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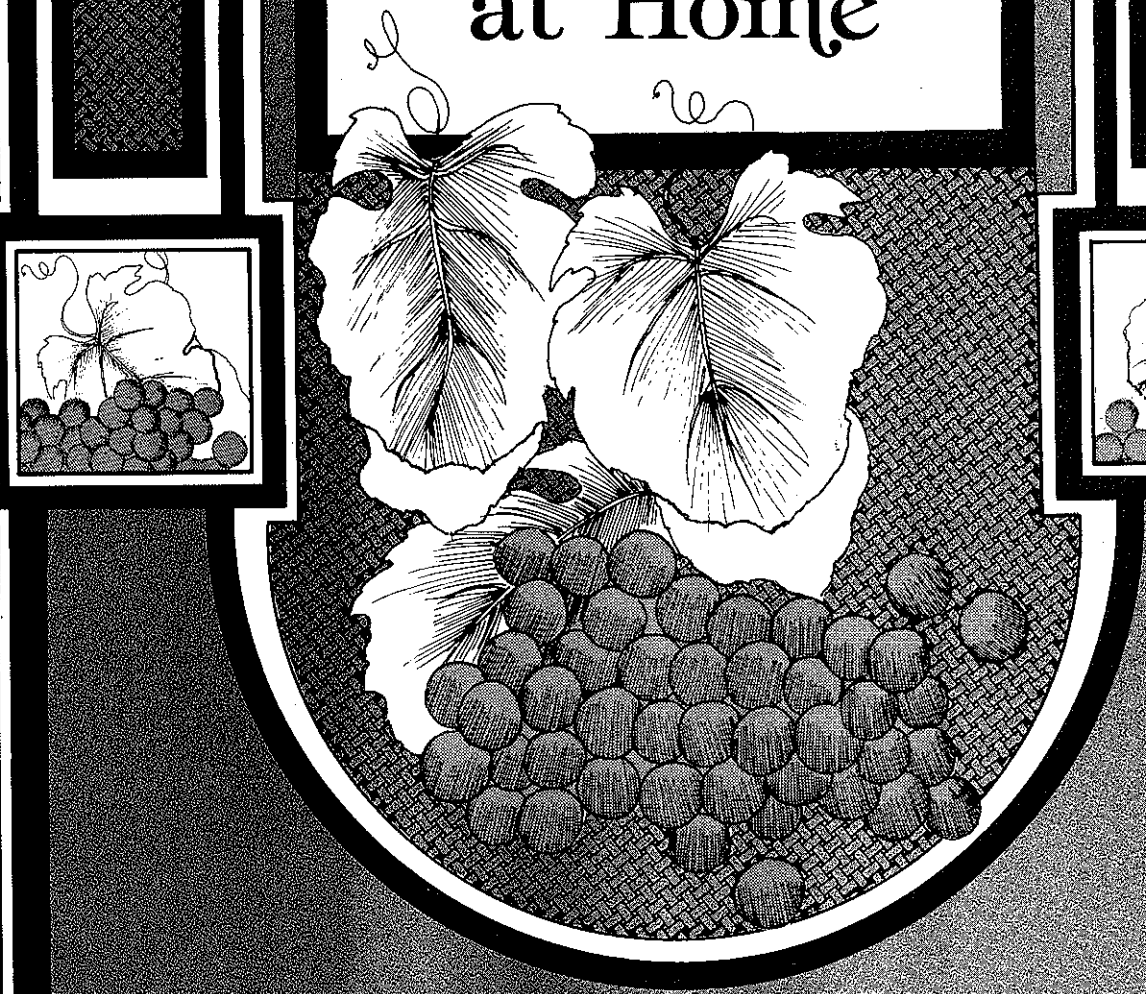
Making Bottle-Fermented Sparkling Wine at Home



