HARD SELTZER FERMENTATION ANALYSIS AND OPTIMIZATION

An overview of the key elements
for a successful hard seltzer fermentation

By Ben Koppenhaver

Overview

- Differences between Hard Seltzer and Beer Fermentation
- What's needed
  - Nutrients - Components/Concentration
  - Yeast - Strain/Pitch rate
  - Water – Alkalinity
- Troubleshooting common issues

How can you create a colorless, flavorless, water/alcohol mixture?

Method 1: “Quick/Dirty” fermentation needing extensive downstream processing

Pro:

- Fast fermentation
- High gravity fermentations possible (bang for your buck)

Con:

- Intense tasting/smelling and hazy base product prior to processing
- Extensive downstream processing needed to purify product
- ***Not attainable for everyone ($$$)***

How can you create a colorless, flavorless, water/alcohol mixture?

Method 2: Calculated fermentation, no/minimal downstream processing necessary

Pro:

- Still a fast fermentation (at below 12 plato)
- Product will look like the most right bottle after fermentation is complete without any downstream processing
- **More accessible ($)**

Con:

- More difficult to make +15% abv liquid (Not impossible)

Goal

- Perfect nutrient blend, not leaving any residual aroma/flavor/color
- Yeast that is neutral, no off flavor producer, fast, and dropping crystal clear
- Optimal water profile (alkalinity/minerals)
- The perfect cell count and concentration of nutrients, so that growth/fermentation will be “just right” leaving nothing behind

Accurate and Precise!
Hole in one!

Part 1. Nutrients

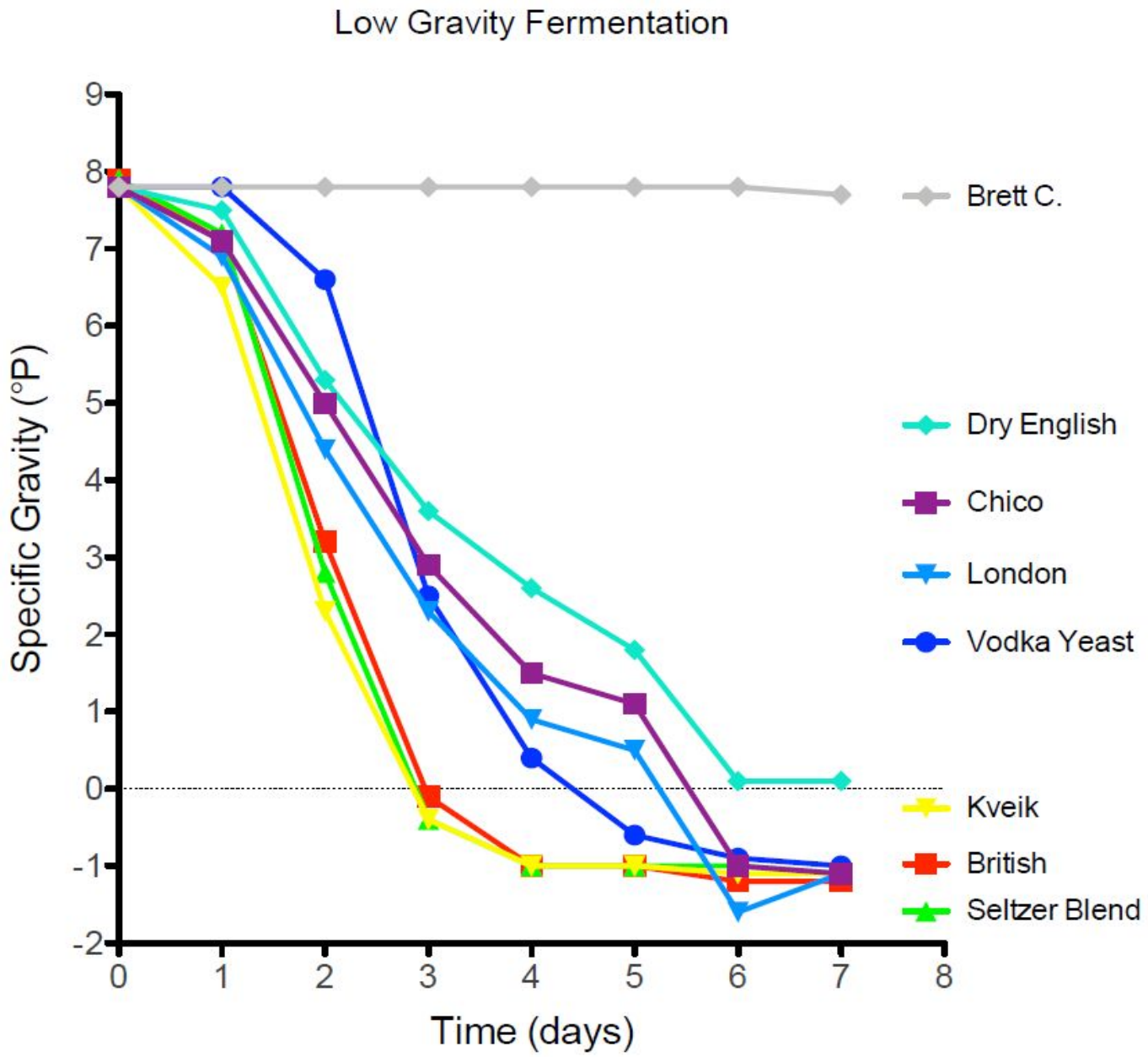
Essential Nutrients for Yeast Growth and Fermentation

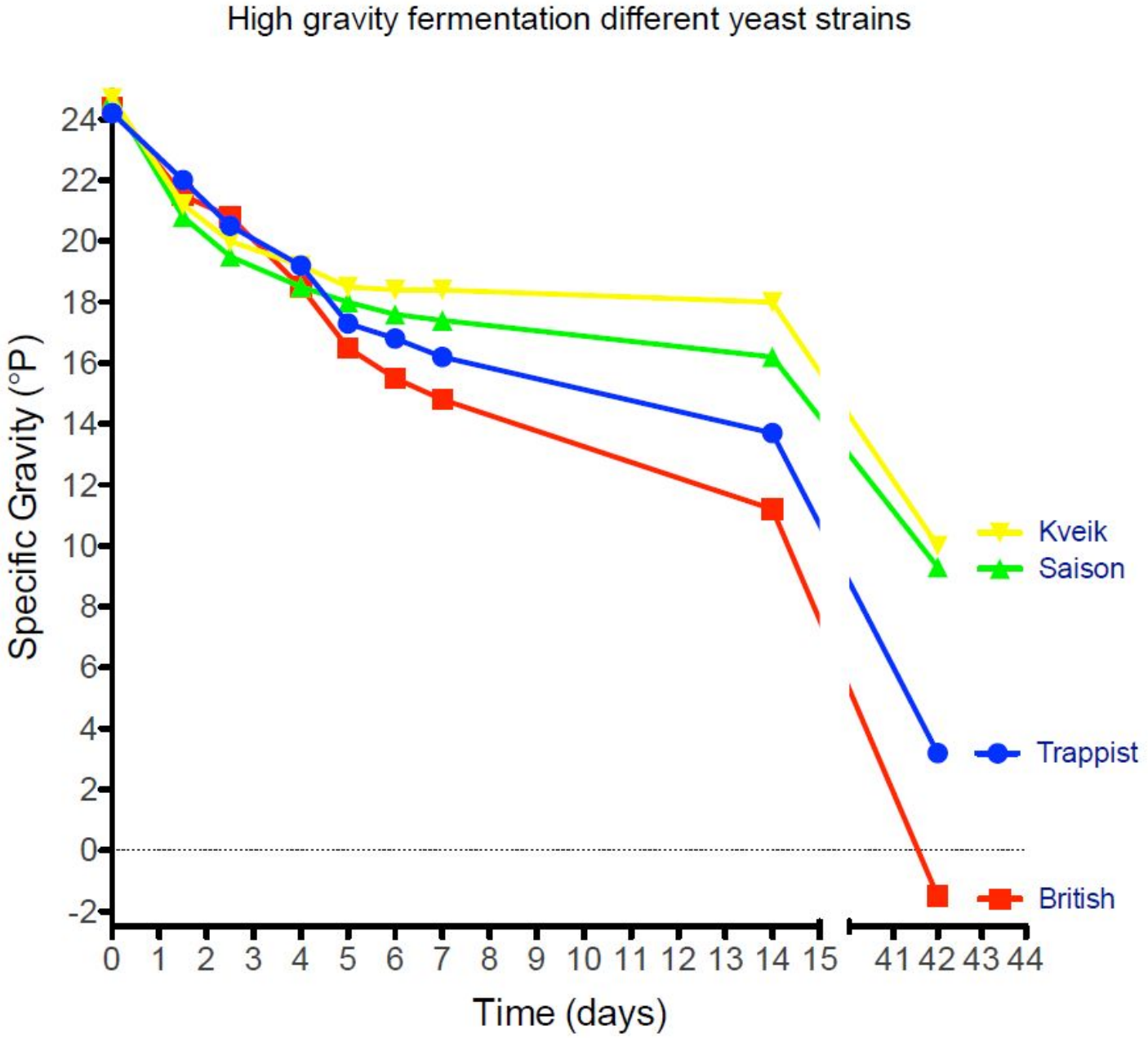
- **Nitrogen**
  - Amino Acids
  - Diammonium Phosphate (DAP)
- **Vitamins/Sterols**
- **Salts**
- **Zinc and Trace minerals**

