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Citrus fruits — Guide to storage

Agrumes — Guide pour l'entreposage

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3631 was developed by Technical Committee ISO/TC 34, *Agricultural food products*, and was circulated to the member bodies in October 1977.

It has been approved by the member bodies of the following countries :

Australia	India	Romania
Austria	Iran	South Africa, Rep. of
Bulgaria	Israel	Spain
Czechoslovakia	Kenya	Thailand
Egypt, Arab Rep. of	Korea, Rep. of	Turkey
Ethiopia	Netherlands	U.S.A.
France	New Zealand	U.S.S.R.
Germany, F.R.	Poland	Yugoslavia
Hungary	Portugal	

No member body expressed disapproval of the document.

Citrus fruits — Guide to storage

0 INTRODUCTION

Citrus fruits are divided into five groups 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 :

- ecological 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.

1 SCOPE AND FIELD OF APPLICATION

This International Standard 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.

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

2 REFERENCES

ISO/R 750, *Fruit and vegetable products — Determination of titratable acidity*.

ISO 2169, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement*.

ISO 2173, *Fruit and vegetable products — Determination of soluble solids content — Refractometric method*.

3 CONDITIONS OF HARVESTING AND PUTTING INTO STORE

3.1 Varieties (Cultivars)

This International Standard concerns fresh fruit intended for storage and belonging to the varieties listed in annex A.

3.2 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 it is therefore recommended that 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;
- acidity and/or the ratio :

soluble solids content (ISO 2173)

acidity expressed as anhydrous citric acid (ISO/R 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.

3.3 Quality characteristics for storage

3.3.1 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 except in damp regions where fruits are liable to stem end-rot.

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 shall be brought to the attention of prospective purchasers. Ethylene-degreeneed fruit may be packed without stem-ends.

3.3.2 Treatment of fruit

3.3.2.1 After a first sorting in order to remove leaves, trash and defective fruits (such as those that are damaged or heavily infected with *Phytophthora*), 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 3 to 5 min, at a temperature varying between 45 and 48 °C. This treatment is effective when carried out shortly after rains and infection in the grove.

Fungicidal treatments must conform to the regulations applying in each of the countries concerned. They must 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 must 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.

3.3.2.2 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 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 (for example, orthophenylphenol, benzimidazol).

The amount of wax can be increased if long storage is contemplated (contents up to 140 mg per kilogram of fruit — maximum authorized amount — have been recommended).

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.

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

3.4 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 which 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.

4 STORAGE CONDITIONS¹⁾

4.1 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 and 18 °C.

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

4.2 Refrigerated storage

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

4.2.1 Pre-cooling

Pre-cooling is recommended 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 %).

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

4.2.2.1 TEMPERATURE

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.

The following table gives, for information, the recommended 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 only is being contemplated, the limiting temperature or even one somewhat lower may be used in order to reduce the risks of fungal damage. As an example, grapefruit may be kept at 9 to 10 °C for 4 to 6 weeks or at 5 to 6 °C for 4 to 6 weeks for grapefruits late in the season.¹⁾

4.2.2.2 RELATIVE HUMIDITY

The relative humidity should be maintained between 85 and 90 % throughout the storage period.

4.2.2.3 AIR CIRCULATION

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

4.2.2.4 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 %).

4.3 Keeping life

This depends on several factors such as variety, ecological and phytosanitary condition, 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 the table of recommended temperatures, which are likely to vary considerably.

1) 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 fly in fruit that is already infested.

