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Microplastics Found in Global Bottled Water, A 147 Billion Dollars Annual Market

By Christopher Tyree and Dan Morrison
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The mercury sprints past 30 degrees Celsius most days on Brazil's world-famous Copacabana Beach.

***Marcio Silva** has walked untold miles here selling bottled water from a cooler to local sun-worshippers and sunburnt tourists alike—half a liter of convenient refreshment and defense against dehydration.*

> "I drink water because water is life, water is health, water is everything," says Silva, who is 51. "I drink it and sell it to others."
>
> "I don't want to sell something bad to people."

The water looks clear, clean, unsullied. So does the bottle. For some, it's a container of convenience. For others, it's a hedge against dirty or unsafe tap water.

Bottled water is marketed as the very essence of purity. It's the fastest-growing beverage market in the world, valued at US$147 billion[1] per year.

But new research by Orb Media, a nonprofit journalism organization based in Washington, D.C., shows that a single bottle can hold dozens or possibly even thousands of microscopic plastic particles.

Tests on more than 250 bottles from 11 brands reveal contamination with plastic including polypropylene, nylon, and polyethylene terephthalate (PET).

When contacted by reporters, two leading brands confirmed their products contained microplastic, but they said Orb's study significantly overstates the amount.

For plastic particles in the 100 micron, or 0.10 millimeter size range, tests conducted for Orb at the State University of New York revealed a global average of 10.4 plastic particles per liter. These particles were confirmed as plastic using an industry standard infrared microscope.

The tests also showed a much greater number of even smaller particles that researchers said are also likely plastic. The global average for these particles was 314.6 per liter.

> "It's disheartening, I mean, it's sad," said **Peggy Apter**, a real estate investor in Carmel, Indiana. "I mean, what's the world come to? Why can't we have just

clean, pure water?"

Some of the bottles we tested contained so many particles that we asked a former astrophysicist to use his experience counting stars in the heavens to help us tally these fluorescing constellations.

Sizes ranged from the width of a human hair down to the size of a red blood cell. Some bottles had thousands. A few effectively had no plastic at all.

One bottle had a concentration of more than 10,000 particles per liter.

Bottled water evokes safety and convenience in a world full of real and perceived threats to personal and public health.

Packaged drinking water is a lifeline for many of the 2.1 billion people worldwide who lack access to safe tap water.[2] The danger is clear: Some 4,000 children die every day from water-borne diseases, according to the World Health Organization.[3]

Humans need approximately two liters of fluids a day to stay hydrated and healthy—even more in hot and arid regions.

Orb's findings suggest that a person who drinks a liter of bottled water a day might be consuming tens of thousands of microplastic particles each year.

How this might affect your health, and that of your family, is still something of a mystery.

Testing the waters

Bottled water manufacturers emphasized their products met all government requirements.

Gerolsteiner, a German bottler, said its tests "have come up with a significantly lower quantity of microparticles per liter," than found in Orb's study.

Nestle tested six bottles from three locations after an inquiry from Orb Media. Those tests, said Nestle Head of Quality **Frederic de Bruyne**, showed between zero and five plastic particles per liter.

None of the other bottlers agreed to make public results of their tests for plastic contamination.

> "We stand by the safety of our bottled water products," the American Beverage Association said in a statement.

Anca Paduraru, a food safety spokeswoman for the European Commission, said that while microplastic is not directly regulated in bottled water, "legislation makes clear there must be no contaminants." The U.S. doesn't have specific rules for microplastic in food and beverages.

Our test of top bottled water brands from countries in Asia, Europe, Africa, and the Americas

was conducted at Professor Sherri Mason's lab at the State University of New York in Fredonia, near the Canadian border on the frigid banks of Lake Erie.

Mason's tests were able to record microplastic particles as small as 6.5 microns, or 0.0065 millimeters.

The invisible plastic in bottled water hides in plain sight.

To reveal it, Mason and her colleagues used a special dye, an infrared laser and a blue light like those used by crime-scene investigators.

Under a laminar airflow hood that sucks dust and airborne particles up and away, each bottle was infused with a dye called Nile Red that binds to plastic polymer. The dyed water was then poured through a glass fiber filter.

When viewed through a microscope, under the blue beam of the crime light, with the aid of orange goggles, the residue from each bottle glowed with the flame-colored fluorescence of sometimes thousands of particles.

> "This is pretty substantial," said **Andrew Mayes**, senior lecturer in chemistry at the University of East Anglia, and developer of the Nile Red method. "I've looked in some detail at the finer points of the way the work was done, and I'm satisfied that it has been applied carefully and appropriately, in a way that I would have done it in my lab."

The study has not been peer reviewed.

Particles over approximately 100 microns were confirmed to be plastic by both Nile Red and Fourier-Transform Infrared Spectrometry (FTIR). Because particles between 6.5 and 100 microns were not analyzed by FTIR, Mason left open the possibility that their number could include other, unknown, contaminants in addition to plastic, though rationally expected to be plastic. As with all science, future methods may allow for even more accurate identification of the tiny particles.

