

Protocol S1. The winemaking process used for mulberry wine from 2012 to 2023.

After harvesting, the mulberries were washed with running water to remove surface dust and then drained. The stems were removed and the fruits were crushed using a destemmer before pumping into 30-ton fermentation tanks. The bv818 yeast (Angel Yeast, Hubei, China) was used for alcoholic fermentation. The initial fermentation temperatures were 20 to 22°C. The temperature and sugar content of the tanks were monitored daily, and the fermentation temperature is adjusted to control the fermentation rate at 1-1.5°Baumé per day. After alcoholic fermentation finished (when sugar content reaches <0.2°Baumé), the wines were then transferred to a plate and frame press to remove pomace. After pressing, the wines were transferred back to the tanks to settle for 90 days at 10°C, during which they were racked twice to remove lees. Following this, the wine in the tanks were filtered with cross-flow filtration system and bottled immediately.

Figure S1 The linear relationship observed the mean values of total anthocyanin concentration, non-bleachable pigment and aging

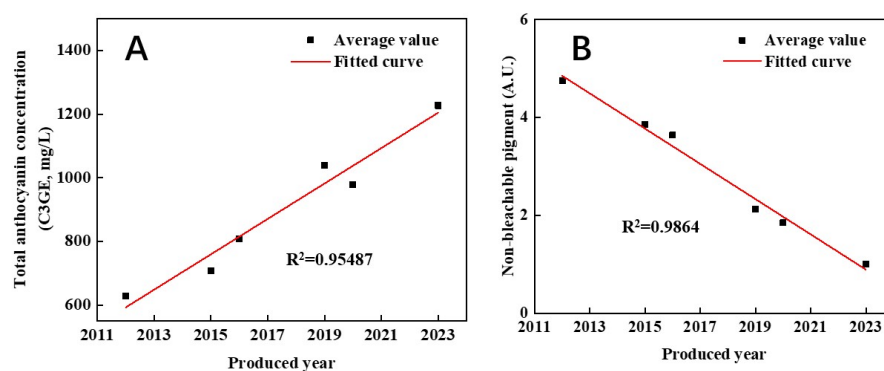


Figure S2 Composition of pigments find in aged mulberry wine. The chromatography were obtained at 520 nm, the cyanidin-3-glucoside (C3G) were identified with a standard sample.

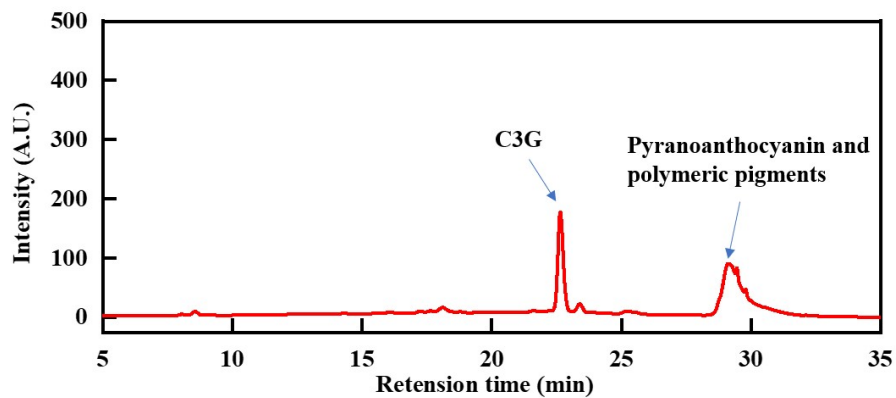


Table S1 Information on temperature and precipitation from March (when fruit sets) to May (when it matures), as well as the total sugar content and pH of the mulberry must before fermentation. We selected the years 2012, 2015, 2018, 2019, 2020, and 2023, which had average temperatures of 20-22.5°C from March to May, monthly average precipitation of 150-185 mm, juice total sugar content of 9.5-10.5°Baumé, and juice pH of 3.1-3.5. Other years were excluded from the sample selection because one or more indicators, such as average temperature, precipitation, total sugar, or pH, exceeded these ranges. Climate data (temperature and precipitation) were provided by the Shantou Meteorological Bureau, the sugar content and pH of the juice were provided by Yayuan Biotechnology Co., Ltd.

| | Average temperature (°C) | Average amount of precipitation (mm/month) | Sugar content (°Baumé) | pH |
|-------|-----------------------------|---|---------------------------|-----|
| 2012 | 20.9 | 165 | 10.4 | 3.2 |
| 2013* | 16.4 | 104 | 8.3 | 3.0 |
| 2014* | 25.2 | 109 | 12.1 | 2.8 |
| 2015 | 21.6 | 172 | 9.8 | 3.5 |
| 2016* | 16.9 | 129 | 8.1 | 2.7 |
| 2017* | 17.3 | 126 | 8.0 | 3.1 |
| 2018 | 20.4 | 169 | 10.2 | 3.4 |
| 2019 | 22.3 | 183 | 10.1 | 3.2 |
| 2020 | 21.4 | 154 | 9.6 | 3.1 |
| 2021* | 25.3 | 253 | 10.3 | 3.4 |
| 2022* | 25.8 | 241 | 10.2 | 3.6 |
| 2023 | 22.1 | 177 | 10.4 | 3.1 |

