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DIVERSITY OF THE UTILITY AND BIOLOGICAL VALUE OF FRUITS OF SOME SWEET PEPPER CULTIVARS

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Abstract. Consumer attractiveness and the usefulness for food processing of sweet pepper are determined by fruits quality values. The large weight, thick pericarp and intensive color at physiological ripeness as well as the share of pericarp to the fruit weight are most important. Such sweet pepper cultivars are now available in Poland. These cultivars are adopted to growing in less favourable environmental conditions and they reveal high stability. The aim of this study was evaluate the open field yielding and comparing the utility and biological value of fruits of seven sweet pepper cultivars adapted to growing under less favorable environmental conditions in terms of the fresh vegetables market usefulness for consumption and processing. The highest average marketable yield of fruits was achieved from 'Caryca F_1' cv., which was larger in comparison to the yield of 'Roberta F_1' and 'Jova' cvs. The yield of remaining cultivars was not significantly different from 'Caryca F_1'cv. Evaluated cultivars showed a great diversity in terms of their utility and biological value of fruits. The 'Mino' cv. was distinguished by the largest weight fruits while 'Jova' cv. by thick pericarp. The great weight of fruit, pericarp thickness and the great weight of edible parts of fruits was shown by 'Caryca F_1' cv., while in a view of the assessed parameters of biological value the most L-ascorbic acid were contained 'Roberta F_1', 'Robertina', 'Corrida F_1' cv. fruits and the extract 'Roberta F_1' cv. fruits.

Key words: *Capsicum annuum* L., fruit quality, marketable yield, vitamin C

INTRODUCTION

The sweet pepper (*Capsicum annuum* subsp. *macrocarpum* L.) belongs to the economically important vegetables of the global reach. This vegetable is popular mainly due to its pro-health properties and taste [Perucka and Materska 2003, Pokluda 2004, Navarro et al. 2006, Topuz and Ozdemir 2007]. This plant comes from regions of warmer climate and it has the large environmental requirements. The yielding of sweet

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pepper in an open field cultivation in less favorable conditions is dependent on the air- and soil temperature in the vegetation period and assortment of the cultivar. Availability of cultivars adapted to growing in less favorable climate for pepper plants and increasing interest of the processing industry in Poland leads to the cultivation of the sweet pepper in the open field on the commercial scale [Kmiecik and Lisiewska 1994, Gajc-Wolska and Skąpski 2002, Buczkowska 2007, Rożek et al. 2012]. Manufacturers have many cultivars both of the native breeding and foreign origin [Buczkowska 2007, Gajc-Wolska et al. 2007]. Yielding in the field of these cultivars in the temperate climate zone is characterized by a relatively high stability, especially in the case of hybrids [Gajc-Wolska and Skąpski 2002, Gajc-Wolska et al. 2007, Korzeniewska and Niemirowicz-Szczytt 2007, Szafirowska and Elkner 2008, 2009]. Fruits of sweet pepper are a rich source of antioxidants, the most important of which is vitamin C present in significant quantities [Kmiecik and Lisiewska 1994, Lee and Kader 2000, Buczkowska and Najda 2002, Perucka and Materska 2003, Orłowski et al. 2004, Pokluda 2004, Frary et al. 2008, Szafirowska and Elkner 2008]. Sweet pepper also accumulates remarkable amounts of minerals, while ripe fruits are the source of carotenoids [Kmiecik and Lisiewska 1994, Perucka and Materska 2003, Pokluda 2004, Gajc-Wolska et al. 2007, Topuz and Ozdemir 2007, Jadczak et al. 2010, Buczkowska and Michałojć 2012]. Dry matter, sugar, and extract contents are also important parameters of the biological value of sweet pepper [Kmiecik and Lisiewska 1994, Gajc-Wolska and Skąpski 2002, Dasgan and Abak 2003, Orłowski et al. 2004, Gajc-Wolska et al. 2007, Buczkowska and Sawicki 2008, Michalik 2010].

