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Deterioration of sweet cherry fruit during storage period

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Abstract

Sweet cherry fruit cv. 'Emperor Francis' and 'Grosse Schwarze Knorpelkirsche' could be stored in cold storage conditions with normal air without big loss. Fruits stored under CA conditions were less affected by fungi during storage period, but later when were kept for 3 days at 20°C were more deteriorated than those stored at the same temperature in normal air. *Botrytis cinerea* and *Monilinia* spp. were the main fungi causing rot of sweet cherry fruit. Low temperature decreased the development of *Monilinia* spp. The most important factor for good fruit storage was the size of baskets. Sweet cherries stored in small baskets containing 0.5 kg of fruits were of good quality after one month of storage; in 2-kg boxes they were more damaged.

INTRODUCTION

The prolongation of stone fruit storage life seems to be necessary for the market demand. The biggest difficulties during sweet cherry storage concerned their susceptibility to fungal diseases and high rate of physiological processes of ripening. Sweet cherries are one of the more important stone fruits on the market.

The results of experiments conducted in various countries showed the possibility of prolongation of sweet cherry storage life up to one month when certain storage conditions are applied. The first is temperature. The temperature should be chosen separately for each cultivar e.g. for 'Haumüllers Mitteldicke' and 'Hedelfinger Freschmaul' the best is +1°C (Schmid, 1976), but 'Bing' has to be stored at −1.1°C (Chen et al., 1981). Deterioration of sweet cherries is positively correlated with storage temperature and its duration (Lidster and Tung, 1980), thus fruits quickly cooled after harvest could be better stored. A very important factor influencing the fruit quality is the mode of fruit picking. Sweet cherries harvested without stems deteriorated more rapidly than those not deprived of them (Whittenberger et al., 1968).

Half of the loss during sweet cherry storage is caused by parasitic fungi such as *Penicillium expansum, Alternaria* spp., and *Botrytis cinerea* (Ceponis and Butterfield, 1981). *Alternaria tenuissima, Botrytis cinerea, Cladosporium herbarum, Fusarium oxysporum* and *Penicillium expansum* were also isolated from sweet cherries by Morales et al. (1974). These fungi developed at 0.5°C and 87% RH.

Prolongation of sweet cherry storage period was obtained under controlled atmosphere (CA) conditions. 'Hedelfinger' and 'Germersdorf' cvs. could be well stored at 0°C and 5% CO_2 : 3% O_2 for 30 days with 9% of loss (Jonescu et al., 1978), 'Burlat' — at 1°C under 20% CO_2 : 3% O_2 (André et al., 1982).

The aim of the experiments was to establish the sweet cherry fruit loss caused by fungi during the storage period. Three temperatures and two concentrations of carbon dioxide in CA storage were tested.

MATERIAL AND METHODS

Experiments were conducted in Skierniewice during three years 1979–1981, and at Miłobądz Experimental Station near Tczew for two years 1980–1981.

Seven cultivars of sweet cherries were under consideration at Miłobądz Exp. Sta. They were: 'Bladoróżowa', 'Early Burlat', 'Early Rivers', 'Emperor Francis', 'Grosse Schwarze Knorpelkirsche', 'Seneca', and 'Wolska'. Fruits were stored at 2°C for 14 days. The experiments were done in four replications; one replication consisted of 8 kg of sweet cherries in one box, harvested from one tree. Fruits after storage were examined, and healthy and deteriorated sweet cherries were weighed separately; the percent of rotted fruit was calculated.

The experiments in Skierniewice were conducted with two cultivars of sweet cherries: 'Grosse Schwarze Knorpelkirsche' and 'Emperor Francis'. Fruits were stored for 15, 30, and 42 days at 2°C, 5°C, and 10°C. The healthy and damaged fruits were counted after the storage period; healthy fruits were stored for additional 3 days at 20°C, and then similarly examined.

The effect of absence of fruit stalk during the storage period under CA at 2°C was examined. Sweet cherries cv. 'Emperor Francis' were stored for 47 days and 'Grosse Schwarze Knorpelkirsche' for 30 days under 20 or 5% carbon dioxide (CO_2) and 3% oxygen concentrations; these conditions were compared with cold storage normal air atmosphere. The experiments were conducted in four replications, one replication consisting of 80 fruits in one basket.

Fungal diseases were established on sweet cherries stored at 10°C for 22 days. Two kinds of baskets were used for fruit storage: wooden baskets with 80 fruits weighing near 0.45 kg, and plastic boxes with 2 kg of sweet cherries. This experiment was conducted in eight replications.

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

RESULTS AND DISCUSSION

Sweet cherries stored for 14 days at 2°C at Miłobądz Exp. Sta. rotted variously in dependence on the cultivar. The fruits of cv. 'Grosse Schwarze Knorpelkirsche' rotted least and 'Emperor Francis' up to 9%, most affected was cv. 'Bladoróżowa' almost in 50% (Table 1). Sweet cherries with stalks rotted less than those without stalks (Table 2). Similar results are reported by Whittenberger et al. (1968).

Table 1

Rotting of fruits of seven sweet cherry cultivars after 14 days of storage at 2° C at Miłobądz Exp. Sta.

Cultivars	Percent of fruit rotted
'Bladoróżowa'	58.7b
'Early Rivers'	49.4b
'Wolska'	48.4b
'Seneca'	47.3b
'Early Burlat'	43.9b
'Emperor Francis'	8.9a
'Grosse Schwarze Knorpelkirsche'	5.2a

Means followed by the same letter do not differ at 5% level of significance.

