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MATURATION OF APPLE CULTIVARS EVALUATED ON THE BASIS OF MULTIFACTORIAL INDICES*

SKLIZŇOVÁ ZRALOST ODRŮD JABLEK ODVOZENÁ Z VÍCEPARAMETROVÝCH INDEXŮ LÁTKOVÝCH SLOŽEK

J. Goliáš, J. Létal, J. Balík, L. Šuderlová

Horticultural Faculty, Mendel University of Agriculture and Forestry at Brno, Lednice na Moravě, Czech Republic

ABSTRACT: Developmental trends during the ripening of apples in which the inflection point coincides with the start of climacteric phase were determined. The level of ethylene production from intact fruit was used as a physiological indicator of ripening combined with three- and four-parameter indices of physical and chemical parameters distinguished by a high variability during the harvesting period. The indices were derived from tissue compounds (soluble solids, titratable acids, content of starch) and fruit firmness.

apples; indices of ripening; firmness skin; firmness flesh; soluble solids; titratable acids; starch index

ABSTRAKT: Kombinací fyziologického ukazatele zrání (produkce etylenu z intaktního plodu) se třemi- a čtyřparametrovými indexy látkových složek, které v období zrání podléhají výrazným změnám, byly stanoveny časové průběhy u jednotlivých termínů zrání, jejichž inflexní bod se shoduje se začátkem klimakterické vývojové fáze stanovené podle produkce etylenu. Některé látkové složky (rozpustná sušina, titrační kyselost, obsah škrobu na řezné ploše) a hodnoty pevnosti plodu (penetrační napětí slupky, penetrační napětí dužniny) byly použity v indexových hodnotách.

jablka; zralostní index; pevnost slupky; pevnost dužniny; rozpustná sušina; titrační kyselost

INTRODUCTION

For a long-term storage of fruits in the ambience of cooling chambers with controled atmosphere it is desirable to harvest fruits in optimal maturation. At this stage fruits markedly stop the increasing of their volume and weight and typical processes of maturation start. Determination of this period is theoretically derived from the climacteric increase in fruit respiration – however, this criterion cannot be used for practical purposes. On the other hand, the production of ethylene as a physiological criterion of the level of maturation is used only rarely.

According to the level of respiration of fruits derived from three-year trials the optimal period of physiological maturation of Granny Smith apples seems to be October 14–28 (Kupferman, 1992). At the outdoor temperature, the premature and late harvests result in the increase of evaporation on market places (Braun et al., 1995). The effect of harvesting period is often evaluated according to the sensory parameters of fruits and incidence of physiological browning one week after storage (Skrzynski, 1996). Streif (1989) considers the optimal maturity as a balance between the capability to a long preservation and the acceptable marketing quality of fruits. From the physiological point of view the maturation is a continuum of many parallel processes of biosynthesis and hydrolysis of supply substances. According to Streif (1989) criteria of ripening are based on objective measurement of parameters significantly influencing the physical properties of fruits.

Softening of fruits, caused by spontaneous pectolysis of pectocellusoses and protopectin, is frequently evaluated by the penetrometric firmness of flesh F (using the standardised stamp with diameter 11 mm – measurement units are usually kg/cm^2), soluble solids content R (°Bx) and starch index S (scale 1–10). So called Streif index (F/R x S) is also used – e.g. around the Bodam lake the cultivar Golden Delicious exhibits following values: F = 8 kg/cm^2, R = 12 °Bx, S = 7 i.e. F/R x S = 0.10. For most apple cultivars F values are in the interval 8–9 kg/cm^2 (0.8–0.9 MPa).

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According to Goffings (1996) the ripening of apple cultivars Jonagold and Golden Delicious can be described by Streif index with higher values for climatic conditions of orchards in Belgium. Luton (1994) combines the maturity index (starch x firmness of flesh) with ethylene concentration in the inner atmosphere of the fruit. He prefers the degradation of starch, and he correlates its decrease with the biogenesis of ethylene. The optimal harvesting period can be estimated seven days beforehand. For objectively determining the level of starch a portable device Starchmeter was designed based on measuring the colour of cut area (Planton, 1994).

In the article, stemming from the work (Goliáš, 1999), there were evaluated tissue compounds (soluble solids content, titratable acids), penetrometric firmness and multifactorial indices describing the changes and developmental trends in these parameters during the ripening of fruits on trees. Results were related to the dynamics of ethylene produced by intact fruits.

MATERIAL AND METHODS

Apple cultivars, fruit samples

Three apple cultivars Angold, Florina and Rezista with resistance to fungal diseases and standard cultivar Golden Delicious were selected from orchards at a research station Mendeleum and school farm in Lednice. On eight harvest dates fruit samples ($n = 6$) were measured immediately after picking for the production of ethylene (Goliáš, 1999) for each cultivar. Spectrometric measurements in the space L*, a*, b* of fruit colour, penetrometric firmness, titratable acids and soluble solids content followed. Harvest dates (since 1. 9. to 18. 10. 1998 in one week intervals) were the same for all cultivars:

1	2	3	4	5	6	7	8
1.9.	6.9.	14.9.	20.9.	27.9.	4.10.	12.10.	18.10.

Parameters of fruit firmness

For measurements of fruit firmness we used a penetrometer connected with PC through an analogue-digital transducer (with on-line recording of deformation curves during the penetration of fruit) (Goliáš et al., 1975). For the evaluation of deformation curves and the estimation of basic parameters of firmness (σ_I – subepidermal injury, σ_{SK} – firmness of skin, σ_{FL} – firmness of flesh) the software NextView version 2.5 was used. The interface between a measurement unit and PC was V24.

For the proper measurement of penetration tension of tissues we used a cylindrical stamp with diameter 7.9 mm and spherical convex apex 0.5 mm. The vertical speed of motor driven stamp was 120 mm/min.

Measuring of fruit colour

Chromaticity diagram Cielab describes the colour by axes a* and b* and brightness by the value L*. Values of parameters a*, b*, and L* were measured by spectrometric equipment Chroma-Meter CT 210 (Minolta). For each fruit six measurements were done around the fruit surface – the first measurement described the cover colour of skin (the level of loss of green colour), whereas the last measurement described the basic colour. Total colour of the whole fruit was computed as a mean for selected harvesting terms and cultivars.

RESULTS AND DISCUSION

Penetrometric fruit firmness

Subepidermal injury of tissues under the skin can be derived from deformation curves as inflections which are detectable especially for the cultivar Florina (Fig. 1). The apex of the curve describes the firmness of skin (point of skin penetration), after stabilising the signal the firmness of flesh can be evaluated. For each fruit four deformation curves were analysed. Average values of firmness parameters are shown in Tab. I.

Spectrometric measuring of fruit colour

The value L* (brightness) is not substantial for the estimation of optimal harvest period as a standalone analytical parameter. Its values are for all selected varieties in very narrow intervals (Tabs. II–V). For the cultivars with green and yellow colour of skin (Golden Delicious, Rezista) the values varied from 59.92 to 77.32. For the red cultivar (Florina) minimal value 33.49 was detected.

The axis a* describes the ratio between green and red colour. Distinctive values can be found for the cultivar Florina. From the second half of September to the end of the harvesting period the ratio increased from –13.06 to +24.88 which corresponds to an increase in ethylene production. Unlike the cultivar Angold the basic colour has a low variability and in full maturity only illuminated parts of fruits colour in red tone.

The axis b* describes the intensity of yellow colour of fruit skin. The most distinctive values were found for the cultivars Golden Delicious and Rezista. Especially for the cultivar Golden Delicious values b* increase during ripening (Tabs. II–V).

Determining the level of ripening based on tissue compounds

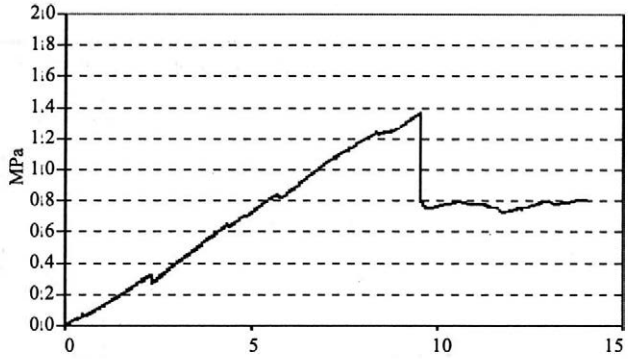
Standardisation of expeditious methods for the effective estimation of optimal harvesting term is still in the process of evaluation. Goliáš (1986) adjusted spectro-

I. Average values of physical and chemical parameters for apple cultivars during the harvest period 1998

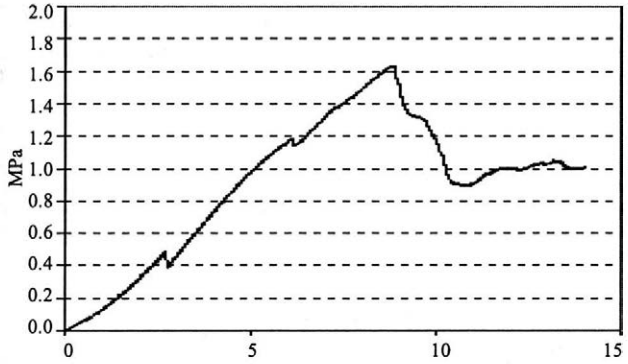
Cultivars	Date	Picking term	Subepidermal injury (MPa)	Firmness of skin (MPa)	Firmness of flesh (MPa)	Content of acids (%)	Soluble solids (°Bx)	Starch index (1–10)	Production of ethylene (µl/kg/h)
Angold	1. 9.	1	0.36	1.20	0.80	0.75	12.04	5.0	0.010
	6. 9.	2	0.35	1.40	0.90	0.74	11.98	4.8	0.047
	14. 9.	3	0.34	1.36	0.86	0.72	13.42	7.4	0.017
	20. 9.	4	0.25	1.10	0.71	0.66	12.76	8.4	0.095
	27. 9.	5	0.27	1.18	0.76	0.70	12.34	8.8	0.450
	4. 10.	6	0.28	1.18	0.75	0.59	11.66	9.6	0.510
	12. 10.	7	0.31	1.23	0.78	0.48	12.70	9.2	0.287
	18. 10.	8	0.32	0.95	0.63	0.46	13.12	9.8	0.350
Florina	1. 9.	1	0.48	1.44	0.98	0.60	10.98	3.4	0.029
	6. 9.	2	0.48	1.58	1.09	0.61	10.76	4.2	0.017
	14. 9.	3	0.42	1.40	1.00	0.53	11.68	8.2	0.006
	20. 9.	4	0.36	1.45	0.97	0.51	12.46	8.6	0.015
	27. 9.	5	0.46	1.46	0.94	0.48	12.38	9.0	0.020
	4. 10.	6	0.36	1.35	0.90	0.51	12.26	9.8	0.396
	12. 10.	7	0.44	1.35	0.90	0.52	13.20	9.8	0.280
	18. 10.	8	0.38	1.32	0.88	0.43	13.02	10.0	0.310
Golden Delicious	1. 9.	1	0.40	1.24	0.86	0.52	10.78	6.2	0.011
	6. 9.	2	0.37	1.14	0.90	0.49	10.82	5.8	0.050
	14. 9.	3	0.31	1.06	0.81	0.47	11.12	7.0	0.011
	20. 9.	4	0.30	1.12	0.81	0.49	11.38	8.4	0.011
	27. 9.	5	0.36	1.18	0.86	0.49	12.96	7.8	0.122
	4. 10.	6	0.31	1.01	0.75	0.42	12.22	9.4	0.146
	12. 10.	7	0.31	1.06	0.74	0.40	12.56	10.0	0.839
	18. 10.	8	0.22	0.84	0.60	0.34	12.64	10.0	1.390
Rezista	1. 9.	1	0.36	1.33	0.97	1.01	11.70	3.0	
	6. 9.	2	0.34	1.31	0.92	1.06	11.92	4.4	0.054
	14. 9.	3	0.36	1.53	1.00	0.70	11.90	5.0	0.037
	20. 9.	4	0.31	1.18	0.82	1.10	13.26	7.4	0.022
	27. 9.	5	0.33	1.17	0.83	0.89	13.32	7.0	0.253
	4. 10.	6	0.27	1.02	0.73	0.93	14.06	8.0	0.290
	12. 10.	7	0.29	1.16	0.78	0.75	13.38	9.0	0.355

II. Changes of colour of apples measured in colour space Cielab for the cultivar Angold during the harvesting period 1998

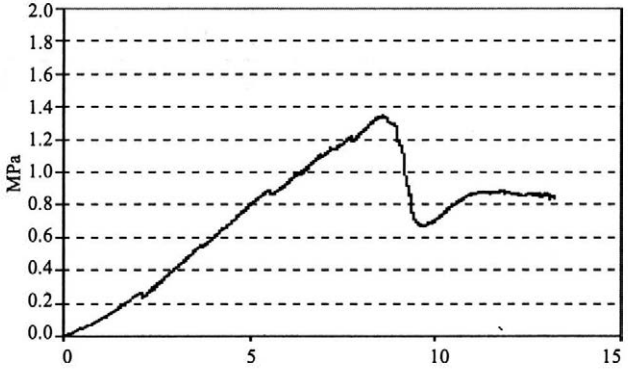
Date	Basic colour			Cover colour			Colouring of the whole surface		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
1. 9.	64.03	–7.07	35.92	52.99	11.75	25.98	59.53	0.23	32.85
6. 9.	68.90	–14.67	39.87	46.07	24.36	20.22	56.10	9.97	27.62
14. 9.	70.27	–12.46	38.23	43.99	25.01	19.88	56.19	9.21	28.33
20. 9.	67.46	–9.98	37.26	43.98	27.68	17.87	52.14	16.04	24.52
27. 9.	71.72	–11.25	38.34	46.06	28.43	20.08	60.05	7.92	29.14
4. 10.	71.30	–14.26	38.43	51.74	18.88	23.95	61.89	2.13	31.48
11. 10.	65.76	–7.68	40.22	46.12	27.73	21.16	56.40	8.85	31.12
18. 10.	71.38	–7.03	40.90	47.99	29.84	22.43	60.47	10.16	32.48



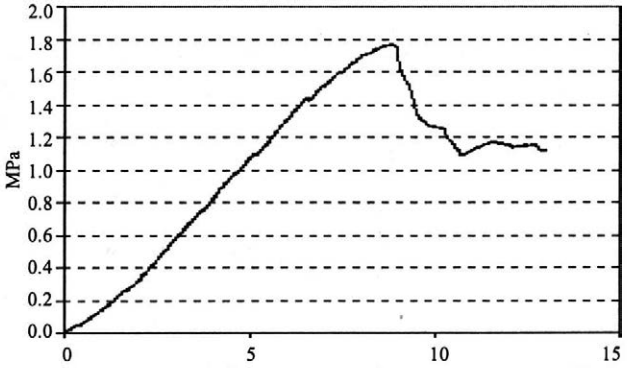
Angold



Florina



Golden Delicious



Rezista

1. Deformation curves for apple cultivars – measured at the beginning of climacteric stage in 1998

III. Changes of colour of apples measured in colour space Cielab for the cultivar Florina during the harvesting period 1998

Date	Basic colour			Cover colour			Colouring of the whole surface		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
1. 9.	67.69	-5.67	34.07	47.26	23.48	15.42	57.44	8.97	23.74
6. 9.	63.88	-0.71	32.39	40.61	30.16	14.43	49.72	18.60	20.78
14. 9.	72.65	-13.06	38.29	40.52	28.64	10.49	53.65	14.05	21.14
20. 9.	72.99	-4.62	34.73	36.59	32.48	9.92	48.73	22.72	17.20
27. 9.	68.34	4.97	29.04	38.84	33.82	11.77	50.15	25.50	18.22
4. 10.	63.22	14.12	28.42	36.83	31.14	11.43	45.63	27.22	17.30
11. 10.	62.92	21.00	29.68	33.49	33.79	10.11	49.82	25.60	21.08
18. 10.	61.08	24.88	30.82	37.39	39.82	14.48	51.48	29.58	24.08

IV. Changes of colour of apples measured in colour space Cielab for the cultivar Golden Delicious during the harvesting period 1998

Date	Basic colour			Cover colour			Colouring of the whole surface		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
1. 9.	70.79	–19.91	44.22	71.51	–18.17	44.48	71.83	–19.20	44.46
6. 9.	69.11	–19.68	44.19	71.70	–19.60	44.44	70.15	–19.96	44.87
14. 9.	69.54	–19.75	43.77	70.01	–19.39	45.20	69.82	–19.52	44.04
20. 9.	70.99	–19.19	43.26	69.98	–19.21	44.82	70.53	–18.97	43.92
27. 9.	71.57	–17.53	44.62	72.42	–14.84	44.06	71.98	–16.39	44.00
4. 10.	74.17	–16.29	44.08	72.21	–9.81	41.62	74.03	–14.75	43.81
11. 10.	72.23	–15.65	46.85	77.32	–11.88	47.39	74.50	–13.90	47.30
18. 10.	75.23	–12.24	50.72	76.44	–8.98	51.84	75.82	–11.28	50.83

V. Changes of colour of apples measured in colour space Cielab for the cultivar Rezista during the harvesting period 1998

Date	Basic colour			Cover colour			Colouring of the whole surface		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
1. 9.	71.83	–18.44	45.40	66.17	–2.82	39.81	70.15	–13.22	44.29
6. 9.	76.49	–15.55	41.89	68.50	8.02	33.88	75.77	–7.77	39.32
14. 9.	68.06	–18.00	43.87	59.92	–3.33	38.89	65.66	–14.46	44.11
20. 9.	74.64	–15.84	44.04	68.86	2.08	43.48	73.01	–6.94	43.44
27. 9.	72.90	–15.06	47.62	75.99	–9.71	45.31	74.87	–12.69	45.87
4. 10.	77.00	–10.74	40.98	67.98	4.30	42.66	75.19	–4.33	39.84
11. 10.	73.38	–10.41	47.11	76.71	–7.06	43.82	74.90	–9.04	46.05

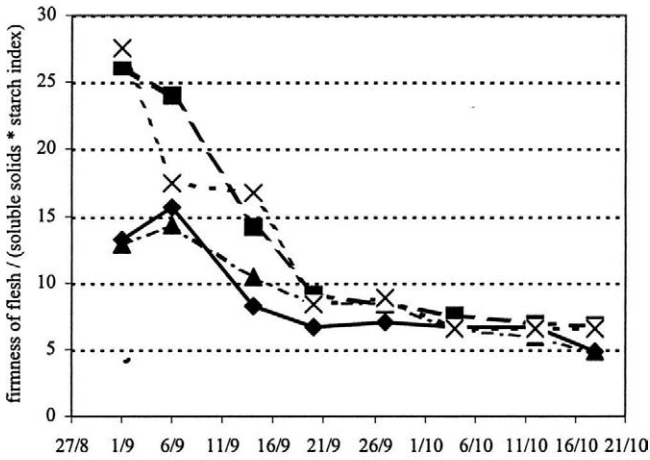
metric measurements of starch in flesh pulp and detected a linear decrease in the concentration of starch during ripening on trees which enables to estimate the harvesting period 14 day before the real maturation of fruits (in the case of apple cultivars Golden Delicious, Jonathan, Idared and Starkrimson). This time-consuming approach is often replaced by determining the level of starch by portable devices based on quick by measuring the colour of cut area (after colouring by iodine). Developed methods are being verified by physiological criteria of ripening for each fruit (Svoboda and Goliáš, 1987).

Besides parameters of firmness and fruit colour the following quantities were also measured: titratable acids, starch index (in the scale 1–10), soluble solids content (°Bx) and the level of ethylene production by intact fruits (μl/kg/h). Average results for selected harvest dates are shown in Tab. I.

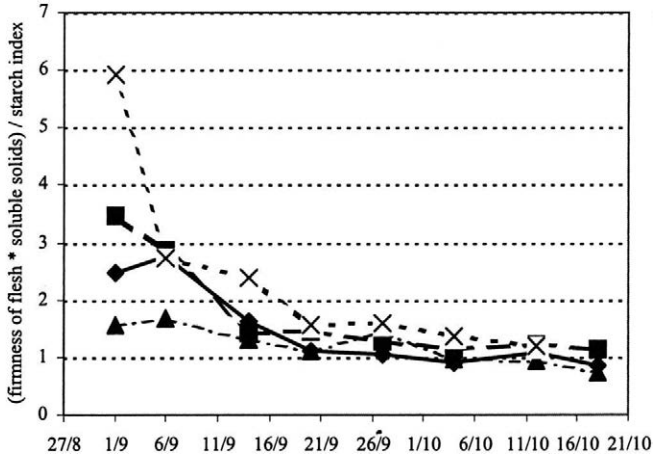
Multi-factorial indices are based on a hypothesis of their expected exponential (or linear) trends with further stabilisation of values and that they would differentiate the cultivars more easily. Moreover, each factor (tissue compound, physical parameter) is expected to be measured by objective and expenditious methods.

So we derived three- and four-factorial indices in which the developmental trends during harvesting period are shown in Figs. 2–6. Fig. 2 shows the computed values corresponding to Streif index, which seems to confirm the hypothesis mentioned above. However, the inflexion point of both phases is nearly the same for selected cultivars, which need not be a precondition in the case of other cultivars.

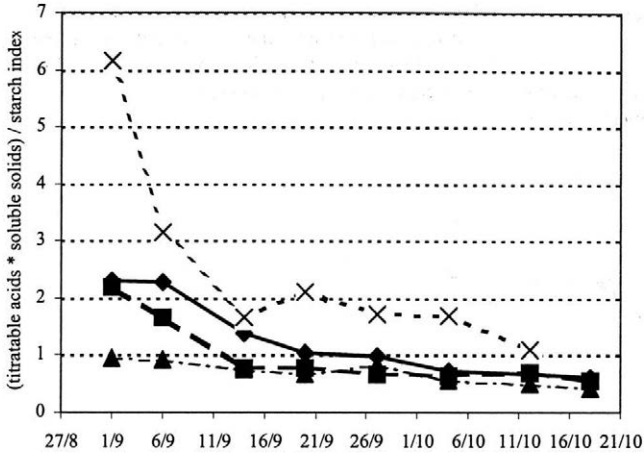
Further combinations of maturation criteria (constructed in four-factorial index) are shown in Figs. 5–6. Including the titratable acids into the indices is justified as the oxidation of acids during ripening is an objective process in fruit tissues, however, in practice it can be hard to collect analytic values.



