

# Report of the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (AESAN) on fruits and vegetables that have a risk of spoilage when presented for sale to consumers in bulk

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## Abstract

In recent years, Spanish legislation has promoted the implementation of a circular economy to minimise the negative effects of waste generation and management.

Thus, Royal Decree 1055/2022 of 27 December on packaging and packaging waste establishes measures aimed at the prevention of waste, the promotion of bulk food sales, the increase of reusable packaging and the promotion of recycling and marking of products. In particular, paragraph 4 of Article 7 states that food retailers shall take the necessary measures to present fresh fruit and vegetables marketed whole in bulk. This obligation shall not apply to fruit and vegetables packed in lots of 1.5 kg or more, fruit and vegetables packed under a protected or registered variety or bearing an indication of differentiated quality or organic farming, as well as fruit and vegetables that present



## 1. Introduction

In line with the need to minimise the adverse effects of waste generation and management on human health and the environment, Law 7/2022, of 8 April, on waste and contaminated soils for a circular economy was published in 2022 (BOE, 2022a). Article 18 (4) provides as follows: *“In order to promote the prevention of single-use packaging, at the latest by 1 January 2023, food retailers with an area equal to or greater than 400 square metres shall allocate at least 20 % of their sales area to the supply of products presented without primary packaging, including the sale in bulk or by means of reusable packaging”*. Consequently, this Law promotes, among other possibilities, the bulk sale of foodstuff in general.

On the other hand, Royal Decree 1055/2022, of 27 December, on packaging and packaging waste, prepared by the Ministry for the Ecological Transition and the Demographic Challenge, carries out a comprehensive review of Spanish regulations in this matter in line with the objectives of the European Union that will allow progress in the implementation of the circular economy and achieve the new packaging recycling objectives for 2025 and 2030 (BOE, 2022b).

The main novelties of this royal decree include measures aimed at the waste prevention, bulk food sales promotion, reusable packaging increase and recycling and marking of products promotion.

In particular, Article 7 (4) states that *“food retailers shall take the necessary measures to present in bulk those fresh fruit and vegetables marketed whole. This obligation shall not apply to fruit and vegetables packed in lots of 1.5 kg or more, or those packed under a protected or registered variety or bearing an indication of differentiated quality or organic farming, as well as those presenting a risk of deterioration or loss when sold in bulk, which shall be determined by order of the Ministry of Agriculture, Fisheries and Food, in coordination with the Ministry for the Ecological Transition and the Demographic Challenge and the Spanish Agency for Food Security and Nutrition, within six months of the entry into force of this Royal Decree”*.

Once the aforementioned list is published, businesses will have 6 months to adapt the sale of fruits and vegetables that do not fall into these cases.

A report has been requested from the Scientific Committee to determine which fruits and vegetables are more prone to deterioration when presented in bulk for sale to the consumer and the possible food safety risks arising from this.

On the other hand, it has been requested the assessment of the potential risk of further deterioration due to the degree of maturity or the removal of certain parts to present them “clean” (such as, for example, celery and clean leek or carrot without leaves) indicating, also, any other necessary considerations.

## 2. Title: fruits, vegetables, tubers and mushrooms

- **Fruits.** The generic name “Fruits” refers to the infructescence, the seed or the fleshy parts of floral organs that have reached an adequate degree of maturity and are suitable for human consumption (BOE, 1978). This report will include the fresh fleshy fruits included in the first section of chapter XXII of the Spanish Food Code (BOE, 1967). Fresh fruits will be presented for

consumption whole, healthy and clean, free of any abnormal external moisture or any strange smell or taste. They should have a normal appearance and development, according to the variety, season and production area (BOE, 1967).

- **Vegetables.** The generic name “Vegetables” refers to any herbaceous horticultural plant that can be used as raw or cooked food (BOE, 1978). There is a specific group of ‘Vegetables’ in which the edible part is constituted by its green organs (leaves, stems or inflorescences). The name ‘Fresh legumes’ refers to the unripe fruits and seeds of leguminous vegetables. Based on the part of the plant to which they belong, vegetables can be distinguished as: fruits, cabbage bulbs, leaves and tender stems, inflorescences, green legumes, fruiting vegetables, roots and young stems, being all included in the first chapter XXI section of the Spanish Food Code (BOE, 1967).
- **Tubers.** The generic name ‘Tubers’ refers to parts of underground stems or roots of some plants, healthy, mature, clean of soil and other impurities and that, in their natural state, or properly preserved, are suitable for human consumption (BOE, 1978). They include potatoes, sweet potatoes, and tiger nuts (chapter XIX of the Spanish Food Code (BOE, 1967)).
- **Mushrooms.** ‘Mushrooms’ are fruiting bodies belonging to certain species of higher fungi, both cultivated and wild, intended to be supplied to the consumer as food (BOE, 2009).

### 3. Causes of deterioration of fruits, vegetables, tubers and mushrooms

Fresh fruits and vegetables are highly perishable products that can easily deteriorate during handling along the supply chain from the producer to the final retailer. Fruits and vegetables contain between 65 and 95 % water and, being living parts of plants, have a continuous post-harvest metabolic activity. This post-harvest metabolic activity makes them change their characteristics depending on the handling, storage and treatment of the product, all of which has a decisive impact on the useful life of the product. The deterioration of fresh products often results in rapid decomposition and thus loss of the product for human consumption, especially in the ripening and senescence phases of the vegetable (James and Zikankuba, 2017).

