

INFLUENCE OF PRE-HARVEST SPRAYS OF CALCIUM CHLORIDE ON POST-HARVEST BEHAVIOR OF MANGO FRUITS, CV.ALPHONSO

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ABSTRACT

Study of post-harvest behavior of mango fruits (*Mangifera indica L.*) Cv.*Alphonso* under pre-harvest spray influence of calcium chloride was carried out at the “A’ block of mango orchard at UAS, Bangalore, GKVK Campus, Karnataka, India. Mango trees were sprayed with 0.5, 1.00 and 1.5 per cent CaCl₂ at 30 days and 15 days before harvest with the objectives of extending the shelf-life of fruits and delay the ripening process. Fruits sprayed with 1.50% at 30 days before harvest took more number of days for ripening (19.22 days) while it was least in control (14.77 days). The shelf-life was extended in mango fruits sprayed with 1.50% CaCl₂ at 30 days before harvest (24.33 days) and it was least in fruits from control trees (18.89 days). Mango physical proprieties like fruit length, breadth, thickness, volume, weight of fruit and pulp weight of the fruits as well as chemical proprieties of fruits such as TSS, total sugars, reducing sugar and non-reducing sugar were improved when trees were sprayed with 1.50% CaCl₂ at 30 days before harvest in fruits. The organoleptic qualities like taste, appearance and overall acceptance of the fruits were good and comparable with that of non-sprayed trees (control) in fruits under studies.

Key Words: *Ripening, shelf-life, physico-chemical parameters, organoleptic evaluation, mango*

Introduction

Alphonso also called as Badami, Apus, Gundu and Khader is one of the finest Indian mangoes and is rated to be the best by many in India and abroad. Alphonso mangos offer an excellent quality with a good sugar/acid ratio and a delightful flavor. Taste is sweet with abundant juice. Alphonso fruit is appropriate for canning purpose and it has a high demand for export. Keeping quality of fruit is good. This cultivar is grown in Ratnagiri District of Maharashtra and in Gujarat.

Statement of purpose

The edible quality of fruit has always been the major concern of researchers. Like all other fresh commodities, the potential market of mango is directly correlated with the quality of the fruits. Mangoes are climacteric and they are harvested at mature green stage (Maria *et al.*, 2004). Mango fruits are also highly perishable, sometimes due to over-ripening; they increase susceptibility on viral and fungus diseases that results into un-marketable fruits (Nagarag *et al.*, 1995). Low fruit calcium levels have been associated with reduced post-harvest life and physiological disorders (Prabu, 2011). So, to solve the problem of short shelf-life of mango fruits, different chemicals are used (Suhardi, 1992). Calcium (Ca^{2+}) has been extensively reviewed as both an essential element and it has a potential role in maintaining post-harvest quality of fruit (Chadha, 2000), however, some other calcium salts especially calcium chloride have been reported in literature to delay the ripening and senescence in fruits by lowering the respiration rate (Singh *et al.*, 1993). Spraying with foliar nutrients like calcium nitrate increase also the number of fruits/tree, fruit set, yield/tree and improved the quality as well as physiological and chemical properties of fruits (Ramzi *et al.*, 2011). Calcium spraying increased the productivity of mango due to the reduction of abscission (Kumar *et al.*, 2006). It enhances the mango quality by increasing the fruit firmness and by maintaining the middle lamella cells. The pre and post-harvest application of chemicals like calcium chloride are known to influence the quality and shelf-life of fruits during storage (Gill *et al.*, 2005).

Therefore, studies have to be carried out with the aim of evaluating the effect of calcium chloride on the shelf-life and improvement of physico-chemical proprieties of fruits in mango (*Mangifera Indica* L.)

General objective

To study the influence of pre-harvest sprays of calcium chloride on post-harvest behavior of mango fruits, Cv.Alphonso

Specific objectives

1. To study the different concentrations of calcium chloride on ripening of studied variety
2. To study the effect of calcium chloride spray on shelf-life of studied variety
3. To assess the effect of calcium chloride spray on physico-chemical properties of studied variety
4. To study the effect of calcium chloride on organoleptic proprieties of studied variety

Hypotheses

1. Pre-harvest spray of calcium chloride delay the ripening of mango and influence the shelf-life.
2. Physico-chemical proprieties of mango will be improved under calcium chloride sprays.

