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Research Article
EFFECT OF DIFFERENT TREATMENTS ON SHELF LIFE OF TANGERINE *CV.* DAISY DURING AMBIENT STORAGE

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Abstract: The research trial was conducted at the laboratory, Department of Agriculture, Khalsa College, Amritsar during 2021-2022. The entire experiment was carried out with twelve treatments T_1 (LDPE- 100 guage), T_2 (LDPE-200 guage), T_3 (HDPE -10µm), T_4 (HDPE-20 µm), T_5 (butter paper wrapping), T_6 (shredding paper), T_7 (newspaper wrapping), T_8 (citrashine wax), T_9 (box wrapping with LDPE-100 guage), T_{10} (coconut oil), T_{11} (mustard oil) and T_{12} (control) had Completely Randomized Design (CRD) replicated thrice. After applying various treatments, the fruits were stored under ambient conditions (23 ± 2 °C; 80% RH). The fruits were analyzed periodically for various quality attributes. Results of the study revealed that the citrashine wax (T_8) coated fruits had an immense effect on the reduction of physiological loss in weight (1.59 %), spoilage loss (2.94 %), better organoleptic rating (6.81 score), TSS (10.30°Brix), titratable acidity (0.73 %), total sugars (6.06 %) and ascorbic acid (22.12 mg/ 100ml juice) up to 21 days of storage. Treatments T_{10} (coconut oil) was found to be the second best treatment with regard to maintain the shelf life of Daisy tangerine fruits. Therefore, citrashine wax coated fruits proved to be quite effective in prolonging the shelf-life and maintaining the quality of Daisy tangerine fruits.

Keywords: *Ambient conditions, Daisy tangerine, Quality Attributes, Storage, Shelf Life*

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Introduction
Citrus, a genus of flowering trees in the Rutaceae family comprises of tangerines, mandarins, sweet oranges, grapefruit, limes, lemon and shaddock are most important fruit crops grown in India. The genus citrus is native to South Asia, East Asia, Malaysia and Indonesian Peninsula, India and China while few genera also originated in Australia or Africa. Daisy tangerine is a cross between Fortune and Fermont mandarin ripens early in mid November. It is suitable for the area having soil pH less than 8 and successfully raised on carrizo rootstocks. Citrus fruit is considered health beneficial as these are having valuable components like vitamin C, carotenoids, flavonoids, pectin, calcium, potassium, soluble and insoluble fiber with numerous benefits such as removing the toxic effects in the body. Each part of citrus fruit contains active ingredients which are present in fruit juice, peel and seed depend upon varieties and maturity stage [1].

Tangerines are also enriched in phytochemicals which are beneficial for the human as vital bioactive medicines. Phytochemicals are naturally present in citrus juices and play an important role in physiological functions and metabolic change of human body [2]. Edible coatings are traditionally used to improve fruit appearance and their preservations. It can result in the creation of a modified atmosphere due to blockage of the pores within the fruits, reducing respiration rate and improving postharvest quality [3].

Coatings of fruits may reduce physical weight loss, retains better fruit quality for longer time due to inhibition of ethylene action which delays ripening and senescence [4]. Hence there is a need to study the effect of various edible coatings and packaging materials in mandarin for increasing its shelf life and maintaining its quality during storage.

Materials and Methods
The present investigation entitled "Effect of different treatments on shelf life of Daisy tangerine during ambient storage'' was conducted in the Department of Agriculture, Khalsa College, Amritsar during the year 2021-2022.

Collection and preparation of samples
Freshly harvested mature tangerine fruits of cv. Daisy having uniform size, disease and bruise free were picked randomly from all the four directions of the trees with the help of secateurs at physiological mature stage of harvest and collected in plastic crates from the Fruit Research Station, Jallowal (Jalandhar) and were brought in cold centrifuge van to the departmental laboratory. In the laboratory, the fruits were sorted and washed with water, thereafter fruits were divided into requisite lot for further handling. In the present study, twelve treatments *viz*. T_1 (LDPE- 100 guage), T_2 (LDPE-200 guage), T_3 (HDPE -10µm), T_4 (HDPE-20 µm), T_5 (butter paper wrapping), T_6 (shredding paper), T_7 (newspaper wrapping), T_8 (citrashine wax), T_9 (box wrapping with LDPE-100 guage), T_{10} (coconut oil), T_{11} (Mustard oil) and T_{12} (control) were given to tangerine fruits.

