

Full Length Research Paper

The effect of Bio-Fresh™ edible coatings on shelf life and quality of pears

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Four concentrations (0.5, 0.8, 1.0 and 1.2%) of edible coating, that is, Bio-Fresh™, were evaluated for beneficial effects on the shelf life of conference pears (*Pyrus communis* L. cv. Conference). Pears were obtained from the cold storage (-1°C and 90% RH) for quality assessment. The Bio-Fresh™ was applied on pears by dipping after 6 months of storage. It was found that the effects of Bio-Fresh™ on pears coated by dipping were significantly effective for maintaining green skin color for all concentrations, and coating of 1.2% Bio-Fresh™ was slightly delayed in the changes of firmness, soluble solids content and retardation of shriveling which effectively reduced weight loss. Coating of Bio-Fresh™ showed negligible observation incidence of cavities and internal browning. Therefore, the results of this study suggest that coating of 1.2% Bio-Fresh™ increased the shelf life of pears without perceptible losses in quality.

Key words: Pears, coatings, dipping, shelf life, quality, Bio-Fresh™.

INTRODUCTION

Pears (*Pyrus communis* L. cv. Conference) are pome fruits relative to the apple and are very popular among the consumers for their thin peel, crisp flesh, rich juice and good taste. Pears are also very perishable and are susceptible to deterioration accompanied with shriveling, softening and decay. Rapid postharvest physiological changes in conference pears are responsible for short ripening period, rapid senescence that results to short shelf life commodity and pose a challenge for their marketing (Lin et al., 2003), and also a serious constraint for efficient handling and transportation (Hasan and Nurhan, 2004). Many storage techniques have been developed over the years to extend the storage life of fruits such as controlled atmospheres (CA) and modified atmosphere packaging (MAP). But in CA and MAP storage studies of the O₂ and CO₂ injury, increase ethanol production, flavor problem due to anaerobic respiration have been reported (Bender et al., 1994). Therefore, alternative practices are required for preservation of pears which increase the shelf life of fresh

pears.

Edible coatings are alternative storage methods for fresh agricultural produce and increasing attention because of environmental consideration and the trends towards the use of convenience foods (Ozden and Bayindirli, 2002). Semi-permeable coating can create a modified atmosphere similar to CA (Nisperos-Carriedo and Shaw, 1990). The atmosphere created by coating can change in response to environmental conditions due to combined effect on fruits respiration and coating permeability. Coatings are also used to extend the shelf life of fruits and improve appearance (Baldwin et al., 1999). Surface coatings can also improve the postharvest quality of horticultural commodities by reducing water loss (Hagenmaier and Baker, 1993), improving the

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finishing of the skin (Hagenmaier and Baker, 1995; Amarante, 1998), and reducing skin susceptibilities (Amarante et al., 2001).

Potential applications and properties of coating and the effects of coating on shelf life extension of fruits have been studied by several researchers such as apples (Rojas-Grau et al., 2007), mango (Srinivasa et al., 2002; Dang et al., 2008), and kiwi (Xu et al., 2001). Coating has been known to prevent fruits and vegetables from deterioration by inhibiting respiration, reducing dehydration, maintaining textural quality, retaining volatile flavor and decreasing microbial growth (Han et al., 2004). However, in some cases, edible coatings were not successful and have degraded fruits' quality (Hagenmaier, 2005). The occurrence of physiological disorders such as core flush and flesh breakdown was induced by improper coatings (Park, 1999). Modification of internal atmosphere by the use of edible coatings can increase disorders associated with high carbon dioxide or low oxygen concentration (Ben-Yehoshua, 1969).

Bio-Fresh™ edible coatings can be an effective application on pears to prolong the shelf life and to avoid postharvest losses. Shewfelt et al. (1987) stated that color change, firmness loss, ethanol fermentation, decay ratio and weight loss of edible coated fruits are important quality parameters. In this respect, the main objective of this study is to investigate the effect of the Bio-Fresh™ at different concentrations on shelf life of 'Conference' pears with respect to quality of pears as determined by color, firmness, soluble solid content, weight loss, and incidence of disorder.

