Effect of maturity stages on shelf life of papaya (*Carica papaya* L.)

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**ABSTRACT**

An experiment using cv. Taiwan was 786 laid out in factorial completely randomized design with thirty treatments and three replications was, carried out at Laboratory of Horticulture Section, College of Agriculture, Dhule (M.S.) during 2017. The experiment comprised of three factors viz., two maturity stages (25% mature and 50% mature), dipping them in aqueous solutions of spermine (1.0 mM and 2.0 mM) and calcium lactate (1% and 2%) for 5 minutes and drying for 30 minutes at room temperature, three packaging materials (newspaper, shrink film and polyethylene bags) were used. Results indicated a significant impact of interaction among maturity stages, spermine and calcium lactate and packaging material on all parameters included in the study. When considered interaction, twenty five percent mature fruits dipped in (2.0 mM) spermine with shrink packaging had the minimum physiological loss in weight. This treatment also recorded the maximum peel to pulp ratio, fruit firmness. The maximum shelf life of 16 days without sacrificing organoleptic quality by manipulating the time of harvesting, packaging and application of spermine.

**Key words:** Maturity stages, Papaya, Packaging, Shelf life, Spermine.

**INTRODUCTION**

Papaya (*Carica papaya* L.) has gained popularity during the recent years because of its ease of cultivation, quick returns, adaptability to diverse soil and climatic conditions. Moreover, papaya fruits are delicious with high nutritive and medicinal value.

The papaya industry is confronted by enormous post-harvest losses due to mechanical injuries during harvesting, poor handling, over ripened and desiccated fruits, post-harvest diseases (anthracnose, stem end rots, rhizopus rot), pest damage, chilling injuries due to improper storage temperature, physiological disorders and inadequate post-harvest infrastructure. As per the survey conducted in Andhra Pradesh and Karnataka, the total post-harvest losses in papaya were around 25% (Gajanana *et al.*, 2010). The respiratory climacteric is just preceded with a similar pattern of increased ethylene production (Bron and Jakomino, 2006).

The stage of harvesting has an important bearing on the shelf life and quality of numerous fruit crops. Bananas harvested at advanced maturity stages had better consumer acceptance (Ahmad *et al.*, 2001). Exogenous application of polyamines have been demonstrated to influence shelf life and quality of various fruit crops such as apple (Kramer *et al.*, 1989), strawberry (Ponappa *et al.*, 1993), plum (Ren *et al.*, 1995), peaches (Martinez -Romero *et al.*, 2000) and in mango and papaya (Purwoko *et al.*, 1998). Postharvest calcium treatments have been widely used to extend shelf-life of fresh fruit (Rico *et al.*, 2006; Manganaris *et al.*, 2007). Calcium lactate prevents cut surface browning and tissue softening of fresh-cut fruit (Munganaris *et al.*, 2005). Azene *et al.* (2011) reported the effects of different packaging materials and storage environment on postharvest quality of papaya fruit.

**MATERIALS AND METHODS**

The experiment was conducted in factorial completely randomized design (FCRD) with thirty treatments and three replications. There were following three factors 1. Factor I (Maturity Stages)M₁ - Colour break stage (25% yellow), M₂ - ½ of the skin is yellow (50% yellow);2. Factor II (Chemical Treatments) S₀ – Control, S₁ – Spermine (1.0 mM), S₂ – Spermine (2.0 mM), S₃ – Calcium lactate (1%), S₄ – Calcium lactate (2%);3. Factor III (Packaging) T₁ – Newspaper wrapping, T₂ – Shrink wrapping and T₃ – Polyethylene bag (2% vents). Uniformed sized papaya fruits were harvested at two different maturity stages were dipped in aqueous solutions of spermine (1.0 mM and 2.0 mM) and calcium lactate ( 1% and 2%) for five minutes. Such treated fruits were dried for 30 minutes at room temperature and then the fruits were packed in three different packaging materials namely newspaper, shrink wrapping in polyethylene sleeve and polyethylene bag (vented) and then used for further investigation. The data collected on different physical and physiological parameters were statistically analyzed by using factorial completely randomized design techniques as described by Panse and Sukhatme (1995) and has been presented and described under appropriate headings.

