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Results of experimental storage of sour cherry (*Prunus cerasus* L.) fruit

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Summary: In utilisation of sour cherry cultivars, the paradigm has gradually changed in the sense that fresh consumption gained much more attention than before on a worldwide scale. Consequently, much more attention is paid to the problems connected with the storage, i.e. preservation of fresh fruit for direct consumption. It is a genuine interest of growers, traders as well as of consumers to be informed about the possibilities of preserving economically the fresh status for a longer period after harvest during the warm summer weather in addition to the lengthening of the harvest season by choosing cultivars of different dates of ripening. Recent results of purposeful experiments indicate that the storability of the fruit of 6 main Hungarian sour cherry cultivars is on the same level ('Érdi bőtermő', 'Debreceni bőtermő', 'Újfehértói fürtös', 'Kántorjánosi', 'Éva', 'Petri'). The traditional conditions facilitated the maintenance of freshness over a 5-week-long period, and the loss of volume was less than 7%. During the first 2 weeks, there was no difference between the cultivars regarding loss of volume and decay, moreover, the effect of time elapsed after harvest and of adversities of transport was not significant. It could be stated that 2 week of storing is safely feasible. We need only 2 °C temperature and 90% of relative humidity. The relations of oxygen and CO_2 of the atmosphere is less decisive than temperature alone. No essential difference has been registered between the storing in plastic trays versus plastic boxes either. A study was performed to assess the modified atmosphere packaging (MAP) effect on Hungarian sour cherries growing in Iran ('Érdi bőtermő and Érdi jubileum') shelf life. The harvested fruits stored at 0 °C under modified atmospheres (15% O_2 and 10% CO_2 and 75% nitrogen) for 6 weeks. Descriptive analysis showed that sour cherry stored in control condition had a higher deterioration rate than those stored in under modified atmosphere, which showed a lower rejection rate and a longer shelf life than those stored in modified atmosphere.

Key words: sour cherry, storability, shelf life, modified atmosphere packing

Introduction

Sour cherry yield of the world is around 1 million t/year produced by 75% in Europe 2005, where the majority is grown in the regions of Central and East-Europe. Sweet cherry is grown everywhere in Europe, whereas sour cherry is a preferred fruit of East Europe (*Kállayné*, 2003). Most sour cherry is produced in Germany (in the eastern territories), Poland and Serbia.

In Asia, the main sour cherry producing countries are Turkey and Iran. The climate and features of the ground are excellent sites for sour cherry production (*Inántsy*, 2004). Turkey produces 100–140 thousand, Iran 60–65 thousand tons per year, and contribute significantly to the world market. Further important quantities are produced in North America, where USA Michigan State is most important (*Kállayné*, 2003).

The majority of sour cherry is traded as a canned product, whereas many consumers of North and East Europe prefer it as a fresh fruit. This moment influences also the choice of variety. Most countries used to concentrate their production on a single variety. In extended parts of Europe, the main variety is 'Schattenmorelle' and its selected clones or hybrids are grown ('Morellenfeuer', 'Fanal' stb.) (*Nyéki* et al., 2005).

Cultivars and harvesting technologies are entirely determined by the claims of the processing industry (*Inántsy*, 2004). The near future promises a gradual shift on the wholesale markets, which will influence the policiy of choosing cultivars and growing practices. Hungary will certainly continue to be a leading producer for the canning industry, but the rate of fruit sold for fresh consumption will increase. This moment should be considered in planning of plantations (understock, planting system, harvesting technology, etc.) as indicated by *Soltész* (2004).

In certain regions of the World, the variability of the sour cherry has been accumulated over historical times as it is an ancient fruit species of the Old World. Contemporary local cultivars represent already results of purposeful selection. One of those gene centres is obviously the Carpathian basin. The majority of cultivars grown in Hungary is derived from this source. Some of them are results of cross breeding ('Meteor korai', 'Érdi bőtermő', 'Érdi jubileum', 'Érdi nagygyümölcsű', 'Favorit', 'Maliga emléke', 'Piramis' etc.),

earlier, i.e. centuries ago selected ones are still maintained ('Pándy meggy', 'Cigánymeggy'), and they are also proofs of the wide range of variability. Other types, as the pipacsmeggy ('Korai pipacsmeggy', 'Pipacs 1') and bosnyákmeggy ('Csengődi') are also derived from the same stocks. A special group of cultivars is represented by the accessions of NE-Hungarian origin ('Újfehértói fürtös', 'Debreceni bőtermő', 'Kántorjánosi', 'Éva', 'Petri'), which are considered to be proofs of a rich variability still unexploited from the point of view of research and development for the recent horticulture (*Szabó*, 2007).

The storage of sour cherry as a fresh fruit has been since long an unexplored question. SASS (1986) reported first about 'Pándy meggy' fruit being maintained in a store over 3–4 weeks with less than 8% loss of volume, which was copiously compensated be higher prices on the market. According to him, low temperature (between –0.5 and +0.5 °C) and an elevated CO_2/O_2 ratio of the atmosphere are favourable. Storability of sour cherry is easier than that of sweet cherry.

Several authors report, that CO_2 concentrations between 10 and 15% and O_2 concentrations between 3 and 10% are adequate for cherry preservation (*Bishop*, 1990 and *Kader*, 1992). *Meheriuk* et al. (1997) report optimal conditions for Sweet heart cherries preservation to be 5% CO_2, 10% O_2 or 4% CO_2, 6% O_2. All these discrepancies could be derived from cultivar effects or different ripeness degree or other experimental variables but it seems clear, that no general recommendations for sour cherry conservation can be established and that each cultivar has to be individually and carefully studied. To achieve this goal, we have characterized post harvest changes that affect quality in those sour cherry cultivars. Therefore, it is necessary to design and optimize processing, storage, and transport conditions.

Material and method

The experiments have been performed at Kecskemét, the Faculty of Horticulture and at Újfehértó, Research and Extension Centre for Fruit Growing in cooled store rooms between 2005 and 2007.

Samples examined at Kecskemét were transported from plantations at Kecskemét (0 km), Szatymaz (70 km), Siófok (160 km) and Újfehértó (230 km). Hand picked fruit was immediately transported and selected as well as put in the store by filling plastic trays 10 kg each.

In the cool storage at Kecskemét all conditions of an up to date plant were given. The room secured an ULO-type technology with the following parameters:

temperature of the store	2–3 °C
oxygen content of the atmosphere	18.3–19.0%
CO_2 content of the atmosphere	0.1–0.3%
relative air humidity	90%.

All experimental lots were measured exactly before put in the store. Each sample represented 200 fruits at least, and the mean volume per fruit was calculated. The state of maturity of the fruit was 90%.

For computing the loss of volume, the initial measurement served as a basis. In order to set a date of the time recommended for storage, not only the changes of quality were considered. The experiment was continued even beyond the date, when the commercial value deteriorated in order to follow up the dynamics of the process specific for each (species and) variety examined.

During the storing period, the lots of samples were supervised every 6^{th}–8^{th} day (i.e. weekly). Each time – the process of loss was traced – weighed with one gram accuracy. Subsequently, every fruit was checked one by one. The properties being checked are explained in the heading and remarks of tables, where the comparison of data is facilitated.

