

Evaluation of sour cherry (*Prunus cerasus* L.) and European plum (*Prunus domestica* L.) varieties for making dried fruits

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Summary: The aim of our drying trials was to determine the drying suitability of stone fruits. The tested species were sour and sweet cherries and European plums too. Data and results of sweet cherry drying were published earlier (Klincsek et al. 2005, 2006). This article containing results of twenty sour cherry and six European plum varieties. Laboratory tests, drying processes and sensory testing were done at Fruit Quality Testing Laboratory of Fruit Science Department of Corvinus University of Budapest. The sensory tests and their valuations were done by the instruction of National Institute for Agricultural Quality Control.

In the case of sour cherries by one year data in 2004 we divided fruits to five categories by suitability for making dried fruit. Varieties in the first two groups are the followings: *most suggested for making dried fruits*: 'Meteor korai' and 'Érdi jubileum'; *suggested*: 'IV-3-48' and 'Piramis'.

In the case of European plums three varieties can be suggested for making dried fruits from the six tested cultivars: 'Révfülöpi'; 'Althann gage' and 'Besztercei'.

Key words: drying process, dried fruits, stone fruits, sour cherries, European plums, quality parameters, sensory test.

Introduction

Dried fruits are well known and preferred for a long time. Those fruits can be dried which are rich in sugar and with good yielding, for example plums, grapes, apricots, pineapple etc. Drying is a kind of preservation technique known since the ancient times (Beke, 1997; Burits & Berki, 1974). By reducing of water content of fruits can be stored for long time free from rots caused by fungal and bacterial infection (Erdélyi, 2004; Edélyi & Polyákné, 2005). During the drying process under low temperature condition with air circulation the most important ingredients (sugars, acids, minerals, vitamins etc.) of fruits are reserved (Szabó, 1996; Vas, 1985). Nutritional facts of fruit products are in Table 1.

By Barta & Vukov's opinion if drying process were done under controlled conditions it can be called as dehydration (Barta & Vukov, 1991). Dried fruits can be consumed in itself as delicious deserts or mixed with several cereals as mueslis. Dried

fruit products made in Hungary can be easily sold in the European markets because they have excellent taste by balanced sugar and acid content. Unfortunately because of the backgrounds of drying (strong seasonality of drying process – mainly in the ripening season of fruits; rising prices of energy; human power shortage etc.) until now mainly plums were used for making dried fruits in commercial quantity. Statistical data of the dried fruit market: export – import values and quantities are shown in Table 2 and Table 3.

Table 2. Export and import values in 1000 \$ of the World, European Union and Hungary

Year	Export value (1000 \$)		Import value (1000 \$)	
	World Market	Hungary	World Market	European Union
2004	402.070	194	186.254	28.455
2005	400.944	278	200.804	26.056

Source: FAOSTAT statistical database, 2005.

Table 3. Changing of export – import quantities of dried plums in the world market and in Hungary (2003).

Ranks	Exporter country	Quantity (t)	Importer country	Quantity country
1.	USA	72.368	Japan	17.325
2.	Chile	29.991	Germany	16.456
3.	Argentina	28.819	Russia	12.291
4.	France	13.772	Mexico	11.037
5.	China	3.222	Brasil	10.443
	Hungary	11	Hungary	331

Source: FAOSTAT statistical database, 2005.

Table 1. Nutrition facts of different fruit products (100g).

Fruit product	Energy (cal.)	Proteins (g)	Fat (g)	Carbon-hydrates (g)
Dried apple	246	1.4	3.4	55.4
Canned apple	80	0.3	0.3	20.2
Dried fig	270	3.5	1.3	62.0
Raisin	276	2.4	6.7	65.0
Dried plum	271	2.3	2.0	61.8
Canned plum	90	0.4	0.3	21.9
Plum jam	234	1.3	1.8	54.0

Source: Nutrition database of fruits and vegetables. www. fitnet.hu

It should enlarge the number of dried fruit species. Since the 1960's in Hungary apple is the second most important species behind the plum as raw material for fruit drying and sold dried apples as apple flakes. By the quality of ingredients stone fruit species – like sweet and sour cherries, apricots – are ideal for making dried fruits for the market. For the growers and dryers need more information about suitability for quality drying of stone fruit cultivars.

