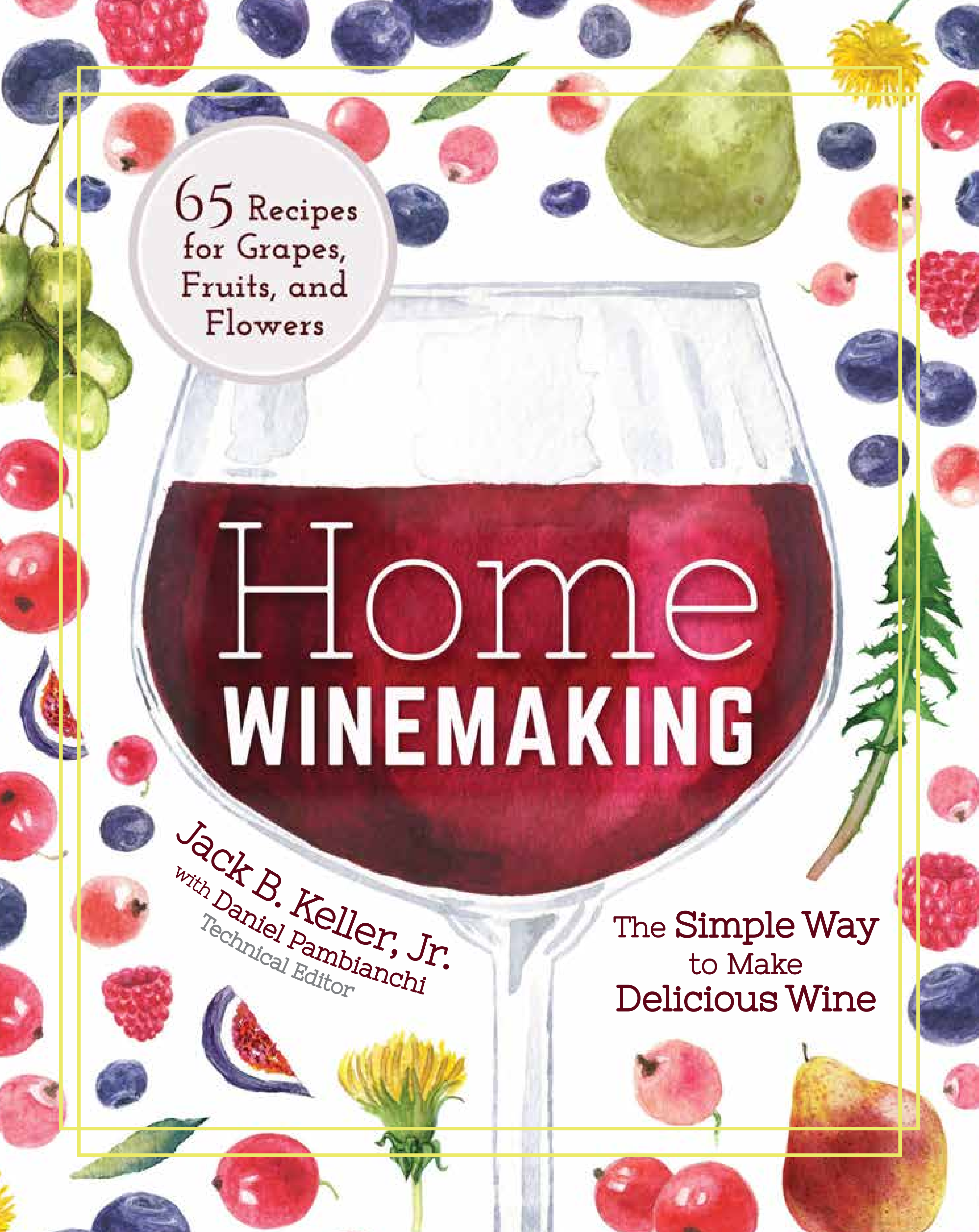

65 Recipes for Grapes, Fruits, and Flowers

Home WINEMAKING

Jack B. Keller, Jr.
with Daniel Pambianchi
Technical Editor

The Simple Way to Make Delicious Wine

Home WINEMAKING

JACK B. KELLER, JR.

with DANIEL PAMBIANCHI,
Technical Editor

Adventure Publications
Cambridge, Minnesota

DEDICATION

This book is dedicated to my wife, Donna, who has put up with years of carboys in every room, suspicious smells from fermenting new ingredients, the fruit press on the kitchen counter when she is trying to prepare meals, clutter from supplies and equipment, and a chest freezer usually full of Ziploc bags of grapes or fruit destined for fermentation that covered up meats and vegetables frozen for consumption. She has also suffered from hundreds of hours of neglect while I tended to my website and blog—hours I can never repay, neglect I can never undo.

It is also dedicated to my stepson Scott, who has tended to me, the house, and the property during very long days and nights when I was glued to the keyboard while writing this book. His contribution was never unnoticed.

Finally, it is dedicated to my late parents, Jack and Rosalie Keller, who left this world too soon to see the fruits of this writing labor but did enjoy years of exotic wines from some of the recipes contained herein. I miss them both terribly.

Jack B. Keller, Jr.
Pleasanton, Texas

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I wish to thank Daniel Pambianchi for agreeing to be technical editor and reviewer for this book. As the saying goes, “If you can swing it, go first class.” Daniel is first class. He not only is a prolific author, his *Techniques in Home Winemaking* is a go-to classic and belongs in every winemaker’s library.

I wish to acknowledge the many years of fellowship with past and present members of the San Antonio Regional Wine Guild. I thank them for all they have taught me and for their forgiveness for the meetings I missed while racing to my deadline and facing medical challenges.

I also wish to acknowledge my wife Donna for her long patience in seeing this work come together and my stepson Scott for attending to my needs as I spent 14–18 hours a day glued to the keyboard for three months straight. Without their support, I doubt the timeline agreed to would have been met.

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INTRODUCTION

Winemaking isn't difficult. The ancient ancestors of the Sumerians made wine 7,000 or possibly 8,000 years ago, so you probably can too. Your wine will be much better than theirs; it likely often was undrinkable stuff that turned into vinegar or smelled horrible, and they tolerated it by adding pine resin or seawater.

Grape wine actually makes itself. The ancient inhabitants of Georgia (circa 8,000 years ago) made large earthenware vessels called *qvevri,* shaped similar to amphora without handles, which they buried in the cool ground for storing grains, nuts, roots, and other edibles. Eventually, someone used one to store grapes, and the weight of the grapes crushed those on the bottom, and the wild yeasts on their skins did what yeasts do: ferment.

When the ancients smelled the odors associated with fermentation, I'm sure they thought storing grapes like this was a bad idea. But, as time passed, the fermentation odors disappeared, replaced by an almost fragrant odor never encountered before. When the vessel was opened, a heady, pleasant-smelling liquid was discovered, and someone tasted it. As more and more was tasted, the participants became intoxicated. Not only did it taste good, but it also made them feel good too.

To these people, the wine was a religious experience—so say their descendants. They've been making the stuff this way ever since—just grapes, no added anything, in *qvevri* buried in the ground. Good batches are reported to be more than just good—some exquisite. We don't hear anything about the bad batches.

This book, on the other hand, will teach you how to make good wine every time, and some of it will be exceptional, some even exquisite.

A Personal Journey

When I was in the second grade, we happened to live about three blocks from my maternal grandparents. One Saturday morning while my father was at work, my mother walked my sister and me to their house. I went out to the garage and found my grandfather making wine from the pears from the tree next to the garage.

He cut up pears then crushed them in a rather large earthenware crock with a length of 4x4 lumber, one end of which was whittled down to resemble the end of a baseball bat. I announced I wanted to help, so he sent me on chores that I realized much later were intended to get me out of his hair while he crushed the chopped up pears. Satisfied, at last, he poured a lot of sugar over them, had me turn on the hose while he filled the crock to a certain level he magically understood and then stirred it with the hand-whittled paddle for what seemed like forever.

I even got to stir it while my grandfather went into the house for a bit. My arms were about to fall off when he returned. He thanked me for my assistance by saying, "This will be our wine—yours and mine." I was thrilled, but never tasted or even saw "our wine" in the coming years. It didn't matter. It existed, and I helped make it.

This was my introduction to winemaking. I didn't understand how the crushed pears, sugar, and water would become wine or how I'd helped, but it was exciting and even a little romantic. As my grandfather worked, he paused now and then to take a sip from a glass of last year's pear wine. He told me, "Never drink your wine until you are making more." Though the math escaped me at the time, he meant that each batch of wine should be at least a year old.

When my grandfather went into the house to clean up, I sneaked a sip from his glass. It was mildly sweet, had a strange effect on my tongue, and didn't taste anything like the pears I knew. I quickly took a second sip. I liked it.

I carried the memories of that experience with me for over 20 years before I returned from my third tour in Vietnam to receive my inheritance from my grandfather, who had passed away during my tour. My inheritance included a cigar box full of wine recipes cut from newspapers, magazines and books, others written out in pencil on pages from various sized note pads, the backs of envelopes, and pieces of cardstock. It is a treasure I still have, although none of the recipes stand up to modern standards without severe modification.

This Book Is for You

Perhaps some of you share similar memories of a grandfather or grandmother, mother, father, uncle, or other family member magically transforming pears, apples, blackberries, figs, elderberries, or rhubarb into wine. If you're like me, you only saw one aspect of the whole process and lacked a vision of the entirety. That's not enough knowledge to make wine. That's why I've written this book for you.

Many of you may have helped friends make wine. The first wine I helped a friend make was a dandelion wine I made with an Army buddy, Bob Keller (no relation). He had the recipe and orchestrated the process. I always seemed to get the job of crushing Campden tablets into powder using a mortar and pestle. We were supposed to age it 15–18 months before sampling, but we were impatient and popped the first cork at about seven months. It was a mistake. We wasted the second bottle at a year—well, we drank it anyway. At almost exactly 18 months, we tasted an excellently transformed wine and became believers of the recommendations tucked away in recipes. This book was actually born in that moment, although I wouldn't think of a book for another four decades. Over time, I learned more about every aspect of winemaking I've encountered, and that knowledge has taken me here.

Perhaps some of you have made or helped make a wine which was disappointing when you sampled it too early or too late. Or perhaps you lacked one of the recipe ingredients and skipped it, thinking the recipe would come out OK anyway, but it didn't. What went wrong? How could one ingredient you'd never heard of spoil your crab apple wine? Well, this book is for you.

Some of you, I know, have made kit wines—wine made from a kit that contains everything you need to make a good wine except water. You know most of the steps to make wine except creating it from scratch—gathering and measuring the additives in the various envelopes that accompanied the kit. You want to expand your knowledge and make blueberry wine all by yourself. This book is for you.

Some of you have been making good wine, even exceptional wine, from scratch, perhaps for years, and are very experienced. You don't really need a beginner's book. But any book written by someone who has made dozens of grand champion or best of show wines might—just might—contain a few insights worth the price of the book. So hopefully this book is for you, too.

You can make wine out of all sorts of things; in fact, when it comes to potential winemaking ingredients, there are no restrictions except this: it must be made from a nontoxic ingredient, and that base ingredient must be fermentable. To illustrate this, I present you with three tales of some perhaps surprising wines.

Bermuda Grass Clippings Wine

At a meeting of a not-so-local wine club I belonged to many years ago, which was comprised mainly of snobs who believed all wines must be from *Vitis vinifera* grapes, preferably red, and that non-grape wines were a travesty, it was my turn to give the "program," meaning I had to talk about something. Had I remembered it was my turn at this meeting, I would have brought in some non-grape wines—perhaps a tomato wine, zucchini wine or an oak leaf wine—to taste, which would have irked the attendees to no end. But I had forgotten, so I just got up and talked.

My theme was, "You can make wine out of anything both nontoxic and fermentable." As examples, I mentioned acorns, dried mushrooms, grapevine prunings, eggplant, parsnips, and anything else I knew would disrupt their sensibilities. My talk was relatively short, with about half of it on how to leach the tannins out of acorns and bamboo roots. After the "presentation," there were no questions.

At the following meeting a month later, one of the members slapped a large paper grocery bag into my chest and said, "Here, ferment this." The top of the bag was folded over and sealed with a dozen or so staples. I set it beside a sofa and ignored it until I left. In my car, I carefully opened the bag and peeked inside. It was filled with about three pounds of Bermuda grass clippings.

Once at home, I wasted no time in bringing three quarts of water to boil in a stockpot while slowly feeding it the grass clippings. I stirred them until they wilted into near-nothingness, reduced the heat, placed a lid on the pot, and went into the living room to watch some TV. An hour later I strained the water into another pot through a colander and a tea towel, set the colander of cooked grass in the sink to cool before discarding and repeated this process with the remainder of the clippings.

When all was said and done I had just under a half gallon of grass clipping-infused water, which I later brought up to a gallon. While the water was still hot, I stirred in my sugar, acid blend, and yeast nutrient. When the water cooled, I tasted it to judge whether to add tannin, which I did—just a pinch. About then I added yeast, stretched a clean towel over the pot, and left it. It took two days to get a nice fermentation, but once started, it took off, finishing just shy of semi-sweet.

I patiently waited for my turn to bring the "mystery wine." The bottle was wrapped in a brown paper bag suitable for wine and sealed just under the rim with masking tape. There would be no peeking. When the tasting time arrived, I poured each member a nice splash and left them to debate it. After discussing the possibilities a while, each member wrote his guess on a slip of paper which I collected and

sorted. I announced that the wine with the most votes was Chenin Blanc, with Chablis taking second place—unusual because the wine tasted like neither.

I then tore off the masking tape and pulled out the bottle with a prominent label reading “Bermuda Grass Clippings Wine.” Watching their faces pleased me to no end. I later entered a bottle of this wine in a local competition and took third place in the “Novelty” category.

Dwarf Nettle Wine

A far-back portion of our property is cursed with dwarf nettles. While not as much of a nuisance as stinging nettles they are nonetheless irritable. One day I had just begun weed-eating them when I noticed that the new growth at the tops lacked the irritable hairs of the older leaves and stems below. I retired the weed-eater and fetched a bucket, gloves, and pruning shears. Within a short time, I had a bucket full of dwarf nettle tops.

In the kitchen, I took my largest stockpot, placed in it a gallon of water, and set that to boil. I slowly fed my nettle tops into the boiling water. Although the bucket was larger than the stockpot and filled with nettle tops, they all managed to wilt. I set the pot to a low boil, placed the top on it, and left it to itself for a little over an hour. The water was drained into another pot, and the colander of cooked nettles was divided—some were chopped and eaten as one would eat cooked spinach and the rest were added to the compost pile. The ones I ate weren’t bad at all, just overcooked.

While the nettle water cooled, I added sugar, acid in the form of one squeezed lemon and two squeezed oranges, grape tannin, and yeast nutrient and stirred until completely dissolved. I also added three very thin slices of ginger, as pure nettle wines tend to lack character. When nearly cooled to room temperature, I sprinkled yeast over the water, placed the lid on the pot and set it aside. The next evening the kitchen began harboring the odors of fermentation.

Eight months later, I entered my last bottle of Dwarf Nettle Wine in the local county fair’s winemaking competition as a novelty wine. It won a Reserve Grand Champion rosette and every drop of it was consumed at the post-competition tasting.

Texas Sandbur Wine

For 11 years, we were blessed to own an English Springer Spaniel named Colita (Coli for short). When we moved to Pleasanton, Texas, we were cursed to have a section of yard overgrown with *Cenchrus echinatus*, the Texas Sandbur. The half-dozen to a dozen sharp spikelets on each seed stem grabbed whatever passed by them. For reasons I never understood, Coli never learned to avoid them.

One day I got home from work to find my wife sitting on the tiled floor next to Coli, using a fork to pull the dozens of spiked seeds from Coli’s long hair. I was immediately sent outside to mow down the sandburs. As I approached the infested area with my mower, I noticed a gentle breeze sending the seed stalks loaded with spikes waving gently to and fro. It was actually beautiful, for in those thousands of burs I saw wine.

Wearing rawhide gloves, I picked the seed stems while the seeds were still green and tossed them into a bucket. When my back ached sufficiently, I went inside and used a fork's tines to strip the spikelets off the stems. When done, I made two more trips outside to "harvest" more burrs. When at last I had a quart of only burrs, I placed them in a 2-quart pot and added two quarts of water. I stirred them occasionally while bringing them to a medium boil, then put on the lid and left them. Twenty to thirty minutes later, I strained them and saved the dark-green water.

I assumed some tannin was present, but no sugar or acids. I developed a recipe from those assumptions. I proceeded as with the previous two wines, only omitting the tannin, and lastly adding more water to make a gallon. The finished wine was neither dry nor sweet, but in between—this is how I preferred my white wines at that time. The color was light straw, with only the very faintest hint that it had once been green. It was nicely flavored but without any noticeable aroma. Despite this deficiency, it won a silver medal in an East Texas wine competition.

A Shared Pattern

From the above tales, it should be obvious that a winemaking pattern is evident. The pattern is there because these wines were made from grass, weeds, and underripe seeds. These require boiling the main ingredient—called the ***base***—to extract whatever sugars, acids, flavors, and other essences that are present. Boiling the base is not a common practice in winemaking, but in the above examples, boiling was the most practical way to proceed.

So how does one know when to boil and when to press, as with grapes? There are several ways to prepare a base for fermentation. Sometimes it is obvious which one to use, and sometimes it isn't. Often there is more than one way, usually dictated by available equipment. I'm sure my grandfather would have preferred to have a crusher to prepare his pears, but he certainly couldn't afford to buy one. His method of crushing the pears worked for him and is the method I used for many years when I started making wine.

In the next chapters, we'll discuss this and many other choices you'll be confronted with when making wine, but at the same time, you have a great deal of latitude to determine how to follow the directions. For example, when a recipe calls for crushing or pressing, I've known folks who sawed off the end of a baseball bat and used the bat as the plunger—much like my grandfather did with his customized piece of 4 x 4 lumber.

Equipment and Supplies

To use this book, you'll need certain equipment that most beginners avoid, but the modest expense is worth it. If you purchase the following items, you will have everything you need to start out, and even to become an intermediate or advanced winemaker.

For one thing, you'll absolutely need a gram scale. When a recipe calls for one (and only one) gram of a certain additive, there just isn't any reliable way to measure it without one. You can buy a digital gram scale for about $10. Get one that can measure at least to one tenth of a gram (0.1 gram).

You'll also need a sulfur dioxide (SO_2) test kit because you'll need to make adjustments to your sulfite additions at the end of each recipe. I cannot predict how much SO_2 will bind with the suspended solids in your wine, so you'll have to measure it. This test kit costs about $20.

The biggest expense will be a pH meter, which should cost around $50, possibly as much as $60. You can use certain litmus test strips to get you in the ballpark of where your pH should be, but they will not be accurate enough for reliability.

If you just can't wait to start a wine while collecting the above instruments, you can take a chance at making a wine with the following:

Basic Gear Checklist

- Hydrometer
- Primary fermenter
- Secondary fermenter (you'll actually need two)
- Airlock
- Siphon hose
- Five wine bottles (screw caps)
- 2 oz. potassium metabisulfite
- 1 oz. tartaric acid
- 2 oz. pectic enzyme
- 1 oz. grape tannin (powder)
- 2 oz. potassium sorbate
- 2 oz. yeast nutrient

Some of the additives will probably only be sold in larger quantities.

Measuring the potassium metabisulfite will be impossible without a gram scale, so you might as well add it to your list. You won't be able to measure acidity, so let your taste buds put you in the ballpark.

Start with Clean, Sanitized Gear

Before you start a batch of wine, make sure you clean, and then sanitize, your gear. These are two distinct steps. As you might expect, cleaning your gear simply involves scrubbing your gear until you can no longer see/feel any soiled materials. There are a variety of cleaning products, such as Easy Clean and One Step, that you can use in this process, and specialized scrub brushes for secondaries can be quite helpful.

After cleaning your gear, you also need to sanitize it before making each batch. This is important. Bacteria, wild yeast, and other contaminants are too small to see and could still be lurking, waiting to ruin your next batch of wine. For that, use Potassium Metabisulfite. It takes two ounces to sanitize a gallon of water. After using the solution, the equipment should not be rinsed; let it drip-dry instead. You'll also need to sanitize any other gear/equipment (primaries, tubing, weights, yarn, etc.) that will come into contact with your wine, for it too can harbor contaminants.

Once your gear is clean, sanitized, and dry, you're ready to make wine.

This Book . . .

In this book, I will try to guide you from fruit to wine as simply as possible, while at the same time letting you know that it requires a certain exactitude.

With that goal in mind, I welcome you to home winemaking.


1

CHAPTER ONE

ESSENTIAL CONCEPTS

This book was written to help you move from start to finish as simply as possible, while respecting you enough to demystify winemaking and make it understandable. Let me explain.

Ages ago, during my bachelor years, a lady I was dating cooked me a wonderful meal. After dessert, I asked her an innocent question about a spice she used in her glazed carrots. I think it was tarragon (which I have added to my glazed carrots ever since). She became very fidgety and suddenly, with quivering lips suggesting she was about to cry (which she did), she said, "I don't know. I just followed the recipe."

I didn't think any less of her, but she may have thought less of herself and was obviously embarrassed. She had followed a recipe and made the dish, yet she could not remember what was in it or why. Fast forward to winemaking.

Understanding the Recipes

You will be making wines according to recipes, but after you read the first few chapters of this book, you will know what you are adding and why. Unless you're making wine from traditional wine grapes, you'll be adding sugar to ensure a certain amount of alcohol by volume, as well as acid and probably tannin to give the wine structure, character and style, pectic enzyme to release the juice and help the breakdown of its pectin, nutrients for the yeast, and sulfites for a host of reasons.

In short, you will not only be following recipes but will know what you are doing along the way. The only thing you may not understand is why the wine is set aside for periods and then racked.

These periods of rest mimic what the author did when making a successful recipe. If a recipe calls for racking a wine to allow it to show clarity, and yours shows clarity sooner than the prescribed time period, you can shorten one of the rest periods without adverse consequence. The recipes are guidelines, not hard-and-fast rules. They are flexible, to a point.

The bulk of the skills you need to become a proficient winemaker are in these first few chapters. And you'll build upon that knowledge in successive chapters. Some of that knowledge is contextual, and some is hands-on, but both are needed.

An Honest Approach

Many books for the beginner are a bit too simple. They list the ingredients, sketch out a method, and hope you can deal with whatever happens along the way. This book differs in that I want you to understand why and when my recipes call for the ingredients/steps that give birth to wine. This, in turn, will help you take pride in your clean, flavorful wines.

Each recipe is written to stand on its own, with all the steps you need, so once you've acclimated yourself to the introductory material, go ahead and jump from a berry wine to a flower wine and then to fruit wine or tropical fruit wine or even a root wine.

You probably will refer back to this chapter until the concepts and language become your own, but these look-backs are expected. Eventually, it will all become routine. When asked to measure some aspect of the wine, we expect the first half-dozen times you'll read instructions for making such a measurement, but in time, with repetition, it will become routine. And when it does, you'll no longer feel like a beginner.

Advanced Concepts

Like anything else, winemaking can involve optional more advanced concepts and techniques which, if executed properly, can improve the final product or completely change the wine type or style. The advanced concepts largely involve organic chemistry, of which I am as much of a fan as I have to be. Generally, they are more scientific, but some are matters of technique. They are not essential to making good or even great wine at home.

To give you a solid introduction, I'll cover basic concepts, as well as advanced ones below; truth to be told, the distinction between the two is often a sometimes blurry line. Fining, for example, is a basic technique, but when addressing certain winemaking problems can be an advanced procedure. Regardless, the essential concepts are addressed below as a lexicon for winemaking. Because of the fine and sometimes blurry lines, certain advanced concepts are also briefly addressed or simply mentioned in passing.

Don't Skip the Text Below, Really

Lexicons are usually arranged alphabetically and can read like a glossary, as you will find below. In navigating it, you will undoubtedly see terms you think you already understand. The temptation to skip them will be natural, but I implore you not to do so. They are listed because they have a direct bearing on how this book is to be interpreted, understood, and followed. The descriptions are as complete as need be for introductory purposes. Some concepts are addressed in later chapters as necessary.

Chapter 1 covers the essential concepts that will build your knowledge base, whether you recognize the terms at first. Reading the lexicon will make the tools, processes and tasks discussed in Chapter 2 much easier to understand. If you want to double-check the meaning of a term, look first in the index or check in Chapter 2.

The Very Basics of Winemaking

If you are new to winemaking it will help you understand the lexicon better if you understand the basics of winemaking itself.

It begins with the selection of the base ingredient the wine will be made from. Whether they be fruit, berries or flowers, they must be fresh, fully developed, and the best of that ingredient you can find. They will be turned into a fermentable form called a must, and it is from this that you will make the wine.

The must is then prepped for fermentation by adjusting its chemistry. Yeast is added and fermentation begins. The wine is transferred from the primary fermenter to a secondary. When fermentation is complete the wine is racked off its lees into another secondary. The wine might be racked at intervals three or even four times, each time becoming clearer.

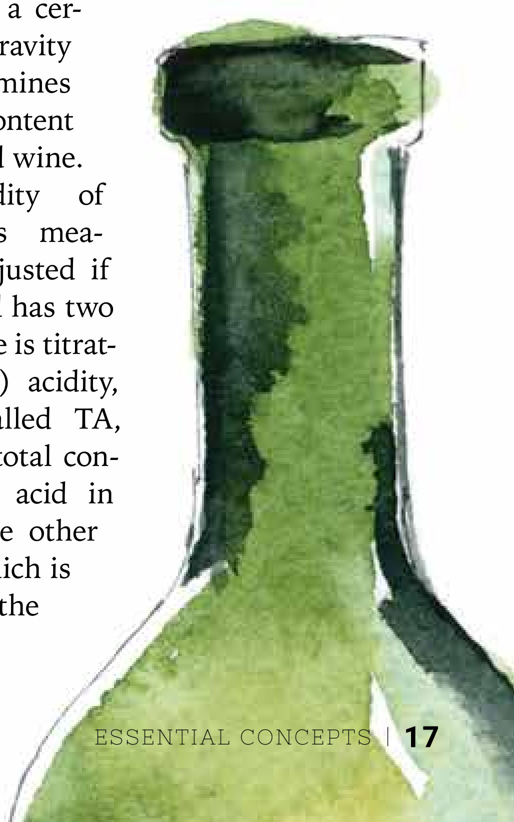
When the wine is clear, it is allowed to rest and maturate (mature) until it is what the winemaker wants. It is then stabilized and bottled. It will then age in the bottles for a specified period before tasting.

