Polish Journal of Food and Nutrition Sciences

DE GRUYTER OPEN

Pol. J. Food Nutr. Sci., 2014, Vol. 64, No. 2, pp. 101–107
DOI: 10.2478/pjfns-2013-0006
http://journal.pan.olsztyn.pl

Original article
Section: Food Quality and Functionality

Characteristics of Selected Quality Traits of Novel Cultivars of Pumpkin (*Cucurbita Maxima* Duch.)

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Key words: pumpkin, yield, color, chemical composition, storage

Only two cultivars of pumpkin: Melon Yellow and Bambino were cultivated in Poland for a long time. Novel cultivars of this species are a significantly more valuable raw material than the old ones. The objective of this study was to characterize four novel cultivars of pumpkin in terms of yielding, weight and size of fruits, contents of dry matter and extract, pH value, and to compare them with conventionally-grown cultivar Bambino. The study demonstrated a significant effect of the season on yielding, weight and size of fruits, as well as flesh color and chemical composition. The new hybrids and cultivars (771, 774 and Justynka F_1) were characterized by considerably higher contents of dry matter and extract compared to Karowita and Bambino cultivars. Over 12 weeks of pumpkin fruits storage, no significant changes were observed in contents of dry matter and extract.

INTRODUCTION

Pumpkin (*Cucurbita maxima*) is a very valuable, though still underestimated, raw material. It fruits may be used to produce pomace juices and naturally-turbid juices, pomaces and mousses, jams and marmalades, as well as candied and dried snacks. Disadvantageous morphological traits (high weight and great sizes of fruits, empty seed case) and poor chemical composition of old pumpkin cultivars hampered their technological application on the industrial scale. For this reason, a need has emerged to develop new, more valuable cultivars of pumpkin.

At the Department of Plants Genetics, Breeding and Biotechnology, Faculty of Horticulture and Landscape Architecture, Warsaw University of Life Sciences - SGGW, investigations have been conducted for years with the aim to improve morphological and physical parameters (size of fruits, flesh thickness, color), chemical composition and health-promoting properties of pumpkin fruits. They resulted in the development of novel cultivars of pumpkin (Amazonka, Ambar, Justynka F_1, Karowita, and Otylia F_1), whilst works on another new cultivars are in progress. The novel cultivars are characterized by higher contents of dry matter, saccharides, carotenoid compounds, vitamin C, protein, and minerals [Niewczas & Mitek, 2007; Niewczas *et al*., 2005]. In addition, their fruits are smaller, which makes their culinary and industrial utilization easier [Korzeniewska *et al*., 2004; Konopacka *et al*., 2010; Sojak & Głowacki, 2010]. Fruits of these novel cultivars do not have the empty case in the seed core, which increases their resistance to damages, *e.g.* during transport, but also extends their shelf life. Small and medium fruits are also easier to harvest and store [Iacuzzo & Dalla Costa, 2009; Seroczyńska *et al*., 2007].

Sparse works have so far been available in Poland on the chemical composition and physical parameters of fruits of novel pumpkin cultivars. Insufficient is also the knowledge on their usability for storage and on changes they undergo in the storage period. Complete characteristics of novel cultivars of pumpkin and their introduction to commercial production as well as dissemination of knowledge on their high nutritive values shall result in increased interest in this raw material in Poland.

MATERIAL AND METHODS

The study material were fruits of two novel cultivars of pumpkin *(Cucurbita maxima* Duch.*)*: Justynka F_1 and Karowita, and of two experimental hybrids (771 and 774). A conventionally-grown cultivar Bambino was used as the reference cultivar. The experiment was conducted in three successive years (2004, 2005 and 2006) on grey-brown podzolic soil, at the experimental field "Wolica", belonging to the Department of Plants Genetics, Culture and Biotechnology, Faculty of Horticulture and Landscape Architecture, Warsaw University of Life Sciences. The experiment was established with the method of randomized blocks in 4 replications, with 12 plants per plot sown from seeds directly to the soil at the spacing of 1x1.6 m. Cultivation measures were limited to thinning and regular weed control.

