MANAGING ACIDITY

BIOLOGICAL & CHEMICAL METHODS

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COLD-CLIMATE CONCERNS

- Excessive acid
  - Reduce tartaric, malic, or both
- Excessive malic acid
  - Targeted demalication
- pH-TA mismatch
  - Control malic?
  - Excessive potassium?

DEACIDIFICATION METHODS

- Biological
  - Malolactic fermentation
    - Malic acid conversion to lactic acid
  - Yeast demalication
    - Malic acid conversion to ethanol, succinic acid
- Chemical
  - Carbonate additions
    - Consumes tartaric acid
  - Double-salt additions
    - Consumes tartaric and malic?

DEACIDIFICATION TRIALS

- **Biological**
  - **Evaluation of yeast demalication activity (2012)**
  - **Partial MLF & back blending (Year 3)**
- **Chemical (Year 3)**
  - **Reassessing ‘double-salt’ additions**
- **Optimization (Year 4)**
  - **Replicated trials of best methods (UMN & Cornell)**

YEAST DEMALICATION

- Commercial strains with known activity:
  - ICV-GRE (18%-25%), 71B(33%), *S.* pombe (variable), ML01(100%)

- Simple diffusion through yeast membrane
  - Lower pH = more dissociation = more malic activity
  - Conversion to succinic acid or ethanol
    - Production varies by fermentation environment
  - Glucose must be present

- Activity unknown in cold-hardy cultivars

YEAST DEMALICATION

- UMN Enology Project
  - Two cultivars
    - Frontenac gris
    - La Crescent
  - Four yeast strains
  - Microfermentations (5 reps) for chemical analysis
  - Scale-up fermentations with selected yeasts for sensory evaluation

YEAST DEMALICATION

	Lalvin C *(Lalvin)*	Exotics *(Anchor)*	Opale *(Lalvin)*	*Torulaspora delbrueckii* *(Lallemand)*	DV10 *(Lallemand)*
Reported Malate Reduction	Up to 45%	Up to 17% observed	0.1 to 0.4 g/L	None Reported	Control
Yeast Type	*S. cerevisiae* var. *bayanus*	Hybrid yeast	*S. cerevisiae*	Non-Saccharomyces	*S. cerevisiae* var. *bayanus*

- *T. delbrueckii* used in combination with Exotics (Frontenac gris) or Opale (La Crescent)
- Standard white wine production methods

FRONTENAC GRIS

DV10 (Lalvin)	Lalvin C	Exotics (Anchor)	TD + Exotics
TA (g/L)	TA (g/L)	TA (g/L)	TA (g/L)
10.03 ±0.007	**9.10** ±0.006	**9.58** ±0.014	**9.37** ±0.003
Malate (g/L)	**Malate (g/L)**	**Malate (g/L)**	**Malate (g/L)**
4.28 ±0.002	**3.48** ±0.002	**3.74** ±0.003	**3.56** ±0.003

All differences in TA and Malate were significant ($p < 0.05$)

	Malate Reduction (%)
Lalvin C	23% lower than DV10
Exotics	15% lower than DV10
TD + Exotics	20% lower than DV10

LA CRESCENT

DV10 (Lallemand)	Opale (Lalvin)	Exotics (Anchor)	TD + Opale
TA (g/L)	TA (g/L)	TA (g/L)	TA (g/L)
9.856 ±0.11	**9.418** ±0.09	**9.24** ±0.06	**9.37** ±0.04
Malate (g/L)	**Malate (g/L)**	**Malate (g/L)**	**Malate (g/L)**
4.78 ±0.05	**4.74** ±0.02	**4.26** ±0.03	**4.70** ±0.02

- No statistical difference between malate levels in DV10, Opale, and TD + Opale ($p > 0.05$)
- *Anchor Exotics* showed a statistical difference in malate reduction between all other yeasts ($p < 0.05$)

	Malate Reduction (%)
Exotics	12% lower than DV10

CARBONATE ADDITIONS

- Neutralization through addition of:
  - potassium bicarbonate (**$KHCO_3$**)
  - calcium carbonate (**$CaCO_3$**)

- Reacts with Tartaric acid (limiting factor)
- Malic acid not affected

CALCIUM CARBONATE ($CaCO_3$)

