

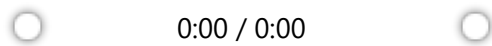
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The 100-Year Quest to Make a Paper Bottle

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8–10 minutes

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SLANGERUP, Denmark—For more than a century, businesses have struggled to solve a curiously complicated challenge: How to make a paper bottle that doesn't get soggy and keeps drinks fresh.

Now they say they are the closest they have ever been.

[Diageo DGE -1.52%decrease; red down pointing triangle▼](#), [Pernod Ricard RI -1.96%decrease; red down pointing triangle▼](#) and [Procter & Gamble PG -0.37%decrease; red down pointing triangle▼](#) are among a raft of companies testing paper-bottle designs they are betting can help their brands stand out on shelves, woo consumers concerned about plastic and cut carbon emissions [associated with glass](#).

But putting liquids in paper is inherently challenging. Paper bottles tested so far have needed an internal plastic barrier to stop them leaking. Companies have struggled with other problems too,

including keeping flavors intact and stopping fizzy drinks from going flat.

The paper-bottle push comes as paper is growing in popularity as a substitute for plastic packaging, with companies already using it to sell chocolate, ice cream, chewing gum and chips.

“People have a very good perception of paper,” said Ron Khan, head of drinks packaging at [PepsiCo PEP 0.35%increase; green up pointing triangle](#)▼, which has run tests to gauge consumers’ appetite for a paper bottle. “The minute consumers saw it we didn’t have to explain the sustainability credentials.”

There isn’t an all-paper bottle on the market, and executives say their eventual cost is hard to judge. Some companies are already selling bottles partly made of paper, but these are two-piece designs where a paper shell houses a separate plastic pouch.

Environmentalists have questioned the merits of substituting paper packaging for plastic. Producing paper requires large amounts of chemicals, energy and water, and has been linked to deforestation. Lining paper with plastic or other coatings can complicate recycling. And if paper ends up in a landfill it can release methane as it breaks down, not all of which is captured.

Despite the uncertainties, consumer-products companies are plowing ahead. Their holy grail is a paper bottle that is easy to recycle, avoids fossil fuel-based plastic and—ultimately—boosts sales.

Danish brewer [Carlsberg](#) says its research suggests paper bottles could attract more female drinkers, and find a home in upscale establishments. Pepsi says paper could better communicate the natural ingredients in its smoothies and juices. [L’Oréal](#) thinks the

ability to emboss paper could help its hand creams stand out on shelves.

Other companies see potential for paper bottles at sports events where glass is banned.

“All materials have their pros and cons,” said Simon Boas Hoffmeyer, head of sustainability at Carlsberg, which has tested paper bottles for beer. “Our impetus for looking at a fiber bottle was to offer consumers the choice of a low-carbon single-use packaging.”

Molding a bottle

In Slangerup, a small Danish town about 20 miles from Copenhagen, packaging company Paboco has been developing paper bottles for Carlsberg, [Coca-Cola KO -0.21%decrease; red down pointing triangle](#) and Pernod, among others.

On a recent visit, its factory was making a test batch of plastic-lined paper bottles for P&G’s Lenor fabric softener.

Here’s how the bottle is made: Pulp, a sludgy mixture of 99% water and 1% fiber, is piped from large vats into a stainless-steel mold. The one-piece bottle that emerges 12 seconds later is 60% water and feels floppy like the spongy insole of a shoe. It is then dried for 45 seconds at around 200 degrees Celsius.

Next, a silicone insert pops into the upside down bottle, pressing it against a porous mold that allows steam to escape as it dries. The now hardened bottle drops onto a laser cutting machine to have its jagged top sliced off, leaving behind a neat opening. The bottle is then flipped upside down so a nozzle can spray a plastic coating inside before it is baked in an oven for 10 minutes at 180 degrees

Celsius to set.

Test batches allow companies to determine the answers to the many unknowns. Will consumers mind if paper shampoo bottles are water stained? How will paper impact supply chains when the bottles don't keep products fresh for as long as glass and plastic? Will drinkers miss the click of glass bottles when they cheer with them?

When Pernod tested paper bottles for Absolut vodka, it found their lightness made them fall over on filling lines designed for glass and that recycling facilities didn't recognize the bottles as paper because of their shape. The bottles were also criticized on social media as amounting to greenwashing because of their thick plastic liner, with some describing them as plastic bottles wrapped in paper shrouds.

For Lena Danielsson, Absolut's head of innovation, the learnings were a valuable step in Pernod's journey to ditch the plastic entirely.

"If we wait until we are perfect we will lose time," Danielsson said. Pernod sees paper bottles as good for picnics and online sales.

A 100-year journey

The quest to make a paper bottle dates back to at least the 1920s when a New York businesswoman, Lydia B. Koch, patented a paper bottle made from two pieces of interleaved two-ply paper. Koch raised \$1 million from investors after promising that her Reinforced Paper Bottle Corp. had a long line of orders, including from the Soviet Union to pack caviar and from the Chinese government to transport water.

Things ended badly when Koch was indicted on fraud charges after the New York attorney general discovered that her paper bottle had earned \$857 over 16 years.

Since then various companies have tried to make paper bottles work with little success. Paper milk cartons caught on in the 1930s and remain common in the U.S. today but include plastic or aluminum linings and aren't bottle shaped. The two-piece bottles currently on sale for wine, spirits and water aren't strong enough to hold fizzy drinks and consumers must break them apart for recycling, separating the paper from the plastic liner.

Paboco spent years working to make a one-piece paper shell that was strong and smooth. One issue was the type of molds used to shape the bottles. It now uses porous molds after discovering that solid ones left a bumpy surface because steam generated during drying couldn't escape.

More recently the company has turned its attention to reducing the plastic liner inside its bottles. The liner currently makes up about 15% of the bottle by weight, down from more than 40% previously. Paboco's aim is 5%, which is thin enough not to interfere with the paper recycling process.

Finding the best materials for different liquids has been challenging. Paboco has used HDPE—the plastic used for milk cartons—inside its bottles but says the material doesn't keep carbonated drinks fizzy because it can't retain carbon dioxide. PEF—a bio-based plastic—worked fine for Carlsberg's beer, but the material is expensive and isn't yet widely available.

Bottle tops aren't yet made with paper. Paboco promised to use paper caps by 2023 but missed its deadline. The obstacle: Paper

fibers swell in moist conditions, meaning the caps weren't a reliable fit. Other manufacturers have stuck with traditional caps or used foil peel-offs.

Despite the challenges, spirits maker Diageo is pushing ahead with several projects. It sees paper bottles as a way to use less glass without diminishing the luxury aspect of its brands.

The company plans to launch mini paper bottles of Baileys in the next few months that will replace some of the brand's plastic bottles. The bottles, which contain a 10% plastic liner, are dry-molded using technology that requires less energy and avoids water.

By contrast, a paper bottle for Johnnie Walker whisky that Diageo promised to launch in 2021 hasn't yet hit shelves. The bottle has a thin liner made from bio-based plastic. Problems have included ensuring the barrier doesn't affect the whisky's taste, making the shelf life last at least one year and ensuring the bottle is robust in hot weather.

"It is proved much more challenging than we anticipated to keep a complex liquid like whisky in paper," said Dave Lütkenhaus, Diageo's breakthrough innovation director. "It's not just cracking one problem, we are trying to crack all these problems as they come along."

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