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California Rare Fruit Growers

Year of the Mango Kicks Off
A Little Taste of Mango
Here's the first mango article of 2007

Mysterious Blood Oranges

ABOUT PIGMENTED CITRUS
MUTATIONS, CHEMISTRY & FLAVOR

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Obscure, Delicious, Mysterious

The Bloods: Mutations, Chemistry and Flavor

Story and numbered images by David Karp©

In the early 1990s a woman named Smith in Moorpark, California, noticed a baffling phenomenon in her garden. One limb of her Valencia tree, which had always borne normal oranges, displayed shocking scarlet fruit. Was someone trying to poison her, she asked Nick Sakovich, a local farm advisor?

To her relief, he identified the red oranges as a rare but spontaneous mutation—a "limb sport," in horticultural lingo. In fact, her Valencia had recapitulated the birth of the blood orange in China, many centuries earlier.

Ms. Smith's fear of poisoning might seem overwrought, but blood oranges often evoke strong, sometimes contradictory reactions. Europeans have long prized their appealing blush, dramatic burgundy flesh, and intense flavor; Americans are split between enthusiastic foodies and the squeamish who recoil at the fruit's sanguinary aura. In the United States blood oranges are redolent of romance and European sophistication, but also vaguely sinister—for instance, my friend Andy Griffin wrote an essay about oranges in the *Godfather* movies beginning, "I want to slice the Godfather's oranges open and see if they bleed." Moreover, the very phytochemicals that give blood oranges their ruddy appearance, rich flavor and health-giving properties, also, paradoxically, render them chemically unstable, thus hindering their marketing.

Blood oranges are varieties of common sweet orange, *Citrus sinsensis,* colored by reddish-purple anthocyanins, water-soluble pigments. "Blonde" oranges such as navels and Valencias derive their orange color from carotenoid pigments; blood oranges additionally contain several anthocyanins, chiefly cyanidin-3-glucoside. This magenta compound is common in many fruits, including apple skins, red currants, cherries and raspberries. Scientists recently discovered that all sweet oranges have the basic genes to produce anthocyanins, but that the genes are turned on only in blood varieties. Specifically, two sets of genes are necessary to make anthocyanins; blonde oranges do have the structural genes, but lack the regulatory genes controlling their expression.

Anthocyanins redden the flowers and fruits of many plants, serving to attract insects and animals for pollination and seed dispersal. They are also present in leaves, where they protect internal cells by blocking harmful ultraviolet light, while selectively admitting light vital for photosynthesis. In citrus, anthocyanins color the flowers and young leaves of lemons, citrons and Ichang papedas, but are otherwise relatively rare. Curiously, no anthocyanins occur in orange trees, except for blood orange fruits.

Blood orange coloration is part science, part mystery. In general, cold winter nights alternating with mild days favor anthocyanin development in rinds and flesh; shaded or partially exposed fruit tend to develop the darkest peels. Sicilians claim that anthocyanins protect their

(turn to page 18)

1 Bream Tarocco orange tree, one of the best strains

GRAHAM BARRY

Ruby Valencia oranges

GRAHAM BARRY

Four Ruby Valencia oranges, standard Valencia at right

CHET ROSTACHER

Pink Valencia juice at left, standard Valencia juice at right

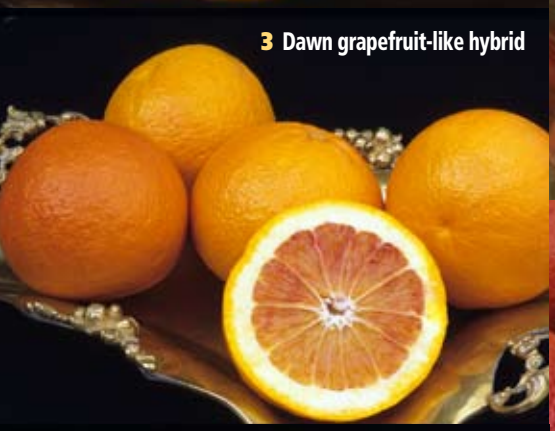
GRAHAM BARRY

Ruby Valencia oranges

GRAHAM BARRY

Ruby Valencia juice, standard Valencia juice at left

2 Valentine grapefruit-like hybrid



3 Dawn grapefruit-like hybrid

4 Sanguinelli, Tarocco and Moro blood oranges

5 Tarocco blood orange

6 Dawn and Valentine grapefruit-like hybrids

7 Moro blood oranges

8 Smith Red Valencia oranges

Mandareds (red mandarins)

