Chemical Characteristics of Fruits of Some Selected Quince (*Cydonia oblonga* Mill.) Cultivars

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Abstract

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The basic chemical characteristics of 22 quince (*Cydonia oblong*a Mill.) genotypes and cultivars were determined: dry matter content, soluble solid content, the contents of organic acids, pectins, and mineral elements (nitrogen, phosphorus, potassium, calcium, and sodium). Quince fruits were harvested in the course of October and thereafter analysed at the stage of consumption ripeness after storage at the temperature of +2°C and a relative air humidity of 85%. The contents of pectins in fruits were high – the cultivar Hruškovitá contained 3.51 ± 0.19 g/100 g FW. The contents of vitamin C were also high, the cultivar Muškatová containing as much as 79.31 ± 2.01 g/100 g FW. The affinity of chemical properties of the individual cultivars was expressed by means of cluster analysis and it was found out that there were no marked differences between pear-shaped (*Cydonia oblonga* subsp. *pyriformis*) and apple-shaped (*Cydonia oblonga* subsp. *maliformis*) forms of fruit.

Keywords: quince (*Cydonia oblonga* Mill.); organic acids; pectins; vitamin C; mineral elements

Quinces (*Cydonia oblonga* Mill.) belong to the group of the oldest cultural plants. They originate from Central Asia and were gradually penetrated also to other parts of the world. Quinces are less suitable for the direct consumption (Hričovský *et al.* 2003) and for that reason they are mostly used either cooked (Alvarenga *et al.* 2008) or preserved (Kyzlink 1990). However, as compared with other species, this fruit tree species is less popular throughout the world. Its predisposition to turning brown and decay is a limiting factor in the long-term storage of this fruit (Gunes 2008). The nutritional value of the fruit is high (Bucsek *et al.* 1996; Kopec & Balík 2008). It is well known that quince fruit shows antioxidant effects (Silva *et al.* 2002) which result from the presence of a number of polyphenolic substances (Fattouch *et al.* 2007), e.g. flavonoids quercetin, rutin, kaemp-

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ferol etc. (Silva *et al.* 2005), and also from increased levels of vitamin C (Tetera 2006). Quinces are important also for the canning industry, especially due to their high contents of pectins (Kyzlink 1990; Forni *et al.* 1994). From the sensory point of view, an intensive quince-like smell represents an important qualitative trait (Lutz & Winterhalter 1992); this is due to an increased content of aromatic substances (Escher & Niclass 1991). Quince fruit can also be used for the production of an aromatic distillate (Naf *et al.* 1991). At present, the possibilities of a commercial use of quinces are intensively studied (Adler 2001).

Based on the shape of fruits it is possible to distinguish two basic form lines of quinces. The pomes of the first one are similar to apples (*Cydonia oblonga* subsp. *maliformis*) while those of the second one are pear-shaped (*Cydonia oblonga* subsp. *pyriformis*). The apple-shaped quinces have an aromatic, drier and harder flesh while that of the pear-shaped is fine and softer (Hričovský *et al.* 2003). One of the objectives of this study was to compare the nutritive characteristics of both lines of varieties and genotypes using several model examples. Besides, the individual genotypes were also compared with each other. The nutritional values of the individual quince varieties may be really considerable (Gunes & Dumanoglu 2005), not only in fresh condition but also in relation to their processing (Alvarenga *et al.* 2008). This study deals with and investigates the varieties commonly grown and approved in many countries, e.g. in Germany, Portugal, and Spain (Schirmer 2000). In addition to this, it also describes a number of genotypes selected within the framework of the breeding work performed in the Czech Republic in the last century. At present, these species are concentrated in an experimental orchard (gene fund) of the Mendel University in Brno.

MATERIAL AND METHODS

Collection and processing of samples for chemical analyses. Quince fruits were harvested at the stage of harvest ripeness (in October), always from three trees of a given variety. The degree of ripeness was determined on the basis of fruit colouring, separability, and the change of fruit peel from a lanuginous to a waxy condition (Silbereisen *et al.* 1996). The fruits were harvested in the experimental orchard during the period of 2006–2008. In the course of the measurements, 5 replications (five randomly chosen fruits) were used for each tree, i.e. altogether 15 replications per cultivar. The samples were stored in controlled atmosphere at the temperature of +2°C (Tuna-Gunes & Koksal 2006). The relative humidity was 85% (Kyzlink 1990). Chemical analyses of the stored fruits were performed in the course of December. For chemical analyses, the whole fruits without the core were used (this means that the flesh and the peel were analysed together). The individual samples were taken by means of quartation after a thorough homogenisation in a laboratory grinder.

