

THE EFFECT OF DIFFERENT SOIL-CLIMATIC CONDITIONS OF GROWING ON COOKING QUALITY OF POTATOES*

K. Hamouz¹, B. Vokál², J. Čepl², P. Dvořák¹

¹*Czech University of Agriculture, Faculty of Agrobiological Sciences, Department of Crop Production, Prague, Czech Republic*

²*Potato Research Institute Havlíčkův Brod, Czech Republic*

In this study we investigated a cooking quality and its components (raw and cooked potato appearance, tuber odour after cooking, tuber flavour, durability of tuber colour after cooking, flesh firmness and sloughing) in potato tubers grown under various soil climatic conditions of traditional potato-growing production region (higher regions) and in warmer, more yielding, mainly beet-growing production region (lower regions). Precise field trials with five potato varieties (early Karin, semi-early Agria, Korela, Rosella and Santé) were carried out during 1995–1997 at six locations in higher regions and at six locations in lower regions (Vokál et al., 1999). Tuber samples removed at harvest were stored under the same conditions, and cooking quality was determined using the method described by Anonimos (1987) in December of each harvest year. Averaged over workplaces and years, annual mean temperature was higher by 1.8 °C (26.5%), during vegetation by 2.1 °C (16.2%) in lower regions. As regard to annual rainfalls, difference was 111 mm (19.6%), during vegetation 70 mm (16.2%) in favour of higher regions. Decisive influence of year was proved, which significantly affected total cooking quality, raw and cooked potato appearance, odour and flavour. Influence of variety was not unambiguous (statistically significant influence was observed in decisive characteristics, i.e. total cooking quality, cooked potato appearance, odour and flavour). Relatively, the best position was found in the Karin variety (cooking type B-BA). The region statistically significant expressed all indices except raw tuber appearance and odour, namely (evaluated over three years) always in favour of lower regions. Total cooking quality reached in this case 61.42 scale points and was better by 6.2%. In relation to flavour, total cooking quality reached 21.28 scale points (better by 4.7%). Comparing the mentioned results with information available, we found that similar work studying influence of different locality conditions is not available.

potatoes; cooking quality; location; variety; year

INTRODUCTION

The level of ware potatoes table value belongs to the most important qualitative markers. Table value is the result of the level of many indicators, to which belongs especially an appearance of raw and cooked tubers, odour, taste, consistence, cooking strength, keeping quality etc. Also cooking type (A, B, C, D) is evaluated, where is mainly information for consumers about variety suitability for different kinds of cooking and utilization (Vokál et al., 2000).

Evaluation of these sensoric characteristics is based on subjective perceptions of the evaluating persons, only colour and consistence can be determined objectively (Leszczyński, 2000).

Table value is influenced especially by cultivar, site conditions, farming practices and phytopathological measures in vegetation and by treatments during the harvest and also by market treatments and by storage (Vokál et al., 2000).

Crucial influence of cultivar (Štorková, 1997) and other factors is connected i.e. with starch content, dry

matter content, nitrogen content and optionally with other components content.

Míča (1990) found negative correlation between potatoes taste and dry matter content and starch content, and on the other hand, positive influence of higher N and K contents in tuber. Optimum N : K ratio in tuber is ranging between 1 : 2.5 and 1 : 2.7. Drift in this ratio results in worse tubers' taste (Míča, 1988).

In the Czech Republic the most important ware potatoes area was traditionally situated in higher regions, that is in potato-growing region (higher areas). In lower, warmer and more fertile regions, what are especially in beet-growing regions (lower areas), mostly early ware potatoes were cultivated. The main reasons for this are i.e. climatic factors, that are more favourable in potato-growing region (Hruška et al., 1974). Cited author states that for potatoes growing in more suitable areas are those, in which the warmest monthly average temperature does not exceed 18.5 °C (in lower regions the average temperature is higher) and precipitation per year is between 700 and 800 mm (in lower areas the average precipitation is significantly lower). Leština, Votoupal (1983) found that under the conditions of

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Table 1. Principal characterization of trial conditions in lower and higher regions (average over localities and years)

