II.C.6. - Cucumbers, Melons, and Watermelons

Our focus here is on three important cucurbits — cucumber, melon, and watermelon — although cucurbits of less significance such as the citron, bur (or West India gherkin), and some lesser-known melons are also briefly discussed. These plants, together with all the sundry squashes and pumpkins, constitute a taxonomic group of diverse origin and genetic composition with considerable impact on human nutrition. The term "cucurbit" denotes all species within the Cucurbitaceae family.

Cucurbits are found throughout the tropics and subtropics of Africa, southeastern Asia, and the Americas. Some are adapted to humid conditions and others are found in arid areas. Most are frost-intolerant so they are grown with protection in temperate areas or to coincide with the warm portion of the annual cycle. Cucurbits are mostly annual, herbaceous, tendril-bearing vines.

The significance of cucurbits in human affairs is illustrated by the abundance of literature devoted to them, albeit much less than that produced on the grains and pulses. Two full-length books have cucurbits as the title (Whitaker and Davis 1962; Robinson and Decker-Walters 1997), and at least four significant publications have been derived from recent conferences on these plants (Thomas 1989; Bates, Robinson and Jeffrey 1990; Lester and Dunlap 1994; Gómez-Guillamón et al. 1996). Moreover, a recent reference book provides an inclusive chapter on cucurbits (Rubatzky and Yamaguchi 1997) and an annual publication is dedicated to their genetics (Ng 1996).

Taxonomy

The Cucurbitaceae family is well defined but taxonomically isolated from other plant families. Two subfamilies — Zanonioideae and Cucurbitoideae — are well characterized: the former by small, striate pollen grains and the latter by having the styles united into a single column. The food plants all fall within the subfamily Cucurbitoideae. Further definition finds cucumber *(Cucumis sativus L.)* and melon *(Cucumis melo L.)* to be within the subtribe Cucumerinae, tribe Melothrieae, and watermelon (*Citrullus lanatus* [Thunb.] Matsum. and Nakai.) is assigned to the tribe Benincaseae, subtribe Benincasinae. The taxonomic sites of West India gherkin (*Cucumis anguria* L.) and citron (*Citrullus lanatus* var. *citroides* [L.H. Bailey] Mansf.) are, as with those just listed, in the same genus. There are about 118 genera and over 800 species in the Cucurbitaceae (Jeffrey 1990a). The melons *(C. melo)* are further subdivided into groups that do not have taxonomic standing but have proved useful horticulturally (Munger and Robinson 1991):

The Cantalupensis group includes cantaloupe, muskmelon (Figure II.C.6.1), and Persian melon. The fruit are oval or round; sutured or smooth; mostly netted, some slightly netted or nonnetted; and abscise from the peduncle when mature. The flesh is usually salmon or orange colored, but may be green and is aromatic. In the United States, the term "muskmelon" and "cantaloupe" may be used interchangeably, but some horticultural scientists (Maynard and Elmstrom 1991: 229) suggest that they be used to distinguish between types of *C. melo* Cantalupensis group. This group includes the previously recognized Reticulatus group.

The Inodorus group consists of winter melon, casaba (Figure II.C.6.2), crenshaw, honeydew, Juan Canary (Figure II.C.6.3), and Santa Claus (Figure II.C.6.4). The fruit are round or irregular, smooth or wrinkled, 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 is made up of the snake or serpent melon and the Armenian cucumber. The fruit are quite long, thin, ribbed, and often curled irregularly.

The Conomon group comprises the oriental pickling melon. This fruit is 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 fruit are small, round to oval, and light green, yellow, or striped. The flesh is firm and yellowish-white in color.

The Mormordica group is made up of the phoot and snap melon. The fruit are oval or cylindrical with smooth skin that cracks as the fruit matures.

Plant and Fruit Morphology

Cucumber, melon, and watermelon plants share many characteristics but also differ in important ways. As a group they are frost-sensitive annuals with trailing, tendril-bearing vines. The plants are mostly monoecious, the flowers are insect-pollinated, and the fruits are variously shaped, many-seeded berries.