For consumers, the sweet pepper fruits characterized by large weight, thick pericarp, and intensive color at full ripeness, are the most attractive [Gajc-Wolska and Skąpski 2002, Nowaczyk et al. 2005, Korzeniewska and Niemirowicz-Szczytt 2007, Nowaczyk and Nowaczyk 2007, 2008, Szafirowska and Elkner 2009, Jadczak et al. 2010]. The value of raw fruits of a given sweet pepper cultivar is determined by the pericarp weight, sometimes referred to as biological fruit weight, as well as the technological fruit weight, which is the biological weight of fruit minus the weight of pericarp at the calyx [Nowaczyk and Nowaczyk 2007, Szafirowska and Elkner 2008, Nowaczyk et al. 2008]. In commercial cultivation of sweet pepper for the industry, the important properties, which determine the suitability of a cultivar are accepted the biological and technological efficiency of the fruit, which are, respectively: percentage of the biological weight of fruit and technological weight of fruit in relation to the fruit weight (%) [Nowaczyk and Nowaczyk 2007, Nowaczyk et al. 2005, 2008].

The aim of this study was to evaluate the yielding and characteristics of fruits of seven sweet pepper cultivars growing in open field in terms of selected parameters of utility and biological value.

MATERIAL AND METHODS

The study was conducted in 2006–2008 in a private farm in Zezulin (51.35°N, 22.85°E) near the city of Lublin, in the lessive soil developed from the loess formations on lime marls containing 1.8% of organic matter in the plow layer. Winter wheat was

the forecrop for sweet pepper. Every year in autumn, the organic fertilization using manure was applied at the rate of 30 t·ha^{-1}. Depending on a year, mineral nutrients contents in the soil were as follows: N-NO_3 15–45, P 90–125, K 100–140, Ca 700–1150, Mg 70–115 mg·dm^{-3}. Mineral fertilization was used two weeks before seedlings planting in quantities: 90–100 kg N (ammonium nitrate), 50–60 kg P (triple superphosphate), 110–130 kg K (potassium sulfate) per 1 hectare. Sweet pepper was foliar-treated: twice with calcium nitrate (1%) and twice with Florovit (0.5%). Sweet pepper was grown from the seedlings in pots prepared in the greenhouse of The University of Life Science in Lublin, The Experimental Station, Lublin-Felin. The tempered seedlings were planted in the field in the third decade of May at spacing 0.67 m × 0.35 m, thus 4.26 plants grew per 1 m^2. Material consisted of fruits of seven sweet pepper cultivars: 'Roberta F_1', 'Robertina', 'Corrida F_1' (Department of Plant Genetics, Breeding, and Biotechnology, SGGW Warsaw), 'Mino' (Capsi-Nova L. and P. Nowaczyk), 'Caryca F_1' (PlantiCo Gołębiew), as well as 'Marysia' and 'Jova' (Czech cultivars, seed distributor – Oseva Polska LTD), which are of a great productive importance in Poland now.

Table 1. Air temperature and total precipitation in 2006–2008 years against a background of many-year averages

	Years	Months				
		May	June	July	August	September
Air temperature (°C)	2006	13.6	16.9	21.9	17.3	15.7
	2007	14.9	18.1	19.1	18.4	12.9
	2008	12.7	17.7	18.3	19.3	12.6
	1951–2005	13.0	16.4	17.8	17.1	12.6
Total precipitation (mm)	2006	59.5	37.9	6.8	198.3	11.0
	2007	80.5	87.8	87.0	37.6	129.8
	2008	101.6	85.9	77.1	45.0	102.2
	1951–2005	57.7	65.7	83.5	68.6	51.6

The experiment was set up as univariate by means of randomized blocks in 4 replicates with 40 plants per plot. The area of each plot was 9.4 m^2. Fruits were harvested at physiological ripeness stage, separately from each replicate, and then total and marketable yield of fruits were assessed. The harvest was carried out from the 2nd decade (cultivars: 'Roberta F_1', 'Robertina', 'Mino', 'Marysia', 'Jova') or from the 3rd decade of August ('Caryca F_1', 'Corrida F_1') to the 3rd decade of September (a final harvest). Fruits randomly selected from each harvest (5 fruits per replicate) were subject to determination of the following utility features: fruit weight (g), then after excision of inedible parts, the pericarp weight, i.e. the biological weight of fruit, and after cutting out the pericarp at the calyx, so-called technological weight of fruit, as well as the pericarp thickness using digital caliper (mm) [Nowaczyk and Nowaczyk 2007, Nowaczyk et al. 2005, 2008]. Each year after the harvest complete, yielding of studied cultivars was

evaluated and the percentage of biological and technological weight of fruit in relation to the whole fruit was calculated, thus determining the average value of the biological productivity of fruits and technological efficiency of fruits (%) of assessed sweet pepper cultivars. Fruits of all cultivars harvested the same period (2nd decade of September) were subject to laboratory analyses. All determinations were performed in 3 replicates: dry matter by means of dryer method (+105°C), L-ascorbic acid by means of Roe method with modifications by Ewelin, total sugars (%) applying Luff-Schoorl method, extract (%) refractometrically.