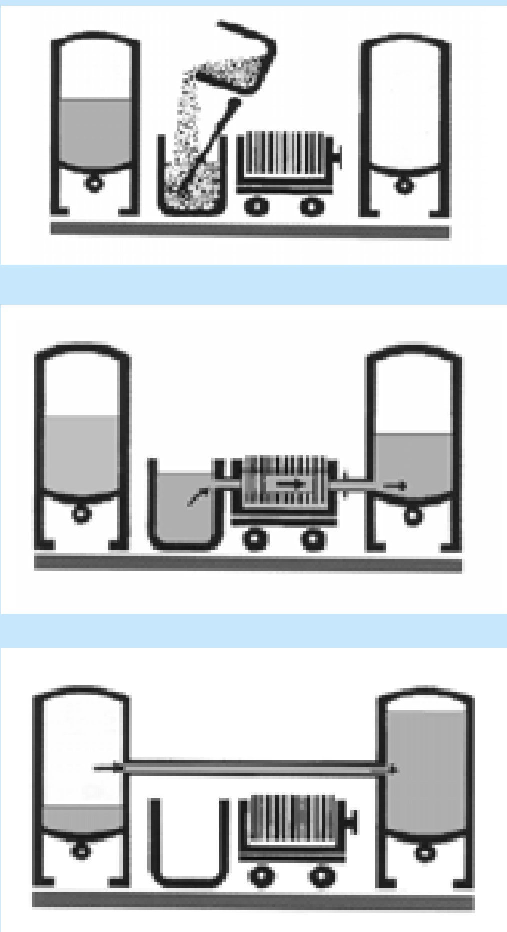
- Addition: 1 g/L ≈ 1.5 g/L drop in TA
- Pros:
  - Corrects very high acidity
- Cons:
  - Best used in juice/must
  - Saturates wine with calcium salt
    - **bitter, chalky**
  - Precipitates over long periods…very long periods

DOUBLE-SALT ADDITION

- **Theory:** Under certain circumstances, calcium carbonate can be used to remove both tartaric and malic acids

- Tartaric acid in 1-5% of juice totally neutralized
- pH adjusted over 5 to deprotonate malic acid
- Neutralized juice returned to tank, resulting in chain-reaction that removes both tartaric and malic acid

DOUBLE-SALT ADDITION



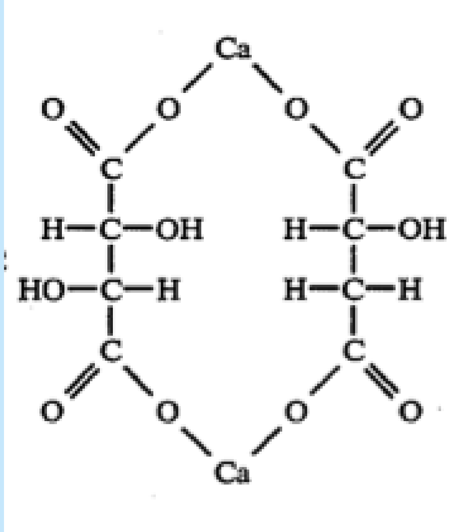
Erbsöh

- **Measure TA and tartaric acid concentration.**
- **Remove 1-5% total juice volume.**
- **Add calcium carbonate with constant stirring.**
- **Add calculated amount of tartaric acid + calcium carbonate with constant stirring**
- **Filter deacidified portion**
- **Return to tank with stirring**

DOUBLE-SALT ADDITION

- **Claims:**
  - Larger acid reductions
  - Calcium carbonate completely consumed = no lingering instability
  - Removes both tartaric and malic acids
  - Acid reduction due to action of 'double salt' – calcium tartro-malate

Can we use double-salt on high-malic wines?



REVISITING DOUBLE-SALT

- **Mythbuster #1:**

Calcium tartro-malate does not form in this universe.

DOUBLE-SALT REVISITED

- What we know:
  - Two salts are involved- calcium tartrate and calcium malate
  - Calcium malate forms very slowly; reaction favors calcium tartrate
  - Calcium carbonate probably doesn’t react completely
  - Total deacidification impossible to determine

- What we still don’t know:
  - How much malic acid can be removed (likely, not much)
  - How this reaction will change in wine due to buffering capacity
  - How much instability will remain from unreacted calcium