MATERIALS AND METHODS

Fruit materials

Pears (*Pyrus communis* L. cv. Conference) were harvested and stored at Ultra Low Oxygen (ULO) (O₂ concentration less than 2%) condition at temperature of -1°C and 90% relative humidity (RH) in the cold storage room for 6 months. The pears were treated with coating concentration of 0.5, 0.8, 1.0 and 1.2% (v/v) for different experiments. The coated pears used for this study were considered to be three batches with comparable ripening and respiration characteristics. Each batch contained four groups of treatments with 30 single fruit replicates for each treatment. The pears were evaluated for color, firmness, soluble solid contents, weight loss and incidence of disorders after storage at 12°C and 90% relative humidity (RH). The experimental set-up was in the following way:

- Pears coated by dipping.
- Shelf-0: Assessment after coating.
- Shelf-1: Assessment after storing for 7 days at 12°C and 90% RH.
- Shelf-2: Assessment after storing for 30 days at -1°C

and 90% RH.

- Shelf-3: Assessment after storing for 30 days at -1°C and 90% RH + 7 days at 12°C and 90% RH.

Bio-Fresh™ edible coatings and coating of fruits

Bio-Fresh™ is an edible coating solution which is composed of sucrose fatty acid ester and carboxymethyl cellulose (CMC) in a concentrated liquid form (distributed by De Leye, Agrottrade, Netherlands). It was diluted with water at a temperature of 37 - 38°C to obtain the desired concentration of 0.5, 0.8, 1.0 and 1.2% (0.83, 1.328 1.66 and 1.992 L Biofresh™ per 100 L of water). The diluted solutions were mixed for a few minutes and then the pears were drenched or dipped in the dilution for a few seconds so that the pears can be thoroughly wetted on all sides. After that the pears were dried by air blowing.

Firmness measurement

The firmness of pears was measured by using a universal texture analyzer (LRX, Lloyd Instruments, Hampshire, UK) by measuring the maximum penetration force required for a 11 mm diameter self cutting plunger to penetrate 1 cm into the pear at a rate of 8 mm/s. The values were taken at two points on the equator of each pear.

Soluble solid content measurement

Soluble solid content was measured from the pressed juice of the pear by means of a refractometer (HANNA, UK) and the results were expressed as ° Brix.

Color measurement

The surface color of pears was directly measured with a spectrophotometer (CM-2500d, Minolta, Japan). The equipment was set up for illuminant D65 and 10° observer angle and calibrated using a standard black reflector plate for zero and white reflector plate for one. The color changes were quantified in the L*,a*,b color space (defined by CIE in 1976). On each pear, five readings in five different areas were taken. The numerical values of a* parameter was employed to calculate the angle.

Incidence of disorders

Pears were cut longitudinally for measuring the internal browning and internal cavities using 30 pears. The flexibility of neck was measured by observing the shrinkage in neck by pressing. The visual evaluation was done for external flexible necks, and internal browning and cavities for pears by hedonic scale. The samples were evaluated using the following hedonic scale: 0 = excellent, 1 = very good, 2 = good, 3 = fairly good, and 4

