VOL. 9, NO. 4, APRIL 2014 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

COMBINED EFFECT OF EDIBLE COATING AND PACKAGING MATERIALS ON POST HARVEST STORAGE LIFE OF PLUM FRUITS

Muhammad Sohail[1], Shamsur Rehman Afridi[1], Rehman Ullah Khan[1], Farman Ullah[2] and Bibi Mehreen[3]
[1]Food Technology Centre, PCSIR Labs Complex, Peshawar, Pakistan
[2]The University of Agriculture, Peshawar, Pakistan
[3]Department of Chemistry, University of Peshawar, Pakistan
E-Mail: msohail294@gmail.com

ABSTRACT

An experiment was conducted to investigate the effect of edible coating and different packaging materials on the post harvest storage life of plum fruits. The edible coating was comprised of [gum arabic (1%) + glycerine (2%)]. After applying the edible coating fruits were stored in different packaging materials such as polyethylene, newspaper, soft board carton, rice paper and wooden crate. While one treatment was kept as control in an open shelf of 48" x 40" neither edible coated nor packed. The physicochemical and organoleptic characteristics such as weight loss, total soluble solids (TSS), decay index, titratable acidity, ascorbic acid content and overall sensory acceptability were determined at an interval of three days up to the successful completion of the study (15 days). Statistical analysis showed that edible coating and packaging materials have significant ($P<0.05$) effects on the weight loss, decay index, acidity and over all acceptability of the plum fruits during storage while non significant results were obtained for ascorbic acid and TSS. The TSS increased during storage but individual packaging had non-significant effect on the TSS. Ascorbic acid decreased from 5.76-4.77mg/100g during storage for all treatments because of its oxidation during storage. Acidity percentage was first decreased (2.31- 1.95%) for nine days and then increased (1.96-1.99%). Similarly significant decrease was observed in overall sensory acceptability (8.85-2.27), while a significant increase was observed in decay index (0-33.92 %) and % weight loss (0-2.27) during storage. Results showed that plum fruits stored in soft board carton with edible coating were found to be most acceptable as per physico-chemical and sensory analyses.

Keywords: plum, storage, post harvest, firmness, decay, weight loss.

INTRODUCTION

Plum (*Prunus domestica*) belongs to the group of deciduous fruits commonly known as stone fruit. It is a major fruit of Pakistan and is grown mostly in temperate regions, while some low chilling verities may be grown in the milder parts of sub-tropical regions of KPK, Quetta and Qallat divisions of Balochistan (Saima, 2001). Plum is very tender and perishable fruit having high percentage of water content (86.6%), calories (48ergs), protein (0.5g), carbohydrates (12.3g), Niacin (0.5mg), Riboflavin (0.03mg), calcium (12mg), P (18mg), Fe (0.5mg), Na (1mg) and K (170mg) per 100 grams of edible portion. All this composition makes plum a good nutritious fruit (USDA, 2010).

Unlike most food products, fresh fruits and vegetables continue to breathe or respire after they have been harvested. This process consumes oxygen and produces carbon dioxide and water vapors. The key to keeping these products fresh for as long as possible is to reduce the respiration rate without harming the quality of the product. The rate of respiration can be reduced by keeping the temperature low, having lower levels of oxygen in the packaging atmosphere and increased levels of carbon dioxide (Khan *et al*., 2007).

The practice of using edible coatings on fruits after harvest to prevent shrinkage from water loss and create a modified internal atmosphere around the fruit is not new, and has a long history in the fruits industries. As with whole fruit, edible coatings may maintain appearance and texture of fruit, and slow down degradation processes, depending on ingredient combinations (Rosario, 1996). Packaging is a mean of providing a correct environmental condition for food. The method of food preservation is much more depending upon the packaging materials. Deterioration is a response to the external circumstances and much of the packaging, which remains in direct contact with food, delay the process of deterioration for the required time. Although chemical preservatives act upon controlling spoilage, but packaging provides support for chemical preservatives in addressing the issue of micro organism. Packaging also lowers the ingress of moisture, oxygen, or foreign odors (Hans, 1992).

Thus critical evaluation of edible coating and different packaging materials for storage stability of fruits is crucial to avoid post harvest losses. The present study was thus made to assess the effectiveness of edible coating and various packaging materials on physico-chemical and organoleptic characteristics stability of plum fruits to identify the most appropriate packaging material along with edible coating for their safe storage.

