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Méthode Cap Classique Part 3: From the end of primary fermentation to preparation and commence of secondary fermentation

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Following primary fermentation, the goal of many MCC producers is to process the cuvée for the secondary fermentation as soon as possible. This enables wine to reach the consumer earlier and takes advantage of the available nutrients to support secondary fermentation. Other producers prefer their base wines to age and develop and uses the secondary fermentation to rejuvenate the wines.

Malolactic fermentation (MLF)

In warmer regions, the prevalent attitude is that a **high malic acid** level in the cuvée, coupled with a **low pH, add life and freshness** to the sparkling wine, thus avoiding MLF in all. However, most producers (especially in Champagne) believe **MLF adds finish and flavour** to the MCC.

The **low pH of sparkling base wine** is a hostile environment for the bacteria. It is therefore crucial to select the correct starter to ensure success. The main bacteria used for MLF is *Oenococcus oeni* and is usually chosen based on its low acetic acid production, its ability to adapt to stress and its survival rate. **Bacteria nutrients** may need to be added, especially if YAN levels were low at the time of harvest. SO_2 concentration should also be kept to a minimum (usually below 20 mg/L) to ensure smooth MLF.

MLF should be completed (malic acid <0.2 g/L) before the second fermentation commences as **MLF bacteria do not settle well during riddling**. Performing MLF during the riddling process also imposes a risk of incomplete MLF due to inhospitable environment such as low pH and higher alcohol content.

Co-inoculation involves initiating primary alcoholic fermentation and MLF at around the same time. This process is well suited for sparkling base wine as the pH is low and fermentation temperatures cool, thus minimising the risk of volatile acidity from sugar catabolism.

Clarification and Stabilisation

After the primary fermentation, the wine should be **clarified and stabilized** to a certain degree before blending, as blending can disturb colloidal and tartrate stabilities. Wines should be **protein stabilized with bentonite**, however, the presence of proteins is also involved in **bubble formation**, so **over-fining** with bentonite should thus be **avoided**. Unlike bentonite, fining with **gelatin-tannins** or **gelatin-silica** gel significantly **increases foaming properties** of the fined wines when compared to non-treated wines. Protein levels should be managed to ensure a protein stable wine without negatively affecting the foamability.

Isinglass or gelatin/tannin may also be used to **reduce phenolic content** and clarify the base wine before blending. It should be noted that the **fining of the juice is a safer practice** compared to wine fining.

The most common method to ensure **tartrate stability** is **cold stabilization**. **Calcium tartrate instabilities**, which will not be precipitated by traditional cold stability treatments, are a **risk** in sparkling wines, especially if calcium-based products have been used. Consider electrodialysis if **calcium levels >60 mg/L**. The use of **CMC should be done carefully** as it can also **remove phenolics and proteins** if CMC is added in high quantities and may affect **foaming**.

Colour can also be adjusted especially for wines made from dark skinned varieties such as Pinot noir. In general, **charcoal** is used for reduction of colour, however, the use of charcoal in base wines have been proven to **diminish foamability significantly**. As with all fining agents, laboratory trails to determine final additions are recommended.

Blending (Assemblage)

In Champagne, it is common practise to **blend** a percentage of the **previous year's cuvée** (reserve) into the fermenting juice or even into the base wine. This leads to the production of a non-vintage wine. **Blending** of some of the **second-cut press material** (taille) into the cuvée can also be done while keeping in mind the effect thereof on especially the **polyphenol** content. After blending and prior to bottling, the wine should be **re-checked for protein and tartrate stabilities**, and may need an additional clarification or fining, as blending may disturb clarity and stability.

The chemical composition of the blend is recommended as follows:

- TA > 7 g/L
- pH < 3.3
- alcohol 10.5-11.5 %
- free SO_2 < 15 mg/L
- copper < 0.2 mg/L
- iron < 5 mg/L
- extract 25 g/L (adds body without making the wine heavy)
- acetaldehyde < 75 mg/L*

*aldehydes may be measured as a quality parameter - higher levels correlate with the amount of SO_2 added during the process as well as the degree of oxidation.

Filtration

Some producers choose to **sterile filter/crossflow filter** the blended wine to **prevent MLF** during secondary fermentation, or to **"clean" the wine** before the secondary fermentation. Not filtering the wine has some risks as **MLF can occur in the bottle** which can hinder the riddling process. If **MLF** has been completed **before bottling**, **extensive filtration does not need to be applied** due to enhanced biological stability.

Foaming substantially **decreased with filtering**, most likely due to the removal of compounds required for foaming. Tests showed a **pore size** of 0.45 µm resulted in the **least foam collapse** and the **best collar stability** compared to 0.2 µm pore size, which resulted in very poor foam formation.

