KIWI STORAGE

Pre and Post-Harvest Storage

STOREX
CONTROLLED ATMOSPHERE

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References from:

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- S.R. Pennycook(1985) Fungal fruits rots New Zealand Journal of Experimental Agriculture.

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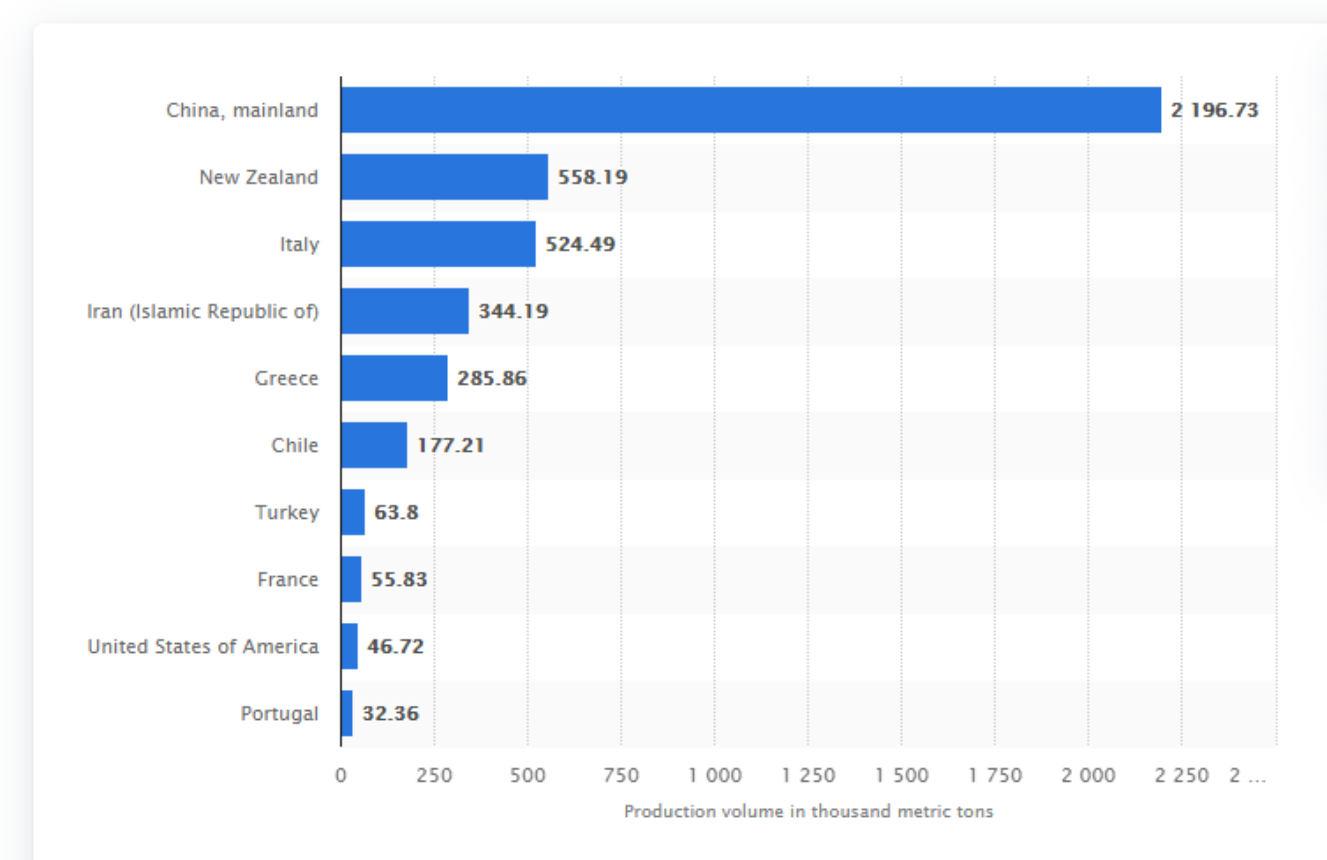
Kiwifruit or Chinese gooseberry is the edible berry of several species of woody vines in the genus Actinidia. The most common cultivar group of kiwifruit is oval, about the size of a large hen's egg: 5–8 centimeters in length and 4.5–5.5 cm in diameter.