Method of coating, packaging and storage
A brush was drenched with particular coating material and coating was applied gently on the surface of fruits. Thereafter fruits were air dried. For packaging desirable quantity of fruits were packed with different materials. The edible coated and packed tangerine fruits were placed in corrugated fiber board boxes and were stored at ambient storage condition.

Physiological loss in weight (%)
The percent loss in weight after each storage interval was calculated by subtracting final weight from the initial weight of fruits and then converted into percentage value or the percentage weight loss was calculated according to the following equation:

PLW (%) = [(Initial weight - Fruit weight) /(Initial weight)] × 100

Spoilage loss (%)
All the fruits from each replication were visually monitored for any kind spoilage loss during storage.

Tangerines that showed any microbial spoilage were considered spoiled fruits. The percentage of fruits spoiled was calculated on the number basis by counting the spoiled fruits and expressed in per cent by using formula:
Spoilage (%) = [(Number of spoiled fruits)/ (Total number of fruits)] × 100

Organoleptic rating
The fruits were rated for this character by a panel of ten judges on the basis of external appearance of fruits, texture, colour, taste, sweetness, flavour, and overall acceptability. A nine point 'Hedonic scale' (1-9) described by Amerine *et al* [5] was used for its inference.

Total soluble solids
The pulp of randomly selected ripened fruits was collected and strained through a muslin cloth. Total soluble solids of strained pulp extract were determined with the help of ATAGO digital hand refractometer and subsequent corrections were made with the help of temperature correction chart at 23°C room temperature.

Titratable acidity
Two ml of strained juice was diluted to 20 ml with distilled water and then titrated against 0.1N NaOH solution using phenolphthalein as an indicator. The end point was noted with change in colour from colourless to light pink. The results were expressed in terms of per cent acidity.
Acidity (%) = [(0.0067 × 0.1 N NaOH used (ml)) / (Juice taken (ml))] × 100

Total sugars
The total sugars were estimated by the method given in AOAC (2000).
Total Sugars (%) = [(Fehling factors (0.05)) / (Volume of filtrate used)] × [(Dilution made) / (Weight of sample taken)] × [(Final volume made)/(Volume of juice taken)] × 100

Ascorbic acid (mg/100ml juice)
Ascorbic acid was estimated by indophenol dye method. Dye factor was determined in mg of ascorbic acid /ml of dye using the following formula:
Ascorbic acid (mg/100g) = (Titre × Dye factor × Volume made) / (Aliquot taken × Volume of sample) × 100

Statistical Analysis
The experiment was laid out in Completely Randomized Design having three replications. The data were analyzed with two-way analysis of variance (ANOVA) and LSD test was used to separate the means. Data were statistically considered significant at $p \leq 0.05$ with the statistical software Statistix 10.

Results and Discussion
Physical Parameters
Physiological loss in weight (%)
The physiological loss in weight of tangerine fruits increased significantly ($p \leq 0.05$) with the advancement of storage period [Fig-1]. Minimum PLW was recorded in T_8 (citrashine wax) and the maximum weight loss was recorded in T_{12} (control) fruits during ambient storage. The reduction in weight loss of wax treated fruits might be due to retardation in the transpiration and respiration process by lenticels and stomata closing of the fruit cell wall. Moisture transpiration through peel is mainly responsible for fruit weight loss resulted into shriveled and wilted appearance fruits [6]. The wax coatings acts as a barrier and prevented water loss and desiccation by affecting the opening of lenticels and stomata also delaying the ageing of rind tissue and transpiration [7]. Gupta and Rattanpal [8] study the effect of citrashine coating on postharvest quality of grapefruit cv. Star Ruby under ambient conditions and the results revealed that the PLW was significantly less in citrashine coated fruits at all storage intervals as compared to control.

