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Steering Committee on Trade Capacity and Standards

Working Party on Agricultural Quality Standards**Specialized Section on Standardization of Fresh Fruit and Vegetables****Seventieth session**

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Item 5 of the provisional agenda

**Sustainable Development Goal 12 and sustainable practices:
food loss and waste prevention related to standards****Good practices in harvest and post-harvest handling of floral
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 floral 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 floral 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 floral 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 cauliflower head 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 dark spotted cauliflower, 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 floral 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

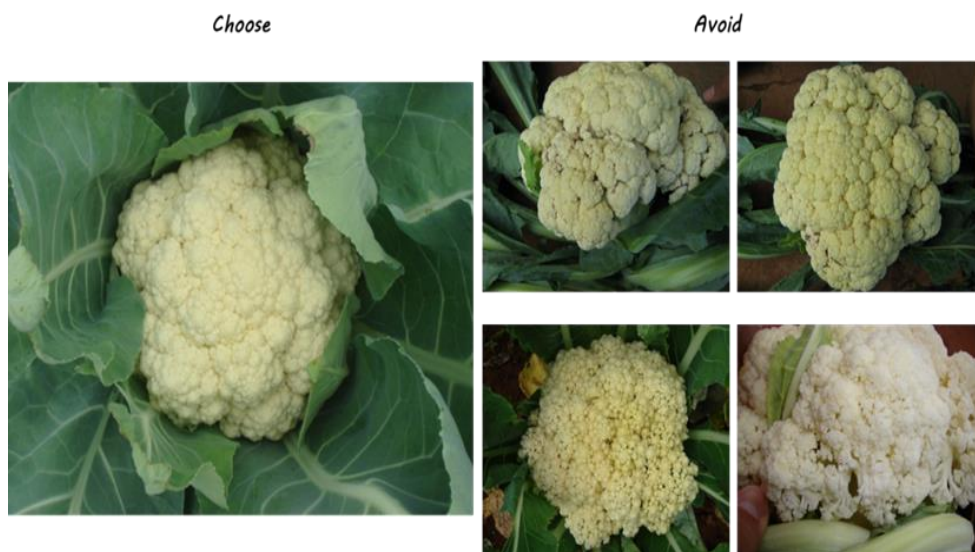
Floral vegetables are among the most perishable vegetables. Shelf-life is limited by a high respiration rate, resulting in rapid senescence, and by a high surface to volume ratio which accelerates water and freshness loss. Proper handling is essential for keeping quality.

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

A. Maturity at harvest

Floral vegetables are harvested when the buds are still closed. Flower opening negatively affects the sensory quality and shelf life.



Photos: Milza Moreira Lana, EMBRAPA









Cauliflower should be harvested when it has reached the desired size, and the heads are firm and tight. Overdeveloped heads become loose and soft, and riciness can develop.

Broccoli should be harvested when the heads are fully formed and compact with the buds tightly closed. The stems should be pale green in colour and tender. Overdeveloped heads become loose and have open flower buds or enlarged buds on the verge of opening.

Artichoke should be harvested when the bud is compact, well-formed, with a typical green or purple colour, a smooth and uniform stem-cut. Overdeveloped buds of Green Globe artichokes have an open or spreading structure; the bracts have a brownish cast and are tough and stringy; and the internal pappas - fibrous central portion of the bud- grows above the top edge of the receptacle.

B. Harvest methods and tools

Cauliflower, broccoli and artichoke are harvested by hand, cutting the head or bud with a sharp knife or similar tool. Harvest aids, conveyors and mobile field units, can be used as demonstrated in the videos listed in annex.

	Choose	Avoid	
<p><i>Harvest cauliflower early in the morning or late in the afternoon. Cut the plants and remove the external leaves, without touching the curd. Keep a few leaves to protect the curd.</i></p>			<p><i>Don't use dirty harvest containers. It increases the chances of biological contamination and the debris can cause physical damage to the curd.</i></p>
<p><i>Place the curds in proper harvest containers. The use of a wheelbarrow prevents soiling of the crates.</i></p>			<p><i>Keeping the leaves induces wilting of the curd. IN addition, when the leaves senesce, they produce ethylene that damages the curd.</i></p>
<p><i>Allow proper ventilation during transport. Stack the crates carefully. Cover the cargo to avoid sun warming and dehydration.</i></p>			<p><i>These crates are too small for the cauliflower, what prevents its proper stacking.</i></p>
			<p><i>Piling and compressing the curds causes warming and physical injuries. Both reduce shelf-life.</i></p>

Photos: Milza Moreira Lana, EMBRAPA

All floral vegetables can benefit from field-packing, especially when pre-cooling equipment is available, and heat field is rapidly removed, preferably within four hours after harvest. Most of the trimming should be made in the field to reduce the cost of transporting parts of the plant that will be later discarded and to minimize disease contamination.

