MALOLACTIC FERMENTATION

CHALLENGES:

Alcohol level
pH
Free and total SO_2
Temperature for rehydration and conversion
Nutrition
Malic acid content

Alcohol level

Ideal is $\leq$ 13%. Becomes increasingly stressful as alcohol rises
Additive effect with other stresses

pH

Ideal range is 3.3-3.5
Higher than pH 3.5, Oenococcus is more prone to acetic acid production.
Lower than pH 3.2, metabolism slows and may stop, depending on vigor of the bacteria.

Free and total SO_2

Free SO_2 should be $\leq$ 8 ppm or it can kill the bacteria (pH dependent).
Total should be $\leq$ 50 ppm.
    Much of bound SO_2 is bound to aldehyde, which bacteria can metabolize, releasing enough free sulfur to damage or kill the bacteria.

Temperature

Rehydrate at 20° C (68° F). Higher mortality at higher temperatures
Ideal temperatures for sequential MLF are 18°-22° C (64°-72° F).
Co-inoculated must can go higher.
Stress of temperature can be additive, especially if combined with high alcohol.

Nutrition

Use complete nutrient derived from yeast.
    For N, will only take up organic N (amino acids, peptides), not ammonia (DAP).
    Depending on strain, requires 8-13 different amino acids.
    Vitamins: Nicotinamide, biotin, thiamine, pantothenic acid.
    Trace elements: Mg, Mn, K.
Feed especially if yeast had high nutrient demands or alcoholic fermentation was difficult (may be an indication of nutrient problems).
If co-inoculating, don't feed until after alcoholic fermentation is complete (and only if necessary).

Malic acid level

Ideal starting level is 2-4 g/L.
<0.5 g/L will not sustain the bacterial population, > 7 g/L is highly stressful.

General actions for dealing with difficult MLF (see MLF Scorecard)

Standard build-up culture is stronger than direct addition.
24-hour build-up (1-Step) is nearly as strong as standard.
Timing of MLF: Sequential vs. Co-inoculation
    Co-inoculation occurs when most stresses are lowest (juice stage).

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Reasons for Malolactic Fermentation (MLF):

1. Soften, naturally de-acidify.
2. Flavor: loss of malic acid, addition of lactic acid, diacetyl (butter).
3. Stabilize wine microbially.

Traditional method: MLF in spring with native culture as the weather warms.

Advantages:

Stronger bacteria due to acclimation (Ribereau-Gayon)
More stable color (V. Gerbaux)

Disadvantages:

Extended time without SO_2
Risk of Brettanomyces or bacterial infection
Mixed culture; potential for biogenic amine formation

Protocol for direct addition culture

Rehydrate at 20 degrees Celsius.
Rehydrate a maximum of 15 minutes before inoculation.
Stir gently into wine avoiding undue aeration.

Sequential Inoculation vs. Co-Inoculation

Timing can affect flavor, microbial impact and stability.

Sequential Inoculation: inoculation at completion of alcoholic fermentation.

1. Higher diacetyl; more complexity (?)
2. Longer, slower MLF
3. Adding culture to alcoholic environment is hard on bacteria
4. Longer time without SO_2; risk of infection
5. Risk of mixed bacterial culture with unknown strains

Co-Inoculation: inoculation 12-24 hours after yeast inoculation.

1. Lower diacetyl; consumed by the yeast.
2. More fresh fruit characters in the wine.
3. Faster, shorter MLF.
4. Added to juice; acclimates during alcoholic fermentation (AF).
5. Shorter time without SO_2; less risk.
6. Less risk of mixed strains, biogenic amines.
7. Risk of acetic acid formation if alcoholic fermentation sticks.

Recent Research:

*Long gap between alcoholic and ML fermentations favors Brettanomyces growth and ethyl phenol (barnyard) formation.
*Short or no gap favors beneficial added bacteria.
*ML bacteria preferentially consume organic acids before consuming sugar and forming acetic acid (S. Krieger-Weber).
*Recommendation for sequential ML: inoculate at 0° Brix by hydrometer. Wine is still warm from AF and as the yeast dies, added bacteria fill the microbial void (V. Renouf).
*Protocol for co-inoculation:

1. Keep SO_2 addition $\leq$30 ppm.
2. Control temperature: too cool and bacteria becomes sluggish; too hot and bacteria dies.
3. Add bacteria 24 hours after yeast (rehydrate per protocol above).
4. Use yeast with low nutrient demands and low SO_2 production.