GRAPE

Taxonomy

Vitus vinifera L., Vitaceae

Botany

Grapes, like apples and pears, originated in the cradle of agriculture, i.e. southwestern Asia south of the Black and Caspian seas, and its cultivation dates back about 6000-7000 years. Although the genus consists of more than 60 species, the vast majority of cultivated grape cultivars belong to the species *V. vinefera*. The grape plant is a perennial, deciduous, woody, climbing vine (liana) with alternately arranged palmately lobed (hand shaped) leaves. Grape flowers are small and perfect with a calyx ring of 5 undeveloped sepals, 5 petals, 5 stamens and a single pistil with a superior ovary. The petals are fused together at their tips to produce a cap (calyptra) that is shed during flowering. The inflorescence is a branched cluster of flowers (panicle) in which the individual branches form an unbranched axis having stalked flowers (raceme). Table grape inflorescences usually have larger clusters with more flowers than wine grape inflorescences. Grape fruits are non-climacteric fleshy berries with 0-4 seeds.

World Production

According to FAOSTAT (http://faostat.fao.org/site/339/default.aspx) grapes are grown commercially in 89 countries and the world production exceeded 67 million tonnes in 2010. The leading fifteen wine and table grape producers for 2010 (million tonnes) were Argentina (2.62), Australia (1.68), Brazil (1.35), Chile (2.76), China (8.65), Egypt (1.36), France (5.85), Germany (1.00), Greece (1.00), Iran (2.26), Italy (7.79), South Africa (1.26), Spain (6.11), Turkey (4.26) and USA (6.78).

Nutrition

The nutritional value* of fresh table grapes (red or green) per 100 g edible portion is:

Water	81%
Calories	69 kcal
Protein	0.72%
Fat	0.16%
Sugars (ripe)	15.5%
Starch (ripe)	0%
Fiber	0.9%
Minerals (mg):	
Calcium	10
Iron	0.36
Magnesium	7
Phosphorous	20
Potassium	191
Sodium	2
Vitamins (mg):	
Vitamin A	66 IU
Vitamin B_1 (thiamin)	0.07
Vitamin B_2 (riboflavin)	0.07
Vitamin C	10.8
Niacin	0.19

*USDA National Nutrient Database for Standard Reference, Release 25 (2013), http://ndb.nal.usda.gov/ndb/search/list

Harvesting and Quality Indices

Grapes are non-climacteric fruit and do not ripen off the plant. Harvesting maturity is determined by SSC or SSC/TA ratio and, in the case of red and black grapes, berry colour. Eating quality is determined by flavour (high SSC or SSC/TA ratio) and berry firmness, and is unfavourably affected by flaccidity and off-flavours. Visual quality is determined by colour, size and freedom from outwardly visible defects, damage, scars, spray residues, cracked berries, stem browning, sunburn, dried berries and decay.

Physiological Disorders

Berry shattering is when berries become dislodged from the berry stem (pedicel). Physiological shattering occurs due to the formation of an abscission layer at the swollen part (bourrelet) of the pedicel where it is attached to the berry. The severity of shattering increases the longer the fruit are left on the vine and is usually higher in seedless cultivars. Treatment of seedless grapes with gibberellin at fruit set to increase cluster and berry size also weakens berry attachment to the pedicel and increases postharvest shattering. Shattering is aggravated by the cumulative postharvest water loss as well as rough handling at harvest and during postharvest handling. Decay shattering occurs due to infection with fungi such as *Botrytis cinerea*, *Alternaria* spp. and *Rhizopus stolonifer*. Such infections also stimulate physiological shattering. Shattering can be reduced by rapid cooling after harvest, maintaining recommended postharvest temperatures and RH, pack depth and packing density, bagging of individual clusters and gentle handling.

Precooling and Storage

Grapes must be rapidly precooled with forced-air as soon as possible after harvest. After precooling, it is recommended that grapes be stored at -1 to 0°C and 90 to 95% RH with a moderate air flow (0.57-1.13 m^3 min^{-1} ton^{-1}). High relative humidity during precooling and storage is required because grapes are very sensitive to moisture loss and losses of as little as 1 to 2% can result in fruit stalk

browning. Such browning is, therefore, a good indicator of the fruits' storage history. Moisture loss of 3 to 5% causes the fruit to lose their gloss and turgidity. To prevent stalk freezing damage, the storage temperature for table grapes should not be allowed to drop below -1°C. The pulp temperature must be maintained at -0.5 to 0°C throughout their storage life. Table grapes are not chilling sensitive. Due to the high SSC of mature berries, their freezing temperature is lower than that of the stalk. Since freezing point is directly related to SSC, immature berries will freeze at higher temperatures than mature ones due to their lower SSC. Grapes can be stored in CA at 2-5% O_2 and 1-5% CO_2. However, CA is not generally recommended for grape storage because it is not commercially viable and is incompatible with SO_2 fumigation required for decay control. In retail outlets, it is recommended that grapes be displayed in a refrigerator or cold table.

Ethylene

Grapes are non-climacteric fruit and as such their ethylene production remains low throughout their entire postharvest life. Although they are not sensitive to ethylene, ethylene at levels exceeding 10 $\mu L\ L^{-1}$ (ppm) may be a secondary factor in berry shattering during storage because ethylene induces the formation of the abscission layer.

Postharvest Pathology

Grey mould or gray mould is the most important and widespread postharvest disease of grapes. This very destructive disease is caused by the fungus *Botrytis cinerea* Pers. and can develop at storage temperatures as low as -0.5°C. In the early stages of the disease the skin of the berry turns brown, becomes loose and is easily detached; a condition known as 'slip-skin'. In the advanced stages of the disease, masses of grey coloured spores appear on the berry surface. Grey mould infection is encouraged by wet conditions and split berries. However, wounding is not a prerequisite for infection and mature uninjured berries may also be attacked. Grey mould is controlled by proper cultivation practices, pre-harvest fungicide sprays, trimming of damaged fruit, careful handling to prevent injury, prompt and rapid cooling after harvest and fumigation with sulphur dioxide. Sulphur dioxide (SO_2) is an effective gaseous fungicide used to control grey mould in grapes. Long-term storage and long-distance transport of table grapes would be impossible without the use of SO_2. Grapes must be fumigated with SO_2 within 12 hours after harvest. Fumigation can be done either through gas or SO_2-releasing pads. These pads are impregnated with sodium metabisulfite that releases SO_2 when it reacts with water. SO_2-release is therefore highly dependent on relative humidity. Exact temperature control and an unbroken cold chain is essential when SO_2-releasing pads are used because temperature fluctuations cause moisture condensation, which can result in excessive SO_2-release and damage to the berries.