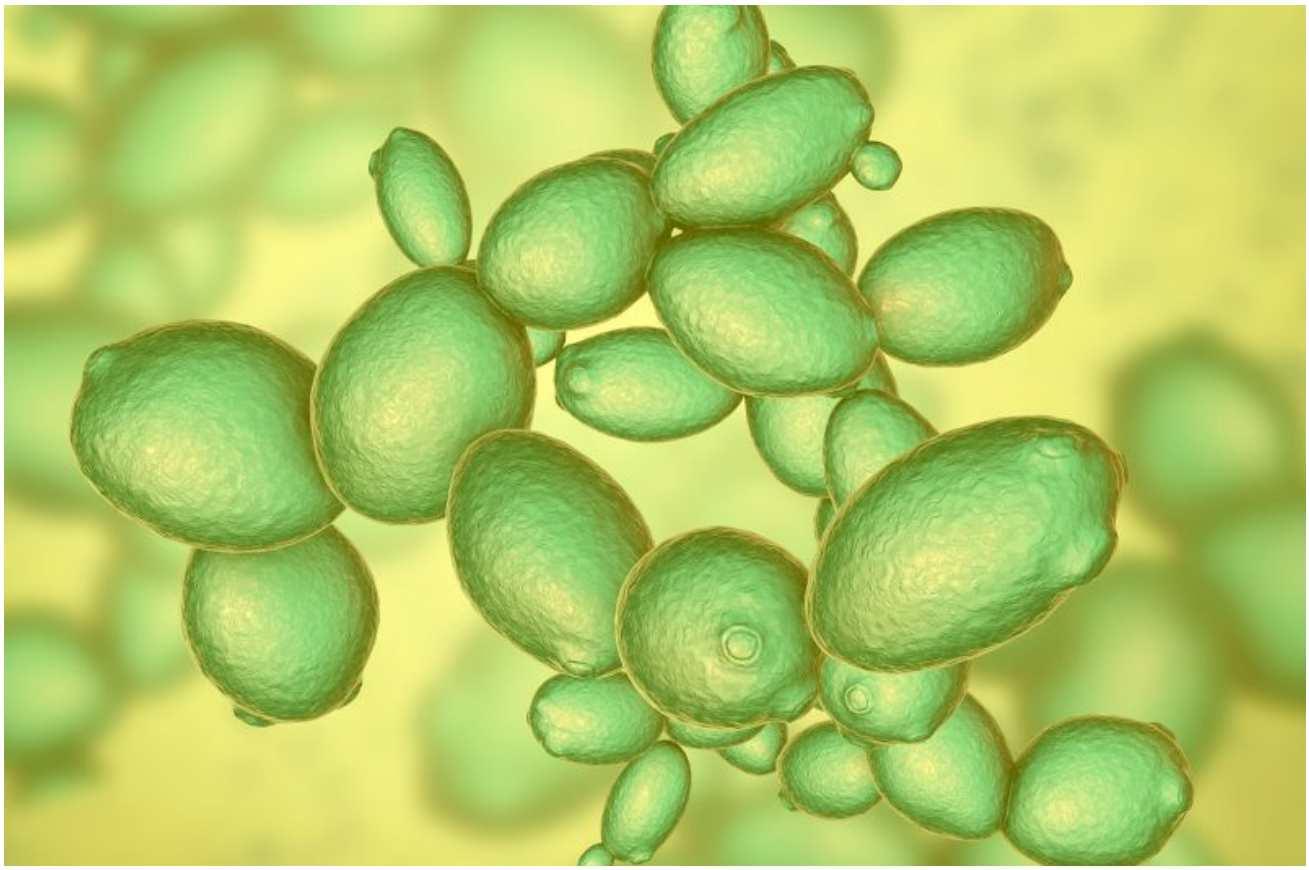
vinetur

Review Finds Multiomics Is Driving the Search for Heat-Tolerant Industrial Yeasts

Researchers say the approach could help develop strains that ferment above 40°C, lowering cooling costs and contamination risks

Monday, August 3, 2026



A new review in the International Journal of Food Microbiology argues that multiomics tools are becoming central to the search for heat-tolerant yeasts that can keep industrial fermentations running at higher temperatures, a shift that could matter for

food production, brewing, biofuels and other fermentation-based industries facing rising energy costs and warmer operating conditions.

The paper, published with the DOI 10.1016/j.ijfoodmicro.2026.111824, was written by Xuexue Rao, Meiyan Li, Linling Li, Quan Yuan, Xiaodan Wang, Wentao Cao, Shuyi Qiu and Xiaoye Luo. It examines how genomics, transcriptomics, proteomics and metabolomics can be combined to explain why some yeasts survive heat stress better than others and how those findings may help breeders and engineers develop strains suited to hotter industrial settings.

