Punjab Horticultural Postharvest Technology Centre
Punjab Agricultural University, Ludhiana

PHPTC Newsletter

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Postharvest Handling and Storage of Kinnow

Citrus fruits play an important role in India's horticulture economy. Citrus fruits are known for their pleasant aroma, thirst-quenching properties, and ability to provide essential vitamin C. Citrus occupies the third position among the fruits following bananas and mangoes. The production level of the country covers around 47 million tons. Among various citrus fruits, Kinnow Juice is highly appreciated by consumer for its fresh and aromatic taste. It is very popular fruit in India and abroad. However, the perishable nature of fruits and vegetables pose a major drawback in their storage, transportation to local and distant markets. Despite its nutritional and commercial benefits, this fruit is not available in off-season due to its poor shelf life of 8-10 days.

India is the world's fifth largest producer of citrus fruits. Citrus fruits are commercially grown in India in Haryana, Punjab, Himachal Pradesh, Rajasthan, Uttar Pradesh and Jammu. Kinnow seed is planted between August to October and harvesting starts when the fruit's external colour becomes orange, from December to February. The best harvesting time is mid-January to mid-February, when the fruit attains a TSS/acid ratio of 12:1 to 14:1. In Punjab, Citrus is grown on 52,836 acres with an annual yield of 10,49,977 tonnes. Kinnow has fetched the importance among all citrus fruits owing to its enriched nutritional profile. The fruit is rich in minerals such as sodium, phosphorus, calcium, iron, copper, zinc and vitamin C.

Nutrients in kinnow per 100 g

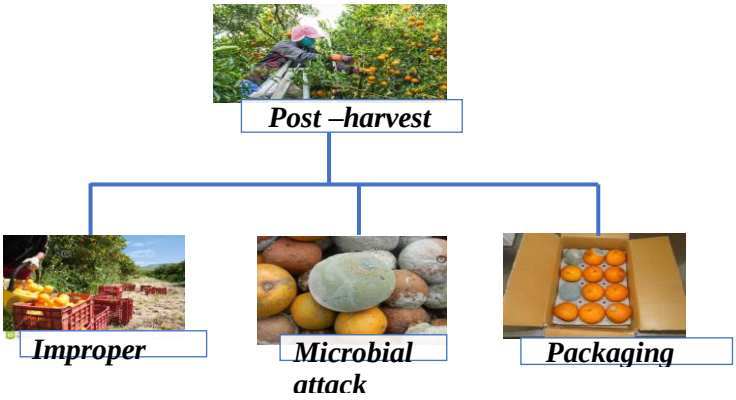
Nutrient	Quantity
Calories	50 Kcal
Carbohydrates	11 grams
Dietary Fibre	2 grams
Sugar	10 grams
Protein	1 gram

(i) Harvesting: Kinnow is usually harvested with pruning scissors / cutters, then dropped to the ground and collected in crates / bags but these practices are not completely followed and ultimately results in significant post-harvest losses. During the post-harvest period, farm-level losses are highest, followed by harvesting, packaging, handling and transportation. Lack of suitable marketing channels and poor post-harvest management methods including improper packaging are the most serious post-harvest issues with kinnow. Harvesting should be followed by disinfection of fruits with 100-150 ppm chlorine solution.

Fig 1. Kinnow harvesting with pruning scissors

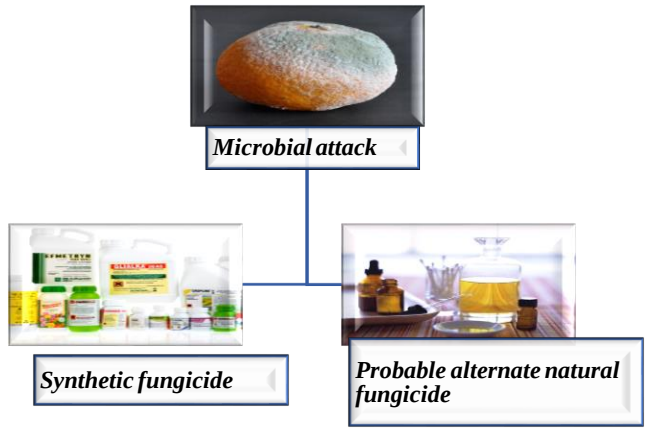
(ii) Waxing and packaging: Waxing of kinnow is a world known practice for its marketing that not only enhances its shelf life but also provides gloss to the fruit, making it appealing to the customer. Currently Food Safety and Standard Authority of India has recommended shellac, carnauba and bees wax coatings. Waxing and grading lines have been set up in various districts of Punjab at five citrus estates *viz.*Abohar, Fazilka, Hoshiarpur, Bhunga and Badal. Farmers and exporters are being facilitated at these packhouses to get the services at very nominal costs.

(iii) Postharvest Issues: Inspite of the upgraded facilities and waxing, the perishable nature of fruits and vegetables pose a major drawback in their storage, transportation to local and distant markets. Hence, the postharvest shelf-life related aspects are of utmost importance. Improper post-harvest handling and packaging practices especially during the glut season, result in deterioration of its quality as well as significant postharvest losses. Further, severe fungal diseases that lead to considerable post-harvest losses are green mold and blue mold caused by *Penicillium digitatum* and *Penicillium italicum*, respectively.



