Effect of harvesting method on quality and storability of grapefruits

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Effect of Harvesting Method on Quality and Storability of Grapefruits

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Abstract: The effect of harvesting method on fruit quality and storability of the pink-fleshed '*Foster*' grapefruits, at 18±1°C and 85%-90% r.h., was evaluated. The traditional method, using a hooked pole, was compared with an improved technique, where the picking pole was equipped with a long cloth sleeve held open by a ring for collecting the harvested fruits. The fruits were stored for three months at 18±1°C and 85%-90% r.h. Fruit samples were taken at specific times for determination of fruit quality in terms of respiration rate, total soluble solids (TSS), water loss and titratable acidity. At the termination of the experiment, the fruits were evaluated for general quality. The results showed that the improved method significantly decreased respiration rate and water loss, delayed TSS accumulation and reduced titratable acidity, resulting in improved fruit quality, reduced post-harvest losses and extended shelf-life of fruits.

INTRODUCTION

Grapefruit (*Citrus paradisi* L.) is one of the most important fruit crops grown in Sudan for local consumption and export. The annual production of grapefruits in Sudan in 2005 was 67 000 tons (FAO 2005).

Judging by palatability and external appearance, the quality of grapefruits grown in Sudan has been commended as superior to fruits grown in other leading citrus-producing areas (Robbie and Fisher 1954). Although the Sudan 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 C (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 Sudan 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 an improved harvesting technique with regard to quality and storability of grapefruits.

MATERIALS AND METHODS

Grapefruits of seedy pink-fleshed *'Foster'* cultivar were harvested at full maturity stage from the orchard of the Department of Horticulture, Faculty of Agriculture, University of Khartoum, located at Shambat ($15^{O}40^{'}$ N,$32^{O}22^{'}$E). Two techniques were used for harvesting fruit samples; namely, the traditional and improved 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 improved 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. About 300 fruits were harvested by each method. 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 18± 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 and 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. Weight loss (%) in fruits was determined every 15 days on the same fruits used for determination of respiration rate, according to the formula: $w_1 = [(w_0 - w_t)/w_0] \times 100$; where w_1 is the percentage weight loss, w_0 is the initial weight of fruits at harvest and w_t is the weight of fruits at the designated time.

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 of pulp extracts. TSS was measured directly from the fruit juice, using Kruss hand refractometer (model HRN-32). Three readings were taken from each sample, and mean values were calculated and corrected according to the refractometer chart. Titratable acidity was determined according to the method described by Ranganna (1979). Thirty grammes 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 milliliters of pulp extract were taken and 20 mls of distilled water were added and titrated against 0.1 N 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 improved 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 improved method. This is probably due to the lack of bruises in fruits harvested by the improved method. Kader (2002) reported that mechanical injury stimulates respiration rate, ethylene production and dehydration of fruits and vegetables.

Weight loss progressively increased during storage and was significantly higher with the traditional method than the improved method (Fig. 2). At the end of the storage period, the weight loss was 51% less in the improved method than in the traditional one. The higher percentage of 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).
Total soluble solids (TSS) increased with storage, regardless of the treatment (Fig. 3). At the end of the storage period, TSS was 13.6% and 11.5% in fruits harvested by the traditional and improved 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 improved method (Fig.3). 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 a positive correlation (r^2 = 0.890) between TSS and weight loss during storage of onions.

Titratable acidity increased slightly during the first 15 days of storage and then progressively decreased in all fruits (Fig. 4). 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. Titratable acidity was continuously higher during storage in fruits harvested traditionally compared to those harvested by the improved method (Fig. 4). This can be explained in terms of 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. In the fruits harvested by the improved 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).

Table 1. Percentage of fruits in each quality grade

Method of harvest	Quality grade				
	Very good	Good	Fair	Poor	Unmarketable
Traditional method	1.5	12.4	23.3	42.3	20.5
Improved method	21.8	27.2	30.1	17.0	3.9

The traditional method of harvesting resulted in mechanical injury, which is the major factor in post-harvest losses of 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). 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

Compared to the traditional method, the improved method of harvesting reduced respiration rate, weight loss, total soluble solids and titratable acidity, improved quality, and extended the shelf-life of grapefruits.

