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Effect of various packaging materials on shelf life and quality of kinnow fruit

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Abstract

Kinnow is a non-climacteric fruit, cultivated in all subtropical and tropical regions of India. In Punjab, it belongs to the subtropical area and occupies about 50% of the fruit tree cultivation area. Due to its quality and high juice content, it is in high demand and provides very good income for kinnow farmers and helps to increase their income. It loses various essential nutrients, especially the ascorbic acid during the storage. To enhance the physiological and biochemical properties under storage conditions different strategies can be used and packaging of fruit plays most crucial role to maintain the quality of fruit during the storage. Packaging films used of different thickness for the packaging minimized the respiration and transpiration loss, retained the firmness and protect the fruit from microbial infection. In this paper we will discuss about different packaging material of different thickness films and quality which is best suitable for the kinnow fruit storage for longer period and how it will enhance the quality of fruit and minimize the PLW and post-harvest losses.

Keywords: Post harvest, Packaging materials, Quality, Shelf life

Introduction

Kinnow is a widespread fruit crop of the mandarin group, hybrid of citrus cultivars namely 'King' (*Citrus nobilis*) and 'Willow Leaf' mandarin (*Citrus deliciosa*) which belongs to the family Rutaceae. Kinnow is widely cultivated in India, originally developed at the University of California Citrus Experimental Station in 1935 and introduced to India in the early 1940s. In India, it is grown in parts of Punjab, Rajasthan, Himachal Pradesh, Haryana, Uttarakhand and Jammu & Kashmir with an overall production area of 0.33 million ha and production of 3.43 million tones (mT). Punjab is India's leading producer of kinnow accounting for 29% of country's total production (0.048mha area and annual production of 1.1mT). The Fazilka district of Punjab occupies 55% of the area and 58% of the total production.

Kinnow is a non-climacteric fruit, which shows no respiration and less ethylene production after storage which increases the shelf life of fruit at a certain level at normal temperature which can be further increased with the help of modern technology and along with that availability of the fruit will also increase in market results in low post harvest losses. Kinnow has many industrial and medicinal uses with delicious taste, attractive color and aroma. It is a nutritionally rich in vitamin C, vitamin B, β -carotene, calcium, phosphorous and other beneficial compounds. It is rich in pectin, cellulose and hemicelluloses. Its juice is rich in Vitamin C and has various antioxidant properties which are required to sustain healthy life. Storage of fruit is very important to retain the nutritional value and shelf life. In kinnow, improper post-harvest handling activities results in deterioration of quality and lowers the price of fruit in market. Fruit loses their major nutrients like minerals, proteins, fibres antioxidants and majorly ascorbic acid during the process of post harvesting process. Post-harvest handling affects the quality of fruit and lowers the price of fruit especially in mandarins 20-25% loss was observed due to poor handling during transportation (PHLRD 2005). Several post-harvest techniques have been introduced internationally to control fruit failure, maintain optimum quality and freshness, and minimize loss (Hagenmaier, 2002; Bajwa and Anjum, 2007) [1]. To improve the shelf life and physiological and nutritional quality of fruit different methods can be used. It depends on the application of good quality skin coatings, packaging materials and method of storage (Mahajan *et al.*, 2015). The packaging on fruit and vegetables reduced the water loss, slow the senescence and aging, impart shine, and provided the better quality and marketing price of fruit. In this paper we will discuss about the different packaging materials that we can use to enhance the shelf life and quality of kinnow. For the packaging purpose different types of packaging material can be used in kinnow fruit

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like crate boxes, newspapers, CFB, plastic crates, Low density polyethylene, high density polyethylene, cling sheets, shrink films etc. and the research done on these are as under.

Effect of packaging materials on the quality and shelf life

In Punjab, one of the study reported that post-harvest losses of kinnow differs in different markets. In Delhi post-harvest loss is 14.87% while in Bangalore it is 21.91%. To minimize these it was suggested to adopt improved packaging materials, cushioning material and cold storage facilities (Gangwar *et al.*, 2007). The quality and shelf life of kinnow fruits were checked with the shrink wrapped packaging. Kinnow mandarin, first washed with 1000 ppm chlorinated water and then wrapped in 60 gauge shrink sheets. It was found that the unwrapped fruits losses 20% of weight and the shrink-film wrapped fruits are firmer and fresher. Quality, appearance, flavour and firmness are better in the shrink-wrapped fruits (Gupta & Raghav., 2000). Average weight loss of film wrapped kinnow was less than 6.1% after 12 weeks of ambient storage when compared with unwrapped fruits which was 23.4% at 8 weeks interval (Dhatt *et al.*, 1999).

