### EU definition of "wine"

The product obtained exclusively from the total or partial alcoholic fermentation of fresh grapes, whether or not crushed, or of grape must.

### Grape maturity

One of the most decisive factors in determining wine quality and style.

- Physiological changes - phenolics & taste
- Biochemical changes - sugars & acids

### Key questions for harvesting

- When
- Forecasting
- Preparing
- How (manual vs machine)

### Harvest date

Grape ripeness
- Sugar
- Acid
- Health
- Phenolic ripeness

Agrochemicals (fungicides, insecticides, herbicides, pesticides, etc)
- Withholding period
- Fermentation and health problems
  - E.g. sulphur \(\rightarrow\) hydrogen sulphide
  - Copper \(\rightarrow\) brown haze, toxic copper salts in wine

Weather
- Rain \(\rightarrow\) dilution, grape swelling and bursting
- Hail

Availability of resources (human and mechanical)

Legal restrictions

### Harvesting - Getting ready

- Estimating the crop (sufficient tank space)
- Checking & cleaning equipment and machinery
- Tanks clean and ready for use
- Oenological products (yeasts, sulphur, enzymes, etc)

### Harvesting - Machine vs Hand

Factors to consider
- Quality
- Speed
- Economics
- Feasibility

**Machine**
- Speed, grapes at peak; cheaper labour costs; cool night
- Damage, oxidation, no selection, cost of machinery, flat land, trellis system (no bush nor pergolas)

**Manual**
- Less damage, more selectivity, slopes, less $ for equipment
- High labour costs (10X machine), slower
- For sparkling wine, carbonic maceration (whole bunches); Tokaji, Beerenauslese, Trockenbeerenauslese (selection of grapes); required by law
7. **Harvesting - Transport & Reception**

- Use shallow picking containers
- Less transfer between containers
- Less dumping heights
- Refrigerated trucks
- Minimize delay before processing

**Oxidation**
- Browning, loss of aroma
- CO2/nitrogen blanket; potassium metabisulphite; harvest at night; min delay

**Microbial growth**
- Eliminate rotten grapes; clean equipment; berry integrity; min delay

**Contamination**
- Rain
- Leaves & stalks
- MOG (material other than grape)
- Soil

8. **Key questions for grape processing**

- Sorting
- De-stemming
- Crushing
  - Type of press
  - Amount of SO2
  - Must treatments

9. **Sorting in French**

- Triage

10. **De-stemming**

- Tannin control and ease of processing
- Egrappoir = de-stemming machine
- Most grapes are de-stemmed
- Not for sparkling wines and carbonic maceration
- Not required for machine harvested grapes

**Pros**
- Prevent release of phenolics, herbaceous flavours, MOG
- More efficient pressing
- Remove water and potassium (absorb colour and alcohol)

**Cons**
- Whites: slower pressing and drainage (not for fine wines)
- Reds: compaction of pomace cap; tannins and colour

11. **Crushing**

- Release free-run juice
- Reduce the solid parts of the grape to the correct condition for fermentation and maceration
- Increase extraction of tannin and colour
- Careful not to damage grape seeds
- Not to crush for semi-carbonic maceration (Spain, Beaujolais, Languedoc-Roussillon for Carignan and Grenache)

- Fouloir = crusher

**Equipment**
- Foot or de-stem/crush
- Heat exchanger
- SO2 to reduce oxidation and prevent microbial spoilage
- Use of pectolytic enzymes to release more juice
### Pressing

Use of minimum pressure
Done at grape reception for whites; after fermentation for reds

70% of the total weight

Skin contact for aromatic whites (Sauvignon Blanc, Semillon, Muscat, Riesling, Gewuztraminer, Viognier)
- 5-10 C
- few to 24 hours
- pectolytic enzyme
Finest aromatic wines
- very gentle whole-bunch pressing
- no skin contact

### Types of press

- **Vertical screw press (basket press)**
  - simple and easy; clear must or wine
  - slow, labour intensive; extraction of bitter phenolics; oxidation
  - high-class wineries; champagne

- **Horizontal screw press (e.g. Vaslin)**
  - more efficient in terms of time and labour; simple; can be automated; prevent oxidation with inert gases
  - rather coarse juice; extraction of bitter phenolics; high pressure reduces quality

- **Pneumatic press (e.g. Willmes)**
  - low pressure; good extraction; less bitter phenolics; high quality juice
  - very slow

