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Bitterness in Apple and Grape Wines[1]

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***Abstract*. The pronounced bitterness found in some apple wines, such as from 'Cortland' but not 'McIntosh' apples (*Malus domestica*Borkh.), is produced during the later stages of fermentation. Bitterness in grape wines is also related to cultivar and some grape parents show a tendency to yield progeny whose fruit makes bitter wine.**

Apple wines are frequently found to be bitter, especially when made from stored apples (2, 9). Bitterness in grape wines has also been reported (4,17). Excessive bitterness is a defect in wines intended for mass markets; such wines should be pleasant tasting and easy to drink. As new juice materials are suggested or tested for wine production, bitterness has taken on a greater importance and requires more scrutiny.

Bitterness is the taste associated with alkaloids such as quinine, and it differs from the taste of astringency that is due, in wines, to tannins (15). Other plant materials causing bitterness are terpenoids and some phenolic compounds (5, 8). Fermentation can result in the formation of bitter-tasting fusel oils and acrolein (4, 11, 14, 15).

The preparation and evaluation of a variety of apple and grape wines lead to the observation that bitterness was associated with particular cultivars, and was more prominent with apple than with grape wines.

Wines were prepared by a standard method (10) in which the initial sugar content of the juice was raised to 20-22% (by weight) with sucrose. Apple wines were made from clarified, depectinized juice using the white wine procedure. Sugar concentrations in unfermented juices were determined with a refractometer. Sugar concentrations in fermentation products were measured by the dinitrosalicylic acid method (18) preceded by treatment with invertase (6). All fermentations were carried out with Montrachet 522 yeast.

Bitterness was evaluated by a taste panel using the paired comparison difference test (7) coupled with a description by the tasters of the degree of bitterness as none, slight, moderate, much or extreme. The panel had previously become familiar with the bitter taste and distinguished it from the astringent taste. Non-parametric statistical procedures (7) were used to evaluate the differences between wines.

Cultivar had an important influence on the bitterness of the apple wine produced. Wines of 11-13% ethanol content were prepared from a number of apple cultivars, both dessert and processing types. Most produced bitter wine. The results with a selection of cultivars repeatedly tested over several years are shown in Table 1. Wines from 'Cortland' apples were often so bitter that they were virtually undrinkable. Included in the testing were some of the non-culinary cider type apples of England and France such as 'Yarlington Mill', 'Dabinett' and 'Kingston Black'. Among the least bitter in this group were 'Nehou', 'Bedan des Partes' and 'Souvenir de Fernand Cognet'. Interactions between cultivars and orchard culture have not been studied.

The bitterness of the apple wines containing 11-13% ethanol was in marked contrast to the low or absent bitterness of hard ciders made from most apple juices with no addition of sugar. Bitterness appeared as the fermentation continued from an ethanol level of 6% upwards to 13% (Table 2). When the 5.3% ethanol cider was fortified to bring it to 13% ethanol, the resulting wine was judged to be somewhat more bitter than the hard cider, but much less bitter than in the wine fermented to 13% ethanol (data not shown).

A similar effect was seen when a 'Cortland' wine was sampled during fermentation (Table 2). As fermentation proceeded the bitterness became more pronounced. Addition of sugar to the high ethanol wine reduced the degree of perceived bitterness somewhat, but did not bring it down to levels seen with the earlier samples.

Treatment of bitter 'Cortland' wines with 2000 ppm of charcoal, or allowing aeration of the wine for 5 hr greatly decreased the bitterness. Similar results have previously been reported for bitter wines (19). Tannin removal with 1000 ppm of polyvinylpyrrolidone

Table 3. Some established hybrid grape cultivars producing bitter wine in 2 or more tests.

Leon Millot (Kuhlman 194-2)
New York Muscat
Seibel 13053
Rougeon (Seibel 5898)
Seyve-Villard 5-247
Seyve-Villard 18-307

Table 1. Bitterness of apple wines produced from different cultivars. All wines fermented to 11–13% ethanol.

