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Apples — Guide to cold storage

Pommes — Guide pour l'entreposage par réfrigération

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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.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, Technical Committee ISO/TC 34 has reviewed ISO Recommendation R 1212 and found it technically suitable for transformation. International Standard ISO 1212 therefore replaces ISO Recommendation R 1212-1970 to which it is technically identical.

ISO Recommendation R 1212 was approved by the Member Bodies of the following countries :

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

No Member Body expressed disapproval of the Recommendation.

The Member Body of the following country disapproved the transformation of ISO/R 1212 into an International Standard :

Poland

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Apples — Guide to cold storage

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes methods for obtaining conditions for the successful cold storage of apples.

The limits of application of this guide are given in the annex.

2 REFERENCE

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

3 CONDITIONS OF HARVESTING AND PUTTING INTO STORE

3.1 Harvesting

The principal criteria used to determine the optimal state of ripeness for harvesting are as follows[1] :

— the ease of picking (the fruit is picked when it is easily separated from its spur; this is not, however, an objective criterion);

— the colour (period of change from green to yellow), which is judged with the aid of standard tables;

— the age of the fruit, expressed as the number of days that have elapsed since full flowering.

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.

3.2 Quality characteristics for storage

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

3.3 Various treatments before storage

The practice of pre-ripening should be forbidden, as it is the source of much wastage in storage.

3.4 Putting into store

The fruit should be put into the cold immediately after harvesting.

3.5 Method of storage

The packages should be of such a kind, and so arranged in the cold store, as to permit free circulation of air. As an indication, storage densities of 200 to 250 kg per cubic metre of usable space, for apples in cases, are considered as maxima that should not be exceeded.

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

4 OPTIMUM STORAGE CONDITIONS[2]

4.1 Temperature

Most varieties of European origin keep in the neighbourhood of + 4 °C; a lower temperature is harmful. Apples of American origin, on the other hand, keep well at 0 °C. There are exceptions : for example the Jonathan variety at 0 °C is sometimes affected by the internal browning which is characteristic of low-temperature disorders.

Table 1 gives the recommended temperatures for different varieties entering into international trade. In controlled-atmosphere storage, the storage temperature is sometimes higher, as shown in table 2.

4.2 Relative humidity

The optimum relative humidity for storage of apples is 90 %.

4.3 Air circulation

There should be a uniform distribution of air within the cold store, the rate of mixing being sufficient to keep the spatial differences in temperature and humidity within reasonable limits. Such devices as carbon filters and air washers, to remove volatile organic products of metabolism, are of doubtful value since such gases have no significant physiological effects at the recommended temperature of storage.

1) Tests for the hardness of the flesh, and for the presence of starch, can also be used.

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

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If the apples are being stored in air, and the cold store is sufficiently gas-tight for carbon dioxide to accumulate, some means of ventilation should be provided.

4.4 Storage life

Table 1 gives the expected storage life for different varieties entering into international trade, under the storage conditions mentioned above.

It is necessary in every case that the storage is not prolonged beyond limits compatible with the maintenance of good quality.

It is also essential to draw samples of the fruit periodically so as to detect immediately the appearance of wastage during storage. Table 1 shows the susceptibility of these varieties to such wastage.

5 ADJUNCTS AND OTHER METHODS OF KEEPING

5.1 Controlled-atmosphere storage

The following gas mixtures are most frequently recommended[1] :

1)	carbon dioxide	5 %
	oxygen	2 %
	nitrogen	93 %
2)	carbon dioxide	10 %
	oxygen	10 %
	nitrogen	80 %
3)	carbon dioxide	0 %
	oxygen	3 %
	nitrogen	97 %
4)	carbon dioxide	5 to 8 %
	oxygen	12 to 15 %
	nitrogen	difference to 100 %

These compositions are given by way of illustration, and it will be for the experts in each country to give any necessary advice on any other kinds of composition, 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.

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 plastics packages

The use of certain types of plastics films known to be suitable for contact with food products permits losses in mass during storage to be reduced considerably. Interesting results have been obtained in this way by lining boxes of apples with plastics film or by covering a certain quantity of cases with a plastics tarpaulin.

