

Science and the Art of Winemaking

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Loxton Cellars, Glen Ellen, CA

Wine has been made for thousands of years!

Unlike most agricultural products, wine can be a luxury product (>\$20/bottle)

People pay more for perceived “quality”

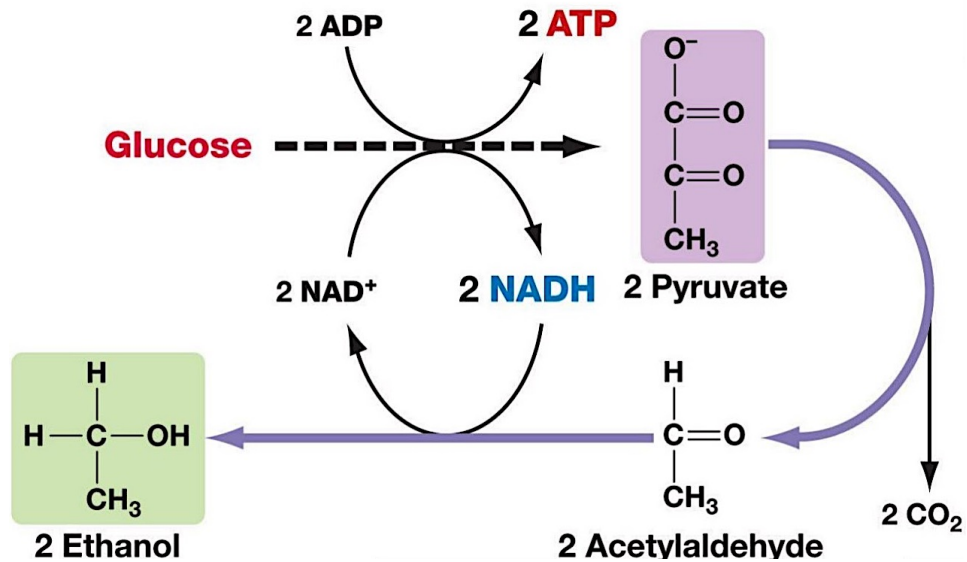
This can be a result of better marketing

Or it can be better wine!

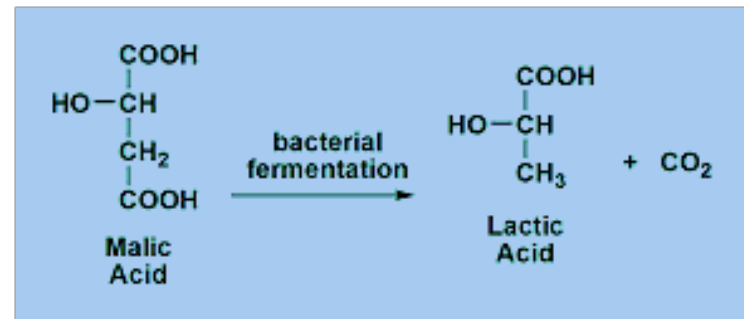
Better wine results from:

- better starting ingredients (grapes)**
- production that maximizes character and protects quality**