HORTSCIENCE MAGAZINE

Grapefruits: Texas Very Red (right) and Rio Red

JOHN DE GRACA

9 Spanish Sanguinelli blood orange

Pink Valencia orange

Pink Valencia (inset)

not to scale

CHET ROISTACHER

CHET ROISTACHER

Texas Very Red grapefruits

JOHN DE GRACA

Title photo Vaniglia Sanguigno, or "Vanilla Blood," acidless orange pigmented by lycopene (as opposed to the anthocyanins which tint blood oranges), from Churchill Orchards, Ojai, Calif. **1** Bream Tarocco is a highly colored strain of Tarocco that originated in Lindsay, Calif. Citrus Variety Collection, UC Riverside. **2** Valentine hybrid: Siamese Sweet pummelo x (Dancy mandarin x Ruby blood orange). Citrus Variety Collection. **3** Dawn hybrid, bred at UC Riverside. **4** From left—Spanish Sanguinelli, Tarocco and Moro, the three blood orange varieties grown in California. **5** Tarocco, the sweetest, most tender-fleshed blood orange variety, rarely grown in California. **6** Dawn (left) and Valentine hybrids, bred at UC Riverside. **7** Moro, the most deeply pigmented blood orange, and the most commonly grown blood variety in California. **8** Smith Red Valencia is a blood bud sport from a Valencia tree in Moorpark, Calif. Citrus Variety Collection. **9** Spanish Sanguinelli late-season blood orange, pigmented chiefly around its membranes. From Art Lange, Reedley, Calif. **Note:** For more info on unnumbered photos, see sidebar on page 18.

blood oranges against the Etna district's wide climatic fluctuations, but it is also possible that the pigmentation is just a superfluous response to this stress, perpetuated by humans because it's pretty. In areas with warm, humid climates, such as Florida, most blood oranges develop only a few flecks of red.

To the vexation of growers, red color varies unpredictably from season to season, from tree to tree, and even within clusters of fruit. Not all dark-fleshed fruit have red rinds; a rosy rind is no guarantee of dark flesh, but when a light chocolate-gray tinges the pores of the rind, then the inside is always maroon.

The Anthocyanin-Flavor Puzzle

Many writers, myself included, have stated that anthocyanins impart to blood oranges a distinctive "berry-like" or "raspberry-like" flavor. In fact, the connection is not so direct, since pure anthocyanins are almost tasteless. According to Geza Hrazdina, a professor of biochemistry at Cornell University who has tasted pure anthocyanin powders, "If you moisten your finger, dip it into the preparation, and lick your finger, you don't get any sensation, except for a slight bitterness." Indeed, the many small fruits colored by anthocyanins, including strawberries, blueberries, and cranberries, vary greatly in flavor, and blood oranges certainly don't smell like raspberries, because they lack the distinctive "raspberry ketone."

That doesn't mean that the red pigments in blood oranges have no link to flavor. Sugar and red pigments are produced by separate pathways, although the two often occur side by side, and in blood oranges, as for many fruits, anthocyanin synthesis requires the transfer of glucose, a sugar molecule. The upshot is that redness often correlates with sweetness, but in light-blood varieties a lack of blush doesn't necessarily mean the fruit is immature. Moreover, anthocyanin synthesis requires many enzyme steps, controlled by many genes, and during that process blood oranges make chemically related substances that influence flavor. Recent analyses of blood orange flavor chemistry have found several distinguishing compounds, such as hydroxycinnamic acids—which are structurally related to a precursor of anthocyanins—along with valencene, and various fatty acids and alcohols, which are unrelated to anthocyanins. Anthocyanins may also interact with aromatic compounds in ways not yet discovered. It appears that no single flavor unites all blood orange varieties; each has its own profile, just as a Valencia tastes different from a navel. In fact, blood orange varieties differ among themselves as much as they do from their blonde relatives.

The best-tasting blood oranges have flesh that is either medium burgundy in color, or lightly streaked with red, according to variety. Late in the season, in March and April, the main blood orange variety grown in the United States, Moro, often has deep violet pulp—almost black—because the fruits are packed with anthocyanins, and also because the pigments change from red to violet as acidity drops with advancing maturity. Though dramatic, these superdark fruits usually have lost so much acidity that

Bloods Beside Oranges

Aside from oranges, half a dozen new citrus varieties pigmented with anthocyanin or lycopene have come to light in recent years—from intentional hybridization, mutations and chance discoveries—although very few people know about them.

