Impact of Pedicel Length and Sap on the Postharvest Quality and Shelf Life of Mango (*Mangifera Indica* L.) Fruit

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Abstract

Mango fruit being nutritious, delicious is very popular all over the world, however, it is a climacteric in nature and has short shelf life. The sap deteriorates the quality, damages the market value and reduces the storage life of the fruit. Pedicel length of the fruit may play an important role in postharvest shelf life of mango fruit. Therefore, this study was conducted to find out the optimum pedicel length at harvest and control the injury due to sap in mango fruits. For this purpose, two commercial varieties Langra and Samar Bahisht Chaunsa of mango fruit were harvested at hard green stage of maturity with 0.5, 2.5, 4.5 and 6.5 cm of pedicel lengths and stored at 30°C till ripening. It was noted that the fruit harvested with 4.5 cm pedicel length was better among the investigated treatment for quality and shelf life. The weight loss and waste percent during ripening process of mango fruit was higher for 0.5 cm pedicel and lower for 4.5 cm pedicel, irrespective of the variety.

***Keywords**:* Mango fruit quality; pedicel length; shelf life; waste percent.

Introduction

Mango is one of the most important tropical and subtropical fruit of the world and is popular both in the fresh and the processed form. However, infections caused by microorganisms are a serious issue of post-harvest losses in mango fruit. Pest and diseases reduce the quality and shelf life of mango fruit up to large extent (Lechaudel and Joas, 2007).

In Pakistan and other developing countries, untrained peoples handle most of the orchards. They neither know the proper harvesting techniques of fruit nor the impact of these over the shelf life and quality of the fruit. This lack of knowledge causes tremendous losses in terms of physical damage, bruising, sap burn injury and later spoilage of mango fruit. One of the impacts of ill harvesting technique is the detachment of pedicel at the harvest time. The fruit ducts containing sap are normally at high pressure and the sap can come out and get deposited at the fruit

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surface as soon as the pedicel abscission zone is broken at harvest (Amin et al., 2008: Joel, 1980; Loveys et al., 1992; Campbell, 1992; Lim and Kuppelweiser, 1993; Bosquez et al., 2000). The sap damages the market value and deteriorates the quality of the fruit (Bagshaw, 1988; Campbell, 1992). To overcome the sap burn or sap problem various techniques have been adopted like, mechanical de-sapping, applying various chemicals (sodium carboximethyl cellulose, sodium lauryl sulphate and calcium hydroxide) and dabbing with vegetable oil, waxes and powder (Landrigan et al., 1991; Baker, 1991; Ledger, 1991; Meurant, 1991).

Similarly, the non-availability of proper storage conditions contributes toward the wastage as well as reduces the market value of the fruit (Saranwong et al., 2004; Subedi et al., 2007). One of the major roles of the storage temperature is to control the rate of biochemical reactions and hence monitors the ripening process or the shelf life (Narain et al., 1998; Baloch et al., 2011). Mango fruit requires meticulous temperature, moisture and ventilation condition. The importance of temperature management in maintaining the quality of fresh fruits and vegetable is well documented (Kader, 1992). To investigate the impact of sap and pedicel length, The fruit was harvested at hard green stage of maturity with following pedicel lengths 0.5 (T_1), 2.5 (T_2), 4.5 (T_3), 6.5 (T_4) cm and stored at 30°C. For the purpose investigation has been performed to identify the best pedicel length and or management strategies to minimize the post-harvest losses so as to save and recover maximum worth out of the valuable food resources of the country.

Materials and methods

Sampling

The experiment was performed over Langra and Samar Bahisht Chaunsa (S.B. Chaunsa) mango varieties. The fruit was harvested at physiologically mature, green hard, outgrown shoulders, pit around the pedicel end, randomly, by hand from Government Fruit Nursery Farm, Agriculture Extension Department, Dera Ismail Khan, Pakistan. Maximum efforts were made to select the fruit uniform in size and shape; free from injury or diseases. The fruit was immediately transferred to laboratory using hard board containers kept at 25°C and the time taken for the transportation was 30 minutes.