- **Tank press (pneumatic press with inert gas)**
  - no oxygen contact; high quality juice
  - very slow; costly

- **Continuous screw press**
  - high throughput; less labour-intensive and time consuming
  - poor quality; bitter phenolics

### Must Treatments

- **Before fermentation**

  SO2
  Clarification
  Enrichment or Chaptalisation
  Must concentration
  De-acidification
  Acidification
  Tannin
  Bentonite
  Flavour and colour enhancing enzymes
  Oxygen

### SO2 in winemaking

- **Prevent oxidation and premature fermentation**
- **Kill bacteria (for whites)**
- **Stun weaker yeasts**
- **Improve extraction of polyphenols from skins (for reds)**

Four properties:
- Antiseptic - kills microorganisms (acetobacter/wild yeasts)
- Antioxidant - binds with oxygen
- Antioxidase - denatures oxidase enzymes
- Combines with acetaldehyde (by-product of oxidation)
16. **Four forms of SO2**  
- potassium metabisulphate powder  
- compressed and liquidified SO2 gas  
- SO2 in solution (5%)  
- Burning sulphur tablets or candles

17. **SO2 levels**  
Based on style of wine, health of grapes, pH  
Lower for organic wines

Recommened -  
White: 60-100 mg/l  
Red: 10-60 mg/l

Limits -  
Dry white: 200 mg/l  
Dry red: 150 mg/l (red wines contain natural anti-oxidants)  
Off-dry white (5g/l sugar): 250 mg/l  
BA/TBA/Sauternes: 390 mg/l (binding power of sugars)

18. **Free, bound and total SO2**  
Free - active, protective, molecular SO2 & sulphurous acid  
Bound - combined with sugars, aldehydes, ketones, inactive  
Total - free + bound

19. **Pre-fermentation clarification**  
Remove solid particles  
Produce cleaner flavours, more finesse, less bitter

Depend on  
- state of the harvest  
- grape processing method  
- wine style required (little for full-bodied, complex wines; more for delicate and highly aromatic wines)

20. **Clarification methods**  
Cold settling (common)  
- debourbage  
- by gravity  
- 12 to 24 hours  
- cool temperature (5-10°C)  
- clear must racked off the sediment (lees)  
- pectolytic enzymes and SO2

Centrifugation  
- high level of clarity  
- harsh, high risk of oxidation, expensive  
- large wineries

Diatomaceous earth filtration  
- for aromatic grapes  
- can strip the must of nutrients for fermentation

