

About The Apple – *Malus domestica*

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TAXONOMY

The cultivated apple, *Malus domestica*, belongs to the Rosaceae (Rose) Family, and the subfamily of Pomoideae; along with pear, quince, loquat and medlar.

Throughout its history of cultivation, at least 10,000 apple cultivars were developed, many of which are now lost. This was due in part to the older practice of seed propagation. Commercially there are about 100 cultivars currently being grown commercially, but only 10 of the most popular make up over 90% of US production.

HISTORY

It is generally believed that the edible apple originated somewhere in Central Asia. There are many other wild species of *Malus*, and it is generally assumed that *M. domestica* evolved from chance hybridization among these wild species. The seeds of these early fruits would likely have been spread by animal and birds. The many native herbivores may have gorged themselves on the apple fruits, selecting those trees producing larger, sweeter, and juicier fruit. They therefore selectively spread seeds from better tasting fruit, aiding the evolution of these features. Selected in this way, the apple gradually changed from a bird's food with edible seeds to a larger Mammal's food with poisonous (cyanide-containing) seeds.

Apples were probably improved through selection over a period of thousands of years by early farmers. Historians have documented the presence of edible apples as early as **6,500 B.C.** when the remains of apples were found among excavations at Jericho in the Jordan Valley and dated to this time period. Many other accounts have been recorded, but in **323 B.C.** Theophrastus described six varieties of apples and discussed why budding, grafting, and general tree care are required for optimum production, and stated that seeds almost always produces trees of inferior quality fruit. The excellent keeping qualities of apples were discovered by at least **100 B.C.**, as the Roman Varro provided written accounts of "fruit houses" for storing apples for winter.

Apples were brought to North America with the colonists in the **1600's**, and the first apple orchard on this continent was said to be near Boston in **1625**. From these New England origins, apples moved west with the pioneers. In **1790**, Thomas Andrew Knight of England begins first controlled apple hybridization program for apple improvement. It was **1904** when J.T. Stinson in an address to the St. Louis Exposition, proclaimed, "*An apple a day keeps the doctor away*". Perdue and the University of Illinois jointly initiated an apple breeding program in **1945** to produce high quality disease resistant apples.

FOLKLORE

There are many myths and legends associated with the apple. Apples were frequently used in Greek, Russian, Norse, and other mythologies as symbols of immortality or reincarnation. One of the most popular stories pertaining to apples is that of Adam and Eve, who ate the "forbidden fruit" of the tree of good and evil in the center of the garden of Eden. Actually the account given in Genesis 2 and 3 never mentions what kind of fruit this tree produced, but numerous works of art commonly depict it as an apple. The Latin noun *Malus* has the dual meaning of either apple or evil, which probably stems from this Bible story. Apples are also symbolic of temptation.

In Greek mythology, Gaia, or Mother Earth, presented a tree with golden apples to Zeus and his bride Hera on their wedding day. These golden apples became involved with many tales of love, bribery and temptation ranging from the abduction of Helen of Troy to the defeat and marriage of Atlanta. The sexual and romantic connotations of the apple were powerful reasons why apples came as a desert at the end of the meal. They not only tasted heavenly and were good for digestion, but were regarded as a cunning transitional aphrodisiac for the pleasures that followed. Is it any wonder that apples became the most sought after fruit on earth?

The Roman Horace, in 100 B.C., noted that Italy had become one big fruit orchard and the perfect meal began with eggs and ended with apples. The Romans even created a deity of the fruit trees, the goddess Pomona. Many cultures since, have responded to the basic human longing for a time and place where men and women could be free from the battle with nature for food and shelter. This place was symbolized by a garden of paradise and pleasure, complete with fruit-laden apple trees.

MEDICINAL PROPERTIES

An apple a day can indeed keep the doctor away, according to recent research in human health. The average apple contains about 5 grams of fiber, important in normal bowel function. As recently discovered in many fruit crops, flavonoids may play an important role in preventing many kinds of cancer, and may also reduce the risk of heart disease and stroke. Eating 2 apples or drinking 12 ounces of apple juice daily was shown to reduce build-up of arterial plaque. Some advocates will even claim that a fresh apple is nature's own tooth brush.

On the darker side, the seeds of apple and pear contain a hydrocyanic acid that will inhibit respiration in humans, resulting in spasms, coma, difficult breathing, and ultimate death. It is said that a man who ate a cup of apple seeds died.

