



Food and Agriculture Organization
of the United Nations

POST-HARVEST MANAGEMENT OF GREEN MUSTARD TO ENSURE QUALITY AND SAFETY

A close-up photograph of fresh green mustard leaves, showing their vibrant green color and prominent veins. The leaves are stacked and appear to be part of a bunch.

GUIDANCE
FOR STAKEHOLDERS
IN THE HORTICULTURAL
SUPPLY CHAIN

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Prepared by E. Esguerra, R. Rapusas
and R. S. Rolle

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Acronyms

DAT	Days after transplanting
FAO	Food and Agriculture Organization of the United Nations
FAVRI	Fruit And Vegetable Research Institute (Viet Nam)
GMS	Greater Mekong Subregion
PHTRC	Postharvest Horticulture Training and Research Center (the Philippines)
RAP	Regional Office for Asia and the Pacific (FAO)
RAS	Rural Advisory Services
SAARC	South Asian Association for Regional Cooperation
TCP	Technical Cooperation Programme
UPLB	University of the Philippines Los Baños

Introduction

Green mustard (*Brassica juncea* L.) is a leafy vegetable (Photo 1) that is popularly consumed in the Socialist Republic of Viet Nam. It is commonly used as an ingredient in the preparation of a number of dishes. It is also fermented into pickles.

Apart from its economic value, green mustard is a good source of vitamins A, C, and K and other micronutrients. It also contains phytonutrients such as glucosinolates, which are associated with unique health benefits such as lowering of cholesterol.



Photo 1. Fully mature green mustard showing desirable quality attributes

Importance of post-harvest handling

Good post-harvest handling is important in maintaining the fresh state of commodities and in assuring the safety of green mustard in the producer to consumer chain.

Losses in quantity and quality negatively impact on horticultural crops between harvest and consumption. Losses in green mustard are generally caused by immaturity, over-maturity, yellowing of leaves, mechanical damage (torn leaves) and decay (Photo 2). These losses are largely the result of poor harvesting, rough handling, and poor packaging and transport conditions.

Every effort must be made to apply good post-harvest handling practice in order to ensure the quality and safety of this leafy vegetable (Photo 3) for consumers.



Photo 2. Green mustard with yellow and torn leaves

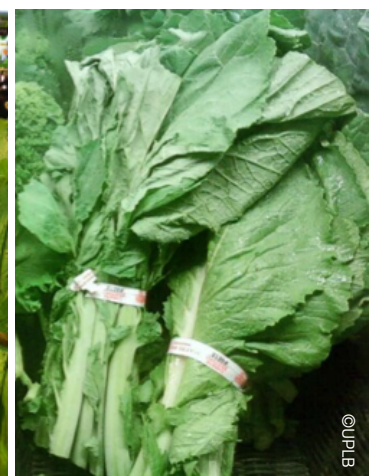


Photo 3. Customers generally prefer fully mature green mustard without roots

Harvest management practices



Photo 4. *Green mustard ready for harvesting*



Photo 5. *Hand-harvesting and bundling of green mustard*

Harvest at the correct stage of maturity. Important considerations during harvesting are the manner in which the green mustard is detached from the plant and the time of harvesting.

Harvest maturity

Green mustard is ready for harvesting when the leaves turn dark green before the plant begins to flower (Photo 4). Leaves are allowed to grow until they reach full maturity. An objective index used by farmers to indicate harvest maturity is the number of days after transplanting (DAT). Based on their experience, green mustard is harvested at 20 to 25 DAT. Green mustard sprouts are harvested at 7 DAT.

Time of harvesting

Green mustard must be harvested at the coolest time of day; either early in the morning or late in the afternoon to minimise shrivelling and the accumulation of field heat. Green mustard must not be harvested very early in the morning or after rain since the brittle, crisp leaves will break during handling. Decay is also likely to occur under high moisture conditions. If there are delays during packing, the harvested mustard must be placed under shade. Mustard is usually harvested late in the afternoon in preparation for early transport to the wholesale market.

Harvest management practices

Harvesting method

Green mustard must be harvested with the aid of a harvesting knife (Photo 5). Soil conditions should be relatively dry so that the soil can be readily removed from the roots. Green mustard is commonly bunched or bundled after trimming using bamboo strips.