The soluble solid content of fruits was monitored twice at the beginning and the end of the experiment by a manual refractometer. The last inspection of volume and quality was performed at the final procedure. The volume of fruits decreased gradually, thus the single fruits lost also their diameter and entered occasionally to a lower size category.

At Újfehértó, the harvested lots of fruit were furnished straight to the cooling store, put into M 10 cases or into plastic trays (0.5 kg) and distributed between different temperatures and atmospheres. The loss of volume and incidence of decay (mould, withering etc.) was followed up, and the inner values were checked regularly.

In 2006 and 2007 experimental lots of cultivars and storing conditions each were placed into M 10 plastic cases and plastic trays. Other details are identical with those explained at Kecskemét.

In Iran sour cherries were manually harvested at commercial maturity and packaged in 5 trays and covered by polyethylene film. Each tray contained 500 g fresh fruits. The harvested fruits under modified atmospheres (15% O_2 and 10% CO_2) and stored at about 0 °C and humidity 95% for 6 weeks. A fifth set of trays was left unpackaged and was used as control. The acidity, soluble solids, resistance to penetration force and color of Fruits were analyzed immediately after harvest and 42 days later (immediately after refrigeration). Statistical analyses were carried out using SPSS-software. Analysis of variance, with the test of least significant difference was performed for each MAP composition

Results and discussion

Results of the storing experiment of 2005 are summarised in *Tables 1–6*. This year happened to be an opportunity of checking also the effects of rainy weather at harvest time. The high incidence of rot due to mould obliged us to stop the experiment earlier by 2 weeks. *Table 7* proved that the variety 'Kántorjánosi' resisted most to rotting, however, this cannot be interpreted directly as storability but rather as resistance to rain. The rate of fruits with small, superficial scares was low (14%) indeed, whereas in other cultivars incidence of this fault was 2–4 times higher. The due

Table 1 Results of storing fruits of the sour cherry cultivar 'Kántorjánosi' *(Kecskemét, 2005)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storage (July 12)	0.0	100.0	100.0	0.0	0.0
After 9 days of storing (July 21)	2.4	100.0	73.2	0.0	26.8
After 16 days of storing (July 28)	2.6	91.2	59.3	8.8	40.7

*Remark: Sound or slightly and superficially scared fruits are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11 (rainy weather)
Method of harvest: manual, without stem
Rate of fruits slightly and superficially injured at the beginning of storing: 13.9%
End of storing: July 28.
Mean volume of fruits before storing: 7.3 g/fruit
Mean volume of fruits at the end of storing: 7.1 g/fruit
Rate of decayed fruits after storing at July 28:
August 3: 40%
August 10: 55%
August 15: 70%

Table 2 Results of storing fruits of the sour cherry variety 'Kántorjánosi' *(Kecskemét, 2005)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storage (July 12)	0.0	100.0	100.0	0.0	0.0
After 9 days of storing (July 21)	2.4	88.6	95.1	11.4	4.9
After 16 days of storing (July 28)	4.2	81.4	17.7	18.6	82.3

*Remark: Sound or slightly and superficially scared fruits are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11 (rainy weather)
Method of harvest: manual, without stem
Rate of fruits slightly and superficially injured at the beginning of storing: 13.9%
End of storing: July 28.
Mean volume of fruits before storing: 5.2 g/fruit
Mean volume of fruits at the end of storing: 5.0 g/fruit
Rate of decayed fruits after storing and held in the store at July 28:
August 3 : 30%
August 10: 60%
August 15: 80%

Table 3 Results of storing fruits of the sour cherry variety 'Újfehértói fürtös' *(Kecskemét, 2005)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storage (July 12)	0.0	100.0	100.0	0.0	0.0
After 9 days of storing (July 21)	2.41	100.0	96.5	0.0	3.5
After 16 days of storing (July 28)	3.2	91.2	28.1	8.3	71.9

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11 (rainy weather)
Method of harvest: manual, without stem
Rate of fruits slightly and superficially injured at the beginning of storing: 38%
End of storing: July 28.
Mean volume of fruits before storing: 5.3 g/fruit
Mean volume of fruits at the end of storing: 5.1 g/fruit
Rate of decayed fruits after storing and held in the store at July 28:
August 3 : 60%
August 10: 85%
August 15: 98%

Table 4 Results of storing fruits of the sour cherry variety 'D' *(Kecskemét, 2005)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storage (July 12)	0.0	100.0	100.0	0.0	0.0
After 9 days of storing (July 21)	2.8	100.0	71.6	0.0	28.4
After 16 days of storing (July 28)	3.9	100.0	20.3	0.0	79.7

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before toring
Site of origin: Újfehértó
Date of harvest: July 11 (rainy weather)
Method of harvest: manual, without stem
End of storing: July 28.
Mean volume of fruits before storing: 6.1 g/fruit
Mean volume of fruits at the end of storing: 5.9 g/fruit
Rate of decayed fruits after storing and held in the store at July 28:
August 3 : 35%
August 10: 60%
August 15: 85%

conclusion of this year was that the harvest at rainy weather and any contact with water is risky.

Results of the experiments of 2006 at Kecskemét are presented in *Tables 8–14*. As the storage period of the cultivars was different, for the sake of comparison the losses of volume during the first 5 weeks are compared *(Table 15)*. Except of the variety 'Dunavecse ½', the loss was similar in the rest of cultivars. No significant difference could be stated between the variety 'Érdi bőtermő' and the 5 local cultivars of NE-Hungary. The loss was between 6.4 and 7.7%. An important conclusion was the exceptionally (i.e. twice as) high loss of volume in the early ripening variety 'Dunavecse ½'.

We checked the relation between fruit size and loss of volume during the period of storing *(Table 16)*. Mean volume of the fruit of 'Dunavecse ½' was 3.6 g. Its higher values of loss could be a consequence of early ripening as

Table 5 Results of storing fruits of the sour cherry cultivar 'Petri' *(Kecskemét, 2005)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storage (July 12)	0.0	100.0	100.0	0.0	0.0
After 9 days of storing (July 21)	2.6	100.0	85.3	0.0	14.7
After 16 days of storing (July 28)	3.8	56.6	9.6	43.4	90.4

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11 (rainy weather)
Rate of fruits with slight and superficial injuries at the beginning: 35%
Method of harvest: manual, without stem
End of storing: July 28.
Mean volume of fruits before storing: 6.4 g/fruit
Mean volume of fruits at the end of storing: 6.1 g/fruit
Rate of decayed fruits after storing and held in the store at July 28:
August 3 : 70%
August 10: 90%
August 15: 95%

Table 6 Results of storing fruits of the sour cherry cultivar 'Éva' *(Kecskemét, 2005)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storage (July 12)	0.0	100.0	100.0	0.0	0.0
After 9 days of storing (July 21)	2.6	100.0	79.8	0.0	20.2
After 16 days of storing (July 28)	4.0	89.1	37.6	10.9	62.4

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11 (rainy weather)
Method of harvest: manual, without stem
Rate of fruits with slight and superficial injuries at the beginning: 28.4%
End of storing: July 28.
Mean volume of fruits before storing: 6.8 g/fruit
Mean volume of fruits at the end of storing: 6.6 g/fruit
Rate of decayed fruits after storing and held in the store at July 28:
August 3: 40%
August 10: 70%
August 15: 80%