Of the whole collection of the individual cultivars and genotypes, the following ones were evaluated and analysed in our experiments:

(1) pear-shaped quince cvs Asenica, Bereckého, Blanár, Brna, BO-3, Buchlovice, Doubravnická, Champion, Hruškovitá, Hemus I, Hemus II, Izobilnaja, Ironda, Morava, Otličnica, and Pinter;

(2) apple-shaped cvs Jurák, Juranská, Kocůrova, Leskovačka, Mir, and Muškátová.

Description of locality. The experimental gene-fund orchard of Mendel University in Brno is situated in the cadastre of the Žabčice village, approximately 20 km southwards from Brno. The altitude is 184 m. The average annual temperature and a fifty-year average sum of precipitation are 9°C (during the growing season 15.6°C) and 553 mm (during the growing season 356 mm), respectively. Genetically, the soils are classified as gleyed alluvial soils developed on the Holocene calciferous sediments with a marked accumulation of organic compounds. As far as the texture is concerned, the topsoil is loamy and the subsoil clayey-loamy.

Chemical analyses. With the exception of the determination of pectin substances and vitamin C, all other chemical analyses were performed using the standard methods described by Novotný (2000).

Dry matter content was determined after drying to constant weight at the standard temperature of 105 ± 2°C. Soluble solid content was estimated by means of polarimetric measurements in the juice obtained after squeezing the fruit. The content of total acids was measured by potentiometric titration; 20 g of homogenised sample were extracted for 30 min in a shaker with 200 ml of re-distilled water at the temperature of 80°C. The extract obtained was filtered and titrated with sodium hydroxide to the pH value of 7.8. The result obtained was converted into the content of acids in g/100 g of FW.

Mineral content assay. The sample was dried to constant weight in a drier at the temperature of 105 ± 2°C. A 1 g portion of the homogenised DM (the size of particles up to 1 mm) was thereafter mineralised in a mixture of concentrated sulphuric acid and 30% hydrogen peroxide. The mineralised samples were quantitatively transferred into a 250-ml volumetric flask whose volume was made up to the mark with re-distilled water. The mineralisate was measured in an atomic absorption spectrometer (PHILIPS PU 9200X, Philips Inc., Eindhoven, the Netherlands). The content of potassium in the mineralisate was determined by means of flame photometry (using the apparatus JENWAY PFP7, Jenway, Dunmow Essex, UK). The content of total nitrogen was determined according to Kjeldahl (using the apparatus KJELTEC TM 2300, Foss, Eden Prairie, USA). The amount of minerals was expressed as mg/100 g of FW.

Pectin substances content assay. The content of pectins was estimated by means of a modified method described by Rop *et al.* (2008). A pulp sample (10 g) was extracted at the temperature of 80°C in a shaker with hydrochloric acid c = 1 mol/dm^3 for a period of 90 minutes. The hydrolysate obtained was quantitatively transferred into a 250-ml volumetric flask and made up to the mark with water. Pectins were thereafter measured photometrically as a coloured complex consisting of the product of thermal decomposition of galacturonic acid with m-hydroxybiphenyl in concentrated H_2SO_4. The samples of 5 ml were gradually taken off and put into 50-ml flasks; thereafter, they were mixed with 6 ml of sodium tetraborate (c = 0.013 mol/dm^3) dissolved in concentrated sulphuric acid, made up to the respective volume with distilled water and boiled for 5 minutes. The boiled samples were allowed to stand for 20 min and thereafter they were measured (at 520 nm) together with the standards in the apparatus Libra S6 (Biochrom

Table 1. Fruit shape, its average weight (g), dry matter content (% w/w), and soluble solid content (% of SSC), n = 15

