

# Evaluation of fruit quality of old apple cultivars originating from the foot of the Carpathian Mountains, for utilization in breeding and in organic farming

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**Summary:** In the frame of the apple breeding program at the Department of Fruit Science old cultivars found in the Carpathian basin were involved in examination as well. Beside testing susceptibility to fire blight (*Erwinia amylovora* of old genotypes (historical, local and regional cultivars) originating from scattered orchards of Visk (foot of the Carpathian Mountains), fruit quality was also evaluated and other open-field observations were made.

According to the results of inner content examinations, 'Szemes alma' and 'Sikulai alma', chosen as gene sources for breeding to resistance against fire blight, had inner content values worthy to mention in some aspects, and competing with those of the control cultivar 'Jonathan'. The quality of 'Pónyik alma', also recommended as a gene source is confirmed by the data of earlier literature. Further three cultivars ('Batul', 'Vilmos renet', 'Zöld sóvári') also proved to be good based on resistance against *Erwinia amylovora*, the first two cultivars are suitable from the point of view of fruit quality, too.

In our field observations, susceptibility to apple scab and powdery mildew was evaluated. Among cultivars selected from the foot of the Carpathian Mountains on the base of resistance against *Erwinia amylovora*, the production value of 'Szemes alma' is worsened by its high susceptibility to apple scab. Further selected cultivars ('Sikulai', 'Pónyik alma', 'Batul', 'Vilmos renet') are not too susceptible to fungal diseases and their fruit quality is also suitable, therefore they can be recommended for direct planting in ecological farming or in restoring scattered orchards.

**Key words:** *Malus x domestica* Borkh., apple cultivar, fruit quality, resistance, gene source, ecological farming

## Introduction

One of the possibilities of developing apple production is spreading environment-conscious technologies, as it is justified by environmental protection, providing consumers with healthy fruit and minimizing production costs. In the case of different environment-conscious cultivation methods with closed or open planting system (integrated intensive production, biological fruit production in ecological farming, self-supplying garden production, scattered and regional orchard, agricultural orchard utilized in a complex way), suitable cultivar selection has special importance. Besides resistance against diseases, further important requirements are competitive fruit quality and suitability to ecological features of the production area.

In the framework of the apple breeding program carried out at the Department of Fruit Science of the Faculty of

Horticultural Science (Tóth et al., 1994), one of our main goals is to explore, select, evaluate and preserve breeding gene sources. For this reason we started to evaluate susceptibility of old genotypes found at the foot of the Carpathian Mountains (historical, local and regional cultivars) to fire blight (Kása et al., 2002). Our aim was to select parent cultivars which – in a breeding process aiming joint needs of multiple resistance and good fruit quality – after crossing with formerly selected genotypes, give progenies in which resistance against scab, powdery mildew and fire blight can be joined by good fruit quality.

Cultivars involved in the study were explored during our expeditions at the foot of the Carpathian Mountains (Visk, Ukraine) in the 1990's (Tóth et al., 2005a). Results of examinations for identifying resistance to *Erwinia amylovora* – on the base of our former paper – are shown in Table 1. According to our field observations, cv. London pippin was highly infected. Our *in vitro* examination results

**Table 1** Susceptibility of apple cultivars to *Erwinia amylovora*, on the basis of evaluation of shoot infection data (Tóth et al., 2005)

Cultivar	Necrotization of the shoots	Disease degree	Bacterium cell numbers
Szemes alma	MR	MR	MR
Pónyik alma	MR	MR	MR
Sikulai	MR	MR	MS
Batul	MR	MR	MS
Zöld sóvári	MR	MS	MS
Vilmos renet	MR	MS	MR
Sárga szépvirágú	MS	MS	MR
Kanadai renet	MS	MS	MR
Fehér Klár	MS	MR	S
Sándor cár	MS	MS	S
Simonffy piros	MS	MS	S
Törökbálint	MS	MS	S
Cserepánya	MS	MS	MS
Börkormos renet	MS	MS	MS
Tafota	MS	MS	S
Sovari nobile	S	MS	S
Nagy zöldalma	S	MS	S
Cox orange pippin	S	S	MS
Rózsa alma	S	S	S
Beregi sóvári	S	S	S
Kisasszony	S	S	S
Baumann renet	S	S	S
Idared	S	S	S
Jonathan M40	S	S	S
Liberty	MR	MR	MS
Remo	MS	MS	MS

MR = moderately resistant, MS = moderately susceptible, S = susceptible.

