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EAST AFRICAN STANDARD

Sapota — Specification and grading



EAST AFRICAN COMMUNITY

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Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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Introduction

In the preparation of this East African Standard, the following sources were consulted extensively:

Fruits and Vegetables Grading and Marking (Amendment) Rules, 2007, Ministry of Agriculture, Government of India, Schedule XXX, *Grade Designation and Quality of Sapota*.

CODEX STAN 193:1995 (Rev.5:2009), *General Standard for Contaminants and Toxins in Foods*

CODEX STAN 228:2001 (Rev.1:2004), *General methods of analysis for contaminants*

Codex Alimentarius website: http://www.codexalimentarius.net/mrls/pestdes/jsp/pest_q-e.jsp

USDA Foreign Agricultural Service website: <http://www.mrldatabase.com>

USDA Agricultural Marketing Service website: <http://www.ams.usda.gov/AMSV1.0/Standards>

USDA Plant Inspectorate Service website: http://www.aphis.usda.gov/import_export/plants

European Union: http://ec.europa.eu/sanco_pesticides/public

Assistance derived from these sources and others inadvertently not mentioned is hereby acknowledged.

This standard has been developed to take into account:

- the needs of the market for the product;
- the need to facilitate fair domestic, regional and international trade and prevent technical barriers to trade by establishing a common trading language for buyers and sellers.
- the structure of the CODEX, UNECE, USA, ISO and other internationally significant standards;
- the needs of the producers in gaining knowledge of market standards, conformity assessment, commercial cultivars and crop production process;
- the need to transport the product in a manner that ensures keeping of quality until it reaches the consumer;
- the need for the plant protection authority to certify, through a simplified form, that the product is fit for crossborder and international trade without carrying plant disease vectors;
- the need to promote good agricultural practices that will enhance wider market access, involvement of small-scale traders and hence making fruit and vegetable production a viable means of wealth creation; and
- the need to keep unsatisfactory produce from the market by allowing the removal of unsatisfactory produce from the markets and to discourage unfair trade practices e.g. trying to sell immature produce at the beginning of the season when high profits can be made. Immature produce leads to dissatisfaction of customers and influences their choices negatively, which disadvantages those traders who have waited until the produce is mature.

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Draft for comments only — Not to be cited as East African Standard

Sapota — Specification and grading

1 Scope

This East African Standard applies to sapota of varieties (cultivars) grown from *Manilkara achras* to be supplied fresh to the consumer, sapota for industrial processing being excluded.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CAC/GL 21, *Principles for the Establishment and Application of Microbiological Criteria for Foods*

CAC/RCP 1, *Recommended International Code of Practice — General Principles of Food Hygiene*

CAC/RCP 44, *Recommended International Code of Practice for the Packaging and Transport of Tropical Fresh Fruit and Vegetables*

CAC/RCP 53, *Code of Hygienic Practice for Fresh Fruits and Vegetables*

EAS 38, *Labelling of prepackaged foods — Specification*

CD/K/378:2010, *Horticultural industry — Code of practice*

3 Description

A much branched, slow growing, evergreen, small to medium sized tree. Under cultivation the tree usually reaches 9-20 m in height and up to 50 cm in diameter. As a forest tree it can attain heights of 30-38 m with diameters of up to 150 cm.

4 Provisions concerning quality

4.1 General

The purpose of the standard is to define the quality requirements for sapota at the export control stage, after preparation and packaging.

4.2 Minimum requirements

4.2.1 In all classes, subject to the special provisions for each class and the tolerances allowed, the sapota must be:

- (a) intact, sound;
- (b) fresh in appearance;
- (c) free from any visible foreign matter;
- (d) practically free from bruising;
- (e) free of pests affecting the general appearance of the produce;
- (f) free of damage caused by pests;

- (g) free of abnormal external moisture;
- (h) free of any foreign smell and/or taste;
- (i) free of damage caused by low or high temperature.
- (j) not be very soft, shriveled or water soaked.

4.2.2 Sapota must be carefully picked and have reached an appropriate degree of development and ripeness in accordance with criteria proper to the variety and/or commercial type and to the area in which they are grown. The development and condition of the sapota must be such as to enable them;

- (a) to withstand transport and handling, and
- (b) to arrive in satisfactory condition at the place of destination.

4.3 Classification

4.3.1 Extra Class

Sapota must be of superior quality. They must be well developed and have all the characteristics and colouring typical of the variety. They must be free of defects.

4.3.2 Class I

Sapota must be of good quality. They must be characteristic of the variety. Following defects may be there, provided they do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package.

- slight defects in shape and colour;
- slight skin defects (i.e. scratches, scars, scrapes and blemishes) not exceeding 2 % of the total surface area.

The defects should not affect the pulp of fruit.

4.3.3 Class II

This grade includes Sapota which do not qualify for inclusion in the higher grades, but satisfy the minimum requirements. Following defects may be there, provided the Sapota retain their essential characteristics as regards the general appearance, quality, the keeping quality and presentation.

- defects in shape and colour,
- skin defects (i.e. scratches, scars, scrapes bruises and blemishes) not exceeding 5% of the total surface area.

The defects should not affect the pulp of fruit.

5 Provisions concerning sizing

- (i) Size is determined by the weight of the fruit.

Class	Weight (in g)
Extra class	101 & above
Class I	81 – 100
Class II	60 – 80

- (ii) The difference in weight between the largest and the smallest fruit in any one package must not exceed:
- 15 g for fruits weighing less than 100 g
 - 20 g for fruits weighing between 100 g and above.

6 Provisions concerning tolerances

Tolerances in respect of quality and size shall be allowed in each package for produce not satisfying the requirements of the class indicated.

6.1 Quality tolerances

6.1.1 "Extra" Class

5 % by number or weight of Sapota not satisfying the requirements of the grade, but meeting those of Class I grade or, exceptionally, coming within the tolerances of that grade.

6.1.2 Class I

10 % by number or weight of Sapota not satisfying the requirements of the grade, but meeting those of Class II or, exceptionally, coming within the tolerances of that grade.

6.1.3 Class II

10 % by number or weight of Sapota not meeting the requirements of the grade but meeting the minimum requirements.

6.2 Size tolerances

For all grades, 10 % by number or weight of Sapota not conforming to the minimum weight and or the size range specified.

7 Provisions concerning presentation

7.1 Uniformity

The contents of each package must be uniform and contain only Sapota of the same origin, variety and/or commercial type, quality and size, and appreciably of the same degree of ripeness and development. The visible part of the contents of the package must be representative of the entire contents. In addition, uniformity of colouring is required for "Extra" Class.

7.2 Packaging

Sapota must be packed in such a way as to protect the produce properly. The materials used inside the package must be new¹, clean, and of a quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly of paper or stamps bearing trade specifications is allowed, provided the printing or labelling has been done with non-toxic ink or glue.

Sapota shall be packed in each container in compliance with CAC/RCP 44.

7.2.1 Description of containers

The containers shall meet the quality, hygiene, ventilation and resistance characteristics to ensure suitable handling, shipping and preserving of the Sapota. Packages must be free of all foreign matter and smell.

¹ For the purposes of this Standard, this includes recycled material of food-grade quality.

7.3 Presentation

The Sapota may be presented as follows:

- (a) Arranged in regular layers in the package. This form of presentation is mandatory for "Extra" Class and optional for Classes I and II;
- (b) Not arranged in packages. This type of presentation is only allowed for Class I and II;
- (c) In individual packages for direct consumer sale of a weight less than 5 kg, either made up by number or by weight of fruit.

8 Marking or labelling

8.1 Consumer packages

In addition to the requirements of EAS 38, the following specific provisions apply:

8.1.1 Nature of produce

If the produce is not visible from the outside, each package (or lot for produce presented in bulk) shall be labelled as to the name of the produce and may be labelled as to the name of the variety and/or commercial type.

8.2 Non-retail containers

Each package must bear the following particulars, in letters grouped on the same side, legibly and indelibly marked, and visible from the outside, or in the documents accompanying the shipment.

8.2.1 Identification

Name and address of exporter, packer and/or dispatcher. Identification code (optional).²

8.2.2 Nature of produce

Name of the produce if the contents are not visible from the outside. Name of the variety and/or commercial type (optional).³

8.2.3 Origin of produce

Country of origin and, optionally, district where grown or national, regional or local place name.

8.2.4 Commercial Identification

- Class;
- Size code for fruit presented in accordance with the size scale or the upper and the lower limiting size code in the case of three consecutive sizes of the size scale;
- Size code (or, when fruit packed by count fall under two adjacent codes, size codes or minimum and maximum diameter in mm) and number of fruit, in the case of fruit arranged in layers in the package;

² The national legislation of a number of countries requires the explicit declaration of the name and address. However, in the case where a code mark is used, the reference "packer and/or dispatcher (or equivalent abbreviations)" has to be indicated in close connection with the code mark.

³ The national legislation of a number of countries requires the explicit declaration of the variety.

- If appropriate, a statement indicating the use of preservatives;
- Net weight (optional).

8.2.5 Official Inspection Mark (optional)

9 Contaminants

9.1 Heavy metals

Sapota shall comply with those maximum levels for heavy metals established by the Codex Alimentarius Commission for this commodity.

9.2 Pesticide residues

Sapota shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity.

10 Hygiene

10.1 It is recommended that the produce covered by the provisions of this Standard be prepared and handled in accordance with the appropriate sections of CAC/RCP 1, CAC/RCP 53, and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

10.2 The produce should comply with any microbiological criteria established in accordance with CAC/GL 21.



Pouteria sapota (Sapote, marmalade)



Chocolate or black sapote



Green sapote types



Mammee apple, Mamey (very large seeds)



Brown Sapote

Draft for comments



Mamey Sapote Tree




Sapodilla fruits

Draft for comment

Annex D
(informative)

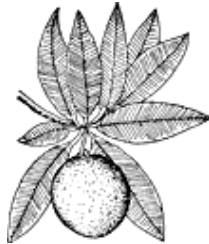
Model certificate of conformity with standards for fresh fruits and vegetables

1. Trader:	Certificate of conformity with the Community marketing standards applicable to fresh fruits and vegetables No. (This certificate is exclusively for the use of inspection bodies)		
2. Packer identified on packaging (if other than trader)	3. Inspection body		
	4. Place of inspection/country of origin ⁽¹⁾	5. Region or country of destination	
6. Identifier of means of transport	7. <input type="checkbox"/> Internal <input type="checkbox"/> Import <input type="checkbox"/> Export		
8. Packages (number and type)	9. Type of product (variety if the standards specifies)	10. Quality Class	11. Total net weight in kg
12. The consignment referred to above conforms, at the time of issue, with the Community standards in force, vide: <u>CD/K/103:2010, Fresh sapota -- Specification and grading</u> _____ Customs office foreseen Place and date of issue Valid until (date): Signatory (name in block letters): <div style="display: flex; justify-content: space-around;"> Signature Seal of competent authority </div>			
13. Observations:			
<input type="checkbox"/> ⁽¹⁾ Where the goods are being re-exported, indicate the origin in box 9.			

Annex D (informative)

Fact sheets

D.1 *Manilkara achras*



Authority	(L)van Royen
Family	Magnoliopsida:Dilleniidae:Sapotales:Sapotaceae
Synonyms	Achras sapota L., Sapota achras Mill.
Common names	Sapodilla, chiku
Editor	
Ecocrop code	2334

Uses

The fruit is eaten fresh, used to flavor ice cream, and made into syrup and jam. A milky latex from the bark is used in chewing gum. The fine, hard wood is used to make various wooden articles. The tree is mentioned as a useful agroforestry species.

Killing temperature

Young trees may be killed by -1°C , but older trees can survive temperatures as low as -3 to -4.5°C for some hours.

Growing period

Perennial. The tree begins to fruit 3-4 years after planting and yields increase up to 25-30 years. The fruit takes about 120 days to mature from flowering. Latex is obtained by tapping the trunk once every 2-3 years.

