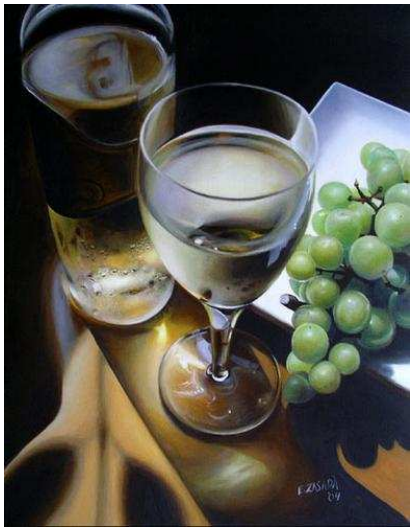
proteinspotlight
> ONE MONTH, ONE PROTEIN <

Issue 78, January 2007
www.proteinspotlight.org

Of froth and haze

Vivienne Baillie Gerritsen

When we raise a glass of wine, rarely do we give a thought to what has been involved in its making. Yet a wine's hue, its taste, its aroma, its sparkle and even the nature of its haze are given the same attention a mother would to her newborn. Many of the qualities of a wine are the doings not only of proteins inherent to the grapes, rice or any other product used to make it, but also to proteins which belong to yeast strains that are added for fermentation, and hence the production of alcohol. Consequently, it is hardly surprising that much time and effort is put into the identification and understanding of such proteins, in the quest to satisfy the palates and aesthetics of many. And the purses of others. Recently, two yeast proteins were discovered. The first is involved in the production of foam as the Japanese rice wine – sake – is brewed, and the second in the production of haze in white wine. Despite a difference in their functions, parts of their sequence are very similar, not to mention identical, and both belong to the cell wall of different strains of *Saccharomyces cerevisiae*.



White Wine and Grapes, Emily Zasada

Courtesy of the artist

Though the rice wine sake is thought of as Japanese and has been so for thousands of years, it may well have been part of China's culture long before. The Japanese, however, were the first to produce it on a wide scale. The idea of making an alcoholic beverage out of rice probably first arose when wet rice cultivation appeared. To kick-start the process of fermentation, the rice was chewed and then spat into bowls. With time though, the virtues of yeast were discovered and the enzymes found in the chewers' mouths were replaced by those of the common Baker's yeast, *Saccharomyces cerevisiae*. Like sake, grape wine was probably also discovered quite by chance when grapes were left to rot. The Egyptians seem to have been amongst the first to have tasted the delights of rotting grapes, well before Christianity. Traces of wine have been found in jars which date back to 3150 BC in the tomb of one of the first kings of Egypt. However, it was the Romans who fully appreciated its merits and wine soon spread all over Europe before Columbus took it across the Atlantic. Both sake and wine were at an early time an integral part of religious and social rites, and have remained so. Not much, it seems, is done without alcohol these days.

In the process of brewing sake, fermentation produces huge amounts of foam – the level of which is used as an indicator of the fermenting progress. Brewing, however, could be made an easier task if there was less froth and researchers set out to find out what was making it in the first place. It turned out that the culprit is a protein that has been baptised AWA1, so named after 'awa' meaning 'froth' in Japanese. AWA1 is a glycosylphosphatidylinositol- or GPI-anchored protein. GPI-anchored proteins are anchored – precisely – to cell membranes by way of their glycosylphosphatidylinositol

moiety. In the case of AWA1, the GPI-anchor grips onto a glucan on the surface of the yeast cell wall. But what creates the froth? Froth seems to occur when certain strains of yeast present cell walls that are hydrophobic. It is believed that the N-terminal end of AWA1 sticks out of the cell wall and presents a hydrophobic region. This particular region would then go fishing for the carbon dioxide bubbles which are a direct product of fermentation. Thus encouraging – so to speak – bubble formation, and hence froth.

The making of grape wine does not suffer from froth but it can lose popularity if haze appears – especially in white wines. Haze – or the lack of it – has become an indicator of quality. Wines with no haze are generally regarded as wines of greater quality than those you cannot see through. Note that, with organic beverages becoming more and more popular, haze is gradually becoming an indicator of original goodness and traditional brewing. Haze in grape wine is caused by the aggregation of wine components – which are still unknown – and grape proteins. Certain strains of *S. cerevisiae* used in wine fermentation actually decrease haze. These strains provide what are known as haze protective factors, or HPFs. One HPF, known as HPF1 is quite well known and resembles in many ways AWA1. Indeed, HPF1 is not only a GPI-anchored protein but is also found on the yeast's cell wall. Its function though is very different: HPF1 reduces the haze in wine by preventing the grape proteins from forming large aggregates with the unknown wine components. It probably does this by competing with the grape proteins to bind the wine components. As a result, no large aggregates are formed and the wine is less turbid.

Haze and froth are two qualities that have great commercial significance (read also Issue 48). Besides using AWA1 to identify different sake yeast strains in order to select those that make less froth, strains that are good at producing it can be introduced into the process of brewing beer where froth spells excellence. Similarly, haze protective factors such as HPF1 could replace current methods that are used to get rid of haze but which frequently modify characteristics that lessen the quality of the wine, by removing aroma components. Certainly, yeast and the magic it performs with fruits and cereals, has travelled through time side by side with humans, not only for the benefit of their senses but also for that of social cohesion.

Cross-references to Swiss-Prot

Cell wall protein AWA1, *Saccharomyces cerevisiae* (Baker's yeast) : Q8TGE1
Haze protective factor 1, *Saccharomyces cerevisiae* (Baker's yeast) : Q05164

References

1. Shimoi H., Sakamoto K., Okuda M., Atthi R., Iwashita K., Ito K.
   The AWA1 gene is required for the foam-forming phenotype and cell surface hydrophobicity of sake yeast
   Appl. Environ. Microbiol. 68:2018-2025(2002)
   PMID: 11916725

2. Brown S.L., Stockdale V.J., Pettolino F., Pocock K.F., de Barros Lopes M., Williams P.J., Bacic A., Fincher G.B., Hoj P.B., Waters E.J.
   Reducing haziness in white wine by overexpression of *Saccharomyces cerevisiae* genes YOL155c and YDR055w
   Appl. Microbiol. Biotechnol. 73:1363-1376(2006)
   PMID: 17024473

3. Cavalieri D., McGovern P.E., Hartl D.L., Mortimer R., Polsinelli M.
   Evidence for *S. cerevisiae* fermentation in ancient wine
   J. Mol. Evol. 57:S226-S232(2003)
   PMID: 15008419

Protein Spotlight (ISSN 1424-4721), http://www.proteinspotlight.org, is published by the Swiss-Prot group at the Swiss Institute of Bioinformatics (SIB).