Trace Elements, Major Impact:
The Role of Zinc in Fermentation

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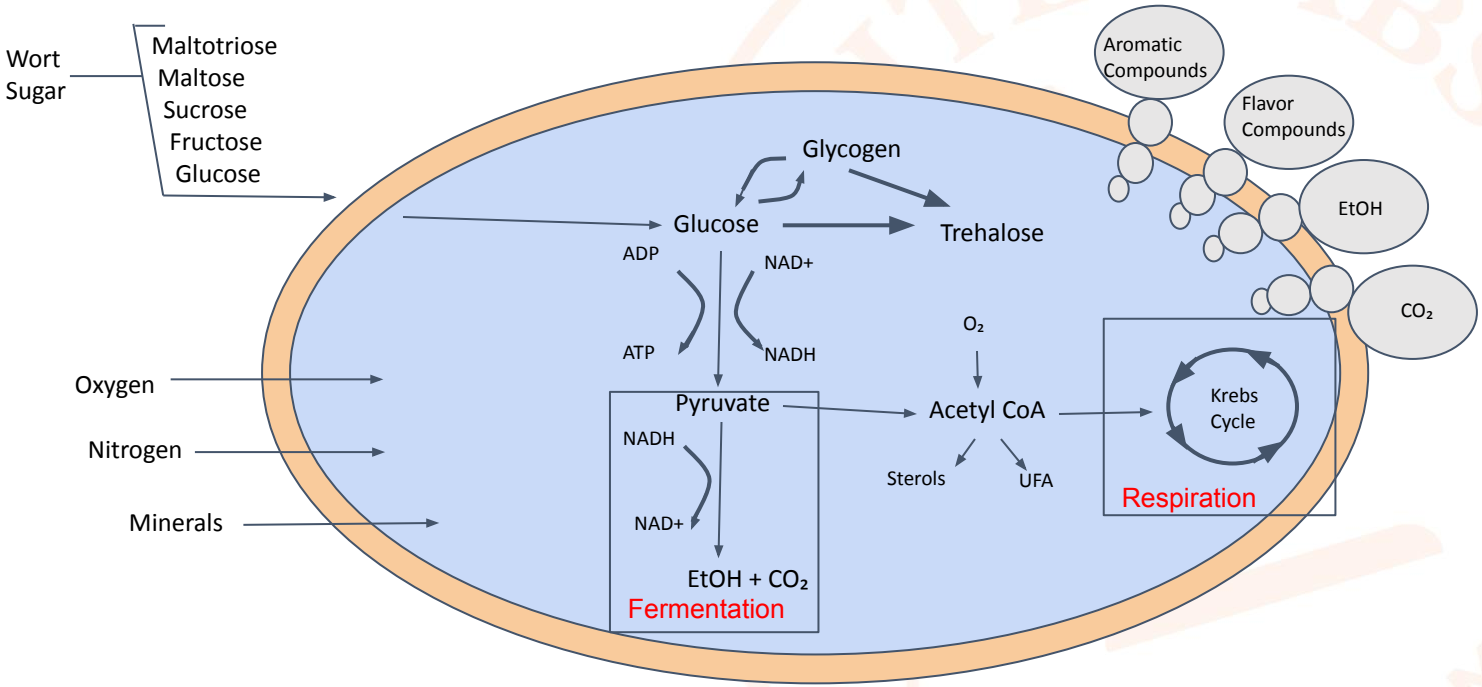
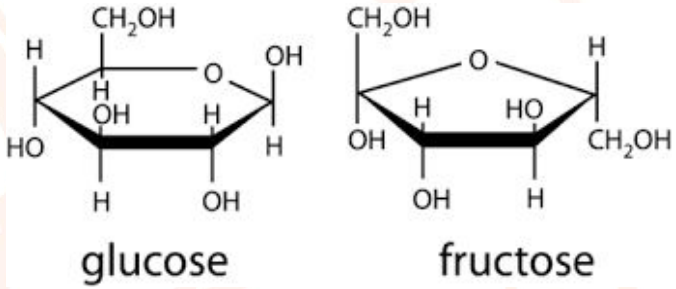
Overview of Yeast Metabolism



