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Effect of Calcium nitrate on physico-chemical changes and shelf-life of aonla *(Emblica officinalis* Gaertn*)* fruits

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ABSTRACT

The experiment was conducted at the Department of Fruit Science, College of Horticulture, Mandsaur during 2013-14 to find out effect of calcium nitrate on physico-chemical changes and shelf-life of aonla fruit. Factorial completely randomized design (FCRD) was selected with four treatments of calcium nitrate (0.5, 1.0 and 1.5 % with control) and four cultivars (Banarasi, Krishna, Kanchan and NA-7). Fruits were treated and stored on 17 December, 2013. Among the treatments tried as post-harvest dip at 1.0 % calcium nitrate treatment proved most effective in respect to increase physico-chemical qualities and shelf-life of aonla fruits. The 1.0 % calcium nitrate treated fruits. Reduced the physiological loss in weight, decay loss, exhibited better quality on account of its favourable effect on total soluble solids, total sugar and in retaining more acidity thereby rendering them acceptable upto period of 15 days. Different cultivars could keep well up to 5 days with 'Excellent' rating and 10 days with 'Good' rating while no variety maintain marketable rating after 15 days storage.

Key words: *Aonla*, calcium nitrate, cultivars, self-life, quality

INTRODUCTION

Aonla (*Emblica officinalis* Gaertn syn. *Phyllanthus emblica* Linn.) belongs to the family Euphorbiaceae. It is called by several names in different parts of country *e.g.,* amalaki, amal, amali and ambala etc. Its cultivation is since immemorial time in India. Aonla has become an important fruit. The fruit is capsular with fleshy exocarp and it has very high nutritive and medicinal qualities. It is richest source of Vitamin 'C' and also contains fair amount of minerals and organic compounds. During storage losses are fruit weight, decay and nutritional quality. The pathological losses in fruits start soon after the harvesting which requires systematic study on shelf-life and storage stability of aonla fruits. In general during storage losses occurs in fruit weight, decay and nutritional quality. The pathological losses in fruits start soon after the harvesting which requires systematic study on shelf- life and stability of aonla fruits. A wide variation in physico-chemical composition has been recorded in different cultivars of aonla which affects the losses during storage different cultivars of aonla. Calcium plays an important role in maintaining the quality of fruits. Post-harvest calcium application have been used to delay aging or ripening to reduce post-harvest decay and to control the development of physiological disorders in fruits. Firming and resistance to softening resulting from addition of calcium have been attributed to the stabilization of membrane systems and the formation of Ca-pectate, which increase rigidity of the middle portion and cell wall of the fruit.

In recent days plant growth regulators have been used for improving the quality, delaying deterioration in storage and thereby increasing shelf life of various fruit crops including aonla. However, due to the high cost of plant growth regulators, it is imperative to find out some other cheaper chemical/chemicals which can be used to improve the shelf life and fruit quality. Chemicals like calcium compounds have been reported to prolong shelf life by affecting the wide range of physiological processes in plants and also inhibit specific aspects of abnormal senescence in aonla fruit (Gangwar *et al.* 2012). Therefore, an attempt has been made in the present study to prolong the shelf life of aonla fruit with calcium nitrate.

MATERIALS AND METHODS

The experiment was carried out at the Department of Fruit Science, College of Horticulture, Mandsaur during the year 2013. There were 16 treatment combinations, four levels of calcium nitrate (0.5, 1.0, 1.5% with control) and four cultivars NA- 7, Kanchan, Francis and Chakaiya. Duration of storage

