New Opportunities in Recycling and Product Manufacture Eliminate the Environmental Hazards Inherent in the Composting of Plastic-Coated Paper Products

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INTRODUCTION

Collecting and processing non-recyclable organic materials at large-scale composting facilities is, without a doubt, a key strategy for decreasing methane formation in landfills, recycling organic waste into soil nutrients and moving communities toward Zero Waste. As the number of curbside residential and commercial compost collection programs in the United States and Canada continues to grow, the quality of the compost that is dispersed into the greater environment will have an impact on human health and the health of local and global ecosystems.

Figure 1. Compost has numerous environmental benefits but must be kept free of plastic fragments.

In this paper, we will show that the plastic-coated paper products that are currently being collected by many programs (as feedstock for large-scale composting facilities) produce both macro- and micro-fragments of non-biodegradable plastic, which then contaminate finished compost, and therefore, the soils where this compost is applied. These fragments would then be available to be transported by wind and water into nearby aquatic ecosystems, and ultimately into marine ecosystems, adding to the growing and serious problem of plastic pollution in these environments.

Over the past five years, there has been a growing concern in the scientific community about the increased accumulation of plastic fragments in the environment, their absorption of persistent organic pollutants (POPs), their ingestion by organisms, and the human health and environmental consequences that may result. Recent research at Woods End Laboratories shows that the coatings on plastic-coated paper products not only retard the breakdown of the paper layers, but also inevitably result in micro and macro-plastics contaminating the finished compost. Once these plastics are dispersed into the environment, they have not been shown to biodegrade. As such, we can expect them to persist indefinitely in a variety of ecosystems and to be so widely dispersed that it will be impossible to clean them up.

As the number of compost collection programs in North America increases over the next decade, and the Zero Waste movement continues to grow, policies and practices that ensure the elimination of these plastic-coated products from the feedstock of composting facilities are imperative if composting is to remain an environmentally sound alternative to the landfilling of organic materials. A critical first step would be for government entities and composting facilities to include plastic-coated products on their list of prohibited materials. The bottom line is that compost should not become a new source of plastic pollution. All segments of society, from consumers to manufacturers to regulators, influence this outcome.

Plastic-coated paper products include milk and juice cartons, hot and cold paper drinking cups, frozen food containers, plastic-lined paper bags, take-out containers and some paper plates. Although most of the manufacturers of these plastic-coated paper products make no claims that their products are compostable, many collection programs accept them in hopes of composting the fiber component, which is either coated with one layer, or sandwiched between two layers, of plastic. In the December 2009 issue of *BioCycle*, an article was published listing 89 municipal composting programs (within 25 counties in nine states), 85 of which are leading the way in residential food waste collection in the U.S. Forty-one of these municipalities (30 of which are in

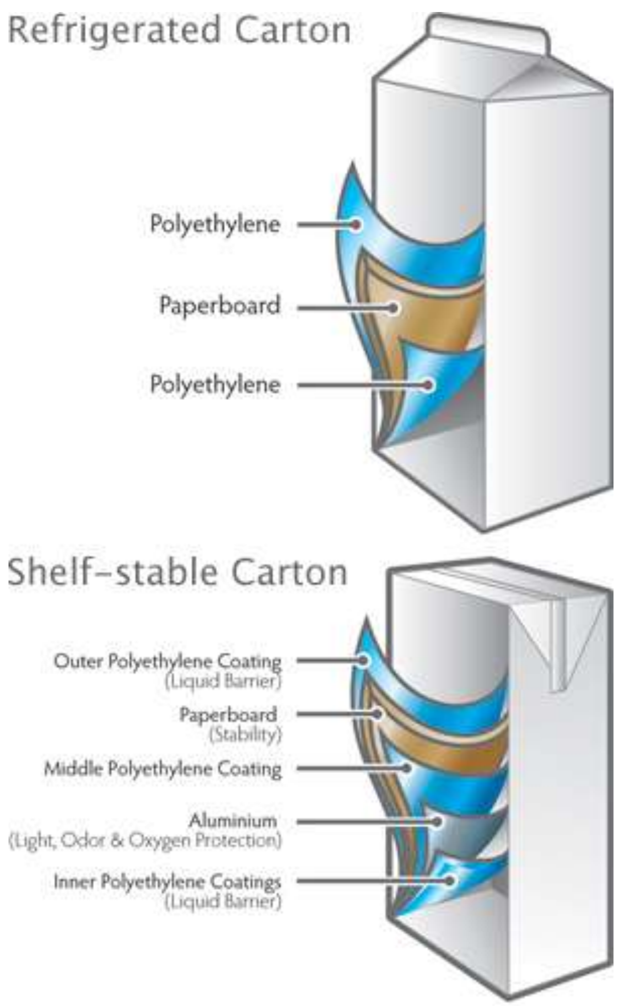
Figure 2. Common plastic-coated food service products and packaging.

