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# Effect of post harvest application of chemicals and different packaging materials on shelf-life of banana (*Musa* spp) cv Robusta

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ABSTRACT

An experiment was conducted in Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural College, Sabour, Bihar during 2010-11 to delay ripening and extend shelf-life of banana (*Musa paradisiaca* L.) fruit. The experiments were undertaken with twelve treatments combinations of $CaCl_2$ (2% or 4%), polyethylene bag, banana dried leaves, newspaper, $CaCl_2$ (2%) + polyethylene bag, $CaCl_2$ (4%) + polyethylene bag, $CaCl_2$ (2%) + banana dried leaves, $CaCl_2$ (4%) + banana dried leaves, $CaCl_2$ (2%) + newspaper, $CaCl_2$ (4%) + newspaper and control. $CaCl_2$ (4%) and $CaCl_2$ (2%) in combination with polyethylene bag were the most potent treatment for enhancing storage period and maintaining physico-chemical characteristics of banana cv Robusta while as $CaCl_2$ (4%) + polyethylene bag were very effectively reduced physiological loss in weight (PLW) and ripening per cent. The maximum retention of bio-chemical constitute like total soluble solids, titratable acidity, and reducing sugars was also obtained in fruits treated with $CaCl_2$ (4%) + polyethylene bag along with increased shelf-life up to 16$^{th}$ day storage period of banana fruits.

**Key words:** Banana, Chemicals, Packaging material, Post harvest storage and Shelf life

India has vast prospective to produce high quality banana (*Musa paradisiaca* L.) fruits and to export them to other countries but it is still limited to local market. This is due to the high perishable nature of fruit, pitiable handling practices and in adequate storage amenities. Consequently, proper handling and management of the ripening process are crucial for the better shelf life of banana fruits.

Packaging exhibited great role in extending the shelf life and minimizing the wastage by inhibiting undesirable physiological events, bruising and pathological deterioration during storage, transportation and marketing. Packaging materials also influenced PLW, TSS, firmness, respiration rate and total sugars of pomegranate and polypropylene bags maintained better quality (Bhatia *et al.* 2013). The suitable packaging materials provides congenial environment which reduces the ethylene production, undesirable bio-chemical changes, ripening, slows down the rate of respiration, desiccation and pathological deterioration of fruits (Singh *et al.* 2007, Singh *et al.* 2008 and Patel *et al.* 2009). Polyethylene bags are used extensively to prolong shipment and storage life of banana and other fruits as they retard respiration and transpiration and retain quality of fruits. Singh *et al.* (2008) reported that the shelf life of strawberry increased up to six days when they were packed in high-density polyethylene pouches. Similarly, the shelf life of passion fruits increased up to five weeks when the fruits were waxed and packed in polyethylene terephthalate packaging (Singh *et al.* 2011). There are several loss reduction technologies devised to minimize the post harvest deterioration and extension of shelf life of banana. The efficiency of different packaging and cushioning materials varies from fruit to fruit. Therefore, selection of suitable packaging material is of primary importance to understand post harvest behaviour of banana fruits as affected by different post harvest treatments to alleviate the post harvest losses, extend shelf life, maintain quality and ensure safety of fruits.

The several chemicals also play significant role in post harvest management of banana fruits by delaying the ripening process. The various chemicals like salicylic acid and 1-methylcyclopropane decreases the activities of enzymes like ACC synthase, cellulase, polygalacturonase and xylanase that regulate the ripening process (Watkins 2006). The use of calcium salts itself as well as combined action of chemical dip with 1% (w/v) calcium chloride, 0.75% (w/v) ascorbic acid and 0.75% (w/v) cysteine help to maintain firmness of fresh cut banana (Vilas-Boas and Kader 2006 and Bico *et al.* 2009) and improve quality of many fruits during storage by minimizing the respiration rate, disease incidence and weight loss. Keeping the above facts, the present investigation was carried out to extend shelf life of banana

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with the post harvest application of $CaCl_2$ with various packaging materials.

