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PRE-HARVEST FOLIAR APPLICATION OF CALCIUM CHLORIDE, BAVISTIN AND BAYLETON ON POST-HARVEST LIFE OF *EMBLICA OFFICINALIS* GAERTN. FRUITS

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Abstract

One per cent calcium chloride + 0.1% bavistin was found to be the most effective pre-harvest treatment to enhance the post-harvest shelf-life of aonla (*Emblica officinalis* Gaertn.) fruits up to 20 days. This treatment had maximum effect on all the attributes of fruit quality like increased levels of TSS, total sugar and non-reducing sugar *vis a vis* low levels of acidity, ascorbic acid and reducing sugar. Minimum weight loss of 4.78 and 4.84% and decay loss 5.95 and 5.82% was also recorded with this treatment. Thus, this treatment doubled the shelf life of aonla fruits during storage at room temperature.

Introduction

Aonla (*Emblica officinalis* Gaertn.) is one of the oldest minor fruit of India and considered to be 'wonder fruit for health' because of its unique properties. It belongs to the family Euphorbiaceae and is native to India, Srilanka, Malaysia and China. Aonla fruit is known by different names such as, 'Amla', 'Amalakki', 'Nelli', 'Indian gooseberry', etc. (Kore *et al.* 2013). Aonla fruit is highly valued among Ayurvedic and other medicines as Trifla and Chyavanprash are well known indigenous medicines in ayurvedic system using aonla. It is acrid, cooling, refrigent, diuretic and laxative. Dried fruits have been reported to be useful in haemorrhages, diarrhoea, dysentery, anaemia, jaundice, dyspepsia and cough.

The fruits are rich source of vitamin C. Being a fruit of highly perishable nature; it is the most difficult to store or transport aonla fruits over long distances. In order to have good returns from this fruit and to avoid market glut it becomes essential to store the fruits for a considerable period during winter season so as to escape immediate marketing and utilization. Extension of storage life may be possible by checking the rate of transpiration, respiration and microbial infection (Dhumel *et al.* 2008). Calcium is known to be an essential plant nutrient involved in a number of physiological processes concerning membrane structure and function and enzyme activity (Jones and Lunt 1967). Calcium has shown promise in quality retention of fruits and vegetables through maintaining firmness, reducing respiratory rates and ethylene evolution (Poovaiah *et al.* 1988) and decreasing storage rots (Conway and Sams 1984). Pre-harvest calcium spray is one of the most important practices of new strategies applied in the integrated production systems, improving fruit characteristics and minimizing fungicides sprays towards the end of the harvest period, since they improve fruit resistance to brown rot (Conway *et al.* 1994). Calcium spray during fruit development provides a safe mode of supplementing endogenous calcium to fresh fruits (Raese and Drake 2000, Singh *et al.* 1993). A number of pathogens attack aonla fruit during the later stages of its growth and development and many of the pathogens continue to proliferate and damage the fruit after harvest rendering large portion of the fruit unfit for consumption. Yadav and

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Singh (2002) reported reduced decay and physiological loss along with enhanced shelf life of aonla fruit by spraying of chemicals and fungicides. Thus to overcome the post-harvest losses in the perishable commodities like aonla, the present investigation was undertaken to study the effect of pre-harvest foliar application of calcium chloride and fungicides on post-harvest life of aonla fruit.

Materials and Methods

Experiments were performed at Research farm, RRSS, Raya, SKUAST-J, Jammu and Kashmir state (32° 39" N 74° 53" E 332 m amsl), India during 2011 - 2012 under rainfed conditions. The aonla fruits cv. *Narendra Aonla-7* (*NA-7*) from ten years old uniform and healthy trees were obtained for experimentation. The treatments comprised of T_1: 1% calcium chloride; T_2: 0.1% bavistin, T_3: 0.1% bayleton, T_4: 1% calcium chloride + 0.1% bavistin, T_5: 1% calcium chloride + 0.1% bayleton, T_6: 0.1% bavistin + 0.1% bayleton; T_7: 1% calcium chloride + 0.1% bavistin + 0.1% bayleton and T_8: control. The pre-harvest sprays were given to fruited trees at 20 and 10 days before harvest. The fruits of uniform size, shape and colour were harvested at proper stage of maturity. The experiment was conducted in randomized block design with four replications. The treated aonla fruits were stored at room temperature and under each treatment two sets of one kg fruits were maintained. One set was used for physiological weight and decay loss and other set of fruits was used for recording physical parameters like fruit-length and width and chemical parameters like TSS, acidity, sugars (reducing, total and non-reducing) and ascorbic acid content. The observations were recorded at 10 days interval during storage at room temperature. The chemical parameters were determined by the method given by Ranganna 1986. The statistical analysis was done by the method of analysis of variance followed by Gomez and Gomez 1984.

