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32

GUIDANCE NOTE

Fresh Produce Safety in Processing and Retail in Ireland

Guidance Note No. 32: Fresh Produce Safety in Processing and Retail in Ireland

This is not a legal document. Guidance notes from the Food Safety Authority of Ireland are intended to help food businesses to comply with their legal obligations.

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SCOPE

This document covers the application of good hygiene practices (GHPs) and good manufacturing practices (GMPs) in the processing and retail sale of fresh produce (i.e. fruit, vegetables, herbs, etc.) in Ireland.

This document is applicable to fresh produce facilities, including packing and grading houses, storage facilities, secondary processing facilities (e.g. pre-prepared vegetable producers), central distribution/wholesale outlets and retail outlets.

Issues relating to the quality of processed fresh produce are not covered in any detail under the scope of this document.

BACKGROUND

In 2001, the Food Safety Authority of Ireland (FSAI), together with an expert working group, produced and published the *Code of Practice for Food Safety in the Fresh Produce Supply Chain in Ireland*.[1] This code of practice (COP) has been an important reference for Bord Bia in the development of various fresh produce quality assurance schemes which have been adopted by the Irish fresh produce industry.

In 2016, at the request of the industry, the FSAI reviewed and updated the 2001 COP. From this review came a new FSAI Guidance Note No. 31, *Fresh Produce Safety in Primary Production in Ireland*.[2] This new guidance note addresses both GHPs and good agricultural practices (GAPs) in the primary production of fresh produce to control, or reduce to a safe level, physical, chemical and microbiological hazards. This new FSAI Guidance Note No. 31 is now recognised as a national guide to good practice in Ireland, and as such, is included in the European Commission register of national guides.[2]

As part of the review of the 2001 COP, the FSAI also examined the processing and retail components of the fresh produce chain in Ireland.[1] It was agreed with the industry that these components would be published in this separate guidance note.

This document is split into three sections. The first deals with general aspects of GHPs and GMPs applicable to both processing and retail. The following two sections deal with more sector-specific issues in relation to GHPs and GMPs as they apply to processing and retail.

1. GOOD HYGIENE AND MANUFACTURING PRACTICES IN PROCESSING AND RETAIL

1.1 Staff hygiene, facilities and health

All staff involved in directly handling fresh produce and those workers indirectly involved (e.g. truck drivers, pest control personnel, buyers, equipment operators, etc.) must be aware of basic hygienic practices. Food handlers involved in processing and retail can contaminate fresh produce just as easily as food handlers involved in primary production activities. The key good hygiene practices in relation to staff hygiene and health are outlined below:

- Before commencing employment, all new staff, including temporary staff, should complete a medical questionnaire or be passed as fit to work with food by a medical doctor.
- Staff should receive basic training in personal hygiene, to include toilet use, and proper techniques for hand washing and drying.
- Staff, as appropriate, should wear suitable protective clothing and footwear.
- Staff suspected or known to be ill should not be allowed to handle fresh produce.
- Staff should report any illness to employers and be excluded from work for an agreed period based on medical advice.
- All visitors or sub-contractors should be made aware of the hygiene and health principles before entering a premises or commencing work.
- Changing facilities should be provided to ensure that staff change their clothes, remove personal items, use toilet facilities and wash their hands before entering the processing/ retail area, and instructions should be provided in all appropriate languages.
- Prominently displayed signage to remind and encourage staff to wash hands should be provided in toilets, production entrances, etc.
- Hand-washing facilities should include the provision of hot water (i.e. typically water at 38 to 40 °C, preferably with hands-free operation), liquid soap and single-use disposable towels or hand driers.

1.2 Water

As the definition of food under Regulation (EC) No 178/2002 on general food law and the Food Safety Authority of Ireland Act, 1998 includes water intentionally incorporated into food during its manufacture, preparation or treatment, food businesses are responsible for the quality of water used directly as an ingredient in food production or indirectly in cleaning or processing during the processing of foods.[3–4]

The quality of the water used by all food businesses must meet the basic standards governing the quality of drinking water (i.e. potable water) intended for human consumption as set out in Council Directive 98/83/EC and implemented in Ireland under the European Union (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014).[5]

The Regulations set down standards for 48 individual microbiological, chemical and indicator parameters, which are outlined in the Regulations in three tables under Part 1 of the Schedule dealing with parameters and parametric values. All drinking water must comply with these parameters and parametric values, summarised below:[5]

- Table A Microbiological parameters (two parameters listed)
- Table B Chemical parameters (26 parameters listed)
- Table C Indicator parameters (20 parameters listed).

Regardless of the water source (e.g. public supply, group water scheme or private supply), the food business is responsible for the quality of the water at the point of compliance (i.e. where the water enters the building and/or at the tap/outlet where it is used in food processing). The food business is also required to maintain the distribution system within the establishment in such a way that it does not cause or potentially cause, contribute to or give rise to a risk of non-compliance with Part 1 of the Schedule in the Regulations. Recommended GHPs are outlined below:

- All water, steam and ice used in the processing and retail of fresh produce must be of potable quality.
- Where water is not of potable quality, an alternative source should be used or treatment of the existing water supply carried out to bring it up to potable water quality standards.
- Where the food business uses its own private supply (e.g. private well), it must ensure that the source of the water is appropriately sited, constructed, and maintained by suitably qualified personnel.
- Where the water supply goes through an internal distribution system, storage or treatment prior to use, the food business will need to carry out additional monitoring (check monitoring (Schedule, Part 2: Table A) plus any of the 48 individual microbiological, chemical and indicator parameters).[5]
- A water distribution map showing water source, storage, hot and cold distribution in the plant, and the locations of the sampling points should be documented.
- If potable water is stored prior to use rather than supplied directly from the rising main, the food business must ensure that the water is suitably protected throughout and remains at drinking water quality (i.e. potable water) when used in processing and/or retail.

