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Postharvest Handling
Technical Bulletin

YAM

Postharvest Care and Market Preparation

Technical Bulletin No. 32

May 2004

POSTHARVEST HANDLING TECHNICAL SERIES

YAM

Postharvest Care and Market Preparation

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

Technical Bulletin No. 32

May 2004

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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

There are several types of yam produced in Guyana. The main type, *Dioscorea alata*, normally produces a single large tuber, often weighing from 5 kg to 10 kg (11 lbs to 22 lbs). The tubers are variable in size and shape and have a brown to gold coloured skin with white or purplish flesh. Another type, *Dioscorea esculenta*, produces a large number of small tubers that typically have numerous uneven sprouting hairs. The tubers have a much indented shape with purplish-brown skin and white flesh. A third type, *Dioscorea cayenensis,* produces tubers of variable size and shape, usually with a pale yellow flesh. Postharvest care is identical for all types of yam. Yams may suffer considerable postharvest losses due to moisture (weight) loss, microbial decay, sprouting, and insect attack. These losses affect both market supply and availability of planting material. Yam tubers are harvested once a year and therefore need to be properly stored for maximum market life.

Harvest Maturity Indices

Several indices can be used to determine when to harvest yams. The foliage of most types of yams begins to wilt and senesce when the tubers mature. Therefore, harvest should take place after a significant portion of the foliage has naturally turned yellow or dried up. Wilted foliage is a sign of physiological maturity of the tuber. Growth of the tuber is essentially completed several weeks prior to visible wilting. Harvest should be completed within 1 or 2 months of wilting, otherwise losses due to tuber rot will occur.

In some types of yams the vines do not wilt or noticeably senesce. In these types, the tubers should be harvested based on the amount of time from planting. Yams reach maturity from 8 to 10 months after planting, depending on the cultivar. Several randomly selected plants can be harvested beginning 8 months after planting to determine the average tuber size in the field.

Harvest Methods

Yam harvesting is usually done manually. A portion of the soil surrounding the tuber(s) is removed prior to lifting the tubers with a spade or other suitable digging tool. Harvest carefully using tools suited to the soil type and paying attention to the depth to which the tubers penetrate. Harvesting is easier when the soil is moist and the soil texture is light. In light soils, the tuber(s) can be slowly lifted out of the ground by pulling the main stem. In heavier soils or during the dry season, harvesting usually requires digging around the tubers to free them prior to lifting the plant or further digging. While digging and lifting, care should be taken not to injure the tubers, which are delicate and easily bruised during harvest and handling. The tubers should never be thrown or dropped. Wounded tissue is an entry point for decay causing micro-organisms. Pile harvested yams in small heaps in the field or place directly into field crates for removal from the field. Avoid leaving the yams exposed to direct sun for longer than 30 minutes.

Yams should be graded in the field and unmarketable, damaged, or diseased tubers should be discarded. Damaged tubers are highly susceptible to decay, particularly if the post-harvest curing is inadequate. Choose only healthy and undamaged tubers for curing and storage. Cotton gloves are typically worn to facilitate field cleaning of the tubers. Sound tubers should be gently dry brushed to remove excess soil prior to curing. The yams should be gently placed in smooth or padded field containers for transport out of the field. Transport from the field to the packinghouse is best carried out using strong, well-ventilated field crates. Transport in mesh or polypropylene sacks will increase the level of skin damage due to abrasion. When locally made containers have sharp edges or rough inner surfaces, a thin fiberboard liner should be used to protect the tubers from damage during handling and transport.

Curing

Proper curing of yams immediately following harvest is one of the simplest and most effective ways to extend storage life, reduce water loss, and minimize decay during storage. The curing treatment should begin as soon as possible after digging. Curing is a process in which the skin thickens and new tissue forms beneath the surface of injured areas in the tuber. The optimal conditions for curing yams are holding the tubers at 29°C to 32°C (85°F to 90°F) and high relative humidity, RH (90% to 95%) for 4 to 5 days immediately following harvest. The curing process does not occur at temperatures below 23°C (73°F) or RH’s below 65%. On the other hand, the temperature should not exceed 35°C (95°F) nor should the RH be so high (i.e. 100%) where moisture condensation occurs on the surface of the yam. Uncured yams will deteriorate faster and lose more weight than adequately cured yams.

Yams can be cured outdoors if piled in a partially shaded area. Cut well dried grasses or straw can be used as insulating materials and the pile should be covered with canvas, burlap or woven grass mats (Figure 1). Curing requires a high temperature and high RH; and the insulated and covered pile will trap self-generated heat and moisture. The covered pile should be left undisturbed for about a week to complete the curing process.

