Original Research Article

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Studies of Various Packaging Materials and Waxing on Quality Traits of Kinnow

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A B S T R A C T

An investigation was conducted at post-harvest laboratory, Department of Horticulture, Lovely Professional University, Punjab during the academic year 2016-17 to study the effect of various packaging materials on fruit quality and shelf life of Kinnow. The packaging films include LDPE (25 micron), HDPE (15 micron), Polypropylene (25 micron), Shrink film (15 micron) and Cling film (15 micron) were used for experimentation. Liquid paraffin wax (10%) was used as a coating material. The fruits were then kept at ambient temperature. In case of quality related traits, the fruits under treatment T11 (Cling film at 15 micron + wax at 10%) recorded the maximum value for “TSS” when compared with other packaging treatments including control at 25th day after storage. With regard to remaining quality related traits, the fruits under treatment T11 (Cling film at 15 micron + wax at 10%) expressed the maximum value for “TSS: acid ratio”, “Total sugars”, “Non-reducing sugars” and “Sugar: acid ratio” at 25th day after storage.

Keywords
Polypropylene, Shrink, Cling, Ambient temperature, Kinnow.

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Introduction

Citrus fruits are grown commercially in tropics and subtropic regions of the world. Kinnow, a mandarin hybrid (King x Willow leaf) occupies the prime position amongst the citrus fruits grown in India. In subtropical regions of Punjab, it occupies around 50% area of fruit growing regions. In Kinnow, improper post-harvest handling practices lead to quality deterioration and fetch poor market price. In mandarin, loss of 20-25% has been estimated due with transportation of fruits from field to market (PHLRD, 2005). Qualitative losses, in sense of caloric and nutritive value, non-acceptability by consumers, and poor edibility are more difficult to measure than quantitative losses of fresh fruits. Among for stored fruits, post-harvest losses account to 20-30%. In most of the storability studies for fruits, it is found to be observed that the levels of CO2 and O2 inside package altered due to fruit respiration and permeability of the film, resulted in recommendation of modified atmosphere packaging (MAP) for fresh fruit storage (Geeson et al., 1981). When the rate of oxygen and carbon dioxide transmission through the package equal the product’s respiration rate then desirable equilibrium modified atmosphere gets created in the package film at right permeability, edible
coatings have long been used for quality retention and shelf life extension of several fresh fruits *viz.*, apple, citrus. They have been applied directly on fruit surface with several mode of application *viz.*, dipping, spraying or brushing to create a modified atmosphere (McHugh and Senesi, 2000). Basically the usage of food grade wax coatings on fresh fruits and vegetables have been approved by the Government of India and with implementation of this technology on with several wax formulations are now-a-days being supplied by suppliers in market. So, the impact of these waxes coating plays a vital role in monitoring the storability of fresh fruits, especially kinnow. However, the role of these waxes alone or in combination with packaging needed much focus on correlating the positive mode of applicability to kinnow.

Materials and Methods

The present investigations were carried out at the horticulture laboratory of Lovely Professional University, Phagwara Punjab, from January to March, 2017.

Selection and harvest of fruits

The fresh kinnow fruits of uniform size and well matured ones were selected. Apart, other traits of healthiness for fruits free from that of disease and bruising on skin were also taken in consideration for selection of fruits for harvest. The selected fruits were randomly picked from entire direction of the plant with the help of secateurs. The act of fruit harvest commenced during the month of February, collected and brought to Horticulture laboratory.

Details of experiment

The experiment was laid out in Completely Randomized Design (CRD). A total of 27 fruits per treatment were divided into equal lots for all 3 replications and each of lot under every replication found to be accumulated with 9 fruits. The treated fruits were kept for storage and observed at 5 days interval upto 25 days.

