
International Standard



1134

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Pears — Guide to cold storage

Poires — Guide pour l'entreposage réfrigéré

First edition — 1980-08-01

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 1134:1980

<https://standards.iteh.ai/catalog/standards/sist/c4a956ec-d0f4-4ba8-83e0-c4fa68d4cec3/iso-1134-1980>

UDC 634.13 : 664.8.037

Ref. No. ISO 1134-1980 (E)

Descriptors : agricultural products, fruits, pears, storage, cold storage.

Price based on 7 pages

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

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 1134 was developed by Technical Committee ISO/TC 34, *Agricultural food products*.

It was submitted directly to the ISO Council, in accordance with clause 5.10.1 of part 1 of the Directives for the technical work of ISO. It cancels and replaces ISO Recommendation R 1134-1969, which had been approved by the member bodies of the following countries :

Australia	Greece	New Zealand
Brazil	Hungary	Poland
Bulgaria	India	Portugal
Chile	Iran	Romania
Colombia	Israel	South Africa, Rep. of
Czechoslovakia	Italy	Turkey
France	Korea, Rep. of	United Kingdom
Germany, F.R.	Netherlands	USSR

No member body had expressed disapproval of the document.

Pears — Guide to cold storage

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes methods for obtaining conditions for the successful cold storage of varieties of pears obtained from *Pyrus communis* Linnaeus until their use in the fresh state.

The limits of application of these methods are given in annex A.

2 REFERENCES

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

AGRI/WP 1/EUR.STAN.1, *Apples and pears* (revised European Standard, recommended by the Working Group on standardization of perishable goods of the Economic Commission for Europe).

3 CONDITIONS OF HARVEST AND PUTTING INTO STORE

3.1 Harvesting

The practical criteria of ripeness most frequently used for defining the best time for harvesting are¹⁾ :

- the basic colour of the outer skin²⁾, which is judged with the aid of a standard table;
- the hardness of the flesh, which is estimated by means of a spring penetrometer;
- the ease of picking;
- the presence of starch in the flesh of the fruits; this can be checked by treating a cross-section of the fruit with an iodine-potassium iodide solution.

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.

Exact timing of the date of harvesting is more important for early varieties than for late varieties (for example Passe Crassane).

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

3.2 Quality characteristics for storage

Fruits put into store shall 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.

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.

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 facilitates an increase of 10 to 20 % in storage density.

4 OPTIMUM CONDITIONS OF STORAGE

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 to $+0,5$ °C.

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

2) 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.

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 pear, it has been possible to recommend a method of keeping based on progressive lowering of the temperature (0 °C; -0,3 °C; -0,8 °C; -1,5 °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, -1 °C) the pears change very little during their period in the cold and it is necessary to submit them to a complementary ripening process at a higher temperature when they leave the cold store. On the other hand, from a certain temperature (+3 °C for Doyenné du Comice pears, +4 °C for Passe Crassane), ripening is slow but can be completed in storage.

Some varieties ripen completely at higher temperatures only if the preliminary 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).

In certain areas, the variety Passe Crassane ripens normally at higher temperature only if it has previously undergone a sufficiently long period in the cold (of the order of 11 weeks at 0 °C). The duration of ripening may be shortened by treatment of the fruit with suitable substances (ethylene). Ethylene is effective only at the beginning of the storage period. The gas is generally used at concentrations of 1 to 2 ‰, the treatment being carried out at a temperature of +18 to +25 °C and at a relative humidity in the neighbourhood of 90 %.

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

Finally, certain varieties (for example Curé) do not withstand cold conditions well, and storing them at low temperature is sometimes responsible for the appearance of more or less widespread internal browning.

Table 1, of annex B, gives the temperatures recommended for a number of varieties.

4.2 Relative humidity

Pears may generally be stored at a relative humidity of the order of 90 %. If the atmosphere is drier, the fruit develops a stronger taste and aroma, but the losses in mass are greater.

4.3 Air circulation

It is recommended that the air circulation ratio be 20 to 30 (see ISO 2169), or that a ventilation of 80 to 100 m³/t/h be used.

4.4 Storage life

Table 1, of annex B, 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

Table 1, of annex B, 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 :

a)	carbon dioxide	5 %
	oxygen	2 %
	nitrogen	93 %
b)	carbon dioxide	7 to 10 %
	oxygen	10 to 13 %
	nitrogen	80 %
c)	carbon dioxide	7 to 10 %
	oxygen	5 %
	nitrogen	85 to 88 %

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.

It should be noted that the storage disorders called "brown heart" and "hard heart" result from the presence of an excess of carbon dioxide 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, in annex C, 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 plastics packages

The use of certain types of plastics films 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 to be prolonged (at 0 °C, it has been possible to keep Doyenné du Comice pears in polyethylene packages for 18 weeks).

Encouraging results have been obtained by lining cases of pears with plastics film.

ANNEX A

LIMITS OF APPLICATION

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 himself decide on any modifications to be made.

