

Composition and storage of pear cultivars from Nagykanizsa

Tóth-Markus, M.¹, Bánáti, D.¹, Adányi, N.¹, Boross, F.¹, Konrád-Németh, C.², Szabó, Z.,³
Soltész, M.⁴ & Nyéki, J.³

¹Central Food Research Institute, Hungary, H-1022 Budapest, Herman Ottó Street 15
tel.: +36 1 3558838 e-mail: m.toth@cfri.hu

²Gyümölcskert cPlc Hungary, H-8900 Nagykanizsa, Csengery street 90

³University of Debrecen Centre for Agricultural and Applied Economic Sciences,
H-4032 Debrecen, Böszörményi út 138., Hungary

⁴Collage of Kecskemét, Faculty of Horticulture, H-6000 Kecskemét, Erdei Ferenc tér 1–3.

Summary: The composition of five pear varieties ('Abate Fétel', 'Bosc', 'Williams', 'Conference', 'Packham's Triumph') grown in Nagykanizsa was investigated in three consecutive years (2008, 2009, 2010). A storage experiment was performed in 2008. Four winter pear cultivars were kept in an ULO store for four months and their parameters measured after two and four months. The parameters tested were: size, weight, water soluble solids, titratable acidity, glucose, fructose, sucrose, water soluble pectin, total polyphenols, free radical scavenging capacity, copper and zinc content. The fruits of 'Conference' and 'Bosc' varieties were found to contain the highest sucrose and total sugar content, while 'Abate Fétel' had the lowest sucrose and highest glucose levels among cultivars tested. 'Williams' pear was the most acidic. Brix, total sugar, sucrose and water soluble pectin were decreased during storage. Titratable acidity slightly decreased in fruits of Conference pear. Polyphenols and free radical scavenging capacity did not show a significant change during storage.

Keywords: pear, storage, sugar, acid, polyphenol, antioxidant capacity

Introduction

The market value of pear is determined primarily by size, weight, appearance, consistency and taste. Although many results on fruit sugars, acids and polyphenols in different cultivars has been published, there are few studies on change of composition of pear during storage (Morvai & Molnár-Perl, 1992, Elgar et al., 1997). Data on cultivars grown in our country are mainly available in Hungarian. Our aim was to fill this gap.

According to literature data shown in Table 1 the main sugars of pear are fructose, glucose and sucrose. The values are given for 1 kg fresh weight.

Hudina and Štampar (2000) determined sugars and acids in 18, European and Asian pear cultivars grown in Slovenia, including all those studied in present paper. Colaric and co-workers (2006, 2007) studied sugars, acids and phenolic compounds in 'Williams' and 'Conference' pear. They detected chlorogenic acid, syringic acid, epicatechin, catechin, sinapic and vanillic acid with chlorogenic acid being dominating. Main organic acids are malic and citric, with shikimic and fumaric existing as minor compounds.

Pear needs suitable post-harvest storage to assure a good transportability and distribution. Elgar et al. (1997) investigated fruit from two winter pear cultivars stored for 20 weeks at -0.5°C . Titratable acidity of ripened fruit decreased with advanced storage: In case of 'Bosc' the acidity changed

from 0.187% to 0.116%, while polyphenolic compounds showed a temporary increase in the first two weeks, and a slight decrease during two months, depending on temperature. Morvai and Molnár-Perl (1992) reported the growth of acids (including ascorbic), sugars and sorbitol during storage of Bosc pear, but the duration and circumstances are not known.

Materials and methods

Materials

'Abate Fétel' was grown in orchard of Gyümölcskert cPlc. at Szepetnek-Bánfapuszta. The area is located 15 km west from Nagykanizsa, with a loamy brown forest soil. The 7-hectare field, where the 'Abate Fétel' rows are grown, is an intensive pear orchard, equipped with irrigator. It was planted in 1997-98 with a spacing of 4×1.4, grafted on quince (*Cydonia oblonga*) rootstock. An affinity trouble is presumed, which seems to be proven by the way and extent of tree dying. The average yield in 2008 was 12.6 kg/tree. 'Abate Fétel' is characterised with a very weak fertility, thus having a low yield and a large size of fruits.