Packaging and coating materials for fruits

The packaging films used in this experimentation were purchased from Jalandhar commercial market area. The materials include LDPE (25 micron), HDPE (15 micron), Polypropylene (25 micron), Shrink film (15 micron) and Cling film (15 micron). Liquid paraffin wax (10%) was used as a coating material.

| Treatments | Treatment Details                  |
|------------|-----------------------------------|
| T<sub>1</sub> | Control (Room temperature)        |
| T<sub>2</sub> | LDPE (25 micron)                  |
| T<sub>3</sub> | HDPE (15 micron)                  |
| T<sub>4</sub> | Polypropylene (25 micron)         |
| T<sub>5</sub> | Shrink film (15 micron)            |
| T<sub>6</sub> | Cling film (15 micron)             |
| T<sub>7</sub> | LDPE (25 micron) + wax (10%)       |
| T<sub>8</sub> | HDPE (15 micron) + wax (10%)       |
| T<sub>9</sub> | Polypropylene (25 micron) + wax (10%) |
| T<sub>10</sub> | Shrink film (15 micron) + wax (10%) |
| T<sub>11</sub> | Cling film (15 micron) + wax (10%) |

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Observations recorded

Chemical parameters

Randomly selected fruits in each treatment of the experimentation were used for assessing the quality parameters. TSS (˚Brix), Titrable acidity, Ascorbic acid (mg/100ml), pH, TSS: acid ratio, Total sugars (%), Reducing sugars (%), Non-reducing sugars (%) and Sugar: Acid. These parameters were determined by the methods described by AOAC.

Statistical Analysis

The data were subjected to statistical analysis as outlined by Panse and Sukhatme (1985). The various comparisons were made after working out the standard errors and critical difference at 5 per cent level of significance.

Results & Discussions

Observations recorded on chemical parameters exhibited significant differences among the treatments in 5, 10, 15, 20 and 25 days after storage of Kinnow. The data presented in the (tables 1–9) is significant.

Among the packaging treatments, the fruits under the treatment T₁ retained maximum ‘TSS’ (11.56˚B), which were on par with each other including T₃ (11.10˚B) at 5 days after storage. The minimum ‘TSS’ was recorded in T₇ (10.20˚B). It was found to be on par with T₀ (10.50˚B) and T₁₀ (10.60˚B). At 25days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₆ retained maximum ‘Titrable acidity’ (1.33%). The minimum ‘Titrable acidity’ was recorded in T₇ (1.17%). At 25days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₆ retained maximum ‘Titrable acidity’ (0.81%). The minimum ‘Titrable acidity’ was recorded in T₁₁ (0.76%). In rest of the treatments, except T₃, no fruits were found to be retained for observation. The decline in acidity might be due to conversion of acids into sugars and its utility in respiration process. Results are in line with the results of Sonkar and Ladaniya (1999) in Nagpur mandarin and Mahajan et al., (2005) in kinnow. The fruits under the treatment T₅ retained maximum ‘Ascorbic acid’ (25.58 mg/100ml), which were on par with each other including T₂ (25.24 mg/100 ml) and T₁₁ (25.16 mg/100ml) at 5 days after storage. The minimum ‘Ascorbic acid’ was recorded in T₁ (21.33 mg/100ml). At 25days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₆ retained maximum ‘Ascorbic acid’ (16.04 mg/100ml). The minimum ‘ascorbic acid’ was recorded in T₁₁ (15.51 mg/100ml). In rest of the treatments, except T₃, no fruits were found to be retained for observation. Ascorbic acid content in fruits is known to decrease during storage possibly due to utilization of organic acids during respiration or their conversion to sugars (Kader, 2002). The trend in case of other treatments might be due to the fact that ascorbic acid is very susceptible to oxidative deterioration (Piga et al., 2003). And the fruits under the treatment T₅ retained maximum ‘pH’ (3.90), which were on par with each other including T₀ (3.72) and T₇ (3.70) at 5 days after
storage. The minimum ‘pH’ was recorded in T₅ (3.42), which were on par with T₂ (3.46) and T₁₁ (3.47). At 25 days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₁₁ retained maximum pH (4.17). The minimum ‘pH’ was recorded in T₆ (4.06). In rest of the treatments, except T₃, no fruits were found to be retained for observation. The juice pH value was gradually increased with the advance in storage period. These results are in line with the findings of El-Hefnawi (2002) in mango; El-Hefnawi et al., (2008) in guava; Artés-Hernández et al., (2004, 2006) in grapes. The fruits under the treatment T₃ retained maximum ‘TSS: Acid ratio’ (9.17), which were on par with each other including T₆ (8.85) and T₁₁ (8.86) at 5 days after storage. The minimum ‘TSS: Acid ratio’ was recorded in T₄ (8.08). It was found to be on par with T₂ and T₁₀ (8.41). At 25 days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₁₁ retained maximum ‘TSS: Acid ratio’ (16.05). The minimum ‘TSS: Acid ratio’ was recorded in T₆ (14.75). In rest of the treatments, except T₃, no fruits were found to be retained for observation. The higher change in TSS: Acid ratio is straightly related to hydrolytic changes in the starch concentration (conversion of starch to sugars). Manazano and Diaz (2003) reported that ‘Valencia’ oranges fruits harvested, sorted, graded and treated with a wax coating found that TSS: Acid ratio was increased with the passage of time. Among the packaging treatments, the fruits under the treatment T₁ retained maximum ‘Total sugars’ (5.82%) at 5 days after storage. The minimum ‘Total sugars’ was recorded in T₇ (5.25%). It was found to be on par with T₄ (5.35%) and T₉ (5.36%). At 25 days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₁₁ retained maximum ‘Total sugars’ (6.12%). The minimum ‘Total sugars’ was recorded in T₆ (5.88%). In rest of the treatments, except T₃, no fruits were found to be retained for observation. The maximum value for sugars might be due to conversion of polysaccharides into soluble sugars, dehydration and transformation of certain cell wall materials like hemicelluloses and pectins and also due to decrease in ascorbic acid content. The results are in line with the findings of Kumar and Chauhan (1990) in mandarin; Haikerwal (2001) in Jaffa sweet orange. And the fruits under the treatment T₇ retained maximum ‘Reducing sugars’ (3.51%), which was on par with each other including T₅ (3.41%), T₆ (3.35%) and T₁₁ (3.35%) at 5 days after storage. The minimum ‘Reducing sugars’ was recorded in T₁ (2.93%). It was found to be on par with T₁₀ (3.11%). At 25 days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₆ retained maximum ‘Reducing sugars’ (3.83%). The minimum ‘Reducing sugars’ was recorded in T₃ (3.14%). In rest of the treatments, except T₁₁, no fruits were found to be retained for observation. The fruits under the treatment T₁ retained maximum ‘Non-reducing sugars’ (2.89%) at 5 days after storage. The minimum ‘Non-reducing sugars’ was recorded in T₇ (1.74%). It was found to be on par with T₅ (1.96%). At 25 days after storage, the observations among various packaging treatments revealed that the fruits under treatment T₁₁ retained maximum ‘Non-reducing sugars’ (2.86%), which was on par with each other including T₃ (2.81%). The minimum ‘Non-reducing sugars’ was recorded in T₆ (2.05%). In rest of the treatments, no fruits were found to be retained for observation. Several internal fruit physiological activities like respiration, transpiration and other metabolic processes enhanced. So, starch gets converted to sugars and reducing sugar quantity increased.
Table.1 Effect of different packaging materials on ‘TSS (ºB)’ in Kinnow

