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The Effect of Some Physical and Chemical Factors on the Apple Quality by Using Shellac as Coating Material

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Abstract: The extension of apple shelf-life is an important goal to be attained. A golden delicious apple have been used to be coating by shellac with concentrations 3, 5, 7 and 9% in absolute ethanol. The coated apples were stored at 5, 25 and 37°C for various periods of storage. It was found that, the weight loss percentages of apples were decreased by using the shellac as coating material as compared with the control (untreated apples). There is a proportional relationship between weight loss and temperature degree but a reversal relationship has been found between the shellac solution concentration and the weight loss percentage. Increasing in total soluble solids has been associated with weight loss, therefore, the high concentration of shellac solution reduce the weight loss in treated apples especially at lower temperature (5°C). Decreasing in titratable acidity has been observed during the storage, especially in the control. The decreasing has been restricted by using high concentration of shellac solution. The present study also refer to the apple expire date at different time, temperature and shellac solution concentrations.

Key words: Physical and chemical factors, shellac, apple quality

INTRODUCTION

Apple (*Malus domestica*) is one of the most frequently consumed fruit. Apple constitute an important part of human diet, as it is a source of monosaccharide, minerals, dietary fiber and various biologically active compounds, such as vitamin C and certain phenolic compounds which are known to act as natural antioxidant (Jihong *et al*., 2007). The organic acids and phenolic compounds along with sugars determine the quality of apple (Dolenc and Stampar, 1997 and Miller and Rice-Evans, 1997).

Many storage techniques have been developed to extend the marketing distances and holding periods for commodities after harvest (El-Anany *et al*., 2009). Different preservation methodologies have been studied. One method of extending post harvest shelf-life is the use of the edible coatings (Baldwin *et al*., 1995). Edible coatings provide a semipermeable barrier against oxygen, carbon dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rates (Baldwin *et al*., 1999 and Park, 1999). Coating is an industrial process which often consists of applying a liquid on the surface of a product of any possible shape to possess new properties. Surface coatings can decrease fruit peel permeability, modify the internal atmosphere, reduce water loss and depress respiration rate (Bai *et al*., 2002 and Banks *et al*., 1993).

Shellac is a natural polymer derived from the hardened secretion of the lac insect (Laccifer lacca) which grows on some specific types of trees in China, India, Burma, Thailand, Laos and Vietnam (USDA, 2002). Shellac is composed of complex mixture of aliphatic and alicyclic hydroxyl acids and their polyesters like, aleuritic acid, shelloic acid, jalaric acid and other compounds (Limmatvapirat *et al*., 2005 and Luangtana-Anan, 2007). Shellac is 100% natural, 100% non toxic and is FDA approved. It is only finish that should be used on children's furniture due to its non toxicity (Farag and Leopold, 2009). Due to the natural origin of shellac and protective properties by forming a superficial protective film, it is widely used in the food industry, sealing, glossing and in pharmaceutical industry where it is used as an acceptable enteric coating material for phytopharmaceuticals and food additives where synthetic polymers do not fit into the product image (Smolinske, 1992 and McGuire and Hagenmaier, 2001).

Shellac was used to coat apples and citrus to improve the appearance by adding gloss, to prevent water loss that leads to shriveling and subsequent loss of marketability and to maintain quality through delayed ripening and senescence. Shellac is recognized as one of the shiniest coatings, was found to improve the appearance and, it is assumed, increased subsequent sales of red and green apple cultivars (Jinhe *et al*., 2003). The present work is studying the effect of shellac as edible coating material on the shelf-life and the quality of apple stored at different temperature, time and shellac concentrations.