More resistant to handling, compared to cauliflower, broccoli can be harvested in large bins that are transported to the packing house, where the heads are selected and packaged. However, field packaging reduces costs as well as potential damage to the heads.

Artichokes are cut by hand with a portion of the stem remaining with the bud. Recommendations on the size of stems vary greatly, from 2.5 to 10 cm below the base. The cut artichokes are placed in cloth bags that the harvesters carry on their backs or in buckets. Care must be taken when transferring the buds from harvest containers to larger bins or selection tables to avoid impact damage.

C. Cleaning of containers, tools and equipment

Reusable bins, buckets, totes and other containers should be kept clean of excess soil, vegetable matter and other debris and therefore washed and sanitized regularly. Tools should be cleaned daily or as needed to keep them clean.

D. Postharvest operations

The main postharvest operations of floral vegetables are selection, grading, packing, pre-cooling and cooling.

Broccoli and cauliflower should be cooled to below 5°C as soon as possible, especially if they have been harvested under warm conditions. Forced air and hydro-vacuum systems are effective methods to cool both. If using hydrocooling, it is important to allow enough time for the core to cool thoroughly and, in the case of cauliflowers, dry the heads before packing. Broccoli should not be stored wet either, as this increases stem rots and discolouration of the cut leaf bases. Room cooling in bins is not recommended unless heads are already less than 15°C at harvest.

In some countries, broccoli is typically packed in waxed cartons or Styrofoam boxes filled with ice. Although very efficient to keep the quality of broccoli after harvest, this system tends to be replaced by field packaging followed by vacuum cooling with or without modified atmosphere. The use of ice is associated with the following problems: need of energy to produce ice; rotting and splitting of the broccoli stem when the ice melts; higher costs of transport; disposal of the waxed cartons.

Cauliflowers and broccoli are very susceptible to moisture loss and respond well to individual packaging in plastic bags or films. However, care must be taken when choosing packaging for broccoli that is not cooled. Due to its high respiration rate, if the broccoli is packed in a plastic film with low permeability to oxygen and kept in warm conditions there is risk that off-flavours develop in the broccoli. In this case, choose films with high permeability which gives some protections against water loss without modifying the atmosphere inside the package.

Hydrocooling and forced-air cooling work well for removing field heat from artichoke. Artichokes can also be packed in ice, but the same constraints as reported for broccoli apply here. For more information on cooling methods, see Annex.

When precooling systems and cold storage are not available, the harvested vegetables should be placed in a fresh and covered area, protected from the wind but well ventilated. If vegetables are stacked in bulk in a way that does not allow proper ventilation around the products, the interior of the stack may get warm from the heat of respiration; it is better to keep products in well stacked ventilated boxes or crates.

Avoid



Choose



Photos: Milza Moreira Lana, EMBRAPA

E. Postharvest infrastructure

The size and complexity of the postharvest infrastructure depends on the volume of production and the complexity of the postharvest operations.

Packing-shed in the field: Suitable for small farms, without cooling facilities which sells vegetables packaged in bulk containers. The harvested produce remain under shade, until delivery to the market. The packing shed, can be constructed with metal tubes and tarpaulin, or other local materials.

Packing house facility: Suitable for medium to large farms, or to associations of small farmers, which sells vegetables packaged in retail units and bulk packages. It includes reception, selecting and packing and dispatch areas, and depending on the scale of operation, pre-cooling facility and cold storage room.

A conveyor system harvest aid, where a mobile packing house is coupled to a tractor, is suitable for large farms. Packaged produce, in bulk or in retails units, are transported to a pre-cooling facility and cooled, before dispatch to the market.

Photos: Michael T. Morales by FLICKR, Milza Moreira Lana, EMBRAPA

A packinghouse or packing shed can be built from scratch or be adapted from an existing facility no longer in use, such as a barn or a greenhouse.³ The University of Vermont-USA website has several studies on packing sheds, with videos, tutorials and interviews with the farms on the pros and cons of their packing sheds design.⁴

IV. Traders and Transporters

Delays in cooling and temperature fluctuations during transport has a negative impact on the

³ Basic guidelines on design, facilities and good practices:
https://www.sfa.gov.sg/docs/default-source/tools-and-resources/resources-for-businesses/ava_vegetablespackaging_9th

⁴ University of Vermont-Studies cases on packing shed:
<https://blog.uvm.edu/cwcallah/post-harvest/>

freshness and keeping quality at retail.



