International Food Research Journal 20(4): 1861-1865 (2013)
Journal homepage: http://www.ifrj.upm.edu.my

Quality evaluation in storage of aonla (*Emblica officinalis* Gaertn.) juice extracted from fruits preserved by steeping in water

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Article history

Received: 29 August 2012
Received in revised form: 18 January 2013
Accepted: 24 January 2013

Keywords

Aonla
Steeping preservation
Juice
Storage
Quality

Abstract

Aonla (*Emblica officinalis* Gaertn.) fruits are preserved either in water or salt solution for a couple of weeks for the commercial preparation of products. In the present study, quality of aonla (cv. Chakaiya) juice prepared from fruits steep preserved in water for 30 days was assessed during storage up to 9 months under ambient conditions. The juice was prepared from fruits withdrawn at 0, 5, 10, 15, 20 and 30 days of steeping preservation in water, pasteurized at 90°C and preserved with 500 ppm SO_2 in glass bottles under ambient conditions. A continuous decrease in TSS (6.7 to 2.6 °B), titratable acidity (1.52 to 0.48%), ascorbic acid (292.0 to 36.5 mg/100 g) and polyphenols (1.32 to 0.76%) were observed in fruits with the prolongation of steeping period. The retention of nutrients was better up to 10 days of fruit preservation, thereafter a sharp decline in nutrients was noticed. Subsequently, the quality of extracted juice was also deteriorated significantly as the steeping preservation of fruits in water prolonged. The contents of ascorbic acid and polyphenols in fresh juice decreased from 309 to 43 mg/100 ml and 3.09 to 0.57 per cent, respectively, when extracted from fruits after 30 days of steeping preservation. In juice, prepared from fruits steep preserved for more than 10 days, the decline in nutritional quality was more pronounced. The quality parameters in juice deteriorated further upon 9 months of storage. The retention of ascorbic acid in juice was found to be around 50 per cent after 4 months of storage when prepared from fresh and 10 days steep preserved fruits. Though polyphenols decreased significantly in juice during storage up to 9 months, the loss was minimum (less than 20%) up to 4 months. TSS and titratable acidity did not change significantly during storage of juice though found slightly reduced. Non-enzymatic browning (NEB) was also minimum (0.040 OD) during initial period of juice storage (up to 4 months). The study indicated that juice extracted from aonla fruits steep preserved in water up to 10 days could retain maximum quality up to 4 months of storage under ambient conditions.

Introduction

The Indian gooseberry (*Emblica officinalis* Gaertn.), also known as Amla or Aonla, belongs to the family Euphorbiaceae and is a native of India, Sri Lanka, Malaysia, Thailand and China. The fruit is establishing its popularity worldwide because of the proven medicinal and nutraceutical properties. Fruits are rich in ascorbic acid and polyphenols and thereby possessing the ability to scavenge free radicals. It has been reported that a single aonla fruit contains almost 20 times more ascorbic acid than two oranges (Yadav *et al*., 2011). Fruits also possess expectorant, antiviral, hypoglycemic and cardio-protective activities (Kalra, 1988). Though the fruit is rich in antioxidants and other nutrients, it is not consumed fresh because of high acidity and astringency. It is, therefore, processed into various value-added products, viz. preserve (murabba), candy, juice, pickle, powder, segments-in-syrup, etc. (Rakesh *et al*., 2004). Aonla juice is one of the important processed products retaining maximum amount of ascorbic acid after processing (Damame *et al*., 2002). It has good potentiality for blended and spiced beverages along with direct consumption as health drink. However, juice suffers from severe browning and loss of ascorbic acid during storage at room temperature affecting its overall acceptability (Bhattacherjee *et al.*, 2012). Storage of juice at low temperature could check the loss of ascorbic acid and non-enzymatic browning up to 6 months (Jain and Khurdiya, 2009).

Aonla juice is commercially prepared either from fresh fruits or fruits preserved either in water or salt solution for a few weeks for extended processing period. The loss of nutrients through leaching from aonla fruits during steeping preservation in salt solution was reported by Ghorai and Sethi (1996). The quality of juice, prepared from steep preserved fruits, can also be affected during storage. The present study was, therefore, aimed to evaluate the loss in

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quality of aonla fruits during steeping preservation in water under ambient conditions as well as assessment of quality of juice extracted from such fruits during ambient storage.

