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Environmentally Preferable Purchasing Rapid Research
Thermal Paper & BPA – Trash or Recycle?

August 2010 (*Updated November 2010*)

Request

Thermal paper receipts contain BPA. Is it a good idea to recycle thermal receipts?

Key Findings

- Thermal paper recycling is a major source of bisphenol A (BPA) release to surface waters. PPRC recommends disposing of all thermal paper receipts in the trash rather than the recycle bin to reduce environmental release of BPA. Trash disposal and subsequent wastewater treatment of landfill leachate should significantly reduce emissions of BPA.
- Recycling thermal paper may increase human exposure to BPA via cross-contamination of food from recycled paper products. BPA has been found in paper towels and other likely food contact papers, and at higher levels in recycled versus virgin papers.
- Recent results suggest that simple handling of thermal paper receipts transfers BPA to hands and fingers. The amounts transferred, microgram quantities, are substantially greater than the amounts of BPA that leach from can-linings or polycarbonate containers under normal circumstances.
- Those concerned about exposure to BPA should take common sense measures to reduce contact with thermal paper, e.g., refusing receipts at ATMs and gas pumps or other point-of-sale transactions, minimizing handling of receipts, and washing hands following handling.
- Some manufacturers have replaced BPA in thermal paper with BPS. The US Environmental Protection Agency is currently assessing the safety of alternatives to BPA in thermal paper through the Design for Environment (DfE) Program. PPRC representatives are participating on the DfE BPA advisory committee.
- The identification and use of safer alternatives in consumer products is a promising long-term strategy to effectively reduce the exposure of people to harmful chemicals.

Background

The potential for human exposure to bisphenol A (BPA) from food cans, sports bottles and baby bottles has been widely reported. In these applications, BPA is chemically-bound as part of a polymer (typically polycarbonate) or epoxy matrix. Small traces of unreacted, free BPA remain within the container materials and can leach into food or drink. BPA is also released when BPA-containing materials break down due to thermal, chemical, or UV attack (1). As containers develop micro-cracks and surface damage with age, they may be more susceptible to breakdown and release of BPA (2).

Experiments in the mid-1930s showed that BPA and similar chemical compounds called biphenyls have the potential to mimic normal human hormone function. BPA and other endocrine disrupting compounds (EDCs) may have effects at extremely small exposures, perhaps only part-per-trillion levels (3; 4; 5). Given the ubiquity of BPA in foods, even canned organic foods, significant exposure may occur on a nearly continual basis (6; 7). In-depth studies to clarify the risk from food are currently under way at the Food & Drug Administration (FDA) and the National Toxicology Program (NTP) (8).

BPA and Thermal Paper

BPA is also widely used in thermal paper. Thermal paper is used in point-of-sale receipts (e.g., for credit card purchases), shipping or other container labels, automated-teller machine receipts, parking tickets, and luggage tags, among other uses. In thermal printing, text or graphics appear as a result of a color-change induced by localized heating of the paper in a thermal printer. No ink is applied in the process.

Thermal printing offers many advantages to retailers and vendors. Thermal printers have fewer moving parts than conventional ink printers and there is no need to replace or refill ink containers or ribbons. One downside to thermal printing is that 100% of the paper is covered with the imaging chemicals in a thin coating. Whether or not there is an image, the chemicals required for imaging remain throughout the paper's lifetime.

Several recent studies have quantified the content of BPA in thermal paper receipts (9; 10). Ordinary retail store receipts contain approximately 1-3% BPA by weight, so a typical individual receipt might contain 10-30 milligrams of BPA (depending on width, length, supplier, etc.). In contrast to cans and plastic containers, all of the BPA in thermal paper is in a free chemical form and has the potential to be more readily released and absorbed.

Exposure to BPA from Thermal Paper Receipts

More common exposures to BPA from thermal paper come from hand-contact. Thermal paper coatings can easily crumble and deposit on skin with casual handling. The BPA from these coating materials could then be ingested following inadvertent hand-food transfer or direct absorption through the skin. In contrast, it is improbable that casual hand contact with a polycarbonate (PC) plastic bottle or any of the myriad of articles made from PC would lead to any significant BPA exposure.