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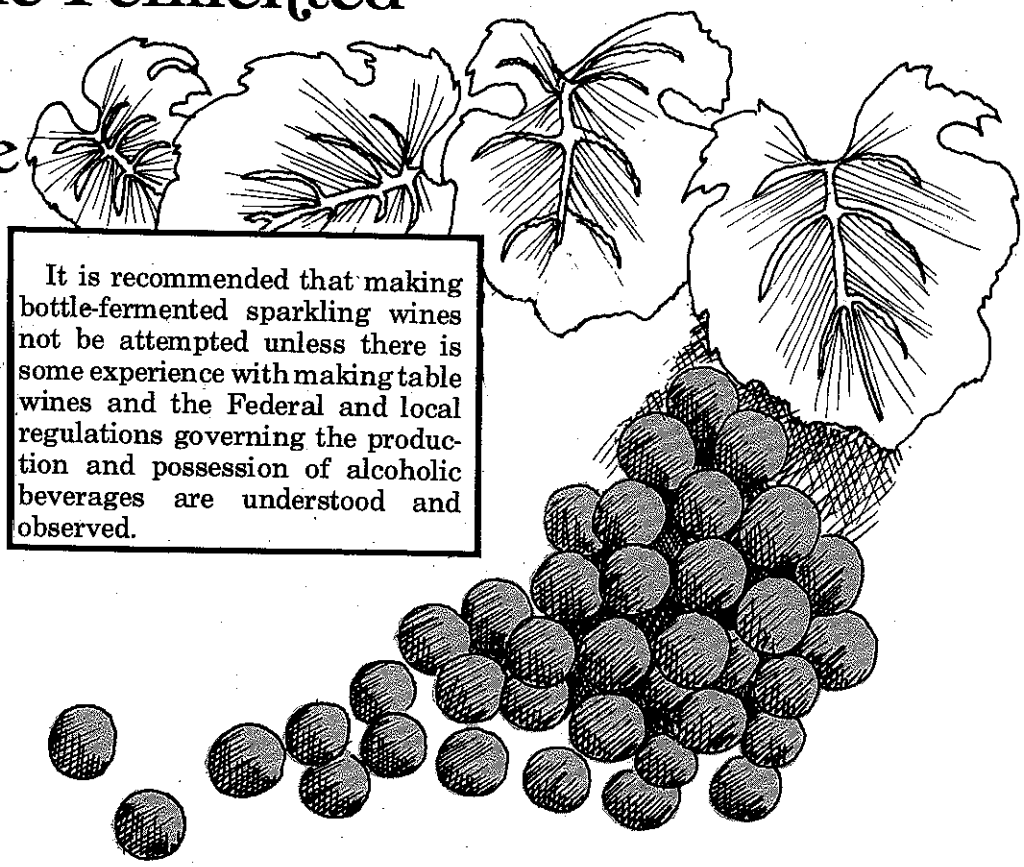

It is recommended that making bottle-fermented sparkling wines not be attempted unless there is some experience with making table wines and the Federal and local regulations governing the production and possession of alcoholic beverages are understood and observed.

Sparkling wine made by the bottle-fermented method or Methode Champenoise (as used in the French province of Champagne) is a wine that contains more than 0.392 grams (g) of carbon dioxide (CO_2) per 100 milliliters (ml). This amount of CO_2 is about 15 pounds per square inch (psi) or 1.0 atmosphere of CO_2 pressure at 15.56°C(2). Most sparkling wines contain 60-80 psi when finished.

All equipment used in making bottle-fermented sparkling wine should be cleaned thoroughly with hot water, steam, trisodium phosphate or sodium carbonate. (*Never use soap or detergents*). Accurate records of all operations should be maintained.

The steps in making sparkling wines are as follow:

Step 1. Preparation of Blend or Cuvée

The sparkling wines are made from blends or cuvées of two, three, four or more wines. Wines to be used for making a sparkling wine should be made from grapes selected for that purpose and preferably from the free-run juice. Only well-made, stabilized, fined and filter-polished still white, red and rose wines should be used for the preparation of a blend or cuvée. The purpose of blending is to obtain certain flavor and aroma qualities, chemical balance and other desired characteristics in the finished product.

The white cuvée should be of light straw to pale yellow color and light in body, with no noticeable defects or off-flavors and practically no residual sugar (dry wine). The alcohol content should be 9.5 to 11.5% by volume. The free sulfur dioxide (SO_2) content should be 0 to 10 parts per million (ppm), with total acidity between 0.7 and 0.9 g/100 ml and pH between 2.9 and 3.5. The cuvée should be free of preservatives (1,2).

About 1% of the cuvée should be withdrawn and set aside for use in finishing the sparkling wine (6).