| Treatments | 5 DAS  | 10 DAS  | 15 DAS  | 20 DAS  | 25 DAS  |
|------------|--------|---------|---------|---------|---------|
| T1         | 11.56  | 12.57   | 14.13   | 0.00    | 0.00    |
| T2         | 10.85  | 11.20   | 11.50   | 12.30   | 0.00    |
| T3         | 11.10  | 11.40   | 11.65   | 12.25   | 12.00   |
| T4         | 10.67  | 10.82   | 11.05   | 11.26   | 0.00    |
| T5         | 10.70  | 10.95   | 11.35   | 11.55   | 0.00    |
| T6         | 10.80  | 11.20   | 11.39   | 11.61   | 11.95   |
| T7         | 10.20  | 10.60   | 11.26   | 11.50   | 0.00    |
| T8         | 10.80  | 11.70   | 11.90   | 12.30   | 0.00    |
| T9         | 10.50  | 10.70   | 11.10   | 12.00   | 0.00    |
| T10        | 10.60  | 10.81   | 11.40   | 11.80   | 0.00    |
| T11        | 10.90  | 11.35   | 11.50   | 11.90   | 12.20   |
| SE(d)      | 0.22   | 0.23    | 0.24    | 0.24    | 0.12    |
| CD (0.05%) | 0.47   | 0.48    | 0.50    | 0.49    | 0.24    |