Table 7 Comparison of the results of storing sour fruits of different cultivars *(Kecskemét, 2005)

Cultivar*	Loss of volume (%)		Rate of decayed fruits after storing (%)			
			A		B	
	week 1	week 2	week 1	week 2	week 1	week 2
Kántorjánosi	2.4	2.6	0.0	8.8	26.8	40.7
Debreceni bőtermő	2.4	4.2	11.4	18.6	4.9	82.3
Újfehértói fürtös	2.1	3.2	0.0	8.3	3.5	71.9
Cultivar 'D'	2.8	3.9	0.0	0.0	28.4	79.7
Petri	2.6	3.8	0.0	0.0	14.7	90.4
Éva	2.6	4.0	0.0	0.0	20.2	62.4
Mean of cultivars	2.5	3.6	1.9	5.9	16.4	71.2

*Remark: Site of origin: Újfehértó
The fruits are taken without stem
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing

well as of smaller fruits. It is generally accepted that the smaller fruits have a higher relative rate of stone. In the fruit samples grown at Újfehértó, the fruit size did not correlate significantly with the loss of volume. Cultivars of fruit size between 4.8 and 6.9 g lost 6.4-6.9% of their volume. It should be remarked that the loss of volume was 1–2% alone due to the transport of 230 km.

In order to facilitate the comarison of cultivars, the scores of rotting have been also related to the storing period of 5 weeks *(Table 17)*. After the first week, there was no significant difference between cultivars regarding the incidence of fruit rot. After a longer period of storing, 'Érdi bőtermő' produced exceptional results, i.e. 11.3% rot after 3 weeks and 50% rot after 4 weeks. It was a surprise to state that 'Dunavecse ½', which showed the most loss of volume did not rot at all. The presumable reason of this fact may be the sudden cooling of the harvested fruit into a cooled room of the farm. In *Table 18*, relation between the rate of scared fruits and the incidence of decay is demonstrated. The variety 'Dunavecse ½' being the most susceptible to be scared, all the same, it was the less afflicted by rot. The probable reason of this contradiction is the quick cooling after harvest on the spot.

Data raised after two weeks of storage on fruits harvested at July 12, 2006 at Újfehértó, are presented in *Table 19*, after 4 weeks storage in *Table 20*. The unequivocal conclusion indicates the decisive role of the temperature, less important being the composition of atmosphere (O_2 and CO_2) of the storing room. The best results are obtained in the check room, where the store was held at 2 °C. Fruits stored in M 10 cases, volume loss was higher and the rate of intact fruit was the lower than on the plastic trays. Under regulated conditions, the rate of withered fruits increased after 4 weeks. The cause of it should be cleared in the future.

The stored fruit was subsequently kept on room temperature (19–22 °C) in order to check its shelf life over one whole week. Relevant data appear in *Table 21*.

Results of the experiments 2007, Kecskemét are shown in *Tables 22–33*. For some cultivars, several tables are needed because the fruits grown at different sites were handled separately. The storing period of cultivars was

Table 8 Results of storing the sour cherry cultivar 'Dunavecse ½' * (Kecskemét, 2006)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (June 16)	0.0	100.0	100.0	0.0	0.0
After 7 days storing (June 23)	1.3	100.0	100.0	0.0	0.0
After 14 days storing (June 30)	3.8	100.0	100.0	0.0	0.0
After 21 days storing (July 7)	11.4	100.0	100.0	0.0	0.0
After 28 days storing (July 14)	12.7	100.0	100.0	0.0	0.0
After 35 days storing (July 21)	14.0	100.0	100.0	0.0	0.0
After 42 days storing (July 28)	14.0	100.0	87.5	0.0	12.5
After 49 days storing (August 4)	15.0	100.0	87.5	0.0	12.5
After 56 days storing (August 11)	16.2	100.0	87.5	0.0	12.5
After 63 days storing (August 18)	17.7	100.0	87.5	0.0	12.5

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits before storing
Site of origin: Kecskemét
Date of harvest: June 16
Method of harvest: manual, with stem
Rate of fruits with slight and superficial injuries at the beginning: 14.5%
End of storing: August 18
Mean volume of fruits before storing: 3.6 g/fruit
Mean volume of fruits at the end of storing:3.0 g/fruit

variable because of their harvest times. For the sake of an objective comparison, the losses of volume after a 6 week period are taken, uniformly *(Table 34)*. There was no significant difference between the cultivars, except 'Érdi bőtermő'. The coincident values of this variety grown at three different sites prove the validity of the observation. Between the 5 cultivars of NE-Hungarian origin, no significant difference in loss of volume was found after 6-week-long cold storage, the loss varied from 7.2 to 8.4%.

The role of mean fruit size should be explored in the rate of loss in sour cherry too *(Table 35)*. Between the stored samples of the cultivars, no significant difference could be stated, their mean value was 5–5.5 g. The conclusion was risked that differences in losses between cultivars of similar fruit size ought to be attributed to other causes (scares, distance of transport, speed of cooling). Data of decay after a 6-week-long storing period are compared in *Table 36*. After the first week spent in store, no difference was stated neither between cultivars nor sites of origin regarding the incidence of decay. Neither a two-week-long storage indicated difference between cultivars. First signs of variable susceptibility of cultivars to decay have been observed in storage after 3 weeks, and became subsequently more

Table 9 Results of storing fruits of the sour cherry cultivar 'Érdi bőtermő' *(Kecskemét, 2006)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (June 30)	0.0	100.0	91.1	0.0	8.9
After 7 days storing (July 7)	2.8	97.8	83.9	2.2	16.1
After 14 days storing (July 14)	3.2	94.2	74.2	5.8	25.8
After 21 days storing (July 21)	4.6	88.7	17.7	11.3	82.3
After 28 days storing (July 28	5.6	49.6	4.0	50.4	96.0
After 35 days storing (August 4)	6.9	43.6	4.0	56.4	96.0
After 42 days storing (August 11)	8.7	40.3	0.0	59.7	100.0
After 49 days storing (augusztus 18.)	10.2	2.9	0.0	97.1	100.0

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits before storing
Site of origin: Újfehértó
Date of harvest: June 29
Method of harvest: manual
Rate of fruits without stem before storing: 100%
Rate of fruits with slight and superficial injuries at the beginning: 5.1%
End of storing: August 18
Mean volume of fruits before storing: 6.0 g/fruit
Mean volume of fruits at the end of storing: 5.4 g/fruit

Table 10 Results of storing fruits of the sour cherry cultivar 'Debreceni bőtermő' *(Kecskemét, 2006)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 13)	0.0	100.0	100.0	0.0	0.0
After 8 days of storing (July 21)	3.0	100.0	100.0	0.0	0.0
After 15 days of storing (July 28)	3.8	96.6	39.6	3.4	60.4
After 22 days of storing (August 4)	4.8	91.8	33.3	8.2	66.7
After 29 days of storing (August 11)	5.6	86.8	29.2	13.2	70.8
After 36 days of storing (August 18)	6.4	78.5	29.2	21.5	70.8

