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Effect of post-harvest treatments on quality attributes i.e. titratable acidity, ascorbic acid and Consumers acceptability of Langra mangoes (*Mangifera indica* L.) during storage

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Abstract
The effect of calcium salts (calcium nitrate and calcium chloride) and Gibberellic acid on quality attributes and consumer's acceptability of Langra mangoes during storage was examined. The fruits were treated with $Ca(NO_3)_2$ at the concentration of 1,2 and 3 per cent, $CaCl_2$ at the concentration of 1,2 and 3 per cent and GA_3 at the concentration of 50, 100 and 150 ppm. Water treated fruits were taken as control. Data were recorded in respect of Titratable acidity, ascorbic acid contents under influence of these treatments. Sensory evaluation was also conducted to assess the consumer's acceptability of treated fruits. All treatments were found effective in maintaining the higher level of these quality attributes as well as the consumer's acceptability of fruits during entire course of the experiment. At end of trial, $Ca(NO_3)_2$at 2% was proved as the best treatment in respect of Titratable acidity and was able to maintain the level of these up to 0.156%. In case of ascorbic acid content and organoleptic scoring GA_3 100 ppm was proved the best. It was able to maintain the level of ascorbic acid up to 27.00 mg/100 gram of pulp and secured an organoleptic score of 83 at the end of experiment.

Keywords: Mango, Langra, calcium nitrate, calcium chloride, ga_3, acidity, ascorbic acid, sensory evaluation

Introduction
Mango (*Mangifera indica* L.), the king of fruits belongs to the family Anacardiaceae. Among the fruits of universal importance, mango is placed on top and is the most popular fruit among millions of people. Mango is fifth widely produced fruit crop of the world after bananas, apples, grapes and oranges. Mango is grown throughout the length and breadth of the country except the temperate and arid regions. The number one mango producing country in the world is India. It contributes approximately 50% of the global mango supply. In India, during 2015-16, it was grown in an area of 2.209 million hectares with a production of 18.643 million tonnes and productivity of 8.4 tonnes/ hectare (Anonymous, 2017) [2].

Mango fruit is an excellent source of Vitamin-A, beta-carotene, alpha-carotene, and beta-cryptoxanthin. It is also a very good source of vitamin-B6 (pyridoxine), vitamin-B9 (folate), vitamin-C (Ascorbic acid) and vitamin-E (Anonymous, 2018) [3]. 100 g of fresh fruit provides 765 IU or 25% of recommended daily levels of vitamin-A. Among the cultivated varieties of Bihar, the variety Langra is most famous and is one of the most popular cultivars of India (Khara *et al*, 2016) [9]. In domestic market this variety has good demand and is able to fetch highest price in the market of Bihar. However, owing to its highly perishable nature and below average keeping quality, export potential of this variety is yet to be capitalised.

Mango showed degradation in quality owing to its high perishability and climacteric pattern of respiration. This massive reduction in the level of quality attributes of fruits is due to fact that sugars along with other organic acids are primary substrate for respiration (Wills *et al.*, 1980) [16]. Therefore, a critical examination becomes imperative to slow down the process of respiration and to maintain the quality parameter for an enhance period of time in order to facilitate longer transportation and extended availability of quality fruits in the market.

Earlier efficacy of pre and post-harvest applications of certain chemicals and growth hormones in maintaining the quality of fruits during storage has been established. Pre-harvest sprays of calcium compounds and GA_3 significantly retained more sugar content and ascorbic acid in mango fruits along with better consumer acceptability during storage (Rani and Brahmachari,

2003) [14]. Banerjee and co-workers (2016) recorded minimum reduction in TSS and maximum retention of acidity with the application of GA_3 during 17 days of storage of Amrapali mango fruits. Mounika *et al*. (2017) [12] recorded higher level of TSS, sugars and acidity in Amrapali mango fruits treated with calcium salts as post-harvest application. Singh *et al.* (2017) [15] while working on Dashehari and Amrapali cultivars of mango proved the potential of calcium nitrate and calcium chloride in preserving valuable attributes of post-harvest quality (TSS, total sugar and acidity contents) of mango of fruits during storage.

