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# Nicotinic acid levels found crucial for yeast fermentation and wine quality, study shows

Research highlights risks of vitamin B3 deficiency in grape must and suggests targeted supplementation to maintain fermentation efficiency

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A recent study published in the journal IVES has brought new attention to the role of nicotinic acid, a form of vitamin B3, in wine fermentation. Nicotinic acid is a precursor for the essential redox cofactors $NAD^+$ and NADP, which are vital for many metabolic processes in yeast. In Saccharomyces cerevisiae, the yeast most commonly used in winemaking, these cofactors are produced under anaerobic conditions exclusively by recycling various forms of vitamin B3. This highlights the importance of having enough nicotinic acid available in grape must during fermentation.

Researchers investigated how a deficiency of nicotinic acid affects fermentation performance in S. cerevisiae and how it influences the metabolic profile of wine. The study used a synthetic grape must with 230 grams per liter of sugar and tested three different concentrations of nicotinic acid: deficient (0.1 mg/L), average (2.0 mg/L), and excessive (4.0 mg/L). The experiments were conducted at 25°C using the commercial yeast strain EC1118™.

The results showed that while fermentation kinetics were similar during the first 24 hours across all treatments, a deficiency in nicotinic acid led to slower fermentation and a 37.5% reduction in yeast biomass production. Excessive levels of nicotinic acid did not improve fermentation rates or biomass compared to normal concentrations, suggesting there is an optimal threshold for supplementation.

The study also measured the concentrations of $NAD^+$ and NADH throughout fermentation. Initially, $NAD^+$ levels increased until the end of the lag phase but dropped sharply as yeast entered exponential growth. This drop reflects increased metabolic activity and cell growth, with $NAD^+$ being rapidly reduced to NADH during glycolysis and other metabolic pathways. In treatments with low nicotinic acid, $NAD^+$ levels became almost undetectable after 24 hours, indicating a severe redox imbalance that slowed fermentation and reduced biomass production.

Further analysis revealed that yeast cells import and use up all available nicotinic acid early in fermentation, before reaching half their maximum population size. After this point, they rely on recycling internal stores of vitamin B3 to maintain $NAD^+$ production. Some export of vitamin B3 back into the medium was also observed, especially at higher initial concentrations.

The impact of nicotinic acid deficiency extended to primary metabolite production. Deficient conditions led to significant increases in glycerol, malic acid, and acetoin as compensatory mechanisms for regenerating $NAD^+$, as well as higher succinic acid but lower acetic acid levels. Ethanol production remained stable regardless of nicotinic acid concentration, underscoring its central role in yeast metabolism.

Deficiencies of vitamin B3 in grape must are less common than those of vitamin B1 (thiamine), which can occur frequently. However, fungal infections such as Botrytis cinerea can deplete nutrients and actively reduce nicotinic acid concentrations after grape processing. Early stages of fermentation also see rapid uptake of thiamine and other B vitamins by yeast, limiting their availability as fermentation progresses. Extended pre-fermentation maceration or sequential inoculation with non-Saccharomyces yeasts may further lower nicotinic acid levels, increasing the risk of deficiency.

To address these risks, supplementation with yeast-derived nutrients containing vitamin B3 is considered a viable strategy in scenarios where deficiency is likely. Controlled oxygen addition during early or mid-fermentation is another promising approach since oxygen enables de novo synthesis of vitamin B3 by yeast, reducing reliance on external sources. However, optimizing both timing and dosage is crucial to ensure adequate niacin production without compromising fermentation.

The study emphasizes that maintaining sufficient levels of nicotinic acid is necessary not only for efficient fermentation kinetics but also for stable metabolite profiles in wine. Deficiency leads to severe redox imbalance due to depleted $NAD^+$ pools, which impairs central metabolic functions and slows down fermentation. Excess supplementation does not provide additional benefits beyond normal conditions.

Species-specific responses were also observed: while S. cerevisiae could complete fermentation under all tested conditions (albeit more slowly when deficient), some non-Saccharomyces species experienced even greater reductions in fermentation rates or premature interruption when deprived of nicotinic acid.

The findings suggest that future research should focus on refining nutrient supplementation strategies and optimizing oxygen management to support $NAD^+$ biosynthesis during winemaking. This would help ensure smooth fermentations and potentially allow winemakers to influence wine’s metabolic profile through targeted interventions based on nutrient availability.