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Postharvest Handling Technical Bulletin

CARAMBOLA (FIVE FINGERS)

Postharvest Care and Market Preparation



Technical Bulletin No. 30

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POSTHARVEST HANDLING TECHNICAL SERIES

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New Guyana Marketing Corporation
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Preface

This publication is part of a series of technical bulletins that seek to provide specific recommendations for improvements in postharvest care and market preparation for selected non-traditional agricultural products. The intended audience for this series is primarily extension agents.

Initial market assessments in current export markets and visits with producers and exporters in Guyana have shown the quality of fresh produce currently exported is uneven and in some instances very poor. Stages all along the export chain from harvest and pre-harvest to transportation and final export are all in need of improvement. Pre-harvest practices, sanitation at the packinghouse, packaging, bacterial and fungal problems, and transportation were all identified as areas where improvement could benefit the quality and increase the shelf life of Guyana's fresh produce exports. The technical bulletins address these issues specific to each product. Harvesting techniques and crop maturity indices are provided. Preparation for market, including cleaning, sorting, packing and transportation are covered. The bulletins address and recommend specific storage conditions, covering temperature and humidity controls. Finally the bulletins address postharvest diseases and insect damage.

The undertaking of these technical bulletins is a joint effort of the Ministry of Fisheries, Crops and Livestock; the New Guyana Marketing Corporation (NGMC) and the National Agricultural Research Institute (NARI) to improve quality, increase production and promote exports. As a team, the three agencies are working on the problems, limitations, and constraints identified in the initial reconnaissance surveys, from production and postharvest handling problems, to packaging and transportation, to final market.

Introduction

Guyana is one of the world's leading producers of carambola (*Averrhoa carambola*). The fruit is locally known as five fingers and is also called starfruit. It is available year round as the trees bear several crops per year. Cultivars vary in their sweetness, with sweet cultivars having a fruit pH of 3.8 to 4.1 and tart cultivars having a fruit pH of 2.2 to 2.6. The most popular cultivars have an agreeable, sub-acid to sweet flavour. The fruit has a thin skin covered with a waxy cuticle and 5 prominent longitudinal ribs, resulting in a star-shaped cross section. The protruding ribs are easily damaged and the fruit must be handled with great care. Carambolas are widely distributed in the domestic market, however, there is little or no export volume.

Harvest Maturity Indices

It generally takes 2 months or more from fruit set to maturity depending upon cultivar, production practices, and weather. Several non-destructive indices, based on external fruit appearance, can be used to determine carambola harvest maturity.

The most widely used index of harvest maturity is external fruit colour. Distinct changes in carambola colour occur as the fruit begin to ripen which can be used to determine harvest maturity. External colour remains of medium green intensity during fruit development. As the fruit approaches maturity, the shade of green becomes lighter. Soon after this, a bit of yellow colouration becomes noticeable. As ripening continues, the fruit will turn more yellow and eventually become completely yellow. Finally, the fruit will turn a deep yellow or orange colour as it becomes fully ripe. Sugar content and sweetness of the fruit on the tree increase as skin colour changes from green to yellow. The ripening stages of carambola are categorized as green, light green, green yellow, yellow green, yellow, and orange (Figure 1) and are described in Table 1.



Figure 1. Ripening stages of carambola; from left to right: green, light green, green yellow, yellow green, yellow, and orange.

Table 1. Terminology used to describe carambola colour as an indication of ripeness stage.

Colour	Description
<i>Green</i>	The surface of the carambola is completely green, of medium intensity.
<i>Light Green</i>	The surface of the carambola is completely light green.
<i>Green Yellow</i>	More than 50 % of the surface is green, with some yellow evident.
<i>Yellow Green</i>	More than 50 % of the surface is yellow, with some green evident.
<i>Yellow</i>	The surface of the carambola is completely yellow.
<i>Orange</i>	The surface of the carambola is completely orange.

The quality and flavour of green stage fruit will be inferior and therefore picking these fruit should be avoided. Fruit harvested at the green stage of ripeness may still be immature and will not ripen properly. The flavour will remain acidic and the fruit may shrivel prematurely, although the external colour will slowly turn yellow at room temperature. For maximal market life, carambolas should be picked at the light green stage (Figure 2). They will be better able to tolerate the stress of handling and transport at this stage.