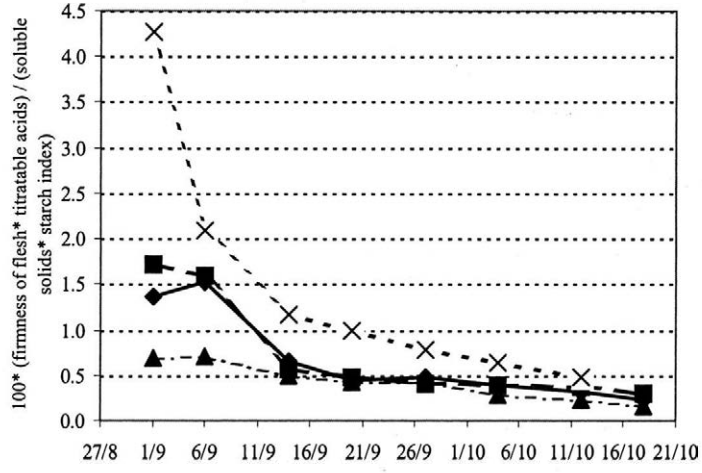
2. Values of three-parameter index firmness of flesh/(soluble solids* starch index) during harvesting period 1998 for apple cultivars Angold, Florina, Golden Delicious and Rezista



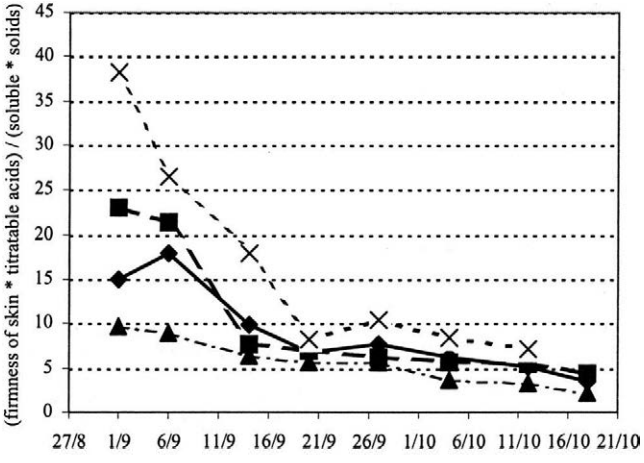
3. Values of three-parameter index (firmness of flesh* soluble solids)/starch index during harvesting period 1998 for apple cultivars Angold, Florina, Golden Delicious and Rezista



4. Values of three-parameter index (titra-table acids* soluble solids)/starch index during harvesting period 1998 for apple cultivars Angold, Florina, Golden Delicious and Rezista



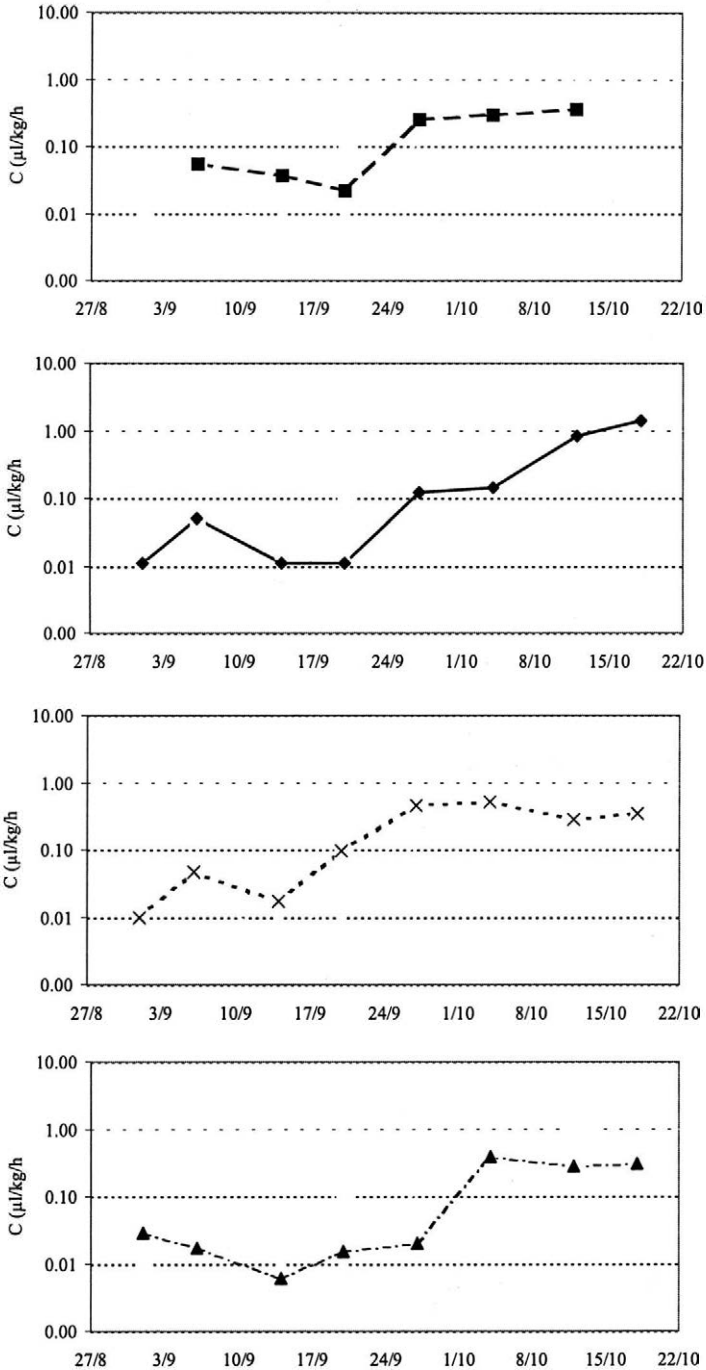
5. Values of four-parameter index (firmness of flesh* titratable acids)/(soluble solids* starch index) during harvesting period 1998 for apple cultivars Angold, Florina, Golden Delicious and Rezista



6. Values of four-parameter index (firmness of skin* titratable acids)/(soluble solids* starch index) during harvesting period 1998 for apple cultivars Angold, Florina, Golden Delicious and Rezista

Relationship between multifactorial indices and physiological criteria

Ethylene production from intact fruits was taken as the main physiological criterion. Developmental trends of ethylene production are shown in Fig. 7. The inflexion point of multifactorial indices (especially according to Streif values) coincides with the beginning of a climacteric increase in ethylene production.



7. Production of ethylene for apple cultivars Angold, Florina, Golden Delicious and Rezista during ripening on trees. Ethylene concentration C (µl/kg/l) indicates the level of physiologic activity of fruits

This trend is confirmed for three cultivars Golden Delicious, Angold, and Rezista, in the case of the cultivar Florina the increase of ethylene concentration is seven days delayed. From the physiological point of view the limit value of ethylene production is 0.1 ml/kg/h, during ripening of fruits the production of ethylene increases with relation to the cultivar, but it is not an exponential increase comparing to cultivars in which the fruits produce ethylene in nominal values across two logarithmic grades (Goliáš, 1999).

CONCLUSION

Physiological ripening of fruits, derived from the ethylene production of intact fruits, was measured during the harvesting period for apple cultivars Angold, Florina, Golden Delicious and Rezista. Evaluation of ethylene production was accompanied by measurements of physical and chemical parameters (titratable acids, soluble solids content, fruit firmness, starch index, colour of fruit). The dynamics of these parameters during ripening and over-maturation of fruits was described by three- and four-factorial indices. Three-factorial index firmness of flesh/(soluble solids content* starch index) seems to describe the inflexion point which coincides for selected cultivars with the beginning of climacteric developmental phase, detected by the ethylene production.

REFERENCES

Braun H., Brosh B., Ecker P., Krumbock K. (1995): Qualitätsänderungen von Äpfeln vor, während und nach CA-Kühllagerung. Mitt. Klosterneub., *45*, 143–206.

Goffings G., Herregods M. (1996): The distribution of ripening of Jonagold and Golden Delicious apples with the herbicide. In: COST 94, 9–10, Lofthus, Norway. 117–126.

Goliáš J., Zehnula K., Bejček L. (1975): Konstrukce víceúčelového přístroje pro měření pevnosti ovoce a zeleniny. Acta Univ. Agric. (Brno) , *23*, 371–378.

Goliáš J. (1986): Zusammenhang zwischen der Aromabildung und dem Stärkeabbau während der Reife von Äpfeln am Baum. Arch. Gartenbau, *34*, 273–283.

Goliáš J. (1999): Vztah produkce etylenu k netěkavým látkovým složkám v období zrání jablek na stromě. Zahradnictví–Hort. Sci (Prague), *26*, 5–9.

Kupferman E. F. (1992): Maturity and storage of apple varieties new to Washington State. Central Valley Postharvest Newsletter, *1*, 1–17.

Luton M. T. (1994): Ten years of optimum harvest date for the variety Cox's Orange Pippin. In: COST 94, June 9–10, Lofthus, Norway. 39–48.

Planton (1994): Harvesting ripeness of apples: the AM 93 starchmeter. No. 98, Infos-Paris. 24–26.

Skrzynski J. (1996): Optimum harvest date study of 4 apple cultivars in Southern Poland. In: COST 94, June 9–10, Lofthus, Norway. 61–66.

Streif J. (1989): Reifeverhalten von Äpfeln mit unterschiedliem Erntermin. In: 1. CA-Lagersymposium für Obstfrüchte mit internationaler Beiteiligung. November 6–10, Halle (S), Martin-Luther-Universität. 72–80.

Svoboda A., Goliáš J. (1987): Účinek Flordimexu na redukci násady plodů broskví a obsah etylenu v době zrání. Sborník ÚVTIZ – Zahradnictví, *14*, 92–98.

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Contact Address:

Prof. Ing. Jan G o l i á š , DrSc., Zahradnická fakulta, Mendelova zemědělská a lesnická univerzita v Brně, 691 44 Lednice na Moravě, Česká republika
Tel. +420 627 34 01 05–7, fax +420 627 34 01 59, e-mail: golias@mendelu.cz

Změna publikačního jazyka ve vědeckých časopisech ČAZV

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A change of publication language in Scientific Journals of the Czech Academy of Agricultural Sciences

At its session on the 6th April 2000, the Presidium of the Czech Academy of Agricultural Sciences adopted a resolution recommending, among other things, to change the publication language in scientific journals published under the Academy patronage. The Presidium proposes to the Publishing Board of the Academy to introduce English as the only language in all scientific journals from the 1st January 2001. The papers written exclusively in English are accepted by the editor's office of the journal Zahradnictví (Horticultural Science) from the 1st July 2000.

QUALITATIVE PROPERTIES OF STORED NEW BREEDS OF TABLE GRAPES

KVALITATÍVNE VLASTNOSTI SKLADOVANÝCH NOVOŠĽACHTENCOV STOLOVÉHO HROZNA

A. Minarovská, V. Horčin

Slovak University of Agriculture, Nitra, Slovak Republic

ABSTRACT: In the research part of our study we were concentrated on the evaluation of the quality of table grapes by selected parameters of chemical, physical and sensory analysis supplemented with investigation of the occurrence of undesirable microscopic fungi. Dynamics of the changes of evaluated traits was studied during storage of samples in the storehouse with adjusted atmosphere. Storage affected the change of different parameters in different way as well as the change of the quality of evaluated samples. It has been shown that storage affects sensory quality above all. Sensory traits like taste, scent and texture decreased during storage. The storage reduced also the quality of instrumentally measured physical parameters – fixing ability of grape berries and firmness of grape skin. Based on the results of sensory and microbiological evaluation of the quality, the best prerequisites for storage in our trial has been demonstrated by the cultivar Guzal' kara and the cultivar Datchny (Dačnyj) seemed to be the less suitable for storage.

table grapes; refrigerated storage; storage

ABSTRAKT: Vo výskumnej časti našej práce sme sa zamerali na hodnotenie kvality stolového hrozna vybranými ukazovateľmi chemickej, fyzikálnej a senzorickej analýzy, doplnené o sledovanie výskytu nežiaducich mikroskopických húb. Dynamika zmien hodnotených znakov sa sledovala počas skladovania vzoriek v sklade s upravovanou atmosférou. Skladovanie rozlične vplývalo na zmenu jednotlivých ukazovateľov a aj na zmenu kvality hodnotených vzoriek. Ukázalo sa, že skladovanie výrazne ovplyvňuje predovšetkým senzorickú kvalitu. Počas skladovania dochádzalo k poklesu senzorických znakov chuti, vône a textúry. Skladovaním tiež klesala kvalita inštrumentálne meraných fyzikálnych ukazovateľov – pútacia sila bobúľ hrozna a pevnosť šupky hrozna. Na základe výsledkov senzorického a mikrobiologického hodnotenia kvality najlepšie predpoklady pre skladovanie v našom pokuse vykazovala odroda Guzal' kara a relatívne ako najmenej vhodná na skladovanie sa javila odroda Dačnyj.

stolové hrozno; chladiarenské skladovanie; kvalita

ÚVOD

Ovocie je dôležitá a ničím nenahraditeľná súčasť potravy človeka. Obsahuje látky blahodárne pôsobiace a potrebné pre zdravý a hodnotný život. Neodmysliteľnou súčasťou ovocia je aj stolové hrozno. Stolovému hroznu patrí vo vyspelých krajinách významné miesto vo výžive. Popri jablkách, tropickom a subtropickom ovocí je súčasťou výživy ako čerstvé ovocie po väčšiu časť roka (Sedláčková, 1999).

U nás sa vo zvýšenej miere konzumuje iba v období zberu (august–október), kedy v ponuke na trhu je aj hrozno dopestované v našich podmienkach. Ponuka trhu je prakticky celoročná, avšak závislá od importu. Skladovanie v našich podmienkach dopestovaného hrozna s cieľom predĺženia obdobia konzumácie sa u nás realizuje len minimálne (Doboš a i., 1995).

Chladiarenské skladovanie je dôležitým prvkom predĺženia obdobia predaja a konzumu stolového hrozna z domácej produkcie. Skladovateľnosť hrozna v chladiarni s upravenou atmosférou závisí okrem skladovacích podmienok aj od odrody (Horčin, 1997).

Na dĺžku skladovania stolového hrozna veľmi výrazne vplývajú skladovacie podmienky. Skladovacia teplota je limitovaná teplotou mrznutia hrozna. Pri dobrom vyzretí väčšina odrôd znáša teplotu skladovania 0 až 2,5 °C, z dôvodu poistenia proti zamrznutiu by teplota nemala klesnúť pod túto hodnotu. Je nutné dodržiavať aj ostatné podmienky skladovania v upravenej atmosfére: koncentráciu plynov (2 % O_2, 2 až 5 % CO_2), vetranie (rýchlosť prúdenia vzduchu 0,2 až 2 m/s) a relatívnu vzdušnú vlhkosť (85 až 90 %) (Magomedov, 1986).

Najväčším nebezpečenstvom pri skladovaní stolového hrozna, ktoré negatívne ovplyvňuje chemickú, fyzikálnu, ale najmä senzorickú kvalitu, je napadnutie a následne rozvoj nežiaducich mikroskopických húb na plodoch a na strapine. Za účelom potlačenia vývoja húb je nutné po zbere hrozno zasíriť, pred skladovaním

cizelovať a počas celého skladovania udržiavať v atmosfére skladu prítomný SO_2. Odporúča sa síriť pri naplnení 1% plynným SO_2 po dobu 20 minút a následne každý týždeň skladovania 0,25% plynným SO_2 po dobu 20 minút (Andert, 1979).

Dôležitým faktorom je kvalita stolového hrozna, najmä ak sa konzumuje ako čerstvé ovocie. Ide nielen o kvalitu senzorickú, výživovo-dietetickú, ale tiež o kvalitu z hľadiska prítomnosti cudzorodých, zdraviu škodlivých látok. Potenciálne riziko predstavujú okrem rezíduí pesticídov aj niektoré kovové prvky.

MATERIÁL A METÓDA

V našom výskume sme sa zamerali na sledovanie kvalitatívnych vlastností novošľachtencov stolového hrozna metódami chemickej, fyzikálnej a senzorickej analýzy. Dynamiku zmien v hodnotených znakoch sme sledovali počas skladovania vzoriek v modelovom sklade s upravovanou atmosférou. Klimatické podmienky v sklade boli 0 °C, 95% relatívna vzdušná vlhkosť, 96 % N_2, 3 % CO_2 a 1 % O_2.

Do pokusu sme vybrali šesť vzoriek stolového hrozna: Ceaus roz x Chibrid bezsemen V-6 21/11 – CRCHIB 21/11 (pracovné označenie 21/11), Dunavský misket x Beauty sedless 22/26 – Onyx (pracovné označenie Onyx), Julski biser x Jubilej 9/14 – JBJU 9/14 (pracovné označenie 9/14), Ceaus roz x (Carica na lozjanta x Bolgar) 3/18 – CRCLBO 3/18 – Ružín (pracovné označenie 3/18), Katta Kurgan x Dodrelabi – KKDO – Guzaľ kara (pracovné označenie Guzaľ kara) a Guzaľ kara x SV 20473 – Dačnyj (pracovné označenie Dačnyj).

Hrozno pochádzalo z oblasti Strekova v Slovenskej republike. Táto oblasť patrí do novozámocko-štúrovskej oblasti, ktorá má v našom pásme najlepšie podmienky na dopestovanie stolových odrôd vynikajúcej trhovej kvality. Skladovanie vzoriek bolo od zberu v mesiaci október do konca mesiaca december. Priebežná kontrola kvality sa uskutočnila po siedmich týždňoch skladovania.

Vo vzorkách stolového hrozna sme sledovali chemické ukazovatele: refraktometrická sušina, obsah organických kyselín, cukornatosť, vitamín C, pH a obsah Cu, Zn, Pb a Cd a fyzikálne ukazovatele: pevnosť šupky na tlak a pútacia sila bobúľ k strapine.

Refraktometrickú sušinu a pH sme určovali inštrumentálne pomocou Abeho refraktometra a pHmetrom.

Celkový obsah organických kyselín prepočítaný na obsah kyseliny vínnej sme stanovovali titračne.

Vitamín C a obsah ťažkých kovov sme vo vzorkách analyzovali polarograficky, metódou DPV Striping pomocou elektródového stojanu Eco-Tribo polarografu pripojeného na počítač.

Cukornatosť stolového hrozna sme merali normalizovaným muštomerom.

Fyzikálne charakteristiky, pevnosť šupky na tlak a pútaciu silu bobúľ k strapine, sme zisťovali na uvologickej váhe.

Senzorickú kvalitu sme hodnotili hodnotiacou skúškou so stupnicou podľa deskriptora pre hodnotenie stolového hrozna. Použili sme deväťbodovú stupnicu, kde najvyššia bodová hodnota zodpovedá najvyššiemu hodnotovému stupňu maximálnej akosti. Deskriptor pre hodnotenie stolového hrozna sleduje senzorickú kvalitu v ôsmich znakoch: strapec, veľkosť a tvar bobúľ, semená, farba bobulí, textúra, šupka, vôňa a chuť (Kopec a Horčin, 1997).

Získané výsledky sme spracovali niekoľkými štatistickými metódami, z ktorých sme do celkového hodnotenia vybrali: štatistické skúmanie variability jednotlivých ukazovateľov, skúmanie rozdielov Friedmanovým testom a skúmanie závislosti medzi senzorickými znakmi a vybranými senzorickými znakmi a chemickými charakteristikami Kendalovým testom nezávislosti.

Senzorické hodnotenie oboch ovocných druhov vykonávala osemčlenná senzorická komisia v priestoroch senzorického laboratória SPU v Nitre. Výber a školenie hodnotiteľov do senzorickej komisie bolo vykonané v súlade s STN 5601 10.

Naša pozornosť sa sústredila aj na identifikáciu plesní, ktoré sú hlavnou príčinou znehodnotenia uskladneného hrozna. Identifikácia plesní sa realizovala elektrónovým mikroskopom a kulturárne, v laboratóriu s riadenými klimatickými podmienkami.

VÝSLEDKY A DISKUSIA

Výsledky chemických a fyzikálnych meraní stolového hrozna počas skladovania sú v tab. I. Refraktometrická sušina sa vo vzorkách pohybovala v rozmedzí 10,9 až 17,6 % na začiatku skladovania a počas skladovania mala klesajúcu tendenciu. V priebehu skladovania sa cukornatosť hrozna väčšiny vzoriek zvyšovala. Len malé zmeny cukornatosti nastali vo vzorkách 3/18 a 9/14. Najvyššiu cukornatosť mala vzorka 21/11 (17,1 kg/hl) a najnižšiu 3/18 (8,2 kg/hl). Kyslosť vzoriek sa v priebehu skladovania v nepatrnej miere zvyšovala. Najvyšší obsah organických kyselín bol vo vzorkách 9/14 (0,89 %) a 3/18 (0,69 %). Ostatné vzorky mali obsah organických kyselín na úrovni 0,5 %.

V sledovaných odrodách stolového hrozna sa obsah vitamínu C pred skladovaním pohyboval v rozmedzí 9,2 až 28,6 mg/kg. Najvyšší obsah mala vzorka Guzaľ kara a najnižší 3/18. Počas skladovania obsah vitamínu C klesal a na konci skladovania sa pohyboval na úrovni 4,9 až 10,3 mg/kg.

Toxické kovy sú skupinou látok, ktoré sa v súčasnosti stali predmetom zvýšeného záujmu a štúdia z hľadiska negatívneho dopadu na zdravie ľudí. Zo sledovaných ťažkých a rizikových kovov sa v najvyššej koncentrácii stanovila Cu a Zn, v rádovo nižších koncentráciách Pb a v nemerateľných koncentráciách Cd. Potešiteľné je zistenie, že ani jeden zo sledovaných kovov nedosiahol maximálne limity zakotvené v Potravinovom kódexe SR (1996) a vo Vyhláške MZ SR č. 2/1994.