Photos: Milza Moreira Lana, EMBRAPA, Volkan Sengor by iSTOCK

Floral vegetables can be stored and transported at temperatures below 5°C, combined with 95–100% RH. Although temperatures as low as 0°C–2°C are recommended in many guidelines, there is a risk of freezing, when the temperature control is not precise. Freezing injury typically appears as water soaked and dark translucent spots.

Under optimal conditions, cauliflower shelf-life can reach up to 4 weeks, depending on the cultivar and seasonal conditions. At 10°C or higher, it deteriorates rapidly, becoming soft and discoloured within only a few days. Broccoli usually remains in excellent condition for at least 3 to 5 weeks under optimal conditions. Below 5°C, ethylene sensitivity is reduced, and storage life is usually ended by rots. Above 5°C storage life is limited by ethylene induced floret yellowing and general deterioration. They yellow within 2–3 days at 20°C. Artichokes can be kept for 2 weeks at 0°C but only 5 days at 10°C.

Broccoli responds well to modified atmospheres (MA) if stored for an extended period (>3 weeks). However, the benefits of MA are marginal when storage temperature is kept lower than 5°C, according to studies conducted in Australia. Broccoli may appear in excellent condition on removal from MA storage but deteriorate rapidly during retail.

During refrigerated storage and/or transport it is important to:

- Check that the relative humidity is satisfactory.
- Minimise water loss by using a large evaporator coil to keep defrosting to a minimum.
- Add moisture to the air in a variety of ways including wetting down the floor, hanging wet hessian curtains, using humidifiers.
- Control air circulation to avoid rapid air movement causing water loss and use protective covers over the products.
- Keep a minimum separation between pallets and walls of 45 cm and of 10 cm between pallets and floors. Such separation allows adequate ventilation and facilitates cleaning and inspection.

When refrigerated storage and transport are not available, stack the packages in a way that allows for proper ventilation, cover the cargo with a light colour tarpaulin and if possible, leave space between the cargo and the cover for the escape of warm air. FAO guidelines recommend fitting a roof on a frame in open-sided or half-boarded trucks. The open sides can be fitted with canvas curtains which can be rolled up or moved aside in sections to allow

loading or unloading at any point around the vehicle. Such curtains can protect the produce from the elements but still allow for ventilation.

Closed vehicles without refrigeration should not be used to carry floral vegetables, except on very short journeys, such as local deliveries from farmers or wholesalers to nearby retailers.

V. Retail

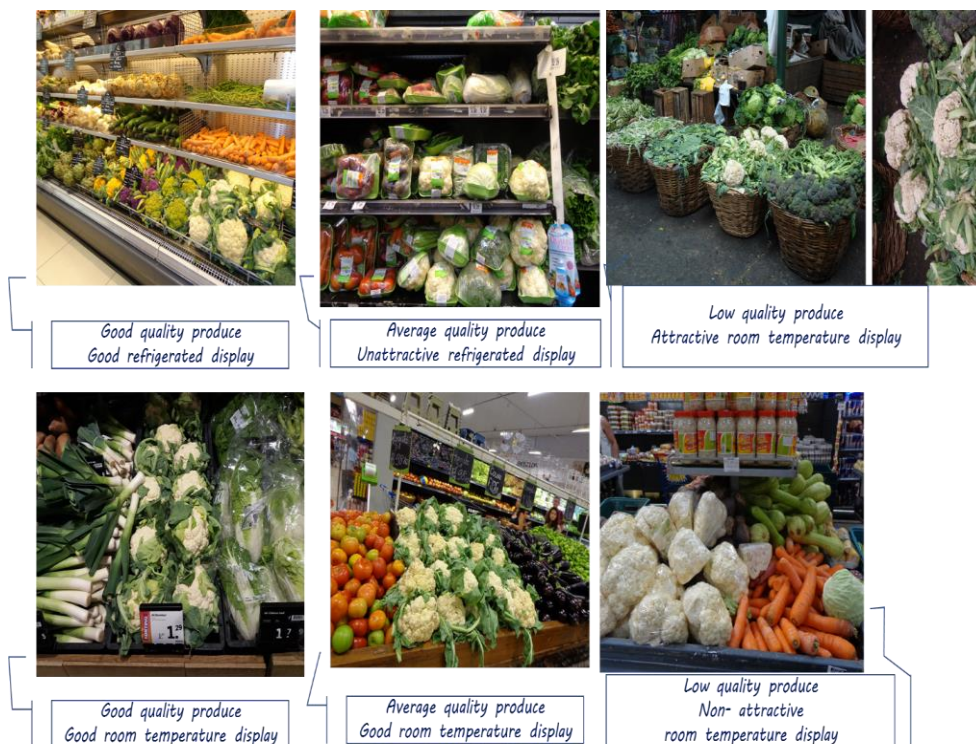
A. Display products appropriately ^{5,6}

Cauliflower in good condition may be displayed satisfactorily for 2 or 3 days at temperatures of 0°C to 10°C. The principal defects of cauliflower that may develop in the retail store are curd blackening (black-spotting), flabbiness of the curds and wilting and yellowing of the leaves.