Step 2. Adjustment of Alcohol Content and Acidity of the Cuvée

The usual content of alcohol (11 to 12%) in dry wines can inhibit yeast somewhat and can prevent refermentation of the cuvée or cause fermentation to proceed extremely slowly. Therefore, dilution to lower the alcohol content to about 10.0 to 10.5% by volume is customary. Suppose that 100

gallons (378.5 liters) of a cuvée with 12% alcohol by volume is to be diluted to 10.5% alcohol content. A formula that can be used is

(V + W) X = (W) (Y), where

V = Volume of water to be added to the cuvée

W = Volume of cuvée to be diluted

X = Percentage of alcohol (by volume) desired in diluted cuvée

Y = Percentage of alcohol (by volume) in the cuvée to be diluted.

Using the above example it follows that

(V + 100) 10.5 = (100) (12)

10.5V + 1050 = 1200

$V = \frac{1200 - 1050}{10.5} = 14.3$ gals of water to be added, or 54.1 liters.

Sparkling wines are invariably more acid than ordinary dry table wines because of CO_2 production. As a general practice, the wines intended for use as a cuvée should be adjusted during preparation of the cuvée. Acidity that is too low or too high must be corrected before the cuvée is dispensed into champagne-type bottles for refermentation.

Step 3. Addition of Sugar

The cuvée must be dry. Residual fermentable sugar must be entered in the calculation of initial sugar content of the cuvée. As a general rule, 0.5 ounces of sugar per gallon (4 grams of sugar per liter) will produce 1 atmosphere of CO_2 pressure or 15 psi. Sparkling wines usually contain 5 to 6 atmospheres or 70 to 90 pounds psi pressure. Therefore, sugar is added at 2 to 2.5 ounces per gallon (16 to 20 grams per liter).

Sucrose or cane sugar is the sugar of choice. After thorough mixing to dissolve the sugar, degrees Brix are checked with a narrow-range hydrometer (-0.5 to +0.5 Brix). For practical purposes, the sugar content should not exceed +0.5 Brix.

Step 4. Addition of Energizers

Energizers serve as nutrients and/or growth substances. Of the essential nutrients required, nitrogen is most frequently in low supply or may be lacking. It may be added to the cuvée as diammonium phosphate, at a rate of 0.5 grams per liter or 4 pounds per 1,000 gallons (4). A source of vitamin B_2 also is added at a rate of 0.05 grams per liter or 0.4 pound per 1,000 gallons of cuvée. A commercial product sold under the trade name of Yeastex® can be used instead, because it serves as a source of nitrogen and vitamins.

Step 5. Addition of Yeast Inoculum

Several champagne yeast strains are commercially available. The yeast must be selected carefully for the purpose of refermentation. It must have the ability to ferment under the conditions in the cuvée (10.5% alcohol) and must be able to produce granular sediment of yeast cells at the completion of fermentation. The yeast starter is grown in the usual fashion in some of the cuvée. When the starter cells are growing actively, the yeast inoculum is added to the cuvée at the rate of 2 to 3% by volume (1).

Step 6. Bottling

The cuvée is agitated to prevent settling of the yeast and is filled into 750 ml-capacity champagne bottles. The bottles are sealed with cork-lined crown caps of best quality. They are capped using a specially designed capper. Champagne bottles are manufactured of heavy glass and have a push-up or punt at the bottom. This provides added strength of the bottle (1). If the temperature is too high, fermentation too fast, sugar content too high or bottles are scratched or defective, bursting of bottles may occur and losses will be excessive. *The bottles should not be re-used.*

Step 7. Fermentation in the Bottle or "Tirage"

The bottles are stacked horizontally (binned on their sides) in a cellar kept at between 15.5 and 21.1° C (60 to 70° F), and the contents are allowed to ferment. The yeast converts sugar into CO_2 and ethyl alcohol, but, unlike the fermentation of still wine, the CO_2 cannot escape and is dissolved in the wine. As a result, considerable pressure (80 to 100 psi) is created in the bottles. The fermentation is rather slow and may proceed for months. More flavor and bouquet develop and permeate the wine the longer the wine is kept in tirage. The ensuing flavor stems from the autolysis of a thin film of yeast cells found on the walls of the bottle, followed by intricate biochemical transformations within the contents of the bottle. Completion of fermentation can be ascertained accurately by correct measurement of the atmospheres of CO_2 pressure.

Step 8. Riddling or "Remuage"

The wine is cleared and riddled at least three months (preferably six months) when fermentation is complete and the wine has aged. In France, riddling is called "remuage," meaning "moving", and the individual performing this process is called a riddler. In riddling, the yeast is settled onto the cork of the crown cap. The purpose is to collect the sediment into a compact mass on the cap.