King County, Washington) do not accept any plastic-coated paper products, leaving 44 municipalities that do accept some or all of the types listed above. King County governments originally accepted these materials before the central processor in the area, Cedar Grove Composting, included them in its list of prohibited materials.

In 2010, Jerry Bartlett, Chief Environmental and Sustainability Officer at Cedar Grove Composting commented:

> "A few years ago, Cedar Grove decided to stop taking plastic-coated paper milk cartons because they were not breaking down in our composting system. The plastic coating would contaminate our finished product if the material made it through the screens. This contamination caused customer complaints and reduced the value of our product. When the screens did pull out the plastic, we were paying twice as much to dispose of it as garbage as we were receiving from the customer to compost it. In addition, after going through our facility, milk cartons became too contaminated with compost for recycling. While taking up capacity in our compost system, the material then ended up being hauled to the landfill as garbage."

Figure 3. Cross sections of carton packaging show the paper fibers surrounded by plastic layers.



One municipality mentioned in the *BioCycle* article includes milk cartons as an acceptable material in its composting program, but does not accept "coated" paper plates or cups. We believe that this discrepancy is due to the common misconception that milk and juice cartons are coated with wax, and therefore, are safe for composting. According to a paper industry source, milk and juice cartons have not been made from wax-coated paperboard for approximately 30 years. All milk and juice cartons are now made with LDPE-coated paperboard (see figure at left).

Almost all plastic-coated paper products are coated by an impregnation process with polyethylene (PE), predominantly low-density polyethylene (LDPE). Polyethylene has not been shown to biodegrade. Instead, it fragments into smaller pieces. Polyethylene (pellet or film) is the standard "negative control" in the ASTM 6400 test regimes to determine compostability of any product when being tested by certifying laboratories.

"The recalcitrance of polyethylene to microbial attack is well established. Albertsson and Karlsson (1988) buried radiolabeled LDPE in humid, composted soil and followed mineralization to 14C-carbon dioxide for ten years. Less than 10% of the LDPE was mineralized." (Palmisano & Pettigrew, 1992)

According to Dr. Anthony Andrady, Senior Research Scientist at North Carolina's Research Triangle:

> "Plastics inevitably must biodegrade, but at such a slow rate that it is of little practical consequence. Polyethylene is not biodegradable in any practical time scale. Except for the small amount that has been incinerated, every bit of plastic manufactured in the world still remains. It is somewhere in the environment." (Weisman, 2007)

MATERIALS AND METHODS

In order to ascertain what actually happens when including plastic-coated paper products in the feedstock of a composting process, Woods End Laboratories, Inc. (Mt. Vernon, Maine) and Eco-Cycle, Inc. (Boulder, Colorado) partnered to test a range of these materials including milk/juice cartons (double-coated LDPE), cups (double-coated LDPE), plates (clay with binders), paper food boat (clay with binders), freezer box (single-coated LDPE) and oven-able tray (double-coated PET) in a controlled biodegradation process.

Woods End Laboratories is a BPI-approved test laboratory and employs ASTM and EN methods to characterize biodegradability. In addition, Woods End labs performed intensive preliminary trials under varying composting scenarios to aid in developing a biodegradable chip bag for Sun Chips.

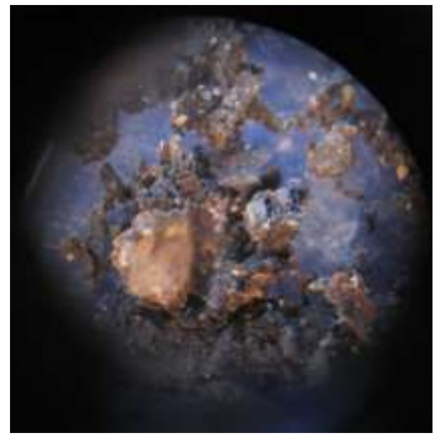


Figure 4. Microscopic analysis of the biodegradation of a paper food boat.