Yeast is a basic workhorse in sectors that include bread, beer, wine, distilled spirits, dairy fermentation, enzymes, pharmaceuticals and ethanol. But most conventional strains lose performance as temperatures rise. According to the review, heat can damage cell structures, disrupt enzymes and reduce fermentation capacity. That creates practical problems for producers: lower yields, slower processing and a greater chance that unwanted microbes will take hold if conditions are not tightly controlled.

The authors say the issue is especially important in processes that already operate in warm climates or under heat-heavy industrial conditions, including tropical beverage fermentation, organic acid production and biofuel manufacturing. In those settings, the ability to ferment at temperatures above 40°C can cut cooling needs and lower contamination risk. The review cites earlier research estimating that an ethanol plant producing 30,000 kiloliters a year could gain $30,000 in net revenue for every 5°C increase in fermentation temperature.

That economic case has pushed researchers to look beyond traditional strain development. The review notes that classic mutagenesis methods are highly random and often inefficient, with a positive mutation rate below 0.1%. Even when they produce more heat-tolerant yeasts, the result may come with weaker fermentation performance. Heat tolerance is not controlled by one gene or one pathway. It is a polygenic trait tied to heat shock proteins, membrane lipids, oxidative stress responses and broader metabolic adjustments inside the cell.

That complexity is why multiomics has drawn attention. Genomics can identify mutations or gene clusters linked to thermotolerance. Transcriptomics tracks which genes switch on or off under heat stress. Proteomics looks at changes in protein abundance and interactions. Metabolomics measures shifts in small molecules that reflect how cells reroute metabolism to survive. Used together, these approaches can build a more complete map of how yeast responds when temperatures climb.

For food and beverage producers, the value of that map is practical as much as scientific. Fermentation performance depends on stable growth, predictable flavor development and resistance to contamination. In brewing or tropical fruit fermentations, strains that remain active at higher temperatures could reduce refrigeration demands and make production more resilient in hot regions. In cheese and other fermented foods, temperature shifts can also change ripening speed and biochemical activity, affecting both timing and product character.

The review describes direct screening as one route to finding useful strains. Researchers have isolated thermotolerant yeasts from compost, hot springs, tropical fruits and traditional fermented foods by enriching samples under warm conditions. Some species within Saccharomyces cerevisiae and genera such as Hansenula, Kluyveromyces, Candida, Saccharomycopsis and Pichia have shown growth at 45°C after adaptive evolution or strain improvement. Even so, the authors say current strain resources still fall short of industrial demand.

What multiomics adds is a way to move from broad screening to targeted improvement. Whole-genome sequencing can compare robust industrial strains with weaker ones to pinpoint candidate genes. Transcriptome studies can show how stress-response pathways behave during fermentation rather than only in static lab tests. Proteomic analysis can reveal whether protective proteins are actually produced in sufficient amounts. Metabolomic data can show whether cells are maintaining membrane integrity, redox balance and energy supply under heat pressure.

The review presents this integrated approach as a tool for directional breeding rather than trial-and-error selection. In principle, once key targets are identified across several layers of biology, breeders can focus on strains more likely to combine thermotolerance

with strong fermentation output. That matters because industry does not need yeasts that merely survive heat; it needs yeasts that keep converting sugars efficiently while preserving product quality.

The paper also points to broader uses beyond alcoholic drinks. Thermotolerant yeasts are relevant to second-generation bioethanol made from lignocellulosic biomass, where simultaneous saccharification and fermentation often benefit from warmer conditions. They may also matter in wastewater treatment and industrial biochemicals production, where process temperatures can already exceed what standard yeasts tolerate comfortably.

Still, the authors are careful about the limits of current research. They note that omics studies often identify correlations rather than clear cause-and-effect relationships. A gene that appears more active during heat stress may not be the reason a strain performs better in a factory setting. Translating predicted targets into stable commercial traits remains difficult. Industrial environments also expose yeast to multiple stresses at once, including ethanol toxicity, acidity and osmotic pressure, not just heat alone.

That gap between laboratory insight and factory performance is likely to shape the next phase of research. The review suggests that future work will need stronger integration between omics data analysis and applied breeding or engineering so that promising markers lead to strains that remain reliable over repeated production cycles. Better data transparency and more refined analytical methods may also help researchers sort meaningful signals from large datasets.

For producers across food, beverage and bioenergy markets, the message is straightforward: higher-temperature fermentation remains attractive because it can lower cooling costs and improve process efficiency, but success depends on yeast strains built for those conditions. The review argues that multiomics is now one of the main tools for finding out how to build them.

The study was supported by research funding tied to Guizhou University young talent programs and provincial innovation projects in China focused on microbial resources for the fermentation industry. The authors reported no known competing financial interests

or personal relationships that could have influenced the work.