Click here for a detailed look at how the study was conducted and read the official lab report.

The plastic inside us

So the bottled water you packed with your child's lunch may be swimming with microplastic.

Is it time to worry? Should Marcio Silva, the Copacabana water salesman, be alarmed? The short answer is that scientists don't really know yet.

According to existing scientific research, the plastic particles you consume in food or drinks might interact with your body in a number of different ways.

As many as 90 percent of microplastic particles consumed might pass through the gut without leaving an impression, according to a 2016 report on plastic in seafood by the European Food Safety Authority.

What about the remaining ten percent?

Some particles might lodge in the intestinal wall. Others might be taken up by intestinal tissue to travel through the body's lymphatic system. Particles around 110 microns in size (0.11 millimeters) can be taken into the body's hepatic portal vein, which carries blood from the intestines, gallbladder, pancreas and spleen to the liver.

Smaller debris, in the range of 20 microns (0.02 millimeters) has been shown to enter the bloodstream before it lodges in the kidneys and liver, according to a 2016 report by the UN's Food and Agriculture Organization.

Ninety percent of the plastic particles we found in our bottled water test were between 100 and 6,5 microns—small enough, according to researchers, for some to cross the gut into your body.

But very little research has been done on how frequently this might occur, or the health burden it might represent—a knowledge gap that some researchers say is in itself reason for concern.

Source: UN Food and Agriculture Organization

Fluorescing particles that were too small to be analyzed by FTIR should be called "probable microplastic," said **Andrew Mayes**, senior lecturer in chemistry at the University of East Anglia, because "some of it might be another, unknown, substance to which Nile Red stain is adhering." Mayes developed the Nile Red method for identifying microplastic.

De Bruyne, of Nestle, noted that Mason's tests did not include a step in which biological substances are removed from the sample. Therefore, he said, some of the fluorescing particles could be false positives – natural material that the Nile Red had also stained. He didn't specify what that material would be.

Mason noted that the so-called "digestion step" is used on debris-filled samples from the ocean or the seashore, and wasn't needed for bottled water.

> "Certainly they are not suggesting that pure, filtered, pristine water is likely to have wood, algae, or chitin [prawn shells] in it?" she said.

Some researchers say consuming microplastics in food and water might not be a serious issue.

> "Based on what we know so far about the toxicity of microplastics—and our knowledge is very limited on that—I would say that there is little health concern, as far as we know," says **Martin Wagner,** a toxicologist at the Norwegian University of Science and Technology. "I mean, that's quite logical because I believe that our body is very well-adapted in dealing with those non-digestible particles."

Wagner says, Orb's bottled water findings are "a very illuminative example of how intimate our contact with plastic is."

> "Plastic doesn't need to travel through the oceans and into fish for you to consume it," he says. "You get it right from the supermarket."

The 2016 evaluation by the European Union estimated that for microplastics consumed with shellfish, "only the smallest fraction may penetrate deeply into organs,"[4] and that our exposure to toxins through this contact is low.

But according to **Jane Muncke**, managing director and chief scientist at the Food Packaging Forum, a Zurich-based research organization, those estimates are largely based on scientific models, and not laboratory studies.

> "What does it mean if we have this large amount of microplastic bits in food?" Muncke says. "Is there some kind of interaction in the gastrointestinal tract with these microparticles… which then could potentially lead to chemicals being taken up, getting into the human body?"
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> "We don't have actual experimental data to confirm that assumption," Muncke says. "We don't know all the chemicals in plastics, even… There's so many unknowns here. That, combined with the highly likely population-wide exposure to this stuff—that's probably the biggest story here. I think it's something to be concerned about."

The Galaxies

We found a wide range of microplastic concentrations in the bottled water we tested. These images show a selection of lab filters as seen through the black and white field of the Galaxy Count app. Our study identified particles between 100 microns and 6.5 microns.

Microplastics are now found in all water sources

So what's best, bottled or tap?

Orb's 2017 tap water study and our current bottled water research used different methods to identify microplastic within globally sourced samples.

Still, there is room to compare their results.

For microplastic debris around 100 microns in size, about the diameter of a human hair, bottled water samples contained nearly twice as many pieces of microplastic per liter (10.4) than the tap water samples (4.45).

Can the world's consumers stomach drinking microplastic?

> "Please name one human being on the entire planet who wants plastic in his or her bottle," said Erik Solheim, executive director of the United Nations Environment Program. "They will all hate it."
>
> "It's the government's responsibility to educate people to know what they're drinking and eating," Apter said, "and how we can prevent this from continuing."

The tiny bits of plastic swirling around in bottled water are a researcher's quarry and a kitchen-table quandary.

> People "have a right to accurate and relevant information about the quality and safety of any product they consume," said **Lisa Lefferts**, senior scientist at the Center for Science in the Public Interest, a U.S.-based advocacy organization. "Since consumers are paying a premium for bottled water, the onus is on the bottled water companies to show their product is worth the extra cost."

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Articles by: **Christopher Tyree** and **Dan Morrison**