Cucumber

Cucumber plants are annual and may be monoecious, andromonoecious, or gynoecious. They have indeterminate trailing vines with angled, hairy stems bearing triangular-ovate, acute three-lobed leaves. Determinate types with compact plants have been developed for gardens. In monoecious types, staminate flowers appear first and are several times more abundant than pistillate flowers. Flowers occur at the nodes, staminate in clusters or singly close to the plant crown with only one flower of the cluster opening on a single day; pistillate flowers are borne singly on the main stem and lateral branches in monoecious types (Figure II.C.6.5) and singly or in clusters on the main stem and lateral branches on gynoecious types.

Pistillate flowers are identified easily by the large inferior ovary that is a miniature cucumber fruit. Both staminate and pistillate flowers are large (2 to 3 centimeters [cm] in diameter) with a yellow, showy five-parted corolla. Fruits of commercial types are cylindrical and green when consumed at the immature, edible stage (Figure II.C.6.6). The fruit surface is interrupted with tubercle-bearing white or black spines. White spines are typical of fruit used for fresh consumption that, if allowed to attain maturity, will be yellow, whereas black-spined fruit is often used for processing (pickles) and is orange at maturity.

Seedless or parthenocarpic cucumbers are another distinctive type. The plants are gynoecious with a fruit borne at each axil (Figure II.C.6.7). They are grown on a trellis in protected, screened culture to prevent bees from introducing foreign pollen, which would cause seeds to develop. Fruits are long, straight, smooth, thin-skinned, and medium to dark-green in color. A slightly restricted "neck" at the stem end of the fruit serves to readily identify this unique type. Cucumber fruit destined for fresh markets has a length/diameter ratio of about 4:1; that used for pickle production has a ratio of about 2:5, whereas parthenocarpic fruit have a ratio of about 6:1. Seeds are about 8 millimeters (mm) long, oval, and white (Lower and Edwards 1986: 173—81).

West India Gherkin

These plants are annual, monoecious climbing vines with flowers, leaves, tendrils, and fruit smaller than those of cucumber. Fruits, which are spiny, yellow, oval, and about 5 cm long, are eaten fresh, cooked, or pickled. The plant may self-seed, escape from cultivation, and become an aggressive weed.

Melon

Melons are mostly andromonoecious and have annual trailing vines with nearly round stems bearing tendrils and circular to oval leaves with shallow lobes. Staminate flowers are borne in axillary clusters on the main stem, and perfect flowers are borne at the first node of lateral branches. Fruits vary in size, shape, rind characteristics, and flesh color depending on variety. Fruit quality is related to external appearance, thick, well-colored interior flesh with high (>10 percent) soluble solids, and a pleasant aroma and taste (Maynard and Elmstrom 1991: 229). It is a common misconception that poor-quality melon fruit results from cross-pollination with cucumber because these species are incompatible. Rather, the poor-quality melon fruit sometimes encountered is due to unfavorable weather or growing conditions that restrict photosynthetic activity and, thereby, sugar content of the fruit. Seeds are cream-colored, oval, and on average 10 mm long.

Watermelon

These plants are monoecious, annual, and have trailing thin and angular vines that bear pinnatifide leaves. Flowers are solitary in leaf axils. Staminate flowers appear first and greatly outnumber pistillate flowers. The flowers are pollinated mostly by honeybees. Fruit may range in size from about 1 kilogram (kg) to as much as 100 kg, but ordinary cultivated types are 3 to 13 kg. Shape varies from round to oval to elongated. Coloration of the rind may be light green, often termed gray, to very dark green, appearing to be almost black (Figure II.C.6.8). In addition, the rind may have stripes of various designs that are typical of a variety or type; thus the terms "Jubilee-type stripe" or "Allsweet-type stripe" are used to identify various patterns. Seed color and size is variable. The tendency in varietal development is to strive for seeds that are small (but vigorous enough for germination under unfavorable conditions) and that are dark-colored rather than white — the latter are associated with immaturity. Flesh may be white, green, yellow, orange, pink, or red. Consumers in developed countries demand red- or deep pink—fleshed watermelons, although yellow-fleshed ones are grown in home gardens and, to a limited extent, commercially (Mohr 1986).

