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Good practices in harvest and post-harvest handling of immature fruit vegetables

Submitted by the secretariat

Summary

In 2021, a second edition of the ECE *Code of Good Practice – reducing food loss and ensuring optimum handling of fresh fruit and vegetables along the value chain* was developed by an ad-hoc drafting group under the Specialized Section for Standardization of Fresh Fruit and Vegetables and presented to the 76th session of the Working Party on Agricultural Quality Standards. The Code of Good Practice contains recommendations for optimal handling of fresh fruit and vegetables along the supply chain avoid food loss. For ease of use, it has separate chapters for different supply chain actors: primary producers, traders, transporters, and retailers.

In addition, to increase the uptake and use of the Code of Good Practice, it was proposed to develop hands-on guidance material with illustrative pictures for practical use (informal document ECE/CTCS/WP.7/2021/Inf.2). Thus, with funding from a United Nations Development Account (UNDA) project, such recommendations have been developed covering four groups of vegetables for which common guidelines and recommendations apply, namely: floral vegetables; immature fruit vegetables; leafy vegetables; and root vegetables.

The present document covers immature fruit vegetables.

The Specialized Section for Standardization of Fresh Fruit and Vegetables is invited to review the draft. It is also invited to consider the merits of covering a wider range of products by similar guidance material, and if so, if it should cover product groups or specific products in line with the trade standards.

Code of Good Practice: Good practices in harvest and post-harvest handling of immature fruit vegetables

I. Introduction

The use of good practices, when vegetables are harvested and subsequently handled, are central in reducing losses and waste. These recommendations, that cover immature fruit vegetables, aim to provide practical guidelines for handling this group of products and thereby to supplement the recommendations given in the Code of Good Practice.[1]

Good practices during harvest and postharvest are important to assure food safety and keeping quality. In this document, emphasis is given to keeping quality, with practices that keep the produce sound, extends shelf life and reduce food loss and waste.

One must have in mind that keeping the produce sound is important to guarantee its safety, but it is not enough. A high-quality cucumber fruit can look good and yet be unsafe due to its contamination with food-borne pathogens or toxic chemicals. On the other hand, a wilt and yellowed cucumber, although a low-quality produce in terms of flavour, can be safe.

The recommendations listed in this guidance do not guarantee food safety. More specific guidelines are available at Codex Alimentarius.[2]

II. Good practices for keeping quality

There is more than one way to implement good practices in the immature fruit vegetables supply chain, depending on the size of the business, the technological level and the market demand on quality and presentation of the produce.

In all cases, the following conditions should be met:

1. Handle the produce as little and as carefully as possible to avoid physical damage.
2. Protect the produce from damaging environmental conditions like direct exposure to sunlight, wind and dust, inappropriate temperature and air humidity and rain or hail, all the way from producer to point of sale.
3. Protect the produce from exposure to ethylene.
4. Keep hygiene in all steps of the supply chain to avoid contamination by plant and foodborne pathogens.
5. Coordinate operations to assure fresh product arrives in the market as soon as possible after harvest.

III. Primary Producers

Immature fruit vegetables have a short shelf-life due to their high metabolic rates and lack of storage reserves. This group includes vegetables such as cucumber, zucchini, eggplant, okra, green beans, green peas and others.

[1] Code of Good Practice – reducing food loss and ensuring optimum handling of fresh fruit and vegetables along the value chain, available at: https://unece.org/sites/default/files/2021-11/WP7_2021_INF1_0.pdf

[2] Codex Alimentarius (2017). Code Of Hygienic Practice for Fresh Fruits and Vegetables: https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXC%2B53-2003%252FCXC_053e.pdf

Proper handling during harvest and postharvest is essential to preserve the quality and to avoid waste. The skin of immature fruit gives a certain degree of protection against water loss and microbial infection. However, this protection is lost when the skin is damaged. Careful handling to avoid cuts and bruising is therefore important to reduce water loss and microbial infection, in particular when refrigeration is not available, since there will be no help from low temperature to reduce the effects of improper handling. In this case, one should count on the natural protection provided by an intact and unblemished skin.

A. Maturity at harvest

Immature fruit vegetables should be harvested when the fruit is at the desirable size and/or colour, when the flesh is firm but not ripe and the seeds are not fully developed. Firmness and external glossiness are common indicators of a pre-maturity condition, while a dull appearance indicates they are over-mature.