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RESULTS AND DISCUSSION

Peel: Pulp ratio (%): Peel pulp ratio on the 2nd and 4th day of storage, MxSxT interaction was found non-significant and on 6th and 8th day it was found significant (Table 1). Peel: pulp ratio was significantly maximum in 25% mature with spermine 2mM and shrink packed fruits (M,S,T) on the 2nd, 4th, 6th and 8th day of storage (14.32, 14.48, 14.24 and 13.71 %), respectively. Lowest peel: pulp ratio was recorded in 50% mature untreated and newspaper packed fruits (M,S,T) on the 2nd, 4th, 6th, and 8th day (10.43, 9.85, 8.24 and 7.85 %), respectively during storage. These results were in confirmation with the findings of Premlata (2009), Serry (2011).

Fruit firmness (kg/cm²): Fruit firmness on the 2nd, 4th, 6th and 8th day of storage, MxSxT interaction was found significant (Table 2). Significantly maximum fruit firmness was observed in 25% mature fruits treated with spermine 2mM and shrink packed fruits (M,S,T) on the 2nd, 4th, 6th and 8th day of storage (5.93, 5.89, 4.91 and 3.77 kg/cm², respectively). Lowest fruit firmness was recorded in 50% mature untreated and newspaper packed fruits (M,S,T) on the 2nd, 4th, 6th, and 8th day (4.01, 3.85, 2.14 and 1.04 kg/cm², respectively) during storage. Similar results were found by Champa et al. (2015) in grape and Gong et al. (2014) in banana.

Table 1: Interaction effect of maturity stages, chemicals and packaging (MxSxT) on peel: pulp ratio (%) during storage.

| Treatments | 2nd day | 4th day | 6th day | 8th day |
|------------|---------|---------|---------|---------|
|            | M₁      | M₂      | M₁      | M₂      | M₁      | M₂      | M₁      | M₂      |
| T₁         | S₀      | 11.60   | 10.43   | 11.33   | 9.85    | 10.31   | 8.24    | 7.48    | 7.85    |
|            | S₁      | 13.41   | 11.53   | 13.44   | 11.48   | 12.75   | 10.94   | 11.59   | 9.71    |
|            | S₂      | 13.99   | 11.63   | 13.91   | 11.32   | 13.44   | 10.56   | 12.65   | 9.68    |
|            | S₃      | 12.36   | 10.88   | 12.40   | 10.63   | 11.79   | 9.92    | 10.89   | 9.42    |
|            | S₄      | 13.15   | 11.16   | 12.66   | 10.98   | 12.04   | 9.39    | 11.24   | 9.18    |
| T₂         | S₀      | 12.09   | 10.78   | 12.12   | 10.28   | 11.63   | 8.86    | 10.68   | 8.35    |
|            | S₁      | 13.63   | 11.84   | 13.62   | 11.89   | 13.07   | 11.58   | 12.38   | 10.21   |
|            | S₂      | 14.32   | 11.89   | 14.48   | 11.92   | 14.24   | 11.53   | 13.71   | 10.48   |
|            | S₃      | 12.60   | 11.09   | 12.82   | 11.11   | 12.55   | 10.71   | 11.92   | 9.80    |
|            | S₄      | 13.12   | 11.40   | 13.36   | 11.46   | 12.98   | 11.14   | 12.05   | 10.26   |
| T₃         | S₀      | 11.92   | 10.64   | 11.98   | 9.85    | 11.41   | 8.57    | 10.13   | 8.20    |
|            | S₁      | 13.50   | 11.69   | 13.52   | 11.57   | 12.99   | 10.94   | 12.08   | 9.93    |
|            | S₂      | 14.02   | 11.80   | 14.17   | 11.65   | 13.71   | 11.03   | 12.93   | 10.15   |
|            | S₃      | 12.49   | 11.00   | 12.44   | 10.91   | 11.72   | 10.19   | 10.69   | 9.55    |
|            | S₄      | 13.12   | 11.25   | 12.81   | 10.92   | 12.10   | 10.41   | 10.84   | 9.91    |
| SE (m) ±   | 0.123   | 0.122   | 0.322   | 0.327   |
| C.D. at 5% | NS      | NS      | 1.74    | 1.91    |