## MATERIALS AND METHODS

The present experiment was carried out at Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural College, Sabour, Bhagalpur during 2010-11. The bunch of banana cv. Robusta were dehanded, washed and treated with $CaCl_2$ (2 or 4%) solution. The surface moisture was dried under shade. The treated or untreated (control) bunches were packed in newspaper, dried banana leaves and LDPE polythene bags (150 gauge) of pouch size (60 cm×60 cm). The total surface area of each polythene bag was 3600 $cm^2$ with perforation (10 holes/bag) and each hole having 4 mm diameter. The experiment was conducted with 12 treatment combinations replicated thrice under completely randomized design (CRD). The ambient condition of the laboratory with storage of fruits during investigation, observation on temperature and humidity inside the room was recorded. The maximum and minimum thermometer was used to measure the maximum and minimum temperature of each day directly in degree celsius. The temperature of dry bulb and wet bulb was recorded for relative humidity in percentage. The maximum temperature ranged from 27.4 to 32.4°C and minimum temperature varied from 9.5 to 16.8°C while, the relative humidity varied from 25.0 to 88.0% during the ambient storage period. The maximum temperature and humidity was recorded in the afternoon about 2:00 pm while the minimum temperature and humidity was observed in the morning at 7.00 am.

The fruits were handpicked to avoid any injury and carried to the experimental laboratory in bamboo basket. Only firm healthy fruits of uniform size and maturity, free from pest, disease, injuries bruises and blemishes were selected for the experiment. Banana hands were selected from mature uniform bunches. One hand with 12 fingers was considered as one experimental unit. Aqueous solution of $CaCl_2$ (2 or 4%) solutions were prepared by dissolving required quantity of chemical in 5 litre of water. Fruits were dipped in this solution for 10 minutes. These treated fruits were air dried. All treatment had two lots. One was for recording physiological loss in weight, ripening percentage, general appearance and other for bio-chemical analysis. The physiological loss in weight of the fruits in percent was calculated at alternate day's interval on initial weight basis using the following formula:

$$\text{PLW (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

The ripening percentage of fruits was determined by visually on the basis of skin colour, sweetness and softness. It was calculated by using the following formula:

$$\text{Ripening (\%)} = \frac{\text{No. of fruits ripened}}{\text{Total no. of fruits}} \times 100$$

TSS (ºBrix) was measured by a hand refractometer (Abbe® model 10450). The titratable acidity of fruits under different treatments was estimated soon after the harvest of fruits and during storage at regular interval for its determination, the method suggested by (Rangana 2010). The reducing sugars were estimated as per methods of Lane and Eynon (1923).

## RESULTS AND DISCUSSION

The physiological loss in weight (PLW) increased with increasing period of storage irrespective of treatments (Table 1). The rate of increase in PLW was the highest in control (20.51%) while, least was observed in fruits packaged in

Table 1 PLW (%) of banana fruit during-4 storage under chemicals and various packages

| Treatment | Period of storage | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|
| | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | |
| $T_1$-$CaCl_2$ @2% | 3.48 | 4.15 | 5.06 | 5.83 | 6.75 | 7.96 | 9.12 | 12.21 | 6.38 |
| $T_2$-$CaCl_2$ @4% | 3.34 | 4.08 | 4.94 | 5.77 | 6.67 | 7.91 | 9.05 | 12.13 | 6.29 |
| $T_3$-Polyethylene Bag | 2.99 | 3.36 | 4.09 | 4.98 | 5.85 | 7.24 | 8.92 | 11.28 | 5.69 |
| $T_4$-Banana dried leaves | 3.96 | 4.59 | 6.71 | 8.83 | 11.16 | 14.55 | 17.08 | 21.89 | 10.24 |
| $T_5$-Newspaper | 5.12 | 5.08 | 8.68 | 10.38 | 14.14 | 18.25 | 23.12 | 28.68 | 13.08 |
| $T_6$-$CaCl_2$ @2% + polyethylene bag | 1.91 | 2.16 | 2.98 | 3.82 | 4.68 | 5.95 | 7.25 | 8.54 | 4.33 |
| $T_7$-$CaCl_2$ @4% + polyethylene bag | 1.78 | 2.02 | 2.85 | 3.70 | 4.52 | 5.82 | 7.12 | 8.38 | 4.19 |
| $T_8$-$CaCl_2$ @2% + Banana dried leaves | 2.44 | 2.59 | 3.69 | 4.70 | 5.88 | 7.56 | 9.26 | 11.08 | 5.50 |
| $T_9$-$CaCl_2$ @4% + Banana dried leaves | 2.36 | 2.47 | 3.56 | 4.58 | 5.72 | 7.36 | 9.02 | 10.84 | 5.35 |
| $T_{10}$-$CaCl_2$ @2% + Newspaper | 2.40 | 2.48 | 2.75 | 3.65 | 4.99 | 6.60 | 8.25 | 10.26 | 4.80 |
| $T_{11}$-$CaCl_2$ @4% + Newspaper | 2.15 | 2.25 | 2.60 | 3.65 | 4.80 | 6.42 | 8.10 | 10.02 | 4.63 |
| $T_{12}$-Control | 8.25 | 12.78 | 13.86 | 16.25 | 23.42 | 28.32 | 34.73 | 41.30 | 20.51 |
| Mean | 3.35 | 4.00 | 5.15 | 6.34 | 8.22 | 10.33 | 12.59 | 15.55 | |
| | | SE diff. mean for | | | | | CD (P=0.05) | | |
| T | | 0.15 | | | | | 0.30 | | |
| D | | 0.13 | | | | | 0.26 | | |
| T × D | | 0.45 | | | | | 0.90 | | |