The yielding results as well as selected parameters of the utility and biological values of fruits were statistically processed by means of variance analysis. The significance of differences was calculated by T-Tukey's multiple confidence at the confidence level of 5%. Characterization of the weather conditions during the sweet pepper cultivation in the field in 2006–2008 on a background of respective parameters in many-year period is presented in Table 1.

RESULTS

Evaluated cultivars of sweet pepper have shown wide variation in the size of the average fruit marketable yield. In 2006–2008, higher mean yield of marketable fruits was harvest from the 'Caryca F_1' (4.45 kg·m^{-2}), than 'Roberta F_1' (3,37 kg·m^{-2}) and 'Jova' (3.46 kg·m^{-2}). The yield of the remaining cultivars was not significantly different from 'Caryca F_1'cv. (tab. 2). Statistically significant differences in the average marketable yield of sweet peppers between years of research were recorded. Considerably lower yield was harvested in 2006 (3.42 kg·m^{-2}) as compared to 2007 (3.98 kg· m^{-2}) and 2008 (4.25 kg· m^{-2}). The share of marketable yield in the total yield was highly significant, as

Table 2. Yielding characterization of seven sweet pepper cultivars

Cultivar	Marketable yield (kg m^{-2})				Share of marketable yield in total yield (%)			
	2006	2007	2008	mean	2006	2007	2008	mean
Roberta F_1	3.21	3.26	3.64	3.37	86.3	89.1	96.1	90.5
Robertina	3.25	3.20	4.95	3.80	85.5	74.6	95.7	85.3
Corrida F_1	3.07	4.09	4.74	3.97	84.5	94.2	96.9	91.9
Caryca F_1	3.95	5.27	4.13	4.45	88.0	96.2	95.7	93.3
Mino	3.62	4.60	4.10	4.11	88.5	84.9	94.7	89.4
Marysia	3.75	4.30	4.05	4.03	88.2	94.8	92.4	91.8
Jova	3.06	3.20	4.12	3.46	85.7	74.3	93.1	84.4
Mean	3.42	3.98	4.25	3.88	86.7	86.9	94.9	89.5
$LSD_{0.05}$								
Cultivar (a)	0.648	0.769	0.805	0.767				
Years (b)				0.382				
Interaction (a × b)				1.150				

it was from 86.7% to 94.9%, on average. In 2006, the marketable yield higher than 3.5 kg·m^{-2} was achieved only from the following cultivars: 'Mino', 'Marysia' and 'Caryca F_1', whereas for the remaining ones it ranged from 3.06 ('Jova') to 3.25 kg·m^{-2} ('Robertina'). A large variation in marketable yield between assessed cultivars was observed in 2007. The lowest marketable yield was obtained from 'Robertina', 'Jova', and 'Roberta F_1' cultivars (3.20–3.26 kg·m^{-2}), while the largest from 'Caryca F_1' (5.27 kg·m^{-2}). Good yield of marketable fruits was also harvested from 'Corrida F_1', 'Marysia', and 'Mino' (4.09–4.60 kg·m^{-2}). In 2008, the marketable yield of fruits from six cultivars ranged from 4.05 kg·m^{-2} ('Marysia') to 4.13 kg·m^{-2} ('Caryca F_1'), and significantly lower from 'Roberta F_1' (3.64 kg·m^{-2}).

Table 3. Fruit weight and thickness of pericarp in the fruits of seven sweet pepper cultivars

Cultivar	Fruit weight (g)				Thickness of pericarp (mm)			
	2006	2007	2008	mean	2006	2007	2008	mean
Roberta F_1	108.0	90.6	104.3	101.0	4.3	5.2	4.6	4.7
Robertina	101.2	107.4	122.2	110.3	4.3	4.7	4.9	4.6
Corrida F_1	99.1	76.8	88.8	88.2	6.0	6.0	4.6	5.5
Caryca F_1	136.0	120.6	112.7	123.1	7.2	7.4	6.5	7.0
Mino	133.4	129.4	109.7	124.2	4.1	5.7	4.8	4.9
Marysia	98.0	97.0	101.3	98.8	4.8	6.6	5.9	5.8
Jova	92.2	101.2	114.4	102.6	6.9	8.4	8.8	8.0
Mean	109.7	103.3	107.6	106.9	5.4	6.3	5.7	5.8
$LSD_{0.05}$								
Cultivar (a)				10.42				1.25
Years (b)				n.s.				n.s.
Interaction (a × b)				42.45				2.49

