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Effect of harvesting dates on quality and storage life of aonla (*Emblica officinalis* Gaertn.) cultivars

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Abstract

Four cultivars of aonla viz., Banarsi, NA-7, Chakaiya and Desi were procured from Central Soil and Water Conservation, Research Farm (CSWCRF), Mansa Devi Complex, Sector-4, Panchkula, Haryana during the year 2005-06 to assess the appropriate time of harvest of aonla cultivars and to improve the quality of fruit at harvest and during storage. An increase in TSS, reducing sugars and ascorbic acid and decrease in tannins content was observed with the advancement of fruit maturity. The best quality fruits were obtained after 28 days of storage at ambient temperature, when the harvesting was done on 15th October in Banarsi, 1st December in NA-7, 15th December in Chakaiya and 15th February in Desi. After storage, fruit from these pickings exhibited the lowest loss in weight and spoilage and retained the highest amount of sugars and ascorbic acid contents whereas earlier or later pickings resulted in marked reduction of these quality parameters.

Key words: Physiological loss in weight, days from full bloom.

Introduction

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.) is known for its medicinal and therapeutic properties since ancient times and is considered as a wonder fruit by health conscious people. It is a prolific bearer and highly remunerative even without much care. Owing to its hardy nature, ability to survive in various kinds of waste lands (arid, semi-arid, saline, coastal, ravines), high productivity per unit area (15-20 t/ha), nutritive and therapeutic values and its suitability for preparation of various products, aonla is becoming an important fruit of the 21st century.

According to recent estimates, aonla has spread over an area of 50,000 ha in the country with an approximate production of 1,75,000 tonnes (Pathak *et al.*, 2003), while in Himachal Pradesh, cultivated aonla covers an area of 1313 ha with a production of 1365 metric tonnes (Anonymous, 2006). Several new varieties of aonla have been introduced in the Shiwalik foothills in the recent past. Though, some work has been done to standardize the cultural operations for different cultivars, yet no systematic research work has been done to standardize the various postharvest handling techniques to prolong the storage quality of fruit. Aonla is harvested by orchardists on the basis of visual maturity, which is highly unscientific and may lead to erroneous judgment, thereby affecting postharvest quality of fruit. To ensure that fruit are available for longer duration either for fresh consumption or processing purposes, it is important to keep the fruit in acceptable condition and also minimizes spoilage. Since storage quality can be affected by fruit maturity at harvest, it is therefore, very important to determine the proper stage of maturity.

Material and Methods

To study the effect of time of harvest on storage quality of aonla fruit, bearing trees of uniform growth of each of the four cultivars (Banarsi, NA-7, Chakaiya and Desi) were selected and marked in the experimental orchard (Block-A III) of Central Soil and Water Conservation Research Farm (CSWCRF), Mansa Devi Complex, Sector-4, Panchkula, Haryana. Fruits of each cultivar were harvested at five fortnightly intervals which were spread over a period of two months. Sampling was started one month before and continued upto one month after the expected date of harvest for each cultivar. For calculating the number of days from full bloom (DFFB) to maturity, full bloom was reckoned to have taken place on the day when more than 80 per cent flowers had opened on randomly selected determinate shoots on marked trees. Harvesting of the fruits from the cultivars viz., Banarsi, NA-7, Chakaiya and Desi was started on Sept 1st, Oct 15th, Nov 15th and Jan 1st, respectively. The fruits were hand picked or plucked by climbing on the trees with the help of bamboo ladder.

Fresh fruits of each cultivar from all sampling dates were stored under ambient conditions and observations pertaining to changes in physico-chemical characteristics of the fruit were recorded at weekly intervals so as to determine the influence of harvest maturity on storage quality. Data pertaining to effect of harvest

maturity in relation to storage were analyzed by RBD as described by Mahony (1985).

