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IMPACT OF ANTIOXIDANTS, PACKAGING MATERIAL AND STORAGE TEMPERATURE ON PHYSIOCHEMICAL PROPERTIES, SENSORY AND SHELF LIFE OF POMEGRANATE ARILS

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ABSTRACT

The present rise in the production and consumption of fresh-cut horticulture produce is a result of modern consumer lifestyles and their need for quick-to-use, natural, and healthy products. Pomegranates' stiff peel, which makes it challenging to extract the seeds, restricts their use as fresh fruit. Due to water loss, softening, increased respiration, aril browning, and microbiological contamination, minimally processed (MP) pomegranate arils lose quality and have a shorter shelf life. The goal of the current research was to determine how antioxidants, packing, and storage temperature affected the physio-chemical properties and shelf life of pomegranate aril. Antioxidants (ascorbic acid, citric acid, and honey) made up factor I; packing material (polyethylene film and punnet) made up factor II; and storage temperature (0°C and 5°C) made up factor III. All three factors were replicated twice in a factorial randomised block design. In terms of physio-chemical characteristics, such as titratable acidity, Ascorbic acid, anthocyanin, and sensory quality features such as colour, flavour, and taste, citric acid at 5 per cent had the highest results among the antioxidant treatments. The combination of citric acid, punnets, and 0°C (A3 + P2 + S1) recorded the best results in physio-chemical parameters, sensory quality, and extending the shelf life (30 days) of pomegranate arils based on the total interaction of all treatments.

Keywords: Pomegranate Aril, Antioxidants, Packaging Material, Storage Temperature and Physio-Chemical Properties

INTRODUCTION

One of the most well-liked table fruits in the world is the pomegranate (Punica granatum L.), which has both therapeutic and nutritional advantages. About 55 - 60 per cent of the weight of a fruit is made up of the edible section (aril), which is mostly made up of 15 - 25 per cent seeds and 75 - 85 per cent juice (AlMaiman and Ahmad, 2002). Fruit arils can be processed into juice, syrup, jam, or wine in addition to being consumed fresh. There has been an increase in interest in finding new food products made using pomegranates during the past several years. Pomegranate arils are sold as a convenience item with little processing because extracting the arils takes a lot of effort (Gil et al., 1996).

The arils will only last a week or up to two weeks after being peeled under modified atmosphere packaging (MAP) conditions at temperatures of 5°C and below, however the full fruit can be stored for 3 to 4 months at temperatures below 10°C (Ghafir et al., 2010). (Lopez-Rubira et al., 2005). Pomegranate arils have a shelf life of 12-14 days when kept at 0 - 2°C and 95 per cent RH. However, there is still no widespread agreement on the ideal temperature for storing pomegranate arils. Packaging is crucial for protecting the quality of pomegranate arils by preventing shrivelling, dehydration, and weight loss (Nicola et al., 2009).

Despite the fact that pomegranates have been the subject of several research around the globe, little is known about how storage temperatures affect the nutritional qualities of pomegranate arils. This is especially crucial because numerous studies have demonstrated that pomegranate fruit quality varies greatly among growing locales (Schwartz et al., 2009). Therefore, the goal of the current inquiry is to ascertain how antioxidants, packing, and storage temperature affect the physiochemical properties and shelf life of pomegranate aril.

MATERIALS AND METHODS

The investigation was conducted to determine the effects of antioxidants, packing materials, and storage temperature on the physiochemical properties and shelf life of pomegranate (cv. Bhagwa) aril Food Park, Jain Valley, Jain Irrigation Systems Limited. Jalgaon. A completely randomised factorial block design was used to replicate three factors twice: factor I, antioxidants (honey, citric acid, and ascorbic acid); factor II, packing material (polyethylene film and punnet); and factor III, storage temperature (0 and 5 degrees Celsius). Weekly reports of observations were made.

