Post-harvest management of banana for quality and safety assurance

Guidance for horticultural supply chain stakeholders
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INTRODUCTION

Bananas are grown in Timor-Leste for their economic and nutritional value. A number of banana cultivars are produced by smallholder farmers mainly for domestic consumption (Photo1). Ripened bananas are consumed as dessert fruit. Immature or green bananas are consumed in the cooked state and are processed into chips. Bananas provide a good source of energy.

Photo 1. Banana cultivars

IMPORTANCE OF POST-HARVEST HANDLING PRACTICE

Good post-harvest handling practice is important in maintaining the quality and assuring the safety of the banana fruit as it moves through the supply chain from producer to consumer. Over-ripening, and mechanical damage caused by bruising and compression are the main causes of losses in banana supply chains (Photo 2).

Consumers in Timor-Leste increasingly demand quality fruits and vegetables. They are looking for and are willing to pay a premium price for good quality bananas (Photo 3). Good post-harvest handling practice of bananas is important in ensuring their safety and quality.
CHARACTERISTICS OF BANANAS THAT AFFECT THEIR POST-HARVEST LIFE

The banana is a living entity. Even after harvest, it is still alive hence it is subject to continued change until it completely deteriorates. A number of changes take place inside the fruit that influence its appearance, flavor, texture and nutritive value, and that cause it to age (Photo 4) and subsequently to rot and decay. While some changes are desirable (e.g. changes associated with ripening such as sweetness), many bring about quality deterioration. These post-harvest changes cannot be stopped but can be slowed down within certain limits through the application of good post-harvest management practice.

Photo 4. Bananas progress through various changes after harvest – Ripening and aging are programmed changes that take place in banana fruit after harvest
**Bananas lose water**

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Bananas are of a high water content. When harvested, bananas can no longer replace the water that is lost from the peel. They are, therefore, subject to shriveling and weight loss resulting in a loss in their marketable weight and their visual quality, if stored under conditions of low humidity. The moisture content of the banana must be maintained in order to retain the quality of the fruit.

**Bananas are prone to decay**

Bananas are susceptible to attack by insects and decay-causing organisms. Attack by insects and decay-causing organisms can promote the rapid deterioration of bananas. Rough handling of bananas can create wounds that could serve as entry points for microorganisms.

Bananas that come into direct contact with the soil are susceptible to microbial contamination (Photo 5) which could pose a food safety risk and lead to illness in humans when consumed.

**Bananas are prone to injury**

Photo 5. **Contact of bananas with the soil will promote decay and cross-contamination**

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Bananas are highly susceptible to injury during handling. Rough handling particularly during transport (Photo 6) and market handling leads to damage. Once damaged, all of the biological processes of the banana – such as respiration and ethylene production – proceed at a very rapid rate leading to rapid deterioration of the quality of the fruit.
HARVEST MANAGEMENT PRACTICES

The quality or the potential quality of bananas is established at harvest and is largely determined by the stage of fruit maturity at which the banana is harvested and the method used to harvest the banana.

**Maturity indices**

Commercially grown bananas are harvested at the green stage at varying stages of maturity. The most common index of maturity is based on the fullness of fruit fingers of the banana (Photo 7).

Some cultivars of bananas are commonly harvested at the “full three-quarters” to “full-green” stage of maturity.

**Photo 7. Change in angularity of banana finger as an index of maturity**
“Light three-quarters” is the stage of maturity at which sharp angles are still present. At the “light full three-quarters,” stage, also termed “three quarters full” or “three-quarters round,” the fingers are still angular. The fingers are full when they are well rounded (Photo 8a). The intermediate between “full” and “light three-quarters” is “full three-quarters,” also referred to as “high three-quarters” or “heavy three-quarters” (Photo 8b).

Bananas harvested at full maturity will develop good peel and pulp color, with full aroma and flavor at the ripe stage (Photo 9). Fruits harvested at an immature stage are of poor quality upon ripening. Harvesting at an advanced stage of maturity on the other hand, may be unsuitable for long distance shipment since ripening will occur during shipment and result in fruit having a shorter shelf life.