Materials and methods

Sour cherries: Samples of sour cherry varieties were collected at Pölöske (Fruit Varieties Testing Station of National Institute for Agricultural Quality Control). The tested sour cherry varieties and their main characters are shown in *Table 4*. Laboratory tests were done at Fruit Quality Testing Laboratory of Fruit Science Department of Corvinus University of Budapest. Coming fruits in ripening order were tested: cleaning – washing, measuring the fresh fruit weight; removing stems, weight measurement of fruits without stems, fruits were pitted, weight of fruit flesh and pit stones were measured separately, measurements of the total sugar content (Brix% by “ATAGO Pal-1” type digital refractometer). 60 pieces of pitted fruits were weighted and putted into the electric dryer box with hot air circulation. For 4 hours the temperature was a bit higher – about 60 °C –, and after that temperature was decreased 40–45 °C. The fruit firmness and fruit consistence was controlled twice a day. Fruits were removed continuously from the dryer when they had dried surface free from fruit juice and the consistence

was flexible like the rubber. Drying process took about 3–5 days. Fruits removed from electric dryer were kept on a net under fresh air condition (about 20–25 °C) for more 5–7 days. Dried fruits were weighted, putted in to paper bags and stored for 3 months until the sensory testing. Sensory test were done at Fruit Science Department of Corvinus University of Budapest by a testing panel containing forty persons. The sensory test and its valuation were done by the instruction of National Institute for ‘Agricultural Quality Control.

European plums: Tested fruits were harvested in Agárd (orchards of Agárd-Frucht Ltd.) and in Szigetcsép (orchards of Fruit Research Station of Horticultural Sciences Faculty of Corvinus University of Budapest). The tested plum varieties and their main characters are shown in *Table 5*. Drying trials were carried out for two years in 2004 and 2005. Applied measurements in 2004: 10 fruits were selected from the sample, the total weight of 10 fruits was measured and the average fruit weight was calculated. After this fruit firmness and Brix% (by “ATAGO Pal-1” type digital refractometer) were measured in two points of each tested fruits (one point on sun exposed side of the fruit and the other point was located on the shaded side fruit). Fruits were pitted and halved into two pieces, the weight of pitted and halved fruits were measured too. Pitted and halved fruits were put into the electric dryer. The temperature in the first five hours of the drying process was a bit higher about 60 °C –, and after that temperature was decreased 40–45°C. Dried fruits were removed from the dryer box when they had flexible consistence, the drying times were described by cultivars. Dried fruits spent about one week on fresh air before they were put into paper bags and stored until

Table 4. The most important fruit characters of grown sour cherry cultivars in Hungary (by Soltész, 2004)