MATERIALS AND METHODS

Selection of fruits

Plum fruits (Fazle Manani variety) having optimum maturity and firm texture were manually picked from the local fruit orchard of PCSIR Labs Complex Peshawar Pakistan and brought to the Food Technology

ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

Centre immediately, where the research work was conducted. After sorting and washing, fruits were dried under a ceiling fan.

Preparation of edible coatings

Edible coating was prepared using 1% gum arabic and 2% glycerine in de ionized water, the solution was mixed thoroughly. The fruits were divided into six lots. Five lots were dipped in this edible coating solution for 10 minutes while one lot was kept as control with out edible coating.

Packaging of the coated fruits

After applying the edible coating the fruits were packed in different packaging materials as shown below and stored at room temperature ($32^oC\underline{+}2$). The control fruits were kept in an open shelf of $48''$ x $40''$ dimension.

T_o = Control
T_1 = News paper
T_2 = Poly ethylene bag
T_3 = Soft board carton
T_4 = Rice paper
T_5 = Wooden crate

Chemicals and reagents

All the chemicals and reagents used were of analytical grade. Gum arabic, glycerine and sodium hydroxide was from Merck (damstadt, Germany) while 2, 6- dichlorophenol indophenol dye, sodium bicarbonate, meta phosphoric acid and phenolphthalein indicator was from Sigma Chemicals Co. (St. Louis, USA).

Glass wares

All the glass wares used were Pyrex, soaked in chromic acid for 24 hours before using and washed several times with water, rinsed with deionised water, oven dried and stored in dust free atmosphere without touching their insides.

Physico chemical analysis

Evaluation for physico-chemical analysis was carried out in Food Technology Centre of PCSIR Labs Complex Peshawar Pakistan. The fruits were assessed initially and after three days interval up to successful completion (15 days) of the study.

Weight loss: Fruit weight loss was determined with the help of a method described by Wang *et al.* (2005). Fruits were weighed after every 3 days and the percent weight loss was calculated by using the following formula:

$$\text{Weight loss (\%)} = \frac{\text{Initial weight- Final weight}}{\text{Initial weight}} \times 100$$

Acidity (%) **and total soluble solids (^{o}brix):** Plum fruits were cut into small pieces and homogenized in a grinder. 10 g of ground sample was suspended in 100 ml of distilled water and then filtered. The filtered juice sample was titrated to pH 8.1 using 0.1M NaOH. Titratable acidity was expressed as % citric acid. The total soluble solid (TSS) was determined in the juice by means of digital refractometer (Atago Co. Ltd., Tokyo, Japan) at 20^oC initially and after each 3 days. Measurements were done in triplicate.

Ascorbic acid: Ascorbic acid (mg/100g) of the fruits was determined by dye reduction method of AOAC (2000).

Fruit firmness (kg)**:** After each three days interval, three fruits were randomly selected from each lot and their firmness was determined by pressing the knob of the penetrometer into the fruit. The average of these three was the firmness of the whole lot.

Fruit decay index (%)**:** Fruit decay was visually evaluated initially and after three days storage interval. Any plum fruit with visible mold growth was considered as decayed. For this purpose first fruit decay rate was assessed by measuring the extent of decayed area on each fruit, and was termed as: 0, no decay; 1, less than 1/4 decay; 2, 1/4–1/2 decay; 3, 1/2–3/4 decay. The average extent of fruit decay was expressed as decay index and was determined using the following formula as described by Wang *et al*. (2005).

$$\% \text{ Decay index} = [(1\times N_1+2\times N_2+3\times N_3)\times 100/(3\times N)]$$

Overall sensory acceptability

Samples were evaluated for overall sensory acceptability based on fruit shape, colour and flavour by a panel of 15 judges at the storage interval of 3 days using 9 Point Hedonic Scale of Larmond (1977).

Statistical analysis

Data on these parameters was taken in triplicate and was analyzed using ANOVA technique appropriate for Randomized Complete Block Design, while means were separated by using LSD test at 5 % level of significance as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSIONS

The percent weight loss calculated at the storage intervals showed that edible coating and different packaging materials have a significant effect on controlling the fruit weight loss because these treatments helped in reducing the rate of respiration and transpiration hence reduced the water loss from the fruit surface. However the treatment T_3 (soft board carton) and T_5 (wooden crate) significantly gave better results as compared to other packaging materials used. While fruits having no packaging materials and not treated with edible coating solution (T_O) showed highest weight loss percentage at the end of storage period (Figure-1). This may be due to the uncontrolled ripening in control fruits. This higher respiration rate also resulted in higher transpiration of water from the fruit surface which led to increase in percentage of weight loss (Sammi and Masud, 2007).

