Journal of Stored Products and Postharvest Research Vol.3 (12) pp. 160 – 166, November 2012
Available online at http://www.academicjournals.org/JSPPR
DOI: 10.5897/JSPPR11.075
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Full Length Research Paper

Quality evaluation of segments-in-syrup as affected by steeping preservation of aonla fruits

Priyanka Nayak[1], Dharmendra Kumar Shukla[2], Devendra Kumar Bhatt[3] and Dileep Kumar Tandon[2]

[1]Manyavar Shri Kashi Ram Ji University of Agriculture and Technology, Banda, India.
[2]Division of Post Harvest Management, CISH, Lucknow, India.
[3]Department of Food Technology, Bundelkhand University, Jhansi, India.

Accepted 4 April 2012

Steeping preservation is one of the technologies comparatively economical and easy to follow for processing fruits for a prolonged period. In the present study, aonla fruits were preserved in solutions, viz: water (control), water + 500 ppm SO_2, water + 2% salt solution + 500 ppm SO_2, water + 5% sugar solution + 500 ppm SO_2 and water + 2% salt solution + 5% sugar solution + 500 ppm SO_2, up to 90 days and fruits were withdrawn at 0, 15, 30, 60 and 90 days of storage for the preparation of product segments-in-syrup. For the preparation of product, aonla fruits were blanched in boiling water for 10 min and segments were separated. The segments were dipped in successive increasing concentration (55, 65 and 72°B) of sugar syrup at room temperature till equilibrium was reached at 72°B. The segments were packed in syrup at 72°B in PET jars and quality parameters were evaluated in segments as well as in syrup. The analyses of fruits showed that the contents of TSS, titratable acidity, ascorbic acid, polyphenols and sugars decreased continuously as the period of steeping preservation of fruits increased. In general, the quality of the product decreased as the storage of fruits in different preservation solutions increased. The fruits preserved in water (control) spoiled up on 90 days of storage. The prepared product from fruits steeped preserved in water up to 60 days was acceptable. Highly acceptable product was obtained from fruits preserved in water + 2% salt solution + 5% sugar solution + 500 ppm SO_2, up to 90 days.

Key words: Aonla, segments-in-syrup, steeping, preservation, blanching.

INTRODUCTION

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.), a versatile fruit tree, belongs to the family Ephorbiaceae. Aonla has been cultivated in India since time immemorial. Besides India, naturally growing aonla trees are also found in different parts of the world, viz: Sri Lanka, Cuba, Puerto Rico, Chiana, Thiland and Japan (Hooker, 1973; Baileri, 1917). The fruit has high medicinal and nutritional value and is one of the richest known sources of ascorbic acid (300 to 1000 mg per 100 g edible portion) depending upon the cultivar and location (Kalra, 1988; Manny and Swamy, 1997). The fruit also contains polyphenols which have antioxidant property and, thus, have good free radical scavenging activity (Shanker, 1969). Polyphenols found in fruits contain gallic acid and ellagic acid, and glucose in the moiety, prevent and/or retard oxidation of ascorbic acid. Therefore, even after processing, aonla fruits retain a major part of ascorbic acid and polyphenols. Its regular use increases body resistance against diseases, prevents aging, improves vitality, stimulates digestive system, cures piles, urinary diseases and diabetes and, therefore, used for manufacturing drugs, cosmetics and herbal products (Prabhu et al., 2003). The *brahma rasayan*, c*hyavanprash* and t*riphala* are famous ayurvedic preparations in which aonla fruit is a major constituent. However, aonla fruit is not consumed freely in fresh form because of its astringent taste. It is, therefore, not popular as a dessert fruit and due to this fact it is processed into value added products (Nayak et al., 2011).

*Corresponding author. E-mail: dkbhatt_2003@ rediffmail.com. Tel: +919453039873.