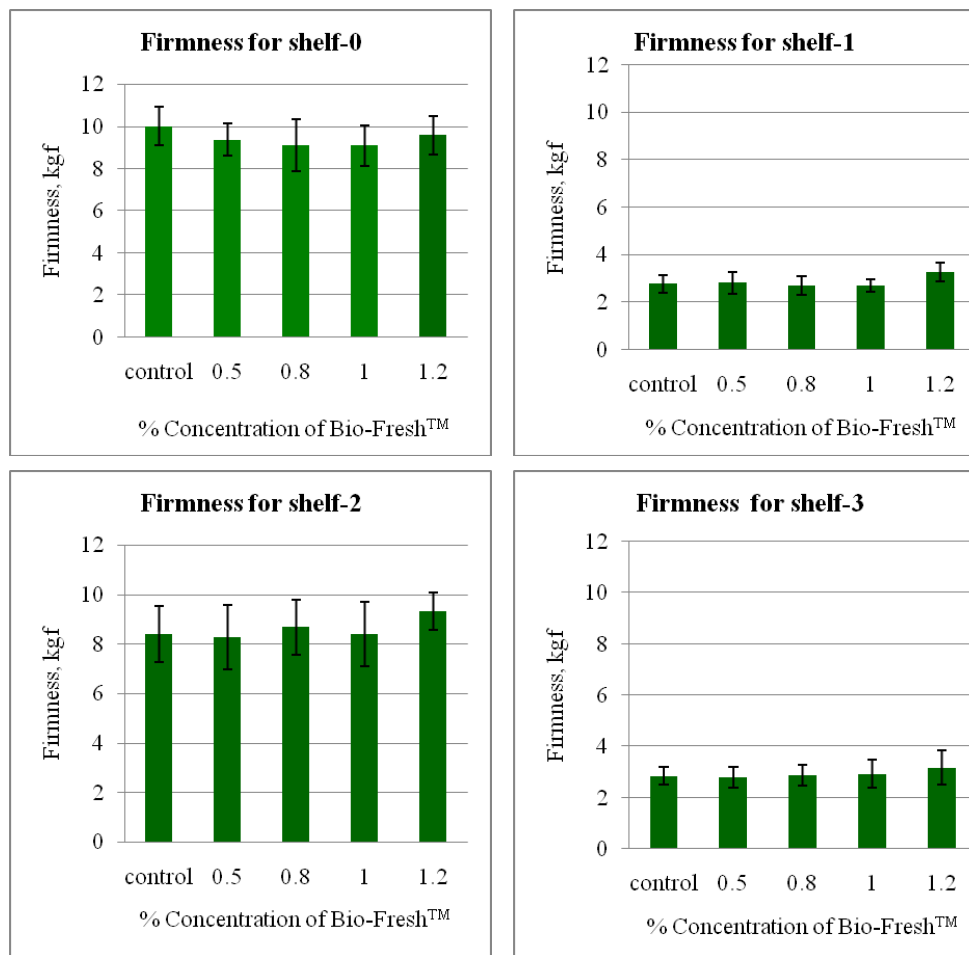


Figure 1. Changes of firmness among different concentrations of Bio-Fresh™ during shelf life study.

= bad for flexible necks. A value of 2 was considered as the commercial acceptability threshold.

Weight loss measurement

The samples were weighted using 30 pears individually with a laboratory balance. The results were expressed as the percentage loss of the initial weight. Weight loss was calculated from the initial weight using the formula:

$$Weight\ loss\ (\%) = \frac{(W_i - W_s)}{W_i} \times 100$$

where W_i was the initial weight and W_s is the weight at the sampling period.

Statistical analysis

Analysis of variance (ANOVA) was applied to the data obtained from each treatment to detect significance of differences at 5% level of significance ($P < 0.05$) to

analyze color, firmness and soluble solid contents and also Tukey mean comparison ($P < 0.05$) was used to see the comparison of each treatment mean. The statistical software that was used was the S-PLUS 8.0 version. All bars in the figure indicated standard error with ±95% confidence interval.

RESULTS AND DISCUSSION

Firmness

The effect of Bio-Fresh™ coating on the firmness of pears was measured. The results showed that all coating concentrations were effective for maintaining firmness. The firmness values were higher during shelf-1 and 2 than control one except shelf-0 (Figure 1) at concentration of 1.2% Bio-Fresh™. The mean comparison test confirmed that only coating of 1.2% Bio-Fresh™ had significantly higher ($p < 0.05$) firmness values than the control sample during shelf-1 and 2.