Cultivar/genotype	Fruit shape	Weight	Dry matter	SSC
Asenica	pear-like	370.0 ± 42.17	14.55 ± 0.10	15.5 ± 0.03
Bereckého		399.2 ± 35.18	14.80 ± 0.11	16.1 ± 0.02
Blanár		206.1 ± 26.57	21.84 ± 0.08	15.4 ± 0.03
Brna		472.1 ± 49.80	15.21 ± 0.08	16.6 ± 0.01
BO-3		328.2 ± 33.59	14.79 ± 0.09	14.0 ± 0.02
Buchlovice		212.3 ± 27.63	13.39 ± 0.11	10.9 ± 0.04
Doubravnická		285.8 ± 43.11	15.16 ± 0.11	14.5 ± 0.01
Champion		374.0 ± 29.17	18.10 ± 0.09	16.5 ± 0.02
Hruškovitá		399.1 ± 61.02	17.22 ± 0.11	16.0 ± 0.02
Hemus I		247.8 ± 45.17	15.85 ± 0.09	15.1 ± 0.03
Hemus II		344.6 ± 49.75	16.30 ± 0.12	15.6 ± 0.01
Izobilnaja		233.0 ± 28.85	19.46 ± 0.12	16.3 ± 0.01
Ironda		228.4 ± 36.17	17.09 ± 0.08	15.7 ± 0.02
Jurák	apple-like	231.8 ± 30.25	16.77 ± 0.11	15.9 ± 0.03
Juranská		89.7 ± 11.54	18.54 ± 0.11	15.5 ± 0.01
Kocůrova		245.7 ± 40.19	16.10 ± 0.08	13.2 ± 0.04
Leskovačka		163.3 ± 25.01	19.59 ± 0.07	15.9 ± 0.02
Mir		297.5 ± 31.54	18.64 ± 0.09	15.1 ± 0.03
Morava	pear-like	314.5 ± 40.77	17.33 ± 0.09	15.8 ± 0.01
Muškátová	apple-like	268.7 ± 31.20	13.73 ± 0.10	12.0 ± 0.02
Otličnica	pear-like	228.1 ± 24.76	18.26 ± 0.09	15.2 ± 0.04
Pinter		136.5 ± 20.13	20.52 ± 0.10	17.7 ± 0.03

Ltd., Cambridge, UK). The content of pectins was expressed as g/100 g of FW.

Determination of ascorbic acid. The determination of ascorbic acid content was carried out by a modified method of Wagner *et al.* (1979) and Miki (1981). 5 g of the sample were weighed into Erleymayer flask followed by adding 25 ml of the extractant methanol:H_2O:H_3PO_4 in the ratio 99:0.5:0.5. The flask with the sample was placed into a water bath at the temperature of 25°C where the sample was extracted for 15 minutes. To keep the sample out of day light, the flask was covered with aluminium foil during the preparation. After the extraction, the content of the flask was filtered through Filtrapak paper No. 390. The filtrate prepared in this way was diluted before injection in ration of extractant and filtered again through a membrane filter Nylon (0.45 µm Nylon filter disk). The instrument used for the ascorbic acid analysis consisted of a solvent delivery pump (Model 582, ESA Inc., Chelmsford, USA), guard cell (Model 5010A, ESA Inc., Chelmsford, USA) working electrode potential K1 = 600 mV, K2 = 650 mV), chromatographic column – Model Supelcosil LC8 (ESA Inc., Chelmsford, USA (150.0 × 4.6 mm), 5 µm particle size, and an electrochemical detector (Coulochem III, ESA Inc., Chelmsford, USA). Chromatographic conditions were constant: 30°C, as a mobile phase methanol:H_2O:H_3PO_4 = 99:0.5:0.5, (filtered through a filter Nylon, 0.2 µm), the type of elution was isocratic, the flow rate of the mobile phase was 1.1 ml/min, the retention time 1.9–2.0 minutes. The content of ascorbic acid was calculated as mg/100 g of FW.

Statistical evaluation. All results were evaluated using the ANOVA variation statistics programme.

