Mamey apple (*Mammea americana* L.)

E. M. Yahia and F. Guttierrez-Orozco, Autonomous University of Queretaro, Mexico

**Abstract:** Mamey apple is mainly eaten raw in fruit salads or made into jellies or ice cream. The fruit is highly perishable which limits its shelf life and transport. The use of low temperatures for its handling and storage is limited because the fruit is sensitive to chilling injury. Therefore, other preservation techniques may represent better options. Very little research has been done on the postharvest physiology and handling of the fruit. Controlled and/or modified atmospheres may be required in order to extend its storage life. In fact, more research on mamey apple is needed in almost all aspects of postharvest physiology and technology. A recent scientific study has found mamey apple to have protective effects on gastric ulcers, using an animal model. Further research on its health benefits would also be beneficial.

**Key words:** *Mammea americana*, postharvest, physiology health benefits.

### 20.1 Introduction

Mamey apple (*Mammea americana*) is an appetizing fruit that is little known outside its area of origin. Its high respiration rate makes it highly perishable which limits its shelf life (Yahia, 2004). Some health benefits have been associated with this fruit, although more scientific research is needed to confirm these. The lack of information on mamey apple postharvest physiology and technology limits the preservation techniques that can be used to conserve its quality during storage and shipping (Yahia, 2004).

#### 20.1.1 Origin, botany, morphology and structure

Mamey apple is a tropical fruit that has received little attention from researchers or the fruit trade. Botanically identified as *Mammea americana*, it belongs to the Guttiferae family and it is also known as mammee apple, mammee, St Domingo.
apricot and South America apricot. It is native to the West Indies and northern South America (Morton, 1987). The mamey apple tree is evergreen and reaches a height of 18–21 m. (See Plate XXXV in the colour section between pages 274 and 275.) It has a short trunk with an oval crown. The fruit is about 300 to 500 g in weight. It is a round to oblate fruit, similar in shape and size to an orange (approximately 7.7–9.8 cm in length and 10.9–8.6 cm in diameter). Although mamey apple is commonly thought to be a drupe, it is actually a berry. The rind is russet coloured, covered in brown spots, tough, thick, leathery and wrinkled and about 4 mm in thickness. The fruit contains a large single seed surrounded by a thin layer of yellow flesh. The endocarp, which is also yellow, is about 2–5 mm thick and fused with the testa. When the fruit is fully ripe, the flesh is appetizingly fragrant. Its flavour is similar to that of the apricot, peach or red raspberry, but some varieties are characterized by an acid flavor. Fruit that are too sour or too sweet are considered of low quality (Morton, 1987; Mourao and Beltrati, 2000; Orwa et al., 2009).

20.1.2 Worldwide importance
Mamey apple is commonly grown in the Bahamas and the Greater and Lesser Antilles. It is rarely cultivated in Mexico and Central America but can be found in Costa Rica, El Salvador and Guatemala. Although in some areas the tree is planted for its fruit, other uses include as a wind barrier and as ornamental shade (Morton, 1987).

20.1.3 Culinary uses, nutritional value and health benefits
The fruit is peeled by marking the skin and removing it in strips and the flesh is eaten raw whether it is eaten on its own or as part of a fruit salad. Sometimes it is also served with cream, sugar or wine or used as an ice cream ingredient. Mamey apple is also used to make jam, and when used for this purpose it can be steeped in wine and sugar or left in salted water for a while to remove bitterness. Mamey apple flesh is also used as a filling in pies, tarts and pastes, and frozen flesh is used for sherbets in some areas (Morton, 1987). The high pectin content in ripe mamey apple fruit makes it an optimal ingredient for jelly when combined with fruits like pineapple that have low pectin content and high acidity.

The nutritional value of mamey fruit is presented in Table 20.1. The main sugars are glucose, fructose and sacarose. The fruit is an important source of provitamin A carotenoids (De Rosso and Mercadante, 2007). Total carotenoid content in mamey apple has been reported to be 6.2 mg 100 g⁻¹ and vitamin A value to be 688 retinol equivalents (RE) 100 g⁻¹ (De Rosso and Mercadante, 2007). Among the carotenoid compounds it contains are 13-cis-β-carotene, trans-β-carotene, 9-cis-β-carotene, trans-β-zeacarotene, trans-β-apo-10' -carotenal, and trans-β-apo-8' -carotenal (Godoy and Rodriguez-Amaya, 1994). Fifty-one volatile compounds responsible for the pleasant flavour in mamey apple have been identified, of which methyl 3-hydroxy-2(S)-methyl propanoate pure enantiomer
Table 20.1 Nutrient value of mamey apple fruit (per 100 g of fruit fresh weight)

