

Allium

Entry prepared by Cindy Liang '08 and Nico Drohojowski '08
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Grapes

Scientific Classification and Etymology

| Scientific Classification | |
|---------------------------|--------------------|
| Kingdom | Plantae |
| Division | Magnoliophyta |
| Class | Magnoliopsida |
| Order | Vitales |
| Family | Vitaceae |
| Genus | <i>Vitis</i> |
| Species | <i>V. vinifera</i> |



The word grape comes from Middle-English of Germanic origin. The word was popularized in the 14th century meaning, “a smooth-skinned juicy greenish-white to deep red or purple berry eaten dried or fresh as a fruit or fermented to produce wine.”¹ Grapes are plants from the genus *Vitis*, the vine family. There is evidence of *Vitis* plants growing wild before the existence of humans. There are a number of different species of grapes, the most common being *V. rotundifolia*, *V. aestivalis*, *V. labrusca*, and *V. vinifera*. Each is specific to a region, but starting in the 19th century many species of grapes were planted in areas of the United States where they normally were not found. This has consequentially globalized grape species, making it possible to enjoy all varieties in any given area.

¹ Merriam-Webster Dictionary



Rotundifolia is specific to the Southeastern United States. Commonly this species is known as Magnolia and Scuppernong grapes. They are known for their low sugar and acid contents, which is great to make dessert wine. The grape also has a thick skin and when harvested only produces small quantity of fruit.



Aestivalis is an American species of grape commonly known as the Norton and Lenior grape. Known for its high sugar, low acid content, this species is used for making dry wines. The grape itself has a thick skin with many seeds.



Labrusca is known as the “fox-grape” that has low sugar and pH levels making it better to eat. This American species is the most common for eating, but also makes a few sweet wines. Varieties include the Concord and Niagara grape, which can be found at any local grocery store.



Vinifera, also known as “the vine that bears wine”, is mostly found in Europe and parts of Asia, but also in California; this grape is used to make wine. Varieties include Sangiovese, Sauvignon Blanc, Syrah, Riesling, Chasselas, Flame Seedless, and Muscat Blanc. They have high sugar content with wide range of berry sizes. This species is also the ideal type for raisins and for transporting, since the sugar content acts as a preserve.

Botanical Description



All *Vitis* are deciduous and are characterized by woody, climbing vines that are generally twelve to twenty meters long. Barks are flaky for older wood, but smooth for younger wood. Leaves grow alternatively on sides, and vary in shapes and sizes depending on the species. Some are round and unlobed while some are cordate and lobed. They can be very small, two to three inches or can grow up to be eight to ten inches. The edges of the leaves are rough and toothed.²



Flowers are small and are yellow-green in color. They usually grow in clusters. There are five each of sepals, petals, and stamens. Ovaries contain two locules each with two ovules. The calyptra falls off at the bottom of the flower and pops off during the

² The Wine Pages, The Plant

blooming season. Perfect-flowered grapes have longer stamens, while the pistillate flowers have short, relaxed stamens.³



Most grapes self-pollinate because the flowers have both a functional pistil and stamens. Pollen grains fall upon the stigma where they germinate. However, grapes that have pistillate flowers must interplant for pollination. Pollination can be done by wind and insects.⁴



³ The Wine Pages, Flower and Pollination

⁴ The Wine Pages, Flower and Pollination

Grapes are small, round, edible berries that grow in dangling clusters on the grape vine. The skin of the grape is generally thin and smooth and is often coated with a fine layer of wax. Berries have a juicy pulp with up to four seeds. The colors of the grapes vary in red, blue, purple and black. Grapes are cultivated in large quantities for table use and for making wine and raisins.⁵



Seeds carry the embryo of genetic material from two parents. Every seedling is genetically unique. Purposeful and natural crosses lead to improvements in color and flavor, quality, and disease resistance. Studying the expression pattern and function of genes expressed in grape berries can also help to ascertain how they influence fruit and wine quality.



⁵ The Wine Pages, The Fruit

According to study released in 2007, “a number of genetically modified (GM) grapes have been created, none yet commercialized.”⁶ GM grapes do exist, and there were twenty-five field test releases in the USA in 1999 and 2005. GM grapes are resistance to disease including powdery mildew, *Botrytis*, *Agrobacterium*, *Clostridium*, *Xylella*, nepovirus and clostervirus.



