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Rapid Research
Safety of PET Water & Beverage Bottles
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Request
Are PET bottles safe for use with food and beverages? Is chemical contamination an issue?

Key Findings
- Both the US FDA and the European Food Safety Authority approve the use of PET for food and beverage packaging without limitations.
- Several unrelated, independent scientific studies have identified PET bottles as a potential source of contamination to foods and beverages. A worst-case interpretation of the literature is that PET bottled water may present a low-level risk of endocrine-disrupting chemical (EDC) exposure.
- Those particularly concerned about EDCs may wish to forgo the use of plastics entirely, but significant contamination exists in our food and water supply apart from plastics use.
- Other consumers may choose to continue to use plastics while lowering their risk of contamination with common sense measures. Avoid heating foods or beverages in plastic containers. Don't re-use plastic bottles that are intended for one-use only as wear and tear may increase the potential of chemicals to leach into beverages.

Background
Consumers have become increasingly concerned with the safety of plastic products, especially food and beverage containers, but also toys, which young children often treat like food! Most of the concern has focused on bisphenol A (BPA, found in polycarbonate) and on phthalates, a class of chemicals used as softeners for many plastic products, such as soft "vinyl" toys.

Pressure from the public and environmental organizations has led to both regulatory and voluntary changes in plastic use. As of February 10, 2009, phthalates have been banned from use in children's toys and childcare items (1). Due to consumer pressure, manufacturers have largely replaced polycarbonate with BPA-free (presumably) plastics for water and baby bottles, however, polycarbonate is still widely found in homes and offices. For example, many offices have water coolers supplied by large water carboys manufactured from polycarbonate. Food cans may pose risks as they are often lined with BPA-containing epoxies or plastics to preserve shelf-life. A recent study by Consumers Union found BPA in a host of canned foods, including organic products and products sold in BPA-free cans (2).

In September 2009, the US Environmental Protection Agency (USEPA) announced that both BPA and phthalate risk would be addressed with new chemical action plans to be released in December 2009, so more changes are undoubtedly on the way (3). In this era of increasing suspicion over the implications of the wide use of plastics, new concerns have now surfaced regarding the safety of polyethylene terephthalate (PET) bottles. PET bottles are used for nearly all soft drinks and single-use water bottles, and a host of processed food containers, including peanut butter, salad dressings, etc. If chemicals are leaching from PET containers to food and beverages, nearly every American would be affected.

2009 Studies of Hormone-activity in Water from PET Bottles

Two studies were published in 2009 investigating contaminants from water bottled in PET. The first, by Barbara Pinto and Daniela Reali studied bottled mineral water (4). The bottled water was passed through a process to extract and concentrate chemicals in the water. The concentrated extract was then fed to special-purpose yeasts, which react to compounds that mimic the activity of human estrogen. Estrogenic activity was found in all tested samples, though the authors suggest that the activity was low in most (90%) of the samples

The second study was conducted by Martin Wagner and Jörg Oehlmann and examined glass, PET and multi-layer TetraPak (paperboard with plastic liners) containers of mineral water (5). In addition to the yeast assay described above, the scientists tested for estrogenic activity using a hormone-sensitive variety of snail. In the presence of estrogen-mimicking substances, these snails produce more offspring. Snails and a growth medium were introduced into *empty* glass and PET bottles. The snails raised in PET bottles produced significantly more offspring than snails raised in glass bottles, suggesting significant estrogenic activity deriving from the plastic itself. Snails raised in glass also produced slightly more offspring than those in control samples.

These new results have created quite a stir in the media and have been widely publicized (6)(7). The response from the plastics and bottling industries has been critical, as might be expected, but they raise some valid issues (8). For example, neither work identifies the suspect chemicals causing the estrogenic activity. Furthermore, in the yeast tests, it is possible that the mineral water was contaminated prior to bottling and no tests were done to rule out this potential confounding factor. Finally, they cite the very low level of hormone-like activity found, consistent with concentrations of estrogens on the order of one-billionth gram per liter.

Prior Research in Safety of Bottled Water

Some industry critics have complained that the water from PET bottles is purported to contain substances *not used* in PET manufacture. Unfortunately for these critics, previous studies *do suggest that phthalates are leaching from PET bottle materials*, even though phthalates are not normally involved in PET production (9). Contaminants could enter somewhere in the bottle manufacturing process. On the other hand, one report suggests that these levels of migration are not plausible given the likely levels of contaminants in PET (10).

Additives compounded with PET to control properties might contain or be contaminated with phthalates or other endocrine-disrupting chemicals. The Environmental Working Group (EWG) has a fairly aggressive stand against plastics for water bottles and a recent report on bottles states (11): *"*Besides the PET polymer, plastic packaging for bottled water also contains a variety of additives, catalyst chemicals that are involved in plastic synthesis process, chemicals that impart physical stability and resistance to packaging, sunscreen chemicals that protect the bottle from discoloration caused by exposure to UV light, and odor-scavenger substances that eliminate the smells associated with chemicals leaching from plastic. The FDA Inventory of Effective Food Contact Substance Notifications lists 23 different chemical products or mixes that may be legally added to PET plastics for bottled water packaging...Upon long-term storage, some of these chemicals could potentially leach from the plastic into the bottled water itself."

