# EFFECT OF PARTIAL COATING OF OLIVE OIL AND STORAGE DURATION ON POSTHARVEST PERFORMANCE OF SWEET ORANGE

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***ABSTRACT:*** *An experiment entitled "Effect of partial coating of olive oil and storage duration on the postharvest performance of sweet orange" was conducted at Post Harvest Laboratory of Department of Horticulture, The University of Agriculture Peshawar. Sweet orange fruits were coated partially 0, 25, 50, 75 and 100% with olive oil and stored up to 80 days. The data were recorded for various parameters after each 20 days up to 80 days of storage. Result of the experiment showed that all the quality parameters were significantly affected by storage duration and partial coating (olive oil). The fruits coated with 100% olive oil had the lowest weight loss (10.33%), Disease incidence (1.86%), TSS (10.21$^{o}$Brix) and pH (4.74) with the highest acidity (1.53%), ascorbic acid content (45.21 mg100ml$^{-1}$), juice content (46.89%) and color score (6.82) after 80 days of storage duration. On the other hand the organoleptic parameters indicated that the heights score for taste (7.79) and aroma (7.76) were recorded in 75% coated fruits after 80 days of storage duration. Based on the results, 75% coating of sweet orange fruits with olive oil is recommended for its storage up to 80 days without any significant loss in quality.*

**Key words:** Partial coating, Olive oil coating, Sweet orange, Storage duration, TSS, Ascorbic acid.

## INTRODUCTION

Citrus (*Citrus sinensis* L.) which is a member of Rutaceae family is a highly valued fruit in Pakistan. It occupies 1$^{st}$ position both in terms of area and production. It has been originated in tropical and subtropical Southeast Asia [1]. It is cultivated commercially all over the world in tropical to subtropical and also in some warm temperate areas to become widely planted fruit tree in the world [2]. Citrus is one of the diversified and the essential commercialized fruit worldwide consist of sweet oranges, grapefruit, mandarins, lime and lemons. Sweet oranges have a maximum area under cultivation and production throughout the world [3]. Its production is 49.8 million metric tons worldwide, and China is the leading producer, followed by Brazil and USA [4]. Sweet orange is worldwide as a good source of ascorbic acid (vitamin C), an excellent antioxidant that builds up the body immune system. Important phytochemicals like liminoids, synephrine, hesperidin flavonoid, polyphenols, pectin, and sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium are also present in citrus. These biologically active compounds avoid arteriosclerosis, cancer, kidney stones, stomach ulcers and a reduction in cholesterol level and high blood which encourage human health [5]. Sweet orange cannot be kept under ordinary condition due to various Pathological and Physiological disorders may occur during long storage duration [6]. Waxing is a method which is used to enhance the fruits, making them more alluring to the customers by enhancing their appearance and extending their shelf life by reducing the rate of respiration and evaporation [7]. Various types of skin coating materials such as Shellic, Paraffin wax, Chitosan wax, Bee wax, etc. have been used to limit moisture losses from the surface of Fuetrell's early, Valencia and Pineapple in Pakistan [8]. Full coating may cause anaerobic respiration within the fruit. In order to prevent anaerobic respiration we use a partial coating of citrus fruit with olive oil to enhance its shelf life. .

## MATERIALS AND METHODS

The experiment "partial coating of olive oil and storage durations on the postharvest performance of sweet orange" was conducted at Post Harvest Laboratory of Horticulture Department, The University of Agriculture Peshawar. The experiment was conducted under completely Randomize Design (CRD) with two factors that were repeated thrice. Sweet oranges were harvested at proper physiological stage of maturity (when fruits achieved a specific color according to variety and region) from Nowshera in December 2016. The fruits were brought to Post Harvest Laboratory of Horticulture Department in bags. These fruits were sorted out to eliminate bruised or diseased ones. The fruits were washed by using tap water to remove spray and dirt residues. All fruits were taken of almost uniform size, one of these fruits were divided into 4 similar parts. Each part were 25% of the fruit, then we calculated the surface area of each part. All fruits 25%, 50%, 75% and 100% were coated partially by multiplying that figure by 2, 3 and 4 respectively. The data were recorded on the following parameters.