Results and Discussion

During the present investigations, it was observed that PLW and fruit spoilage increased significantly (Table 1) with an increase in storage duration in all the cultivars. The percent PLW as well as fruit spoilage were also recorded to be higher in fruits from earlier sampling dates. Thereafter, these parameters declined to record the lowest values on a particular date, specific to each cultivar and again following an upward trend towards the close of sampling. Singh *et al.* (2005) recorded higher weight loss in the cultivar NA-7, followed by Chakaiya and minimum in the cultivar NA-10 after 10 days of storage. The decrease in PLW of fruits with increasing maturity might be due to the formation of a natural waxy layer concomitant to maturation, which could help in reduction in moisture and respiratory losses, as such a layer is reported to be formed during maturation in many fruits (Wills *et al.*, 1980). The highest fruit spoilage after 28 days storage was recorded in the Banarsi fruit harvested on the first picking date and lowest in Chakaiya harvested on the 3rd sampling date. The findings of Neeraj *et al.* (2004) further support the increase in spoilage rot in aonla fruit during storage as was observed during the present studies.

The TSS contents in general increased as the storage period advanced upto 28 days (Table 2). At the end of 28 days of storage, TSS was observed to be highest in fruits that were harvested on the 5th sampling date recording values of 10.16, 11.24, 13.36 and 13.05° Brix in the cultivars Banarsi, NA-7, Chakaiya and Desi, respectively. The increase in TSS contents in fruits during storage might be ascribed to transformation of pectic substances, starch, hemicelluloses or other polysaccharides into simple sugars and also dehydration of fruits due to loss of moisture during storage (Singh *et al.*, 2005) The reducing sugars content during storage maintained an increasing trend throughout storage period in all the cultivars (Table 2) with the increase being significant between successive storage intervals. The maximum reducing sugars contents after 28 days of storage were generally recorded in fruits picked on the 4th sampling date in the cultivars Banarsi (173 DFFB), NA-7 (223 DFFB) and Desi (298 DFFB). However, in Chakaiya, the reducing sugars content after 28 days of storage was highest in fruits picked on 3rd sampling date (258 DFFB). After the same storage duration, the reducing sugars content were usually lower in fruits from earlier harvests with the lowest being recorded in fruits from the 1st sampling date. The increase in sugars content during storage can be attributed to loss of moisture from fruit tissue which results in concentration of fruit juice ,and hydrolysis of insoluble polysaccharides into sugars during storage. These observations are in accordance with the findings of other workers who also found an increase in these biochemical constituents in aonla during storage (Singh *et al.*, 2005; Gupta and Mukherjee, 1982; Neeraj *et al.*, 2002). The increase in sugars content on each successive sampling date could be the result of translocation of additional photosynthates into the fruit during the additional time they remained on the trees.

The ascorbic acid contents in all the cultivars declined significantly with successive storage intervals (Table 3) with the decrease being more pronounced in fruits from earlier picking dates. With an increase in the maturity of fruits, the decrease in ascorbic acid contents during storage slowed down and therefore the highest ascorbic acid contents after 28 days storage were recorded in fruits from the 4th sampling date in the cultivars Banarsi (173 DFFB) and Desi (298 DFFB) and after the 3rd sampling date (258 DFFB) in Chakaiya. A large variation in the decreasing trend of ascorbic acid content among different cultivars was observed which might be due to the genetic variability among them. The decrease in ascorbic acid content may also be associated with ascorbic acid oxidase activity in the fruits (Mapson, 1970) which usually increases as the fruit mature. Ghorai and Sethi (1996) also observed that the ascorbic acid content in the cultivars Desi and Banarsi decreased from the initial values after 12 day of storage period under ambient conditions. Singh *et al.* (2005) also observed such variation in retention of ascorbic acid contents in different aonla cultivars. They observed maximum ascorbic acid contents in the cultivar Krishna, followed by NA-10, Chakaiya and the lowest in NA-7 after storage of 10 days. The present results are also in accordance with the findings of Neeraj *et al.* (2002) and Singh *et al.* (2003) who also observed a similar decrease in ascorbic acid content during storage.