Part 2. Yeast

Yeast Strain Selection

- Key Qualifiers
  - Tolerant to stressful conditions
    - Capable of higher gravity fermentation
  - Neutral flavor
  - Neutral aroma
    - No Sulfur or other off-aromas
  - Fast Attenuation
  - High Flocculation


Low Gravity Fermentation
Specific Gravity (°P)
9
8
7
6
5
4
3
2
1
0
-1
-2
0
1
2
3
4
5
6
7
8
Time (days)
Brett C.
Dry English
Chico
London
Vodka Yeast
Kveik
British
Seltzer Blend

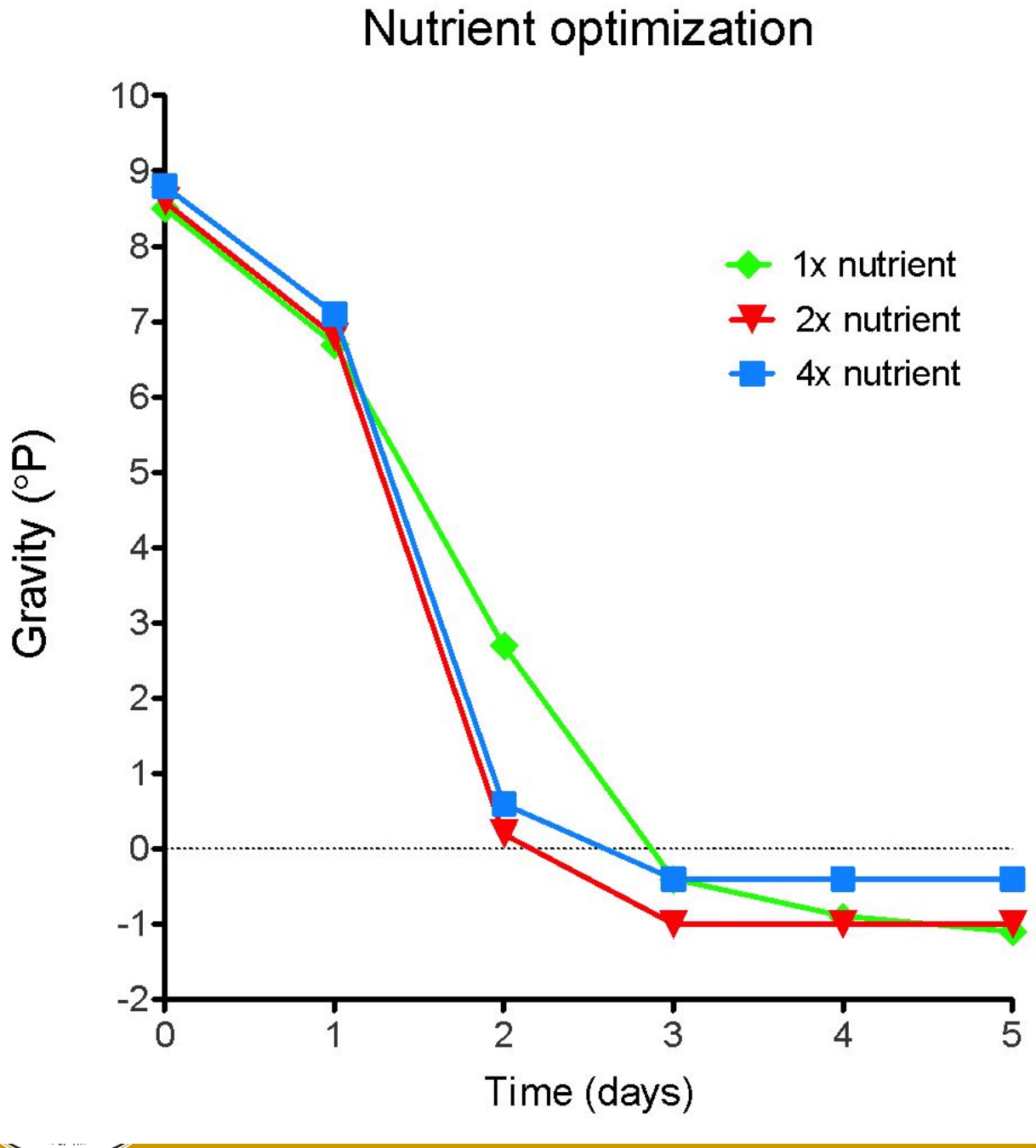

High gravity fermentation different yeast strains
Specific Gravity (°P)
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 41 42 43 44
Time (days)
Kveik
Saison
Trappist
British

Yeast Strain Analysis

- In-House blind tasting
- British and Kveik Strains met our goal
- Fast, Clean, Neutral end product

Part 3.
Balancing Yeast and Nutrients

Nutrient Effect at 8 Plato

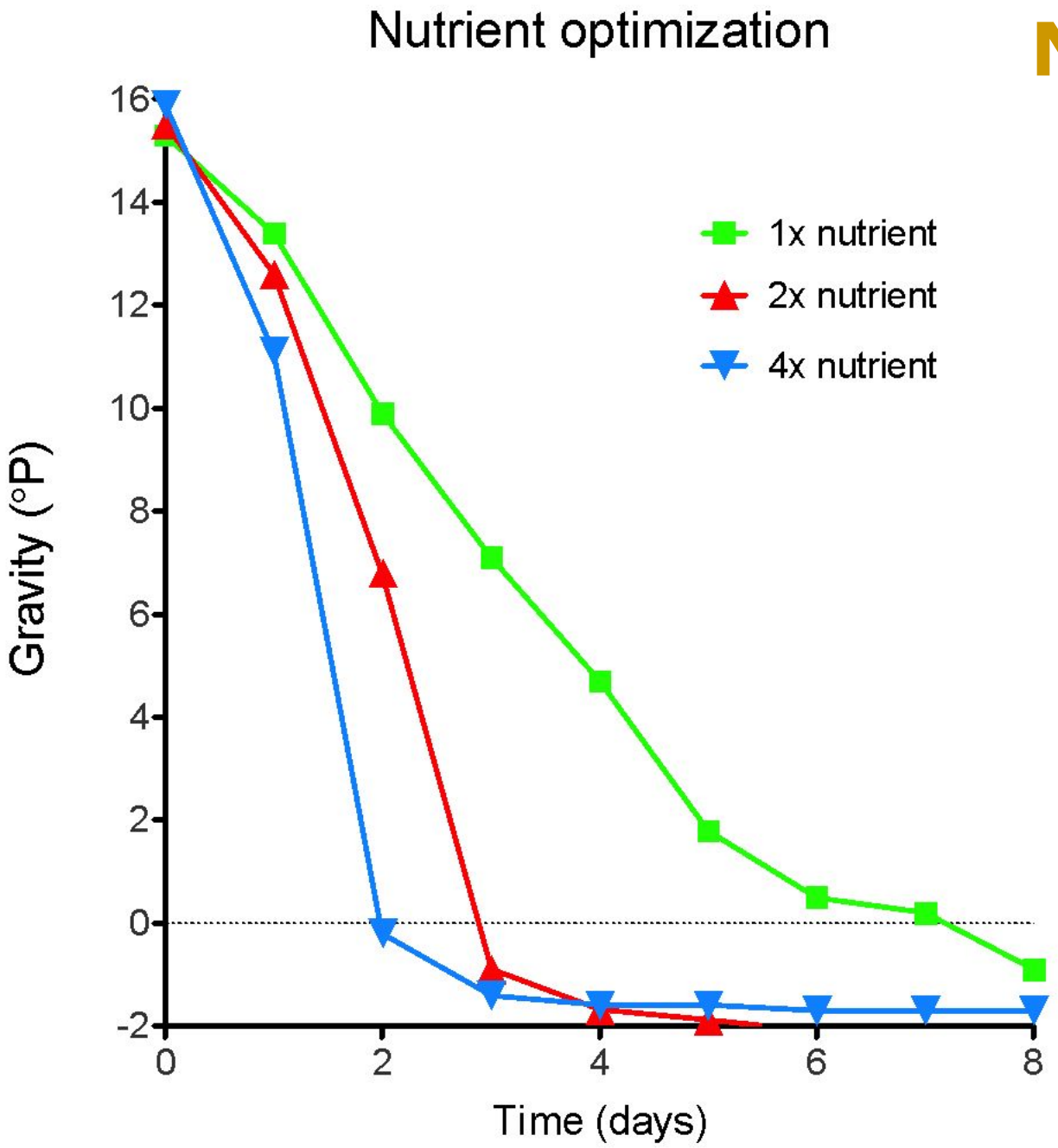


1x nutrients = 2 grams of nutrients/L (235g/bbl)

More nutrients means a slightly faster fermentation.

Levels out after 4 grams of nutrients per L.

