi, Bandung), East Java Province (Surabaya, Malang), and Banten Province (Tangerang). The team purchased the first batch from October to November 2019, the second batch from May to November 2020, and the third batch in June 2022.

As the samples from Indonesia included microwave popcorn bags made in the U.S., the team decided to purchase eleven samples of microwave popcorn bags in the U.S. for comparison. The samples were collected from May to November 2020 (included in batch 2) and in April 2022 (included in batch 3). The team purchased the samples from the U.S. online and from conventional markets in Indiana and California.

Annex A provides a detailed description of the samples.

Table 3 Number of samples per year included in this survey

SAMPLES PURCHASED	RECYCLED RUBBER CRUMBS	TEXTILE/ APPAREL	FOOD CONTACT MATERIALS		THERMAL PAPER
			PAPER POPCORN BAGS	PAPER FOOD CONTACT MATERIALS	
Batch 1, 2019	1	8	1	3	1
Batch 2, 2020	-	5	10 Indonesia 10 U.S.	-	-
Batch 3, 2022	-	-	7 Indonesia 1 U.S.	-	-

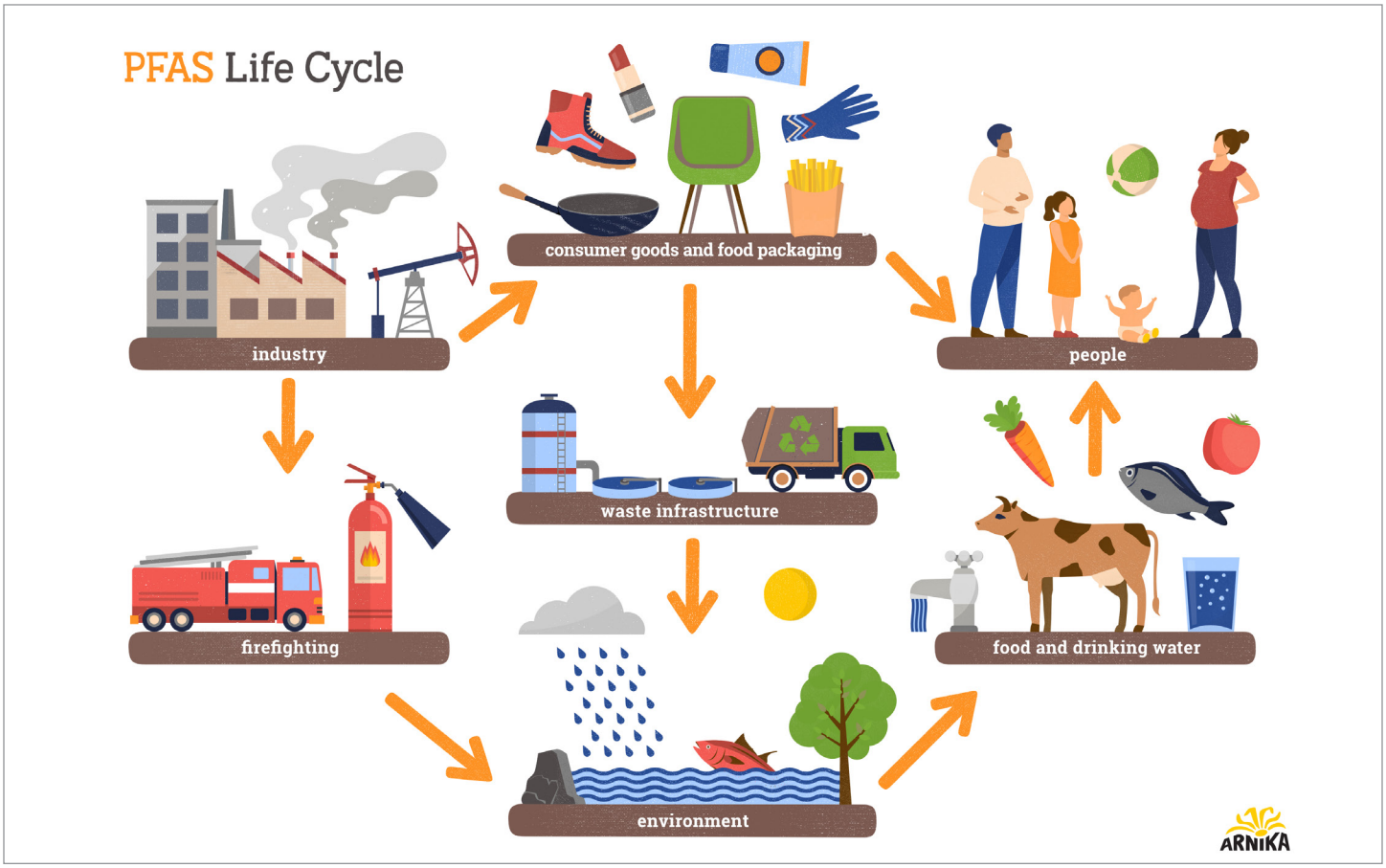


Figure 2 Sources of PFAS and PFAS Life Cycle. Credit: Arnika

2.2 ANALYTICAL METHODS

During the first batch of the analysis (2019), 30 PFAS chemicals were analyzed, while the second (2020) and third batches (2022) were upgraded to 55 and 56 PFAS chemicals, respectively. Tested PFAS chemicals for each batch are available in Annex A.

All samples were analyzed at the University of Chemistry and Technology[92] in Prague, Czechia using ultra-high performance liquid chromatography interfaced with tandem mass spectrometry with electrospray ionization in negative mode (UHPLC-MS/MS-ESI-). For isolation of selected per- and polyfluoroalkylated substances (PFAS), ultrasound-assisted extraction using a mixture of methanol:ethyl acetate (1:1, v/v) was applied.

Expanded uncertainty was calculated using coverage factor k=2, corresponding to a coverage probability of approximately 95%. The lab followed the EA-4/16 and manual Kvalimetrie 11 (issued by EURACHEM CZ) to calculate and state uncertainty. Uncertainty of sampling is not covered. Compliance is evaluated with respect to the uncertainty of test results according to the Guide ILAC-G8.

3. RESULTS

Almost all the tested samples (93.7%) contained detectable PFAS (above the limit of quantitation or LOQ). In textiles/apparel samples, 84% of the samples contained PFAS, and in paper samples, 97% samples contained PFAS. The only tested sample of recycled rubber crumbs also contained PFAS (see Figure 3). The restriction limit of 25 ppb proposed in the EU for any PFAS was exceeded in 34 of 48 (71%) tested samples.

Figure 4 shows the PFAS chemicals detected or quantified in tested samples of different groups (textile, paper, rubber crumb). Globally-banned PFOA, as well as 8:2 FTOH, a PFOA precursor (a chemical that PFOA metabolizes from) were more common in textiles than in paper samples.

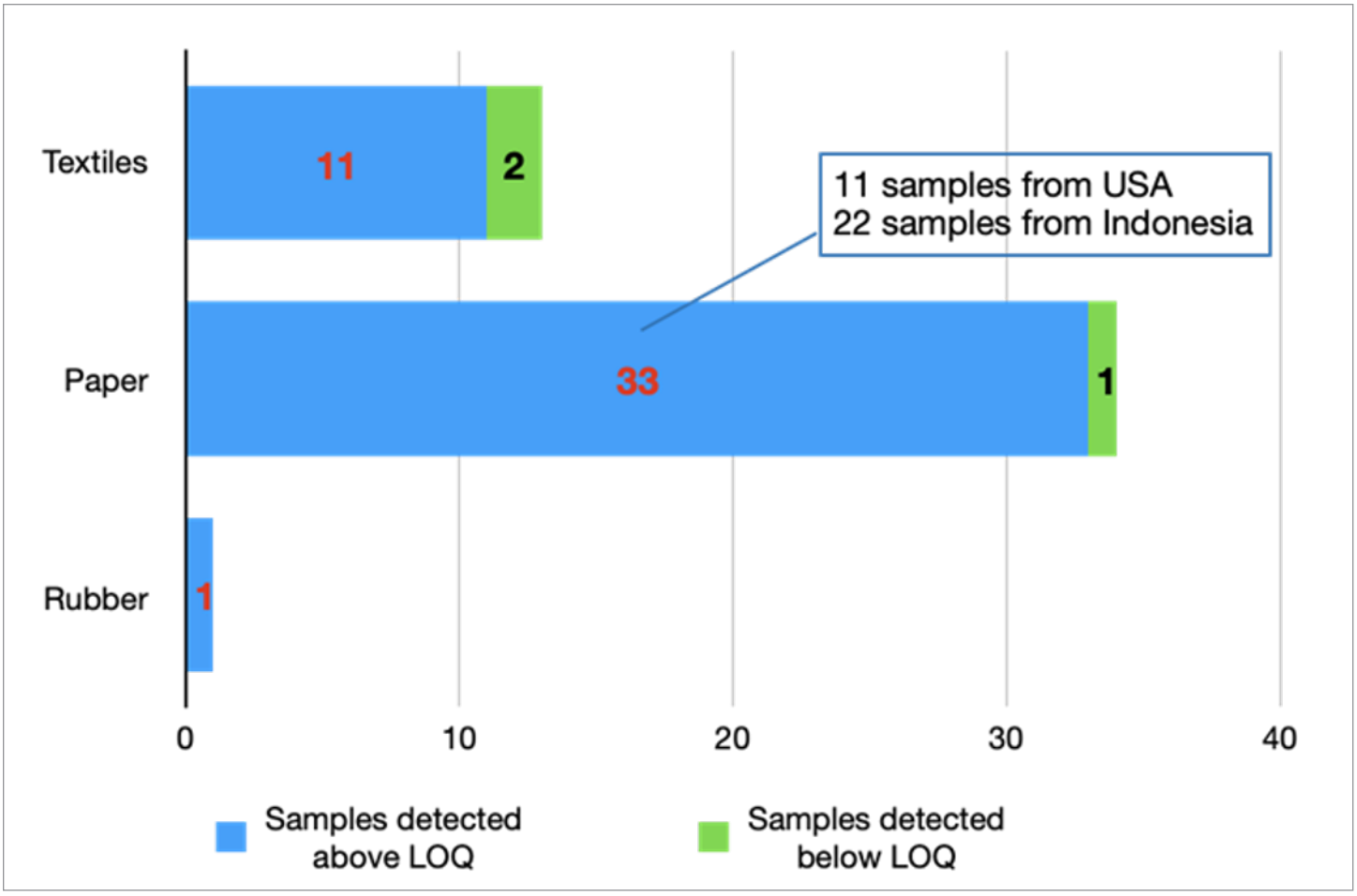


Figure 3 Samples with analyzed PFAS above the limit of quantitation (LOQ)

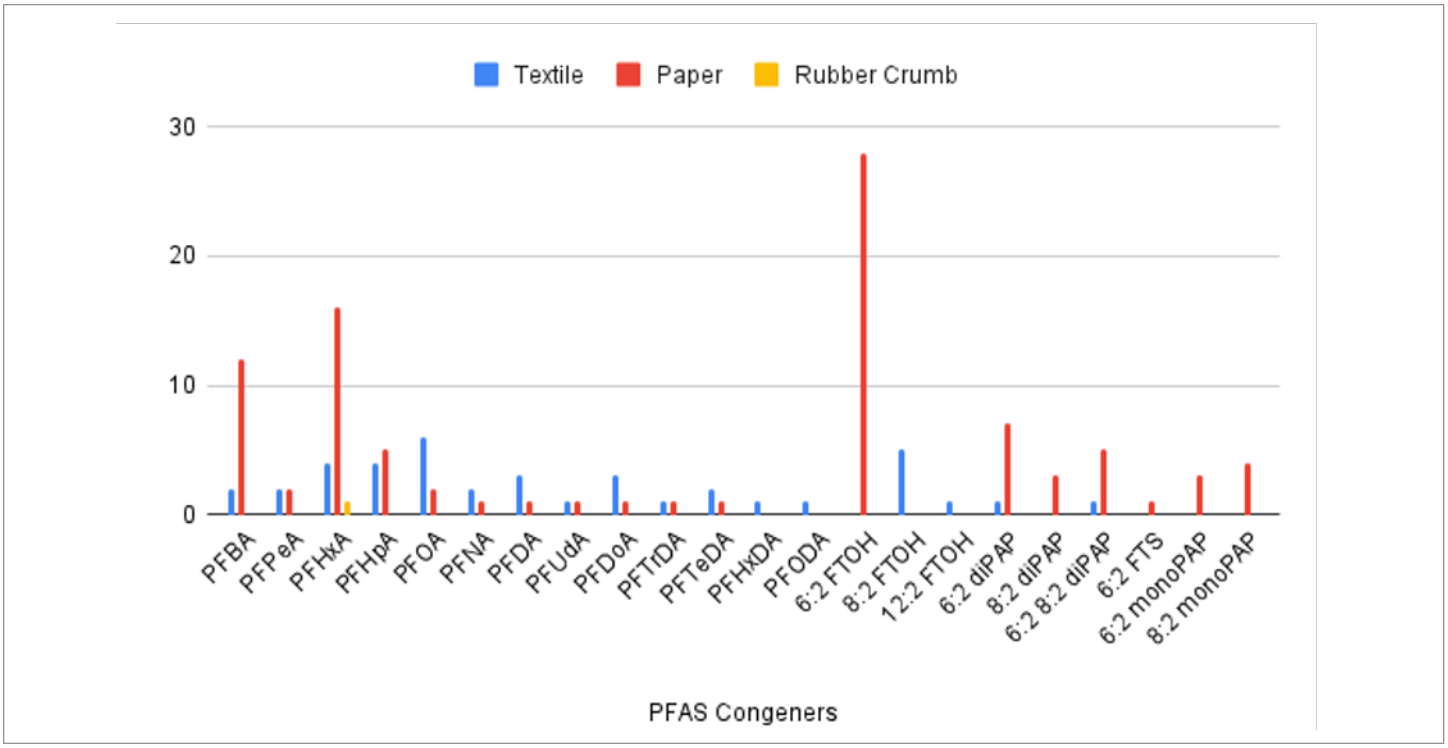


Figure 4 Frequency of PFAS chemicals in tested samples of different groups

3.1 FINDINGS OF PFAS IN SAMPLES FROM INDONESIA

Thirty-four out of thirty-seven (91%) of all tested samples from Indonesia contained PFAS. The majority of the samples from Indonesia, 62% or twenty-three out of thirty-seven, exceeded the restriction limit of 25 ppb proposed in the EU for any PFAS. The identified PFAS chemicals were perfluorocarboxylic acids (PFCAs), namely, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, and PFHxDA; fluorotelomer alcohols (FTOH), namely 6:2 FTOH (or known as FHET), 8:2 FTOH (or known as FOET), and 12:2 FTOH; fluorotelomer phosphate diesters, namely, 6:2 diPAP, 8:2 diPAP; and 6:2 8:2 diPA;, fluorotelomer sulfonic acid 6:2 FTS; and polyfluoroalkyl phosphoric acid monoesters, namely, 6:2 monoPAP and 8:2 monoPAP (see Figure 5). The PFAS chemical measured in the highest concentration was **6:2 diPAP** at **30,178 ng/g** in a hijab sample (IDN-TX-11).