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period was 5, 10 and 15 days and unit was 1 kg fruits/bag with three replications in factorial completely randomized design (CRD). The fruit samples were stored 16 × 3 = 48 under each storage period and analyzed after 5, 10 and 15 days. Physico-chemical composition of fresh fruit was recorded immediately after harvest. The fruits of each cultivar were divided in four equal groups. Three groups of each cultivar were dipped separately in 0.5, 1.0 and 1.5 per cent calcium nitrate solution and one group of each cultivar dipped in water for 30 minutes. Each group was kept in open trays after surface drying as per treatments and stored under ambient conditions. Physiological loss in weight under each treatment was calculated after certain storage period. The decay loss was calculated on weight basis. Total soluble solids content was recorded with the help of hand refractometer. Sample was taken from each treatment and drop of juice was placed on the glass of refractometer and values were corrected to 20°C with the help of temperature correction chart (AOAC, 1970). Acidity was estimated in terms of malic acid titrated against NaOH solution using phenolphthalein as an indicator. Total sugar content was estimated with the help of 'Fehling solution method'. Organaleptic evaluation was made by the panel of four judges on the basis of various quality attribute *viz*., appearance of fruits, taste, flavour and aroma, colour and texture and rating marks were allotted out of 100. Mark score was 0-40 'poor rating', 41-75 'good' and 76-100 'excellent'.

RESULTS AND DISCUSSION

The results revealed that different post harvest calcium nitrate treatments influenced physiological weight loss (PLW), decay loss and total soluble solids of the aonla fruits during storage period (Table 1). The physiological loss in weight is an important parameter in maintaining the freshness of the fruit (Kumar *et al.,* 2011). The physiological loss in weight per cent of fruits increased with the progress of storage. The minimum physiological loss in weight was recorded in 1.0% Ca $(NO_3)_2$ after 5 days (5.04%), 10 days (7.29%) and 15 days (15.37%) followed by 1.5% Ca $(NO_3)_2$, whereas maximum was under control. Among the cultivars, maximum physiological loss in weight was found in Banarasi (20.14%) and minimum in NA-7 (14.40%) after 15 days of storage. All the cultivars exhibited lower physiological loss when treated with calcium nitrate (1.0%) as compared to untreated ones. However the degree of loss increased with the progress of storage. The highest weight loss of untreated fruits is due to increased storage breakdown associated with higher respiratory rate as compared to calcium nitrate treated fruits. The possible reason for reduced weight loss by chemicals may be due to some chemical changes within the fruits; resulting in retention of more water against the rate of evaporation. Gangwar *et al.* (2012) reported that the highest weight loss of untreated fruits is due to increased storage breakdown associated with higher respiratory rate as compared to Calcium nitrate treated aonla fruits. Similar finding had been reported by Kumar *et al.* (2005), Dhumal *et al.* (2008), Yadav and shukla (2009) and Singh *et al.* (2014).

The decay loss (%) of fruit was significantly lower in 1.0% Ca $(NO_3)_2$ treated fruits as compared to remaining treatments after different storage periods. The higher decay loss was recorded in control (18.09%) and it was lowest in 1.0% Ca $(NO_3)_2$ treatment (16.83%). Among cultivars, the minimum decay loss was found in NA-7 after different storage period while maximum was found in NA-7 (15.67%) after 15 days of storage. Rotting of the fruit is another important fruit quality parameter and occurrence of rotting adversely affects the shelf-life of fruits. Rotting caused due to infection by fungus, mainly *blue mould (Penicillium citrinum)* makes the fruit soft and affected fruits as they develop bad odour**.** The dip of Calcium nitrate resistance to the fruits against the pathogens, which resulted in least decay loss, rotting of fruits increased with the advancement of storage period. Thus, elimination and/or reduction of rotting during storage are crucially important for preserving the good quality of fruits. In the present investigation, application of calcium nitrate alone allowed minimum rotting during storage. The role of Calcium nitrate in reducing decay loss has been reported in aonla by Singh *et al.* (2005), Gangwar *et al.* (2012) and Singh *et al.* (2014).

Table 1: Effect of different doses of calcium nitrate on physiological loss in weight, decay loss, TSS and acidity of aonla fruits during storage