Stripped to its essentials, these are the basics of winemaking.

The Basic Chemistry of Winemaking

When we prep the must for fermentation by adjusting its chemistry, do so gently and purposefully. If the must is not at the volume we desire, that is corrected with juice, concentrate, or sweetened water. The wine is brought to a certain specific gravity which determines the alcohol content of the finished wine.

The acidity of the wine is measured and adjusted if required. Acid has two faces. One face is titratable (or total) acidity, commonly called TA, which is the total concentration of acid in the must. The other face is pH, which is a measure of the



strength of the acids present. pH is the inverse of TA, meaning the lower the pH (strength of the acids) the higher the TA (concentration of the acids). Of the two, pH is the more important throughout the winemaking process to the end product, wine. If acid reduction is required, calcium carbonate is added sparingly.

Tannins are polyphenolic compounds that add texture to wines, especially red wines. They contribute to mouthfeel and body. Their bitterness is a balance against the sourness of excessive acidity. White wines naturally have reduced tannins.

Pectin is a water-soluble polysaccharide found in most fruit. It binds the cell walls of the fruit together. It is undesirable as it forms a haze in wines. It is broken down both in the preparation of the must for fermentation and the clarification of the wine with an enzyme called pectinase.

Potassium metabisulfite is a salt of metabisulfite with a pungent odor that is added to both must and wine to achieve an aseptic level of microbiological stability. It plays many roles in winemaking and is an essential compound to understand. Its active ingredient, once it is added to wine, is sulfur dioxide.

With these basics behind us, let's explore the lexicon for winemaking for details.

A Lexicon for Winemaking

Acetic Acid: An organic acid that imparts the sour taste to vinegar; it's formed by the action of bacteria belonging to the genus *Acetobacter*. Some acetic acid, however, is produced by yeast during fermentation.

***Acetobacter*:** The principal bacteria genus, consisting of many species, responsible for converting alcohol into acetic acid—vinegar—in the presence of oxygen.

Acidity: Acid helps balance the wine and gives it structure. It is responsible for freshness, tartness, and crisp taste. If wine has too much acid the wine tastes too tart; if there's too little, it tastes flat or insipid. Acid isn't just necessary for good taste; it also repels harmful microorganisms. Yeast also require some acid in the winemaking process.

Acid performs other vital services; its tartness helps offset a wine's fruity sweetness, and it dampens the burning taste of pure alcohol by making it seem sweeter than it is. Later in the process, acid facilitates chemical changes that help develop the aroma of the base as well as bottle bouquet (see page 21). Acid also helps mature and age the wine. The greater the acidity, the lower the pH, which, in general, helps slow down the rate of oxidation, and stronger acids (lower pH) require less sulfite to stabilize the wine.

Acids in wine usually originate from the acids present in the base and acid added by the winemaker. In grapes, the more important acids include tartaric, malic and some citric acid, although citric is unstable and easily metabolized into other compounds. Malic or citric usually are the dominant acids in fruit, berry and other non-grape base ingredients and are almost always supplemented with acid additions. Finally, some acids, such as lactic, succinic, and acetic are actually created in small amounts by the yeast during fermentation. Some of these may gain importance after the primary fermentation is complete: lactic acid may be welcome while acetic acid (think vinegar) is not.

There are two measures of acidity, TA and pH. TA measures the titratable (or total) acid in the wine, or the concentration of acids, while pH measures the relative strength of those acids; pH is the inverse of TA. The lower the pH, the stronger the acid, and, generally, the higher the TA will be (indicating more acid). It is pH, not TA, that indicates how well a must or wine can combat oxidation and microbial invasion. It also influences how much SO_2 (see page 69) is needed to keep a wine aseptic (free of harmful microorganisms).

Table 1. Probable TA Ranges for Table Wines

WINE TYPE	TA RANGE (g/L)
Sherry	5.0–6.0
Red, Non-Grape	5.0–6.0
White, Non-Grape	5.0–6.5
Red Grape, Dry, Demi-Sec	6.0–7.0
Red Grape, Sweet	6.5–8.0
White Grape, Dry, Demi-Sec	6.5–7.5
White Grape, Sweet	7.0–8.5
Dessert, Sweet	7.5–10.5

Data for Table 1 from Jack Keller's *Winemaking Home Page*, Internet, September 2010

Note: These are "probable" ranges because the actual TA should depend on the acid required to balance the dryness or sweetness of the wine. A TA of 10.0 or higher in non-dessert wines is tolerable if that is what is required to balance the wine.

The pH of wines can vary greatly, but there are some magic numbers to take note of. At the start of fermentation, white wines and rosés should have a pH of 3.1–3.3. A pH below 3.1 will be highly acidic, and the yeast may not respond well to it. Red wines should have a pH of 3.3–3.4. A pH above 3.55 will be at risk of contamination by bacteria and invites faster oxidation. Consider pH 3.41–3.54 a buffer zone, with 3.55 being the barrier you do not wish to cross.

So, how much acid are we talking about? Different wines tolerate different levels of acidity. The numbers are somewhat variable because acid is a key ingredient in a wine's balance, along with sugar, tannin, and alcohol, and many different combinations/proportions of each can result in a balanced wine. But generally, the acid levels shown on Table 1 correspond to those specific types of wine.

Airlock: A device that fits into a ***bung*** and is designed so that air can escape the ***secondary*** but also has a liquid trap that prevents air from entering the secondary fermenter. The liquid is usually water, water mixed with a little glycerol, or water containing 3-10 percent ***sulfur dioxide***, or a spirit such as vodka. When recipes say to "affix an airlock" or words similar in meaning, it means to insert a bung containing an airlock into the mouth of the secondary.

Anthocyanins: In grapes, these are the pigments that contribute the red and purple colors to wines. In most other fruits, they provide bright reds, purples, blues, and indigos.

Antioxidant: Additives such as ascorbic acid and sulfur dioxide which, when added in the right quantities, protect against oxidation, especially when the wine is exposed to the air during processes such as racking, filtering, and bottling.

Base: The base is the primary flavor ingredient, and there may be more than one in a given wine. In home winemaking, the rules behind naming wines follow a certain logic that may not be apparent at first. Apart from water, the first-named ingredient is usually the one with the greatest volume in the recipe. So if you're making a wine with more strawberries than raspberries, it's strawberry-raspberry wine, but there are exceptions and sometimes the ingredient providing the most flavor "names" the wine.

Bases and Naming Wines: When it comes to naming conventions, there are a few others that have been informally adopted to keep in mind.

- **Flower bases** are always named first, even when a second ingredient has the dominant flavor, such as hibiscus-kiwi wine or rose petal-strawberry wine.
- **Herbal and spice** ingredients are always named first, regardless of their volume, such as cinnamon-pineapple wine. Multiple herbal ingredients are usually named by their flavor appearance when the wine is consumed, such as parsley-basil-sage wine.
- **Body-building** ingredients, such as grape concentrate, raisins or sultanas, are usually not named, but since they do influence the flavor somewhat may be named at the discretion of the winemaker. An example might be cactus blossom-sultana wine.
- **Multiple flavors**, such as Concord-blackberry-blueberry wine, typically are blends of two or more finished wines with the forward flavor (the one you taste first) declared first in the name, but multiple flavors could also be two bases, such as blackberries and blueberries, fermented together. When co-fermented, even in 50-50 proportions, one flavor usually dominates the whole and it's the first-named ingredient in the wine's name.
- **Chocolate** is a forward-flavor ingredient that nonetheless traditionally takes a back seat in the wine's name, as in strawberry-chocolate wine.
- **Rhubarb** is a popular base where it grows because it tends to adopt the flavor of whatever other base it ferments with and therefore it also takes a back seat in the name regardless of its volume, as in raspberry-rhubarb wine.

Names can be as specific as the winemaker wants them to be. I once made wine from a wild grape that I couldn't identify with certainty and added to it a noble grape variety I could, but in fairness I named it "Grape-Grape Wine." The judges got a chuckle out of it, but only a second-place chuckle.

Note: The rules aren't "official"; it's just how things are usually done, but feel free to do it another way if it pleases you.

Bottle Sickness: A period following bottling during which the wine seems dull, uninspiring, and possibly unpalatable. This is a temporary condition that usually lasts no longer than a month, and rarely two. Because all wines experience bottle sickness to some degree, never consume a wine immediately after bottling, even if the recipe says you may drink it right away.

Bottle sickness can occur after any period of agitation. Traveling a long distance is a prime example. Another is a short distance where the bottle is laid on its side and free to roll with the turns of a vehicle.

Bottle Aging: Once the wine is stored anaerobically (bottled, without access to oxygen), the wine undergoes reductive aging. In this process, chemical changes occur (including polymerization, esterification, and micro-oxygenation), and these changes are what propel the wine to its apex, and eventually its inevitable decline. During this journey, the wine constantly undergoes chemical changes that may result in a perceived delicate but defined bouquet, subtle but complex flavors, a smoother texture and mouthfeel, and, rarely, a silkiness in taste and finish. Even if the wine doesn't reach such heights, it will still improve in most ways, resulting in a good wine.

Entire chapters have been written on the chemistry of bottle aging, so I'm not going to summarize that here. Let us just say it is real, very dynamic—the same wine cannot be consumed on two consecutive days due to subtle chemical changes—and the process can go very well or very wrong (see ***Wine Storage***).

Bouquet: The complex, vaporous scent(s) released when a cask or bottle is opened, derived from volatile acids, esters, and other aromatic compounds formed during aging. Bouquet may rapidly dissipate or be slowly released if the wine is warmed in your hand and swirled in the glass, but when gone, the wine is left with the fragrance of the fruit or another base from which the wine was made. This fragrance is the aroma of the base ingredient(s).

Bulk Aging (Maturation):
See ***Maturation (Bulk Aging).***

Bung: This is the rubber stopper with a hole in it to accommodate the airlock. Bungs come in various sizes and fit the various sizes of jug mouths. It is best to bring your secondary to a local home brew shop and get the jug fitted with the correct size. A proper fit is one with half the bung in the jug and half out.

Caramelized: The taste and/or odor of caramel is achieved by heating a sweet wine. In non-grape wines, this characteristic is often produced by cooking the fruit to extract the juice, set the color, or extract polyphenolic compounds from the skins. The browning of sugar most often produces this character, which is why recipes say to bring water to boiling, remove from heat, and *then* add sugar. A juice that is steam-extracted will not be caramelized, but steaming may set the pectin, making it very difficult to remove. The perception of some caramel is desired in some wines (e.g. sweet Sherries) but considered a fault in most others.

Chaptalize: To add sugar to a must or juice to increase its alcohol potential. The word is a method named after Frenchman Jean-Antoine Chaptal, who in 1801 accurately calculated the amount of sugar to add to a juice to increase potential alcohol.

Citric Acid: The principal organic acid in citrus and many other fruits. It is a minor acid in grapes. When added to wines, it is always added after fermentation has finished. It should be avoided, if possible, in red wines, as it is converted into undesirable substances during red winemaking. It is used in whites only to push the acidity up a small amount.

Clarify: The process of how a wine becomes clear. This occurs when all of the yeast and microscopic bits of pulp from the base ingredients settle to the bottom of the secondary fermenter, leaving a clear wine without haze. A wine that has clarified entirely and is crystal clear is called brilliant.

Complexity: A wine with multiple layers of bouquet, aromas, flavors, and nuances, all of which are perfectly balanced, harmonious, and delightful.

Decant: To pour clear wine gently from a bottle into a serving container (decanter or carafe) so as not to disturb the bottle sediments and thereby leave them behind. Decant also can mean allowing a wine to "breathe" before one serves it.

Degas: The process of removing dissolved carbon dioxide from a wine to bring it to stillness. Vigorous stirring, either manual or mechanical, or applying a vacuum are the two most common ways of achieving this. When using a vacuum, be very careful. The author once used too much vacuum and, an instant after the wine degassed, the 5-gallon carboy imploded, releasing glass and wine over a wide area. It required two hours to clean up.

Demi-Sec: A French term that means "semi-dry" and indicates a wine that is neither dry nor sweet, but closer to dry than sweet. Although usually reserved for sparkling wines, it is gaining frequent use when describing still wines. Wine is usually perceived as demi-sec when its specific gravity is in the range of 1.000 to 1.003. It is usually Americanized as Semi-Dry.

Diammonium Phosphate (DAP): One of the major ingredients in many yeast nutrients and energizers, serving as their basic source of nitrogen. Also known as DAP. There is much that could be written about DAP and, in commercial winemaking, how its dosage is calculated, but when it comes to home winemaking, we are only going to be adding predetermined, but sufficient, doses.

Earthy: Non-grape wines with an unpleasant odor/taste of damp soil are often described as earthy. Most wines made from roots (beet, carrot, parsnip, rutabagas, turnip) possess an earthy quality that diminishes to neutral over time—usually two years, but possibly more—and should not be served until neutralized by age. In homemade wines, whenever earthiness is perceived, it is a fault, though it may be desirable in some red wines.

Enzyme: Any of the numerous protein molecules produced by living organisms (including yeast) and functioning as catalysts in biochemical reactions. Even though they are derived from living materials, enzymes are not alive. Enzymes emerge intact from the catalytic reactions they produce and are denatured (rendered inactive) by pH extremes and high temperatures. Usually, an enzyme acts only on a specific molecule (substrate), so an enzyme that acts upon pectin will not act upon starch. In winemaking, most of the essential enzymes are produced by yeast, but some are not and must be introduced by the winemaker. Some of the more important enzymes in winemaking are:

- **Amylase:** An enzyme that catalyzes the hydrolysis of starch, producing maltose and dextrin.
- **Cellulase:** Any of several enzymes that catalyze the breakdown of cellulose.
- **Invertase:** An enzyme that catalyzes the hydrolysis of sucrose into an equal mixture of glucose and fructose.
- **Lactase:** An enzyme that catalyzes the breakdown of lactose, resulting in glucose and galactose.
- **Lipase:** Any of a group of enzymes that catalyze the hydrolysis of triglycerides into glycerol and fatty acids.
- **Maltase:** An enzyme that catalyzes the breakdown of maltose to glucose.
- **Pectinase:** An enzyme that catalyzes the breakdown of pectin to pectic acid and methanol.
- **Zymase:** The name given to the group of enzymes that yeast use to transform sugar into alcohol.

Esters: Volatile, aromatic, organic compounds formed during alcoholic fermentation and by the chemical interaction of the wine's alcohol, acids, and other components during maturation.

Ethanol: An alcohol, C2H5OH, produced as the principal alcohol in an alcohol fermentation by yeast. Also, known as ***ethyl alcohol***.

Ethyl Acetate: An ester produced by fermentation. When ethyl acetate exists in sufficient quantity, it produces a slightly sweet, fruity, vinegary smell. Too much is considered a flaw, detectable as a nail polish remover smell and can occur in wines affected by advanced oxidation.

Fermentation Vessels: There are usually two classes of containers in which we conduct fermentation.

Primary fermenters: These are large-mouthed for easy access. They make it easy to add base and other ingredients and manipulate and extract solids from the must when desired. These containers were traditionally glazed earthenware crocks or large stockpots made of enameled metal. They gave way to glass jars, food-grade plastic buckets, and stainless steel pots.

Primaries must be larger—it's recommended they are twice as large—than the amount of must placed in them. This is because any solids in the must will be lifted to the surface by carbon dioxide created by the yeast during fermentation. The lifted material or foam will form a "cap" on the surface that rises above the liquid. Even base material contained in cotton or nylon straining bags will rise and float above the surface. These bags and any cap that forms will need to be "punched down" several times per day until time for removal. These actions prevent the material from drying out and becoming a breeding ground for unwanted microorganisms capable of ruining your wine.

There are many specialized containers made of plastic or stainless steel specifically produced for primary fermentation. Unless you simply like spending money, these are not necessary. Food-grade plastic buckets come in a variety of sizes that will satisfy most home winemakers' needs. In the many years I have been making wine I have never needed more primary space than my assortment of primaries allows. Also, I have never found enough money lying around to spend on what I really don't need.

Secondary fermenters: These are relatively small-mouthed jugs, demijohns or carboys into which the fermenting liquid in the primary is transferred at the appropriate time and in which fermentation will finish under an airlock. The primary is sealed with a rubber or similar elastic material called a bung. A bung is a stopper-like closure with a hole in it to accommodate an airlock. The airlock allows CO_2 produced by the yeast to escape the container while preventing atmospheric gases (especially oxygen) from entering. This moves the yeast from an aerobic environment (the primary) into an anaerobic environment (the secondary).

Plastic secondary containers are much lighter than glass carboys. While I have neither owned nor used any of these products, I see no reason to avoid them except as vessels for maturation beyond 90 days. In the long term, nothing beats glass or stainless steel.

As with primaries, there are many specially designed plastic or stainless steel secondary vessels designed to make the winemaker's job easier. Some claim to combine the jobs of both primary and secondary. They may, but not without considerable work that is not guaranteed to produce safer results than transfer from primary to secondary and then ***racking*** (see page 60) from one secondary to another when needed.

Finish: The final flavor, texture, and impression that remains on the palate after a wine is swallowed. A finish may be brief or long, the longer being preferred as long as it is pleasant. Many off-flavors can spoil a finish. These can range in severity (in competition judging) from a blemish to a deficiency to a fault, while a favorable finish only strengthens the positive score.

Flat: A taste denoting a wine with insufficient total acidity. The taste is truly flat, lifeless, and wholly wrong. Technically, it is the absence of the sour taste. This taste appears in wines with a pH greater than 3.75 and a titratable acidity less than 0.5%. Wine with an opposite fault—too much total acidity—is known as ***acidulous***.

Fructose: This is one of two simple (reducing) fermentable sugars in grapes and other fruit, the other being glucose. Isolated, fructose is approximately twice as sweet as glucose. In wine, a higher fructose concentration will result in a heightened sweetness threshold (i.e. it will be sweeter).

Gassy: A wine with carbonation, usually produced by a secondary fermentation in the bottle, but sometimes also unexpectedly and unintentionally produced by malolactic (bacterial) or alcohol (yeast) fermentation.

Geranium: A fault caused by sorbic acid degradation, usually the addition of potassium sorbate to a wine that has undergone malolactic fermentation. This scent is characterized by the odor of geraniums, which is produced by 2-ethoxy-hexa-3,5-diene.

Glucose: One of two simple fermentable sugars in grapes and other fruit, the other being fructose. Glucose is approximately half as sweet as fructose.

Glycerol: A colorless, odorless, slightly sweet, syrupy substance produced naturally during fermentation that gives the palate an impression of smoothness in a wine. Also known as ***glycerin***.

Gross Lees: Theses are loose sediments containing a large quantity of fine pulp from the fruit or other base materials from which the wine is made as well as dead yeast cells. The gross lees precipitate, but do not compact well on their own and therefore are loosely layered in the wine. Gross lees can be compacted somewhat by adding gelatin to the wine, or they can be coarsely filtered or, in commercial winemaking, centrifuged to recover much of the wine trapped within them.

Herbaceous: An odor suggestive of herbs or broken green stems of plants. It is a positive characteristic if just suggestive of the base and not too pronounced, but a fault if it's excessive or stems from spoilage.

Hot Wine: A wine with excessive alcohol that creates a burning, prickly sensation in the mouth.

Hydrogen Sulfide: H_2S for short, hydrogen sulfide is produced in all wines when yeast metabolizes various forms of sulfur. In excess, it creates an undesirable, rotten-egg-like smell in wine. If not corrected, the wine will be ruined, as the gas will transform into mercaptan with skunky odors, and eventually disulfides, with sewage-like smells.

Hydrolysis: The cleavage of a chemical compound via reaction with water, such as the dissociation of a dissolved salt or the catalytic conversion of starch to glucose. Also, the breaking down of a chemical compound into two or more simpler compounds via a reaction with water. Some proteins and complex carbohydrates in wine are broken down by hydrolysis that is catalyzed by enzymes that were added to the must or created by the yeast.

Hydrolyze: To undergo hydrolysis, or to break up by reacting with water (see ***hydrolysis***).

Hydrometer: Although a simple instrument for measuring the amount of sugars dissolved in a must or wine through the measurement of ***specific gravity (SG)***, it is *the* essential instrument in winemaking. See pages 31 and 55.

Inoculate: To add an active, selected culture of yeast or malolactic bacteria to a must, juice or an unfinished wine.

Lees: Just about (not quite, but just about) anything that precipitates from the wine before it is consumed can be called lees.

Technically, lees are suspended solids from the winemaking process and include particles of ingredients, dead yeast cells, precipitated proteins and tannins, and MLF culture.

- **Gross Lees:** Larger particles form the bulk of what is called the gross lees. These lees are thicker and looser than fine lees and contain more wine interspersed that could be lost when racking if the lees are discarded. Many winemakers rack down to the gross lees, then rack the gross lees into a container to be compacted so the contained wine can be recovered. That is one way to recover otherwise lost wine. Another is to fine the wine with gelatin before racking to compact the gross lees *in situ*. This, too, recovers the wine from the lees.
- **Fine Lees:** When the yeasts begin their die-off, they fall to the bottom and form a thin layer of very fine lees. These lees are well compacted and contain very little wine to be lost.

There is another use for the fine lees if you are going to be around for at least three months after your scheduled racking. Inspect the lees. If fine lees are depositing on top of the gross lees, rack immediately and allow a clean deposit of fine lees. Then leave the wine on the fine lees (a process called *sur lie*—pronounced sur lee—French, meaning leave on lees) and stir them thoroughly every week or so for at least three months. This process is called *bậtonnage*—pronounced *bah-toe-nawge*—French, meaning stir into the wine. *Bậtonnage* is usually conducted for a year, but some effect can be noted after three months, but a year is far better.

The effects of *sur lie* and *bậtonnage* are pronounced after a year. These include: enhanced flavors and complex aromas; reduced astringency; increased roundness, volume and length to the palate; and a host of other benefits.

These positive effects occur because of the complex chemistry involved in yeast cell autolysis (decay). When yeasts die and decay their cell walls start to break down and release a whole host of beneficial substances into the wine. As the yeast is dead, there's no life left in the cell walls to fend off these attacks. Think of it as a slow, chemical dismantling.

Malic Acid: The dominant organic acid in young grapes, which slowly diminishes as the grapes ripen; malic acid is considered the sharpest-tasting of the acids in grapes. It also is the dominant acid in many fruit and berries such as apples and blackberries. 0.9 g/L (3.4 g/gal.) will raise the acidity of a must or wine by 1%.

Maturation (Bulk Aging): The period in between when fermentation, both primary and secondary, ends and the wine is finished and ready for bottling is called maturation. In reality, this phase should be thought of as oxidative maturation, for it occurs within the conditions in which exposure to O_2 exists. During this time the wine might be fined, could be undergoing *sur lie* and *bậtonnage*, might be oaked, or could simply be sitting unpampered by itself. Along the way, it loses its yeasty and spritzy characters and begins an odyssey of change.

To appreciate maturation, think of it as a journey of chemical evolution. When fermentation ends, the wine is raw. It has all the building blocks required for its type and style, but those blocks, as well as the components that make up each of them, do not blend well yet. And so their chemical components begin to react to and with each other, interacting, combining, and changing until an approximate equilibrium of mostly new compounds is attained. It is at this point, or as close to it as the winemaker can estimate, that oxidative maturation ends.

Several esters are produced during fermentation and these produce the fresh, fruity character of young wines, especially white wines and some reds. The chemical compounds produced that are responsible for these esters continue to evolve during maturation. Some become more obvious, some less, and some are preparing for an appearance later in the future. The aromas donated by the base, and the developing, but still embryonic, bouquet are not static.


A hydrometer

Concurrently, maturation (and aging) can affect the wine's acidity, presenting small but perceptible losses. Esterification of acids removes components (carboxyl groups) intricately related to the sour sensation. The instability of tartrates in wine results in deacidification. The polymerization of tannins and their subunits with themselves, proteins, pigments (anthocyanins), peptides, and sugars (polysaccharides), especially in red wines, is responsible for the most perceptible changes during maturation—assuming the wine wasn't allowed early oxidation. Within weeks, an increase in astringency may be perceived in the wine; this results from a greater astringency in medium-size tannins, predominately from oak, as opposed to fewer large-size tannins. However, the relentless binding of tannins with other components results in further reductions in bitterness and astringency. This process (called glycosylation) does two things. It further lessens the astringency of the tannins while eventually slightly increasing the perceived sweetness of the wine. Along the way, the wine loses some of its fresh fruitiness. After bottling, it will lose much of the rest.

What happens in the bottle will probably remain a mystery, but the wine will deliver hints when consumed. Depending on the type and rate of oxygenation, the underlying taste and aroma components of the base will undergo changes consistent with their chemistry, revealing glimpses of the recent past. When consumed, the wine will release a bouquet while eventually slightly increasing the perceived sweetness of the wine. Along the way, the wine loses some of its fresh fruitiness. After bottling, it will lose much of the rest.

When consumed, the wine will release a bouquet of previously non-existent esters and new aromas constructed on its journey. Aromas are dictated by the base.

Bouquet is dictated by the entirety of the process. See ***Bulk Aging (Maturation).***

Must: Must is the base prepared for and during initial primary fermentation. Except for recipes where a base is prepared by boiling and straining, bases are usually chopped, crushed, mashed, or otherwise rendered to juice that will make the wine. In this condition, it is added to a ***primary*** container with water and other additives, and then it is called a must. For country wines (i.e., wines not made from traditional wine grapes), the must typically contains the prepared base, water, perhaps a body-enhancer, added sugar, acid, sulfites, pectic enzyme, yeast nutrient, and yeast.