In order to perform this study, the Disintegration Test, part of ASTM D 5338 "Test Method for Determining Aerobic Biodegradation of Plastic Materials under Controlled Composting Conditions,"[1] was employed. It is a subset of the group of tests of compost biodegradability specified in ASTM D 6400. The disintegration test process was considered the most relevant since it is often employed by labs when examining coated materials to determine if the coating impedes biodegradation and requisite break-up of other natural materials. This study is not technically an ASTM D 6400 test since such a test is not normally used for known non-degradable products. Under the ASTM D 6400 provision also employed for BPI-approval of bioplastics, a product must attain 90% disintegration to less than 2mm size within 12 weeks (84 days). The study team extended the benefit of the doubt by conducting the test out to 180 days.

Woods End modified the Disintegration Test process to include 30x and 100x digital microscopy to examine fine fragments, a procedure not included in ASTM methodology. This overall process was reported in an earlier published study which Woods End performed for the City of New York (2005). In that process, the compost disintegration test procedure was developed to include ultrasonic sieving down to 300 microns as a means to extract finer plastic fragments below the visible range. (Brinton, 2005)

[1] ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States

Similarly, Page & Leonard at the University of Alberta reported a lab sieving test process following meticulous field screening to report on the fate of non-degradable foreign matter carried into composts from non-source separated MSW. (Page & Leonard, 2002)

RESULTS

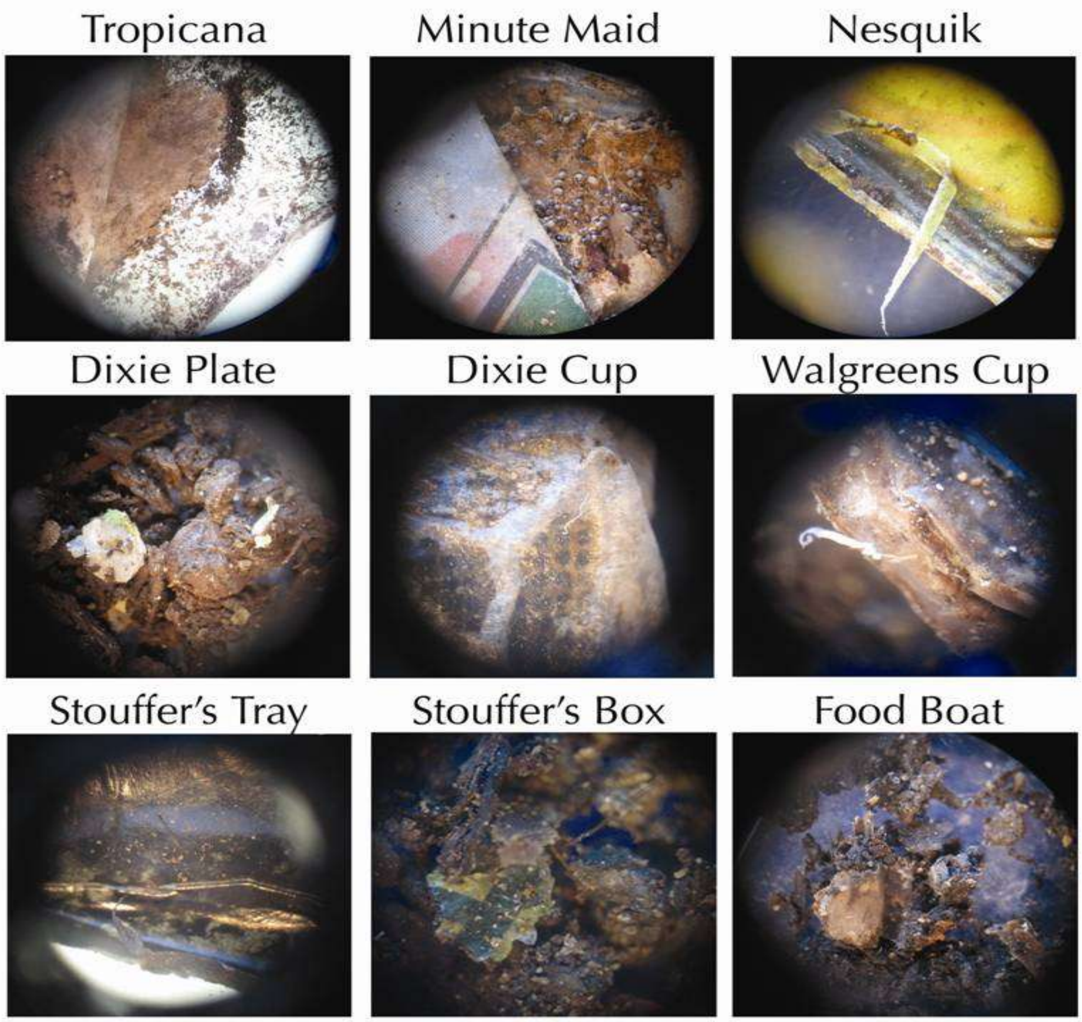
The test clearly showed three significant findings:

