

# Better Wine through Chemistry

© 2007

Jan & Tom Cobett  
American Wine Society

*"Promoting Wine Appreciation Through Education"*



# What is wine?

- According to the Bible, wine is made only from grapes
- It is probable that the first wine, undoubtedly made by accident, was made from red grapes

Most of the world's wine  
is not great  
and does not pretend to be.

*Philip Wagner*

# What is wine?

- If you crush any ripe fruit and keep it covered in a clean container, over time, it will ferment and become a beverage containing ethanol
- If you don't consume this wine as soon as it is drinkable, it will begin to rapidly deteriorate, unless, you understand how to use **Chemistry** to preserve and enhance the wine

The difference between primitive winemaking and enlightened winemaking is that one is laborious and uncertain in its result.

The other is less laborious and more certain.

*Philip Wagner*

# How is wine produced?

- Ripe grapes are separated from their stems and then crushed
- Natural or cultured yeasts convert the sugars to alcohol
- The skins contribute color and tannins
- The pulp, skins and seeds are pressed to liberate wine

# Grapes Contain

- 70-80% Water
- 10-25% Sugar (glucose and fructose)
- 0.5-1.5% Acid (tartaric and malic)
  - Hot, dry climates produce low acid grapes
  - Cool, wet climates produce high acid grapes

# Grapes Contain

- 0.2-0.3% Minerals (sulfates, phosphates and chlorides)
- 0.05-0.1% Nitrogen Compounds (yeast food) and Pectin (causes hazy wine)
- Thiamines and Antioxidants (good stuff)



# Sugar and Acid need to be “balanced”

- Too much residual sugar is “flabby” or “cloying” if sufficient acid is not present
- Deficient sugar can be corrected by adding beet, cane or grape sugar
- Sugar contents above about 30% will create some residual sugar in the wine after fermentation

# Sugar and Acid need to be “balanced”

- Too much acid without sufficient residual sugar is “tart”
- Deficient acid can be corrected by adding Tartaric, Citric, Phosphoric or Sulfuric Acid
- Too much acid can be reduced by chemical (adding a base like Calcium Carbonate), biological (malo-lactic fermentation), or dilution methods

# Healthy wines must have acids for longevity

- White wines generally have a pH of 2.8 to 3.4 and have higher acid than red wines
- Red wines generally have a pH of 3.4 to 3.8 and have lower acid than white wines

**2% Sugar will produce  
about 1% Carbon Dioxide  
and 1% Ethanol (Ethyl  
Alcohol)**

**30° Brix = 15% alcohol**

# Without natural or cultured yeast, fermentation won't happen

- Natural yeasts are risky (might be great, might be awful)
- Cultured yeasts usually have a “killer factor” that destroys natural yeasts
- Cultured yeasts can accentuate aroma, mouth feel, color and longevity (These are the reasons why we use them)

**If you want a red wine to taste like Italian Brunello, use a cultured yeast that comes from the grapes used to make Brunello.**

## Lalvin BM45

# The Big Movement in winemaking

BM45 was isolated in the early 1990's in collaboration with the Consorzio del Vino Brunello de Montalcino and the University of Siena. BM45 is a relatively slow starter and is well suited for long maceration programs. It has high nitrogen requirements and can produce H<sub>2</sub>S if nutrient starved. BM45 produces high levels of polysaccharides resulting in wines with great mouthfeel and improved color stability. BM45 is used on red varieties to contribute jam, spice and earthy elements. It also is used to minimize vegetal characteristics.

**The minor reaction between the alcohol and the acids will produce a small amount of esters.**

- A little bit of ester is good
- Too much ester is what we call vinegar



# What can go wrong?

- The wine looks bad
- The wine smells bad
- The wine tastes bad

# What can go wrong?

- The wine starts out pretty good but is not doing well by the time Easter rolls around
- The wine tastes pretty good and you drink most of it right away only to find out that the two bottles that you saved for next year are actually even better by the time you drink them

# How can we prevent the problems?

- Add Nitrogen (feed the yeast during fermentation)
- Add Oxygen (keep the yeast healthy during fermentation)
- Add Sulfur (most important additive to wine)

# Sulfur in Wine

- Antiseptic
  - Destroys unwanted molds and bacteria during fermentation
- Antioxidant
  - Eliminates oxidation (browning)
- Preservative
  - Eliminates haze and prevents the formation of acetaldehydes (vinegar)

# Sulfur in Wine

- Goes away after it does its job
- May be added by
  - Bubbling  $\text{SO}_2$  Gas
  - Adding Potassium Meta Bisulfite (easier)
    - 1 gram into 1 gallon will give about 150 ppm of  $\text{SO}_2$