The undissolved solids in the must eventually have to be removed so the remaining liquid can be further fermented and then clarified for bottling. For the home winemaker, straining or containing the pulp are the most common and practical practices. Filtering a wine is a step reserved for polishing a clear or nearly clear wine, not for straining visibly suspended solids. Attempting this will burn out your filter's pump.

Straining catches larger pulp for further processing or disposal. Certain fruit or berries tend to disintegrate during fermentation, so straining such materials is not an option, but containing them is easy. Traditional methods of containment include cotton bags, cotton mesh bags like those used by painters, or nylon mesh straining bags designed for this purpose. Nylon stockings also have a place in winemaking. The bags are tied closed and contain the solids for easy eventual removal from the liquid.


Must in a primary fermenter

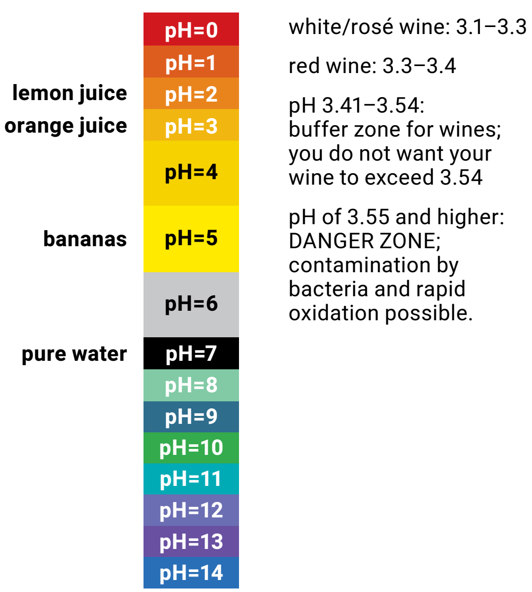
Nose: The smell of a wine, combining both its aroma and bouquet, thereby revealing the character of the base from which it was made and the character of its maturation.

Off: An unexpected, indistinct, slightly offensive odor or taste in wine, which is considered a minor fault.

Oxidation: The process of reaction between many molecular components of wine with oxygen, resulting eventually in a darkening (browning) of the wine and the development of undesirable odors and flavors.

Pectin: A water-soluble carbohydrate (polysaccharide) that binds cell walls together, especially in ripe fruit; it can ruin a wine by causing an unsightly haze or, in severe cases, a gelatinous mass to form. Luckily, the enzyme pectinase can break down pectin molecules and prevent them from causing any haze.

pH: A chemical shorthand for [p]otential of [H]ydrogen, used to express relative acidity or alkalinity in solution, in terms of strength rather than amount, on a logarithmic scale. A pH of 7 is neutral; above 7 increases in alkalinity and below 7 increases in acidity. Because the scale is logarithmic, a pH of 3 is ten times more acidic than a pH of 4, but a pH of 2 is 100 times more acidic than a pH of 4. (See ***Acidity.***)



Pomace: The residue of pressed pulp, skins, and pips of apples, grapes, or any fruit after pressing. When pressed under great pressure, a pomace cake or brick results. Pomace from appropriate fruit can be ameliorated with sugar, water, and yeast nutrients (possibly acid and tannin will also be required) and a second wine can be made. The pomace provides enough flavor for a reduced volume of wine and should contain enough viable yeast (assuming the pulp was pressed after an initial period of fermentation) to continue fermentation.

Potassium Bitartrate: A salt of potassium and tartaric acid which can precipitate out of wine as crystals under chilled conditions. Cold processing white, rosé, and overly acidic red wines is aimed at precipitating this salt, after which the wine is racked cold off the crystals to prevent them from dissolving into the wine as it warms and then precipitating in the bottle.

Potential Alcohol: The potential amount of alcohol that can be expected from a given must based on its measured specific gravity. (See ***Specific Gravity***.)

Residual Sugar: The amount of sugar, both fermentable and unfermentable, left in a wine after fermentation is complete or permanently halted by stabilization.

Fermentation is complete when either all the fermentable sugar has been converted by the yeast into alcohol and carbon dioxide as byproducts or when the concentration of alcohol produced reaches a level that is toxic to the yeast, and they die. Fermentation is permanently halted by stabilization through several means involving intervention by the winemaker.

Sachet: A paper, foil, mylar, or plastic packet of dehydrated, freeze-dried, dried, or active dried yeast. A sachet typically holds 5 grams of product, although 8-gram sachets are becoming common.

Sauerkraut: An odor in wines, attributed to lactic acid, that have undergone excessive malolactic fermentation. This fault is most often found in wines made from malic-dominate bases (such as blackberry) which undergo unchecked malolactic fermentation.

Sec: French for dry. A wine becomes dry when all or most of the sugar within it has been converted through fermentation into alcohol and carbon dioxide. Wine is usually perceived as dry when residual sugar is at or below a specific gravity of 0.995.

Second Wine: A wine made from the pomace or strained pulp obtained from making the first wine is a second wine. A second wine will require that the pomace or pulp be ameliorated with water, sugar, yeast nutrients, and possibly acid and tannin, but usually not a pectic enzyme. Sulfites, however, should be introduced at once to achieve a free SO_2 of 45–55 ppm. A second wine cannot usually be made in the same volume as the original wine from which the pomace or pulp was obtained, but a volume of ⅓ to ⅔ the original is usually attainable.

Semi-dry: (See ***Demi-sec***.) The term denoting a wine as neither dry nor sweet, but closer to dry than sweet. Although usually reserved for sparkling wines, it is gaining frequent use describing still wines. Wine is usually perceived as semi-dry when its specific gravity is in the range of 1.000 to 1.003. The French call such wine **demi-sec**, which has been bastardized into the half-English, half-French term semi-sec.

Semi-Sec: See ***Demi-Sec*** and ***Semi-dry.***

Semi-Sweet: The term denoting a wine as neither dry nor sweet, but closer to sweet than dry. Although usually reserved for sparkling wines, it is gaining frequent use describing still wines. Wine is usually perceived as semi-sweet when its specific gravity is in the range of 1.004 to 1.007. The French term for this type of wine is *demi-doux*.

Silky: An incredibly smooth, lush, and finely textured wine. The French term is *soyeux*.

Skunky: A severe off-odor caused by mercaptan formation. See ***Hydrogen Sulfide.***

Sourness: A tart taste in wines, associated with acids, is perceived as sour. The degree of sourness in acid is a function of the pH of the wine and its titratable acidity. In technical terms, it is the hydrogen ion (actually, the hydronium ion) that stimulates the sour taste on the taste buds. The order of decreasing sourness of the primary organic acids in wine is tartaric, malic, citric, lactic, and succinic. Wines with a pH less than 3.1

or a titratable acidity more than 0.9% will taste sour unless balanced with an appropriate amount of residual sugar.

Specific Gravity: In winemaking, specific gravity (SG) is the ratio of any liquid's density to the density of pure water at a given temperature, with pure water having an SG of 1.000 at a tested temperature. Specific gravity is very important in winemaking because we start with a must whose liquid is heavier than water (i.e., whose SG is higher than 1.000) and ferment it until its SG is near or below 1.000. This reduction in SG is caused by the fermentation of sugars (which are heavier than water) into ethanol (with a SG of 0.789, considerably lighter than water).

A completely dry wine, with no residual (unfermented) sugar, very rarely will have a density below 0.990.

A finished wine with an SG higher than 1.000 (for example, 1.008) will contain some residual sugar and be perceptibly sweet, while finished wines with an SG lower than 1.000 (for example 0.996) are perceived as slightly to very dry. It is essential to measure a must's SG with a hydrometer before yeast is introduced to know the must's potential alcohol (PA) and again when fermentation is finished to know the wine's true alcohol as a percentage of volume, which is also known as percent alcohol by volume (ABV).

Measuring specific gravity with a hydrometer

Today's hydrometers also display the results in degrees Brix, another unit of measure of a liquid's sugar content and preferred by many. One degree Brix equals one percent of sugar by weight. A ***refractometer*** is another instrument that measures Brix. I have both instruments and use the refractometer to measure the Brix of a grape or fruit or berry in the field but use the hydrometer in the winemaking processes (from preparing the must and into the bottling process). My references in this book will be SG, not Brix.

Stuck Fermentation: A fermentation that has started but then stops before converting all fermentable sugar into alcohol and carbon dioxide or before reaching the toxicity level of the particular yeast strain(s) involved. A stuck fermentation is usually due to an imbalance in the ingredients or to temperature extremes unacceptable to the yeast.

Sucrose: A natural, crystalline disaccharide found in grapes, most fruit, and many plants. This is the type of refined sugar obtained from sugar cane, sugar beets and other sources which, when added to a must or juice to make up for deficiencies in natural sugar, must be hydrolyzed (inverted) into ***fructose*** and ***sucrose*** by acids and enzymes in the yeast before it can be used as fuel for fermentation. The winemaker can invert the sugar before adding to the must to save the yeast some work.

Sulfur Dioxide: Appropriate amounts of sulfur dioxide (SO_2) are used in winemaking for their antioxidant, antimicrobial, and preservative properties, but SO_2 also possesses additional benefits. It inhibits the activity of wild yeast strains so desired strains have time to dominate the fermentation, it slows browning initially and during aging and, if a ***malolactic fermentation (MLF)*** is desired later (or not at all), SO_2 will delay or stop it from occurring, depending on the SO_2 level maintained.

It is helpful to think of SO_2 as an antimicrobial, an antioxidant, and as a preservative during different phases of winemaking, while never forgetting the other benefits that overlap. Very early, SO_2 is introduced primarily for its antimicrobial benefits, to kill unwanted microbes and stun unwanted wild yeast affixed to the base. During this phase, we want oxygen (O_2) in our must because the wine yeast strain we introduce needs O_2 to propagate. But once the yeast saturates the must we deny it O_2, forcing it to make alcohol instead of more yeast. Here, the antioxidant benefits of SO_2 are appreciated. Finally, during maturation and bottling, we rely upon the preservative properties of SO_2 to make our wine last more than a year. But the other roles are always there.

Adding and maintaining an aseptic level of SO_2 is rather complicated. It involves adding a sulfite salt which dissociates into molecular SO_2 (for protection against microbial spoilage) and bisulfite (for protection against chemical oxidation), each in amounts dependent upon the must's or wine's pH, temperature, and to a lesser degree its alcoholic content. Here, however, we will try to simplify the concepts so you will understand how to add and maintain an aseptic level of SO_2.

SO_2 is usually introduced through the addition of ***Campden tablets*** or sulfite salts of potassium (e.g., ***potassium metabisulfite***) or sodium (e.g., sodium bisulfite), although we will not discuss sodium bisulfite here. The appropriate amount to use under controlled conditions is determined by several factors, including the amount of free SO_2 already in the must or wine, the amount desired after the addition, and the wine's pH.

There are some numbers that operate behind the scene during calculations. Except for the first one, you probably won't be aware of them directly, but you need to know they are there.

- Only 57.6% of the sulfite will dissociate and become free to bind with constituents of the must or wine now and in the future. This is a fact. You can't change it.
- 93 to 99% of the amount of sulfite dissociated is ionized bisulfite (HSO_3^-).
- 0.7 to 7% of the amount of sulfite dissociated is molecular SO_2.
- The sum of bisulfite and molecular SO_2 concentrations is referred to as free SO_2.

Both HSO_3^- and SO_2 play important roles in ensuring the health of a must or wine, but it is the molecular SO_2 that is of key importance for our wine. Each is delivered in dose amounts primarily dictated by how much free SO_2 is already present in the wine, the wine's pH, and how much free SO_2 is needed. That last one is tricky. Because only 57.6% of the sulfite will dissociate, and because some of what dissociates will become bound fairly rapidly, one needs to add more than what is merely needed. The 57.6% is built into the calculations in this book (Chapter 2), but the rest is up to you. Every winemaker adopts a strategy that makes him or her comfortable. Personally, I like to build up sulfite level 25% above what is needed as a fudge factor. But with successive additions of sulfite, the fudge factor can be reduced. The things that bind with SO_2 will largely have already been bound by the time we stabilize, until we back sweeten.

Adding SO_2 to your wine will be covered in Chapter 2 but it is worth noting that in the recipes in this book the compound SO_2 refers to all three forms combined.

Sultana: A small, pale golden-green grape originating in Smyrna, Turkey. It is the most widely planted variety in California, where it goes by the name of Thompson Seedless. It is the common "white" or "golden" raisin sold in America.

Sweetness: We all recognize this taste sensation most commonly associated with wines with residual sugars (glucose and fructose), glycerol, ethanol, and 2,3-butanediol (the latter in trace amounts). While the threshold for detecting sweetness (as sugars) is about 1% by volume, the threshold for classifying a wine as sweet is commonly 2% by volume (specific gravity of 1.008) for a wine with 12% alcohol by volume. Sweetness does appear to soften some flavor components and blend with others to enhance their recognition. A wine with poor fruit flavor as a dry wine may possess more recognizable fruitiness when sweetened.

Tannin: Tannins are found in the leaves, stems, skins, and seeds of most fruit and berries. Tannins are polyphenolic compounds with an affinity for binding to and precipitating proteins. If there were just one tannin compound, it would be considerably less difficult to characterize it, but there are several, if not many. And this is just counting the tannins in the plant parts being made into wine. If one adds oak (chips or extract) to the wine, then there are many more.

Once tannins are incorporated into the must and subjected to fermentation, the chemistry gets very complicated. While you don't need to delve into all those details, there are few things to understand.

Tannin compounds not only bind to proteins but also to each other and many other constituents of wine. Tannin compounds can both break apart into subunits, which also bind to things and can link together and to other constituents to form "long chains" which are heavier and more susceptible to precipitation than a tannin molecule bound to a single protein.

Tannins contribute to mouthfeel through astringency and bitterness. It is thought that tannins bind with proteins in saliva and precipitate them out, leaving a feeling of astringency. Astringency is characterized by a feeling of dryness and friction within the mouth. In its extreme, it is often described as the cheeks being drawn inward and the tongue being lifted. These are physical feelings rather than elements of taste, but the fact is that astringency contributes to mouthfeel in notable ways. A Cabernet Sauvignon with heavy tannins is described as both heavy in the mouth and chewable.

Tartaric Acid: The strongest organic acid in grapes. It is considered the best acid for raising the acidity in an acid-deficient must or wine. 1 g/L (3.8 g/gal.) will raise acidity 1%.

Texture: The impression on the palate delivered by dense, intense, and full-bodied wines.

Thin: A wine lacking body. A wine with a viscosity approximately the same as water.

Titratable Acidity: Also called TA and sometimes total acidity, titratable acidity is the sum of the fixed and volatile acids present in a wine. This is determined by a chemical process called titration. The titratable acidity is usually expressed in terms of tartaric acid, even though the other acids are also measured. Titratable acidity is expressed either as a percentage or as grams per liter. For example, 0.7% TA is the same as 7 grams per liter (or 7 g/L) TA.

Ullage: See ***Bottling***.

Unctuous: The thick, often unpleasant, almost syrupy texture of too-sweet wine.

Vinegar: "Sour wine," caused by vinegar-producing bacteria, most notably *Acetobacter*. These bacteria are usually airborne but also carried by the so-called vinegar fly (also known as the fruit fly).

Volatile Acidity: Also known as VA, volatile acidity is the acidity produced by volatile acids as opposed to fixed acids. Fixed (non-volatile) acids are those occurring naturally in the grape or fruit base, those added by the vintner, and those non-volatile acids created during fermentation which are stable-fixed. Volatile acids are those created during fermentation or reduction processes (aging) and they are unstable, or those created during spoilage by *Acetobacter*. They can be altered through further reduction or they can evaporate from the wine altogether. Acetic acid and butyric acid are the two most notable volatile acids in wine. In small amounts, VA contributes to a wine's ***bouquet***, which is transitory, but if VA is too intense, it will spoil the wine.

Wild Yeast: Any mixture of the thousands of yeast strains that may be airborne or found naturally on fruit; wild yeast does not refer to the cultured wine yeast deliberately added to a must. Grapes, fruit and the air often contain spoilage bacteria, molds or yeast which can destroy a wine's quality, but if no spoilage yeast or

Wild yeast on Oregon grape berries

bacteria are present in the must during the fermentation process, wild yeast can produce an acceptable wine. Due to the risk from spoilage organisms, prudent winemakers treat their must with an aseptic dose of sulfite to kill non-yeast organisms, stun wild yeasts into temporary inactivity, and thereby allow their own choice of cultured yeast to dominate the fermentation. Also, see ***Yeast.***

Wine Cellaring (storage): Wine aged at 80 degrees F. will age quickly and decline before the damage is noticed. Cork closures cellared in dry climates will dry out, permitting oxygen to enter the bottle; the wine will oxidize quickly and probably leak all over the place.

Wine racks displayed in open rooms will suffer premature browning from exposure to sunlight and possibly fluorescent lighting.

The miracle that happens inside the bottle is of no consequence if the wine is abused during aging. Home winemakers may not be able to achieve ideal cellar temperatures or humidity; however, there are still many ways to protect the wine.

If wine racks cannot be located in dark, semi-humid areas with stable temperatures, wine can still be stored fairly safely. Empty cardboard wine cases can usually be obtained from wine and liquor stores. Wine can safely be stored in these with corked bottles inserted upside down. If the box has no closure, any cover that will protect the wine from light will do: cardboard, folded newspaper, old towels, etc.

The cases can then be stored in any area with a fairly stable temperature. This kind of "cellar" may not live up to the image portrayed in movies of the 2,000-bottle wine cellar with floor-to-ceiling wine racks, but it is practical if a suitable basement, cellar, walk-in closet, under-stairs storage, or other areas simply do not exist. Avoid using a laundry room if possible due to excessive vibrations from the washing machine, and it should go without saying that the garage is probably the worst location of all.

More than one winemaker has laid his bottles horizontally under the bed, and that is a fairly safe location.

Wine Stabilizer: ***Potassium sorbate***, sold by the brand name "Sorbistat K," which produces sorbic acid when added to the wine. When active fermentation has ceased, and the wine is racked the final time after clearing, ½ teaspoon added to 1 gallon of wine will prevent future fermentation. ***Sodium benzoate***, sold as "Stabilizing Tablets," is another type of fermentation inhibitor. These are primarily used with sweet wines and sparkling wines, but may be added to table wines which exhibit difficulty in maintaining clarity after fining or are sweetened to some degree. For sweet wines, the final sugar syrup and stabilizer may be added at the same time. Also, see ***Potassium Sorbate*** and ***Sodium Benzoate.***

Wine Yeast: Yeast cultured especially for winemaking, with such desirable attributes as high alcohol tolerance, firmer sediment formation, and less flavor fluctuation. Wine yeasts are usually obtained from a winemaking/brewing specialty shop or by mail order. See entries for ***Yeast*** on starting a culture before adding to a must.

Winemaking Environment: The winemaker must provide a near-constant environment favorable to ***fermentation*** and ***maturation***. Here we are talking about maintaining the temperature, humidity, and light requirements most favorable to the healthy biological and chemical progression required to make wine. Ideally, temperature should not exceed 70 degrees F., humidity should be maintained between 55 and 70 percent, and exposure to filtered sunlight and fluorescent lighting should be zero. For most home winemakers, these are impractical, if not impossible, goals. But we do the best we can.

Wine-laden carboys should be stored in basements, closets, specialty built cabinets, or dedicated rooms where lighting can be mitigated. In the absence of these options, we cover them with cloth, opaque plastic (black trash bags are ideal light blockers), mylar, cardboard, or you can just stick them in dark corners and hope for the best. Be sure to store wine in an insulated, temperature controlled-room, as this will limit the changes from day to night. For most of us, we don't have much control over humidity, but it can be moderated by a home cooling system. Air conditioning removes humidity, but it also removes heat.

If you cannot meet all of these requirements, don't be discouraged. The author cannot meet them either and has made award-winning wines for decades. Indeed, the overwhelming majority of all people who make wine at home, including those in the tropics, deserts and far north, cannot meet them, and they do just fine. The environmental goals are just ideals for which we aim.

Wood Aging: This is the process of maturing wine in barrels or casks before bottling. This process allows young wines to soften and absorb some of the wood's flavors and tannins and allows the wine's flavors to become concentrated through slight evaporation through the wood. White oak is the overwhelming wood of choice for wood aging, although mesquite, hickory, pecan, apple, orange, and cherry wood can also contribute unique qualities to wines aged with their chips or shavings. The taste a wood tends to impart in wine reflects the wood's smell. Also, see ***Oaking***.

Woody: A wine fault denoting too much (too long) contact with wood, usually oak.

Yeast: Single-cell microorganisms (they are fungi, actually) characterized by asexual reproduction by budding, and in the process synthesize carbohydrates (saccharides) into energy, carbon dioxide, and alcohol. Yeast have been used for thousands of years to make bread and alcoholic beverages. While over 1,500 species of yeast have been identified, almost all wine is made using the species *Saccharomyces cerevisiae*.

- **Wild Yeast:** *Saccharomyces cerevisiae* is a yeast species found naturally on grapes and other fruit, but so are many other genera and species that exhibit less than desirable traits. Many strains of *S. cerevisiae* have been isolated that exhibit traits favorable to making wine. Since we are unable to separate the desirable yeasts from the undesirable, treat all wild yeasts the same: expose them to a dose of SO_2 calculated to render them dormant for a while, during which we introduce a selected culture of yeast proven to be tolerant of SO_2. By the time that the dormant wild yeast decide the environment is favorable to them, the inoculated culture has already dominated the must to the point where the wild yeast cannot survive, they are literally crowded out and starved of O_2.

- **Wine Yeast:** There are dozens of cultured wine yeasts, each isolated and selected for specific traits favorable to the process of winemaking or to the wine itself. Some are more tolerant to SO_2 than most, others are more alcohol tolerant, while others produce more precursors for fruity or floral esters. Some are recommended for red wines, others for white.

Selecting an appropriate yeast strain is but one of the chores some winemakers agonize over, while others select an all-purpose strain and stick with it batch after batch after batch. Over time, most amateur winemakers keep 2–4 specific strains in their refrigerator, proven tools for almost any challenge. At one time, I had 29 strains I evaluated for efficacy across many varieties of base ingredients. Today I keep seven or eight strains that I know will produce most styles of wine I choose to make from just about anything I chose to turn into wine.

One responsibility of the winemaker is to know just what a particular yeast needs in terms of nitrogen, other nutrients, and temperature needs. I have troubleshooted many batches of wine that have just given up before completing fermentation. Too many times, the fault was selecting a yeast strain that could not handle the amount of sugar in the must or using a yeast strain with high nitrogen needs and then not providing enough nitrogen.

Yeast Energizer: There are many proprietary blends of DAP, magnesium sulfate, yeast hulls, and vitamin B complex that are used to energize yeast activity from start to finish, and also to supplement mead, berry, herb, spice, and vegetable wines.

For other wines, if you use both types of nutrients, you should not encounter a stuck or sluggish fermentation. A stuck fermentation is one where yeast activity never adequately starts or stops before fermentation is complete. A sluggish fermentation is one where yeast activity slows and might become stuck. While there are several other reasons a fermentation could become stuck or sluggish, inadequate nutrition is the number one cause. If you do encounter either one, a yeast energizer should solve the problem.

Yeast energizer contains multiple sources of nitrogen as well as yeast hulls and vitamin B complex. It should not be confused with complete yeast nutrient. However, there are products, Super-Ferment is an example, that combine yeast nutrient with yeast energizer. Generally, such products are best used with mead, herb, spice and vegetable wines, but are useful with other bases as well.

Yeast Nutrient: In most musts, the chosen yeast requires more nutrients than is found naturally in the original materials used to make the wine. The exceptions are specific wine grapes that are grown in the right vineyard, with the right climate, in the right year and married to a specific wine yeast suited for just one wine style. Assume a lug of these exceptional grapes fell into your lap. You would need a wine laboratory to determine the exceptional quality of the grapes and recommend the correct yeast to produce the wine style you desire. Assume, as a beginner, that all musts require yeast nutrients.

Yeast nutrients come in two forms, generic yeast nutrient, and complete yeast nutrient. You may need both.

Yeast Starter: The winemaker has the awesome responsibility of getting the yeast started. There are several ways of doing this. You can sprinkle it on the top and wait a couple of days to see if it is just a slow starter or it simply isn't starting at all. You can sprinkle it on the top and stir it in and suffer the same agony. Or you can make a yeast starter solution and know within three or four hours whether it's going to start or not.

You might well be wondering why not assume it's going to start: why all this worry? There are two reasons it might not start. First, it might be too old. Yeast packets and jars bear a "best used by" date of two years from the packaging date. I've been in stores that have some wine-making supplies tucked away in a corner and found yeast packets eight years and more past their best used by dates.