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TABLE 1. Mean air temperature and precipitation sums in the vegetation period of winter squash.

Month	Temperature (°C)				Rainfalls (mm)			
	2004	2005	2006	Long-term	2004	2005	2006	Long-term
May	12.8	14.3	14.5	14.2	52.9	56.3	62.2	51.6
June	16.6	16.8	18.6	17.1	38.8	56.0	30.7	70.8
July	18.6	21.0	23.8	18.6	57.8	74.7	23.4	75.2
August	19.8	18.6	18.3	18.2	52.0	8.6	194.9	59.6
September	14.5	16.6	16.2	13.5	20.1	32.6	30.6	49.0

TABLE 2. Yield of marketable fruit ($t \cdot ha^{-1}$).

Years	Cultivar					Mean
	771	774	Justynka F_1	Karowita	Bambino	
2004	26.81^{aA}	31.31^{aB}	31.13^{aB}	28.31^{aA}	42.69^{aC}	32.05^{a}
2005	26.94^{aA}	28.56^{aA}	38.94^{bB}	29.13^{aA}	50.81^{aC}	34.87^{a}
2006	48.06^{bBC}	51.06^{bC}	40.38^{bB}	29.13^{aA}	62.94^{bD}	46.31^{b}
Mean	33.94^{A}	36.98^{A}	36.82^{A}	28.86^{A}	52.15^{B}	37.75

Values as denoted by the same large letter in the lines, and small letter in the columns, do not statistically significantly differ at $\alpha=0.05$.

Pumpkin fruits were collected at the end of September, at the stage of full ripeness. Commercial yield and mean weight of commercial fruits were determined within the 3-year study period. Since the beginning of October till the end of December, the fruits were stored in a non-heated foil tunnel, where they were protected against frost. The storage temperature reached *ca*. 8–10°C. After the harvest, the weight, yield and size of fruits, as well as flesh thickness were determined. The flesh of the fruits was analyzed immediately after harvest and during storage using for: content of dry matter [PN-90/A-75101/03], total extract content [PN-90/A-75101/02], active acidity [PN-90/A-75101/06], and color parameters (L*a*b*). Color measurements were carried out using a Konica Minolta CM-3600d spectrophotometer, at diaphragm of 8 mm, observer of 10° and light of D65. The measurements were conducted at pericarp cross-section with the length of *ca*. 5 cm, cut out from the central part of the specimen of pumpkin fruits collected for analyses. At each fragment of the pericarp, 9 measurements were carried out at different sites.

Fruits of the evaluated cultivars and hybrids of pumpkin were analyzed in four terms: term I – immediately after the harvest, term II – 4 weeks after the harvest, term III – 8 weeks after the harvest, and term IV – 12 weeks after the harvest. At each of these terms, 6 fruits of each cultivar were collected. Next, from each of these fruits, sections of flesh were collected with sizes of *ca*. 15 × 15 cm from the part of the fruit most exposed to sun. The sunny side is opposite to the shaded side – resting on the ground, having a lighter color and a flattened surface. The pieces of flesh were peeled manually, de-stoned, disintegrated, and subject to immediate heating in a microwave oven by Amica (3 min, 750W) in order to inactivate enzymes. Next, they were rapidly cooled, packed to 100-mL jars, frozen and stored at a temperature of -18°C until analyzed. Each of the six fruits of the investigated cultivar was analyzed separately.

Two out of the five analyzed cultivars and hybrids were characterized by a shorter storage period in particular study years, *i.e*. 771 hybrid and Karowita cv. In turn, in the years 2004 and 2005, the 771 hybrid could not be analyzed in term IV owing to spoilage. Further on, Karowita cv. was subject to spoilage before term IV (*i.e.* after 10 weeks of storage) in the year 2004, whereas in the year 2006 its spoilage occurred exceptionally early, namely before term III (*i.e.* after 6 weeks of storage).

Results achieved in the study were analyzed statistically using two-way analysis of variance. The significance of differences was verified with the Tukey's test at a=0.05. All computations were made with the Statgraphics 5.0 software.

