ACTA AGROBOTANICA
vol. 39, z. 2 — 1986
195-200

The quality of sweet cherries stored under hypobaric conditions

H. BORECKA

Research Institute of Pomology and Floriculture, Pomologiczna 18, 96-100 Skierniewice, Poland

(Received: September 13, 1985)

Abstract

Sweet cherries cvs 'Emperor Francis' and 'Grosse Schwarze Knorpelkirsche' were stored under hypobaric conditions, 5 kPa and 25 kPa at 2°C. These sweet cherries could be stored for 30 days without a high losses. Sweet cherries of both cvs tasted the best after storage under LPS, worse — under CA, and the worst in normal air. Titrate acidity decreased during the storage period, the percent of soluble solids decreased for 15 days after which it increased. Mostly *Botrytis cinerea* and *Monilinia* spp. destroyed the sweet cherries during storage. *Penicillium* spp. affected fruits by less than 1% under kPa, and those subsequently stored for 3 days at 20°C. Hypobaric storage 5 kPa at 2°C seems to be patricularly good for storage of sweet cherries cv 'Emperor Francis'.

INTRODUCTION

The maintenance of the good quality of some horticultural crops was noticed under low pressure (LPS) conditions (Lougheed et al., 1978; Salunkhe and Wu, 1974; Sharpless and Langridge, 1973; Wu and Salunkhe, 1972; Spalding, 1979). The extention of sweet cherries storage life seems to be an important economic problem. Some cvs of sweet cherries could be stored for one month in normal air or under controlled atmosphere (CA) cold storages with quite good results, but some others could be stored for a shorter period only (Borecka and Wojtas, 1986; Perritt and Mason, 1965; Chen et al., 1981). The prolongation of sweet cherry storage life seems to be possible using hypobaric storage conditions (Alique et al., 1979).

Fungi causing fruit rot are a very important factor in the deterioration of sweet cherries in storage (Harvey et al., 1972). The main

fungus causing sweet cherry rot in the USA is *Monilinia fructicola*, but in Europe, *Monilinia laxa* is most common (Jones, 1985). In Poland *Botrytis cinerea* Pers. is a very important fungus causing sweet cherry rot during storage (Borecka and Wojtas, 1986) probably because of flower infection in the orchard and due to well developing rot from latent infection at low temperature in storage.

It is necessary to store fruits from treated trees, because of the high significance of fungi diseases during storage. Fungicide treatment in the orchard particularly during the flowering period decreased the flower infection by fungi and this decreased the sweet cherry fruit rot during storage (Jones, 1985; Mappes, 1984; MacSwan, 1976).

The aim of these experiments was to determine the influence of low pressure storage conditions on the quality of two cvs of sweet cherry fruits.

MATERIAL AND METHODS

Experiments were conducted in 1000 l low pressure containers equiped with automatically regulated pressure; a Servomex industrial oxygen analyser operating on parametric principles was used for oxygen measurement; the carbon dioxide content was established using an infrared CO_2 analyser.

Two cultivars of sweet cherries were under our consideration: 'Emperor Francis' ('Büttnera Czerwona') and 'Grosse Schwarze Knorperkirsche' ('Czarna Późna'). The fruits were stored under low pressure (LPS) 5 kPa, under controlled atmosphere (CA) 5% CO_2 : 3% O_2, and in normal air at 2°C. Sweet cherries of both cvs were stored for 30 days and 'Emperor Francis' additionally for 60 days. The next year, fruits cv. 'Emperor Francis' were stored under LPS conditions: 5 kPa, 25 kPa and in normal air. Storage periods were: 15, 30, and 42 days. After these periods fungi causing fruit rot were identified. After the storage period the healthy fruits were subsequently stored in normal air at 20°C for 3 days.

All experiments were conducted in four replications, one replication consisted of 80 fruits in one basket.

The quality of stored fruits was evaluated on the basis of the amount of rotten fruit and their taste after storage. After each storage period, the number of rotten cherries was counted and the percent of fruit rot was calculated. Titrate acidity, using 0.1 n KOH, pH and percent of soluble solids using a refractometer, were also analysed. The taste of the fruit was evaluated by 6 persons according to a scale from 1 to 5, where 5 was the best taste.

The percentage values for statistical analysis were transformed to Bliss degrees. The mean figures were compared by Student's t-test.

RESULTS AND DISCUSSION

The quality of sweet cherries evaluated on the basis of the taste of fruit and fruit rot, depended on cultivar, lenght of storage, and storage conditions.

The taste of fruit of both tasted cvs was very good after 30 days of storage under 5 kPa, worse — under 5% CO_2 : 3% O_2, and the worst in normal air when stored for the same period.

The sweet cherries subsequently stored for 3 days at 20°C in normal air tasted variously: 'Emperor Francis' stored before under 5 kPa tasted better than 'Grosse Schwarze Knorpelkirsche', but the latter were a bit better than the former when they had previously been stored before under 5% CO_2 with 3% O_2 or in normal air (Table 1).