Table 2. Average contents of organic acids (g/100 g FW), pectin substances (g/100 g FW), and vitamin C (mg/100 g FW), n = 15

Cultivar/genotype	Organic acids	Pectin substances	Vitamin C
Asenica	1.05 ± 0.11	2.15 ± 0.17	75.21 ± 3.15
Bereckého	0.87 ± 0.09	1.75 ± 0.18	58.60 ± 2.17
Blanár	1.45 ± 0.10	2.47 ± 0.14	61.24 ± 2.51
Brna	0.36 ± 0.05	2.12 ± 0.20	79.15 ± 3.70
BO-3	0.40 ± 0.03	2.51 ± 0.13	62.18 ± 1.53
Buchlovice	0.69 ± 0.05	2.66 ± 0.15	65.25 ± 1.95
Doubravnická	1.03 ± 0.07	2.14 ± 0.17	70.54 ± 2.01
Champion	1.01 ± 0.06	2.87 ± 0.18	69.30 ± 2.11
Hruškovitá	0.90 ± 0.05	3.51 ± 0.19	41.12 ± 1.56
Hemus I	0.81 ± 0.07	1.90 ± 0.12	47.26 ± 1.55
Hemus II	0.72 ± 0.05	2.23 ± 0.11	50.86 ± 1.69
Izobilnaja	0.86 ± 0.09	2.05 ± 0.15	78.90 ± 1.80
Ironda	1.15 ± 0.06	3.06 ± 0.17	66.50 ± 3.66
Jurák	1.01 ± 0.05	2.94 ± 0.26	74.85 ± 2.14
Juranská	0.85 ± 0.04	2.12 ± 0.12	69.15 ± 1.79
Kocůrova	0.66 ± 0.04	1.87 ± 0.19	76.91 ± 2.28
Leskovačka	1.29 ± 0.08	2.54 ± 0.11	75.88 ± 1.09
Mir	0.55 ± 0.03	2.88 ± 0.17	61.15 ± 1.18
Morava	0.88 ± 0.04	3.07 ± 0.17	57.35 ± 1.22
Muškátová	0.57 ± 0.03	2.24 ± 0.16	79.31 ± 2.01
Otličnica	1.13 ± 0.06	2.15 ± 0.21	70.83 ± 1.59
Pinter	1.53 ± 0.07	2.72 ± 0.13	55.87 ± 2.66

The statistical data were calculated according to Snedecor and Cochran (1967) when using the statistical package Unistat, v. 5.1 and Office Excel® Microsoft. In our research work, we used the most prominent fuzzy clustering algorithm – the fuzzy c-means algorithm (FCM): spherical clusters of approximately the same size in Unistat, v. 5.1 program. Membership degrees between zero and one are used in fuzzy clustering instead of crisp assignments of the data to clusters (Hoppner 2002).

RESULTS

The results of chemical analyses of the individual cultivars and genotypes are presented in Tables 1–3.

When evaluating the average weight of fruits, the cultivar Brna was found to produce fruits with the average weight of 472.1 g. The cv. Bereckého also produced fruits with the average weight of nearly 400 g. On the other hand, the lowest average weight of fruits (89.7 g) was recorded in the case of the apple-shaped form of the cv. Juranská. The content of DM in pear shaped quince forms was very high (e.g. in the cv. Blanár as much as 21.84% w/w). However, high DM contents were also found out in some apple-shaped forms of quinces: e.g. in the cv. Leskovačka this was as much as 19.59% w/w. When measuring soluble solid contents, the differences between the individual cultivars were statistically significant and ranged from 12.0% (cv. Muškatová) to 17.7% (cv. Pinter).

The cultivar Brna showed a low content of total acids (only 0.36 g/100 g FW). On the other hand, in the cv. Pinter, the total content of acids was 1.53 g/100 g FW. Smaller but statistically significant differences were found out in the contents of

