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Citrus fruits — Guidelines for storage

Agrumes — Lignes directrices pour l'entreposage

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 3, *Fruits and vegetables and their derived products*.

This second edition cancels and replaces the first edition (ISO 3631:1978), which has been technically revised. The main changes compared with the previous edition relate to storage temperatures, durations and cultivars.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Citrus fruits are divided into five major groups from different species which differ from each other in their behaviour during transport and should therefore be considered separately from the point of view of storage conditions. The groups are the following:

— oranges;

— mandarins, tangerines and their hybrids;

— lemons;

— grapefruits and their hybrids;

— limes.

Citrus fruits undergo little change after harvesting. They have no climacteric phase, and should therefore be harvested ready for consumption.

Peel colour is not always an indication of maturity; there is not necessarily a direct relation between colour and degree of ripeness.

The keeping life of the fruit depends on several factors, including the following:

— growing climate conditions;

— agrotechnical factors (nature of rootstock, size of fruits, method of pruning, etc.);

— harvesting conditions (time of picking, condition of fruit at harvest);

— degree of maturity and treatments during storage; keeping temperature;

— relative humidity of the store.

The longer the fruits remain on the trees after they have reached edible condition, the shorter the time they can be kept after harvest. However, growth regulators can be used to enhance the keeping quality of late harvest fruit.

Citrus fruits — Guidelines for storage

1 Scope

This document specifies the conditions required for good keeping of the following groups of citrus fruits during their storage with or without refrigeration, in stores or in various transport equipment (such as containers, railway cars, trucks or ships):

— oranges: *Citrus sinensis* (Linnaeus) Osbeck;

— mandarins: *Citrus reticulata* Blanco;

— lemons: *Citrus limon* (Linnaeus) N. L. Burman;

— grapefruits: *Citrus paradisi* Macfadyen;

— limes:

  — *Citrus aurantifolia* (Christmann) Swingle;

  — *Citrus latifolia* Tanaka.

Detailed information concerning cultivars in these different groups is given in Annexes A and B.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Conditions of harvesting and putting into store

4.1 Varieties (cultivars)

This document concerns fresh fruit intended for storage and belonging to the varieties listed in Annex A.

4.2 Harvesting

The fruits should be harvested when they have reached the stage of maturity that makes them fit for consumption. Harvesting may be temporarily interrupted when weather conditions (rain, etc.) are likely to have an adverse influence on the keeping qualities.

Fruit collected from the ground is often infected with *Phytophthora,* and therefore dropped fruit should not be harvested.

The maturity criteria usually considered are the following:

— juice content, expressed as a percentage by mass (the juice content may vary slightly as a result of the conditions and duration of storage);

— flavour;

— titrable acid (TA) and/or the TSS/TA ratio, which is calculated by the formula $\frac{x}{y}$

where

x is the total soluble solids content (see ISO 2173);

y is the acidity expressed as an hydrous citric acid (see ISO 750).

The values to be adopted for these last two criteria depend on the varieties under consideration, and on ecological conditions. They should therefore be considered only in relation to the variety and to a well-defined area of production. Reference should be made to the specialized documents that have been published on the subject in the different areas of production.

4.3 Quality characteristics for storage

4.3.1 Condition of fruit at harvesting

Fruits intended for storage should be clean, firm and without blemishes (damage caused by pickers' fingernails, insect punctures, bruises, etc.). There should be no evidence of fungal or physiological disorders. They should retain their calyces.

Ethylene degreening is not advisable for fruit intended for long storage. This treatment hastens the physiological development of the fruit and shortens its keeping life. If it has been carried out, this fact should be brought to the attention of prospective purchasers. Ethylene-degreened fruit may be packed without stem-ends.

4.3.2 Treatment of fruit

4.3.2.1 After a first sorting in order to remove leaves, trash and defective fruits (such as those that are damaged or heavily infected with *Penicillium*), the fruits are preferably washed by spraying (which reduces the risk of infection) or by sprinkling or soaking in tanks. They are then rinsed and brushed and receive a fungicidal treatment. This should be applied as soon as possible after harvesting. For fruit picked with a high degree of turgidity, treatment should be delayed for 24 h after picking. Lemons and limes are not always washed.

The fungicidal treatment is carried out with a solution or a suspension of a fungicidal product and, in the case of infection by *Phytophthora*, can include a heat treatment carried out by dipping the fruit in a treating solution or water for 1,5 min to 5 min, at a temperature varying between 35 °C and 48 °C. This treatment is effective when carried out shortly after rains and infection in the grove.

Fungicidal treatments are applied as applicable. They should not leave visible deposits on the fruits.

The fungicidal treatment is generally followed by rinsing in order to ensure that the fungicide residues after treatment do not exceed the limits authorized.

A certain period of exposure to air before washing and fungicidal treatment renders the skins less turgid and less subject to bruising, which may arise during subsequent handling. As any bruising may lead to rotting, this procedure should only be followed in the case of fruit from areas of production in a dry climate. As a general rule, this period should not exceed 24 h.

4.3.2.2 After treatment, the fruit can be covered with a wax in order to replace the natural coating of the fruits which is partly or entirely removed by washing and brushing. By way of an example, emulsions of carnauba wax, beeswax, extracted or paraffin waxes, and polyethylene based wax may be used for this purpose. An approved fungicide may be incorporated into the wax (e.g. orthophenylphenol, benzimidazol).

The amount of wax can be increased if long storage is contemplated. (Up to 140 mg per kilogram of fruit is permitted.)

A second sorting is usually carried out after treatment and is followed by size grading. These operations should be carried out very carefully to avoid damage to the skin of the fruit.