Table 1. Effect of harvest maturity on physiological loss in weight (PLW %) and spoilage (%) during storage of aonla cultivars

Sampling date	Physiological loss in weight (%) Storage Duration in Days (I)					Spoilage (%) Storage Duration in Days (I)				
	7	14	21	28	Mean	7	14	21	28	Mean
Banarsi										
1st Sep.	1.83	12.41	19.27	25.64	14.79	0.00	3.26	9.48	24.86	9.40
15th Sep.	1.76	12.38	19.25	25.57	14.74	0.00	3.21	9.43	24.81	9.36
1st Oct.	1.72	12.35	19.21	25.52	14.70	0.00	3.15	9.40	24.74	9.32
15th Oct.	1.67	12.26	19.13	25.41	14.62	0.00	3.15	9.37	24.71	9.31
1st Nov.	1.68	12.33	19.18	25.45	14.66	0.00	3.16	9.39	24.76	9.33
Mean	1.73	12.35	19.21	25.52		0.00	3.19	9.43	24.79	
CD (P=0.05)										
	S = NS		I = 0.15		S x I = NS	S = NS		I = 0.39		Sx I = NS
NA-7										
15th Oct.	1.79	12.37	18.92	24.31	14.35	0.00	3.17	8.70	21.50	8.34
1st Nov.	1.78	12.32	18.83	24.29	14.30	0.00	3.10	8.66	21.36	8.28
15th Nov.	1.74	12.26	18.77	24.15	14.23	0.00	3.05	8.60	21.35	8.25
1st Dec.	1.74	12.25	18.75	24.11	14.21	0.00	3.07	8.58	21.31	8.24
15th Dec.	1.75	12.26	18.79	24.16	14.24	0.00	3.06	8.63	21.37	8.26
Mean	1.77	12.28	18.80	24.21		0.00	3.09(2	8.62	21.29	
CD (P=0.05)										
	S = NS		I = 0.13		S x I = NS	S = NS		I = 0.19		Sx I= NS
Chakaiya										
15th Nov	1.73	12.07	17.62	23.50	13.73	0.00	3.01	8.15	20.62	7.94
1st Dec	1.71	11.98	17.57	23.41	13.67	0.00	3.00	8.07	20.54	7.90
15th Dec	1.67	11.89	17.51	23.29	13.59	0.00	2.94	8.01	20.43	7.84
1st Jan	1.67	11.86	17.54	23.32	13.60	0.00	2.93	8.04	20.46	7.85
15th Jan	1.68	11.85	17.57	23.35	13.61	0.00	2.94	8.05	20.48	7.87
Mean	1.70	12.00	17.54	23.37		0.00	2.96	8.05	20.52	
CD (P=0.05)										
	S = NS		I = 0.18		S x I = NS	S = NS		I = 0.23		SxI = NS
Desi										
1st Jan.	1.76	12.53	19.65	25.60	14.72	0.00	2.93	10.41	23.72	9.26
15th Jan.	1.73	12.34	19.08	25.00	14.54	0.00	2.69	10.89	23.41	9.25
1st Feb.	1.73	11.87	18.91	24.73	14.31	0.00	2.55	9.97	23.00	8.88
15th Feb	1.70	1174	18.82	24.69	14.27	0.00	2.51	9.90	22.83	8.81
1st March	1.71	11.77	18.84	24.73	14.27	0.00	2.53	9.92	22.86	8.83
Mean	1.74	12.02	18.96	24.95		0.00	2.64)	10.22	23.16	
CD (P=0.05)										
	S = NS		I = 0.17		S x I = NS	S = NS		I = 0.25		SxI = 0.04

Table 2. Effect of harvest maturity on TSS content (°B) and reducing sugars content (%) during storage of aonla cultivars