Table 3. Average contents of mineral elements (mg/100 g FW), $n = 15$

Cultivar/genotype	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sodium
Asenica	62.57 ± 6.47	12.95 ± 1.81	165.87 ± 14.15	9.31 ± 1.24	4.36 ± 0.53	1.16 ± 0.17
Bereckého	82.88 ± 5.26	15.54 ± 1.50	152.44 ± 17.02	7.40 ± 0.95	6.95 ± 0.54	2.51 ± 0.15
Blanár	72.07 ± 5.12	19.66 ± 1.33	174.72 ± 19.41	12.88 ± 1.17	5.46 ± 0.59	1.74 ± 0.11
Brna	65.40 ± 7.31	17.34 ± 2.08	158.18 ± 13.17	13.68 ± 1.29	8.21 ± 0.79	2.43 ± 0.18
BO-3	82.82 ± 7.22	14.64 ± 1.19	107.97 ± 10.81	8.57 ± 0.57	5.17 ± 0.29	2.95 ± 0.15
Buchlovice	61.59 ± 4.50	12.85 ± 1.73	140.59 ± 9.54	8.83 ± 1.02	4.95 ± 0.41	2.41 ± 0.09
Doubravnická	68.22 ± 6.12	16.22 ± 1.11	137.96 ± 17.11	7.27 ± 0.65	4.24 ± 0.56	1.51 ± 0.17
Champion	74.21 ± 8.42	15.57 ± 1.53	157.47 ± 8.39	12.85 ± 0.78	7.96 ± 0.40	3.25 ± 0.15
Hruškovitá	86.10 ± 7.32	18.59 ± 1.04	222.14 ± 14.25	14.12 ± 1.02	8.61 ± 0.29	1.72 ± 0.14
Hemus I	74.50 ± 6.90	15.22 ± 1.80	158.50 ± 9.88	12.36 ± 0.81	9.19 ± 0.62	2.69 ± 0.19
Hemus II	71.72 ± 3.04	14.99 ± 1.09	166.26 ± 7.31	12.38 ± 0.75	7.82 ± 0.70	1.95 ± 0.12
Izobilnaja	103.14 ± 4.55	17.51 ± 1.22	190.71 ± 9.10	19.07 ± 1.84	11.09 ± 0.54	2.91 ± 0.14
Ironda	85.45 ± 7.37	17.26 ± 1.17	162.36 ± 8.68	15.04 ± 0.59	8.77 ± 0.32	1.88 ± 0.11
Jurák	55.34 ± 5.07	17.27 ± 1.39	167.70 ± 10.14	11.40 ± 1.08	5.86 ± 0.80	2.68 ± 0.15
Juranská	85.28 ± 3.11	20.76 ± 2.04	190.96 ± 12.52	14.46 ± 1.12	8.71 ± 0.24	3.15 ± 0.16
Kocůrova	59.57 ± 2.23	16.10 ± 1.57	169.05 ± 8.16	7.40 ± 0.85	5.79 ± 0.35	2.89 ± 0.09
Leskovačka	82.28 ± 4.29	19.59 ± 1.29	190.02 ± 8.99	14.10 ± 1.41	7.24 ± 0.39	4.11 ± 0.11
Mir	104.38 ± 4.14	23.11 ± 1.51	199.45 ± 10.53	10.81 ± 1.05	8.57 ± 0.47	3.91 ± 0.11
Morava	72.79 ± 6.75	17.50 ± 1.72	169.83 ± 7.12	9.35 ± 0.79	6.75 ± 0.28	1.55 ± 0.19
Muškátová	78.26 ± 3.83	18.67 ± 1.89	181.24 ± 8.54	15.10 ± 1.20	7.27 ± 0.30	0.82 ± 0.08
Otličnica	111.39 ± 5.21	22.46 ± 1.80	251.99 ± 8.47	15.33 ± 1.31	9.67 ± 0.42	1.27 ± 0.10
Pinter	77.98 ± 4.46	18.26 ± 1.44	190.84 ± 9.11	10.26 ± 0.97	5.54 ± 0.21	1.64 ± 0.13

Table 4. Membership coefficients for selected nutritional parameters of quinces in 3 clusters