Results and Discussion

Pre-harvest foliar application of calcium chloride, bavistin and bayleton statistically influenced the physical and chemical characteristics of aonla fruit during storage at room temperature. The size (length and width) of fruits decreased with the increase in storage period. However, the treated fruits maintained higher values of fruit size as compared to the control. During the various storage periods maximum length and breadth of aonla fruit was observed in the treatment (T_4) 1% calcium chloride + 0.1% bavistin (Table 1).

Physiological loss in weight increased with the advancement of storage period. Minimum physiological weight loss was recorded in T_4 treatment (1% Calcium chloride + 0.1% bavistin) followed by treatment T_5 (1% calcium chloride + 0.1% bayleton) as compared to the control where maximum physiological weight loss was recorded during the study period. Increase in physiological loss in weight with increase in storage period in the present investigation is in conformity with the findings of Singh *et al.* 1981 who reported gradual increase in weight loss with the increase in storage period of guava. The losses due to decay were observed from 20 days of storage and onwards; however, from 20 days of storage the decay losses increased significantly up to 30 days of storage. However the losses were less in treated fruits as compared to the control during the study period. This might be due to higher firmness of fruits which might have delayed the pathogen and other micro-organisms' infection for longer period. Among various treatments, the lowest percentage of decay loss was recorded with the treatment (T_4) 1% calcium chloride + 0.1% bavistin (Table 2).

Table 1. Effects of pre-harvest sprays on length and breadth of aonla (cv. *NA-7*) during different storage periods.

Treatments	Length (cm)				Breadth (cm)			
	Days of storage				Days of storage			
	0	10	20	30	0	10	20	30
1% calcium chloride	3.24	3.02	2.82	2.70	3.98	3.60	3.22	2.50
0.1 % bavistin	2.99	2.81	2.73	2.50	3.62	3.42	3.30	2.24
0.1% bayleton	2.84	2.72	2.54	2.42	3.46	3.06	2.94	2.10
1% calcium chloride + 0.1% bavistin	3.99	3.62	3.38	3.12	4.26	4.12	4.05	3.80
1% calcium chloride + 0.1% bayleton	3.88	3.53	3.39	3.10	4.10	3.86	3.58	3.42
0.1% bavistin + 0.1% bayleton	2.72	2.47	2.28	2.09	3.14	2.97	2.68	2.02
1% calcium chloride + 0.1% bavistin + 0.1% bayleton	3.41	3.17	3.02	2.80	4.00	3.75	3.40	3.24
Control	2.54	2.34	2.16	2.12	2.95	2.54	2.26	2.08
Mean	3.20	2.98	2.79	2.61	3.69	3.41	3.18	2.70
CD (p = 0.05)								
Treatments			0.41				0.52	
Storage			0.29				0.37	
Treatment × storage			NS				NS	

Table 2. Effect of pre-harvest spray on physiological weight loss and decay loss of aonla (*cv. NA-7*) during different storage period.

Treatments	Physiological weight loss (%)				Decay loss (%)			
	Days of storage				Days of storage			
	0	10	20	30	0	10	20	30
1% calcium chloride	--	2.85	5.82	7.89	--	--	12.05	19.6
0.1 % bavistin	--	3.70	7.04	4.73	--	--	10.58	14.82
0.1% bayleton	--	3.29	6.54	8.56	--	--	11.59	16.58
1% calcium chloride + 0.1% bavistin	--	2.26	5.18	7.08	--	--	--	5.82
1% calcium chloride + 0.1% bayleton	--	2.68	5.56	7.84	--	--	--	8.06
0.1% bavistin + 0.1% bayleton	--	3.52	7.19	10.26	--	--	4.3	10.12
1% calcium chloride + 0.1% bavistin + 0.1% bayleton	--	3.10	6.98	7.98	--	--	6.9	9.38
Control	--	3.94	7.42	14.06	--	--	19.2	27.94
Mean	--	3.17	6.46	5.52	--	--		
CD (p = 0.05)								
Treatments			1.43					
Storage			0.88					
Treatment × storage			2.48					

Table 3. Effect of pre-harvest spray on total soluble solids and acidity of aonla (*cv. NA-7*) during different storage period.