On the other hand, GM grapes are created by inserting bacteria genes to the DNA of the cells, making grapevines susceptible to infections. Therefore, the potential hazards of GM grapes have not been completely addressed. GM grape juice and wine might not be safe to drink for they might cause cancer and disease, and might contain toxins and allergens.⁷

⁶ GM Grapevines & Toxin Wines

⁷ GM Grapevines & Toxic Wines

Nutritional Value



Grapes are so useful in that every part of it can be used for culinary purposes. They can be very nutritious and beneficial to human beings at the same time. The skins can be used for food coloring and the pulp and juice can be used for jams, raisins and wines.⁸ The seeds are used as oil and the leaves for dolmas⁹. Compounds in grapes help fight cancer, heart disease, degenerative nerve disease and others. Grape skins contain resveratrol¹⁰, which is a powerful antioxidant that may prevent cancer and cardiovascular disease. The antioxidant helps to lower the levels of cholesterol circulating in the body and hence reduces cholesterol deposition in the arteries. Several studies have shown that the antioxidant also has protective effect against prostate cancer. Grape seed extract is used as a natural antihistamine¹¹ and anti-inflammatory agent. As a food, grape seeds are high in fatty acids yet low in their effect on blood cholesterol levels. As a fruit, grapes are

⁸ Encyclopedia of Food and Culture, 144

⁹ A dish of tomatoes, green peppers, vine leaves, or eggplants stuffed with a mixture of meat, rice, and spices.

¹⁰ One of the polyphenols; it is a natural compound found in the skin of red grapes or red wine that may protect against cancer and cardiovascular disease.

¹¹ A medicine used to treat allergies and hypersensitive reactions and colds; works by counteracting the effects of histamine on a receptor site.

an excellent source¹² of vitamin C. Drying causes grapes to lose their water, but they retain their minerals, vitamins, fiber and about 324 calories per 100 grams.¹³ The nutritional values of grapes make them suitable for maintaining optimum health. In particular, 100 grams of grapes offer 191 milligrams of potassium and 14 milligrams of calcium¹⁴. Potassium and calcium are both important in transmitting nerve impulses and are therefore necessary to maintain efficient nervous system function. Grapes also offer approximately 0.63 gram of protein and 0.9 gram of dietary fiber, which is important for maintaining good digestive health.



Moreover, grapes may also be potent against viruses and tumors because of their high concentration of another polyphenol, tannin¹⁵. Tannins are absorbed directly into the intestinal tract where they do the most good. In addition, drinking red wine may help prevent the negative effects of high-calorie diets and lower the levels of heart disease. Thus, red wines have beneficial effects on the heart and blood vessels. However, a study

¹² Foods that are an “excellent source” of a particular nutrient provide 20% or more of the Recommended Daily Value, based upon United States Department of Agriculture (USDA) guidelines.

¹³ Encyclopedia of Food and Culture, 146

¹⁴ See Table 1: Nutritional Content of American Grapes.

¹⁵ A virus fighter.

has shown that drinking two or more glasses may offset the benefit and “may expose individuals to a higher risk of heart attacks, stroke or chronic high blood pressure”.¹⁶



Table 1: Nutritional Content of American Grapes (raw, 100 grams)

| Nutrient | Value per 100 g |
|-------------------|------------------------|
| Water | 81.3 g |
| Energy | 67 kcal |
| Protein | 0.63 g |
| Total lipid (fat) | 0.35 g |
| Carbohydrate | 17.15 g |
| Fiber | 0.9 g |
| Sugars | 16.25 g |
| Calcium (Ca) | 14 mg |
| Iron (Fe) | 0.29 mg |
| Magnesium (Mg) | 5 mg |
| Potassium (K) | 191 mg |
| Vitamin C | 4 mg |
| Vitamin B-6 | 0.11 mg |
| Vitamin A, IU | 100 IU |

USDA National Nutrient Database for Standard Reference

¹⁶ Floras

Cultivation Origins/Uses



The cultivation of grapes dates back to 3500-1000 B.C.E. The earliest recorded accounts of harvesting grapes were depicted in Egyptian hieroglyphics, and later in Greek and Roman cultures.¹⁷ Wine was the primary use for grapes in early civilizations, but occasionally was cultivated to eat either fresh or dried.¹⁸

