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Effect of post harvest treatments on keeping quality of Aonla fruits in liquid medium during storage

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Abstract
The present investigation was conducted in the month of February to April on aonla fruits impregnated in liquid subjected to be treated with different chemicals (NaCl, KMS, Calcium lactate, EDTA, SB) in the combination of 15% NaCl (T_1), 15% NaCl +0.05% KMS (T_2), 15% NaCl +0.05% KMS+0.2% Calcium lactate (T_3), 15% NaCl +0.05% KMS+0.1% EDTA (T_4), 15% NaCl +0.05% SB (T_5), 15% NaCl +0.05% SB+ 0.2% Calcium lactate (T_6), 15% NaCl+0.05% SB+0.1% EDTA (T_7), 15% NaCl+0.025% KMS +0.025% SB (T_8) with the objective to enhance the shelf life fruits. The chemical changes were analyzed at fortnight interval with regards to TSS, acidity, ascorbic acid, phenol and NEB value of fruits during storage up to 60 days. Treatment (s) i.e., T_7 (15 % NaCl + 0.05 % SB + 0.1 % EDTA) and T_6 (15 % NaCl + 0.05 % SB + 0.2 calcium lactate) in combination with EDTA or calcium lactate in liquid medium effectively preserved and retained aonla fruits in better fruit quality in terms of low non enzymatic browning, higher ascorbic acid, acidity and TSS content up to two months of storage at ambient temperature.

Keywords: Aonla, post harvest dip treatments, keeping quality

Introduction
Aonla (*Emblica officinalis* Geartn.) is one of the oldest minor fruits of India and considered to be a "wonder fruit for health" because of its unique properties. It belongs to the family Euphorbiaceae and is native to India, Sri Lanka, Malaysia and China (Jain and Khurdiya, 2004). It is known by different names such as '*Amla*, *Amalakki*, *Nelli*, Indian gooseberry', etc. It is one of the most important fruits of the tropics and subtropics of the Indian subcontinent. In India, it occupied an area of 108 thousand hectare, production of 989 thousand tonnes with 10.87 tonnes/ha productivity (Anonymous, 2017) [2]. Chemical treatments play an important role in increasing the shelf life of *aonla*. During storage, physico-chemical and biochemical changes affect the final texture and quality of fruits. The effect of elucidating the maintenance of fruit quality has been based on the modifications taking place in the cell wall (Brummell *et al*., 2004) [3], with calcium having a profound effect on the above changes (Singh and Singh, 1999) [15] and it combined with Ca, Na its salt and permitted food preservatives namely KMS and SB used in liquid medium impregnation of aonla fruits for enhancing the shelf life during storage. Keeping this in view the present experiments were undertaken.

Material Method
The present investigation was conducted on aonla cv. NA-7 in the Post Harvest Technology Laboratory, Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, in the month of February to April. The experiment was comprised of 15% NaCl (T_1), 15% NaCl +0.05% KMS (T_2), 15% NaCl +0.05% KMS+0.2% Calcium lactate (T_3), 15% NaCl +0.05% KMS+0.1% EDTA (T_4), 15% NaCl +0.05% SB (T_5), 15% NaCl +0.05% SB+ 0.2% Calcium lactate (T_6), 15% NaCl+0.05% SB+0.1% EDTA (T_7), 15% NaCl+0.025% KMS +0.025% SB (T_8). All the treatments were replicated thrice in Completely Randomized Design. For each treatment used three kg fruits and solution were prepared by dissolving the desired quantity of chemicals as per treatment in distilled water. The fruits were washed with water then kept into plastic bucket and prepared liquid medium was poured and level was maintained 10 cm above the fruits and stored at ambient temperature that varied from 25°C to 45°C during studies. Observations were taken at 15 days interval up to 2 month of storage

(0, 15th, 30th, 45th and 60th days of storage). All data were analyzed statistically as per suggested by Panse & Sukatme (1985).

Results and Discussion

Total Soluble Solids (TSS)

The retention or minimum increase in TSS content of fruit during storage is desirable for preservation of good fruit quality. It is clear from the data TSS content of *aonla* fruit increased with the advancement of storage during the entire period of experimentation under all chemical treatments but the rate of increase was significantly higher in T_6 treatment (15% NaCl + 0.05% SB + 0.2% Calcium lactate) than in other treatments. The minimum increase in TSS from 10.36°Brix to 12.69°Brix (22.49%) was recorded in T_1 treatment (15% NaCl) while maximum increase in TSS content from 10.47°Brix to 16.05°Brix (53.29%) was recorded in T_6 treatment (15% NaCl + 0.05% SB + 0.2% Calcium lactate) at the end of the storage.

