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Tree growth and inner characteristics of fruits in pear cultivars

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Summary The aim of study was to investigate growth (crown growth and trunk diameter) and fruit characteristics [dry matter content (%), pectin (%), total acid (%) contents] of 10 pear cultivars ('Móri császár', 'Nyári Kálmán', 'Mogyoródi óriás', 'Fehérvári körte', 'Szegfű körte', 'Hóka', 'Piroska', 'Mézes körte'). The crown development of the cv. 'Fehérvári körte' can be regarded as outstanding among the examined cultivars. The growth of the cv. 'Mogyoródi óriás' was low, this cultivar showed the poorest growth vigour. The width of the crown in several cultivars developed at a similar rate as the height of the crown. Outstanding values were shown by cvs. 'Fehérvári körte' and 'Móri császár'. The development of trunk diameter was the highest for cvs. 'Piroska' and 'Hóka', and large growth of trunk diameter can be seen on cv. 'Fehérvári körte'. Cvs. 'Mogyoródi óriás' and 'Mézes körte' showed weak growth. Outstanding dry matter content of fruits was measured on cvs. 'Fehérvári körte' and 'Mézes körte'. The total acid content of fruits of cvs. 'Mézes körte' and 'Fehérvári körte' was significantly different from the total acid content of cv. 'Mogyoródi óriás'. Pectin content was low in fruits of cvs. 'Mogyoródi óriás' and 'Fehérvári körte', while cv. 'Mézes körte' contained significantly more pectin. Vitamin C content we found was rather high in cvs. 'Mézes körte' and 'Fehérvári körte'.

Key words: pear, growth rate, trunk diamater, dry matter, pectin, total acid, vitamin C

Introduction

Many questions still remain unanswered about the origins of the pear. In addition to the wild pear species *Pyrus communis* L. indigenous in Hungary, *Horn* (1936) mentions another species that became domesticated here: it comes from Georgia and it is called *Pyrus nivalis* JACK. Later, *Porpáczy* (1937) pointed out a third species called *Pyrus sinensis* LOE: this species comes from Manchuria, Korea and China and it is one of the ancestors of the Kieffer pear which is renowned for its good productivity in the Great Hungarian Plain. Describing the origins of the domesticated pear, *Janick* (1982) writes that pear is the second most significant deciduous fruit tree after apple, well known since prehistoric times. In Hungary, there are about 500 pear cultivars, with a huge range of regional and local differences, which are either the result of a conscious selection process by the population or they are cultivars that grew from seeds (*Brózik,* 1957). The wide range of pear cultivars greatly differ in their production characteristics and susceptibility to diseases and pests (*Holb,* 2003, 2005). During the past 10 years, the world pear production has exceeded 10 million tons per year. In 1998, Asia accounted for 60% of production, while Europe accounted for 24%. In Hungary there are three major production regions. The Western Transdanubian production region includes Győr-Moson-Sopron, Vas and Zala counties. This region provides 30% of the domestic pear production. The second major area is Pest county where pear is produced mainly in home gardens and allotments. This region accounts for 17–20% of the total domestic production and supplies Budapest directly. The third major area is the Northern Hungarian production region where the valley of the river Bodrog provides excellent microclimate for pear, with Heves, Nógrád, Borsod-Abaúj-Zemplén counties accounting for 15–16% of pear production.

Due to its nutritional and consumption value, pear is a very important fruit. While it has low energy and protein content, it is an important source of minerals and vitamins. Its high potassium content is also worth mentioning. Its high potassium-sodium ratio is particularly valuable, as it contributes to providing the right ion ratios in food. The most significant constituents of pear are vitamins C, B_1, B_2, E, folic acid and niacin *(Horváthné,* 2000). Horváthné (2000) also points out that the carbohydrate content of the pear greatly differs from that of other fruits, as the glucose and fructose ratio has values between 0.4–0.6 in pome fruits, while this value is 0.24 in pears. The acid content of pears is rather low, but its pleasant aroma provides pleasant eating properties.

Material and method

The cultivars were planted with two or four trees in the pear gene bank at Keszthely in 1981. The rootstocks of all cultivars of the pear gene bank is wild pear grown from seed. In 1999, a few cultivars were transferred from the gene bank mentioned above to the experimental garden of the Department of Horticulture, Faculty of Agriculture (Mosonmagyaróvár), University of North Hungary. The cultivars were first grafted on to 'BA-29 Provance' rootstock. Lean spindle crowns were developed, with 3 x 0.9 m row and stem spacing.