Presently, a number of products like juice, preserve, candy, powder, pickle, etc., are prepared from aonla fruits. Aonla segments-in-syrup, a new product developed at the Institute, has good nutritional quality as compared to preserve (Nayak and Tandon, 2006; Bhattacharjee et al., 2012). Aonla is a highly perishable fruit and its shelf life is poor (Singh et al., 2005). Hence, its preservation is necessary for the preparation of products for a longer period. Steeping preservation of fruits and vegetables involving permissible chemical preservatives is one of the methods to enhance their storability without much deterioration in the quality (Sethi and Maini, 2000). Therefore, the present investigation was undertaken to assess the loss in quality of fruits as well as segments-in-syrup prepared from aonla fruits steeped preserved in water and different solutions.

MATERIALS AND METHODS

Mature aonla fruits of aonla cv. Chakaiya, obtained from the experimental farm of CISH, Lucknow, were washed thoroughly under tap water. The fruits were steeped preserved in different solutions, viz: water (control, T1), water + 500 ppm SO_2 (T2), water + 2% salt solution + 500 ppm SO_2 (T3), water + 5% sugar solution + 500 ppm SO_2 (T4) and water + 2% salt solution + 5% sugar solution + 500 ppm SO_2 (T5) in glass jars of 1 kg capacity at room temperature. There were four replications having 500 g fruits each. The water (control) was changed twice a week. The fruits were withdrawn at 0, 15, 30, 60 and 90 days of storage for the preparation of product segments-in-syrup. The fruits were blanched in 2% alum solution for 10 min and then segments were separated manually. The separated segments were dipped in sugar syrup of 55°B having 500 ppm SO_2 as potassium metabisulphite and kept for one day at room temperature. Next day, the segments were taken out from the syrup and the syrup was concentrated to 65°B by boiling and adding extra sugar. The segments were dipped again in sugar syrup and kept for two days at room temperature. Thereafter, TSS of syrup was increased to 72°B by boiling and adding extra sugar after removing the segments. The segments were dipped again in sugar syrup (72°B) and kept at room temperature for another two days. The segments were then packed with sugar syrup (72°B) by adjusting the TSS in airtight 500 g capacity PET jars for quality evaluation.

The quality parameters, viz: TSS, titratable acidity, ascorbic acid, polyphenols, total sugars and reducing sugars at each withdrawl stage in steeped preserved fruits and products (both segments and syrups) were analyzed as per methods described by Ranganna (1997). The sensory quality of the product on the basis of colour, texture and taste was assessed by 5 semi skilled judges on Hedonic scale. The data was analyzed statistically and reported at 5% significance level (Panse and Sukhatme, 1961).

RESULTS

Changes in biochemical characters of steeped preserved fruits

The data on biochemical characters of fresh and steeped preserved aonla fruits are presented in Table 1. Fresh aonla fruit contained 9.7°B TSS, 1.7% titratable acidity, 309 mg 100 g^{-1} ascorbic acid, 1.73% polyphenols, 7.4% total sugars and 1.6% reducing sugars. The fruits steeped in water (T1) were spoiled up on 90 days of storage. A continuous decrease in TSS of preserved fruits was noticed except in fruits stored in sugar solution where it increased. After 60 days of storage treatment, T1 showed minimum content of TSS (4.5°B). Maximum TSS content (8.7°B) was noted in fruits of treatment T4 (water + 2% sugar solution + 500 ppm SO_2) at 15 days of storage which increased gradually to 9.3°B after 90 days of storage. Titratable acidity decreased in all the treatments as the storage period prolonged. Minimum (0.83%) titratable acidity was observed in treatment T4 after 15 days of storage, which further declined to 0.46% after 90 days of storage. On the other hand, maximum acid content (0.95%) was recorded in treatment T3 (water + 2% salt solution + 500 ppm SO_2) in fruits after 90 days of storage. The ascorbic acid declined from 309 mg 100 g^{-1} in fresh fruits to 172 mg 100 g^{-1} in fruits steeped preserved in treatment T3 after 90 days of storage. Similarly, polyphenols content decreased in steeped preserved fruits. Maximum content (1.50%) of polyphenols was noticed in treatment T3, whereas minimum (1.36%) in treatment T1 after 15 days of fruit storage. After 90 days of fruit preservation, highest (0.82%) polyphenols content was recorded in treatment T3 and lowest (0.66%) in treatments water + 2% sugar solution + 500 ppm SO_2 (T4) and water + 2% salt solution + 5% sugar + 500 ppm (T5).

