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The background of the entire page is a dense, close-up photograph of many green tomatoes. A white-bordered rectangular inset in the center contains a photograph of several ripening tomatoes, showing a gradient from green to red.

**Post-harvest management
of tomato for quality and
safety assurance**

*Guidance for horticultural
supply chain stakeholders*

Post-harvest management of tomato for quality and safety assurance

Guidance for horticultural supply chain stakeholders

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INTRODUCTION



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Tomato (*Lycopersicon esculentum* Mill.) is a vegetable crop popularly consumed in Bangladesh. It is commonly used for table consumption in fresh form or as an ingredient in many cooked dishes. Aside from its economic value, tomato is good for human nutrition since it is a source of Vitamins C, A and K, potassium, and carotenoids such as lycopene and carotene which act as antioxidants.

IMPORTANCE OF POST-HARVEST HANDLING

Proper post-harvest handling is important in maintaining the quality and insuring safety of the fruit while being brought to consumers on time, and in meeting buyers' specifications and trade requirements.

Post-harvest losses – Losses in quantity and quality occur between harvest and consumption. In tomatoes, losses occur due to immaturity, over-ripening, mechanical damage, and decay (Photo 1). These losses can be attributed to poor harvesting method, rough handling, improper packaging and poor transport conditions. Unless these losses are minimized, the gains from production and the potential income cannot be realized. Post-harvest losses represent a waste of the resources – land, labour, energy, water, fertilizer, etc. that went into producing the crop. Every effort must, therefore, be made to minimize these losses.

Consumers are now increasingly paying attention to quality. They are looking for and are willing to pay a premium price for good quality produce that is safe. Preservation of the nutritive value goes hand in hand with the prevention of quality deterioration.

With changing consumer tastes and lifestyles and the continuous growth of supermarkets and the demands from institutional buyers, more attention in post-harvest handling of tomato to satisfy their demand for better quality (Photo 2) and safe produce.

Photo 1. **Nature of losses in tomato: decay, over-ripening and mechanical damage**



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Photo 2. **Good quality tomatoes are required by institutional buyers like supermarkets**



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CHARACTERISTICS OF TOMATO FRUIT AFFECTING POST-HARVEST LIFE

In general, post-harvest technology can only maintain, not improve or little if any, the quality of harvested fruit. Therefore, the main objective of any post-harvest technology is to keep fruit quality and safety as high as possible until it reaches the final consumer.

Tomato fruits undergo programmed changes

The tomato fruit, being a living tissue is subject to continuous change (Photo 3) until it completely deteriorates. The process of ageing and eventual dying in living tissues is called senescence. There are programmed changes inside the fruit that influence appearance, flavor, texture and nutritive value that cause them to age. While most changes are desirable like those occurring during ripening, some changes are deteriorative. These post-harvest changes cannot be stopped but can be slowed down within certain limits.

Tomato fruits lose water

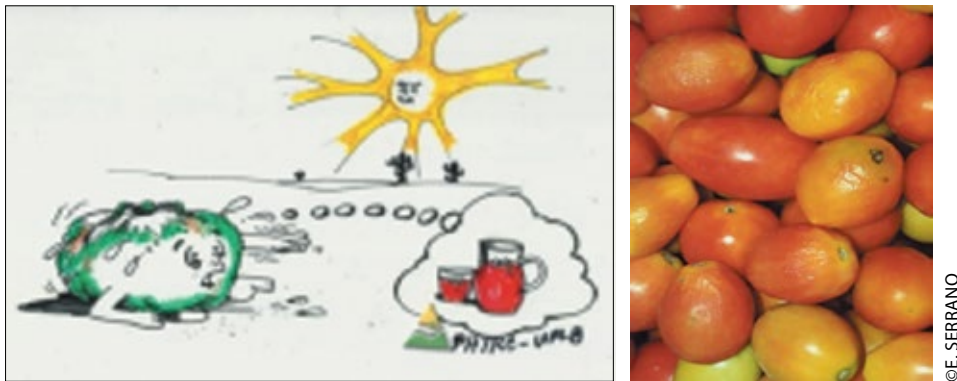
Tomato fruits consist mainly of water and when harvested, it can no longer replace the water that is lost. Conditions like high temperature and low relative humidity result in water loss hence the loss in marketable weight. Water loss from the fruit results also in shriveling (Photo 4). Exposing fruit to the sun results in rapid water loss.