The other cultivars tested were grown at the Feketesár Orchard of Gyümölcskert cPlc. The area is located 15 km south from Nagykanizsa, with a non-calcareous, sandy

Table 1: Sugars, acids and polyphenols in pears

Author, date	Cultivar	Glucose (g/kg)	Fructose (g/kg)	Sucrose (g/kg)	Citric acid (g/kg)	Malic acid (g/kg)	Total acid (g/kg)	Total polyphenol (mg/kg)
Fourie et al., 1991	Bosc	13.6	49.9	30.9				
Morvai & Molnár-Perl 1992	Bosc	19.9	55	6.1	0.6	2.6		
SOUCI et al., 2000	not given	15–16.9	60.7–77	12.4–25	1.4	1.7		
USDA database	not given	27.6	62.3	7.8				
fineli database	not given	20	42	8			4	
Hudina et al., 2000	Williams	4.8	39.9	34	1.7	1.1		
	Conference	4.9	23.7	11.3	0	2.3		
	Packham	11.6	34.7	5.3	0.4	3.2		
	Fétel	16.3	43.6	6.6	0.4	3.2		
	Bosc	10.5	42.5	21.6	0.1	4.1		
	Packham	18.2	56.9	5.3				
Yasunori & Iki, 2002	Williams							167
Colaric et al., 2006	Williams	9.42	73.5	7.94	max 3.05	max 2.24		447–616
Colaric et al., 2007	Conference	7.63–14.75	48.5–76	6.6–18.53	0.21–0.22	1.97–4.25		162–231

humic soil. The pear orchard is cca 83 hectares, young plantation, planted in several phases (1997, 1999, 2000, 2001, and 2003). The biennial bearing characterizing pome fruits was present in 2008 to a small extent. The average crop yield was 37–45 kg in 2008 in fields planted in 1997–1999, 27–35 kg in fields planted in 2000–2001, while less than 5 kg in field planted in 2003.

‘Bosc’: planted in 1997, 1999, 2000, 2001, 2003, spacing 6×3 m or 5×3 m on a wild pear, (*Pyrus pyraeaster*), Farold 69–87 or *Pyrodwarf* rootstock, Crown shape: free spindle. Produces few flowers, hardly drops any of them. Bosc exhibits a constant yield, fruits have always large size.

‘Williams’ pear: planted in 1997, 1999, 2000, 2001, 2003, spacing 6×3 m or 5×3 m on a wild pear, (*Pyrus pyraeaster*), Farold 69–87 or *Pyrodwarf* rootstock, Crown shape: free spindle. It brings many flowers, covering almost the whole tree, but drops much of it. This cultivar is also able for regular production

‘Packham’s Triumph’: planted in: 1997, 2000, 2001, Spacing: 6×3 m or 5×3 m on a wild pear (*Pyrus pyraeaster*), Farold 69–87 or *Pyrodwarf* rootstock. Crown shape: free spindle. One of parents is ‘Williams’ pear, so it has similar characteristics in flowering and bearing.

‘Conference’: planted in 1999. Spacing 5×3 m on a Farold 69–87 rootstock, crown shape: free spindle. This cultivar is able to bring a high crop yield, but it is liable to biennial bearing. It is characterised by parthenocarp fruit production, often even the core is vestigial. In 2008 ‘Conference’ brought nice large size fruits at Feketesár.

Storage: Gyümölcskert cPlc performs pear storage in its own ULO (Ultra low oxygen level) storage room. Pears were

kept about three to four months in store. Controlled atmosphere values were as follows: O₂ level: 3.0–5.0%, CO₂ level: 0.9–1.0%, temperature: –0.5–0.0 °C

The free radical 1,1-diphenyl-2-picrylhydrazyl (DPPH) and standard Trolox, (6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid) were obtained from Fluka (Buchs, Switzerland). Other reagents were of analytical grade and purchased from Reanal (Budapest, Hungary).

Methods used

Pear fruits were washed and then the size and weight of 50 fruits was measured according to Hungarian Standard MSZ 967-1:1982. From approximately five kg sample one kg optimally ripened, sound fruit was selected, core removed and disintegrated unpeeled using a Waring (Torrington, USA) blender. The blended fruit sample was used in the different measurements and chemical analyses.

