

LOSSES OF KINNOW MANDARIN DURING TRANSPORTATION

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ABSTRACT : The kinnow fruits were harvested on 30th January, 2000 and 25th March, 2000. Unwaxed (Fresh fruits), waxed and unwaxed (stored fruits) were sent to Defence Food Research Laboratory (DFRL), Mysore to find out the losses during transportation. Fruit weight loss due to physiological disorder was less in waxed as compared to unwaxed fruits. Minimum fruit rot (4.44%) was recorded in unwaxed (fresh fruits) and maximum (14.97%) in waxed fruits which was stored for 75 days under cold storage (Temp. 4- 5°C and R.H. 85-90%). The T.S.S. acidity and ascorbic was found less in infected fruits as compared to in healthy fruits. Organoleptic characteristics of juice in waxed, unwaxed and infected fruits were tested after transportation and found that waxed fruits accepted more as compared to unwaxed and infected fruits during transportation.

Key Words : Kinnow, fruit, loss, transportation.

Kinnow mandarin (*Citrus reticulata* Blanco) is the hybrid variety and crossed between the Willow leaf mandarin (*Citrus deliciosa*) and King orange (*C. nobilis*) (Ghosh, 1985). It is very popular in Northern India mainly due to its wide adaptability high yield and more juice content. It is quite possible that a large quantity of fruits damage during transportation from North India to other parts of country and abroad. The fruit losses cause due to means of transportation, packaging material, environmental condition and distance (Jain, 1989). Citrus fruits have comparatively larger shelf life, however, more than 50% losses have been reported in Nigerian marketing system by Aworth *et al.* (1991). A combination of fungicide and wax emulsion was found effective in loss reduction (Mann, *et al.*, 1988). Dhutt *et al.* (1991) established the efficacy of HDPE film on retention of quality of kinnow fruits. The post harvest losses in Nagpur mandarin from farm level to New Delhi were assessed and reported that fruits were lined 20.91% when transported by truck and 23.27% by train (Anon, 1997). Packaging materials are also affect on transportation loss of kinnow and it was varied 3.60 to 13.80 per cent.

Therefore, an investigation was under taken to find out the losses of stored and fresh fruits, the status

of physio-chemical and organoleptic characteristics of stored fruits during transportation from Central Institute of Post Harvest Engineering and Technology (CIPHET), Abohar (Punjab) to Defence Food Research Laboratory, (DFRL), Mysore (Karnataka) by train or/and bus.

MATERIALS AND METHODS

Mature fruits of "kinnow" were harvested by method of cutting with scissors and fruits collected in HDPE crate on two dates i.e. 30th January and 25th March, 2000 from Billa Patti, Abohar. The harvested fruits were packed in Corrugated Fiber Board (CFB) boxes and transported from CIPHET, Abohar to DFRL, Mysore in three batches separately.

The first batch of fruits was sent on 6th Feb., 2000, second on 26th March, 2000 and third on 14th April, 2000. The weight of fruits with box was taken at the time of dispatching and regarded as 43.40 kg, 50.23 kg and 39.70 kg respectively. First batch was the waxed with fruits and was stored under ambient condition for seven days, unwaxed-fresh fruits of second batch and waxed as well as unwaxed fruits of third batch stored under cold storage (Temperature 4-5°C; R.H. 85-90%) for 75 days, were packed in CFB boxes

Table-1 : Fruit weight during transportation from CIPHET, Abohar to DFRL, Mysore.