Materials and Methods

Mature and healthy aonla fruits of cv. Chakaiya, procured from the experimental farm of the institute, were washed thoroughly under running tap water and preserved in water for 30 days in steel container (50 L capacity) at room temperature (15-20°C). The water was changed twice a week to avoid the appearance of microbial growth. The fruit samples were withdrawn in triplicate at 0, 5, 10, 15, 20 and 30 days of preservation for quality evaluation. Juice was extracted after each withdrawal of fruits with a hydraulic press (Bajaj Machinen, New Delhi) at 10.3 MPa (1500 lb/inch^2) pressure after crushing the fruits in a fruit mill. It was pasteurized at 90°C for 2 min and preserved with 500 ppm SO_2 as potassium metabisulphite in presterlized glass bottles (200 ml capacity) up to 9 months under ambient conditions (15-35°C, 50-80% R.H.).

Both fruits and juice, in triplicate, were subjected to analysis for various quality parameters at periodical intervals during preservation and storage. Total soluble solids (TSS) were measured by using hand refractometer (Erma, Japan), while titratable acidity and ascorbic acid were estimated by titrimetric methods using 0.1N NaOH and 2,6-dichlorophenol indophenol dye solutions, respectively (Ranganna, 2000). Polyphenols content in fruits and juice were estimated spectrophotometrically at 760 nm using Follin and Ciocalteu's phenol reagent (AOAC, 1984). Non-enzymatic browning (NEB) in juice was determined by measuring the optical density (OD) values of methanol extracted samples at 440 nm in a UV-VIS spectrophotometer (Labomed Inc, USA). The data obtained were subjected to statistical analysis as per the standard methods (Snedecor and Cochran, 1967) at 5% significance level.

Results and Discussion

Changes in quality parameters in fruits during steeping preservation

All the quality parameters like TSS, titratable acidity, ascorbic acid and polyphenols decreased significantly in fruits throughout the 30 days of steeping preservation in water (Table 1). Initially the reduction in quality was slow up to 10 days of preservation, thereafter it declined sharply. TSS decreased from 6.7 to 5.5°Brix in fruits preserved up to 10 days in water, which further declined to 2.6°Brix in fruits preserved up to 30 days. Titratable acidity of preserved fruits decreased slightly from 1.52 to 1.29 per cent until 10 days of fruit preservation but declined sharply after that and only 0.48 per cent acidity was recorded in fruits after 30 days of preservation. The loss in the contents of TSS and titratable acidity was 17.9 and 15.1 per cent, respectively, up to 10 days of fruit preservation, while it was 61.2 and 68.4 per cent, respectively, after 30 days of fruit preservation. Ascorbic acid was also lost severely (87.5%) after 30 days of steeping, while the loss was moderate (21.4%) up to 10 days of steeping. It decreased from 292.0 to 229.4 mg/100 g in fruits steeped up to 10 days and finally to 36.5 mg/100 g in fruits steeped up to 30 days. The contents of polyphenols declined from 1.32 per cent in fresh fruits to 1.10 and 0.76 per cent in fruits after 10 and 30 days of steeping, respectively. The loss in polyphenols amounted to 42.4 per cent in fruits steep preserved up to 30 days. The main reason for loss of these nutrients was leaching as all of them are water-soluble and may leach easily into water due to osmosis. Ascorbic acid is also sensitive to oxidation and the oxidation by dissolved oxygen in water might be another cause for its heavy loss during prolonged preservation. Similar type of losses in acidity, ascorbic acid and polyphenols due to leaching has been reported by Ghorai and Sethi (1996) during preservation of aonla fruits up to 30 days in a steeping solution containing 10% salt, 200 ppm SO_2 and 0.5% acetic acid. They observed more than 70, 54 and 35 per cent losses in ascorbic acid, polyphenols and acidity, respectively, after 30 days of steeping preservation.