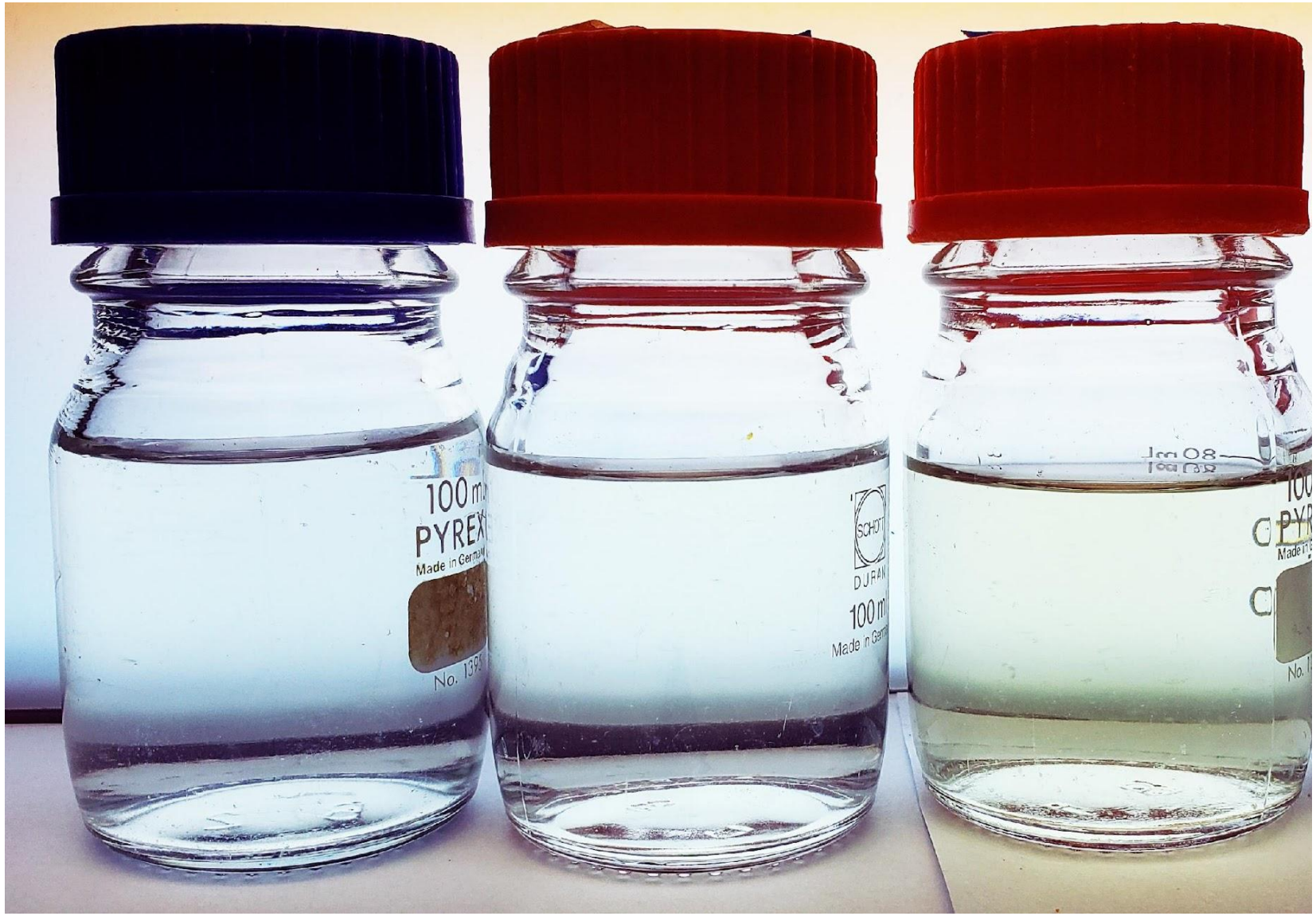
Nutrient Effect at 16 Plato



Nutrient concentration has huge effect on
fermentation efficiency (makes sense)

More seems to be better

Nutrient Effect at 8 Plato



1x Nutrient

2x Nutrient

4x Nutrient

Nutrient Effect at 16 Plato

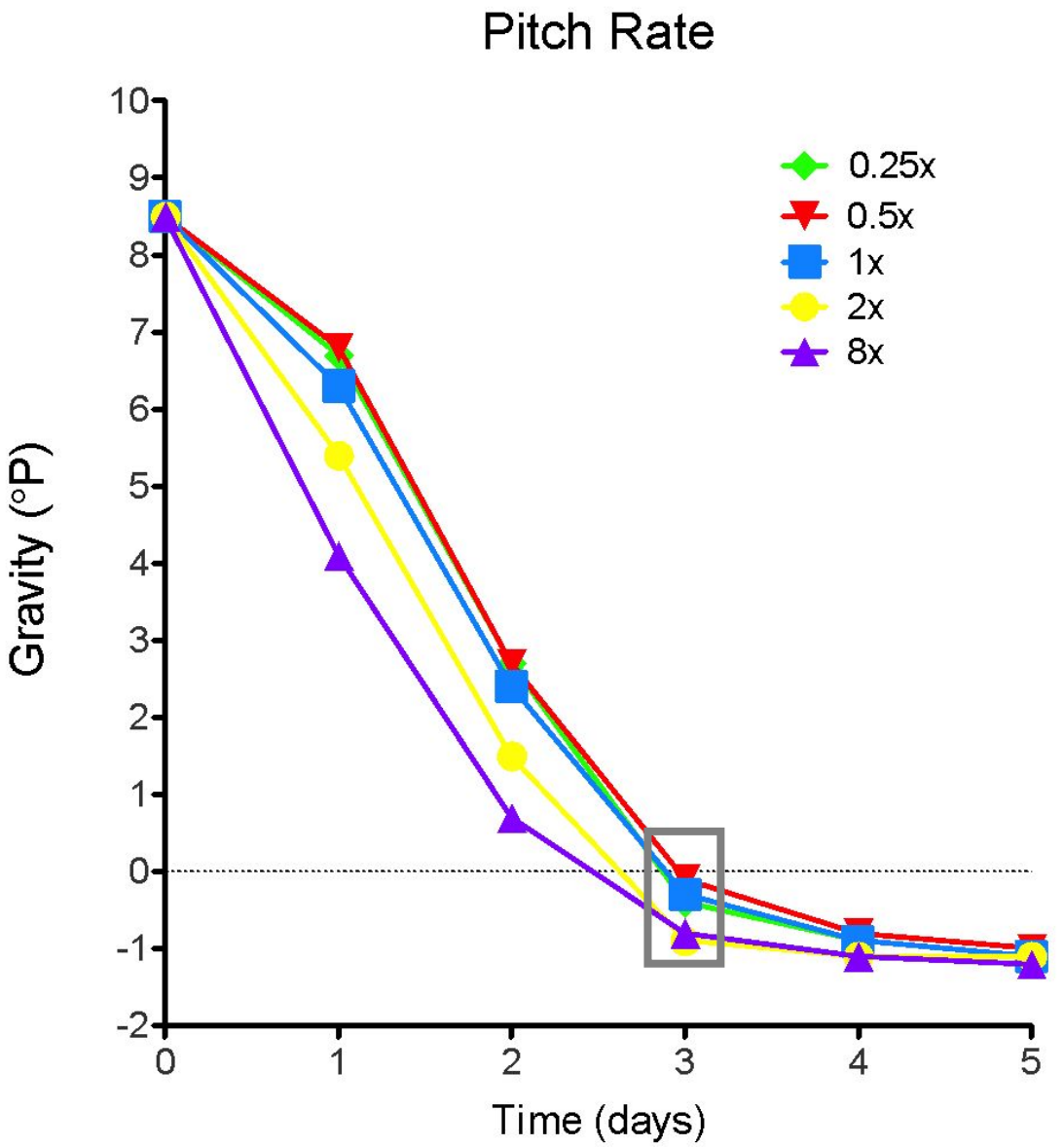
1x Nutrient

2x Nutrient

4x Nutrient

What about pitch rate?

Pitch Rate at 8 Plato

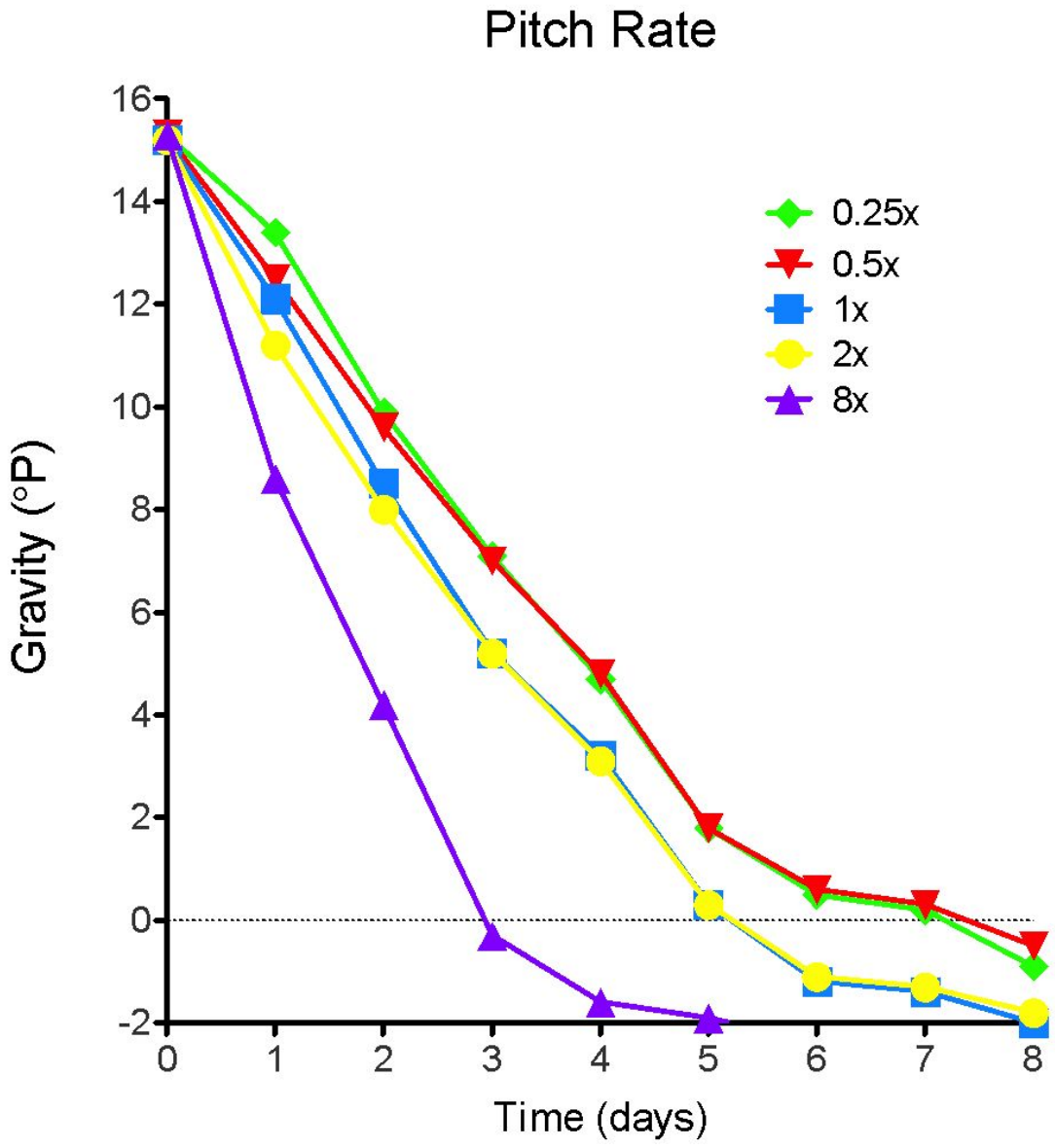


1x Pitch Rate = 7 million cells/mL (Typical Ale Pitch Rate)

