The Pharma Innovation Journal 2022; 11(12): 5856-5859

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 5856-5859

www.thepharmajournal.com
Received: 15-11-2022
Accepted: 19-12-2022

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Effect of pre-harvest chemical treatment on post-harvest quality and shelf life in guava

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Abstract
The current study was carried out during the winter of 2021–2022, at the college of agriculture, Latur. The research was carried out at the Instructional-cum-Research Farm, P.G. Laboratory, Department of Horticulture, College of Agriculture, Latur, V.N.M.K.V., Parbhani (M.S). During the Kharif season of 2021, fruit crops were chosen, and study was conducted using a Randomized Block Design (RBD) with three replications and nine treatments. Study resulted that, treatment T_4- calcium nitrate @1.5% found significant for chemical parameters such as maximum TSS (9.53%), minimum acidity (0.41%) maximum reducing sugar (4.85%), maximum non-reducing sugar (3.73%), maximum total sugar (8.58%), maximum ascorbic acid (168.98mg/100gm), maximum TSS: Acid ratio (13.91), minimum PLW (13.30%) minimum Spoilage percentage (32.41%) and maximum Shelf life (8.33 days) at 9th day of storage, whereas, control treatment was inferior among all treatments at ambient storage condition.

Keywords: Guava, shelf life, $Ca(NO_3)_2$, pre-harvest, $CaCl_2$

Introduction
Guava leaves are born on petioles (5-10 mm) that are oppositely oriented along the stem. The leaf blades are oval in shape (9-15cm long and 4-8cm wide), ovate-elliptic to oblong-elliptic in shape, with pointy points. The leaves are hairy at underside, and the colour is a dark green. A large central vein (mid rib) runs through each leaf, with 10-25 pairs of lateral veins.
Over 12.18 thousand hectares of guava were planted in Maharashtra in 2020–2021, producing 129.75 thousand tonnes (https://www.indiastatagri.com) (Database of NHB, Ministry of Agriculture, Gov. of India, 2020-2021). With a productivity of 10.65 MT/ha, guava was grown on 12.92 thousand hectares in 2021–2022, producing 132.57 thousand tonnes with a productivity of 10.26 MT/ha. India had a total of 308.09 thousand hectares under cultivation in 2020–2021, producing 4582.30 thousand tonnes of guava with a yield of 14.87 MT/ha. Whereas India's total area under cultivation rose to 306.64 thousand hectares in 2021–2022, guava production fell to 4516.16 thousand tonnes, and overall productivity similarly fell to 14.73 MT/ha.
As a part of the cell wall, calcium, which comprises calcium chloride and calcium nitrate, plays a vital role in generating cross bridges, which impact cell wall strength and are considered as the final barrier before cell separation. Calcium also inhibits aberrant senescence and reduces respiration rate, ethylene generation, protein breakdown, weight loss, and rotting, which are all positive effects on the marketing and storage of fruits.

Material and Methods
The experimental farm orchard is situated in the Vasantrao Naik Marathwada Agriculture University, Parbhani's Department of Horticulture, College of Agriculture, Latur. Latur is 515 metres above mean sea level and is located between $18^0$25' North latitude and $76^0$37' East longitude. The region is classified as semi-arid tropical. With an average rainfall, the yearly precipitation is primarily concentrated during the monsoon months of June to October.

Result and Discussion
Data with respect to all parameters observed during research is presented in table no 1. Accordingly.

Total Soluble Solids (%)
TSS was found maximum in treatment T_4 (9.53%) at 9th day of storage respectively, followed by treatment T_2 (9.05%) at 9th day, however, minimum TSS was found in treatment T_9 i.e.

control (6.57%) at 9th day of storage. The higher starch to sugar conversion as a result due to hydrolytic enzymes being activated by calcium may be due to rise in sugar level. The possible cause is the hydrolytic enzymes' degradation of complex polymers into simple molecules and because sugars and other soluble substances are quickly mobilized by growing fruits. Hence, TSS was found higher in calcium treated fruits. Respectively similar report was also illustrated by, Gautam *et al.* (2010) [14] in guava fruit, Vani *et al*. (2020) [13] in guava, Rajput *et al*. (2008) [9] in guava cv. 'Gwalior' and Panwar *et al*. (2017) [7] in litchi, Dhakad *et al.* (2020) [5] in guava cv. 'Allahabad Safeda'.