Soluble solids, titratable acidity (mg/kg) total polyphenols (mg/kg as gallic acid equivalent), free radical scavenging activity (TEAC: mmol/kg), copper and zinc (mg/kg) were measured as described previously (Tóth-Markus et al., 2010). Glucose, fructose and sucrose were determined enzymatically according to Hungarian standards MSZ EN 1140 and MSZ EN 12146. The water soluble pectin was measured from the five-fold diluted pear puree according to IFU 26. Calibration was performed with galacturonic acid. (Precision of the method within laboratory is approximately 10%.)

The values from chemical analyses were fresh weight-related and are given as means and standard deviation of triplicate samples.

Table 2: Size and weight of pears

Cultivar	Date	Width avg. (cm)	Greatest width (cm)	Smallest width (cm)	Length avg (cm)	Greatest length (cm)	Smallest length (cm)	Avg. weight (g)
Williams	01.08.2008.	6.60	7.32	5.81	8.43	9.85	7.38	175
Bosc	02.09.2008.	7.31	8.68	6.53	10.51	11.95	8.52	258
Packham's Triumph	03.09.2008.	7.04	8.11	5.95	8.45	9.98	7.32	199
Conference	30.08.2008.	6.57	7.54	5.58	9.61	11.80	8.15	184
Abate Fétel	02.09.2008.	6.74	7.45	5.95	11.40	13.90	9.22	218
Williams	01.09.2009.	6.72	7.75	5.68	8.65	11.20	7.12	190
Bosc	02.09.2009.	7.50	8.62	5.95	12.19	13.55	10.03	275
Packham's Triumph	01.10.2009.	7.96	8.95	6.92	9.72	11.78	8.04	279
Conference	01.10.2009.	6.67	7.39	6.03	10.24	11.55	8.95	190
Abate Fétel	01.10.2009.	7.61	9.22	6.55	12.50	15.05	9.95	301
Williams	12.08.2010.	6.80	7.74	5.48	8.98	10.16	7.35	201
Bosc	25.09.2010.	7.14	8.19	6.06	9.62	11.08	8.35	213
Packham's Triumph	25.09.2010.	7.54	8.28	6.69	8.37	9.65	7.06	229
Conference	25.09.2010.	6.98	7.58	6.38	12.32	9.53	7.28	218
Abate Fétel	25.09.2010.	6.66	7.50	6.02	10.98	15.12	8.02	212

Results and discussion

As it is well known that weather has a strong influence on fruit properties, a short description is given on the weather conditions of years 2008–2009 at the orchard near Nagykanizsa.

2008.: It was a hot summer with poor precipitate, a +41–+42 °C peak temperature in July. High temperature tried trees, there were also sunburst fruits. There was a significant damage by *Psylla pyri* and sooty mould, grown on honeydew. The continuous irrigation raised the expenses. Crop yield was relevant to the age and condition of trees. Storage was finished in February. Loss on storage was minimal. This was the best year of the interval studied.

2009 started promising, a frost-free blooming and good fruit set. The time of fruit growths was rich in precipitation. *Psylla* infection was weak. *Erwinia amylovora* and *Venturia* caused minimal problem. Afterwards two hailstorms destroyed a significant part of crop. The harvested crop was partly damaged and there was a 7–10% loss in storage.

2010 is found to be an intermittent year. The fluctuating temperature at the end of winter and beginning of March shocked the trees. The greatest problem is the poor bud differentiation of the main cultivar 'Bosc'. The night chills influenced fruit set adversely, further deteriorating the chances of fruit growth. None of the other cultivars produced the expected crop yield. Only 'Packham' approximated the expectations in yield. Because of the extraordinarily rainy weather there was a minimal need for irrigation, but the weather favoured bacterial and fungal infections.

The size and weight values measured in three consecutive

years with five cultivars are summarized as Table 2. The average weights per piece are generally lower than those given by Hudina and Štampar (2000). 'Williams' pear (Figure 1) had the lowest weight per piece in all the three crop years.