BOTANICAL DESCRIPTION

Plant – The small to medium sized tree develops a spreading canopy, to 30 feet in wild, generally 6-15 feet in cultivation. Tree size and shape is heavily dependent on rootstock and training system used. Leaves are elliptical with serrate margins, dark green with light pubescence on underside.

Flowers – Petals are white when open, but have red-pink undersides when opening, hence the “pink” bloom stage. The ovary is inferior, embedded in the floral cup. It contains 5 locules, usually 2 seeds per locule. The inflorescence is a cyme of 4-8 flowers, with the center flower opening first. The central flower is often called the “King blossom”, and has the potential to produce a larger fruit than the other flowers. Flowers are produced terminally from mixed buds (containing both leaves and flowers) and on spurs. Spurs form on 2-year-old and older wood on some cultivars, and generally grow only a fraction of an inch each year. Initiation of floral buds (fruit producing) occurs during the summer before blossom period.

Pollination – Most cultivars are self-unfruitful. Cross-incompatibility is rare, so most cultivars that bloom at the same time will serve as pollinizers, including crab apples. A few cultivars are pollen-sterile. Honey bees and Mason bees are the most effective pollinators.

Fruit-- A special fruit type is given to the apple and related fruits – the *pome*. The bulk of the fleshy edible portion derives from the floral cup, not the ovary as in most other fruit. The apple contains 5 seed cavities with generally 2 seeds each with complete pollination. Seeds are relatively small and black, and mildly poisonous. Fruiting usually starts 3-5 years after grafting.

GENERAL CULTURAL

Soils and Climate – Deep, well-drained, loamy soils with pH 6-7 are best, but apples are grown on a wide variety of soils worldwide.

Apples are adaptable to various climates, but can be considered best adapted to the cool temperate zone from about 35-50 degrees latitude. They have a more northern range than many other tree fruits due to relative late blooming and extreme cold hardiness. Generally, fruit quality is best in temperate climates with high light intensity, with warm (not hot) days and cool nights. This accounts for the success of apple culture in eastern Washington State, which has a cool, desert-like climate.

Apples require about 1000-1600 hours of chilling (<45F) to break dormancy. The wood and buds of dormant trees are hardy to -40F, but open flowers and young fruitlets are killed by brief exposure to 28F or less. Apples are among the latest blooming tree fruits, and are therefore less frost prone than other species at any given location.

Most apples reach maturity about 120-150 days after bloom, with a few cultivars maturing in as short as 70 days, and others as long as 180.

Propagation – Commercially, apples are T-budded or chip-budded in the nursery, and sold as 1-year-old whips on 1.5 to 2-year-old rootstocks. Rootstocks are also produced vegetatively, generally by mound layerage. Young apple trees are more expensive than other species due to the use of clonal rootstock and the extra time required to produce trees. Seedling rootstocks are still used in some of the extreme cold regions, and in countries where non-intensive orchards exist. The seed obtained from processing plants, is inexpensive and easy to propagate.

Rootstocks – Hundreds of years of selection and decades of research has led to more rootstock choices for apple than practically all other major temperate tree fruits combined. There is a remarkable range of tree size control available among rootstocks. In addition, apple rootstocks vary greatly in cold hardiness and disease tolerance.

Several series of rootstocks are available, the most popular being the Malling and Malling-Merton. The single letter “M” stands for “Malling”, after the East Malling research station in England where these rootstocks were introduced. The “MM” designates “Malling-Merton”, since these stocks were a joint venture between the East Malling station and an institute located in Merton, England. Another important series is Budagovsky (Bud” or “B”).

In the US the most common are M.26 (Dwarf), M.7 (semi-dwarf), and M.9 (dwarf). Intensive plantings are almost exclusively on M.9. The M.27 rootstock is the most dwarfing, and trees are actually too small to be used commercially. M.9 is the most dwarfing of the commercially viable rootstock. They can easily be managed at 6 feet high.

Almost all dwarf and semi-dwarf trees require staking because of poor anchorage and leaning due to heavy fruit loads borne in early years. The use of these stocks is often combined with a trellis or stake. To circumvent some of the problems of dwarfing rootstocks, 3-part trees (interstocks) are used in some applications. Poor anchorage can be avoided by using the strong rooted MM series rootstock with a short length of the more dwarfing M.9 or B.9 grafted between rootstock and scion. By default, trees that are top-worked to new cultivars have an interstem.

