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Role of Packaging on Shelf Life and Quality of Kinnow – A Review

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Citrus fruits are grown commercially in tropics and subtropical regions of the world. A mandarin hybrid, Kinnow (King x Willow leaf), one among the citrus group, secures the leading position among the other citrus fruits that were grown in India. Under subtropical regions of Punjab, it occupies around 50% area of fruit growing regions. Due to its nature, kinnow considered as a precocious, prolific bearer with excellent fruit quality and better juice content. Kinnow fruits due to its attractive orange yellow colour rind attracts consumers and gains better market potential that helps to obtain assured income by growers. As of these characters, kinnow tends to acquire greater demand not only in Indian markets, but also in other countries *viz.,* Sri Lanka, Thailand, Bahrain, Kuwait and Saudi Arabia.

Keywords: Kinnow, Post harvest, Packaging, Quality, Shelf life.

In Kinnow, improper post-harvest handling activities results in deterioration of quality and prefers lesser market price. Especially with mandarins, the post harvest loss of 20-25% has been estimated due with poor handling and inefficacy with transportation (PHLRD, 2005). Qualitative losses, in sense of caloric and nutritive value with non preference by consumers, deprived edibility are more difficult to measure than quantitative losses of fresh fruits (Kader, 2005).

Post harvest treatments play a vital role in enhancing the keeping quality of fruits (Deka *et. al.,* 2006). In harvested fruits, loss in water vapour, results in shrinkage with peel, turgidity reduction and lowered resistance to gas diffusion, results in negative consequences with the taste and flavour (D'Aquino *et al.,* 2001). Many facts have been reported in view of rendering solution to the issue for enhancement of fresh produce shelf life. According to Panhwar (2006), worldwide post-harvest losses in fruits are as high as 30-40 percent and it seems to be more in some developing countries. Reducing post harvest losses ensures food safety, both in quantity as well as quality that prefers to every inhabitant in our planet. In view to above statement, the studies pertaining to packaging and their impact on quality and shelf life of kinnow were critically accessed in this review under various conceptual facts.

Effect of packaging on physical parameters of fruits

Farooqi and Ahmad (1988) made a study to assess the impact of various wax emulsions *viz.,* Fruitex, Britex-561 and SB65 over orange, kinnow, lemon and grape fruit. It was found to be observed that wax coating improved external appearance of fruits and reduced weight loss, retained fruit firmer, and fresh look.

Dhatt *et al*., (1991) reported that in the treatment of kinnow fruits wrapped with shrink wrap films with 25 micron thickness registered lesser weight loss (2%) and fruits also tasted better.

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Dhatt and Randhawa (1991) observed the average weight loss was minimum (6.1%) in the treatment with polymeric wrapped film and maximum (23.4%) in unwrapped. It was also observed, in individually wrapped kinnow fruits with high density polyethylene (HDPE) film, storability extended for about 8 weeks at ambient condition.

According to Dhatt *et al*., (1995) the maximum weight loss of 25.57 and 45.31 percent was observed in unwrapped fruits after 30 and 60 days. But in other packaging treatments, the weight loss in individually wrapped fruit was 1.54 (Imazalil 500ppm), 3.85 (Imazalil 1000 ppm) and 6.33 per cent (2,4-D 200 ppm) after 30, 60 and 90 days.

Ladaniya *et al*. (1997) reported that the minimum weight loss in fruits of Nagpur mandarin observed in the treatment of fruits wrapped with heat shrinkable film individually. In vice versa, the weight loss in fruits increased with extended storage period.

According to Sonkar and Ladaniya (1998) the technique of tray-over wrapping of Nagpur mandarin with linear low density polyethylene (LLDPE) stretch cling film extended the shelf life upto 2 months. The individual film wrapping of Nagpur mandarin fruit using stretch cling film after carbendazim treatment extended the storability to 60 days under refrigerated condition and possessed minimum weight loss.

Randhawa *et al*., (1999) reported that, the wrapping of Nagpur mandarin fruits reduced water loss drastically (1-2%) as compared with non-wrapped fruits (13.29%) after 60 days of storage under refrigerated condition.

