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Pre-harvest chemical sprays for enhancing shelf life and fruit quality of jamun

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Abstract

An experiment was conducted to study the effect of different pre-harvest sprayed chemicals *i.e.* calcium chloride (1.0, 1.50, 2.0%), GA_3 (50, 100 ppm), potassium sulphate (1.0, 2.0%) and control (water spray) on shelf life and post harvest quality of jamun cv. Goma Priyanka at ambient temperature under semi-arid conditions of western India. Increase in physiological loss in weight (PLW), spoilage percentage and decrease in titratable acidity, ascorbic acid, total sugar and anthocyanin content with advancement of storage period were general phenomena in all the treatments. However, TSS, and TSS: acidity ratio initially increased and thereafter decreased, respectively irrespective of treatments. Minimum spoilage loss was recorded in the fruits treated with $CaCl_2$ 2.0% (13.33%) closely followed by $CaCl_2$ 1.50% (17.28%). Same treatment also showed lowest PLW (13.65%) on the last day of storage and exhibited 3.03 days of economic shelf life, while control had 1.68 days of economic shelf life under ambient conditions. Highest PLW (18.17%) and spoilage (25.34%) were recorded in the control on the last day of storage (4^{th} day). In general, shelf life of jamun fruits increased with the increase in concentration of calcium chloride. It may be concluded that $CaCl_2$ 1.50 to 2.0% can be sprayed before harvest of fruits for enhancing the shelf life and maintaining fruit quality of jamun under ambient conditions.

Key words: Pre-harvest spray, jamun, PLW, spoilage, economic shelf life

Introduction

Jamun (*Syzygium cumini* Skeels) belongs to the family Myrtaceae, highly adapted to diverse environmental conditions, is widely distributed in India up to an altitude of 1600 m. The anthocyanins, fibers and ellagitannins which are present in the pulp are important in reducing the oxidative stress-induced diseases. Jamun berries contain carbohydrates, iron, sugars, minerals, protein and the pharmacologically active phytochemicals like flavonoids, terpenes, and anthocyanins (Singh *et al.*, 2019). The powdered seeds have also reputation of being useful in the treatment of diabetes. These seeds are claimed to contain alkaloid, jambosine, and glycoside jambolin or antimellin, which halts the diastatic conversion of starch into sugar and seed extract has lowered blood pressure. The ripe jamun fruits are consumed fresh and can also be processed into many value added products like jam, jellies, squash, cider, nectar, wine, vinegar, RTS *etc.* Because of its hardy nature and various uses, it has great potential for commercial exploitation in wastelands and dry-land horticulture. Jamun fruits are very perishable in nature, which is a major problem in its marketing (Singh *et al.*, 2019a). Due to increased awareness among masses regarding its nutraceutical value and health benefits resulting in increased demand of jamun fruits day by day. However, due to its perishable nature, the fruit quality deteriorates the very next day of harvesting (Nayak and Panda, 2020). Therefore, there is a need to extend the shelf life of jamun fruits with desirable marketable quality. So this experiment was conducted to study the effect of pre-harvest chemical sprays on shelf life and fruit quality of jamun fruits.

Materials and Methods

The present investigation was conducted during the year 2016 at experimental farm of CHES, Vejalpur, Godhra. The fruiting trees were sprayed with different concentration of $CaCl_2$ (T_1-1.0%, T_2-1.50%, T_3-2.0%), GA_3 (T_4-50 ppm, T_5-100 ppm), K_2SO_4 (T_6-1.0%, T_7-2.0 %) and water (T_8 control) twice with the help of foot sprayer. First pre-harvest spray of different chemicals was done on April 05 and second spray was applied after 20 days of first spray. The experiment was conducted under Randomized Block Design which was replicated thrice. The handpicked mature fruits of jamun cv. Goma Priyanka from different treatments having uniform size, undamaged and free from blemishes were collected for the study on post-harvest shelf life and fruit quality. The collected fruits were stored at ambient temperature ranging between 25$\pm$2°C. The physiological loss in weight, spoilage loss, total soluble solids and titratable acidity were determined by standard methods. Economic shelf life (in days) of fruits was determined by counting the number of days, on the date after which cumulative spoilage percentage of fruits in particular treatment exceeded 12%, from the date of harvest of the fruits (Singh *et al.*, 2005). Ascorbic acid, total sugar anthocyanin contents were determined by the methods advocated by A.O.A.C. (1990). The collected data were analyzed statistically and per cent data were angularly transformed and the critical differences (CD) at 0.05 level of probability were worked out for comparing the means.

