Research Article

Evaluation of Antioxidant Activity in Different Cultivars of Aonla (*Emblica officinalis* G.) Under Ambient Conditions

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Abstract

The investigation was conducted by keeping healthy fruits of aonla for each cultivar in cardboard boxes at room temperature in four replications. The experiment was carried out to evaluate the effect of cultivars of aonla on the ascorbic acid, total phenols, flavonoids and antioxidant activity during the storage. From the findings, it was concluded that the ascorbic acid content, flavonoids as well as antioxidant activity decreased with increasing storage period whereas total phenols increased during the storage. Ascorbic acid and total phenols were highest in fruits of cv. Chakaiya during storage whereas minimum in Krishna and Kanchan, respectively. Flavonoids as well as antioxidant activity was maximum in Kanchan throughout the storage.

Keywords: Aonla, Cultivars, Room Temperature, Ascorbic Acid and Antioxidant Activity

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Introduction

Aonla is presently an underutilized fruit, but has enormous potential in the world market. It is almost entirely unknown in the world market and needs to be popularized. Aonla is being exported under the category of Ayurvedic and Unani herbs [1]. It is also known by different names such as 'Amla', 'Amalakki', 'Nelli', 'Indian gooseberry' etc. [2]. Aonla fruit is highly nutritive with a great medicinal use and the richest source of ascorbic acid. It contains 300-900mg of ascorbic acid per 100g pulp [3]. Ascorbic acid is an important antioxidant component for human health. Consumption of aonla fruit is increasing in raw as well as in processed form due to its high ascorbic acid content [4].

Antioxidants are able to prevent or inhibit oxidation processes in human body as well as in food products [5, 6]. Antioxidants have prominent role in human health. These substances when added to food prevent the oxidation of unsaturated fats, palatability and wholesomeness of food. Different kinds of antioxidants have been found in various fruits, vegetables and medicinal plants which scavenge reactive oxygen species including free radicals such as super oxide ion and hydroxyl radicals by ionizing radiation which causes lipid peroxidation of fats and implicates many disease like malaria, heart diseases, strokes and diabetes [7].

Potent antioxidant properties are observed in aonla due to high ascorbic acid and polyphenol content that is credited with prevention of the oxidation of ascorbic acid. Free and bound phenolic compounds in aonla showed higher level of antioxidant activity due to higher level of poly phenols [8]. Aonla is one of the important sources of antioxidants that's why it is preferred in medicines such as chavanprsah and Ayurvedic medicines in the form of powder as well as murabba. Aonla exhibit antioxidant properties due to high level of ascorbic acid and provide protection for human dermal fibroblasts against oxidative stress. It is used traditionally as a laxative, appetite stimulant and to treat indigestion, diarrhea, anemia and jaundice [9]. Phenolic compounds are considered to be health promoting phytochemicals. Therefore, present study was conducted to evaluate the changes in antioxidant activities in different cultivars of aonla under Haryana agro-climatic conditions during storage at ambient temperature.

Materials and Methods

Present investigations were carried out in post harvest laboratory of the Department of Horticulture, and in Department of Botany & Plant Physiology, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Fully mature aonla fruits of five cultivars (cv.) namely Chakaiya, Banarasi, Hathijhul, Krishna and Kanchan of uniform size, color and free from blemishes were harvested from the orchard of the Horticulture department with the help of

secateurs keeping small intact pedicel with each fruit. Two kg of fruits of each cultivar of aonla namely Chakaiya, Banarasi, Hathijhul, Krishna and Kanchan were packed in cardboard boxes with newspaper as cushioning material. Each box was treated as one replicate and all the treatments were replicated four times. Fruits were stored at room temperature. Three fruits at random were taken from each replication for analysis of quality parameters such as ascorbic acid, phenols and flavonoids etc. in fresh fruits and then at two days interval.

Ascorbic acid (mg/100 g)

Ascorbic acid content was estimated by the method given by AOAC [10], using fresh peeled sample stored under room temperature.

Total phenols (mg/100 g)

The total phenols in the fruit tissue were estimated by method given by Amorium *et al*. [11] using Folin-ciocalteau's reagent.

Flavonoids

Flavonoids were determined by aluminum chloride colorimetric assay, as described by Marinova *et al*. [12].