Common names

Sapodilla, Chicle, Chicle tree, Dilly, Naseberry, Marmalade plum, Nispero, Tree tomato, Small sapote, Sawo, Sapotille, Nefle d'Amerique, Zapotillo, Chicozapote, Nispero, Chico, Chicopote, Chicku, Chico, Sapote, Sapote amarillo, Sapota, Chika, Sapoti, Talalog, Sapote a gomme, Sapodilla plum, Surinam medlar, Breiapfel, Sapotaapfel, Nisporo de Nicaragua, Zapote de abeja, Zapote de chicle, Bully tree, Sapotilha, Nisperd, Chiku, Ciko, La-mut-farang.

Further information

Scientific synonyms: *M. zapota*, *M. zapotilla*, *Achras sapota*, *Ackras Cosaguigo*, *A. zapodilla*, *Nispero achras*, *Sapota achras*, *Calocarpum* spp, *Lucuma nervosa*. Sapodilla is a native of Central America. It thrives near the seashore in the humid tropical lowlands below 500-900 m, but can be found up to 2500 m in elevation and can also be grown in some subtropical regions. It does not like a hot dry summer, but is quite drought resistant. The tree is salt sensitive, though it withstands salt sprays close to the sea and can be grafted on rootstocks of *M. hexandra* to allow fruit production on saline land. With its tough branches the tree tolerates strong winds, but on sandy soils the tree can be uprooted by the wind. A good tree may yield up to 2500-3000 fruits per year or about 250-300 kg. Annual yields per ha of 20-30 t have been reported in Florida, 20-25 t in the Philippines and 20-80 t in India.

D.2 *Manilkara zapota*

Authority	(L.) P. Royen
Family	Magnoliopsida:Dilleniidae:Sapotales:Sapotaceae
Synonyms	Achras zapota L. (1753), Pouteria mammosa (L.) Cronquist (1946), Nispero achras (Miller) Aubreville (1965)
Common names	sapodilla, sapodilla plum, chicozapote, chiku, naseberry, beef apple, chicle, sapoti, sapotizeiro, sapotillier, sawo manila, ciku, sawo londo, chico, lomut, lamud, lamut, lamut-farang, xabôchê, hông xiêm, tâm lư'c
Editor	
Ecocrop code	7605

D.3 *Pouteria sapota*

Authority	(Jacq.) H. More & Stearn
Family	
Synonyms	
Common names	sapote, mamee zapote, marmalade plum, zapote, mamey zapoteo, mamey colorado, zapota grande, sapota grande, unique', grosse sapote
Editor	
Ecocrop code	8917

Description

A medium-sized evergreen or deciduous tree reaching 20-30 m or sometimes even 40 m in height, with a trunk diameter of up to 1 m in diameter. The crown has thick branches and dense foliage. The leaves are ovate or lanceolate. The fruit can have different shapes, may weigh 0.5-3 kg and has a hard skin of a dull, reddish colour.

Uses

The fruit can be eaten fresh or be used to make jams, ice-creams and sauces. When cooked it can be used as a substitute for apple puree and may also be used in confectionery. An oil extracted from the seeds has medicinal properties and can be used to fix paintings on handicrafts. The seeds can be milled and used in confectioneries. The sap from the bark and green fruits is irritant to the eyes and skin, but it also has medicinal properties. The timber can be used for furniture, carts and other objects. It is used as a shade tree for coffee.

Killing temperature

Young trees are injured by frost while mature trees may withstand -2°C for short periods.

Growing period

Perennial, with the first harvest 7-8 years from planting.

Common names

Sapote, Mamey sapote, Mamme sapote, Marmalade plum, Marmalade fruit, Mamee, Sapotier, Grosse sapote, Mamey colorado, Mamey zapote, Mamey colorado, Zapote grande, Zapote, Grosse sapote, Tzapotl, Chico-mamey, Ciko mama, Tru'ng ga.

Further information

Scientific synonym: *Calocarpum mammosum*, *C. sapota*, *Lucuma mammosa*. Sapote is native to the humid lowlands of Central America and southern Mexico. It is a tree of the lowland tropics and can be grown at elevations between sea level and 1000 m or rarely up to 1400 m. Even short dry periods may cause shedding of leaves.

D.4 *Pouteria sapota* (Jacq.) H.E. Moore & Stearn

Pouteria mammosa (L.) Cronquist
Lucuma mammosa Gaertn.
Achradelpha mammosa Cook

The word "sapote" is believed to have been derived from the Aztec "tzapotl", a general term applied to all soft, sweet fruits. It has long been utilized as a common name for *Pouteria sapota* (Jacq.) H.E. Moore & Stearn (syns. *P. mammosa* (L.) Cronquist, *Lucuma mammosa* Gaertn., *Achradelpha mammosa* Cook, *Vitellaria mammosa* Radlk., *Calocarpum mammosum* Pierre, *C. sapota* Merrill, *Sideroxylon sapota* Jacq.). Alternate vernacular names include *sapota*, *zapote*, *zapote colorado*, *zapote mamey*, *lava-zapote*, *zapotillo*, *mamey sapote*, *mamee sapote*, *mamee zapote*, *mamey colorado*, *mamey rojo*, *mammee* or *mammee apple* or red sapote. In El Salvador, it is known as *zapote grande*, in Colombia as *zapote de carne*; in Cuba, it is *mamey*, which tends to confuse it with *Mammea americana* L., a quite different fruit widely known by that name. The usual name in Panama is *mamey de la tierra*; in Haiti, *sapotier jaune d'oeuf*, or *grand sapotillier*; in Guadeloupe, *sapote à creme*; in Martinique, *grosse sapote*; in Jamaica, it is marmalade fruit or marmalade plum; in Nicaragua, it may be called *guaicume*; in Mexico, *chachaas* or *chachalhaas* or *tezonzapote*; in Malaya and the Philippines, *chico-mamei*, or *chico-mamey*.

The sapote belongs to the family Sapotaceae, the same family as the sapodilla (*Manilkara zapota* van Royen) which has also been called *sapote*, *zapote*, or *zapote chico* to distinguish it from the larger fruit.

Description

The sapote tree is erect, frequently to 60 ft (18 m) sometimes to 100 or 130 ft (30 or 40 m) with short or tall trunk to 3 ft (1 m) thick, often narrowly buttressed, a narrow or spreading crown, and white, gummy latex. The evergreen or deciduous leaves, clustered at the branch tips, on petioles 3/4 to 2 in (2-5 cm) long, are obovate, 4 to 12 in (10-30 cm) long, and 1 1/2 to 4 in (4-10 cm) wide, pointed at both ends. The small, white, to pale-yellow 5-parted flowers emerge in clusters of 6 to 12 in the axils of fallen leaves along the branches. The fruit may be round, ovoid or elliptic, often bluntly pointed at the apex, varies from 3 to 9 in (7.5-22.8 cm) long, and ranges in weight from 1/2 lb to 5 lbs (227 g-2.3 kg). It has rough, dark-brown, firm, leathery, semi-woody skin or rind to 1/16 in (1.5 mm) thick, and salmon-pink to deep-red, soft flesh, sweet and pumpkin-like in flavor, enclosing 1 to 4 large, slick, spindle-shaped, pointed seeds, hard, glossy-brown, with a whitish, slightly rough hilum on the ventral side. The large kernel is oily, bitter, and has a strong bitter-almond odor.

Origin and Distribution

The sapote occurs naturally at low elevations from southern Mexico to northern Nicaragua. It is much cultivated and possibly also naturalized up to 2,000 ft (600 m) and occasionally found up to 5,000 ft (1,500 m) throughout Central America and tropical South America. It is abundant in Guatemala. In the West Indies, it is planted to a limited extent from Trinidad to Guadeloupe, and in Puerto Rico, Haiti and Jamaica, but mainly in Cuba where it is often grown in home gardens and along streets and for shading coffee because it loses its leaves at the period when coffee plants need sun, and the fruit is extremely popular. It is grown only occasionally in Colombia, Ecuador, Venezuela and Brazil. It was introduced into the Philippines by the early Spaniards but is grown only around Cavite and Laguna on Luzon and Cagayan on Mindanao. From the Philippines, it was carried to southern Vietnam where the fruit is eaten when very ripe.

The sapote has existed in Florida for at least a century. The prominent horticulturist, Pliny Reasoner, included it in his report in the U.S. Department of Agriculture's Pomological Bulletin in 1887. Subsequently, seeds were brought into the United States on various occasions. In 1914, the Office of Foreign Seed and Plant Introduction received seeds from the Costa Rican National Museum, San José (P.I. #39357). Mr. Ramon Arias-Feraud supplied seeds from Panama in 1918 (P.I. #46236). In July, 1919, seeds from Laguna, Philippines, were sent by the Bureau of Agriculture, Manila (P.I. #47516). More seeds from Costa Rica were presented by Mr. Carlos Werckle in October, 1919 (P.I. #47956). Seeds of a superior selection were obtained and planted at the Federal Experiment Station, Mayaguez, Puerto Rico, in 1939.

Despite the favorable comments that accompanied these and other introductions, the sapote was represented by only a few scattered trees in southern Florida for a long time. One of the discouraging factors was the tree's slowness in coming into bearing. William J. Krome, a leading pioneer, planted a seedling on his property in Homestead in 1907 and it bore its first fruits in 1949, after having suffered repeated setbacks from freezes and hurricanes over the years, and it was then only 18 ft (5 1/2 m) high. Other trees in more protected locations had fared much better.

The arrival of many Cubans in Dade County during the past 2 decades has created an active demand for the fruits and for the trees for home planting, and some commercial orchards of 5 to 20 acres (2-8 1/3 ha) or more have been established. In 1983, one man with 15 trees in his backyard was selling the fruits to Cuban people and bringing in seedlings 5 ft (1 1/2 in) high from the Dominican Republic at \$100 each. Such enthusiasm has spurred efforts to develop practical methods of vegetative propagation and one expert propagator is now selling grafted trees at \$10.50 each, wholesale. In the fall of 1984, a nursery had acquired a stock of 1,000 of these trees and one customer bought them all. Thus has the status of the sapote risen dramatically in southern Florida because of an ethnic change in the population.

Varieties

There is much seedling variation in the sapote. Superior selections have been made in Cuba, Central America and in Florida in recent years. The following named cultivars are being cultivated domestically or commercially, or merely being tested in Florida:

'AREC No. 3'—Seed received from Isle of Pines, Cuba, 1940. Seedling grown at AREC, Homestead. Grafted trees planted later. Fruit medium to large, 14 to 26 oz (400-740 g). Flesh pink; of poor to good quality; contains 3-4 seeds. Ripens July-Sept. Tree of medium size, a fair bearer; probably useful source of seeds for rootstocks.

'Cayo Hueso'—A selection from the Dominican Republic; favored by Cubans.

'Chenox'—Obtained by Lawrence Zill from Belize. Grafted trees being tested at AREC, Homestead, and elsewhere.

'Copan' ('AREC No. 1')—Seed received from Cuba in 1938. Seedling set out in field at AREC, Homestead, 1940. Grafted trees planted out in 1975; later propagated by nurseries. Fruit of medium size; 15-32 oz (425-900 g). Flesh red, of excellent quality; contains 1 seed. Fruit ripens in July-Aug. Tree is of spreading habit and medium in size. Leaves turn red in Dec., then become brown and are shed in spring.

'Cuban No. 1'—Believed to have originated in Cuba but introduced from El Salvador. Fruit large; 9 in (22.8 cm) long; weighs 2.2 lbs (1 kg).

'Flores'—A Guatemalan selection introduced by Tom Economou of Miami and being tested at AREC, Homestead.

'Francisco Fernandez'—A Cuban selection named for the Miami man who introduced it into Florida.

'Magana'—Introduced from El Salvador in 1961. Seedling set in field at AREC, Homestead, in 1952. Grafted trees planted in 1975. Later propagated by nurseries. Fruit large to very large; 26 to 85 oz (740-2,400 g). Flesh pink, of good to excellent quality; contains 1 seed. Fruit matures in less than 12

mos (Apr.-May). Tree is small, slow-growing; may fruit 1 yr. after planting. Bears poorly in Puerto Rico; very well in Florida. Evergreen.

