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Postharvest Application of Edible Coatings and Low Temperature Storage Affect the Storability of Fresh Plums

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Abstract—*The combined effects of edible coatings and low temperature on the quality maintenance and shelf life of plums were investigated. Plum fruits were treated with edible coatings, namely, Semperfresh™ (1:3) vegetable wax (1:5), lac based (2:3) and water dip (control) after short distance transportation to the laboratory. Analytical determinations were made after 7, 14, 21, 28 and 35 days at 2 ºC. The colour changes were significantly delayed by the use of edible coatings. Our results revealed that control fruits showed higher losses during transportation due to compression injury as compared to edible coated fruits. All the coatings significantly reduced the changes in hue and chroma. The fruit decay was also delayed significantly in coated fruits. Amongst the different coatings applied, lac based coating was found to be the best in maintaining maximum colour and overall fruit quality followed by Semperfresh™ and vegetable wax coating in comparison to control samples. Low temperature and application of the coatings also resulted in prolonging the postharvest life of the fruit. Overall results suggest that the treatment of plum fruit with edible coatings was found to be the best to maintain quality of plums upto 35 days.*

Keywords*: Plum, storage life, edible coating, Semperfresh™, vegetable wax, lac based.*

1. INTRODUCTION

Plum is a highly perishable fruit with a short shelf life. It is known as a healthy fruit containing abundant vitamins and minerals. Its quality loss is a main concern during storage, transportation and marketing. To delay the ripening of plum fruit, several treatments have been used to enhance the shelf life of plum fruit, such as modified atmosphere packaging, low temperature storage and treatment with chemical agents of 1-1-MCP and chlorine dioxide etc. (Bal, 2013; Chen & Zhu, 2011). Given the perishable nature of fruit of plum, the use of low temperature storage is necessary to delay changes related to ripening such as respiration rate, ethylene production, softening, pigment changes and reduction in acidity (Guerra and Casquero, 2008). However, low temperature storage is not enough to preserve quality of plum fruit at optimum levels during transportation, marketing and storage, often leading to the incidence of severe chilling injury symptoms, evident as translucency and mealiness. Therefore, appropriate postharvest technologies combined with cold storage are needed. In this sense, various treatments prior to low temperature storage, such as 1-methylcyclopropene, calcium, polyamines and modified atmosphere packaging (Valero and Serrano, 2010) have been reported.

Application of edible coatings has been a popular preservation method in recent years because it is a more economical and easier procedure compared to other postharvest treatment methods. It works to control a modified internal gas composition and protective barrier that control dehydration, improves textural quality and retard the microbial growth by forming a thin film layer of edible, natural and biodegradable substances on fresh fruit. Different types of edible coatings as polysaccharides, lipids, proteins and composed films are employed. These edible coatings show promise as environmentally friendly quarantine treatments and can be placed on a surfaces of fruit through different ways like spraying and dipping. Coating consists of a thin layer of edible material that is applied to the surface of the fruit which is later consumed together with the commodity.

The objective of this work was to evaluate the effect of edible coatings namely, Semperfresh™, vegetable wax and lac based on decay and quality characteristics of plum fruit during its cold storage. Semperfresh™ is composed of sucrose esters with high proportion of short-chain unsaturated fatty acid esters, sodium salts of CMC, and mixed mono and diglycerides. Lac resin is a secretion by the insect *Laccifer lacca* and is composed of a complex mixture of aliphatic acyclic hydroxyl acid polymers. Vegetable waxes such as carnauba wax are derived from the palm tree leaves (*Copoernica cerifera*).

2. MATERIALS AND METHODS

2.1 Fruit material and experimental design

The plum fruits cv. Santa Rosa was harvested at climacteric stage of maturity in the month of July, from a private orchard at Kullu (Himachal Pradesh). Harvested plum fruits procured

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from the private orchard were transported to laboratory, subjected to application of different edible coatings, namely, Semperfresh™ (1:3), vegetable wax (1:5), lac based (2:3) and control (distilled water dip), air-dried for 1 h and then packed in punnets having holes for ventilation followed by storage at 2 ± 1°C, for further study.

2.2 Analytical determinations

Observations on decay and colour were recorded during storage at low temperature (2 ± 1°C). Fruit decay loss was calculated by counting the diseased and healthy plums in each treatment at regular intervals and expressed as percentage. Skin colour was determined using Hunter Lab System (model: Miniscan XE PLUS). The colour value was expressed chroma index (Chroma = $(a^2+b^2)^{1/2}$) and hue angle ($\tan^{-1}$ b/a) by using corresponding L*, a* and b* values.

2.3 Statistical analysis

Two way analysis of variance was performed on the data sets using SAS 9.3 software and significant effects ($P < 0.05$) were noted. The data were expressed as means ± SEM of triplicate analysis.

3. RESULTS

3.1 Colour

Changes in hue angle [arctan (b/a)] and chroma $[(a^2+b^2)^{1/2}]$ of control and coated plum fruits during storage at low temperature in given in Figs. 1 and 2. In general, hue angle and chroma decreased significantly ($P < 0.05$) during storage. The fruit became redder and darker along with increased storage time. Control samples revealed progressive decrease in hue angle with the progression of storage. In contrast, the decrease in hue angle was slower and more gradual in the coated fruits, irrespective of the coating. Amongst the coatings, Semperfresh™ and lac based resulted in the slowest decrease in hue angle but the decrease continued until the end of storage. While not significantly different, best control of changes in fruit colour in terms of chroma values were observed in Semperfresh™ and lac based coated fruits.

