Effect of white fleece on the selected quality parameters of early potato (*Solanum tuberosum* L.) tubers

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ABSTRACT

The effects were tested of white fleece on the contents of ascorbic acid, nitrates, and polyphenols in 1999 and 2000, and on the carotenoids content in 2000 and 2001 in tubers of two early potato varieties (Adora and Impala) in field trials on two cultivation sites (Přerov n/Labem and Prague-Troja). Early irrigated potatoes were cultivated according to the uniform methodology for field trials. Two variants were compared – cultivated plants covered with white fleece (Pegas-Agro UV 17) and the controls without any covering. The tubers were harvested three times in intervals of 7–16 days. The results were statistically tested by ANOVA and Tukey's methods. Ascorbic acid content showed a tendency to higher values in the potatoes covered with white fleece as compared with the control samples (average increase by 12.3%). The effect of the fleece was significantly affected by the potato genotype and the year of cultivation (cv. Adora showed a content higher by 12.54% in comparison with the control). The tendency to reduce nitrate levels was observed in potato tubers cultivated under the fleece, especially in the second term of harvest (on average by 14.34%). The decrease between the first and the third term of harvest was apparent. The higher was the maturity of potato tubers, the lower nitrate content was found. Significant differences were found between the varieties (P = 0.0058) and the cultivation sites (P = 0.0399). The effect of white fleece on polyphenol content was not statistically significant. However, the effect of the year of cultivation on the polyphenols content was significant (P = 0.0094). The effect of white fleece on the carotenoids content was not statistically significant but a tendency to lower contents in the variant with white fleece was found (by 7.2%). The sites and the varieties affected the carotenoids contents significantly (P = 0.0028 and P = 0.0417, respectively).

Keywords: potato tuber quality; white fleece; ascorbic acid; nitrates; polyphenols; carotenoids

Early potato growers aim to enhance their competition ability on the market by improving the potato quality and enhancing and stabilising the yields from the beginning of early harvest terms. One of the possible solutions represents growing early potatoes under white fleece.

Potato tubers contain secondary metabolites as well as major compounds. Polyphenolic compounds represent substrates for enzymic browning of potatoes that occurrs during peeling, cutting or grating raw potato tubers. *L*-tyrosine (1–2.10^{-3}M) and chlorogenic acid (2–6.10^{-4}M) are the major polyphenolic potato constituents (Matheis 1987, Delgado et al. 2001). Polyphenolic compounds, esp. chlorogenic acid, together with ferric cations contribute to potato darkening after their cooking (Griffiths et al. 1992, Laerke et al. 2002). The rate of enzymic browning depends on many factors such as the concentration and the type of phenolic compounds (Lachman et al. 1996), the concentration and substrate specificity of polyphenoloxidases, the concentration of oxygen, and the concentration of naturally occurring inhibitors of browning (Almeida and Nogueira 1995). Differences in the potato-browning rate are caused rather by quantitative than qualitative differences of polyphenolic constituents of potato tubers (Ramamurthy et al. 1992, Cantos et al. 2002). Polyphenolic content in potato tubers is affected by the conditions of cultivation and by the potato varieties (Hamouz et al. 1997).

Ascorbic acid content in potato tubers attracts interest as an important source of vitamin C in human nutrition (Hamouz et al. 1999, Tudela et al. 2002b). Ascorbic acid concentration in tubers influences the degree and the rate of the enzymic browning of potatoes because it is a naturally occurring inhibitor of this process (Almeida and Nogueira 1995).

Carotenoids are also efficient antioxidants involved in the antioxidant network (Canfield 1993, Järvinen 1995, Mayne 1996, Fučíková et al. 1997). In potato tubers, they represent on average 3 mg/kg (Duke 1992) but van Dokkum et al. (1990) reported the mean total carotenoid content of only 0.75 mg/kg. According to Duke (1992), the prevailing carotenoids are β-carotene (1 mg/kg) and its derivative β-carotene-5,6-monoepoxide. However, Ong and Tee (1992) found lutein (0.13–0.60 mg/kg) and β-carotene (0.03–0.40 mg/kg) as the most occurring carotenoids. Granado et al. (1992) reported in an early variety as major components lutein (0.12 mg/kg), zeaxanthin (0.04 mg/kg)

Research Project MSM 412100002 of the Faculty of Agronomy of the Czech University of Agriculture in Prague supported this work.

and β-carotene (0.01 mg/kg). Also Heinonen et al. (1989) found lutein and zeaxanthin (0.13–0.60 mg/kg) and β-carotene (0.032–0.077 mg/kg) as major carotenoids.