The contents of total and reducing sugars decreased as the preservation of fruits in different solution increased. Maximum (3.6%) total sugars content was noted in T4, while minimum (2.3%) in T2 after 90 days of storage. Reducing sugars content was maximum (0.90%) in T4 and minimum (0.76%) in T2 after 90 days of fruit storage.

Changes in biochemical characters of the prepared product

The data on biochemical characters of segments and syrup are presented in Tables 2 and 3, respectively. The segments of the product contained 72.0°B TSS, 1.2% titratable acidity, 113 mg 100 g^{-1} ascorbic acid, 0.90% polyphenols, 48.7% total sugars and 18.9% reducing sugars, while syrup contained 72.0°B TSS, 1.08% titratable acidity, 98 mg 100 g^{-1} ascorbic acid, 0.51% polyphenols, 46.4% total sugars and 17.6% reducing sugars when prepared from fresh fruits. The maximum (92 mg 100 g^{-1}) ascorbic acid content in segments was recorded in treatment T4, while minimum (65 mg 100 g^{-1}) in treatment T5 when the product was prepared from 15 days steeped preserved fruits. Highest (56 mg 100 g^{-1}) ascorbic acid content in segments was found in treatment T4, while lowest (37 mg 100 g^{-1}) in treatment T5 when the product was prepared from fruits stored for 90 days. Similarly, maximum (40 mg 100 g^{-1}) ascorbic acid content in syrup was recorded in treatment T4, while minimum (25 mg 100 g^{-1}) in treatment T5 when the product was prepared from 90 days stored fruits.

Table 1. Quality evaluation of steeped preserved aonla fruits.

Treatments	Storage period (days)	T1	T2	T3	T4	T5	CD at 5%		
							Treatments	Storage period	Treatments × period
TSS (°B)	0	9.7	9.7	9.7	9.7	9.7	0.30	0.30	0.67
	15	5.7	6.1	6.5	8.7	8.0			
	30	5.0	5.5	5.7	8.9	8.4			
	60	4.5	5.1	5.3	9.0	8.5			
	90	Spoiled	4.6	5.0	9.3	8.7			
Titratable acidity (%)	0	1.7	1.7	1.7	1.7	1.7	0.97	0.97	0.21
	15	1.33	1.36	1.30	0.83	0.95			
	30	1.18	1.22	1.15	0.70	0.83			
	60	1.10	1.10	1.00	0.58	0.66			
	90	Spoiled	0.90	0.95	0.46	0.60			
Ascorbic acid (mg/100 g)	0	309	309	309	309	309	NS	32.4	73.5
	15	279	284	272	270	261			
	30	233	248	240	243	240			
	60	214	216	203	229	221			
	90	Spoiled	179	172	208	206			
Polyphenols (%)	0	1.73	1.73	1.73	1.73	1.73	0.026	0.026	0.059
	15	1.36	1.46	1.50	1.40	1.40			
	30	1.05	1.08	1.12	1.06	1.03			
	60	0.85	0.87	0.93	0.86	0.83			
	90	Spoiled	0.75	0.82	0.66	0.66			
Total sugar (%)	0	7.4	7.4	7.4	7.4	7.4	0.22	0.22	0.50
	15	3.4	3.7	3.9	5.0	4.5			
	30	3.2	3.3	3.4	4.6	4.2			
	60	2.7	2.9	3.0	3.8	3.8			
	90	Spoiled	2.3	2.5	3.6	3.3			
Reducing sugar (%)	0	1.6	1.6	1.6	1.6	1.6	0.46	0.46	0.10
	15	1.06	1.03	1.10	1.36	1.20			
	30	0.86	0.96	0.98	1.26	1.00			
	60	0.73	0.80	0.86	1.06	0.96			
	90	Spoiled	0.76	0.78	0.90	0.86			