Table 2: Interaction effect of maturity stages, chemicals and packaging (MxSxT) on fruit firmness (kg/cm²) during storage.

| Treatments | 2nd day | 4th day | 6th day | 8th day |
|------------|---------|---------|---------|---------|
|            | M₁      | M₂      | M₁      | M₂      | M₁      | M₂      | M₁      | M₂      |
| T₁         | S₀      | 5.17    | 4.01    | 4.41    | 3.85    | 3.63    | 2.14    | 2.57    | 1.04    |
|            | S₁      | 5.69    | 4.68    | 5.63    | 4.57    | 4.69    | 3.62    | 3.49    | 2.64    |
|            | S₂      | 5.79    | 4.82    | 5.75    | 4.73    | 4.81    | 3.76    | 3.65    | 2.71    |
|            | S₃      | 5.26    | 4.27    | 5.19    | 4.21    | 4.34    | 3.39    | 3.16    | 2.51    |
|            | S₄      | 5.48    | 4.49    | 5.39    | 4.41    | 4.51    | 3.43    | 3.32    | 2.57    |
| T₂         | S₀      | 5.24    | 4.21    | 4.54    | 4.12    | 3.76    | 3.38    | 3.23    | 1.17    |
|            | S₁      | 5.76    | 4.79    | 5.71    | 4.71    | 4.78    | 3.72    | 3.62    | 2.83    |
|            | S₂      | 5.93    | 4.96    | 5.89    | 4.88    | 4.91    | 3.83    | 3.77    | 2.87    |
|            | S₃      | 5.43    | 4.42    | 5.31    | 4.37    | 4.46    | 3.52    | 3.29    | 2.70    |
|            | S₄      | 5.64    | 4.64    | 5.56    | 4.52    | 4.65    | 3.56    | 3.43    | 2.74    |
| T₃         | S₀      | 5.20    | 4.16    | 4.49    | 3.91    | 3.72    | 3.32    | 3.19    | 1.12    |
|            | S₁      | 5.72    | 4.75    | 5.67    | 4.63    | 4.72    | 3.66    | 3.57    | 2.76    |
|            | S₂      | 5.87    | 4.91    | 5.83    | 4.79    | 4.87    | 3.80    | 3.72    | 2.81    |
|            | S₃      | 5.33    | 4.34    | 5.22    | 4.30    | 4.42    | 3.47    | 3.21    | 2.59    |
|            | S₄      | 5.58    | 4.57    | 5.51    | 4.48    | 4.58    | 3.51    | 3.38    | 2.68    |
| SE (m) ±   | 0.013   | 0.019   | 0.022   | 0.030   |
| C.D.       | 0.039   | 0.054   | 0.064   | 0.087   |
Physiological loss in fruit weight (%): The interaction between M×S×T was found significant for physiological loss in fruit weight on the 10th, 12th, 14th, and 16th day of storage (Table 3). Physiological loss in fruit weight was significantly minimum in 25% mature spermine 2 mM fruits with shrink packaging (M1S1T1) on the 10th, 12th, 14th and 16th day (9.42, 12.83, 16.63 and 20.37 %, respectively). Maximum physiological loss in fruit weight was in 25% mature spermine 1 mM treated fruits with polyethylene packaging (M1S2T1) on the 14th and 16th day (19.70 and 23.95 %) during storage. Similar results were found by Bron and Jacomino (2006), Premlata (2009).