n.s.: not significant

There were significant differences between cultivars and related to the parameters determining the utility value of fruits. Cultivars 'Mino' (124.2 g) and 'Caryca F_1' (123.1 g) were characterized by the fruit of the highest mean weight, while 'Corrida F_1' (88.2 g) and 'Marysia' (98.8 g) by the lowest (tab. 3). In 2006 and 2007, fruits of the following cultivars were distinguished by the highest weight: 'Mino' and 'Caryca F_1', while in 2008, 'Robertina' cv. The largest difference in the utility value parameters of fruits of assessed sweet pepper cultivars was recorded in relation to the pericarp thickness (tab. 3). 'Jova' cv. was distinguished by the thickest pericarp wall (mean 8.0 mm) as compared to fruits of 'Robertina', 'Roberta F_1', and 'Mino' (4.6–4.9 mm, on average). Based on the variance analysis, no significant differences in the pericarp thickness and other parameters of the utility value of assessed cultivars between years of research, were found. Fruits of evaluated cultivars showed a large variation in the weight of edible parts. This was evidenced by values of their biological and technological weights

(tab. 4). Fruits of 'Caryca F_1' (106.8 g) and 'Mino' (105.1 g) were characterized by significantly the highest average pericarp weight as compared to other cultivars (72.8–94.0 g). Fruits of these cultivars were distinguished by the greatest biological and technological weights in 2006 and 2007, whereas in 2008 'Robertina' cv. fruits were outstanding. In all the years of research, significantly the lowest biological (65.4–78.6 g) and technological weight (58.0–59.8 g) was recorded for fruits of 'Jova' cv. On the basis of the share of biological and technological weight of the fruit in the total mass of the fruit (%), biological and technological efficiency of sweet pepper fruits was determined (fig. 1). It has been shown that the biological efficiency of fruit of assessed cultivars in 2006–2008 was in the range from 82.9 to 85.5%, while technological efficiency of fruits from 68.8 to 70.3%, respectively. 'Jova' cv. was characterized by the lowest biological and technological fruit efficiency. Depending on the year of study, the biological efficiency of that cultivar fruits ranged from 64.6 to 80.6%, and the technological efficiency was only from 58.0 to 59.8% of the whole fruit weight.

Table 4. Biological weight and technological weight of fruits of seven sweet pepper cultivars

Cultivar	Biological weight (g)				Technological weight (g)			
	2006	2007	2008	mean	2006	2007	2008	mean
Roberta F_1	85.1	78.8	88.1	84.0	67.6	62.3	69.0	66.3
Robertina	86.6	87.6	107.8	94.0	73.8	73.5	88.2	78.5
Corrida F_1	89.3	67.6	75.9	77.6	73.7	63.6	63.4	66.9
Caryca F_1	117.2	110.5	92.8	106.8	97.6	91.1	76.1	88.3
Mino	117.1	104.3	93.9	105.1	88.0	84.2	76.8	83.0
Marysia	87.1	84.8	88.8	86.9	69.2	71.6	72.6	71.1
Jova	74.3	65.4	78.6	72.8	58.0	58.5	59.8	58.8
Mean	93.8	85.6	89.4	89.6	75.5	72.1	72.3	73.3
$LSD_{0.05}$								
Cultivar (a)				6.92				6.25
Years (b)				n.s.				n.s.
Interaction (a × b)				28.00				25.48

n.s.: not significant

Sweet pepper fruits contained mean dry matter content at the level of 7.69% (tab. 5). Evaluated cultivars were statistically different in relation to the dry matter weight of fruits. Significantly the highest mean dry matter was determined in the fruits of 'Roberta F_1' (8.21%) as compared to other cultivars, in which the dry matter weight of fruits was from 7.27% ('Caryca F_1') to 7.79% ('Robertina'). There was no statistical difference between the years of research in the dry matter of fruits of evaluated sweet pepper cultivars. Dry matter in sweet pepper ranged from 7.33 (2006) to 7.88% (2007). In 2006 and 2007, the largest amounts of dry matter were determined in fruits of 'Roberta F_1', the smallest in fruits of 'Caryca F_1' cv., while in 2008, the highest dry matter was contained in 'Corrida F_1' cv., and the lowest – 'Marysia' cv.