Treatments		PLW (%)			Decay loss (%)			TSS (^{o}Brix)		
		Storage period(days)			Storage period(days)			Storage period(days)		
		5^{th}	10^{th}	15^{th}	5^{th}	10^{th}	15^{th}	5^{th}	10^{th}	15^{th}
Ca $(NO_3)_2$ levels (%)										
Control (Water dip)	C_0	5.6	10.2	19.4	2.8	10.3	18.1	11.3	11.5	11.6
0.5	C_1	5.4	8.1	18.4	2.8	9.9	17.8	11.5	11.7	11.8
1.0	C_2	5.0	7.3	15.4	2.5	9.0	16.8	11.9	12.2	13.0
1.5	C_3	5.4	8.3	17.7	2.6	9.5	17.6	11.6	11.9	12.5
S. Em±		0.13	0.10	0.05	0.014	0.02	0.02	0.06	0.07	0.08
CD (P=0.05)		NS	0.30	0.15	0.041	0.06	0.06	0.18	0.21	0.22
Varieties (V)										
NA-7	V_1	4.2	6.7	14.4	2.2	8.5	15.7	12.6	12.8	13.2
Kanchan	V_2	5.3	7.3	17.1	2.6	9.2	16.6	10.9	10.9	11.6
Francis	V_3	5.8	9.3	18.8	2.8	9.8	17.9	12.2	12.7	12.9
Chakaiya	V_4	6.2	10.5	20.1	3.2	11.3	20.1	10.6	10.9	11.2
S. Em±		0.13	0.10	0.06	0.014	0.02	0.02	0.06	0.07	0.08
CD (P=0.05)		0.38	0.30	0.17	0.041	0.06	0.06	0.18	0.21	0.22
Interaction										
NA-7 (Control)	V_1C_0	4.4	9.0	15.9	2.3	8.8	16.1	12.3	12.5	12.6
NA-7 x 0.5% Ca $(NO_3)_2$	V_1C_1	4.3	6.4	15.3	2.3	8.8	16.0	12.5	12.7	12.7
NA-7 x 1.0% Ca $(NO_3)_2$	V_1C_2	3.8	5.0	12.4	2.0	8.2	15.1	12.9	13.3	14.0
NA-7 x 1.5% Ca $(NO_3)_2$	V_1C_3	4.3	6.4	14.0	2.1	8.3	15.5	12.7	12.5	13.5
Kanchan (Control)	V_2C_0	5.5	9.5	18.5	2.7	9.9	17.4	10.6	10.8	10.9
Kanchan x 0.5% Ca $(NO_3)_2$	V_2C_1	5.3	6.4	17.9	2.7	9.2	17.0	10.8	10.9	11.1
Kanchan x 1.0% Ca $(NO_3)_2$	V_2C_2	5.0	6.3	14.3	2.5	8.6	16.0	11.2	11.2	12.3
Kanchan x 1.5% Ca $(NO_3)_2$	V_2C_3	5.2	7.0	17.9	2.6	8.9	16.1	11.0	10.8	11.9
Francis (Control)	V_3C_0	6.0	10.3	20.9	2.9	10.3	18.5	12.0	12.2	12.3
Francis x 0.5% Ca $(NO_3)_2$	V_3C_1	5.8	9.4	19.3	2.9	10.1	18.1	12.2	12.4	12.6
Francis x 1.0% Ca $(NO_3)_2$	V_3C_2	5.3	8.4	16.5	2.7	9.2	17.1	12.6	13.0	13.5
Francis x 1.5% Ca $(NO_3)_2$	V_3C_3	5.8	9.3	18.4	2.7	9.8	18.0	12.1	13.1	13.2
Chakaiya (Control)	V_4C_0	6.4	11.8	20.3	3.4	12.2	20.3	10.3	10.5	10.6
Chakaiya x 0.5% Ca $(NO_3)_2$	V_4C_1	6.2	10.8	21.2	3.4	11.7	20.0	10.5	10.7	10.8
Chakaiya x 1.0% Ca $(NO_3)_2$	V_4C_2	5.6	9.3	18.3	2.8	10.1	19.1	10.8	11.2	12.0
Chakaiya x 1.5% Ca $(NO_3)_2$	V_4C_3	6.2	10.3	20.7	3.0	11.3	20.9	10.6	11.2	12.5
S. Em±		0.27	0.21	0.12	0.03	0.04	0.04	0.12	0.14	0.15
CD (P=0.05)		NS	0.60	0.34	0.08	0.12	0.11	NS	0.42	NS