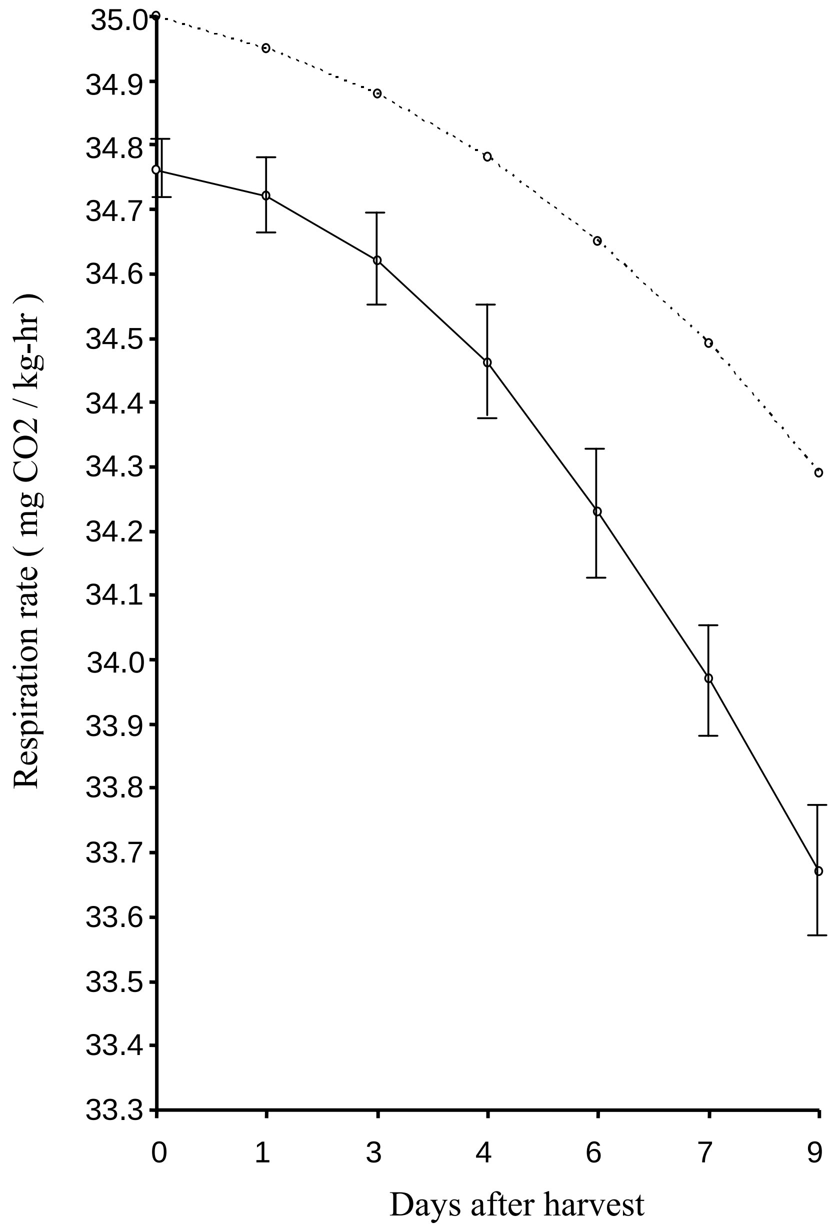

Fig. 1. Changes in respiration rate of 'Foster' grapefruits harvested by the traditional (-------) or improved (——) method during storage at 18 ± 1°C and 85%-90% r.h. Vertical bars represent LSD (5 %).