Seedless watermelon. Each fruit of standard-seeded watermelon varieties may contain as many as 1,000 seeds (Figure II.C.6.9) and their presence throughout the flesh makes removal difficult.

Hybrid seedless (triploid) watermelons have been grown for over 40 years in the United States. However, only recently have improved varieties, aggressive marketing, and increased consumer demand created a rapidly expanding market for them. The seedless condition is actually sterility resulting from a cross between two plants of incompatible chromosome complements. The normal chromosome number in most living organisms is referred to as $2n$. Seedless watermelons are produced on highly sterile triploid ($3n$) plants, which result from crossing a normal diploid ($2n$) plant with a tetraploid ($4n$). The tetraploid is used as the female or seed parent and the diploid is the male or pollen parent. Since the tetraploid seed parent produces only 5 to 10 percent as many seeds as a normal diploid plant, seed cost is 10 to 100 times more than that of standard, open-pollinated varieties and 5 to 10 times that of hybrid diploid watermelon varieties.

Tetraploid lines, usually developed by treating diploid plants with a chemical called colchicine, normally have a light, medium, or dark-green rind without stripes. By contrast, the diploid pollen parent almost always has a fruit with a striped rind. The resulting hybrid triploid seedless melon will inherit the striped pattern, though growers may occasionally find a nonstriped fruit in fields of striped seedless watermelons, the result of accidental self-pollination of the tetraploid seed parent during triploid seed production. The amount of tetraploid contamination depends upon the methods and care employed in triploid seed production. Sterile triploid plants normally do not produce viable seed. However, small, white rudimentary seeds or seed coats, which are eaten along with the fruits as in cucumber, develop within the fruit. The number and size of these rudimentary seeds vary with the variety. An occasional dark, hard, viable seed is found in triploid melons. Seedless watermelons can be grown successfully in areas where conventional seeded varieties are produced, although they require some very unique cultural practices for successful production (Maynard 1996: 1—2). With proper care, such watermelons have a longer shelf life than seeded counterparts. This may be due to the fact that flesh breakdown occurs in the vicinity of seeds, which are absent in seedless melons.

Citron

The citron plants resemble those of watermelon except that their leaves are broader and less pinnate. The fruits also resemble watermelon externally, but the rind is quite hard and the flesh is white to light green and may be quite bitter. Because fruit rinds are used to make pickles and are also candied, the citron is also called a "preserving melon." Plants escaped from cultivation may prove to be aggressive weeds in crop fields.

History and Ethnography of Production and Consumption

Relatively little research literature in cultural anthropology, archaeology, or social history focuses specifically on the species of cultivated cucurbits under consideration here. Indeed, some classic as well as recent important texts on the origins of agriculture make no mention of them (Reed 1977; Smith 1995). There are at least four reasons for this lacuna. First, these cultigens are not part of the complex carbohydrate "cores" of the diets found in centers of state formation (see Mintz 1996) and thus have not received the same attention as other staple food crops. Second, the primary centers of domestication for both melon and watermelon are in sub-Saharan Africa, where the exact timing, locations, and processes of domestication are still poorly understood (see Cowan and Watson 1992). Third, some researchers suggest that "cucurbits are usually poorly preserved among archaeological remains. The features considered most indicative of domestication are characteristics of the peduncle (stem), which is rarely preserved. The earliest remains are seed specimens, which often occur in extremely low frequencies because they are likely to have been consumed" (McClung de Tapia 1992: 153). Finally, the ethnographic record contains limited data on the production and consumption of these crops (with a few notable exceptions), reflecting their secondary significance both materially and symbolically in most human societies.