ARPN Journal of Agricultural and Biological Science

The data pertaining to vitamin C content is shown in Figure-2. Ascorbic acid is an important nutrient quality parameter and is very sensitive to degradation due to its oxidation compared to other nutrients during food processing and storage (Veltman *et al*., 2000). A decrease in the mean values of ascorbic acid was seen during the storage intervals. Only treatment T_o (control) and T_2 (polyethylene) differ significantly while the other treatments are non significant at 5% level of probability, which shows that all other packaging materials have same retention power of ascorbic acid except control and polyethylene materials.

The statistical analysis showed that edible coating and different packaging materials had a significant ($P<0.05$) effect on controlling the decay index of the plum fruits during storage (Figure-3). In the beginning of the study all the fruits were having no decay but at the end of the 15 days, maximum decay (85.41%) was depicted by control fruits, followed by T_2 (62.33%), while the minimum decay was shown by sample T_3 (34.23%) followed by T_4 (42.36%). The minimum decrease of decay content in coated and soft board carton packed fruits may be due to the fact that the packaging materials and edible coating did not allow the fruits to the external environment. Therefore the edible coating and packaging materials raise the possibility of producing fruits less susceptible to decay during storage (Jiang and Li 2001).

Initially the TSS content of the plum fruits (T_o, T_1, T_2, T_3, T_4, and T_5) was 10.7, 10.8, 10.9,10.8, 10.7 and 10.8 which increased to 15.1, 13.8, 12.9, 12.1, 13.1 and 12.8 ºbrix, respectively. Although total soluble solids increased significantly with the increase in storage time at 5% level of probability. But the treatment results showed negligible difference among the coated fruits stored in different packaging materials (Figure-4). However after 15 days of storage, increase in TSS was significantly ($P \leq 0.05$) higher in control sample compared to the treated fruits. The slower increase of TSS in edible coated fruits packed in soft board carton (T_3) and other packaging materials might be due to the fact that edible coating formed a thin layer on the surface of fruits which delayed degradation process. The increase in TSS was probably due to the hydrolysis of polysaccharides and concentrated juice content as a result of dehydration with the passage of storage time (Akhtar *et al*., 2010). Previously Hussain *et al.* (2004) also found no significant changes in total soluble solids in oranges stored in polyethylene bags.

The data regarding fruit firmness is shown in Figure-5. The mean values of fruit firmness significantly ($P<0.05$) decreased from 1.9 to 0.3 kg during 15 days storage. Initially the fruit firmness of the samples T_o, T_1, T_2, T_3, T_4, and T_5 was 1.9, 1.9, 1.8, 1.9, 1.8 and 1.8 kg respectively which were reduced to 0, 0.1, 0.2, 0.7, 0.4 and 0.5 kg, respectively at the end of the storage period. After 15 days of storage, control fruits recorded a decrease of 100% in firmness as against the 94.74%, 88.89% and 63.16%, 77.78% and 72.22% in T_1, T_2, T_3, T_4 and T_5, respectively. Edible coating and packaging materials increased firmness of fruits due to the decreased water loss, as the movement of water molecules slows down, the destruction of cell structure membrane was also reduced (khan *et al*., 2007).

The pattern of changes in acidity (%) was unique. There was a decrease in acidity percentage during first nine days of storage and then an increase was observed for all the fruits (see Figure-6). The acidity of samples (T_o to T_5) on day first was 2.31, 2.33, 2.35, 2.31, 2.29 and 2.29 % which were gradually decreased to 1.61, 1.99, 1.81, 2.17, 1.99 and 0.99%, respectively on day 9 and then slowly increased to 1.69, 1.98, 1.87, 2.19, 2.04 and 2.12%, respectively after 15 days storage. This may be due to the degradation of biochemical constituents of the ripened fruits during respiration resulting in certain acids at the end of the storage period. According to Bhattacharya (2004) acidity is often used as an indication of maturity, he stated that acidity declines during the initial stages of ripening and then started to increase again probably due to the fact that microbial activities increased the acid content of the fruits because of the fermentation at the end of the storage.