The total soluble solids exhibited increasing trend in all the cultivars under different treatments with the progress of storage period. The total soluble solids content was recorded maximum in 1.0% Ca $(NO_3)_2$ (12.96°Brix), whereas, minimum was in control (11.63°Brix) after 15 days of observation. Among the cultivars, maximum amount of total soluble solids was found in NA-7, while minimum was recorded in Chakaiya after different storage periods. The highest amount of total soluble solids (13.96°Brix) was recorded under NA-7+1.0% Ca $(NO_3)_2$ treatment after 15 days of storage. The increase of total soluble solids during storage may be due to the breakdown of complex polymers into simple substances by hydrolytic enzymes, that may have further metabolized during respiration and level got decreases during subsequent storage. Similar improvement and retention of TSS has also been reported with calcium salts by Kumar *et al.* (2005), Singh *et al.* (2005), Yadav and Shukla (2009), Tripathi and Shukla (2011), Gangwar *et al.* (2012) in Aonla.

Table 2: Effect of different doses of calcium nitrate on acidity, total and organoleptic rating of aonla fruits during storage

Treatments		Acidity (%)			Total Sugar (%)			Organoleptic rating		
		Storage period(days)			Storage period(days)			Storage period(days)		
		5th	10th	15th	5th	10th	15th	5th	10th	15th
$Ca(NO_3)_2$ levels (%)										
Control (Water dip)	C_0	2.0	1.8	1.6	4.9	5.3	5.5	6.7	5.1	4.0
0.5	C_1	2.0	1.9	1.6	5.1	5.6	6.0	7.3	6.1	5.0
1.0	C_2	2.1	2.0	1.8	5.5	6.5	7.3	7.9	6.8	5.6
1.5	C_3	2.0	1.9	1.7	5.3	6.2	6.7	7.5	6.4	5.2
S. Em±		0.06	0.04	0.04	0.07	0.08	0.03	0.06	0.05	0.02
CD (P=0.05)		NS	NS	0.10	0.21	0.24	0.09	0.18	0.14	0.06
Varieties (V)										
NA-7	V_1	1.7	1.6	1.5	4.1	5.0	5.5	7.4	6.2	5.0
Kanchan	V_2	2.0	1.9	1.6	4.5	5.2	5.8	7.3	6.1	5.0
Francis	V_3	1.9	1.8	1.6	5.6	6.3	6.8	7.3	6.1	5.0
Chakaiya	V_4	2.5	2.3	2.0	6.7	7.2	7.5	7.3	6.0	4.9
S. Em±		0.05	0.04	0.04	0.07	0.08	0.03	0.06	0.05	0.02
CD (P=0.05)		0.16	0.12	0.10	0.21	0.24	0.09	NS	NS	0.06
Interaction										
NA-7 (Control)	V_1C_0	1.7	1.5	1.5	3.8	4.1	4.4	6.7	5.1	4.0
NA-7 x 0.5% $Ca(NO_3)_2$	V_1C_1	1.7	1.6	1.5	4.0	4.8	4.8	7.6	6.3	5.1
NA-7 x 1.0% $Ca(NO_3)_2$	V_1C_2	1.8	1.6	1.6	4.3	5.8	6.7	8.0	6.9	5.7
NA-7 x 1.5% $Ca(NO_3)_2$	V_1C_3	1.7	1.6	1.5	4.2	5.2	5.9	7.4	6.3	5.3
Kanchan (Control)	V_2C_0	1.9	1.8	1.5	4.0	4.4	4.6	6.9	5.0	4.0
Kanchan x 0.5% $Ca(NO_3)_2$	V_2C_1	1.9	1.8	1.6	4.3	4.8	5.5	6.9	6.0	5.0
Kanchan x 1.0% $Ca(NO_3)_2$	V_2C_2	2.0	1.9	1.8	4.9	6.0	6.8	7.8	6.8	5.6
Kanchan x 1.5% $Ca(NO_3)_2$	V_2C_3	2.0	1.8	1.6	4.7	5.7	6.1	7.8	6.8	5.2
Francis (Control)	V_3C_0	1.8	1.7	1.5	5.4	5.8	5.9	6.7	5.1	4.1
Francis x 0.5% $Ca(NO_3)_2$	V_3C_1	1.8	1.7	1.5	5.5	5.9	6.4	7.5	6.1	4.9
Francis x 1.0% $Ca(NO_3)_2$	V_3C_2	1.9	1.8	1.7	5.7	6.8	7.5	7.9	6.9	5.5
Francis x 1.5% $Ca(NO_3)_2$	V_3C_3	1.9	1.8	1.6	5.6	6.5	7.1	7.7	6.4	5.3
Chakaiya (Control)	V_4C_0	2.4	2.3	1.8	6.2	6.8	7.1	6.6	5.2	4.0
Chakaiya x 0.5% $Ca(NO_3)_2$	V_4C_1	2.4	2.3	1.9	6.7	7.0	7.3	7.3	6.0	5.0
Chakaiya x 1.0% $Ca(NO_3)_2$	V_4C_2	2.5	2.4	2.1	7.0	7.5	7.9	7.8	6.8	5.5
Chakaiya x 1.5% Ca $NO_3)_2$	V_4C_3	2.5	2.3	2.1	6.8	7.3	7.6	7.4	6.1	5.2
S. Em±		0.11	0.08	0.07	0.15	0.17	0.07	0.12	0.09	0.04
CD		NS	NS	NS	NS	NS	0.19	0.35	0.27	NS