DOUBLE-SALT REVISITED

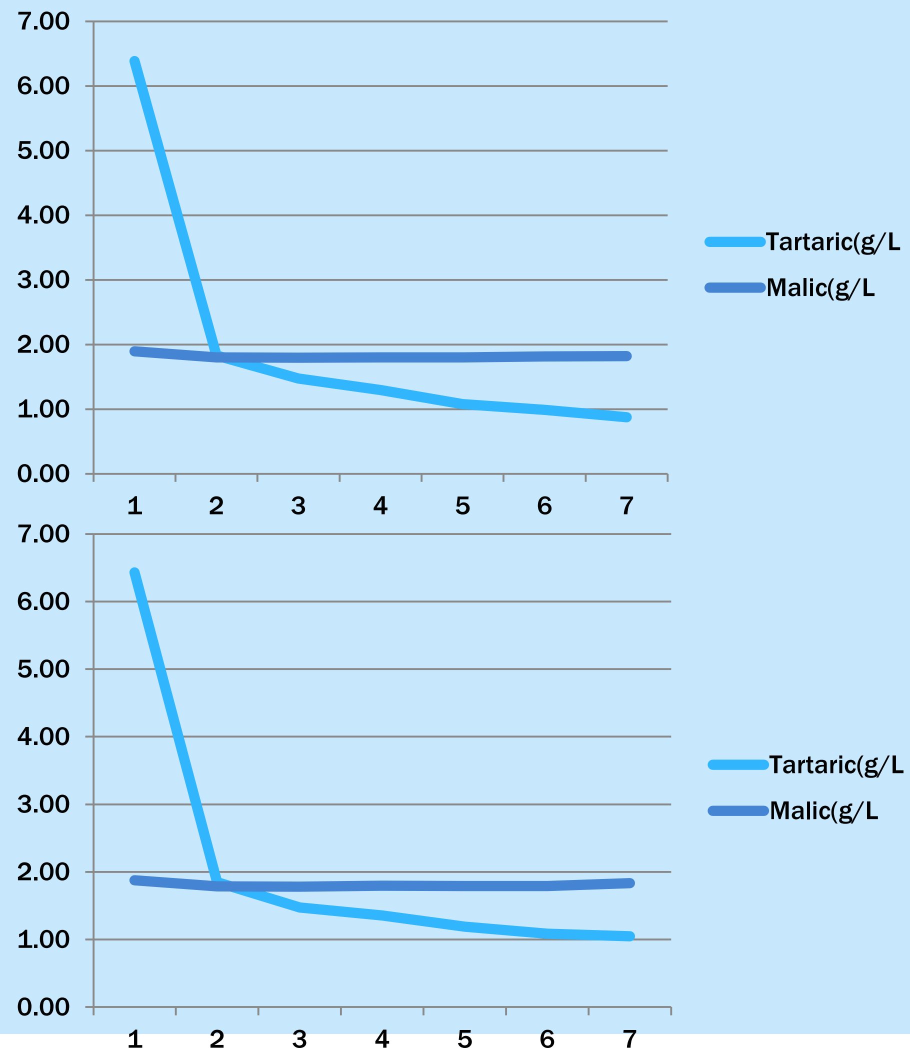
- Cornell Enology Extension
- Two cultivars:
  - Frontenac gris
  - La Crescent
- Methods:
  - Modeling trials
  - Juice double-salt
  - Wine double-salt

DOUBLE-SALT MODELING

- 500ml from 2gal duplicate lots
- $CaCO_3$ addition with stirring
- HPLC organic acid & pH check at 0, 15 min, 30 min, 1 hour, 2, 4, 8.
- Timed samples filtered, returned and tracked 48hr