1) the plastic coatings did not biodegrade
2) the coatings retarded the biodegradation of the paper layer, and when coated on both sides, little degradation occurred
3) micro-plastic fragments were shed from all of the plastic-coated samples, contaminating the finished compost, including those samples that remained largely intact due to the double-sided coating.

Figure 5. Before and after photos of a plastic-coated paper juice carton show the plastic coating separating from the paperboard.

In reality, any plastic fragments smaller than ½ inch (about 12mm) remaining after 12 weeks would most likely pass through into the final compost, since composters do not generally sieve finer than this (or at best, under suited, dry conditions, a 3/8 inch or 9mm sieve may be used). In any event, the laboratory team also attempted to distinguish very small plastic fragments from larger ones by examining under a dissecting scope. This enabled the detection of pieces smaller than 2mm. In addition, previous work by Woods End and Department of Sanitation-NYC (Brinton, 2005) found that if plastic bags, textiles and diaper materials are present in MSW that goes to compost facilities, extremely fine PE fragments and strands as small as 100 microns are universally present in composts- that is, impossible to ever recover or screen out.

Figure 6. Residual fragments in compost at 30x.



In all cases, in the materials tested in the most recent test, the lab observed microscopic fragments whenever visible fragments were also observed. Visual observation would be sufficient in these cases to spot the potential for finer fractions.

Clearly, synthetic PE and other coatings also inhibited the biodegradation process of the underlying degradable paperboard material. Double-coating almost entirely inhibited it. Also evident from the testing was an obvious delaminating that took place, meaning the non-degradable plastic coating layer, although originally injected into the paperboard, came free and began to separate off of the carrier material.

An important characteristic influencing the nature of fragmentation and delaminating was observed in the degree of brittleness of the coating. While this was not – and could not initially be separately observed – it was apparent to the researchers that some coatings were brittle, and therefore caused fragmentation, and others less so. Brittleness can be a quality in the polymer itself that when exposed to heat may transition into a less tensile state. This is not to be confused with biodegradation, but is included under the heading of "disintegration" as defined in ASTM D 5338. For purposes of reference, the full ASTM D 6400 specification also requires a CO_2-evolution test to ascertain that disintegrated materials are also biodegradable. However, since companies manufacturing products used in this study are not stating them to be compostable, this CO_2 test was not performed.

Table 1. Non-compostables increase processing costs for composting facility. *Figures courtesy of Jerry Bartlett, Cedar Grove Composting.*

Processing	Per Ton Cost
Transport to Facility	$10
Grinding/Mixing	$4
Active Composting	$20
Screening	$2
Transport to Landfill	$10
Landfill Cost	$85
Cost per Ton to Process Non-Compostables	**$131**
Revenue per Ton (avg. tip fee)	$40
Loss per Ton (including Loss of Product Sale $9)	**$100**

The overall findings showed that coated containers could be readily classed into two groups: materials that would likely be recovered on a large screen after composting, and those that could not be recovered. With only one possible exception, all PET and LDPE double-coated materials did not compost sufficiently to become incorporated into compost, and therefore would be screened out. All these materials were also found to be malleable and non-brittle.

