EFFECT OF BEE WAX COATING ON THE ORGANOLEPTIC CHANGES IN FRUIT OF SWEET ORANGE (Citrus sinensis L.) CV. “BLOOD RED”

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ABSTRACT
An experiment is conducted to evaluate the influence of bee wax on the organoleptic changes in fruits of sweet orange (Citrus sinensis L.) cv. “Blood Red” at Horticulture Department, University of Arid Agriculture, Rawalpindi during 2004 - 05. Bee wax at the rate of 1%, 3% and 5% along with constant level of 0.5% benlate was used for proposed study. Results indicated that all waxing treatments maintained the texture, colour and taste. However, after 56 days of storage an abnormal taste was detected by the judges in fruits, which were not treated with wax coatings when stored at room temperature. In this trial, bee wax used at the rate of 5% along with 0.5% benlate performed better results for citrus storage than all other treatments and is recommended for waxing of Blood Red oranges, kept at room temperature during the months of January, February and March in Rawalpindi conditions.

INTRODUCTION
Citrus is the most important fruit crop being grown in Pakistan on an area of 0.1765 million hectares, producing 1.7603 million tons annually. Sargodha, Faisalabad, Sheikhupura and Multan districts of the Punjab province are the main citrus growing areas of Pakistan which constitutes major part of the export. Pakistan exported 85374 tones of citrus fruits, worth Rs. 147.5 millions during 2003 - 04. Kinnow account for 75% of the total, while oranges constitute 10% (GOP, 2004).

There is an area of ecological conditions in Potohar region that produces excellent Blood Red oranges having attractive shade on skin and deep red to purplish-pigmented pulp with special delightful aroma that makes the commodity in great demand in country and as a potential candidate for export. Their demand increases from February onwards with increase in prices. Sweet oranges have great demand in Gulf, Europe and East Asia and to increase the export volume, it is necessary for the fruits to remain fresh and keep good quality during the transit. But under ordinary conditions, sweet oranges cannot be stored for long duration due to various physiological and pathological disorders (Malik, 1994), as a result farmers have to sell their produce in bulk causing a glut condition in the market. In this way, farmers cannot get good prices and lose share in the profit. In financial terms post harvest losses 30-40% and it tune to millions of rupees annually (vary time to time). It is important to reduce this loss as well as maintain their quality for distant national and international market, and regulate fruit supply during the late season (Anonymous, 1996).

Citrus fruits have a natural waxy layer on the outer surface that is partially removed during washing. An extra discontinuous layer of wax applied artificially with sufficient thickness and consistency to prevent anaerobic respiration within the fruit provides the necessary protection against decay organisms. Tiny injuries and scratches on the surface of fruits can be sealed by wax application. Another obvious advantage of waxing is the enhancement of the gloss of fruits and vegetables. Appearance is therefore improved, making the produce more acceptable to the consumers (Pantastico, 1997).

Various types of skin coating materials (bee wax, paraffin wax, carnauba wax, chitosin wax, CaCl₂, shellic and CMC etc.) have been used to restrict moisture loss from the surface of Kinnow, Feutrell’s early, Pineapple and Valencia late cultivars in Pakistan (Ahmed et al. 1997, Farooqi et al. 1981). To reduce the loss of moisture from surface of fruits through evaporation, transpiration and respiration, to reduce the metabolic activities within the fruits especially respiration and to reduce the effect of decay-causing microorganism we use post harvest treatments (Malik, 1994). Post harvest handling operations should be conducted according to the requirement of the commodity. Pre-cooling or washing, drying, grading, proper packing, transportation and storage are all crucial in maintaining taste, flavour and edibility of fruits (Meena and Yadav, 2001).

Keeping in view the high quality of Blood Red oranges produced in this area, the studies were designed to standardize the wax coating formulations for enhancement of shelf life with low deterioration in quality.

MATERIALS AND METHODS
The experiment was conducted at Postgraduate Laboratory of Horticulture Department, UAAR University of Arid Agriculture, Murree Road, Rawalpindi – Pakistan.
during 2004 - 05. Blood Red oranges were harvested at proper physiological stage of maturity (when the fruits attained a specific color according to the variety and area) from Haripur in January 2004. The fruits were brought to Horticulture Department Laboratory, UAAR in crates. These fruits were sorted out to remove diseased or bruised ones. The fruits were washed using tap water to remove dirt and spray residues etc and dried under fan. The clean dried fruits were then divided into 4 main lots each containing 90 fruits. Each treatment was replicated three times.