It has always seemed curious that while anthocyanin is characteristic of the flowers and young leaves of citrons and lemons, it never shows up in the mature fruits. Almost never, perhaps: *Ornamental Citrus Fruits,* a book published in Italy in 2000, has an intriguing photograph of what is said to be a lemon-citron hybrid with an anthocyanin-pigmented rind. *Citrus limonimedica* Lush. 'Pigmentata', a "Limone cedrato rosso" or "Red lemon," reads the description, although a photo of a cut fruit has suspiciously orange-colored flesh, and the text says that the flowers are "strongly perfumed, like orange flowers." This oddity "is a recent natural hybrid not coming from historical collections but from private Tuscan collections," said a representative of the Oscar Tintori company (www.oscartintori.it), which maintains a "Garden Hesperidarium" of unusual citrus varieties in Tuscany.

Citrus scientists have long maintained that there is no such thing as a pure mandarin pigmented with anthocyanin, but much to my surprise, at a recent gathering a highly respected, authoritative source (who did not wish to be identified) showed me a convincing photograph of a blood Ponkan growing in Japan. The regular Ponkan is a typical mandarin, common in Asia but rare in the U.S. The blood mutation is the "product of tissue culture trickery," a rare example of a graft chimera, said my source, who added: "I'd give a body part for that." However, the fruit is less sweet than a normal Ponkan, and the tree is weak; this prodigy is "in the hands of a private group," which for the present is "sitting on it" and very secretive.

Of course it is possible to introduce pigmentation into mandarin-like fruits by hybridization, and this is the approach taken by breeders at the Istituto Sperimentale per L'Agrumicoltura in Acireale, Sicily, who have now released selections from their second generation of crosses. All are triploid, and thus seedless, an added bonus. On my visit 10 years ago I tasted Tacle and Clara, two crosses of Monreal clementine and Tarocco blood orange; now there are over 100 acres of such blood mandarins in cultivation in Italy, according to Dr. Giuseppe Reforgiato Recupero. A few years ago he and his colleagues introduced Alkanta (Oroval clementine x Tarocco) and Mandared (Nules clementine x Tarocco). According to Nigel Grech, a plant pathologist, and researcher for Visalia-based Future Fruits, Mandared, which ripens in February in the San Joaquin Valley, is the pick of the lot, because "it has more developed pigmentation, and it's a more consistent bearer." Grech and his colleagues have retained an exclusive license for Mandared in the United States, and have assigned the rights to propagate the variety to Willits & Newcomb Nursery, which may have trees available as soon as spring 2008. They may be marketed as Red Nules, added Mr. Grech.

Pure pummelos and grapefruits pigmented with anthocyanin are not recorded, but Drs. Robert Soost and James Cameron, citrus breeders at the University of California at Riverside, came up with hybrid blood grapefruit-like citrus as part of the work that resulted in the Oroblanco and Melogold several decades ago. The most promising pigmented selection, nicknamed 'Valentine' because it matures in mid-February, is Siamese Sweet pummelo x (Dancy mandarin x Ruby blood orange); it combines large size and low acidity from its pummelo parent, complex, floral taste from the Dancy, and juicy red pulp from the Ruby. This fruit is a favorite at the UCR Citrus Variety Collection, where there are about half a dozen trees in trials, and hopefully before too long it will be available as a home garden variety. "We don't have a firm plan, but we will probably release it in a couple years, as an unpatented variety," said Dr. Mikeal Roose, the current UCR citrus breeder.

Another noteworthy blood hybrid, sometimes nicknamed 'Dawn,' is Siamese Sweet pummelo x Ruby blood orange. It's smaller and less highly pigmented than Valentine, but equally delicious, and seedless.

A more conventional offering, but still very exciting, is a new high-lycopene grapefruit that showed up as a bud sport on a Rio Red tree at the Texas A&M University-Kingsville Citrus Center in Weslaco, Texas. Both the skin and the flesh are darker than those on any known grapefruit, including Star Ruby, according to Eliezer Louzada and John De Graca, scientists at the station. "From the mutated limb we have propagated new trees, which haven't borne fruit yet, but we expect that they will produce next year," said Dr. De Graca. "Dr. Louzada is hoping this will be the next new variety, but we are still a few years away from any release," he added in a recent message. ***—D.K.***

they taste flat, and also tend to develop an unpleasant musty aroma. This happens because hydroxycinnamic acids, which enhance the taste of prime blood oranges, later deteriorate to form vinylphenols, which impart nasty off-flavors that are medicinal or moldy.

