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Effect of calcium chloride sprays on ripening, shelf-life and physical chemical proprieties of mango fruits (*Mangifera indica L.*) Cv.Totapuri

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Effect of calcium chloride sprays on ripening, shelf-life and physical chemical proprieties of mango fruits (Mangifera indica L.) Cv.Totapuri was carried out at the "A' block of mango orchard at UAS, Bangalore, GKVK Campus, Karnataka, India. Mango trees were sprayed with 0.50%, 1.00% and 1.50% $CaCl_2$ at 30 days and 15 days before harvest. The results revealed that spraying of $CaCl_2$ delayed the process of ripening of fruits when compared to fruits from control trees. Mango Cv. Totapuri took more number of days for ripening (19.89 days) when trees were sprayed with 1.50% $CaCl_2$ at 30 days befre harvest. The shelf-life also was extended in mango Cv. Totapuri trees sprayed with 1.50% $CaCl_2$ at 30 days before harvest (25.89 days) and physical-chemical proprieties were improved compare to fruits from non-sprayed trees.

Keywords: Ripening, shelf-life, physico-chemical proprieties, calcium chloride, Totapuri

INTRODUCTION

The Totapuri mango is a cultivar that is widely grown for commercializing in south India. It is a heavy yielder and it is regular bearing cultivar. In India, it is known also as Bangalora, Collector, Kallamai, Killi, Gilli, Mukku, Sandersha, and Thevadiyamuthies. Totapuri is the name that is mostly used in Bangalore, while in the rest part of India people use to call it Bangalora. In 1901, Totapuri was imported to Florida as Sandersha and in the 1960s as Totapuri. The cultivar is the parent of at least two Florida mango cultivars, Anderson and Brooks (Susser, 2001)

Totapuri is one of the main cultivars grown in India, primarily in Andhra Pradesh and is liked for pulp, along with Alphonso and Kesar. The tree is medium size with greenish yellow fruits. Fruit is medium to large and it has a prominent beak in shape of about 6-8 inches. Colour is green yellow. The fruit quality is good. That cultivar contains Vitamin A, E, B5 and C that are are important for the skin growth and its antioxidant enzymes provide nourishment to body while increasing resistance power. There is a central large seed in these mangoes covered by the pulp that has a pale to bright yellow colour. The skin of the fruit is usually thick and the colour can vary from green to yellow (Susser, 2001).

Plants need a high quantity of Nitrogen and potassium for their growth (Atkinson *et al.*, 1990) and Calcium is another important secondary plant nutrient. It is a constituent of cell wall and it plays an important role in carbohydrate change into sugars (Elliot, 1996).

Calcium is not considered as a leachable nutrient (Cheung, 1990). High levels of insoluble calcium such as calcium carbonate contain in soils, despite that crops grown in these soils will often show a calcium deficiency (Boyonton et al., 2006). Calcium can only be supplied in

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the xylem sap (Banath et al., 1966). The calcium uptake in some crops will be reduced by the presence of high amount of other cations such as magnesium, ammonium, iron, aluminium and especially potassium, due to their antagonistic effect for their absorption (Kulkarni et al., 2010). The most commonly observed deficiency symptoms of calcium in plants are necrosis at the tips and margins of young leaves, bulb and fruit abnormalities, deformation of affected leaves, highly branched, short, brown root systems, severe, stunted growth, and chlorosis (Jones and Lunt, 1967). Calcium will be toxic if it is supplied in excess quantities (Kumar et al., 2006). The productivity of mango will be increased by the spray of calcium due to the abscission reduction (Kumar et al., 2006). It enhances the mango quality by increasing the fruit firmness and by maintaining the middle lamella cells. Treatment with calcium nitrate and calcium chloride (0.6-2.0%) delayed ripening after harvest, lowered weight loss and reduced respiration rates (Bender, 1998). CaCl2 showed improvement of fruits storability under cold storage (Wahdan et al., 2011). The pre and post-harvest application of chemicals like calcium chloride and calcium nitrate are known to influence the quality and shelf-life of fruits during storage (Gill et al., 2005). Hence the present studies were undertaken under Karnataka conditions especially in Bangalore with the followings objectives:

1. To evaluate the different concentrations of calcium chloride on ripening of certain varieties of mango
2. To study the effect of calcium chloride spray on shelf-life of different varieties of mango.
3. To study the effect of calcium chloride spray on physico-chemical properties of mango.

