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

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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 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 9 days, whereas non-washed arils recorded a shelf life 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. Arils treated with SH 200 ppm plus AA 5000 ppm was found superior for organoleptic attributes.*

Key words: *Arils, Antioxidants, Shelf Life, Quality*

INTRODUCTION

Pomegranate (*Punica granatum* L.) belongs to family lythraceae and due to its hardy nature, minimum water requirement, response to high technological practices; high yield, fine table and therapeutic values, excellent keeping quality and export potential have made pomegranate highly lucrative and remunerative[3].

The edible part of the fruit is called 'aril' and constitutes 52 per cent of total fruit weight (w/w), comprising 78 per cent juice and 22 per cent arils[14]. 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[1,25].

Pomegranate consumption is limited due to difficulty in peeling to obtain the seeds. Presenting pomegranate seeds 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.

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In pigmented products, an additional problem is the discolouration caused by oxidation of phenolic pigments and other phenolic compounds catalyzed by phenolases or peroxidases[10]. Since the colour of pomegranate seeds 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 development[26]. 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 under taken to find out the effect of different washing treatments on shelf life and quality of minimally processed pomegranate aril cv. Bhagwa.

MATERIALS AND METHODS

The present experiment was carried out at college of Horticulture in collaboration with Post Harvest Technology Research Station, Dr. Y.S.R.HU, 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 treatments with the experimental design was complete randomized block design with factorial concept and replicated thrice.

Seven different washing treatments were tested including distilled water, SH and solutions of 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 analysed.

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 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 colorometric 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 °Brix[24]. 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 Eyon (AOAC, 1965)[4]. Ascorbic acid was estimated by the method presented by Ranganna (1986) [24]. 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 scale[2]. 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 Sukhatme[21].

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 a shrivelled appearance of the arils. Significantly minimum PLW was observed in arils washed with SH 200 ppm plus AA 5000 ppm (0.98)

whereas, non-washed aris (5.81) recorded highest PLW (Table 1). In all the treatments studied in the present investigation, the 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[18,19]. Dehydration and shrivelling were observed when arils were stored unpacked, leading to unacceptable appearance and quality[10].

Spoilage (%)

The storage life and spoilage (Table 1) 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 (2.25), whereas non-washed arils (4.92) recorded highest spoilage 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[6,10].

Shelf life (days)

Pomegranate arils are highly perishable and have a short shelf life (Table 1). Treatment SH 200 ppm plus AA 5000 ppm (9.00 days) recorded highest shelf life 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 CO_2 concentration inside the package, and consequently further bringing down the rate of respiration[8,13&15] also reported similar results while studying storage of sapota. Control arils had minimum shelf life compared to washing with antioxidants. This might be due to effective increase in the rate of respiration and transpiration[9].

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

Hunter color L*, a* & b* (Table 2) 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*) recorded in arils washed with SH 200 ppm plus AA 5000 ppm (22.87, 19.78 and 6.37) and non-washed arils (20.91, 18.28 and 5.45) recorded lowest. During successive storage period the Lab* value of aril decreased, showing a decrease in brightness, redness & yellowness[10]. 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 darker[6].

Total soluble solids (^{o}Brix)

TSS of aril was gradually decreased with each successive storage period. Significantly maximum TSS (Table 3) was recorded in arils washed with SH 200 ppm plus AA 5000 ppm (15.88) and whereas, non-washed arils (17.71) recorded lowest TSS. In the experiments decrease in TSS at advanced stage is owing to the increased rate of respiration in later stage of storage[17] 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[7,23&25].

Brix-acid ratio

Minimum brix-acid ratio (Table 3) recorded in arils washed with SH 200 ppm plus AA 5000 ppm (43.88) whereas, non-washed arils recorded maximum brix-acid ratio (50.80) because the brix-acid ratio decreased significantly in all treatments mainly due to a decrease in titrable acidity during storage[5,11].

Sugars

Significant variation was observed with respect to sugar content (Table 4) 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 (7.35) whereas, non-washed arils (7.12) recorded lowest sugars and may be due to utilization of sugars in respiration as suggested

by Pool *et al*. (1972)[22]. 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 respiration[18].

Ascorbic acid (mg/100g)

Ascorbic acid (Table 4) highest was recorded in arils washed with SH 200 ppm plus AA 5000 ppm (8.38) 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 dehydroascorbic acid by oxidative enzymes and decrease in ascorbic acid during storage might be due to oxidation and direct effect of storage temperature on vitamins[16,23&28].