'Mayapan' ('AREC No. 2')—Seed sent from Isle of Pines, Cuba, in 1940. Fruit a little above medium size; 18 to 40 oz (510-1,135 g). Skin very scurfy. Flesh red, of good quality though slightly fibrous; contains 1 seed. Tree is erect and tall. Grafted trees slow to fruit but produce well after the lapse of a few years.

'Pantin'(or 'Key West')—In 1956, Pantin family in Miami provided budwood from a seedling tree in Key West. Fruit of medium size; 14 to 40 oz (400-1,130 g). Flesh pink to red, of excellent quality, fiberless; contains 1 seed. Tree is tall. Grafted trees grow slowly at first, bear little or no fruit for 2-3 years, then growth rate increases and yield is good. Leaves become brown in winter. Grafted trees sold by nurseries.

'Progreso'—Obtained by Lawrence Zill from Belize. Grafted trees being tested at AREC, Homestead, and elsewhere.

'Tazumal'—AREC, Homestead, received seedling tree from El Salvador in 1949. Grafted and planted several trees in 1975. Fruit is of medium size, 14 to 30 oz (400-850 g). Flesh pink, of good quality; contains 1-2 seeds. First crop ripens Jan.-Feb.; second crop, July-Aug. Tree is of medium size, fast-growing, bears regularly and heavily. Grafted trees sold by nurseries. Usually evergreen. In western Puerto Rico, there are some high-yielding trees producing large fruits 2.2 lbs (1 kg) or more in weight having dark-red flesh.

Climate

The sapote tree is limited to tropical or near-tropical climates. In Central America, it flourishes from sea-level up to 2,000 ft (610 m); it is less common at 3,000 ft (914 m); and rare at 4,000 ft (1,220 m). Occasional trees have survived at 5,000 ft (1,500 m) but these grow slowly and fruit maturity is considerably delayed. Young specimens are highly cold-sensitive and the large leaves of the tree are subject to damage by cold winds. The sapote has been found too tender for California. It thrives in regions of moderate rainfall—about 70 in (178 cm) annually—and is intolerant of prolonged drought. Even a short dry spell may induce shedding of leaves.

Soil

The tree makes its best growth on the heavy soils—deep clay and clay loam—of Guatemala but it does well on a wide range of soil types, even infertile, porous sand. It was originally believed unsuited to the oolitic limestone soils of southern Florida. However, with adequate planting holes, it has proved to be long-lived and fruitful in Dade County. The tree will not thrive where there is poor drainage, a high water table, or impermeable subsoil restricting root development.

Propagation

Sapote seeds lose viability quickly and must be planted soon after removal from the fruit. They normally germinate in 2 to 4 weeks. Removal of the hard outer coat will speed germination. The seeds must be planted with the more pointed end upward and protruding 1/2 in (1.25 cm) above the soil in order to assure good form in the seedling. Rodents are attracted to the seeds and cause considerable losses in Cuba. Seedlings should be grown only in experimental plantings intended for selection of desirable characters, or for use as rootstocks. Normally seedlings will not bear until they are 8 to 10 years old and they do not necessarily come true from seed. In Cuba, seeds are taken only from esteemed trees that are isolated from those of low quality in order to avoid any detrimental influence through cross-pollination. For fruit production, the sapote is best propagated vegetatively and it will then produce fruit in 1 to 4 years, depending on the cultivar. Air-layering is seldom successful. Cuttings treated with indolebutyric acid fail to root. Various methods of grafting have been tried. Approach-grafting has been commonly practiced in Cuba and is a reliable but somewhat cumbersome technique. Chip-budding has given good results at times. Side-veneer grafting is considered most feasible in Mexico and Florida. It has been achieved with 80 to 98% success utilizing 1-yr-old defoliated trees in the February-May dry season, but still presents difficulties. Ing. Filiberto Lazo, a horticulturist of long experience in Cuba, has provided detailed instructions for tip-grafting

which he proved to be practical. The seedlings for use as rootstocks are first grown in 1-quart (.94 liter) containers and, when the first tender leaves appear, are transplanted into gallon (3.8 liter) containers and kept in semi-shade until the leaves are full-grown and dark-green. At this stage they are given more sun and are fertilized and watered faithfully. Within a year the stem will be 3/4 in (2 cm) thick and ready for grafting. An important point is to select budwood (scion) that is not as thick as the rootstock. The scion may be prepared by one of two methods: a) select from a tree that you wish to propagate a branch that has flowered; cut off the tip just below the leaves. About 10 to 12 days later the lateral buds of the beheaded branch begin to swell and this is the time to clip off the scion, 8 in (20 cm) in length, wrap it in a damp cloth, and proceed to graft as soon as possible; or b) clip off the terminal 8 in (20 cm) or more of a branch that has flowered, then immediately cut off the apex with the leaves, wrap the decapitated scion in a damp cloth and keep in the nursery until you see the lateral buds of the scion begin to swell; then proceed to graft.

The first cut in the rootstock should be a transverse one with pruning shears, leaving the stem about 1 ft (30 cm) high. Because of the copious latex, one must wait for it to drain out before going ahead. When the flow stops, take the scion (prepared either way), clip off 2 in (5 cm) or more from the base, leaving the scion about 6 in (15 cm) long. Using the budding knife, make a diagonal cut from 2 1/2 in (6.25 cm) below the tip downward, the slant terminating at the side opposite the side where it was begun. A reverse cut of the same length is made in the tip of the rootstock so that the base of the scion and the tip of the rootstock will fit together perfectly and the bark will match up. The scion must then be tightly bound to the rootstock with polyethylene ribbon, leaving no air-space, and covering all of the scion up to 2 1/2 in (6.25 cm) above the rootstock. A rubber band is put around over the polyethylene to make sure the wrapping is completely secure. When the scion has developed mature leaves, this is a sign that the graft has taken. The plastic is removed from the scion except for the part covering the graft which is left on until the scion has developed a quantity of leaves and displays distinct vigor. The grafted plant is ready to set out in the field one year later. Inferior cultivars, or grafted trees that have been frozen back, can be topworked by veneer-grafting mature or "juvenile-like" scions onto interstocks (seedling tops prepared for the purpose).

Spacing

Planting distances may vary with the fertility of the soil and the form and growth habit of the cultivar. On rich soil, sapote trees of spreading habit should be no less than 30 ft (9 m) apart each way. Lazo preferred a spacing of 40 ft (12 m) on an equilateral triangle. Where the soil is less fertile and the cultivar is fairly compact, the distance may be reduced to 25 ft (7.5 m).

Culture

Sapote trees do not require elaborate care, but should be given the advantage of adequate holes, pre-enriched, and routine fertilizer applications, at first high in nitrogen to stimulate vegetative growth. When nearing fruiting age, the tree will benefit from applications of a balanced fertilizer in spring and fall, the amount increasing each year. In dry seasons, frequent watering is desirable until the tree is well established. Grafted trees grow more slowly than seedlings and do not grow as tall, which is a distinct advantage in harvesting.

Harvesting and Yield

It is not easy to determine when the sapote is sufficiently mature to harvest. Some say the fruits are picked when they show a reddish tinge. Actually, in Cuba, 10 or 12 fruits from each tree are sampled by removing a small part of the rind and judging the color of the flesh. If it has achieved maximum color for that particular cultivar, the entire crop is deemed ready to pick. Fruits are not harvested from trees in active vegetative growth (a state called "primavera"), because they will never ripen completely. Harvesting of large trees requires a picking pole with a cutter and a basket to catch the fruits; or workers must use ladders and twist the fruit until the stem breaks. Trees that become too tall may be topped so that the crop will be within reach. After picking, the stem is close-clipped and the fruits are packed in boxes or baskets to avoid injury. There are no available figures on productivity but it is said in Cuba that trees on fertile soil will live for at least 100 years and bear abundantly throughout their lives.

Keeping Quality

A fully mature sapote will ripen in a few days. If shipped right after picking, the fruits can be sent to distant markets. In the past, they were exported from Mexico and Cuba to the United States.

Pests and Diseases

Sapote leaves and roots are attacked by the West Indian sugar cane root borer, *Diaprepes abbreviatus*, in Puerto Rico. The red spider mite, *Tetranychus bimaculatus*, may infest the leaves. The fungus, *Colletotrichum gloeosporioides*, causes anthracnose on the leaves and fruit stalks in rainy seasons and causes fruits to fall prematurely. Leafspot resulting from attack by the fungus *Phyllosticta sapotae* occurs in Cuba and the Bahamas but seldom in Puerto Rico. In addition, black leaf spot (*Phyllachora sp.*) and root rot (*Pythium sp.*) may occur in Florida.

Food Uses

The sapote is credited with sustaining Cortez and his army in their historic march from Mexico City to Honduras. The fruit is of such importance to the Indians of Central America and Mexico that they usually leave this tree standing when clearing land for coffee plantations or other purposes. They generally eat the fruit out-of-hand or spooned from the half-shell. In urban areas, the pulp is made into jam or frozen as sherbet. In Cuba, fibrous types are set aside for processing.

A prominent dairy in Miami has for many years imported sapote pulp from Central America to prepare and distribute commercially as "Spanish sherbet". In Cuba, a thick preserve called "*crema de mamey colorado*" is very popular. The pulp is sometimes employed as a filler in making guava cheese.

The decorticated seeds, called *zapoyotas*, *sapuyules*, or *sapuyulos*, strung on sticks or cords, are marketed in the Isthmus of Tehuantepec, Mexico, and in Central America. The kernel is boiled, roasted and mixed with cacao in making chocolate—some say to improve the flavor, others say to increase the bulk, in which case it is actually an adulterant. In Costa Rica, it is finely ground and made into a special confection. Around Oaxaca, in southern Mexico, the ground-up kernel is mixed with parched corn, or cornmeal, sugar and cinnamon and prepared as a nutritious beverage called "pozol".

Food value per 100 g of edible portion*

Calories	114.5
Moisture	55.3-73.1 g
Protein	0.188-1.97 g
Fat	0.09-0.25 g
Carbohydrates	1.41-29.7 g
Fiber	1.21-3.20 g
Ash	0.89-1.32 g
Calcium	28.2-121.0 mg
Phosphorus	22.9-33.1 mg
Iron	0.52-2.62 mg
Carotene	0.045-0.665 mg
Thiamine	0.002-0.025 mg
Riboflavin	0.006-0.046 mg
Niacin	1.574-2.580 mg
Ascorbic Acid	8.8-40.0 mg
<i>Amino Acids:</i>	
Tryptophan	19 mg
Methionine	12 mg
Lysine	90 mg
*Analyses made in Cuba and Central America.	

Toxicity

De la Maza, in 1893, reported that the seed has stupefying properties, and this may be due to its HCN content. One is cautioned not to rub the eyes after handling the green fruit because of the sap

exuding from the cut or broken stalk. The milky sap of the tree is highly irritant to the eyes and caustic and vesicant on the skin. The leaves are reportedly poisonous.

Other Uses

Seeds: Early in the 19th Century, the seeds were used in Costa Rica to iron starched fine linen. The seed kernel yields 45 to 60% of a white, semi-solid, vaseline-like oil which is edible when freshly extracted and refined. It is sometimes used in soap and considered to have a greater potential in the soap industry, in cosmetics and pharmaceutical products. It was used in olden times to fix the colors on painted gourds and other articles of handicraft. The seeds have served as a source of Noyeau scent in perfumery. The nectar of the flowers is gathered by honeybees.

Trees: The trees are seldom cut for timber, unless they bear poor quality fruit. There is very little sapwood. The heartwood is buff or brown when fresh, becoming reddish with age; sometimes resembles mahogany but is redder and more or less mottled with darker tones. It is fine-grained, compact, generally hard and fairly heavy, strong, easy to work and fairly durable. It is rated as suitable for cabinetwork and is made into furniture, but mostly serves for building carts, and for shelving and house frames.