| Batch | Treatment | CIPHET Abohar | | DFRL Mysore | | |
|--------------------|-------------------------------|---------------------------|-------------------|-------------------------|-------------------------|-----------------|
| | | Initial fruit weight (kg) | Date of packaging | Final fruit weight (kg) | Date of arrival/opening | Weight loss (%) |
| 1 st * | Waxed-7 days stored fruits | 43.4 | 05-02-2000 | 42.1 | 09-02-2000 | 3.00 |
| 2 nd * | Unwaxed-fresh fruit | 50.23 | 25-03-2000 | 47.85 | 29-03-2000 | 4.75 |
| 3 rd ** | | | | | | |
| (a) | Waxed-5 days stored fruits | 19.20 | 13-04-2000 | 18.40 | 17-04-2000 | 4.16 |
| (b) | Unwaxed-75 days stored fruits | 20.50 | 13-04-2000 | 19.50 | 17-04-2000 | 4.87 |

* : Fruits from five boxes

** : Fruits from two boxes for a and b treatments.

with two layers. In first and second batches an average of 20 fruits in each layer, while in third batch 19 fruits were packed at upper layer and 43 fruits at lower layer. These were separated by 5 ply craft papers. The size of CFB boxes was used as 46 cm x 27 cm x 27 cm and made of 7 ply of craft paper with four holes 2.5 cm diameter each. The fruits were treated with Citrashine wax (FMC Corporation, Citrus Systems Division, Riverside, California-Lindsay, California) which content 0.1% benzimidazole fungicide. The waxing was done by waxing and grading machine at waxing and grading station, of Moujgarh, Abohar (Punjab).

The fruits were transported from CIPHET, Abohar to DFRL, Mysore by train (Air Condition/general coach) and bus. The physiological losses (in weight) was determined by initial fruit weight and final fruit weight and was differentiated and expressed in percentage. The visual symptoms of rotted fruits were recorded after five days in percentage at DFRL,

Mysore and cumulative per cent of rotted fruits during transportation was calculated. Chemical analysis was done for acidity (anhydrous citric acid), ascorbic acid for 75 days stored fruits as per method described by Ranganna (1986). TSS was estimated by hand refractometer.

RESULTS AND DISCUSSION

The present findings reveal that shelf life of fruit and its loss were varied from batch to batch transportation from CIPHET, Abohar to DFRL Mysore. Table 1 shows that the fruit weight was decreased by 3.00-4.87% during transportation. However, in third batch, both waxed and unwaxed fruits (which was stored for 75 days), about 0.7% fruit weight loss, comparatively, there was less loss in waxed fruits, as compared to unwaxed of the same batch but the weight loss was more in third batch followed by other two batches. Minimum fruit rot (4.44%) was recorded in second batch unwaxed (fresh fruits). Maximum fruit rot

Table-2 : Fruit loss during transportation from CIPHET, Abohar to DFRL, Mysore.

| Batch | Treatments | Layer of packaging | No. of fruits in CFB boxes | Fruit rot | | Fruits loss (%) |
|-----------------|---------------------------------|--------------------|----------------------------|-----------|---------|-----------------|
| | | | | Fungal | Injured | |
| 1 st | Waxed fruits stored for 7 days | Upper layer | 100 | 5 | 2 | 7.00 |
| 2 nd | --do-- | Lower layer | 100 | 21 | -- | 21.00 |
| | Unwaxed fresh fruits | Upper layer | 111 | 2 | 1 | 2.70 |
| | --do-- | Lower layer | 115 | 2 | 1 | 1.74 |
| 3 rd | Waxed fruits stored for 75 days | Upper layer | 32 | 8 | -- | 25.00 |
| (a) | --do-- | Lower layer | 89 | 15 | 1 | 17.98 |
| | Unwaxed | Upper layer | 43 | 6 | -- | 13.95 |
| | fruits stored for 75 days | | | | | |
| (b) | --do-- | Lower layer | 83 | 9 | -- | 10.84 |

Table-3 : Physio-chemical characteristics of kinnow fruits after transportation from CIPHET, Abohar to DFRL, Mysore after 75 days stored under cold store.