TABLE — Recommended temperature

Cultivars	Country of production	Refrigerated storage					
		Short-term		Medium-term		Long-term	
		Temperature °C	Weeks expected	Temperature °C	Weeks expected	Temperature °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
	U.S.A. (California)					+ 2 to + 7	6 to 8
	Spain	+ 10 to + 12	4	+ 8 to + 10	8	+ 2	14 to 16
	U.S.A. (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
	U.S.A. (Texas)					0	
	West Indies					+ 7	
Mossambi	India	+ 15 to + 18	3 6*			+ 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 + 2 to + 7 + 7 + 4,5	5 to 8 4 to 8
Mandarins							
	Australia					+ 7	
	India	+ 15 to + 18	2 3*			+ 5 to + 7	3 to 6 8 to 10*
	Israel	+ 17	2			+ 5 to + 8	4
Clementines	Morocco	+ 8	2	+ 6	3	+ 4 to + 5	4
	Spain					+ 4 to + 5	4 to 6
Clemnules	Spain					+ 4 to + 5	4 to 6
Satsuma	Spain	+ 10 to + 12	1 to 2	+ 6 to + 8	3	+ 4	8
Lemons							
Green lemons	Rep. of South Africa					+ 11	12 to 16
	Israel	+ 10 to + 17	6	+ 13 to + 14	6 to 12	+ 12 to + 16	13 to 14
	New Zealand						14
	U.S.A. (California)	+ 12 to + 13	3			+ 12 to + 13	13 to 20
Coloured lemons	Israel	+ 8 to + 17	4	+ 10 to + 14	4 to 6	+ 0 to + 5	3 to 6
	New Zealand					+ 13 to + 14	6 to 8 10 to 14
Grapefruit							
	Australia					+ 9 to + 10,5	
	Israel	+ 8 to + 15	4	+ 8 to + 12	4 to 6	+ 10 to + 12	6 to 12
						+ 8 to + 10	10
	India					+ 7 to + 9	12
	U.S.A.					+ 10 to + 15	4 to 12
	Rep. of South Africa					+ 11	12 to 14
Limes							
	U.S.A. (Florida)					+ 4 to + 10 + 10	3 to 8 3 to 4
Yellow	India	+ 15 to + 18	5 days 2*			+ 11 to + 13	7
Green	India	+ 15 to + 18	5 days 2*			+ 11 to + 13	8

* Waxed fruits.

ANNEX A

LIST OF CULTIVARS AND THEIR SYNONYMS

A.1 ORANGES**A.1.1 Sub-group of "Navels"**

A.1.1.1 Washington Navel : Washington, Bahia Navel

A.1.1.2 Thomson Navel : Thompson Navel, Thomson, Thomson's Navel, Navel Nice

A.1.1.3 Leng Navel

A.1.2 Sub-group of "Fine-Blonds" (of low seeds type)

A.1.2.1 Shamouti

A.1.2.2 Cadenera : Cadena Fina, Cadena Sin Hueso, de la Cadena, Castellana, Cornice de la Cadena Fina, Précoce de Valence, Précoce des Canaries, Rharb, Espagne sans pépins, Valence sans pépins, de Valence

A.1.2.3 Maltaise blonde : Petite Jaffa

A.1.2.4 Hamlin

A.1.2.5 Vernia, Verna

A.1.2.6 Valencia late

A.1.2.7 Salustiana

A.1.2.8 Mossambi/Sathgudi

A.1.3 Sub-group of "Common-Blonds" (seeded)

A.1.3.1 Marrs Early

A.1.3.2 Parson Brown

A.1.3.3 Pineapple

A.1.4 Sub-group of "Semi-blonds"

A.1.4.1 Maltaise sanguine : Maltaise demi-sanguine, Portugaise, Portugaise sanguine, Portugaise demi-sanguine

A.1.4.2 Grosse sanguine or Double fine améliorée : Sanguine ovale double fine, Washington sanguine

A.1.4.3 Double fine : Ovale de Sangre, Rojo oval, Ampollar, Sanguine ovale double fine, Double fine, Sanguine double fine

A.1.4.4 Sanguinelli

A.1.5 Sub-group of "Bloods"

A.1.5.1 Moro

A.1.5.2 Tarocco

A.1.5.3 Ruby Blood

A.2 MADARINS**A.2.1 Sub-group of True Mandarins**

A.2.1.1 Mandarin group : Mandarine d'Algérie, Mandarine de Blidah, Mandarine de Boufarik, Mandarine de Bougie, Mandarine de Nice, Mandarine de Valence, Mandarine d'Australie, Mandarine Dupre, Mandarine de Paterne, Mandarine Avana, Mandarine Dai-Dai, Mandarine Ba-Hamed, Mandarine Beladi, Mandarine Beledi, Mandarine Effendi, Mandarine Youssef, Effendi, Mandarine Willow-Leaf, Mandarine Willow-Leaved

A.2.1.2 Oneco

A.2.2 Sub-group of "King and Tangors"