Previous research indicated that the inhibition activities

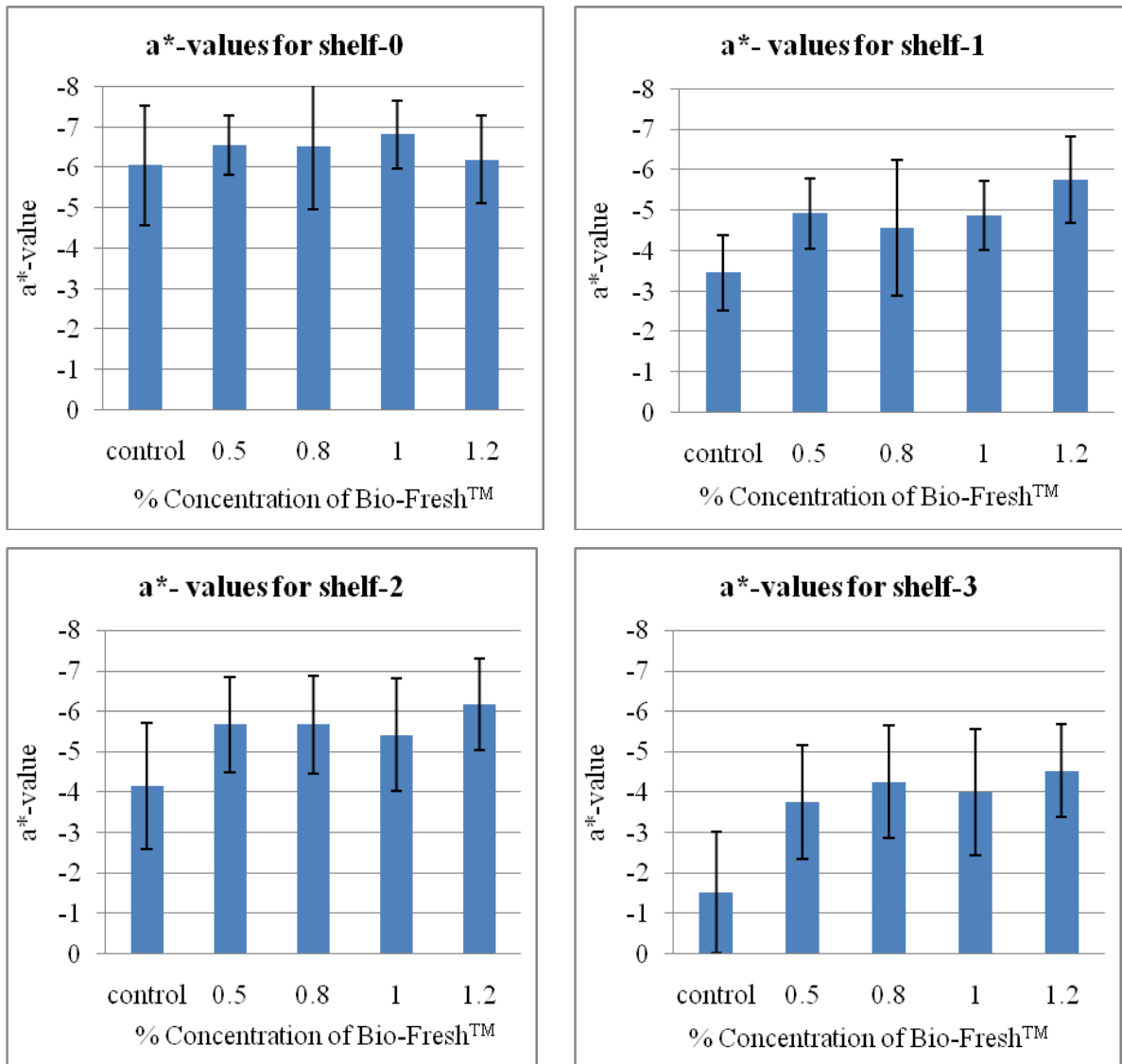


Figure 2. Changes of color among different concentrations of Bio-Fresh™ during shelf life study.

of pectin degrading enzymes was closely related to fruit softening and contributed to firmness maintenance by reducing the rate of metabolic process during ripening (Zhou et al., 2008). The results indicated that 1.2% coating concentration of Bio-Fresh™ maintained firmness by inhibiting the activities of pectin degrading enzymes and inhibiting water loss (Figure 1) on pears coated by dipping. Coating of 1.2% Bio-Fresh™ may also be used to make internal atmosphere modification (low oxygen and high carbon dioxide concentrations) on pears. Salunkhe et al. (1991) found that low oxygen and high carbon dioxide reduce the activities of these enzymes and allow the retention of the firmness during storage. Hence, results of the research nicely reflect the findings by Yaman and Bayindirli (2002) for cherries, Sumnu and Bayindirli (1995) for Amasya apples coated with

Semperfresh™, and Amarante et al. (2001) for pears coated with carnauba bases wax.