RESULTS AND DISCUSSION

The individual study years differed between each other in temperature and precipitation (Table 1). These differences affected, to a various extent, morphological parameters and chemical composition of pumpkin fruits.

Exceptionally warm was the year 2006, when higher temperatures were noted in the vegetative season, compared to the multi-year average. In all three years of the study, the temperatures recorded in July and September were also higher than the multi-year average.

In terms of precipitation, May of 2004–2006 was characterized by values exceeding the multi-year average. August which in 2005 was an exceptionally dry month (sum of precipitation: 8.6 mm), in 2006 turned out to be exceptionally wet (sum of precipitation: 194.9 mm).

Weather conditions in the successive years of the study had a significant impact on the yield of pumpkin (Table 2). For most of the investigated cultivars, the highest commercial yield was noted in 2006, and the mean yield for the five analyzed cultivars was in that season higher by over 10 $t \cdot ha^{-1}$ than in the two previous years. For cultivars 771 and 774, the yield in 2006 was almost 2-fold higher than in the previous years. The weather conditions varying in particular years of the study had no significant effect on differences

TABLE 3. Average weight of marketable fruit (kg).

Years	Cultivar					Mean
	771	774	Justynka F_1	Karowita	Bambino	
2004	2.05^{aD}	4.08^{aB}	2.39^{abC}	2.42^{bC}	8.76^{aA}	3.94^{a}
2005	2.08^{aD}	3.85^{abB}	2.50^{aC}	2.85^{abC}	8.53^{aA}	3.96^{a}
2006	1.95^{bC}	3.64^{bB}	2.02^{bC}	3.16^{aB}	8.98^{aA}	3.95^{a}
Mean	2.03^{C}	3.86^{B}	2.30^{C}	2.81^{C}	8.76^{A}	3.95

Explanatory notes as in Tab. 2

TABLE 4. Dimensions and thickness of fruit flesh (cm).

Attribute	Years	Cultivar					Mean
		771	774	Justynka F_1	Karowita	Bambino	
Height	2004	11.2^{aC}	20.3^{aA}	15.0^{abB}	10.9^{bC}	22.0^{bA}	15.9^{a}
	2005	11.3^{aD}	20.8^{aA}	13.8^{bC}	10.6^{bD}	21.0^{bA}	15.5^{a}
	2006	11.0^{aE}	22.1^{aB}	17.2^{aC}	13.3^{aD}	29.9^{aA}	18.7^{a}
	mean	11.2^{C}	21.1^{A}	15.3^{B}	11.6^{C}	24.3^{A}	16.7
Width	2004	20.2^{aA}	21.6^{aA}	19.7^{aB}	17.6^{bC}	23.4^{aA}	20.5^{a}
	2005	20.1^{aA}	18.9^{aB}	20.6^{aA}	17.2^{bB}	24.1^{aA}	20.2^{a}
	2006	18.5^{aC}	20.5^{aB}	17.8^{bC}	20.4^{aB}	28.2^{aA}	21.1^{a}
	mean	19.6^{A}	20.3^{A}	19.4^{A}	18.4^{A}	25.2^{A}	20.6
Ratio	2004	0.6^{aB}	0.9^{aA}	0.8^{abAB}	0.6^{aB}	1.0^{aA}	0.8^{a}
	2005	0.6^{aB}	1.1^{aA}	0.7^{bB}	0.6^{aB}	0.9^{aA}	0.8^{a}
	2006	0.6^{aB}	1.1^{aA}	1.0^{aA}	0.7^{aB}	1.1^{aA}	0.9^{a}
	mean	0.6^{B}	1.0^{A}	0.8^{AB}	0.6^{A}	1.0^{A}	0.8
Flesh thickness	2004	3.9^{abA}	3.4^{aA}	3.8^{aA}	3.3^{aA}	3.0^{bA}	3.5^{a}
	2005	4.1^{aA}	3.3^{aB}	3.3^{aB}	3.4^{aB}	3.0^{bB}	3.4^{a}
	2006	3.3^{bB}	4.2^{bA}	3.3^{aB}	3.8^{aAB}	4.6^{aA}	3.8^{a}
	mean	3.8^{A}	3.6^{A}	3.5^{A}	3.5^{A}	3.5^{A}	3.6