4.3.2.3 It is advisable that information on the surface treatment used be made available to prospective purchasers.

4.4 Putting into store

Citrus fruits should be put into store immediately following the end of the treatment of the fruits.

The fruits can be stored unwrapped or wrapped in tissue paper (wraps which may be impregnated with diphenyl). Wrapping prevents damaged fruits from spreading contamination to neighbouring fruits and diminishes loss of mass of fruits during transport and storage. Papers impregnated with fungicide can be replaced by porous substrates impregnated with fungicides that are placed between the layers of fruit.

Fruit is placed (in layers or loose) in wooden, plastics or large metal frame and wire containers, or in corrugated cardboard cartons. The fruits should be pressed lightly together in order to prevent movement (after it has settled) during transport, but not so tightly as to cause bruising. The lids should press lightly on the fruit, without causing damage. The boxes should be handled with care.

For information on damage to citrus fruit during storage, see Annex C.

5 Storage conditions

5.1 Storage without refrigeration

Good quality fresh fruit can be stored immediately after harvesting at the place of production in well-ventilated premises at temperatures varying between 10 °C and 18 °C.

5.2 Refrigerated storage

5.2.1 General

For definitions and measurement of the physical quantities affecting storage, see ISO 2169.

Refrigerated storage can be carried out with or without pre-cooling.

5.2.2 Pre-cooling

Pre-cooling should be applied when the fruit is to be kept for long periods and final temperature should be reached within a maximum of 3 to 4 days.

The following conditions should be applied:

— the pre-cooling temperature adopted is that for keeping;

— air-circulation ratio: 100 to 200;

— relative humidity: to be kept as high as possible (of the order of 90 %).

5.2.3 Short-, medium- and long-term refrigerated storage

5.2.3.1 Temperature

The storage temperature depends, among other factors, on the species and variety of the fruit, the area of production, the physiological condition, the degree of ripeness and the anticipated length of keeping.

Table 1 gives, for information, the temperatures according to varieties and areas of production.

Some species of fruit have a temperature limit for long keeping below which deterioration of the fruit occurs. However, if a short-term storage is only being contemplated, the limiting temperature or even one somewhat lower may be used in order to reduce the risks of fungal damage. For example, grapefruit may be kept at 9 °C to 10 °C for 4 to 6 weeks, or at 5 °C to 6 °C for 4 to 6 weeks for grapefruits late in the season. For varieties which are relatively unaffected by cold, a treatment of 10 to 12 days at 0 °C may be applied in order to kill the fruit flies in fruit that is already infested.

5.2.3.2 Relative humidity

The relative humidity should be maintained between 85 % and 95 % throughout the storage period.

5.2.3.3 Air circulation

An air-circulation ratio of 25 to 50 is maintained throughout the storage period.

5.2.3.4 Fresh air change

Fresh air change should be continuous, at a rate of once or twice per hour according to the storage temperature, in order to prevent accumulation of carbon dioxide (of the order of 0,2 % to 1,0 %).

5.3 Keeping life

The keeping life depends on several factors, such as variety, ecological and phytosanitary conditions, date of harvesting, damage from harvesting or resulting from handling, treatment at harvesting, care in handling, and keeping temperature. Examples of periods of keeping are given in Table 1, which are likely to vary considerably.

Table 1 — Refrigerated storage temperatures

Cultivars	Country of production	Refrigerated storage					
		Short-term		Medium-term		Long-term	
		Tempera-ture °C	Weeks expected	Tempera-ture °C	Weeks expected	Tempera-ture °C	Weeks expected
Oranges							
Camargo	Brazil					+2	12
	Rep. of South Africa					+4	10
Valencia late	Rep. of South Africa					+4,5	10 to 14
	Australia					+2,5 to +7	10 to 14
	USA (California)					+2 to +7	6 to 8

[a] Waxed fruits.

Table 1 *(continued)*

Cultivars	Country of production	Refrigerated storage					
		Short-term		Medium-term		Long-term	
		Temperature °C	Weeks expected	Temperature °C	Weeks expected	Temperature °C	Weeks expected
	Spain	+10 to +12	4	+8 to +10	8	+2	14 to 16
	USA (Florida)					−1 to +1	8 to 12
	Israel	+2 to +10	6	+2 to +4	6 to 10	+2	10 to 14
	Morocco	+4 to +6	4	+2 to +4		+2 to +3	8
	USA (Texas)					0	
	West Indies					+ 7	
Mossambi	India	+15 to +18	3 6[a]			+1 to +2	12 to 16
Navel	Spain	+10 to +12	2	+6 to +10	6	+2 to +3	10 to 12
	Morocco	+6	4	+4	6	+3	8
Castellana	Spain					+1	10 to 12
Salustiana	Spain	+10 to +12	2	+6 to +10	6	+2	16
Shamouti	Israel, Lebanon	+4 to +15	4	+4 to +8	4 to 6	+4 to +5	6 to 8
Verna	Spain	+10 to +12	4	+6 to +10	8	+2	14 to 16
Washington, Navel	Australia					Early: +4,5 to +5,5	
						Late: +4,5 to +7	
	USA (California)					+2 to +7	5 to 8
	West Indies					+7	
	Rep. of South Africa					+4,5	4 to 8
Olinda Valencia *(Citrus sinensis(L.) Osbeek*)	Iran					+4	10 to 12
Tarocco Blood (*Citrus sinensis(L.) Osbeek*)	Iran					+2 to +3	10 to 12
Thomson Navel (*Citrus sinensis(L.) Osbeek)*	Iran					+4	10 to 14

[a] Waxed fruits.