Flotation  
- bubbling small amounts of N, CO2 or air  
- catching and floating solid particles  
- skimmed off by a rotary suction device  
- large wineries or cooperatives
| 21. Enrichment          | Adding sugar to increase potential alcohol  
|                        | No effect on wine sweetness  
|                        | Permitted in cool regions  
|                        | Unusually cool summer or early harvest in warm regions  
|                        | Not allowed in Italy/Spain  
| 22. Forms of sugar for enrichment | Sucrose (beet sugar) or cane sugar - chaptalisation  
|                        | RCGM (rectified concentrated grape must) - enrichment  
|                        | 1 kg of sugar increase vol of wine by 0.63 l  
|                        | White: 1% abv require 17 g/l sugar  
|                        | Red: 1% abv require 19 g/l sugar (evaporation due to higher fermentation temp & pumping over)  
| 23. Must concentration techniques | Vacuum evaporation  
|                        | - water evaporates at low temperature of 20 C  
|                        | - loss of aromas, hence use of chilled aroma trap  
|                        | Reverse osmosis  
|                        | - high pressure applied to must against a membrane filter  
|                        | - no loss of aromas  
|                        | - also used to remove alcohol and volatile acidity  
|                        | Cryoextraction  
|                        | - chill grapes to remove water in from of ice  
|                        | - no loss of aromas  
| 24. EU Rules on enrichment | Wine must be > 8.5% alcohol  
|                        | Enriched wine < 11.5% (white) or 12% (red and rose)  
|                        | Concentration not to increase alcohol by > 2% or reduce vol by 20% (whichever is lower)  
|                        | Only one enrichment method and no blending of differently enriched wines  
| 25. Potential alcohol | alcohol level that would result if all sugars are fermented  
| 26. Actual alcohol | actual alcohol level after fermentation  
| 27. Residual sugar | unfermented sugars (natural or added) left in the wine  
|                        | expressed as g/l or %  
| 28. Total alcohol | actual alcohol + potential alcohol from residual sugar  
| 29. Natural alcohol | total alcohol in an un-enriched must or wine  
| 30. De-acidification | Tartaric acid cannot be reduced by > 1 g/l  
|                        | Not permitted in warmest regions - CIII(b)  
|                        | Increase pH, therefore risk of microbial infection and decrease effectiveness of SO2  
| 31. De-acidification methods | Tartaric only  
|                        | - potassium bicarbonate (potassium tartrate crystals)  
|                        | - calcium carbonate (leaves high level of calcium tartrate)  
|                        | Malic only  
|                        | - malolactic fermentation  
|                        | Both tartaric and malic  
|                        | - double-salt de-acidification  
|                        | - Acidex (specifically prepared calcium carbonate with small amount of calcium tartrate-malate)  
|                        | - calcium tartrate-malate crystals |
| **Acidification** | "buffering" effects  
logarithmic pH scale  
- more acid to alter pH from 3.2 to 3.0 than from 3.8 to 3.6  
CII and CIII zones  
Not in Rhone  
Tartaric acid for acidification  
- 1.5 g/l in must; 2.5 g/l in wine  
Citric acid  
- 1 g/l in must  
- never added before fermentation  
- metabolised by yeast and bacteria to form acetic acid |
| **Tannin** | Added before fermentation  
Protection from oxidation  
Stabilize colour  
Improve mouth feel |
| **Bentonite** | Fining agent in form of clay  
Remove proteins  
Non-selective and remove flavour compounds |
| **Flavour and colour enhancing enzymes** | Aid juice extraction  
Optimise extraction of aroma precursors  
Improve colour extraction  
Increase efficiency of settling  
Developed from fungi  
Added at crushing |
| **Use of oxygen in winemaking** | Hyperoxidation  
Development of yeasts at start of fermentation  
Revitalization of yeast  
Micro-oxygenation of harsh polyphenols in barrels  
Anaerobic maturation after bottling (not for screwcaps)  
Add complexity and character in anaerobically made wines |
| **Oxidases** | Laccase  
- grey rot  
- SO2 resistant  
- pasteurisation (heating must to 65-70 C)  
Tyrosinase  
- controlled by SO2  
Copper and iron |
| **Reductive (anaerobic) handling** | Minimize exposure to oxygen  
SO2  
Low temperatures  
Inert gases used to flush out presses, pipes, vats  
Reductive taint - sulphur dioxide becomes hydrogen sulphide |
| **Oxidative (Aerobic) handling** | Minimal use of SO2  
Controlled exposure to oxygen  
Develop complex flavours and aromas  
Enzymatic oxidation of phenolics is encouraged  
Form insoluble polymers removed by clarification  
More stable wine  
Production of oloroso Sherry, tawny Port, vin jaune from the Jura, some Tokaji |
<p>| | |</p>
<table>
<thead>
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</table>
| **40. Hyperoxidation** | Bubbling air through the juice  
Colour stabilisation in white wines  
Can decrease aromalics (e.g. Sauvignon Blanc) |
| **41. Effects of excessive oxygen** | Acetaldehyde (ethanal) --> flat sherry-like flavour  
Bitter-tasting components from oxidation of phenolics  
Spoilage bacteria, e.g. acetic bacteria |
| **42. Ascorbic acid** | Vitamin C  
Antioxidant  
No antiseptic effect  
Used without SO2 --> hydrogen peroxide (bleaching agent) |
| **43. Alcoholic fermentation** | glucose/fructose + yeasts --> ethanol + CO2 + energy  
180 g sugar --> 92 g alcohol + 88 g CO2  
Saccharomyces yeast  
16-18 g/l sugar needed to produce 1% abv (8 g/l)  
Glucose  
- dominant early in ripening process  
- yeast prefer glucose  
Fructose  
- dominant in very ripe grapes  
- late harvest or botrytis-affected grapes  
- difficult to ferment fructose-rich grape must to dry wine |
| **44. Rate of fermentation** | Concentration of sugars  
Availability of oxygen  
Temperature  
Type and quantity of yeasts  
Nutrient content of the must  
SO2 |
| **45. Fermentation ceases** | All sugar consumed  
Alcohol reaches 15% killing yeasts  
Increasing pressure of CO2 to 7 atmospheres  
Chilling to low temperature (5 C)  
SO2  
Pasteurisation (80 C for a few second)  
Removing yeasts (filtration, centrifuge)  
Fortification with spirit |
| **46. By-products of fermentation** | Glycerol (Glycerine) - smoothness and weight of wine  
Acetaldehyde  
Ethyl acetate (nail polish)  
Aroma esters  
Fusel oils, e.g. methanol |
### Fermentation vessels