Explanatory notes as in Tab. 2

in Karowita cv. yielding, which indicates it to be an exceptionally stable cultivar in this respect. However, its mean commercial yield of the years 2004–2006 was the lowest out of all analyzed cultivars – 28.86 t·ha^{-1}. A similar mean yield, reaching 33.94–36.98 t·ha^{-1}, was observed for cultivars 771, 774 and Justynka F_1. The most fertile turned out to be Bambino cv. – 52.15 t·ha^{-1}. In the case of this cultivar, Sztangret *et al*. [2001] achieved the commercial yield ranging from 48.10 to 51.73 t·ha^{-1} in a three-year study period, whereas a higher yield accounting for 74.20 t·ha^{-1} was reported by Niemirowicz-Szczytt *et al*. [1996].

The mean weight of fruits of the investigated pumpkin cultivars was significantly differentiated by the cultivar (Table 3). Fruits of cultivars 771, Justynka F_1 and Karowita were the smallest, with the mean weight of a single fruit ranging from 2.03 (hybrid 771) to 2.81 kg (Karowita cv.). Medium size fruits with the weight of 3.86 kg were reported for 774 hybrid, whereas the highest weight of fruits reaching 8.76 kg on average was noted for Bambino cv.

The mean weight of pumpkin fruits immediately after the harvest differed in particular study years (Table 3). Those years were characterized by diversified atmospheric conditions, which evoked various effects on each of the cultivars. The most equalized weight of fruits in particular study seasons was observed for Bambino cv. and for 771 hybrid. The remaining cultivars responded differently to atmospheric conditions occurring in the successive years of the study. For the experimental hybrid 771, the highest mean weight of fruits was achieved in the years 2004–2005. In turn, the size of fruits of 774 hybrid and Justynka F_1 cv. was positively affected by weather conditions in seasons 2005 and 2004, respectively, whilst in the year 2006, the largest fruits were obtained from Karowita and Bambino cultivars. Different genotypes may respond individually to atmospheric conditions in particular years [Harvey *et al*., 1997; Seroczyńska *et al*., 2007].

The investigated cultivars and hybrids of pumpkin differed between each other also in terms of the size of their fruits (Table 4). The smallest height of fruits was noted in the case of 771 hybrid and Karowita cv., with the mean height in the range of 11.2–11.6 cm. Higher fruits were these of Justynka F_1 cultivar – 15.3 cm, whereas fruits with height over 20 cm originated from 774 and Bambino cultivars – with the mean height of their fruits accounting for, respectively 21.1 and 24.3 cm.

TABLE 5. Colour parameters of fruit flesh.

Colour parameters	Cultivar					Mean
	771	774	Justynka F_1	Karowita	Bambino	
L*	65.98^{C}	69.67^{AB}	68.60^{A}	67.52^{B}	66.49^{BC}	67.65
a*	27.03^{A}	26.41^{AB}	27.11^{A}	24.63^{B}	26.39^{A}	26.31
b*	50.61^{B}	54.83^{A}	54.24^{A}	51.72^{B}	49.71^{B}	52.22

Values as denoted by the same large letter in the lines do not statistically significantly differ at $\alpha=0.05$.

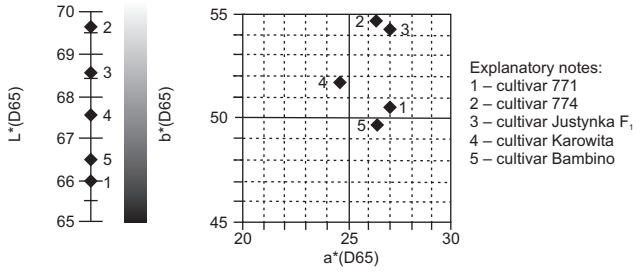

FIGURE 1. Mean values L*, a*, b* parameters of fruit flesh of examined pumpkin cultivars.