Treatments	Total soluble solids (°Brix)				Acidity (%)			
	Days of storage				Days of storage			
	0	10	20	30	0	10	20	30
1% calcium chloride	9.18	10.22	10.67	11.14	1.70	1.80	1.56	1.56
0.1 % bavistin	8.92	9.74	9.96	10.75	1.69	1.67	1.57	1.48
0.1% bayleton	8.60	9.36	9.80	10.12	1.63	1.59	1.53	1.44
1% calcium chloride + 0.1% bavistin	10.86	11.18	11.94	12.24	1.85	1.96	1.78	1.60
1% calcium chloride + 0.1% bayleton	10.62	11.06	11.82	12.15	1.80	1.84	1.72	1.66
0.1% bavistin + 0.1% bayleton	8.50	8.67	8.92	9.52	1.55	1.50	1.48	1.42
1% calcium chloride + 0.1% bavistin + 0.1% bayleton	9.88	10.42	10.80	11.32	1.84	1.80	1.76	1.64
Control	7.90	7.96	8.10	8.34	1.60	1.64	1.46	1.38
Mean	9.35	9.83	10.25	10.74	1.71	1.73	1.61	1.52
CD (p = 0.05)								
Treatments			1.39				0.06	
Storage			0.98				0.08	
Treatment × storage			3.44				0.12	

Table 4. Effect of pre-harvest spray on reducing and total sugars of aonla (cv. *NA-7*) during different storage periods.

Treatments	Reducing sugars (%)				Total sugars (%)			
	Days of storage				Days of storage			
	0	10	20	30	0	10	20	30
1% calcium chloride	2.84	2.89	2.54	2.32	4.72	5.00	4.96	4.79
0.1 % bavistin	2.80	2.85	2.50	2.26	4.60	4.96	4.87	4.72
0.1% bayleton	2.75	2.78	2.40	2.21	4.54	4.92	4.68	4.60
1% calcium chloride + 0.1% bavistin	3.22	3.36	3.06	2.92	5.98	5.54	5.42	5.18
1% calcium chloride + 0.1% bayleton	3.07	3.20	3.04	2.64	5.26	5.45	5.39	5.12
0.1% bavistin + 0.1% bayleton	2.73	2.74	2.32	2.20	4.50	4.78	4.66	4.55
1% calcium chloride + 0.1% bavistin + 0.1% bayleton	2.90	2.84	2.74	2.60	4.90	5.42	5.34	5.10
Control	1.98	2.16	2.10	1.89	3.87	3.58	3.16	2.94
Mean	2.86	2.55	2.65	2.59	4.80	4.96	4.81	4.63
CD (p = 0.05)								
Treatments			0.36				1.04	
Storage			0.27				0.68	
Treatment × storage			0.73				1.87	

Table 5. Effect of pre-harvest spray on non-reducing sugars and ascorbic acid of aonla (*cv. NA-7*) during different storage periods

Treatments	Non-reducing sugars (%)				Ascorbic acid (mg/100 g)			
	Days of storage				Days of storage			
	0	10	20	30	0	10	20	30
1% calcium chloride	1.88	2.20	2.48	2.47	718.2	660.5	523.2	468.6
0.1 % bavistin	1.86	2.22	2.47	2.45	712.0	642.5	516.1	472.6
0.1% bayleton	1.82	2.19	2.38	2.40	706.5	636.7	508.5	462.5
1% calcium chloride + 0.1% bavistin	2.76	2.80	2.36	2.26	734.5	682.2	562.1	520.2
1% calcium chloride + 0.1% bayleton	2.19	2.34	2.35	2.46	730.2	670.3	532.4	500.3
0.1% bavistin + 0.1% bayleton	1.80	2.06	2.44	2.40	698.0	632.7	500.1	445.8
1% calcium chloride + 0.1% bavistin + 0.1% bayleton	2.06	2.49	2.66	2.48	726.1	662.1	526.3	481.3
Control	1.89	1.42	1.06	1.05	675.1	587.3	442.8	432.8
Mean	2.03	2.22	2.28	2.25	712.6	646.1	513.9	476.5
CD (p = 0.05)								
Treatments			0.40				32.4	
Storage			0.26				26.3	
Treatment × storage			0.74				64.5	