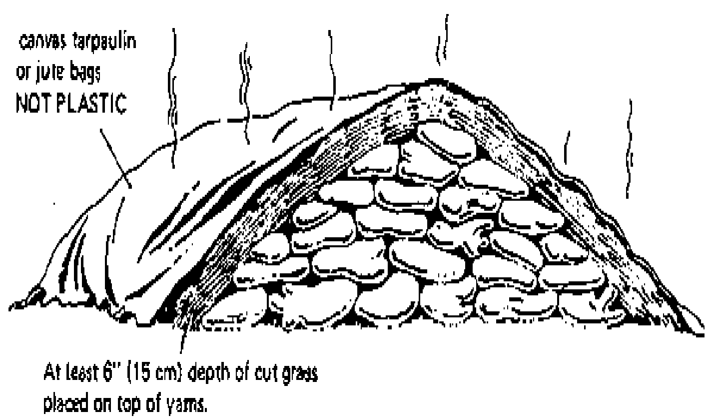


Figure 1. Cut-away view of outdoor curing of yams.

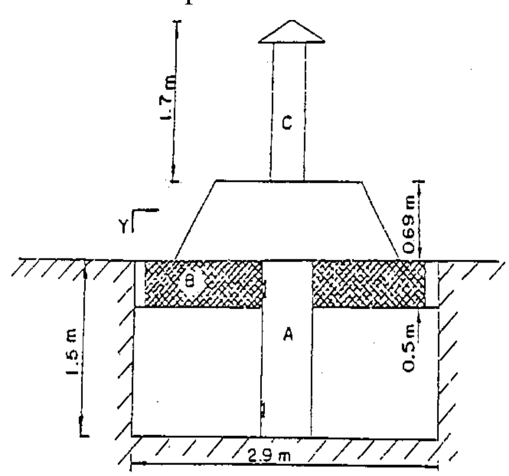
Yams can also be cured inside a protected structure at ambient temperature, provided the RH is high. A high RH can be obtained by wetting the floor or using a small electric humidifier. The tubers can be left in their field crates during curing, provided that they are well-ventilated and sufficiently strong enough to be stacked.

Yams should never be washed prior to curing and/or storage, as this will promote decay. However, any injured or decayed portions of the tuber can be cut clean and rubbed with alkaline material (lime, chalk or wood ashes) to discourage re-infection. The tubers should be stored in bins or crates, and washed only prior to packing for market. Yams which haven't been cured should be marketed soon and not exported.

Storage

After the yams have been adequately cured, they should be moved to a longer term storage facility. Tubers which have partially deteriorated following curing should be separated from the marketable tubers before storing. Only sound, healthy tubers are suitable for storage. If not done previously, the tubers should be graded according to size prior to storage so that a uniform quality can be provided at any time.

Yams can be stored for up to several months inside properly ventilated, non-refrigerated covered storage structures. These types of structures include pits in the ground, trenches, silos, and covered piles in the field. Ground pits along Guyana's coast are not appropriate due to the high level of the water table. The amount of postharvest loss can be considerable using traditional yam storage structures. Bacterial and fungal decay, insect and rodent attack, and sprouting are all common problems associated with ambient temperature storage inside rudimentary structures. These structures are used mainly for early crop yams harvested before the end of the rainy season that will be kept only for limited periods. Continuous inspection of tubers is very difficult and in many cases impossible. Therefore, in most traditional storage structures the postharvest losses are detected only when the yams are removed prior to sale. The amount of loss depends on the type of storage structure, yam cultivar, length of storage, and frequency of monitoring for decayed tubers. Yams should be inspected at least every two weeks. Remove decayed tubers immediately to prevent further contamination. Partially damaged tubers may be chipped and dried or used immediately.



A: Door
B: Grilled Openings
C: Chimney

Figure 2. Simple ventilated cellar covered with a metal cupola for storing several hundred yams.

A simple ventilated cellar for storage of about 200 tubers can be built by digging a rectangular pit 3 m (10 ft) long by 1 m wide (4 ft) by 2 m (5 ft) deep. A cupola-shaped metal roof is used to protect against penetration of rainwater in the cellar (Figure 2). Grilled openings and a chimney in the center improve the ventilation. The chimney is painted black, which increases air movement through the storage facility. The temperature inside the in-ground cellar will typically range from 21°C and 24°C (70°F and 75°F), which is considerably lower than ambient above-ground air temperature. The average relative humidity in the cellar generally varies between 80% to 90%, which is close to optimal. Although the temperatures inside the cellar are not optimal for long term storage, they are significantly better than storing at ambient temperatures. Again, such a pit would not be appropriate in areas where the water table is high.