Swiss researchers demonstrated that thermal paper coating materials are transferred from receipts to fingers through normal handling (11). Though the amounts of coating transferred were small, they contained microgram quantities of BPA. The Environmental Working Group has postulated that this may be responsible for the higher levels of BPA found in the blood of retail workers, who may handle hundreds of receipts daily (10). Researchers at the University of Missouri-Columbia have indicated their interest in initiating studies on absorption via skin exposure in the very near future (Summer 2010) (12).

Receipt papers also pose a potential risk of high-exposure by direct ingestion. If someone, perhaps a child, were to accidently ingest a single receipt, they would swallow the equivalent of thousands of times the amount of BPA leached to water from PC bottles [typical levels ~0.2 nanograms per milliliter (13)].

Environmental Release of BPA from Thermal Paper Receipts

The European Union's conducted a thorough risk assessment of BPA, finalized in 2008 (14). The analysis estimated environmental emissions from all significant uses of BPA in the European market. Thermal paper production is one of the smallest industrial uses of BPA, approximately 0.2 % of the market in the EU. However, due to intensive water use and the free available chemical nature of BPA in paper coatings, recycling of thermal paper generates the largest industrial source of BPA entering wastewater treatment plants (WWTPs). BPA is relatively well-removed in modern wastewater treatment (90+% removal rates are common), but given the large entering volumes, recycling is still a significant source of surface water emissions (14; 15). BPA is toxic to aquatic life and release of endocrine-disrupting compounds to surface waters has been linked to problems in the normal reproductive development of fish, reptiles and birds (16).

Approximately 50% of thermal paper is use in point-of-sale receipts in Europe (14). The European Thermal Paper Association estimates that 15% of this volume is recycled. Recycled paper can be used to produce a wide range of paper types, from toilet paper, paper towels, newsprint, and copy paper to folding cartons and containerboard for boxes. Depending on the need, recycled paper may be cleaned (deinked) and bleached, as it is before addition to very bright and white paper grades, or left relatively dirty, as it is before addition to the corrugated "medium" between cardboard box paper layers. As a result, the levels of BPA in new paper production can vary substantially. In one study, containerboard (for corrugated boxes) and carton board (used for cereal, rice, small boxed parts, etc.) were highest in BPA (17). Others report that recycled products contain

BPA at ten or more times the level of BPA in virgin products (18). As this new paper circulates again through use, disposal, and recycle, additional BPA is released to the environment.

The Paper Industry Association Council reports that roughly 21 million tons of paper ended up in landfills in 2009 (19). While only a small fraction of that paper is thermal paper, over time, BPA from thermal paper is released and contaminates landfill leachate. A recent summary of landfill leachate suggests a wide-range of BPA concentrations (1-17,000 micrograms per liter), depending on the landfill sourcing and, perhaps, country-specific factors (1). Unfortunately, too few measurements are available to report a typical value for U.S. landfills.

In the best scenarios, landfill leachate is collected and sent to treatment with other local wastewater. As reported above, the removal rates in WWTPs are generally high. Furthermore, studies have shown that BPA is fairly well degraded by microbes and other breakdown mechanisms in the environment. Cousins et al. report a half-life in water and soil of 4.5 days, due to breakdown by microorganisms under aerobic conditions (20).

Recycle versus Trash Disposal of Thermal Paper

In past decades, thermal paper was in wide use for fax machines. The large sheets of slick, floppy paper were clearly distinguishable from ordinary office papers and the routine advice was to keep thermal paper out of the recycle bin. With the virtual elimination of thermal fax paper, thermal receipt paper is more likely to enter home and office recycle bins. A scan of several municipal websites [City of Seattle and King County (Washington State), Los Angeles and Chicago] did not find any specific or differentiated instructions for recycling either thermal paper or receipt paper.