The results revealed that post harvest calcium nitrate treatments influenced acidity, sugars and organoleptic values of the aonla fruits during storage (Table 2). The acidity content decreased in all the cultivars under different treatments with an increase in storage period. The maximum acidity (2.05%) was observed in 1.0% $Ca(NO_3)_2$ after 5 days of storage, whereas minimum was recorded in control (1.59%) after 5 days of storage. Among the cultivars, highest acidity content was found in Chakaiya (2.01%) after 5 days of storage and minimum (1.59%) in NA-7 after 15 days of storage. The acidity decrease in aonla fruit may be due to utilization of organic acid in respiration and conversion of acids into salt and sugars by enzymes. The decrease in acidity with calcium nitrate has also been reported by Dhumal *et al.* (2008) and Gangwar *et al.* (2012) in aonla, Kumar *et al.* (2011) in guava by and Singh and Mandal (2000) in litchi. The total sugar content in aonla fruit increased during storage (Table 2). The maximum total sugar content (7.49%) was recorded in Chakaiya after 15 days of storage and minimum in NA-7 (5.47). Among the treatments maximum total sugar content (7.26%) was noticed in 1.0% $Ca(NO_3)_2$. As regards the interaction effect, it was maximum (7.92%) under Chakaiya+1.0% $Ca(NO_3)_2$ after 15 days of storage. Total sugar and reducing sugar increased up to 5^{th} days of storage at room temperature followed by a decrease. The initial increase may be due to the conversion of starch into simple sugars and decrease later on could possibly be due to utilization of these sugars in respiration during storage. Application of calcium nitrate or calcium salts retained higher sugar content over control during storage. They might have reduced the rate of respiration and delayed the onset of senescence. Similar results were also reported by Kumar *et al.* (2011), Tripathi and Shukla (2011), Gangwar *et al.* (2012) in aonla and Singh and Mandal (2000) in litchi.

The maximum organoleptic ratings were observed under the treatment of 1.0% Ca $(NO_3)_2$ and fruits were found "excellent and good" after 5 days and 10 days, respectively. Among the cultivars, NA-7 recorded maximum organoleptic value followed by Kanchan, Francis and Chakaiya. It may be assumed that higher rate of losses in weight during storage might have been due to raised energy requirement during storage.

On the basis of findings it may be concluded that among the treatments, 1.0% Ca $(NO_3)_2$ proved most effective with respect to physico-chemical qualities and shelf-life of aonla fruits. The calcium nitrate (1.0%) significantly reduced the physiological (in weight) and pathological losses and exhibited higher organoleptic rating with longer shelf-life. Besides, the fruits also exhibited better quality on account of its favourable effect on total soluble solids, total sugar and more ascorbic acid and acidity, thereby rendering them acceptable upto period of 10 days. Different cultivars could be stored well up to 5 days with "Excellent" rating and 10 days with "Good" rating while no variety maintain marketable rating after 15 days storage.

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