**Weight loss (%):**

Weight loss was calculated by the following formula.

$$\text{Weight loss (\%)} = \frac{\text{Weight of fresh fruits - Weight after interval}}{\text{Weight of fresh fruits}} \times 100$$

**Total Soluble Solids ($^{0}$Brix):**

Total soluble solid was calculated with a handhold refractometer (Zeiss, ATAGO model NAR-3T, Japan).

**Percent juice content (%)**

Percent juice content was measured by the following formula.

$$\text{Percent juice content} = \frac{\text{Weight of extracted juice}}{\text{Fruit weight}} \times 100$$

**Ascorbic acid content (vitamin C):**

Ascorbic acid (vitamin C) content was measured by using the phenol indophenol dye method (AOAC, 1990).

**Acidity (%):**

Acidity of sweet orange juice was measured by taking "10 ml" of juice from each sample and was diluted by using distilled water into a 100 ml beaker. 2-3 drops of phenolphthalein were added for the end point. Then the samples were titrated against "N/10 NaOH". The results was expressed as percent (%) citric acid.

$$\text{Acidity\%} = \frac{\text{N/10 NaOH used} \times 0.0064}{\text{Weight or volume of sample used}} \times 100$$

**Determination of Disease incidence**

Disease appeared on the fruit surface was measured after each storage duration. The severity of disease was measured according to the percentage of disease area infested per fruit. Then the percentage score were compared with a 5-point scale, where 0 = 0% area infested, 1 = 1-5% area infested, 2 = 6-15% area infested, 3 = 16-30% area infested and 4 = 31-100% area infested.

**Organoleptic evaluation:**

Sample of the sweet orange was evaluated Organolaptically for color, taste and aroma. Sample was presented to panel of trained judges to compare them and to assign the score between 0 to 9. Where 9 was represented extremely liked and 0 represent extremely disliked. The following questionnaire was provided to each judge.

Questionnaire format:

Name…….Date……..Sample No…….

| S. No | Color | Taste | Aroma | Value |
|---|---|---|---|---|
| | | | | |

**Statistical Analysis:** The data was statistically analyzed by using statistical computer software "statistics" having two factors (CRD) for computing ANOVA [28].

## RESULTS AND DISCUSSION

**Weight loss (%)**

The data in table 1 showed that various levels of partial coating (olive oil) and storage duration significantly influenced the weight loss of sweet orange fruit. While there interaction had a non-significant effect on the weight loss. The weight loss of fruits increased with increased in storage duration. Maximum weight loss (28.53%) was recorded in fruits stored for storage duration of 80 days (table 1). [9] Weight loss increased with prolonged storage duration which is due to the loss of moisture from the fruit surface after their harvest. Partial coating has also a significant effect on weight loss. After 80 days of storage duration maximum weight loss (17.60%) was recorded in the untreated fruits, while minimum weight loss (10.33%) was recorded in the fruit treated with 100% olive oil (table 1).The decline in weight loss in coated fruit was possibly due to the effects of coatings as a semi permeable obstacle against carbon dioxide, oxygen, moisture and solute movement, thereby decreasing the respiration rate, water loss and alternatively oxidation reaction [10]. The reduction in weight loss was due to the influence of edible coating which act as a semipermeable barrier against carbon dioxide, oxygen due to which respiration rate become decline and as a result moisture loss and loss in weight become decrease [11].

**Juice content (%)**

The data in table 1 indicated that various level of partial coating (olive oil), storage duration and also their interaction had a significant effect on juice content of sweet orange. The interaction of partial coating and storage duration showed that maximum juice content (56.44%) is noted at 0 days of storage in 100 % coated fruits, while the minimum juice content (29.76%) were recorded at 80 days of storage in control fruits (table 1). Maintaining the maximum amount of juice content by the coated fruit is possibly due to the reduce respiration rate from the fruit and thereby the loss of water become reduced [10]. Coating material act as a barrier for carbon dioxide, oxygen and moisture and hence thereby reducing the respiration rate and the loss of moisture become decline [12,13] Also find similar results that coated fruit has higher juice content as compared to uncoated fruits.