A yam barn is another commonly used traditional structure. Fast-growing, live trees are used to create a rectangular structure, and form the framework of the barn as well as provide shade (Figure 3). The barns vary in design and construction but all consist in principle of a vertical or nearly vertical wooden framework to which the tubers are fastened individually with string or other local cord material. The frames are usually 1 m to 2 m (3ft to 6 ft) in height but can be as much as 4 m (13 ft) high and are from 2 m (6ft) upwards in length according the amount of material to be stored. The vertical posts of the frame are made from wooden posts or sections of live trees which root when set in the ground (i.e. species of *Dracaena*). This reduces the risk of collapse as a result of termite attack or rotting and also helps to provide shade. Poles of 5 cm to10 cm (2 in to 4 in) in diameter are placed in the ground about 1 m apart and cross members of lighter wood, bamboo, or palm-leaf midribs are attached. To these are fastened lighter vertical sticks providing a fairly rigid structure. The walls are covered with woven plant material. The yam tubers are hung up to a height of 2 m to 3 m (6 ft to 9 ft), (Figure 4). A thatched roof may be added for shade or the branches sprouting from the live poles may provide the only shade. This structure is popular for its simplicity and modest cost. However, the temperature and humidity are similar to the ambient air and therefore are not ideal for optimal storage. The temperature inside traditional storages typically ranges from 30°C to 35°C (86°F to 95°F), which is considerably higher than the ideal storage temperature of 12.5°C (54.5°F).

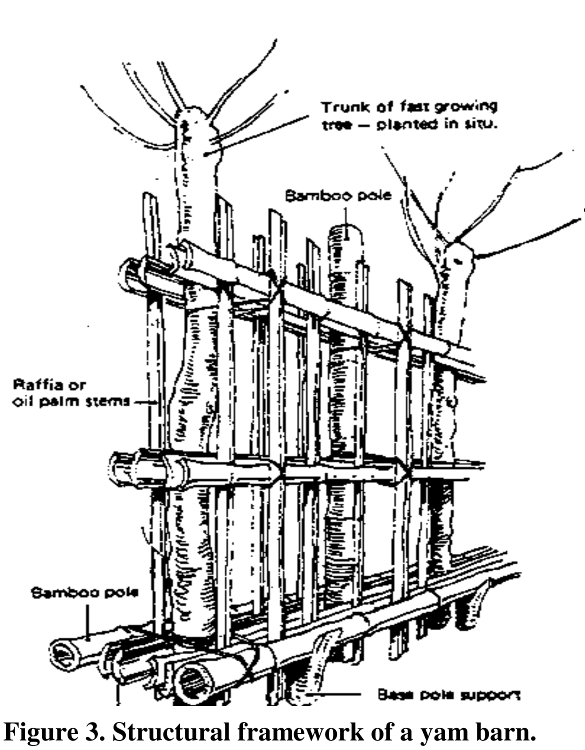


Figure 3. Structural framework of a yam barn.

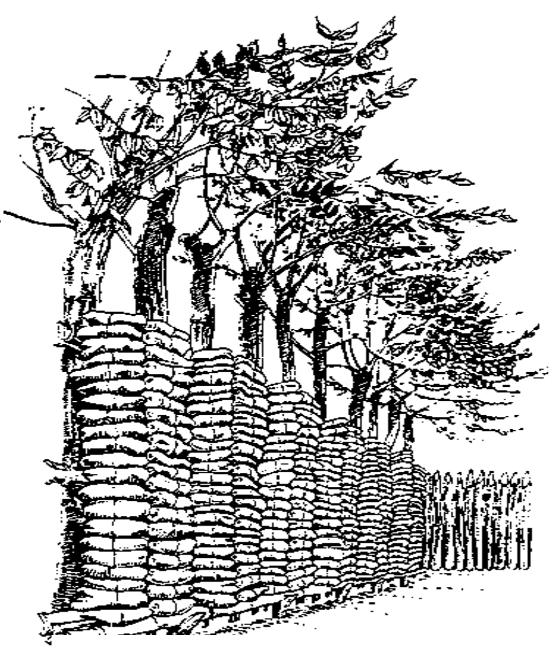


Figure 4. Inside of barn showing tying of yams.

There are several types of larger storage structure designs that can hold about 3 tons (3,000 kg or 6,614 lb) of yams and can also be made from locally available materials (wood, bamboo, straw, etc). Dimensions vary according to need. One such structure consists of a raised hut mounted on poles fitted with anti-rodent shields (Figure 5). The floor should be about 1 m above the ground. The rodent guards consist of metal sheets that are wrapped around all poles and have a length of at least 30 cm (12 in). In some areas, protective measures against termites have to be considered. A simple and cheap method is dipping the lower part of the legs that support the hut into wood preventatives or neem oil. Inside the raised hut, the yams should be stored on shelves so that they can be inspected easily and rotten tubers should be removed. Large tubers are placed one layer deep, while small tubers are placed two or three layers deep. The raised hut provides excellent natural aeration, facilitates regular checks, and can be locked. It also prevents access by rodents, and can be used for storing other commodities.

