3 Grape juice processing
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3.1 History of grape juice processing in North America

The fruit juice processing industry of the United States is said to have been started by Dr Thomas B. Welch and his son Charles in Vineland, New Jersey in 1868. By applying the theory of Louis Pasteur to the processing of Concord grapes, they were able to produce an 'unfermented sacramental wine' for use in their church. By 1870 this grape product was being produced on a small scale for local church use.

By 1893, grape juice had become a national favorite beverage in the United States as thousands sampled it at the Chicago World’s Fair. It was during this year that Dr Charles Welch turned his full attention to the marketing of grape juice. In 1897 a new plant location was chosen for processing operations at Westfield, New York. Some 300 metric tons of grapes were processed that year; in 1989 Welch’s, now one of the largest producers of processed grape juice in the world, handled some 186,000 metric tons of grapes.

3.2 Grape cultivars

In the United States, four broad classes of grapes are grown: *Vitis labruscana*, hybrids of the northeastern United States native grape; *Vitis vinifera*, European grapes common to California area; *Vitis rotundifolia*, the southern and southeastern Muscadine grapes; and French hybrids. Prior to the discovery of the Americas the species, *Vitis vinifera*, supplied the known world’s grapes. *Vinifera* grapes are still among the most important in the world but in harsh climates these grapes cannot tolerate severe winters, diseases, and pest problems.

When selections of *Vitis labrusca* were crossed with other grapes, new varietals were produced, such as *Vitis labruscana*. Ephraim Bull was a horticulturalist who pioneered in this cross-breeding and selection process with native American grapes. The Concord grape, a varietal almost synonymous with grape juice in the United States, was a seedling that Bull found in his vineyard. Its parentage is still unknown. Virtually the entire unfermented grape juice industry has developed from this one cultivar.

The average production of Conocrds is approximately 4–5 tons per
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acre in eastern United States. Yields can reach 7–8 tons in western states. Cultural practices such as irrigation, pruning severity and fertilization can have a very significant influence upon the quality and quantity of grapes harvested (Morris et al., 1983).

There are now many hybrids of the native species available for use in the industry. Some of the older cultivars are: Catawba, Delaware and Niagara. The Concord grape, grown throughout the cooler regions of the United States and Canada, is still the principal grape for the industry.

Though not possessing as large a market share in unfermented grape juice, there are some Vinifera grapes processed into grape juice. They tend to be much higher in sugar and lower in acidity than the Lubruscana grapes, and consequently are not as flavorful.

The genus, Vitis, is generally considered to consist of two sub-species, Euvitis and Rotundifolia. All grape species other than muscadines fall into the Euvitis sub-genus; muscadines alone make up the sub-genus, Rotundifolia. For this reason some botanists do not classify muscadines as grapes. Some basic differences are identifiable such as clustering of the berries and pit configuration, however, muscadines are utilized in an identical fashion and treatment as the Euvitis sub-genus. Consequently, in matters of commerce and functionality, muscadines are considered grapes.

3.3 The chemistry of grape juice

The quality of grape juice can be described almost entirely by its chemistry. Its color is caused by anthocyanins, their glucosides and condensation products (Hrazdina and Moskowitz, 1981), its taste by acids, sugars and phenolics (Ribéreau-Gayon, 1968) and its aroma by a diverse mixture of volatile secondary metabolites in very low concentrations (Schreier et al., 1976). Since 1967 over 1000 research papers have been abstracted by Chemical Abstract Service describing the chemistry of grapes and grape juice. In these papers thousands of chemicals and their reactions in grapes are described. However, only a small percent of these chemicals are responsible for the quality attributes that people perceive when they drink grape juice. Table 3.1 lists the major components of grape juice, their concentrations and the quality attributes they determine.

This table shows clearly why it is possible to predict sweetness (Shallenberger, 1980), sourness and acidity (Plane et al., 1980) in grape juice by measuring certain carbohydrates and organic acids. These compounds are major constituents of grape juice and are measurable by some very simple techniques. For many years the sugar and acid content of grapes has been used to set standards of quality resulting in new horticultural and processing techniques that modify the sugars and acids in grapes in order to optimize juice quality. These developments are the direct result of our knowledge of the