

Cucumber, melon, and watermelon are originally from the Old World (primarily Africa and Asia). Although they are in the same family (Cucurbitaceae) with the squashes, pumpkins, and gourds (mostly of the genus *Cucurbita*), they are only distantly related. The *Cucurbita* species are from the New World (primarily Central and South America).

Watermelon, cucumber, and melon plants are trailing or vining, tendril-bearing, frost-sensitive annuals. They are mostly monoecious (separate staminate and pistillate flowers, sometimes referred to as male and female flowers) and require various insects, especially bees, to effect pollination. The fruits are variously shaped, multiseeded, specialized berries called pepos. Together, plants in this family are called cucurbits.

Watermelon (*Citrullus lanatus*)

Watermelon is originally from central and southern Africa. The citron (*Citrullus lanatus* var. *citroides*) grows wild there, and is thought to be related to the wild ancestor of watermelon. The related species known as Egusi melon (*Citrullus colocynthis*) is found wild in west Africa and is also thought to be related to the wild ancestor of watermelon.

Watermelon is consumed for its fresh fruit, pickled rind, glacé candy, and for its dry seeds (harvested from confectionary type cultivars). The watermelon fruit contains 93 percent water, with small amounts of protein, fat, minerals, and vitamins (Table 1). In some arid regions, watermelon is used as a valuable source of water. The major nutritional components of the fruit are carbohydrates (6.4 g/100 g), vitamin A (590 IU), and lycopene (4,100

CUCUMBERS, MELONS, AND OTHER CUCURBITS. Watermelon (*Citrullus lanatus*), cucumber (*Cucumis sativus*), and melon (*Cucumis melo*) are major crop species in the cucurbit or vine-crop family (the Cucurbitaceae), an important family of flowering plants (the angiosperms). The family also includes squash, pumpkin, and gourds.

TABLE 1

Nutritional composition of cucumber, melon, and watermelon (amounts per 100 g edible portion)

Nutrient	Cucumber (slicing)	Cucumber (pickling)	West Indies gherkin	Casaba melon	Honeydew melon	Musk- melon	Watermelon (fruit)	Watermelon (seeds)
Water (percent)	96	96	93	92	90	90	93	5.7
Energy (kcal)	13	12	17	26	35	35	26	567
Protein (g)	0.5	0.7	1.4	0.9	0.5	0.9	0.5	25.8
Fat (g)	0.1	0.1	0.3	0.1	0.1	0.3	0.2	49.7
Carbohydrate (g)	2.9	2.4	2.0	6.2	9.2	8.4	6.4	15.1
Fiber (g)	0.6	0.6	0.6	0.5	0.6	0.4	—	4.0
Ca (mg)	14	13	26	5	6	11	7	53
P (mg)	17	24	38	7	10	17	10	—
Fe (mg)	0.3	0.6	0.6	0.4	0.1	0.2	0.5	—
Na (mg)	2	6	6	12	10	9	1	—
K (mg)	149	190	290	210	271	309	100	—
Vitamin A (IU)	45	270	270	30	40	3,224	590	—
Thiamine (mg)	0.03	0.04	0.1	0.06	0.08	0.04	0.03	0.1
Riboflavin (mg)	0.02	0.2	0.04	0.02	0.02	0.02	0.03	0.12
Niacin (mg)	0.30	0.4	0.4	0.40	0.60	0.57	0.20	1.4
Ascorbic Acid (mg)	4.7	19.0	51.0	16.0	24.8	42.2	7.0	—
Vitamin B6 (mg)	0.05	0.4	0.4	—	0.06	0.12	—	1.4

SOURCE: Gebhardt, Cutrufelli, and Matthews, 1982; Haytowitz and Matthews, 1984; Rubatzky and Yamaguchi, 1997.

$\mu\text{g}/100\text{g}$, range 2,300–7,200), an anticarcinogenic compound found in red flesh watermelon. Lycopene may help reduce the risk of certain cancers, such as prostate, pancreas, and stomach. The lycopene content of the new dark red watermelon cultivars is higher than in tomato, pink grapefruit, or guava. Orange flesh types do not contain lycopene, but have a high carotene (vitamin A) content. Citron and Egusi type watermelons are used to feed cattle in Africa. Watermelon seeds are rich in fat and protein.

