

Wine making

History of Wine

- Wine was first consumed in areas of modern Iran around 5000 to 6000 BC.
- Wine in the 17th century was available in large quantities and was safer to drink than water and some ales
- By 1970 wine making became something not just for the experts.
 - Improvement in technology led to standardization of taste & styles.
 - Europe is the major producer of wine.
- Canada major wine regions are Ontario, British Columbia, Quebec & Nova Scotia.
 - Canadian wine economy is a \$6.8 billion industry (approximately \$31 of domestic economic impact.) producing 220 million bottles of wine a year.
 - Wine in Canada provides a tourist attraction with 1,600 vineyards
- Revitalization of the ON industry
 - 1974 province issued first winery license since 1929 to Inniskillin
 - Ontario's Wine economy \$3.3 billion.

Wine Categories

- Wines are classified based on the %alcohol/vol

Grapes varieties

- *Vitis vinifera* – European grapes are all of the same species. Not winter hardy and sensitive to NA molds. Good acid, sugar, and tannins
- *Vitis labrusca* – Wild NA varieties. Highly resistant to cold and pathogens. Strong flavour, low sugar, high acid, low tannin.
- *Vitis riparia* – Wild NA varieties. Highly resistant to cold, and pathogens. Moderately strong flavour, low sugar high acid.
- American Hybrids (all three) - Grapey Flavour, winter and disease hardiness.
- French hybrids – Vidal blanc, Baco noir, Marechal Foch. Sugar and acid like vinifera but less tannin. More winter hardy.

Grapevine propagation

- Vegetatively – propagated plant (identical plants will grow)
- Union of a rootstock (in ground) and scion (above ground) to provide disease protection, specifically phylloxera, and desirable fruit characteristics

Growth Requirement

- Natural climbers
- Commercial production
 1. High light requirement for fruitfulness.
 2. Indeterminate growth habit – must be hedged to control growth
 3. Requires support – hence need for trellis
 4. Well drained soils.

Viticulture

- Factors that impact wine quality: Grape variety, climate and weather, Site climate topography, soil drainage & fertility.
- Different varieties need different heat units.
- Poor wine quality can result from growing in the wrong site.

Veraison – Grape ripening

- Colour change in red cultivars, sugars begin to accumulate
- During ripening:
 1. Grape berry sweels
 2. Sugars accumulate
 3. Acids diminish
 4. Tannins and pigments form
 5. Aromas are formed

Sugar

- Sugar in juice is measured by refractometry or hydromrtry.
- Sugar converted to alcohol by yeast.
- Attenuation = fermentation of sugar to ethanol
- Imparts balance, weight/viscosity, “richness”

Acids

- Most acids originate from the grapes but some come from the fermentation process
- Acid intensity depends on type and concentration of acid
- Salt – minor role in wine, Contribution in: wine that has been chemically de-acidified, High pH wine, Enhanced by acidity.
- Bitterness – Flavonoid phenolics main bitter compounds in wines. Tannin polymers precipitate = decline in bitterness.
- Bitter compounds; alcohol, glycosides, terpenes, alkaloids
- Sensory interactions; sweetness, acidity accentuate bitterness, temp effects.

Tactile sensations

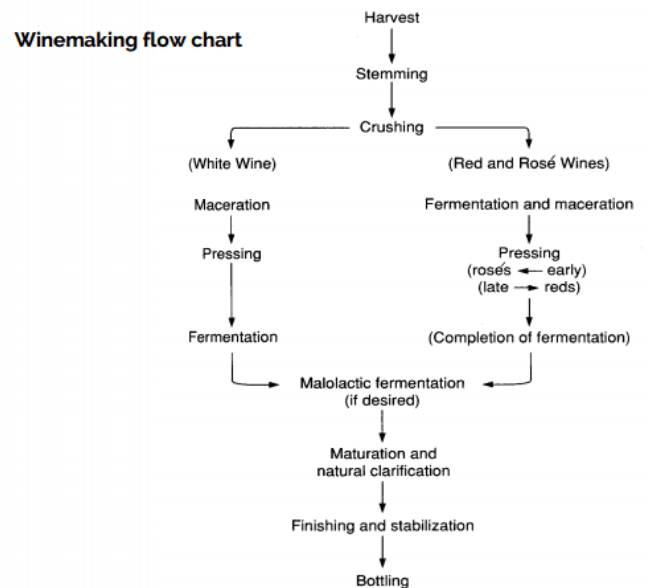
- Wine components with tactile properties: Carbon dioxide, ethanol, glycerol, tannin, sugar.
- Harvest decision is dependent on the weather forecast and monitoring the acid and phenolic levels. Time of day to pick.