Color

The color changes have been quantified in the L*, a*, b* color space. The a*-values were correlated best with visual observance of green color: more negative a*-values indicated more green color. Therefore, color data were expressed as a*-values. The statistical analysis revealed that Bio-Fresh™ was significantly ($p < 0.05$) effective for retaining the green color of pears (Figure 2). Coating of 1.2% Bio-Fresh™ had higher negative values than other concentrations, except shelf-0, and had significantly more negative a*-values than the control sample.

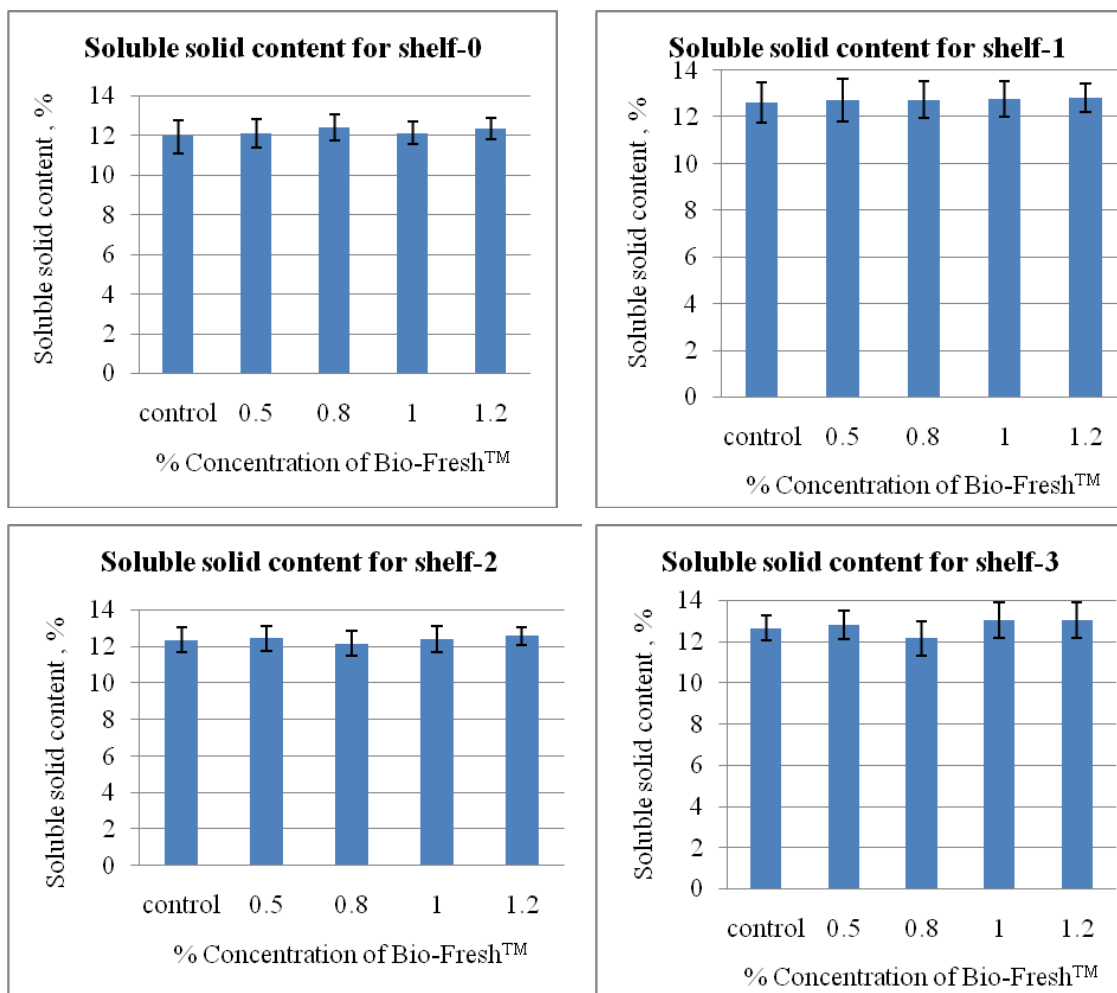


Figure 3. Changes of soluble solid content among different concentrations of Bio-Fresh™ during shelf life study.