Null Hypotheses

1. Pre-harvest spray of calcium chloride does not delay the ripening of mango and it does not influence the shelf-life
2. Physico-chemical proprieties of mango will not be improved under calcium chloride sprays

Material and Methods

Studies on ripening, shelf-life, physico-chemical parameters and organoleptic evaluation of mango fruits (*Mangifera indica L.*) Cv. Alphonso were carried out at the “A” block of mango orchard at UAS, GKVK Campus, Bangalore, Karnataka, India. The experiment was carried out with Complete Randomized Design with three replications. Alphonso trees were sprayed with CaCl_2 at 30 days and 15 days before harvest. Data on number of days taken for ripening of fruits, shelf-life of fruits, physico-chemical parameters of fruits and organoleptic qualities of fruits were recorded. **T₁**: Control (no spray), **T₂**: 0.50% spray of calcium chloride at 30 days before harvest, **T₃**: 1.00% spray of calcium chloride at 30 days before harvest, **T₄**: 1.50% spray of calcium chloride at 30 days before harvest, **T₅**: 0.50% spray of calcium chloride at 15 days before harvest, **T₆**: 1.00% spray of calcium chloride at 15 days before harvest, **T₇**: 1.50% spray of calcium chloride at 15 days before harvest.

Site

The experiment was carried out at University of Agricultural Sciences, Bangalore, GKVK campus, India located at the latitude of 12° 58' North; longitude 77° 35' East and altitude of 930 meters above mean sea level. The soil type is red sandy to lateritic soil with little clay content and the trees are 35 old years.

Season

The experiments were carried out in 35 year old mango trees grown in “A” block of mango orchard, University of Agricultural Sciences, Bangalore, GKVK campus during the year 2011-2012.

Variety used: Alphonso

Alphonso (Haapoos in Marathi, Badami in Kannada) is a mango cultivar that is considered by many to be one of the best in terms of sweetness, richness and flavor. It has considerable shelf life of a week after it is ripe making it exportable. It is also one of the most expensive kinds of mango and is grown mainly in *Kokan* region of western India. It is in season April through May and the fruit weigh between 150g and 300g each. The Alphonso mango is named after Alfonso de Albuquerque. This was an exquisite and expensive variety of mango that he used to bring on his journeys to Goa. The variety grown in Ratnagiri district of the Kokan region of Maharashtra is supposed to be the best. It's also the most expensive amongst the sub-breeds of Alphonso. In most of the Indian market sub-varieties are fetching the price of good quality alphonso. These varieties neither have the sweetness, nor have the flavour of hapoos (Susser, 2001).

Observations recorded**Number of days taken for ripening of fruit**

Immediately after the harvest of the fruits stalk was removed and fruits were washed with clean water and liquid soap and the days from the harvesting till the ripening were accounted.

Shelf-life of fruit

The shelf-life of fruit was accounted from the date of harvesting to the shelf- life expiration date.

Physical parameters of fruit

The fruits were harvested at optimum stage of maturity, stalks were removed, and the sap was drained out carefully and washed with clean water and liquid soap.

Length of fruit

The length of the fruit from stalk end to the apex of the fruit was determined at harvest stage with the help of vernier caliper and expressed in centimeters.

Breadth of fruit

The breadth of fruit was determined as the maximum linear distance between two shoulders of the fruit with the help of vernier caliper and expressed in centimeters.

Thickness of fruit

The thickness of the fruit was measured at the linear distance between the two checks of the fruit with the help of vernier caliper and expressed in centimeters.

Volume of fruit

The volume of the fruit was measured by the conventional water displacement method and expressed in milliliter

Weight of fruit

Immediately after the harvest of the fruit, stalk was removed and the weight of the raw fruit was recovered in grams.