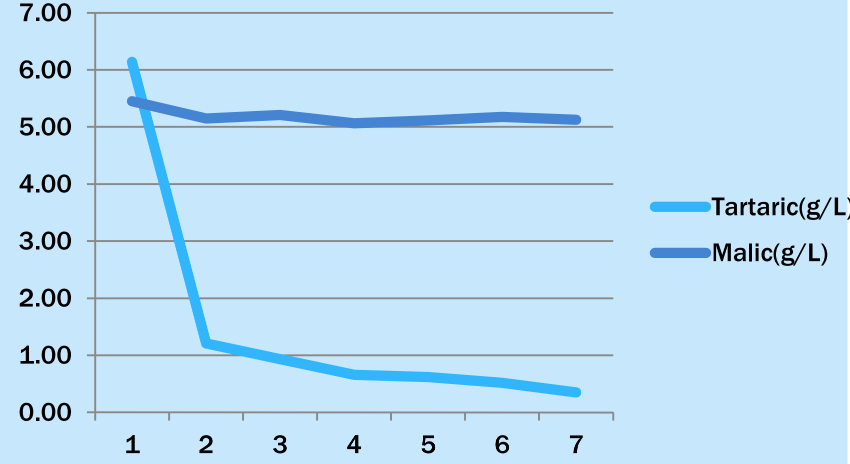
MODELING, SCENARIO 1

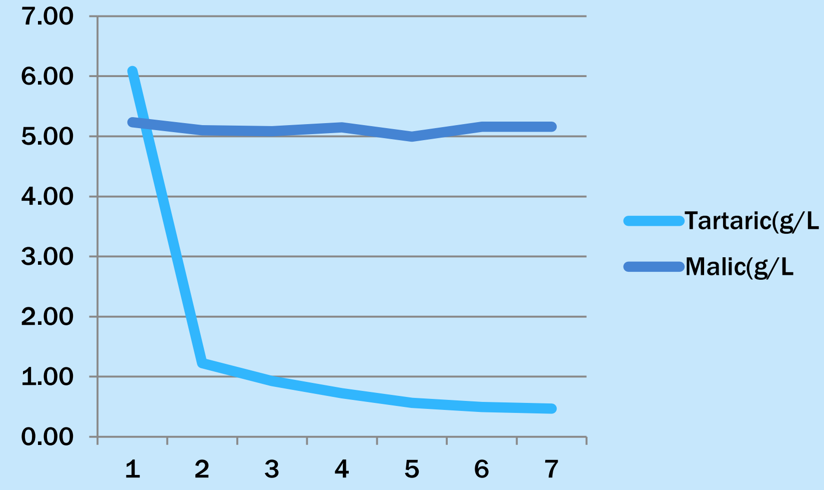
- Does order of operation matter?
  - Theory: adding juice to $CaCO_3$ will allow for a higher pH, favoring malic removal.
  - Compare "juice first" to "$CaCO_3$ first."



MODELING, SCENARIO 2

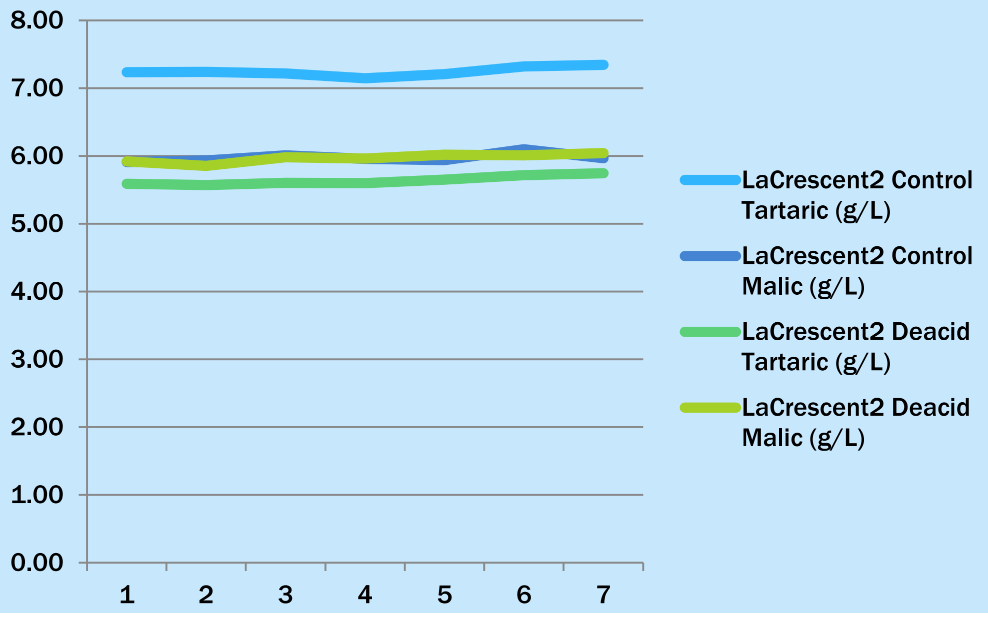
- Does relative concentration matter?
  - Theory: More malic acid will allow for better removal.
  - Add malic acid to create roughly 1:1 ratio.
  - Also compare order of operations as in Scenario 1.





MODELING, SCENARIO 3

- **Does time matter?**
  - **Theory: More de-acidification happens after we stop watching.**
  - **Compare deacidified with control juice, starting the clock after adjustment and filtration.**



FERMENTATION TRIALS

Juice at harvest

Cultivar	Brix	pH	TA	Tartaric	Malic
La Crescent	24.8	3.06	14.3	8.0	7.8
Front Gris	25.3	3.08	14.6	9.6	5.6

Wines following treatment & cold stabilization

Cultivar	pH	TA	Tartaric	Malic
La Crescent Control	3.10	11.9	2.8	7.1
La Crescent Deacidification	3.31	10.4	1.9	6.9
Frontenac Gris Control	3.06	11.8	4.0	5.5
Frontenac Gris Deacidification	3.24	10.1	2.6	5.6

SUMMARY

- Demalication of yeast varies by strain, and is largely unexplored in cold-hardy hybrids.
- In theory, Double-Salt can remove malic, but only after all tartaric is consumed, and only in the treatment aliquot.
- The double salt… isn't.

- Future work:
  - Partial and blended MLF
  - Amelioration
  - Biological + chemical

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