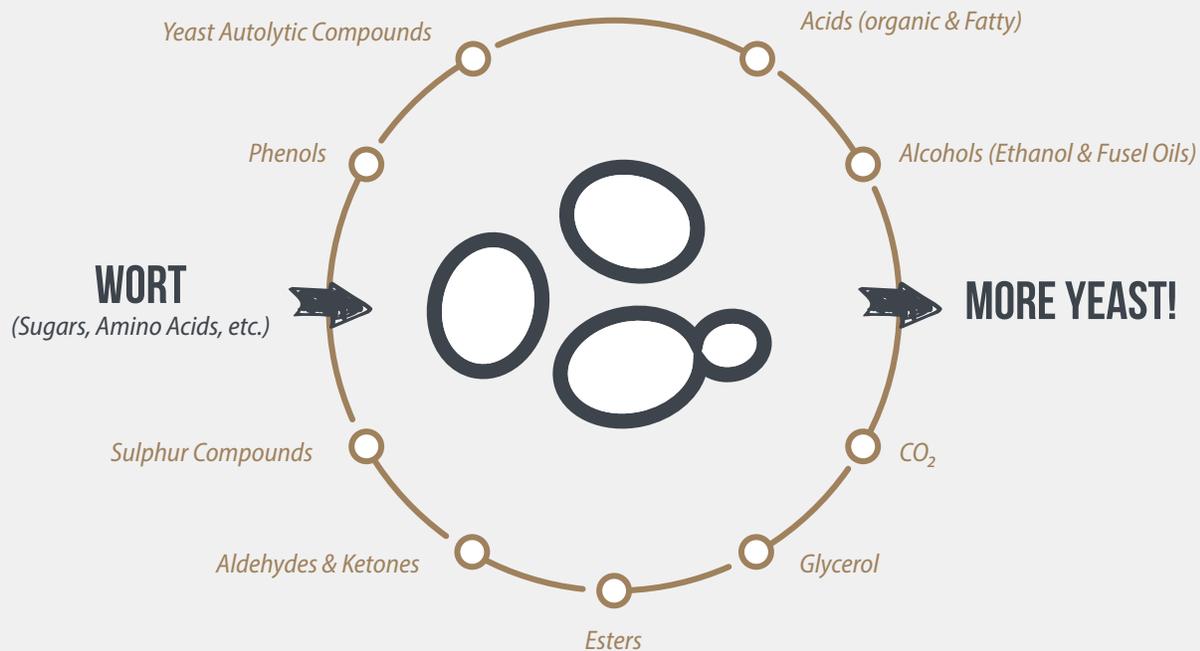


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YEAST NUTRITION FUNDAMENTALS



Brewer's yeast, also commonly known as *Saccharomyces*, are living cells that, in the most basic terms, use carbon sources to produce alcohol and CO₂. However, there are hundreds of other reactions that occur in yeast cell, along with many intermediate compounds. In general, yeast during fermentation can produce CO₂, acids (organic and fatty), alcohols (ethanol and fusels), glycerol, esters, aldehydes and ketones, sulphur compounds, and some phenolic compounds and autolytic compounds. To do many of these necessary reactions for fermentation and to develop new cells, yeast cells need the correct "food" or nutrients. Yeast nutrients are a major factor of influence on overall health and fermentation performance. By adding nutrients, one can "improve alcohol yield, reduce fermentation time, enhance yeast viability and vitality, and increase diacetyl removal, as well as control undesirable flavor compounds"¹

However, the world of yeast nutrients can be daunting. This document will go over the biggest questions:

- **WHAT ARE THE NECESSARY NUTRIENTS FOR BREWING?**
- **WHAT ROLE DO THESE NUTRIENTS PLAY?**
- **HOW MUCH IS NEEDED (ON A GENERAL AVERAGE BASIS)?**