As another result of the peculiar chemical composition of blood oranges, when they are juiced, pasteurization, concentration and storage degrade quality far more than for blonde oranges. As the pigments shift, the juice turns brownish-red; enzymes specific to blood oranges precipitate the pulp, causing a cloudy texture; and aromas are altered. Historically these problems have kept the fruit from being marketed as juice.

In compensation, blood oranges are exceptionally high in phytochemicals with antioxidant properties, including anthocyanins, hydroxycinnamic acids, hesperidin and vitamin C, all present in greater amounts than in blonde varieties. Studies have shown that these compounds scavenge free radicals that can cause cancer; lower LDL cholesterol, the type that fosters heart disease; and protect against diabetes.

Blood Oranges Origins in China

Mutations from blonde to blood oranges have occurred a number of times in various citrus-growing areas of the world, probably first in China, in or near where sweet oranges originated. In the 1950s scientists found blood oranges growing in the mountains of Hunan, and the Chinese raise these native blood oranges, called "Xuechen," in dooryards, said Xiuxin Deng, a citrus specialist at Huazhong Agricultural University. It's not clear, however, whether such Chinese blood oranges were in some way ancestral to modern varieties grown in the Mediterranean region and United States. The blood oranges now grown commercially in China, on some 2,500 acres, are modern Italian varieties.

The first surviving European mention of blood oranges came in 1646 when Giovanni Battista Ferrari, a Roman Jesuit scholar, wrote in his great treatise on citrus, *Hesperides Sive de Malorum Aureorum Cultura et Usu,* that a Genoese missionary had brought from the Philippines a variety similar to other sweet oranges, but "with purple-colored flesh, which tastes strangely different, like grape." It seems unlikely that blood oranges would have been grown in the Philippines, where it never even gets chilly enough to turn rinds from green to orange, much less to provide a red blush, but perhaps the variety was appreciated for fine flavor, whatever the color, or was in transit from China. Later, two Florentines, the painter Bartolomeo Bimbi (1648–1730) and the botanist Pietro Antonio Micheli (1679–1737), depicted blood oranges.

In his *Traité du Citrus* (1811), Georges Gallesio observed that the *"oranger à fruit rouge,"* less sweet than common oranges, was then commonly cultivated in Malta, Provence and Liguria. In the *Histoire Naturelle des Orangers* (1818–1822), Antoine Risso noted that it was formerly believed that the blood orange resulted from the grafting of a common orange on pomegranate rootstock. He described the *"Orange de Malte,"* which, like many modern blood oranges, was spherical, of medium size, with a pebbly rind, few seeds, and red pulp of excellent flavor. For many years the name Malta was applied as a general term for blood oranges, and a sauce made with the fruit is still called "maltaise" in traditional French cookery.

In Sicily the first blood oranges were called "Sanguigne," a name that referred both to blood oranges in general and to the oldest variety, Sanguigno Semplice. The variety's rind is well-colored, the flesh less so, and it is fairly seedy. It fetched low prices at local markets, but better blood orange varieties led to expanded cultivation by the late 19th century, as exports to America and northern Europe flourished.

A Visit to Blood Orange Central

Italy, Spain and North Africa are the only places where blood oranges are commercially important today, and Sicily, where blood oranges account for 60 percent of orange production—some 155,000 acres—is the primary center of their cultivation and appreciation. To understand the fruit's mystique at the source, I spent two weeks in eastern Sicily visiting growers, shippers and citrus scientists.

I paid a call on Dr. Francesco Russo, the dean of blood orange researchers, who retired as director of variety improvement at the Istituto Sperimentale per L'Agrumicoltura, the island's leading center for citrus studies. As we chatted in his elegant parlor in the seaside village of Santa Tecla, he filled in much geographical and historical background concerning Sicilian citrus. The eastern coast of Sicily, from Messina in the north down to Syracuse, is lemon country; in the south-central part, west of Agrigento, navels predominate; around Palermo, in the north-central part, there are mostly lemons, and a few oranges and mandarins; inland from Catania, blood oranges and mandarins flourish. In this area 5 to 20 miles from the sea, on fertile volcanic soil erupted by Mt. Etna, hot summers bring the fruit sweetness; cold winter nights alternating with mild days favor the red-

Sources of Bloods

California Citrus Specialties (*Lance Walheim, Mike Foskett*). Grows and wholesales Moro, Tarocco and Spanish Sanguinelli blood oranges.

dening of rinds and flesh. The season runs from December through April or May, and the leading varieties are Tarocco, Moro and Sanguinello.

