Evaluation of characteristics affecting the market value of table potatoes after washing

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ABSTRACT

Skin scuffing is a problem of washing of the individual potato varieties, which is particularly important at harvests of physiologically immature tubers. Washing of such tubers cannot be recommended. Discoloration of scuffed tuber parts is another problem, which is exhibited by gray, brown to black color. Greening of washed tubers is mostly influenced by storage manner that also affects tuber sprouting. Mechanical damage, occurrence of several diseases, abiotic injuries, pest damages is also a problem. Various responses of potato varieties were found to tuber washing. Varieties with rough, netted skin, physiologically immature tubers, infected with diseases, mechanically damaged, susceptible to soft rot, expressing abiotic changes are not suitable for the washing. Tubers of varieties with smooth and bright skin, without scuffing, with later greening in the light, free of disease and abiotic injury presence and non-damaged by pests are suitable for washing. From this view the best results of tuber washing were obtained with varieties and hybrids: Adéla, Astoria, Belladonna, Dali, Ditta, Flavia, Futura, Katka, Kordoba, Kornelie, Lady Christl, Laura, Milva, Princess, Redstar, Rosara, Samantana, Satina, Secura, Velox, Vera, Victoria, KE 524-11, KE 12-83.

Keywords: potatoes; table potato washing; varietal response; problems

The washing of table potatoes is a substantial consumer's requirement. The consumer requires clean tubers, without admixtures, with typical skin color that will be attractive for him. Washing potatoes before selling could be a helpful tool. The requirements for market handling of potato tubers are continuously higher and who wants to keep up with the strong competition on the market, has to respect them. The washing of table potatoes can cause many problems associated with tuber mechanical damage, high disease occurrence, pest injuries, greening and other defects. From the practical experiences it is known that tubers of individual potato varieties respond to the washing in different ways. A quite high attention is paid to various ways of washing and brushing of table potatoes (Frenzel 1995, Geyer 1996, Geyer et al. 1999 and others). In several countries, the washing of seed potatoes is performed as well, namely for the phytosanitary reasons, then its purpose is the removal of soil-borne pests and diseases, especially bacteria of Erwinia genus and nematodes (Nematoda). An attention is also paid to tuber and washing water disinfection (Vrieze 2001, Wicks and Morgan 2002). The authors did not know any other research studies concerning the response of different varieties to the washing of table potatoes.

MATERIAL AND METHODS

In the 2001–2004 field trials with potato varieties were established in the regions differing in climatic conditions to study the suitability of tubers for the washing. The trials were set up in three localities:

1. Valečov Research Station. It is situated in the Bohemian-Moravian Highland, where lighter, loam-sandy soils mostly prevail. The above sea level is 460 m, the long-term normal of annual mean temperature is 6.99°C. The long-term normal of annual rainfalls is 652 mm. Varieties of all maturity types were included into the trials there. The planting was done in the end of April and/or during first days of May. Potatoes were harvested according to the growing period, very early potatoes beginning August, medium-early ones beginning September and medium-late to late ones in the second half of September.

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2. The agricultural university enterprise of the Mendel Agriculture and Forestry University Brno, in the Southern Moravia. Clay-loam to clay soils are predominant there. The above sea level is 184 m, the annual mean temperature is 9.0°C, the long-term normal of annual rainfalls is 553 mm. Only very early and early varieties were used for the trials there. Individual varieties were harvested in the second half of June.
3. Přerov nad Labem – in Polabí. This region is suitable for growing of early potatoes. Sandy-loam to sandy soils are prevalent there. The above sea level is 180 m, the annual mean temperature is 9.7°C, total long-term normal of annual rainfalls is 557 mm. Only very early potato varieties were included into the trials there. The harvest was done in two dates, during first days of June and two or three weeks after the first date.

The technology recommended for respective utility type of growing was applied during the vegetation (Vokál et al. 2001). When needed, late blight and Colorado potato beetle were controlled. The washing of potato tubers was done a day after the harvest, in an electrical laboratory drum washing machine equipped with brushes. Washed tubers were stored in three different ways for 14 days.

