Influence of yeast strain choice on the success of Malolactic fermentation

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INTRODUCTION

• Changing conditions dictate different microbial population dynamics
  – e.g. high pH, SO$_2$ addition levels, cleaning and sanitation practices

• Winemaker must manage the microbial populations throughout the process
  – Cold Soak to bottling

• Co-existing *Saccharomyces* and *Oenococcus* populations must be compatible, if not:
  – Ethanolic fermentation issues
  – Malolactic fermentation issues
Saccharomyces cerevisiae

• ~180 enological strains available
  – Genetically different
    • Requirements may differ
    • Results may differ

  – Interactions with other organisms may differ!
    • Yeast: Yeast interactions
      – Positive, Negative or Neutral
    • Yeast: Bacteria interactions
      – Positive, Negative or Neutral
Oenococcus oeni

• ~ 30 enological strains available
  – Strict environmental limitations
    • Alcohol
    • pH
    • FSO₂/TSO₂
    • Temperature
    • Malic acid concentration
    • Nutrient status
POSSIBLE ORGANISM COMBINATIONS

- ~180 enological strains *S. cerevisiae*
- ~30 enological strains *O. oeni*
- 180x30...
  - 5400 possible combinations
    - assuming only 1 yeast and 1 bacteria present
  - Prediction for rate of success?
    - Dependant upon the combination
      - Various outcomes
ALCOHOLIC AND MALOLACTIC FERMENTATIONS

• Malolactic fermentations should not be considered as an afterthought
  – Alcoholic fermentation dictates the success rate!

• Easy ALF=Easy MLF
• Challenging ALF=Difficult MLF
• Planned in conjunction...
Inhibition of *O. oeni* by *S. cerevisiae*

**Ethanol production**
- Affects the capacity of the bacteria to grow
  - Select strain which is resistant to the Ethanol level

**SO₂ production**
- Yeast strains classed as high, medium or low producers
  - Production can vary from <20mg/L to >90mg/L
  - Amount depends on the availability of nutrients and the presence of compounds in the must that can bind SO₂
    - Know what levels are present!

Loss of viability can be partially attributed to the inhibition of the ATPase activity
Inhibition of *O. oeni* by *S. cerevisiae*

- Medium Chain Fatty Acids
  - Target and alter the bacterial membrane, interfere with ability to consume Malic Acid, and limit growth

<table>
<thead>
<tr>
<th>Wine</th>
<th>Malic Acid (day 4)</th>
<th>Malic Acid (day 14)</th>
<th>% degradation after 14 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.19</td>
<td>0.53</td>
<td>81</td>
</tr>
<tr>
<td>Wine + C6 145µM</td>
<td>2.24</td>
<td>0.46</td>
<td>84</td>
</tr>
<tr>
<td>Wine + C8 145µM</td>
<td>2.33</td>
<td>0.70</td>
<td>75</td>
</tr>
<tr>
<td>Wine + C10 145 µM</td>
<td>2.46</td>
<td>1.18</td>
<td>58</td>
</tr>
<tr>
<td>Wine + C6 52µM + C8 71µM + C10 µM</td>
<td>2.40</td>
<td>1.45</td>
<td>49</td>
</tr>
</tbody>
</table>
Nitrogen requirements: mg of YAN necessary to consume 1g of sugar
Inhibition of *O. oeni* by *S. cerevisiae*

- Alterations of acidity
  - Utilization of Malic acid, or production of Succinic acid
    - Differential Malic Acid consumption by different strains

- Glutamic Acid deficiency
  - Essential for growth

- Aromatic Compounds
  - \( \beta \)-phenylethanol

- Anti-bacterial metabolites?
Stimulation of *O. oeni* by *S. cerevisiae*

- Yeast autolysis rate
  - Strain dependant
    - Influences the nutritional composition of the medium
      - Releasing amino acids, peptides, mannoproteins
        » Mannoproteins have dual functions
          » Detoxification of medium by absorption
          » Protection of cells from polyphenolic inhibition
Inhibition of *S. cerevisiae* by *O. oeni*

- Production of Acetic Acid
- Glucosidase Production
- Bacterial protease production
- Production of other yeast inhibitors?
BACTERIA: BACTERIA INTERACTIONS

• **L. brevis**
  – Produces Brevicin
    • Small thermostable protein (3kDa)
    • Broad range of action
      – Can inhibit *O. oeni, P. damnosus, L. brevis*

• **L. casei**
  – Produce Caseicin
    • Higher MWt, less stable
    • Inhibits fructose uptake
OVERVIEW

• Wine is the result of complex interactions between organisms

• Yeast strain choice does have an impact on the success rate of MLF

• Interaction is dependant upon:
  – Yeast and bacteria strain present
  – Juice/Must/Wine conditions
  – Winemaking practices
    • E.g. timing of inoculation
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QUESTIONS

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