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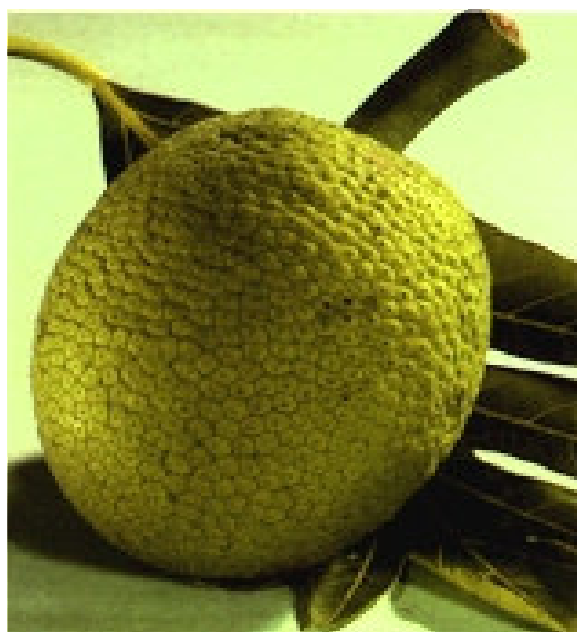


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## Postharvest Handling Technical Bulletin

# BREADFRUIT

## Postharvest Care and Market Preparation



Technical Bulletin No. 24

May 2004

# **POSTHARVEST HANDLING TECHNICAL SERIES**

# **BREADFRUIT**

## **Postharvest Care and Market Preparation**

Ministry of Fisheries, Crops and Livestock  
New Guyana Marketing Corporation  
National Agricultural Research Institute

Technical Bulletin No. 24

May 2004



With the assistance of the United States Agency for International Development

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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 post harvest handling problems, to packaging and transportation, to final market.

## Introduction

Breadfruit (*Artocarpus altilis*) is a relatively minor fruit in Guyana, with almost the entire production volume marketed domestically. Small amounts are also exported to Canada and the U.S. Breadfruit is a seedless breadnut, producing nearly spherical fruit with a diameter of 10 cm to 30 cm (4 in to 12 in) and a weight of 1 kg to 4 kg (2 lb to 9 lb). The trees take from 3 to 7 years to begin production. Once in production, the tree sets fruit more or less continuously, with fruit in all stages of development being present on the tree year around. However, there are generally two or three main fruiting periods.

## Harvest Maturity Indices

Breadfruit is typically ready for harvest about 3 months after flowering. The proper stage for harvesting breadfruit depends on the intended use. Breadfruit has a high starch content and is used as a vegetable when mature but not ripe, and as a dessert when ripe. During ripening, the starch turns to sugar and the fruit develops a sweet custard taste. The principal external indices of harvest maturity are skin colour, texture and appearance of the fruit surface, and firmness.

Breadfruit should be harvested when green in colour and firm in texture if it is to be used as a starchy vegetable. The fruit should be left to ripen and harvested at a later stage when used as a dessert. The skin colour of ripe fruit becomes yellow-green with red-brown areas. In addition, the stem of ripe fruit becomes yellow-green in colour.

The texture and appearance of the fruit surface is indicative of harvest maturity. The surface of breadfruit is patterned with irregular polygon shaped segments which flatten and enlarge upon maturity. Breadfruit harvested as a starchy vegetable should have noticeable protruding segments on the surface that tend to be angular and ridged, while the individual segments of dessert-stage fruit should be smoother, flatter, and more round. Harvest maturity is also indicated by the presence of latex stains on the surface of the fruit and a lack of luster. Fruit are ready for harvest as a starchy vegetable once small drops of latex appear on the surface or brown stains become noticeable (Figure 1). The amount of brown staining intensifies as the fruit become fully ripe.

Fruit firmness can also be used to determine harvest maturity. Unripe starchy fruit will be solid and not yield when squeezed, while ripe dessert-stage fruit will be noticeably softer and yield when squeezed.

The principal internal indices of breadfruit maturity are flesh colour and sugar composition. The flesh of mature but unripe breadfruit is white, starchy, and somewhat fibrous. Fully ripe breadfruit has a pale yellow flesh colour and is



**Figure 1. Brown stains on the fruit surface from latex exudation indicate harvest maturity.**

somewhat soft and fragrant. Unripe breadfruit has very little sugar and is consumed primarily for its starchy texture. The pulp of unripe breadfruit typically contains 25% to 30% carbohydrate, half of which is starch. As the fruit continues to mature, the flesh becomes noticeably sweeter due to conversion of some of the starch into sugar.

