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DETERMINATION AND COMPARISON OF HARVEST BY TRADITIONAL AND MODERN METHODS ON QUALITY AND STORABILITY OF GRAPE FRUIT

Waseem Ahmed[1*], Saeed Ahmed[1], Aman Uallah[2] and Rashid Ahmed

[1]*Institute of Horticultural Sciences, University of Agriculture Faisalabad, Pakistan*
[2]*Post Harvest centre, University of Agriculture Faisalabad, Pakistan*
[3]*Department of Crop Physiology, University of Agriculture Faisalabad, Pakistan*
Corresponding author E-mail address: waseemuaf12@yahoo.com

ABSTRACT

Determination and Comparison of harvesting by traditional and modern methods on fruit quality and storability of the Ray Ruby and Shamber of grapefruits, at 8±1°C and 85-90% relative humidity were evaluated. The traditional method, using a hooked pole, was compared with a modern technique, where the picking pole was equipped with along cloth sleeve held open by a ring for collecting the harvested fruits. The fruits were stored for three months at 8±1°C and 85-90% relative humidity. Fruit samples were taken at specific times for determination of fruit quality in terms of respiration rate, heat production total soluble solids (TSS), physiology weight loss (PWL) and titratable acidity vitamin C, sugar (Total sugars , reducing, non reducing). At the termination of the experiment, the fruits were evaluated for general quality parameter. The results showed that the modern method significantly decreased respiration rate, heat production and physiology weight loss, delayed TSS accumulation and reduced titratable acidity maintained sugar level, resulting in improved fruit quality, reduced post-harvest losses and extended shelf-life of fruits.

Keywords: Grape fruit, modern method, physiology weight, ray ruby, storability.

INTRODUCTION

Citrus ranks first with respect to area and production in Pakistan among the fruit crops (Anonymous, 2011). Pakistan stands at 12th position among the citrus producing country. Total area under citrus cultivation in Pakistan is 2150 (000 Acres) (Anonymous, 2011). Total citrus production in Pakistan is 490.27 (000 tones). Grape fruit is one of the most important members of citrus species (Citrus Paradisi Macf.) Ray Ruby and Shamber grapefruit is one of the most popular pigmented grapefruit varieties planted mostly in the Pakistan. Grapefruit (Citrus paradisi Macf.) is one of the most important fruit crops grown in Pakistan for local consumption and export. Judging by palatability and external appearance, the quality of grapefruits grown in Pakistan has been commended as superior to fruits grown in other leading citrus-producing areas (Robbie and Fisher, 1954). Although the Pakistan has great potential to produce and export high quality grapefruits, the harvesting methods and post-harvest handling practices are still not taken care of by many producers and distributors. Faulty harvesting and rough handling at the orchard directly affect market quality and nutritive value of fruits. Mechanical injuries, such as bruising, surface abrasions and cuts, can result in fungal infection, increased respiration rate, ethylene production, dehydration of tissues and water loss and accelerated losses in vitamin (Lee and Kader, 2000; Kader, 2002; Abu-Goukh and Mohamed, 2004). Care in harvesting and handling of grapefruits is necessary to reduce post-harvest losses and preserve quality of the fruit. The traditional method of harvesting grapefruits in Pakistan causes bruises and injuries to the fruits, and later makes them unattractive and shortens their shelf-life. This study compares the traditional method of harvesting with a modern method of harvesting technique with regard to quality and storability of grapefruit.