While the finding that double LDPE and PET-coated paperboard will most likely be screened out as an entire fraction may seem somewhat of a positive result, it should be pointed out that the coating is inhibiting composting of the paperboard— i.e., the entire material should be classed as "non-compostable" (even though the majority of the weight of the material is natural paperboard). As has been the experience at Cedar Grove Compost Facility, these materials add to the cost and decrease the efficiency of compost operations (see Table 1).

The one exception was observed with a single-coated LDPE freezer box, a container for noodles. It very nearly passed the 58°C disintegration in composting test and did pass this test at 25°C (room temperature composting). It is therefore likely that the entire material would pass through a compost screen and end up as visible plastic contaminant in the compost. This produces the scenario of fine fragments of non-degradable plastics entering the food web.

In addition, and very importantly, the study showed conclusively that micro-plastic fragments are shed from all tested samples that were plastic-coated, even those that remained predominantly intact. Even though the intact fragments will probably be screened out, the micro-plastic fragments that they shed will result in contamination of the finished compost.

It is also important to note that although coated paper plates are usually clay-coated, one of our samples contained 20% acrylic mixed with the clay, which resulted in acrylic fibers evident in the finished compost. In addition, approximately 10% of all paper plates (according to industry sources) are coated with polyethylene and would be expected to shed micro-plastics in the same way as the other polyethylene-coated samples.

Just how much plastic from plastic-coated packaging is ending up in the compost?

To get an idea of the contribution from these products to the plastic contamination in compost, Woods End Laboratories decided to test and quantify the amount of plastic that remains from an average food scrap-filled milk carton (a practice that is encouraged by several composting programs for convenient collection of household food scraps).

A gable top carton weighs approximately 75g, 15g of which is pure PE plastic (20% of total weight), and can hold about 1.5 kg of food scraps. If all of the plastic coating fractionated into the scraps through the normal composting process, this would contribute 0.01% (15/1500) plastic, which equates to 100ppm. This may sound insignificant, but plastic film is an extremely lightweight, pervasive material, and can be measured in other ways to reflect its true presence.

New EU standards have been developed by the German Compost Association requiring the surface area of plastic in compost to be measured. The clean compost standard is 800mm^2 surface area / liter of compost, or about 1.2 sq.inch of plastic per quart of compost. It was based on numerous rankings of objectionable plastic visually observed applied against the tested surface area. In this case 800mm^2 translates into 35 square inches per cubic foot of compost (or a sq. yard of plastic in a cubic yard of compost)! The PE film on most gable top cartons is about 2-3/thousands in thickness, and therefore based on a standard weight of 50g per sq.meter can be calculated to contribute 387 square inches surface area of plastic per cubic foot of compost. This significantly exceeds the European plastic contamination standard.

DISCUSSION

Some have argued that just because plastic fragments are generated by plastic-coated paper products in the composting process does not mean that they are harmful to the environment. Recent scientific evidence from around the globe, however, disagrees strongly with this assertion.

Once the plastic fragments have been distributed (through the application of compost to the soil) into the larger environment, the question remains: What consequences do they have for ecosystems? Both micro- and macro-plastic fragments are of concern. The detrimental effects of macro-plastics on wildlife are well documented, particularly in aquatic environments. New research (described below) indicates that micro-plastics may have equally detrimental effects on smaller organisms. It is also well known that the majority of plastic debris in aquatic environments is land-based in origin.

Figure 7. Additional testing performed with a 2mm sieve.

There is good evidence that both the micro and macro-plastic fragments found in compost that is then applied to the soil will exacerbate this problem (Page & Leonard, 2002). Because these fragments are carried by both wind and surface run-off, their migration from the site where the compost is applied (regardless of location) into aquatic and then marine environments is inevitable.