Cucumber

Cucumbers are generally believed to have originated in India, and archaeological and linguistic evidence suggests that they have been cultivated throughout western Asia for at least 3,000 years (Hedrick 1919: 208; Whitaker and Davis 1962: 2—3; Sauer 1993: 45; Robinson and Decker-Walters 1997: 62). From India, the cucumber spread to Greece and Italy — where the crop was significant in the Roman Empire — and slightly later to China and southern Russia. In classical Rome, Pliny reported greenhouse production of cucumbers by the first century, and the Emperor Tiberius was said to have had them at his table throughout the year (Sauer 1993: 46). Cucumbers probably were diffused into the rest of Europe by the Romans and later throughout the New World via colonialism and indigenous trade networks. The earliest records of their cultivation appear in France by the ninth century, Great Britain by the fourteenth century, the Caribbean at the end of the fifteenth century, and North America by the middle of the sixteenth century (Hedrick 1919: 208).

Colonial encounters between Europeans and Native Americans resulted in the rapid diffusion of cucumbers throughout North America. The Spanish began growing them in Hispaniola by 1494, and less than a century later European explorers were noting that a wide range of Native American peoples from Montreal to New York, Virginia, and Florida were cultivating them, along with a large variety of other crops including maize, beans, squash, pumpkins, and gourds. By the seventeenth century, Native American groups on the Great Plains were also cultivating cucumbers — this in a region where the Spanish had been particularly significant in the diffusion of horses and guns, as well as Old World cultigens such as watermelons and cucumbers (see Wolf 1982).

Like other cucurbits, cucumbers have a wide range of consumption uses cross-culturally. They are generally eaten fresh or pickled and are particularly important in the diets of people living in Russia and East, South, and Southeast Asia, where they may also be served as a fresh or cooked vegetable. In India, the fruits are used in the preparation of chutney and curries. Cucumber seeds, young leaves, and cooked stems are also consumed in some parts of Asia.

In addition, since at least the nineteenth century, cucumbers have been used in the production of a large variety of cosmetics, including fragrances, body lotions, shampoos, and soaps (Robinson and Decker-Walters 1997: 63; Rubatzky and Yamaguchi 1997: 585).

Melon

Melon is generally thought to have originated in western Africa (Zeven and Zhukovsky 1975: 30; Bailey 1976: 342; Purseglove 1976: 294; Whitaker and Bemis 1976: 67), with China or India as possible secondary centers of diversity. Wild melons growing in natural habitats have been reported in desert and savanna zones of Africa, Arabia, southwestern Asia, and Australia. As Jonathan Sauer notes, it is unclear where melon was domesticated and "it is conceivable that it was independently domesticated from different wild populations in Africa and southwestern Asia" (Sauer 1993: 44). Melon was an important food crop in ancient China, where archaeological data suggest that it has been cultivated for over 5,000 years (Robinson and Decker-Walters 1997: 23). Archaeological evidence also suggests that melon was cultivated in Iran some 5,000 years ago and in Greece and Egypt about 4,000 years ago

(Zohary and Hopf 1988). Given the fruit's probable African origin, this evidence points to a very early date for the first domestication of melon. Tropical forest swidden systems in Africa typically have yams or manioc as dominant staple food crops with melons among the numerous and multiple secondary crops (Harris 1976: 318).

As with cucumbers, melons were cultivated in the Roman Empire and diffused throughout Europe by the Middle Ages where the "variety and quality of melon cultivars were evidently greatly increased by selection in Medieval gardens" (Sauer 1993: 44). As with cucumbers and watermelons, melons were introduced to the New World by Spanish colonial settlers in the late fifteenth and early sixteenth centuries and subsequently spread very rapidly among Native American horticultural groups. Later during the eighteenth century they reached the Pacific Islanders via British explorers.