MATERIALS AND METHODS

Our experiment was conducted in Orange Research station Sargodha, during the mid seasons. Fifteen uniform 12-year-old grapefruit cv.'Ray Ruby and Shamber ' trees grafted onto sour orange rootstock, 6 m × 6 m spacing, were used. Each tree represented done replicate. The trees were grown using similar cultural practices of irrigation, fertilization, pest management and weeding to those of producers of Sargodha. The orchard soil texture was sand loamy, pH was 8.2, electrical conductivity (EC) was1.0 $dS \cdot m^{-1}$ and $CaCO_3$ content was 35.0%. Five 30 days-interval harvests were carried out, beginning on 01 Sep and 01 January 2010-2011, in both seasons. Two techniques were used for harvesting fruits samples; namely, the traditional and modern methods. In the traditional method, the fruits were snapped by a hook attached to a long bamboo pole, and the falling fruits were then collected in field containers. In the modern method, a long bamboo pole equipped with a long cloth sleeve, held open by a ring, was used. When the pedicel was severed, the fruits dropped into the sleeve, moved smoothly downwards to be received by the picker from the open-end of the sleeve and packed into plastic field containers. For each date, 10 fruit from

each replicate (tree) were randomly collected at the periphery of the tree. Fruits were washed and cut into halves. Juice was extracted using an extractor and weighed to calculate the juice percentage (w/w). The juice was filtered by Whatman filter paper No. 1 to exclude juice sacs and other precipitates. Total soluble solids (TSS) percentage was measured using a digital refractometer (Atago, R_X 5000, and Japan). Finally, juice titratable acidity (TA), sugars expressed as citric acid percentage, and were determined by titration with 0.1 N NaOH to determine total acidity calculations were made according to the formula of Hortwitz (1960). Fruits were selected for their uniformity in size, colour and freedom from blemishes. They were washed, dried and packed separately in carton boxes lined with perforated polyethylene sheets. The samples were stored at 8 ± 1°C and 85%-90% relative humidity for three months. Twelve fruits from each replicate were taken every 15 days, from the stored samples, for determination of respiration rate, Heat production and Physiology weight loss (%) of fruits. Respiration rate was determined using the total absorption method of Charlimers (1956) and was expressed in mg CO_2 per kg-hr. Physiology Weight loss (%) in fruits was determined every 15 days on the same fruits used for determination of respiration rate, according to the formula: $w1 = [(w_0 - w_t)/w_0] \times 100$; where w_1 is the percentage weight loss, w_0 is the initial weight of fruits at harvest and wt is the weight of fruits at the designated time. Heat production of fruit calculated as heat production multiply mg CO_2 /kg.hr by 122 to get kcal/metric ton/day. Three fruits picked randomly from each replication, other than those used for respiration and weight loss, every 15 days during storage, for determination of total soluble solids (TSS) and titratable acidity Three readings were taken from each sample, Thirty gram of pulp of fruits from each replicate were homogenized in 100 mls of distilled water for one minute in a Sanyo Solid State blender (model SM 228 P) and centrifuged at 10 000 rpm for 10 min in a Gallenkamp portable centrifuge (CF 400). The volume of the supernatant, which constituted the pulp extracts, was determined. Five milliliter of pulp extract was mixed 20 ml of distilled water and titrated against 0.1N NaOH, using phenolphthalein as indicator. Titratable acidity was expressed as percent citric acid. At the end of the storage period, the fruits were evaluated for general quality. Fruits were graded according to the general appearance into five categories: very good, good, fair, poor and unmarketable. The percentage of fruits in each category was calculated. The analysis of variance and Fisher's protected LSD test with a significance level of $P \leq 0.05$ were performed on the data (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The respiration curves of fruits harvested by the traditional or improved methods exhibited a typical non-climacteric pattern (Fig.1). This finding supports Kader's (2002) classification of grapefruits as non-climacteric fruits. Similarly, Aharoni (1968) reported that citrus fruits, harvested near horticultural maturity, show gradual decline in respiration rate and produce no ethylene. The initial respiration rate was significantly lower in fruits harvested by the modern method, compared to the traditional method and retained this during storage (Fig.1). Similar results were reported for mangoes (Abu-Goukh and Mohamed, 2004). Respiration rate decreased from 35.0 mg CO_2 / kg-hr at harvest to 34.3 mg CO_2/ kg-hr after 90 days in storage in fruits harvested traditionally, while it decreased from 34.8 to 33.7 mg CO_2 / kg-hr in the fruits harvested by the modern method. This is probably due to the lack of bruises in fruits harvested by the modern method. Kader (2002) reported that mechanical injury stimulates respiration rate, ethylene production and dehydration of fruits and vegetables. Physiology Weight loss progressively increased during storage and was significantly higher with the traditional method than the modern method (Fig 2). At the end of the storage period, the physiology weight loss was 6% less in the modern method than in the traditional one that was 51%. The higher percentage of physiology weight loss of fruits harvested by the traditional method was most probablely to bruises caused by the falling of fruits on the ground. Bruising and abrasion damage the surface organization of the tissues; thereby leading to much flux of water vapour through the damaged area (Wills et al. 1998). Mechanical damage greatly accelerates the rate of water loss from produce (Kader 2002; Abu-Goukh and Mohamed 2004). The heat production at end of storage for modern method was 3794.2 kal/ metric tons/days in modern method than traditional method was 3538 kal/ metric tons/days figure (Fig.3). Total soluble solids (TSS) increased with storage, regardless of the treatment (Fig. 4) at the end of the storage period; TSS was 8 brix and 5 brix and 9 brix in fruits harvested by the traditional and modern methods, respectively. This is in agreement with the findings of Attia (1995) who reported an increase in TSS percent during storage of oranges. At the end of the storage period, the TSS was 18.3% higher in fruits harvested by the traditional method than by the modern method (Fig.4). The content of vitamin C in modern method is significantly higher than in the juices reconstituted from concentrate at tradition method (Fig. 5) (respectively 38.3 mg 100 g^{-1} and 33.1 mg 100g^{-1}). This was most probably due to the higher weight loss in fruits harvested traditionally (Fig.2). Salih and Abdalla (1982) found an increase in TSS during storage of orange, and they attributed this to the loss in moisture content which led to the concentration of TSS. Abu-Goukh *et al*. (2001) reported appositive correlation ($r^2 = 0.890$) between TSS and physiology weight loss during storage of onions. Titratable acidity increased slightly during the first 15 days of