(Tóth et al., 2005b) show, that among cultivars originating from the foot of the Carpathian Mountains, 'Szemes alma', 'Pónyik' and 'Sikulai' proved to be more resistant than resistant control apple cultivars ('Remo', 'Liberty'). In the case of cv. 'Batul', the same tolerance as that of cv. 'Remo' was experienced. Susceptibility of cultivars 'Zöld sóvári' and 'Vilmos renet' hardly exceeded that of cv. 'Remo'. We proved that among cultivars classified as moderately resistant, 'Szemes alma', 'Pónyik' and 'Sikulai', – because of their outstanding shoot and fruit resistance – can be counted as sources of resistance in breeding programs aiming at resistance against *Erwinia amylovora*.

Exterior, sense-data and nutrition biological data are important quality criteria for consumers. The breeder's success can be bigger during selection of progenies, if fruit quality of the cultivar carrying resistance is also satisfactory. Therefore, knowing the fruit quality of gene sources involved in examination is important.

For this purpose, before and collaterally with evaluating susceptibility to fire blight, we examined fruit quality of historical cultivars from the foot of the Carpathian Mountains as possible gene sources, and formerly published the first results of this examination (Tóth et al., 2005a). In this paper, we introduce our cumulated results of evaluating fruit quality of cultivars involved in tests in connection to fire blight susceptibility, as well as experiences of other open field observations. Besides selecting suitable gene sources,

our goal is to select cultivars recommendable for planting in different environment-conscious cultivation methods.

## Materials and methods

### Habitat facilities and plantation features

For the examination of fruit quality, fruits were harvested from a scattered orchard in the outskirts of the villages Visk and Grengyes. The habitat is situated alongside the upper flow of the river Tisza, at the crossing of the Bereg flatland and the chain of Carpathian Mountains, on the foot of a mountain chain, at an altitude of about 400 m above sea level. The type of soil is non-calcareous brown forest soil, 20–25 cm thick, with 3.2–4.0% humus content and a pH value of 4–4.5. The average yearly precipitation is about 800–1000 mm, while the yearly average temperature is 6–8 °C. Mean temperature in June is 19–20 °C, in January -4.2– -4.5 °C, the number of frostless days is 170–175, the number of vegetation days is 190–195. Spring frosts end in the second part of April, autumn frosts begin in the middle of October. In winter the soil freezes to a depth of 60 cm (Ljubimova, 1964).

Most of the trees stand on a seedling or M4 rootstock. Soil surface under the 30–100 years old trees of large spacing is covered by natural herbaceous vegetation, which is utilized as meadow and grazing land. In the period after beginning our examinations in 1997, five years proved to be of good harvest in the case of most cultivars.

### Evaluation methods

Because the area of the experiment was difficult to access, all cultivars were harvested at the same time in 1997, 1998 and 2001. In 2003 we were able to harvest most of the cultivars two times. Evaluation of fruit quality was carried out on the base of a 15-piece average sample. After examining weight, size and colour, acid and soluble dry matter content were measured from 4–4 fruits, and flesh firmness from 10 fruits.

Analytical tests were carried out in the fruit analytical laboratory of the Department, except in 2001, when measurements were done in the laboratory of Wink Producing and Trading Ltd. in Vásárosnamény.

Flesh firmness was measured by a Magness-Taylor hand penetrometer. Juice yield pressed out by a juice extractor was defined in mass percentage. Acid content was determined by NaOH titration, referring to malic acid. To measure water soluble dry matter content, we used a hand refractometer in the first two years, later a digital one (PR-101). Sugar content was determined from water soluble dry matter content using a conversion table of the International Sugar Chemistry Association. From sugar and acid content values we calculated the sugar/acid ratio and the quality index using *Thiault's* (1970) formula, another name for it is pomona value (Pomona value = sugar content (g/l) + 10 x acid content (g/l)).

In determining absorbency (transparency), fineness was measured in 625 nm from a sample 11,5 Bx in absorbency (%), (UNICAM 5625 UV/VIS Spectrometer) adjusting 100% to distilled water. The lower this value is, the finer is the observed material. To determine polyphenol content, after solution preparation we measured absorbency in 720 nm with a spectrophotometer, nulled to distilled water.