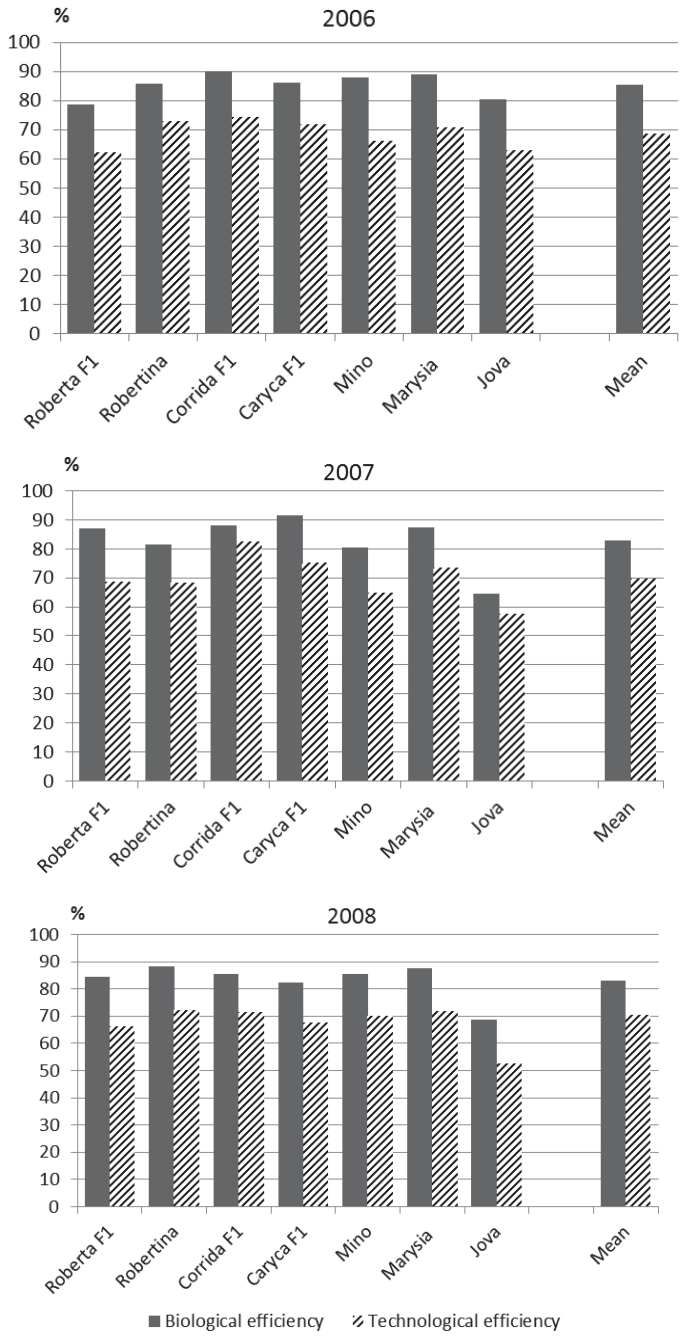

Fig. 1. Biological and technological efficiency of sweet pepper fruits

Fruits of evaluated cultivars showed a considerable variation in the content of extract (tab. 5). Its highest mean level was determined in fruits of 'Roberta F_1' cv. (7.0%) as compared to fruits of 'Caryca F_1' cv. (5.8%). Remarkable differences in the extract amounts were observed in the years of study. In 2006, the average extract content in sweet pepper was 6.6%. Based on the variance analysis, no significant differences in the amount of extract in fruits between the assessed cultivars were recorded, while in 2007, significantly more extract was determined in fruits of 'Marysia', 'Robertina', and 'Roberta F_1' cv. (7.0–7.5%) as compared to 'Mino' and 'Caryca F_1' cv. (5.5–5.6%). In 2008, the content of extract also varied depending on the cultivar. Significantly more extract was recorded rather in fruits of 'Corrida F_1' cv. (6.7%) than 'Caryca F_1' cv. (5.9%).