Figure 2. Carambola fruit at the light green stage of ripeness.

Fruit allowed to ripen to a yellow or orange stage of maturity before picking will have a significantly shorter market life. Yellow and orange stage fruit will be much more susceptible to bruising and injury during harvest and postharvest handling. This will result in more deterioration and postharvest decay.

The harvest maturity stage depends on the intended market destination and the time needed to market the fruit. Carambolas intended for export should be harvested at the light green to green yellow stage. Ideally, fruit destined for export should be harvested when a yellow colour begins to develop in the furrow between the ribs while the tips of the ribs (fins) remain green. Fruit at this stage of maturity will store well and be able to be exported to distant markets. The fruit will turn completely yellow in colour during storage. Carambolas sold in local markets can be harvested at the light green stage if they will be held for more than several weeks, or they can be allowed to develop more yellow colour before picking. Fruit for nearby markets that will be sold within several days can be left on the tree until the yellow colour stage. Fruit are sweetest when allowed to ripen on the tree, but firmness diminishes and market life is reduced. Carambolas do not increase in sugar content after picking. Therefore, if market demand is for carambolas with optimum sweetness, the fruit should be left to ripen on the tree until the yellow colour stage. However, fruit which are harvested at the complete yellow stage will typically have a market life of less than 1 week.



Figure 3. Fully developed mature carambola fruit at proper size for harvest.

Fruit size may also be used to determine harvest maturity. Each cultivar has a typical average fruit size which can be used as a guide for establishing maturity. Marketable fruit are generally 8 cm to 15 cm (3 in to 6 in) in length (Figure 3).

Harvest Methods

Carambola fruit is harvested manually and should be cut or clipped from the tree. The recommended harvest tools include knives or clippers with a sharp-edge. The fruit should be handled gently at all times in order to minimize bruise damage and subsequent postharvest loss. Fruit should not be allowed to drop to the ground, as it will result in impact bruising, mechanical injury, and surface scarring. Postharvest deterioration of dropped fruit will be rapid, the fruit will shrivel, and brown spots will develop on the skin surface and rib edges, lowering the market quality.

The initial sorting of marketable versus unmarketable fruit should be made at the time of picking. Severely damaged or defective fruit should be put into a separate container and discarded in a location away from the carambola trees to minimize the build-up of disease inoculum in the area. The remaining marketable fruit, whether intended for local or export destinations, should be carefully placed in the field container to avoid injury to the delicate fruit ribs. The fruit should be placed horizontally in the field container to reduce friction at the rib edges and each layer should be covered with paper. Several different types of field containers can be used for carambola. The container should be lined with a soft material, such as paper or polyfoam padding. The field container should contain no more than 10 kg (22 lb) of fruit and should be put in a shaded area when full.

Woven synthetic sacks should not be used for harvesting or transport of carambolas. They provide little or no protection to the fruit and considerable damage will result to the delicate protruding ribs. Rib-edge browning is generally the result of surface abrasions and other types of bruising of carambola fruit transported in sacks (Figure 4). The browning intensity increases as more water is lost from the fruit. Also, synthetic sacks usually do not have adequate ventilation and may contain in excess of 10 kg (22 lb) of fruit, which is also undesirable.

The least expensive field container is a reed basket. However, the uneven inside surface of the basket often results in fruit scarring and skin abrasions when there is movement or vibration of the basket. Also, this type of field container is not strong enough to be stacked without causing some damage to the fruit.

A better field container is a wooden crate, which is much stronger and can be stacked without damaging the fruit. The ideal type of field container is a durable plastic crate which is well ventilated and has a smooth inside finish. Plastic crates can be easily cleaned, are stackable, and do not damage the fruit (Figure 5).



Figure 4. Rib-edge browning due to tissue abrasion of fruit packed synthetic sacks.



Figure 5. Durable plastic field crate with smooth inner surfaces to minimize fruit injury.

