

Royal Brewers' Competition

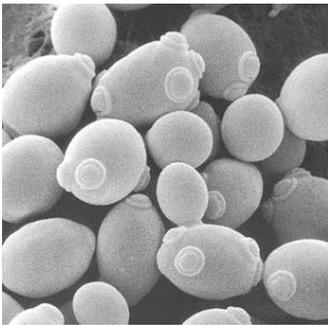
Lilies War XXVII

HL. Eynon Llangenydd

Adventures in Yeast

History and Genetics (This section outlines the “technical” part of the project and is rife with yeasty genetic goodness.)

I have become fascinated by the transition from the production of ales to the production of lager beer in Bavaria in the 15-16th centuries. Many sources suggest that Bavarian brewers were the first to discover that some beer could ferment in the cool storage of caves and cellars. It is difficult to say when this cold fermented beer first appeared. In fact, it may be that there is no single point in time at which lager beer appeared. Several sources cite a 1420 Munich Town Council record as mentioning “cold fermented” beer that is assumed to be a predecessor of what we call lager beer today (German Beer Institute, 2006; Jackson, 1999). On the other hand, at least one author suggested that lager beer didn't officially emerge until 1500 (Mosher, 2004), yet another suggested that the mid-19th century ushered lager into the Munich and Vienna areas (Noonan, 1996).



So, we do not have unequivocal evidence of a point in time when lager beer emerged. We also do not know the process by which these lager yeasts came into being. However, modern genetic investigation and knowledge about the effects of selective pressure on yeast strains by brewers may give us some possible explanations. Recently, some investigators suggested that lager yeasts emerged over a transition period during which yeast hybridized to enable previously thermotolerant yeast (ale yeasts) to become cryrotolerant.

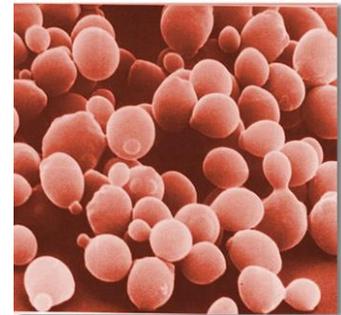
Today we dub these cryrotolerant species lager yeast and they are able to ferment in cold temperatures.

First, a little terminology is in order. While there are hundreds of species of yeasts that have been described in scientific literature, only a few have been specifically linked to the production of quality drinks and breads. *S. cerevisiae* is the most frequently used yeast species in baking and wine-making (although many strains of this species exist). It is also a thermotolerant yeast that is used to produce ales at higher temperatures and is sometimes called a top-fermenting yeast. *S. pastorianus* (sometimes called *S. carlsbergensis*) is a cryrotolerant yeast that can ferment at cooler temperatures and is often referred to as a lager or bottom-fermenting yeast.

Earlier research suggested that the cold-fermenting *S. pastorianus* was a hybrid of *S. cerevisiae* and another species, *S. bayanus* (Martini & Kurtzman, 1985; Rainieri, 2006). *S. bayanus* has often been used as a synonym for *S. uvarum*, which is a dubious assumption based on the most modern genetic analysis of the *S. uvarum* genome (Rainieri, 2006). I won't get into that controversy here! The view taken by most researchers was that the non-*S. Cerevisiae* component of *S. pastorianus*' genotype was accounted for by the genes contributed by *S. Bayanus*.

This view, that *S. Cerevisiae* and *S. Bayanus* hybridized to produce *S. Pastorianus*, is questioned by Libkind, et al. (2011) in some recent research. They isolated a yeast from Patagonia, *S. eubayanus*, that is a 99.5% match to the part of the genome of *S. pastorianus* that is not attributable to *S. cerevisiae*. Essentially, these authors suggest that today's main lager yeast is a hybrid of *S. cerevisiae*, the traditional ale yeast, and a yeast that has never been isolated in Europe, but hails from the New World, namely *S. eubayanus*.

This poses some temporal problems. If lager beer was being produced in 15th century Europe, it could not have been a *S. cerevisiae/S. eubayanus* hybrid since a potential carrier of *S. eubayanus* to the new world would have to post date returns of voyages to South America, which would be well into the 16th century.



Several possibilities may account for this (and this list is not exhaustive).

1. It may be that what we consider lager beer today actually emerged later than the 1420 reference cited above.
2. Some hybrid, yet unidentified, may have produced lager beer in the 15th century.
3. *S. eubayanus* may have been transported to Europe sometime in the 16th century and hybridized with *S. cerevisiae* to become the preferred yeast for producing lager beer.
4. *S. Eubayanus* existed in Medieval Europe and hybridized with *S. cerevisiae* even though the former has never been isolated in the wild in Europe.

What seems reasonable to assume is that at some point in history, a hybridization occurred such that previously thermotolerant yeast evolved into a cryrotolerant species under the selective pressure of brewers who observed and tasted the benefits of cold fermentations. These benefits go beyond merely the fermentation temperatures. Genes in lager yeasts code for different proteins that affect specific metabolic processes of the

yeasts and determine which, and at what levels, the yeast can process different types of sugars (but that is an issue for another paper).