Coatings of Bio-Fresh™ were more pronounced for the substantial effect on changes in skin color. All coating concentrations were significantly good for maintaining the green color of pears during different shelf life. Coating of 1.2% Bio-Fresh™ was more effective for retention of green color than control sample and other treatments. The beneficial effect of Bio-Fresh™ coatings on skin color can be explained by proper blockage of pores (lenticels and stomata) as well as cracks of the skin (Amarante, 1998). Similar results were found on banana coated with sucrose fatty acid esters (Momen et al., 1997), cherries coated with Semperfresh™ (Yaman and Bayindirli, 2002), and on pears (Amarante et al., 2001).

Soluble solid contents (SSC)

The soluble solid content is a common physical quality (maturity) indicator for fruits and fruit juices. Statistical analysis of the data revealed that all coating

concentrations were not significantly varied for retention of the soluble solid content during different shelf conditions but showed similar level of soluble solid content (Figure 3).

Soluble solids and organic acids of fruits are substrates that are consumed by respiration during storage (Ozden and Bayindirli, 2002; Yaman and Bayindirli, 2002). In this study, only 1.2% coating were slightly effective for the retention of soluble solid content compared to control and other treatments because of lower metabolic activities of pears during storage. Similar results were found with Zhou et al. (2008), Hasan and Arslan (2004) and Ju et al. (2000).

Weight loss

This quality parameter is quite crucial, since every loss in weight is translated into an economic loss. Additionally, the weight loss has a strong impact on the pears

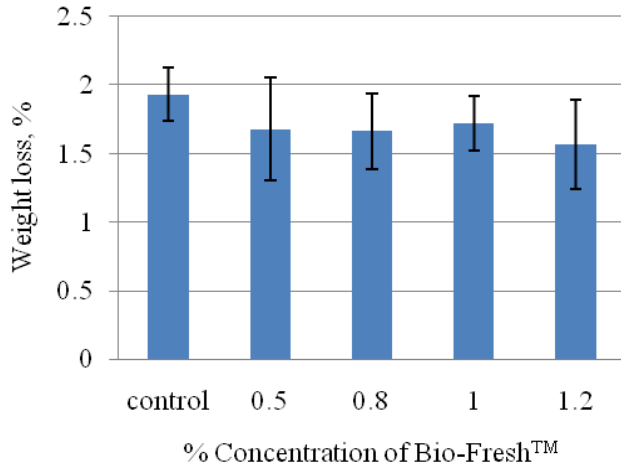


Figure 4. Weight loss among different concentrations of Bio-Fresh™.

appearance due to shrinkage or shriveling. Coating of pears with Bio-Fresh™ showed the variation of weight loss with storage time for coated and uncoated pears. The results (Figure 4) showed that coating of 1.2% Bio-fresh™ significantly reduced the weight loss among all coating concentrations.

The main mechanism contributing to the weight loss is the evaporation activated by a gradient in water vapor at different locations in fruit (Yaman and Bayindirli, 2002). Water diffuses preferentially through a liquid aqueous phase in the cuticle, where water conductance is considerably higher rather than through pores (Amarante et al., 2001). In this study, pear coated by dipping method showed coating of 1.2% Bio-Fresh™ was slightly effective for inhibition of weight loss during storage. The reason for the reduction in weight loss may be due to the blockage of lenticels and stomata (Amarante, 1998) as evidenced by the reduction in respiration and gas exchange (Hagenmaier and Baker, 1993).

Incidence of disorders

Edible coating can increase disorder of pears associated with high CO₂ or low O₂ by modification of the internal atmospheres of pears. To check the effects of Bio-Fresh™ edible coating, the following disorders were observed:

Cavities and internal browning

The analysis of variance revealed (Figure 5) that there were no significant observations of cavities and internal browning in pears during different shelf conditions compared to control sample in pears for different concentrations of Bio-Fresh™.