However, besides compounds desirable in human nutrition, potato tubers contain also some constituents that could in certain amounts represent a health risk. Current statutory limit for nitrate (NO_3^-) content in the Czech Republic is 300 mg/kg, for early potatoes (until 15 July) 500 mg/kg of fresh tubers. The contents of polyphenol compounds, ascorbic acid, and carotenoids in potato tubers are influenced by numerous factors. The most important ones are the variety, soil, and climatic conditions, the technology of cultivation, tuber maturity and injury, storage duration, and temperature. The nitrate contents in tubers are influenced both by nitrogen fertilisation and also to a great extent by weather and site conditions, by growth regulators and other factors (Míča and Vokál 1990, Míča and Zrůst 1992). Knowledge about particular influence of individual factors is not unambiguous. Míča and Vokál (1992) determined nitrate content in potato tubers and concluded that the basic prerequisite for a low nitrate content in tubers is sufficient of precipitations (500 mm during the vegetation period should ensure nitrate content meeting the legislation requirements). It depends also on the precipitation distribution during the vegetation period and on other factors. E.g. cool weather, a small number of sunny days and rich precipitations decrease photosynthetic activity and eventuate a limited nitrate accumulation. Augustin et al. (1977) reported a decrease of nitrate nitrogen at higher soil moisture levels in peeled potato tubers cultivated at 65 or 85% soil moisture level during the vegetation period. A significant influence of the year of cultivation was demonstrated by Cieslik (1994) in trials with five potato varieties.

The aim of this work was to evaluate the effect of early potatoes cultivation under white fleece thus changing microclimatic conditions affecting the factors important for potato tuber quality – the contents of polyphenols, ascorbic acid, carotenoids, and nitrates.

MATERIAL AND METHODS

Cultivation method and field trials

The uniform methodology of cultivation for field trial establishment and performance with irrigated early potatoes was applied on two cultivation sites (Přerov n/Labem [A] and Prague-Troja [B]). Two early varieties Adora and Impala were used in the uncovered control variant and the variant with fleece Pegas-Agro UV 17 (four parallel determinations). Every plot had an area of approximately 8 m^2 and was divided into two rows. Twenty-five tubers were planted out in one row with the planting space of 0.625 × 0.25 m in the site A, and of 0.70 × 0.25 m in the site B, respectively. Different planting spaces were caused by different mechanical equipment on both sites of cultivation. The fleece was applied immediately after planting (30 March 1999, 4 April 2000 or 5 April 2001) and taken off on 18 May 1999, 4 May 2000 or 10 May 2001. In the site A, herbicide Sencor 70 WP was applied (0.5 kg/ha) prior to covering with fleece, while in the site B the pests were eliminated only mechanically. Eight irrigation doses were applied in the site A in 1999 and 2000, and five doses in 2001 (in total 107, 102 and 83 mm, respectively). Similarly, in the site B five irrigation doses were used in 1999 (80 mm), six doses in 2000 (96 mm) and four doses in 2001 (91 mm).

Characteristics of the cultivation sites

Přerov nad Labem (site A) – the site is situated in a beet growing region, barley subtype, 178 m above the sea level. The experimental fields are situated on planar, equal experimental plots. Geological subsoil is formed by aluvial Quarternary gravel sand on which medium pervious soils, sandy loam soils and clay soils with favourable physical properties were formed. The soils are medium deep or deep, well arable. Among soil types Orthic Luvisol prevails with neutral soil reaction.

Prague-Troja (site B) – the site is situated in a beet growing region, mean altitude is 180 m above the sea level. The plots are situated on pleistocennic Vltava River alluvial terrace with a downhill to southwest. The soil type is Orthic Luvisol, sandy loam soil. Arable layer is 0.2 m deep, pH value 7.2. Natural fertility of soil is low, mineral inorganic fertilisers are quickly washed out.

Characteristics of climatic conditions on the sites and temperature data for 1999–2001

Site A – the region lies in climatic region B2, mildly warm and dry with temperate winters. Average year

Table 1. Climatic characteristics of the cultivation sites in the period April–June in 1999–2001

	Mean temperatures April–June (°C)			Mean deviations April–June (°C)			Mean precipitation April–June (mm)			Percentage of long-term mean (%)		
Year	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Site A	15.0	15.6	14.5	0.2	0.6*	–0.3	56.9	37.6	75.0	92.1	60.9**	121.5
Site B	14.5	14.9	13.7	0.3	0.8*	–0.5	41.6	31.7	57.7	69.1	52.7**	96.0

* warm year, ** dry year

Table 2. Ascorbic acid, nitrate and polyphenol contents in potato tubers in 1999 and 2000