Table 2 Ripening percent of banana fruit during storage under chemicals and various packages

| Treatment | Period of storage | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | 00 | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | |
| $T_1$-$CaCl_2$ @2% | 0.00 | 4.32 | 5.45 | 8.95 | 11.08 | 21.02 | 56.25 | 72.10 | 98.28 | 34.68 |
| $T_2$-$CaCl_2$ @4% | 0.00 | 4.12 | 5.25 | 8.65 | 11.29 | 20.62 | 55.02 | 70.05 | 97.36 | 34.04 |
| $T_3$-Polyethylene Bag | 0.00 | 4.38 | 6.75 | 11.29 | 15.12 | 25.86 | 70.62 | 78.62 | 100.00 | 39.08 |
| $T_4$-Banana dried leaves | 0.00 | 6.35 | 9.25 | 18.62 | 21.53 | 58.20 | 74.25 | 83.45 | 100.00 | 46.46 |
| $T_5$-Newspaper | 0.00 | 6.75 | 10.12 | 18.12 | 35.42 | 61.23 | 85.38 | 93.50 | 100.00 | 51.32 |
| $T_6$-$CaCl_2$ @2% + polyethylene bag | 0.00 | 4.09 | 5.25 | 8.36 | 11.02 | 20.15 | 54.25 | 62.35 | 90.26 | 31.97 |
| $T_7$-$CaCl_2$ @4% + polyethylene bag | 0.00 | 4.06 | 5.20 | 8.32 | 10.96 | 20.12 | 54.06 | 62.12 | 89.00 | 31.73 |
| $T_8$-$CaCl_2$ @2% + Banana dried leaves | 0.00 | 4.48 | 5.69 | 10.65 | 12.85 | 26.35 | 53.25 | 70.32 | 93.80 | 34.67 |
| $T_9$-$CaCl_2$ @4% + Banana dried leaves | 0.00 | 4.35 | 5.65 | 10.24 | 12.11 | 26.16 | 52.32 | 69.02 | 92.12 | 33.99 |
| $T_{10}$-$CaCl_2$ @2% + Newspaper | 0.00 | 4.36 | 6.32 | 10.28 | 13.92 | 23.12 | 60.18 | 69.25 | 98.08 | 35.69 |
| $T_{11}$-$CaCl_2$ @4% + Newspaper | 0.00 | 4.29 | 6.12 | 10.14 | 13.45 | 22.85 | 59.15 | 68.89 | 97.06 | 35.22 |
| $T_{12}$-Control | 0.00 | 10.23 | 19.29 | 30.23 | 36.72 | 82.35 | 97.04 | 98.85 | 100.00 | 59.34 |
| Mean | 0.00 | 5.15 | 7.53 | 12.82 | 17.12 | 34.00 | 64.31 | 74.86 | 96.33 | |
| | | | SE diff. mean for | | | | | CD (P=0.05) | | |
| T | | | 0.62 | | | | | 1.23 | | |
| D | | | 0.54 | | | | | 1.06 | | |
| T × D | | | 1.87 | | | | | 3.69 | | |

$CaCl_2$ (4%) + perforated polyethylene bag (4.19%). The reduction in weight loss with the application of $CaCl_2$ could be attributed to reduced rate of respiration and inhibition in cellular disintegration by maintaining protein and nucleic acid synthesis. The ventilated polyethylene bags acted as a barrier for the smooth passage or diffusion of moisture and gases to the atmosphere. Polyethylene bag maintained higher humidity, higher $CO_2$ accumulation and low ambient temperature inside polyethylene bags. Thus, reduced the rate of respiration and release of free water and inhibited catabolic activities. The results obtained in this regards also get support with the work done by Emerald and Sreenarayan (1999) in banana, Singh *et al*. 1998 in mango, Siddiqui *et al*. (1999) in ber, Singh *et al.* (2007) in passion fruit and Singh *et al.* (2011) in purple passion fruit.