1. laid on a tray
2. in an original sealed, perforated, printed, transparent film, commonly used in the shops
3. in a sealed, non-perforated, transparent film

During the storage, shop conditions were simulated i.e. temperature (18–22°C) and illumination (200–400 lux).

Immediately after the washing, following parameters were evaluated:

► Skin scuffing using a 9-point scale:

1. no scuffing
3. skin scuffed to 10% of tuber surface – slight scuffing
5. skin scuffed on 11–20% of tuber surface – intermediate scuffing
7. skin scuffed on 21–50% of tuber surface – strong scuffing
9. skin scuffed on more than 50% of tuber surface – very strong scuffing

► Discoloration of scuffed tuber parts was evaluated 24 hours and 4 days after the washing. A 9-point scale was used for the evaluation:

1. no discoloration
3. very slight, insignificant discoloration
5. slight discoloration (graying, browning)
7. strong discoloration (browning of scuffed parts)
9. very strong discoloration (brown to black)

► The supplier of washed potatoes is responsible for their quality for 14 days after the supply. Therefore sprouting was also evaluated. Dormancy breaking and tuber sprouting was investigated after the tuber washing in different terms, in all three storage variants. The final assessment was carried out 14 days after the storage and it was decisive for the assessment. Sprout number, sprout length in mm and a rate of dormancy breaking or sprouting were determined. A 9-point scale was used for the evaluation:

1. tubers not sprouted, and/or dormancy not broken
3. tubers not sprouted, dormancy weakly breaks
5. weak sprouting of tubers, dormancy broken, eyes chitted
7. intermediate sprouting of tubers, sprout length less than 10 mm
9. strong sprouting of tubers, sprout length more than 10 mm

► Skin greening was measured in all the assessments using a 9-point scale:

1. no skin greening
3. very slight, mostly insignificant greening
5. slight skin greening
7. strong skin greening
9. very strong and considerable skin greening

► Flesh greening was evaluated in halved tubers, cut in the direction from rose-end to stem-end 14 days after the storage of washed potatoes using a 9-point scale:

1. no flesh greening
3. very slight, insignificant greening, directly under the skin
5. slight greening directly under the skin
7. strong greening under the skin, reaching up to 1 mm of flesh
9. very strong and considerable greening under the skin reaching more than 1 mm of flesh

► Occurrence of tuber diseases, abiotic and pest injuries was studied immediately after the washing and during potato storage. From diseases, presence of common scab, soft rot, potato leak, late blight, black scurf, silver scurf was evaluated on a 9-point scale, where 1 = no infection, 9 = very strong infection (Wenzl and Demel 1967). Eventual tuber damage by virus diseases, particularly PVY – necrotic strain was also measured. From the abiotic injuries, secondary growth, jelly end rot, malformations, growth cracks, enlarged lenticels and internal rust spot were evaluated. Changes in disease (silver scurf, late blight, rots) occurrence were also recorded.

Mentioned characters were evaluated after 24, 48 hours, 4, 7 and 14 days after the tuber washing. The presence of glycoalkaloids was studied in chosen varieties using HPLC (Zrůst et al. 2000). The evaluation of meteorological conditions was carried out according to Kožnarová and Klabzuba (2002).

RESULTS AND DISCUSSION

The highest scuffing was found at early harvests of physiologically immature tubers from the region Polabí. The washing of tubers from very early harvests is problematic and could not often be recommended. So-called new potatoes originating from first harvests done mostly during the first days of June are popular among Czech consumers, although the skin is often strongly scuffed. Tubers harvested in this way have to be introduced on the market and consume as soon as possible, then they lose turgor, become soft and are easily subjected to diseases. Lower, often only slight, sometimes no scuffing was found in Žabčice at harvests done in the end of June and in very early potato varieties in the locality Valečov. The rose-end was the most scuffed part of tuber. Several differences were found between individual years. The highest scuffing was shown in 2001, when high rainfalls were recorded in July, August and September, the lowest scuffing was shown in 2003, when lack of rainfalls and high temperatures were recorded in given months. Considering the varieties, the lowest skin scuffing was found in those ones with shorter growing period, even within one-vegetation group. Intermediate to strong skin scuffing was found in several varieties with very long growing period, for example the variety Bionta.