Liqueur de Tirage

Yeast

Wineries differ in the composition of the additives during the preparation of the secondary fermentation and in general it is considered to be a winery secret. As with the primary fermentation, the **yeast** used for the second fermentation must be able to perform in certain conditions. Together with the **attributes** mentioned in the *Primary Fermentation* section (Part 2 of this Blog series), the following yeast attributes are desirable: **alcohol** tolerant, **cold** tolerant, SO_2 tolerant, **minimum** SO_2 **production**, **ability to ferment to dryness**, **pressure** tolerant, **dies** following fermentation, **does not stain** the wall of the bottle, **desirable flocculating ability** (efficient riddling), produces **no off-odours** and has a **desirable effect on carbonation**.

Difficulty in riddling has led to the development "agglomerated yeast" to reduce the need for riddling agents and to facilitate the riddling step. The yeast will obviously also affect the final aroma composition of the wine and can be selected according the specific characteristics and style of wine desired. Unfortunately, some "agglomerated yeast" strains gained a reputation of contributing unwanted odours to the wine and the usage thereof has since decreased significantly.

Yeast culture preparation protocol can be found in the *Vinlab manual* on page 136. In general, **inactive dried yeast** is used. This direct preparation **lowers the risk of contamination** (compared to the multiplication procedure which is cultivated from one initial batch of yeast). The preparation should have viable yeast population of 1-1.5 x 10^6 cells/mL in the bottle. **Higher yeast populations** will ferment at a **faster rate**, but will also result in a **larger amount of spent yeast cells** at the end of fermentation which can negatively influence the efficiency during disgorging. **Lower yeast populations** may result in **incomplete fermentations**. Yeast should be carefully prepared as per manufactures instructions to achieve high viability and to reduce the incidence of stuck fermentation. **Yeast nutrition** is important to avoid reductive odours and stuck fermentations and could be especially important in older cuvées that are nutritionally deficient. In the US, the addition of 24 g/hL **DAP** is not uncommon.

Sugar addition

The **amount of sugar** added will affect the bottle **pressure** as well as the concentration of **alcohol** and should be kept in consideration, especially with the availability of improved permeable **crown caps** that can **handle increased bottle pressures**. Final pressure of between **4-6 bar** are usually ideal (per regulations the wine should be >3 bar to be classified as MCC). **2.3-2.6˚B** (23-26 g/L residual sugar) will **yield** approximately **1.2-1.5 % alcohol** depending on the yeast conversion rate. A lesser amount of sugar is usually added (22-24 g/L) to **avoid excess pressure** within the bottle, especially when using crown caps with low permeability. RS additions are detailed in the *Vinlab manual* on page 137 and should be calculated according to the **alcohol concentration of the base wine** and the **required pressure in the bottle**. The concentration of sugar in the base wine before secondary fermentation should also be kept in consideration when calculating additions. Keep in mind that **CO_2** is **more soluble at higher alcohol** levels.

Sucrose or glucose (dextrose) can be added, while other producers use **sugar syrups**. Studies have shown that European and Chilean producers mainly use sugar beet, while sugar cane is used in Brazil and Argentina. It is unlikely that the type of sugar is to influence the aroma composition of the wines.

Riddling agent additions

To enhance riddling ability (sedimentation of the yeast), disgorgement and possibly wine palatability, some vintners add **riddling aids** at the time of cuvée bottling. **Isinglass, bentonite, tannin, gelatin,** diatomeous earth and alginates can all be used, usually **in combinations**, to assist with riddling and disgorgement. In Europe, the most popular riddling agent used is **bentonite** (0.01-0.04 g/L), probably due to its relatively inert nature. Again, **care should be taken not to over-fine** the wine as the addition of bentonite has shown to **decrease the foaming** height and stability due to protein removal.

Other riddling agents are also available on the market and the choice of agent should accommodate the **expected time of sur lie** (aging on the lees before disgorgement). **Clays** are often prepared for **young wines**, while **gelatins** are used for **aged or older wines**.

Pure bentonite can be used for **manual riddling**, while agents that contain a **percentage of potassium alginate** (a polysaccharide) has the ability to form a **gel** in acidic conditions (or very stable gels with calcium cation) and allows **rapid formation of film-type sediments** allowing quicker riddling. The alginate also produced wines with **better foamability**. This riddling agent is often used when **mechanical riddling** is employed.

Some producers will add a **small amount** of **SO_2** at bottling. This helps protect the wine against oxidation and unwanted biological growth. This addition needs to be kept to a **minimum** (15-20 free SO_2) as too high alcohol and SO_2 concentration **could lead to stuck secondary fermentation**. When this is employed, the choice of **yeast strain** needs to be carefully considered to ensure the yeast have **sufficient SO_2 resistance**.

