FRUIT WINES

Requisites for Successful Fermentation

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Fruits other than the vinifera varieties of grapes are fermented differently during the process of wine making. Because most of the fruits are low in sugar content and high in acidity even at the peak of maturity, fruit wines are ameliorated with sugar and/or water before, during, and after fermentation, a practice unlawful in the fermentation of other wines. Because good fruit wine should retain the characteristic fresh flavor of the original fruit, fruit wines are fermented rapidly and are aged usually around 6 months. Longer aging, ordinarily considered a necessity in wine growing, is detrimental to fruit wines. As a result, growers of fruit wines encounter problems not experienced by other wine makers. Typical problems in the production of fruit wines are: loss of delicate fruit flavors due to high fermentation and pasteurizing temperatures, and discoloration of heavily pigmented fruits due to low pasteurizing temperatures and short aging period.

FRUIT WINES are wines made from fruits other than the vinifera varieties of grapes. There are four major groups of fruit wines: the pome fruits, such as apples and pears; stone fruits, such as cherries and plums; berries, such as loganberries and blackberries; and Labrusca grapes, such as Concord and Niagara.

Because the fruits are grown in climatic conditions unfavorable for the development of sugar, their sugar content is in general low, and the acidity high. For this reason the law permits amelioration of fruit wines with sugar and/or water before, during, and after fermentation (*5*).

A good fruit wine should retain the characteristic fresh flavor of the original fruit. This has been the most difficult and delicate requirement confronting the growers of fruit wines. To produce a fruit wine of highest quality, several points must be observed.

Selection of Fruit

Only sound fruits, rich in flavor, can produce wines of high quality. The selection of a good fruit to start with is, therefore, of utmost importance. As the flavor of most fruit is developed at the peak of maturity, ripe or sometimes even slightly overripe fruits are desirable for the fermentation of fruit wines. Extremely overripe fruit, however, should be avoided. Immature or spoiled fruit should never be used.

Selection of Yeast Strain

As compared to vinifera grapes, selection of yeast strain is rather a simple matter in the fermentation of fruit wines. In the fermentation of vinifera grapes, the yeast is responsible in part for the development of flavors. A certain type of wine must use a certain strain of yeast in order to develop the characteristic flavor desired. In contrast, the characteristic flavor of a fruit wine is largely derived from the flavor of the fruit. The yeast has very little to do with the final flavor of the wine. The yeast, however, has an indirect influence on the retention of the fruit flavor, as more fruit flavor is retained by a yeast that ferments rapidly and well at low temperatures. Completeness of fermentation is not so important, as most fruit wines are sweet wines.

Yeast strains, such as Champagne and Burgundy, are satisfactory for the fermentation of fruit wines.

Initial Sugar Content

In the fermentation of vinifera grapes the initial sugar content of the must is usually high, sometimes as high as 30%. In the fermentation of fruit wines, however, high initial sugar content is considered detrimental, because high sugar content slows down the rate of fermentation and prevents a good start. For rapid starting and steady fermentation the initial sugar content of the fruits should not exceed 16%. Fortunately, most of the fruits used for wine making are not that sweet. When a must is to be ameliorated with sugar, it is important that the total sugar content be kept below 16%. Further amelioration can be done after the fermentation has had a good start. Amelioration in small installments is desirable.

Fermentation Temperatures

It is generally believed that the final flavor of a fruit wine is derived from two sources: the fruit itself and chemical development during and after fermentation. In both cases, temperature is