Apart from Bambino cv. (25.2 cm), the analyzed cultivars of pumpkin differed significantly in terms of mean width of fruits (18.4–20.3 cm) (Table 4).

The mean shape coefficient calculated based on the height and width of fruits was the lowest for 771 hybrid and Karowita cv., and reached 0.6 (Table 4). Less flattened fruits with the shape coefficient of 0.8 were observed for Justynka F_1 cultivar. In turn, fruits with the most spherical shape were these of 774 hybrid and Bambino cv., with the shape coefficient of 1.0.

No significant differences were noted between the cultivars in flesh thickness. Their mean flesh thickness ranged from 3.5 to 3.8 cm. According to Jędrzejczak & Szemiel [1981], the minimal flesh thickness of pumpkin fruits suitable for processing reaches 3 cm, which means that all cultivars analyzed in our study may be used for industrial processing.

Figure 1 and Table 5 present mean color parameters of fruit flesh of pumpkin cultivars examined in 2006.

The mean value of L* parameter describing brightness of the flesh of analyzed pumpkin fruits was the highest in the case of 774 hybrid (69.67), and the lowest in the case of 771 hybrid (65.98) (Table 5, Figure 1). The statistical analysis confirmed differences in brightness of flesh color between the cultivars. Nawirska-Olszańska [2011] also demonstrated significant differences between six analyzed cultivars of pumpkin in terms of color brightness, with values of this parameter ranging from 52.67 to 61.08. In turn, in the investigated pumpkin cultivars Cumarasamy *et al*. [2002] determined values of L* parameter to range from 61.58 to 65.58, whereas in cultivars analyzed by Thomson *et al.* [2001] values of this parameter ranged from 67.57 to 74.17.

Mean values of a* parameter, denoting the red color, fitted within the range from 24.63 in Karowita cv. to 27.11 in Justynka F_1 cv. (Table 5, Figure 1). The mean value of this parameter differed statistically significantly between the cultivars. In pumpkin cultivars analyzed by Nawirska-Olszańska [2011], the value of a* parameter ranged from 17.73 to 26.06, whilst in cultivars examined by Cumarasamy *et al*. [2002] from 15.99 to 20.52. Considerably lower values, ranging from 3.4 to 3.7, were noted by Bycroft *et al*. [1999].

The b* parameter represents the yellow color. In the investigated pumpkin cultivars, its mean value in fruit flesh was the lowest in Bambino cv. (49.71) and the highest in 774 hybrid (54.83) (Table 5, Figure 1). Mean values of this parameter assayed in fruits of Justynka F_1 cv. and 774 hybrid were significantly higher than in the other cultivars. The results achieved were remarkably lower than those reported by Cumarasamy *et a*l. [2002], who for the analyzed cultivars of pumpkin determined values of b* parameter in the range of 68.00 to 72.56. In turn, Nawirska-Olszańska [2011] achieved results fitting within the range of 40.09 to 47.72, thus being lower than in our study.

The chemical composition of the analyzed pumpkin fruits was found to depend on three main factors, these being: cultivar, storage time after harvest, and vegetative season (2004––2006).

The mean content of dry matter in fruits of most of the analyzed pumpkin cultivars was significantly higher in years 2004 and 2005 than in the year 2006 (Table 6). An exception was Bambino cv., in which slightly higher dry matter content was determined in 2006 than in the previous years.

Immediately after the harvest (term I of analyses), the content of dry matter in particular cultivars was significantly diversified. The highest dry matter content was assayed for fruits of: 771 and Justynka F_1 (respectively: 17.3 and 17.0%). The novel hybrid cultivar 774 was characterized by dry matter content of 14.1 %, whereas Karowita and Bambino cultivars – by dry matter content of 9.7 and 7.1 %, respectively.

During storage of the analyzed pumpkin fruits, changes were observed in their dry matter content, however the mean differences were not statistically significant (Table 6).

Dry matter content of fruits is subject to fluctuations during storage, which is due on the one hand to respiration processes and on the other hand to simultaneously proceeding transpiration [Gajewski, 2001].

