BENTONITE

Vitiben and KWK Traditional Bentonite

Source:
Bentonite is clay with high montmorillionite content, mined in Wyoming and South Dakota. There are many kinds and preparations of bentonite, only a few of them suitable for wine. DO NOT use bentonite sold for any other purpose for addition to wine. Sodium bentonites are the most popular types in the U.S.A. Other countries often use calcium bentonite, which may have greater or lesser protein removal activity than sodium bentonite but almost always clarify less well.

Differences among brands depend on montmorillionite content and percentage of impurities such as sand. The KWK brand is common in the industry, but there are others, including Vitiben from Baroid Corp.

Characteristics:
A hydrated aluminum silicate, bentonite has a negative charge, reacting with positively charged particles such as proteins. In solution, it behaves like a series of small, absorbent plates.

Legalities:
No more than 2 gallons of water may be used to dissolve each pound of bentonite, and the total amount of water introduced from all sources may not exceed 1% of the wine. There is no legal maximum aside from the water restrictions.

Use:
Bentonite is used for protein removal and/or clarification in grape wines (white, rose, blanc de noirs and light reds), and wines from other fruits. All wines contain proteins of various types, but in wines with little tannin, some proteins may coagulate to form a granular precipitate when the wine is warmed. For this reason, protein precipitation is called “heat instability.”

Most non-red wines need bentonite fining to remove protein, but almost all red wines are naturally protein-stable. Most Vinifera reds are stable because of their tannin content, unless made by carbonic maceration or in a very light style. Test reds made from non-Vinifera varieties to be sure they do not need bentonite. Bentonite strips color and flavor from a red wine, so it is seldom used in reds unless needed to precipitate protein, not just for clarification.

No matter how clear a wine appears before bottling, if it still contains too much protein, a fine, dusty haze will form in the bottle when the wine is warmed to a higher temperature than it encountered during cellaring. Transportation in hot weather and/or storage in a warm place are common errors leading to protein haze. Once it happens, protein coagulation is irreversible. The wine is unharmed, and the sediment is odorless and flavorless, but it is unsightly, offending consumers.

How warm a temperature is needed to cause precipitation varies from wine to wine, depending on pH, the amount of protein and other components present. Some wines are so unstable that warming to 70^{o}F for an hour will cause proteins to precipitate, while others can spend days over 90°F without forming a haze. High-pH wines are less stable than low-pH ones with the same amount of protein.

In white wines, bentonite is often the only fining agent needed, though some whites require further clarification. The customary sequence is to determine how much bentonite is needed to remove the protein, then check for clarity. If the wine has not cleared with the bentonite needed for protein stability, gelatin followed by kieselsol will usually clarify it, unless the haze is microbial. Bentonite can help settle yeasts but is ineffective against bacterial hazes.

Dose:
The amount of bentonite needed to achieve protein stability varies with the year, type of fruit, growing region, and other factors. In general, wines with low pH require less than high-pH wines. Acid adjustments should be made before bentonite trials, because the bentonite dose will be affected by the pH shift, invalidating the trials.

Some varieties consistently need more bentonite for protein stability than others, and wines in some climates tend to contain more protein.

For instance, a Riesling may take only 1-2 lbs/1000G, a Chardonnay might need 2-4 lbs/1000G, a Gewurztraminer or Sauvignon Blanc could require still more. Some wines especially high-pH or warm-climate ones, need 10-20 lbs/1000G to achieve protein stability, at the expense of flavor.

Addition of 50 ppm of tannin can reduce the bentonite dose in wines needing huge amounts, as may treatment with gelatin/kieselsol.

Timing of bentonite addition:
Bentonite use before and during white wine fermentations is controversial. The settling action of bentonite on elemental sulfur dust particles and other unwanted solids must be weighed against the disadvantage of removing nutrients by fining and racking before fermentation, so juice fining should be practiced with caution.

Added during fermentation, bentonite gives yeasts particulate material to attach to, but it also settles well, bringing yeasts and bacteria with it into the lees. Bentoniting during fermentation can be beneficial provided that it is not added while yeast activity is slowing down and that the wine is not racked off the lees until completely dry. Lees may be stirred near the end of fermentation.