Antioxidant activity (DPPH free radical scavenging activity)

The antioxidant activity of the fruit extracts was evaluated by DPPH free radical scavenging method according to the method of Shimada *et al.* [13].

Results and Discussion

Ascorbic acid (mg/100 g)

Maximum ascorbic acid content was observed on the initial period of storage i.e. 0 day (**Table 1**) in all the cultivars of aonla. The decreasing trend in ascorbic acid content during storage could be attributed to the conversion of L-ascorbic acid into dehydro-ascorbic acid in presence of ascorbic acid oxidase enzyme. Nayak *et al*. [1] also observed decrease in ascorbic acid content in aonla during storage. Ascorbic acid content decreased from 3rd to 15th day of storage. Ascorbic acid content decreased from 555.86 mg/100 g (0day) to 538.05 mg/100 g on 3rd day, 518 mg/100 g on 6th day, 495.20 mg/100 g on 9th day, 475.65 mg/100 g on 12th day to 456.53 mg/100 g on 15th day of storage when considered on mean basis irrespective of different cultivars. Among the different cultivars of aonla studied, maximum ascorbic acid was recorded in fruits of cv. Krishna after 15 days of storage whereas minimum ascorbic acid content was observed in fruits of cv. Chakaiya at the same period of storage. Large variation in decreasing trend of ascorbic acids in different cultivars of aonla might be associated with genetic variability among the cultivars. The decreasing ascorbic acid content might also be associated with differential activity of ascorbic acid oxidase in the fruits [14]. Gangwar *et al*. [15] has also reported similar decrease in ascorbic acid content with advancement of storage period in different cultivars of aonla.

Total Phenols

Results presented in **Table 2** indicate that content of total phenols increased with increasing period of storage in all the cultivars of aonla fruit. The key enzyme in phenol biosynthesis is phenylalanine ammonium lyase, which leads to formation of phenols [16]. Leja *et al*. [16] reported that an increase in phenol content might also be due to lower activity of polyphenoloxidase, so that oxidation processes were minimized. In present investigation, increase in phenol content might have been associated with either increase in PAL or decrease polyphenoloxidase enzyme activity.This might also be due to loss of water from the fruit surface which resulted in increase in phenolic concentration. Among the different cultivars of aonla studied, total phenol content was shown to be cultivar dependent. Fruits of cv. Chakaiya showed maximum total phenol content at the end of the storage i.e. on 15th day whereas minimum total phenols were recorded in fruits of cv. Banarasi at the same period of storage. Variation of increase in phenols during storage among the different cultivars of aonla might be due to differential activity of

phenylalanine ammonium lyase and polyphenoloxidase enzymes. Differential increase in total phenols during storage has also been reported in apple cultivars [17].

Table 1 Ascorbic acid content (mg/100 g) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature.

Cultivars (C)	Ascorbic acid (mg/100g)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	569.50	553.70	536.93	512.07	491.00	476.70	523.32
BANARASI	552.80	534.07	516.53	494.13	473.77	451.43	503.78
HATHIJHUL	562.53	544.50	524.60	497.13	476.76	457.43	510.49
KRISHNA	542.27	519.27	493.43	476.23	459.40	441.27	488.64
KANCHAN	553.20	537.73	518.50	496.46	477.30	455.83	506.50
Mean	555.86	538.05	518.00	495.20	475.65	456.53	
CD at 5%, C= 4.86, D= 6.04, CxD= 8.55							

Table 2 Total phenols (%) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature

Cultivars (C)	Total phenols (%)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	1.41	1.52	1.63	1.77	1.84	1.90	1.68
BANARASI	1.23	1.33	1.43	1.51	1.60	1.63	1.45
HATHIJHUL	1.31	1.43	1.49	1.54	1.59	1.67	1.50
KRISHNA	1.34	1.44	1.51	1.57	1.65	1.78	1.55
KANCHAN	1.28	1.39	1.47	1.55	1.61	1.65	1.49
Mean	1.31	1.42	1.51	1.59	1.66	1.73	
CD at 5%, C=0.03, D= 0.03, CxD= 0.08							