Site	Variety	Year	Ascorbic acid (mg/kg)		Nitrates (mg/kg)		Polyphenols (mg/kg)	
			white fleece	control	white fleece	control	white fleece	control
A	Adora	1999/I	198	42.7	206	202	414	383
A	Adora	2000/I	121	95.3	116	118	575	544
A	Impala	1999/I	59.7	33.1	285	227	394	365
A	Impala	2000/I	115	91.4	234	267	505	490
A	Adora	1999/II	84.8	176	110	243	464	373
A	Adora	2000/II	210	198	29.0	51.0	575	544
A	Impala	1999/II	120	117	394	313	394	412
A	Impala	2000/II	222	135	135	141	504	490
A	Adora	1999/III	132	174	141	140	476	349
A	Adora	2000/III	23.9	25.9	74.8	168	612	549
A	Impala	1999/III	159	156	258	240	349	478
A	Impala	2000/III	120	98.9	193	257	663	568
B	Adora	1999/I	178	33.9	252	220	338	401
B	Adora	2000/I	66.1	110	207	198	351	330
B	Impala	1999/I	69.6	204	295	305	316	374
B	Impala	2000/I	87.7	58.8	371	413	304	336
B	Adora	1999/II	181	118	91.0	111	377	435
B	Adora	2000/II	141	117	147	170	448	397
B	Impala	1999/II	152	137	219	300	386	344
B	Impala	2000/II	134	90.1	415	584	306	337
B	Adora	1999/III	170	228	177	174	478	433
B	Adora	2000/III	85.0	96.4	34.3	41.8	594	569
B	Impala	1999/III	265	251	257	268	370	406
B	Impala	2000/III	189	137	214	399	540	531

I – first date of harvest (2 June 1999 or 31 May 2000), II – second date of harvest (10 June 1999 or 15 June 2000), III – third date of harvest (24 June 1999 or 28 June 2000)

temperature is +8.8°C, average year total precipitations are 622 mm.

Site B – the site belongs to warm climatic region A2, dry, with temperate winters and shorter sunshine. Average year temperature is +9.0°C, average year total precipitations are 487 mm.

Climatic characteristics in the periods from April to June 1999–2001 are given in Table 1.

Determination of total polyphenols. Four round-shape tubers of 4–5 cm diameter were selected for every characteristic sample. Peeled potato tubers were homogenised in the shortest time using a kitchen mixer and for the determination 10 g was weighed into 100 ml volumetric flask. The flask was filled up with 80% ethanol to the mark and after a vigorous agitation for 5 min and homogenisation, the solution was left to settle for 5 min. After sedimentation, 5 ml aliquots were pipetted for the determination. After dilution with distilled water to aproximately 30 ml, 2.5 ml of Folin-Ciocalteau's reagent p.a. (Nycom, Prague, Czech Republic) were added. After agitation and 3 min standing, 7.5 ml 20% Na_2CO_3 p.a. solution was added and the volume was made up to the mark with distilled water. After a vigorous agitation and two hours standing at laboratory temperature, the absorbance of the blue solution was measured against blank in cuvettes of 0.5 cm thickness at $\lambda = 765$ nm on Spekol 11 spectrophotometer (Zeiss, Jena, Germany). Polyphenol compounds were expressed as gallic acid content on dry matter (DM) basis. Two parallel determinations with each sample were performed.

Determination of ascorbic acid. Four round shape potato tubers of 4–5 cm diameter were washed, weighed, and homogenised with a weighed amount of oxalic acid solution [28 g $(COOH)_2.2\ H_2O$ in 1 l]. The homogenate was filtered and ascorbic acid was determinated in the filtrate polarographically by the method of standard addition on the Eco-Tribo polarograph (Polaro-Sensors, Prague) under the following parameters: initial potential = 250 mV, final potential 300 mV, rate 20 mV/s, bubble period 120 s, number of scans 1, static period 1 s, height of pulse 50 mV, width 80 mV. Two parallel determinations with each sample were performed.

Determination of nitrates. For the nitrate content determination, an extract of potato tubers was prepared (after the addition of $CuSO_4$, $Al_2(SO_4)_3$ and Ag_2SO_4) and analysed using ion selective electrode (ISE) method (Nitrate XQ-1 Orion, Boston, USA) according to Davídek et al. (1977).