storage and then progressively decreased in all fruits during storage (Fig. 6). This is in line with the findings of El-Zeftawi (1976), who found an increase in acidity during storage of 'Valencia' oranges, up to 6 weeks of storage, and a decline towards the end of the storage period.

Table 1. Percentage of fruits in each quality grade

Method of Harvest	Very good	Good fair	Poor	Unmarketable
Traditional method	1.5	12.4	42.3	20.5
Improved method	21.8- 27.2	30.1- 17.0	-	1.2

Table 2. Changes in Total Sugar (%) of Ray Ruby and Shamber by traditional and modern methods during Storage at 8 ˚C at relative humidity 95%.

Total Sugar (%)	Ray Ruby							Shamber						
Days after storage (8˚C)	0	15	30	45	60	75	90	0	15	30	45	60	75	90
Traditional methods	6	5	5	4	4	4	3	3.5	3	3	2	2	2	2
Modern methods	7.5	7	6	6	6	5.5	5	5.5	5.5	5.5	5	5	4.5	4
LSD value	Traditional methods = 1.23 Modern Methods = 0.95							Traditional methods = 1.43 Modern Methods = 0.93						

Table 3. Changes in reducing Sugar (%) of Ray Ruby and Shamber by traditional and modern methods during Storage at 8 ˚C at relative humidity 95%.

Reducing Sugar (%)	Ray Ruby							Shamber						
Days after storage (8˚C)	0	15	30	45	60	75	90	0	15	30	45	60	75	90
Traditional methods	3.5	3	3	2	2	2	2	3.5	3	3	2	2	2	2
Modern methods	5.5	5.5	5.5	5	5	4.5	4.5	5	5	5	4	4	4	4
LSD value	Traditional methods = 1.33 Modern Methods = 0.85							Traditional methods = 1.43 Modern Methods = 0.73						

Table 4. Changes in non reducing Sugar (%) of Ray Ruby and shamber by traditional and modern methods during Storage at 8 ˚C at relative humidity 95%.