Cultivar	Diameter of fruit (mm)	Average fruit weight (g)	Fruit shape	Colour of fruit skin	Fruit firmness	Stone / flesh ratio %
'IV-3-48'	20–21	3.5	Flatted round	dark red	Moderate firm	4–5
'Meteor korai'	21–22	4.0–5.0	Flatted round	Carmine red	Moderate firm	4–6
'Csengődi'	21–22	5.0	Elongated round	Dark carmine	Moderate firm	4–5
'Korai pipacs'	21–22	5.0	Rounded	Light red	Moderate firm	4
'Favorit'	22–24	6.0	Flatted round	Light red	Soft	4–6
'Körösi korai'	20	4.0	Elongated round	Dark red	Soft	5–6
'Érdi jubileum'	21–23	5.0–6.0	Rounded	Dark carmine	Firm	4–6
'Érdi bötermő'	21–23	5.5–6.0	Elongated round	Dark carmine	Moderate firm	5–6
'Maliga emléke'	23–25	6.5–7.5	Flatted round	Dark carmine	Moderate firm	5–6
'Cigány C404'	14–16	3.0	Round	Dark red	Moderate firm	6–7
'Cigány C7'	18–20	4.0	Round	Dark red	Moderate firm	6–7
'Cigány C59'	18–20	4.0	Round	Dark red	Moderate firm	6–7
'Pándy 48'	21–24	5.0–6.0	Flatted round	Dark red	Moderate firm	8
'Pándy 119'	21–24	5.0–6.0	Flatted round	Dark red	Moderate firm	8
'Pándy 279'	21–24	5.0–6.0	Flatted round	Dark red	Moderate firm	8
'Debreceni bötermő'	22–24	5.3	Rounded	Dark red	Slightly soft	8–10
'Kántorjánosi'	22–23	5.3	Flatted round	Red	Firm	8–10
'Újfehértói fürtös'	18–23	5.0	Flatted round	Shining red	Moderate firm	8–10
'Piramis'	24–26	7.5–8.0	Flatted round	Dark carmine	Moderate firm	7–8
'Oblacsinszka'	16–17	2.5–3.0	Rounded	Dark red	Moderate firm	8

Table 5. The most important fruit characters of tested European plum cultivars

(Sources: Szabó, 1997; Szabó, 2003; Tóth & Surányi, 1980; Soltész, 1998; Tomcsányi, 1979; Brózik & Kállay, 2000; Brózik & Kállay, 2001; Tóth et al., 2005)

Cultivar	Diameter of fruit (mm)	Average fruit weight (g)	Fruit shape	Colour of fruit skin	Fruit firmness	Clinging to the stone
'Besztercei'	28–30	15–20	Elongated	Dark blue, bloomy	Firm	Freestone
'Bluefre'	40–44	45–60	Ellipsoid, asymmetrical	Blackish blue, strongly bloomy	Soft	Freestone
'Cacanska rodna'	30–34	30–35	Elongated	Dark blue, bloomy	Firm	Freestone
'Althan gage'	39–42	40–45	Regular rounded	Purple and red blushed; bloomy	Firm	Freestone
'Stanley'	30–35	30–40	Elongated with rounded end, asymmetrical	Dark blue, bloomy	Firm	Freestone
'Szarvasi'	ND	23–26	Elongated	Dark blue	Moderately firm	Freestone when full ripped
'Révfülöpi'	ND	22–26	Elongated	Dark blue	Firm	Freestone

*ND = No data

the sensory test. In 2005 fruits were dried in two ways with pit stone and without it, but in one piece (after pitting fruits were closed back). Measurements and the drying technique was the same as year before. Sensory test of fruits dried with and without stone were organized in the same time but their results were valued separately. (Simon & Bulkai, 2005)

Results and discussion

Sour cherries: Results – the measured and calculated data – of sour cherry fruit tests are shown in Table 6. Tested varieties are in order by the dried weight – fresh fruit weight ratio (Table 6).

By the weight of pitted fruits compared to the fresh fruit weight the following varieties gave the most favourable results: 'Meteor korai', 'Korai pipacs', 'Favorit', 'Piramis', 'IV-3-48' and 'Pipacs 2' (Table 6).

By the dried fruit making ratio (the weight of dried fruits compared to the fresh fruit weight) the following cultivars gave the highest values: 'Meteor korai', 'Pipacs 2', 'Érdi jubileum' 'IV-3-48', 'Kántorjánosi' and 'Korai pipacs' (Table 6).

The following varieties had the lowest water loss data (it means in the case of these varieties need to invest the lowest quantity of energy for the drying process to evaporate the unnecessary water): 'Meteor korai', 'Érdi jubileum' 'Pipacs 2' 'Újfehértói fűrtös', 'Kántorjánosi' and 'IV-3-48' (Table 6).