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MATERIALS AND METHODS

Golden delicious apples have been used in this study. The apples were chosen to be identical and to some extent are same in their weights. The injury apples were discarded and the suitable apples were taken with their stems to make the dipping process easiest. Shellac solution concentrations 3, 5, 7 and 9% were prepared by using ethanol 99%. The crude solutions were settle for 24 hr. at room temperature before the filtration processes have begin with steel sieve of 300 µm pore size and then with No. 1 Wattman filter papers. The clean apples were completely dipping in the clear solution of each concentration and exposed to air fan for drying. The treated and control apples were stored at different temperature 5, 25 and 37°C for various periods of storage (by days). Some quality factors have monitored throughout the experiment, weight loss%, total soluble solids (TSS%), total acidity and the spoilage date of the apples (expire date). The total acidity (as malic acid) has been determined according to (Egan *et al.*, 1988), the TSS% was measured by using Abbe refractometer and an accurate Sartorius balance was used to record the changing in apples weight.

RESULTS AND DISCUSSION

Apples usually are coated before marketing, primarily to improve their appearance. Other benefits of coatings include shelf-life extension, reduction of weight loss and respiration rate, ripening retardation and quality maintenance (Saftner *et al.*, 1998). Shellac-coated fruits exhibited high flesh firmness, most likely due to delayed ripening by a modification of the internal atmosphere or due to less weight (water) loss. Since control fruit lost more water, the shrinkage has been appeared (Jinhe *et al.*, 2003). As shown in Fig. 1, 2 and 3, there was a proportional relationship between the weight loss percentages and the storage period. The Fig. showed a reversal relationship between the concentration of shellac solutions and the weight loss percentages in apple fruits. High weight loss percentages were associated with the control fruits (untreated samples). The Fig. 1, 2 and 3 showed another relationship between the temperature degrees and the loosing in stored apple weights. At 5°C, the control apples have lost as an average 2.97% of its initial weight after 30 days of storage comparing with 1.650, 1.287, 1.150 and 1.087% loss in coated apples respectively by using 3, 5, 7 and 9% of shellac solution concentrations at the same time of storage. At high temperature degrees (25 and 37°C), the weight loss percentages going to be more and more, its 9.67 and 24.00% at 25 and 37°C in the control apples after 16 days comparing with 6.45 and 13.75% by using 3% shellac solution; 5.50 and 10.00%; 4.75 and 6.40% and 3.79 and 3.30% by using 5, 7 and 9% shellac solutions respectively. If we are looking for the expire date of apple, it was 14 days at 5°C for the

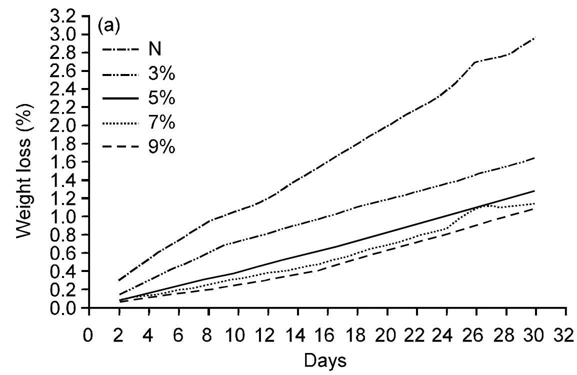

Fig. 1: Weight loss percentages in apples at 5°C by using 3, 5, 7

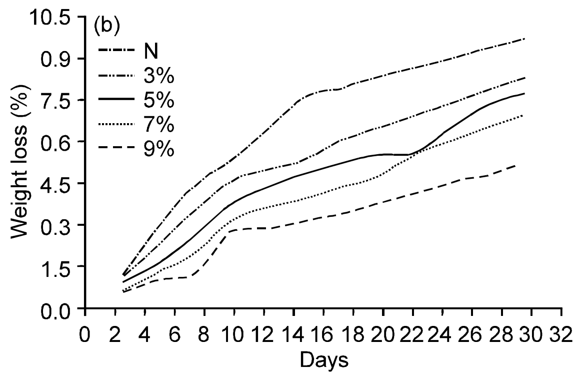

Fig. 2: Weight loss percentages in apples at 25°C by using 3, 5, 7 and 9% shellac solutions as compared with control and 9% shellac solutions as compared with control