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.

MATERIAL AND METHODS

Effect of calcium chloride sprays on ripening, shelf-life and physical chemical proprieties of mango fruits (Mangifera indica L.) Cv.Totapuri was carried out at the “A’ block of mango orchard at University of Agricultural Sciences (UAS), Ghandi Krishi Vigna Kendra (GKVK) Campus, Bangalore, Karnataka, India in 2011. Complete Randomized Design was used with three replications. Cv. Totapuri trees were sprayed with CaCl2 at 30 days and 15 days before harvest. Data on number of days taken for ripening of fruits and the shelf-life 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. Method used for the studies are detailed below:

Site of experiment

The soil of the experimental site was red sandy loam, with slightly acidic (pH 6.44), medium in organic carbon (0.55 %), medium in available Nitrogen (288.549 kg ha^{-1}), in available potassium (175.08 kg ha^{-1}) and in phosphorus (38.49 kg ha^{-1}). The experiment was carried out at University of Agricultural Sciences, Bangalore, GKVK campus, India located at the latitude of 12° 58’ North; longitude 77^{0} 35’ East and altitude of 930 meters above mean sea level.

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.

Description of mango variety Totapuri

Totapuri mangoes grow on spreading short-trunked trees that have thick dark green leaves. A Totapuri mango fruit hang from the branches either singly or in bunches. It is along with prominent beak in shape of about 6-8 inches and has thick and green skin yellow or a fanciful combination of these colours. Being an excellent source of Vitamin A and C, Totapuri mangoes have a rich flavor and they are delicious in taste. There is also a central large seed in these mangoes which is surrounded by the pulp that ranges from pale to bright yellow (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.