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11
Method of harvest: manual, without stem
Rate of fruits with slight and superficial injuries at the beginning: 4.5%
End of storing: August 18
Mean volume of fruits before storing: 6.6 g/fruit
Mean volume of fruits at the end of storing: 6.2 g/fruit

Table 11 Results of storing fruits of the sour cherry cultivar 'Újfehértói fürtös' *(Kecskemét, 2006)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 13)	0.0	100.0	100.0	0.0	0.0
After 8 days of storing (July 21)	2.6	100.0	100.0	0.0	0.0
After 15 days of storing (July 28)	3.5	89.3	66.2	10.7	33.8
After 22 days of storing (August 4)	4.7	83.6	43.7	16.4	56.3
After 29 days of storing (August 11)	5.5	80.0	26.1	20.0	73.2
After 36 days of storing (August 18)	6.8	72.6	26.8	27.4	73.2

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11
Method of harvest: manual, without stem
Rate of fruits with slight and superficial injuries at the beginning: 3.2%

Table 12 Results of storing fruits of the sour cherry cultivar 'Kántorjánosi' *(Kecskemét, 2006)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 13)	0.0	100.0	100.0	0.0	0.0
After 8 days of storing (July 21)	2.3	100.0	100.0	0.0	0.0
After 15 days of storing (July 28)	3.5	96.7	66.7	3.3	33.3
After 22 days of storing (August 4)	4.3	91.5	56.5	8.5	43.5
After 29 days of storing (August 11)	5.2	86.4	47.8	13.6	52.2
After 36 days of storing (August 18)	6.5	74.7	40.6	25.3	59.4

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11
Method of harvest: manual, without stem
Rate of fruits with slight and superficial injuries at the beginning: 3.4%
End of storing: August 18
Mean volume of fruits before storing: 5.7 g/fruit
Mean volume of fruits at the end of storing: 5.3 g/fruit

Table 13 Results of storing fruits of the sour cherry cultivar 'Éva' *(Kecskemét, 2006)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 13)	0.0	100.0	97.2	0.0	2.8
After 8 days of storing (July 21)	2.9	100.0	97.2	0.0	2.8
After 15 days of storing (July 28)	4.0	88.8	26.4	11.2	73.6
After 22 days of storing (August 4)	4.8	83.9	26.4	16.1	73.6
After 29 days of storing (August 11)	5.7	75.9	25.0	24.1	75.0
After 36 days of storing (August 18)	6.6	70.0	23.6	30.0	76.4

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11
Method of harvest: manual, without stem
Rate of fruits with slight and superficial injuries at the beginning: 4.3%
End of storing: August 18
Mean volume of fruits before storing: 6.9 g/fruit
Mean volume of fruits at the end of storing: 6.4 g/fruit

Table 14 Results of storing fruits of the sour cherry cultivar 'Petri' *(Kecskemét, 2006)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 13)	0.0	100.0	100.0	0.0	0.0
After 8 days of storing (July 21)	3.2	100.0	100.0	0.0	0.0
After 15 days of storing (July 28)	4.3	96.7	71.8	3.3	28.2
After 22 days of storing (August 4)	5.1	91.3	51.8	8.7	48.2
After 29 days of storing (August 11)	5.9	86.5	39.3	13.5	60.7
After 36 days of storing (August 18)	6.9	77.5	26.7	22.5	73.3

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits without stem before storing
B= Rate of slightly and superficially injured fruits without stem before storing
Site of origin: Újfehértó
Date of harvest: July 11
Method of harvest: manual, without stem
Rate of fruits with slight and superficial injuries at the beginning: 7.2%
End of storing: August 18
Mean volume of fruits before storing: 5.6 g/fruit
Mean volume of fruits at the end of storing: 5.2 g/fruit

Table 15 The loss of volume in sour cherry fruits of different cultivars during cool storage (Kecskemét, 2006)

Cultivars (in the sequence of ripening dates)	Loss of volume%				
	week 1	week 2	week 3	week 4	week 5
Dunavecse ½	1.3	3.8	11.4	12.7	14.0
Érdi bőtermő	2.8	3.2	4.6	5.6	6.9
Debreceni bőtermő	3.0	3.8	4.8	5.6	6.4
Újfehértói fürtös	2.6	3.5	4.7	5.5	6.8
Kántorjánosi	2.3	3.5	4.3	5.2	6.5
Éva	2.9	4.0	4.8	5.7	6.9
Petri	3.2	4.3	5.1	5.9	6.9
Mean of varietes	*2.6*	*5.2*	*5.7*	*6.6*	*7.7*

Table 16 Relation between fruit size and the loss of volume in the store according to cultivars (Kecskemét, 2006.)

Cultivar	Mean fruit size before storage g/fruit	Loss of volume after a 5-week-long period spent in storage (%)
Dunavecse ½	3.6	14.0
Újfehértói	4.8	6.8
Petri	5.6	6.9
Kántorjánosi	5.7	6.5
Érdi bőtermő	6.0	6.9
Debreceni bőtermő	6.6	6.4
Éva	6.9	6.6
Mean of cultivars	*5.6*	*7.7*

Table 17 Decay of sour cherry fruits during a 5-week-long cold storage period according to cultivars (Kecskemét, 2006)

Cultivars (in the sequence of ripening dates)	Decay of fruits (%) *				
	week 1	week 2	week 3	week 4	week 5
Dunavecse ½	0.0	0.0	0.0	0.0	0.0
Érdi bőtermő	2.2	5.8	11.3	50.4	56.4
Debreceni bőtermő	0.0	3.4	8.2	13.2	21.5
Újfehértói fürtös	0.0	10.7	16.4	20.0	27.4
Kántorjánosi	0.0	3.3	8.5	13.6	25.3
Éva	0.0	11.2	16.1	24.1	30.0
Petri	0.0	3.3	8.7	13.5	22.5
Mean of cultivars	*0.3*	*5.4*	*9.9*	*19.3*	*26.2*

* Remark: Fruits taken to the store were entirely sound without apparent signs of injuries

Table 18 Relation between injuries of fruits and their decay during the storing period in sour cherry cultivars (Kecskemét, 2006)

Cultivar	Rate of scared fruits before storage (%)	Rate of decayed fruits after a 5-week-long period of storage
Dunavecse ½	3.6	14.0
Újfehértói fürtös	3.2	28.8
Kántorjánosi	3.4	26.5
Éva	4.3	32.0
Debreceni bőtermő	4.5	23.0
Érdi bőtermő	5.1	56.5
Petri	7.2	26.2
Dunavecse ½	14.5	12.5
Mean of cultivars	*6.0*	*29.4*

* Remark: Data refer to both sound as well as to superficially scared fruits

Table 19 Results of an experimental storage over a two-week-long period (Újfehértó, 2006)