### **Harvest Methods**

The fruit on a tree are of different physiological ages and do not reach maturity simultaneously. Therefore, harvesting involves climbing the tree and/or using a long pruning pole, where the fruit is cut and caught by hand or in a net, before hitting the ground. Where the fruit can be reached, they should be harvested by snapping the stem of the fruit off the tree at the point adjacent to the branch, and not the fruit. Latex typically exudes from stems cut too short, and if allowed to contact the fruit surface will result in brown staining. Stem length should generally be between 5 cm to 12.5 cm (2 in to 5 in). When the stem is cut too short, it should be allowed to drain before putting the fruit in the harvest container. Care must also be taken to avoid damage to the fruit surface during harvest. Latex exudes from damaged tissue and causes staining.

Breadfruit should never be knocked from the tree or dropped to the ground, as the resultant bruising will cause rapid softening and a significant reduction in market life. After detachment, the fruit should be carefully lowered to the ground and placed on a clean surface in a shaded area with the stem pointed outwards. The stem should be re-cut with a sharp knife to a length of several centimeters. The cut stem should be oriented downward to prevent latex exudation onto the fruit surface and subsequent brown staining of the skin. The latex flow will soon cease and the fruit should be graded in the field to remove decayed, damaged, undersized, over-ripe, or stem-less fruit.

The marketable breadfruit should be transferred to a strong wooden or durable plastic field container which is well ventilated and has a smooth inside finish to avoid abrasion damage of the fruit surface. Synthetic sacks or mesh bags should not be used as field containers. The coarse texture of the woven fabric will cause abrasion damage to the fruit surface as the sacks are transported. As a result, latex exudation will occur and the fruit surface will be stained

The field containers should be carefully loaded and stacked in the transport vehicle to minimize handling damage to the fruit. There should be adequate ventilation through the field containers and the transport vehicle should have a protective cover over the breadfruit containers. 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 packing area or consolidation facility, the field containers should be unloaded with care and put in a shaded well-ventilated area protected from rain.

### **Preparation for Market**

Various steps should be followed in preparing breadfruit for market. These involve cleaning, grading/sorting, packing, possibly waxing, and in some cases storage.

### *Cleaning*

The initial step in preparing breadfruit for market is to clean the surface of the fruit and remove any dirt or adhering leaf tissue. Latex stains should be avoided by using careful harvesting and handling practices. However, once the fruit surface has been stained, it is generally not possible to remove the stains.

Small scale operations usually choose to clean the individual fruit by wiping them with a damp cloth. Larger volume operations may choose to use a water dump tank or overhead spray wash system to clean the fruit. In order to avoid the spread of disease, the wash water should be clean and regularly sanitized by maintaining a 150 ppm sodium hypochlorite concentration and a water pH of 6.5. The chlorine level and pH of the wash water should be checked frequently during the day with paper test strips or portable meters. Following cleaning, the fruit should be placed on a flat surface to air dry prior to grading/sorting, possibly waxing, and packing.

### *Grading/Sorting*

The next step in market preparation involves making a final selection of the fruit according to the requirements of the market. The quality requirements of export grade breadfruit are considerably more stringent than domestic marketed fruit. However, there are no domestic or international grade standards for breadfruit. Regardless of the market destination, the fruit should be sorted according to size, shape, firmness, and appearance. The fruit should be mature, firm, clean, free of objectionable latex stains, uniformly shaped, free of wounds and cracks, and free of sunburn, insect damage and decay. In addition, the fruit should have an intact green stem with a length of several centimeters.

Breadfruit intended for the export market should have a minimum weight of 1.2 kg (2.5 lb) and a maximum weight of 3 kg (6.6 lb). The fruit should be classified into several different sizes. Fruit classified as large should weigh between: 2 kg to 3 kg (4.4 lb to 7 lb). Fruit classified as small should weigh between 1.2 kg to 2 kg (3 lb to 4.4 lb). Fruit shape can be either round or ovoid and the diameter should be between 20 cm to 30 cm (8 in to 12 in).