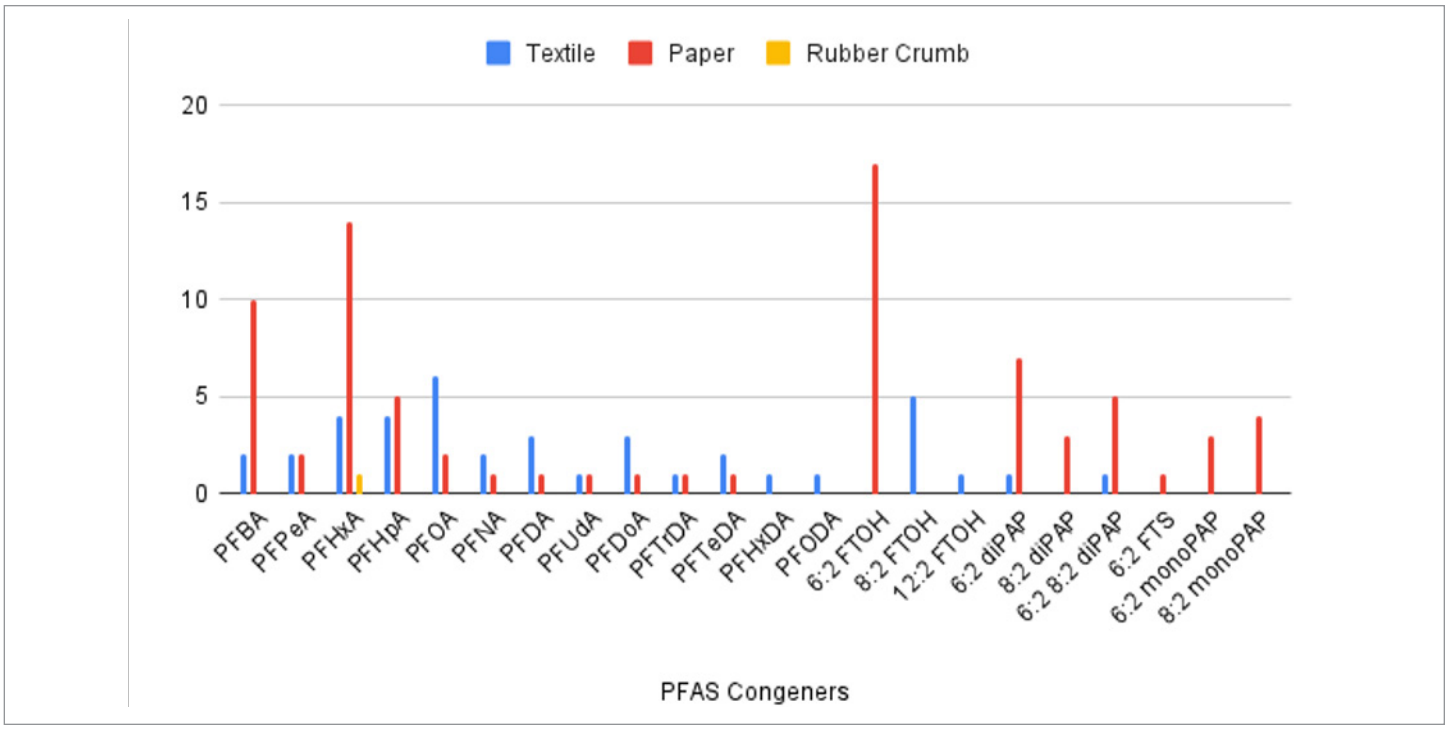


Figure 5 Frequency of PFAS chemicals identified in samples from Indonesia

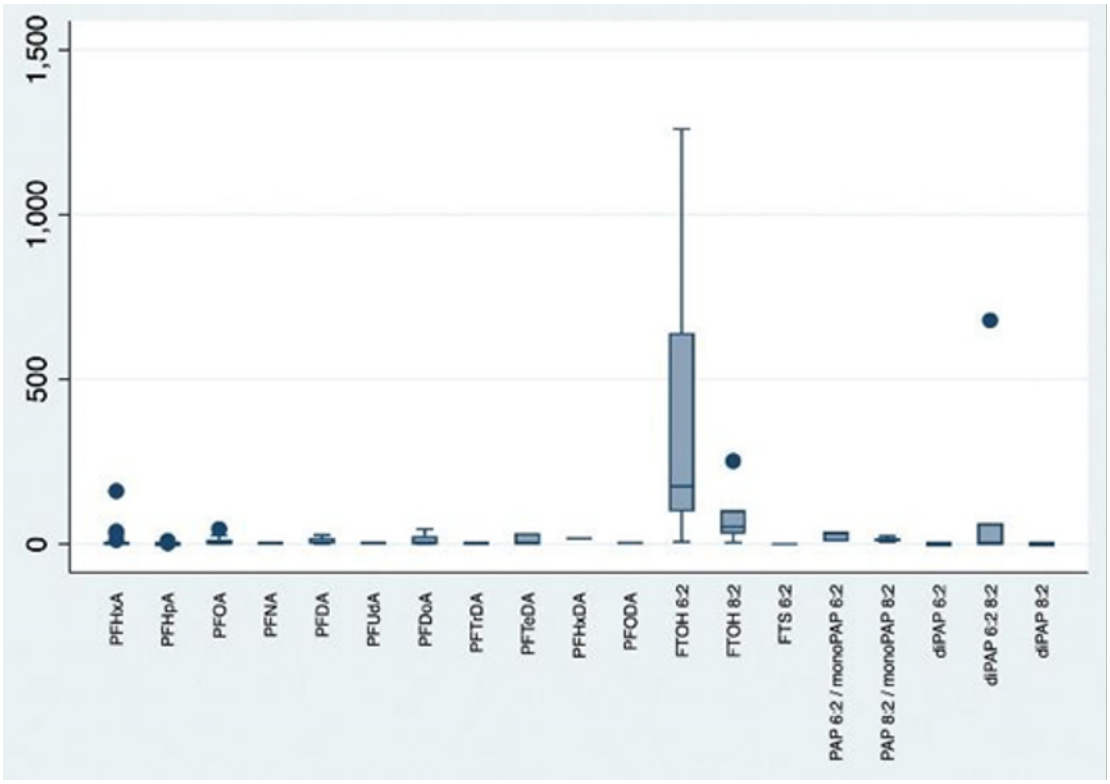


Figure 6 PFAS concentration in all samples from Indonesia (paper, textile, and rubber crumbs) in ng/g.
IDN-TX-13/2020 in 6:2 diPAP concentration (30,178 ng/g) and IDN-PA-15/2020 in 6:2 diPAP concentration (2,043 ng/g) are excluded from this graph due to high values (outlier)

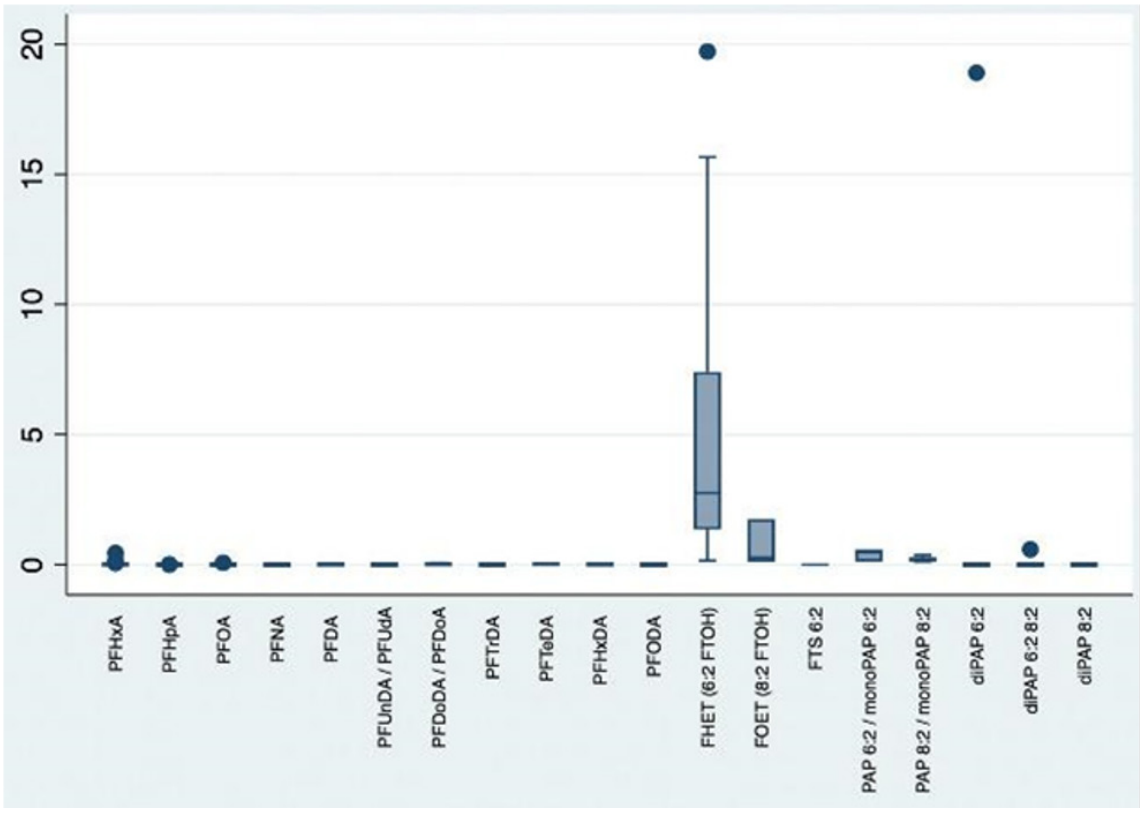


Figure 7 Density of PFAS of all samples from Indonesia (paper, textile, and rubber crumbs) in ng/cm2.
IDN-TX-11/2020 and IDN-TX-13/2020 are excluded from this graph due to high values (outliers).

3.1.1 PAPER SAMPLES FROM INDONESIA

Data provided in Figure 8 below shows that **22 of 23 (95.6%) of paper samples sold in the Indonesian market contain PFAS.** The majority of the samples, 74% (17 out of 23), exceed the restriction limit of 25 ppb proposed in the EU for any PFAS. The PFAS chemicals identified were perfluorocarboxylic acids (PFCA): PFBA, PFPeA, PFHxA, PFHpA, and PFOA, and fluorotelomer alcohols (FTOH), namely 6:2 FTOH, and 6:2 diPAP. The highest PFAS concentration was **6:2 diPAP at 2,043 ng/g measured** in a Preferred Kettle Corn popcorn bag (IDN-PA-15).

Figure 9 below shows that 6:2 FTOH and PFHxA are the two most frequent PFAS chemicals found in paper samples from Indonesia.

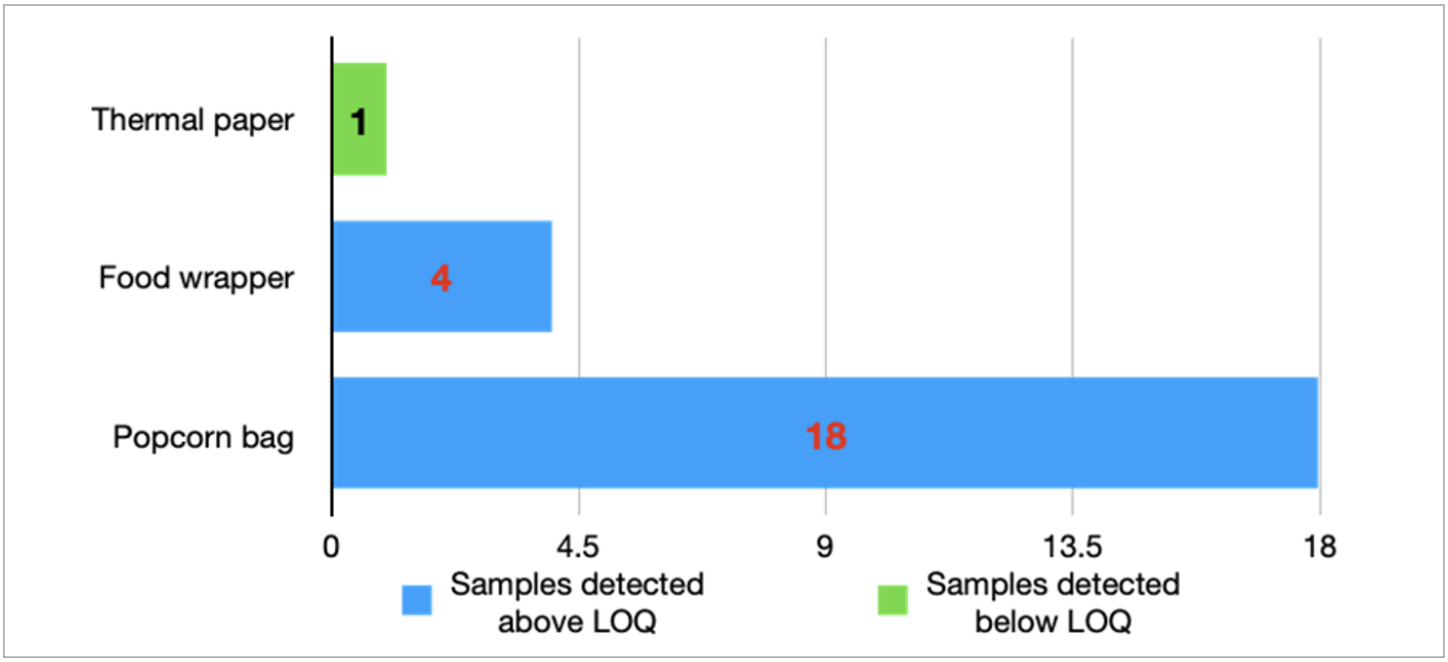


Figure 8 Frequency of PFAS chemicals identified in samples from Indonesia

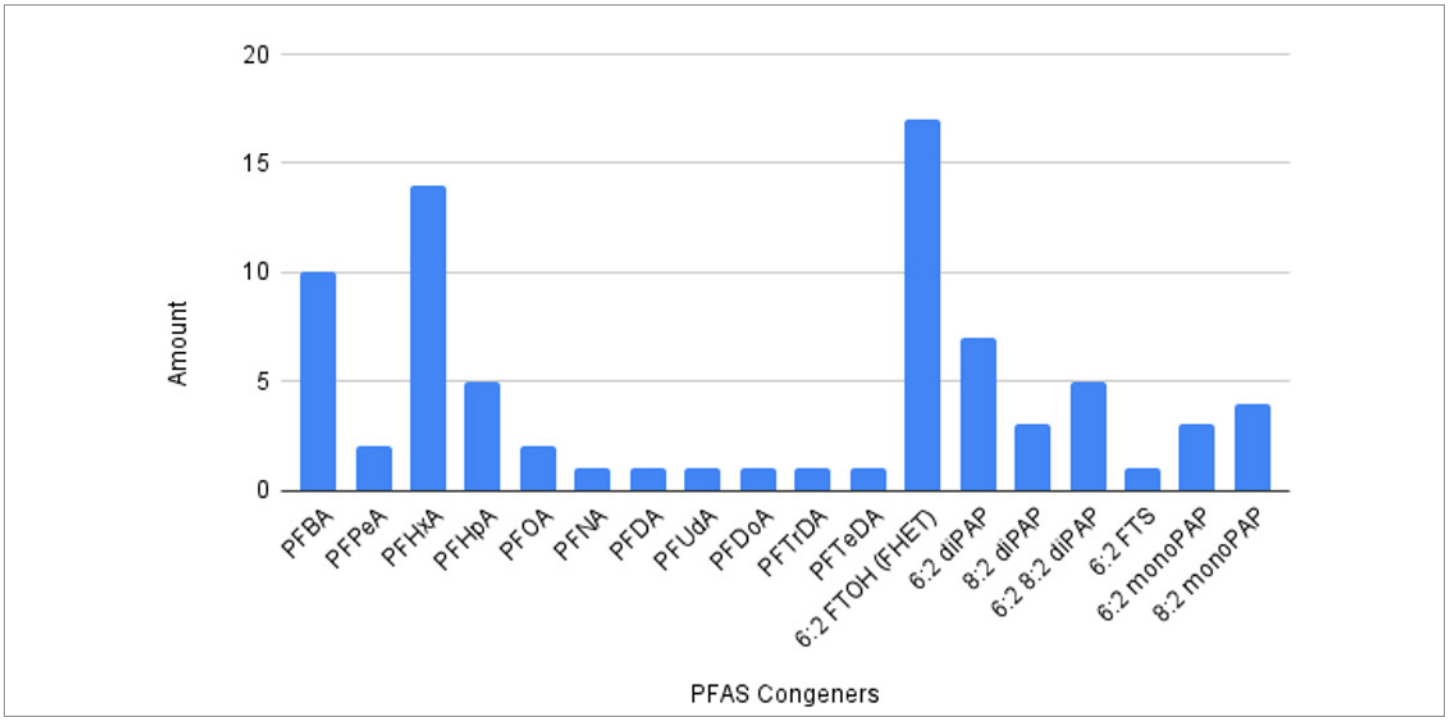


Figure 9 Frequency of PFAS chemicals identified in Indonesian paper samples

3.1.2 TEXTILE AND APPAREL SAMPLES FROM INDONESIA

Eleven out of thirteen tested textile samples (85%) were found to contain PFAS chemicals above the limit of detection or quantification (see Figure 10). Almost half of the tested samples (six of thirteen or 46%) exceed the restriction limit of 25 ppb proposed in the EU for any PFAS. The identified PFAS are: perfluorocarboxylic acids, PFCAs (PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFOdA), fluorotelomer alcohols, FTOH (8:2 FTOH, and 12:2 FTOH), and fluorotelomer phosphate diesters (6:2 diPAP, and 6:2 8:2 diPAP).

PFOA and 8:2 FTOH were the most frequently identified PFAS in textiles samples (see Figure 11 below). The PFAS chemical measured at the highest concentration among textile samples was **6:2 diPAP** identified in a hijab (IDN-TX-11) at **30,178 ng/g or ppb**.