Region	Mean altitude (m)	Mean temperature (°C)			Rainfalls (mm)		
		yearly	vegetation period		yearly	vegetation period	
			normal	average 1995–1997		normal	average 1995–1997
Lower	224	8.6	15.2	15.1	556	360	432
Higher	531	6.8	12.7	13.0	677	425	502

higher altitude (670 m), more frequent precipitation (1020 mm per year) and lower average year temperatures (5.8 °C), the table value and taste of tubers were worse. The aim of this study was to compare influence of different soil-climatic conditions, influence of area, cultivar and year, on very important ware potatoes marker – the table value and its components.

MATERIALS AND METHODS

During 1995 and 1997 in precise field experiments at six locations in higher regions and at six locations in lower regions were cultivated ware potatoes, mostly medium-ripening varieties Agria, Karin (early cultivar), Korela, Rosella and Santé with an aim to determine influence of different ecological conditions of the crops-growing area on indicators, which characterize i.e. yield and quality of potatoes. Table 1 shows basic data about experimental conditions. Detailed information was published by Hamouz et al. (1999).

Using the same farming practices and plant protection, the yield was determined and tuber samples collected during a harvest were analysed. Table value and its components were determined by degustation in December in harvest year according to described methodology (Anonymous, 1987). The results were evaluated statistically using variance analysis (SAS 6.12).

RESULTS AND DISCUSSION

On average, compared to long term normal (Table 1), tendency of relatively minimum deviation in average temperature during vegetation period (more significant in higher regions – by 2.4%) was observed.

Complex indicator, characterizing relatively well quality of the tubers, is total table value (Fig. 1), which can reach up to 100 points. In average of the whole set, the most important was region and also influence of cultivar and year was statistically important. It is interesting that this fact also applied to individual experimental years, but its influence was not unambiguous. During 1995 and 1997, significantly higher level was proved in lower areas, and in 1996 it was proved in higher areas. Vegetation period in 1996 was colder in lower regions at all work-places (in average by 0.6 °C) and temperature could influence individual components influencing level of the total table value, so that it was decreased under the level found in higher areas. This year was also interest-

ing because of the table value being the highest in higher regions and the lowest in lower regions of all experimental years. Total level of table value was in lower regions significantly higher (by 3.58 point, that is by 6.2%), and so a supposition, that table value is better in higher regions was not confirmed (Hruška et al., 1974). Statistically significant influence of the tested cultivars (Fig. 2) was found in 1995 and 1997, but confirmative difference was found only between the most favourably situated variety Karin and variety Rosella in 1995. In the whole average group was determined significant tendency in favour of varieties Karin, Santé and Agria in comparison with varieties Korela and Rosella. Also influence of a year was significant (Fig. 3) for the results in 1997, which were much better compared to average results in 1995 and 1996.

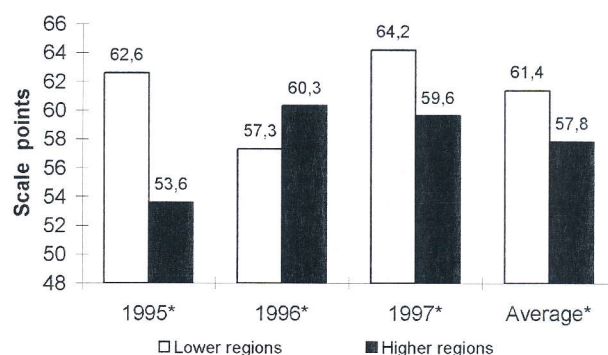


Fig. 1. Effect of regions for cooking quality (scale points according to ČSN). Average 5 varieties from 6 sites every regions. LSD_{0.05} = 3.46 (1995); 2.72 (1996); 1.92 (1997); 1.57 (Average). * significant different between regions