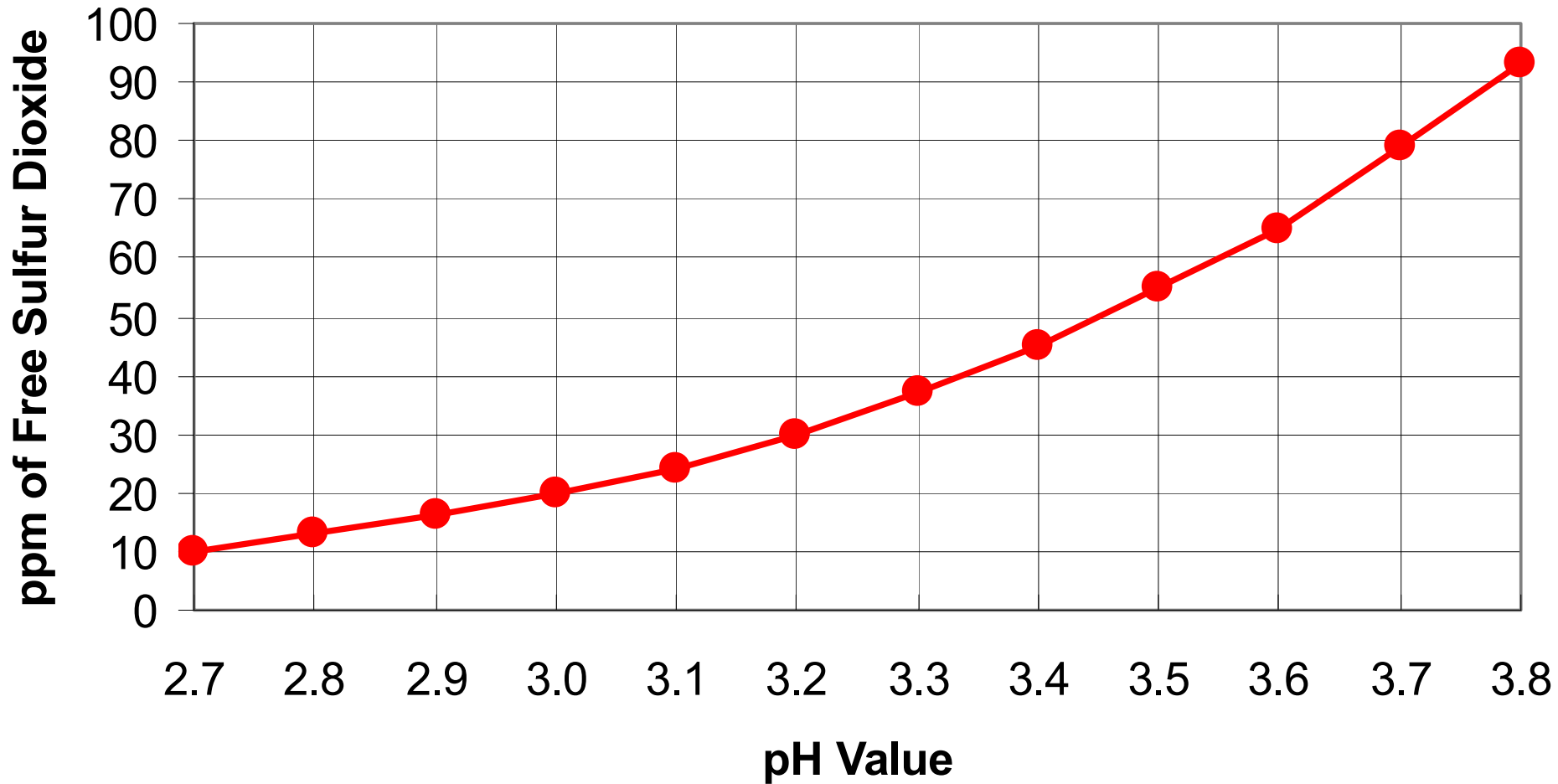
# Sulfur in Wine

- Remove Sulfur with aeration
- Slosh it around
  - Dead yeast cells generate Sulfur
  - Rack the wine off the lees to get rid of the Sulfur odor

# Sulfur in Wine

- The winemaker needs to fix Sulfur problems as soon as possible
- If high Sulfur is allowed to exist for any length of time, it is possible to generate Mercaptans – Sulfur compound
  - Mercaptans are just about the most foul smelling chemicals known to man – used to odorize Natural Gas

# Free Sulfur Dioxide Required as a Function of pH Value to maintain 1.0 to 2.0 ppm Molecular Sulfur Dioxide (from E. Peynaud and Y. Margalit)