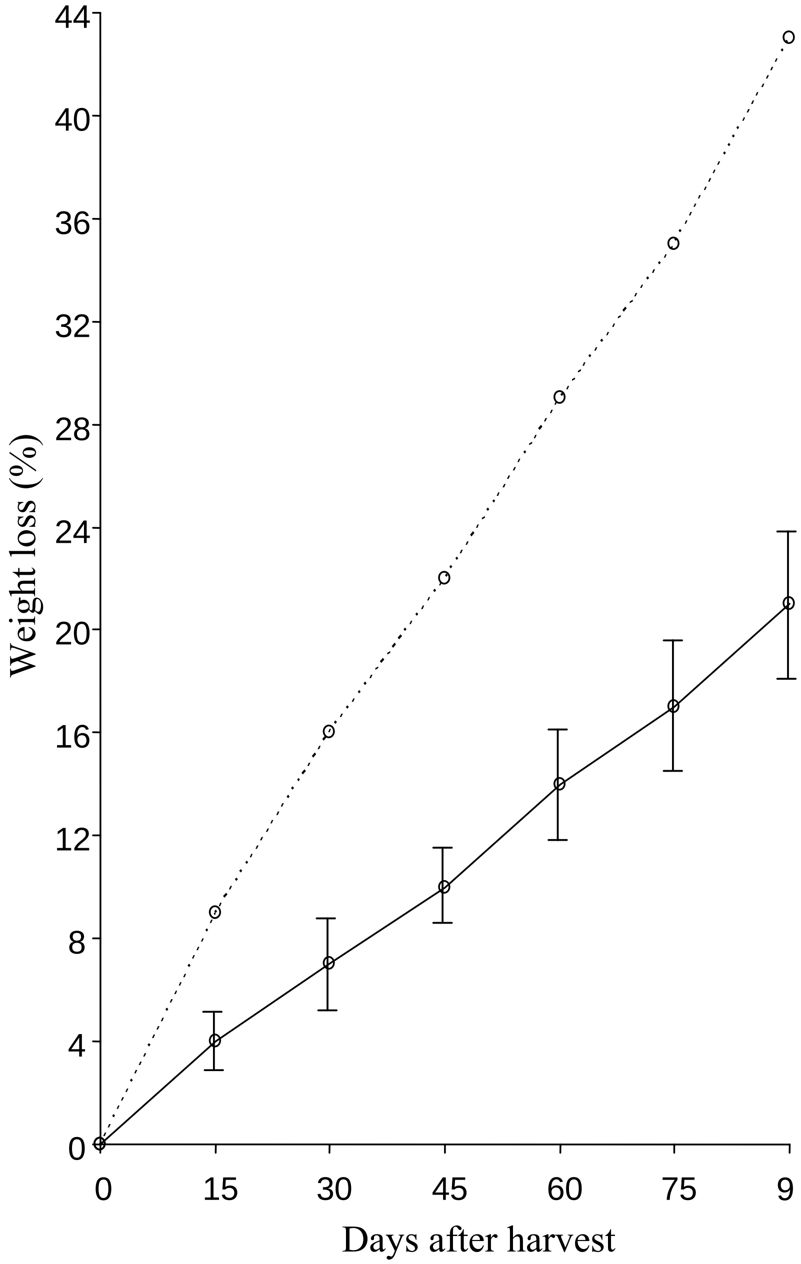

Fig. 2. Changes in weight loss of 'Foster' grapefruits harvested by the traditional (----) or improved (—) method during storage at 18 ± 1°C and 85%-90% r.h. Vertical bars represent LSD (5 %).