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Approximate value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water content</td>
<td>85.5-87.6 %</td>
</tr>
<tr>
<td>Calories</td>
<td>44.5-45.3</td>
</tr>
<tr>
<td>Protein</td>
<td>0.470-0.088 g</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>11.52-12.67 g</td>
</tr>
<tr>
<td>Fat</td>
<td>0.15-0.99 g</td>
</tr>
<tr>
<td>Fibre</td>
<td>0.80-1.07 g</td>
</tr>
<tr>
<td>Ash</td>
<td>0.17-0.29 g</td>
</tr>
<tr>
<td>Calcium</td>
<td>4.0-19.5 mg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>4.0-19.5 mg</td>
</tr>
<tr>
<td>Iron</td>
<td>0.15-2.51 mg</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>688 RE</td>
</tr>
<tr>
<td>Total carotenoids</td>
<td>6.25 mg</td>
</tr>
<tr>
<td>13-cis-β-carotene</td>
<td>40-60 µg</td>
</tr>
<tr>
<td>trans-β-carotene</td>
<td>1000-1820 µg</td>
</tr>
<tr>
<td>9-cis-β-carotene</td>
<td>10-50 µg</td>
</tr>
<tr>
<td>trans-β-zeacarotene</td>
<td>70-90 µg</td>
</tr>
<tr>
<td>trans-β-apo-10'-carotenal</td>
<td>360-640 µg</td>
</tr>
<tr>
<td>trans-β-apo-8'-carotenal</td>
<td>740-1480 µg</td>
</tr>
<tr>
<td>Thiamin</td>
<td>0.017-0.030 mg</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.025-0.068 mg</td>
</tr>
<tr>
<td>Niacin</td>
<td>0.160-0.738 mg</td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>10.2-22.0 mg</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>5 mg</td>
</tr>
<tr>
<td>Methionine</td>
<td>5-6 mg</td>
</tr>
<tr>
<td>Lysine</td>
<td>14-35 mg</td>
</tr>
</tbody>
</table>

Sources: Morton (1987); Godoy and Rodriguez-Amaya (1994); De Rosso and Mercadante (2007)

and 2-methyl butanoic acid are the most significant. Carboxylic acids and $C_{13}$-norisoprenoids (mainly 2-methyl butanoic acid, 4-hydroxy-β-ion-one and 4-oxo-β-ionol) accounted for the majority of aglycones after hydrolysis of the bound aroma compounds (Morales and Duque, 2002).

The ground seeds of mamey apple have been used as an insecticide and larvicide for many years (Crombie, 1999) and, without the embryo, they can also be used to make an antihelmintic infusion for adults (Morton, 1987). Liquor is also made from the flowers and taken as a tonic or digestive (Morton, 1987). An infusion of the fresh or dry leaves is believed to help in cases of intermittent fever and extracts of the leaves are effective against *Mycobacterium tuberculosis* (Frame *et al.*, 1998). In addition, antimalarial properties have also been suggested (Brandao *et al.*, 1985).
The pharmacological properties of mamey apple have been extensively analysed. Ethanol (EtOH) and dichloromethane (DCM) extracts obtained from mamey apple were found to have a protective effect against gastric ulcer induced by HCl/EtOH, using a mouse model. The inhibition of ulcerative lesion index was 54 and 86% for EtOH and DCM extracts, respectively. The same extracts reduced gastric acid secretion, thus increasing gastric pH. This effect is probably due to an induction of endogenous prostaglandins and mucus synthesis (Toma et al., 2005).

Compounds from this fruit called mammein and coumarins have shown antitumor activity (Finnegan et al., 1972). Coumarins isolated from the stem bark of mamey apple also showed cytotoxicity against human epidermoid cancer cell line 9K-B and antimicrobial activity against Staphylococcus aureus (Ouahouo et al., 2004). Fifteen isoprenylated coumarins identified in mamey apple have shown strong cytotoxic activity in human colon cancer cell lines HT-29, SW-480, and HCT-116, which appears to be mediated by apoptosis induction (Ouahouo et al., 2004). Out of these, ten coumarins exhibited high antioxidant activity. Higher concentration of mamey apple coumarins has been found in the root as compared to the flesh (Yang et al., 2006). The flavonols catechin and epicatechin have also been identified in mamey apple (Yang et al., 2005).

20.2 Fruit development and postharvest physiology

20.2.1 Fruit growth, development and maturation
Total soluble solids increase during maturation. Acidity is low (0.089–0.091 %) in fully ripe fruit while the sugar content is high (117–128 g kg⁻¹) (Manzano-Mendez and Dris, 2001).

20.2.2 Respiration, ethylene production and ripening
Mamey apple is a climacteric fruit (Yahia, 2004). Its respiration rate at 27°C is 28–40 mg CO₂ kg⁻¹ hr⁻¹, and ethylene production rate up to 400 μl kg⁻¹ hr⁻¹ are among the highest found in fruits (Akamine and Goo, 1978; Yahia, 2004). When harvested at the mature green stage, mamey apple fruit ripens in 3–4 days.

20.3 Maturity and quality components and indices
Mamey apple fruit are commonly harvested at the ripe stage, although, as already mentioned, since they are climacteric, mature green fruit ripen well in 3–4 days after harvest (Morean, 1991). The skin of fully ripe fruit turns slightly yellow. Sometimes this is not apparent and it is necessary to scratch a small portion of the peel with a fingernail. If a green colour is present, the fruit is not ready for harvesting; a yellow colour indicates that the fruit is ready to eat.