Cultivar, clone	Treatment+	In plastic trays		Into M10 cases harvested fruits	
		Loss of volume (%)	Sound fruits (%)	Loss of volume (%)	Sound fruits (%)
Debreceni bőtermő	A	4.54	94.7	5.36	93.21
	B	4.06	99.26	5.00	95.18
	Ø	**2.61**	**99.65**	**3.18**	**97.71**
Kántorjánosi	A	4.73	88.04	5.56	97.75
	B	3.95	97.89	5.56	96,32
	Ø	**2.83**	**98.50**	**1.75**	**98.48**
Újfehértói fürtös	A	4.79	85.96	7.14	87.60
	B	4.14	96.19	5.26	88.15
	Ø	**2.92**	**99.49**	**3.51**	**98.91**
Éva	A	4.64	95.79	7.27	80.78
	B	3.88	98.10	4.76	93.17
	Ø	**2.68**	**99.22**	**3.45**	**99.20**
Cultivar 'D'	A	5.68	63.85	5.09	92.23
	B	4.48	74.82	4.55	85.64
	Ø	**2.59**	**98.44**	**3.39**	**93.25**
Petri	A	4.09	95.02	3.45	95.98
	B	3.69	95.50	4.08	89.26
	Ø	2.77	96.01	3.23	88.08
Mean		**3.83**	**94.34**	**4.52**	**92.82**

Remark: Beginning of storage July 12.
+ Legend:
A= 1 °C; 2.4–3–4% oxygen; 0.0–0.8% carbon-dioxid
B= 3 °C; 3.5–4.8% oxygen; 0.0–0.9% carbon-dioxid
Ø= 2 °C; normál atmosphere

convincing. After 6 weeks, 'Érdi bőtermő' decayed at a rate of more than 60%. Less susceptible was 'Újfehértói fürtös' (where 43.5% of fruits rot). The rest of cultivars ('Debreceni bőtermő', 'Kántorjánosi', D clone, 'Petri', 'Éva') showed nearly similar data (22.5–30.0%) without significant difference.

Table 37 will help to evaluate the role of scares on the fruit in the progress of decay. *Table 38*, on the other hand, claims to answer the question whether soluble solid content of the fruit may modify the process of loss as well as of decay during the storage? As example, the variety 'Érdi bőtermő' could be mentioned. Fruits of lower soluble solid content (harvested ripe but somewhat earlier) from Siófok loss less volume and were more sound than those harvested and taken to the store at a more advanced stage of ripening. Consequently, we have to be cautious with the date of harvest especially with the cultivars of earlier ripening.

Table 20 Results of a four-week-long period of storage with sour cherry cultivars (Újfehértó, 2006)

Cultivar, clone	Treatment+	Loss of volume (%)	After a four-week-long period of storage: Sound fruits (%)	Decayed, mouldy (%)	wilted (%)	faulty (%)
Debreceni bőtermő	A	8.2	71.6	0.3	**27.0**	1.1
	B	6.5	92.6	0.7	6.0	0.7
	Ø	**5.5**	**97.8**	0.4	1.2	0.6
Kántorjánosi	A	8.4	64.3	0.5	**32.5**	2.7
	B	7.6	81.0	0.8	**16.8**	1.4
	Ø	**5.8**	**90.0**	1.2	4.2	4.6
Újfehértói fürtös	A	8.7	68.2	0.6	**29.3**	1.9
	B	6.8	86.2	1.0	**10.9**	1.9
	Ø	**6.1**	**91.2**	0.4	6.7	1.7
Éva	A	8.4	80.4	0.1	**19.2**	0.3
	B	7.2	86.2	1.2	**10.9**	1.7
	Ø	**5.5**	**95.4**	0.2	2.1	2.3
Cultivar 'D'	A	9.9	23.0	0.5	**75.8**	0.7
	B	8.3	58.2	1.3	**36.4**	4.1
	Ø	**5.3**	**91.2**	0.4	5.3	3.1
Petri	A	7.8	72.9	0.2	**23.3**	3.6
	B	6.9	79.2	1.1	**9.3**	**10.4**
	Ø	**5.7**	**89.8**	0.4	2.9	6.9

Remark: Beginning of storage July 12.
+ Legend:
A= 1 °C; 2.4–3–4% oxygen; 0.0–0.8% carbon-dioxid
B= 3 °C; 3.5–4.8% oxygen; 0.0–0.9% carbon-dioxid
Ø= 2 °C; normál atmosphere

Table 21 Shelf life of different sour cherry cultivars (Újfehértó, 2006)

Cultivar	In trays: Loss of volume (%)	Rate of sound fruits (%)
Debreceni bőtermő	3.69	91.75
Kántorjánosi	3.95	80.03
Újfehértói fürtös	4.45	74.93
Éva	3.70	89.31
Cultivar 'D'	3.92	85.21
Petri	4.23	85.98

Remark: Date of putting on the shelf: 2006, August 12.
Date of evaluation: 2006, August 18.

Results of the storing experiments at Újfehértó 2007 are summarised in *Table 39*. Similar to the previous year, it could be concluded that the best results are expected in a store with a normal atmosphere, at 2 °C temperature. The loss of volume was the highest and the rate of sound fruits the lowest in the earlier ripening variety 'Érdi bőtermő'. The role of atmosphere in storage suggested by an earlier paper with the variety 'Pándy meggy' (*Sass*, 1986) are not verified and need additional check.

The changes of chemical composition (soluble solids, sugar, acid) in the stored fruits are visualised in *Table 40*. It could be stated that soluble solids, including sugars and acid content diminished substantially. We need to decide

Table 22 Results of storing fruits of the sour cherry cultivar 'Érdi bőtermő' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%): A	B	Rate decayed fruits (%): A	B
Before storing (June 15)	0.0	100.0	100.0	0.0	0.0
After 7 days of storing (June 22)	3.5	100.0	100.0	0.0	0.0
After 14 days of storing (June 29)	5.7	99.8	92.1	0.2	7.9
After 21 days of storing (July 6)	7.8	91.1	60.5	8.9	39.5
After 28 days of storing (July 13)	9.9	74.8	18.4	25.2	81.6
After 35 days of storing (July 20)	12.0	49.0	0.0	51.0	100.0
After 42 days of storing (July 27)	14.8	39.6	0.0	60.4	100.0
After 49 days of storing (August 3)	17.4	22.2	0.0	77.8	100.0
After 56 days of storing (August 10)	18.5	13.3	0.0	86.7	100.0

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly and superficially injured fruits before storing
Site of origin: Szatymaz
Date of harvest: July 15
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 3.0%
End of storing: August 10
Mean volume of fruits before storing: 4.1 g/fruit
Mean volume of fruits at the end of storing: 3.3 g/fruit

Table 23 Results of storing fruits of the sour cherry cultivar 'Érdi bőtermő' *(Kecskemét, 2007)

Loss of volume (%)	Rate of comestible fruits (%): A	B	Rate decayed fruits (%): A	B
2.0	100.0	100.0	0.0	0.0
3.8	99.7	81.2	0.3	18.8
5.0	93.6	38.7	6.4	61.3
6.5	77.8	25.4	22.2	74.6
8.0	62.4	18.8	37.6	81.2
10.0	53.4	8.8	46.6	91.2
12.2	14.8	4.4	85.2	95.6
14.5	7.7	0.0	92.3	100.0

*Remark: Sound or slightly and superficially scared fruits are selected and stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly and superficially injured fruits before storing
Site of origin: Újfehértó
Date of harvest: June 18
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 10.2%
End of storing: August 10
Mean volume of fruits before storing: 5.2 g/fruit
Mean volume of fruits at the end of storing: 4.5 g/fruit