Wild watermelons have hard, non-sweet, sometimes bitter, white flesh. Through plant breeding, the domesticated watermelon now being grown has fruit with a protective rind, sweet edible flesh, and bright red color. Specialty cultivars are available with orange, yellow, or white flesh.

Through history, watermelon was distributed throughout the world as trade and knowledge of central Africa developed. The crop was grown in India by at least 800 C.E., and in China by 1100 C.E. The Moorish conquerors of Spain introduced watermelon into Europe, where it was noted in Cordoba in 961 C.E. and Seville in 1158 C.E. Watermelon's spread into northern Europe was relatively slow, since it was not noted in the British Isles until late in the sixteenth century, perhaps because of the generally unfavorable climate for watermelon culture in much of Europe. About this time, watermelons were introduced into the New World, with culture of the plants noted in the Massachusetts colony in 1629. The introduction of watermelon into other parts of the world has followed established trade routes.

In the United States, Thomas Jefferson, as indicated in his garden record, was a watermelon gardener at Monticello, as was Henry David Thoreau in Concord, Massachusetts. Mark Twain wrote in *Pudd'n'head Wilson* that "The true southern watermelon is a boon apart and not to be mentioned with common things. It is chief of the world's luxuries, king by the grace of God over all the fruits of the earth. When one has tasted it, he knows what the angels eat." Even today, watermelon exerts an influence over popular culture in festivals throughout the rural South.

Watermelon is grown commercially in areas with long frost-free warm periods. Plants are widely spaced because of the long, trailing vines. They may be established in the field by planting seeds or by transplanting containerized plants. Management of plant pests (weeds, insects, and diseases, including nematodes) is essential during the production period. Three-fourths of the world production is grown in Asia (Table 2), with China the leading country in production.

Watermelons are grown in most states of the United States, but the major producers are in the South and West (Florida, Georgia, California, and Texas). The fruits are harvested by hand, with the most experienced workers doing the cutting (removal of the fruit from the vine) and

TABLE 2

World production of cantaloupe and melon, cucumber and gherkins, and watermelon (1997)

Continent or area	Production (mg x 1000)		
	Cantaloupe (melon)	Cucumber (gherkin)	Watermelon
Africa	1,045	390	2,679
North & Central America	1,966	1,589	2,539
South America	427	76	1,497
Asia	12,071	20,245	35,730
Europe	2,421	3,504	3,601
Oceania	78	22	90
World	18,009	25,827	46,135

SOURCE: FAO Production Yearbook 51 (1997).

the others loading the bins or trucks. The fruits are shipped to markets throughout the country, with some exported to Canada.

Watermelon fruit will keep for two to three weeks after harvest if it is stored properly at 10 to 15°C and 90 percent RH. Besides whole watermelons, it is becoming popular to sell watermelon in pre-cut halves, quarters, slices, and chunks. Whole fruit are usually cut in the store under cold, aseptic conditions since the cut product does not ship or store well. Seedless watermelons are especially popular for pre-cut sales, since that shows their seedless quality.

In the 1800s, most watermelon was grown for local sales. Development in the last few decades of rapid shipping in refrigerated railroad cars and trucks has led to distribution of watermelon throughout the United States from major production areas. Southern production areas begin shipping early in the year, and the harvest continues throughout the summer in more northern areas.

Depending on the cultivar, watermelon fruit are produced in different sizes: ice box, small, medium, large, or giant; different shapes: round, oval, blocky, or elongate; different rind patterns: gray, narrow stripe, medium stripe, wide stripe, light solid, or dark solid; different flesh colors: white, yellow, orange, or red; and different types: seeded or seedless. Commercially, the most popular seeded cultivars are red flesh, blocky shape, and large sized (8–11 kg), like the cultivar Allsweet. For seedless watermelons, the popular cultivars are red flesh, oval shape, and medium sized (5–8 kg), like the cultivar Tri-X-313. Per capita consumption of watermelons in the United States is 7.2 kg (Table 3). Watermelon seeds can be harvested and roasted for eating as well.

