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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 Horticulture, C.S.A. University of Agriculture and Technology, Kanpur during the year 2006-07 to find out effect of calcium nitrate on physico-chemical changes and shelf-life of aonla fruit. Completely Randomized Design (CRD) was selected with four treatments of calcium nitrate (0.5, 1.0 and 1.5 per cent with control) and four other treatments of cultivars (Banarasi, Krishna, Kanchan and NA-7) and 5 days, 10 days and 15 days of storage period. Experiments unit was 1 kg fruit in perforated polythene bags. Fruits were treated and stored on 17 November, 2006. As regards among the treatments tried as post-harvest dip at 1.0 per cent calcium nitrate treatment proved most effective in respect to increase physico-chemical qualities and shelf-life of aonla fruits. The 1.0 per cent calcium nitrate treated fruits significantly reduced the physiological loss in weight, pathological loss, exhibited better quality on account of its favourable effect on total soluble solids, total sugar and in retaining more ascorbic acid and acidity thereby rendering them acceptable upto period of 15 days. Different cultivars could keep well up to 5 days with 'Excellent' rating, 10 days with 'Good' rating while only NA-7 and Krishna with 'Fair' rating upto 15 days.

Keywords : *Aonla, calcium nitrate, cultivars, self-life, quality.*

Aonla 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 (Chadha, 1). It is more popular in Uttar Pradesh, where it is largely cultivated in the district of Pratapgarh, Azamgarh, Varanasi and Jaunpur (Bajpai and Shukla, 2). At present, in production aonla ranks next to mango in U.P., Pratapgarh has been declared as aonla fruit belt and Agri-export zone (Prasad and Singh, 14).

The fruit is capsular with fleshy exocarp and it has very high nutritive and medicinal qualities. Chopra and Nagask (6) pointed out that fermented liquor of fruit is used in dyspepsia and cough. 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. A wide variation in physico-chemical composition has been recorded in different cultivars of aonla (Pathak *et al.*, 13). Calcium plays an important role in maintaining the quality of fruit (Huber, 8).

MATERIALS AND METHODS

The experiment was carried out to find out effect of calcium nitrate on physico-chemical changes and shelf-life of aonla fruit at the Department of Horticulture, C.S.A. University of Agriculture and Technology, Kanpur during the year 2006-07. There were 16 treatments combinations, 4 treatment of calcium nitrate as 0.5%, 1.0%, 1.5% with control and 4 treatments of cultivars *i.e.* Banarasi, Krishna, Kanchan and NA-7. Duration of storage period was 5, 10 and 15 days and unit was 1 kg fruits/bag with three replications in Completely Randomized Design (CRD). The fruit samples were stored $16 \times 3 = 48$ under each storage period and analyzed after 5, 10 and 15 days. Calcium nitrate was dissolved in the distilled water and physico-chemical composition of fresh fruit was recorded immediately after

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harvest. The fruits of each cultivar were divided in four equal groups. Three groups of each cultivar 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 perforated bags 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 pathological 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, 1). Acidity was estimated in terms of malic acid titrated against NaOH solution using phenolphthalein as an indicator. The ascorbic acid content was calculated as mg/100 g of pulp by the method of AOAC (1). 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', 41-60 'fair', 61-80 'good' and 81-100 'excellent'.

RESULTS AND DISCUSSION

The result obtained in present investigation reveal that different post harvest calcium nitrate treatments on aonla fruit influenced various parameters (Table 1). The physiological loss in weight is an important parameter in maintaining the freshness of the fruit (Kumar *et al.,* 10). The physiological loss in weight per cent of fruits increased with the progress of storage. The minimum per cent physiological loss in weight was recorded in 1.0% Ca $(NO_3)_2$ after 5 days (5.02%), 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 (20.66%) and minimum in NA-7 (14.39%) 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. Faust (7) 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 fruits. The present observations are supported by Nath *et al*. (12) and Singh (18).

The pathological 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 pathological loss was recorded in control (17.09%) and it was lowest in 1.0% Ca $(NO_3)_2$ treatment (2.55%). Among cultivars, the minimum pathological loss was found in NA-7 after different storage period while maximum was found in Banarasi (18.84%) after 15 days of storage. Spoilage was mainly due to blue mould as reported by Singh and Kumar (19) and spoilage of fruits during storage by blue mould in aonla reported by Setty (16).

The ascorbic acid content in aonla fruits decreased under all the treatments with advancement of storage period. The higher content of ascorbic acid was observed in 1.0% Ca $(NO_3)_2$ (516.45 mg/100 g pulp) after 5 days of storage, while the lowest (419.40 mg/100 g) was in control after 15 days of observation. As regards the cultivar, the maximum ascorbic acid content was recorded in Banarasi, whereas minimum was in Krishna after differnet storage period. The results are supported by Kumar *et al.* (9) and Singh *et al*. (20).