Table 6. Measured and calculated quality characters of fresh and dried sour cherry fruits (2004)

Cultivar	Average fruit weight (g)	Stem / fresh fruit weight ratio (%)	Flesh weight / fresh fruit weight ratio (%)	Dried weight / fresh fruit weight ratio (%)	The ratio of waterloos (%)
'Cigánymeggy 7'	4.66	1.23	82.72	9.87	88.06
'Körösi korai'	4.59	2.22	84.44	11.11	86.84
'Oblaesinszka'	3.21	2.13	78.72	11.91	84.87
'Cigánymeggy 404'	4.65	2.50	77.50	12.50	83.87
'Cigánymeggy 59'	4.15	1.85	79.63	12.96	83.73
'Maliga emléke'	6.14	2.33	87.20	13.72	84.27
'Érdi bőtermő'	6.59	1.85	87.04	14.81	82.89
'Piramis'	7.67	1.74	89.57	15.60	82.52
'Pándy 48'	7.21	1.73	85.55	15.89	81.42
'Pándy 279'	6.22	3.28	83.60	16.39	80.39
'Debreceni bőtermő'	6.19	3.29	85.5	16.44	80.8
'Pándy 119'	6.61	2.56	85.90	16.66	80.60
'Újfehértói fűrtös'	5.31	5.88	82.35	17.06	82.93
'Korai pipacs'	5.54	2.44	90.24	17.07	82.93
'Kántorjánosi'	6.22	1.92	86.54	17.30	80.00
'IV-3-48'	4.12	3.1	89.08	17.60	80.24
'Érdi jubileum'	4.98	2.40	89.6	18.07	78.97
'Pipacs 2'	6.13	2.83	87.75	18.37	79.07
'Meteor korai'	5.14	1.83	90.28	19.26	78.66

Table 7. The results of sensory test of dried sour cherry fruits. (varieties are ranked by the total score, 2004)

Cultivar	Fruit colour	Appereance	Fruit flesh consistence	Taste	Total score
'Kőrösi korai'	2.55	2.07	2.03	2.12	8.77
'Cigány C404'	3.57	3.07	2.75	2.46	11.85
'Oblacsinszka'	3.43	2.67	3.05	2.72	11.87
'Cigány C7'	3.48	2.93	2.8	2.78	12.00
'Újfehértói fürtös'	3.41	3.03	2.74	2.84	12.03
'Favorit'	3.58	3.33	3.3	2.47	12.68
'Cigány 59'	3.72	3.32	3.07	2.62	12.72
'Kántorjánosi'	3.48	3.7	3.35	2.58	13.12
'Pándy 279'	3.42	3.38	3.25	3.23	13.28
'Érdi bőtermő'	3.59	3.20	3.48	3.07	13.35
'Maliga emléke'	3.6	3.73	3.37	2.65	13.35
'Korai pipacs'	3.3	3.56	3.89	3.28	14.02
'Pipacs 2.'	3.18	3.58	3.96	3.32	14.05
'Debreceni bőtermő'	3.88	3.82	3.47	3.42	14.58
'Pándy 48'	3.85	3.88	3.48	3.38	14.60
'Pándy 119'	4.02	3.78	3.42	3.8	15.02
'Piramis'	4.28	3.9	3.9	3.62	15.70
'Érdi jubileum'	4.35	4.37	4.18	4.05	16.95
'IV-3-48'	4.43	4.3	4.33	4.33	17.40
'Meteor korai'	4.58	4.58	4.38	4.28	17.83
SD 5%	0.49	0.49	0.51	0.55	0.44

