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Pears — Cold storage

Poires — Entreposage réfrigéré

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 1134 was prepared by Technical Committee ISO/TC 34, *Agricultural food products*, Sub-Committee SC 14, *Fresh fruits and vegetables*.

This second edition cancels and replaces the first edition (ISO 1134:1980), which has been technically revised.

Annexes A and B of this International Standard are for information only.

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International Organization for Standardization

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Introduction

This International Standard provides guidance of a very general nature only. Because of the variability of the fruit according to the time and place of cultivation, local circumstances may make it necessary to specify other conditions of harvesting or other physical conditions in the store.

This International Standard does not apply unreservedly, therefore, to all varieties in all climates, and each specialist will decide on any modifications to be made.

Moreover, it does not take into account the role played by horticultural factors, and wastage during storage is not dealt with. The importance of these two subjects has not been forgotten, but the influential factors (i.e. ecological or agrotechnical factors) are not very well known; moreover, the origin of many of the most frequent physiological disorders of pears is still uncertain, as are often the appropriate means of combating them. It was therefore considered difficult to prepare recommendations on these two points.

Nevertheless, it was considered useful to give, in annex B, a few recommendations which appear sufficiently well founded in the present state of knowledge.

Subject to all possible restrictions arising from the fact that fruits are living material and may vary considerably, the application of the guidance contained in this International Standard should enable much wastage in cold storage to be avoided and long-term storage to be achieved in most cases.

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Pears — Cold storage

1 Scope

This International Standard gives guidance on conditions for the successful cold storage of varieties of pears (*Pyrus communis* Linnaeus) up to their use in the fresh state.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2169:1981, *Fruits and vegetables — Physical conditions in cold stores — Definitions and measurement*.

AGRI/WP.1/EUR.STAN.1, *Apples and pears*.¹⁾

- b) Firmness of the flesh: estimated by means of a spring penetrometer.
- c) The total soluble solids content of the fruit, which should be at least 10 % at harvest: determined by a refractometer.
- d) Ease of separation.
- e) Presence of starch in the flesh of the fruits: checked by treating a cross-section of the fruit with an iodine/potassium iodide solution.

The values obtained from these criteria are not universally valid; for a given variety they vary from one region to another and it is for the grower to decide on his own criteria for picking, on the basis of experience.

Determination of the optimum harvest time is more important for early varieties (for example, Coscia) than for late varieties.

The fixing of the time of harvesting has greater importance for controlled-atmosphere storage than for storage in air.

3 Conditions for harvesting and storage

3.1 Harvesting

The practical criteria of ripeness most frequently used for defining the best time for harvesting²⁾ are the following.

- a) Basic colour of the outer skin:³⁾ judged with the aid of a standard table.

3.2 Characteristics for storage

Fruit put into store should be of quality "extra" and "I", the characteristics of which are defined in AGRI/WP.1/EUR.STAN.1.

Fruit put into cold store should be sound, free from bruises or physiological disorders, and free from any visible sign of fungal or bacterial attack. It should be clean and free from any trace of water in the liquid state.

1) Revised European Standard, recommended by the Working Party on Standardization of Perishable Produce and Quality Development of the Economic Commission for Europe.

2) The number of days after flowering is also used sometimes as a criterion for harvesting.

3) The basic colour should be distinguished from the red anthocyanin pigmentation, the intensity and extent of which vary according to the variety and, to some extent, with exposure to sunlight.

3.3 Putting into store

The fruit should be put into the cold store as soon as possible after harvesting, the temperature being lowered to a value suitable for the variety.

Rapid removal of field heat and precooling of harvested pears are essential for long storage.

3.4 Method of storage

The fruit should be handled with care. The packages should allow free circulation of air. Storage densities of about 250 kg per cubic metre of usable space are recommended for a stack of pallets.

The use of box pallets provides an increase of 10 % to 20 % in storage density.

4 Optimum storage conditions

4.1 Temperature

The pears should be kept at as low a temperature as possible, subject only to avoiding the risk of freezing. In general, the best results are obtained at -1°C to $+0,5^{\circ}\text{C}$.