In 1997 and 1998, we made organoleptic tests as well. 'Idared' produced in the Szigetcsép plantation was offered to deciders as a control cultivar. Examined characteristics in case of unpeeled apple were (maximum point is 25): size, colour, peel quality (chewability, thickness), flesh substance (flesh firmness, juiciness, meltability), taste (flavour, scent, aroma). In the case of peeled apples (maximum point is 10) flesh substance and taste was tested by consumers.

For evaluation of data we used the MiniStat program. Comparison of cultivars was carried out by the method of Tukey-Kramer, by one-respect comparison of independent samples.

## Results and discussion

### Quality and inner values of fruits from the aspects of breeding

Among fruit quality values of apple cultivars collected at the foot of the Carpathian Mountains, Table 2 shows our results concerning fruit size and coloration. Cultivars 'Baumann renet', 'Kanadai renet' and 'Tafota' had the biggest fruit size. On the base of form index values it can be stated, that form of cv. 'Sárga szépvirágú' is elongated, while fruits of the cvs. 'Baumann renet', 'Cox orange renet', 'Cserepánya', 'London pippin', 'Szemes alma', 'Tafota', 'Törökbálint', 'Nagy zöldalma' are more flattened, and fruits of other examined cultivars are closer to the spherical form.

Table 2 Size and colour of the fruits (Visk, 1997)

Cultivar	Weight (g)	Diameter (mm)	Height (mm)	Shape index	Deepness of coloration (1-5)	Coloration (%)
Batul	89	60	48	0.80	4.1	21
Baumann renet	200	79	63	0.79	5.0	82
Beregi sóvári	111	66	52	0.80	4.5	55
Cox orange pippin	105	65	52	0.79	3.8	26
Cserepánya	111	67	52	0.78	4.2	63
Kanadai renet	158	73	59	0.81	3.1	17
Kisasszony	104	64	52	0.81	4.7	59
London pippin	114	66	50	0.76	0	0
Nagy zöldalma	133	71	55	0.77	0	0
Sovári nobile	103	63	50	0.80	4.9	61
Rózsa alma	106	64	53	0.83	4.8	100
Sárga szépvirágú	125	67	64	0.95	4.2	22
Sikulai	79	58	48	0.82	4.9	93
Szemes alma	110	67	52	0.78	1.5	14
Tafota	163	77	59	0.78	4.5	65
Törökbálint	127	70	54	0.77	4.6	88
Vilmos renet	107	64	55	0.86	4.8	89
Zöld sóvári	81	57	49	0.86	4.9	81

In the case of the cover colour of the fruits, cvs 'Rózsa alma', 'Sikulai alma', 'Vilmos renet' and 'Törökbálint' were outstanding, coloration of cv. 'Rózsa alma' was almost 100%. Beside these four cultivars, deepness of coloration was great in 'Baumann renet' and 'Nemes sóvári' as well. Fruits of 'London pippin' and 'Nagy zöldalma' had no cover colour, while coloration on fruits of 'Kanadai renet' and 'Szemes alma' was just shaded and of low intensity (Table 2).

Most of the examined cultivars are winter apples. According to local experiences, they can be stored well till spring even under simple circumstances. As a result of this, high flesh firmness and acid content values were measured at