Table 1. Quality of aonla fruits (cv. Chakaiya) steep preserved in water

Quality parameters	Steeping period of fruits (days)					
	0	5	10	15	20	30
TSS (°Brix)	6.7	5.5	5.5	3.0	2.8	2.6
Acidity (%)	1.52	1.39	1.29	0.73	0.60	0.48
Ascorbic acid (mg/100 g)	292.0	252.8	229.4	63.9	50.4	36.5
Polyphenols (%)	1.32	1.23	1.10	0.87	0.81	0.76
CD at 5%	Parameters (P)		Steeping period (SP)		P x SP	
	0.414		0.507		1.013	

Changes in quality of fresh aonla juice extracted from steep preserved fruits

The loss of nutrients from fruit during storage was directly reflected in juice extracted from fruits after each withdrawal. The yield of juice, extracted from steep preserved fruits, along with the changes in quality characteristics is presented in Table 2. The juice yield varied between 53.1 to 58.8 per cent, which was non-significant. TSS declined from 7.2 to 2.0°Brix in juice extracted from fresh and 30 days

Table 2. Quality of fresh aonla juice extracted from steep preserved fruits in water

Quality parameters	Steeping period of fruits (days)					
	0	5	10	15	20	30
Juice yield (%)	54.7	58.8	53.1	56.6	56.5	56.4
TSS (°Brix)	7.2	6.9	5.0	3.0	2.0	2.0
Acidity (%)	1.56	1.37	1.04	0.61	0.49	0.34
Ascorbic acid (mg/100 ml)	309	300	197	82	55	43
Polyphenols (%)	3.09	2.58	2.02	1.25	1.05	0.57
NEB (OD at 440 nm)	0.011	0.008	0.005	0.003	0.003	0.001
CD at 5%	Parameters (P)		Steeping period (SP)			P x SP
	1.132		1.240			2.772

Table 3. Changes in quality parameters in aonla juice during storage

Storage of juice (months)	Steeping period of fruits (days)					
	0	5	10	15	20	30
			TSS (°Brix)			
0	7.2	6.9	5.0	3.0	2.0	2.0
2	6.8	6.2	4.8	3.2	2.4	2.0
4	6.4	6.0	4.5	3.1	2.4	2.0
6	6.6	6.0	4.6	3.2	2.4	2.0
9	6.5	6.0	4.5	3.2	2.4	2.0
CD at 5%	Juice Storage (JS)		Steeping period (SP)			JS x SP
	0.055		0.060			0.134
			Titratable acidity (%)			
0	1.56	1.37	1.04	0.61	0.49	0.34
2	1.35	1.21	0.98	0.66	0.46	0.36
4	1.20	1.18	0.92	0.66	0.41	0.35
6	1.18	1.08	0.92	0.63	0.39	0.30
9	1.14	1.05	0.92	0.59	0.36	0.26
CD at 5%	Juice Storage (JS)		Steeping period (SP)			JS x SP
	0.011		0.012			0.028
			NEB (OD at 440 nm)			
0	0.011	0.008	0.005	0.003	0.003	0.001
2	0.036	0.039	0.026	0.026	0.022	0.014
4	0.053	0.049	0.040	0.029	0.026	0.015
6	0.071	0.067	0.046	0.030	0.029	0.018
9	0.091	0.076	0.066	0.032	0.030	0.021
CD at 5%	Juice Storage (JS)		Steeping period (SP)			JS x SP
	0.0008		0.0008			0.002

