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## COLOUR DEVELOPMENT AND FRUIT QUALITY OF EARLY HARVESTED KINNOW MANDARIN

Omer Hafeez Malik<sup>1</sup>, Aman Ullah Malik\*<sup>1</sup>, Maria Akram Javaid<sup>1</sup>, Shamsa Ghafoor<sup>1</sup>, Muhammad  
Sohail Mazhar<sup>1</sup> and Qasim. E. Qureshi<sup>2</sup>

<sup>1</sup>Postharvest lab Institute of Horticultural Sciences University of Agriculture, Faisalabad, Pakistan

<sup>2</sup>Roshan Enterprises, Kot Momin Road, Bhalwal, District Sargodha

\*Email: malikaman1@yahoo.com

**Abstract**

Peel colour is an important criterion and fruit with typical colour of the cultivar is preferred by the consumer. Although, Kinnow is a late maturing cultivar, but its harvest has been advanced by 2-3 months overtime, from its normal harvesting season, with the onset of colour break. This study was aimed to find out the effect of early harvesting on fruit colour development and other quality parameters. Fruit of three different sizes (small, medium and large) with four colour levels (L<sub>1</sub>: 90% yellow colour, L<sub>2</sub>: 70% yellow colour, L<sub>3</sub>: 50% yellow colour, L<sub>4</sub>: 25% yellow colour) were harvested on 1<sup>st</sup> December, 2006. Fifteen fruit were included in each level of colour development. The fruit were stored at two different temperatures (4±1°C with 80-85% RH and at ambient conditions: 25±1°C) for 18 days. The data regarding extent of colour development and other quality parameters including fruit firmness and TSS were recorded after 18 days of storage. The results showed that fruit placed at ambient conditions developed more colour (8.32) than fruit placed in the cold store (7.51). Overall, for early harvest of Kinnow mandarin, fruit with minimum of 70% yellow colour should be selected for proper colour development and quality at destination.

**INTRODUCTION**

Pakistan is blessed with vast agricultural resources on account of its fertile land, well-irrigated plains, extremes of weather, and centuries old tradition of farming. Pakistan is one of the few countries of the world where fruit are grown in cool temperate climate (apples, plums, pears, cherries), warm temperate (apricots, grapes, pomegranates and melon), and subtropical climate (citrus, mango, banana, dates and guava). Citrus is among the major fruit and accounts for 32% of the total Pakistan fruit production of 6.3 million tonnes. Kinnow accounts for 67% of the total Pakistan citrus production of 1.4 million tonnes. In our citrus industry, Kinnow has become dominant citrus cultivar. The climatic conditions of the Punjab province suits best to the production of Kinnow. The prolific bearing habit and superior quality of this fruit has fetched widespread applause both inside and outside the country.

Today Kinnow is the leading exportable fruit commodity of Pakistan to Russian States, Iran and Gulf States and thus a rich source of foreign exchange. However, Kinnow is facing stiff

competition due to high quality standards demanded in the international markets. Maximum returns from this crop could only be achieved by determining proper harvesting time and proper postharvest handling techniques.

Kinnow is a late maturing cv. However, in our country the time of harvest is usually determined by the need of market. Thus such fruit picked at improper time, being of low quality, bring less return to exporters (Ghaffar, 1991). Due to increasing demand of Pakistani Kinnow in export markets the early Kinnow harvest starts as early as from mid-November while January to March is the peak season for harvesting Kinnow mandarin (Sabir, 2006).

So far, no such information is available as whether the early harvested Kinnow develops proper colour at destination. Moreover, there is no information available that how does early harvesting affect the quality at postharvest stage. This study was aimed to find out the consequences of early harvest on the external colour and physico-chemical characteristics of Kinnow, harvested at different colour developmental stage and stored at different temperatures.

## **MATERIALS AND METHOD**

Kinnow fruit harvested on 1<sup>st</sup> December 2006, were processed (washed & waxed) at Roshan Enterprises, Kot Momin Road, Bhalwal. Sixty fruits of three different sizes (small, medium and large) with four colour levels were selected.

L<sub>1</sub>: 90% colour (Orange Yellow)

L<sub>2</sub>: 70% colour

L<sub>3</sub>: 50% colour

L<sub>4</sub>: 25% colour

Fifteen fruits were included in each level. The fruits were stored at two different storage conditions (4±1°C with 80-85% RH; ambient - 25±1°C) for 18 days. After storage fruit were analyzed for extent of colour development and other quality parameters including fruit firmness and TSS. The experiment was conducted in postharvest lab, Institute of Horticultural Sciences, University of Agriculture, Faisalabad.

## **RESULTS AND DISCUSSION**

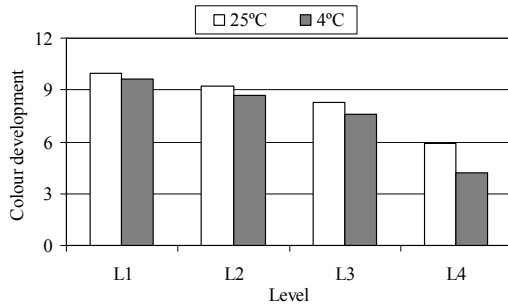
### **Effect on Colour Development, Firmness and TSS**

Data regarding peel colour development showed significant results for colour levels. In both storage temperatures, L<sub>1</sub> gained more colour followed by L<sub>2</sub>, L<sub>3</sub> and L<sub>4</sub> but the overall colour development percentage was more in fruit stored at ambient conditions (Figure 1). The results regarding effect of fruit size on colour development were non-significant. More colour development in the fruit placed at ambient conditions as compared to those placed at 4±1°C seems to be the result of minute quantity of ethylene production at high temperature (Figure 2). Our results are in accordance with the findings of Lallan et al. (2005), who reported that fruit placed at ambient conditions developed more colour as compared to those placed in the cold store.