Perez-Guzman *et al.*, (1999) studied the effect of individual seal packaging of 'Dancy' mandarin (*Citrus reticulata*) with polyolefin (0.019 mm) and PVC (0.025 mm) and reported that the minimum weight loss was observed under refrigeration storage.

Deshmukh *et al.*, (1999) observed the effect of film wrapping and low temperature (5-6^{0}C) on storage quality of sweet orange cv. Mosambi and reported that, both the treatments were found to be positive with the parameters viz., minimized weight loss and fruit diameter.

Ladaniya (2003) reported that packing of 'Mosambi' orange with stretchable cling with shrinkable cryovac and shrinkable LDPE registered minimum weight loss and spoilage upto 40 days, under 20 to 25° C storage.

In an investigation made by Hussain *et al*., (2004) on citrus by using Uni-Packaging with polyethylene, it was found to be observed that the treatments tends to have profound effect in enhancing the shelf life and maintenance of external appearance, taste, and texture.

Ramin and Khoshbakhat (2008) accessed the impact of packaging with high density polyethylene (HDPE) bags of thickness 30µm on acid lime. The film found to have microperforations and the storage of fruits @ 20°C and 10°C minimized the weight loss of acid lime fruits.

Jadhao *et al*., (2008) observed that storage of kagzi lime in 200 gauge perforated polypropylene bags registered the minimum in physiological loss in weight and diameter at the end of 70 days of cold storage.

Nasciment *et al*., (2011) evaluated the effect of cold storage of Murcott mandarins subjected to treatment with modified atmosphere and observed that the fruits treated with wax and/ or packed in flexible packaging material extended shelf life for 30 days. Observations on physico-chemical traits and disease incidence on fruits revealed that observation of fruits at thirty days of storage at 10±1°C, retained greater intensity of skin colour than that of control. The fruits (with or without wax) packed in flexible bags showed lower weight loss (<10%) and extended shelf life up to sixty days at 10±1°C followed by seven days at 25°C.

Hassan *et. al*., (2013) accessed the impact of wax coating on fruit quality of tangerine citrus (*Citrus reticulata*). Fruits were coated with 3 different concentrations of wax emulsion (10, 12 and 15%) and gets stored at two temperature levels (5 and 25°C) with 85-90% RH. The results revealed that the dual concept of having wax coating (12%) and storage (5°C) found to be most effective.

Mahajan *et al.,* (2013) investigated the effect of surface coating on fruit quality of kinnow and observed that those fruits coated with the formulations of 'Nipro Fresh SS 40T and SS 50', air dried and later packed in CFB boxes, showed significant effect in delaying weight loss.

Dhillon *et. al*., (2016) experimented the fruits of Daisy mandarin by packing in paper

moulded trays and wrapping by various packaging films of heat shrinkable film (15 ì), cling (15 ì) and low density polyethylene (25 ì LDPE) film. The results revealed that, shrink film helped in reducing the loss in weight (1.12%) and decay incidence (0%), for 15 days under storage.

Effect of packaging on physiological parameters of fruits

According to Raghav and Gupta (2003), the individually wrapped fruits could be stored for 84 days with acceptable eating quality and less PLW (4.0%). It was found to be at nominal level upto 40 days in unwrapped control (37.0%) of fruits at ambient condition. Apart, the waxing treatments were quite effective in extending the shelf life and diminishing PLW even after 21 days of storage.

Upadhayaya and Sanghavi (2006) made a study with different treatment of kinnow mandarin as 4 %$CaCl_2$ and packed the fruits in perforated (0.2%) polythene bags. The results revealed that the treatments tends to reduce the physiological weight loss of fruits during storage and extended the storability upto 42 days under ambient condition.

Sharma *et al.* (2007) reported that kinnow mandarins with 150 gauge polythene bag package with bael leaf extract, exhibited the maximum reduction in PLW as compared to untreated control.