Wine making process

- Harvesting
 - Machine low cost immediate production.
 - Hand high cost storage option available.
- Sorting – take only ripe grapes & remove MOG
- Crusher- destemmer
 - Crusher – crush the grapes using rollers that allow seeds to pass through and not be crushed.
 - Destemmer – separates the seeds and stems from the juice and skin.
 - Must is mostly sugar and water.
- There are several different types of presses used in the press process

White wine making

- Must sits to extract aromas, phenolics from skins and seeds prior to pressing.



- Pressing separates, seeds from the must **before** fermentation (bladder press most common)
- Some whites need to be clarified before fermentation.
- Juice are pumped into tank to refrigerate for 24hr
- Settled juices are then racked off their lees

Red Wine Making

- Pressing separates, seeds from the must **after** fermentation
- Unpressed red grapes go through maceration and fermentation
- Ethanol produced during fermentation helps extract components out of the skin and seeds
- Extraction of colour pigment
- Fermenting the must is pumped over the cap to max extraction through the skin/seed to juice contact.

Alcoholic fermentation

- Sugar + oxygen = CO₂ + ethanol + heat
- Major sugars are glucose or fructose
- Anaerobic Fermentation: 1 glucose = 2 CO₂ + 2 ethanol; 54 Kcal

Sugar additions

- Amelioration (must/juice increase production), Chaptalization (increase alcohol concentration), Edulcoration (sweetens wine)

Yeast

- *Saccharomyces cerevisiae*
- Different strains can impact the aroma and mouth feel of the wine
- For picking strains you need to consider, alcohol tolerance, compatibility with Malolactic fermentation

The fermentation process

- Whites and roses fermented in cool -15 to -18°C
- Reds use the heat generated by fermentation 25 to 30°C

Malolactic fermentation

- Softens wines acidity
- Uses *Lactobacillus*, *Oenococcus oeni*, *Pediococcus*
- Takes several weeks.

After Fermentation

- Whites racked and pumped into clean tanks; sulfur dioxide levels are adjusted
- Reds are pressed and pumped into stainless steel tanks and settled, racked, and pumped into either oak barrels or tanks

Purpose of oak aging

- Slows oxidation of wine, softens the wine, stabilizes the colour, enhances flavour.

Toasting

- Softens the phenol extraction, creates caramelized compounds, creates aromatic compounds.

Racking and clarification

- Wine is removed from barrels off lees after 9-12 months and pumped into stainless tanks
- Naturally by settling and racking or intervention by filtration or centrifuge
- Fining: addition of agents which agglomerate and settle the must or new wine.

Finishing

- A group of wine operation to make sure that the wine once bottles will remain relatively stable. (Physical & chemical, microbiologically)
- Microbial stability
 - Free of fermentable sugar
 - Sterile filtration
 - Sulfur dioxide
 - Sorbic acid
 - Modern winery hygiene

Alcoholic fermentation

- Process of deriving energy from oxidation of organic compounds.
- The electron acceptor in this is acetaldehyde

CO₂ & heat

- Process takes place somewhere where CO₂ can escape without letting oxygen in

Nitrogen

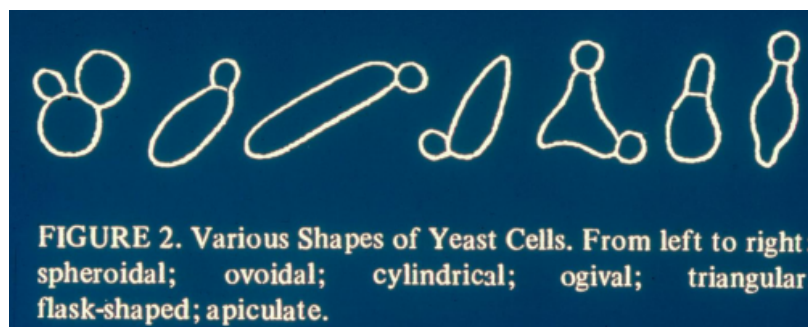
- Most important yeast nutrient
- Assimilable nitrogen is the only source that can be used by yeast.
- Proline cannot be used by yeast
- [Nitrogen] is impacted by grape variety, vintage, vineyard microclimate, management practices.
- Wineries typically measure the YAN concentration in the must and will adjust if the concentration is less than 150mg/L
- Not enough nitrogen = slow fermentation

Fermentation supplements

- Di-ammonium phosphate (DAP)
- Ferm-aid

Selection Criteria

- Cold tolerant
- Ethanol tolerance
- Sugar tolerance
- Stuck fermentation
- Non-foaming
- Flocculating
- Fermentation bouquet
- Terpene release
- Estery bouquet
- Anything else you can imagine