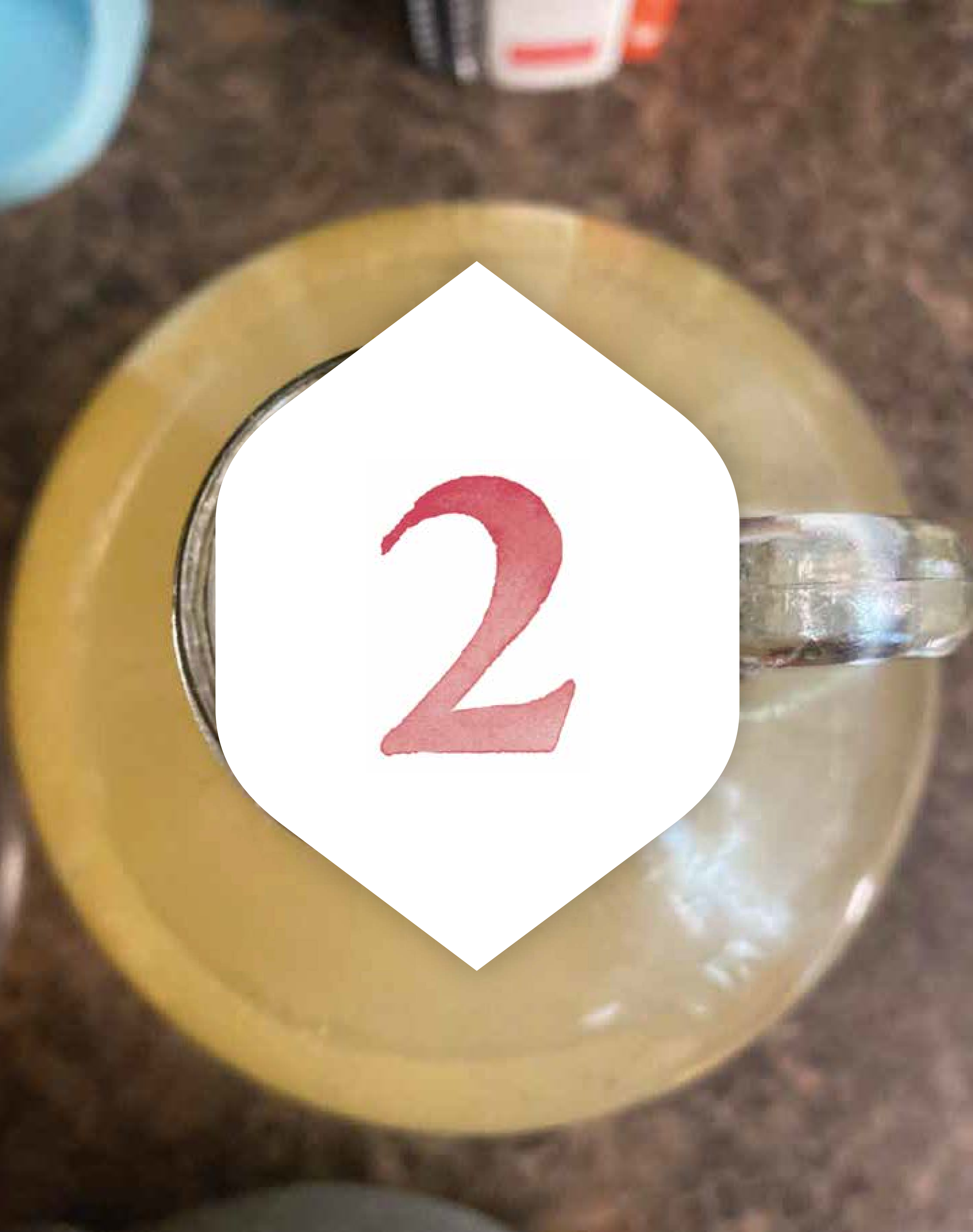
But the yeast may have been dead when they arrived at the store. Dried yeast cultures preferably should be stored and transported under refrigeration. They rarely are. Sealed inside of cargo trailers and box trucks, they can bake in the summer heat. The quickest way to prove

Wine yeast, up-close

or disprove the viability of a yeast culture is to make a yeast starter solution.

First, let's explore the idea behind it all. Healthy rehydrated yeasts in a favorable environment will double their population every 2–3 hours. A 5–8-gram packet of wine yeast contains around 20 billion dehydrated yeast cells. When hydrated in a friendly environment, they will show viability within 15–30 minutes and will begin propagating within 2–4 hours, doubling in numbers as each cell grows a second cell through a process known as budding. Once propagation begins, it can continue every 2–3 hours until their numbers reach a density where resources required for propagation—sugar, nutrients, O_2—become too scarce. At this point, the yeast will stop propagating and settle down to just making CO_2 and ethanol.

Zest: While "zest" is a quality a good, fresh wine might possess, when mentioned as an ingredient in the recipes in this book, zest refers to the grated rind of lemon, orange, grapefruit, or lime. Only the colored portion of the rind is used, as the white pith is bitter and will spoil the batch. When a recipe calls for two lemons, both the zest and the extracted juice are intended unless otherwise noted.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CHAPTER TWO

A WINEMAKER'S TOOLS

If Chapter 1 left you feeling a little dizzy, relax. It's called information overload, and it happens to everyone who makes wine. Maybe not at the outset, but eventually. In a while, you'll understand why that learning curve is necessary and never really ever over.

A winemaker's tools help you apply essential concepts that aren't self-evident. This chapter will provide the missing links between many essential concepts and their real-world applications. It will also introduce and flesh out a few more.

Acid

We previously learned that there are two measures of acidity, TA and pH. TA measures the titratable (or total) acid in the wine, or the concentration of acids, while pH measures the relative strength of those acids; pH is the inverse of TA, meaning the lower the pH (the stronger the acids), the higher the TA (the more acids) generally. These do not measure the same things. TA can be expressed as g/L or as a percentage (*e.g.*, 6.5 g/L = .65% TA), but pH can only be expressed as a logarithmic value (*e.g.*, 3.4 pH).

TA: Titratable acidity is the ability of an alkaline base to neutralize acids in wine and is easily measurable using an acid test kit. Total acidity is the total amount of acid in wine and would be the better measure of TA if there were a simple way to measure it in one's home, but there isn't. But the two are so close to each other that the terms practically mean the same thing. So just think of TA as a rough equivalent for total acidity; it will make no difference to the wine. To determine total acidity of your wine, you need to determine the TA of your wine in a process called titration. You can also taste the TA levels, but that is something no one can teach you.

Acid Blend: Non-grape musts are almost always deficient in acid, and acid needs to be added. Home brew and winemaking shops sell a generic product called acid blend, which usually contains equal amounts of tartaric, malic, and citric acids. I do not recommend using this product in this ratio as microorganisms can easily convert citric acid into other compounds, including acetic acid, rendering one-third of your addition unstable and unreliable.

It is far safer to make your own acid blend by purchasing and mixing equal parts of tartaric and malic acid. Both are sold in a crystalline form. You need not make more than a 2- or 4-ounce batch at a time unless you are making large batches of wine. Store the acids and the blend in airtight containers in a dark, cool place (like a cabinet or closet). If you want to add some citric acid to your blend, minimize it to no more than 20%. In this book, we generally add specific acids as required rather that a blend, but the blends will work as substitutes for the specifics.

Testing for TA: Testing the TA of a must or wine is simple if you have the correct equipment and reagents. If you don't, there are numerous inexpensive acid test kits. Country Wines has a Wine Acid Titration Kit for a little over $10. Vintner's has an Acid Test Kit for just under that price. And there are others as well. Look for a kit that contains a graduated test tube, a syringe, sodium hydroxide (NaOH) with a concentration of 0.2N, and phenolphthalein (pronounced "fee nol fa lein").

Testing is simple and straightforward. The only thing you need to supply (besides the must or wine to be tested) is distilled water. Just follow the instructions and you'll obtain the TA of your must or wine. The distilled water is a necessity. The usual method of testing is to place 15 mL of must/wine into a graduated test tube, add distilled water to bring the volume to approximately 100 mL, followed by three drops of phenolphthalein. Shake the sample to mix thoroughly. Draw 10 mL of 0.2N sodium hydroxide into a syringe and slowly add 0.5 mL to the test tube, shaking it to mix. I recommend wearing rubber gloves because sodium hydroxide is caustic. The color will change: white wines will turn pink, and red wines will turn dark gray. Wait at least a minute to see if the color changes back to its original hue. If it does, add another 0.5 mL of sodium hydroxide to the tube and repeat the color change steps. Repeat this procedure until the color does not change back to its original hue. Then calculate the amount of sodium hydroxide added to the sample. Every 1 mL equates to 1 g/L of TA. If you added 5.5 mL of 0.2N sodium hydroxide, the TA would be 5.5 g/L. Perform this test

A pH meter and common wine-making chemicals in good, strong light because with red wines it can be very difficult to recognize the final color change. An easy alternative method of determining your TA is using a pH meter and titrating to an endpoint of 8.2.

pH: The abbreviation pH is short for potential of Hydrogen, and refers to a logarithmic scale measuring the concentration of hydrogen ions in a substance; the lower half of the scale consists of acidic materials, with alkaloids on the upper half. This simply means that the lower the number is on the scale, the higher the acidity. Note: Because the scale is logarithmic, it means that a substance with a pH of 3 is 10 times more acidic than one with a pH of 4. A substance with a pH of 2 is 100 times more acidic than one with a pH of 4.

Most wines have a pH between pH 3.0–3.5. A pH of 3.55 is considered a safe threshold for sound wine, as certain harmful bacteria can more easily tolerate higher pH. Additionally, oxidation occurs much more rapidly at pH 3.55 and above, and this is something SO_2 will struggle to resist. In the other direction, some wines with pH as low as 3.0 are very drinkable if the acid is offset by residual sugar, glycerol (also called glycerine, produced during fermentation), and alcohol to create a ***balance*** between sweetness and tartness.

Some winemakers swear by pH and never look at TA. In this book, we will generally go by pH but be aware of TA when needed to bring the taste of acid into a tolerable window. The numbers matter, but so do your taste buds.

TA is easy to measure with a TA testing kit or with a pH meter, although each test uses consumables, which eventually have to be replaced. Supplies are plentiful: check eBay.

pH meter: While we are not going to rely entirely on pH, when we need to measure it, we wish to do so accurately. To do this, we will need a ***pH meter***. This will require you to invest in an inexpensive pH meter with ATC (automatic temperature compensation). By inexpensive, I mean

between $50 and $70, not the cheap $5 to $10 mini-meters for testing water. Stay away from those that measure plus/minus 0.1 pH accuracy with single-point calibration. You will appreciate one with plus/minus 0.01 pH accuracy, usually with 2- or 3-point calibration. Remember that in a logarithmic scale—hundredths matter. Every pH meter comes with its own operating instructions, so consult them before using yours.

Litmus Strips: If you need to save up for a pH meter, you can at least get an idea of where your wine's pH might be by using winemaker's litmus strips. Their accuracy can be off by as much as a factor of 10, but they usually will tell you if you're within or close to the window where wine resides: pH 3.0–3.5. It is helpful if you can find a litmus test graduated to increments of 0.5. Hydrion makes such a pH strip, with a pH range of 0.0–6.0.

Testing for TA with a pH meter: This is so simple it should be illegal. You only need your pH meter, a 10-mL plastic syringe, your pH meter calibration solutions (for pH 4 and pH 7), fresh 0.2N sodium hydroxide (NaOH), distilled water which has been boiled and then cooled, and a completely degassed sample of your must or wine. You will also need a beaker (glass) of about 250 mL (1 cup) capacity (a glass measuring cup would work fine). Remember, only measure TA before adding yeast and when you are sure fermentation has ended.

To start off, follow the manufacturer's instructions to calibrate your pH meter, first to pH 7, and then to pH 4.

Clean the syringe with the distilled water and measure 15 mL of your wine in the beaker—enough to contact your pH meter's electrode. Place the pH meter in the beaker, ensuring the electrode has good contact with the wine. Measure the wine's pH and leave the meter on and in the beaker.

Clean the syringe very well with the distilled water and draw exactly 10 mL of NaOH. For safety's sake, you should be wearing rubber gloves, as NaOH is very caustic. Also, remember that 10 mL is the same as 10 cc.

With one hand, hold the beaker and pH meter and with the other begin adding the NaOH, 1 mL at a time, Swirl the beaker after each addition and monitor the pH.

Continue adding NaOH and monitoring the pH. When the pH passes 7.0, slow down the amount of NaOH added. It is very easy to overshoot the endpoint, so add 1 drop at a time at pH 7.0 and higher and swirl after each drop. Pay close attention to the pH monitor reading.

When the endpoint of pH 8.2 is reached, look carefully at the syringe and write down the amount of NaOH used to reach the endpoint. The number of mL used is the TA of the wine. For example, if you used 7.3 mL, the TA is 7.3 g/L, or 0.73%.

Dispose of the wine in the beaker, return unused NaOH to the bottle it came from, and clean the syringe thoroughly with the distilled water. Rinse the pH meter electrode with the distilled water. Blow on the electrode to speed up its drying, and then rinse it again with the distilled water, help it dry, and then either use it to measure the TA of another must or wine or return it to its storage bin. Be careful not to touch the electrode with your hands.

Adjusting TA and pH: Most of the recipes in book this will require the addition of acid either because the base contains too little acid (*e.g.*, plums, pears, figs) or practically none at all (*e.g.*, dandelions, parsnips, nettle tips), or because the addition of water dilutes the natural acidity level too much.

Raising Acidity: This is far simpler than reducing it. To raise (increase) TA, you simply add acid. Acid corrections must occur before fermentation if possible, or if not, as soon as possible. The addition of 1 g/L (3.8 g/gal.) of tartaric acid will raise the TA by 1 g/L (0.1%). Only minor adjustments should be made after fermentation, as they will taste harsher as the wine ages.

When adjusting acid, proceed in baby steps, even if you know you have a way to go. Very large adjustments can skewer the actual results for a few hours. A good process is to make an adjustment, stir the must well to integrate the adjustment, wait 30 minutes, and then continue adjusting further.

Reducing TA: The reducing agent of choice is water. Most non-grape bases will require dilution with water to get you to a gallon, and water will dilute the TA. Never make your acid reductions before your must is fully diluted. Also, consider that fermentation can reduce TA by 0.5 to 1.0 g/L. If malic acid is the major acid present, Lalvin 71B wine yeast can metabolize 20–35 percent more malic acid than most other yeasts, so if you use it, assume the TA will be reduced by 1 g/L. Dilute the must first, measure TA, and then decide if you need to reduce the acidity more and by how much, factoring in a loss of 0.5 to 1 g/L to fermentation. However much is left to reduce must be reduced with a buffer.

The buffers of choice for reducing TA are calcium carbonate and potassium bicarbonate. Either buffer will work, but potassium bicarbonate is the least desirable option if your major acid is not tartaric. It's the go-to choice for grapes but few other bases. So, for non-grape wines, the buffer of choice will be calcium carbonate. Note: When using calcium carbonate, the must cannot be cooler than 60 degrees F.

Calcium carbonate: The must should be treated after ***amelioration*** (diluting with water) but before fermentation. The must should not be cooler than 60 degrees F. Adding calcium carbonate will cause a dramatic reaction in the must. There's no better way to describe it, except there will be an eruption of foam that will rise almost as high or higher as the height of the must. That means if your primary is only 2 gallons and you're making 1 gallon of wine, the foam could almost reach the rim of the primary. Indeed, it might surpass it, making a giant mess to clean up. My primary for 1-gallon batches is a 3-gallon glass canister with a lid obtained at Walmart. What is really nice about it is that you can see the wine, the lees, and the tip of the racking cane.

The desired dose is 0.66 g/L (2.5 g/gal.) to lower TA by 1 g/L (0.1%). Lowering the acidity by more than 1 g/L should be done in 1 g/L stages. Add 1 g/L, stir well despite the rising foam. It will take 2–3 hours for the must to settle down, perhaps even longer. When it is settled and calm, stir in another adjustment. A total dosage of 3 g/L is the maximum that can be added without the possible detection of a chalky taste in the wine. Notice the word used was "possible." Taste the wine. Ask someone else to taste it. Then decide if you can add more.

The calcium carbonate will turn excess acid into calcium tartrate crystals, which will precipitate over time. Post-fermentation, the wine should be matured for at least three months to ensure the crystals settle in secondaries rather than in bottles.

Potassium Bicarbonate: When making wine from grapes, potassium bicarbonate is the buffer of choice. A 0.66 g/L addition will reduce TA by 1 g/L. The addition of potassium bicarbonate releases a great deal of CO_2. When adding to any must or wine, the containment vessel (primary) should have at least 50% free headspace to contain the large amount of foam produced. The operative phrase was "at least." In addition, it should not be added to very cold musts or wines as most of the released CO_2 will then remain dissolved in the wine, creating a carbonation problem requiring considerable attention.

Reducing pH: One of the downsides to making a white wine from, say, dandelions, is that dandelions have such a low natural acidity that I have never been able to measure it. The natural TA is 0–0.5 g/L, and the pH is around 7. It is, therefore, necessary to raise TA while at the same time lowering pH. In both cases, the jump to the desired numbers is quite a leap. Adding tartaric acid will send you well on your way to your desired numbers. You will not reach both numbers at the same time because TA and pH are not proportional. The final additions are "fine-tuning" and can be done with malic and even citric acid if necessary.

As pointed out in Chapter 1, rosé and white wines should be adjusted to as close to pH 3.3 as possible. Red wines should be adjusted to pH 3.4. If recipes specify using acid blend, this is just for the initial addition. Remember, you'll be using your own blend of tartaric and malic acids. For all further adjustments, use tartaric acid. The age-old rule-of-thumb for tartaric acid additions is that 1 g/L of tartaric acid will reduce the pH by 0.1, except that every 4 g/L of tartaric only decreases the pH by up to 3 g/L due to what is called the buffering effect in acid chemistry.

There is a tendency to measure the pH and calculate the tartaric acid addition based on this rule-of-thumb. For small adjustments of 1–3 g/L, this is fine, but if your adjustment is more than 4 g/L of tartaric acid, it is prudent to conduct a bench trial to better guide you to the amount of tartaric acid to add.

Bench Trials: To conduct a bench trial, dissolve 10 grams of tartaric acid in 15–20 mL of distilled water. Use only distilled water. Add more distilled water to bring the total to 100 mL, making a 10% solution. Now set out 5 glasses or beakers, and to each add exactly 100 mL of your juice or strained must. The first is your control, so set it aside. To the next 4 add 1, 2, 3, and 4 mL of the 10% solution, respectively. Each mL of the 10% solution in 100 mL of distilled water is equivalent to 1 g/L of tartaric acid or 1 g/L in a 100-mL sample of juice or must. Using your pH meter, measure the pH in each glass. When one of the glasses meets your target, you know how much tartaric acid to add to your must/juice/wine to achieve your desired pH. If none of the glasses meet your needs, add more 10% solution to total 5, 6, 7, and 8 mL of solution. Sooner or later you'll meet your mark.

Meeting your mark is just part of conducting a bench trial where taste will be affected. So taste the juice or wine in the glass that hit your target. If it is too tart, you'll want to find the sweet spot between it and the dose before it. If it's too flat, you have a way to go.

A word about Acidex™: As you delve into the literature of winemaking, at some point you will probably run across a product called Acidex and its step-child Acidex Super-K. These are both avenues into what is known as double-salt precipitation that reduces high acidity levels by reducing both tartaric and malic acids. Don't go there. The products are only specified for grape musts and wines and even then carry a certain amount of risk. Reviews and anecdotal testimony offer mixed results. At best, double-salt precipitation is an advanced technique for grape wines, and such products shouldn't be used in non-grape wines.

Acid Blend: See **Acid**, subsection **TA**.

Airlock: Also referred to as a fermentation trap, this marvelous invention has an S-shaped airway that allows you to close it off with a little water, metabisulfite solution, or vodka. The CO_2 produced by the yeast rises through the airlock, forces its way through the liquid as bubbles, and escapes to contribute to climate change. These come in a variety of sizes and shapes, none holding an advantage over the others.

Amelioration: This is a fancy word often thought to mean "to add water." It is sometimes used interchangeably with dilution, although that is usually technically incorrect. Dilution refers to making something thinner. Amelioration refers to improving something that's unsatisfactory. We ameliorate to improve a juice that has, for example, high acidity, or astringency or herbaceousness.

We usually ameliorate to correct high acidity. But we can also ameliorate to correct astringency, as with persimmons.

Acidity is inversely proportional to the volume of the must/wine. If we double the volume with water, the TA will be halved, but the pH will only be affected slightly because the strength of the acid has not changed all that much. We cannot calculate the pH change without knowing more than we want about the acid present. So we'll pretend there is no change in our pH.

Autolysis: The decomposition of dead yeast cells that can be favorable or unfavorable, depending on the wine, the yeast, and the process involved. The favorable process can occur in wines that are aged ***sur lie*** ("on the lees"). Certain wines such as Chardonnay and Sauvignon Blanc benefit from autolysis because they gain complexity during the process that enhances their structure and mouthfeel. They gain extra body and aromatic complexity. Aging ***sur lie*** is usually conducted with an accompanying regime of periodic lee stirring that can result in a creamy, viscous mouthfeel.

Amylase: An enzyme that catalyzes hydrolysis of starch into dextrin and maltose. It can effectively be used to neutralize starch haze, which emerges from the active fermentation of starchy ingredients, such as root vegetables, or residual starch haze post-fermentation. It is used only when starch is the obvious culprit.

Balance: The pleasurable, proportional correctness of a wine's many aromatic and taste components in harmony, but especially alcohol, acidity, sugar, and tannin, describes balance. The taste or aroma of the base ingredient (fruit, flower, or another botanical component), or its absence, may also be said to contribute to balance, although this is a minor consideration and should more correctly be associated with the wine's character. A wine is balanced when its acidity, tannins, alcohol, and sweetness all sit around the table as equals. No one of them has ascendancy over the other three. Each plays a unique part. Body also contributes to balance.

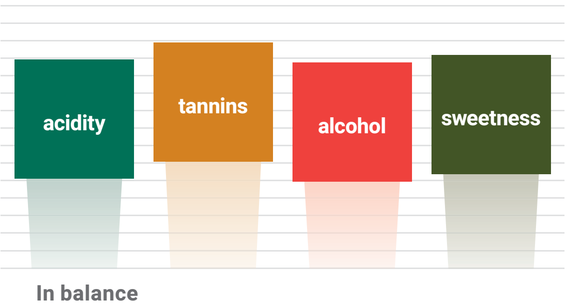
Acidity softens with time. A wine bottled with just a bit too much acidity may have perfect acidity in a year or two. So which acidity expresses a correct balance? Here we enter a world of nuance. If we know where the wine is in its evolution, we should have an idea of where it is going. We can then say the wine "is balanced today" or the wine "is balanced next year," not "will be balanced" but "is" because we know it to be true. It takes experience to know that, or think we know it. The beginning winemaker should stay rooted in the here and now.

Tannins, and the phenolic family they belong to, are such a nuisance at times, but when they aren't, they are usually in deficiency or balance. If they cannot be noted at all when they should be (as in a big red) their absence is a deficiency, but their absence in a white is no big deal. The recipes in this book slip a little tannin in every white wine simply because it adds to the notion of "wine." We don't want astringency in our lemon wine, but we don't simply want an alcoholic lemonade either. Tannins put a little snap in there without cracking the whip.

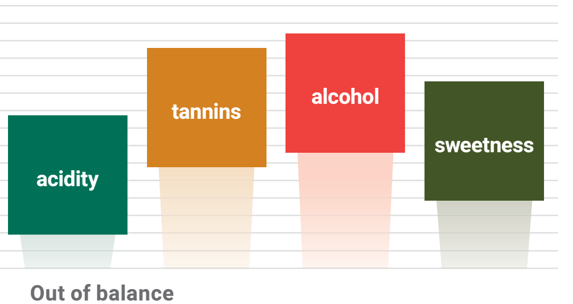
Alcohol can be sweet, or it can be hot, or it can even be a no-show. How is this? Well, if there's too much alcohol, it's on the hot side. If you want heat, drink spirits. Wine is more refined. But if there isn't enough alcohol, it's the same as a no-show. You know it when you taste it because it's not there. And then there can be a slight sweetness in alcohol. It is about age. A slightly aggressive alcohol profile gets smoothed and rounded out with time, and this mitigation hits the palate as a slight shift toward the sweet side.

Sweetness, not sugar, is what is at the table. Sure, sweetness includes the sugars, but it also includes the sweet perception of aged alcohol, glycerol, and the "sweetness" of oak tannin as opposed to the "bitterness" of grape tannin.

To muck things up a bit, an awful lot of people think that "body" belongs in a



In balance



Out of balance

conversation of balance. They argue that a wine without body is out of balance with its potential, but now we're entering the world of metaphysics. Every wine judging score sheet I have ever seen has an item on it called "body." A wine either has it, or it doesn't. Whether it belongs at the balance table is the debate, with no fixed resolution in sight. You may opt either way without argument from this author.

Blending: The process of combining different wines to create a composite that's better than any of the individual wines. The wines blended might be from different varieties, vintages, or regions, have aged in different circumstances (in wood vs. without), or even be wines made from different fruit. Blending is often used to balance high TA wines with low TA ones. For our purposes, we will almost always be referring to blending wines of different fruit or other bases.

Blending Trials: When blending wines, conduct bench trials with measured quantities that are smaller than the whole to get it right. Some winemakers like to use 75.7 mL because it is 2% of 1 U.S. gallon, and results can be multiplied by 50 to arrive at the total addition of the blender (wine to add) to the blended (wine receiving the blender).

Trials are conducted by usually setting up 5 glasses containing the same amount of wine to be blended. One glass is the control sample (untouched) and is set aside. To the remaining 4 glasses, we add differing measured amounts of the blender, such as 5 mL, 10 mL, 15 mL, and 20 mL. Now we taste each glass, starting with the least amount of blender. It may be that 5 mL and 10 mL are not enough, but 15 mL is a bit much. The correct amount is between 10 mL and 15 mL.

We can move the 10 mL glass to number 2 (remember, number 1 is our control) and the 15 mL glass to number 5. To glass 3 we might add 12 mL, and to 4 we might add 13 mL. Now we taste again. Chances are we'll find our perfect blend. Suppose 10 mL is still not enough, but 12 mL is too much. By deduction, the solution is 11 mL.

Bottling: Transferring the wine to bottles should be done as gently as possible so as not to agitate it and introduce unwanted O_2. This can be done as simply as running a hose from a secondary to a lower bottle, initiating suction that pulls the wine down the hose, and allowing the wine to enter a tilted bottle or an upright one when the exit end of the hose has a ***bottling tip*** attached. The latter is a device with a valve inside that closes when the hose is lifted from the bottom and opens when pressed. There are variations of this device.

The bottle is filled to within a half- to three-quarters of an inch of where the bottom of the closure (cork or screw cap) will be. This minimizes the ***ullage***, or airspace, in the bottle.

Bottles are then labeled and stood upright for three days to allow the headspace, or ullage, to equilibrate with the wine. Screw-capped bottles need not be so pampered. They can immediately be stood up, laid on their sides or stored upside down, the latter so you can read the labels while lying on the floor on your back, sober or otherwise.