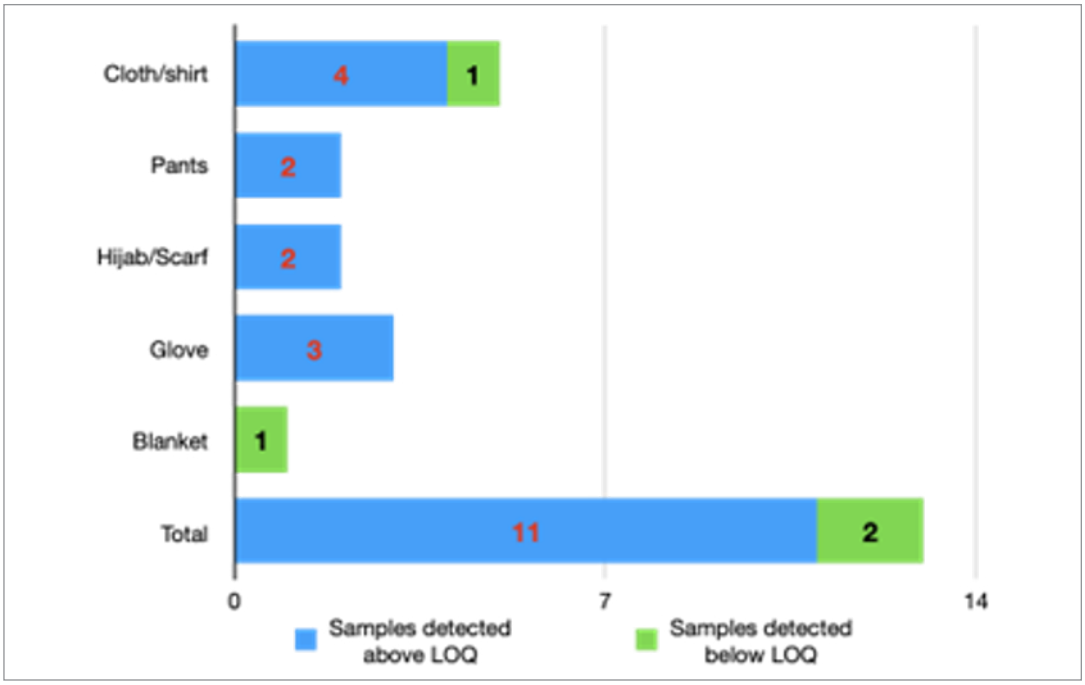


Figure 10 Textile samples containing PFAS chemicals

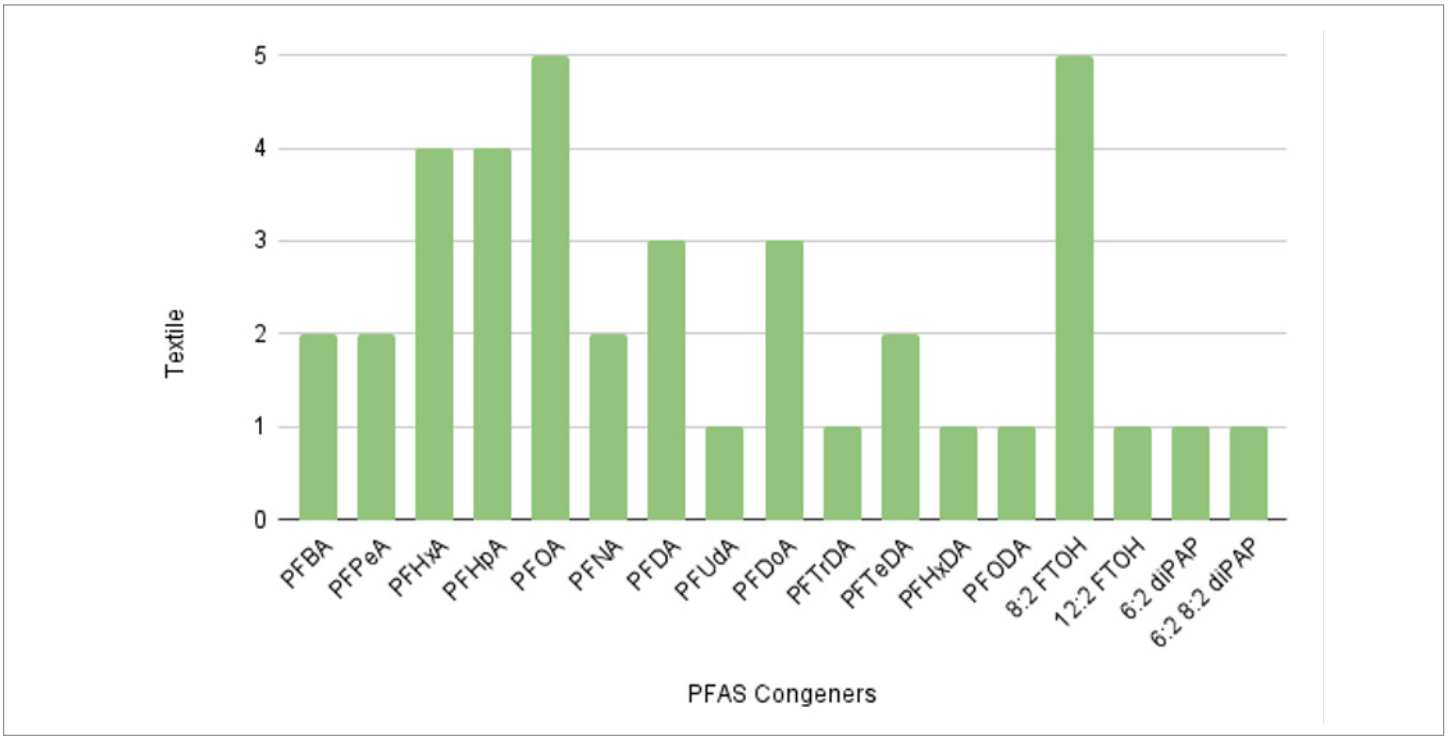


Figure 11 Frequency of PFAS chemicals in textile samples

The distribution of concentration of all detected PFAS chemicals in textile samples is shown in Figure 12. The concentration of 8:2 FTOH was measured only in samples from batch 2 (year 2020) but not in any earlier batches.

Because the Indonesian regulation SNI 8360:2017 sets a weak threshold limit for PFOS and PFOA product disclosure, the concentration of these chemicals in textile samples was below this threshold. However, a hijab sample and a child's shirt sample (IDN-TX-01 and IDN-TX-04) exceeded the existing, but weak, POPs regulation (EU) 2019/1021 limit of 25 ppm for PFOA. The current EU proposal sets the restriction limit of 25 ppb for any PFAS.

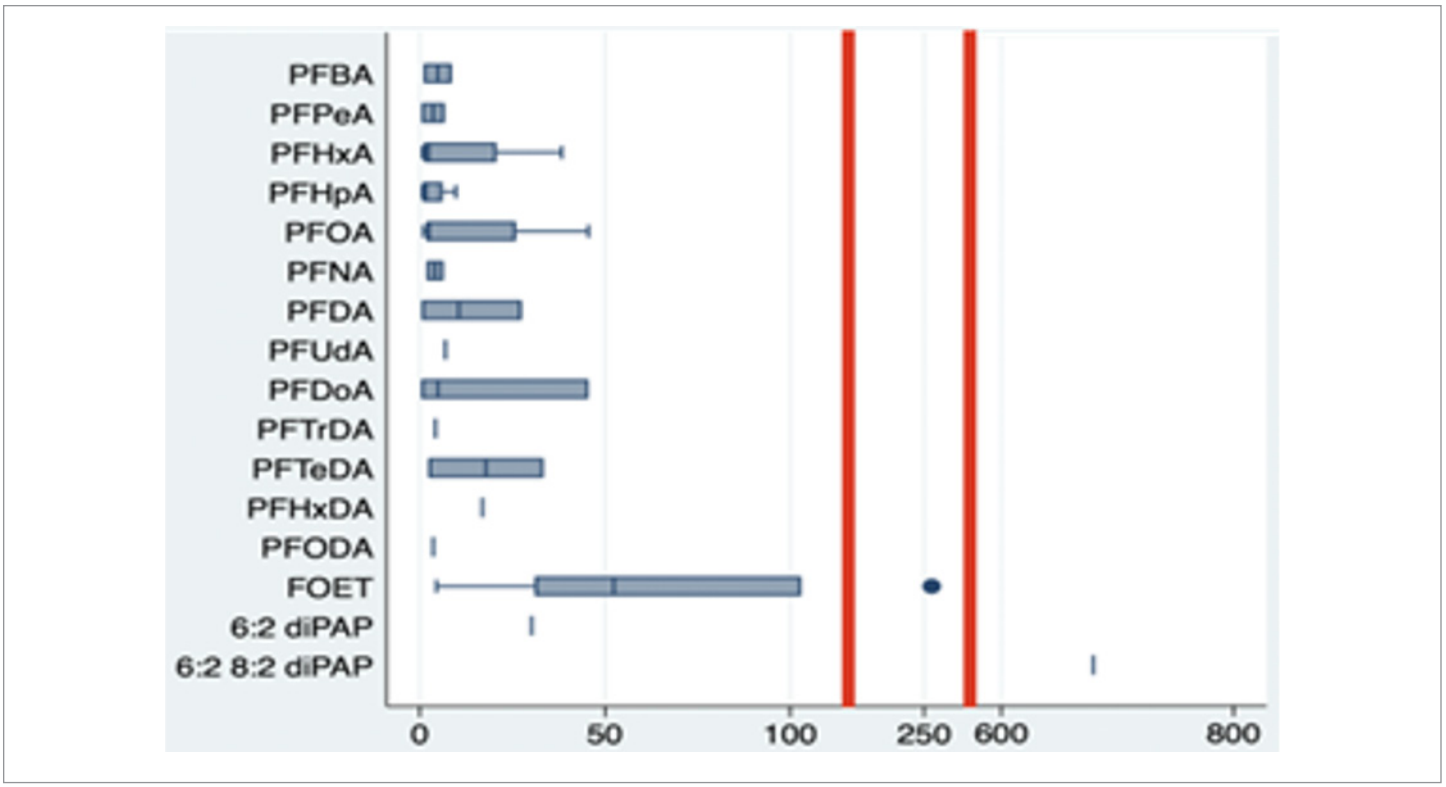


Figure 12 Distribution of PFAS chemicals concentration in textile samples (ng/g or ppb)

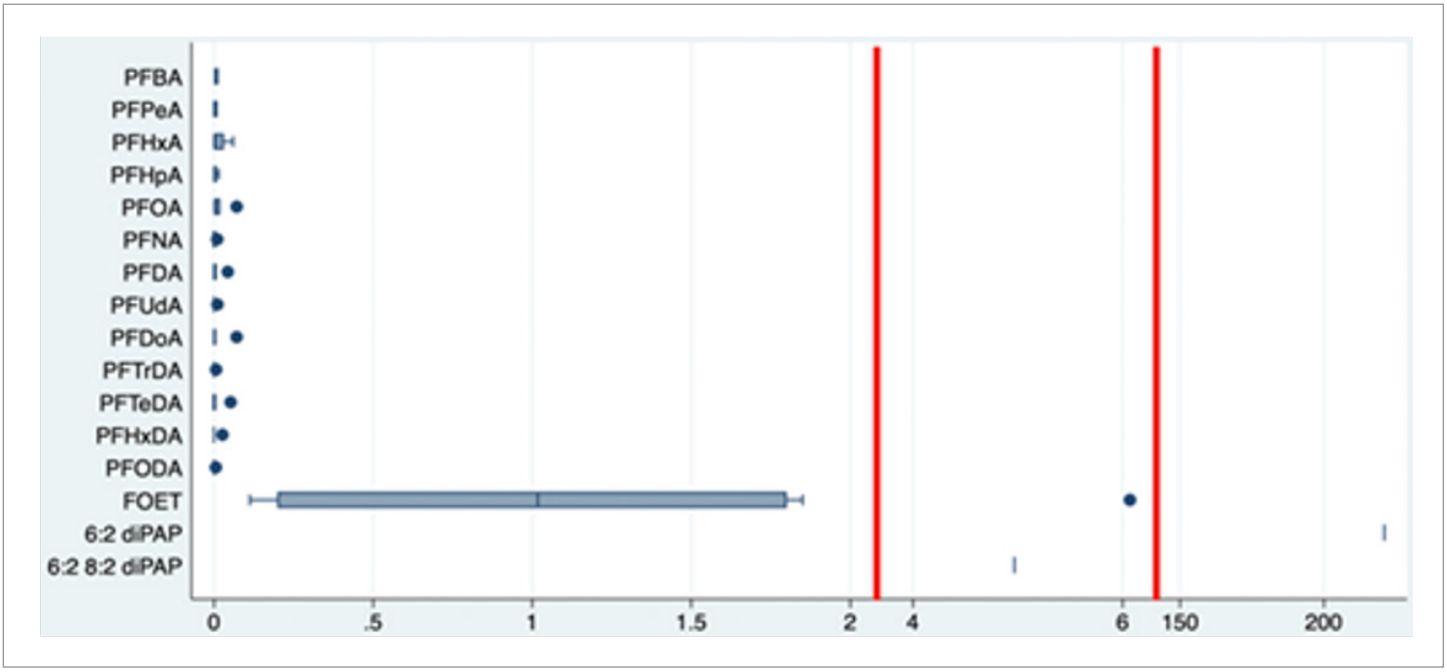


Figure 13 Distribution of PFAS analytes density in textile samples (µg/cm2)

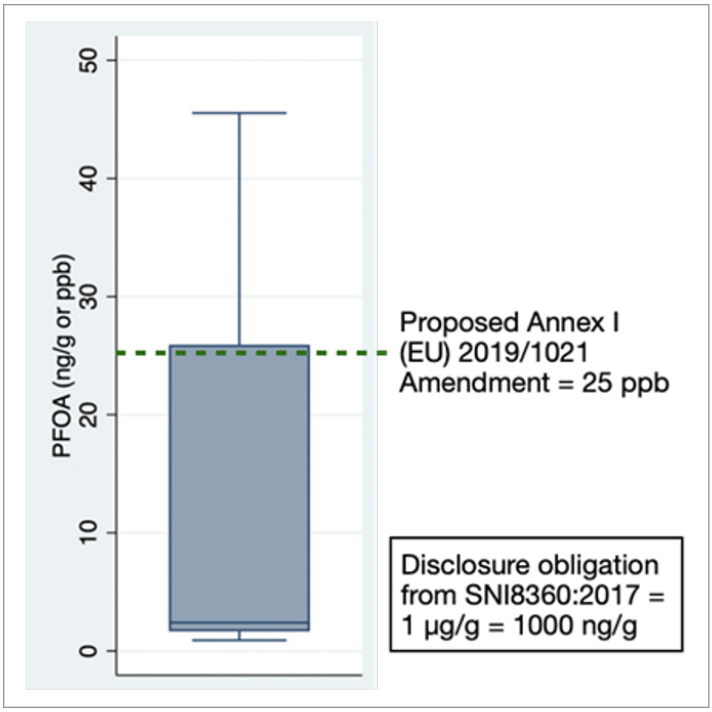


Figure 14 Concentration reference values vs. PFOA concentration observed in this study.

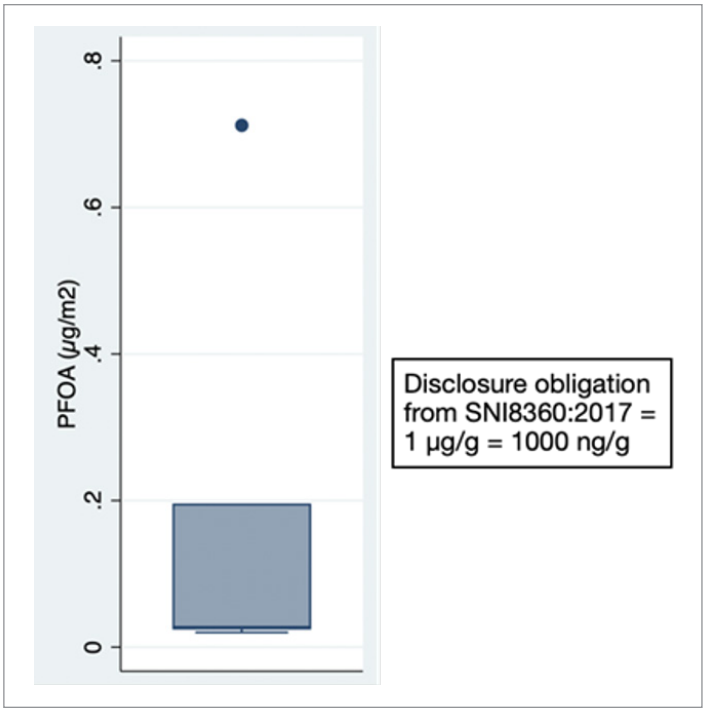


Figure 15 Density reference values vs. PFOA density observed in this study.

3.2 PFAS IN PAPER POPCORN BAGS FROM INDONESIA AND THE U.S.

PFAS chemicals were identified in all analyzed popcorn bags for microwaving at levels exceeding the proposed restriction limit of 25 ppb for any PFAS in the EU. In Indonesia, the highest PFAS chemical concentration was measured in the Preferred Kettle Corn popcorn bag (IDN-PA-15) and was **6:2 diPAP with 2,043 ng/g**. In addition to 6:2 diPAP, the identified PFAS chemicals were 6:2 8:2 diPAP and 6:2 FTOH. In the U.S., the highest PFAS chemical concentration was measured in the Jolly Time Blast O Butter popcorn bag (USA-PA-11), which was **6:2 FTOH with 730 ng/g**. In addition to 6:2 FTOH, the identified PFAS chemicals were PFBA and PFHxA.

Figures 18 and 19 below show that 6:2 FTOH and PFHxA are the two most frequent PFAS chemicals found in paper microwave popcorn bags from Indonesia and the U.S.

Figure 20 below shows 6:2 FTOH concentration distribution in tested paper popcorn bags sourced from Indonesia and the U.S. The median concentration of 6:2 FTOH of paper samples from Indonesia at 175.17 ng/g in Jolly Time Blast O-Butter (IDN-PA-20) is lower than the one from the U.S. at 332 ng/g in a Cousin Willie Real Butter bag (USA-PA-06). However, the highest concentration of 6:2 FTOH was observed in microwave instant popcorn sold in Indonesia at 1,260.05 ng/g in Preferred Extra Butter (IDN-PA-22).