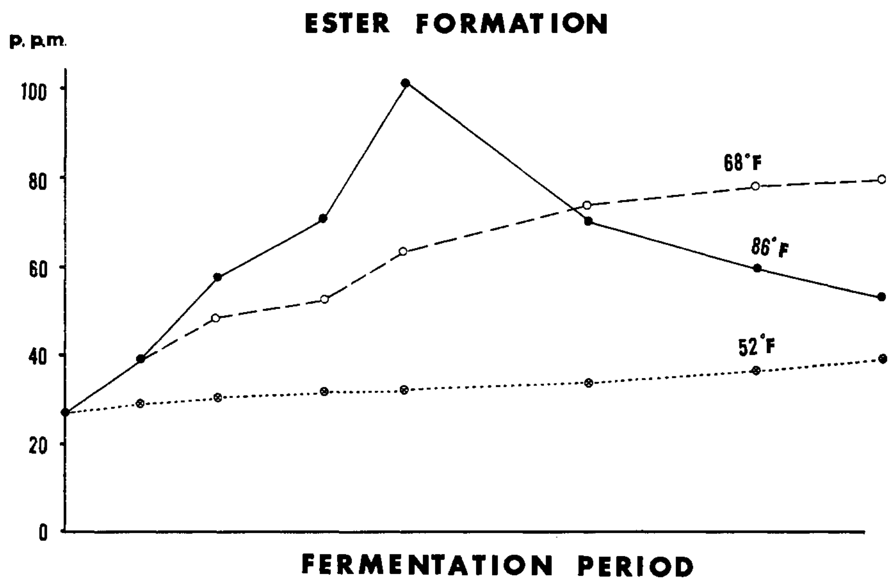


Figure 1. Ester formation in apple wine at different fermentation temperatures

important. Low temperature fermentation will retain more fruit flavor, but too low a temperature will slow down the rate of fermentation. Therefore, maintaining a medium temperature is desirable. Around 68° F. is considered satisfactory for the fermentation of fruit wines.

Temperature is also important in the development of the fruit wine flavor during fermentation. Scurti and Nelson (*3, 4*) found that the flavor developed is largely due to the formation of esters, and experiments conducted in these laboratories have shown that the ester value of a fruit wine is related to the fermentation temperature. Figure 1 illustrates the ester formation in apple wine at different fermentation temperatures. At 86° F. the ester formation was very fast until it reached a peak, and then it dropped. At the end of the fermentation 52 p.p.m. of ester was left in the wine. At 68° F., the ester value increased steadily, although the increase was slower near the end of the fermentation period. At the end of fermentation there was 79 p.p.m. esters in the wine. At 52° F. the esters increased very slowly through the entire fermentation period. Only 39 p.p.m. was found at the end of fermentation.

The experiments showed that for the maximum development of esters in fruit wines, the fermentation temperature should be around 68° F. Higher temperatures may develop more esters at the beginning, but will also lose them faster. At lower temperatures the esters develop rather slowly, and the rate of fermentation is also slow.

Nitrogen Content

The nitrogen content of fruits varies considerably. Figure 2 shows the nitrogen content of some popular fruits used for wine making. Apples have the lowest nitrogen content of all the fruits; their average nitrogen content is about 0.01%, approximately one tenth that of vinifera grapes. Other fruits have nitrogen content comparable to the vinifera grapes. Amelioration dilutes the nitrogen content. In the case of loganberry and currant, although both fruits have high nitrogen content, the nitrogen is reduced considerably after amelioration. As not all the nitrogen present in the fruits is in the form available to the yeast, to ensure rapid fermentation of fruits of low nitrogen content, extra nitrogen in the form of urea or ammonium phosphate should be added at the beginning of fermentation. Usually 0.1% urea is sufficient. Aside from the use of urea, Yang, Thomas, and Wiegand (*7*) reported beneficial results obtained from the use of pectic enzymes at the beginning of fermentation. Higher yield and better appearance were observed in wines treated with pectic enzymes.

Sulfur Dioxide

Excessive use of sulfur dioxide should be avoided in the fermentation of fruit wines. Too much sulfur dioxide inhibits the yeast activity and thus slows down the fermentation process. Excessive sulfur dioxide also impairs the delicate fruit flavors and bleaches the dark-colored wines (*1*). The use of a moderate dosage of sulfur dioxide is, however, in many cases beneficial in maintaining the general quality of a fruit wine. About 100 p.p.m. is recommended.

Some fruit wine makers have pasteurized their must and done away with sulfur dioxide. Pasteurized must is believed to produce a high quality wine, although it requires extra equipment and additional cost.

Aeration

As oxygen has a stimulating effect on the growth of yeast, occasional aeration during fermentation is helpful in increasing the yeast activity (*2*). Aeration is not necessary during the first 2 or 3 days of fermentation, as a considerable amount of dissolved oxygen is present in the fruit pulp, but after 4 or 5 days of fermentation the must should be aerated. The frequency of aeration will depend on the the fermentation condition in progress. As many as three to four aerations a day may be practised if necessary.

Sugar-Acid Ratio

In order to bring out the fullest flavor of a fruit wine, a proper sugar-acid ratio is important. Virtually all fruit wines are sweet. The degree of sweetness depends on the amount of fixed acid present. A sugar-acid ratio of 10 to 1 is considered a good balance. Some fruit wines, such as the Kosher type, are much sweeter than average, and frequently have 30 to 1 sugar-acid ratio.

As the wines are to be sweetened sooner or later, it is not necessary to ferment them dry. As soon as the desired alcohol content has been attained, the fermentation can be stopped by pasteurization.

Aging

Fruit wines should not be aged long (*10*); 6 months to a year is sufficient. Some fruit wines have been sold as young as 3 months, but this is exceptional, and at least 6 months of aging is recommended in order to mellow the harsh taste and produce a balanced flavor and smooth texture. Long aging, ordinarily considered as a necessity in many vinifera grape wines, is detrimental to fruit wines. The flavor and aroma are lost, and the color changes (*9*).