DAS: Days after storage

Table.2 Effect of different packaging materials on ‘Titrable Acidity (%)’ in Kinnow

| Treatments | Titrable Acidity (%) | 5 DAS  | 10 DAS  | 15 DAS  | 20 DAS  | 25 DAS  |
|------------|----------------------|--------|---------|---------|---------|---------|
| T1         |                      | 1.33   | 1.19    | 0.93    | 0.00    | 0.00    |
| T2         |                      | 1.29   | 1.14    | 0.98    | 0.96    | 0.00    |
| T3         |                      | 1.21   | 1.15    | 1.03    | 0.95    | 0.78    |
| T4         |                      | 1.32   | 1.16    | 1.05    | 0.98    | 0.00    |
| T5         |                      | 1.25   | 1.10    | 0.99    | 0.91    | 0.00    |
| T6         |                      | 1.22   | 1.13    | 1.04    | 0.97    | 0.81    |
| T7         |                      | 1.17   | 1.12    | 1.03    | 0.96    | 0.00    |
| T8         |                      | 1.24   | 1.17    | 1.09    | 0.98    | 0.00    |
| T9         |                      | 1.22   | 1.06    | 0.94    | 0.91    | 0.00    |
| T10        |                      | 1.26   | 1.11    | 1.01    | 0.95    | 0.00    |
| T11        |                      | 1.23   | 1.09    | 0.99    | 0.92    | 0.76    |
| SE(d)      |                      | 0.03   | 0.02    | 0.02    | 0.02    | 0.01    |
| CD (0.05%) |                      | 0.06   | 0.05    | 0.04    | 0.04    | 0.02    |

DAS: Days after storage
Table 3 Effect of different packaging materials on ‘Ascorbic Acid (mg/100ml)’ in Kinnow

| Treatments | Ascorbic Acid (mg/100ml) | | | |
|------------|--------------------------|---|---|---|---|
|            | 5 DAS | 10 DAS | 15 DAS | 20 DAS | 25 DAS |
| T₁         | 21.33 | 17.52 | 12.49 | 0.00 | 0.00 |
| T₂         | 25.24 | 22.17 | 19.02 | 17.36 | 0.00 |
| T₃         | 23.74 | 21.87 | 19.62 | 17.42 | 15.75 |
| T₄         | 23.85 | 21.9 | 19.48 | 17.74 | 0.00 |
| T₅         | 25.58 | 22.24 | 19.2 | 17.86 | 0.00 |
| T₆         | 24.37 | 21.71 | 19.89 | 18.11 | 16.04 |
| T₇         | 23.33 | 21.2 | 18.43 | 17.13 | 0.00 |
| T₈         | 24.51 | 22.08 | 18.77 | 17.83 | 0.00 |
| T₉         | 23.15 | 21.43 | 18.17 | 16.82 | 0.00 |
| T₁₀        | 24.83 | 22.39 | 19.25 | 17.08 | 0.00 |
| T₁₁        | 25.16 | 22.89 | 19.41 | 17.24 | 15.51 |
| SE(d)      | 0.50 | 0.45 | 0.38 | 0.34 | 0.15 |
| CD (0.05%) | 1.04 | 0.93 | 0.80 | 0.71 | 0.31 |

DAS: Days after storage

Table 4 Effect of different packaging materials on ‘pH’ in Kinnow

| Treatments | pH | | | |
|------------|----|---|---|---|---|
|            | 5 DAS | 10 DAS | 15 DAS | 20 DAS | 25 DAS |
| T₁         | 3.90 | 4.10 | 4.30 | 0.00 | 0.00 |
| T₂         | 3.46 | 3.76 | 3.87 | 4.00 | 0.00 |
| T₃         | 3.67 | 3.86 | 3.83 | 3.98 | 4.13 |
| T₄         | 3.65 | 3.81 | 3.91 | 3.97 | 0.00 |
| T₅         | 3.42 | 3.72 | 3.97 | 4.03 | 0.00 |
| T₆         | 3.58 | 3.80 | 3.86 | 3.94 | 4.06 |
| T₇         | 3.70 | 3.88 | 4.00 | 4.10 | 0.00 |
| T₈         | 3.56 | 3.78 | 3.96 | 4.02 | 0.00 |
| T₉         | 3.72 | 3.87 | 3.98 | 4.10 | 0.00 |
| T₁₀        | 3.54 | 3.73 | 3.90 | 4.12 | 0.00 |
| T₁₁        | 3.47 | 3.69 | 3.91 | 4.08 | 4.17 |
| SE(d)      | 0.08 | 0.08 | 0.08 | 0.08 | 0.04 |
| CD (0.05%) | 0.16 | 0.17 | 0.17 | 0.16 | 0.08 |