Getting to the point: What is this project REALLY about?

What would beer have tasted like during this transition period? It is difficult to say. One way to get at least a little insight into this would be to do some experimentation. How? Once again, there are several possibilities.

1. The most authentic approach is the most ambitious. A brewer could attempt to hybridize a yeast by exerting selective pressure on a modern thermotolerant yeast that, through many iterations of increasingly cooler fermentations, produces a cryrotolerant yeast. Alternatively, the brewer could begin with a modern cryrotolerant yeast and through selective pressure of increasing temperatures produce a yeast that would tolerate higher temperature.
2. A less ambitious, and admittedly less authentic method would be to pitch both ale and lager yeasts into the same wort. Fermenting that wort at different temperatures might provide some insight into the flavor characteristics that Medieval Brewers produced.
3. An even less ambitious method (and this is the one I chose to begin my “yeast journey”) would be to find a modern yeast that has wide temperature variations and taste profiles that can be found in both ales and lagers.

The yeast I chose for this project was Wyeast’s Bohemian Lager (2124). This yeast has a fermentation range from 45-68F degrees. It produces the crisp, malty lager character in the colder temperatures, but also purportedly (according to the Wyeast profile) produces some esters that we associate with ales fermented at the warmer temperatures.

THE BEER

I decided to brew a beer with ingredients readily available in 15th and 16th century Bavaria: rye malt, barley malt, wheat malt, and hops. The *Reinheitsgebot*, issued by Duke Albert IV in 1487 and another incarnation in 1516 by Duke William IV, decreed that beer is to be made of barley, water, and hops (Arnold, 2005; Hieronymus, 2010; Unger, 2004; Warner, 1992). The beer brewed for my project would not have been sanctioned without special dispensation after these decrees went into effect. The project beer might be labeled a rogenbier. Roggenbiers usually contain a variety of grains, but modern standards usually suggest that at least 50% of the grain bill should be rye. The project beer is closer to 40%.



Personally, I like rye in beer, but it does have a fairly aggressive flavor profile and I didn't want to overwhelm any esters that might result from the higher temperature fermentation. That is the reason for the 40 rather than 50% of rye in the grain bill.

I used Hallertau hops because it hails from the Hallertau region of central Bavaria. It is considered a Noble Hop and is commonly used in beer of low bitterness from this geographical region.

The recipe and procedures follow.

List of Ingredients and Procedures for this Project

4lbs Malted Rye
4lbs Vienna malted barley
2lbs Pale malted barley
8oz Cara Wheat
4oz Caramel Rye
4oz Carafa III
1.5oz Hallertauer Hops (4.1AA)
1pkg Wyeast Bohemian Lager Yeast (2124)

All grains were crushed and mashed in 156 degree water (approximately 2qt/lb of malt) for 60 minutes, stirring every 15 minutes. After draining the wort from the tun, the grain was sparged with enough 170 degree water to bring the beginning boil to 7.5gal. Hops were added at the beginning of the boil, which lasted for 60 minutes. The wort was cooled to 75 degrees and the yeast was pitched after aeration.



Initial fermentation occurred at 68 degrees for 2 days during which fermentation was quite vigorous.

At that point, the beer was moved to a temperature controlled freezer and was reduced to 48 degrees over the next two days. The fermentation continued for 10 more days at that temperature and was then racked to a secondary fermentation container and lagered for approximately 2.5 months at 37-40 degrees. It was bottled on 4/7/2013.

Original Gravity: 1.050
Final Gravity: 1.012
IBU: 20.4
SRM: 17
Alcohol by Volume: 5%

The Result

The beer is quite mild in character. To me, this beer tastes much more like a lager than an ale, which makes sense given the procedures. Unfortunately, I do not detect much that I can deem an ester flavor. I taste the crisp maltiness of a lager on the front end of the taste. The rye character is more detectible on the finish.

References

- German Beer Institute. (2006). Retrieved from <http://www.germanbeerinstitute.com/history.html>.
- Jackson, M. (1999). *The birth of lager*. Retrieved from <http://www.beerhunter.com/documents/19133-000255.html>.
- Libkind, D., Hittinger, C. T., Valerio, E., Goncalves, C., Dover, J, Johnston, M., Goncalves, P., & Sampaio, J. P. (2011). Microbe domestication and the identification of the wild genetic stock of lager-brewing yeast. *Proceedings of the National Academy of Sciences*, 108, 14539-14544.
- Martini, A. V., & Kurtzman, C. P. (1985). Deoxyribonucleic acid relatedness among species of the genus *Sensu Stricto*. *International Journal of Systematic Bacteriology*. 35, 508-511.
- Mosher, R. (2004). *Radical brewing*. Boulder, CO: Brewers Publications.
- Noonan, G. J. (1999). *New brewing lager beer*. Boulder, CO: Brewers Publications.
- Rainieri, S., Kodama, Y., Kaneko, Y., Mikata, K., Nakao, Y., & Ashikari, T. (2006). Pure and Mixed Genetic Lines of *bayanus* and *pastorianus* and Their Contribution to the Lager Brewing Strain Genome. *Applied and Environmental Microbiology*, 72, 3968–3974.