Nutrients in Fermentation

- Oxygen (from aeration or agitation)
- Carbohydrates (sugars)
- Amino acids (nitrogen)
- Minerals (**Zinc**, Calcium, Magnesium)
- Fat (sterols, fatty acids)
- Vitamins



BUILDS HEALTHY CELL MEMBRANES FOR PROPER FERMENTATIONS AND TRANSPORT

Lifecycle of Yeast

Early fermentation

- Yeast uses all the dissolved oxygen; there is no detectable uptake of glucose

8-16 hours

- First sign of active fermentation

24 hours

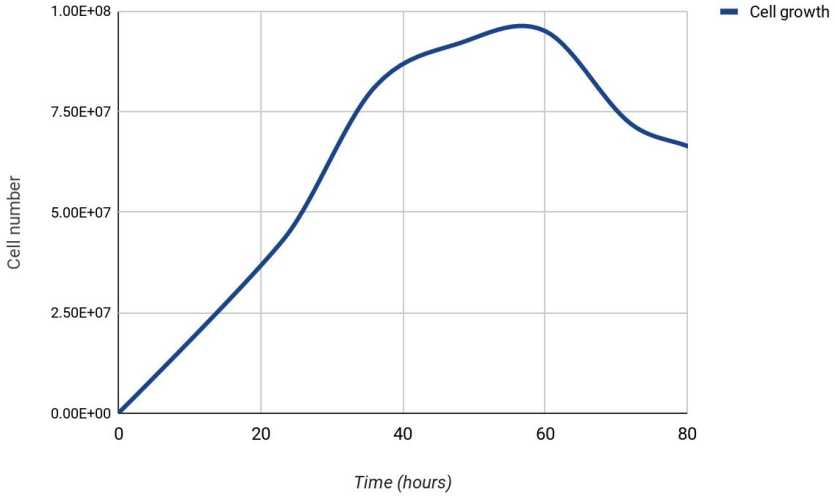
- Budding yeast cells observed
- The temperature, if uncontrolled, rises due to heat generated by the fermentation

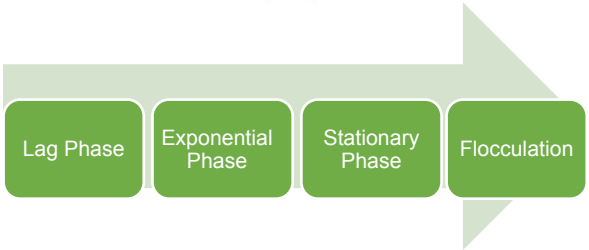
24-48 hours

- The rate of yeast growth and carbohydrate assimilation reaches a maximum

Post 48 hours

- The pH falls to a minimum of 3.8 - 4.4 before rising slightly towards the end of fermentation





Yeast Nutrition

Trace Minerals

All under 1 mg/L (<1 ppm)

- **Zinc** → specific cofactor for alcohol dehydrogenase
  - only mineral not available for yeast in the FV
- **Magnesium** → cofactor for yeast metabolic enzymes
- **Calcium** → essential in yeast flocculation pathway
- **Manganese** and **Potassium**