Figure-7 explains the overall sensory acceptability of control and the edible coated plum fruits stored in different packaging materials with respect to the consumer's point of view. It divulged that control fruits (T_o) showed the lower overall sensory acceptability (0.4) as compared to other treated fruits (T_1, 1.5) (T_2, 1.8) (T_3, 3.8) (T_4, 2.5) (T_5, 3.6) at the end of the storage study. On the basis of the overall sensory acceptability, the coated fruits stored in soft board carton (T_3) showed the excellent overall sensory acceptability (3.8) followed by wooden crate (T_5, 3.6). The higher overall acceptability of fruits subjected to edible coating and stored in different packaging materials is due to the positive effect of the treatments on delaying the processes responsible for decaying, solubilization of pectic substances and loss of volatiles (Han *et al*., 2004). Hence the higher retention of quality attributes like fruit firmness and appearance in edible coated plum fruits stored in soft board carton were responsible for their higher overall sensory acceptability values. These results are in agreement with the findings of Vargas et al., (2008) who observed that increasing storage time cause progressive degradation, which leads to decrease in overall sensory acceptability. However packed fruits were rated superior in appearance, aroma, flavour, texture and overall acceptability.

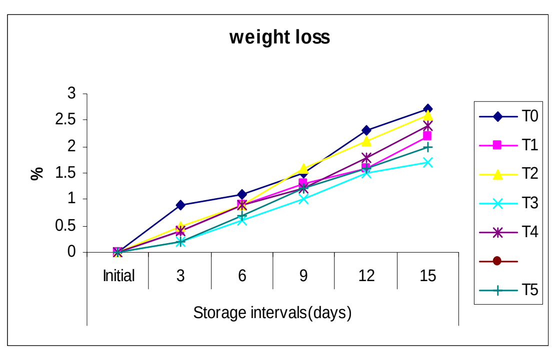

Figure-1. Effect of different packaging materials on weight loss % of plum fruits.

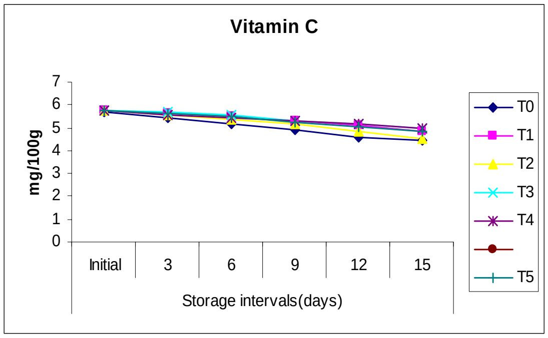

Figure-2. Effect of different packaging materials on vitamin C (mg/100g) of plum fruits.

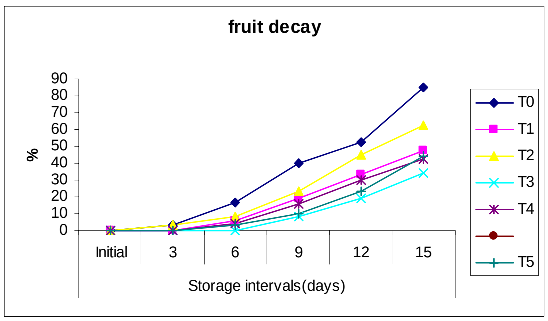

Figure-3. Effect of different packaging materials on decay index % of plum fruits.

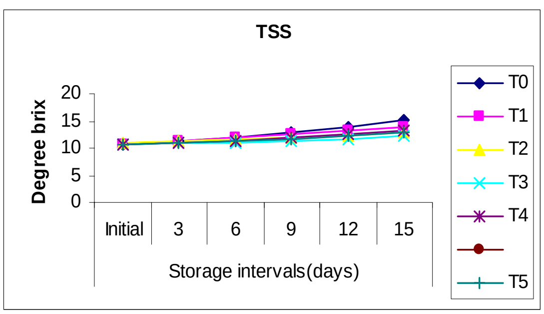

Figure-4. Effect of different packaging materials on TSS (°brix) of plum fruits.

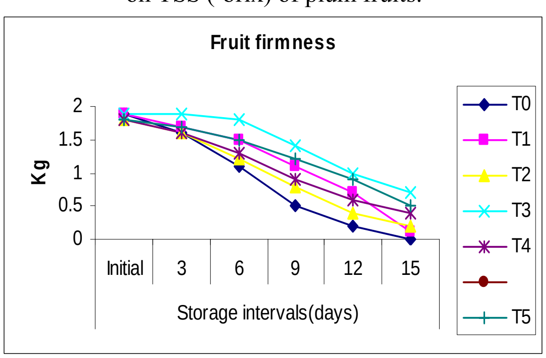

Figure-5. Effect of different packaging materials on fruit firmness (kg) of plum fruits.

