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## Postharvest Handling Technical Bulletin

# CABBAGE

## Postharvest Care and Market Preparation



Technical Bulletin No. 25

May 2004



# **POSTHARVEST HANDLING TECHNICAL SERIES**

## **CABBAGE**

### **Postharvest Care and Market Preparation**

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

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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

Various types of cabbages are grown in Guyana, with the most popular ones being the compact single-head type (*Brassica oleracea*) and the non-heading Chinese or pak choi type (*Brassica campestris*). Mature single-head cultivars have a low to moderate respiration rate and can be stored for several months at the appropriate temperature. On the other hand, the non-heading pak choi type has a higher respiration rate and significantly shorter market life.

## Harvest Maturity Indices

Determining the optimal time to harvest cabbage is often difficult and differs between heading and non-heading types. Most heading-type cultivars are ready to harvest several months after transplanting. The principal harvest maturity index is based on size. Heading-type cabbage may be harvested as small as 10 cm (4 in) in diameter and continued until 15 cm to 25 cm (6 in to 10 in). Harvest maturity for heading-types is also based on head compactness and firmness to the touch (Figure 1). A firm or compact head is mature. A compact head can be only slightly compressed with moderate hand pressure. A very loose head is immature and should not be harvested (Figure 2). Harvest maturity may also be based on arrangement of the wrapper leaves; when they are spread and the head is exposed it is usually mature. A mature cabbage has a well-developed head and good weight in comparison to its size. Mature cabbage has a longer postharvest life than immature cabbage.



Figure 1. Mature compact cabbage head ready for harvest.



Figure 2. Immature loosely compact cabbage head.

Cabbage should be harvested promptly when the heads are firm and mature. Delaying harvest even a few days beyond maturity can result in split heads and increased incidence of field disease, particularly during wet weather.

Pak choi type cabbage is usually ready for harvest within 7 weeks after transplanting, although this may vary according to cultivar and environmental conditions. Size is the



principal indicator of harvest maturity and this is largely based on market demand. Pak choi should have well-formed upright petioles tightly adhering together (Figure 3). Pak choi should always be picked when leaves are fresh and crisp and before the outer leaves turn yellow.



**Figure 3. Ideal harvest stage for pak choi.**

### **Harvest Methods**

Cabbage is harvested by hand by bending the head (or stalk in the case of pak choi) to one side and cutting it with a sharp knife or small machete. The cutting instruments should be sharpened frequently to reduce harvesting effort and lessen picker fatigue. The head should not be removed by snapping or twisting it, as this practice damages the head and results in jagged appearing stems which extend too far out from the base of the head. Broken stems are also more susceptible to decay. The stalk should be cut flat and as close to the head as possible, yet long enough to retain two to four wrapper leaves. Extra leaves act as cushions during handling and may be desired in certain markets. Yellowed, damaged, or diseased wrapper leaves should be removed. Heads with insect damage and other defects should be discarded. In the case of pak choi types, any damaged or dead leaves should be removed and the base should be trimmed flush with the first petiole.

Cabbage should be put in baskets or well-ventilated picking containers and taken out of the field immediately after harvest. Cabbage put in non-ventilated field sacks will heat up due to tissue respiration and start to wilt. It is recommended that harvesting be conducted during the coolest time of the day, preferably in the morning when the head is most turgid. It is essential that heads not harvested be left undamaged because fields may be harvested as many as three times for maximum yield.

### **Preparation for Market**

Harvested cabbage is particularly susceptible to wilting and should be removed from the field and direct sunlight as soon as possible. The cabbage should be taken to a well-ventilated shaded area for packing and transport to market (Figure 4). When there is a

delay of more than an hour or two between harvest and packing, a spray of clean water to the leaves can help prevent dehydration.

A simple field packing station can be constructed from wooden poles and a sheet of polyethylene. Thatch over the roof will provide shade and keep the station cool. The structure should be oriented so that the roof overhang keeps out the majority of the sun's rays.

### *Cleaning*

The first step in preparing cabbage for market is to remove the torn and loose outer wrapper leaves so the head has a clean, compact, and fresh appearance (Figure 5).

Only 3 to 6 tight wrapper leaves should be left on the head. Loose leaves interfere with ventilation between heads, which is important whether the cabbage is packed for market or put into storage.