**Acidity (%)**

The data in table 2 showed that various level of partial coating (olive oil) and storage duration significantly influenced percent acidity of sweet orange fruit, while there interaction had a non-significant effect on percent acidity. The acidity of fruits decreased with the increase in storage duration. The higher acidity (1.68 %) was found at 0 days of storage which tend to decrease to the minimum of (1.24 %) after 80 days of storage duration (table 2). The reduction of acidity in sweet orange with prolonged storage duration is due to the use of organic acid as a source of energy and respiration and thereby reduction in acidity percentage [14]. Among the partial coating highest acidity1.53% (table 2) was recorded at 100% coated fruits, while minimum acidity 1.41%(table 2) was recorded in untreated fruits. The maximum acidity in coated fruit is probably due to the reduce respiration rate and may therefore delay the utilization of stored organic acid [13].

**Ascorbic acid content ($mg100ml^{-1}$)**

The data in table 1 showed that various levels of partial coating (olive oil) and storage duration significantly influenced the ascorbic acid content of sweet orange fruit, while there interaction had a non-significant effect on ascorbic acid content. The ascorbic acid content of fruits decreased with the increase in storage duration to the minimum of (27.39 $mg100ml^{-1}$) after 80 days of storage duration. [15,26] find similar result that with prolonged storage duration ascorbic acid content trend to decline. Among the partial coating highest ascorbic acid content (45.21 $mg100ml^{-1}$) was recorded in 100% coated fruits, while lowest ascorbic acid content (41.24 $mg100ml^{-1}$) was recorded in untreated fruits. Maintaining the maximum ascorbic acid content is the positive effect of coating which act as barrier for oxygen from entering the fruits due to which the oxidation of ascorbic acid become reduced [12].

**TSS ($^{o}$Brix)**

Data concerning TSS of sweet orange are given in table 1. Data in table 1 revealed that partial coating, storage duration and also their interaction (fig 3) had a significant effect on TSS of sweet orange. A significant increase in TSS (12.61$^{o}$Brix) was recorded after 80 days of storage duration as compared to fresh fruit (8.93$^{o}$Brix). In case of partial

coating highest TSS (10.40 $^{o}$Brix) was recorded in the untreated fruits, while lowest TSS (10.21$^{o}$Brix) was recorded in the fruit treated with 100% olive oil. The TSS of the coated fruits is lower than uncoated fruits are due to decline in respiration rate as the coating material act is a barrier for carbon dioxide and oxygen and hence reduce the conversion of polysaccharides into soluble solid [17]. In [16] authors find similar result that with prolonged storage duration TSS of the fruit trend to increase. Others [18] found the increased in TSS in control fruits indicate that the conversion of polysaccharides present in fruit in decline to soluble sugar by the action of various enzymes.

**Disease incidence (%)**

Data in table 2 concerning disease incidence of sweet orange indicated that storage duration and partial coating significantly affected diseases incidence, while their interaction are found to be non-significant. The disease incidence increased to the maximum of (7.66%) after 80 days of storage duration as compared to fresh fruit (0.00%). In case of partial coating maximum diseases incidence (3.46%) was recorded in untreated fruit, while lowest diseases incidence (1.86 %) was recorded in the fruit treated with 100% olive oil.[10] The disease incidence by coating is possibly due to the reduction of metabolic reaction by decreasing the rate of respiration and thus delay the senescence of fruit. [23] Coating slowed down the respiration rate, reduced the color changes of flesh and skin and thus increased the storage life. Olive oil contained phenolic compound which is a strong antioxidant and is effective against oxidative stress and other related diseases [24].