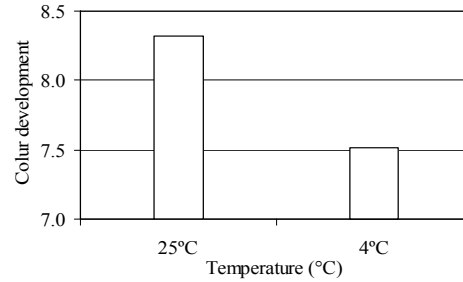
As regard fruit firmness, the small sized fruit retained more firmness followed by medium and large sized fruits. Moreover, fruits placed in cold store retained more firmness than the fruit placed at ambient temperature as shown in (Figure 3). This may be due to the fact that metabolic processes are highly dependent on storage temperature. Fruit stored at ambient temperature undergo ripening process at an accelerated rate than those stored at 4°C.

Data on fruit TSS showed that fruit with colour level L<sub>1</sub> (90% orange) had more TSS followed by L<sub>3</sub>, L<sub>2</sub> and L<sub>4</sub> at ambient conditions while L<sub>2</sub> had more TSS followed by L<sub>1</sub>, L<sub>4</sub> and L<sub>3</sub> in cold store (Figure 4). Small sized fruit had more TSS (11.82° Brix) followed by medium (10.46° Brix) and then large sized fruits (9.77° Brix) as shown in Figure 5. These results are in accordance with the findings of Kihara et al. (1982), who found that small and medium sized fruit had higher TSS when compared with large sized fruit as shown in Figure 4. Moreover, fruit placed at ambient

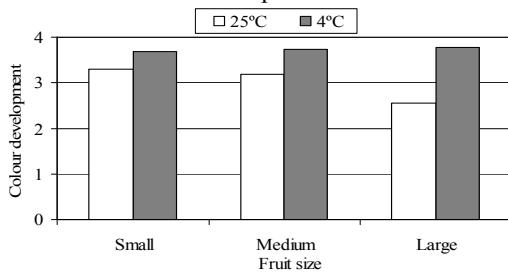
conditions have more TSS (10.81°Brix) than fruit placed in cold store (10.55° Brix) as shown in Figure 6. This could be due to the provision of conditions for higher metabolic processes in which stored complex food material resulted in high amount of total soluble solids. Similar results have been reported by Jwanda and Singh (1978). These results are also in accordance with the findings of Anonymous (2003) who reported that small sized fruit have high level of total soluble solids followed by medium and then large sized fruits which have low contents of TSS.



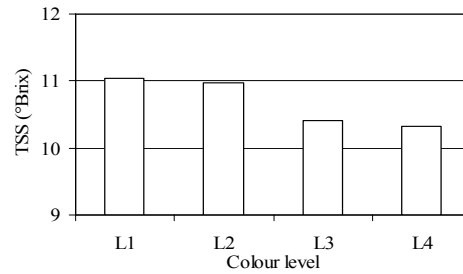
**Figure 1:** Effect of colour levels at harvest and storage temperature on fruit peel colour development



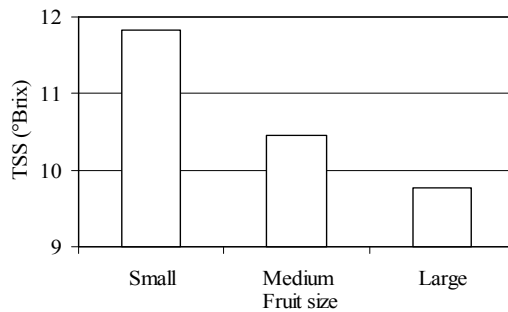
**Figure 2:** Effect of storage temperatures on fruit peel colour development



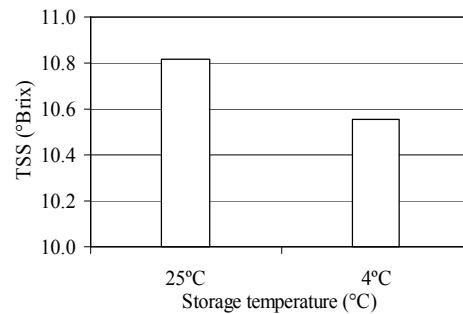
**Figure 3:** Effect of fruit size and temperature on firmness



**Figure 4:** Effect of colour levels on TSS



**Figure 5:** Effect of fruit size on TSS



**Figure 6:** Effect of storage temperatures on TSS

## **CONCLUSION**

Fruit with 90% colour development ( $L_1$ ) at harvest gained complete yellow colour at both temperatures: fruit with 70% colour at harvest developed almost 90% colour and fruit with 50% colour did not gain reasonable amount of colour after storage. Thus it is suggested that for early harvest only fruit with minimum of 70% colour development should be selected.

## **Acknowledgements**

Roshan Enterprises, Bhalwal, Sargodha, Pakistan

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