I. Chemické a fyzikálne ukazovatele kvality stolového hrozna počas skladovania (v čerstvej hmote) – Chemical and physical indicators of the quality of table grapes during storage (in the fresh mass)

Ukazovateľ[1]	Termín stanovenia[2]	Vzorky[3]					
		3/18	21/11	9/14	Onyx	Dačnyj	Guzaľ kara
Pevnosť šupky[4] (N)	pred skladovaním[11]	16,80	13,10	11,80	6,42	8,12	11,88
	po skladovaní[12]	13,96	8,50	7,58	5,08	6,28	9,95
Pútacia sila bobúľ k strapine[5] (N)	pred skladovaním	4,12	6,20	3,95	5,20	6,20	6,53
	po skladovaní	3,44	4,35	2,46	4,12	4,04	4,20
Obsah kovov[6] Cu (mg/kg)	pred skladovaním	5,83	2,7	3,06	2,12	1,29	1,76
Zn (mg/kg)		2,85	0,34	1,24	1,48	0,53	0,19
Pb (mg/kg)		0,098	0,058	0,054	0,003	0,004	0,012
Cd (mg/kg)		n.m.	n.m.	n.m.	n.m.	n.m.	n.m.
Cukornatosť[7] (kg/hl)	pred skladovaním	8,2	17,1	9,9	16	11	13,9
	1. kontrola[13]	9,4	13,9	11	11,7	10,3	12,8
	po skladovaní	9,6	13,4	9,6	10,8	9,5	11,5
Organické kyseliny[8] (%)	pred skladovaním	0,69	0,51	0,89	0,53	0,56	0,53
	1. kontrola	0,78	0,64	1	0,58	0,63	0,64
	po skladovaní	0,79	0,66	1,02	0,61	0,62	0,67
pH	pred skladovaním	3,02	3,13	2,84	3,08	2,84	3,14
	1. kontrola	3,13	3,41	3,1	3,22	3,02	3,26
	po skladovaní	3,21	3,52	3,15	3,37	3,09	3,3
Refraktometrická sušina[9] (%)	pred skladovaním	10,9	17,6	15,6	15,75	15,6	14,85
	1. kontrola	10,4	16,3	14,5	14,5	12,2	12,8
	po skladovaní	9,8	15,9	14,2	13,9	11,6	12,4
Vitamín C[10] (mg/kg)	pred skladovaním	9,2	13	13,7	27,2	25,7	28,6
	kontrola	7,8	11,25	8,5	10,98	15	11,6
	po skladovaní	4,9	6,4	5,1	8,4	10,3	7,6

[1]indicator, [2]date of determination, [3]samples, [4]firmness of skin, [5]fixing strength of berries to grape-stalks, [6]content of metals, [7]sugar content, [8]organic acids, [9]refractometric dry matter, [10]vitamin C, [11]before storage, [12]after storage, [13]control 1

II. Senzorická kvalita stolového hrozna počas skladovania (podľa mediánu) – Sensory quality of table grapes during storage (after median)

Deskriptor[1]	3/18			21/11			9/14			Onyx			Dačnyj			Guzaľ kara		
	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.
Strapec[2]	5	5	7	7	7	7	7	6	5	6,5	5	5	7	5	4	7	5	5
Veľkosť a tvar bobúľ[3]	6	5	5	5	5	5	5	5	5	5	5	4	4	3	3	7	7	7
Semená[4]	5	5	5	5	5	5	5	5	4	5	4,5	4	5	5	4,5	5	5	4,5
Farba bobúľ[5]	8	6	5	7	7	5	7	6	3	8	7	5	8	6	4	8	8	6
Textúra[6]	9	7	3	7	5,5	3	5,5	4	3	7	5	2,5	6	4,5	2	5	5	4
Šupka[7]	9	7	4	9	7	4	7,5	5	4	8	5	3	5	4	3	5	5	4,5
Vôňa[8]	9	7	3	5	4	3	7	5	3	7	5,5	3	3	2	2	8	6,5	5
Chuť[9]	6	5	3	8	5	3	7	5	3	8	6	4	4	3	2	7	6,5	5
Celková kvalita[10]	6,9	5,6	3,6	6,6	5,6	4,3	6,4	5,1	3,8	6,7	5,3	3,9	5,2	4,2	3,2	6,6	5,9	4,8

I = pred skladovaním – before storage
II = 1. kontrola – control 1
III = po skladovaní – after storage

[1]descriptor, [2]bunch, [3]size and shape of berries, [4]seeds, [5]colour of berries, [6]texture, [7]skin, [8]scent, [9]taste, [10]total quality

Sledovanie fyzikálnych vlastností ukázalo niektoré rozdiely medzi vzorkami. Vzorky 3/18 a Guzaľ kara vykázala v parametri pevnosť šupky na tlak vo veľkej miere zachovanie pôvodných vlastností počas skladovania. Pútacia sila bobúľ k strapine sa v priebehu skladovania znižovala. Celkove možno konštatovať, že zmeny fyzikálnych vlastností počas skladovania boli malé a hodnoty sledovaných parametrov sa menili v rozsahu 10 až 20 %.

V senzorickej kvalite (tab. II) boli vzorky 21/11, 9/14, 3/18, Guzaľ kara a Onyx pred skladovaním vyrovnané a Friedmanovým testom sme medzi nimi nezistili štatisticky preukazné rozdiely. Výnimku tvorila vzorka Dačnyj, ktorá dosiahla nižšie bodové hodnotenie v znakoch vôňa a chuť. Počas skladovania stolového hrozna dochádzalo k zmenám senzorickej kvality predovšetkým v znakoch vôňa, textúra, chuť a šupka, kde hodnota variačného koeficientu dosahovala úroveň 35 %. Naproti tomu nízkou variabilitou sa vyznačovali znaky: semená, veľkosť a tvar bobúľ a strapec.

Sledovaním senzorickej kvality na konci skladovania môžeme skonštatovať, že najlepšie predpoklady pre skladovanie zo skúmaných odrôd vykázala odroda Guzaľ kara, ktorá sa na základe výsledkov Friedmanového testu štatisticky preukazne líšila od ostatných vzoriek. Táto mala najlepšiu senzorickú kvalitu a ostatné odrody prekonala vo veľmi dôležitých znakoch textúra, ktorá na konci skladovania bola hodnotená ako pevná, ďalej vo vôni, ktorá bola príjemná hroznová a v chuti, ktorá bola dobrá. Ostatné sledované odrody v znakoch textúra, vôňa a chuť dosahovali len priemernú a pri odrode Dačnyj dokonca podpriemernú kvalitu.

Kendalovým testom nezávislosti sme vo vzorkách stolového hrozna pred skladovaním zistili kladnú štatistickú závislosť medzi senzorickými znakmi veľkosť a tvar bobúľ – vôňa, textúra – šupka. Kladná, štatisticky preukazná, závislosť bola zistená aj v prípade senzorického znaku chuť bobúľ a chemického znaku cukornatosť a fyzikálneho znaku pevnosť šupky na tlak a senzorického znaku textúra. Všetky zistené závislosti boli testované na hladine štatistickej významnosti $\alpha = 0{,}05$.

V jednotlivých vzorkách skladovaného hrozna sa identifikovala aj prítomnosť fytopatogénnych húb. Najnižší počet sa identifikoval vo vzorke Guzaľ kara. Boli to huby *Alternaria alternata* Link., *Penicillium cyclopeaum* Link., *Botrytis cinerea* Pers.. V ostatných vzorkách sa identifikovali štyri plesne: *Penicillium cyclopeaum* Link., *Penicillium expansum* Link., *Botrytis cinerea* Pers. a *Coniella diplodiella* Link. Hnitie spôsobené plesňou sivou je pri skladovaní hrozna najnebezpečnejšie. Nebezpečnosť vyplýva z veľkého množstva konídií schopných infekcie. *Penicillium expansum* Link. je pôvodcom tzv. modrej hniloby, spôsobujúcej mäknutie pletív. *Penicillium cyclopaeum* Link. vytvára šedozelené a modrozelené kolónie, ktoré vyrastajú na značne poškodenom hrozne. *Alternaria alternata* Link. patrí k psychrofilnej mikroflóre a jej nebezpečnosť spočíva v tom, že je schopná vegetovať pri veľmi nehostinnej teplote 0 °C. Z hľadiska ochrany hrozna pred hnitím má veľký význam sírenie pred uskladnením a počas celého skladovania.

LITERATÚRA

Andert A. (1979): Snížení ztrát u skladovaného ovoce a zeleni-ny použitím chladu a tepla. Praha, ÚVTIZ. 32–38.

Doboš A., Valachovič A., Sedláčková B. (1995): Štúdia optimalizácie kvality a rozšírenia uplatnenia hrozna a jeho výrobkov vo výžive. Úloha priameho zadania MP SR, Bratislava.

Horčin V. (1997): Skladovanie ovocia, zeleniny a hrozna. 1. časť – Látkové zloženie a skladovanie. Bratislava, Corvex Training. 91 s.

Kopec K., Horčin V. (1996): Senzorická analýza ovocia a zeleniny. Nitra, Universum. 194 s.

Sedláčková B. (1999): Ekonomizácia skladovania stolového hrozna v intenzívnych podmienkach. [Záverečná správa.] Bratislava, VÚVV.

Magomedov M. G. (1986): Biologičeskije osobennosti grozdi kak osnova technologii chranenija i transportirovki vinograda. Vinograd i vino Rosii, č. 6, 12–15.

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Kontaktná adresa:

Ing. Andrea M i n a r o v s k á, Slovenská poľnohospodárska univerzita, Tr. A. Hlinku 2, 949 01 Nitra, Slovenská republika
Tel.. +421 87 650 87 70, e-mail: doplní autor

SEPARATION EFFICIENCY OF REVERSE OSMOSIS UNDER MODEL CONDITIONS*

SEPARAČNÍ ÚČINNOST REVERZNÍ OSMÓZY V MODELOVÝCH PODMÍNKÁCH

J. Balík, J. Veverka

Horticultural Faculty of the Mendel University of Agriculture and Forestry at Brno, Lednice na Moravě, Czech Republic

ABSTRACT: The aim of this study was to evaluate separation efficiency of a hyperfiltration polyamide membrane AFC 99 (manufactured by the firm PCI Membrane Systems Ltd., England) in the process of reverse osmosis using a model solution medium and to apply the obtained results in the process of membrane separation of grape wines and/or musts with the purpose of improvement of their qualitative parameters. The model solution was made from distilled water, refined ethanol, malic acid, tartaric acid, acetic acid, citric acid, glucose, fructose and inorganic salts of sodium, calcium, magnesium and potassium. During the process of reverse osmosis, some physical parameters were followed, e. g. output of the apparatus and temperature of model solution. Changes in concentrations of low molecular substances in retentate (concentrate) and permeate were evaluated by means of analytical methods. The measured output of the apparatus with the filtering surface of membranes 0.9 m^2 and working pressure of 6.0 MPa was 16.2 $l/m^2/h$. The process of separation by means of reverse osmosis lasted 37 minutes and the initial volume of model solution was reduced by 38%. It was also demonstrated that it was necessary to use cooling, especially with regard to its practical application when filtering grape musts and wines. Measured values of retention coefficients of low-molecular substances study,especially complete concentration of reducing sugars and permeability of tested membrane for molecules of ethanol and acetic acid, open way to its successful application for concentration of grape musts during the process of reverse osmosis and production of wines with a low content of alcohol as well as for the treatment of acetified wines within the regime of diafiltration.

reverse osmosis; coefficient of retention; anions; cations; ethanol; reducing sugars; wine

ABSTRAKT: Cílem práce bylo stanovení separační účinnost hyperfiltrační polyamidové membrány v procesu reverzní osmózy na modelovém kapalném médiu a získané výsledky využít v procesu membránové separace révových vín, případně moštů za účelem zlepšení jejich kvalitativních parametrů. Modelový roztok byl připraven z destilované vody, rafinovaného kvasného lihu, kyseliny jablečné, vinné, octové a citronové, glukózy, fruktózy, anorganických solí sodíku, vápníku, hořčíku a draslíku. V průběhu reverzní osmózy byly sledovány fyzikální parametry procesu jako výkon zařízení a teplota modelové kapaliny a analyticky vyhodnocovány změny v koncentraci sledovaných nízkomolekulárních složek v retentátu (koncentrátu) a permeátu. Separační účinnost reverzní osmózy byla sledována na hyperfiltrační polyamidové membráně ACF 99 a zařízení fy PCI Membrane Systems Ltd. (England) ve třech po sobě následujících opakováních. Pro vyjádření separační účinnosti procesu byly použity retenční koeficienty vybraných látkových složek. Změny sledovaných parametrů v průběhu separace byly znázorněny graficky v závislosti na objem odebraného permeátu jako průměrné hodnoty (obr. 1–3). Variabilita průměrných hodnot retenčních koeficientů (tab. I) byla doložena jejich výběrovými variačními koeficienty v procentech. Naměřený výkon použitého zařízení o filtrační ploše membrán 0,9 m^2 při tlaku 6,0 MPa činil 16,2 $l/m^2/h$. Proces separace reverzní osmózou trval 37 minut a během něj se objem u původní modelové kapaliny snížil o 38 %. Byla potvrzena potřeba zapojit chlazení, zejména s ohledem na praktické použití při ošetřování révových moštů a vín. Naměřené hodnoty retenčních koeficientů sledovaných nízkomolekulárních látek, zejména úplné koncentrování redukujících sacharidů a permeabilita použité membrány pro molekuly etanolu a kyseliny octové otvírají reálnou možnost úspěšného využití testované membrány ke koncentrování révových moštů v procesu reverzní osmózy a pro výrobu nízkoalkoholických vín, případně nápravy vín naoctělých v režimu diafiltrace.

reverzní osmóza; retenční koeficient; aniony; kationy; etanol; redukující sacharidy; víno

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INTRODUCTION

At present, membrane processes are more and more important in wine technology, however, they involve not only processes enabling to obtain a sparkling beverage (i. e. microfiltration or ultrafiltration) but also to carry out reverse osmosis which goes beyond the limits of classical filtration techniques due to its physical principle of separation (Troost, 1988). Delfini et al.. (1992) tested various methods of must treatment with regard to the quality of future wines. These authors compared wines produced from musts with natural contents of sugars and wines made from juices sweetened with rectified musts and/or musts concentrated by means of reverse osmosis. The obtained results indicate that application of reverse osmosis in wine industry is possible, especially with regard to the improvement of musts in years with less favourable natural concentrations of sugar in grapes. Experimental results published by Ribéreau-Gayon (1995) also describe reverse osmosis as an efficient method of elimination of methods of chaptalisation and/or evaporation under vacuum. The Office International de la Vigne et du Vin in Paris (OIV) adopted a resolution at its Congress in Punta del Este (Uruguay) at the end of 1995 approving the use of reverse osmosis as a method for increasing the alcohol content of wine, as it does not have any detrimental effects on the sensory properties. Producers will therefore be able to incorporate the method into their winemaking operations (Camilla, 1996). However, technological possibilities resulting from application of reverse osmosis involve not only concentration of grape musts but also an intentional separation of certain substances from wine because their reduction or even elimination can significantly increase the quality of the final product (Cuenat et al., 1989).

MATERIAL AND METHODS

For experimental purposes, altogether 71 litres of model solution were prepared from distilled water, refined ethanol, selected organic acids, monomeric sugars and soluble mineral salts. Portions of individual low-molecular substances were selected in a uniform manner within the framework of groups under study and with regard to their concentrations occurring usually in grape wines. The following compounds were used: tartaric acid, malic acid, acetic acid and citric acid in amounts of 2.5 g/l, cations of sodium, calcium, magnesium and potassium in amounts of 200 mg/l, glucose and fructose in amounts of 2.5 g/l and ethanol in concentration of 10% vol. The model solution was carefully mixed, stored at room temperature for 24 hours and thereafter decanted. Concentrations of individual components of model solution (Tab. I) were estimated immediately before the beginning of separation.

I. Material balance of separation of model solution by reverse osmosis

	Retentate		Permeate	Retention coefficient	Variation coefficient
	Initial state	Final state			
	(g/l)	(g/l)	(g/l)		(%)
Reducing sugars	4.7	7.7	0.0	1.00	0.0
Tartaric acid	2.8	4.3	0.0	1.00	0.0
Malic acid	2.5	4.0	0.0	1.00	0.0
Citric acid	2.3	3.8	0.0	1.00	0.0
Acetic acid	3.0	3.6	1.5	0.64	5.1
Ethanol	81.0	99.6	48.6	0.51	4.8
	(mg/l)	(mg/l)	(mg/l)		(%)
K^+	26	53	8	0.73	19.9
Na^+	211	331	21	0.92	2.4
Ca^{2+}	162	250	23	0.89	2.1
Mg^{2+}	193	304	9	0.96	2.3

Separation efficiency of reverse osmosis was studied using a hyperfiltration polyamide membrane AFC 99 and an apparatus manufactured by the firm PCI Membrane Systems Ltd (England) in three subsequent replications. Membrane separations of 23.5 litres of model solution were carried out using the working pressure of 6.0 MPa and flow cooling with tap water. Physical parameters of the separation process as output of the apparatus and temperature of model solution were recorded in the course of reverse osmosis. Changes in concentrations of the aforementioned low-molecular substances in the concentrate and permeate were recorded and analytically evaluated. For the estimation of organic acids and cations, the method of capillary isotachophoresis by means of the apparatus Ionosep 900.1 (manufacturer Recman Ostrava, Czech Republic) was used (Balík, 1998). Con-

centrations of ethanol, soluble dry matter and reducing sugars as well as the relative density were estimated using methods corresponding with the Regulation (EEC) No. 2676/90 (Mac Sharry, 1990). The efficiency of the process of separation was defined using retention coefficients of selected components mentioned above (Trong and Neel, 1983):

$$\frac{c_r - c_p}{c_r}$$

c_r = concentration of substance in retentate
c_p = concentration of substance in permeate

Changes in parameters under study were recorded in the course of separation process and plotted as average values depending on the volume of obtained permeate. Variability of average values of tabular retention coefficients was documented by means of variation coefficients expressed in percent (Lamoš and Potocký, 1989).

$$\frac{100 \cdot s(x)}{\bar{x}}$$

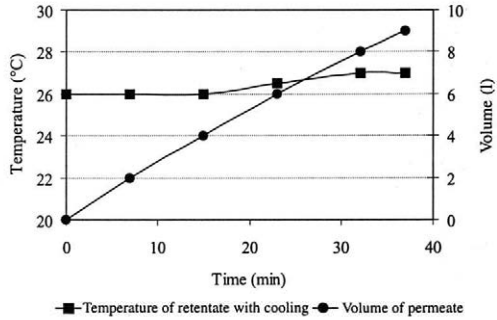
$s(x)$ = standard deviation
$\bar{x}$ = average

RESULTS AND DISCUSSION

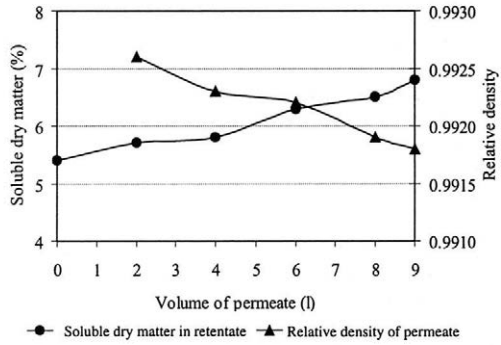
The process of separation by means of reverse osmosis lasted 37 minutes and enabled to obtain altogether 9 litres of permeate, this means that the initial volume of model solution was reduced by 38%. For chemical analyses, samples (150 ml) of both permeate and retentate were taken always after obtaining 2 litres of permeate. Time dependence of increase in volume of permeate was practically functional, i. e. 2 litres of permeate within 7.5 minutes. The measured output of this apparatus with filtering surface of membranes 0.9 m^2 and pressure 6.0 MPa was 16.2 $l/m^2/h$. Regarding earlier data (Balík and Goliáš, 1997) about a steep increase in temperatures of both permeate and retentate due to a high friction of circulating solution and working pressure it was decided to use tap water as a cooling medium. Temperatures of permeate and retentate, as measured during individual samplings, were always the same and increased from initial 26 °C to final 27 °C. From the practical point of view, this temperature is acceptable for treatment of grape musts and wines (Fig. 1).

The content of soluble dry matter (represented in our model solution above all by reducing sugars and organic acids) increased from initial 5.4% to 6.8%. At the beginning of concentration process, this value was significantly influenced by the presence of ethanol. To the end of this experiment, however, the actual increase in concentration of soluble dry matter did not correspond with the degree of condensation of retentate by 62%. Under our separation conditions, this observation was associated to a certain extent also with the permeability of tested membranes for some low-molecular substance. The continuously decreasing value of relative density of sampled permeate indicated an increase in concentrations of some compounds, especially of ethanol (Fig. 2).

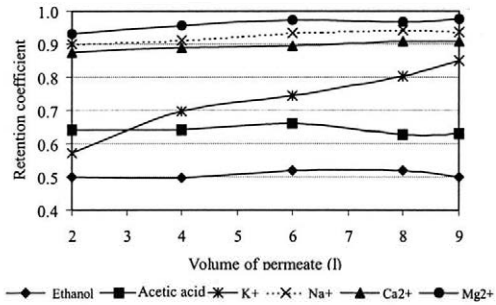
In permeate, concentration of ethanol slightly increased with the duration of separation process up to 48.6 g/l. In retentate, concentration of ethanol increased from initial 81.0 g/l to final 99.6 g/l. This means that, in spite of



1. Time dependence of increase in the permeate volume and the retentate temperature during the separation process



2. Dependence of concentration of soluble dry matter in retentate and of relative density of permeate on the volume of permeate



3. Changes in retention coefficients of selected compunds in the course of separation

a certain permeability of tested membrane for ethanol molecules, the content of ethanol in model solution before the membrane was increased due to a significantly higher penetration of water molecules. An analogous dynamics of changes was observed in the concentration of acetic acid both in retentate and permeate; however, the average coefficients of retention of acetic acid and ethanol were 0.64 and 0.51 respectively. A higher variability of retention coefficients of acetic acid and ethanol was probably associated with their natural volatility and supported also by a continuous flow of model fluid from the retention tank (with barometric pressure) to the filtration system (with working pressure of 6.0 MPa) and back (Tab. I, Fig. 3).

The other organic acids under study, i. e. tartaric acid, malic acid and citric acid, were not found in permeate within the whole process of reverse osmosis. Impermeability of tested membrane for these acids was reflected also in their final concentrations in retentate and corresponded with the total volume of filtered permeate. This was valid also in case of data about an increasing concentration of reducing sugars on the side of retentate because it corresponded with an increase in the content of total non-volatile acids in retentate. As far as these parameters were concerned, a high stability of retention coefficients was observed also in repeated experiments (Tab. I). On the other hand, metallic ions showed lower retention coefficients and higher variability of results during the process of reverse osmosis. The lowest reliability of results was observed in K^+, obviously due to precipitation of tartaric acid and potassium. A low concentration of K^+ in retentate (as compared with other metallic ions added at the beginning of this process) was probably associated with precipitation of tartaric acid and potassium and with removal of crystals of potassium hydrogen tartate by means of decantation carried out before the beginning of reverse osmosis (Tab. I, Fig. 3).

CONCLUSIONS

The paper discusses problems occurring during the process of reverse osmosis and separation efficiency of tested membrane in individual stages of the experiment, as expressed by means of filtered amounts of permeate. Obtained results indicate that there is a real chance to evaluate experimentally the process of reverse osmosis also when using some native materials, e. g. grape must and/or wine. Regarding the current tendencies to use membrane processes in technologies of wine production, this process requires further studies.

REFERENCES

Balík J. (1998): Vinařství – návody do laboratorních cvičení. 1. vyd. Brno, ES MZLU. 98 s.

Balík J., Goliáš J. (1997): Changes of wine composition in the process of reverse osmosis. In: Int. Hort. Sci. Conf.: Biological and Technical Development in Horticulture, Lednice na Moravě. 85–90.

Camilla V. (1996): The O.I.V. agrees to reverse osmosis for enrichment purposes. Enotecnico, *32*, 17–18.