Results and Discussion

The physiological loss in weight (PLW) gradually increased in all the treatments with the advancement of storage period (Table 1). $CaCl_2$ 2.0% was the most effective treatment in retaining the PLW during all the days of observations and showed only 13.65% PLW on 4th day of storage followed by $CaCl_2$ 1.50% (17.38%). The highest PLW (26.47%) was recorded in the control on 4th day of storage. The increased weight loss in untreated jamun fruits might be due to increased storage breakdown associated with higher transpiration and respiration rate compared to treated fruits. The lower weight loss in calcium treated jamun fruits is attributed to membrane functionality and integrity maintenance with lower losses of phospholipids and proteins and reduced ion leakage which could be responsible for lower weight loss (Vandana *et al*., 2015). Similar results were observed in jamun (Dalvadi *et al*., 2018, Mishra *et al*., 2018, Vandana *et al*., 2015) and guava (Mishra *et al*., 2003).

Spoilage of jamun fruits started on 3rd day of storage in all the treatments except calcium treated fruits where it started on 4th day of storage (Table 1). The minimum spoilage loss was recorded in $CaCl_2$ 2.0% (15.08%), which was closely followed by $CaCl_2$ 1.50% (17.28 %) while the maximum spoilage loss was in the control (31.27 %) on 4th day of storage. The reduction in fruit spoilage calcium treated fruits might be due to its effect on firmness of fruit tissue by retarding rate of respiration and preventing cellular disintegration which leads to delayed senescence (Singh *et al*., 1993). This is in complete agreement with findings of Dalvadi *et al*., 2018, Mishra *et al*., 2018, Vandana *et al*., 2015 in jamun. On the basis of spoilage within 12%, the maximum economic shelf life (3.03 days) was recorded by $CaCl_2$ 2.0%, however the control recorded 1.68 days only. Total soluble solids (TSS) increased in all the treatments during 3rd day storage and then decreased (Table 2). It was found to be maximum (20.57°B) in the control and minimum (16.33°B) in the fruits treated with $CaCl_2$ 2.0% followed by $CaCl_2$ 1.50% on the 3rd day of storage. Increase in TSS during storage might be associated with the transformation of pectic substances, starch, hemi-cellulose or other polysaccharides in soluble sugar and also with the dehydration of fruits (Nayak and Panda *et al*., 2020). Similar results were obtained by Vandana *et al*. (2015) during storage of jamun fruits. During storage, the titratable acidity gradually decreased in all the treatments (Table 3). The minimum acidity (0.31%) was recorded in the control on the last day of storage, while the maximum was observed in $CaCl_2$ 2.0% (0.45%) closely followed by $CaCl_2$ 1.50 %. Fruits treated with GA_3 also retained more acidity on the last day of storage in comparison to control. This could be due to retarding of ripening by calcium treated fruits as a result of reduced ethylene activity that could delay in the utilization of organic acids in the enzymatic reactions of respiration. The maintenance of higher level of titratable acidity by calcium treated fruits is in conformity with the findings of Vandana *et al*. (2015) in jamun and Mishra *et al*. (2003) in guava. The balance ratio between TSS and acidity is a basic to the judgment of the quality of fruits (Table 3). The TSS (°Brix) and acidity are usually satisfactory indices in many fruits, wherein increasing sugar concentration and decreasing titratable acidity occurs in the ripening processes. The results of this experiment also followed the same pattern of change in TSS: acidity ratio *i.e.* the TSS: acid increased with advancement of storage up to 3rd day and the next day all fruits were spoiled (Table 3). The maximum TSS: acid ratio found in K_2SO_4 2.0% (49.12) on 3rd while the minimum TSS: acid ratio on 3rd day was observed in $CaCl_2$ 2.0% (32.73). This could be due to retarding of ripening by calcium treated fruits as a result of reduced ethylene activity resulting in slow rate of degradation while higher increase in sugar concentration and decrease in acid content of fruits day by day in other treatments may be due higher rate of degradation. This type of result was also found by Nayak and Panda (2020).

Total sugar gradually decreased in all the treatments which continued until the end of the storage period (Table 3). It was found to be maximum (3.17%) in the $CaCl_2$ (2.0%) and minimum in control fruits (2.29%) on the last day of storage (4th day). Reduced increment in sugars during storage in the treated fruits was due to less weight loss that caused less dehydration of the fruits. These findings are in agreement with the findings of Nayak and Panda (2020) in jamun.

Table 1. Effect of treatments on PLW and spoilage of jamun during ambient storage

Treatment	PLW (%)			Economic shelf-life (days)	Spoilage (%)		
	Days after harvest				Days after harvest		
	2	3	4		2	3	4
T_1	6.74	11.63	17.94	2.57	5.08	11.58	19.21
T_2	6.20	11.38	17.38	2.63	4.92	10.69	18.87
T_3	6.09	9.89	13.65	3.03	3.88	9.19	15.08
T_4	8.43	14.45	19.20	2.08	7.05	12.15	26.85
T_5	7.71	14.05	18.69	2.13	6.84	12.30	23.92
T_6	6.82	14.94	21.59	2.00	6.91	12.05	26.10
T_7	6.36	14.58	22.14	2.06	7.17	12.09	25.41
T_8	10.22	17.82	26.47	1.68	9.83	14.20	31.27
Mean	7.32	13.59	19.63	-	6.46	10.41	23.34
CD (p= 0.05)	T= 0.26, D= 0.18, D x T= 0.52			0.10	T= 0.34, D= 0.24, D x T= 0.68		