> “Estimates of plastic in the world’s oceans exceed 100 million tons. Though 20% comes from ocean sources like derelict fishing gear, 80% comes from land, from our watersheds.” (Algalita Marine Research Foundation, 2007)

> “A study of archived plankton samples from the northeast Atlantic showed that the abundance of microscopic plastics in the water column has increased considerably over the last 40 years, and this trend mirrors the global rise in plastic production. Similar particles were also found on beaches throughout the United Kingdom, and therefore micro-plastic particles appear to be a widespread contaminant that has accumulated across a range of habitats (Thompson et al., 2004). Recent work on plastic debris found within the Tamar Estuary (UK) has identified acrylic, polyamide, polyethylene, poly (ethylene: propylene), polyester, polyethylene terephthalate, polybutylene terephthalate, polyoxylmethylene, polypropylene, polystyrene, polyurethane, and polyvinylchloride." (Browne et. al., 2009)

Most research to date has focused on marine environments. Plastic fragments and fibers have been shown to accumulate in marine environments and to be ingested by living organisms. The next questions we must ask are: 1.) How does this accumulation of plastics effect wildlife? 2.) Do the plastic fragments bioaccumulate up food chains? and 3.) Are there possible consequences for human populations?

Figure 8. Plastic debris is accumulating on shorelines and in marine environments.

> "Large (>5mm) plastic debris is frequently ingested by a range of species, including fish, turtles, birds and cetaceans (Derraik 2002). Microplastic is much smaller, occupying the same size range as plankton. Hence, there is a greater potential for ingestion by a wide range of animals. For a given size, low-density plastic will float and will be available for uptake by filter feeders or planktivores, whereas high-density plastics, such as polyvinyl chloride (PVC), will tend to sink and accumulate in sediments where they are more likely to be ingested by deposit feeders." (Browne et. al., 2009)

> "To determine the potential for microscopic plastics to be ingested, we kept amphipods (detritivores), lugworms (deposit feeders), and barnacles (filter feeders) in aquaria with small quantities of microscopic plastics. All three species ingested plastics within a few days." (Thompson et. al., 2004)

> "Researchers have documented that the filter-feeding animals, such as mucous web feeding jellies and salps, were found to be heavily impacted by plastic fragments. The smaller the fragments, the fewer of them were found to be free floating, indicating that filter feeders had caught them. Filter feeders are at the lower end of the food chain, and fifty species of fish and many turtles are known to eat them, thus accumulating plastic in their stomachs." (Tamanaha & Moore, 2007)

> "The persistence of particles of microplastic in the hemolymph of *M. edulis* (species of mussel) for over 48 days has implications for predators, including birds, crabs, starfish,

> predatory whelks, and humans." (Browne, Dissanayake, Galloway, Lowe & Thompson, 2008)

Accumulation of plastic fragments in the gut of an animal can also result in the translocation of small fragments into the circulatory and lymph systems.

> "Laboratory trials have shown that amphipods (detrivores), barnacles (filter feeders), and lugworms (deposit feeders) ingest small PVC plastic fragments (mean size 230 μm) (Thompson et al., 2004). In addition, filter-feeding polychaetes, echinoderms, bryozoans, and bivalves have been shown to ingest 10-μm polystyrene microspheres during feeding assays (Ward & Shumway, 2004). Recently, mussels (*Mytilus edulis*) have been shown to ingest and accumulate polystyrene beads as small as 2 μm in their gut cavity. If microplastic particles are taken up by the gut epithelial lining, then further transport around the body is possible. Qualitative research in rodents has shown that solid polystyrene microspheres can readily transfer (translocation) from the gut to the lymphoid system (Hussain et al., 2001). The lymphoid system supplies the circulatory system, and hence these particles will then have the potential to be transferred to other tissues around the body. Given that the rodent digestive system is similar to many other organisms, translocation of ingested microplastic from the gut around the body of aquatic animals is likely." (Browne et. al., 2009)

"The presence of particles of microplastic in the circulatory system may restrict blood flow causing damage to the vascular tissues and

Oxo materials: Will they fragment in composts?

"Oxo-degradable" is a new term and new plastic presence, and raises specific questions pertaining to disintegration without biodegradation. Oxo-degradable refers to a TDPA pro-oxidant additive complex put into polyethylene. The additives include potentially dangerous heavy metals (cobalt, nickel, zinc, barium and titanium) and testing has shown that in some cases metals found in Oxo-plastic violate metals standards used for biodegradation standards in certain countries. These additives are designed to induce schism of the non-degradable polyethylene (PE) chains, making them eventually low-enough in molecular weight to be biodegraded. So far this has been proven to occur only under ideal, accelerated test conditions of dry heat followed by insertion into wet microbe rich environments. In any event, the entire process requires 1-2 years to break up and initiate degradation of the polyethylene chains.

