šlo vplyvom zmeny prostredia a technológie k strate tejto vlastnosti. Odrody sa stali veľmi citlivé k tejto chorobe. V roku 2007 sa objavil aj nebezpečný škodca vlnačka krvavá (*Eriosoma lanigerum*), ktorá býva indikátorom neselektívneho používania insekticídov. Je to paradox pretože v sade sa nepoužívajú iné ako povolené insekticídy. Najviac boli napadnuté odrody Rosana, Selena a Júlia. Ďalej sme zistili, že vplyvom viacročného mechanického obrábania v rade došlo k vyselektovaniu ťažko likvidovateľných burín ako sú pichliač roľný (*Cirsium arvense* L.), pýr plazivý (*Elytrigia repens* L.) a žihľava dvojdomá (*Urtica dioica* L). Z dosiahnutých výsledkov vyplynulo, že ekologické pestovanie jabloní ako trvalá monokultúra je veľmi zraniteľná. Preto odporúčame v praxi zakladať a pestovať týmto spôsobom menšie plochy ekologických výsadieb s odrodami rezistentnými k chrastavitosti jabloní (*Venturia inaequalis*). Vzhľadom na súčasný stav odporúčame výsadbu preradiť do systému integrovanej produkcie, ktorej základom je integrovaná výživa a ochrana rastlín. Integrovaná produkcia jabloní zlepší ich zdravotný stav, potlačí hospodársky škodlivé buriny a stabilizuje nielen produkciu, ale aj ekonomiku, ktorá z dimenzií udržateľného poľnohospodárstva v súčasnom období v SR predstavuje dimenziu kľúčovú.

Kľúčové slová: ekologické pestovanie, rezíduá, rezistentné, tolerantné, pesticídy, buriny

Ďakujem firme Galafruit & CO, s.r.o. Malá Tŕňa, ktorá mi umožnila vykonať poloprevádzkové pokusy.

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VARIABILITY IN SOLUBLE SOLID CONTENT OF APPLES AS A QUALITATIVE TRAIT FOR NORM-SETTING ACTIVITIES IN THE EUROPEAN UNION

VARIABILITA ROZPUSTNEJ SUŠINY JABĹK AKO AKOSTNÉHO ZNAKU PRE NORMOTVORNÚ ČINNOSŤ EURÓPSKEJ ÚNIE

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In technical standards, requirements concerning quality of fresh apples are defined on the base of sensory criteria. As far as measurable traits are concerned, the standards contain only data about dimensions and weight of fruit. The estimation of numeric values of soluble solid content (SSC) is based partly on technical and economic parameters and partly on requirements of the world market. For the time being, the Commission of Normalization. negotiates the limits data about SSC that could be used for the market standard. In years 2005, 2006 and 2007, values of SSC were estimated in 18 apple varieties originated from seven countries sold in market network of the Slovak Republic. The overall average of all measurements and all varieties (n = 1 080) reached a value 13.3±1.2 %. Variability of SSC content was mainly influenced by the apple variety. The highest contents of SCC were estimated in the following varieties: Pinova, Red Winter, Topas, Melrose, Rubinola, Jonagored and Fuji.

Key words: quality requirements, quality parameters, standardization, apple varieties, soluble solid content

When developing quality standards, it is necessary to select only a limited number of parameters among an endless series of various quality traits. The standardization is a decision-making process, within the framework of which it is defined, which properties should be evaluated and how they should be estimated. Quality standards must respect requirements of producers, merchants and customers. The generally valid EU commercial standards for apples refer to a wide, taxatively specified assortment of apples (their list involves more than 200 varieties and tens of mutations) produced under different conditions of individual EU countries (Commission Regulation (EC) No 85/2004). This standard is applicable at all levels of the market and contains, among others, permitted deviations of individual traits, individual quality categories and individual varieties. Today, there is a common market standard for apples within the framework of the whole EU; see Consolidated versions of Commission Regulation (EC) No. 85/2004 (on 31 May 2008).

The elaboration of such standards is rather demanding and for that reason each standard is gradually specified and defined in such a way that it could be generally applicable. In technical standards, requirements concerning quality of fresh apples are defined on the base of sensory criteria. Of measurable traits, these standards contain only data about dimensions and weight of fruit as well as their limit deviations and tolerances. Recently there are efforts to extend the set of measurable traits and to use also values about the soluble solid content (SSC) and firmness of fruit and about the sugar content. The definition of these numeric values is based partly on technical and economic parameters and partly on requirements of the world market. The sugar content is estimated by means of conventional refractometry; although the results obtained by this method are only approximate and provide orientative estimation of sugar content, it is rapid and practicable and provides reproducible results. For the time being, there are discussions concerning limiting data about SSC that could be used for the market standard of the Commission of Normalization.