steeped fruits, respectively. The losses in titratable acidity, ascorbic acid and polyphenols in juice ranged between 1.56 to 0.34 per cent, 309 to 43 mg/100 ml and 3.09 to 0.57 per cent, respectively, when prepared from fresh and 30 days preserved fruits. It accounted for 78.2, 86.1 and 81.6 per cent losses in acidity, ascorbic acid and polyphenols in juice prepared from 30 days preserved fruits. The contents of these nutrients were much higher in juice (1.04% acidity, 197 mg/100 ml ascorbic acid and 2.02% polyphenols) extracted from fruits preserved up to 10 days in water. The decline in quality parameters was initially slow (up to 10 days of steeping) followed by a sharp decline thereafter. When juice was extracted from fresh fruits, the content of ascorbic acid increased slightly and that of polyphenols increased significantly (more than double) in juice than in fruits due to their high water solubility. Damame *et al.* (2002) have also reported that the amount of ascorbic acid was higher in aonla juice than in fruits because of its better solubility in water. A decreasing trend in the contents of ascorbic acid and polyphenols in an aonla product (segments-in-syrup) was noticed when it was prepared from fruits stored up to 9 days under ambient conditions (Nayak *et al*., 2011). A slight degree of non-enzymatic browning (NEB) was observed in juice extracted from fruits steep preserved for 0 and 5 days (0.011 and 0.008 OD). However, it was negligible in juice prepared from fruits steep preserved for more than 10 days (OD values ranged between 0.001 - 0.005) (Table 2). The negligible browning in juice obtained from fruits steep preserved for more than 10 days might be attributed to the loss of colour from fruits during prolonged period of steeping along with the loss of ascorbic acid and polyphenols through leaching. Shinoda *et al.* (2005) in orange juice and Bhattacherjee *et al.* (2011) in aonla juice have mentioned earlier that degree of browning in fruit juices during storage changed with the changes in ascorbic acid and polyphenols contents, which proved that both ascorbic acid and polyphenols played an important role in browning of fruit juices.

Changes in quality parameters in juice during storage

The data on chemical composition of aonla juice during 9 months of storage are presented in Table 3. The storage study revealed that TSS did not change significantly throughout the storage period of juice. TSS in juice, prepared from fresh, 5 days or 10 days steep preserved fruits, decreased marginally from 7.2 to 6.5°Brix, 6.9 to 6.0°Brix and 5.0 to 4.5°Brix, respectively, after 9 months of storage. A decreasing pattern in titratable acidity of juice was noticed throughout the storage period. However, when juice was extracted from 15 days preserved fruits, a marginal increase (from 0.61 to 0.66%) was noticed which finally decreased to 0.59 per cent after 9 months of storage (Table 3). Acidity decreased significantly in juice during 9 months of storage from 1.56 to 1.14 per cent, 1.04 to 0.92 per cent and 0.34 to 0.26 per cent, when prepared from fresh, 10 or 30 days steep preserved fruits, respectively. Similar decreasing pattern in titratable acidity in aonla juice was observed by Bhattacherjee *et al.* (2012) during 8 months of storage at low, high and room temperatures. Titratable acidity decreased at a faster rate during initial period of juice storage (4 months) but at a slower rate thereafter particularly in juice extracted from fresh, 5 or 10 days steep preserved fruits.

The most significant change in quality of juice during storage was noticed in terms of ascorbic acid content, which decreased continuously in all the juice samples throughout the storage period (Figure 1a). It decreased from 309 to 111 mg/100 ml, 197 to 73 mg/100 ml and 43 to 8 mg/100 ml in juice prepared from fresh, 10 or 30 days steep preserved

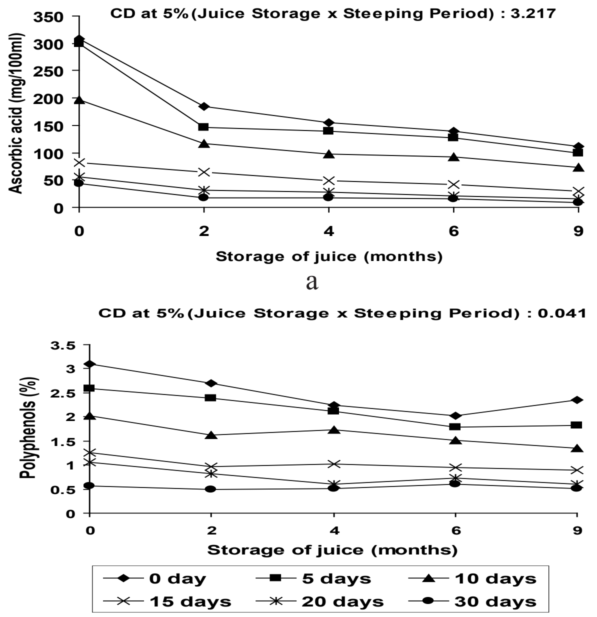

Figure 1. Changes in (a) ascorbic acid and (b) polyphenols contents in aonla juice, extracted from steep preserved fruits in water, during storage under ambient conditions