Spoilage loss (%)
The spoilage increased significantly ($p \leq 0.05$) with the progression of storage period is presented in [Fig-2]. Minimum spoilage was recorded in T_8 (citrashine wax) treatment and maximum spoilage was recorded in T_4 (HDPE -20 µm) wrapped fruits during ambient storage. The wax treated fruits inhibits the loss of moisture from the rind thereby reducing the decay incidence. Mohan *et al* [9] reported minimum decay incidence in Kinnow fruits treated with beeswax-8 % + carbendazium). The reason behind maximum spoilage loss in HDPE -20µm might be due to accumulation of excessive moisture in packaging materials due to restricted movement of water as a result anaerobic conditions and breakdown of enzymes which encouraged the multiplication of micro flora. Yameshita and Benassi [10] observed spoilage loss in polythene films without ventilation.

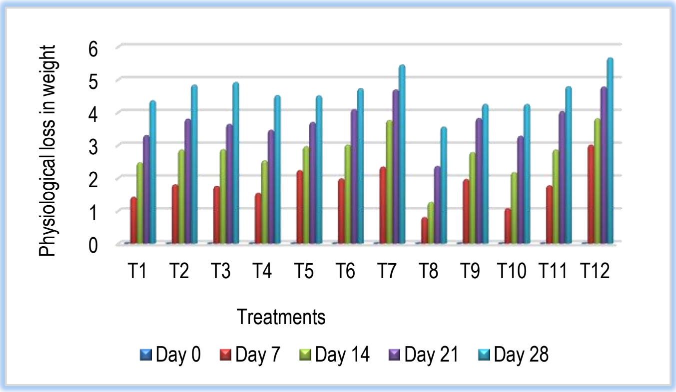

Fig-1 Effect of various treatments on physiological loss in weight (%) of Daisy tangerine fruits

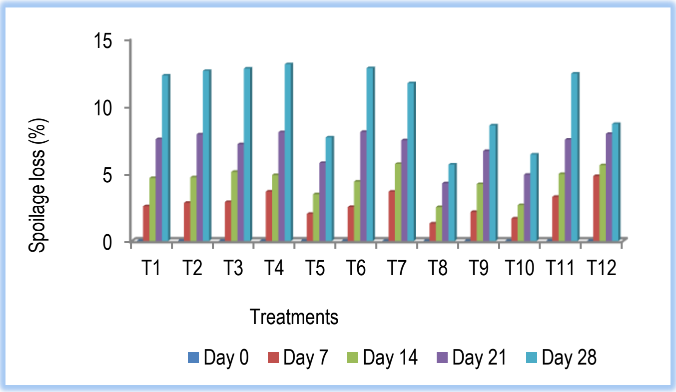

Fig-2 Effect of various treatments on spoilage loss (%) of Daisy tangerine fruits

Organoleptic rating (1-9 hedonic scale)
The fruits treated with T_8 (citrashine wax) retained the highest organoleptic rating upto 21[th] day of storage afterwards organoleptic rating got declined as presented in [Fig-3]. The highest organoleptic rating was noted in tangerine fruits coated with T_8 (citrashine wax) followed by T_{10} (coconut oil) with while the lowest sensory quality (5.72) was recorded under T_{12} (control) fruits. Mahajan *et al* [11] reported that fruits treated with pure coconut oil helps in delay in ripening, uniform colour development in later period of storage in Kinnow fruits. Bisen *et al* [12] reported that in Kagzi lime fruits maximum appearance acceptability of fruits was retained under coconut oil without any objectionable change followed by liquid paraffin wax.

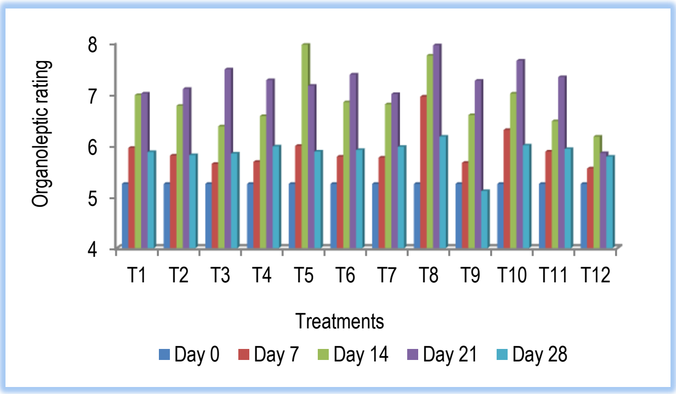

Fig-3 Effect of various treatments on Organoleptic rating (1-9 hedonic scale) of Daisy tangerine fruit