Organoleptic evaluation

Among the washing treatment SH 200 ppm plus AA 5000 ppm (3.82) recorded highest organoleptic evaluation (Table 1) and non-washed arils (3.03) recorded a minimum. This might be due to the breakdown of ascorbic acid during storage of products[18]. The unwashed arils showed lowest organoleptic score, which might be due to reduced respiratory activity at low temperature. Similar results were obtained by in pomegranate[26].

Table 1: Effect of washing treatments on physiological loss in weight (%), spoilage (%) and shelf life (days) of pomegranate arils cv. Bhagwa

Treatments	Storage period (days)								
	Physiological loss in weight (%)				Spoilage (%)				Shelf life
	3	6	Mean	9	3	6	Mean	9	(days)
W_1	0.80	4.22	2.26^{bc}	3.79	2.91	4.51	3.71^{f}	6.46	6.75^{c}
W_2	0.47	2.65	1.55^{ab}	2.22	1.87	3.38	2.63^{c}	5.33	8.49^{ab}
W_3	0.58	3.07	1.82^{ab}	2.64	2.08	3.68	2.88^{d}	5.63	8.03^{b}
W_4	0.69	3.90	2.29^{ab}	3.37	2.21	3.81	3.01^{e}	5.76	7.83^{b}
W_5	0.15	1.82	0.98^{a}	1.39	1.45	3.05	2.25^{a}	5.00	9.00^{a}
W_6	0.25	2.24	1.24^{ab}	1.81	1.66	3.26	2.46^{b}	5.21	8.67^{ab}
W_7	5.65	5.97	5.81^{d}	-	3.51	6.85	4.92^{g}	-	4.33^{d}
Mean	1.22^{a}	3.41^{b}			2.24^{a}	4.08^{b}			
	S.Em±		CD at 5%		S.Em±		CD at 5%		CD at 5%
Days (D)	0.40		1.15		0.16		0.47		
Treatments(T)	0.21		0.61		0.09		0.25		0.94
D x T	0.56		NS		0.23		NS		

Figures with same alphabets did not differ significantly; NS–Not significant. (-) indicates spoilage of aril on particular day.

W_1 – Water

W_2 – Sodium hypochlorite 200 ppm

W_3 – Water + Ascorbic acid 5000 ppm

W_4 – Water + Citric acid 5000 ppm

W_5 – Sodium hypochlorite 200 ppm + Ascorbic acid 5000 ppm

W_6 – Sodium hypochlorite 200 ppm + Citric acid 5000 ppm

W_7 – No washing

Table 2: Effect of washing treatments 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	9	0	3	6	Mean	9	0	3	6	Mean	9
W_1	22.43	22.07	21.78	22.10^{c}	21.41	19.96	18.28	17.99	18.74^{bc}	17.78	6.55	5.78	5.59	5.98^{b}	5.44
W_2	22.43	22.94	22.57	22.65^{ab}	22.19	19.96	19.34	19.05	19.45^{a}	18.89	6.55	6.39	6.21	6.38^{ab}	6.06
W_3	22.43	22.76	22.39	22.53^{abc}	22.01	19.96	19.07	18.78	19.27^{ab}	18.62	6.55	6.28	6.09	6.30^{ab}	5.94
W_4	22.43	22.43	22.06	22.31^{bc}	21.68	19.96	18.86	18.57	19.13^{ab}	18.41	6.55	6.11	5.92	6.20^{ab}	5.77
W_5	22.43	23.28	22.91	22.87^{a}	22.53	19.96	19.83	19.54	19.78^{a}	19.38	6.55	6.51	6.32	6.46^{a}	6.17
W_6	22.43	23.14	22.77	22.78^{ab}	22.39	19.96	19.78	19.49	19.74^{a}	19.33	6.55	6.47	6.28	6.43^{ab}	6.13
W_7	22.43	20.54	19.75	20.91^{d}	-	19.96	17.73	17.16	18.28^{c}	-	6.55	5.08	4.72	5.45^{c}	-
Mean	22.43^{a}	22.45^{a}	22.03^{b}			19.96^{a}	18.98^{b}	18.65^{b}			6.55^{a}	6.09^{b}	5.88^{b}		

	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%
Days (D)	0.18	0.52	0.24	0.70	0.16	0.45
Treatments(T)	0.12	0.34	0.16	0.45	0.10	0.30
D x T	0.31	0.90	0.42	NS	0.27	NS

Figures with same alphabets did not differ significantly; NS–Not significant. (-) indicates spoilage of aril.

