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Use of microscale fermentations in grape and wine research

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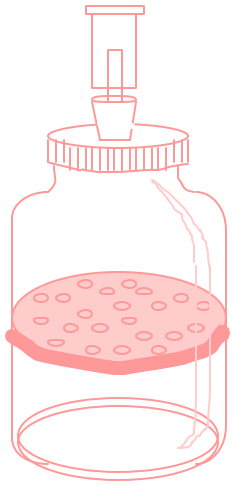
• Small-scale fermentations are very useful in research because they allow replications, assessment of multiple variables in a controlled way, mitigation of field and processing variability as a confounding factor, and the conservation of fruit resources. This is particularly important for viticultural field trials where the field design generally results in smaller fruit lots than those required for production scale winemaking. However, the correlation between the ultimate chemical composition of small versus production scale wines has not been adequately determined. Specifically, whether the extraction they achieve is representative of commercial-scale fermentations has been questioned. These authors decided to compare the resulting Pinot noir wines of a *micro-fermentation* and a *commercial fermentation.*

• Here is how the **commercial winemaking** was conducted. Grapes were destemmed, crushed, and divided into 4.5 ton open-top fermentors. Then, they underwent 4 days of cold-soak (7°C). The cap was mechanically punched down once daily during cold-soak, then twice daily with an additional pump-over during alcoholic fermentation. Samples were taken every 2 days. The tanks were pressed on day 10 using a bladder press.

• And here is how the **microscale winemaking** was conducted. The grapes (3.5 kg) were destemmed by hand, crushed with a hand-operated crusher and divided into 4-liter jars equipped with a fermentation airlock and a plastic screen to keep the cap submerged (a photo appears in the original paper). Berries were treated to a 4 day cold-soak (7°C). Jars were blanketed with dry ice at all times. Samples were taken every 2 days with a plastic syringe fitted to a long tube. Jars were pressed on day 14 using a Buchner funnel fitted with a rubber stopper and an Erlenmeyer filtration flask.



Microscale fermentation vessel
(4 liters)

• **Comparison of temperature control.** During the cold-soak, the commercial scale fermentation failed to reach the target temperature due to cooling inefficiency. In contrast, the microscale fermentation target temperature was easily achieved by controlling the temperature of the room.

• **Comparison of rate of phenolic extraction.** 1) The commercial fermentation had higher phenolic concentration (proanthocyanidins and monomers) than the microscale one. In fact, had the wines been pressed on Day 8, the phenolic concentration of the microscale fermentation would have been half that of the commercial one! (For this reason, microscale fermentations were allowed an additional 4 days of post-fermentation maceration, after which their phenolic levels still lagged behind). 2) Microscale fermentations showed a late "spike" of red pigments and skin proanthocyanidins which was absent in the commercial scale fermentations. The authors attribute this to the longer maceration of the smaller fermentations having the effect of enhancing grape tissue breakdown. *[Editor's note: However, a critical factor here is the differences in temperature attained by the two different scales of winemaking. Temperature dramatically affects extraction as well as rates of polymerization and loss of volatile compounds.]*

• 3) The largest extraction difference observed between the two fermentation scales was at the level of seed phenolic compounds. Flavanol extraction started on Day 4 for the commercial fermentations, but only on Day 8 for the microscale ones, remaining low throughout the whole fermentation. [*When I emailed one of the authors regarding how they could track whether a given wine component was of skin or seed origin, he kindly explained that they did that by determining the tannin subunit composition in the skin and seed tissue prior to fermentation, and then comparing it with the wine compound whose origin they wanted to find.*]

• **Comparison of final phenolic profile**. 1) Commercial wines had higher *flavanol monomers*, as well as higher *proanthocyanidin* concentrations (with no difference in degree of polymerization). 2) Interestingly, microscale fermentations had higher *anthocyanins* and higher *color intensity* (with no difference in hue). The authors believe it is possible that the lower anthocyanin levels in the commercial fermentations may be due to their higher rate of incorporation into polymeric species due to the increased oxygen availability ~~of~~ in the commercial fermentations (compared to a dry ice-blanketed jar).

• So, to summarize, microscale fermentations have pluses and minuses.
Some pluses are:
- the option to **conduct replications** of any particular treatment;
- the option to compare many treatments;
- variability across replicates is very low;
- the use of dry ice minimizes oxidation (as confirmed by the low volatile acidity).
The main minus is:
- **the extraction profile is not representative of commercial fermentations**.

Despite the above drawback, the authors believe that microscale fermentations remain highly valuable in research, as they allow investigation and rapid assessment of a wide range of treatments that would be impossible to accommodate with large fermentations. Still, they believe the microscale fermentor used here could be modified to improve extraction. For instance, temperature could be set slightly higher to compensate for lower extraction, or a punch-down device could be added. *[I think, perhaps, a magnetic stirrer could also be incorporated to maintain the phenolic gradient between the liquid and solid phases at all times.]* This research has the tremendous value of opening our eyes regarding what small-scale fermentations can do for us, and what they cannot. *[Editor's note: These findings are consistent with the Master's dissertation conducted by Karna Sacchi at UCD. She discovered that extraction is dependent upon both the build up of a cap and the elevated temperatures attained by that cap.]*

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