Pursuant Commission Regulation (EC) No 1619/2001, the minimum size of apples (i.e. their diameter and weight) is used as the main criterion of their ripeness besides their organoleptic traits. Regarding the present technical development in the field of methods of strength measurements and of sugar content as well as with regard to the occurrence of new markets for ripe small apples it is desirable to reduce their minimum size as it is used in EU. At the same time, new criterions of ripeness (i.e. sugar content and strength) should assure that this reduction in size will not result in such a situation that the market will be glutted with unripe and/or too small apples.

Sugars are the main component of SSC in apples. Apple fruit contains glucose (2.6–5.6 %), fructose (6.5–11.8 %) and saccharose (1.5–5.3 %), their contents are changing but fructose always predominates. In the course of fruit development, the content of sugars increases at first linearly as a result of assimilation and later on due to the hydrolysis of reserve polysaccharides (Kyzlink, 1990). After the harvest, the content of sugars gradually begins to decrease, the rate of this descent is dependent on conditions of ripening and storage (Ackermann et al., 1992). Besides sugars, there is a number of other compounds that are present in the SSC of apples. Under normal practical conditions the refractometric data are held for orientative evaluation about the SSC and/or even about the content of sugars (usually in samples, the SSC of which consists predominantly of sugars as it is in case of apples). However, this information may differ (in dependence on other components of biological origin) from exact data about SSC and the content of sugars. As other soluble components of apples (monosaccharides, acids etc.) have a similar index of refraction, it is possible to accept refractometric data as a conventional reading of SSC and use it as one of parameters for the evaluation of the ripeness of apples. This reading is expressed as refractometric dry matter in per cent (%) or in Brix degrees (°Bx) (Kopec a Němcová, 2008). In last years positive correlative data between refractometric determination of SSC and non-destructive NIR method in fruit were published (Walsh et al., 2004; Qing et al., 2008).

The evaluation of SSC of apples is in the focus of permanent attention because of many reasons (Hoehn et al., 2003). Various authors developed simulation models of sugar formation in the course of apple fruit development with regard to effects of growing conditions (Lakso and Johson, 1990) or of genotype (Beruter, 2004). Some authors study possibilities of an active modification of SSC by means of pre-harvest treatment (Moor et al., 2006). SSC is an important quality criterion when selecting genetic resources from the assortment of traditional varieties for the purposes of apple breeding (Tóth et al., 2004). Some authors also look for new, non-destructive methods of quality evaluation (including SSC), e.g. infrared spectroscopy (Baumgartner et al., 2007).

Quality of three apple varieties grown in Slovenia was evaluated with regard to the possibility of selection and recommendation of suitable varieties for further growing. The highest content of SSC (16.4 %) and the best results of sensory evaluation expressed the variety Pink Lady (SSC ranged from 15.7 to 17.1 %). The corresponding results for cultivars Idared and Granny Smith were 15.4 % (14.5–16.0 %) and 12.5 % (11.5–13.7 %), respectively (Babojelič, 2007). Similar results concerning the relationship between SSC and results of sensory evaluation were also obtained for 12 varieties originating from the southern hemisphere (Koprinska, 1996). As far as the evaluation of values of SSC is concerned, there are efforts in EU to obtain new data, which will enable to optimize this method on one hand and to extend the current standard by another, until now not used a measurable trait. This paper contributes to our knowledge about variability of this new market trait of apple quality.

Material and methods

In years 2005, 2006 and 2007, contents of SSC matter were estimated in 18 apple varieties sold in distribution channels of the Slovak Republic. These apples originated from altogether seven countries (see tables). Samples of apples of both domestic and foreign origin were obtained by means of customary methods in selected wholesales, hypermarkets, supermarkets and retail shops. Obtained samples were intentionally followed in the course of November and December to minimize effects of storage conditions and, therefore, to eliminate possible loses SSC due to respiration of fruit. Regarding the sources of samples it was not possible to collect more detailed characteristics of individual samples, so that only date of sampling, country and year could be recorded.