fruits, respectively, after 9 months of storage under ambient conditions. The decline was faster up to 2 months and became slower until 9 months of storage. Around 50 per cent of ascorbic acid could be retained in juice extracted from fresh, 5 or 10 days steeped fruits up to 4 months of storage. The loss of ascorbic acid was comparatively less (around 60%) in juice prepared from fruits steep preserved up to 15 days than in juice extracted from fruits steep preserved for more than 15 days, where the losses were more than 75 per cent. Since ascorbic acid is a heat sensitive water soluble vitamin prone to oxidation, its massive loss during later period of storage might be due to the increase in room temperature (from 15 to 35°C) as well as its oxidation to dehydroascorbic acid by dissolved oxygen in juice. Bhattacherjee *et al.* (2012) have also observed that storage of aonla juice at room temperature (20-30°C) up to 8 months resulted in a loss of 41.6 per cent of ascorbic acid, which further increased to 86.2 per cent when juice was stored at higher temperature (40 ± 2°C). Significant loss of ascorbic acid in aonla juice and other products have also been reported by several workers (Kumar and Singh, 2001; Damame *et al*., 2002) during storage at room temperature.

A variable but decreasing trend in the content of polyphenols was noticed in juice during storage (Figure 1b). When juice was obtained from fresh, 10 or 30 days steep preserved fruits and stored up to 9 months under ambient conditions, the content of polyphenols decreased from 3.09 to 2.35, 2.02 to 1.34 and 0.57 to 0.51 per cent, respectively. The retention of polyphenols after 9 months of storage was maximum (89.5%) in juice extracted from 30 days steeped fruits followed by juice extracted from fresh fruits (76.0%). However, the retention of polyphenols was better (82.2 and 86.1%) in juice extracted from 5 or 10 days steep preserved fruits up to 4 months of storage. Though a significant loss of polyphenols (42.4%) was noticed in fresh fruits preserved up to 30 days in water, the same was not reflected in stored juice extracted from such fruits, but the intensity of loss in juice during storage was low because the initial amount was very less. The loss of polyphenols in aonla juice during 9 months of storage under ambient conditions has also been observed by Bhattacherjee *et al.* (2011). They mentioned that some individual polyphenols like caffeic acid and kaempferol decreased continuously throughout the storage of juice resulting into the loss of total polyphenols. Gliszezynska and Tyrakowska (2003) have also reported a decrease in the contents of phenolic acids (5-21%) and flavonoids (8-19%) in apple juice stored under ambient conditions up to 11 months. Since polyphenols are water-soluble compounds sensitive to oxidation, degradation of total polyphenols in juice during long term storage was expected.

The most significant change in physical appearance was noticed in terms of browning, which is a common feature in aonla juice during storage. Non-enzymatic browning (NEB) increased moderately in all the juice samples, irrespective of steeping period of fruits, throughout the storage period (Table 3). The increase in NEB was slightly higher in juice extracted from early stages of steep preserved fruits as compared to juice obtained from fruits preserved for longer period. This might be due to the loss of colour as well as ascorbic acid and polyphenols during prolonged steeping period. In juice prepared from 0, 10 or 30 days steep preserved fruits, NEB increased from 0.011 to 0.091, 0.005 to 0.066 and 0.001 to 0.021 OD, respectively, during 9 months of storage. The browning was minimum in juice stored up to 4 months, thereafter it increased rapidly. The increase in ambient temperature from 15 to 35°C during storage might have aggravated browning in aonla juice. The degradation of ascorbic acid in juice during long storage period might be another reason for increase in NEB. Wong and Stanton (1989) have suggested that reactions involving ascorbic acid contributed more to overall browning in kiwi fruit juice during storage as compared to Maillard reaction. As aonla juice is very low in sugar and protein contents, the chances of Maillard reaction as major contributing factor for browning of juice during storage are least. Similar observations regarding the increase in NEB in aonla juice during storage at room temperature have also been reported earlier (Jain and Khurdiya, 2009; Bhattacherjee *et al*, 2012). The increase in browning with the increase in storage temperature as well as duration has also been reported in apple and peach juices (Burdurlu and Karadeniz, 2003; Buedo *et al.*, 2001).

