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Plastic (Not) Fantastic: Food Containers Leach a Potentially Harmful Chemical Is bisphenol A, a major ingredient in many plastics, healthy for children and other living things?

By David Biello

Bisphenol A (BPA) is a ubiquitous compound in plastics. First synthesized in 1891, the chemical has become a key building block of plastics from polycarbonate to polyester; in the U.S. alone more than 2.3 billion pounds (1.04 million metric tons) of the stuff is manufactured annually.

Since at least 1936 it has been known that BPA mimics estrogens, binding to the same receptors throughout the human body as natural female hormones. And tests have shown that the chemical can promote human breast cancer cell growth as well as decrease sperm count in rats, among other effects. These findings have raised questions about the potential health risks of BPA, especially in the wake of hosts of studies showing that it leaches from plastics and resins when they are exposed to hard use or high temperatures (as in microwaves or dishwashers).

The U.S. Centers for Disease Control (CDC) found traces of BPA in nearly all of the urine samples it collected in 2004 as part of an effort to gauge the prevalence of various chemicals in the human body. It appeared at levels ranging from 33 to 80 nanograms (a nanogram is one billionth of a gram) per kilogram of body weight in any given day, levels 1,000 times lower than the 50 micrograms (one millionth of a gram) per kilogram of bodyweight per day considered safe by the U.S. Environmental Protection Agency (EPA) and the European Union's (E.U.) European Food Safety Authority (EFSA).

Studies suggest that BPA does not linger in the body for more than a few days because, once ingested, it is broken down into glucuronide, a waste product that is easily excreted. Yet, the CDC found glucuronide in most urine samples, suggesting constant exposure to it. "There is low-level exposure but regular low-level exposure," says chemist Steven Hentges, executive director of the polycarbonate / BPA global group of the American Chemistry Council. "It presumably is in our diet."

BPA is routinely used to line cans to prevent corrosion and food contamination; it also makes plastic cups and baby and other bottles transparent and shatterproof. When the polycarbonate plastics and epoxy resins made from the chemical are exposed to hot liquids, BPA leaches out 55 times faster than it does under normal conditions, according to a new study by Scott Belcher, an endocrine biologist at the University of Cincinnati. "When we added boiling water [to bottles made from polycarbonate] and allowed it to cool, the rate [of leakage] was greatly increased," he says, to a level as high as 32 nanograms per hour.

A recent report in the journal *Reproductive Toxicology* found that humans must be exposed to levels of BPA at least 10 times what the EPA has deemed safe because of the amount of

the chemical detected in tissue and blood samples. "If, as some evidence indicates, humans metabolize BPA more rapidly than rodents," wrote study author Laura Vandenberg, a developmental biologist at Tufts University in Boston, "then human daily exposure would have to be even higher to be sufficient to produce the levels observed in human serum."

The CDC data shows that 93 percent of 2,157 people between the ages of six and 85 tested had detectable levels of BPA's by-product in their urine. "Children had higher levels than adolescents and adolescents had higher levels than adults," says endocrinologist Retha Newbold of the U.S. National Institute of Environmental Health Sciences, who found that BPA impairs fertility in female mice. "In animals, BPA can cause permanent effects after very short periods of exposure. It doesn't have to remain in the body to have an effect."

But experts are split on the potential health hazards to humans. The Food and Drug Administration has approved its use and the EPA does not consider it cause for concern. One U.S. National Institutes of Health (NIH) panel agreed, but another team of government scientists last year found that the amount of BPA present in humans exceeds levels that have caused ill effects in animals. They also found that adults' ability to tolerate it does not preclude damaging effects in infants and children.

"It is the unborn baby and children that investigators are most worried about," Newbold says, noting that BPA was linked to increased breast and prostate cancer occurrences, altered menstrual cycles and diabetes in lab mice that were still developing.

Fred vom Saal, a reproductive biologist at the University of Missouri–Columbia, warns that babies likely face the "highest exposure" in human populations, because both baby bottles and infant formula cans likely leach BPA. "In animal studies, the levels that cause harm happen at 10 times below what is common in the U.S." says vom Saal, who also headed the NIH panel that concluded the chemical may pose risks to humans.