Kiwis are small fruits that pack a lot of flavor and plenty of health benefits. Their green flesh is sweet and tangy. It's also full of nutrients like vitamin C, vitamin K, vitamin E, folate, and potassium. They also have a lot of antioxidants and are a good source of fiber.

Kiwis production worldwide in 2019 (in 1000 metric tons).



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Growing conditions

Most kiwifruit plants grow best in either full sun or light shade. Kiwifruit generally need slightly acidic soil that has a pH between 6.0 and 6.5. If your soil is too alkaline, you can try to acidify it to make conditions right for growing kiwifruit. The soil must be moist but well-drained.

Climate

It may surprise you to know that kiwis will thrive in just about any climate that experiences at least a month of below 7degree C temperatures in winter. The vines need a period of cold to set fruit. The kiwis available at the grocery store, Actinidia deliciosa, are native to China.

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Kiwis varieties

There are **more than forty known varieties** of kiwi, spanning the globe from California to New Zealand to Greece. New Zealand's Hayward is the standard grown all over the world. All kiwi varieties can be put into four categories: arctic, hardy, fuzzy, and hairless. Some types need to be grown in sub-tropical climates and will die in temperatures below 10 degrees. However, others are hardy enough to succeed in Russia and survive and even thrive in temperatures as low as negative 30.

For those with shorter growing seasons and cold winters, varieties such as Ananasnaya, Dumbarton Oaks, Geneva, and Issai are excellent options. These are hardy varieties explicitly made for colder climates.

Types of Kiwi

- Green Kiwi. The green kiwi is the most common kiwi.
- Golden Kiwi. The golden kiwi, also known as Actinidia chinensis.
- Hardy Kiwi.
- Anananzaya Kiwi.
- Dumbarton Oaks Kiwi.
- Geneva Hardy Kiwi.
- Andrey Hardy Male Russian Kiwi.
- Natasha Russian Kiwi.

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Preharvest conditions and Harvest

Harvesting time

Kiwi fruit has attained full size in August, however, it is not mature enough for kiwi harvesting until late October to early November when the seeds have turned black and the sugar content has risen.

In kiwi harvest management three degrees of fruit maturity are known:

- The first is botanical maturity, which occurs when the flow of nutrients into fruits is stopped. They're reached the final shape and size.
- The second is usable maturity when fully develop fruits have all typical qualities of meat such as strength, taste and smell and they're suitable for consumption. This maturity is usually achieved only in the warehouse.
- The third is technological maturity that indicates the degree of ripeness for immediate use. It coincides with a usable maturity, but fruits are harvested later. Fruits are ready for harvest when they're sufficiently softened at the point where the petiole connects with the fruit meat. Too early harvested fruits are not durable in storage and excessively lose their weight.

Kiwi fruit has attained full size, but it's not mature enough for harvesting until the seeds have turned black and the sugar content has risen.

Although fruit will soften off the vine after the sugar content is 4%, the sweet flavor has not developed until the content increases to 6-8%. After kiwi harvesting, the starch is converted to sugar and will then be ready to eat once the fruit contains an astonishing 12-15% sugar.

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Commercial kiwi growers use a tool called a refractometer, which measures the amount of sugar in the fruit to determine the time of a kiwi fruit harvest (about 6.5% or greater).

Manually refractometer

Digital refractometer

Harvesting method

The method in the past was unreliable (the harvest was started on a randomly selected date),as a result of differences in ripeness between regions and orchards. Kiwis are harvested by hand so when harvesting kiwi handle with care, as they bruise easily and damaged fruit has a limited storage life.

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To harvest kiwi, snap the stem at the base of the fruit. Again, softness is not a great determiner for readiness. Size, date, and when in doubt, cut open a fruit to access the seeds inside– when seeds are black, it is time for kiwi fruit harvest. Remove the larger fruit when harvesting kiwi and allow the smaller to remain on the vine and attain some size. The fruits are collected in a harvesting bag and then put into stacking crates.

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Post-Harvest diseases

Among postharvest diseases, gray mold, caused by the fungal pathogen *Botrytis cinerea*, is the most devastating.