Effect is small, faster drop in gravity initially, finishing at roughly the same time

Lowering pitch rate to 1.9 million cells/ml has no detrimental effect on fermentation

What about pitch rate?

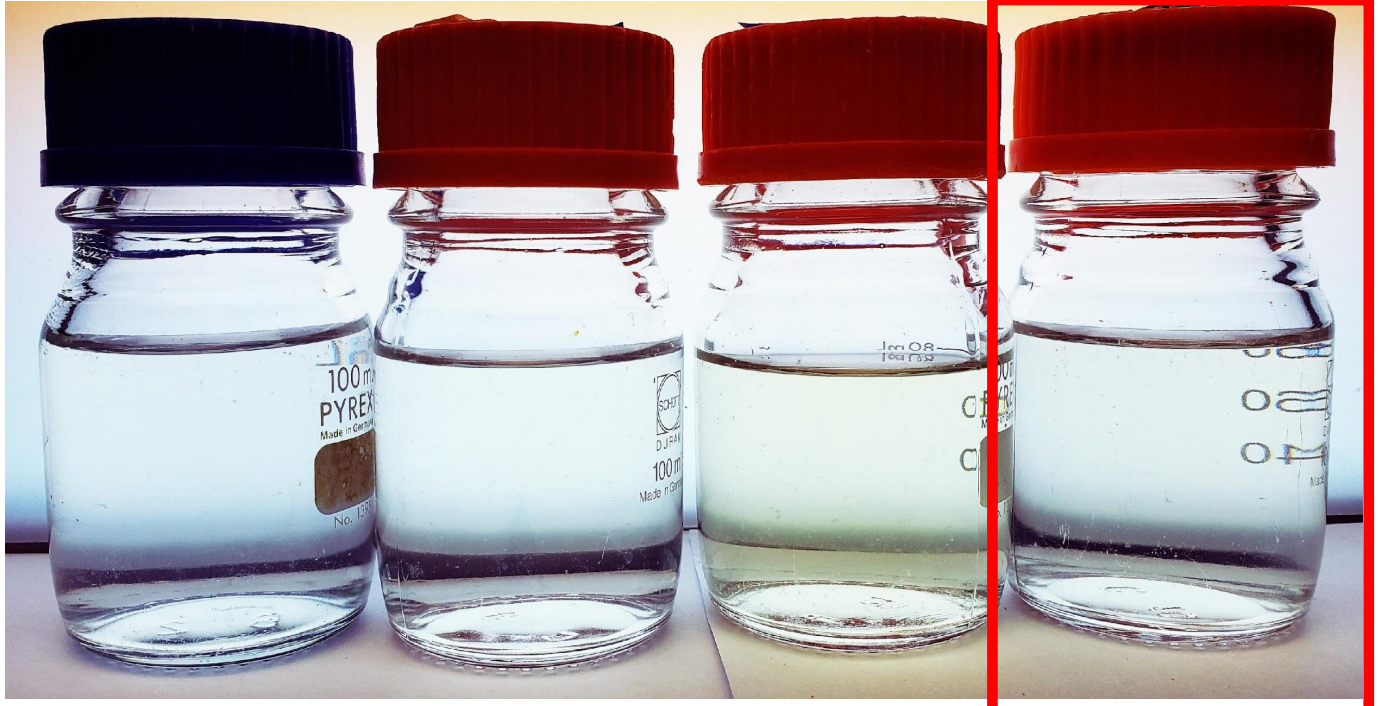


Pitch Rate at 16 Plato

1x Pitch Rate= 7 million cells/mL (Typical Ale Pitch Rate)

Large pitch rate speeds things along (comparable to beer fermentation)

Initial difference in attenuation disappears after 3 days:
(1x & 2x) and (0.25x & 0.5x) are almost identical curves respectively