Medicinal Uses: In Santo Domingo, the seed kernel oil is used as a skin ointment and as a hair dressing believed to stop falling hair. In Mexico, 2 or 3 pulverized kernels are combined with 10 oz (300 g) castor oil for application to the hair. In 1970, clinical tests at the University of California at Los Angeles failed to reveal any hair-growth promoting activity but confirmed that the oil of sapote seed is effective in stopping hair-fall caused by seborrheic dermatitis. The oil is employed as a sedative in eye and ear ailments. The seed residue after oil extraction is applied as a poultice on painful skin afflictions.

A seed infusion is used as an eyewash in Cuba. In Mexico, the pulverized seed coat is reported to be a remedy for coronary trouble and, taken with wine, is said to be helpful against kidney stones and rheumatism. The Aztecs employed it against epilepsy. The seed kernel is regarded as a digestive; the oil is said to be diuretic. The bark is bitter and astringent and contains lucumin, a cyanogenic glycoside. A decoction of the bark is taken as a pectoral. In Costa Rica a "tea" of the bark and leaves is administered in arteriosclerosis and hypertension. The milky sap is emetic and anthelmintic and has been used to remove warts and fungal growths on the skin.

Related Species

The **green sapote**, *Pouteria viridis* Cronq., (syns. *Calocarpum viride* Pitt.; *Achradelphia viridis* O.F. Cook), is called *injerto*, *injerto verde* or *raxtul* in Guatemala; *zapote injerto* in Costa Rica; white faisan or red faisan in Belize. The tree is erect, to 40 or even 80 ft (12-24 m) in height, its young branches densely brown-hairy. It possesses an abundance of white, gummy latex. The leaves are clustered at the tips of flowering branches and irregularly alternate along non-fruiting limbs. They are oblanceolate, pointed, 4 to 10 in (10-25 cm) long, 2 to 2 3/4 in (5-7 cm) wide; hairy on the upper midrib and downy-white beneath. Flowers, borne in groups of 2 to 5 in the leaf axils and massed along leafless branches, are tubular, 5-lobed, pinkish or ivory and silky-hairy. The fruit varies from nearly round to ovoid, pointed at the apex and sometimes at the base; may be 3 1/2 to 5 in (9-12.5 cm) long and 2 1/2 to 3 in (6.25-7.5 cm) thick, with thin, olive-green or yellow-green skin dotted with red-brown and clinging tightly to the flesh. The flesh is light-russet, of fine texture, melting, fairly juicy and sweet; of better flavor than the sapote. There may be 1 or 2 dark-brown, shiny, elliptic or ovate seeds to 2 in (5 cm) long, with a large, dull, grayish hilum on one surface. The fruit is picked while hard and held until soft. The flesh is generally eaten raw, spooned from the skin, but a preserve is made from it in Guatemala.

The tree is native and common in the wild in Guatemala and Honduras; rarer in Costa Rica and southward to Panama; at elevations between 3,000 and 7,000 ft (900-2,100 in). The fruits are commonly marketed.

In 1916, 50 seeds from fruits on the market in Guatemala were introduced by the United States Department of Agriculture (S.P.I. #43788). Experimental plantings were made in California and Florida. More seeds were sent by Dr. Wilson Popenoe from the Lancetilla Experimental Garden at

Tela, Honduras, in 1929 (S.P.I. #80383). Other introductions followed. There were no survivors in California or Florida in 1940. Trees 8 to 10 ft (2.4-3 m) high at the Agricultural Research and Education Center, Homestead, Florida, were killed by a flood in 1948. A private experimenter, William Whitman, obtained budwood from Honduras in 1954 and grafted it onto sapote rootstock. Other such grafts were made by a commercial fruit grower and the first fruits were borne in 1961. Subsequently, grafted trees were offered for sale by the Brooks-Tower Nursery and various seedlings have been distributed to private growers. The tree seems to flourish with little care on rich hammock soil but needs regular fertilizing on limestone. The Cuban May beetle feeds on the leaves. Seedlings begin to bear when 8 to 10 years old. The crop ripens in fall and winter.

Food value per 100 g of edible portion*

Moisture	68.1-69.5 g
Protein	0.152-0.283 g
Fat	0.24-0.28 g
Fiber	1.2-1.6 g
Ash	0.69-1.38 g
Calcium	18.6-35.7 mg
Phosphorus	22.1-23.6 mg
Iron	0.57-0.74 mg
Carotene	0.031-0.069 mg
Thiamine	0.009-0.017 mg
Riboflavin	0.027 mg
Niacin	1.88-1.189 mg
Ascorbic Acid	49.9-62.3 mg
*Analyses made in Guatemala.	

The latex (chicle) has been commercially collected and marketed like that from the sapodilla for use in chewing gum. The wood is reddish, fine-grained, compact, strong, durable; occasionally used in construction, carpentry, turnery, and for furniture and paneling in Guatemala.

D.5 White Sapote
***Casimiroa edulis* Llave.**

The genus *Casimiroa* of the family Rutaceae was named in honor of Cardinal Casimiro Gomez de Ortega, a Spanish botanist of the 18th Century*. It embraces 5 or 6 species of shrubs or trees. Of these, 3 shrubby species, *C. pubescens* Ramirez, *C. pringlei* Engl. and *C. watsonii* Engl., are apparently confined to Mexico and have received scant attention. An additional species, *C. emarginata* Standl. & Steyerl., was described in 1944, based on a single specimen in Guatemala. It may be merely a form of *C. sapota*, below.

[*The genus *Casimiroa* was actually named after Casimiro Gomez, an Otome Indian from the town of Cardonal, Hidalgo, Mexico, a martyr of Mexico's war of independence.]

Of the 3 larger-growing forms, the best known is the common white sapote, called *zapote blanco* by Spanish-speaking people, *abché* or *ahache* by Guatemalan Indians, and Mexican apple in South Africa, and widely identified as *C. edulis* Llave & Lex. The *matasano* (or *matazano*), *C. sapota* Oerst., is often not distinguished from *C. edulis* in the literature and the name *matasano* has been applied to other species in various localities. The woolly-leaved white sapote, known to the Maya as *yuy* and set apart in Guatemala as *matasano de mico*, has been commonly considered a distinct species, *C. tetrameria* Millsp., but it may be only a variant of *C. edulis*.

Description

White sapote trees range from 15 to 20 ft (4.5-6 m) up to 30 to 60 ft (9-18 m) in height. They have light-gray, thick, warty bark and often develop long, drooping branches. The leaves, mostly evergreen are alternate, palmately compound, with 3 to 7 lanceolate leaflets, smooth or hairy on the underside. The odorless flowers, small and greenish-yellow, are 4- or 5-parted, and borne in terminal and axillary panicles. They are hermaphrodite or occasionally unisexual because of aborted stigmas.

The fruit is round, oval or ovoid, symmetrical or irregular, more or less distinctly 5-lobed; 2 1/2 to 4 1/2 in (6.25-11.25 cm) wide and up to 4 3/4 in (12 cm) in length; with thin green, yellowish or golden skin coated with a very thin bloom, tender but inedible; and creamy-white or yellow flesh glistening with many tiny, conspicuous, yellow oil glands. The flavor is sweet with a hint or more of bitterness and sometimes distinctly resinous. There may be 1 to 6 plump, oval, hard, white seeds, 1 to 2 in (2.5-5 cm) long and 1/2 to 1 in (1.25-2.5 cm) thick, but often some seeds are under-developed (aborted) and very thin. The kernels are bitter and narcotic.

C. edulis has leaves that are usually composed of 5 leaflets, glabrous to slightly pubescent on the underside, and 5-parted flowers. The fruit is somewhat apple-like externally, generally smooth, fairly symmetrical and 2 1/2 to 3 in (6.25-7.5 cm) wide. *C. sapota* is very similar but the leaves usually have only 3, somewhat smaller, leaflets. The woolly-leaved white sapote usually has 5 leaflets, larger and thicker than those of *C. edulis* and velvety-white on the underside, and all the parts of the flowers are in 4's. The fruits are usually 4 to 4 1/2 in (10-11.25 cm) wide, ovoid, irregular and knobby, with rough, pitted skin, and there are often gritty particles in the flesh.

Origin and Distribution

The common white sapote occurs both wild and cultivated in central Mexico. It is planted frequently in Guatemala, El Salvador and Costa Rica and is occasionally grown in northern South America, the Bahamas, West Indies, along the Riviera and other parts of the Mediterranean region, India and the East Indies. It is grown commercially in the Gisborne district of New Zealand and to some extent in South Africa. Horticulturists in Israel took serious interest in white sapotes around 1935 and planted a number of varieties. The trees grew well and produced little in the coastal plain; bore good crops in the interior and commercial prospects seemed bright but the fruit did not appeal to consumers and was too attractive to fruit flies. White sapotes have not done well in the Philippines. The common species was introduced into California by Franciscan monks about 1810, and it is still cultivated on a limited scale in the southern part of that state. In Florida, it was first planted with enthusiasm. Today it is seldom seen outside of fruit tree collections. Of course, many of the trees planted have been seedlings bearing fruits of inferior size and quality, but even the best have never attained popularity in this country.

C. sapota is wild in southern Mexico and Nicaragua, commonly cultivated in Oaxaca and Chiapas. The woolly-leaved white sapote is native from Yucatan to Costa Rica and has not been widely distributed in cultivation. According to Chandler, the fruits are objectionably bitter in California. In southern Florida, the woolly-leaved is sometimes planted in preference to *C. edulis*.

White sapote trees often are grown strictly as ornamentals in California. They are planted as shade for coffee plantations in Central America.

Varieties

Clonal selections were made in California from about 1924 to 1954, and several also in Florida. Some of these may actually be chance hybrids. A surprising number have been named and propagated: 'Blumenthal', 'Chapman', 'Coleman', 'Dade', 'Flournoy', 'Galloway', 'Gillespie', 'Golden' or 'Max Golden', 'Johnston's Golden', 'Harvey', 'Lenz', 'Lomita', 'Maechtlen', 'Maltby' or 'Nancy Maltby', 'Nies', 'Page', 'Parroquia', 'Pike', 'Sarah Jones', 'Suebelle', or 'Hubbell', 'Walton', 'Whatley', 'Wilson', 'Wood', 'Yellow'.

'**Coleman**'—was one of the first named in California; fruit is oblate, somewhat lobed, furrowed at apex; to 3 in (7.5 cm) wide; skin is yellow-green; flesh of good flavor (22% sugar) but resinous; seeds small. Fruit ripens from late fall to summer. Tree somewhat dwarf; leaflets small and tend to twist. Difficult to propagate.

'**Dade**'—grown at the Agricultural Research and Education Center, Homestead, Florida from a seed of a selected fruit of a local seedling tree. It was planted in 1935 and fruited in 1939. Round; skin golden-yellow tinged with green, thin; flesh of good, non-bitter flavor. There are 4 to 5 seeds. Ripens in June-July. The tree is low-growing and spreading, with smooth leaflets.

'Gillespie'—originated in California; fruit is round, 3 in (7.5 cm) wide; skin is light-green with russet cheek, fairly tough, rough; flesh is white, of very good flavor. Tree is prolific bearer.

'Golden', or 'Max Golden'—woolly-leaved; fruit conical, depressed at apex; up to 4 1/2 in (11.25 cm) wide; skin yellow-green, fairly tough; flesh has strong flavor, somewhat bitter; few seeds.

'Harvey'—originated in California; round; 3 1/2 in (9 cm) wide; skin smooth, yellow-green with bright orange cheek; flesh cream-colored to pale-yellow; not of the best flavor. Tree is a prolific bearer.

'Maechtlen'—named for the parent, an old tree on property owned by the Maechtlen family in Covina, California. Propagated by budding and sold by nurserymen in the 1940's.

'Maltby', or 'Nancy Maltby'—originated in California; round, faintly furrowed, blunt-pointed at apex, base slightly tapered; large; skin yellow-green, smooth, of good flavor but slightly bitter. Tree bears well.

'Parroquia'—originated in California; oval, 2 1/2 in (6.25 cm) wide, 3 in (7.5 cm) long; skin yellow-green, smooth, thin; flesh ivory, of very good flavor. A fairly prolific bearer.

'Pike'—originated in California; rounded or oblate, slightly 5-lobed; to 4 in (10 cm) wide; skin green, very fragile; flesh white to yellowish, of rich, non-bitter, flavor. The tree bears regularly and heavily in California and South Africa.