Harvesting too early will decrease productivity and can negatively impact shelf-life since smaller fruits are more prone to water loss due to a higher surface area to volume ratio and a relatively thin cuticle. Harvesting too late, on the other hand, results in produce of low sensorial quality due to yellowing, toughening, fibrousness, presence of hard seeds or bitterness, depending on the vegetable.

These vegetables undergo very rapid change in morphology and chemical composition and because of that they require very frequent harvest. For okra, zucchini and cucumber, it can be as frequent as every day or every other day.

B. Harvest methods and tools

Early morning is the best time to harvest, while it is still cool but after dew has dried from the fruit.

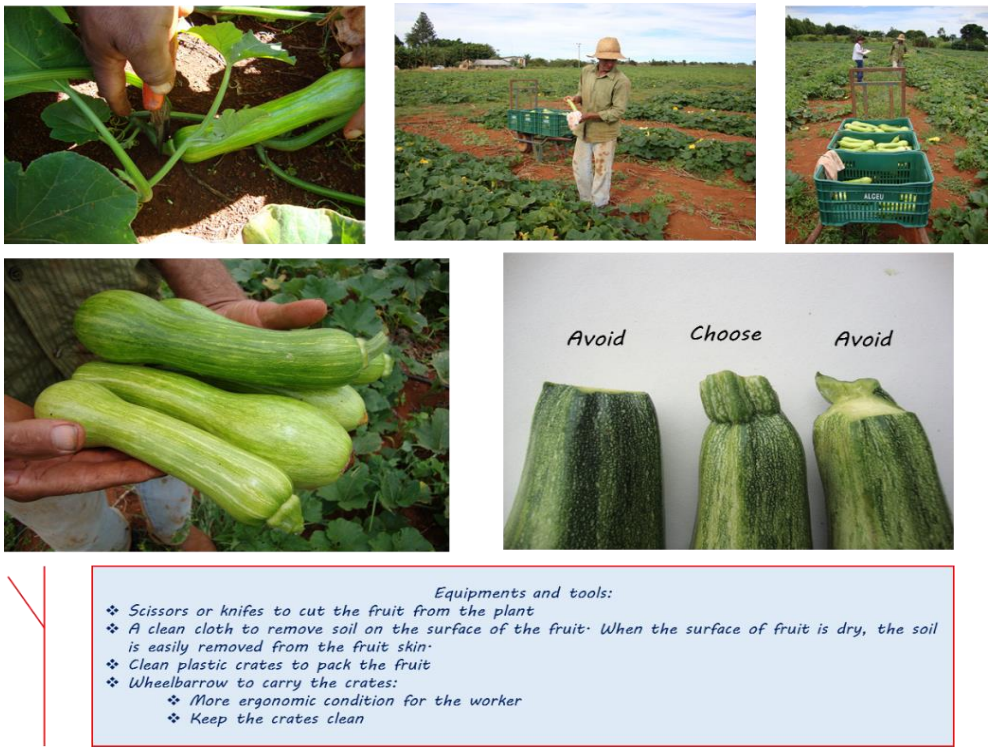
Use scissors or clippers to cut the stems just above the fruit. Although some fruits can be picked by turning the fruit parallel to the stem and quickly snipping it off, it is not easy to do it right and both the fruit and the plant can be damaged in this process.

Most immature vegetables have very soft skin. To avoid punctures, keep fingernails trimmed or use gloves.

During harvest, keep the harvest container close as you move down the row so you can gently place the fruits inside, instead of throwing them. When possible, use a wheelbarrow to carry the containers and keep them clean. When not possible, be careful when stacking the containers to prevent the soil from the bottom of one container soiling the fruits in the one under it. Avoid transferring fruits from one container to another. If imperative, do it gently and limit, as much as possible, the drop height. This will prevent bruising of the skin and internal damages that will show later as softened, water soaked or darken areas.

The same principle applies when harvesting with the aid of foldable conveyor belts coupled to a tractor. The produce, picked by hand, is placed on the lateral belt and distributed for sorting and packing in a shaded trailer connected to the tractor, or collected into bins and later transported to the packinghouse.

Do not stack too many fruits in in the harvest container, to avoid compression damage. Preferably, place the fruits with stems all facing one direction to prevent scratching of the skin by the peduncle of another fruit and soiling of the skin by latex dropping from the cut surface.