Cuenat P., Kobel D., Zufferey E. 1989: Reverse osmosis and oenology. Bull. O.I.V., *64*, 189–210.

Delfini C., Corino L., Castino M., Lanati D. (1992): Use of reverse osmosis for concentrating musts in comparison with addition of rectified concentrated musts and cluster thinning. Vignevini, *19*, 46–48.

Lamoš F., Potocký R. (1989): Pravdepodobnosť a matematická štatistika. 1. vyd., Bratislava, Alfa. 344 s.

MacSharry R. (ed.) (1990): Community methods for the analysis of wines. Official Journal of European Communities L 272, *33*, 192 p.

Ribéreau-Gayon P. (1995): Enrichment: potential application of reverse osmosis and evaporation under vacuum. Enotecnico, *31*, 95–103.

Trong Q. N., Neel J. (1983): Characterization of ultrafiltration membranes. J. Mem. Sci., *14*, 111–128.

Troost G. (1988): Technologie des Weines. 6. Neubearb. Aufl. Stuttgart, Ulmer. 995 s.

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Contact Address:

Ing. Josef Balík, Zahradnická fakulta, Mendelova zemědělská a lesnická univerzita v Brně, 691 44 Lednice na Moravě, Česká republika

Tel. +420 627 34 01 05–7, fax +420 627 34 0159, e-mail: balikj@zf.mendelu.cz

SELECTION OF A NEW GROUP OF MINIATURE DAHLIAS (*DAHLIA PINNATA* CAV.)

VYŠLECHTĚNÍ NOVÉ SKUPINY MINIATURNÍCH JIŘINEK (*DAHLIA PINNATA* CAV.)

J. Václavík

Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Průhonice, Czech Republic

ABSTRACT: Breeding of 13 miniature dahlias of a new type from vegetative propagation was terminated in 1999. Plants are 400–500 mm high and 500–700 mm in width, they are coming into flower early and produce exuberant flowers for a long time. Pompon flower heads 40–60 mm in diameter are self-cleaning and their fading is not visible on plants. Both tubers and young plants are suitable for bedding and pot plantings. This type is based on a random, double-flowering seedling that was isolated from single-flowering dahlias of Topmix group in 1970 and on clone 33/75 produced by its open pollination. By pair crossing of clone 33/75 with pompons and low cultivars a multicolor group was selected that received the working name "rosettes". To achieve a miniature height and earliness of coming into flower this material was crossed with dahlia cv. Figaro, which furnished the required traits but deteriorated commercial properties of hybrids. The parental plants for five cultivars were produced in 1990 by crossing the intermediary clones with selected cultivars. The parental plants for other 5 cultivars were selected by a polycross of some clones in 1993. Cultivars with yellow color were produced by mutation after irradiation with gamma-rays of radioisotope Co^{60}. When tested for the tomato spotted wilt virus by DAS-ELISA, the irradiated materials had a high proportion of plants with increased values of absorbance, especially in the first year after irradiation. It is not possible to reliably identify the presence of the quarantine virus of tomato spotted wilt in these materials. A total of 248 components were used for crossing in the course of the rosette group breeding; they yielded 136 seed progenies and 16,580 hybrid seeds. Sixty-one tubers were irradiated that produced 2 602 plants. 523 selected plants and their vegetative progenies were evaluated in a clone nursery.

dahlias; crossing; mutation induction; group of "rosettes"; tomato spotted wilt virus

ABSTRAKT: V roce 1999 bylo dokončeno šlechtění skupiny 13 vegetativně množených odrůd zakrslých jiřinek pro sadovnické použití. Jedná se o miniaturní rostliny dorůstající výšky 400 až 500 mm, s vynikající pokryvností (šířka rostlin 500 až 700 mm) a dlouhodobým spolehlivým kvetením. Odrůdy nakvétají mimořádně raně od konce června a bohatě kvetou až do zmrznutí. Květní úbory mají tvar plnokvětých kulovitých dekoračních jiřinek, jsou umístěny na celém povrchu rostliny a dosahují průměru 40 až 50 mm. Na rostlině současně kvete 30 až 50 úborů. Předností skupiny je samočisticí schopnost, při níž nevzhledné odkvétající úbory jsou překrývány novými, nebo na rostlině vůbec nevznikají a vyzrálé zavadající květy z úboru samovolně opadávají. Odrůdy jsou vhodné pro velkoplošné výsadby v městské zeleni, pro menší skupinové výsadby v zahrádkách, k soliterním výsadbám pro zpestření trvalkových partií i k pěstování v hlubších kameninových nádobách. Květní úbory, umístěné horizontálně na pevných stopkách, jsou využitelné pro drobné aranžerské práce z řezaných květů. K okrasným výsadbám lze použít hlízy i výrazně levnější mladé rostliny z řízků, které vytvoří bohatě kvetoucí porost. Matečné hlízy produkují 35 až 100 ks dobře kořenících řízků, z nichž narůstají kvalitní, spolehlivě přezimující hlízy. Mladé rostliny nakvétají ve skleníku během května a mohou být přenášeny do venkovních výsadeb již kvetoucí. Základem tohoto typu byl náhodný plnokvětý semenáč izolovaný v roce 1970 z jednoduše kvetoucích jiřinek skupiny Tompix a klon 33/75 získaný po jeho volném opylení. Párovým křížením klonu 33/75 s pomponkami a nízkými odrůdami byla vyšlechtěna mnohobarevná skupina s pracovním označením „rozetky". Pro dosažení miniaturní výšky a ranosti nakvétání byl tento materiál ještě křížen s odrůdou Figaro, který poskytl požadované znaky, ale zhoršil hospodářské vlastnosti hybridů. Křížením rozpracovaných klonů s vybranými odrůdami byli v roce 1990 získáni výchozí jedinci pro pět odrůd. Hromadným křížením vybraných klonů byli v roce 1993 vyšlechtěni výchozí jedinci pro dalších pět odrůd. Odrůdy se žlutou barvou byly získány mutací po ozáření gama-paprsky radioizotopů Co^{60}. Ozářené materiály vykazovaly při testování na viry bronzovitosti rajčete metodou DAS-ELISA velký podíl rostlin se zvýšenými hodnotami absorbance, zejména v prvním roce po ozáření. U těchto materiálů nelze spolehlivě identifikovat přítomnost karanténního viru bronzovitosti rajčete. Během šlechtění skupiny rozetek bylo pro křížení použito 248 komponentů, které poskytly 136 semenných potomstev a 16 580 hybridních rostlin. Ozářeno bylo 61 hlíz, které vyprodukovaly 2 602 rostlin. Ve školce

klonů bylo hodnoceno 523 vybraných jedinců a jejich vegetativních potomstev. S výjimkou odrůdy Domino, která je udržována a množena v ČR, byla celá skupina rozetek odprodána k výlučnému množení do Nizozemska. Kolekce je tvořena 12 vegetativně rozmnožovanými odrůdami s barvami: bílá, žlutá, oranžově žlutá, oranžová, oranžově červená, červená, tmavě červená, světle růžová, růžová, karmínová, světle purpurová a tmavě purpurová. V mezinárodních pokusech společnosti Bloembollenbemiddelingsbureau Cebeco Nederland B.V. v letech 1996 až 1998 se tato skupina prosadila v konkurenci celosvětového šlechtění jako nenovější typ sadovnické jiřinky a v roce 1999 byla zařazena do nizozemského množení.

jiřinky; křížení; indukce mutací; skupina „rozetky"; virus bronzovitosti rajčete.

INTRODUCTION

Garden dahlias are a popular object of crossing for their variability, combining ability and easy growing. A lot of amateurs as well as professional breeders in many countries have been concerned with the production of new cultivars since the beginning of the 19th century, and the numbers of selected dahlia cultivars have been much higher than in the assortments of all plant genera. It is estimated that several thousand cultivars of this species have been selected in the territory of the present Czech Republic for the last 200 years. Currently, several hundred new cultivars are introduced throughout the world every year but the worldwide production of dahlias has stagnated in the last 20 years. Production can be revived by new ways of use only. Easy growing, long-time flowering and resistance of dahlias to pollutants of the urban environment are important promising properties in view of a larger-scale use of this plant in municipal greenery. Cultivars esthetically and economically competitive with the commonly used annuals should be available for landscaping purposes (Václavík, 1998). The objective of this study was to breed a multicolor group of dahlias of low habit, with good coverage and long-time exuberant flowering. Commercial properties of new cultivars were a priority: namely high production of easily rooting cuttings, reliably wintering tubers of satisfactory growth and biological resistance to pathogens.

MATERIAL AND METHODS

Breeding commenced at a breeding station at Heřmanův Městec in 1970 by selection of a double-flowering seedling from the progeny of single-flowering dahlias of Topmix group; the seedling was designated as 2/70. Its habit corresponded to that of the foundation group (height 650 mm, miniature leaves and flower heads, much -branched) but it had double, flat, purple-pink flowers 50 mm in diameter. It was never determined whether ray flower multiplication was caused by a natural mutation or by uncontrolled crossing with a double-flowering cultivar since no analogical change was observed in the foundation material. On the other hand, seedlings of clone 2/70 that came from open pollination in 1974 showed partial inheritance of maternal habit traits including double flower. Four plants were isolated from this progeny: clone 33/75, 700 mm in height and with double red flowers, was taken as a foundation clone of the whole future group.

Intentional breeding commenced in 1977 based on pair crossing of mother plant 33/75 with nine pompon paternal components that were to improve the structure of flower head. Fertility of 11 clones of a new type available at that time was tested by open pollination in 1978 (clone 2/70, 4 selections from 1975 and 6 selections from 1978). Pair crossing continued in 1980 and 1981: mother plant 33/75 was crossed with the entire available assortment of cultivars and new intermediary breedings of the pompon group and park low cultivars. Parallelly, sib crossing of mother plant 33/75 with related clones of this type including back-cross with foundation clone 2/70 was carried out. Individual selections from progenies of 1980/81 crosses received a working name "rosettes".

A specimen of seed of generatively propagated mixture Dahlia var. Figaro, lot No. 280.70, was obtained from the Royal Sluis firm in 1982. It was a mixture of duplex dahlias which were of low but not homogeneous growth habit (300–600 mm in height) and early coming into flower (from mid-June). These two traits, extraordinary ones for dahlias, were additionally included among the breeding targets of a newly selected group. The inclusion of new parameters increased heterogeneity of the relatively steady gene pool of this genotype. Twenty-two plants of a desirable type (early and low with several rows of ray flowers) were selected from Figaro cv. seedlings, but they produced only weak tubers, most of them did not winter at all.

The method of open group pollination was used in 1984: 27 clones of rosettes coming from 1982 selections and 2 clones of Figaro cv. from 1982 selections were planted in outdoor spatial isolation and they produced viable tubers. As the representation of Figaro cv. was not sufficiently high, generative progeny from the seed reserve of this mixture (100 plants) was planted as a part of this group. Plants were pollinated by insects and seeds of the mother plants were sown separately.

The polycross method of group pollination was employed in 1988. Selected components planted in transportable crates were grown in outdoor isolation, later in August they were transferred into an isolated greenhouse to be pollinated by bees from separated combs (Václavík, 1987). This practice failed in 1988, so hand pollination was used in two-day intervals until the end of October

because dahlia fertility increases on short days (Hammett, 1987; Václavík, 1987). Pollen was transferred from plant to plant in a variable sequence with a small brush (pipe cleaner) to which remnants of pollen from the preceding components were stuck (partly controlled pollination with pollen mixture). The group consisted of 62 components (37 rosettes, 17 Figaro hybrids, 3 low pompons, 5 low decorative cultivars) that participated in pollination, but seeds were produced by 39 mother plants only.

The polycross method of group pollination continued in 1991: 35 typical rosette clones selected from breedings of the preceding years were pollinated. Besides the components for constitution of white and yellow color, plants with good self-cleaning ability and other desirable traits and properties (low habit, early flowering, high-quality tuber, high production of cuttings) were included in the group.

Positive effects of seed overstorage on germination were observed in long-time stored seed of Dahlia mignon as early as in the seventies. The seed is stored in dry ambient conditions at a temperature about 15 °C for 1–2 years; it increases germination energy and emergence in dahlias (Václavík, 1987). One-year overstorage was used during the breeding of progenies from 1980, 1985, 1988 and two-year overstorage in seed reserves from 1984. But breeding work based on continual evaluation of progenies is slowed down by this method.

The induction of mutations with gamma-rays of radioisotope Co^{60} was used in 1996 (Borsos, 1987; Gála, 1987). Dahlia tubers were exposed to irradiation with a dose of 18 Gy for 30 minutes on the 3rd Dec. 1996, and they were immediately planted to obtain and isolate shoot apexes. Rosette clones 60/90, 8/93 and 44/93 were irradiated, 34 tubers in total. Cuttings were taken between 5th Feb. and 1st June 1997 until mother tubers were completely exhausted. These mostly chimeric mutations had to be stabilized by cloning in the next years. Radiation breeding continued in 1997, when doses of 15 and 25 Gy were used. A total of 27 tubers of rosettes were irradiated, including plants with sectoral mutations that were selected after irradiation in the preceding year (Gála, 1987).

RESULTS AND DISCUSSION

The first pair crosses of clone 33/75 with pompon-type paternal components in 1977 (progenies E 301–309) produced 6 selection plants, but none of them participates in the gene pool of the selected group. Due to problematic seed production in 1977, fertility of all 11 clones of this new type was tested by open pollination in 1978. Seed was produced by six clones but no promising individual was isolated in their progenies (F 30–35). Mother plant 33/75 had both the highest seed performance and the highest heritability of desirable traits. Large-scale pair crossing of this mother plant with a collection of pompons and low cultivars was carried out in 1980–1981. A total of 1,323 seeds were produced from 44 successful cross combinations (progenies G 60–91 and H 31–42); out of them, 62 plants of different colors except white were isolated in 1982. In these materials given a working name "rosettes", the effect of pompon-type paternal components resulted in an improved shape of flower heads but the basic traits of plants did not change including plant height of 600–750 mm and late date of coming into flower (July to August). Good commercial properties of the foundation material (tuber quality and high production of cuttings) were maintained. The parallel sib and back crossing with parental clone 2/70 did not yield any positive results.

Pair crossing was not a method usable for further breeding due to its high time consumption and low seed yield. Each flower head had to be pollinated 5–10 times, pollen was hard to collect and the bulk of the cross combinations of double dahlias failed to be produced. Dr. Hammett, a New Zealand breeder, reported similar conclusions (Hammett, 1987). Therefore open group pollination was used in 1984 to check the fertility of newly selected clones of rosettes and their combining ability with Figaro cv., which was included in a breeding program as an additional component. Thirty-one seed progenies were produced (L 177–207); Figaro cv. was a mother plant in 23 out of these progenies, rosette clones in eight. 200 seeds of each progeny were planted in 1985 (the remaining seeds were kept as reserves): 44 Figaro-rosette hybrids (low, early, double-flowering ones) were selected from among them. Mutual combining ability of both groups was demonstrated by transitional forms between both types that occurred in all progenies. Clone 26/85 (mother plant 130/82) came from selections of this crossing; it was registered under the name Domino in 1993 as the first cultivar of a new type. It is a purple-pink dahlia meeting all requirements of this group for habit traits, but the quality of its tubers is not good. This primary commercial trait was largely worsened in most materials from the 1984 progenies as a result of crossing with Figaro cv.

Breeding of two clones of rosettes with high seed performance continued in 1985; they were included in isolation II/85 (open group pollination of pompons and ball dahlias) but out of 650 seeds that were planted in 1987 (progenies M 157–158) only ten plants were selected that did not share in the gene pool of selected cultivars. These progenies confirmed hybridization of rosettes with Figaro cv. by type segregation in the 2nd generation. Following the evaluation of seedlings from crossing in 1984, two selected seed reserves (progenies L 203–204) were planted at a total amount of 1 700 seeds, and 190 plants were selected. Five of these selections became the foundation material of all future cultivars and they came from mother plants 104/82 = (clone 33/75 x Bela) x group crossing 1984 (1 selection that produced white and yellow cultivars) and 130/82 = (clone 33/75 x Peter) x group crossing 1984 (4 selections).

A group polycross was used for further breeding in 1988. Out of 62 components, 39 mother plants produced

a total of 5,969 seeds. These progenies (T 101–139) were planted in 1990, and 127 rosettes with required traits and properties were selected. These cultivars were produced following the vegetative propagation of five of them: pink (clone 18/90), red (22/90), orange red (27/90), light purple (33/90) and carmine (60/90). This material was not found to contain any good-quality clones white and yellow in color that are necessary for the flower group to be complete for users' needs.

In order to produce the latter colors a group polycross of 35 clones of intermediary rosettes continued in 1991. Close genetic affinity of the used components was reflected by fertility problems. It was not possible to transfer mother plants to a greenhouse for technical reasons, so seed yield in outdoor conditions was low. A total of 838 seeds was harvested from 14 mother plants (progenies B 1–14). The seeds were planted in 1993 and 56 plants were selected. The following cultivars stemmed from these selections after vegetative propagation: white (clone 6/93), dark red (50/93), dark purple (15/93), orange (9/93) and light pink (clone 44/93, which was registered in CR in 1998 under the name Baby). No good -quality plant yellow in color was produced by the above crossing either.

Induction of mutations was used in 1996 and 1997. Tubers of three rosette clones irradiated in 1996 (34 tubers) produced 1,967 plants by vegetative propagation; 23 color mutants were isolated from among them in the growing season 1997. Mutant no. 145/97 was a parental plant for a cultivar orange-yellow in color. As a part of plants from cuttings did not come into flower in the first year, these non-flowering plants were set out anew in 1998 and mutant 913/98 was isolated, which was the parental plant of a purely yellow cultivar. Both these chimeric mutants had to be stabilized by cloning in 1998–1999. 635 plants were produced from 6 lots of rosettes irradiated in 1997: 13 color mutants were selected in 1998 but all of them were discarded from further breeding following the tests for tomato spotted wilt virus.

Overall DAS-ELISA testing of *Dahlia* materials for infection by tomato spotted wilt virus in February 1999 revealed that irradiated materials had a high proportion of tubers with increased values of absorbance above 0.1 at A_{405}, so it was necessary to discard them from further growing as questionably infected plants. 87% of demonstrably mutated plants selected in 1998 showed this defect (45 out of 52 tubers). In the other vegetative progenies from irradiated tubers (/non/irradiated apexes) increased absorbance values were recorded in 38% of plants (138 out of 363 tubers). On the other hand, in vegetative progenies from demonstrably mutated tubers that were selected in 1997 (irradiation in 1996) 47% of plants (60 out of 127 tubers) showed increased absorbance values.

This reaction is likely to be evoked by changes in the protein structures of plants as a result of irradiation and it fades away in the following years (see selections 1997) similarly like visually discernible morphoses in the habit of mutated plants. The reaction is cultivar-specific. It was not expressed in 7 progenies (99 tubers) at all while the values were increased in 4 progenies (31 tubers) in all tests but none of the values reached the boundary of significant TSWV infection (absorbance 0.4). A questionable increase in the values in nonirradiated materials (new breedings, maintenance breeding, gene pools) was detected in 24% of plants only (349 out of 1 429 tubers). Taking into account demonstrated nonspecificity of DAS-ELISA tests, which are the only usable method of detection of this quarantine pathogen in large-scale production of dahlias, further induction of mutations by gamma-rays of radioisotope Co^{60} should be considered for dahlia breeding.

Mutant 116/97 white in color and mutant 120/97 of very light purple color and with darker ray tips were selected from the irradiated cultivar Baby (clone 44/93) in 1997. In case foreign tests of these two clones are positive, they will be used to enlarge the group of rosettes; breeding work on this type of dahlia will be terminated in this way.

REFERENCES

Borsos S. (1987): Experiments with radiation breeding of dahlias in Hungary (in Czech). In: Proc. Dahlia Breeding, Hrádek nad Nisou, Sempra Praha. p. 31.

Gála M. (1987): Radiation breeding of dahlias at Turnov Breeding Station (in Czech). In: Proc. Dahlia Breeding, Hrádek nad Nisou, Sempra Praha. 33–39.

Hammett K. R. W. (1987): Strategy of dahlia breeding (in Czech). In: Proc. Dahlia Breeding, Hrádek nad Nisou, Sempra Praha. 19–23.

Václavík J. (1987): Goals and methods of dahlia breeding (in Czech). In: Proc. Dahlia Breeding, Hrádek nad Nisou, Sempra Praha. 25–31.

Václavík J. (1998): Dahlias for the third millennium (in Czech). In: 1998 Year-Book. Prague, DAGLA Dahlia Breeders' Union. 18–20.