The stem end should be trimmed close to the base of the head so it does not protrude more than 2 cm (.75 in). A fresh cut of the stem end will be necessary if it is discoloured. However, it is very important not to cut the stem end too short so part of the base of the head is cut. This will cause a loss of wrapper leaves and head integrity (Figure 6).



**Figure 4. Harvested cabbage should be taken to a shaded, well-ventilated packing area.**



**Figure 5. Trimmed and cleaned cabbage heads ready for sorting and packing.**



**Figure 6. Trimming the stem end too short (center and left heads) destroys head integrity.**



Pak choi will also benefit from re-cutting the base if it is discoloured or damaged (Figure 7).

**Figure 7. Well-trimmed stem end of pak choi ready for packing.**



### *Sorting*

Cabbage should be sorted according to size, shape, and compactness of the head. There are 3 established size categories (small, medium, large) for domestic marketing of cabbage, based on the weight of the head. Small sized heads weigh 0.8 kg (1.7 lb) or less, medium sized heads weigh between 0.9 kg and 1.4 kg (1.7 lb and 3 lb), and large sized cabbage heads weigh 1.5 kg (3 lb) or more. Only the cabbage with crisp and turgid leaves should be packed for market. The heads should be a colour typical of the cultivar (i.e. green, red, or pale yellow-green), firm, heavy for the size and free of insect, decay, seed stalk development and other defects.

### *Packing*

Heading-type cabbages are generally packed in fiberboard cartons, wooden or wire-bound crates, or mesh bags holding about 23 kg (50 lb). Uniformity of head size and the proper count per carton are important. Normally 18 to 22 heads are packed in a 23 kg (50 lb) container. Cartons and crates are easier to stack and load and provide considerably more protection to the cabbage than mesh bags (Figure 8).



**Figure 8. Uniform sized cabbage packed in strong well-ventilated wooden crates.**

Pak choi cabbage should be packed in fiberboard cartons usually holding between 10 kg to 18 kg (22 lb to 40 lb), depending upon market preference. Pak choi may be bunched into groups of 3 to 5 plants using a string or rubber band. Care must be taken as plants bruise easily.

### **Temperature Control**

The optimal storage temperature for all cabbage types is 0°C (32°F). This maintains a very low respiratory activity in the cabbage and greatly inhibits decay. Chinese cabbage



is much more perishable than heading types and should be cooled within several hours after harvest and held as close to the ideal postharvest temperature of 0°C (32°F) as possible. The maximum market life of pak choi under ideal conditions is 2 weeks. At ambient temperatures the pak choi leaves will rapidly wilt and become unmarketable after only 1 to 2 days. The need for immediate cooling after harvest is not as necessary for heading types of cabbage. However, for maximum storage life, heading types should be cooled within a day after harvest. Market life at 0°C will be 4 to 6 weeks.

Deterioration of cabbage is accelerated under non-refrigerated temperatures and is associated with discolouration of the stem end, leaf wilting, loss of fresh green colour, and postharvest decay. Storing cabbage at ambient temperature will require extensive trimming of the leaves to maintain a marketable head.

### **Relative Humidity Control**

Cabbage is a leafy vegetable susceptible to significant moisture loss and wilting after harvest. The high surface area and numerous openings in the leaf surface (stomates) make an easy route for tissue water loss. In order to minimize the loss of crispness and wilting of the leaves it is very important to maintain a high relative humidity (RH) in the storage atmosphere. The optimal RH for cabbage is 95%. Pak choi can be stored at 0° C (32°F) for several weeks, as long as the relative humidity is greater than 85%.

### **Principal Postharvest Diseases**

The most common postharvest decays of cabbage are bacterial soft rot, gray mould, dark leaf spot, *Phytophthora* rot, *Rhizoctonia* rot, and watery soft rot. Storage diseases can be controlled by preventing wounds during harvest and handling, trimming off the infected outer leaves, followed by storing the cabbage as close to 0°C (32°F) as possible. In addition, the use of clean seed and pre-harvest application of fungicides will reduce inoculum and lower the incidence of postharvest diseases. Effective fungicides include chlorothalonil (Daconil), iprodione (Rovral), and copper products.

