

## Wine Corks

About half of the world's corks are grown in Portugal, principally in southern Portugal. After the trees reach maturity (25 years), about every 9 years the bark is stripped from cork oaks. The first stripping is known as virgin cork and is generally unsuited for wine closures. After cutting, the cork may spend a year in the forest before being transported for processing. As might be expected, a host of organisms, i.e., molds, bacteria, and yeast, have been isolated from cork wood prior to processing.

During processing, the cork slabs are first graded and then boiled in water for about one hour. Boiling would be expected to kill all microorganisms. Some microbes do survive, however, perhaps being located in the lenticel tissue where incomplete penetration of the water occurs. Additionally, the cork slabs may become contaminated simply due to the high titer of microorganisms in the air within processing plants. High levels of mold spores - particularly *Penicillium glabrum* have been found in cork following boiling. The boiling step, although designed to rid the cork of contamination may indeed promote microbial growth due to the increased water activity of the cork following boiling.

Following boiling, the cork slabs are stacked to flatten them and to equilibrate the moisture within the slabs. Naturally, mold grows on the slabs, particularly those on the outside of the stack. The slabs are then cut into strips and corks punched out. It is safe to say that the mold content has little or no direct effect on the sensory quality of the corks at this time - otherwise processing changes would have been instigated years ago.

Most corks after grinding and shaving are bleached by dipping in a solution of chlorine (approximately 35%). This is followed by a rinse with a 0.6% oxalic acid solution, followed by a water rinse. The corks are then sun dried, surface dried or subjected to vacuum drying. The water content in the corks is then about 6-8% which inhibits most microbial growth.

The bleaching step is considered by some to be the major source of musty cork off odor and flavor. During bleaching, chlorophenols are formed from the direct chlorination of the cork lignin. Chlorophenols may then be methylated (CH<sub>3</sub> group added) to form 2, 4, 6 trichloroanisole (2, 4, 6-TCA). 2, 4, 6-TCA has a musty odor and is one of the most potent odorants known. The odor threshold needed to give the typical musty cork odor in wine is only 30 ng/L. A nanogram (ng) is equivalent to 1 x 10<sup>-9</sup> grams. Studies report finding up to 130 ng/L of 2, 4, 6-TCA in corked wines and up to 40 ng in the cork itself.

Molds may also play a role in the formation of 'corky' wines. Some molds can easily methylate chlorophenols to form chloroanisoles. Whether or not off aromas from cork microflora can be prevented by simply using nonbleached corks is still unresolved. It is safe to say that there is increased interest in using either non-bleached corks or corks which have been bleached using hydrogen peroxide instead of chlorine compounds - such products are now available.

Research has isolated a host of organisms from raw cork, new cork and corks extracted from bottled wines. They found a significant group of organisms which were able to produce compounds which they described as: phenolic, earthy, moldy, rancid, potato and pharmaceutical. This underscores the need for cork sterilization at the factory and the maintenance of sterility at the winery.

The sorting process combined with storage at the factory allows for high levels of microbial growth. Many believe that this time between possible bleaching and disinfection and use is where the real problem arises. During this time, recontamination of the corks can occur, particularly if the water activity of the cork is high. Water activity is the moisture content available for microbial growth or enzymatic activity. It is essentially a measure of the free water. Naturally, as the moisture content of a substance is lowered so is the water activity.

As a generalization, if corks are transported at 20°C, then they should be maintained below 8% moisture. At this temperature and moisture content the water activity is generally low enough to inhibit mold growth. Fortunately, this moisture content is consistent with the operation of most corkers.

To help ensure that corks are free of microorganisms that may affect wine quality winemakers either treat corks with sulfur dioxide before bottling and/or purchase treated corks from suppliers. Generally suppliers treat corks with gaseous SO<sub>2</sub> or with ionizing radiation. It's been demonstrated that SO<sub>2</sub> treatment achieves nearly 100% inactivation of molds present in corks. Bacterial counts were not as effectively reduced, possibly because of resistance of spores from organisms such as Bacillus. Sulfur dioxide treatments satisfy the major prerequisite of elimination of mold from corks, however, direct mold growth in corks stoppered into wine may not be the sole cause of cork related off odors and flavors. As stated, mold growth during processing or shipping may produce metabolites which are both responsible for tainted wines and which are unaffected by SO<sub>2</sub> treatments.

To help minimize the likelihood of cork problems - know what you are buying. Are the corks bleached? What is the moisture content when shipped? How are the corks sterilized? Do they remain sterile in your cellar?

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