Main Italian Blood Varieties

The origin of Sanguinello is uncertain, but it was most likely a mutation of Sanguigno discovered in the 19th century near Paternò, south of Mt. Etna. The diminutive "ello" implies light blood coloration, and indeed strains of this type—it's really a group of similar, related clones—typically are less ruddy than Moro and Tarocco, but not nearly as light as true "half-blood" varieties. Sweet and rich-flavored, Sanguinello ripens a bit later than other Italian varieties, and it hangs well on the tree, so it's generally marketed from February to April. One common strain is named Sanguinello Moscato for its supposed flavor of muscat grape—yet another forced attempt to convey the elusive flavor of blood oranges.

Tarocco, the king of blood oranges, is a mutation of Sanguinello discovered around 1900, reputedly in Francofonte, and named either for the resemblance of the original strain to a toy top—it can have a "neck", like a Minneola tangelo—or after the Italian word for tarot cards. Medium to large in size, with tender, rag-free flesh, and a sweet, well-balanced flavor, Tarocco is hailed in Italy as the supreme *"arancia da tavola,"* or table orange, and represents 60 percent of the country's blood orange production. In chemical composition it in some ways resembles the navel orange, although it lacks that fruit's distinctive aroma. Often the pulp is attractively bicolored, blonde at the stem end, and red at the blossom end. The variety seems genetically unstable and has given rise to several dozen named mutations, differing in season, fruit size, color and growing habit.

Moro ("Moor"), which developed near Lentini from Sanguinello Moscato in the early 20th century, is prized for its reliable and often intense pigmentation: the rind is sometimes completely covered in red, and the flesh ranges from burgundy-streaked to almost black. Ripening early in the season, from December to March, Moro is popular on export markets for its dramatic color, but it is comparatively tart, and in Italy it is primarily used to make thick, tangy, dark-hued juice.

"In the old days," recalled Russo, who started at the Institute in 1947, "Tarocchi came mostly from Francofonte, Sanguinelli from Paternò, and Mori from Lentini. Now I should say that is not valid any more—the younger generation don't care about the tradition of the place."

The Sicilians definitely delight in their blood oranges, however, and proudly maintain that nowhere else are blood varieties so superb. At Catania's La Fiera market, bathed by golden morning light in winter, scooters beep and shoppers bustle between stalls of sheep's milk ricotta and pepato cheeses, glistening sardines, fragrant fennel, and heaping baskets of Tarocchi, some cut in half to reveal their ruby flesh. All over town, from the backs of three-wheeled trucks, weathered Tarocco vendors cry *"dolcissimi!"*—"mine are the sweetest!" Long after midnight, crowds gather at kiosks to sip the vermilion-colored juice blended with mineral water.

Sicilians traditionally eat their blood oranges at the end of a meal. They rarely serve them in restaurant dishes, except for dessert, but at home Sicilians love blood oranges in a salad with red onions, olive oil, salt, pepper, and often, fresh fennel. Along the Via Etnea, Catania's main boulevard, crowded in early evening with a spirited *passeggiata,* I sampled blood orange cake and gelato, as well as marzipan faux oranges, but my favorite sweets, at the famous *pasticceria* A. Savia, were *quaresimali*: chewy Carnival biscotti of almond paste, pistachio, and dried orange rind.

Citrus Crisis Beleaguers Growers

The bounty of Sicilian blood oranges is not good news for everyone. As I toured the groves, passing meadows of fluorescent yellow-green flowers, and peered into ancient, abandoned farmhouses, I met many growers who lamented the *"crisi degli agrumi,"* the "citrus crisis." Italy produces more than three billion pounds of blood oranges yearly, far exceeding domestic demand. Most farms are small (under three acres on average), and wages are high, so production costs are twice Spain's, ten times Morocco's. Since barriers to free trade in citrus were eliminated in the 1990s, cheap foreign blondes have been beating out Italian bloods on export markets.

In Francofonte, famous for the quality of its Tarocchi, I met Antonino and Mario Turiano supervising the 1996 harvest. As workers on ladders filled crates with oranges and heaved them onto a truck, and a goat chomped calmly on a spiny cactus pear, the genial brothers gesticulated emphatically, interrupting each other to pour out their woes: "It costs 300 lire to produce a kilo of Tarocchi, but we get paid 250. … Often we leave the oranges on the ground. … We can't continue like this! … People say we should sell, but to whom?"

