

Eliminating Forever Chemicals from CSU Dining Hall Food Packaging

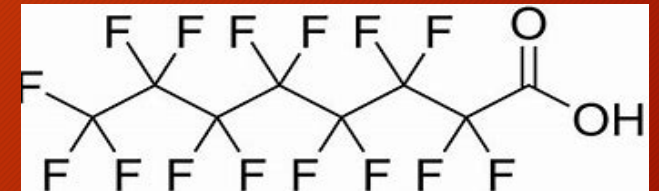
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Introduction to PFAS¹

- Per- and polyfluorinated alkyl substances (PFAS) are a highly complex group of chemicals containing aliphatic chains of fluorine-bonded carbons
- **The Good**
 - Chemically and thermally stable due to strong C-F bond
 - Easily tunable
 - Hydrophobic
 - Lipophobic
 - Aqueous surface tension-lowering properties



Perfluorooctanoic acid (PFOA)



PFAS a.k.a “Forever Chemicals”²

- Name given to describe environmentally persistent and bioaccumulative PFAS
- Roughly 4,000 species
 - Mainly to avoid health/env. regulations

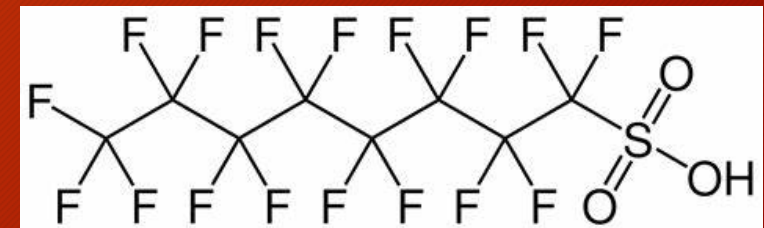
What makes them “forever”?

- Incredible bond strength
- Perfluorinated moiety remains almost unmutated in the environment for an extremely long time (~3.5 years in humans)
- Cannot be broken down by biological means

PFAS a.k.a. “Forever Chemicals”³

Why are we concerned?

- Bioaccumulation in fatty tissue is leading to toxicity
- Health Implications
 - Risk of Cancer
 - Decreased fertility and reduced fetal growth
 - Disruption of several organs during pregnancy
 - Thyroid hormone disruption
 - Decreased liver cell viability



Perfluorooctane sulfonate
(PFOS)

Previous Detection in Food Packaging^{4,5}

- Compost Piles
 - Commercial and residential
 - Loads **with** food packaging
 - 7.94-11.5 ng/g PFOS + PFOA
 - Loads **without** food packaging
 - 0.54-2.75 ng/g PFOS + PFOA
- Popcorn Bags
 - American/European bags contain short chain PFAS (C₄-C₈)
 - 3.0-30ng/g of PFOA
 - Asian (India & China) bags contain long chain PFAS (C₈-C₁₆)
 - 51-60ng/g
 - Degradation intermediates found in all

Our Research Goal: Detect presence of PFAS
in various food packaging materials

Dining Hall Samples

Cups & Lids

- Coca-Cola Cup
- Coffee Cup (2 types)
- Straws
- Plastic Lid
 - Cold Drinks
 - Hot Drinks

Containers & Silverware

- Soup Bowl
- To-Go Box (2 types)
- French Fry Container
- Spoon
- Knife

Wrappings

- Sandwich Wrapper
- Pizza Box
- Foil
- Parchment Paper

Extraction Method



1. Cut up sample and place in PP tube
2. Add 3mL of 99:1 MeOH/NH₄OH
3. Add 20μL 100ppb internal standard
4. Vortex briefly



1. Sonicate for 20 mins in water bath
2. Transfer liquid to glass test tube
3. Evaporate liquid off completely using N-evap (20 min cycle)

**PROCESS WAS REPEATED
3 TIMES**

Final Steps

1. Rehydrate sample with 1mL of MeOH
2. Add ~20mg of ENVI-Carb to sample
3. Vortex 30 sec
4. Centrifuge for 30 min
5. Extract 100μL for LCMS analysis

Results: No PFAS Detected

**LOD shown in ng/g

Sample #	PFBA	PFPeA	PFBS	4:2 FTS	PFHxA	PFPeS	PFHpA	PFHxSK	6:2 FTS	PFOA	PFHpS	PFOS
1	0.263	0.263	0.026	0.105	0.052	0.026	0.105	0.052	0.105	0.052	0.052	0.052
2	0.417	0.417	0.042	0.167	0.083	0.042	0.167	0.083	0.167	0.083	0.083	0.083
3	0.278	0.278	0.028	0.111	0.056	0.028	0.111	0.056	0.111	0.056	0.056	0.056
4	0.152	0.152	0.015	0.060	0.030	0.015	0.060	0.030	0.060	0.030	0.030	0.030
5	0.067	0.067	0.007	0.027	0.013	0.007	0.027	0.013	0.027	0.013	0.013	0.013
6	0.294	0.294	0.029	0.118	0.059	0.029	0.118	0.059	0.118	0.059	0.059	0.059
7	0.385	0.385	0.038	0.154	0.077	0.038	0.154	0.077	0.154	0.077	0.077	0.077
8	0.385	0.385	0.038	0.154	0.077	0.038	0.154	0.077	0.154	0.077	0.077	0.077