- **Stainless steel tanks**
  - easy to clean and maintain
  - allow temperature control
  - rotofermenters

- **Wooden fermentation vessels**
  - piece (228 liters) in Burgundy
  - barrique (225 litres) in Bordeaux, New World
  - open top wooden vats - 1000-5000 litres
  - wood retains heat well, need temp control
  - difficult to keep clean
  - chestnut, cherry, acacia & wallnut

- **Cement tanks**
  - lined with glass or epoxy
  - cheap
  - easy to clean and maintain
  - no oxygen exchange
  - simple temp control

### Uninoculated fermentations

- Started by indigenous yeasts
  - Kloeckera/Hanseniaspora
  - Candida
  - Metschnikowia
  - Saccharomyces takes over
  - Saccharomyces cerevisiae
  - Around 4% alcohol
  - Saccharomyces cerevisiae takes over

- Pro: complex wine
- Cons: off-flavours, oxidation, microbiological spoilage
- Pied de cuve - starter culture

### Inoculated fermentation

- Commercially available active dry yeast
  - different strains of Saccharomyces cerevisiae
  - higher tolerance of SO2
  - higher tolerance of sugar levels (Lalvin Rhone 2226)
  - higher glycerol production levels (Maurivin Cru-Blanc)
  - efficient extraction of phenolics and enhancement of tannin structure for high quality reds (Lalvin Rhone 2323)
  - low temperature tolerant for very fruity whites (R2)
  - Sauvignon Blanc yeasts for aroma/thiol fixing (Lalvin K1V-1116)

- Pro: active fermentation onset
- handle highly clarified juice
- fermentation rate more even and easy to control
- no off-flavours or aromas
- efficient conversion of sugar to alcohol
- decreased risk of stuck fermentations
- low volatile acidity (acetic acid) production

- Attributes
  - tolerance to higher sugar levels (Lalvin Rhone 2226)
  - higher glycerol production levels (Maurivin Cru-Blanc)
  - efficient extraction of phenolics and enhancement of tannin structure for high quality reds (Lalvin Rhone 2323)
  - low temperature tolerant for very fruity whites (R2)
  - low foaming (champagne yeasts, e.g. Premier Cuvee for secondary fermentation in bottle)
  - Sauvignon Blanc yeasts for aroma/thiol fixing (Lalvin K1V-1116)
50. **Monitoring and controlling fermentation**

**Density**
- measures sugar (not alcohol)
- Baume (France): relative density
- Brix or Balling (Australia, NZ, US): hydrometer measurement
- Oechsle (Germany, Switzerland): hydrometer scale
- Babo (Italy), same as KMW (Austria)

**Temperature**
- controls the rate of fermentation
- chill white grapes/must in warm climates
- fermentation releases heat

**Aeration**
- yeast needs oxygen
- reds: pumping over (remontage) or punching down (pigeage)

**Finishing the fermentation**
- density drops below 1
- 2 g/l of unfermentable sugars in dry wines

51. **Temperature in fermentation**

**Optimum fermentation temperature range**
- whites: 10 - 18 C
- reds: 20 - 32 C

**Excessively high temperature**
- oxidation, microbiological spoilage and instability
- loss of aroma and flavour compounds, alcohol
- slow or stuck fermentation (above 35 - 38 C)

**Excessively low temperature**
- retention of isoamyl acetate (banana/pear) in whites
- poor extraction of colour and tannins in reds
- sluggish fermentation
- high levels of ethyl acetate and volatile aroma

52. **Options for finishing the fermentation**

**Aromatic dry white wines**
- chill the new wine
- add SO2 (40-100 mg/l)
- remove lees (settling or fining agent)
- rack clean wine and bottle

**Full-bodied Chardonnay**
- fermented in oak barrels
- extended lees contact, with lees stirring
- MLF
- after MLF, sulphited and left to mature in oak