Fermentation is done by yeasts



Bacteria do a second fermentation









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**



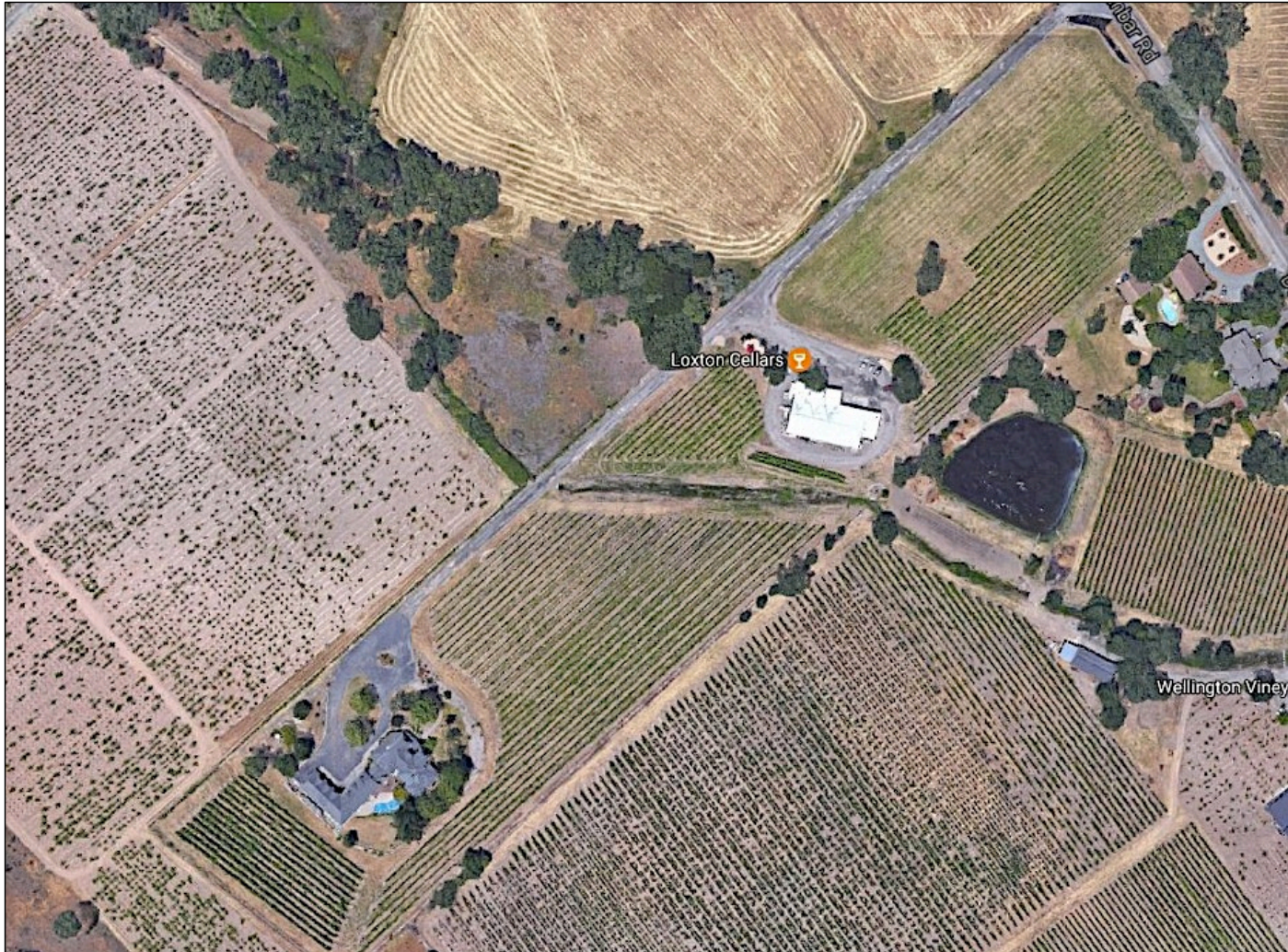
Loxton

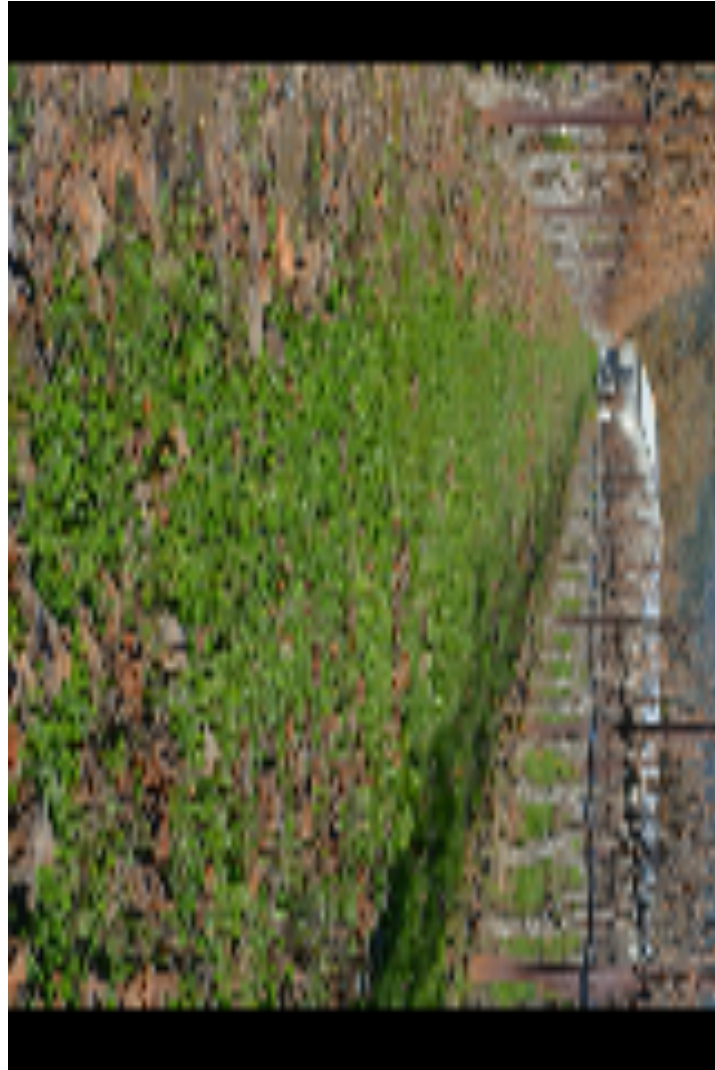
**Rossi Ranch
Glen Ellen
Sonoma Valley**