**Table 1.Effect of partial coating of olive oil and storage duration on weight loss, juice content, pH, TSS and Vit-C contents of sweet orange fruit.**

| Storage Duration (Days) | Weight loss (%) | Juice Content (%) | TSS ($^{o}$Brix) | VIT-C (mg-100ml) | Acidity (%) |
|---|---|---|---|---|---|
| **0** | 0.00 e | 56.26 a | 8.93 e | 59.26 a | 1.68 a |
| **20** | 8.13 d | 50.05 b | 9.72 d | 49.72 b | 1.57 b |
| **40** | 13.8 c | 43.25 c | 10.94 c | 42.6 c | 1.45 c |
| **60** | 20.00 b | 37.23 d | 11.8 b | 34.9 d | 1.38 d |
| **80** | 28.53 a | 32.58 e | 12.61 a | 27.39 e | 1.24 e |
| **Partial Coating** | | | | | |
| **0%** | 17.60 a | 41.79 d | 11.4 a | 41.32 c | 1.41 c |
| **25%** | 16.73 ab | 41.81 d | 11.22 a | 41.24 c | 1.42 c |
| **50%** | 14.2 bc | 43.65 c | 10.71 b | 42.4 bc | 1.46 b |
| **75%** | 11.6 cd | 45.23 b | 10.51 b | 43.65 b | 1.50 ab |
| **100%** | 10.33 d | 46.89 a | 10.21 c | 45.21 a | 1.53 a |
| **LSD α 0.01** | **3.20** | **0.76** | **0.26** | **1.44** | **0.03** |
| **SD X PC Interaction** | NS | *fig 1 | *fig 2 | NS | NS |

**Table 2.Effect of partial coating of olive oil and storage duration on Disease incidence, Color, Taste and Aroma of sweet orange fruit**

| Storage Duration (Days) | Diseases incidence (%) | Color | Taste | Aroma |
|---|---|---|---|---|
| **0** | 0.00 d | 9.00 a | 9.00 a | 9.00 a |
| **20** | 0.00 d | 7.51 b | 8.09 b | 8.09 b |
| **40** | 2.13 c | 5.94 c | 5.70 c | 6.36 c |
| **60** | 4.00 b | 3.73 d | 4.02 d | 4.75 d |
| **80** | 7.66 a | 2.50 e | 3.08 e | 2.97 e |
| **Partial Coating** | | | | |
| **0%** | 3.46 a | 4.96 d | 5.42 c | 5.66 c |
| **25%** | 3.46 a | 5.01 d | 5.46 c | 5.79 c |
| **50%** | 2.80 a | 5.72 c | 7.38 b | 7.29 b |
| **75%** | 2.20 a | 6.16 b | 7.79 a | 7.76 a |
| **100%** | 1.86 c | 6.82 a | 3.84 d | 4.67 |
| **LSD α 0.01** | **0.88** | **0.2** | **0.2** | **0.18** |
| **SD X PC Interaction** | NS | *fig 3 | *fig 4 | *fig 5 |