Table 2

Influence of stalks removal and storage conditions on sweet cherry fruit rot

Storage conditions	Percent of rotted fruit			
	'Grosse Schwarze Knorpelkirsche'		'Emperor Francis'	
	without stalks	with stalks	without stalks	with stalks
	days at 2°C			
	30		47	
20% CO_2:3% O_2	2.7	0.8	12.2	2.1
5% CO_2:3% O_2	2.1	0.2	6.9	1.8
Normal air	8.1	5.0	9.1	3.5
	4.0 b	1.4a	9.2b	2.4a
Rotting of fruits subsequently stored for 3 days at 20°C				
20% CO_2:3% O_2	19.8b	9.1a	3.1ab	3.9ab
5% CO_2:3% O_2	57.3d	40.8c	2.0a	12.0c
Normal air	21.3b	10.5ab	11.5c	4.8b

Explanation as in Table 1.

The influence of CA conditions on the quality of sweet cherries depended on the cultivars. 'Grosse Schwarze Knorpelkirsche' rotted a little less under CA conditions than in normal air, but this difference was not significant. Healthy fruits

of this cultivar taken from CA conditions and then stored for 3 days at 20°C rotted variously; those stored under 5% CO_2: 3% O_2 of the highest percent rotted. A similar reaction was observed of fruits of 'Emperor Francis' with stalks. CA conditions did not significantly decrease the rotting of the tested sweet cherry cultivars.

The influence of temperature on fruit deterioration depended on the cultivar. Fruits cv. 'Emperor Francis' stored for 15 days at 2°C or 5°C rotted similarly — less than 5%, but at 10°C the rot increased up to 11%. Sweet cherries taken from 5°C and stored for 3 days at 20°C rotted less than those taken from 2°C, when the storage period was longer than 15 days (Table 3).

Table 3

Influence of temperature and storage length on rotting of fruits of sweet cherry cv. 'Emperor Francis' with stalks

Temperature	Percent of rotted fruit after storage period, in days		
	15	30	42
2°C	5.2a	11.0b	45.7d
5°C	2.6a	6.7ab	20.8c
10°C	10.7b	100 e	
	Rotting of fruits stored subsequently for 3 days at 20°C		
2°C	24.1b	65.8d	68.3d
5°C	13.8ab	20.1b	7.7a
10°C	41.0c		

Explanation as in Table 1.

The fruits of 'Emperor Francis' are rather light pink, so small changes of skin color are well visible. Low temperature was suggested (Schmid, 1976; Chen et al., 1981) for storage of sweet cherry cultivars of dark red color. It is high probable that changes of skin color in this case are difficult to notice.

Fruits stored for 22 days at the highest of all tested temperatures were carefully examined and fungi causing rot were identified. These fruits could not be stored longer because secondary parasites could develop on the rotted fruits. Sweet cherries cv. 'Emperor Francis' were mostly infected by *Botrytis cinerea*, less by *Monilinia* spp., but kept afterwards at 20°C were mostly deteriorated by *Monilinia* spp. (Table 4). It seems that a temperature of 10°C decreases the development of *Monilinia* fungi, but does not influence *Botrytis* rot of fruits. Infection by both fungi takes place in orchards in blossoming time (Jarvis, 1977; Willer, 1970), so chemical treatments of trees are of great importance for decreasing infection of fruits in storage, but this problem is beyond the scope of the present paper.

The influence of the type and size of baskets was significant. Sweet cherries stored in small baskets were less infected by fungi, particularly by *Botrytis cinerea*. Those stored in plastic boxes were more squeezed and scratched than those in small baskets, therefore invasion by fungi was higher (Table 4).

Table 4

Pathogenic fungi causing rot of sweet cherries cv. 'Emperor Francis' fruits stored for 22 days at 10°C in baskets of various size

Fungus	Percent of fruit rotted	
	in small baskets (80 fruits 0.45 kg)	in boxes (2 kg)
Botrytis cinerea	13.5b	37.5c
Monilinia spp.	3.8a	9.6b
	Rotting of fruits stored subsequently for 3 days at 20°C	
Botrytis cinerea	1.2a	
Monilinia spp.	28.0b	

Explanation as in Table 1.

Pathogenic fungi such as *Fusarium* or *Alternaria* reported by Morales et al. (1974) and Ceponis and Batterfield (1981) were absent on our sweet cherries. *Penicillium* spp. developed on overripe fruits or on fruits infected by some other fungi; sometimes fungi, secondary parasites, were observed; these were *Mucor* or *Rhizopus*.

Sweet cherries cv. 'Emperor Francis' and 'Grosse Schwarze Knorpelkirsche' could be stored in normal air cold storage without great loss but in small baskets. The possibility of sweet cherries storage could significantly increase their supply on the market.

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Badania nad gniciem czereśni w czasie przechowywania

Streszczenie

Stwierdzono, że czereśnie odmian 'Büttnera czerwona' ('Emperor Francis') i 'Czarna Późna' ('Grosse Schwarze Knorpelkirsche') mogą być przechowywane bez dużych strat w chłodni zwykłej. Warunki kontrolowanej atmosfery (KA) tylko nieznacznie obniżały porażenie owoców w czasie ich przechowywania, natomiast w czasie dodatkowego przechowywania przez 3 dni w 20°C czereśnie takie gniły w znacznie większym stopniu od tych, które przechowywano w chłodni zwykłej. Głównymi sprawcami gnicia czereśni były grzyby *Botrytis cinerea* i *Monilinia* spp. Niska temperatura hamowała w znacznym stopniu rozwój zwłaszcza grzybów z rodzaju *Monilinia*. Dużą rolę w porażeniu owoców miało pozostawienie szypułek oraz wielkość opakowań. Czereśnie przeznaczone do przechowywania powinny mieć szypułki i być pakowane w pojemniki nie przekraczające 0.5 kg. Tak przechowywane owoce były dobrej jakości nawet po miesiącu przechowywania.