Bentoniting before or during fermentation is not recommended for juices with a history of stuck fermentations, unless a sweet wine is desired. To stop a fermentation to leave some residual sugar, wines are bentonited, chilled, settled, and racked off the lees.

Most wines are treated with bentonite in the winter, after they have been racked at least once and the SO2 has been adjusted. If acid adjustment is planned, it should be done before adding bentonite, because a pH rise (acid removal) makes a wine less protein-stable, and a drop in pH (acid addition) makes it more stable. Malolactic fermentation can also make a previously stable wine unstable because of the pH rise.

Cold-stabilization is traditionally done after bentonite, however, so the wine is not too cold when bentonite is added. Bentonite works very poorly at cold temperatures. Many wineries fine with bentonite, then (without racking), add any other fining agents needed, then turn on the jackets (or open the door in winter in a cold climate) for cold stabilization. The tartrates help compact the fining lees and the wine can be racked off clear and stable.

Oak extractives can change protein stability a bit, so whites that were fined before long barrel aging sometimes need a little more bentonite later. Blending can also affect stability; a blend of two or more protein-stable wines is NOT necessarily protein-stable itself. Retest protein stability after blending.

Preparation:
Use water, never wine, to dissolve bentonite. Prepare a lab solution at 5% or less, usually 4.5 or 4.8%. For example, if you want 100 mL of a 4.5% solution, weigh 4.5 grams of bentonite, add to 80 mL water, bring to 100 mL with more water. To use a 1-gram sample, make 22 mL of solution for 4.5%, 21mL for 4.8%.

Preparation instructions vary depending on the type of bentonite.

Traditional KWK (light, salt & pepper gray, coarsely granular): Stir KWK very slowly into hot water (160-180^{o}F, not boiling), stirring to break up lumps as they form. Allow to rest at least one day, then homogenize with paint mixer, eggbeater, or patient stirring to smooth out lumps. Solution lasts for months.

Vitiben (medium-light gray, granules similar size, no salt & pepper appearance): Dissolve in cool tap water just before using, stirring constantly to prevent lumps. Do not add dry. Vitiben should dissolve in 5-10 minutes. Prepare a new solution each time for best correlation with cellar results.

Other bentonite brands should be prepared according to the supplier's directions.

Lab Trials:
If possible, try different bentonite types or brands to determine which will be most effective on each wine. At least, try several different addition levels, corresponding to reasonable doses for that wine. Yearly variations are so great that it is false to assume that a wine will need the same amount as it did last year.

Calculate appropriate amounts to put in sample bottles (250mL, 375mL, or 750mL are common sizes), from the charts in "Lab Trials of Cellar Additions." If you are not sure what levels to use, try 1, 2, 3, and 4 lbs/1000 gallons; do more trials at higher levels if these prove unstable. Leave one bottle with no addition to act as a "control" sample. Label all bottles carefully.

Using a plastic pipette, add the bentonite to wine that is at approximately the same temperature as the wine in the cellar (this is very important!). Mix the sample bottle by stirring, inverting, or some other mechanical method that approximates the way it will be mixed in the cellar, rather than shaking. (Note: remove cotton plug with a pin to rinse and reuse plastic pipettes.)

Allow the samples to rest undisturbed at least overnight, then observe for clarity and run a protein stability trial (incubation) on the untreated wine and on each trial bottle.

Filtering trial samples:
When the bentonite fining trials have settled (or if testing a sample without doing trials), pour some wine from each bottle, including the control bottle, into a small beaker or cup. Try not to disturb any sediment present.

Filter 10 mL of each trial or sample through a membrane filter into a screw-cap test tube, using a Swinnex filter holder or other lab membrane filtration setup. Or, filter more wine through a 47mm filter holder if you want to incubate a larger sample.

To use a Swinnex, unscrew it into 2 pieces. Place a 25mm membrane filter (0.45 m is best) on top of the grid on the bottom piece. Wetting the filter can help hold it onto the Swinnex bottom. Most brands of membrane filters can be used with either side up. Discard the blue sheets that separate each filter. Put the rubber O-ring on top of the filter, then carefully screw both pieces of the filter together, making sure that the filter does not slip off the exact center of the Swinnex.