LALLEMAND

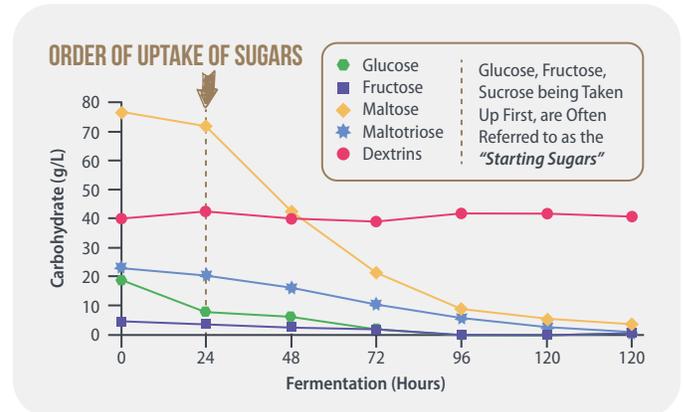
In an ideal world, all-malt wort should provide the necessary components for successful fermentations: sugars, amino acids, vitamins, and minerals. However, we don't always have the most ideal situations or ingredients; i.e. low-quality malt or zinc deficiency. Also, high-gravity wort or high-adjunct fermentations may not provide the essential balance of compounds for the yeast to do their jobs correctly. Yeast nutrients can supplement where these recipes and ingredients fall short. In the end, poor yeast nutrition can create poor beer due to stressed yeast cells and sluggish fermentations.

So, what are the key nutrients for brewing, and what ones are provided by wort?

• SUGARS:

Sources of carbon are in the form of carbohydrates, otherwise known as fermentable sugars. These are known to be provided by wort (from malt) or from added adjuncts. Brewer's yeast has no problem with utilizing monosaccharide sugars such as glucose and fructose, or disaccharides such as maltose and sucrose. Trisaccharides, like maltotriose, are metabolized by most *Saccharomyces*, but not all – it is strain dependent. Even when metabolized, it is done very slowly. Dextrins, or Oligosaccharides, are found in wort but is unused by brewing yeast and will end in the final beer product. Strains such as *Saccharomyces cerevisiae* var. *diastaticus* can assimilate dextrins due to the secretion of enzymes that hydrolyze dextrins into smaller, fermentable sugars.

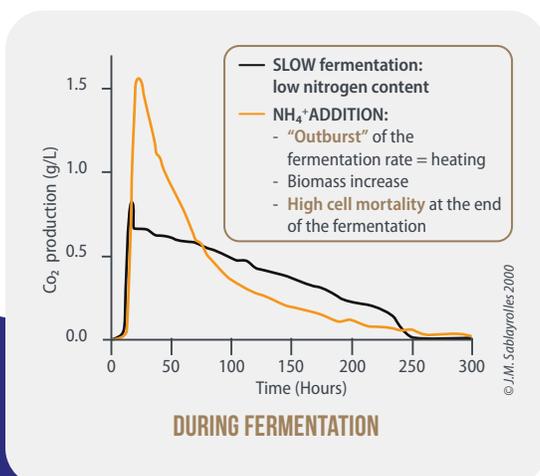
Brewing yeast has a preferred order of sugars that it will uptake. Glucose, fructose, and sucrose will typically be taken up first, which is why they are commonly referred to as the 'starting sugars'. Once glucose disappears, the uptake of maltose (which is the majority of sugars available) will begin.



• OXYGEN:

Although oxygen is injected separately and not included in wort or a yeast nutrient, it is an essential component of yeast metabolism. It is typically needed immediately after yeast pitch/start of fermentation* as a necessary growth factor. Oxygen/air is needed for biosynthesis of key membrane components: it ensures adequate cell population for fermentation, enables cells to synthesize sterols, ergosterols, oleic acid (unsaturated fatty acids), maintains membrane integrity, and supports glycogen metabolism. There are variable requirements of necessary oxygen addition, anything from 8-16ppm of DO prior to pitching is often found to be acceptable. The general rule of thumb is: 1ppm O₂ per 1°P.

* Oxygen/air is not normally required for standard fermentations using active dry yeast on first pitch, because when dry yeast is produced, it's in presence of copious amounts of oxygen and is therefore filled with sterols.