Similar to measurements of the total concentration, the 6:2 FTOH area-concentration median value is lower in samples from Indonesia (2.75 ng/cm2) compared to the one from the U.S. (3.445 ng/cm2) (see Figure 21 below). However, the highest 6:2 FTOH area-concentration or density was observed in microwave instant popcorn sold in Indonesia at 19.714 ng/cm2 in Preferred Extra Butter (IDN-PA-22). **According to those findings, there are no obvious differences in PFAS levels between the microwave popcorn bag samples from Indonesia and the U.S.**

Looking at the PFHxA concentration (see Figure 22), the median value of Indonesia-purchased sample Jolly Time Blast O Butter (IDN-PA-3) is at 1.895 ng/g, while the maximum was detected at 160.85 ng/g. Both values were observed in instant microwave popcorn samples. The PFHxA concentration of the U.S.-purchased samples were detected only in microwave popcorn at 3.25 ng/g in Jolly Time Mallow Magic (USA-PA-2) and 0.303 ng/g in Jolly Time Blast O Butter (USA-PA-11). The PFHxA density (area-concentration) median value of Indonesia-purchased samples was 0.0074 ng/cm2, while the maximum value was detected at 0.45 ng/cm2 in Jolly Time Blast O Butter (IDN-PA-11). PFAS density levels in the U.S.-purchased samples were detected at 0.03 ng/cm2 in Jolly Time Magic Mallow (USA-PA-2) and 0.0047 ng/cm2 in Jolly Time Blast O Butter (USA-PA-11) (see Figure 23).

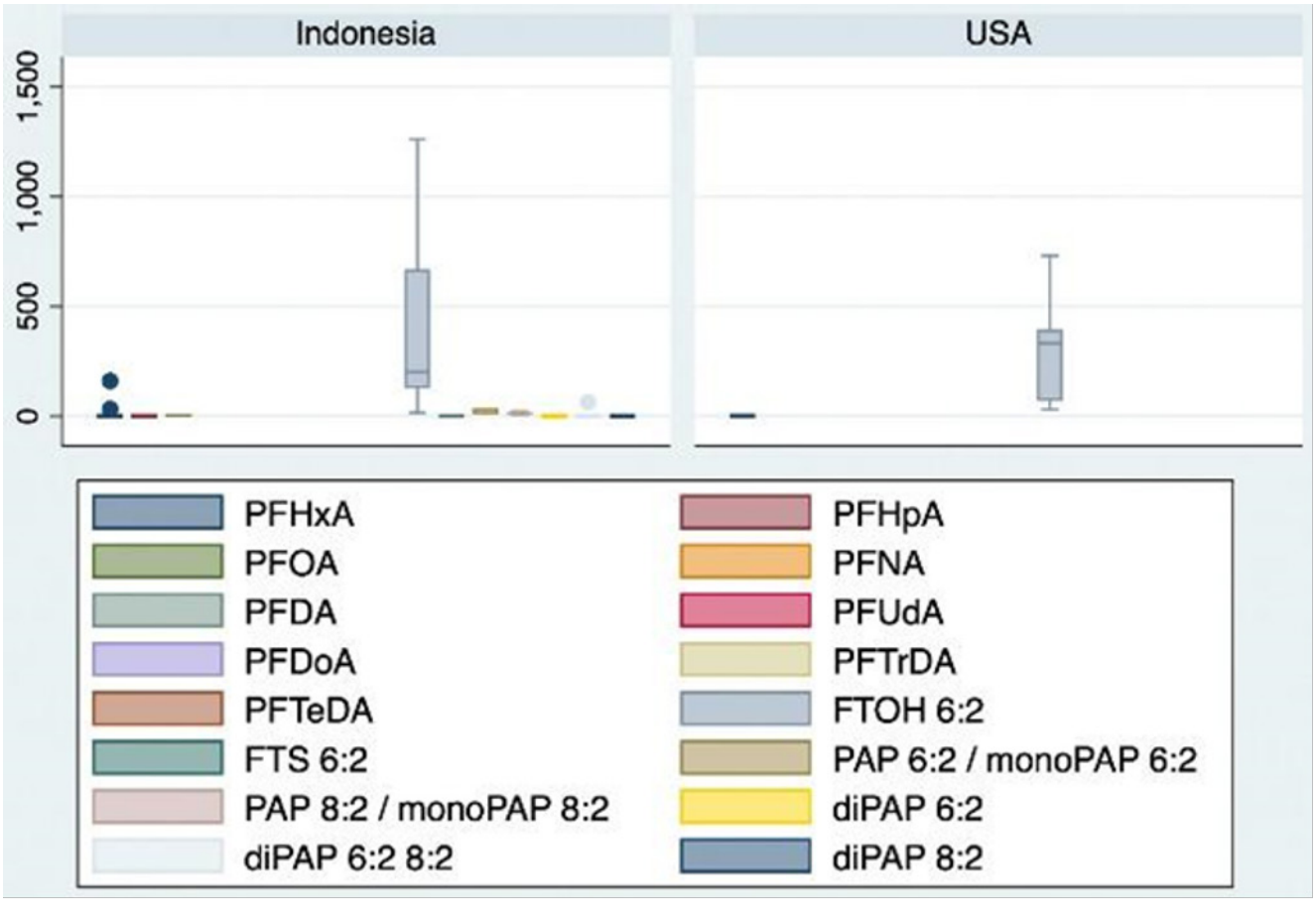
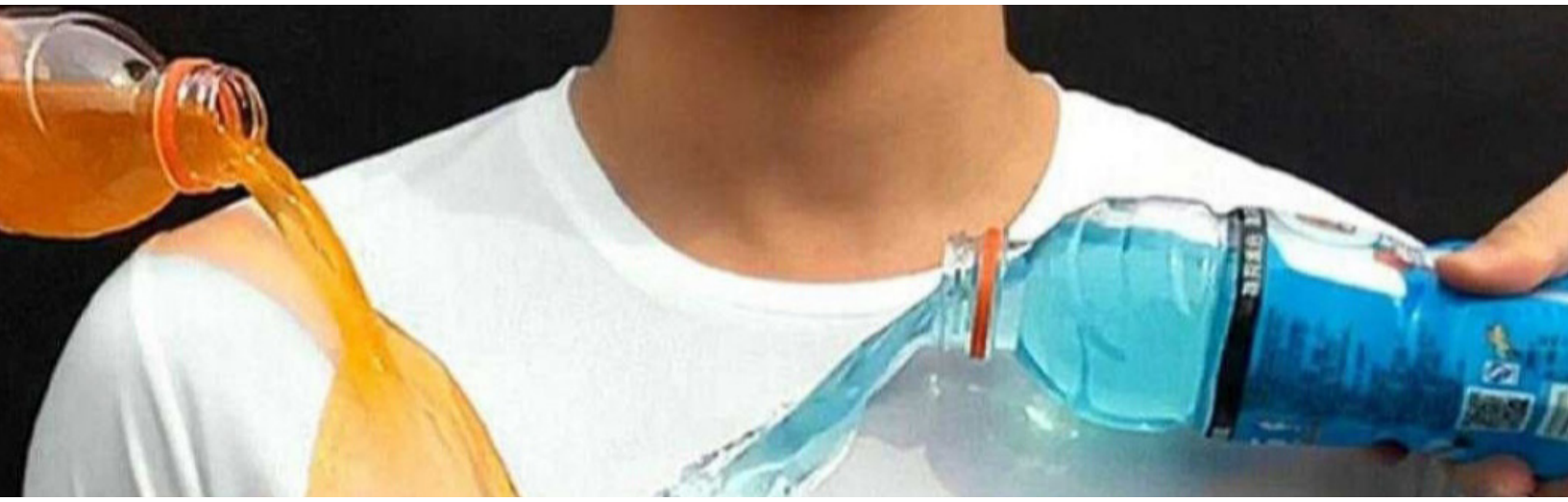


Figure 16 PFAS concentration distribution in popcorn bag samples from Indonesia and the U.S. in ng/g. IDN-PA-15/2020's 6:2 diPAP concentration (2,043 ng/g) is excluded from this figure due to high values.



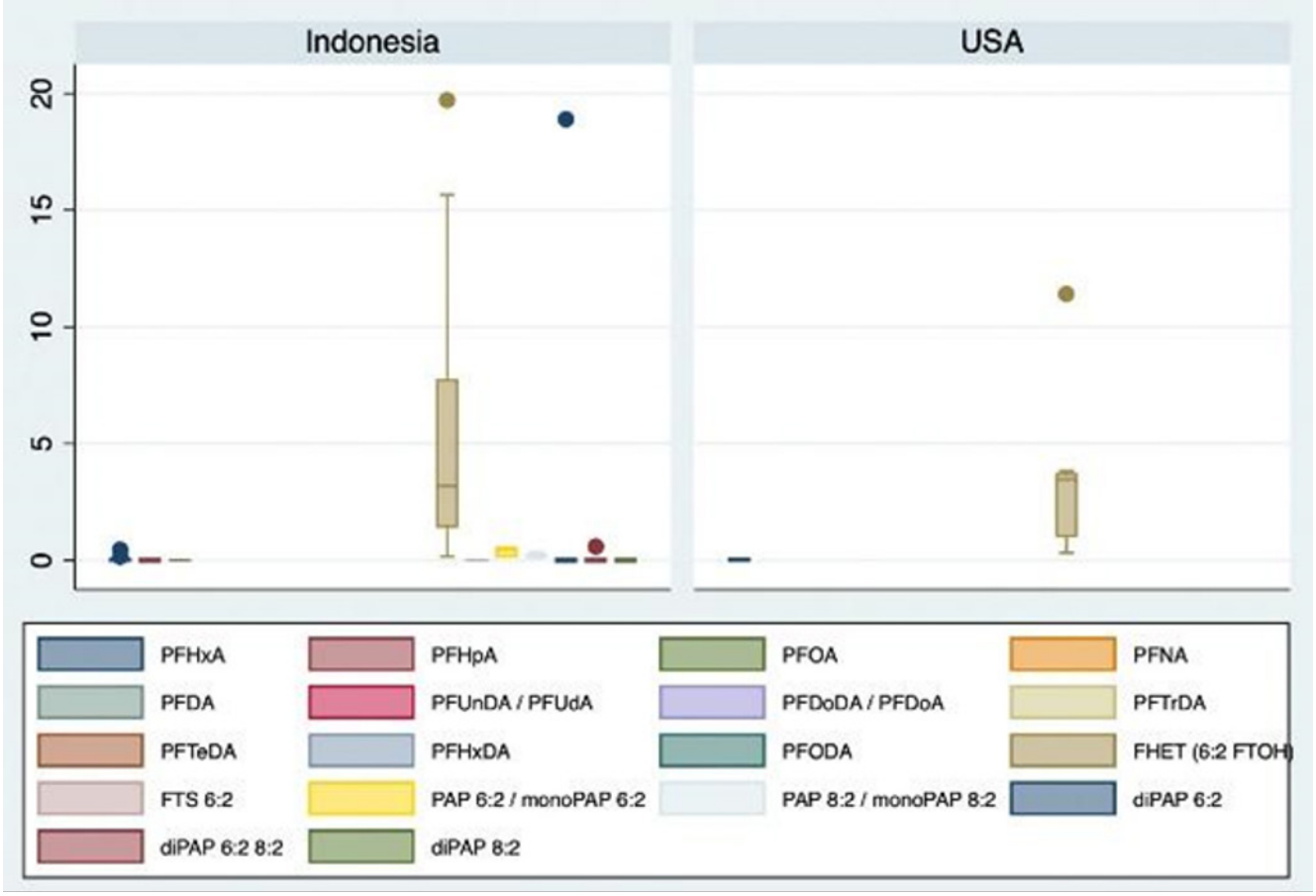


Figure 17 PFAS density distribution in popcorn bag samples from Indonesia and the U.S. in ng/cm^2.
IDN-PA-15/2020's 6:2 diPAP density (18,9 ng/cm^2) is excluded from this figure due to high value.

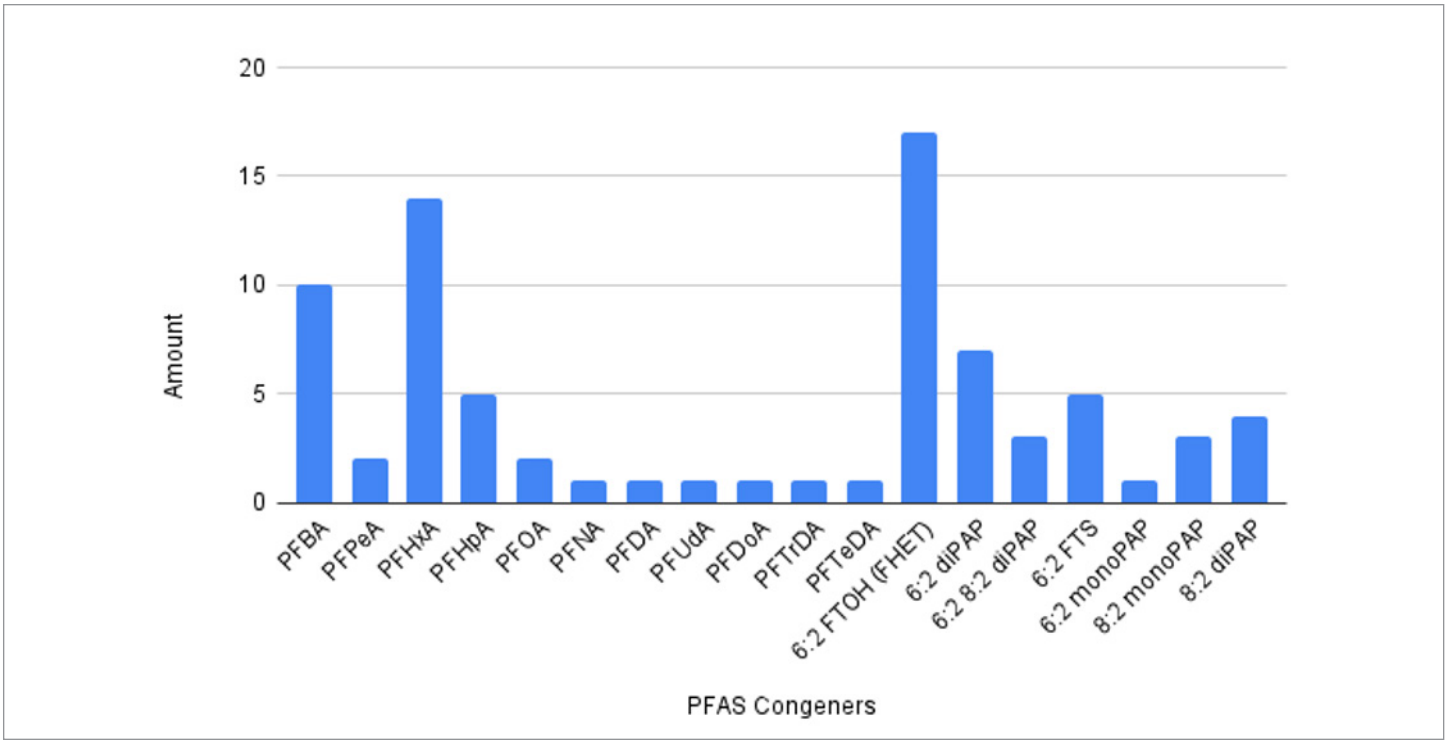


Figure 18 Frequency of PFAS chemicals identified in Indonesian popcorn bag samples.

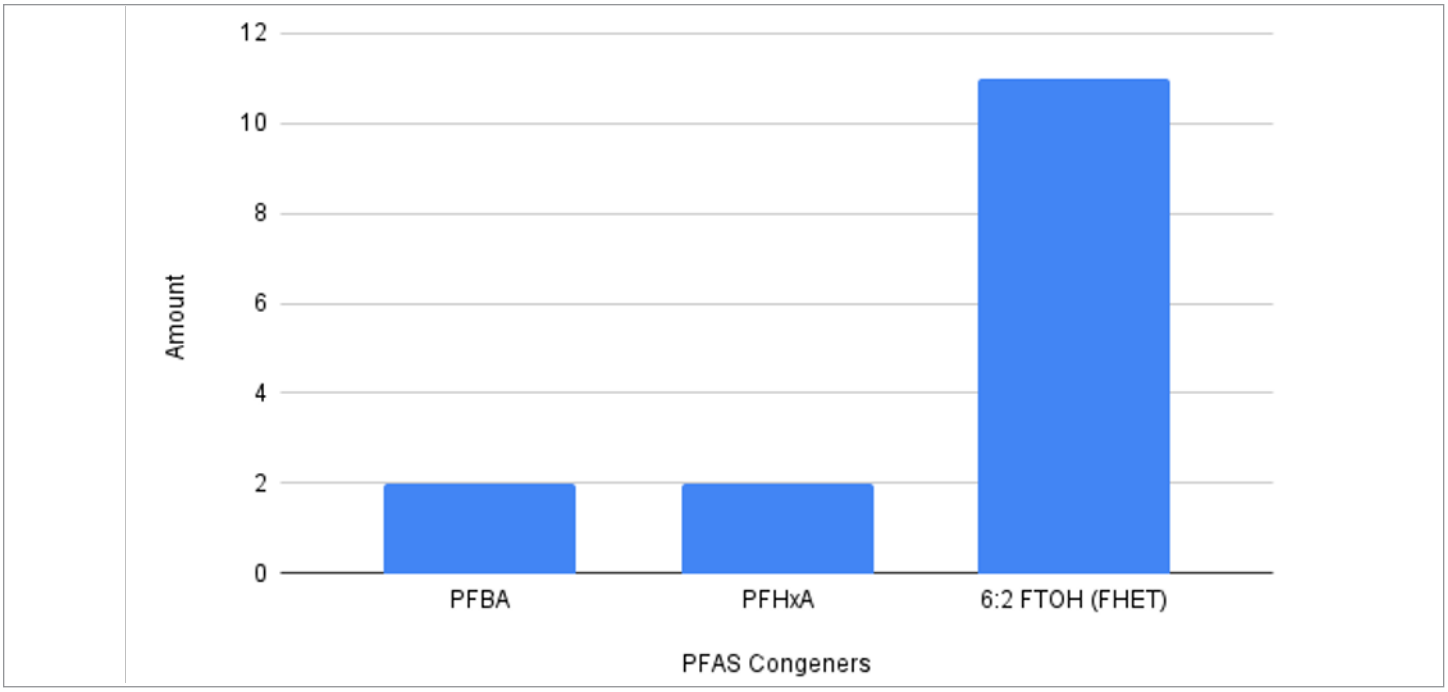


Figure 19 Frequency of PFAS chemicals identified in U.S. popcorn bag samples.