Weight of fruit peel

The ripped fruits were peeled off using a knife and weight of the peel was recorded in grams.

Weight of fruit pulp

The mango pulp from the ripe fruits was separated from the peel and the stone and the weight was expressed in grams. The percentage weight of pulp to that of total weight of fruit was also computed.

Weight of the stone

The stones of ripe mango fruits belonging to different cultivars were separated from the pulp and their weight was recorded in grams.

Chemical composition of fruit

The fruits harvested from each tree were employed to estimate the chemical composition of fruit. Total soluble solids, total sugars, reducing sugar, non-reducing sugar and titratable acidity have been estimated.

TSS

Total soluble solids content of a solution was determined by the index of refraction. This was measured using a refractometer, and was referred to as the degrees Brix.

Total sugars

The content of total sugars present in ripe fruit of different cultivars of mango was estimated by the phenol sulphuric acid method (Dubios *et al.*, 1951) and expressed in per cent.

Reducing sugar

The reducing sugar content of the ripe mango pulp was estimated by Di-nitro salicylic acid method developed by Miller (1972) and expressed in per cent.

Non-reducing sugar

The non-reducing sugar content of the mango pulp was calculated by the subtracting the reducing sugar content of mango pulp from that of total sugar.

Titrateable acidity

Titrateable acidity was estimated from the pulp of ripe mango fruits. One gram of pulp from each replication in each treatment was homogenized using a pestle and mortar and the volume was made up to 20 ml with distilled water. It was then titrated against 0.1N sodium hydroxide solution to a phenol phatalein end point. The acidity was expressed as per cent malic acid (Ranganna, 2003).

Organoleptic qualities of fruit (Standard reference to be quoted)

The ripe mango fruits of selected varieties were subjected to organoleptic evaluation by a panel of six judges. The evaluation was carried out on a 100 score scale prepared on the basis of principles of organoleptic evaluation (Amerine *et al.*, 1965), which had points for peel colour (15 score), pulp colour (15 score), texture of pulp (20 score), flavor of pulp (20 score) and taste of pulp (30 score). The overall acceptance of the fruits was also worked out by adding points scored for each of these characters.

The scoring of each character was based on the following criteria:

| If the sample are | Peel (15) | colour (15) | Pulp (15) | colour (20) | Pulp (20) | Texture (20) | Pulp (20) | flavor (20) | Pulp (30) | taste |
|-------------------|-----------|-------------|-----------|-------------|-----------|--------------|-----------|-------------|-----------|-------|
| Very good | 13-15 | | 13-15 | | 16-20 | | 16-20 | | 25-30 | |
| Good | 9-12 | | 9-12 | | 11-15 | | 11-15 | | 17-24 | |

| | | | | | |
|----------|-----|-----|------|------|------|
| Average | 5-8 | 5-8 | 7-10 | 7-10 | 9-16 |
| Bad/poor | 0-4 | 0-4 | 0-6 | 0-6 | 0-8 |

Signature:

Statistical analysis of data

The mean values of data on all the characters were subjected to statistical analysis as per the procedure outlined (Sundar-Raj *et al.*, 1972) and the results have been presented and discussed at the probability of 5 per cent and 1 per cent.

Results and Discussion

Number of days taken for ripening of fruits: The data in Table 1 showed that significantly delay of ripening of fruits was found in Cv. Alphonso when trees were sprayed with 1.50% CaCl_2 at 30 days before harvest (19.22 days). The reason might be that pre-harvest applications are more useful early in the development of fruits rather than when applied late. Similar observations were noticed by Penter and Stassen, 2000. The delay of ripening by CaCl_2 may be attributed to higher fruit calcium levels that lead to the reduction of respiration and ethylene production rates (Singh *et al.*, 2003).

