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## Understanding Brettanomyces

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### Introduction

In March 1994 the Cornell University Agricultural Research Station at Geneva NY. (N.Y.S.A.E.S.) hosted the 23rd annual New York Wine Industry Workshop. This two-day event is well attended by most New York wineries as well as by many representatives from Ontario wineries. In addition, there are usually a number of serious amateurs present, soaking up technical information to improve basement, or garage, production. The 1994 session was no different with members of A.W.O. representing Toronto, Ottawa and Niagara in attendance.

You might not know what Brettanomyces is, nor why you need to understand it. I didn't until I found myself in the midst of a mild, but enthusiastic, scientific debate about the merits of the beneficial effects this yeast strain has on a wine, as opposed to the potential damage it can do to a wine. The debate in the commercial wine industry seems to have evolved to differentiate 'good Brett' from 'bad Brett'. It appears that the progress of Brettanomyces in a wine leads to an evolution in aromas, as opposed to an enhancement of one aroma indicator. The volatile phenols produced in red wine by Brettanomyces are characterized by descriptors ranging from "barvard" and "leather" to "clove" and "strong spice" to "smoky - B.B.O." to "phenolic" "medicinal"

from barnyard and leather, to clove and strong spice, to smoky – D.D.Q., to phenolic, medicinal, “band aid” and even “animal”.

The presentation made by Erik Olsen of Chateau Ste. Michelle Winery, Washington was accompanied by a tasting of three wines with varying levels of 4-ethyl phenol, which is a byproduct of Brettanomyces.

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1992 Cabernet Sauvignon: This was plummy, jammy and ‘juice-like’ — it did not have a vinous quality about it. It was tested for Brett, but no 4-ethyl phenol was found.

1989 Cabernet Sauvignon, Chateau Ste. Michelle, Washington: This wine had a beautiful black currant nose, showing lots of fruit and very attractive varietal characteristics. Laboratory tests revealed 4-ethyl phenol to be 3 ng/ml. The Wine Spectator gave this wine a score of 88 points.

1989 Chateau Pichon Longueville Comtesse de Lalande, Pauillac: This wine differed greatly from the Washington State wine, showing a classic round Bordeaux bouquet, where the berry character might be described as ‘cassis’, with just a hint of burnt wet wood offering complexity; this wine had less fruit and had distinctive barnyard aroma, though desirable — it was quite harmonious. Tests showed this wine to have 15,800 ng/ml of 4-ethyl phenol. The Wine Spectator gave this wine a score of 92 points.

1993 Merlot, N.Y.S.A.E.S., Finger Lakes: This young wine was deliberately doctored in the lab with 16,000 ng/ml of 4-ethyl phenol. Some of the descriptors for this sample include: dusty, grassy, fishy, vegetal, burnt wood, extreme dirty sock, foul, chemical, pungent. There was a distinctive mousy aroma remaining in the mouth after tasting — for those brave enough to taste it. The bouquet was most objectionable, to the point of being noxious.

The questions that rose uniformly across the lecture hall were: How much Brett do you need in order to be awarded a 92 by the Wine Spectator?, and, How do we attain it? Read the following article by Erik Olsen and keep these descriptors in mind when sampling in your cellar. There is a considerable amount of technical detail, particularly with reference to tests and treatments that are not available to the home winemaker. However, the paper offers a unique insight into the dilemmas facing commercial wineries and hopefully some tips for the home cellar-rat.

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## **Brettanomyces: Occurrence, Flavour Effects and Control**

*by Erik Olsen, Chateau Ste. Michelle Winery, Woodinville, Washington*(Abridged version – reprinted with permission from New York State Agricultural Experiment Station, Cornell University, Geneva, NY.) Brettanomyces is one of the most complex and controversial yeast issues a winemaker encounters when making red wine. To some, even the slightest hint of Brettanomyces character is cause for a wine’s rejection. To others, Brettanomyces is viewed as an integral part of red wine character, providing an essential dimension of complexity. Regardless of the passion winemakers have for or against Brettanomyces, it is important to have a clear understanding of how winemaking practices impact the development of Brettanomyces in wine.