Flavonoids

Results are presented in **Table 3** predicts that maximum flavonoids were observed in aonla fruits of all the cultivars at initial period of storage i.e. 0 day. Flavonoids decreased with increasing period of storage in different cultivars of aonla. Decrease in flavonoids on 3rd, 6th, 9th and 12th day was observed as a result of which aonla fruits of all cultivars retained minimum flavonoids on 15th day of storage. The enzymatic oxidation of flavonoids occurs during storage. Decrease in flavonoid content might also be due to increase in peroxidase (POX) enzyme activity (one of the enzymes is known to be involved in flavonoid oxidation) [18]. Fruits of cv. Kanchan had maximum flavonoid content at the end of the storage i.e. on 15th day whereas minimum flavonoid content was recorded in fruits of cv. Chakaiya on the same period of storage. Variation in flavonoid content among the different cultivars of aonla could be attributed to varietal characteristics. This might be due to differential activity of POX enzyme in different cultivars during storage. These results of differential decrease in flavonoid content during storage are in harmony with those obtained in broccoli cultivars [19].

Antioxidant activity (DPPH free radical scavenging activity)

Among the various cultivars studied, maximum free radical scavenging activity was observed in fruits of cv. Kanchan (73.1%) followed by fruits of cv. Krishna (70.7%) whereas minimum free radical scavenging activity was observed in fruits of cv. Hathijhul (58.8%) followed by cv. Banarasi (59.8%) which was at par with each other when considered on mean basis irrespective of storage period. Decrease of antioxidant capacity could be due to ascorbic acid degradation occurring during storage [20]. In present investigation, decrease in free radical scavenging activity might

be because of decrease in ascorbic acid as well as flavonoid content which have been reported already in present study itself. Among the different cultivars of aonla studied, variation in free radical scavenging activity was observed. Maximum free radical scavenging activity was observed in fruits of cv. Kanchan on 15th day of storage whereas minimum free radical scavenging activity was recorded in fruits of cv. Hathijhul on same period of storage. This might be due to differential ascorbic acid oxidase as well as POX activity among the cultivars during storage. The decrease in antioxidant activity during storage has also been reported in different cultivars of lettuce [21, 22].

Table 3 Flavonoids (mg/g) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature

Cultivars (C)	Flavonoids (mg/g)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	1.42	1.37	1.33	1.28	1.24	1.20	1.31
BANARASI	1.53	1.49	1.44	1.40	1.37	1.34	1.43
HATHIJHUL	1.47	1.43	1.38	1.33	1.29	1.25	1.36
KRISHNA	1.65	1.61	1.58	1.52	1.48	1.42	1.54
KANCHAN	1.78	1.73	1.70	1.66	1.61	1.55	1.67
Mean	1.55	1.53	1.49	1.44	1.40	1.35	
CD at 5%, C= 0.03, D= 0.05, CxD = 0.08							

Table 4 Free radical scavenging activity (%) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature

Cultivars (C)	Free radical scavenging activity (%)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	68.5	65.3	63.6	60.7	59.2	58.1	62.6
BANARASI	65.3	62.8	60.7	58.4	56.1	55.3	59.8
HATHIJHUL	63.6	62.1	60.3	58.3	55.3	53.1	58.8
KRISHNA	75.1	74.3	72.1	69.1	67.3	66.4	70.7
KANCHAN	78.2	76.3	74.6	71.3	69.8	68.6	73.1
Mean	70.1	68.2	66.1	63.6	61.5	60.3	
CD at 5%, C = 1.3, D = 1.8, CxD = 2.6							

Conclusion

From the present study, it can be concluded that among the five cultivars of aonla studied, fruits of *cv*. Chakaiya showed higher retention of ascorbic acid and total phenols during storage whereas antioxidant activity and flavonoid content was maximum in fruits of *cv*. Kanchan, respectively.

References

[1] Nayak P, Bhatt D K, Shukla D K and Kumar D. Evaluation of aonla (Emblica officinalis G.) segments-in-syrup prepared from stored fruits. Research Journal of Agricultural Science. 2011, 43(2): 252-257.

[2] Shekhawat S, Rathore N S and Kaushik R A. Advances in processing and product development of aonla (*Emblica officinalis*) in Indian context-A review. International Journal of Food and Nutritional Sciences. 2014, 3(6): 242-247.

[3] Baliga M S and Dsouza J J. Amla (*Emblica officinalis* G.), a wonder berry in the treatment and prevention of cancer. European Journal of Cancer Prevention. 2011, 20:225-239.

[4] Kumar P and Khatkar B S. Physico-chemical properties and nutritional composition of aonla (*Emblica officinalis*) varieties. International Food Research Journal. 2015, 22(6):2358-2363.