Based on the results obtained by Seroczyńska *et al*. [2007] and those achieved in our study, it may be concluded that Bambino cv. demonstrates the least differences in the mean dry matter content in different study years.

Nawirska-Olszańska [2011] was analyzing 5 cultivars of pumpkin after harvest and after 3 months of storage. In most of them, a decrease was observed in dry matter content after the storage. Similar dependencies were noted in the reported study.

TABLE 6. Dry matter content (%).

Years	Period	Cultivar					Mean
		771	774	Justynka F_1	Karowita	Bambino	
2004	I	20.1^{aA}	15.1^{bB}	19.6^{aA}	10.2^{aC}	6.7^{bD}	14.3^{a}
	II	17.2^{bA}	15.6^{abA}	16.9^{bA}	10.1^{aC}	6.7^{bD}	13.3^{a}
	III	18.0^{bA}	16.3^{aB}	16.6^{bAB}	10.4^{aC}	7.5^{aD}	13.8^{a}
	IV	-	14.8^{bB}	15.8^{cA}	-	6.4^{bC}	12.3^{a}
	mean	18.4^{A}	15.5^{B}	17.2^{AB}	10.2^{C}	6.8^{D}	13.6
2005	I	17.5^{aA}	15.7^{aB}	17.7^{aA}	9.8^{aC}	7.1^{aD}	13.6^{a}
	II	15.0^{bA}	14.4^{bA}	14.8^{bA}	9.4^{aB}	7.2^{aC}	12.2^{a}
	III	17.0^{aA}	15.6^{aB}	17.6^{aA}	9.8^{aC}	6.5^{aC}	13.3^{a}
	IV	-	15.2^{aA}	16.9^{aA}	10.0^{aB}	6.5^{aC}	12.2^{a}
	mean	16.5^{AB}	15.2^{B}	16.8^{A}	9.8^{C}	6.8^{D}	13.0
2006	I	14.3^{bA}	11.4^{cB}	13.6^{bA}	9.0^{aC}	7.6^{aD}	11.2^{a}
	II	13.0^{cA}	12.6^{bAB}	12.3^{cB}	6.9^{bC}	7.0^{bC}	10.4^{a}
	III	15.0^{aC}	14.5^{aA}	14.7^{aA}	-	7.0^{bB}	12.8^{a}
	IV	14.3^{bA}	11.3^{cC}	13.5^{bB}	-	6.7^{bD}	11.5^{a}
	mean	14.2^{A}	12.5^{B}	13.5^{AB}	8.0^{C}	7.1^{C}	11.0
Mean (2004–2006)	I	17.3^{aA}	14.1^{aB}	17.0^{aA}	9.7^{aC}	7.1^{aD}	13.0^{a}
	II	15.1^{abA}	14.2^{aA}	14.7^{aA}	8.8^{aB}	7.0^{aC}	11.9^{a}
	III	16.7^{aA}	15.5^{aA}	16.3^{aA}	10.1^{aB}	7.0^{aC}	13.1^{a}
	IV	14.3^{bA}	13.8^{aB}	15.4^{aA}	10.0^{aC}	6.5^{aD}	12.0^{a}
Mean		15.8^{A}	14.4^{A}	15.8^{A}	9.6^{B}	6.9^{B}	12.5

Values as denoted by the same large letter in the lines, and small letter in the columns, do not statistically significantly differ at $\alpha=0.05$;
I – no storage; II – after 4 weeks of storage; III – after 8 weeks of storage; IV – after 12 weeks of storage.

Dry matter content in determined cultivars: Karowita and Bambino is consistent with that provided by literature, range from 5.9 to 12.4% for Karowita cv., and from 4.5 to 11.4% for Bambino cv. [Gajewski *et al*., 2008; Konopacka *et al.*, 2010; Nawirska *et al*., 2008; Nawirska-Olszańska, 2011; Paulaskiene *et al*., 2006; Seroczyńska *et al*., 2007].