For measurements altogether 10 apples from each sample were used. Two slices were cut off from each tested fruit (Fig. 1). One slice was obtained from the most coloured part of the apple while the other from the opposite side, so that it was possible to obtain an average sample of SSC contained in an apple pulp. For measurements, a mixed juice sample was obtained by pressing both aforementioned slices. SSC was estimated in a digital refractometer Pocket PAL-1, which is

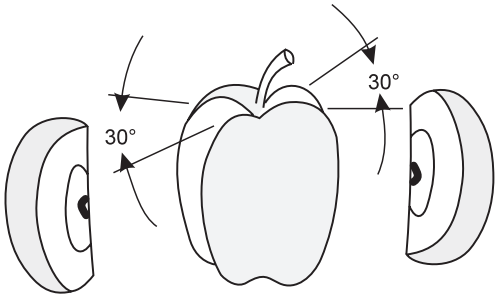

Figure 1 Method of apple sampling
Obrázok 1 Metóda odoberania vzoriek z jablka

calibrated to show values of refraction index at the standard temperature of 20 °C; in addition, it can also show concentrations of pure saccharose solution in mass percent at 20 °C. Measured values were corrected according to the temperature of measured sample. Results of SSC (%) are presented as means and standard deviation. Statistical analysis of obtained data was performed using the method of ANOVA and Tukey test with HSD intervals (high standard deviation) by using statistical software Statgraphics.

Results and discussion

A three-year study of 18 apple varieties from the distribution network of the Slovak Republic was performed (Table 1). The overall average of SSC of all measurements and all varieties (n = 1 080) was 13.3 % and the average standard deviation was 1.2 %. The highest deviations in SSC contents were recorded in varieties Braeburn, Fuji and Rubinola while the most stable results were recorded in the varieties Jonathan, Red Winter, and Rubin (Table 1).

Results of variance analysis of the content of SSC are presented in Fig. 2, with confidence intervals obtained by Tukey test of significant differences, regardless to the date of sampling. The highest overall average content of SSC (15.5 %) was estimated in apples of the variety Fuji and its values of confidence interval ranged from 14.6 to 16.5 %. On the other hand, the lowest average content of SSC (12.1 %) was recorded in the variety Jonathan (with the range of confidence interval 11.2–13.1%). The difference between both varieties was statistically highly significant (P = 0.01). A statistically significant difference (P = 0.05) between varieties Jonathan and Jonagored was also determined. Using the Tukey test of significant differences for contents of SSC, three homogenous groups of apple varieties were determined. Group C with the highest concentration of SSC involved the following varieties: Pinova, Red Winter, Topas, Melrose, Rubinola, Jonagore, and Fuji (Table 2).

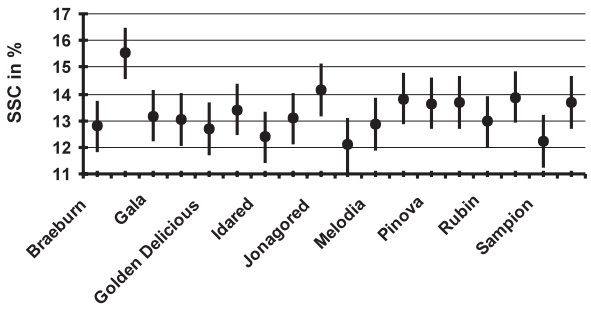

Figure 2 Mean of soluble solid content and Tukey HSD intervals (P = 0.95; n = 60) in apples in all monitored terms depending on cultivars

Obrázok 2 Priemerné hodnoty obsahu rozpustnej sušiny jabĺk v závislosti od odrôd a Tukey HSD intervaly (P = 0,95; n = 60)

Differences of measured values of SSC and their dependence on the date of sampling are presented in Table 3. The lowest SSC content of all 180 tested apples was recorded in samples obtained in November 2005. These results showed that the sampling date for measurements of SSC did not reveal significant effect on recorded values. The most important effect on the variability of measurements was that of the apple variety (Matuškovič a Paulen, 2005).