The Greeks were the first to have an extensive harvest for grapes. Although wine was the primary reason for growing, consumption of grapes also became popular. There was even a god of wine named Dionysus, which was later changed to Bacchus. Greek

¹⁷ University of Georgia

¹⁸ Walker, Lee, Boggs, ET all

wine was usually mixed with a variety of herbs, spices, and diluted with water because it was so thick.¹⁹

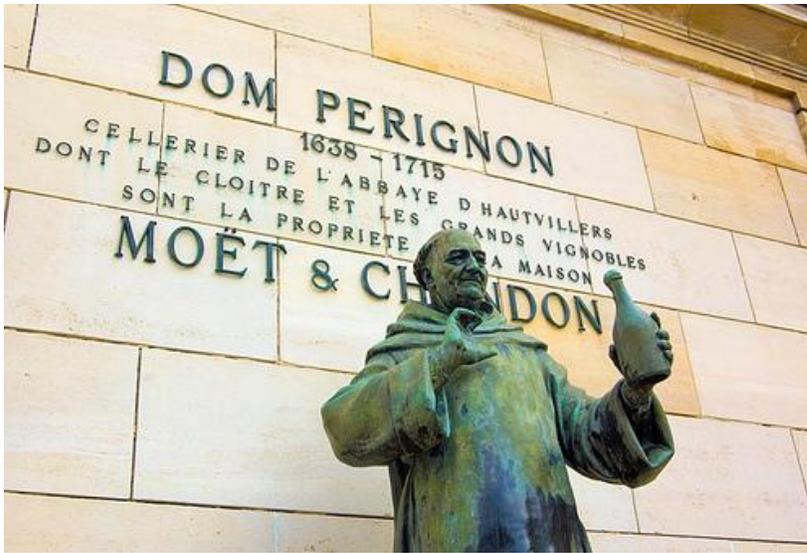


In Roman culture, wine was also usually diluted, with more water than wine, as well as with honey at times. It was considered “uncivilized” to drink wine how people consume it today.²⁰ The Romans were the first to understand that soil conditions, the harvest, as well as different ways of production all affected the taste and quality of the grape/wine. When Roman civilization collapsed, so did the wine production. It was now only a product of the Church used in religious ceremonies.²¹

¹⁹ National Grape Cooperative Inc.

²⁰ Classics Unveiled

²¹ National Grape Cooperative Inc.



Benedictine monks became the largest wine producers in Europe, mainly in France and Germany. Wine was traded for other goods in markets that were not grown at the monasteries. Perhaps the most famous wine producing monk came from the Champagne region in France named Dom Perignon.²² The use of grapes spread from culture to culture through the consumption and trade of wine. Although at times popular to eat, it was not until Spanish missionaries brought grapes to the Americas that grape use shifted from wine to a food.

In the 1700's Spanish missionaries brought grapes to the New World and found that they grew very well. As well as some species that they introduced, many native species were found. Today a majority of grape production in the U.S. comes from California, Washington, Oregon, New York, Pennsylvania, and Michigan.²³ Today grape production is for a variety of products coming from all regions of the world. The most popular is still being wine; however juices, jams, and raisins still account for a large percentage of grape usage. According to the Food and Agriculture Organization, 75,866

²² Wikipedia

²³ University of Georgia

square kilometers of the world are dedicated to grapes. About 71 percent of the entire grape production in the world is used for wine, 27 percent is used for fresh fruit while the rest of the 2 percent is dedicated to dried fruit. The area devoted to vineyards is increasing by approximately 2 percent per year.²⁴

Table 2: Top Grape Producing Countries

| Top 10 | Countries | Area dedicated | % of World Production |
|---------------|------------------|------------------------|------------------------------|
| 1 | Italy | 8,270 km ² | 13 % |
| 2 | France | 8,640 km ² | 12 % |
| 3 | Spain | 11,750 km ² | 10 % |
| 4 | USA | 4,150 km ² | 8 % |
| 5 | China | 1,780 km ² | 8 % |
| 6 | Turkey | 8,120 km ² | 6 % |
| 7 | Iran | 2,860 km ² | 4 % |
| 8 | Argentina | 2,080 km ² | 4 % |
| 9 | Australia | 1,642 km ² | 3 % |
| 10 | Chile | 1,319 km ² | 3 % |

