Wine yeast nutrients 101

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There are a very wide variety of wine yeast nutrients available under many different brand names. The choice presented to winemakers is staggering and overwhelming, and can be quite confusing.

These nutrients are classified as complex yeast nutrients, yeast hulls, rehydration nutrients, rehydration protectants, inactivated yeast-based products to enhance mouthfeel, glutathione enriched nutrients, aroma enhancing nutrients, vitamin mixes, mannoproteins, etc. So what are the differences amongst these nutrients and when does one use what? And, most importantly, are they really necessary or can simple, plain old diammonium phosphate (DAP) be used instead?

The following article addresses these questions and will hopefully provide you, the winemaker, with more clarity on the issue. It will also hopefully provide the ammunition to distinguish between a salesperson looking to make a quick buck by driving the fear of the apocalypse into you if you don't use complex yeast nutrients, and an honest, qualified technical consultant giving you the best advice for your specific fermentation conditions.

With the exception of pure vitamin mixes, all of the above mentioned nutrients contain inactivated yeasts (dead yeasts), or parts of dead yeasts, as a very important ingredient in the mix. The reason for this is that live yeast cells are little cannibals and will feed on dead yeast cells as a source of nutrients. So, what is in a dead yeast cell that a live one would want? First, we have to look at the basic morphology of yeast.

The yeast is an organism consisting of one cell only. This one cell is surrounded by a cell wall, followed by a space called the periplasmic space, a cell membrane and the cytoplasma, or the inside of the yeast. In the inside of the yeast, there are many important organelles, of which the vacuole is the most mentioned in winemaking.

The cell wall consists of mainly mannoproteins and glucans and is responsible for giving form to the yeast cell and providing a physical protection barrier for the inside of the cell. The cell wall is linked

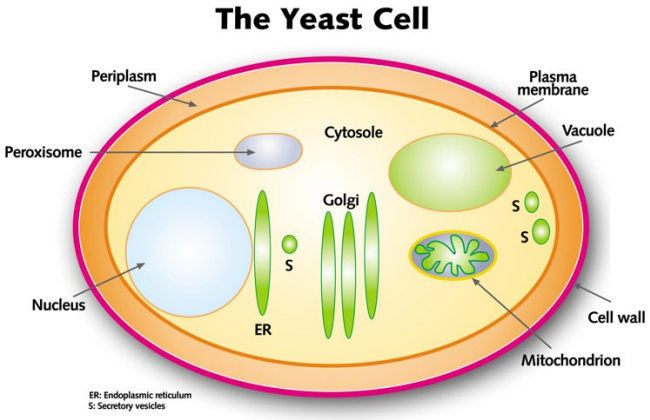

Figure 1. A simplified representation of the yeast cell.
Source: www.bit.ly/11mxsU

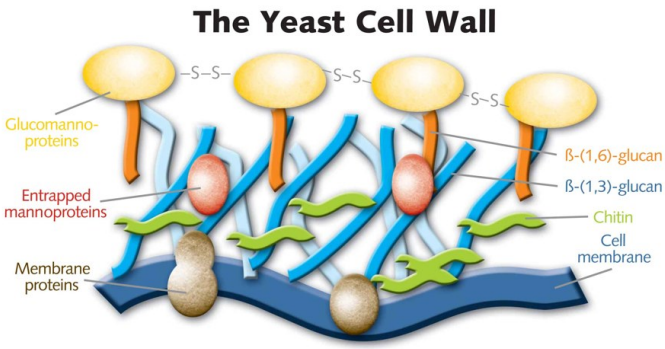

Figure 2. A simplified representation of the yeast cell wall.
Source: www.bit.ly/11mxsU

to the cell membrane across the space by glucan and chitin chains. The space contains various enzymes responsible for regulating yeast metabolism, one of them being invertase, which is responsible for hydrolysing sucrose to glucose and fructose.

The cell membrane is the police officer who regulates what comes into, and what goes out of, the yeast cell. It consists mainly of sterols and lipids. These sterols and lipids are responsible for membrane integrity. Proper membrane integrity ensures yeast survival under fermentation conditions as well as proper uptake of sugars and amino acids. Various factors, such as incorrect rehydration, winery propagation (mother tanking), high sugar stress and increasing alcohol levels, to name a few, can compromise membrane integrity.