Biochemical Parameters

Total soluble solids (%)

TSS content in tangerine fruits increased up to 21st day of storage and then got declined [Fig-4]. Minimum total soluble solids were recorded in citrashine wax and maximum total soluble solids were estimated under control fruits. The faster TSS increment in the untreated fruits might be due to faster metabolic activities through respiration and transpiration than in fruits treated with different postharvest coatings and packaging. Rokaya *et al* [13] revealed that fruits treated with wax (10 %) were significantly superior because of slow and gradual increment in TSS change whereas in control, it was increased at faster pace. Gradual increase in TSS of fruits treated with coating material may be justified by the twin role of coating material that acting as a physical barrier for transpiration losses and creating a modified atmosphere resulting in building of internal CO_2 and depletion of O_2 [14]. Similar results were noticed in pear [15] and in Nagpur mandarin [16].

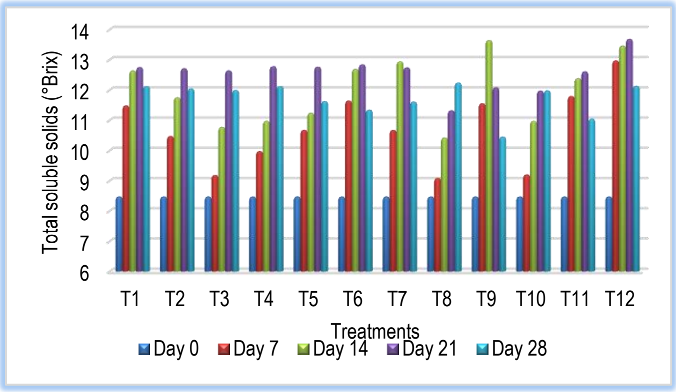

Fig-4 Effect of various treatments on total soluble solids (%) of Daisy tangerine fruit

Titratable acidity (%)

Different treatments given to tangerine showed declining trend of titratable acidity with respect to storage intervals is presented in [Fig-5]. Titratable acidity observed highest in T_8 (citrashine wax) which was followed by T_{10} (coconut oil) and minimum titratable acidity was recorded in T_{11} (mustard oil). The coatings facilitated in better maintenance of titratable acidity than control fruits, which could had positive role of coatings in delaying the process of ripening in fruits [17]. Patriaca *et al* [18] registered the coatings were effective in better retention of titratable acidity in Kinnow. The decrease of acid per cent during storage period could be the destruction of organic acids through oxidation and consumption of these acids, as an organic substrate in the respiration process of fruit tissues. The progress of storage period was found to raise the respiration rate of the fresh fruits [19].

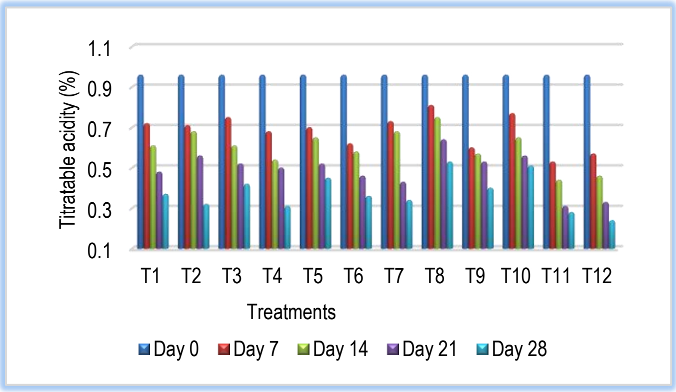

Fig-5 Effect of various treatments on titratable acidity (%) of Daisy tangerine fruit

Total sugars (%)

Total sugars increased up to 21st day in treated fruits except control where total sugars increased up to 14th day then got declined [Fig-6]. Maximum total sugars were reported in T_{12} (control) fruit with and minimum total sugars in T_8 (citrashine wax) treated fruits. The maximum value for sugars in untreated fruits might be due to the conversion of polysaccharides into soluble sugars, dehydration and transformation of certain wall materials like hemicelluloses and pectin and also decrease in ascorbic acid content. The lowest per cent of sugars in some treatments might be due to delayed transpiration, respiration and ripening processes and also delayed activity in the conversion of polysaccharides into soluble sugars and ascorbic acid into dehydroascorbic acid. The present findings are supported by Pandey *et al* [20] and Mahajan *et al* [11] who showed increasing trend of total sugars in guava fruits up to 8 days of storage and then decreased under all treatments.