(University of Georgia)

²⁴ Wikipedia, Grape

Optimal Growing Conditions



Grapes are grown on vines that can penetrate deep into the ground. The vine consists of three parts: a root system, trunk, and shoots/canes. The root system is a vast network sometimes reaching depths of 25-40 feet. For the most part, however, they are in the 2-5 foot range. The trunk varies in diameter and is responsible for distributing water and nutrients throughout the plant. Shoots/canes appear from the previous years inactive buds. Once the old buds have hardened in the winter months, they then become fertile and sprout flowers and grape clusters.²⁵

Grapes should be planted with optimal sun exposure throughout the day. Each plant needs plenty of room, 8 feet is recommended for optimal yield. When planting a grapevine, dig a large enough hole so that all roots can fit neatly without intruding on other crops or plants. Since the root system can be extensive the depth of the hole is dependent on the size of the plant.²⁶

²⁵ Jauron, Nonnecke, Lewis, and Gleason

²⁶ Cornell Cooperative Extension Publication



Before planting, it is important to soak the roots in water for a few hours to absorb water. When you go to plant dig a deep hole, as stated earlier, and fill in with dirt.²⁷ Make sure to plant a few inches of the trunk for added stability. Once in the ground, water the vine with an inch of water (an inch of surface water showing) and if the climate is especially dry, water every 4-5 days. After the initial setting period of 7-10 days, trim back vine to one cane so that well developed fruit clusters can form.²⁸



²⁷ Jauron, Nonnecke, Lewis, and Gleason

²⁸ Jauron, Nonnecke, Lewis, and Gleason

Optimal soil requirements can be found on the table below. You may need to add specific nutrients so that the grapevine can grow. Mulch so that weeds and other unwanted plants do not interfere with growth.

Table 3: Soil Nutrients for Grapes

| Element | Deficient | Below Normal | Normal | Above Normal |
|----------|-----------|--------------|--------|--------------|
| N (%) | 1.8 | 2 | 2.5 | 3 |
| P (%) | 0.24 | 0.25 | 0.35 | 0.4 |
| K (%) | 1.45 | 1.5 | 2 | 2.5 |
| Ca (%) | 0.59 | 0.6 | 1.7 | 2.5 |
| Mg (%) | 0.29 | 0.3 | 0.7 | 0.9 |
| Mn (ppm) | 45 | 50 | 150 | 200 |
| Fe (ppm) | 48 | 50 | 150 | 200 |
| Cu (ppm) | 6 | 7 | 30 | 50 |
| B (ppm) | 24 | 25 | 40 | 50 |
| Zn (ppm) | 18 | 20 | 35 | 50 |

(Cornell Cooperative Extension Publication)

Cultural Contexts



Wine is deeply associated with our agriculture, cuisine, civilization and society. Its cultural influences have firmly established its value in our society. In history, drinking vessels in numbers suggest that wine was an important ingredient of the feast at least from the early Bronze Age onwards. Wine also played an important role in ancient ceremonial life. Wine symbolized the “Juice of the Gods” and was mainly used in worshipping the gods during sacrifices and ceremonies, thus drinking of wine was appreciated and valued as a religious matter. Wine was frequently poured in libations before being drunk by the participants. Wine was necessary for celebration of the Catholic Mass because wine is used to identify as the blood of Christ. Consequently, the use of wine in religious celebrations became a religious tradition.



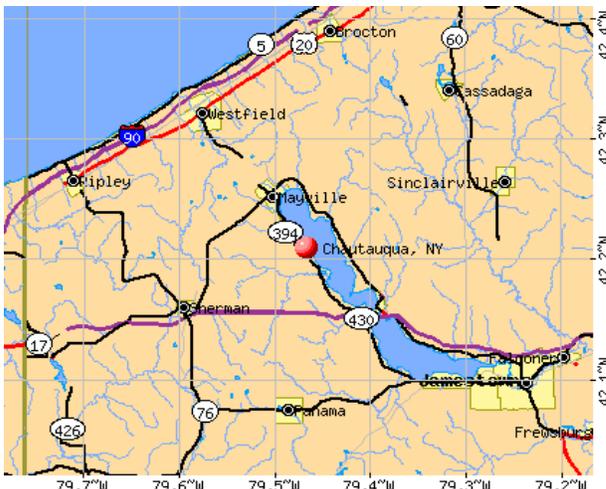
In the modern world, wine still plays an important role in special events and celebrations, but now wine consumption is a leisure activity. People drink wine because it is fashionable, and it is a kind of social status. In places such as Germany, beer was banned and considered pagan and barbaric, while wine consumption was viewed as civilized.²⁹