### **Occurrence**

Brettanomyces sp. include nine different species of which the two most often found in wine are *B. intermedium*, and *B. lambicus*. These species of Brettanomyces are capable of growing in both red and white wines, although they are most often associated with red wines. Brettanomyces has been isolated from wines in nearly all

they are most often associated with red wines. *Brettanomyces* has been isolated from wines in nearly all winemaking regions of the United States and throughout the world. It is unlikely that there are any winemaking regions where the potential for *Brettanomyces* growth should not be considered.

There have been several attempts to isolate *Brettanomyces* from grapes at harvest, but generally they have not shown reliable growth. It appears that *Brettanomyces* becomes established in a winery over time and spreads as wines come in contact with contaminated areas. Within a winery, areas which are difficult to clean harbor the highest populations of *Brettanomyces*. Areas which typically provide suitable niches for *Brettanomyces* are must lines, dirty crush equipment, wooden cooperage, or any tank or transfer line which is not cleaned effectively. There have also been suggestions that the fruit-fly can carry *Brettanomyces*. Obviously the cleaner the winery, the more control one may have over *Brettanomyces*.

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Wooden cooperage is by far the most notorious for carrying *Brettanomyces*. This is not surprising since wood is virtually impossible to sanitize and since *Brettanomyces* sp. produce the enzyme B-glucosidase which allows it to grow on the wood sugar cellobiose. New barrels contain higher amounts of cellobiose than used barrels, and therefore have the potential to support higher *Brettanomyces* populations. Cellobiose in barrels occurs as a result of the firing process cooperages use to toast the barrels. The B-glucosidase enzyme of *Brettanomyces* cleaves the disaccharide cellobiose to produce glucose molecules which are then used for growth.

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## Flavour Effects

There are four key byproducts of *Brettanomyces* growth which can impact the flavour and aroma of a wine. These byproducts are esterases, volatile fatty acids, tetrahydropyridines, and volatile phenols. Each of these byproducts affects specific changes to the aroma of a wine. Since these substances occur together in a typical *Brettanomyces* infection, they can produce a very complex array of "brett" aromas. Furthermore, since these compounds have such low sensory thresholds, as few as four cells per bottle have been cited as causing typical "brett" aroma in a wine.

Esters are an important part of a wine's aroma, and are responsible for many of the fruity characters in a wine. Most esters are produced during fermentation by the yeast *Saccharomyces*, and are slowly lost by hydrolysis as the wine ages. *Brettanomyces* may accelerate the loss of fruity character in a wine because it produces esterase activity which can degrade important fruity esters.

The volatile fatty acids produced by *Brettanomyces* that impact wine quality are quite diverse. The most well known to winemakers is acetic acid. This is produced during *Brettanomyces* growth by the oxidation of ethanol and can lead to the formation of ethyl acetate which can have an acetone type aroma. Isovaleric, isobutyric, 2-methyl-butyric are other important volatile fatty acids produced by *Brettanomyces* that can impact wine quality. Although *Brettanomyces* infection may produce these compounds, it is also possible that they are formed bacteriologically from lactic acid bacteria or acetic acid bacteria.

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The tetrahydropyridines are responsible for the mousy aroma often associated with *Brettanomyces* infection. The aroma of tetrahydropyridines is largely affected by its concentration in the wine; at low concentrations it may have a bready, popcorn or cracker aroma, but at higher concentrations it may have the more obnoxious mousy or horsy aroma. The occurrence of mousy aroma does not necessarily indicate that a *Brettanomyces* infection is responsible. Tetrahydropyridines arise not only from *Brettanomyces*, but may also be synthesized by

heterofermentative lactobacilli such as *Lactobacillus brevis* and *L. hilgardii*. The substrates required for synthesis of these very volatile compounds are lysine, and either ethanol or propanol.

The aromatic compounds that are specifically produced from *Brettanomyces* are the volatile phenols. These compounds are synthesized from ferulic acid or cinnamic acid. In pure form, 4-ethyl phenol has a “band-aid” aroma; 4-ethyl guaiacol, has a wet burnt wood aroma. In wine these volatile phenols can give aromas such as: strong spice, phenolic, medicinal, clove-like, smoky, animal, or barnyard. Since these compounds are only produced by *Brettanomyces*, presence of 4-ethyl phenol may be a good indicator of *Brettanomyces* growth in wine.

