PFAS organics recycling literature review and data audit

Overview

Composting reduces the amount of waste going to landfills or incineration, benefits soil health, and reduces the need for chemical fertilizers. Per- and polyfluoroalkyl substances (PFAS) are used in many products and have been found globally, in air, water and soil. PFAS are an operational challenge for composters. In 2020, the Minnesota Pollution Control Agency contracted with Wood Environment and Infrastructure Solutions, Inc. (Wood) to conduct a literature review of all existing research on PFAS in materials that come into compost facilities. This literature review was conducted to better identify potential sources of PFAS at compost sites and help shape proactive management and policy development. The review identifies data gaps and provides recommendations for the next phase of research.

Scope of the literature review

Wood reviewed more than 160 academic papers published prior to summer 2020 on the topics of PFAS and food, food waste, food packaging, yard waste, and pesticides. All “inputs” to a compost site (i.e. items listed as acceptable on organics recycling education materials) were considered, including a summary of PFAS measured in food contact material (FCM), food, and yard materials.

Findings

Both long-chain and short-chain perfluoroalkyl acids are prominent in food waste. These analytes will leach as-is and long chains may degrade or transform to terminal products such as PFOS, PFOA, PFBA, PFPeA, PFHxA, and PFHpA. Polyfluoroalkyl substances continue to be prominent in FCM and specifically food packaging. These can degrade further to perfluoroalkyl acids, as listed above.

Food contact materials: The highest PFAS concentrations across all sources evaluated is by far FCMs. Nine different categories of food contact materials were evaluated, including compostable products. Literature found that PFAS concentrations in microwave bags and paper tableware were generally one to four orders of magnitude greater than all other categories of FCM. Eliminating food packaging will likely reduce, but not entirely eliminate, PFAS from compost or contact water. For FCM, none of the literature defined the materials tested as certified by the Biodegradable Products Institute (BPI), and BPI testing results of products are not publicly available.

Yard waste: Maximum PFAS concentrations for trees and shrubs were generally higher than in food sources but lower than in FCM. For potential PFAS sources for yard waste sites, trees and shrubs (roots, leaves, needles), and herbicides/pesticides were considered. No analytical data was found for pesticides.

Food: Generally, PFAS found in food sources was less than PFAS found in FCM and yard waste. Seven different food categories were evaluated as potential PFAS sources including bakery items, dairy, eggs, fish and seafood, fruit, vegetables, and meat. PFAS concentrations were generally higher in eggs, fish and seafood, and vegetables, with maximum concentrations one to two orders of magnitude greater than the other food sources. However, in many cases research was conducted near known PFAS emitters.

Gaps and limitations

For FCM, literature did not specify if compostable products had a BPI certification. BPI is an industry leader in efforts to prevent PFAS use in FCM by requiring “no intentionally added PFAS” and a limit of 100 parts per million total fluorine. According to Wood, there hasn't been enough research yet to determine the efficacy of these certification requirements.

For many food items and yard waste, samples were biased high, because they were collected in the vicinity of fluorochemical manufacturing or firefighting training areas where PFAS were used for 30 or more years.

No available literature evaluated yard waste specifically. The literature considered tree leaves, grass, roots, and pine needles as akin to yard waste, even though they don't meet the state's definition of yard waste. For pesticides, there was no available literature illustrating that PFAS ingredients were part of the product formulation nor used in pesticide/herbicide application.

For PFAS analytical methodologies, there are a few commonly applied analytical methods to measure general fluorine content or targeted speciation of chain length and specific structural details of analytes, but comparisons between studies can be complicated when methodologies used to measure PFAS differ.

Data was pulled worldwide, since few studies exist on this topic. Variability may be related to proximity of a major source (such as a fluorochemical manufacturing facility or a military base that uses firefighting foams containing PFAS), or to country-specific activities related to policy and regulations on PFAS.

More research is needed to document PFAS pathways throughout the compost process (i.e., how much PFAS travels with contact water and how much remains in the finished compost).

While other countries have "tolerable weekly intake" levels for some PFAS in certain foods, the U.S. does not have a comparable threshold.

More research is needed to determine health and safety thresholds in compost and soils. Test methodologies are improving for testing PFAS in soils/composts, but more work is being done to standardize test methods.

Recommendations

The findings from this literature review reinforce the policies laid out in the Minnesota PFAS Blueprint, 2021, including the banning of non-essential uses of PFAS. Wood made several recommendations for further research, based on the results of the literature review. Here are some, but not all, of those recommendations:

- Evaluate FCM products commonly used in Minnesota, certified by BPI and disposed of at Source Separated Organic Materials (SSOM) sites in Minnesota.
- Inventory and evaluate incoming loads at SSOM sites to understand composition and variability of input. Once that is determined, establish a sampling plan to analyze PFAS in the incoming loads, active piles, contact water, compost ready for sale, and residuals to determine where, when, and what PFAS are introduced into the process, so sources can be controlled and releases mitigated.
- Further evaluate yard waste since literature was not available for yard waste in general. Additional sampling is recommended for various types of yard waste (leaves and grass clippings as an example) and in various locations (rural vs. urban areas).
- Evaluate potential ambient source contributions in the vicinity of SSOM and yard-waste sites across Minnesota.