Wine is much more expensive compared to beer and other alcohols. The cost is

²⁹ Wikipedia, History of Wine

only part of the charm; refined wines are often presented as luxuries during special events. Wine advertisements often convey a message of elegance and cultivation which attracts consumers to pay attention to the quality of life. As wine becomes the latest fashion accessory, more and more people are learning about wine appreciation. It leads to an increased wine consumption, imports, and prices. Today, the role wine plays in enhancing people's status have made it a tool in the endless dinners that are an essential part of restaurant businesses.

History of New York Grapes in the 19th Century



Chautauqua District

Somewhere near Portland, New York in Chautauqua County the first grape vineyard was created by Deacon Elijah Fay in 1818.³⁰ The Chautauqua “grape belt” is on the southeastern side of Lake Erie. The area of land stretches about 3 miles long and 50 miles wide, passing through almost the entire county. Most of the land is suitable for

³⁰ Hedrick, 390

growing grapes because of the fertile soil provided by the lake.³¹ The region is exceptional for growing grapes because of the climate fluctuation due to Lake Erie. It, “hold[s] back vegetation in spring, equalize[s] night and day temperatures of summer, lengthen[s] the growing season and ward[s] off autumn frosts.”³²

The first variety planted in 1818 was *Vitis labrusca*, primarily Catawba and Isabella grapes known for their sweet taste.³³ The vines grew very lavishly, but did not produce fruit until 4 years later due to various complications. Deacon Fay was still not satisfied with the quality of wine he was producing, until he imported species of grapes grown on Long Island. His big start was in 1824 when he produced ten gallons of wine, which marked the first wine production in the region. Within twenty-five years Deacon and his nephew Lincoln began to commercially produce wine and the sale of vines. Although grapes were sometimes consumed, most of the grape production and sale in the 19th century was through wine. By the late 19th century over 600 acres of land in Chautauqua County are used to grow grapes.³⁴ Today Chautauqua County has over 1550 commercial farms of which 15,500 acres are devoted to growing grapes. Additionally there are eight wineries that produce a variety of wines.³⁵

³¹ Hedrick, *New York Grapes*, 73

³² Hedrick, *New York Grapes*, 75-76

³³ *Encyclopedia of Food*, 141

³⁴ Hedrick, *New York Grapes*, 77

³⁵ Crocker

Central Lakes/Finger Lake Region



There are at least five different climate conditions in the Central Lakes region. Although grouped together as one, the grapes from this region differ depending on what lake they are closest to.³⁶ The main reason why grapes grow so well in this region is due to past glacial activity, which left a number of “finger lakes” as well as very fertile soil. Similar to the Chautauqua region, frost in this area is very rare due to the large bodies of water. Another reason for the prosperous grape growth in the area is due to the depth of the soil. Vines do not thrive in shallow soils and often require loamy soil reaching to depths of 30 feet. Soil in this area typically extends to depths greater than 30 ft as well as drains water quickly and effectively.³⁷

The most common types of grapes grown in the region are *Vitis labrusca* (similar to the Chautauqua region) and *Vitis vinifera*. Depending on the level of acidity in the soil

³⁶ Hedrick, New York Grapes, 81

³⁷ Newman, 310

one of these species of grapes will be grown. Soils typically in the northern section of the region are slightly higher in acid content as well as lime so *V. vinifera* is grown.³⁸

The first record of grape and wine production in the area was in 1829 when William Warner Bostwick planted two different strands of grapes, Isabella's and Catawba's.³⁹ These varieties did not take long to prosper and others began to take notice. Soon others planted vines and cultivated grapes for fresh fruit consumption. Grape production took off in the region. Many people in the area started growing Isabella and Catawba grapes commercially. In 1847 the first shipment of grapes outside the region was sent to New York City.⁴⁰

Wine production soon developed when a few German immigrants planted two acres of grapes. Cultivating grapes in the same manner as they once did in Germany, Jacob Larrowe and Orlando Shephard were able to recreate similar tasting wine in the Finger Lakes region.⁴¹ Soon other variety of grapes such as Niagara, Concord, and Delaware were planted because they could survive the harsh winters better. Wine production in the region flourished because of the number of awards won, including gold medals at the 1876 Paris International Exposition.⁴² What started out as a two acre plot of grapes grew to over 25,000 acres by the turn of the century.