Given the concerns surrounding the potential endocrine-disrupting activity of BPA, PPRC advises that thermal receipt papers be disposed of in the trash rather than recycled. Recycling poses a risk for free release of BPA-containing coating materials in recycling facilities as well as the possibility to contaminate new paper production. Furthermore, these recycled paper products are often used for primary (directly in contact with food) or secondary (packaging around an separate internal package) food packaging, and there is at least some possibility that contaminants could migrate to food.[1]

Disposing of thermal paper in the trash provides at least some time and opportunity for BPA to break down within a landfill (though the anaerobic conditions in many landfills often do not favor breakdown). Ultimately, landfill leachate should be collected and treated, which will further reduce BPA levels. While leachate treatment will still emit some BPA to surface waters, this is preferable to recycling BPA through paper use and re-use.

Many communities now accept paper products and food waste in community collection programs. If thermal paper receipts end up in a composting process, BPA would likely be present in compost or compost tea. These additions may be inadvertent, for example, in Seattle, shredded paper can be added to food waste. Households shred mostly financial papers, so these may at times include credit card and other thermal receipts. In 2002, a German study reported two measurements of BPA in “compost water samples,” at 24.8 and 145.9 micrograms per liter (21). These levels are again much larger than normal concentrations in food and beverage sources. In general, the short half-life of BPA in soil suggests that these levels would be reduced by aerobic processes fairly quickly after application, but the exposure risk is probably best avoided by keeping thermal papers out of materials for compost.

BPA-Free Thermal Paper

Because of concerns over BPA exposure, Japanese manufacturers voluntarily replaced BPA in thermal paper with the transition completed in 2001 (22). While no information is available on the Japanese substitutes, recent reports mention that Appleton Paper, the largest U.S. manufacturer of thermal paper, has been using bisphenol S (BPS) as a replacement for BPA since 2006 (23). BPS is a close chemical relative of BPA. Despite the recent attention on thermal paper and the news of the availability of BPA-free thermal paper,

[1] Those this is likely small compared with canned food exposures where linings usually contain BPA as a component.

PPRC has found no discussion regarding the safety of BPS versus BPA in paper. A recent press release by Appleton also reports only that their thermal papers are BPA-free and a search of the Appleton website found no information on BPS (24).

Most of the standard chemical safety databases contain little or no information on BPS. Recent literature reports vary on the endocrine-disrupting potential of BPS, though it has generally been considered to have weaker estrogenic activity than BPA (25). A recent report suggests that BPS is more resistant to breakdown in the environment than BPA (26). As part of an Action Plan for BPA, the United States Environmental Protection Agency (USEPA) has begun a collaborative multi-stakeholder BPA-alternatives assessment process through the Design for Environment program (27). This process, expected to conclude in 2011, will assemble data to assess the human and environmental safety profiles of BPA and proposed alternatives. Until these or earlier safety results are available, PPRC advises that any thermal paper be disposed of rather than recycled, regardless of purported chemical composition.

Conclusions

BPA has been under scrutiny due to concerns over potential endocrine disrupting activity. US regulatory bodies are actively working to quantify the risks of BPA exposure and to identify possible safe alternatives to BPA in common uses like thermal paper.

Recent results suggest that simple handling of thermal paper receipts may lead to significant BPA transfer to fingers. Studies are likely to begin in the near future to quantify absorption of BPA from thermal paper handling. In the meanwhile, those concerned about exposure to BPA should take common sense measures to reduce exposure. Refusing receipts at ATMs and gas pumps, and other point-of-sale transactions and hand-washing after handling would be reasonable and simple first steps.

Some manufacturers have replaced BPA in thermal paper with BPS. There is little data available to assess whether these BPS-containing papers are safer for human contact. Until more complete results are available, individuals should treat all thermal papers as an equal hazard.

PPRC recommends putting all thermal paper receipts in the trash rather than the recycle bin. Recycling thermal paper opens up the possibility of human exposure to BPA or other biphenyls like BPS from additional handling and contamination of recycled paper products. Trash disposal should lead, in most cases, to a significant reduction in environmental release of BPA via break down in wastewater treatment plants. Additional data are needed to understand the fate of BPA and biphenyls in landfills. While BPA is moderately susceptible to environmental breakdown, BPS may be somewhat more persistent.

The controversy over BPA is far from over, but the coming months should provide considerable additional data on risks of exposure to BPA and alternatives. In addition, there are companies working to replace paper receipts with electronic receipts (e.g., Alletronic). While no rapid conversion is expected, concerns over BPA safety may offer another catalyst for change.

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