# Out of Balance?

- Add Sugar

- Potassium Sorbate will be needed to prevent re-fermentation; inhibits growth of yeast
- If Sorbate is used, do not let the wine go through Malo-lactic fermentation (keep  $\text{SO}_2$  above about 60 ppm)
  - If Sorbated wines go through Malo-lactic fermentation they will smell like Geraniums
  - There is no way to correct this fault

# Out of Balance?

- Add Acid
  - Tartaric (cream of tartar)
  - Citric
  - Acid Blend (Tartaric, Citric & Malic)
  - Sulfuric
  - Phosphoric

# Color out of whack?

- Add color with extract from Colobel grapes
- Remove Color
  - Add Bentonite (will absorb pigment)
  - Add Poly Vinyl Polypyrrolidone (PVPP)
  - Add Sulfites (will bleach out color)
  - Add Hydrogen Peroxide

# What else?

- Remove odors
  - Pass through activated Carbon
- Remove haze
  - Add Flocculants
- Remove foam
  - Add antifoam (Silicones)
- Improve “mouth feel”
  - Add Glycerin

# Plus all the chemicals we use for analytical testing

- pH Value
- Total Acid
- Total SO<sub>2</sub>

# **Better Wine through Chemistry?**

**How about**  
**No Good Wine**  
**without Chemistry!**

# **How to fix bad wines**

(How to score more points)



# The Most Common Faults

- Oxidized Wine
- Bacterial Problems
- Out of Balance Wine
  - Not enough Acid
  - Too much Acid

# The Most Common Faults

## ■ Oxidized Wine

- Measure the pH Value and correct it
- Add sufficient Potassium Meta Bisulfite
- Learn how to use Titrettes



Titrets®

hand-held titration cells for titrimetric analysis



# The Most Common Faults

- Bacterial Problems
  - Measure the pH Value and correct it
  - Add sufficient Potassium Meta Bisulfite
  - Keep everything clean

# The Most Common Faults

- Out of Balance Wine
  - Not enough Acid
  - Too much Acid
  - Enough Acid for good taste and long life
    - Red Wines – pH 3.4-3.6
    - White Wines – pH 3.0-3.4
    - If you have higher Acid (lower pH) you need less Sulfur Dioxide

# Grape Characteristics

- Eastern Grapes tend to be higher in Acid
- Western Grapes tend to be lower in Acid
- Grapes sold to home winemakers tend to be not the highest quality
- Blending Eastern and Western Grapes is often a good idea

# Let's fix a low acid wine!

- Everyone has 2 glasses of red wine
- The wine is a 2006 Nebbiolo from Lake County California
- The wine has a **pH Value of 4.17**
- We would like to adjust the pH Value to about 3.60

# Let's evaluate the Nebbiolo

- Look at the wine
  - Is it a bright purple-red color?
- Smell the wine
  - Can you smell the fruit?
- Taste the wine
  - Is it a bit flat?



# How do we fix this wine?

- Add Acid to get the pH down to 3.60
- Which Acid should we use?
  - What do you have to work with?
  - Some acids are more powerful (you will need to use less of Sulfuric Acid than Acid Blend)
- How much Acid do we need to add?

**Measure the pH of the  
Base Wine**

# Put some of the base wine into a graduated cylinder

- If you have a 1000 ml. cylinder
  - Add 10 grams of the Acid you want to use
- If you have a 100 ml. cylinder
  - Add 1 gram of the Acid you want to use
- In either case, this is a 1% addition of Acid to the base wine

**Measure the pH of the  
wine with the acid  
addition**

# 2006 Nebbiolo

- Base wine had a pH of 4.17
- Adding 1 gram of Acid Blend to 100 ml of wine dropped the pH to 2.97
  - A total shift of 1.20
- To drop the pH to 3.57 (a total shift of 0.60) we would only need to add half the amount (0.5 ml)
  - That's an addition of 0.5% of Acid Blend

# 2006 Nebbiolo

- The glass of wine contains about 45 ml of Nebbiolo (1.5 ounces)
- 0.5% addition to 45 ml is about 0.225 grams of Acid Blend
- The plastic bag contains 0.225 gram of Acid Blend
- Add the Acid Blend to the second glass of Nebbiolo



COPPER SOLUTION  
0.01 @ 25C  
Avoid contact with skin, eyes,  
clothing & growths on scalp.  
Wash with skin and eyes.  
Lot # 1314

COPPER SOLUTION  
0.01 @ 25C  
Avoid contact with skin, eyes,  
clothing & growths on scalp.  
Wash with skin and eyes.  
Lot # 1314

58 0.55  
4.15 4.17  
100 ml  
AB 20A  
pH 5.57





Mettler

Titrets<sup>®</sup>

4.5-1000 in. Wt.