Amid growing concern, Rep. John Dingell (D–Mich.) chairman of the House Committee on Energy and Commerce, has launched an investigation into BPA, sending letters last month to the FDA and seven manufacturers of infant products sold in the U.S. requesting information on any BPA safety tests as well as specific levels in the baby goods. The companies that make Similac, Earth's Best and Good Start have already responded, confirming that they coat the inside of their cans with BPA but that analyses did not detect it in the contents. They also emphasize that FDA has approved BPA for such use.

"Based on the studies reviewed by FDA, adverse effects occur in animals only at levels of BPA that are far higher orders of magnitude than those to which infants or adults are exposed," says FDA spokeswoman Stephanie Kwisnek. "Therefore, FDA sees no reason to ban or otherwise restrict the uses now authorized at this time."

FDA first approved BPA as a food container in 1963 because no ill effects from its use had been shown. When Congress passed a law—the Toxic Substances Control Act of 1976—mandating that the EPA conduct or review safety studies on new chemicals before giving them the nod, compounds like BPA were already on the market. Therefore, they were not subject to the new rules nor required to undergo additional testing unless specific concerns had been raised (such as in the case of PCBs). "The science that exists today supports the safety of

BPA," ACC's Hentges says, based largely on research his organization has funded.

But other studies since 1976 have shown that small doses (less than one part per billion) of estrogenlike chemicals, such as BPA, may be damaging. "In fetal mouse prostate you can stimulate receptors with estradiol at about two tenths of a part per trillion, and with BPA at a thousand times higher," vom Saal says. "That's still 10 times lower than what a six-year-old has." In other words, children six years of age were found to have higher levels of BPA's by-product glucuronide in their urine than did mice dosed with the chemical that later developed cancer and other health issues.

Further complicating the issue is the stew of other estrogen-mimicking chemicals to which humans are routinely exposed, from soy to antibacterial ingredients in some soaps. The effects of such chemical mixtures are not known but scientists say they may serve to enhance the ill effects of one another. "The assumption that natural estrogens are somehow immediately good for you and these chemicals are immediately bad," Belcher says, "is probably not a reasonable assumption to make."

The chemical industry argues that unless BPA is proved to have ill effects it should continue to be manufactured and used, because it is cheap, lightweight, shatterproof and offers other features that are hard to match. "There is no alternative for either of those materials [polycarbonate plastics and epoxy resins] that would simply drop in where those materials are used," Hentges says.

Not so, says vom Saal, who notes that there are plenty of other materials, such as polyethylene and polypropylene plastics, that would be fine substitutes in at least some applications. "There are a whole variety of different kinds of plastic materials and glass," he says. "They are all more stable than polycarbonate."

Concern over BPA is not confined only to the U.S. Japanese manufacturers began to use natural resin instead of BPA to line cans in 1997 after Japanese scientists showed that it was leaching out of baby bottles. A subsequent study there that measured levels in urine in 1999 found that they had dropped significantly.

A new E.U. law (Registration, Evaluation, Authorization and Restriction of Chemical Substances, or REACH), which took effect last year, requires that chemicals, such as BPA, be proved safe. Currently, though, it continues to be used in Europe; the EFSA last year found no reason for alarm based on rodent studies. European scientists cited multigenerational rat studies as reassuring and noted that mouse studies may be flawed because the tiny rodent is more susceptible to estrogens.

For now, U.S. scientists with concerns about BPA recommend that anyone sharing those worries avoid using products made from it: Polycarbonate plastic is clear or colored and typically marked with a number 7 on the bottom, and canned foods such as soups can be purchased in cardboard cartons instead.

If canned goods or clear plastic bottles are a must, such containers should never be microwaved, used to store heated liquids or foods, or washed in hot water (either by hand or in much hotter dishwashers). "These are fantastic products and they work well ... [but] based on my knowledge of the scientific data, there is reason for caution," Belcher says. "I have made a decision for myself not to use them."