Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Browning Index of New Apple Genotypes Developed for Fresh-cut and Processing

Maojun Zhang[1, 2], Cui Yu[1, 3], Marie Thérèse Charles[1], Andrei Bondar[1] , Jennifer DeEll[4], H.P. Vasantha Rupasinghe[5] and Shahrokh Khanizadeh[1] *

[1] Horticulture Research and Development Centre, Agriculture and Agri-Food Canada, 430 Gouin Blvd., St-Jean-sur-Richelieu, QC, Canada, J3B 3E6; [2]Pomology Institute, Jilin Academy of Agricultural Sciences, 303 Kemao Street, Gongzhuling, Jilin, P.R. China, 136100; [3]College of Horticulture, Shenyang Agricultural University, 120 Dongling Road, Shenyang, Liaoning, P.R. China, 110161; [4]Ontario Ministry of Agriculture, Food and Rural Affairs, 4890 Victoria Ave N, Box 8000, Vineland Station, ON, Canada, L0R 2E0; [5]Department of Environmental Sciences, Nova Scotia Agricultural College, Box 550, Truro, NS, Canada, B2N 5E3.

Abstract

Post-cut enzymatic browning of apples is a very important issue for the fresh-cut industry because of its negative impact on the appearance and quality of processed product. The rate and intensity of enzymatic browning are affected by several pre-, post-harvest and handling factors. The objectives of the present study were to assess browning propensity of 8 advanced and semi-advanced apple lines (Table 1) compared to 4 named varieties. Browning intensity of cut apple surface was evaluated subjectively using visual assessment and objectively using a chromatometer. There were significant differences between the tested genotypes for cut surface browning. 'Reinette Russet' displayed the highest browning indexes independent from the cutting tool or assessment methods. 'Eden™', a recently released line from Agriculture and Agri-Food Canada (AAFC), exhibited the lowest browning indexes. Almost all the tested genotypes evaluated visually and with a chromatometer had lower browning values when a surgical blade was used compared to a stainless steel knife. The former method could be recommended to the industry to improve quality and reduce post-cut browning of apple slices. There was a significant interaction, between the genotypes and the method (tool) used, indicating that some lines responded differently to the method used for slicing. In summary, tested genotypes SJCA39R5A80, SJCA37R5A76, JCA21R5A20, SJCA14R3A10 had relative high enzymatic browning and are not recommended for apple slices production, while SJCA28R6A73 and SJCA30R6A10 had relative low enzymatic browning value and might be suitable for apple slices industry.

Introduction

The color is a very important parameter used by the consumer to appraise general appearance and quality of fresh fruits and vegetables. This parameter is also greatly appreciated by the processing industry because of its influence on food choices. Appearance and color of fresh fruit are mainly determined by the individuals corresponding to their genetic background, but are also affected by cultivation, environment factors, harvesting time, pre-, post-harvest conditions and the processing methods (Wang et al. 2007; Khanizadeh et al. 2008; Khanizadeh et al. 2008). Considerable studies (Spanos et al. 1992; Robards et al. 1999.) have been done on browning mechanism during fruit processing. Polyphenol oxidase (PPO) was identified as one of the major enzymes which transform certain phenols in the fruit to orthoquinones, leading to formation of brown polymer (mealins).

Introduction (cont'd)

The rate and intensity of enzymatic browning depend on PPO concentration, polyphenolic substrate content, oxygen availability, pH value and temperature (Martinez and Whitaker, 1995). Little or no research has been done on the effect of the tool used to prepare sliced apples and its interaction within a wide range of genotypes.

The objective of this research was to evaluate newly selected apple lines for processing, specially for their browning susceptibility, and also to determine if the method of cutting has an effect on browning index measured both visually and objectively.

Materials and methods

The fruits of all apple genotypes were harvested at maturity from AAFC, L'Acadie Experimental Farm, QC.

Twelve randomly selected apples were used for each genotype to evaluate the browning susceptibility of fresh-cut slices prepared with a surgical blade or a stainless steel knife respectively.

All fruits were cut on transversal section, and sliced apples were kept at room temperature to evaluate the extent of oxidation. Color change on the sliced surface was measured with a chromatometer, as described by Buera et al. (1986), and visually. Color change was assessed after 24 hour, using ranking scale where 0 = no browning; 1 = trace browning; 2 = moderate browning; 3 = severe browning and 4 = extreme browning. The reading values were recorded, using a Minolta Chrome Meter CR- 200, and used to calculate the browning index (BI) as described by Buera et al. (1986). The data recorded for BI were compared to the ones obtained by visual rating. All data were submitted to a statistical analysis using SAS software. The means were separated according to the Tukey's Studentized Range test ($P < 0.05$).