Non Reducing Sugar (%)	Ray Ruby							Shamber						
Days after storage (8˚C)	0	15	30	45	60	75	90	0	15	30	45	60	75	90
Traditional methods	6	5	5	4	4	4	3	6	5	5	4	4	4	3
Modern methods	7.5	7.5		6	6	5	5	7.5	7	6	6	6	5	5
LSD value	Traditional methods = 1.25 Modern Methods = 0.35							Traditional methods = 1.23 Modern Methods = 0.35						

Titratable acidity was continuously higher during storage in fruits harvested traditionally compared to those harvested by the modern method maintained (Fig. 6). This can be explained in terms of physiology weight loss, which was higher in fruits harvested traditionally, and concentration of the acid in the fruit tissues. It was reported that waxing, which reduces water loss, decreases acidity during storage of orange (Salih and Abdalla, 1982; Martinez *et al*., 1991), mango (Mohamed and Abu-Goukh, 2003) and tomato (Ahmed and Abu-Goukh, 2003).At the end of the storage period, all fruits were evaluated for general quality.

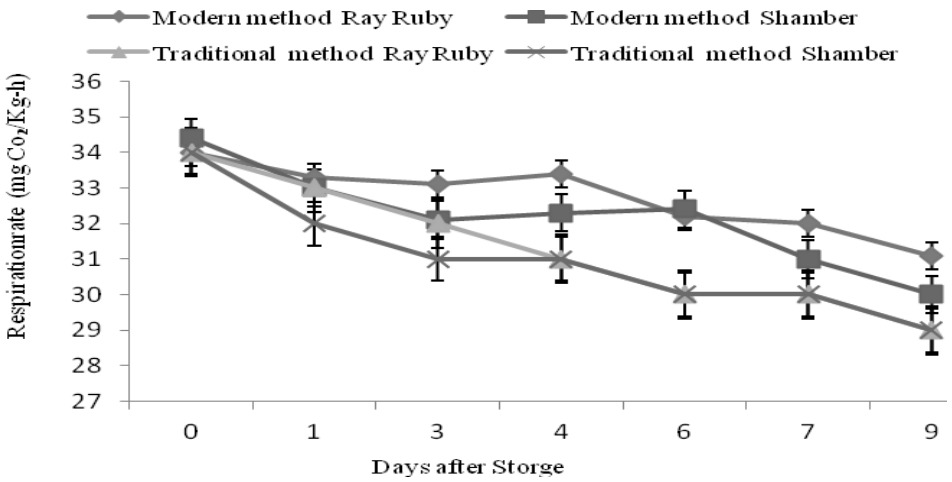

Fig. 1. Changes in Respiration rate of Ray Ruby and Shamber by traditional modern methods during storage at 8º C at relative humidity 95%

