



How much wine to expect per tonne of grapes?

A winery's production size is often described in the wine trade by the number of bottles or cases produced, while winemakers tend to talk about the number of tonnes crushed and a viticulturist might define production by yield from their vineyard. But how do these numbers correlate? In this article, Senior Oenologist Geoff Cowey explores how many cases of wine might be expected from a metric tonne of grapes processed by different size wineries, considering a range of possible variables.

How does the overall annual number of tonnes of grapes crushed relate to litres of wine produced?

Extraction rates in Australia are calculated annually as beverage wine volume reported after fermentation divided by the total tonnes of grapes crushed (Wine Australia 2021). The mean extraction rate between 2007-08 and 2019-20 for white wine was 687 L/tonne (range: 651-733L/tonne) and for red wine was 714 L/tonne (range 689-733 L/tonne), making a combined mean around 700 L/tonne. These extraction rates provide a high-level view of Australian wine production only and do not include losses or gains that occur during post-fermentation winemaking steps or packaging.

What is in a tonne of grapes?

About 20-25% by weight of a tonne of grapes is removed during winemaking and this amount can be larger in smaller wineries. The material removed consists of grape stalks (2-5%), skins (5-20%), seeds (3-6%) and small pieces of pedicel and grape pulp/solids (4%) (Boulton 1996, Nerantzis and Tataridis 2006). The remaining 70-80% of the weight of grapes is the grape juice, predominantly water, plus dissolved sugars and acids.

How much juice is extracted from white grapes?

In white wine production grapes are crushed, drained and/or pressed to separate the juice from the skins before fermentation. Initial free run juice/light pressing achieves 500-600 L/tonne; pressing can achieve another 100-150 L; and a final volume of more than 800 L/tonne is possible for some varieties with harder pressing (Anon 1986). Juice clarification is the process responsible for the largest volume losses during white winemaking. Cold settling using clarification enzymes can cause 5-10% volume loss, flotation using enzymes causes 3-7% volume

loss, while combinations of settling/flotation and centrifuging can result in losses as low as 3% (Nordestgaard and Abbott 2016, Barlow 2015). The exact losses experienced will depend on factors including the use of clarification enzymes, the press type and the degree of pressing/quantity of solids initially extracted. Keeping a portion of the lighter solids is desirable for inclusion in ferments. Larger companies recover juice volume from solids via centrifuging or cross-flow filtration; however, juice recovered by processing heavy lees through rotary drum vacuum filtration is not always returned to the initial parcel. Due to the pre-fermentation clarification, fermentation lees in white winemaking tend to be minimal (1-3%).

How much juice/wine is extracted from red grapes?

For red wine production, pressing occurs after fermentation when skins and pulp have largely been broken down. Draining/pressing can achieve up to 700-800 L/tonne subject to variety, press type and pressure applied. Gross red wine fermentation lees constitute the highest percentage of losses during red winemaking (4-10%), with minor lees lost throughout the remaining winemaking processes.

What are typical losses during maturation? The angels' share and the devil's cut?

When wine is matured in barrel rather than tank, some of the liquid evaporates over time, around 2-5% of the barrel volume each year (Howard 2015). Historically, this loss was known as 'the angels' share'. In addition, a new dry 300 L hogshead barrel can also absorb 5-6 L of wine (2%) into the wood when first filled, and this is sometimes known as 'the devil's cut'.

What are typical losses during stabilisation, clarification and bottling?

Heat stabilisation of white wine using sodium bentonite (5% slurry in water, volume addition 0.5-2%) can produce 5% lees. Wine losses during filtration and packaging range between 0.5 and 5%, with larger losses in smaller production runs. Losses occur due to wetting of filter membranes, wine transfers and recirculation, non-conforming product, breakages, sampling, tasting and analysis. For a 1000 L volume of wine, small changes such as a high fill volume can see 83 fewer bottles packaged, or 6% loss in stock.

Are there volume gains anywhere in the winemaking process?

A maximum of 70 mL/L (7%) of water can be added during winemaking through all additions and finings, but generally any volume gained tends to be balanced by the wine volume lost through racking after these operations, and lees lost during earlier clarification steps. Tartaric acid addition facilitates solids removal by way of potassium bitartrate precipitation. Red pomace includes yeast biomass generated during fermentation. Large wineries that propagate a yeast culture in a different juice can see a 1% volume addition. The main allowable gain, if required, is through limited water additions to dilute high-sugar grape juice or must prior to fermentation (to a minimum of 13.5 degrees Baumé). For example, dilution of must from 15 to 13.5°Bé would be achieved through an 11% dilution (by volume) with water.

What final extraction rates of finished wine could be expected from tonnes crushed, taking into account all the steps that happen post-fermentation?

A minimum combined juice/wine loss of 6-7% (40-50 L/tonne) could be expected from the initial extracted juice/wine to the final packaged product. Larger wineries would likely achieve higher

overall extraction rates due to scale, process efficiencies and lees recovery, or lower declared rates if recovered juice or wine is used for other purposes such as making wine-based beverages or grape products. For smaller wineries or some premium wine styles a lower final extraction rate of around 600-650 L/tonne (Bacic 2003) would be expected. Using these extraction values as a guide, the number of bottles, cases and pallets of wine from a mass of fruit can be estimated for different size wineries (Table 1).

For further information about winemaking volume losses or other technical winemaking or viticulture questions, contact the AWRI helpdesk on (08) 8313 6600 or helpdesk@awri.com.au

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Table 1. Estimation of finished bottles/cases/pallets of wine produced per tonne of grapes using different extraction rates for different winery sizes

Winery size (tonnes, cases)	Extraction rate (L/tonne of grapes)	Number of 750 mL bottles	Number of 12-bottle cases	Number of 56-case pallets
Small (50 t, <5000 cases)	600	40,000	3,333	60
Medium (500 t, <50,000 cases)	650	433,333	36,111	645
Large (5,000 t, <500,000 cases)	700	4,666,667	388,889	6944

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