Brettanomyces bruxellensis

- Very hard to get rid of.
- Lives in wood barrels
- Produces vinyl phenols from wine phenolic compounds with sensory characteristics of horse, band-aid, burnt plastic.
- Spread through infected wine and wooden/plastic containers

Hanseniaspora

- Budding
- Found on grapes
- Apart of the normal early fermentation flora
- Produces ethyl acetate; High ethyl acetate = wine fault

Zygosaccharomyces

- Spoilage yeast (fructophilic)
- Ellipsoid shape & reproduce through multilateral budding
- High tolerance of stressful conditions (high sugar, ethanol, acidic pH)
- Common source of contamination = grape must or sweetened vines.
- Spoilage due to secondary fermentation in bottle.

How sparkling wines are similar

- High acidity on grapes
- 2nd fermentation produces CO₂
- Most incorporate a way of keeping gas dissolved under pressure in the wine while separating it from the lees

Three ways to make wine sparkle

1. Ferment a still wine a second time in a closed bottle by adding yeast and sugar.
 2. Re-ferment wine in bulk in a large tank, remove and bottle under pressure.
 3. Inject it with CO₂.
- Fruit or yeast driven

Tirage

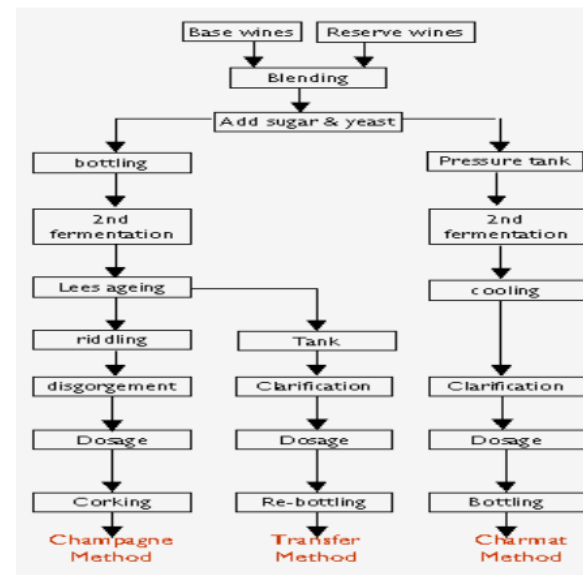
- Yeast added to sugared juice and added to the cuvee
- Sugar is calculate to give 5 atmospheres pressure in the final product.
- After this it is sent to the cellars for the second fermentation.

Yeast autolysis

- Enzymatic breakdown of dead yeast cells
- Occurs after the 2nd fermentation and last a long time
- Adds aromas and flavours
- Releases “reducing enzymes” which inhibit oxidation
- Absorbs essential yeast nutrients.
- Reduces need for tartate precipitation
- Riddling = inverting the bottle to let it set

Icewine

- Late harvest dessert wines
- Grapes have naturally frozen
- 1st made in Canada in 1980's



- Challenges
 - Fermentation are slow
 - Wine yeast only double 2-3 times
 - Other natural wild yeast can compete
 - Difficult to reach target ethanol
 - High sugar = stress response in yeast
 - High levels of acetic acid and glycerol in the wine.
- Temperature
 - Needs to drop to -8 or colder
 - The longer they are out there the more susceptible to disease and predation (bunch rots)
- Harvesting and pressing the grapes
 - Below -8°C for harvesting and pressing
 - If too cold the juice will be too concentrated
 - Juice is concentrated to at least 35 Brix
 - Berries kept frozen till pressed
- Pressing frozen grapes
 1. Add frozen grapes to press
 2. Pressing
 3. High brix juice
 4. Frozen 'cake'

Yield

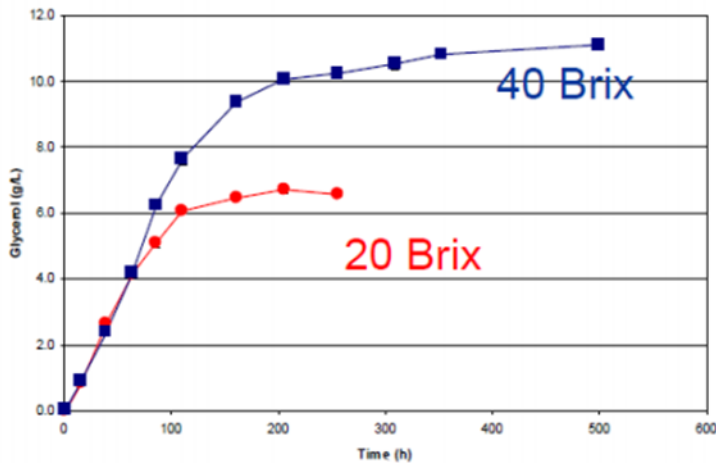
- 1 tonne of grapes = 300L at 40 Brix
- Concentrated juice cause yeast cells to shrink