³⁸ Newman, 310

³⁹ Hedrick, New York Grapes, 83

⁴⁰ Newman, 307

⁴¹ Hedrick, New York Grapes, 83

⁴² Newman

Hudson River District



In 1827, a Quaker named Robert Underhill decided to import grape vines from Europe for the purpose of producing wine. He had just completed a self-sustaining village where a variety of different fruits and vegetables were grown. Growing grapes proved to be far more difficult. It took him close to two decades to produce grapes suitable for making wine and consumption. By crossing European varieties with native species in the region he was able to produce grapes that could survive the harsh weather as well as produce a berry with a full flavor.⁴³

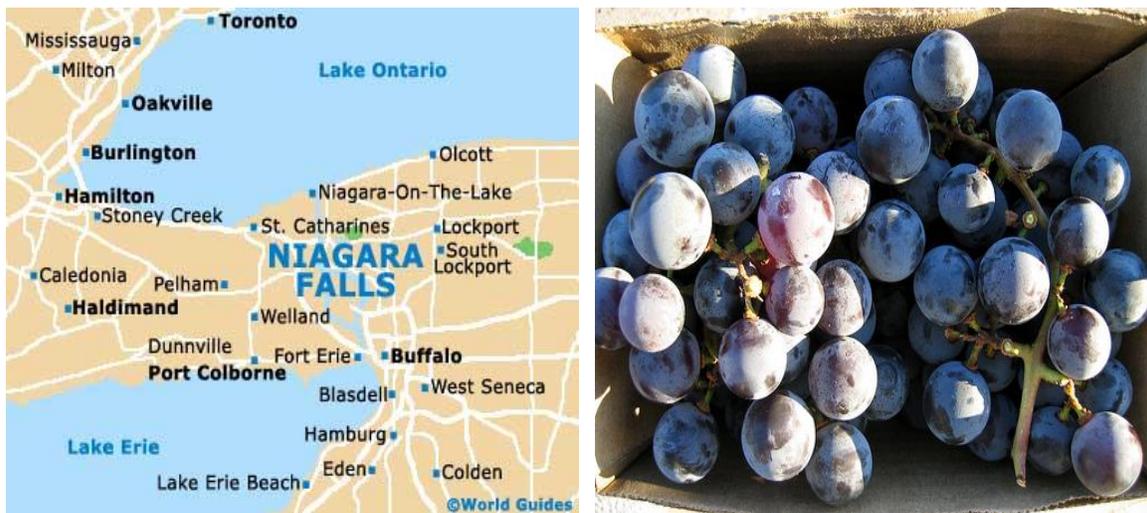
The district stretches throughout the entirety of the Hudson River. The topography of the region differs in altitude, rainfall, and soil conditions. Much of the area in valley receives far less rainfall during the spring, which makes for great grape yield. The grapes produced in this region are similar to the rest of the make up of New York State, Isabella and Catawba grapes. What makes this region different is its wide scaled production of grapes and wine.⁴⁴

⁴³ Haynes

⁴⁴ Hedrick, New York Grapes, 90

Often called the birthplace of American viticulture, the Hudson River district was host to a number of different wineries. The number of different varieties exceeded every other part of the state. In terms of acreage, Delaware grapes were grown the most followed by Niagara, Worden, Moore Early, Bacchus, Pocklington, Campbell Early, Hartford and Vergennes. The total production the 1900 was close to \$300,000.⁴⁵ Although prosperous, many of these grapes were subject to insect infestation because of the proximity to the river.