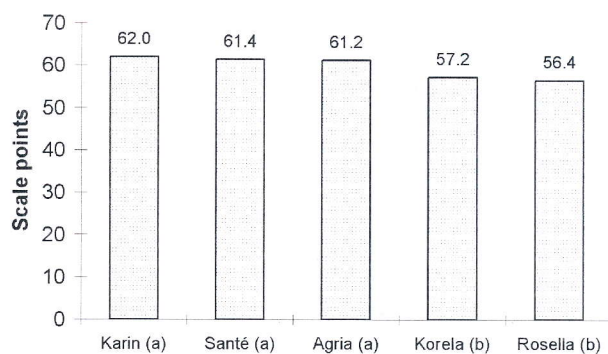


Fig. 2. Effect of varieties for cooking quality (scale points according to ČSN). Triennial average 12 sites. LSD_{0.05} = 3.48. Differences between mean values designated with the same letters are not significant

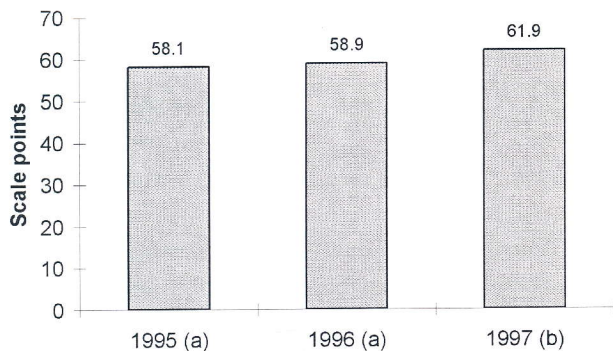


Fig. 3. Effect of years for cooking quality (scale points according to ČSN). Average 5 varieties from 6 sites every regions. $LSD_{0.05} = 2.31$. Differences between mean values designated with the same letters are not significant

Appearance of the raw tubers (Table 2), which can be evaluated by up to 12 points, was significantly statistically influenced only in case of better results in lower regions in 1997. Influence of a region (in other years and in average), likewise in cultivars (the most favourably was evaluated variety Karin), was not significant. Significant influence of the year was connected with favourable influence on the raw tubers appearance in 1997 (difference in 1995 exceeded limit of statistical significance).

It is interesting that **appearance of the cooked tubers** (Table 3) with maximum limit of 16 points was significantly statistically influenced not only by a year, but also by a region and by a variety. More favourable evaluation acquired tubers from lower regions (statistically significantly and unambiguously in all years). Varieties Karin and Agria had in average much better appearance compared to other cultivars in experiment. It was mostly due to the results found in 1995 (in the following years

Table 2. Raw potato appearance according to ČSN (0 to 12 scale points)

Index		1995			1996			1997			Average			
		\bar{x}	$LSD_{0.05}$	sign.	\bar{x}	$LSD_{0.05}$	sign.	\bar{x}	$LSD_{0.05}$	sign.	\bar{x}	$LSD_{0.05}$	sign.	
Region	lower	8.57	0.60	a	8.90	0.50	a	9.57	0.54	a	9.01	0.31	a	
	higher	8.60		a	9.00		a	8.87		b	8.82		a	
Year	1995										8.58	0.45	b	
	1996										8.95		a	b
	1997										9.22		a	
Variety	Karin	8.83	1.34	a	8.92	1.11	a	9.58	1.20	a	9.11	0.68	a	
	Santé	9.00		a	9.00		a	9.08		a	9.03		a	
	Agria	8.50		a	9.08		a	8.75		a	8.78		a	
	Korela	8.08		a	9.08		a	9.33		a	8.83		a	
	Rosella	8.50		a	8.67		a	9.33		a	8.83		a	

Differences between mean values designated with the same letters are not significant; \bar{x} – mean value scale points, $LSD_{0.05}$ – least significant difference, sign. – significance

Table 3. Cooked potato appearance according to ČSN (0 to 16 scale points)