In this step, bottles are placed neck down at about an 80° angle (3) in 2.5" (6.3 cm) diameter holes spaced about 6" (15 cm) apart in specially designed racks ("A" frames). A protective face and throat shield should be worn by the riddler, along with protection for hands, arms and legs in case of bottle breakage.

To dislodge the sediment from the walls, the bottle is given a short sharp turn (usually 1/4 of a turn in clockwise direction on days 1, 3 5--- and in the opposite direction on days 2, 4 6---) and is dropped back into the rack with a jolt. Different techniques are used by different riddlers. The riddling may be finished in a week (if the wine is easily clarified) or may require a month or longer. Clarity is established by visual inspection (often with the aid of a light source held behind the bottle) of several bottles selected at random.

Step 9. Disgorging

The bottles are disgorged when the wine is "clear". This is the removal of sediment (deposited on the crown cap) without loss of wine. Stated otherwise, disgorging is the freezing of an ice plug in the neck of the bottle with a brine solution or by other methods (4) and removal of the crown cap to allow the ice to push the yeast sediment out ahead of it, thus clarifying the contents of the bottle.

The bottles are removed carefully (neck down) from the riddling racks before disgorging and are stored in a chiller where they are held at about -4°C (25°F) for several days to several weeks. This holding period serves to eliminate tartrates and to assure CO_2 retention by the wine. Red wines often are allowed a longer cold-holding period than are the whites.

After chilling, the bottles are placed (neck down) in a prepared solution of coarse salt and crushed ice or in a mechanically cooled refrigerant (diluted ethyl alcohol, glycol, etc.) so that the solution reaches about one inch (2.5 cm) up the neck of the inverted bottles (4). Contents of the neck freeze, and the sediment forms a solid plug of ice. The freezing time will be between 10 to 15 minutes at a temperature of -15°C (5°F). Disgorging should be done with care to guard against abrupt temperature changes that may crack the bottles.

The bottle then is removed and turned upright at about a 45° angle, and the cap is removed with a cap opener. The ice and sediment with it are pushed out by the CO_2 pressure. To prevent the ice plug from being discharged into open space, a "window" can be cut in the side of a container so that the neck of the bottle can be inserted in it. The ice plug and sediment are then trapped in the container when discharged from the bottle.

Properly performed, this operation leaves the bottle and its remaining contents brilliantly clear. As some CO_2 and wine are lost by this operation, it is recommended that the thumb be placed over the mouth of the bottle to minimize loss and that the bottle be placed gently on a table.

Step 10. "Dosage"

Dosage is the addition of syrup to adjust the sweetness of the wine and restore the contents lost during disgorging. Most people seem to prefer dry sparkling wine, but such wines may taste unpleasantly tart without a little sugar. How much sugar to add depends on the preference of the winemaker.

The dosage syrup usually consists of about 60 grams of cane sugar (sucrose) in 100 ml of a mixture of 90 parts of the original cuvée (or a compatible well-aged, high quality table wine) and 10 parts of high-proof, high-quality brandy (1). The practice of adding brandy is used only infrequently today because the natural grape flavors developed with sound fermentation and aging techniques are preferred. Dosage also must contain SO_2 preservative calculated to raise the SO_2 content in the sparkling wine to about 50 ppm. The usual volume of dosage is 50 ml. However, if this does not bring the volume in the bottle to 750 ml, the wine from another bottle without dosage is used to make up the deficiency (for "topping up").

Dosage is administered with a special machine that provides establishment of a closed system and an equilibrium before further processing. Adding dosage by hand also is possible if extreme caution is practiced; otherwise, excessive effervescence may ensue, and large losses may be experienced.

Step 11. Closure, Wire Hooding and Capsuling

Finished sparkling wines are corked and wire hooded. Corking involves using natural corks (preferably laminated) or plastic stoppers. Natural corks need to be softened by presoaking in warm water 40 to 45 minutes or in glycerol (about 2%) held at 26.6°C (80°F) for about one hour. A specially made machine must be used to drive the corks into the bottles. A cork about 1.22″(31 mm) diameter by 1.89″ (48 mm) long is driven about 0.83″ (21 mm) into a bottle with a mouth diameter of 0.63″ to 0.67″ (16.3 to 16.7 mm) (2). Recently developed plastic stoppers of high quality are applied by hand, using a mallet to drive them into the bottle. They do not require presoaking and are ordinarily leak tight.

