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# Physiological and Quality Response of Guava Fruits to Posture during Storage

**S. Siddiqui, R.K. Sharma, and O.P. Gupta**
***Department of Horticulture, Haryana Agricultural University, Hisar 125 004, Haryana, India***

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***Abstract.*** **Fruits from the winter season crop of guava *(Psidlum guajava* L.) were harvested at the green mature stage and stored at ambient conditions in three postures: 1) natural, pedicel end vertically upward; 2) reverse, pedicel end vertically downward; and 3) horizontal, pedicel end sideways. Fruits in the natural posture showed minimum physiological loss in weight, ripening percentage, ethylene and $CO_2$ evolution rates, and maximum soluble solids and ascorbic acid concentrations during storage. Organoleptic rating and other characteristics indicate that guava fruits should be packed in the natural posture to retain better quality for longer periods.**

Guava is a productive and remunerative crop. Its nutritive value is also high. It bears two annual crops under north Indian conditions, i.e. during the summer rainy and winter dry seasons. Generally, the winter crop is preferred, due to its high quality and longer shelf life.

The shelf life of various fruits varies from crop to crop, year to year, and area to area. Floor management and irrigation practices, maturity stage, location of fruit on the tree, and storage environment also cause variation in quality (Drake and Fellman, 1987; Krishna Prakash et al., 1983; Luton and Holland, 1986; Patten et al., 1989; Van Zyl and Wagner, 1986). Posture of fruits and vegetables in storage reportedly also exerts a significant effect on their postharvest freshness (Usu-

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Table 1. Effect of fruit posture on physiological weight loss (w/w) of guava during storage.[z]

| | Physiological weight loss (%) | | | | |
|---|---|---|---|---|---|
| | Days in storage | | | | |
| Posture | 3 | 6 | 9 | 12 | 15 |
| Natural | 1.47 a | 3.80 a | 5.60 a | 8.22 a | 11.42 a |
| Reverse | 1.39 a | 3.82 a | 5.69 a | 8.28 a | 11.35 a |
| Horizontal | 1.63 b | 4.96 b | 6.62 b | 9.78 b | 12.63 b |

[z]Means of 10 replications separated in columns by LSD at $P = 0.05$.

Table 2. Effect of fruit posture on respiration and ethylene evolution rates of guava during storage.

| | Days in storage[z,y] | | | |
|---|---|---|---|---|
| Posture | 6 | 9 | 12 | 15 |
| | *Respiration (mg $CO_2$/kg per hour)* | | | |
| Natural | 36.2 a | 47.6 a | 17.3 a | 12.6 a |
| Reverse | 46.5 b | 55.6 b | 23.3 ab | 20.2 b |
| Horizontal | 52.4 c | 72.6 c | 30.1 b | 20.0 b |
| | *Ethylene ($\mu l \cdot kg^{-1} \cdot h^{-1}$)* | | | |
| Natural | 17.5 a | 21.6 a | 19.6 a | 9.3 a |
| Reverse | 19.6 b | 29.8 b | 22.8 b | 11.7 b |
| Horizontal | 19.0 b | 28.8 b | 22.1 b | 11.0 b |

[z]Means of 10 replications separated in columns for each measurement by LSD at $P = 0.05$.
[y]Values on day 0 were 34.6 $mg \cdot kg^{-1} \cdot h^{-1}$ for $CO_2$ production and 15.5 $\mu l \cdot kg^{-1} \cdot h^{-1}$ for ethylene production.

Table 3. Effect of fruit posture on soluble solids concentration (SSC), acidity, and ascorbic acid contents of guava during storage.

| | Days in storage[z,y] | | | | |
|---|---|---|---|---|---|
| Postures | 3 | 6 | 9 | 12 | 15 |
| | *SSC (%)* | | | | |
| Natural | 11.8 a | 12.0 a | 11.8 a | 11.4 a | 10.0 a |
| Reverse | 11.0 b | 10.0 b | 9.6 b | 9.0 b | 9.0 b |
| Horizontal | 11.0 b | 10.3 b | 9.0 c | 8.4 c | 8.9 b |
| | *Acidity (mg/100 g)* | | | | |
| Natural | 408 a | 600 a | 720 a | 824 a | 812 a |
| Reverse | 479 b | 720 b | 854 b | 890 b | 868 b |
| Horizontal | 435 a | 660 c | 784 c | 882 c | 812 a |
| | *Ascorbic acid (mg/100 g)* | | | | |
| Natural | 360 a | 352 a | 363 a | 156 a | 123 a |
| Reverse | 352 a | 363 a | 345 b | 152 a | 127 a |
| Horizontal | 338 b | 360 a | 330 c | 132 b | 95 b |

[z]Means of 10 replications separated in columns for a given component by LSD at $P = 0.05$.
[y]Values on day 0 were 11.3% for SSC, 384 mg/100 g for acidity, and 316 mg/100 g for ascorbic acid.