Index		1995			1996			1997			Average		
		\bar{x}	$LSD_{0.05}$	sign.	\bar{x}	$LSD_{0.05}$	sign.	\bar{x}	$LSD_{0.05}$	sign.	\bar{x}	$LSD_{0.05}$	sign.
Region	lower	10.83	0.95	a	9.23	0.82	a	11.23	0.86	a	10.43	0.50	a
	higher	9.20		b	9.17		a	9.20		b	9.19		b
Year	1995										10.02	0.73	a
	1996										9.20		b
	1997										10.22		a
Variety	Karin	11.17	2.13	a	10.08	1.82	a	10.25	1.91	a	10.59	1.10	a
	Santé	10.25		a b c	9.08		a	9.67		a	9.67		a b
	Agria	11.00		a b	9.00		a	11.42		a	10.47		a
	Korela	8.75		b c	8.83		a	9.67		a	9.08		b
	Rosella	8.92		c	9.00		a	10.08		a	9.33		b

Differences between mean values designated with the same letters are not significant; \bar{x} – mean value scale points, $LSD_{0.05}$ – least significant difference, sign. – significance

only insignificant tendency for better results of these varieties was found). Tendency for favourable evaluation of the year 1997 was found also for this indicator (in 1996 significantly).

Odour of tubers after cooking (Table 4) is evaluated by up to 8 points and belongs to important markers of ware potatoes quality, even though there is not enough information about influence of environment and cultivar on aromatic compounds influencing this trait (Ulrich et al., 1998). Genotype plays probably very important role in sensoric evaluation, which was confirmed by the results of experiments, although cultivars sequence and results from individual years indicate a possibility of different reaction of varieties on ecological conditions of individual years. A year influenced statistically significantly odour of the tubers and again 1997 was the best year. Difference in 1995 and in 1996 was always significant. Influence of a region was not important, although

better results were attained for lower areas, however they were not confirmed in individual years (in 1995 significantly better lower areas, in other years not significantly better higher areas).

Relatively the least influence on a **taste of tubers** (Table 5), what is a crucial component of the table value (up to 40 points), had the region. In average significantly better taste was found in lower regions, but in individual years there was a tendency in favour of higher areas (in 1997 and significantly in 1996). Favourable result found in average of the whole experiment was connected with evaluation in 1995, when difference found in favour of the lower regions was very significant (26.1%). More important influence belonged to variety and year compared to region. Results found by Dobíáš (1986) are thus partially confirmed, saying that taste is i.e. cultivar trait, which is influenced by year and growing conditions. In average the best results acquired cultivar Karin.

Table 4. Cooked potato odour according to ČSN (0 to 8 scale points)

Index		1995			1996			1997			Average		
		\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.
Region	lower	6.33	0.47	a	5.77	0.59	a	6.53	0.34	a	6.21	0.27	a
	higher	5.37		b	6.30		a	6.60		a	6.09		a
Year	1995										5.85	0.40	b
	1996										6.03		b
	1997										6.57		a
Variety	Karin	6.00	1.05	a	6.08	1.32	a	6.67	0.76	a	6.25	0.60	a
	Santé	5.58		a	6.42		a	7.00		a	6.33		a
	Agria	6.50		a	6.67		a	6.50		a	6.56		a
	Korela	5.83		a	4.58		b	6.25		a	5.56		b
	Rosella	5.33		b	6.42		a	6.42		a	6.06		a

Differences between mean values designated with the same letters are not significant; \bar{x} – mean value scale points, LSD_{0.05} – least significant difference, sign. – significance

Table 5. Cooked potato flavour according to ČSN (0 to 40 scale points)

Index		1995			1996			1997			Average		
		\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.
Region	lower	21.77	1.92	a	20.20	1.34	a	21.87	0.99	a	21.28	0.83	a
	higher	17.27		b	21.83		B	21.87		a	20.32		b
Year	1995										19.52	1.22	b
	1996										21.02		a
	1997										21.87		a
Variety	Karin	21.08	4.27	a	22.17	2.99	a	23.75	2.21	a	22.33	1.84	a
	Santé	20.42		a	22.75		a	22.33		a	21.83		a
	Agria	20.08		a	22.08		a	21.75		a	21.31		a
	Korela	18.67		a	19.25		b	21.83		a	19.92		b
	Rosella	17.33		a	18.83		c	19.67		b	18.61		c

Differences between mean values designated with the same letters are not significant; \bar{x} – mean value scale points, LSD_{0.05} – least significant difference, sign. – significance

It is interesting that the lowest level of taste was found in tubers of cultivar Rosella. Also this marker is probably strongly dependent on genotype characteristics and influence of other factors is not very important. Significance of the year can be influenced also by certain subjectivity in degustation. The most favourably situated year 1997 provided much better level of taste in comparison with 1995.