Ralf Norrman and Jon Haarberg (1980) explore the semiotic role of cucurbits in Western literature and culture and extend this analysis to selected non-Western cultural contexts. Focusing on melons, watermelons, and cucumbers (as well as other domesticated cucurbits), these authors note that cucurbits generally have deep, profound, and complex multivocal symbolic associations with sex and sexuality, fertility, vitality, moisture, abundance, opulence, luxury, gluttony, creative power, rapid growth, and sudden death. More specifically, they note that melons are highly associated with status in colder climate European societies because historically they were "seasonal, expensive and scarce, with all the symbolic development that a commodity with such characteristics usually goes through" (Norrman and Haarberg 1980: 16). Cucurbits also appear frequently in non-Western cosmologies, for example, "in Burmese and Laotian mythology, the creation of man started from a cucurbit" (Norrman and Haarberg 1980: 26). As with other key symbols marked by binary oppositions, symbolic meanings attached to cucurbits can also be employed to convey a broad variety of negative symbolic associations along race, class, and gender lines.

Melon has a large number of different cultivars and a range of cross-cultural consumption uses parallel to the other species of cucurbits discussed in this chapter. Fruits are typically eaten uncooked, although they may also be cooked or pickled in some Asian cuisines. The seeds of some cultivars are roasted and consumed in parts of India. Dried and ground melon seeds are used as food in some African societies. Melon fruits, roots, leaves, and seeds play important roles in the treatment of a wide range of health problems in Chinese traditional medicine (Robinson and Decker-Walters 1997: 69—70).

Watermelon

Watermelons, which were originally domesticated in central and southern Africa (Whitaker and Davis 1962: 2; Robinson and Decker-Walters 1997: 85), are an important part of the "most widespread and characteristic African agricultural complex adapted to savanna zones" in that they are not only a food plant but also a vital source of water in arid regions (Harlan, de Wet, and Stemler 1976; Harlan 1992: 64). Indeed, V. R. Rubatzky and M. Yamaguchi (1997: 603) refer to watermelons as "botanical canteens." In a number of traditional African cuisines, the seeds (rich in edible oils and protein) and flesh are used in cooking. Watermelon emerged as an important cultigen in northern Africa and southwestern Asia prior to 6,000 years ago (Robinson and Decker-Walters 1997: 24). Archaeological data suggest that they were cultivated in ancient Egypt more than 5,000 years ago, where representations of watermelons appeared on wall paintings and watermelon seeds and leaves were deposited in Egyptian tombs (Ficklen 1984: 8).

From their African origins, watermelons spread via trade routes throughout much of the world, reaching India by 800 and China by 1100. In both of these countries, as in Africa, the seeds are eaten and crushed for their edible oils. Watermelons became widely distributed along Mediterranean trade routes and were introduced into southern Europe by the Moorish conquerors of Spain, who left evidence of watermelon cultivation at Cordoba in 961 and Seville in 1158 (Watson 1983). Sauer notes that "watermelons spread slowly into other parts of Europe, perhaps largely because the summers are not generally hot enough for good yields. However, they began appearing in European herbals before 1600, and by 1625, the species was widely planted in Europe as a minor garden crop" (Sauer 1993: 42). Their first recorded appearance in Great Britain dates to 1597.

Watermelons reached the New World with European colonists and African slaves. Spanish settlers were producing watermelons in Florida by 1576, and by 1650 they were common in Panama, Peru, and Brazil, as well as in British and Dutch colonies throughout the New World (Sauer 1993: 43). The first recorded cultivation in British colonial North America dates to 1629 in Massachusetts (Hedrick 1919: 172).

Like cucumbers and melons, watermelons spread very rapidly among Native American groups. Prior to the beginning of the seventeenth century, they were being grown by tribes in the Ocmulgee region of Georgia, the Conchos nation of the Rio Grande valley, the Zuni and other Pueblo peoples of the Southwest, as well as by the Huron of eastern Canada and groups from the Great Lakes region (Blake 1981). By the mid-seventeenth century, Native Americans were cultivating them in Florida and the Mississippi valley, and in the eighteenth and early nineteenth centuries the western Apache of east-central and southeastern Arizona were producing maize and European-introduced crops including watermelons as they combined small-scale horticulture with hunting and gathering in a low rainfall environment (Minnis 1992: 130—1). This fact is ethnographically significant because other transitional foraging—farming groups, such as the San people of the Kalahari Desert of southern Africa, have parallel subsistence practices involving watermelons. Watermelons and melons were also rapidly adopted by Pacific Islanders in Hawaii and elsewhere as soon as the seeds were introduced by Captain James Cook (1778) and other European explorers (Neal 1965).

