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New Gel Makes Alcohol 50% Less Toxic, Curbs Organ Damage

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It sounds like a gimmick. Drink a couple glasses of wine and feel only half as intoxicated as you normally would — and sustain less damage to your liver and other organs.

But that's the promise of a new gel, developed by researchers in Switzerland, that changes how the body processes alcohol. The gel has only been tested in mice so far, but the researchers hope to make it available to people soon. The goal: To protect people from alcohol-related accidents and chronic disease — responsible for more than three million annual deaths worldwide.

"It is a global, urgent issue," said study coauthor Raffaele Mezzenga, PhD, a professor at ETH Zürich, Zürich, Switzerland.

The advance builds on a decades-long quest among scientists to reduce the toxicity of alcohol, said Che-Hong Chen, PhD, a molecular biologist at Stanford School of Medicine, Stanford, California, who was not involved in the study. Some probiotic-based products aim to help process alcohol's toxic byproduct acetaldehyde in the gut, but their effects seem inconsistent from one person to another, Chen said. Intravenous infusions of natural enzyme complexes, such as those that mimic liver cells to speed up alcohol metabolism, can actually produce some acetaldehyde, mitigating their detoxifying effects.

"Our method has the potential to fill the gap of most of the approaches being explored," Mezzenga said. "We hope and plan to move to clinical studies as soon as possible."

Usually, the liver processes alcohol, causing the release of toxic acetaldehyde followed by less harmful acetic acid. Acetaldehyde can cause DNA damage, oxidative stress, and vascular inflammation. Too much acetaldehyde can increase the risk for cancer.

But the gel catalyzes the breakdown of alcohol in the digestive tract, converting about half of it into acetic acid. Only the remaining 45% enters the bloodstream and becomes acetaldehyde.

"The concentration of acetaldehyde will be decreased by a factor of more than two and so will the 'intoxicating' effect of the alcohol," said Mezzenga.

Ideally, someone would ingest the gel immediately before or when they begin consuming alcohol. It's designed to continue working for several hours.

Some of the mice received one serving of alcohol, while others were served regularly for 10 days. The gel slashed their blood alcohol level by 40% after half an hour and by up to 56% after 5 hours compared with a control group given alcohol but not the gel. Mice that consumed the gel also had less liver and intestinal damage.

"The results, both the short-term behavior of the mice and in the long term for the preservation of organs, were way beyond our expectation," said Mezzenga.

Casual drinkers could benefit from the gel. However, the gel could also lead people to consume more alcohol than they would normally to feel intoxicated, Chen said.

Bypassing a Problematic Pathway

A liver enzyme called alcohol dehydrogenase (ADH) converts alcohol to acetaldehyde before a second enzyme called aldehyde dehydrogenase (ALDH2) helps process acetaldehyde into acetic acid. But with the gel, alcohol transforms directly to acetic acid in the digestive tract.

"This chemical reaction seems to bypass the known biological pathway of alcohol metabolism. That's new to me," said Chen, a senior research scientist at Stanford and country director at the Center for Asian Health Research and Education Center. The processing of alcohol before it passes through the mucous membrane of the digestive tract is "another novel aspect," Chen said.

To make the gel, the researchers boil whey proteins — also found in milk — to produce stringy fibrils. Next, they add salt and water to cause the fibrils to crosslink, forming a gel. The gel gets infused with iron atoms, which catalyze the conversion of alcohol into acetic acid. That conversion relies on hydrogen peroxide, the byproduct of a reaction between gold and glucose, both of which are also added to the gel.

A previous version of the technology used iron nanoparticles, which needed to be "digested down to ionic form by the acidic pH in the stomach," said Mezzenga. That process took too long, giving alcohol more time to cross into the bloodstream. By "decorating" the protein fibrils with single iron atoms, the researchers were able to "increase their catalytic efficiency," he added.

What's Next?

With animal studies completed, human clinical studies are next. How soon that could happen will depend on ethical clearance and financial support, the researchers said.

An "interesting next step," said Chen, would be to give the gel to mice with a genetic mutation in *ALDH2*. The mutation makes it harder to process acetaldehyde, often causing facial redness. Prevalent among East Asian populations, the mutation affects about 560 million people and has been linked to Alzheimer's disease. Chen's lab found a chemical compound that can increase the activity of ADH2, which is expected to begin phase 2 clinical trials this year.