Examined cultivars

There is only limited amount of data available in the literature on the origins of the cultivars examined by us. Information on the origins of these cultivars was published among others by Iváncsics (1995). In our experiment we examined the following cultivars: 'Móri császár', 'Nyári Kálmán', 'Mogyoródi óriás', 'Fehérvári körte', 'Szegfű körte', 'Hóka', 'Piroska', 'Mézes körte'.

Rootstocks of pear cultivars

The practice of using rootstock in Hungary used to show an opposite trend to the European practice: in Hungary the nurseries used in about 90% wild pear seedlings, while the proportion of quince rootstock did not reach 10%. In the 1990s, the popularity of quince rootstock grew a little. The quince rootstock used in our experiment was the cultivar 'BA 29 Provance', which is known for its vegetative propagation, semi-dwarf growth vigour, excellent compatibility, low tolerance of chalky soil, medium winter tolerance and excellent resistance to crown gall disease (*Agrobacterium tumefaciens*) (*Hrotkó*, 1995).

Methods

The height and width of the crown was determined yearly exactly in centimetres after the foliage was shed.

The aim of measuring the trunk diameter was to determine the yearly widening and growth of the trunk by variety. The measurements were made in the dormant period, yearly. The trunk diameter was measured with a vernier calliper on 2 trees per cultivar, 10 centimetres above the grafting point.

The number of scaffold branches was also determined during the rest period (before pruning). On the central shaft, we looked at the number of branches developed during the growing season. When examining the vegetative properties we based our work on the methodology developed by *Gyuró* et al. (1981).

During fruit ripening we measured the nutritional value of the cultivars: we determined the dry matter content (%), pectin (%), total acid (%) contents as well as the vitamin C content in mg/100 g units.

The laboratory measurements were carried out by the employees of AGLAB Kft. When carrying out the measurements and calculations we used the method described by *Gasztonyi* (1987).

The measurement of the dry matter content: after being weighed the fruits were dried at 105 C° to permanent mass level (180 minutes).

The measurement of pectin content: preparation of pectin content non-dissolvable in alcohol: we added 220ml 96% ethyl alcohol to 50g blended fruit which then was boiled for 20 minutes and then filtered. We added 125ml 80% alcohol to the sediment, boiled it again for 20 minutes and filtered it. The sediment was washed with acetone, dried and made into a powder.

The determination of vitamin C content: from the finely chopped sample we weighed 1g with 0.01g precision. We made it into a pulp with 0.5g quartz sand and 0.5ml glacial acetic acid in a porcelain braying mortar. The pulp then was washed into a 100ml Stift test tube, which then was filled with distilled water to the marked level. The prepared and shaken solution was filtered through clean filter paper.

The determination of the total acid content: it was determined by titration with 0.2 mole NaOH solution, calculating the missing mls, using a phenolphthalein indicator.

Results and discussion

Tree growth measures

Crown development of the 'Fehérvári körte' variety can be regarded as outstanding among the examined cultivars (*Figure 1*). The growth of the cv. 'Mogyoródi óriás' stagnated; thus this cultivar showed the poorest growth vigour.

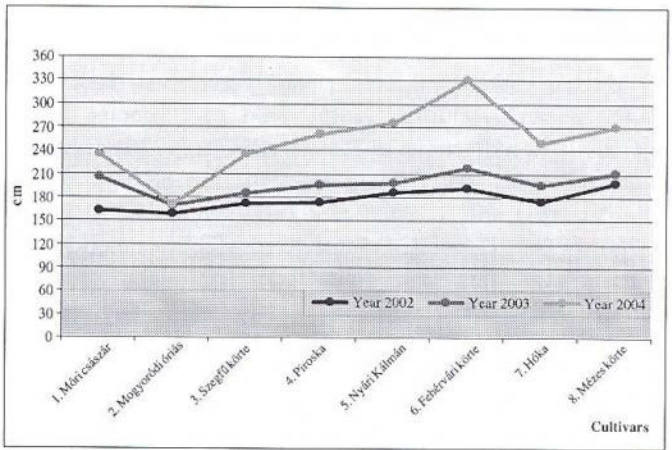

Figure 1 Crown height of eight pear cultivars (Mosonmagyaróvár, 2002–2004

We observed that in 2002–2004 the width of the crown in several cultivars developed at a similar rate as the height of the crown (*Figure 2*). Outstanding values were shown by the cvs. 'Fehérvári körte' and 'Móri császár'. In terms of crown width the cvs. 'Mogyoródi óriás', 'Nyári Kálmán' and 'Mézes körte' showed weaker development. We have to highlight the 'Nyári Kálmán' as this cultivar, while showing poor cross-sectional growth, showed vigorous vertical growth, and the side leader branches were also striving into a vertical direction to such a degree that made creating a lean spindle form questionable.