Table 5. Content of dry matter and extract in the fruits of seven sweet pepper cultivars

Cultivar	Dry matter (%)				Extract (%)			
	2006	2007	2008	mean	2006	2007	2008	mean
Roberta F_1	8.04	8.65	7.94	8.21	7.0	7.5	6.4	7.0
Robertina	7.61	8.02	7.74	7.79	7.0	7.3	6.2	6.8
Corrida F_1	7.04	7.52	8.23	7.60	6.5	5.6	6.7	6.3
Caryca F_1	6.83	7.42	7.55	7.27	6.0	5.5	5.9	5.8
Mino	7.31	7.91	7.73	7.65	6.8	6.9	6.4	6.7
Marysia	7.44	8.03	7.03	7.50	6.6	7.0	6.5	6.7
Jova	7.05	7.63	7.54	7.41	6.5	6.8	6.5	6.7
Mean	7.33	7.88	7.68	7.63	6.6	6.7	6.4	6.6
$LSD_{0.05}$								
Cultivar (a)				0.346				0.13
Years (b)				n.s.				0.25
Interaction (a × b)				1.420				0.52

n.s.: not significant

Fruits of assessed cultivars contained high concentration of L-ascorbic acid – an average of 251.5 mg·100 g^{-1} f.m. (tab. 6). Statistically significant differences between evaluated cultivars in terms of this component content, were recorded. Definitely the largest mean level of L-ascorbic acid was determined in fruits of 'Corrida F_1' (308.4 mg·100 g^{-1} f.m.), while the smallest fruits of 'Marysia' and 'Caryca F_1' (211.1–211.8 mg·100 g^{-1} f.m.), as well as 'Mino' (228.2 mg·100 g^{-1}). Statistical diversity of L-ascorbic acid content between years of study was proved for fruits of all assessed sweet pepper cultivars. Significantly the largest mean amounts of the component was accumulated by sweet pepper in 2006 (289.5 mg·100 g^{-1}) as compared to 2007 (270.5 mg·100 g^{-1}) and 2008 (194.5 mg·100 g^{-1}). In 2006 and 2007, fruits of 'Corrida F_1' cultivar were distinguished by the highest abundance in L-ascorbic acid, as well as 'Roberta F_1' and 'Robertina' in 2008.

Table 6. Content of L-ascorbic acid and total sugars in the fruits of seven sweet pepper cultivars

Cultivar	L-ascorbic acid (mg 100 g^{-1} f.m.)				Total sugars (%)			
	2006	2007	2008	mean	2006	2007	2008	mean
Roberta F_1	337.3	264.2	239.4	280.3	1.88	1.65	2.74	2.09
Robertina	302.3	238.4	276.6	272.4	1.94	1.79	2.95	2.23
Corrida F_1	352.6	376.1	196.5	308.4	2.87	1.94	3.08	2.63
Caryca F_1	227.2	264.9	143.3	211.8	1.94	1.82	2.34	2.37
Mino	236.5	294.5	153.7	228.2	1.93	1.89	2.48	2.10
Marysia	282.3	211.9	139.1	211.1	2.59	2.30	3.27	2.72
Jova	288.1	243.2	213.1	248.2	2.13	1.89	2.59	2.20
Mean	289.5	270.5	194.5	251.5	2.18	1.90	2.92	2.33
$LSD_{0.05}$								
Cultivar (a)				4.24				0.165
Years (b)				8.26				0.323
Interaction (a × b)				17.46				0.682

The content of total sugars in sweet pepper was 2.33%, on average (tab. 6). The largest mean of total sugars were determined in fruits of 'Marysia' cv. (2.72%), 'Corrida F_1' cv. (2.63%), and 'Caryca F_1' cv. (2.37%). Statistically significant differences of sugars content in sweet pepper were found in each year of study. More sugars were accumulated in fruits of assessed cultivars in 2008 as compared to the content of these nutrients in fruits harvested in 2006 and 2007.

DISCUSSION

The marketable yield of sweet pepper achieved in 2006–2008 near Lublin was comparable to that obtained in the region in other studies [Buczkowska and Bednarek 2005, Buczkowska 2007, Rożek et al. 2012], as well as results of other authors carried out in other Polish regions [Gajc-Wolska and Skąpski 2002, Gajc-Wolska et al. 2007, Korzeniewska and Niemirowicz-Szczyt 2007, Szafirowska and Elkner 2008, Michalik 2010]. The significant diversity in yielding of this vegetable was noticed the years of the experiment. In 2006 a considerably lower marketable yield was obtained. It was due to changing weather conditions during cultivation. In 2006 the meteorological conditions were less favourable for fruits ripening. In August the mean daily temperature was lower in comparison with the years 2007–2008. moreover, very high rainfalls whose sun exceeded almost 3 times the perennial values for this month were observed. The success of the filed cultivation of sweet pepper is greatly determined by a proper cultivar selection. This study took into account the cultivars that were also distinguished in other research by a high stability of yielding in the field under less favorable environmental conditions and are important for large-scale production [Gajc-Wolska and Skąp-