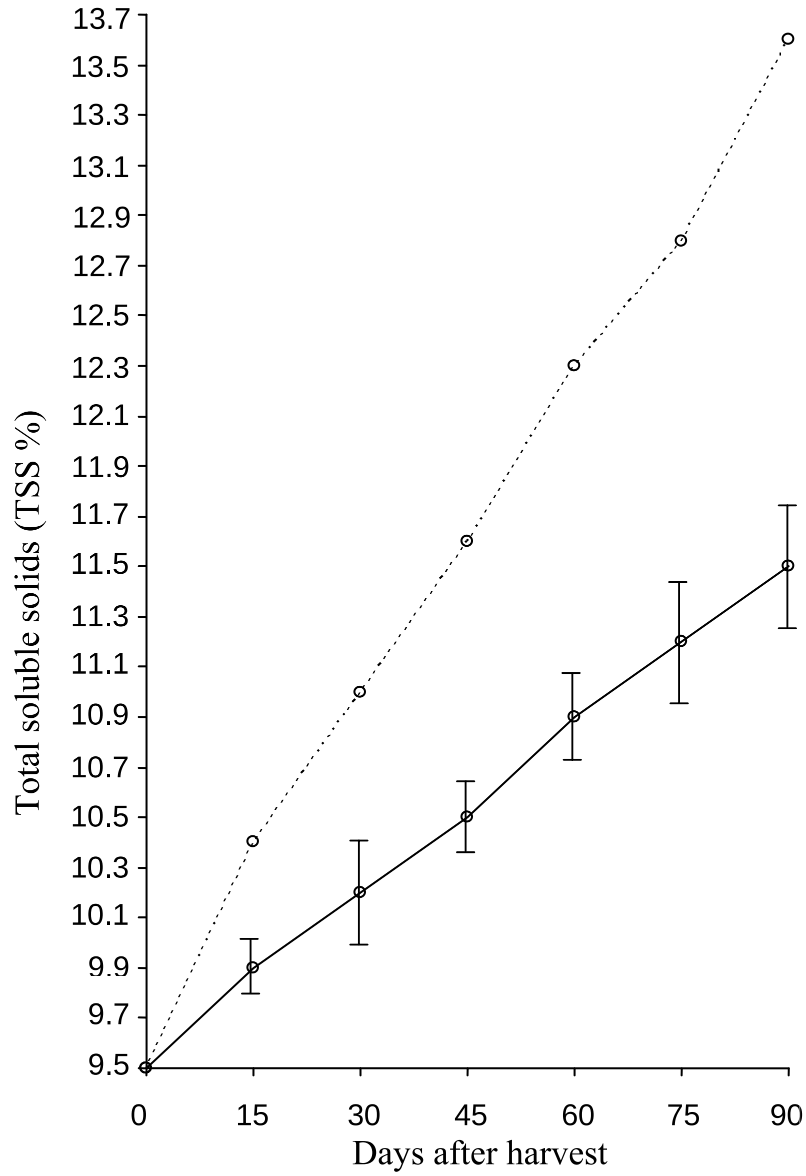

Fig. 3. Changes in total soluble solids (TSS) of 'Foster' grapefruits harvested by the traditional (------) or improved (——) method during storage at 18 ± 1°C and 85%-90% r.h. Vertical bars represent LSD (5 %).