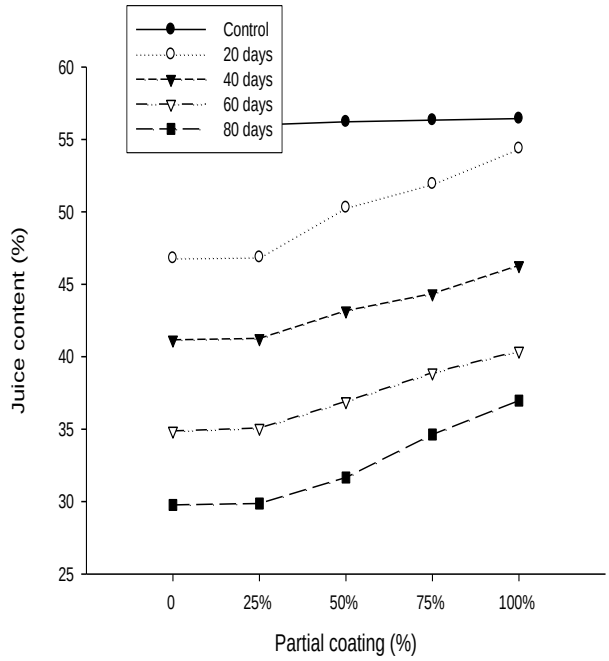


***Fig 1: 1.Effect of partial coating of olive oil and storage duration on juice content (%) of sweet orange fruit.**

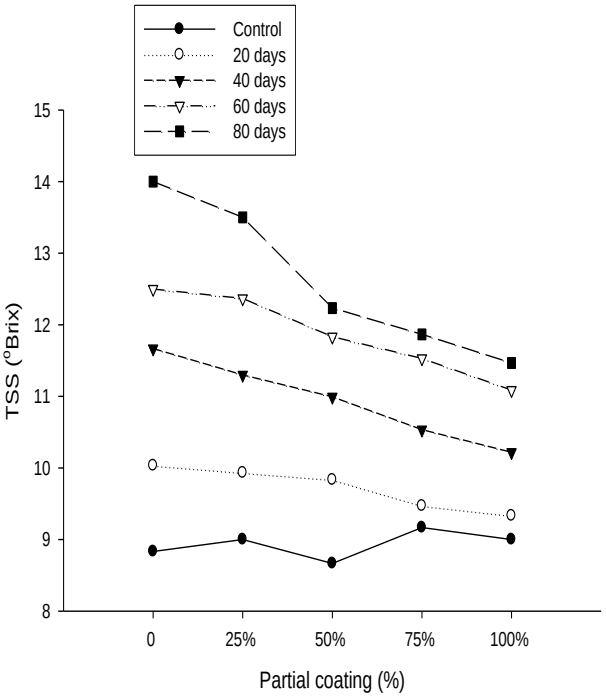


**Fig 2: Effect of partial coating of olive oil and storage duration on TSS of sweet orange fruit.**

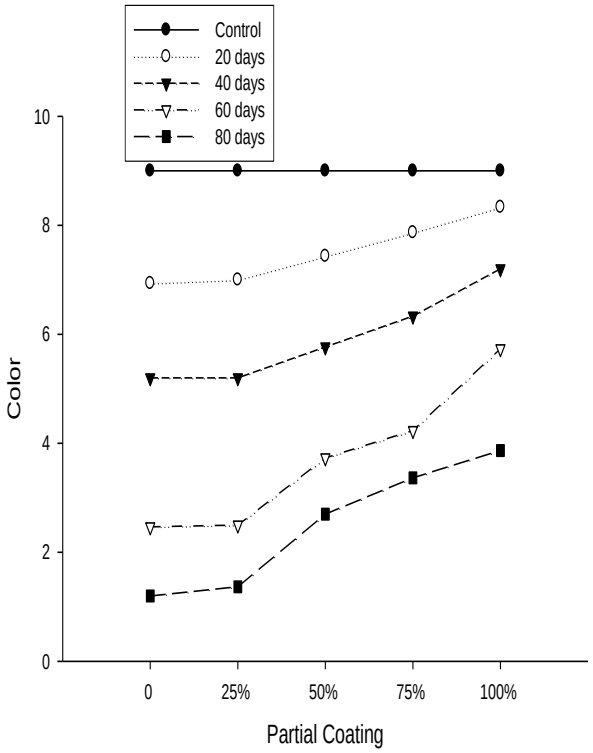


***Fig 3: Effect of partial coating of olive oil and storage duration on color of sweet orange fruit.**

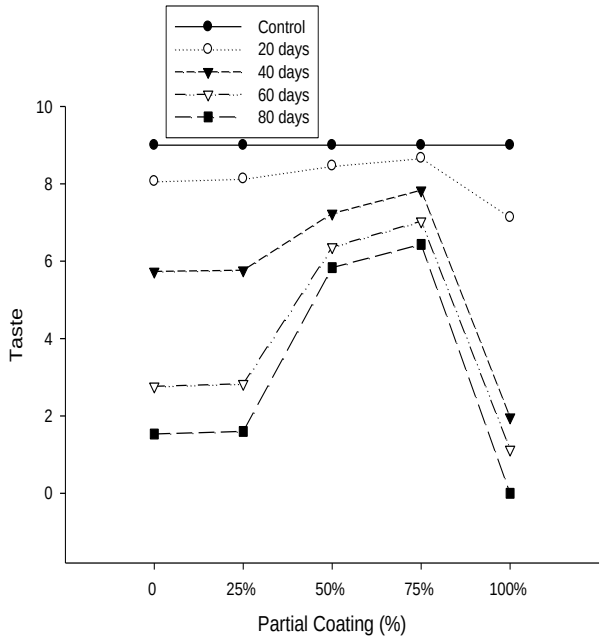


***Fig 4: Effect of partial coating of olive oil and storage duration on taste of sweet orange fruit.**

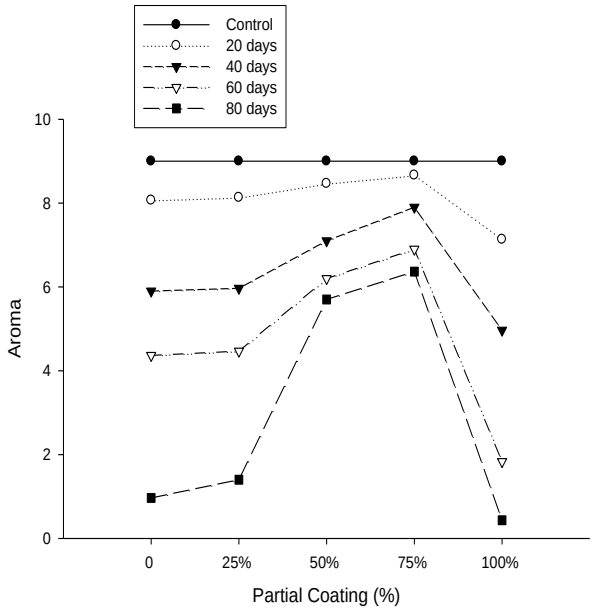


***Fig 5: Effect of partial coating of olive oil and storage duration on aroma of sweet orange fruit.**

**Taste**

The data in table 2indicated that various level of partial coating (olive oil), storage duration and also their interaction (fig 4) had a significant effect on taste of sweet orange. The maximum score for taste (9.00) was recorded for fresh fruits which significantly decreases to a minimum of (3.08) after 80 days of storage duration. Fruit coated 100 % with olive oil showed the lowest score (3.84) for taste, while a maximum score (7.79) for taste was recorded in 75 % coated fruits. The minimum test score in 100% coated fruit may be due to anaerobic respiration which led to increased ethanol production and subsequently odd flavors [25]. Coating act as a semi permeable obstacle against carbon dioxide, oxygen, moisture and solute movement, thereby decreasing the respiration rate, water loss and alternatively oxidation reaction due to which fruit taste is acceptable to consumer [10].