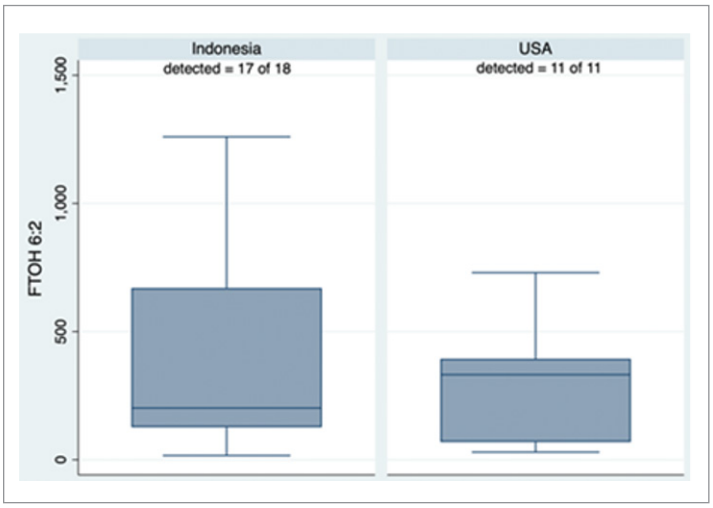


Figure 20 Concentration distribution of 6:2 FTOH across popcorn bags for microwaving (ng/g or ppb).

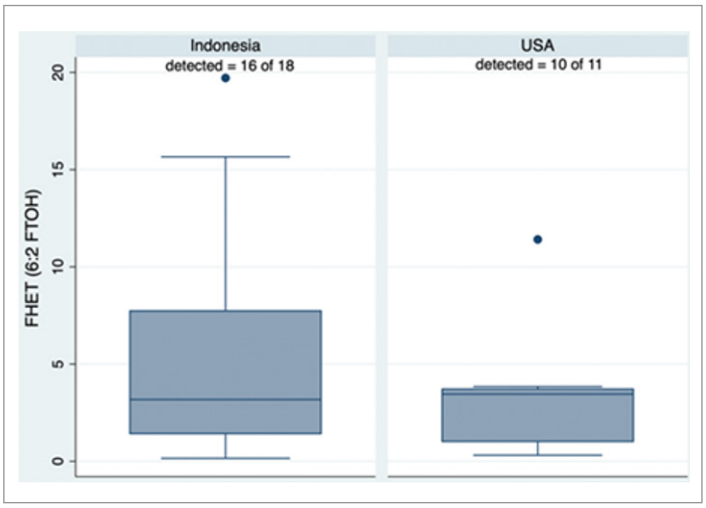


Figure 21 Density distribution of 6:2 FTOH across popcorn bags for microwaving related to area of tested packaging (ng/cm2).

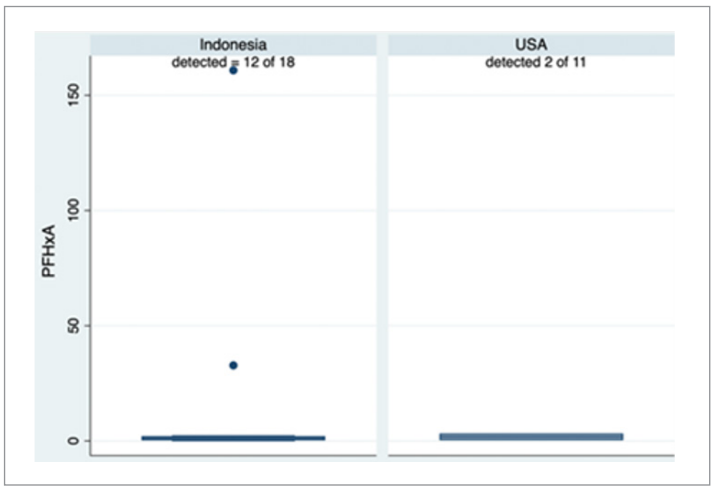


Figure 22 FHxA concentration distribution across paper microwave popcorn bags (ng/g or ppb).

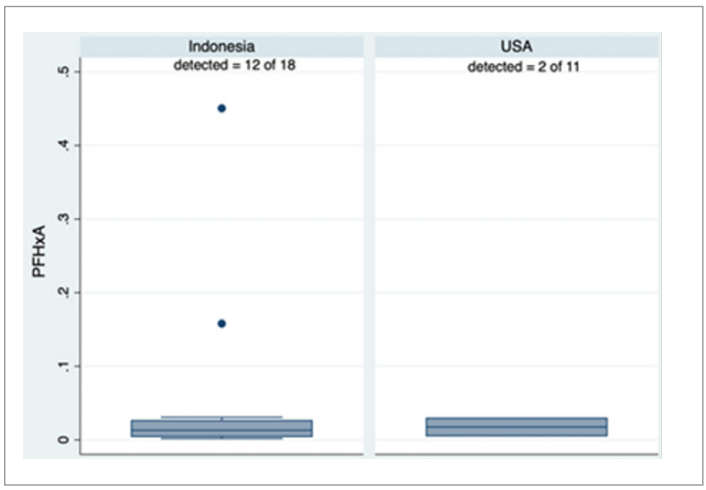


Figure 23 Density of PFHxA across paper microwave popcorn bags related to area of tested packaging (ng/cm2).

3.3 SUMMARY OF RESULTS

3.3.1 OVERALL FINDINGS

- 45 out of 48 (**94 %**) samples contained PFAS at levels exceeding the Limit of Quantitation (LOQ).
- The restriction limit of 25 ppb proposed in the EU for any PFAS was exceeded in 34 out of 48 (71%) tested samples.
- 34 out of 37 (**92%**) of samples purchased on the market in Indonesia tested positive for PFAS, including:
  - 11 out of 13 (**85%**) textile samples
  - 22 out of 23 (**96%**) paper samples, including 11 microwave popcorn bags
  - 1 out of 1 rubber crumb sample (**100%**)
- All microwave popcorn bags (Jolly Time, Preferred and ACT II) purchased in Indonesia tested positive for PFAS at levels exceeding LOQ. The measured concentration exceeds the restriction limit of 25 ppb proposed in the EU for any PFAS.
- All microwave popcorn bags (Jolly Time, Preferred and Cousin Willie's) purchased in the U.S. market tested positive for PFAS at levels exceeding LOQ. The measured concentration exceeds the restriction limit of 25 ppb proposed in the EU for any PFAS.

3.3.2 IDENTIFIED PFAS CHEMICALS

- 22 types of PFAS chemicals were found in samples included in this study. Identified PFAS substances included: **PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFODA, 6:2 FTOH, 8:2 FTOH, 12:2 FTOH, 6:2 diPAP, 8:2 diPAP, 6:2 8:2 diPAP, 6:2 FTS, 6:2 monoPAP, and 8:2 monoPAP.**
- Samples of U.S. brands of microwave popcorn purchased in Indonesia and the U.S. both contained **6:2 FTOH, PFHxA, and PFBA**.
- The most frequently identified PFAS chemicals among tested samples were **6:2 FTOH (FHET), PFHxA, PFBA, PFHpA, 6:2 diPAP, and PFOA**.

3.3.3 FINDINGS IN SAMPLES FROM INDONESIA

- 11 out of 13 (**84.6%**) textile samples sold on the Indonesian market contained PFAS.
- The majority of the samples from Indonesia, 23 of 37 (62%) exceeded the restriction limit of 25 ppb proposed in the EU for any PFAS.
- 22 out of 23 (**95.6%**) paper samples sold in the Indonesian market contained PFAS. The PFAS chemical identified in the highest concentration in a textile sample purchased in Indonesia was **6:2 diPAP**, with **30,178 ng/g** in a hijab (batch 2, year 2020).
- The PFAS chemical identified in the highest concentration in a paper sample purchased in Indonesia was **6:2 diPAP,** with **2,043 ng/g** in the Preferred Popcorn Kettle Corn (batch 2, year 2020), an imported microwave popcorn bag from the U.S.

4. DISCUSSION

4.1 PFAS IN MICROWAVE POPCORN BAGS AND PAPER PACKAGING

Surprisingly, the highest levels of PFAS among the analyzed samples were present in a food item: microwave popcorn. PFAS in microwave popcorn bags can migrate into the oil, making the chemicals available for ingestion. [93, 94, 95] This can add to existing exposure from polluted food and water. A 2019 study of human exposure in the US found that microwave popcorn consumption was associated "...with significantly higher serum levels of PFOA, PFNA, PFDA, and PFOS..." and "an increase in PFDA among those who ate popcorn daily over the last 12 months." [96]

A study in 2019 found that people who regularly ate microwave popcorn tended to have significantly higher PFAS levels in their blood, based on a decade of data about the eating habits of more than 10,500 people gathered by the U.S. Centers for Disease Control and Prevention.[97]

According to the Indonesian Statistic Bureau, Indonesia imported US$3 million of popcorn from the U.S. in 2021 (HS code 10059010).[98] One research firm estimates [99] that the global popcorn market will reach more than US$18 billion by 2023, and Asia-Pacific is predicted to be the fastest-growing market from 2022 to 2031. Thus, exposure of the Indonesian population to PFAS chemicals from microwave popcorn will likely increase if restrictions are not applied.

This study shows that PFAS are widely used in microwave popcorn products in the U.S. and Indonesia. Consumers can be exposed to PFAS from using these products, leading to increased PFAS levels in the human body.[100]

4.1.1 DIPAPS, 6:2 FTOHS, AND PFCAS IN POPCORN BAGS

The microwave popcorn products with the highest PFAS concentrations contained **2,043 ng/g** of **6:2 diPAP** (in a Preferred Kettle Corn popcorn bag purchased in Indonesia) and **730 ng/g** of **6:2 FTOH** (in a Jolly Time Blast O Butter microwave popcorn purchased in the U.S.). Different representatives of PFCAs were measured in all microwave popcorn products, but typically in lower concentrations than 6:2 FTOH. The presence of PFCAs in samples can result from FTOH degradation.

Toxicological concerns regarding diPAPs and FTOHs are related to their toxic properties and to the toxic properties of their degradation products. DiPAPs and FTOHs break down into PFCAs in abiotic conditions as well as in the human body (they are so-called "precursors" of PFCA). The toxicological effects of diPAPs, FTOHs and their metabolites (PFCAs) are associated with hepatotoxicity, development of mammary gland cancer, negative impacts on the reproductive system, and developmental disorders (see Table 1. Toxic effects of selected PFAS chemicals).

4.1.2 COMPARISON OF DIPAP, 6:2 FTOH, AND PFCA FINDINGS WITH OTHER STUDIES

DiPAP, FTOHs, and PFCAs are typical PFAS chemicals identified by different researchers in food packaging from various countries. Similarly to our findings, a study by Trier et al. in 2011 found that 5 out of 14 food contact material samples contained diPAPs. Four of the five samples containing diPAPs were microwave popcorn paper bags.[101]

An Arnika and IPEN study [102] on PFAS in disposable fast-food wrapping concluded that FTOHs were the most frequently detected PFAS chemicals in European analyzed samples. The same research hypothesizes that side-chain fluorotelomer-based polymers can be sources of FTOH, but these polymers are not measurable by methods used in either study. The measured concentrations of PFCAs in this study are within the ranges of other studies.

A study of Spanish microwave popcorn products found levels up to **280 ng/g and 405 ng/g** of **PFBA** and **PFHxA**, respectively. Additionally, **PFPeA, PFHpA** and **PFOA** were also quantified, ranging from **15 ng/g to 73 ng/g.**[103] Concentrations ranging from **37 to 99 ng/g** and **63 to 198 ng/g** were also reported for **PFHpA** and **PFOA** in Spanish microwave popcorn products, respectively.[104]

Another study reported that in microwave popcorn products from the Greek market, Zafeiraki et al. (2014) found the levels of **PFBA, PFHxA,** and **PFHpA** up to **PFBA, PFHxA and PFHpA** up to **275.84 ng/g, 341.21 ng/g** and **5.19 ng/g** respectively.[105] Begley et al. (2008)[106] reported that PFOA content in PFAS-treated papers from the U.S. market ranged from **300 to 1200 ng/g**.

4.1.3 JOLLY TIME MISLEADS CONSUMERS

Several Jolly Time brand microwave popcorn products contained PFAS chemicals. Products produced in the USA were purchased from an e-commerce platform. The product purchased in Indonesia (specified as Jolly Time Blast O-Butter) has been registered at the Indonesian Food and Drugs Administration BPOM RI ML 873209015004.[107]

In contrast to the very high PFAS levels in Jolly Time popcorn products sold in Indonesia, Jolly Time's FAQs website[108] accessed on 2019 and Jolly Time's sales account on Amazon.com[109] accessed on 2021 stated that *"Our bag manufacturers confirm the grease resistant treatment in JOLLY TIME Popcorn microwave popping bags is not produced with PFOA or PFC [perfluorinated chemicals or PFAS]"* (see Figure 24 and Figure 25). Jolly Time's claim about PFAS-free microwave popcorn products appears on numerous lists of products described as safe, despite containing PFAS substances.

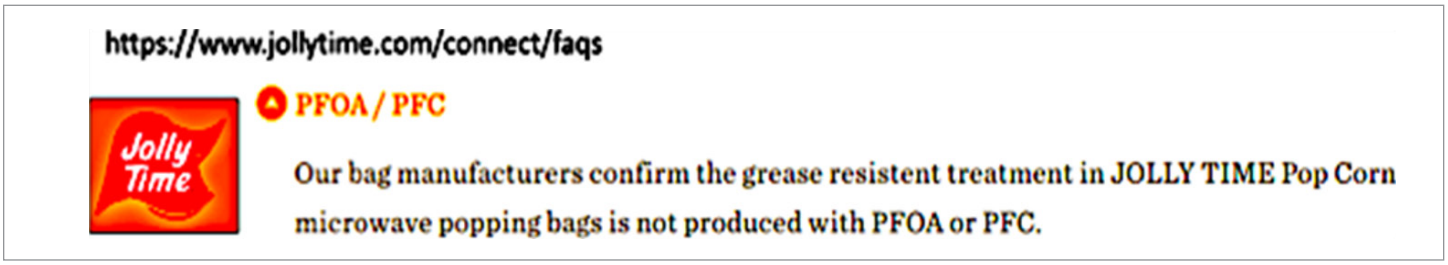


Figure 24 Small sign on Jolly Time old FAQs website stating that no PFOA/PFC was used in microwave popcorn bags produced in the U.S.

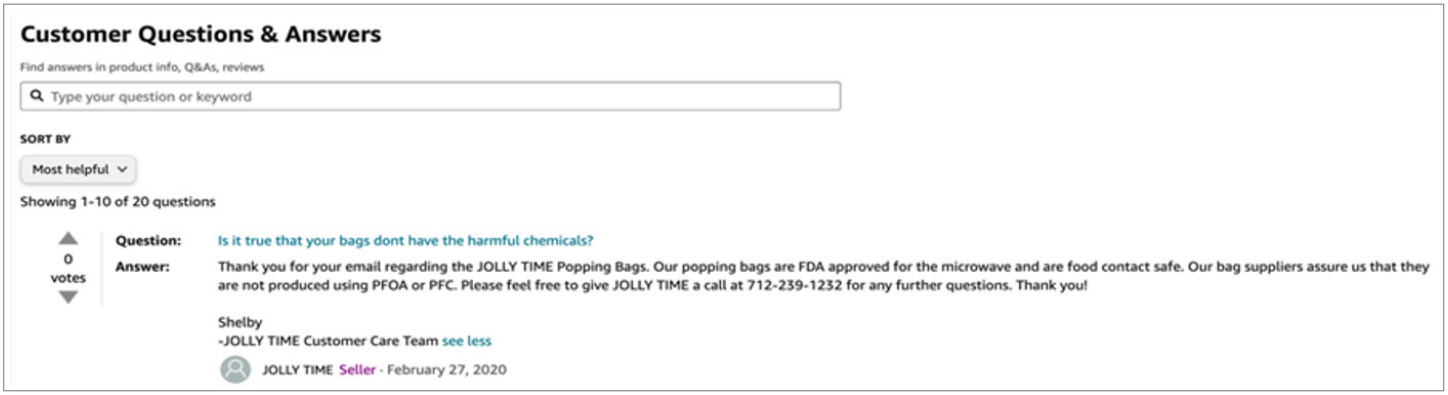


Figure 25 Jolly Time response on Amazon consumer forum.