Closures: There has long been a debate as to whether natural cork, synthetic cork, or screw caps offered the best closure for the wine bottle. In terms of permitting premature oxidation, the screw cap has surely proven in 10-year side-by-side trials to allow almost no passage of post-bottling O_2 into the container.

In terms of wine development due to micro-oxygenation, the natural cork is without peer. By natural cork, I mean one that is 100% a homogeneous piece of cork, not bits of pieces of cork bound together to form an amalgamated "cork" closure.

Corker: For the home winemaker, there are hand corkers and floor corkers.

- **Hand corker:** These come in a variety of designs, each of which utilizes a different mechanical principle to get the cork in the bottle. The simplest one is a plunger-type and utilizes your brute strength to force the cork into the bottle, requiring more force than you might imagine. An improvement on the plunger-type is the lever-type, which harnesses lever action to push the cork and requires less brute force. There are several designs of lever-type hand corkers, including double-lever types, some of which require an extra set of hands to operate easily. The compression-type hand corker uses the same principles as are used in certain floor models.
- **Floor corker:** These are celebrated for their ease of use and adaptability. When the corker is open, a bottle is stood upright on a spring-loaded pedestal while a cork is inserted into a chamber walled-in by four movable brass irises. When the handle is in a backward or open position, the chamber is open so it can receive a cork. When the lever is brought forward, the irises close ever tighter around the cork and compress it, while at the same time a steel plunger is driven down to push the cork down out of the chamber and into the wine bottle. The plunger is adjustable and can drive the cork to specific depths. When the operation is complete, the lever is again laid back, opening the chamber and releasing the bottle. One can cork bottles as fast as one can remove a corked bottle, position an uncorked one, load a cork into the chamber, swing the lever forward to cork the bottle and back again to release the newly corked bottle. A floor corker is essential to making corking an effortless and enjoyable task.

Ullage: The airspace between the wine and the bottom of whatever contains it—the bottom of an airlock or the bottom of a cork. This airspace is critically important in the healthy development of wine. Any such space is filled with air, of which roughly 20% is O_2. In the case of an airlock, it will be removed several times (testing, racking, tasting) and each time that airspace (ullage) will be replenished with fresh air containing 20% O_2, which will be dissolved into the wine while you are adding sulfites to keep the stuff out. In the bottle, the 20% oxygen in the space above the wine will interact with the wine over time and contribute to its eventual oxidation. While this is a given, there is no reason to provide more oxygen than necessary, so if you are thinking, if a half-inch is good then a quarter-inch should be better. No. Changes in temperature and atmospheric pressure will cause the wine to expand and contract periodically. The expanding ullage will push against the cork and over time cause it to lose its grip on the walls of the bottle. You don't want that—one-half-inch to three-quarter-inch.

Capsule: A foil, plastic, or mylar sleeve that fits over the cork of a corked bottle, giving it a finished appearance. The capsule is heat sensitive and easily shrunk around the bottle with a directed heat source such as a blow-dryer.

Calcium Carbonate: See ***Acid***, subsection ***Reducing TA***.

Fining: A fermenting wine is cloudy because of the incredible number of yeast and other particulates in suspension. As the sugar in the must gets consumed by the yeast or the yeast produce too much alcohol to survive in, wholesale death occurs, and any suspended yeast cells begin falling to the bottom of the secondary. In theory, when the last yeast cell is dead and all particulates have precipitated, the wine should be perfectly clear. If it isn't, we look for reasons. Usually, pectin creates a slight haze and a dose of pectic enzyme does the trick. If not, the problem most likely is something in suspension, and so we turn to a fining agent to clear the wine.

Most of what is suspended in the wine will carry a positive or negative charge. Fining agents also carry a positive or negative charge. Opposite charges attract, so if we use the correct fining agent in the correct dosage, most of what is in suspension will have a fining agent particle attached to it and, having gained mass and weight, will fall to the bottom, with other particulates falling by gravity, leaving the wine clear.

Two-part fining agents include a positively-charged agent and one that is negatively-charged. They are added at different, spaced times (follow the instructions on the packet) so that they don't merely attract each other. Between the two, they should get everything in suspension. Any haze that remains should be removed by an appropriate enzyme or other fining agent.

Fining Agents: There are many individual fining agents on the market, each preferred by advanced or commercial winemakers who learned their trade years ago, in college or under the apprenticeship of a seasoned master winemaker. Many fining agents are less expensive than what will be recommended here, but those recommended here are simpler to use and will get the job done. Generally speaking other fining agents are complex, more advanced tools than are suited for the beginner.

We'll only be using four fining agents: polyvinylpolypyrrolidone (sold as PVPP or Polyclar), bentonite, and gelatin, as the need arises, and then we'll follow the directions supplied by the manufacturer as there are various formulations. So, where is the fourth?

Aside from these three, our approach is to ensure that when you need to use a fining agent and do not know if you are dealing with positive or negative charged particles, or if they are charged, you need to get the job done anyway with as little fuss as possible. For that peace of mind, we'll be using the 2-part fining system utilizing products such as Super-Kleer KC or Kitosol 40.

Polyvinylpolypyrrolidone (PVPP or Polyclar): An inert, synthetic polymer used in both red and white wine to reduce the level of phenolic compounds associated with browning and astringency through hydrogen bonding, PVPP is effective against a wide variety of low molecular weight polyphenols. It can remove oxidized flavors and aromas to an extent without itself impacting flavor or aroma, and it can reduce or remove bitterness.

PVPP should be used early on to freshen a wine. Since there are several manufacturers, always follow the accompanying instructions and rack soon after use as instructed.

Bentonite: This is a very fine clay used as a fining or clarifying agent in wine to remove proteins, to achieve Heat Stabilization, or to remove another fining agent. Bentonite has a negative, attracting charge which attracts positively charged particles suspended in wine and carries them to the lees at it settles. It is especially effective at fining yeast, and other persistent protein-based particles. It helps polish the wine to brilliance, purify the color, and reduce certain off-flavors.

Bentonite is mixed with water to form a slurry, which has to sit a while to set (allow the clay to absorb as much water as it is capable of absorbing). It is then stirred into the wine, post-fermentation, gently but thoroughly. The wine is then gently stirred every hour for the remainder of the day (at least four times) to

maintain its suspension and attract more suspended particles. The colder the wine, the stronger bentonite's charge will be and the better its effectiveness. The wine is later racked off the bentonite lees.

Because bentonite deposits vary in the strength of the charge of its particles, bentonites from different mines have slightly different instructions. Follow the manufacturer's instructions for its use.

Gelatin: A natural extractant from animal parts, gelatin is well-suited to reduce larger molecular suspended phenols and tannins. It reduces or removes bitterness and astringency and improves mouthfeel.

Gelatin is primarily for use in red wines because it would strip a white of what few tannins it possesses, although it is possible to "seed" white wine with tannin before gelatin fining in order to leave the wine's natural tannins in place, but that process is beyond the scope of this book.

Follow the manufacturer's instructions on mixing the gelatin and carefully calculate the dose. Excess gelatin can create protein instability and actually cause cloudiness in white wine.

Within three days of its use, the wine should be fined with a negatively charged fining agent such as Kieselsol or racked. This points to the problem with most fining agents—they do half the job and rely on another to finish the job. At one time, I had seven different fining agents in my refrigerator with notes on what to use prior or next and the preferred order of use. After using Super-Kleer™ just once, I began reducing my inventory of fining agents.

Gelatin will deteriorate over time, so always purchase fresh gelatin before use.

Super-Kleer KC™: This product consists of premeasured and packaged portions of kieselsol and chitosan. Its strength is that the two components provide positive and negative charges, ensuring that the widest range of suspended solids will be fined. The kieselsol is added first and a minimum time later (1–3 days, but I

recommend 2–3 days) the chitosan is dissolved in warm water and gently stirred in. Wine will clear in 24–48 hours, but this will not remove pectin haze or reactants to hard water.

Super-Kleer KC costs about $3–4 per dose. An alternate product using the same ingredients is Kitosol 40, which is considerably more expensive and no more effective.

Gram Scale: We will be working with additives measured in grams, and for this, a gram scale is a necessity. Although there are rough conversions (e.g., ½ teaspoon equals X grams), they are indeed rough. Harbor Freight sells gram scales for under $10, both in the store and online.

Hydrometer: A hydrometer is a weighted glass bulb with printed scales for comparing the density of a liquid with that of distilled water. There are many variants of the hydrometer. Some have only one scale, some two, but most have three, specific gravity (for measuring dissolved sugar), degrees Brix (another scale for measuring dissolved sugar), and potential alcohol (PA).

The bulb is larger in diameter on the weighted end than along the portion containing the scale, which, by comparison, is rather skinny. The hydrometer is used in conjunction with a test cylinder that holds a sample of the liquid to be queried, usually about a cup. It is useful to think of both items, together, as the hydrometer, however inaccurate that may be. Next to the airlock, the hydrometer is the most useful tool a winemaker can possess. The hydrometer is to the winemaker what the compass is to the mariner.

The specific gravity (SG) scale will usually read from 0.990 to 1.120. The SG of distilled water is 1.000. If you fill a test cylinder with water and float your hydrometer in it, the water surface should rest at the 1.000 calibration mark. As you dissolve sugar (or anything else) in the water, the hydrometer will float higher because the density, or weight, of the dissolved sugar and other suspended solids) is holding it up against a known scale. One pound of sugar dissolved in one U.S. gallon of water will float the hydrometer to the 1.046 level. A reading of 46 is the gravity of the dissolved sugar, but 1.046 is the specific gravity; it's specific to distilled water. You can say, "a gravity of 46" or "a specific gravity of 1.046." To be accurate and well-understood in conveying the measurement, use SG.

Table 2 (see page 57) shows some hydrometer Specific Gravity (SG) readings and the Potential Alcohol of that SG. The third column shows the amount of sugar in a US gallon to achieve that SG reading, while the fourth column shows the amount of sugar required to be added to a US gallon (containing no sugar until now) to achieve the same SG. The final column shows how the volume of a US gallon increases as the sugar is added to reach the SG shown.

I have demonstrated, through careful tests, that sugars containing residual molasses (brown sugar, Demerara, Turbinado, Muscovado, Sugar-in-the-Raw, etc.) raise the specific gravity a little higher than processed white sugar, but the difference is negligible in 1-gallon batches. With 5- or 6-gallon batches, it registers a noticeable difference. But the shift in flavor profile offsets that difference.

How to Use a Hydrometer

An amount of liquid, either wine or juice strained from the must, is placed in the test cylinder and the glass bulb is lowered into it. How much liquid? Usually ½ to 1 cup, just enough so that the glass bulb floats freely from the bottom. Because bubbles of air and carbon dioxide (CO_2) gas can attach themselves to the glass instrument, it is necessary to spin it in the cylinder to dislodge them. Also, wine contains CO_2 so samples should be degassed as much as possible to get more accurate hydrometer readings.

When the instrument stops spinning and bobbing and comes to rest, get down at eye level with where the scale is at the top of the test liquid. It is natural for liquids to rise slightly around objects they embrace. You will see this rise at the test cylinder wall and the floating instrument. The rise above the actual level of the liquid is called the meniscus. You read the scale where it intersects the bottom of the meniscus, the true level of the liquid.

Whatever the number is, write it down! It is a good (and very useful) habit to create a log page for the wine you are making. Here you should make a note of everything—all ingredients (and how much of each), all measurements, all calculations, all lengths of time between steps you take, etc. I cannot tell you from memory how I made a Best in Class Black Cherry Wine in 1996, but I can turn to my wine log for the wine and it is all there, including where I bought the black cherries. Yes, I posted the basic recipe for this wine on my website, but it is generic for that attempt. In my wine log, I note exactly how much acid I added, when I tested for sulfites, how much I added to raise the free SO_2, and much more. Get in the habit of writing it down!

When all is said and done, and the fermentation appears to be finished, measure the SG again. This number should be somewhere between 0.990 and 1.000. (this is known as fermenting to dryness). Suppose your must had a starting SG of 1.096. Fermented to 1.000, the wine would have an ABV of 13% (read the PA scale for 1.096 and it is 13%). That brings us to 1.000. Now suppose your wine finished with an actual SG of 0.992. That extra 0.008 below 1.000 means something. Use the table on page 57 to obtain the approximate value in ABV—I say approximate because the values below 1.000 are all fractions with many digits right of the decimal point, which have been rounded up or down as appropriate.

Thus, if we add 1.1% ABV to 13% ABV, we arrive at a finished ABV of approximately 14.1%.

Also, please note that fermentation produces heat from the activity of the yeast. Most hydrometers are calibrated to give correct readings at 60 or 68 degrees F. Higher temperatures thin the wine somewhat and result in lower readings than you'd get at the calibrated temperature. For details on how to adjust for your temperature, see the table on page 57.

Fermentation temperatures above 95 degrees F. put your yeast at risk. Don't allow it to go that high. You can cool a fermentation down in several ways. Here are two.

Place the primary or secondary in a pan of cold water and then later add a few ice cubes to the water. Add more at half-hour intervals—not too many at any time or you risk putting the yeast in shock, which is every bit as bad. The goal is a gradual lowering of the temperature. Use a thermometer to monitor your process.

A second method is to wrap a damp towel around the vessel and allow evaporation to drop the temperature (a reduction of 8–10 degrees is not uncommon). You can aim a fan at the vessel to speed up evaporation and increase cooling slightly, but remember to keep the towel damp and not let it dry out.

The hydrometer is to the winemaker what the compass is to the mariner.

Table 2. Specific Gravity, Potential Alcohol & Sugar

SPECIFIC GRAVITY	POTENTIAL ALCOHOL (% ABV)	AMOUNT OF SUGAR IN US GALLON	AMOUNT OF SUGAR ADDED TO US GAL.	VOLUME WITH SUGAR ADDED TO US GAL.
1.010	0.9	1.7 oz.	2.1 oz.	1 gal. 0.8 oz.
1.015	1.6	3.4 oz.	4.2 oz.	1 gal. 2.4 oz.
1.020	2.3	5.8 oz.	6.7 oz.	1 gal. 4.0 oz.
1.025	3.0	7.5 oz.	8.3 oz.	1 gal. 5.6 oz.
1.030	3.7	10 oz.	10.8 oz.	1 gal. 6.4 oz.
1.035	4.4	12.5 oz.	13.3 oz.	1 gal. 8.0 oz.
1.040	5.1	14.0 oz.	15.0 oz.	1 gal. 8.8 oz.
1.045	5.8	15.8 oz.	1 lb 0.7 oz.	1 gal. 10.4 oz.
1.050	6.5	1 lb 1.5 oz.	1 lb 3.3 oz.	1 gal. 11.2 oz.
1.055	7.2	1 lb 3.0 oz.	1 lb 4.8 oz.	1 gal. 12.8 oz.
1.060	7.8	1 lb 5.0 oz.	1 lb 6.5 oz.	1 gal. 13.6 oz.
1.065	8.6	1 lb 6.5 oz.	1 lb 9.0 oz.	1 gal. 15.2 oz.
1.070	9.2	1 lb 8.0 oz.	1 lb 11.5 oz.	1 gal. 16.0 oz.
1.075	9.9	1 lb 9.8 oz.	1 lb 14.0 oz.	1 gal. 17.6 oz.
1.080	10.6	1 lb 11.5 oz.	1 lb 15.6 oz.	1 gal. 18.4 oz.
1.085	11.3	1 lb 14.0 oz.	2 lb 2.2 oz.	1 gal. 20.0 oz.
1.090	12.0	1 lb 15.6 oz.	2 lb 4.6 oz.	1 gal. 21.6 oz.
1.095	12.7	2 lb 1.3 oz.	2 lb 7.2 oz.	1 gal. 22.4 oz.
1.100	13.4	2 lb 3.0 oz.	2 lb 9.6 oz.	1 gal. 24.0 oz.

Data for Table 2 derived from Jack Keller's *Winemaking Home Page*, Internet, October 2016

Table 3. Potential Alcohol Below 1.000

FINAL SPECIFIC GRAVITY	ADD TO STARTING POTENTIAL ALCOHOL
1.000	0.0
0.998	0.3
0.996	0.6
0.994	0.8
0.992	1.1
0.990	1.4

Table 4. Adjusting Hydrometer Reading for Temperature

DEGREES F.	ADD SG TO READING
70	0.001
77	0.002
84	0.003
95	0.005
Above 95	Don't Go There

Invert Sugar: The product of the hydrolysis of sucrose, which is glucose and fructose. Yeast ferment invert sugar more rapidly than sucrose, such as simple cane sugar, because they do not have to break the sucrose down into glucose and fructose themselves. Invert sugar can be made by dissolving two parts sugar into one part water, adding two teaspoons lemon juice per pound of sugar, bringing this almost to a boil, and holding it there for 30 minutes (without allowing it to boil). If not to be used immediately upon cooling, this can be poured into a sealable jar, sealed, and cooled in the refrigerator. Invert sugar can be used to sweeten finished wine as long as potassium sorbate is used to prevent re-fermentation.

Jelly-Bag: A bag used to isolate or strain the solid fermentation media from the wine.

They are similar to nylon straining bags, but shorter and usually fitted with a drawstring so they can be closed and hung while the liquid drips from the pulp. They can also be made of cotton or linen for containing ground spices.

Litmus Strips: See ***Acid*** subsection ***pH.***

Malolactic Fermentation (MLF): When malic acid is predominant and too high, MLF may be the best way to reduce some of that acid. MLF is enabled by malolactic bacteria (MLB) that may hitchhike in on the fruit being fermented or be introduced by the winemaker in a commercial culture of selected bacteria. The latter is preferred over the wild bacteria, much like selected cultures of wine yeast are preferred over wild yeast. MLF is an advanced tool not covered in this book.

Methylated Spirits: Denatured alcohol is used to check if a hazy wine is caused by pectin. Add 3–4 fluid ounces of methylated spirit to a fluid ounce of wine. If jelly-like clots or strings form, then the problem is most likely pectin and the wine should be treated with a pectic enzyme.

Mincer: A powered or manual device for chopping fruit, grain, vegetables, or meats into very small pieces. The size of the pieces can usually be regulated by changing chopping blades. This device is very useful for chopping large quantities of fruit, especially dried fruit and raisins. Fruit with hard seeds should be de-seeded before mincing.

Nutrient: Food for yeast or malolactic bacteria, containing nitrogenous matter, yeast-tolerant acid, vitamins, and certain minerals. While sugar is the main food for yeast, nutrients are the "growth hormones," so to speak, and essential to a healthy, complete fermentation.

Oaking: The process of immersing oak chips, shavings, particles, cubes, "beans," or sticks into wine to simulate having aged the wine in an oak barrel or keg. The oak may be natural or toasted (light, medium, or heavy toast). Oaking allows young wines to soften and absorb some of the wood's flavors and tannins. However, most light, delicate wines should not be oaked.

Pectic Enzyme: The enzyme pectinase is available in powdered or liquid form. When it encounters pectin, it catalyzes the breakdown of pectin molecules. We will be using the powdered form as it is most easily prescribed in quantity—

1 teaspoon, ½ teaspoon, etc.—and has a much longer shelf life.

We use it initially to counter any pectin released by ingredients and prevent it from cursing our wine with pectin haze. That early addition also helps break down molecular barriers that prevent the juices in the base from freely flowing. It will never make them flow freely, but it sure helps release them.

Without going into the biochemistry of the process, pectinase engages pectin, and when finished with that engagement is available to engage more, if encountered. It is not "used up," but some are always engaged and not available (think of it as temporarily bound and not free for immediate use elsewhere). In the end, there may not be enough to completely rid a wine of all pectin, resulting in a slight haze we'd rather not see there.

When asked in a recipe to check clarity and correct if necessary, we add a bit more and evaluate the results. "A bit more" can be as much as half of what was initially used. If the amount added fails to eliminate the haze, we add a bit more (maybe ¼ of our initial addition) and continue doing so until the haze is gone or, if nothing has changed, switch to another enzyme, such as amylase if we have a starch base.

Residual pectinase isn't harmful and imparts no taste or other sensory characteristics. Still, we always want to use it minimally and not just dump teaspoon after teaspoon into our wine. It is a soluble solid and will add density to your wine, skewing SG readings. When our hydrometer reads 1.000, we want to know it is measuring sugar, not sugar and pectin.

In commercial winemaking pectic enzyme generally refers to a cocktail of enzymes that each attack different parts of the pectin molecules most common in grapes. We are not primarily making wine with grapes, and when we do turn to grapes, we may be using native (wild) grapes or hybrids of native and European grapes such as Concord, Niagara, Diamond, etc. For these grapes, our pectinase-based enzyme will work just fine.

pH: See ***Acid*** subsection ***pH***.

pH meter: See ***Acid*** subsection ***pH***.

Potassium Bicarbonate: See ***Acid*** subsection ***Reducing TA***.

Potassium Metabisulfite: One of two salts of sulfite which may be used to sanitize winemaking equipment and utensils (the other being ***Sodium Metabisulfite***). Campden tablets are the tablet form of potassium metabisulfite. (Campden tablets of sodium metabisulfite are also available.) Its action, in water or wine, inhibits harmful bacteria through the release of sulfur dioxide, a powerful antiseptic. (Also see ***Sulfur dioxide***.)

It can be used for sanitizing equipment and washing fruit from which wine will be made. For equipment, a 1% solution (10 grams dissolved in 1 liter of water) is sufficient for washing and rinsing. After using the solution, the equipment should not be rinsed again.

For protecting the must, a 10% solution is made (10 grams dissolved in 100 mL of water). Three milliliters of this 10% solution added to a U.S. gallon of must will add approximately 45 ppm of sulfur dioxide (SO_2) to the must. One should wait at least 12 hours after adding this to the must before adding the yeast.

Both bottles of solution (1% and 10%) should clearly be labeled with the respective strength, active compound, and date formulated to prevent disastrous mistakes; both may be stored in a cool, dark place for several months without affecting potency. Potassium metabisulfite has a shelf life of about a year. In other words, you will need to replace it every year. When you buy it, write the date a year from then on the label, so you'll know when you have to replace it.

Potassium Sorbate: Sold under the brand name "Sorbistat K" (among others) and affectionately as "wine stabilizer," potassium sorbate produces sorbic acid when added to the wine. It serves two purposes. When active fermentation has ceased, and the wine is racked the final time after clearing, ½ teaspoon added to 1 gallon of wine will render any surviving yeast incapable of multiplying. Yeast living at that moment can continue fermenting any residual sugar into alcohol and CO_2, but when they are inhibited, no new yeast will be able to cause future fermentation. It should always be used in conjunction with potassium metabisulfite as the wine will not be truly stabilized without them both. It is primarily used with sweet wines and sparkling wines but should be added to table wines which are sweetened before bottling.

Press: To use pressure to force the juice out of fruit pulp, or a device used to achieve this result. Home winemakers have found ingenious ways to press their fruit without spending big bucks. Early on, I used two pieces of plywood, about 2 x 2 feet and ½ inch thick. My straining bag with fruit was placed between them, and I then loaded the upper piece with a layer of bricks, then additional bricks stacked in layers until the addition of more bricks yielded no new juice. The bottom piece of plywood had a channel routered around it, near the edges, that exited to the outside where I placed a bucket to collect the juice—sanitizing the plywood before and after use was a chore that eventually motivated me into purchasing a basket press.

Primary Fermenter: It is useful to have a variety of primary sizes. I've found that 2- and 3-gallon primaries are perfect for 1-gallon batches. You can usually cheaply acquire food-grade plastic buckets, with lids, from your local donut bakery. There are two donut chains I hit ages ago and scored 2-, 3-, 5-, and 8-gallon buckets for $8 total. Each of these originally contained gelled fillings or prepared toppings.

Punching Down the Cap: The process of pushing the layer (cap) of skins, seeds, and pulp, which are lifted to the surface by CO_2 released by yeast, down into the juice during fermentation. This facilitates the extraction of color, flavor, acids, and tannins and, equally important, ensures that the cap doesn't dry out and develop unwanted mold.

Racking: As fermentation concludes, rising CO_2 diminishes and is unable to keep large, small, and micro solids in suspension. They then begin falling and create sediment called lees. It is necessary to siphon the wine off the lees to improve clarity and prevent off-flavors and odors as the lees decompose. This process of siphoning the wine from a lees laden fermenter to a clean, sanitized fermenter is called racking. Racking the wine off the lees allows clarification and aids in stabilization. A ***Racking Hose*** or tubing is used and can be attached to a ***Racking Cane*** to make this task easier.

Because racking agitates the wine, it drives SO_2 out while allowing O_2 in. Repeated racking lowers free SO_2 levels and places the wine at risk. Thus, racking should be done only when necessary.

Racking Cane: A stiff, plastic tube, usually "L"-shaped, that is attached to the racking hose to make racking easier. A protective cap is placed over the lower end of the cane that allows liquid to be drawn into the cane from above rather than below while keeping most large solids out. The cap allows the tip of the cane to be lowered close to the lees without unduly disturbing them. The lower tip of the racking cane should initially be held about midway between the surface and the lees and gradually lowered as the volume decreases due to the siphoning.

Racking Hose: A flexible, clear plastic hose, usually ⅜ inch in inner diameter, used to siphon wine from one vessel to another. It is used in both racking and bottling operations.

Secondary Fermenter: For the beginner, it is suggested you begin making wine from scratch with 1-gallon batches. All recipes in this book are 1-gallon batches. These allow you to learn and master the basics with the least resources invested.

A secondary fermenter

Remember, any batch requires two secondaries: one for fermentation and the other to rack into, at which point the used one can be cleaned and sanitized, and their roles reversed.

In a less plasticized age, it was easy to collect 1-gallon secondaries. You walked into any supermarket and bought a gallon of apple juice or cider. It's not so easy anymore, although gallon glass jugs of cider are still around if you look hard.

The next best glass secondary for small batches is the 4-liter jug. Buy your favorite wine in bulk and re-use the jug. But when you re-use it, you are making four liters of wine, not a gallon. No worry, you'll still put away five bottles and then have a couple of glasses left over for the winemaker.