The total soluble solids content in the fruits increased apparently during storage, which might be due to hydrolysis of polysaccharides (starch) into monosaccharides (sugars) and increase in concentration of fruit due to dehydration. A similar increase in total soluble solids content with the increase in storage period was observed in different stored fruits by Kalra and Bhardwaj (1981) [9], Verma and Gupta (2004) [17], Kumar *et al*., (2009) [10], Manolopoulou and Varzakas (2011) [11], Ediriweera *et al*., (2012) [5], Gupta and Deen (2013) [6].

Acidity (%)

During storage period, acidity of fruits showed continuous decrease until the last day of storage in the present investigation. At the end of experimentation the maximum acidity was found in T_7 (0.812%) closely followed by T_6 (0.792%) and minimum in T_1 (0.612%) treatment. It was observed that various treatments applied either effectively maintained the acidity or allowed little decline in the acidity of the fruits. The decrease in acidity observed during storage could be attributed to the chemical interaction between the organic constituents of the fruits induced by the temperature and action of enzymes. The minimum decrease in acidity during storage by application of different chemical treatments was also observed by Damodaran *et al*., (2001) [4], Singh and Borase (2003) [16], Verma and Gupta (2004) [17], Kumar *et al*., (2009) [10], Manolopoulou and Varzakas (2011) [11].

Ascorbic acid (mg $100g^{-1}$)

The ascorbic acid content of the *aonla* fruits during storage reduced with the advancement of storage period because the ascorbic acid is very sensitive to oxidation. This may be due to oxidation of ascorbic acid into dehydroascorbic acid by enzyme ascorbinase. The minimum decrease in ascorbic acid content of *aonla* fruit from 401.0 to 296.1 mg $100g^{-1}$ fruit pulp (35.42%) was recorded in T_3 treatment (15% NaCl + 0.05% KMS + 0.2% Calcium lactate) while maximum decrease in ascorbic acid content from 526.5 to 357.6 mg $100g^{-1}$ fruit pulp (47.23%) was recorded in T_7 treatment (15% NaCl + 0.05% SB + 0.1% EDTA) at the end of the storage.

The rate of decrease in ascorbic acid content of *aonla* fruit was significantly affected by different chemical treatments. Because the combined application of sodium chloride, potassium meta-bi-sulphite and calcium lactate reduced the oxidation of ascorbic acid during storage for longer time. Losses in ascorbic acid content and effect of different chemical treatments were also noticed by various workers Yadav *et al.* (2017) [18] and Pandey *et al.* (2006) [13].

Phenols (%)

The rate of decrease in phenol content was significantly affected by different chemical treatments during storage. In the present investigation, the maximum phenol (0.357%) was observed in T_6 treatment (15% NaCl + 0.05% SB + 0.2% Calcium lactate) and minimum (0.298%) in T_1 treatment (15% NaCl). The phenols content of the fruits during storage decreased with the advancement of storage period because the phenols are sensitive to oxidation. The higher phenols content of the fruits due to sodium benzoate, calcium lactate treatments might be because both these chemicals reduced phenols oxidation. The findings of the present investigation are supported by Hamauzu and Kume (2005) [7] in fresh prunes, Patthamakanokporn *et al.* (2008) [14] in guava, Singh and Borase (2003) [16] and Kumar *et al*., (2009) [10] in different fruits and vegetables.

Non-enzymatic browning

Browning reactions are of prime importance because these adversely affect the appearance, flavour, and nutritive value of fruits. Variability in browning of various fruit is caused by three types of general reactions i.e.

- Nitrogenous compounds and sugar.
- Organic acid and sugar.
- Nitrogenous compounds and organic acid.

Data presented in Table 5 indicates that the non-enzymatic browning was enhanced under all the chemical treatments with the advancement of storage period. However, the non-enzymatic browning was significantly lower (0.357) in T_7 treatment (15% NaCl + 0.05% SB + 0.1% EDTA) as compared to other treatments at the end of storage. A gradual increase in browning in *aonla* fruits with increase in storage period at room temperature might be due to the enzymatic and non-enzymatic reactions in the fruits. The fruits treated with sodium chloride, sodium benzoate and EDTA showed minimum non-enzymatic browning during storage. The possible reasons might be due to inactivation of enzymes by sodium chloride, sodium benzoate and protective action of β-carotene against non-enzymatic browning. Results of this experiment are in agreement with Kumar *et al*., (2009) [10], Manolopoulou and Varzakas (2011) [11], Ediriweera *et al*., (2012) [5], Gupta and Deen (2013) [6].