4.1.4 ALTERNATIVES EXIST AND SOME COMPANIES GO PFAS-FREE

PFAS use in microwave popcorn products can be eliminated as the PFAS function in food contact materials is not essential for society, and feasible alternatives exist. For example, when thinking of food packaging alternatives, wraps and liners can use wax-coated paper, plates can use kaolin clay-coated and reusable plates, and pizza boxes can be made of uncoated paper.[110] High-density paper, such as cardboard for pizza, prevents any oil transmission and does not require PFAS treatment.[111]

An Arnika and IPEN study[112] demonstrated that regulation is the strongest incentive for companies to clean up their act. The study showed that one company had abandoned the use of PFAS in Denmark to comply with the Danish restriction. However, analysis of samples from the same company in Czechia, Germany, and the United Kingdom, bought at the same time, demonstrated intentional PFAS treatment, highlighting different practices and double standards depending on the national regulation. These findings showed that without regulation, the same company is not moving away from PFAS.

Some of the major chains have already announced that they are eliminating PFAS use in food packaging due to environmental and health concerns and the availability of viable alternatives. In December 2020, the major online retailer Amazon prohibited the intentional use of PFAS in all of Amazon's kitchen brand food contact materials in the EU and the U.S. The same year, the U.S. Food and Drug Administration (FDA) announced that three manufacturers agreed to a **voluntary phase-out** of 6:2 fluorotelomer alcohol (6:2 FTOH), which has been used as food-contact packaging substances. This phase-out target should be achieved in 2023.[113]

In January 2021, McDonald's committed to phasing out PFAS globally from its customer packaging by 2025. In January 2023, IPEN and the Toxics-Free Future campaign surveyed four popcorn companies, whose samples were included in the Nexus3-IPEN study "Toxic Hazards in Microwave Popcorn" regarding their policies on PFAS in their microwave popcorn brands. American Popcorn, Ramsey Popcorn, and Preferred Popcorn did not respond. Conagra replied that it is eliminating PFAS from its Act II popcorn bags.

A February 10, 2023 email from Conagra Corporate Communications to IPEN noted that "We removed PFAS last year from the packaging used for our ACT II microwave popcorn products in the U.S., and as of March 2023, we will no longer use PFAS in the packaging for our microwave popcorn products sold internationally under our ACT II brand."

4.2 PFAS IN TEXTILE PRODUCTS

PFAS are widely used in waterproof textile products (clothing and apparel) in Indonesia. The PFAS-treated products include hijabs, adult shirts, a children's shirt, a children's t-shirt, fire suit gloves, and jogging track/pants.

PFAS are volatilized, weathered, and washed out from the textile products during their use.[114] Up to 30 times higher FTOH concentrations were found in the interior of sportswear stores compared to outdoor stores, leading to increased exposure to textile sellers.[115] When PFAS-treated articles are disposed of at the end of life, PFAS migrate from the waste into the landfill leachates,[116, 117] are emitted with incineration fumes and ashes,[118, 119] or are recycled into new products.[120, 121]

The use of PFAS in textiles in Indonesia increases both environmental pollution and human exposure of the Indonesian population, as PFAS are emitted into the environment at every stage of the textile product (i.e., during production, use and final disposal). Moreover, the PFAS uses identified in tested textile products are not essential and alternatives exist.

4.2.1 GLOBALLY BANNED PFOA AND PFOA PRECURSORS PRESENT IN INDONESIAN CLOTHES AND APPAREL

The hijab and the children's t-shirt in this study exceeded the weak EU regulatory limit set in POPs regulation of 25 ppm (ng/g) PFOA. The level of PFOA in the children's T-shirts was 1.8 times higher than the EU regulatory limit (25 ppm or ng/g).[122] The PFOA level in the hijab was 26 ng/g, slightly exceeding the EU regulatory limit. These results are highly concerning, as PFOA belongs among globally banned and highly toxic persistent organic pollutants listed under the Stockholm Convention.

In addition to PFOA, the PFAS chemicals found in textiles from Indonesia were fluorotelomer alcohols, FTOH (8:2 FTOH, 12:2 FTOH), fluorotelomer phosphate diesters (6:2 diPAP, and 6:2 8:2 diPAP), and other perfluorocarboxylic acids, and PFCAs, namely, PFBA, PFPeA, PFHxA, PFHpA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, and PFOdA.

Fluorotelomer alcohols are starting chemicals and intermediate degradation by-products in the production of the majority of commercial PFAS, including fluorotelomer-based polymers (FTPs), which were likely used to make the tested products waterproof. The use of FTPs, therefore, undermines the intention of the Stockholm Convention to globally stop emissions of PFOA, its salts and PFOA-related compounds via measures to eliminate the production and use of the chemicals under the scope, as it results in environmental exposure to PFOA. The presence of FTPs in the products must be confirmed in specific laboratory analyses targeting such polymers.

FTOHs have been shown to be released from products similar to those investigated here (see table 1. Toxic effects of selected PFAS chemicals). During wearing and ageing of water-repellent clothes, 8:2 FTOH degrades to perfluorocarboxylic acids (PFCAs; including the globally banned perfluorooctanoate or PFOA) (see table 1). In the long run, FTOHs present in waste may also degrade into PFCAs and pollute the environment (see table 1).

In addition to FTOHs, 6:2 diPAP and 6:2/8:2 diPAP were present in a hijab bought in Indonesia. There are multiple toxicological concerns regarding FTOHs and diPAPs and their degradation products (see chapter on DiPAPs and 6:2 FTOH in paper samples for more details).

4.2.2 PFAS IDENTIFIED IN CLOTHES FOR CHILDREN AND WOMEN

Among all the products tested, the product with the highest PFAS concentration was a waterproof hijab. Hijabs are widely worn by young girls and women in Indonesia. A 2014 survey[123] in Indonesia found that 64% of

survey participants wear a hijab. Another sample with significant PFAS levels was a water-repellent children's t-shirt. This children's shirt is 100% cotton, marketed as water and stain resistant and made in Indonesia. Children represent a significant proportion (26%, 71 million)[124] of the Indonesian population and are particularly sensitive to toxic chemicals such as PFAS.

The use of PFAS in products for children and women raises serious concerns, as PFAS are known to be endocrine disrupting chemicals (EDCs) that negatively affect thyroid hormones. Accurate functioning of thyroid hormones is important at several stages of life, including children's development and women's hormonal health during pregnancy and the postmenopausal age. For example, it is a vital factor in fetal and newborn's brain development during pregnancy and in the first months after birth. It is also a critical factor for menopausal symptoms.

A growing number of studies reveal sources and scenarios for which dermal exposure to PFAS can occur. Studies on PFAS and their potential precursors in various consumer products and clothing could indicate dermal absorption as a potentially important route of human exposure.[125]

4.2.3 LEVELS OF PFAS IN CLOTHES FROM OTHER STUDIES

Studies by IPEN and Arnika from China, Russia, and Czechia[126, 127] show results similar to the findings presented in this study. One exception – diPAPs are not common in textile samples from other countries, as found in the hijab from Indonesia.

In Denmark, 86% sof children's clothes and infant sleeping bags samples contained total fluorine above the detection limit in the outer material. The concentration varied with an average of 72,700 μg/m^2.[128] Another study analyzed PFAS in children's clothes from Canada, USA, and Mexico and found that the most frequently detected PFASs were PFOA (45%) and PFHxA (43%).[129]

A study of PFAS in consumer products on the market in Norway included shoes for toddlers along with outdoor jackets for adults and children.[130] PFOA was found in three jackets ranging from 1.7 ng/g to 6.6 ng/g. The highest PFAS level in any product was in a jacket containing 11 ng/g PFHxA. The children's water-repellent t-shirt analyzed here contained a much greater variety of PFAS substances at significantly higher levels.

According to Xia (2022), PFAS levels in school uniforms were significantly higher than in other children's textile products, such as bibs, hats, stroller covers, and swimsuits, but comparable to outdoor wear. PFAS concentrations were found in school uniforms made of 100% cotton. The estimated median potential children's daily exposure to PFAS via dermal exposure through school uniforms was 1.03 ng/kg of body weight.[131]

4.2.4 ALTERNATIVES TO WATERPROOF PFAS-TREATED TEXTILES EXIST

One of the textile products did not contain any PFAS substances: a waterproof tracksuit (IDN-TX-07). This sample indicates that waterproof textiles without PFAS substances are available in the Indonesian waterproof apparel market. This evidence could facilitate the implementation of PFAS prohibitions and the Stockholm Convention ban on PFOA use in consumer textiles, which entered into force[132] in Indonesia on December 3, 2020, along with most countries.

Safer alternatives are available for PFAS use in textiles. Paraffin and silicone-based chemistries serve as substitutes that provide water repellence.[133] Non-chemical alternatives for textiles include tightly woven fabrics and plant-based materials.[134]

4.3 PFAS IN RUBBER CRUMBS

Crumb rubber is a recycled rubber produced from automotive and truck scrap tires. It is often used in artificial turf as cushioning.[135] Rubber crumb is the third generation of artificial turf and is most widely used nowadays. The first generation featured short pile fibers without infill and the second generation featured longer fibers and sand infill.[136]

Based on the test result, the rubber crumb sample from Indonesia contains the perfluorocarboxylic acid, **PFHxA**. PFHxA concentrations are found in biota and humans.[137] Effects of PFHxA in humans are found

to influence the nervous system, brain development, endocrine system, and thyroid hormones. Moreover, once PFHxA enters our system, its elimination takes approximately eight years.

Findings of PFAS in rubber crumb used in artificial turf have been found in other studies. In 2019, the US Public Employees for Environmental Responsibility (PEER) and The Ecology Centre tested 36 artificial turf carpets and found elemental fluorine and specific PFAS chemicals like GenX and PFOS.[138]

4.3.1 PFAS FROM ARTIFICIAL TURF CAN IMPACT CHILDREN'S HEALTH

In 2014, Amy Griffin, a women's soccer coach at the University of Washington, realized that several goalkeepers had developed cancer after playing on turf fields and began to count the athletes in the same situation. By January 2019, she had listed 260 football, baseball, lacrosse, and soccer players with cancer. However, so far scientists have focused on the chemicals in the rubber crumbs spread over turf and not on the other components of the plastic grass.[139]

According to the US Children's Environmental Health Centre of the Icahn School of Medicine at Mount Sinai, children may be exposed to chemicals in artificial turf either from touching or swallowing the crumb rubber pellets that make up the backing or possibly from breathing chemicals that off-gas into the air. The pellets can also get into shoes or clothing and end up in cars and homes.[140] The use of PFAS-rich rubber crumb in artificial turf can lead to additional exposure to children and young sports players in Indonesia.

4.3.2 RUBBER CRUMB PRODUCTION RATES CAN INCREASE PFAS RELEASES INTO THE ENVIRONMENT

Indonesia is one of the world's largest rubber-producing countries, with the U.S. and Japan as the most prominent destinations for exports in the last five years.[141] Based on data from the Central Bureau of Statistics (*Badan Pusat Statistik*/BPS), Indonesia's crumb rubber export volume reached 2.09 million tons in January-November 2021. However, this value only grew 4% compared to the same period the previous year, which was 2.01 million tons. Meanwhile, the total export value of crumb rubber was US$3.56 billion from January to November 2021. This value grew 36.38% compared to the previous year's period of only US$2.61 billion. Rising rubber prices in the global market have significantly increased rubber export value. These facts can lead to further emissions of PFAS and increased exposure of the Indonesian population in the upcoming period.

Artificial turf will release PFAS on a field and when it is landfilled, illegally dumped, or while awaiting recycling methods after removal. When the fibers of turf experience mechanical abrasion, the chemicals may be released from the fibers. Moreover, the widespread dumping of old turf in landfills or other sites has led to water contamination.[142]

Despite these facts, Indonesia is one of the major exporters of crumb rubber, which is widely used in kindergartens, playgrounds, sports facilities, and public places. Indonesia currently has no regulations regarding the restriction of POPs and other harmful chemicals in crumb rubber.

4.4 REGULATING PFAS AS A CLASS

Ministers of Environment from Denmark, Luxembourg, Norway, and Sweden submitted a proposal for regulating PFAS as a class to the European Commission in January 2023. The "Elements for an EU-strategy for PFASs"[143] provides five reasons for regulating PFAS as a class:

- Regulating individual substances or arrowhead substances (subgroups) will take too long to effectively manage the risk from these substances.
- All PFAS, in themselves or their degradation products, are extremely stable in the environment.
- Some PFASs have documented toxicity. With the present knowledge, and based on similarities between PFAS, concerns are raised for the whole group.
- Human and environmental exposure to many PFAS occurs and combination effects can be expected.
- A group approach is needed to avoid regrettable substitution. PFAS that are regulated are often replaced by similar, but not yet regulated, PFAS.

The Strategy notes that a PFAS phase-out could begin by *"regulating consumer uses, as these are more likely to be non-essential (e.g., clothing, cosmetics, toys and food contact materials)."* It also places the responsibility on the chemical industry to share information on the chemical identity of PFAS substances and to provide toxicity data.

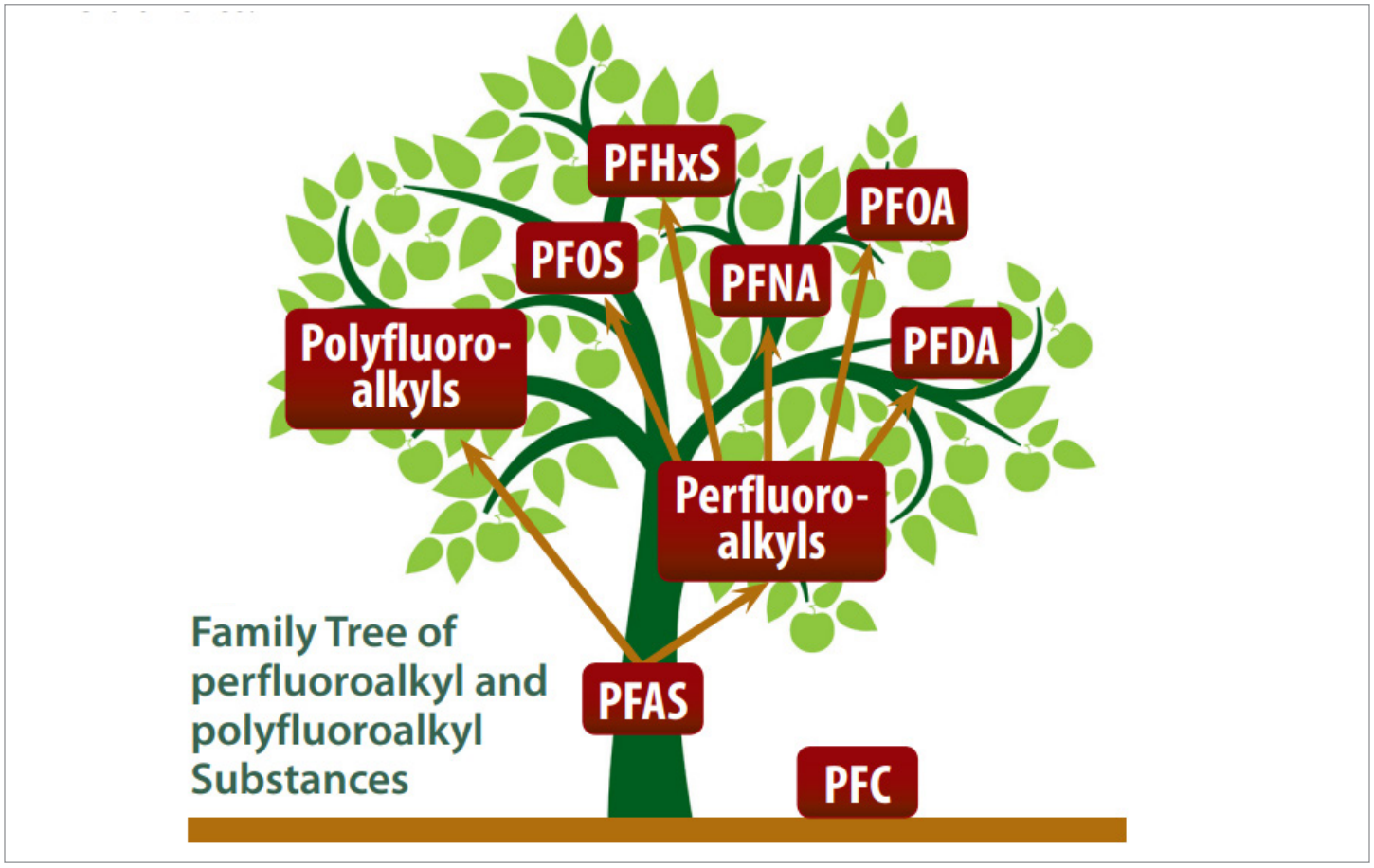


Figure 26 Family tree of PFAS. Image credit: Agency for Toxic Substances and Disease Registry, Centre for Disease Control and Prevention, USA.

5. CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates that various PFAS substances are associated with severe adverse health risks and environmental effects. PFAS are used to maintain water-repellency and grease-proof characteristics of consumer products on both the Indonesian and U.S. markets.

The restriction limit of 25 ppb proposed in the EU for any PFAS was exceeded in 34 of 48 (71%) tested samples. PFOA has already been listed in the Stockholm Convention for global restriction and elimination. The data highlights the importance of urgent actions to prohibit the production, sale, and use of PFAS as a class and in all non-essential uses.