Load a plastic dispenser (syringe-type) by inserting the nose into the control sample (or the lowest fining level if there is no control sample), pulling back on the plunger. Once the dispenser is full, fit its nose into the top of the Swinnex, twisting a little to lock into place. Push down on the plunger to filter wine into a screw-cap test tube, leaving a 1-2 mL space in the tube to allow for expansion of the wine during incubation.

Incubation for protein stability:
Incubate the tubes at 140^{o}F (60^{o}C) for 24 hours. About 95% of the protein present will be denatured and will form a haze or sediment in the tube. This incubation procedure is used by many wineries, but different temperature and times may be selected. No one really expects wines to be heated to 140^{o}F; this is the temperature needed to precipitate nearly all the unstable proteins. Longer times will be needed to precipitate proteins at lower temperatures.

Incubation can be done in a water bath or an incubator. Without either, incubation can be logistically difficult, though not impossible. An electric frying pan filled with water, or a beaker of water on a coffee warmer are possible means of incubation. Or, build a box with a light bulb and thermostat, and thermometer in it.

The temperature should not vary more than +/- 5^{o}C, even at night. Fluctuations into higher temperatures can cause pigments and other material to precipitate. Ovens and toaster ovens are too variable in temperature to be suitable.

After the incubation period, remove the tubes and refrigerate for 6-12 hours after removing from the incubator. Refrigeration is a necessary part of the test and should not be omitted! Allow tubes to warm to room temperature before examining.

Though some wineries read the tubes the same day they are taken from the refrigerator, the results will be more accurate if the tubes stand at room temperature for 1-2 days after refrigeration before reading. The protein coagulates slowly upon cooling and tubes that appear clear at first may form a haze a day or so later.

Reading the incubated samples:
Check the tubes for sediment or cloudiness with a high-intensity light in front of a black background, or read NTU in nephelometer or turbidimeter. When the NTU changes very little from one trial to the next, the wine is considered stable.

If reading tubes visually, compare each trial with the next lower one and the next higher one. A large, flocculent precipitate indicates extreme instability, while a very light haze means that the wine is only slightly unstable. Estimating stability is easiest if the tubes are compared to each other and to the control sample.

Frequent interferences are precipitated pigments (red and rose wines mostly), yeast growth, and residual bentonite from incomplete filtration of the sample. Diatomaceous earth has been mistaken for protein instability in several cases. Some nutrients that are soluble at normal wine temperature cloud upon heating.

To determine whether a precipitate is caused by protein or by other material, check the amounts of sediment in the tubes representing different amounts of bentonite. If it is protein, the degree of cloudiness will diminish with increasing bentonite additions. The sample may also be examined under a phase contrast microscope to identify the precipitate. Loose, granular aggregates of protein are easily distinguished from bentonite, yeast, pigment, or other interfering particles.

Fining the wine:
Lab trials do not always translate exactly to the cellar. When the main batch of wine has been fined with bentonite, filter and incubate a sample to be sure that protein stability was achieved. If not, additional bentonite fining is required.

In the cellar, a common solution is 1 lb bentonite per gallon of water (note legal water addition limit of 1% from all sources). This solution is too thick to measure accurately in the lab.

The bentonite used in the cellar should be the same type, prepared in the same way as in the lab, and the wine should be at similar temperature. For instance, if the wine is at 55^{o}F in the cellar, lab trials also should be done at around 55^{o}F. Doing lab trials at warmer temperatures than in the cellar can result in underfining because bentonite is less effective in cold wine.

Bentonite must be mixed in very well, for a period of at least 15 minutes, or dosed in-line while racking or circulating.

Chemical tests:
Chemical tests for protein stability are not recommended as they may give misleading results. Trichloroacetic acid or Bentotest can aid in deciding which bentonite levels to use in lab trials, since they show whether a wine is slightly or very unstable. To use Bentotest, (a yellow, light-sensitive molybdate solution) put 9 mL wine and 1 mL Bentotest in a test tube, observing for haze with a high-intensity light. The cloudier it is, the more bentonite will be needed.

An ethanol test can be used to demonstrate potentially insoluble protein, though pectin also reacts with ethanol to form a haze. Mix a few mL of wine with the same amount of undenatured 190-proof (95%) ethanol (high-proof or “Everclear,” not sold in many states including California). A precipitate indicates protein, pectin, or certain polysaccharides.