Calcium chloride (1%) and bavistin (0.1%) treatment (T_4) had the best effect on per cent TSS of *NA-7* aonla fruits stored at room temperature among all the treatments. The effect of pre-harvest spray was visible from the date of harvest and had maximum TSS throughout the storage period of aonla fruit among the various chemicals and their combinations tried. Calcium compounds are reported to increase the TSS in other tropical fruits like ber (Gupta *et al.* 1987), guava (Bhadu 1983) and *Baramasi* lemon (Sindhu and Singhrot 1996). Acidity in stored aonla fruit increased up to 10 days of storage and then decreased continuously thereafter. The initial increase might be due to the start of anaerobic respiration and thereafter the decrease in acidity during storage could be attributed to the conversion of acids into salt and sugars by the enzyme particularly invertase. The statistically significant values of acidity were observed in fruits treated with 1% calcium chloride + 0.1% bavistin (T_4); however, minimum values of acidity were found in the control (Table 3). Calcium has been reported to increase and maintain high acidity in other fruits such as guava (Singh 1985) and Kinnow mandarin (Kumar and Chauhan 1989).

The level of reducing sugars was higher on the date of harvest in *NA-7* aonla fruits which were given pre-harvest treatments of 1% calcium chloride, 0.1% bavistin, 0.1% bayleton and their combinations. 1% calcium chloride, 0.1% bavistin, 1% calcium chloride + 0.1% bayleton, 0.1% bavistin + 0.1% bayleton and control slightly increased the level of reducing sugars up to 10 days without any such increase in 0.1% bayleton, 1% calcium chloride + 0.1% bavistin and 1% calcium chloride + 0.1% bavistin + 0.1% bayleton. However, reducing sugars decreased after 10 days of storage at room temperature followed by a decrease thereafter. The initial increase may be due to the conversion of starch into simply sugars and the decrease later could possibly be due to utilization of these sugars in respiration. Calcium is reported to protect total sugars in guava (Singh 1985) and grapes (Kumar 1982). Among the eight treatments, 1% calcium chloride + 0.1% bavistin (T_4) recorded the statistically significant highest values; whereas the lowest values of total sugars was observed in the control during the period under study. However, total sugars level decreased after 10 days in all the treatments. These results are in conformity with the findings of Singh 1985 (Table 4).

Non-reducing sugars in all the treatments increased during storage. Pre-harvest spray of 1% calcium chloride + 0.1% bavistin + 0.1% bayleton maintained the statistically highest level of non-reducing sugars followed by 1% calcium chloride + 0.1% bavistin, 1% calcium chloride + 0.1% bayleton, 1% calcium chloride, 0.1% bavistin, 0.1% bayleton, 0.1% bavistin + 0.1% bayleton and control during the period under study. In the present investigation, ascorbic acid content decreased in all the treatments during storage. However, treated fruits recorded significantly higher amounts of ascorbic acid content during different storage periods over the control fruits. During storage, statistically highest ascorbic acid content was recorded in the treatment 1% calcium chloride + 0.1% bavistin, whereas, statistically lowest values were observed in the control during the period under study (Table 5). Ojha (1987) has reported 10% loss in ascorbic acid content after 10 days of storage, whereas Pathak (1988) recorded 7% loss in ascorbic acid after 6 days of storage. Other workers have also reported that calcium nitrate protects the loss in ascorbic in Kinnow mandarin (Kumar and Chauhan 1990) and oranges (Rana *et al.* 1992).

It is concluded that foliar application of calcium chloride, bavistin and bayleton had a favourable effect on the post harvest life of aonla fruit. 1% calcium chloride + 0.1% bavistin was found to be the most effective preharvest treatment to enhance the post harvest life of aonla fruit.

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