

Shelf Life and Quality of Minimally Processed Pomegranate Arils cv. Bhagwa as Influenced by Antioxidants

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Received: 25.07.2017 | Revised: 9.08.2017 | Accepted: 10.08.2017

ABSTRACT

Minimally processed pomegranate arils cv. Bhagwa, are washed with antioxidants viz., sodium hypochlorite (SH) 200 ppm, ascorbic acid (AA) 5000 ppm and citric acid (CA) 5000 ppm packed in open plastic cups then stored at 5°C to the best quality preservation. Arils washed with SH 200 ppm plus AA 5000 ppm recorded lowest PLW, spoilage and increased shelf life upto 6 days over control of 4.33 days only. Hunter color Lab values (L*, a* & b*), TSS, brix-acid ratio, sugars, ascorbic acid were also recorded significantly highest in arils washed with SH 200 ppm plus AA 5000 ppm and the same treatment found to be superior with respect to the organoleptic attributes.

Key words: Arils, Antioxidants, Shelf life, Hunter color Lab values (L*, a* & b*) Quality.

INTRODUCTION

Pomegranate (*Punica granatum* L.) belongs to family lythraceae, due to its hardy nature, minimum water requirement, response to high technological practices, fine table and therapeutic values, excellent keeping quality and export potential have made the pomegranate highly lucrative and remunerative³.

The edible part of the fruit is called 'aril' constituting 52 per cent of total fruit weight (w/w) comprising of 78 per cent juice

and 22 per cent arils¹². Pomegranate arils are rich in vitamin C, vitamin K, antioxidants and polyphenols such as tannins, quercetin and anthocyanins which are good for heart and have anti-cancer properties^{1,22}.

Pomegranate consumption is limited due to difficulty in peeling to obtain the seeds. Presenting pomegranate arils in 'ready-to-eat' form would be a convenient and desirable alternative to encourage the consumption of fresh fruits and may also help to the demand for increase pomegranate cultivation.

Cite this article: Naik, R.D., Prasad M.D., Joshi, V., Padmavathamma, A.S. and Naik, S.C., Shelf Life and Quality of Minimally Processed Pomegranate Arils cv. Bhagwa as Influenced by Antioxidants, *Int. J. Pure App. Biosci.* 5(4): 1022-1027 (2017). doi: <http://dx.doi.org/10.18782/2320-7051.5616>

In pigmented products, an additional problem is the discolouration caused by oxidation of phenolic pigments and other phenolic compounds catalyzed by phenolases or peroxidases⁹. Since the colour of pomegranate arils is the most important quality attribute for consumers, its stability must be preserved. Minimally processed pomegranate arils have less post-harvest life and arils washed with antioxidants viz., citric acid, ascorbic acid are helps to prevent microbial development²³. Lack of appropriate information regarding washing treatments of the arils for quality exports led to the development of appropriate technologies to orient for export of arils from the state of Telangana. However, little work on washing of pomegranate arils has been done so far. Therefore a study has been undertaken to find out the effect of different washing treatments on shelf life and quality of minimally processed pomegranate aril cv. Bhagwa.

MATERIAL AND METHODS

The present experiment was carried out at College of Horticulture, Dr. Y.S.R.HU Rajendranagar in collaboration with Post Harvest Technology Research Station, Rajendranagar, Hyderabad. The experiment was conducted by washing the minimally processed pomegranate arils with antioxidants viz., sodium hypochlorite (SH) 200 ppm, ascorbic acid (AA) and citric acid (CA) having seven treatments with factorial complete randomized block design and replicated thrice.

Seven different washing treatments were tested including distilled water, SH and AA and CA with and without chlorine. After peeling, seeds were divided into uniform groups (120 g) and each was dipped in 5 L of appropriate solution. Washing treatments were carried out at 23°C. Arils were dipped in sodium hypochlorite 200 ppm for 5 min followed by dipping for 30 sec. in a solution of AA (5 g/L) and CA (5 g/L). Then arils were air dried for 30 min at 23°C to remove residual water before analysis. The following parameters were analyzed.

Physiological loss in weight of the

arils was recorded on every 3 days and subtracted from the initial weight. The mean loss of weight in grams in relation to initial weight was calculated and expressed as percentage. The number of fruit arils spoiled in each replication were counted and expressed in percentage. The spoilage was determined based on shrivelling and fungal infection and subsequent rotting of the arils. The shelf life of arils was determined by recording the number of days the arils remained in good condition in storage. The stage wherein more than 5 per cent of the stored arils became unfit for consumption was considered as end of shelf life in that particular treatment and expressed as mean number of days. The colour of the arils in each replication were instrumentally determined by using a colorimetric spectrophotometer (Model: colorflex, Hunter lab, West Virginia, USA) and expressed in Hunter scale (L*, a* and b*).