| Treatment | Weight of two fruits (gm) | Peel weight (gm) | Juice weight (gm) | TSS (%) | Acidity (Citric acid) (%) | Ascorbic acid (mg/100 ml juice) |
|-----------------|---------------------------|------------------|-------------------|---------|---------------------------|---------------------------------|
| Waxed | 354 | 98 (27.68)* | 165 (46.60) | 10.40 | 0.44 | 16.67 |
| Unwaxed | 323 | 80 (24.98) | 156 (48.30) | 9.5 | 0.37 | 9.53 |
| Infected | 332 | 77 (23.19) | 146 (43.98) | 8.4 | 0.26 | 8.33 |
| t-values at 2df | | 19.25 | 37.03 | 16.26 | 7.2 | 4.43 |

* The values in per cent of in-parentheses.

Table-4 : Organoleptic characteristics of kinnow fruits stored for 75 days under cold store.

| Treatments | Grading out of 9 marks | | | Overall acceptance |
|------------|------------------------|-------|-------|--------------------|
| | Colour | Aroma | Taste | |
| Waxed | 6.95 | 6.85 | 6.91 | 6.68 |
| Unwaxed | 6.55 | 5.68 | 5.55 | 5.73 |
| Infected | 5.64 | 4.18 | 4.55 | 4.82 |

(14.97%) was recorded in third batch and it was also noted that the fruit rot due to fungal infection was more in waxed fruit as compared to unwaxed. It was also observed that fruit firmness was reduced due to long duration of storage and thus, the chance of fungal infection was more in loose rind fruit (Table 2). The fungi such as *Penicillium digitatum*, *P. italicum*, *Alternaria citri*, *Aspergillus niger*, *A. flavus*, *Aspergillus* spp. and *Mucor* sp. were identified. Among them *P. italicum* and *A. citri* were prominent on the fruit surface in waxed and unwaxed fruits. Mechanical injury was less as compared to fungal infection in all batches, because extra care was taken during transportation.

The physio-chemical characteristics were analysed in third batch and three types of fruits such as waxed, unwaxed and fungal infected were taken of the testing. Table 3 shows that T.S.S. (8.4%), acidity (0.26%) and ascorbic acid (8.33 mg/100 ml juice) were found less in infected fruits as compared to waxed and unwaxed fruits. Organoleptic characteristic of the same juice were tested on the basis of V-9 hedonic scale. It was noted that out of 9 marks, waxed fruits was found 6.68, unwaxed 5.73 whereas infected fruits were not accepted (Table 4).

The physiological weight loss was reduced during storage and transportation due to transpiration from fruit surface, thereby leading to shriveling and poor marketability (Sadashivan *et al.*, 1972). During transpiration of fruit, the weight loss is less in waxed fruits due to the reduction of transpiration rate on the fruit surface (Josani *et al.*, 1983).

Kinnow fruit is rotted during transportation by

mainly fungi. Vir (1984) also reported that damage during transportation and storage caused by mechanical injury, physiological factors and various fungi including *Penicillium italicum*, *P. digitatum*, *Aspergillus niger*, *Geotrichum candidum* and *Botryodiplodia theobromae*. Fungal infection was caused may be due to injuries made on the fruit surface during handling for waxing and grading where in case of unwaxed fruits there was minimum handling. They were directly packed after harvesting.

The decrease in ascorbic acid content during storage was also reported by Chandawat *et al.* (1978). Ascorbic acid went on decreasing with the advancement of storage time. Waxed-stored fruits showed significantly high content of vitamin C as compared to unwaxed but less as fresh fruits (Sharma, *et al.*, 1992). Total soluble solids gradually increased during storage and a similar trend was also observed earlier in kinnow mandarin (Jawanda, *et al.*, 1978). The increase was probably due to the hydrolysis of polysaccharides and concentration of juice as a result of dehydration (Nagar, 1993). The acidity was decreased during storage due to the utilization of acids in respiratory process. It can be concluded that the waxing of fruits is beneficial in reducing weight loss during transportation but more care is required to avoid injuries on fruit surface during handling for waxing and grading of fruits.

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