**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

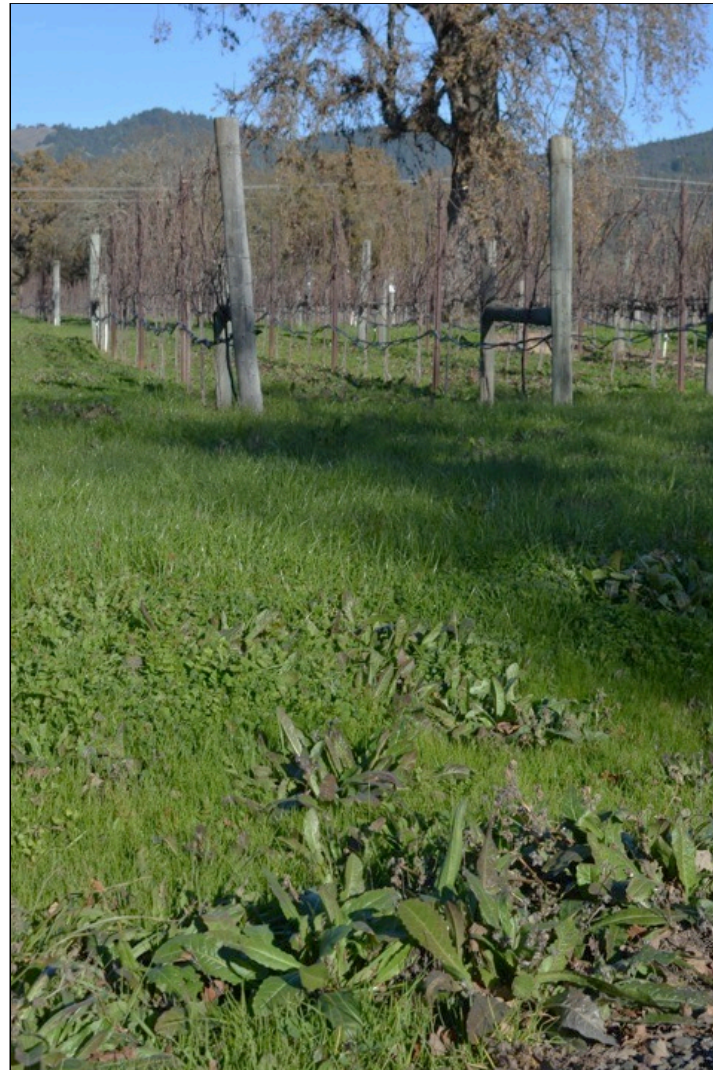
Fertile soils



Main flower:

Prickly oxtongue

Wet soils





Estate: same grape (Syrah) and same climate

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



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

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

Better winemaking I :

You must still pick the grapes on the right day!

