Science and the Art of Winemaking

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Loxton Cellars, Glen Ellen, CA
Unlike most agricultural products, wine can be a luxury product (>\$20/bottle)

People pay more for perceived “quality”

This can be a result of better marketing

Or it can be better wine!

Better wine results from:

- better starting ingredients (grapes)

- production that maximizes character and protects quality
Fermentation is done by yeasts

Bacteria do a second fermentation

Glucose

2 ADP → 2 ATP

2 NAD⁺ → 2 NADH

2 Pyruvate

2 Ethanol

2 Acetaldehyde

2 CO₂
How to get better grapes?

• Match variety with climate
  - heat summation requirements change for different varieties
    low for Chardonnay, high for Cabernet
  (in degrees F>65)

• Farming practices
  - manage airflow and sunlight in vine and fruit zone
  - grow enough leaves to ripen fruit but then want energy to fruit
  - not vine growth (by managing water stress and nutrition)
  - want uniformity across vineyard blocks
The vines are trained upwards to allow sunlight into the fruit zone
- increasing color and minimizing mold and rot,
  getting better pH and sugar
Main Flower:

Calendula

Fertile soils
Main flower:

Prickly oxtongue

Wet soils
Estate: same grape (Syrah) and same climate

Red: dry soils, low fertility, irrigate early, till alternate rows, roots for dry soils, pick early, make red wine

Blue: more vigor, irrigate later, no till to allow weeds to compete, pick later, make red wine

Purple: Wet soils, roots to match this, no till to help dry out soils, 35% bigger berries, no irrigation, make rose wine

Blue #2: irrigate late, till alternate rows, pick last, make dessert style wine
Better winemaking 1:

You must still pick the grapes on the right day!

Picking decisions:

based on:  flavor
          skin and seed maturity
          weather
          scheduling
          picker availability
          pH (has implications for microbial stability)
          sugar (determines alcohol)
          vine and grape condition

These are very important
HOW NON-ALCOHOLIC WINE IS MADE
Reverse Osmosis

ALCOHOLIC WINE

MULTIPLE PASSES THROUGH PROCESS TO COMPLETELY REMOVE ALCOHOL

WINE CONCENTRATE

WATER

DISTILLATION

ALCOHOL + WATER
plus a few others: ethyl acetate & acetic acid

SEMI-PERMEABLE MEMBRANE

Pump
Some Wine Components and Their Molecular Weights

<table>
<thead>
<tr>
<th>Wine Component</th>
<th>Molecular Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>18</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>44</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>44</td>
</tr>
<tr>
<td>Ethanol</td>
<td>46</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>60</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>88</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>90</td>
</tr>
<tr>
<td>Malic acid</td>
<td>134</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td>150</td>
</tr>
<tr>
<td>Volatile phenols</td>
<td>120 to 150</td>
</tr>
<tr>
<td>Glucose/Fructose</td>
<td>180</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>&gt;300</td>
</tr>
</tbody>
</table>

- Acetic acid from bacteria
- Volatile phenols from errant yeast
- smoke taint?
Better Winemaking II

Fermentation methods: temperature
yeast
Extraction techniques

These do not seem so important, it seems a forgiving system.

For Loxton Cellars: Open tanks with screens
Manual mixing of skins and juice, 2-4X per day
Extraction for 3-5 days prior to fermentation
Fermentation for 7-15 days, Temperature<92F
No added yeast
Where do the yeast come from – added or resident?  
- work done by ETS Lab, St. Helena, CA

The yeast seem to be resident to the winery
Chemistry and aging in barrels

Wineries spend a large part of their budget on wine barrels.

French oak barrels are almost $1000 each, from Missouri about $400.

There is much romance in barrels, but is there any science?
RAW MATERIAL VARIABILITY OCCURS BOTH

→ Inter-individual and → Intra-individual

Snakkers, 2000; Doussot, 2000, 2002
Feuillat, 2003, Prida, 2006

Masson et al, 1995, 1996; Mosedale et al., 1996

2 sessile oaks, 20 feet apart in the Tronçais forest

Dr. Marie-Laure Badet-Murat
Ellagitanin content of 4 staves coming from external (Out) / internal (Int) concentric rings of 2 different trees of the same forest & specie (Q. robur)*

Ellagitannins in oak wood varies:
- from one tree to another
- according to the position of wood in the tree (radial gradient)

*Masson et al, 1995, 1996; Mosedale et al., 1996
3 classes of ellagitannin concentrations

Dr. Marie-Laure Badet-Murat
Measure ellagitannin content of EACH STAVE prior to coopering barrel using near infrared spectroscopy (NIRS).
RELATION BETWEEN TANNIN CONTENT & GEOGRAPHIC ORIGIN?
Trial done in collaboration with the ONF and Château LATOUR

Wood origin: 9 forests in France

Wood seasoning: 30 months
Wood toasting: gradual 170
225L Barrels in DUPLICATE

TRIALS ON 2013 & 2014 VINTAGES
WINE: LATOUR BLEND (95 % CS)
BARRELING: January after MLF
AGING PERIOD: 15 months (analysis carried out at the end of aging)
RELATION BETWEEN TANNIN LEVEL & GEOGRAPHIC ORIGIN?

Trial done in collaboration with the ONF and Château LATOUR

2013 VINTAGE

2014 VINTAGE

Dr. Marie-Laure Badet-Murat
RELATION BETWEEN TANNIN LEVEL & GEOGRAPHIC ORIGIN?

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2014 VINTAGE

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“……maximum concentrations increased by approximately one order of magnitude with each 25 °C increase in toasting temperature”


Furfurals and 5-methyl-furfurals posses caramelization characters like caramel and butterscotch
Evolution of DO during aging: Impact of TP

Médoc, Pauillac, CS – 2015
Barreling after MLF (aging 12 months)

| ABV (% Vol.) | 13.47 |
| pH          | 3.66  |
| TPI         | 62    |

1 day after BARRELLING

RACKING
Conclusion:

In an almost infinitely complex system, the modern winemaker must have knowledge of earth sciences, biological sciences, chemistry, biochemistry and microbiology....as well as a clear understanding of “quality” and a sense of ”style”.

At the end of the day, however, it is the consumer that makes the determination of what is of value.....and a degree in psychology might be just as important!