The ripening of banana fruits was observed from 2 days to 16 days of storage. Data revealed that the ripening percentage varied from 20.12 to 82.35% at 10 days of storage. At the age of 10 days of storage, the treatment $CaCl_2$ (4%) + polyethylene bag registered 20.2% ripening while as 82.35% ripening was recorded in control (Table 2). Data further shown that calcium chloride (4%) along with polythene bags was equally good for delaying the ripening process. The decrease in ripening rate with calcium chloride might be due to reduction in endogenous substrate catabolism by limiting the diffusion of substrates from the vacuole to the cytoplasm (Scott and Wills 1975). Calcium feeding also inhibits ethylene biosynthesis and retards activities of various enzymes and maintains firmness of fruits. These results are in agreement with the findings of Singh *et al*. (1998) in mango, Singh *et al.* (2007) in passion fruit and Singh *et al.* (2011) in purple passion fruit.

The various packaging materials have caused significant influence on the TSS content of fruits. There was a gradual

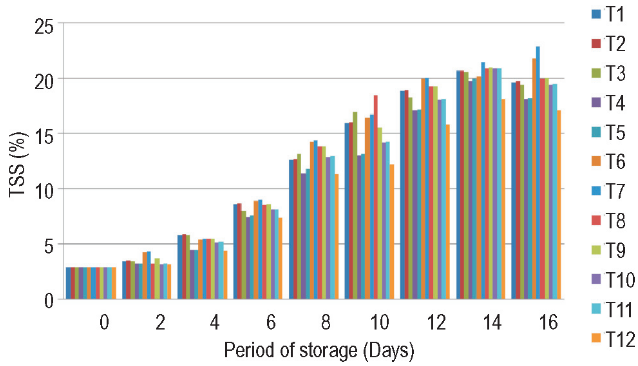


Fig 1 TSS (%) of banana fruit during storage under various packages

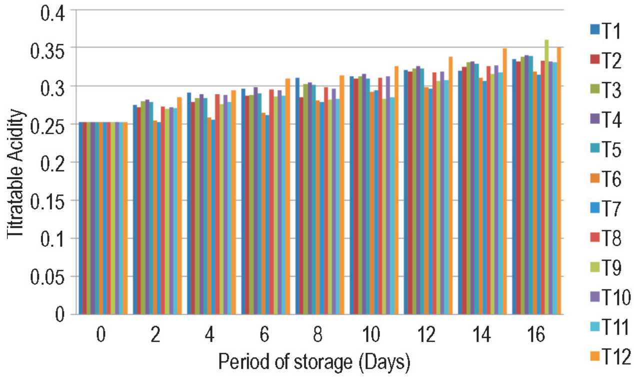


Fig 2 Titratable acidity of banana fruit during storage under various packages

enhancement in total soluble solids (TSS) of fruits with advancement of storage period, regardless of treatments up to 14th day of storage, afterwards it decreased except fruits packed in $CaCl_2$ (4%) + perforated polyethylene bag and

$CaCl_2$ (2%) + perforated polyethylene bag which exhibited increasing trend (Fig 1). The TSS reached to the maximum (22.86 $^o$Brix) at 16 days of storage under fruits treated with $CaCl_2$ (4%) + polyethylene bag as compared to control (17.05 $^o$Brix). The appearance of the banana at this stage was good for marketing owing to good organoleptic test which showed statistical parity with $CaCl_2$ (2%) + polyethylene bag having TSS content of 21.82 $^o$Brix. Similar views were expressed by Choudhary *et al*. (2003) in sapota, Singh *et al.* (2007) in passion fruit and Singh *et al.* (2011) in purple passion fruit.

In present investigation, titratable acidity exhibited the increasing trend with the enhancement of storage period up to 14$^{th}$ day thereafter it declined. The higher percentage of titratable acidity of banana fruits were maintained by fruit packaged in perforated polyethylene bag with $CaCl_2$ (4%) treatment as compared to other treatments at the end of storage period (Fig 2). It appears that fruit cells utilized organic acids as a respiratory substrate during Hipening and storage. This finding is in close conformity with reports of Faridi (2001) in sapota and Hailu *et al.* (2012) in banana.

The levels of reducing sugar increased gradually, irrespective of treatments up to 14$^{th}$ day of storage and declined further. On termination (16$^{th}$ day) of trial maximum content of reducing sugar was recorded in fruit treated with $CaCl_2$ (4%) and proved its superiority over remaining treatment. Hydrolysis of starch yielding mono and di-saccharides is one of the reasons for increase in level of reducing sugar. The higher level of reducing sugar under the influence of this applied chemical was probably due to reduced rate of catabolic activities and less utilization of this sugar in respiration. These results are in close conformity with those obtained by Chandramanti *et al.* (1991) in banana, Singh and Mandal (2000) in litchi, Singh *et al.* (2007) in passion fruit and Singh *et al.* (2011) in purple passion fruit.