Most of the breakdown from glucose and fructose to ethanol happens in the cytoplasm. Once ethanol is formed, it is secreted into the medium. The yeast also secretes various other by-products of fermentation such as glycerol, acetic acid, H_2S and esters into the medium. The vacuole is important because it stores various enzymes and amino acids needed for protein synthesis in yeast metabolism. Protein synthesis is important to provide enzymes for sugar uptake, sugar breakdown and yeast biomass formation.

So, why this very basic lesson in yeast morphology? Well, because complex yeast nutrition is based on what either the cell walls, or cell membranes, or cell insides (called yeast extract), or the combination of all of the above, can do to enhance the fermentation performance of live yeast cells. There are basically five different inactivated yeast-based products on the market:

1 Inactivated yeast – the whole yeast cell has been killed by heat. It contains the cell wall, cell membrane and whole inside of the yeast. Inactivated yeasts are still intact and cannot be distinguished from live yeast cells under a microscope unless they are stained with a colour stain. Dead yeast cells absorb colour but live ones don't.
2 Yeast autolysate – the whole yeast cell is killed and then exposed to glucanase enzymes at 45°C for a certain time period. The result is that the cell wall, that contains glucans, is partially degraded and the cell membrane and the 'soluble inside' of the yeast are more exposed, and therefore more available, to the hungry cannibals lurking around for a bite.

3 Yeast hulls/ghosts – this is the insoluble yeast cell wall fraction of yeast autolysate after centrifugation. Depending on the washing process used during the manufacturing of yeast hulls, they may or may not contain parts of the cell membrane.
4 Yeast extract – the supernatant of yeast autolysate, or in plain English, the soluble insides of yeast cells once the insoluble cell walls and cell membranes have been removed.
5 Specific yeast fractions – e.g. mannoproteins. Mannoproteins are a specific cell wall constituent and production thereof requires further processing of yeast cell walls.

For the production of these products, a critical yeast biomass production is needed during which various enrichment procedures can be performed. Examples of such procedures include vitamin, mineral and glutathione enrichments.

What are the different types of commercial products?

Seeing that Anchor Yeast does not have first-hand knowledge of the production processes of competitor products, the following information is based on what is provided on product specification leaflets or can be merely speculation based on the description of how the product works.

1 Complex yeast nutrients mainly consist of inactivated yeast and ammonium salts such as DAP and ammonium sulphate (not permitted in all countries). Although inactivated yeast can be a good source of vitamins and minerals, some suppliers supplement their nutrients with added vitamins (usually thiamine) and minerals (usually magnesium sulphate – not permitted in all countries). Complex yeast nutrients can also contain yeast extract, although this is rare – the reason being that yeast extract is very strong in flavour (Marmite is pure yeast extract), and unless the supplier has a source of odourless yeast extract, it can impart a negative aroma to the wine. It is, however, a very good source of nutrients for the fermenting yeast since it contains a high concentration of organic nitrogen (amino acids).

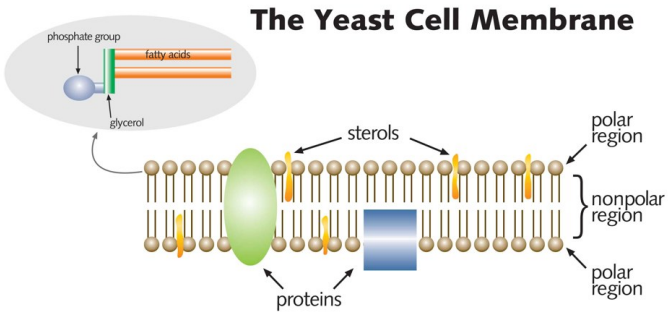

Figure 3. A simplified representation of the yeast cell membrane.
Source: www.bit.ly/3G1e4z