- If non-potable water is in use by a food business during processing, the food business must be able to ensure that it is not mixed with potable water. The potable water supply must be properly segregated and marked. Non-return valves must be fitted where necessary.
- Where a food business collects and stores waste waters for flushing toilets, etc., it should not be connected to a distribution network or internal plumbing system in such a way that it can compromise a drinking water supply. If non-return valves are used to separate the two supplies, there is still a risk of contamination if the valve fails.

Further information is available in the FSAI Factsheet on potable water quality for food businesses.[6]

1.3 Recall and traceability

A recall and traceability system (which includes water, packaging materials and packaging gases) must be in place so that the source of fresh produce and raw materials can be established in the event of a food safety incident occurring. Traceability records should be retained in a format that allows access in a timely manner by both the food business and the relevant competent authority. It is strongly recommended that the food business refers to FSAI Guidance Note No. 10, *Product Recall and Traceability (Revision 3)* for further information.[7]

1.4 Packaging

The extent and type of packaging used will vary according to the type of fresh produce, as different fruit and vegetables may be handled, processed and packaged in different ways. Lettuce, for example, may be packed directly in the field immediately after harvest before going to distribution or transported to packing houses where it may be re-packaged. Alternatively, it may go for further processing where it is shredded, washed and bagged in a protective atmosphere.[8]

However, regardless of what packaging is used and when, it must comply with the requirements of current legislation on food contact materials.[9] The following is recommended as good practice for the packaging of fresh produce by retailers prior to display:

- All packaging used with fresh produce should be handled and stored appropriately before use.
- Prior to packaging, all produce should be inspected visually for physical contaminants and mechanical damage.
- Any produce showing signs of bacterial breakdown (i.e. spoilage) should be discarded prior to and during packaging.
- Any packaging operations should be carried out in accordance with GHPs.

- Produce should be handled gently throughout the packaging process and placed gently into outer containers.
- Outer containers should also be carefully stacked during assembly to avoid product damage.
- The type of packaging used for fresh produce should be appropriate; *e.g. for some fresh produce the packaging should be ventilated and, where necessary, allow gaseous exchange and product cooling to avoid condensation.*

Further information on food contact materials is available in an FSAI Factsheet.[10]

1.5 Product shelf life

The following is recommended as good practice for shelf life of fresh produce:

- The shelf life of fresh produce should be defined by either the supplier, the central distribution centre or the retailer, should take account of any relevant shop-floor retail conditions and should be based on real-life conditions, which may include temperature abuse.
- Shelf life declarations should not be altered to facilitate stock rotation, retail sale, etc.
- Fresh produce should be fit for consumption for several days after purchase.
- The chill distribution (as applicable) chain should be maintained.
- It is strongly recommended that retailers refer to the FSAI Guidance Note No. 18, *Validation of Product Shelf-life (Revision 3)* for further information.[11]

1.6 Labelling

Fresh produce which has been processed or altered in form by peeling, slicing, chopping, shredding or other treatment, such as washing, prior to being packed and sold to consumers is subject to the relevant labelling conditions outlined in the provision of food information to consumers (FIC) legislation Regulation (EU) No 1169/2011.[12]

The FIC legislation also includes requirements for allergen information to be displayed to consumers.[12] In Europe, 14 allergens are now recognised and the presence of any of these allergens must be indicated to consumers in either prepacked or non-prepacked foods, including fresh produce.

Allergen management in fresh produce processing is the same as for other hazards and should be an integral part of the food business' food safety management system. An effective allergen management system should consider all operations from sourcing of raw materials through processing and packaging to the finished product, including any new product development.

2. PROCESSING OF FRESH PRODUCE

2.1 Introduction

Processing of fresh produce refers to fresh fruits, vegetables, mushrooms and edible flowers as well as sprouted seeds which have been processed, or altered in form, by peeling, slicing, chopping, shredding or other treatment such as washing prior to being packed and sold to consumers.

Food businesses involved in the processing of fresh produce (excluding primary producers covered under FSAI Guidance Note No. 31) must comply with the general hygiene requirements outlined under Annex II of Regulation (EC) No 852/2004.[2, 13] As such, the implementation of a food safety management system based on the principles of Hazard Analysis and Critical Control Point (HACCP) is required in these businesses. While some aspects of HACCP will be covered in this document, the general aspects of developing and implementing a HACCP system will not.

Processing facilities with poor hygienic design in their layout, design and construction, equipment, and poor hygiene practices can contribute to significant contamination of fresh produce. Care should be taken to ensure that fresh produce is not contaminated by wash water, process equipment or workers. Contamination from dirty floors, drains and equipment surfaces can be transferred easily to fresh produce and should be avoided.

2.2 Layout, design and construction

Appropriate layout, design and construction of a facility processing fresh produce will help minimise the risk of contaminating fresh produce. Recommended GHPs are outlined below:

- The process flow should ensure that produce moves through the facility in one direction from input (i.e. low care/risk area), where there can be high levels of contamination, to output (i.e. high care/risk area), where there should be lower levels of contamination. Contamination from earlier steps in the process should not be allowed to enter later steps in the process due to poor plant layout.
- Good processing design requires the segregation of 'low care' and 'high care' production areas. This means that produce is washed thoroughly before going from a low care preparation area to a high care area. In the low care area, produce is initially prepared, washed or peeled so that it can be effectively washed through a partition from low care to high care. In a high care area the risk of physical contamination from packaging, metal/glass/Perspex and poor hygiene conditions can be minimised through GHP and GMP. The segregation of processing personnel in both low care and high care is critical. GMP dictates that packaging surrounding produce that has arrived from the field or storage area travels in a reverse direction from the produce.