But Sicilians are rolling up their sleeves to fight, by emphasizing the unique and health-giving properties of their blood oranges. In March 1996, Sicilian growers got a boost when the "Arancia Rossa di Sicilia" was granted an *"indicazione geografica protetta,"* a guarantee of quality and origin—similar to the D.O.C. for wines—that is part of a labeling program developed by the European Union in cooperation with the Italian government. The I.G.P. restricts the designation to blood oranges from the classic growing region in eastern Sicily that meet the project's standards for size, sweetness, and color.

To enhance the prestige of Sicilian blood oranges, Princess Maria Carla Borghese, who grows organic blood oranges on her estate, Il Biviere, in Lentini, started a program called *"Le Arance della Salute"*—"Oranges of Health." On the last Saturday in January, volunteers sell bags of Mori and Tarocchi in hundreds of piazzas throughout Italy to benefit cancer research.

For years commercial processing of blood orange juice was infeasible, because it turned muddy brown and lost flavor, but with recent advances (partly involving low-temperature handling), supermarkets now offer cartons of chilled "*spremuta.*" Tropicana sells blood orange juice across Europe, and Volcano brand Sicilian blood orange juice is exported to the United States.

Blood Orange Wrappers in Italy

As one might expect from Italians, their blood oranges are elegantly dressed. When the export trade in Sicilian blood oranges emerged at the end of the last century, shippers started using thin paper wrappers to protect the fruit against desiccation and mold. These *"scacchetti"* usually bore the name of the variety and the producer or shipper, as well as colorful images designed to stimulate the imagination of buyers in distant lands. Some reflect the Sicilian landscape (Etna erupting orange juice); others are pure fancy (singing cats, a Tarocco wearing a Walkman). After 1960, carnauba wax replaced wrappers on most citrus, but their use continued on blood oranges, especially for

export, to distinguish this premium fruit.

For years I collected these wrappers, always crinkled from use. The last night of my trip, as I dined at one of Catania's best restaurants, a distinguished-looking businessman at the next table overheard my talk of blood oranges. He turned out to be Placido Manganaro, third-generation owner of Sicily's leading printer of wrappers. Though it was almost midnight and my plane was leaving early the next morning, I accepted his invitation to visit his factory south of Catania. He opened the security gates, turned on the lights, and showed me the printing presses. Finally, he let me loose in the archives. In a feverish hour, I gathered a collection of 350 wrappers.

In 2005 Sicilian growers launched a campaign called Sweet Peel to promote fresh blood orange exports to the United States. I always look for imported Italian blood oranges at fancy markets in the Northeast, but perhaps because U.S. agricultural regulations require the fruit to spend 10 to14 days in cold storage, to kill off insect pests, and blood oranges are susceptible to temperature and storage mishandling, they often disappoint. The truth is, California can grow blood oranges that are just as good, and they're fresher.

Early History in the United States

In the mid-19th century Downing's *Fruits and Fruit Trees of America* praised Maltese and Blood-Red oranges for their "excellent flavor." In the early years of California orange growing, farmers tried many varieties before focusing on navels and Valencias. It was probably one such pioneer, Thomas A. Garey, who imported Malta Blood oranges from Florida or the Mediterranean in the 1870s. By the 1880s this was a widely planted variety, in such demand that counterfeiters reportedly injected dye into regular oranges to sell them as bloods. May 23, 1891, the *Citrograph,* a Redlands newspaper, vaunted "tons of luscious, blood-red fruit" from the "southern citrus empires" of Riverside, San Diego, Los Angeles and Orange counties.

Though of outstanding flavor, Maltas were lightly colored and unproductive, so they eventually lost out to other varieties. But Edmund Patterson, Jr., a crusty Redlands grower who recently celebrated his 100th birthday, still cherishes a Malta Blood tree planted in 1886. One afternoon, as he mused over the oval fruit, lightly mottled with red, he recalled the vanished groves:

"When I was a school kid, many ranches had three or four rows of Malta Bloods. When the fruits got ripe in March and April, we'd ship them to the East, where Christians bought them around Easter, and Jews for a holiday before that. But the packing house manager would cuss when the customers wanted 50 cartons of bloods in a 1,000-carton car. We pulled out the bloods about 1939, because the demand for them faded, but kept this tree next to the guest house. It's nice to have around, just an odd variety."

