COMPOSITION OF GRAPES *

prepared by

James J. Kissler, U.C. Farm Advisor

PHYSICAL MAKE-UP OF FRUIT

Grape clusters consist of stems and berries.

Stems - The stems account for 2 to 6 per cent of the total weight of a cluster at harvest (depending on variety). Stems vary as to length of parts, toughness, and adherence to the berries. These stem characteristics can be important in the selection of a variety.

Example: Table grapes should have long stem parts (loose clusters), tough stems that don't break down in transit to market, berries that don't shatter, and stems that don't dry or brown quickly. Wine grapes for mechanical harvesting should have brittle stem parts and berries that don't adhere too tightly.

Seeds - The seeds can account for 0 to 10 per cent of the weight of the fruit (depending on variety). Seeds are generally objectionable in table and raisin grapes. Seeds contain 5 to 8 per cent tannin and 10 to 20 per cent oil.

Skins - The skins of the berries account for 5 to 12 per cent of the total weight. The skin is covered with a layer of cutin (waxy substance) which protects the berries from water loss and attack of organisms. Skins contain most of the color, aroma, and flavor constituents of the berries.

Small berry varieties have a greater percentage of skin to pulp than large berry varieties, therefore have more color, aroma, and flavor. This explains why most of the premium wine varieties have small berries.

Skins are high in vitamin C, and red grape skins contain a large amount of tannin (3 to 6 per cent).

Pulp - The juice yield depends on the variety's lack of pulpiness. Burger variety has very little pulp; Concords are quite pulpy. One ton of grapes can yield from 160 to 195 gallons of juice (depending on variety).

Texture - The ripe berries of some varieties are firm and hard, others are soft. Soft berries make poor table grapes because they are not crisp when bitten into. Also, soft berries are more susceptible to mechanical injury and decay.

CHEMICAL MAKE-UP OF THE FRUIT

Most grape growers think sugar is the only important part of the grape. Sugar is but one of the many important chemicals in grapes. Listed in the following table

---

* Presented at San Joaquin County Grape School, December 1976, at U.C. Agricultural Extension Auditorium, 420 S. Wilson Way, Stockton, California 95205.

are some of the important organic and inorganic components of grape juice.

COMPOSITION OF GRAPES*

Ranges in percentages of the more important organic and inorganic components of freshly expressed juice, by volume

	Per cent
Water	70-85
Carbohydrates	15-25
Dextrose (glucose)	8-13
Levulose (fructose)	7-12
Pentoses	0.08-0.20
Pectin	0.01-0.10
Insitol	0.02-0.08
Organic acids	0.3-1.5
Tartaric	0.2-1.0
Malic	0.1-0.8
Citric	0.01-0.05
Tannins	0.01-0.10
Nitrogenous compounds	0.03-0.17
Protein	0.001-0.01
Amino	0.017-0.11
Humin	0.001-0.002
Amide	0.001-0.004
Ammonia	0.001-0.012
Residual	0.01-0.02
Mineral compounds	0.3-0.5
Aluminum	T-0.003
Boron	T-0.007
Calcium	0.004-0.025
Chloride	0.001-0.010
Copper	T-0.0003
Iron	T-0.003
Magnesium	0.01-0.025
Manganese	T-0.00051
Potassium	0.15-0.25
Phosphate	0.02-0.05
Rubidium	T-0.001
Silicic acid	0.0002-0.005
Sodium	T-0.020
Sulfate	0.003-0.035

T indicates trace

Sugars - The healthy grape leaves manufacture most of the sugars in the fruit and for vine maintenance; green berries contribute a little. Therefore it is important to have adequate leaf area for a given crop load. Dr. Kliewer found that the leaf area should be at least 10 square centimeters per gram of fruit, or 4,540 sq. cm. per pound of fruit. This is equivalent to about 22 to 26 leaves for an average size cluster. Reduction

* Source: General Viticulture, A. J. Winkler, 1962

of the leaf area per cluster below this critical level will result in smaller berries, lower sugar and acid content, poor fruit quality, and poor fruit color.