Table 24 Results of storing fruits of the sour cherry cultivar 'Érdi bőtermő' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (June 14)	0.0	100.0	100.0	0.0	0.0
After 8 days of storing (June 22)	1.1	100.0	69.2	0.0	30.8
After 15 days of storing (June 29)	3.4	99.4	23.1	0.6	76.9
After 22 days of storing (July 6)	6.0	97.2	23.1	2.8	76.9
After 29 days of storing (July 13)	7.4	88.6	0.0	11.4	100.0
After 36 days of storing (July 20)	8.8	73.3	0.0	26.7	100.0
After 43 days of storing (July 27)	9.9	59.9	0.0	40.1	100.0
After 50 days of storing (August 3)	12.1	36.0	0.0	64.0	100.0
After 57 days of storing August 10)	13.6	21.6	0.0	78.4	100.0

*Remark: Sound or slightly and superficially scared fruits are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly and superficially injured fruits before storing
Site of origin: Siófok
Date of harvest: July 14
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 0.7%
End of storing: August 10
Mean volume of fruits before storing: 5.7 g/fruit
Mean volume of fruits at the end of storing: 4.9 g/fruit

subsequently, what is the critical level of declining content of each constituent mentioned, which may cause commercial consequences in the quality of the commodity.

The evolution of fruit characteristics before and after of storage is shown in *Table 41*. Significant differences have been found in the pH of fruits between two cultivars.

The pH significantly rose during the storage. No significant difference has been found in the soluble solids content between cultivars before and after storage. They remained almost constant during the experiment with values approximately 23 and 24 Brix, may be as a result of no water loss suffered by this samples.

Titratable acidity shows a similar behavior than in comparable experiments of previous studies in 'Bigarreau Burlat' cherry (*Rem* et al., 2000): It shows a gradual decrease after 42 days in samples.

Flesh firmness tests were showed no significant variation of Érdi jubileum before and after storage However, in the case of 'Érdi bőtermő' showed a significant decrease in the Flesh firmness. However, panel test and sensorial analysis shows that the fruits of mentioned cultivars to remain acceptable for consumers over 6 weeks.

In conclusion Packaging cherries in polypropylene micro perforated films allow a considerable extension of their post harvest shelf-life. Firmness decreased after 7 weeks. Titratable acidity declined steadily over the storage period.

Table 25 Results of storing fruits of the sour cherry cultivar 'Debreceni bőtermő' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 2)	1.0	100.0	100.0	0.0	0.0
After 7 days of storing (July 9)	2.0	100.0	100.0	0.0	0.0
After 11 days of storing (July 13)	2.2	100.0	85.5	0.0	14.5
After 18 days of storing (July 20)	3.4	99.2	78.9	0.8	21.1
After 25 days of storing (July 27)	5.2	97.3	63.8	2.7	36.2
After 32 days of storing (August 3)	7.0	92.0	49.0	8.0	51.0
After 39 days of storing (August 10)	8.5	79.3	14.8	20.7	85.2

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of injured fruits before storing
Site of origin: Újfehértó
Date of harvest: July 28
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 14.6%
End of storing: August 10
Mean volume of fruits before storing: 5.8 g/fruit
Mean volume of fruits at the end of storing: 5.3 g/fruit

Table 26 Results of storing fruits of the sour cherry cultivar 'Debreceni bőtermő' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (June 20)	0.0	1000	–	0.0	–
After 9 days of storing (June 29)	1.7	100.0	–	0.0	–
After 15 days of storing (June 29)	3.1	98.8	–	1.2	–
After 17 days of storing (July 6)	4.3	95.4	–	4.6	–
After 24 days of storing (July 13)	5.7	84.4	–	15.6	–
After 31 days of storing (July 20)	7.3	68.6	–	31.4	–
After 38 days of storing (July 27)	9.2	52.1	–	47.9	–
After 45 days of storing (August 3)	10.5	34.0	–	60.0	–

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing
Site of origin: Siófok
Date of harvest: June 20
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 0.0%
End of storing: August 10
Mean volume of fruits before storing: 5.0 g/fruit
Mean volume of fruits at the end of storing: 4.3 g/fruit

Table 27 Results of storing fruits of the sour cherry cultivar 'Újfehértói fürtös' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 2)	0.0	100.0	100.0	0.0	0.0
After 11 days of storing (July 13)	1.4	100.0	89.4	0.0	10.6
After 18 days of storing (July 20)	3.0	99.4	87.0	0.6	13.0
After 25 days of storing (July 27)	5.0	97.5	56.5	2.5	43.5
After 32 days of storing (August 3)	6.6	84.5	34.1	15.5	65.9
After 39 days of storing (August 10)	7.7	49.2	5.2	50.8	94.8

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing
Site of origin: Újfehértó
Date of harvest: July 1
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 10.2%
End of storing: August 10
Mean volume of fruits before storing: 4.3 g/fruit
Mean volume of fruits at the end of storing: 3.9 g/fruit

Table 28 Results of storing fruits of the sour cherry cultivar 'Újfehértói fürtös' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (June 28)	0.0	100.0	100.0	0.0	0.0
After 8 days of storing (July 6)	1.8	100.0	100.0	0.0	0.0
After 15 days of storing (June 13)	3.5	99.5	100.0	0.5	0.0
After 22 days of storing (July 20)	5.3	96.8	79.1	3.2	20.9
After 29 days of storing (July 27)	6.8	84.7	47.5	15.3	52.5
After 36 days of storing (August 3)	9.1	63.8	17.3	36.2	82.7
After 42 days of storing (August 10)	13.5	49.2	4.3	50.8	95.7

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing
Site of origin: Siófok
Date of harvest: June 27
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 9.3 %
End of storing: August 10
Mean volume of fruits before storing: 5.7 g/fruit
Mean volume of fruits at the end of storing: 4.9 g/fruit

Table 29 Results of storing fruits of the sour cherry cultivar 'Kántorjánosi' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 2)	0.0	100.0	100.0	0.0	0.0
After 11 days of storing (July 13)	2.5	100.0	92.2	0.0	7.8
After 15 days of storing (July 20)	4.0	99.7	86.8	0.3	13.2
After 22 days of storing (July 20)	5.6	97.2	63.7	2.8	36.3
After 25 days of storing (July 27)	7.3	81.0	35.7	19.0	64.3
After 32 days of storing (August 3)	8.0	64.8	12.4	35.2	87.6

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing
Site of origin: Újfehértó
Date of harvest: June 28
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 19.2 %
End of storing: August 10
Mean volume of fruits before storing: 5.7 g/fruit
Mean volume of fruits at the end of storing: 5.2 g/fruit

Table 30 Results of storing fruits of the sour cherry cultivar 'Kántorjánosi' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (June 20)	0.0	100.0	–	0.0	–
After 9 days of storing (June 29)	1.9	100.0	–	0.0	–
After 16 days of storing (July 6)	3.5	98.4	–	1.6	–
After 23 days of storing (July 13)	4.8	95.5	–	4.5	–
After 30 days of storing (July 20)	6.4	88.0	–	12.0	–
After 37 days of storing (July 27)	8.1	79.6	–	20.4	–
After 44 days of storing (August 3)	9.9	70.4	–	29.6	–
After 51 days of storing (August 11)	11.2	55.4	–	44.6	–

