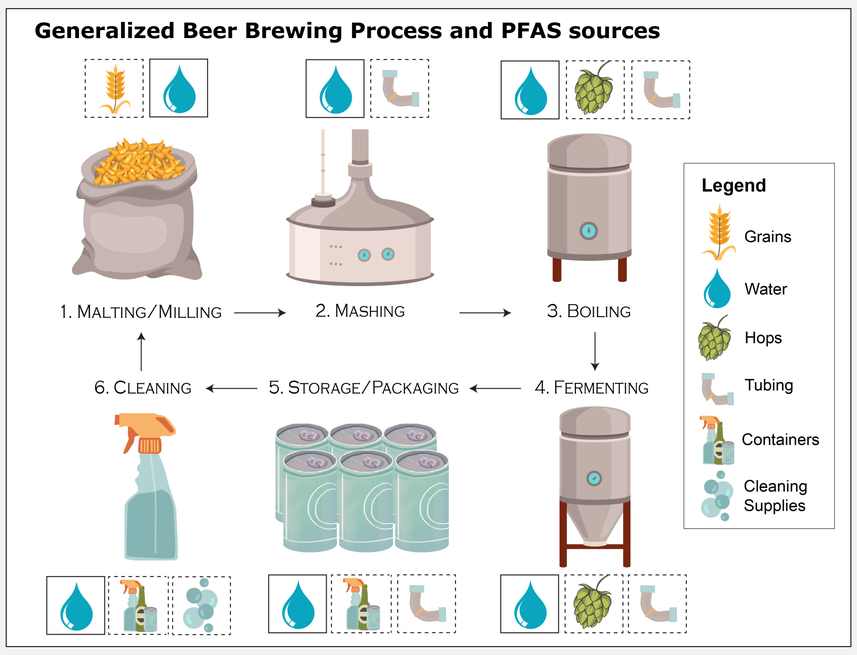
Hold My Beer: The Linkage between Municipal Water and Brewing Location on PFAS in Popular Beverages

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PFAS and the Beer Brewing Process

PFAS are a class of more than 16,000 synthetic chemicals with water-resistant and stain-repelling properties. Widely used in consumer products and industrial manufacturing, they are often called "forever chemicals" due to their persistence in the environment. PFAS can cause various health issues, including reproductive, cardiovascular, liver, kidney, immune, and cancer effects. As research revealed that nearly every American has PFAS in their blood, the U.S. Environmental Protection Agency (EPA) addressed the prevalence of PFAS in contaminated drinking water as being a major contributor to widespread exposure by setting regulatory limits for 5 PFAS.

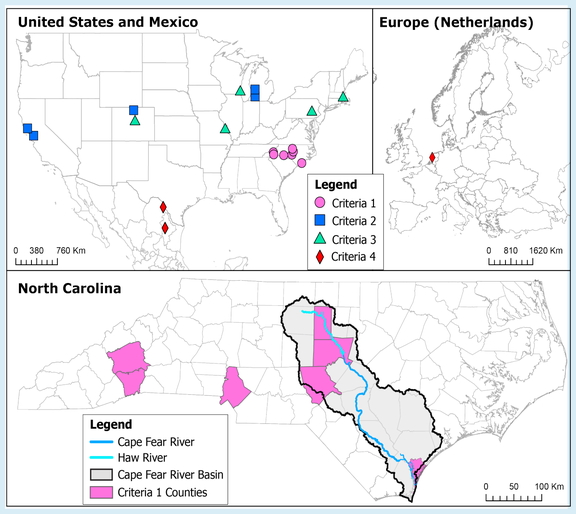


The essential ingredients of beer, the ones that make up the unique flavor and appearance of each variety, are malt, hops, and yeast. However, **beer is more than 90 percent water**! While breweries typically filter and treat their source water, existing processes may not remove contaminants such as PFAS. **If there are PFAS in the water, there could be PFAS in the beer.**

Study Methods

- First study to adapt EPA Method 533 to measure PFAS in beers.
- Selected 23 canned beers available for purchase in North Carolina stores (August 2021) based on 4 criteria.
- Analyzed one aliquot from each can in a six-pack.
- Averaged state-reported municipal drinking water PFAS data (2018-2021) by county.
- Health risk calculated using reference oral doses (RfD) and cancer slope factors (CSF) from U.S. EPA's Human Health Toxicity Assessments.