Treatment Details

Factor I	A_1 – Chlorinated water (150 ppm)
	A_2 – Chlorinated water (150 ppm) + ascorbic acid (5 per cent)
	A_3 – Chlorinated water (150 ppm) + citric acid (5 per cent)
	A_4 – Chlorinated water (150 ppm) + honey 10 per cent
	A_5 – Chlorinated water (150 ppm) + honey 20 per cent
Factor II	P_1 – Polyethylene film
	P_2 – Punnets packaging
Factor III	S_1 – Refrigerated storage at 0°C
	S_2 – Refrigerated storage at 5°C

Organoleptic Evaluation on Storage

Sensory parameter was evaluated out by five people testing team and expressed in numbers.

Shelf life

Observations were recorded at weekly interval and shelf life was calculated based on the physical, chemical, sensory and microbial parameters and expressed in days.

RESULTS AND DISCUSSION

Influence of Antioxidants, Packaging Material and Storage Temperature on Quality Characters

Quality of ready-to-eat pomegranate arils in terms of total soluble solids, titratable acidity, ascorbic acid, anthocyanin, total sugars, and reducing sugars is crucial since it directly affects consumer acceptance and monetary value. The quality metrics of pomegranate arils that had undergone minimum processing had significantly varied depending on the antioxidants, packaging materials, and storage temperature.

The quality parameters in the current study gradually increased throughout all of the storage procedures. It may be caused by the gradual reduction in moisture content of the arils during storage and the ensuing rise in nutrient concentration in the tissue. Due to moisture loss and the consequent rise in total sugar content, the respiratory rate would be low. Citric acid, at 5 per cent, has the highest level of acidity in this experiment. After treatment, titratable acidity exhibited a modest increase but remained nearly constant throughout storage. Kim et al. (2009), and Hussain et al. (2008) all noted the same tendency and concluded that the addition of an antioxidant to the sample caused these changes in the physio-chemical properties.

Among the storage temperature, maximum acidity was recorded by 0°C (Table.1.). Titratable acidity and citric acid greatly contribute to the flavour of pomegranate arils (Dafny-Yalin et al., 2010). Higher storage temperature caused a decreasing effect on titratable acidity level in arils, while lower storage temperatures caused decreased titratable acidity after 14 days. This is in agreement with studies by Ayhan and Esturk (2009) who reported declining titratable acidity levels over time during increased temperature. Citric acid, punnets, and storage temperatures of 0 °C had the maximum acidity, according to a comparison of the total interactions of all the treatments. The high levels of acidity in fruits treated with chemicals may be produced by internal carbon dioxide accumulation that led to acidosis after dissolving and producing carbonic acids. Additionally, these outcomes agreed with those of Carrillo et al. (1995).

Pomegranate aril colouring and antioxidant activity are related to anthocyanin (such as cyanidin and delphinidin) (Tzulker et al., 2007). According to Jaiswal et al. (2010), anthocyanin was reasonably heat stable in the absence of oxygen but significantly decreased (65 per cent) when both heat and oxygen were present. These authors hypothesised that total anthocyanin would be more easily destroyed by the enzyme Polyphenol oxidase (PPO).

Due to the high sensitivity of ascorbic acid to the phenolase enzyme, temperature, pH, oxygen, and light (Coultate, 2007), a loss in ascorbic acid during storage was anticipated. Pomegranate cultivars were shown to have low ascorbic acid concentrations in their fruit, which gradually decreased over time (Ghafir et al., 2010). When a natural supply of ascorbic acid was used, the ascorbic acid level in pomegranate aril was maintained for 28 days (Molina et al., 2009).