In turn, Konopacka *et al*. [2010] found that mean dry matter content accounted for 11.4 % in Justynka F1 cv., which is also consistent with the results obtained in the present study. The results of analyzes of hybrids 771 and 774 have not been previously reported in the literature.

Literature data indicate that in novel cultivars of pumpkin the content of dry matter may reach even up to 18%, whereas in older cultivars, *i.e.* Bambino or Melonowa Żółta, it may range from 5 to 9% [Danilchenko *et al*., 2004; Korzeniewska & Niemirowicz-Szczytt, 1992; Niemirowicz-Szczytt *et al*., 1996; Sztangret *et al*., 2001].

Analyzing dry matter content in other cultivars of pumpkin available in the literature a high diversity can be seen in this regard. Pumpkins can be divided into three groups: cultivars with low content of dry matter ranging from 8.1 to 11.3% [Corrigan *et al*., 2006; Guiné *et al*., 2011; Souci *et al*., 2008], cultivars with medium content ranging from 14.5 to 19.6% [Corrigan *et al*., 2006], and cultivars with high content of dry matter at the level of 21.1 to 33.2% [Corrigan *et al*., 2006; Cumarasamy *et al*., 2002; Hurst *et al*., 1995]. The investigated cultivars Karowita and Bambino belong to the group with a low content of dry matter, whereas Justynka F_1 cv., hybrids 771 and 774 belong to the group with a medium content of this parameter. It can be said the value of this parameter is highly dependent on the cultivars of pumpkin.

According to Niemirowicz-Szczytt *et al*. [1996], the high content of dry matter assures long storage period of fruits. In the case of the analyzed pumpkin cultivars, this proved true only for Justynka F_1 cv. and 774 hybrid. Correlations observed in our study between dry matter content and length of the storage period were not always consistent with the observation reported in literature. It means, therefore, that the length of storage period depends not only on genetic factors but also on cultivation conditions occurring in particular season.

Soluble solid content of different pumpkin fruits harvested between 2004–2006 and stored for 12 weeks is collected in Table 7. The highest content corresponded to 771 and 774 hybrids and Justynka F1 cultivar (11%), followed by Karowita cv. (8.2%) and, finally cv. Bambino (6.0%). These results are consistent with those presented by Krzysik & Bogucka [1981] for cv. Bambino and other novel pumpkin cultivars.

The highest mean content of extract in fruits of most of the analyzed cultivars and hybrids was determined in 2005. An exception was 771 hybrid, in the case of which the highest extract content was noted in 2004. The worst season in terms of this parameter turned out to be the year 2006. Only in Bambino cv. was the extract content slightly higher in 2006 than in 2004.

During storage the content of soluble solids did not change significantly ($P<0.05$) for the 12 studied weeks (Table 7).

TABLE 7. Soluble solids content (%).