Treatments

Mango fruit was harvested at hard green stage of maturity with different pedicel lengths 0.5 (T_1), 2.5 (T_2), 4.5 (T_3), 6.5 (T_4) cm. The length was measured with Vernier caliper. The fruit was analyzed for different

parameters and stored at 30°C, while the relative humidity (RH) was kept at 64% till ripening, using Hot Pack incubator (Philadelphia, PA).

Analysis

Two hundred and fifty mango fruits were selected for each variety and test. Each analysis was carried out thrice and the data presented is the average of the repeated analysis over the period of three years. Mangoes were analyzed for different parameters at harvest as well as at the ripened stage. The two-factor experiment was laid out in Completely Randomized Design (CRD) with three replications. The ripened stage of the fruit was detected through the variation in firmness, color and sugar contents with the passage of time (Shorter and Joyce, 1998).

Organoleptic evaluation

The aroma, taste, flavor and skin color of all the samples were carried out using Hedonic scale (Larmond, 1977). A panel of twenty one experts whose age was 20-45 years was made on their consistency and reliability of judgment. 21 mango fruits of each sample were selected randomly and were cut into six pieces. The material so obtained was equally divided among the experts. Panelists were sent to different booths which were built for the purpose and had sufficient light to judge the real color of the sample. Panelists were asked to score the difference between samples by allotting the numbers from 0-10 (0-2 means extremely disliked, 2-4 fair, 4-6 good 6-8 very good and greater than 8 means excellent aroma, taste and flavor). The skin color of mango samples was graded as 0-2 means green, 2-4 light green, 4-6 light yellow, 6-8 yellow and 8-10 full yellow. Measurement of external firmness was taken with a Bosch penetrometer (model FT 327). The firmness was determined by the force (g- mm^{-2}) necessary for a 2 mm probe to puncture the fruit peel at four different points and taking average of the values. The values obtained were rescaled according to Hedonic scale for comparison purpose (Larmond, 1977); 10-8 means firm, 8-6 slightly soft, 6-4 soft, 4-2 were over soft.

Measurement of moisture contents

The moisture contents were calculated by taking 10 g of fruit pulp and dried in an oven up to constant weight at 76°C and calculating the loss in weight (AOAC, 2000).

Measurement of pH

The pH value was measured using a Microprocessor pH meter supplied by Denver, USA.

Measurement of acidity

The total titratable acidity was determined by titrating 100mL of juice against sodium hydroxide having concentration as 0.1 N (AOAC, 2000). The end point in this case was determined when the mixture containing juice, phenolphthalein (an indicator) and sodium hydroxide turned pink.

Measurement of Total soluble solids

Pulp from five mango fruit was obtained and mixed thoroughly. Total soluble solids were measured from the mixed pulp of ten gram using digital refractometer (Atago-Palette PR 101, Atago Co. Ltd., Itabashi-Ku, Tokyo, Japan).

Measurement of Total Solids

For the estimation of total solids (TS), pulp from five mango fruit was obtained and mixed thoroughly. Thirty grams of the mixed fresh sample of pulp was dried in an oven at 76°C and TS was obtained (AOAC, 2000).

Measurement of Ascorbic acid

Pulp of five mango fruit was blended with 3% metaphosphoric acid for at least half an hour. The blend was first centrifuged and then filtered through Whatmann filter paper. The filtrate was then titrated against the standard 2, 6 dichlorophenol dye and ascorbic acid was calculated (AOAC, 2000).

Measurement of Total sugar

For the measurement of total sugar the pulp obtained from the 5 mango fruits was homogenized for at least half an hour. The homogenized material was then filtered through a Whatman filter paper. The refractive index of the filtrate was measured using digital refractometer (Atago-Palette PR 101, Atago Co. Ltd., Itabashi-Ku, Tokyo, Japan) and sugar was estimated by standard curve method (AOAC, 2000).

Measurement of Total Carotenoids

Total carotenoids of pulp were estimated by following the method of Anwar et al., (2008). Briefly, a known amount of mango pulp was dispersed in acetone and the slurry was filtered through Whatman filter

paper. The residue was washed with a mixture of equal volume of acetone, ether and n-hexane. The organic and aqueous phases were separated, and the organic layer was dried using anhydrous Na_2SO_4 to remove traces of water from the filtrate. The carotene in organic layer was determined spectroscopically using standard curve of β-carotene and was expressed as µg/g.