Picking decisions:

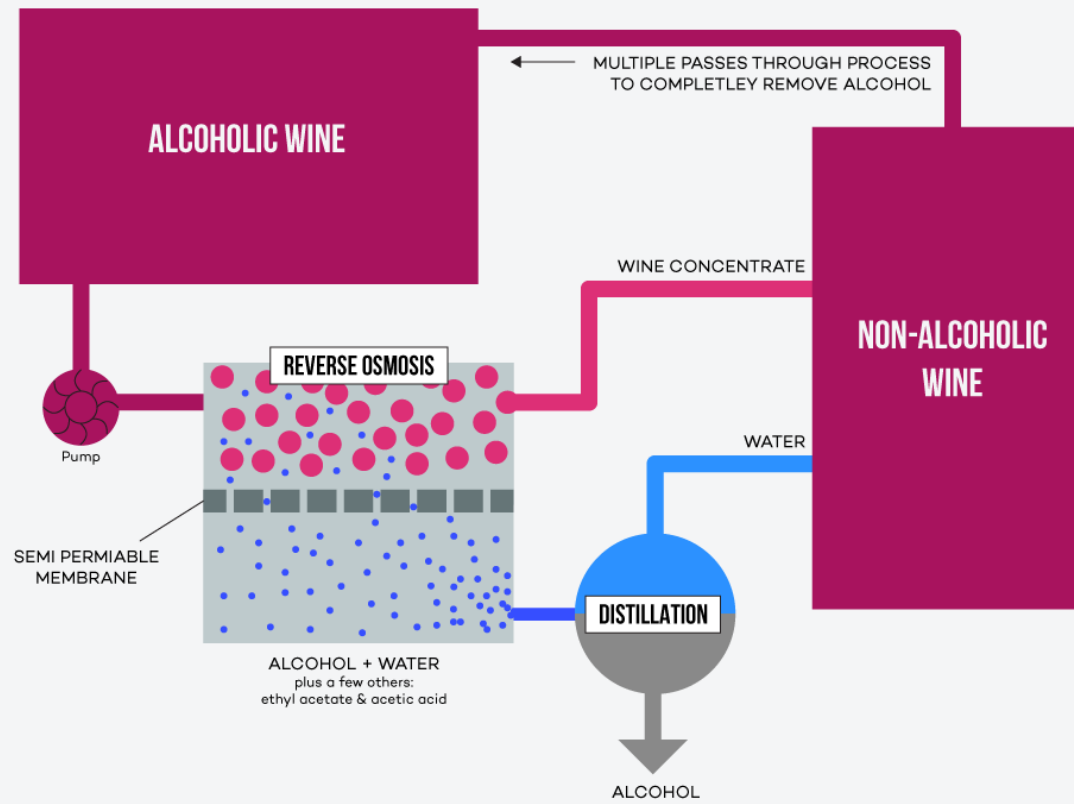
based on:

- 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



Some Wine Components and Their Molecular Weights

Wine Component	Molecular Weight	
Water	18	
Carbon Dioxide	44	
Acetaldehyde	44	
Ethanol	46	
Acetic acid	60	
Ethyl acetate	88	
Lactic acid	90	"tight" RO ↑
Malic acid	134	
Tartaric acid	150	
Volatile phenols	120 to 150	"loose" RO ↑
Glucose/Fructose	180	
Flavonoids	>300	

- **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.

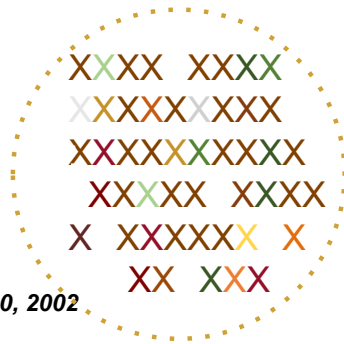
French oak barrels are almost \$1000 each, from Missouri about \$400

There is much romance in barrels, but is there any science?

