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R 1212

APPLES

GUIDE TO COLD STORAGE

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 1212, *Apples – Guide to cold storage*, was drawn up by Technical Committee ISO/TC 34, *Agricultural food products*, the Secretariat of which is held by the Magyar Szabványügyi Hivatal (MSZH).

Work on this question led to the adoption of Draft ISO Recommendation No. 1031 which was circulated to all the ISO Member Bodies for enquiry in October 1966. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

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 opposed the approval of the Draft.

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in April 1970, to accept it as an ISO RECOMMENDATION.

ISO Recommendation | R 1212 | April 1970

APPLES

GUIDE TO COLD STORAGE

INTRODUCTION

This ISO Recommendation 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 ISO Recommendation 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 ISO Recommendation does not take into account the role played by horticultural factors, and wastage in 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 apples is still uncertain, as are often the appropriate means of combating them. It has therefore seemed difficult to prepare international recommendations on these two points.

Nevertheless it has seemed useful to give, in an appendix and for purposes of record, 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 ISO Recommendation should enable much wastage in cold storage to be avoided and long-term storage to be achieved in most cases.

1, SCOPE

This ISO Recommendation describes methods for obtaining conditions for the successful cold storage of apples.

2. CONDITIONS OF HARVESTING AND PUTTING INTO STORAGE

2.1 Harvesting

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

- 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.

2.2 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.

2.3 Various treatments

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

2.4 Putting into storage

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

2.5 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.

3. OPTIMAL CONDITIONS OF STORAGE

3.1 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 in Annex A 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, Annex B.

3.2 Relative humidity

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

3.3 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.

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.

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

3.4 Storage life

Table 1 in Annex A 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 in Annex A shows the susceptibility of these varieties to such wastage.

4. ADJUNCTS AND OTHER KEEPING PROCESSES

4.1 Controlled-atmosphere storage

The following gas mixtures are most frequently recommended*:

(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 in Annex B summarizes, for certain varieties, the gas mixtures which have given the best results, and also the recommended temperature and the expected storage life.

4.2 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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* 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 %

ANNEX A

TABLE 1 – Storage in air

Variety	Recommended temperature °C	Expected storage life (in 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 + 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	

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

TABLE 1 – **Storage in air** (*concluded*)

Variety	Recommended temperature °C	Expected storage life (in months)	Susceptibility to wastage during storage
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
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

ANNEX B

TABLE 2 – Controlled-atmosphere storage

Variety	Recommended temperature °C	Recommended mixtures Carbon dioxide %	Oxygen %	Expected storage life (in months)
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

APPENDIX

ROLE OF THE GROWER AND WASTAGE DURING STORAGE

The information given in this Appendix on the role of the grower and wastage during storage are, like the main text of this ISO Recommendation, of a very general nature. It is for specialists to amplify them, if necessary, by comments appropriate to their national varieties.

Z.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 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.

Z.2 WASTAGE DURING STORAGE

In general, a distinction is made between

(*a*) cryptogamic disorders, and
(*b*) physiological disorders.

Z.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. Certain countries have, however, prohibited these.

Z.2.2 Physiological disorders

Table 3 on pages 10 and 11 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 can amplify this table by investigations, in particular, of Jonathan spots, withering, brown heart, and internal browning in the form of small spots between the seed cavities.