In the cultural history of the United States, Thomas Jefferson was an enthusiastic grower of watermelons at his Monticello estate, Henry David Thoreau proudly grew large and juicy watermelons in Concord, Massachusetts, and Mark Twain wrote in *Puddn'head Wilson:* "The true southern watermelon is a boon apart and not to be mentioned with commoner things. It is chief of this 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." Ellen Ficklen has documented the important role of watermelons in American popular culture in numerous areas including folk art, literature, advertising and merchandising, and the large number of annual summer watermelon festivals throughout the country with "parades, watermelon-eating contests, seed spitting contests, watermelon queens, sports events, and plenty of food and music" (1984: 25).

Growing and exhibiting large watermelons is an active pastime in some rural areas of the southern United States. Closely guarded family "secrets" for producing large watermelons and seeds from previous large fruit are carefully maintained. According to *The Guinness Book of Records,* the largest recorded watermelon in the United States was grown by B. Carson of Arrington, Tennessee, in 1990 and weighed a phenomenal 119 kg (Young 1997: 413).

African slaves also widely dispersed watermelon seeds in eastern North America, the circum-Caribbean, and Brazil. In the southern United States — where soil and climate conditions were optimal for watermelon cultivation — this crop ultimately became stereotypically, and often negatively, associated with rural African-Americans (see Norrman and Haarberg 1980: 67—70). Watermelons have subsequently figured as key symbols in the iconography of racism in the United States as seen during African-American protest marches in Bensonhurst, Brooklyn, in 1989, where marchers were greeted by Italian-American community residents shouting racial slurs and holding up watermelons.

In the ethnographic record of cultural anthropology, watermelons have perhaps figured most extensively in discussions of foragers and agro-pastoralists of the Kalahari Desert in southern Africa. As early as the 1850s, explorer David Livingstone described vast tracts of watermelons growing in the region. The anthropologist Richard Lee notes that watermelons, in domestic, wild, and feral varieties, constitute one of the most widespread and abundant plant species growing in the central Kalahari Desert. They are easily collected by foraging peoples and "the whole melon is brought back to camp and may be cut into slices for distribution. The melon itself may be halved and used as a cup, while the pulp is pulverized with the blunt end of a digging stick. The seeds may be roasted and eaten as well" (Lee 1979: 488).

Watermelons are among the most popular cultigens for forager-farmers in the Kalahari for the following reasons: "First, they provide a source of water; second, they are relatively drought-resistant, especially when compared to seed crops like sorghum and maize; and third, dried melons are an article of food for both humans and livestock and, after they have been cut into strips and hung on thorn trees to dry, they are easy to store" (Hitchcock and Ebert 1984: 343).

Elizabeth Cashdan emphasizes the point that "normally, when one thinks of agriculture one thinks of food resources, but . . . where the dominant factor governing mobility is the availability of moisture, it is appropriate that agriculture should be used to produce a storable form of moisture" (Cashdan 1984: 316). This cultivated water supply allows some Kalahari Desert groups to remain sedentary during both rainy and dry seasons, and watermelons are often stored in large quantities by these societies (Cashdan 1984: 321).

The collection of watermelons by foragers and their incipient domestication by such groups yields insights into probable scenarios for domestication.