Antimony trichloride, the catalyst mentioned in the EWG quote above, is commonly used during the manufacture of PET (12), and is listed by the International Agency for Research on Cancer (IARC) as a possible carcinogen (Group 2B). Antimony has been detected at low levels in water from PET bottles (13).

Independent Statements on Safety of PET for Food/Beverage Contact

By and large, PET has been considered one of the "good" plastics, safe for use with food and water. A common plastics memory aid can be found in various sources:

One, four, five and two,
all of these are good for you.

referring to the recycle code numbers found on plastic containers, where 1 is PET, 2 is high-density polyethylene (HDPE), 4 is low-density polyethylene (LDPE) and 5 is polypropylene (PP). On the other hand, 3 (PVC), 6 (styrene) and 7 are to be avoided. The 7-category is a catchall group, but includes the BPA-

containing polycarbonate (PC) materials, but also common PC replacements, such as Eastman's TRITAN polymer. For the most part, regulators and even some environmental groups suggest PET is safe.

The Natural Resources Defense Council has a recent guide to bottled water (14). They mention two commonly cited issues with PET water bottles: 1) the leaching of the catalyst used during polymerization (antimony chloride described above), and leaching of acetaldehyde (primarily from thermally degraded bottles), however, they consider the levels of these leachates in bottled water to be harmless. Similarly, the Sierra Club Green Home site suggests avoiding polycarbonate (risk of BPA exposure), but still lists PET as one of the "...[s]afer plastics for food and beverages" (15).

Germany has among the strictest safety standards in the world and their Federal Institute for Risk Assessment considers PET water bottles to be safe (16). In a review of the Wagner 2009 PET bottle study, they suggested that the results should be seen as preliminary and questioned the relevance of the study for human safety (17).

It should be noted that for most of the contaminants of concern, the levels found in foods and beverages are well below those considered safe by US and European regulatory agencies (18)(19). Both polycarbonate and PET are and remain approved for use in food and beverage packaging. Critics complain that the regulations are out-of-date and ignore the latest research (20).

Conclusions

Both the US FDA and the European Food Safety Authority approve the use of PET for food and beverage packaging without limitations. Nevertheless, several unrelated, independent scientific studies have identified PET bottles as a potential source of contamination to foods and beverages. Whether the particular contaminants and their concentrations are important for human safety is not settled in the scientific literature. The current regulatory atmosphere seems to be shifting in favor of "proof of safety" over "proof of risk," so stronger protective action from government may be on the way.

In the meanwhile, a worst-case interpretation of the literature is that PET bottled water presents a low-level risk of endocrine-disrupting chemical (EDC) contamination. Those particularly concerned about EDCs may wish to forgo the use of plastics entirely. Be aware that an individual's exposure to EDCs would not change much if they only avoided PET bottled-water, while continuing to consume processed foods, e.g., tomatoes packaged in BPA-containing epoxy-lined cans[1]. Even tap water in some locations contains EDCs (21).

Other consumers may choose to continue to use plastics while lowering their risk of contamination with common sense measures. Avoid heating foods or beverages in plastic containers. Don't re-use bottles that are intended for one-use only. Wear and tear may increase the potential of chemicals to leach into beverages.

Unfortunately, as we intentionally and unintentionally continue to pollute our environment, we are reaping what we have sown. Introduced chemicals, pharmaceuticals, pesticides, fertilizers, industrial chemicals, etc., are returning to us through the air, our ground water and from our food crops. In many cases, foods and beverages, even water, are contaminated *prior to* the packaging process. Packaging contaminants may simply add another dose to this ongoing contamination process.

Resources

- The full Environmental Working Group study of bottled water is available on the internet: http://www.ewg.org/BottledWater/Bottled-Water-Quality-Investigation-Test-Results
- EWG Database of pollutants in US tap water: http://www.ewg.org/tap-water/home
- The US Food and Drug Administration (USFDA) has a database of permissible food contact substances: http://www.fda.gov/Food/FoodIngredientsPackaging/FoodContactSubstancesFCS/ucm116567.htm
- The Natural Resources Defense Council article on bottled water safety: http://www.nrdc.org/thisgreenlife/0902.asp
- Pediatric Environmental Health Specialty Unit's fact sheet on choosing plastics: http://www.aoec.org/PEHSU/documents/bpa_patient_july_8_08.pdf

[1] Acidic foods tend to cause more leaching from can-liners, but BPA-containing liners leach into all foods at some level.

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