Because Botrytis infection occurs via the picking wound that is created as the fruit is detached from its pedicel during harvest, orchard fungicide applications cannot directly control the disease. However, they can contribute indirectly, by reducing the level of Botrytis inoculum present at harvest. The two critical periods for this purpose are:

1. Late blossom-early petal fall, to prevent the buildup of heavy Botrytis sporulation on senescing petals and
2. Pre-harvest, to minimize the risk of Botrytis contamination of the picking wounds during harvesting and post-harvest handling of the fruits.

Not only *Botrytis* is a reason for fungal defects, also *Cadophora* and *Alternaria* could led to significant losses.

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Post-Harvest Storage

Kiwifruit is one of the most recently domesticated temperate fruit crops. The consumption of fresh kiwifruits is booming due to its numerous health benefits. The postharvest physiology of kiwifruit is rather complex and is very sensitive to exogenous ethylene. The lack of proper maturity harvest indices is a major drawback in postharvest management, except for the soluble solids content (SSC), which is widely used as a harvest index. Many pre- and postharvest factors are involved in the deterioration of fresh fruit quality and storage life. Therefore, the development of novel techniques to maintain the quality and shelf life of fruits after harvesting is a major challenge.

Recent postharvest and storage techniques like :

- The use of ethylene scrubber and blockers,
- Surface coatings,
- Postharvest fungicides,
- Heat treatments,
- Ionizing radiation, and the use of bioagents,
- Controlled atmosphere (CA) storage, and modified atmosphere packaging (MAP), along with cold chain management, are helping to address the call for preserving quality.

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Ethylene and Controlled Atmosphere (CA)

The kiwifruit is a climacteric fruit that is extremely responsive to low concentrations of ethylene, even at low temperatures. At harvest the fruit has a high starch content, and during ripening the soluble solids content of the fruit may double, largely as a result of starch hydrolysis. Rapid flesh softening during the first 6 to 8 weeks of storage(at –0.6^{0}C- 0^{0}C) is paralleled by, and may be linked to the reduction in starch content.

Kiwifruit maturity is generally judged by soluble solids content at harvest. Though soluble solids content of ripened fruit is a better measure of horticultural maturity, it has not been developed as an inspection procedure. A maximum maturity standard based upon flesh firmness has been proposed.

Deterioration problems in Kiwis **are related to ethylene sensitivity.**

Flesh softening increases the susceptibility to handling injuries and to the development of fruit rot. Fruit injuries can accelerate ethylene production. An ethylene-carbon dioxide-induced physiological disorder can accelerate deterioration in controlled atmosphere storage. Ethylene exposure before cooling can accelerate fruit softening during subsequent storage. Storage temperatures above 0°C and elevated ethylene are equally harmful in accelerating flesh softening.

Elevated carbon dioxide inside sealed polyethylene liners (approximately 0.04 mm) will slow softening, but potassium permanganate is required to reduce ethylene accumulation.

Controlled atmosphere storage
(2% oxygen + 5% carbon dioxide + < 0.02 µl liter^{-1} ethylene) at 0°C has been most effective in maintaining flesh firmness and delaying deterioration.

Accumulated evidence suggests that kiwifruit should be harvested with ≥ 6.5% soluble solids content and when ripe fruit will be ≥ 14% soluble solids content, but with flesh firmness ≥ 63 N (determined by a penetrometer with an 8 mm tip). Ethylene exposure should be avoided and ventilation or ethylene oxidation procedures used to maintain ≤ 0.02 µl liter $^{-1}$ ethylene in the storage atmosphere (< 0.01 µl liter^{-1} is preferred). Fruit should be thoroughly forced-air cooled, commencing within 6 hours of harvest, and stored at 0°C and 90–95% relative humidity, and for long storage placed under 2% oxygen.

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The new technology (1-methylcyclopropene, 1-MCP) inhibits the action of ethylene, the natural ripening hormone of kiwis. It has been shown to inhibit ethylene production, retard respiration rate, delay or prevent softening, and substantially reduce storage disorders in various pear cultivars. In case 1-MCP is applied, contact your 1-MCP supplier for further information and instruction about the storage conditions to be applied.

1-MCP extends Shelf life of Kiwifruit

Packaging

Because of their high impact- and pressure-sensitivity, kiwifruit are packaged in single layers in wooden, cardboard or plastic trays with plastic inserts. To prevent large weight losses due to evaporation, the fruit is wrapped in perforated film. The individual trays contain up to 45 items and are palletized.

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