#### ***Bacterial Soft Rot***

Bacterial soft rot is caused by various bacterial species including *Erwinia*, *Pseudomonas*, and *Xanthomonas*. These bacteria are typically secondary disease pathogens that enter the tissue at the time of wounding or follow primary fungal invasions. Infected tissue quickly decays and turns into a soft, slimy, foul-smelling mess at ambient temperatures (Figure 9). Care should be taken to avoid injury during harvest and handling. Cabbage should also be held at a cool temperature to minimize



**Figure 9. Bacterial soft rot decay of cabbage.**

bacterial soft rot growth. Development of bacterial soft rot at the cut stem end can be prevented by spraying with a 15% solution of alum (aluminum potassium sulfate) in water (Figure 10). After treatment, the stem end should be allowed to dry for 20 to 30 minutes before packing. Application of lime powder to the stem end will also help minimize the establishment of bacterial soft rot (Figure 11).



**Figure 10. Spray application of alum to the stem end to prevent bacterial soft rot.**



**Figure 11. Treating the stem end by pressing it into a bag of lime powder.**

### *Gray Mould*

Gray mould, caused by the fungus *Botrytis cinerea*, is most commonly found on stored cabbage grown under wet conditions. The fungus persists in the soil, on crop debris, and in unsanitary storage facilities. Symptoms begin as brown water-soaked areas on the outer leaf surface. Under humid storage conditions a whitish mould develops, which eventually darkens into a brownish-gray mass (Figure 12). Once established on the leaf surface, the fungus can attack and decay healthy tissue and produce a nesting mould growth inside a packed container. The optimal temperature for growth of gray mould is 20°C (68°F). Decay can be minimized, although not completely controlled, by rapid cooling of the cabbage after harvest and storage at 0°C (32°F).



**Figure 12. Extensive gray mould growth on the surface of a red cabbage.**

### *Dark Leaf Spot*

This disease is caused by the fungus *Alternaria brassicae*. Infection usually begins prior to harvest although disease symptoms may not be apparent. In the initial stages of this disease small dark spots appear on the outer leaves. The spots rapidly enlarge at ambient temperatures and within the infected spots are large masses of dark spores (Figure 13).



Under wet conditions, infection may occur by direct penetration of intact leaf tissue via the stomatal pores. Even after trimming, cabbage may still undergo serious rotting in storage. Decay is slowed by cold temperature storage.

### *Phytophthora Rot*

Phytophthora rot is caused by the soil-borne fungi *Phytophthora porri*, which is typically found in poorly drained areas of the field. This disease is most severe on cabbage produced during the rainy season. Symptoms typically begin as a dark brown firm rot of the stem end, gradually progressing into the head (Figure 14). Cavities tend to form in the stalk tissue and sparse white mould strands may be observed. The decayed tissue produces a distinctive sour odour. Gray water-soaked blotches may also appear on the outer leaves. The disease can be spread by contaminated cutting knives. Fungicides are largely ineffective against this pathogen. Sanitary cultural practices, well-drained soils, clean cutting knives, and refrigeration after harvest all minimize the development of Phytophthora rot.

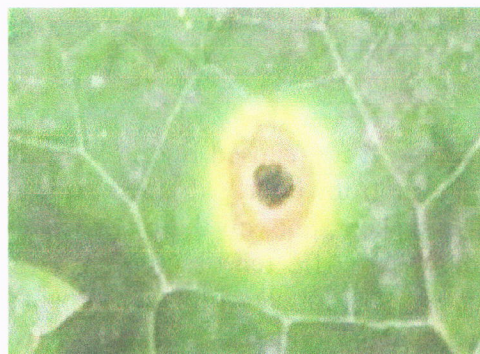


Figure 13. Dark leaf spot lesion on cabbage.



Figure 14. Phytophthora rot progressing from the stem end into the center of the head.

### *Rhizoctonia Rot*

Rhizoctonia rot is caused by another common soil-borne fungus, *Rhizoctonia solani*. This disease is favoured under wet conditions, especially when there is contact between the soil and the base of the cabbage head. Symptoms begin as sunken black lesions on the lower leaf midribs in contact with the soil. Circular spots later appear on the lower leaves (Figure 15). In addition, small irregularly shaped lesions may develop on the tops of the heads, gradually coalescing and darkening. Eventually head rot may follow. As decay progresses, a dark mould spreads over the surface. Rhizoctonia rot can be controlled after harvest by storing the cabbage at cool temperatures, since the fungus grows very slow below 10°C (50°F).