• NITROGEN:

Without sufficient nitrogen, yeast will not ferment. Wort will provide nitrogen in the form of proteins, peptides, amino acids, and ammonium salts. Brewing yeast will utilize amino acids (FAN) and ammonium salts but have the general inability to uptake peptides and proteins. Typically, free amino nitrogen (FAN) should be around 150mg/L, but can range from 100-300mg/L or ppm. When brewing with all-malt, the addition of nitrogen is not necessarily required. If adjuncts are added to the mash, this can dilute the amount of nitrogen in the wort and an external source or yeast nutrient would be beneficial for the fermentation. Nitrogen is necessary for successful fermentations as it's integrated into new yeast proteins that are responsible for yeast cell function. It is highly associated with yeast fermentation performance.

NOTE

There is a difference between organic vs inorganic nitrogen. Inorganic source of nitrogen is in the form of ammonium salts. (Mineral). It is typically used to supplement nitrogen-deficient fermentations (DAP addition). Compare to organic nitrogen this form is quickly assimilated by yeast to create biomass in the first step of fermentation while organic nitrogen (amino acid & peptide) are gradually assimilated by yeast resulting in a better efficiency to complete alcoholic fermentation.

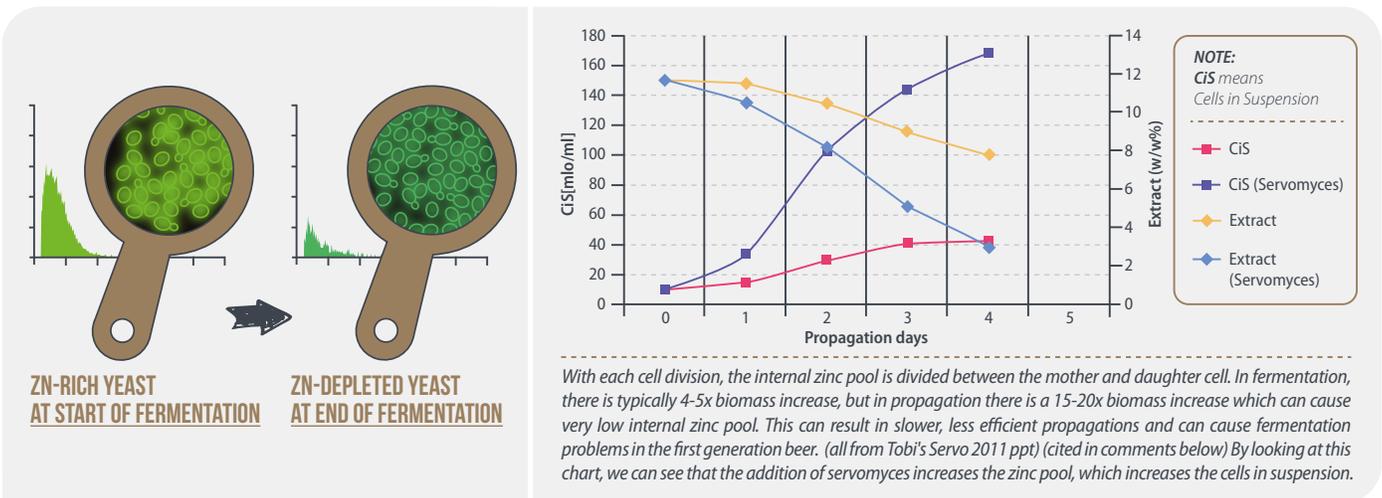
VITAMINS:

Vitamins are essential for total yeast health. Brewer's wort should be sufficiently supplied with vitamins such as: folic acid, thiamine, riboflavin, pantothenic acid, niacin, inositol, and biotin. However, biotin can be deficient, and can be supplemented as part of an added yeast nutrient. These vitamins are critical for enzyme function and yeast growth, and commonly act as co-factors for enzymatic reactions. Biotin is a very important vitamin to note, because it is a catalyst for multiple important reactions such as "amino acid metabolism, fatty acid biosynthesis, and energy metabolism."²

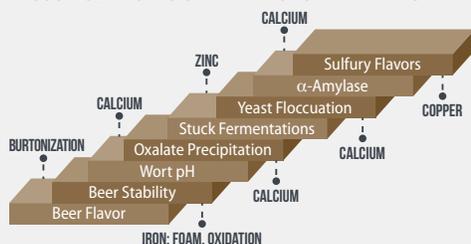
MINERALS:

Phosphate (P), potassium (K), calcium (Ca), magnesium (Mg), and zinc (Zn) are essential minerals for proper yeast performance and successful fermentations. Typically, P and K should be in sufficient supply from brewer's wort, but Zn can be deficient and the Mg:Ca ratio can be off.