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Contact Address:

Ing. Jiří V á c l a v í k , Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, 252 43 Průhonice, Česká republika
Tel. +420 2 67 75 00 38

ANTIOXIDANT CONTENTS AND COMPOSITION IN SOME FRUITS AND THEIR ROLE IN HUMAN NUTRITION

OBSAH A SLOŽENÍ ANTIOXIDANTŮ VE VYBRANÝCH DRUZÍCH OVOCE A JEJICH VÝZNAM V LIDSKÉ VÝŽIVĚ

J. Lachman, M. Orsák, V. Pivec

Faculty of Agriculture, Czech University of Agriculture, Praha, Czech Republic

ABSTRACT: Fruits and vegetables are significant sources of antioxidants in human nutrition both in direct consumption and in the form of juices. Natural antioxidants regarding their chemical structure could be divided in polyphenols (flavonoids, anthocyanins, phenolcarboxylic acids, and coumarins), carotenoids, and tocopherols. Also ascorbic acid and selenium possess effective antioxidant activity. Major sources of antioxidants in direct consumption and in fruit juices within our fruits are apples, aronia berries, pears, apricots, cherries or sour cherries (morellos), red grapes, and black and red currants. One of the richest antioxidant sources within Czech fruits is black currant both in direct consumption as well as in the juice form. It is one of the richest flavonoid compound sources (anthocyanins 10 000–40 000 mg/kg, leucoanthocyanidins 2 600–14 200 mg/kg and catechins 5 500–13 800 mg/kg). There are contained also flavonols (55 mg of myricetin and 33 mg of quercetin/kg). Also ascorbic acid content is high (1 200–10 030 mg/kg), as well as α-tocopherol (22–120 mg/kg). In red currant the content of these compounds is substantially lower (300–2 554 mg of ascorbic acid/kg, 8–59 mg of α-tocopherol/kg and 27 mg of quercetin/kg of fruits. Aronia berries and juice are rich in polyphenolic antioxidants (10 000–20 000 mg/kg), from these compounds are significant above all anthocyanins (6 500–8 500 mg/kg dry matter) and catechins (200 mg/kg). Black chokeberries are significant source of natural anthocyanin colorants. In pears is expressively contained caffeic acid (43–19 700 mg/kg) and phenolic amino acid tyrosine (30–185 mg/kg) that together with other antioxidants of phenolic nature (anthocyanins 68 mg/kg of peels, quercetin 28 mg/kg) and ascorbic acid (40–250 mg/kg) contribute to antioxidant complex. Pears contain 0.6–31 mg of α-tocopherol/kg. Red grapes are rich in anthocyanidin complex (as high as 31 000–33 000 mg/kg dry matter) and phenolic acids (chlorogenic 1 400 mg/kg, isochlorogenic 200 mg/kg, neochlorogenic 20 mg/kg, caffeoylquinic 200 mg/kg) that can influence each other synergically. In particular it is important resveratrol content (5 mg/l) that possesses many healthy positive effects. In apricots the polyphenol complex is presented above all with tannins (600–1 000 mg/kg), but they are rich in amino acid tyrosine (290–2 125 mg/kg), too. Among other present antioxidants there is not negligible ascorbic acid content (100–745 mg/kg) and carotenoid content (11.3 mg/kg) is within selected fruits the highest one. Apples are noted for higher anthocyanidin content (95–1 000 mg/kg) and ascorbic acid content (20–402 mg/kg) that works in synergy with other antioxidants of flavonoid nature (21–72 mg of quercetin/kg). In sour cherries (morellos) high ascorbic acid content (70–873 mg/kg) and carotenoids (1–10 mg/kg) prevail and they contribute above all to their antioxidant complex. In flavonols quercetin is present above all (38 mg/kg). Together with data on the antioxidant contents of fruits published previously these data summarize a base for an evaluation of potentially sources of antioxidants in Czech Republic.

antioxidants; polyphenols; ascorbic acid; carotenoids; tocopherols; selenium; black currant; aronia; pears; red grapes; apricots; apples; sour cherries (morellos)

ABSTRAKT: Ovoce a zelenina jsou významnými zdroji antioxidantů v lidské výživě jak ve formě přímé spotřeby, tak i ve formě ovocných šťáv. Přírodní antioxidanty vzhledem k jejich chemické struktuře mohou být rozděleny na polyfenoly (flavonoidy, antokyany, fenolkarboxylové kyseliny a kumariny), karotenoidy a tokoferoly. Účinnou antioxidační aktivitu mají také askorbová kyselina a selen. Mezi našimi druhy ovoce jsou hlavními zdroji antioxidatů jak ve formě ovoce, tak i ve formě ovocných šťáv jablka, plody černého jeřábu, hrušky, meruňky, třešně a višně, červené hrozny a černý a červený rybíz. Jedním z nejbohatších zdrojů antioxidantů v našem ovoci je černý rybíz jak při přímé konzumaci, tak i ve formě šťávy. Je jedním z nejbohatších zdrojů flavonoidních látek (obsahuje 10 000 až 40 000 mg/kg antokyanů, 2 600 až 14 200 mg/kg leukoantokyanidinů a 5 500 až 13 800 mg/kg katechinů). Zastoupeny jsou rovněž flavonoly

(55 mg myricetinu a 33 mg kvercetinu/kg). Také obsah askorbové kyseliny je vysoký (1 200 až 10 030 mg/kg), stejně i α-tokoferolu (22 až 120 mg/kg). U červeného rybízu je obsah těchto látek podstatně nižší (300 až 2 554 mg askorbové kyseliny/kg, 8 až 59 mg α-tokoferolu/kg a 27 mg kvercetinu/kg plodů). Plody a šťáva jeřábu černého – aronie – jsou bohaté na polyfenolické antioxidanty (10 000 až 20 000 mg/kg), z nichž významné jsou především antokyany(6 500 až 8 500 mg/kg sušiny) a katechiny (200 mg/kg). Plody jeřábu černého jsou významným zdrojem přírodních antokyanových barviv. V hruškách je výrazně zastoupena kávová kyselina (43 až 19 700 mg/kg) a fenolická aminokyselina tyrozin (30 až 185 mg/kg), které spolu s dalšími antioxidanty fenolické povahy (antokyany – 68 mg/kg slupek, kvercetinem – 28 mg/kg) a askorbovou kyselinou (40 až 250 mg/kg) přispívají k antioxidačnímu komplexu. Hrušky obsahují 0,6 až 31 mg α-tokoferolu/kg. Červené hrozny vinné révy jsou bohaté na obsah antokyanového komplexu (31 000 až 33 000 mg/kg sušiny) a fenolickými kyselinami (chlorogenová 1 400 mg/kg, isochlorogenová 200 mg/kg, neochlorogenová 20 mg/kg, kávoylchinová 200 mg/kg), které vzájemně působí synergicky. Zvláštní pozornost zaslouží obsah resveratrolu (5 mg/l), který má řadu zdravotně pozitivních účinků. V meruňkách je polyfenolický komplex zastoupen především taniny (600 až 1 000 mg/kg), ale jsou také bohaté na aminokyselinu tyrozin (290 až 2 125 mg/kg) a z dalších antioxidantů na askorbovou kyselinu (100 až 745 mg/kg). Obsah karotenoidů (11,3 mg/kg) je u meruněk mezi druhy ovoce jedním z nejvyšších. Jablka mají vyšší obsah antokyanů (95 až 1 000 mg/kg) a askorbové kyseliny (20 až 402 mg/kg), která působí synergicky i s dalšími antioxidanty flavonoidního charakteru (21 až 72 mg kvercetinu/kg). U višní převládá vysoký obsah askorbové kyseliny (70 až 873 mg/kg) a karotenoidů (1 až 10 mg/kg), které především přispívají k jejich antioxidačnímu komplexu. Z flavonolů je zde zastoupen především kvercetin (38 mg/kg).

antioxidanty; polyfenoly; askorbová kyselina; karotenoidy; tokoferoly; selen; černý rybíz; aronie; hrušky; červené hrozny; meruňky; jablka; višně

INTRODUCTION

Antioxidants are compounds that help the organisms to neutralize free radicals and protect cells against their damage effects and the formation of tumors. Free radicals can attack biomolecules (lipids, proteins, DNA) or their biomembrane. As antioxidants could be evaluated all compounds that have at pH = 7.0 more negative potential as + 0.816 (redox potential of O_2). Antioxidant molecule has to react with free radicals more quickly than free radicals react with lipids and the products of the reaction with free radicals have not to be pro-oxidants. In very tight correlation (r=0.992) are antiinlammatory effects of antioxidants and scavenging effect. At present time antioxidants are classified as nutraceuticals, phytonutrients, phyto or functional foods.

Basically, fruits and vegetables are important dietary sources of antioxidants in human nutrition regarding the form of direct consumption as well as the form of fruit juices and beverages (Kühnau, 1976). Natural antioxidants regarding their chemical structure could be classified to polyphenols (flavonoids, anthocyanins, phenolcarboxylic acids and coumarins), carotenoids and tocopherols. Also ascorbic acid and selenium possess effective antioxidant activity. Within fruits produced in Czech Republic the dominant sources of antioxidants in the form of fruits as well as in the form of fruit juices are apples, aronia fruits, pears, apricots, cherries and sour cherries, red grapes and black and red currants.

Recently, Wang et al. (1996) have investigated antioxidant activity of twelve fruits and five samples of fruit juices obtained on the market on the basis of an automated measuring of absorbancy capacity of oxygen radicals (ORAC assay). Rich in antioxidants are strawberries on the basis of fresh matter where a series strawberries > plums > oranges > red grapes > kiwi > red grapefruits > white grapes > bananas > apples > tomatoes was obtained, as well as on the basis of dry matter where a series strawberries > plums > oranges > red grapefruits > tomatoes > kiwi > red grapes > white grapes > apples > honeydew melons was estimated.

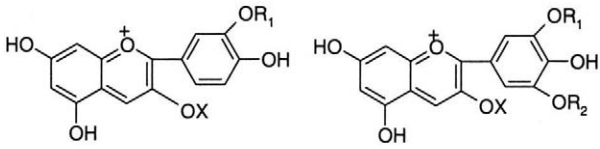
Significantly greater percentage of antioxidant activity remains in fruit sauce (more than 90% of total activity) in comparison with stampings. Regarding the appraisal of fruit juices it was obtained a series grape juice > grapefruit juice > tomato juice > orange juice > apple juice.

MAJOR SOURCES OF ANTIOXIDANTS

Polyphenols of aronia fruits [*Aronia melanocarpa* (Michx.) Elliot]

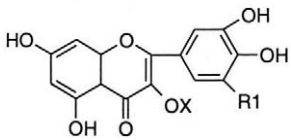
Aronia fruits, also known as black chokeberries, are very rich in polyphenols and anthocyanins. Hernandez and Ossess (1998) referred that aronia fruits contain up to 10–20 g total polyphenols and 4–8.5 g anthocyanins in 1 kg. β-Carotene is here abundantly present, too, at levels 7.5–50 mg/kg. Juices prepared from black chokeberries are also rich in antioxidants of polyphenolic character – 12.30 mg total polyphenols /l, 34.54 mg anthocyanins/l. Aronia fruits are rich in β-carotene – 7 IU/l and ascorbic acid (106.9 mg/l). Wilska-Jeszka et al. (1992) referred that aronia fruits contain relatively high amounts of epicatechin – 200 mg/kg. Strigl et al. (1995a, b) obtained by extraction with ethanol 6 500–8 500 mg anthocyanins/kg DM. They estimated the concentration 3 070–6 310 mg anthocyanins/kg in fresh fruits. The only present anthocyanin was cyanidin and the monosaccharides were contained in the following ratios: 68.9%

galactose, 27.5% arabinose, 2.3% xylose and 1.3% glucose. These monosaccharides are attached at position 3 as monoglycosides (Koswig and Hofsommer, 1995; Fig. 1). Kaack and Kuhn (1992) estimated in an average anthocyanin contents black chokeberries comparable with that of elderberries – 7 500–9 500 mg/kg. Wilska-Jeszka and Korzuchowska (1995, 1996) determined that chlorogenic acid (Fig. 3) enhances the intensity of anthocyanin coloration in aronia and strawberry sauces, esp. at pH values 3.2–3.6. Anthocyanin colorants from black chokeberries are valuable naturally occurring pigments. Czapski-Kaczmarek (1995) describes procedure for their extraction with water, re-extraction with 60–80% ethanol and acetone and adjusting to values 1.5-4.0 before thickening. Color of anthocyanin solutions depends on many factors such as their concentration, type of solvent, temperature, pH, and colorant structure. Considerable negative effect has the exposure to visible light or UV irradiation (Pizlo and Dobrazanska, 1995). Oszmianski and Krzywicki (1992) obtained from 1 kg of aronia fruits after ultrasound procedure with 10 kg acetone after 2 h and agitation for 15 min and extraction of liphophilic compounds with 10 kg petrolether from acetone 200 g 40% water solution of anthocyanins containing 4.2% anthocyanin monomers. Borissova et al. (1994) gave information that flavonoids obtained from natural juice *A. melanocarpa* had higher antiinlammatory effects in comparison with rutin.



R_1 = H: cyanidin
R_1 = CH_3: peonidin
R_1 = R_2 = H: delphinidin
R_1 = OCH_3, R_2 = H: petunidin
R_1 = R_2 = OCH_3: malvidin
X = gal, ara, xyl, glu, rut, glu-glu, gentiobiose

1. Dominant fruit anthocyanins



R_1 = H: quercetin
R_2 = OH: myricetin
X = rha, glu, gal, xyl, ara, glu-rha, glu-xyl, glucuronic acid

2. Dominant fruit flavonoids

Antioxidant complex of bioflavonoids and ascorbic acid in apples (*Malus pumila* Mill.)

Significance of apple flavonoids for human health results from their rating as a source of these compounds in human nutrition (Tab. I) and the effect on diminishing of the risk of coronary diseases (Tab. II).

I. Dominant sources of polyphenolic antioxidants in The Netherlands (Hertog et al., 1992, 1993)

	Total intake (%)	Content of polyphenols (mg/kg)	Content of ascorbic acid (USDA Rel. 12, 1998) (mg/kg)
Tea	48.1	250 000/dry matter of leaves 5 000 Q, 3 200 K, 1 040 M	0
Onion	28.9	284–486 Q	64
Apples	7.1	95–100 A, 21–72 Q	57
Kale	3.6	110 Q, 211 K	1 200
French beans	2.9	32–45 Q, 15–91 K	12
Endive	2.2	< 1.3 Q, 46 ± 42 K	240
Red wine	0.9	4.1–16 Q*, 6.9–9.3 M*	0
Apple juice	0.7	28.85–115.49*, 2.5 Q*, < 0.5 K*	17–416 enriched
Orange juice	0.6	3.4 Q*, < 0.5 K*	532
Leek	0.5	< 1 Q, 30 ± 23 K	120
	Σ 95.5		

A = apigenin; K = kaempferol; Q = quercetin; M = myricetin
* (mg/l)

II. Dominant dietetic sources of flavonoids in Finland (Knekt et al., 1996)

Source of polyphenols	Population	Relative coronary heart disease risk in the highest and lowest intake
Apples	Women	0.57 (0.36–0.91)
Apples	Men	0.81 (0.61–1.09)
Onion	Women	0.50 (0.30–0.82)
Onion	Men	0.74 (0.53–1.02)

Polyphenolic complex of apples involves glycosides of flavonols: kaempferol – astragalin, i.e. kaempferol-3-O-glucoside (Hegnauer, 1973), quercetin – quercitrin (quercetin-3-O-rhamnoside), isoquercitrin, hyperoside (quercetin-3-O-galactoside), quercetin-3-O-xyloside, avicularin (quercetin-3-O-arabinoside) and rutin (Henke, 1963; Fig. 2). The other flavonoid type is present by flavanones, among them above all naringin (naringenin-7-O-rhamnoglucoside), which is of bitter taste and could be converted to dihydrochalcone phloretin and eriodictyol-7-O-glucoside. In polyphenolic complex chlorogenic acid is also contained. As main red apple colorant was determined cyanidin-3-O-galactoside (Swain, 1962). Mazza and Velioglu (1992) determined in red apple cultivar Scugog 95-100 mg anthocyanins in 1 kg of apples. The most present compound was chlorogenic acid, in anthocyanins cyanidin-3-O-galactoside > cyanidin-3-O-glucoside > cyanidin-3-O-arabinoside > cyanidin-3-O-xyloside. Hertog et al. (1992) determined contents of quercetin in apples as 21–72 mg/kg and this contents was dependent on a given cultivar. Spanosa and Wrolstadt (1992) refer to leucoanthocyanidins as typical compounds contained in apples. Typical for apple juice is dihydrochalcone phloridzin (Fernandez de Simon et al., 1992), important compound for the characterization of purity of apple juices. Delage et al. (1991) found in apple juice chlorogenic, *p*-coumaric and protocatechuic acids and further (+) – catechin, (-) – epicatechin, phloridzin (glucoside of phloretin) and di-, tri- and tetrameric procyanidins. Pierzynowska-Korniak et al. (1993) determined in apple concentrates obtained in early, semi-early and late cultivars the largest amounts of polyphenols in concentrates prepared from early cultivars. The most present was *o*-coumaric, vanillic and *p*-hydroxyphenylacetic acids. Hertog et al. (1993b) estimated in apple juice 2.5 mg quercetin/l, myricetin was present only in traces.

Together with polyphenolic compounds is an important component of apple antioxidant complex also ascorbic acid that in antioxidant function is directly related with polyphenolic complex. Fragner et al. (1961) report ascorbic acid contents in apples 18–64 mg/kg, in stewed apples 10 mg/kg and dried apples 120 mg/kg. Duke (1992) gives ascorbic acid content in apple fruits in ranking 20–402 mg/kg. Ascorbic acid and organic acids have also synergic effect in color changes of fruits (Usami and Chiba, 1994). Behrens and Madère (1994) found in apple juices as main form ascorbic acid, only in lesser amount isoascorbic acid and oxidized dehydroascorbic and dehydroisoascorbic acids were present.

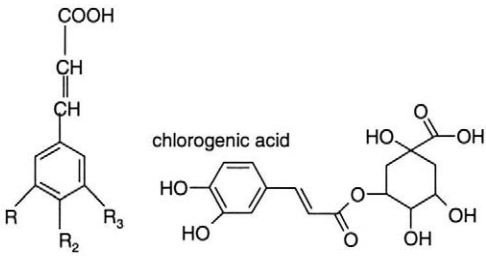
Antioxidant effects of ascorbic acid confirm also Almeida and Nogueira (1995) who for lowering of polyphenol oxidase activity use the combination of ascorbic acid with citric or ethylendiaminetetraacetic acids, resp. similar results obtained Aubert et al. (1992).

Content of flavonoids and ascorbic acid in apples is affected by many extrinsic and intrinsic factors, as maturity degree, cultivar, climatic conditions, year, conditions of storage and technological processing.

Recently, it was discovered by Lister et al. (1994) that flavonoid complexes from the skins of a green apple cultivar Granny Smith and a red apple cultivar Splendour were very similar with the most contained glycosides of quercetin and proanthocyanidins. But in red cultivar it was estimated that during maturation the synthesis of glycosides of cyanidin was as high as 1 000 mg/kg fresh matter. Mahajan (1994) and Barden and Bramlage (1994a) refer that the contents of total polyphenols and other in water soluble antioxidants decreased in the course of storage process, meanwhile the contents of antioxidants soluble in fats increased. Also during development of fruit biosynthetic changes could be observed, e.g. shift in monomeric to oligomeric structures leading to the formation of procyanidins at the end of growth period. In the same manner ascorbic acid content decreases during storage (Barden and Bramlage, 1994b). Mayr et al. (1995) demonstrated structure of trimer of epicatechin – (4 β,6) – epicatechin – (4 β,6) – epicatechin (E-B5). Bae et al. (1994) found that the synthesis of anthocyanins begins in interval from 60 to 90 days after flowering and that induction of coloration is affected by light irradiation that affectivity decreases progression blue light > white light > red light. Liu and Hwang (1991) found the highest ascorbic acid contents in mature fruits, whereas unripened or over-ripened fruits show lower levels. A positive taste correlation with ascorbic acid contents was found.

Chlorogenic acid content in apple juice is also influenced by technological procedures, e.g. thermic processes (Chen et al., 1993). Miller et al. (1995) used total antioxidant activity as a marker of deterioration of apple juice during its storage. They determined that ascorbic acid activity represented only a little percentage of total antioxidant activity of long term stored apple juice (about 1%), whereas chlorogenic acid and glycosides of phloretin were considerably more effective constituents (about 32% and 11%). Arakawa (1991) determined in different apple cultivars (Jonathan, Fuji, Jonagold and Tsugaru) that changes in anthocyanin content during maturation are dependent on temperature, cultivar and packaging. In Jonathan cultivar the optimal temperature for anthocyanin accumulation was in unpacked apples 15–25 °C and in packed apples it reached values from 20 to 25 °C. In Tsugaru and Fuji cultivars were these values lower, 15–20 °C and 20 °C, in Jonagold cultivar the optimal temperature value showed the lowest level. The polyphenol antioxidants were stable under storage

conditions, but ascorbic acid content decreased. These compounds share also on the susceptibility of cultivars to enzymatic browning. Amiot et al. (1992) determined that factors influencing enzymatic browning are chlorogenic acid and flavanol contents. The rate of catechin degradation increased with chlorogenic acid effect and with reciprocal oxidative reactions. Significant was relative equilibration between the contents of hydroxycinnamic derivatives and flavanols. Kermasha et al. (1995) estimated with high-pressure liquid chromatography contents of total polyphenols in apple juices in interval 29–116 mg/l. The main contained compounds were chlorogenic acid, coumaroylquinic acid and phloridzin, in lesser amounts caffeic, *p*-coumaric, ferulic, gallic, and protocatechuic acids and catechin (Fig. 3 and 4 were present).



R_1, R_3 = H, R_2 = OH: p-coumaric acid

R_1 = H, R_2, R_3 = OH: caffeic acid

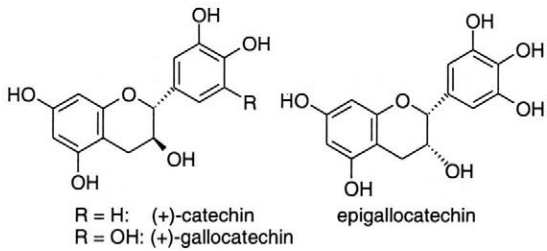
3. Dominant phenolic acids in fruits

Piretti et al. (1996) found in apple cultivar Granny Smith, that polyphenolic compounds play an important role in fruit damage. It was observed a decrease of glycosides of quercetin and their conversion to flavan-3,4-diols that further in oxidative way polymerize to oligomeric and polymeric proanthocyanidins. Content of assumed polyphenolic compounds, e.g. anthocyanins, increases after pre-harvest application of some compounds, such as D-galactose (0.25 M), D-glucose (0.25 M), kinetin (10^{-6} M) or ethephone (100–600 mg/kg) on apples and leaves of apple trees (Bae et al., 1995).

In carotenoid contents there could be found great cultivar differences (Müller, 1997). Cultivar Elstar contained 1.4 mg of total carotenoids per kg. The most present were violaxanthin, β-carotene, lutein and antheraxanthin (0.6, 0.2, 0.2, and 0.2 mg/kg). In lesser amounts are in apples contained neoxanthin, cryptoxanthin-diepoxide, cis-β-carotene, β-cryptoxanthin and zeaxanthin (0.1, 0.1, 0.04, 0.04 and 0.03 mg/kg). On the other hand, apples of the cultivar Jak. Fischer contained only 0.7 mg of total carotenoids per kg. The most present were lutein, β-carotene and violaxanthin (0.3, 0.11 and 0.10 mg/kg). In little amounts are contained β-cryptoxanthin, neoxanthin, antheraxanthin, cis-β-carotene, α-cryptoxanthin and zeaxanthin (0.08, 0.03, 0.03, 0.02, 0.01 and 0.01 mg/kg), (Fig. 5 and 6).

Antioxidants of black currants (*Ribes nigrum* L.) and red currants (*Ribes rubrum* L.)