DAS: Days after storage
Table 5: Effect of different packaging materials on ‘TSS: Acid ratio’ in Kinnow

| Treatments | TSS: Acid ratio |
|------------|------------------|
|            | 5 DAS | 10 DAS | 15 DAS | 20 DAS | 25 DAS |
| T1         | 8.69   | 10.56  | 15.19  | 0.00   | 0.00   |
| T2         | 8.41   | 9.82   | 11.73  | 12.81  | 0.00   |
| T3         | 9.17   | 9.91   | 11.31  | 12.89  | 15.38  |
| T4         | 8.08   | 9.32   | 10.52  | 11.48  | 0.00   |
| T5         | 8.56   | 9.95   | 11.46  | 12.69  | 0.00   |
| T6         | 8.85   | 9.91   | 10.95  | 11.96  | 14.75  |
| T7         | 8.71   | 9.46   | 10.93  | 11.97  | 0.00   |
| T8         | 8.70   | 10.09  | 11.80  | 13.18  | 0.00   |
| T9         | 8.60   | 10.41  | 11.61  | 12.93  | 16.05  |
| T10        | 8.71   | 9.46   | 10.93  | 11.97  | 0.00   |
| SE(d)      | 0.18   | 0.21   | 0.24   | 0.25   | 0.15   |
| CD (0.05%) | 0.37   | 0.43   | 0.51   | 0.51   | 0.31   |

DAS: Days after storage

Table 6: Effect of different packaging materials on ‘Total Sugars (%)’ in Kinnow

| Treatments | Total Sugars (%) |
|------------|------------------|
|            | 5 DAS | 10 DAS | 15 DAS | 20 DAS | 25 DAS |
| T1         | 5.82   | 5.92   | 6.37   | 0.00   | 0.00   |
| T2         | 5.39   | 5.48   | 5.62   | 6.25   | 0.00   |
| T3         | 5.51   | 5.58   | 5.64   | 6.19   | 5.95   |
| T4         | 5.35   | 5.43   | 5.60   | 5.71   | 0.00   |
| T5         | 5.37   | 5.53   | 5.50   | 5.69   | 0.00   |
| T6         | 5.40   | 5.61   | 5.67   | 5.78   | 5.88   |
| T7         | 5.25   | 5.45   | 5.73   | 5.75   | 0.00   |
| T8         | 5.41   | 5.54   | 5.70   | 6.21   | 0.00   |
| T9         | 5.36   | 5.44   | 5.57   | 5.90   | 0.00   |
| T10        | 5.43   | 5.49   | 5.81   | 5.92   | 0.00   |
| T11        | 5.40   | 5.50   | 5.78   | 5.85   | 6.12   |
| SE(d)      | 0.11   | 0.12   | 0.12   | 0.12   | 0.06   |
| CD (0.05%) | 0.23   | 0.24   | 0.25   | 0.25   | 0.12   |

DAS: Days after storage
Table.7 Effect of different packaging materials on ‘Reducing Sugars (%)’ in Kinnow

| Treatments | Reducing Sugars (%) |
|------------|---------------------|
|            | 5 DAS   | 10 DAS   | 15 DAS   | 20 DAS   | 25 DAS   |
| T1         | 2.93    | 3.21     | 3.78     | 0.00     | 0.00     |
| T2         | 3.31    | 3.37     | 3.57     | 4.09     | 0.00     |
| T3         | 3.20    | 3.26     | 3.80     | 4.27     | 3.14     |
| T4         | 3.27    | 3.22     | 3.75     | 3.80     | 0.00     |
| T5         | 3.41    | 3.42     | 3.47     | 3.61     | 0.00     |
| T6         | 3.35    | 3.51     | 3.93     | 3.10     | 3.83     |
| T7         | 3.51    | 4.01     | 3.91     | 3.80     | 0.00     |
| T8         | 3.19    | 3.37     | 3.81     | 3.54     | 0.00     |
| T9         | 3.25    | 4.11     | 3.78     | 4.11     | 0.00     |
| T10        | 3.11    | 3.19     | 3.62     | 3.70     | 0.00     |
| T11        | 3.35    | 3.46     | 4.16     | 2.93     | 3.26     |
| SE(d)      | 0.07    | 0.07     | 0.08     | 0.07     | 0.03     |
| CD (0.05%) | 0.14    | 0.15     | 0.16     | 0.15     | 0.06     |