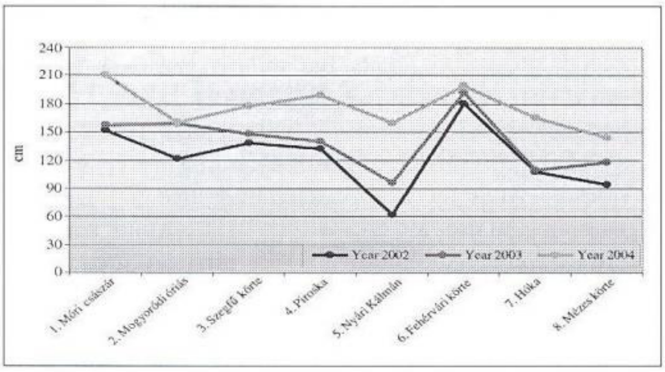

Figure 2 Crown with of eight pear cultivars (Mosonmagyaróvár, 2002–2004

As regards the development of trunk diameter we have to point out the cvs. 'Piroska' and 'Hóka', and we can also see the growth of trunk diameter in the case of the quickly developing cv. 'Fehérvári körte' (*Figure 3*). Weaker growth was measured on cvs. 'Mogyoródi óriás' and 'Mézes körte'.

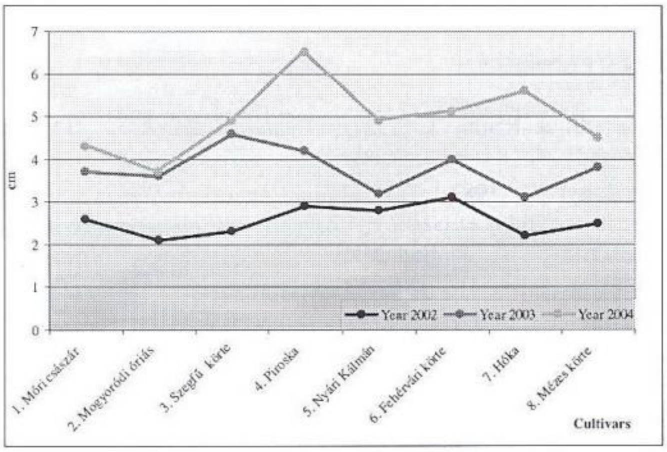

Figure 3 Trunk diamater of eight pear cultivars (Mosonmagyaróvár, 2002–2004

In 2004 'Szegfű körte' and 'Mézes körte' developed the highest number of scaffold limbs (*Figure 4*). In the case of cv. 'Piroska' growth of the trunk diameter and the development of scaffold limbs showed a harmonious development over the years. In addition to their quick

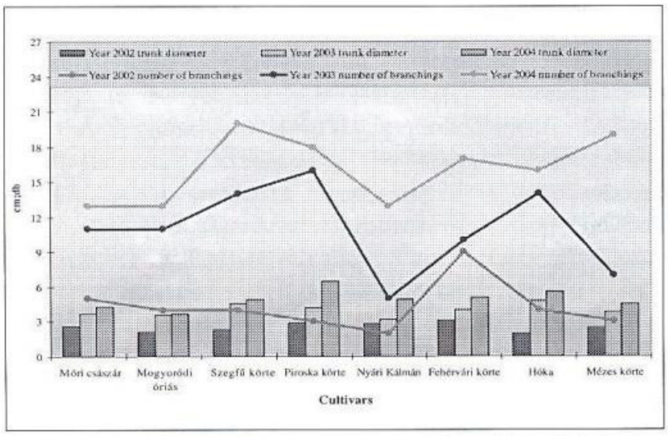

Figure 4 Development of trunk diamater and branching of eight pear cultivars (Mosonmagyaróvár, 2002–2004

development, cv. 'Piroska' showed the best fertilisation results. Describing the fertilisation conditions of open-pollinated flowers, *Nyéki* (1980) demonstrated those authors who provide different fruit setting percentages for achieving optimal yield, and as a summary he concludes that the 4–8% fruit setting values after the June fall – as we also saw it in the case of the 'Piroska' variety – lead to good yield and do not provide ground for alternance which is common in candidate cultivars.