Watermelon is served fresh as slices, as chunks (often in fruit salad), as juice, and as edible seeds for the confectionary types. In the United States, watermelon has typically been part of the summer picnic, where the

TABLE 3

Per capita consumption of cucumber, melon, and watermelon in the United States, 2000

Vegetable crop or group	Consumption (kg/person)
Cucumber (fresh)	3.13
Cucumber (processed)	2.18
Honeydew melon	1.27
Muskmelon	5.44
Watermelon	7.21
All vegetables (fresh)	104.33
All vegetables (processed)	102.06

SOURCE: USDA (2000), VGS-281.

giant (15 kg) fruit is popular. Picnic events that feature watermelon include eating contests (who can eat the most), seed spitting (who can spit the seeds the farthest), or greased watermelon games (which team can move a greased watermelon—which floats but is hard to hold onto—over to its side of the lake). However, watermelon is no longer just a summer fruit and is becoming an everyday fruit like apples, bananas, and oranges.

Cucumber (*Cucumis sativus*)

The cucumber is thought to have originated in India, where it is found wild and is cultivated in many diverse

forms. Accessions of *Cucumis sativus* L. var. *hardwickii* may be related to the original ancestors of the cucumber, and have been collected in the foothills of the Himalaya Mountains. These forms are not directly useable in agriculture because of their bitter fruit, dormant seeds, and late maturity. However, they have some traits that have been transferred to elite cultivars by plant breeders.

Secondary centers of diversity for the cucumber exist in China and the Near East. Related species are *Cucumis bystris* from China and the African *Cucumis*, such as melon (*Cucumis melo*), gherkin (*Cucumis anguria*), and their wild relatives.

Cucumbers were probably domesticated in Asia and then introduced into Europe, where the first cultivars were selected in the 1700s. The first cucumbers were brought to the Americas by Christopher Columbus, and Native Americans were growing cucumbers from Florida to Canada by the early 1500s. Formal plant breeding began in the United States in the 1880s, when cultivars diverged into fresh-market (slicing) and processing (pickling) types.

The cucumber is grown for its fruits, which are eaten fresh or pickled in most countries, but which are also eaten fried (usually when fruit have been harvested at a more mature stage). Slicing and pickling cucumber fruit are mostly water, but they provide some vitamin A and C, especially when pickled with dill and other spices (Table 1). Cucumber is the ideal food for people having trouble with body weight, because it is mostly water, with some fiber, and few calories. Cucumber causes burping and mild stomach upset in some people when eaten raw, but not when soaked in vinegar or pickled before eating. Cucumber is also among 35 fruits, vegetables, and herbs identified by the National Cancer Institute as having cancer-protective properties.

Cucumbers are served and eaten at home and in restaurants (especially fast food establishments) where pickle chips or relish are served on hamburgers and hot dogs. Pickles are also served as appetizers. Fresh cucumbers are sliced and served in salads or as garnishes to add color to the meal. Per capita annual consumption of fresh cucumber is 3.1 kg and processed cucumber 2.2 kg in the United States (Table 3).

Cucumber is used in most countries in the world, where particular types have been developed to fit local requirements. The common types are American pickling, American slicing, European greenhouse, Middle Eastern (Beit Alpha), Dutch pickling (parthenocarpic), oriental trellis, and specialty (such as the round or "lemon" cucumber). Some types referred to as cucumber, such as Armenian cucumber, are actually melon (*Cucumis melo*).

Fresh-market cucumbers are grown primarily in the southern and western states of the United States, especially Florida, Georgia, North Carolina, Texas, and California. Processing cucumbers are grown from Mexico to Canada so they are available year around for processors,

**WEST INDIAN GHERKIN (*CUCUMIS ANGURIA*)**

The West Indian gherkin (*Cucumis anguria* var. *anguria*), also known as the bur gherkin, was thought to have originated in the Caribbean, but now is considered to be of African origin. The African progenitor is *Cucumis anguria* var. *longaculeatus*, formerly called *Cucumis longipes*. It was probably brought to Brazil and the West Indies (where it got its name) by Africans in the slave trade. The term gherkin is also used for the pickling type of cucumber, especially the small sizes.

Fruit of the bur gherkin are smaller (5 cm) than those of the cucumber, but the defining characteristic of this species is the long peduncle or fruit stem (up to 20 cm in length). The fruit are light yellow to pale green, and are covered with short, fleshy spines. The fruit are eaten fresh or pickled.

often at a considerable distance from the production site. About 80 percent of the world's cucumber production is in Asia (Table 2), with China being the leading producer (Table 4).