Broccoli may be displayed for 2 or 3 days at temperatures of 4.5°C to 10°C. At temperatures above 13°C, broccoli ages rapidly, the buds turn yellow or brown, and early stages of decay soon appear. Without refrigeration, only one day shelf life can be expected because of wilting and yellowing.

Artichokes can be kept satisfactorily for few days at display temperatures of 4.5°C to 10°C. Artichokes often show brown discoloration of the outer leaves, which may be caused by bruises or by freezing.

At temperatures, lower than 10°C, floral vegetables may be lightly sprinkled to minimize wilting and drying, but at warm temperatures, sprinkling with water encourages the development of decay where water settles between the leaves and buds.



⁵ See Retail outlet display considerations in <https://www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf>

⁶ For more on Display and merchandising tips for artichoke, broccoli and cauliflower, see: <https://www.producemarketguide.com/produce>

B. Choose responsible promotional campaigns

Promotional campaigns to increase purchases encourage consumers to buy more products than they, or their household, may be able to consume. Such purchases often result in food waste. Instead, promote diversity of vegetables consumption for healthy eating and give advice on proper household storage. Give tips and recipes to make most of the vegetables available at the market, so that customers can replace one vegetable by another, when they don't find what they want. Broccoli and cauliflower, for instance, are exchangeable in many dishes.

C. 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*.⁷

⁷ 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>

Annex

Additional information and links

General

To know more about postharvest disorders and diseases of broccoli and cauliflower see:
<https://www.postharvest.net.au/product-guides/cauliflower/>
<https://www.postharvest.net.au/product-guides/broccoli/>

Harvest methods and tools

Field-packaging broccoli in large areas: https://www.youtube.com/watch?v=ZwEnW0IKl_c
Harvesting broccoli with back packs: <https://www.youtube.com/watch?v=ygWpxcJTxVo>
Harvesting broccoli in small areas: <https://www.youtube.com/watch?v=dUYiFqh0IJM>
Field-packaging cauliflower in large areas:
https://www.youtube.com/watch?v=kVuLBdN_tx8
Harvesting cauliflower in small areas: https://www.youtube.com/watch?v=-he_Y97ypJk
Harvesting artichoke, with backpicks: <https://www.youtube.com/watch?v=zkaDaNuN5gw>
; <https://www.youtube.com/watch?v=GjZTvgR-Nfs>
Harvesting artichoke without backpicks: <https://www.youtube.com/watch?v=vsIzY5ILeJc>

Cleaning of containers, tools and equipment

To know more about cleaning harvest containers and tools, see:
<https://extension.umn.edu/growing-safe-food/cleaning-and-sanitizing-tools-harvest-containers-and-surfaces>,
<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/food-safety/good-agricultural-practices/8-4-harvest-tools-containers>
Cleaning harvest equipment: <https://www.youtube.com/watch?v=YdzPzz6E60k>

Postharvest operations

Comparison on cooling methods for broccoli:
<https://www.postharvest.net.au/postharvestfundamentals/cooling-and-storage/cost-of-cooling-a-case-study-with-broccoli/>
Postharvest operations of cauliflower in South Asia countries:
http://www.ipcinfo.org/fileadmin/user_upload/food-loss-reduction/TCP_RAS_3502_Info_sheets/Cauliflower-Brochure.pdf

Postharvest infrastructure

Basic guidelines on design, facilities and good practices:
https://www.sfa.gov.sg/docs/default-source/tools-and-resources/resources-for-businesses/ava_vegetablespackaging_9th
University of Vermont-Studies cases on packing shed: <https://blog.uvm.edu/cwcallah/post-harvest/>

Refrigeration and transport

To know more about refrigeration and transport, including guidelines for specific produce, see:
Protecting Perishable Foods During Transport by Truck and Rail:
<https://edis.ifas.ufl.edu/pdf%5CHS%5CHS132800.pdf>
Code of practice for packaging and transport of tropical fresh fruit and vegetables:
RECOMMENDED INTERNATIONAL CODE OF PRACTICE FOR (fao.org)

Retail

See Retail outlet display considerations in
<https://www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf>

For more on Display and merchandising tips for artichoke, broccoli and cauliflower, see:
<https://www.producemarketguide.com/produce>