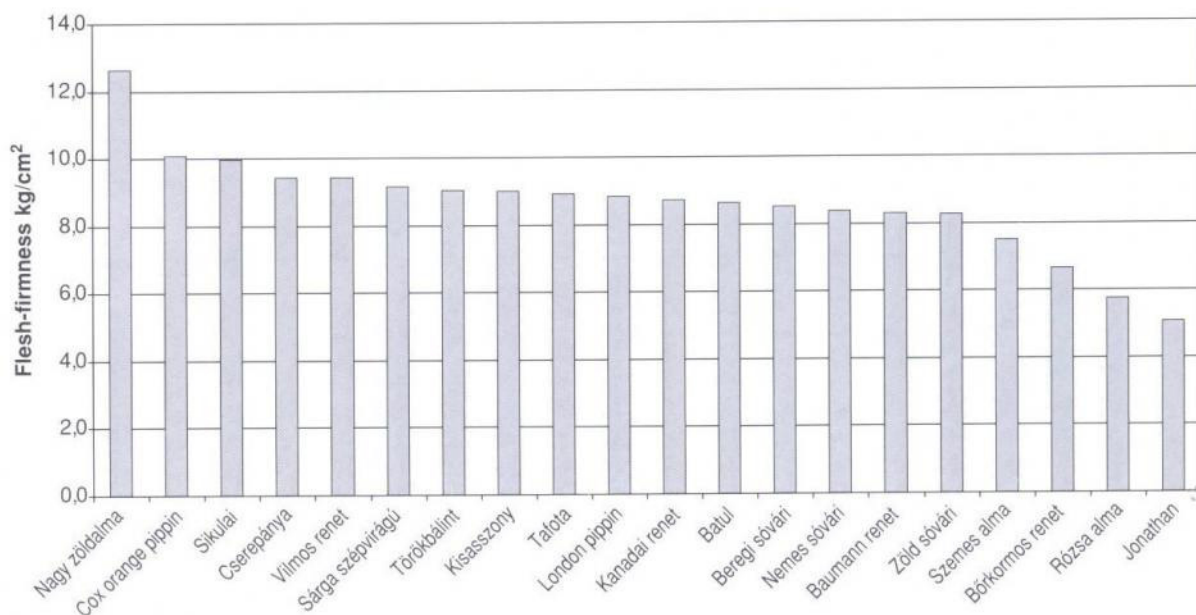


Figure 1 Average firmness of the fruits

**Table 3** Classification of cultivars on the base of acid content

Low (below 0,7%)	Middle (between 7–0,91%)	High (above 0,92%)
acid content of the fruits		
Jonathan Sovári nobil Sándor cár Simonffy piros Zöld sóvári	Beregi sóvári Börkormos renet Cox narancs renet Cserepánya Kisasszony London pippin Sárga szépvirágú Sikulai Tafota Törökbálint Vilmos renet	Batul Baumann renet Kanadai renet Nagy zöldalma Rózsa alma Szemes alma

**Table 4** Classification of cultivars on the base of soluble dry matter content values

Low (below 12%)	Middle (between 12,1–13,4%)	High Magas (above 13,5%)
soluble dry matter content		
Baumann renet Sovári nobil Simonffy piros Zöld sóvári	Beregi sóvári Kisasszony London pippin Nagy zöldalma Sárga szépvirágú Sikulai alma Szemes alma Tafota Törökbálint Vilmos renet Zöld sóvári	Batul Börkormos renet Cox orange pippin Cserepánya Kanadai renet Jonathan Rózsa alma

the autumn harvest (*Figure 1*). Exceptions are 'Simonffy piros', in which acid content, and 'Jonathan', in which flesh firmness was significantly lower than that of others. Fruit flesh of 'Rózsa alma' and 'Börkormos renet' was moderately

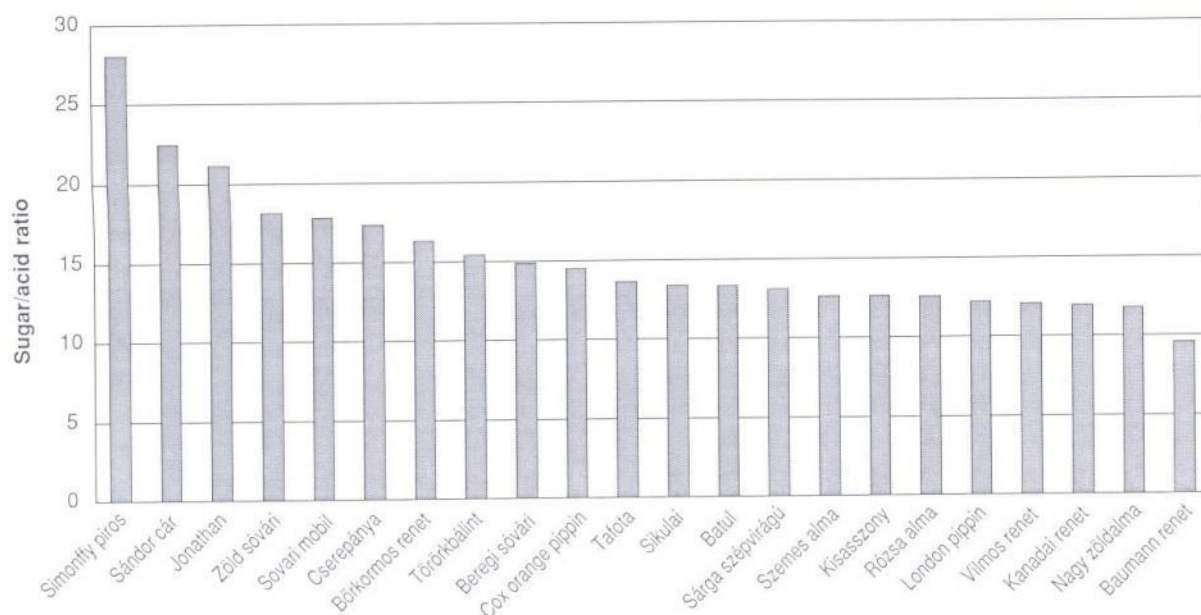
firm, while fruit firmness of other cultivars involved in examination was of outstanding value, 7 kg/cm<sup>2</sup> and above. Outstandingly high flesh firmness was measured every year in the case of cvs 'Batul', 'Cserepánya', 'Kisasszony', 'London pippin' and 'Sikulai'.