Outside India, these fungi are managed presently by synthetic fungicides like Carbendazim 50 WP, imazalil and thiabendazole. Currently, none of the fungicides are recommended in India for Kinnow to cater postharvest losses. Furthermore, with their continuous and indiscriminate use, the target organisms develop resistance along with the concurrent health issues. Waxing with commercial shellac is the only alternative that adds a gas exchange barrier to restore the shiny surface of the kinnow. With increasing awareness, customers expect safer alternatives with potentially non-toxic effects on humans and animals in order to ensure microbiological food safety. As a result, significant emphasis has been placed on improving the quality, safety, and security of food systems against microbial deterioration and the associated toxins.

(iv) Ecofriendly alternate to synthetic fungicides: Plant essential oils (EOs) and their constituents are getting prominence in the commercial food industry due to their potential antimicrobial properties and aroma. Essential oils, being promising antifungal agents have provided a solution for replacement of synthetic fungicides. Among various EOs, tulsi essential oil of few species can be a good alternate to synthetic fungicide owing to its diverse antimicrobial properties. Tulsi based shellac coatings can thus, provide a safe and effective alternate to cater the postharvest losses in Kinnow. Two species *O. gratissimum* and *O. viride* showed promising antimycotic potential against both target fungi viz. green mold and blue mold. The major component found in Tulsi *i.e*, eugenol has also been tested and found to be more promising than the corresponding oils.



Method to use Tulsi/Eugenol based shellac Coating on Kinnow

Ocimum Essential Oil (@2-3%)/Eugenol (@1-2%)

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Dropwise addition to **s**hellac wax coating (100ml)

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Stirring

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Tulsi/Eugenol shellac coating on Kinnow by using waxing and grading line

Waxing of Kinnow with Tulsi/Eugenol shellac coatings: Mature Kinnow mandarin fruits at commercial ripening stage without any visible defects should be selected for coating. The fruits were washed and disinfected with chlorine water (100-150 ppm) followed by coating with tulsi essential oil/eugenol based coating at PHPTC. The fruits were dried at ambient conditions and graded and stored at 5.0 ±2°C and 90-95% RH for 60 days.

Storage studies: The effect of coatings on treated fruits versus untreated fruits was evaluated from their physiological parameters at regular intervals from 30th day till 60 days of storage. Physiochemical parameters such as juice yield, firmness, physiological weight loss (PLW), spoilage, TSS, titratable acidity, ascorbic acid and reducing sugar were taken and evaluated. The per cent spoilage and Physiological loss in weight was reduced by 2 to 3 % in eugenol-shellac treated fruits with maximum efficacy followed by tulsi essential oil than shellac alone.Hence eugenol-shellac may be a promising upcoming green alternate to synthetic fungicides to improve postharvest shelf life of Kinnow.

Spoilage Incidence in stored Kinnow fruits after 60 days under cold store conditions (5.0 ± 2°C)

Recommendation in 301st REC meeting:
Tulsi's eugenol (1%)
Or
Tulsi essential oil (2%)
Help in extending the shelf life of kinnow fruits with acceptable quality for 60 days under cold storage condtions
Storage period: 60 days
Storage conditions: cold store (5.0 ±2°C)

Permissible limits/ Safety Issues: The US Food and Drug Administration (FDA) classifies EOs as "generally recognized as safe" (GRAS) secondary metabolites of aromatic plants. It is pertinent to mention that eugenol has also been provided exemption from the tolerance limits by United States-Environment Protection agency (US-EPA) in year 2022 and thus can be safely used for enhancing postharvest shelf life of Kinnow by controlling postharvest fungal infestation.

PHPTC Activities

1) Establishment of Proximate Analysis Laboratory: A new laboratory for proximate analysis in foods has been established by adding new instruments such as soxhlet apparatus, dietary fibre, crude fibre and K. Jeldahl apparatus for the estimation of protein, fat, crude fibre and carbohydrate in fresh and processed food commodities. This laboratory will cater the requirement of labelling requirement of food industries and FPOs.

2) Front Line Demonstration at Abohar & Bhunga:

- Under the sponsored project of NHM wherein the grant of 5 lakh has been received by PHPTC, front line demonstration of Eugenol @ 1% and tulsi oil @ 2% in wax as green post harvest treatment were conducted at Balaji Packhouse having waxing and grading line, Abohar and at Citrus Estate, Bhunga.

- A Seminar on postharvest handling and storage of Kinnow fruits was conducted at Citrus Estate Bhunga, Hoshiarpur. Dr Satbir Singh Gosal, Vice Chancellor, PAU, Ludhiana was the Chief Guest. Dr BVC Mahajan, Director, Punjab Horticultural Postharvest Technology Centre emphasized that Kinnow is much less demanded in the North region due to cold weather. However, the demand of Kinnow fruit in southern states is comparatively high. Therefore, farmers should send their produce after proper waxing, grading and packing to distant markets for getting better price. Sh Jaspal Singh Assistant Director Horticulture enlightened the farmers to avail the benefit of various schemes under National Horticulture Mission Programme for creating postharvest infrastructure at farm level. Dr Satbir Singh Gosal Vice Chancellor advised the farmers to formulate cooperatives for better marketing of their valuable produce to domestic and distant markets. He also guided the farmers to follow the standard pre-harvest and postharvest practices to maintain the quality of their crops as recommended by Punjab Agricultural University. Dr Ritu Tandon, Dr Swati Kapoor and Dr Pooja practically demonstrated the use of green fungicide based on tulsi essential oil or its component eugenol as an effective antifungal agent that can be used by mixing these in already used citrus wax coatings. This will help in reducing spoilage incurred during transportation of Kinnow to distant markets.

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