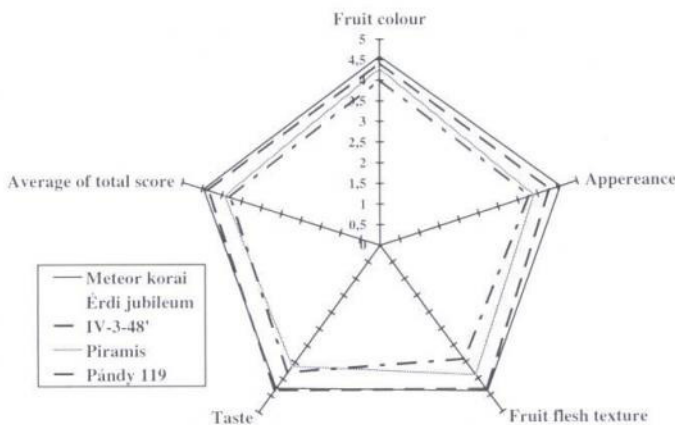


Figure 1 ray diagram of the first five ranked sour cherry dried fruit cultivars by the valuated characters (2004).

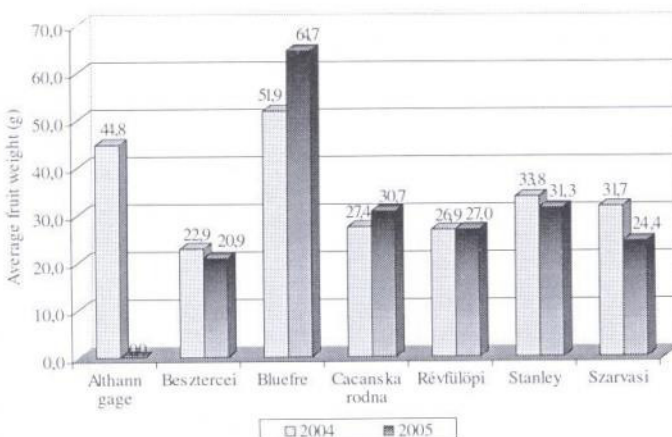


Figure 2 The average fruit weight of tested cultivars in the two trial years.

The results of sensory test of dried fruits after 3 months storage are shown in Table 7 and Figure 1.

By one year data (fruit quality and sensory test) in 2004 varieties were divided to five categories by suitability for making dried fruit: *most suggested*: 'Meteor korai' and 'Érdi jubileum'; *suggested*: 'IV-3-48' and 'Piramis'; *medium suggested*: 'Pándy 119', 'Pándy 48', 'Debreceni bőtermő', 'Pipacs 2' and 'Korai pipacs'; *less suggested*: 'Maliga emléke', 'Pándy 279', 'Kántorjánosi', 'Cigánymeggy 59', 'Favorit', 'Érdi bőtermő', 'Újfehértói fürtös' and 'Cigánymeggy 7'; *not preferred*: 'Oblacsinszka', 'Cigánymeggy 404' and 'Kőrösi korai'.

European plums:

Fruit size: The changing of average fruit weights by cultivars and trial years are shown in Figure 2. By the average fruit weight the following ranks were found:

In 2004: 1. 'Bluefre' (51.88g), 2. 'Althann gage' (44.78g), 3. 'Stanley' (33.77g), 4. 'Szarvasi' (31.67g), 5. 'Cacanska rodna' (27.44g), 6. 'Révfülöpi' (26.86g), 7. 'Besztercei' (22.89g).

In 2005-ben: 1. 'Bluefre' (64.67g), 2. 'Stanley' (31.33g), 3. 'Cacanska rodna' (30.71g), 4. 'Révfülöpi' (26.96), 5. 'Szarvasi' (24.38g), 6. 'Besztercei' (20.90g).

Average fruit sizes in 2004 were in agreement with the literature of plums (Szabó, 2001). Fruit sizes in 2005 are different from in year before (Figure 2). Some varieties ('Bluefre' and 'Cacanska rodna') had bigger fruit size in 2005 than in 2004. Maybe it was caused by the more rain in 2005 (in April to August 263mm was fallen in 2004 and the in same period in 2005 it was 379mm rainfall). Fruit size of 'Beszter-

cei', 'Stanley' and 'Szarvasi' cultivars was less in the second trial year. The reason of this difference is the over cropping in 2005 because it was optimal weather conditions in flowering and fruit setting time. In the case of 'Révfülöpi' there were no differences in fruit size between the two trial years.