- Floors should be easily cleaned, durable, not subject to slippage, and hard wearing. Some fresh produce (such as onions) contains acids, which, through time, will have a detrimental effect on the standard of poor-grade flooring. Ideally, floors should be sloped, coved to walls, fitted with drains and finished with a material which will withstand aggressive wear and tear.
- Walls and ceilings should be constructed of an acceptable food-grade material that is washable and impervious so that bacteria are not harboured in seals, seams or cracks. If a room in the facility is refrigerated, then the walls should be clad with insulation panels suitable for use in food preparation areas.
- The design of the drainage system should ensure that in all instances the drained water will flow opposite to the direction of product flow and prevent the accumulation of standing water in or around drains. The following is recommended:
  - Ensure drains are accessible for cleaning and sloped to facilitate drainage
  - Avoid the use of trench drains particularly in areas where ready-to-eat fresh produce is processed or exposed
  - Ensure drains do not flow from areas where raw fresh produce is stored, processed or exposed (i.e. low care) to areas where ready-to-eat fresh produce is processed or exposed (i.e. high care)
  - Ensure drains from toilets are downstream of drains serving processing areas.
- Use positive pressure systems for air management in high care areas with a minimum of an F7 filter to minimise contamination of fresh produce.

2.3 Produce decontamination

Water is often chemically treated for decontamination purposes to kill microorganisms in the water, on the surfaces of processing equipment and on the fresh produce in contact with the water. However, the effectiveness of chemical water treatments in decontaminating the surface of fresh produce depends on the geometry of the surface of the produce, the ability of the chemical to 'wet' the surface, the contact time and the environmental conditions (e.g. temperature, pH, etc.).

2.3.1 Use of chlorine

In Ireland, the most common chemical water treatment is the use of chlorine and derived compounds such as chlorine gas and calcium/sodium hypochlorite to produce treated or chlorinated water.[8, 14–15] Liquid chlorine and hypochlorites are the most commonly used forms of chlorine. Both forms are moderately effective in decontaminating surfaces of processing equipment, water itself and surfaces of fresh produce being processed. To optimise the decontamination effects of water with chlorine for use on fresh produce, the controls indicated in sections 2.3.2 to 2.3.6 are recommended.[8, 14–22]

2.3.2 Chlorine concentration

The chlorine concentration should be controlled using automatic chlorine monitoring and dosing equipment because chlorine is consumed (i.e. inactivated) by any organic material (i.e. field dirt, debris) on fresh produce or in the wash water. In addition, chlorine can be stripped out of the wash water by evaporation if very turbulent Jacuzzi-type washing systems are employed.

- Free chlorine concentrations of between 50 and 150 ppm (mg/L) are used for fresh produce in Ireland, with concentrations depending on the type of fresh produce being washed. The following is recommended:
- Only use the minimum effective concentration of chlorine in the wash water.
- The free chlorine concentration (i.e. the chlorine that is available in the water for sanitising/decontamination purposes) should be monitored and controlled. For example, if the concentration in the wash tank is too low, it will have minimal effect on bacteria reduction, whereas too high a concentration can result in chemical residues on the fresh produce, which may be a food safety hazard.

Test kits are available to check free chlorine levels and these should be used at regular intervals (i.e. at least every hour or more frequently) to ensure the effectiveness of the decontamination treatment.

2.3.3 Residence time

The residence time (i.e. contact time) of fresh produce with chlorine in the wash tank is also very important, since an inadequate residence time will have a minimal effect on microbial reduction. In general, the greater the chlorine concentration used, the shorter the residence time required within the tank. However, a balance based on tank capacity, allowable chlorine concentration and absence of chlorine tainting, all of which ensure microbial reduction, should be achieved by the processor. Residence times of between one and three minutes are used for fresh produce in Ireland, with times varying depending on the concentration of chlorine and the type of fresh produce being washed.

2.3.4 Temperature

The water temperature in the chlorine wash tank should be carefully controlled to maximise the efficiency of chlorine and minimise the risk posed by internalisation of pathogens in the fresh produce. Processors should understand the conflicting demands in this area. To be at its most effective, chlorine should be in water at elevated temperatures (at least 8 °C to 10 °C). However, prepared fresh produce will maintain its best quality if field heat is reduced and produce is quickly brought to and maintained at a temperature of ≤5 °C (with some exceptions). See Section 2.9 for further information.

2.3.5 pH

The pH of the wash water will also have an impact on chlorine efficiency. In this respect it is important to control the pH of the wash water to maximise chlorine efficacy. Normally this can be achieved through regular, routine pH monitoring of the wash water and the use of food-grade citric acid to control the pH in the range of approximately 6.5 to 7.5. The efficacy of chlorine will be maximised within this pH range.

Monitoring and control is best carried out with a pH probe and automatic dosing. However, pH titration kits can also be quick and effective. It is important to note that a low pH will promote corrosion of steel in the presence of chlorine, and toxic chlorine gas is produced below pH 4.

2.3.6 Rinsing

The final step in this process is the rinsing of the fresh produce in chilled (i.e. ≤5 °C), potable water. The washing of fresh produce in any water treated with biocides like chlorine should always be followed by a rinse step with potable water. In the case of chlorine, the wash step will help remove chlorine and chlorine by-products (e.g. trihalomethanes). As such, the potable water used for rinsing should receive no additional chlorination by the processor, although it may contain low chlorine concentrations from other sources (e.g. public water supplies can have a free chlorine level, typically <1 ppm). See Section 2.6 for further information on washing and rinsing of fresh produce.