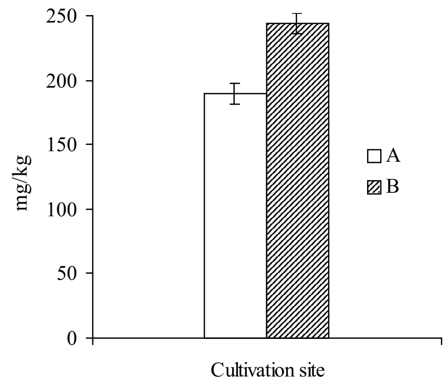

Figure 1. Effect of the cultivation site on nitrates content

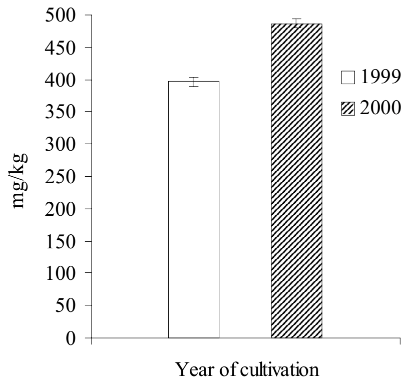

Figure 2. Effect of the year of cultivation on polyphenols content

Determination of carotenoids. Potato chips were prepared from 15 g of average sample (four potato tubers) and left to freeze in closed Petri dishes in a freezer for approximately 10–12 h. The frozen samples were then freeze-dried for approximately 12 h. The samples were then slightly disintegrated in narrower beakers with a glass rod and 10–15 ml acetone was added. The beakers containing the samples were covered with tinfoil to prevent light activity and stored for 2–3 days in a refrigerator. The beakers were then put in an ultrasound bath and sonicated for 20 min, and the samples were filtered through a glass frit. The yellowish filter cake was washed three times with 5 ml acetone until the cake acquired white colour. The filtrates were quantitatively transferred to 25 ml volumetric flasks and made up to the mark (if resulting extract volume was over 25 ml, the redundant acetone was evaporated under nitrogen flow). In the case of turbidity, the acetone extract was filtered through a fold paper filter of medium density. The absorbance of the acetone extracts was then measured in 1 cm cuvettes at λ = 444 nm against acetone and the total carotenoid content in mg/kg of sample was expressed as lutein equivalent from the equation:

$$(K + X)_L = \frac{A_{444} \cdot 25}{0.259} \cdot \frac{15}{m} \text{ (mg/kg)}$$

where: $(K + X)_L$ – total carotenoid content (carotenes and xanthophylls)
A_{444} – absorbance of acetone extract at λ = 444 nm
m – sample weight (g)

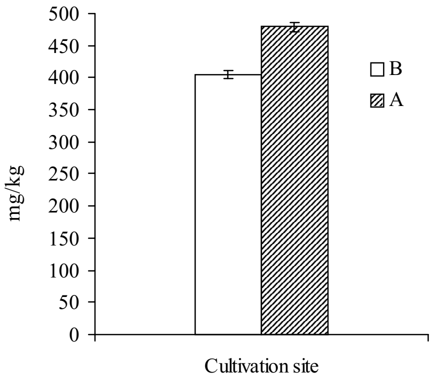

Figure 3. Effect of the cultivation site on polyphenols content

Table 3. Carotenoids content (expressed as lutein) in potato tubers (mg/kg)

Site	Variety	Year	White fleece	Control
A	Adora	2000/I	15.4	7.4
A	Adora	2001/I	13.4	15.9
A	Impala	2000/I	8.5	12.5
A	Impala	2001/I	10.6	16.1
A	Adora	2000/II	19.4	20.3
A	Adora	2001/II	19.8	18.4
A	Impala	2000/II	10.1	14.0
A	Impala	2001/II	13.9	15.6
A	Adora	2000/III	15.9	13.3
A	Adora	2001/III	19.4	19.2
A	Impala	2000/III	21.5	14.3
A	Impala	2001/III	13.8	16.8
A	Adora	2000/IV	5.6	9.6
A	Impala	2000/IV	4.5	4.3
B	Adora	2000/I	14.9	16.6
B	Adora	2001/I	6.5	9.2
B	Impala	2000/I	2.6	4.0
B	Impala	2001/I	1.9	3.1
B	Adora	2000/II	7.2	5.3
B	Adora	2001/II	8.6	6.4
B	Impala	2000/II	0.8	0.3
B	Impala	2001/II	7.5	12.7
B	Adora	2000/III	20.5	17.5
B	Adora	2001/III	19.8	18.4
B	Impala	2000/III	12.5	16.1
B	Impala	2001/III	13.6	15.8
B	Adora	2000/IV	0.2	3.0
B	Impala	2000/IV	0.4	0.1