'Suebelle', or 'Hubbell'—originated in California; round; medium to small; skin green or yellowish-green; of excellent flavor (22% sugar). Tree is precocious and blooms and fruits all year. Fairly widely planted in California.

'Wilson'—originated in California; round to oblate; medium to large; skin smooth, medium thick; flesh of high quality and excellent flavor. Fruit ripens in fall and winter or more or less all year. Tree bears heavily and has been rather widely planted in California.

'Yellow'—originated in California; oval with pointed apex, furrowed; skin is bright-yellow and fairly tough; flesh is firm. Fruit keeps well. Tree bears regularly and heavily in California.

Pollination

There is a great variation in the amount of pollen produced by seedlings and grafted cultivars. Some flowers bear no pollen grains; others have an abundance. Sterile pollen or lack of cross-pollination are suggested causes of aborted seeds and heavy shedding of immature fruits. In Florida, flowers of some heavy-bearing, double-cropping, trees have been observed so heavily worked by bees that their humming is heard several feet away.

Climate

The white sapotes can be classed as subtropical rather than tropical. *C. edulis* is usually found growing naturally at elevations between 2,000 and 3,000 ft (600-900 m) and occasionally in Guatemala up to a maximum of 9,000 ft (2,700 m) in areas not subject to heavy rainfall.

In California, light frosts cause some leaf shedding but otherwise do not harm the tree. Mature trees have withstood temperature drops to 20° F (-6.67° C) in California and 26° F (-3.33° C) in Florida without injury.

The trees prosper near the coast of southern California where the mean temperature from April to October is about 65° F (18° C). They do poorly and often fail to survive further north near San Francisco where the mean temperature for the same period is 57° to 58° F (13.89°-14.44° C). The woolly-leaved is somewhat less hardy than the common white sapote.

Soil

As long as there is good drainage, the trees will do very well on sandy loam or even on clay. In California, some of the early plantings were on light, decomposed granite soil, and they were fruitful for many years. In Florida, the trees grow and fruit well on deep sand and on oolitic limestone, though, on the latter, they may become chlorotic. They are fairly drought-resistant.

Propagation

White sapotes are commonly grown from seeds and seedlings usually begin to bear in 7 or 8 years. Grafting is a common practice in California and Florida in midsummer. Seedlings of 'Pike', being vigorous growers, are preferred as rootstock. Shield-budding and side-grafting in spring onto stocks up to 3/4 in (2 cm) thick give good results. Cleft grafts and slot grafts are made on larger rootstocks and when topworking mature trees. Grafted trees will start bearing in 3 or 4 years. Commercial growers in New Zealand have had success with air-layers. Cuttings are very difficult to root.

Culture

In California, the young trees are cut back to 3 ft (0.9 m) when planted out, in order to encourage low-branching. As the branches elongate, some pruning is done to induce lateral growth.

Fertilizer formulas should vary with the nature of the soil, but, in general, the grower is advised to follow procedures suitable for citrus trees. Many white sapote trees have received little or no care and yet have been long-lived. One of the original trees in Santa Barbara, California, was said to be over 100 years old in 1915.

Season

In the Bahamas, the fruits ripen from late May through August. In Mexico, flowering occurs in January and February and the fruits mature from June to October. In Florida there is usually just a spring-summer crop, but a heavy-bearing woolly-leaved tree in Miami blooms in December, fruits in the spring, blooms again and produces a second crop in the fall. In California, 'Pike' and 'Yellow' bloom in the spring and again in late summer and fall, the fruits from late blooms maturing gradually over the winter. 'Suebelle' blooms for 6 to 8 weeks in spring and again in midsummer and fruits ripen in September and October.

Harvesting

Mature fruits must be clipped from the branches leaving a short piece of stem attached. This stub will fall off naturally when the fruits become eating-ripe. If plucked by hand, the fruits will separate from the stem if given a slight twist but they will soon show a soft bruised spot at the stem-end which quickly spreads over much of the fruit, becoming watery and decayed. The fruits must be handled with care even when unripe as they bruise so easily and any bruised skin will blacken and the flesh beneath turns bitter. If picked just a few days before fully ripe and ready to fall, the fruits turn soft quickly but they can be picked several weeks in advance of the falling stage and most will develop full flavor. 'Pike', however, if picked a month early, will take 2 weeks to ripen and will be substandard in flavor. Fruits that have ripened on hand will keep in good condition in the home refrigerator for at least 2 weeks. Fruits from commercial orchards are graded for size, wrapped individually to retard full ripening, packed in wooden boxes, and well-padded for transportation under refrigeration.

Pests and Diseases

The white sapote has few natural enemies but the fruits of some cultivars are attacked by fruit flies. Black scale often occurs on nursery stock and occasionally on mature trees in California.

Food Uses

Within its native range, the white sapote is commonly eaten out-of-hand. The flesh of ripe fruits may be added to fruit cups and salads or served alone as dessert, but it is best cut into sections and served with cream and sugar. Sometimes it is added to ice cream mix or milk shakes, or made into marmalade. Even in their countries of origin, where the fruits may at times appear in markets, their repute is due largely to a belief in their therapeutic value, while, at the same time, there prevails a fear that over-indulgence may be harmful. The epithet "matasano" (interpreted as "kill health") has a

sinister connotation. Dr. J.B. Londoño, in his *Frutas de Antioquia*, published in Medellin, Colombia, in 1934, referred to the white sapote as disagreeable and indigestible. Some years ago in Central America there were unsuccessful efforts to manufacture from the pulp an acceptable preserve. In processing trials at the Western Regional Research Laboratory of the United States Department of Agriculture, Albany, California, technologists decided that white sapotes; are not suitable for either canning in sirup or freezing as a puree.

Food value per 100 g of fresh pulp*

Moisture	78.3 g
Protein	0.143 g
Fat	0.03 g
Fiber	0.9g
Ash	0.48g
Calcium	9.9 mg
Phosphorus	20.4 mg
Iron	0.33 mg
Carotene	0.053 mg
Thiamine	0.042 mg
Riboflavin	0.043 mg
Niacin	0.472 mg
Ascorbic Acid	30.3 mg
*According to analyses made in El Salvador.	

As bearers of edible fruits, the white sapotes, despite their prolificacy, will doubtless continue to occupy the minor position which they now hold in subtropical horticulture.

Toxicity

The seed is said to be fatally toxic if eaten raw by humans or animals.

Other Uses

Seeds: In 1959, Dr. Everette Burdick, Consulting Chemist, of Coral Gables, Florida, made several extractions from the kernels, securing small amounts of needle-like yellow crystals. From one process, a yellow resinous mass resulted which functioned as an attractive and lethal bait for American cockroaches, having the advantage of killing on the spot rather than at some distance after ingestion of the poison. The United States Department of Agriculture's Agricultural Handbook 154, *Insecticides from Plants*, mentions no experiments with *Casimiroa* seed extracts but reports that extracts from branches and leaves of *C. edulis* are non-toxic to both American and German roaches.

Wood: The wood is yellow, fine-grained, compact, moderately dense and heavy, medium strong and resistant, but not durable for long. It is occasionally employed in carpentry and for domestic furniture in Central America.

Medicinal Uses: The ancient Nahuatl name for the fruits, "cochitzapotl", is translated "sleepy sapote" or "sleep-producing sapote", and it is widely claimed in Mexico and Central America that consumption of the fruit relieves the pains of arthritis and rheumatism. This belief may stem only from the oft-quoted statement to this effect by Dr. Leopoldo Flores in *Manual Terapeutica de Plantas Mexicanas*, published in 1907, although the Mexican National Commission has received frequent reports of anti-arthritic, anti-rheumatic effects from physicians and their patients.

The eminent Francisco Hernandez, in his writings during the period 1570-1575 (translated and published as *Rerum Medicarum Novae Hispaniae* in 1651), noted that eating the fruit produced drowsiness. He referred to the seeds as "deadly poison" but efficacious, when crushed and roasted, in healing putrid sores. This vulnerary use of the seeds is cited in the obsolete *Farmacopea Mexicana*, where the fruit is mentioned as a vermifuge. For many years, extracts from the leaves, bark, and especially the seeds have been employed in Mexico as sedatives, soporifics and tranquilizers.

The narcotic property of the seeds was first identified as an alkaloid by Dr. Jesus Sanchez of Mexico in his thesis, *Breve estudio sobre la almendra del zapote blanco*, in 1893; and, in 1898, it was made the subject of chemical study by an especially appointed commission. One of the investigators, Alfonso Altimirano, reported the isolation of a glucoside as a pale yellow, amorphous mass, at first sweet but with a prolonged bitter aftertaste. White sapote derivatives were among the medicinal plant products displayed at the St. Louis Exposition in 1904 and explained in the slender book, *Materia Medica Mexicana: A Manual of Mexican Medicinal Herbs*, prepared by the Mexican National Commission for that occasion.

In 1900, a quantity of white sapote seeds was sent from Mexico to F.H. Worlee & Co., in Hamburg, Germany, with an accompanying explanation that both the fruit and the seeds possessed sleep-inducing principles but without the undesirable after-effects of opium. This material came to the attention of W. Bickern. He proceeded to work on the seeds, from which he obtained a substance which he called an alkaloidal glycoside, *casimirin*. In France, several investigators confirmed the narcotic nature of the seeds. Subsequently, Frederick Power and Thomas Callan of the Wellcome Chemical Research Laboratories in London, declared that, though they isolated 6 substances including 2 alkaloids, *casimiroine* and *casimiroedine*, there was "no evidence of the presence of a definite glucoside or a so-called glucoalkaloid ...and physiological tests conducted with animals ...likewise failed to confirm . . . reported hypnotic or toxic properties." Meanwhile, the seed extracts, in liquid, capsule, or tablet form, continued in use in Mexico, one product bearing the trade name "Rutelina".

In 1934, José de Lille proceeded to test the effect on blood pressure of dogs. He found a dose of .20 g per kilo of animal weight to be definitely hypotensive. A large dose (1 g) administered to a dog weighing 11 lbs (5 kg) produced a drastic lowering of blood pressure which persisted even after a brief rise induced by injecting adrenalin. In 1936, M. Mendez described the preparation of a tincture of "a clear yellow color with neither special odor nor taste" which produces "a state of depression in the entire nervous system, especially in the sensory sphere, and sleep." Dr. Faustino Miranda reported that an infusion of the leaves of *Casimiroa sapota* is used for similar purposes, and he assumed that this species has the same properties as *C. edulis*. According to *Materia Medica Mexicana*, the extracts from the leaves and bark are half as strong as those from the seeds and can be safely administered to children. In Costa Rica, the leaf decoction is taken as a treatment for diabetes.

In 1956, four chemists, F. Kinel, J. Rosso, O. Rosenkranz and F. Sondheimer, on the staff of the Mexican branch of the pharmaceutical company, Syntex, undertook chemical studies of the seeds. They did not find the "gluco-alkaloid" *casimirin*, but isolated 13 substances, 6 of which coincided with those reported by Power and Callan. One of these, *casimiroolid*, was later found by F. Sondheimer, A. Meisels and F. Kinel, to be identical with *obacunone*, an attribute of citrus oil. Of the 7 additional compounds, one *palmitamide*, had not previously been noted in the plant kingdom. Another, *N-benzoyltyramine*, they suggested might have much to do with the reputed potency of the seed, for *tyramine* is one of the active principles of ergot (is also found in mistletoe and thistle) and is well known for its physiological action. The main alkaloid of the seeds, *casimiroedine*, representing 0.143%, was crystallized in the form of needles.