Table 4. Effect of fruit posture on organoleptic rating (10-point basis) of guava during storage.

| | Days in storage[z,y] | | |
|---|---|---|---|
| Posture | 6 | 9 | 12 |
| Natural | 7.8 a | 6.3 a | 4.0 a |
| Reverse | 6.8 b | 5.0 b | 1.7 b |
| Horizontal | 7.0 c | 4.8 b | 2.0 b |

[z]Means of 25 one-fruit replications separated by LSD at $P = 0.05$.
[y]The rating on day 0 was 4.2 for all postures.

shizaki et al., 1987). We therefore studied the effect of various postures of stored winter season guava fruits on their shelf life.

Uniformly sized fruits were harvested at the green mature stage from the winter season crop of 9-year-old 'Allahabadi Safeda' guava trees at the experimental orchard of the Horticulture Dept., Haryana Agricultural Univ., Hisar. The fruits were stored for 12 days at ambient conditions (25 ± 5C) in wooden boxes lined with shredded paper, in one of three postures: 1) natural, pedicel end vertically upward, as for fruit growing on the tree; 2) reverse, pedicel end vertically downward; and 3) horizontally, pedicel end sideways. Fifteen fruits ( ≈ 2.5 kg total) were packed in a single layer in each box and there were 10 boxes in each treatment. Observations were recorded at 2-day intervals for physiological loss in weight (PLW), percentage of fruit that ripened and that decayed, soluble solids concentration (SSC) (using a hand refractometer), total acidity and ascorbic acid concentration by titrametric Assn. of Official Analytical Chemist methods (1980). Ethylene evolution rates were determined using gas liquid chromatography (model 5700, Aimil-Nucon, Delhi) and CO, production rates by means of an Infrared Gas Analyzer (Model 225-MK3, Analytic Development, London). Organoleptic rating was by a panel of five judges taking into consideration fruit color, general appearance, and flavor. Only fruits from the first five boxes from each treatment were used for organoleptic rating. Fruits scoring lower than 5 out of 10 were considered unacceptable. The same fruit was examined only once. The statistical design for all characteristics was a completely randomized design. Data were subjected to analysis of variance and means were separated by least significant difference at $P = 0.05$.

Physiological weight loss increased with storage period (Table 1). The loss was higher in fruits kept horizontally than in others. Fruit in the natural and reverse postures had similar PLW throughout storage. Fruit weight loss during storage is attributed to loss of moisture and reserve food materials by evapotranspiration and respiration, respectively. However, Usushizaki et al. (1987) reported that fruit posture did not affect moisture loss from apples. Therefore, the increased PLW for fruit in the horizontal posture may have been due to the relatively high rate of respiration by the fruits.

The rate of respiration was lowest in fruits stored in the natural posture (Table 2). Usushizaki et al. (1987) obtained the same results, which they related to decreased adenosine triphosphate (ATP) levels, apparently due to increased ATP use associated with increased respiration in fruits in other than a "natural" posture.

In all postures, ethylene evolution increased up to the 9th day and then decreased on further storage (Table 2). Fruits kept in the natural posture evolved less ethylene than those in the other postures. However, the rates were similar for fruit in the reverse and horizontal postures. Similarly, Usushizaki et al. (1987) reported that less ethylene was evolved from apples stored in the same posture as that when they were on the tree.

The percentage of fruit that ripened was not significantly affected by fruit posture up to the 6th day (5.0% to 6.l%), however, on the 9th day of storage, least ripening was observed in the natural posture (40%) followed by the horizontal (50%) and the reverse (60%) postures. All fruit in all postures had ripened by the 12th day of storage. The increased rate of ripening in the reverse and horizontal postures may be due to increased ethylene evolution in these postures. (Table 2).

There was no decay in any of the treatments throughout the storage period (data not shown).

The SSC remained comparatively high in natural posture and higher than in the others (Table 3). However, there was no significant difference in fruit in the reverse and horizontal postures, except on the 9th and 12th days of storage when SSC was higher for fruit in the reverse than in the horizontal posture. The high SSC in natural posture may be due to less use of sugars for respiration. Usushizaki et al. (1987) reported that changes in starch and sugar contents with storage differ in various postures.

Acidity increased and ascorbic acid content decreased progressively with increase in storage time in all postures (Table 3). Throughout the storage period, acidity was lowest in fruits kept in natural posture, whereas the ascorbic acid concentration tended to be lowest in the horizontal position.

Organoleptic ratings remained higher throughout the storage period for the fruits kept in the natural posture than for those in the other postures (Table 4). However, reverse and horizontal postures were rated mostly similarly. Fruits in all postures were unacceptable on the 12th day of storage. The low PLW, high SSC, and maintenance of other quality characteristics during storage may be responsible for the high organoleptic rating of the fruits kept in the natural posture. Such a direct correlation of organoleptic quality of 'Allahabadi Safeda' guava with SSC has also been shown by Yamadagni et al. (1987).

Guava fruits should be stored in their natural posture, having the pedicel end vertically upwards, to best retain their quality during storage. The basis of the response described remains unknown for guava and other fruits.

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