Cultivar/genotype	Cluster 1	Cluster 2	Cluster 3
Asenica	0.0018	0.9912	0.0070
Bereckého	0.0044	0.0265	0.9287
Blanár	0.0092	0.0160	0.9748
Brna	0.0030	0.9849	0.0121
BO-3	0.0073	0.0098	0.9829
Buchlovice	0.0615	0.1423	0.7963
Doubravnická	0.0051	0.9925	0.9900
Champion	0.0230	0.8385	0.8017
Hruškovitá	0.9484	0.0127	0.0389
Hemus I	0.9802	0.0046	0.0152
Hemus II	0.9688	0.0059	0.0253
Izobilnaja	0.0035	0.9828	0.0137
Ironda	0.0081	0.0128	0.9791
Jurák	0.0029	0.9836	0.0136
Juranská	0.0056	0.9661	0.9049
Kocůrova	0.0065	0.9682	0.0253
Leskovačka	0.0017	0.9912	0.0071
Mir	0.0410	0.0233	0.9357
Morava	0.0819	0.0363	0.8818
Muškátová	0.0121	0.9413	0.0466
Otličnica	0.0334	0.7261	0.6569
Pinter	0.1421	0.0625	0.8015

vitamin C (Table 2). The measured values ranged from 41.12 mg/100 g FW (cv. Hruškovitá) to as much as 79.31 mg/100 g FW (cv. Muškátová). High contents of pectins were found out in the cvs Morava (3.07 g/100 g FW), Ironda (3.06 g/100 g FW), and Jurák (2.94 g/100 g FW), while the lowest one was determined in the cv. Kocůrova (1.87 g/100 g FW).

As far as the mineral elements are concerned, the highest contents of potassium were found out in the cvs Otličnica and Hruškovitá (251.99 mg per 100 g FW and 222.14 mg/100 g FW, respectively). The content of phosphorus was much lower and ranged from 12.85 mg/100 g FW (cv. Buchlovice) up to 23.11 mg/100 g FW (cv. Mir); the content of calcium ranged from 7.27 mg/100 g FW (cv. Doubravnická) to 19.07 mg/100 g FW (cv. Izobilnaja). The content of magnesium ranged from 4.24 mg/100 g FW (again cv. Doubravnická) to 11.09 mg/100 g FW (cv. Izobilnaja), and that of sodium from 0.82 mg/100 g FW (cv. Muškátová) to 4.11 mg/100 g FW (cv. Leskovačka). The highest contents of nitrogen were found out in the cvs Izobilnaja, Mir, and especially Otličnica (111.39 mg/100 g FW).

DISCUSSION

Quince fruit is less suitable for the direct consumption. Due to this fact, this fruit species is less popular worldwide than other species of core fruit (e.g. apples or pears). In spite of this, they show many outstanding technological and nutritional parameters; this fact has also been corroborated by our experiments. Thus, for example, in some cultivars at the stage of consumption ripeness the content of vitamin C was above 70 mg/100 gFW.

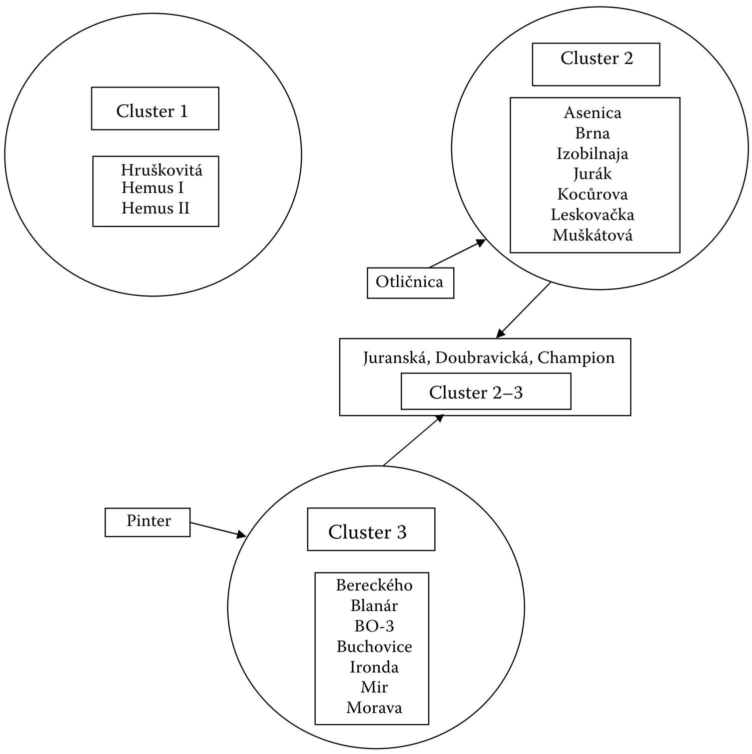

Figure 1. Fuzzy cluster analysis of quinces

In the circle are presented typical representatives: of Cluster 1, Cluster 2 and Cluster 3 2–3; 1–3 representatives, the properties of which are on the boundary of two clusters. Arrows pointing to the clusters – species which are not typical representatives of individual clusters; however, their properties are similar