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1) The following similar compositions have also been recommended :

–	In Australia :	carbon dioxide	2 to 3 %
		oxygen	2 to 3 %
		nitrogen	94 to 96 %
–	In New Zealand :	carbon dioxide	2 %
		oxygen	3 %
		nitrogen	95 %

TABLE 1 – **Storage in air**

Variety	Recommended temperature °C	Expected storage life months	Susceptibility to wastage during storage
Reine des Reinettes	+ 4	3	– susceptible to internal low-temperature browning below + 2 °C
Cox's Orange Pippin	+ 3 to + 4	3	– bitter pit – internal low-temperature browning below + 3 °C
Belle de Boskoop	+ 3 to + 4	5 to 6	– scald – internal low-temperature browning below to + 3 °C
Jonathan	+ 2 for one month + 1 for the succeeding month and thereafter at 0	4 to 5	– internal low-temperature browning – Jonathan spots – internal browning due to ageing
	+ 3 to + 4	3	
Canada Reinette	+ 4	4 to 5*	– bitter pit – internal low-temperature browning – browning due to ageing
	+ 7	4	
Richared	0	6	
Clochard's Reinette	+ 2	7 to 8	– insufficient colour at temperatures below + 5 °C
	+ 5	5 to 6	
Golden Delicious	– 1 to 0	7	– only for fruits coloured at harvesting
	+ 2 to + 4	5	– soft scald – lenticel rot
Mans Reinette	0 to + 1	7	– late scald – lenticel rot
	+ 3 to + 5	5 to 6	
Stayman Winesap	0 to + 2	4 to 5	– very susceptible to scald and disorders due to fungi
Winesap	0 to + 2	5 to 6	
Red Delicious	0 to + 2	6	– disagreeable flavour after 6 months' storage
Starking (Delicious Red)	0 to + 2	5 to 6	
Winter Banana	+ 2 to + 3	4 to 5	
Calville Blanc	+ 4	5	– bitter pit
Ontario	+ 4	5 to 6	– very susceptible to scald – internal browning at temperatures below + 2 °C
Blenheim Orange	+ 3 to + 4	2 to 3	
Bramley's Seedling	+ 3 to + 4	3 to 4	
Laxton's Superb	+ 3	3 to 4	
Mac Intosh	0 to + 1	4 to 5	– susceptible to internal browning limited to small spots in the seed cavities
Morgenduft = Imperatore	0 to + 2	5 to 7	– scald – lenticel rot
Abbondaza	+ 2 to + 4	4 to 6	– internal low-temperature browning
Rosa di Caldaro	+ 2	5 to 6	– internal low-temperature browning

* The storage life of apples grown at altitude might be prolonged to 6 or 7 months.

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TABLE 1 (*concluded*)

Variety	Recommended temperature °C	Expected storage life months	Susceptibility to wastage during storage
Renetta Champagne	0 to + 2	7 to 8	– spots
Granny Smith	0	5	– scald – core browning
Sturmer Pippin	+ 2 to + 3	6	– scald – internal browning

TABLE 2 – **Controlled-atmosphere storage**

Variety	Recommended temperature °C	Recommended mixtures		Expected storage life months
		Carbon dioxide %	Oxygen %	
Bramley's Seedling	+ 3 to + 4	8 to 10	11 to 13	6 to 8
Cox's Orange Pippin	+ 3 to + 4	5	2,5	4 to 5
		0	2	5
Golden Delicious	0	10	10	7 to 8
		5	2	
		2	3	
Jonathan	+ 3	0	3	6
	+ 3,5	9	12	
		7	13	
	+ 4	6	15	
		8	12	
Starking (Delicious Red)	0	5	3	6 to 8
	+ 3	0 to 3	3	
Laxton's Superb	+ 4,5	10	2,5	6 to 7
		6	14	
Mac Intosh	+ 3,5	5	3	
		7	14	
Winston	+ 2 to + 3	7	13	8 to 9
Belle de Boskoop	+ 4	5	2	6 to 8
Richared	0	5	2	6 to 8
		10	10	6 to 7
Stayman Winesap	0	5	2	6 to 8
Winesap	0	5	2	6 to 8
Sturmer Pippin	+ 2 to + 3	2	3	8
		5	3	
		5	5	
		7	7	
Rome Beauty	0	2	3	7

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