Juice composition

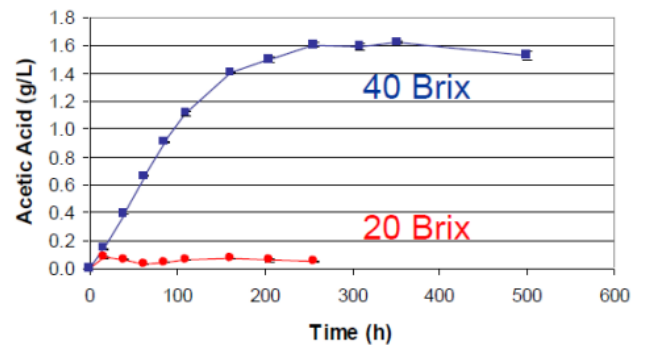
298 Vidal icewines

	Soluble Solids (°Brix)	Yeast Assimilable Amino Acid Nitrogen (mg N/L)	Ammonia Nitrogen (mg N/L)	Total Yeast Assimilable Nitrogen (mg N/L)	pH	Titratable Acidity (g/L tartaric acid)	Malic Acid (g/L)
Avg	39.3 ± 1.7	498 ± 105	57 ± 19	555 ± 120	3.38 ± 0.16	10.5 ± 1.5	7.8±1.3
Low Value	32.0	182	6	188	2.96	7.0	4.9
High Value	46.1	738	118	846	3.98	14.6	11.0

Glycerol production



Acetic acid production



overcoming the challenges

1. Juice concentration; keep below 42 Brix
2. Use enough yeast (inoculate at 0.5g/L)
3. Allow yeast to get use to concentrated juice.
4. Give yeast vitamins and minerals to help them overcome the stress

What is Sherry

- Fortified white wine
- Additional alcohol added to 20%

How's is sherry made?

- 2 basic styles:
 - Fino: pale, dry, lowest alcohol, biological aging
 - Oloroso: darker, dry or sweet, oxidative agent
- Grapes used Palomino fino and Pedro Ximenez

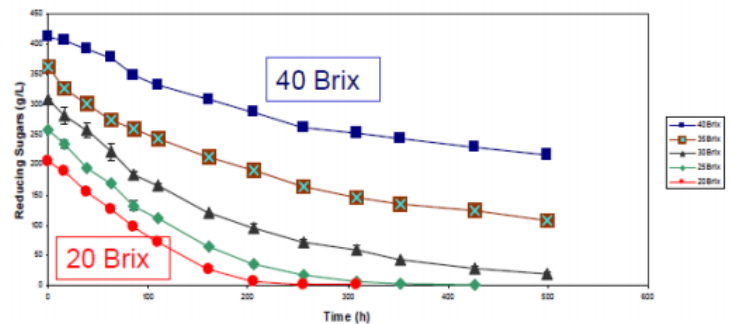
Fortification

- Depending on the style, finished wine is fortified with grape spirit to 15.5 – 22%
- Lower % alcohol allows formation of “flor” for fino; protects from oxidation
- Oloroso 16 to 18% fortification; flor is killed

Fino Sherry and Flor

- Good film-forming yeast cells
- Floats on surface of a wine
 - Biological aging
 - When fermentable sugars are used up, these yeasts can use oxygen from the atmosphere to produce waxy coating that floats.
 - Produces acetaldehyde (rancio)

Reduced sugar consumption



- Taste profile: pale, straw colour, pungent nose, rancio, dough, almonds, dry light taste.
- Amontillado
 - Both biological and oxidative aging
 - Partially aged with flor yeast
 - Yeast killed with increased fortification and further aged
 - Taste profile: Amber to mahogany colour, slight rancio with nutty nose, light, smooth palate, dry to off-dry styles
- Oloroso
 - Oxidative aging
 - No flor yeast
 - Barrel aged
 - Higher alcohol content
 - Taste profile: intense mahogany colour, deep nutty, caramel aromas, smooth, full bodies with highest viscosity and long finish, Dry – sweet styles

Solera system: Fractional blending

- Wine is withdrawn from the group containing the youngest wine in the solera to top up the older wines.
- Ensures that the flor does not die and kept alive for 6 years

Flor yeast

- Alcohol ranges from 13 – 15%
- *S. Beticus* found in about 75% on soleras, especially on younger wines
- *S. montuliensis* found in older wines
- Commercial flor yeast strains that can be used to inoculate the wine post fermentation.