Years	Period	Cultivar					Mean
		771	774	Justynka F_1	Karowita	Bambino	
2004	I	14.5^{aA}	11.3^{cC}	12.0^{cB}	8.8^{aD}	6.1^{aE}	10.5^{a}
	II	13.1^{cA}	10.5^{dC}	11.1^{dB}	7.5^{bD}	5.1^{cE}	9.5^{a}
	III	14.0^{bA}	12.5^{aC}	13.5^{aB}	8.7^{aD}	5.9^{aE}	10.9^{a}
	IV	-	11.8^{bB}	12.5^{bA}	-	5.4^{bC}	9.9^{a}
	mean	13.9^{A}	11.5^{B}	12.3^{B}	8.3^{C}	5.6^{D}	10.3
2005	I	12.6^{bB}	12.9^{aB}	13.8^{aA}	8.7^{bC}	5.6^{bD}	10.7^{a}
	II	11.6^{cA}	12.3^{aA}	10.3^{bB}	7.9^{cC}	6.4^{aD}	9.6^{a}
	III	13.7^{aA}	12.3^{aB}	13.7^{aA}	8.6^{bC}	6.3^{aD}	10.9^{a}
	IV	-	12.5^{aB}	13.9^{aA}	9.1^{aC}	6.3^{aD}	10.5^{a}
	mean	12.6^{A}	12.5^{A}	13.8^{A}	8.6^{B}	6.2^{C}	10.7
2006	I	6.9^{cC}	9.3^{bA}	7.9^{bB}	7.0^{aC}	6.4^{aC}	7.5^{a}
	II	9.0^{bB}	10.5^{aA}	10.0^{aA}	6.0^{bC}	6.3^{aC}	8.4^{a}
	III	9.1^{bB}	10.2^{aA}	9.8^{aA}	-	5.1^{bC}	8.6^{a}
	IV	11.3^{aA}	8.9^{bC}	10.1^{aB}	-	5.4^{bD}	8.9^{a}
	mean	9.1^{A}	9.7^{A}	9.5^{A}	6.5^{B}	5.8^{B}	8.3
Mean (2004–2006)	I	11.3^{aA}	11.2^{aA}	11.2^{aA}	8.2^{aB}	6.0^{aC}	9.6^{a}
	II	11.2^{aA}	11.1^{aA}	10.5^{aA}	7.1^{aB}	5.9^{aB}	9.2^{a}
	III	12.3^{aA}	11.7^{aA}	12.3^{aA}	8.7^{aA}	5.8^{aC}	10.2^{a}
	IV	11.3^{aA}	11.1^{aA}	11.7^{aA}	9.1^{aB}	5.7^{aC}	9.8^{a}
Mean		11.5^{A}	11.3^{A}	11.4^{A}	8.3^{A}	5.9^{A}	9.7

Explanatory notes as in Tab. 6

TABLE 8. pH of fruit flesh.

Years	Cultivar					Mean
	771	774	Justynka F_1	Karowita	Bambino	
2004	7.5^{aA}	6.9^{aAB}	7.3^{aA}	$6.9^{a\ B}$	6.6^{aB}	7.0^{a}
2005	7.0^{abAB}	7.0^{aA}	7.4^{aA}	6.9^{aB}	6.7^{aB}	7.0^{a}
2006	6.7^{bA}	6.5^{bA}	7.1^{aA}	6.4^{bB}	6.7^{aB}	6.7^{a}
Mean	7.1^{A}	6.8^{A}	7.3^{A}	6.7^{A}	6.6^{A}	6.9

Explanatory notes as in Tab. 2

According to literature, the content of extract in pumpkin fruits is in the range from 2.4 to 14.0% [Danilchenko, 2000; Harvey *et al*., 1997; Nawirska-Olszańska, 2011], which is consistent with results achieved in the present study.

Table 8 presents mean pH values of the analyzed pumpkin fruits. Owing to a low acidity (ranging from 0.07 to 0.17 g of citric acid/100 g f.w.), the pH value of pumpkins was close to neutral. Depending on cultivar, the mean pH value of pumpkin fruits ranged from 6.4 to 7.5. In turn, in the analyzed eleven cultivars of pumpkin, Paulauskiene *et al*. [2006] noted the pH value to range from 5.9 to 7.0.

CONCLUSIONS

The vegetative season had a significant effect on the yield, weight and chemical composition of fruits of the analyzed pumpkin cultivars.

The novel hybrids 771 and 774, and Justynka F_1 cv. were characterized by significantly higher contents of dry matter and extract compared to Karowita and Bambino cultivars.

During 12 weeks of storage, no significant changes were observed in dry matter and extract contents of the five analyzed pumpkin cultivars.

Out of the analyzed novel cultivars and hybrids, worthy of special attention are Justynka F_1 cv. and 774 hybrid, that could be stored for 12 weeks in all three years of the study. Also they were characterized by significantly more favorable chemical composition, which increases their technological usability.

Justynka F_1 cv. and the 774 hybrid can be successfully used to obtain products such as purees, pickles, frozen food, candied fruit, dried fruit, naturally cloudy juices and jams.

ACKNOWLEDGEMENTS

The study was financed from statutory funds of the Warsaw University of Life Sciences (SGGW), Poland.

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Submitted: 18 July 2013. Revised: 17 January 2014. Accepted: 22 January 2014. Published on-line: 23 April 2014.