Packaging materials such as shrink wrap, plastic wrap, and low-density polyethylene film are effectively used to improve the shelf life of fruits by reducing water loss, respiration rate and ripening. Several studies have been conducted to determine effective packaging materials for kinnow to minimize deterioration during storage. Cling films and shrink films of fruit are used as modified atmosphere packaging. 125 µm and 25 µm shrink films are used to wrap the fruit. The results of this experiment showed that the 125 µm shrink films package is superior to the 25 µm package. Packages using 125 µm shrink wrap showed high fruit firmness, minimal rot, high Titrable acidity, high TSS, high ascorbic acid, and high total sugar. These results show that shrink films improves the shelf life of kinnow (Singh *et al.*, 2018).

Packaging material along with edible coatings also showed positive results in improving the quality of kinnow fruit. Polyethylene packaging along with edible oil and wax coating were applied on kinnow to check the storage quality of Kinnow mandarin. In experiment, fruit was covered with different types of edible oils like neem oil, coconut oil, olive oil and mustard oil and wax coatings like Citra shine. The high-density polyethylene is also used to cover the Kinnow mandarin fruit. It was observed in the results that high-density polyethylene with neem oil covered fruits contains highest amount of fruit juice and have less spoilage during storage (Randhawa *et al.*, 2009).

The effect of packaging materials on the shelf life of vermicelli supplemented with enzyme processed kinnow fruit. Low density poly ethylene pouches and the bi-axially oriented polypropylene (BOPP) pouches were used. Results from the study suggested that the packaging material with Bi-axially oriented polypropylene showed best results as compared to low density poly ethylene packaging material. BOPP is good for commercial purposes and it does not affect the physiological properties of the fruit also as compared to the low density poly ethylene pouches (LDPE), (Singla *et al.*, 2021) [6].

High density poly ethylene with 0.01%, 0.02% perforation and no perforation, low density polyethylene with 0.01%, 0.02% perforation and no perforation and PP with 0.01%, 0.02% perforation and no perforation were used to check the effect of different packaging material on the quality and

storage life of Kinnow fruit. The tray packed in LDPE, HDPE and PP with 0.02% perforation had higher TSS value (10.10, 9.80 and 9.53 °Brix) as compared to the films without perforation (Sohi *et al.*, 2016) [7].

The effect of pre storage treatments and packaging on the quality of Kinnow fruit were checked with 22 different types of packaging materials were used like CFB boxes, low density poly ethylene, high density poly ethylene and plastic crate etc. along with chlorine wash, carbendazim dip were also used. It was found that the use of high density poly ethylene bags having gauze size 20 microns along with washing of fruits with 100 ppm chlorine solution for the storage of kinnow fruit provided best results (BVC *et al.*, 2006) [3].

Modified atmospheric packaging films showed positive impact on fruit quality and cold storage life of Kinnow. Different types of modified packaging films like polypropylene, high density polyethylene (HDPE), low density polypropylene (LDPE) of different size (25 microns and 38 microns) were used under cold storage conditions. The results indicated that the packaging with polypropylene films with pinholes (25 microns) are most effective for maintaining the quality of fruit (Baswal *et al.*, 2020) [2].

Kinnow peel, a rich source of ascorbic acid, pectin, naringin and Limon in which is wasted during processing of kinnow into various products. In one of the investigation, products of kinnow (peel candy & powder) were packed in four different packaging materials (HDPE, LDPE, laminate bag and glass jar) and stored under ambient temperature i.e. 37-44 °C, relative humidity 56% and refrigerated conditions 4-6 °C, relative humidity 95% for 60 days to study the effect of storage conditions and packaging material. Product compatibility was tested regularly (0, 30 and 60 days) during storage by biochemical, microbiological analysis, and sensory evaluation of peel candy and powders. All packaged materials were able to keep the microbial load below the limit. The candy packaged in the HDPE bag and the peel powder packaged in the laminated bag were generally acceptable and microbiologically stable up to 60 days of storage under ambient and refrigerated conditions (Sidhu *et al.*, 2016).

Uni-Packaging with polyethylene in citrus showed profound effect in enhancing the shelf life and maintaining the external appearance, taste, and texture (Hussain *et al.*, 2004). Mahajan and Singh (2014) in an experiment noticed the effect of shrink film packaging on kinnow fruits. It had positively improved the storage life and better quality retention was observed for 20 days as compared with 10 days in unpacked control. Packaging of kinnow fruits with 100 gauge LDPE bag packaging in combination with evaporative cool chamber and Rice Husk Ash showed positive results in terms of highest overall acceptability. Dhillon *et al.*, (2016) observed the importance of various packaging films to the shelf life and quality of daisy mandarin under ambient conditions. Various packaging treatments were used, including wrap film (15 inches), heat shrink film (15 inches), and low density polyethylene film (25 inches LDPE). The results show that shrink wrap has a positive effect on extending shelf life and maintaining quality of fruit for up to 15 days. Mahajan *et al.*, (2013) studied the effect of surface coatings on the quality of kinnow, and it is important to air-dry the fruits coated with the "Nipro Fresh SS40T and SS50" formulation and later pack them into CFB crates. It was found that it showed positive effect on delay in weight loss.