The total soluble solids content 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 $(NO_3)_2$ (13.20°Brix), Whereas, minimum was in control (11.55°Brix). Among the cultivars, maximum total soluble solids was found in Banarasi, while minimum was recorded in NA-7 after different storage periods. The

Table 1: Effect of calcium nitrate on physico-chemical changes of aonla.

Cultivar	After 5 days storage					After 10 days storage					After 15 days storage				
	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean
1. Physiological loss in weight (PLW)															
Banarasi (V_1)	6.45	6.24	5.91	6.18	6.19	11.85	10.39	9.35	10.28	10.46	22.34	21.25	18.34	20.69	20.66
Krishna (V_2)	6.01	5.83	5.37	5.77	5.74	10.29	9.35	8.45	9.28	9.34	20.89	19.28	16.47	18.39	18.75
Kanchan (V_3)	5.48	5.26	5.03	5.21	5.24	9.50	6.41	6.33	7.07	7.32	18.49	17.85	14.27	16.85	16.86
NA-7 (V_4)	4.37	4.19	3.78	4.29	4.09	9.03	6.40	5.03	6.38	6.71	15.89	15.29	12.38	14.01	14.39
Mean	5.57	5.38	5.02	5.29		10.16	8.13	7.29	8.25		19.40	18.41	15.37	17.48	
2. Pathological loss (%)															
Banarasi (V_1)	3.22	3.17	2.90	3.05	3.09	12.10	11.60	10.02	11.17	11.22	19.33	19.05	18.11	18.90	18.84
Krishna (V_2)	2.62	2.61	2.53	2.56	5.58	9.92	9.15	8.53	8.89	9.12	16.45	15.98	14.97	15.11	15.62
Kanchan (V_3)	2.89	2.85	2.71	2.75	2.80	10.25	10.07	9.12	9.75	9.79	17.46	17.15	16.14	16.99	16.93
NA-7 (V_4)	2.25	2.20	2.02	2.18	2.16	8.82	8.78	8.15	8.33	8.52	15.12	14.97	14.13	14.46	14.67
Mean	2.74	2.70	2.55	2.63		10.27	9.90	8.95	9.53		17.09	16.78	15.83	16.36	
3. Ascorbic acid content (mg/100 g)															
Banarasi (V_1)	603.54	609.68	620.32	614.64	612.04	564.34	572.47	594.27	586.25	579.33	512.65	536.28	579.38	552.68	545.24
Krishna (V_2)	439.65	446.79	454.48	449.95	447.71	405.38	416.78	431.82	422.78	419.19	378.45	391.45	410.29	402.46	395.66
Kanchan (V_3)	480.78	487.40	503.36	492.38	490.98	428.47	435.65	473.49	461.35	449.74	391.67	409.67	449.65	421.38	418.09
NA-7 (V_4)	472.08	478.54	487.65	481.50	479.94	425.68	431.42	471.58	454.64	445.83	394.84	405.42	452.84	425.55	419.66
Mean	499.01	505.60	516.45	509.61		455.96	464.08	492.79	481.25		419.40	435.70	473.04	450.51	

Contd......

table 1 contd..........

