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Effect of Different Packaging Materials on Post-Harvest Status of Mandarin (*Citrus reticuleta* Blanco)

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Abstract

Five treatments viz plastic (20 µ) wrapping (T_1), plastic (20 µ) with 5 holes wrapping (T_2), plastic (20 µ) with 10 holes wrapping (T_3), Newspaper wrapping (T_4), Jute wrapping (T_5), no packaging materials (control) (T_6) with three replication were used. Physical attributes including shelf life, weight loss, color index, pathological disorder and marketability were observed in every three days. Plastic (20 µ) with 5 holes wrapping (T_2) was found best. This provides suitable environment for gaseous exchange and lowers transpiration and moisture loss rate and increases shelf life of fruits. The maximum shelf life (45 days) was recorded in T_2. Weight loss was maximum in T_6 followed by T_4 and T_5. The color change was rapid in T_1 followed by T_3 and T_6. T_1 and T_3 were severely affected by the pathogens causing greenish color in the samples. Marketability was higher in T_2 up to 42 days from storage followed by T_4 and T_5.

Keywords: *Citrus reticulata;* Post harvest; Packing material; Shelf life

Introduction

Mandarin Orange (*Citrus reticulata*), is one of the important and highly commercial citrus fruit of Nepal. It contributes to augmenting food availability, improvements in nutrition, generation of employment and income and also helps in maintaining the environment [1]. The exact location of origin of Mandarin fruit is not clearly identified though it is believed to be native to Southeastern Asia and Philippines. The spread of Mandarin to Europe from Asia was very slow. In Asia it is abundantly grown in Japan, Southern China and India. The tree is more drought-tolerant than the fruit. The mandarin is tender and is damaged easily by cold. It can be grown in tropical and subtropical areas. In Nepal mandar in orange is grown in the hilly areas.

Being a non-climacteric fruit, Mandarin do not have the peculiar rise in ethylene production and respiration after harvest, as observed in like climacteric fruits as apple and mango during fruit ripening. However, the endogenous ethylene or exogenously applied ethylene may have impacts on fruit shelf life and quality [2]. Likewise, its rate of respiration, which is an important determinant of the fruit shelf life, is influenced by temperature, humidity, movement of air, composition of gases, bruises and microbial infection [3].

Research is underway for improving fruit shelf life through modified atmosphere techniques using different types of packaging materials i.e. paper as the lining material, bagging, individual paper wrapping, polyethylene sheet lining, individual polyethylene shrink wrapping or seal packing, cardboard boxes covered with high and low density polyethylene etc. [4]. In an investigation, fruits of mature, green lemon and grapefruit fruits were sealed in low density polyethylene (LDPE) or high density polyethylene (HDPE; less permeable to O_2, CO_2 and water vapour) bags, and stored at 8°C for 3 months. Results showed that sealed packaging significantly reduced the incidence of chilling injury and decay. Weight loss was decreased by sealed packaging, while HDPE was more effective for decay control. Fruit total soluble solids content or acidity was not significantly affected [5].

Materials and Methods

The experiment was carried out from March 9 to July 23 2015 AD at post-harvest laboratory of HICAST Kalanki, Kathmandu, Nepal to determine the effect of different packaging materials of mandarin on post-harvest status. Five treatments *viz* plastic (20 µ) wrapping (T_1), plastic (20 µ) with 5 holes wrapping (T_2), plastic (20 µ) with 10 holes wrapping (T_3), Newspaper wrapping (T_4), Jute wrapping (T_5), no packaging materials (control) (T_6) with three replication were used.

Mandarin were brought to the laboratory from retailers shop in Kalanki and checking and rejecting abnormal, diseased and damaged fruits was done. The post-harvest status evaluation mandarin fruits were kept in ambient room temperature (18-25°C) and relative humidity (50-85%). Temperature and relative humidity of the observation were measured with the help of thermo-hygrometer. Qualities were observed in 2 days interval in the observation room on the visual basis.

Weight loss

Weight loss was measured by using the weighing machine. Weights was taken from first day till the samples were rejected at the interval of 2 days. The weight loss was calculated in percentage using standard procedure as mentioned in AOAC [6].

Weight Loss (%) = wt. of first interval – wt. of second interval × 100 / wt. of first interval

Color index

Color index was determined by using the visual observation method. The recordings were taken in 2 days interval.

Pathological disorder

To determine the severity of pathological disorders scaling was done from 1 to 5 i.e. 1 representing no disorder, 2 for slightly disordered, 3 for moderately disordered, 4 for highly disordered and 5 for extremely disordered. Samples were rejected if they reach the stage where they could not have any market value.

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Marketability

Marketability was done from the visual perceptions. To determine the marketability of Mandarin scaling was done from 1 to 4 i.e. 1 for highly marketable, 2 for moderately marketable, 3 for slightly marketable and 4 for not marketable. The samples were kept in the lab till they are supposed to fetch some market prices.