2.4 Safety issues associated with chlorine

Despite the perceived benefits of using chlorinated water, its use to treat water can result in the formation of contaminants such as trihalomethanes formed by a reaction of chlorine with natural organic matter in water (i.e. the colouring agents of water). There is a direct relationship between the degree of colour in the water prior to chlorination and the concentration of trihalomethanes after chlorination.[23–24]

Other by-products such as chlorate and perchlorate can also be formed during chlorination of water, and contaminate the water. Chlorate and perchlorate have been linked to adverse health effects, as they can influence thyroid functions of humans and animals.[25–27] Where chlorine is obtained from hypochlorite, chlorate and bromate formation can be an issue depending on the bromide content of salt used in the manufacture and subsequent conditions of storage of hypochlorite.[25, 28]

Some research has also questioned chlorine's usefulness as a decontaminant because typical log reductions of bacteria and viruses can be less than two logs, and internalised microorganisms cannot be eliminated by current procedures of chlorinated washing. [8, 29–30]

Other chemicals have been tested for their antimicrobial ability, but few are used extensively in Ireland currently. Briefly, these include ozone, hydrogen peroxide, quaternary ammonium compounds, peroxyacetic acid, electrolyzed oxidizing water, trisodium phosphate, iodine/bromine and organic acids.[17, 31–32] However, despite safety concerns, chlorine remains the most common chemical water treatment used by industry in Ireland.

2.5 Cleaning and sanitation of equipment and surfaces

A realistic and rigidly applied cleaning and sanitation schedule should be implemented and its efficiency assessed on a regular basis. Recommended GHPs are outlined below:

- Soil and mud should be removed from outside the facility as much as practically possible to reduce the build-up of dirt within the facility.
- All equipment used in the facility should be hygienically designed to allow adequate cleaning and sanitation.
- All equipment should be cleaned after use. Mud, soil and fresh produce debris should be first removed from equipment. Then equipment should be washed with a detergent and rinsed before washing with a chemical disinfectant and rinsing with potable water.
- If cooling equipment is being used, it should be cleaned and sanitised after use and inspected for leaks and damage. If a leak is noticed, then do not distribute the product packed since the last clear inspection of the equipment because it could be chemically contaminated.
- Ancillary equipment such as knives, blades, boots and protective clothing should be cleaned and disinfected at the end of each day.
- All tables used in processing areas should be constructed of stainless steel, with stainless steel legs and frames. The use of wooden-topped tables is not acceptable due to the difficulty of thoroughly cleaning wood surfaces.

- Bins should be plastic or stainless steel or other material that will facilitate cleaning and sanitation and will not easily rust, chip or fracture, which could contaminate the food or harbour microorganisms.
- A log should be kept of ancillary equipment and breakages should be accounted for and noted in the log, together with preventative actions taken to ensure that produce is not contaminated by metal, plastics, wood, etc. Exposed glass should not be used anywhere in the production area.
- All staff involved in cleaning and sanitation should receive adequate instruction and training to ensure correct usage of chemicals and effective sanitation of the equipment.
- All containers for fresh produce should be in good repair and be made of material appropriate for use with food.[10]
- Before and after use, containers for fresh produce should be cleaned and disinfected while ensuring that the method of disinfection does not cause chemical contamination of the produce.
- High-pressure hoses should not be used to clean drains, as they can aerosolise the contents of the drain and lead to product contamination.

2.6 Washing and rinsing of fresh produce

Washing and rinsing are important steps in the processing of fresh produce, particularly if raw fresh produce is sold as a ready-to-eat product (e.g. bagged shredded lettuce).

Washing (primary and secondary) is the removal of soil, other gross debris, and plant tissue discharges (i.e. exudates) that occur during cutting. While washing may reduce microbiological contamination, it will not eliminate it; therefore, minimising potential for contamination is important in assuring the highest microbiological quality.[8] The industry emphasis is therefore to prevent the produce becoming contaminated in the first place through the introduction of strict controls at the primary level as outlined under FSAI Guidance Note No. 31.[2] Processors should consider the following recommendations in the washing and rinsing of fresh produce:[1–2, 8, 10, 18–19, 33–38]

- Only potable water or chlorinated potable water should be used for washing of fresh produce.
- Only potable water should be used for rinsing of fresh produce.
- All water used by the processor during washing and rinsing operations should be replaced frequently to reduce the risk of contaminating produce.
- Seek professional advice before purchasing, installing and using any water treatment system such as water chlorination systems.

- Equipment for washing and rinsing should be hygienically designed to minimise the build-up of soil and dirt and facilitate cleaning and sanitation of the equipment following use.

  Note: *Root crops bring a lot of soil into the processing environment and need washing with several changes of water. Salad crops with minimal soil adhesion may present a greater food safety risk than many root crops because they are less likely to be cooked before consumption.*

- Bacteria present in cracks, crevices, pockets and natural openings in the skin of fresh produce are often inaccessible to washing. Waxy cuticles on some fruit and vegetables repel water and the fine hairs on others prevent water from reaching surfaces.

- If fresh produce is not subject to bruising, then vigorous washing increases the chances of removing microbiological or chemical hazards. Surface scrubbing using brushes is even more effective, but only if the brushes are regularly cleaned and sanitised.

  Note: *Some fresh produce grown in Ireland, such as strawberries and raspberries, are not washed or cooled. Instead they are packed in the field following harvest, where the risk of contamination is high.*

- The effectiveness of the washing process should be validated to ensure that it is capable of removing microbial contamination on the range of produce processed under normal conditions. It is important to know the levels of contaminants on produce entering the process, the levels of contaminants on produce leaving the process and the steps in the process that are critical for the reduction of the hazards and how they are controlled.