The treatments were as follows:

<table>
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<tr>
<th>Treatments</th>
<th>Description</th>
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<tr>
<td>$T_0$</td>
<td>Control</td>
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<tr>
<td>$T_1$</td>
<td>Fruits treated with 1% Bee wax + 0.5% Benlate</td>
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<tr>
<td>$T_2$</td>
<td>Fruits treated with 3% Bee Wax + 0.5% Benlate</td>
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<tr>
<td>$T_3$</td>
<td>Fruits treated with 5% Bee Wax + 0.5% Benlate</td>
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All lots of fruits were packed according to the experimental layout and stored at room temperature in the existing laboratory during 2004 - 05.

**Data Collection**

Data on randomly selected fruits in each treatment per replication were recorded at 7 days interval during the experiment on the following parameters.

**Organoleptic Evaluation**

Organoleptic evaluation for external appearance and flavour for all the samples was carried out by scoring method of Krum (1955) as described below:

A panel of ten judges, which ranged in age from 24 – 40 years, was chosen on their consistency and reliability of judgment. The method involved presenting the panel members with 10 samples, asking them to evaluate for organoleptic parameters. Panelists were allowed to retaste any sample, if needed. Panelists were required to express the difference between samples by allotting to each the number from 1 – 10, where 0 represented disliked extremely and 10 represented like extremely for colour, taste and texture.

Data were statistically analyzed using Completely Randomized Design (CRD) and means were compared by using DMR test as recommended by Chase and Bown (1997).

**RESULTS AND DISCUSSION**

Statistically analyzed data regarding organoleptic changes in fruits of sweet orange (Citrus sinensis) cv. “Blood Red” as affected by different wax coatings are discussed below:

**Taste**

The data of wax coating treatments revealed that 5% Bee Wax had produced appreciable results (5.40) for taste. Minimum score (4.59) was recorded with $T_0$ (control) and it was at par with the fruits treated with 1% and 3% Bee Wax that showed 4.63 and 5.07 scores of taste. The data of wax coating treatments (during 2005) revealed that 5% Bee Wax had produced appreciable results (5.19) for taste. It was at par with fruits treated with 3% and 1% Bee Wax that showed 4.78 and 4.67 scores of taste, respectively. Minimum score (4.22) was recorded with fruits which is not treated with any wax and it was at par with fruits coated with 1% Bee Wax that showed 4.67 score of taste (Fig. 1).

As the bee wax at the rate of 5% with 0.5% benlate delayed the ripening and also converted the starch into sugars, which balanced the sugar acid ratio. Increase in sugar rendered the fruits much sweeter. Control treatment did not balance the sugar acid ratio. Because acids might have been increased in this case and less conversion of starch into sugars is also observed. Also this might be due to the microorganism that can cause anaerobic respiration and taste is deteriorated. The present results are similar with the findings of Wang et al. (2004) who revealed that due to the waxes eating quality was good without unpleasant taste in fruits of Jincheng orange variety. Similar results were also reported by Ladaniya (2001) who investigated that taste score was highest after 30 days in fruits of ‘Musambi’ sweet orange (Citrus sinensis) treated with Sta-fresh 451 wax.

The data of storage intervals (during 2004) showed that 1st day had the highest value (6.42) of taste and it was at par with 7th day, 14th and 21st that showed 6.23, 6.09 and 5.90 values of taste. Lowest value (2.81) of taste was recorded on 56th day. It was at par with 49th day that showed 3.23 score of taste. The data of storage intervals (during 2005) showed that 1st day had the highest value (6.47) of taste and it was at par with 7th day that showed 6.52 value of taste. Lowest value (2.76) of taste was recorded on 56th day. It was at par with 49th day that showed 3.00 score of taste (Fig. 2).

1st day have highest score of taste, this might be due to best sugar to acid ratio as taste is dependent on this ratio. This ratio improved due to ripening which lead to the formation of sugars from starches, also the converting sugar might be present there. The increase in sugar renders the fruit much sweeter and therefore more acceptable. The taste in fruit is very important, as it is one of the factors that determine the
consumer’s acceptability. The taste of fruit is due to the sugar acid ratio and optimum proportion of this ratio is as essential for maintaining the sweetness in taste. Sweetness due to sugars and sourness due to organic acids are the dominant component in the taste of many fruits (Kays, 1997). The results were tally with findings of Lewinsohn et al. (2001) they observed that breeding of improved flavor of fruits has mainly been characterized to control sugar to acid ratio and improved texture and storage characteristics of product. The characteristic taste of fruit is not only due to the sugar acid ratio, but also due to a large extent to different volatile compounds. Similar results were also reported by Alam and Paul (2001) who studied the effects of cellulose-based coating (carboxyl methyl cellulose) on the shelf life of Kinnow fruits and found that carboxyl methyl cellulose coating (0.5%) were the most suitable for extending the shelf life up to 40 days without adversely affecting the quality but taste scores were lowered when storage life increased.