Cultivar	After 5 days storage					After 10 days storage					After 15 days storage				
	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean
4. Total soluble solids (TSS) (°Brix)															
Banarasi (V_1)	13.29	13.47	13.87	13.72	13.58	13.51	13.68	14.53	14.31	14.00	13.62	13.74	14.96	14.53	14.21
in0Krishna (V_2)	11.97	12.16	12.58	12.34	12.26	12.22	12.45	13.15	13.02	12.71	12.31	12.58	13.54	13.20	12.90
Kanchan (V_3)	10.62	10.76	11.21	11.05	10.91	10.79	10.90	11.78	11.46	11.23	10.90	11.17	12.31	11.90	11.57
NA-7 (V_4)	10.33	10.48	10.84	10.68	10.58	10.48	10.75	11.46	11.23	10.98	10.67	10.88	12.00	11.46	11.25
Mean	11.55	11.71	12.12	11.94		11.75	11.94	12.73	12.50		11.87	12.09	13.20	12.77	
5. Total sugars (%)															
Banarasi (V_1)	7.48	7.66	8.05	7.82	7.75	7.82	8.06	8.53	8.27	8.17	8.11	8.30	8.92	8.63	8.49
Krishna (V_2)	5.42	5.48	5.72	5.64	5.56	5.76	5.95	6.79	6.54	6.26	5.96	6.45	7.56	7.12	6.77
Kanchan (V_3)	4.05	4.28	4.86	4.73	4.48	4.43	4.75	5.98	5.65	5.20	4.65	5.54	6.83	6.08	5.77
NA-7 (V_4)	3.81	3.95	4.34	4.15	4.06	4.15	4.82	5.85	5.26	5.02	4.42	4.78	6.72	5.95	5.46
Mean	5.19	5.34	5.74	5.58		5.54	5.89	6.78	6.43		5.78	6.26	7.50	6.94	
6. Acidity content (%)															
Banarasi (V_1)	2.43	2.45	2.52	2.46	2.46	2.26	2.28	2.42	2.33	2.32	1.87	1.93	2.15	2.05	2.00
Krishna (V_2)	1.84	1.86	1.90	1.87	1.86	1.72	1.75	1.91	1.82	1.80	1.49	1.52	1.73	1.59	1.58
Kanchan (V_3)	1.93	1.94	2.00	1.96	1.95	1.82	1.83	1.93	1.86	1.86	1.51	1.58	1.81	1.63	1.62
NA-7 (V_4)	1.70	1.71	1.75	1.73	1.72	1.54	1.58	1.64	1.60	1.59	1.48	1.52	1.59	1.54	1.53
Mean	1.97	1.99	2.04	2.00		1.83	1.86	1.97	1.90		1.58	1.63	1.82	1.70	
7. Organoleptic rating evaluation															
Banarasi (V_1)	69.78	78.58	90.05	86.32	81.18	50.49	60.53	73.38	63.27	61.91	24.78	29.28	52.47	31.57	34.52
Krishna (V_2)	72.34	81.24	91.46	90.48	83.88	53.69	71.76	76.92	73.85	69.05	32.36	35.72	57.35	38.78	41.05
Kanchan (V_3)	69.62	85.68	93.37	89.53	84.55	49.37	64.38	75.17	68.92	64.46	29.98	32.46	56.95	35.28	38.66
NA-7 (V_4)	75.53	88.25	95.54	94.39	88.42	58.72	72.42	80.38	78.83	72.58	35.62	39.65	64.57	41.83	45.41
Mean	71.81	83.43	92.60	90.18		53.06	67.27	76.46	71.1		30.68	34.27	57.83	36.86	

highest total soluble solids (14.96°Brix) content was recorded under treatment combination of Banarasi and 1.0% Ca $(NO_3)_2$ after 15 days of storage. The result is in close proximity with findings of Kumar *et al.* (10) and Roychaudhary *et al.* (15).

The total sugar content in aonla fruit increased during storage (Table 1). The maximum total sugar content (8.49%) was recorded in Banarasi after 15 days of storage, while minimum was found in NA-7 (5.46). Among the treatments maximum total sugar content (7.5%) was noticed in 1.0% Ca $(NO_3)_2$. As regards the interaction effect, it was maximum (8.92%) under treatment of combination of V_1T_2 after 15 days of storage. The increased conversion of starch into sugar due to activation of hydrolytic enzymes by calcium could be responsible for increases in sugar content (Chahal and Bal, 5; Saba *et al.*, 16). Kumar *et al.* (10) also reported that aonla fruits treated with Ca $(NO_3)_2$ showed maximum sugar level.

The acidity content in per cent decreased in all the cultivars under different treatments with an increase in storage period. The maximum acidity (2.04%) was observed in 1.0% Ca $(NO_3)_2$ after 5 days of storage, whereas minimum was recorded in control (1.58%). Among the cultivars, highest acidity content was found in Banarasi (2.46%) after 5 days of storage and minimum (1.53%) in NA-7 after 15 days of storage. The acidity decrease in aonla fruit may be due to utilization of organic acid in respiration. Jha *et al.* (9) also reported that the acidity of mango fruits decreased with the advancement of storage period due to conversion of acids into salt and sugars by enzymes. With regard dipping 1.0% Ca $(NO_3)_2$ retained the maximum level of acidity in aonla fruit (Upadhyay and Dixit, 21).

The maximum organoleptic ratings were observed under the treatment of 1.0% Ca $(Na_3)_2$ 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 Krishna, Kanchan and Banarasi. It may be assumed that higher rate of losses in weight during storage might have been due to raised energy requirement during storage. The results are supported by Bhalerao *et al.* (3) and Mir *et al.* (11).

On the basis of findings achieved in the present investigation it may be concluded that among the treatments tried as post-harvest dip, 1.0% Ca $(NO_3)_2$, treatment proved most effective with respect to physico-chemical qualities and shelf-life of aonla fruits. The calcium nitrate 1.0% treated fruits significantly reduced the physiological loss in weight, pathological loss exhibited higher organoleptic rating with longer shelf-life. Besides, the fruits also exhibited better in quality on account of its favourable effect on total soluble solids, total sugar and in retaining more ascorbic acid and acidity, thereby rendering them acceptable upto period of 15 days. Different cultivars could be keep well up to 5 days with "Excellent" rating, 10 days with "Good" rating while only NA^{-7} and Krishna with "Fair" rating upto 15 days.

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