Outstandingly high acid content and refraction value, as well as Pomona value calculated from it were experienced in 'Börkormos renet' and 'Kanadai renet'. Because of low rate of all the three values mentioned above, 'Sovári nobil' and 'Simonffy piros' can be considered as of weak inner quality. However, 'Cserepánya' proved to have high soluble dry matter content. *Tables 3 and 4* show the classification of cultivars on the basis of acid content and soluble dry matter content values measured in three or four years.

As regards sugar/acid ratio (*Figure 2*) calculated from sugar and acid content values, 'Simonffy piros', 'Sándor cár' and 'Jonathan' show up among examined cultivars. On the other hand, in the case of Renet apples and 'Nagy zöldalma' sugar/acid ratio values were the lowest.

Pomona values calculated from the average values of three or four years are shown in *Figure 3*. The average of our several years' values regarding 'Jonathan' corresponds to former data of *Váradyné in Gyuró (1990)*. It can be stated, that most of the examined cultivars have higher Pomona values than 'Jonathan', which is famous for its good inner quality. As regards quality index, 'Simonffy piros', 'Sovári nobil' and 'Sándor cár' fall behind 'Jonathan' significantly. Comparing to the earlier data of *Váradyné in Gyuró (1990)* it can be stated, that Pomona value of 'Simonffy piros' is even lower than that of cultivar 'Starking'.

In organoleptic tests (*Table 5*) in 1998, 'Idared' from the Szigetcsép habitat as a control cultivar had the best results regarding all characteristics. This cultivar, harvested from an integrated production technology orchard, was in the first place in most cases. On the surface, this could mean, that