[5] Borowska J, Owoce i warzywa jako zródło naturalnych przeciwutleniaczy (Fruits and vegetables as source of natural antioxidants). Przem. Ferm. Owoc. Warz.2003, 1, 11-12 [in Polish].
[6] Pareek S and Kitinoja L. Aonla. In: Post Harvest Biology and Technology of Tropical and Subtropical Fruits. 2011,Vol II, (E.M.Yahia, ed.) Woodhead Publishing Lt. UK. pp. 65-97.
[7] Khan K H. Role of *Emblica officinalis* in medicine-A review. Botany Research International.2009, 2: 218-228.
[8] Suresh K G, Nayaka H, Dharmesh S M and Salimath P V. Free and bound phenolic antioxidants in amla (*Emblica officinalis*) and turmeric (Curcuma longa). Journal of Food Composition and Analysis. 2006, 19:446-452.
[9] Talwar G P, Dar S A, Rai M K, Reddy K V R, Debashis M, Kulkarni S V, Doncel G F, Buck C B, Schiller J T, Muralidhar S, Bala M, Agrawal S S, Bansal K and Verma J K. A novel polyherbal microbicide with inhibitory effect on bacterial fungal and viral genital pathogens. International Journal of Antimicrobial Agents.2008, 32(2):180-85.
[10] AOAC (1990) Official Methods of Analysis, Association of Official Analytical Chemists. Washington, D.C.
[11] Amorium M V, Dougall D K and Sharp W R. The effect of carbohydrate and nitrogen concentration on phenol synthesis in Paul's Scarlet Rose cells grown in tissue culture. Plant Physiology. 1997, 39:91-95.
[12] Marinova D, Ribarova F and Atanassova M. Total phenolics and total flavonoids in Bulgarian fruits and vegetables. Journal of University of Chemical Technology and Metallurgy. 2005,40: 255-60.
[13] Shimada K, Fujikawa K, Yahara K and Nakamura T. Antioxidative properties of xanthan on the autoxidation of soybean oil in cyclodextrin emulsion. Journal of Agricultural and Food Chemistry.1988, 40:945-948.
[14] Mapson C W. Vitamins in fruits: Stability of L-ascorbic acid. In: Biochemistry of fruits and their products, Academic Press, London.1970, pp. 376-387.
[15] Gangwar S, Shukla H S, Katiyar D and Pandey V. (2012) Effect of calcium nitrate on physiochemical changes and shelf life of aonla (*Emblica officinalis* Gaertn) fruits. HortFlora Research Spectrum. 1(3):253-258.
[16] Leja M, Mareczek A, Starzyniska A and Roziek S. Antioxidant ability of broccoli flower buds during short-term storage. Food Chemistry. 2001, 72:219-222.
[17] Matthes A and Schmitz-Eiberger M. Polyphenol content and antioxidant capacity of apple fruit: Effect of cultivar and storage conditions. Journal of Applied Botany and Food Quality. 2009, 82:152-157.
[18] Hounsome, N, Hounsome, B, Tomos, D and Edwards-Jones, G. Changes in antioxidant compounds in white cabbage during winter storage. Postharvest Biology and Technology, 2009, 52:173-179.
[19] Balouchi Z, Peyvast G A, Ghasemnezhad M and Saadatian M. Changes of antioxidant compounds of broccoli (*Brassica oleracea* L. var. Italica) during storage at low and high temperatures. South Western Journal of Horticulture, Biology and Environment.2011, 2:193-212.
[20] Dupont M S, Mondin Z, Williamson G and Price K R. Effect of variety, processing, and storage on the flavonoid glycoside content and composition of lettuce and endive. Journal of Agricultural and Food Chemistry. 2000, 48(9):3957-3964.
[21] Llorach R, Sanchez A M, Barberan F A T, Gil M I and Ferreres F. Characterisation of polyphenols and antioxidant properties of five lettuce varieties and escarole. Food Chemistry. 2008, 108(3):1028-1038.
[22] Serea C, Barna C O, Manley M and Kidd M. Effect of storage temperature on the ascorbic acid content, total phenolic content and antioxidant activity in lettuce (*Lactuca sativa* L.). The Journal of Animal & Plant Sciences. 2014, 24(4):1173-1177.

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