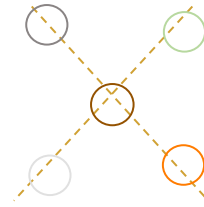


RAW MATERIAL VARIABILITY OCCURS BOTH

→ Inter-individual **and** → Intra-individual



*Snackers, 2000 ; Doussot, 2000, 2002 ;
Feuillat, 2003, Prida, 2006*



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



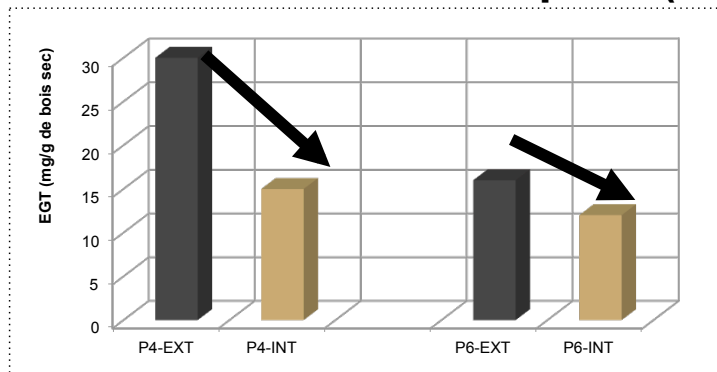
**2 sessile oaks, 20 feet apart
in the Tronçais forest**

Dr. Marie-Laure Badet-Murat

RAW MATERIAL VARIABILITY

→ Intra-individual

Ellagitannin content of 4 staves coming from external (Out) / internal (Int) concentric rings of 2 different trees of the same forest & specie (Q. robur)*



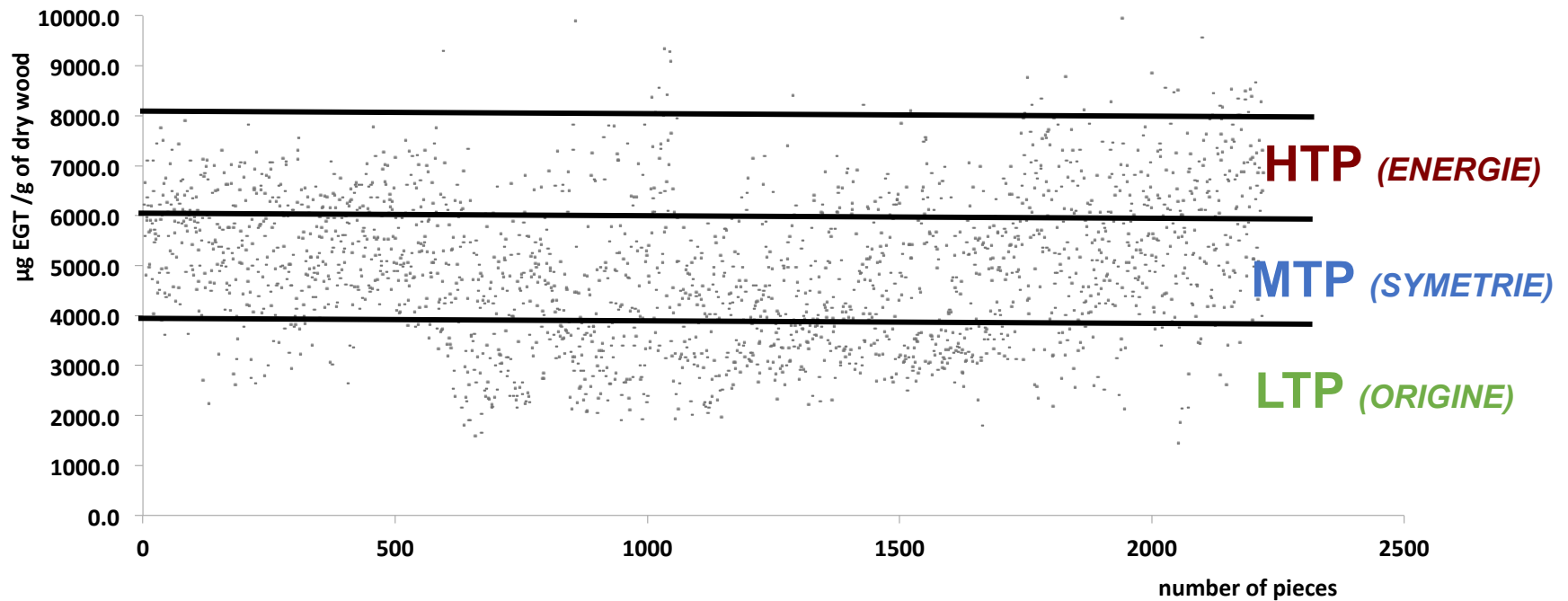
Ellagitannins in oak wood varies:

- 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

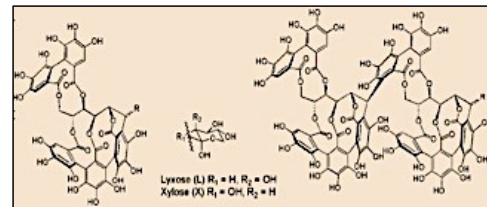
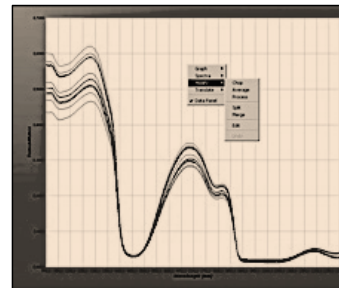
Dr. Marie-Laure Badet-Murat

→→ 3 classes of ellagitannin concentrations



OUR ANSWER: A NEW APPROACH TO SORT OAK WOOD TANNIN POTENTIAL (TP)

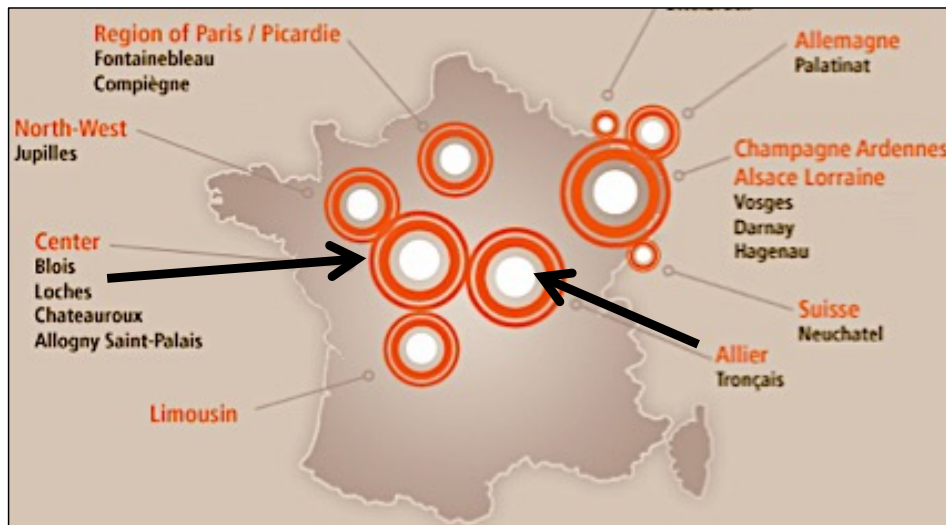
→→ Measure ellagitannin content of EACH STAVE prior to coopering barrel using near infrared spectroscopy (NIRS).



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)

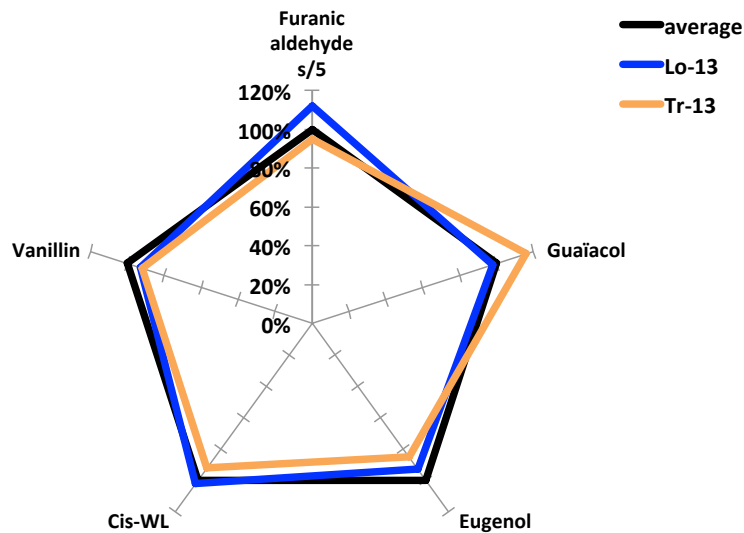
BARRELING: January after MLF

AGING PERIOD: 15 months (analysis carried out at the end of aging)