Sampling date	TSS (°B)						Reducing sugars (%)					
	Storage Duration in Days (I)						Storage Duration in Days (I)					
	0	7	14	21	28	Mean	0	7	14	21	28	Mean
Banarsi												
1st Sep.	7.60	7.74	7.98	8.18	8.40	7.98	2.28	2.30	2.38	2.51	2.73	2.44
15th Sep.	8.30	8.41	8.62	8.90	9.13	8.67	2.73	2.76	2.85	3.00	3.16	2.90
1st Oct.	9.00	9.09	9.34	9.60	9.89	9.38	3.05	3.12	3.25	3.25	3.63	3.26
15th Oct.	9.12	9.30	9.57	9.83	10.05	9.57	3.38	3.51	3.63	3.88	4.10	3.70
1st Nov.	9.23	9.38	9.68	9.97	10.16	9.68	3.30	3.47	3.60	3.79	4.06	3.64
Mean	8.65	8.78	9.04	9.30	9.53		2.95	3.03	3.14	3.29	3.54	
CD (P=0.05)												
	S = 0.17		I = 0.17		S x I = NS		S = 0.03		I = 0.03		S x I = NS	
NA-7												
15th Oct.	8.00	8.12	8.39	8.54	8.77	8.36	2.62	2.69	2.83	2.97	3.03	2.83
1st Nov.	8.80	8.89	8.97	9.20	9.66	9.10	2.77	2.82	2.95	3.08	3.20	2.96
15th Nov.	9.50	9.66	9.92	10.14	10.45	9.93	3.14	3.23	3.45	3.62	3.73	3.43
1st Dec.	10.00	10.14	10.40	10.67	10.94	10.43	3.20	3.26	3.44	3.64	3.76	3.46
15th Dec.	10.20	10.30	10.61	11.05	11.24	10.68	3.13	3.24	3.40	3.59	3.76	3.42
Mean	9.30	9.42	9.66	9.92	10.21		2.97	3.05	3.21	3.38	3.50	
CD (P=0.05)												
	S = 0.22		I = 0.22		S x I = NS		S = 0.07		I = 0.07		S x I =NS	
Chakaiya												
15th Nov	9.40	9.60	9.90	10.00	10.24	9.83	2.95	2.98	3.07	3.21	3.36	3.11
1st Dec	10.50	10.80	10.92	11.08	11.46	10.95	3.16	3.20	3.32	3.49	3.67	3.37
15th Dec	12.00	12.14	12.32	12.70	13.10	12.45	3.75	3.83	3.98	4.21	4.38	4.03
1st Jan	12.10	12.29	12.79	12.98	13.24	12.68	3.67	3.78	3.92	4.17	4.36	3.98
15th Jan	12.20	12.38	12.76	13.05	13.36	12.75	3.49	3.66	3.80	4.14	4.35	3.89
Mean	11.24	11.44	11.74	11.96	12.28		3.40	3.49	3.62	3.84	4.02	
CD (P=0.05)												
	S = 0.59		I = NS		S x I = NS		S = 0.07		I = 0.07		S x I =NS	
Desi												
1st Jan.	9.00	9.13	9.45	9.58	9.73	9.38	1.49	1.53	1.57	1.62	1.65	1.57
15th Jan.	10.00	10.15	10.51	10.66	10.82	10.43	1.92	1.95	1.98	2.06	2.14	2.01
1st Feb.	11.50	11.69	12.10	12.29	12.48	12.01	2.11	2.14	2.24	2.31	2.36	2.23
15th Feb	11.80	12.00	12.37	12.61	12.83	12.32	2.19	2.23	2.28	2.34	2.39	2.29
1st March	12.00	12.20	12.70	12.83	13.05	12.55	2.10	2.18	2.25	2.31	2.38	2.24
Mean	10.86	11.03	11.43	11.59	11.78		1.96	2.01	2.06	2.13	2.18	
CD (P=0.05)												
	S = 0.20		I = 0.20		S x I = NS		S = 0.03		I = 0.03		S x I =NS	

Table 3. Effect of harvest maturity on ascorbic acid content (mg/100g) and tannins content (% gallotannic acid) during storage of aonla cultivars