Table 1

The rot and taste of sweet cherries depending on the length and storage conditions

Storage conditions	'Emperor Francis'				'Grosse Schwarze Knorpelkirsche'	
	Days of storage					
	30		60		30	
	A	B	A	B	A	B
Fruits stored at 2°C only						
5 kPa	1.6 ab	5	17.6 bc	4.0	2.8 b	5
5% CO_2:3%O_2	0.2 a	3.9	17.6 bc	3.6	0.6 a	3.6
Normal air	2.5 ab	3.3	30.3 c	3.6	5.3 b	2.9
Healthy fruits subsequently stored for 3 days at 20°C in normal air						
5 kPa	2.5 a	5	53.0 c	4.7	23.5 ab	4.3
5% CO_2:3% O_2	2.1 a	4.7	18.6 b	3.5	40.9 b	4.9
Normal air	0.2 a	3.3	52.5 c	4.4	11.0 a	3.7

Means marked with same letter do not differ significantly at 5%.
A — Percent of rotted fruits. B — Taste of fruits according to a scale from 0 to 5 where 5 was the best taste.

The rotting of sweet cherries depended on the cultivar, e.g. 'Emperor Francis' rotted less than 'Grosse Schwarze Knorpelkirsche'. Storage conditions similarly influenced both cvs., they rotted the least under 5 kPa. 'Emperor Francis' under LPS or CA conditions could be stored longer than 'Grosse Schwarze Knorpelkirsche' which stored for more than 30 days rotted by nearly 70%. Fruits cv. 'Emperor Francis' stored for 60 days rotted similarly under LPS and CA conditions, but the taste

Table 2

The rot, taste, soluble solids and acidity of sweet cherries cv. 'Emperor Francis' depending on the length of storage and storage conditions at 2°C

Storage conditions	5 kPa			25 kPa			Normal air		
Days of storage	15	30	42	15	30	42	15	30	42
% of rooted fruit caused by fungi									
Botrytis cinerea	1.3	1.9	10.6	0.9	12.2	31.9	2.8	5.0	41.6
Manilinia spp.	0.3	2.8	0.7	3.4	1.9	0.6	0.3	6.9	4.0
Penicillium spp.	0.3	0	0.3	0	0	0	0	0	0
Total	1.9 a	4.7 ab	11.6 ab	4.3 ab	14.1 b	32.5 bc	3.1 ab	11.9 b	45.6 c
Taste	5.0	5.0	3.5	5.0	4.1	2.0	5.0	3.6	2.0
% of soluble solids	17.2 bc	16.3 ab	17.8 c	16.4 ab	15.7 a	16.7 b	16.0 ab	19.8 d	16.8 bc
Acidity as % of malic acid	0.72 f	0.54 c	0.48 b	0.64 e	0.48 b	0.42 a	0.63 e	0.60 d	0.43 a
pH	4.4 a	4.5 b	4.7 c	4.4 a	4.7 c	4.8 d	4.4 a	4.5 b	4.8 d
Healthy fruits subsequently stored for 3 days at 20°C in normal air									
% of rotted fruit caused fungi									
Botrytis cinerea	19.4	36.2	11.7	12.7	21.9	27.2	21.2	55.3	66.5
Monilina spp.	7.7	3.7	0.7	7.8	5.6	0	6.2	15.1	0.5
Penicillium spp.	0	1.8	0.4	5.0	1.1	0	0	1.5	0
Rhizopus spp.	1.4	0	0	0	0	0	1.3	0	0
Total	28.5 ab	41.7 b	12.8 a	25.5 ab	28.6 ab	27.2 ab	28.7 ab	71.9 c	67.0 c
Taste	5.0	4.2	bitter taste	5.0	4.1	bitter taste	5.0	3.6	bitter taste

of the cherries was different; those stored under LPS were much better than those stored under CA (Table 1).

Pressure of 25 kPa was unfavourable for a storage period longer than 15 days, but sweet cherries subsequently stored for 3 days at 20°C in normal air, rotted less than those stored before under 5 kPa (Table 2).

Sweet cherries were affected during the storage period mostly by *Botrytis cinerea*, less by *Monilinia* spp. Other fungi such as *Penicillium* spp. were noticed under 5 kPa or on fruits subsequently stored at 20°C. During this last period, *Rhizopus* spp. was also identified (Table 2). This takes place probably because of some very small and difficult to notice splits of the fruit skin under very low pressure; the number of affected fruits was very small (Table 2).

Fruit contents varied when stored under LPS; the percentage of soluble solids decreased during the first 30 days of storage and next increased, reaching a maximum after 60 days. Fruits stored in normal air contained the highest percent of soluble solids after 30 days of storage, next it decreased; the pH increased during the storage period under all tested conditions (Table 2).