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing (did not occur)
Site of origin: Siófok
Date of harvest: June 20
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 0.0 %
End of storing: August 10
Mean volume of fruits before storing: 5.3 g/fruit
Mean volume of fruits at the end of storing: 4.6 g/fruit

Table 31 Results of storing fruits of the sour cherry cultivar 'D' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 2)	0.0	100.0	100.0	0.0	0.0
After 11 days of storing (July 13)	1.5	100.0	87.0	0.0	13.0
After 18 days of storing (July 20)	3.8	98.8	78.0	1.2	22.0
After 25 days of storing (July 27)	4.3	94.1	66.1	5.9	33.9
After 32 days of storing (August 3)	6.2	84.3	47.6	15.7	52.4
After 39 days of storing (August 10)	7.6	67.3	7.1	32.7	92.9

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing
Site of origin: Újfehértó
Date of harvest: June 29
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 12.9 %
End of storing: August 10
Mean volume of fruits before storing: 5.5 g/fruit
Mean volume of fruits at the end of storing: 5.0 g/fruit

Table 32 Results of storing fruits of the sour cherry cultivar 'Petri' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 2)	0.0	100.0	100.0	0.0	0.0
After 11 days of storing (July 13)	1.3	100.0	90.5	0.0	9.5
After 18 days of storing (July 20)	2.8	99.5	82.8	0.5	17.2
After 25 days of storing (July 27)	4.5	94.6	60.5	5.4	39.5
After 32 days of storing (August 3)	6.3	77.7	26.8	22.3	73.2
After 39 days of storing (August 10)	7.7	62.5	8.1	37.5	91.9

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing
Site of origin: Újfehértó
Date of harvest: June 30
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 28.2 %
End of storing: August 10
Mean volume of fruits before storing: 5.3 g/fruit
Mean volume of fruits at the end of storing: 4.8 g/fruit

Table 33 Results of storing fruits of the sour cherry cultivar 'Éva' *(Kecskemét, 2007)

Dates of the storing experiment	Loss of volume (%)	Rate of comestible fruits (%)		Rate decayed fruits (%)	
		A	B	A	B
Before storing (July 2)	0.0	100.0	100.0	0.0	0.0
After 11 days of storing (July 13)	1.4	100.0	79.9	0.0	20.1
After 18 days of storing (July 20)	2.6	98.8	73.6	1.2	26.4
After 25 days of storing (July 27)	4.0	92.2	52.5	7.8	47.5
After 32 days of storing (August 3)	6.1	79.0	31.4	21.0	68.6
After 39 days of storing (August 10)	7.6	62.3	8.6	37.7	91.4

*Remark: Sound or slightly and superficially scared fruits without stem are stored separately
Legend: A= Rate of entirely sound fruits before storing
B= Rate of slightly injured fruits before storing
Site of origin: Újfehértó
Date of harvest: June 29
Method of harvest: manual
Rate of fruits with slight and superficial injuries at the beginning: 12.9 %
End of storing: August 10
Mean volume of fruits before storing: 5.5 g/fruit
Mean volume of fruits at the end of storing: 5.0 g/fruit

Table 34 Loss of volume during storage in sour cherry fruits of different cultivars (Kecskemét, 2007)

Cultivars (in sequence of their harvest time)	Loss of volume%					
	week 1	week 2	week 3	week 4	week 5	week 6
Érdi bőtermő	2.6	4.7	6.8	8.4	10.3	12.3
Debreceni bőtermő	1.1	1.9	2.8	3.7	5.5	7.2
Újfehértói fürtös	1.0	1.6	3.3	5.2	6.7	8.4
Kántor-jánosi	1.5	2.2	3.7	5.2	6.8	8.1
Cultivar 'D'	1.0	1.5	3.8	4.3	6.2	7.6
Petri	0.9	1.3	2.8	4.5	6.3	7.7
Éva	0.6	1.4	2.6	4.0	6.1	7.6
Mean of cultivars	*1.2*	*2.1*	*3.7*	*5.0*	*6.8*	*8.4*

Remark: Beginning of storage July 12.
+ Legend:
A= 1 °C; 2.4–3–4% oxygen; 0.0–0.8% carbon-dioxid
B= 3 °C; 3.5–4.8% oxygen; 0.0–0.9% carbon-dioxid
Ø= 2 °C; normál atmosphere

Table 35 Relation between the size of fruit and the loss of volume during storage in fruits of different sour cherry cultivars (Kecskemét, 2007.)

Cultivar	Mean fruit size before storage g/fruit	Loss of volume during storage (%)
Érdi bőtermő	5.0	12.3
Újfehértói fürtös	5.0	8.4
Éva	5.2	7.6
Petri	5.3	7.7
Debreceni bőtermő	5.4	7.2
Kántorjánosi	5.5	8.1
Cultivar 'D'	5.5	7.6
Mean of cultivars	*5.3*	*8.4*

Table 36 Decay of during cool storage in sour cherry cultivars (Kecskemét, 2007)

Cultivars (in sequence of their harvest time)	Loss of volume%					
	week 1	week 2	week 3	week 4	week 5	week 6
Érdi bőtermő	0.3	6.4	22.2	37.6	46.6	85.2
Debreceni bőtermő	0.0	0.0	0.8	2.7	8.0	20.7
Újfehértói fürtös	0.0	0.0	0.6	2.5	15.5	50.8
Kántor-jánosi	0.0	0.0	0.3	2.8	19.0	35.2
Éva	0.0	0.0	1.2	7.8	21.0	37.7
Petri	0.0	0.0	0.5	5.4	22.3	37.5
Cultivar 'D'	0.0	0.0	1.2	5.9	15.7	32.7
Mean of cultivars	*0.04*	*0.9*	*3.8*	*9.2*	*21.2*	*42.8*

Remark: All samples are grown at Újfehértó and sound fruits were selected only before storing

Table 37 Relation between the injury of fruits and the incidence of decay during storage in sour cherry cultivars (Kecskemét, 2007)

Cultivar	Site of origin	Rate of injured fruits storing	Rate of before decayed fruits after a 6-week-long period of storage (%)
Érdi bőtermő	Siófok	0.7	87.0
Érdi bőtermő	Szatymaz	3.0	84.0
Érdi bőtermő	Újfehértó	10.2	81.0
Újfehértói fürtös	Siófok	9.3	51.0
Kántorjánosi	Siófok	0.0	47.0
Debreceni bőtermő	Siófok	0.0	47.0
Petri	Újfehértó	28.2	39.0
Újfehértói fürtös	Újfehértó	10.2	39.0
'D' Újfehértó	12.9	37.0	
Kántorjánosi	Újfehértó	19.2	31.0
Éva	Újfehértó	14.2	21.0
Debreceni bőtermő	Újfehértó	14.6	18.0
Mean of cultivars	–	*10.2*	*48.5*

* Remark: Fruits were not selected before storage

Table 38 Relation between the content of soluble solids and the loss of volume in sour cherry fruits of different cultivars (Kecskemét, 2007)