The greatest levels for ascorbic acid were found in the current investigation at low storage temperatures (Table.2.). At increasing storage temperatures, Ghafir et al. (2010) observed decreasing ascorbic acid levels in the "Shlefy" cultivar. In the "Hicaz" cultivar, ascorbic acid degradation appeared to slow significantly at higher storage temperatures. A plausible explanation for the rise in ascorbic acid is the oxidation and condensation of these substances as a result of packing and antioxidant treatments. In the current study, arils treated with 5 per cent citric acid had the highest anthocyanin content, while arils treated with chlorinated water had the lowest levels. A drop in the anthocyanin concentration of the juice and a slight coloration of the washing solutions suggest some juice from arils and seeds may have leaked into the washing solutions.

Arils packed in punnets had the highest anthocyanin concentration of all the packaging methods over the preservation period (Table.3.). Higher anthocyanin levels could potentially be the result of decreased oxidation and condensation of these chemicals (Choi et al., 2002). The combination of citric acid, punnets, and storage temperature 0°C produced the maximum anthocyanin content while storing arils, according to an analysis of the effectiveness of all the interactions.

Regarding total sugars and reducing sugars, it was shown that citric acid at 5 per cent recorded the lowest total sugar level during the storage period among the antioxidant treatments). TSS level and soluble sugar content in pomegranate arils are tightly correlated (Dafny-Yalin et al., 2010). TSS was therefore evaluated to determine whether there were soluble sugars in pomegranate arils. Sweet pomegranate arils revealed high sugar (fructose and glucose) and low citric acid levels, whereas high citric acid concentration recorded the low sugar (fructose and glucose) levels (Melgarejo et al., 2000).

Influence of Antioxidants, Packaging Material and Storage Temperature on Sensory (Colour, Flavour and Taste) Quality Changes

Data on sensory characters revealed that, all the treatments were significantly different from each other on 21st and 28th days of storage. Among the different treatments and their interactions revealed that, the treatment A3P2S1 (citric acid five per cent + punnets + 0°C) recorded the highest sensory characters like colour, flavour and taste (Prakash *et al*., 2021).

Influence of Antioxidants, Packaging Material and Storage Temperature on Shelf Life.

The treatment $A_3P_2S_1$ (citric acid 5 per cent + punnets + 0 °C) recorded the highest shelf life up to 30 days with physical, chemical, and microbiological quality, according to data on the shelf life of arils and their interactions (Fig.1.). The outcomes in several cultivars of pomegranate arils were in agreement with Sepulveda *et al.* (2001).

CONCLUSION

Application of antioxidants citric acid with 5 per cent reported the greatest physio-chemical characteristics, sensory quality attributes, among the various post-harvest treatments. Packing of pomegranate arils with punnets recorded highest physio-chemical characteristics and sensory quality attributes. The same pattern was observed when arils were stored at 0°C. As a result, it is noted that treating the arils with 5 per cent citric acid, packaging in punnets, and storing at 0 °C resulted in the highest physiochemical, sensory characters and a shelf life extension of up to 30 days.

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Fig.1. Effect of antioxidants, packaging material and storage temperature on shelf life (days) of pomegranate arils.