The harvest containers of carambola fruit should be transported to a nearby collection or consolidation site the same day of harvest. The containers should be carefully loaded and stacked in the transport vehicle in order to minimize damage to the delicate skin and protruding ribs. There should be adequate ventilation through the field containers and the transport vehicle should have a protective cover over the crates of fruit. Ideally, the fruit should be transported during the coolest time of the day in order to minimize heat build-up inside the transport vehicle. Upon arrival at the consolidation facility, the containers should be unloaded with care and never dropped. They should be handled as little as possible to avoid unnecessary damage. The crates should be stacked in a shaded well ventilated area.

Preparation for Market

Various steps should be followed in preparing carambola for market. These involve cleaning, grading/sorting, and packing. These operations should be carried out in an easily accessible, shaded area which is protected from rain.

Cleaning

The first step in market preparation involves the cleaning of the harvested carambola. If the fruit surface is clean, shiny, and without dust or dirt, it may directly be put on the sorting table for grading and packing. However, in most cases the harvested fruit will need some degree of cleaning.

The fruit surface should be cleaned by washing in potable water in which a mild detergent has been added. Dirt and stains can be removed by gently rubbing the fruit surface with the fingertips or by using a very soft bristled brush or cotton cloth. The water used for cleaning should be sanitized with 150 ppm hypochlorous acid and adjusted to a pH of 6.5. The water should be frequently checked to ensure the recommended concentration of hypochlorous acid and pH level are maintained. It is also very important to keep the wash water free of debris and suspended sediments which may cause abrasion injury and browning of the delicate skin tissue. After cleaning, the fruit should be carefully transferred to a flat surface or table for air drying prior to inspection and packing.

Sorting/Grading

The next step in market preparation involves sorting and grading the fruit according to the standards required of the market. The fruit should be carefully sorted according to size, colour, shape, and amount of surface blemishes. Fruit should be clean, firm, free from visible signs of disease, mature, uniformly coloured, and free from damage which detracts from the appearance or edibility of the fruit (i.e. bruises, cuts, healed or open cracks, insect damage, sunburn, etc.). The skin should not be spongy or puffy, although up to 20% of the fruit in any lot can show signs of wilting and skin puffiness. At least 80% of the fruit should have the shape characteristic of the cultivar.

Three different classes have been established by the National Bureau of Standards for domestic marketing of carambola (Extra Class, Class 1, Class 2). Extra Class carambola should be of superior quality and free from defects (with the exception of very slight superficial defects). Class 1 carambola must be of good quality, although slight defects in colour, shape, and scars/bruises are allowed (Figure 6). The total surface area affected with these defects shall not exceed 5%. Class 2 carambola do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified above. Defects in colour, shape, and scars/bruises are allowed, provided the total surface area affected with these defects does not exceed 10%.



Figure 6. Class 1 (left) and unacceptable (right) carambola in the domestic market.

Three different sizes have been established for domestic marketing. Carambola classified as small weigh between 80 gm to 129 gm (3 oz to 5 oz.), medium sized carambola weigh between 130 gm (5 oz) to 190 gm (7 oz), and large sized fruit weigh more than 190 gm (7 oz).

Tolerances with respect to quality and size are allowed in each package for fruit not satisfying the requirements of the class. In the case of Extra Class carambola, up to 5% of the fruit number or weight in the package may not meet the established requirements for the class, although they must meet the requirements of Class 1. In the case of Class 1 carambola, up to 10% of the fruit number or weight in the package may not meet the established requirements for the class, although they must meet the requirements of Class 2. In the case of Class 2 carambola, up to 10% of the fruit number or weight in the package may not meet the established requirements for the class, nor the minimum requirements, although the fruit must not be rotted or affected by another type of deterioration rendering it unfit for consumption.

The quality standards of export grade fruit should meet the minimum requirements of Extra class fruit. Export quality fruit must be firm, uniformly coloured, and symmetrical with 5 ribs. The fruit must also be free of insect damage, physical injury, disease, brown discolouration, and other surface blemishes. The skin colour should be light green to green yellow in order to withstand the rigors of air transport and in-land distribution in the destination country. The flesh should be translucent, crisp, juicy, and without fiber. A minimum fruit size of 130 gm (5 oz) is needed for most export markets. Export market fruit are typically sorted according to size (weight) into 3 categories: small, medium, and large. Small fruit weigh between 130 gm to 160 gm (5 oz to 6 oz), medium sized fruit weigh between 160 gm to 190 gm (6 oz to 7 oz), and large size fruit weigh more than 190 gm (7 oz). In each export carton, up to 10% of the fruit may fall outside the designated size category.