Cork and plastic stoppers are further secured by putting appropriate wire hoods over them. The loop of the hood is fitted under the "ridge" of the bottle, and the two ends are brought together and twisted until the loop fits snugly against the neck of the bottle.

The finished bottles are rinsed outside by hand wiping, rotating brushes or water sprays and are stored horizontally for a brief period (2 to 3 months) at a relatively constant temperature of 10° to 15.5°C (50 to 60°F) to set the cork into the bottle, to allow the dosage liquor to "marry" with the wine and to detect the leaker bottles. Further aging appears to be of no great advantage. The bottles then are inspected, labeled, foiled and flounced, and the wine is ready to be served.

Suggested Equipment and Supplies

1. *Wine hydrometer* -0.5 to +0.5 Brix
2. *Potassium metabisulfite*
3. *Reagents, glassware and other equipment* needed for determination of pH, total acid, volatile acid, free and total SO_2, alcohol, extract, etc.
4. *Yeast.* Active dry yeast is preferred. It should contain about 20 to 30 billion live yeast cells per gram. Most common strains are *Saccharomyces bayanus* ("Pasteur" - U.C. Davis Enology # 595; and "California Champagne" - U.C. Davis Enology # 505), "Ay Champagne" - U. C. Davis Enology # 503 and "BYL" - Berkeley Yeast Laboratory (2).
5. *Yeast nutrients(s),* vitamins, growth factors, etc.
6. *Cane sugar*
7. *"A" frame(s)*
8. *Champagne bottles.* "Stock" 750 ml. bottles 32 to 35 ounces in weight, designed to withstand pressures of seven gas volumes at 50°C or about 220 pounds per square inch gauge (psig). Color of the bottles is either champagne green (dark green) or emerald green. The finish of the neck should accommodate a crown cap, a natural cork and/or a plastic stopper. Bottles also should have a special surface coating that helps to protect them during handling (2).
9. *Crown caps* usually are 26 mm in diameter and are coated tinplate or stainless steel. Cap liners are ground cork with vinyl disks or elastomer plastic (2).
10. *Corks.* Natural cork is preferred. Corks are about 31

mm in diameter and about 48 mm in height. Upper part of cork is composed of cork particles, 2 to 6 mm in size, bonded together with a polypropylene resin. Laminated corks have two or three disks, about 6 mm thick, which are bonded to the bottom of the cork. Most corks have a light band of paraffin about 18 mm wide around the body. Corks are sold in plastic bags of 1,000 to 5,000 (2).

11. *Plastic stoppers* are made of polyethylene plastic and vary in shapes. All have a dome-shaped head 31 to 33 mm in diameter and a hollow shank 18 to 18.5 mm in diameter and 30 to 35 mm long. On the shank are 4 to 6 raised rings 0.2 mm high. Plastic allows for slow passage of gases and the wine has a shorter shelf life than cork-sealed wine (2).
12. *Wire hoods* are used to secure the cork or plastic closure to the bottle. Hoods used for natural corks are 36 mm high with dome-shaped tinplate disk 29 mm in diameter. Wire hoods without disks are 32 mm high and are used for plastic stoppers (2).
13. *Carbon dioxide (CO_2) pressure testing apparatus* (optional)
14. *Freezer* (neck freezing)
15. *Dosage - syruping machine* (optional)
16. *Triple beam balance*
17. *Thermometer(s)*
18. *Refrigerator*
19. *Crown capper*
20. *Corker*
21. *Foils* (gold, red, pink) and foil crimper
22. *Aging cellar*
23. *Other*

Appendix

A. Approximate conversion to Metric Measures*

Symbol	When you know	Multiply by	To find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectars	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric ton	t
		VOLUME		
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in^3	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	centimeters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	degrees Farenheit	5/9 (after subtracting 32)	degrees Celsius	°C

*From "National Bureau of Standards, 1976, Special Publication 365, U.S. Department of Commerce, Washington, D.C. 20234."

B. Approximate conversion from Metric Measures*

Symbol	When you know	Multiply by	To find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectars (10,000m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric ton (1,000 kg)	1.1	short tons	
		VOLUME		
mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in^3
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic feet	yd^3
		TEMPERATURE (exact)		
°C	degrees Celsius	9/5 (then add 32)	degrees Farenheit	°F

*From "National Bureau of Standards, 1976, Special Publication 365, U.S. Department of commerce, Washington, D.C. 20234."

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