Inner content of fruits

In the case of a few cultivars which had been steady producers for years and showed excellent values as for their nutritional value, we carried out examinations to help us determining the possibilities of using the individual cultivars for the food processing industry. The data on the dry matter content came from the laboratory tests carried out at Keszthely in 1990–1994 and from the laboratory tests on ripening fruit at Mosonmagyaróvár in 2000. The values and the statistical analysis are included in *Table 1*. Outstanding dry matter content was demonstrated by the 'Fehérvári körte' and 'Mézes körte' cultivars. There was no significant difference between the cultivars at P=5% level.

Table 1 Dry matter content of three pear cultivars

Cultivar	Six-year average (%)	Standard Deviation	CV(%)	Sx	Significant Difference P=5%
Mogyoródi Óriás	15.77	2.124	13.47	0.867	A
Mézes körte	16.39	0.599	3.65	0.244	A
Fehérvári körte	17.1	1.753	9.99	0.716	A

The total acid content was also determined in 1990-1994, as well as in year 2000. The highest total acid content was shown by cvs 'Mézes körte' (0.328%) and 'Fehérvári körte'.

Table 2 Total acid content of three pear cultivars

Cultivar	Six-year average	Standard Deviation	CV(%)	Sx	Significant Difference P=5%
Mogyoródi óriás	0.26	0.070	26.87	0.029	A
Mézes körte	0.32833	0.072	22	0.029	B
Fehérvári körte	0.3	0		0	B

Table 2 shows that the total acid content of cvs. 'Mézes körte' and 'Fehérvári körte' was significantly different from the total acid content of the cv. 'Mogyoródi óriás'.

The six-year data on pectin content are included in *Table 3*. Particularly low levels were found in cvs. 'Mogyoródi óriás' and 'Fehérvári körte', while cv. 'Mézes körte' contained significantly more pectin, though even this figure is below the desired levels of 3.0–3.5%.

Table 3 Pectin content of three pear cultivars

Cultivar	Six-year average	Standard Deviation	CV(%)	Sx	Significant Difference P=5%
Mogyoródi óriás	0.16	0.015	9.68	0.006	B
Mézes körte	0.26	0.045	17.37	0.018	A
Fehérvári körte	0.16	0.016	10.1	0.005	B

The vitamin C content of the cultivars was also examined in 1990-1994 as well as in 2000 and the findings are shown in *Table 4*. Except for cv. 'Mogyoródi óriás', the vitamin C content we found was rather high in cvs. 'Mézes körte' and 'Fehérvári körte'. These values reach the vitamin C content of mass produced cultivars. It was also found that cv. 'Mogyoródi óriás' had significantly lower, while cv. 'Fehérvári körte' had significantly higher values compared with the vitamin C content of cv. 'Mézes körte'.

Table 4 Vitamin C content of three pear cultivar

Cultivar	Six-year average	Standard Deviation	CV(%)	Sx	Significant Difference P=5%
Mogyoródi óriás	3.535	1.410	39.89	0.576	B
Mézes körte	7.845	2.816	35.89	1.149	A
Fehérvári körte	8.34	1.785	20.3	0.733	B

Basic requirements of use for the food processing industry

We can group the suitability criteria of pear cultivars for food processing as follows:

1. Dried fruit: the cultivars suitable for drying are the ones which have white flesh, low in grit cells, have intensive aroma and have a higher acid content. Finer dried fruit can be made from bigger fruit, while less valuable dried fruit can be made from cultivars with smaller fruit.
2. Through alcoholic fermentation we can produce a final product from cultivars with higher sugar content and an adequate level of acid content (high acid content has a fermentation- preventing effect).
3. Jam can be made from cultivars with a high pectin (0.3%) and dry matter (18–20%) content. Sugar content is also important and the flesh should be free of grit cells.
4. Most cultivars are suitable for making fruit spreads, fruit jelly and paste, as the food industry provides all the additional matters which contribute to making good quality finished products, but solidity and flesh free of grit cells is still a basic requirement.
5. Semi-finished fruit products (pulp, puree) require fruit with high dry matter content and with a lower level of ripeness, while for semi-finished fruit juice products it is preferable to use ripe or over-ripe fruit.
6. Fruit drinks require cultivars with high dry matter and high acid content (3.0–3.5%).
7. For canned food, it is recommended that we use cultivars which have medium sized fruit (about 6 cm in diameter), flesh free of grit cells, appropriate dry matter content and characteristic aroma.
8. In the preparation of fruit juices, it is a basic requirement that cultivars with higher vitamin C content (8–10 mg/100g) and high dry matter and total acid content be used. Based on the above, in the "*Summary*" chapter we have drawn our conclusions on the suitability for food processing of the cultivars examined in our experiment.

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