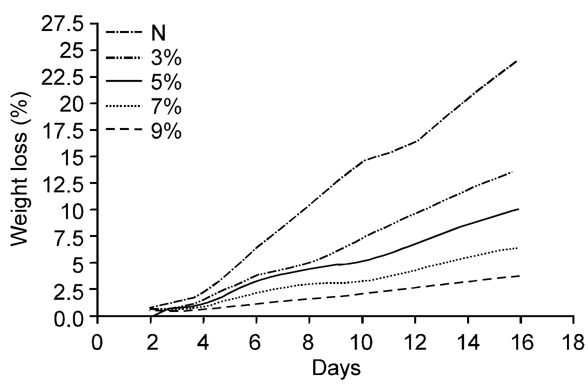

Fig. 3: Weight loss percentages in apple at 37°C by using 3, 5, 7 and 9% shellac solutions as compared with control

control samples comparing with 20, 24, 28 and 30 days for 3, 5, 7 and 9% shellac-coated apples respectively at the same temperature. The expire dates for the apples stored at high temperature degrees are closer, at 25°C, referred to 8, 14, 20, 22 and 24 days for control (0), 3,

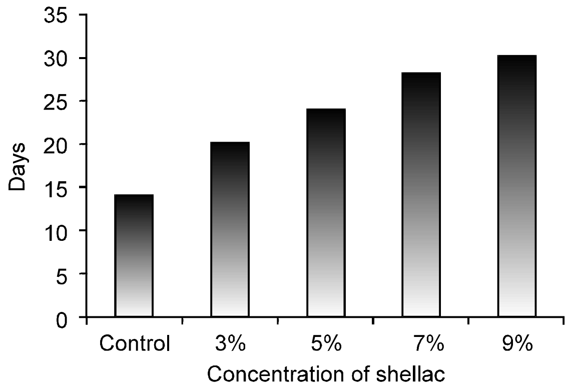

Fig. 4: The expire date (validity) of coated apples at 5°C as

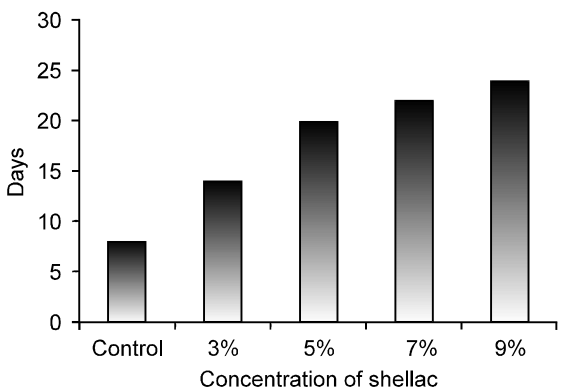

Fig. 5: The expire (validity) of coated apples at 25°C as compared with the control. compared with the control

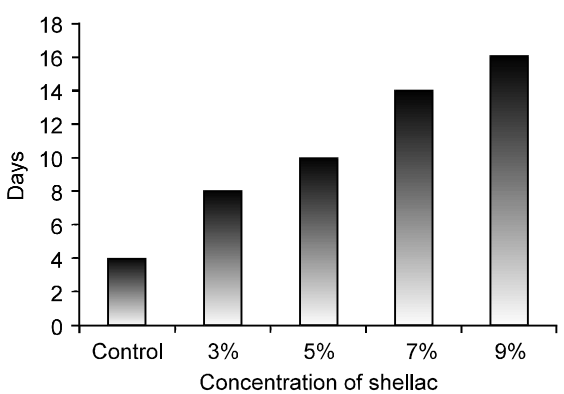

Fig. 6: The expire date (validity) of coated apples at 37°C as compared with the control