Table 1 Content of soluble solid content (%) in different apple cultivars in monitored terms

Cultivar (1)	2005		2006		2007	
	November	December	November	December	November	December
Braeburn	11.2±1.5*	11.9±1.2	13.5±1.0	14.3±1.0	13.6±1.2	12.2±1.5
Fuji	16.4±1.7	13.9±1.9	16.0±1.6	14.8±1.5	14.0±1.5	18.0±1.3
Gala	13.3±0.8	14.1±0.7	13.0±0.6	13.5±1.0	12.6±0.9	12.5±1.1
Gloster	11.8±0.8	12.2±0.8	13.7±0.9	13.2±0.9	13.4±1.0	13.9±0.8
Golden Delicious	12.8±0.6	12.8±0.3	12.7±0.5	12.5±0.8	12.9±0.4	12.4±0.6
Granny Smith	12.9±0.3	13.7±0.4	13.6±0.8	13.3±0.5	13.6±0.6	13.4±0.6
Idared	12.2±0.3	12.7±0.6	12.2±0.4	12.7±0.9	12.4±0.7	12.1±0.7
Jonagold	12.3±0.8	13.2±0.7	13.0±1.0	13.9±0.8	13.7±0.8	12.4±0.7
Jonagored	13.3±0.6	14.0±0.4	14.4±0.8	15.1±0.5	14.3±0.6	13.8±0.6
Jonatan	11.6±0.4	11.9±0.8	12.4±0.5	12.0±0.6	12.4±0.6	12.4±0.3
Melodia	9.9±1.4	14.9±1.0	11.9±1.0	13.4±0.8	14.0±1.2	13.1±0.7
Melrose	14.3±1.0	14.0±1.3	15.5±0.7	13.5±0.8	13.2±1.0	12.4±1.3
Pinova	15.0±1.1	14.8±1.0	13.5±0.5	12.1±1.0	12.9±1.0	13.6±0.6
Red Winter	13.1±0.5	14.1±0.6	12.8±0.5	13.7±0.7	14.5±0.8	13.9±0.5
Rubin	13.2±0.3	13.0±0.4	12.8±0.8	13.0±0.3	13.2±0.7	12.6±0.9
Rubinola	12.7±1.2	14.3±1.1	12.9±1.2	15.8±1.0	14.0±1.1	13.6±0.8
Sampion	10.2±1.0	12.3±1.1	12.5±0.8	12.5±0.8	12.5±1.0	13.4±1.0
Topas	12.8±1.2	14.9±1.2	12.3±0.9	12.8±0.6	14.6±1.2	14.7±1.0

*mean ± standard deviation (n = 10) * priemer ± štandardná odchýlka

Tabuľka 1 Obsah rozpustnej sušiny (%) v sledovanom období pri rôznych odrodách jabĺk
(1) odroda

Table 2 Mean of soluble solid content in apples in all monitored terms and homogeneous groups of cultivars

Cultivars (1)	Soluble solid content in % (2)	Homogeneous groups (3)
Jonatan	12.1	A
Sampion	12.2	AB
Idared	12.4	AB
Golden Delicious	12.7	AB
Braeburn	12.8	AB
Melodia	12.9	AB
Rubin	13.0	AB
Gloster	13.0	AB
Jonagold	13.1	AB
Gala	13.2	AB
Granny Smith	13.4	AB
Pinova	13.7	ABC
Red Winter	13.7	ABC
Topas	13.7	ABC
Melrose	13.8	ABC
Rubinola	13.9	ABC
Jonagored	14.2	BC
Fuji	15.5	C

* high standard deviation (Tukey, P = 0.95, n = 60)

Tabuľka 2 Priemerné hodnoty obsahu rozpustnej sušiny
(1) odroda, (2) rozpustná sušina, (3) homogénne skupiny

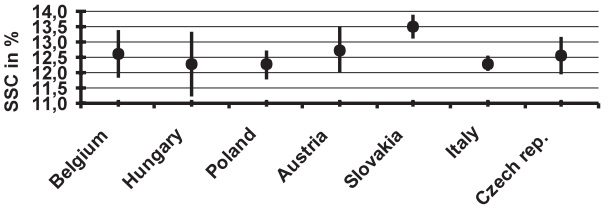

Figure 3 Mean of soluble solid content and Tukey HSD intervals ($P = 0.95$) in all monitored terms depending on the apple origin

Obrázok 3 Priemerné hodnoty obsahu rozpustnej sušiny jabĺk vo všetkých termínoch v závislosti od ich pôvodu, Tukey HSD intervaly ($P = 0,95$)

Tested apples (altogether 920) originated most frequently from 7 countries (Tab. 4). The less frequent apples (altogether 160) originated from Chile, New Zealand, Germany, France, the Netherlands, Spain, and Slovenia. The most frequent apples originated from Italy (280) and Slovakia (180). This corresponds also with different widths of confidence intervals of average contents of SSC in dependence on the origin of samples as evaluated by analysis of variance. The highest average content of SSC was recorded in apples grown in Slovakia (13.5 %), which were significantly different from apples originating from Poland and Italy. There were two homogenous groups of apple origin: Group B with a higher content of SSC involved apples from Slovakia, Belgium, Czech Republic, Austria and Hungary (Tab. 4; Fig. 3).