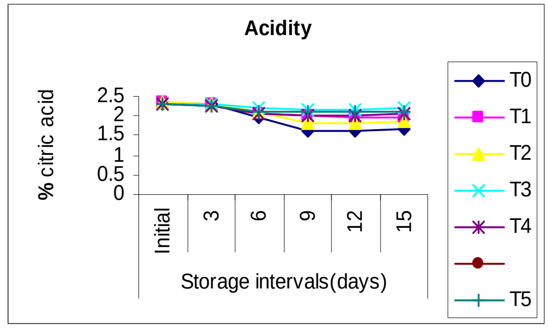

Figure-6. Effect of different packaging materials on acidity % of plum fruits.

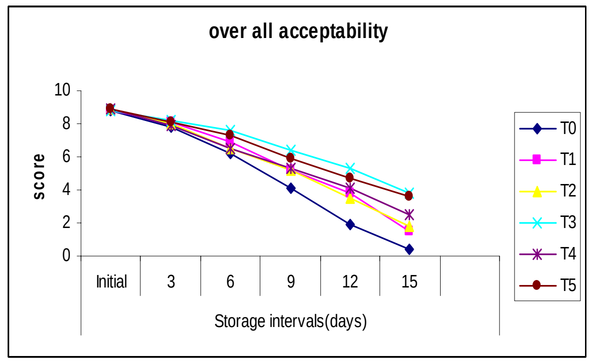

Figure-7. Effect of different packaging materials on over all acceptability of plum fruits.

CONCLUSIONS

The results led to a conclusion that edible coated plum fruits stored in soft board carton exhibited good storage stability followed by wooden crate as compared to other packaging materials used.

REFERENCES

Akhtar A., Abbasi N. A. and Hussain A. 2010. Effect of calcium chloride treatments on quality characteristics of loquat fruit during storage. Pak. J. Bot. 42(1): 181-188.

AOAC. Association of Official and Analytical Chemists. 2000. 15th Ed (Helrich, K.). Arlington, Virgina, USA.

Bhattacharya G. 2004. Food Processing Journal, http://www.timesb2b.com/food processing /html. Accessed July 15, 2013.

Gomez K. A. and Gomez A. A. 1984. Statistical procedure for agricultural research. 2nd Edition. pp. 8-22.

Han C., Zhao Y., Leonard S.W. and Traber M.G. 2004. Edible coatings to improve storability and enhance nutritional value of fresh and frozen strawberries (Fragaria×ananassa) and raspberries (Rubus ideaus). Post harvest Biol. Tech. 33: 67-78.

Hans Y.S.H. 1992. The guide book of food chemical experiments. Pekin Agricultural University Press, Pekin, USA.

Hussain I., Asif M., Ahmed M., Khan M. and Shakir I. 2004. Effect of Uni-Packaging on the Post Harvest Behavior of Citrus Fruits in N.W.F.P. Pak. J. Nutr. 3(6): 336-339.

Jiang Y. and Li Y. 2001. Effects of chitosan coating on postharvest life and quality of longan fruit. Food Chem. 73: 139-143.

Khan D., Khan A. R., Bibi S., Ali S. and Khalil I. A. 2007. Storage stability of persimmon fruits (diospyros kaki) stored in different packaging materials. J. Agri. Bio. Sci. 2(2): 20-23.

Larmond E. 1977. Laboratory method of sensory evaluation of food. Canada Deptt. Agri. Ottawa, Canada.

Rosario M. J. G. 1996. Formulation of ready to drink blends from fruits and vegetable juices. J. Phil. Agri. Res. 9(3): 201-209.

Saima N. 2001. M.Sc. (Hons) Thesis. Quality improvement and shelf life extension of plum fruit. Horticulture Department. Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan.

Sammi G. S. and Masud T. 2007. Effect of different packaging systems on storage life and quality of tomato during different ripening stages. Int. J. Food Safety. 9: 37-44.

USDA. 2010. National nutrient database for standard references. p. 23.

Vargas M., Pastor C., Chiralt A., McClements D.J. and Gonz´alez-Mart´ınez C. 2008. Recent advances in edible coatings for fresh and minimally processed fruits. Crit. Rev. Food Sci. Nutr. 48: 496-511.

Veltman R. H., Kho R.M., Vanschaik A.C.R., Sanders M. G. and Oosterhaven J. 2000. Ascorbic acid and tissue browning in pears under controlled atmosphere conditions. Post Harvest Bio. Tech. 19(2): 129-137.

Wang Y., Tian S. S. P. and Xiu Y. 2005. Effect of high oxygen concentration on anti oxidant enzymes in peach fruits during post harvest periods. J. Food Chem. 91: 99-104.