Total soluble solids was determined by using ERMA hand refractrometer and expressed as °Brix²¹. The brix–acid ratio was arrived at by dividing the total soluble solids with titratable acidity. Sugars were determined by the method of Lane and Eyon⁴. Ascorbic acid was estimated by the method presented by Ranganna²¹. Sensory evaluation was done by panel of 15 personnel of both the genders at College of Horticulture and Post Harvest Technology Research Station for standard organoleptic attributes using the 5 point hedonic scale². Score card contains various aril quality attributes viz., color, appearance and overall acceptability.

The data obtained was subjected to statistical analysis as per the procedure outlined by Panse and Sukhatme¹⁸.

RESULTS AND DISCUSSION

Physiological loss in weight (%)

Physiological loss in weight (PLW) indicates the total moisture lost during storage and ripening, which results in desiccation and shrivelled appearance of the arils (Table 1). Significantly minimum PLW was observed in arils washed with SH 200 ppm plus AA 5000 ppm (2.48) whereas, non-washed arils

recorded highest PLW (5.81).

PLW increased with increase in the storage period, which may be due to loss of water from the arils and the enhanced period of exposure of arils to atmosphere and increased respiration may have resulted in loss of weight in the form of water^{16,17}. Dehydration and shrivelling were observed when arils were stored unpacked, leading to unacceptable appearance and quality⁹.

Spoilage (%)

The storage life and spoilage of arils are directly related to the rate of respiration. Significantly least spoilage recorded in arils washed with SH 200 ppm plus AA 5000 ppm (3.33), whereas non-washed arils (5.18) recorded highest spoilage, this might be due to the oxidation of the phenolic compounds during storage, indicating that the stabilization of anthocyanin pigments is essential in order to achieve good quality^{9,6} as shown in (Table 1)

Total soluble solids (°Brix)

It is evident from the TSS of arils was gradually increased with each successive storage period. Significantly maximum TSS (Table 1) was recorded in arils washed with SH 200 ppm plus AA 5000 ppm (16.05) and whereas, non-washed arils (15.98) recorded lowest TSS. In the experiments decrease in TSS at advanced stage is owing to the increased rate of respiration in later stage of storage¹⁵ and the lower temperature reduces the activity of degradative enzymes responsible for buildup of TSS, whereas lower respiration at lower temperature results in highest retention of TSS at cool chamber and cold storage^{7,20&24}.

Brix-acid ratio

Minimum brix-acid ratio (Table 1) recorded in arils washed with SH 200 ppm plus AA 5000 ppm (38.32) whereas, non-washed arils recorded maximum brix-acid ratio (51.91) mainly due to a decrease in titrable acidity during storage^{5,10}.

Shelf life (days)

With respect to the shelf life (Table 1), among the treatments, SH 200 ppm plus AA 5000 ppm recorded highest shelf life (6.00 days)

and non-washed arils recorded a minimum shelf life (4.33 days).

The shelf life was increased due to washing with antioxidants which was attributed to reduction in gaseous exchange and increase in CO₂ concentration inside the package, and consequently further bringing down the rate of respiration¹¹. Control arils had minimum shelf life compared to washing with antioxidants. This might be due to effective increase in the rate of respiration and transpiration⁸.

Hunter colour (L*, a* and b*)

Hunter color L*, a* & b* is a good indicator of changes in the aril brightness, redness and yellowness. The red color of pomegranate fruit arils may be due to anthocyanin pigments. The value of arils gradually decreased with each successive storage period and there was significant difference among washing treatments with respect to Hunter color L*, a* and b*.

Maximum Hunter color (L*, a* and b*) (Table 2) recorded in arils washed with SH 200 ppm plus AA 5000 ppm (22.28, 19.65 and 6.37) and non-washed arils (20.99, 18.28 and 5.45) recorded lowest (Table 2). During successive storage period the Lab* value of arils decreased, showing a decrease in brightness, redness & yellowness⁹. Decrease in redness (a*) indicating a loss of anthocyanins or the production of browning compounds and decrease in lightness (L* values) indicates that the arils become darker⁶.