Pulp consistence and cooking strength (Table 6) was significantly influenced only by region in favour of warmer areas. This finding did not apply to the year 1996, in which a value measured in samples from lower regions showed significantly higher consistence. Year and variety influence did not play any important role. Findings in literature are not unambiguous. According to D o b i á š (1986), consistency of tubers is an important variety trait relatively little influenced by environment, on the other hand, S t o r e y and D a v i e s (1992) except

an important influence of varieties reported also significant influence of environment and according to G r a y and H u g h e s (1978) influence of climate, location and fertilization on texture is not very often unambiguous, considering complex interaction of environmental factors during tuber growth. In our experiments the highest value was in the variety Karin (this tendency was not confirmed in 1997).

Keeping quality (intensity of changes in colour after cooking) was significantly influenced only by the region (Table 7). More favourable results were found in lower regions despite the fact that in 1996 better level of this trait was found in higher regions. In this year the difference was insignificant (in other years the difference was significant in favour of lower regions). Influence of variety and year was in average insignificant, what is contrary to the results of D o b i á š (1986), but finding of this author, that total variation of this trait is not large

Table 6. Flesh firmness and sloughing according to ČSN (0 to 16 scale points)

Index		1995			1996			1997			Average		
		\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.
Region	lower	10.33	0.81	a	9.13	0.42	a	10.10	0.46	a	9.86	0.33	a
	higher	9.30		b	9.57		b	9.07		b	9.31		b
Year	1995										9.82	0.49	a
	1996										9.35		a
	1997										9.58		a
Variety	Karin	10.75	1.80	a	9.67	0.93	a	9.17	1.04	a	9.86	0.74	a
	Santé	9.33		a	9.33		a	9.58		a	9.42		a
	Agria	9.92		a	8.83		a	10.00		a	9.58		a
	Korela	9.25		a	9.50		a	9.67		a	9.47		a
	Rosella	9.83		a	9.42		a	9.50		a	9.58		a

Differences between mean values designated with the same letters are not significant; \bar{x} – mean value scale points, LSD_{0.05} – least significant difference, sign. – significance

Table 7. Colour durability of cooked potatoes according to ČSN (0 to 8 scale points)

Index		1995			1996			1997			Average		
		\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.	\bar{x}	LSD _{0.05}	sign.
Region	lower	4.73	0.48	a	4.30	0.47	a	4.87	0.70	a	4.63	0.32	a
	higher	3.93		b	4.40		a	4.10		b	4.14		b
Year	1995										4.33	0.47	a
	1996										4.35		a
	1997										4.48		a
Variety	Karin	4.75	1.08	a	4.25	1.04	a	3.58	1.56	b	4.19	0.70	a
	Santé	4.75		a	4.50		a	5.17		a	4.81		a
	Agria	4.83		a	4.42		a	4.33		a	4.53		a
	Korela	3.58		c	4.67		a	4.58		a	4.28		a
	Rosella	3.75		b	3.92		a	4.75		a	4.14		a

Differences between mean values designated with the same letters are not significant; \bar{x} – mean value scale points, LSD_{0.05} – least significant difference, sign. – significance

and can be placed among traits with low variability. Still it is interesting that the most favourably evaluated cultivar Karin was in this case evaluated less favourably. In general, better results found in samples from lower regions could be explained by warmer and more arid climate and weather conditions during experimental years at these localities, which correspond with findings of Storey and Davies (1992).