### *Waxing*

Breadfruit may benefit from a postharvest wax application. Waxing reduces postharvest weight loss, minimizes shriveling, and extends market life. A thin coating of paraffin wax is most commonly used. It is applied by rapidly dipping the fruit in a solution of liquid paraffin. A carnauba-based wax may be used if the market prefers a more shiny surface. The simplest ways to make a carnauba wax application are as a manual rub or an overhead spray of water-emulsion wax as the fruit are rotating on a bed of soft brushes.

## *Packing*

Breadfruit is packed in various types of containers, depending on the market destination. A strong, stackable, well-ventilated wooden crate is preferred for domestic marketing. The crates should be lined with newspaper to minimize abrasion of the breadfruit surface. Packing of breadfruit in large synthetic or mesh sacks should be avoided, as these types of containers offer little or no protection to the fruit. Considerable bruise damage and skin abrasion may occur to the breadfruit during transit and handling.

Breadfruit destined for export is typically packed in strong, well-ventilated fiberboard cartons weighing either 9 kg or 18 kg (20 lb or 40 lb). Fruit are packed according to count (size). A single layer of uniformly sized and shaped fruit is put in each carton. Thin fiberboard dividers are used to separate the fruit within the carton in order to minimize surface abrasion and skin damage.

## **Temperature Control**

The optimum storage temperature for breadfruit is 12.5°C (55°F). Potential market life at this temperature will be 3 weeks. Storage at higher temperatures will result in fruit softening and significantly reduce market life. Holding breadfruit at ambient temperature will likely allow for no more than 1 week of market life. On the other hand, holding breadfruit below 12°C (54°F) will result in chilling injury. Storage of breadfruit in poorly ventilated areas or with other high ethylene producing fruits should be avoided.

## **Relative Humidity**

The optimal relative humidity (RH) for holding breadfruit is between 90% to 95%. Weight loss and shriveling of the fruit surface is significantly higher at low RH's.

## **Principal Postharvest Diseases**

Breadfruit is susceptible to several different postharvest diseases, although to a lesser degree than many other tropical fruit. Fungal and bacterial infections are usually seen when the fruits are very ripe and the internal structure begins to break down. Physical damage is the major cause of postharvest decay of unripe breadfruit. Physical damage may be incurred during harvest, by rough handling, from improper packaging, or during transport. Wounds such as punctures, cuts, abrasions, and cracks provide potential points of entry for decay organisms.

Postharvest decay can be adequately controlled by following a regular sanitation program in the field, application of pre-harvest fungicides, careful harvesting and handling practices to avoid wounding of the fruit, and holding the fruit at 12.5°C (55°F).

The principal postharvest fungal diseases causing fruit decay are brown rot (*Phytophthora palmivora*), soft rot (*Rhizopus artocarpi*), and pink rot (*Botryobasidium*



*palmivora*). Brown rot is usually the most common and produces circular to oval-shaped brown lesions on the fruit surface.

## **Postharvest Disorders**

### *Chilling Injury*

Storage of breadfruit at temperatures below 12°C (54°F) will result in chilling injury (CI). It is a type of low-temperature injury that becomes more severe as the temperature decreases and the length of exposure increases. Damage from CI may occur within 7 days of storage at 4°C (40°F). Symptoms of CI include a brown scald-like discolouration of the skin, internal browning of the flesh, increased water loss, increased susceptibility to decay, and detrimental changes in flavour. Fruit texture will also be adversely affected, as the flesh will not soften uniformly.

## 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.

### **OTHER PLANNED PUBLICATIONS**

Cabbage: Postharvest Care and Market Preparation.

Calaloo: Postharvest Care and Market Preparation.

Coconut: Postharvest Care and Market Preparation.

Cucumber: Postharvest Care and Market Preparation.

Lemon: Postharvest Care and Market Preparation.

Starfruit: Postharvest Care and Market Preparation.

Tangerine: Postharvest Care and Market Preparation.

Yam: Postharvest Care and Market Preparation.

## Harvest Maturity Indices

Breadfruit is usually ready for harvest about 3 months after flowering. The proper stage for harvesting breadfruit depends on the intended use. Breadfruit has a high starch content and is used as a vegetable when mature but not ripe, and as a dessert when ripe. During ripening, the starch turns to sugar and the fruit develops a sweet custard taste. The principal external methods of determining harvest maturity are skin colour, texture and appearance of the fruit surface and firmness.