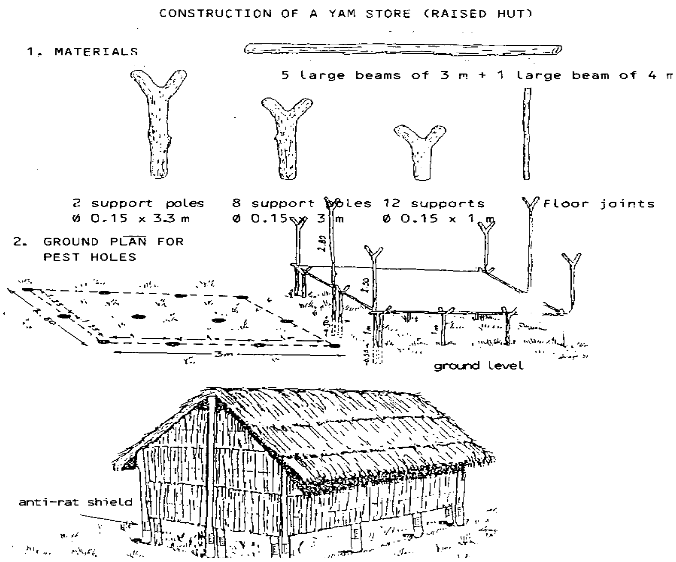


Figure 5. Construction of a raised hut storage structure.

A second structure is a combination cellar-hut (Figure 6). A trench 4 m x 2 m x 1.8 m deep (13 ft x 6.6 ft x 6 ft deep) is dug in the ground and enclosed with mud walls 60 cm (24 in) outside the edges of the trench, which provide space for air movement. Wooden planks forming a duckboard are placed in the bottom of the trench and covered with straw to provide insulation of the tubers from the soil. Alleys about 30 cm (12 in) wide, are established between the walls of the trench and the stacks of yams and between the stacks themselves (50 cm or 20 in wide). The alleys facilitate air circulation and tuber inspection. A high relative humidity is established inside the cellar-hut which results in less tuber weight loss and dehydration. Again, the use of pits is not recommended in areas of a high water table.

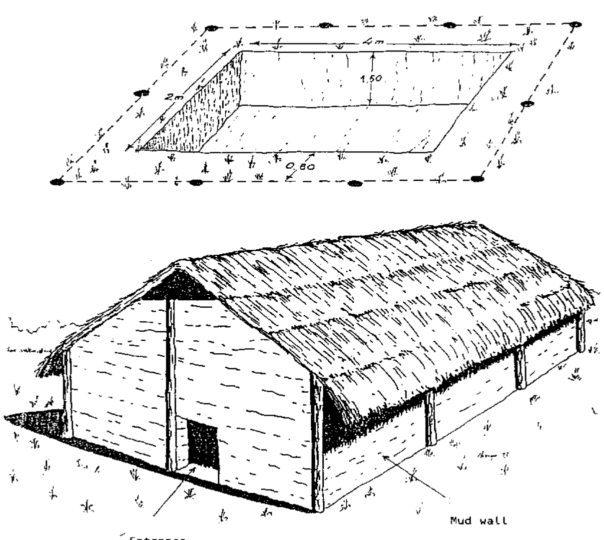


Figure 6. The cellar-hut storage structure.

If handled correctly, good quality yams may be stored successfully for several months under ambient temperatures with little change in quality and minimal postharvest losses. The storage life of yams is limited to their dormancy period, after which they begin to sprout and quickly lose their dietary value. Cultivars vary in their dormancy period (generally between 2 to 4 months) and potential storage life.

Storage durations up to 5 to 6 months can be realized under refrigerated 13°C (55°F) conditions inside insulated storage buildings. Prolonging the storage life for this length of time will allow for the capture of high market prices when the yam supply is diminished. Properly constructed storage facilities will have adequate ventilation, protection from sunlight, and access for regular inspection. Concrete floors will help prevent rodent entry, as will screens on windows, vents and drains. Storage structures should be cleaned thoroughly before storing yams and kept clean at all times. The area outside the storage structure should also be kept free of weeds and debris to discourage rodents.

Temperature

The ideal storage temperature for yams is 13°C (55°F). At this temperature, most yam cultivars can be stored for up to 6 months. However, at temperatures of 27°C to 30°C (81°F to 86°F), yams will typically store for only 3 to 5 weeks in a marketable condition. Marine containers used for exporting yams should be set at 13°C during transit.

Relative Humidity

Although yams are relatively high in dry matter, the tubers still can lose considerable amounts of moisture during storage. Moisture loss is undesirable since it results in tuber shriveling and in some cases the formation of small internal cavities. Also, yams are mostly sold by weight and any moisture loss which occurs during storage will directly reduce the potential economic return for the crop. In order to minimize postharvest moisture (weight) loss and tuber shriveling, yams should be stored in a high relative humidity (RH) area. Ideally, yams should be stored at 90% to 95% RH. A high storage RH can be obtained by covering the tubers with yam vines, straw or similar material of plant origin. Use of supplemental humidifiers or water vaporizers is an effective way of obtaining a high RH inside enclosed storage areas that are well insulated.