Criteria 1	Brewed in North Carolina with high levels of PFAS in drinking water (n=10)
Criteria 2	Brewed in other U.S. states with high levels of PFAS in drinking water (n=5)
Criteria 3	Popular national U.S. beers (n=5)
Criteria 4	Popular international beers (n=3)



Estimated Daily Intake (EDI)

$$\text{EDI (mg/kg/day)} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

Hazard Quotient

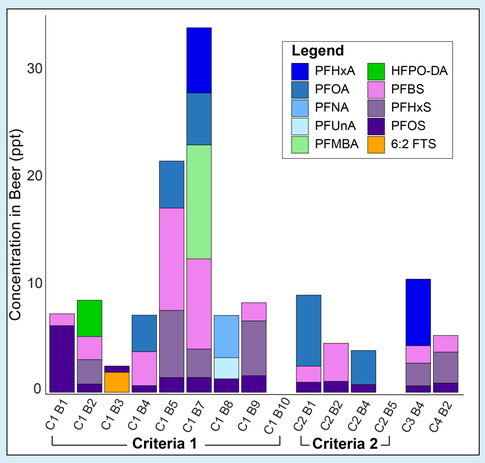
$$\text{HQ} = \frac{EDI}{RfD}$$

Incremental Lifetime Cancer Risk (ILCR)

$$\text{ILCR} = EDI \times CSF$$

C = PFAS concentration in beer (mg/L)
BW = Average adult body weight (70 kg)
IR = Daily ingestion rate (L/day): 1 beer = 0.5 L
Low IR = 1 beer/week, Medium IR = 1 beer/day, High IR = 5 beers/day
EF = Exposure frequency (365 days/year)
ED = Exposure duration (21-70 years old)
AT = Averaging Time (EF x ED)

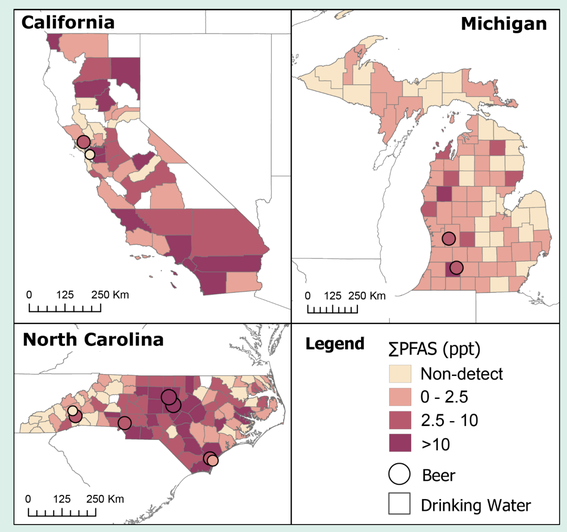
Results: PFAS in Beer



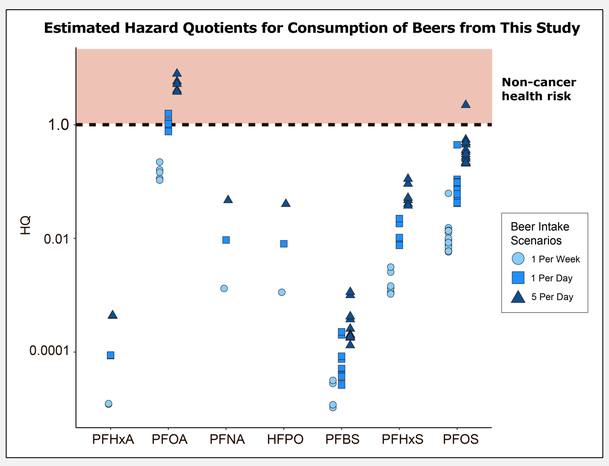
- At least one **PFAS detected in most beer samples analyzed (95%)** with variation from can-to-can in some six-packs.
- Perfluorosulfonic acids, particularly PFOS, were most frequently detected and had highest replicate-averaged concentrations.
- Phased-out, long-chain legacy PFAS (PFOA/PFOS) were still present in beers.
- Beers from breweries near elevated levels of PFAS in drinking water had higher likelihood of PFAS detections compared to larger-scale U.S. or international beers.
- Three beers **exceeded the U.S. EPA's maximum contaminant level** (MCL) for drinking water for PFOA, and one North Carolina beer exceeded the MCL for PFOS.

