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'Navel Orange'

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Navel oranges, classified as one of the four groups of sweet orange (*Citrus sinensis* (L.) Osbeck) (17), are among the highest quality citrus fruits grown around the world. The genus Citrus and close relatives are members of the Rutaceae family. Navel oranges, are primarily marketed for the fresh domestic, gift fruit, and/or export markets and usually bring premium prices to the citrus grower. 'Washington Navel' is perhaps the principal fresh fruit orange cultivar in the world.

Origin

Originating in China, the sweet orange was brought first to Portugal, distributed in Europe in the 16th century, and eventually found its way to Brazil (17). The earliest description of a navel orange was published in Rome by John Baptiste Ferrarius, a monk of the Society of Jesus in 1646 (6). About 1820, a navel orange of excellent quality was found near the village of Bahia in Brazil (5). Locally it was called "Laranja de Umbigo" but later renamed the 'Bahia Navel.' It was reported to be a limb sport of the 'Selecta' sweet orange.

Because it was propagated indiscriminately, several forms of budwood lines were distributed around the world. In 1870, William Saunders, USDA, had 12 'Bahia Navel' trees sent to Washington, D.C. in tubs where they were grown in a greenhouse. These trees were used for budwood to propagate large numbers of trees for distribution, primarily to Florida and California (1, 11) and thus the name 'Washington Navel' was popularized. The 'Washington Navel' was first exhibited at the Riverside (CA) Citrus Fair in 1879 where it attracted much attention. At the time, there was some confusion over a second navel type ('Australian Navel') which was introduced into California from Australia but was of inferior quality (17). An interesting account of the early history of the Navel orange can be found in Coit (2).

Production Areas

Navel oranges are adaptable to a wide range of climatic regions. For example, they are commercially important in the U.S. (California, Arizona, and Florida), Mexico, South Africa, Australia, Argentina, Uruguay, Brazil, Spain, Italy, Greece, Turkey, Morocco, Algeria, and Japan, among other countries. Navel cultivars are most productive, and generally produce the highest quality fruit, in Mediterranean climates with warm days and cool nights and less productive in arid and some subtropical areas (4). According to Davies (4), the growth of navel trees is controlled by temperature in the subtropics and by rainfall in the tropics. It is a faster growing tree and produces poorly colored fruit in tropical and subtropical climates. High temperatures during bloom especially can reduce fruit set (3). In Mediterranean regions, navel oranges usually have less insect and disease problems and are less blemished when compared to fruit from tropical and subtropical regions.

Navel oranges are extremely sensitive to soil and climatic environments. Stresses such as soil moisture deficiency and high temperatures make it particularly vulnerable to fruit drop (3). Navel oranges are especially adapted in the cool, dry irrigated desert regions of California where it attains optimum fruitifulness and quality. At sea level in the tropics, navel

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oranges are nearly inedible with thick peel, poor color, and dry flesh.

Cultivars

Several cultivars make up the class of navel oranges which have a small secondary fruit embedded in the apex of the primary fruit. 'Washington Navel' is the most widely grown and commercially important navel oranges. In fact, most navel cultivars originated from 'Washington Navel' either as limb sports or as nucellar seedlings. 'Washington Navel' is an exceptionally high quality dessert orange with crisp flesh texture, melting pulp, seedless, sweet flavor, and ease of peeling. It is best suited for salads or eating out of hand. It ripens in California from November to May. In Florida, it is among the earliest of the sweet oranges, ripening in October through January (12, 15).

Other important navel cultivars (14) include: 'Navelina,' a limb sport from California considered important in Spain and Italy. It was introduced from the U.S. to Spain in 1933 and from Spain to Italy in the 1960's.

'Newhall,' originated in Duarte, California as a bud mutation of 'Washington Navel' in 1955. It is grown commercially in Spain.

'Palmer,' originated as a nucellar seedling in the 1930's in South Africa.

'Marrs,' a somatic variant of 'Washington Navel,' is a low acid, early maturing orange grown primarily in Texas and northern Mexico. It ripens from November to January. It lacks a secondary fruit, so it cannot be considered a true navel orange.

'Navelate,' originated as a sport of 'Washington' in Spain in 1948.

'Lane Late,' was found in New South Wales, Australia in 1963 and is now popular in Australia and California.

'Leng,' also a limb sport of 'Washington Navel,' was found in 1934 and is grown in Australia.

Other navel cultivars, mostly grown in California, include 'Atwood,' 'Carter,' 'Fisher,' 'Gillette,' 'Robertson,' 'Skaggs Bonanza,' and 'Thompson.' 'Baianinha' is widely planted in Brazil. 'Dream' and 'Summerland' are old line navel types originating as nucellar seedlings of the navel cultivars grown in Florida; many are unnamed nucellar seedlings with improved characteristics distributed through the Florida Budwood Registration Program.

Fruit Characteristics

'Washington Navels' are among the earliest maturing of the orange cultivars. Because of complete pollen and partial ovule sterility, the fruit are seedless. They are of large size (3-3 1/2 inches), easily peeled, have sweeter flavor, and lower acid content than other sweet orange cultivars. They have a thick skin.

The unique feature of the navel orange is the development of a partially formed secondary fruit which develops within the primary fruit (extranumerary fruit) (9). Rind protrusions may be formed from the secondary into the primary fruit. The structure at the blossom end resembles a navel.