Preparation for Market

Cleaning

The first step in market preparation is cleaning of the external surface of the tuber with a soft brush or cloth to remove large dirt particles. Relatively clean tubers sold in the domestic market may not require any further cleaning (Figure 7). However, yams intended for export typically must be thoroughly cleaned before packing. These yams should be washed by hand in clean water with 150 ppm hypochlorous acid to remove any remaining dirt and to sanitize the tuber surface. The root hairs should also be removed. Water pH should be maintained at 6.5 for optimal sanitizing activity of the hypochlorous acid. The cleaning water needs to be changed regularly to prevent the build-up of soil particles and contaminants. A fungicide treatment (500 ppm thiabendazole) is also recommended. The fungicide can be applied as a dip or overhead spray. After washing and fungicide treatment, the yams should be graded and packed according to market requirements and importer specifications.

Figure 7. Non-washed, but relatively clean yams for sale in the domestic market.

Grading/Sorting

Remove all badly damaged, cut, crushed or punctured tubers. The intact marketable tubers should be graded according to size and shape. Export destined tubers should be between 15 cm to 30 cm (6 in to 12 in) long and 10 cm to 20 cm (4 in to 8 in) in diameter. Yams of uniform size and shape should be packed in each carton. The skin should be smooth and dark brown. The internal flesh should be firm and uniformly coloured, without any indication of darkening. Depending on the type and the cultivar, yam flesh colour should either be pale yellow or white.

Packaging

After grading, the yams should be placed in a clean, strong, well-ventilated carton. The carton should have a bursting strength between 275 lb to 300 lb per inch. A two-piece full telescopic corrugated carton is preferred. A double-walled self-locking waxed carton is also acceptable. The surface of the tubers should be thoroughly dried prior to packing. Wet or damp yams should not be packed into cartons destined for export, as surface mould will soon develop. Yams destined for export are typically loose packed inside the cartons. Additional protection may be provided by wrapping alternate tubers with soft paper (Figure 8). Some importers in the U.K. prefer yams packed in peat moss, coconut fiber, or sawdust (Figure 9), but due to phytosanitary reasons, this practice is not allowed for exports to the U.S. Net carton weights are typically 13 kg, 18 kg, or 21 kg (30 lbs, 40 lbs, or 45 lbs) depending on the market and importer requirements. For marine shipments, an additional 5% packing weight is needed to account for weight loss during transport. Cartons must not be overfilled during packing.

Figure 8. Export market yams alternately wrapped in tissue paper.

Figure 9. Yams packed in peat moss and coconut fiber for the U.K. market.

Principal Postharvest Diseases

Yams are susceptible to postharvest decay by several different fungal and bacterial pathogens. Rodents and insect pests also attack yams during curing and storage, increasing the likelihood of postharvest deterioration. The most common postharvest diseases are listed below.

Blue and Green Mould

Blue and green mould are two of the most common postharvest diseases of yams. Both are caused by the fungus *Penicillium*, but the species differs. Typical symptoms include a blue or green mould growth associated with cut or damaged surfaces (Figure 10). In some cases, the inside of the yam may rot without any exterior symptoms. The rotted tissue is pale to dark brown, and may be firm or soft. Tubers are likely to be contaminated at harvest, and infection occurs via wounds. Decay is particularly rapid at temperatures between 15°C and 20°C (59°F to 68°F). Control of blue and green mould can be obtained by careful handling to minimize skin injury and immediate curing of the tubers after harvest to promote rapid wound healing. Use of a fungicide dip after harvest can also reduce the incidence of these diseases.

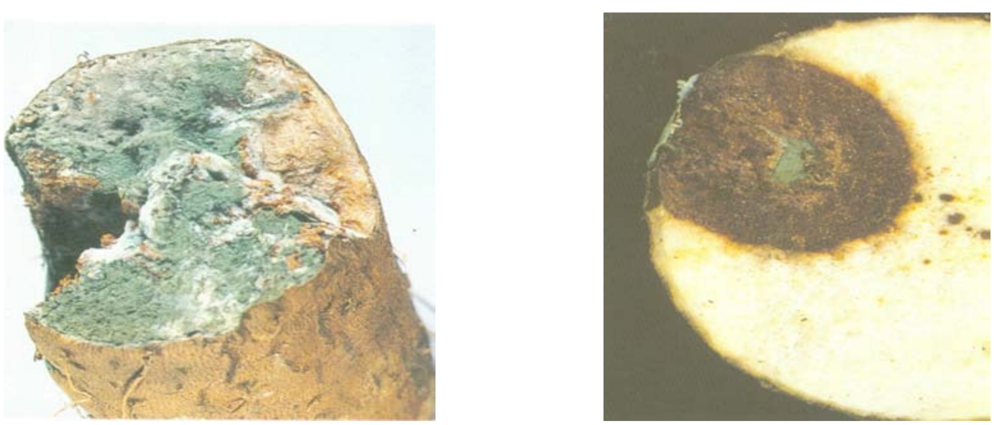


Figure 10. Blue mould (left) and green mould (right) decay of yams.