W_1 – Water
W_2 – Sodium hypochlorite 200 ppm
W_3 – Water + Ascorbic acid 5000 ppm
W_4 – Water + Citric acid 5000 ppm
W_5 – Sodium hypochlorite 200 ppm + Ascorbic acid 5000 ppm
W_6 – Sodium hypochlorite 200 ppm + Citric acid 5000 ppm
W_7 – No washing

Table 3: Effect of washing treatments on total soluble solids and brix-acid ratio of pomegranate arils cv. Bhagwa

Treatments	Storage period (days)									
	Total soluble solids (^{o}Brix)					Brix-acid ratio				
	0	3	6	Mean	9	0	3	6	Mean	9
W_1	15.98	15.79	15.56	15.78^{cd}	15.37	42.35	47.85	55.57	48.49^{c}	59.16
W_2	15.98	15.88	15.65	15.84^{abc}	15.46	42.35	44.11	47.42	44.66^{ab}	49.87
W_3	15.98	15.84	15.61	15.81^{abc}	15.42	42.35	45.26	48.78	45.46^{ab}	51.4
W_4	15.98	15.81	15.58	15.79^{bc}	15.39	42.35	46.50	50.25	46.37^{bc}	53.07
W_5	15.98	15.94	15.71	15.88^{a}	15.52	42.35	43.08	46.21	43.88^{a}	48.50
W_6	15.98	15.91	15.68	15.86^{ab}	15.49	42.35	44.19	47.52	44.69^{ab}	49.97
W_7	15.98	15.73	15.42	15.71^{d}	-	42.35	50.74	59.31	50.80^{d}	-
Mean	15.98^{a}	15.84^{b}	15.60^{c}			42.35^{a}	45.96^{b}	50.72^{c}		

	S.Em±	CD at 5%	S.Em±	CD at 5%
Days (D)	0.01	0.07	1.14	2.20
Treatmens(T)	0.01	0.04	0.75	1.44
D x T	0.02	NS	1.98	3.81

Figures with same alphabets did not differ significantly; NS–Not significant. (-) indicates spoilage of aril on particular day.

W_1 – Water
W_2 – Sodium hypochlorite 200 ppm
W_3 – Water + Ascorbic acid 5000 ppm
W_4 – Water + Citric acid 5000 ppm
W_5 – Sodium hypochlorite 200 ppm + Ascorbic acid 5000 ppm
W_6 – Sodium hypochlorite 200 ppm + Citric acid 5000 ppm
W_7 – No washing

Table 4: Effect of washing treatments on total sugars (%), ascorbic acid (mg/100g) and organoleptic evaluation (5 point scale) of pomegranate arils cv. Bhagwa

Treatments	Storage period (days)										
	Total sugars (%)					Ascorbic acid (mg/100g)					Organoleptic evaluation
	0	3	6	Mean	9	0	3	6	Mean	9	
W_1	8.31	8.11	7.96	8.13^{b}	7.71	8.53	8.30	7.91	8.24^{b}	7.59	3.29^{c}
W_2	8.31	8.21	8.06	8.19^{ab}	7.81	8.53	8.41	8.06	8.33^{a}	7.52	3.75^{a}
W_3	8.31	8.17	8.02	8.17^{ab}	7.77	8.53	8.36	7.99	8.29^{a}	7.49	3.51^{b}
W_4	8.31	8.14	8.00	8.15^{ab}	7.74	8.53	8.34	7.96	8.28^{a}	7.44	3.45^{b}
W_5	8.31	8.27	8.12	8.23^{a}	7.87	8.53	8.48	8.13	8.38^{a}	7.66	3.89^{a}
W_6	8.31	8.24	8.09	8.21^{ab}	7.84	8.53	8.44	8.09	8.35^{a}	7.62	3.86^{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}	8.17^{b}	8.00^{c}			8.53^{a}	8.36^{b}	7.98^{c}			
	S.Em±		CD at 5%			S.Em±		CD at 5%			CD at 5%
Days (D)	0.03		0.08			0.05		0.14			
Treatmens(T)	0.02		0.05			0.03		0.09			0.18
D x T	0.05		NS			0.08		NS			

Figures with same alphabets did not differ significantly; NS–Not significant. (-) indicates spoilage of aril on particular day.

W_1 – Water
W_2 – Sodium hypochlorite 200 ppm
W_3 – Water + Ascorbic acid 5000 ppm
W_4 – Water + Citric acid 5000 ppm
W_5 – Sodium hypochlorite 200 ppm + Ascorbic acid 5000 ppm
W_6 – Sodium hypochlorite 200 ppm + Citric acid 5000 ppm
W_7 – No washing

CONCLUSION

Arils washed with SH 200 ppm plus AA 5000 ppm recorded a shelf life of 9 days as well as superior in quality when stored at 5^{o}C

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