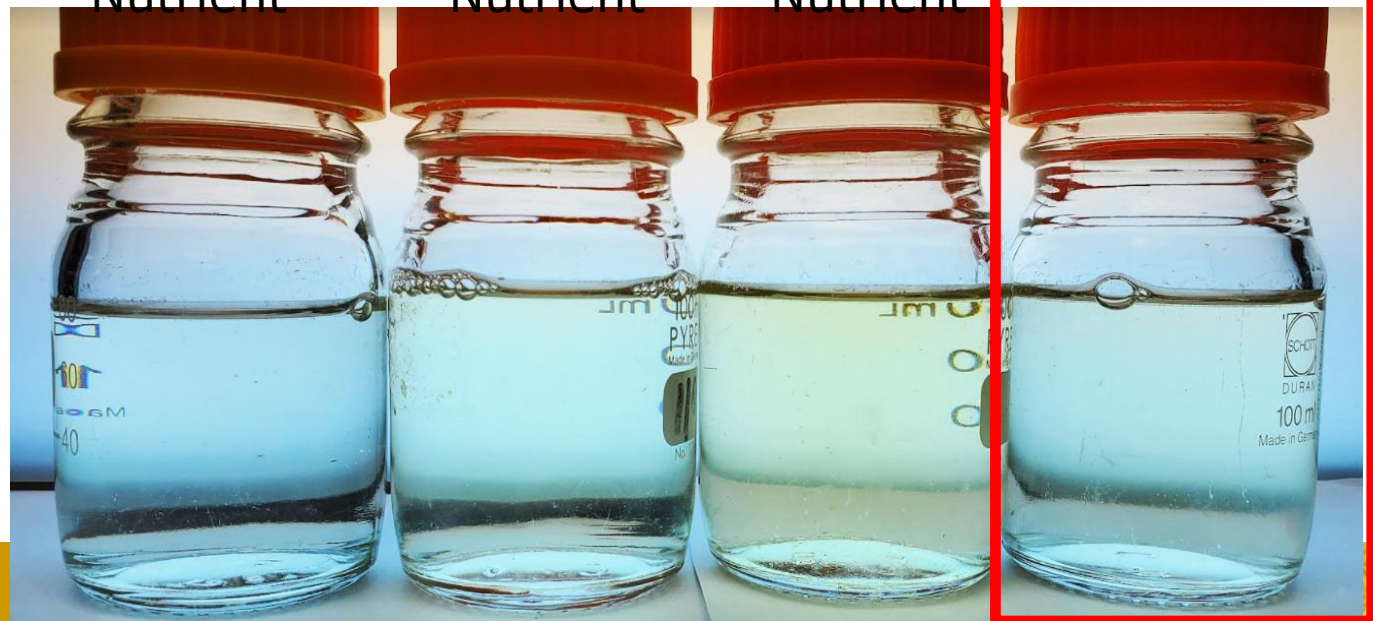


1x Nutrient

2x Nutrient

4x Nutrient

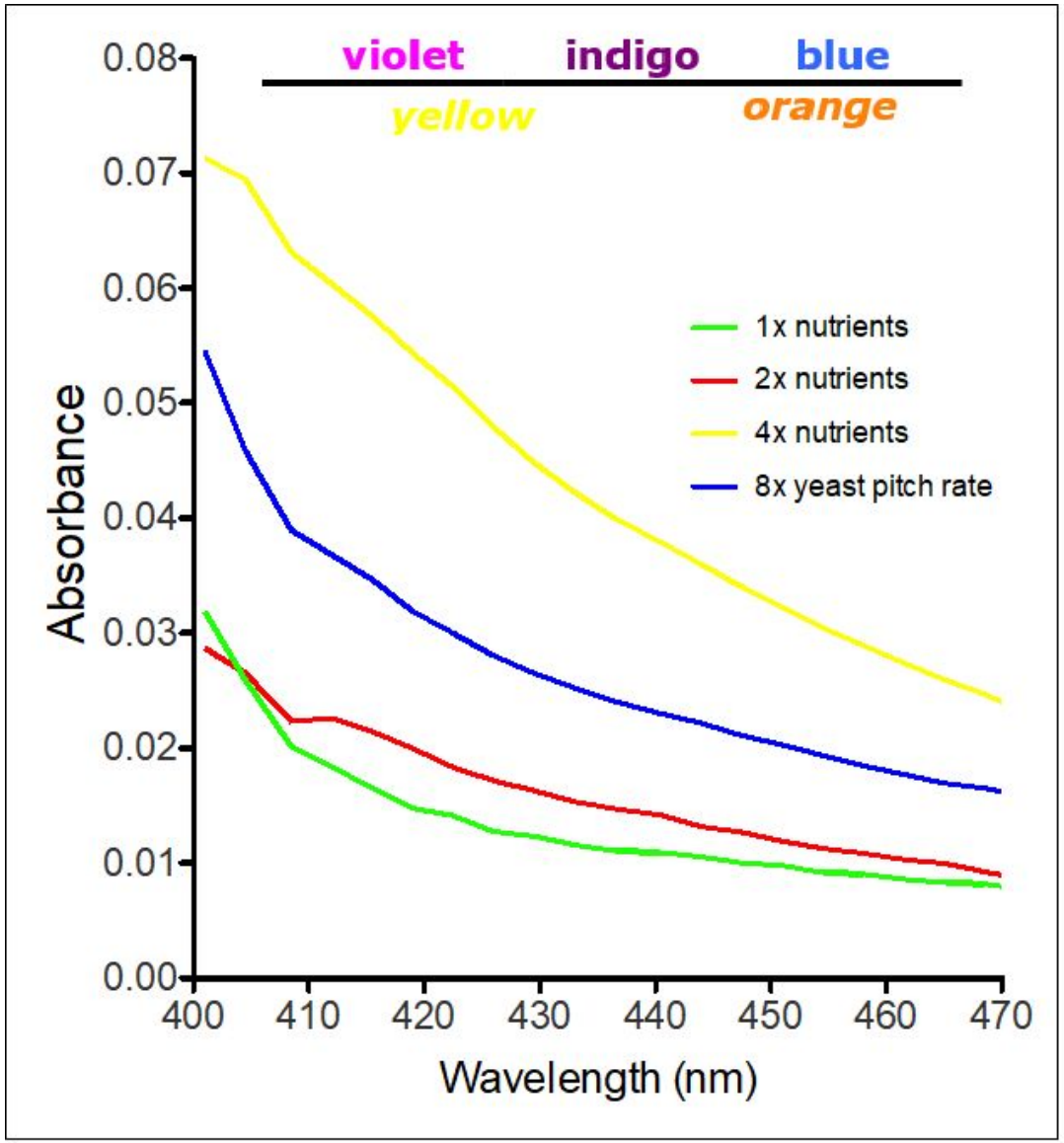
1x Nutrient
8x pitch rate



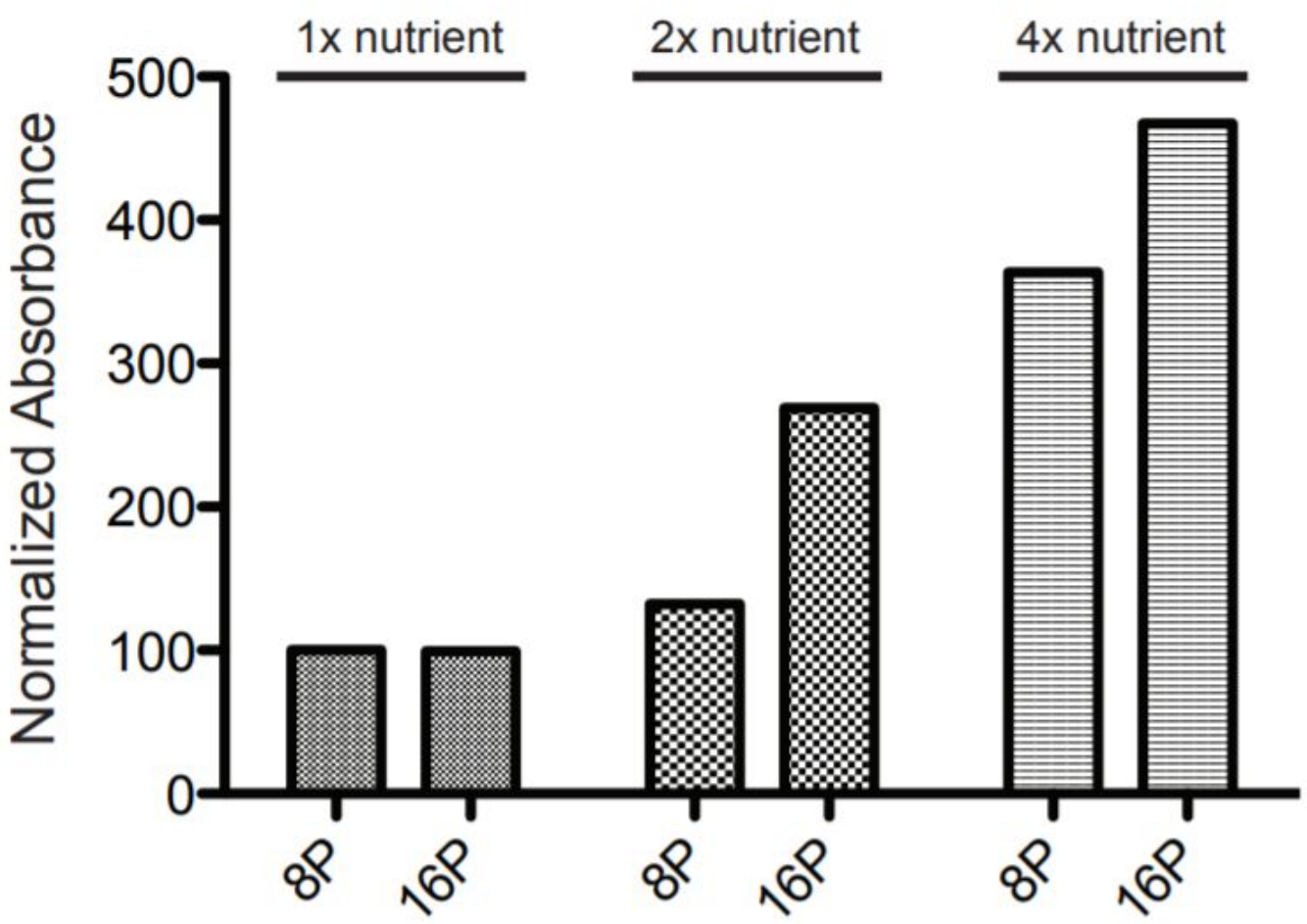
8 Plato

16 Plato

Color Analysis at 8 Plato



Color Effect - Nutrient



Measurements undiluted at 430nm

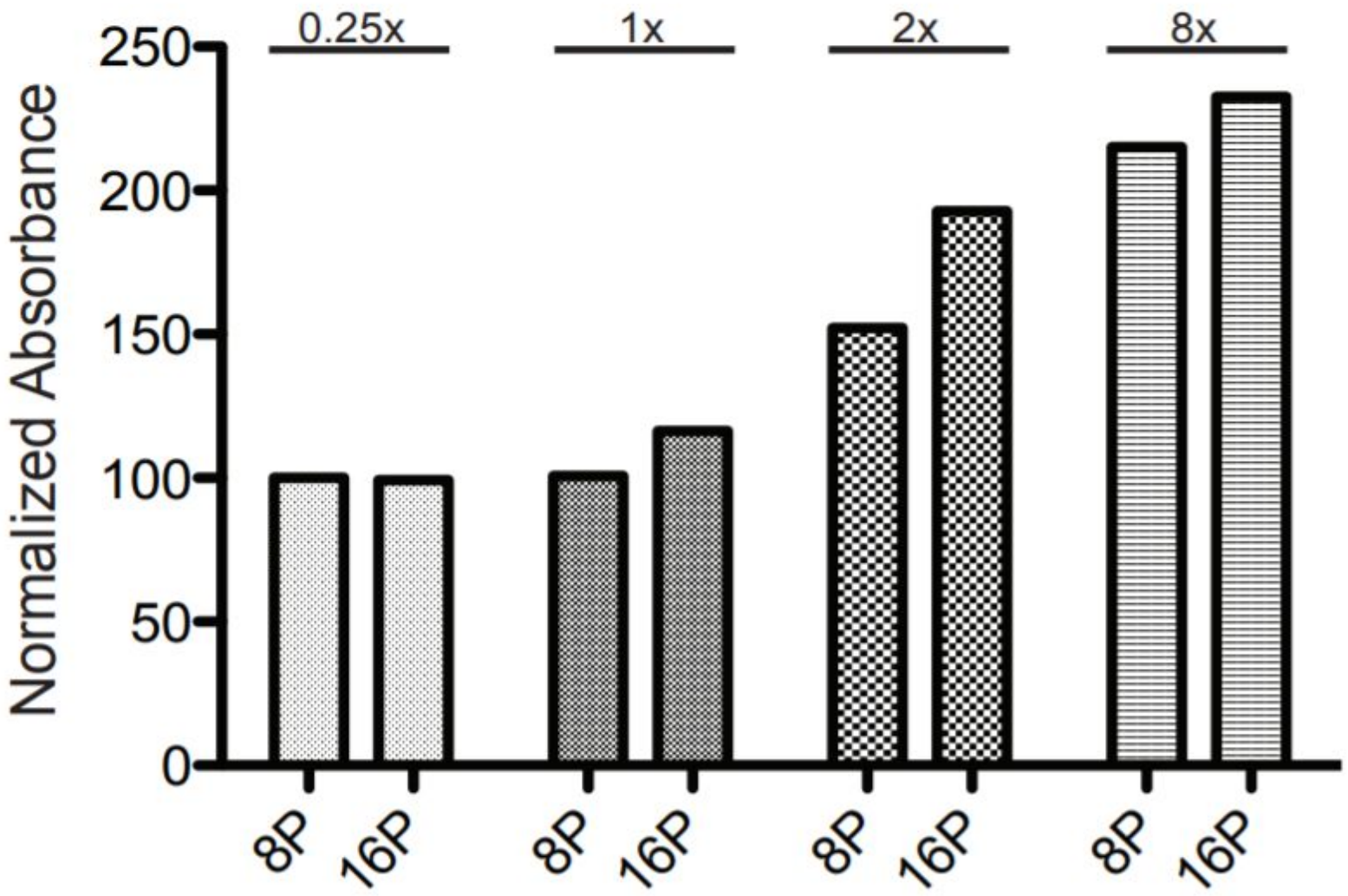
At 1x nutrients, color of 8 and 16P finished product is identical