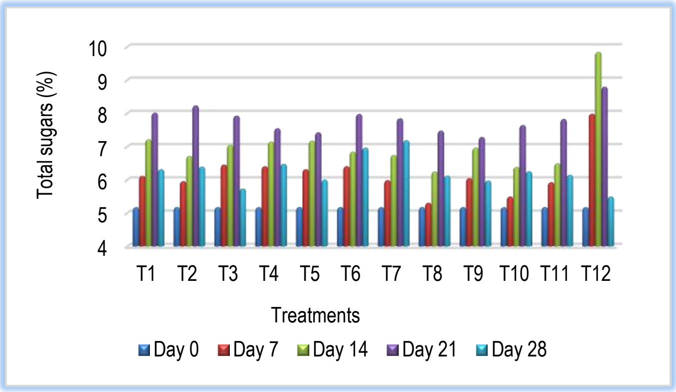

Fig-6 Effect of various treatments on total sugars (%) of Daisy tangerine fruit

Ascorbic acid content (mg/100 ml juice)

Ascorbic acid content decreased significantly ($p \leq 0.05$) throughout the storage period. The highest ascorbic acid content was recorded in T_8 (citrashine wax) treated fruits and lowest ascorbic acid content was recorded in T_{12} (control) fruits. This decline might be due to oxidation of ascorbic acids resulting in formation of dehydroascorbic acid [19]. The results of this study are in line with Bisen *et al* [12] who reported that ascorbic acid of Kagzi lime decreased respectively with increased of storage period because of oxidation of ascorbic acid. Coconut oil coated mandarin fruits also registered reduction in ascorbic acid during storage [21].

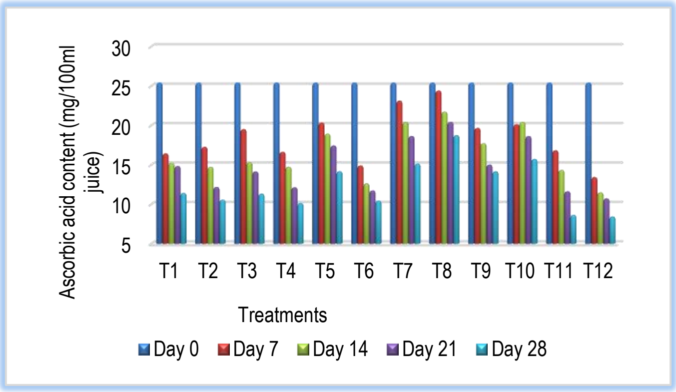

Fig-7 Effect of various treatments on ascorbic acid content (mg/100ml juice) of Daisy tangerine fruit

Conclusion

The postharvest treatment of citrashine wax was found to be the most effective in minimizing physiological loss in weight, spoilage losses while maintaining the total soluble solids, total sugars, titratable acidity, better organoleptic rating and ascorbic acid content of fruits up to three weeks. Treatment T_{10} (coconut oil) was found to be the second best treatment with regard to maintaining the shelf life of Daisy tangerine fruits. Therefore, application of citrashine wax coating on tangerine cv. Daisy considered the most benefit tested in extending the shelf life and quality of fruits.

Application of research: Research is helpful throughout the international level in order to reduce the post harvest losses in mandarin as there are huge postharvest losses due to the perish ability nature of the mandarin fruits.

Research Category: Postharvest Management, Quality Control

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Study area / Sample Collection: Horticulture Laboratory, Fruit Research Station, Jallowal, Jalandhar

Cultivar / Variety / Breed name: Tangerine cv. Daisy

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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