- A temperature differential between the water used for washing and rinsing and the fresh produce temperature (i.e. typically the fresh produce is warmer than the water) has been highlighted as a risk factor for the internalisation of pathogens such as *Salmonella* in some fresh produce, as it can induce infiltration of the water into the fresh produce. Fresh produce with high water contents (e.g. apples, celery, and tomatoes) are more susceptible to internalisation through openings in the peel such as stem-end vascular tissue, stomata, puncture wounds, etc.

- If the temperature of the water is lower than the temperature of the produce, the temperature differential can force water into the fruit or vegetable. If this water is contaminated, then the produce may become contaminated on the inside. As such, control of water temperature and regular changing of water used in washing and rinsing is recommended to minimise this risk. It is recommended that in these cases the temperature of the pre-wash/initial wash water is 10 °C higher than the fresh produce if possible. Subsequent washing and rinsing should be carried out in cold water at ≤5 °C to remove field heat and maintain quality.[1, 8, 10, 19–19, 33–38]

2.7 Drying/de-watering of fresh produce

Where possible, a de-watering step should be used to remove excess water following washing and rinsing. However, excess water should be removed gently to prevent damage to the produce. Although no scientific data supports the assumption that drying reduces the growth of pathogens, dry produce is less likely to become re-contaminated and support the growth of pathogens.[18]

Excess water can be separated from the fresh produce by simple draining, or alternatively, where leafy bulky products are involved, by spin drying or drying in fluidised drying tunnels. Care should be taken to ensure that the washed material is treated appropriately, that proper stock rotation is achieved and that the air temperature within the drying area or room is maintained as low as possible (≤5 °C).

2.8 Transport and storage of fresh produce

Transport and storage are steps in the fresh produce supply chain that can easily be overlooked. Poor hygiene practices at these stages can contaminate a previously uncontaminated crop. If this happens, it is unlikely that further processing will reduce the contamination to safe levels. Similarly, processors should ensure that fresh produce is not further contaminated during transport to the factory or storage prior to processing. The recommended GHPs to minimise the risk of contaminating fresh produce in transport and storage are outlined below:

- Processors should ensure that the fresh produce they purchase has been produced in accordance with GAPs and GHPs, such as those outlined in the FSAI Guidance Note No. 31.[2]
- Vehicles used previously to transport chemicals or soil amendments such as manure should not be used to transport fresh produce. If previous loads prior to cleaning and sanitation were chemicals (pesticides, fertilisers, etc.), manure, or animals and animal products, the risk of contamination may be high. Consider using alternative transport or, where this is not possible, clean and disinfect the vehicle appropriately.
- Vehicles should be inspected for pests, odours, dirt and debris before loading. Include inspection of any containers that may be used during transport. Remove all foreign matter from vehicles and containers and clean appropriately.
- Produce loads being transported should always be covered with a clean cover to prevent contamination during the journey. Mud thrown from wheels, bird droppings, etc. can all contaminate uncovered produce during transport.

- Fresh produce should be loaded onto vehicles in a way that minimises damage because damaged produce is more likely to become contaminated. If chilled transport is necessary, produce should be loaded to ensure that the correct airflow around the load. Training may be necessary to ensure that workers are aware of good practice in this area.
- Where appropriate, when fresh produce is being transported over long distances (usually off the farm), operators should work with haulage contractors to ensure that chill temperatures (as appropriate) are maintained from the loading bay to the receiving bay.[39]
- Storage facilities can be stand-alone units or part of a processing or retail enterprise. Irrespective of the size or location the same standards apply. The fabrication of the facility should be of the same standard applied to processing and retail facilities. Personal hygiene of workers should also be of the same standard.
- All storage facilities, including refrigerated storage, should be in good structural condition.
- In the case of refrigerated storage and cold rooms, the door should open both from the inside and from the outside.
- Procedures should be in place that outline the cleaning and sanitation of storage facilities, stock rotation and the types of stock which can be stored in a particular location or storage area.
- Containers and packaging materials should be stored in a clean, dry place away from potential contact with pests, soil and manure or water condensation from overhead structures/equipment.
- On intake, fresh produce should be placed in the relevant storage area or racking as soon as possible and held at the correct storage temperature until processing.
- All fresh produce in storage should be appropriately covered to prevent contamination.
- All fresh produce should be stored off the ground to minimise the risk of contamination.
- Pallets should be stacked and orders picked in such a way that fresh produce is not damaged, either through crushing from heavier product placed on top or through collapse of pallets in the transport stage to final customer.

2.9 Temperature control

- All locations where temperature control is required should be monitored and records of temperatures kept on file, including air, water and fresh produce temperatures.
- All temperature monitoring equipment should be regularly calibrated.
- Procedures should be in place that outline the actions that need to be taken in the event of a loss of temperature control.
- Some fresh produce will require refrigerated storage. A temperature of ≤5 °C is recommended unless, for quality reasons, the fresh produce is unsuitable for refrigerated storage (e.g. bananas, basil, etc.). Please see Appendix 1 for further information.

  Note: *While bananas are not produced in Ireland, bananas are one of the largest-volume lines among fruits and vegetables imported and sold in Ireland. While there are no major food safety issues related to bananas, information on their growing, harvesting and importation in Ireland is provided in Appendix 2.*

3. RETAIL SALE OF FRESH PRODUCE

3.1 Introduction

Retail sale is typically the final step in the fresh produce food chain prior to consumption. However, fresh produce is vulnerable at this stage to microbial contamination from water, packaging, staff and customers in contact with the produce, and the general retail environment. The following sections will outline the key areas to reduce risk to fresh produce safety, from suppliers to transport and distribution through to retail sale.