**Figure 2** Average sugar/acid ratio in the fruits

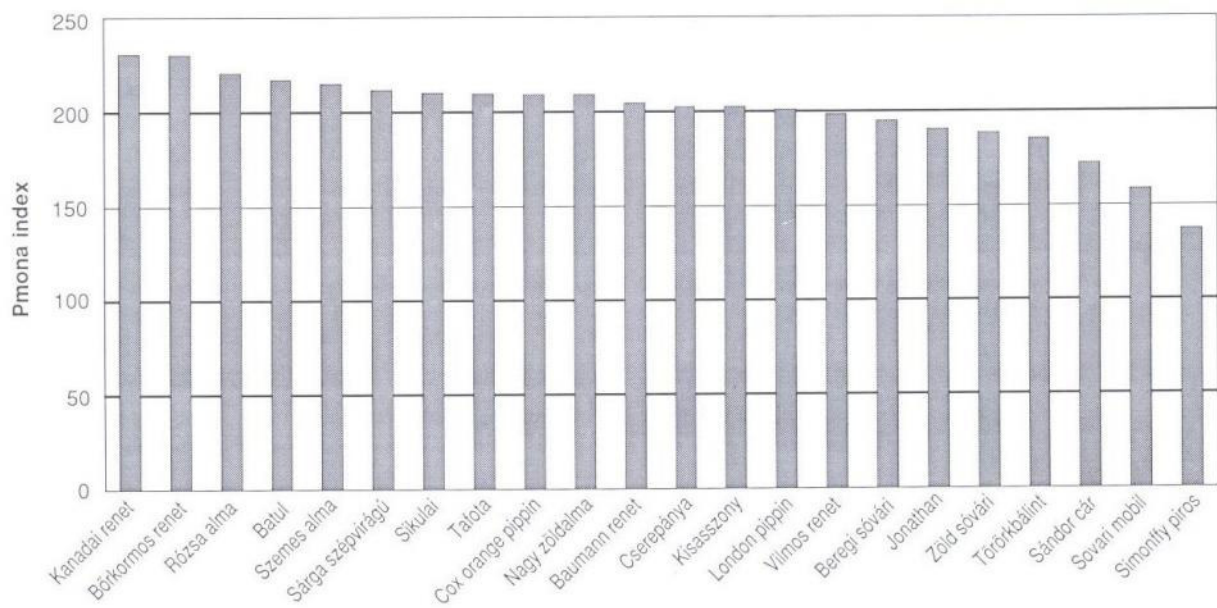


Figure 3 Average Pomona value of the fruits

historical apple cultivars cannot compete with any of the popular current market cultivars. This is modified significantly by the fact, that all the other cultivars in organoleptic tests were harvested from untreated scattered orchards. Therefore, it has to be acknowledged, that according to test results, 'Kanadai renet' and 'Vilmos renet' had good marks after 'Idared' in both years. Among cultivars tested only in 1997, 'Baumann renet' was the first after 'Idared', and it proved to be better than 'Idared' regarding taste and flesh substance. 'Vilmos renet' showed up from tested samples with its flesh substance and taste, 'Sikulai' with its colour, and 'Batul' with its taste.

Cultivar 'Szemes alma', highlighted on the basis of its resistance against *Erwinia amylovora* in our previous work,

was ranked in the last place by consumers on the basis of its outer features and tasting as well, therefore, this cultivar is not accepted for fresh consumption. On the basis of its coloration, 'Sikulai' was highly ranked in both testing years, but its points to size and peel quality were weak, and this degraded its ranking of general aspect. On the basis of its taste, it was ranked among weaker cultivars, which contradicts on one hand former evaluations (Morgan & Richards, 1993) and pomological descriptions featuring its taste as pleasant (Mahács, 1926, Nagy-Tóth, 1998), and our results concerning Pomona value on the other.

During juice and purée production, fineness of the fruit juice pressed out of fruits is highly important from the aspect of quality, which can be characterized by measuring

Table 5 The results of organoleptic tests of old cultivars

Cultivar	Size		Colour		Skin		Flesh		Taste		In all	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
Batul	14	6	12	8	11	6	6	6	3	6	10	8
Baumann renet	2	.	2	.	2	.	1	.	1	.	2	.
Beregi sóvári	9	4	9	3	10	11	4	11	9	11	8	6
Cox orange pippin	8	5	14	6	4	5	8	10	5	5	9	5
Cserepánya	6	9	5	10	16	8	14	8	15	9	11	11
Kanadai renet	4	2	13	9	3	2	3	4	7	8	4	4
Kisasszony	7	11	7	7	7	7	17	3	4	4	6	9
London pippin	5	7	8	11	8	9	7	9	8	7	5	10
Nagy zöldalma	11	.	16	.	14	.	15	.	10	.	15	.
Sovári nobile	15	3	11	4	9	3	13	5	14	3	13	2
Sárga szépvirágú	12	.	14	.	6	.	11	.	9	.	12	.
Sikulai	17	10	6	2	17	10	10	7	13	10	14	7
Szemes alma	13	.	15	.	15	.	16	.	16	.	17	.
Tafota	3	.	3	.	5	.	9	.	12	.	3	.
Vilmos renet	10	8	4	5	13	4	5	2	6	2	7	3
Zöld sóvári	16	.	10	.	12	.	12	.	11	.	16	.
Idared*	1	1	1	1	1	1	2	1	2	1	1	1

\* from Szigetecsp, grown in integrated orchard

transparency (absorbency), and correlating this value with water or air. Polyphenol content influences not only suitability for juice production, but the health saving value of cultivars as well, playing a great role – together with other inner materials (eg. carotenoids) – in the prevention of cardiac and vascular diseases, cancer and asthma among others, according to Boyer & Liu (2004). From the point of view of either fresh consumption or processing, it is important to select cultivars with the best inner quality, and for this purpose Table 6 shows these two quality parameters of old apple cultivars involved in our examinations.