Total sugar content of fresh fruits: The results of total sugar tests are shown in Table 8. Results are mostly harmonized with data in the literature (Szabó, 1997; Szabó, 2003; Tóth-Surányi, 1980; Soltész, 1998; Tomcsányi, 1979; Brózik & Kállay, 2000; Brózik & Kállay, 2001; Tóth et al., 2005). By our expectation 'Althann gage' had the highest sugar content. In both trial years 'Bluefre' was among varieties with low sugar content. 'Besztercei' – with high sugar content and quality ingredients by the literature – in our trial had lower sugar content than we expected. It was only in group with medium sugar content. Reasons could be the virus infection of trees and over cropping. 'Cacanska rodna' was among varieties with medium sugar content in both the trial years. 'Révfülöpi' continuously had higher sugar content than in the literature (Tóth et al., 2005) and it was one of the plum varieties with high sugar content. In both trial years 'Stanley' and 'Szarvasi' varieties were in the group of varieties with low sugar content. Varieties with lower sugar content in 2005 than 2004 are 'Bluefre', 'Stanley', 'Szarvasi'. Probably it was caused by heavy summer rains and alternation of summer heats. By this way fruit juice became diluted (thinner) by the absorbed extra water.

Table 8. The average total water soluble sugar content in the two trial years (2004, 2005).

Variety	2004		Variety	2005	
'Bluefre'	15.85	a	'Bluefre'	14.72	a
'Besztercei'	17.20	a	'Besztercei'	20.03	b
'Cacanska rodna'	19.40	b	'Cacanska rodna'	21.43	b
'Szarvasi'	21.65	c	'Szarvasi'	17.02	a
'Stanley'	21.80	c	'Stanley'	16.73	a
'Révfülöpi'	22.50	c	'Révfülöpi'	24.21	c
'Althann gage'	22.60	c			

*Note: the same significance groups are signed with the same letters.

Fruit flesh firmness of fresh fruits: In 2004 results of fruit firmness were in agreement with our expectation (Table 9): 'Bluefre' had the softest fruits; 'Althann gage' had slightly harder fruits than we expected (probably fruits were harvested before full ripped status); 'Révfülöpi' in full ripening had outstanding fruit firmness.

In 2005 varieties had much softer fruits than in 2004 year therefore 2005 was a year with extreme low fruit firmness and it was by two causes:

- increased fruit juice content by heavy rains in August;
- alternation of heavy rains and extreme summer heat in ripening season therefore some plum cultivars had faster fruit ripening process and ripped earlier than in 2004. In 2005 fruits of 'Révfülöpi', 'Besztercei' és a 'Cacanska rodna' were harvested one week earlier than in 2004 and with higher sugar content.

Table 9. Firmness of fresh plum fruits in 2004 and 2005.

Fajta	2004		Fajták	2005	
'Bluefre'	1,0	a	'Bluefre'	0,26	a
'Stanley'	2,46	b	'Stanley'	1,22,	c
'Besztercei'	2,62	b	'Besztercei'	1,74	d
'Althann gage'	2,78	b			
'Szarvasi'	2,81	b	'Szarvasi'	0,40	ab
'Cacanska rodna'	3,0251	b	'Cacanska rodna'	0,34	ab
'Révfülöpi'	3,48	b	'Révfülöpi'	0,66	b

Sensory test of dried plums: In the first trial year in 2004 plum fruits were a bit over dried and varieties with higher moisture content ('Althann gage') had much better dried fruit consistence. 'Althann gage' is different type from the other varieties (depending to *Prunus italica* L species) with higher sugar and fruit juice content, lighter and thinner fruit skin. Dried 'Althann gage' fruits had more flexible consistence and higher sugar content therefore sensory tester persons compared the other varieties to 'Althann gage'. By this way we did not kept objective results. For the second year 'Althann gage' was removed from list of the tested cultivars and fruits were dried more carefully and the dried fruit consistence was much better than year before. Finally we had more objective results of the sensory test. That is the reason why in this article results of sensory test are presented only by the second trial year (2005) (Table 10).