Table 2. Effect of treatments on TSS and acidity of jamun during ambient storage

Treatment	TSS (°B)				Acidity (%)			
	Days after harvest				Days after harvest			
	1	2	3	4	1	2	3	4
T_1	13.20	14.67	17.44	12.14	0.67	0.57	0.45	0.36
T_2	13.05	14.13	17.18	12.33	0.65	0.59	0.45	0.41
T_3	13.23	13.88	16.33	14.73	0.66	0.63	0.50	0.45
T_4	13.35	14.85	19.24	13.44	0.74	0.61	0.48	0.36
T_5	13.29	14.44	18.76	13.36	0.74	0.62	0.50	0.38
T_6	13.59	14.79	20.37	11.80	0.70	0.56	0.43	0.29
T_7	13.34	14.95	20.14	11.34	0.72	0.54	0.41	0.31
T_8	13.45	15.15	20.57	11.32	0.75	0.60	0.46	0.27
Mean	13.31	14.61	18.75	12.56	0.704	0.590	0.46	0.35
CD (p= 0.05)	T= 0.19, D= 0.14, D x T= 0.39				T= 0.007, D= 0.005, D x T= 0.015			

Table 3. Effect of treatments on TSS: acidity and total sugar of jamun during ambient storage

Treatment	TSS: acidity				Total sugar (%)			
	Days after harvest				Days after harvest			
	1	2	3	4	1	2	3	4
T_1	19.70	25.73	38.75	33.72	10.26	8.11	5.73	2.48
T_2	20.07	23.94	38.17	30.12	10.29	8.15	5.77	2.49
T_3	20.04	22.03	32.66	32.73	10.30	8.25	6.05	3.17
T_4	18.04	24.34	40.08	37.33	10.25	8.05	5.15	2.35
T_5	17.95	23.29	37.52	35.15	9.87	8.13	5.23	2.42
T_6	19.41	26.41	47.37	40.68	10.16	8.06	5.20	2.40
T_7	18.52	27.68	49.12	36.58	10.20	8.09	5.18	2.40
T_8	17.93	25.25	44.71	41.92	10.25	7.80	5.19	2.29
Mean	18.96	24.83	41.05	36.03	10.19	8.08	5.438	2.50
CD(p= 0.05)	T= 0.37, D= 0.26, D x T= 0.74				T= 0.13, D= 0.09, D x T= 0.26			

The ascorbic acid content of fruits decreased progressively during storage in all the treatments (Table 4). The maximum ascorbic acid content (19.42 mg/100 g) was retained by $CaCl_2$ (2.0%) closely followed by GA_3 (100 ppm) on last day of storage (16.28 mg/100 g), while it was least in the control (12.35 mg/100g). Activities of oxidizing enzymes might be reduced due to binding activity of calcium treated fruits that might have been resulted the higher level of ascorbic acid content up to last day of storage. This finding is in agreement with those of Gol *et al*. (2015) in jamun and Mishra *et al*. (2003) in guava. Data presented in Table 4 revealed a significant reduction in the anthocyanin content at all the storage intervals in all the treatments. The maximum anthocyanin content (4.36 mg/100 g) was retained by $CaCl_2$ (2.0%) closely followed by $CaCl_2$ (1.50 %) on last day of storage (4.33 mg/100 g), while it was recorded the least in the control (3.47 mg/100g) on 4th day of storage. In comparison to the control fruits, all of the treated fruits maintained their anthocyanin concentration at a higher level which might be due to the inhibition of the polyphenol oxidase enzyme activity in treated fruits (Gol *et al*., 2015).

On the basis of spoilage loss and fruit quality attributes of treated fruits, it may be concluded that fruits treated with $CaCl_2$ 2.0% could be stored up to day 3 during storage at ambient temperature under semi arid ecosystem of Gujarat.

Table 4. Effect of treatments on ascorbic acid and anthocyanin content during ambient storage

Treatment	Ascorbic acid (mg/100 g)				Anthocyanin (mg/100g)			
	Days after harvest				Days after harvest			
	1	2	3	4	1	2	3	4
T_1	41.72	32.71	26.66	14.63	7.02	6.45	4.78	4.31
T_2	43.81	34.57	28.24	15.25	7.11	6.58	4.89	4.33
T_3	45.53	38.03	31.36	19.42	7.16	6.76	5.37	4.36
T_4	43.35	34.02	27.44	15.36	7.05	6.33	4.58	4.29
T_5	44.23	35.20	27.58	16.28	7.08	6.61	4.62	4.33
T_6	43.55	34.44	26.63	14.30	7.01	6.28	4.42	4.27
T_7	43.40	34.33	27.05	14.83	7.04	6.30	4.45	4.30
T_8	41.50	31.60	25.89	12.35	7.02	6.39	4.64	3.47
CD (p= 0.05)	T= 0.31, D= 0.22, D x T= 0.62				T= 0.09, D= 0.07, D x T= 0.19			

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