Sodium Benzoate: Often sold as "Stabilizing Tablets," sodium benzoate is used, one crushed tablet per gallon of wine, to stop future fermentation. It is used when active fermentation has ceased, and the wine has been racked a final time after clearing. It is generally used with sweet wines and sparkling wines but may be added to table wines which exhibit difficulty in maintaining clarity after fining. For sweet wines, the final sugar syrup and crushed tablet may be added at the same time. When using it to stabilize a wine, it must be used in conjunction with an aseptic dose of ***potassium metabisulfite***. When used, it is used instead of ***potassium sorbate***. In this book, we only use ***potassium sorbate***. See ***Potassium Sorbate***.

Sodium Metabisulfite: One of two compounds commonly used to sanitize winemaking equipment and utensils, the other being ***potassium metabisulfite***. Sodium metabisulfite is also sold in the sodium bisulfite form. Either form, in must or wine, inhibits harmful microorganisms through the release of sulfur dioxide (SO_2), a powerful antiseptic. It can be used for sanitizing equipment, but the U.S. government prohibits its inclusion in commercial wine and thus should not be used to protect the must from which wine is to be made.

Some winemakers prefer to use the sodium salt for sanitizing equipment and the potassium for protecting the wine. This book does not endorse such a procedure, as the residual sodium cannot help but make its way into the wine. Also, having two solutions on hand is an accident waiting to happen. See ***Potassium Metabisulfite.***

Sorbate: See ***Potassium Sorbate.***

Stabilization: Fermented wine has run its course in terms of fermentation, and the yeasts have begun their great die-off. If they do so before all the available sugar is consumed, the wine is inherently unstable. Almost all finished wines contain a few live yeast cells and various microorganisms that could spell disaster for the wine if bottled. Other conditions may exist that produce undesirable effects.

Stabilization is a multi-layered process as there are several types of stabilization. No wine will need each type of stabilization, but all will need the first, and many will need two. Ignore at your own risk.

Microbiological Stabilization: Yeast, malolactic bacteria and many other microorganisms can go dormant if their environment changes too much. If they determine they cannot survive the change they either die off or wait to see if the environment becomes more favorable. If, during dormancy, they decide that they can survive, they begin doing what nature programmed them to do. Yeast will consume sugar and continue the primary fermentation. Malolactic bacteria will metabolize any residual malic acid and continue the secondary fermentation. Other bacteria can turn the wine rancid. If the wine has been bottled, any one of these scenarios can ruin your wine. That's why microbiological stabilization is important.

Microbiological stabilization is achieved by raising the SO_2 to an aseptic level of 30 mg/L or more and adding ½ teaspoon of potassium sorbate per gallon. The SO_2 takes care of everything but the yeast, and the potassium sorbate dissociates as sorbic acid and prevents the growth and activity of yeast, thereby rendering them incapable of further reproduction. They still have to die, but neither the SO_2 nor the sorbate will kill them. They die naturally, and since they are the last of the culture that made the wine, we hope they rest in peace.

Cold Stabilization: Dissolved molecules of tartaric acid can bind and react with excess potassium to form what is called potassium bitartrate, which is unstable. Potassium bitartrate can precipitate out of solution as crystals over time and with minor changes in ambient temperature. In white wines, the crystals look like broken glass and are unsightly. In red wines, the crystals are largely unnoticed until the bottle is almost empty. Potassium bitartrate is cream of tartar and harmless if consumed, but the crystals can be removed from the wine before it is bottled.

The wine has to be chilled to near freezing for potassium bitartrate to precipitate completely. The kitchen refrigerator can accommodate gallon jugs, but a 5-gallon carboy will occupy most of its space. When upgrading to a newer model, many winemakers keep an old refrigerator just to cold stabilize their wines. Others age their wines until winter comes, but don't set your carboys outside and forget them. If the contents freeze, the carboys will burst. You've been warned. Check the carboys every few hours and bring them inside if ice begins forming on their inner walls. When the ice melts, they can be brought back outside until ice reforms. Just be vigilant. It is best to bring them outside on cold nights that do not reach freezing.

Heat Stabilization: A wine possessing an excess of proteins can react unfavorably to warm temperatures. The proteins can break down and precipitate out of solution in two phases. First, the clear wine becomes hazy or even cloudy. Second, the protein molecules begin binding to each other and form a loose deposit of fluff in the bottle. While this fluff has little if any effect on the taste of the wine, the swirling fluff is unsightly and reflects unfavorably on the winemaker. This is almost exclusively a white wine and rosé problem and a white grape wine problem at that. I say almost exclusively because a very few non-grape white wines can experience this problem.

Fining with bentonite will produce a bond between the bentonite and proteins which, upon settling to the bottom, allows us to rack the wine off the deposit. There are four things to say here. First, bentonite will strip some of the flavor and aroma from the wine if used excessively. Second, there are different bentonites, and some produce compact lees while others produce loose, fluffy lees. The latter, which is sodium-based bentonite (not calcium-based), is more desirable because it is more reactive and thus, less of it is required, and it alters the character of the wine the least. Third, the only way to determine how much bentonite is required is through bench trials, trying 0.25 g/L, 0.50 g/L etc. to a maximum of 1.0 g/L until the least amount that gets the job done is determined. Fourth, because the lees will be loose and fluffy, it would be prudent to fine the wine a second time, after the bentonite has settled, with a small amount of gelatin, which helps clear the wine and compacts the bentonite.

Starter Solution: A solution of water, juice, sugar, and nutrients into which a culture of yeast is introduced and encouraged to multiply as quickly as possible before adding to a must. The purpose of the starter solution is to achieve a greater density of yeast than contained in the original culture sample; this way, the cultured yeast will quickly dominate the fermentation process, literally smothering out any wild yeast that might be present. It is also used to restart a ***Stuck Fermentation***. See ***Yeast Starter*** for a method of creating a starter solution.

Straining Bags: Containing the pulp of fruit and berries makes the whole process easy when the pulp needs to be separated from the liquid. This is especially true of strawberries, kiwi fruit, raspberries, blackberries, and other fruit or berries that completely fall apart during fermentation. Containment is the solution.

Cotton bags have long been used for this purpose and I used them for years; I still have a couple. Yeast have no problem getting through the cotton weave. The bags can be washed for reuse but have one important drawback. As the cotton soaks up sugars, either added or naturally in the contained pulp, yeast attack the cotton to get at the sugars, and after a dozen or so uses the bags are weakened and can burst when removed from the primary or pressed.

Cotton mesh painter bags suffer the same drawback to a lesser extent but also are not as efficient as nylon straining bags designed for larger capacities and easy tie-offs. Nylon straining bags come in different mesh sizes useful in making beer and wine, but in winemaking, smaller mesh sizes usually are more desired. These bags can be cleaned, sanitized, and reused many times.

Women's nylons and pantyhose are really useful for the above-mentioned fruit and berries. They stretch quite a bit and hold far more material than you might imagine. Cut the feet off around calf-high, but get your partner's permission before you raid her stash of pantyhose. If they are your own pantyhose, please carry on. Use sanitized yarn to tie them closed.

Raw sugar

Sugar: Without sugars (and yeast) there could be no wine. Yeast convert sugars, through enzymatic actions, into alcohol and CO_2. In the process, there is a little bit that the yeast convert into energy for their own metabolic needs. Thus, sugars provide both the fuel for the yeast and the raw materials for the alcohol in our wines.

When chaptalizing a must (adding sugar), there are many choices, each bringing something different to the wine. Some of these are:

Bar Sugar: This sugar's crystal size is the finest of all the types of granulated sugar. It is ideal for sweetening finished wine because it dissolves easily. It is also called "superfine" or "ultrafine" sugar. In England, a sugar very similar to bar sugar is known as caster or castor, named after the type of shaker in which it is often packaged. Commercially, it can be purchased as "Baker's Sugar."

Barbados Sugar: A British specialty brown sugar, very dark brown, with a particularly strong molasses flavor. The crystals are slightly coarser and stickier in texture than "regular" brown sugar. Also, known as ***Muscovado Sugar***. It delivers a heavier-tasting, molasses-like sweetness that is often an acquired taste.

Brown Sugar: Sugar crystals coated in a molasses syrup with natural flavor and color. Many sugar refiners produce brown sugar by boiling a special molasses syrup until brown sugar crystals form. A centrifuge spins the crystals dry. Some of the syrup remains, giving the sugar its brown color and molasses flavor. Other manufacturers produce brown sugar by blending a special molasses syrup with white sugar crystals. Dark brown sugar has more color and a stronger molasses flavor than light brown sugar. Lighter brown sugars are more commonly used in winemaking than darker ones, as the richer molasses flavors in the darker sugar tend to mask the flavor profile of the wine's base, but both have their place.

Demerara Sugar: A light brown sugar with large golden crystals that are slightly sticky. While this sugar is often expensive, it has a unique, unmatched flavor that in turn gives the wine a unique flavor profile and character.

Dextrose: An isomer form (the invert) of glucose, actually called dextroglucose (D-glucose) with a right-axis polarization (a.k.a. "right-handed glucose"); it is found naturally in sweet fruits and honey.

Fructose: One of two simple (reducing) fermentable sugars in grapes and other fruit, the other being glucose. Isolated, fructose is approximately twice as sweet as glucose. In wine, a higher fructose concentration will result in a heightened sweetness threshold.

Galactose: Sometimes called lactose, although it is not lactose proper—lactose is a disaccharide of galactose and glucose. It is not desired as a residual sugar in wine, as it oxidizes to form mucic acid.

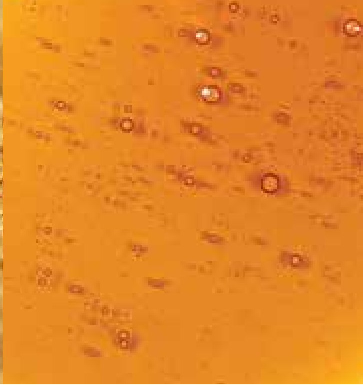
Glucose: One of two simple fermentable sugars in grapes and other fruit, the other being fructose. Glucose is approximately half as sweet as fructose. An isomer form of glucose, dextrose, is considered to be glucose.

Honey: Honey varieties vary widely; they generally are a complex mixture of right-axis glucose (about 30% dextrose), left-axis fructose (about 38 to 40% levulose), maltose (about 7%), and a surprising number of other sugars (3 to 5%; see ***Sugars and Honey,*** pg. 68) in water with proteins, minerals, pollens, bee parts, and other solids interspersed. Honey purity and quality also vary widely, as do the "varieties" of honey. "Variety" is attributed to the predominant flower


Barbados sugar


Brown sugar


Demerara sugar


Honey


Invert sugar


Jaggery


Molasses


Piloncillo

the bees visited while making the honey (such as clover, orange, wildflower, raspberry, sage, heather, etc.). Only purified honey should be used in winemaking—the purer the better.

Invert Sugar: The product of the hydrolysis of sucrose, which is glucose and fructose. Yeast ferment invert sugar more rapidly than sucrose, such as simple cane sugar, because they do not have to break the sucrose down into glucose and fructose themselves. Invert sugar can be made by dissolving two parts sugar into one part water, adding two teaspoons lemon juice per pound of sugar, bringing this almost to a boil, and holding it there for 30 minutes (without allowing it to boil). If not to be used immediately upon cooling, this can be poured into a sealable jar, sealed, and cooled in the refrigerator. Invert sugar can be used to sweeten finished wine as long as potassium sorbate is used to prevent re-fermentation.

Jaggery: Raw or semi-refined palm sugar, made in the East Indies by evaporating the fresh juice of several kinds of palm trees, but specifically that of the palmyra.

Lactose: A sugar comprising one glucose molecule linked to a galactose molecule and found only in milk products. It has a slightly sweet taste and is much less soluble in water than most other sugars. The human body breaks it down into galactose and glucose. Because it is not ordinarily fermentable until separated into its component sugars, it can be used to boost residual sweetness.

Levulose: An isomer form (the invert) of fructose, with a left-axis polarization (a.k.a. "left-handed fructose") found naturally in sweet fruits and honey.

Maltose: A crystalline sugar formed from starch (specifically malt) and the amylolytic ferment of saliva and pancreatic juice. It consists of two linked glucose molecules and is completely fermentable.

Molasses: The filtered residue of sugar refinement after the crystallized portion has been removed. "Light molasses" is roughly 90% sugar, while "blackstrap molasses" is only 50% sugar and 50% refinement residue. It may have sulfur compounds added to sterilize and stabilize it. This makes it generally undesirable as sugar for wine, as it could encourage the formation of hydrogen sulfide. It is similar to treacle. Molasses can be used to add complexity to a finished wine prior to bottling if it is for personal consumption. Otherwise, honey is a better choice.

Muscovado Sugar. See ***Barbados Sugar.***

Piloncillo: A Latin American brown sugar, which is semi-refined and granulated. It is sometimes sold in solid cone-shaped cakes, where the sugar is scraped off the cake as needed. The taste is quite different than American brown sugar, which is actually refined sugar to which molasses has been added. It can be used to sweeten a wine prior to bottling and create a unique flavor profile.

Raffinose: A complex sugar (trisaccharide) found primarily in grains, legumes, and some vegetables. It has little value in winemaking and is only slightly sweet.

Raw Sugar: Crystalline sugar obtained from the evaporation of cane, beet, maple, or some other syrup. Raw cane sugar is sold as "Sucanat." Raw beet sugar is said to be unsavory. Raw sugar should not be equated with the product "Sugar in the Raw."

Rock Candy: Large sucrose crystals, usually clear but may be tinted with flavorings. Some people drop a piece of rock candy in the wine bottle before filling it, where it slowly dissolves and sweetens the wine.

Stachyose: A complex sugar (tetrasaccharide) found in a few grains, most legumes, and some vegetables. It has little value in winemaking and is less sweet than raffinose.

Sucrose: A natural, crystalline disaccharide found in grapes, most fruit, and many plants. This is the type of refined sugar obtained from sugar cane, sugar beets and other sources which, when added to a must or juice to make up for deficiencies in natural sugar, must be hydrolyzed (inverted) into fructose and glucose by acids and enzymes in the yeast before it can be used as fuel for fermentation. It can also be inverted by the winemaker before adding to the must or wine.

Sugar in the Raw: See ***Turbinado Sugar.***

Treacle: The inverted sugar made from the residue of refinement and very similar in taste to molasses, although treacle is generally darker. There is even a "black treacle" with roughly the same taste as "blackstrap molasses." If you like the taste, it is more useful in winemaking than molasses.

Turbinado Sugar: A raw sugar that has been partially processed, removing some of the surface molasses. It is a blond color with a mild brown sugar flavor that enhances some wine bases like no other sugar can. It is marketed as Turbinado Sugar and as Sugar in the Raw.

Sugars and Honey: We tend to think of honey as liquid sugar, a super-thick syrup flavored with various flower nectars. Many winemakers add a little honey to wine to give it a mellow but sweet finish, as honey contains a number of sugars, and not all of them are fermentable. But the overwhelming majority of them, given enough time, will ferment. The very complexity of some requires a long time for the yeast to break them down into a fermentable form.

Over 75% of the sugars in honey are dextrose, levulose, and maltose. Sucrose—common table sugar—usually comprises only about 1–½% of the total. A small quantity might be brachyose (isomaltose), erlose, kojibiose, maltulose, panose, theanderose, turanose, and other exotic disaccharides and oligosaccharides. Yeast can eventually reduce all that can be reduced into fermentable sugars, but it sometimes takes quite a few steps and therefore quite a while. People wonder why meads take so long to ferment out. You just read the answer.

Conventional wisdom says that 1.25 pounds of honey can be substituted for 1 pound of sugar in any wine recipe to produce an equivalent amount of alcohol; substitute honey for all of the sugar and you make some form of honey wine or mead. The 1.25 pounds of honey for 1 pound of sugar is based on the fact that most honey averages around 80% solids, give or take 2%. The math is reliable on average, so don't worry about the give or take.

Sulfur Dioxide

Appropriate amounts of sulfur dioxide (SO_2) are used in winemaking for their antioxidant, antimicrobial, and preservative properties, but SO_2 also possesses additional benefits. The nine benefits of sulfur dioxide on wine that I like to cite are:

- Antioxidant properties (limits undesirable reactions of wine substances with oxygen)
- Can inhibit most wild yeast
- Inhibits acetic acid bacteria (think vinegar)
- Inhibits lactic acid bacteria*
- Helps prevent browning
- Helps stabilize color in red wines
- Keeps wine fresher
- Allows longer storage of wine
- Sanitizing agent for winemaking equipment

*If an MLF is desired later or not at all, SO_2 will delay or stop it from occurring, depending on the SO_2 level maintained. Usually, 40 mg/L or higher will prevent MLF from occurring, but the SO_2 does not kill the ML bacteria. It only creates an environment inhospitable for the bacteria to flourish. When the SO_2 level drops below that mark, which it will over time, MLF may occur.

It is useful to expound upon some information from Chapter 1 and above.

- Only 57.6% of the sulfite will dissociate as SO_2 and become available to protect wine. While this is theoretically true, in reality, many variables are at work to decrease that number. The age of the metabisulfite is the easiest variable to understand. You'll probably never achieve 57.6%, but our calculations pretend you can. Don't worry. They work.
- 93 to 99 percent of the amount of sulfite dissociated is ionized bisulfite or free SO_2 (HSO_3-). This is the form that provides antimicrobial protection.
- 0.7 to 7 percent of the amount of sulfite added is molecular SO_2. This is the form that provides antimicrobial protection.

Both HSO_3- and molecular SO_2 play important roles in ensuring the health of a must or wine, but it is the molecular SO_2 that is the more important of the two in our wine. Each is delivered in dose amounts primarily dictated by how much free SO_2 is already present in the wine, the wine's pH, and how much is needed.

It is easy to say too much about SO_2, but one should remember that between any consecutive two points listed above are four additional values. For example, between pH 3.50 and 3.55 are 3.51, 3.52, 3.53, and 3.54, which is why a pH meter capable of +/- 0.01 accuracy is so important. One must extrapolate values between the points on the tables, above. For example, a reading of pH 3.53 for a red wine (Table 6), which falls midway between 3.50 (25 mg/L) and 3.55 (29 mg/L) of free SO_2, is extrapolated as 27.5 mg/L, the midway point between the two.

Table 5. Free SO_2/pH points for white wine stabilized at 0.80 mg/L molecular SO_2 in mg/L

pH	2.90	2.95	3.00	3.05	3.10	3.15	3.20	3.25	3.30	3.35
SO_2	11	12	13	15	16	19	21	23	26	29
pH	**3.40**	**3.45**	**3.50**	**3.55**	**3.60**	**3.65**	**3.70**	**3.75**	**3.80**	**3.85**
SO_2	32	37	40	46	50	57	63	72	79	91

Table 6. Free SO_2/pH points for red wine stabilized at 0.50 mg/L molecular SO_2 in mg/L

pH	2.90	2.95	3.00	3.05	3.10	3.15	3.20	3.25	3.30	3.35
SO_2	7	7	8	9	10	12	13	15	16	18
pH	**3.40**	**3.45**	**3.50**	**3.55**	**3.60**	**3.65**	**3.70**	**3.75**	**3.80**	**3.85**
SO_2	20	23	25	29	31	36	39	45	49	57

Data for Tables 5 and 6 derived from *2018–2019 Gusmer Enterprises, Inc. Wine Products Catalog*, the chart on page 64. Napa, CA: Gusmer Enterprises, Inc., 2018

Using Campden tablets: I will place a heavy bet that every other winemaking book out there aimed at the beginner suggests using Campden tablets to deliver SO_2 to your must or wine. The main arguments are that they are so convenient, and they deliver a known dose.

This book will suggest just the opposite. Do not use Campden tablets.

To deliver the appropriate amount of SO_2, one needs to know the amount of SO_2 in different doses of Campden, a whole tablet, a half tablet, a quarter tablet, and so on. You also need to know if the tablets contain potassium metabisulfite or sodium bisulfite and whether they were manufactured for the British market or the American market. I'll bet dollars to donuts you cannot learn these things. Why are they important?

Potassium metabisulfite and sodium bisulfite aren't the same things and not the same strength; they do not contain the same amount of sulfite. Therefore the dosages differ, slightly, but they differ. If they were manufactured for the British market, they contain a set dose for one Imperial gallon: 4.5 liters. If they were manufactured for the American market, they contain a set dose for a US gallon: 3.785 liters. So again, the dosages differ, slightly, but they differ. Finally, potassium is better than sodium, as we want to limit our intake of the latter for health reasons. The different doses outweigh the convenience of crushing a tablet. It is better to measure the crystalline potassium metabisulfite salt on a gram scale.

Finally, if you ever were to crush a Campden tablet for use in winemaking, you would need a mortar and pestle. It is not all that easy or quick to pulverize that hard tablet into a fine, dissolvable powder. After reducing it to a powder, it still has to be dissolved before adding to your primary or secondary. Suppose you draw off 2 cups of juice and add the powder. It will take you 3–4 minutes (or longer) of constant stirring to get that powder to dissolve. I did this often for almost a year before concluding there's nothing convenient about Campden tablets.

Using potassium metabisulfite: There are two ways to add potassium metabisulfite to your must or wine. You can weigh the calculated dose of the crystalline salt each time an addition is required, or you can make a known-strength solution and calculate your additions using that.

The first way works with the solid (crystalline) form of the salt. You can weigh and add it to your must or wine directly, or you can dissolve the salt in a little water or juice and then stir that into the whole batch. The first method is fairly straightforward and the one used in this book.

If you need to add 0.5 gram, you weigh out that much, stir it into some water, juice, or wine until dissolved, and stir that into the primary. When racking, add the sulfite to the wine the day before it is racked or add it to the new secondary.

Making up a solution (below) and adding it works just as well. Many people think it works better.

Adding the solid: Adding the potassium metabisulfite to the must or wine requires very little math. The following calculations were already done for you to simplify the recipes, but it is important you know how to do them.

You need to know the amount of SO_2 you have to add, by weight. Suppose you want to add 28 mg/L to your 1-gallon batch of wine. We need to remember four things:

- 1 gal. = 3.785 L
- We will convert mg/L to grams needed
- SO_2 = 57.6% of potassium metabisulfite by weight, or 0.576
- 1000 converts mg/L (parts per million, or ppm) to g/L and mL to liters

The formula for adding the solid form of potassium metabisulfite is:

$$\frac{\text{desired free } SO_2 \text{ mg/L} \times 3.785 \text{ L/gal.} \times \text{gal. of wine}}{1000 \times 0.576} = \text{grams potassium metabisulfite}$$

The following math solves the amount of potassium metabisulfite needed to provide 28 mg/L (ppm) of SO_2 in one gallon of juice or wine:

$$\frac{28 \text{ mg/L} \times 3.785 \text{ L/gal.} \times 1 \text{ gal.}}{1000 \times 0.576} = 0.18 \text{ g}$$

If we needed 28 mg/L for a 5-gallon batch, we would simply replace the 1 gallon with 5 gallons:

$$\frac{\textbf{28 mg/L x 3.785 L/gal. x 5 gal.}}{\textbf{1000 x 0.576}} = \textbf{0.92 g}$$

It should be stressed that the examples above were all based on the need to produce a certain amount of molecular SO_2 and raise the wine to an aseptic level. Both tasks are pH-dependent, and it makes no difference if you are adding this to red or white wine, each with its own molecular SO_2 needs; the formula will comply with Tables 5 and 6 and get the right answer. There isn't one formula for reds and another for whites.

Adding the solution: The easiest method to make up a stock 10% metabisulfite solution is to weigh out 10 grams of potassium metabisulfite and dissolve it in 75 mL of cool water. Once completely dissolved, carefully add cool water until the total liquid is 100 mL. You now have 10 g/100 mL or 100 g/L (100 mg/mL), a 10% potassium metabisulfite solution.

The previous formula need only be adjusted to account for the $\%SO_2$ solution as mg/mL:

$$\frac{\textbf{desired free } SO_2 \textbf{ mg/L x 3.785 L/gal. x gal. of wine}}{\textbf{100 mg/mL x 0.576}} = \textbf{volume potassium metabisulfite}$$

Using the same problem as in ***adding the solid***, we add the 10% SO_2 solution to the equation as 100 mg/mL:

$$\frac{\textbf{28 mg/L x 3.785 L/gal. x 5 gal.}}{\textbf{100 mg/mL x 0.576}} = \textbf{9.2 mL}$$

Storing your sulfite solution: Metabisulfite solutions degrade rather quickly in storage. Always date the jar/bottle with an expiration date three months from when the solution was made. The culprit is O_2, always up to no good after helping our yeast culture get a running start. The sulfites simply oxidize during storage. Use glass, not plastic, containers with tight-fitting closures. Measure what you need and close the jar up again. Be mindful of the airspace above the solution. As that space grows, the O_2 available for oxidation increases. It is helpful to have several empty containers in various sizes so you can transfer the solution to a smaller one as the solution is used up.

While we are on the subject of the shelf life of the 10% solution, you need to know that you will need to replace your potassium metabisulfite every year. When you buy it, write the date a year from then on the label so you'll know when you have to replace it.

Final thoughts on SO_2: We must never lose sight of the fact that some of the SO_2 we add will become bound, some lost to racking and bottling, and some lost to oxidation during maturation and bottle aging. We will never really have what we added except for the first few minutes after adding it. When asked to add a certain amount, which will remain fairly constant throughout the recipes that follow, we must do it. And the amount added must be as accurate as our digital gram scales can weigh it.