Photo 3. **Programed change in tomato like ripening**



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Photo 4. **Shriveling in tomato as a consequence of water loss**



Tomato fruits are prone to injury and decay

Tomatoes are also prone to injury. When the fruit is damaged, the biological processes like respiration and ethylene production proceed at a very fast rate leading to rapid deterioration. Practices like packing in bamboo baskets with rough and pointed edges and sitting on packaged tomatoes during transport (Photo 5) will injure tomatoes. The damage may not be seen at the green stage but may show up later during retail as compression and discoloration in the flesh.

Tomatoes are also susceptible to attack of insects and decay-causing organisms which can eventually result in faster deterioration. Rough handling may create wounds which serve as entry points for decay-causing organisms. Wounds are also avenues for water loss and can speed up the ripening process.

Photo 5. **Improper handling like packing in bamboo baskets and sitting on packed tomatoes during transport lead to damage on the fruits**



HARVEST MANAGEMENT PRACTICES

Harvesting at the proper stage of maturity, the manner in which the fruit is detached from the tree and the time of harvesting are important considerations during harvesting.

Harvest maturity

Tomatoes can be harvested at any stage of maturity and the distance from the production site to the consumption area should be considered. Tomatoes are ready for harvest as soon as they are mature but still green. Representative samples of green mature fruits are cut crosswise and if the seeds slide without being cut, then the tomatoes of the same variety can be considered mature (Photo 6). Immature fruits when picked, fail to develop full color and flavor and deteriorates easily.

Time of harvesting

Pick tomatoes during the cooler part of the day. It is recommended to harvest up to noontime and to keep the harvested fruits in a shaded area soon after picking. A rise in fruit temperature occurs when the fruits are left exposed to the sun (Photo 7). Heating up will result in accelerated ripening of fruits.

Photo 6. **External and internal appearance of mature green tomatoes**



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Photo 7. **Exposure of newly harvested tomatoes will result in heat build-up and accelerated ripening**



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Harvesting method

Harvest tomato carefully by hand picking. Mature fruit is best removed by a “lift, twist and pull” technique (Photo 8a). Harvesters should have trimmed fingernails to prevent injury to the fruit. The use of clean gloves during picking will minimize damage on the fruit caused by fingernails (Photo 8b). Harvesters should observe good personal hygiene during harvesting.

Harvested tomatoes should be placed in clean collecting containers such as plastic pails with smooth inside finish (Photo 9a) and then transferred to field containers like the stackable plastic crates once filled (Photo 9b).

The fruit should be handled carefully during harvesting. Practices like throwing tomatoes into the container, dropping and dragging of containers during hauling causing fruits to bump against each other must be prevented. These poor handling practices will result in both visible and non-visible damages like internal bruising. Visible injuries can be in the form of cuts, punctures or abrasion. Internal damage will appear later as brown or black discoloration in the seed area or manifested as faster ripening and increased susceptibility to decay.

Photo 8. **Hand-picking of tomato fruit (a), and use of gloves during harvesting prevents damage on the fruit (b)**



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Photo 9. **Collecting pails and stackable plastic crates are appropriate field containers of harvested tomatoes**



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POST-HARVEST HANDLING OPERATIONS

Post-harvest operations refer to activities done to the fresh produce in preparation for marketing to meet the requirements of the target market. These operations can be done in the field, in collection centers or in a packinghouse. The packing area should provide adequate protection from sun and rain, kept clean at all times, and pet animals should be kept away from the packing area. All workers should maintain a high degree of personal hygiene and where appropriate, should wear suitable protective clothing and head covering.