Reddy *et al*., (2008) evaluated the role of several packing materials on shelf life and quality of acid lime. The results showed that the packing of fruits with LDPE treatment found to be most effective in preventing the physiological loss in weight of acid lime.

According to Sonkar *et al.,* (2009) kinnow fruits packed with cling film, registered better performance in respect of PLW under ambient conditions.

Jawandha *et al.,* (2012) examined the impact of LDPE packaging and several chemicals on kinnow at ambient storage condition. The results revealed that the kinnow fruit treated with boric acid @3 % + LDPE packaging without perforation recorded minimum physiological loss in weight.

Mandal (2015) studied the role of lac-wax, citrashine and shrink wrapping of fruits on storability of kinnow. The fruits treated with waxes and individually shrink wrapped in LDPE (19i) and packed in 4 kg CFB boxes and stored under ambient condition. The results revealed that the maximum PLW was observed in control, whereas, shrink wrapped and lac-wax treated fruits effectively reduced PLW.

Effect of packaging on quality parameters of fruits

Ahmad *et al*., (1979) examined the impact of waxing and lining material on storability of kinnow and observed the treatment recorded better impact with quality traits. The results revealed ascorbic acid and citric acid content tend to decreased in vice versa sugars and sugar/acid ratio increased under storage.

Farooqi and Ahmad (1988) analyzed the impact of wax emulsions of fruitex, Britex-561 and SB65 coating over orange, kinnow, lemon and grape fruit. No significant changes found to be observed with acidity, and sugar contents in all the examined fruits.

Singh and Singh (1988) reported that maximum TSS (11.6%) was observed in non-sealed fruits after four week of storage. However, it was reversed after eight weeks of storage, when higher TSS observed in all type of wrapped fruits.

According to Dhatt *et al.,* (1991), kinnow fruits which were under storage showed slow increase in sugars with to individual shrink wrapped fruits than that of unwrapped control.

Kaushal and Thakur (1996) reported that the fruits under sealed packaging treatment registered the decreased level of titrable acidity under cool chamber storage. The fruits treated with 1% bavistin and packed in polyethylene bags exposed decreased ascorbic acid under storage. However, the fruits in sealed packaging exhibited gradual increase in sugar content than that of those fruits in untreated control.

According to Raghav and Gupta (2000) the individual shrink wrapped kinnow fruits showed lower sugar content than unwrapped kinnow fruit, with film thickness of 25 micron. Fruits maintained better flavour and quality (TSS, Acidity, Ascorbic acid, Sugars) upto 8 weeks than that of the unwrapped fruits found to get stored at ambient conditions.

Thakur *et al*., (2002) reported that the fruits stored after carbendazim treatment and packed with 150 gauge thickness LDPE bags observed to be effective in retaining better fruit

quality under storage. In a vice versa, the total sugar content of fruits remained to be increased throughout the period of storage.

Juliana *et al*., (2004) analyzed minimally processed 'Champagne' oranges (*Citrus reticulate* × *Citrus sinensis*) for certain physicochemical and microbiological characteristics under various packaging treatments. Those packed in lidded polystyrene containers, polyethylene and PVC films retained superiority in overall visual appearance for fresh with a few characteristic changes up to a storability for 8 days.

Hussain *et al*., (2004) studied the effects of polyethylene packing on citrus fruits. The result revealed that uni-packaging technique had no impact over pH in citrus fruit. T.S.S observed to be enhanced under storage but not with those under individual packaging. In vice versa, ascorbic acid decreased from 1.59-0.63% under storage condition.

Kaur *et al.,* (2004) studied the effectiveness of wax in combination with fungicides on the storage behaviour 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.

Ladaniya *et al.,* (2005) conducted an experiment to study the effect of sub-optimum low temperature storage of 'Nagpur' mandarin along with wax coating and intermittent warming. The results of the study revealed, the intermittent warming and wax coating are useful for extending the storability of 'Nagpur' mandarin up to 75 days.

Reddy *et al*., (2008) analyzed the impact of various packing materials on shelf life and quality of acid lime. The packing of fruits with LDPE found to be most effective in minimizing the pH, ascorbic acid, increase in TSS, and acidity.