Acidity (%)

Minimum acidity was found in treatment T_4 - $Ca(NO_3)_2$ @ 1.5% (0.41%) at 9th day of storage, followed by treatment T_6 - SA @ 750ppm (0.42%) at 9th day of storage, whereas, maximum acidity was found under treatment T_9 i.e. control (0.51%) at 9th day of storage. Acidity goes on decreasing day by day during storage of guava fruits. It might be caused by a chemical's inhibiting impact on an enzyme that breaks down and converts acids into sugars when the fruit ripens. Similar reports related to acidity found by, Vani *et al.* (2020) [13] in guava, Tripathia and Shukla (2011) [15] in Aonla and Panwar *et al*. (2017) [7] in litchi.

Table 1: Effect of pre-harvest chemical treatment on post-harvest quality of guava cv. 'Sardar'

Treatments	TSS (%)	Acidity (%)	RS (%)	Non-RS (%)	TS (%)	AA (mg/100g)	TSS: Acid	PLW (g)	Spo. Per. (%)	Shelf life (day)
T_1 - CaCl2 @ 1.0%	8.71	0.44	4.30	3.34	7.64	144.95	12.20	16.10	39.66	6.81
T_2 - $CaCl_2$ @ 1.5%	9.05	0.43	4.47	3.61	8.08	150.91	13.18	15.67	33.33	8.10
T_3 - $Ca(NO_3)_2$ @ 1.0%	7.43	0.45	4.24	3.43	7.68	165.61	10.85	14.63	35.98	7.50
T_4 - $Ca(NO_3)_2$ @ 1.5%	9.53	0.41	4.85	3.73	8.58	168.98	13.91	13.30	32.41	8.33
T_5 - SA @ 500 ppm	7.53	0.48	4.19	3.26	7.45	155.31	10.74	18.38	48.21	5.60
T_6 - SA @ 750 ppm	8.20	0.42	4.27	3.40	7.67	163.59	12.25	17.02	46.43	5.81
T_7 - Chel. Zn @ 0.5%	8.43	0.44	3.97	3.03	7.00	142.46	11.61	19.45	50.00	5.40
T_8 - Chel. Zn @ 1%	8.62	0.48	4.03	3.10	7.10	141.64	11.81	18.52	45.83	5.89
T_9 – Control	6.57	0.51	3.83	1.57	5.40	129.22	10.05	25.94	55.71	4.84
SE (m)	0.10	0.01	0.16	0.13	0.03	1.17	0.20	0.19	1.66	0.05
C.D. @ 5%	0.30	0.02	0.48	0.38	0.09	3.54	0.60	0.58	5.02	0.17

Where, TSS- total soluble solids, RS- reducing sugar, TS- total sugar, AA-ascorbic acid, PLW- physiological loss in weight.

Reducing Sugar (%)

Reducing sugar with maximum level was found in treatment T_4 - $Ca(NO_3)_2$ @ 1.5% with (4.85%) at 9th day of storage which was at par with T_2 - $CaCl_2$ @ 1.5% with (4.47%) at 9th day, Whereas, minimum reducing sugar was found under treatment T_9 i.e. control (3.83%) at 9th day of storage. The higher sugar level due to enhanced conversion of starch to sugars brought on by hydrolytic enzymes activation due to calcium. Similar findings were also reported by, Vani *et al.* (2020) [13] in guava, Tripathia and Shukla (2011) [15] in Aonla.

Non-reducing sugar (%)

Treatment T_4 i.e. $Ca(NO_3)_2$ @ 1.5% showed maximum non-reducing sugar at 9th day of storage with (3.73%) which was at par with T_2- $CaCl_2$ @ 1.5% at 9th day with (3.61%). However, minimum non-reducing sugar was found under treatment T_9 i.e. control at 9th day with (1.57%) of storage. Increased in non-reducing sugar was might be due to calcium's activation of hydrolytic enzymes, which increases the conversion of starch into sugars, may be to blame for the rise in sugar concentration. Findings related to similar report were also illustrated by, Vani *et al.* (2020) [13] in guava, Tripathia and Shukla (2011) [15] in Aonla.

Total sugar (%)

Treatment T_4 - $Ca(NO_3)_2$ @ 1.5% was found with maximum total sugar i.e. (8.58%) at 9th day of storage which was at par with T_2 - $CaCl_2$ @ 1.5% with (8.08%) at 9th day. whereas, minimum total sugar was found under treatment T_9 i.e. control (5.40%) at 9th day of storage observations. Guava fruits with calcium treatments kept their level of total sugars substantially higher. The higher sugar level might be due to enhanced conversion of starch to sugars due to calcium's activation of hydrolytic enzymes. Similar findings regarded with total sugar also reported by, Vani *et al.* (2020) [13] in guava, Tripathia and Shukla (2011) [15] in Aonla.