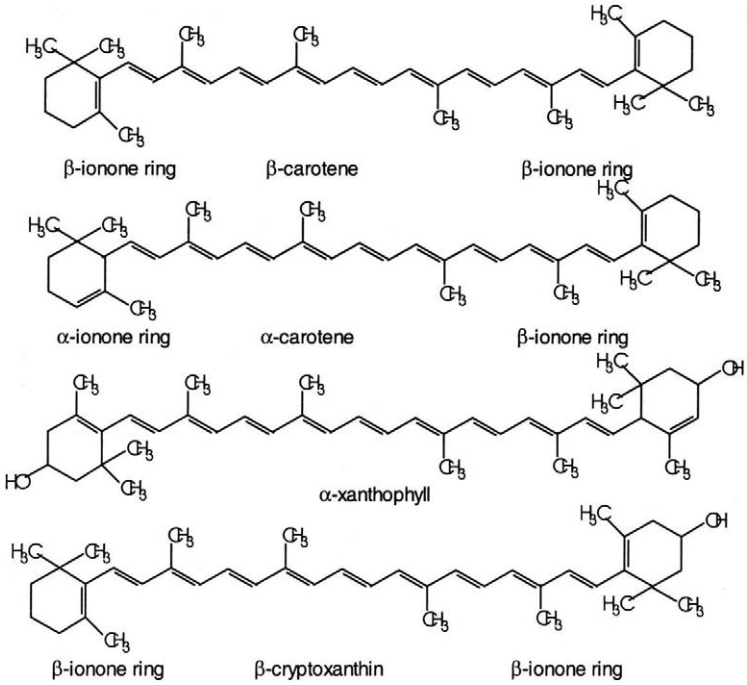
According to Hertog et al. (1992) the fruits of black currants contain 13 mg/kg quercetin. Duke (1992) declares that black currants contain 5 500–13 800 mg/kg (+)-catechin that is the main antioxidant in black currants. The other constituent is represented with anthocyanins (10 000–40 000 mg/kg) in free form or attached in glycosidic form of anthocyanins (3 000 mg/kg). Within these anthocyanins the most contained are above all glycosides of cyanidin and delphinidin – 3-O-β-diglucoside, 3-O-β-D-glucoside and 3-O-rutinoside (Chandler and Harper, 1962). Kaack (1988) identified in black currants 3-O-glucosides and 3-O-rutinosides of delphinidin and cyanidin. Also glycosides of quercetin



R = H: (+)-catechin
R = OH: (+)-gallocatechin
epigallocatechin

4. Dominant fruit catechins

and its free form are present. Glycosides of quercetin are contained in the form of 3-O-β-D-glucoside, quercitrin, isoquercitrin and rutin. Phenolcarboxylic acids present significant constituents of black currants – caffeic, ferulic, *o*- and *p*-coumaric acids that are attached as 1-O-β-D-glucopyranosides (Köppen and Herrmann, 1977), protocatechuic, syringic and gentisic acids, methylsalicylate and different isomers of chlorogenic acid – chlorogenic, neochlorogenic and trans-chlorogenic acids. Tanchev et al. (1986) report as main phenolic acids of black currant juice 2,5-dihydroxybenzoic and *p*-coumaric acids. In black currants also other flavonoids were found – kaempferol and myricetin and flavanol (+) – gallocatechin. In other parts of plant evidence for cyanidin and delphinidin was provided. In leaves it is contained up to 4 600 mg/kg flavonoids and 85 000 mg/kg tannins and in polyphenolic



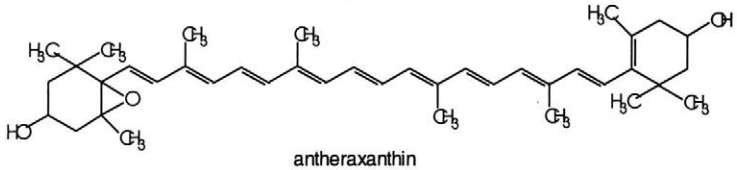
5. Dominant fruit carotenoids

compounds bound form of salicylic acid – methylsalicylate and flavonoid glycoside rutin. Wildanger and Herrmann (1973) and Köppen and Herrmann (1977) appreciate as dominant flavonoid compound of black currant myricetin and in anthocyanins delphinidin and cyanidin. In black currants Rosenthals langtraubige Schwarze cultivar they estimated 55 mg myricetin in 1 kg fresh matter and 33 mg quercetin. These data were confirmed also by Francis and Andersen (1984) who separated from black currants 3-O-glucosides and 3-O-rutinosides of cyanidin and delphinidin. Meaningful differences exist within individual cultivars as confirm the results obtained by Nilsson and Trajkovski (1977; Tab. III). However, in red currants as dominant flavonoid quercetin (27 mg/kg) is present. Jankelevicz et al. (1985, 1986) report for black currants 6 600–22 500 mg/kg anthocyanins, 2 600–14 200 mg/kg leucoanthocyanidins, 440–3 300 mg/kg catechins, 1 390–3 550 mg/kg ascorbic acid and 14 510–36 500 mg/kg vitamin P. Gaas (1987) estimated 395–2 494 mg/kg leucoanthocyanidins in fruits. Pfannhauser and Riedl (1983) found in black currant juice *p*-coumaric, caffeic and ferulic acids. Adulteration of black currant juice could be estimated on the basis of quercetin-3-O-β-glucuronide (Wald et al., 1986). Boronczyk et al. (1985) refer to stampings of black currant fruits after pressing 1 550–2 400 mg/kg anthocyanins, whereas in fresh fruits the contents of anthocyanins was 830–840 mg/kg, and after thermic treatment 840–870 mg/kg and depectinization 1 030–1 040 mg/kg. Extract of black currant fruits contained ≤ 1 032 mg/l anthocyanins after long-term storage, in red currants only 103 mg/l. Jankelevicz et al. (1986) report in different black currant cultivars 6 600–22 500 mg/kg anthocyanins, 2 600–14 200 mg/kg leucoanthocyanidins and 440–3 300 mg/kg catechins. During maturation contents of organic acids and phenolic compounds decrease and leucoanthocyanidins convert to anthocyanidins (Badgaa et al., 1983).

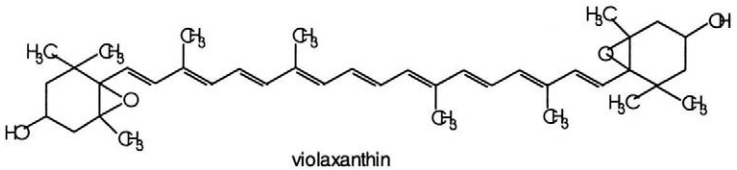
In black currants other antioxidants are also contained in great deal (Duke, 1992): ascorbic acid (1 200–10 030 mg/kg) and α-tocopherol (22–120 mg/kg). In carotenoids it is lutein (4.4–22 mg/kg) and β-carotene (1–8 mg/kg). Shirko and Yaroshewicz (1983) report 930–3 400 mg/kg vitamin C content.

Processing and storage of black currant juice (Lachman et al., 1991) affect the contents of ascorbic acid and anthocyanins, too. Nadolna and Kwasniewska (1987) refer that losses of ascorbic acid during processing of black currant juice were 30% and that of anthocyanins ≅ 3%. During storage of juice at 18–20 °C for six months losses of vitamin C content were 8–25% and anthocyanins 41–81%. Kwaśniewska et al. (1987) confirm that during thickening of black currant juice the losses of vitamin C and anthocyanins were little, but during storage for ten months' period at temperature 18–20 °C content of anthocyanins decreased 2.9–4.9 fold and ascorbic acid by 51–54%. Lower storage temperature is much more

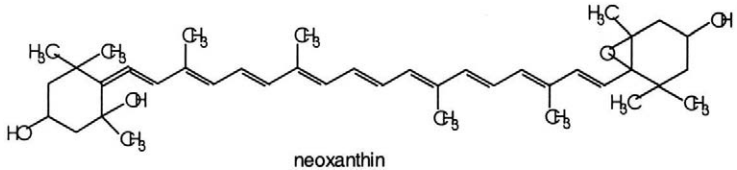
6. Carotenoids of zeaxanthin type



antheraxanthin



violaxanthin



neoxanthin

III. Anthocyanin composition in species and hybrids within black and red currants (%)

Anthocyanidin	Del		Cya					
Glycoside type	3-gl (%)	3-gl-rh (%)	3-gl (%)	3-gl-rh (%)	3-gl-xy (%)	3-gl-gl (%)	3-gl-rh -gl (%)	3-gl-rh -xy (%)
Ribes nigrum L.								
Boskoop Giant	16	32	20	32	-	-	-	-
Brödtorp	22	32	14	32	-	-	-	-
Erkheikki	16	42	13	29	-	-	-	-
Ribes dikuscha (Fischer ex Turcz.) Jancz.	16	49	10	25	-	-	-	-
Ribes ussuriense Jancz.	17	42	17	24	-	-	-	-
Ribes floridum (L'Héritier) Jancz.	15	18	30	37	-	-	-	-
Ribes dikuscha x Brödtorp F_1 (82)	15	38	10	37	-	-	-	-
Hybrids								
Ribes nigrum x *aureum* F_1	11	9	34	46	-	-	-	-
Ribes nigrum x *sanguineum* F_1	18	37	12	33	-	-	-	-
Ribes rubrum	-	-	18	31	15	-	-	36
Ribes rubrum L. wild	-	-	11	21	27	-	-	41
Raby Castle			(+)	29	(+)	-	-	58
Ribes rubrum x Vita långklasiga F_3	-	-	17	24	35	-	-	24
Ribes pallidum Otto et Dietrich	-	-	13	22	15	23	12	15
Ribes holosericum Otto et Dietrich	-	-	5	7	28	22	22	16
Ribes houghtonianum Jancz.			4	17	14	24	17	24

Del = delphinidin; Cya = cyanidin; gl = glucose; rh = rhamnose; xy = xylose

favorable because at 4 °C losses of anthocyanins were only 11–37% anthocyanins and 11–22% ascorbic acid. Juices obtained by enzymatic technological way contain greater amounts of anthocyanins (Kozma-Kovacs and Sarkany, 1986). Didenko et al. (1984) reported for storage of black currant fruits for five months period at –18 °C 50% loss of ascorbic acid content.

Red currants contain lesser amounts of these compounds. These are above all red anthocyanin pigments – glycosides of cyanidin: 3-O-β-D-glucosylrutinoside, 3-O-rutinoside, 3-O-sambubioside, 3-O-sophoroside, 3-O-xylosylrutinoside and cyanin. In the glycosidic form is in the anthocyanin complex contained delphinidin as 3-O-β-D-glucoside (Kaack, 1988). The other constituents present phenolcarboxylic acids – *p*-hydroxybenzoic acid and salicylic acid both in free form as well as in bound form as methylsalicylate. Red currants contain 300–2 554 mg/kg ascorbic acid and 8–59 mg/kg α-tocopherol. In carotenoids are present β-carotene (0.25–4 mg/kg) and lutein (0.47–2.30 mg/kg). Black and red currants contain also in little amount selenium.

From the leaves of red currant were isolated also relatively complicated glycosides of quercetin – e.g. 3-O-(2′′-O-α-L-rhamnopyranosyl-6′′-O-α-L-rhamnopyranosyl)-β-D-glucopyranoside (Siewek et al., 1984). Calamita et al. (1983) isolated from dried leaves of black currant astragalin, isoquercitrin, myricetin-3-O-glucoside, rutin, kaempferol-3-O-glucorhamnoside and 3-O-glucoxyloside and quercetin-3-O-glucoxyloside.

Black and red currants are among different fruits rich in carotenoid content. Müller (1997) estimated in black currants 2.3 mg/kg total carotenoids. In carotenoid complex the most present are lutein, β-carotene, neoxanthin and violaxanthin (1.8, 0.14, 0.14, and 0.11 mg/kg). In lesser amounts are contained antheraxanthin, γ-carotene and β-cryptoxanthin (0.06, 0.03 and 0.03 mg/kg). Red currants contain lesser amounts of total carotenoids (1.0 mg/kg). Also in red currants as main constituents are present lutein, β-carotene and antheraxanthin (0.7, 0.09 and 0.07 mg/kg). Only in little amounts are contained cis-β-carotene, α-carotene, neoxanthin and zeaxanthin (0.03, 0.03, 0.03, and 0.02 mg/kg).

Antioxidants of sour cherries and morellos (*Prunus cerasus* L.)

Sour cherries contain as high as 38 mg/kg quercetin (Hertog et al., 1992). Polyphenolic complex is considerably various. Anthocyanins are here mainly contained, among them above all cyanidin and its 3-O-glycosides: glucoside, diglucoside and gentiobioside and peonidin and its 3-O-rutinoside (Duke, 1992). In sour cherries are also present leucocyanidin and catechins – (+)-catechin, epigallocatechin and epicatechin. In flavonoids sour cherries contain kaempferol and its glycoside kaempferide, quercetin and in the whole plant were found its glycosides: 3-O-β-D-glucoside, quercitrin and prunetin. In sour cherries was also found taxifolin-3-O-heteroside. Among isoflavonoids are in sour cherries present genistein, genistin and prunetin (List and Hörhammer, 1969-1979). In phenolcarboxylic acids are contained chlorogenic, cryptochlorogenic, isochlorogenic, neochlorogenic, *p*-coumaric acids and phenolic amino acid L-tyrosine. In the whole plants other polyphenolic constituents were confirmed – from phenolcarboxylic acids caffeic, ferulic, gallic, *p*-hydroxybenzoic, vanillic acids and methylsalicylate and from flavonoids apigenin, chrysin, tectochrysin, kaempferol and kaempferide, quercetin, rutin, quercetin-3-O-β-D-glucoside, taxifolin and its 3-O-glucoside, further coumarin and dihydrocoumarin, epicatechin, from anthocyanins peonidin-3-O-diglucoside. Kaack (1988) found in sour cherries above all 3-O-glycosides of cyanidin and peonidin. These are 3-O-glucoside, 3-O-rutinoside, 3-O-sophoroside and 3-O-glucosylrutinoside of cyanidin and peonidin-3-O-rutinoside. Moreover, in stems are reported cyanidin-3-O-glucosylrhamnosylglucoside, 3-O-rutinoside and 3-O-sophoroside. The bark of some cherry trees is very rich in tannins (50 000–70 000 mg/kg). Sour cherries contain 70–873 mg/kg ascorbic acid, 1–10 mg/kg carotenoids – in this amount β-carotene presents 1-6 mg. In sour cherries is reported β-ionone, too (Duke, 1992). Müller (1997) estimated in morellos 10.0 mg/kg total carotenoids. In this complex the most present are cis-β-carotene, antheraxanthin, α-carotene and lutein (3.4, 0.7, 0.6 and 0.5 mg/kg). Only in minimal amounts are in the complex present violaxanthin, β-cryptoxanthin, α-cryptoxanthin and zeaxanthin (0.3, 0.2, 0.2 and 0.2 mg/kg). Phytoene was identified and quantified in sour cherries, too (0.5 mg/kg). However the cherries contain only 3.3 mg/kg total carotenoids. Violaxanthin, neoxanthin and antheraxanthin (0.7, 0.7 and 0.6 mg/kg) are mainly contained in this complex. β-Carotene, α-cryptoxanthin and zeaxanthin (0.2, 0.2 and 0.12 mg/kg) are present at average levels. β-Cryptoxanthin, cis-β-carotene and α-carotene (0.09, 0.07 and 0.06 mg/kg) are contained in this complex only at negligible levels.

Antioxidants of apricots (*Prunus armeniaca* L.)

Apricots contain in average 25 mg/kg quercetin (Hertog et al., 1992). It is present both in the free form as well as in the glycosidic form such as isoquercitrin and 3-O-β-D-diglucoside. The other glycosides of quercetin are referred in the whole plant – 3-O-galactoside, 3-O-glucoside, 3-O-rhamnoside and rutin that is in leaves contained in the amount of 17 000 mg/kg. Phenolcarboxylic acids are contained in apricot fruits – amino acid tyrosine (290–2 125 mg/kg), chlorogenic and neochlorogenic acids and the contents of tannins are rather high, too (600–1 000 mg/kg). Whereas in fruits the content of kaempferol is low (< 2 mg/kg), in the whole plant and leaves were identified its glycosides – 3-O-galactoside, 3-O-glucoside and 3-O rutinoside. Caffeic acid and

p-coumaric acid were identified in the whole plant and cyanidin presents red anthocyanin (Duke, 1992). Duke (1992) informs that apricots contain 100–745 mg/kg ascorbic acid and 13–189 mg/kg β-carotene. In apricot fruit are present also α,γ and ξ-carotenes. According Müller (1997) apricots contain lesser amounts of carotenoids – 11.3 mg/kg total carotenoids. β-Carotene and cis-β-carotene are contained in the highest amounts (7.1 and 1.9 mg/kg). Carotenoid complex of apricots is very abundant and variable: β-cryptoxanthin, γ-carotene, lutein, violaxanthin and α-carotene (0.6, 0.5, 0.4, 0.2 and 0.2 mg/kg). Neoxanthin, antheraxanthin, α-cryptoxanthin and zeaxanthin form minor constituents (0.14, 0.09, 0.08 and 0.06 mg/kg). Phytoene and phytofluene (10.5 and 4.5 mg/kg) are the other constituents of apricots.

Antioxidants of grapes (*Vitis vinifera* L.)

Polyphenolic complex of red grapes is constituted above all from phenolcarboxylic acids and anthocyanins. Sondheimer (1958, 1964) refers to content of phenolcarboxylic acids contained in one kilogram of fresh fruits: 1 400 mg chlorogenic, 200 mg isochlorogenic, 20 mg neochlorogenic and 200 mg caffeoylquinic acids. *p*-Coumaric acid attached to anthocyanins was found, too (Ohta et al., 1978). In anthocyanin complex contained in the skins of grapes Willstätter and Zollinger (1915) have isolated already in the year 1915 oenin, i.e. malvidin-3-O-β-D-glucoside and Brown (1940) in the year 1940 petunin, i.e. petunidin-3,5-O-β-diglucoside. Piergiovanni and Volonterio (1980) extracted from grapes thirteen anthocyanins in the form of acylated and unacylated monoglycosides. These are 3-O-β-D-monoglucosides of five anthocyanidins – delphinidin, petunidin, cyanidin, malvidin and peonidin (Blanco et al., 1980; Silenzi, 1981; Gonzales-San Jose and Diez de Bethencourt, 1987). Ohta et al. (1978) confirmed that 3-O-monoglucosides of malvidin and peonidin are present both as free and as well as acylated with *p*-coumaric acid and their content depends on cultivar (2 100–5 300 mg/kg dry matter). Also Pergiovanni and Volonterio (1981) confirm cultivar differences above all in the content of acetyl- and *p*-coumaroylglycosides of anthocyanidins. Akuta et al. (1977) besides monoglycosides identified also 3,5-O-β-diglucosides of petunidin, malvidin and peonidin both as unacetylated as well as acylated with *p*-coumaric acid. Matsudomi et al. (1977a) refer that content of anthocyanins in 1 kg dry matter of skins was 106 000 mg with next percentage differentiation: 33.0% malvidin-3,5-O-diglucoside, 20.7% peonidin-3,5-O-diglucoside, 9.2% malvidin-3-O-glucoside, 9% petunidin-3-O-glucoside, 5.3% malvidin-3-O-(p-coumaroyl)monoglucoside, 4.6% petunidin-3,5-O-diglucoside, 4.4% peonidin-3-O-glucoside, 4.0% malvidin-3,5-O-diglucoside acylated with *p*-coumaric acid, 3.5% peonidin-3,5-O-diglucoside acylated with *p*-coumaric acid, 3.1% delphinidin-3-O-glucoside, 2.0% delphinidin-3,5-O-diglucoside and 1.2% peonidin-3-O-(*p*-coumaroyl)glucoside.

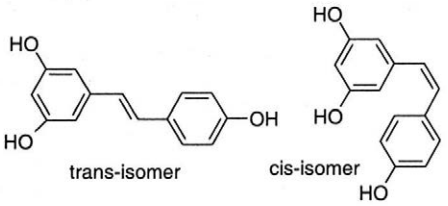
As Matsudomi et al. (1977b) report, individual cultivars differentiate in both, total content of anthocyanins, as well as in their percentage proportions. E.g. cultivar Campbell Early contained 33 000 mg anthocyanins/kg dry matter and cultivar Muscat Bailey A 31 000 mg/kg dry matter. Cultivar Campbell Early contained above all malvidin-3,5-O-diglucoside acylated with *p*-coumaric acid (23.2%), malvidin-3-O-glucoside (16.3%), malvidin-3,5-O-diglucoside (123.2%), peonidin-3-O-glucoside (8.8%), and delphinidin-3,5-O-diglucoside (8.4%), whereas cultivar Muscat Bailey A malvidin-3-O-glucoside (34.0%), malvidin-3,5-O-diglucoside acylated with *p*-coumaric acid (20.0%) and malvidin-3-O-(*p*-coumaroyl)glucoside (11.5%). Akuta et al. (1977) found similar dependency in Koshu and Gros Colman cultivars where main contained glycosides were malvidin-3-O-glucoside (50% and 45%), peonidin-3-O-glucoside (15% and 20%), petunidin-3-O-glucoside (3% and 5%), delphinidin-3-O-glucoside (3% and 5%), and delphinidin-3-O-glucoside (2% and 5%). Acylated anthocyanins were present only in traces.

Wenzel et al. (1987) classified fifty grape cultivars regarding their content of anthocyanins into five groups – Pinot noir, Trollinger, malvidin group, group with equal portions of main anthocyanins and hybrid group. Cultivar differences in the contents of monoglycosides and diglycosides of delphinidin, petunidin, cyanidin, malvidin and peonidin were confirmed elsewhere (Shiraishi et al., 1986, 1988; Bakker and Timberlake, 1985; Hebrero et al., 1988). Shiraishi and Watanabe (1988) estimated amounts of glycosides of anthocyanins in Black Olympia, Izunishiki and Pione cultivars as follows: malvidin > delphinidin > petunidin > cyanidin > peonidin.

In flavonoids grapes contain in considerable amounts glycosides of myricetin (Tomas-Lorene et al., 1988) and quercitrin, i.e. quercetin-3-O-rhamnoside (Williams and Wender, 1952). Content of anthocyanins in grape skins (cv. Cencibel) is changing during maturation in three phases (the first phase "moderate" and the third phase "stagnant" are low, the second "linear" phase is rapid). This course of accumulation is characteristic for most of anthocyanin glycosides (Budín, 1983; Gonzales et al., 1986; Glories, 1988) their content is linearly proportional to the content of soluble saccharides (Popescu et al., 1986). Stability of anthocyanin complex during storage of concentrates depends on many factors, such as pH value, addition of citric, tartaric, or ascorbic acids, tannin, D-fructose, D-glucose, sucrose, invert saccharide, maltodextrine KMS-X, storage temperature, light exposure (Tanchev, 1980; Crosby et al., 1983; Hwang et al., 1986; Lachman et al., 1990). Hertog et al. (1983b) estimated in grape juice 4.4 mg/l quercetin and 6.2 mg/l myricetin.