Photos: Milza Moreira Lana, EMBRAPA

C. Cleaning of containers, tools and equipment

Immature fruits are easily bruised. Cleaning the containers is important not only to avoid contamination but to prevent bruising of the skin, which rapidly evolves to darkening and rotting. Debris can be removed with water and a brush or with a pressure washer.

Cutting tools should be cleaned, sanitized and sharpened regularly. Blunt tools damage the peduncle and a rough-cut surface deteriorates more easily.

To avoid cross contamination, it is a good practice to colour code or label containers that are used in the field and keep them separated from those used for transporting the product for the market.

D. Postharvest operations

Immature fruit vegetables usually do not undergo extensive sizing, sorting and grading. Field packing is therefore a good option to reduce handling and physical damage. However, it can be better to size and grade in a packaging house when customers ask for different classes and packages of the same produce. If the packing house is air conditioned, there is the added benefit of removing the vegetable more quickly from the field to the refrigerated environment.

There is no need to rinse or wash unless dirt has adhered to the vegetables. Alternatively, the fruits can be cleaned with a clean moistened cloth, during or after harvest.

The more common pre-cooling methods for immature fruit vegetables are hydrocooling and forced-air cooling. When using hydrocooling, care must be taken to keep the water clean to avoid cross contamination.

When hydrocooling and refrigeration are not available, keep vegetables in the shade, in a well ventilated and fresh area. Stack the packages in a way that allows proper ventilation, to remove heat of respiration.

Crates made of cardboard, wood or plastic can be used, as far as they have a smooth inner surface, are palletized and hold one or few layers of fruits

Photos: Milza Moreira Lana, EMBRAPA

E. Postharvest infrastructure

Regardless of size and complexity, the packaging house must include reception, processing and dispatch areas. When more complex operations are performed, or when the scale of production is larger, areas for administrative operations, precooling facilities, cold storage and material and packaging storage areas are added. The arrangement of these areas should facilitate the work and avoid cross-contamination of the vegetable.

When postharvest operations are performed in the field, it is advisable to install mobile shade units to keep the produce under shade until it is transported. These units can be used as a packing shed where the fruit is selected and packed.

In small and medium sized farms selection and grading is usually done manually. For large scale operations, automated sorting and packing lines using machine vision are available for cucumbers, eggplant and zucchini.

IV. Traders and Transporters

Immature fruit vegetables are not adapted to long term storage and most of them are susceptible to chilling injury. Refrigeration is used to extend shelf-life a few days and to avoid loss during transport.

Temperature should be above 10 to 12ºC, depending on the produce, with the exception of green peas and green beans that benefit from lower temperatures.[3] Symptoms of chilling injury usually do not show up during storage, but when the produce is transferred to room temperature. As the induction of chilling injury is related to exposure time, it may be possible

[3] For more information, see Code of Good Practice – reducing food loss and ensuring optimum handling of fresh fruit and vegetables along the value chain, available at: https://unece.org/sites/default/files/2021-11/WP7_2021_INF1_0.pdf

to transport chilling sensitive produce at a slightly lower temperature than recommended, for brief periods of time.

In addition to temperature, the relative humidity of the transportation unit should be monitored and adjusted to prevent either dehydration or condensation and dripping water from cooling units reaching the produce.

Immature fruits are very sensitive to ethylene. In mixed loads it is necessary to prevent ethylene damage by using ethylene scrubbers or ventilating the cargo frequently by opening ventilation doors.

To prevent overheating in non-refrigerated transport it is important to allow adequate ventilation of the packages through proper stacking and to protect the load with a light colour tarpaulin.[4]

V. Retail

A. Display products appropriately[5]

Immature fruit vegetables are easily damaged. Display in few layers to avoid compression and remove damaged fruits to inhibit rummaging by customers, looking for undamaged ones.

When using a refrigerated display remember to set the right temperature to avoid chilling injury or display small amounts of produce, so that they don't remain under chilling temperatures long enough to induce damage.

Although these vegetables benefit from high humidity, they should not have free water on the surface. This can induce decay, especially if the temperature is high and the fruit is bruised.