R. W. Robinson and D. S. Decker-Walters suggest a general process for cucurbits that has a plausible fit with the history and ethnography of watermelons in the Kalahari Desert:

> Aboriginal plant gatherers were probably attracted to some of these products, particularly the relatively large, long-keeping and sometime showy fruits. After fruits were taken back to camp, seeds that were purposely discarded, accidently dropped or partially digested found new life on rubbish heaps, settlement edges or other disturbed areas within the camp. Eventually, recognition of the value of the resident cucurbits led to their tolerance, horticultural care and further exploitation. Finally seeds . . . were carried by and exchanged among migrating bands of these incipient cultivators, gradually turning the earliest cultivated cucurbits into domesticated crops. (Robinson and Decker-Walters 1997: 23)

Such a process of domestication is somewhat different from those analyzed for cereal grains, where early transitional forager-farmers exploited densely concentrated stands of the wild ancestors of later domesticated varieties.

Cross-cultural uses of watermelon are quite varied. They are primarily consumed fresh for their sweet and juicy fruits and are often eaten as desserts. In some African cuisines, however, they are served as a cooked vegetable. The rind may be consumed in pickled or candied form. In parts of the former Soviet Union and elsewhere watermelon juice is fermented into an alcoholic beverage. Roasted seeds of this crop are eaten throughout Asia and the Middle East, and watermelon seeds are ground into flour and baked as bread in some parts of India. In addition, watermelons are also sometimes used as feed for livestock (Robinson and Decker-Walters 1997: 24—7, 85; Rubatzky and Yamaguchi 1997: 603).

Variety Improvement

Cucumber

Early cucumber varieties used in the United States were selections of those originally brought from Europe. American-originated varieties such as ‘Arlington White Spine’, ‘Boston Pickling’, and ‘Chicago Pickling’ were developed in the late nineteenth century. Cucumber is prone to a large number of potentially devastating diseases, and its rapid trailing growth makes chemical control of foliar and fruit diseases quite difficult. As a result, interest in the development of genetic disease tolerance has long been the focus of plant breeding efforts and has met with great success: Tolerance to at least nine diseases has been incorporated into a single genotype. The first monoecious hybrid, ‘Burpee Hybrid’, was made available in 1945. Although seed costs were higher, multiple advantages of hybrids were soon recognized. Commercial companies built large research staffs to develop hybrids that provided proprietary exclusivity in those species where appropriate. Gynoecious hybrids made their appearance in 1962 when ‘Spartan Dawn’ was introduced. This all-female characteristic has since been exploited in both pickling and fresh-market types (Wehner and Robinson 1991: 1—3).

Melon

An 1806 catalog lists 13 distinct melon sorts derived from European sources (Tapley, Enzie, and Van Eseltine 1937: 60). Management of plant diseases in melon presents the same difficulties as with cucumbers. Accordingly, incorporation of disease tolerance into commercial types has been a major objective of plant breeders. One type, ‘PMR 45’, developed by the U.S. Department of Agriculture and the University of California in 1937, represented an enormous contribution because it provided resistance to powdery mildew *(Erisiphe cichoracearum),* which was the most devastating disease of melons in the arid western United States. This variety and its descendants dominated the U.S. market for about 40 years (Whitaker and Davis 1962: 57—9). Hybrids, which now predominate in the Cantalupensis group, began to appear in the mid-1950s with the introduction of ‘Burpee Hybrid’, ‘Harper Hybrid’, and others (Minges 1972: 69, 71).

Watermelon

Tolerance to fusarium wilt *(Fusarium oxysporum* f. sp. *niveum)* and anthracnose *(Colletotrichum orbiculare),* which was a prime objective of watermelon breeding programs, was achieved with the development of three varieties that dominated commercial production for almost four decades. ‘Charleston Gray’ was developed by C. F. Andrus of the U.S. Department of Agriculture in 1954, ‘Crimson Sweet’ by C. V. Hall of Kansas State University in 1964, and ‘Jubilee’ by J. M. Crall at the University of Florida in 1963 (Figure II.C.6.10). These varieties are no longer used to any extent, having been replaced by hybrids of the Allsweet and blocky Crimson Sweet types because of superior quality, high yields, and an attractive rind pattern. In Japan and other parts of Asia, watermelon varieties in use are susceptible to fusarium wilt, so they are grafted (Figure II.C.6.11) onto resistant root stocks (Lee 1994). In addition to diploid hybrids, triploid (seedless) hybrids are expected to dominate the watermelon market in the near future.