To address potential threats posed by PFAS substances, the Nexus3 Foundation and IPEN recommend the following:

For the Indonesian government as a Party to the Stockholm and Basel Conventions:

- Work for a class-based approach of listing all PFAS for global elimination under the Stockholm Convention.
- Define all PFAS-contaminated waste as hazardous waste based on their H11 (delayed or chronic toxicity) characteristics.
- Work for PFAS waste limits ("low POPs content levels") no higher than 0.025 mg/kg for PFOS, PFOA or PFHxS and their salts and 10 mg/kg for the sum of PFOS, PFOA, PFHxS and their related compounds.
- Promote the replacement of PFAS with safe alternatives.

For the Ministry of Environment and Forestry:

- Implement Stockholm Convention amendments listing PFOA, PFOS and PFHxS in national regulations and support the removal of all exemptions and acceptable purposes.
- Prohibit PFAS as a class, including implementing the Stockholm Convention prohibitions of PFOS, PFOA, and PFHxS.
- Update the National Implementation Plan of the Stockholm Convention in Indonesia.
- Monitor PFAS substances in the environment.
- Add PFAS as a class to the list of hazardous substances.
- Determine a health-protective standard for PFAS content in drinking water and the environment.
- Develop an action plan to manage PFAS-containing wastes.

For Indonesia's Food and Drug Administration:

- Prohibit the sale and importation of PFAS-treated food contact materials (e.g., microwave popcorn).
- Prohibit PFAS use in food contact materials and packaging in Indonesia.

For the Ministry of Trade:

- Prohibit manufacturing and importation of consumer goods containing PFAS, including kitchen utensils, food packaging, textiles, and textile products and toys, among other uses.
- Producers must provide information regarding PFAS in products sold in Indonesia.

For the Ministry of Industry:

- Prohibit PFAS as a class, including its use in textiles, textile products, fire-fighting foams (AFFF), paper, and electronics industries.
- Producers must provide information regarding PFAS in products manufactured in Indonesia.

For the Ministry of Agriculture:

- Prohibit PFAS as a class, used as an active or inert additive ingredient for pesticides.

For the Ministry of Health:

- Conduct human biomonitoring related to occupational health in paper, textile, firefighting, and other industries that potentially use PFAS in their process.
- Determine a health-protective standard for PFAS content in drinking water, food, and human biomarkers.

For the National Standardization Agency (BSN):

- Determine health-protective standard for PFAS content in products, drinking water, food, and the environment.

For industries:

- Stop the use of PFAS in new products and publicly disclose PFAS content in existing products with clear warning signs/labels/ icons on products.
- Companies that have shifted to fluorine-free alternatives should get their products certified through independent, third-party verification procedures to increase the customer's ability to choose products with no added PFAS.

For public health groups, consumer organizations and other concerned entities:

- Support the elimination of PFAS and conduct activities to inform the public about PFAS exposure.

For all stakeholders:

- Come together and unite in alerting the public about the hidden pollution and harms posed by PFAS substances and support and implement a strong policy to eliminate PFAS in Indonesia.

Annex A Limit of quantitation (LOQ) of analysed PFAS chemicals. Analysed PFAS congeners and their LOQs.

NO.	CHEMICAL	FULL NAME	CAS	LOQ (NG/G)		
				1ST BATCH (2019)	2ND BATCH (2020)	3RD BATCH (2022)
1	PFBA	Perfluorobutanoic acid	375-22-4	<0.3	<1.70	<0.025
2	PFPeA	Perfluoropentanoic acid	2706-90-3	<0.3	<1.70	<0.025
3	PFHxA	Perfluorohexanoic acid	307-24-4	<0.3	<1.70	<0.025
4	PFHpA	Perfluoroheptanoic acid	375-85-9	<0.3	<1.70	<0.025
5	PFOA	Perfluorooctanoic acid	335-67-1	<0.3	<1.70	<0.025
6	PFNA	Perfluorononanoic acid	375-95-1	<0.3	<1.70	<0.025
7	PFDA	Perfluorodecanoic acid	335-76-2	<0.3	<1.70	<0.025
8	PFUnDA	Perfluoroundecanoic acid	2058-94-8	<0.3	<1.70	<0.025
9	PFDoDA/ PFDoA	Perfluorododecanoic acid	307-55-1	<0.3	<1.70	<0.025
10	PFTrDA	Perfluorotridecanoic acid	72629-94-8	<0.3	<1.70	<0.025
11	PFTeDA	Perfluorotetradecanoic acid	0376-06-07	<0.3	<1.70	<0.025
12	PFHxDA	Perfluorohexadecanoic acid	67905-19-5	<0.3	<1.70	<0.05
13	PFODA	Perfluorooctadecanoic acid	16517-11-6	<0.3	<1.70	<0.05
14	PFPrS	Perfluoropropane sulfonic acid	423-41-6	<0.3	<1.70	<0.025
15	PFBS	Perfluorobutane sulfonic acid	375-73-5	<0.3	<1.70	<0.025
16	PFPeS	Perfluoropentane sulfonic acid	2706-91-4	<0.3	<1.70	<0.025
17	PFHxS	Perfluorohexane sulfonic acid	355-46-4	<0.3	<1.70	<0.025
18	PFHpS	Perfluoroheptanesulfonic acid	375-92-8	<0.3	<1.70	<0.025
19	PFOS	Perfluorooctane sulfonic acid	1763-23-1	NA	NA	<0.025
20	br-PFOS	Branched isomer of perfluorooctanesulfonic acid	1763-23-1	<0.3	<0.30	NA
21	L-PFOS	Linear-chain isomer of perfluorooctan e sulfonic acid	1763-23-1	<0.3	<1.30	NA
22	PFNS	Perfluoronona nesulfonic acid	68259-12-1	<0.3	<1.70	<0.025

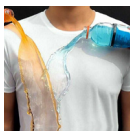
Annex A, Continued Limit of quantitation (LOQ) of analysed PFAS chemicals. Analysed PFAS congeners and their LOQs.

NO.	CHEMICAL	FULL NAME	CAS	LOQ (NG/G)		
				1ST BATCH (2019)	2ND BATCH (2020)	3RD BATCH (2022)
24	PFUnDS	Perfluoroundecane sulfonic acid	749786-16-1	NA	NA	<0.025
25	PFDoDS	Perfluorododecane sulfonic acid	79780-39-5	NA	NA	<0.025
26	PFTrDS	Perfluorotridecane sulfonate	72629-94-8	NA	NA	<0.025
27	PFDoS	Perfluorododecane sulfonic acid	120226-60-0	<0.3	<1.70	NA
28	PFDoS	Perfluorooctanesulfonamide	754-91-6	<0.3	<1.70	<0.025
29	N- MeFOSA	N-Methylperfluorooctanesulfonamide	31506-32-8	<0.3	<1.70	<0.025
30	N-EtFOSA	N-Ethyl-perfluorooctanesulfonamide	4151-50-2	<0.3	<1.70	<0.025
31	ADONA	Ammonium 4,8-dioxa-3H-perfluorononanoate	958445-44-8	<0.3	<1.70	<0.025
32	HFPO-DA	Hexafluoropropylene oxide-dimer acid	13252-13-6	<0.3	<1.70	<0.025
33	9Cl-PF3ONS	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate	73606-19-6	<0.3	<1.70	<0.025
34	11Cl-PF3OUDS	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonate	83329-89-9	<0.3	<1.70	<0.025
35	4:2 FTOH	4:2 Fluorotelomer alcohol	2043-47-2	NA	<0.80	<0.80
36	6:2 FTOH	6:2 Fluorotelomer alcohol	647-42-7	NA	<1.60	<1.60
37	8:2 FTOH	8:2 Fluorotelomer alcohol	678-39-7	NA	<1.60	<1.60
38	10:2 FTOH	10:2 Fluorotelomer alcohol	865-86-1	NA	<16	<16.0
39	12:2 FTOH	12:2 Fluorotelomer alcohol	39239-77-5	NA	detected/ND	detected/ND
40	14:2 FTOH	14:2 Fluorotelomer alcohol	60699-51-6	NA	detected/ND	detected/ND
41	16:2 FTOH	16:2 Fluorotelomer alcohol	65104-67-8	NA	detected/ND	detected/ND
42	18:2 FTOH	18:2 Fluorotelomer alcohol	65104-65-6	NA	detected/ND	detected/ND
43	20:2 FTOH	20:2 Fluorotelomer alcohol	-	NA	detected/ND	detected/ND
44	4:2 FTS	4:2 Fluorotelomer sulfonic acid	757124-72-4	NA	<5.20	<0.05

Annex A, Continued Limit of quantitation (LOQ) of analysed PFAS chemicals. Analysed PFAS congeners and their LOQs.

NO.	CHEMICAL	FULL NAME	CAS	LOQ (NG/G)		
				1ST BATCH (2019)	2ND BATCH (2020)	3RD BATCH (2022)
46	8:2 FTS	8:2 Fluorotelomer sulfonic acid	39108-34-4	NA	<26.0	<2.5
47	10:2 FTS	10:2 Fluorotelomer sulfonic acid	120226-60-0	NA	<26.0	<2.5
48	12:2 FTS	12:2 Fluorotelomer sulfonic acid	120226-60-0	NA	detected/ND	detected/ND
49	14:2 FTS	14:2 Fluorotelomer sulfonic acid	149246-64-0	NA	detected/ND	detected/ND
50	16:2 FTS	16:2 Fluorotelomer sulfonic acid	1377603-17-2	NA	detected/ND	detected/ND
51	6:2 PAP / 6:2 mono-PAP	6:2 Polyfluoroalkyl phosphoric acid monoester	57678-01-0	NA	<260	<2.5
52	8:2 PAP / 8:2 mono-PAP	8:2 Polyfluoroalkyl phosphoric acid monoester	57678-03-02	NA	<260	<2.5
53	6:2 diPAP	6:2/6:2 Fluorotelomer phosphate diester	57677-95-9	NA	<26.0	<0.05
54	6:2 8:2 di-PAP	6:2/8:2 Fluorotelomer phosphate diester	943913-15-3	NA	<26.0	<0.05
55	8:2 diPAP	8:2/8:2 Fluorotelomer phosphate diester	678-41-1	NA	<26.0	<0.05
56	PFBPA	2,3,4,5,6-Pentafluorobenzylphosphonic acid	52299-24-8	NA	<260	<2.5
57	PFHxPA	Perfluorohexyl phosphonic acid	40143-76-8	NA	<26.0	<0.25
58	PFOPA	Perfluorooctyl phosphonic acid	40143-78-0	NA	<26.0	<0.25
59	PFDPA	Perfluorodecyl phosphonic acid	52299-26-0	NA	<26.0	<0.25

Annex B List of Samples. Description of tested samples.

NO.	SAMPLE CODES	BATCH/ YEAR	TYPES OF PRODUCTS	BRAND/ COMPANY	CATEGORY	COUNTRY OF PRODUCTION	COUNTRY OF PURCHASE	PRICE (IDR)	PRODUCT DESCRIPTION	PRODUCT IMAGE
1	IDN-TX-01	1/2019	Waterproof hijab	Milyard Hijab	Textile	Indonesia	Indonesia	85,000	Waterproof Material: Voal	
2	IDN-TX-02	1/2019	Waterproof shirt	-	Textile	-	Indonesia	67,500	Water repellent or anti fouling up to 5 years. Material: 95% polyester	
3	IDN-TX-03	1/2019	Waterproof kids' clothes	-	Textile	-	Indonesia	25,000	Waterproof Material: Parachute	
4	IDN-TX-04	1/2019	Waterproof kids' clothes	Locals	Textile	Indonesia	Indonesia	126,000	Water repellent-Material: 100% cotton	
5	IDN-TX-05	1/2019	Fire suit (gloves)	-	Textile	Indonesia	Indonesia	65,000	Not Available	
6	IDN-TX-06	1/2019	Waterproof pants	Neturehike	Textile	China	Indonesia	195,000	Waterproof Material: Polyester	
7	IDN-TX-07	1/2019	Tracksuits	Tiento	Textile	Indonesia	Indonesia	234,000	100% elastic Water, salt, and chlorine resistant-Material: Import spandex	
8	IDN-TX-08	1/2019	Fire Blanket	Loschdeche	Textile	-	Indonesia	173,000	Not Available	
9	IDN-TX-09	2/2020	Adult T-Shirt	Fashion	Textile	-	Indonesia	48,900	Waterproof, anti-stain Material: 100% premium cotton	
10	IDN-TX-10	2/2020	Hiking Gloves	Naturehike	Textile	China	Indonesia	119,900	Material: Polyester	
11	IDN-TX-11	2/2020	Hijab	Umama	Textile	Indonesia	Indonesia	25,000	Material: Polyester	
12	IDN-TX-12	2/2020	Short pant	Amazing	Textile	Indonesia	Indonesia	94,000	Waterproof Material: Taslan	

Annex B, Continued List of Samples. Description of tested samples.

NO.	SAMPLE CODES	BATCH/ YEAR	TYPES OF PRODUCTS	BRAND/ COMPANY	CATEGORY	COUNTRY OF PRODUCTION	COUNTRY OF PURCHASE	PRICE (IDR)	PRODUCT DESCRIPTION	PRODUCT IMAGE
13	IDN-TX-13	2/2020	Gloves	Golove Joy	Textile	-	Indonesia	103,000	Material: Fleece and Polyester	
14	IDN-PA-01	1/2019	Thermal paper	Printech	Paper	Indonesia	Indonesia	12,500	Heat resistant	
15	IDN-PA-02	1/2019	Burger wrap paper	-	Paper	Indonesia	Indonesia	28,500	Oil and heat resistant	
16	IDN-PA-03	1/2019	Popcorn bag	Jolly Time	Paper	USA	Indonesia	28,000	BPOM RI ML 873209015004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
17	IDN-PA-04	1/2019	Food paper bag	-	Paper	Indonesia	Indonesia	45,000	Oil resistant, Food grade	
18	IDN-PA-05	1/2019	Food box	-	Paper	Indonesia	Indonesia	68,000	Oil and water resistant. Material: Ivory and glossy inner laminating	
19	IDN-RB-01	1/2019	Rubber crumb	-	Paper	-	Indonesia	5,000	Black 20-80 mesh Not mixed with tire cord and fluff Material: styrene-butadiene rubber (SBR)	
20	IDN-PA-06	2/2020	Popcorn bag	Jolly Time	Paper	USA	Indonesia	39,900	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	

Annex B, Continued List of Samples. Description of tested samples.

NO.	SAMPLE CODES	BATCH/ YEAR	TYPES OF PRODUCTS	BRAND/ COMPANY	CATEGORY	COUNTRY OF PRODUCTION	COUNTRY OF PURCHASE	PRICE (IDR)	PRODUCT DESCRIPTION	PRODUCT IMAGE
21	IDN-PA-07	2/2020	Popcorn bag	Jolly Time	Paper	USA	Indonesia	28,900	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
22	IDN-PA-08	2/2020	Popcorn bag	Jolly Time	Paper	USA	Indonesia	28,900	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
23	IDN-PA-09	2/2020	Popcorn bag	Jolly Time	Paper	USA	Indonesia	29,000	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
24	IDN-PA-10	2/2020	Popcorn bag	Jolly Time	Paper	USA	Indonesia	29,900	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
25	IDN-PA-11	2/2020	Popcorn bag	Jolly Time	Paper	USA	Indonesia	28,000	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
26	IDN-PA-12	2/2020	Popcorn bag	Preferred popcorn	Paper	USA	Indonesia	14,950	BPOM RI ML 373209003528 Produced by: Clark's Snacks, New Albany, US of North America, USA Imported by: PT ACE Hardware Tbk, Jakarta 11610, Indonesia	

Annex B, Continued List of Samples. Description of tested samples.

NO.	SAMPLE CODES	BATCH/ YEAR	TYPES OF PRODUCTS	BRAND/ COMPANY	CATEGORY	COUNTRY OF PRODUCTION	COUNTRY OF PURCHASE	PRICE (IDR)	PRODUCT DESCRIPTION	PRODUCT IMAGE
27	IDN-PA-13	2/2020	Popcorn bag	Preferred popcorn	Paper	USA	Indonesia	7,450	BPOM RI ML 373209002528 Produced by: Clark's Snacks, New Albany, US of North America, USA Imported by: PT ACE Hardware Tbk, Jakarta 11610, Indonesia	
28	IDN-PA-14	2/2020	Popcorn bag	Preferred popcorn	Paper	USA	Indonesia	14,950	BPOM RI ML 373209003528 Produced by: Clark's Snacks, New Albany, US of North America, USA Imported by: PT ACE Hardware Tbk, Jakarta 11610, Indonesia	
29	IDN-PA-15	2/2020	Popcorn bag	Preferred popcorn	Paper	USA	Indonesia	14,950	BPOM RI ML 373209003528 Produced by: Clark's Snacks, New Albany, US of North America, USA Imported by: PT ACE Hardware Tbk, Jakarta 11610, Indonesia	
30	IDN-PA-16	2/2020	Instant noodle cup	Popmie	Paper	Indonesia	Indonesia	5,400	Produced by: PT Indofood CBP Sukses Makmur Tbk. Bekasi 17520, Indonesia	
31	IDN-PA-17	3/2022	Popcorn bag	Jolly Time	Paper	USA	Indonesia	28,900	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
32	IDN-PA-18	3/2022	Popcorn bag	Jolly Time	Paper	USA	Indonesia	29,000	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	

Annex B, Continued List of Samples. Description of tested samples.