**Off-dry white wines**
- stop fermentation before dryness
- chilled (< 5 C)
- racked and filtered to remove yeasts

**Sweet fortified wines (Port/vins doux naturels)**
- add alcohol to > 15% abv

**Red wines**
- maceration to extract tannins and pigments
- New World: fermentation completed in barrels, then MLF
| 53. **Fermentation problems** | Stuck fermentations  
Yeast nutrient issues  
Hydrogen sulphide formation  
Carbon dioxide poisoning |
|---|---|
| 54. **Stuck fermentation** | results in  
- hydrogen sulphide (VA)  
- microbial spoilage  
- residual sugar  
caused by  
- too hot (> 35 C) or too cold  
- nutrients depleted  
- alcohol level (uninoculated fermentation)  
prevented by  
- adequate aeration at onset of fermentation  
- 100 - 150 mg/l di-ammonium phosphate (DAP)  
- 0.5 mg/l thiamine (vitamin B)  
- temperature control  
"kick-start"  
- adjust temperature  
- add DAP and thiamine  
- re-inoculate with Saccharomyces Bayanus |
| 55. **Yeast nutrient issues** | Low yeast nutrients in rotten fruit and clarified must  
Add DAP (200 mg/l) and thiamine (1.0 mg/l)  
Ammonium sulphate liberates ammonium and SO2 |
| 56. **Hydrogen sulphide formation** | Yeasts deprived of nitrogren (ammonium)  
Break down amino acids to release H2S  
Rotten eggs |
| 57. **Carbon dioxide poisoning** | Colourless, odourless, potentially lethal  
Heavier than oxygen  
Good ventilation required  
Measure oxygen using a meter |
| 58. **White winemaking** | Grapes pressed before fermentation  
Good quality whites  
- healthy, ripe grapes  
- careful and quick processing  
- protection from oxidation  
Key decisions  
- whole bunch press or de-stem and crush before pressing  
- de-acidify, acidify, increase sugar levels  
- skin contact (maceration pelliculaire) or press immediately  
- clarify must before fermentation  
- inoculate  
- fermentation vessel  
- fermentation temperature (14 - 20 C)  
- lees contact  
- MLF (No SO2, 16 - 18 C)  
- oak  
- maturation prior to bottling |
59. **Fermentation temperature for whites**

- Optimum 14 - 20 C
- Fruit preservation
- > 20 C reduce esters and increase alcohol

Aromatic whites
- 11 - 15 C to retain fruit esters
- 10 - 13 C to retain volatile esters but produce intense smelling esters (isoamyl acetate)

After fermentation, lower temp to 12 C for yeast settling

60. **Lees contact**

- Protect wine from oxidation
- Add texture
- Autolysis of yeast in lees
- Muscadet

Reduction problems
- H2S --> onion-like mercaptans, difficult to remove
- Oxygen by lees stirring or wine racking
- Pass through copper pipe or add copper sulphate

Lees stirring (battonage)
- Wine in barrique (Chardonnay)
- Barrel stackers with rollers to avoid excess oxygen
- Bubbling gas in tank

61. **Rose winemaking**

- Drawing-off method
  - Saignee or bleeding
  - De-stemmed, crushed and sulphited grapes
  - 6 - 48 hours of skin contact
  - Cooler temp to retain fruit aromatics and freshness
  - Higher temp for more colouring
  - Fermented at 15 - 20 C
  - No MLF to retain fresh natural acidity
  - Clarified, stabilised and bottled young
  - Anjou, Bordeaux Clairet, Cotes de Provence

Direct pressing
- Freshly harvested red grapes
- Not to extract too much tannin
- Pale pink
- Cotes de Provence, Languedoc

Blending
- Rose Champagne, New World Roses
- Not permitted in EU for still roses

62. **Definition of "red wine"**

A macerated wine.

Extraction of solids from grape cluster (specifically from skins, seeds and possibly stems) accompanies the alcoholic fermentation of the juice.

63. **Red winemaking**

- Skin contact during the alcohol phase and colour of the grape; extraction of phenolic compounds (polyphenolics or polyphenols); pressing after fermentation

5 main steps
- Pre-fermentation processing
- Alcoholic fermentation
- Draining and pressing
- MLF
- Maturation
| **64. Two main types of phenolic compounds** | Non-flavonoids  
- simple phenolics  
- benzoic and cinnamic acids  