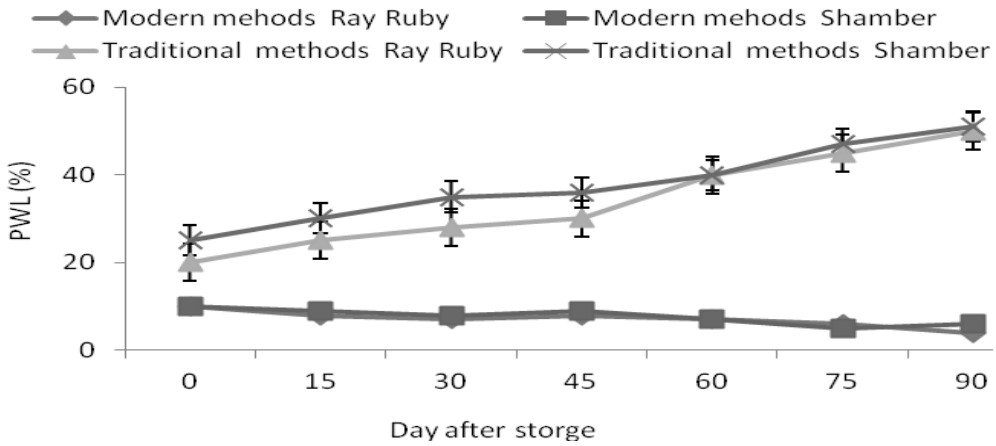

Fig.2. Changes in Physiology weight loss of Ray Ruby and Shamber by tradition and modern methods during storage at 8º C at relative humidity 95%

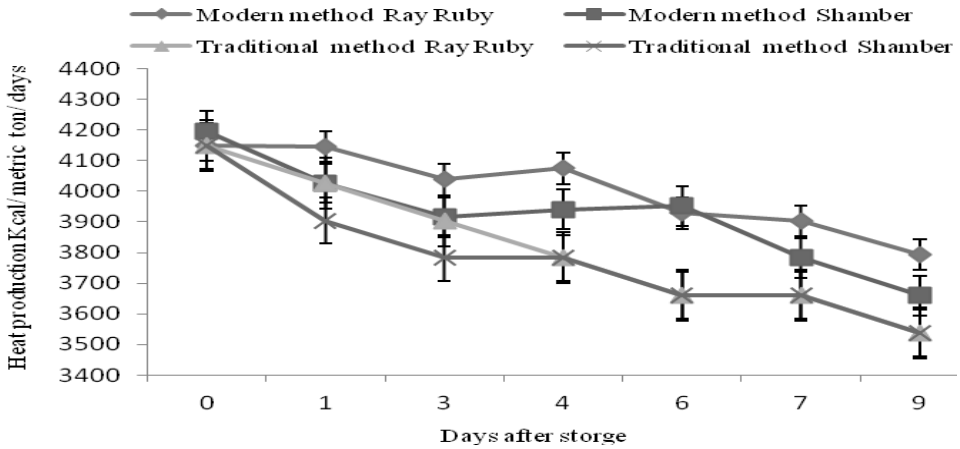

Fig.3. Changes heating production of Ray Ruby and Shamber by tradition modern methods during storage at 8º C at relative humidity 95%.

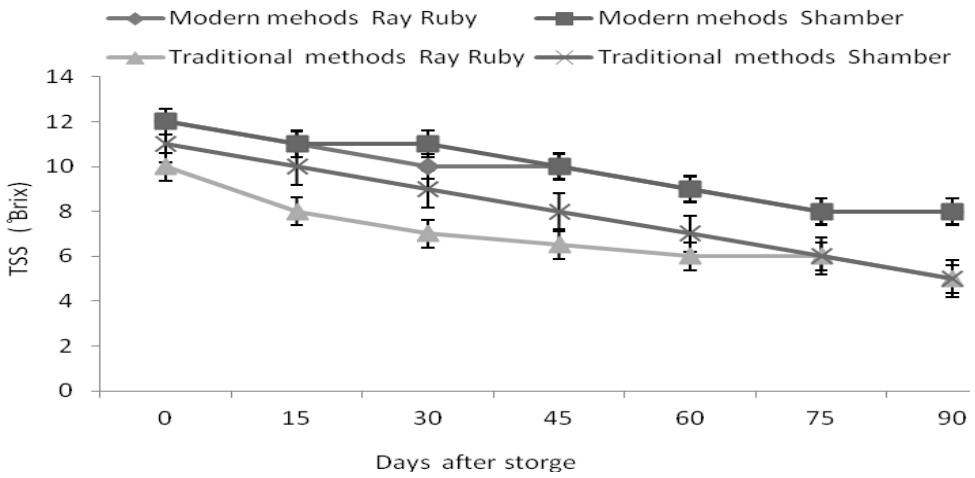

Fig. 4. Changes Total soluble solid of Ray Ruby and Shamber by tradition modern methods during storage at 8ºC at relative humidity 95%.