Table S2 The calculated and reported Retention Index (RI) of the corresponding compounds. The RI is calculated using the formula: $RI = 100n + 100 \times (t_x - t_n)/(t_{n+1} - t_n)$, where: t_x is the retention time (in minutes) of the compound being analyzed, t_n and t_{n+1} are the retention times (in minutes) of normal alkanes with n and $n+1$ carbon atoms, respectively, and $t_n < t_x < t_{n+1}$. The reported RI (appeared as RI*) was obtained from national institute of standards and technology, US department of commerce (<https://webbook.nist.gov/chemistry/cas-ser/>).

| | CAS | Molecular formular | RI* | RI |
|-------------------|-----------|--|------|------|
| Isoamyl acetate | 123-92-2 | C ₇ H ₁₄ O ₂ | 861 | 865 |
| Phenethyl acetate | 103-45-7 | C ₁₀ H ₁₂ O ₂ | 1121 | 1140 |
| Ethyl acetate | 141-78-6 | C ₄ H ₈ O ₂ | 599 | 601 |
| Hexyl acetate | 142-92-7 | C ₈ H ₁₆ O ₂ | 991 | 996 |
| Ethyl lactate | 687-47-8 | C ₅ H ₁₀ O ₃ | 988 | 792 |
| Ethyl hexanoate | 123-66-0 | C ₈ H ₁₆ O ₂ | 974 | 976 |
| Diethyl succinate | 123-25-1 | C ₈ H ₁₄ O ₄ | 1137 | 1149 |
| Ethyl octanoate | 106-32-1 | C ₁₀ H ₂₀ O ₂ | 1160 | 1181 |
| Ethyl dodecanoate | 106-33-2 | C ₁₄ H ₂₈ O ₂ | 1568 | 1578 |
| Ethyl palmitate | 628-97-7 | C ₁₈ H ₃₆ O ₂ | 1940 | 1980 |
| Ethyl | 7452-79-1 | C ₇ H ₁₄ O ₂ | 878 | 882 |
| 2-methylbutanoate | | | | |
| Ethyl pentanoate | 539-82-2 | C ₇ H ₁₄ O ₂ | 872 | 876 |
| Ethyl propionate | 105-37-3 | C ₅ H ₁₀ O ₂ | 688 | 692 |
| 2-Phenylethanol | 60-12-8 | C ₈ H ₁₀ O | 1072 | 1084 |
| Nonanol | 143-08-8 | C ₉ H ₂₀ O | 1158 | 1166 |
| 2-Methylpropanol | 78-83-1 | C ₄ H ₁₀ O | 610 | 612 |
| Hexanol | 111-27-3 | C ₆ H ₁₄ O | 848 | 853 |
| 1-Pentanol | 71-41-0 | C ₅ H ₁₂ O | 763 | 767 |
| 2,3-butanediol | 513-85-9 | C ₄ H ₁₀ O ₂ | 630 | 633 |
| 2-propanol | 67-63-0 | C ₃ H ₈ O | 476 | 477 |
| Formic acid | 64-18-6 | CH ₂ O ₂ | 510 | 512 |

Table S3 The odor activity value (OAV) of the compounds detected in the mulberry wines.

| | 2012 | 2015 | 2018 | 2019 | 2020 | 2023 | Odorant series |
|-------------------------|------|------|------|------|------|------|----------------------|
| Isoamyl acetate | 1.1 | 1.0 | 1.2 | 1.5 | 1.7 | 1.7 | Fruity, sweet |
| phenethyl acetate | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 1.1 | Floral, sweet |
| Ethyl acetate | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | Fruity, balsamic |
| Hexyl acetate | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 1.7 | Floral |
| Ethyl lactate | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | Solvent |
| Ethyl hexanoate | 3.7 | 3.7 | 3.6 | 3.6 | 4.3 | 4.3 | Fruity |
| Diethyl succinate | 0.6 | 0.5 | 0.4 | 0.5 | 1.4 | 1.4 | Fatty, spicy |
| Ethyl octanoate | 0.4 | 0.3 | 0.2 | 0.3 | 0.4 | 0.5 | Fruity, floral |
| Ethyl dodecanoate | 7.4 | 58.8 | 7.4 | 42.9 | 8.9 | 44.3 | Fruity |
| Ethyl palmitate | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | Fruity, sweet, fatty |
| Ethyl 2-methylbutanoate | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | Fruity |
| Ethyl pentanoate | 5.6 | 3.5 | 2.1 | 3.6 | 0.0 | — | Fruity |
| Ethyl propionate | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | Fruity, sweet |
| 2-Phenylethanol | 3.3 | 2.1 | 5.5 | 1.8 | 2.8 | 3.5 | Fruity, sweet |
| Nonanol | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | Fruity, fatty, green |
| 2-Methylpropanol | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Solvent |
| Hexanol | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Herbaceous |
| 1-Pentanol | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Fruity |
| 2,3-butanediol | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | Fruity |
| 2-propanol | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | Fruity |
| Formic acid | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Solvent |