Titratable acidity

Titratable 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

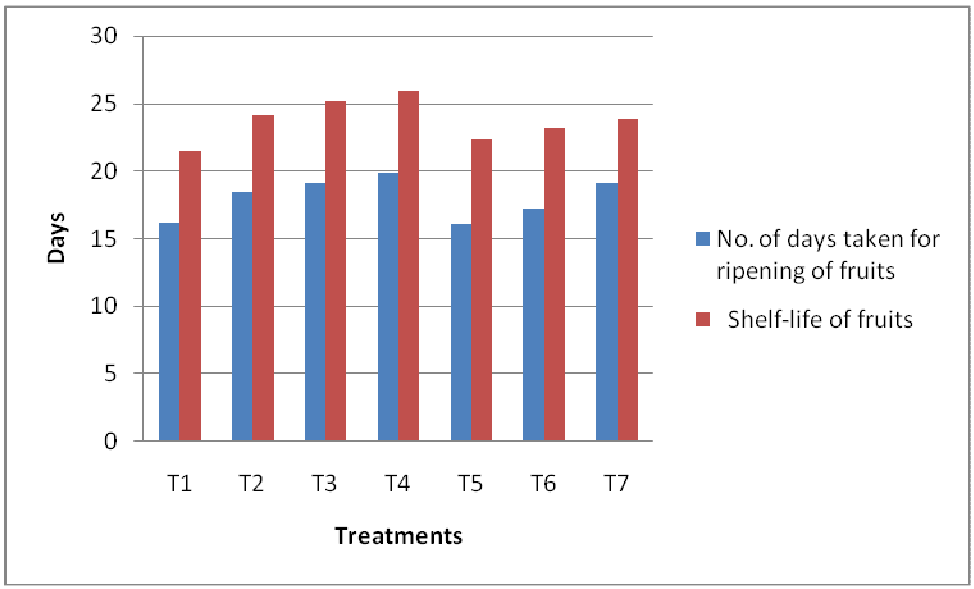

Figure 1. Effect of $CaCl_2$ spray on number of days taken for ripening and shelf-life of mango fruits in Cv. Totapuri
T_1: Control; T_2: 0.5% $Cacl_2$ spray 30 DBH; T_3: 1.00% $Cacl_2$ spray 30 DBH
T_4: 1.50% $Cacl_2$ spray 30 DBH; T_5: 0.5% $Cacl_2$ spray 15 DBH; T_6: 1.00% $Cacl_2$ spray 15 DBH
T_7: 1.50% $Cacl_2$ spray 15 DBH

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).

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 presented in Figure 1 showed that significantly delay of ripening of fruit was found in Cv. Totapuri when trees were sprayed with 1.50% $CaCl_2$ at 30 days before harvest (19.89 days). The delay could be attributed to the fact 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. Higher fruit calcium levels in fruits leads to the reduction of respiration and ethylene production rates thus delay the ripening of fruits. These findings are in agreement with the reports of Hewajulige *et al.* (2003) and Gill *et al.* (2005).

Shelf-life of fruits

Results regarding the shelf-life of fruits are presented in Figure 1. Shelf-life of fruits was significantly long in Cv. Totapuri when trees were sprayed with 1.50% $CaCl_2$ at 30 days before harvest (25.89). The extension of shelf-life was more important when fruits were sprayed at 30 days before harvest. The reason of extension of shelf-life by $CaCl_2$ sprays might be due to the fact that where fruits are harvested at the correct maturity; calcium plays a number of roles such as an increase in fruit firmness relative to control. This leads to benefits like a slower ripening and increased shelf-life. The present findings are in close conformity with those of Gore (2005).

Physical parameters of fruits

The mango Cv.Totapuri showed significantly high fruit length (12.49 cm), breadth (7.73 cm), thickness (6.97 cm), volume (341.33 ml), weight of fruit(347.89 g) and pulp weight of fruit (215.56 g) when trees were sprayed with 1.50% $Cacl_2$ at 30 days before harvest (table 1)

Table 1. Effect of CaCl2 spray on physical parameters of mango fruits in Cv. Totapuri

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	11.46	7.07	6.09	226.67	231.11	139.89	21.00	36.67
T_2: $CaCl_2$ 0.50% spray at 30DBH	12.08	7.39	6.50	277.67	281.11	184.55	33.22	48.00
T_3: $CaCl_2$ 1.00% spray at 30DBH	12.36	7.58	6.69	330.00	337.66	198.89	37.89	51.00
T_4 : $CaCl_2$ 1.50% spray at 30DBH	25.89	7.73	6.97	341.33	347.89	215.56	42.11	54.33
T_5: $CaCl_2$ 0.50% spray at 15DBH	11.50	7.25	6.26	243.44	240.00	152.22	28.00	43.11
T_6: $CaCl_2$ 1.00% spray at 15DBH	11.54	7.38	6.32	254.33	255.66	157.89	34.33	46.89
T_7: $CaCl_2$ 1.50% spray at 15DBH	11.61	7.44	6.45	263.33	267.67	175.44	39.00	51.11
F test	**	**	**	**	**	**	**	**
SEm±	0.05	0.06	0.08	6.93	5.07	3.82	1.75	1.6
C.D. at 5%	0.09	0.13	0.16	14.86	10.88	8.18	3.76	3.39
C.V. (%)	0.48	0.98	1.42	3.06	2.23	2.68	6.38	4.08