NO.	SAMPLE CODES	BATCH/ YEAR	TYPES OF PRODUCTS	BRAND/ COMPANY	CATEGORY	COUNTRY OF PRODUCTION	COUNTRY OF PURCHASE	PRICE (IDR)	PRODUCT DESCRIPTION	PRODUCT IMAGE
33	IDN-PA-19	3/2022	Popcorn bag	Jolly Time	Paper	USA	Indonesia	29,000	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
34	IDN-PA-20	3/2022	Popcorn bag	Jolly Time	Paper	USA	Indonesia	28,000	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
35	IDN-PA-21	3/2022	Popcorn bag	Jolly Time	Paper	USA	Indonesia	39,900	BPOM RI ML 873209018004 Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA. Imported by: PT United Harvest Indonesia, Jakarta 11630, Indonesia	
36	IDN-PA-22	3/2022	Popcorn bag	Preferred popcorn	Paper	USA	Indonesia	36,000	BPOM RI ML 373209003528 Produced by: Clark's Snacks, New Albany, US of North America, USA Imported by: PT ACE Hardware Tbk, Jakarta 11610, Indonesia	
37	IDN-PA-23	3/2022	Popcorn bag	ACT II	Paper	USA	Indonesia	50,000	Not registered in BPOM Manufactured by: Conagra Brands Distributed by Conagra Brands P.O. Box 3534, DEPT. A2 Chicago, IL 60654	
38	USA-PA-01	2/2020	Popcorn bag	Jolly Time	Paper	USA	USA	41,850	Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA	
39	USA-PA-02	2/2020	Popcorn bag	Jolly Time	Paper	USA	USA	15,670	Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA	

Annex B, Continued List of Samples. Description of tested samples.

NO.	SAMPLE CODES	BATCH/ YEAR	TYPES OF PRODUCTS	BRAND/ COMPANY	CATEGORY	COUNTRY OF PRODUCTION	COUNTRY OF PURCHASE	PRICE (IDR)	PRODUCT DESCRIPTION	PRODUCT IMAGE
40	USA-PA-03	2/2020	Popcorn bag	Jolly Time	Paper	USA	USA	150,000	Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA	
41	USA-PA-04	2/2020	Popcorn bag	Jolly Time	Paper	USA	USA	29,850	Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA	
42	USA-PA-05	2/2020	Popcorn bag	Preferred popcorn	Paper	USA	USA	314,850	Produced by: Clark's Snacks, New Albany, US of North America, USA	
43	USA-PA-06	2/2020	Popcorn bag	Cousin Willie's	Paper	USA	USA	29,850	Produced by: Ramsey Popcorn Co., Inc, Home of Cousin Popcorn, 5645 Clover Valley Rd NW, Ramsey, IN 47166, USA	
44	USA-PA-07	2/2020	Popcorn bag	Cousin Willie's	Paper	USA	USA	29,850	Produced by: Ramsey Popcorn Co., Inc, Home of Cousin Popcorn, 5645 Clover Valley Rd NW, Ramsey, IN 47166, USA	
45	USA-PA-08	2/2020	Popcorn bag	Cousin Willie's	Paper	USA	USA	29,850	Produced by: Ramsey Popcorn Co., Inc, Home of Cousin Popcorn, 5645 Clover Valley Rd NW, Ramsey, IN 47166, USA	
46	USA-PA-09	2/2020	Popcorn bag	Cousin Willie's	Paper	USA	USA	37,500	Produced by: Ramsey Popcorn Co., Inc, Home of Cousin Popcorn, 5645 Clover Valley Rd NW, Ramsey, IN 47166, USA	
47	USA-PA-10	2/2020	Popcorn bag	Cousin Willie's	Paper	USA	USA	29,850	Produced by: Ramsey Popcorn Co., Inc, Home of Cousin Popcorn, 5645 Clover Valley Rd NW, Ramsey, IN 47166, USA	
48	USA-PA-11	3/2022	Popcorn bag	Jolly Time	Paper	USA	USA	29,850	Produced by: American Pop Corn Company, Sioux City, IOWA 51102, USA	

Annex C PFAS concentration in tested samples

Concentration of PFAS chemicals in textile samples

SAMPLE CODES	CONCENTRATION (NG/G)								
	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUdA	PFDoA
IDN-TX-01/2019	1.01	<0.3	3.19	2.51	25.92	1.79	10.54	<0.3	4.87
IDN-TX-02/2019	<0.3	0.45	0.66	0.64	1.82	<0.3	0.43	<0.3	0.32
IDN-TX-03/2019	<0.3	<0.3	<0.3	<0.3	1.66	<0.3	<0.3	<0.3	<0.3
IDN-TX-04/2019	8.63	6.73	38.27	9.72	45.54	6.38	27.48	6.89	45.49
IDN-TX-05/2019	<0.3	<0.3	<0.3	<0.3	0.91	<0.3	<0.3	<0.3	<0.3
IDN-TX-06/2019	<0.3	<0.3	1.45	0.63	2.97	<0.3	<0.3	<0.3	<0.3
IDN-TX-07/2019	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
IDN-TX-08/2019	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
IDN-TX-09/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70
IDN-TX-10/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70
IDN-TX-11/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70
IDN-TX-12/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70
IDN-TX-13/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70

Concentration of PFAS chemicals in textile samples (continued)

SAMPLE CODES	PFTrDA	PFTeDA	PFHxDA	PFODA	8:2 FTOH	8:2 FTOH	6:2 diPAP	6:2 8:2 diPAP
IDN-TX-01/2019	<0.3	2.23	<0.3	<0.3	NA	NA	NA	NA
IDN-TX-02/2019	<0.3	<0.3	<0.3	<0.3	NA	NA	NA	NA
IDN-TX-03/2019	<0.3	<0.3	<0.3	<0.3	NA	NA	NA	NA
IDN-TX-04/2019	4.20	33.39	16.90	3.64	NA	NA	NA	NA
IDN-TX-05/2019	<0.3	<0.3	<0.3	<0.3	NA	NA	NA	NA
IDN-TX-06/2019	<0.3	<0.3	<0.3	<0.3	NA	NA	NA	NA
IDN-TX-07/2019	<0.3	<0.3	<0.3	<0.3	NA	NA	NA	NA
IDN-TX-08/2019	<0.3	<0.3	<0.3	<0.3	NA	NA	NA	NA
IDN-TX-09/2020	<1.70	<1.70	<1.70	<1.70	52.40	Not detected	<26.0	<26.0
IDN-TX-10/2020	<1.70	<1.70	<1.70	<1.70	4.47	Not detected	<26.0	<26.0
IDN-TX-11/2020	<1.70	<1.70	<1.70	<1.70	252.00	Not detected	30,178.00	679.00
IDN-TX-12/2020	<1.70	<1.70	<1.70	<1.70	31.00	Not detected	<26.0	<26.0
IDN-TX-13/2020	<1.70	<1.70	<1.70	<1.70	103.00	detected	<26.0	<26.0

Concentration of PFAS chemicals in rubber crumb samples

SAMPLE CODES	CONCENTRATION (NG/G)
	PFHxA
IDN-RB-01/2019	0.31

Concentration of PFAS chemicals in paper samples purchased in Indonesia-part 1

SAMPLE CODES	CONCENTRATION (NG/G)											
	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUdA	PFDoA	PFTrDA	PFTeDA	6:2 FTOH
IDN-PA-01/2019	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	NA
IDN-PA-02/2019	<0.3	<0.3	3.58	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	NA
IDN-PA-03/2019	274.47	14.16	160.85	0.97	3.04	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	NA
IDN-PA-04/2019	2.47	<0.3	12.13	0.94	2.85	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	NA
IDN-PA-05/2019	<0.3	<0.3	<0.3	<0.3	<0.3	0.47	0.48	0.51	0.63	0.59	0.48	NA
IDN-PA-06/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	156
IDN-PA-07/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	170
IDN-PA-08/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	71.1
IDN-PA-09/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	16.6
IDN-PA-10/2020	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	161
IDN-PA-11/2020	52.8	3.01	32.8	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	<1.70	98.4

Concentration of PFAS chemicals in paper samples purchased in Indonesia-part 2

SAMPLE CODES	CONCENTRATION (NG/G)									
	PFBA	PFHxA	PFHpA	6:2 FTOH	6:2 FTS	6:2 PAP / 6:2 monoPAP	8:2 PAP / 8:2 monoPAP	6:2 diPAP	6:2 8:2 diPAP	8:2 diPAP
IDN-PA-12/2020	<1.70	1.83	<1.70	641.00	<26.0	<260	<260	<26.0	<26.0	<26.0
IDN-PA-13/2020	<1.70	2.20	<1.70	531.00	<26.0	<260	<260	<26.0	<26.0	<26.0
IDN-PA-14/2020	<1.70	2.04	<1.70	923.00	<26.0	<260	<260	<26.0	<26.0	<26.0
IDN-PA-15/2020	<1.70	1.96	<1.70	699.00	<26.0	<260	<260	2,043	63.7	<26.0
IDN-PA-16/2020	<1.70	<1.70	<1.70	6.71	<26.0	<260	<260	<26.0	<26.0	<26.0
IDN-PA-17/2022	0.157	0.120	<0.025	19.60	0.310	38.0	7.45	0.236	0.108	0.063
IDN-PA-18/2022	0.061	0.228	<0.025	395.00	<0.25	30.3	23.9	0.206	0.131	0.085
IDN-PA-19/2022	0.126	0.272	0.045	229.00	<0.25	7.74	11.9	0.168	0.082	0.053
IDN-PA-20/2022	0.081	0.262	<0.025	175.00	<0.25	<2.5	9.90	0.098	0.059	<0.05
IDN-PA-21/2022	0.140	<0.025	<0.025	<1.60	<0.25	<2.5	<2.5	0.077	<0.05	<0.05
IDN-PA-22/2022	0.485	0.509	0.055	1,260.00	<0.25	<2.5	<2.5	<0.05	<0.05	<0.05
IDN-PA-23/2022	0.327	0.185	0.059	1,000.00	<0.25	<2.5	<2.5	0.072	<0.05	<0.05

Concentration of PFAS chemicals in paper samples purchased in Indonesia-part2

SAMPLE CODES	CONCENTRATION (NG/G)		
	PFBA	PFHxA	6:2 FTOH
USA-PA-01/2020	<1.70	<1.70	68.80
USA-PA-02/2020	2.16	3.25	69.40
USA-PA-03/2020	<1.70	<1.70	29.90
USA-PA-04/2020	<1.70	<1.70	273.00
USA-PA-05/2020	<1.70	<1.70	384.00
USA-PA-06/2020	<1.70	<1.70	332.00
USA-PA-07/2020	<1.70	<1.70	359.00
USA-PA-08/2020	<1.70	<1.70	394.00
USA-PA-09/2020	<1.70	<1.70	106.00
USA-PA-10/2020	<1.70	<1.70	437.00
USA-PA-11/2022	0.288	0.303	730.00

Annex D PFAS area-concentration (density)

Area-Concentration of PFAS chemicals in textile samples

SAMPLE CODES	AREA-CONCENTRATION (µG/M2)												
	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUdA	PFDoA	PFTrDA	PFTeDA	PFHXDA	PFODA
IDN-TX-01/2019	0.008	<0.005	0.024	0.019	0.196	0.014	0.08	<0.005	0.037	<0.005	0.017	<0.005	<0.005
IDN-TX-02/2019	<0.005	0.007	0.011	0.01	0.029	<0.005	0.007	<0.005	0.005	<0.005	<0.005	<0.005	<0.005
IDN-TX-03/2019	<0.005	<0.005	<0.005	<0.005	0.02	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
IDN-TX-04/2019	0.135	0.105	0.599	0.152	0.712	0.1	0.43	0.108	0.711	0.066	0.522	0.264	0.057
IDN-TX-05/2019	<0.005	<0.005	<0.005	<0.005	0.024	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
IDN-TX-06/2019	<0.005	<0.005	0.013	0.006	0.026	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Density or Area-Concentration of PFAS chemicals in textile samples

SAMPLE CODES	AREA-CONCENTRATION (NG/CM2)		
	8:2 FTOH	6:2 DIPAP	6:2 8:2 DIPAP
IDN-TX-09/2020	1.750	<1.6	<1.6
IDN-TX-10/2020	0.113	<1.6	<1.6
IDN-TX-11/2020	1.850	221.000	4.968
IDN-TX-12/2020	0.285	<1.6	<1.6
IDN-TX-13/2020	6.070	<1.6	<1.6

Area-Concentration of PFAS chemicals in paper samples

SAMPLE CODES	DENSITY OR AREA-CONCENTRATION (µG/M2)												
	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUdA	PFDoA	PFTrDA	PFTeDA	PFHXDA	PFODA
IDN-PA-02/2019	<0.005	<0.005	0.014	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
IDN-PA-03/2019	2.70	0.14	1.58	0.01	0.03	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
IDN-PA-04/2019	0.014	<0.005	0.068	0.005	0.016	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
IDN-PA-05/2019	<0.005	<0.005	<0.005	0.006	<0.005	0.011	0.011	0.012	0.015	0.014	0.011	0.007	0.006

Area-Concentration of PFAS chemicals in paper samples (continued)

	AREA CONCENTRATION (NG/CM²)					
SAMPLE CODES	PFBA	PFPeA	PFHxA	6:2 FTOH	6:2 diPAP	6:2 8:2 diPAP
IDN-PA-06/2020	<0.015	<0.015	<0.015	1.440	<0.24	<0.24
IDN-PA-07/2020	<0.015	<0.015	<0.015	2.180	<0.24	<0.24
IDN-PA-08/2020	<0.015	<0.015	<0.015	0.628	<0.24	<0.24
IDN-PA-09/2020	<0.015	<0.015	<0.015	0.154	<0.24	<0.24
IDN-PA-10/2020	<0.015	<0.015	<0.015	1.670	<0.24	<0.24
IDN-PA-11/2020	0.725	0.041	0.450	1.350	<0.24	<0.24
IDN-PA-12/2020	<0.015	<0.015	0.023	8.130	<0.24	<0.24
IDN-PA-13/2020	<0.015	<0.015	0.031	7.410	<0.24	<0.24
IDN-PA-14/2020	<0.015	<0.015	0.023	10.600	<0.24	<0.24
IDN-PA-15/2020	<0.015	<0.015	0.018	6.460	18.900	0.589
IDN-PA-16/2020	<0.015	<0.015	<0.015	0.214	<0.24	<0.24

Area-Concentration of PFAS chemicals in paper samples (continued)

SAMPLE CODES	AREA CONCENTRATION (NG/CM²)									
	PFBA	PFHxA	PFHpA	6:2 FTOH	6:2 FTS	6:2 monoPAP	8:2 monoPAP	6:2 diPAP	6:2 8:2 diPAP	8:2 diPAP
IDN-PA-17/2022	0.0025	0.0019	<0.0003	0.308	0.005	0.5950	0.1170	0.0037	0.0017	0.0010
IDN-PA-18/2022	0.0010	0.0036	<0.0003	6.186	<0.003	0.4740	0.3740	0.0032	0.0020	0.0013
IDN-PA-19/2022	0.0020	0.0043	0.0007	3.606	<0.003	0.1220	0.1880	0.0026	0.0013	0.0008
IDN-PA-20/2022	0.0013	0.0041	<0.0003	2.750	2.749	<0.003	0.1550	0.0015	0.0009	<0.0005
IDN-PA-21/2022	0.0022	<0.0003	<0.0003	<0.015	<0.003	<0.003	<0.03	0.0012	<0.0005	<0.0005
IDN-PA-22/2022	0.0076	0.0080	0.0009	19.7140	<0.003	<0.003	<0.03	<0.0005	<0.0005	<0.0005
IDN-PA-23/2022	0.0051	0.0029	0.0009	15.6580	<0.003	<0.003	<0.03	0.0011	<0.0005	<0.0005

Area-Concentration of PFAS chemicals in paper samples (the U.S. samples)

SAMPLE CODES	DENSITY OR AREA-CONCENTRATION (NG/CM²)		
	PFBA	PFHxA	6:2 FTOH
USA-PA-01/2020	<0.015	<0.015	<0.015
USA-PA-02/2020	0.020	0.030	0.648
USA-PA-03/2020	<0.015	<0.015	0.314
USA-PA-04/2020	<0.015	<0.015	1.690
USA-PA-05/2020	<0.015	<0.015	3.540
USA-PA-06/2020	<0.015	<0.015	3.840
USA-PA-07/2020	<0.015	<0.015	3.370
USA-PA-08/2020	<0.015	<0.015	3.630
USA-PA-09/2020	<0.015	<0.015	0.988
USA-PA-10/2020	<0.015	<0.015	3.750

Area-Concentration of PFAS chemicals in paper samples (the U.S. samples)

SAMPLE CODES	DENSITY OR AREA-CONCENTRATION (NG/CM²)		
	PFBA	PFHxA	6:2 FTOH
USA-PA-11/2022	0.0045	0.0047	11.4100

Density or area-concentration of PFAS chemicals in rubber crumb samples

SAMPLE CODES	DENSITY OR AREA-CONCENTRATION (NG/CM²)	
	PFHxA	PFNA
IDN-RB-01/2019	0.017	0.009

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