T1- water, T2- water + 500 ppm SO_2, T3- water + 2% salt solution + 500 ppm SO_2, T4- water + 2% sugar solution + 500 ppm SO_2 and T5- water + 2% salt solution + 5% sugar + 500 ppm.

The polyphenols content in segments as well as in syrup decreased as the steeping preservation of fruits prolonged. The polyphenols content in segments was minimum (0.41%) in T2, while maximum (0.47%) in treatments T4 and T5 and in syrup it was minimum (0.25%) in T4 and maximum (0.32%) in water + 500 ppm SO_2 (T2) when the product was prepared after 90 days of preserved fruits.

Maximum (51.2%) total sugars was noted in segments of the product in treatment T3, prepared from 90 days stored fruits, while lowest (45.0%) in T1, prepared from 15 days stored fruits. Maximum (50.6%) total sugars was noted in syrup of the product T3, prepared from 90 days stored fruits, while lowest (46.5%) in T1, prepared from 15 days stored fruits. Similarly, reducing sugars content was maximum (20.6%) in segments of treatment T2, prepared from 90 days stored fruits, while lowest (17.2%) in T2, prepared from 15 days stored fruits. Maximum (18.7%) reducing sugars was noted in syrup of the product in treatment T5, prepared from 90 days stored

Table 2. Quality evaluation of the segments of the product prepared from steeped preserved aonla fruits.

Treatments	Storage period (days)	T1	T2	T3	T4	T5	CD at 5%		
							Treatments	Storage period	Treatments × period
TSS (°B)	0	72.0	72.0	72.0	72.0	72.0	0.80	0.71	1.60
	15	72.0	72.0	72.0	72.0	72.0			
	30	72.0	72.0	72.0	72.0	72.0			
	60	72.0	72.0	72.0	72.0	72.0			
	90	Spoiled	72.0	72.0	72.0	72.0			
Titratable acidity (%)	0	1.20	1.20	1.20	1.20	1.20	0.53	0.53	0.11
	15	1.00	1.03	1.06	1.00	1.00			
	30	0.96	0.93	0.96	0.93	0.90			
	60	0.83	0.90	0.90	0.86	0.86			
	90	Spoiled	0.80	0.80	0.76	0.76			
Ascorbic acid (mg/100 g)	0	113	113	113	113	113	0.91	0.91	2.04
	15	76	84	83	92	65			
	30	58	74	67	87	51			
	60	42	57	46	66	42			
	90	Spoiled	39	38	56	37			
Polyphenols (%)	0	0.90	0.90	0.90	0.90	0.90	0.41	0.41	0.09
	15	0.72	0.74	0.70	0.73	0.77			
	30	0.56	0.62	0.62	0.65	0.70			
	60	0.48	0.50	0.53	0.57	0.59			
	90	Spoiled	0.41	0.43	0.47	0.47			
Total sugars (%)	0	48.7	48.7	48.7	48.7	48.7	0.16	0.16	0.35
	15	45.0	48.3	48.2	49.9	47.3			
	30	46.4	49.6	50.2	50.5	48.3			
	60	46.6	48.9	50.6	50.4	48.9			
	90	Spoiled	47.4	51.2	49.6	50.4			
Reducing sugars (%)	0	18.9	18.9	18.9	18.9	18.9	0.16	0.16	0.35
	15	18.7	17.2	18.3	15.7	17.9			
	30	19.3	19.7	19.7	18.9	19.0			
	60	19.2	20.2	19.3	19.0	19.3			
	90	Spoiled	20.6	19.6	19.2	19.6			