Shelf-life of fruits: Results regarding the shelf-life of fruits are presented in Table 1. Significantly long shelf-life of fruit was recorded in Cv. Alphonso when trees were sprayed with 1.50% CaCl_2 at 30 days before harvest (24.33 days). That might be to the fact that calcium enhances fruit firmness relative to control which leads to slower hastening and extends the shelf-life. These results are in accordance with earlier reports of Gill *et al.* (2005)

Table 1: Effect of CaCl_2 spray on number of days taken for ripening and shelf-life of mango fruits in Cv. Alphonso

| Treatments | No. of days taken for ripening of fruits | Shelf-life of fruits (days) |
|---|--|-----------------------------|
| T ₁ : Control | 14.77 | 18.89 |
| T ₂ : CaCl_2 0.50% spray at 30DBH | 17.33 | 21.89 |
| T ₃ : CaCl_2 1.00% spray at 30DBH | 18.33 | 23.22 |

| | | |
|---|-------|-------|
| T ₄ : CaCl ₂ 1.50% spray at 30DBH | 19.22 | 24.33 |
| T ₅ : CaCl ₂ 0.50% spray at 15DBH | 16.23 | 20.11 |
| T ₆ : CaCl ₂ 1.00% spray at 15DBH | 17.33 | 20.67 |
| T ₇ : CaCl ₂ 1.50% spray at 15DBH | 18.44 | 22.11 |
| F test | ** | ** |
| SEm± | 0.49 | 0.27 |
| C.D. at 5% | 1.04 | 0.58 |
| C.V. (%) | 3.42 | 1.54 |

DBH: Days before harvest ; **: Significant at 1%;

Table 2: Effect of CaCl₂ spray on physical parameters of mango fruits in Cv. Alphonso

| Treatments | Physical parameters of fruits | | | | | | | |
|---|-------------------------------|--------------------|----------------------|-------------------|------------------|-----------------|-----------------|------------------|
| | Fruit length (cm) | Fruit breadth (cm) | Fruit thickness (cm) | Fruit volume (ml) | Fruit weight (g) | Pulp weight (g) | Peel weight (g) | Stone weight (g) |
| T ₁ : Control | 9.24 | 7.15 | 6.62 | 219.87 | 225.58 | 107.78 | 18.44 | 24.22 |
| T ₂ : CaCl ₂ 0.50% spray at 30DBH | 9.59 | 7.68 | 7.24 | 279.00 | 281.11 | 164.33 | 27.89 | 32.22 |
| T ₃ : CaCl ₂ 1.00% spray at 30DBH | 9.74 | 7.97 | 7.59 | 295.67 | 296.00 | 175.67 | 34.44 | 35.67 |
| T ₄ : CaCl ₂ 1.50% spray at 30DBH | 9.81 | 8.50 | 8.16 | 311.66 | 315.23 | 205.33 | 37.89 | 39.00 |
| T ₅ : CaCl ₂ 0.50% spray at 15DBH | 9.31 | 7.33 | 6.82 | 235.33 | 242.67 | 145.66 | 23.22 | 26.66 |
| T ₆ : CaCl ₂ 1.00% spray at 15DBH | 9.43 | 7.45 | 6.88 | 254.33 | 252.33 | 154.55 | 29.00 | 32.11 |

| | | | | | | | | |
|--|------|------|------|--------|--------|--------|-------|-------|
| T ₇ : CaCl ₂ 1.50% spray at 15DBH | 9.54 | 7.74 | 7.03 | 264.44 | 262.23 | 175.44 | 34.67 | 35.77 |
| F test | ** | ** | ** | ** | ** | ** | ** | ** |
| SEm± | 0.06 | 0.14 | 0.07 | 4.00 | 3.72 | 4.14 | 3.72 | 2.16 |
| C.D. at 5% | 0.14 | 0.31 | 0.16 | 8.58 | 7.98 | 8.89 | 7.99 | 4.64 |
| C.V. (%) | 0.84 | 2.29 | 1.26 | 1.84 | 1.72 | 3.18 | 15.98 | 8.17 |

DBH: Days before harvest ; **: Significant at 1%;