Conclusion

The study indicated that the retention of ascorbic acid and polyphenols was better in fruits steep preserved up to 10 days in water, thereafter they declined sharply. The reduction in these nutrients was also reflected in juice extracted from the preserved fruits. The storage study of juice indicated that extracted juice could be stored up to 4 months under ambient conditions by retaining good amounts of nutrients and exhibiting minimum browning. Therefore, it can be concluded from the study that commercial preparation of good quality juice from fruits steep preserved up to 10 days in water can be possible which can retain maximum quality up to 4 months during storage under ambient conditions.

References

A.O.A.C. 1984. Official methods of analysis. Association of Official Analytical Chemists, Washington D.C., USA.

Bhattacherjee, A. K., Tandon D. K., Dikshit, A. and Kumar, S. 2011. Effect of pasteurization temperature on quality of aonla juice during storage. Journal of Food Science and Technology 48 (3): 269-273.

Bhattacherjee, A. K., Dikshit, A., Kumar, S. and Tandon, D. K. 2012. Quality of aonla juice as affected by storage temperature. Beverage and Food World 39 (4): 54-56.

Buedo, A. P., Elustondo, M. P. and Urbicain, M. J., 2001. Non-enzymatic browning of peach juice concentrate during storage. Innovative Food Science and Emerging Technologies 1 (4): 255-260.

Burdurlu, H. S. and Karadeniz, F. 2003. Effect of storage on nonenzymatic browning of apple juice concentrates. Food Chemistry 80 (1): 91-97.

Damame, S. V., Gaikwad, R. S., Patil, S. R. and Masalkar, S. D. 2002. Vitamin C content of various aonla products during storage. Orissa Journal of Horticulture 30 (1): 19-22.

Ghorai, K. and Sethi, V. 1996. Varietal suitability of amla (Desi and Banarasi) fruits for storage and preservation. Indian Food Packer 50 (1): 11-18.

Gliszezynska, S. A. and Tyrakowska, B. 2003. Quality of commercial apple juices evaluated on the basis of the polyphenols contents and the TEAC antioxidant activity. Journal of Food Science 68 (5): 1844-1849.

Jain, S. K. and Khurdiya, D. S. 2009. Ascorbic acid content and non-enzymatic browning in stored Indian gooseberry juice as affected by sulphitation and storage. Journal of Food Science and Technology 46 (5): 500-501.

Kalra, C. L. 1988. The chemistry and technology of amla (*Phyllanthus emblica*) – A resume. Indian Food Packer 42 (4): 67-82.

Kumar, S. and Singh, I. S. 2001. Storage studies of aonla fruit products at ambient temperature. Progressive Horticulture 33 (2): 169-173.

Nayak, P., Bhatt, D. K., Shukla, D. K. and Tandon, D. K. 2011. Evaluation of aonla (*Phyllanthus emblica* G.) segments-in-syrup prepared from stored fruits. Research Journal of Agricultural Science 43 (2): 252-257.

Rakesh, Arya, S. S. and Moond, S. K. 2004. Processing products of aonla. Processed Food Industry 7 (4): 20-23.

Ranganna, S. 2000. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd edn. New Delhi, India: Tata McGraw Hill Publishing Company Ltd.

Shinoda, Y., Komura, H., Homma, S. and Murata, M. 2005. Browning of model orange juice solution: factors affecting the formation of decomposition products. Bioscience Biotechnology and Biochemistry 69 (11): 2129-2137.

Snedecor, G. W. and Cochran, W. G. 1967. Statistical Methods. Ames: Iowa State University Press.

Wong, M. and Stanton, D. W. 1989. Nonenzymic browning in kiwifruit juice concentrate systems during storage. Journal of Food Science 54 (3): 669-673.

Yadav, M. K., Patel, N. L. and Hazarika, A. 2011. Effect of pre-drying treatments and drying methods on ascorbic acid of dehydrated aonla product during storage. Beverage and Food World 38 (12): 20-21.