TRIPLE BEAM BALANCE  
200 SERIES  
2610

OHAUS

5 lb 2oz



## ACID BLEND, Powder

40% Tartaric, 40% Malic, & 20 % Citirc acid

Used to increase acidity in acid deficient wines  
and treat high pH wines prior to cold stabilization.

**WARNING:** *May cause eye, skin and respiratory  
irritation. Flush with plenty of water after eye  
contact. Avoid breathing dust.*

Presque Isle Wine Cellars  
9440 W Main Rd, North East PA 16428  
(814) 725-1314

Net weight: 8 lbs. ( 3.63 kg )





# 2006 Nebbiolo

- Is this glass better than the first glass?
- Look at the wine
  - Is it a bright purple-red color?
- Smell the wine
  - Can you smell the fruit now?
- Taste the wine
  - Is it still a bit flat?

# 2006 Nebbiolo

- Instead of needing over 100 ppm of Sulfur Dioxide at pH 4.17
- It now needs only 60 ppm of Sulfur Dioxide at pH 3.57
- The acid adjusted wine will last longer

**What does our wine  
production area look like?**

Probably very much like yours!



A large red hand-cranked mashing machine mounted on a wooden stand. The machine has a prominent red flywheel with three spokes. The stand is made of light-colored wood and has a white metal frame. The machine is positioned against a wooden pegboard wall.

A stainless steel keg with a wooden airlock on top. The keg has "KAISER-BUSCH-TIG" embossed on it. A white bucket is placed in front of it, containing some wooden planks. A black cable is connected to the bucket.

A collection of stainless steel kegs and white buckets. One keg has a white bucket on top. Several kegs have airlocks on top. A red tool is visible in the background. The kegs are arranged in a row, and the buckets are stacked on top of them.





Blue Label  
2000  
100% Pure Malt  
100% Pure Malt  
100% Pure Malt  
100% Pure Malt

WMS  
WMS







Label on a dark glass fermenter in the back row.

Label on a dark glass fermenter in the middle row.

Label on a green glass bottle in the middle row.

Label on a large glass carboy on the right.

Label on a dark glass fermenter in the middle row: DU CHER FRAIS

Label on a dark glass fermenter in the middle row.

Label on a dark glass fermenter in the middle row: DU CHER FRAIS

Label on a white plastic jug in the foreground.

Label on a white plastic jug in the foreground.

Label on a white plastic jug in the foreground.

Label on a white plastic jug in the foreground.

Label on a cardboard box on the left: JE

Label on a cardboard box on the left: MASON JAR

Label on a cardboard box on the left: CITRUS

Label on a cardboard box on the left: 304 STED

Label on a cardboard box on the left: R

Label on a white plastic jug in the foreground: Cavalier

Label on a white plastic jug in the foreground: Hot

1978 VINYL  
2000 PROD. M. KOST  
GEORGES DUBOUEF

19066  
OH-41168  
MI-924-7  
PA-4079

80686-00140  
19066  
OH-41168  
MI-924-7  
PA-4079  
12-750 ML

102728-00-00  
102728-00-00

BW-727  
EAU FRANK  
MAKES CHAMPAGNE

12 F/B BORD.  
750 ml CK

THE JAYDOR  
EXPOSITION  
ORDER

LODI  
domnay

ACACIA  
ACACIA WISKEY  
MAY, CALIFORNIA DISTRICT, CALIFORNIA

12 X 750 ML

'03 Chambourcin  
BEER 48:00  
00/01/21  
117266

EDGE

Vinegar

Vinegar  
RAYMOND

ALAK  
MARTIN & BIRD  
FONTECA

ect from frost and heat  
00 Dry Riesling



Large Trash  
30 GALLON  
DROPTOP

Trash  
30 GALLON  
DROPTOP



STREHN  
2002 RIESLING-  
GENURZTRÄMMER  
OCTOBER 2002  
121750 161G  
+467662

2/750 M

100% Riesling  
Genurztrammer

100% Riesling  
Genurztrammer

100% Riesling  
Genurztrammer

100% Riesling  
Genurztrammer

100% Riesling  
Genurztrammer

100% Riesling  
Genurztrammer

HEAD

toastedhead.com





103325

Beringer

CRANFLA



Pinocchio  
12x750ml  
Product of Italy

12 LITERS  
SOU FRESH  
TEN HIGH  
KENTUCKY  
12 x 750ml

12 x 750ml

12 TR  
DOM  
WHIT

**Any questions?**

# Better Wine through Chemistry

Jan & Tom Cobett  
American Wine Society

*"Promoting Wine Appreciation Through Education"*