Table 10. Ranking of pitted and dried plums by the result of sensory test in 2005.

Rank	Colour	Appearance	Fruit flesh consistence	Taste, flavour	Total score
I.	'Stanley' 4.18 b	'Besztercei' 3.94 b	'Révfülöpi' 3.97 b	'C. rodna' 3.61 B	'Révfülöpi' 15.26 c
II.	'C. rodna' 4.00 ab	'Révfülöpi' 3.73 ab	'C. rodna' 3.89 b	'Révfülöpi' 3.57 B	'C. rodna' 15.02 c
III.	'Besztercei' 3.97 ab	'C. rodna' 3.63 ab	'Besztercei' 3.65 b	'Besztercei' 3.36 Ab	'Besztercei' 14.84 bc
IV.	'Bluefre' 3.94 ab	'Stanley' 3.42 ab	'Szarvasi' 2.89 a	'Bluefre' 3.10 Ab	'Bluefre' 13.07 ab
V.	'Révfülöpi' 3.92 ab	'Szarvasi' 3.28 a	'Bluefre' 2.78 a	'Szarvasi' 2.76 A	'Stanley' 12.73 a
VI.	'Szarvasi' 3.47 a	'Bluefre' 3.23 a	'Stanley' 2.36 a	'Stanley' 2.76 A	'Szarvasi' 12.36 a

In 2005 fruits with or without stone were dried and tested parallel. Result of sensory test was valuated separately but it was harmonise. Sensory testing persons did not know the name of varieties but they could see the code numbers of tested cultivars (it was different code number of the same variety for pitted drying and with stone drying). The ranking of pitted dried fruits and stoned dried fruits were similar to each other. It means that sensory testing panel (persons) worked consider and consequent way.

In both series in ranking the first three varieties were the same (Tables 10 and 11): 1. 'Révfülöpi', 2. 'Cacanska rodna' and 3. 'Besztercei'. These varieties by their fresh and dried

Table 11 Ranking of plums dried with stone by the result of sensory test in 2005.

Rank	Colour	Appearance	Fruit flesh consistence	Taste, flavour	Total score
I.	'C. rodna' 4.44 C	'Stanley' 4.13 d	'Révfülöpi' 4.07 c	'Révfülöpi' 4.21 c	'Révfülöpi' 16.34 c
II.	'Révfülöpi' 4.02 bc	'Révfülöpi' 4.02 cd	'Besztercei' 3.84 bc	'Besztercei' 3.28 b	'C. rodna' 15.02 bc
III.	'Stanley' 3.84 bc	'C. rodna' 3.81 bcd	'C. rodna' 3.81 bc	'Bluefre' 3.13 b	'Besztercei' 14.34 b
IV.	'Besztercei' 3.78 B	'Besztercei' 3.42 abc	'Bluefre' 3.50 abc	'C. rodna' 2.94 b	'Stanley' 13.31 ab
V.	'Bluefrei' 3.42 ab	'Bluefre' 3.23 a	'Stanley' 3.15 ab	'Szarvasi' 2.60 ab	'Bluefre' 13.28 ab
VI.	'Szarvasi' 3.05 a	'Szarvasi' 3.15 a	'Szarvasi' 2.89 a	'Stanley' 2.18 A	'Szarvasi' 11.71 a

fruit quality are strongly suggested to use for making dried fruits. There were ranked alternately in 4. and 5. places 'Stanley' and 'Bluefre' varieties. In pitted dried fruit series 'Stanley' was ranked further back because it was half clingstone and stones were separated from fruit flesh by difficulties. That is the reason why 'Stanly' is suggested to use only for making stoned dried fruit.

By our results 'Szarvasi' is less suggested to use for drying.

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