New evidence shows that humidity inhibits the "Oxo-degradation" process and other tests show steady warmth is required (>20-70°C) or the cleavage process is retarded.

Consensus is emerging that it makes no sense to introduce Oxo-degradable bags into compost; therefore these bags should not be used to transport food scraps or other biodegradable waste to a compost site. In a recent series of tests recommended by an Oxo proponent, Woods End Labs and Mother Earth News placed Oxo bag material under hot, arid conditions for several months, with no apparent fragmentation. View the results of this test.

"The rationale as to why and how biodegradation of plastics is good for the environment has been lost. Making the plastic polymer to break down into small fragments, even making them so small that they are invisible to the naked eye by chemical (hydrolytic, oxidative, or photo) or biological means is not good for the environment and could have serious negative environmental consequences. In other words, 'degradation,' or making plastics degrade, is not an acceptable option. Therefore, it is good for the environment, if and only if, the degraded fragments are completely consumed by the microorganisms present in the disposal environment—that is, removed from the environment and safely enters the food chain of the microorganisms." (Narayan, 2005) changes in cardiac activity." (Browne et. al., 2008)

"…medical studies on both rodents and humans have also shown that particles of polyvinylchloride and polystyrene less than 150µm can translocate from the gut cavity to their lymph and circulatory systems." (Browne et. al., 2008)

More research needs to be done to see how micro-plastics affect soil ecosystems. Logic states that soil organisms may be similarly affected by the accumulation of these contaminants in the soil.

"There are accounts of inadvertent contamination of soils with small plastic fragments as a consequence of spreading sewage sludge (Zubris & Richards, 2005), of fragments of plastic and glass contaminating compost prepared from municipal solid waste (Brinton, 2005) and of plastic being carried into streams, rivers and ultimately the sea with rain water and flood events (Page & Leonard, 2002). However, there is a clear need for more research on the quantities and effects of plastic debris in natural terrestrial habitats, on agricultural land and in freshwaters." (Thompson, Moore, vom Saal & Swan, 2009)

Plastic fragments have been shown to concentrate POPs that have accumulated in the surrounding environment. These high concentrations of POPs, if transported into the circulatory and lymph systems of animals, including humans, may result in unintended exposure to these toxins and unknown consequences for soil ecosystems, aquatic ecosystems and human health.

Figure 9. Plastic fragments may be a transport mechanism for toxic POPs into humans and other animals.

"During manufacture, a range of chemical additives are incorporated into plastic, including catalysts (organotin), antioxidants (nonylphenol), flame retardants (polybrominated diphenyl ethers), and antimicrobials (triclosan). In addition to chemicals used in manufacture, plastic has been shown to adsorb and concentrate hydrophobic contaminants, including polychlorinated biphenyls, dichlorodiphenyl trichloroethane, and nonylphenol, from the marine environment at concentrations several orders of magnitude higher than those of the surrounding seawater (Mato et al., 2001). If plastics are ingested, they could act as a mechanism facilitating the transport of chemicals to wildlife. This may be particularly relevant for microplastics since they will have a much greater ratio of surface area to volume than larger items and hence are likely to have greater potential to transport contaminants." (Browne et. al., 2009)

> "…ingested particles of micro-plastic can persist in the hemolymph of mussels for over 48 days and therefore could provide a route for the transport of chemicals to various tissues." (Browne et. al., 2008)

> "PCBs and DDE were found to accumulate in plastic pellets in concentrations up to 105-106 times higher than surrounding seawater….Plastic resin pellets have been also found in the stomachs of marine birds. The uptake of pellet-sorbed contaminants to their tissues is a concern." (Mato et. al., 2001)

> "The Algalita Marine Research Foundation reports that degraded plastic residues can attract and hold hydrophobic elements like PCB and DDT up to one million times background levels. The PCBs and DDTs are at background levels in soil, and diluted out so as not to pose significant risk. However, degradable plastic residues with these high surface areas concentrate these highly toxic chemicals, resulting in a toxic time bomb… posing serious risks." (Narayan, 2005)

Precautionary Principle

When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

Although some of these studies report findings on types of plastics other than PE, and on pellets rather than other fragment shapes, the concerns expressed would apply equally to PE fragments from compost.