Flavonoids  
- catechins (tannin)  
- resveratrol  
- anthocyanins (red pigments in skin cells)  
- tannin can react with anthocyanins to fix colour  
- pigmented tannins polymerise with age and precipitate out |
| --- | --- |
| **65. Three factors of phenolic extraction** | Temperature of fermentation  
DAP management  
Duration of skin contact |
| **66. Pre-fermentation processing** | De-stemming and crushing (not for carbonic maceration)  
Fill vessel to < 80% capacity  
20 - 80 mg/l SO2 (wild yeasts, bacteria, oxidative enzymes)  
Must adjustment (acidification, enrichment)  
Pre-ferment maceration (or "cold soak") to extract aromas  
- Cooled to 4 - 15 C and kept for 3 - 7 days (80-100 mg/l SO2) |
| **67. Fermentation temperature for reds** | 20 - 32 C  
Higher temp increase breakdown of skin cells and level of dissolution of phenolics  

Moderate temp (25 C)  
- good colour extraction  
- preservation of primary fruit aromas  
- minimal to moderate tannin extraction  

Thermovinification  
- heating grape to 45 C  
- rather coarse wines with "burnt" aromas |
| **68. Cap management** | Pomace cap  
Methods  
- pumping-over (remontage)  
- punching down (pigeage)  
- rackand return (delestage)  
- submerged cap  
- rotovinification  
- autovinification |
69. **Pumping-over**

Remontage

- with or without aeration
- pump, hose, fixed spray head
- done 1-3 times a day

**Benefits**
- simple
- good extraction
- tank of wine becomes homogenised
- aeration prevents reduction, aids yeasts
- prevents cap from drying out

**Wines**
- Cabernet Sauvignon, Merlot
- medium to high quality
- rich, full-bodied structure
- no vegetal or bitter characters

70. **Punching down**

Pigeage

**Manual (paddle)**
**Automatic (stainless steel cone attached to a hydraulic piston)**

Done 1-3 times a day

**Benefits**
- gentle extraction
- less harsh or bitter compounds
- good dispersion of temperature
- avoid bacterial spoilage on surface of cap

**Disadvantages**
- labour intensive if done manually
- Merlot and Cabernet Sauvignon more rustic in flavour

**Wines**
- Pinot Noir and premium Syrah

71. **Rack and return**

Delestage

- Tank is drained into another tank, then pumped back over the cap
- done once per day or twice during fermentation
- after initial peak of temp
- middle of fermentation

**Benefits**
- complete mixing and breaking up of cap
- good aeration
- extraction of phenolics
- seeds can be removed

**Disadvantages**
- too extractive
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Submerged cap method</strong></td>
<td>Fermenting fluid filled to over head boards/perforated screen that trap pomace beneath Constant contact</td>
<td>Benefits - good extraction - no risk of pomace cap drying out and VA</td>
<td>Disadvantages - extraction can be difficult as skins are compressed</td>
</tr>
<tr>
<td><strong>Rotovinification</strong></td>
<td>Rotofermenter - horizontal cylindrical fermentation vessel - motor</td>
<td>Benefits - fast - thorough mixing - good extraction - automatic and computer-controlled - pomace kept wet</td>
<td>Disadvantages - expensive - robust supporting framework - reduction problems - over extraction</td>
</tr>
<tr>
<td><strong>Autovinification</strong></td>
<td>Autovinifier, or Algerian Ducellier system - extended version of pumping-over - sealed vats - CO2 pumps must into top reservoir - cascades back into lower chamber</td>
<td>Benefits - no external power - fully automated - good extraction of colour and tannins</td>
<td>Disadvantages - difficult to control rate of extraction</td>
</tr>
<tr>
<td><strong>Fermentation management of reds</strong></td>
<td>Complexity of maceration dynamics</td>
<td>Wines - red Port - light, good quality wine in N Afriaca</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor density and temp Control of temp Control of aeration Pumpovers and/or cap punching Skin contact time (post-fermentation maceration)</td>
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</tbody>
</table>
### Duration of skin contact

- Extraction enhanced by:
  - higher temp
  - increase in alcohol

- Extent of phenolic extraction:
  - avoid extraction from poor quality grapes
  - shorter (around 8 days) for light, easy, early-drinking reds
  - longer (3 weeks) for full-bodied reds
  - extended (> 1 months) for high quality vintages

- Pectolytic enzymes to increase extraction
- Anthocyanin extracted first (temp)
- Tannin extracted by higher temp and alcohol

### Draining and pressing

- Free-run wine and press wine

- Fining of press wine
- Residual sugar in press wine to ferment out

### Maturation

- Lees contact:
  - reducing properties
  - fuller, smoother wines
  - mannoproteins released by lees autolysis
  - inhibit tartrate crystalization
  - bind with tannins to reduce astringency

### Malolactic fermentation (MLF)

- Conversion of malic acid in a wine to lactic acid through the action of naturally-occurring or added bacteria