Keeping these facts in view, an investigation was carried out to find the effect of calcium salts and GA_3 on quality attributes *i.e.* titratable acidity, Ascorbic acid and consumers acceptability of langra mangoes during storage.

Materials and Methods

The experiment was conducted in the Department of Botany, Jai Prakash University Chapra (Bihar) during the cropping year of 2018-19. The physiologically matured fruits were purchased from the market and carried to the experimental laboratory in bamboo baskets. The maturity was judged on the basis of fruit colour changes from greenish to the pinkish, flatness of the tubercles and smoothness of the epicarp as suggested by Pandey and Sharma (1998) [13]. The fruits divided in different lots were dipped for five minutes in aqueous solution of different chemicals at different concentrations separately. The experiment consisted of 10 treatments which are $Ca(NO_3)_2$ and $CaCl_2$ each at 1%, 2% and 3% per cent, and GA_3 at the concentration of 50, 100 and 150 ppm and Control. The control fruits were dipped in water and kept for comparison. Fruits were stored after air drying at room temperature. The storage was terminated on the day when the fruits exhibited 12 per cent or more loss due to rotting under best treatment. The data were recorded on titratable acidity (%), ascorbic acid and sensory evaluation. For determination of titratable acidity, the method suggested by A.O.A.C. (1970) [1] was followed. Ascorbic acid content of juice was determined by titrating freshly extracted juice against 2,6-dichlorophenol indophenol dye following the method suggested by A.O.A.C. (1970) [1]. To assess the consumer's acceptability organoleptic evaluation was conducted by score card system with the panel of five judges. The organoleptic rating was recorded on the basis of scores obtained on shape, colour and shine (20 Marks), texture and firmness (20 marks), taste (20 marks) flavour (20 marks) and overall general appearance (20 marks). On the basis of organoleptic scores so obtained a rating was given as excellent for a score of 90-100, good for 80-89, fair for 70-79 and poor for a score of less than 70.

Results and Discussion

Titratable acidity (%): During entire period of trial it was observed that the titratable acidity content of fruits was gradually decline and this gradual decline was irrespective of treatment applied (Table-1, Fig.-1). However the rate of decline was different under the influence of different treatments. On last day of observation maximum acidity (0.156%) was with $Ca(NO_3)_2$ at 2 per cent which showed parity with GA_3 100 ppm whereas, the minimum acidity (0.085%) was recorded under control. This result is in consonance with the findings of Dhillon and Kaur (2013) [6] and Mounika *et al*. (2017) [12]. According to Echevema and Valich (1989) [7], depletion in acid content is due to the use of organic acids for energy production and partly alcoholic fermentation. Slow reduction in acidity with calcium nitrate can be attributed to the reduced rate of respiration and ripening of mango fruits.

Table 1: Titratable acidity (%) of mango fruits during storage under different post-harvest treatments.

Treatments	Days in Storage						Mean
	0	3	6	9	12	15	
T_1- $Ca(NO_3)_2$ at 1%	1.283	0.765	0.473	0.294	0.160	0.110	0.514
T_2- $Ca(NO_3)_2$ at 2%	1.283	0.947	0.595	0.394	0.229	0.156	0.601
T_3- $Ca(NO_3)_2$ at 3%	1.283	0.910	0.535	0.358	0.222	0.140	0.575
T_4- $CaCl_2$ at 1%	1.283	0.735	0.458	0.263	0.138	0.097	0.496
T_5- $CaCl_2$ at 2%	1.283	0.800	0.503	0.335	0.193	0.130	0.541
T_6- $CaCl_2$ at 3%	1.283	0.770	0.485	0.310	0.175	0.124	0.525
T_7- GA_3 at 50 ppm	1.283	0.741	0.463	0.281	0.149	0.103	0.503
T_8- GA_3 at 100 ppm	1.283	0.925	0.554	0.373	0.225	0.151	0.585
T_9- GA_3 at 150 ppm	1.283	0.817	0.519	0.349	0.208	0.133	0.552
T_{10}- Control (Water)	1.283	0.716	0.431	0.240	0.127	0.085	0.480
Mean	1.283	0.813	0.502	0.320	0.183	0.123	
SEm±	0.00	0.010	0.019	0.011	0.002	0.002	
CD at 5%	0.00	0.023	0.043	0.024	0.005	0.006	