5, 7 and 9% shellac solution concentrations, while it were 4, 8, 10, 14 and 16 days for 0% (control), 3, 5, 7 and 9% shellac solution concentrations at 37°C respectively. If we are looking for the expire date of apple (Fig. 4, 5 and 6), it was 14 days at 5°C for the control samples comparing with 20, 24, 28 and 30 days for 3, 5, 7 and 9%

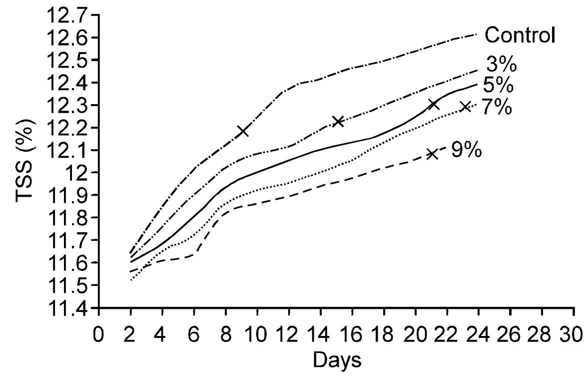

Fig. 7: The development of total soluble solids (TSS%) at 5°C by

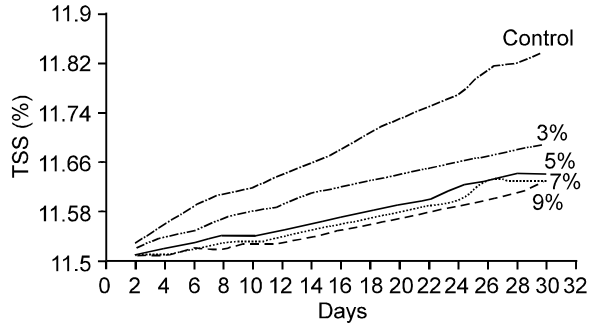

Fig. 8: The development of total soluble solids (TSS%) at 25°C by using 3, 5, 7 and 9% shellac solutions comparing with control. using 3, 5, 7 and 9% shellac solutions comparing with control

shellac-coated apples respectively. The expire dates for the apples stored at high temperature degrees are, at 25°C, referred to 8, 14, 20, 22 and 24 days for control (0), 3, 5, 7 and 9% shellac solution concentrations, while it were 4, 8, 10, 14 and 16 days for 0% (control), 3, 5, 7 and 9% shellac solution concentrations at 37°C respectively. The validity (the expire date) of the apple fruits to be consumed by the consumers have been restricted according to the internal bad changes in the fruit flesh which are taking place after a certain time of storage at the applied temperatures. Although, the external appearance is still acceptable, the black heart and the crispiness of the internal fruit flesh are the more noticeable changes. These undesirable changes are refer to damage in the coating layer which permit the oxygen to be permeate freely in side, in addition to the damage in internal flesh which liberate the polyphenol oxidase. Other changes in total soluble solids and total acidity are also associated with expire dates of apple fruits.

Figure 7, 8 and 9, showed the effect of shellac coatings on the Total Soluble Solids (TSS%) of apples at different temperatures and storage time as compared with untreated apples (control). As a result to the water loss

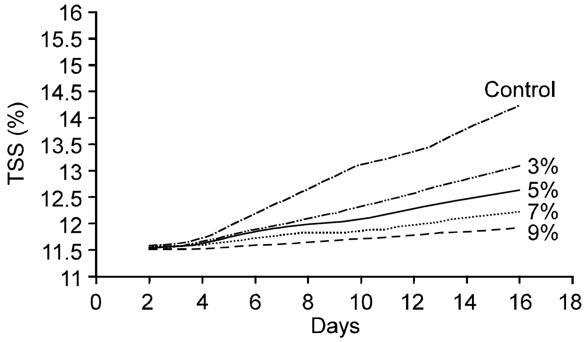

Fig. 9: The development of total soluble solids (TSS%) at 37°C by using 3, 5, 7 and 9% shellac solutions comparing with control