I – first date of harvest (31 May 2000 or 7 June 2001), II – second date of harvest (15 June 2000 or 14 June 2001), III – third date of harvest (28 June 2000 or 27 June 2001), IV – fourth date of harvest (3 August 2000)

Table 4. Analysis of variance for ascorbic acid content, type III, sums of squares

Source	Sum of squares	*Df*	Mean square	*F*-ratio	*P*-value
Main effects					
A. cultivation site	3167.78	1	3167.78	4.33	0.1728
B. date of harvest	23955.20	2	11977.60	16.38	0.0575
C. fleece treatment	2684.72	1	2684.72	3.67	0.1954
D. variety	777.15	1	777.15	1.06	0.4109
E. year	9357.67	1	9357.67	12.80	0.0700

Table 5. Analysis of variance for nitrate content, type III, sums of squares

Source	Sum of squares	*Df*	Mean square	*F*-ratio	*P*-value
Main effects					
A. cultivation site	36106.70	1	36106.70	23.55	0.0399*
B. date of harvest	24245.10	2	12122.60	7.91	0.1123
C. fleece treatment	10079.20	1	10079.20	6.57	0.1244
D. variety	263858.00	1	263858.00	172.11	0.0058*
E. year	4208.26	1	4208.26	2.74	0.2394

* statistically significant at level $P < 0.05$

Statistic evaluation. The results obtained (mean values from three parallel determinations) were statistically evaluated by ANOVA and Tukey's method with Statgraphics programme.

RESULTS

Temperatures in the periods from April to July in 1999 and in 2001 can be evaluated as normal, in 2000 as slightly warmer. Average temperatures on the cultivation site A were slightly warmer in comparison with that on the site B. The sum of precipitations was higher on the site A (average 56.48 mm) as compared with the site B (average 43.66 mm). Precipitations were slightly below the long-term mean, highly below the mean in 1999 and 2000 and slightly above the mean in 2001.

Ascorbic acid. In the tubers cultivated under fleece a tendency was observed to an increased ascorbic acid content as compared with the control (by 15.0 mg/kg, 12.3%) (Table 2). The tendency was more apparent on the site A. The effect of the fleece on ascorbic acid content was substantially affected by the genotype of the given variety in combination with the year conditions (esp. in Adora variety – an average increase by 14.8 mg/kg, 12.5%). An average increase of ascorbic acid on the site A was 18.5 mg/kg (16.5%), and on the site B 11.4 mg/kg (8.7%). No significant differences were found but the date of harvest was the most important factor for ascorbic acid content. Statistically significant interaction was found ($P = 0.0484$) between the date of harvest and the year.

Nitrates. The nitrate contents observed did not exceed the statutory limit of 500 mg NO_3^-/kg (Table 2). The mean level in the control variant for all years, varieties and sites was higher in comparison with the covered variant by 29.0 mg/kg (14.3%). The tendency was not statistically significant but it was more apparent on the cultivation site B (by 42.0 mg/kg, 18.8%). Nitrate content decreased during maturation between the first and the second dates of harvest. The effect of the fleece was not, on the average, statistically significant, the highest effect of white fleece having been observed in the second period of harvest. Significant differences were found between varieties – see Table 5 ($P = 0.0058$, cv. Impala by 148.3 mg/kg, i.e. by 104.1% higher than cv. Adora) and the cultivation sites (Table 5, Figure 1) – $P = 0.0399$.

Polyphenols. A tendency, however insignificant, to an increased polyphenol content in the variant with fleece could be found for the first harvest date. On the average, the variant with fleece exceeded the control by 1.2% only (Table 2). The highest effect of white fleece was found in the third term of harvest. Statistically significant was the effect of the year of cultivation (Table 6, Figure 2) at $P = 0.0094$ (in 2000 by 90.5 mg/kg, i.e. by 22.8% higher than in 1999), the cultivation site ($P = 0.0137$, Figure 3) and the date of harvest ($P = 0.0226$). Differences between varieties were above the level of statistical significance ($P = 0.0573$), content of polyphenols was in average higher in cv. Adora by 105.8 mg/kg (8.32%).