Production, Consumption, and Nutritional Composition

Production

Cucumber. As Table II.C.6.1 indicates, well over half of world cucumber and gherkin production occurs in Asia (the term "gherkin" is used here to denote small cucumber, rather than bur or West India gherkin). Though significant production also occurs in Europe and in North and Central America, China accounts for about 40 percent of world production. Other Asian countries with high cucumber production are Iran, Turkey, Japan, Uzbekistan, and Iraq. Only the United States, Ukraine, the Netherlands, and Poland are world leaders outside of Asia in cucumber production. Yields in the leading producing countries range from 8.6 tons per hectare (ha) in Iraq to 500 tons/ha in the Netherlands. The extraordinary yields in the Netherlands are because of protected culture of parthenocarpic types (United Nations 1996: 134—5).

Melon. As with cucumber, Asia produces more than half of the world’s melon crop (Table II.C.6.2). Whereas Europe, North and Central America, and Africa are important world production centers, China produces about 25 percent of the world’s crop. Turkey and Iran are also leading melon-producing countries. Yields in the leading countries range from 13.0 tons/ha in Mexico to 26.9 tons/ha in China (United Nations 1996: 122—3). In Japan, melons are usually grown in greenhouses. The very best ones are sold to be used as special gifts. Prices shown (Figure II.C.6.12) are roughly U.S. $50, $60, and $70 each.

Watermelon. Asia produces about 60 percent of the world’s watermelons with major production in China (23 percent), Turkey (12 percent), Iran (9 percent), Korea Republic (3 percent), Georgia (3 percent), Uzbekistan (2 percent), and Japan (2 percent) (Table II.C.6.3). Yields in the major producing countries range from 11.3 tons/ha in

Uzbekistan to 30.4 tons/ha in Japan (Figure II.C.6.13), where much of the production is in protected culture (United Nations 1996: 146—7).

Consumption and Nutritional Composition

Cucurbits, as previously discussed in this chapter, are an important part of the diet in the United States (Table II.C.6.4), where the annual consumption of watermelon, melon, and cucumber amounts to just over 17 kg per person (USDA 1996). Cucurbit fruits are high in moisture and low in fat, which makes them popular with consumers interested in healthy diets (Table II.C.6.5). Those with orange flesh like muskmelon and winter squash are excellent sources of vitamin A. Orange-fleshed cucumbers have been developed recently from crosses between United States pickling cucumber varieties and the orange-fruited "Xishuangbanna" cucumber from the People's Republic of China. The provitamin A carotene content of these cucumbers is equivalent to other orange-fleshed cucurbits (Simon and Navazio 1997). Moderate amounts of essential inorganic elements and other vitamins are provided by the cucurbit fruit. Aside from the low fat content and high vitamin A content of some cucurbit fruits, their principal value in the diet of people living in developed countries is in their unique colors, shapes, flavors, and adaptability to various cuisines.

The internal quality of watermelon fruit is a function of flesh color and texture, freedom from defects, sweetness, and optimum maturity. Unfortunately, these criteria cannot, as a rule, be assessed without cutting the melon. So many watermelons of inferior or marginal quality have been marketed that consumers have increasingly lost confidence in the product. The current supermarket practice of preparing cut and sectioned watermelon provides at least partial assurance of quality to the purchaser, but no indication of sweetness. In Japan, the quality of whole watermelon fruit is assessed by nuclear magnetic resonance (NMR) before marketing. Soluble solids and flesh integrity can be determined nondestructively in seconds (Figure II.C.6.14). As mentioned, because of their exceptional quality, such watermelons can be sold locally for the equivalent of about U.S. $50—$70 (Figure II.C.6.15).

In contrast to the composition of the pulp, watermelon seeds, which are used for food in various parts of the world, are low in moisture and high in carbohydrates, fats, and protein. Varieties with very large seeds have been developed especially for use as food in China, where more than 200,000 tons are produced annually on 140,000 ha land (Zhang 1996).

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