Niagara District



By far the smallest grape region in New York State, the Niagara district reaches 4700 acres. With similar climate and soil conditions to that of the Chautauqua region, the species of grapes are almost identical. The region is the home to the Niagara Grape, but mostly produces Concord grapes because of the grapes ability to withstand harsh temperatures.⁴⁶ Grapes in this region were introduced in 1886. Today many of the

⁴⁵ Hedrick, New York Grapes, 91

⁴⁶ Bulas

vineyards and commercial grape growers no longer exist because of the many problems associated with the harsh climate and fungal diseases.⁴⁷

⁴⁷ Hedrick, *New York Grapes*, 94

Bibliography

- Bulas, Paul. "Some Reflections on Niagara." www.winelabels.org. 2002. 3 Mar. 2008 <<http://www.winelabels.org/artniag.htm>>.
- Crocker, Elizabeth. "Chautauqua County, New York." 1979. 3 Mar. 2008 <<http://www.co.chautauqua.ny.us/general/overviewframe.htm>>.
- Floras, John S., Jonas Spaak, and Anthony C. Merlocco. "Ed Wine Heart Benefits No Different to Other Alcohols: Study." Beverage Daily. 13 Feb. 2008. American Journal of Physiology, Heart and Circulatory Physiology. 13 Feb. 2008 <<http://www.beveragedaily.com/news/ng.asp?id=83239-polyphenols-red-wine-heart-health>>.
- "GM Grapevines & Toxic Wines." The Institute of Science in Society. 1 Oct. 2007. The Institute of Science in Society. 17 Feb. 2008 <http://www.i-sis.org.uk/GMGrapevines_and_ToxicWines.php>.
- "Grapes - Vitis Spp." University of Georgia. 31 Mar. 2008 <<http://www.uga.edu/fruit/grape.html#ORIGIN>>.
- "Grapes, American Type (Slip Skin), Raw." USDA National Nutrient Database for Standard Reference 0913. USDA National Nutrient Database for Standard Reference. Clinton, NY. 31 Mar. 2008 <<http://www.nal.usda.gov/fnic/foodcomp/search/>>.
- "Grapes." Def. 1-4. Dictionary.Com. 23 Feb. 2008 <<http://dictionary.reference.com/browse/Grapes>>.
- "Grapes." Merriam-Webster Dictionary. 18 Feb. 2008 <<http://www.merriam-webster.com/dictionary/grapes>>.
- Haynes, Rebecca. "Grapes of the Hudson Valley." The Information Resource for New York's Hudson Valley. 3 Mar. 2008 <<http://www.hudsonriver.com/winehist.htm>>.
- Hedrick, Ulysses P. A History of Agriculture in the State of New York. New York State Agricultural Society, 1933.
- Hedrick, Ulysses P. The Grapes of New York. Albany: J, B. LYON COMPANY, 1908.
- "History of Wine." Wikipedia. 31 Mar. 2008 <http://en.wikipedia.org/wiki/History_of_wine>.
- Jauron, Richard, Gail Nonnecke, Donald Lewis, and Mark Gleason. "Growing Grapes in the Home Garden." Iowa State University Horticulture Guide (1997): 1-8.

- Katz, Solomon H., and William W. Weaver, eds. "Grapes." Encyclopedia of Food and Culture. 1st ed. 1 vols. Charles Scribner_Sons, 2002.
- Kipple, Kenneth F., and Krienhild C. Ornelas, eds. "Grapes." Cambridge World History of Food. 2nd ed. 2000.
- Mirza, Sumair, and Jason Tsang. "Roman Food." Rome Exposed. 2007. 31 Mar. 2008
<<http://www.classicsunveiled.com/romel/html/romefood.html>>.
- Newman, James L. "Wines, and Regional Identity in the Finger Lakes Region, Geographical Review." 76 (1986). JSTOR. Hamilton College, Clinton. 31 Mar. 2008.
- Reisch, Bruce I., Robert M. Pool, David V. Peterson, Mary-Howell Martens, and Thomas Henick-Kling, comps. Wine and Juice Grape Varieties for Cool Climates. Cornell University. 8 Feb. 2008
<<http://www.nysaes.cornell.edu/hort/faculty/reisch/bulletin/wine/index2.html>>.
- The Wine Pages, "Grapes - Botanical Description - Botany.". 17 Feb. 2008
<<http://www.thewinepages.com/grapes-botany.html>>.
- Walker, Amanda R., Elizabeth Lee, Jochen Bogs, Debra A. McDavid, Mark R. Thomas, and Simon P. Robinson. "White Grapes Arose Through the Mutation of Two Similar and Adjacent Regulatory Genes." The Plant Journal (2007): 772-785.