ski 2002, Buczkowska 2007, Gajc-Wolska et al. 2007, Korzeniewska and Niemirowicz-Szczytt 2007]. The overall objective of this study was to characterize and evaluate the selected utility and biological traits of fruits of seven sweet pepper cultivars. Assessed cultivars showed a wide diversity of studied parameters. In terms of the fruit weight and the weight of edible parts (biological and technological weight), fruits of 'Mino' and 'Caryca F_1' cv. appeared to be the most impressive. The attractiveness of latter one, as well as that of 'Roberta F_1', referring to these characteristics has been shown in other works [Szafirowska and Elkner 2008, 2009, Rożek et al. 2012]. The pericarp thickness is very important utility and technological feature [Gajc-Wolska and Skąpski 2002, Buczkowska 2007, Korzeniewska and Niemiriwicz-Szczytt 2007, Nowaczyk and Nowaczyk 2007, Nowaczyk et al. 2008, Rożek et al. 2012]. Fruits of 'Jova' and 'Caryca F_1' cv. were characterized by the thickest pericarp. Results of previous works indicate that fruits of 'Caryca F_1' cv. and other cultivars and hybrid lines had thicker pericarp than those of stabilized cultivars [Buczkowska 2007, Korzeniewska and Niemirowicz-Szczytt 2007, Jadczak et al. 2010]. Szafirowska and Elkner [2008, 2009] considering remarkable biological and technological efficiency of 'Caryca F_1' cv. fruits, recommend it as the leading for conventional and organic cultivation. Rożek et al. [2012] also showed that fruits of 'Caryca F_1' and 'Roberta F_1' cv. from a single harvest represent a large utility value and can provide a good raw material for the processing. Fruits of 'Jova' cv. have a high weight of the edible parts in the entire mass (about 50%), and therefore, this cultivar is not suitable for commercial production, especially for industry. There were no statistically significant differences between the years of research relating to the studied traits of sweet pepper. This shows that the fruit weight, pericarp thickness, and the weight of edible parts of fruits, are relatively stable genetic characteristics, especially in heterosis cultivars and can slightly vary due to environmental factors, especially weather and agronomy [Gajc-Wolska and Skąpski 2002, Jadczak et al. 2010]. Variation of the dry matter was recorded in fruits of evaluated cultivars. The dry matter content in fruits of all assessed cultivars did not significantly differ between the years of research. This is due to the fact that dry weight and the extract content in sweet pepper fruits are determined by the varietal characteristics, fruit ripeness phase, and to a lesser extent by other factors [Kmiecik and Lisiewska 1994, Gajc-Wolska and Skąpski 2002, Dasgan and Abak 2003, Orłowski et al. 2004, Pokluda 2004, Ayuso et al. 2008, Buczkowska and Sawicki 2008, Jadczak et al. 2010, Michalik 2010]. Hot pepper fruits contain much more dry matter [Buczkowska and Najda 2002, Topuz and Ozdemir 2007]. Sweet pepper fruits are an abundant source of vitamin C, the accumulation of which depends on varietal traits [Frary et al. 2008], although it is also modified by environmental, agrotechnical, and post-harvest conditions [Lee and Kader 2000, Gajc-Wolska and Skąpski 2002, Szafirowska and Elkner 2008]. Ripe fruits of assessed sweet pepper cultivars were characterized by large amounts of L-ascorbic acid – its mean content reached over 250 $mg \cdot 100g^{-1}$, which are values similar to those found by other authors [Gajc-Wolska and Skąpski 2002, Golcz and Kozik 2004, Orłowski et al. 2004, Pokluda 2004], and higher than those quoted in previous works [Kmiecik and Lisiewska 1994, Lee and Kader 2000, Buczkowska and Najda 2002, Gajc-Wolska et al. 2007, Topuz and Ozdemir 2007, Buczkowska and Sawicki 2008, Szafirowska and Elkner 2008, Michalik 2010, Milenković et al. 2012]. The largest quantities of L-ascorbic acid