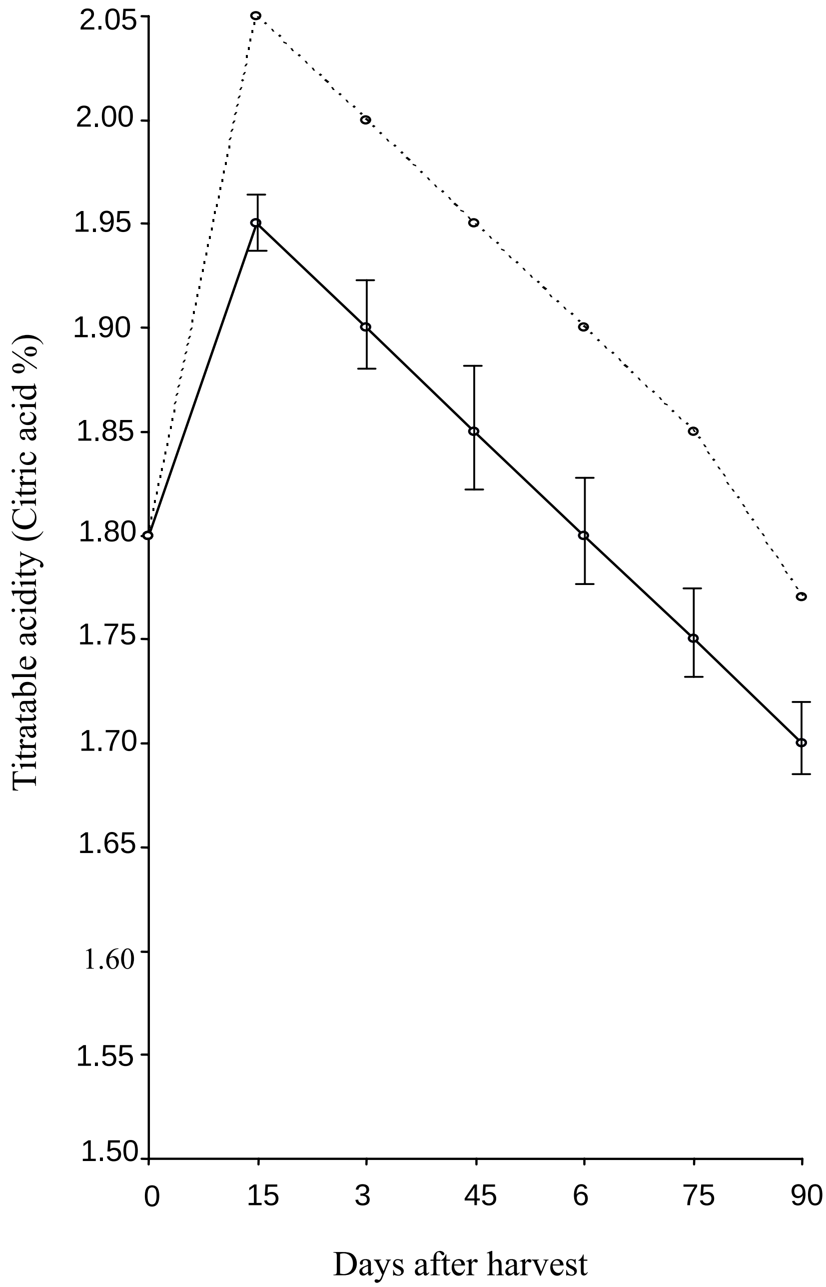

Fig. 4. Changes in citric acid of 'Foster' grapefruits harvested by the traditional (----) or improved (—) method during storage at 18 $\pm$ 1^{O}C and 85%-90% r.h.
Vertical bars represent LSD (5 %).

REFERENCES

Abu-Goukh, A.A. and Mohamed, H.I. (2004). Effect of harvesting method on quality and shelf-life of mango fruits. *Journal of Tropical Science* 44, 73-76.

Abu-Goukh, A.A.; Mofadal, H.I. and Abu-Sarra, A.F. (2001). Post-harvest quality and storability of twenty onion cultivars at 'Jabal Marra' area-Sudan. *University of Khartoum Journal of Agricultural Sciences* 9(2**)**, 236-253.

Aharoni, Y. (1968). Respiration of oranges and grapefruits harvested at different stages of development. *Plant Physiology* 43, 99-107.

Ahmed, I.H. and Abu-Goukh, A.A. (2003). Effect of maleic hydrazide and waxing on ripening and quality of tomato fruit. *Gezira Journal of Agricultural Science* 1(2), 59-72.

Attia, M.M. (1995). Effect of postharvest treatments on fruit losses and keeping quality of "*Balady*" oranges through cold storage. *Alexandria Journal of Agricultural Research* 40**(**3), 349-363.

Charlimers, R.A. (1956). Respiration rate. In: *Quantitive Chemical Analysis*. R. A. Charlimers (Ed.). Oliver and Bayd Ltd. Edinburgh and London, 101-102.

El-Zeftawi, B.M. (1976). Cool storage to improve the quality of '*Valencia'* oranges. *Journal of Horticultural Science* 51(3),411-418.