At 2x nutrients, color increase nearly 100% with 16P compared to 8P

At 4x nutrients color difference between 8P and 16P becomes percentually smaller (~23%), both have stronger yellow color

Higher gravity amplifies the color contribution of the nutrients

Color Effect - Pitch Rate



Measurements undiluted at 430nm

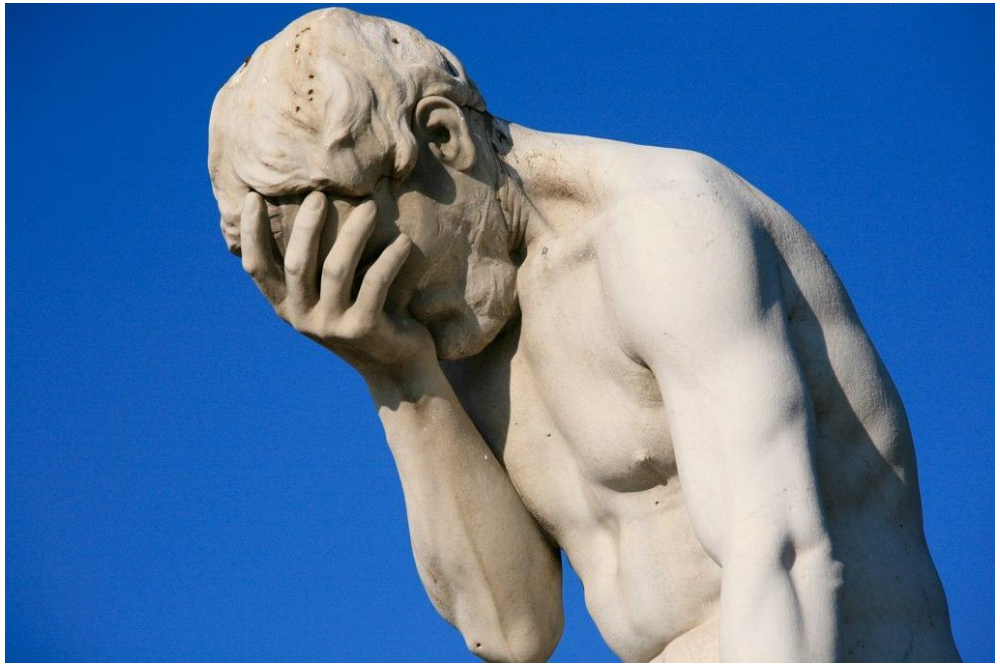
Similar effect as nutrient contribution

At 2x pitch rate, color increase ~25% at 16P compared to 8P

At 8x pitch rate color difference between 8P and 16P becomes percentually smaller (~9.5%), both have clear yellow color

Higher gravity amplifies the color contribution of initial pitch rate although less so than the nutrient

Why Has My Hard Seltzer Fermentation Stalled?



- Imbalance in Yeast/Nutrient and starting Gravity
- Water may be too Soft

Part 3. Water

What is Alkalinity?

- Alkalinity is a measure of the buffering capacity of water.
- Dependent on the presence of bicarbonates, carbonates and hydroxides.
- A way to measure the water's ability to neutralize acids.

Sample ID : WATER AT THE LAB

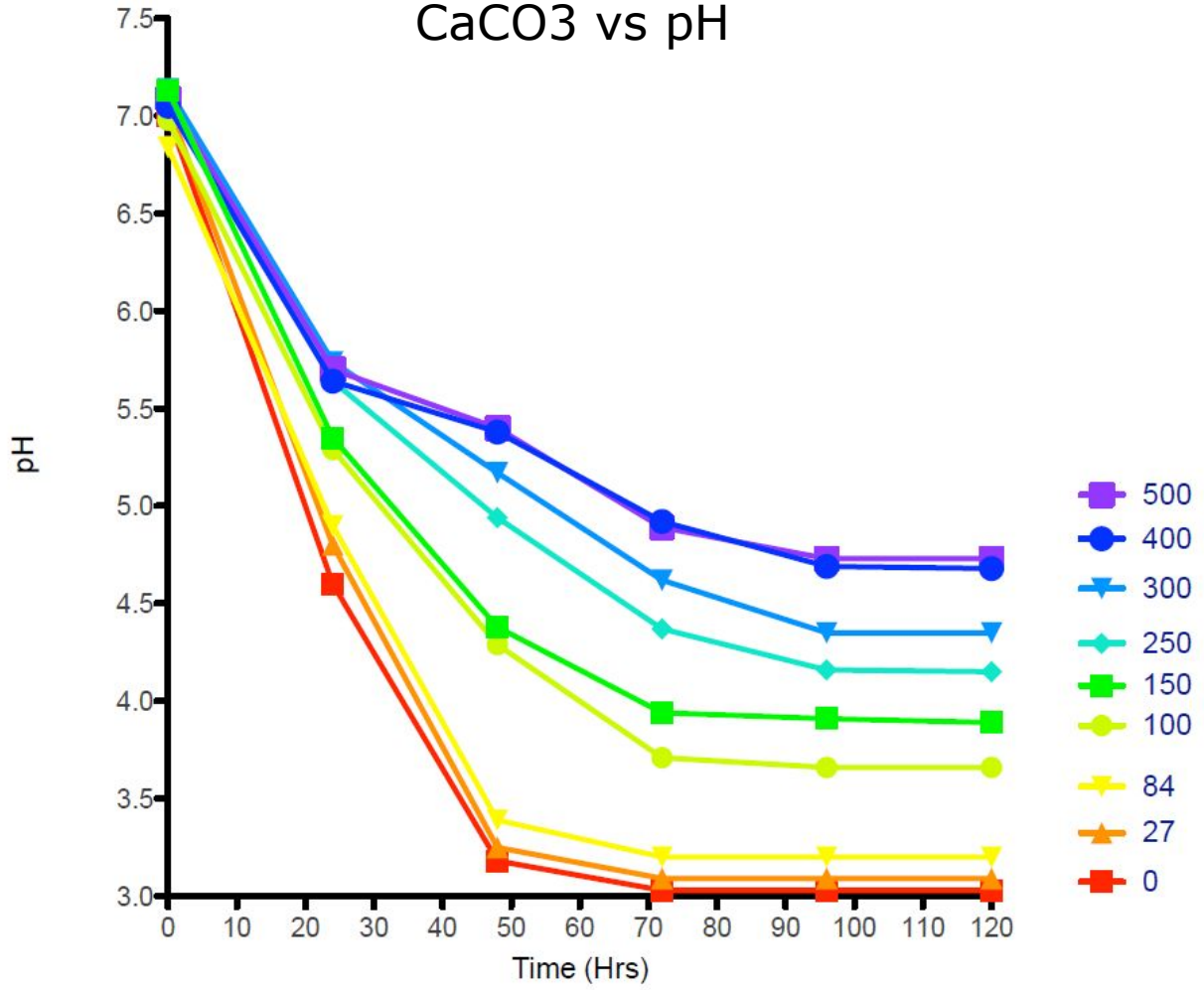
pH	7.6
Total Dissolved Solids (TDS) Est, ppm	190
Electrical Conductivity, mmho/cm	0.32
Cations / Anions, me/L	3.2 / 2.9
	ppm
Sodium, Na	12
Potassium, K	2
Calcium, Ca	35.4
Magnesium, Mg	10
Total Hardness, $CaCO_3$	129
Nitrate, NO_3-N	0.9 (SAFE)
Sulfate, SO_4-S	11
Chloride, Cl	14
Carbonate, CO_3	< 1.0
Bicarbonate, HCO_3	105
Total Alkalinity, $CaCO_3$	86
Total Phosphorus, P	0.12
Total Iron, Fe	< 0.01