A.2.2.1 King of Siam : Mandarin King of Siam

A.2.2.2 Temple : Mandarin Temple

A.2.2.3 Murcott

A.2.2.4 Ellendale Tangor

A.2.3 Sub-group of "Satsumas" : Unshiu

A.2.3.1 Satsuma Wase

A.2.3.2 Satsuma Owari

A.2.4 Other sub-group of Mandarins

A.2.4.1 Clementine, Clemenules, Monreal

A.2.4.2 Wilking : Mandarin Wilking

A.2.4.3 Dancy : Dancy Tangerine

A.2.4.4 Robinson : Robinson Tangerine

A.2.4.5 Santra

A.2.4.6 Som Keaw-arn

A.3 LEMONS

A.3.1 Sub-group "Eureka"

A.3.1.1 Eureka

A.3.1.2 Villa Franca

A.3.2 Sub-group "Vernia"

A.3.2.1 Vernia Berna

A.3.3 Sub-group "Everbearing"

A.3.3.1 Quatre saisons

A.3.3.2 P.S.P. : P.S.P. sans pépins

A.3.4 Sub-group "Probable Hybrids"

A.3.4.1 Meyer

A.3.5 Sub-group "Lisbon"

A.3.5.1 Lisbonne

A.3.5.2 Sicilian, Bearss

A.4 GRAPEFRUITS

A.4.1 Sub-group "Blond Grapefruit"

A.4.1.1 Marsh Seedless (seedless)

A.4.1.2 Duncan (seeded)

A.4.1.3 Maccarty (seeded)

A.4.2 Sub-group "Pink and red Grapefruit"

A.4.2.1 Foster (seeded)

A.4.2.2 Thompson

A.4.2.3 Pink Marsh

A.4.2.4 Ruby Red

(seedless)

A.4.2.5 Burgundy

A.4.3 Sub-group of "Tangelos"

A.4.3.1 San Jacinto

A.4.3.2 Sampson

A.4.3.3 Minneola

A.4.3.4 Orlando

A.4.3.5 Seminole

A.4.3.6 Wakiwa

A.4.3.7 Nova

A.5 TRUE LIMES

A.5.1 West Indies Lime (Key lime) : Lime mexicaine, "Mexican lemon", Citron Gallet, Kaghzi Nibbu

A.6 LARGE-FRUITED LIMES

A.6.1 Persian (Tahiti) : Bearss

ANNEX B

LIST OF PRINCIPAL COMMERCIAL CULTIVARS AND PRODUCING COUNTRIES¹⁾

Cultivar (principal designation)	Producing countries	Cultivar (principal designation)	Producing countries
B.1 ORANGES		B.1.4 Sub-group of "Semi-Bloods"	
B.1.1 Sub-group of "Navels"		Maltese	Algeria, Tunisia
Mossambi	India	Sanguinello	Spain, Italy, Morocco
Navel	Republic of South Africa, Algeria, Australia, Brazil, Spain, Greece, Israel, Morocco, U.S.A.	Washington blood (improved double fine)	Algeria, Morocco, Tunisia
Navelate	Spain	B.1.5 Sub-group of "Bloods"	
Navelina	Spain	Moro	Italy
B.1.2 Sub-group of "Fine-Blonds" (of low seeds type)		Ruby	U.S.A.
Hamlin and various blonds	Algeria, Brazil, Greece, Morocco, U.S.A.	Common bloods	Algeria, Spain, Greece, Italy, Morocco
Ovale	Italy	Tarocco	Italy
Peira	Brazil	Washington blood	
Salustiana	Spain, Morocco	B.2 MANDARINS	
Shamouti	Cyprus, Israel, Turkey	Santra	India
Tomango	Republic of South Africa	Satsuma	Spain, Japan, Turkey, Israel
Valencia late	Republic of South Africa, Algeria, Australia, Brazil, Cyprus, Spain, Greece, Israel, Morocco, Tunisia, Turkey, U.S.A.	Clementine	Algeria, Spain, Morocco, Tunisia, Israel
Vernia	Spain, Morocco	Monreal	Algeria, Spain, Morocco, Tunisia, Israel
B.1.3 Sub-group of "Common-Blonds" (seeded)		Wilking	Morocco, Israel
Various	Spain, Italy, Greece, Republic	Som Keaw-arn	Thailand
Parson Brown,	of South Africa, U.S.A.	True Mandarins	Algeria, Spain, Greece, Italy, Israel, Japan, Tunisia, Turkey, U.S.A.
Pineapple	(Florida, Texas)		

1) Non-restrictive list.