Results: No PFAS Detected

**LOD shown in ng/g

Sample #	PFNA	PFNS	PFDA	8:2 FTS	N-MeFOS SA	FOSA	PFDS	PFUdA	N-EtFO SSA	PFDoA	PFTTrDA	PFTTeDA
1	0.105	0.052	0.105	0.105	0.052	0.052	0.052	0.105	0.052	0.105	0.105	0.052
2	0.167	0.083	0.167	0.167	0.083	0.083	0.083	0.167	0.083	0.167	0.167	0.083
3	0.111	0.056	0.111	0.111	0.056	0.056	0.056	0.111	0.056	0.111	0.111	0.056
4	0.060	0.030	0.060	0.060	0.030	0.030	0.030	0.060	0.030	0.060	0.060	0.030
5	0.027	0.013	0.027	0.027	0.013	0.013	0.013	0.027	0.013	0.027	0.027	0.013
6	0.118	0.059	0.118	0.118	0.059	0.059	0.059	0.118	0.059	0.118	0.118	0.059
7	0.154	0.077	0.154	0.154	0.077	0.077	0.077	0.154	0.077	0.154	0.154	0.077
8	0.154	0.077	0.154	0.154	0.077	0.077	0.077	0.154	0.077	0.154	0.154	0.077

Results: No PFAS Detected

**LOD shown in ng/g

Sample #	PFBA	PFPeA	PFBS	4:2 FTS	PFHxA	PFPeS	PFHpA	PFHxSK	6:2 FTS	PFOA	PFHpS	PFOS
9	1	1	0.1	0.4	0.2	0.1	0.4	0.2	0.4	0.2	0.2	0.2
10	0.313	0.313	0.031	0.125	0.063	0.031	0.125	0.063	0.125	0.063	0.063	0.063
11	0.278	0.278	0.028	0.111	0.056	0.028	0.111	0.056	0.111	0.056	0.056	0.056
12	0.217	0.217	0.022	0.087	0.043	0.022	0.087	0.043	0.087	0.043	0.043	0.043
13	-	-	-	-	-	-	-	-	-	-	-	-
14	0.313	0.313	0.031	0.125	0.063	0.031	0.125	0.063	0.125	0.063	0.063	0.063
15	1.25	1.25	0.125	0.5	0.25	0.125	0.5	0.25	0.5	0.25	0.25	0.25
16	1.667	1.667	0.167	0.667	0.333	0.167	0.667	0.333	0.667	0.333	0.333	0.333

Results: No PFAS Detected

**LOD shown in ng/g

Sample #	PFNA	PFNS	PFDA	8:2 FTS	N-MeFOS SA	FOSA	PFDS	PFUdA	N-EtFO SSA	PFDoA	PFTTrDA	PFTTeDA
9	0.4	0.2	0.4	0.4	0.2	0.2	0.2	0.4	0.2	0.4	0.4	0.2
10	0.125	0.063	0.125	0.125	0.063	0.063	0.063	0.125	0.063	0.125	0.125	0.063
11	0.111	0.056	0.111	0.111	0.056	0.056	0.056	0.111	0.056	0.111	0.111	0.056
12	0.087	0.043	0.087	0.087	0.043	0.043	0.043	0.087	0.043	0.087	0.087	0.043
13	-	-	-	-	-	-	-	-	-	-	-	-
14	0.125	0.063	0.125	0.125	0.063	0.063	0.063	0.125	0.063	0.125	0.125	0.063
15	0.5	0.25	0.5	0.5	0.25	0.25	0.25	0.5	0.25	0.5	0.5	0.25
16	0.667	0.333	0.667	0.667	0.333	0.333	0.333	0.667	0.333	0.677	0.667	0.333

Acceptable Dose Limits

- PFASs have been announced as emerging contaminants in the food chain by the European Food Safety Authority (EFSA), which have recently established the tolerable weekly intakes(TWI) of 4.4 ng/kg bw/week PFAS
- (130lbs) 59kg → 260ng/week
- (300lbs) 136kg → 600ng/week
- Detection limits range from 50ng/kg to 1600ng/kg

Conclusions

- You'd need to ingest a ton of food packaging to get sick
- The dining hall food packaging appears to be safe

References

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Thanks for listening!