Moreover, this International Standard 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 D, 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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ANNEX B

TABLE 1 – Storage in air

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

ANNEX C

TABLE 2 – Controlled-atmosphere storage

Variety	Temperature °C	Recommended mixtures		Reference	Expected storage life
		Carbon dioxide %	Oxygen %		
Williams' Bon Chrétien ¹⁾	-1 to 0	4	2	France	24 weeks
		5	5		
		2 to 4	2	Germany	16 to 20 weeks
		5	16	Australia	
		5 to 10	2,5	USA	
5	5	Canada			
Beurré Bosc	0	5	16	Australia	22 weeks
Beurré Diel	0	10	10	Switzerland	
Doyenné du Comice	0	5	2 to 3	United Kingdom	Not very satisfactory
		10	10	Switzerland	
Beurré Hardy	0	10	10	USA	
Passe Crassane	+1	5 to 10	5 to 10	France	28 to 32 weeks
	0	10	10	Switzerland	
	6 to 8	10	2 to 10	Italy	
Packham	0	5	16	Australia	

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.

ANNEX D

ROLE OF THE GROWER AND WASTAGE DURING STORAGE

D.0 INTRODUCTION

The following recommendations on the role of the grower and on wastage during storage are, as in the main text, of a very general nature. It therefore rests with specialists to amplify them, if necessary, in a manner appropriate to their national varieties.

D.1 ROLE OF THE GROWER (Influence of ecology and method of cultivation)

The generally unfavourable influence of certain ecological and agrotechnical factors is now better known.

Under these conditions, and since it is also necessary to supply the market from the first weeks after harvesting, it is desirable not to put into cold storage at all (or to put in only for a short period) fruit of which the unfavourable ecological background is liable to make good keeping a matter of delicate balance. This applies especially to

- fruit of large size;
- fruit from young trees;
- fruit from trees which are lightly loaded or closely pruned;
- fruit from trees which have been too heavily manured or treated with unbalanced fertilizer, particularly if the nitrogen content is too high;
- fruit harvested during a rainy period.

It should also be pointed out that after a cold, damp summer, keeping is delicately balanced, and finally that irrigation should be carried out with care and that any excess is detrimental to keeping.

D.2 WASTAGE IN STORAGE

In general, a distinction is made between cryptogamic and physiological disorders.

D.2.1 Cryptogamic disorders

Disorders originating from micro-organisms (whether parasites entering through wounds, or latent parasites) are very numerous. There are hardly any means of combating these, other than preventive measures concerned with :

- care in all handling operations;
- sorting of sound from unsound fruit immediately before putting them into the cold store;
- preliminary disinfection of the cold store and packages;
- frequent disinfection of sorting rooms;
- systematic removal of sources of contamination in the orchard (cankers, rotten fruit, etc.);
- use of packages impregnated with antiseptics, if not prohibited.

The use of fungicidal aerosols has been recommended. Some countries have, however, prohibited these.

D.2.2 Physiological disorders

Table 3 classifies the most important data relating to the most frequent disorders.

The data are very general and may not apply to particular local conditions.

Specialists may amplify the table by investigations, in particular, of withering and of brown heart.

TABLE 3 – Physiological disorders

Designation and description of the change	Horticultural factors (ecology, date of harvesting) and factors relating to conditions in the cold store provoking or revealing the disorder	Remedies, preventive measures	Susceptible varieties
Frost Glassy appearance of the flesh and epidermis, general softening.	<ul style="list-style-type: none"> – Lowering of temperature below the freezing point 	<ul style="list-style-type: none"> – Prevent the lowering of temperature 	
Brown heart Dark brown zone in the neighbourhood of the core. Fissures appear later.	<ul style="list-style-type: none"> – Late harvesting – Delay in putting into cold storage – Excessive concentration of carbon dioxide 	<ul style="list-style-type: none"> – Avoid high contents of carbon dioxide 	<ul style="list-style-type: none"> – Beurré Bosc – Beurré Clairgeau
Internal browning due to ageing The flesh becomes brown, more or less dark; it is dry and mealy.	<ul style="list-style-type: none"> – Late harvesting – Delay in putting into cold storage – Large fruit and fruit from poor harvest – Too long duration of storage 	<ul style="list-style-type: none"> – Storage should not be continued when the risks of internal browning are considerable 	<ul style="list-style-type: none"> – Passe Crassane – Clapp's Favorite – Williams
Scald Browning of epidermis, over whole area in bad cases.	<ul style="list-style-type: none"> – Premature harvesting – Large fruit – Insufficient changing of the atmosphere 	<ul style="list-style-type: none"> – Thorough and frequent ventilation of the cold store – Use of controlled atmosphere – The following may also be mentioned : use of chemical products and oiled paper 	<ul style="list-style-type: none"> – Williams'¹⁾ Bon Chrétien – Beurré Clairgeau – Doyenné du Comice – Packham – Curé – Beurré Hardenport

1) It should be mentioned that scald on Williams' Bon Chrétien pears is not of the same kind as that found on apples or on other varieties of pears, and that the preventive measures suggested are therefore not suitable for the Williams variety and for certain other varieties of pears.