Carotenoids. Higher values were found in the control samples nearly in all cases in comparison with potatoes covered with fleece (on the average by 7.2%), but the increase was not statistically significant (Tables 3 and 7). The highest effect of white fleece on the first date of harvest was proved. Statistically significant was the effect of the cultivation site ($P = 0.0028$, Figure 4) and variety ($P = 0.0417$, Figure 5). The variety Adora exceeded on the average cv. Impala by 3.5 mg/kg, i.e. by 37.1%, thus

Table 6. Analysis of variance for polyphenols content, type III, sums of squares

Source	Sum of squares	*Df*	Mean square	*F*-ratio	*P*-value
Main effects					
A. cultivation site	66808.0	1	66808.0	71.58	0.0137*
B. date of harvest	80805.7	2	40402.8	43.29	0.0226*
C. fleece treatment	1707.3	1	1707.3	1.83	0.3088
D. variety	14911.1	1	14911.1	15.98	0.0573
E. year	98336.4	1	98336.4	105.35	0.0094*

* statistically significant at level $P < 0.05$

Table 7. Analysis of variance for carotenoids content, type III, sums of squares

Source	Sum of squares	*Df*	Mean square	*F*-ratio	*P*-value
Main effects					
A. cultivation site	375.436	1	375.436	10.18	0.0028*
B. fleece treatment	7.60666	1	7.60666	0.21	0.6521
C. variety	163.228	1	163.228	4.43	0.0417*
D. year	142.479	1	142.479	3.87	0.0563

* statistically significant at level $P < 0.05$

confirming the fact that the tuber colour and carotenoid content are the dominant attributes of a variety. The year of cultivation exceeded the level of the statistical significance (in 2001 by 1.1 mg/kg i.e. by 8.8% higher compared with 2000 – in 2000 average daily temperatures by the turn of April and May exceeded 25°C while in 2001 the average value was 14.7°C).

DISCUSSION

Donnely et al. (2001) examined the effects of the season-long exposure to elevated carbon dioxide and/or ozone concentrations on cv. Bintje tuber quality. They found that the tuber nitrogen content was reduced by elevated CO_2 in 1998 and 1999 ($P < 0.05$), but the nitrate content was decreased only in 1999 ($P < 0.05$). Elevated CO_2 reduced citric acid content in 1998 ($P < 0.05$) and increased ascorbic acid content in 1999 ($P < 0.05$). The data reported are in agreement with our results of the fleece effect – a higher ascorbic acid content and a lower nitrate content in the variant covered with the fleece where CO_2 concentration could be higher (Donnely et al. 2001). Vorne et al. (2002) confirmed these results – with increasing CO_2 exposure glycoalkaloid and nitrate concentrations decreased and, moreover, citric acid content decreased, which implies a higher risk for discolouration on cooking. The total ascorbate content showed statistically significant differences between genotypes both at harvest and after storage (Dale et al. 2003), which is in accordance with our results.

The concentration of the major polyphenols present – chlorogenic acid and 5-, 4-, and 3-caffeoylquinic acids – increased over 15 days of illumination (Percival and Baird

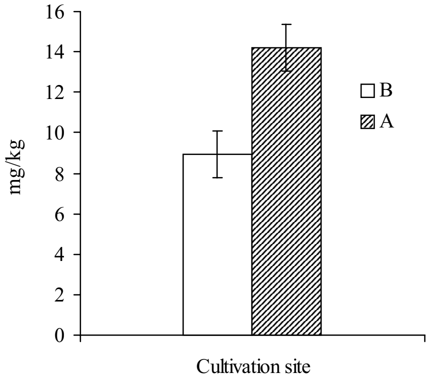

Figure 4. Effect of the cultivation site on carotenoids content

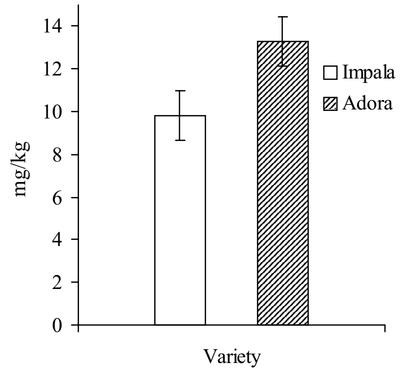

Figure 5. Effect of the variety on carotenoids content

2000). Light exposure increased 5-, 4-, and 3-caffeoylquinic acids accumulation rates in cv. King Edward. Irrespective of the storage period and the light source, ratios of 5-:4-:3-caffeoylquinic acids were ca 85:15:0 on day 0 and, respectively, 52:42:6 on day 15. The exposure to sodium and fluorescent light promoted in all cases higher rates of accumulation than did the exposure to high-pressure mercury light sources. The rates of accumulation in response to light were cultivar-dependent. On the other hand, Tudela et al. (2002a) found that the flavonol induction was higher in fresh-cut potatoes stored under light than in the dark; caffeic acid derivatives, however, were not affected. This corresponds to the insignificant differences in polyphenol contents obtained in our experiments between the control and the variants with white fleece. This could be also in connection with aphid control and virus transmission throughout polypropylene sealed fibre fleeces and polyethylene nettings (Harrewijn et al. 1991). Field experiments with potatoes showed that one particular fleece completely protected the plants against virus transmission whereas in the uncovered plots up to 25% of plants became infected. Ascorbic acid and polyphenols are very tightly bound in the antioxidant net to each other and this fact could explain the controversial effect of white fleece on carotenoid and polyphenol contents regarding the dates of harvest.