Botryodiplodia Rot

Figure 11. Distinct line of demarcation between Botryodiplodia-rotted and healthy tissue.

Botryodiplodia rot, caused by the fungus *Botryodiplodia theobromae*, is another common postharvest disease of yams. Infection typically occurs via injuries at the time of harvest. Affected tissue is either dark brown or black, with a distinct brown line between diseased and healthy tissue (Figure 11). The rotted tissue may be soft and water-soaked, or firm and dry, depending on the temperature and the presence of secondary decay organisms. At high temperatures (i.e. 30°C or 86°F), rotting is rapid. After several months of storage the rotted tubers become shriveled mummies. Control is obtained by careful harvesting and handling to avoid physical injury to the tuber. Proper curing is very important to permit healing of the wounds incurred during harvest. Storage of yams at 13°C (55°F) will substantially reduce the amount of decay. Yams stored for extended periods should be inspected every two weeks and partially decayed tubers should be discarded.

Fusarium Rot

The fungus *Fusarium* is a common soil-borne pathogen that infects yam tubers. Infection is typically associated with wounds or insect and nematode damaged tissue. Symptoms of Fusarium infection include dry, off-coloured tissue bordered by a brown margin. In humid environments, the yam surface may become covered with dense white mould (Figure 12). Protection against Fusarium is obtained by avoiding physical injury to the tissue and rapid curing after harvest. In addition, storage at 13°C (55°F) will significantly slow decay development. Dipping the tubers in a postharvest fungicide soon after harvest may also provide additional control.

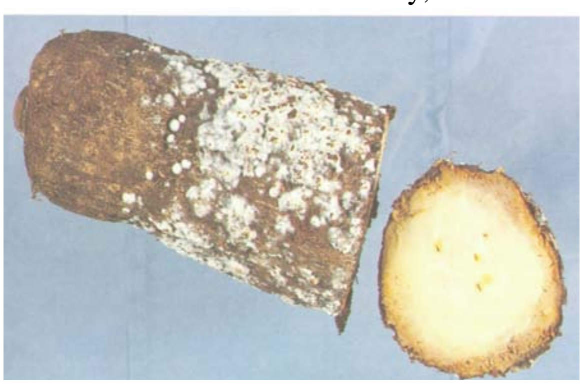


Figure 12. Dense white mould on surface of Fusarium-infected yam.

Rhizopus Rot

Watery rot, caused by the fungus *Rhizopus*, is one of the most rapidly developing storage rots of yams. Symptoms include a soft, watery rot that progresses rapidly and may rot an entire yam in a week. Infected tissue is mottled brown and soft, and in a humid atmosphere the infected area is soon covered with large amounts of white mould. The mould will eventually turn black. Watery rot can be minimized by careful handling to avoid injury and wounding of the tubers along with prompt curing at optimum temperature and humidity. Rhizopus is a wound pathogen and is not effective in colonizing healthy tissue. The postharvest fungicide 2,6-dichloro-4-nitroaniline (Botran) applied just prior to packing may reduce Rhizopus decay during transport to export market destinations.

Principal Postharvest Insects

Mealybugs are common insect pests which infest yams during storage. Several different species attack the tubers, including *Aspidiella hartii* and *Planococcus dioscorea*. They form whitish colonies which can cover the whole tuber. The insects suck the juice out of the yam which results in a significant weight loss and secondary decay. Yams infested with mealybugs are generally not marketable. Several different moth species may also be detrimental to the tubers during storage. The pyralid moth (*Euzopherodes vapidella*) normally infests the tubers shortly after harvest. It lays its eggs in existing wounds, but can also penetrate healthy areas of the skin. The larvae eat the internal flesh, leaving only the corked epidermis. Termites can also attack yams during storage and eat out a whole tuber within a few weeks. Postharvest insect control is obtained by good sanitation practices, removal of infested tubers during storage, and the use of appropriate fumigants and insecticides.

Storage Disorders

Sprouting

Yams have a natural dormancy period which occurs shortly after physiological maturity of the tubers (wilting point). The storage potential of yams is correlated with their length of dormancy. The storage life of yams is finally terminated by the breaking of dormancy and subsequent sprouting. The duration of natural dormancy differs according to the cultivar and the type of yam, but generally ranges between 4 and 18 weeks. Storage temperature greatly influences the extent of the dormancy period. Following the dormant period, sprouting will occur at temperatures above 13°C (55°F). Sprouting is more rapid at higher temperatures and results in a decrease in tuber quality. The yellow yam has a shorter dormancy period than the white yam and consequently will sprout sooner. Storage life of the tubers can be extended by as much as a month by breaking off the emergent sprouts when they reach 2 cm to 3 cm long (about 1 inch). All sprouts should be removed before they have attained a length of 5 cm (2 in).