Popular apple rootstocks and characteristics

<u>Rootstock</u>	<u>Size reduction</u> (% of full size)	<u>Precocity</u>
M.27	25	High
Budagovsky 9	30	High
M.9	35	High
M.26	40	High
Mark	40	High
M.7	65	Medium
MM.106	75	Medium
M.2	80	Medium
M.4	80	Medium
MM.111	85	Low
Seedling	100	Low

Planting Design – The range of rootstocks available for apples permit a wide variety of orchard designs and tree training systems. In most cases, trees are grown in rectangular arrangements or in hedgerows. Conventional apple orchards on seedling rootstocks require spacing of 20X20 ft. or wider. Semi-dwarf trees require a spacing of about 15X15 ft., and dwarf trees spacing can be reduced to 10X10 ft. or slightly closer. In an orchard setting with several rows of trees and where tractors and other powered equipment will be used, is advisable to increase the distance between rows by several feet to allow passage.

Training System – World wide, the most common training system for apple is the central leader. This is where one branch is allowed to grow vertically and form the main bole upon which scaffold limbs are spaced at selected intervals. This system works well in areas of high light intensity and long sunny days.

In the coastal areas of Oregon, where every possible ray of light needs to be captured and utilized, the open-center system is preferred. At an early age, 3-5 branches, evenly spaced around the tree, and located at different levels, are selected for the main scaffold branches. With pruning and limb bending, the selected branches are positioned to grow at the angle of about 60 degrees from vertical. This open-center, or vase-like, training system allows the maximum amount of light penetration for better fruit quality.

Pruning – Pruning is typically done when trees are still dormant in late winter. Unwanted wood however, can be removed any time of the year. The severity and type of pruning cuts depend on bearing habit, fruit size, inherent tree vigor, and training system. Most apples bear fruit on spurs, so one objective in pruning is to retain spurs on 2-year-old and older wood, exposing them to light as much as possible. Since long 1-year-old shoots will not bear fruit, they are removed unless needed to fill in an open space in the tree or to replace declining fruiting wood. For the most part, pruning is a hands-on learning experience, but you can start with a good book or learn from an experienced friend.

HARVEST

Maturity – Several methods are available for determining optimal harvest time. Days from full bloom is relatively consistent from year-to-year for different cultivars, and provides a rough estimate of picking date. As maturity approaches, apples soften, so a fruit firmness meter can be used to measure the force required to puncture the flesh. Target values of firmness vary by cultivar and intended storage method, with firmer fruit reserved for long-term storage. Soluble solids can be measured with a refractometer, giving an indication of fruit sugar content, which increases as apples ripen. Starch is broken down into sugars during ripening, and a quick iodine stain test on a half-cut apple can be used to indicate how far along this process has occurred. This method is also used on stored apples to assess remaining shelf-life. The back-yard grower may start consumption as soon as the seeds turn dark, the background color (if present) turns yellow, and the apple tastes good. If you can not eat an entire apple before your stomach turns sour, it is too green.

Harvest Method – Apples must be picked by hand to avoid bruising, which reduces quality grade and increases storage losses. Fruit also must be picked carefully to avoid damaging the fruiting spur, where next season's fruit will be borne. Do not reach and pull, but rather hold the fruit gently in the hand and rotate it upwards, as if you are trying to un-hook it from the spur or attachment point. *Apples are to be un-hooked – not snatched.* If the apple does not release when raised slightly above horizontal, it is likely not ripe.

Storage – The apple is one of the few fruits that can tolerate long-term storage without significant loss of quality. Commercially, apples are stored in a controlled atmosphere where the oxygen is reduced to 2-3% and CO₂ is elevated slightly to retard respiration. Firmer, less ripe fruit are placed in long-term storage, while more mature fruit are sold directly or placed in short-time storage.

At home, apple storage can be extended by packing firm unblemished fruit in tight boxes or plastic bags and refrigerated at about 34 degrees.

CONTRIBUTION TO DIET

Apples have a broad spectrum of food uses: pies and cakes, jams, sauces and juices, apple butter, dried apples, and much more. Apple juice has surpassed orange juice consumption in the USA. A medium sized apple contains about 80 calories, and is unusually high in fiber: generally about 5 grams per fruit (mostly from pectin). In 2001, United States consumers ate an average of 45.2 pounds of apples and processed apple products. About 60% of these are eaten fresh. More apples are consumed world-wide than all the other tree fruits combined.