Sugars

Significant variation was observed with respect to sugar content (Table 3) in the arils washed with antioxidants. The loss of acids during storage might be due to their utilization in inversion of non-reducing sugars to reducing sugars and participation of acids in the formation of non-enzymatic browning products. Highest sugars (total) recorded in arils washed with SH 200 ppm plus AA 5000 ppm (8.17) whereas, non-washed arils (8.02) recorded lowest sugars and may be due to utilization of sugars in respiration¹⁹. The higher level of sugars on initial day would have stimulated carbon flow through

glycolysis, increasing cytoplasmic pyruvate and thereby other TCA intermediates, leading to an increase in NAD(P)H in the matrix and ultimately stimulating oxidase activity, an enzyme responsible for the alternative pathway of respiration¹⁶.

Ascorbic acid (mg/100g)

Ascorbic acid content (Table 3) was recorded highest in arils washed with SH 200 ppm plus AA 5000 ppm (8.36) whereas, non-washed arils (8.12) recorded minimum ascorbic acid due to Ascorbic acid content decreased as the storage period increased. This may be attributed to the degradation of ascorbic acid

to dehydro ascorbic acid by oxidative enzymes and decrease in ascorbic acid during storage might be due to oxidation and direct effect of storage temperature on vitamins^{14,20&25}.

Organoleptic evaluation

Among the washing treatments, SH 200 ppm plus AA 5000 ppm (3.82) recorded highest organoleptic score (Table 3) and non-washed arils (3.03) recorded minimum score. This might be due to the breakdown of ascorbic acid during storage of products¹⁶. The unwashed arils showed lowest organoleptic evaluation, which might be due to reduced respiratory activity at low temperature.

Table 1: Effect of antioxidants on physiological loss in weight (%), spoilage (%), total soluble solids (^oBrix), brix-acid ratio and shelf life (days) of pomegranate arils cv. Bhagwa

Treatments	Storage period (days)														Shelf life (days)
	Physiological loss in weight (%)			Spoilage (%)			Total soluble solids (oBrix)				Brix-acid ratio				
	3	6	Mean	3	6	Mean	0	3	6	Mean	0	3	6	Mean	
W1	4.72	5.04	4.88 ^d	2.91	6.25	4.58 ^f	15.98	16.01	16.04	16.01 ^{bc}	42.35	40.02	37.30	39.95 ^a	4.44 ^c
W2	3.15	3.47	3.31 ^b	2.08	5.44	3.76 ^c	15.98	16.05	16.08	16.02 ^{ab}	42.35	38.21	35.73	38.82 ^a	5.60 ^{ab}
W3	3.56	3.89	3.73 ^c	2.29	5.63	3.96 ^d	15.98	16.03	16.06	16.02 ^{ab}	42.35	39.10	36.50	39.38 ^a	5.43 ^{ab}
W4	4.4	4.72	4.56 ^d	2.70	6.04	4.37 ^e	15.98	16.02	16.05	16.01 ^{bc}	42.35	39.07	36.48	39.32 ^a	5.06 ^b
W5	2.32	2.64	2.48 ^a	1.66	5.00	3.33 ^a	15.98	16.08	16.11	16.05 ^a	42.35	37.40	35.02	38.32 ^a	6.00 ^a
W6	2.74	3.06	2.90 ^b	1.87	5.21	3.54 ^b	15.98	16.06	16.09	16.04 ^{ab}	42.35	38.29	35.76	38.84 ^a	5.81 ^a
W7	5.65	5.97	5.81 ^e	3.51	6.85		15.98	15.99	16.02	15.98 ^c	42.35	51.58	61.62	51.91 ^b	4.33 ^c
Mean	3.80 ^a	4.11 ^b		2.43 ^a	5.77 ^b		15.98 ^c	16.03 ^b	16.06 ^a		42.35 ^a	40.52 ^{ab}	39.77 ^c		
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
Days (D)	0.14		0.41	0.20		0.57	0.02		0.03	0.77		3.27			5%
Treatments (T)	0.08		0.22	0.10		0.30	0.01		0.02	0.50		2.14			0.58
D x T	0.20		NS	0.28		NS	0.04		NS	1.33		5.67			

Figures with same alphabets did not differ significantly;

NS–Not significant.

W₁ – Water

W₂ – Sodium hypochlorite 200 ppm

W₃ – Water + Ascorbic acid 5000 ppm

W₄ – Water + Citric acid 5000 ppm

W₅ – Sodium hypochlorite 200 ppm + Ascorbic acid 5000 ppm

W₆ – Sodium hypochlorite 200 ppm + Citric acid 5000 ppm

W₇ – No washing

Table 2: Effect of antioxidants on Hunter color L*, a* and b* of pomegranate arils cv. Bhagwa