None or slight		Moderate		Extreme	
McIntosh	a[z]	Pound Sweet	bc	Royal Red Delicious	cd
Idared	a	Wayne	c	Winesap	cd
Conical Rome	a	Golden Delicious	c	Cortland	d
Roanoke	ab	Vance Delicious	c	Cowin Rome	d

[z]Mean separation by Duncan's multiple range test, 5% level.

Table 2. Effect of pre-fermentation sugar content and the duration of fermentation on bitterness in 'Cortland' apple wines.

Variable	Wine composition (%): Residual sugar	Wine composition (%): Ethanol	Taste: degree of bitterness
Pre-fermentation sugar concentration			
10.1%	0.2	5.3	none a[z]
14%	0.3	8.2	slight b
22%	0.8	13.0	extreme c
Fermentation time			
0 days	19.8	0.0	none a
8 days	9.7	5.8	none a
30 days	0.6	11.6	extreme b

[z]Mean separation by Duncan's multiple range test, 5% level.

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Table 4. Frequency of bitter wines produced from seedling hybrid grapes.

	Wines judged					
	1973		1974		1975	
Type	No. tested	Bitter (%)	No. tested	Bitter (%)	No. tested	Bitter (%)
Red	211	29	216	23	242	39
White	113	32	110	21	112	24

Table 5. Seedling wine grape crosses yielding a high percentage of progeny producing bitter wines.

Parentage	Number of progeny yielding bitter wines	Total number of progeny tested
Chancellor x NY 41547 (Catawba x *V. labrusca*)	17	24
NY 33277 (S.6339 x NY 10589) x Chancellor	11	24
S. V. 18-307 x Buffalo	9	14
NY 33009 (Eumelan x (Fredonia x Black Minukka)) x Chancellor	7	15
Ill. 796-1 (Jaeger 70 x Victorias Choice) x Ill. 182-1 (S. 14664 x S.V. 20-385)	5	6

according to the method of Anderson and Sowers (1) did not reduce the bitterness, confirming that the bitterness found here was not associated with tannin materials.

The lack of bitterness in low ethanol 'Cortland' hard ciders indicates that the bitter materials of the wine were not present in the original juice. They appear to be produced during the later stages of fermentation and may arise from yeast metabolism rather than by transformation of an apple constituent. However, since apple cultivar was a factor in its production one must suspect that some apple juice factor induces the yeast to make the bitter principal.

Other fruits might show a similar cultivar influence on bitterness. Many years of grape wine tasting records (13), both from seedling selections and from established wine cultivars are available at the Geneva Experiment Station. These records show that some well-tested cultivars are frequently judged bitter (Table 3). When the older French and American hybrid cultivar records were examined, it was found that in the 1958-1973 period 16% of the red wines and 10% of the white wines were noted to have bitterness as a component of their taste description.

The percentage of grape cultivars producing bitter wines appears to be much greater in recent seedling selections undergoing initial wine quality assessments at Geneva (Table 4). Both the red and the white selections gave similar percentages of bitter wines. Some parents gave particularly high percentages of seedling yielding bitter wine (Table 5).

The rare reports of bitterness in wines made from *Vitis vinifera* grapes have usually associated the condition with the presence of undesirable micro-organisms (3). Careful sulfiting prevented this bacteriological problem from developing in our experimental wines.

Our results indicate that bitterness in grape wines is related to cultivar. It would appear that centuries of selection against bitterness has virtually eliminated bitter types in the *Vitis vinifera* group. Furthermore, considerable selection has resulted in the retention of very few bitter sorts in the group of established French and American hybrid cultivars. New progenies carried a much higher percentage of bitter types.

Research on bitterness of apple wine is in a very early stage. The importance of fruit cultivar is evident and, at present, selection of non-bitter cultivars seems the most practical way to obtain a non-bitter apple wine. Such selection has apparently gone on with grapes. Perhaps other fruits that have economic potential for wine making can be selected in the same way.

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