Cavities arise from brown tissue because of time course of internal browning (Lammertyn et al., 2000).

Browning disorder caused by imbalance oxidative and reductive processes due to metabolic gas gradients inside the fruit, leading to an accumulation of reactive oxygen species which may induce loss of membrane integrity through the enzymatic oxidation of phenolic compounds to brown color polymer compound (Franck et al., 2007). The Bio-Fresh™ coating applied by drenching and dipping exhibited well for inhibition of cavities and internal browning during shelf life study of pears.

Shriveling

Fresh produce is susceptible to shriveling due to water loss. The effects of Bio-Fresh™ coating on pears to reduce shriveling which allows the retardation of water loss were evaluated. The incidence of shriveling was observed when pears were coated by dipping in Bio-Fresh™ solution. The statistical analysis results showed that the effects of coating of 1.2% Bio-Fresh™ was significantly effective to reduce the incidence of shriveling on pears during shelf-2 (Figure 6). During other shelf conditions, all coatings were not successful due to high standard error although some coating concentrations of Bio-Fresh™ exhibited good for shelf-2 and 3.

Shriveling was caused due to water loss by respiration and transpiration (Woods, 1990). Coating of 1.2% Bio-Fresh™ was statistically effective to reduce the shriveling during shelf- 2 and 3 condition. Similar results were found by Diaz-Sobac et al. (1996) for mango coated with CMC and sorbitan fatty acid ester, and Zhou et al. (2008) for pears coated with Semperfresh™.

Conclusion

Pears coated by dipping showed that all coating concentrations of Bio-Fresh™ delayed the change in color of pears but there was a small effect on firmness, soluble solid contents (SSC), weight loss and reduction of shriveling during storage. Incidence of cavities and internal browning were negligible because coating of Bio-Fresh™ acted more effectively to maintain membrane integrity and to inhibit cavities and internal browning. The benefits of Bio-Fresh™ edible coating on pears resulted from 37 days of shelf life with perceptible quality for only coating of 1.2% Bio-Fresh™ concentration at condition of -1°C and 90% relative humidity. So, the results of this study suggest the use of 1.2% Bio-Fresh™ edible coating for extending the shelf life of pears.

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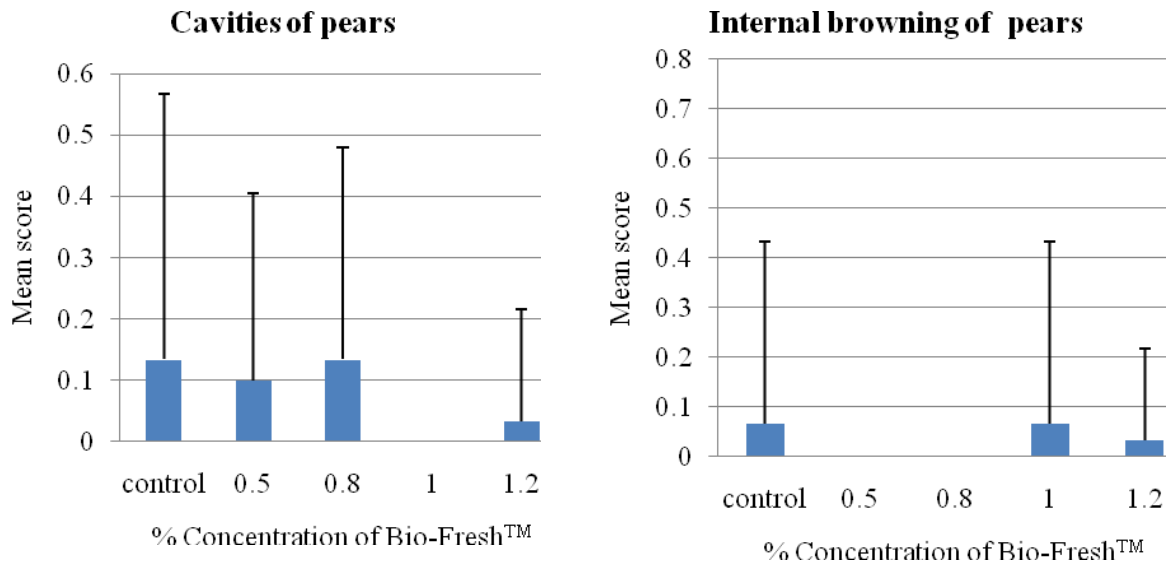