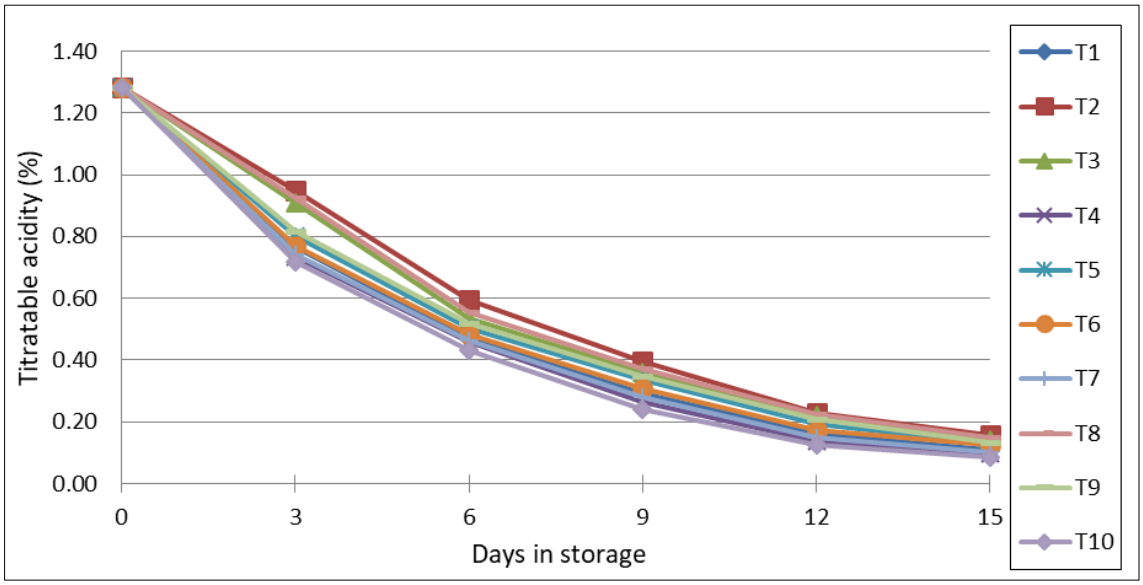

Fig 1: Titratable acidity (%) of mango fruits during storage

Ascorbic acid (mg/100 gram of pulp): The mean content of ascorbic acid reduced continuously from first day (120.90 mg/100 g pulp) to last day (18.27 mg/100 g pulp) of storage (Table-2, Fig.-2). At the end of storage the post-harvest application of $GA_3$100 ppm was the most prominent in retaining the ascorbic acid to maximum level (27.00 mg) which was closely followed by $Ca(NO_3)_2$ at 2 per cent with 25.56 mg of ascorbic acid content. Significantly minimum (14.32 mg) ascorbic acid content on the last day of storage was estimated under control. Higher retention of ascorbic acid following GA_3 and $Ca(NO_3)_2$ treatments has also been reported by Mahajan *et al.* (2011) [11] in guava and Jakhar and Pathak (2016) [8] in mango fruits. The higher level of ascorbic acid under the influence of these chemicals might be due to reduced rate of respiration leading to lower rate of oxidation of ascorbic acid.