"<" - Not Detected / Below Detection Limit

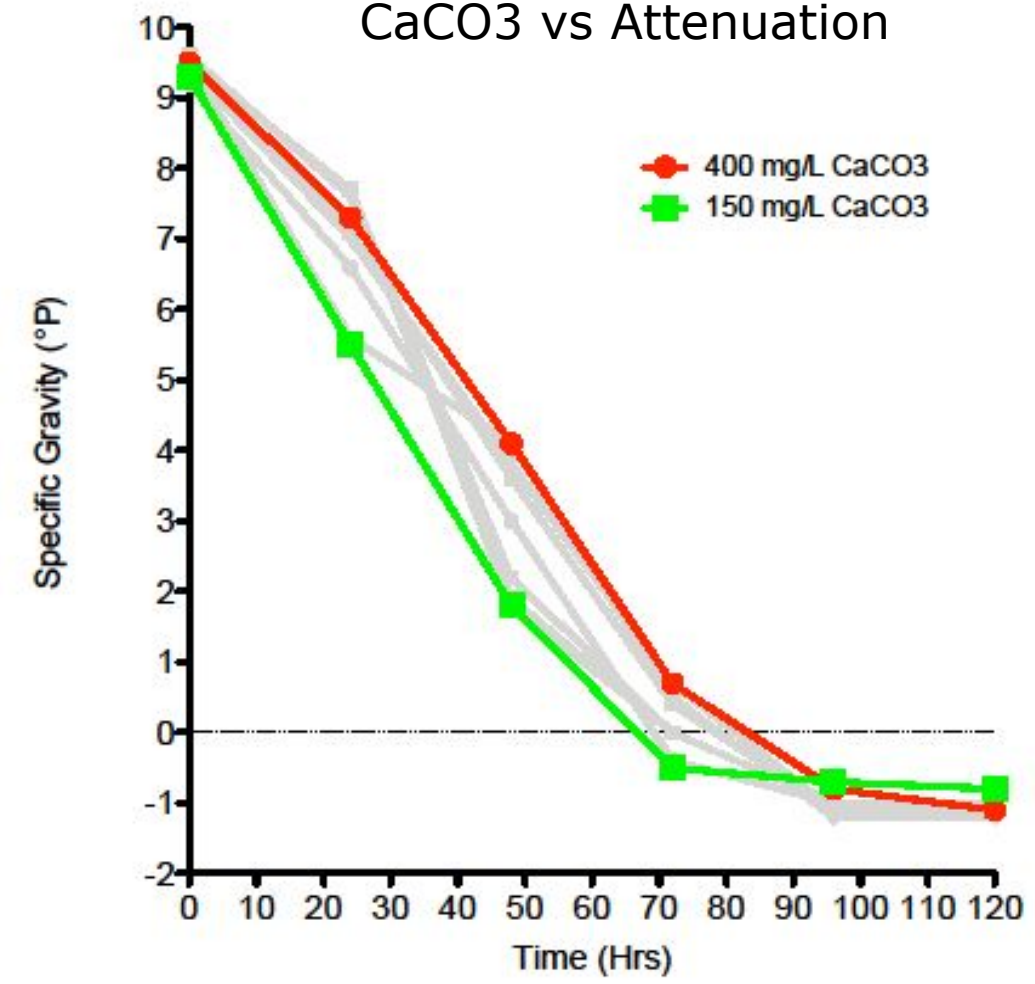
Alkalinity vs Attenuation

¼ x Yeast Pitch Rate = 1.9 million cells/mL

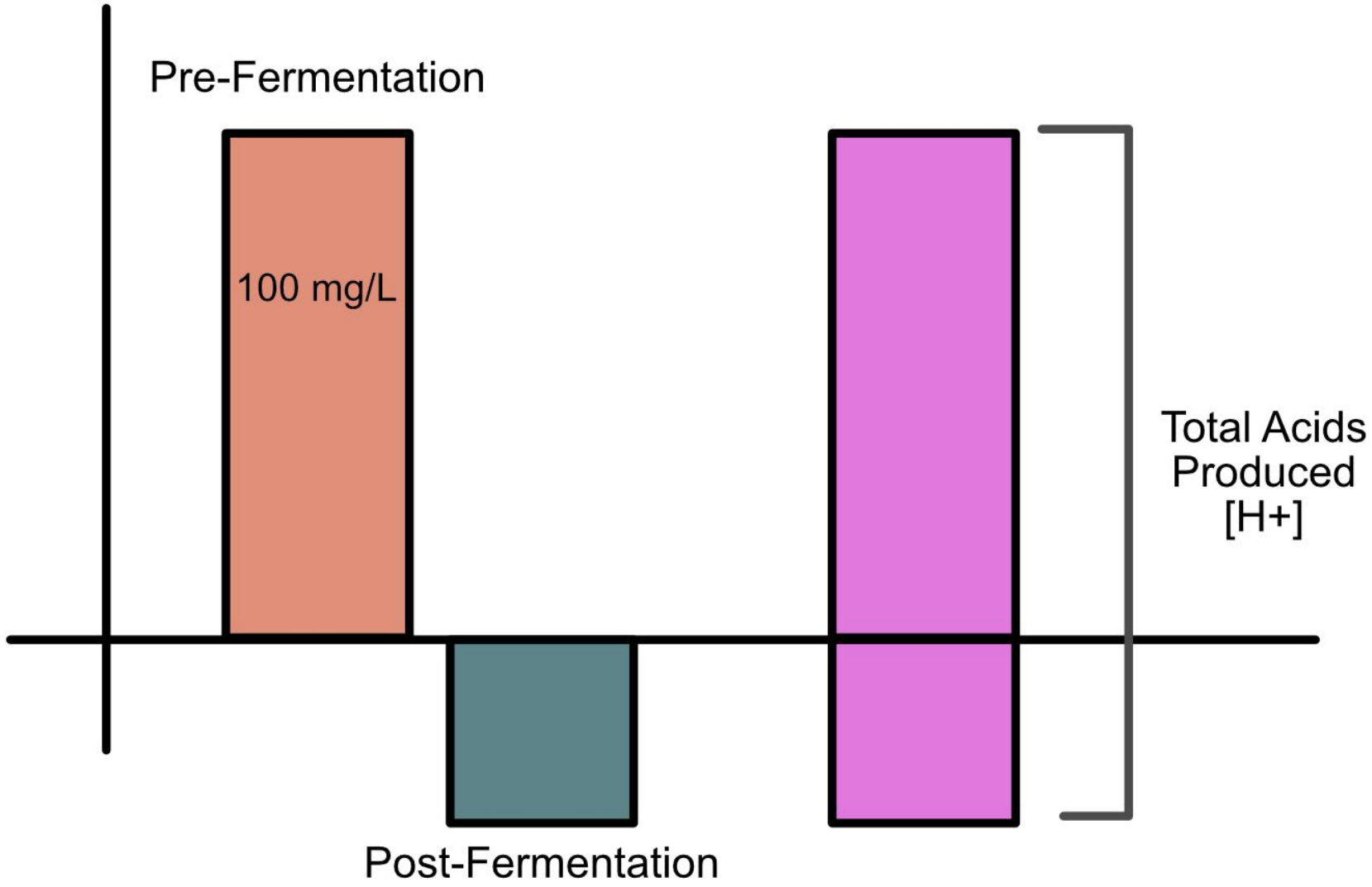
CaCO3 vs pH



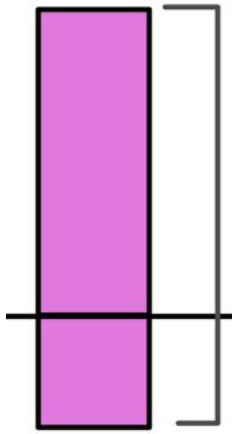
CaCO3 vs Attenuation

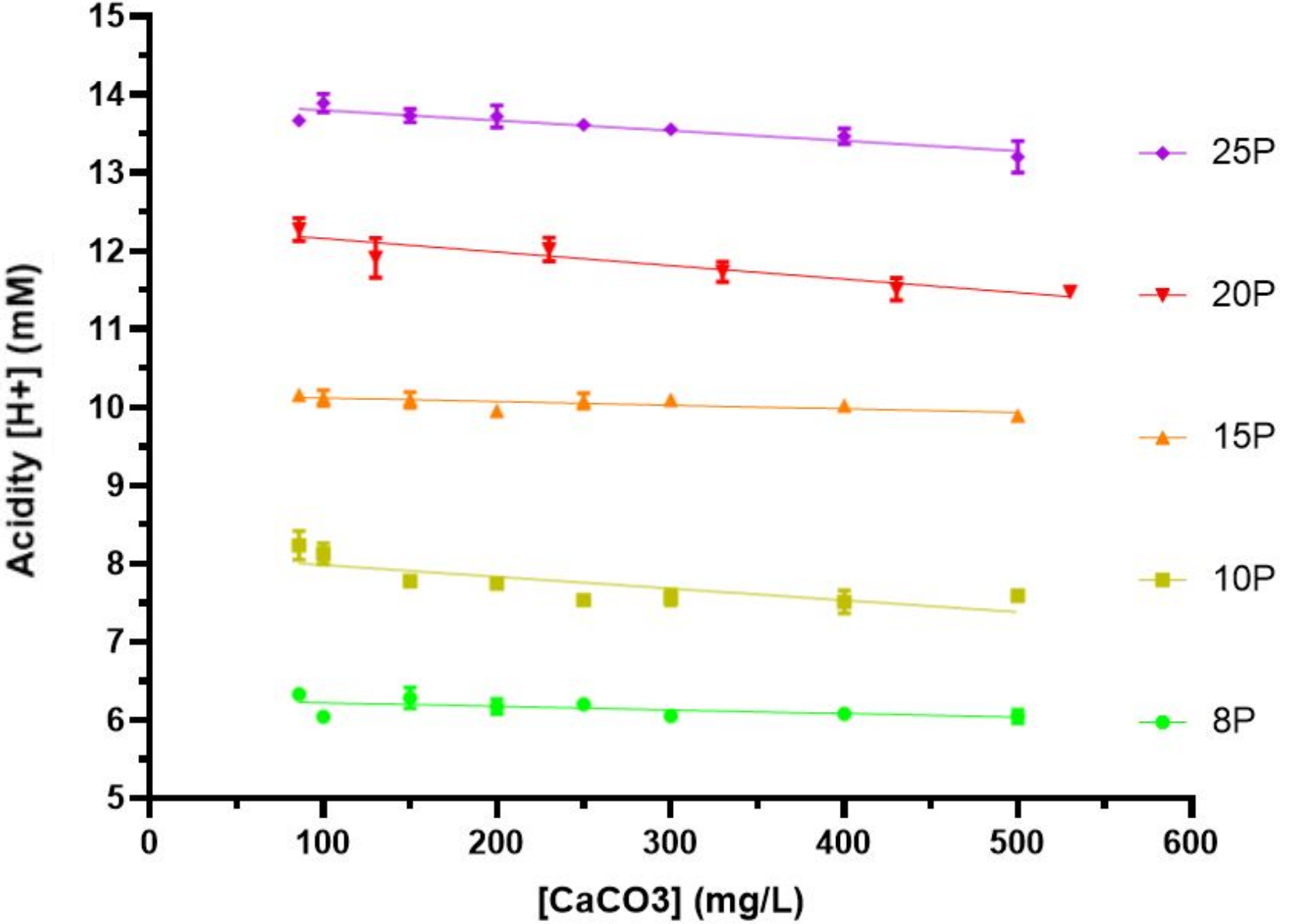


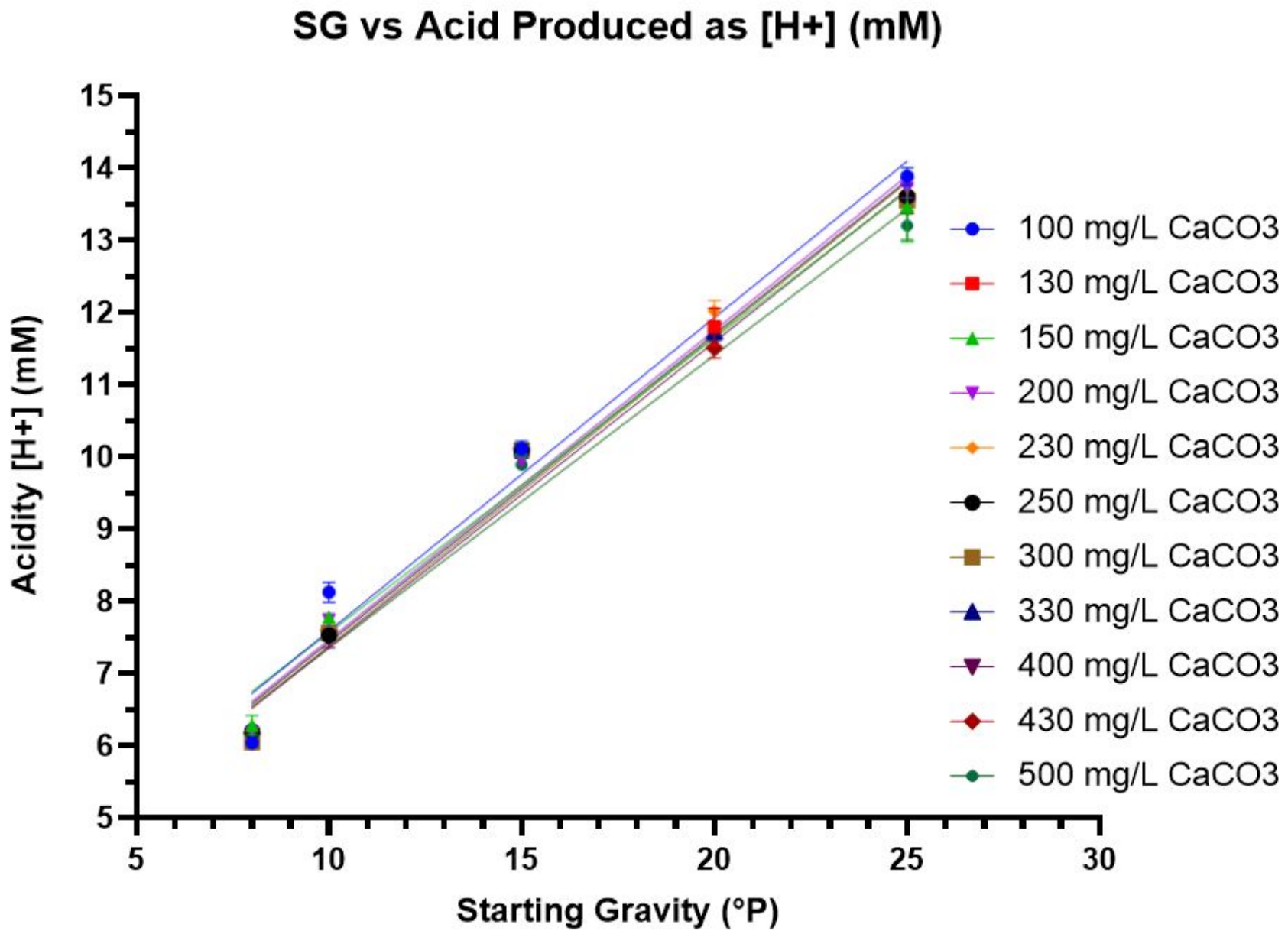
Acidity Produced = Alkalinity Neutralized + Titratable Acidity



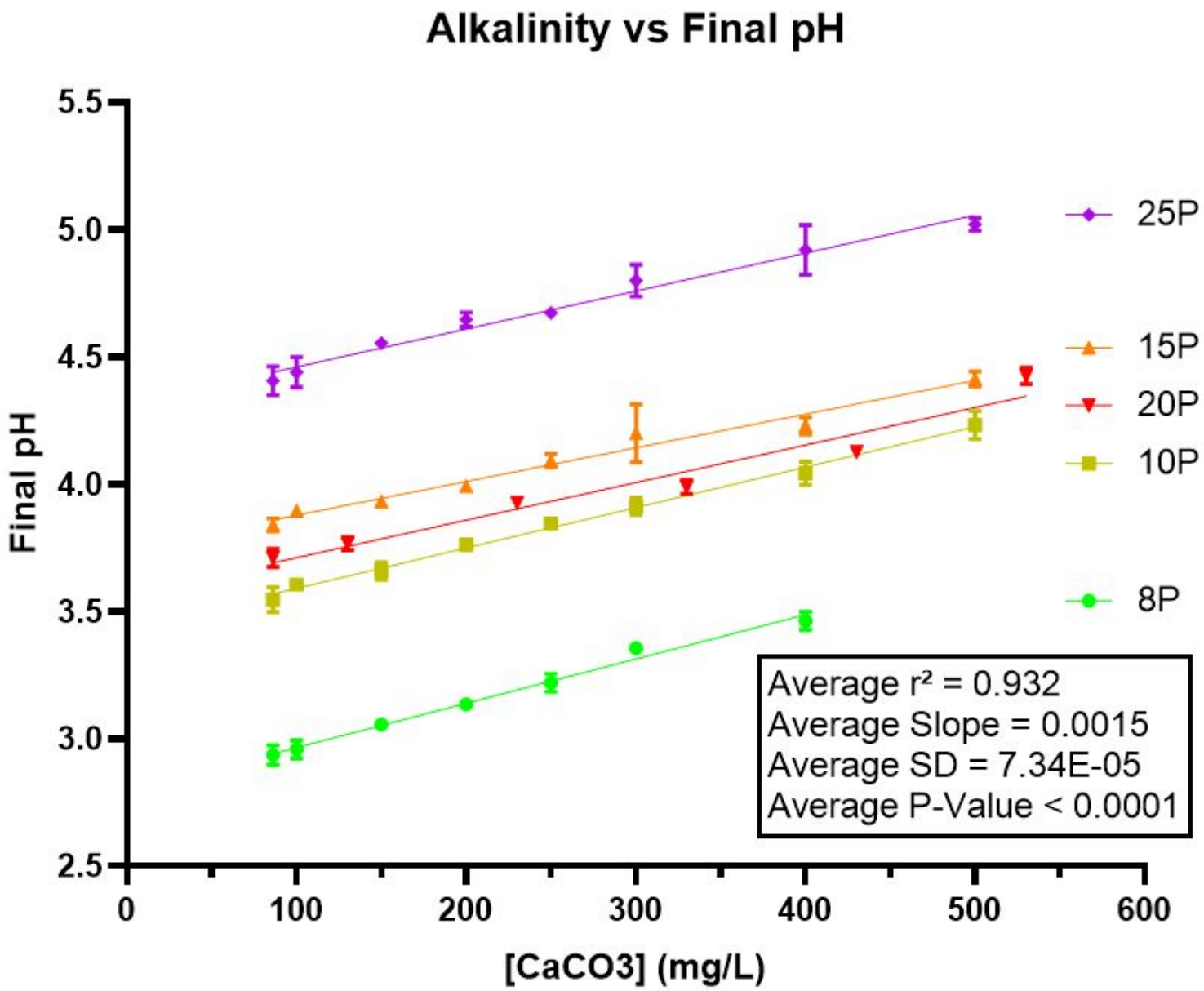
Initial Water Alkalinity vs Acid Produced






SG vs Acid Produced as [H+] (mM)
Acidity [H+] (mM)
15
14
13
12
11
10
9
8
7
6
5
5
10
15
20
25
30
Starting Gravity (°P)
100 mg/L CaCO3
130 mg/L CaCO3
150 mg/L CaCO3
200 mg/L CaCO3
230 mg/L CaCO3
250 mg/L CaCO3
300 mg/L CaCO3
330 mg/L CaCO3
400 mg/L CaCO3
430 mg/L CaCO3
500 mg/L CaCO3

For every 100ppm CaCO3 the final pH increases by ~0.2



Conclusions

- Major contributing factors :
  - Yeast strain
    - Neutral flavor/aroma, Fast Attenuation, High Flocculation
    - Less is more
  - Yeast Nutrients
    - A balanced between concentration and starting gravity is key!
    - Color production is increased with a higher starting gravity
  - Water Hardness/ Alkalinity
    - Some alkalinity is essential for success
    - Alkalinity influences terminal pH
- Proper expectations and understanding between color, attenuation speed, and buffering effects is essential

Thank You!

Any Questions?

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