Table 3: Interaction effect of maturity stages, chemicals and packaging (M×S×T) on physiological loss in fruit weight (%) during storage.

| Treatments | 2nd day | 4th day | 6th day | 8th day |
|------------|---------|---------|---------|---------|
|            | M1 | M2 | M1 | M2 | M1 | M2 | M1 | M2 |
| T1         | S0 | 0.00 | 0.00 | 2.49 | 3.31 | 5.46 | 5.89 | 7.74 | 13.38 |
|            | S1 | 0.00 | 0.00 | 1.81 | 2.37 | 4.34 | 5.31 | 7.42 | 9.21 |
|            | S2 | 0.00 | 0.00 | 1.88 | 2.19 | 4.38 | 5.89 | 7.93 | 9.91 |
|            | S3 | 0.00 | 0.00 | 2.32 | 2.11 | 4.72 | 6.25 | 8.49 | 10.59 |
|            | S4 | 0.00 | 0.00 | 2.05 | 2.65 | 5.00 | 6.49 | 7.62 | 10.84 |
| T2         | S0 | 0.00 | 0.00 | 2.01 | 2.22 | 4.67 | 5.43 | 8.12 | 13.06 |
|            | S1 | 0.00 | 0.00 | 1.43 | 2.06 | 4.58 | 5.27 | 7.46 | 8.60 |
|            | S2 | 0.00 | 0.00 | 1.38 | 1.77 | 3.62 | 5.26 | 6.47 | 8.73 |
|            | S3 | 0.00 | 0.00 | 2.09 | 1.92 | 4.84 | 5.08 | 7.59 | 9.96 |
|            | S4 | 0.00 | 0.00 | 1.77 | 1.94 | 3.98 | 4.89 | 6.98 | 9.12 |
| T3         | S0 | 0.00 | 0.00 | 2.38 | 2.39 | 3.82 | 5.56 | 7.25 | 13.20 |
|            | S1 | 0.00 | 0.00 | 1.75 | 2.31 | 4.33 | 5.93 | 8.04 | 10.04 |
|            | S2 | 0.00 | 0.00 | 1.72 | 1.98 | 4.45 | 5.54 | 6.64 | 9.51 |
|            | S3 | 0.00 | 0.00 | 2.07 | 1.99 | 4.92 | 6.14 | 7.54 | 10.90 |
|            | S4 | 0.00 | 0.00 | 1.96 | 2.39 | 4.48 | 5.40 | 6.86 | 10.17 |

SE (m) ± 0.00 0.087 0.045 0.093
C.D. at 5% 0.00 0.248 0.129 0.264

Table 4: Interaction effect of maturity stages, chemicals and packaging (M×S×T) on shelf life (days) of papaya during storage.

| Treatment | Shelf Life (Days) | Treatment | Shelf Life (Days) |
|-----------|------------------|-----------|------------------|
| M1S2T1    | 9.33             | M1S2T1    | 7.66             |
| M1S2T2    | 10.00            | M1S2T2    | 8.00             |
| M1S2T3    | 9.33             | M1S2T3    | 7.66             |
| M1S2T4    | 12.00            | M1S2T4    | 9.33             |
| M1S2T5    | 15.66            | M1S2T5    | 10.00            |
| M1S2T6    | 15.66            | M1S2T6    | 9.66             |
| M1S2T7    | 12.33            | M1S2T7    | 10.66            |
| M1S2T8    | 16.00            | M1S2T8    | 11.00            |
| M1S2T9    | 15.66            | M1S2T9    | 10.33            |
| M1S2T10   | 12.00            | M1S2T10   | 9.00             |
| M1S2T11   | 12.33            | M1S2T11   | 9.66             |
| M1S2T12   | 12.33            | M1S2T12   | 9.33             |
| M1S2T13   | 12.33            | M1S2T13   | 9.00             |
| M1S2T14   | 12.66            | M1S2T14   | 10.33            |
| M1S2T15   | 12.66            | M1S2T15   | 10.00            |

SE (m) ± 0.554
C.D. at 5% 1.569
CONCLUSION

Based on the overall study, it can be inferred that for increasing shelf life and improving quality of papaya fruits cv. Taiwan 786 should be harvested at 25% maturity, dipping them in 2.0 mM spermineand wrapping in shrink packaging (M₅S₁T₂) as this treatment had minimum physiological loss in fruit weight, highest fruit weight, peel weight, pulp weight and firmness. Fruits thus treated had a shelf life of 16 days with the best colour, flavour, texture and taste.

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