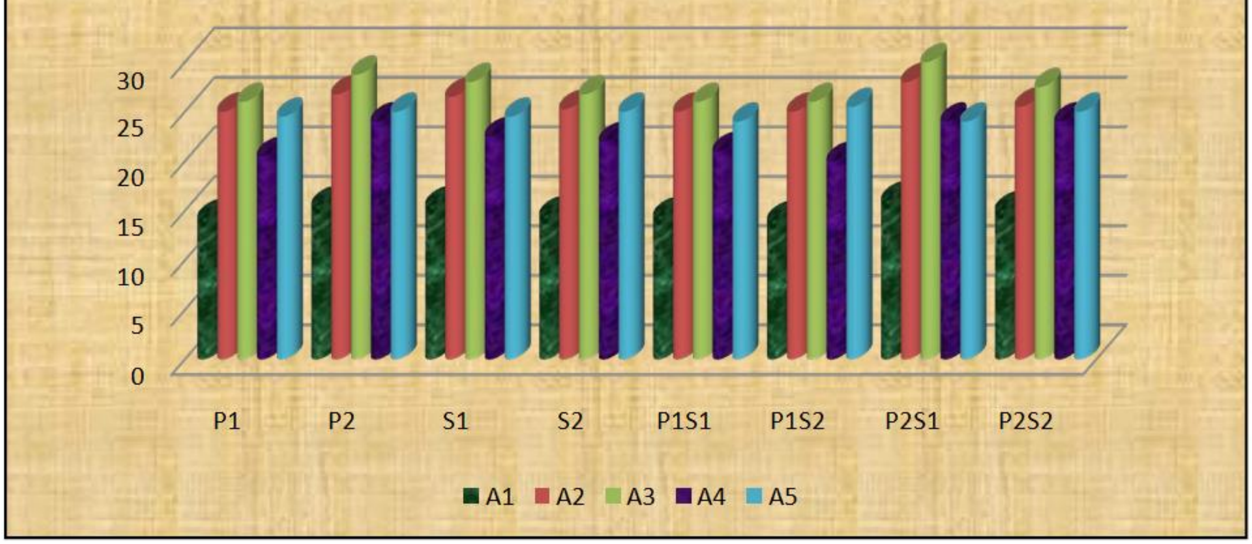

Table 1: Effect of Antioxidants, Packaging Material and Storage Temperature on Titratable Acidity (%) (7th and 30th day)

Initial – 0.33																		
Treatments	**P_1**		**P_2**		**S_1**		**S_2**		**P_1S_1**		**P_1S_2**		**P_2S_1**		**P_2S_2**		**Mean**	
	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day
A_1	0.30	0.32	0.32	0.37	0.34	0.37	0.28	0.30	0.29	0.36	0.28	0.29	0.37	0.39	0.31	0.38	**0.31**	**0.35**
A_2	0.48	0.52	0.49	0.50	0.49	0.54	0.48	0.48	0.47	0.48	0.47	0.48	0.51	0.53	0.50	0.56	**0.49**	**0.51**
A_3	0.60	0.67	0.67	0.70	0.69	0.69	0.58	0.68	0.54	0.68	0.63	0.66	0.72	0.73	0.66	0.68	**0.64**	**0.69**
A_4	0.32	0.37	0.35	0.37	0.39	0.39	0.29	0.36	0.36	0.31	0.29	0.35	0.42	0.46	0.29	0.33	**0.34**	**0.37**
A_5	0.40	0.43	0.33	0.44	0.39	0.50	0.34	0.37	0.42	0.37	0.30	0.37	0.36	0.51	0.39	0.50	**0.37**	**0.44**
Mean	**0.42**	**0.46**	**0.43**	**0.48**	**0.46**	**0.50**	**0.39**	**0.44**	**0.42**	**0.44**	**0.39**	**0.43**	**0.48**	**0.52**	**0.43**	**0.49**		

	SEd		CD (0.05)			
	7th day	30th day	7th day	30th day		
A	0.009	0.010	0.010	0.020		
P	0.006	0.008	NS	NS	A	Additives
S	0.006	0.008	0.010	0.010	P	Packaging material
AP	0.010	0.010	0.020	NS	S	Storage temperature
AS	0.010	0.010	0.020	0.040	NS	Non-significant
PS	0.008	0.010	0.010	NS		
APS	0.010	0.020	NS	0.050		

Table 2: Effect of Antioxidants, Packaging Material and Storage Temperature on Ascorbic acid (ppm) (7th and 30th day)