Table 6 The quality of the fruit juice (2001)

Cultivar	Recovery (%)	Absorbency 420nm (water=0)	Polyphenol mg/l)
Batul	55	1.24	1633
Baumann renet	52	2.28	890
Beregi sóvári	52	0.35	1478
Börkormos renet	54	0.98	1996
Kanadai renet	51	0.87	1581
Kisasszony	56		938
Nagy zöldalma	58	0.92	1405
Sovári nobil	59	1.29	992
Rózsa alma	48	0.44	404
Sándor cár	53	1.97	642
Sárga szépvirágú	56	1.50	1167
Sikulai	55	0.90	1091
Simonfy piros	57	1.12	979
Szemes alma	54	0.73	1462
Tafota	54	0.31	1371
Törökbálint	52	1.73	644
Vilmos renet	53	0.93	988
Zöld sóvári	68	0.87	1050
Naményi Jonathan	58	0.38	1096

According to our results, it can be stated, that in 2001 cv. 'Zöld Sóvári' had the highest juice capacity. Further outstanding cultivars are in this respect 'Nemes sóvári', 'Naményi Jonathan', 'Nagy zöldalma' and 'Simonffy piros'. In the case of fineness (absorbency), measured values of 'Tafota', 'Beregi sóvári' and 'Rózsa alma' were as high as that of the control cultivar 'Naményi Jonathan', but pressed fruit juice of 'Baumann renet' and 'Sándor cár' was unfavourably cloudier. As regards polyphenol content, 'Börkormos renet', 'Batul', 'Kanadai renet', 'Beregi sóvári' and 'Szemes alma' had the best results among examined cultivars. Besides this, cultivar 'Sikulai', which proved to be good on the basis of resistance against *Erwinia amylovora*, and cultivar 'Zöld sóvári' had better or similar values as the control 'Jonathan', and polyphenol content of fruits of 'Vilmos renet' approached that of 'Jonathan' as well.

On the basis of inner content examination results, it can be stated as a summary, that inner values of 'Szemes alma' and 'Sikulai alma', selected as gene sources for breeding to resistance against *Erwinia amylovora*, are worthy to highlight in some aspects, and even competed with the control cultivar 'Jonathan' regarding some inner

characteristics. Racskó et al. (2005) published similar results regarding 'Sikulai', however, they thought the quality of 'Pónyik alma', selected by us as the third possible gene source, good as well.

From the three further cultivars ('Batul', 'Vilmos renet', 'Zöld sóvári') presenting similar resistance to *Erwinia amylovora* as resistant control cultivars ('Remo' és 'Liberty'), the first two cultivars are suitable on the basis of fruit quality as well. Fruit quality parameters (such as firmness, sugar content and Thiault index) of some scab resistant apple cultivars was evaluated by some Hungarian authors (Gonda et al., 2000, 2004), however, they do not evaluate *Erwinia amylovora* susceptibility.

Therefore it can be stated, that significance and value of the examined old and local cultivars cannot be judged solely on the basis of present market needs. Comparing to control cultivars 'Jonathan' and mainly 'Idared', most of old cultivars would not be competitive, but on the basis of some of their quality features and their resistance, they can play a role as a rich genetic source for cultivar breeding on one hand, and can be recommended for cultivation in different extensive environment conscious cultivation methods on the other.

#### Experiences of open field observations

Flowering time of cultivars in most years is the end of April, and beginning of May. On the base of full bloom period, cultivars 'Baumann renet', 'Börkormos renet', 'Kanadai renet' and 'Vilmos renet' were of early flowering in the last vegetation period. Outstandingly high shoot development could be measured in the case of cultivars 'Beregi sóvári', 'Börkormos renet', 'Kanadai renet', 'Sikulai' and 'Vilmos renet'. Fruit fall of most cultivars is moderate, except for cultivar 'Sárga szépvirágú', where only a slight fruit fall was experienced. Ripening time of fruits is the end of September, beginning of October.

In the frame of our open field observations, we evaluated susceptibility to apple scab and powdery mildew. Among the three possible gene sources selected from cultivars originating from the foot of the Carpathian Mountains on the basis of resistance against *Erwinia amylovora*, the production value of 'Szemes alma' is worsened by its high susceptibility to apple scab. The other two cultivars ('Sikulai', 'Pónyik alma') are not too susceptible to fungal diseases and their fruit quality is also suitable, therefore, they can be recommended not only as gene sources of breeding, but for direct planting in ecological orchards or in renewing scattered orchards.

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