Shelf life

Shelf life of the samples was determined by various observations like pathological disordered and marketability. If the samples were not able to get any market value then they were rejected and the shelf life of those samples was determined.

Statistical analysis

The data were tabulated in excel sheet and statistically analyzed with the procedures described by Gomez and Gomez [7].

Results and Discussion

Effect of packaging materials treatments in shelf life

Among the various post-harvest status parameters of mandarin, shelf life is one of the major parameter determining the storage quality of mandarin. The data pertaining the effects of packaging materials treatments on shelf life is presented in (Figure 1).

The maximum shelf life was found in T_2 (22 days) which was followed by T_4 and T_5 (14 days) whereas the minimum shelf life was found in T_6 (9 days).

According to Kader and Arpaia [8], the most important factors affecting postharvest shelf life and quality include rootstock, cultivar, cultural practices, harvest conditions, and maturity stage, while the postharvest factors involve the operational efficiency, pre-cooling, various fruit treatments (fungicide, waxes etc.) and storage conditions.

Effect of packaging materials treatments in weight loss

The maximum physiological weight loss was found in T_6 (Control) which was 10.02 percent followed by T_4 (Newspaper wrapping) which was 9.35 percent whereas the minimum physiological weight loss observed in T_2 (Plastic with 5 holes (20 µ) wrapping) which was 0.28 percent followed by T_3 (Plastic with 10 holes (20 µ) wrapping) which was 0.58 percent (Table 1).

The weight loss was increased linearly in T_1 (Plastic (20 µ) Wrapping) and T_6 (Control) but in all other treatments weight loss was not linear. This is due to ambient room condition varying in temperature and relative humidity.

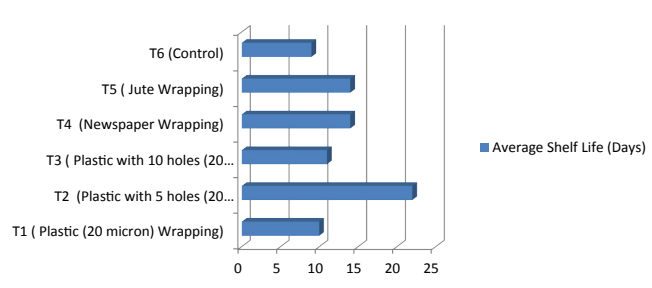

Figure 1: Effect of packaging materials treatments in Shelf life of Mandarin *(Citrus reticulata)*.

So the minimum weight loss was noted in packaging material treatment provided with Plastic with 5 holes (20 µ) wrapping. Transpiration is the major process leading to weight loss. The fruits packed in newspaper and jute wrapping were more affected than fruits packed in plastic wrapping. It means fruits in newspaper and jute wrapping produced higher rates of transpiration which resulted in decreased weight due to loss of moisture. Low weight loss was noted in fruits packed in plastic wrapping because of reduced levels of transpiration and evaporation within the package.

Gonzalez et al. [9] reported that plastic covering plays an important role in preventing dehydration by creating a saturated micro-atmosphere around the fruit. Moreover, the polyethylene films have the characteristic feature of reducing the rate of transpiration by restricting the diffusion of gases and feedback mechanism. This finding strongly agrees with Farooqi et al. [10] who reported that polyethylene and polyethylene green are impermeable to water; unipacking in such materials raises the humidity around the commodity and decrease moisture loss and results in decrease in weight loss.

Effect of packaging materials treatments in color index

The initial yellow color of mandarin fruit gradually turned into light yellow along with increase in storage days. In some treatments the light yellow color changed to green color.

The change in color was rapid in T_1 (Plastic (20 µ) Wrapping), T_3 (Plastic with 10 holes (20 µ) Wrapping) and T_6 (Control) after 6 days of storage. Whereas T_2 (Plastic with 10 holes (20 µ) Wrapping) was affected minimum by the color change (Table 2).

The change in color index is due to the level of CO_2 inside the treatments. This finding strongly agrees with Baldwin et al., [11], Buttery et al., [12], Buttery et al., [13] who reported that Ethylene and CO_2 production influence the qualitative nature of colour, flavour volatiles, sugars, and organic acids in tomato, which determines whole concept of fruit quality. In the process of fruit ripening to decay changes occur in the pattern of climacteric ethylene production. Eugenol decreases during ripening increased in concentration, peaking in the turning, pink, or red stage of maturity, all flavor components except ethanol and hexanol in the red stage.

Effect of packaging materials treatments in pathological disorder

The pathological disorder increased linearly with the increase in days of storage. T_1 (Plastic (20 µ) wrapping) and T_3 (Plastic with 10 holes (20 µ) wrapping) were severely affected by the pathogens causing greenish color in the samples. The minimal pathological disordered was found in T_2 (Plastic with 5 holes (20 µ) wrapping) followed by T_4 (Newspaper wrapping) and T_5 (Jute wrapping) (Table 3).