REFERENCES

Almeida M.E.M., Nogueira J.N. (1995): The control of polyphenoloxidase activity in fruits and vegetables: a study of the interactions between the chemical compounds used and heat treatment. Plant Foods Hum. Nutr., *47*: 245–256.

Augustin J., Mc Dole R.E., Painter G.C. (1977): Influence of fertilizer, irrigation, and storage treatments on nitrate content of potato tubers. Am. Potato J., *54*: 125–136.

Canfield M. (1993): Co-oxidative reactions of carotenoids. In: Carotenoids in human health, San Diego, CA.

Cantos E., Tudela J.A., Gil M.I., Espin J.C. (2002): Phenolic compounds and related enzymes are not rate limiting in browning development of fresh-cut potatoes. J. Agr. Food Chem., *50*: 3015–3023.

Cieslik E. (1994): The effect of naturally occurring vitamin C in potato tubers on the levels of nitrates and nitrites. Food Chem., *49*: 233–235.

Dale M.F.B., Griffiths D.W., Todd D.T. (2003): Effects of genotype, environment and post harvest storage on the total ascorbate content of potato (*Solanum tuberosum*) tubers. J. Agr. Food Chem., *51*: 244–248.

Davídek J. et al. (1997): Laboratory manual of food analysis. SNTL, Prague. (In Czech)

Delgado E., Sulaiman M.I., Pawelzik E. (2001): Importance of chlorogenic acid on the oxidative potential of potato tubers of two German cultivars. Potato Res., *44*: 207–218.

Dokkum W. van, Vos R.H. de, Schrijver J. (1990): Retinol, total carotenoids, beta-carotene, and tocopherols in total diets of male adolescents in the Netherlands. J. Agr. Food Chem., *38*: 211–216.

Donnelly A., Lawson T., Craigon J., Black C.R., Colls J.J., Landon G. (2001): Effects of elevated CO_2 and O_3 on tuber quality in potato (*Solanum tuberosum* L.). Agr. Ecosyst. Environ., *87*: 273–285.

Duke J.A. (1992): Handbook of phytochemical constituents of grass herbs and other economic plants. FL CRC Press, Boca Raton.

Fučíková A., Mader P., Vodičková H. (1997): Effect of dietary carotenoids on animal organism. Živoč. Výr., *42*: 229–239. (In Czech)

Granado F., Olmedilla B., Blanco I., Rojas-Hidalgo E. (1992): Carotenoid composition in raw and cooked Spanish vegetables. J. Agr. Food Chem., *40*: 2135 –2140.

Griffiths D.W., Baine H., Dale M.F.B. (1992): Development of a rapid colorimetric method for the determination of chlorogenic acid in freeze-dried potato tubers. J. Sci. Food Agr., *58*: 41–48.

Hamouz K., Lachman J., Pivec V., Orsák M. (1997): The effect of the conditions of cultivation on the content of polyphenol compounds in the potato varieties Agria and Karin. Rostl. Výr., *43*: 541–546. (In Czech)

Hamouz K., Lachman J., Vokál B., Pivec V. (1999): Influence of environmental conditions and type of cultivation on the polyphenol and ascorbic acid content in potato tubers. Rostl. Výr., *45*: 293–298.

Harrewijn P., Denouden H., Piron G.M. (1991): Polymer webs to prevent virus transmission by aphids in seed potatoes. Entomol. Exp. Appl., *58*: 101–107.

Heinonen M.I., Ollilainen V., Linkola E.K., Varo P.T., Koivistoinen P.E. (1989): Carotenoids in Finnish foods: vegetables, fruits, and berries. J. Agr. Food Chem., *37*: 655–659.

Järvinen R. (1995): Carotenoids, retinoids, tocopherols and tocotrienols in the diet, the Finnish mobile clinic health examination survey. Int. J. Vitam. Nutr. Res., *65*: 24–30.

Lachman J., Pivec V., Orsák M. (1996): Polyphenols and enzymatic oxidative browning of potatoes regarding their quality. In: Proc. Symp. Chemical reactions in foods III, Prague: 17–20.

Laerke P.E., Christiansen J., Veierskov B. (2002): Colour of blackspot bruises in potato tubers during growth and storage compared to their discolouration potential. Postharv. Biol. Technol., *26*: 99–111.