Results: Linkage to Municipal Drinking Water

- Counties in North Carolina and California had higher average ∑PFAS in drinking water than counties in Michigan.
- North Carolina counties within the Cape Fear River Basin had higher ∑PFAS in drinking water than other parts of the state. Beers with the largest number of PFAS detected were also from this region.
- A county in Michigan had the highest PFOA concentration in drinking water and beer among the counties evaluated in the study.
- ∑PFAS, PFOA, and PFBS **concentrations in beer strongly and positively correlated with county drinking water concentrations** (r = 0.82, 0.90, and 0.71, respectively), but not PFOS (r = −0.09).



Results: Risk Assessment for Beer Consumers



HQ > 1 indicates potential for adverse, non-cancer health effects

Is there a health risk from consuming PFAS in beer?

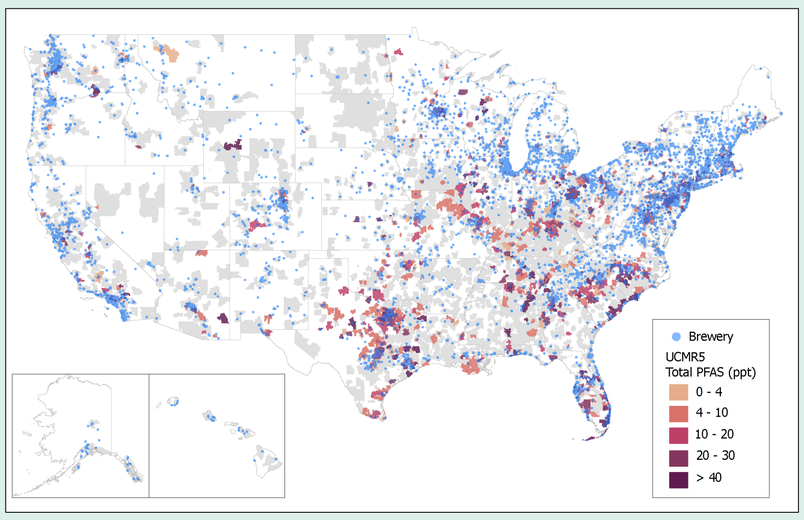
- Low consumption (1 beer/ week): No non-cancer risks for any beer.
- Medium consumption (1 beer/ day): Non-cancer health risks from PFOA for some beers tested.
- High consumption (5 beers/ day): Non-cancer health risks from PFOA for all beers with PFOA detected, and from PFOS in one beer.
- There were no cancer risks from PFOA or PFOS for any beer tested.

Note that this does not take into account cumulative exposure risk.

Looking Ahead

At least 18% of U.S. breweries were located within zip codes served by public water supplies with detectable PFAS, based on municipal drinking water ∑PFAS data as of July 2024 (*** with data reporting still in progress).

Note: U.S. brewery locations from Breweries Collectibles Club of America as of August 2024. Areas in white have not been sampled for PFAS in municipal water at the time the data was received from the 5th Unregulated Contaminant Monitoring Rule (UCMR5) testing. Areas in gray were sampled for PFAS, but they were not detected.



Recommendations

For Breweries

- ✓ Test source water or review local water utility results
- ✓ Verify water filtration systems are effectively removing PFAS from source water
- ✓ Implement water filtration systems if PFAS are detected
- ✓ Ensure PFAS-contaminated water is not used for brewing

For Drinking Water Utilities

- ✓ Identify sources of PFAS
- ✓ Enhance filtration systems
- ✓ Monitor PFAS levels to maintain standards compliance
- ✓ Keep customers and consumers informed
- ✓ Collaborate with local breweries using water for brewing

For Consumers

- ✓ Check water quality near brewery location
- ✓ Support local breweries that take on extra costs for filtration
- ✓ Choose beers from regions with lower PFAS in drinking water
- ✓ Stay informed

Peer-Reviewed Article

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