Variety	Site of origin of samples	Refractometric readings before storage (%)	Loss of volume during storage (%)	Rate of decayed fruits after 6 weeks in storage*
Érdi bőtermő	Siófok	13.5	9.9	40.1
Debreceni bőtermő	Siófok	13.8	9.2	47.9
Újfehértói fürtös	Siófok	14.8	13.5	50.8
Kántorjánosi	Siófok	15.0	9.9	29.6
Érdi bőtermő	Szatymaz	15.1	14.8	60.4
Cultivar D	Újfehértó	15.7	7.6	32.7
Petri	Újfehértó	16.4	7.7	50.8
Debreceni bőtermő	Újfehértó	16.5	8.5	20.7
Éva	Újfehértó	17.9	7.6	37.7
Kántorjánosi	Újfehértó	18.5	8.0	35.2
Érdi bőterm	Újfehértó	18.1	12.2	85.2
Újfehértói fürtös	Újfehértó	19.3	7.7	50.8

* Before storage, sound fruits were selected

Table 39 Results of storing experiments with sour cherry cultivars (Újfehértó, 2007)

Cultivars	Beginning of storage	Treatment+	After the end of storage				
			week/ loss (%)	week/ sound fruits (%)	week/ decayed, mouldy fruits (%)	week/ wilted (%)	week/ foulty fruits (%)
Érdi bőtermő	June 18	A	6/13.3	6/27.3	6/3.4	6/**58.8**	6/**10.1**
		B	9.6	49.8	3.2	**38.2**	**8.8**
		C	10.5	63.3	3.4	**24.1**	**9.2**
		Ø	**7.1**	**85.6**	3.6	5.0	5.8
Debreceni bőtermő	June 28	A	5/7.3	5/97.0	5/0.9	5/2.0	5/0.1
		B	6.2	98.5	0.2	1.2	0.1
		C	7.0	96.7	1.3	1.7	0.3
		Ø	**6.1**	98.4	1.3	0.0	0.3
Kántorjánosi	June 28	A	5/7.2	5/90.6	5/2.9	5/4.0	5/2.5
		B	6.9	96.0	1.6	2.3	0.1
		C	7.3	94.1	1.6	3.9	0.4
		Ø	**6.5**	95.2	2.2	0.8	1.8
Újfehértói fürtös	July 02	A	4/8.0	4/91.3	4/1.9	4/5.5	4/1.3
		B	6.7	83.7	1.1	**12.6**	2.6
		C	6.8	87.9	1.6	**10.1**	0.4
		Ø	**4.7**	**99.0**	0.2	0.2	0.6
Cultivar 'D'	June 29	A	5/8.0	5/87.4	5/2.3	5/**10.1**	5/0.2
		B	6.8	89.1	0.9	**8.9**	1.1
		C	7.5	94.3	1.8	3.4	0.5
		Ø	**5.2**	**95.5**	2.9	0.1	1.5
Petri	June 30	A	5/8.3	5/88.5	5/1.8	5/**9.0**	5/0.7
		B	6.8	92.7	1.4	4.5	1.4
		C	7.9	91.4	3.2	4.4	1.0
		Ø	**5.2**	**96.8**	1.8	0.3	1.1
Éva	July 02	A	4/7.2	4/90.7	4/0.9	4/6.8	4/1.6
		B	7.0	82.5	2.1	**11.6**	3.8
		C	7.2	92.4	2.1	4.2	1.3
		Ø	**5.7**	89.8	1.9	0.6	7.7

+ Legend:
A = 1 °C; 3–5% oxygen; 0.0% carbon-dioxid
B = 2 °C; 3–5% oxygen; 0.0% carbon-dioxid
C = 3 °C; 3–5% oxygen; 0.0% carbon-dioxid
Ø = 2 °C; normal atmosphere

Table 40 The changes of chemical composition in fruits of sour cherry cultivars during cold storage (Újfehértó, 2007)

Variety	Beginning of storage	End of storage	Content in soluble solids (m/m %)		Sugar content (m/m %)		Acid content (m/m %)	
			1*	2*	1*	2*	1*	2*
Érdi bőtermő	June 18.	July 30.	18.00	15.24	15.60	13.0	0.95	0.81
Debreceni bőtermő	June 28.	August 01.	17.50	14.16	16.40	12.8	1.15	0.74
Kántorjánosi	June 28.	August 01.	18.10	16.88	17.00	14.5	1.03	0.64
Variety 'D'	June 29.	July 30.	19.30	15.27	17.20	13.0	1.11	0.64
Petri	June 30.	July 30.	22.65	14.70	20.20	12.8	1.61	0.50
Újfehértói fürtös	July 02.	August 06.	20.43	14.71	18.20	13.8	1.80	0.55
Éva	July 02.	August 06.	20.25	14.64	17.80	13.1	1.70	0.64

Remark: **1***: before storage; **2***: after storage

Table 41 Effect of storage period on the quality and quantity characteristic of sour cherry cultivars

Cultivars	Treatments	PH	Brix (%)	Titratable acidity (%)	Sugar/acid	Flesh firmness
Érdi jubileum	Before storage	3, 55 d	24.30 a	1.63 a	15.35 b	5.83 b
Érdi jubileum	After 42 days storage	3, 82 b	23.27 a	1.15 b	21.72 a	5.60 b
Érdi bőtermő	Before storage	3, 65 c	23.81 a	1.49 a	16.34 b	6.39 a
Érdi bőtermő	After 42 days storage	3, 90 a	23.79 a	1.12 b	22.54 a	5.96 b

The mean values compared with Duncan Multiple Range Test for differences among treatments (in each column, entries with the same letters are not different at 5% level of significance)

Conclusions

Under Hungarian conditions we may risk the following statements as summarising our results:

- For the purpose of storing, fruits ought to be picked by hand, absolutely, even for the shortest term planned for storage.
- Care should be taken by all possible means to save the fruits from damages as physical scare and any adversities threatening throughout all phases of technology and environmental risks (weather, plant protection, harvest, transport, packing), because minimal scares may cause serious losses during storage.
- All items containing more than 10% of scared fruits should be culled out carefully before putting them into the store, or excluded from storing for a longer time than 1 – 2 weeks.
- Rotting fruits ought to be eliminated at harvest or at least before storing because they are serving as inocula of decay.
- Fruits should be cooled soon after being harvested, or the vehicles should be equipped with cooling engines being active during transport.
- The fruit destined to be stored should represent high quality and perfect health. This is indispensable but not the sole criterium of success; there are also other conditions to be considered.
- The main and decisive purpose of storing is to meet the claims of the fresh consumption.
- One of the motives is certainly the intention of avoiding the concurrent offer of sellers and postpone the sale.
- The purpose of storing is lastly the improvement of marketing conditions, i.e. to achieve better income by higher selling price. However, costs and losses of storage have to be subtracted carefully from the higher price in order to justify the postponed sale.
- In Hungary, early ripening sour cherry cultivars are not suitable for being stored by two reasons, first, they are less tolerant to storing, on the other hand, the stored fruit will compete with the fresh fruit of the late ripening, high quality cultivars, thus the advantages of storing will be frustrated.
- The potential value of storage will be enhanced gradually by the increasing popularity of eating fresh fruit in general. Closer attention is deserved for the information related to the suitability of cultivars.
- Experiences related to conditions and techniques of storage are appreciated by entrepreneurs of commerce – especially during the hot summer time – as fruits are hardly kept on the shelf for more than 2 days without cooling equipment.

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