DAS: Days after storage

Table.8 Effect of different packaging materials on ‘Non-Reducing Sugars (%)’ in Kinnow

| Treatments | Non-Reducing Sugars (%) |
|------------|-------------------------|
|            | 5 DAS   | 10 DAS   | 15 DAS   | 20 DAS   | 25 DAS   |
| T1         | 2.89    | 2.71     | 2.59     | 0.00     | 0.00     |
| T2         | 2.08    | 2.11     | 2.05     | 2.16     | 0.00     |
| T3         | 2.31    | 2.32     | 1.84     | 1.92     | 2.81     |
| T4         | 2.08    | 2.21     | 1.85     | 1.91     | 0.00     |
| T5         | 1.96    | 2.11     | 2.03     | 2.08     | 0.00     |
| T6         | 2.05    | 2.10     | 1.74     | 2.68     | 2.05     |
| T7         | 1.74    | 1.44     | 2.02     | 1.95     | 0.00     |
| T8         | 2.22    | 2.17     | 1.89     | 2.67     | 0.00     |
| T9         | 2.11    | 1.33     | 1.79     | 1.79     | 0.00     |
| T10        | 2.32    | 2.30     | 2.19     | 2.22     | 0.00     |
| T11        | 2.05    | 2.04     | 1.62     | 2.92     | 2.86     |
| SE(d)      | 0.04    | 0.04     | 0.04     | 0.04     | 0.03     |
| CD (0.05%) | 0.09    | 0.09     | 0.09     | 0.09     | 0.06     |

DAS: Days after storage
**Table 9** Effect of different packaging materials on ‘Sugar: Acid ratio’ in Kinnow

| Treatments | Sugar: Acid ratio |
|------------|-------------------|
|            | 5 DAS  | 10 DAS  | 15 DAS  | 20 DAS  | 25 DAS  |
| T1         | 4.37   | 4.97    | 6.84    | 0.00    | 0.00    |
| T2         | 4.17   | 4.80    | 5.73    | 6.51    | 0.00    |
| T3         | 4.55   | 4.85    | 5.47    | 6.51    | 7.62    |
| T4         | 4.05   | 4.68    | 5.33    | 5.82    | 0.00    |
| T5         | 4.29   | 5.02    | 5.55    | 6.25    | 0.00    |
| T6         | 4.42   | 4.96    | 5.45    | 5.95    | 7.25    |
| T7         | 4.48   | 4.86    | 5.56    | 5.98    | 0.00    |
| T8         | 4.36   | 4.73    | 5.22    | 6.33    | 0.00    |
| T9         | 4.39   | 5.13    | 5.92    | 6.48    | 0.00    |
| T10        | 4.30   | 4.94    | 5.75    | 6.23    | 0.00    |
| T11        | 4.39   | 5.04    | 5.83    | 6.35    | 8.05    |
| SE(d)      | 0.09   | 0.10    | 0.12    | 0.12    | 0.07    |
| CD (0.05%) | 0.19   | 0.21    | 0.25    | 0.26    | 0.15    |

DAS: Days after storage

The results are in line with findings of Gul et al., (1990) who observed that the effect of Fruitex (wax emulsion) on blood red oranges during room storage found that non-reducing sugars increased during storage. And the treatment T3 retained maximum ‘Sugar-Acid ratio’ (4.55), which were on par with each other including T7 (4.48) and T6 (4.42) at 5 days after storage. The minimum ‘Sugar-Acid ratio’ was recorded in T4 (4.05). It was found to be on par with T2 (4.17). At 25days after storage, the observations among various packaging treatments revealed that the fruits under treatment T11 retained maximum ‘Sugar-Acid ratio’ (8.05) The minimum ‘Sugar-Acid ratio’ was recorded in T6 (7.25). In rest of the treatments, except T3, no fruits were found to be retained for observation.

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