Alique et al. (1979) established that the sweetness of cherries depended on the content of acids, not on the sugars in the fruit. In these experiments, the percent of soluble solids decreased and increased during storage, and the titrate acidity decreased all of the time, so it is very highly probable that the content of acids determined the fruit sweetness. Experiments conducted by Alique et al. (1979) concerned only one cv. and the value of low pressure used there was intermediate to those examined in the experiments presented here; the temperature was also much lower than that used in these experiments, but the results were similar — a very low percent of destroyed fruits stored under LPS conditions. Good results with CA conditions were also obtained by Bertolim (1972) with cherries cv. 'Durone Nero 1', but he did not establishe the tase of fruits after storage. The presented results on the quality of cherries are similar to his.

Sweet cherries could be stored under LPS or CA conditions without large losses, particularly 'Emperor Francis' and the storage period could be longer than one month, but the length of storage depended mostly on the cv. and season. A temperature lower than 2°C used in some experiments seems to be too low for our cvs of sweet cherries.

REFERENCES

Alique R., Rodrigo M. E., Canet W., 1979. Experiments of the hypobaric storage of Picota cherries. XV-th Int. Congr. of Refrigeration, 23 - 29 Sept. 1979. C_2, 106.

Bertolim P., 1972. Indagine preliminare sulla conservatione refrigerata delle citiege. Notiziario del CRIOF 3: 8.
Borecka H., Wojtas B., 1986. Deterioration of sweet cherry fruit during storage period. Acta Agrobot. 39: 000 - 000 in press.
Chen M. P., Mellenthin W. M., Kelly S. B., Facteau T. J., 1981. Effects of low oxygen and temperature on quality retention of 'Bing' cherries during prolongated storage. J. Am. Soc. Hort. Sci. 106: 533 - 535.
Harvey J. M., Smith W. L., Jr, Kaufman J., 1972. Market diseases of stone fruits: cherries, peaches, nectarines, apricots and plums. USDA Handb. 414: 64.
Jones A. L., 1985. Brown rot control in Michigan Proceedings Brown Rot of Stone Fruit Workshop 55: 4 - 8. Special Report New York State Agr. Exp. St. Geneva, Cornell University Itaca.
Lougheed E. C., Murr D. P., Berard Luce, 1978. Low pressure storage for horticultural crops. Hort. Sci. 13: 21 - 27.
MacSwan I. C., 1976. Cherry (Black Republican Sweet) (*Prunus avium*). Brown rot blossom blight (*Monilinia fructicola* and *M. laxa*). Fung. Bact. Test Results, Dep. of Bot. and Plant Path., Oregon State University Corvallis, Oregon, p. 7.
Mappes D., 1984. Bekämpfung von Blüten und Zweigdüre (*Monilinia laxa*) im Obstbau, Obstbau 9: 174 - 176.
Perritt S. W., Mason J. L., 1965. Controlled atmosphere storage of sweet cherries. Proc. Am. Soc. Hort. Sci. 87: 128 - 130.
Salunkhe D. K., Wu M. T., 1974. Subatmospheric storage of fruits and vegetables. Lebensmitt wiss. Technol. 7: 261 - 267.
Sharpless R. O., Langride I. W., 1973. Reduced pressure storage. Rept. E. Malling Res. Sta., 1972, p. 108.
Spalding D. H., 1979. Low pressure (Hypobaric) storage of several fruits and vegetables. Proc. Fla. State Hort. Soc. 92: 201 - 203.
Wu M. T., Salunkhe D. K., 1972. Subatmospheric pressure storage of fruits and vegetables. Utah Sci. 33: 29 - 31.

Jakość czereśni przechowywanych w warunkach obniżonego ciśnienia

Streszczenie

Czereśnie odmian 'Büttnera Czerwona' ('Emperor Francis') i 'Czarna Późna' ('Grosse Schwarze Knorpelkirsche') przechowywano w warunkach obniżonego ciśnienia 5 kPa i 25 kPa w 2°C przez miesiąc z bardzo małymi stratami. Czereśnie przechowywane w warunkach obniżonego ciśnienia odznaczały się dobrym smakiem, gorsze były te, które przechowywano w zmodyfikowanej atmosferze, a najgorsze — w normalnej atmosferze.

Kwasowość miareczkowa malała w czasie okresu przechowywania; zawartość ekstraktu w owocach malała do 15 dni przechowywania, a następnie wzrastała.

Najważniejszymi czynnikami chorobotwórczymi występującymi na przechowywanych czereśniach były grzyby *Botrytis cinerea* i *Monilinia* spp. Grzyby z rodzaju *Penicillium* porażały owoce przechowywane w 5 kPa poniżej 1%, a także te, które przechowywano dodatkowo przez 3 dni w temp. 20°C.