Cleaning/washing

In places where tomatoes are not staked or trellised and grown during the rainy season, soil particles may adhere on the fruit (Photo 10). Soil-borne decay-causing microorganisms can cause fruit rots thus the need to clean them prior to marketing. A disinfectant like sodium hypochlorite (ordinary bleaching solution) can be added to the clean water (4 tablespoon per gallon of water). Washing in 2 percent sodium bicarbonate (20 grams baking soda per liter of water) was shown to reduce storage rot. Fruits should be dried properly prior to packaging.

Tomatoes can also be cleaned by wiping them with moist cloth (Photo 11). Insure however, that the water and the cloth used in wiping the fruit are clean to prevent contaminating the fruit.

Photo 10. **Newly harvested dirty tomatoes should be washed in chlorinated water**



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Photo 11. **Wiping of tomatoes with moist clean cloth**



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Sorting/grading

Good quality tomatoes are generally preferred by buyers, thus sorting/grading is a necessary operation. Sorting is the grouping of tomatoes based on the criteria of the one classifying and there is no definite set of standards followed. After harvest, tomatoes are arbitrarily classified as "Class A" (excellent quality) or "Class B" (with minor defects). The names of the grades are determined or specified by the buyer.

Good quality and safe tomato fruits are mature, clean, well-formed, free from insect and disease damage, free from mechanical damage (Photo 12) such as cuts, abrasion and punctures, free from microbial, chemical and physical contamination.

Tomato fruits with the following defects, on the other hand, are most likely to be rejected (Photo 13):

- ◆ Insect-and disease-damaged.
- ◆ Mechanically-damaged such as cuts, punctures, abrasion, compression.
- ◆ With preharvest defects such as deformation and cracks.

Photo 12. **Good quality tomato fruits**



Photo 13. **Common forms of rejection of tomato**



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Photo 14. **Sorting of tomatoes using a sorting table (a) which is good practice, and sorting on the ground (b) which may lead to microbial contamination**



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Sorting is done using a simple sorting table (Photo 14 (a)) where sorters are positioned on both sides of the sorting table. Sorted tomatoes are packed directly in the container. With the use of sorting table, contact of the fruit on the soil is prevented. Sorting of tomatoes on the ground with plastic sheet as underlay (Photo 14 (b)) may contaminate the fruit and is inconvenient for the sorter. The sorting tables must be cleaned preferably disinfected with chlorinated water after using.

Classifiers or sorters should practice good personal hygiene such as washing their hands with soap or detergent before handling the produce. There should also be provision for workers' comfort during sorting/grading since uncomfortable position during sorting leads to fatigue hence inappropriate sorting procedures.

PACKAGING

Proper packaging is essential in maintaining product quality during transport and subsequent handling. The basic functions of packaging are to contain sufficient volume of produce, to protect the contents, to sell the produce, and to inform the buyer about the produce.

Packaging materials

Rigid containers such as plastic crates are highly recommended for tomatoes since they provide adequate protection against compression damage (Photo 15). They have smooth inside finish and can be easily cleaned. They are also stackable and reusable/returnable (Photo 16). Although more expensive than the traditional packaging containers, plastic crates have been shown that in long run use (5-6 years), the packaging cost per kg of produce is relatively cheaper.

Plastic bags, plastic sack and red mesh bags do not provide adequate protection to the contents (Photo 17). They are readily damaged and will lead to fruit deterioration. Injuries often incurred include compression manifested as flattened areas and breaks in the skin (Photo 18).