Initial – 0.29																		
Treatments	**P_1**		**P_2**		**S_1**		**S_2**		**P_1S_1**		**P_1S_2**		**P_2S_1**		**P_2S_2**		**Mean**	
	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day	7th day	30th day
A_1	0.28	0.16	0.28	0.19	0.30	0.22	0.27	0.13	0.28	0.16	0.25	0.10	0.32	0.22	0.29	0.23	**0.28**	**0.18**
A_2	0.67	0.41	0.69	0.42	0.74	0.45	0.62	0.38	0.77	0.37	0.64	0.39	0.71	0.48	0.60	0.43	**0.68**	**0.42**
A_3	0.83	0.60	0.88	0.70	0.87	0.66	0.84	0.64	0.84	0.62	0.83	0.57	0.92	0.71	0.84	0.69	**0.86**	**0.65**
A_4	0.47	0.17	0.52	0.24	0.62	0.22	0.37	0.19	0.59	0.20	0.29	0.15	0.65	0.24	0.45	0.24	**0.50**	**0.21**
A_5	0.50	0.29	0.56	0.41	0.55	0.35	0.51	0.35	0.41	0.40	0.31	0.18	0.70	0.52	0.71	0.30	**0.53**	**0.35**
Mean	**0.55**	**0.33**	**0.59**	**0.39**	**0.62**	**0.38**	**0.52**	**0.34**	**0.58**	**0.35**	**0.46**	**0.28**	**0.66**	**0.43**	**0.58**	**0.38**		

	SEd		CD (0.05)			
	7th day	30th day	7th day	30th day		
A	0.010	0.010	0.030	0.020		
P	0.010	0.007	0.020	0.010	A	Additives
S	0.010	0.007	0.020	0.010	P	Packaging material
AP	0.020	0.010	NS	0.030	S	Storage temperature
AS	0.020	0.010	0.050	0.030	NS	Non-significant
PS	0.010	0.010	0.030	0.020		
APS	0.030	0.020	0.070	0.040		

Table 3: Effect of Antioxidants, Packaging Material and Storage Temperature on Anthocyanin (ppm) (7th and 30th day)

Initial – 450 ppm																		
Treatments	P_1		P_2		S_1		S_2		P_1S_1		P_1S_2		P_2S_1		P_2S_2		Mean	
	7^{th} day	30^{th} day	7^{th} day	30^{th} day	7^{th} day	30^{th} day	7^{th} day	30^{th} day	7^{th} day	30^{th} day	7^{th} day	30^{th} day	7^{th} day	30^{th} day	7^{th} day	30^{th} day	7^{th} day	30^{th} day
A_1	473.50	214.59	578.00	239.20	603.00	227.98	448.50	225.81	458.00	223.36	439.00	205.82	717.00	232.60	489.00	245.81	**525.75**	**226.90**
A_2	765.50	533.53	787.50	543.55	786.50	545.47	766.50	531.61	777.00	540.15	756.00	526.91	798.00	550.80	775.00	536.31	**776.50**	**538.54**
A_3	860.00	793.64	937.00	890.24	960.00	865.97	837.00	817.91	904.00	859.50	770.00	727.78	970.00	908.04	950.00	872.45	**898.50**	**841.94**
A_4	783.00	284.99	761.00	379.82	777.50	317.88	766.50	346.93	782.00	294.32	751.00	275.66	740.00	418.20	815.00	341.45	**772.00**	**332.41**
A_5	788.00	383.38	632.50	542.93	717.00	468.58	703.50	457.73	621.00	384.36	786.00	382.41	644.00	552.80	790.00	533.06	**710.25**	**463.16**
Mean	**734.00**	**442.03**	**739.20**	**519.15**	**768.80**	**485.18**	**704.40**	**476.00**	**708.40**	**460.34**	**700.40**	**423.72**	**773.80**	**532.49**	**763.80**	**505.82**		

	SEd		CD (0.05)			
	7th day	30th day	7th day	30th day		
A	21.210	1.950	44.250	4.070		
P	13.410	1.223	NS	2.570	A	Additives
S	13.410	1.230	27.980	2.570	P	Packaging material
AP	30.000	2.760	62.580	5.750	S	Storage temperature
AS	30.000	2.760	62.580	5.750	NS	Non-significant
PS	18.970	1.740	NS	3.640		
APS	42.420	3.900	88.500	8.140		