Discoloration of parts, where the skin is scuffed, could be a considerable problem for potato washing. The discoloration is expressed at first by gray, later freckled brown color of scuffed parts. For some varieties the discoloration was recorded 24 hours after the washing on parts, where the skin was scuffed. In other varieties discoloration did not occur or only occurred in a non-significant way. The highest discoloration at early harvests was found in varieties: Impala, Karlena, Krasa a Vitesse. The lowest discoloration was found in varieties: Astoria, Fresco, Komtesa, Lady Christl, Rosara and Velox.

The way of storage of washed potatoes, variety and year had the highest influence on tuber greening. Early and strong greening was found in varieties: Bionta, Filea, Karin, Karmela, Komtesa, Korela, Krasa, Magda, Marella, Marena, Sante and Veronika. Very slow and slight greening was found in varieties: Adora, Agria, Asterix, Belladonna, Berber, Delikat, Ditta, Flavia, Lady Christl, Lady Rosetta, Laura, Milva, Nicola, Ornella, Quarta, Raja, Red Scarlet, Redstar, Rosara, Rosella, Secura and Symfonia. In the rest of the varieties intermediate greening was determined. In red-skinned varieties lower greening was visually recorded. For the variant 3, where the tubers were stored in sealed packages, slower and slighter skin greening was determined. Eight selected varieties with various greening intensity were studied to what extent the way of tuber illumination influenced tuber greening. Two types of 36 W Phillips lamps were used – green and white, with an illumination of 700–840 lux. Differences between various illuminations were non-significant for both skin and flesh greening. Tuber glycoalkaloid content (α-solanine and α-chaconine) was also measured. However, derived results are not convincing, so it is not possible unambiguously to associate tuber greening with presence of studied glycoalkaloids.

Sprouting of washed tubers was a further studied index. It was mostly influenced by the way of storage and especially microclimatic conditions in packages and also dormancy of given variety. The earliest and strongest sprouting was found in tubers of varieties stored in the variant 3, i.e. in a sealed, non-perforated film, further in the variant 2, in a perforated film. Tubers from the variant 1, laid on a tray, were mostly without signs of sprouting or expressed weak signs of sprouting. Table 1 presents results of sprouting. The lowest number of varieties, only four, was included among varieties with strong and early sprouting. The group of varieties, where tubers did not sprout, consisted of 8 varieties. More varieties contained in the group, where dormancy was broken and tubers were slightly chitted 14 days after placing into simulated shop's conditions. Thirty-five varieties were included in this group. The highest number of varieties, 47 ones, was involved in the group, where tubers sprouted; however, the sprout length did not exceed 10 mm. These results, although extreme storage conditions were used, practically comply with the results of Kürzinger (2004), who studied the dormancy period (not-sprouting of tubers) in different varieties in Germany. He divided varieties into 7 groups according to the response to sprouting, from very weak sprouting (group 1) to strong sprouting (group 7). Grouping varieties according to sensitivity to sprouting is significant in regard to selection of the most suit-