Thus, sodium benzoate preservative treatment (s) i.e., T_7 (15 % NaCl + 0.05 % SB + 0.1 % EDTA) and T6 (15 % NaCl + 0.05 % SB + 0.2 calcium lactate) in combination with EDTA or calcium lactate in liquid medium effectively preserved and retained aonla fruits in better fruit quality in terms of low non enzymatic browning, higher ascorbic acid, acidity and TSS content up to two months of storage at ambient temperature.

Table 1: Effect of post harvest chemical treatments on total soluble solids (°Brix) of *aonla* fruit during storage

Treatments	Storage period (days)				
	0	15	30	45	60
T_1	10.36	11.24	11.98	12.24	12.69
T_2	10.49	12.98	12.98	13.55	14.54
T_3	10.53	13.62	13.63	14.05	14.96
T_4	10.74	12.58	12.59	13.16	14.37
T_5	10.57	13.23	13.25	13.95	14.70
T_6	10.47	14.03	14.05	15.07	16.05
T_7	10.95	13.71	13.71	14.12	15.14
T_8	11.04	13.81	13.81	14.56	15.70
S. Em ±	0.130	0.150	0.161	0.162	0.173
CD (p=0.05)	0.376	0.433	0.463	0.467	0.498

Table 2: Effect of post harvest chemical treatments on acidity (%) of *aonla* fruit during storage

Treatments	Storage period (days)				
	0	15	30	45	60
T_1	1.540	1.003	0.712	0.672	0.612
T_2	1.605	0.932	0.932	0.792	0.722
T_3	1.388	0.851	0.852	0.782	0.702
T_4	1.666	0.931	0.932	0.802	0.732
T_5	1.623	0.911	0.912	0.802	0.752
T_6	1.837	0.961	0.962	0.893	0.792
T_7	1.926	1.059	1.059	0.992	0.812
T_8	1.725	0.932	0.934	0.862	0.761
S. Em ±	0.007	0.007	0.008	0.011	0.010
CD (p=0.05)	0.020	0.021	0.022	0.032	0.028

Table 3: Effect of post harvest chemical treatments on ascorbic acid (mg $100g^{-1}$ fruit pulp) of *aonla* fruit during storage

Treatments	Storage period (days)				
	0	15	30	45	60
T_1	401.2	387.4	371.3	346.3	287.5
T_2	416.6	373.6	373.6	352.5	291.2
T_3	401.0	372.1	372.5	349.1	296.1
T_4	433.9	387.1	387.5	379.3	301.9
T_5	408.9	366.3	366.7	349.4	290.5
T_6	442.5	397.2	397.6	372.4	343.3
T_7	445.5	416.8	416.8	390.5	357.6
T_8	416.6	371.3	371.3	349.1	280.4
S. Em ±	5.705	4.838	4.824	4.848	4.114
CD (p=0.05)	16.43	13.94	13.90	13.96	11.85

Table 4: Effect of post harvest chemical treatment on phenol (%) of *aonla* fruit during storage

Treatments	Storage period (days)				
	0	15	30	45	60
T_1	0.827	0.663	0.457	0.392	0.298
T_2	0.833	0.462	0.462	0.402	0.306
T_3	0.833	0.499	0.499	0.434	0.326
T_4	0.822	0.462	0.462	0.402	0.302
T_5	0.834	0.512	0.512	0.443	0.332
T_6	0.846	0.549	0.549	0.493	0.357
T_7	0.839	0.530	0.531	0.462	0.343
T_8	0.840	0.539	0.539	0.479	0.352
S. Em ±	0.010	0.006	0.007	0.006	0.004
CD (p=0.05)	0.029	0.017	0.019	0.016	0.013

Table 5: Effect of post harvest chemicals treatments on NEB of *aonla* fruit during storage

Treatments	Storage period (days)				
	0	15	30	45	60
T_1	0.057	0.086	0.297	0.390	0.414
T_2	0.068	0.290	0.290	0.313	0.396
T_3	0.067	0.326	0.327	0.350	0.413
T_4	0.057	0.303	0.304	0.305	0.390
T_5	0.061	0.288	0.289	0.335	0.402
T_6	0.062	0.253	0.254	0.266	0.363
T_7	0.100	0.283	0.283	0.277	0.357
T_8	0.086	0.315	0.315	0.413	0.490
S. Em ±	0.001	0.003	0.004	0.004	0.005
CD (p=0.05)	0.003	0.010	0.011	0.013	0.013

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