What about the intriguing religious link? The egg shape of the Malta Blood may have inspired its popularity at Easter; perhaps the symbolism of Christ's blood also played a part. The Jewish holiday was probably Purim, when the *mishloach manot,* a gift platter of baked goods sent to neighbors and relatives, traditionally included an orange. At Passover, too, Sephardic Jews baked orange cakes. It makes even more sense when one recalls that in Europe, Jewish traders controlled the early export trade of Sicilian blood oranges from Messina.

The first strain of Malta Blood, which was round, originated as a "seedling sport of the ordinary sweet orange," according to a 1922 book on the fruits of the island. The Malta Egg-Blood, a less strongly pigmented but better-flavored variety widely exported in the 19th century, originated as a sport on an oval-fruited sweet orange tree in 1850, and eventually supplanted the earlier strain.

In modern Tunisia the oval Malta Blood is still a major variety, grown on 13,000 acres. Much of the crop is exported to France, where "Maltaises" are prized for their sweet, delicate flavor and tender flesh, despite their light coloration. But Americans have always eaten with their eyes, and in the early 1900s the Ruby, a round Italian variety that sometimes produced darker fruit, began to replace the Malta Blood in California. Unlike most blood oranges, which typically have just a seed or two, it was fairly seedy. By mid-century it was virtually the only blood orange grown in California, and only on a very small scale. Packing houses, attuned to mass production of uniform fruit, disdained unreliably pigmented blood oranges. At the lowest ebb, no commercial market existed, just a few scattered trees in groves owned by Italians, who sold the fruit as a novelty.

The first Moros and Taroccos arrived in California in the early 1940s, but didn't supplant the Ruby until the 60s. In the early 80s increased interest in specialty fruits, along with a taste for blood oranges in Americans who had traveled to Europe, fed a mini-revival. High prices attracted growers, and plantings increased steadily until about 1993. As new trees came into bearing, production surged, and by the late 90s the market was glutted. Eventually the cycle turned, and recently growers have been planting bloods again.

Blood Oranges in California Today

About 350 of the 500 acres of blood oranges in California grow in the "citrus belt" along the southeastern edge of the San Joaquin Valley, from Bakersfield to north of Fresno. In this microclimate, dangerous frost-laden air drains down to lower elevations, but it's still chilly enough to produce deep-colored bloods. Most of the other plantings, including many small and organic groves that sell at farmers markets, are in Southern California, in north San Diego, Ventura and Riverside counties.

More than 90 percent of California blood oranges are Moros, favored by growers because the trees are vigorous and productive, and the fruits "color up" most reliably. As in Sicily, the harvest runs from December to April, but the first Moros tend to be tart, and by March specimens grown in the San Joaquin Valley taste like old tennis sneakers. Bloods mature a month later in Southern California, where Moros can retain good flavor into April, or even later in some years. Some grocers try to avoid the sanguinary stigma of blood oranges by calling them "red," "burgundy" or "raspberry" oranges; Sunkist, the cooperative that markets the majority of California bloods, labels all of them "Moro" oranges.

California growers have not planted many Taroccos, despite their superb eating quality, because the prevailing local strain has exhibited prolonged juvenility, a flaw that perhaps arose when the original Tarocco clone was repropagated by seed to rid it of disease. Whatever the cause, the trees are excessively thorny, and take six or seven years (versus four for the Moro) to bear fruit, which often fail to develop good color, especially on the rind.

"Nothing pisses off a retail buyer faster than sending him blank blood oranges," observed Lance Walheim, a pioneer in growing and marketing specialty citrus in the San Joaquin Valley. "It's ironic, because

Taroccos absolutely have the best flavor, but when they come on, there are a lot of cheap Moros. I don't know whether people are familiar enough with the varieties to distinguish among them."

The Best Selections to Grow

California growers have selected, from slight mutations in their groves, several improved Tarocco strains, the best-colored of which is the Bream. It's a lengthy, expensive process to import foreign varieties into the United States and make sure they're free of disease, but recently Sun Pacific, a large citrus grower, privately has brought in two superior modern Tarocco selections from Sicily, so in a few years this finest of oranges may be more common in the U.S.

