DOI : 10.5958/0974-0112.2016.00125.0

Indian J. Hort. 73(4), December 2016: 619-622

Short communication

Effect of harvesting date and packaging materials on core browning and phenolic contents of pear cv. Punjab Beauty during storage

Kirandeep Kaur* and W.S. Dhillon**

Department of Horticulture, Punjab Agricultural University, Ludhiana 141 004

ABSTRACT

Core browning in pears is characterized by softening and browning of tissues and development of cavities. It is one of the major disorders that develop during storage of pears. The relationship between core browning, total phenolic contents in relation to harvest time and packaging materials during storage was investigated in pear fruits cv. Punjab Beauty. Results indicated that core browning incidence was significantly higher in fruits from the last harvest. The fruits harvested 125 and 140 days after full bloom had 2.88 and 5.57 per cent core browning incidence, respectively after a storage period of 60 days, as compared to 13.30 per cent incidence in fruits harvested 155 days after full bloom. It is concluded that the lower incidence of internal browning in early harvested fruits was due to the presence of higher level of total phenolic contents than in late harvested fruits. Among the various packaging materials, CFB boxes proved to be the most effective in reducing the core browning in the fruits.

Keywords: Core browning, packaging, phenols, *Pyrus communis*, storage.

Browning is an important disorder of pear fruit which can lead to considerable economic losses as the symptoms are internal and cannot be observed visually without cutting the fruit in half. Internal browning of the core and/ or flesh usually occurs during handling, processing and storage of pear (Crisosto *et al*., 1). The browning phenomenon usually impairs the sensory properties of products due to associated changes in colour, flavour and softening (Kim *et al*., 7). Core browning is a serious post-harvest disorder of pear fruit. It is characterized by development of firm, brown and sharply defined area of breakdown near the core. Browning in fruit is caused by the enzymatic oxidation of phenolic compounds by polyphenoloxidase (PPO). The degree of browning depends on the nature and amount of endogenous phenolic compounds and the activity of PPO (Goupy *et al*., 5). Core breakdown in pears depend on several variables in a more complicated way than assumed. Reviewing the browning disorders in pears, Franck *et al*. (3) suggested that it is unsatisfactory to evaluate the effect of single factors individually. The disorder causes large economic losses in stored pears. Many publications exist on pear browning disorders during storage, each one with its own approach and focus. However, the literature concerning changes in phenolics, stage of maturity and effect of packages on core browning during storage is much more contradictory. As this disorder is critical for consumer acceptance, we aimed to investigate the effects of several pre- and post-harvest factors, and their interactions with the growing season and the storage duration, on the development of core browning incidence. In addition, various packaging materials were used to examine their potential effect on browning development.

Present study was carried out at the Department of Horticulture and Punjab Horticultural Post-harvest Technology Centre, PAU, Ludhiana during 2013-14. Pear cv. Punjab Beauty fruits were harvested at three different stages, *i.e.*, pre-optimum (125 days after full bloom), optimum (140 days after full bloom) and post-optimum (155 days after full bloom) were air-dried and packed in corrugated fibre board (CFB) boxes and stored at 0-1°C and 90-95% RH in walk-in-cool chambers. The observations on various quality attributes were recorded at 30, 45, 60 and 75 days storage interval. In the second experiment, uniform sized and disease-free fruits of pear cv. Punjab Beauty were harvested at optimum stage of maturity randomly from all sides of the tree. The fruits were collected in crates, kept in shade and immediately shifted to laboratory for further studies. The fruits were washed with chlorinated water (100 ppm) and air-dried. These fruits were then packed in corrugated fiberboard (CFB) boxes with low density polyethylene (LDPE) liners, CFB boxes with high density polyethylene (HDPE) liners, CFB boxes and wooden boxes and stored in walk-in-cool chamber at 0-1°C and 90-95% relative humidity. The observations for core browning and phenolic contents were recorded after 30, 45, 60 and

*Corresponding author's E-mail: drkirankang@gmail.com

**ADG, Horticultural Science, Krishi Anusandhan Bhawan-II, Pusa Campus, New Delhi 110012

75 days of storage. After every storage interval, the fruits were removed from each box and core browning was assessed on number basis by counting the fruits that were cut longitudinally into four equal parts and rated as percentage of incidence of the cut surface. The internal browning assessment was performed on three replications with each replication.

For phenolic content estimation, 5 ml of the juice was taken and volume was made to 25 ml by addition of 80 per cent ethanol for extraction. It was evaporated for drying and the residue was dissolved in 10 ml of distilled water. Total phenolic content of the extracts was determined with Folin-Ciocalteu colorimetric method (Velioglu *et al*., 9). Extract (0.5 ml) was mixed with 0.5 ml Folin-Ciocalteu reagent. The contents were mixed by manual shaking for 15-20 sec. After 3 min., 0.50 ml of saturated sodium carbonate solution was added and the solution was diluted to 5 ml with deionised water. The reaction mixture was then incubated in dark at room temperature for 2 h and its absorbance was measured at 630 nm against deionised water using a dual beam UV-Vis spectrophotometer (T-60, PG Instruments, UK). The total phenolic content was determined using a standard curve of gallic acid at 0.02-0.1 mg/ ml concentrations. Total phenolic content was calculated for each sample and expressed as milligrams of gallic acid equivalent per 100 ml of juice.