**Aroma**

Data regarding aroma of sweet orange ise given in table 2. Te Data in table 2 revealed that partial coating, storage duration and also their interaction (fig 4) had a significant effect on aroma of sweet orange fruit. The maximum score for aroma (9.00) was recorded for fresh fruits which significantly decreases to a minimum of (3.08) after 80 days of storage duration. Fruit coated 100 % with olive oil showed the lowest score (4.67) for aroma, while a maximum score (7.76) for aroma was recorded in 75 % coated fruits. The maximum score for aroma was found in 75% coated fruits which may be due to delays in ripening of treated fruits, which maintain the aroma for a longer period of time and release pleasant flavor in such fruits [26]. The minimum score for aroma in 100% coated fruit may be due to anaerobic respiration which led to increased ethanol production and subsequently odd flavors [25]. The decrease in aroma score with prolonged storage duration was also confirmed by [26] which give the reason for it that all the citrus family members contain oil glands in their skin which release the specific flavor in a natural way.

**Color**

Data regarding color score of sweet orange is given in table 2 which revealed that partial coating, storage duration and also their interaction (fig 5) had a significant effect on color of sweet orange fruit. Fresh fruit has a maximum color score (9.00) which decreased significantly to (2.50) after 80 days of storage. Fruit coated 100 % with olive oil showed highest score (6.82) for color, while the lowest score (4.96) for color was recorded in untreated fruits. The maximum score for color was found in 100% coated fruits and it may be due to the reduced respiration rate in such fruits due to which the loss of colorful pigment from the fruit surface is reduce and hence the color score is high [27]. The loss of color with prolonged storage duration is due to the loss of color pigment in the form of evaporation from the surface of fruits[27].

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