It was concluded that the significantly higher shelf life of banana was found in $CaCl_2$ (4%) + polyethylene bag and $CaCl_2$ (2%) + polyethylene bag among all treatments and it reduced physiological loss in weight (PLW), ripening per cent as well as maximum retention of bio-chemical constitute like total soluble solids, titratable acidity and reducing sugars up to 16$^{th}$ day storage period of banana cv. Robusta.

## REFERENCES


Bhatia K, Asrey R, Jha S K, Singh S and Kannaujia P K 2013. Influence of packaging material on quality characteristics of minimally processed Mridula pomegranate (*Punica granatum*) arils during cold storage. *Indian Journal of Agricultural Sciences* **83**(8): 872–6.

Bico S L S, Raposo M F J, Morais R M S C and Morias A M M B. 2009. Combined effects of chemical dip and/or carrageenan coating and/or controlled atmosphere on quality of fresh-cut banana. *Food Control* **20**(5): 508–14.

Choudhary S, Ray D P, Das B K and Sahu G S. 2003. Effect of pre and post harvest chemical treatments on ripening, quality and storage life of sapota *Manilkara achras* (Mill) Forsberg cv. Pala. *Orissa Journal of Horticulture* **31**(2): 54–7.

Emerald M E F and Sreenarayanan V V. 1999. Prolonging storage life of banana fruits by sub-atmospheric pressure. *Indian Food Packer* **53**(3): 22–5.

Faridi S M R A. 2001. Effect of calcium and packaging materials on ripening and quality characters of sapota (*Manilkara achras* (Mill) Forsberg.). M Sc (Ag) thesis, RAU, Pusa, Bihar.

Hailu M, Workneh T S and Belew D. 2012. Effect of packaging materials on the quality of banana cultivars. *African Journal of Agricultural Research* **7**(7):1 226–37.

Lane J H and Eynon L. 1923. Determination of reducing sugar by Fehling solutions with methylene blue as indicator. *Journal of the Society of Chemical Industry* **42**: 32–7.

Patel R K, Singh A, Yadav D S, Bhuyan M and Deka B C. 2009. Waxing, lining and polyethylene packaging on shelf life and juice quality of passion fruit during storage. *Journal of Food Science and Technology* **46**(1): 70.

Patil, S N and Hulamani, NC 1998. Effect of post-harvest treatments on physical characters and shelf life of banana fruits. *Karnataka Journal of Agricultural Sciences* **11**(2): 535–7.

Rangana S. 2010. Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw Hill Ltd, New Delhi.

Scott H K and Wills R B H. 1975. Post harvest application of calcium as a control of storage breakdown of apple. *Horticulture Science* **10**: 210–7.

Siddiqui S, Srivastava A and Sharma R K. 1999. Shelf-life of ber (*Zizyphus mauritiana* Lamk) fruits as affected by hot water treatment and modified atmosphere. *Haryana Journal Horticulture Science* **28** (3&4): 179–88.

Singh A, Nath A, Buragohain J and Deka B C. 2008. Quality and shelf life of strawberry fruits in different packages during storage**.** *Journal Food Science and Technology* **45**(5): 439–42.

Singh A, Yadav D S, Patel R K and Bhuyan M. 2007. Effect on shelf life and quality of passion fruit with polythene packaging under specific temperature. *Journal of Food Science & Technology* **44**(2): 201–4.

Singh A, Yadav D S, Patel R K, Nath A and Bhuyan M. 2011. Wax coating and padding materials influence quality and shelf life of purple passion fruit during storage. *Indian Journal of Horticulture.* **68**(2):246–9.

Singh J P and Mandal B K 2000. Role of wrappers and post harvest application of calcium nitrate on the storage behaviors of sub-tropical litchi cv. Manaraji. *Journal of Applied Biology* **10**(1): 37–42.

Singh S, Brahmachari V S and Jha K K 1998. Effect of calcium and polyethylene wrapping on storage life of mango. *Indian Journal Horticulture* **55**(3): 218–22.

Tharanathan R N, Yashoda H M and Prabha T N. 2006. Mango (*Mangifera indica* L.) The king of fruits- An overview. *Food Reviews Int.* **22**: 95–123.

Vilas-Boas E V and Kader A A 2006. Effect of atmospheric modification, 1-MCP and chemicals on quality of fresh-cut banana. *Postharvest Biology and Technology* **39**: 155–62.

Watkins C B. 2006. The use of 1-methylcyclopropene (1-MCP) on fruits and vegetables. *Biotechnology Advances* **24**(4): 389–409.