In the last two decades blood oranges have fallen out of commercial cultivation in Spain, but in California the Spanish Sanguinelli (different from the Italian Sanguinello), appears in small quantities late in the season, from March to May. Oval in shape, it has a bright cherry-red blush on the rind, and moderate internal color, concentrated at the segment walls. Growers say they taste good, but I find that they tend to be dry, and I've never had one that made me want more. In my opinion, the Smith Red Valencia, California's native blood orange, offers the best combination of good production, color and flavor, and it holds well on the tree until April.

Blood oranges' relatively short harvest places them at a disadvantage in American commerce, where retailers and foodservice users demand consistent supplies, but one California citrus company is looking to extend the season by bringing in a range of Turkish varieties that mature over eight months. Many times over the years, I've received desperate phone calls from magazine food photographers looking for blood oranges in August and September, when none was available for love or money, but recently a few contraseasonal imports have arrived from Australia.

Cousin Cara Cara and Other Lycopene-Pigmented Oranges

In the United States blood oranges have never quite made it into the mainstream, but another pigmented mutation, the dark pink-fleshed Cara Cara navel orange, has vaulted in the last two decades from novelty to supermarket staple. Although sometimes confused for a blood variety, it's different in origin, chemistry and taste: it's pigmented with lycopene, a reddish-pink carotenoid that colors pink grapefruits, tomatoes, watermelons and guavas. (Like anthocyanins, lycopene is a potent antioxidant and may help to prevent cancer.) Cara Cara also contains relatively high amounts of beta-carotene, compared to standard navel oranges. Externally it resembles a regular navel with a light pink blush; on the inside, it's a gorgeous deep salmon when harvest starts in November and December, although by the end of the season, in March and April, the color fades slightly. The pulp is relatively low in acidity, with a mild, almost tutti-frutti flavor.

This variety originated as a sport on a limb of a Washington Navel at the Hacienda Cara Cara, in Venezuela, in the early 1970s. In the United States it was first planted in Florida in the early 1990s, and marketed as a "red navel." As grown in Florida, however, Cara Cara is pale, watery and insipid, and it has faded from commercial cultivation there. The variety is richer in color and flavor in California, where more than 2,200 acres have been planted.

The anthocyanins in blood oranges are synthesized from the carotenoids that dominate in blonde oranges, but by contrast the lycopene in Cara Cara results from the interruption of enzymatic processes before some of the yellow-orange carotenoids are created. In Cara Cara the interruption appears to be different or less complete than in red grapefruit, as beta-carotene is still produced; as a result the juice is pinkish-orange, not pure pink. Moreover, the mutation that created Cara Cara resulted in a plant that can be genetically unstable, so that limbs sometimes revert to the straight navel orange type, or bear fruits that are Cara Cara on one half, normal navel on the other.

Lycopene mutations similar to Cara Cara have occurred in several regions and orange groups. The oldest appears to be Vaniglia Sanguigno ("Vanilla Blood"), an Italian variety of acidless orange which taste a bit like an orange Creamsicle; a few growers in the San Joaquin Valley sell it as a novelty, but there's virtually no commercial production. The Sarah variety of Israel is a pink-fleshed sport of Shamouti common orange, a standard variety in the Eastern Mediterranean. In South Africa the Kirkwood navel is similar to Cara Cara, but with deeper lycopene color.

Most important, in South Africa growers have discovered several lycopene sports of Valencia. Navels, including Cara Cara, aren't ideal for processing, because the juice develops a syndrome called delayed bitterness, but Valencia is the world's preeminent juice orange. Chester Roistacher, a plant pathologist now retired from the University of California at Riverside, encountered a Pink Valencia at the Hope Farm, near Tzaneen, South Africa, in 1977, but when he later tried to obtain budwood for grafting, it was unavailable. "I kicked myself ever afterwards for not getting it while I could," he said. In the 1990s, however, the so-called Ruby Valencia was found near Nelspruit. South Africa citrus scientists are still studying several clones of Ruby Valencia, with varying sizes and numbers of seeds, and are preparing to chose one for commercial introduction, said Graham Barry of Citrus Research International.

Since supermarkets typically carry a dozen or more differently formulated orange juices (with unstrained pulp, high calcium, etc.), it seems likely that some day pinkish-red orange juice may be commonly available, just as there are red and yellow forms of grapefruit juice. It can take a while for new fruits to catch on, but lycopene orange varieties, like bloods, appear to have all the ingredients for success: they're attractive, different, tasty and healthful.

David Karp *writes about and photographs fruit for articles in* The New York Times *and other publications, and for a book on fruit to be published by W.W. Norton. This article is a version of a chapter from that work.*

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