Marking of fruit as waste

Fruit was considered as waste when it was either infected by a disease and/or its firmness value was less than 4 in hedonic scale.

Statistical analysis

Each value was expressed as the mean of three independent experiments. Data were assessed by analysis of variance (ANOVA) through Duncan's multiple range tests using SPSS software (SAS Institute Inc., Cary, NC).

Results and Discussion

The organoleptic parameters of Langra and Samar Bahisht Chaunsa mango fruit stored at 30°C were measured at their ripened stage. The results indicated that the color, aroma, taste and flavor values were highest for T_3 and lowest for T_1; firmness values were also lowest for T_1, but the results of T_2 and T_4 were not much different, irrespective of the variety (Table 1). The sap symptom was more on T_1 (0.5cm pedicel) as compared to others due to short pedicel lengths which considerably reduced the consumer acceptance and fruit value (Menezes et al., 1995; Campbell, 1992; Loveys et al., 1992). On the other hand, the results obtained for T_4 were not better than T_3 one of the plausible explanation is that energy, water etc of the fruit is consumed to carry out all types of biological reactions and to maintain such a long stem which resulted a decrease in quality. The values of T_3 were significantly different from other treatments, but T_2 and T_4 values were not significantly different among each other under the limit $P < 0.05$.

The chemical constituents of Langra and Samar Bahisht Chaunsa mango fruit stored at 30°C were measured at their ripened stage. The results showed that the sugar, carotenoid, pH, soluble solids and moisture contents were highest for T_3 and lowest for T_1 as compared to others, irrespective of the variety (Table 2). At the time of harvest, if the pedicel length is very short the sap falls on the skin of fruit and spoil the mango fruit (Menezes et al., 1995; Campbell, 1992). The acidity, ascorbic acid

and total solids contents were highest for T_1 and lowest for T_3; T_2 and T_4 were non-significantly different under the limit $P < 0.05$.

Table 1
Average value of organoleptic parameters measured at ripened stage for Langra and Samar Bahisht Chaunsa mango fruit stored at 30℃.

Variety	T*	Color	Firmness	Aroma	Taste	Flavor
Langra	T_1	6.79^{c}	7.13^{b}	6.96^{c}	7.45^{c}	7.38^{c}
	T_2	7.68^{b}	7.69^{a}	7.91^{b}	7.99^{b}	7.94^{b}
	T_3	8.16^{a}	7.81^{a}	8.51^{a}	8.47^{a}	8.41^{a}
	T_4	7.49^{b}	7.51^{a}	7.49^{b}	7.83^{b}	7.78^{b}
S.B.Chaunsa	T_1	6.95^{c}	7.31^{b}	7.45^{c}	7.58^{c}	7.55^{c}
	T_2	7.98^{b}	7.78^{a}	8.04^{b}	8.09^{b}	8.04^{b}
	T_3	8.45^{a}	7.88^{a}	8.51^{a}	8.59^{a}	8.54^{a}
	T_4	7.72^{b}	7.64^{a}	7.61^{b}	7.88^{b}	7.85^{b}

*T stands for treatments. T_1, T_2, T_3 and T_4 stand for the fruit harvested with 0.5, 2.5, 4.5 and 6.5cm pedicel lengths, respectively.
†Values having different superscript in the columns are significantly different under the limit of $P < 0.05$. The comparison has been made within the variety.

Table 2
Average values of chemical constituents measured at ripened stage for Langra and Samar Bahisht Chaunsa mango fruit stored at 30℃.