Table 2: Ascorbic acid (mg/100 gram of pulp) of mango fruits during storage under different post-harvest treatments.

Treatments	Days in Storage						Mean
	0	3	6	9	12	15	
T_1- $Ca(NO_3)_2$ at 1%	120.90	109.00	74.23	41.33	28.49	14.94	64.82
T_2- $Ca(NO_3)_2$ at 2%	120.90	117.00	90.34	60.03	45.92	25.56	76.63
T_3- $Ca(NO_3)_2$ at 3%	120.90	113.39	84.88	52.23	39.04	19.13	71.60
T_4- $CaCl_2$ at 1%	120.90	107.35	72.21	39.43	35.37	14.61	64.98
T_5- $CaCl_2$ at 2%	120.90	111.85	78.42	47.87	33.91	17.03	68.33
T_6- $CaCl_2$ at 3%	120.90	109.99	75.52	43.89	30.71	16.10	66.19
T_7- GA_3 at 50 ppm	120.90	111.06	76.98	45.31	32.67	16.33	67.21
T_8- GA_3 at 100 ppm	120.90	117.65	91.77	62.21	46.07	27.00	77.60
T_9- GA_3 at 150 ppm	120.90	112.00	81.33	49.61	35.02	17.65	69.42
T_{10}- Control (Water)	120.90	105.00	71.45	37.25	22.89	14.32	61.97
Mean	120.90	111.43	79.71	47.92	35.01	18.27	
SEm±	0.00	0.33	0.41	0.91	0.06	0.78	
CD at 5%	0.00	0.68	1.49	2.50	0.17	1.61	

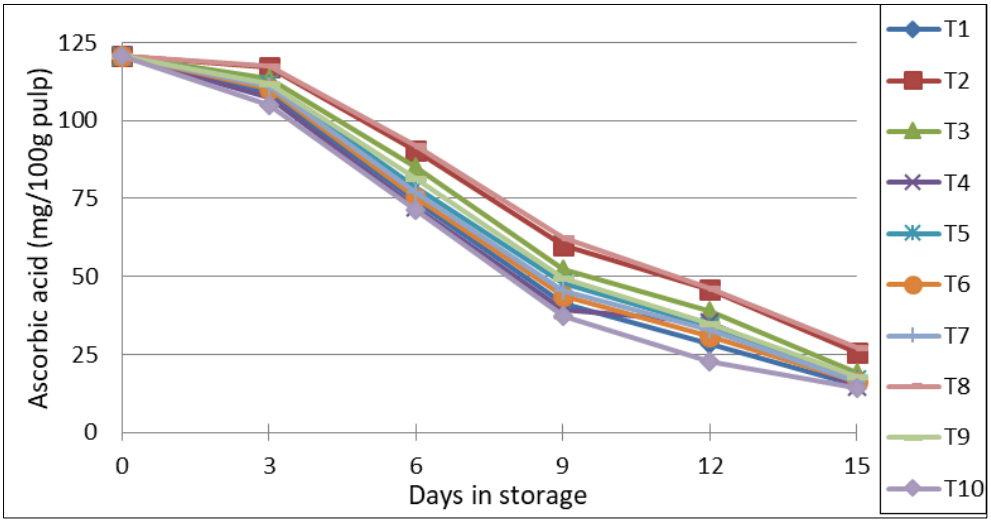

Fig 2: Ascorbic acid (mg/100g pulp) of mango fruits during storage

Sensory evaluation

All the treatments applied were potent in maintaining the organoleptic rating of fruits in comparison to control during the course of storage (Table-3, Fig.-3). The fruits were under excellent grade maximum up to 12 days and the treatments which were able to maintain this are GA_3 100 and 150 ppm and $Ca(NO_3)_2$ at 2 and 3 percent. At the end, the highest score of 83.00 was secured by GA_3 100 ppm followed by $Ca(NO_3)_2$ at 2 percent (T_2) with a score of 81.00 and had fruits of good grade. On the other hand, fruits under control scored poor grade and thus organoleptically non-acceptable.Observations on similar lines were noted by some earlier workers also (Brahmachari *et al.*, 1999; Kumar 2005) [5, 10].