Packing

Carambolas should be packed in strong, well-ventilated containers that have a smooth inner surface to protect against abrasion injury to the delicate fruit ribs. Wooden containers lined with newspaper, a thin cloth, or soft padding, are appropriate for the domestic market. Durable plastic crates are also acceptable. Synthetic or mesh sacks should not be used as they provide little or no protection to the fruit.

Carambolas packed for export are typically put in well-ventilated fiberboard cartons of either 3 kg or 9 kg (7 lb or 20 lb) net weight size, depending on market destination. The fruit should be oriented in a vertical position, with the stem end resting on an insert of foam padding. This minimizes damage to the rib edges. The fruit are packed according to individual fruit count (i.e. size) and the most common number of counts per 3 kg carton is 16, 20, 26, and 30. A 16-count fruit is considered to be a large size, 20 count a medium size, 26 count a small size, and 30 count an extra small size. The carton dimensions are 34.5 cm x 27.4 cm x 13.8 cm (13.6 in x 10.9 in x 5.4 in). The larger 9 kg (20 lb) carton usually contains 60, 70, or 98 count size fruit. The inside of the carton should be lined with a thin layer of foam or padding to minimize bruise damage and abrasion of the delicate skin tissue. Additional protection to the fruit is often provided in the form of Styrofoam sleeves (Figure 7) or plastic over-wraps (Figure 8). Thin fiberboard inserts can also be used to separate individual fruit (Figure 9).

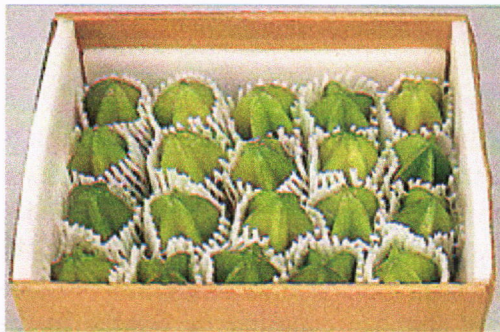


Figure 7. Carambola fruit wrapped in individual Styrofoam sleeves for export.



Figure 8. Plastic overwrapping of 20-count fruit in 3 kg export carton.



Figure 9. Thin fiberboard inserts separate fruit into individual cells inside the carton.

Temperature Control

Carambola fruit should be held at 6°C (43°F) for maximum postharvest life. At this temperature light green harvested fruit will have a potential market life of up to 2 months. Light green stage or more advanced maturity stage fruit will develop a normal yellow or orange colour after they are transferred to warmer temperatures for ripening. Some improvement in flavour may also be noted due to a loss of acidity. Storage of carambola at 10°C (50°F) will also significantly extend postharvest life. Carambolas picked at the first sign of yellowing will remain in good condition for up to 1 month at 10°C (50°F). Holding the fruit at higher temperatures will result in fruit softening and increased ripening. Light green maturity stage fruit stored at 16°C (60°F) will have a maximum market life of 3 weeks, while fruit stored at 21°C (70°F) will have a 2 week maximum market life. Storage of carambola at 5°C (41°F) or below should be avoided as the fruit will suffer chilling injury and not ripen properly.

Humidity Management

The ideal relative humidity (RH) for holding carambola is between 90% to 95%. This will minimize postharvest weight loss and rib dessication, which leads to an unsightly dark discolouration along the edge of the ribs. Rib discolouration or browning can be severe if the fruit are held below 70% RH. Symptoms become visible when the carambolas lose 5% or greater of their weight due to water stress.

Principal Postharvest Diseases

Management and control of postharvest diseases begins in the field. Proper cultural practices are necessary to avoid the build-up of high levels of inoculum responsible for postharvest decay. These practices include proper tree spacing to avoid overcrowding, periodic pruning to allow more air movement through the canopy, regular foliar fungicide applications (i.e. mancozeb, benomyl, iprodione, and/or copper fungicides), and removal of fallen leaves under the tree. Incidence of postharvest decay can also be minimized by careful harvesting and handling practices to avoid injury to the delicate skin tissue, cleaning of the fruit, proper wash water sanitation, and holding the fruit at 6°C (43°F).