**Colour**

In case of colour mixed pattern of increase and decrease in flesh colour scores was observed. But on the whole there was an increase in flesh colour. The evaluation of flesh colour of Blood Red oranges was carried out by an expert panel of judges. The results indicated that there was a non-significant difference among the flesh colour scores of different wax coating treatments. Wax coating might have no effect on colour because colour developed prior to storage at the time of picking. Wax coating did not cause any effect on anthocyanin pigment of the flesh.

**Texture**

The data of wax coating treatments during 2004 showed that the bee wax applied at the rate of 5% i.e. T3 had the most scores (6.51) of texture. It was at par with the fruits treated with 3% and 1% Bee Wax that showed 6.18 and 6.14 scores of texture respectively. While least scores (5.37) was recorded in untreated fruits i.e. control treatment. The data of wax coating treatments during 2005 showed that bee wax applied at the rate of 5% along with 0.5% benlate had the highest scores (7.33) of texture. While the fruits treated with no wax i.e. control treatment had 5.37 score (Fig. 3).

The fruits treated with 5% bee wax plus 0.5% benlate act as surface finisher, by reducing the evaporation and improve the texture of fruit and also avoid the wrinkling of fruits and maintained the firmness throughout storage period. While control treatment might delay the hydrolytic cleavage of pectoprotein into lower molecular weight fractions, which are soluble in water. So these might have caused softening of fruits (Mc. Millium, 1989). These results are correlated with the findings of Ladaniya and Sonker (1997) who reported maximum retention of natural freshness and firmness was recorded when fruits were waxed and stored for up to 21 days of storage in case of *Nagpur mandarin*.

The data of storage intervals during 2004 showed that highest scores (7.04) of texture of fruits were recorded on 1st day. It was at par with 14th day showed 6.76 score of texture. Lowest scores (5.04) were recorded on 56th day. The data of storage intervals during 2005 showed that highest scores (7.62) of texture of fruits were recorded on 1st day. It was at par with 14th and 21st days showed 7.38 and 7.29 scores of texture, respectively. Lowest scores (5.10) were recorded on 56th day (Fig. 4).

In the initial stages the texture of fruits become more palatable but eventually the plant structure disintegrates. During ripening and maturation, pectoprotein (insoluble form of pectic substances) is gradually broken down to lower molecular weight fraction, which are more soluble in water and cause softening of fruits (Wills et al. 1981). Pectic substances are primarily responsible for the firmness of fruits.

The softening of fruits is also brought about by the action of pectic enzymes i.e. estrase and polygalacturonidase found in the tissues (Weichmann, 1987). Softening is accompanied by the catabolism of polymeric carbohydrate especially pectic substances and hemicellulose. The extent of subsequent softening is related to the storage temperature, as described by Chaplin et al. 1991 and Sankat et al. 1994. The structural properties of fruits may later due to the storage carbohydrates (pectin) or due to the cell wall (Wills et al. 1981).

The results are further in accordance with findings of Alam and Paul (2001), according to them CMC (carboxyl methyl cellulose) treated fruits (kinnow) exhibited at an initial increase, followed by a gradual decrease in firmness of the fruit irrespective of the coating. Similarly Thai et al. (2001) found that carnauba wax retarded the loss of firmness in mangoes but overall firmness decreased during storage.
Fig. 1. Effect of bee wax coating treatments on the taste of sweet orange cv. "Blood Red" during 2004 and 2005.

Fig. 2. Effect of different storage intervals (days) on the taste of sweet orange cv. "Blood Red" during 2004 and 2005.

Fig. 3. Effect of bee wax coating treatments on the texture of sweet orange cv. "Blood Red" during 2004 and 2005.
Fig. 4. Effect of different storage intervals (days) on the taste of sweet orange cv. “Blood Red” during 2004 and 2005.

REFERENCES