were accumulated by fruits of 'Corrida F_1' cv., while the smallest – 'Caryca F_1' and 'Marysia' cv. Considerable differences of this vitamin content between years of the research were observed for all assessed cultivars. The lowest concentration of L-ascorbic acid was accumulated by sweet pepper in 2008. It may result from the fact that prior to the fruit harvest (2nd decade of September 2008), less favorable weather conditions occurred, which also affected the L-ascorbic acid accumulation in sweet pepper [Buczkowska and Najda 2002]. Total sugars contents (determined by means of Luff-Schoorl method) were lower as compared to those found by other author who used the same method [Buczkowska and Najda 2002, Orłowski et al. 2004, Gajc-Wolska et al. 2007, Michalik 2010]. The extract content in sweet pepper fruits amounted to 6.6 %, on average, which are comparable results to those published by other researchers [Kmiecik and Lisiewska 1994, Gajc-Wolska and Skąpski 2002, Buczkowska and Sawicki 2008] or much higher than those reported by Shukla et al. [2011] in 'California Wonder' cv. fruits.

Based on the results presented in this study, it can be concluded that the amount of extract in sweet pepper fruits is a varietal feature, which can be modified only within certain limits by environmental or agronomic factors. A cultivar, in fruit of which the extract content was the smallest, was 'Caryca F_1', which has been previously shown [Buczkowska and Sawicki 2008]. This cultivar should be regarded as distinctive referring to yielding as well as fruit utility value, however, selected parameters of biological value indicate that fruits of other cultivars evaluated in present study were characterized by a greater biological value.

CONCLUSIONS

The sweet pepper cultivars assessed in this work were distinguished by relatively high stability of yielding in the field under a temperate climate. The highest marketable yield of fruits was achieved from 'Caryca F_1' cv., than 'Roberta F_1' and Jova. The yield of remaining cultivars was not significantly different from 'Caryca F_1'cv. They showed, however, a very large variation in estimated parameters of the utility and biological values of fruits.'Caryca F_1'and 'Mino'cv. appeared to be the most attractive in reference to the fruit weight. Their fruits were characterized by the highest weight of edible parts and a large share of the pericarp weight in total weight of fruit. Fruits of 'Caryca F_1' cv. were also outstanding in terms of pericarp thickness. This feature of fruits greatly determines the selection of a given cultivar for large-scale growing and market attractiveness of fruits. Czech 'Jova' cv., fruits of which have very thick pericarp, can be recommended for the amateur cultivation. 'Roberta F_1', 'Robertina', and 'Corrida F_1' cv. achieved the greatest biological value; their dry matter, L-ascorbic acid, and extract contents were the highest. 'Caryca F_1' cv. plants accumulated relatively small amounts of dry matter and extract, and in particular L-ascorbic acid as compared to other cultivars.

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RÓŻNORODNOŚĆ WARTOŚCI UŻYTKOWEJ I BIOLOGICZNEJ OWOCÓW KILKU ODMIAN PAPRYKI SŁODKIEJ

Streszczenie. Atrakcyjność konsumpcyjną oraz przydatność surowcową odmian papryki slodkiej warunkują cechy jakościowe owoców. Za najważniejsze uważa się dużą masę owoców, grubą owocnię, intensywną barwę w dojrzałości fizjiologicznej a także udział masy perykarpu w całej masie owocu. Aktualnie w Polsce dostępne są odmiany paryki

słodkiej o takich owocach. Odmiany te odznaczają się także dostosowaniem do uprawy w mniej korzystnych warunkach środowiska i dużą stabilnością plonowania. W niniejszej pracy dokonano oceny plonowania w polu i porównania wartości użytkowej i biologicznej owoców siedmiu odmian papryki słodkiej w aspekcie przydatności do bezpośredniego spożycia oraz dla przetwórstwa. Największy średni plon handlowy owoców otrzymano z odmiany Caryca F_1, który był większy w porównaniu z plonem odmian Roberta F_1 i Jova. Plon pozostałych odmian nie różnił istotnie od plonu odmiany Caryca F_1.Oceniane odmiany wykazywały duże zróżnicowanie pod względem wartości użytkowej i biologicznej owoców. Owocami o największej masie wyróżniła się odmiana Mino, zaś najgrubszym perykarpem odmiana Jova, również odmiana Caryca F_1 charakteryzowała się owocami o dużej masie, grubym perykarpie i dużej masie części jadalnej. Najwięcej kwasu L-askorbinowego zawierały owoce odmian Roberta F_1, Robertina i Corrida F_1, a ekstraktu – Roberta F_1.

Słowa kluczowe: *Capsicum annuum* L., jakość owoców, plon handlowy, kwas L-askorbinowy, ekstrakt

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