A difference of 1°C in storage temperature has a profound effect on the time for which the pears can be kept. It has been shown that, during cold storage, the freezing-point of the fruit falls slightly; it is on this account that, for Williams' Bon Chrétien pears, it has been possible to recommend a method of storage based on progressive lowering of the temperature (0°C ; $-0,3^{\circ}\text{C}$; $-0,8^{\circ}\text{C}$; $-1,5^{\circ}\text{C}$). This procedure has enabled the storage life to be appreciably prolonged, but it is difficult to carry out since it is not possible to maintain a large bulk of fruit at a sufficiently uniform temperature in a cold store.

The course of development of the fruit during storage depends on the choice of storage temperature. When the temperature of the cold store is low (0°C to -1°C) the change in ripening characteristics of the pears is very slow during cold storage and it is necessary to submit them to a complementary ripening process at a higher temperature when they are removed from the cold store. On the other hand, from a certain temperature ($+3^{\circ}\text{C}$ for Doyenné du Comice pears, $+4^{\circ}\text{C}$ for Passe Crassane), ripening is slow but can be completed in storage.

Some varieties ripen completely at higher temperatures only if the storage period at low temperature has not been too long (for example, Comtesse de Paris, Doyenné du Comice, Kaiser, Abbé Fetel, Louise Bonne d'Avranches and Williams' Bon Chrétien).

An accidental rise in storage temperature can initiate ripening, which continues when the fruit is again exposed to the cold.

Table 1 gives the storage temperature and duration recommended for a number of varieties.

4.2 Relative humidity

Pears may generally be stored at a relative humidity of between 90 % and 95 %.

4.3 Air circulation

An air circulation ratio of 20 to 30 (see ISO 2169) or ventilation of $80\text{ m}^3/\text{h}$ to $100\text{ m}^3/\text{h}$ per tonne of fruit is recommended.

4.4 Storage life

Table 1 gives the expected storage life under the conditions mentioned above, for a number of varieties. Storage should not be prolonged beyond limits compatible with the maintenance of good quality.

Samples of fruit should be taken in such a way as to detect the appearance of any wastage.

4.5 Operations at the end of storage

The recommended ripening temperature for pears after storage is 15°C to 18°C .

The ripening may be accelerated by ethylene treatment. The gas is generally used at concentrations of 1 % to 2 %, the treatment being carried out at a temperature of $+18^{\circ}\text{C}$ and at approximately 90 % relative humidity.

Table 1 gives the varieties which should undergo a complementary ripening after cold storage.

5 Adjuncts and other keeping processes

5.1 Controlled-atmosphere storage

The following gas mixtures are most frequently recommended:

| | |
|----------------|----------------|
| carbon dioxide | 1,0 % to 3,0 % |
| oxygen | 2,0 % to 5,0 % |

These compositions are given only as a guide, and it is for the experts in each country to give any necessary advice on other kinds of compositions according to the particular requirements of each variety, as regards the content of carbon dioxide or of oxygen in the atmosphere or on account of particular local conditions. Annex A gives an example of this.

It should be noted that the storage disorders called "brown heart" and "hard heart" result from the presence of an excess of carbon dioxide (above 5 %) in the atmosphere. It is necessary to avoid the use of mixtures with a high carbon dioxide content for storing varieties known to be susceptible to these disorders (for example, Doyenné du Comice, Beurré Bosc, Williams' Bon Chrétien).

Table 2 summarizes, for certain varieties, the gas mixtures which have given the best results, and also the recommended temperature and the expected storage life.

5.2 Storage in plastic packages

The use of certain types of plastic film which are known to be suitable for contact with food products permits losses in mass during storage to be reduced considerably and, in certain cases, the storage life in the cold is prolonged. Plastic films should be perforated with small holes to prevent a build-up of CO₂. The level of CO₂ should not be above 3 % within the liners, or core and flesh browning may develop. Film liners will extend the storage life of several cultivars of pears by 4 to 8 weeks.