Sampling date	Ascorbic acid (mg/100g) Storage Duration in Days (I)						Tannins (% gallotannic acid) Storage Duration in Days (I)					
	0	7	14	21	28	Mean	0	7	14	21	28	Mean
Banarsi												
1st Sep.	173.50	154.41	136.50	121.20	112.78	139.68	0.57	0.57	0.59	0.63	0.68	0.61
15th Sep.	256.46	232.00	212.50	191.40	167.98	212.07	0.56	0.57	0.60	0.63	0.65	0.60
1st Oct.	385.25	360.60	326.80	280.35	234.62	317.52	0.54	0.54	0.57	0.61	0.65	0.58
15th Oct.	480.00	444.00	403.45	372.10	314.72	402.85	0.51	0.52	0.55	0.58	0.64	0.56
1st Nov.	483.50	445.36	401.34	371.48	312.42	402.82	0.49	0.51	0.55	0.60	0.64	0.56
Mean	355.74	327.27	296.12	267.31	228.50		0.53	0.54	0.57	0.61	0.65	
c												
	S = 8.30		I = 8.30		S x I = 18.57		S = NS		I = 0.06		S x I = NS	
NA-7												
15th Oct.	243.46	218.00	206.60	192.86	160.76	204.34	0.55	0.58	0.63	0.65	0.69	0.62
1st Nov.	315.25	290.06	277.45	231.20	209.64	264.72	0.54	0.55	0.59	0.63	0.66	0.59
15th Nov.	402.30	378.16	361.80	315.10	278.38	347.15	0.52	0.54	0.56	0.63	0.65	0.58
1st Dec.	411.50	382.69	361.96	317.50	279.95	350.28	0.50	0.52	0.55	0.58	0.62	0.55
15th Dec.	414.21	385.29	363.59	318.20	279.00	352.06	0.48	0.48	0.54	0.59	0.63	0.54
Mean	357.34	330.84	314.04	274.77	241.55		0.52	0.53	0.57	0.62	0.65	
CD (P=0.05)												
	S = 3.85		I = 3.85		S x I = 8.61		S = NS		I = 0.05		S x I = NS	
Chakaiya												
15th Nov	260.50	245.50	216.10	168.93	129.93	204.20	0.79	0.82	0.87	0.93	0.96	0.87
1st Dec	343.20	326.74	287.63	227.23	174.99	271.96	0.62	0.64	0.65	0.71	0.74	0.67
15th Dec	434.41	414.92	366.47	292.63	225.63	346.86	0.57	0.58	0.65	0.69	0.73	0.64
1st Jan	437.00	416.90	367.00	293.60	223.87	347.67	0.54	0.56	0.64	0.70	0.73	0.63
15th Jan	439.40	419.00	368.59	291.31	224.00	348.46	0.52	0.55	0.60	0.69	0.74	0.62
Mean	382.90	364.45	321.16	254.74	195.68		0.61	0.63	0.68	0.74	0.78	
CD (P=0.05)												
	S = 6.82		I = 6.82		S x I = 15.26		S = 0.02		I = 0.02		S x I = NS	
Desi												
1st Jan.	215.00	191.35	172.25	154.00	141.05	174.73	0.83	0.83	0.88	0.95	0.98	0.89
15th Jan.	340.50	318.40	275.90	248.70	227.30	282.16	0.78	0.79	0.84	0.86	0.92	0.84
1st Feb.	485.00	452.00	390.36	353.00	322.04	400.48	0.71	0.73	0.77	0.80	0.85	0.77
15th Feb	491.40	460.13	399.30	357.46	333.14	408.29	0.69	0.71	0.75	0.78	0.84	0.75
1st March	495.42	461.00	399.00	356.87	329.30	408.32	0.69	0.72	0.75	0.79	0.84	0.76
Mean	405.46	376.58	327.36	294.01	270.57		0.74	0.76	0.80	0.84	0.89	
CD (P=0.05)												
	S = 5.51		I = 5.51		S x I = 12.33		S = 0. 02		I = 0.02		S x I = NS	

In the present study, tannin content increased significantly in all the cultivars with a progressive increase in storage duration from 7 to 28 days. The trends of increase in tannin content during storage were not affected by the sampling dates as the highest and the lowest tannin contents were recorded in fruits from the first and last samplings in all the cultivars at the time of harvest and after storage. The increase in tannin contents during storage (Table 3) may be because of the concentration effect due to loss of moisture from fruits and reduced activity of polyphenol oxidase activity during storage (Singh *et al.*, 2005). Tannins may also be synthesized in aonla fruit during storage as a natural defense mechanism against infection by diseases causing micro-organism as they play a vital role in disease resistance (Farkas and Kiraly, 1962).

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