Sur Lie Aging: French for "on the lees," this is the process of leaving the lees in the wine for a few months to a year, accompanied by a regime of periodic stirring. Certain wines such as Chardonnay and Sauvignon Blanc benefit from autolysis because they gain complexity during the process that enhances their structure and mouthfeel. It gives them extra body and increases their aromatic complexity. Aging *sur lie* with lees stirring can result in a creamy, viscous mouthfeel. See ***Autolysis.***

Sweet Reserve: A sample of the original juice from which a wine is made is used to sweeten the finished wine after fermenting to dryness and stabilizing. The sweet reserve is either refrigerated or frozen until needed. When making a sweet reserve from whole fruit, such as strawberries, peaches, or plums, the fruit must be crushed and pressed, and the juice stood in a tall, clear, glass bottle in a refrigerator until the juice separates (*i.e.*, pulp sediment settles to the bottom of the bottle). The clear juice is very carefully racked off the sediment and stored for the reserve. The sediment can be lightly pressed through a double layer of sanitized muslin cloth, and the liquid obtained allowed to separate again, with the clear juice again removed and stored with the sweet reserve. The advantage of using a sweet reserve to sweeten a stabilized dry wine is that it adds sweetness, fresh flavor, and natural aroma to the wine. It may also improve the color of the finished wine somewhat.

Tannins: We noted earlier that acid gives structure to your wine, assuming it is in balance with other components: tannin, sugar, alcohol, and aromatics. What acids contribute to structure tannins contribute to complexity.

Tannins arrive from two, possibly three, sources. They originate in the base and are transferred to the must during maceration (fermentation on the pulp). They also originate in oak, whether barrel, chips, or extract, and again are extracted by the wine. In the absence of a tannic base, they may also be added by the winemaker in the form of powdered grape or oak tannin or liquid extracts. In this book, we use powdered grape tannin.

Balanced tannins present a sensory equilibrium between tannins originating in the base (or added by the winemaker) and those extracted from oak. Balanced tannins age more gracefully than those out of balance and are often described as soft, smooth, or silky. Over time, tannins polymerize with themselves and other polyphenols, changing in stages and forming longer molecular chains that are perceived as less harsh, more rounded, and softer.

Tartaric Acid: An acid found in grapes and several other fruits, tartaric is the strongest organic acid in our musts/wines.

Thermometer: For both primaries and secondaries, there are digital thermometers for winemaking that stick to the outside of the vessel or float inside. The outside models are convenient because they are non-intrusive and can be left on for the duration of the fermentation, offering a reading at a glance.

Yeast Nutrient: In most musts, our chosen yeast requires nutrients over what is naturally found therein. The exceptions are specific wine grapes grown in a perfect climate and with a perfect yeast for a given style. Assume a lug of these exceptional grapes fell into your lap. You would need a wine laboratory to figure what to do next, so assume, as a beginner, that all musts require yeast nutrients.

If you walk into any home brew shop or visit their online store, you'll find a generic product called yeast nutrient. With rare exceptions, this is diammonium phosphate (DAP), a nutrient rich in nitrogen, and one of the best bargains in the shop.

Generic yeast nutrient is often not enough for many fermentations. Yeasts also need micronutrients, key vitamins, minerals, free amino acids, sterols, and unsaturated fatty acids, that may not be available in the must and certainly are not available in DAP alone. Complete yeast nutrients are available in products such as Fermaid K and Superfood. These alone are often all that is needed, but if your yeast requires high nitrogen, then supplementation with DAP will be needed at the beginning of fermentation and halfway through it to ensure the wine will finish dry.

Most home winemaking recipes (even those on my website) almost always specify one teaspoon of yeast nutrient per gallon of wine. Although this is 4–5 times what is needed for the rare must requiring little if any added nutrients, it does provide a yeast with high nitrogen demands a more than adequate supply. However, yeast with high nutritional demands will probably still require a micronutrient supplement, in which case you should use 1 g/gal. of DAP and 1 g/gal. of supplement and be prepared to add more DAP if the wine does not appear it will finish dry.

Yeast Starter Solution: The "use by" dates on the yeast packets are mere suggestions. I have used yeast nine years past that date with success using a yeast starter. The starter compounds the number of viable yeast cells over time. Yeasts can propagate every 2–3 hours, so in theory, the yeast population of a culture can double every 2–3 hours. That means that in 8 hours, the population potentially can increase 16-fold, 12 hours 64-fold, and so on. Use the entire packet, even for 1-gallon batches, to build a super yeast starter that will kick-start a fermentation almost at once.

What to Do

To 1 cup lukewarm water (about 100–102 degrees F.) dissolve ¼ tsp sugar and a pinch of yeast nutrient. Add yeast culture, stir, cover the container, and set in a warm place.

After 2 hours, add ¼ cup water.

After another 2 hours, add ¼ cup water, ¼ tsp sugar, and a pinch of yeast nutrient. Stir.

After another 2 hours, add ¼ cup water.

After another 2 hours, add a pinch of yeast nutrient and ¼ cup of juice from your must.

Repeat the last step every 2 hours until you pitch the yeast starter. Stir well.

I like to husband a starter solution for at least 12 hours. If it is an old packet and starts slowly, that's usually enough time to develop a healthy culture, but if not, we can always increase the time.

Yeast Strain Selection: Selecting the correct wine yeast strain is one of the most important decisions the winemaker will make. With literally dozens and dozens of strains to select from, the task seems daunting. But the fact is that most strains are developed for specific *Vitis vinifera* varieties, specific styles, harvests, or other situations that most home winemakers will not encounter.

There are a handful of strains that are most useful for our needs. Over the years I have used over 60 cultures—the exact number is unknown because I did not take notes for several years. I even imported over 20 yeasts from the United Kingdom and Germany, with postage usually costing more than the yeasts. I had very good records of 60–62 yeast cultures until a water leak ruined a box of notes on many subjects.

Lemon zest

But a half dozen strains had become so routine that they became my go-to strains, my yeast toolbox as it were. A couple of other strains are always on standby for specific needs, and I keep a database of strains so I can search it when a need arises.

I keep about 30 sachets of yeast in a plastic box in my refrigerator to always have my favorite strains on hand, including 2–4 of each of my favorite go-to strains. You might only want a third that many if you make a lot of wine unless you buy your yeast when you make the wine.

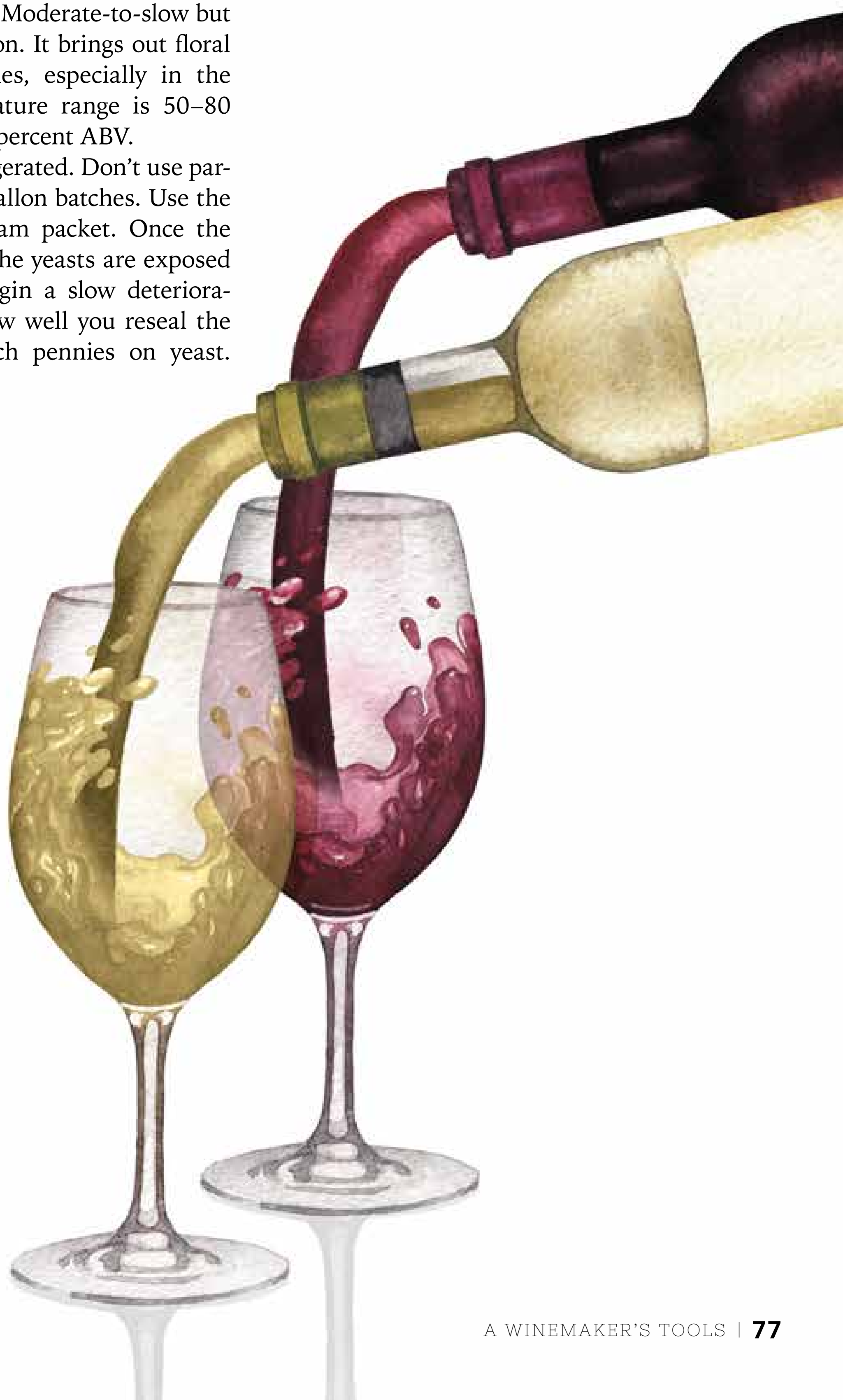
Zest: There is a difference of opinion in the use of citrus zest in winemaking. One camp believes the oils in the zest hamper and can even stall fermentation. The other camp, where this author sleeps, says bull roar. Having used zest in my winemaking almost from the beginning, I have never experienced any negative effects on fermentations.

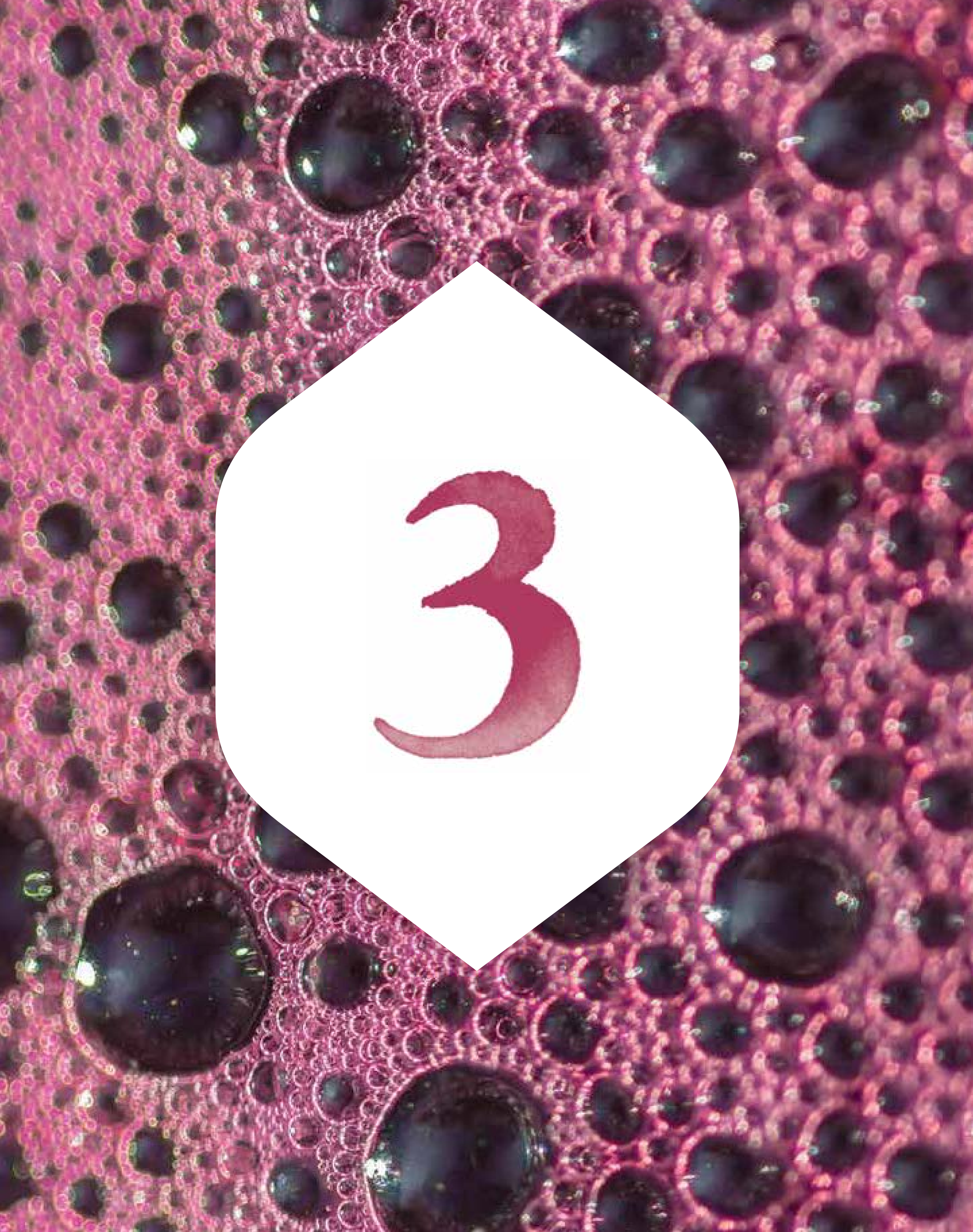
The Best Yeast Strains for Country Wines

- **Lalvin 71B**: Can metabolize 20–35% more malic acid than other yeasts, noted for producing fruity reds and rounder, smoother, more aromatic wines that tend to mature quickly. This is a great, go-to yeast for off-dry fruit wines. Temperature range is 60–85 degrees F., 14% ABV.
- **Lalvin BA11**: Promotes clean, aromatic, varietal characteristics, excellent esters, intensified mouthfeel, and lingering flavors in white fruit wines. Temperature range is 68–86 degrees F., 16% ABV.
- **Lalvin EC1118**: One of the most popular wine yeasts in the world. Low foam, productive at low temperatures, good for heavy suspended pulps, produces very compact lees, fast fermenter. A preferred choice in making sparkling wines, restarting stuck fermentations, low pH musts, excellent sensory properties. Temperature range 39–95 degrees F., 18% ABV.
- **Lalvin K1**: Tends to express freshness in fruit, produce flowery esters with good retention, ferments well under stressed conditions, and dominates almost any fermentation. Can restart stuck fermentation and ferment to 20% ABV if nutrients and nitrogen are sufficient. Temperature range is 59–86 degrees F.
- **Lalvin R2**: Use this yeast whenever a Sauternes strain is desired. It has an excellent temperature range, contributes esters, rarely sticks, and fermentation is fast. Temperature range is 42–86 degrees F., 16% ABV.
- **Lalvin RC-212**: A traditional Burgundy strain famous for big reds, it is suitable for black and red fruit. Tolerant of concurrent MLF, high temperatures, has excellent color stability. Requires high nitrogen and nutrients. Temperature range is 68–86 degrees F., 14–16 percent ABV.
- **Lalvin DV10**: The original Champagne isolate with relatively low oxygen and nitrogen demands. Known for clean fermentations that respect varietal character. Both reds and whites, and excellent for country wines. Fast fermenter under stressful conditions of low pH. High total SO_2 tolerance. Low foaming with low volatile acid production. Temperature range is 50–96 degrees F., 18% ABV.
- **Red Star Côte des Blancs**: Excellent for white wines as well as grapes,

fruit, cider, mead. Moderate-to-slow but steady fermentation. It brings out floral and fruity qualities, especially in the bouquet. Temperature range is 50–80 degrees F., 12–14 percent ABV.

Keep yeast refrigerated. Don't use partial packets for 1-gallon batches. Use the whole 5- or 8- gram packet. Once the packet is opened, the yeasts are exposed to air and will begin a slow deterioration, no matter how well you reseal the packet. Don't pinch pennies on yeast. Yeast is cheap.





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CHAPTER THREE

PUTTING IT ALL TOGETHER

You may well be wondering how all this fits together. We'll be using the language introduced in Chapters 1 and 2, so if you have to refer back to them that's all right. My first winemaking book, a thin paperback, did not explain things well upfront, and I was constantly highlighting key procedures as they were introduced so I could find them more easily when thumbing back through previous pages looking for meanings. I've tried my best to spare you that time-wasting chore.

Demystifying Winemaking: A Crash Course in Wine-Making

There are endless books on making wine from grapes, the perfect fruit for making balanced wines. They contain just about the right proportions of sugars, acids, tannins, pigments, and everything else you need to make good wine. Other fruits are not so blessed.

Making wines from other fruits and materials is a bit complicated, not because they lack sufficient sugar, which is easily added, but because they possess acid levels all over the place. Our biggest challenge is to measure and adjust their acid content. This is almost always done before fermentation is initiated, but there are exceptions.

Making non-grape wines can be divided into several steps, none of which are trivial. Some require considerable time. While some country winemaking books rush you to have drinkable wine in 3–4 months, we will allow the wine to mature and age according to its nature. For some wines, this may take as long as it takes many grape wines to complete the same journey.

The Basic Steps for Making Country Wine

1. First, inspect your ingredients for quality and ripeness, culling out any with damage, bruises, moldy or rotten parts, or those that aren't quite ripe.
2. Base ingredients are chopped, crushed, mashed, or otherwise prepared for fermentation. Appropriate amounts of sugar, acid, tannin, enzymes, nutrients, SO_2 and water are carefully combined.
3. An appropriate dry wine yeast is rehydrated and added to the must.
4. Fermentation carried out aerobically is closely managed. Skins, pulp, and seeds undergo a modest fermentation but then are removed, drained or pressed, and discarded. Additional nutrients may be added. The juice is transferred to a secondary and aerobic fermentation ended. Anaerobic fermentation is carried to a first racking.
5. Anaerobic fermentation, i.e. in a fermenter protected from air, is managed until the wine is clear. It is maturated according to its character, stabilized, and bottled.
6. Bottles are aged for a period that is determined by tasting.
7. These steps, with some modifications based on ingredients, are the paradigm for 99% of all non-grape winemaking. If you have never made wine before, they may still seem a bit mysterious. We will now try to demystify the process.

Selecting Ingredients

Good wine is made in the vineyard, orchard, briar patch, garden, or wherever the base ingredients originate. You cannot make them better than they are, except if you allow fruit to continue ripening for a few days on the kitchen counter.

Berry and fruit bases should be uniformly ripe. A few underripe berries will change the character of the whole, and not for the better. Don't hesitate to cull anything suspect. Of course, such berries are still good for eating (I usually do this on the spot).

If you don't have enough base material for a batch of wine, and it's perishable, freeze whatever you have in freezer-grade Ziploc bags until you have enough. A way to save space in the freezer is to crush things that yield juice readily, like berries, in the bags so the bags lay flatter than they would have. Label the bags with the material, weight, and date frozen.

Buying from Grocery Stores

If you have to buy your ingredients in a produce or supermarket, the produce manager is often a good source of information. Comice pears, when fully ripe, are one of the sweetest and juiciest pear varieties around. I always ask my produce manager when to expect them, and he always knows within a week or two.

Farmers' Markets and Local Producers Are Better

When I buy carrots for Carrot Whiskey (page 238), I always buy them at a local farmer's roadside stand. They are never more than a day out of the ground and are many times sweeter, fresher, and tastier than those found in my local supermarkets. This is also my source for Sugar Pie Pumpkins and watermelons (for both wines, see Chapter 11). If you live in a city and don't have farmers' roadside stands, look for an area farmers market. There usually is one, although it may be between you and an outlying small town.

Straining Bags

Most winemakers I know call them nylon straining bags because that describes them well. But I can always tell the winemakers with beer-making backgrounds; they call them grain bags. They also call winemaking "brewing," which it's not, but back to the bags.

Nylon straining bags are indispensable to home winemaking because they save you from a lot of work. My first containment bags were cotton. They worked well at containment but could not stand up to the pressures of pressing and often burst. When not used for pressing duties, they only lasted a dozen or so fermentations before they eventually burst. Nylon was a Godsend. It was strong enough to survive the press, and yeast didn't weaken it.

If you've never made wine, you'll be surprised just what yeast can do to berries and soft-fleshed fruit. Even hard fruit, like apples and cooking pears, will be reduced tremendously after chopping and crushing because the yeast can get into them better in that condition. Very fine suspended matter will still find its way into the must when the base, or what is left of it, is eventually pressed or drip-drained. Still, you'll come to love fine mesh.

The bags come in various sizes, both physically and in terms of the mesh. Over the years, I've discovered that the two finest mesh sizes are the most useful. For the majority of bases, we'll be using the fine-meshed bag, which does the best job at containment and, when allowed, pressing.


Preparing the must

Mashing Fruit

The recipes for most fruit and vegetables say to put them into nylon straining bags and mash them. Really soft fruit, like apricots, peaches, and plums (page 179) can easily be mashed with the bottom of a flat-bottomed wine bottle or certain potato mashers.

When mashing dark berries (page 127), by hand or otherwise, it is smart to wear rubber gloves. Many dark berries can stain hands for several days. Also, be careful to mash them deep inside the primary to contain juice splatters. Some can stain clothing permanently.

Adding Ingredients

In all recipes in this book, ingredients are added in sequences that are based on tradition and science. Winemakers have a certain leeway with some additives but not in others.

Sugar

Sugar, for example, can be added in stages—so much upfront and the rest later. This is usually the preferred method when making high-alcohol wines (14% ABV and higher) wines. Too much sugar upfront can create too much density in the juice itself. Excessive density may impede flow of substances in and out of yeast, and prevent yeast from expelling their waste products, ethanol and CO_2.

Sulfites

We will not be adding sulfites in stages because this would require you to conduct a test for free SO_2 at each racking. Instead, only two additions are required, an initial one, and one at stabilization.

Sulfites can also be added incrementally, and, in fact, this is the preferred method—add them as needed. When making wine from traditional wine grapes, adding excessive sulfites before pitching the yeast, especially in reds, can prevent malolactic fermentation (MLF) from occurring when it is desired. In this book, because we consider MLF a more advanced technique beyond our actual needs, we will use sulfites to prevent it altogether.

Yeast Starter Solution

While every recipe in this book except Watermelon Wine (page 334) uses the same words to describe hydrating and pitching the yeast, it is nonetheless hoped that one will get in the habit of making a yeast starter solution (page 74). This ensures that a viable yeast culture will be introduced, it also adds a vastly increased yeast population to the must. This vast population guarantees a vigorous fermentation with a fraction of the lag time the-more general hydration method stated in the recipe requires. Add a well-made, extended starter, and a vigorous fermentation is often evident within an hour or two.

Pectic Enzyme

Although not carved in stone, it is nonetheless a convention in country wines not to add pectic enzyme before adding sulfites. As the recipes in this book don't depend on malolactic fermentation (MLF), we don't have to load the pectic enzyme upfront and wait until fermentation concludes before adding sulfites. Both can be added before the yeast is introduced. For that reason, when the recipes in this book (with two exceptions) direct you to add sulfites, wait 12 hours, and then add the pectic enzyme. The 12-hour waiting period after adding sulfites and SO_2 is the minimum. Most winemaking manuals request 24 hours. In my experience, anywhere from 12–24 hours is sufficient.

Clearing the Wine

At what point does must become wine? The answer is probably around the first racking, but I always think of it as must until it begins to clear, when it obviously becomes wine. A fermenting must will be opaque. It will look like some form of whey or milk of magnesia, usually tinted with a hue associated with the color of the base. That is often an illusion. The colors we see in a base aren't often incorporated into the wine. They end up as a very fine dusting among the lees, and the wine we are left with has a slight hue (if any) integrated into an otherwise clear liquid. We call it white wine.

Seeing a wine "fall clear" for the first time is a magical experience. The milky substance we've been husbanding suddenly starts clearing toward the top. The milkiness begins to fall, slowly but steadily, like a curtain, leaving above it a liquid that is clear, or at least absent the cloudiness we've grown used to. Reds and dark bases like blackberries, red grapes, and beets assume their inherent colors, but they are clear. It is wonderful to watch. It may take a half-hour or three hours to complete, but it is a magical sight.

Upon seeing this, our first impression is that the wine is actually clear. Relative to what it was before, the wine is clear, but it's not clear enough to be a finished wine. It is still a bit hazy, cloudy, or simply unclear. We want a wine that is absolutely brilliant—crystal clear, like a diamond.

Improving Clarity

So back to our somewhat-clear wine. We'd like to improve its clarity. If it doesn't have a starch or pectin haze and isn't cloudy because of some errant bacteria, it will most likely clear on its own. It just might take a long time. Most often, tiny suspended (often microscopic) particles prevent the wine from clearing. Even though they are small, they reflect and refract light, making their presence known. The vast majority eventually obey the laws of gravity and end up on the bottom of the secondary. We don't want to disturb them, but we do need to very carefully rack the wine, leaving them forever behind. With that said, you need to realize it is very easy to disturb the lees and send those microscopic particles floating back up into the wine. It is also very easy to approach the bottom of the secondary with a racking cane and inadvertently suck the very fine lees up into the newly racked wine.

Fining

Suppose we don't want to wait months for these particulates to settle out or we don't want to risk disturbing the lees when moving the jug to rack it. We can speed things along by fining the wine. Fining is the introduction of an ingredient containing an abundance of either positively or negatively charged ions. These attract whatever oppositely charged particles might be suspended in the wine. The combined weight of the fining agent and the captured suspended matter is enough to cause them to settle out within a few days, and then the clarified wine can be racked off them.

It is more than likely we will not know whether the particulates in suspension are positive or negative in charge. In that case, we can use a 2-part fining regime, where one part is positively charged and the other is negatively charged, just to make sure we capture all the particulates. The only caveat is that if we do not wait long enough for the first agent to settle before adding the second, the two agents will simply attract each other, and we have wasted our time and money. It is essential we follow the instructions for the agents exactly.