Matheis G. (1987): Polyphenol oxidase and enzymatic browning of potatoes (*Solanum tuberosum*). II. Enzymatic browning and potato constituents. Chem. Mikrobiol. Technol. Lebensm., *11*: 33–41.

Mayne S.T. (1996): Beta-carotene, carotenoids, and disease prevention in humans. Faseb J., *10*: 690–701.

Míča B., Vokál B. (1990): Changes in total and nitrate nitrogen contents in potato varieties and at different fertilising. Rostl. Výr., *36*: 355–366. (In Czech)

Míča B., Vokál B. (1992): Nitrates in potato tops and tubers. Rostl. Výr., *38*: 825–833. (In Czech)

Míča B., Zrůst J. (1992): The effect of growth-regulators on nitrate content in tubers. Rostl. Výr., *38*: 835–840. (In Czech)

Ong A.S.H., Tee E.S. (1992): Natural sources of carotenoids from plants and oils. In: Methods in enzymology. Acad. Press, *213*: 142.

Percival G.C., Baird L. (2000): Influence of storage upon light-induced chlorogenic acid accumulation in potato tubers (*Solanum tuberosum* L.). J. Agr. Food Chem., *48*: 2476–2482.

Ramamurthy M.S., Maiti B., Thomas P., Nair P.M. (1992): High-performance liquid chromatography determination of phenolic acids in potato tubers (*Solanum tuberosum*) during wound healing. J. Agr. Food Chem., *40*: 569–572.

Tudela J.A., Cantos E., Espin J.C., Thomas-Barberan F.A., Gil M.I. (2002a): Induction of antioxidant flavonol biosynthesis in fresh-cut potatoes. Effect of domestic cooking. J. Agr. Food Chem., *50*: 5925–5931.

Tudela J.A., Espin J.C., Gil M.I. (2002b): Vitamin C retention in fresh-cut potatoes. Postharv. Biol. Technol., *26*: 75–84.

Vorne V., Ojanpera K., de Temmerman L., Bindi M., Hogy P., Jones M.B., Lawson T., Persson K. (2002): Effects of elevated carbon dioxide and ozone on potato tuber quality in the European multiple-site experiment “CHIP-project”. Eur. J. Agron., *17*: 369–381.

Received on March 14, 2003

ABSTRAKT

Vliv bílé netkané textilie na vybrané kvalitativní parametry hlíz raných brambor (*Solanum tuberosum* L.)

V přesných polních pokusech v letech 1999 a 2000 byl sledován vliv bílé netkané textilie na obsah askorbové kyseliny, nitrátů a polyfenolů a v letech 2000 a 2001 na obsah karotenoidů v hlízách dvou odrůd raných brambor (Adora a Impala) na dvou lokalitách (Přerov n/Labem a Praha-Troja). Zavlažované rané brambory byly pěstovány podle jednotné metodiky pro přesné polní pokusy. Byly porovnány dvě varianty – s pokryvem netkanou bílou textilií (Pegas-Agro UV 17) a kontrolní na volném pozemku. Získané výsledky byly vyhodnoceny statisticky metodou ANOVA a Tukeyho testem. U brambor pokrytých netkanou textilií byl zjištěn trend k vyšším průměrným hodnotám obsahu askorbové kyseliny při srovnání s kontrolní variantou (průměrný nárůst o 12,3 %). Vliv textilie byl výrazně ovlivněn genotypem a ročníkem (Adora vykázala o 12,5 % vyšší obsah ve srovnání s kontrolní variantou). U hlíz pěstovaných pod textilií byl zjištěn trend k nižším hodnotám dusičnanů, zvláště ve druhém termínu sklizně (průměrně o 14,3 %). Statisticky významné rozdíly byly nalezeny mezi odrůdami (P = 0,0058) a lokalitami (P = 0,0399). Vliv netkané textilie na obsah polyfenolů nebyl statisticky významný. Statisticky významný vliv na obsah polyfenolů vykázal ročník (P = 0,0094), lokalita a termín sklizně. Odrůda Adora obsahovala průměrně vyšší množství polyfenolů. Vliv textilie na obsah karotenoidů nebyl statisticky významný, avšak u varianty s textilií se projevil trend k nižšímu obsahu (o 7,2 %). Statisticky významný byl vliv ročníku a odrůdy (P = 0,0028 a P = 0,0417).

Klíčová slova: kvalita hlíz brambor; netkaná textilie; askorbová kyselina; dusičnany; polyfenoly; karotenoidy

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