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## Control

There are some basic methods for prevention of *Brettanomyces* growth in wine, but most have detrimental effects on wine quality. Decreasing pH, increasing SO<sub>2</sub>, decreasing aging temperature, avoiding barrels, and sterile filtration are all going to be effective at controlling *Brettanomyces*, yet they pose obvious problems to winemakers. It is important for each winery to assess whether their wines need drastic treatment to prevent “brett growth”, or if a more liberal approach is warranted.

*Brettanomyces* is sensitive to sulfur dioxide and can be readily controlled by maintaining 0.5 molecular SO<sub>2</sub>. Yet, for years winemakers have reduced the amount of sulfites used in winemaking, since high concentrations of SO<sub>2</sub> slow the phenolic polymerization and softening that occur during aging. In addition, winemakers are producing wines that are less tart and have higher pH. The higher the pH, the more SO<sub>2</sub> is needed to obtain 0.5 molecular; a wine at pH 3.30 requires 16 ppm free SO<sub>2</sub>, a wine at pH 3.75 needs 45 ppm free SO<sub>2</sub>. Winemakers continue to keep lower sulfite concentrations to improve the mouth feel of the wines, they may, however, lose perceived quality improvements if *Brettanomyces* grows out of control.

Sterile filtration is very effective at removing *Brettanomyces*. Sterile filtration is also very effective at stripping fruit character, reducing viscosity, and creating a harder tannic mouth feel in red wine. Very few wineries would consider sterile filtering red wines prior to barrel aging or even prior to bottling. In some cases where a single wine could contaminate an entire blend, some type of filtration may be desirable to prevent spread of *Brettanomyces*.

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Low temperature generally suppresses the growth of all yeasts, including *Brettanomyces*. By reducing aging temperatures, one can limit the potential for wines to be overrun with brett. A slight temperature reduction of five to ten degrees can have a significant effect on brett growth. The disadvantage of cooler aging temperatures, however, is that the wines will develop slower, phenolic polymerization rates decrease, and evaporation and concentration of the wines is reduced.

Barrels are essential for producing quality red wines, yet as mentioned above they are often implicated in the spread of *Brettanomyces*. Especially if one buys used barrels, there is the potential to import *Brettanomyces*, as well as other undesirable microbes. There is no effective way to sterilize a barrel without destroying it. If one chooses to buy used barrels, it may be appropriate to increase the sulfite concentrations for wines aged in such barrels.

Brett growth after bottling can destroy a wine. The off aromas tend to be more pronounced, the wines can become cloudy, and sediments can develop. These defects are not acceptable to most consumers. There are some management techniques available if one decides to live with brett and merely wishes to avoid brett growth

Brettanomyces tends to grow in a bell shape curve, usually with cell counts peaking six to ten months after barreling. It appears that the cells use up a certain substrate and then die off. It is important to monitor Brettanomyces growth at each racking to see if the cell counts have peaked. Many winemakers feel if the populations of brett are decreasing prior to bottling, it is less likely a "brett bloom" will occur in the bottle.

Some winemakers blend early to reduce chances of "brett bloom" in the bottle. Theoretically, this would allow the entire blend to go through a "brett peak" and become potentially more stable to "brett" infection. If blending is done just prior to bottling, there is the possibility that an uninfected blend component will provide substrate for the otherwise "brett stable" blend. The earlier the blend is made, the greater the potential to obtain "brett stability". Blending early, however, does create problems for the winemaker, who must predict how the young wines will show in an aged blend.

Frequent monitoring of topping up wines may also prevent the spread of "brett". The quickest way to introduce "brett" to all of one's wine is by topping the entire cellar with a barrel of "brett" infected wine. Choosing a topping wine that has previously shown no growth for Brettanomyces reduce the chance of contaminating uninfected wines.

Some wineries have correlated "brett stability" with residual sugar content at bottling. Even though a wine may be dry with less than 1 g/L residual sugar, this could be enough to support a "brett bloom" in the bottle. If possible, delaying sulfite addition after fermentation until wines are well below 0.5 g/L residual sugar might avoid residual sugar brett uses for growth after bottling.

Currently there are only two methods which can virtually eliminate Brettanomyces at bottling. Sterile filtration, which many avoid with reds, and more recently DMDC (Velcorin). DMDC, or dimethyl dicarbonate, is a sterilant which has been used with dealcoholized wines, and may have some application in sterile bottling without the use of membranes. DMDC is extremely hazardous, and the equipment needed for using it is cost prohibitive for most small wineries.

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