Checking the Free SO_2

It was my initial inclination to ask you to do what I try to do, check the free SO_2 whenever the wine is exposed to oxygen. This means almost every racking. But then I lamented over the fact that I was trying to make the recipes simple, and that would complicate them considerably. Besides, that is not what I did as a beginner and had I been required to do it I may have never made more than a few wines. Would I rather you check the free SO_2 from time to time? Yes, but you need not do so. Follow the recipes here and the wine will turn out fine regardless.

There is another reason I didn't ask you to check free SO_2 periodically. That is money. Each test costs you money as consumables are used up and need to be replaced. I do not want you to spend money you don't need to spend. I want you to save your money for necessities, like that pH meter.

I felt uneasy requiring you to purchase a pH meter right upfront. I made wine for

19 years before I purchased a pH meter, and yet once I did I wished I had done so 19 years earlier. But I will say this about pH meters. They are far less expensive today than they were when I purchased mine. I have seen decent ones on eBay for about $40, but much better ones are to be had for $50-$70. This brings up another item I require you to purchase—the gram scale.

When I first decided I needed to measure additives using a gram scale, they cost over $120. I happened to be blessed at the time to work in a medical research lab, and we had gram scales all over the place. And these weren't the cheap $120 ones either.

It was impractical for me to halt my winemaking until the next day when I could measure my additive (usually potassium metabisulfite), so I bought a case of 144 small screw-cap glass vials and filled most of them with specific amounts of potassium metabisulfite. I thought accurate measures were that important. I still do, and so I ask you to bite the bullet and spend around $10 on a digital gram scale. Accurate measurements of potassium metabisulfite are that important. And isn't it wonderful that technological and manufacturing advances have brought the digital gram scale down from $120 for a cheapie to around $10?

A TA test kit is optional. They aren't that expensive—around $20—but I believe pH is more important than TA, so I place the expenditures in that direction. I did not always feel that way. For almost two decades, I fought off the pH enthusiasts. I started in the TA camp and saw no reason to change. But slowly, over the years, I came to recognize that pH could offer so much more insight into what is happening inside the wine and where it needed to go than could TA.

If you read in Chapter 2, under ***Acid***, subtopic ***Testing for TA with a pH Meter***, that your pH meter picked up the tab for the TA test kit, I apologetically correct that impression. You'll still need to buy a minimum quantity of sodium hydroxide, a graduated beaker, and a syringe. These individual items cost about as much as just buying the test kit.

After years of measuring TA and tasting the results, I went almost three years measuring TA by taste alone (not recommended that beginners attempt this). I wasn't always right, but I was never far from wrong. I couldn't do that with pH. For pH, I needed a meter. You will too.

Maturation

All of the rests that we give the must and the wine allow gravity to take hold of the must and wine, letting it clear and drop the suspended solids in it. The yeast itself takes the longest to drop. It is during this period when we are waiting for those very fine lees to form, sometimes no more than a light dusting, that the wine is undergoing maturation or bulk aging.

Maturation means coming into maturity. Maturation is one of two critical periods in the life of the wine, the other being bottle aging, for it is when the subtle chemical changes occur that build the character and style of our wine. Maturation creates the basis of the wine, and bottle aging takes it to its potential. During maturation, the two major components of change, the acids, and phenols (especially tannins) undergo their most significant interactions and evolutions.

Maturation is actually an indefinite period. The periods specified in the recipes are based on my experience, and your wine may take slightly less time to mature or quite possibly more. But one thing is certain: one day the wine will taste just right and be ready to bottle. You will know it when you taste it: the rough edges are gone, the wine is smoother, and the major taste components are in balance. If the wine is ready to age for the long haul, the tannins and acidity will say so. It is a wonderful feeling to taste your wine and just know the wine is ready to bottle. I wish I could be there when it first happens to you.

Bottle Aging

Some wines can, and should, be consumed fairly young. Others need to age a few months to reach their potential. Others need a long sleep before they are ready. The hardest part is waiting.

It is legitimate to wonder why "mature" wine, and bottled, at that, needs to age. Well, it is one thing to be ready to leave home and another to be ready for marriage. We have all gone through these stages, and every parent has watched his or her children go through them as well. It is a stretch to compare that with a wine's journey, but it is the first of the two best analogies I could come up with. Being ready to bottle and being ready to drink are simply two different milestones.

Here's another analogy: I love to make spaghetti sauce. I follow no recipe. I just know what essentials are required and start with them: stock, meat, tomato sauce, onions and garlic, salt, and pepper. Then I start adding whatever else I want in there, black olives, chunky mushrooms, a little thinly sliced celery, and so forth. I allow a certain amount of time to pass for the components to cook, and I taste, make what adjustments might be required, add a little red wine, reduce the heat to a barely perceptible simmer, put on the lid, and walk away. I allow the flavors to mingle, mix, and finally meld together. A half-hour, hour, however long it takes, I'll know it's ready when I taste it. Perfect. I turn off the heat and make the spaghetti, pop the garlic bread under the broiler, and it all comes together at once.

Did you follow that analogy? The base, the additives, the cooking (maturation), and then the aging, and when everything blends into a magnificent sauce, you just know it. Wine goes through similar stages. We just need faith and patience.

Back in the late 1970s, Orson Welles was the advertising voice for Paul Masson wines, with their signature slogan, "We will sell no wine before its time." Modify the slogan from "sell" to "drink" and you've got perfect advice for every home winemaker.

If you're interested in making wine out of a particular type of base or material, I've outlined some advice about issues to look forward to—and look out for—when making wine from each. I've also shared a number of stories about making wine from such materials. Some are funny, some may be surprising, but all, I hope are instructive.

Wine From Berries

Berry wines are flavorful, colorful, and often unique. They have long been a favorite of home winemakers for those reasons, and they can often be gathered in the wild for free. The wines bode well at 12% ABV, but at 13% and higher, they often require too much added sugar to balance and rarely can be presented dry. They can, however, be made into commendable port-style wines, with ABV reaching 18%.

Making wine from berries is both easy and challenging. It is easy because most berries readily ferment. It is challenging because most berries, not all, but most, have low a pH and high TA.

TA is fairly easy to correct. Adding an equal volume of water to a volume of juice will reduce the TA by half. Unfortunately, this has very little effect on pH, requiring other strategies to raise the pH.

Our friendly yeast, Lalvin 71B, can help when malic acid is present. Sweetening to counter the acidity is also possible and often will pull the wine together, although the resulting wine can be too sweet for many palates.

Preparing the must differs from berry to berry. It is sometimes advantageous to use a prepared juice rather than the actual berry. This is especially true if the berry isn't widely cultivated or found in nature.

When Buying Juice, Beware of Preservatives

If you're buying juice for winemaking at a supermarket, always inspect the label carefully. The ingredients must not contain any preservatives that will prevent fermentation. These include examples such as

sorbic acid (E200), sodium sorbate (E201), potassium sorbate (E202), calcium sorbate (E203), benzoic acid (E210), sodium benzoate (E211), potassium benzoate (E212), calcium benzoate (E213), sulfur dioxide (E220), sodium sulfite (E221), sodium bisulfite (E222) sodium metabisulfite (E223), potassium metabisulfite (E224), and potassium sulfite (E225).

Ascorbic acid, often listed as a preservative, is an antioxidant and will not subdue an active fermentation.

Of course, preservatives are not an issue when obtaining concentrates and juices from a winemaking/home brew shop. Concentrates are convenient for making larger batches of wine.

With other categories of wine, I sort of review them here before moving on. Not so with berry wines. The introduction of each wine in the chapter is more than sufficient, and anything I say here would be plagiarizing my own work.

Wine From Fruit

Here we limit our selections to fruits grown in temperate regions. It is readily available in markets, roadside stands, U-Pick orchards, and even trees in your yard.

The common fruits are pomes (apples, pears, quince) and stone fruit (apricots, peaches, nectarines, plums, cherries), but figs and persimmons also make good wine. Each fruit is prepared according to its composition and character. None are especially challenging, even when it comes to getting acidity levels under control, and therefore all are well-suited for the beginning winemaker.

My first winemaking experience was assisting in making a dandelion wine. I enjoyed it, but I wanted to do it myself. The dandelions had disappeared, but I hoped they'd come back (not for another year), and I knew I needed certain equipment and supplies, and so I set about collecting them. I didn't have any secondaries, so I went to my local supermarket and bought three 1-gallon glass jugs of apple juice, which I fermented into my first solo wines and was left with three secondaries.

Back then, there were no plastic jugs. Now, it seems, there are no glass jugs. But I have recently found them in certain large chain stores catering to the healthy-minded. You just have to look. I also discovered that many roadside fruit stands present their fruit juices in glass. So if you're looking for secondaries, look harder.

You can also buy jug wines in glass. They are usually 4 liters, just a few shot glasses more than a US gallon. They work just fine, and you have wine to drink.

Fruit Wines Are Perfect for Experimenting

Fruit wines beg to be played with. Adding herbs and spices to the fermentation yields a variety of flavors that make the wine more interesting. Blending wines does the same thing.

I know a fellow in Tennessee who has made over 200 variations of pear wine just by playing around with herbs, spices, bark, roots, flowers, other fruit, and blends. He once broke out a bottle that contained 18 different flavors, mostly herbs, and barks, but also anise, clove, and nutmeg.

As a self-appointed project, I once set out to make an apple wine that tasted like apple pie. I made three batches before I was satisfied. The only thing it lacked was the crust. I now know how to get that flavor, too, but have not married it all together. Some day . . .

Peach

Peach wines, like those of apple and pear, are perfect canvases for nuance, and in wine, nuance is what we're looking for. For your first peach wine(s), it is best just to try to capture the full flavor of your fruit. Add a little premium honey at the end, but easy on the additions, especially at first. If you add too much cinnamon, say, it will not taste like peach wine. Wait to unleash your creative additions/ingredients until you've captured the essence of the peach variety you're working with. Remember, your result won't taste like the fresh fruit, but of the wine from that fruit. You'll know when you capture it.

For any given fruit, there are likely hundreds of varieties and cultivars, each with its own character. Take peaches, for example. In the United States, more than 300 varieties are grown. Globally, there are more than 2,000 varieties.

Years ago I bought some early white-fleshed peaches and discovered a virtual treasure trove of flavor. At home, after eating just one, I drove back to the supermarket I purchased them from and talked to the produce manager. He could not tell me off-hand what variety it was, but after a few minutes of pleading, he got on the phone and called his distributor. It turns out the peach is a variety called Champion, a tender, juicy freestone peach with a sweet, delicate flavor. I bought enough for a gallon of wine, and a year later was so rewarded that I didn't want to part with even a bottle to see how it fared in competition. I just mentally awarded myself a Best of Show and drank it all. Don't squander your treasures.

When you find what you really like, stay with it. Every year when the first white-flesh peaches arrive, I buy just one and eat it in the parking lot. If it is Champion, I know it right away and go back in and buy more, with juice still dribbling from my beard.

Wine From Tropical Fruit

Tropical fruits are, well, fruits from the tropics, and the subtropics. In Chapter 7, we look at 12 tropical fruits that make excellent wines. Five of them are citrus. I could have added 3–4 more citrus and they would all make different wines, but I didn't want the chapter to reflect just the *Citrus* genus of the *Rutaceae* family.

With the exception of the banana, with a TA of about 3 g/L, almost all tropical fruit is tangy and acidic. Lemons and limes can have a TA of 50 g/L, a daunting thought. That isn't a TA you're likely to run into, but it's a possibility.

Every time I make lemon wine, which is nothing like hard lemonade, they make great wine. It is always a bit tart, like all lemon beverages, but it's good. My favorite lemon is the Meyer lemon. You can actually eat them without making a face the whole time. I did not include it here, but plan to do so in my next book; it is a good foundation for unusual wine blends. But then so are regular lemon wines.

There are 24 lemon varieties I could reference, but three popular varieties represent most of what we buy at the supermarket: Lisbon, Eureka, and Bearss.

The vast majority of winemakers who have mastered lemon wine have done so because they have one or more lemon trees. We had a lemon tree years ago when I was growing up, and it produced so many lemons we could not drink lemonade fast enough to keep up with it.

Mango

Mango is one of my favorite tropicals. It, too, has multiple varieties. I just buy what the market carries, but when my wife and I land in Hawaii it is a different matter altogether. When you visit a large farmer's market, you can see physical differences in the mangoes, and by asking a few vendors who are *not* selling mangoes you can gather several opinions of which are the best. (If you ask a vendor selling them the answer will always be the variety he or she is selling.)

Mangoes make great wine. I had an acquaintance in Honduras who made a couple of batches of mango wine, consulted with me to negotiate a minor problem he was having, and before I knew it, he had established a mango winery. He said he was surrounded by mango trees, everyone had one or more, but very few people knew how easy it was to convert all that fruit into wine.

Passionfruit

The passionfruit is avoided by many simply because they are unfamiliar. Big mistake. They are a different fruit, to be sure, but flavorful and satisfying. Native to Brazil, they can only be grown in the South or in states like Florida or California, although a wild vine was discovered in Maryland of all places in the 1980s. Go figure.

I have never tasted it, but I was told by a reliable horticulturist that one variety of passionfruit (Scarlet Flame) tastes like strawberries, and another (Maypop) has a distinct apricot flavor. The most common commercial variety in the United States is the Purple Granadilla. Its purple skin hides an orangish flesh with delicious, sweet, aromatic, subacidic flavor. It's good eaten out of hand, made into jelly, mixed with ice cream, but also good in beverages, including wine.

Pineapple

If you don't think of Hawaii when you see a pineapple then you haven't lived. There is no sweeter, more fragrant and flavorful pineapple than one harvested the morning of the day you encounter it. They simply lose much of that freshness within 24

Pomegranate

The pomegranate is a truly magnificent fruit. As the thick rind dries on the tree, it locks in the hundreds of small juice sacs, called arils, keeping the seeds viable. That juice is sweet and flavorful, inviting all manner of wildlife to seek them out, spreading the seeds in the process.

Eventually the outer rind of fruit still on the tree finally splits, exposing the aril to the elements. Breezes spread the sweet scent as a calling card, and the winged seed-dispensers come in for a meal.

The flavor of pomegranate depends almost entirely on the variety and the nutrients and moisture the tree can extract from the soil. In bad years, the sweetness and flavor can be thin, so the tree drops some fruit and the remainder stays small, concentrating all that is to give in the waiting arils. In good years, the tree cannot produce enough fruit, and the fruit it does produce is huge, some with as many as 1,000 arils and packed with rich, sweet, flavorful juice.

Only a lack of imagination would pass this fruit by as a source of good wine. Besides the grape, it is the only fruit mentioned by name in the Bible as a wine source (Song of Solomon 8:2). The wine can be thin, especially if consumed too young, but as it ages it gains body, structure, and texture.

I once had a 5-gallon carboy of 3-year-old pomegranate wine, the longest my patience would wait, which, when I finally bottled it, was already better than most grape wines littering the shelves of stores everywhere. There was a woman I met at a nearby winery who had just purchased a premium bottle of strawberry reserve, back-sweetened with pure, clarified strawberry juice. During our chit-chat, I mentioned I had just bottled a pomegranate wine. She immediately offered to trade me the $30 bottle of the strawberry reserve, which I knew to be ambrosia, for a bottle of the pomegranate. I drove home, only 11 or 12 miles away, and fetched her a bottle of the pomegranate. Upon later drinking the strawberry, as good and rich as it was, I realized that she got the better end of the trade.

Get hold of some pomegranates and make some wine, and then practice patience for as long as you can. If you practice long enough, you'll be richly rewarded.

hours, so most of the pineapple we eat on the mainland is past its peak before it's ever delivered to our market.

I've been convinced a long time that the only way to make the very best pineapple wine is to make it in Hawaii. And then I slowly began to realize something. Canned pineapple is closer to the fresh flavor of a newly harvested one than the ones we can buy in our supermarkets. I began reading the history of the pineapple industry in Hawaii. It is both fascinating and intricate. James Dole is given credit by almost everyone as the driving force and innovator in the Hawaiian pineapple industry. His work in mechanizing the processing and canning of fresh pineapples and planting the dominant variety largely contributed to the industry's growth. He was not alone, nor was he key to every innovation, but he was ever-present and more than willing to reap the rewards of pioneering work done by others. Why am I telling you this? Because he was largely responsible for ensuring that canned pineapple tastes almost as good as the fresh fruit. So I tip my hat to him as I open the cans of pineapple that will give birth to my wine.

Starfruit

If you live in the tropics and know of someone with a carambola tree, try to become good friends. Its fruit, the starfruit, is a culinary and winemaking delight. It makes a wonderful dry white but is probably most often bottled semi-sweet.

The starfruit has considerable amounts of oxalic acid, making it an acquired taste for those who haven't tried one before. But since the wine is made lightly spiced with cinnamon, you shouldn't even notice the oxalic acid in the wine.

This wine comes with a health warning. If you have kidney stones or have suffered kidney failure, you should regretfully not consume this wine or fruit. A small sip to see what it tastes like should be okay, but not a glass.

Tangerine

Tangerines are a favorite citrus snack. Easy to peel, reliably sweet, they are just a good snack food. As one of my aunts said at a family reunion, "You can eat tangerines and smile the whole time." In other words, their acidity level isn't as grimace-inducing as lemons, say.

When fermented along with Valencia, Blood, or Cara-Cara oranges, tangerines make for a very nice wine with a unique flavor profile. Better yet, all one has to do is assemble and prepare the ingredients. The wine makes itself.

Oddly, tangerine is not a wine seen that often in competitions. When entered, a well-made tangerine wine will always do well. That doesn't mean there won't be better wines it has to compete against, but that is true for every wine, period.

13

CHAPTER THIRTEEN

HELPFUL RESOURCES

Appendix A. Abbreviations and Equivalent Measures

Abbreviations used in this book

Cup = c
degrees Celsius = degrees C
degrees Fahrenheit = degrees F
fluid ounce = fl. oz.
Gallon = gal.
Gram = G
Liter = L
Milligram = mg
Milliliter = mL
Ounce = oz.
parts per million = ppm
Pound = lb. (plural lb.)
specific gravity = SG
tablespoon = tbsp
teaspoon = tsp
trademark = ™

U.S. Equivalents (Rounded)

1 oz. = 28.35 g
1 g = 0.035 oz.
1 lb. = 16 oz. = 454 g
1 L = 0.26 gal.
1 fl. oz. = 29.57 mL
1 gal. = 128 fl. oz. = 3.785 L
1 qt. = 32 fl. oz. = 946.24 mL
1 mL = 0.034 fl. oz.
1 tsp = 5 mL
1 tbsp = 15 mL
1 cup = 8 fl. oz. = 237 mL

Raise TA

Tartaric acid
raise TA by 0.1%
1 g/L
3.785 g/gal.
Malic acid
raise TA by 0.1%
0.9 g/L
3.407 g/gal.

Lower TA

Calcium carbonate
lower TA by 0.1%
0.67 g/L
2.536 g/gal.

Appendix B. 231 Edible Flowers Suitable for Making Wine

Many years ago I began compiling a list of edible flowers. Because they are edible, I reasoned, they should be suitable for making wine. After several years of adding occasional flowers to that list, which was a prolonged, piecemeal effort, I published it on my website. It is not the exact list as in the table below, but it is almost the same.

There are three comments I'd like to say about the list at right. First, all the flowers listed have been validated as both edible and non-toxic to humans, although they may be toxic to certain domesticated animals.

Second, the word "suitable" may be theoretical in certain cases, as some flowers are very small, and it would take a long while to collect enough to make wine. Yet, I have done so with the small flowers of the Kudzu vine. It took more than a couple of hours to collect enough flowers to attempt a batch, which was delicate and could have used a couple hundred more flowers.

Finally, I completed this list after reviewing the literature over years, and I haven't made wine out of everything on this list. The list is a sample of what is probable, but be sure to confirm edibility yourself first.

231 Edible Flowers Suitable for Making Wine

Allegheny barberries
Alliums
Angelica flowers
Anise hyssop flowers
Apple blossoms
Apricot petals
Arugula flowers
Bachelor's button petals
Banana blossoms
Basil flowers
Bean blossoms
Bee balm petals
Begonias
Bellflowers
Bergamots
Bermuda buttercups
Birch flowers
Bird cherry flowers
Black locust blossoms
Borage blossoms
Broccoli flowers
Buffalo gourd blossoms
Burnet flowers
Butterfly ginger flowers
Cactus blossoms
Calendula petals
Camellias
Carnations
Chamomile flowers
Charlocks
Cherry blossoms
Chervil flowers
Chicory petals
China rose petals
Chinese catalpas
Chinese chives
Chinese hibiscus
Chinese lanterns
Chive blossoms
Chocolate lilies
Chrysanthemums
Cinnamon rose petals
Clary flowers
Clovers
Cloudberry petals
Coltsfoots
Columbines
Common milkweed
Common thistles
Coreopsis
Coriander flowers
Cornflower petals
Corn poppies
Cowslips
Crab apple blossoms
Currant flowers
Dahlias
Daisies
Dandelion petals
Day flowers
Daylilies
Dianthus
Dill flowers
Dog violets
Elderberry flowers
English daisy petals
English primroses
Evening primroses
Feijoa flowers
Fennel flowers
Field garlic flowers
Gardenia blossoms
Garden sorrel flowers
Garlic flowers
Geraniums
Ginger petals
Gladiolus flowers
Golden wattles
Good King Henries
Gorse flowers
Grapefruit blossoms
Grape hyacinths
Green wattles
Hawthorn flowers
Hibiscus flowers
Hog plum flowers
Hollyhocks
Honeysuckle flowers
Huisache
Hyacinth bean flowers
Hyssops
Impatiens
Indian cress flowers
Indigo bush flowers
Iron cross plant flowers
Jamaica sorrels
Japanese apricot blossoms
Japanese honeysuckle flowers
Japanese plum blossoms
Jasmine flowers
Johnny jump-ups
Joshua tree blossoms
Judas tree flowers
Kenaf flowers
Kudzu flowers
Kumquat blossoms
Lavateras
Lavender flowers
Leek flowers
Lemon blossoms
Lemon verbenas
Lespedezas
Lilacs
Lilac oxalis
Lily buds
Lime blossoms
Linden flowers
Locust blossoms
Lovage flowers
Magnolia petals
Mallow blossoms
Marigolds
Mariposa lilies
Marjoram flowers
Marsh marigolds
Marsh violets
Maypops
Meadowsweets
Melilots
Mimosa flowers
Mint flowers
Monardas
Morning star lilies
Mountain bells
Mush mallows
Mustard flowers
Nasturtiums
Nectarine blossoms
Okra blossoms
Onion flowers
Orange blossoms
Oxeye daisies
Oyster plant flowers
Pansies
Passion flowers
Pea blossoms
Peach blossoms
Pear blossoms
Peonies
Pineapple guava flowers
Pineapple sage flowers
Pink sorrels
Plum blossoms
Prairie onion flowers
Prickly pear blossoms
Primroses
Pumpkin blossoms
Purple milkweed flowers
Purple sage blossoms
Queen Anne's lace
Quince blossoms
Radish flowers
Red alders
Redbuds
Red clover
Rhubarb flowers
Rose petals
Roselle flowers
Rosemary flowers
Rose of Sharon petals
Russian sage flowers
Safflowers
Sage blossoms
Salmonberry petals
Salsify flowers
Savory flowers
Scarlet runner bean blossoms
Scotch brooms
Scotch thistles
Shallot flowers
Sloe blossoms
Snapdragons
Sorrels
Southern magnolia petals
Spiderwort petals
Spring beauty flowers
Squash blossoms
Strawberry flowers
Sunflower buds
Sunflower petals
Sweet briars
Sweet coltsfoots
Sweet pepper flowers
Sweet violets
Sweet Williams
Sweet woodruff flowers
Tangerine blossoms
Tansies
Thimbleberry petals
Thyme flowers
Tiger lily buds
Tree peonies
Trout lilies
Tulip petals
Verbenas
Violas
Violets
Water hyacinths
Water lily petals
Water lotus petals
Wax gourd blossoms
Western columbine
Western redbuds
White alders
White clovers
White trumpet lilies
Wild columbines
Wild onion flowers
Wild plum blossoms
Wild raspberry petals
Wild rose petals
Winter sweets
Wood rose petals
Wood sorrels
Woody thistles
Yarrow flowers
Yellow bells
Yellow butterfly bush flowers
Yellow rockets
Yellow sorrels
Yucca blossoms

Use the list as you will. There are many flowers on it that have long been made into wine. Finding the recipes grows more difficult with time, as the major search engine most of us use (Google) is increasingly more commercial—search the name of a flower, and you're very likely to get pages of products with the flower in their names.

Note: When foraging for flowers or any other materials for making wine, always confirm your identification and rule out toxic look-alikes.

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About the Author

Jack Keller lived in Pleasanton, Texas a half-hour south of San Antonio. Winemaking was his passion and for decades he made wine from just about anything both fermentable and nontoxic. Jack developed scores of recipes and tended to gravitate to the exotic or unusual, having once won first place with jalapeño wine, second place with sandbur wine, and third with Bermuda grass clippings wine.

Jack was six times elected President of the San Antonio Regional Wine Guild, was a certified home wine judge, periodic contributor to *WineMaker Magazine*, and creator and author of *The Winemaking Home Page*, which was the largest home winemaking website in the world and the first winemaking blog on the internet.

Jack grew a few grapes and was married to his high school sweetheart Donna (née: Bennett). He was a mentor to thousands of amateur winemakers and communicated through his Facebook page, Jack Keller Winemaking (https://www.facebook.com/JackKellerWinemaking/). He passed away in 2020.

About the Technical Editor

Daniel Pambianchi is a well-known winemaking author, lecturer and consultant, and seasoned winemaker both as an amateur and professional having owned and operated a small commercial winery in Niagara Wine Country in Ontario, Canada. His bestselling book *Techniques in Home Winemaking* has become the go-to reference textbook by advanced amateurs and small-winery operators alike. His area of expertise is wine chemistry in which he performs extensive studies in his wine analysis lab. He is a member of the American Society for Enology and Viticulture, the Australian Society of Viticulture and Oenology, and the American Wine Society. Daniel lives in Montreal, Quebec (Canada).

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