Photo 15. Tomatoes packed in rigid plastic crates thus providing adequate protection to its contents



Photo 16. **Stackable and returnable/reusable plastic crates for tomatoes**



Photo 17. **Tomatoes packed in red mesh bags and stacked several layers high resulting in fruit damage**



Photo 18. **Injuries in the form of breaks in the skin and compressed areas due to poor packaging**



Considerations in the use of plastic crates

- ◆ Hygiene – plastic crates should be thoroughly cleaned with soap/detergent after use (Photo 19). Sanitizer such as sodium hypochlorite reduce microbial load in plastic crate.
- ◆ Handling – handle with care during loading, stacking and unloading; do not drop. Don't use as seats when sorting (Photo 20).
- ◆ Storage – store in a clean area that will prevent harborage of insects and rodents. Store 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.
- ◆ Do not use as storage container for chemicals (fertilizers and pesticides) if used for fresh produce.

TRANSPORT

The main objective in transport is to insure that tomatoes will arrive in top quality condition to the final market. Tomatoes often undergo three (3) transport stages: (a) farm to collection center

Photo 19. **Dirty plastic containers as source of contamination (a); clean plastic crates after use (b)**



Photo 20. **Bad practice in the use of plastic crate as seat**



or packing shed, (b) packing shed to wholesale market, and (c) wholesale market to retail market. In all of these stages, follow the proper transport practices given below:

- ◆ Handle containers gently; they should not be dropped or thrown on to each other.
- ◆ Do not seat on top of packed tomatoes during field transport (Photo 21).
- ◆ Containers at the bottom should not be used as steps to allow stacking to a greater height especially if semi-rigid containers like cartons are used.
- ◆ Do not expose tomatoes to the sun during transport.
- ◆ Allow air to circulate in the stacks or piles of produce by providing space in between stacks. If canvass is used as cover, provide space for air to pass through at the bottom and top of stack; Use light colored material as cover as this will reflect heat.
- ◆ Minimize delays or facilitate transfer of packages from one part of the market to another; four-wheeled hand trolleys (Photo 22) will minimize damage during unloading and transfer of produce packed in plastic crates.

Photo 21. Bad practices during the different transport stages of tomato: (a) farm to collection center with farmers sitting on packed tomatoes and (b) collection center to wholesale market



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Photo 22. Four-wheeled trolley facilitates transfer of produce



Photo 23. Transport vehicle used as storage area of farm tools and materials



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- ◆ Observe cleanliness of the transport vehicle; produce safety is compromised when:
 - there are decaying remains of produce from the previous shipment
 - insects and rodents nesting in the vehicles
 - vehicle used as storage area of farm implements when not in use (Photo 23)

HANDLING AT WHOLESALE AND RETAIL MARKETS

The wholesale and retail markets serve as the outlets of tomato farmers, collectors and other traders. The basic rules that should be observed are as follows:

- ◆ Unload containers from the transport vehicle under cover/shade with careful handling to minimize mechanical damage.
- ◆ Re-sort tomatoes using sorting table (Photo 24).
- ◆ Discard culls properly.
- ◆ Re-grade tomatoes according to size, appearance and stage of ripeness as the case maybe depending on the requirement of the target market.
- ◆ Place tomatoes in a clean storage room in the wholesale market; keeping packed tomatoes near vegetable trimmings, culls and wastes will lead to contamination (Photo 25).

Photo 24. **Re-sorting of tomatoes in the wholesale market**



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Photo 25. **Tomatoes packed in plastic crates and kept in clean wholesale stall (a), and tomatoes in plastic crates placed near culls and wastes (b)**



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- ◆ In the retail market, it is best to sell tomatoes in retail packs (Photo 26) since this will prevent frequent handling of customers when they select tomatoes. Frequent handling of customers may also lead to contamination. If retail packaging cannot be done, tomatoes should be placed in appropriate containers during retail display. Displaying tomatoes loose on the ground with plastic mat underlay may not provide adequate protection from contamination (Photo 27).
- ◆ When retailing in open-air market and roadside stalls, tomatoes on display should be under shade for sun and rain protection.

Photo 26. Tomatoes in retail packs (in supermarkets) and in retail display in wet markets



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Photo 27. Proper display of tomatoes in retail market (a), and loose display of tomatoes on ground with mat underlay may lead to fruit contamination (b)



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