© Woodhead Publishing Limited, 2011
20.4 Postharvest handling factors affecting quality

20.4.1 Temperature management
Mamey apple fruit are sensitive to chilling injury and thus low storage temperatures must be avoided to prevent the development of undesirable flavours and odours, flesh browning and softening (Yahia, 2004). Fruit kept at 27°C for 2 weeks had higher total soluble solids than those kept at 15°C (11.1 and 9.6%, respectively), while pH, total acidity, and sugar concentration did not differ (Manzano-Mendez and Dris, 2001).

20.4.2 Atmosphere
Fruit stored at 27°C or 15°C for 2 weeks under controlled atmosphere (5.1% CO$_2$, 5.6% O$_2$, 89.3% N$_2$), did not differ in their content of total soluble solids (TSS). However, when kept in normal air, fruit at 27°C had higher TSS contents. Temperature of 15°C and controlled atmosphere were reported to delay fruit ripening (Manzano-Mendez and Dris, 2001; Yahia, 1998; 2008).

20.5 Physiological disorders
As already mentioned, mamey apple fruit is sensitive to chilling injury (Yahia, 2004). Chilling injury symptoms include failure to ripen, accelerated softening, development of brown spots in the pulp and development of off-flavours and aromas (Yahia, 2004).

20.6 Pathological disorders
Leaves of the mamey apple tree can be attacked by a black mildew (*Aulographum melioloides*) (Orwa et al., 2009). The tree can be attacked by heart rot, which can enter through basal scars and infect old trees.

20.7 Insect pests
Old trees can be attacked by wet-wood termites (Orwa et al., 2009).

20.8 Postharvest handling practices

20.8.1 Harvest operations
The mamey apple season is from May to July in the Bahamas. However, in Barbados fruits begin to ripen in April, and in Florida they ripen from late June until August. The fruit are harvested by clipping the stem, leaving a small part of the peduncle attached (Morton, 1987).
20.8.2 Control of ripening and senescence
Ripening of mamey apple can be delayed by storage temperatures of 15 ± 2°C and controlled atmosphere conditions (5.1% CO$_2$, 5.6% O$_2$, 89.3% N$_2$) (Manzano-Mendez and Dris, 2001; Yahia, 1998; 2008).

20.8.3 Recommended storage and shipping conditions
Since the fresh fruit is perishable, it may be more suitable to export the fruit's pulp (rather than the fresh whole fruit). The stability of untreated, sterilized or pasteurized pulp of mamey apple during storage at −30°C for 90 days has been studied. Physicochemical parameters such as pH, °Brix, and acidity were less variable in thermally treated fruit than in untreated fruit. Ascorbic acid degradation was lower in fruit that were pasteurized and thermal treatment also inhibited microbial growth during storage (Cedeño et al., 2010).

20.9 Processing
A patent application filed in 2008 describes effective dehydration methods to obtain stable powders of mamey apple pulp with prolonged shelf life (up to 1 year) at ambient temperature. This powder conserves the original organoleptic properties of fresh mamey fruit according to the inventors. Through this method, the fruit can be preserved for longer periods, as the water loss, enzymatic degradation, decay, and transport and storage problems of the fresh product are avoided. Ascorbic or citric acids are added to the powder (0.01–2%) to preserve the product. The powder can be rehydrated in water, milk, juice, etc., and used in the same way as the fresh pulp, which makes the product very flexible. The production process of mamey apple powder includes selecting the fruit, which are then washed and sanitized. They are then cut and seeded and the pulp is dehydrated by methods such as hot air (60–120°C for 0.5 to 4 h), microwave (60–110°C for 3 to 50 min), or thermal drying using temperatures from 60 to 120°C for 0.5 to 4 h. The skin of mamey apple fruit is separated from the pulp at the end of this first dehydration stage. After that, the pulp is subjected to an additional dehydration step using the same conditions. Dried pulp is ground and citric or ascorbic acids are added. The final product is packed in plastic or glass bottles or polyethylene bags (Jimenez-Mendoza, 2008).

20.10 Conclusions
Mamey apple are mainly eaten raw in fruit salads or made into jellies or ice cream. A recent scientific study has found that mamey apple has protective effects against gastric ulcers, but further research on its health-promoting properties is necessary. The fruit is highly perishable which limits its shelf life and transport. The use of low temperatures when handling the fruit is limited because it is sensitive to
chilling injury and therefore other preservation techniques may be better options. Very little research has been done on postharvest physiology and handling of the fruit. Controlled and/or modified atmospheres may be required to extend the storage life of this fruit. More research on mamey apple is warranted.

20.11 References


Crombie L (1999), Natural product chemistry and its part in the defense against insects and fungi in agriculture, Pestic Sci, 55, 761–774.


Toma W, Hiruma-Lima CA, Guerrero RO and Souza Brito ARM (2005), Preliminary studies of Mammea americana L. (Gutiferae) bark/latex extract point to an effective antulcer effect on gastric ulcer models in mice, Phytomedicine, 12(5), 345–350.
Yahia EM, editor (2008), ‘Modified and controlled atmospheres for the storage, transportation, and packaging of horticultural commodities’, CRC Taylor & Francis, Boca Raton, FL.