Treatments	Storage period (days)											
	Hunter color L*				Hunter color a*				Hunter color b*			
	0	3	6	Mean	0	3	6	Mean	0	3	6	Mean
W ₁	22.43	21.27	21.22	21.64 ^b	19.96	18.11	17.54	18.53 ^{cd}	6.55	5.34	4.98	5.62 ^b
W ₂	22.43	22.08	22.03	22.18 ^{ab}	19.96	19.12	18.55	19.21 ^{abc}	6.55	6.22	5.86	6.21 ^a
W ₃	22.43	21.95	21.90	22.10 ^{ab}	19.96	18.89	18.32	19.05 ^{abc}	6.55	6.09	5.73	6.12 ^a
W ₄	22.43	21.83	21.79	22.01 ^{ab}	19.96	18.56	18.32	18.83 ^{bcd}	6.55	5.98	5.62	6.05 ^{ab}
W ₅	22.43	22.24	22.20	22.28 ^a	19.96	19.78	19.21	19.65 ^a	6.55	6.47	6.11	6.37 ^a
W ₆	22.43	22.17	22.12	22.24 ^a	19.96	19.54	18.97	19.49 ^{ab}	6.55	6.35	5.99	6.30 ^a
W ₇	22.43	20.54	20.00	20.99 ^c	19.96	17.73	17.16	18.28 ^d	6.55	5.08	4.72	5.45 ^b
Mean	22.43 ^a	21.72 ^b	21.61 ^b		19.96 ^a	18.81 ^b	18.24 ^c		6.55 ^a	5.93 ^b	5.57 ^c	
	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%	S.Em±		CD at 5%
Days (D)	0.20		0.57	0.24		0.68	1.67		0.48			
Treatments (T)	0.13		0.37	0.16		0.45	0.11		0.31			
D x T	0.35		NS	0.42		NS	0.29		NS			

Figures with same alphabets did not differ significantly;

NS–Not significant.

W₁ – Water

W₂ – Sodium hypochlorite 200 ppm

W₃ – Water + Ascorbic acid 5000 ppm

W₄ – Water + Citric acid 5000 ppm

W₅ – Sodium hypochlorite 200 ppm + Ascorbic acid 5000 ppm

W₆ – Sodium hypochlorite 200 ppm + Citric acid 5000 ppm

W₇ – No washing

Table 3: Effect of antioxidants on total sugars (%), ascorbic acid (mg/100g) and organoleptic evaluation (5 point scale) of pomegranate arils cv. Bhagwa

Treatments	Storage period (days)								Organoleptic evaluation
	Total sugars (%)				Ascorbic acid (mg/100g)				
	0	3	6	Mean	0	3	6	Mean	
W ₁	8.31	8.09	7.82	8.07 ^{bc}	8.53	8.28	7.63	8.12 ^b	3.22 ^c
W ₂	8.31	8.19	7.92	8.14 ^{ab}	8.53	8.38	8.02	8.31 ^a	3.68 ^a
W ₃	8.31	8.16	7.89	8.12 ^{ab}	8.53	8.35	7.99	8.29 ^a	3.44 ^b
W ₄	8.31	8.14	7.87	8.10 ^{abc}	8.53	8.33	7.97	8.28 ^a	3.38 ^b
W ₅	8.31	8.23	7.96	8.17 ^a	8.53	8.45	8.09	8.36 ^a	3.82 ^a
W ₆	8.31	8.21	7.94	8.15 ^{ab}	8.53	8.41	8.05	8.33 ^a	3.79 ^a
W ₇	8.31	8.02	7.75	8.02 ^c	8.53	8.19	7.63	8.12 ^b	3.03 ^d
Mean	8.31 ^a	8.15 ^b	7.88 ^c		8.53 ^a	8.34 ^b	7.95 ^c		
	S.Em±			CD at 5%	S.Em±			CD at 5%	CD at 5%
Days (D)	0.03			0.09	0.05			0.14	
Treatments (T)	0.02			0.06	0.03			0.09	
D x T	0.05			NS	0.08			NS	0.14

Figures with same alphabets did not differ significantly;

NS–Not significant.

W₁ – Water

W₂ – Sodium hypochlorite 200 ppm

W₃ – Water + Ascorbic acid 5000 ppm

W₄ – Water + Citric acid 5000 ppm

W₅ – Sodium hypochlorite 200 ppm + Ascorbic acid 5000 ppm

W₆ – Sodium hypochlorite 200 ppm + Citric acid 5000 ppm

W₇ – No washing

CONCLUSION

Arils washed with SH 200 ppm plus AA 5000 ppm recorded a shelf life of 6 days as well as found to be superior in quality aspects in terms of highest TSS, sugars, ascorbic acid and organoleptic evaluation.

Acknowledgement

Thanks to Dr. Y.S.R Horticultural University for financial assistance and advisory committee for technical advice.

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