The experiment was laid out in completely randomized block design with factorial arrangement having three replications. Total samples analyzed were 36 for each set of experiment and each replication comprised of 2 kg fruits. The data of two seasons was pooled and subjected to analysis of variance (ANOVA) using SAS 9.3 (2011) to find out the significance of different treatments. The treatment combinations significant at $p \leq 0.05$ were subjected to mean comparison using Tukey's HSD.

The core browning incidence and severity varied with harvest dates (Table 1). Post-optimum stage harvested fruits had a significantly ($p \leq 0.01$) higher incidence of core browning than pre-optimum and optimum stage harvested fruits after 60 and 75 days of storage. Core browning appeared after 45 days of storage to the level of 0.27 per cent in post optimum harvested fruits, which later on increased up to 6.28 percent after 75 days of storage. The fruits harvested at optimum and pre-optimum stage of maturity showed no core browning up to 45 days of storage. In general, the browning tendency of pear fruit increases with advancing maturity and core browning can be avoided by early harvesting of pears (Lin *et al*., 8; Veltman *et al*., 10). A decrease in total phenolic content of early and late harvested fruit was observed during storage. The total phenolic content declined slowly during storage in pre-optimum and optimum stage harvested fruits, while there was a sharp decline in fruits harvested at later stage. Phenolics may be degraded during storage and their decline is higher in the more mature fruit. Total phenolic content have been found to be influenced by maturity and postharvest storage of most fruit, as well as by several external and internal factors affecting phenolic metabolism. Total phenolic acid contents decreased in pear fruit during storage, from 30 days after storage (4.62 mg GAE/ ml) to 75 days after storage (2.24 mg GAE/ ml). In this study, TPC declined sharply with the delay in harvest time during storage, and a decrease in TPC was observed with increase in core browning incidence.

Table 1. Effect of harvesting time and storage period on core browning (%) and phenols (mg GAE/100 ml) of pear cv. Punjab Beauty.

Storage period (days)	Harvesting time	Core browning (%)	Phenols (mg GAE /ml)
30	H1	0.00^{f}	6.85^{a}
	H2	0.00^{f}	6.18^{b}
	H3	0.00^{f}	5.52^{abc}
45	H1	0.00^{f}	5.98^{ab}
	H2	0.00^{f}	5.18^{bc}
	H3	2.26^{e}	4.18^{cd}
60	H1	2.88^{e}	4.13^{cd}
	H2	5.57^{d}	3.12^{de}
	H3	13.30^{b}	1.98^{ef}
75	H1	9.44^{c}	3.18^{de}
	H2	12.45^{b}	2.42^{ef}
	H3	21.01^{a}	1.12^{f}
LSD ($p \leq 0.05$)			
Harvest time (H)		0.63	0.73
Storage period (S)		0.72	0.85
H × S		1.26	1.47

H1= pre-optimum, H2 = optimum, H3 = post-optimum, Means followed by different superscript letters in the same column are significantly different by Tukey's test ($P < 0.05$).

Pear fruits recorded a significant ($p \leq 0.01$) increase in core browning incidence due to polyethylene packaging films with increasing storage period as compared with CFB boxes (Table 2). There were no symptom of core browning up to 30 days of storage in all the treatments but after 45 days 0.44 per cent was noticed in fruits packed in CFB boxes with LDPE liners. But at later stages, it increased in all the treatments. However, browning scores of pear fruits were found to be lowest in fruits packed in CFB boxes. The higher

incidence of core browning in fruits packed in CFB boxes with LDPE and HDPE liners with the prolongation of storage period is in agreement with the findings of De Castro *et al*. (2) who reported that high CO_2 in storage causes development of browning which can be further aggravated by low O_2 concentrations. The results revealed a considerable diversity in the total phenolic content among the different packaging materials used. The phenols decreased with the storage time, with the rates depending on the storage intervals. Comparing the influence of different packaging materials on core browning, wooden boxes were found to be least protective against phenolic degradation. Phenolics content followed a declining trend with advancement in storage, but the rate of loss of phenolics was slow down by CFB packaging.