Jadhao *et al*., (2008) observed that the kagzi lime stored with 200 gauge perforated polypropylene bags recorded the minimum loss in TSS, TSS/acid ratio and the maximum content of acidity and ascorbic acid at the end of 70 days under cold storage.

Shein *et. al*., (2008) examined the influence of wax coating over post harvest quality of 'Sai Nam Peung' mandarin orange. The fruits were coated with teva wax (18% food grade shellac, polyethylene) and placed under cold storage for 1 month. In the study, it was observed that there was no significant difference in T.S.S/ T.A ratio during storage.

Randhawa *et al*., (2009) accessed impact of HDPE packaging in addition with edible oil and wax coating for assessing storability of kinnow. The results of the study exposed that after 45 days of ambient storage, the highest palatability rating was recorded. The fruits coated with neem oil with HDPE packaging registered maximum juice content and minimum spoilage during storage. However, the maximum value for TSS and PLW registered with untreated control.

Sahid and Abbasi (2011) analyzed the influence of wax coating on sweet orange cv. Blood Red. The results of the study revealed that wax treatment (5%) maintained positiveness in terms of pH, TSS, titartable acidity, TSS/acid ratio, sugars (total, reducing, and non-reducing) and ascorbic acid of fruits.

According to Mahajan *et al.,* (2013) the kinnow those treated with 'Nipro Fresh SS 40T or SS 50' expressed significant delay in the alteration of TSS, titratable acidity and vitamin-C level of kinnow observed under storage

Jawandha *et al*., (2014) assessed the response of Baramasi lemon under modified atmosphere packaging on storage. The healthy fruits after disinfestation with 0.1% bavistin solution for 2 minutes and wax coating were packed (four fruits in each pack) in high density polyethylene (HDPE) and low density polyethylene (LDPE) bags. The results of the study revealed that fruits treated with bavistin @ 0.1% and packed in LDPE bags registered betterness in quality with regard to juice content, and acidity during 50 days of ambient storage.

Mahajan and Singh (2014) noticed the shrink film packaging of kinnow fruits improved the storage life and better quality retention for 20 days as against 10 days in unpacked control.

Jhalegar *et al*., (2015) accessed the role of surface coating with lac based wax, Citrashine, P-104 and Niprofresh on quality of kinnow. The results indicated the surface coatings extended storability and quality of kinnow fruits even upto 60 days.

According to Singh and Yadav (2015) packaging of kinnow fruits with 100 gauge LDPE bag packaging combined with evaporative cool chamber plus rice husk ash (RHA) maintained superiority in terms of highest overall acceptability.

Chaudhary *et al*., (2015) reported that 'Star Ruby' grapefruits (*Citrus paradisi*, Macf.) stored upto 16 weeks at 10 °C in micro or macro perforated bags did not had negative value in terms of ascorbic acid, acidity, and TSS content.

Mandal (2015) made a study on role of lac-wax, citrashine and shrink wrapping of fruits on storability of kinnow. The results indicated that individually shrink wrapped, lac-wax and citrashine coated fruits extended the storability upto 21 days of storage in ambient conditions without altering quality.

Dhillon *et al*., (2016) observed the significance of different packaging films on shelf-life and quality of Daisy mandarin under ambient conditions. The fruits were exposed to various packaging treatments *viz*., heat shrinkable film (15 ì), cling (15 ì) and low density polyethylene (25 ì LDPE) film. The results of the study revealed that shrink film proved to be effective in extending the storability and quality retention upto 15 days as compared to that of control (5 days).

CONCLUSION

Kinnow, as a non-climacteric fruit, shows no respiratory peak and also tends to ethylene production in normal conditions after harvest. Thereby, usage of different packaging material for fresh fruit marketing widely a common practice that helps in extending storability by reducing shrinkage, weight loss and occurrence of various blemishes. Promotion of proper packaging technique with suitable storability condition enhance the availability of kinnow can be extended in market.

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