3.2 Supplier control

The following points are recommended as good practice for retailers in supplier control of fresh produce:

- Only use fresh produce suppliers with a proven track record in supplying quality fresh produce.
- Existing and new suppliers should follow the GAPs and GHPs outlined in the FSAI Guidance Note No. 31.[2]
- Premises and operations of all new and existing central distribution centre suppliers should be audited periodically to assure the safety of the produce supplied.
- Fresh produce should be inspected at delivery for date coding (if applicable), integrity of seals, cleanliness of containers, etc.
- Visual quality should be inspected in case of damage or physical contamination.
- Consideration should be given to selecting suppliers that have an externally accredited quality system (e.g. Bord Bia, GLOBALG.AP, etc.) in place.

3.3 Transport

The following points are recommended as good practice for transport of fresh produce to a central distribution centre and/or retail store:

- Transport vehicles should be fitted with proper refrigeration and temperature logging devices to ensure that optimum transport temperatures are maintained.
- Recommended transport temperatures (with the exception of chill-sensitive fresh produce) are ≤5 °C. Please see Appendix 1 for further information.
- Calibration of thermometers and cooling equipment must be carried out at regular intervals to ensure compliance with specified holding temperatures.
- All containers should be stored off the floor of the vehicle on either pallets or shelving. This ensures good air movement and greater temperature control within the vehicle and reduces the risk of physical contamination.

- During stacking of pallets, boxes should be stacked in alternate directions, to promote air movement and greater temperature control throughout the pallet.
- Cognisance of the potential physical hazards (e.g. staples, wood splinters, etc.) associated with packaging and storage equipment (e.g. pallets) used in transport, especially when stacking, is strongly recommended.

3.4 Storage

The following is recommended as good practice for retailers in storage of fresh produce:

- Recommended storage temperatures (with the exception of chill-sensitive fresh produce) are ≤5 °C. Please see Appendix 1 for further information.
- Doors of chill rooms should remain closed to maintain constant temperature and air temperatures should be logged at regular intervals.
- Regular checking of temperature at different locations within the storage area is recommended to ensure consistency and homogeneity of temperature across the entire storage area.
- Fresh produce received should be placed in a designated storage area as soon as possible, with appropriate segregation of old and fresh stock.
- Pallets should be labelled with the date of receipt into the premises to aid traceability.
- All fresh produce should be stored off the floor (preferably on pallets), and top crates/ boxes should remain covered.
- Any rejected or waste produce should be removed from storage areas, clearly labelled as waste and disposed of as soon as possible.

3.5 Retail sale

The following is recommended as good practice in the handling and sale of fresh produce at retail outlets:

- Fresh produce should be handled carefully when being mounted on displays to avoid bruising and product damage.
- Fresh produce should not be over-stacked in display units to prevent overheating (due to lack of air circulation) and produce bruising. Most fresh produce, and particularly soft produce, should be displayed in original containers to protect from damage.
- Fresh produce on display should be visually inspected on a regular basis for signs of damage, breakdown, physical contaminants and spillages. Any poor-quality produce should be removed from sale and stored in a segregated waste produce area for disposal.

- Fresh produce on display should be continually rotated (i.e. older stock displayed towards the front). Daily checks of date codes should be conducted to ensure that stock is rotated and out-of-date stock is removed from display. Any fresh produce cut for display should be covered and discarded after use.
- Fresh produce should be placed in chilled storage overnight (as applicable), with any produce remaining at retail display being covered.
- Packaged, prepared vegetables should be handled with care and not over-packed as this could damage the package seal. These packages should be stored in dark conditions prior to sale to preserve shelf life.
- To limit microbial growth, care should be taken to ensure that these packages are not subjected to temperature abuse during storage.
- Display units should be approximately 1100 mm in height, be moveable or stand 225 mm clear of the ground to facilitate cleaning.
- A sneeze screen or canopy (where appropriate) should be provided in order to protect food from contamination. The distance between the unit and the base of the screen should be approximately 225 mm.
- Display units should be constructed of suitable materials and have no ridges or lips where dirt may accumulate.
- Display units and trays should be constructed of suitable materials that facilitate simple cleaning and designed to prevent the accumulation of dirt.
- If utensils are required, they should be at least 300 mm long and constructed of materials suitable to be in contact with food and easily cleaned (e.g. stainless steel).
- If containers are required, (e.g. for salads) they should be constructed of materials suitable to be in contact with food and easily cleaned (e.g. stainless steel).
- All produce display units should be cleaned and disinfected on a regular basis, after use and after any spillages.
- Adequate lighting should be provided to aid inspection of produce. All light bulbs should be shatterproof.

3.5.1 Chilled display

Chilled display units are recommended for certain fresh produce to limit microbial growth. The following is recommended as good practice for chilled display units:

- Temperatures of chilled display units should be monitored to ensure that the appropriate temperatures are maintained.
- Product temperatures should also be monitored to ensure that there is consistency between indicated chilled display unit temperatures and product temperatures.
- Appropriate action should be taken if temperatures are outside the specification.
- Temperature monitoring equipment must be calibrated regularly.
- The chilled display unit should be capable of maintaining the temperature at ≤5 °C.
- All fresh produce should be stored and displayed below the level of the refrigerant coil.
- A temperature monitoring probe should be installed in the warmest part of the display unit with a digital temperature display visible to consumers.
- The display unit should have an automatic defrost mechanism.