> "Model calculations and experimental observations consistently show that polyethylene accumulates more organic contaminants than other plastics such as polypropylene and polyvinyl chloride (PVC)." (Teuten et. al., 2009)

The scientific evidence to support these concerns has increased exponentially over the past five years, as the question of the effects of plastic fragments on living systems has become a hot topic for some in the scientific community. Clearly the potential for harm out weighs any benefit gained by bringing plastic-coated paper products into the compost stream.

This seems to be a perfect case for invoking the Precautionary Principle. When there is credible scientific evidence about the potential risks of an action, the Precautionary Principle is a concept that can guide us towards the most environmental alternative. It states: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." (Science and

Environmental Health Network, 1998) The principle has been referenced in UN and EU treaties and protocols since the 1990s, and has been adopted by several US communities throughout the 2000s. It is has been applied to fields such as nanotechnology, GMOs, threats to biodiversity and the introduction of new chemicals. Conventional risk-based analysis, which uses science and economics to determine how much harm is "acceptable," is replaced by questions about whether the harm is necessary, if the benefits outweigh the potential risks and if better alternatives exist.

We would argue that in this case there are better alternatives to the composting of these materials that do more to move society towards Zero Waste. These include new recycling markets for cartons and coatings for paper products that are truly compostable.

RECOMMENDATIONS FOR MOVING FORWARD

As stated earlier, a critical first step would be for government entities and composting facilities to follow the lead of Cedar Grove Composting and include plastic-coated products on their list of prohibited materials. In addition, the US Composting Council (USCC), as the principal trade association for the composting industry, could contribute significantly to solving this problem. The USCC is best positioned to be the disseminator of up-to-date information for food waste collection program planners. Woods End and Eco-Cycle recommend the USCC use its existing annual conference, newsletter, website and other resources to educate program planners on the following points:

1. The "highest and best use" for all cartons is to recycle them, not to compost them. Domestic markets and accessible foreign markets exist and are strengthening for this material. Four major carton manufacturers recently formed a new organization dedicated to improving residential and commercial carton recycling opportunities throughout the US called the Carton Council, www.aseptic.org/cartons.html. They are available to help planners route cartons through the local recycling infrastructure and advise on the best markets.

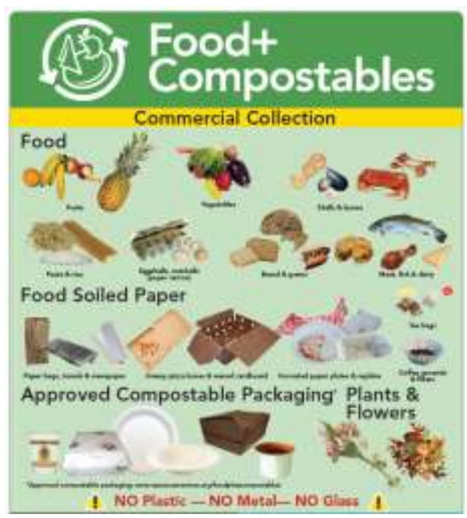


Figure 10. Compost guidelines such as these from the City of Seattle should exclude plastic-coated paper products unless they meet ASTM 6400, EN 13432 or BPI standards.

2. For uses that require a coated paper product, only certified tested products per ASTM 6400 or EN 13432, or the Biodegradable Products Institute (BPI) approved products, should be allowed in food waste collection programs.

3. The USCC should house educational materials for compost program planners to dispel consumer confusion over packaging label claims of compostable vs. biodegradable, and what products need to be certified as compostable. This should also include educational materials that planners can use to encourage the use of durable foodware whenever possible.

Finally, composters cannot solve this problem without the full cooperation of the packaging industry. Organizations such as the American Plastics Council and the Sustainable Packaging Coalition must work with the major packagers to develop clear symbols on all packaging that make it easy for consumers to determine whether a container is compostable, recyclable or must be landfilled. The use of misleading terms used to describe packaging such as "biodegradable" or "earth-friendly" must stop. And it is the responsibility of the packaging industry to verify that packaging labeled as compostable is truly compostable according to the above standards.

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