The 'Washington Navel' orange is male-sterile. Its flowers produce no viable pollen (16), and it undergoes defective embryo sac development as well (7). Because of this sexual sterility and its parthenocarpic capability, it regularly produces seedless fruit. However, not all navel cultivars produce completely seedless fruit. Seedless navel cultivars have arisen by spontaneous mutation from closely related seedy forms (13).

Fruit Quality

'Washington Navel' develops a delayed bitterness in the juice and, therefore, is not suitable for juice processing. Limonic acid (a non bitter precursor) is converted to the bitter principle, limonin, when the juice sacs are ruptured during juice extraction. This reaction takes about 30 minutes to develop at a level where it can be detected and tasted (10). Some cultivars such as 'Marrs' contain lower levels of limonin than 'Washington.' Further, 'Washington Navel' is more subject to certain physiological disorders than other sweet orange cultivars, e.g.,

core dryness, granulation, stylar end dryness, and splitting (9).

Productivity

Navel trees in general are not productive. It is especially a shy bearer in Florida.

Low yields have been attributed to excessive fruit drop at various times of the year (4). In Florida, 25% loss of crop has occurred during the June drop period (usually in May). Heavy fruit drop (15-20%) may continue through the summer (mid-June to mid-August). A period of fruit drop also occurs in the fall (September to October) when the fruit are approaching maturity. Finally, navel fruit are subjected to preharvest drop after legal maturity is reached. In addition, navel oranges are susceptible to postbloom fruit drop caused by the *Colletotrichum* fungus.

Total bearing acreage of navel oranges in California, Arizona, and Florida in 1996-97 were 124,000, 4,900, and 26,434, respectively. This represented 45, 14, and 4% of the total citrus acreage (1). In 1996-97, Florida produced a total of 6,400,000 90 lb boxes of navels. Thirty-three percent of the Florida crop was processed. The total value of production was $24,928,000 of which $22,313,000 was from fresh market sales. Packinghouse eliminations account for nearly all of the processing navels. California produced 40,000,000 boxes of navels in 1996-97, 86% of which were sold fresh (13% exported), for a total value of $294,690,000 (1). Fourteen percent was processed. Forty percent of the total citrus production in California is in navels.

New selections are being tested around the world to identify superior late ripening navel oranges for increased market opportunities and higher returns to growers (8).

Literature Cited

1. Anon. 1998. Florida Agricultural Statistics: Citrus Summary 1996-97. Florida Dept. of Agr. and Consumer Services. Tallahassee, FL. 45 pp.
2. Coit, J. E. 1922. Citrus Fruits. Macmillan Co., New York. 520 pp.
3. Coit, J. E. and R. W. Hodgson. 1919. An investigation of the abnormal shedding of young fruits of the Washington navel oranges. Univ. Calif., Berkeley, Public. Agric. Sci. 3:283-368.
4. Davies, F. S. 1986. The navel orange. In: Hort. Reviews 8:129-180. Avi Pub. Co. Inc., Westport, CT.
5. Dorsett, P. H., A. D. Shamel, and W. Popenoe. 1917. The navel orange of Bahia; with notes on some little-known Brazilian fruits. USDA Bull. 445. 35 pp.
6. Ferrarius, J. B. 1646. The Hesperides or about the golden apples: Their culture and use. Rome (cited by Coit (2)).
7. Frost, H. B. and R. K. Soost. 1968. Seed reproduction: development of gametes and embryos. In: The Citrus Industry, pp.290-324, W. Reuther, L. D. Batchelor and H. J. Webber (eds.). Univ. Calif. Press, Berkeley.
8. Gallasch, P. T. 1996. Evaluating new selections of late hanging navel orange. Proc. Int. Soc. Citricult. 1:193-197.
9. Lima, J. E. O. and F. S. Davies. 1984. Secondary-fruit ontogeny in navel orange. Amer. J. Bot. 71:532-541.
10. Nagy, S. 1996. Factors affecting the flavor of citrus fruits and their juice products. Chapter 3. In: Quality Control Manual for Citrus Processing Plants, Vol. III, pp. 104-129, J. B. Reed, P. E. Shaw, C. M. Hendrix, Jr., and D. L. Hendrix (eds.). AgScience, Inc., Auburndale, FL.
11. Saunders, W. 1886. Notes on orange culture. USDA Rept., Washington, DC. 687 pp.
12. Saunt, J. 1990. Citrus varieties of the world. Sinclair Int. Ltd., Norwich, England. 128 pp.
13. Soost, R. K. and J. W. Cameron. 1975. Citrus. In: Advances in Fruit Breeding, pp 507-540, J. Janick and J. N. Moore (eds.). Purdue Univ. Press, West Lafayette, IN.
14. Starrantino, A., G. R. Recupero, and F. Russo. 1992. Performance of ten 'Navelina' nucellar lines obtained from the embryos of a single seed. Proc. Int. Soc. Citricult. 1:76-78.
15. Tucker, D. P. H., C. J. Hearn, and C. O. Youtsey. 1995. Florida Citrus Varieties. Florida Cooperative Extension Service. SP102. 57 pp. Gainesville, FL.
16. Webber, H. J. 1894. Results in crossing navel oranges. Proc. Fla. State Hort. Soc. 7:62-64.
17. Webber, H. J. 1948. Cultivated varieties of citrus. In: The Citrus Industry, Vol. 1, pp. 475-668, H. J. Webber and L. D. Batchelor (eds.), Univ. Calif. Press, Berkeley.