Table 1. Sprouting of tubers of evaluated potato varieties

Tubers do not sprout, eyes dormant	Tubers weakly sprout, dormancy broken, eyes chitted			Tubers intermediately sprout, sprout length < 10 mm				Tubers strongly sprout, sprout length > 10 mm
Agria	Adora	Magda	Saturna	Adéla	Impala	Lady Roseta	Redstar	Berber
Bionta	Arnika	Monalisa	Secura	Angela	Inova	Laura	Remarka	Minerva
Dali	Astoria	Nicola	Sibu	Asterix	Karin	Liseta	Rosella	Nora
Granola	Baltica	Octan	Solara	Belana	Karlena	Marabel	Samantana	
Panda	Belladonna	Ornella	Symfonie	Colette	Karmela	Merkur	Santana	
Sirius	Cicero	Presto	Vaneda	Diana	Komtesa	Milva	Sante	
Vladan	Cinja	Princess	Vera	Donald	Kordoba	Moli	Tomensa	
	Delikat	Producent	Victoria	Fambo	Korela	Mondial	Ukama	
	Ditta	Provento	Vineta	Felsina	Kornelie	Morene	Velox	
	Futura	Romula	Vivaldi	Filea	Korneta	Quarta	Veronika	
	Inovator	Rosara		Flavia	Krasa	Raja	Vilma	
	Katka	Satina		Goltika	Lady Christl	Red Scarlet	Vitesse	

able storage conditions for given variety and for a decision about sprout suppression of tubers, which are necessary to be stored for a long time (Rasocha and Hausvater 1999).

Differences between varieties in tuber greening, discoloration and sprouting were statistically assessed with usage of analysis of variance. Summary results are present in Table 2. The calculated value of test index F exceeded the table value F of distribution for $\alpha = 0.05$ in all studied characters of all maturity groups. An alternative hypothesis A was accepted consisting in existence of statistically significant differences between compared means of individual characters.

The potato washing markedly reveals defects, diseases, abiotic injuries and damages visible on skin and also promotes infection of some diseases or their further development and distribution. Various forms of common scab largely impairing tuber appearance are the biggest problem. For this reason, washing of potatoes cannot be often recommended for tubers with stronger infection of this pathogen. Furthermore, the washing of common scab-infected tubers promotes secondary infection by other pathogens, particularly from the group of bacteria and fungi and it has a negative impact on tuber shelf life. The problem is occurrence of black scurf, silver scurf and some rots, especially soft rot and tuber rot (Hausvater et al. 2001). The occurrence of abiotic injuries, which markedly limits use of some potato tubers for the washing, is influenced by extreme weather conditions and site to the highest degree. The grower could also contribute to an increased presence of abiotic injuries e.g. with insufficient haulm destruction before harvest and re-growths. In these cases secondary growth, tuber malformations, early sprouting etc. frequently occur (Zrůst and Rasocha 1996). The susceptibility or resistance of variety to harmful agent plays an important role. Both the grower and processor of table potatoes have to take this fact into account.

The tuber washing of studied varieties was markedly influenced by growing conditions of the given year. The variety and pest infection has a significant effect. The varieties with rough, netted skin, physiologically immature, infected by diseases e.g. common scab; black scurf and silver scurf are not suitable for the washing. Tuber of varieties showing higher mechanical damages, cracks, secondary growth, malformations and varieties susceptible to soft rot are also not suitable for the washing. Tuber of varieties with smooth and bright skin, without scuffing, with later greening in the light, without disease and abiotic change occurrence are considered very suitable for the washing. From this view, following varieties and hybrids were found the most suitable for the washing: Adéla, Astoria, Belladona, Dali, Ditta, Flavia, Futura, Katka, Kordoba, Kornelie, Lady Christl,

Table 2. Analysis of variance

	Very early varieties			Early varieties			Medium-early varieties			Medium-late to late varieties		
	tuber greening	discolored	tuber sprouting	tuber greening	discolored	tuber sprouting	tuber greening	discolored	tuber sprouting	tuber greening	discolored	tuber sprouting
Degrees of freedom f_1	19			31			18			12		
f_r	60			96			57			39		
F-test	40.355	43.547	42.35	9.831	5.706	5.683	17.839	4.561	5.667	34.599	3.671	4.727
Critical value	1.75			1.57			1.75			2.02		
Significance between varieties	*	*	*	*	*	*	*	*	*	*	*	*

Range test Tukey, confidence level: 95

Laura, Milva, Princess, Redstar, Rosara, Samantana, Satina, Secura, Velox, Vera, Victoria, KE 524-11, KE 12-83.

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