Bottling for fermentation (Tirage)

At the bottling line, the **mixture** of yeast, nutrients, sugar, riddling agents and possibly SO_2 are added to each bottle. **Homogeneity** within the bottle is important and **care should be taken especially when using a syrup** so it does not settle out of solution. Cuvée homogeneity can be monitored by measuring the density. Some producers feel the need to **slightly aeriate** the wine during the bottling process, this should be done with extreme **caution** for obvious reasons. Another option would be to choose the crown cap according to its oxygen permeability rate.

It is important to understand the disgorging of wines to be able to determine the **original bottle fill** volume. The level of filling will also depend on the volume of desired **dosage volume** and, in general, disgorgement loss **should not exceed 2%**. After filling the bottle and adding the yeast mixture, a bedule (a hollow polyethylene cup) can be added to the bottle. This prevents leakage and direct contact of the wine with the metal crown cap and also aids in disgorgement.

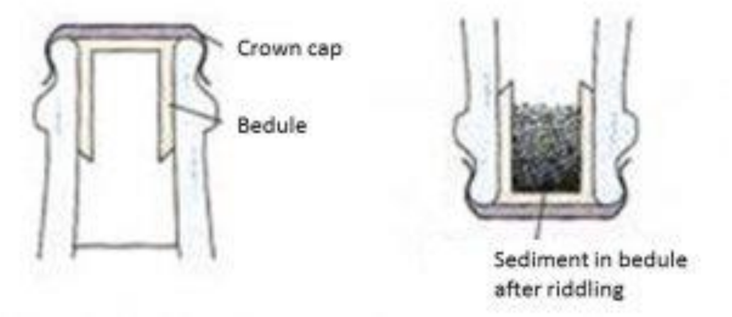

Figure 1. Bedule placement to aid riddling.

The wine can then be capped, usually with a crown cap. **Crown caps** are generally made of **stainless steel, coated mild steel or aluminium** and should contain the appropriate **liner**, be able to seal and crimp properly and should preferably be corrosion-resistant. Crown caps can vary in their **oxygen permeability** rate and ranges from 500 µg/L to more than 3000 µg/L (accumulated over 2 years). Variations of sealants within the crown cap exist such as plastic and cork and a tight and proper seal is of utmost importance to prevent loss of wine due to increased pressure.

Not only is the sealing important for the wine development, but the **bottle colour** has also been found to affect the wine colour and aroma changes over time. Low density polyethylene films (LDPE) have been found to protect wines for 60 % longer than bottles without the **photoprotecting film**. Bottle colour differ in its protecting abilities and the order of protection has been reported as Flint < Arctic Blue < French Green < Antique Green with low-wavelenghth visible, UV light being primarily responsible for the unwanted changes within the wine.

Secondary Fermentation

The secondary fermentation ideally occurs between **10 and 15˚C** (minimum fluctuations) and should be completed after 15-60 days. **High temperatures** during secondary fermentation is believed to result in **coarse bubbles** that are larger with less retention. Fermentation rate will be negatively affected when yeast populations, yeast nutrition, fermentation temperature and pH are lower, as well as when alcohol levels, phenol content and free SO_2 levels are higher. The **risk of stuck fermentation increases** when

- Base wine alcohol > 12.5%
- Base wine free SO_2 > 15-20 mg/L (lower pH will also influence the SO_2 effect)
- Yeast have not been prepared or acclimatized adequately and sufficiently
- Insufficient yeast nutrition
- Temperature of cuvée is too low
- Temperature fluctuations during secondary fermentation

Lower phenolic content will also reduce the risk of stuck fermentation and wines with more pigment tend to ferment more slowly.

Fermentation within the bottle can usually be observed as a ring of CO_2 bubbles around the base of the air bubble. The progress may be **monitored** by drawing a random, representative sample and measuring the **decrease in RS** and **increase in pressure**.

Most producers store their bottles with the **neck slightly down** so the air bubble in the bottle moves away from the neck and thus avoids bottle staining. The bubble can also be used as a "scrubber" to free stuck yeast deposits prior to remuage/riddling.

Care must also be taken to avoid too rapid fermentation rate and the development of reductive off-odours.

A few wine terms:

Riddling involves the gradual tilting of the bottle neck-down ('sur pointe'), meanwhile rotating it by small increments, clockwise and anti-clockwise. As the angle of tilt increases, the forces of gravity draw the sediment into the neck.

Assemblage is blending, both in terms of the blend of different grape varieties or the blend of different base wines.

Tirage is the process of MCC bottling in preparation for secondary fermentation.

Prise de mousse refers to the secondary fermentation in the bottle caused by adding yeast along with sugar and/or juice to the base wine; during this process the foam/bubbles of MCC is formed.

Liqueur de Tirage is a syrupy mixture of wine, sugar and yeast that is added to sparkling wines to induce secondary fermentation.

Sur Lie is the winemaking process of aging wine on the lees.

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Figure source

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