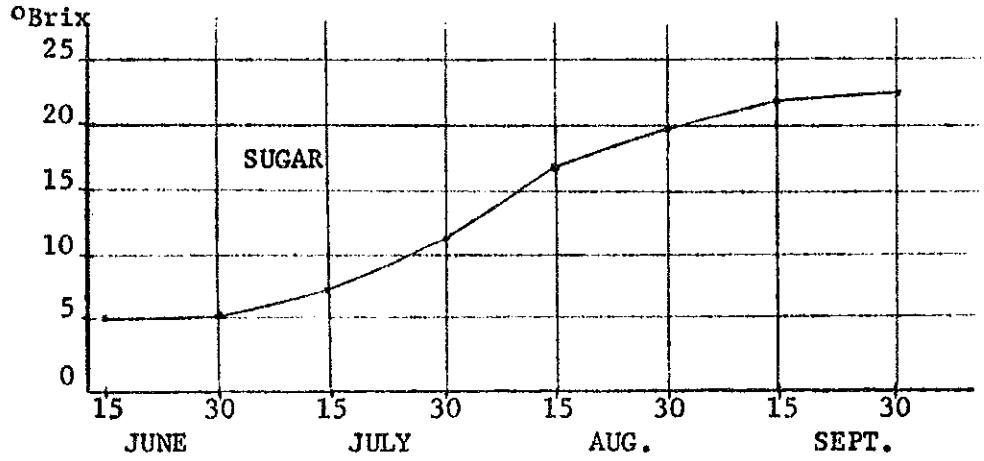
The process of photosynthesis is used to manufacture carbohydrates (sugars and starches). This manufacturing process occurs in the green leaves. Photosynthesis can be expressed by the following:

$$6\ CO_2 + 6\ H_2O + \text{light energy} \xrightarrow{\uparrow} C_6H_{12}O_6 + 6\ O_2$$

Carbon dioxide (from air) + water (from soil) + sunshine = sugar + oxygen (goes off into atmosphere)

The sugars produced in the leaves move through the phloem. During early summer the vines are growing rapidly; most of the sugars are then used in the growth of shoots, leaves, roots, and in the increase of berry size. After the berries are three-fourths of full size, the vines have nearly stopped active growth. The leaves continue to manufacture sugars and then those sugars begin to accumulate in the leaves and woody parts of the vine. They are then translocated to the fruit. Soon a rapid build-up of sugar in the berries occurs.

Example: Change in sugar during ripening of grapes



The proper cut-off date of irrigation is important so that sugar accumulation in the fruit is not delayed. Late season growth is detrimental to sugar accumulation and wood maturity.

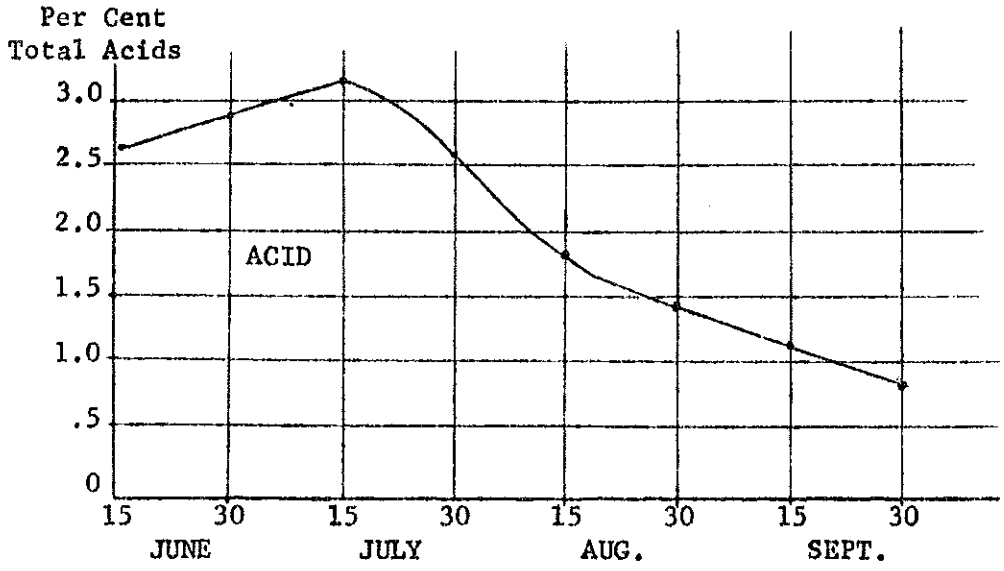
Sugars of grapes are primarily glucose and fructose. Fructose is much sweeter than glucose. A refractometer or hydrometer is used to measure the soluble solids (sugar content) of the juice. It is expressed as °Brix or degree balling, but growers think of it as the per cent sugar in the juice. (For details see "Hydrometers vs. Refractometers for Sugar Testing") The desired sugar content depends on what the grape is used for.