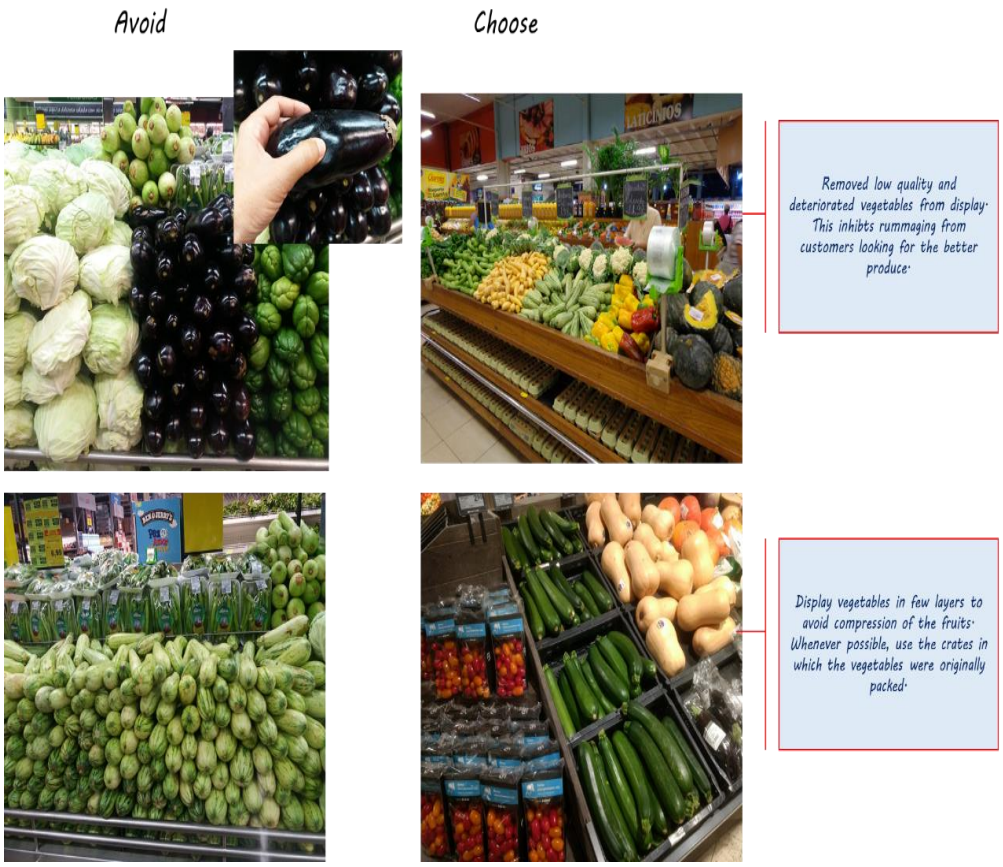
B. Measure the losses and waste

Recording losses and waste from production to wholesale levels will help to identify weak links and increase awareness throughout the distribution chain. Methods have been described, for example by the ECE, in its guide Simply Measuring - Quantifying Food Loss & Waste: UNECE food loss and waste measuring methodology for fresh produce supply chains.[6]

[4] More detailed information on transport of fruit vegetables, including guidelines for specific produce and produce compatibility, can be found in: Protecting Perishable Foods During Transport by Truck and Rail, University of Florida, 2019, available at: https://edis.ifas.ufl.edu/pdf%5CHS%5CHS132800.pdf

[5] Retail outlet display considerations for individual produce are available at USDA (2016), The Commercial Storage of Fruits, Vegetables and Florist and Nursery stocks, Agriculture Handbook Number 66, United States Department of Agriculture, February 2016, available at: www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf

[6] ECE (2020), Simply Measuring - Quantifying Food Loss & Waste: UNECE food loss and waste measuring methodology for fresh produce supply chains, ECE/TRADE/453, Geneva 2020. Available at: https://unece.org/sites/default/files/2021-04/FoodLossMeasuringMethodology.pdf



Photos: Milza Moreira Lana, EMBRAPA

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Annex

Additional information and links

General

For more information on harvest and postharvest of specific vegetables, see:
Cowpea, garden egg-eggplant, egusi, okra: Lost crops of Africa- Volume II - Vegetables: 16 Okra | Lost Crops of Africa: Volume II: Vegetables | The National Academies Press (nap.edu)
Cucumber: Microsoft Word - Cucumber PH Information Sheet _GEO_.doc (newgmc.com)
Cucumber, eggplant and green beans: Product guides | Postharvest Management of Vegetables
Cucumber, eggplant, green beans, sweet corn, zucchini: Growing for Wholesale: Grading and Packing Guidelines by Crop - Cornell Vegetable Program - Cornell University - Cornell Cooperative Extension
Cucumber, eggplant, green beans, okra, peas, sweet corn, zucchini:
https://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/
Green beans: Post-harvest management of snap bean for quality and safety assurance (fao.org)
Okra: http://www.newgmc.com/gmc_docs/brochures/Okra.pdf