Physical parameters of fruits: Cv. Alphonso recorded significantly higher fruit length (9.81 cm), breadth (8.50 cm), thickness (8.16 cm), volume (311.66 ml), weight of fruit (315.23 g) and pulp weight of fruit (205.33 g) when trees were sprayed with 1.50% CaCl₂ at 30 days before harvest (Table 2). That could be to the fact that pre-harvest applications are more successful early in the development of fruits rather than when they are applied late just before harvest. The improvement observed in the fruit quality due to calcium chloride could be attributed to its effects in influencing formation and changes of carbohydrates and carbohydrate enzymes, others reasons might be the reduction of abscission and the calcium influence in maintaining the middle lamella cells. The findings obtained in the present investigation can be compared to those obtained by Wahdan *et al.* (2011)

The weight of fruits, weight of peel, weight of pulp and weight of stone of fruits were maximum in fruits from trees sprayed with 1.50% CaCl₂ at 30 days before harvest compared to control trees. Data showed also that maximum weight loss of fruits occurred in control treatment while lowest loss was recorded in 1.50% CaCl₂ sprayed trees. Calcium applications have been known to play a role in membrane functionality and maintenance. It could be the reason for the lower weight loss recorded in calcium sprayed fruits. The results fall in line with the earlier reports of Kazemi *et al.* (2011).

Chemical parameters of fruits: The data presented in Table 3 showed that significantly higher TSS of fruit (19.23⁰Brix) was observed in Cv. Alphonso when trees were sprayed with 1.50% CaCl₂ at 30 days before harvest. Significantly higher percentage of total sugars (13.77 %) was observed in Cv. Alphonso when trees were sprayed with 1.50% CaCl₂ at 30 days before harvest. Reducing sugar content of fruit was statistically higher in Cv. Alphonso (2.70 %) when trees were sprayed with 1.50% CaCl₂ at 30 days before harvest. Non-reducing sugar content of fruit was statistically higher in Cv. Alphonso (11.07%) when trees were sprayed with 1.50% CaCl₂ at 30 days before harvest and with respect to titratable acidity of fruits, the minimum percentage (0.14%) was recorded in Cv. Alphonso when trees were sprayed with 1.50% CaCl₂ at 30 days before harvest. The reason of the increase of TSS during storage periods might be the

transformation of organic matter of fruits to soluble solids under enzymatic activities and CaCl_2 influence. The general increase of TSS of fruits has been recorded by Wahdan *et al.* (2011).

The increase in sugars content of mango fruits could be due to normal ripening process that leads to senescence and to the transformation of some carbohydrates components as starch to sugars by the enzymatic activities. The increase in the sugars of fruits has been recorded by Wahdan *et al.* (2011). Reduction of acidity content may be due to the change of acid into sugars under enzyme invertase influence during storage period. The findings obtained in the present investigation can be compared to those obtained by Omayama *et al.* (2010).

Table 3: Effect of CaCl_2 spray on chemical composition of mango fruits in Cv. Alphonso

| Treatments | Chemical composition of fruits | | | | |
|---|--------------------------------|------------------|--------------------|------------------------|------------------------|
| | TSS ($^{\circ}$ Brix) | Total sugars (%) | Reducing sugar (%) | Non-reducing sugar (%) | Titratable acidity (%) |
| T ₁ : Control | 15.14 | 13.23 | 2.40 | 10.83 | 0.29 |
| T ₂ : CaCl_2 0.50% spray at 30DBH | 17.73 | 13.49 | 2.54 | 10.95 | 0.24 |
| T ₃ : CaCl_2 1.00% spray at 30DBH | 18.57 | 13.63 | 2.64 | 10.99 | 0.19 |
| T ₄ : CaCl_2 1.50% spray at 30DBH | 19.23 | 13.77 | 2.70 | 11.07 | 0.14 |
| T ₅ : CaCl_2 0.50% spray at 15DBH | 15.78 | 12.72 | 2.45 | 10.27 | 0.27 |
| T ₆ : CaCl_2 1.00% spray at 15DBH | 16.68 | 13.08 | 2.53 | 10.55 | 0.24 |
| T ₇ : CaCl_2 1.50% spray at 15DBH | 17.63 | 13.28 | 2.60 | 10.68 | 0.18 |
| F test | ** | ** | ** | ** | ** |
| SEm\pm | 0.34 | 0.07 | 0.03 | 0.07 | 0.02 |
| C.D. at 5% | 0.73 | 0.16 | 0.07 | 0.14 | 0.03 |
| C.V. (%) | 2.41 | 0.67 | 1.56 | 0.75 | 9.26 |