Example: Table wines, 19° to 23° Brix; dessert wines, 24° Brix or over.

Acids - The principal acids of the grape are tartaric, malic, citric, ascorbic, and phosphoric. Tartaric and malic account for over 90 per cent of the total acids, but tartaric at maturity is usually the major acid. The titratable acidity due to tartrates was 45 to 81 per cent in varieties at maturity (grown at U.C. Davis).

Acid content is determined by a titration process and is expressed as per cent tartaric acid. The acidity of grapes can vary from .30 to 1.20 per cent, depending on variety and atmospheric temperatures. Early in the season the growing berries increase in acid until they are one-half their full size. During ripening, acid content gradually decreases.

Example: Change in acid during ripening of grapes



Temperatures during ripening have a big influence on acid content of mature grapes. A variety will be higher in acid in a cool growing region than if grown in a hot region, with sugar at the same ^{o}Brix. Low temperatures at night stimulate the formation of acid. Temperatures above 86^{o} F cause the acid level to decline. The acids are metabolized in respiration at higher temperatures. If premium table wines are to be produced in a warm or hot region, then a trellis system should be used that gives good foliage coverage of the fruit. Grapes exposed to the sun are lower in acid content than those grown in the shade.

There are considerable differences in acid content among varieties. Only medium to high acid varieties should be used for table wines in San Joaquin County.

The acids in table wines are important because they

--give a good balance in flavor and taste
--increase the aging and storage life
--increase the stability of wines

--prevent spoilage

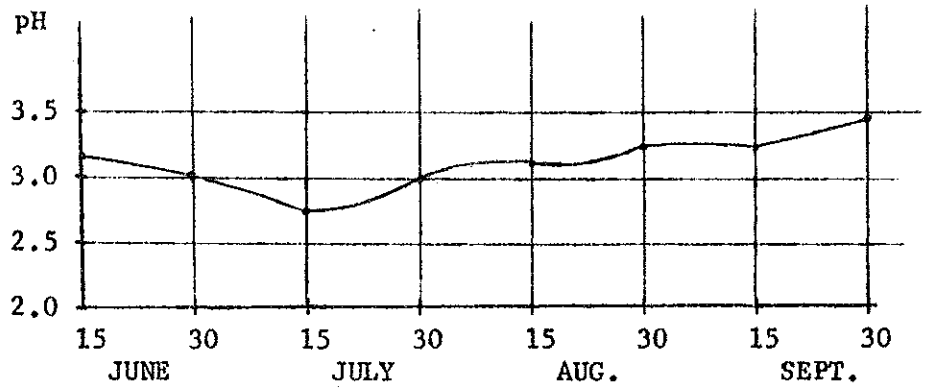
The ideal acid content depends on variety and how it's to be used.

Example: Table wines, .65 to .9%; dessert wines, .5 to .6%

pH - This is a chemical symbol used to express both acidity and alkalinity. A pH of 7 is neutral--lower numbers are on the acid side, and numbers greater than 7 are alkaline. Grapes have a pH range of approximately 2.7 to 3.8. A low pH is desirable for table wine production because the fermentation will be cleaner and the wine less liable to attack by disease organisms.

Grape color is affected by acidity and pH. Color is reddish and brilliant in fruit of moderate to high acidity and low pH. Color tends to be more bluish and dull in fruit of low acidity and high pH (hot region grapes).

Example: Change in pH during ripening of grapes



The desired pH for table wines is 3.35 or less; dessert wines 3.65 or less.

Color - Early in the season the green color of the grape skin is chlorophyll. As ripening begins, this chlorophyll begins to fade out and soon other colors appear.

The color of grapes is found in the cells of the skin. However, a few varieties do have colored pulp (example: Alicante Bouschet, Rubired, Royalty). There are several different pigments that account for the many different colors in grapes. Factors that influence color are

--Temperature - In hot regions pigment formation is inhibited in many varieties of red and black grapes.

--Light is needed to color Tokays. Without light, no color will appear. When Zinfandel is placed in a black bag prior to coloring, it will develop about the same color as it would out in the open.

Importance of Color - Table grapes need attractive colors because appearance is what sells grapes to the housewife. Brilliant colors are important for wine sales. To extract color from the grapes, they are fermented on the skins.