Role of Zinc in Yeast Cells

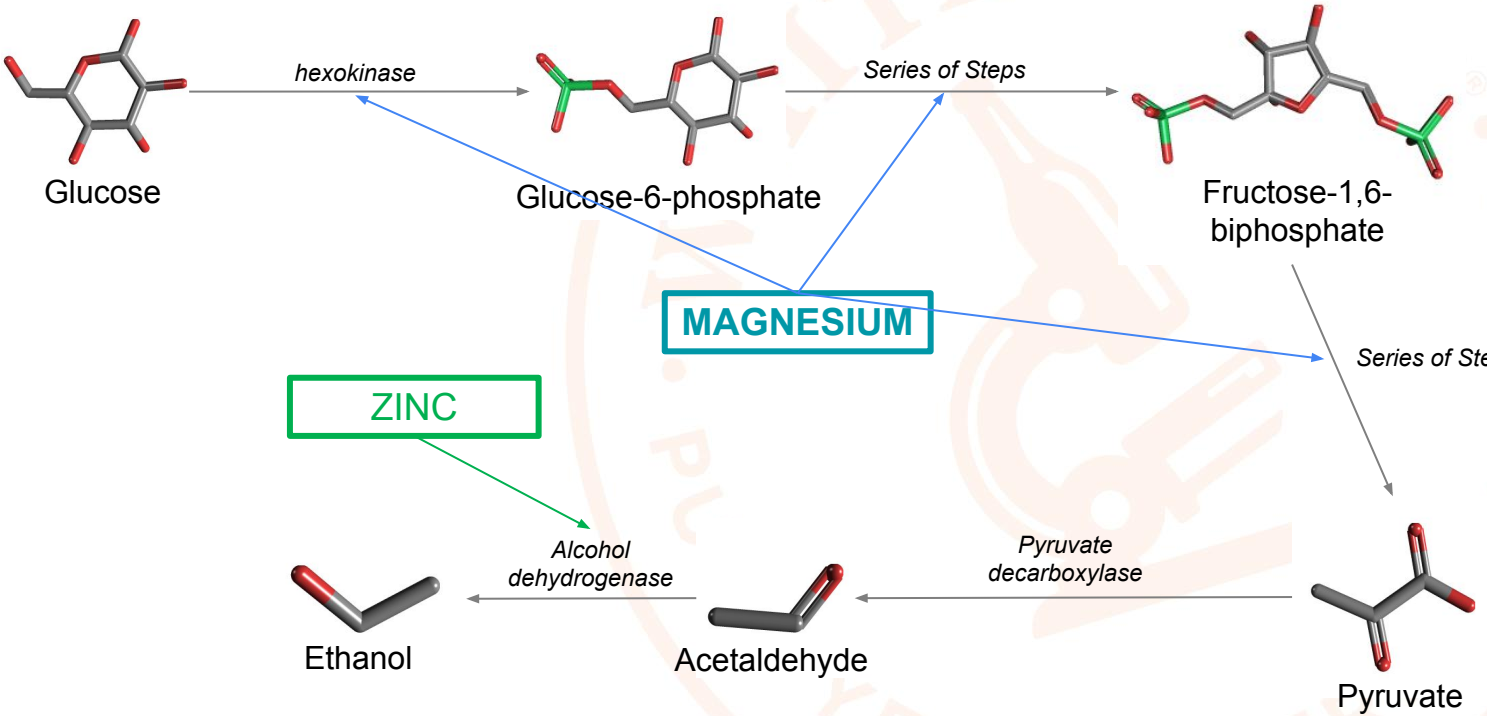
Alive, active, and efficient

Roles: Structure, Cofactor, Regulatory

- DNA/RNA related proteins
- Amino acid metabolism
- Stress resistance
- pH and CO2 balance in the cell
- Ethanol production

★ Budding and yeast cell cycle
★ Membrane integrity
★ Protein synthesis
★ Enzymatic activity

Ethanol Production



Fermentation Improvements

Performance

- Support cell division & yeast growth
- Reduce fermentation timeline
- Improve fermentation consistency
- Prevent sluggish or stuck fermentations
- Increase yeast attenuation
- Support yeast flavor/metabolite production
- Improve yeast flocculation and harvest consistency
- Sustain yeast viability
- More generations!