**The deterioration of fresh products may result from biological factors, including microbiological, physiological, biochemical and physical factors** acting on the products (Table 1). These factors can be caused by improper handling of products during harvest, transport and storage, ineffective quality control and adverse storage, transport and distribution conditions. In addition, time and temperature are key determinants of deterioration (United Nations, 2007).







## 6. Objectives of packaging of fruits, vegetables, tubers and mushrooms

Royal Decree 1055/2022 of 27 December on packaging and packaging waste, in its Chapter 1, Article 2, defines "Packaging" as any product manufactured with materials of any nature and used to contain, protect, handle, distribute and present goods, from raw materials to finished articles, at any stage of the manufacturing, distribution and consumption chain (BOE, 2022b). In addition, primary and secondary packaging are defined as:

- Sale packaging or primary packaging. Any packaging designed to constitute a sales unit to the final consumer or end user at the point of sale, whether covering the product in whole or only partially, but in such a way that the content cannot be modified without opening or modifying said packaging.
- Grouped packaging or secondary packaging. Any container designed to constitute at the point of sale a grouping of a certain number of sales units, whether it is to be sold as such to the user or final consumer, or if it is used solely as a means of replenishing the shelves at said point and can be separated from the product without affecting its characteristics.

Many studies in the literature recognise that the packaging of fruits and vegetables is an effective technology to prolong the shelf life of these products, which are usually perishable (Oliveira et al., 2015). **The packaging of fruits and vegetables made available to the consumer aims to protect the product from mechanical damage and adverse environmental conditions during its handling and distribution**, its main functions being (Thompson and Mitchell, 2007):

- Provide physical protection against mechanical damage: open wounds (cuts or punctures) or bruises due to impacts, compression, vibration or abrasion.
- Provide protection against water loss. Many fruit and vegetable products suffer deterioration such as wilting, wrinkling or drying due to water loss during handling and marketing. This water loss is due to water vapour pressure difference between the product which is normally close to saturation (100 %) and the surrounding environment which is drier. The package offers a partial barrier against the movement of water vapour.
- Provide safety to the product as it prevents contamination and contact with the hands of manipulators and consumers.
- Facilitate special treatments, such as, for example, grapes packed with pads containing sodium metabisulfite, or asparagus, which must be packed vertically and with a wet pad that reduces their dehydration.
- Allow labelling and facilitate traceability.

## 7. Food safety in bulk fruits and vegetables

The exposure of unpackaged products at point of sale, and their handling increases the risk of contamination by foodborne pathogens. Such contamination may pose an increased risk if the fruits or vegetables have suffered previous mechanical damage, since the growth potential of pathogenic bacteria during the useful life of the product is higher. No studies address contamination and microbial growth specifically during bulk sales. However, the situation can be expected to be ana-

logous to any other waiting time at room temperature, aggravated by the manipulation by potential consumers. In this regard, microorganisms on the plant surface can penetrate through wounds or bruises producing hydrolytic enzymes that cause cell necrosis and maceration of plant tissues (Abbot and Boraston, 2008). The greater exposure surface and the release of water create a hydrophilic microenvironment that favours the adherence of microorganisms and their survival throughout storage. For example, previous studies have shown that *Salmonella* and pathogenic strains of *Escherichia coli* reached population sizes 10 times higher than those presented in intact tissues (Aruscavage et al., 2008) (Brandl, 2008) in which surface hydrophobicity facilitates the elimination of microorganisms by the application of decontamination treatments. Hydrophobicity also causes the modification of the distribution of microorganisms on the surface of tissues (Marik et al., 2020).

In the case of *Listeria monocytogenes*, its growth under storage conditions may be favoured by an increase in temperature and relative humidity, as well as a lower population density of the microbiota present in the product. For example, Aytac and Gorris (1994) observed that the behaviour of *L. monocytogenes* was different in legume shoots since the pathogen proliferated to a greater extent in those samples with a lower density of native microbiota. On the other hand, temperature and relative humidity during storage influence the growth of *L. monocytogenes*. In this sense, Huang et al. (2020) demonstrated that storage at temperatures above 20 °C exponentially increased *L. monocytogenes* population in various types of plant-based foods. Other factors associated with surface structure and nutrient availability were studied by Flessa et al. (2005), demonstrating that *L. monocytogenes* did not proliferate in those samples that remained intact compared to those with a higher surface humidity.

At the consumer level, it should be noted that contamination by pathogens can be minimised in cooked or peeled products, but can persist in those simply washed or even consumed without washing.

## 8. Fruits, vegetables, tubers or mushrooms at risk of spoilage or spoilage when sold in bulk

Royal Decree 3423/2000 defines the “Product sold in bulk” as that product that has not been previously packaged and is weighed in the presence of the consumer (BOE, 2000).

The purpose of this report is to determine in which cases, provided that the quantity of product made available to the consumer is less than 1.5 kg, some of these functions cannot be ignored. As stated above, those that have a greater importance are **the protection against mechanical damage, the minimisation of water loss and the avoidance of microbial contamination**. Bulk sales can lead to a greater possibility of contamination, due to handling, along with the possible loss of integrity and consistency, and the presence of wounds, which can trigger microbial and enzymatic deterioration, in the retail trade itself or at the consumer’s home (Gil et al., 2015). Mechanical damage results in the rupture of cell walls and membranes leading to the release of oxidative enzymes, bringing the substrates contained in the vacuoles into contact with the polyphenolic compounds and giving rise to enzymatic browning (Mitsuhashi-Gonzalez et al., 2010). The injuries produced as a result of mechanical damage accelerate physiological processes such as respiration, evapotrans-









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