- 3 species of lactic acid bacteria:
  - Lactobacillus
  - Leuconostoc
  - Pediococcus

- Traditionally in tank
- Today, commonly in barrel for better oak integration

- Biologically more stable wine
- Softer, rounder acidity
  - malic is sharp (unripe apples)
  - lactic is softer (milk)

- By-products:
  - diacetyl (buttery richness)
  - higher VA

### Conditions for MLF

- pH between 3.3 - 3.5
- Temp between 18 - 25 C
- < 50 mg/l total SO2
- Certain amount of nutrients

### Preventing MLF

- Clarify (remove nutrients and bacteria)
- SO2 addition after primary fermentation
- Low storage temp (< 12 C)
- pH below 3.1
- Clean containers
- Sterile filtration & bottling
82. **Encouraging MLF**
- Keep wine in lees
- Low levels of SO2
- Warm temp (18 - 22 C)
- pH above 3.3
- Add Leuconostoc oenos (freeze-dried)

83. **Monitoring MLF**
- CO2
- Reduction of malic acid
- Paper chromatography
- Enzymatic analysis

84. **Effects of MLF**
- Deacidification
  - cool climates
  - incomplete ripening

  **Stability**
  - consuming bacteria nutrients
  - useful in reds as lack of protection of added SO2

  **Loss of primary fruit aromas**
  - detrimental to aromatic whites

  **Addition of aromatic compounds e.g. diacetyl**
  - spoil fruit aromas of Riesling or Sauvignon Blanc

  **Increase VA**
  - breakdownof citric acid

  **Spoliation if lactic acid bacteria not controlled**
  - SO2, low pH, equipment hygiene

  **Should never occur in the bottle**

85. **Carbonic maceration**
- Fermentation within berries; no yeast; anaerobic respiration of grapes converts sugars to ethanol

  - Whole bunch
  - Blanket with CO2
  - Intercellular fermentation
  - 2% abv and aromatic compounds
  - Decrease in malic acid, increase in pH
  - 1-3 weeks
  - Aromas of bananas, kirsch, cherry, plum

86. **Semi-carbonic maceration**
- Beaufolais
- Combination of extra- and intracellular fermentation
- No CO2 blanket
- Vat filled with grape bunches
- Fermentation of crushed bunches at bottom release CO2
- Intercellular fermentation of upper layer bunches
- Deeply coloured, fruity wines with soft tannins

87. **Therminocination**
- Heat to 60 - 80 C for 20 - 30 minutes then cool to fermentation temp

  **Max colour extraction**
  - "Time saver"
  - Destroy damaging oxidative enzymes in rotten grapes
  - Pectolytic enzymes and aromas destroyed

  **Not for premium reds**
88. **Flash expansion**

Flash detente
Pre-heat grapes to 65 - 90 C and place in vacuum
Grapes cooled immediately to 30 - 35 C
Rapid release of anthocyanins and tannins
Juice drained off

89. **Sparkling winemaking**

Bottle fermented

**Traditional Method (methode champenoise)**
- produce dry base wine
- no SO2 added at end of fermentation
- add liqueur de tirage and yeast
- bottled and sealed (cork or crown seal)
- secondary fermentation to increase 1.2 - 1.3% abv
- autolysis of yeasts to add complexity
- riddled by hand or automatic riddling machines (remuage)
- disgorgement
- add liqueur d'expedition
- sealed by cork and wire cage (muselet)
- further aging
- packing and distribution
- Champagne, Cava, premium sparkling wines
- complex wines, bready, biscuit flavours

**Transfer Method**
- fermented wine emptied into pressurized tank
- cooled to -5 C
- add dosage (sweetening wine)
- filter to bottle
- slight loss of quality
- mid-market New World sparkling wines

**Tank Method (cuve close or Charmat)**
- secondary fermentation in sealed pressurised tank
- lees contact
- sweetened, filtered and bottled under pressure
- lower production costs
- German Sekt and Prosecco
- coarser and broader bubbles

**Carbonation (Pompe bicyclette)**
- chill wine
- bubble carbon dioxide into it
- very inferior method

**Asti Method & Methode Ancestrale**
- Moscato
- must pumped into a pressure vessel and yeast added
- CO2 allowed to escape to atmosphere
- 5% abv: valves closed to trap CO2
- 6-9% abv and 60-100 g/l sugar: cooled to 0 C
- clarified, filtered and bottled
### Fortified Winemaking