DBH: Days before harvest ; **: Significant at 5%

while results were low in control trees: length (11.46 cm), breadth (7.07cm), thickness (6.09 cm), volume (226.67 ml), weight of fruit (231.11 g) pulp weight of fruit (139.89 g). In trees sprayed at 30 days before harvest, significantly maximum length, breadth, thickness and volume of fruits were noticed in trees sprayed by $CaCl_2$ (1.50%), whereas, they were minimum in the control. That may due to the effectiveness of early pre-harvest application of calcium in the development of fruits rather than just before harvest. The better quality due to supplying trees with calcium chloride could be attributed to its influence on enhancing formation and translocation of carbohydrates and carbohydrate enzymes, other reasons might be the reduction of abscission and the effect of calcium in maintaining the middle lamella cells. The present results are in close conformity with those of Yogeratnam and Greenham (1982), Kumar *et al.* (2006) and Wahdan *et al.* (2011).

Moreover, the weight of fruits and weight of pulp were maximum in fruits from trees sprayed with 1.50% $CaCl_2$ at 30 days before harvest, whereas they were minimum in control trees. From results we can observe that maximum weight loss of fruits occurred in control treatment while lowest loss was observed in 1.50% $CaCl_2$ sprayed trees. Calcium applications have been known to be effective in membrane functionality and integrity maintenance which may be the reason for the lower weight loss found in calcium treated fruits. Mahajan and Dhatt (2004) reported that pear fruits treated with $CaCl_2$ proved to be most effective in reducing weight loss compared to no treated fruits during 75 days storage period. These results are also in accordance with earlier reports of Kazemi *et al.* (2011), Kardum (2004) and Gore (2005).

Chemical parameters of fruits

The data presented in Table 1 showed that significantly higher TSS of fruits (16.73 ^{0}Brix) was observed in Cv. Totapuri when trees were sprayed with 1.50% $cacl_2$ at 30 days before harvest. Total sugar (11.89 %), reducing sugar (1.95 %), non-reducing sugar (9.94 %) were also higher in fruits from trees sprayed with 1.50% at 30 days before harvest, and about the titratable acidity, studies showed that the minimum percentage (0.10 %) was obtained also in trees sprayed with 1.50% at 30days before harvest while it was maximum(0.20 %) in non-sprayed trees. Experiments demonstrated that TSS increased gradually up to the end of storage periods. The change in TSS during storage periods might be a result of the transformation of organic compounds in fruits into total soluble solids throughout the enzymatic activities and reactions under $CaCl_2$ effect. The results fall in line with the earlier reports of Wahdan *et al.* (2011), Ramzi *et al.* (2011) and Patil *et al.* (2003).

The data of experiments showed that there was a significant increase in total sugars, reducing sugar and non- reducing sugar as the storage period advanced to reach its maximum values at the end of storage period. This increase in sugar content of mango fruits could be due to normal ripening process that causes the senescence and also to the conversion of some carbohydrate compounds like starch to sugars by the enzymatic reactions. In all experiments, where trees were sprayed with $CaCl_2$, maximum percentage of total sugars, reducing sugar and non-reducing sugar of fruits were recorded among trees sprayed with $CaCl_2$ (1.50%) at 30 days before harvest. However, total sugars, reducing sugar and non-reducing sugar of fruits were minimum in control trees. The general increase in the sugars of fruits has been recorded by Wahdan *et al.* (2011), Gore (2005) and Kardum (2004).

About the titrable acidity, data showed that in all experiments a decrease of titratable acidity of fruits. Titratable acidity of fruits was minimum in 1.50% $CaCl_2$ sprayed trees at 30 days before harvest, whereas, it was maximum in control trees. The reason of decrease in acidity content may be due to the change of acid into sugars by enzyme invertase during storage period. The findings obtained in the present investigation are in accordance of those obtained by Wahdan *et al*. (2011), Elham *et al*. (2011) and Dhaliwal and Mahajan (2010).

CONCLUSION

Mango cultivars sprayed with 1.50% $CaCl_2$ at 30 days before harvest showed best results with regard to number of days taken for ripening of fruits, shelf-life of fruits, size and shape as well as chemical composition of fruits.

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