**Photo 8.** Bananas harvested at “full” (a) and “full three-quarters” (b) stages of maturity

**Photo 9.** Full color development of banana at the ripe stage when harvested fully mature

**Harvesting method**

Good harvesting practice is a key requirement to assuring the quality of fruits. Recommended good practice for harvesting, include:

- Placing a prop that can be made by two crisscrossing bamboo poles or forked angle branches and cutting below the prop, followed by removal of the prop to allow the trunk to fall gently to the ground.
✦ Cutting one side of the trunk partially at an angle followed by a similar cut on the other side before pulling down the trunk (Photo 10a). This is usually done by one individual.

✦ Where two individuals are involved in harvesting, one can make a notch on the trunk a few feet below the bunch in order to allow the bunch to come down gently, while the second worker receives the bunch as it falls so that it does not touch the ground (Photo 10b).

**Minimizing damage, contamination and deterioration during harvesting and field handling**

✦ Every effort must be made to prevent contact of harvested bunches of bananas with the soil, by placing the harvested bananas on top of banana leaves (Photo 11).

✦ Latex staining of field-de-handed bananas must be prevented by placing bananas on top of leaves with the rib (of the leaves) exposed. The rib supports the crown into the leaf blade (Photo 12).

✦ When field-packing de-handed bananas, the crown portion must be wrapped until the mid portion of the hand with paper (Photo 13) to prevent abrasion and latex staining of other fruits.

✦ Bananas must not be exposed to the sun as this will lead to rapid moisture loss and rapid ripening. Shade can be provided by using a canvass tent in the field or by covering with layers of banana leaves.

✦ Banana bunches must be placed on top of cushioning material when being transported from the farm to the collection site or packing shed, in order to avoid bruising and injury (Photo 14).

Photo 10. **Harvesting bananas employing one (a) or two persons (b)**
✦ Field-de-handed bananas are easier to handle in the field since they can be neatly piled with banana leaves as separators and cushions (Photo 15a); when transferred in bunches (Photo 15b), there is an increased likelihood of mechanical damage.

✦ Stackable plastic crates are the best field containers (Photo 16) since they provide adequate protection to the fruits.

Photo 11. **Use of layers of banana leaves as underlay prevents contamination of bananas with soil**

Photo 12. **Prevention of latex staining in field-de-handed bananas**

Photo 13. **Wrapping the crown until the mid portion of the banana hand, to prevent abrasion and latex staining**
Photo 14. **Motorcycle equipped with cushion to carry bananas from the farm to the packing shed**

Photo 15. **Field-de-handed bananas are easier to transport (a); bananas transported in bunches are prone to damage (b)**

Photo 16. **Stackable plastic crates as field containers for bananas**
POST-HARVEST HANDLING OPERATIONS

Post-harvest handling operations refer to operations used to prepare the bananas for marketing. These operations can be done in the field, in collection centers or in a packinghouse. The packing area must provide adequate protection from sun and rain, and must be kept clean at all times. Pet animals must be kept away from the packing area. All workers must apply good practice and observe good hygiene.

De-handing of bananas

De-handing is the separation of hands and removal of the stalk of the banana (Photo 17a). De-handing is best done with a de-handing knife that is curved to fit the crown (Photo 17b) of the banana.

Some bananas destined for the local market in Timor-Leste are de-handed with about 10 cm of the stalk retained (Photo 17c). Clean gloves should be used when de-handing bananas (Photo 17d).

Photo 17. De-handing of bananas (a); a de-handing knife (b); common method of de-handing bananas for local markets in Timor-Leste (c); use of clean gloves during de-handing (d)

Washing

Washing removes dirt from the surface of the banana and coagulates exuded latex from the cut surface of the crown, thereby reducing staining. Bananas destined for sale to institutional buyers like hotels, supermarkets and food service establishments may need to be washed if they are not bagged.
Grading/sorting

Grading is the process of classifying the produce into groups according to specific criteria accepted by the industry such as quality and size.

Sorting on the other hand, is the grouping of bananas based on the criteria of the one classifying the bananas. No definite set of standards is followed during sorting. Bananas are generally sorted prior to sale. Freedom from mechanical damage, foreign matter, decay, freshness, maturity, and size are some of the quality criteria considered during sorting.