Zinc is an essential trace element that is typically taken up rapidly by yeast early in fermentation. Generally, 0.15-0.3ppm zinc (0.15-0.30 mg zinc/L) is the minimum requirement needed for proper metabolism. It contributes to protein synthesis and yeast growth, protects enzymes, stabilizes the protein and membrane systems, and accelerates maltose and maltotriose uptake, which in turn can provide faster fermentations, and better flocculation and attenuation.³ Zinc is necessary in the last step of alcohol production. It activates an enzyme called alcohol dehydrogenase (ADH), which is the terminal enzyme in the fermentation pathway that leads to ethanol. Zinc deficiencies can cause stuck fermentations and flocculation problems, so it is commonly added through external sources of zinc sulfate, nutrient blends that contain zinc, or by adding a zinc-enriched yeast like Servomyces. Deficiencies can be common when serial repitching of yeast and with yeast propagation.



RECOGNISED ROLES OF METAL IONS IN BREWING



NOTE – PROPAGATION

Metal ions, such as calcium, iron, zinc, and copper, are necessary minerals that are required for cell growth, cell division, stress tolerance of yeast and maintenance of cell structure. Here you can see a few examples where these metals play vital roles.

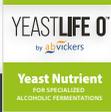
COMPARING YEAST NEEDS Vs WHAT ALL-MALT WORT OFFERS Vs HIGH SUGAR ADDITION OFFERS (ALTERNATIVE BEVERAGES)

The chart below answers the questions: What do yeast need? What are these needs for? Noting that each brewing environment and situation is different we can see that when using 100%wort, oxygen, zinc, and biotin may be required. For sugar fermentations, yeast nutritional needs are much higher.

Sources	YEAST NEEDS**	FOR WHAT?	WORT CONTAINS
C	Monosaccharides, disaccharides, etc	Energy Source; organic material	Glucose (Monosaccharide), Fructose, Sucrose, and Maltose (disaccharides), Maltotriose, etc.
N	Ammonia, amino acids, and peptides; ~100-300ppm	Yeast cell function; overall yeast performance & Aromatic compound biosynthesis	Mainly amino Acids (typically enough N)**
O	8ppm+	Ergosterol and unsaturated fatty acid synthesis; organic material	NONE
VITS	Thiamine, biotin, pantothenic acid, niacin, etc.	Enzyme function and yeast growth; metabolism	Thiamine, pantothenic acid, niacin, biotin (more biotin can be needed!), etc.
MINERALS	Mg, Ca, Zn, Mn, P, K, S...	Ca – flocculation Mg – enzyme cofactor, cell division Mn – enzyme cofactor Zn – alcohol dehydrogenase	Cu, Fe, Mn, Zn (but often not enough Zn!)

* Requirements for fermentation may differ from propagation

** Amounts required may vary between strains, environments, and beverage produced.

	 Servomyces™	 YeastLife Extra™	 YeastLife O™
Product description	Active yeast enriched in Zinc	Complex nutrient blend containing organic and inorganic nitrogen, minerals (ZN, Ca) and vitamins.	100% Yeast autolysates blend to provide bioavailable nitrogen, vitamins and minerals.
Application	- Zinc deficient media and propagation	- Re-pitching - Low nutrient wort / high adjuncts - Stuck fermentation : high stress - Poor / variable quality malt	- Specialized alcoholic fermentation with high sugar concentration and potential low nitrogen content. - Balanced nutrition to avoid off flavor production. - Enhanced mouthfeel.
Nitrogen Level	Negligible	1g/hL = 1.6 ppm	1g/hL = 0.6ppm
Zinc Level	1g/hL = 0.6ppm	1g/hL = 0.028ppm	Negligible
Recommended Dosage Rate	1g/hL	4-10g/hL	30-250g/hL depending on application

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