Chilling Injury

Storage of yams at temperatures below 13°C (55°F) will result in a type of physiological breakdown of the tuber known as chilling injury (CI). The amount of CI depends on the specific temperature and the length of time the tubers are exposed to chilling temperatures. In all cases, the amount of damage from CI will be greater as the temperature decreases and the length of exposure time increases. Slight injury may occur as soon as 2 days at 4°C (40°F) or 5 days at 8°C (46°F). Typical symptoms of CI include external pitting and sunken lesions on the tuber surface followed by fungal decay (Figure 13). Darkening and brown spotting of the flesh is an undesirable internal quality defect of chilling injured yams.

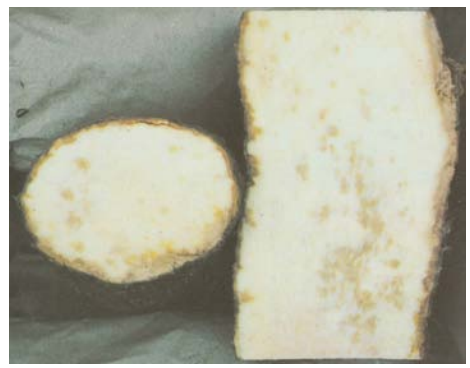


Figure 13. External symptoms of CI (left) include sunken lesions and mould growth, while internal symptoms (right) include brown spotting of the flesh.

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.

Harvest Maturity Indices

One of the best signs of maturity for yams are the plant leaves. The leaves begin to wilt and age when the tubers mature. Harvest should take place after a large amount of the leaves have naturally turned yellow or dried up. Harvest should be completed within 1 or 2 months of wilting.

In some types of yams the vines do not wilt or noticeably age. In these types, the tubers should be harvested based on the time from planting. Yams reach maturity 8 to 10 months after planting, depending on the cultivar. Several randomly selected plants should be harvested beginning 8 months after planting to determine average tuber size in the field.

Harvest Methods

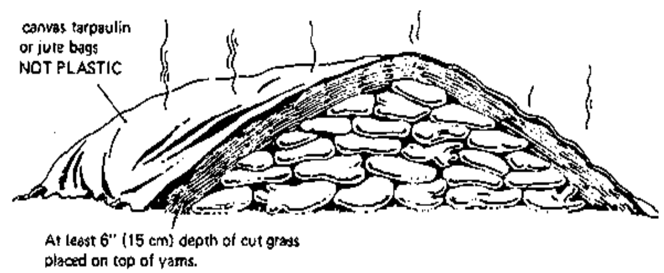
For best results, harvest carefully using tools suited to the soil type and paying attention to how deep the tubers are in the soil. Harvesting is easier when the soil is moist. In light soils, the tuber(s) can be slowly lifted out of the ground by pulling the main stem. In heavier soils or during the dry season, harvesting usually requires digging around the tubers to free them before lifting the plant or further digging. While digging and lifting, care should be taken not to injure or throw the tubers, which are delicate and easily bruised. Put harvested yams in small piles in the field or place directly into field crates for removal from the field. Avoid leaving the yams exposed to direct sun for longer than 30 minutes.

Yams should be graded in the field and damaged or diseased tubers should be throw out. Choose only healthy and undamaged tubers for curing and storage. Healthy tubers should be gently dry brushed with cotton gloves to remove excess soil prior to curing. The yams should be gently placed in smooth or padded well-ventilated field containers for transport out of the field. Transport in mesh or polypropylene sacks will increase the level of skin damage due to abrasion.

Curing

Proper curing of yams immediately following harvest is one of the simplest and most effective ways to extend storage life, reduce water loss, and minimize decay during storage. Curing is a process in which the skin thickens and new tissue forms beneath the surface of injured areas in the tuber. The best conditions for curing yams are 29°C to 32°C (85°F to 90°F) and high relative humidity (RH) (90% to 95%) for 4 to 5 days immediately following harvest. The temperature should not be greater than 35°C (95°F) nor should the RH be so high (i.e. 100%) where moisture condensation occurs on the surface of the yam. Uncured yams will decay faster and lose more weight than correctly cured yams and should be marketed quickly.

Yams can be cured outdoors if piled in a partially shaded area. Cut and dried grasses or straw can be used as insulating materials and the pile should be covered with canvas, burlap or woven grass mats. The covered pile should be left alone for about a week to complete the curing process.



Yams can also be cured inside a protected structure at ambient temperature, provided the RH is high. The tubers can be left in their field crates during curing, as long as they are strong and well-ventilated.

Yams should never be washed prior to curing and/or storage, as this will promote decay. However, any injured or decayed portions of the tuber can be cut clean and rubbed with alkaline material (lime, chalk or wood ashes) to discourage re-infection.

Storage Temperature

The best storage temperature for yams is 13°C (55°F). At this temperature, most yam cultivars can be stored for up to 6 months. However, at temperatures of 27°C to 30°C (81°F to 86°F), yams will usually keep in storage for only 3 to 5 weeks in a marketable condition. Bacterial and fungal decay, insect and rodent attack, and sprouting are all common problems associated with average temperature storage.