Pre-harvest and harvest operations and efficiency

To know more on preharvest and harvest operations to increase harvest efficiency, see:
Cornell University Cooperative Extension of Schuyler County, Preharvest Preparations - YouTube
Cornell University Cooperative Extension of Schuyler County, Harvest Efficiency Squash and Cucumbers - YouTube

Maturity at harvest

Recommendations on horticultural maturity indices for individual produce are available at the website of University of California, Division of Agriculture and Natural Resources (UCDAVIS). Produce fact sheets:
https://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/
USDA (2016), The Commercial Storage of Fruits, Vegetables and Florist and Nursery stocks, Agriculture Handbook Number 66, United States Department of Agriculture, February 2016, available at: www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf

Harvest methods and tools

Field-packing of zucchini using harvest conveyors:
https://www.youtube.com/watch?v=iycZz9nv858
Field-packing of zucchini using wheelbarrow:
https://www.youtube.com/watch?v=o9k8WVSdub4
Cheap and easy to build wheelbarrow:
https://ainfo.cnptia.EMBRAPA.br/digital/bitstream/item/108845/1/EMBRAPA-COT-99-light.pdf (portuguese)

Cleaning of containers, tools and equipment

How to choose harvest containers: Bins, Buckets, Baskets & Totes – UVM Extension Ag Engineering
How to clean harvest containers: https://blog.uvm.edu/cwcallah/files/2021/11/How-to-Clean-Bins-VAAFM.pdf
Management of reusable plastic crates: https://www.fao.org/3/i0930e/i0930e00.pdf

Postharvest operations

Temperature management after harvest:
https://hortinnovlab.plantsciences.ucdavis.edu/T9L2-Cooling/
Hydrocooling and sanitation of recirculated water:
https://ufdcimages.uflib.ufl.edu/IR/00/00/16/76/00001/CV11500.pdf
Forced-air cooling:
http://ufdcimages.uflib.ufl.edu/IR/00/00/45/11/00001/AE09600.pdf

Postharvest infrastructure

General guidelines on packaging house operations: https://www.sfa.gov.sg/docs/default-source/tools-and-resources/resources-for-businesses/ava_vegetablespackaging_9th
Establishing and managing smallholder vegetable packhouses to link farms and markets: https://avrdc.org/download/publications/from_the_field/postharvest/Packhouse-manual-english.pdf
Wash sinks for small farms: https://blog.uvm.edu/cwcallah/files/2019/01/Sinks-Factsheet-V1.0.pdf
Cheap and clean tables to select fruits:
https://www.infoteca.cnptia.EMBRAPA.br/infoteca/bitstream/doc/985610/1/cot98.pdf (in Portuguese)
Mobile cheap packing-shed:
https://ainfo.cnptia.EMBRAPA.br/digital/bitstream/item/111172/1/COT-100-X.pdf (in Portuguese)

Refrigeration and transport

Protecting Perishable Foods During Transport by Truck and Rail, University of Florida, 2019: https://edis.ifas.ufl.edu/pdf%5CHS%5CHS132800.pdf
Chilling injury in fruit vegetables, how to measure and track temperature: https://youtu.be/aYcYNhz3810
General principles in managing cooling of vegetables: https://youtu.be/VVDvVHa7xVA ; https://hortinnovlab.plantsciences.ucdavis.edu/T9L3-Cooling/
Coolboot: see: https://horticulture.ucdavis.edu/sites/g/files/dgvnsk1816/files/extension_material_files/technologies_CoolBot.pdf
Evaporative cooling: https://d-lab.mit.edu/sites/default/files/inline-files/Evaporative%20Cooling%20Best%20Practices%20Guide.pdf
Refrigerated transport: https://hortinnovlab.plantsciences.ucdavis.edu/T11L3-Transportation/

Retail

Retail outlet display considerations for individual produce are available at USDA (2016), The Commercial Storage of Fruits, Vegetables and Florist and Nursery stocks, Agriculture Handbook Number 66, United States Department of Agriculture, February 2016, available at: www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf

Salad Vegetables. Look at Sales Strategies and Dynamic Displays:
https://www.producemarketguide.com/produce