3.5.2 Misting

In some retail outlets (although not widespread in Ireland), misting of fresh produce at retail display is used to improve the appearance of fresh produce and extend shelf life. Misting of fresh produce can also help maintain moisture in the fresh produce while on display, as moisture loss can reduce the size and weight of produce. However, in some cases, misting of fresh produce can cause problems such as mould growth and rot. There is evidence of excessive misting leading to increases in microbial numbers on fresh produce.[40–41] In relation to misting, the following is recommended as good practice:

- All water used for misting purposes must comply with the current standards of potable or drinking water.[5–6]
- The automated system used to store and deliver the water as mist to the fresh produce should be hygienically designed (dead ends, excessively long pipes, etc. can allow microbial growth), constructed of suitable materials (e.g. stainless steel) and facilitate cleaning and disinfection.
- Ensure all water is removed from the system when not in use. Water left stagnant in the system (e.g. in pipes during the night) facilitates microbial growth.
- Ensure that the system is cleaned and disinfected on regular basis.

3.6 Preparing fresh produce in retail stores

The following is recommended as good practice for in-store fresh produce packing by retailers:

- Preparation in retail stores must take place in a suitable area with cleanable surfaces and procedures to avoid the risk of cross-contamination with other raw produce.
- Fresh produce should be prepared with utensils confined for use with fresh produce, including containers, chopping boards and knives.
- All utensils should be cleaned and disinfected daily and as necessary.
- Only potable water should be used for fresh produce preparation/cleaning.
- The shelf life (i.e. use-by date) should not be longer than two days from preparation.
- Date of preparation should be noted on holding containers.
- Produce should be covered with food-grade cling film to prevent physical contamination when not on display.
- Prepared fresh produce should be stored at ≤5 °C.
- Regular temperature monitoring of prepared produce should be carried out using a calibrated, clean temperature probe.

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APPENDIX 1 OPTIMAL TEMPERATURES FOR FRESH PRODUCE GROWN IN IRELAND[a]

Product	In storage (°C)	In distribution (°C)	In retail display (°C)	Comments
Apples *(eating)*	1–2	1–10	Ambient	
Apples *(cooking)*	2–3	1–10	Ambient	
Basil	10–15	10–15	Ambient	
Beansprouts	1–3	2–5	<5	
Blackberries	1–2	2–5	<5	
Blackcurrants	1–2	2–5	<5	
Blueberries	1–2	2–5	<5	
Broccoli	1–3		<5	Retailers display at ambient
Cabbage	1–3	6	<5	Retailers display at ambient
Carrots	1–3		<5	Retailers display at ambient
Cauliflower	1–3		<5	Retailers display at ambient
Celery	1–2	2–5	<5	Retailers display at ambient
Cherries	1–2	2–5		
Cucumbers	10–12	7–15	Ambient	
Gooseberries	1–2	2–5		
Herbs *(excluding basil)*	1–3		<5	Retailers display at ambient
Lettuce *(whole)*	1–2	1–5	<5	
Leeks		6		
Mushrooms *(whole)*	1–3	3–8	<5	Retailers display at ambient
Onion *(whole)*	0		Ambient	
Peppers *(all colours)*	7–10	7–15	Ambient	
Pak Choi	1–3		<5	
Pears				Retailers display at ambient

Product	In storage (°C)	In distribution (°C)	In retail display (°C)	Comments
Plums				Retailers display at ambient
Potatoes				Retailers display at ambient
Parsnips	14	6		Retailers display at ambient
Raspberries	1–2	2–5	<5	
Redcurrants	1–2	2–5		
Rhubarb				Retailers display at ambient
Salad leaves[b]	1–2	2–5	<5	
Spinach	1–3	2–5	<5	
Strawberries	1–2	2–5	<5	Retailers display at ambient
Spring onions	1–3	2–5	<5	Retailers display at ambient
Sprouted seed	1–3	2–5		
Tomatoes	8–12		Ambient	
Turnip/Swede	14	14		Retailers display at ambient
Watercress	1–2	2–5	<5	
Others	1–3		<5	

[a] All values are given for guidance purposes only. Please refer to notes on optimal temperatures.

[b] Including bagged salads.

Notes on optimal temperatures

- All fresh produce should be handled carefully to avoid bruising and breaking the skin. Such damage will encourage deterioration and rotting.
- While 0 °C is a very desirable temperature for most fresh produce, fresh cut especially, it can lead to freezing or freeze burn if products are in airflows of −2 °C or lower, which is necessary to get the main chill cabinet area down to 0 °C.

- Proper storage conditions (i.e. temperature and humidity) are needed to maintain expected storage life, safety and quality of fresh produce. Optimal storage temperature ranges given are the optimal temperatures at which fruits and vegetables should be stored. Some fruits and vegetables are susceptible to damage if stored or displayed below optimal storage temperatures.
- Fresh fruits need low temperature and high relative humidity to reduce respiration and slow down the metabolic process.
- Spraying with water may be effective by keeping the temperature low (evaporative cooling) and the surface 100% humid. Water sprinkling is designed to enhance the freshness and shelf life of certain produce. Only potable water should be used for this purpose.
- Many fruits give off ethylene, a natural, colourless, odourless gas that promotes ripening. Products sensitive to ethylene should not be stored with products producing ethylene. Exposure to ethylene may soften the flesh, adding a bitter taste to the product and/or accelerating ripening. Fruits release more ethylene gas than vegetables, so it is best to store fruits and vegetables separately. For example, store fruits such as apples, avocados, bananas, melons, peaches, pears and tomatoes separately from broccoli, cabbage, cauliflower, spinach, kale and other leafy greens as these are sensitive to ethylene.
- It is important to store and display fruits and vegetables within their optimal humidity ranges to ensure produce freshness and to prevent wilting or deterioration. Most produce stored at 5 °C or higher requires between 85% and 95% humidity. Most produce stored below 5 °C requires between 90% and 98% humidity.
- Most fresh produce is temperature sensitive and should be stored in the coolest part of the house/premises when refrigerated space is not available. Some produce, particularly those from the tropics such as pineapple and bananas, are chill sensitive and should not be stored in the refrigerator (Appendix 2).
- Chill-sensitive commodities are those subjected to chill injury when stored at low temperatures. Chill injury of fresh produce is regarded by retailers as a serious quality issue, as well as skin scald, failure to ripen and flesh breakdown. Chill-sensitive commodities include apricots, asparagus, avocados, bananas, snap beans, cucumbers, citrus fruits, peaches, peppers, plums, sweet potatoes, tomatoes and basil.
- Potatoes should be stored in cool, dark, well-ventilated areas to avoid greening and sprouting.