Variety	T*	Total sugar (%)	TC (µg/g)	A (%)	AA (mg/I00g)	pH	MC (%)	TSS (%)	TS (%)
Langra	T_1	20.58^{c}	58.21^{c}	0.57^{a}	83.01^{a}	5.11^{c}	69.41^{c}	21.82^{c}	30.59^{a}
	T_2	21.99^{b}	63.16^{b}	0.50^{a}	80.05^{b}	5.22^{b}	71.41^{b}	22.61^{b}	28.59^{b}
	T_3	22.79^{a}	65.35^{a}	0.45^{b}	76.12^{c}	5.41^{a}	72.32^{a}	23.68^{a}	27.68^{c}
	T_4	21.46^{b}	63.82^{b}	0.51^{a}	80.31^{b}	5.17^{b}	71.16^{b}	22.36^{b}	28.84^{b}
S.B.Chaunsa	T_1	23.01^{c}	84.19^{c}	0.47^{a}	68.47^{a}	5.21^{c}	68.10^{c}	24.12^{c}	31.90^{a}
	T_2	24.31^{b}	89.61^{b}	0.43^{a}	65.48^{b}	5.48^{b}	69.51^{b}	25.22^{b}	30.49^{b}
	T_3	25.11^{a}	92.21^{a}	0.34^{b}	60.28^{c}	5.59^{a}	70.48^{a}	26.16^{a}	29.49^{c}
	T_4	24.01^{b}	89.09^{b}	0.44^{a}	65.87^{b}	5.41^{b}	69.15^{b}	25.02^{b}	30.85^{b}

*T, TC, A, AA, MC, TSS and TS stand for treatments, total carotenoids, acidity, ascorbic acid, moisture contents, total soluble solids and Total solids, respectively. T_1, T_2, T_3 and T_4 stand for the fruit harvested with 0.5, 2.5, 4.5 and 6.5cm pedicel lengths, respectively.
†Values having different superscript in the columns are significantly different under the limit of $P < 0.05$. The comparison has been made within the variety.

The shelf life of mango fruit was longest for T_3 and lowest for T_1, irrespective of the variety (Figure 1). The sap symptom was highest for T_1

due to short pedicel length and was significantly different from others treatments, which resulted a decrease in shelf life of the fruit (Menezes et al., 1995; Campbell, 1992; Loveys et al., 1992).

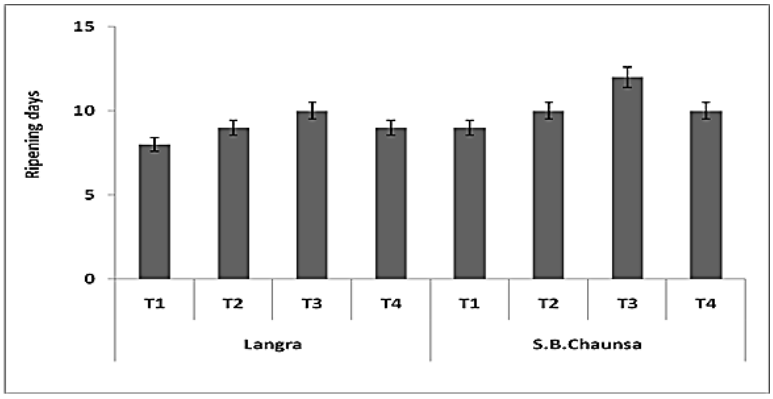

Figure 1: Time required by the fruit to reach at the ripened stage as a function of treatment and at 30°C storage temperature.

T_1, T_2, T_3 and T_4 stand for the fruit harvested with 0.5, 2.5, 4.5 and 6.5cm pedicel lengths, respectively. The weight loss and waste percent at the ripened stage of mango fruit was lowest for T_3 and highest for T_1 (Figures 2 & 3). The reason behind it can be that the sticky sap browned, hardened and stained the fruit surface and provoked the skin necrosis. The damaged areas of the skin can subsequently become a site for secondary infections and caused breakdown of the flesh, which further decreased the value and storage life of the fruit. The sap flow also caused the mangoes to lose water hence it was more de-shaped as compared to T_3 (Menezes et al., 1995; Campbell, 1992; Diaz de Leon-Sanchez et al., 2005; Loveys et al., 1992; Holmes et al., 1993). The results obtained for T_4 were not better than T_3 because the long pedicel became dead vary soon and exposed to atmosphere which acted as host for different diseases. The result indicated that the T_3 (4.5cm pedicel) was best among the investigated treatment for quality and shelf life.