Table 3 shows the compositional characteristics of cultivars during storage. The changes in glucose, fructose and sucrose at harvest and after two and four months in ULO store can be seen on Figure 2. The water soluble solids (Brix), total sugar, sucrose and water soluble pectin were all decreasing during storage. This is not in agreement with the conclusion of work of Morvai and Molnár-Perl (1992), in



Figure 1: Williams pear at Nagykanizsa

Table 3: Characteristics of pear during storage

Cultivar	Date	Brix(degree)	Titr acidity pH 8.1 avg (g/kg CA)	Titr acidity pH 8.1 std. dev (g/kg CA)	Total poly- phenol avg (GAE mg/kg)	Total poly- phenol std. dev (GAE mg/kg)	TEAC avg (mmol/kg)	TEAC std. dev (mmol/kg)	Water soluble pectin (g/kg)
at harvest									
Bosc	02.09.2008.	16.1	1.38	0.15	143	88	1.4	0.1	1.49
Packham's Triumph	03.09.2008.	14.8	1.48	0.08	468	4	2.2	0.1	1.93
Conference	30.08.2008.	17.4	1.26	0.13	120	24	1.5	0.2	2.06
Abate Fétel	02.09.2008.	15	1.44	0.18	676	5	4.8	0.2	1.56
taken from store at 10th November, 2008									
Bosc	02.09.2008.	15.2	1.49	0.08	178	22	1.7	0	1.57
Packham's Triumph	03.09.2008.	14	1.49	0.01	411	22	2.6	0.1	1.57
Conference	30.08.2008.	16.9	1.41	0.03	134	5	1.2	0.1	1.13
Abate Fétel	02.09.2008.	14.8	1.8	0.02	836	9	5.3	0.2	1.2
taken from store at 12th January, 2009									
Bosc	02.09.2008.	14.3	1.63	0.05	251	3	1.2	0.0	1.23
Packham's Triumph	03.09.2008.	12.9	1.45	0.03	516	4	2.6	0.5	0.6
Conference	30.08.2008.	16.9	1.13	0.02	234	26	1.0	0.0	0.7
Abate Fétel	02.09.2008.	14.2	1.48	0.03	805	69	5.1	0.1	0.67

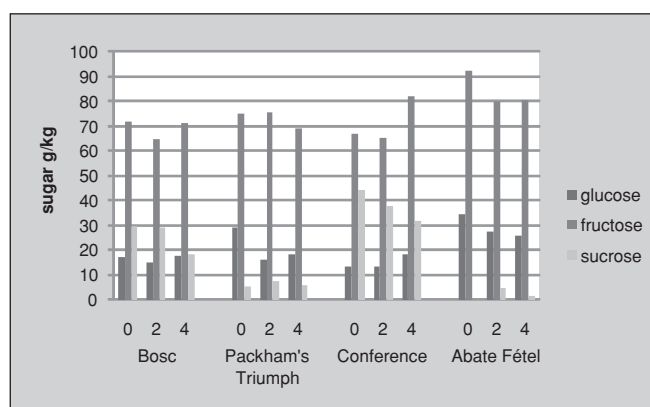


Figure 2: Change in sugar components during 4 months storage

which storage conditions were not described: Decline of water content could lead to a virtual increase of sugars and acids. According to our study, titratable acidity remained practically constant, except that slight decrease was observed in fruits of the cultivar Conference. Polyphenols and free radical scavenging capacity did not show a significant change during four months storage.

As comparing the composition of pear cultivars in three consecutive years, (Table 4 and Figure 3), 'Conference' and 'Bosc' contained the highest sucrose level, while 'Williams' pear was found to contain the highest acidity among the cultivars tested. 'Conference' had the highest total sugar content, while 'Abate Fétel' had the lowest sucrose and highest glucose of the cultivars tested. The high sucrose

content is interesting, as the AIJN Code of Practice gives an upper limit of 15 g/kg for 100% pear puree. All the sugars measured by our team are much higher (often double) than the values of *Hudina* and *Štampar* (2000) found in Slovenian grown fruits.

The content of water soluble pectin present in pears changed from 0.43 ('Williams' 2009) to 2.06 g/kg ('Conference', 2008).