The principal postharvest diseases of carambola are caused by various fungi, including alternaria rot, anthracnose, and sooty mould.

Alternaria Rot

Alternaria rot, caused by the fungus *Alternaria alternata*, typically infects immature green stage fruit while on the tree and remains dormant until ripening. Symptoms include the development of small black circular spots, 0.5 mm to 1 mm (0.02 in to 0.04 in) in diameter, on the fruit surface. The spots grow and coalesce to cover a substantial part of the fruit. Later, the disease progresses into the flesh which darkens and becomes soft. Alternaria rot is especially severe on fruit which have chilling injury.

Anthracnose

Anthracnose, caused by the fungus *Colletotrichum gloeosporioides*, is another disease that infects green fruit prior to harvest and remains dormant until the fruit ripens. Typical symptoms include small black spots and/or larger black lesions on the surface of the skin. The lesions may coalesce and penetrate deep into fruit, resulting in extensive fruit rotting. Ripe yellow stage fruit, with its weaker and softer skin, are more susceptible to anthracnose than green or light green stage fruit. Anthracnose is always more severe during the rainy season.

Sooty Mould

Sooty mould, caused by the fungus *Leptothyrium*, causes a blackish discolouration of the fruit surface. The fungus does not typically penetrate the skin and the mould growth is usually superficial, without causing fruit rot. However, the appearance of the fruit is negatively affected. In the case of mild infections, the sooty mould fungus can be removed by gently rubbing the fruit surface to remove the superficial mould growth.

Postharvest Disorders

Chilling Injury

Carambola is a tropical fruit and is adversely affected by exposure to low temperature. Chilling injury (CI) will occur at 5°C (41°F) and below. Damage from CI is cumulative and depends on both the temperature and exposure time. Carambola will be irreversibly damaged by CI if held at 0°C (32°F) for longer than 1 week or at 5°C (41°F) for longer than 6 weeks. Symptoms of CI include the formation of pits and sunken lesions on the fruit surface, irregular external colour development during ripening, rib-edge browning, internal tissue darkening, off-flavour development, and increased postharvest decay. These symptoms will develop more rapidly on fruit marketed at ambient temperature following exposure to CI-inducing temperatures.

ANNEX I

PUBLICATIONS IN THE POSTHARVEST HANDLING TECHNICAL BULLETIN SERIES

PH Bulletin No. 1	Pineapple: Postharvest Care and Market Preparation, November 2002.
PH Bulletin No. 2	Plantain: Postharvest Care and Market Preparation, June 2003.
PH Bulletin No. 3	Mango: Postharvest Care and Market Preparation, June 2003.
PH Bulletin No. 4	Bunch Covers for Improving Plantain and Banana Peel Quality, June 2003.
PH Bulletin No. 5	Papaya: Postharvest Care and Market Preparation, June 2003.
PH Bulletin No. 6	Watermelon: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 7	Peppers: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 8	Oranges: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 9	Tomato: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 10	Okra: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 11	Pumpkin: Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 12	Lime: Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 13	Grapefruit: Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 14	Passion Fruit: Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 15	Green Onions: Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 16	Sweet Potato: Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 17	Eggplant (Boulanger): Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 18	Avocado (Pear): Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 19	Bitter Melon: Postharvest Care and Market Preparation, January 2004.
PH Bulletin No. 20	Bora: Postharvest Care and Market Preparation, April 2004.
PH Bulletin No. 21	Cassava: Postharvest Care and Market Preparation, April 2004.

PH Bulletin No. 22	Eddoes: Postharvest Care and Market Preparation, April 2004.
PH Bulletin No. 23	Ginger: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 24	Breadfruit: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 25	Cabbage: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 26	Calaloo: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 27	Coconut: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 28	Cucumber: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 29	Lemon: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 30	Starfruit: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 31	Tangerine: Postharvest Care and Market Preparation, May 2004.
PH Bulletin No. 32	Yam: Postharvest Care and Market Preparation, May 2004.