Ascorbic acid (mg/100g)

Treatment T_4 - $Ca(NO_3)_2$ @ 1.5% (168.98 mg/100gm), at 9th day of storage with maximum ascorbic acid content which was significantly at par with T_3 - $Ca(NO_3)_2$ @ 1.0% with (165.61 mg/100g) at 9th day. However, minimum total sugar was found under treatment T_9 i.e. control (129.22mg/100gm) at 9th day of storage observations. Increased in ascorbic acid might be due to increased retention of ascorbic acid during storage by calcium application may be attributed to the slow rate of oxidation and ongoing production of its precursor, glucose-6-phosphate, during the conversion of starch into other sugars. Glucose-6-phosphate is important for production of L-ascorbic acid and also consistent with findings by Vani *et al.* (2020) [13] in guava, Dhakad *et al*. (2020) [5] in acid lime, and Tripathia and Shukla (2011) [15] in Aonla.

TSS: Acid ratio

TSS: acid ratio was found maximum in treatment T_4 - $Ca(NO_3)_2$ @ 1.5% with (13.91), at 9th day of storage respectively which was significantly followed by T_2 - $CaCl_2$ @ 1.5% (13.18) at 9th day. However, minimum TSS acid was found under treatment T_9 i.e. control (10.05) at 9th day of storage observations. Results regarding TSS: acid ratio of fruit crops were in line with, and illustrated by, Vani *et al.* (2020) [13] in guava cv. 'Allahabad Safeda', Tripathia and Shukla (2011) [15] in aonla and Dhakad *et al.* (2020) [5] in acid lime.

PLW (Physiological Loss in Weight) (%)

PLW was found minimum in treatment T_4 with (13.30%), at 9th day of storage which was significantly at par with T_3 (14.63%) at 9th day. However, maximum PLW was found under treatment T_9 i.e. control (25.94%) at 9th day of storage observations. Fruits treated with chemical significantly reduce respiration of fruits due to binding of calcium compound with pectin compound and formation of calcium pectate-bridge. The application of calcium typically results in a rise in calcium concentration, which may impact cell metabolism processes as well as the structure and operation of cell walls and membranes. Chemical changes inside the fruits that cause more water to be retained despite the rate of evaporation may be the cause of the slower weight loss caused by chemicals. This might be because calcium has a role in restricting respiration, which was linked to altered membrane permeability. The result obtained in the present study are in agreement with report illustrated by Vani *et al.* (2020) [13] in guava cv. 'Allahabad Safeda', Dhakad *et al.* (2020) [5] in acid lime, and Singh *et al.* (2015) in Aonla.

Spoilage percentage at an interval of 3rd, 6th and 9th day

Treatment T_4 - $Ca(NO_3)_2$ @ 1.5% found with minimum spoilage percentage (32.41%), at 9th day of storage which was significantly at par with T_2 - $CaCl_2$ @ 1.5% - (33.33%) at 3rd and 6th and 9th day. However, maximum spoilage percentage was found under treatment T_9- control (55.71%) at 9th day of storage observations. The results may due to cell walls' pectins are strongly bound by calcium ions, which also create cationic bridges between pectic acids and other acidic polysaccharides. Pectolytic enzymes have a harder time accessing the cell walls when these bridges are present. Findings related to similar results regarding spoilage percentage were illustrated by Vani *et al.* (2020) [13] in guava cv. 'Allahabad Safeda', Singh *et al*. (2015) worked in aonla fruit crop and Sinha *et al.* (2019) in plum fruit.

Shelf life

Maximum retained shelf life was found in T_4 - $Ca(NO_3)_2$ @ 1.5% (8.33 days) which was significantly at par with T_2 - $CaCl_2$ @ 1.5% (8.10 days). However, minimum shelf life was found in T_9 – Control (4.84 days) respectively. Increase in shelf life was might be due to calcium component of the cell wall which plays a significant part in the formation of cross-bridges, influence cell wall strength and are thought to be the final barrier before cell separation, it is possible that calcium sprays have improved shelf life. Similar relevant positive findings for shelf life were reported by Vani *et al*. (2020) [13] in guava cv. 'Allahabad Safeda' and Dhakad *et al*. (2020) [5] in acid lime (*Citrus aurentifolia*).

Conclusion

Foliar application of $Ca(NO_3)_2$ @ 1.5% one month before harvesting was found superior in chemical parameters like total soluble solids, acidity, reducing sugar, non-reducing sugar, total sugar, ascorbic acid, tss: acid ratio and shelf life like PLW, spoilage percentage of guava fruits which was closely at par with $CaCl_2$ @ 1.5% application.

Acknowledgement

This study was made possible with the help of Department of Horticulture, College of Agriculture, Latur, VNMKV, Parbhani for providing necessary facilities for the experiment and my research guide for their entire support and guidelines during conducting the experiment.

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