Results and Discussion

There were significant differences between the tested genotypes (Table 1). 'Reinette Russet' and 'MacIntosh Summerland' displayed the highest enzymatic browning and their visual and browning index (BI) were 3.25 and 2.00 and 3.24 and 2.25 for knife and blade respectively.

The visual rating and browning index of 'Cortland', a standard cultivar used in processing due to its low browning, were 2.13 and 15.0 and 1.29 and 12.8 for knife and blade respectively. The values recorded for 'Cortland' were significantly higher than those of 'Eden™', a newly released CV from the AAFC breeding program (Khanizadeh et al 2006). Eden™ had the lowest BI and visual ranking while SJCA28R6A73 and SJCA30R6A10 had similar or lower BI and visual ranking compared to Cortland. The ranking of the genotypes according to both BI and visual ranking was similar no matter which technique was used to prepare the sliced apples. However, in general, more browning was observed when the stainless steel knife was used. This might be due to the additional damage of the cell by stainless steel knife vs the surgical blade. The stainless steel knife is relatively thicker and sharpless than the surgical blade and that may cause more cell damage, consequently more browning due to the oxidation of the cell content expose to air.

Conclusion

In summary, tested genotypes SJCA39R5A80, SJCA37R5A76, SJCA21R5A20 and SJCA14R3A10 had relative high enzymatic browning values and they may not be suitable for processing apple slices. On the other hand, SJCA28R6A73 and SJCA30R6A10 had relative low enzymatic browning values and are good candidates to compete against 'Cortland' in food processing industry. It is recommended that this potential be further tested.

Table1. Mean values of browning for tested genotypes measured by different assessing method

Genotype	Slice by Knife [U]		Slice by Blade [V]	
	Visual	BI [W]	Visual	BI
Reinette Russet	3.25a	31.8a	2.00b	31.9a
MacIntosh Summerland	3.24a	24.3c	2.25a	22.1b
Eden	1.21g	13.6i	1.00g	12.2f
Cortland	2.13bc	15.0h	1.29de	12.8f
SJCA39R5A80	2.13bc	24.4c	1.28edf	22.7b
SJCA37R5A76	1.97d	26.3b	1.25ef	22.1b
SJCA30R6A10	1.79e	19.3e	1.25ef	16.9d
SJCA28R6A73	1.58f	16.7g	1.33d	15.1e
SJCA21R5A20	2.21b	25.8b	1.25ef	21.5b
SJCA20R7A64	1.58f	17.7gf	1.33d	20.3c
SJCA16R5A15	2.08c	18.5ef	1.54c	17.5d
SJCA14R3A10	1.92d	21.1d	1.21f	14.6e
$LSD_{0.05}$	0.10	1.16	0.08	0.95

Value was mean of 6 replicates. All experiments were conducted in duplicate with fruit at optimum maturity.

[U] Knife used in experiment was a commercial stainless steel knife.

[V] Blade used in experiment was surgical blade.

[W] BI was Browning index and calculated by the formula BI = (x-0.31)/0.172)×100.x was from Y, x, y value measured by Minolta Chrome Meter CR-200.

Means within the column followed by the same letter are not significantly different Tukey's Studentized Range test ($P<0.05$).

References

Buera, M.P., Lozano, R.D., Petriella, C., 1986. Die. Farbe. 32, 318-322.
Khanizadeh, S., Y. Groleau, A. Levasseur, M.T. Charles, R. Tsao, R. Yang, J. DeEll, C. Hampson, and P. Toivonen. 2006. HortScience 41(6):1513-1515.
Khanizadeh, S., S.T. Tao, S.L. Zhang, R. Tsao, D. Rekika, R. Yang and M-T Charles. 2008. Journal of Food, Agriculture & Environment 6(2): 306 – 311.
Khanizadeh, S., R. Tsao, D. Rekika, R. Yang, M-T Charles and V. Rupasinghe. 2008. Journal of Food Composition and Analysis. (in press).
Martinez, M. V. and Whitaker, J. R. 1995.The biochemistry and control of enzymatic browning. Trends Food Sci. Technol. 6: 195-200.
Robards, K., P. Prenzler, P. Tucker, G. Swatsitang and W. Glover. 1999.Food Chemistry 66: 401-436.
Spanos,G.A. and R.E. Wrolstad. 1992. Journal of Agricultural and Food Chemistry 40: 1478-1487.
Wang Q. L., S. Khanizadeh and C. Vigneault. 2007. Stewart Postharvest Review 3(3): 1-8.

© 2008 *** Corresponding author- khanizadehs @agr.gc.ca**

Canada