FAO (2005). *Production Yearbook*, Vol. 59. Food and Agriculture Organization of the United Nations (FAO), Rome

Gomez, K.W. and Gomez, A.A. (1984). *Statistical Procedures for Agricultural Research*. 2nd edition. John Wiley and Sons, Inc., New York, pp, 75-165.

Kader, A.A. (2002). *Postharvest Technology of Horticultural Crops*. 3rd edition. Cooperative Extension, University of California, Division of Agriculture and Natural Resources. Special Publication 3311. 535 p.

Lazan, H.; Ali, Z.M.; Mohd, A.A. and Nahar, F. (1987). Water stress and quality decline during storage of tropical leafy vegetables. *Journal of Food Science* 52, 1286-1292.

Lee, S.K. and Kader, A.A. (2000). Preharvest and postharvest factors influencing vitamin C content of horticultural crops. *Journal of Postharvest Biology and Technology* 20, 207-220.

Macnish, A.J.; Joyce, D.C. and Hetherington, S.E. (1997). Packaging to reduce water loss can delay ripening of mango (*Mangifera indica* L.) fruit. *Australian Journal of Experimental Agriculture* 37,463-467.

Martinez, J.M.; Cuquerella, J.; Rio, M.D.; Mateos, M. and Ded, R.M. (1991). Coating treatment in postharvest behaviour of oranges. *Proceedings of the Conference of Technical Innovations in Freezing and Refrigeration of Fruits and Vegetables.* Davis, California, U.S.A. July 1989. pp. 79-83.

Mohamed, H.I. and Abu-Goukh, A.A. (2003). Effect of waxing and fungicide treatment on quality and shelf-life of mango fruits. *University of Khartoum Journal of Agricultural Sciences* 11(3), 322-339.

Ranganna, S. (1979). Titratable acidity. In: *Manual of Analysis of Fruit and Vegetable Products*. S. Ranganna, (Ed.). Tata McGraw Hill Publ. Co. Ltd. New Delhi, pp. 7-8.

Robbie, J. and Fisher, F. W. (1954). Ministry of Agriculture, Sudan Government. Bulletin 10, 42.

Salih, O.M. and Abdalla, Y.M. (1982). Postharvest improvement handling and storage of Sudanese oranges. Food Research Center Reports, Shambat, Sudan.

Wills, R.; McGlasson, B.; Graham, D. and Joyce, D. (1998). *Postharvest*: *An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. 4th edition. CAB International, Wallingford Oxan, U. K. 262p.

تاثير طريقة الحصاد على جودة وطول فترة تخزين ثمار القريب فروت

فاطمة على الشيخ وأبوبكر على أبوجوخ

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موجز البحث: تم تقويم تأثير طريقة الحصاد ومدة التخزين في درجة حرارة 18± 1 درجة مئوية و 85%-90% رطوبة نسبية على جودة ثمار القريب فروت صنف "الفوستر" ذو اللب الأحمر. قورنت طريقة الحصاد التقليدية ، باستخدام عصا ذات خطاف ، بطريقة حصاد محسنة حيث أضيف لأداة القطف التقليدية كيس طويل من القماش مثبت على حلقة معدنية تحت الخطاف لاستقبال الثمار المقطوفة. تم تخزين الثمار لمدة ثلاثة أشهر تحت ظروف درجة حرارة 18 ± 1 درجة مئوية و 85%-90% رطوبة نسبية . أخذت عينات الثمار فى أوقات محددة لتقدير جودة الثمار التى تمثلت فى معدل التنفس ، وتراكم المواد الصلبة الذائبة الكلية ، ونسبة فقد الماء ، والحموضة . وعند نهاية التجربة تم تقويم الجودة العامة للثمار . أظهرت النتائج أن طريقة الحصاد المحسنة قد أدت معنوياً إلى خفض معدل التنفس وفقد الماء وتأخير تراكم المواد الصلبة الذائبة الكلية وخفض الحموضة فى الثمار ، وبالتالى تحسين فى جودة الثمار وتقليل فواقد ما بعد الحصاد وإطالة فترة التخزين مقارنة بطريقة الحصاد التقليدية .