The lower spoilage percentage in polyethylene films lined boxes and crates might be due to retardation of enzymatic activity of post-harvest pathogens. Whereas, an increase in spoilage of pear fruits with the advancement of storage period was noted by Sandhu and Singh [14].

Effect of packaging materials treatments in marketability

The marketability change of mandarin fruit decreased rapidly along with the increase in storage days. T_2 (Plastic with 5 holes (20 µ) wrapping) have the marketability change up to 42 days of storage followed by T_4 (Newspaper wrapping) and T_5 (Jute wrapping). Due to the pathological infection T_1 (Plastic (20 µ) Wrapping) was not marketable from 12 days of storage (Table 4).

Treatments	Days of Storage																Mean	Median
	Weight loss (%)																	
	0	03	06	09	12	15	18	21	24	27	30	33	36	39	42	45		
T_1	_	0.51	0.67	0.72	0.85	-	-	-	-	-	-	-	-	-	-	-	0.68	0.72
T_2	_	0.39	0.45	0.52	0.35	0.10	0.30	0.10	0.60	0.10	0.20	0.20	0.10	0.20	0.30	0.41	0.28	0.60
T_3	_	0.47	0.40	0.57	0.90	-	-	-	-	-	-	-	-	-	-	-	0.58	0.57
T_4	_	11.39	10.50	7.85	8.61	8.42	-	-	-	-	-	-	-	-	-	-	9.35	7.85
T_5	_	5.56	5.38	3.93	4.06	4.24	-	-	-	-	-	-	-	-	-	-	4.63	3.93
T_6	_	11.47	10.70	7.91			-	-	-	-	-	-	-	-	-	-	10.02	10.70
F-Value		180.1562	227.3973	122.3772	271.1721	3.330944	-	-	-	-	-	-	-	-	-	-	-	-
CV (%)		102	99.36	94.08	145.77	204.96	-	-	-	-	-	-	-	-	-	-	-	-
CD (0.05)		8.65	8.04	5.76	5.66	4.98	-	-	-	-	-	-	-	-	-	-	-	-
SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.83	-

Table 1: Effect of packaging materials treatments in Weight loss of Mandarin *(Citrus reticulata)*.

Treatments	Days of Storage															
	Color Index															
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
T_1	1	1	2	3	3	-	-	-	-	-	-	-	-	-	-	-
T_2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
T_3	1	1	2	2	3		-	-	-	-	-	-	-	-	-	-
T_4	1	1	1	1	2	2	-	-	-	-	-	-	-	-	-	-
T_5	1	1	1	1	2	2	-	-	-	-	-	-	-	-	-	-
T_6	1	1	2	2			-	-	-	-	-	-	-	-	-	-

*1= Yellow, 2= Light Yellow, 3= Green

Table 2: Effect of packaging materials treatments in Color index of Mandarin *(Citrus reticulata)*.

Treatments	Days of Storage															
	Pathological Disorder															
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
T_1	1	1	3	4	5	-	-	-	-	-	-	-	-	-	-	-
T_2	1	1	1	1	1	1	1	1	1	1	2	2	3	3	3	3
T_3	1	1	2	3	5	-	-	-	-	-	-	-	-	-	-	-
T_4	1	1	1	1	2	3	-	-	-	-	-	-	-	-	-	-
T_5	1	1	1	1	2	2	-	-	-	-	-	-	-	-	-	-
T_6	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-

*1= No disorder, 2= Slightly disordered, 3= Moderately disordered, 4= Highly disordered, 5= Extremely disordered

Table 3: Effect of packaging materials treatments in Pathological disorder of Mandarin *(Citrus reticulata)*.

Treatments	Days of Storage															
	Marketability															
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
T_1	1	1	2	3	4	-	-	-	-	-	-	-	-	-	-	-
T_2	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	4
T_3	1	1	2	3	4	-	-	-	-	-	-	-	-	-	-	-
T_4	1	2	2	3	3	4	-	-	-	-	-	-	-	-	-	-
T_5	1	2	2	3	3	4	-	-	-	-	-	-	-	-	-	-
T_6	1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-

*1= Highly Marketable, 2= Moderately

Table 4: Effect of packaging materials treatments in marketability of Mandarin *(Citrus reticulata)*.

The minimal marketability change was found in T_6 (control) in which marketability chance remained up to 9 days only. The sample was found not marketable because of the inability to maintain its physiological firmness.

The disease development proceeds due to advancement in autocatalytic changes as the storage period are increased, which in turn decreases the market and consumer acceptability of fruit [15].

Conclusion

The shelf life, weight loss, color index, pathological disorder, marketability of mandarin were remarkably influenced by various packaging materials. Among the various packaging material treatments Plastic (20 μ) with 5 holes wrapping was found effective in improving shelf life, minimizing weight loss, slow change in color index, lower pathological disorder and higher marketability.

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