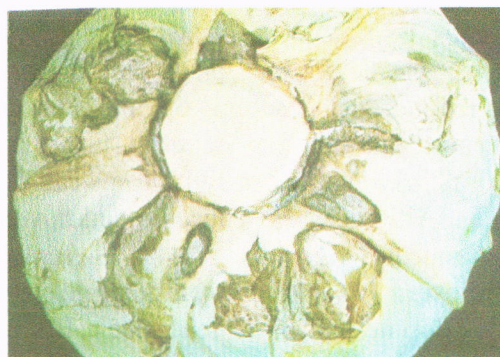


Figure 15. Rhizoctonia rot of cabbage.



### *Watery Soft Rot*

Watery soft rot, caused by the fungus *Sclerotinia sclerotiorum*, is common on cabbages produced from poorly drained soils or during the rainy season. Symptoms appear as water-soaked spots on the outer leaves. The spots eventually coalesce into a leaky soft tissue mass. Affected tissue often turns grey, giving rise to a fluffy white mould which eventually is dotted with black fungal bodies. In contrast to bacterial soft rot, there is no disagreeable odour associated with watery soft rot. Sanitary production practices will reduce the build-up of the fungus in the soil. Weeds should be controlled because they harbour the fungi and their foliage creates a moist environment favouring disease development.

### **Postharvest Disorders**

#### *Yellowing*

Storing cabbage at ambient temperature will result in a gradual loss of green chlorophyll pigment and yellowing of the outer leaves. Cabbage is also sensitive to ethylene, which causes both leaf yellowing and leaf abscission (Figure 16). Adequate ventilation during storage is important to maintain very low ethylene levels in the storing area. In addition, cabbage should not be stored in close proximity with fruit which emit high amounts of ethylene.

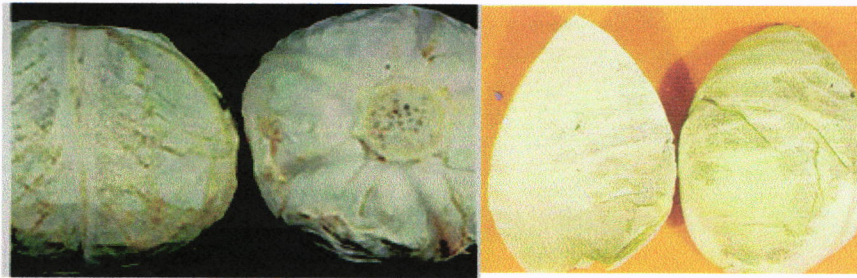


**Figure 16. Exposure of cabbage to ethylene during storage will cause yellowing.**

#### *Black Leaf Speck*

Black leaf speck, also called pepper spot, is a disorder commonly observed on heads which have been in storage, although symptoms can be found in the field on over-mature heads. Symptoms begin with the development of individual specks, randomly distributed over the leaf. The black specks result from discolouration and collapse of tissue surrounding the natural openings (stomata) in the leaves. Initially the specks are minute in size, but they may develop further in storage and coalesce into lesions as large as 2 mm (0.08 in) in diameter. Symptoms can often be seen well into the center of the head (Figure 17). Although the cause is unknown, high rates of fertilizer and cultural conditions promoting vigorous growth increase plant susceptibility. Low storage temperatures followed by warmer temperatures enhance development. Ethylene does not promote development of black leaf speck. Both heading-type and Chinese cabbage cultivars vary widely in their susceptibility to this disorder. High rates of potassium in the soil have been shown to significantly reduce the severity of the disease.





**Figure 17. Black leaf speck of cabbage.**

### *Physical Injury*

Breakage of the outer midribs of the cabbage often occurs due to rough harvesting and handling practices. The damaged midribs often discolour and turn brown. They are also very susceptible to postharvest decay. The midribs of over-mature heads are more susceptible to breakage or cracking.



## **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.

### **OTHER PLANNED PUBLICATIONS**

- 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.