APPENDIX 2 INFORMATION ON BANANAS

Bananas are grown in tropical climates within 30° latitude north and south of the equator, with most large production between the 20° north and south lines of latitude. Optimum temperatures for production of bananas are between 26 °C and 30 °C. If temperatures drop below 20 °C, growth and fruit maturation will be slowed. Bananas need abundant rainfall, typically requiring an average of 5 cm of rainfall per week; however, irrigation is commonly used. Long hours of sunlight are also required for the successful production of bananas.

Banana plants are sterile, so are propagated by rhizomes (in a similar manner to potatoes) or by meristem culture. Once planted in the field, the time to maturity of a stem typically takes 9 to 12 months. After this time a flower appears, and three months thereafter the fruit is harvested. After the bunch is harvested, the stem that bore the fruit is left to die back naturally, or is cut back, as only one bunch is produced per stem. During growth of the producing stem, suckers from the rhizome are continually controlled by pruning, with only one selected to develop into the next producing stem. In this way, production on a plantation is continuous. The lack of marked seasonality in these tropical regions leads to the volume of bananas produced on mature plantations being relatively constant all year round.

The banana plant itself grows in an unusual way. When fully grown and ready to bear fruit, it reaches from 2.5 m to 9 m in height and measures from 23 cm to 41 cm in diameter at its base. While often referred to as a tree, the banana plant is not a tree because it does not contain true woody tissue. The main stem is composed of thick sheaths wrapped tightly in overlapping layers. The banana is technically regarded as an herbaceous plant or herb.

Nine or ten months after planting, the plant blossoms and the stalk that is to bear the bunch grows up through the centre of the trunk, comes out of the top, then bends over. First, the tiny bananas turn downwards, but as they grow they turn outwards and upwards towards the sun and so remain until fully developed, which would be after a further three months. Each plant bears only a single bunch or stem carrying approximately 100–200 separate bananas. A special plastic is placed over the stem to protect it from wind and insect damage.

Most bananas are picked green after a finite growing period on the plantation. The exact time will depend on the length of the ocean voyage to market. Strict age and grade control of each stem or bunch of bananas ensures that a uniformity is achieved that will enable even ripening when the fruit reaches ripening rooms in Ireland. When selecting the fruit on the plantation, trained cutters are used to select the fruit according to how long it has been growing (this is called age control). Coloured ribbons are tied around each bunch to identify how old it is. Callipers can also be used to assess the grade and thickness of the bananas. Once a bunch meets an agreed specification, it is cut down.

The banana bunches are then transferred to packing stations for further inspection and preparation. At the packing stations the individual hands or whorls of fruit are removed from the stem, washed, and cut into the clusters typically seen at retail. The fruit is monitored during washing in the washing tank and any misshapen, cut or damaged fruit is removed. Washing removes any latex (brown liquid emitted from the crown) from the bananas. Stains are also removed by gently sponging the fruit by hand. The cool water in the tanks also begins to cool the bananas down and slow the ripening process. After washing, selected fruit is packed in cartons for transport to the port.

Packing is a specialised skill and done in such a way as to stop clusters from falling around each other, which leads to scarring and bruising in transit. It must be done in such a way that the tunnel pad and internal polythene liner are used to prevent the top row damaging the lower one or the one adjacent to it, and so that the whole net weight fits neatly into the box without any clusters standing upright where they would be damaged by the lid closing on top of them.

The cartons are then loaded into reefer trucks for the journey to the shipping port. At loading, quality control is carried out on random samples on the quay while the ship is being loaded. The ships are referred to as reefer vessels. The fruit is examined and scored and these data are passed on to Ireland so that the same checks there can evaluate quality after the Atlantic crossing. The Atlantic crossing takes between 12 and 14 days to complete.

Once boxed, time is especially critical to bananas. The prime consideration is to reduce the temperature to 14 °C and remove the field heat from the pulp of the fruit as quickly as possible. It can take 24–48 hours on board the ship for the banana pulp temperature to reach the necessary 14 °C without damage. Over the past decade, bananas in transit have benefited from greater handling protection by the increasing usage of unitised cargoes. Containers and pallets are now the normal modes of transportation.

On arrival in Ireland, the containers are discharged and placed onto waiting trucks for transport to ripening centres. On arrival at the ripening centres, further inspection takes place before the bananas are unloaded into ripening rooms. In these rooms the bananas are ripened under controlled conditions to meet both customers' volume requirements and colour (degree of ripeness) preferences. Typically, a combination of mild temperature increase coupled with the introduction of small quantities of the natural gas ethylene into the ripening rooms will re-trigger the ripening process. The ripening process typically takes six to seven days to complete.

Following ripening, the fruit is dispatched on trucks to retail outlets. It is important that during winter months the fruit is not exposed to low temperatures which will turn the bananas a greyish colour. It is therefore imperative that bananas are protected from cold temperatures and stored and transported between 12 °C and 18 °C, ideally at 14 °C.

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