Investigations of the bark from the trunk and roots of *C. edulis* were undertaken for Syntex by J. Iriarte, F. Kinel, O. Rosenkranz and F. Sondheimer. No *casimiroedine* was found but 12 substances were identified, only 2 of which, *zapotin* and *casimiroin*, occur in the seeds. The root bark contained .22% of the latter, while the seeds yielded only 0.0076%. In 1957, Meisels and Sondheimer announced that one of the bark alkaloids, *edulein*, which they had considered new, is identical with an alkaloid found in the bark and leaves of *Lunaria amara* Blanco, a citrus relative of Malayan origin. In 1958, R.T. Major and F. Dürsch, of the Cobb Chemical Laboratory, University of Virginia, working under a grant from Merck & Co., isolated from *C. edulis* seeds a compound which they identified as *N^β, N^β-dimethylhistamine*, formerly found in nature only in the sponge, *Geodia gigas*. J.S.L. Ling, S.Y. P'an and F.A. Hockstein, of Chas. Pfizer & Co. Research Laboratories, Brooklyn, New York, in experimental work with this compound in rabbits, dogs and cats, observed strong vasodepressive action. Dr. Hockstein suggested that all of the hypotensive properties and at least part of the sedative and pain-relieving qualities could be attributed to this compound, which "is not considered acceptable in man".

In early July of 1960, the writer furnished approximately 2 bushels of largely overripe, fallen fruits of *C. edulis* and the woolly-leaved white sapote to Delta Pharmaceuticals of Hialeah, Florida. They readily extracted from the seeds a soporific substance, 50 mg of which, taken by humans, induced sound sleep within 2 hours, with no apparent ill effects. The extract also acted as a narcotic on goldfish.

The following statement (translated from Spanish) is made in a communication received in 1961 from the Sección Administrativa, Dirección de Control de Medicamentos, Secretaría de Salubridad y Asistencia, Mexico City: "In Mexico, the white sapote is not used other than in folk medicine and not in any way by pharmacists nor doctors; neither is it an official drug in the Pharmacopoeia".

In India, extensive studies have been made of the seeds, roots and bark, which contain histamine derivatives with strong hypotensive activity, as well as furoquinoline alkaloids and 2-quinolones and 4-quinolones, including *edulein*, *edulitin*, *edulinine* and *casimiroin*. Also present are coumarins, flavonoids, and limonoids, including *zapoterin*, *zapotin*, *zapotinin*, *casimiroid*, *deacetylominilin*, and 7-*o-bacunol*. Leaves and twigs yield *isoplimpelinin* (diuretic) and *n-hentriacontane* (anti-inflammatory).

D.6 Sapote, Green

Injerto

C. viride Pettier

The white sapote tree is a large - up to 80 feet - tropical evergreen with leaves up to 12 inches long by 4 inches wide. Fruits are ovoid or elliptical, 3 to 6 inches long, with usually one large seed. The fruit peel is thin, scurfy and roughened. Flesh is red or reddish brown, firm and somewhat granular, with a rich, sweet flavor.

The green sapote tree is similar to the white, but with smaller leaves. Fruits are similar in size and other characteristics to the white sapote.

Season, bloom to maturity: 6 to 8 months.

Production in U. S.: No data. Dooryard trees only.

Use: Fresh eating, preserves.

D.7 Sapodilla

Manilkara zapota van Royen

Manilkara achras Fosb.

Manilkara zapotilla Gilly

One of the most interesting and desirable of all tropical fruit trees, the sapodilla, a member of the family Sapotaceae, is now known botanically as *Manilkara zapota* van Royen (syns. *M. achras* Fosb., *M. zapotilla* Gilly; *Achras zapota* L., *A. zapota* L.; *Sapota achras* Mill.).

Among numerous vernacular names, some of the most common are: *baramasi* (Bengal and Bihar, India); *buah chiku* (Malaya); *chicle* (Mexico); *chico* (Philippines, Guatemala, Mexico); *chicozapote* (Guatemala, Mexico, Venezuela); *chikoo* (India); *chiku* (Malaya, India); dilly (Bahamas; British West Indies); *korob* (Costa Rica); *mespil* (Virgin Islands); *mispel*, *mispu* (Netherlands Antilles, Surinam); *muy* (Guatemala); *muyozapot* (El Salvador); naseberry (Jamaica; British West Indies); neeseberry (British West Indies); *nispero* (Puerto Rico, Central America, Venezuela); *nispero quitense* (Ecuador); sapodilla plum (India); *sapota* (India); *sapotí* (Brazil); *sapotille* (French West Indies); tree potato (India); *Ya* (Guatemala; Yucatan); *zapota* (Venezuela); *zapote* (Cuba); *zapote chico* (Mexico; Guatemala); *zapote morado* (Belize); *zapotillo* (Mexico).

Description

The sapodilla is a fairly slow-growing, long-lived tree, upright and elegant, distinctly pyramidal when young; to 60 ft (18 m) high in the open but reaching 100 ft (30 m) when crowded in a forest. It is strong and wind-resistant, rich in white, gummy latex. Its leaves are highly ornamental, evergreen, glossy, alternate, spirally clustered at the tips of the forked twigs; elliptic, pointed at both ends, firm, 3

to 4 1/2 in (7.5-11.25 cm) long and 1 to 1 1/2 in (2.5-4 cm) wide. Flowers are small and bell-like, with 3 brown-hairy outer sepals and 3 inner sepals enclosing the pale-green corolla and 6 stamens. They are borne on slender stalks at the leaf bases. The fruit may be nearly round, oblate, oval, ellipsoidal, or conical; varies from 2 to 4 in (5-10 cm) in width. When immature it is hard, gummy and very astringent. Though smooth-skinned it is coated with a sandy brown scurf until fully ripe. The flesh ranges in color from yellowish to light- or dark-brown or sometimes reddish-brown; may be coarse and somewhat grainy or smooth; becomes soft and very juicy, with a sweet flavor resembling that of a pear. Some fruits are seedless, but normally there may be from 3 to 12 seeds which are easily removed as they are loosely held in a whorl of slots in the center of the fruit. They are brown or black, with one white margin; hard, glossy; long-oval, flat, with usually a distinct curved hook on one margin; and about 1/4 in (2 cm) long.

Origin and Distribution

The sapodilla is believed native to Yucatan and possibly other nearby parts of southern Mexico, as well as northern Belize and Northeastern Guatemala. In this region there were once 100,000,000 trees. The species is found in forests throughout Central America where it has apparently been cultivated since ancient times. It was introduced long ago throughout tropical America and the West Indies, the Bahamas, Bermuda, the Florida Keys and the southern part of the Florida mainland. Early in colonial times, it was carried to the Philippines and later was adopted everywhere in the Old World tropics. It reached Ceylon in 1802.

Cultivation is most extensive in coastal India (Maharashtra, Gujarat, Andhra Pradesh, Madras and Bengal States), where plantations are estimated to cover 4,942 acres (2,000 ha), while Mexico has 3,733.5 acres (1,511 ha) devoted to the production of fruit (mainly in the states of Campeche and Veracruz) and 8,192 acres (4,000 ha) primarily for extraction of chicle (see under "Other Uses") as well as many dooryard and wild trees. Commercial plantings prosper in Sri Lanka, the Philippines, the interior valleys of Palestine, as well as in various countries of South and Central America, including Venezuela and Guatemala.

Cultivars

In most areas, types are distinguished merely by shape, as 'Round' and 'Oval' in Saharanpur, India. Several named cultivars are grown for commercial or home use in western and southern India: '**Kalipatti**', small, early, high quality; '**Calcutta Special**', large, late; '**Pilipatti**', small, midseason to late; '**Bhuripatti**', small, midseason; '**Jumakhia**', small, in clusters, late; '**Mohan Gooti**', small, midseason, not very sweet; '**Kittubarti**', very small, ridged, very sweet; '**Kittubarti Big**', large, but of inferior quality; '**Cricket Ball**', very large, with crisp, granular, very sweet flesh but not distinctive in flavor; '**Dwarapudi**', similar, but not quite as big, sweet and very popular; '**Bangalore**', large, ridged, and '**Vavivalasa**' are oval and popular in the Circars but are only medium-sweet and bear poorly.

Other prominent cultivars in India are '**Jonnavalosa-I**', of medium size, pale-fleshed, sweet; '**Jonnavalosa-II**', of medium size, ridged, with yellowish-pink flesh, sweet but not agreeable in flavor; '**Jonnavalosa Round**', large, ridged, with cream-colored flesh, very sweet; '**Gauranga**', small, lop-sided, ridged, very sweet, bears heavily; '**Ayyangar**', large, very thick-skinned, sweet, rose-scented; '**Thagarampudi**', of medium size, thin-skinned, very sweet; '**Oaka**', small, rounded to oval, of good flavor and popular. Among the lesser-known are '**Badam**', '**Bhuri**', '**Calcutta Round**', '**CO. 1**' ('Cricket Ball' X 'Long Oval'), '**Dhola diwani**', '**Fingar**', '**Gavarayya**', '**Guthi**', '**Kali**', and '**Vanjet**'.

A dwarf type called '**Pot**' bears early and can be maintained as a pot specimen for 10 years.

Henry Pittier, in 1914, described what he deemed a "remarkable variety" called *nispero de monte* at Patiño, Panama. The trees do not exceed 26 ft (8 m) in height and bear small, oblate fruits in dense clusters.

In Indonesia, sapodillas are classed in two main groups: 1) Sawo maneela, normal-size trees having narrow, pointed leaves; and 2) Sawo apel, low, shrublike trees, with oblong leaves broadest above the middle. Belonging to group #1 are the common cultivars '**Sawo betawi**' (fruit large, in clusters of 2-4, popular, perishable, ripening in 3 days from picking); '**Sawo koolon**' (fruit large, solitary, thick skinned, with firm flesh, shipping well); '**Sawo madja**' (large, with persistent scurf, pulp of fine texture,

sweet with an acid tang). Belonging to group #2 are '**Sawo apel bener**' (fruits small in clusters of 3-6, thick-skinned); '**Sawo apel klapa**' (fruits medium-size, with persistent scurf). Some others are little grown because the fruits are either very small, too sandy, too gummy, or too dry.

In Mexico, some superior selections are known merely as '**SCH-02**', '**SCH-03**', '**SCH-07**', '**SCH-08**', and '**SCH-28**'.

In Florida, seedling selections of high quality have been named and vegetatively reproduced. The first of these was '**Russell**' from Islamorada in the Florida Keys, named and propagated by R.H. Fitzpatrick. It is nearly round, up to 4 in (10 cm) in diameter and length, brown-scurfy with gray patches, and luscious, reddish flesh. It is not a dependable bearer. The second, '**Prolific**', a seedling grown at the Agricultural Research and Education Center, Homestead, and released in 1941, is round-conical, 2 1/2 to 3 1/2 in (6.25-9 cm) long and broad, with smooth, pinkish-tan flesh. The skin is lighter than that of the 'Russell' and tends to lose much of the scurf as it ripens. The tree bears early, consistently and heavily. Of later selection, '**Modello**' is a good quality fruit but not a heavy producer; '**Seedless**' yields poorly; '**Brown Sugar**' is a good, regular, high yielder; handles and keeps well.

Some introduced cultivars being tested in Florida include: '**Boetzberg**', '**Larsen**', '**Morning Star**', '**Jamaica 8**', and '**Jamaica 10**'. '**Tikal**', a recent seedling selection, seems very promising. It is light-brown, elliptic to conical, much smaller than 'Prolific', but of excellent flavor and comes into season very early. Several cultivars not recommended because of low yield in southern Florida are '**Addley**', '**Adelaide**', '**Big Pine Key**', '**Black**', '**Jamaica No. 4**', '**Jamaica No. 5**', '**Martin**' and '**Saunders**'.

In 1951, in Jamaica, I visited an English gentleman who had a very special sapodilla tree which bore great quantities of tiny sapodillas, no more than 1 1/2 in (4 cm) in diameter. They were all seedless and he served them chilled, whole.

In the Philippines, selected cultivars, '**Ponderosa**', '**Java**', '**Sao Manila**', '**Native**', '**Formosa**', '**Rangel**', and the 'Prolific' from Florida are maintained by the Bureau of Plant Industry for propagation and distribution to farmers. 'Sao Manila' fruits mature in 190 days and ripen 3 to 5 days after picking. Hybridization studies have been conducted in India.