No established quality standards are followed in local markets in Timor-Leste. Price is merely based on agreement of both parties (supplier and buyer). Bananas are commonly sorted according to size (length of fingers). Bananas are classified as A, B or C based on size and external appearance-smoothness, freedom from defects or blemishes and decay (Photo 19). Although specific quality standards are not normally required, local markets and institutional buyers, particularly hotels and supermarkets demand fruit of better quality (Photo 18).
BULK PACKAGING

Good bulk packaging is essential in maintaining the quality of bananas during transport and subsequent handling. The basic functions of bulk packaging are to provide adequate protection to the bananas, to contain convenient quantities of bananas, to facilitate the transportation, handling and distribution of bananas.

Bulk packaging containers for bananas

Rigid containers such as plastic crates are highly recommended for the bulk packaging of bananas since they provide adequate protection against compression damage (Photo 20). Plastic crates have a smooth inside finish and can be easily cleaned. They are also stackable and reusable/returnable. Although more expensive than traditional packaging containers, such as woven baskets, plastic crates are re-useable and economical in use over the long term.

Wooden crates are also rigid bulk packaging containers that provide protection during transport. Lining materials (such as newspaper) are placed between hands of bananas (Photo 21a) and the crate is lined with fresh banana leaf sheaths (trunk) to prevent damage to fruits caused by the rough inside finishing of the crates (Photo 21b). Over-packing should be avoided since it leads to bruising and compression damage (Photo 20c) of the bananas.

Photo 20. Bananas packed in stackable plastic crates with newspaper liners on all sides to prevent latex staining of the crate
Plastic sacks and round palm baskets are also commonly used for the bulk packaging of bananas in Timor-Leste (Photo 22). Their use is not, however, recommended for bananas since they are semi-rigid containers and do not provide adequate protection to the bananas.

Photo 22. The use of plastic sacks and round palm baskets is not recommended for the transportation of bananas
Good practice for the use of plastic crates

✦ Plastic crates must be thoroughly cleaned with soap/detergent after use (Photo 23).

✦ Plastic crates must be stored in a clean area that will not attract the breeding of insects and rodents. The crates must be stored separately from chemicals and farm machinery to prevent contamination. Crates should not be left exposed to the external environment since they will readily wear out (Photo 24).

✦ Plastic crates used for the bulk packaging of bananas must not be used as a container for chemicals (fertilizers and pesticides).

Photo 23. Dirty plastic crates (a) as source of contamination; cleaned plastic crates after use (b)

Photo 24. Plastic crates exposed to the environment will readily wear out
TRANSPORTATION

Transportation is one of the critical stages in the banana supply chain. Poor transport conditions, rough handling, and delays in transportation contribute to losses in banana supply chains.

Bananas are transported:

✦ From the field to the collection site.
✦ From the collection site to the retail market.

Good transport practice for Bananas:

✦ Bananas must be carefully handled. They must not be dropped or thrown on to each other; The transport vehicle must not be overloaded as overloading increases the risk of damage to the fruits.

✦ Bananas at the bottom of the transport vehicle should not be used as steps to allow stacking to a greater height (Photo 25).

✦ Air circulation in the stacks or piles of produce is of critical importance in preventing heat build-up. This is facilitated by providing space in between stacks. For bananas
transported in bulk or in bunches (Photo 25), heat build-up will occur leading to premature ripening during transit.

✦ The use of stackable plastic crates as transport containers (Photo 26) is highly recommended since they provide adequate protection to bananas during transport.

✦ If canvass is used as a cover over the bananas; provisions must be made for air circulation through the stack. Light colored material is preferred as a cover as it will reflect heat.

Photo 26. **Stackable plastic crates as transport containers of bananas**

Photo 27. **Unsanitary storage or holding conditions in the retail markets compromise food safety**
HANDLING AT RETAIL MARKETS

Retail markets serve as outlets for banana producers, and collectors. The basic rules that should be observed in retail markets are as follows:

1. Containers from the transport vehicle must be unloaded under cover/shade with careful handling to minimize mechanical damage.

2. Bananas must be re-sorted using a sorting table; culls must be properly discarded.

3. Bananas must be re-graded according to size, appearance and stage of ripeness as the case may be depending on the requirement of the target market.

4. When distribution cannot be completed in one day, unsold bananas must be kept under clean storage conditions with proper ventilation. Keeping bananas under unsanitary conditions (Photo 27) will lead to contamination and could compromise their safety.

5. At the retail market, bananas should be displayed in an elevated tray or rack and not on the ground (Photo 28) since the possibility of contamination on the ground is high.
REFERENCES


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