Harvested green mustard must not be placed directly on the ground (Photo 6a) as this will lead to contamination and could pose a health hazard to consumers. Harvested mustard must be placed in collecting containers such as plastic crates with the root base down (Photo 6b).



Photo 6. Green mustard may become contaminated if left on the ground (a); place in collecting containers, such as a plastic crate, (b) to minimise the risk of contamination

Post-harvest handling operations



Photo 7. Good quality green mustard



Photo 8. Green mustard is normally sold in markets with the roots intact

Post-harvest operations refer to activities undertaken to prepare fresh produce for the market. These operations can be undertaken in the field, at collection centres or in a packinghouse. The packinghouse area should provide adequate protection from sun and rain and must be kept clean at all times. Animals must be kept out of the packing area. All workers should maintain a high degree of personal hygiene and, where appropriate, should wear suitable protective clothing and a head covering.

Sorting

Buyers prefer good quality green mustard, thus sorting is necessary. Green mustard can be sorted right after harvest or before packing. Good quality green mustard should have leaves that are fresh, fairly tender, clean, well trimmed, and free from decay, discolouration, foreign material, insects, mechanical damage or that caused by coarse stalks (Photo 7).

Trimming

Trimming refers to the removal of unwanted parts that are likely to be rejected by the consumer. Roots are generally removed since they may harbour organisms that cause decay and food spoilage, which may pose health risks. It is customary in Viet Nam, to sell green mustard with the roots intact (Photo 8) because it is thought that the produce will have a longer storage life.

Washing will not ensure that hazards are eliminated, especially if only tap water is used. It is therefore recommended that the roots are trimmed prior to washing and selling. A clean knife must always be used for trimming.

Post-harvest handling operations

Cleaning/washing

Cleaning removes extraneous materials and renders the commodity more saleable.

Green mustard is generally washed twice in tap water (Photo 9). The first washing removes the soil particles adhering to the roots, while the second is used to rinse the mustard. The use of tap water alone may not eliminate decay-causing organisms such as the bacterial soft rot organism and those that cause food spoilage. It is highly recommended that chlorinated water be used for the second washing.

It is also recommended that the water used for washing be changed frequently to eliminate the risk of contamination from dirt in the water.

Drying after washing

Green mustard must be dried to eliminate the excess water on the leaves that may enhance decay. It is common practice to dry washed green mustard overnight on the ground on a cemented floor with or without a plastic sheet underlay (Photo 10). This is bad practice as the ground can be a source of contamination. Green mustard is best dried on top of drying racks made of slatted bamboo.



Photo 9. Green mustard is washed in tap water twice (a). Dirty water after the first wash (b)



Photo 10. Air-drying of washed green mustard on cemented floor

Packaging



Photo 11. Stackable plastic crates are appropriate containers for green mustard



Photo 12. Common materials and methods used to package green mustard that lead to mechanical damage: round iron basket (a); bamboo basket (b); round plastic basket (c); and plastic bag (d)

Good bulk packaging is essential in maintaining the quality of green mustard during transportation and subsequent handling. The basic functions of bulk packaging are to contain sufficient quantities of green mustard, to protect the green mustard during transportation and to facilitate handling.

Bulk packaging containers

Rigid containers such as plastic crates are highly recommended for packing green mustard since they provide adequate protection against damage from compression and abrasion (Photo 11). The smooth inside finish of plastic crates allows them to be easily cleaned. Plastic crates are stackable, reusable and returnable. Although more expensive than traditional packaging containers such as bamboo baskets, plastic crates last from 5 to 6 years, which is longer than traditional packaging. The packaging cost per kilogram of produce packaged in plastic crates is relatively cheaper.