Breadfruit should be harvested when green in colour and firm in texture if it is to be used as a starchy vegetable. The fruit should be left to ripen and harvested at a later stage when used as a dessert. The skin colour of ripe fruit becomes yellow-green with red-brown areas. In addition, the stem of ripe fruit becomes yellow-green in colour.



The texture and appearance of the fruit surface shows harvest maturity. The surface of breadfruit is patterned with irregular polygon shaped sections that flatten and enlarge when mature. Breadfruit harvested as a starchy vegetable should have sections that are angular and ridged noticeably that stick out on the surface, while the individual segments of dessert-stage fruit should be smoother, flatter, and more round. Harvest maturity can be judged by the occurrence of latex stains on the surface of the fruit and a lack of shine. Fruit are ready for harvest as a starchy vegetable once small drops of latex appear on the surface or brown stains become noticeable. The amount of brown staining increases as the fruit become fully ripe.

Fruit firmness can also be used to determine harvest maturity. Unripe starchy fruit will be solid and not yield when squeezed, while ripe dessert-stage fruit will be noticeably softer and yield when squeezed. The principal internal indices of breadfruit maturity are flesh colour and sugar composition. The flesh of mature but unripe breadfruit is white, starchy, and somewhat fibrous. Fully ripe breadfruit has a pale yellow flesh colour and is somewhat soft and fragrant.

Unripe breadfruit has very little sugar and is consumed primarily for its starchy texture. As the fruit continues to mature it becomes sweeter due to conversion of some of the starch into sugar.

## Harvest Methods

The fruit on a tree are of different physiological ages and do not reach maturity at the same time. Therefore, harvesting involves climbing the tree and/or using a long pruning pole, where the fruit is cut and caught by hand or in a net, before hitting the ground. Where the fruit can be reached, they should be harvested by snapping the stem of the fruit off the tree at the point closest to the branch, and not the fruit. Latex typically comes from stems cut too short, and will stain the fruit surface brown. Stem length should generally be between 5 cm to 12.5 cm (2 in to 5 in). When the stem is cut too short, it should be allowed to drain before putting the fruit in the harvest container. Care must also be taken to avoid damage to the fruit surface during harvest. Latex also comes from damaged tissue and causes staining.

Breadfruit should never be knocked from the tree or dropped to the ground. This will bruise the fruits and cause rapid softening of the tissue and shorten market life. After cutting the fruit from the tree, the fruit should be carefully lowered to the ground and placed on a clean surface in a shaded area with the stem pointed outwards. The stem should be re-cut with a sharp knife to a length of several centimeters. The cut stem should be oriented downward to prevent latex from dripping onto the fruit surface which causes brown staining of the skin. The latex flow will soon end. The fruit should be graded in the field to remove decayed, damaged, undersized, over-ripe, or stem-less fruit.

The marketable breadfruit should be transferred to a strong wooden or durable plastic field container that is well ventilated and has a smooth inside finish to avoid damage of the fruit surface. Synthetic sacks or mesh bags should not be used as field containers. The coarse texture of the woven fabric will cause scratches and damage to the fruit surface as the sacks are transported. This can result in more latex stains.

The field containers should be carefully loaded and stacked in the transport vehicle to minimize handling damage to the fruit. There should be good ventilation through the field containers and the transport vehicle should have a protective cover over the containers.

Ideally, the fruit should be transported during the coolest time of the day in order to reduce heat build-up inside the transport vehicle. Field containers should be unloaded with care immediately after transport to the packaging facility, put in a shaded well-ventilated area and protected from rain.

## Preparation for Market

### *Cleaning*

The initial step in preparing breadfruit for market is to clean the surface of the fruit and remove any dirt and leaf tissue. Latex stains should be avoided by using careful harvesting and handling practices. Once the fruit surface has been stained, it is usually not possible to remove the stains. Small scale operations usually choose to clean the individual fruit by wiping them with a damp cloth. Larger volume operations may choose to use a water dump tank or overhead spray wash system to clean the fruit. In order to avoid the spread of disease, the wash water should be clean and regularly sanitized by maintaining a 150 ppm sodium hypochlorite concentration and a pH of 6.5. This is equal to 2 oz of household bleach (such as Marvex) per 5 gallons of water, or .3 liters of bleach per 100 liters of water. The chlorine level and pH of the wash water should be checked frequently during the day with paper test strips or portable meters. Following cleaning, the fruit should be placed on a flat surface to air dry prior to grading/sorting, possibly waxing, and packing.