DBH: Days before harvest ; **: Significant at 1%;

Organoleptic qualities of fruits: Results pertaining to the shelf-life of fruits are presented in Table 4. Organoleptic qualities of mango fruits Cv. Alphonso when trees were sprayed with different concentrations of CaCl_2 at 30 and 15 days before harvest showed a good quality of fruit when compared to control trees (82.31 points). Singh *et al.* (1993) also studied the changes in post-harvest quality of mangoes affected by pre-harvest application of calcium chloride and they observed that there were no significant changes on skin green colour when fruits were ripened. Partially green colour of peel in treated fruits by calcium components treatment showed that there is a relationship of its components with physiological phenomenon occurred in colour development (Muhammad *et al.*, 2008). 1.50% CaCl_2 sprayed trees at 30 days before harvest showed maximum score of pulp colour and pulp texture of fruits. However, the score was minimum in fruits from no sprayed trees (control). The pulp flavor and the pulp taste were highest in control trees, whereas, they were minimum in fruits from 1.50% CaCl_2 sprayed trees at 15 days before harvest. Gofure *et al.* (1997) showed that the increase in concentration of calcium salts on mango fruits leads to delay of hastening but had negative effect on fruit quality by inducing skin shriveling and reducing flavor and taste of the fruits.

Table 4: Effect of CaCl_2 spray on organoleptic qualities of mango fruits in Cv. Alphonso

| Treatments | Organoleptic qualities of fruits | | | | | |
|---|----------------------------------|------------------|-------------------|------------------|-----------------|--------------------------|
| | Peel colour (15) | Pulp colour (15) | Pulp texture (20) | Pulp flavor (20) | Pulp taste (30) | Overall acceptance (100) |
| T ₁ : Control | 12.67 | 12.30 | 14.50 | 16.42 | 26.42 | 82.31 |
| T ₂ : CaCl_2 0.50% spray at 30DBH | 12.58 | 13.17 | 15.42 | 15.68 | 25.35 | 82.20 |
| T ₃ : CaCl_2 1.00% spray at 30DBH | 11.67 | 13.32 | 15.62 | 15.57 | 24.62 | 80.80 |
| T ₄ : CaCl_2 1.50% spray at 30DBH | 11.42 | 13.43 | 15.75 | 15.50 | 23.82 | 79.92 |
| T ₅ : CaCl_2 0.50% spray at 15DBH | 11.45 | 12.52 | 14.65 | 15.07 | 23.80 | 77.49 |
| T ₆ : CaCl_2 1.00% spray at 15DBH | 10.90 | 12.73 | 14.90 | 14.75 | 23.06 | 76.34 |
| T ₇ : CaCl_2 1.50% spray at 15DBH | 10.77 | 12.93 | 15.20 | 14.25 | 22.53 | 75.68 |

| | | | | | | |
|-------------------|------|------|------|------|------|------|
| F test | NS | ** | NS | NS | ** | ** |
| SEm± | 0.81 | 0.19 | 0.65 | 0.67 | 0.82 | 1.90 |
| C.D. at 5% | – | 0.43 | – | – | 1.75 | 4.06 |
| C.V. (%) | 8.52 | 1.86 | 5.21 | 5.30 | 4.12 | 2.92 |

DBH: Days before harvest ; **: Significant at 1%; NS: Non significant

Conclusion

The present study showed that the ripening, shelf-life, physico-chemical parameters and organoleptic evaluation of Alphonso were improved when mango were sprayed with CaCl₂ 1.50% at 30 days before spraying.

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