The use of round iron baskets, lined with recycled plastic sacks, may not provide adequate protection to the green mustard (Photo 12a). If not adequately lined, the rough edges of the iron basket may damage the leaves. Similarly, packing green mustard in bamboo baskets (Photo 12b), and round plastic baskets (Photo 12c) may damage the leaves, especially if over-packed. It is a common practice also to pack green mustard in large plastic bags (Photo 12d), which are often over-packed. In the wholesale markets it is common to see green mustard that is not packed but tied in large bundles. All these practices result in damaged leaves

Packaging

Considerations when using plastic crates

- ✓ **Hygiene** – plastic crates must be thoroughly cleaned with soap/detergent after use (Photo 13).
- ✓ **Handling** – crates must be handled with care during loading, stacking and unloading; crates must not be dropped or used as seats when sorting.
- ✓ **Storage** – crates must be stored in a clean area that will prevent infestation by insects and rodents. To prevent contamination the crates must be stored separately from chemicals and farm machinery. Crates should not be left exposed to sun and rain because they will wear out quickly.
- ✓ Crates must not be used as storage containers for chemicals such as fertilizers and pesticides, if they are to be used for fresh produce.



Photo 13. Dirty plastic containers are a source of contamination (a); plastic crates must be cleaned after use (b)

Transport



Photo 14. Vegetables packed in plastic bags with the handler sitting on top



Photo 15. Wet cloth covering packed produce to minimise water loss

Prior to reaching the consumer, green mustard often undergoes three transportation steps: (a) farm to collection centre or packing shed; (b) packing shed to wholesale market; and (c) wholesale market to retail market. Good transport practice must be followed at each step:

- ✓ Containers must be handled gently; they should not be dropped or thrown on to each other.
- ✓ Containers at the bottom of the stack should not be used as steps to allow stacking to a greater height.
- ✓ Stacked containers of packed vegetables must not be used as a seat (Photo 14).
- ✓ Air must be allowed to circulate in the stacks or piles of produce by providing space between the stacks. If a canvas cover is used, space must be left to allow the air to pass through at the bottom and top of a stack. The use of a light coloured material as cover is generally preferred, as this will reflect heat.
- ✓ Good temperature management is important especially during hot and dry weather. Water loss can lead to wilting. Loss in marketable weight can be prevented if the crates are covered with a wet cloth during transportation (Photo 15).

Transport

- ✓ The vehicle used to transport the fresh produce must be kept clean so as not to compromise produce safety. It should not harbour:
 - decaying remains of produce from the previous shipment
 - insects and rodents
 - and must not be used to store farm implements when not in use (Photo 16).



Photo 16. Transport vehicle used to store farm tools and materials

Handling at wholesale and retail markets



Photo 17. *Vegetables displayed on the ground with a plastic mat as underlay*



Photo 18. *Vegetables, including green mustard, on a retail display cart or on tables*

Wholesale and retail markets serve as outlets for green mustard farmers, collectors and other traders. The following basic rules should be observed in these markets:

- Containers must be unloaded with care from the transport vehicle under cover/shade to minimise mechanical damage
- Green mustard **must not be displayed on the ground** even if a plastic mat or sheet is used as underlay (Photo 17), as this will lead to microbial contamination, especially during the rainy season when rain splashes on to the displayed mustard. **Use a cart or display racks** to better protect the produce from microbial contamination from the ground (Photo 18).
- When retailing in open-air markets and roadside stalls, displayed green mustard should be kept under shade for protection from sun and rain.

Bibliography

Cantwell, M.I. & Kasmire, R.F. 2002. Postharvest handling systems: flower, leafy, and stem vegetables. *Postharvest Technology of Horticultural Crops*. 423-433.

FAO Report. 2012. Third mission report to project Lead Technical Officer under TCP/RAS/3310 – *Capacity-development to reduce post-harvest losses in horticultural chains in GMS countries*. Bangkok, the Kingdom of Thailand, Food and Agriculture Organization of the United Nations – Regional Office for Asia and the Pacific.

Kanlayanarat, S., Rolle, R. & Acedo, A. 2009. *Horticultural chain management for countries in Asia and the Pacific Region: a Training Package*. FAO RAP 2009/2006. Bangkok, the Kingdom of Thailand, Food and Agriculture Organization of the United Nations – Regional Office for Asia and the Pacific.

Kitinoja, L. & Kader, A.A. 2002. *Small-scale post-harvest handling practices: a manual for horticultural crops, Fourth Edition*. United States, Postharvest Technology Research and Information Center, University of California, Davis.

Rapusas, R.S. & Rolle, R.S. 2009. *Management of reusable plastic crates in fresh produce supply chains – a technical guide*. Bangkok, the Kingdom of Thailand, Food and Agriculture Organization of the United Nations – Regional Office for Asia and the Pacific.