Browning disorders in pear fruits are caused by imbalance between oxidative and reductive processes, which leads to the accumulation of reactive oxygen free radicals (Franck *et al*., 3). Phenols are well known for their free radical scavenging activity. This activity depends upon the concentration and composition of polyphenols. Phenolic content of fruits decreased with advancement of storage period. Similar observations have been reported by Kaur *et al*. (6) in pear fruits. It might be due to oxidation of phenols by the activity of polyphenolic oxidase enzyme. Browning changes have been correlated with a decrease in total phenolics and an increase in polyphenol oxidase activity (Gil *et al*., 4). Membrane damage in cell structures induced during storage allows these phenolics to react with PPO. The lower phenolic contents recorded at the end of storage may be as a result break up of cellular structure leading to oxidation of total phenols. Disruption of the membrane allows for PPO and phenolic compounds to come into contact and the phenolic compounds are oxidized to form the browning pigments.

Table 2. Effect of packaging materials and storage periods on core browning (%) and phenols (mg GAE/100 ml) of pear cv Punjab Beauty.

Storage period (days)	Packaging	Core browning (%)	Phenols (mg GAE /ml)
30	P1	0.00h	5.29ab
	P2	0.00h	5.85a
	P3	0.00h	6.15a
	P4	0.00h	5.92a
45	P1	4.30f	3.43cde
	P2	1.29g	4.07bcd
	P3	0.00h	5.25ab
	P4	0.31gh	4.73abc
60	P1	13.29c	2.18ef
	P2	8.77e	3.87cd
	P3	4.65f	4.05bcd
	P4	10.50d	3.45cde
75	P1	25.25a	0.98f
	P2	16.48b	1.25f
	P3	10.58d	2.94de
	P4	15.75b	2.07ef
LSD ($p \leq 0.05$)			
Packaging material (P)		0.41	0.83
Storage Interval (S)		0.65	0.72
P × S		1.29	1.45

CFB boxes with LDPE Liners, P2 = CFB boxes with HDPE Liners, P3 = CFB boxes, P4 = Wooden boxes, Means followed by different superscript letters in the same column are significantly different by Tukey's test ($p<0.05$).

It can be concluded from the present study that the incidence of internal browning was related to harvest date, the late picking date having the higher browning than early picking date. Total phenolic content declined during storage in early and late harvested fruit as the incidence and severity of internal browning increased but the decrease was more abrupt in late harvested fruits. Hence, fruit picked at the post-optimum maturity level, *i.e.*, 155 days after full bloom had a higher incidence of internal browning as compared to fruits picked earlier. Among the various packaging materials used CFB boxes provided better protection from core browning.

REFERENCES

1. Crisosto, C.H., Garner, D., Crisosto, G.M., Sibbett, S. and Day, K.R. 1994. Late harvest and delayed cooling induce internal browning of 'Ya Li' and 'Seuri' Chinese pears. *Hort. Sci.* **29**: 667-70.

2. De Castro, E., Biasi, W., Tustin, S., Tanner, D., Jobling, J. and Mitcham, E.J. 2007. Carbon dioxide-induced flesh browning in Pink Lady apples. *J. American Soc. Hort. Sci*. **132**: 713-19.

3. Franck, C., Lammertyn, J., Ho, Q.T., Verboven, P., Verlinden, B. and Nicolai B.M., 2007. Browning disorders in pear fruit. *Postharvest Biol. Tech.* **43**: 1-13.

4. Gil, M.I., Tomas-Barberan, F.A., Hess-Pierce, B. and Kader, A.A. 2002. Antioxidant capacities, phenolic compounds, carotenoids and vitamic C of nectarine, peach and plum cultivars. *J. Agric. Food Chem.* **50**: 4976-82.

5. Goupy, P., Amiot, M.J., Richard-Forget, F., Duprat, F. and Aubert, S. and Nicolas, J. 1995. Enzymatic browning of apple phenolic extracts by apple polyphenoloxidase. *J. Food Sci.* **60**: 497-501.

6. Kaur, S., Dhillon, W.S. and Mahajan, B.V.C. 2012. Effect of diphenylamine on core browning, antioxidant metabolites, fruit firmness and enzyme's activity in pear cv. Yali. *Prog. Agri.* **12**: 56-62.

7. Kim, M.J., Kim, Y. and Park, I. 2005. Prevention of enzymatic browning of pear by onion extract. *Food Chem*. **89**: 181-84

8. Lin, L., Li, Q.P., Wang, B.G., Cao, J.K. and Jiang, W.B. 2007. Inhibition of core browning in 'Yali' pear fruit by post-harvest treatment with ascorbic acid. *J. Hort. Sci. Biotech.* **82**: 397-402.

9. Velioglu, Y.S., Mazza, G., Gho, L. and Onmah, B.D. 1998. Antioxidant activity and total phenolics in selected fruits and vegetables and grain products. *J. Agric. Food Chem.* **46**: 4113-17.

10. Veltman, R., Lentheric, L., Van Der Plas, H. and Peppelenbos, W. 2003. Internal browning in pear fruit (*Pyrus communis* L. cv 'Conference') may be a result of a limited availability of energy and antioxidants. *Postharvest Biol. Tech.* **28**: 295-302.

Received : January, 2016; Revised : October, 2016;
Accepted : November, 2016