Total polyphenol content and free radical scavenging activity was excellent in 'Abate Fétel' variety, followed by 'Packham's Triumph', the maximum total phenol is 836 mg/kg fresh weight. The measured polyphenol content is a bit less than the results of *Leontowicz et al.* (2002), who found about 2 g/kg for peeled pear and about 4 g/kg for peel.

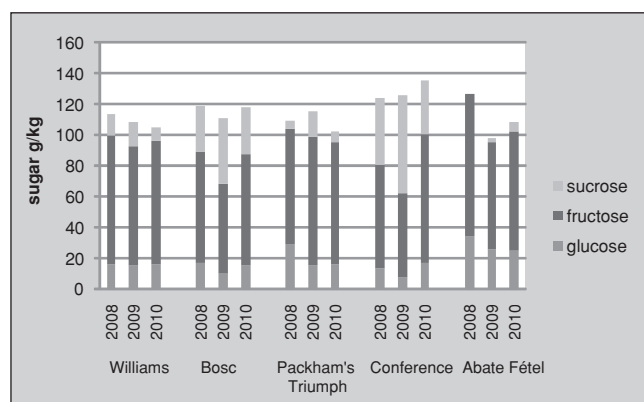
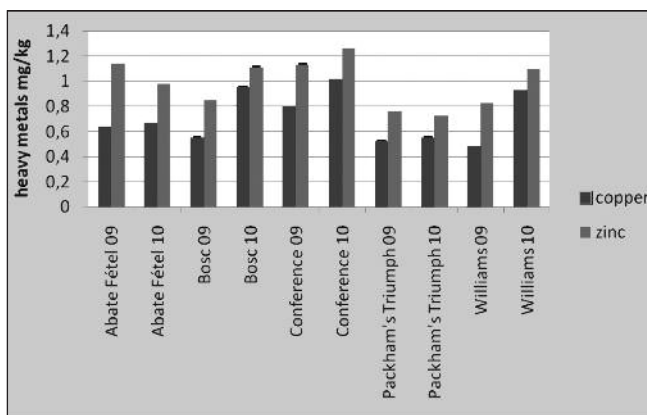


Figure 3: Main sugars of pears 2008–2010

Table 4: Characteristics of pear cultivars in 2008-2010 period

Cultivar	Date	Brix(degree)	Titr acidity pH 8.1 avg (g/kg CA)	Titr acidity pH 8.1 std. dev (g/kg CA)	Total poly- phenol avg (GAE mg/kg)	Total poly- phenol std. dev (GAE mg/kg)	TEAC avg (mmol/kg)	TEAC std. dev (mmol/kg)	Water soluble pectin (g/kg)
Williams	01.08.2008.	14.9	1.85	0.11	215	48	1.8	0	1.7
Bosc	02.09.2008.	16.1	1.38	0.15	143	88	1.4	0.1	1.49
Packham's Triumph	03.09.2008.	14.8	1.48	0.08	468	4	2.2	0.1	1.93
Conference	30.08.2008.	17.4	1.26	0.13	120	24	1.5	0.2	2.06
Abate Fétel	02.09.2008.	15	1.44	0.18	676	5	4.8	0.2	1.56
Williams	01.09.2009.	15.3	3.34	0.06	383	15	1.8	0.1	0.433
Bosc	02.09.2009.	14.3	1.34	0.1	391	67	1.6	0.1	1.777
Packham's Triumph	01.10.2009.	15	1.67	0	836	43	4.5	0	0.524
Conference	01.10.2009.	15	1.1	0.16	522	56	2.4	0.1	0.779
Abate Fétel	01.10.2009.	13.8	2.01	0.1	830	48	4.2	0.2	0.757
Williams	12.08.2010	13.1	2.52	0.02	346	40	2	0.1	1.147
Bosc	25.09.2010.	15.4	2.27	0.03	322	9	2.3	0	1.013
Packham's Triumph	25.09.2010.	13.2	1.29	0.08	396	17	2.8	0	0.792
Conference	25.09.2010.	15.9	1.63	0	200	12	1.2	0	1.01
Abate Fétel	25.09.2010.	13.5	2.08	0.05	698	18	4.6	0.1	1.11

**Figure 4:** Copper and zinc content in pears 2009–2010

Our value is similar to the sum of phenolic compounds found by Colaric et al. (2006) in 'Williams' pear (44,7–61,6 mg/100 g). Yasunori and Iki (2002) report 16,7 mg polyphenol/100 g fresh weight also in Williams pear. They detected a slight temporary increase of polyphenols in the first two weeks of storage, and a decline to the starting value at about two months of storage. Alvarez-Fernandez et al (2011), stated a value range of 0.62–0.74 mg/100 g fresh weight values for total phenols in Blanquilla pears.