2 Rehydration nutrients – these nutrients contain no ammonium salts. They are mainly inactivated yeasts that are supplemented with either extra minerals or vitamins, or both. Although inactivated yeasts are intact yeast cells, their cell membranes that regulate flow of molecules in and out of the cells are badly damaged through the inactivation process. Small molecules such as vitamins, minerals, amino acids and nucleic acids can 'leak out' of the cells and have an impact not only on the fermentation efficiency, but also on the aroma and flavour production of the fermenting yeasts. Rehydration nutrients are therefore not only sold as a nutrient source, but also as possible aroma enhancement tools. The effect of a rehydration nutrient on volatile thiols in Sauvignon Blanc has been demonstrated.
3 Rehydration protectant – only one company has the patent to produce and sell such a product. A rehydration protectant is a partially autolysed inactivated yeast. The partial autolysation exposes the sterols in the cell membrane so that they become more readily available to be incorporated into the cell membranes of the fermenting yeast. The purpose of a rehydration protectant is therefore to enhance alcohol tolerance.
4 Yeast nutrients for organic wine production – these should be (Anchor Yeast cannot confirm whether manufacturers do this) partially autolysed inactivated yeasts. The idea is to allow the fermenting yeasts access to the 'insides' of the dead yeast cells for a source of organic nitrogen (amino acids), since the addition of inorganic nitrogen during the production of organic wine is not permitted.
5 Yeast hulls – cell walls can have very good adsorbing capacities, depending on how they were produced. Their main role during fermentation is to bind to toxic medium chain fatty acids secreted by the fermenting yeasts, thereby detoxifying the environment and allowing the fermenting yeast to ferment to dryness. If yeast cell walls contain parts of the cell membrane, they can also be a source of sterols and lipids. Theoretically, yeast cell walls are therefore not 'nutrients'. Care should be taken when using cell wall based products because the exposed lipids can oxidise and give off odours to the wine. Make sure the product is fresh and within the expiry date. Suppliers must use special packaging. Do not exceed the maximum recommended dosage.
6 Inactivated yeast based products recommended for white wine longevity – theoretically, this type of product is not sold as a nutrient but rather as a source of glutathione. It is normally recommended for white wines made from grape varieties that contain volatile thiols. Glutathione is also a thiol that has anti-oxidative capacities. This product is normally inactivated yeast that was glutathione enriched during its production process.
7 Yeast derived mouth-feel enhancing products – various commercial products are recommended for this purpose. They are usually specific yeast fractions (such as mannoproteins) that have mouth-feel enhancing capabilities. These products also do not serve the purpose of a 'yeast nutrient'.

When to use what?

Complex yeast nutrients

Certain yeast strains always benefit from the use of a complex yeast nutrient regardless of the conditions of the must. They are genetically just not competent enough to perform optimally under normal winemaking conditions.

Low YAN musts require the use of complex yeast nutrients since a low YAN is usually also an indication of low vitamin and mineral content. Research done by the Institute for Wine Biotechnology at the University of Stellenbosch proved that stuck fermentations could occur if a medium is mineral or vitamin deficient. The medium that was supplemented with certain complex yeast nutrients fermented to dryness while the medium suplemented with DAP only got stuck. A vitamin shortage can also lead to the production of sulphur-like off odours.

Rehydration nutrients

Yeast strains differ from each other in terms of nutrient demands. The nutrient demand of a particular strain is not necessarily linked to the alcohol tolerance of that particular strain. When the YAN of the juice is very low (below 100 milligrams per litre), the use of a rehydration nutrient is recommended for some strains. Complex yeast nutrients are normally added after the onset of fermentation because they contain ammonium salts (refer to www.newworldwinemaker.com for more detailed information on yeast nutrient management). So the various components of complex yeast nutrients such as amino acids, vitamins, minerals, sterols and lipids are not available from the start of fermentation. A rehydration nutrient will provide these components from the start and also only provide them to the yeast that will be conducting the fermentation.

In every must, there is a certain percentage of wild yeast and bacteria that will also happily eat the nutrients provided, therefore some yeast strains are fine with complex yeast nutrients added after the onset of fermentation, while others benefit more from the early addition of a rehydration nutrient. In most cases, it is not necessary to use both types of products in one fermentation, however, certain stressful must conditions, combined with certain yeasts, will require the use of both. In some cases, it could be more economical to simply switch to a more robust yeast with a lower nutrient demand than to use a massive amount of nutrients to pull the fermentation through.

Certain rehydration nutrients can also have a positive effect in the production of volatile thiols, so it might be beneficial to use such products in the production of Sauvignon Blanc, Colombard and Chenin Blanc.