fruits, while lowest (15.7%) in T1, prepared from 15 days stored fruits. The sensory evaluation of the product was assessed on the basis of colour, appearance, texture and taste and overall average score was worked out on a 9 point Hedonic scale. The data are presented in Table 4. The product prepared from 15 days preserved fruits from treatment T4 scored highest (8.1) followed by treatment T2 (7.3). The treatment T4 scored maximum (7.6) followed by treatment T2 (7.5) when the product was prepared from 90 days preserved fruits. However, the texture and taste of the product prepared from treatment T4 (7.8 and 7.2, respectively) was the best along with treatment T2 (7.6 and 7.6, respectively), while that prepared from treatments T3 (4.8 and 4.6, respectively) and T5 (4.8 and 4.6, respectively) were less acceptable when prepared from 90 days stored fruits.

In general, the organoleptic quality of the product decreased with the prolongation of the preservation period of fruits.

DISCUSSION

Aonla cv. Chakaiya was steeped preserved in different

Table 3. Quality evaluation of syrup of the product prepared from steeped preserved aonla fruits.

Treatments	Storage period (days)	T1	T2	T3	T4	T5	CD at 5%		
							Treatments	Storage period	Treatments × period
TSS (°B)	0	72.0	72.0	72.0	72.0	72.0	0.80	0.71	1.6
	15	72.0	72.0	72.0	72.0	72.0			
	30	72.0	72.0	72.0	72.0	72.0			
	60	72.0	72.0	72.0	72.0	72.0			
	90	Spoiled	72.0	72.0	72.0	72.0			
Titratable acidity (%)	0	1.08	1.08	1.08	1.08	1.08	0.42	0.41	0.08
	15	0.90	0.86	0.90	0.90	0.80			
	30	0.88	0.83	0.93	0.90	0.76			
	60	0.78	0.80	0.80	0.80	0.73			
	90	Spoiled	0.76	0.86	0.83	0.66			
Ascorbic acid (mg/100 g)	0	98	98	98	98	98	0.88	0.80	1.92
	15	63	68	63	82	56			
	30	48	59	46	75	44			
	60	37	44	35	48	35			
	90	Spoiled	30	28	40	25			
Polyphenols (%)	0	0.51	0.51	0.51	0.51	0.51	0.22	0.20	0.04
	15	0.49	0.41	0.44	0.41	0.45			
	30	0.43	0.39	0.37	0.38	0.40			
	60	0.37	0.37	0.33	0.34	0.34			
	90	Spoiled	0.32	0.27	0.25	0.28			
Total sugars (%)	0	46.4	46.4	46.4	46.4	46.4	0.14	0.14	0.29
	15	46.5	49.1	48.5	48.1	47.4			
	30	48.8	50.3	50.0	47.8	47.2			
	60	46.6	49.4	50.4	46.6	48.4			
	90	Spoiled	49.0	50.6	47.2	46.6			
Reducing sugars (%)	0	17.6	17.6	17.6	17.6	17.6	0.12	0.14	0.31
	15	15.7	16.2	17.3	17.2	17.3			
	30	16.9	17.7	17.6	17.9	17.7			
	60	16.4	17.3	17.2	17.8	17.3			
	90	Spoiled	17.0	17.4	17.5	18.7			