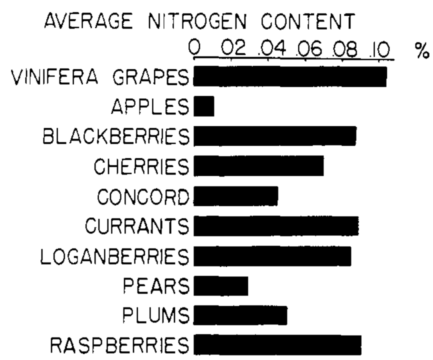
When market conditions necessitate long storing of fruit wines, the old wines should be blended with young wines to bring back their natural fruit flavors (*8*).

Pasteurization

Most wines are not fortified. They have an alcohol content of 12 to 14% by volume. To stabilize the wine two pasteurizations are generally practised: one after fermentation, the other before bottling.

Higher temperatures are usually used

Figure 2. Nitrogen content of fruits used for wine making



for the first pasteurization, generally between 160° and 180° F. The first pasteurization kills the yeast cells in order to stop the fermentation, precipitate the proteinous materials, and hydrolyze the excessive pigment, which, if not removed before bottling, will separate out in the bottles (*6*).

The second pasteurization, immediately before bottling, employs a lower temperature, usually about 140° F.

Summary

The following points should be observed for the successful fermentation of fruit wines.

1. Use sound, ripe fruit.
2. Use fast-fermenting yeast strains.
3. Keep the initial sugar content of the must below 16%.
4. Maintain the fermentation temperature at about 68° F.
5. Add about 0.1% urea to supplement the nitrogen.
6. Avoid excessive use of sulfur dioxide; about 100 p.p.m. is recommended.
7. Aerate the must to maintain the maximum yeast activity.
8. Regulate a good sugar-acid ratio, about 10 to 1.
9. Do not age the wine too long. Six months to 1 year is sufficient.
10. Pasteurize the wine twice, after fermentation and before bottling.

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MALODOROUS FERMENTATION

Acidic Constitutents of Zapatera of Olives

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In an attempt to find the microorganisms responsible for the malodorous fermentation of olives, known as "zapatera" spoilage in the California industry, it became necessary to determine the acidic end products of this spoilage. Conventional chromatographic methods were used to separate and identify the acids that had been recovered from the olive brines by ether extraction. Normal brines contained only acetic and lactic acids, whereas zapatera brines also contained formic, propionic, butyric, and succinic acids.

ZAPATERA SPOILAGE, whose presence in Spanish green olives was first recorded by Cruess (*10*) in 1924, is a malodorous fermentation also found in storage fruit used for ripe process, Sicilian, and Spanish-type olives in California (*11, 21, 22*). This abnormality is characterized by the development of a very penetrating, unpleasant odor in olives undergoing fermentation. In the early stages of spoilage the odor is usually described as cheesy or sagey but, as deterioration progresses, it develops into a foul, fecal stench. In other types of cured olives, such as the "Greek style," lactic acid fermentation does not occur.

Under California conditions "zapatera" spoilage, unlike butyric fermentation (12), occurs when the desirable lactic acid fermentation is allowed to cease before the pH of the brine has decreased below 4.5. At the onset of spoilage, the pH of the affected brine increases while the titratable acidity decreases. There is a continuous loss in acidity as the spoilage progresses.

The cause of zapatera is obscure. Smyth (*18*), apparently the only one to report on the bacteriology of this spoilage, concluded that it was due "to one or more of a group of spore-forming, proteolytic, facultative rods normally present in the soils of Andalusia." Persistent inability to isolate bacteria capable of causing this spoilage prompted studies of the acidic end products of this spoilage, because it was believed that the possession of such knowledge would simplify the search for the causative organisms.

Materials and Methods

The samples examined included normal, suspected, and known spoiled brines from Spanish-type olives collected in California as well as imported brines from Spanish green olives.

Each brine was subjected to clarification with zinc hydroxide, allowed to stand overnight, and filtered before removal of the acids by conventional liquid-liquid extraction with ethylether for 30 hours. After removal of the ether, the total acids were determined by titration with 1 *N* sodium hydroxide to the phenol red end point and the neutralized solution was evaporated to dryness and dried overnight in a desiccator.

For acids below butyric, the salts were dissolved in sufficient hydrochloric acid to give a solution between 0.1 and 0.2 *N* with respect to total acid as hydrochloric acid and with sufficient extra to make 0.01 *N* hydrochloric acid in excess. The mixture of acids in each brine so treated then was separated by partition on a silica gel column, using chloroform and various mixtures of 1-butanol in benzene