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Grape-derived nanoparticles cut red wine yellowing by 92.5% in laboratory tests

Researchers said the particles formed complexes with quercetin that protected anthocyanin pigments in model wine solutions.

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A study published Wednesday in Food Chemistry reported that nanoparticles made from mannoproteins and grape polysaccharides can bind with quercetin in model red wine solutions, a process that was associated with restoring red color and limiting the

yellowing that can develop as wine changes over time.

The research focused on what happens when mannoprotein-grape polysaccharide nanoparticles, identified as MGPN, are introduced into red wine model systems that also contain quercetin, a natural flavonoid found in grapes and other plants. According to the study, the interaction between the nanoparticles and quercetin produced complexes that were linked to better color performance in the liquid.

Color is a central quality marker in red wine. Consumers often read it as a sign of age, style, and condition before they smell or taste the product. That makes color stability an important issue for wineries, especially because the red and purple tones in wine depend heavily on anthocyanins, pigments that can break down or shift chemically during storage and handling. When those pigments degrade, wines can lose brightness and move toward less desirable shades.

The Food Chemistry study examined the mechanism behind that process in a controlled setting rather than in finished commercial wine. The researchers found evidence that MGPN can complex with quercetin and that this interaction helps protect anthocyanins from degradation. In practical terms, that means the nanoparticles may help preserve the pigments responsible for red wine’s characteristic appearance.

The study summary said the effect was especially notable in the presence of calcium or potassium ions. Under those conditions, the yellowish tone in the model wine solutions was reduced by as much as 92.5%. The paper described that result as part of a mechanistic exploration of how the complexes form and how they influence color restoration.

The findings add to a growing body of research on the use of food-grade biopolymers and nanoscale structures to stabilize sensitive compounds in beverages. In this case, the materials under study are closely tied to winemaking itself. Mannoproteins are commonly associated with yeast cell walls and are already familiar in enology, while grape polysaccharides come from grape-derived material. That may make the approach more relevant to wine production than systems built from less familiar additives.

The work also centers on quercetin, which has received attention in wine science for its role in oxidation, haze, and phenolic behavior. By showing that quercetin can participate in complexes with MGPN that are associated with improved color, the study offers a new way to think about a compound that is often discussed mainly in relation to stability problems or precipitates.

For the beverage sector, the study points to a possible tool for improving product consistency and visual quality in red wines. If the same effect is confirmed outside laboratory models, producers could eventually use this kind of nano-polyphenol interaction to help recover or maintain color during processing or aging. That would be especially relevant for wines where appearance can shift because of storage conditions, raw material variation, or normal chemical evolution. The idea could also interest developers working on other polyphenol-rich beverages, although the current research was specific to model red wine solutions.

The paper’s emphasis on mechanism is also important. Much of beverage formulation depends not only on whether an additive or treatment works, but on understanding why it works and under which chemical conditions. By linking color restoration to the formation of MGPN-quercetin complexes and to the protection of anthocyanins, the study gives wineries and beverage scientists a more detailed basis for evaluating whether the approach might fit existing production systems.

At the same time, the research was conducted in model solutions, which are simplified systems designed to isolate chemical interactions. That means the findings do not automatically translate to all finished red wines, where alcohol level, pH, tannins, metal ions, sulfur dioxide, filtration, and storage history can all affect pigment chemistry. Commercial validation would be needed to determine how the approach performs in real production environments and whether it can be scaled in a practical and cost-effective way.

Still, the study provides new evidence that targeted interactions between nanoparticles and phenolic compounds may influence one of the most visible quality traits in wine. In an industry where small changes in color can shape consumer perception and product value, that makes the results relevant beyond the laboratory, particularly for producers looking for more precise ways to preserve the appearance of red wines over time.