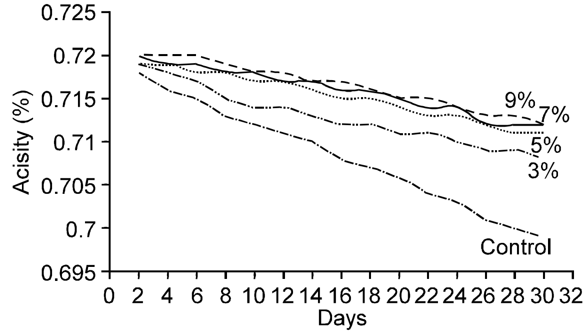

Fig. 11: Decreasing of titratable acidity during apple storage at 25°C y using shellac as coating material. by using shellac as coating material

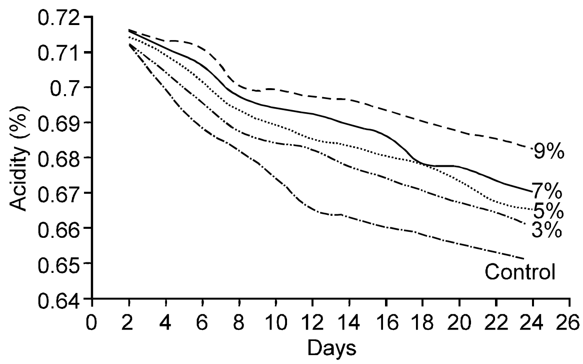

Fig. 10: Decreasing of titratable acidity during apple storage at 5°C

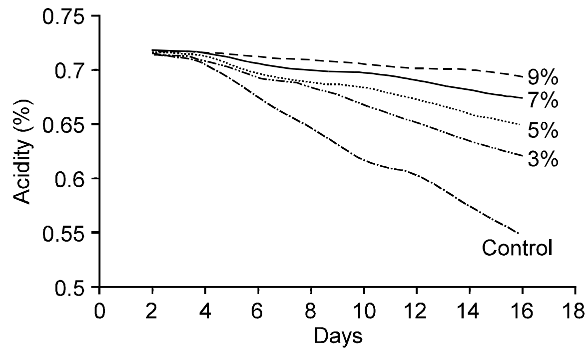

Fig. 12: Decreasing of titratable acidity during apple storage at 37°C by using shellac as coating material

there is a development in the total soluble solids percentages associated with the storage period.

There were reverse relationships between the concentration of shellac solutions and the development in Total Soluble Solids (TSS%) as compared with the initial value. High percentages in TSS are associated with the control fruits. A proportional relationship has taken place between the development in total soluble solids and temperature degree. High percentages in TSS have been obtained by using 37°C as compared with 25 and 5°C. The increase in total soluble solids percentages are associated with the loss in apple weight (water) percentages.

Figure 10, 11 and 12, show the decreasing in titratable acidity during storage by using different levels of shellac concentrations. Since, organic acid such as malic acid is a substrate for respiration action, a reduction in acidity will taking place and, hence, an increase in pH values was obtained. By using coating materials such as shellac, the respiration rates will decrease and therefore may delay the exhausting of organic acids (Yaman and Bayindirli, 2002). Patricia *et al.* (2005) indicated that the coating by applying polyvinyl chloride as coating material were effective in retention of titratable acidity of strawberry fruits during the storage periods. Retention of titratable acidity was indeed reported for various fruits all treated with semperfresh (Bayindirli *et al.*, 1995 and Summu and Bayindirli, 1995). The same observations were reported by Pre-Aymard *et al.* (2005), that the coating with 1-methyl cyclopropene has reduce the acidity loss of Anna apple stored at 20°C for 12 days.

Conclusion: Shellac as a natural resin has considerable advantages on apple shelf-life. High shellac solution concentration and low temperature degree retained the fresh quality of apples as compared with control.

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