### *Grading/Sorting*

The next step in market preparation is making a final selection of the fruit according to the requirements of the market. The quality requirements of export grade breadfruit are considerably more strict than domestic marketed fruit. However, there are no domestic or international grade standards for breadfruit. Regardless of the market, the fruit should be sorted according to size, shape, firmness, and appearance. The fruit should be mature, firm, clean, free of large latex stains, evenly shaped, free of wounds and cracks, and free of sunburn, insect damage and decay. In addition, the fruit should have an intact green stem with a length of several centimeters.

Breadfruit for the export markets should have a minimum weight of 1.2 kg (2.5 lb) and a maximum weight of 3 kg (6.6 lb). The fruit should be classified into several different sizes. Fruit classified as large should weigh between: 2 kg to 3 kg (4.4 lb to 7 lb). Fruit classified as small should weigh between 1.2 kg to 2 kg (3 lb to 4.4

lb). Fruit shape can be either round or oval and the diameter should be between 20 cm to 30 cm (8 in to 12 in).

#### *Waxing*

Breadfruit may benefit from a postharvest wax. Waxing reduces postharvest weight loss, minimizes shriveling, and increases market life. A thin coating of paraffin wax is most commonly used. It is applied by rapidly dipping the fruit in a solution of liquid paraffin. A carnauba-based wax may be used if the market prefers a shiny surface. The simplest ways to make a carnauba wax application are as a manual rub or an overhead spray of water-emulsion wax as the fruit are rotating on a bed of soft brushes.

#### *Packing*

Breadfruit is packed in various types of containers, depending on the market. A strong, stackable, well-ventilated wooden crate is preferred for domestic marketing. The crates should be lined with newspaper to minimize scratches to the surface. Packing of breadfruit in large synthetic or mesh sacks should not be done; these types of containers offer little or no protection to the fruit. Considerable bruising and scratching may occur during transit and handling.

Breadfruit destined for export is usually packed in strong, well-ventilated fiberboard cartons weighing either 9 kg or 18 kg (20 lb or 40 lb). Fruit are packed according to count (size). A single layer of evenly sized and shaped fruit is put in each carton. Thin fiberboard dividers are used to separate the fruit within the carton in order to minimize surface and skin damage.

#### **Temperature Control**

The best storage temperature for breadfruit is 12.5°C (55°F). Market life at this temperature will be about 3 weeks. Storage at higher temperatures will result in fruit softening and short market life. Holding breadfruit at average temperatures will likely allow for no more than 1 week of market life. Avoid storing breadfruit in poorly ventilated areas or with other high ethylene producing fruits.

Storing breadfruit at temperatures below 12°C (54°F) will result in chilling injury (CI). It is a type of low-temperature injury that becomes more severe as the temperature decreases and the length of exposure increases. Damage from CI may occur within 7 days of storage at 4°C (40°F). Symptoms of CI include a brown scald-like discoloration of the skin, internal browning of the flesh, increased

water loss, increased decay, and negative changes in flavour. Fruit texture will also be affected, as the flesh will not soften evenly.

The optimal relative humidity (RH) for holding breadfruit is between 90% to 95%. Weight loss and shriveling of the fruit surface is significantly higher at low RH's.

#### **Principal Postharvest Diseases**

Fungal and bacterial infections are usually seen when the fruits are ripe. The major cause of postharvest decay of breadfruit is physical damage to the fruit, which usually happens during harvest, through rough handling, poor packaging, or during transport. Wounds such as punctures, cuts, scratches, and cracks provide potential points of entry for decay.

Postharvest decay can be controlled by following a regular sanitation program in the field, application of pre-harvest fungicides, careful harvesting and handling practices to avoid wounding of the fruit, and holding the fruit at 12.5°C.

The main postharvest diseases are brown rot, soft rot, and pink rot. Brown rot is usually the most common and produces circular to oval-shaped brown spots on the fruit surface.

#### **Technical bulletins also available on Waxing Fruits and Vegetables. Contact:**

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With the assistance of  
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**New Guyana Marketing Corporation**

# **BREADFRUIT**

## **Postharvest Care and Market Preparation Information Sheet**



*This information sheet provides growers and agriculture extension personnel with a summary of the recommended harvest and postharvest handling practices for breadfruit. A more technical and detailed bulletin is available from the New Guyana Marketing Corporation (NGMC) and the National Agricultural Research Institute (NARI).*