solutions, viz: water (control, T1), water + 500 ppm SO_2 (T2), water + 2% salt solution + 500 ppm SO_2 (T3), water + 5% sugar solution + 500 ppm SO_2 (T4) and water + 2% salt solution + 5% sugar solution + 500 ppm SO_2 (T5) and the product segments-in-syrup was prepared at 0, 15, 30, 60 and 90 days of storage. The fruits stored in water (T1) were spoiled after 60 days of steeped preservation. A continuous decrease in TSS of the fruits was recorded in all the treatments except T4 and T5 where sugar was in the preservation solution. The titrarable acidity also decreased continuously in the fruits steeped in different solutions. The maximum ascorbic acid content in fruits was recorded in treatment T4 (208 mg 100 g^{-1}) followed by T5 (206 mg 100 g^{-1}) after 90 days of preservation. The maximum poyphenols content in fruits was recorded in treatment T3 followed by T2 after 90 days of preservation. The data indicated that the fruits could be preserved with minimum loss in quality parameters and without spoilage containing SO_2 as an added preservative up to 90 days. Sethi and Maini (2000) have also reported that fruits could be stored safely for fairly long periods in chemical solution consisting of chemical preservatives (potassium metabisulphite) along with salt, sugar and spices in water. Kumar and Shukla, (2009)

Table 4. Sensory evaluation of the product segments-in-syrup prepared from steeped preserved aonla fruits.

Treatments	Storage period (days)	Colour	Appearance	Texture	Taste	Overall average (out of 9)
Fresh fruit	0	8.2	8.4	8.1	8.5	8.3
T1	15	7.6	7.6	6.4	6.4	7.0
	30	7.8	7.6	6.4	6.6	7.1
	60	7.6	7.4	6.4	6.2	6.9
	90	Spoiled	Spoiled	Spoiled	Spoiled	
T2	15	7.6	7.0	7.2	7.4	7.3
	30	8.2	8.0	7.4	6.4	7.5
	60	8.0	7.8	7.8	7.6	7.8
	90	7.4	7.4	7.6	7.6	7.5
T3	15	8.0	8.2	5.5	5.1	6.7
	30	5.0	5.0	5.2	5.2	5.0
	60	5.1	5.0	5.0	4.5	4.9
	90	4.6	4.4	4.8	4.6	4.6
T4	15	7.8	8.2	8.4	8.0	8.1
	30	8.0	8.0	8.0	8.0	8.0
	60	8.0	7.8	7.8	7.6	7.8
	90	8.2	7.4	7.8	7.2	7.6
T5	15	7.8	8.0	5.5	5.5	6.7
	30	5.2	5.1	5.4	5.1	5.2
	60	5.0	5.2	5.0	4.8	5.0
	90	4.8	4.6	4.8	4.6	4.7

CD at 5% treatments 0.30, storage period 0.30 and treatments x period 0.67.

have stated that aonla fruits could be stored in 15% steeping salt solution with minimum quality loss for 3 months. Premi et al. (1998) successfully preserved aonla fruits in a steeping solution (10% salt, 0.5% acetic acid and 200 ppm sulphur dioxide) up to 3 months. The product segments-in-syrup, prepared from steeped preserved fruits was evaluated for their quality parameters.

The analysis of segments of the product showed that the contents of titratable acidity, ascorbic acid and polyphenols decreased continuously in all the treatments, while total and reducing sugars varied slightly. The maximum ascorbic acid content in segments was recorded in treatment T4 followed by treatment T1 after 90 days of preserved fruits. The maximum ascorbic acid content in syrup of the product was recorded in treatment T4 followed by treatment T2 after 90 days fruit preservation. The maximum contents of polyphenols in segments and syrup were recorded in treatments T4 and T2, respectively, from 90 days of fruit preservation. The sensory quality of the product segments-in-syrup was highly acceptable even after it was prepared from 90 days of preserved fruits of treatments T2 and T4. The product prepared from treatments T3 and T5 were not acceptable. It was inferred from the study that segments-in-syrup of good quality could be prepared from the steeped preserved fruits up to 90 days of storage in a solution containing water + 500 ppm SO_2 (T2) and water + 2% sugar solution + 500 ppm SO_2 (T4).

ACKNOWLEDGEMENT

Authors acknowledge with thanks the help provided by Mr. Abhay Dixit, Central Institute for Subtropical Horticulture, Lucknow during the course of investigation.

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