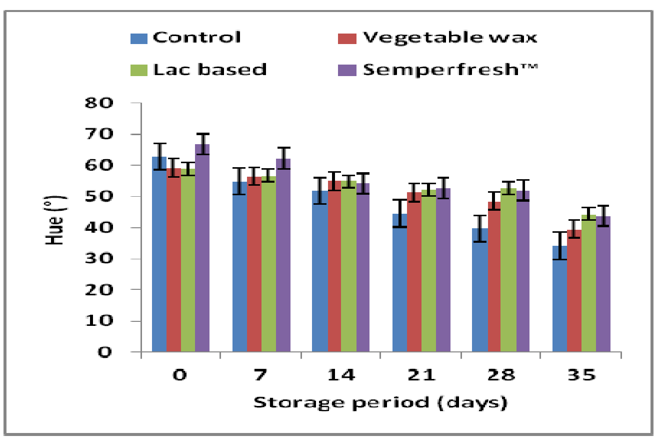

Fig. 1: Effect of edible coatings on hue angle in plum stored at 2 ± 1°C

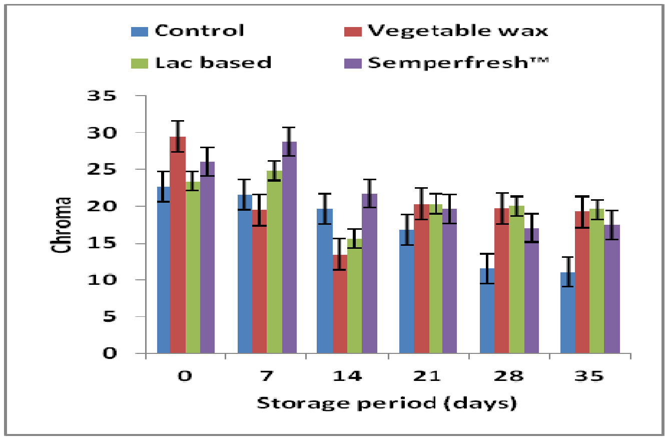

Fig. 2: Effect of edible coatings on chroma in plum stored at 2 ± 1°C

In general, the changes in skin colour in terms of chroma values was significantly higher in control (water dipped) plums stored at 2 ± 1ºC. For all the colour components, the influence of coatings and duration was found to be significant.

3.2 Fruit decay

Fruit decay of 'Santa Rosa' plums was significantly ($P < 0.05$) affected by the coatings. The fruit decay was significantly ($P <$ 0.05) lower at low temperature storage conditions (2 ± 1°C). At the end of storage period, highest fruit rot was observed in control (water dipped) fruits that were treated after transportation and stored at 2 ± 1°C. Lowest decay was observed in fruits with lac based coated which was lower than the control samples stored under cold conditions. The interaction effect of coating and storage duration was found to be statistically significant (data not shown).

4. DISCUSSION

4. 1Colour

Coated plums had a higher gloss than the control ones, with Semperfresh™ coated fruits having the highest gloss followed by lac based treatment. Skin colour changed during storage in all plum fruit samples to dark purple as could be inferred from the decrease in the chroma and hue angle, the decline being least for coated plums stored at cold temperature storage (2 ± 1°C) (Figs 1 and 2). This might be due to the synthesis of anthocyanins, the pigment contributing to the purple colour of plum fruits. Changes in colour of plum fruit were delayed by application of all edible coatings and also during low temperature storage suggesting a delay in the ripening of the plum fruit and retardation of the metabolic activities by the edible coatings, as also by the low temperature which ultimately led to inhibition of the anthocyanin synthesis. Eum *et al.* (2009) and Valero *et al.* (2013) also reported a similar trend in coated plums. Valero *et al.* (2013) also reported that

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colour changes were lower during low temperature storage of alginate coated plum fruits.

4.2 Fruit decay

Our findings revealed that, coatings were able to control the fruit rotting very effectively for fruits stored at 2 ± 1°. Highest fruit rot was observed in control (water dipped) fruits that were treated after transportation. This may be attributed to higher physiological activities and softer texture at this temperature which makes them prone to attack by pathogens. The fruits coated with lac based and Semperfresh™ showed a decreased disease incidence during storage because of low ethylene evolution rates and firmer texture as a result of which fruits were protected from attack by pathogens. These findings are supportive to the findings of Han *et al*. (2004), El-Anany *et al*. (2009) and Goncalves *et al*. (2010), who reported a decrease in the decay incidence in strawberries, apple and plums, respectively on application of different surface coatings.

5. CONCLUSIONS

The results showed that edible coatings are effective as postharvest treatments to extend storage life of plum fruits. The edible coatings evaluated in this study showed different effects on prolonging the storage life of the plums with lac based showing the most promising effects, closely followed by Semperfresh™ and vegetable wax. Coatings with cold temperature storage extended storage life by reducing decay incidence and maintaining the quality characteristics such as colour. In terms of storability, the coating treatment with lac based and Semperfresh™ were most effective to increase the plum storage period with optimal quality by one week in 2 ± 1ºC stored fruits more than uncoated samples.

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