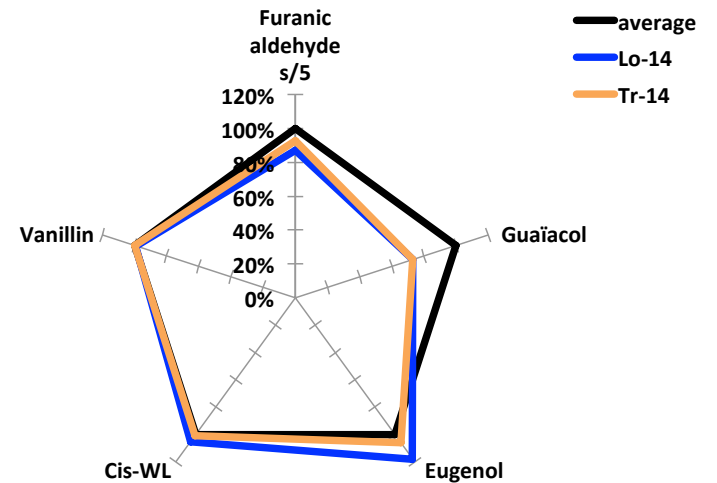
RELATION BETWEEN TANNIN LEVEL & GEOGRAPHIC ORIGIN?

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2013 VINTAGE



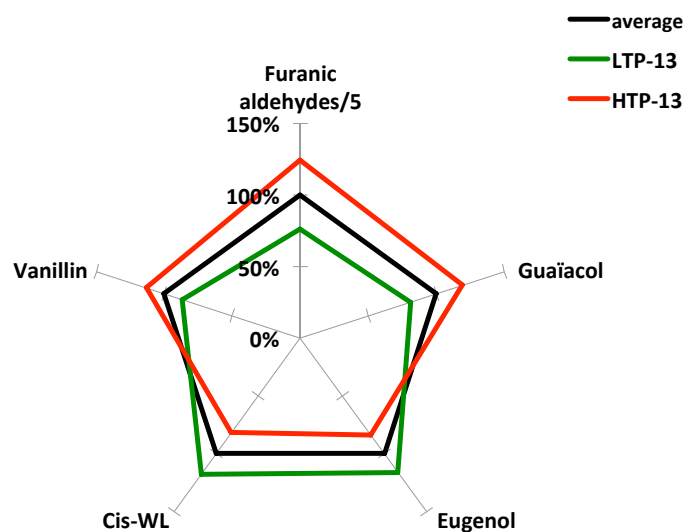
2014 VINTAGE



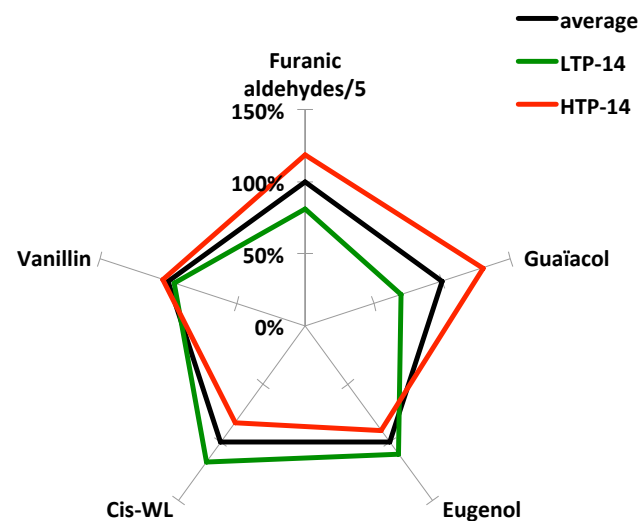
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2013 VINTAGE