Cucumbers are harvested by hand for fresh-market use, and by hand or machine for processing use. Michigan and Wisconsin have an estimated 50 to 75 percent and 25 to 50 percent machine harvest, respectively. Once-over harvest machines destroy the vines as they harvest the fruit (pickling type only). After harvest, the fruit are cooled, graded, packed, and shipped. The cucumbers will have fewer post-harvest rots and a longer storage life if they are cooled soon after harvest.

Fresh-market cucumbers are transported to market and displayed for a few days for sale to consumers. The fruit may be shrink wrapped in polyethylene or coated with vegetable wax to extend shelf life, or they may be sold with no protection. For fresh-market cucumbers, storage at 50°F (10°C) and 95 percent relative humidity (RH) will permit the produce to hold for approximately two weeks after harvest. The American slicing type cucumber has a thick tough skin to reduce shipping damage and increase storage life. Pickling cucumbers are graded and then loaded into tanks of brine (salt water) for fermentation and storage.

The pickling industry originally used brine tank storage to provide brine stock (pickles) to the factory during the off-season. Currently, however, more than half of the crop is processed without brining. Pasteurization is used to produce fresh pack pickles, and refrigeration is used to produce overnight pickles. Fermentation in brine tanks is used less for storage now, and more to produce particular types and flavors (for example, by using acetic acid or lactic acid fermentation).

Storage of pickling cucumber is usually in barrels, pails, jars, or plastic pouches. Preservation is by fermentation, pasteurizing, or refrigeration. For pickling cucumber, it is common and economical for growers to supply markets around the world. For example, growers in India and Sri Lanka supply small pickles in barrels of vinegar or salt brine to processors in Europe and North America.

In the 1700s, cucumber production in the United States probably was small scale; individuals and families would grow a few plants in their garden for the home, probably using the fruit fresh during the summer harvest season and pickled (using a favorite recipe to preserve the fruit) during the off-season. In the 1800s, family farmers grew small areas of cucumbers to supply the fresh market and pickle companies. Even when growers became specialized in cucumber production in the 1900s, family farmers continued to supply small size (grade 1, under 26 mm diameter) fruit to pickle companies. Large field crews generally do not harvest each field every day and usually do not search the vines for small fruit as required to produce a high percentage of grade 1 fruit from the field.

TABLE 4

Leading countries in production of cantaloupe and melon, cucumber and gherkin, and watermelon (MT x 1000) in 1997

Cantaloupe (melon)	Cucumber (gherkin)	Watermelon
China	China	China
Turkey	Turkey	Turkey
Iran	Iran	United States
United States	United States	Iran
Spain	Japan	Republic of Korea

SOURCE: FAO Production Yearbook 51 (1997).

Cucumber production is now being done by growers with large farms, specialized equipment, and excellent marketing skills. The small-scale production of cucumber has also increased, as home gardening in the United States has become very popular.

The major modification made to the cucumber in the 1930s was to begin breeding for disease resistance. In the 1960s, gynoecious cucumbers (pistillate or female flowers at every node) were developed, and are now used to make gynoecious hybrids using bee pollination (rather than the more expensive hand pollination). The gynoecious hybrid cucumber, usually with 15 percent monoecious hybrid pollenizer seeds blended into the seed packet, is a major success story. Current cultivars are resistant to anthracnose, downy mildew, powdery mildew, angular leafspot, scab, fusarium wilt, cucumber mosaic virus, and other major diseases found throughout the United States.

Plant breeders have developed a new type of cucumber capable of being grown in the greenhouse. The modifications include making the plant gynoecious (all pistillate or female flowers) and parthenocarpic (fruit set without pollination to eliminate the need for bees or hand pollination, and making the fruit seedless), and of high quality (genetically bitter-free plant for mild-flavored fruit).

Other modifications made by plant breeders include the development of cultivars having large diameter fruit for use in chipping. Thus, a sandwich or hamburger can be made using one large-diameter pickle chip rather than three of the standard size. However, that development was negated by the use of large pickling cucumbers (grade 3) sliced longitudinally to make a rectangular chip. Two of those can be used on a sandwich or hamburger instead of the single large chip, and the quality is often superior.