Climate

The sapodilla grows from sea level to 1,500 ft (457 m) in the Philippines, up to 4,000 ft (1,220 m) in India, to 3,937 ft (1,200 m) in Venezuela, and is common around Quito, Ecuador, at 9,186 ft (2,800 m). It is not strictly tropical, for mature trees can withstand temperatures of 26° to 28° F (-3.33° to -2.2° C) for several hours. Young trees are tenderer and apt to be killed by 30° F (-1.11° C) unless the stem is banked with sand or wrapped with straw and burlap during the cold spell. A number of sapodilla trees have lived for a few years in California without fruiting and then have succumbed to cold. Cool nights are considered a constant limiting factor. However, I have learned of one tree in a protected location in the Sacramento Valley that has survived for many years, reaching a large size and fruiting regularly. The sapodilla seems equally at home in humid and relatively dry atmospheres.

Soil

The sapodilla grows naturally in the calcareous marl and disintegrated limestone of its homeland, therefore it should not be surprising that it is so well adapted to southern Florida and the Florida Keys. Nevertheless, it flourishes also in deep, loose, organic soil, or on light clay, diabase, sand or lateritic gravel. Good drainage is essential, the tree bearing poorly in low, wet locations. It is highly drought-resistant, can stand salt spray, and approaches the date palm in its tolerance of soil salinity, rated as ECe 14.20.

Propagation

Seeds remain viable for several years if kept dry. The best seeds are large ones from large fruits. They germinate readily but growth is slow and the trees take 5 to 8 years to bear. Since there is great variation in the form, quality and yield of fruits from seedling trees, vegetative propagation has long been considered desirable but has been hampered by the gummy latex. In India, several methods are practiced: grafting, inarching, ground-layering and air-layering. Grafts have been successful on

several rootstocks: sapodilla, *Bassia latifolia*, *B. longifolia*, *Sideroxylon dulcificum* and *Mimusops hexandra*. The last has been particularly successful, the grafts growing vigorously and fruiting heavily.

In Florida, shield-budding, cleft-grafting and side-grafting were moderately successful but too slow for large-scale production. An improved method of side-grafting was developed using year-old seedlings with stems 1/4 in (6 mm) thick. The scion (young terminal shoot) was prepared 6 weeks to several months in advance by girdling and defoliating. Just before grafting the rootstock was scored just above the grafting site and the latex "bled" for several minutes. After the stock was notched and the scion set in, it was bound with rubber and given a protective coating of wax or asphalt. The scion started growing in 30 days and the rootstock was then beheaded. Some years later, further experiments showed that better results were obtained by omitting the pre-conditioning of the scion and the bleeding of the latex. The operator must work fast and clean his knife frequently. The scions are veneer-grafted and then completely covered with plastic, allowing free gas exchange while preventing dehydration. Success is deemed most dependent on season: the 2 or 3 months of late summer and early fall.

In the Philippines, terminal shoots are completely defoliated 2 to 3 weeks before grafting onto rootstock which has been kept in partial shade for 2 months. However, inarching is there considered superior to grafting, giving a greater percentage of success. Homeowners often find air-layering easier and more successful than grafting, and air-layered trees often begin bearing within 2 years after planting.

In India, 50% success has been realized in top-working 20-year-old trees--cutting back to 3 1/2 ft (1 m) from the ground and inserting scions of superior cultivars.

Culture

Seedlings for grafting are best grown in full sun, kept moist and fertilized with 8-4-8 N P K every 45 days.

Trees set out in commercial groves should be spaced 30 to 45 ft (9-13.5 m) apart each way.

In India, the plants are placed in deep, pre-fertilized pits and manured twice a year, sometimes with the addition of castor bean meal or residue of neem seed (*Azadirachta indica* A. Juss.), wood ash and/or ammonium sulfate. In an experiment at Marathwada Agricultural University, Parbhani, India, with 8-year-old trees planted at 12 m, application of 28 oz (800 g) N/tree increased trunk size and number and weight of fruits. Combined application of this amount of N plus 6 1/4 oz (176 g) P and 5 3/4 oz (166 g) K/tree gave the highest fruit yield. Fertilizer experiments over a period of 25 years at Gujarat Agricultural University revealed that N alone increases yield by 70%, a combination of N and P elevates yield by 90%, and combined N and K, 128%, over that of control (unfertilized) trees. Of course, optimum nutrient formulas depend on the character of the soil. In South Florida's limestone a mixed fertilizer of N, P, K, Mg in a 4-7-5-3 ratio is recommended in spring, summer and fall.

Most mature sapodilla trees receive no watering, but irrigation in dry seasons will increase productivity. In some parts of India, brackish or saline water is sometimes used to reduce vegetative growth and promote fruiting.

Season

The fruits mature 4 to 6 months after flowering. In the tropics, some cultivars bear almost continuously. In India, the main season is from December to March. The trees bear from May to September in Florida, with the peak of the crop in June and July. In Mexico, there are two peak seasons: February-April and October-December.

Harvesting

Most people find it difficult to tell when a sapodilla is ready to pick. With types that shed much of the "scurf" on maturity, it is relatively easy to observe the slight yellow or peach color of the ripe skin, but with other types it is necessary to rub the scurf to see if it loosens readily and then scratch the fruit to make sure the skin is not green beneath the scurf. If the skin is brown and the fruit separates from the stem easily without leaking of the latex, it is fully mature though still hard and must be kept at room

temperature for a few days to soften. It is best to wash off the sandy scurf before putting the fruit aside to ripen. It should be eaten when firm-soft, not mushy.

In the Bahamas, children bury their "dillies" in potholes in the limestone to ripen, or the fruits may be wrapped in sweaters or other thick material and put in drawers to hasten softening. Fruits picked immature will shrivel as they soften and will be of inferior quality, sometimes with small pockets of gummy latex.

In commercial groves, it is judged that when a few fruits have softened and fallen from the tree, all the full-grown fruits may be harvested for marketing. If in any doubt, the grower should cut open a few fruits to make sure the seeds are black (or very dark-brown). Pickers should use clippers or picking poles with bag and sharp notch at the peak of the metal frame to cut the fruit stem.

In India, the fruits are spread out in the shade to allow any latex at the stem end to dry before packing. The fruits ship well with minimal packing.

Yield

The 'Prolific' sapodilla yields 6 to 9 bushels per tree annually; or, 200 to 450 lbs (90 to 180 kg). 'Brown Sugar' yields 5 to 8 bushels. In India, it is said that a productive tree will bear 1,000 fruits in its 10th year and the yield increases steadily. At 30-35 years of age, the tree should produce 2,500 to 3,000 fruits annually. A great deal depends on the cultivar. A 10-year-old 'Oval' tree gave 1,158 fruits weighing 184 lbs (128.8 kg), while a 10-year-old 'Cricket Ball' bore 353 fruits weighing 112 lbs (50 kg). Hand-pollination has been found to increase fruit set.

Keeping Quality and Storage

Mature, hard sapodillas will ripen in 9 to 10 days and rot in 2 weeks at normal summer temperature and relative humidity. More than 50 years ago, sapodillas were shipped from Java to Holland, held at 40°-50° F (4.44-10° C) for 3 days, and they ripened satisfactorily after arrival. They were smoked over burning straw for a few hours before packing. Storage trials in Malaya demonstrated that mature, hard sapodillas stored at 68° F (20° C) will ripen in 10 days and remain in good condition for another 5 days. In Venezuela, mature fruits held at 68° F (20° C) and 90% relative humidity were in excellent condition at the end of 23 days. Lower temperatures, in efforts to prolong storage life, seriously retard ripening and lower fruit quality. Low relative humidity causes shriveling and wrinkling. Humid conditions promote sogginess. If long storage is necessary, the fruits may be kept at 59°-68° F (15°-20° C) in a controlled atmosphere of 85-90% relative humidity, 5-10% (v/v) CO₂, with total removal of C₂H₄ to delay ripening.

Firm-ripe sapodillas may be kept for several days in good condition in the home refrigerator. At 35° F (1.67° C), they can be kept for 6 weeks. Fully ripe fruits frozen at 32° F (0° C) keep perfectly for 33 days.

Pests and Diseases

In general, the sapodilla tree remains supremely healthy with little or no care. In India, it is sometimes attacked by a bark-borer, *Indarbela (Arbela) tetraonis*. Mealybugs may infest tender shoots and deface the fruits. A galechid caterpillar (*Anarsia*) has caused flower buds and flowers to dry up and fall. In Indonesia, caterpillars of *Tarsolepis remicauda* may completely defoliate the tree. A caterpillar, *Nephopteryx engraphella*, feeds on the leaves, flower buds and young fruits in parts of India. The ripening and overripe fruits are favorite hosts of the Mediterranean, Caribbean, Mexican and other fruit flies.

Various scales, including *Howardia biclavis*, *Pulvinaria* (or *Chloropulvinaria*) *psidii*, *Rastrococcus iceryoides*, and pustule scale, *Asterolecanium pustulans* Ckll., may lead to black sooty mold caused by the fungus *Capnodium sp.* on stems, foliage and fruits. In some years, during winter and spring in Florida, a rust (possibly *Uredo sapotae*) may affect the foliage of some cultivars. A leaf spot (*Septoria sp.*) has caused defoliation in a few locations. The moth of a leaf miner (*Acrocercops gemoniella*) is active on young leaves. Other minor enemies have been occasionally observed.

In India, it may be necessary to spread nets over the tree to protect the fruits from fruit bats.

Food Uses

Generally, the ripe sapodilla, unchilled or preferably chilled, is merely cut in half and the flesh is eaten with a spoon. It is an ideal dessert fruit as the skin, which is not eaten, remains firm enough to serve as a "shell". Care must be taken not to swallow a seed, as the protruding hook might cause lodging in the throat. The flesh, of course, may be scooped out and added to fruit cups or salads. A dessert sauce is made by peeling and seeding ripe sapodillas, pressing the flesh through a colander, adding orange juice, and topping with whipped cream. Sapodilla flesh may also be blended into an egg custard mix before baking.

It was long proclaimed that the fruit could not be cooked or preserved in any way, but it is sometimes fried in Indonesia and, in Malaya, is stewed with lime juice or ginger. I found that Bahamians often crush the ripe fruits, strain, boil and preserve the juice as a sirup. They also add mashed sapodilla pulp to pancake batter and to ordinary bread mix before baking. My own experiments showed that a fine jam could be made by peeling and stewing cut-up ripe fruits in water and skimming off a green scum that rises to the surface and appears to be dissolved latex, then adding sugar to improve texture and sour orange juice and a strip of peel to offset the increased sweetness. Skimming until all latex scum is gone is the only way to avoid gumminess. Cooking with sugar changes the brown color of the flesh to a pleasing red.

One lady in Florida developed a recipe for sapodilla pie. She peeled the ripe fruits, cut them into pieces as apples are cut, and filled the raw lower crust, sprinkled 1/2 cup of raisins over the fruit, poured over evenly 1/2 cup of 50-50 lime and lemon juice to prevent the sapodilla pieces from becoming rubbery, and then sprinkled evenly 1/2 cup of granulated sugar. After covering with the top crust and making a center hole to release steam, she baked for 40 minutes at 350° F (176.67° C). In India, it has been shown that ripe fruits can be peeled and sliced, packed in metal cans, heated for 10 minutes at 158° F (70° C), then treated for 6 minutes at a vacuum of 28 in Hg, vacuum double-seamed, and irradiated with a total dose of 4×10^5 rads at room temperature. This process provides an acceptable canned product.

Ripe sapodillas have been successfully dried by pretreatment with a 60% sugar solution and osmotic dehydration for 5 hours, and the product has retained acceptable quality for 2 months.

Mr. Edward Smith of Crescent Place, Trinidad, made sapodilla wine and told me that it was very good. Young leafy shoots are eaten raw or steamed with rice in Indonesia, after washing to eliminate the sticky sap.

Food Value

Immature sapodillas are rich in tannin (proanthocyanadins) and very astringent. Ripening eliminates the tannin except for a low level remaining in the skin.