Hot Side Contribution

Zinc

	Malt Blend A	Malt Blend B	Malt Blend C
Dough In	1.20	1.48	1.37
End of Conversion	0.42	0.66	0.59
Vorlauf	0.15	0.27	0.19
90min. Boil	0.04	0.10	0.06

Data represents Zinc Levels (ppm)

Adapted from: An Investigation of Zinc Concentrations in Brewhouse Worts - Marvin Oaveloose

MBAA Technical Quarterly, Vol. 24, ppl09-112, 1987

Hot Side Loss

From Study at White Labs Copenhagen Nov 11, 2018

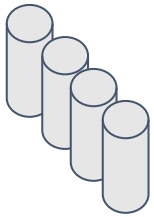
	Zn	Ca	Mg
Malt Extract Mix	11	270	680
In Fermentor t=0	0.66	160	150
In Fermentor t=48 hr	<0.005	150	120
(Sterile Filtered)	< 0.005	110	30

(Data represents Mineral Levels in ppm)

Cold Side Zinc

Heretic Brewing Experimentation

- They had ongoing fermentation difficulties with various beers.
- They tested cold wort - super low!
- They developed this method for their 30 Bbl system



Pre-sterilize 250 ml bottles with correct concentration of zinc for batch size

Add one dose per 30 Bbl knockout when pitching yeast

Results:

1. Fermentation troubles went away! (they also got O_2 to 10ppm)
2. They were able to make many new difficult styles of beers.

Zinc Addition

Target

Target range: 0.15 - 0.5ppm (0.25-0.3ppm)

- **Hot side** - binds to trub, difficult to determine how much will end up in the fermenter
- **Cold side** - more control, better accuracy, sanitary considerations

Zinc Needs

Strain dependent - dial in dosage for individual strain if needed

May require higher dosing if:

- High gravity
- High adjunct
- Any environment that increases stress or requires more yeast cells

Goal of healthy, consistent fermentations is to minimize yeast stress

Too Much Zinc

Look for:

- Sluggish fermentation
- Lower attenuation
- Early flocculation
- Large drops in viability (toxicity)
- Change in consistency of slurry

➔ Cumulative effect in future generations is usually most noticable

Zinc Products

Servomyces

Servomyces is an organic yeast nutrient that contains naturally zinc-enriched yeast hulls.

- Dosage Rate: 1g Servomyces per 100 liters of wort (1.17g/bbl)
- Patented process by which brewers yeast is grown in the presence of metal ions, including zinc and magnesium, and then dried and killed.

Zinc Products

Zinc Buddy

Sterile & Ready-to-use, Cold-side Zinc Solution

- Stimulates protein synthesis & yeast growth
- **Increased attenuation**, up to 95% on all-malt beers
- Beer reaches terminal gravity in 1-2 fewer days, for most ales
- Beer clarifies faster
- **Improved beer sensory:** lower diacetyl, lower sulfur, faster dry hop rest (due to hop creep).
- **> 5% increase in viability of harvested yeast**
- Better flocculation, resulting in a 10-15% denser cell concentration at harvest
- **More Robust Yeast for Repitching**

	Dosage	Target Concentration
Beer:	10mL/hL (13mL/bbl)	0.2 ppm
Non-Malt:	15mL/hL (18mL/bbl)	0.3 ppm
Directions for use:	Add to fermentor with yeast pitch to ensure sufficient homogenization.	

Zinc Products

Other Methods

Zinc Sulfate Heptahydrate

- Make 1% solution (1g/100mL)
- Calculate dosage
- Add 1% sterile solution to FV when filling or in-line

Variables:

Batch Size (1bbl = 117L)

Target Concentration (0.2ppm)

- 0.2mg Zn / 1L wort

Solution Concentration (10mg/mL)

Calculation:

0.2ppm x 117L = 23.4mg / 10mg/mL

= 2.34mL per bbl

Conclusion

Action Items

1. Track, document, analyze current fermentations
2. Determine Zinc product and dosing method
3. Calcuate dosage
4. Monitor, document, analyze
5. Dial in dosage rates

Questions?
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