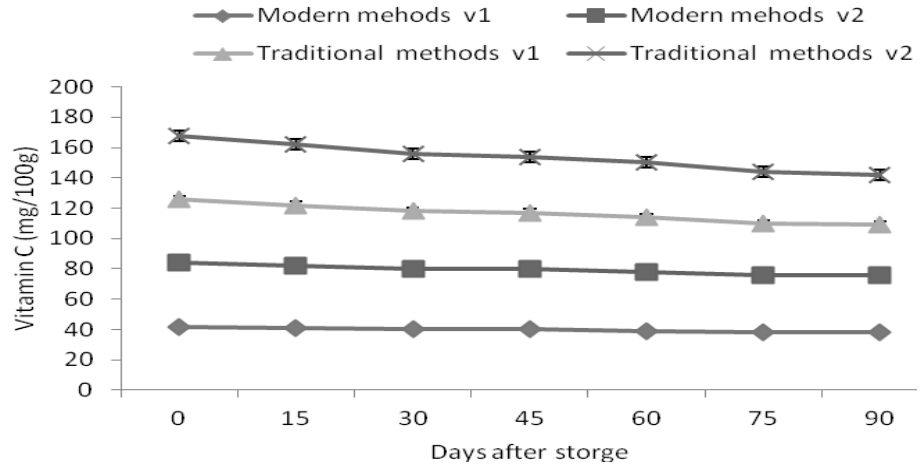

Fig.5. Changes Vitamin C of Ray Ruby and Shamber by tradition modern methods during storage at 8º C at relative humidity 95%.

The total sugar level at the end of storage in modern methods was 5% and 3 % in fruit harvested in traditionally method (Table 2). The reducing sugar were 2 % of the fruit harvested by the tradition method and 4.5 % harvested by the modern method (Table 3). The non reducing sugar was 2 % of the fruit harvested by the tradition method and 4% harvested by the modern method (Table 4). No difference found statically both cultivars. In the fruits harvested by the modern method, more than 20% were in the very good quality grade and more than 27% were in the good grade. In contrast, only 1.5% of the fruits harvested by the traditional method were graded very good and only 12.4% were in the good grade (Table 1). On the other hand, 20.5 % of the fruits harvested traditionally were unmarketable and 42.3% were poor, compared to only 3.9 % unmarketable and 17.0 % in the poor grade in the improved method. Similar results were reported for mangoes (Abu-Goukh and Mohamed, 2004). The traditional method of harvesting resulted in mechanical injury, which is the major factor in post-harvest losses of horticulture traditional method horticultural commodities. Mechanical injury causes loss of visual quality characterized by unsightly abrasions, bruises and cuts. Such injuries lead to an increase in the general metabolic rate (wound response) as the produce tries to seal off the damaged tissues (Wills *et al*., 1998). Mechanical injuries stimulate respiration, ethylene production and dehydration of tissues (Kader 2002; Abu-Goukh and Mohamed, 2004). Physiology Water loss of only 5 % causes many horticultural commodities to appear wilted and shriveled. Even in the absence of visible wilting, water loss can result in reduced quality (Lazan *et al*., 1987; Abu-Goukh and Mohamed, 2004) and early ripening and senescence (Macnish *et al*., 1997; Mohamed and Abu-Goukh, 2003).

CONCLUSION AND RECOMMADTIONS

Compared to the traditional method, the modern method of harvesting reduced respiration rate, physiology weight loss titratable acidity increased fruit quality parameter such as total soluble solids, Vit C and sugars (TS, RS, and NRS). Both varieties of grape fruit (Ray Ruby, Shamber) improved quality , extended the shelf-life.

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