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Table 1 — Storage in air

| Variety | Recommended temperature °C | Expected storage life (weeks) | General remarks |
|--------------------------|----------------------------|-------------------------------|--|
| Docteur Guyot | 0 to + 1 | 3 to 4 | Complementary ripening necessary |
| Williams' Bon Chrétien | – 1 to 0 | 9 to 11 | Complementary ripening necessary Susceptible to scald Ripens between + 10 °C and + 24 °C only |
| Beurré Bosc | – 1 | 14 to 28 | Susceptible to brown heart |
| Beurré Clairgeau | – 1 to – 0,5 | 18 to 20 | Complementary ripening necessary Susceptible to scald Susceptible to brown heart |
| Beurré Diel | 0 to + 1 | 8 to 12 | |
| Curé | 0 to + 1 | 16 to 20 | 5 months maximum |
| Louise Bonne d'Avranches | 0 to + 1 | 6 | Tendency to shrivelling |
| | – 1 to 0 | 0 to 12 | |
| Doyenné du Comice | – 1 to 0 | 8 to 12 | Complementary ripening necessary Does not ripen further after 2 1/2 months at + 1 °C In certain areas, does not ripen normally after 2 to 3 months at 0 °C |
| | + 2 to + 3 | 6 | Ripens at this temperature Susceptible to scald |
| Épine du Mas | 0 to + 1 | 12 to 16 | |
| Beurré Hardy | 0 | 12 to 20 | Complementary ripening necessary |
| Passe Crassane | 0 | 20 to 22 | Does not ripen normally in some areas unless previously stored in cold conditions (11 weeks at 0 °C) |
| | – 4 | about 17 | |
| Comtesse de Paris | 0 | 20 to 22 | Does not ripen normally after too prolonged storage in the cold |
| Packham | + 2 to + 3 | 8 | Susceptible to warming |
| | – 1 to 0 | 18 to 20 | |
| Conference | 0 to + 1 | 24 to 28 | Susceptible to warming |
| Comtesse de Charnoux | – 0,5 | 8 to 20 | Complementary ripening necessary |
| Abbé Fétel | 0 | 10 to 12 | Does not ripen normally after 3 months of storage |
| Ankara | 0 | 20 | Complementary ripening necessary Bitterness occurs after too prolonged storage in the cold |
| Rocha | – 0,5 to 0 | 28 to 32 | |

Table 2 — Controlled-atmosphere storage

| Variety | Temperature °C | Recommended mixtures | | Reference | Expected storage life weeks |
|--------------------------------------|-------------------|----------------------|-------------|----------------|--------------------------------|
| | | Carbon dioxide % | Oxygen % | | |
| Williams' Bon Chrétien ¹⁾ | 0 | 4 | 2 | France | 24 |
| | – 1 to 0 | 4,5 | 3 | Italy, Germany | 16 to 20 |
| | – 1 | 2 to 3 | 2 to 3 | Australia | |
| | – 0,6 to – 1 | 0,8 to 1,0 | 2,5 to 3,0 | USA | |
| | 0 | 2 | 2 | Switzerland | |
| Beurré Bosc | – 1 | 2 to 3 | 2 to 3 | Australia | 22 |
| | | 0,6 to 1,0 | 2,5 to 3,0 | USA | |
| Packham | 0 | 5 | 16 | Australia | |
| Rocha ²⁾ | | | | Portugal | |
| Doyenné du Comice | 0 | 5 | 3 | Italy | Not very satisfactory |
| | | 2 | 2 | Switzerland | |
| | – 0,6 to – 1 | 2 | 2 | USA | |
| | – 0,6 to 0 | 2 | 16 | Netherlands | |
| | 0 | 5 | 2 to 3 | United Kingdom | |
| Passe Crassane | 5 | 5 | 5 | France | 28 to 32 |
| | 0 | 5 | 3 | Italy | |

NOTE — Data taken from Ryall L.A. and Pentzer W.T. *Handling, Transportation and Storage of Fruits and Vegetables*. Vol. 2, *Fruits and Tree Nuts*. Westport, Connecticut: AVI Co., 2nd edn., 1982.

1) The controlled-atmosphere storage of Williams pears is delicately balanced, as it entails the need to harvest fruit intended for this kind of cold storage at exactly the right time.

In some countries, such as the United Kingdom, controlled-atmosphere storage is no longer recommended for this variety.

2) Transportation is not in a controlled atmosphere.