If we compare table values and their indicators with available information, we find that similar study monitoring influence of different site conditions is not available. It did not come up to expectation (Hruška et al., 1974; Míča, 1988) that in ware potatoes grown in lower regions with poor precipitation – e.g. Zrůst (1984) refers to a critical importance of water – and especially in warmer regions should be the resulting table value worse. This expectation is probably related to supposition, that in these areas tubers will contain more starch (dry matter), so we can expect decrease in table value (Míča, 1990). It is interesting that even this assumption was not fulfilled, because in average the content of dry matter in lower regions was higher (21.67%), but not significantly, only by 0.18% of dry matter content (Vokál et al., 1999). Additionally in 1997, when the total table value reached the highest level, the highest content of dry matter in tubers was also found. The results prove, that production of quality ware potatoes is possible in the areas of the Czech Republic intended i.e. for growing of very early cultivars. Influence of cultivars put in experiment was statistically significant for majority of indicators (except for appearance of the raw tubers, keeping quality after cooking and suprisingly pulp consistency and cooking strength) and confirmed published results (Dobiáš, 1986; Štorková, 1997). Relatively best characteristics had cultivar Karin, which is cultivar of cooking type B-BA (Med, 2001). Other cultivars belong to the cooking type B, variety Korela belongs to the cooking type B-BC.

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Vliv rozdílných půdně-klimatických podmínek pěstování na stolní hodnotu brambor.

Scientia Agric. Bohem., 36, 2005: 134–140.

V práci byla sledována stolní hodnota a její složky (vzhled syrových a vařených hlíz, vůně hlíz po uvaření, chuť hlíz, trvanlivost barvy po uvaření, pevnost dužniny a rozvařivost) u hlíz brambor vypěstovaných v rozdílných půdně-klimatických podmínkách tradiční bramborářské zemědělské výrobní oblasti (vyšší oblasti) a v teplejší,

úrodnější, především řepařské zemědělské výrobní oblasti (nižší oblasti). Přesné polní pokusy s pěti odrůdami (raná Karin, polorané Agria, Korela, Rosella a Santé) se uskutečnily v letech 1995 až 1997 na šesti stanovištích ve vyšších a na šesti stanovištích v nižších oblastech (V o k á l et al., 1999). U vzorků hlíz odebraných při sklizni a skladovaných za jednotlivých podmínek byla vždy v prosinci sklizňového roku zjišťována stolní hodnota podle popsané metody (A n o n y m o u s , 1987). V průměru pracovišť a let byla v nižších oblastech průměrná roční teplota vyšší o 1,8 °C (26,5 %), ve vegetaci pak o 2,1 °C (16,2 %). V případě úhrnu ročních srážek činil rozdíl 111 mm (19,6 %), ve vegetaci 70 mm (16,2 %) ve prospěch vyšších oblastí. Potvrdil se rozhodující vliv ročníku, který významně ovlivnil celkovou stolní hodnotu, vzhled syrových a vařených hlíz, vůni a chuť. Vliv odrůdy nebyl zcela jednoznačný (statisticky významný vliv byl však zjištěn u rozhodujících znaků, tj. u celkové stolní hodnoty, vzhledu vařených hlíz, vůně a chuti). Relativně nejlepší postavení bylo zaznamenáno u odrůdy Karin (varný typ B-BA). Oblast se projevila statisticky významně u všech ukazatelů s výjimkou vzhledu syrových hlíz a vůně, a to (při hodnocení průměru tří let) vždy ve prospěch nižších oblastí. Celková stolní hodnota činila v jejich případě 61,42 bodů a byla o 6,2 % lepší, v případě chuti pak 21,28 bodů (o 4,7 % lepší). Pokusy prokázaly, že nižší, teplejší oblasti mají předpoklady pro produkci kvalitních konzumních brambor i přes relativní nedostatek srážek.

brambory; stolní hodnota; stanoviště; odrůda; ročník

Contact Address:

Doc. Ing. Karel H a m o u z , CSc., Česká zemědělská univerzita v Praze, Fakulta agrobiologie, potravinových a přírodních zdrojů, katedra rostlinné výroby, Kamýcká 957, 165 21 Praha 6-Suchbát, Česká republika, tel.: +420 224 383 548, e-mail: hamouz@af.czu.cz