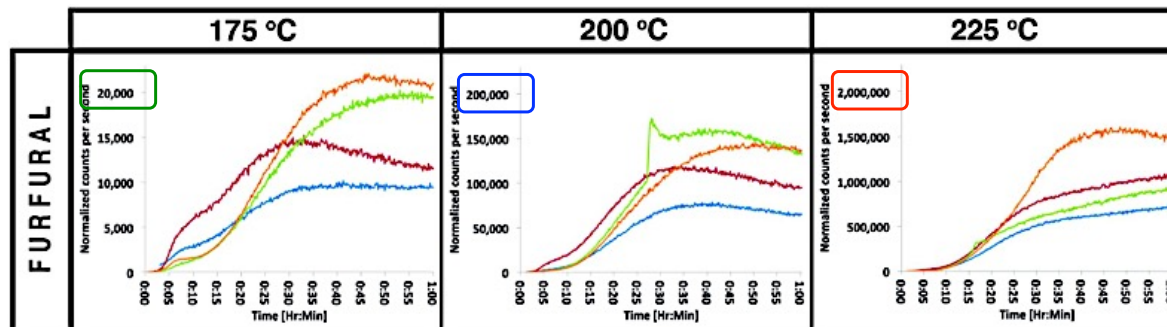
2014 VINTAGE



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

Farrell, R. R. et al. Real-Time Mass Spectrometry Monitoring of Oak Wood Toasting: Elucidating Aroma Development Relevant to Oak-aged Wine Quality. Sci. Rep. 5, 17334; doi: 10.1038/srep17334 (2015).



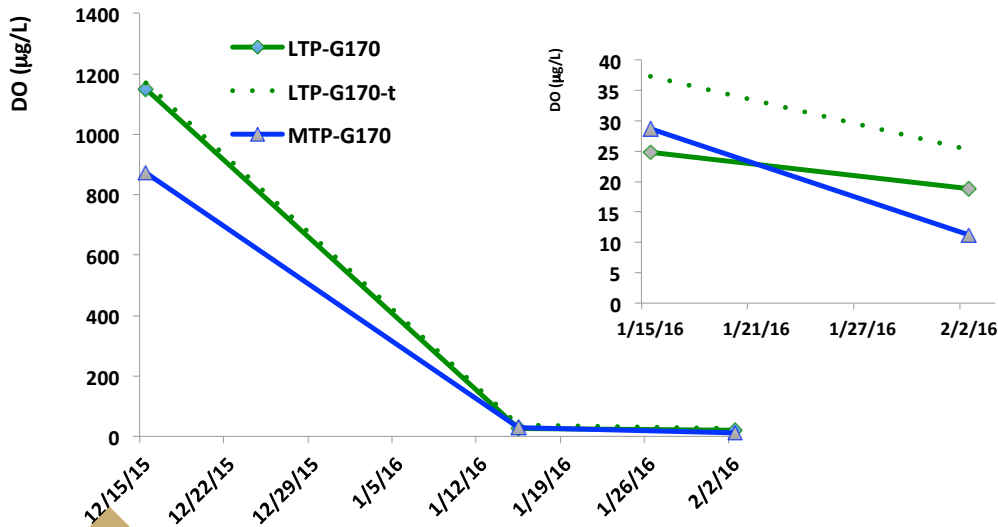
Furfurals and 5-methyl-furfurals possess caramelization characters like caramel and butterscotch



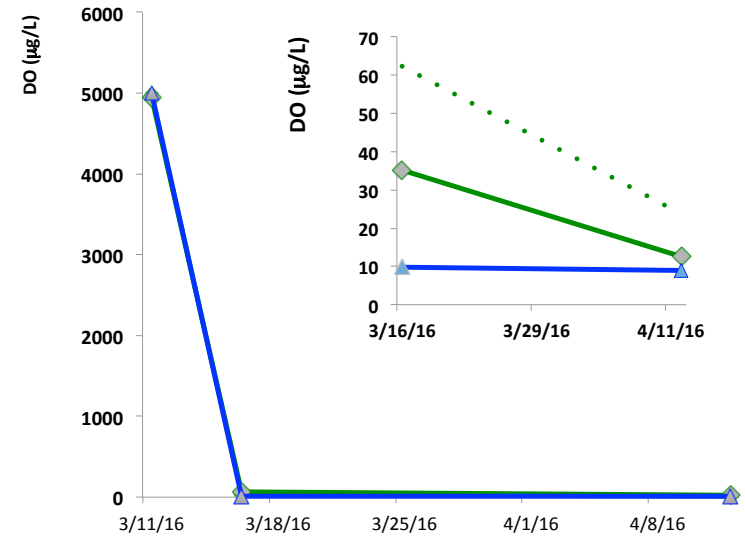
Evolution of DO during aging: Impact of TP

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

ABV (% Vol.)	13,47
pH	3,66
TPI	62



1 day after BARRELING



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!