Upadhayaya and Sanghavi (2006) [8] kinnow carried out study

several treatments, including a 4% CaCl₂ concentration and packing in perforated (0.2%) polythene bags. The findings showed that the treatments have a tendency to lessen the physiological weight loss of fruits during storage and to increase the fruit's ability to be stored for up to 42 days in an ambient environment.

According to Sharma *et al.*, (2007) kinnow mandarins packaged in 150 gauge polythene bags with bale leaf extract showed the greatest reduction in PLW when compared to the untreated control. Adhesive film-wrapped kinnow fruit performed better in terms of PLW under ambient conditions (Sonkar *et al.*, 2009). Effects of LDPE packaging and some chemicals on Kinnow at ambient conditions. The results showed that boric acid-treated kinnow fruit with 3%+ LDPE packaging without perforation showed minimal physiological weight loss (Jawandha *et al.*, 2012).

The impact of lacwax, Citra shine, and fruit shrink packing on the ability to store kinnow was examined by Mandal (2015). The fruits were waxed, individually shrink-wrapped in LDPE (19 cents), packed in CFB cartons of 4 kg, and kept at room temperature. The findings showed that the largest PLW was found in the control, whereas fruits that had been shrink-wrapped or treated with lac wax significantly decreased PLW. Fruits packed in 150 gauge thickness LDPE bags and stored after receiving Carbendazim treatment were found to be more successful at preserving fruit quality over time. Contrarily, throughout the duration of storage, the total sugar content of

fruits continued to rise (Thakur *et al.* 2002).

The effectiveness of wax in combination with fungicides on the storage behavior of seal packaged kinnow mandarins. The observations on physico-chemical characteristics of the fruits recorded after 30 and 60 days of ambient storage, expressed that the treatment of fruits to Imazalil 1000 ppm with HDPE film wrapping registered better fruit appearance, quality and low rate of pathological rotting (Kaur *et al.*, 2004).

Different packaging materials viz. LDPE (25 micron), brown paper bags, corrugated fiber board boxes, newspaper were used for the fruit packaging. At intervals of 15 days till 45 days, observations were noted. Throughout the entire storage period, the PLW, TSS, TSS: TA ratio and pH showed an upward trend, whereas the weight, length, and width and Titrable acidity showed a downward trend. During storage, the fruits corrugated fiber board packaging showed the least amount of volume loss and PLW compared to other methods (Kumar *et al.*, 2022).

To study the effect of packaging material on the kinnow different packaging materials were used like LDPE (25 µm), HDPE (15 µm), Shrink film (15 µm) and Cling film (15 µm), Polypropylene (25 µm) along with liquid paraffin wax (10%). In experiment it was observed that Cling film at 15µm in combination with wax (10%) recorded maximum TSS, TSS: acid ratio, Total sugars, Non-reducing sugars and Sugar: acid ratio when compared with other packaging material at 25 days after storage (Singh *et al.*, 2017).

Table 1: Effect of packaging material on kinnow mandarin

S. no	Packaging material used	Effect	Reference
1	Shrink wrapped packaging	Improved the quality, appearance, flavour and firmness	Gupta & Raghav., 2000
2	HDPE	Retained the quality of fruit under storage conditions	BVC <i>et al.</i> , 2006 ^[3]
3	HDPE	High fruit juice content and less spoilage	Randhawa <i>et al.</i> , 2009
4	HDPE	Improved the TSS and quality of fruit.	Sohi <i>et al.</i> , 2016 ^[7]
5	HDPE	Kinnow product was microbiologically stable for 60 days under storage conditions.	Sidhu <i>et al.</i> , 2016
6	Cling film	Improved TSS, TSS: Acid ratio, Total sugars, non-reducing sugars and Sugar: Acid ratio at 25 days interval as compared to control	Singh <i>et al.</i> , 2017
7	Shrink film packaging	Improved the Titrable acidity, TSS content, firmness and total sugar content	Singh <i>et al.</i> , 2018
8	Polypropylene	Improved quality of fruit under cold storage conditions.	Baswal <i>et al.</i> , 2020 ^[2]
9	BOPP	Improved the shelf life and did not affect the physiological activity	Singla <i>et al.</i> , 2021 ^[6]
10	LDPE	Increased trend of PLW, TSS, TSS:TA ratio, and pH whereas decreased trend of weight, length, and width and Titrable acidity was observed	Kumar <i>et al.</i> , 2022

Conclusion

Usage of packaging material in kinnow is a common practice now a days, which has efficiently enhanced the physiological quality of kinnow during the storage, extended the shelf life period, reduced the shrinkage, physiological loss of weight and decay of fruit. Proper packaging material when used with proper technique including the thickness of packaging material along with the coating material can enhance the shelf life, quality as well as helped in minimizing the post-harvest loss of fruit. The films used as a packaging material are permeable to gases and vapors and can modify the micro atmospheric conditions of the fruit which can further leads to the delay in deterioration.

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