Analyses of 9 selections of sapodillas from southern Mexico showed great variation in total soluble solids, sugars and ascorbic acid content. Unfortunately, the fruits were not peeled and therefore the results show abnormal amounts of tannin contributed by the skin:

Moisture ranged from 69.0 to 75.7%; ascorbic acid from 8.9 to 41.4 mg/100 g; total acid, 0.09 to 0.15%; pH, 5.0 to 5.3; total soluble solids, 17.4° to 23.7° Brix; as for carbohydrates, glucose ranged from 5.84 to 9.23%, fructose, 4.47 to 7.13%, sucrose, 1.48 to 8.75%, total sugars, 11.14 to 20.43%, starch, 2.98 to 6.40%. Tannin content, because of the skins, varied from 3.16 to 6.45%.

Toxicity

The seed kernel (50% of the whole seed) contains 1% saponin and 0.08% of a bitter principle, sapatinin. Ingestion of more than 6 seeds causes abdominal pain and vomiting.

Other Uses

Chicle: A major by-product of the sapodilla tree is the gummy latex called "chicle", containing 15% rubber and 38% resin. For many years it has been employed as the chief ingredient in chewing gum but it is now in some degree diluted or replaced by latex from other species and by synthetic gums.

Chicle is tasteless and harmless and is obtained by repeated tapping of wild and cultivated trees in Yucatan, Belize and Guatemala. It is coagulated by stirring over low fires, then poured into molds to form blocks for export. Processing consists of drying, melting, elimination of foreign matter, combining with other gums and resins, sweeteners and flavoring, then rolling into sheets and cutting into desired units.

The dried latex was chewed by the Mayas and was introduced into the United States by General Antonio Lopez de Santa Ana about 1866 while he was on Staten Island awaiting clearance to enter this country. He had a supply in his pocket for chewing and gave a piece to the son of Thomas Adams. The latter at first considered the possibility of using it to make dentures, then decided it was useful only as a masticatory. He found he could easily incorporate flavoring and thus soon launched the chicle-based chewing-gum industry. In 1930, at the peak of production, nearly 14,000,000 lbs (6,363,636 kg) of chicle were imported.

Efforts have been made to extract chicle from the leaves and unripe fruit but the yield is insufficient. It has been estimated that 3,200 leaves would be needed to produce one pound (0.4535 kg) of gum.

Among miscellaneous uses: the latex is employed as birdlime, as an adhesive in mending small articles in India; it has been utilized in dental surgery, and as a substitute for gutta percha. The Aztecs used it for modeling figurines.

Timber: Sapodilla wood is strong and durable and timbers which formed lintels and supporting beams in Mayan temples have been found intact in the ruins. It has also been used for railway crossties, flooring, native carts, tool handles, shuttles and rulers. The red heartwood is valued for archer's bows, furniture, bannisters, and cabinetwork but the sawdust irritates the nostrils. Felling of the tree is prohibited in Yucatan because of its value as a source of chicle.

Bark: The tannin-rich bark is used by Philippine fishermen to tint their sails and fishing lines.

Medicinal Uses: Because of the tannin content, young fruits are boiled and the decoction taken to stop diarrhea. An infusion of the young fruits and the flowers is drunk to relieve pulmonary complaints. A decoction of old, yellowed leaves is drunk as a remedy for coughs, colds and diarrhea. A "tea" of the bark is regarded as a febrifuge and is said to halt diarrhea and dysentery. The crushed seeds have a diuretic action and are claimed to expel bladder and kidney stones. A fluid extract of the crushed seeds is employed in Yucatan as a sedative and soporific. A combined decoction of sapodilla and chayote leaves is sweetened and taken daily to lower blood pressure. A paste of the seeds is applied on stings and bites from venomous animals. The latex is used in the tropics as a crude filling for tooth cavities.

Annex E (informative)

Codex, EU and USA pesticide residue limits

Users are advised that international regulations and permissible Maximum Residue Levels (MRL) frequently change. Although this International MRL Database is updated frequently, the information in it may not be completely up-to-date or error free. Additionally, commodity nomenclature and residue definitions vary between countries, and country policies regarding deferral to international standards are not always transparent. This database is intended to be an initial reference source only, and users must verify any information obtained from it with knowledgeable parties in the market of interest prior to the sale or shipment of any products. The developers of this database are not liable for any damages, in whole or in part, caused by or arising in any way from user's use of the database.

Results Key

MRL values in *(Italics)* are more restrictive than US

--- indicates no MRL value is established.

Cod, EU, etc. indicates the source of the MRL and EXP means the market defers to the exporting market.

All numeric values listed are in parts per million (ppm), unless otherwise noted

Sapote, Black	US	Cod	EU 1
Azoxystrobin	2	---	<i>{0.05}</i>
	1. European Union does not maintain a specific MRL for the Azoxystrobin/Sapote, Black combination, but does maintain an MRL of 0.05 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 2
Bifenazate	7	---	<i>{0.01}</i>
	2. European Union does not maintain a specific MRL for the Bifenazate/Sapote, Black combination, but does maintain an MRL of 0.01 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Boscalid	1.5	---	<i>{0.05}</i>
	US	Cod	EU
Buprofezin	0.9	---	<i>{0.05}</i>
	US	Cod	EU 3
Carfentrazone-ethyl	0.1	---	<i>{0.01}</i>
	3. European Union does not maintain a specific MRL for the Carfentrazone-ethyl/Sapote, Black combination, but does maintain an MRL of 0.01 PPM for its "Fruit Fresh or Frozen; Nuts" group.		
	US	Cod	EU 4
Cyprodinil	1.2	---	<i>{0.05}</i>
	4. European Union does not maintain a specific MRL for the Cyprodinil/Sapote, Black combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU 5
Fenpropathrin	1	---	<i>{0.01}</i>
	5. European Union does not maintain a specific MRL for the Fenpropathrin/Sapote, Black combination, but does maintain an MRL of 0.01 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Fludioxonil	0.45	---	<i>{0.05}</i>
	US	Cod	EU 6
Glyphosate	0.2	---	<i>{0.1}</i>
	6. European Union does not maintain a specific MRL for the Glyphosate/Sapote, Black combination, but does maintain an MRL of 0.1 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 7
Imidacloprid	1	---	<i>{0.05}</i>
	7. European Union does not maintain a specific MRL for the Imidacloprid/Sapote, Black combination, but does maintain an MRL of 0.05 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 8
Metalaxyl-M (Mefenoxam)	0.4	---	<i>{0.05}</i>
	8. European Union does not maintain a specific MRL for the Metalaxyl-M (Mefenoxam)/Sapote, Black combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		

	US	Cod	EU
Methoxyfenozide	0.6	---	{0.02}
	US	Cod	EU 9
Myclobutanil	3	---	{0.02}
	9. European Union does not maintain a specific MRL for the Myclobutanil/Sapote, Black combination, but does maintain an MRL of 0.02 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 10
Pyraclostrobin	0.6	---	{0.02}
	10. European Union does not maintain a specific MRL for the Pyraclostrobin/Sapote, Black combination, but does maintain an MRL of 0.02 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 11
Pyridaben	0.1	---	0.5
	11. European Union does not maintain a specific MRL for the Pyridaben/Sapote, Black combination, but does maintain an MRL of 0.5 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 12
Pyriproxyfen	1	---	{0.05}
	12. European Union does not maintain a specific MRL for the Pyriproxyfen/Sapote, Black combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU 13
Spinetoram	0.3	---	{0.05}
	13. European Union does not maintain a specific MRL for the Spinetoram/Sapote, Black combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Spinosad	0.3	---	{0.02}
	US	Cod	EU 14
Trifloxystrobin	0.7	---	{0.02}
	14. European Union does not maintain a specific MRL for the Trifloxystrobin/Sapote, Black combination, but does maintain an MRL of 0.02 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 15
Triflumizole	2.5	---	{0.1}
	15. European Union does not maintain a specific MRL for the Triflumizole/Sapote, Black combination, but does maintain an MRL of 0.1 PPM for its "Miscellaneous fruit" group.		
Sapote, mamey			
	US	Cod	EU 16
Azoxystrobin	2	---	{0.05}
	16. European Union does not maintain a specific MRL for the Azoxystrobin/Sapote, mamey combination, but does maintain an MRL of 0.05 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 17
Bifenazate	7	---	{0.01}
	17. European Union does not maintain a specific MRL for the Bifenazate/Sapote, mamey combination, but does maintain an MRL of 0.01 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Boscalid	1.5	---	{0.05}
	US	Cod	EU
Buprofezin	0.9	---	{0.05}
	US	Cod	EU 18
Carfentrazone-ethyl	0.1	---	{0.01}
	18. European Union does not maintain a specific MRL for the Carfentrazone-ethyl/Sapote, mamey combination, but does maintain an MRL of 0.01 PPM for its "Fruit Fresh or Frozen; Nuts" group.		
	US	Cod	EU 19
Cyprodinil	1.2	---	{0.05}
	19. European Union does not maintain a specific MRL for the Cyprodinil/Sapote, mamey combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU 20
Fenpropathrin	1	---	{0.01}
	20. European Union does not maintain a specific MRL for the Fenpropathrin/Sapote, mamey combination,		

	but does maintain an MRL of 0.01 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Fludioxonil	0.45	---	{0.05}
	US	Cod	EU 21
Glyphosate	0.2	---	{0.1}
	21. European Union does not maintain a specific MRL for the Glyphosate/Sapote, mamey combination, but does maintain an MRL of 0.1 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 22
Imidacloprid	1	---	{0.05}
	22. European Union does not maintain a specific MRL for the Imidacloprid/Sapote, mamey combination, but does maintain an MRL of 0.05 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 23
Metalaxyl-M (Mefenoxam)	0.4	---	{0.05}
	23. European Union does not maintain a specific MRL for the Metalaxyl-M (Mefenoxam)/Sapote, mamey combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Methoxyfenozide	0.6	---	{0.02}
	US	Cod	EU 24
Myclobutanil	3	---	{0.02}
	24. European Union does not maintain a specific MRL for the Myclobutanil/Sapote, mamey combination, but does maintain an MRL of 0.02 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 25
Pyraclostrobin	0.6	---	{0.02}
	25. European Union does not maintain a specific MRL for the Pyraclostrobin/Sapote, mamey combination, but does maintain an MRL of 0.02 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 26
Pyridaben	0.1	---	0.5
	26. European Union does not maintain a specific MRL for the Pyridaben/Sapote, mamey combination, but does maintain an MRL of 0.5 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 27
Pyriproxyfen	1	---	{0.05}
	27. European Union does not maintain a specific MRL for the Pyriproxyfen/Sapote, mamey combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU 28
Spinetoram	0.3	---	{0.05}
	28. European Union does not maintain a specific MRL for the Spinetoram/Sapote, mamey combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Spinosad	0.3	---	{0.02}
	US	Cod	EU 29
Trifloxystrobin	0.7	---	{0.02}
	29. European Union does not maintain a specific MRL for the Trifloxystrobin/Sapote, mamey combination, but does maintain an MRL of 0.02 PPM for its "Inedible peel, small" group.		
	US	Cod	EU 30
Triflumizole	2.5	---	{0.1}
	30. European Union does not maintain a specific MRL for the Triflumizole/Sapote, mamey combination, but does maintain an MRL of 0.1 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU 31
Azoxystrobin	2	---	{0.05}
	31. European Union does not maintain a specific MRL for the Azoxystrobin/Sapote, White combination, but does maintain an MRL of 0.05 PPM for its "Inedible peel, small" group.		
Sapote, White	US	Cod	EU 32
Glyphosate	0.2	---	{0.1}
	32. European Union does not maintain a specific MRL for the Glyphosate/Sapote, White combination, but does maintain an MRL of 0.1 PPM for its "Inedible peel, small" group.		

	US	Cod	EU 33
Pyriproxyfen	0.3	---	{0.05}
	33. European Union does not maintain a specific MRL for the Pyriproxyfen/Sapote, White combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU 34
Spinetoram	0.3	---	{0.05}
	34. European Union does not maintain a specific MRL for the Spinetoram/Sapote, White combination, but does maintain an MRL of 0.05 PPM for its "Miscellaneous fruit" group.		
	US	Cod	EU
Spinosad	0.3	---	{0.02}

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