The obtained results can be used as agenda in further negotiations of European Commission about changes in the market standard for apples. The obtained results do not differ

Table 3 Soluble solid content of apples in different sampling terms

Sampling terms (1)	Mean (2)	*HSD interval (3)	Homogeneous groups (4)
	in %		
November – 2005	13.3	12.2–12.7	A
November – 2006	13.8	12.7–13.3	A
November – 2007	14.0	12.9–13.4	A
December – 2005	14.0	12.9–13.5	A
December – 2006	14.0	12.9–13.5	A
December – 2007	13.9	12.8–13.4	A

* high standard deviation (Tukey, $P = 0.95$, $n = 180$)

Tabuľka 3 Obsah rozpustnej sušiny vo vzorkách jabĺk pri rôznych termínoch
(1) termín odberu, (2) priemer, (3) HSD interval, (4) homogénne skupiny

Table 4 Mean of soluble solid content in apples from different countries and homogeneous groups

Country (1)	Samples per country (2)	Soluble solid content in % (3)	Homogeneous groups (4)
Poland	140	12.3	A
Italy	280	12.3	A
Hungary	60	12.3	AB
Austria	80	12.8	AB
Czech Replik	100	12.6	AB
Belgium	80	12.6	AB
Slovakia	180	13.5	B

Tukey, $P = 0.95$

Tabuľka 4 Priemerné hodnoty obsahu rozpustnej sušiny v rôznych krajinách
(1) krajina, (2) počet vzoriek na krajinu (3) obsah rozpustnej sušiny (4) homogénne skupiny

from values recorded in other countries. Data about the content of SSC in apples from Slovenia resistant to Venturia inaeqalis (apple scab) indicated a wider variability and a more expressed effect of the year condition. In 2002, the average value of SSC of all 18 tested varieties was 11.50 % (9.5–12.9 %) and in 2003 the average value reached 13.9 % (12.6–15.7 %). Significant intervarietal differences also noted Godec (2004). Vachůn (2001) analyses an extensive set of SSC data of five apple varieties obtained within a period of three experimental years. In the first year, the total average of measurements was 14.87 % (12.09–18.98 %), in the second one 14.90 % (12.29–18.28 %), and in the third one 14.74 % (11.82–17.77 %). Intervarietal differences were significant and for example the variety Golden Delicious was a genotype with a high content of SSC. It is obvious that there is a considerable variability in the content of SSC, so that it will be rather difficult to define a limit value, which could significantly indicate that the apples with a lower value are unripe and should be eliminated from distribution. However, this is a measurable value, which shows the lowest variability among all quality traits.

Súhrn

Požiadavky vzťahujúce sa ku kvalite jabĺk sú v technických normách definované ako zmyslové kritériá. Z merateľných znakov obsahujú normy iba údaje rozmerové a hmotnostné. Určenie číselných hodnôt rozpustnej sušiny vychádza z technicko ekonomickej účelnosti a z požiadaviek svetového trhu. O limitujúcich údajoch rozpustnej sušiny, použiteľných pre obchodnú normu rokuje v súčasnosti komisia pre normalizáciu. V rokoch 2005, 2006 a 2007 boli sledované hodnoty 18 odrôd jabĺk v obchodnej sieti Slovenskej republiky pôvodom zo siedmych krajín. Celkový priemer zo všetkých meraní a všetkých sledovaných odrôd (n = 1 080) dosiahol hodnoty 13,3±1,2 %. Rozhodujúci vplyv na variabilitu hodnôt rozpustnej sušiny mala odroda jabĺk. Najvyšší obsah rozpusnej sušiny bol zistený pri odrodách Pinova, Red Winter, Topas, Melrose, Rubinola, Jonagored a Fuji.

Kľúčové slová: akostné požiadavky, akostné znaky, štandardizácia, odrody jabĺk, rozpustná sušina

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