Effects of flor yeast

1. Protection of oxygen
2. Decrease of sugars (dry style)
3. Decrease of the ethanol metabolism
4. Decrease of glycerol
5. Increase of acetaldehydes.

SO₂ management

- Forms of sulfur dioxide in wine
- Free SO₂; active as antimicrobial and antioxidant

Monitoring SO₂

- Free SO₂ both good and bad in wine making
- Constantly have to monitor and adjust levels
- Ripper method titration is most common method measuring free SO₂
- Potassium metabisulfite is the most common form of SO₂ addition

SO₂ as a fault

- Too much is a bad thing
- May inhibit MLF
- Decolourize wines
- Dominate wine aroma
 - Sharp irritating aroma

Visible wine faults

- Improper stabilization
 - Growth by micro-organisms
 - Precipitates
- Bubbles in still wine
 - 2nd fermentation
- Oxidation
 - Premature browning
 - Improper closures
 - Exposure to oxygen during winemaking

Aroma wine faults

- Undesirable volatile compounds as a fermentation by-product

Taste wine faults

- Results in an unbalanced wine
- Too much sugar, acid, astringent
- Mouthfeel
 - Too astringent, too much alcohol.

Cork

- Bark of the cork tree
- Western Mediterranean

Cork taint

- % of wines will show cork derived taints
- (2,4,6-trichloroanisole) TCA is the compound
- Can contribute to aromatic characteristics

The chemistry

- Wines made from mouldy grapes contaminated oak, poorly washed underground or concrete tanks can contribute similar aromas

Prevention

- Reduce use of chlorine based cleaners
- Some processing changes
- Sanitation and cleanliness
- Screen cork for taint

Volatile acidity

- Organic acids steam-distillable (acetic, formic, propionic, butyric)
- VA = acetic acid + ethyl acetate
- Acetic (vinegar) and Ethyl acetate (nail polish remover)

How formed

- Undesirable microbial activity
- Aerobic metabolism in wine
- Film yeasts
- Ices wine (osmo-regulation)

Prevention

- Fruit/juice
 - Minimize damage
 - SO₂ additions
 - Settling and clarification

- High and early inoculation with *S. Cerevisiae*
- Wine
 - Hold at a cool temperature and low pH

How infection occurs

- Capable of growing in both red and white wines (reds more)
- Population become established over time and then the wine comes into contact with contaminated areas.

How to control

- Decrease wine pH
- Increase SO₂
- Decrease aging temperature
- Avoiding barrels
- Sterile filtration
- Clean winery

Hydrogen sulphide

- Rotten egg smell
- Produced in either early or late fermentation
- How it is produced
 - Greater with higher pH, fermentation temperature and juice solids levels.
 - Nitrogen deficiency in juice
- How to prevent
 - Exogeneous source of nitrogen
 - Carried off with fermentation gases
 - Purging (aeration)
 - Cooperfining
 - Early removal important

Mercaptans

- Reaction of H₂S with ethanol
- Off odour descriptions (ethane thiol) – skunk
- Prevention of H₂S formation critical, very difficult to remove.

Dimethyl disulphide

- Found in red and white
- Low concentrations (may enhance fruit flavour)
- High concentration

Oxidation

- Wine fault resulting from excessive exposure to oxygen
- Oxidation of wine = detrimental
- Prevention important because little remediation once oxidized

Sensory perception

- Low concentration = reduced aroma and flavour intensity
- High concentration = brown pigment, bitterness, Aldehydic notes

Causes of oxidation

- Chemical or microbial contamination
- Post fermentation
- Winery transfer operations

- Bottling and ageing

Mousey taint

- Microbiological fault caused by spoilage yeasts in wine
- 2-acetyl-3,4,5,6-tetrahydropyridine responsible for taint
- Prevention = adequate sulfur dioxide levels maintained during the winemaking and wood maturation.

Diacetyl

- Produced by *Oenococcus oeni*
- Low levels contributes to sensory aroma
- High concentration buttery flavour

Geranium taint

- Metabolism of potassium sorbate by lactic acid bacteria
- Proper sterile filtration and SO₂ management to prevent LAB infection
- Low sensory threshold
- Aroma of geranium leaves

Ropiness

- Production of dextrans and polysaccharides by certain lactic acid bacteria
- Increased viscosity that lends itself to slimey or fatty mouth feel
- Cause: improper SO₂ management