Melon (*Cucumis melo*)

Melon originated in southern Africa and has many wild relatives there. Related species include cucumber (*Cucumis sativus*), the West Indian gherkin (*Cucumis anguria*), and the



A cucumber melon in the Kalahari Desert of southern Africa. This region is also the genetic homeland of the watermelon. © ANTHONY BANNISTER: GALLO IMAGES/CORBIS.

horned cucumber (*Cucumis metuliferus*). Cucurbits, including melons, have complex symbolic associations with sex and sexuality, fertility, abundance, and gluttony. They may denote wealth in areas where melons do not normally grow.

Melon fruit have a high water content (about 90 percent), and contain sugars and fiber. Nutrients found in melon include vitamin C, and in the case of muskmelon (and other orange-fleshed types), carotenes. Nutritional compositions of casaba, honeydew, and muskmelon (cantaloupe) are shown in Table 1.

The major changes made by plant breeders to the domesticated melon compared with wild relatives have been to add disease resistance, remove seed dormancy, increase fruit size, increase the size of the mesocarp (the edible portion of the fruit), improve the quality, reduce the frequency of defects, and increase the sugar content.

Melon was brought from Africa to Europe and Asia, and from Europe to the Americas. It is now cultivated throughout the world, where specific types have been bred for local use. A useful horticultural classification of melons follows:

- The *Cantalupensis* group includes cantaloupe, muskmelon, and Persian melon. The fruits are oval or round; sutured or smooth; mostly netted, some slightly netted or nonnetted; and abscise from the peduncle when mature. The flesh is aromatic and is usually salmon or orange in color, but may be green. In the United States, the term "muskmelon" and "cantaloupe" are used interchangeably, but some horticultural scientists suggest that they be used to distinguish between types of the *C. melo Cantalupensis* group. This group includes the *Reticulatus* group used in some older classifications.
- The *Inodorus* group includes winter melon, casaba, Crenshaw, honeydew, Juan Canary, and Santa Claus. The fruits are round or irregular, smooth or wrin-

kled, but not netted; nor do they abscise from the peduncle at maturity. The flesh is mostly green or white, occasionally orange, and not aromatic.

- The *Flexuosus* group includes the snake or serpent melon and the Armenian cucumber. The fruits are quite long, thin, ribbed, and often curled irregularly.
- The *Conomon* group includes the oriental pickling melon. The fruits are smooth, cylindrical, and may be green, white, or striped. The flesh is white and can taste either sweet or bland.
- The *Dudaim* group includes mango melon, pomegranate melon, and Queen Anne's melon. The fruits are small, round to oval, and light green, yellow, or striped. The flesh is firm and yellowish-white in color.
- The *Momordica* group includes the phoot and snap melon. The fruits are oval or cylindrical with smooth skin that cracks as the fruit matures.

Melons require a long growing season with warm, sunny days and cool nights to achieve maximum quality. Plants are established by seeds or containerized plants after danger of frost is past. Stringent management of plant pests is necessary for high yield and quality. As with other cucurbits, it is necessary to have a large honeybee population to facilitate pollination. Asia produces about two-thirds of the world supply, with China being the largest producer (Tables 2 and 4). Several countries in Central America are major melon producers for export to the United States in late winter and early spring. In the United States, most melons are produced in California, Arizona, Texas, and Georgia. In Japan, melons are grown in greenhouses to produce high quality fruit commonly used as gifts.

Melons are harvested by hand from the vine. Maturity in the *Cantalupensis* group is by separation of the fruit from the peduncle (fruit stem) with minimal force. Maturity in the *Inodorus* group melons is not as easily determined, and they may be treated with ethylene after harvest to enhance the ripening process during transit to the market. Cantaloupes are best stored at 3°C and 95 percent RH, whereas other melons are best stored at 7°C and 95 percent RH. The effective postharvest life is about two weeks for both types.

Melon is served fresh as slices, chunks, or juice. Chunks are often used in fruit salad, made into melon balls and frozen, or prepared and sold in grocery stores to be eaten as is. Total per capita melon consumption in the United States is about 7 kg (Table 3). The vitamin A and C content make melon a nutritious food (Table 1).

See also Fruit; Squash and Gourds; Vegetables.

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Todd C. Webner
Donald N. Maynard