In Figure 2, the T_1, T_2, T_3 and T_4 stand for the fruit harvested with 0.5, 2.5, 4.5 and 6.5cm pedicel lengths, respectively. In Figure 3, the T_1, T_2, T_3 and T_4 stand for the fruit harvested with 0.5, 2.5, 4.5 and 6.5cm pedicel lengths, respectively.

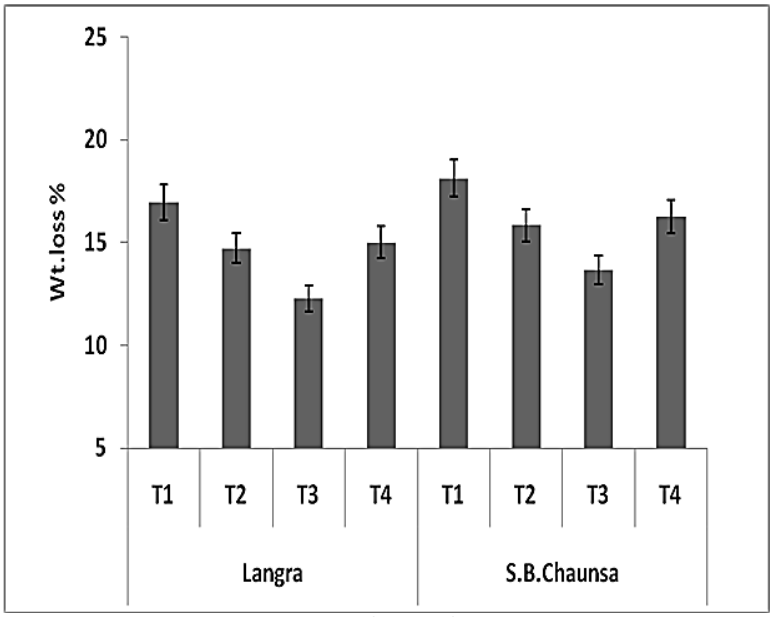

Figure 2: Weight loss percent (Wt. loss %) of mango fruit measured at the ripened stage as a function of treatment and at 30°C storage temperature.

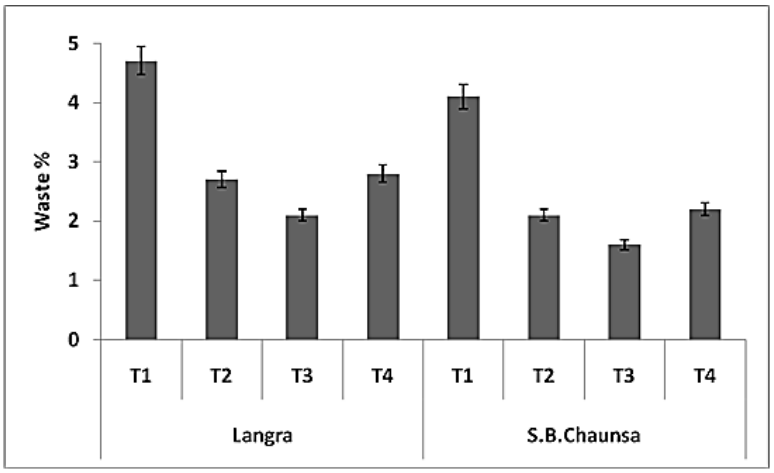

Figure 3. The waste percent of the fruit during the ripening process stored at 30°C.

Conclusions

The mango fruit was harvested at hard green stage of maturity with 0.5, 2.5, 4.5, 6.5cm pedicel lengths. The fruit was stored at 30°C till ripening. The result indicated that the 4.5cm pedicel was the best pedicel length among the investigated ones for quality and shelf life of the fruit.

The weight loss and waste percent during ripening process of mango fruit was lowest for 4.5cm pedicel and highest for 0.5cm pedicels length, irrespective of the variety of fruit and storage temperature. It is therefore recommended that during the harvest of mangoes, pedicel length be kept about 4.5cm to avoid wastage of the fruit.

Acknowledgements

Provision of lab facilities/support of Gomal University, Pakistan is highly acknowledged. The statistical analysis was performed by Department of Statistics, Gomal University, Pakistan.

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