Comparing the copper and zinc content of pears in two consecutive years (Figure 4), zinc was always higher. Copper in 2010 was higher in all cultivars than in 2009. Both heavy metals are well under the AIJN Code of Practice limit (5 mg/kg)

Acknowledgements

This work was financed by NFÜ TECH_08-A3/2-2008-0373 grant.

References

- Álvarez-Fernández A, Melgar JC, Abadía J & Abadía A (2011): Effects of moderate and severe iron deficiency chlorosis on fruit yield, appearance and composition in pear (*Pyrus communis* L.) and peach (*Prunus persica* (L.) Batsch). *Environmental and Experimental Botany*, 71: 280–286.
- Association of the Industry of Juices and Nectars from Fruits and Vegetables of the European Union (A.I.J.N.) (2005): Code of Practice for evaluation of fruit and vegetable juices 6-8-reference guideline for pear
- Colaric M, Štampar F, Solar A & Hudina M (2006): Influence of branch bending on sugar, organic acid and phenolic content in fruits of 'Williams' pears (*Pyrus communis* L.) *Journal of the Science of Food and Agriculture*, 86: 2463–2467.
- Colaric M, Štampar F & Hudina M (2007): Content levels of various fruit metabolites in the 'Conference' pear response to branch bending. *Scientia Horticulturae*, 113: 261–266.
- Elgar HJ, Watkins CB, Murray SH & Gunson FA (1997): Quality of 'Beurre Bosc' and 'Doyenne du Comice' pears in relation to harvest date and storage period. *Postharvest Biology and Technology*, 10: 29–37.
- Fourie PC, Hanmann CF & Oberholzer HM (1991): Sugar content of fresh apples and pears in South Africa. *Journal of Agricultural and Food Chemistry*, 39: 1938–1939.

<http://www.finel.fi/food.php?foodid=28917&lang=en>
(2011.02.22)

http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl
(2011.02.22)

Hudina M & Štampar F (2000): Sugars and organic acids contents of European (*Pyrus communis* L.) and Asian (*Pyrus serotina* REHD.) pear cultivars. *Acta Alimentaria*, 29 (3): 217–230.

IFU 26 (1995): Pectin

Leontowicz H, Gorinstein S, Lojek A, Leontowicz M, Číž M, Soliva-Fortuny R, Park YS, Jung ST, Trakhtenberg S & Martin-Belloso O (2002): Comparative content of some bioactive compounds in apples, peaches and pears and their influence on lipids and antioxidant capacity in rats. *Journal of Nutritional Biochemistry*, 13: 603–610.

Morvai M & Molnar-Perl. I (1992): Simultaneous gas chromatographic quantitation of sugars and acids in citrus fruits, pears,

bananas, grapes, apples and tomatoes. *Chromatographia*, 34 (9–10): 502–504.

MSZ EN 1140-2:1995 Fruit and vegetable juices. Enzymatic determination of D-glucose and D-fructose content. NADPH spectrometric method

MSZ EN 12146:1998 Fruit and vegetable juices. Enzymatic determination of sucrose content. NADPH spectrometric method

Souci SW, Fachmann W & Kraut H (2000): *Food composition and nutrition tables*, 6th.ed., Medpharm Scientific Publishers Stuttgart, CRC press, Boca Raton, London, New York, Washington, D.C., 1030–1031.

Yasunori H. & Iki S (2002): Changes in polyphenolic compounds and antioxidant functions in ‘Bartlett’ pear fruit during storage and postharvest ripening. *Food Preservation Science*, 28 (1): 25–32.