Rehydration protectants

The role of a rehydration protectant is to provide sterols and lipids to the live yeast cells. It is used during rehydration so that the sterols and lipids are only available to the inoculated yeast and not the wild yeasts present in the must. A rehydration protectant is used for certain yeast strains under stressful must conditions such as low fermentation temperatures (13°C or below), high fermentation temperatures (28°C and above – which is not recommended but practised by many winemakers nonetheless) and high sugar musts (for some yeast strains above 13.3 Baumé (24°Brix) and for others above 13.9-14.4Be (25 or 26°Brix)). A rehydration protectant can also be a nutrient source in providing vitamins and minerals to the fermenting yeast.

Pure vitamin mixes

The use of pure vitamin mixes is not permitted in all countries. These mixes normally contain the most important vitamins needed during fermentation. Research at the Institute for Wine Biotechnology at the University of Stellenbosch in South Africa showed that inactivated yeast-based products can be as effective, if not more effective, than pure vitamin mixes to prevent stuck fermentations. The addition of vitamins to a fermenting must is recommended for very low, as well as very high, YAN musts. In very high YAN musts, the ratio of pantothenate (a vitamin involved in the production of sulphur containing amino acids) to YAN can be distorted and, as a result, sulphur-like off odours can form, even if there is enough nitrogen present.

Yeast hulls (cell walls)

Currently, yeast hulls are mostly used for sluggish or stuck fermentations. Their main role is to detoxify the must from medium chain fatty acids that are secreted by the struggling yeast and that are toxic to the very yeast from where they originated. Due to the production process of yeast hulls, it is an expensive product compared to other types of nutrients, so winemakers tend to use it only when they already have a problem. However, a smaller dosage can be used as a preventative measure for some yeast strains or must conditions; for instance, during the fermentation of a yeast with a low nutrient demand and/or a high YAN must. In such a case, the use of a complex yeast nutrient may not be necessary, however, extreme fermentation temperatures, pesticide residues or high alcohols might cause the fermenting yeast to stress and produce medium chain fatty acids.

Medium chain fatty acids are also inhibitory to malolactic bacteria and can delay or inhibit malolactic fermentation (MLF). Certain

grape varieties such as Merlot are more prone to MLF problems. Certain wine conditions such as high alcohol and low temperatures are also more conducive to MLF problems. It is therefore wise to ensure the best possible conditions for MLF, since in most cases problems arise due to the cumulative effect of various factors instead of just one factor. By adding yeast hulls during fermentation, one therefore ensures a better environment for the yeast, as well as the bacteria, in the subsequent MLF.

Yeast hulls can also be used after fermentation on finished wines to remove cork-like taints such as anisoles. Anisoles can be derived from corks, wood treatment products and chlorinated sanitation chemicals used in wineries. They impart a mouldy smell to wines.

Glutathione enriched inactivated yeast

These types of products are added at the start of fermentation and are used to enhance the longevity of volatile thiol containing white wines. Most white grape varieties contain some percentage of volatile thiols. Glutathione itself is a grape-derived thiol and is present in grape juice. It is highly oxidisable, so it is advisable, in addition to the use of certain winemaking practices, to add additional glutathione to the must in order to ensure adequate must levels.

The addition of pure glutathione to grape must is not allowed, but the addition of glutathione enriched inactivated yeast is. Research showed that wines from musts that had glutathione added during fermentation three years previously had an increased volatile thiol content, better colour and lower concentrations of the compounds associated with atypical ageing. So, for white wines destined for ageing longer than 12 or 18 months, a product like this can be beneficial.

Mannoproteins

Mannoproteins can have two important roles in winemaking. They can enhance mouth feel and, more importantly, contribute toward improving tartrate stability. They are sold as a pure product or as part of cell wall fractions. Specific cell wall fractions further enhance mouth-feel through the polysaccharide (mostly glucans) content of cell walls. This type of product is usually recommended for red wines.

The bottom line regarding these types of products is that it is not a clear-cut science of what to use and where. The yeast strain and the specific conditions of the must will greatly determine which product to use. As a winemaker, it is wise to familiarise yourself with the differences amongst the different products in order to be able to determine which one will be most appropriate for your needs. The supplier must be able to make a recommendation. In some cases, the solution to your specific needs might be as simple as switching to another yeast strain to conduct the fermentation. The economics of the whole exercise must be taken into account as well. And yes, in many cases, simple plain old DAP will do. ■

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