Relative Humidity

Moisture loss is undesirable since it results in tuber shriveling and in some cases the formation of small internal cavities. Ideally, yams should be stored at 90% to 95% relative humidity (RH).

Preparation for Market

Cleaning
The outer surface of the tuber should be cleaned with a soft brush or cloth to remove large pieces of dirt. Relatively clean tubers sold in the domestic market may not require any further cleaning. Yams planned for export should be washed by hand in clean water (pH 6.5) with 150 ppm hypochlorous acid to remove any remaining dirt and to sanitize the tuber surface. This is equal to 2 oz of household bleach (such as Marvex) per 5 gallons of water, or 0.3 liters of bleach per 100 liters of water. The cleaning water needs to be changed regularly to prevent the build-up of soil particles and contaminants. A fungicide treatment (thiabendazole or 2,6-dichloro-4-nitroaniline) is also recommended.

Grading/Sorting
Remove all badly damaged, cut, crushed or punctured tubers. The marketable tubers should be graded according to size and shape. Export destined tubers should be between 15 cm to 30 cm (6 in to 12 in) long and 10 cm to 20 cm (4 in to 8 in) in diameter. Yams of uniform size and shape should be packed in each carton. The skin should be smooth and dark brown. The internal flesh should be firm and uniformly coloured, without any indication of darkening. Depending on the type and the cultivar, yam flesh colour should either be pale yellow or white.

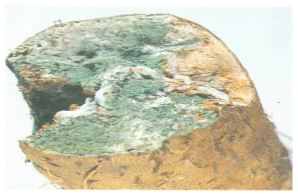
Packaging

After grading, the yams should be placed in a clean, strong, well-ventilated carton. The surface of the tubers should be thoroughly dried prior to packing to prevent surface mould from developing. Yams intended for export are usually loose packed inside the cartons. Additional protection may be provided by wrapping every other tubers with soft paper. Net carton weights are typically 13, 18, or 21 kg (30, 40, or 45 lbs) depending on importer requirements.

Principal Postharvest Diseases

Yams are vulnerable to a number of postharvest diseases. Infection usually occurs through wounds received during harvest and handling. Decay is particularly fast at ambient temperatures. Control of postharvest decay can be done by careful handling to minimize skin injury and immediate curing of the tubers after harvest to promote rapid wound healing. Storage of yams at 13°C (55°F) will considerably reduce the amount of decay. Yams stored for long periods should be inspected every two weeks and partially decayed tubers should be discarded. Application of a fungicide during packing can also reduce the rate of decay.

Blue and Green Mould

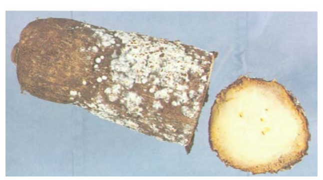


Typical symptoms include a blue or green mould growth associated with cut or damaged surfaces. In some cases, the inside of the yam may rot without any outer indication. The rotted tissue is pale to dark brown, and may be firm or soft.

Botryodiplodia Rot

Affected tissue is either dark brown or black, with a distinct brown line between diseased and healthy tissue. The rotted tissue may be soft and water-soaked, or firm and dry, depending on the temperature and the presence of secondary decay organisms. After several months of storage the rotted tubers become shriveled mummies.

Fusarium Rot



Symptoms are dry, off-coloured tissues bordered by a brown margin. The yam surface may become covered with thick white mould.

Watery (Rhizopus) Rot

Symptoms include a soft, watery rot that progresses rapidly. Infected tissue is brownish and soft, and in a humid atmosphere the infected area is soon covered with large amounts of white mould. The mould will eventually turn black.

Storage Disorders

Sprouting

The storage life of yams is limited to their inactive or dormancy period, after which they begin to sprout and quickly lose their dietary value. Cultivars vary in their dormancy period, which is generally between 1 to 4 months. Following the dormancy period, sprouting will occur at temperatures above 13°C (about 55°F). Sprouting is more rapid at higher temperatures and results in a decrease in tuber quality. Storage life of the tubers can be extended by as much as a month by breaking off the budding sprouts when they reach 2 cm to 3 cm long (about 1 inch).

Chilling Injury

Storage of yams at temperatures below 13° C (55°F) will result in a breakdown known as chilling injury (CI). Damage from CI is greater as the temperature decreases and the length of exposure increases. Slight injury may occur as soon as 2 days at 4°C (39°F) or 5 days at 8°C (46°F). Typical CI symptoms include sunken spots on the tuber surface followed by decay. Flesh darkening and spotting are internal symptoms.

Technical bulletins are also available on waxing fruits and vegetables, curing and hot bath treatment.
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YAM

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 yam. A more technical and detailed bulletin is available from the New Guyana Marketing Corporation (NGMC) and the National Agricultural Research Institute (NARI).