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Chilean researchers use CRISPR to help wine yeast ferment with less nitrogen

The project targets a nutrient-sensing pathway linked to stalled fermentations that can cause losses for winemakers

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A research team at the University of Santiago de Chile is studying how wine yeast can keep fermenting when nitrogen is scarce, a common problem in winemaking that can slow or stop fermentation and force producers to add nutrients to grape must.

The project is led by Eduardo Kessi, a researcher at the university's Center for Food Science and Technology Studies, through a Fondecyt Regular 2026 grant with support from Dicyt-Usach. According to the university, the work aims to understand the genetic and molecular mechanisms that allow some yeast strains to adapt better than others when nitrogen levels are low.

Nitrogen is one of the key nutrients yeast needs to stay active during fermentation, along with carbon sources, vitamins and minerals. In wine production, low nitrogen in grape must has long been a challenge because yeast activity can weaken before sugars are fully converted into alcohol. That can lead to sluggish or stuck fermentations and significant production losses.

Kessi said nitrogen supplementation has become a routine practice in the wine industry to stabilize fermentation. His team is trying to determine whether some yeasts can perform efficiently even under low-nitrogen conditions, which could eventually help reduce reliance on those additions.

The research centers on TORC1, short for Target of Rapamycin Complex 1, a cellular signaling pathway that helps coordinate yeast growth based on nutrient availability. In simple terms, it acts as a biological sensor that helps yeast detect whether conditions are favorable for growth, division and continued fermentation.

Kessi said the pathway is important across eukaryotic organisms. In humans, TORC1 has been linked to cancer research, while in yeast it is tied more directly to how cells respond to nutrients. In fermentation, that matters because if yeast senses that nitrogen is too limited, growth can stop and fermentation may stall.

To investigate that response, the team plans to work with different yeast strains from different ecological niches, including both domesticated and wild strains. The goal is to identify genetic variants associated with activation of the TORC1 pathway under low-nitrogen conditions.

Those variants will then be edited into a commercial wine yeast strain using CRISPR-Cas tools, according to the university. Kessi said the approach allows precise changes in the genome without introducing external genes, making it possible to test whether

specific variants improve fermentation performance when nitrogen is limited.

If successful, the work could point to more stable and efficient fermentations in wine production. It could also have broader implications for beverage makers because nitrogen shortages are not only a technical issue in wineries but a cost and consistency issue across fermentation-based production. Better understanding how yeast responds at the genetic level could eventually support more reliable processes and lower use of artificial supplementation in wine and potentially other fermented drinks.

The university said the project also seeks to contribute to biotechnology tools that could make fermentation more efficient and sustainable. For winemakers, that could matter as climate, temperature, water availability and soil conditions continue to shape grape development and composition before harvest, affecting the raw material that enters fermentation.

Kessi said wine remains one of Chile’s most important industries, making fermentation research especially relevant. He also argued that basic science deserves continued public funding even when immediate commercial applications are not yet clear, because discoveries in one field can later prove useful in others.

According to the university, the project was recently awarded and will focus first on identifying which genetic differences are tied to stronger performance under nutrient stress before testing those changes in commercial wine yeast.