The published data on the content of vitamin C in apples differ. According to Kovačíková *et al.* (1997), the maximum value determined was 46 mg/100 g FW while in pears the content did not exceed a half of this value (Sanchez *et al.* 2003). Of all core fruit species, the highest content of vitamin C can be found out in the fruit of Common Sea-buckthorn (*Hippophae rhamnoides*) (Kopec & Balík 2008) and on average it can be as high as 400 mg/100 g FW (Gutzeit *et al.* 2008). High levels of vitamin C can also be found out in some species of the genus *Rosa* (Yoruk *et al.* 2008). The variability in the content of organic acids was very high (from 0.36 to 1.53 g/100 g FW) and was determined by the genetic potential of plants (Gunes & Dumanoglu 2005). However, quinces are well-known above all due to their high content of pectin substances, which predetermine their fruit for the production of fruit spreads, mainly on the basis of their gelatinising capability in acid environment and the presence of saccharose (Kyzlink 1990). Out of the other core fruit species, a high content of pectins can be found out for example in apples (Baker 1997), which are processed in industrial facilities, similarly as citrus fruit (Tamaki *et al.* 2008). In apples, the average content of pectins is approximately 1.1 g/100 g FW (Kopec 1998) and in our experiments the majority of quince cultivars contained more than 2 g/100 g FW (Table 2). Quinces can also be used for the manufacturing of many other products, e.g. aromatic distillates (Naf *et al.* 1991). In this context is it necessary to mention not only the importance of the soluble solid content but of mineral elements as well. Mineral elements, especially calcium and its complexes with galacturonic acid, are also important in the field of the production of fruit spreads because they participate in the formation of gels (Saarimaa *et al.* 2007). The measured contents not only of calcium but also of some other elements (magnesium, potassium, and phosphorus) were similar to the values given in tables and standards used in the alimentary industry (Kovačíková *et al.* 1997; Kopec 1998). Lower values were recorded only in the case of sodium (Table 3). In apples, the contents of this element may be up to 45 mg/100 g FW (Kyzlink 1990) while in pears the average values are approximately 5 mg/100 g FW (Kovačíková *et al.* 1997); in our experiments, the values found were similar. It is known that quince trees show a high capability to uptake sodium even from salinated soils (Musacchi *et al.* 2006). The highest contents were measured in the case of potassium because this is a predominant mineral element in the majority of fruit tree species (Kovacs & Meresz 2004).

The main contribution of this study consists in the comparison of 22 various cultivars and genotypes with regard to their basic chemical properties. In this context, it is necessary to emphasise that, with regard to a low number of cultivars cultivated in the world, this collection of cultivars and genotypes is really unique (Schirmer 2000). The results obtained may be used for further popularisation and breeding of this fruit tree species. The similarity between the individual species was expressed by means of cluster analysis (Figure 1). The characteristics of the variety Champion, which is the most popular in the world (Hričovský *et al*. 2003), represented a transient type between two clusters. The cluster analysis also indicated that the apple-shaped (*Cydonia oblonga* subsp. *maliformis*) and pear-shaped (*Cydonia oblonga* subsp. *pyriformis*) lines of cultivars and genotypes are similar, and that it has not been demonstrated that they are generally different as far as the chemical composition of their fruits is concerned.

CONCLUSION

Quinces (*Cydonia oblonga* Mill.) belong to less popular species of the core fruit. However, they also often show outstanding nutritional and technological properties. This was also demonstrated in our experiments, within the framework of which altogether 22 cultivars and genotypes were compared. Using the cluster analysis, the varieties under study were classified on the basis of their chemical properties. The results presented may be used when popularising this fruit tree species, and also when studying the properties of new genetic resources.

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