Grapes or red wine represent one of the richest sources of polyphenolic phytoalexin resveratrol – trans-3, 5,4′-tri-

hydroxystilbene (Fig. 7), (up to 5 mg/l red wine) that decreases a risk of coronary heart diseases by 40% (Jeandet et al., 1991, 1994). It is produced by grapes *Vitis vinifera* L. and *Vitis labrusca* L. as a response against attack of fungi *Botrytis* sp. (Jeandet et al., 1995a,b), during maturation its content decreases. In grapes it is also contained in the bound form as glucoside. An average resveratrol content stated in red wines was 0.684–0.912 mg/l,



7. Structures of resveratrol isomers

but extremely its content can reach as high as 2.28 mg/l, whereas in white wines this value is considerably lower (0.132–0.137 mg/l). More humid weather causes higher resveratrol levels (Jeandet et al., 1993). Mattivi et al. (1995) extracted from grape skins trans- and cis- resveratrol and its trans- and cis-β-D-glucopyranoside. Authors evaluate factors that influence mutual relationships of these compounds – concentration of ethanol, hydrolytic cleavage of glucose moieties in the molecule and trans/cis izomeration. Korhammer et al. (1995) isolated from grape roots *r*-2-viniferin, i.e. oligostilbene (tetramer of resveratrol) and in grape leaves ε-viniferin, i.e. dimer of resveratrol. Melzoch et al. (2000) describe resveratrol content in the skins in interval 500–1 000 mg/kg and in Czech red wines 1.4–9.0 mg/l.

According to Müller (1997) data, grapes contain 0.3 mg/kg total carotenoids. In this complex are mainly contained lutein, neoxanthin, antheraxanthin, β-carotene and zeaxanthin (0.1, 0.03, 0.03, 0.03, and 0.03 mg/kg). In lesser amounts are contained cis-β-carotene, violaxanthin, β-cryptoxanthin and α-carotene (0.01, 0.01, 0.005, and 0.003 mg/kg).

Antioxidants of pears (*Pyrus communis* L.)

Duke (1992) states as main polyphenolic antioxidants contained in pears caffeic acid (43–19 700 mg/kg) and quercetin (28 mg/kg of pericarp). In pears are considerably contained amino acid tyrosine (30–185 mg/kg), catechin and cyanidin-3-O-β-D galactoside, too. In the all plant phenolcarboxylic acids were as the other constituents identified, such as cis- and trans-chlorogenic acids, cis- and trans- isochlorogenic acids, cis- and trans-neochlorogenic acids and cis- and trans-*p*-coumaroylquinic acids. Caffeic acid is often present in bound form, e.g. as trans-caffeoylarbutin. Dominant for pears are glycosides of isorhamnetin, kaempferol and quercetin – from isorhamnetin are derived 3-O-β-D-glucoside, 3-O-rhamnosylgalactoside and 3-O-rhamnosylglucoside, from kaempferol 3-O-β-D-glucoside, 3-O-β-D-galactoside, 3-O-arabinoside and 3-O-rutinoside and from quercetin 3-O-β-D-galactoside, 3-O-arabinoside and 3-O-rutinoside. As other constituents are in this complex contained epicatechin and hydroquinone. Oleszek et al. (1994) identified with spectral methods in pears mainly glycosides derived from quercetin glycosylated at position 3 – rutinoside, glucoside and malonylglucoside and from isorhamnetin glycosylated at position 3 – rutinoside, galactorhamnoside, glucoside, malonylglucoside and malonylgalactoside. Other essential constituents of polyphenolic complex of pears are bound forms of phenolic acids – 5′-caffeoylquinic, *p*-coumaroylquinic, *p*-coumaroylmalic and dicaffeoylquinic acids. Amiot et al. (1995) state for nine pear cultivars as dominant 5′-caffeoylquinic acid and (-)-epicatechin. Difference in the contents of polyphenolic compounds is affected rather by cultivar than by the degree of maturity. Also conditions of storage influence content of polyphenolic compounds – storage in the air atmosphere tends to the accumulation of polyphenols in greater deal than in the atmosphere with CO_2 (1% or 3%). Degree of browning is in high correlation with the content of esters of hydroxycinnamic acids and flavanols. Dussi et al. (1995) by high – pressure liquid chromatography and thin layer chromatography identified in skins of pears of Sensation Red Barlett cultivar as main cyanidin-3-O-β-D-galactoside and as minor peonidin-3-O-β-D-galactoside. Their contents was 68.3 mg/kg of skins. Irradiation with light of different wavelength (400–500 nm) for one-month period before the harvest increases anthocyanin content and coloration. Utashiro and Yamada (1996) confirm considerable differences in the content of polyphenolic compounds within individual pear cultivars. Content of total polyphenols was in the Le Lectier cultivar that possesses astringent taste 2–4-fold higher in comparison with cultivars without astringent taste (Margueritte Marillant and La France). Polyphenol content related to fresh matter was the highest in the phase of fruit formation (beginning May), and then it decreased until the harvest.

Pears contain among other types of antioxidants 40–250 mg/kg ascorbic acid, 0.6–31 mg/kg α-tocopherol, among carotenoids 1–11 mg/kg lutein and 0.17–1.7 mg/kg β-carotene and 0.001 mg/kg selenium, too. After Müller (1997) pears contain total carotenoids in lesser amounts (0.8 mg/kg). Only lutein and neoxanthin are present in significant amounts (0.6 and 0.1 mg/kg). The other constituents are contained in minor amounts – β-carotene, violaxanthin, β-cryptoxanthin, antheraxanthin, and α-cryptoxanthin (0.04, 0.03, 0.01, 0.01, and 0.004 mg/kg). Fragner et al. (1961) refer to pears vitamin C content 33–40 mg/kg, for stewed pears 20 mg/kg. Behrens and Madère (1994) describe also other forms of ascorbic acid – dehydroascorbic and isoascorbic acids and their oxidized form. Gonzales and Pujola (1995) confirm that during storage at 0 °C and 90% relative humidity for pe-

riod of 17 weeks (period for consumption and commercial utilization of Blanquilla pears) the considerable decrease of ascorbic acid content was observed in first phases in contrary to the contents of saccharides and organic acids.

CONCLUSION

One of the richest sources of antioxidants among our fruits are black currants both, in direct consumption, as well as in the form of black currant juice (Tab. IV). Among antioxidants the most present are flavonoids (anthocyanins, leucoanthocyanidins and catechins). Flavonols are contained, too. Also ascorbic acid content is high. In red currants the content of these components is considerably lower.

Fruits and juice of black chokeberries are rich in polyphenolic antioxidants, among them anthocyanins and catechins are significant above all. Aronia berries are significant sources of natural anthocyanin colorants.

In pears caffeic acid and phenolic amino acid tyrosine are considerably present. These compounds together with

IV. Content of major antioxidant types in selected fruits

Fruits	Polyphenols (mg/kg)	Ascorbic acid (mg/kg)	Carotenoids (mg/kg)	Tocopherols (mg/kg)
Black currants (*Ribes nigrum* L.)	5 500–13 800[1], 440–3 300 catechins[2] 830–840[3], 6 600–22 500[2], 10 000–40 000[1] anthocyanins 2 600–14 200[2], 395–2 494[4] leucoanthocyanidins 55[5] myricetin 13[6], 33[5] quercetin	1 200–10 030[1], 1 390–3 550[2], 930–3 400[7]	2.3[8]	22–120[1] α-tocopherol
Red currants (*Ribes rubrum* L.)	27[9] quercetin	300–2 554[1]	1.0[8]	8–59[1] α-tocopherol
Aronia fruits (*Aronia melanocarpa* (Michx.) Elliot)	10 000–20 000[10] polyphenols 4 000–8 000[10], 7 500–9 500[11], 3 070–6 310[12], 6 500–8 500/dry matter[12] anthocyanins 200[13] epicatechin[8]	106.9 mg/l[10]	7.5–50[10] β-carotene	
Pears (*Pyrus communis* L.)	43–19 700[1] caffeic acid 30–185[1] tyrosine 68.3[14]/peels anthocyanins 28[1] quercetin	40–250[1], 33–40[15]	0.8[8]	0.6–31[1] α-tocopherol
Grapes (*Vitis vinifera* L.)	1 400[16] chlorogenic acid 200[16] isochlorogenic acid 200[16] caffeoylquinic acid 20[16] neochlorogenic acid 2 100–5 300/dry matter[17], 31 000–33 000/dry matter[18], 106 000/dry matter of skins[19] anthocyanins 5/l red wine[20] resveratrol		0.3[8]	
Apricots (*Prunus armeniaca* L.)	600–1 000[1] tannins[q] 290–2 125[1] tyrosine 25[6] quercetin	100–145[1]	11.3[8]	
Apples (*Malus pumila* Mill.)	95–100[21], 1 000[22] anthocyanins 21–72[6] quercetin 28.85–115.49/l juice[23] polyphenols	18–64[15], 20–402[1]	0.7–1.4[8]	
Sour cherries (*Prunus cerasus* L.)	38[6] quercetin	70–873[1]	1–10[1, 8]	

[1]Duke (1992), [2]Jankelevicz et al. (1986), [3]Boronczyk et al. (1985), [4]Gaas (1987), [5]Köppen and Herrmann (1977), [6]Hertog et al. (1992), [7]Shirko and Yaroshewicz (1983), [8]Müller (1997), [9]Nilsson and Trajkovski (1977), [10]Hernandez and Ossess (1998), [11]Kaack and Kuhn (1992), [12]Strigl et al. (1995a,b), [13]Wilszka- Jeszka et al. (1992), [14]Dussi et al. (1995), [15]Fragner et al. (1961), [16]Sonheimer (1958), [17]Ohta et al. (1978), [18]Matsudomi et al. (1977b), [19]Matsudomi et al. (1977a), [20]Jeandet et al. (1991, 1994), [21]Mazza and Velioglu (1992), [22]Lister et al. (1994), [23]Kermasha et al. (1995)

other antioxidants of phenolic structure (anthocyanins, quercetin) and ascorbic acid contribute to the antioxidant complex.

Red grapes are rich in anthocyanin contents and phenolic acids (chlorogenic, isochlorogenic, neochlorogenic, caffeoylquinic acids) that influence each other synergically. Special attention should be devoted to resveratrol contents that possesses many healthy effects.

In apricots the polyphenolic complex is present above all with tannins, but apricot fruits are rich in amino acid tyrosine, too. Within other antioxidants ascorbic acid contents is not insignificant, but in carotenoid contents apricots are the highest sources among fruits.

Apples are characteristic with important anthocyanin and ascorbic acid contentss. Ascorbic acid works in synergy with other antioxidants of flavonoid character.

In sour cherries and morellos the high ascorbic acid contents and carotenoids prevail and these compounds contribute mainly to their antioxidant complex.

REFERENCES

Akuta S., Ohta H., Osajima Y. (1977a): Anthocyanin pigments in fruits harvested in Japan. V. Minor anthocyanin pigments in Kyoho grape peels. Nippon Shokuhin Kogyo Gakkaishi, *24,* 346–349.

Akuta S., Ohta H., Osajima Y., Matsudomi N., Kobayashi K. (1977b): Anthocyanin pigments in fruits harvested in Japan. VI. Anthocyanin pigments in *Vitis vinifera* varieties, Koshu and Gros Colman grapes. Nippon Shokuhin Kogyo Gakkaishi, *24*, 521–523.

Almeida M. E. M., Nogueira J. N. (1995): The control of polyphenol oxidase 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.

Amiot M. J., Tacchini M., Aubert S., Nicolas J. (1992): Phenolic composition and browning susceptibility of various apple cultivars at maturity. J. Food Sci., *57*, 958–962.

Amiot M.J., Aubert S., Nicolas J., Goupy P., Aparicio P. (1992): Phenolic composition and browning susceptibility of various apple and pear cultivars at maturity. Bull. Liaison – Group Polyphenols, *16*, 48–51.

Amiot M. J., Tacchini M., Aubert S. Y,. Oleszek W. (1995): Influence of cultivar, maturity, stage, and storage conditions on phenolic composition and enzymic browning of pear fruits. J. Agric. Food Chem., *43*, 1132–1137.

Arakawa O. (1991): Effect of temperature on anthocyanin accumulation in apple fruit as affected by cultivar, stage of fruit ripening and bagging. J. Hort. Sci., *66*, 763–768.

Aubert S., Amiot M. J., Bartholin G., Tacchini M., Nicolas J. (1992): Anthocyanin stability of apple purees. Bull. Liaison – Group Polyphenols, *16*, 52–55.

Badgaa D., Kobozev I. V., Kinyakin M. F., Bednarskaya I. G. (1983): Change in the biochemical composition of fruits of fruit and berry plants during ripening in relation to growth conditions. Izv.. Sel.-choz. Akad. Timirjazeva, *2,* 123–132.

Bae R., Na L., Seung K. (1995): Effects of some treatments on the anthocyanin synthesis and quality during maturation in Fuji apple. Han'guk Wonye Hakhoechi, *36*, 655–661.

Bae R. N., Lee S. K. (1994): Effects on some preharvest treatments on the anthocyanin synthesis and quality in Fuji apple. Han'guk Wonye Hakhoechi, *35*, 599–609.

Bakker J., Timberlake C. F. (1985): The distribution of anthocyanins in grape skin extracts of port wine cultivars as determined by high performance liquid chromatography. J. Sci. Food Agric., *36*, 1315–1324.

Barden C. L., Bramlage W. J. (1994a): Accumulation of antioxidants in apple peel as related to preharvest factors and superficial scald susceptibility of the fruit. J. Am. Soc. Hort. Sci., *119*, 264–269.

Barden C. L., Bramlage W. J. (1994b): Relationships of antioxidants in apple peel to changes in α-farnesene and conjugated trienes during storage, and to superficial scald development after storage. Postharvest Biol. Technol., *4*, 23–33.

Behrens W. A., Madère R. (1994): Ascorbic acid, isoascorbic acid, dehydroascorbic acid, and dehydroisoascorbic acid in selected food products. J. Food Compos. Anal., *7*, 158–170.

Blanco V., Fernandez M., Buil P., Videgain V., Vega F. A. (1980): Anthocyanins in Valdizarbe (Navarra) grapes. Bull. Liaison – Group Polyphenols, *9*, 101–104.

Borissova P., Valcheva S., Belcheva A. (1994): Antiinflammatory effect of flavonoids in the natural juice from Aronia melanocarpa, rutin and rutin – magnesium complex on an experimental model of inflammation induced by histamine and serotonin. Acta Physiol. Pharmacol. Bulg., *20*, 5–30.

Borończyk P., Białkowska M., Gwardys P., Fatyga K., Pokrywka B. (1985): Bilans barwników antocyjanovych w koncentratach z czarnych porzeczek. Przem. Ferment. Owocowo-Warzywny, *29*, 26–28.

Budín R. (1983): Accumulation of anthocyanins, sugars and organic acids during the phenophase of ripening of Sylvaner and Sen Loran berries. Vinohrad (Bratislava), *21*, 111–113.

Calamita O., Malinowski J., Strzelecka H. (1983): Flavonoid compounds in black currant (*Ribes nigrum*) leaves. Acta Pol. Pharm., *40*, 383–387.

Chandler B. V., HARPER K. A. (1962): A procedure for the absolute identification of anthocyanins; the pigments of black currant fruit. Aust. J. Chem.,*15*, 114–120.

Chen Ch. Ch., Lin S .S., Yuo S .H., Chen Ch. Ch. (1993): Changes of phenolic compounds in aseptically packed reconstituted red grape juice and clarified apple juice during thermal processing and storage. Shipin Kexue (Taipei), *20*, 381–393.

Crosby W. H., Fulger CH. V., Haas G. J. – Nesheiwat D. M. (1983): Stabilized anthocyanin dye and its use as a food coloring. Ger. Offen. DE 3,310,361 (Cl. A 23L1/2 75), 06 Oct. 1983, US Appl. 363,973, 31 Mar 1982: 11 pp.

Czapski J., Kaczmarek R. (1995): Extraction of anthocyanins from chokeberries. Pol. PL 167,541 (Cl. C09B61/00), 30 Sep 1995, Appl. 295,672, 18 Aug 1992: 3 pp.

Delage E., Bohuon G., Baron A, Drilleau J. F. (1991): High-performance liquid chromatography of the phenolic compounds in the juice of some French cider apple cultivars. J. Chromatogr., *555*, 125–136.

Didenko R. A., Gukalina T. V., Burova T. E., Kovalenko T. V. (1984): Evaluation of the quality of berries during freezing and storage. Cholod. Tech., *9*, 29–31.

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

Dussi M. C., Sugar D., Wrolstad R. E. (1995): Characterizing and quantifying anthocyanins in red pears and the effect of light quality on fruit color. J. Am. Soc. Hort. Sci., *120*, 785–789.

Fernandez de Simon B., Perez-Ilzarbe J., Hernendez T., Gomez-Cordoves C., Estrella I. (1992): Importance of phenolic compounds for the characterization of fruit juices. J. Agric. Food Chem., *40*, 1531–1535.

Fragner J. et al. (1961): Vitamíny, jejich chemie a biochemie. Praha, ČSAV, 735–737.

Francis G. W., Andersen O. M. (1984): Droplet counter – current chromatography of anthocyanins. J. Chromatogr., *283*, 445–448.

Gaas D. A. (1987): Chemical composition of fruits of *Ribes* L. species of central Yakutia. Rastit. Resur., *23*, 76–80.

Glories Y. (1988): Anthocyanins and tannins from wine: organoleptic properties. Prog. Clin. Biol. Res., *280*. 123–134.

Gonzales M. L., Garrido J. L., Diez C., Santa-Maria G. (1986): Changes in anthocyanins during maturation of grapes (*Vitis vinifera* var. Cencibel). Bull. Liaison – Group Polyphenols, *13*, 389–393.

Gonzales-San Jose M. L., Diez de Bethencourt C. (1987): Presencia de pigmentos antocianicos en el reino vegetal noc referencia especial al genero *Vitis*. An. Edafol. Agrobiol., *XLVI*, 157–162.

Gonzales C., Pujola M. (1995): Variations of sugar, organic acids and vitamin C in Blanquillas pears during cold storage. Alimentaria (Madrid), *268*, 49–52.

Hebrero E., Santos-Buelga C., Rivas-Gonzalo, J. C. (1988): High performance chromatography – diode array spectroscopy identification of anthocyanins of *Vitis vinifera* cultivar Tempranillo. Am. J. Enol. Vitic., *39*, 227–233.

Hegnauer R. (1973): Chemotaxonomie der Pflanzen. Bd. 6. Dicotyledoneae: Rafflesiaceae – Zygophyllaceae. Basel, Stuttgart, Birkhäuser Verlag.

Henke M. (1963): Phytochemische-systematische Untersuchung über die Flavonoide der Gattung Malus. Flora, *153*, 358.

Hernendez D., Ossess O. (1998): Aronia: Healthy alternative to cranberry juice. Aronia Berry Inc., 1853, Union Street, San Francisco, CA 94 123, www.aronia.com/health.htm.

Hertog M. G. L., Hollman P. C. H., Katan M. B. (1992): Contents of potentially anticarcinogenic flavonoids of 28 vegetables and 9 fruits commonly consumed in the Netherlands. J. Agric. Food Chem., *40*, 2379–2383.

Hertog M. G. L., Hollman P. C .H., Katan M. B., Kromhout, D. (1993a): Intake of potentially anticarcinogenic flavonoids and their determinants in adults in the Netherlands. Nutr. Cancer, *20*, 21–29.

Hertog M. G. L., Hollman P. C. H., Van De Putte B. (1993b): Contents of potentially anticarcinogenic flavonoids of tea infusions, wines, and fruit juices. J. Agric. Food Chem., *41*, 1242–1246.

Hwang S. W., Chen N. E., Jan H., W. (1986): Studies on extraction and stabilities of the pigments of grape B_{2119}. Shin Pin Ko Hsueh (Taipei), *13*, 51–59.

Jankelevicz B. B., Melechina A. A., Eglite M. (1985): Vitamin content in different organs of black currant bushes. Latv. PSR Zinat. Akad. Vestis, *1*, 94–98.

Jankelevicz B. B., Melechina A. A., Eglite M. (1986): Vitamin content of black currants. Tautsaimn. Derigo Augu Agroteh. Biol., 114–118.

Jeandet P., Bessis R., Gautheron B. (1991): The production of resveratrol (3,5,4′-trihydroxystilbene) by grape berries in different developmental stages. Am. J. Enol. Vitic., *42*, 41–46.

Jeandet P., Bessis R., Maume B. F., Sbaghi M. (1993): Analysis of resveratrol in Burgundy wines. J. Wine Res., *4*, 79–85.

Jeandet P., Bessis R., Sbaghi M., Meunier, P. (1994): Occurrence of resveratrol-β-D-glucoside in wine. Preliminary studies. Vitis, *33*, 183–184.

Jeandet P., Bessis R., Sbaghi M., Meunier P., Trollat, P. (1995a): Resveratrol contents of wines of different ages. Relationship with fungal disease pressure in the vineyard. Am. J. Enol. Vitic., *46*, 1–4.

Jeandet P., Bessis R., Sbaghi M., Meunier P. (1995b): Production of the phytoalexin resveratrol by grapes as a response to Botrytis attack under natural conditions. J. Phytopathol.,*143*, 135–139.

Kaack K. (1988): Semi-quantitative spectrophotometric determination of fruit juice adulteration by anthocyanin analysis. Danish J. Plant Soil Sci., *92*, 279–287.

Kaack K., Kuhn B. F. (1992): Black chokeberry (*Aronia melanocarpa*) for manufacture of a food colorant. Tidsskr. Pl.-Avl, *96*, 183–196.

Kermasha S., Goetghebeur M., Dumont J., Couture R. (1995): Analyses of phenolic and furfural compounds in concentrated and non-concentrated apple juices. Food Res. Int., *28*, 245–252.

Knekt P., Jarvinen R., Reunanen A., Maatela J. (1996): Flavonoid intake and coronary mortality in Finland: A cohort study. Brit. Med. J., *312*, 478–481.

Köppen B. H.,Herrmann K. (1977): Flavonoid glycosides and hydroxycinnamic acid esters of black currants (*Ribes nigrum*). 9. Phenolics of fruits. Z. Lebensm.-Unters. Forsch., 164, 4, 263–268.

Korhammer S., Reniero F., Mattivi F. (1995): An oligostilbene from *Vitis* roots. Phytochemistry, 38, 1501–1504.

Koswig S., Hofsommer H. J. (1995): HPLC method for determination of anthocyanins in colored juices and other pigmented foods. Fluess. Obst., *62*, 125, 128–130.

Kozma-Kovacs E., Sarkany P. (1986): Spectrophotometric analysis of fruits and fruit containing anthocyanins. Bull. Liaison – Group Polyphenols, *13*, 473–475.

Kühnau J. (1976): The flavonoids: a class of semi-essential food components: their role in human nutrition. World Rev. Nutr. Diet, *24*, 117–120.

Kwaśniewska I., Nadolna I., Lisowska G. (1987): Zmiany barwy i zawartości witaminy C w procesie produkcji i przechowywania soku zagęszczonego z czarnej porzeczki. Przem. Ferment. Owocowo-Warzywny, *31*, 19–22.