Table 3: Sensory evaluation of mango fruits during storage under different post-harvest treatments

Treatments	Days in Storage						Mean
	0	3	6	9	12	15	
T_1- $Ca(NO_3)_2$ at 1%	36	55	82	95	84	67	69.83
T_2- $Ca(NO_3)_2$ at 2%	36	58	90	94	93	81	75.33
T_3- $Ca(NO_3)_2$ at 3%	36	56	86	92	91	76	72.83
T_4- $CaCl_2$ at 1%	36	54	81	94	81	65	68.50
T_5- $CaCl_2$ at 2%	36	56	86	96	89	71	72.33
T_6- $CaCl_2$ at 3%	36	56	82	95	86	68	70.50
T_7- GA_3 at 50 ppm	36	56	83	95	88	68	71.00
T_8- GA_3 at 100 ppm	36	57	91	95	94	83	76.00

T_9- GA_3 at 150 ppm	36	56	87	93	91	74	72.83
T_{10}- Control (Water)	36	60	82	93	76	58	67.50
Mean	36	56.40	85.00	94.20	87.30	71.10	
SEm±	00	0.71	0.40	0.39	0.24	0.70	
CD at 5%	00	1.40	1.23	1.19	1.12	2.25	
Grade			**Score**				
Excellent			90-100				
Good			80-89				
Fair			70-79				
Poor			Less than 70				

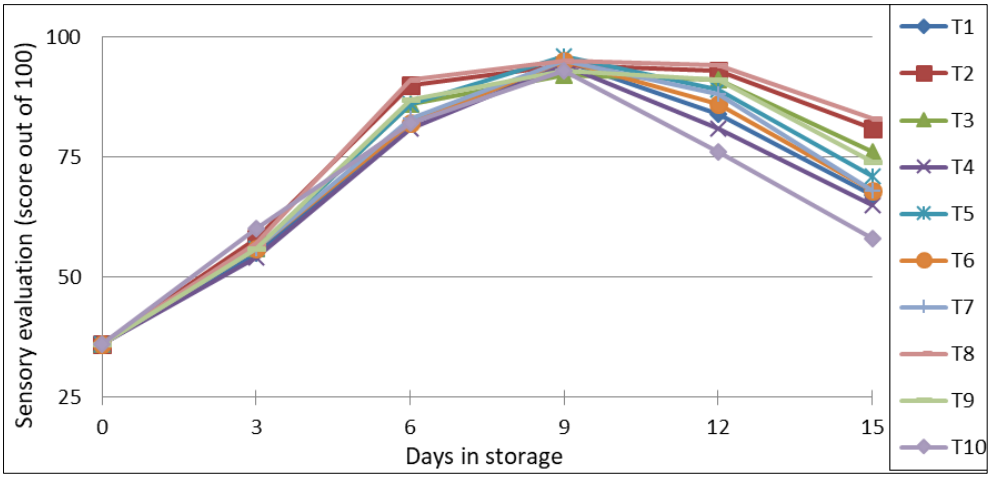

Fig 3: Sensory evaluation (score out of 100) of mango fruits during storage

Conclusion

All treatments were found effective in maintaining the higher level of the quality attributes as well as the consumer's acceptability of fruits during entire course of the experiment. At end of trial, $Ca(NO_3)_2$ at 2% was proved as the best treatment in respect of Titratable acidity, Ascorbic acid. In case of ascorbic acid content and organoleptic scoring GA_3 100 ppm was proved as the best. Hence it can safely be concluded that calcium nitrate at 2 per cent and GA_3 at 100 ppm as post-harvest application can be used during storage of mango fruits in order to improve the quality attributes and maintain the consumer acceptability.

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