Figure 5. Incidence of cavities and internal browning on pears among different concentrations of Bio-Fresh™.

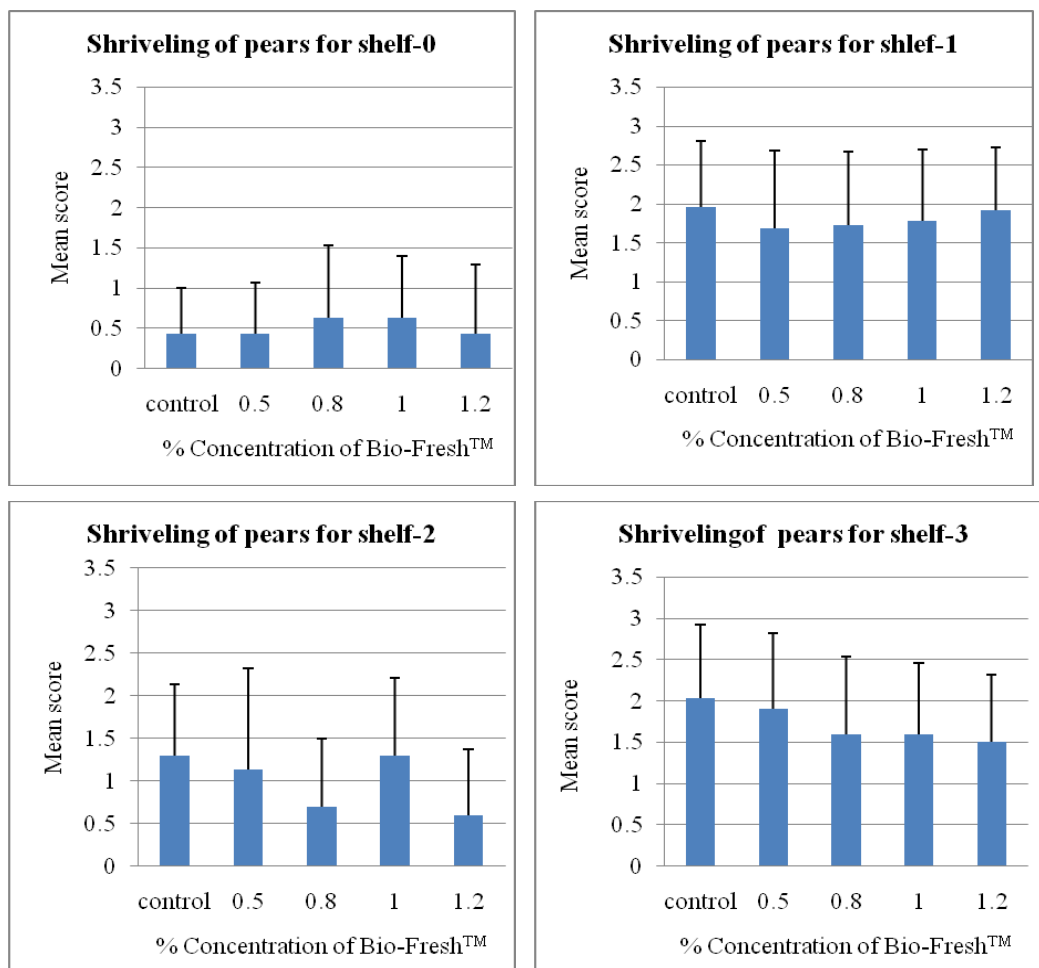


Figure 6. Incidence of shriveling on pears among different concentrations of Bio-Fresh™ during shelf life study.

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