Lachman J., Řeháková V., Pivec V., Hubáček J. (1990): Stabilita anthokyanových barviv v upravených extraktech plodů bezu černého (*Sambucus nigra* L.) a výlisků hroznů révy vinné (*Vitis vinifera* L.). [Závěrečná zpráva HS 159/30/89.] ČZU, Praha. 82 pp.

Lachman J., Řeháková V., Pivec V., Hubáček J. (1991): Stabilita anthokyanových barviv v upravených extraktech výlisků plodů brusnice borůvky (*Vaccinium myrtillus* L.), meruzalky rybízu (*Ribes silvestre* /Lam./ Mert. et Koch.) a plodů bezu černého (*Sambucus nigra* L.). Zhodnocení krmné hodnoty výlisků borůvek a rybízu. Stanovení optimálních podmínek extrakce plodů bezu černého (*Sambucus nigra* L.). Příprava extraktu bezinek. [Závěrečná zpráva HS 202/30/90.] ČZU, Praha. 89 pp.

List P.H., Hörhammer L. (1969–1979): Hager's Handbuch der Pharmazeutischen Praxis. Vols. 2-6. Berlin, Springer Verlag.

Lister C. E., Lancaster J. E., Sutton K. H., Walker, J. R. L. (1994): Developmental changes in the concentration and composition of flavonoids in skin of a red and a green apple cultivar. J. Sci. Food Agric., *64*, 155–161.

Liu H. I, Hwang I. H. (1991): The ascorbic acid contents of fruits of Taiwan. Zhonghua Nongye Yanjiu, *40*, 280–290.

Mahajan B. V. C. (1994): Biochemical and enzymic changes in apple during cold storage. J. Food Sci. Technol., *31*, 142–144.

Matsudomi N., Yamamura M., Ohta H.,Osajima Y., Akuta, S. (1977a): Anthocyanin pigments in fruits harvested in Japan. IV. Anthocyanin pigments in grape peels of Bailey Alicant A (teinturier cultivar). Nippon Shokuhin Kogyo Gakkaishi, *24*, 342–345.

Matsudomi N., Yamamura M., Kobayashi K., Ohta H., Akuta S. (1977b): Anthocyanin pigments in fruits harvested in Japan. III. Anthocyanin pigments in two bluish purple grape cultivars, Campbell Early and Muscat Bailey A. Nippon Shokuhin Kogyo Gakkaishi, *24*, 279–285.

Mattivi F., Reniero F., Korhammer S. (1995): Isolation, characterization, and evolution in red wine vinification of resveratrol monomers. J. Agric. Food Chem., *43*, 1820–1823.

Mayr U., Treutter D., Santos-Buelga C., Bauer H., Feucht W. (1995): Developmental changes in the polyphenol concentrations of Golden Delicious apple fruits and leaves. Phytochemistry, *38*, 1151–1155.

Mazza G., Velioglu Y. S. (1992): Anthocyanins and other phenolic compounds in fruits of red-flesh apples. Food Chem., *43*, 113–117.

Melzoch K., Filip V., Buckiová D., Hanzlíková I., Šmidrkal J. (2000): Resveratrol – occurrence in wine originating from Czech vineyard regions and effect on human health. Czech J. Food Sci., *18*, 1–6.

Miller N. J., Diplock A. T., Rice-Evans C. A. (1995): Evaluation of the total antioxidant activity as a marker of the deterioration of apple juice on storage. J. Agric. Food Chem., *43*, 1794–1801.

Műller H. (1997): Determination of the carotenoid contents in selected vegetables and fruits by HPLC and photodiode array detection. Z. Lebensm.-Unters. Forsch. A, *204*, 88–94.

Nadolna I., Kwaśniewska I. (1987): Zmiany barwy i zawartości witaminy C w procesie odtwarzania i przechowywania soku pitnego z czarnej porzeczki. Przem. Ferment. Owocowo-Warzywny, *31*, 23–26.

Nilsson F., Trajkovski V. (1977): Färgpigment hos arter och hybrider inom släktet Ribes L. Reports Agric. Coll. Sweden, *282, Ser.A*, 1–20.

Ohta H., Akuta S., Shiraishi S., Osajima Y. (1978): Anthocyanin pigments in fruits harvested in Japan. VII. Anthocyanin pigments of three Y-grape strains backcrossed by *Vitis vinifera* varieties. Nippon Shokuhin Kogyo Gakkaishi, *25*, 421–425.

Oleszek W., Amiot M. J., Aubert S. Y. (1994): Identification of some phenolics in pear fruit. J. Agric. Food Chem., *42*, 1261–1265.

Oszmianski J., Krzywicki M. (1992): Method for obtaining anthocyanins. Pol. PL 158,707 (Cl. C09B61/00), 30 Sep 1992, Appl. 275,155,07 Oct 1988. 5 pp.

Pfannhauser W., Riedl O. (1983): Anthocyanins. Formation, extraction and analysis of natural food dyes. Ernährung (Wien), *7*, 560–564.

Piergiovanni L., Volonterio G. (1980): Chromatographic techniques for studying anthocyanin fraction in grapes. Riv. Vitic. Enol., *33*, 289–308.

Piergiovanni L., Volonterio G. (1981): Study on the anthocyanin fraction of red grapes. Vignevini, *8*, 49–53.

Pierzynowska-Korniak G., Zadernowski R., Markiewicz K. (1993): Zmiany zawartości polifenoli i metali w produkcji koncentratów soku jabłkowego. Przem. Ferment. Owocowo-Warzywny, *37*, 20–22.

Piretti M.V., Gallerani G., Brodnik U. (1996): Polyphenol polymerization involvement in apple superficial scald. Post Biol. Technol., *8*, 11–18.

Pizło A., Dobrzańska E. (1995): Stabilność wybranych antocyjanów w wódkach. Przem. Ferment. Owocowo-Warzywny, *39*, 14–16.

Popescu I. V., Ionita V., Tudorache A., Marinescu E., Bilciurescu A. (1986): Quantitative and qualitative evaluation of anthocyanins during grapes maturation in case of some *Vitis* cultivars. Bull. Liaison – Group Polyphenols, *13*, 491–493.

Shirko T. S., Yaroshewicz I. V. (1983): Change in the chemical composition of Belorussian black currants. Konservn. Ovosh. Promyshlennost, *6*, 36–37.

Shiraishi S., Watanabe Y., Okubo H., Uemoto S. (1986): Anthocyanin pigments of black-purple grapes related to cultivar Kyoho (*Vitis vinifera* L .x *V. labrusca* L.). Engei Gakkai Zasshi, *55*, 123–129.

Shiraishi S., Watanabe Y. (1988): Color development of grapes. II. Anthocyanin pigments in the blue-black tetraploid grape cultivars Black Olympia, Pione, and Izunishiki (*Vitis vinifera* L. x *V. labrusca* L.). Engei Gakkai Zasshi, *57*, 17–21.

Siewek F., Galensa R., Herrmann K. (1984): Isolation and identification of a branched quercetin triglycoside from *Ribes rubrum* (*Saxifragaceae*). J. Agric. Food Chem., *32*, 1291–1293.

Silenzi E. (1981): Column chromatographic separation and identification of anthocyanins in enocyanin of *Vitis vinifera*. Riv. Soc. Ital. Sci. Aliment., *10*, 407–410.

Sondheimer E. (1958): On the distribution of caffeic acid and the chlorogenic acid isomers in plants. Arch. Biochem. Biophys., *74*, 131–138.

Sondheimer E. (1964): Chlorogenic acids and related depsides. Botan. Rev., *30*, 667–712.

Spanos G. A., Wrolstad R. E. (1992): Phenolics of apple, pear, and white grape juices and their changes with processing and storage. A review. J. Agric. Food Chem., *40*, 1478–1487.

Strigl A. W., Leitner E., Pfannhauser W. (1995a): Qualitative and quantitative analyses of the anthocyanins in black chokeberries by TLC, HPLC, and UV-VIS spectrometry. Z. Lebensm.-Unters. Forsch., *201*, 266–268.

Strigl A. W., Leitner E., Pfannhauser W. (1995b): Chokeberries as natural food colorant source. Dtsch. Lebensm.-Rundsch., *91*, 177–180.

Swain T. (1962): Economic importance of flavonoid compounds: foodstuffs. In: Geissman T. A (ed.): The Chemistry of Flavonoid Compounds. Oxford, N.Y., London, and Paris, Pergamen Press. 513–552.

Tanchev S. (1980): Thermal degradation kinetics of anthocyanins. Bull. Liaison – Group Polyphenols, *9*, 105–113.

Tanchev, S. – Ioncheva, N. – Genov, N. – Mal'chev, E. (1986): Identification of phenolic acids in black currants juice (*Ribes nigrum*) and their transformations during thermal treatment. Bull. Liaison – Group Polyphenols, *13*, 370–373.

Tomas-Lorente F., Ferreres F., Tomas-Barberan F. A., Albaladejo J., Guzman G. (1988): HPLC analysis for the characterization of marmalades and juices. Aliment. Equipos Tecnol., *7*, 167–169.

Usami A., Chiba K. (1994): Ascorbic acid and organic acids for prevention of discoloration of fruits and vegetables. Jpn. Kokai Tokkyo Koho JP 06,181,684 [94,181,684] (Cl. A23B7/154), Jul 1994, Appl. 92/119,819,13 Apr 1992. 5 pp.

USDA Nutrient Database for Standard Reference (1998): Release 12.

Utashiro K., Yamada H. (1996): Changes in polyphenol contents during fruit growth and ripening of pear cultivars on different rootstocks. Engei Gakkai Zasshi, *64*, 779–786.

Wald B., Galensa R., Herrmann K. (1986): Detection of adulteration of black currant products with blackberry juice by determination of flavonoids with HPLC. Fluess. Obst., *53*, 349–352.

Wang H., Cao G., Prior R. L. (1996): Total antioxidant capacity of fruits. J. Agric. Food Chem, *44*, 701–705.

Wenzel K., Dittrich H. H., Heimfarth M. (1987): Anthocyanin composition in berries of different grape varieties. Vitis, *26*, 65–78.

Wildanger W., Herrmann K. (1973): Die phenolischen Inhaltsstoffe des Obstes. II. Die Flavonole des Obstes. Z. Lebensm.-Unters. Forsch., *151*, 103–108.

Williams B. L., Wender S. H. (1952): The isolation and identification of quercetin and isoquercitrin. J. Am. Chem. Soc., *74*, 4372–4373.

Willstätter R., Zollinger E. H: (1915): Coloring matter of the grape and the whortleberry. Annales, *408*, 83–109.

Wilska-Jeszka J., Los J., Pawlak M. (1992): Wild plant fruits as a source of catechins and proanthocyanidins. Bull. Liaison – Group Polyphenols , *16*, 246–250.

Wilska-Jeszka J., Korzuchowska A. (1995): Chlorogenic acid interaction with anthocyanins of chokeberries and strawberries. Colloq. – Inst. Natl. Rech. Agron., *69* (Polyphenols 94): 211–212.

Wilska-Jeszka J., Korzuchowska A. (1996): Anthocyanins and chlorogenic acid copigmentation. Influence on the color of strawberry and chokeberry juices. Z. Lebensm.-Unters. Forsch., *203*, 38–42.

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Contact Address:

Doc. Ing. Jaromír L a c h m a n , CSc., Česká zemědělská univerzita, Agronomická fakulta, Kamýcká 129, 165 21 Praha 6-Suchdol, Česká republika
Tel. +420 2 24 38 27 20, fax +420 2 20 92 16 48, e-mail: lachman@af.czu.cz

VEGETABLE SEED PRODUCTION

PRODUKCE OSIVA ZELENINY

Raymond A. T. George

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Increasing vegetable crop production, advances in seed production technologies, changes in legislative regulations and commercial strategies have led to the need of updating the first edition of the book Vegetable Seed Production which has been published by Longman in 1985. The book is largely based on information acquired by the author, a former senior lecturer (University of Bath, U.K.) and consultant of the United Nations Food and Agriculture Organization (Rome, Italy), when involved in vegetable seed projects and associate training programmes in developing countries, as well as teaching undergraduate and postgraduate students in the U.K.

The first six chapters (Organization, Principles of Seed Production, Agronomy, Harvesting and Processing, Storage, Seed Handling, Quality Control and Distribution) provide consistent and recent information about legislation, control and organization of seed production, distribution, handling and about general technical and agronomic possibilities and approaches to the seed production. The chapter Organization is aimed at role, range, classification and importance of vegetables, seed industry and its role in agricultural development, sources of its financial and technical assistance, the role of plant breeders and of the International Plant Genetic Resources Institute. Fundamental principles of plant nomenclature, cultivar names, trials, identification and classification are explained, as well as principles of seed quality control and seed certification. The chapter Principles of Seed Production explains biological background of pollination and fertilization, deals with methods of pollination, conditions of successful seed production and principles of hybrid construction. The chapter Agronomy is focused on environmental conditions for seed production, growing technologies and describes approaches to the maintenance of cultivar purity. The chapter Harvesting and Processing defines stages of harvesting, types of material to be harvested and principles of seed-processing, describes different types of seed- processing machines and equipment for seed drying. The chapter Storage deals with biological principles of seed longevity, pre-harvest and pre-storage factors influencing this feature, defines storage period, summarizes effect of storage environment on seed, describes different storage methods, facilities, equipment and assumes principles of store management. The chapter Seed Handling, Quality Control and Distribution characterizes principles of seed company planning and production, system of monitoring seed quality, packaging, promotion, price structure and distribution.

Chapters 7–19 deal with special information about taxonomy, cultivation needs, isolation, seed cleaning and storage of the most important groups of vegetables ranged according to the botanical families: *Chenopodiaceae, Compositae, Cruciferae, Cucurbitaceae, Leguminosae, Solanaceae, Umbelliferae, Alliaceae, Gramineae, Amaranthaceae* and *Malvaceae*. Each chapter deals separately with the most important vegetable species and includes their basic characteristics, origin and intraspecific classification according to the plant organs used as vegetable. It contains a comprehensive and well structured list of characters used by UPOV for the cultivar description, roguing stages and main characters to be observed for ensuring the uniformity and identity of cultivar. The next part informs about plant needs of soil pH, nutrition and irrigation during cultivation and special features of species important for the seed production (e.g. sex expression in cucurbitaceous vegetables). Information about flower biology, pollination, isolation and technology of seed harvesting reviews traditional and recent approaches to these operations. Data about potential seed yield and the main seed-borne pathogens are essential and valuable for the planning of production, protection and handling activities.

The book also includes comprehensive and recent bibliography in the chapter References, a list of addresses of seed-related organizations referred to in the text and an Index of technical and botanical terms, English and Latin names of plant species.

The most important information on the topic is summarized in the book, information is clear, understandable, complex and sufficient. The most recent information about legislation, control, testing, handling and agronomy in the general part and about exact botanical taxonomy, plant description and seed production in the special part, together with a detailed description of seed production technology gives to this book a high value. The subject of the book provides an essential reading for university students, technicians and practitioners of horticulture and seed production in both developed and developing countries. It can be used also in approaches to *ex situ*, *in situ* and on-farm conservation of genetic resources.

Prof. Dr. A. Lebeda, Dr. E. Křístková

CUCURBITACEAE 2000 – THE VIIth EUCARPIA MEETING ON CUCURBIT GENETICS AND BREEDING

CUCURBITACEAE 2000 – VII. KONFERENCE EUCARPIA O GENETICE A ŠLECHTĚNÍ TYKVOVITÝCH

International contacts of scientists, researchers and breeders working with cucurbitaceous vegetables from around the world are quite broad and intense. Scientific meetings are organized by both the ISHS – International Society of Horticultural Science - (last one in Adana, Turkey, 1997) and by the ASHS – American Society of Horticultural Science – (in USA, 1998). The information about scientific progress is published each year in the Cucurbit Genetics Cooperative Report through the American committee of this society and cucurbitologists have also a special club, The Cucurbit Network, aimed at botanical features of cucurbitaceous plants. These frequent formal and informal contacts enable effective cooperation and support scientific progress in this area. Eucarpia conferences on genetics and breeding of cucurbitaceous vegetables are organized every four years.

Cucurbitaceae 2000 – the VIIth Eucarpia Meeting on Cucurbit Genetics and Breeding was organized by the Agricultural Research Organization, Newe Ya´ar Research Center and held in Israel on 19–23 March 2000 with the participation of nearly 140 scientists, researchers, breeders and representatives of seed and breeding companies from 26 countries (Albania, Armenia, Austria, Brazil, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Israel, Italy, Japan, Kenya, Latvia, The Netherlands, Philippines, Poland, Russia, Spain, Sweden, USA and Yugoslavia). The conference venue was the Ma´ale Hahamisha Guesthouse (10 km west of Jerusalem), surrounded by tranquil forests, providing all participants with favorable conditions for scientific proceedings.

The scientific programme reflected progress achieved during the last four years since Cucurbits Towards 2000 – the VIth Eucarpia Meeting, held in Málaga (Spain) in 1996. A total of 78 contributions were presented as lecture and poster presentation in sections: Genetics and Germplasm, Breeding and Genetics, Insect Pests, Phytopathology – Air-borne Diseases, Phytopathology – Soil-borne Diseases, Virology, Molecular Biology, Fruit Quality and Postharvest.

The most important results can be summarized as follows. The breeding of cucurbits is aimed at disease and pest resistance, high yield, and high nutritional value. All conventional and new methods and approaches to achieve these goals are dependent upon basic and multilateral knowledge of plant material.

Diversity of a genetic resource plays an important role in the process of creation of new varieties. They have not only a commercial importance but also historical and cultural one. The effectiveness of exploitation of genetic resources is primarily based on their exact taxonomical ranging, evolutionary studies and knowledge of the capacity of interspecific and intraspecific hybridization of cultivated species and their wild relatives.

Cucumber downy mildew, powdery mildew of cucurbits, fusarium wilt, *Cladosporium cucumerinum* and in several locations *Monosporascus cannonballus* are considered to be the most important fungal pathogens of cucurbitaceous vegetables. Studies of the genetics of resistance are conducted using conventional approaches and also with the help of molecular markers. In the process of resistance breeding and creation of a resistant material new methods, such as grafting (also for obtaining resistance to powdery mildew), protoplast fusion, and *in vitro* regeneration of interspecific hybrids are explored.

Methods of molecular biology are explored especially for the construction of genetic maps of cucumbers, melons, watermelons and squash. Results obtained through molecular analyses are studied with regard to resistance to fungal and viral pathogens.

The study of biochemistry and changes of fruit quality during ripening is relevant and important for improving melon production and transport techniques.

In the Czech Republic, the work with genetic resources of cucurbitaceous vegetables, e.g. evaluation of disease resistance, attempts to create interspecific hybrids, is developed in Olomouc. Two institutions, Workplace of the Gene Bank in Olomouc (Research Institute of Crop Production Praha-Ruzyně) and Palacký University in Olomouc cooperate in this programme. Results obtained during the last four years by a group of five people were presented at the conference, focusing on interactions between *Cucurbita pepo* morphotypes and powdery and downy mildews and protoplast fusion of *C. melo* and of wild *Cucumis* spp. and embryo cultures of cultivated and wild species of the genus *Cucumis* after *in vitro* pollination.

All contributions presented to the conference were published as full-length papers in Acta Horticulturae no. 510,

edited by Nurit Katzir and Harry S. Paris. The book is of excellent scientific quality and has a highly professional design.

The scientific sessions were accompanied by a field excursion to the Zohar Experiment Station at En Tamar by the Dead Sea. The principal experimental programme of this station is aimed at cultivation of melons. Actually, the influence of different methods for soil treatment and grafting for resistance of melons to *Monosporacsus cannonballus* are under investigation. Fruits of melon are exported from the region to Europe and highly effective facilities for washing, waxing, packing and cooling of fruits before transport are used.

Cucurbitaceae 2000 passed in a very friendly atmosphere and spirit of cooperation. The programme was very well prepared and participants received also space for discussions about official and un-official joint projects and for establishing new contacts and cooperation.

Cucurbitaceae 2004, the VIIIth Eucarpia Meeting on Cucurbit Genetics and Breeding, will be held in Olomouc, Czech Republic, in 2004. Preliminary information about this meeting can be obtained from Prof. Dr. Aleš Lebeda (Palacký University, Faculty of Science, Department of Botany, Šlechtitelů 11, 783 71 Olomouc-Holice, Czech Republic; e-mail: lebeda@prfholnt.upol.cz).

Prof. Dr. Aleš Lebeda
Palacký University, Faculty of Science, Department of Botany, Šlechtitelů 11, 783 71 Olomouc-Holice, Czech Republic

Dr. Eva Křístková
Research Institute of Crop Production, Department of Gene Bank, Šlechtitelů 11, 783 71 Olomouc-Holice, Czech Republic

POKYNY PRO AUTORY

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Rozsah původních prací nemá přesáhnout 10 stran psaných na stroji včetně tabulek, obrázků a grafů. V práci je nutné používat jednotky odpovídající soustavě měrových jednotek SI.

Rukopis má být napsán na papíře formátu A4 (30 řádek na stránku, 60 úhozů na řádku, mezi řádky dvojité mezery). K rukopisu je vhodné přiložit disketu s textem práce, popř. s grafickou dokumentací pořízenou na PC s uvedením použitého programu. Tabulky, grafy a fotografie se dodávají zvlášť, nepodlepují se. Na všechny přílohy musí být odkazy v textu.

Pokud autor používá v práci zkratek jakéhokoliv druhu, je nutné, aby byly alespoň jednou vysvětleny (vypsány), aby se předešlo omylům. V názvu práce a v souhrnu je vhodné zkratek nepoužívat.

Název práce (titul) nemá přesáhnout 85 úhozů a musí dát přesnou představu o obsahu práce. Jsou vyloučeny podtitulky článků.

Krátký souhrn (Abstrakt) musí vyjádřit všechno podstatné, co je obsaženo v práci, a má obsahovat základní číselné údaje včetně statistických hodnot. Nemá překročit rozsah 170 slov. Je třeba, aby byl napsán celými větami, nikoliv heslovitě.

Rozšířený souhrn prací v češtině nebo slovenštině je uveřejňován v angličtině, měly by v něm být v rozsahu cca 1–2 strojopisných stran komentovány výsledky práce a uvedeny odkazy na tabulky a obrázky, popř. na nejdůležitější literární citace. Je vhodné jej (včetně názvu práce a klíčových slov) dodat v angličtině, popř. v češtině či slovenštině jako podklad pro překlad do angličtiny.

Literární přehled má být krátký, je třeba uvádět pouze citace mající úzký vztah k problému. Tato úvodní část přináší také informaci, proč byla práce provedena.

Metoda se popisuje pouze tehdy, je-li původní, jinak postačuje citovat autora metody a uvádět jen případné odchylky. Ve stejné kapitole se popisuje také pokusný materiál a způsob hodnocení výsledků.

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