**Types**
- Port, Sherry, Madeira
- Muscat in Australia, S France, Greece, Italy
- Vin de Constance (S Africa)
- Malaga (S Spain)
- Mavrodaphne (Greece)
- Commandaria (Cyprus)

**Methods**
- fortified during fermentation
- fortified after fermentation

### Fortification during fermentation

**Vins doux naturels**
- Muscat, Grenache (S France)
- at 5% abv, add high-strength grape spirit (95% abv)
- 15 - 18% abv

**Port**
- maceration in granite troughs (lagares)
- fermentation at high temp (> 30 C)
- drain wine at 6 - 9% abv
- 1 part of spirit (77 - 79% abv) to 4 parts of wine
- 18 - 19% abv

**Maturation**
- 550 litre "pipe"

**Port quality**
- base wine
- single vintage or blend
- time in cask
- filtered?

**Styles**
- Ruby Port (< 3 yrs)
- Tawny Port (longer oxidative time)
- Late Bottled Vintage Port (4-6 yrs)
- Vintage (2-3 yrs)

### Fortification after fermentation

**Sherry**
- Town of Jerez
- Palamino, Pedro Ximenez
- 70% free run for Finos, next 20% for Oloroso
- acidified with tartaric acid
- 600 litre oak butts
- uninoculated fermentation (25 - 30 C)
- dry wine, low in alcohol (11 - 11.5%)
- Finos/flor (14.5 - 15.5%) (biologically aged)
- Oloroso (18%) (oxidatively aged)
- Amontillado (aged both biologically and oxidatively)
<table>
<thead>
<tr>
<th>93. <strong>Solera system</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Criadera (row)</td>
</tr>
<tr>
<td>- simple solera: 3 - 4 criaderas</td>
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<tr>
<td>- complex solera: 14 criaderas</td>
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<tr>
<td>- bottom row called Solera</td>
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<tr>
<td>Fractional blending</td>
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<tr>
<td>- no more than 1/3 of contents drawn</td>
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<tr>
<td>- complex wines</td>
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<tr>
<td>- replenish nutrients for flor</td>
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<tr>
<td>Finos: 3 - 5 yrs</td>
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<tr>
<td>Amontillados/Olorosos: 5-10 yrs</td>
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<tr>
<td>Swettened prior to bottling</td>
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<tr>
<td>- Pedro Ximenez (Cream Sherries and Sweet Olorosos)</td>
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<td>- concentrated grape juice (Pale Cream Sherries)</td>
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<tr>
<td>Membrane-filtered for Finos and Manzanilla (salty)</td>
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<td>94. <strong>Sweet wines</strong></td>
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<tr>
<td>3 main methods</td>
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<tr>
<td>- interrupting the fermentation</td>
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<td>- adding a sweet component</td>
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<tr>
<td>- concentrating the natural sugars</td>
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<tr>
<td>95. <strong>Interrupting the fermentation</strong></td>
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<tr>
<td>Fortification</td>
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<tr>
<td>- Vins doux naturels e.g. Muscat de Beaumes de Venise</td>
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<td>- Moscatel de Valencia</td>
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<tr>
<td>- Liqueur Muscats e.g. Rutherglen Muscat</td>
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<tr>
<td>Add SO2 and lower temp</td>
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<tr>
<td>96. <strong>Adding a sweetening component</strong></td>
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<tr>
<td>RCGM</td>
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<tr>
<td>Sussreserve (unfermented grape juice)</td>
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<tr>
<td>- German QbA wines</td>
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<tr>
<td>- Rheingau, Rheinhessen, Mosel</td>
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<tr>
<td>97. <strong>Concentration of sugars</strong></td>
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<tr>
<td>Drying, e.g. on straw mats</td>
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<tr>
<td>- passerillage</td>
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<tr>
<td>- Amarone, Vin Santo (Italy, Santorini), PX Sherry (Spain)</td>
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<tr>
<td>Freezing</td>
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<tr>
<td>- Icewine/Eiswein</td>
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<tr>
<td>Noble rot</td>
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<tr>
<td>- botrytis cinerea</td>
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<tr>
<td>- Riesling, Semillon, Chenin Blanc</td>
</tr>
<tr>
<td>- Sauternes, Monbazillac in France; Tokaji in Hungary; Beerenauslese and Trokenbeerenauslese in Germany and Austria; botrytis Semillon in Australia</td>
</tr>
</tbody>
</table>